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GEOLOGICAL AND GEOCHEMICAL ASPECTS OF URANIUM DEPOSITS

A Selected Annotated Bibliography--Vol. 1

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Information Division

GEOLOGICAL AND GEOCHEMICAL ASPECTS OF URANIUM DEPOSITS A SELECTED, ANNOTATED BIBLIOGRAPHY

VOL. 1

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Ecological Sciences Information Center
Information Center Complex

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ABSTRACT

This bibliography was compiled by selecting 580 references from the Bibliographic Information Data Base of the Department of Energy's (DOE) National Uranium Resource Evaluation (NURE) Program. This data base and five others have been created by the Ecological Sciences Information Center to provide technical computer-retrievable data on various aspects of the nation's uranium resources. All fields of uranium geology are within the defined scope of the project, as are aerial surveying procedures, uranium reserves and resources, and universally applied uranium research. References used by DOE-NURE contractors in completing their aerial reconnaissance survey reports have been included at the request of the Grand Junction Office, DOE. The following indexes are provided to aid the user in locating reference of interest: author, keyword, geographic location, quadrangle name, geoformational index, and taxonomic name.

PREFACE

The National Uranium Resource Evaluation (NURE) Program of the Department of Energy (DOE) consists of two key elements: (1) the search for and evaluation of uranium deposits in the United States and (2) the development of improved assessment, exploration, and production methods. The Ecological Sciences Information Center (ESIC), Information Center Complex, Information Division, Oak Ridge National Laboratory, provides information support to the NURE project and is part of a large-scale computer-oriented system called the Grand Junction Office Information System. The purpose of the system is to facilitate the storage, compilation, synthesis, and extraction of NURE data. ESIC has the responsibility of building six data bases for NURE; each contains unique information, but all have a cross-referencing capability which allows for thorough data extraction. A brief description of the six files is presented below:

1. *Bibliographic Information File*—Includes documents on the geology of uranium deposits and aerial reconnaissance methods; references from the bibliographic file have been compiled in this bibliography.

2. *Quadrangle File*—Describes geographic, aerial reconnaissance, and planning data of the 621 quadrangles being surveyed in the United States.

3. *Contractor Report File*—Gives the radiometric data obtained from the aerial reconnaissance missions and summarizes the techniques utilized by the NURE contractors.

4. *Uranium Mines File*—Denotes the geographic location and mine property number of over 5000 uranium mines in the United States.

5. *Geounits File*—Summarizes lithology of all formations encountered in quadrangles surveyed by NURE contractors

6. *Numeric File*—Catalogs references to existing files of geographically indexed information pertaining to geology, spectrography, and other NURE-related interests.

This bibliography represents the first of a series of publications to be compiled by ESIC for the NURE program. It consists of 580 abstracted references dating from 1905 to 1977. Major emphasis has been placed on uranium geology, encompassing deposition, origin of ore deposits, ore controls, lithology, petrology, and prospecting. Other subject areas included are aerial reconnaissance techniques; uranium reserves and resources of the United States, Brazil, and Australia; and laboratory research or universally applied studies involving the geochemistry and chemical analyses of uranium. Although most of the literature is related to uranium, some documents pertaining to the general geology of important regions have been included.

Whenever possible, geographic information on the areas studied is presented. The state, county, section, township, range, and 15- or $7^1/_2$-minute quadrangle are generally designated. The study areas are then categorized into one-degree by two-degree National Topographic Map Series (NTMS) quadrangles and assigned a four-digit number (designated by the Bendix Field Engineering Corporation). This combination enables the user to obtain all data on a particular geographic location. Geologic formations, mines, claims, rivers, and regional structures located near a specific research site are named if they are applicable to the research.

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References cited in the Grand Junction Office contractor reports on aerial radiometric reconnaissance surveys have also been abstracted and included when possible. The literature is sorted by subject category as listed in the Contents and is arranged alphabetically by author. Indexes are provided for the purpose of simplifying search techniques and reducing the time for obtaining material on a select subject. The following indexes begin on page 193: author, keyword, geographic location, quadrangle name, geoformational index, and taxonomic name.

Because of certain computer-printing limitations, various methods are utilized to indicate subscripts and superscripts:

1. 10(E+3) or 10(E−3) stands for 10^3 or 10^{-3} respectively
2. U308 designates U_3O_8
3. U 235 means ^{235}U
4. X2 indicates X^2

All the published literature references are contained in the NURE Bibliographic Data Base and are available for searching upon submission of specific requests. The services of ESIC are free to all DOE-funded researchers. All inquiries for information services should be addressed to:

National Uranium Resource Evaluation Program
Ecological Sciences Information Center
Oak Ridge National Laboratory
P.O. Box X, Building 2028
Oak Ridge, TN 37830

Phone: (615) 483-8611, Ext. 3-6524 or 3-6173
FTS 850-6524 or 850-6173

ACKNOWLEDGMENTS

F. M. Eckerson of the Grand Junction Office of the Department of Energy has guided the Ecological Sciences Information Center in the establishment of the NURE data bases. H. A. Pfuderer and J. T. Ensminger of ESIC and A. A. Brooks of the Computer Sciences Division, UCC-ND, have provided assistance, guidance, and expertise in the compilation of the NURE data bases.

Julia A. Watts of the Environmental Sciences Division, UCC-ND, was responsible for manipulating the NURE data files into a format compatible with the AM-748 phototypesetter at ORNL. Evelyn Daniel ordered, catalogued, and filed all literature and created a system to maintain and update all manual files. Opal Russell of the Central Research Library, ORNL, located the difficult-to-find documents. Susan Richardson and the staff of the Information Sciences and Operations Section of the Information Center Complex were responsible for the computer production of this document. Cathy Fore and members of the ESIC staff offered constructive suggestions to aid in the development of a more inclusive, concise, and useful bibliographic data base of which this publication is a part.

SAMPLE REFERENCE

A - Subject Category	F - Publication Description
B - Record Number (of reference)	G - Publication Date
C - Author	H - Abstract
D - Corporate Author	I - Abstractor's Initials
E - Title	J - Comments

(A) **MAPPING, SURVEYING, AND LOCATION OF DEPOSITS**

(B) (149)

(C) (D) Olsen, J. C., USGS, Lakewood, Co.

(E) (F) (G) **Uranium Deposits in the Cochetopa District, Colorado, in Relation to the Oligocene Erosion Surface.** USGS Open File Report 76-222, 13 pp. (1976)

(H) The principal uranium deposit in the Cochetopa district, at the Los Ochos mine, is in Junction Creek Sandstone, Morrison Formation, and Precambrian rocks. The deposit is localized just beneath the restored position of the old land surface that was buried by Oligocene volcanic rocks and has since been eroded away near the mine. Contours drawn on this ancient surface show the position of the paleovalley of the ancestral Cochetopa Creek, which flowed northward through the district slightly east of its present position. The Los Ochos uranium deposit is in the Los Ochos fault zone near the point where it is crossed by the pre-volcanism Cochetopa paleovalley. This localization suggests the possibility that the fault zone provided the conditions favorable for deposition of uranium from ground waters moving through overlying volcanic rocks and down the ancient
(I) paleovalley on the pre-Oligocene unconformity. (Auth)

(J) This report is based on a talk given at the USGS Uranium and Thorium Research and Resource Conference held December 8-10, 1975, at Golden, Colorado.

GEOLOGY AND MINERALOGY

<1>

Kendall, E.W.; University of California, Graduate Division, Department of Geology, Berkeley, CA

Trend Orebodies of the Section 27 Mine, Ambrosia Lake Uranium District, New Mexico. GJO-936-2, 78 pp. (1972)

The trend ore consists of flattened, elongate, ellipsoidal masses of Westwater Canyon sandstone, whose pore space has been filled with ore phases. Field relations and isotope studies have restricted the age of ore formation to some time between host-sediment deposition (late Jurassic) and mid-Cretaceous. Moving from south to north across the ore trend there is a general increase in size and grade of successive ore pods, along with a rise in stratigraphic position. The orebodies represent a slowly migrating reaction zone in which phases are destroyed by oxidation and dissolution at the southern (up dip) edge and are reprecipitated at the north side edge of the ore trend. The ore consists principally of pyrite, calcite, and a submicroscopic mixture of humic material and the uranium silicate, coffinite. Vanadium and selenium phases and an amorphous molybdenum sulfide, jordisite, are also associated with the orebodies. Pyrite-bearing sands surround the ore, and iron oxides are absent for hundreds of feet from ore. Calcite of a definite trend-ore age is present at the north side of the ore trend and appears to have been destroyed in the central and southern portions. Except for quartz being etched in ore and overgrown outside, the degree of alteration of host rock silicates shows no marked relationship to ore. (Auth)(PAG)

<2>

Humphreys, M., and G.M. Friedman; Rensselaer Polytechnic Institute, Department of Geology, Troy, NY

Radioactive Trace Elements in Upper Devonian Clastic Rocks, North-Central Pennsylvania. AT-3982, 12 pp. (1972)

Local concentrations of uranium occur in north-central Pennsylvania. The dominant lithofacies encountered in this region may be interpreted as representing meandering stream channels and associated overbank deposits. The uranium concentrates at the base of gray, crossbedded channels or sheet sands. Coalified wood fragments and local concentrations of malachite occur in close association with the uranium deposits. Sampling on a regional basis confirms observations that the uranium deposits occur at preferred stratigraphic levels, whereas the rock above and below these levels is relatively barren of uranium. (Auth)

<3>

Jensen, M.L.; Yale University, Laboratory of Economic Geology, New Haven, CT

Sulfur Isotopes and the Origin of Sandstone-Type Uranium Deposits.
Economic Geology, 53, 598-616. (1958)

An isotopic study of sulfide minerals associated with sandstone-type uranium deposits of the Colorado Plateau and Wyoming indicates S 32 S 34 ratios of these 57 samples varying between 21.93 to 23.32. The majority, however, exhibit ratios that are highly enriched in the lighter isotope compared to the ratio of primordial sulfur that is assumed to be similar in ratio to meteoritic troilites, which vary in ratio from 22.18 to 22.24. The samples are predominantly pyrite and marcasite, but chalcopyrite, covellite, and bornite are included, even though the sulfide mineral species appears to have no relationship to the specific ratio obtained. There is, furthermore, no indication of a difference between ratios obtained from sulfides collected within uranium ore zones in comparison to ratios of sulfides occurring in either adjacent or distant barren uranium ground. The formations (Triassic to Eocene) from which the samples were collected have no obvious correlation with the ratios, nor does the presence or absence of lignitic, woody, or other carbonaceous matter show any correlation with the ratios. The relatively broad spread of these high ratio values, especially of those samples collected from one deposit, is very suggestive of hydrogen sulfide derived from anerobic bacteria. It is suggested that sulfate waters in Mesozoic sediments of the Colorado Plateau area were reduced by anerobic bacteria to hydrogen sulfide when these waters encountered carbonaceous-rich zones that provided an environment and energy source for the bacteria. The hydrogen sulfide may have remained where formed or may have migrated to locales barren of carbonaceous matter, but most likely did both. At a later date, about 60 to 75 million years ago, ore solutions moving through these more porous and permeable channels encountered the very effective reducing agent of hydrogen sulfide which brought about the concentration of uranium through precipitation of the soluble uranyl ions to relatively insoluble UO_2. At the same time iron sulfate was precipitated as relatively insoluble sulfides. (Auth)

<4>

Stuckey, J.L.; North Carolina Department of Conservation and Development, Raleigh, NC

North Carolina: Its Geology and Mineral Resources. North Carolina State University Print Shop, Raleigh, North Carolina, 550 pp. (1965, May)

The six chapters of the comprehensive report on the geology, geography and mineral resources of North Carolina takes an in-depth look at North Carolina's natural setting, physiography, geologic, topographic and physical history, as well as the increasing importance of its mineral resources. The history of the development of geology in North Carolina is also studied, emphasizing the work of numerous contributors in the field. (MBW)

<5>

Chenoweth, W.L. (Comp.), E.H. Baltz, Jr. (Comp.), S.W. (Comp.) West, and C.T. (Comp.) Smith; AEC, Resource Potential Division, Grand Junction, CO

Road Log from Cortez, Colorado to Gallup, New Mexico, Road Log from Gallup, New Mexico to Albuquerque, New Mexico, Road Log from Albuquerque, New Mexico to the Ojo del Espiritu Santo Grant, New Mexico, Stratigraphic Relationships and Nomenclature Chart, Stratigraphic Sections, Comments on Points of Interest. Report 082172, 30 pp. (1972, August)

Three road logs, stratigraphic sections, general geology, points of interest, history of the area, and other comments were compiled for the United States Uranium Tour Guidebook. The tour followed the 24th International Geological Congress held September 11-23, 1972. (PAG)

<6>

Craig, L.C., C.N. Holmes, R.A. Cadigan, V.L. Freeman, T.E. Mullens, and G.W. Weir; USGS, Washington, DC

Stratigraphy of the Morrison and Related Formations, Colorado Plateau Region, a Preliminary Report. USGS Bulletin 1009-E, (pp. 125-168); TEI-180, 64 pp. (1955)

Three subdivisions of the Jurassic rocks of the Colorado Plateau region are: the Glen Canyon group, mainly eolian and fluvial sedimentary rocks; the San Rafael group, marine and marginal marine sedimentary rocks; and the Morrison formation, fluvial and lacustrine sedimentary rocks. In central and eastern Colorado the Morrison formation has not been differentiated into members. In eastern Utah, northeastern Arizona, northwestern New Mexico, and in part of western Colorado, the Morrison may be divided into a lower part and an upper part; each part has two members which are differentiated on a lithologic basis. Most of the carnotite deposits of the Morrison formation are in the Salt Wash member. They are found entirely within the sandstone and mudstone facies of the Salt Wash member. Lithofacies studies have delimited an area relatively favorable for the occurrence of ore within the area of this facies. Most of the carnotite deposits occur in areas where sandstones of the Salt Wash are relatively well-sorted and probably have a relatively high permeability. The resultants of dip directions of cross-laminae in the sandstones of the Salt Wash and the trends of ore "rolls" show similar radial patterns and may indicate that the shapes of carnotite deposits were influenced by primary sedimentary structures; however, the ore deposits show little detailed control by sedimentary structures, for in many places the ore cuts across the bedding and lamination. Three distinct possible sources for the uranium of the carnotite deposits may be postulated: 1) the rocks of the source area of the Salt Wash member of the Morrison formation, 2) a post-Salt Wash hydrothermal source in the Colorado Plateau region, and 3) disseminations in post-Salt Wash sedimentary rocks. (Auth)(PAG)

The title of USGS-TEI-180 published in 1951 is "Preliminary Report on the Stratigraphy of the Morrison and Related Formations of the Colorado Plateau Region".

<7>

Klepper, M.R., and D.G. Wyant; USGS, Washington, DC

Notes on the Geology of Uranium. USGS Bulletin 1046-F, (pp. 87-148). (1957)

The report attempts to synthesize the great volume of information on the geology of individual deposits and types of deposits, geochemistry, distribution, and features that may be important in searching for and appraising uranium deposits. The report deals with processes that concentrate uranium; describes types of uranium deposits; and discusses the clustering of uranium deposits within provinces, and provides some clues for prospecting and appraisal. (Auth)(PAG)

<8>

Gangloff, A.; Commission d'Energie Atomique, Direction des Productions, Fontenay-aux-Roses, France

Notes Sommaires sur la Geologie des Principaux Districts Uraniferes Etudies par la CEA. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 77-105), 386 pp.; IAEA-PL-391 16, (pp. 77-105), 386 pp. (1970, October)

Major characteristics of uranium deposits of the vein type and deposits located in sedimentary rocks and the theories as to the genesis of the deposits are presented. When prospecting for uranium in a sedimentary medium, attention should be paid to the fact that workable deposits may be found in unusual geological contexts. Such is the case with the Bakouma deposit in the Central African Republic. There the ore bodies are formed from a fine argilo-silico-phosphate Paleocene material filling the fossil karsts in proterozoic dolomites. The uranium is present in the tetravalent state in a carbonated fluorapatite network comprising as much as 50% of the sediment. The origin of this mineralization is still something of a puzzle. (Auth)(PAG)

<9>

Sorensen, H.; University of Copenhagen, Institute of Petrology, Copenhagen, Denmark

Low-Grade Uranium Deposits in Agpaitic Nepheline Syenites, South Greenland. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 151-159), 386 pp.; IAEA-PL-391 22, (pp. 151-159), 386 pp. (1970, October)

The latest major intrusion in the Precambrian Gardar alkaline igneous province in south Greenland is the Ilimaussaq massif which is made up mainly of agpaitic nepheline syenites. The latest members of the intrusion, lujavritic nepheline syenites, are locally enriched in U and Th. Three main types of deposits are distinguished: (1) steenstrupine and monazite rhabdophanite in analcime-natrolite rich fine-grained lujavrites without eudialyte; 200-600 ppm U, 200-2000 ppm Th; (2) steenstrupine, monazite rhabdophanite and thorite in medium- to fine-grained lujavrites and their contact-metasomatically altered fine-grained lujavrites and lavas of the roof of the intrusion, 100-3000 ppm U and 50-1300 ppm Th; and (3) late hydrothermal veins associated with the lujavrites which are enriched in U, Th, Re, Be, Nb, Li etc., but are of limited extent. Mineralized fractures also occur and around Ilimaussaq and other Gardar intrusions, but are not of any economic interest. (Auth)

<10>

Stipanicic, P.N.; Comision Nacional de Energia Atomica, Buenos Aires, Argentina

Conceptos Geostructurales Generales Sobre la Distribucion de los Yacimientos Uraniferos con Control Sedimentario en la Argentina y Posible Aplicacion de los Mismos en el Resto de Sudamerica. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 205-216), 386 pp.;

IAEA-PL-391/24, (pp. 205-216), 386 pp. (1970, October)

From the experience gained within Argentine territory, it would seem that many of the principal uranium deposits of the stratiform type contained in sedimentary rocks are very closely linked with the presence, in their vicinity, of large peneplained areas in which fertile rocks outcrop. The genesis of these deposits must in principle have entailed (apart from fulfillment of the conditions necessary for the host rock to permit uranium concentration, precipitation, and so on) leaching of the uranium, starting in the source areas; these areas are in fact the peneplains referred to above, after exposure to degradation, weathering, and so on, for lengthy periods. Since some of the geological events playing a part in the above-mentioned geomorphological configurations are common to the whole of South America which is also true in certain instances of the composition of the terrain - it is felt that the Argentine experience oculd be extrapolated beyond the geographical bounds of the country and be applied in prospection for uranium-bearing deposits in other parts of the continent. In this connection, and after selection of sedimentary formations with characteristics such as to make them favorable hosts, it is suggested that a regional analysis be made to ascertain the presence of neighboring peneplains that have been clearly defined at any particular stage of their geological history. On the basis of the existing data on uranium deposits in Argentine territory, the most important formations could be those arising late in the Pre-Cambrian, Middle Devonian, Middle Permian, end of the Triassic and beginning of the Tertiary periods. However, one should not disregard other diastrophic stages, such as those which either locally or regionally may have been highly active, thereby permitting development of extensive peneplain areas. (Auth)

<11>

Gabelman, J.W.; AEC, Washington, DC

Metallotectonic Control of Uranium Distribution. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970.
International Atomic Energy Agency
Publications, Vienna, Austria, (pp. 187-204), 386 pp.; IAEA-PL-391/15, (pp. 187-204), 386 pp. (1970, October)

Zoning of particular metal deposits around alteration centres distinguishes mineral districts of certain ranges of mineralization temperature. Grouping of similar districts into adjacent linear regional zones arranged in temperature-paragenetic sequence establishes regional zoning and a mineralization temperature-intensity gradient oriented across the zones. The mineral zones are correlative and coextensive with zones of deformation intensity for both compressional (orogenic) and tensional (taphrogenic) phases of tectonic activity in circumcontinental mobile belts. Mineralization intensity gradients match deformation intensity gradients. Therefore, each phase of the tectonic cycle is considered capable of generating a concurrent or somewhat later mineralization cycle. The frictional heat of shallow orogeny is believed capable of concerting all available ground fluids into hydrothermal fluids that can leach, mobilize, and redistribute elements according to their temperature stability, thus producing regional zones. Taphrogeny, which occurs dominantly in hinterlands from which low-temperature elements have been flushed, involves deep faults that may tap the mantle and introduce new elements, including those of low temperature stability. Uranium is most stablilized in lowest temperature environments and thus seeks a regional zonal position at the extreme foreland end of mineralization gradients of either type. The consistency of this relation, in mobile belts throughout the Americas, justifies its extension to mobile belts of any age throughout the world to allow prediction of most uraniferous regions. Metallotectonics of the Iberian peninsula, interpreted for the first time, indicate that uranium has migrated to the lowest temperature environments possible in the central Meseta where it exists in Tertiary deposits. Without metallogenic data, the optimum regional positions for uranium in the rest of the world are predicted from tectonic analysis of mobile belts. Regions most favorable by this method include the world's most significant uranium districts. (Auth)

<12>

Harshman, E.N.; USGS, Denver, CO

Uranium Ore Rolls in the United States. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna,
Austria, April 13-17, 1970. International Atomic Energy Agency Publications,
Vienna, Austria, (pp. 219-232), 386 pp.; IAEA-PL-391/4, (pp. 219-232), 386 pp. (1970, October)

About 40% of the uranium ore reserves in the United States, minable at $8 per pound of contained U3O8, are in roll-type deposits in the State of Wyoming. The host rocks are arkosic sandstones, deposited in intermontane basins under fluvial conditions, and derived from the granitic cores of mountain ranges that flank the basins. The host rocks are Eocene and possibly Paleocene in age and are, or were, overlain by a sequence of continental tuffaceous siltstones, sandstones and conglomerates 400-700 m thick. Most of the ore is unoxidized and lies below the water table. It contains pyrite, uraninite, coffinite, marcasite, hematite, ferroselite and native selenium. The orebodies range in size from a few hundred thousand tons of material containing 0.10 - 5% U3O8. *As mined, the ore averages about 0.25%* U3O8. The orebodies are genetically related to and lie at the margins of large tongues of altered sandstone. The character of the alteration and the distribution of several elements within and near the altered sandstone suggest that the ore-bearing fluid was ground water, neutral to slightly alkaline and oxidizing with respect to the elements being transported. Roll-type deposits in littoral and fluvial sandstones have recently been discovered in the Gulf Coastal Plain area of Texas. These deposits appear to be similar to the Wyoming deposits in form, distribution of elements, and genesis. (Auth.)

<13>

Robertson, D.S.; David S. Robertson and Associates Limited, Toronto, Ontario, Canada

Uranium, Its Geological Occurrence as a Guide to Exploration. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 267-284), 386 pp.; IAEA-PL-391 3, (pp. 267-284), 386 pp. (1970, October)

Uranium is a lithophile element and as such it is concentrated by processes active in the crust. About 90% of the world's reserves occur in basal Huronian conglomerates and post Paleozoic sandstones. It is suggested that significant expansion of reserves under current economic conditions requires the finding of further reserves of these types. The ore deposits in the basal Huronian are of detrital origin. They are restricted in time to a period after the development of extensive acid crust but before the evolution of an oxidizing atmosphere. Because of this they are of extremely restricted occurrence. The post Paleozoic sandstone ore deposits, called Western States type, are formed by leaching of uranium from granite surfaces, volcanic sediments or arkoses, the movement of uranium in groundwater and its precipitation by organic material. It appears that the processes necessary, which continue to the present time, take place only in arid to semi-arid climates. Because of this, the areas of the earth in which such deposits can be found are limited. (Auth)

<14>

Way, J.H., and G.M. Friedman; Rensselaer Polytechnic Institute, Department of Geology, Troy, NY

Radioactive Trace Elements in Middle and Upper Devonian Clastic Rocks, Catskill Mountain Area, New York. AT (30-1)-3982, 23 pp. (1972, March 21)

Uranium concentrates in spotty lenses of interbedded braided and alluvial stream deposits of Upper Devonian age. Occurrences are of low uranium content (less than 400 ppm), but above the background of 1 to 5 ppm. The concentrations occur in roadcuts along Route 17 in gray and green channel sandstones and in some gray-colored zones beneath sandstones at the top of red mudstone lenses. Where the uranium concentrates, plant debris, pyrite nodules and malachite tend to be common. While these uranium concentrations are uneconomic, they are of interest because of their similarity to Upper Devonian occurrences of uranium in northeastern Pennsylvania. Similar spotty uranium concentrations may occur in Upper Devonian rocks throughout the Catskill Mountains. (Auth)

<15>

Shawe, D.R., and H.C. Granger; USGS, Denver, CO

Uranium Ore Rolls - An Analysis.
Economic Geology, 60(2), 240-250, (1965)

Sharply discordant, curved uranium ore layers in sedimentary rocks are commonly called rolls and can be either a subsidiary or dominant form of a deposit. Although environmental differences among rolls have not previously been described, at least two types can be distinguished. Rolls of the Colorado Plateau type are surrounded by a wide halo of reduced altered rock. They probably formed in favorable strata before or during maximum burial prior to major structural deformation and are not genetically related to uplift and denudation. Rolls of a type found in the Tertiary basins of Wyoming are bounded on one side by relatively oxidized altered rock and on the other by relatively reduced rock. They probably formed near the surface following major deformation, uplift, and denudation. It seems probable that the ore-bearing solutions that formed the Colorado Plateau type of roll flowed parallel to the roll axis, whereas it is possible that solutions flowed through the roll front in the type of roll common in the Tertiary basins. This conclusion is borne out by studies of similar rolls in the USSR. A proper understanding of the various spatial relations between roll-type deposits and altered rock can be a useful guide to exploration for uranium deposits in sedimentary rocks. (Auth)

<16>

Swineford, A., J.C. Frye, and A.B. Leonard; Illinois Geological Survey, Urbana, IL; University of Kansas, Lawrence, KS; Kansas Geological Survey, Topeka, KS

Petrography of the Late Tertiary Volcanic Ash Falls in the Central Great Plains. Journal of Sedimentary Petrology, 25(4), 243-261. (1955)

Lenticular deposits of volcanic ash in the Miocene and Pliocene strata of western Kansas and western Nebraska are described petrographically. These include 14 ash falls of known stratigraphic position. All the ash studied is classed as vitric tuff and most of the falls are rhyolitic in composition. A regular or progressive change through time in the character of the ash does not occur. Ash falls are particularly common in the lower half of the Ash Hollow member of the Ogallala formation where it is estimated that volcanic material constitutes more than three percent of the volume of the sediments. (Auth)

<17>

Vickers, R.C.; USGS, Washington, DC

Geology and Monazite Content of the Goodrich Quartzite, Palmer Area, Marquette County, Michigan. USGS Bulletin 1030-F, (pp. 171-185). (1956)

The Palmer area, which is on the south limb of the Marquette synclinorium, consists of a downfaulted block of Precambrian sedimentary rocks about 4 miles long and three-quarters of a mile wide. The block is composed mainly of middle Huronian Ajibik quartzite and Negaunee iron-formation and upper Huronian Goodrich quartzite. Monazite occurs in the Goodrich quartzite as rounded detrital grains concentrated mainly in the matrix of quartz pebble conglomerate which is interbedded with coarse-grained quartzite. Correlation of gamma-ray logs of drill holes which penetrate an apparent thickness of 1,100 feet of Goodrich quartzite and enter the underlying Negaunee iron-formation shows that most of the monazite occurs more than 300 feet above the base of the Goodrich quartzite. Drill-core specimens contain as much as 54 pounds of monazite per ton of rock. Outcrops of Goodrich quartzite, which are practically restricted to the lower 200 feet of the formation, contain an average of 2.9 pounds of monazite per ton. Samples from locally derived erratics contain as much as 110 pounds of monazite per ton. Laboratory work indicates that more than 85 percent of the monazite is recoverable by gravity methods after grinding and sizing. (Auth)

<18>

Wilmarth, V.R.; USGS, Washington, DC

Geology of the Garo Uranium-Vanadium Copper Deposit, Park County, Colorado. USGS Bulletin 1087-A, (pp. 1-21). (1959)

The Garo deposit, in the west-central part of Park County, Colorado, was mined for uranium, vanadium, and copper in 1951 and 1952. The ore minerals that constitute the deposit are in three complexly faulted sandstone beds of the Maroon formation of Pennsylvanian and Permian age, on the northeast flank of the northwest-trending Garo anticline. Most of the ore that has been mined came from the youngest sandstone bed (bed 1), but some ore has been produced from the oldest sandstone bed (bed 3). Channel samples from the ore bodies in bed 1 contain as much as 0.48 percent uranium and 1.37 percent V2O5, whereas samples from sandstone bed 3 contains as much as 0.062 percent uranium and 0.49 percent V2O5. Copper has been produced from sandstone bed 1. Within the ore bodies the ore minerals–tyuyamunite, metatyuyamunite, volborthite, carnotite, covellite, chalcocite, azurite, and malachite–occur in fissure veins and as disseminated grains between the detrital grains in the sandstone. The dominant gangue minerals are calcite, hematite, and chalcedony. The original minerals–chalcocite, covellite, pyrite, and possibly uraninite and montroseite–have been oxidized and only small remnants of the primary sulfide minerals were observed in the ore. Oxidation of the primary uranium and vanadium minerals resulted in the formation of tyuyamunite, metatyuyamunite, volborthite, and carnotite and small quantities of uranophane and calciovolborthite. The intersection of faults which cut the rocks of the Maroon formation should be used as a guide in prospecting for uranium in the vicinity of Garo. (Auth)(MBW)

<19>

Houston, R.S.; Univeristy of Wyoming, Department of Geology, Laramie, WY

Aspects of the Geologic History of Wyoming Related to the Formation of Uranium Deposits. Contributions to Geology, 8(2), 67-79. (1969)

Geologic history suggests that we may see in Wyoming uranium deposits and end product of a long and complex sequence of events; in effect, a modification of Gruner's multiple-migration accretion hypothesis. This concept is very similar to that of others who also suggest a redistribution process for formation of roll-type deposits facilitated by bacteria that create a strongly oxidizing and low pH environment on the altered or up-dip side of deposits. Various possibilities probably exist for the source, transportation mechanism, and method of deposition of uranium in the formations of early Eocene age in Wyoming. It is believed that the deposits are an end product of processes that may well have culminated in roll-type deposits late in the geologic history of Wyoming. This hypothesis suggests that other, perhaps lower grade occurrences of uranium, may be found down-dip or at some distance beyond the convex side of the rolls. (Auth)(PAG)

<20>

Webb, M.D.; Kerr-McGee Corporation, Oklahoma City, OK

Stratigraphic Control of Sandstone Uranium Deposits in Wyoming. Contributions to Geology, 8(2), 121-129. (1969)

A conceptual model is presented which proposes that the Wyoming uranium deposits in Tertiary sandstones are post depositional accretions largely related to facies changes developed in major paleo-drainages. These facies changes represent the optimum location of carbonaceous accumulation in coarse permeable sandstones along the paleostream margins. Sediments were largely derived from granitic and metamorphic terrains adjacent to the basins of deposition. The uranium was derived from the source terrain and after mobilization was deposited and redistributed by connate, phreatic and vadose waters. Uranium concentration was initiated during the period of compaction by direct absorption in humic components and by a system of microorganisms living on the carbonaceous substrate. Later Tertiary uplift introduced extensive oxidation into the system creating major modification and reaccretion of uranium in the same geochemically favorable carbonaceous environment. These late oxidation phases are postulated to have been responsible for most of the economically exploitable deposits. In the uplift and oxidation cycles the physiological activities of at least two genera of microorganisms played a significant role in both the mobilization and in the accretion of uranium. (Auth)

<21>

Trimble, D.E.; USGS, Washington, DC

Geology of the Michaud and Pocatello Quadrangles, Bannock and Power Counties, Idaho. USGS Bulletin 1400, 88 pp. (1976)

The Michaud and Pocatello quadrangles comprise an area in southeastern Idaho extending eastward from the American Falls Reservoir, in the Snake River Plain, and including the Pocatello Range and the northern part of the Bannock Range, in the Basin and Range physiographic province. The mountainous parts are underlain principally by thick marine sedimentary rocks of Precambrian and Cambrian age but also contain a fairly complete section of Paleozoic rocks. Mesozoic rocks are absent in the area. Tertiary rocks crop out extensively in the foothills and are limited to volcanic tuffs. Quaternary deposits cover more than half the area and include basalt, pediment gravel, loess, and lacustrine and fluvial deposits. (Auth)(MBW)

<22>

Vine, J.D.; USGS, Washington, DC

Geology and Uranium Deposits in Carbonaceous Rocks of the Fall Creek Area, Bonneville County, Idaho. USGS Bulletin 1055-I, (pp. 255-294), 315 pp. (1959)

Uranium occurs in carbonaceous rocks of the Bear River formation, of Early Cretaceous age, in the Fall Creek area, Bonneville County, Idaho. The principal deposit is at the Fall Creek coal prospect in sec. 4, T. 1 S., R. 42 E., where impure coal contains an average of about 0.02 percent uranium. Geologic mapping and sampling have demonstrated that the zone of uranium-bearing rocks is widespread in the area and is repeated in outcrop several times, owing to folding and faulting of the enclosing strata, although exposures suitable for sampling and analysis are few. Analytic data suggests a possible geochemical relation between uranium, germanium, and molybdenum. Four general hypotheses are advanced for the origin of uranium in carbonaceous rocks, but comparison of the deposits with other occurrences of uranium-bearing carbonaceous rocks suggests that an epigenetic hypothesis of deposition by downward percolating meteoric water seems best able to explain the occurrence of uranium in the Fall Creek area. Core drilling was inconclusive in demonstrating the areal extent of the radioactive units. Most of the holes did not reach the uranium-bearing strata, because the area is one of structural complexity, with faulting, thinning of incompetent strata, and increasingly steep dips at depth. About 61/2 million tons of coaly shale, carbonaceous shale, and carbonaceous limestone with an average grade of about 0.02 percent uranium is believed to be in the area. This estimate is based on the average thickness and grade of uranium-bearing strata exposed in the Fall Creek coal prospect, by drill-hole data, and by the inferred extent of these strata over an area of slightly more than 400 acres. (Auth)

<23>

Mapel, W.J., and W.J. Hail, Jr.; USGS, Washington, DC

Tertiary Geology of the Goose Creek District, Cassia County, Idaho, Box Elder County, Utah, and Elko County, Nevada. USGS Bulletin 1055-H (pp. 217-254), 315 pp. (1959)

The Goose Creek district is an area of about 260 square miles in the northern and central parts of an intermontane basin in southern Idaho and adjacent parts of Utah and Nevada. Tertiary rocks exposed in the district include the Payette formation, of Miocene or Pliocene age, and the overlying Salt Lake formation, of Pliocene age. Both formations contain thin beds of carbonaceous shale and lignite. The Tertiary sedimentary rocks rest unconformably on a large body of Tertiary rhyolite exposed in the mountains bordering the district on the southeast, and on a thick undifferentiated sequence of Carboniferous and older rocks, limestone, quartzite, and shale, exposed in the mountains to the west and northeast. The Payette and Salt Lake formations are tilted in a general easterly direction, with an average dip of about 3 degrees. Normal faults with displacements ranging from a few feet to as much as 900 feet cut the Tertiary sequence at various places. Lignite has been mined for local use from both the Payette and Salt Lake formation, but most of the lignite has a large content of ash and is of little commercial value. Concentrations of as much as 0.1 percent uranium occur locally in lignite and carbonaceous shale in the lower part of the Salt Lake formation. Most of the uranium-rich beds are on the flanks and in the trough of a shallow syncline in T16S, R21E, Idaho. Other mineral resources include building stone and bentonite. (Auth)(MBW)

<24>

Shawe, D.R.; USGS, Washington, DC

Geologic History of the Slick Rock District and Vicinity, San Miguel and Dolores Counties, Colorado. USGS Professional Paper 576-E, 19 pp. (1976

Paleozoic and Mesozoic sedimentation and tectonics in the region around Slick Rock, Colorado produced a favorable environment for sandstone-type uranium-vanadium deposits. The Paradox basin that formed in late Paleozoic time in part controlled deposition of strata in Late Jurassic time that are the hosts of the ore deposits. Upper Cretaceous marine shale served as a source rock for the deposits when compaction expelled uranium- and vanadium-bearing pore waters in Late

Cretaceous and early Tertiary time. (Auth)

<25>

Hedges, L.S.: South Dakota Geological Survey, Vermillion, SD; University of South Dakota, Science Center, Vermillion, SD

Geology and Water Resources of Campbell County, South Dakota, Part 1: Geology. South Dakota Geological Survey Bulletin 20, 39 pp. (1972)

Pre-Pleistocene rocks range in age from Precambrian through Late Cretaceous. All of the rocks from Precambrian through much of the Cretaceous are found in the subsurface and their presence and description are inferred mainly by extrapolation of subsurface data from surrounding counties. Limestones and dolomites of Paleozoic age which are about 1500 feet thick, overlie the Precambrian rocks. Sediments of Cretaceous age, about 2500 feet thick, overlie the Paleozoic rocks and consist chiefly of sandstone and shale with some limestone and marl. Cretaceous rocks present in the subsurface are, oldest to youngest: Inyan Kara Group, Skull Creek Formation, Dakota Formation, Graneros Shale, Greenhorn Limestone, Carlile Shale, Niobrara Marl and most of the Pierre Shale. The Virgin Creek, Mobridge, and Elk Butte Members of Pierre Shale and the Fox Hills Formation of Cretaceous age are exposed along the Missouri River trench and the uplands in the northwest part of the county. Surficial deposits of glacial drift, as much as 475 feet thick, mantle the bedrock formations except along the walls of the Missouri River trench. Several deep bedrock channels contain sediments that consist of outwash and a complex outwash-alluvium deposit of pre-late Wisconsin age, glacial till, and the Pollock Formation. The Pollock Formation is a new name proposed for proglacial late Wisconsin lacustrine deposits in the Mound City Channel and the Ancient Grand Channel. Loess-covered drift in the western one-third of the county, formerly correlated with the Iowan and Tazewell undifferentiated drift, has been tentatively correlated with the late Wisconsin stage. Extensive areas of collapsed outwash and the presence of ice-walled lake plains, ice-walled gravel plains, and collapsed lake plains indicate the former presence of superglacial drift and subsequent deposition as stagnation drift. (Auth)(PAG)

<26>

Schmidt, R.G., W.T. Pecora, B. Bryant, and W.G. Ernst; USGS, Washington, DC

Geology of the Lloyd Quadrangle Bearpaw Mountains, Blaine County, Montana. USGS Bulletin 1081-E, (pp. 159-188). (1961)

About 25 percent of the quadrangle is underlain by sedimentary rocks of Middle Jurassic to Recent age, 15 percent by intrusive and extrusive igneous rocks of middle Eocene age, and 60 percent by surficial deposits of late Pliocene, Pleistocene, and Recent ages. The sedimentary rocks are subdivided into 19 formations, which have a total stratigraphic thickness in the Bearpaw Mountains region of about 8,000 feet. However, in the Lloyd quadrangle the exposed sedimentary section is about 5,000 feet thick. The igneous rocks of the Lloyd quadrangle range in composition from subsilicic-alkalic to silicic-alkalic and represent the shonkinite-syenite and monzonite families. The intrusive varieties occur as stocks, plugs, dikes, and sills. The extrusive varieties are part of a volcanic pile that consists predominantly of interlayered flows of mafic and felsic lava and beds of mafic and felsic pyroclastic rocks. Analcime trachyte flows and breccias are interlayered with the mafic and felsic flows in the youngest part of the volcanic pile. As mapped, the flow rock units include some irregular pluglike bodies of intrusive rock that are indistinguishable from and merge with the flows. The estimated maximum stratigraphic thickness of the layered volcanic sequence is about 15,000 feet. Within the area mafic lava flows exceed felsic lava flows in areal distribution by a ratio of about 3 to 2. However, porphyritic latite, the intrusive equivalent of the felsic flow rocks, is more abundant than the shonkinitic rocks, the intrusive equivalent of the mafic flow rocks. The principal structural feature of the area is the Bearpaw Mountains structural arch, an eastward-trending belt of uplifted and deformed sedimentary rocks that has been extensively intruded by a great variety of igneous rocks. The arch is bounded by a northern and southern volcanic field, each of which covers an area of about 300 square miles. Faulted rocks in and adjacent to the volcanic fields demonstrate that deformation occurred before, during, and after volcanism. It cannot be determined in this quadrangle if disruption of initial layering in the volcanic field is more likely the result of successive collapse and tilting along high-angle normal faults or of landsliding toward the plains. (Auth)(PAG)

<27>

Ordway, R.J.; State Teacher's College, New Paltz, NY

Geology of the Buffalo Mountain-Cherokee Mountain Area,
Northeastern Tennessee. Bulletin of the Geological Society of America, 70, 619-636. (1959)

The Buffalo Mountain-Cherokee Mountain area in northeastern Tennessee includes about 45 square miles and is located along the southeast border of the Appalachian Valley and Ridge geomorphic province. The mountainous part of the area is underlain almost entirely by the Buffalo Mountain thrust sheet, which has been separated by two minor thrust faults into three imbricate thrust blocks. Cambrian and Precambrian rocks in the Buffalo mountain thrust sheet consist of the Unicoi, Hampton, and Erwin formations (Chilhowee group) and the Shady dolomite. Younger, Cambrian-Ordovician rocks beneath the thrust sheet include the Honaker limestone, Nolichucky shale, Knox dolomite, and Athens shale. During or following the thrusting, all the rocks in the area were folded into a synclinorium trending northeast-southwest. Some folding apparently preceded the thrusting. Several "shear faults" mapped by Keith in this area do not appear to exist. An interesting feature of the structure is the number of slices that have been found between older rocks, and slices of older rocks between younger. Cleavage and a low-rank metamorphism are present. Deformation probably occurred in late Paleozoic time during the Appalachian orogeny. (Auth)

<28>

Rose, A.W.; Alaska Department of Natural Resources, Division of Mines and Minerals, Juneau, AK

Geology of Part of the Amphitheatre Mountains, Mt. Hayes Quadrangle,
Alaska. Alaska Department of Natural Resources, Geology Report No. 19, 14 pp. (1966, February)

Reconnaissance geologic mapping in the Amphitheatre Mountains north of the Denali Highway shows that basalt and andesite flows, silicic tuffs and tuffaceous sediments, and andesite agglomerate of the Triassic Amphitheatre formation are intruded by gabbro, granite, and peridotite. Some of the gabbro appears to occur as a thick layered sill or lopolith; other gabbro and diabase occur as sills in the tuffs and tuffaceous sediments. In general the sediments and sills dip gently northward. A layer of mafic gabbro about 150 feet thick contains about 22 percent iron in magnetite and ilmenite. A magnetic concentrate contained 47 percent iron and 11.1 percent TiO_2. Stream sediment sampling detected several copper anomalies which deserve follow-up. (Auth)

<29>

Stafford P.T.; USGS, Washington, DC

Stratigraphy of the Wichita Group in Part of the Brazos River Valley, North Texas.
USGS Bulletin 1081-G, (pp. 261-280). (1960)

Rocks comprising the Wichita group (Permian) crop out in Texas in a north-southward-trending area extending from the Red River on the Oklahoma-Texas border to the Llano uplift in central Texas. The outcrop of the Texas Wichita group discussed in this report lies in the southern part of the Brazos River drainage basin, extending from central Callahan and Eastland Counties northward to central Throckmorton and southwestern Archer Counties. Most rocks in the mapped area belong to the Wichita group, which includes about the lower half of the rocks of the Leonard series (Permian) and all of the rocks of the Wolfcamp series (Permian). The group consists of seven units, which are, in ascending order: the Pueblo, Moran, Putnam, Admiral, Belle Plains, and Clyde formations, and the Lueders limestone. Each formation is divided into as many as six members. The lithology of the Wichita group gradually changes from central to north Texas. In the Colorado River valley area in central Texas, a marine shale and limestone facies predominates. Northward, the marine beds decrease in number and red beds become predominant. In north Texas, near the Red River, most of the section is comprised of a marginal marine red-bed facies of shale and sandstone. (Auth)(MBW)

<30>

Santos, E.S.; USGS, Washington, DC

Stratigraphy of the Morrison Formation and Structure of the Ambrosia Lake

District, New Mexico. USGS Bulletin 1272-E. 30 pp. (1970)

In the Ambrosia Lake district, McKinley and Valencia Counties, northwestern New Mexico, the Morrison Formation of Late Jurassic age is divided into three formal members; the Recapture Member at the base is overlain successively by the Westwater Canyon and Brushy Basin Members. The Recapture Member, 125-245 feet thick, is composed of clayey sandstone, sandstone, claystone, and siltstone. The Westwater Canyon Member, 30-270 feet thick, is mainly a crossbedded fluvial arkosic sandstone interstratified with mudstone. A unit at the top of the member is locally referred to as the Poison Canyon sandstone, an informal name of economic usage. The Brushy Basin Member, 60-200 feet thick, consists of pale-grayish-green mudstone with scattered lenses of sandstone rarely more than 25 feet thick. The Ambrosia Lake district occupies the most folded and faulted part of the homoclinal south flank of the San Juan Basin. Major structural elements in the region are believed to be related to the uplift of the Zuni Mountains, which is inferred to have taken place between early Eocene and late Pliocene time. This period of deformation was characterized by horizontal compressive forces and the development of folds and strike-slip faults. Uplift of the Colorado Plateau during middle and late Tertiary, and possibly Quaternary, time was probably accompanied by east-west-directed tension which produced north- and northwest-trending normal faults and joints. (Auth)

<31>

Osterwald, F.W., and B.G. Dean; USGS, Washington, DC

Relation of Uranium Deposits to Tectonic Pattern of the Central Cordilleran Foreland. USGS Bulletin 1087-I, (pp. 337-390). (1961)

Within the 15 tectonic units of the Cordilleran foreland, uranium deposits can be related to the following large-scale structural environments: crests of large-scale anticlines; troughs of major basins; flanks of large-scale uplifts where smaller structures are arranged in echelon; flanks of large-scale uplifts where subordinate structures are parallel to the major structure; conjunctions of major structures where trends intersect or merge with loss of identity of one or all trends and without an associated pattern of smaller scale structures; conjunctions of major structures where trends intersect or merge with loss of identity of one or all trends and where subordinate structures are parallel to or in echelon with the trend of one or all major structures. Many uranium deposits can be more closely related by second-order discrimination to small- to intermediate-scale structures. Repetitions of the patterns to which known deposits are related may provide clues to areas containing presently unknown deposits. (Auth)(MBW)

<32>

Lewis, R.Q. and D.E. Trimble; USGS, Washington, DC

Geology and Uranium Deposits of Monument Valley, San Juan County, Utah. USGS Bulletin 1087-D, (pp. 105-131). (1959)

Exposed consolidated sedimentary rocks in the Monument Valley area, Utah, range from Permian to Jurassic in age and attain an aggregate thickness of more than 3,000 feet. As all the uranium-vanadium deposits in the area are restricted to the Shinarump member of the Chinle formation of Late Triassic age, this study was principally concerned with that unit. The contact between the Shinarump member of the Chinle formation and the underlying Moenkopi formation is marked by a number of deep scour channels cut into the Moenkopi and filled with sandstone and conglomerate of the Shinarump. All the uranium-vanadium ore deposits are restricted to the lower channel sediments of the Shinarump. All channels are considered worthwhile areas for prospecting. The ore deposits are small tabular to lenticular bodies that range from a few inches to 10 feet in thickness and are commonly less than 20 feet in width. The ore minerals replace the cementing material in the sandstone and coat fractures, joints, and bedding planes. The common uranium ore mineral is tyuyamunite. Uranophane, autunite, and uraninite are also present in important quantities. The common vanadium mineral is corvusite; navajoite and hewettite are found in lesser amounts. The deposits are zoned both laterally and vertically, with the higher grade vanadium ore generally below and downdip from the uranium. In general the deposits are oxidized or partly oxidized. Most of the ore is the yellow hydrous uranium vanadate; however, quantities of black unoxidized ore, containing uraninite and vanadium minerals with an intermediate valence are found in the deeper parts of some deposits. Good guides to ore within channel sediments are high radioactivity, uranium, vanadium, and copper minerals, and fluorescent silica, commonly hyalite. (Auth)

<33>

Ross, C.P.; USGS, Washington, DC

Geology of the Southern Part of the Lemhi Range, Idaho. USGS Bulletin 1081-F, (pp. 189-260). (1961)

The report covers the southern part of the Lemhi Range and adjacent areas in Butte and Clark Counties in central Idaho. The Paleozoic rocks vary markedly in thickness within the mapped area and most of them are thinner than their equivalents farther north and west. The Brazer limestone and associated beds are very thick and include beds of post-Mississippian age. The Swauger quartzite was flexed before the Paleozoic rocks were laid down. The latter have been arched and, locally, complexly folded, probably in several pulses of deformation. In addition, the Brazer limestone is crenulated in unsystematic fashion. The whole assemblage has been broken by steep thrusts, apparently belonging to a single zone that has been so folded as to produce a zigzag pattern. The steep thrusts are locally overridden by more gently inclined thrusts. Relatively recently the Lemhi Range appears to have been uplifted with concomitant downflexing of the valleys on either side. Prospecting for lead, zinc, copper, and other metals began in the area about 1880. Many of the deposits are replacements in carbonate-bearing rocks and all are in zones of fracture, including thrust faults. (Auth)(MBW)

<34>

Wilmarth, V.R.; USGS, Washington, DC

Yellow Canary Uranium Deposits, Daggett County, Utah. USGS Circular 312, 8 pp. (1953)

The Yellow Canary uranium deposit is on the west side of Red Creek Canyon in the northern part of the Uinta Mountains, Daggett County, Utah. Two claims have been developed by means of an adit, three opencuts, and several hundred feet of bulldozer trenches. No uranium ore has been produced from this deposit. The deposit is in the pre-Cambrian Red Creek quartzite. This formation is composed of intercalated beds of quartzite, hornblendite, garnet schist, staurolite schist, and quartz-mica schist and is intruded by dioritic dikes. A thick unit of highly fractured white quartzite near the top of the formation contains tyuyamunite as coatings on fracture surfaces. The tyuyamunite is associated with carnotite, volborthite, iron oxides, azurite, malachite, brochantite, and hyalite. The uranium and vanadium minerals are probably alteration products of primary minerals. The uranium content of 15 samples from this property ranged from 0.000 to 0.57 percent. (Auth)

<35>

Vine, J.D., and G.W. Moore; USGS, Washington, DC

Uranium-Bearing Coal and Carbonaceous Rocks in the Fall Creek Area, Bonneville County, Idaho. USGS Circular 212, 10 pp. (1952)

Uraniferous coal, carbonaceous shale, and carbonaceous limestone occur in the Bear River formation of Early Cretaceous age at the Fall Creek prospect, in the Fall Creek area, Bonneville County, Idaho. The uranium compounds are believed to have been derived from mildly radioactive silicic volcanic rocks of Tertiary age that rest unconformably on the older rocks and once overlay the Bear River formation and its coal. Meteoric water, percolating downward through the silicic volcanic rocks and into the older rocks along joints and faults, is believed to have brought the uranium compounds into contact with the coal and carbonaceous rocks in which the uranium was absorbed. (Auth)

<36>

Adler, H H.; AEC, Washington, DC

The Conceptual Uranium Ore Roll and its Significance in Uranium Exploration. Economic Geology, 59(1), 46-53. (1964, January)

The results of independent geologic studies referred to are integrated to produce a logical and consistent concept explaining the formation of uranium ore rolls. Idealized patterns of ore accumulation at reduction-oxidation boundaries provide a basis for evaluating the geologic potential for uranium discovery in new areas. Alteration features in sandstone, attributed to differences in the redox potential of ground water, are believed to be an important guide to ore distribution. (Auth)

<37>

Hostetler, P.B., and R.M. Garrels; USGS, Denver, CO; Harvard University, Laboratory of Mining Geology, Cambridge, MA

Transportation and Precipitation of Uranium and Vanadium at Low Temperatures, with Special Reference to Sandstone-Type Uranium Deposits.
Economic Geology, 57(2), 137-167. (1962, March)

Uranium and vanadium in sandstone-type deposits of the western United States apparently have been transported to their present environment from external sources by low-temperature aqueous solutions. In the paper an attempt is made to interpret the characteristics of aqueous solutions capable of transporting significant quantities of uranium and vanadium through continental sedimentary rocks, and the changes in these characteristics that might result in precipitation of uraninite and other ore minerals in concentrations of ore grade. On the basis of present knowledge, the transportation environment is shown to be that of weakly alkaline, moderately reducing ground water, with an average or larger than average concentration of dissolved carbonate species. Precipitation is induced by reduction, probably by carbonaceous material or hydrogen sulfide, or both. Uranium is transported mainly in the form of the highly stable uranyl dicarbonate and tricarbonate complexes. Precipitation results from reduction of hexavalent aqueous uranium species to form uraninite, reduction of tetravalent vanadium to form montroseite, and fixation of uranyl ions by combination with potassium ions and quinquivalent vanadium to form the mineral carnotite. (Auth)

<38>

Bain, G.W.; Amherst College, Amherst, MA

Uranium Deposits in Southwestern Colorado Plateau. RMO-982 (Rev.), 59 pp. (1952)

Almost all the uranium in the Shinarump is in a jasperoid conglomerate in the lowest part of the channels. It is asserted that the uranium was originally contained in the jasperoid pebbles. The deposits can be geographically zoned on the basis of their mineralogic character into an eastern vanadium-excessive zone, a central vanadium-sufficient zone, and a western and southern vanadium-deficient zone. Many mines, prospects, and occurrences are described, including the Graysill mine near Placerville, Colorado, the Monument No. 1, Monument No. 2, Skyline, and Whirlwind mines in the Monument Valley district, and the Yellow Jacket and Hot Shot mines in the Circle Cliffs area. The Graysill mine is a vanadium deposit in the Entrada formation of Jurassic age, and the other mines are uranium or vanadium-uranium deposits in channel sediments of the Shinarump. (Auth)(MBW)

<39>

Baker, A.A.; USGS, Washington, DC

Geologic Structure of Southeastern Utah.
American Association of Petroleum Geologists Bulletin, 19(10), 1472-1507. (1935)

Southeastern Utah, lying within the Colorado Plateau, is characterized by several types of structural features, including huge asymmetrical upwarps, domes associated with laccolithic intrusions, the southern edge of the Uinta Basin structural depression, a north-trending zone of normal faults at the west edge of the Plateau, and a group of numerous folds, faults, and faulted folds that are found in a limited area near Moab. Folding has occurred in the region several times since the end of the Mississippian, but the principal deformation that is reflected in the structure of the surface rocks took place at the end of the Cretaceous or early in the Tertiary and, therefore, was related to the Laramide orogeny. The large domical uplifts have a northerly trend and are strongly asymmetric, with the steep limb toward the east; they were formed at the end of the Cretaceous, possibly as a reflection in the surface rocks of more or less vertical uplifting along deep-seated reverse faults. The group of numerous smaller folds, faults, and faulted anticlines in the part of the region near Moab also is believed to have been formed near the end of the Cretaceous; the deformation is obviously related to the presence of the plastic salt-bearing beds of the Pennsylvanian Paradox formation beneath the surface rocks, because the structural features of this type near Moab are typically developed only within the area underlain by the Paradox formation and because the salt-bearing beds have been intruded into the overlying rocks at the crests of some of the folds. Events in the Tertiary structural history of the region include the intrusion of igneous rocks in four isolated mountain groups, the downwarping of the Uinta Basin, and the development of the zone of normal faults at the west edge of the Plateau; it is not possible to determine the order of these events, or to determine whether they represent different modes of expression of one period of crustal disturbance. (Auth)

<40>

Baker, A.A.; USGS, Washington, DC

Geology of the Monument Valley - Navajo Mountain Region, San Juan County, Utah. USGS Bulletin 865. 106 pp. (1936)

The geology of an area in southeastern Utah is described. Exposed sedimentary formations range in age from Pennsylvanian to Quaternary, they have an aggregate average thickness of about 8,000 feet, and most are of continental origin. Small volcanic necks and dikes of Tertiary age crop out at three localities. The principal geologic structure is a gentle westerly dip off of the Monument upwarp, but this is interrupted by several small transverse folds and the large dome of Navajo Mountain. The report includes a geologic map of the area at a scale of 1:96,000. Small copper deposits (and, more recently uranium deposits) have been found in this area in the Shinarump conglomerate of Triassic age. (Auth)

<41>

Baker, A.A.; USGS, Washington, DC

Geology of the Green River Desert - Cataract Canyon Region, Emery, Wayne, and Garfield Counties, Utah. USGS Bulletin 951, 122 pp. (1946)

Exposed formations in this region range in age from Pennsylvanian to Late Cretaceous and have an aggregate thickness of about 6,500 feet. The rocks consist of interbedded marine and continental sedimentary formations which are described. The most conspicuous structural feature in the area is the steeply dipping monocline along the east side of the San Rafael Swell. The southern part of the area includes part of the gently dipping northern end of the Monument upwarp. The rocks are broken by numerous small normal faults, of which most have small displacements. The report includes a geologic map and a structural geologic map of the region at a scale of 1:62,500. Uranium and vanadium deposits in the area include those at Temple Mountain in the Shinarump conglomerate of Triassic age and those southwest of Green River, which are in the Salt Wash member of the Morrison formation of Jurassic age. (Auth)

<42>

Baker, A.A., C.H. Dane, and J.B. Reeside; USGS, Washington, DC

Revised Correlations of Jurassic Formations of Parts of Utah, Arizona, New Mexico, and Colorado. American Association of Petroleum Geologists Bulletin, 31(9), 1664-1668. (1947)

The authors have modified the correlations proposed in their paper of 1936. The most important change concerns the Wingate and Entrada sandstones. The Wingate sandstone at its type locality at Fort Wingate, New Mexico, is now correlated with the Entrada. It is proposed that the name Wingate be retained for the sandstone forming the lower part of the Glen Canyon group, with the understanding that the original type locality of the Wingate be abandoned. (Auth)

<43>

Dane, C.H.; USGS, Washington, DC

Geology of the Salt Valley Anticline and Adjacent Area, Grand County, Utah. USGS Bulletin 863, 184 pp. (1935)

Exposed sedimentary formations in this area range in age from Pennsylvanian to Late Cretaceous; crystalline Precambrian rocks are exposed on the Uncompahgre Plateau in the northeastern part of the area. The Salt Valley anticline, a salt structure, is a prominent fold broken by many faults; its crest is in part dropped into a structural trough. For the most part the rocks are tilted at low angles and warped into broad folds. The rocks in the eastern part of the area are displaced by many normal faults. The report includes a geologic map and a structure contour map of the area at a scale of 1:62,500. Vanadium-uranium deposits at Polar

Mesa and in an area southeast of Thompson, Utah, are in the Salt Wash member of the Morrison formation of Jurassic age. Carnotite and other vanadium and uranium minerals replace carbonaceous material and impregnate light-colored lenticular sandstone beds. (Auth)

<44>

Sharp, W.N., and A.B. Gibbons; USGS, Washington, DC

Geology and Uranium Deposits of the Southern Part of the Powder River Basin, Wyoming. USGS Bulletin 1147-D, 60 pp. (1964)

The Powder River Basin, in northeastern Wyoming, is a physiographic unit composed of sedimentary rocks, ranging in age from Cambrian to Oligocene which overlies the crystalline basement, and totals 13,000 feet in thickness. The Fort Union Formation of Paleocene age and the Wasatch Formation of Eocene age crop out over most of the central part of the basin. The Fort Union Formation is represented by about 3,000 feet of continental deposits and is divided into a lower unit composed dominantly of fine-grained sandstone and an upper unit characterized by white-weathering clayey siltstone. The Wasatch Formation, which unconformably overlies the Fort Union, consists of approximately 1,000 feet of clay and siltstone containing thick lenses of coarse-grained, arkosic sandstone. The Wasatch is separable areally into two facies - a partly peripheral, generally drab, fine-grained facies, and a central generally coarse-grained facies. The coarse-grained facies is subdivided according to two predominant colors of sandstone - drab and red. The red coloring, due to hematite, is restricted to a relatively narrow zone along the axis of the basin. The Powder River Basin was relatively stable during and after Eocene time, but structures indicative of minor instability are found. The uranium deposits in the basin occur in the lensing sandstone units of the Wasatch Formation within the area of predominantly red sandstone. The uranium minerals consist mainly of uraninite and tyuyamunite, which occur both in concretionary masses and as disseminations in uncemented sandstone. The areal distribution of red sandstone and of the uranium deposits within the basin, in addition to the similarity of the deposits, strongly suggests a regional common control for the development of both features. The results of the study support contentions that the red sandstone zone in the Wasatch and the uranium deposits are related in time and in origin. The process of concentrating the uranium, vanadium and manganese began with moderate folding along the axis of the basin. The uranium is thought to have been derived from the clastic material which was deposited in the basin and formed the sandstone lenses. (Auth)(MBW)

<45>

Sharp, W.N., E.J. McKay, F.A. McKeown, and A.M. White; USGS, Washington, DC

Geology and Uranium Deposits of the Pumpkin Buttes Area of the Powder River Basin, Wyoming. USGS Bulletin 1107-H, (pp. 541-638), (1964)

The Pumpkin Buttes area is on the east flank of the synclinal structural trough of the Powder River Basin of northeastern Wyoming. The Wasatch formation, of fluviatile origin, is about 1,500 feet thick and is composed of sandstone lenses randomly dispersed through a sequence of drab yellowish-gray to tan claystone, siltstone, carbonaceous shale, and thin coal seams. The sandstone lenses, which contain all the known occurrences of uranium in the area, are from 500 feet to several miles wide, 1 to 8 miles long, and 10 to 100 feet thick. Uranium deposits are closely related to the hematite-red coloring in the sandstone lenses. Tyuyamunite, metatyuyamunite, carnotite, uranophane, and trace amounts of hewettite and pascoite are disseminated in yellowish-brown or grayish-yellow sandstone where it is in contact with red sandstone. Calcite is generally abundant at the contact. Where the contact is very irregular and forms irregular podlike extensions of red into drab sandstone, concentrations of secondary uranium minerals may occur in the drab sandstone. Uraninite, pyrite, and paramontroseite associated with coalified wood occur as cement in pods in red sandstone near irregular contacts with drab sandstone. Uranophane is chiefly in the cores and is peripheral to manganese oxide concretions. All uranium minerals are contemporaneous with calcite. The concentrations of uranium, vanadium, iron, manganese minerals, and calcite seem to have formed by the redistribution and concentration of original components of the sandstone lenses. This is suggested by a) the apparent redistribution of limy material within sandstone lenses, b) the epigenetic drab-to-red color change associated with uranium deposits in sandstone lenses, c) the general unaltered condition of clay beds and the low uranium content of coal and carbonaceous shale between sandstone lenses, and d) the lack of faults and widespread sandstone units that would serve as channels for interformational or intraformational circulation of mineralizing waters. Oxidized uranium and vanadium minerals and manganese oxides formed in a general alkaline oxidizing environment. Unoxidized minerals, paramontroseite and uraninite with associated pyrite, formed in small local zones of a low redox potential, predominantly around coalified wood. (Auth)(MBW)

<46>

Davidson, D.F.; USGS, Washington, DC

Distribution of Coarse- and Fine-Grained Rocks in the Wasatch Formation and Their Relationship to Uranium Deposits, Powder River Basin, Wyoming. TEM-676, 12 pp. (1953)

The Wasatch formation of Eocene age in the Powder River Basin apparently grades from predominantly coarse-grained rocks at the southern end to fine-grained rocks at the northern end of the basin. In the central part of the basin where the two rock types are mixed the uranium deposits occur. The significance of this relationship is not known, and further studies are recommended. (Auth)

<47>

Dix, G.P., Jr.; AEC, Grand Junction, CO

Reconnaissance of the Uranium Deposits of the Lockhart Canyon - Indian Creek Area, San Juan County, Utah. RME-4038, 20 pp. (1953)

Copper-uranium deposits occur in the Bogus Tongue member of the Cutler formation of Permian age in the Lockhart Canyon - Indian Creek area. Exposed consolidated sedimentary rocks in the area range in age from Permian to Jurassic, and the beds are essentially horizontal. The Bogus Tongue member, about 670 feet thick, is predominantly red and consists of siltstone, sandstone, and cross-bedded arkose. The mineral deposits are associated with discontinuous lenses of white arkose which, presumably, were once red. Small amounts of copper and uranium minerals occur as concretions and along bedding planes and arkose-mudstone contacts, but the better deposits are those in which the uranium and copper minerals are disseminated in the arkose lenses. The recognized uranium minerals are uranophane, zeunerite, and trogerite. Copper sulfides are present in the concretions, and secondary copper minerals are present in the other types of deposits. (Auth)

<48>

Fischer, R.P.; USGS, Denver, CO

Sedimentary Deposits of Copper, Vanadium - Uranium and Silver in Southwestern United States. Economic Geology, 32(7), 906-951. (1937)

Widely distributed deposits of copper (Red Beds type), vanadium-uranium and silver, occurring in sandstones and shales of Permian (Entrada Sandstone), Triassic (Shinarump Conglomerate), and Jurassic (Morrison Formation) age, exhibit many common features and are thought to have had a similar origin. Mineralization, although mostly discontinuous, is recurrent at certain stratigraphic horizons. Commonly the ore bodies are distinctly lenticular and in some cases it can be demonstrated that mineralization was restricted to a particular lens. *Chalcocite pseudomorphs* after plant fossils show undeformed cell structure, suggesting mineralization previous to deep burial. Geologic structures, such as faults and folds appear to be post-mineralization and show no genetic relationship to ore deposition. This evidence opposes current ideas of mineralization by circulating meteoric waters or ascending thermal solutions, and it is believed that the concentration of the metals occurred at the time of deposition of the enclosing sediments. It is suggested that these metals may have been concentrated from dilute solutions by organisms. (Auth)

<49>

Dodd, P.H.; AEC, Grand Junction, CO

Happy Jack Mine, White Canyon, Utah. RMO-660, 23 pp. (1950)

The uranium deposit at the Happy Jack mine is in a lenticular, coarse-grained sandstone bed near the middle of the Moenkopi formation of Triassic age. (Subsequent investigations have shown that the host bed is at the base of the Shinarump conglomerate of Triassic age.) The porous, permeable sandstone bed thickens to about 20 feet at the portal of the mine, presumably due to the filling of a paleostream channel. This channel appears to be the major control of the deposit. Pitchblende and base metal sulfides occur in the unoxidized portion of the deposit, and secondary copper and uranium minerals occur near the outcrop. The uranium content is depleted near the outcrop due to surficial leaching. Because of the mineral assemblage, the deposit is believed to be of hydrothermal origin. Exposed consolidated sedimentary rocks in the area range in age from Permian to Jurassic, and dip 1 degree - 3 degrees W. (Auth)

<50>

Duschatko, R.W.; Columbia University, New York, NY

Fracture Studies in the Lucero Uplift, New Mexico, Final Report. RME-3027. 49 pp. (1953)

The Lucero uplift is a transitional tectonic element situated along the boundary of the Colorado Plateau and the Rio Grande graben belt of central New Mexico. The eastern margin of the structure has been complexly faulted during two (or more) periods of Tertiary deformation. Evidence is presented in support of the hypothesis that both stages of tectonic development involved primarily vertical movement along sharp monoclinal flexures possibly emanating from displacement along deep seated fracture zones. The composite fracture pattern developed over the uplift indicates that the faults and joints are essentially parallel and were produced by a common cause. The dominant fracture pattern is regional and indicates primary east-west lateral elongation with secondary north-south stretching of the sediments due to bending of the rock between the primary fractures. (Auth)

<51>

Ellsworth, P.C., and K.G. Hatfield; AEC, Grand Junction, CO

Geology and Ore Deposits of Mesa 6, Lukachukai District, Arizona. RMO-802. 12 pp. (1951)

Vanadium-uranium deposits on Mesa 6 are in a fine- to medium-grained sandstone unit in the Salt Wash member of the Morrison formation of Jurassic age. The mineralized sandstone lies about 60 feet above the base of the formation and is underlain by a blue-green mudstone. Carnotite and vanoxite occur in mudstone seams and impregnate the sandstone. Light tan sandstone, the most favorable host rock in the Lukachukai Mountains, is relatively scarce on Mesa 6. The area of best mineralization lies on a structural flat about a thousand feet southwest of the axis of the Lukachukai syncline. (Auth)

<52>

Ellsworth, P.C., and A. Mirsky; AEC, Grand Junction, CO

Preliminary Report on Relation of Structure to Uranium Mineralization in the Todilto Limestone, Grants District, New Mexico. RME-4020. 15 pp. (1952)

Investigation of the structure of the Todilto limestone of Jurassic age in the Grants district indicates a genetic relationship between the folds in the Todilto limestone and joints resulting from the Zuni Uplift. Drill-hole data show that the larger ore bodies in the Todilto limestone are on anticlines. The ore bodies are elongate in a manner that suggests control by a conjugate joint system; they appear to trend in general conformity with the folds. (Auth)

<53>

Bain, G.W.; Amherst College, Amherst, MA

Geology of the Fissionable Materials. Economic Geology, 45(4), 273-323. (1950, June)

Deposits of uranium and thorium have characteristics of mineralogy and geologic occurrence with geographic distribution pattern that facilitates estimating the resources in each type. Positions for known geographic occurrences are shown on maps and the geologic control over the distribution for each type is reviewed in the text. Occurrences are classified under primary or hypogene types, sedimentary or bedded deposits, and oxidized bodies. At present the primary deposits are the principal source of supply and currently only mesothermal lodes seem to have productive value. Primary uranium deposits are either in massifs or close to the margin of Shields. The center of Shields has no known or indicated concentrations. Marine beds, which accumulated very slowly at high pH (hydrocarbon and phosphorite bearing strata which interrupt the organic food cycle) have above average uranium. Some of these marine deposits and many lake beds and soil layers of steppe climate have the contained uranium reconcentrated slightly when concretion-forming processes affect them. Concentrations of oxidized uranium mineral occur in the pedalfer type soil areas where acidity declines at depth: it appears in the pedocal type soil areas at the surface or at the watertable in the special instance where acidity is sustained by oxidation of sulphide masses. Sources of uranium can be in either primary hypogene minerals or is sedimentary deposits. (Auth)(PAG)

<54>

Everhart, D.L.; AEC, Division of Raw Materials, Geologic Branch, Washington, DC

Origin of Uranium Deposits: A Progress Report. Mining Engineering. 6(9), 904-907. (1954, September)

The uranium deposits of the world exhibit a broad variety of character and geologic environment. Uranium has a high solubility over a wide range in pH, temperature, and pressure, but there are a number of very effective precipitants, including carbonaceous matter and high base-exchange clays. The origin of the uranium deposits in many geologic environments is reasonably clear. The greatest doubts as to origin concern the disseminated deposits in sedimentary rocks, particularly those deposits on the Colorado Plateau. The field relations of most of these deposits suggest that primary structures in the sediments were instrumental in localizing the deposits. In a few areas, however, field relations strongly suggest that the deposits may be genetically related to faults, fractures, or salt dome structures. (Auth)

<55>

Finch, W.I.; USGS, Washington, DC

Geology of the Shinarump No. 1 Uranium Mine, Seven Mile Canyon Area, Grand County, Utah. USGS Circular 336. 14 pp. (1954)

The Shinarump No. 1 uranium deposit is about 12 miles north of Moab, Utah, on the west flank of the Moab anticline and about 700 feet west of the Moab fault. The rocks dip about 8 degrees NW; the formations are of sedimentary origin and range in age from Permian to Jurassic. Uraniferous material occurs mainly in three zones in the lower 25 feet of the Chinle formation of Triassic age. The Shinarump No. 1 deposit is in the lowermost zone, which is made up of from 5 to 10 feet of siltstone with some interbeds of mudstone, sandstone, and conglomerate. The ore deposit is not in a channel fill but in flat-bedded sedimentary rocks that were deposited on an irregular surface. The deposit consists of discontinuous lenticular layers of mineralized rock, irregular in outline, that, in general, follow the bedding. The ore minerals occur in the more poorly sorted parts of the siltstone and in stringers of coarse sand in the siltstone. The rocks near the deposits are bleached from red to gray and green. Uraninite, the principal uranium mineral, is associated mainly with chalcopyrite and pyrite. The uraninite occurs as small grains disseminated in the siltstone and replacing wood. Rich concentrations of uranium occur in seams as much as half an inch thick along bedding planes. The uraninite is later than or simultaneous with most sulfides except chalcocite, which is, in part, later than uraninite. The Shinarump No. 1 deposit is thought to be of hydrothermal origin and to have been formed in Late Cretaceous or Early Tertiary time. Guides to ore in the area are the presence of bleached siltstone, carbonaceous material, and copper sulfides. (Auth)

<56>

Fischer, R.P.; USGS, Denver, CO

Deposits of Vanadium-Bearing Sandstone. In Vanderwilt, J.W., Mineral Resources of Colorado. Colorado Mineral Resources Board, (pp. 451-456). (1947)

Deposits of vanadium-bearing sandstone occur in western Colorado and adjacent parts of Utah, Arizona, and New Mexico. The principal ore-bearing rocks are the Shinarump conglomerate of Triassic age, and the Entrada sandstone and Morrison formation, both of Jurassic age. The ore is sandstone impregnated with vanadium minerals, although some plant fossils are richly mineralized. The vanadium deposits form irregularly tabular layers whose long axes nearly parallel the bedding, but the deposits do not follow the beds in detail. They are irregularly distributed and have a wide range in size. The limits of the vanadium-bearing sandstone are usually fairly well defined. Wherever the ore layer, or an edge of it crosses the bedding in a smooth curve, the structure is called a "roll". Fossil logs and the rolls in any one area usually have a common orientation. The host beds range from horizontal to steeply dipping, but most of the deposits are in gently dipping beds. Faulting is locally common, but the deposits apparently are not genetically influenced by faulting nor by Tertiary intrusive igneous rocks. Origin and controls of the ore deposits have not been definitely established, but the deposits probably were formed by precipitation from ground-waters before regional deformation and possibly shortly after deposition of the ore-bearing beds. The source of the vanadium is not known but is thought to be great volumes of adjacent beds which were slightly vanadiferous. (Auth)(MBW)

<57>

Fischer, R.P.; USGS, Denver, CO

Origin of the Colorado Plateau Vanadium Deposits. Washington Academy of Science Journal, 39(3), 109. (1949)

The vanadium deposits of the Colorado Plateau occur in sandstone beds of Mesozoic age. Most of them are restricted to a few stratigraphic horizons, along which they have a wide but spotty areal distribution. The ore minerals mainly impregnate sandstone, partly or completely filling the pore spaces of the rock. The ore bodies are irregularly shaped in plan and in section they form tabular or lenticular layers that lie nearly parallel to the bedding. These layers do not follow the beds in detail, however, and for this reason the ore in its present form cannot be syngenetic but rather had to have been precipitated from solutions after the sands had accumulated. It is difficult to rationalize the localization and character of the deposits as originating from hydrothermal or ground-water solutions that might have been introduced into the ore-bearing beds along through-going, vertical structures resulting from regional deformation or igneous activity. The habits of the ore and the location of the deposits show a close relationship to sedimentary structures and conditions that would certainly influence at one time or another the flow of solutions along or through the ore-bearing beds. It is suggested that the vanadium ore was precipitated from ground waters moving along the beds during a period of active circulation shortly after the sands accumulated. Precipitation probably was caused by relatively slight changes in composition of the waters, resulting from reactions in an environment of decaying organic matter, reactions at a water table, or the mixing of two solutions. (Auth)(MBW)

<58>

Fischer, R.P., and L.S. Hilpert; USGS, Washington, DC

Geology of the Uravan Mineral Belt. USGS Bulletin 988-A, (pp. 1-13). (1952)

The name Uravan mineral belt is applied to a narrow, elongate area in southwestern Colorado in which carnotite deposits in the Morrison formation have a closer spacing, larger size, and higher grade than those in adjoining areas. The belt extends from Gateway through Uravan to Slick Rock. The deposits within the belt tend to be clustered in patches of favorable ground 1,000 feet or more in width and usually a mile or more in length. These patches of favorable ground, and the deposits within them, generally are elongate normal to the trend of the mineral belt. Similarly the fossil logs and the ore rolls within the deposits have a dominant orientation normal to the belt. The mineral belt probably was localized by geologic conditions extant during the time the ore-bearing Morrison formation was deposited. These geologic relations allow the projection of the belt under deep cover between points of exposure and offer the chance of discovering moderately large reserves of carnotite ore in the unexplored parts of the belt. (Auth)(MBW)

<59>

Fischer, R.P., W.L. Stokes, and L.F. Smith; USGS, Washington, DC

Geology of the Rifle Creek Vanadium Area, Garfield County, Colorado. USGS Strategic Minerals Investigations Preliminary Report, 5 pp. (1944)

The vanadium deposits at the Rifle and Garfield mines, northeast of Rifle, Garfield County, Colorado, are in the Entrada sandstone of Upper Jurassic age. The rocks in the area dip southward at moderately low angles, but this dip is locally disrupted by small folds and faults. Exposed formations include the Triassic Red Beds, the Entrada sandstone and Morrison formation of Jurassic age, and the Dakota sandstone and Mancos shale of Cretaceous age. The ore is light colored, cross bedded, fine-grained sandstone impregnated with vanadium minerals, the most important of which is a fine-grained micaceous mineral of uncertain composition. Fossil carbonaceous material has not been observed. The deposits occur in three layers which range in thickness from a feather-edge to as much as 30 feet and average about 5 feet. The ore layers are generally nearly conformable to formation contacts; they normally cross inclined bedding. At the Rifle mine, the lower ore layer forms an elongate deposit that has been mined for nearly 5,000 feet. An altered zone at the top of the Red Beds is locally vanadiferous; the thicker parts of the altered zone are spatially related to vanadium deposits in the overlying Entrada sandstone. (Auth)

<60>

Gregory, H.E.; USGS, Washington, DC

Geology of the Navajo Country - A Reconnaissance of Parts of Arizona, New Mexico, and Utah. USGS Professional Paper 93, 161 pp. (1917)

The geology of the Navajo country, an area in northeastern Arizona and adjacent parts of Utah, Colorado, and New Mexico, is described. Exposed consolidated sedimentary rocks in the region are mostly of Triassic, Jurassic, and Cretaceous age, but rocks of Precambrian, Pennsylvanian, and Eocene age also are present. Relatively large areas in the Carrizo Mountains and in the Hopi Buttes area are underlain by igneous rocks. Smaller bodies of igneous rocks are widely distributed. The sedimentary rocks in the region are horizontal or tilted at low angles except where they have been sharply folded by monoclines. Two major structural basins (now called San Juan Basin and Black Mesa Basin) and three major uplifts (now called Zuni uplift, Defiance uplift, and Monument uplift) are present in the region. The report includes a geologic map of the Navajo country at a scale of 1:500,000. In Monument Valley a uranium-vanadium mineral, probably carnotite, was found among the pebbles of the Shinarump conglomerate and in association with petrified wood of the Chinle formation, both of Triassic age. (Auth)

<61>

Gregory, H.E.; USGS, Washington, DC

The Kaiparowits Region, A Geographic and Geologic Reconnaissance of Parts of Utah and Arizona. USGS Professional Paper 164, 161 pp. (1931)

The sedimentary rocks of the Kaiparowits region are chiefly of Triassic, Jurassic, and Cretaceous age, but Eocene rocks cap the highest plateaus, and Permian sandstones and limestones are present in the upwarps. Extrusive igneous rocks of Tertiary age blanket an area in the northwest part of the region. The Waterpocket monocline and the East Kaibab monocline are the major flexures of the region. The Circle Cliffs upwarp, the Kaibab upwarp, and the Kaiparowits downwarp cover large areas and are modified by smaller folds. The Paunsugunt fault in the northwest part of the region has a displacement of 1,500 feet. The report includes a geologic map of the region at a scale of 1:250,000. (Auth)

<62>

Grier, A.W. (Ed.); Not given

Geology of Portions of the High Plateaus and Adjacent Canyon Lands, Central and South-Central Utah. Proceedings of the Intermountain Association of Petroleum Geologists, Fifth Annual Conference, Guidebook, held in Salt Lake City, Utah. 130 pp. (1954)

The publication, a field conference guidebook, includes papers on the geomorphology, structural history, stratigraphic correlations, and the stratigraphy of the Carboniferous, Permian, Triassic, Jurassic, and Cretaceous and Tertiary rocks. Each of the formations is described. The stratigraphy and structure of the Capitol Reef area, the Kaiparowits region, and the Paunsugunt Plateau region are described. The guidebook also contains papers on the oil and gas fields of the region and the uranium deposits at Temple Mountain. A number of geologic and structural maps and sections at various scales are included. (Auth)

<63>

Gruner, J.W.; University of Minnesota,

Minneapolis, MN

Annual Report for July 1, 1950 to June 30, 1951, Part II, Origin of the Uranium Deposits in the Shinarump Formation - A Preliminary Study. RMO-837, 27 pp. (1951)

Features common to many or all of the uranium deposits in the Shinarump conglomerate of Triassic age are reviewed. Most of the deposits are associated with fossil carbonaceous material and are near the base of channels cut into the underlying rocks, in most places the Moenkopi formation, and are filled with irregular lenses and beds of conglomerate, sandstone, and clay. Commonly there is a thin bleached zone directly under the contact. The unoxidized parts of the deposits are independent of present day large-scale topography. The uranium may be associated with vanadium or copper or neither, but pyrite is almost always present in the unoxidized ore. Hypotheses of the origin of the uranium deposits discussed are the hydrothermal hypothesis, concentration from surface waters, and concentration from circulating meteoric waters. The hypothesis that flowing cold waters deposited the uranium is favored. Organic matter is thought to be the precipitating agent. The deposits have remained essentially unchanged by subsequent geologic processes. (Auth)

<64>

Gruner, J.W., A. Rosenzweig, and D.K. Smith; University of Minnesota, Minneapolis, MN

The Mineralogy of the "Mi Vida" Uranium Ore Deposit of the Utex Exploration Company in the Indian Wash Area, Utah. In Annual Report for April 1, 1953 to March 31, 1954, (pp. 15-27); RME-3094, (pp. 15-27). (1954)

The Mi Vida vanadium-uranium ore deposit is in calcareous sandstone and mudstone lenses in the Chinle formation of Triassic age. The area is on the southwest flank of the Lisbon Valley anticline, and the rocks strike 15 degrees - 30 degrees NW and dip about 10 degrees SW. The ore body is covered with impervious shale and siltstone. The mineralogy of the host rock and ore minerals is described, and the origin of the deposit is discussed. Uraninite is the major uranium mineral, but tyuyamunite and metatyuyamunite also are recognized. Montroseite, doloresite, and other unidentified vanadium minerals are present. The ore minerals are associated with abundant carbonaceous materials. (Auth)

<65>

Gruner, J.W., C.C. Towle, and L. Gardiner; University of Minnesota, Minneapolis, MN; AEC, Denver, CO

Uranium Mineralization in Todilto Limestone Near Grants, McKinley County, New Mexico. Economic Geology, 46(7), 802; Geological Society of America Bulletin, 62(12), 1445. (1951)

Uranium ores have been found in Todilto limestone near Grants, New Mexico, about 75 miles west of Albuquerque. The rocks are a part of the southern rim of the San Juan Basin and dip gently northward. The Todilto is practically conformably underlain by Entrada sandstone. The Summerville formation overlies it. The limestone in the area under discussion varies from 3 to 20 feet in thickness. Usually, the upper part shows considerable recrystallization. It is in this portion that most of the mineralization is found. Here, the minerals carnotite, tyuyamunite, uranophane, and some amorphous, ill-defined uranium-vanadium compounds partly replace the calcite. Fluorite has been found in two places replacing calcite. Pitchblende in minute blebs has been identified. The lower, thinly bedded limestone contains uranium only along joints and fractures. Very minor amounts of uranium minerals have been discovered in the basal few feet of the overlying Summerville. It may be stated tentatively that the uranium content is probably of syngenetic origin. Diagenesis caused recrystallization of the upper Todilto and some concentrations of the ore. Circulating ground water caused much later solution and reprecipitation in the ores. (Auth)

<66>

Grutt, E.W., Jr.; AEC, Casper, WY

Geologic Notes on Some Wyoming Uranium Districts. Mines Magazine, 45(3), 106-108. (1955)

Uranium in Wyoming occurs in veins in Precambrian rocks, in sedimentary rocks of Paleozoic and Mesozoic age, and in sedimentary rocks of Tertiary age. The deposits in sedimentary rocks of Tertiary age are most important. In the Owl Creek Mountains, in the Pedro Mountains, and in the Laramie Mountains, uraninite occurs in hydrothermal veins in Precambrian rocks. Carnotite deposits occur in sandstones of the Inyan Kara group of Early Cretaceous age on the northwest flank of the Black Hills. Uranium deposits in the Powder River Basin occur in the Wasatch formation of Eocene age in two broad areas. In the Pumpkin Buttes area, there are two types of deposits: disseminated and concretionary. Both occur in coarse-grained arkosic sandstone but are not usually found together. The deposits in Converse County are mostly of the disseminated type. The uranium deposits near Lance Creek, on the southeast margin of the Powder River Basin are mostly in arkosic sandstone in the White River formation of Oligocene age. In the Gas Hills area, the majority of the deposits occur in gently dipping coarse-grained arkosic sandstone of the Wind River formation of Eocene age. A number of uranium minerals are disseminated in the host rock. In the Owl Creek Mountains, meta-autunite is disseminated along seams or bedding in tuffaceous sediments of the Wind River formation. In the Crooks Gap area in the Green Mountains, uranophane and other uranium minerals are disseminated in very coarse-grained sandstone and conglomerate in the lower part of the Wasatch formation of Eocene age. Near Baggs, Wyoming, and Maybell, Colorado, uranium minerals are irregularly disseminated in sandstone of the Browns Park formation of Miocene age. (Auth)

<67>

Love, J.D.; USGS, Washington, DC

McComb Area, Wyoming. In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, December 1, 1953 to May 31, 1954, (pp. 175-181); TEI-440, (pp. 175-178). (1954)

The McComb area is in the northern part of the Wind River Basin near the Owl Creek Mountains in Fremont County, Wyoming. Most of the uranium deposits in the area are in the Tepee Trail formation of Late Eocene age. Autunite, schroeckingerite, and other uranium minerals o[illegible] in bentonitic claystone, bentonitic sandstone, arkosic sandstone, and boulder conglomerate. Radioactivity is also present locally in adjacent Precambrian granite. (Auth)

<68>

Love, J.D.; USGS, Washington, DC

Preliminary Report on Uranium in the Gas Hills Area, Fremont and Natrona Counties, Wyoming. USGS Circular 352. 11 pp. (1954)

Uranium deposits occur in the Thermopolis shale of Cretaceous age, in the Wind River formation of Early Eocene age, and in middle Eocene rocks in the Gas Hills area of central Wyoming. The Cretaceous and older rocks are folded; the Tertiary rocks are essentially horizontal. The Wind River formation was deposited on an irregular erosion surface developed on the Cretaceous and older rocks. The uranium deposit in the Thermapolis shale is near the contact with the Wind River formation. The uranium was probably deposited in the shale from ground water solutions ponded by the erosion surface. The deposit is not of ore grade. In most of the uranium ore deposits in the Wind River formation the uranium minerals meta-autunite, uranospinite, and an unidentified uranium mineral are disseminated in medium- to coarse-grained or conglomeratic sandstone, but some small low-grade deposits have been found in carbonaceous shale. Some of the deposits are in clayey sandstone, and some are associated with ferruginous concretions or beds. Samples selected from the deposits have contained as much as 10 percent uranium. The uranium occcurrence in the middle Eocene rocks is near the base of the sequence in a ferruginous coarse-grained conglomeratic sandstone. It does not contain ore-grade material. The author suggests that the uranium was leached from younger tuffaceous Tertiary rocks by ground water and transported downward and laterally to favorable environments of deposition. (Auth)

<69>

Lindgren, W.; Not given

Vanadium and Uranium Ores in Sandstone. In Mineral Deposits, 4th Edition, McGraw-Hill Book Company, Inc., New York, (pp. 409-415). (1933)

Vanadium with some uranium and a trace of radium is common in gently inclined, white, cross-bedded sandstones of the McElmo formation (Morrison formation) and La Plata sandstone (Entrada sandstone), both of Jurassic age, in western Colorado and eastern Utah. The three most important minerals are carnotite, vanoxite, and roscoelite. The carnotite ores are always associated with fossil wood. It is suggested that the uranium and vanadium were concentrated by possibly tepid meteoric waters which derived the metals from terrigenous sediments resulting from the disintegration of Precambrian igneous rocks and pegmatites. (Auth)

<70>

Love, J.D.; USGS, Washington, DC

Uranium in the Mayoworth Areas, Johnson County, Wyoming - A Preliminary Report. USGS Circular 358, 7 pp. (1954)

The uranium mineral tyuyamunite occurs in a hard gray oolitic marine limestone at the base of the Sundance formation of Jurassic age in the Mayoworth area, Wyoming. This limestone bed is about 20 feet thick in the area, but it thins and disappears to the north and south. The remainder of the Sundance formation is composed of marine sandstone and shale. The Sundance in this area is underlain by the Chugwater formation of Triassic age and is overlain by the Morrison formation of Jurassic age. The area is on the east flank of the Bighorn Mountains, and the rocks dip 10 degrees - 15 degrees NE. Metatyuyamunite coats fractures in the limestone and replaces the oolites. Selected samples contain as much as 0.71 percent uranium. Radioactivity is also present along some ferruginous brown clayey partings in the limestone. Dinosaur bones in the Morrison formation were radioactive wherever tested, but no significant amount of radioactivity was noted in the surrounding rocks. The uranium was apparently deposited in the limestone from ground water solutions. It is suggested that the uranium was derived from the White River formation of Oligocene age; the White River formation truncates the older rocks about 2500 feet structurally higher than the uranium deposits. (Auth)

<71>

Lowell, J.D.; AEC, Grand Junction, CO

Applications of Cross Stratification Studies to Problems of Uranium Exploration. RME-44. (1953)

Uranium ore bodies in the lower part of the Morrison formation of Jurassic age in the Chuska Mountains area in northeastern Arizona are elongated in the dierrection of ancient stream channels. Interactions of ancient stream systems appear to be favorable loci for the deposition of uranium ore. These stream directions and intersections can be reconstructed and projected by mapping and analysis of cross-stratification. Mineral-bearing solutions appear to have followed networks of paleochannel scour-fills, moving through them along the path of greatest permeability. Where the velocity of the moving solutions was reduced by especially permeable rocks, uranium ore was deposited, provided that a suitable geochemical environment existed. (Auth)

<72>

Lowell, J.D.; AEC, Grand Junction, CO

Applications of Cross Stratification Studies to Problems of Uranium Exploration, Chuska Mountains, Arizona. Economic Geology. 50(2), 177-185; RME-44, 17 pp. (1955)

Uranium ore bodies in the lower part of the Morrison formation of Jurassic age in the Chuska Mountains area in northeastern Arizona are elongated in the direction of ancient stream channels. Intersections of ancient stream systems appear to be favorable loci for the deposition of uranium ore. These stream directions and intersections can be reconstructed and projected by mapping and analysis of cross-stratification. Mineral-bearing solutions appear to have followed networks of paleochannel scour-fills, moving through them along the path of greatest permeability. Where the velocity of the moving solutions was reduced by especially permeable rocks, uranium ore was deposited, provided that a suitable geochemical environment existed. (Auth)

Title of RME-44 report is "Applications of Cross Stratification Studies to Problems of Uranium Exploration".

<73>

McKee, E.D., C.G. Evensen, and W.D. Grundy; University of Arizona, Tucson, AZ

Studies in Sedimentology of the Shinarump Conglomerate of Northeastern

Arizona. RME-3089. 48 pp. (1953)

Studies of sedimentary features of the Shinarump conglomerate in northeastern Arizona include analyses of composition, texture, and cross-stratification, examination of small-scale primary structures and of features of the basal contact, and the accumulation of data on stratigraphic relations and the controls of mineralization. Much of the detrital sediment included in the Shinarump conglomerate was transported by streams from the south and southwest. The formation developed as a regressive sandstone, forming a blanket deposit across a surface of small hills, valleys, and stream channels. The types of deposition were rigidly controlled by water level. Field relations indicate that lateral and downward moving solutions, following the paths taken by ground water today, introduced the mineral matter. Channels cut into the underlying Moenkopi formation appear to have determined major directions of movement of the solutions; local sedimentary traps of several types within these channels have been responsible for ore accumulation. Carbonaceous matter and some varieties of clay deposits are associated with mineralization in many sedimentary traps. (Auth)

<74>

McKelvey, V.E., D.L. Everhart, and R.M. Garrels; USGS, Washington, DC; AEC, Washington, DC

Summary of Hypotheses of Genesis of Uranium Deposits. In USGS Professional Paper 300, (pp. 41-53), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 551-561), 825 pp. (1956)

The origin and distribution of uranium in several geologic environments are discussed. The uranium deposits in sandstones on the Colorado Plateau are probably epigenetic. Certain studies have shown that the uranium probably came from a deep-seated source, but it is possible that the uranium was derived from volcanic ash or other dispersed sources within the sedimentary pile and transported to the site of deposition by circulating waters or petroleum. Whatever the source, the path the ore solutions followed in the sandstones was determined mainly by sedimentary structures. The precipitation of uranium likely is brought about by reduction, perhaps related to decaying organic matter. (Auth)

<75>

McKnight, E.T.; USGS, Washington, DC

Geology of Area Between Green and Colorado Rivers, Grand and San Juan Counties, Utah. USGS Bulletin 908, 147 pp. (1940)

Exposed sedimentary formations in this area range in age from Pennsylvanian to Upper Cretaceous. Most of the Permian, Triassic, and Jurassic formations are of continental origin; the Pennsylvanian and Upper Cretaceous formations are mostly marine. The dominant structure of the area is a gentle regional dip to the north. Superposed on the regional dip are several folds, some of which may be due to the intrusion of salt. The report includes a geologic map and structural geologic map of the area, both at the scale of 1:62,500. (Auth)

<76>

Masters, J.A.; AEC, Grand Junction, CO

Uranium Deposits on Southwest Rim of Lukachukai Mountains, Northeast Arizona. RMO-911, 10 pp. (1951)

Vanadium-uranium deposits on the southwest rim of the Lukachukai Mountains are in the Salt Wash member of the Morrison formation of Jurassic age. The Salt Wash member is composed of red and gray, fine-grained quartzose sandstones interbedded with red and gray shales and siltstones. Carnotite and vanoxite are associated with carbonaceous material, and impregnate cross-bedded channel sandstone 45 and 100 feet above the base of the Salt Wash sandstone. The host rock is light to dark gray, whereas rocks in other units are commonly red. However, not all gray sandstone is mineralized. The deposits are on the opposite side of the Lukachukai Mountains from the mineralized belt on northeast rim and extend from Dry Bone to Camp Mesa. (Auth)

<77>

Masters, J.A.; AEC, Grand Junction, CO

Geology of the Uranium Deposits of the Lukachukai Mountains Area, Northeast Arizona. RME-27, 23 pp. (1953)

A concentration of vanadium-uranium ore bodies occurs in fine- to very fine-grained sandstone of the Salt Wash member of the Morrison formation of Jurassic age in a north-south belt across the Lukachukai Mountains. The belt extends from Mesa 1 to Mesa 5 on the north side, and from Two Prong Mesa to Step Mesa on the south side of the mountains. The ore belt conforms to a lenticular sandstone and mudstone facies and is bounded on the west by a massive sandstone facies and on the east by a mudstone-minor sandstone facies. Changes in permeability influenced the movement of mineral-bearing solutions by causing their diversion, damming, and concentration. Permeability trends follow paleostream channels, and ore bodies lie in and are elongated parallel to these channels. The presence of carbonaceous material and, possibly, mudstone caused precipitation of uranium from solution. Ore most commonly occurs in gray and limonitic-brown sandstone; and, in the vicinity of ore, the associated mudstone is usually gray. The ore solutions presumably bleached the rocks from red to gray or brown. Carnotite and vanoxite impregnate sandstone and "trash piles", and replace fossil logs. Some ore bodies are rolls. The association with bleached sandstone and mudstone is common to both. (Auth)(MBW)

<78>

Miller, L.J.; AEC, Grand Junction, CO

Ore Textures of Uraninite and Associated Minerals from the Colorado Plateau Uranium Deposits. Geological Society of America Bulletin, 64(12), 1453-1454. (1953)

Uraninite in the ore deposits of the Colorado Plateau is present as a replacement mineral. It replaces the clay cement of the quartz grains, the quartz overgrowths, asphaltite, organic matter, and in some cases sulfide minerals. The exsolution texture of chalcopyrite and bornite indicates deposition at a high temperature. A comparison of the large amount of alteration at the Marysvale uranium deposit and the low amount of alteration of the Plateau deposits suggests a low-temperature deposition for the Plateau deposits. (Auth)

<79>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Stratigraphy of the Southeastern Utah Uranium Region. In Stokes, W.L. (Ed.), Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 16-47), 115 pp. (1954)

Exposed sedimentary formations in southeastern Utah range in age from Mississippian to Tertiary; every system is represented. Older sedimentary rocks may be present but are not exposed. Each of the exposed formations is described. Uranium ore has been produced from 21 formations on the Colorado Plateau; seven contain uranium deposits that have more than 1,000 tons. The bulk of the production in southeastern Utah has come from the Shinarump and Chinle formations of Triassic age, and from the Morrison formation of Jurassic age. These three formations are discussed in more detail than others. (Auth)

<80>

Gruner, J.W.; University of Minnesota, Minneapolis, MN

The Uranium Mineralogy of the Colorado Plateau and Adjacent Regions. In Stokes, W.L. (Ed.), Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 70-77), 115 pp. (1954)

Uranium and vanadium minerals occurring in rocks of the Colorado Plateau and adjacent regions are presented in two comprehensive tables. Each mineral is described by chemical composition; color; lustre; specific gravity; system and habit; cleavage; associations; geologic occurrence; and the author's remarks. (PAG)

<81>

Shoemaker, E.M.; USGS, Washington, DC

Structural Features of Southeastern Utah and Adjacent Parts of Colorado, New

Mexico, and Arizona. In Stokes, W.L. (Ed.), Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 48-69), 115 pp. (1954)

The major uplifts of southeastern Utah are the San Rafael Swell, Circle Cliffs uplift, the Uncompahgre uplift, and the Monument Uplift; the major basins are the Kaiparowits Basin, the Henry Mountains Basin, and the Uinta Basin. Each of the uplifts and basins is an asymmetric fold, bounded on one side by a major monocline. Five series of salt structures, some of which have collapsed crests, occur mainly in a northwest-trending belt in an area in Colorado and Utah. The laccolithic mountain groups in Utah, the Henry, La Sal, and Abajo Mountains, consist of stocks of igneous rocks from which radiate tongue-shaped masses. Sills, dikes, small laccoliths, and diatremes are distributed irregularly in parts of southeastern Utah. The tectonic history of the region is reviewed. The regional pattern was established prior to Cambrian time. Slight folding in Permian time probably initiated the rise of the salt intrusions, and they continued until late in Jurassic time. In the Late Cretaceous, the area was inundated by the sea and covered with about 5,000 feet of sediments. Probably in latest Cretaceous time, most of the larger structures assumed essentially their present form, and the laccolithic mountain groups were intruded. In Late Tertiary time the entire area was uplifted. (Auth)

<82>

Proctor, P.D.; Utah Geological and Mineralogical Survey, Salt Lake City, UT

Geology of the Silver Reef (Harrisburg) Mining District, Washington County, Utah. Utah Geological and Mineralogical Survey Bulletin 44, 169 pp. (1953)

The Silver Reef mining area in southwestern Utah contains the only known occurrence in the United States of commercial bodies of silver ore in sandstone with minor copper-uranium-vanadium minerals. The ore bodies are restricted to the Silver Reef sandstone member of the Chinle formation of Triassic age, and they occur on the limbs and nose of the northeast-trending and plunging Virgin anticline and a subsidiary anticline and syncline. The deposits are associated with carbonaceous materials in lenses of light-colored quartzose sandstone and may be localized in channels in the Silver Reef sandstone. The author concludes that the metals in the Silver Reef deposits were derived from volcanic tuffs by ground or surface waters and precipitated in proximity to carbonaceous material in the Silver Reef sandstone. The silver was further concentrated by secondary enrichment. (Auth)(MBW)

<83>

Rapaport, I., J.P. Hadfield, and R.H. Olson; AEC, Grand Junction, CO

Jurassic Rocks of the Zuni Uplift, New Mexico. RMO-642, 45 pp. (1952)

The Zuni uplift is an asymmetrical, elliptical dome in the southeastern corner of the San Juan basin. It is approximately 65 miles long by 40 miles wide, elongated in a northwesterly direction. In the central part of the uplift, Precambrian crystalline and metamorphic rocks are exposed. About a thousand feet of Paleozoic, and more than three thousand feet of Mesozoic, sedimentary rocks overlie the Precambrian basement. Tertiary and Quaternary lava flows cover limited areas. Jurassic sedimentary rocks of this region, in ascending order, are divided into the Glen Canyon group, the San Rafael group, and the Morrison formations. The Wingate formation is the only member of the Glen Canyon group. The San Rafael group consists of, in ascending order, the Carmel, the Entrada, the Todilto, the Summerville, and the Bluff formations. The Morrison formation is divided into the Recapture Creek, the Westwater Canyon, and the Brushy Basin members. Rock types include shale, siltstone, sandstone, and limestone. All Jurassic formations, except possibly the Carmel, are of continental origin. The regional stress responsible for the Zuni dome appears to have been essentially one of vertical uplift, probably in Early or Middle Tertiary time. Structural relief is more than 6,600 feet. The joints and faults seem to be tensional, normal to the direction of most bending and normal to the bedding. (Auth)

<84>

Reinhardt, E.V.; AEC, Grand Junction, CO

Uranium-Copper Deposits Near Copper Canyon, Navajo Indian Reservation, Arizona. RMO-902, 13 pp. (1952)

Copper-uranium deposits in the Copper Canyon area of the Monument Valley district in Utah and Arizona, occcur in the Shinarump conglomerate of Triassic age near the base of channels cut into the underlying Moenkopi formation of Triassic age. The deposits, which are relatively small, are all less than 20 feet above the base of the channels, and the best concentrations are in the lower five feet. The ore contains a much as 0.68 percent U3O8. Carnotite, the principal uranium mineral, impregnates sandstone and replaces fossil carbonaceous material. The copper minerals occur similarly but also are found higher in the section. There is no constant ratio between the copper and uranium content of the deposits. Exposed consolidated sedimentary rocks range in age from Permian to Jurassic, and dip 1 degree - 2 degrees NW. (Auth)

<85>

Robeck, R.C.; USGS, Denver, CO

Uranium Deposits of Temple Mountain. In Guidebook of the Fifth Annual Field Conference of the International Association of Petroleum Geologists. Geology of Portions of the High Plateaus and Adjacent Canyon Lands, Central and South-Central Utah. Salt Lake City, (pp. 110-111). (1954)

The uranium deposits at Temple Mountain, Utah, are in the so-called Mossback sandstone unit of the Chinle formation of Triassic age. The area is on the southeast flank of the San Rafael Swell. The uranium is associated with wood fragments and petroleum residue (asphalt) in the lower part of a 100-foot thick cliff-forming sandstone bed. (Auth)

<86>

Schlottman, J.D., and L.E. Smith; AEC, Denver, CO

Preliminary Report on Uranium Mineralization in the Troublesome Formation, Middle Park, Grand County, Colorado. RME-1042. 14 pp. (1954)

Uranium has been found in the Troublesome formation in Middle Park, Colorado. The Park is a basin between the Front and Park Ranges in which pre-Cambrian, Permo-Pennsylvanian, Jurassic, Cretaceous and Tertiary rocks have been uplifted, folded and faulted. Uranium occurs in sandstones, clays and conglomerates of the lower 160 feet of the Troublesome formation of Tertiary age, and throughout an area extending 10 miles east-west and four miles north-south. The individual deposits vary from one to four feet in thickness and from 10 to 20 feet in length; they are about half as wide as they are long. Carnotite, autunite, and schroeckingerite are found with brown and green vanadium minerals and carbonaceous detritus. Although these deposits are small and of low grade, it is probable that they will yield some uranium ore. Further geologic study and exploration are needed to completely evaluate them. (Auth)

<87>

Sharp, W.N., E.J. McKay, and F.A. McKeown; USGS, Washington, DC

Powder River Basin, Wyoming. TEI-490. (pp. 117-119); In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, June 1 to November 30, 1954. (pp. 117-119). (1954)

The uranium deposits in the Pumpkin Buttes area of the Powder River Basin are associated with a zone of interbedded, dominantly red sandstone lenses and claystone strata near the middle of the Wasatch formation of Eocene age. The red color boundary locally transects primary sedimentary features. Iron-manganese-uranium concretions are scattered erratically in the red sandstone at most places, although in some places they are associated with primary sedimentary features. Disseminated uranium ore with some iron and manganese and concentrations of carbonate is associated with a sharp color change from primarily buff and gray to red sandstone. (Auth)

<88>

Sharp, W.N., F.A. McKeown, E.J. McKay, and A.M. White; USGS, Washington, DC

Geology and Uranium Deposits of the Pumpkin Buttes Area, Powder River Basin, Wyoming. In USGS Professional Paper 300, (pp. 371-374), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland. August 8-20. 1955. United Nations. New York. (pp. 403-406). 825 pp. (1956)

The Pumpkin Buttes are located in the Powder River Basin, an asymmetrical syncline which trends north-northwest. The Wasatch formation of Eocene age crops out over most of the basin. Older rocks are exposed along the perimeter of the basin, and remnants of the White River formation of Oligocene age cap the Pumpkin Buttes. The regional dip in the Pumpkin Buttes area ranges from 30 to 100 feet per mile to the northwest. The uranium deposits in the Pumpkin Buttes area are spatially related to a zone of predominantly red sandstone within the normally buff or gray Wasatch formation. The contacts between red and buff or gray parts transect all sedimentary structures and lithology within a sandstone unit. Tyuyamunite and carnotite are disseminated in buff or gray sandstone near and at the contact with red sandstone. Calcite is abundant at the contact. Uranophane occurs chiefly in the cores of, and peripheral to, manganese-iron oxide concretions; these deposits are small but high grade. It is suggested that the deposits of oxidized uranium minerals were derived from initial deposits which were formed under reducing and mildly alkaline conditions. The source of the uranium may be some of the components of the sandstone. (Auth)

<89>

Shawe, D.R.; USGS, Washington, DC

Significance of Roll Ore Bodies in Genesis of Uranium-Vanadium Deposits on the Colorado Plateau. In USGS Professional Paper 300. (pp. 239-241). 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy. Vol. 6. Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations. New York. (pp. 335-337). 825 pp. (1956)

Roll ore bodies are generally layered deposits that crosscut sandstone bedding in sharply curving forms. They are found principally in sandstone lenses and layers, usually in the upper part of the Salt Wash sandstone member of the Morrison formation of Jurassic age; they are less common than tabular deposits both in this member and in other ore-bearing units of the Colorado Plateau. Roll ore deposits are found principally near the base of thick sandstone units where numerous thin well-defined mudstone layers are interbedded with thin sandstone layers. In places, rolls, which commonly terminate against an upper and lower mudstone layer, are split into two distinct rolls by the development along their axes of a third thin mudstone layer. The long ores of rolls may be continuous for many hundreds of feet in the plane of thin sandstone layers. In many places rolls have continuity with tabular ore bodies which are essentially parallel to bedding planes. It is possible that roll ore bodies were formed by precipitation of minerals at an interface between solutions of different composition and density, and that flow of the ore-bearing or active solution as it passed through connate waters in the sediments was influenced strongly by local sedimentary features. Many similarities between roll ore bodies and the more common tabular ore bodies in sedimentary rocks on the Colorado Plateau suggest a common origin for the two types. Thus, analysis and interpretation of details of roll ore bodies may clarify genesis of the uranium-vanadium ore deposits on the Colorado Plateau. (Auth)

<90>

Smith, J.F., Jr., E.N. Hinrichs, and R.G. Luedke; USGS, Washington, DC

Progress Report on Geological Studies in the Capitol Reef Area, Wayne County, Utah. TEI-203, 29 pp. (1952)

Small uranium deposits occur predominantly in a thin clay bed at the base of the Shinarump conglomerate of Triassic age in the Capitol Reef area. Zippeite and metatorbernite are the uranium minerals present and are associated with copper minerals, carbonaceous material, a thick bleached zone at the top of the underlying Moenkopi formation, and channels or scours in the top of the Moenkopi. Consolidated sedimentary rocks in the Capitol Reef area range in age from Permian to Jurassic and have an aggregate thickness of over 3,000 feet. The stratigraphy is described in considerable detail. The area is on the northeast and east flank of a topographic and structural dome. (Auth)

<91>

Mirsky, A.; AEC, Grand Junction, CO

Preliminary Report on Uranium

Mineralization in the Dakota Sandstone, Zuni Uplift, New Mexico. RME-47, 21 pp. (1953)

Uranium deposits occur in sandstone and carbonaceous shale of the Dakota sandstone of Cretaceous age along the north and northeast flank of the Zuni uplift. The Dakota sandstone regionally truncates older rocks. The sandstone units are buff to gray, fine- to medium-grained, cross-bedded, plane-bedded, or massive, and are interbedded with blue or gray mudstone and carbonaceous shale. Most beds are lenticular, and the formation is about 50 feet thick. The uranium mineral, metatyuyamunite, is closely associated with carbonaceous material and iron oxides. The deposits are in or marginal to paleostream channels. Joints may partially control the location of the deposits. Except for one deposit in carbonaceous shale, all are in sandstone. (Auth)

<92>

Mitcham, T.W., and C.G. Evensen; AEC, Grand Junction, CO

Uranium Ore Guides, Monument Valley District, Arizona. Economic Geology. 50(2), 170-176. (1955)

The contact between the Shinarump conglomerate and the Moenkopi formation, both of Triassic age, is a marked erosional unconformity. Basal Shinarump sediments fill ancient stream channels incised into the underlying Moenkopi. Uranium ore deposits are commonly found in these stream channels. Paleostream channels are the prime guide to ore in the Shinarump. Twenty-seven others of varying degrees of usefulness are summarized. (Auth)

<93>

Moore, G.W., and M. Levish; USGS, Washington, DC

Uranium-Bearing Sandstone in the White River Badlands, Pennington County, South Dakota. USGS Circular 359, 7 pp. (1955)

Uranocircite is locally disseminated in the lower two feet of a channel sandstone in the Chadron fromation of Oligocene age in the White River Badlands. The sandstone is yellowish-gray and coarse-grained; it is directly underlain by an impermeable bed of bentonitic claystone. Metatyuyamunite was found at one place in a bed of freshwater limestone in the Chadron formation. At several localities, carnotite forms very thin coatings on the outer surfaces of chalcedony veins in the overlying Brule formation, also of Oligocene age. The uranium was probably leached form the overlying volcanic ash beds by descending meteoric waters and carried by these waters to an environment favorable for deposition. (Auth)

<94>

Muilenburg, G.A., and W.D. Keller; Missouri Geological Survey and Water Resources, Jefferson City, MO

Carnotite and Radioactive Shale in Missouri. American Mineralogist, 35(3-4), 323-324. (1950)

Carnotite and possibly other radioactive minerals have been found in a quarry in the Spergen limestone of Mississippian age about five miles north of Ste. Genevieve, Ste. Genevieve County, Missouri. The carnotite forms a thin film along a joint in the limestone. A thin parting of highly radioactive black shale overlies the occurrence; the carnotite is thought to have been derived from this shale parting. (Auth)

<95>

Mullens, T.E., and V.L. Freeman; USGS, Denver, CO

Lithofacies Study of the Salt Wash Sandstone Member of the Morrison Formation. Geological Society of America Bulletin, 63(12), 1340. (1952)

The Salt Wash sandstone, the lower member of the Upper Jurassic Morrison formation in a large part of the Colorado Plateau, is the product of an aggrading fluvial system and consists of lenticular beds of light-colored cross-laminated sandstone and conglomeratic sandstone irregularly interbedded with mudstone, claystone, and horizontally laminated sandstone. The fluvial deposits are divided into stream and flood-plain deposits; the stream deposits include all sediments interpreted as deposited from moving water, the flood-plain deposits include all deposits interpreted as deposited from slack water. Areal variations in the Salt Wash lithofacies are shown by isopach and isolith maps. Interpretations of the areal variations in Salt Wash lithofacies indicate piedmont-type deposition by a distributary drainage system from one principal source area. The distributary drainage radiated outward from south-central Utah and spread sediments to the north and east in a fan-shaped pattern. The total thickness of the deposits and relative proportion of stream deposits decrease rather uniformly away from the apex of the fan. In the Four-Corners area, wwhere the Salt Wash member interfingers with the Bluff sandstone member of the Morrison, the development of the fan shape was interrupted as the distributary streams encroached on the sand dunes of the Bluff sandstone member. (Auth)

<96>

Phoenix, D.A.; USGS, Washington, DC

Relation of Carnotite Deposits of Permeable Rocks in the Morrison Formation, Mesa County, Colorado. In USGS Professional Paper 300, (pp. 213-219). 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 321-325). 825 pp. (1956)

The uppermost, almost continuous, layer of sandstone in the Salt Wash member of the Morrison formation of Jurassic age contains most of the carnotite deposits in southwestern Colorado and southeastern Utah. This layer is composed of broadly lenticular strata of sandstone separated by fine-grained laminated sediments collectively called mudstone. The prevailing trend of sedimentary structures is unique to each stratum. This suggests that each stratum was deposited within the channel margins of a shallow aggrading stream while that stream was essentially fixed in position. Carnotite deposits are localized in a mudstone and lenticular sandstone facies. The permeability of sediments in the uppermost layer is influenced by both lithologic character at the time of deposition and the effects of diagenesis, but in general the sediments expected to be most permeable originally are still the most permeable. Laminated mudstone and siltstone are the least permeable and bedded sandstone is the most permeable, except locally where the original porosity has been reduced by interstitial clay, quartz overgrowths, and calcite and iron oxide cement. The sedimentary rocks are less permeable normal to bedding than parallel to bedding. In the plane of bedding, they are slightly more permeable parallel to the trend of linear aggregates of sand grains than normal to these aggregates. Light-colored unoxidized sandstone is also somewhat more permeable than dark unoxidized sandstone and is also somewhat more permeable than dark-colored oxidized sandstone of similar appearance. Coefficients of transmissivity (the product of the total thickness and average coefficient of permeability per unit thickness) determined on samples from drill holes in an area of 4 1 2 square miles, which includes the area of Calamity claim group and the Outlaw Mesa area in Mesa County, Colorado, show that carnotite deposits are localized where the rocks in the uppermost layer are most transmissive; they are uncommon where rocks in the uppermost layer are least transmissive. (Auth)

<97>

Chester, J.W.; AEC, Grand Junction, CO

Geology and Mineralization of Hunts Mesa, Monument Valley, Arizona. RMO-801, 9 pp. (1951)

Copper-uranium ore deposits on Hunts Mesa occur in the Shinarump conglomerate of Triassic age in channels cut into the underlying Moenkopi formation. Secondary copper and uranium minerals are found in each of the two exposed channels. Even though the Shinarump conglomerate forms the cap of the mesa, the outcrops of the channels are poorly exposed. (Auth)

<98>

Stugard, F., Jr.; USGS, Washington, DC

Two Uranium Deposits in Sandstone, Washington and Kane Counties, Utah. Geological Society of America Bulletin, 63(12), 1373. (1952)

Carnotite and vanadium, copper, and silver minerals occur as small lenticular deposits in sandstone of the Chinle formation of Triassic age at Silver Reef, Washington County, Utah. A nearby mass of traclyte porphyry is thought to be the source of the metal-bearing hydrothermal solutions that formed the deposits. At the Bulloch properties in Kane County, disseminated autunite constitutes a blanket deposit in Jurassic sandstone just below the unconformity between the Jurassic and Cretaceous Systems. The source of the uranium is not known. (Auth)

<99>

Towk, C.C., and I. Rapaport; AEC, Denver, CO

Uranium Deposits of the Grants District, New Mexico. Mining Engineering, 4(11), 1037-1040; Economic Geology, 47(1), 128. (1952)

Uranium mineralization along the north flank of the Zuni Uplift in northwest New Mexico was discovered in 1950. Irregular, blanket-type uranium deposits are in terrestrial Jurassic sediments. The principal ore-horizon is the upper recrystallized portion of the Todilto limestone. This limestone erodes as benches one-half to three miles wide, enabling relatively cheap exploration and open-pit mining. Ore deposits have also been discovered in the sand lenses of the Morrison formation, 500 to 800 feet stratigraphically above the Todilto. The Morrison erodes into steep cliffs, necessitating more expensive exploration and mining methods. The uranium minerals in the Todilto are carnotite, tyuyamunite, and uranophane; finely disseminated pitchblende is found where the deposits are removed from the effects of superficial oxidation. Gangue minerals are pyrite, hematite, calcite, and traces of barite and fluorite. The sandstone ores in the Morrison contain carnotite and schroeckingerite, associated with limonite and organic material. The ore deposits are believed to have achieved their present form by the lateral percolation of slightly heated Tertiary waters. Uranium, however, may have originally been contributed during the Jurassic. (Auth)

<100>

Troyer, M.L., E.J. McKay, P.E. Soister, and S.R. Wallace; USGS, Washington, DC

Summary of Investigations of Uranium Deposits in the Pumpkin Buttes Area, Johnson and Campbell Counties, Wyoming. USGS Circular 338, 17 pp (1954

Uranium occurrences in the Pumpkin Buttes area are predominantly in sandstones of the Wasatch formation of Eocene age. The Pumpkin Buttes area lies in the topographic and structural Powder River Basin. The Wasatch formation is here about 1500 feet thick, and is underlain by the Fort Union formation of Paleocene age and overlain by the White River formation of Oligocene age. Except for the thin capping of White River rocks on the high buttes, the rocks exposed in the area are of the Wasatch formation. The uranium occurrences are in gray- to buff-colored sandstones that are closely associated with a red sandstone zone 450 to 900 feet above the base of the Wasatch formation. The sandstone in this zone is typically massive and cross-bedded, medium- to coarse-grained, feldspathic, and friable to moderately well cemented; a few beds are tuffaceous. The uranium occurrences are of two principal types: concretionary and disseminated. The concretionary deposits are small irregular masses in which the principal uranium mineral is uranophane. These also contain vanadium minerals and a large amount of iron and manganese oxides. The uranium content is locally as high as 15 percent. The deposits are as much as 10 feet in maximum dimension, but are usually smaller, and may occur in clusters. The disseminated deposits occur as irregular zones in which metatyuyamunite irregularly impregnates the sandstone; little or no iron and manganese oxides are visible. In general, the sandstone in the concretionary deposits is cleaner than that in the disseminated deposits. Two geologic maps of the area are included in the report. One shows the locations of uranium occurrences and radioactivity anomalies; the other shows the distribution of favorable sandstones in the east central part of the area. (Auth)

<101>

Tschanz, C.M.; USGS, Washington, DC

Guadalupita, New Mexico. In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, December 1, 1953 to May 31, (pp. 72-73); TEI-440, (pp. 72-73). (1954)

The copper-uranium deposits in the Guadalupita area are in the steeply dipping Sangre de Cristo formation of Pennsylvanian and Permian age in a sandstone member near the middle of the formation. The deposits are localized by sedimentary structures in stream-laid sandstone beds that overlie the members that contain most of the larger copper deposits. Particularly favorable for uranium deposits are those parts characterized by local cut-and-fill structures, carbonized plant remains, chalcopyrite, gray or black clay galls, visible copper or vanadium minerals, and distinctive pink sandstone. Most of the uranium in sandstone is in a black ferric oxide, but metatyuyamunite is locally abundant. (Auth)

Earlier progress was reported in TEI-390, Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, June 1 to November 30, 1953, (pp. 81-90).

<102>

Vickers, R.C.; USGS, Washington, DC

Belle Fourche Area, Northern Black Hills, South Dakota. In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, June 1 to November 30, 1954, (pp. 209-210); TEI-490, (pp. 209-210). (1954)

The uranium deposits in the Belle Fourche area are near the horizontal change in color from pink or red sandstone to gray or buff sandstone within the lower unit of the Fall River formation of Cretaceous age. In detail the pink to buff contact cuts across the minor structures but in general parallels the regional strike of the beds. The deposits also seem to be related to local structural features such as flattening or reversal of the dip. (Auth)

<103>

Vine, J.D., and G.E. Prichard; USGS, Washington, DC

Uranium in the Poison Basin Area, Carbon County, Wyoming. USGS Circular 344, 8 pp. (1954)

Uranium deposits occur in sandstone in the Browns Park formation of Miocene age in the Poison Buttes area west of Baggs, Wyoming. The Browns Park formation overlies the slightly tilted Wasatch and Green River formations of Eocene age. The unit in which the deposits lie is a soft, light-colored, cross-bedded quartzose fine- to medium-grained sandstone that contains minor amounts of tuffaceous material. The uranium minerals, mostly uranophane and schroeckingerite, are associated with brown, green, gray, or yellow sandstone. The uranium minerals coat fractures and are disseminated in the sandstone. They were probably deposited at their present site by ground water solutions of unknown origin. The Browns Park formation in this area contains an unusually large amount of selenium. (Auth)

<104>

Walker, G.W.; California Division of Mines and Geology, San Francisco, CA

Rosamond Uranium Prospect, Kern County, California. California Division of Mines and Geology Special Report 37, 8 pp. (1953)

Small quantities of autunite and another radioactive mineral occur in tuffaceous sedimentary rocks of the Rosamond formation of Miocene age at the Rosamond prospect, about 10 miles south of Mojave, Kern County, California. The autunite occurs principally as coatings on fracture and joint surfaces and, to a lesser extent, as disseminations in the tuffaceous rocks adjacent to faults. A waxy, reddish-brown to black radioactive material is found in small quantities on slickensided fault surfaces associated with iron oxides and chlorite. (Auth)

<105>

Weeks, A.D.; USGS, Washington, DC

Red and Gray Clay Underlying Ore-Bearing Sandstone of the Morrison Formation in Western Colorado. TEM-251, 19 pp. (1951)

As a result of a preliminary study of the clays that underlie the ore-bearing sandstone of the Morrison formation of Jurassic age, the chief clay mineral has been tentatively identified as hydrous mica. Chemical analyses show that the red clay contains more total iron than the gray clay, and that more of the iron in the gray clay is in the ferrous state. Spectrographic analyses of minor constituents show no significant difference between the red and gray clay except in iron content. Quartz and carbonate have a wide range in quantity that is not related to the color of the clay. Insufficient evidence is available to indicate whether the gray color was produced by alteration of the red clay. (Auth)

<106>

Weeks, A.D.; USGS, Washington, DC

Mineralogic Study of Some Jurassic and Cretaceous Claystones and Siltstones from Western Colorado and Eastern Utah. TEI-285, 22 pp. (1953)

The clay minerals and water-soluble minerals identified in 50 samples of siltstone and claystone from Jurassic and Cretaceous formations suggest some distinctive characteristics for these formations and some differences in source area or environment of deposition. Hydromica predominates in the samples of Summerville, Salt Wash member of the Morrison, and Burro Canyon formations, whereas montmorillonite derived from volcanic ash is found in the Brushy Basin member of the Morrison formation. Kaolinite in the Dakota sandstone is probably related to the regional unconformity at the base of the Dakota. Size analyses show that most of the samples are siltstones. (Auth)

<107>

Weeks, A.D., M.E. Thompson, and R.B. Thompson; USGS, Washington, DC

Mineral Associations and Types of Uranium Ores on the Colorado Plateaus. Geological Society of America Bulletin, 64(12), 1489-1490. (1953)

Uranium ores from the Colorado Plateau are classified in two main types: (1) uranium with vanadium, (2) uranium with copper and or other metals. Each type is subdivided into highly oxidized and relatively unoxidized ore. The vanadium-uranium ratio of the vanadiferous ores ranges from about 30:1 at Placerville and Rifle, Colorado, to about 1:1 at Temple Mountain, San Rafael district, Utah. The chief uranium minerals of the highly oxidized ore are the uranyl vanadates: carnotite, tyuyamunite, and metatyuyamunite. The unoxidized vanadiferous ores are black and contain a new black uranium mineral, pitchblende, montroseite, and at least two other low-valence vanadium oxides. They are associated with base-metal sulfides. The oxidized nonvanadiferous ore is characterized by yellow, orange, or green uranium minerals and blue or green copper minerals. The unoxidized nonvanadiferous ore is also black and contains pitchblende, and new uranium mineral mentioned above, and base-metal sulfides. (Auth)

<108>

Cornwall, H.R.; University of Nevada, Mackay School of Mines, Reno, NV

Geology and Mineral Deposits of Southern Nye County, Nevada. Nevada Bureau of Mines and Geology Bulletin 77, 49 pp. (1972)

Southern Nye County, along the southwestern boundary of Nevada, is underlain by a wide variety of rocks that range in age from Precambrian to Quaternary. Older Precambrian rocks, consist of gneissic granite and quartz monzonite and quartzbiotite schist. Younger Precambrian rocks, are composed of quartzite, siltstone, micaceous shale or schist, and lesser amounts of marble, dolomite, and limestone. Paleozoic rocks have a distribution similar to that of the younger Precambrian rocks and range in age from Early Cambrian to Pennsylvanian. Limestone and dolomite predominate in most of the Paleozoic section, but sandstone, siltstone, shale, and argillite are abundant in the Lower and Middle Cambrian and Mississippian units. Mesozoic intrusions of granodiorite and quartz monzonite crop out in two areas near the north end of Yucca Flat. Mesozoic or Tertiary megabreccias composed of limestone and dolomite of Cambrian Age occur in several areas in the southern and western parts of the county. Tertiary volcanic and associated tuffaceous clastic rocks cover a large part of the central and northern portions of southern Nye County. A conglomeratic unit commonly lies at the base of this section and unconformably overlies older rocks. Pyroclastic tuffs and welded tuffs (ash flows) ranging in composition from dacitic to quartz-latitic and rhyolitic are most abundant. The intermontane basins in the county are covered by Tertiary and Quaternary alluvial fans and playa lake deposits. Quaternary basalt flows and cinder cones, some very young, are present in several lowland areas scattered around the county. Several patterns of structural deformation are recognized in the county. The Precambrian and Paleozoic rocks have been moderately to intensely deformed by folding, thrust and related tear faulting, and strike-slip faulting, mainly in Cretaceous time. The development of the 9 or 10 calderas or grabens with associated domes, elevated blocks, and normal faults resulted from volcano-tectonic activity in the Miocene and Pliocene. Basin-range faults ranging in age from Miocene to Holocene are present throughout most of the county. Twenty-three mining districts are scattered throughout the county. (Auth)(MBW)

<109>

Stewart, J.H., and G.A. Williams; USGS, Washington, DC

Stratigraphic Relations of the Triassic Shinarump Conglomerate and a Prominent Sandstone Unit of the Chinle Formation in Southeastern Utah.
Geological Society of America Bulletin, 65(12), 1387. (1954)

Recent field work in southern Utah indicates that the Shinarump conglomerate is not so extensive as was formerly thought, and that rocks called Shinarump conglomerate in east-central and central Utah are actually a separate unit. Field relations indicate that the Shinarump conglomerate extends from the type section in northwestern Arizona to a northwest-trending line passing about 10 miles north of White Canyon, in southeastern Utah, where it pinches out. The Shinarump conglomerate is generally less than 100 feet thick and consists of light-colored coarse- to very coarse-grained cross-stratified conglomeratic sandstone. A prominent sandstone in the Chinle formation lying 200 feet above the top of the Shinarump conglomerate in White Canyon correlates with the unit called Shinarump in central and east-central Utah. The prominent sandstone averages about 50 feet in thickness and is composed of light-colored fine- to medium-grained cross-stratified conglomeratic sandstone. Northward from White Canyon this sandstone overlaps the underlying part of the Chinle. The known distribution of this sandstone indicates that it was deposited as a mass about 60 miles wide and 150 miles long extending northwestward from southwestern Colorado to central Utah. The Shinarump conglomerate and the prominent sandstone are both interpreted to be stream deposits formed by northwest-flowing streams. (Auth)

<110>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Morrison Formation and Related Deposits in and Adjacent to the Colorado Plateau. Geological Society of America Bulletin, 55(8), 951-992. (1944)

The Morrison formation in and adjacent to the Colorado Plateau is discussed. The Salt Wash, Brushy Basin, Recapture Creek, and Westwater Canyon members are considered equivalent to the type Morrison and are almost certainly of Jurassic age. The San Rafael group of Jurassic age and beds tentatively classed as Lower Cretaceous are also considered. Lithology, distribution, and paleogeography of all units are discussed, and changes in nomenclature and correlation are recommended. (Auth)

<111>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Geology of the Utah-Colorado Salt Dome Region with Emphasis on Gypsum Valley, Colorado. Utah Geological Society Guidebook 3, 50 pp. (1948)

The geology and origin of salt anticlines and related structures in the Paradox Salt Basin in Utah and Colorado, are discussed. Sedimentary rocks ranging in age from Pennsylvanian to Recent are exposed in the area, and Precambrian rocks are exposed to the northwest in the Uncompahgre Plateau. The evaporite deposits of the Paradox formation of Pennsylvanian age are overlain by nearly 6,000 feet of younger rocks. The major structural trend, northwest-southeast, was established prior to the deposition of the Pennsylvania evaporites. Intrusion and solution of the salt has produced long, narrow, collapsed anticlines. Salt flowage has been continuous or sporadic since Permian time. (Auth)

<112>

Stokes, W.L.; USGS, Washington, DC

Carnotite Deposits in the Carrizo Mountains Area, Navajo Indian Reservation, Apache County, Arizona, and San Juan County, New Mexico.
USGS Circular 111, 5 pp. (1951)

Carnotite deposits occur in the Salt Wash member of the Morrison formation of Jurassic age in the area surrounding the Carrizo Mountains in northeastern Arizona and northwestern New Mexico. Tertiary intrusive igneous rocks form the core of the mountain mass, and Mesozoic sedimentary rocks surround the mountains. The Salt Wash member in this area is a light-colored fine-grained cross-bedded lenticular sandstone interbedded with shale and is from 60 to 200 feet thick. Carnotite may occur at any stratigraphic level within it. The ore bodies are irregular tabular masses up to 15 feet thick and a few hundred feet wide, and are nearly parallel to the major bedding of the sandstone. The ore bodies are generally clustered in ill-defined areas a few thousand feet across. The origin of the deposits is not clearly understood, but they are thought to have been formed from ground water solutions shortly after the sands accumulated. (Auth)

<113>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Sedimentary Patterns and Uranium Mineralization in the Morrison Formation of the Colorado Plateau. Geological Society of America Bulletin, 64(12), 1516. (1953)

In spite of concentrated study, the problem of the genesis of the uranium deposits of the Salt Wash sandstone member of the Morrison formation remains unsettled. It is generally believed that the Salt Wash is a fluvial deposit made up of coarser fractions deposited in the channels and finer fractions deposited on the flood plains. The ore deposits occur in the sandstone lenses usually in association with fossil vegetation. Most ore bodies contain elongate masses of higher-grade material which are called "rolls"; fossil logs, when present, lie parallel with the associated rolls. The current directions which prevailed during the deposition of the sandstones can be determined through mapping of cross-lamination and other primary features. Detailed study of the ore bodies made in certain districts show that the rolls lie mostly parallel with the direction of flow of the depositing streams as revealed by cross-lamination. This is thought to mean that the subsurface solutions which brought together the various constituents of the ore traveled through the sand lenses in essentially the same patterns and directions as the original surface streams. Other problems such as the ultimate source of the constituents of the ore and the time of mineralization may also be solved by aid of sedimentary studies. (Auth)

<114>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Relation of Sedimentary Trends, Tectonic Features, and Ore Deposits in the Blanding District, San Juan County, Utah. RME-3093 (Part 1). 40 pp. (1954)

Field studies of the Salt Wash member of the Morrison formation in the Blanding district indicate a relation between tectonic features, river courses, the accumulations of fossil vegetation, and the formation of ore bodies. It is thought that the Monument upwarp exerted some influence on stream directions in Salt Wash time, and that carbonaceous material, which localized the uranium deposits, was preferentially deposited at the bends of streams. (Auth)

<115>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Some Stratigraphic, Sedimentary, and Structural Relations of Uranium Deposits in the Salt Wash Sandstone, Final Report - April 1, 1952 to June 30, 1954. RME-3102. 50 pp. (1954)

Investigations of the Salt Wash member of the Morrison formation of Jurassic age in Arizona and Utah included the following general problems: nature and origin of primary structures and their use in tracing zones that are favorable or unfavorable to mineralization; relation of sedimentary properties of Salt Wash sandstones to primary structures and ore formation; occurrence and meaning of the repetition of rock types in the Salt Wash; relation of fossil plants or other organic material to sedimentary patterns and ore; and relation of sedimentary patterns to mineralized areas and to ancient structural features. Environments favorable for the deposition of uranium minerals probably were created by buried organic matter. Growth and burial of plants in Salt Wash time was not uniform but was concentrated along old river bends which are now shown by curving patterns of sediments. The areas of pronounced bends and greater than average amounts of organic matter are thought to occur in places where normal directions of flow were changed or where deflections of current took place due to tectonic features. Such areas can be located and followed by observation and analysis of primary structures and other sedimentary properties. (Auth)

<116>

Stokes, W.L., and W. Sadlick; University of Utah, Salt Lake City, UT

Sedimentary Properties of Salt Wash Sandstones as Related to Primary Structures, Part II, Technical Report for April 1, 1952 to March 31, 1953.
RME-3067, 26 pp. (1953)

Field and laboratory studies of primary sedimentary structures of the Salt Wash member of the Morrison formation of Jurassic age in the Carrizo Mountains of Arizona indicate that uranium deposits are more likely to be found between the flood plain and the more central parts of the channel sands because this environment was most favorable to plant growth and burial which in turn was favorable to ore deposition. This zone can be identified with the aid of primary structures and by sedimentary analysis. (Auth)

<117>

Strobell, J.D., Jr.; USGS, Denver, CO

Stratigraphic Relations in the Carrizo Mountains Area, Northeastern Arizona and Northwestern New Mexico.
Geological Society of America Bulletin, 65(12), 1310-1311. (1954)

Formations exposed in the Carrizo Mountains area range in age from Permian to Eocene. The De Chelly sandstone mmember of the Cutler formation (Permian) is underlain by Cutler red beds and unconformably overlain by Shinarump conglomerate (Late Triassic); the Moenkopi formation (Early and Middle Triassic) is absent. The Chinle formation (Late Triassic) is restricted to Gregory's lower three divisions; red siltstone is the lower member of a twofold Wingate sandstone. The Kayenta formation (Jurassic) and Navajo sandstone (Jurassic) thin southward and disappear within the Carrizo Mountains area. The San Rafael Group (Middle and Late Jurassic) comprises five formations: Carmel formation, Entrada sandstone, Todilto limestone, Summerville formation, and Bluff sandstone. Carmel is present only in the western half of the area, an Todilto only along the eastern edge. Where Carmel pinches out, Entrada rests unconformably without detected angularity upon Wingate. The Morrison formation (Late Jurassic) comprises four members - Salt Wash, Recapture, Westwater Canyon, and Brushy Basin. Possible equivalents of the Burro Canyon formation (Early Cretaceous) are not differentiated from the Morrison. Dakota sandstone (Late Cretaceous) unconformably overlies the Morrison and is conformably succeeded by marine Mancos shale. Nondeposition of Moenkopi, convergence of Kayenta, Navajo, Carmel, and Todilto, and thinning and lithologic change in other formations suggest intermittent uplift during Mesozoic time. These rocks were folded, truncated, and subsequently covered by Chuska sandstone (Eocene). (Auth)(MBW)

<118>

Peirce, H.W., S.B. Keith, and J.C. Wilt; University of Arizona, Tucson, AZ; Arizona Bureau of Mines, Tucson, AZ

Coal, Oil, Natural Gas, Helium, and Uranium in Arizona. Arizona Bureau of Mines Bulletin 182, 289 pp. (1970)

Data were assembled to assist in developing a fundamental understanding and geological perspective to the occurrence of coal, petroleum, natural gas, helium, and uranium in Arizona. Formations, geochemistry, and locational data are included. A unified bibliography involving each of these commodities is presented at the end of the report. Numerous tables and illustrations which concisely summarize significant data are included within each section, in the appendix and as accessory plates. (PAG)

<119>

Dahl, A.R., and J.L. Hagmaier; Exxon Company, Casper, WY; Exxon Company, Denver, CO

Genesis and Characteristics of the Southern Powder River Basin Uranium Deposits, Wyoming, USA.
IAEA-SM-183/5, (pp. 201-218). (1974)

Uranium deposits in the southern Powder River Basin of Wyoming are excellent examples of large roll-type ore bodies. The host rocks are Paleocene sandstones deposited as point bars by a meandering stream. The source of uranium is tuffaceous and arkosic debris indigenous to the sedimentary sequence containing the host rocks. The largest deposits of highest grade occur near the distal margins of permeable, slightly dipping sandstones where they grade laterally into organic-rich siltstones, claystones and lignites deposited in backswamp or flood basin environments. The deposits are epigenetic in origin, formed by precipitation of uranium from groundwater solutions that moved through the host rocks from a recharge area southwest of the deposits towards a discharge area northeast of the deposits. The deposits are large because the host rocks are extensive and the groundwater system remained relatively stable. Pyrite formed early in and around the host units through a biogenic process utilizing sulphate-reducing bacteria. This was important in establishing a permissive geochemical environment for later ore genesis. Oxidation of pyrite by incursing groundwater caused sulphite to form. Sulphite disproportionation into SO4(2 minus) and HS(minus) developed the final reducing mechanism for uranium precipitation in the ore rolls. Deposit characteristics and associated alteration products are compatible with the chemical theory of Granger and Warren. (Auth)

<120>

Rackley, R.I.; Consulting Geologist, Casper, WY

Environment of Wyoming Tertiary Uranium Deposits. American Association of Petroleum Geologists Bulletin, 56(4), 755-774. (1972, April)

Four major uranium districts in Tertiary rocks of central Wyoming are in fluvial sandstones derived from the granitic rock of the ancestral Sweetwater arch and deposited in adjacent intermontane basins. Sediment transported southward into the Great Divide basin was deposited on an apron of alluvial fans. Sedimentation in the Gas Hills area of the Wind River basin was on an alluvial fan in which ridges of older rock disrupted the normal development of the fan. Sediment in west Shirley basin was deposited on an alluvial fan, but in east Shirley basin and in the Powder River basin sedimentation was channel and flood-basin deposits of a meandering stream. The sandstones are subarkosic to arkosic, medium grained to conglomeratic, angular and poorly sorted. Sandstones intertongue with green or carbonaceous shales. Sedimentation was in a warm, humid climate with abundant vegetation. Decay of the organic material created reducing conditions in the sediment which caused partial carbonization of some of the plant debris, formation of pyrite, and precipitation of uranium minerals. Following burial, uplift-induced changes in the hydrodynamic system caused an invasion of the reduced sediment by oxygenated water far below the static water table. This caused destruction of carbonaceous material, oxidation of pyrite, and accumulation of uranium and other susceptible metals in a wave or front just ahead of the invading oxidizing environment. Oxygenated waters, aided by THIOBACILLUS FERROOXIDANS, oxidized pyrite to produce sulfuric acid and ferric sulfate, a strong oxidizer, which leached uranium and other susceptible elements. In the reducing part of the cell, anaerobic bacteria, including the sulfate reducer DESULFOVIBRIO, consumed the organic material in the sediments and the sulfates from the oxidizing area, to produce hydrogen, hydrogen sulfide, and a mildly alkaline, strongly reducing environment which precipitated pyrite, uranium, and other metals on the front. Migration of the cell was controlled by the permeability of the sandstone and by availability of carbon and pyrite. (Auth)(PAG)

<121>

Santos, E.S.; USGS, Washington, DC

Lithology and Uranium Potential of Jurassic Formations in the San Ysidro-Cuba and Majors Ranch Areas, Northwestern New Mexico. USGS Bulletin 1329, 22 pp. (1975)

The aggregate thickness of sedimentary rocks of Jurassic age near the eastern and southeastern margin of the San Juan Basin in Sandoval County, New Mexico, is about 1,150 feet (350 meters). The Entrada Sandstone at the base is overlain successively by the Todilto, Summerville, and Morrison Formations. The Entrada Sandstone, 97-227 feet (30-69 m) thick, consists of a lower, silty member composed of red and brown siltstone and fine-grained sandstone, and an upper, sandy member composed of brown and white sandstone. The Todilto Formation, 5-125 feet (1.5-38 m) thick, consists of a lower, limestone unit about 5 feet (1.5 m) thick, and an upper, massive white gypsum unit. The Summerville Formation, 0-50 feet (0-15 m) thick, consists of variegated, interstratified mudstone, claystone, siltstone, and sandstone. The Morrison Formation, 750-870 feet (229-265 m) thick, is divided into three members; the Recapture Member at the base, 200-350 feet (61-107 m) thick, is overlain successively by the Westwater Canyon Member, 0-240 feet (0-73 m) thick, and the Brushy Basin Member, 200-350 feet (61-107 m) thick. The

Recapture Member consists mainly of red and white color-banded fine-grained sandstone. The Westwater Canyon and Brushy Basin Members consist mainly of red and green mudstone interstratified with grayish-orange arkosic sandstone. The upper unit of the Brushy Basin Member is called the Jackpile sandstone, a name of economic usage. It is 0-165 feet (0-50 m) thick and consists of white and grayish-orange fine-, medium-, and coarse-grained arkosic sandstone. A comparison of ore-bearing sandstone units in the Ambrosia Lake and Laguna mining districts with equivalent sandstone units in the area studied reveals many similarities, in color, texture, mineral composition, and minor-element distribution. Differences are minor and most of the sandstone in the Morrison Formation above the Recapture Member in the area studied is considered to be a potential host for uranium ore deposits. (Auth)

<122>

Stewart, J.H., G.A. Williams, H.F. Albee, O.B. Raup, and R.A. Cadigan: USGS, Washington, DC

Stratigraphy of Triassic and Associated Formations in Part of the Colorado Plateau Region. USGS Bulletin 1046-Q, (pp. 487-576). (1959)

Stratigraphic studies of the Triassic and associated formations were made in southeastern Utah and adjoining parts of Colorado and Arizona. Five principal lines of investigation were followed: regional stratigraphy, sedimentary petrology, pebble studies, sedimentary-structure studies, and lithofacies studies. The formations studied are the Cutler formation, Coconino sandstone, and Kaibab limestone of Permian age; and the Moenkopi formation, Chinle formation, and Wingate sandstone of Triassic age; and the Kayenta formation and the Navajo sandstone of Jurassic age. Most of the uranium deposits in the Triassic rocks are in the Shinarump, Monitor Butte, and Moss Back members of the Chinle formation, and in the base of undifferentiated Chinle. The deposits are generally near the base of the Chinle, regardless of which unit of the formation lies in that position. The deposits lie in broad northwestward-trending belts near the north limit of the respective units. Many determinations have been made of the types of clay minerals in the sandstones in the Triassic and associated formations. Evidence supports the hypothesis that much of the hydromica in the Chinle is the result of alteration of montmorillonite in the presence of soluble potassium salts. Thin-section studies of ore-bearing sandstone and barren sandstone in the Shinarump and Moss Back members of the Chinle formation suggest that uranium ore occurs predominantly in sandstone that contains 20 percent or more kaolin, and that strata containing 15 to 35 percent kaolin should be considered more favorable for the occurrence of uranium than strata containing less than 15 percent kaolin. (Auth)(PAG)

<123>

Adler, H.H.; AEC, Division of Raw Materials, Washington, DC

Interpretation of Color Relations in Sandstone as a Guide to Uranium Exploration and Ore Genesis. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 331-344), 386 pp.; IAEA-PL-391 13, (pp. 331-334), 386 pp. (1970, October)

Most of the uranium mined in the United States of America occurs in red or drab fluvial sandstone and is associated with a pyritiferous carbonaceous facies formed during and shortly after sandstone deposition. Many of the ore deposits, particularly the roll-type deposits, have formed by accretion of uranium along or near oxidized borders of the reduzate facies. The ore accumulated by recyclic oxidation-reduction and solution-deposition of uranium and other elements. The uranium deposits are closely related to hematite-red and limonite-drab coloring in the sandstone. The pigmentation, which is post-diagenetic and most likely related to geologically recent groundwater circulation in the sediments, results from the release of iron during oxidation of pyrite by oxygenated groundwater below the water-table. Limonite is formed initially but may subsequently dehydrate to hematite. Dehydration may be episodic since drab-red boundaries are usually sharp. The transformation is accelerated under warm climatic conditions and possibly conforms to periods during which groundwater temperatures were slightly elevated. Iron may also be taken up by montmorillonite or removed by circulating groundwaters resulting in a pale green or bleached color in the oxidized sandstone. The color of the sandstone can be used to determine the extent of the tongue of oxidative alteration and to define areas favorable for exploration. (Auth)

<124>

Rogers, J.J.W.; Rice University,
Department of Geology, Houston, TX

Geochemical Significance of the Source Rocks of Some Graywackes from Western Oregon and Washington. Texas Journal of Science, 18, 5-20. (1966)

Petrographic and radiometric studies of the eugeosynclinal graywackes of western Oregon and Washington indicate an almost complete absence of granitic, continental debris. The absence of a cratonic source is apparently typical of many other geosynclinal deposits, as demonstrated by their high Na/K ratio and their low content of potassium feldspar. The source rocks (basalts, quartz diorites, and some keratophyres) for the Oregon and Washington graywackes are identical to the rocks now exposed in the eastern portion of the orogenically active Greater Antilles island arc, where the igneous rocks have been derived with little or no differentiation from the upper mantle. The scarcity of continental granitic material in the volumetrically important graywackes of many areas renders mass balances between sediments and igneous source rocks inaccurate if the average composition of the igneous rocks is calculated by assuming a large proportion of granite. (Auth)

<125>

Rosholt, J.N., R.E. Zartman, and I.T. Nkemo; USGS, Denver, CO

Lead Isotope Systematics and Uranium Depletion in the Granite Mountains, Wyoming. Geological Society of America Bulletin, 84, 989-1002. (1973, March)

Isotopic composition and concentration of lead in whole rock and microcline and concentration of uranium and thorium in whole-rock samples of granite from the Granite Mountains, Wyoming, have been determined. The lead isotopic composition in the whole rocks was found to be highly radiogenic with a range in Pb 206/Pb 204 of 19.58 to 42.27; the corresponding range in microclines is 15.39 to 22.44. A Pb 206/Pb 204 versus Pb 207/Pb 204 plot of the whole-rock data yields an apparent isochron age of 2,790 plus or minus 80 million years as the time of crystallization of the granite. Chemically determined values of U 238/Pb 204 in the whole rocks lie between 3.3 and 18.4 and are too low to account for the amount of radiogenic lead observed. A material balance of lead, thorium, and uranium components indicates that an average of approximately 75 percent of the amount of uranium required to produce the radiogenic lead was removed from the rocks, whereas, on the average, there was no apparent loss of thorium. Loss of uranium from the granite is demonstrated to extend at least to a depth of 165 feet in a drill core. The average uranium loss from the samples analyzed represents about 20 g uranium per 1,000 kg of rock that apparently was removed during the Cenozoic and that probably constitutes the major source of uranium now in ore deposits in central Wyoming basins. The lead isotopic composition of the microclines indicates that lead was mobilized within the granite and was isolated in the feldspar during a thermal event about 1,640 plus or minus 120 million years ago. However, there is no evidence that the whole rocks themselves became open systems at that time. Whole-rock and microcline isochrons intersect at Pb 206/Pb 204 and Pb 207/Pb 204 of 13.77 and 14.86, respectively, indicating a characteristic U 238/Pb 204 of 8.96 in the source region of the granite magma. (Auth)

<126>

King, R.U., B.F. Leonard, F.B. Moore, and C.T. Pierson; USGS, Washington, DC

Uranium in the Metal-Mining Districts of Colorado. USGS Circular 215, 10 pp. (1953)

Many varieties of abnormally radioactive rocks and ores have been found in Colorado, but only a small proportion of these contain uranium in sufficient quantities to be of possible commercial interest. The most favorable ground in Colorado for uranium ore deposits, exclusive of the Colorado Plateaus, is the central mineral belt. Here potentially important uranium deposits also occur in metalliferous veins in pre-Cambrian igneous and metamorphic rocks, usually in association with Tertiary intrusive rocks. The deposits also occur in Paleozoic, Mesozoic, and Tertiary rocks that surround the pre-Cambrian core of the Rocky Mountains. Uranium deposits of eight types occur in Colorado: (1) disseminations in sedimentary rocks, (2) veins, (3) replacement deposits, (4) volcanic breccia pipes, (5) disseminations in igneous and metamorphic rocks, (6) pegmatites, (7) radioactive inclusions in rhyolite, and (8) hot-spring deposits in the Colorado Plateaus; vein deposits are the most important in the metal-mining districts. Pitchblende is the most common uranium mineral in the vein deposits. In Colorado pitchblende has been found in six kinds of veins: (1) pyritic gold, (2) lead-zinc-silver, (3) fluorite, (4) telluride, (5) pyrite-siderite, and (6) polymineralic-hydrocarbon veins. Detailed studies have shown that several geologic guides are useful in prospecting for new deposits. The include (1) stratigraphic position, (2) mineral associations, (3) sedimentary structure, (4) rock alteration, and (5) regional zoning. In addition the following relations may be useful: (1) uranium deposits are commonly associated with post-Cretaceous volcanism; (2) uranium is commonly found in metal-mining districts that have produced gold, silver, lead, and copper; (3) accumulations of radon and helium are theoretically related to deposits of uranium; (4) many uranium deposits are associated with bostonite dikes; (5) uranium deposits seem to occupy a definite place in some types of hypogene zonal patterns; and (6) the purple variety of fluorite and the smoky variety of quartz are believed to be related to radioactivity. (Auth)(MBW)

<127>

Ormond, A.; AEC, Division of Raw Materials, Denver Area Office, Casper, WY

Preliminary Report on the Geology of Uranium Deposits in the Browns Park Formation in Moffat County, Colorado, and Carbon County, Wyoming.
TID-26356, 30 pp.; TM-D-1-18, 30 pp. (1957, June)

Uranium was first discovered in the Browns Park Formation in 1951 in the Miller Hill area of south-central Wyoming. Since that time economically important deposits in this formation have been discovered and developed in the Poison Basin of south-central Wyoming and in the Maybell area of northwest Colorado. The Browns Park is the youngest formation (Miocene) in the region and overlies older rocks with angular unconformity. The formation consists of a basal conglomerate, fluviatile, lacustrine, and eolian sandstones and locally a few thin beds of clay, tuff, and algal limestone. The sandstones are predominantly fine- to medium-grained and consist of quartz grains, scattered black chert grains, and interstitial clay. The uranium deposits are of the sandstone-impregnation type and are not confined to specific stratigraphic horizons. The important ore minerals are autunite and uranophane in oxidized sandstones, and uraninite and coffinite in unoxidized sandstone. Uranium is often associated with limonite and calcium carbonate in concretionary forms. Woody material, thought to play an important part in the deposition of uranium in many sandstone-type deposits, is not present in the deposits of the Browns Park Formation. However, organic carbon in the form of petroleum and petroleum residues has been observed in association with uranium in both the Poison Basin and the Maybell areas. (Auth)

<128>

Branson, C.C., A.L. Burwell, and G.W. Chase; Oklahoma Geological Survey, Norman, OK

Uranium in Oklahoma, 1955. Oklahoma Geological Survey Mineral Report 27, 22 pp. (1955)

As of this date no radioactive deposit of proven commercial value has been found in the state. Nearly all worthwhile deposits have been found in areas of less than 20 inches of rainfall, but it is by no means proven that the ores are leached from all rocks in regions of greater rainfall. Uranium is held by carbon as shown by the fact that most commercial deposits are in coal or carbonaceous rocks. Uranium salts in solution occur in brines, none as yet shown to be profitable to process for extraction. Other ores have been found in volcanic bodies and pegmatites. These are to be sought along faults, dikes, sills, and in rocks affected by volcanism. The report discusses and summarizes the occurrence of uranium in sandstone lenses of southwestern Oklahoma, carbonized plant remains in northcentral Oklahoma, and copper deposits not associated with plant remains. Asphaltic deposits, asphaltic pellets, bleached areas in red rocks, phosphatic black shales, brines, and miscellaneous occurrences are also covered. (Auth)(MBW)

<129>

Pettijohn, F.J.; Johns Hopkins University, Baltimore, MD; USGS, Washington, DC

Chemical Composition of Sandstones - Excluding Carbonate and Volcanic Sands. In Fleischer, M. (Ed.), Data of

Geochemistry. United States Government Printing Office. Washington. DC. 21 pp.; USGS Professional Paper 440-S. 21 pp. (1963)

Sandstones range from virtually pure silica to complex chemical compositions; some, the graywackes, for example, are not greatly different from many igneous rocks in bulk composition. Forty-eight representative analyses of the principal classes of sandstone (orthoquartzites, subgraywackes, graywacke, and arkose) are tabulated. From about 150 published analyses an average of the major elements in each class and an arithmetic mean for sandstone as a whole have been calculated. The data on minor and trace elements have been summarized. An approximate average has been estimated for these elements. Sample inadequacies do not justify calculated averages or standard deviations. Data are given to show relation of chemical composition of sandstones to their grain size and mineral composition. In general, silica diminishes with decreasing grain size, whereas alumina, K2O, and water increase. The variation of other constituents is less dependent on size. The detrital components of sands range from nearly pure quartz to mixtures of quartz, feldspar, and rock particles; hence sandstones show simple to complex chemical compositions. The composition is a function not only of the detrital components but also of the cement. The common cements, quartz and calcite, lead to enrichment in silica or in lime and carbon dioxide. The composition is also a function of source rock, completeness of weathering, diagenesis, and other postdepositional changes. These factors are discussed, but supporting data are not generally available. The distribution of the chemical elements in the minerals of sandstones is discussed in general terms; detailed analysis is not possible from presently available data. (Auth)

<130>

Finch, W.I.; USGS, Washington, DC

Geology of Uranium Deposits in Triassic Rocks of the Colorado Plateau Region. USGS Bulletin 1074-D, (pp. 125-164). (1959)

Important uranium deposits are widely distributed in the Triassic rocks of the Colorado Plateau region. These deposits, which have been the second most important domestic source of uranium in the United States, have also yielded vanadium, copper, and radium during various periods of mining in the past 50 years. Most of the deposits in Triassic rocks are in the Shinarump and Moss Back members of the Chinle formation, but some important deposits are also in other members in the lower part of the Chinle, particularly in beds within 50 feet of the Middle Triassic unconformity. In northeastern Arizona, eastern Utah, and western Colorado three mineral belts have been outlined, each bounded by a pinchout. These belts, which contain about 20 percent of the areas underlain by the Chinle formation, are the Monument Valley belt, the east White Canyon belt, and the Moab belt. The chief unoxidized uranium minerals, uraninite and coffinite, and the oxidized uranium minerals, carnotite and tyuyamunite, impregnate the rocks, forming disseminated ores. Fossil wood replaced by these minerals and the associated iron and copper minerals constitute the high-grade ore. Most of the ore averages between 0.20 and 0.30 percent U3O8 and some ores average either between 1 and 2 percent V2O5 or between 1 and 2 percent Cu. The ore bodies are irregularly distributed and form uneven tabular and concretionary masses that lie essentially parallel to the bedding of channels and lenses filled with coarse clastic material. They range in content from a few tons to more than a hundred thousand tons. It is believed that in early Tertiary time ground water leached uranium and other ore metals from overlying mudstone beds or from the ore-bearing rocks themselves and redeposited the metals in favorable sedimentary and tectonic structures. (Auth)

<131>

Pierce, A.P., G.B. Gott, and J.W. Mytton; USGS, Washington, DC

Uranium and Helium in the Panhandle Gas Field, Texas, and Adjacent Areas. USGS Professional Paper 454-G, 57 pp. (1964)

The Panhandle gas field (Upper Pennsylvanian to Lower Permian) originally contained the largest commercial helium reserve in the United States. It also contains anomalous concentrations of radon. The reservoir rocks contain from 2 to 4 ppm of uranium. The uranium content of the crude oil peripheral to the gas field ranges from less than 1 to 300 ppb. The uranium content of the brine is from less than 0.1 to about 10 ppb. The highest concentration of uranium is in the cap rocks which have been estimated to contain between 10 to 20 ppm through a thickness of about 250 feet. The uranium in these rocks is concentrated in asphaltite which contains about 1 percent uranium. X-ray analyses of asphaltite nodules show the presence of uraninite, chloanthite-smaltite, and pyrite. Although uraninite has been identified in some of the nodules, in others the uranium-bearing compound, which may be a metallo-organic complex, is not known. The asphaltite occurs as botryoidal nodules and is nearly always associated with anhydrite and celestite that occur as cements in siltstone and as fillings in fractures and solution cavities in dolomite. The asphaltite is probably a petroleum derivative; the uranium and other metals within it were derived from the rocks in which the asphaltite now occurs, and were concentrated in petroleum compounds. Subsequent radiation damage changed the physical and chemical characteristics of the original organic material. The distribution of uraniferous asphaltite indicates that it is the source of the abnormally high radon concentration in the gases from a number of wells. The highest concentrations of helium in the Panhandle field occur along the western boundary at points where faulting has brought the gas-reservoir rocks into contact with the uraniferous asphaltic rocks that normally overlie the gas reservoir. These rocks are unusually radioactive over a large area southwest of the field, and may have been the source of a significant part of the helium that has accumulated in the gas reservoir. (Auth)(MBW)

<132>

Soister, P.E.; USGS, Washington, DC

Geology of the Puddle Springs Quadrangle, Fremont County, Wyoming. USGS Bulletin 1242-C, 36 pp. (1967)

The Puddle Springs quadrangle is near the south-central edge of the Wind River Basin in central Wyoming. It includes most of the western part of the Gas Hills uranium district and the original uranium ore reserves totaled at least 1 million tons. Only the ore-bearing Wind River Formation, which underlies about half the quadrangle, was studied in detail. The Puddle Springs Arkose Member is more than 500 feet thick and consists of massive coarse conglomeratic arkosic sandstone and beds of granite granule-to-boulder conglomerate, fine-grained sandstone, siltstone, claystone, and carbonaceous shale. This member has all the known uranium deposits in the quadrangle. The arkose is generally oxidized and yellow to gray at the surface but is unoxidized and greenish to bluish gray near and below the water table. Two granite cobble-and-boulder conglomerate beds were mapped in the Puddle Springs quadrangle; they are about 10-30 feet thick and 100 feet apart stratigraphically. The lower of the two, the Dry Coyote Conglomerate Bed, contains many uranium deposits; most uranium deposits in the quadrangle lie from 150 feet below to 50 feet above this bed. The overlying Muskrat Conglomerate Bed has no known uranium deposits. Original uranium ore reserves of the quadrangle probably totaled at least 1 million short tons with an average uranium content of 0.25 percent. Mining has been continuous since 1955. Uranium minerals occur in arkosic sandstone, conglomerate, siltstone, and carbonaceous shale. The ore deposits generally are blanket-like bodies in arkosic sandstone or in siltstone. The largest ore deposits of the district are at or near the ground-water table and are only partly oxidized. More than 40 authigenic minerals compose or are associated with the deposits; they include minerals of arsenic, selenium, and molybdenum, as well as minerals of uranium. Coffinite and uraninite are the main ore minerals in the unoxidized deposits; meta-autunite, phosphuranylite, an unnamed yellow uranium phosphate, and uranophane are the main ore minerals in the oxidized deposits. Radiochemical analyses indicate a Pleistocene age for at least some of the uranium deposits. The available evidence favors the theory that arkosic sediments of the Puddle Springs are the main source of the uranium and that migration and deposition is still in progress. (Auth)(MBW)

<133>

Glover, L.; USGS, Washington, DC

Stratigraphy and Uranium Content of the Chattanooga Shale in Northeastern Alabama, Northwestern Georgia, and Eastern Tennessee. USGS Bulletin 1087-E, (pp. 133-168). (1959)

In northeastern Alabama, northwestern Georgia, and eastern Tennessee, the Chattanooga shale of Late Devonian age ranges in thickness from 0 to more than 40 feet. Most of the shale is of the Gassaway member, though the Dowelltown member is present in part of eastern Tennessee. Beds of Dowelltown age were found in a small area in Alabama and Georgia, but the member is not recognized there. The Chattanooga shale and the overlying Maury formation, which is chiefly of

Mississippian age, are progressively overlapped in the vicinity of Birmingham, Alabama. Along the eastern margin of the late Chattanooga sea, which coincided roughly with the region studied, stable shelf conditions prevailed, but the degree of stability was somewhat less than that to the west in the Eastern Highland Rim area. This difference is indicated in the east by the somewhat more silty and sandy sections, intraformational conglomerates, greater range in thickness of the shale, and in a few places by preservation of basal conglomerate. Phosphate nodules and minor amounts of chert were deposited in the east. Occasional influxes of greater than usual amounts of inorganic material produced the gray beds common in the Chattanooga. Less stable conditions of deposition and wide distribution of phosphatic black shale account for the generally low uranium content (less than 0.005 percent) of the Chattanooga shale in the region studied. (Auth)(MBW)

<134>

Wilmarth, V.R., and D.H. Johnson; USGS, Washington, DC

Uranophane at Silver Cliff Mine, Lusk, Wyoming. USGS Bulletin 1009-A. (pp. 1-12). (1954)

The uranium deposit at the Silver Cliff mine near Lusk, Wyoming, consists primarily of uranophane which occurs as fracture fillings and small replacement pockets in faulted and fractured calcareous sandstone of Cambrian age. The country rock in the vicinity of the mine is schist of pre-Cambrian age intruded by pegmatite dikes and is unconformably overlain by almost horizontal sandstone of Cambrian age. The mine is on the southern end of the Lusk Dome, a local structure probably related to the Artville uplift. In the immediate vicinity of the mine, the dome is cut by the Silver Cliff fault, a north-trending high-angle reverse fault about 1,200 feet in length with a stratigraphic throw of 70 feet. Uranophane, metatorbernite, pitchblende, calcite, native silver, native copper, chalcocite, azurite, malachite, chrysocolla, and cuprite have been deposited in fractured sandstone. The fault was probably mineralized throughout its length, but because of erosion, the mineralized zone is discontinuous. The principal ore body is about 800 feet long. The uranium content of material sampled in the mine ranges from 0.001 to 0.23 percent uranium, whereas dump samples range from 0.076 to 3.39 percent uranium. (Auth)(MBW)

<135>

Vine, J.D., and G.E. Prichard; USGS, Washington, DC

Geology and Uranium Occurrences in the Miller Hill Area, Carbon County, Wyoming. USGS Bulletin 1074-F. (pp. 201-239) (1959)

Uranium occurs in the North Park formation of Pliocene age in the Miller Hill area, about 25 miles south of Rawlins, Carbon County, Wyoming. It consists principally of water-worked fine-grained pyroclastic debris and detrital mineral grains and includes several fresh-water limestone beds. Beds of brecciated silicified limestone 3 to 10 feet thick contain the principal concentrations of uranium. Lesser concentrations are found in calcareous sandstone and quartzite. Uranophane, the principal uranium mineral, has been deposited in vugs as fracture and surface coatings, and as a disseminated constituent of the rock. The uranium deposits in the Miller Hill area are thought to be a secondary concentration deposited from ground-water solutions that leached disseminated uranium from thick porous beds of tuffaceous sandstone in the North Park formation. It is suggested that the mechanism for deposition was the reaction of silica- and uranium-rich ground water upon contact with limestone. The higher grade concentrations may represent further recent surficial enrichment of uranium due to evaporation of capillary moisture; however, uraniferous limestone that is continuously exposed to weathering for a relatively long period of time is eventually leached. As much at 0.5 percent uranium is contained in grab samples, but only about 1,000 tons of rock is known to contain as much as 0.03 percent uranium. Visual spectrographic analyses of 31 samples of mineralized limestone are tabulated. (Auth)(MBW)

<136>

Swanson, V.E.; USGS, Washington, DC

Oil Yield and Uranium Content of Black Shales. USGS Professional Paper 356-A. 44 pp. (1960)

Oil yield and uranium determinations for more than 500 samples of oil shales are recorded in the report. A broad geographical area of the continental United States has been studied, amounting to 13 states, which range from Montana to Colorado, and from New York to Alabama. Slightly more than half of the samples are from the Chattanooga shale (Late Devonian), and its correlative eastern and midcontinent shale units. A positive relationship between oil yield and uranium content exists for some, but not all of the shales. Some of the samples obtained from the Chattanooga shale and the Antrim shale have a particularly high correlation; however, in other shale samples such as the Phosphoria formation, the uranium is more closely related to the phosphate content of the rock. Whereas the oil from these shales is inherent to and derived directly from the organic matter, most of the uranium is attached to or precipitated in the presence of organic matter just before or during the time of deposition of the organic-rich sediment. It is suggested that two types of organic matter should be distinguished, the sapropelic type derived principally from algae pollen and spores, resins, and the fatty tissues of animals, and the humic type which is derived principally from cellulose and lignin or the woody parts of plants. Only where the proportion of sapropelic to humic type of organic matter remains the same in an otherwise homogeneous black shale will the oil yield and uranium content have a high positive correlation. (Auth)(MBW)

<137>

Witkind, I.J.; USGS, Washington, DC

Uranium Deposits at Base of the Shinarump Conglomerate, Monument Valley, Arizona. USGS Bulletin 1030-C, (pp. 90-130). (1956)

Exposed sedimentary rocks on the Navajo Indian Reservation in Apache and Navajo Counties, northeastern Arizona, range from the Halgaito tongue of the Cutler formation (Permian) to the Salt Wash member of the Morrison formation (Jurassic). The dominant structural element of the area is the Monument upwarp, a large asymmetrical anticline whose northern end is near the junction of the Green and Colorado Rivers in Utah and whose southern end disappears near Kayenta, Arizona. Asymmetrical anticlines with steeply dipping east flanks and gently dipping west flanks are superimposed on the upwarp. These subsidiary structures trend northward. The uranium-ore bodies are localized in conglomeratic sandstone of the Upper Triassic Shinarump conglomerate that fills stream channels scoured in the underlying Lower and Middle Triassic Moenkopi formation. These channels range from narrow and shallow, 15 feet wide and 10 feet deep, to broad and deep, 2,300 feet wide and 70 feet deep. Two types of channels can be distinguished - a short type, less than 2 miles long, and a long type, traceable for distances greater than 2 miles. Plant matter in the form of trees, branches, and twigs was deposited with Shinarump sediments in the channels. It is probable that when the Shinarump conglomerate was invaded by mineralizing solutions the uranium ore was deposited primarily in localities formerly occupied by the plant material. Also, it is thought that the short channels are more likely to have ore accumulations than long channels. (Auth)

<138>

Anderson, D.C.; Utah Construction and Mining Company, Riverton, WY

Uranium Deposits of the Gas Hills. Contributions to Geology, 8(2), 93-103, (1969)

Sedimentary rocks exposed in the Gas Hills Uranium District include sandstones, limestones, dolomites, shales, and tuffaceous sandstone, mudstones, and shales. They range in age from Cambrian to Miocene and have a composite thickness of over 14,000 feet. Volcanism occurred during late Eocene time, as evidenced by relic vents found at the southern end of the Rattlesnake Hills, and by local volcanic debris found in the middle and upper Eocene rocks. The source beds for the uranium deposits are arkosic sandstones interstratified with lensing mudstones and shales. Two distinct types of sandstone are present in the Wind River Formation. The youngest is yellowish-orange to yellowish-gray arkose, derived primarily from Precambrian gneissoid and granitoid rocks; it contains little clay, abundant calcium carbonates, and limonite cement, and is host for all uranium deposits of the district. The second type of sandstone is pale yellowish-gray to pale olive, derived from areas of schists of Precambrian age; it contains abundant clay matrix. There are four types of uranium deposits found in the district, the most important being the solution-front deposits. They were formed along the margins of highly altered, tabular sand beds that are enclosed by overlying and underlying fine-grained siltstone, claystone, and carbonaceous mudstone beds. Solution fronts can be followed for long distances and individual ore bodies are found along them that may reach thousands of feet in length. The solution fronts are ideally crescentic or "C" shaped when viewed in cross section, with thin mineralization forming the tips of the crescents. The uranium minerals occur as earthy brown to black coatings on and interstitial fillings between the quartz sand grains. The primary uranium ore minerals are coffinite and uraninite. The three other types of deposits include transitional bedded, oxidized, and residual remnant deposits. There have been several quite-large transitional bedded deposits mined, but the oxidized and residual remnant deposits are usually small and difficult to mine. Ground waters trapped by the southward tilting of the Tertiary rocks during late Miocene time became stagnated. These waters dissolved uranium and other elements from the enclosing rocks, and after erosion had exposed the highest beds of the Wind River Formation, the mineral-rich solutions gained egress, from the enclosing sand aquifers, toward the north and the solution-front ore deposits began to form. (Auth)(PAG)

<139>

Melin, R.E., Consulting Geologist, Denver, CO

Uranium Deposits in Shirley Basin, Wyoming. Contributions to Geology, 8(2), 143-149. (1969)

Uranium deposits in Shirley Basin occur in arkosic sandstone beds of the Eocene Wind River Formation. The Wind River ranges from a wedge-out to about 500 feet thick and consists of light gray fine-grained to conglomeratic sands mostly less than 100 feet thick interlayered with green clay-silt beds. In the mines area the beds dip about one degree north-northeast. Uranium deposits consist of disseminations and impregnations of uraninite, calcite, pyrite, and marcasite in arkosic sands. Much of the uranium is in crescentic rolls, but important amounts are in tabular bodies near the rolls. The larger ore bodies in the mines area are distributed along the down-dip and lateral periphery of tongues of altered ground. Obvious alteration effects include a color change from pale gray to light tan or yellowish-gray, and removal of pyrite, calcite, and carbonaceous material. The deposits apparently were formed by migrating reactive ground water solutions that collected uranium from the ground it altered, moved uranium downstream, and concentrated it in emplacements at interfaces between altered ground and unaltered ground. (Auth)

<140>

Gabelman, J.W.; AEC, Division of Raw Materials, Washington, DC

The Flat Top Uranium Mine, Grants, New Mexico. RME-4112, 81 pp.; TID UC-51, 81 pp. (1970, October)

The exhausted Flat Top uranium mine in the Todilto Limestone, Grants, New Mexico, was mapped at a scale of 1:240 in 1957 as a prototype replacement ore body of about 50,000 tons in the top of a shallow, elongate dome. The Todilto Limestone, about 16 feet in average thickness, is the only limestone in the stack of Triassic and Jurassic continental sandstones and mudstones. This limestone and the Jurassic Morrison sandstones about 500 feet above are the only formations in the district with significant uranium ore. The Flat Top ore body was one of a cluster composing the Poison Canyon subdistrict, which occupies one of several N45E cross synclines about 3 miles wide plunging down the northeast flank of the Zuni uplift. Excluding the Zuni arch as an order of fold, the folds of the Poison Canyon group are considered first-order harmonic folds. The Flat Top north-oriented elongate dome is a large member of a conjugate rectilinear system of second-order harmonic folds hundreds of feet long. Five faults with displacements of hundreds of feet cut the limestone mining areas in the Grants district. Todilto uranium ore bodies are unoxidized replacements of limestone, partly oxidized replacements, or oxidized secondary fracture stockworks whose uranium has migrated from primary replacements. Each small ore body and the large composite deposit were enclosed by wide alteration envelopes in which limestone had been bleached, organic carbon removed, and bedding and jointing gradually destroyed by recrystallization in outwardly decreasing intensity. All the small ore bodies were concentrations of individual uraninite or coffinite lenses or pods, each no more than a few inches long. The dominant primary uranium mineral was pitchblende; coffinite was minor. The patterns of structure and mineral distribution determined for this mine are indicated by examination of other Todilto mines to be generally applicable to uranium mineralization in the limestone of the

Grants district. (Auth)(MBW)

<141>

Masursky, H., and G.N. Pipiringos;
USGS, Washington, DC

Uranium-Bearing Coal in the Red Desert Area, Sweetwater County, Wyoming.
USGS Bulletin 1055-G, (pp. 189-215), 315 pp. (1959)

Uranium-bearing coal occurs in the Red Desert area of Sweetwater County, Wyoming, in a zone 15 miles wide which extends in a northwesterly direction for 30 miles north of Wamsutter, Wyoming. The thickest coal is found along the transition zone between the fluviatile sandstone of the Wasatch formation and the lacustrine shale of the Green River formation, both of Eocene age. The greatest concentrations of uranium in the coal occur locally where the beds are overlain by conglomerate of possible Miocene age. The close relationship between uranium in the coal and the permeability of the adjacent beds indicates that the uranium is of epigenetic origin. The Luman No. 1 coal bed, the principal objective of a drilling program in 1952, contains about 12 million short tons of subbituminous coal that averages 3.9 feet in thickness, under not more than 75 feet of overburden. The uranium content of the Luman No. 1 bed averages about 0.006 percent, the ash content averages about 20 percent, and the uranium content of the ash averages about 0.030 percent. The average heating value of the coal in the "as received" condition is 7,600 Btu. The average uranium content of other coal in the rest of the area is about 0.003 percent, although locally, as at Creston Ridge in the southeastern part of the area, impure coal contains as much as 0.051 percent uranium. The study indicates that the coal in the Red Desert area is of interest primarily as a fuel resource and contains only small concentrations of uranium. Thin carbonaceous shale interbedded with coarse-grained sandstone to the north and east of the principal area underlain by coal, however, may contain high-grade deposits of uranium. (Auth)(MBW)

<142>

Moore, G.W., R.E. Melin, and R.C. Kepferle; USGS, Washington, DC

Uranium-Bearing Lignite in Southwestern North Dakota. USGS Bulletin 1055-E, (pp. 147-166), 315 pp. (1959)

Beds of uranium-bearing lignite were mapped and sampled in the Bullion Butte, Sentinel Butte, HT Butte, and Chalky Buttes areas in southwestern North Dakota; they occur at several stratigraphic positions in the Sentinel Butte member of the Fort Union formation of Paleocene age. A total of 261 samples from 85 localities were collected for uranium analysis. Lignite containing as much as 0.045 percent uranium, 10.0 percent ash, and 0.45 percent uranium in the ash was found. the average uranium content of the lignite is about 0.013 percent. About 27 million tons of lignite in beds about 2 feet thick underlie the four areas. Surface samples of the lignite average more than 30 percent ash. The principal factor that seems to influence the concentration of uranium in the lignite beds is the stratigraphic position of the beds in relation to the base of the overlying White River group of Oligocene age. All uranium-bearing beds closely underlie the base of the White River group. The relative concentration of uranium is modified by other factors, however, as beds enclosed in permeable rocks are more uraniferous than beds in impermeable rocks, and thin beds have a greater uranium content than thick beds. In addition, a thick lignite bed commonly has a greater concentration in the top part of the bed. These and other factors suggest that the uranium is of secondary origin and that it was leached from volcanic ash in overlying rocks of Oligocene and Miocene age. Probably the uranium is held in the lignite as part of a metallo-organic compound. (Auth)

<143>

Granger, H.C., and R.B. Raup; USGS, Washington, DC

Geology of Uranium Deposits in the Dripping Spring Quartzite, Gila County, Arizona USGS Professional Paper 595, 108 pp. (1969)

Uranium deposits in the Dripping Spring Quartzite of younger Precambrian age occur largely as disseminated veins in a carbon- and potassium-rich siltstone facies near diabase intrusive bodies, also of Precambrian age. The Dripping Spring is a formation in the Apache Group, which is a sequence of clastic sedimentary rocks, dolomitic limestone, and basalt flows. Uranium deposits in the Dripping Spring are found only in the upper member, which is composed largely of siltstone and very fine-grained sandstone. The Apache Group, and particularly the upper member of the Dripping Spring, is extensively intruded by sill-like sheets of diabase interconnected by dikes. Effects of regional metamorphism on these rocks are negligible, but the upper member of the Dripping Spring is locally metamorphosed adjacent to large diabase bodies. Metamorphism was accomplished without much change in the chemical composition of the potassium-rich siltstone except for the addition of sodium which is believed to be related to the alkalic aplite stage of diabase differentiation. In the area that contains most of the uranium deposits, rocks are affected by several northward-trending monoclinal folds of prediabase age. Most of the uranium deposits occur in the gray unit of the upper member of the Dripping Spring, either above or below a thin quartzite stratum called the barren quartzite. The vein minerals are largely disseminated in the wallrock adjacent to a poorly defined central joint or fracture zone. Locally, uraninite forms small lenticular fissure fillings, but these are sparse. Isotope ages, determined for the uraninite, indicate an age of about 1,050 million years. (Auth)(MBW)

<144>

Hawley, C.C., and F.B. Moore; USGS, Washington, DC

Geology and Ore Deposits of the Lawson-Dumont-Fall River District, Clear Creek County, Colorado. USGS Bulletin 1231, 92 pp. (1967)

The Lawson-Dumont-Fall River district, a mining district with an area of 15-square-miles in the Front Range mineral belt, is in Clear Creek County, Colorado. The district is underlain by Precambrian rocks, which are cut by small bodies of early Tertiary igneous rocks. The Precambrian rocks consist of a generally conformable succession of metamorphic gneiss intruded by igneous rocks, some of which are metamorphosed. The gneiss consists chiefly of fine- to medium-grained biotite gneiss and two types of quartzo-feldspathic gneiss - microcline-quartz-plagioclase-biotite gneiss and granite gneiss and pegmatite. The rocks of Tertiary age are porphyritic and occur as dikes, stocks, and partly concordant bodies. They belong to three petrographic groups: hornblende granodiorite; quartz monzonite; and bostonite. Unconsolidated Quaternary deposits, mainly moraines, outwash, solifluction debris, and alluvium, mantle the bedrock surface in the stream valleys on some gently rolling uplands and north-facing forested slopes. All but the alluvium are related to Pleistocene glaciation. The Precambrian gneiss is bent into three large open folds which dominate the structure of the area. These folds trend north-northeast and, from west to east, are the Lawson syncline, the Dumont anticline, and the Bald Mountain syncline. All the rocks are jointed. The faults of the district were formed in Precambrian and in Laramide time. The largest faults, which are traceable for miles in and near the district, strike northwest and northeast. The smaller faults, striking east, east-northeast, and west-northwest, contain most of the major veins of the district. The ore deposits are in fissure veins which formed by a combination of openspace filling and replacement. The ore deposits are dominantly gold- and silver-bearing base-metal sulfide deposits. Uranium ores have also been produced from one mine. The productive veins can be classed according to mineralogy into three main types - pyrite, composite, and galena-sphalerite. Veins of the three types are distributed in a zonal pattern. The wallrock of all the veins is altered. In general, the veins are surrounded by an envelope of sericitized and silicified rock, which grades outward through argillized rocks into fresh rock. Some ores were formed or enriched by supergene processes. The ores were deposited late in the period of Laramide igneous and structural activity, probably by carbon dioxide- and sulfur-rich solutions carrying metals in complex ions. (Auth)(MBW)

<145>

Shawe, D.R., G.C. Simmons, and N.L. Archbold; USGS, Washington, DC

Stratigraphy of Slick Rock District and Vicinity, San Miguel and Dolores Counties, Colorado. USGS Professional Paper 576-A, 108 pp. (1968)

The Slick Rock district covers about 750 square miles in western San Miguel and Dolores Counties, in southwestern Colorado. Deposition of Paleozoic sedimentary rocks in the district and vicinity was principally controlled by development of the Paradox Basin, and of Mesozoic rocks by development of a depositional basin farther west. Sedimentary rocks rest on a Precambrian basement consisting of a variety of rocks, including granite and amphibolite. The maximum total thickness of sedimentary rocks underlying the district is 13,000 feet, and prior to extensive erosion in the late

Tertiary and the Quaternary it may have been as much as about 18,000 feet. The lower 5,000 feet or more of the sequence of sedimentary rocks consists of arenaceous strata of early Paleozoic age overlain by dominantly marine carbonate rocks and evaporite beds interbedded with lesser amounts of clastic sediments, of late Paleozoic age. Overlying these rocks is about 4,500 feet of terrestrial clastic sediments, dominantly sandstone with lesser amounts of shale, mudstone, siltstone, and conglomerate, of late Paleozoic and Mesozoic age. Above these rocks is as much as 2,300 feet of marine shale of late Mesozoic age. Perhaps about 5,000 feet of clastic sedimentary rocks, dominantly sandstone and in part shale, of late Mesozoic and early Cenozoic age, overlay the older rocks of the district prior to late Cenozoic erosion. Igneous rocks of Tertiary age crop out in only one small area in the district, but they intruded extensively in the Mancos Shale east of the district, and, as shown by deep oil test wells, appear to be intruded widely in the Paradox Member of the Hermosa Formation in the southern and southeast part of the district. Surficial deposits of Quaternary age include glacial till, terrace gravels, alluvial fans, landslide debris, loess, other soil, alluvium, colluvium, and talus. (Auth)(MBW)

<146>

Rose, A.W.; Alaska Department of Natural Resources, Division of Mines and Minerals, Juneau, AK

Geological and Geochemical Investigations in the Eureka Creek and Rainy Creek Areas, Mt. Hayes Quadrangle, Alaska. Alaska Department of Natural Resources, Geology Report No. 20, 37 pp. (1966, May)

The Eureka Creek and Rainy Creek areas are on the south slope of the Central Alaska Range just south of the Denali fault, a major strike-slip fault. The major rock types in both areas include schist, phyllite, slate, and gneiss of uncertain age; andesitic to dacitic volcanics and sediments of Mississippian or Pennsylvanian age; Rainy Creek basalt and associated sediments of Mississippian or Pennsylvanian age; Permian Mankomen formation; and Triassic Amphitheatre basalt, argillite, and limestone. These bedded rocks were intruded by several granitic to dioritic plutons and later by dunite, peridotite, and gabbro. Tertiary Gakona formation and glacial deposits cover the older rocks in parts of the area. Recurrent north-south regional compression in late Mesozoic and Tertiary time resulted in east-west reverse and thrust faults, and northeast tear faults. These structures are modified by north-south and northwest faults, and cut by steep east-west faults along which the Alaska Range was uplifted during Tertiary time. A magnetite-bearing skarn deposit was found on the east side of the Maclaren Glacier and appears to warrant a magnetometer survey. Numerous copper and copper-nickel shows are present in the area, as well as minor amounts of abestos. Fifteen groups of stream sediment anomalies are recognized. The most significant seem to be copper-lead anomalies from streams draining dunite near Rainy Creek and copper-lead anomalies between Broxson Gulch and Landslide Creek in a poorly-exposed area bordered by strongly pyritized volcanics. Numerous zinc-molybdenum anomalies are spatially associated with pyritic black slate and argillite. Samples of the slate do not contain anomalous zinc content, and further work is needed to explain the anomalies. (Auth)

<147>

Witkind, I.J.; USGS, Washington, DC

The Uranium-Vanadium Ore Deposit at the Monument No. 1-Mitten No. 2 Mine, Monument Valley, Navajo County, Arizona. USGS Bulletin 1107-C, (pp. 219-242). (1961)

The Monument No. 1-Mitten No. 2 uranium-vanadium mine is in a remote sector of the Navajo Indian Reservation, Navajo County, Arizona. Near the mine, the strata range in age from Permian (De Chelly sandstone member of the Cutler formation) to Late Triassic (Shinarump member of the Chinle formation). Erosion has removed most of the Shinarump from the Monument No. 1 area, and only several small remnants remain. Two of these, each about 2,000 feet long, are part of a once continuous channel fill; they aline to form a broad curve trending northwestward. The channel ranges in width from 50 to 280 feet, and has been scoured about 50 feet into the underlying strata. Three major lithologic units make up the basal channel fill: trash-pocket conglomerate, silica-cemented sandstone, and calcite-cemented sandstone. Ore minerals impregnated parts of both the trash-pocket conglomerate and the silica-cemented sandstone and formed an ore body that was collinear with the channel and that extended for about 650 feet. The ore body, which has been mined out, ranged in width from 10 to 95 feet and in thickness from 1 to 18 feet. Lenses of the calcite-cemented sandstone were enclosed in the ore body. The core of the ore body consisted of low-valent relatively unoxidized minerals. Adjacent to and overlying the core were two incomplete concentric sheaths of oxidized minerals, the more intensely oxidized minerals being farthest from the core. The ore body was probably oxidized in place. The uraniferous material was in approximate equilibrium. The ratio of vanadium to uranium for the mine was about 2.5:1. The ore adjacent to calcite-cemented sandstone lenses, possibly the carbonate, was instrumental in precipitating the ore minerals from the ore-bearing solution. (Auth)(MBW)

<148>

Baker, A.A.; USGS, Washington, DC

Geology and Oil Possibilities of the Moab District, Grand and San Juan Counties, Utah. USGS Bulletin 841, 95 pp. (1933)

Exposed sedimentary formations in the Moab district range in age from lower Pennsylvanian to Upper Cretaceous. Rock types include evaporites, limestone, shale, mudstone, sandstone, arkose, and conglomerate. One small igneous plug is present. The beds have been folded into low anticlines and shallow synclines during several periods of deformation. Some of this deformation is due to the intrusion of salt plugs. The beds are cut by numerous small normal faults. The report includes a geologic map and a geologic structure map of the area at a scale of 1:62,500. Disseminated deposits of uranium and vanadium minerals in the area are irregularly distributed in the Salt Wash sandstone member of the Morrison formation of Jurassic age. (Auth)

<149>

Baker, A.A., C.H. Dane, and J.B. Reeside; USGS, Washington, DC

Correlation of Jurassic Formations of Parts of Utah, Arizona, New Mexico, and Colorado. USGS Professional Paper 183, 66 pp. (1936)

Jurassic formations on the Colorado Plateau and adjacent areas are described, redefined, and correlated. The rock units are subdivided into the Glen Canyon group (Wingate sandstone, Kayenta formation, Navajo sandstone), the San Rafael group (Carmel formation, Entrada sandstone, Curtis formation, Summerville formation), and the Morrison formation. Ten series of columnar sections are presented and discussed, the distribution and thickness of the formations are shown, and the conditions of deposition are interpreted. (Auth)

<150>

Curran, T.F.V.; Not given

Carnotite in Paradox Valley, Colorado. Engineering Mining Journal, 92(27), 1287-1288. (1911)

Carnotite ore bodies in Paradox Valley crop out at about the same stratigraphic level, have a blanket form, and are as much as four feet thick. The ore as mined contains from 6 to 15 percent uranium oxide. The economic geography of the area is discussed, and some of the mines and claims are briefly described. (Auth)

<151>

Shawe, D.R.; USGS, Denver, CO

Reconnaissance Geology and Mineral Potential of Thomas, Keg, and Desert Calderas, Central Juab County, Utah. USGS Professional Paper 800-B, (pp. 67-77). (1972)

Three recently recognized calderas in the Thomas Range, Keg Mountains, and Desert Mountain, central Juab County, Utah, offer exploration possibilities for undiscovered ore deposits. Three major episodes of volcanic activity in the region were 1) early Tertiary eruption of intermediate-composition lavas and agglomerates; 2) middle Tertiary eruption of silicic ash-flow tuffs resulting in collapse of the three calderas; and 3) late Tertiary-Quaternary eruption of basalt and alkali rhyolite. After caldera collapse, magmas invaded parts of the ring-fracture zones or resurgently domed the calderas. Mineralization that formed ore deposits peripheral to the Thomas caldera probably was nearly concurrent with eruption of the late alkali rhyolite. The ore deposits have yielded important amounts of manganese, fluorspar, uranium, and beryllium. Prospecting for deposits of these commodities is warranted where parts of the Thomas caldera rim, as well as of the Keg and Desert caldera rims, are covered by postmineralization surficial deposits. Deep exploration for base and precious metals may be justified beneath the manganese and fluorspar deposits. (Auth)

<152>

De Vergie, P.C., and W.A. Carlson; AEC, Grand Junction, CO

Investigation of the "C" Group Area, San Juan County, Utah. RME-4011, 13 pp. (1953)

Uranium deposits on the "C" group of claims, about 20 miles southwest of Moab on the west side of the Colorado River, are in the Shinarump conglomerate of Triassic age in sandstone lenses near the base of a large paleostream channel cut about 50 feet into the underlying Moenkopi formation of Triassic age. Carbonaceous material is abundant in the ore zone, and uraninite and base-metal sulfides impregnate the sandstone and replace carbonaceous material. The host rock is a coarse- to fine-grained sandstone cemented by calcite. (What was called Shinarump conglomerate in this area is now correlated with a sandstone member of the Chinle formation of Triassic age.) (Auth)

<153>

Dix, G.P., Jr.; AEC, Grand Junction, CO

The Uranium Deposits of Big Indian Wash, San Juan County, Utah. RME-4022 (Rev.), 15 pp. (1954)

Uranium deposits in the Big Indian Wash area have been found in the Cutler formation of Permian age and in the Chinle formation of Triassic age. The area lies on the southwest flank of the Lisbon Valley anticline, and the rocks in the mineralized area dip about 15 degrees SW. Formations exposed in the area range in age from Pennsylvanian to Cretaceous. The upper part of the Cutler formation consists of mudstone, siltstone, and lenses of coarse-grained arkosic sandstone. The uranium minerals, carnotite and becquerelite, are disseminated in the lenses of arkosic sandstone. Uranium deposits in the Chinle formation are in a gray, medium-grained micaceous sandstone near the base of the formation. The uranium minerals, uraninite, carnotite, and tyuyamunite, are associated with carbonaceous material, pyrite, montroseite, and roscoelite. The largest mine in the area, the Mi Vida mine, is in the Chinle formation. The deposits at the Big Buck mine and the Purple Paint and Small Fry claims are in the Cutler formation. (Auth)

<154>

Droullard, R.F., and E.E. Jones; AEC, Grand Junction, CO

Investigations of Uranium Deposits Near Sanostee, New Mexico. RMO-909, 7 pp. (1951)

Uranium-vanadium deposits occur in the Recapture member of the Morrison formation of Jurassic age in the Sanostee area, San Juan County, New Mexico. Vanadium minerals and carnotite-type minerals are disseminated in fine- to medium-grained sandstone in the upper portion of the Recapture member. The deposits, generally less than 20 feet in outcrop length, are contained within slightly radioactive altered zones. (Auth)

<155>

Everhart, D.L.; AEC, Washington, DC

Reconnaissance Examinations of Copper - Uranium Deposits West of the Colorado River. RMO-659, 19 pp. (1950)

Several small copper-uranium deposits have been found in southwestern Utah along the contact of the Shinarump and Moenkopi formations of Triassic age. The deposits are highly localized and apparently erratic in their distribution. The mineralogy is similar and consists of secondary copper, uranium, and copper-uranium minerals which impregnate sandstone and coal parting planes of shale. The deposits described are in the Capitol Reef, Circle Cliffs, Silver Reef and other areas. The deposits at Silver Reef are not at the Shinarump-Moenkopi contact, but higher in the section, in the Silver Reef sandstone member of the Chinle formation of Triassic age. Exploration of the region has only begun, and the known deposits are not developed. (Auth)

<156>

Davis, D.L., and D.L. Hetland; AEC, Salt Lake City, UT

Uranium in Clastic Rocks of the Basin and Range Provinces. In USGS Professional Paper 300, (pp. 351-359), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 387-391), 825 pp. (1956)

Uranium occurs in Tertiary lake sediments and water-laid tuffs at widely separated areas in the Basin and Range province of Nevada and California. Miocene lake sediments near Tonopah, Nevada, are composed chiefly of uniform finely stratified pyroclastic rocks and diatomaceous earth interbedded with discontinuous lenses of collophinite and uraniferous opal. Uranium minerals have not been identified, but anomalous radioactivity can be detected over an area about 1 mile wide and 8 miles long. Trenching and drilling have exposed marginal-grade material to a depth of 40 feet in 1 locality. Near Olancha, California, gently dipping lakebeds of the Coso formation of Pliocene age contain autunite on fracture surfaces in iron-stained zones. The locality is characterized by extensive faulting and volcanism. Only select samples from this area contained ore-grade material. Stratified rocks in the Virgin Valley of northwestern Nevada consist of early Pliocene water-laid vitreous tuff and diatomaceous earth which contain discontinuous layers of opal. Small amounts of carnotite occur as fracture coatings of fine layers in the opal lenses, and a yellow fluorescent mineral, possibly schroeckingerite, is disseminated in the volcanic tuff. A uraniferous deposit in water-laid tuff in Lander County, Nevada, occurs in a topographic basin near the head of Dacie Creek that is surrounded by hills of rhyolite, andesite, and basalt. Appreciable radioactivity appears to be confined to minor fractures in the tuffs, although no uranium minerals have been observed. Near Hawthorne, Nevada, carnotite occupies a series of closely spaced vertical fractures in tuffaceous sandstone of the Esmeralda formation. The area is capped by basaltic flows, and a small rhyolite plug is in fault contact with the uranium-bearing sandstone. Carnotite-type minerals have been found in a thin bed of soft water-laid tuff in the Panaca formation of Pliocene age in Lincoln County, Nevada. Minor amounts of carbonaceous material are present, and there is no apparent alteration or silicification of the mineralized stratum. The uranium minerals in all the deposits generally are not in radioactive equilibrium, and the uranium content as determined by radiometric analyses is usually lower than by chemical analyses. This would suggest recent formation of the uranium minerals. Structural control is not readily apparent in any of the deposits, but small fractures and faults may have localized mineral concentrations. (Auth)

<157>

Finch, W.I.; USGS, Washington, DC

Uranium in Terrestrial Sedimentary Rocks in the United States Exclusive of the Colorado Plateau. In USGS Professional Paper 300, (pp. 321-327), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 600-604), 825 pp. (1956)

Large uranium deposits occur in sandstones of Cretaceous age in the Black Hills region of South Dakota and Wyoming and in tuffaceous sandstone of Tertiary age in Wyoming, Texas, and Nevada. Small deposits occur in terrestrial sedimentary rocks in Pennsylvania, Oklahoma, New Mexico, and other places exclusive of the Colorado Plateau. Carnotite deposits in sandstone of Cretaceous age in the Black Hills are clustered in poorly defined areas in the northern and southern parts of the region. The deposits contain more vanadium than uranium and consist of irregular tabular or lenticular layers that, in general, follow the bedding and have distinct boundaries. The main ore minerals are carnotite and corvusite. The most favorable areas for large deposits are where sandstone lenses that contain abundant mudstone and thin-bedded sandstone coincide with structural terraces. Economic uranium deposits were discovered in tuffaceous sandstones of Tertiary age in the Wyoming basins in 1951 and in the Texas coastal plain and Nevada basins in 1954. Large areas of similar rock types in the United States remain untested. In general, these uranium deposits have different habits, mineralogy, and apparent geologic controls than those in Mesozoic sandstones of the Colorado Plateau and Black Hills regions. The Tertiary deposits occur most commonly as poorly defined bodies of disseminated uranium arsenate, silicate, and phosphate minerals in poorly bedded tuffaceous sandstone or sandy tuffaceous rocks. Relation of the deposits to sedimentary structures is obscure. Vanadium and copper minerals are generally absent, except in Nevada where abundant carnotite has been reported. Uraninite occurs in several deposits in Wyoming. Carbonaceous material is either absent or apparently unrelated to the uranium minerals. The known deposits are nearly or completely oxidized and some appear to be related to the Recent topography and ground-water systems. Small deposits in upper Paleozoic rocks of Pennsylvania, Oklahoma, New Mexico, and other places are similar to those on the Colorado Plateau. The host rocks are most commonly lenses of light-colored sandstone, and the ore deposits are closely related to the sedimentary structures. Uranium minerals replace carbonaceous material and are commonly associated with vanadium and copper minerals and altered mudstone. Other small deposits of uranium are found in terrestrial rocks of many ages in many places throughout the United States. (Auth)

<158>

Fischer, R.P.; USGS, Denver, CO

Uranium-Bearing Sandstone Deposits of the Colorado Plateau. Economic Geology, 45(1), 1-11. (1950)

The uranium-bearing sandstone deposits of the Colorado Plateau are commonly referred to as carnotite deposits. They have been the principal domestic source of uranium, radium, and vanadium. The deposits are largely restricted to a few stratigraphic zones, along which they have a wide but spotty areal distribution. The ore minerals mainly impregnate sandstone, though in places fossil plants are richly mineralized. Most of the ore bodies are small, but have a wide range in size, and within individual deposits the ore has a considerable range in thickness and grade. The deposits are irregularly tabular or lenticular, with their long axes nearly parallel to the bedding, but the ore does not follow the beds in detail. The ore is thought to have been precipitated from ground-water solutions after the enclosing sands had accumulated and before regional deformation. Sedimentary structures that seem to have controlled the movement of these solutions and the features that probably localized the ore deposits are described, and their application as guides to ore finding is explained. (Auth)

<159>

Gott, G.B., R.S. Jones, E.V. Post, and W.A. Braddock; USGS, Washington, DC

Black Hills, South Dakota. In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, December 1, 1953 to May 31, 1954, (pp. 64-72);
TEI-440, (pp. 64-72). (1954)

Several relationships between the vanadium-uranium deposits in the Edgemont district and the characteristics of the host rocks have been noted which may have value as aids to predicting ore. The most favorable host rock appears to be the thickest sandstone in the lower part of the Lakota formation of Cretaceous age. The deposits generally occur where the sandstone contains numerous mudstone "splits". Many of the carnotite deposits occur on structural terraces. A characteristic purplish-pink iron oxide stain impregnates the sandstones adjacent to many of the deposits; this color appears to be one of the more useful guides to ore. Silica and carbonate cement are associated with the deposits in some places, but also are present in areas where ore is not known to exist. (Auth)

<160>

Gregory, H.E.; USGS, Washington, DC

The San Juan Country, A Geographic and Geologic Reconnaissance of Southeastern Utah. USGS Professional Paper 188, 123 pp. (1938)

Exposed sedimentary formations in this region range in age from Pennsylvanian to Upper Cretaceous. The formations are described, and a number of measured sections are presented. Relatively large masses of intrusive igneous rocks are present in the Abajo Mountains. The major structural features in the area are the Sage Plain downwarp, the Monument upwarp, and the intervening Comb Ridge monocline. Smaller folds locally modify the major structures. The includes a reconnaissance geologic map of the region at a scale of about 1:500,000. (Auth)

<161>

Griggs, R.L.; USGS, Washington, DC

Datil Mountain Area, New Mexico. In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, June 1 to November 30, 1954, (pp. 129-130); TEI-490, (pp. 129-130). (1954)

Uranium deposits occur in the Mesaverde formation of Cretaceous age and in the Baca formation of Tertiary age in this area. The uranium is concentrated at the contact of porous sandstones with underlying impermeable shale beds and shale stringers. At one locality the uranium is in the wedge edge of a lenticular sandstone in the Baca formation. Yellow uranium minerals are visible in some prospects but the uranium in an unidentified form is associated mainly with ferruginous and carbonaceous material in sandstone. (Auth)

<162>

Gruner, J.W.; University of Minnesota, Minneapolis, MN

Annual Report for July 1, 1952 to March 31, 1953. RME-3044, 58 pp. (1953)

The report is divided into six independent parts. In Part I, preliminary results of field work in the White Canyon and San Rafael Swell areas are reported. The "Flop-Over" at Temple Mountain is described, and the structure is interpreted as collapse due to an unknown cause. In Part II, four categories of uranium-bearing carbonaceous materials are discussed. They are: (1), lignitic plant material, (2), asphaltite, (3), gilsonite, and (4), liquid hydrocarbons. Uraniferous asphaltite is common in the Temple Mountain mines, where it occurs interstitial to sand grains and as globules. Part III deals with the synthesis of certain uranium minerals. In Part IV the changes in color from red to green of the silts and shales associated with uranium deposits and uraniferous horizons are discussed. The color change is due to the destruction of the red coloring matter, hematite, either by reduction of the iron or by chemical reaction of the hematite with hydromicas. Part V is a discussion of the quantity of disseminated uranium present in the sedimentary rocks of the Colorado Plateau, and how it could have been concentrated into economic ore bodies. Part VI is a discussion of the syngenetic and hydrothermal hypotheses for the origin of the uranium deposits of the Colorado Plateau. It is believed that the ore minerals probably were precipitated from acidic sulfate groundwater solutions. The uranium may have been derived from a magmatic source or from a sedimentary source. A number of observed facts that may be pertinent to the problem are presented. The hypothesis is favored that the uranium was derived from the sediments. (Auth)

<163>

Gruner, J.W., L. Gardiner, and D.K. Smith; University of Minnesota, Minneapolis, MN

Mineral Associations in the Uranium Deposits of the Colorado Plateau and Adjacent Regions - Interim Report. RME-3092, 48 pp. (1954)

The mineral associations in uranium deposits on the Colorado Plateau are reported. The mineral associations and paragenetic sequence of the ore minerals are similar in most of the deposits, notwithstanding the preponderance of vanadium-bearing minerals in some deposits and sulfides in others. "Black ores", containing uraninite and coffinite, are unoxidized and not necessarily of hydrothermal origin. (Auth)

<164>

Laverty, R.A., and E.B. Gross; AEC, Grand Junction, CO

Paragenetic Studies of Uranium Deposits of the Colorado Plateau. In USGS Professional Paper 300, (pp. 195-201), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955, United Nations, New York, (pp. 533-539), 825 pp. (1956)

A compilation of the paragenetic sequences of several uranium ore deposits of the Colorado Plateau presents evidence for the deposition of the ore under reducing conditions by migrating solutions at a time considerably later than the deposition of the host rock. Host rocks for the uranium all contain organic material, and most contain calcite or limestone, and seams or lenses of mudstone, siltstone, or clay. The organic material and the calcite were the two main precipitants of the black uranium ore minerals, and the lenses and seams of clay-rich rocks are guides in some regions. In places, base-metal sulfides have been precipitants. The uranium minerals occur as cements or replacements during the intermediate stage of the cementing sequence. This rules out syngenetic deposition in place and probably places the time of deposition in the Late Cretaceous or early Tertiary. The fluvial clastic rocks deposited in Mesozoic time in an oxidizing environment are the major uranium-producing formations. Reducing conditions prevailed, owing to decomposition of organic material and limited water circulation; marine submergence in part of the Cretaceous prolonged this condition. The major uranium deposits lie in a zone 10-40 miles from laccoliths intruded into rocks of the Plateau in early to middle Tertiary time. (Auth)

<165>

Luedke, R.G.; USGS, Washington, DC

Tectonic Map of the Colorado Plateau. TEM-301. (1953)

The structure of the Colorado Plateau is characterized by broad uplifts and basins, monoclinal folds, and salt anticlines. These structures are locally modified by large and small faults and by intrusive igneous rocks. Extensive areas of extrusive igneous rocks occur near the margins of the Colorado Plateau. Each of these features is discussed. The map shows structural contours and fault lines and indicates the areas of salt structures and intrusive and extrusive igneous rocks. (Auth)

<166>

McKay, E.J.; USGS, Washington, DC

Geology of the Atkinson Creek Quadrangle, Colorado. USGS Map GQ 57 (With text). (1955)

The Atkinson Creek quadrangle is one of eighteen 7-1 2 minute quadrangles in the carnotite-producing area of southwestern Colorado that are being mapped as part of a study of the carnotite deposits. The regional geology and the stratigraphy, structure, and mineral deposits of the area are described. Rocks exposed in the eighteen quadrangles mapped consist of crystalline Precambrian rocks and sedimentary rocks that range from Late Paleozoic to Quaternary. Crystalline rocks crop out only in the northeastern part of the area along the flanks of the Uncompahgre Plateau; the rest of the area is underlain by sedimentary rocks. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The uranium-vanadium deposits are mostly restricted to the upper layer of sandstone lenses in the Salt Wash member of the Morrison formation of Jurassic age. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals, but rich concentrations are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. The ore bodies range from small irregular masses that contain a few tons of ore to large tabular masses containing many thousands of tons; most ore bodies are relatively small and contain only a few hundred tons. Margins of ore bodies may be vaguely or sharply defined. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts of the sandstone lenses, and commonly near the base of the lenses. The trend of the long direction of the deposits and the trend of the rolls in the sandstones are roughly parallel to the trend of the fossil logs in the sandstone and to the average of resultant dip of the cross-bedding in the sandstone. (Auth)

<167>

Hess, F.L.; USGS, Washington, DC

A Hypothesis for the Origin of the Carnotites of Colorado and Utah. Economic Geology, 9(7), 675-688. (1914)

The composition and areal occurrence of carnotite are described, and previous hypotheses for the origin of the carnotite deposits are reviewed. The carnotite deposits on the Colorado Plateau occur in nearly white, cross-bedded, medium-grained sandstone and are closely associated with fossil carbonaceous material. The carnotite impregnates the sandstone in aureoles around carbonaceous material and replaces plant debris and that part of fossil logs which evidently was most decayed at the time of burial. The hypothesis that the metals were weathered from veins and carried in solution to a shallow sea where they were absorbed or precipitated by decaying organic matter is proposed. Upon the lifting, draining, and aerating of the rocks the minerals were oxidized to form carnotite and other minerals. During and after oxidation, the carnotite moved outward slightly to form aureoles around the carbonaceous matter.

(Auth)

<168>

Hess, F.L.; USGS, Washington, DC

Uranium, Vanadium, Radium, Gold, Silver, and Molybdenum Sedimentary Deposits. In Ore Deposits of the Western States. American Institute of Mining and Metal Engineers, New York, (pp. 450-481), 797 pp. (1933)

Uranium and vanadium deposits are widely distributed on the Colorado Plateau in rocks of Triassic and Jurassic age. The vanadium may occur without visible vegetal fossils, but the uranium is nowhere found without carbonaceous material, either fossiliferous or petroliferous. The uraniferous asphaltite deposits at Temple Mountain, Utah, are in the Shinarump conglomerate of Triassic age. Large deposits of vanadium ore occur in very fine-grained sandstone of the La Plata (Entrada) sandstone of Jurassic age near Placerville, Colorado. The vanadium mineral, roscoelite, impregnates the sandstone to form broad thinly lenticular ore bodies. The edges are enclosed in a halo of sandstone in which is disseminated a chromium mineral, mariposite. The carnotite deposits in the Morrison formation of Jurassic age are in cross-bedded sandstones in the lower part of the formation. Many deposits are confined to replaced logs and halos around them. It is suggested that the metals were removed from dilute solutions directly or indirectly by decaying carbonaceous matter at the time of deposition of the sediments. (Auth)

<169>

Isachsen, Y.W., and C.G. Evensen; AEC, Grand Junction, CO

Geology of Uranium Deposits of the Shinarump and Chinle Formations on the Colorado Plateau. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 350-367), 825 pp.; In USGS Professional Paper 300, (pp. 263-280), 739 pp. (1956)

The Shinarump conglomerate is a continental deposit consisting dominantly of light-gray sandstone with lenses of grit and conglomerate, and lesser interbedded mudstone. Basal Shinarump fills former stream channels cut in underlying beds. Carbonaceous plant material is a common constituent of this filling. Commercial ore is restricted to channel fill. Ore preferentially occurs low on the flanks of these channels or at their base. Ore bodies in the Shinarump conglomerate tend to be elongated parallel to channel trends and commonly are localized along a sandstone-mudstone interface. The Chinle formation is predominantly a fluvial sequence of red to brown siltstones and mudstones interbedded with sandstones and conglomerate. Carbonaceous plant remains are widely distributed in the formation, and asphaltite occurs locally. Ore bodies in the Chinle are not restricted to channels nor to any one stratigraphic unit in the formation; however, most major deposits occur in sandstones or coarser clastics within the lower half of the formation. In some of the larger ore deposits in the Chinle formation at Big Indian Wash major ore controls appear to be structural rather than sedimentary. Copper, copper-uranium and vanadium-uranium deposits have been found in both these formations. Oxidized and unoxidized ore minerals commonly occur together, resulting in rather extensive mineralogic suites. The dominant economic mineral in most deposits is uraninite. Ore minerals occur mainly as disseminations in sandstones, siltstones, and conglomerates and as grains replacing carbonaceous plant material and calcite cement. Localization of ore in channel-fill and other permeable clastic units suggests that transmissivity is a dominent physical ore control. Geochemically, the place of ore deposition appears to be largely determined by the distribution of such substances as carbonaceous matter, calcite, certain clays, and possibly pyrite capable of causing precipitation of the uranyl ion through changes in Eh and pH, as well as by adsorption and base-exchange phenomena. Where uranium occurs in an asphaltite-uraninite complex, as at Temple Mountain, the hydrocarbons are regarded as having migrated into the ore zone later than the uraninite. Bleaching of or other discoloration of red beds, both below and above certain uranium deposits in the Shinarump and Chinle formations, suggests alteration associated with ore deposition. Isotopic age determinations indicate that uranium is epigenetic; the source of the uranium is not known. (Auth)

<170>

Jones, D.J.; University of Utah, Salt Lake City, UT

Sedimentary Features and Mineralization of the Salt Wash Sandstone at Cove Mesa, Carrizo Mountains, Apache County, Arizona. RME-3093 (Part 2). 40 pp. (1954)

Uranium deposits at Cove Mesa are in sandstone beds in the Salt Wash member of the Morrison formation of Jurassic age. Mineralized areas flank the curving trends of areas which have a high sandstone-shale ratio. The Salt Wash paleostream channels changed direction from northwesterly to northeasterly in the Cove Mesa area. Areas marginal to Salt Wash channels, particularly where the channels changed direction, are apparently more favorable for the occurrence of uranium deposits. Cyclic repetition of rock types was observed in the Salt Wash member. The sequence is a massive, friable sandstone, capped by a thinner, strongly cross-bedded sandstone, and is normally repeated three times. The uranium deposits are largely confined to the massive, friable type of sandstone. (Auth)

<171>

Rapaport, I.; AEC, Grand Junction, CO

Interim Report on the Ore Deposits of the Grants District, New Mexico. RMO-1031, 19 pp. (1952)

Uranium deposits in the Grants district occur in the Todilto limestone and in the Morrison formation, both of Jurassic age. The deposits are on the northeast flank of the Zuni uplift and on the Lucero uplift. Unexposed deposits may exist in the intervening McCarty syncline. Exposed rocks range from Precambrian to Tertiary in age. The deposits in the Todilto limestone are in the upper, coarse, crenulated, recrystallized part of the formation. Pitchblende is associated with calcite, pyrite, barite, and fluorite. Uranium vanadates, uranium silicates, and hematite are found in the oxidized parts of the deposits. Some of the deposits are associated with minor semi-cylindrical bulges or anticlines that have no intervening synclines. The deposits seem to follow a zone between the silty limestone facies to the south and the gypsiferous limestone facies to the north. Joints and faults also may have had an influence on the movement and emplacement of ore. The uranium minerals in the Morrison deposits are mainly carnotite with some schroeckingerite and are associated with carbonaceous material and limonite. Carnotite impregnates sandstone, coats fractures, and replaces fossil logs. Paleostream channels, diastems, intricate facies changes, and the presence of organic material seem to localize the ore. The uranium, iron, sulfur, barium, and fluorine probably were transported in solution in hydrothermal waters to the place of deposition. The ore-bearing solutions moved essentially laterally and undoubtedly were mixed with ground water. (Auth)

<172>

Rosenzweig, A., J.W. Gruner, and L. Gardiner; AEC, Grand Junction, CO; University of Minnesota, Minneapolis, MN

Widespread Occurrence and Character of Uraninite in the Triassic and Jurassic Sediments of the Colorado Plateau. Economic Geology, 49(4), 351-361. (1954)

Numerous uranium deposits in the sedimentary rocks of the Colorado Plateau contain uraninite. Although this mineral is not restricted to any one formation, the majority of its occurrences are in the Chinle and Shinarump formations of Triassic age. There are two principal modes of occurrence of uraninite, one with sulfides of copper, the other in asphaltic bodies. In both types, the association with fossil plants is the rule. Uraninite generally replaces cell walls of the plants, and the copper sulfides are more apt to fill the cells. Under these conditions the hardness and reflectivity of the uraninite may differ considerably from that of hydrothermal vein uraninite. The paragenesis of the minerals is complex and somewhat obscure, but a formation of the uraninite contemporaneous with, or shortly followed by, copper sulfides is suggested. (Auth)

<173>

Miller, L.J.; AEC, Grand Junction, CO

Uranium Ore Controls of the Happy Jack Deposit, White Canyon, San Juan County, Utah. Economic Geology, 50(2), 156-169; RME-33, 34 pp. (1955)

The copper-uranium deposit at the Happy Jack mine is in a paleostream channel which contains sediments of the Shinarump conglomerate of

Triassic age. The host rock is a coarse-grained to conglomeratic quartzose sandstone which contains abundant carbonaceous material. This unit is present only in the channels; it is overlain by an intra-channel mudstone unit of the Shinarump and is underlain mainly by dense mudstones of the Moenkopi formation of Triassic age. The ore is associated with organic material, sedimentary structures, and deep areas within the channel. Lithologic controls include bedding planes, petrologic traps, scours within the Shinarump, and basal Shinarump mudstone. Uraninite and copper sulfides impregnate the sandstone and replace carbonaceous material and secondary overgrowths on quartz grains. The ore minerals are nearly contemporaneous. Secondary uranium and copper minerals are minor. The normally red sediments in the vicinity of the ore deposit have been bleached to green, but there is no other evidence of alteration within the deposit. Channels within the Shinarump formation of Triassic age are thought to be the principal uranium ore control in White Canyon, southeastern Utah. Intrachannel controls include carbonaceous matter, lithologic changes, and bedding planes. (Auth)

The report, entitled "Uranium Ore Controls of the Happy Jack Deposit, White Canyon, San Juan County, Utah", was published in 1953 as an AEC report (RME-33).

<174>

Miller, L.J.; AEC, Grand Junction, CO

Uranium Ore Controls in the Happy Jack Mine and Vicinity, White Canyon, Utah. Economic Geology, 47(7), 774; Geological Society of America Bulletin, 63(12), 1280. (1952)

The copper-uranium deposit at the Happy Jack mine is in a paleostream channel which contains sediments of the Shinarump conglomerate of Triassic age. The host rock is a coarse-grained to conglomeratic quartzose sandstone which contains abundant carbonaceous material. This unit is present only in the channels; it is overlain by an intra-channel mudstone unit of the Shinarump and is underlain mainly by dense mudstones of the Moenkopi formation of Triassic age. The ore is associated with organic material, sedimentary structures, and deep areas within the channel. Lithologic controls include bedding planes, petrologic traps, scours within the Shinarump, and basal Shinarump mudstone. Uraninite and copper sulfides impregnate the sandstone and replace carbonaceous material and secondary overgrowths on quartz grains. The ore minerals are nearly contemporaneous. Secondary uranium and copper minerals are minor. The normally red sediments in the vicinity of the ore deposit have been bleached to green, but there is no other evidence of alteration within the deposit. Channels within the Shinarump formation of Triassic age are thought to be the principal uranium ore control in White Canyon, southeastern Utah. Intrachannel controls include carbonaceous matter, lithologic changes, and bedding planes. (Auth)

<175>

Nininger, R.D.; AEC, Washington, DC

Minerals for Atomic Energy. D. Van Nostrand Company, Inc., New York, 367 pp. (1954)

The book is a guide to exploration for uranium, thorium, and beryllium minerals. Part One describes the minerals and mineral deposits that are the sources and potential sources of these metals. Representative uranium deposits on the Colorado Plateau and in other areas are reviewed. Part Two is a survey of the various areas of the world with respect to their favorableness for new deposits of these minerals with particular attention to the United States. Part Three covers prospecting equipment and techniques, the use of the Geiger and scintillation counters, evaluation of deposits, and details of prices, markets, and governmental controls. Appendices include mineral identification tables, classifications of ore deposits, testing and analysis procedures, and other pertinent information. (Auth)

<176>

Page, L.R.; USGS, Washington, DC

Interim Report of Geologic Investigation, Lost Creek Schroeckingerite Deposits, Sweetwater County, Wyoming. TEM-183A, 3 pp. (1950)

Schroeckingerite occurs principally as rounded aggregates as much as one inch in diameter in green, brown, or purple clay, and also as tiny flakes disseminated in sand or sandy clay. The clays are lower Eocene or younger in age and are interbedded with arkosic sands and grits. These beds are overlain by Pleistocene and Recent sands and gravels which conceal the ore-bearing material. The ore beds are relatively continuous along the strike; but, because schroeckingerite is an efflorescent mineral, the deposit probably does not extend to any great depth. The schroeckingerite deposits appear to be associated with the Cyclone Rim fault which is believed to have been the channelway for the uranium-bearing solutions. Suggestions for prospecting are included. (Auth)

<177>

Weir, D.B.; USGS, Washington, DC

Geologic Guides to Prospecting for Carnotite Deposits on Colorado Plateau. USGS Bulletin 988-B, (pp. 15-27). (1952)

The report describes the geologic features that can be used to appraise the favorableness of ground in guiding diamond-drill exploration for carnotite deposits in the Upper Jurassic Morrison formation on the Colorado Plateau. It is based on a statistical study on the geologic logs. The most useful features consist of the thickness and color of the ore-bearing sandstone, the altered mudstone associated with the ore-bearing sandstone, the altered mudstone associated with the ore-bearing sandstone, and the abundance of carbonaceous material in the sandstone. Although each feature can be used alone to appraise the favorableness of the ground, an appraisal based on all of them together is more useful. A method of expressing this in numerical values is suggested. The results obtained appear to be at least twice as favorable as the drilling results obtained with little or no geologic guidance. (Auth)(MBW)

<178>

Wherry, E.T.; USGS, Washington, DC

Carnotite Near Mauch Chunk, Pennsylvania. USGS Bulletin 580-H, (pp. 147-151). (1915)

Carnotite occurs in scattered lenses in a 40-foot layer of coarse-grained conglomerate near the base of the Pottsville formation of Pennsylvanian age about a mile north of Mauch Chunk, Pennsylvania. The outcrop extends for about 2,000 feet along a road cut. The uranium and vanadium are thought to have been original constituents of the host formation. They were later transported by and precipitated from ground-water. (Auth)

An earlier article by Wherry on this occurrence is in the American Journal of Science, 4th Series, 33(198), 574-580.

<179>

Peole, F.G., and G.A. Williams; USGS, Washington, DC

Direction of Sediment Transport in the Triassic and Associated Formations of the Colorado Plateau. In USGS Professional Paper 300, (pp. 227-231), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 326-330), 825 pp. (1956)

Clastic sediments in certain depositional environments develop characteristic features, called sedimentary, primary, or original structures, that reflect the direction in which the transporting medium was moving. These structures include channels, cross-strata, current lineation, and ripple marks; cross-strata are the most useful. From primary structures the direction of transport can be determined, and, as many ore bodies are localized in channel-filling sandstones and tend to be elongate parallel to the channels, these structures are useful guides in the exploration for uranium and vanadium ore deposits. In addition to original structures, fossil-log orientations can be used to supplement the data. Sedimentary-structure studies on the Colorado Plateau have been made on rocks that range in age from Permian through Jurassic. Studies made in the Moenkopi formation, Shinarump conglomerate, and Chinle formation, all of Triassic age, indicate a northwestward direction of sediment transport. The Wingate sandstone of Triassic age and Navajo sandstone of Jurassic age show a southeastward direction. The Kayenta formation of Jurassic age and the Entrada sandstone of Jurassic age have a southwestward direction and the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin members of the Morrison formation of Jurassic age, in general, show a northeastward direction of sediment transport. (Auth)

The conference paper is entitled "Direction of Transportation of the Sediment Constituting the Triassic and Associated

Formations of the Colorado Plateau".

<180>

Stokes, W.L.; University of Utah, Salt Lake City, UT

Primary Sedimentary Trend Indicators as Applied to Ore Finding in the Carrizo Mountains, Arizona and New Mexico.
RME-3043 (Part 1), 48 pp. (1953)

Field studies in three areas in the Carrizo Mountains region indicate that uranium deposits in the Salt Wash member of the Morrison formation are more common in areas where there are well-marked shifts in fluvial trends within the Salt Wash. These changes in stream directions may have been due to paleostructures or to the confluence of paleostreams. The increased favorability of such areas is thought to be due to an increase in the amount of plant debris deposited or buried in place along the stream bends. (Auth)

MAPPING, SURVEYING, AND LOCATION OF DEPOSITS

<181>

Ruzicka, V.; Canada Geological Survey, Ottawa, Ontario, Canada

New Sources of Uranium. Canadian Mining Journal, 96, 41-44. (1975, April)

Uranium deposits of epigenetic origin such as coals and metasomatic deposits, and deposits of syngenetic origin such as sedimentary-metamorphic, effusive-sedimentary, and shale deposits outside Canada are briefly reviewed. Certain uranium bearing formations have been previously found in other parts of the world, but not in Canada. However, there is new evidence that these uranium deposits do exist in Canadian territory. (Auth)(PAG)

<182>

Roehler, H.W.; USGS, Denver, CO

Mineral Resources in the Washakie Basin, Wyoming and Sand Wash Basin, Colorado. In Wyoming Geological Association Guidebook, Twenty-Fifth Field Conference, 1973, (pp. 47-56). (1973)

The combined Washakie and Sand Wash Basins form a roughly circular area about 75 miles in diameter that encompasses the remote southeast part of the greater Green River Basin in southwest Wyoming and northwest Colorado. This desert landscape conceals a wealth of mineral resources including oil and gas, oil shale, bituminous sandstone, coal, uranium, uraniferous phosphate, placer gold, and zeolites. The paper summarizes the history of discovery and the geologic and geographic occurrence of the mineral resources, and in part evaluates the deposits. (PAG)

<183>

Chenoweth, W.L., and R.C. Malan; AEC, Grand Junction, CO

The Uranium Deposits of Northeastern Arizona. In Guidebook of Monument Valley and Vicinity, Arizona and Utah, New Mexico Geological Society. Twenty-Fourth Annual Conference held October 4-6, 1973, 23 pp. (1973, June)

Three percent of the U.S. production of uranium has come from deposits in northeastern Arizona and adjacent areas in Utah and New Mexico. The Chinle, Morrison, Bidahochi, Kayenta, Moenkopi, Navajo, and Toreva formations are located in this area. Tables of geochemical data, maps and charts of deposits are included. (PAG)

<184>

Chenoweth, W.L.; ERDA, Grand Junction, CO

Uranium Deposits of the Canyonlands Area. In Four Corners Geological Society Guidebook, 8th Field Conference, Canyonlands, Utah, 1975, (pp. 253-260). (1975)

The Canyonlands area of southeastern Utah contains major deposits of uranium in the Chinle Formation and significant deposits in the Morrison and Cutler Formations. The Lisbon Valley, White Canyon, Moab, Inter-River, Richardson Basin, Cane Creek-Indian Creek, Montezuma Canyon, La Sal, Cottonwood Wash, and Dry Valley districts are also included in the Canyonlands area. The historical geology, locational data, and geochemical analyses for these formations and districts are presented. (PAG)

<185>

Chenoweth, W.L.; AEC, Grand Junction, CO

Uranium Occurrences of the Nacimiento-Jemez Region, Sandoval and Rio Arriba Counties, New Mexico. In New Mexico Geological Society Guidebook, 25th Field Conference, Ghost

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Ranch (Central-Northern N.M.), 1974, (pp. 309-313). (1974)

Uranium in the Nacimiento Jemez region of north-central New Mexico occurs in rocks of Pennsylvanian, Permian, Triassic, Jurassic, Cretaceous, and Tertiary age. Deposits consist of uranium minerals disseminated in sandstone, siltstone, carbonaceous shale, coal, and limestone and in association with carbonized plant debris in sandstone and in "red bed" copper deposits. Uranium minerals fill interstices of a silicified rhyolite breccia at a single occurrence. Known deposits are small and subeconomic. Slightly more than 600 tons of ore have been produced to date. (Auth)

<186>

Langen, R.E., and A.L. Kidwell; Exxon Company, Denver, CO

Geology and Geochemistry of the Highland Uranium Deposit, Converse County, Wyoming. The Mountain Geologist, 11, 85-93. (1974, April)

The Highland ore deposit, discovered in 1968, is located in the southern part of the Powder River basin, Wyoming. Uranium mineralization consists of sooty, black uraninite and coffinite coating sand grains and is concentrated along the margin of Tertiary sandstone channels. Uranium was transported by oxidizing solutions moving along the buried channels and spreading out into the less permeable channel-edge sands to form typical rolls and tabular deposits. Unaltered sandstones are light gray to gray-buff. Where the sandstones have been oxidized, the colors are various shades of red, yellow and yellowish brown. An Oligocene source for the uranium is proposed; however, leaching of the arkosic host sediments may have provided an additional source. (Auth)

<187>

Adams, S.S., H.S. Curtis, and P.L. Hafen; The Anaconda Company, Uranium Division, Grants, NM

Alteration of Detrital Magnetite-Ilmenite in Continental Sandstones of the Morrison Formation, New Mexico. IAEA-SM-183 36, (pp. 219-253). (1974)

Minor amounts of magnetite and ilmenite are now present locally in the fluvial sandstones of the Morrison Formation. Where these minerals are absent or strongly altered, particularly within and adjacent to uranium deposits, the sands contain authigenic leucoxene, anatase, and perhaps other titanium oxide minerals. Studies of thin sections and heavy mineral concentrates from drill-hole cuttings and core have identified stages in the alteration of ilmenite and magnetite. These alterations are interpreted to have occurred in oxygen-deficient ground waters through the selective dissolution of iron from the magnetite and ilmenite. This dissolution may have been promoted by dissolved organic species. The sites of altered titaniferous magnetite and ilmenite are now occupied by clots of titanium oxides. The intensity of a series of periods of alteration, resulting from variations in the oxidation potential within the ground waters, can be recognized in some instances. It is suggested that the chemical conditions which produced the alteration assemblages described here are essentially those under which the uranium deposits formed. Most important, the interpretation of these alteration assemblages in thin sections and drill cuttings is a useful exploration guide for those deposits in which there is an antipathy between detrital ilmenite and magnetite and uranium mineralization. (Auth)

<188>

Dennison, J.M.; University of North Carolina, Department of Geology, Chapel Hill, NC

Uranium Potential of Mississippian Mauch Chunk-Pennington Groups in Virginias and Maryland. Proceedings of the West Virginia Academy of Science, 44, 160-161. (1972)

The Mauch Chunk Group is mostly clastic with conspicuous reddish shales and siltstones and reddish, greenish, and gray sandstones occurring in the interval between the Greenbrier Limestone and Pottsville Group in Maryland and West Virginia. Equivalent strata between the Newman Limestone and Pottsville Group are called Pennington Formation or Group in Virginia, Kentucky, and Tennessee. From Lee County, Virginia, to Randolph County, West Virginia, the Mauch

Chunk Pennington Group is divided into the Bluefield Formation (800-1250 feet), Hinton Formation (800-1350 feet), Princeton Conglomerate (20-50 feet), and Bluestone Formation (400-800 feet). The sandstones are probably subgraywacke and are too low in feldspar content for optimum protore. Carbonized organic debris occurs in some sandstones, and thin coals are developed from Wise County, Virginia, to Randolph County, West Virginia. Mauch Chunk sedimentation patterns show fining-upward cycles characteristic of alluvial deposition. In West Virginia a typical cycle consists from base upward of channel sandstone, reddish shale and siltstone, commonly a nodular limestone, occasional underclay, and even locally coal. Marine limestone intertongues occur especially in the lower Mauch Chunk and should provide good correlation surfaces. The Mauch Chunk strata are among the most promising rocks for uranium exploration in Maryland and West Virginia. The Pennington Group of Virginia also should be seriously examined, but in Kentucky and Tennessee the Pennington passes westward into marine shale, limestone, and dolomite beds which are unlikely to contain uranium ore. (Auth)(PAG)

<189>

Waters, A.C.; Johns Hopkins University, Department of Geology, Baltimore, MD

Some Uranium Deposits Associated With Volcanic Rocks, Western United States. RME-2049, 20 pp. (1955, November)

Nineteen uranium-bearing localities in the western United States are summarized. These deposits were chosen because they were suspected of having some genetic connection, either directly or indirectly, with Tertiary volcanism. One objective was to compare the uranium mineralization with other kinds of hypothermal mineral deposits commonly found in volcanic areas (i.e., quicksilver, antimony, arsenic, silver). The uranium-bearing deposits associated with volcanic rocks were analyzed and classified into genetic types, and outlined for probable conditions under which they were deposited. Their salient geologic features were also briefly described. (Auth)(MBW)

<190>

Gabelman, J.W.; AEC, Division of Production and Materials Management, Washington, DC

Radon Emanometry of Starks Salt Dome, Calcasieu Parish, Louisiana. RME-4114, 75 pp. (1972, March)

Starks dome was surveyed in 1970 to detect subsurface radon emanations. The salt plug cap, about 3,700 feet in diameter and 1,200 feet deep, is penetrated by hundreds of drill holes through which sulfur and salt have been produced. Oil is derived from small Miocene sand lenses over and alongside the plug at depths of 1,000 to 4,000 feet. Alpha counts were made on soil gas pumped from the bottom of freshly drilled 3-foot holes. Gamma counts were obtained from hole bottoms and the surface. Northeast and northwest traverses across the dome illustrate weak anomalies around the periphery and locally in the interior. The difference in alpha and gamma profiles suggest radon derived from radium at depth rather than from soil. The peripheral anomaly may be controlled by marginal ring faults and the interior anomalies by radial faults; such structures offer convenient and efficient migration channels. No anomalies are directly associated with drill holes, which thus do not serve as channels, perhaps because of casing. The salt plug brine and cap sulfur are not radioactive. Uranium and more abundant thorium identified in petroleum are the probable radon sources. Thorium and uranium are most plentiful in the crude petroleum fraction, less in brine separated from oil, and least in the solid mineral residue that nevertheless contains the most daughter products. Petroleum is well known to scavenge uranium but has less effect on thorium because of the latter's lower surficial mobility. Variations in emanation exceeding the range of anomality were noted in base-station measurements, governed by temperature, pressure, and water content of the soil. A program to measure and evaluate these variations is in progress to establish corrections for future surveys. (Auth)

<191>

McGregor, D.J.; South Dakota Geological Survey, Vermillion, SD

Mineral and Water Resources of South Dakota. South Dakota Geological Survey Bulletin No. 16, 313 pp. (1975)

The revised edition of the report incorporates new developments in mineral and water resources, their distribution and mode of occurrence, uses in industry, and the factors affecting their exploration. The future outlook on new discoveries and enlargement of knowledge of water supplies, including environmental problems is discussed. The future development, production, reserves, resources, sandstone deposits, lignite deposits, and minor occurrences of uranium in South Dakota are briefly presented. A comprehensive list of references and maps is included. (PAG)

The first edition of this report was published in 1964.

<192>

Shawe, D.R., N.L. Archbold, and C.C. Simmons; USGS, Denver, CO; USGS, Belo Horizonte, Brazil

Geology and Uranium-Vanadium Deposits of the Slick Rock District, San Miguel and Dolores Counties, Colorado. Economic Geology, 54, 395-415; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 2, Survey of Raw Material Resources, held in Geneva, Switzerland, September 1-13, 1958. United Nations, New York, (pp. 515-522). (1959)

Sedimentary rocks known in the Slick Rock district in southwestern Colorado range in age from Devonian to Cretaceous, and aggregate about 13,000 feet in maximum thickness. Important uranium-vanadium production has come from deposits in the Salt Wash member of the Morrison formation of Late Jurassic age. Most of the known ore deposits are in the north part of the Slick Rock district in a belt called the Dolores ore zone. The zone lies along the Dolores fault zone but is wider than the fault zone. All known deposits are associated with abundant carbonaceous plant material. Uranium-vanadium deposits in the district are chiefly tabular to lenticular and are roughly parallel to the sedimentary bedding. Some ore bodies, however, are narrow, elongate, and curve sharply across bedding; these bodies have been called "rolls" by the miners. Mineral zoning is evident in some roll bodies. Uranium-vanadium deposits in the district occur only in sandstone that is considered to be epigenetically altered, and the most extensive epigenetic changes have occurred close to ore bodies. (Auth)(MBW)

<193>

Curtiss, R.E.; University of South Dakota, Vermillion, SD; South Dakota Geological Survey, Vermillion, SD

A Preliminary Report on the Uranium in South Dakota. Report No. 79, 102 pp. (1955, June)

The report gives basic fundamentals and general information for prospectors and reviews known uranium deposits and suggests areas favorable for prospecting. The carbonaceous siltstone and lignite deposits of the Cave Hills area, sandstone-type deposits in the Slim Buttes area, and the Edgemont mining district are known deposits. Areas of South Dakota such as the Black Hills and Missouri River area are areas favorable for prospecting. (PAG)

<194>

Miller, T.P.; USGS, Anchorage, AK

Hardrock Uranium Potential in Alaska. USGS Open File Report 76-246, 7 pp. (1975)

The report of uranium deposits in hardrock (non-sedimentary rocks) in Alaska includes a summary of the Bokan Mountain area, the major hardrock mining area and fourteen other localities where uranium and thorium have been reported, generally near the margins of intrusive rocks. Maps showing the distribution of Mesozoic plutonic rocks in western Alaska, and locations of hardrock occurrences of uranium and thorium minerals are included. (PAG)

<195>

Vickers, R.C.; USGS, Washington, DC

An Occurrence of Autunite, Lawrence County, South Dakota. USGS Circular 286, 5 pp. (1953)

An occurrence of autunite was found in the northern part of the Black Hills, South Dakota, during a reconnaissance for radioactive deposits.

The autunite occurs as fracture coatings and disseminations in siltstone of the Deadwood formation of Cambrian age and is concentrated mainly in the lower 2 feet of the siltstone at the contact with an intrusive rhyolite porphyry; the radioactive zone is exposed in two old workings, which are 90 feet apart. An 18-inch vertical channel sample of the autunite-bearing siltstone contained 0.048 percent uranium. The gangue minerals are fluorite and limonite. The uranium is believed to have been introduced into the siltstone by solutions of magmatic origin that migrated along the lower contact of the siltstone after or during emplacement of the porphyry. (Auth)

<196>

Weissenborn, A.E., and W.S. Moen; Washington Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA

Uranium in Washington. In Livingston, V.E., Jr., (Comp.), Energy Resources of Washington, Information Circular No. 50, (pp. 83-97), 158 pp. (1974)

The largest known reserves of uranium in Washington are on the Spokane Indian Reservation. Uranium ore is present in the Mount Spokane area of Spokane County and the Lost Creek area of Pend Oreille County, but total reserves for these areas are probably less than 100,000 pounds. Almost all the uranium minerals are in the metamorphosed sedimentary rock associated with small, steep faults which cut the Precambrian Togo formation near its contact with the quartz monzonite of the Cretaceous Loon Lake batholith. Uranium minerals are found in the interbedded tuffaceous sandstone, arkose and carbonaceous shale of the Gerome Andesite of Oligocene age. Minerals containing uranium in Washington are uraninite, an oxide (and pitchblende, a variety of uraninite); coffinite and uranophane, silicates; and autunite, meta-autunite, phosphuranylite, and torbernite, all of which are phosphates. (PAG)

<197>

Livingston, V.E., Jr., (Comp.); Washington Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA

Energy Resources of Washington. Washington Department of Natural Resources Information Circular No. 50, 158 pp. (1974)

The report provides information on Washington's known and potential energy sources. The five energy sources covered are—geothermal, coal, oil and gas, uranium, and hydroelectric. An article on the implications of terrestrial heat flow on the location of geothermal reservoirs, and articles on each specific energy source were compiled for the inventory. (PAG)

<198>

Heron, S.D., Jr., and H.S. Johnson, Jr.; South Carolina Development Board, Division of Geology, Columbia, SC; Duke University, Geology Department, Durham, NC

Radioactive Mineral Resources of South Carolina. MR-4, 3 pp. (1969)

South Carolina's principal uranium resources are associated with phosphate deposits of the Cooper Marl and Hawthorn Formation in the lower Coastal Plain. Available analyses indicate an average equivalent uranium content of 0.043 percent in the phosphate rock. Phosphate resources are on the order of tens to hundreds of millions of tons of concentrate but the deposits currently appear to be economically marginal. Recovery of the uranium will probably always be feasible only as a by-product of phosphate production. The only other known uranium in South Carolina is present in trace amounts in a few pegmatites and at scattered localities in gneissic and granitic rocks of the Piedmont. Thorium occurs in relative abundance in small to moderately large monazite placers in the Piedmont and Coastal Plain. (Auth)

<199>

Staatz, M.H.; USGS, Washington, DC

Thorium in the United States. USGS Open File Report No. 76-192, 7 pp. (1976)

Thorium is roughly five times as abundant as uranium in the earth's crust. It occurs in seven types of economic or subeconomic deposits. Beach placers occur along the Atlantic coast from Virginia to Florida. Stream placers containing monazite are common in central Idaho and in the Piedmont area of North and South Carolina. Unconsolidated sedimentary rocks containing monazite occur in the McNary Sand in western Tennessee. Consolidated sedimentary rocks include the large Elliot Lake Precambrian deposits in Canada which extends into northern Michigan. The Conway Granite in New Hampshire and the Darby pluton in Alaska are low grade deposits found in igneous rocks. The largest deposit of thorium in carbonatites is in the Powderhorn district in Colorado. Vein deposits contain the largest high grade amounts of thorium. The fifteen known veins are in Montana, Idaho, Wyoming, Colorado, California, Wisconsin, New Mexico, Arizona, Utah, and Alaska. (PAG)

<200>

Love, J.D.; USGS, Washington, DC

Preliminary Report on Uranium Deposits in the Miller Hill Area, Carbon County, Wyoming. USGS Circular 278, 10 pp. (1953)

A sequence of radioactive rocks of Miocene age, the Browns Park formation, in the Miller Hill area of southern Wyoming is more than 1,000 feet thick. The formation crops out in an area of about 600 square miles, and consists of a basal conglomerate, tuffs, tuffaceous limy sandstones, and thin persistent radioactive algal limestones. Uranium is concentrated in both algal limestones and in tuffaceous limy sandstones. The uranium may have been deposited at least in part with the sediments, rather than at a later date. The highest uranium values were found in a widespread algal limestone bed, which contains as much as 0.15 percent uranium. Values of 0.01 percent uranium or more were obtained from 8 samples taken from about 200 feet of stratigraphic section in the Browns Park formation. An airborne radiometric survey was made of the west half of the area. Ground check of all anomalies reported at that time showed that they were in localities where the background radiation was much higher than average. Additional localities with high background radiation were found on the ground to the east of the area surveyed with airborne equipment. (Auth)

<201>

White, M.G.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits Along the Upper Porcupine and Lower Coleen Rivers, Northeastern Alaska. USGS Circular 185, 13 pp. (1952)

The highest equivalent-uranium content found in the sedimentary rocks on the upper Porcupine River, northeastern Alaska, is 0.005 percent. Rhyolitic dikes associated with a granitic intrusive a few miles north of the Porcupine, along the international boundary, contain about 0.006 percent equivalent uranium, which is attributed to small amounts of disseminated radioactive accessory minerals. The granite also is slightly radioactive. (Auth)

<202>

Finch, W.I.; USGS, Washington, DC

Uranium in Eastern New Mexico. USGS Open File Report, 19 pp. (1972)

Known uranium occurrences in eastern New Mexico are all small; total production of uranium ore is less than 50 tons and reserves are a few hundred tons. The most numerous and largest deposits are near the base of the middle fluviatile sandstone member of the Chinle Formation of Late Triassic age. Uranium deposits of ore grade occur in the Morrison, Chinle, Yates, and Sangre de Cristo Formations; uraniferous rock of sub-ore grade occurs in the Santa Rosa, Redonda, and Gatuna Formations, and in Pleistocene ash. (Auth)

<203>

Chenoweth, W.L., and R.C. Malan; AEC, Uranium Workshop, Grand Junction, CO

Significant Geologic Types of Uranium Deposits, United States and Canada. AEC Paper No. 5, 54 pp. (1969, October)

The geologic and geographic setting of the significant uranium deposits in the United States is described and classified in two categories according to mode of occurrence: (1) stratiform deposits, mainly in continental fluvial sediments, comprising over 96% of the total U.S. production plus ore reserves; (2) vein deposits, which include contact, pipe and vein deposits comprising less than 4% of the U.S. total. The age, origin, lithology and other geologic features of the host rocks which exemplify the ore habits are discussed. The mineralogy and distribution of the ore deposits are briefly mentioned in comparing the major districts. Some comments are pointed toward favorable geologic environments and favorable in contrast to unfavorable lithologic criteria, but the genesis of the ore is not discussed. A brief description of the significant Canadian deposits is also given. (Auth)

<204>

Chenoweth, W.L.; AEC, Production Evaluation Division, Grand Junction, CO

The Boyd Uranium Deposit in the Fruitland Formation, San Juan County, New Mexico. RME-107, 13 pp. (1958, September)

Uranium occurs in a sandstone lens in the lower part of the Upper Cretaceous Fruitland formation at the Boyd claims, 14 miles northwest of Farmington, New Mexico. No uranium minerals are visible, but microscopic uranium minerals from a zone at the base of the sandstone lens were identified. Ground-water leaching has removed much of the original deposit; only that in the lower portion of the host rock remains. (Auth)

<205>

Not given; Alaska Department of Natural Resources, Division of Geological Survey, College, AK

General Alaskan Mineral Information. Alaska Department of Natural Resources Information Circular No. 5, 8 pp. (1971, July 8)

The brief description of the mineral resources of Alaska includes information on the first production of uranium in 1957, which was a periodically mined high-grade ore deposit discovered on Bokan Mountain in the Ketchikan district. Promising uranium properties lie in the near vicinity and other prospects such as Brooks Mountain and Seward Peninsula where the mineral zeunerite is found are located in other parts of Alaska. (PAG)

<206>

Curry, D.L.; AEC, Production Evaluation Division, Grand Junction, CO

Geologic Studies and Reconnaissance for Uranium in Southeastern Montana. TM-D-1-12, 32 pp. (1959, June)

The region discussed in the report occupies an area of about 20,000 square miles in the southeastern part of Montana. Lignite- and coal-bearing strata of late Cretaceous and Paleocene age immediately underlie more than two-thirds of the region, and rocks of Precambrian to Recent age crop out elsewhere in the region. Small deposits of uranium have been found in carbonaceous rocks in the Tongue River member of the Fort Union formation of Paleocene age on the east flank of a small syncline in the Ollie-Carlyle district of Fallon and Wibaux Counties. Small ore-grade occurrences have also been found in carbonaceous rocks in the Hell Creek formation of late Cretaceous age on the west flank of a larger syncline in the Long Pine Hills of Carter County. The uranium in the region was probably derived from leaching of the once-extensive uraniferous White River and Arikaree formations of Oligocene and Miocene age. Transportation of the uraniferous solutions may have been by lateral ground-water migration through partially confined or artesian aquifers. Nearly all known uranium occurrences are in strata possessing at least minor amounts of carbonaceous material, which has a strong affinity for uranium. Deposition of uranium may have been favorably influenced by reductions in the rate of ground-water flow due to decrease in dip. The most promising part of the region for the discovery of uranium ore appears to be the eastern one-third, where most known occurrences exist, and the Big Horn Mountains in the extreme west.
Commercial-grade uranium deposits have been discovered in the Madison limestone of Mississippian age of Big Pryor Mountain, a few miles west of the Big Horn Mountains. (Auth)

<207>

Not given; USGS, Washington, DC

Selected Papers on Uranium Deposits in

the United States. USGS Circular 220, 35 pp. (1952)

The distribution, mineralogy, and occurrences of uranium are reviewed. The six papers summarize knowledge of primary deposits; pitchblende, fluorite, sandstone, shale, limestone, and lignite, and secondary deposits; oxides, phosphates, silicates, vanadates, arsenates, sulfates, and carbonates. (PAG)

<208>

Kaiser, E.P., and L.R. Page; USGS, Washington, DC

Distribution of Uranium Deposits in the United States. In USGS Circular 220, (pp. 1-7), 35 pp. (1952)

Uranium deposits in the United States may be grouped as deposits with structural control, and deposits with stratigraphic control. The deposits with structural control include veins, breccias, and pipes; disseminated deposits associated with fractures; pyrometasomatic deposits; and pegmatites. The deposits with stratigraphic control include phosphates, carbonaceous shales, and lignites; limestone and dolomite; deposits of the carnotite type; and surficial or caliche deposits. Most of the known uranium deposits are in the western United States. Arizona, Utah and Colorado contain the largest number of deposits. The deposits with structural control, except the uraniferous pegmatites, are commonly in or related to igneous rocks of post-Cretaceous age, and many of them are associated with Tertiary volcanic rocks. Notably few deposits are genetically related to pre-Cambrian rocks and to Jurassic intrusives. The pegmatite deposits of the western United States are believed to be pre-Cambrian; those of the eastern United States are post-Devonian. Carbonaceous shales, phosphates, and lignites are restricted, for the most part, to terranes of Paleozoic and Tertiary age. Most of the carnotite-type deposits are in sedimentary rocks of Mesozoic age, and the most productive deposits are in rocks of Jurassic age. Study of the distribution of known deposits indicates that the principal favorable areas for further prospecting are those in or near Triassic and Jurassic sedimentary rocks and Tertiary igneous rocks. (Auth)

<209>

Wilmarth, V.R., H.L. Bauer, Jr., M.H. Staatz, and D.G. Wyant; USGS, Washington, DC

Uranium in Fluorite Deposits. In USGS Circular 220, (pp. 13-18), 35 pp. (1952)

The association of small quantities of fluorite with uranium minerals in veins has been reported for many localities. Recent studies in Colorado, Utah, Wyoming, and New Mexico further indicate that uranium is a common constituent of many fluorite deposits. Fluorite deposits known to contain uranium occur in breccia zones, veins, pipes, and bedded replacement deposits. These deposits can be grouped on the basis of essential minerals as fluorite, fluorite-quartz-sulfide, and fluorite-sulfide deposits. The deposits contain pitchblende or other primary uranium minerals, together with such secondary uranium minerals as schroeckingerite, torbernite, autunite, uranophane, carnotite, and sklodowskite. In some deposits the uranium occurs as fine-grained primary minerals disseminated through the fluorite ore body; in others the uranium is in the fluorite itself in a form not yet identified. Secondary uranium minerals coat fracture surfaces and vugs in both the ore bodies and adjacent wall rocks. Purple fluorite is commonly associated with radioactive deposits, but because of the many exceptions to this rule it is of limited value. (Auth)

<210>

King, R.U., F.B. Moore, and E.N. Hinrichs; USGS, Washington, DC

Pitchblende Deposits in the United States. In USGS Circular 220, (pp. 8-12), 35 pp. (1952)

Pitchblende is found in the United States in veins and breccia zones, pyrometasomatic deposits, pegmatites, and sedimentary rocks. On the basis of past production, the deposits in veins and breccia zones are of the greatest commercial significance. Most of the vein deposits containing pitchblende are in the Front Range mineral belt of Colorado, but a few are in Arizona, Idaho, Montana, Nevada, and Utah. The pitchblende deposits in the Front Range mineral belt appear to be coextensive with alkali-rich Tertiary intrusive rocks, but a similar relation is not known elsewhere in the United States. Pitchblende-bearing vein deposits can be classified on the basis of mineral association as quartz-sulfide type, quartz-sulfide-carbonate type, quartz-sulfide-carbonate-hematite type and fluorite-quartz type. Pitchblende is finely disseminated in deposits of the fluorite-quartz type. In mesothermal veins, pitchblende occurs as pods and stringers distributed erratically over relatively narrow vertical limits. In many deposits, pitchblende occurs both as hard botryoidal masses and as powdery films and coatings. The metallic minerals commonly associated with pitchblende in vein deposits include galena, sphalerite, chalcopyrite, pyrite, silver minerals, and gold. In contrast to well-known deposits in Canada and Africa, cobalt or nickel minerals have been found in only a few of the domestic pitchblende-bearing veins. In a few places, veins containing secondary uranium minerals near the surface contain pitchblende at depth. The relationship of pitchblende-bearing veins to types of wall-rock alteration has not been clearly established. (Auth)

<211>

Stugard, F., Jr., D.G. Wyant, and A.J. Gude, 3rd; USGS, Washington, DC

Secondary Uranium Deposits in the United States. In USGS Circular 220, (pp. 19-25), 35 pp. (1952)

Reconstituted, or secondary, uranium minerals found in domestic deposits include oxides, phosphates, silicates, vanadates, arsenates, sulfates, and carbonates. Next to the vanadates carnotite and tyuyamunite, the most abundant are the phosphates autunite and torbernite and the silicate uranophane. Less common secondary uranium minerals are the oxides "gummite" and pitchblende; the phosphates dumontite and uranocircite; the silicates kasolite, sklodowskite, and soddeite; the arsenates zeunerite and uranospinite; the sulfates zippeite, uraconite, and johannite; and the carbonate schroeckingerite. Other secondary minerals, in general, are only of mineralogic interest. Many secondary uranium mineral deposits show no obvious relation to known primary uranium minerals. The deposits now being mined at Marysvale, Utah, however, are surface expressions of pitchblende-bearing deposits. Recent studies indicate that formation of secondary minerals has in some places resulted in concentration and elsewhere in dispersion of uranium. Concentrations from ground water have formed extensive deposits of schroeckingerite in Sweetwater County, Wyoming. Many uranium compounds appear to be highly soluble and mobile. Successful distinction between secondary deposits resulting from concentration and those resulting from dispersion of primary deposits has not generally been made to date. Some sooty pitchblende is secondary. (Auth)

<212>

Gott, G.B., D.G. Wyant, and E.P. Beroni; USGS, Washington, DC

Uranium in Black Shales, Lignites, and Limestones in the United States. In USGS Circular 220, (pp. 31-35), 35 pp.; Geological Society of America-New York Bulletin, 62, 1535. (1952)

Small quantities of uranium occur in carbonaceous deposits at a great many localities in the United States, but the amount rarely exceeds 0.1 percent. The most common uranium-bearing carbonaceous deposits are in the black marine shales, principally of Paleozoic age, exposed in the eastern and central parts of the United States. The uranium content of most of these shales ranges from a few thousandths to a little more than 0.01 percent. Another type of low-grade uranium-bearing carbonaceous deposit is represented by some of the lignite deposits of Tertiary age in Montana, Nevada, North Dakota, South Dakota, and Wyoming. The uranium content of these uraniferous lignites is comparable to that of the black shales. The concentration of uranium in the lignite ash, however, is considerably greater than in the black shales. Several widely distributed uranium deposits in limestone, most of which are low grade, have been discovered recently in Missouri, New Mexico, New Jersey, Utah, and Vermont. The limestones range in age from pre-Cambrian to Tertiary. In some of these deposits the uranium is associated with phosphatic, carbonaceous, or argillaceous material. In others, secondary uranium minerals occur as fillings in fractures and vugs. (Auth)

<213>

Wyant, D.G., E.P. Beroni, and H.C. Granger; USGS, Washington, DC

Some Uranium Deposits in Sandstones. In USGS Circular 220, (pp. 26-30), 35 pp. (1952)

The uranium deposits in sandstone of the Jurassic Morrison and Entrada formations of the Colorado Plateaus are relatively well known and have long been the principal sources of domestic uranium and vanadium. Not so well known are uranium deposits in other sandstones that range in age from Paleozoic to Recent. Of the uranium deposits in sandstone, some are of the type common to the Colorado Plateaus, but many others differ from this type in mineralogy, host rock, localization, and possible origin. The deposits may be grouped on the basis of mineral or metal assemblage into uranium-vanadium deposits; copper-uranium-vanadium-carbonized wood deposits; uraniferous asphalt deposits; and miscellaneous deposits including carbonate deposits. In general these deposits occur in lenses of argillaceous sandstone or conglomerate interbedded with shales. Common associated materials are iron oxide, carbon, and copper compounds. The localization of some of these deposits appears to be controlled by initial sedimentary features of the enclosing rock, that of others by porosity, fractures, and proximity to the surface. Some of the uranium minerals may have been deposited from ground water, some may have formed by weathering and oxidation of other minerals, and some may be hydrothermal in origin. (Auth)

<214>

Olson, J.C.; USGS, Lakewood, CO

Uranium Deposits in the Cochetopa District, Colorado, in Relation to the Oligocene Erosion Surface. USGS Open File Report 76-222, 13 pp. (1976)

The principal uranium deposit in the Cochetopa district, at the Los Ochos mine, is in Junction Creek Sandstone, Morrison Formation, and Precambrian rocks. The deposit is localized just beneath the restored position of the old land surface that was buried by Oligocene volcanic rocks and has since been eroded away near the mine. Contours drawn on this ancient surface show the position of the paleovalley of the ancestral Cochetopa Creek, which flowed northward through the district slightly east of its present position. The Los Ochos uranium deposit is in the Los Ochos fault zone near the point where it is crossed by the pre-volcanism Cochetopa paleovalley. This localization suggests the possibility that the fault zone provided the conditions favorable for deposition of uranium from ground waters moving through overlying volcanic rocks and down the ancient paleovalley on the pre-Oligocene unconformity. (Auth)

This report is based on a talk given at the USGS Uranium and Thorium Research and Resource Conference held December 8-10, 1975, at Golden, Colorado.

<215>

Christman, R.A., A.M. Heyman, L.F. Dellwig, and G.B. Gott; USGS, Washington, DC

Thorium Investigations 1950-52, Wet Mountains, Colorado. USGS Circular 290, 40 pp. (1953)

Reconnaissance investigations for uranium were made in the Wet Mountains thorium district. The size of this new district is not known, but the deposits found are in an area 20 miles long and about 10 miles wide, the southwest boundary of which extends north-northwestward from Querida and Rosita, Custer County, into Fremont County, Colorado. Most of the deposits, however, are in the southeastern half of this area. Thorite has been tentatively identified as the principal radioactive mineral. It commonly is associated with barite, quartz, galena, fluorite, limonite, pyrite, and rare-earth oxides. Some of the shear zones perhaps can be traced for more than a mile, but the largest known thorium-bearing ore body is 300 feet long, 26 feet wide, and 400 feet deep. Channel samples from the veins contain as much as 4.5 percent equivalent ThO_2. The uranium content is generally about 0.002 percent. Eleven diamond-drill holes, totaling 3,291.2 feet have explored five shear zones on the Haputa ranch. Three ore bodies of possible economic interest are indicated in two interconnecting shear zones. (Auth)(PAG)

<216>

Pierson, C.T., and Q.D. Singewald; USGS, Washington, DC

Results of Reconnaissance for Radioactive Minerals in Parts of the Alma District, Park County, Colorado. USGS Circular 294, 9 pp. (1953)

The pitchblende in the Alma mining district, Park County, Colorado is associated with Tertiary veins of three different geologic environments: (1) veins in pre-Cambrian rocks, (2) the London vein system in the footwall block of the London fault, and (3) veins in a mineralized area east of the Cooper Gulch fault. Pitchblende is probably not associated with silver-lead replacement deposits in dolomite. Secondary uranium minerals, as yet undetermined, are associated with pitchblende on two London vein system mine dumps and occur in oxidized vein material from dumps of mines in the other environments. Although none of the known occurrences is of commercial importance, the Alma district is considered a moderately favorable area in which to prospect for uranium ore because 24 of the 43 localities examined show anomalous radioactivity; samples from anomalously radioactive localities, which include mine dumps and some underground workings, have uranium contents ranging from 0.001 to 1.66 percent. (Auth)(PAG)

<217>

Becraft, G.E.; USGS, Washington, DC

Preliminary Report on the Comet Area, Jefferson County, Montana. USGS Circular 277, 8 pp. (1953)

Several radioactivity anomalies and a few specimens of sooty pitchblende and other uranium minerals have been found on the mine dumps of formerly productive base- and precious-metal mines along the Comet-Gray Eagle shear zone in the Comet area in southwestern Montana. The shear zone is from 50 to 200 feet wide and has been traced for at least 5 1/2 miles. It trends N 80 degrees W across the northern part of the area and cuts the quartz monzonitic rocks of the Boulder batholith and younger silicic intrusive rocks, as well as prebatholithic volcanic rocks, and is in turn cut by dacite and andesite dikes. The youngest period of mineralization is represented by chalcedonic vein zones comprising one or more discontinuous stringers and veins of crypto-crystalline silica in silicified quartz monzonite and in alaskite that has not been appreciably silicified. In some places these zones contain no distinct chalcedonic veins but are represented only by silicified quartz monzonite. These zones locally contain uranium in association with very small amounts of pyrite, galena, ruby silver, argentite, native silver, molybdenite, chalcopyrite, arsenopyrite, and barite. At the Free Enterprise mine, uranium has been produced from a narrow chalcedonic vein that contains disseminated secondary uranium minerals and local small pods of pitchblende and also from disseminated secondary uranium minerals in the adjacent quartz monzonite. (Auth)

<218>

Vickers, R.C.; USGS, Washington, DC

Alteration of Sandstone as a Guide to Uranium Deposits and Their Origin, Northern Black Hills, South Dakota. Economic Geology, 52(6), 599-611. (1957, September)

Several uranium deposits are present in the Fall River sandstone of Early Cretaceous age on the northeast flank of the Black Hills, Butte County, South Dakota. The deposits are within a fine-grained, well-sorted, persistent basal sandstone unit that ranges in thickness from 2 to 18 feet and dips about 4 degrees NE. Detailed mapping of about 2 square miles surrounding the deposits has shown that all the uranium occurrences and most of the areas of high radioactivity are where the color changes in the basal sandstone from reddish on the up-dip side of the occurrences to yellowish-gray or buff on the down-dip side. Radioactivity measurements show that uranium is distributed almost continuously along the sinuous red-buff contact for more than 5 miles. Laboratory work indicates that the red color is caused by hematite resulting from the alteration of ferrous iron minerals and hydrous ferric oxides. The close association of the red-buff contact and the uranium deposits suggests that the two were formed by the same solutions. The uranium was probably deposited originally from ground water that moved down-dip and gradually changed from an oxidizing solution near the surface to a mildly reducing solution at depth. Concentrations of uranium have resulted from the localization of reducing conditions caused perhaps by structures superimposed on the regional dip, local thinning or decrease in permeability of the sandstone, or concentrations of pyritiferous carbonaceous material. The red alteration is probably the result of pre-Oligocene weathering that has extended downward in the more permeable beds about 200 feet below the ancient erosion surface. Oxidation of the primary uranium during the present weathering cycle has resulted in the formation of carnotite and possibly other secondary uranium minerals. (Auth)

<219>

Jarrard, L.D.; Montana Bureau of Mines and Geology, Montana School of Mines, Butte, MT

Some Occurrences of Uranium and Thorium in Montana. Montana Bureau of Mines and Geology Miscellaneous Contribution No. 15, 90 pp. (1957)

The report summarizes and condenses the present knowledge of the occurrences of uranium and thorium in Montana and attempts to suggest certain guides based on the geological features of the state and on the geologic criteria observed at other deposits. Information on prospecting instruments and methods, prospecting and mining laws, and appraisals and testing is included. (PAG)

<220>

MacKevett, E.M., Jr.; USGS, Washington, DC

Geology and Ore Deposits of the Kern River Uranium Area, California. USGS Bulletin 1087-F, (pp. 169-222). (1960)

In the Kern River uranium area, an area of about 30 square miles in northeastern Kern County, California, small uranium deposits are erratically distributed along fractures, most of them within the Isabella granodiorite. The deposits probably are too small and of too low grade to be worth mining on a large scale, but they contain local concentrations of ore. Uranium was first discovered in the area in January 1954 at the Miracle mine. Four shipments of uranium ore, totaling about 189 tons, were made in 1954 and 1955; 2 were from the Miracle mine and 2 from the Kergon mine. The most valuable shipment was the first one from the Miracle mine, which consisted of 46 tons of ore containing 0.53 percent uranium. The other shipments contained, respectively, 0.14 percent, 0.18 percent, and 0.16 percent uranium. The principal ore mineral is autunite, but minor amounts of sooty pitchblende, carnotite, and metazeunerite have been found. Common gangue minerals are scarce or altogether lacking in most of the deposits, and wallrock alteration is generally weak or absent. Most of the deposits probably formed in low-temperature near-surface environments and are epithermal. Some of the numerous hot springs in the area and nearby may have influenced uranium deposition. A possible alternative explanation for the origin of some of the deposits is that the uranium was derived from the Isabella granodiorite. This rock locally contains abnormal amounts of uranium, and it is conceivable that some uranium was leached from it and subsequently deposited in fractures. Minor gold deposits, in both lodes and placers, and small tungsten deposits associated with quartz veins or disseminated in tactite also occur in the area. (Auth)

<221>

MacKevett, E.M., Jr.; USGS, Washington, DC

Geology and Ore Deposits of the Bokan Mountain Uranium-Thorium Area, Southeastern Alaska. USGS Bulletin 1154, 125 pp. (1963)

The Bokan Mountain uranium-thorium area includes about 71 square miles on the southern part of Prince of Wales Island and is largely underlain by plutonic rocks. Metasedimentary and metavolcanic rocks, probably of Devonian age, underlie about 5 percent of the area. The plutonic rocks, which are probably Cretaceous in age, range from pyroxenite to peralkaline granite and syenite, but they consist chiefly of diorite, quartz diorite, granodiorite, and quartz monzonite. The peralkaline granite, an uncommon rock type, forms a boss about 3 square miles in areal extent and contains abnormal quantities of many minor elements. Pegmatite and aplite dikes are common in and near the boss, but uncommon elsewhere. Fine-grained mafic dikes, chiefly of andesite and dacite, are abundant throughout most of the area, and diabase, rhyolite, and quartz latite dikes are sparsely distributed. The rocks are cut by numerous faults and joints. Most of the uranium-thorium deposits are genetically related to the peralkaline granite, and they occur either in the boss or within an altered (albitized) aureole, as much as 1 1 2 miles wide, that surrounds the boss. Many radioactive minerals and a few minerals that contain rare earths and niobates were identified during the investigation. The minor elements of the rocks and ores were investigated by semi-quantitative spectrographic analyses, and an endeavor was made to trace the distribution of 29 minor elements throughout the plutonic rock sequence. (Auth)(PAG)

<222>

Patterson, J.A.; AEC, Division of Raw Materials, Washington, DC

Character of the United States Uranium Deposits. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria. (pp. 117-127). 386 pp.; IAEA-PL-391 2. (pp. 117-127). 386 pp. (1970, October)

Uranium deposits are widespread in the western United States and occur in a variety of geologic environments. However, resources are preponderately in tabular disseminated deposits in sedimentary host rocks of the Colorado Plateau and the Wyoming Basins. The deposits of the Plateau area are largely in sandstone of Jurassic or Triassic ages. In the Wyoming Basins, the deposits are in sandstones of Tertiary age. The 3100 deposits reported are log normally distributed with a median size of only 2.5 short tons U3O8. The 25 largest deposits (over 3000 short tons of U3O8 each contain about half the U.S. resources. Most known deposits are comparatively shallow, less than 700 feet deep, but important deposits are being found at depths exceeding 2000 feet. The ores are predominantly uraninite and coffinite types. (Auth)

<223>

Bowie, S.H.U.; Institute of Geological Sciences, London, United Kingdom

World Uranium Deposits. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 23-33). 386 pp.; IAEA-PL-391 19. (pp. 23-33). 386 pp. (1970, October)

Peneconcordant uranium deposits in quartz-pebble conglomerates and in medium- to coarse-grained sandstones constitute the most important concentrations of uranium known at present. Discordant occurrences of vein, pegmatite or contact metamorphic type contain smaller but significant tonnages which generally have to be relatively high grade to be worked economically. Major peneconcordant deposits are those of the Elliot Lake - Blind River area of Canada, the Colorado Plateau of the USA and the Witwatersrand basin in the Republic of South Africa. Important new deposits also occur in the Tin Mersoi basin of Niger. France, Australia and Spain have reserves of over 10,000 short tons of uranium oxide in discordant but also to variable extents in peneconcordant deposits. (Auth)

<224>

Roeber, M.M., Jr.; New Mexico Bureau of Mines and Mineral Resources, Homestake Mining Company, Grants, NM

Possible Mechanics of Lateral Enrichment and Physical Positioning of Uranium Deposits, Ambrosia Lake Area, New Mexico. New Mexico Bureau of Mines and Mineral Resources Circular 118, (Suppl.), 16 pp. (1972)

Two ages of uranium enrichment are recognized in the Ambrosia Lake area deposits. Although each age of enrichment is mechanically and chemically somewhat different from the other, both are lateral variations of the more commonly known supergene enrichment processes. Secondary lateral enrichment processes were superimposed around some deposits that resulted from an earlier age of lateral enrichment. Consequently, younger deposits now engulf older deposits in parts of the area. The paper briefly illustrates the possible mechanics of enrichment and the physical positioning of the Ambrosia Lake area deposits and compares them with sedimentary uranium deposits in other areas. (Auth)(MBW)

<225>

Girdley, W.A., J.E. Flook, and R.E.

Harris; Lucius Pitkin Incorporated, Grand Junction Operations, Grand Junction, CO

Subsurface Stratigraphy and Uranium-Vanadium Favorability of the Morrison Formation, Sage Plain Area, Southeastern Utah and Southwestern Colorado. GJO-912-21, 97 pp. (1975, August)

Four members of the Morrison Formation of Late Jurassic age are present in all or part of the Sage Plain and adjacent areas of Colorado and Utah, and each comprises a sandstone and mudstone assemblage of fluvial origin. These are, in ascending order, the Salt Wash, Recapture, Westwater Canyon, and Brushy Basin Members. Configuration of Morrison depositional patterns is best determined by the thickness and lithofacies distribution of its members. Lithofacies parameters that are most readily determined from well logs include the net sandstone, the percent sandstone, and the number of thick (greater than 20 feet) sandstones. These parameters essentially reflect the relative distribution of sandstone and mudstone and therefore aid in differentiating channel and floodplain depositional realms. Presumably, the occurrence together of abundant sandstone and a large number of thick individual sandstones is indicative of a predominantly channel facies which is the most favorable environment for uranium deposits in the Morrison. Logs of several petroleum test wells in the thickened interval of the Salt Wash fan indicate anomalous radioactivity in Salt Wash sandstone. The area underlain by the thick sandstone-rich Salt Wash interval is the single most favorable one for uranium potential. Additional prospective areas for Salt Wash uranium deposits are the Disappointment Valley and Dry Creek synclines. The Westwater Canyon Member contains sufficient sandstone to be a suitable uranium host but it has only one known uranium occurrence. The bentonitic mudstone of the Brushy Basin Member may be a source of uranium. (Auth)(MBW)

<226>

Ferm, J.C., and M.C. Galloway; University of South Carolina, Department of Geology, Columbia, SC

Permo-Carboniferous Depositional Environments and Radioactivity in Eastern United States. GJO-7405, 82 pp. (1971, May 31)

Although Permo-Carboniferous, rocks of eastern United States have long been known to be of fluvial or deltaic origin, recent developments in environmental diagnosis have led to a much sharper definition of the relationships between rock types and specific environments. This knowledge has made possible relatively detailed mapping of depositional units and a better understanding of the source rocks from which these sediments were derived. The present analysis of the Permo-Carboniferous rocks of eastern United States shows a complete range of depositional environments from offshore marine to alluvial. In some parts of the sequence, all of these environments were formed in an oxidizing setting whereas, in other parts, an essentially oxidizing offshore province was separated from a reducing fluvio-deltaic zone by a major beach barrier system. All of the fluvio-deltaic sediments contain at least some volcanic detritus and organic woody matter is generally common. Most of these rocks, at least before intense compaction, are sufficiently permeable to permit transmission of ore-bearing fluids. Although no significant quantities of uranium are now known in the Appalachian Permo-Carboniferous, some possible prospective areas are indicated in central and eastern West Virginia, eastern Pennsylvania, easternmost Kentucky and north central Alabama. (Auth)(MBW)

<227>

Melin, R.E.; Utah Construction and Mining Company, Mineral Development and Geology Department, Salt Lake City, UT

Description and Origin of Uranium Deposits in Shirley Basin, Wyoming. Economic Geology, 59(5), 835-849. (1964)

Large, rich uranium deposits in Shirley Basin, Wyoming, exist in arkosic sandstone beds of the Wind River formation and apparently were deposited from weakly acidic, relatively reducing uraniferous ground water solutions that originated in the same formation. The mineralizing solutions presumably invaded alkaline ground and were neutralized; uranium was deposited in the zone where neutralization took place. Uraninite is the principal uranium mineral in the deposits, and the deposits also contain calcite and small amounts of hematite, pyrite, and marcasite. Uraninite is paragenetically younger than calcite, and calcite is younger than hematite. Ground transgressed by the acid mineralizing solution is distinctively altered, and this alteration consists of change in color of the sand, removal of calcite and pyrite, and formation of limonite and nontronite. Uranium was presumably leached from arkosic sandstone and conglomerate units of the Wind River formation by slightly acidic ground water in areas permeated by the acid ground water; the solution subsequently migrated into normal alkaline ground. The acidity of the solution was consumed as it moved through alkaline ground, and the neutralization resulted in precipitation first of uranium oxide, then calcite, and finally ferric hydroxide from the mineralizing solution. Continuing encroachment of mineralized acid ground water redissolved these numerals on the acid side of the neutralization zone and moved them toward the alkaline side, thus causing the neutralization zone to migrate continuously during the emplacement process. The final position of the neutralization zone is the presently existing mineralized envelope. (Auth)

<228>

Wyant, D.G.; USGS, Washington, DC

The East Slope No. 2 Uranium Prospect, Piute County, Utah. USGS Circular 322, 6 pp. (1954)

The secondary uranium minerals autunite, metatorbernite, uranophane, and schroeckingerite occur in altered hornfels at the East Slope No. 2 uranium prospect. The deposit in sec. 6, T. 27 S., R. 3 W., Piute County, Utah, is about 1 mile west of the Bullion Monarch mine which is in the central producing area of the Marysvale uranium district. Hornfels, formed by contact metamorphism of rocks of the Bullion Canyon volcanics bordering the margin of a quartz monzonite stock, is in a fault contact with the later Mount Belknap rhyolite. The hornfels was intensely altered by hydrothermal solutions in pre-Mount Belknap time. Hematite-alunite-quartz-kaolinite rock, the most completely altered hornfels, is surrounded by orange to white argillized hornfels containing beidellite-montmorillonite clay, and secondary uranium minerals. The secondary uranium minerals probably have been derived from pitchblende, the primary ore mineral in other deposits of the Marysvale area. The two uranium-rich zones, 4 feet and 5 feet thick, have been traced on the surface for 60 feet and 110 feet, respectively. Channel samples from these zones contained as much as 0.047 percent uranium. The deposit is significant because of its position outside the central producing area and because of the association of uranium minerals with alunitic rock in hydrothermally altered hornfels of volcanic rocks of early Tertiary age. (Auth)

<229>

West, W.S., and J.J. Matzko; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951, Chapter D: Buckland-Kiwalik District, 1947. In USGS Circular 250, (pp. 21-27), 31 pp. (1953)

Radioactive minerals are widely distributed in the Buckland-Kiwalik district of the Seward Peninsula, Alaska. Localized concentrations of uranothorianite, the most important uranium mineral found, occur in the headwaters of Peace River, Quartz Creek, and Sweepstakes Creek on the slopes of Granite Mountain; in the Hunter Creek-Connolly Creek area, and on the south slope of Clem Mountain. Although the source of the uranothorianite and the other radioactive minerals has not yet been discovered because of tundra cover and heavy talus deposits, these minerals probably occur as accessories in granitic rocks. The concentration of uranothorianite in placers at the head of the Peace River is believed to be the only lead to a possible high-grade uranium deposit. At this locality uranothorianite and its alteration product gummite, associated with hematite, limonite, powellite, pyrite, chalcopyrite, bornite, molybdenite, gold, silver, and bismuth, occur in the gravels of a restricted drainage basin near a syenite-andesite contact. A low-grade copper sulfide lode was previously reported in granite near the location of these placers. Concentrates from these placers contain from about 0.2 to about 0.8 percent equivalent uranium or about ten times the equivalent uranium content of the average uranothorianite-bearing concentrates from other localities in the eastern Seward Peninsula. (Auth)

<230>

Stokes, W.L.; Utah Geological and Mineralogical Survey, Salt Lake City, UT; University of Utah, College of Mines and Mineral Industries, Salt Lake City, UT; USGS, Washington, DC

Uranium-Vanadium Deposits of the Thompsons Area, Grand County, Utah with Emphasis on the Carnotite Ores. Utah Geological and Mineralogical Survey Bulletin 46,. (1952, December)

The Thompsons area, a contributor of uranium and vanadium ores, covers an area in north-central Grand County, Utah, of about 200 square miles. The ore bodies consist of a concentration of various uranium and vanadium minerals in sand lenses. Most of the ore minerals occupy pore spaces in the sandstone. The largest and richest ore bodies are elongate and crudely semicylindrical "rolls" that occur in groups in the sand lenses. The ore is nearly always accompanied by organic material of some kind, by limonite staining in associated sandstones, and by blue-green color alterations in the mudstones below the deposits. It is assumed that the ore minerals were deposited from ground water in the vicinity of decaying organic materials shortly after the enclosing sandstones accumulated. As organic material seems to be essential to ore formation, considerable attention has been given to factors that favor the accumulation of plant material on flood plains. It is concluded that the edges of thicker sand channels, especially along meander curves, are favorable sites for plant accumulation and hence for the formation of ore deposits. (Auth)(MBW)

<231>

Beroni, E.P., F.A. McKeown, F. Stugard, and G.B. Gott; USGS, Washington, DC

Uranium Deposits of the Bulloch Group of Claims, Kane County, Utah. USGS Circular 239, 9 pp. (1953)

The Bulloch group of uranium claims is in T40S, R9W, Kane County, Utah. In June, 1950, 8.5 tons of submarginal ore was shipped to the Marysvale purchasing depot of the Atomic Energy Commission; this shipment assayed 0.16 percent U3O8. Uranium compounds are finely disseminated in clay, carbonized wood fragments, iron oxide concretion, petrified logs, sandstone, and conglomerate of the lower part of the Dakota sandstone and upper part of the Summerville formation. Small quantities of the uranium minerals carnotite, tyuyamunite, and autunite were recognized in the conglomerate and sandstone on Lynn Nos. 2 and 3 claims. Exposures of three uraniferous lenses, each less than 75 feet long, contain as much as 0.1 percent uranium. The presence of uranium in ground water and in plants indicates that the uranium is being redistributed by ground water and may suggest the presence of concealed ore deposits nearby. (Auth)

<232>

Klemic, H., J.H. Eric, J.R. McNitt, and F.A. McKeown; USGS, Washington, DC

Uranium in Phillips Mine - Camp Smith Area, Putnam and Westchester Counties, New York. USGS Bulletin 1074-E, (pp. 165-199). (1959)

Uraniferous rock was discovered in the Phillips mine - Camp Smith area in 1953. Precambrian rocks of the Hudson Highlands of the New England physiographic province underlie the area. Hornblende pegmatite intrudes hornblende gneiss and diorite. The hornblende pegmatite and diorite are conformable with regional structures in the gneiss. Crosscutting bodies of oligoclase-quartz pegmatite intrude the diorite and hornblende gneiss. Uraninite occurs in hornblende pegmatite and in adjacent hornblende gneiss and diorite in an elongate zone that is mineralized with magnetite and iron sulfides. The uraninite is in crystals and grains, most of which range from a millimeter to a centimeter in diameter. The isotopic age of a crystal of uraninite from the hornblende pegmatite is about 920 million years. Magnetite was probably emplaced during the latest stages of the consolidation of the hornblende pegmatite and is associated with secondary augite resulting from the alteration, possibly pneumatolytic, of hornblende in the pegmatite and adjacent rocks. The solutions that deposited magnetite and altered hornblende to augite embayed and rounded some of the uraninite crystals. Iron sulfides probably were deposited by hydrothermal solutions that followed the main channels through which the hornblende pegmatite magma and the magnetite solutions had been introduced. Later, oligoclase-quartz pegmatite intruded the area discordantly. The lead-alpha age of zircon from the oligoclase-quartz pegmatite is about 620 million years. (Auth)(MBW)

<233>

Klemic, H.; USGS, Washington, DC

Uranium Occurrences in Sedimentary Rocks of Pennsylvania. USGS Bulletin 1107-D, (pp. 243-288). (1962)

In Pennsylvania, uranium deposits occur in sedimentary rocks of late Devonian to Late Triassic age in the Appalachian Plateaus, Valley and Ridge, and Piedmont provinces. The uranium occurrences in Upper Devonian rocks are commonly associated with gray sandstone or shale that contains copper minerals and carbonaceous plant fossils, but this association is not marked in the largest deposits with the greatest concentration of uranium. The occurrences in the Upper Mississippian and Lower Pennsylvanian beds are in rocks that commonly contain carbonaceous material but do not have megascopically noticeable copper minerals. Those in the Triassic rocks contain small amounts of carbonaceous material, traces of copper, and some pyrite. Uraninite and possibly another black form of uranium oxide probably are primary minerals. Secondary uranium vanadates, phosphates, carbonates, silicates, and possibly arsenates are found in the various deposits. Spectrographic and chemical analyses show that the abundance of uranium is independent of the abundance of any other element. The only relation noted is that lead, vanadium and selenium are most abundant in rocks in which uranium is also abundant. Some of the uranium deposits probably formed by syngenetic deposition, others by early epigenetic concentrations, and a few by relatively recent leaching and redeposition by ground water. Of the many known uranium occurrences, only two, both in Carbon County, seem to be deposits of potential economic value. (Auth)(MBW)

<234>

Renfro, A.R.; Teton Exploration Drilling Company Incorporated, Casper, WY

Uranium Deposits in the Lower Cretaceous of the Black Hills.
Contributions to Geology, 8(2), 87-92. (1969)

The Black Hills have produced approximately four million pounds of U3O8. All of the known uranium ore bodies are in continental and marginal marine sandstone of the Lower Cretaceous, Inyan Kara Group. The Inyan Kara Group is comprised of the Lakota and overlying Fall River Formations which represent the proximal and distal portions of a single, transgressive depositional system. The regional depositional environments that affected each formation indirectly affected the geometric complexity and extent of related uranium deposits. Uranium deposits of the Inyan Kara Group are of the roll front type. They were deposited by down-plunge migrating geochemical cells which were initiated during the Laramide orogeny. Passage of geochemical cells through the host rocks caused physical and chemical changes that are excellent exploration guides. These changes include oxidation of massive, pore filling pyrite, destruction of disseminated carbon, and leaching of indigenous uranium. The source of uranium in the Inyan Kara roll fronts is considered to be the altered host sandstone. This conclusion is supported by relative lack of uranium in altered ground as opposed to relative abundance of uranium in fresh ground. Extensive low grade reserves are indicated or inferred in the northern Black Hills. Typical deposits contain approximately 250,000 pounds of U3O8 per mile of roll front. Individual roll fronts can be traced for tens of miles though they do not everywhere contain ore grade mineralization. Similar roll fronts are anticipated to extend, with interruption, around the Black Hills. Such deposits ultimately will be the main source of uranium in the Black Hills. (Auth)

<235>

Bailey, R.V.; Consulting Geologist, Casper, WY

Uranium Deposits in the Great Divide Basin-Crooks Gap Area, Fremont and Sweetwater Counties, Wyoming.
Contributions to Geology, 8(2), 105-120. (1969)

The Great Divide Basin - Crooks Gap area encompasses approximately 3,500 square miles in south-central Wyoming. Uranium mineralization has been found in three types of deposits in this area: (1) low-grade deposits associated with Eocene sub-bituminous coal and carbonaceous shale in the central and eastern part; (2) low grade caliche-type deposits of schroeckingerite in Eocene sediments in the north-central part; and (3) higher grade deposits, some of which are minable, in Eocene sandstone and conglomerate at Crooks Gap at the north edge of the basin. It has been estimated that there are more than 60 million pounds of U3O8 associated with minable coal in the Great Divide Basin, and additional unestimated quantities in carbonaceous shales. The schroeckingerite deposits are believed to be small, and the mineral is water soluble. Production plus minable reserves at Crooks Gap are estimated at between 11 and 12 million pounds U3O8. Evidence presented in previous studies indicates that the uranium associated with the coal was derived from overlying Miocene sediments. A similar theory is postulated for the origin of uranium found in the schroeckingerite deposits. As a working hypothesis, it is suggested here that the uranium in the Battle Spring Formation at Crooks Gap also originated in younger volcanic-rich sediments, and that the uranium, subsequent to its release from the tuffaceous rocks, migrated in neutral to slightly alkaline, weakly oxidizing ground water into the highly permeable Battle Spring Formation where Eh and pH changes resulted in uranium concentration in zones along geochemical interfaces. (Auth)

<236>

Davis, J.F.; Union Pacific Railroad Company, Natural Resources Division, Laramie, WY

Uranium Deposits of th. Powder River Basin. Contributions to Geology, 8(2), 131-141. (1969)

Uranium in the Powder River Basin is in the form of geochemical roll fronts associated with a decrease in permeability in arkosic sandstones of the Wasatch Formation and to a limited extent, the Fort Union Formation. Previously mined deposits were for the most part oxidized. Many of the recent discoveries are more extensive unoxidized ore bodies. The host sands are correlated over several miles. The origin of the uranium is postulated to be the Oligocene, Miocene, and Pliocene tuffs which once covered the area. Hydrolysis of the tuffs produced an alkaline ground water which dissolved the uranium and carried it as a uranium-tricarbonate ion. The solutions were carried by coarse, regionally transmissive sand units which were stained pinkish-red by hematite, formed from oxidation of pyrite by oxygen in the solutions. Cores of unaltered Wasatch arkosic sand contain less than two ppm U, whereas cores from well back in the altered rock contain 18 ppm U. The ore deposits are usually multiple 'C'-shaped rolls distorted by variations in the gross lithology. The individual rolls range in thickness from two to 20 feet and may be several thousand feet in length. Low-grade (.05-.10% U3O8) protore, up to 40 feet thick and several hundred feet wide, is commonly present on the unaltered side of the higher-grade roll front. The unoxidized ore bodies are protected from weathering by silt and claystone overburden. Important variations are noted in mass mean diameter of the sand grains, and in organic carbon, carbonate, manganese, selenium, sulphate, chromium, and vanadium amounts in the altered, unaltered, and mineralized zones. In the unoxidized ore deposits studied, the U/eU ratio is almost universally high. (Auth)

<237>

Duffield, W.A., and R.D. Weldin; USGS, Washington, DC; US Bureau of Mines, Washington, DC

Mineral Resources of the South Warner Wilderness, Modoc County, California. USGS Bulletin 1385-D, 31 pp. (1976)

The mineral resources of the South Warner Wilderness were appraised by making a geologic map, sampling bedrock and stream sediments by spectrographic analysis, examining all known mineral claims, and interpreting an aeromagnetic map. The area is underlain by 5,000 feet of coarse clastic sedimentary rocks of Oligocene age and 5,000 feet of basaltic to rhyolitic volcanic rocks of Miocene age. Although minor amounts of optical calcite, zeolites, and semiprecious stones, such as hyaline opal and petrified wood, are present, the area holds no potential for commercial development now or in the foreseeable future. (Auth)(MBW)

<238>

Duncan, D.C.; USGS, Washington, DC

A Uranium-Bearing Rhyolitic Tuff Deposit Near Coaldale, Esmeralda County, Nevada. USGS Circular 291, 7 pp. (1953)

A small deposit of uranium-bearing rhyolitic tuff is exposed at the northern end of the Silver Peak Mountains. The deposit consists of weakly mineralized welded tuff containing veinlets and small irregular pods of higher grade uranium-bearing rock. The conspicuous ore minerals are autunite and phosphuranylite, which coat some fractures and partly fill some feldspar crystal cavities in the tuff. Uranium is also present in small amounts in siliceous material that occurs as scattered veinlets and as matrix of a breccia pipe. Numerous limonite-stained joint surfaces on the welded tuff also contain small amounts of uranium. No identifiable uranium minerals were found in the siliceous vein material or in the limonite-stained fracture coatings. Several samples collected from weathered outcrops contained from 0.002 to 1.86 percent uranium. (Auth)

<239>

Love, J.D.; USGS, Washington, DC

Preliminary Report on Uranium Deposits in the Pumpkin Buttes Area, Powder River Basin, Wyoming. USGS Circular 176. 37 pp. (1952)

A roll in sandstone which was outlined by yellow and black highly radioactive minerals was discovered in the Wasatch formation at the Pumpkin Buttes area, in the Powder River Basin. An average of grab samples taken from various parts of the roll contained 15.14 percent uranium. Vanadium oxide content of the samples ranges from 0.35 to 2.44 percent. The available evidence of origin suggests that the uranium was carried downward from the White River formation tuff, through aquifers in the Wasatch formation, and concentrated in favorable host rocks. It is possible that other parts of the more than 12,000 square miles of the Powder River Basin surrounding Pumpkin Buttes might yield as rich uranium deposits as those described in the report. The commercial grade of some of the ore, the easy accessibility throughout the area, the soft character of the host rocks and associated strata, and the fact that strip mining methods can be applied to all the deposits known at the present time, make the area attractive for exploitation. (Auth)(MBW)

<240>

Staatz, M.H., and H.L. Bauer, Jr.; USGS, Washington, DC

Virgin Valley Opal District, Humboldt County, Nevada. USGS Circular 142, 7 pp. (1951)

Nineteen claims in the Virgin Valley opal district, Humboldt County, Nevada, were tested radiometrically for uranium Numerous discontinuous layers of opal are interbedded with a gently-dipping series of vitric tuff and ash which is at least 300 feet thick. Silicification of the ash and tuff has produced a rock that ranges from partly opalized rock that resembles silicified shale to completely altered rock that is entirely translucent, and consists of massive, brown and pale-green opal. Carnotite, the only identified uranium mineral, occurs as fracture coatings or fine layers in the opal; in places, no uranium minerals are visible in the radioactive opal. The uranium content of each opal layer and of different parts of the same layer, differs widely. On the east side of Virgin Valley four of the seven observed opal layers are more radioactive than the average; the uranium content ranges from 0.002 to 0.12 percent. On the west side of the valley only four of the fifteen observed opal layers are more radioactive than the average; the uranium content ranges from 0.004 to 0.047 percent. Material of the highest grade was found in a small discontinuous layer of pale-green opal on the east side of Virgin Valley. The grade of this layer ranged from 0.027 to 0.12 percent uranium. (Auth)(MBW)

<241>

Page, L.R., and J.A. Redden; USGS, Washington, DC

The Carnotite Prospects of the Craven Canyon Area, Fall River County, South Dakota. USGS Circular 175, 18 pp. (1952)

The known carnotite occurrences in the Craven Canyon area, Fall River County, South Dakota, are restricted to the basal 100 to 150 feet of the Lower Cretaceous Lakota sandstone; most are within 50 feet of a distinctive, paper-weathering, nonradioactive, carbonaceous, 1- to 3-foot black shale that is 100 to 125 feet above the top of the underlying Morrison formation. Three favorable zones have been recognized: a zone 20 to 30 feet above the carbonaceous shale horizon; a zone 20 to 30 feet below the carbonaceous shale horizon; and a zone about 25 feet below the above. The deposits generally are parallel to bedding, but in detail are cross-cutting. Widespread carnotite stains coat fractures in and adjacent to the deposits. These stains are commonly associated with an unidentified, green mineral stain that contains uranium and vanadium. (Auth)(MBW)

<242>

Gill, J.R.; USGS, Washington, DC

Reconnaissance for Uranium in the Ekalaka Lignite Field, Carter County, Montana. USGS Bulletin 1055-F, (pp. 167-179), 315 pp. (1959)

Beds of uranium-bearing lignite 1.5 to 8 feet thick occur in the Fort Union formation of the southern part of the Ekalaka Hills, Carter County, Montana. Data from surface outcrops indicate that an area of about 1,400 acres is underlain by 16.5 million tons of uranium-bearing lignite. The uranium content of the lignite beds ranges from 0.01 to 0.034 percent, the average being about 0.005 percent. Ironstone concretions in the beds of massive coarse-grained sandstone in the upper part of the Fort Union formation contain 0.005 percent uranium in the northern and eastern parts of the area. These beds of sandstone are favorable host rocks for uranium occurrences and are lithologically similar to beds of massive coarse-grained sandstone of the Wasatch formation in the Pumpkin Buttes area of the Powder River Basin. (Auth)

<243>

Gill, J.R., H.D. Zeller, and J.M. Schopf; USGS, Washington, DC

Core Drilling for Uranium-Bearing Lignite, Mendenhall Area, Harding County, South Dakota. USGS Bulletin 1055-D, (pp. 97-146), 315 pp. (1959

Core drilling for data on uranium-bearing lignite in the Mendenhall area, near the center of the Slim Buttes, Harding County, South Dakota, was conducted by the Geological Survey in the summer of 1951 and by the Bureau of Mines during the period October 1952-July 1953. Samples from 49 core holes having a total footage of 11,146 feet, drilled in an area of about 9 square miles, indicate a reserve of about 127 million tons of lignite, of which about 49 million tons contain an average of 0.005 percent uranium or more. The uranium-bearing lignite averages 5.4 feet in thickness and occurs in the Ludlow member of the Fort Union formation of Paleocene Age. Fuel analyses of about 130 samples indicate that the lignite contains about 15 percent ash, 37 percent moisture, 24 percent fixed carbon, 24 percent volatile matter, and 1.5 percent sulfur and has a heating value of about 5,800 Btu (as received condition). In the Slim Buttes, exclusive of the Mendenhall area, approximately 60 square miles are underlain by uranium-bearing lignite having an average thickness of five feet and an average uranium content of 0.007 percent or more, and having a potential reserve of 340 million tons of uranium-bearing lignite. The core samples indicate only the stratigraphically highest lignite bed beneath the unconformity at the base of the Chadron formation of Oligocene age contains appreciable quantities of uranium. Data indicate that the uranium in the lignite is of secondary origin, having been leached and transported by ground water from the mildly radioactive tuffaceous rocks that unconformably overlie the lignite-bearing strata. (Auth)

<244>

Bachman, G.O., J.D. Vine, C.B. Read, and G.W. Moore; USGS, Washington, DC

Uranium-Bearing Coal and Carbonaceous Shale in the La Ventana Mesa Area, Sandoval County, New Mexico. USGS Bulletin 1055-J, (pp. 295-315), 315 pp. (1959)

Uranium-bearing coal, carbonaceous shale, and carbonaceous sandstone of Late Cretaceous age occur on and adjacent to La Ventana Mesa, Sandoval County, New Mexico. The uranium is present in three lenticular beds forming a mineralized zone several feet thick at the base of the La Ventana tongue of the Cliff House sandstone. An epigenetic origin for the uranium from groundwater solutions that ultimately derived the uranium from the Pleistocene Bandelier rhyolite tuff is suggested. The content of uranium in the coal is as much as 0.62 percent and in the coal ash is as much as 1.34 percent. It is estimated that 132,000 tons of coal and carbonaceous shale containing an average of 0.10 percent uranium are present on La Ventana Mesa. (Auth)

<245>

Denson, N.M., G.O. Bachman, and H.D. Zeller; USGS, Washington, DC

Uranium-Bearing Lignite in Northwestern South Dakota and Adjacent States.
USGS Bulletin 1055-B, (pp. 11-57), 315 pp. (1959)

In northwestern South Dakota and adjacent areas, uranium-bearing lignite beds occur at many horizons in the Hell Creek formation of Late Cretaceous age and in the overlying Ludlow, Tongue River, and Sentinel Butte members of the Fort Union formation of Paleocene age. Analyses for uranium of 275 samples of lignite taken from outcrops or obtained by auger-drilling and of about 1,000 core samples of lignite show that many of the lignite beds contain 0.005-0.02 percent uranium, and their ash contains 0.05-0.10 percent. Almost a fifth of the lignite occurs in beds suitable for strip mining and averages 4 feet in thickness. The stratigraphically highest lignite beds in the area have the greatest content of uranium, and the concentration of uranium is greatest at the top of thick lignite beds, diminishing progressively downward to a vanishing point in their lower parts. Variations in permeability of the rocks overlying the mineralized lignite beds seem to be related to the concentration of uranium. Field relations thus suggest that the uranium is of secondary origin and has been introduced after the accumulation and marked regional uplift and warping of the lignite beds and associated rocks. Carbonaceous material - lignite or carbonaceous shale - is believed to have taken the uranium from solution by ion exchange or by the formation of organo-metallic compounds. Geologic factors that seem most significant in controlling the distribution and concentration of uranium in these beds of lignite are the following: stratigraphic proximity of the lignite to the base of the White River group; permeability of the rocks overlying the lignites; adsorptive properties and porosities of the constituents of lignite; present and past position of the ground-water table; and the amount of uranium in the original White River and Arikaree sediments. (Auth)(MBW)

<246>

West, W.S., and M.G. White; USGS, Washington, DC

The Occurrence of Zeunerite at Brooks Mountain, Seward Peninsula, Alaska.
USGS Circular 214, 7 pp. (1952)

Zeunerite occurs near the surface of a granite stock on the southwest flank of Brooks Mountain, Alaska. The largest deposit is at the Foggy Day prospect. Zeunerite is disseminated in hematite which partially or totally fills openings and vugs in a highly oxidized lens-shaped body of pegmatitic granite and, to a minor extent, in openings and cracks in the weathered granite enclosing the lens. Although a few specimens from the pegmatitic lens contain as high as 2.1 percent equivalent uranium, the average content of the lens rock is between 0.1 and 0.2 percent equivalent uranium and that of both the lens material and the surrounding zeunerite-bearing granite is about 0.07 percent equivalent uranium. A smaller concentration of zeunerite occurs as surface coatings on a few of the quartz-tourmaline veins that occupy joint fractures in granite on Tourmaline No. 2 claim. The vein material here contains about 0.05 percent equivalent uranium. Zeunerite, in trace amounts, was identified in a sample from a site near Tourmaline No. 2 claim and in two samples from other sites near the Foggy Day prospect. The zeunerite at these three localities is probably related in source to the Tourmaline No. 2 claim and Foggy Day prospect deposits. Although no primary uranium minerals were found, it is possible that a primary mineral zone may occur below the zone of oxidation at the Foggy Day prospect. (Auth)

<247>

Clinton, N.J., and L.W. Carithers; AEC, Grand Junction, CO

Uranium Deposits in Sandstones of Marginal Marine Origin. In USGS Professional Paper 300, (pp. 445-449), 739 pp. (1956)

Uranium deposits are now known to occur on the Colorado Plateau in sandstones deposited in a marine or a nearshore terrestrial environment. This is in contrast to the wholly continental origin of the highly productive Morrison formation of Jurassic age and Chinle and Shinarump formations of Triassic age. The shoreline sandstones originated as beach and fluvial deposits which commonly intertongue with shales and carbonaceous beds of marine and paludal origin. Uranium is known in the marine Curtis formation of Jurassic age and also in several marine and terrestrial sandstones related to the Late Cretaceous sea. Occurrences are associated with local changes of facies, accumulations of carbonaceous material, or both. All are within or near regions of post-Cretaceous tectonic disturbances. The potential production of uranium from the shoreline sandstones on the Plateau is not known; to date only a small tonnage of marginal grade has been mined. It is only recently that commercial uranium deposits have been discovered in rock of this origin, and an increasing number of discoveries is being made. (Auth)

<248>

Gruner, J.W.; AEC, Washington, DC; University of Minnesota, Minneapolis, MN

A Comparison of Black Uranium Ore Deposits in Utah, New Mexico and Wyoming. In USGS Professional Paper 300, (pp. 203-205), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 530-532), 825 pp. (1956)

Four areas of important unoxidized uranium deposits are compared. They are great distances apart and range in age from Triassic to Eocene. All of the ores are in poorly sorted arkosic sandstones which contain much organic carbon. Vanadium is absent in ores from the Eocene. Uraninite and coffinite are the identified dark-colored uranium bearers. Parageneses are very similar, and nearly the same geologic processes were operative in producing these concentrations of uranium. Highly reducing conditions were instrumental in the deposition of these "black ores". They are primary in the sense that the oxidized yellow ores are derived from them. (Auth)

<249>

Mapel, W.J.; USGS, Washington, DC

Uraniferous Black Shale in the Northern Rocky Mountains and Great Plains Regions. In USGS Professional Paper 300, (pp. 469-476), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 445-451), 825 pp. (1956)

Deposits of black shale that range in age from Precambrian to Late Cretaceous crop out or were penetrated in drilling test wells for oil and gas at many places in the northern Rocky Mountains and Great Plains regions of the United States and southern Canada. The radioactivity and uranium content of many of these formations has been investigated by sampling outcrops and drill cuttings and by the examination of gamma-ray logs of oil and gas wells. The investigations show that certain black shales contain from 0.005 to 0.01 percent uranium. Of particular interest for its radioactivity is a black shale of early Mississippian (Kinderhook) age that is known variously as the Bakken formation, the Kinderhook shale, or the Exshaw formation. This formation was penetrated in drilling wells in much of the Williston basin region of Montana, North Dakota, and adjacent parts of Canada. It ranges in thickness from a few inches to as much as 100 feet and at many places consists of 2 highly radioactive beds of black shale separated by a bed of gray calcareous sandstone, siltstone, or dolomite. Samples of black shale from this formation in 4 oil and gas test wells in Montana and North Dakota contain from 0.005 to 0.008 percent uranium. In the mountainous regions of Montana and northern Utah, a thin bed of black shale of the same age and at the same stratigraphic position contains as much as 0.005 percent uranium. An isoradioactivity map of the Bakken formation based on gamma-ray logs, suggests that the radioactivity is greatest near the northeastern corner of Montana and decreases concentrically outward from this point. The area of maximum radioactivity coincides roughly with the area in which the formation is thickest. Other formations that contain beds of black shale of unusually high radioactivity include the basal part of the Brazer limestone of late Mississippian age in northern Utah, the Heath shale of late Mississippian age in central Montana, the Minnelusa sandstone of Pennsylvanian age in eastern Wyoming and western South Dakota, and parts of the Pierre shale of late Cretaceous age in eastern Montana and parts of adjacent States. (Auth)

<250>

Boardman, R.L., B.E. Ekren, and H.E. Bowers; USGS, Washington, DC

Sedimentary Features of Upper Sandstone Lenses of the Salt Wash Member and Their Relation to Uranium-Vanadium Deposits in the Uravan District, Montrose County, Colorado. In USGS Professional Paper 300, (pp. 221-226), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955, United Nations, New York, (pp. 331-334), 825 pp. (1956)

A detailed study of the rimrock formed by the upper sandstone lenses of the Salt Wash member of the Morrison formation of Jurassic age in the Uravan district was completed late in 1954. These lenses contain all the principal uranium-vanadium deposits in the district. The data acquired during this study have been integrated with information derived from detailed mine mapping, from cursory mine examinations, and from partial compilation of the logs of more than 3,000 drill holes of the U.S. Geological Survey in the district. The trend of sedimentary structures in the Uravan district are, in general, eastward, normal to the northward trend of the Uravan mineral belt. The long axes of the ore bodies and the trends of areas geologically favorable for ore are nearly parallel to the strike of the sedimentary features. An in-echelon arrangement of ore deposits on Club Mesa and Long Park is believed to be a reflection of an in-echelon arrangement of the sedimentary structures in those areas. The individual sandstone lenses of the upper part of the Salt Wash may not be extensive regional aquifers. It is improbable that the ore-bearing sandstone lenses of the productive Long Park area were continuous or connected with the principal ore-bearing sandstone lens in the Club Mesa area. Data concerning the sedimentary structures, together with known fracture relations, make it unlikely that the genesis, mineralization, and concentration of ore in the Uravan district were controlled by faults or fractures. The relations observed in this study are perhaps more easily explained by the leaching, solution, and concentration of ore penecontemporaneously with deposition of the sandstone. (Auth)

<251>

Dodd, P.H.; AEC, Grand Junction, CO

Examples of Uranium Deposits in the Upper Jurassic Morrison Formation of the Colorado Plateau. In USGS Professional Paper 300, (pp. 241-262), 739 pp. (1956)

The 4B mine and vicinity, Poison Canyon mine, Basin No. 1 mine and the area of the Wedding Bell group were chosen to demonstrate common but controversial geologic features of deposits in the Morrison formation (Upper Jurassic) of the Colorado Plateau. These are on the flanks of major regional structures, and the beds dip from 1 degree to 2 1 2 degrees. Fractures are prominent in the 4B and Poison Canyon mines but only slightly developed in the Basin No. 1 mine and Wedding Bell group. Secondary minerals occur on fractures in the Poison Canyon deposit, and curved fractures bound ore rolls in the Wedding Bell group. Vertical fractures do not control ore in the 4B or Basin No. 1 mines. Minor faults with associated fractures in the Poison Canyon mine displace the ore body, and increased grade and thickness is found adjacent to the faults; however, the Poison Canyon ore body is elongated along the trend of sedimentary structures which is normal to the faults and fracturing. All deposits are in the channel facies of lenticular interbedded sandstone and mudstone. The host sandstone has been altered from light red to light gray or tan. The associated mudstone lenses also have been altered from red and brown to gray to bluegreen near ore bodies. Carbonate concentrations are associated with ore pods in the 4B and Basin No. 1 mines. The ore bodies are, with the exception of rolls, nearly concordant tabular disseminations of ore minerals filling interstices of sandstone. They have an irregular outline but are generally elongated parallel to the trend of sedimentary structures; a number of ore bodies, although irregularly spaced, may form rough groups along this trend. The 4B mine and Wedding Bell group are oxidized deposits containing high-valent uranium and vanadium minerals, and the Poison Canyon and Basin No. 1 mines contain low-valent ore minerals that are believed to be primary. The ratio of vanadium to uranium ranges from 0.5:1 in Poison Canyon to 40:1 in zones of the Basin No. 1 mine. Zoning of metal ratios is suggested in the 4B area and Basin No. 1 mine. Carbonaceous material is associated to some extent with all the ore bodies; some is replaced by ore minerals and some, although within the ore body, is not replaced. The deposits are probably epigenetic. It is believed that pressure and temperature changes were unimportant in precipitation of the ore minerals. The facies change between fast- and slack-water fluvial sediment is believed to represent significant pH and Eh changes in environment which localized deposition. The deposits consequently display a preferred orientation and localization along the trends of channel lithofacies. (Auth)

<252>

Grutt, E.W., Jr.; AEC, Casper, WY

Uranium Deposits in Tertiary Sedimentary Rocks in Wyoming and Northern Colorado. In USGS Professional Paper 300, (pp. 361-370), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 392-402), 825 pp. (1956)

The discovery of carnotite ores in sandstone strata of the Wasatch formation (Eocene) in the Powder River Basin of Wyoming in 1951 was the forerunner of other uranium discoveries in widely separated parts of Wyoming and in adjacent Moffat County, Colorado. The deposits all have similar geologic environments in sedimentary host rocks of Eocene, Oligocene, of Miocene age. Most deposits occur in medium- to coarse-grained or conglomeratic sandstones of fluviatile origin. Torrential crossbedding is a common feature of these sandstones, and they characteristically contain carbonaceous material and calcareous, ferruginous, or phosphatic cement. The character of ore mineralogy in different areas suggests the probability of mineral provinces. Uranium vanadates are abundant in the Powder River Basin; phosphates and arsenates are the common minerals in the Wind River Basin; and silicates and sulfates are plentiful in the Green Mountains, Great Divide Basin and Washakie Basin. The presence of uraninite has been established in the Wind River Basin, Powder River Basin, Green Mountains, and the Washakie Basin. Stratigraphic and lithologic ore controls are important in all districts, and evidence indicates that structural features play an important though often obscure role. Fractures have been mapped as an ore control at several deposits. The size and shape of individual deposits differs greatly within the same area. The deposits containing uranium minerals disseminated in sandstone strata as grain coatings and interstitial fillings seem to be the best. (Auth)

<253>

Gillerman, E., and D.H. Whitebread; USGS, Washington, DC

Uranium-Bearing Nickel-Cobalt-Native Silver Deposits, Black Hawk District, Grant County, New Mexico. USGS Bulletin 1009-K, (pp. 283-313). (1956)

The Black Hawk district, Grant County, New Mexico, has had high-grade silver ore mined from it in previous years, but is not presently mined. Pre-Cambrian quartz diorite gneiss, which intrudes quartzite schist, monzonite, and quartz monzonite, is the most widespread rock in the District. The quartz diorite gneiss is intruded by many pre-Cambrian and younger rocks, including diorite, granite, diabase, monzonite porphyry, and andesite, and is overlain by the Upper Cretaceous Beartooth quartzite. The ore deposits are in fissure veins that contain silver, nickel, cobalt, and uranium minerals. The ore minerals, which include native silver, argentite, niccolite, millerite, skutterudite, nickel skutterudite, bismuthinite, pitchblende, and sphalerite, are in a carbonate gangue in narrow, persistent veins, most of which trend northeast. Pitchblende has been identified in the Black Hawk and the Alhambra deposits and unidentified radioactive minerals were found at five other localities. The deposits that contain the radioactive minerals constitute a belt 600 to 1,500 feet wide that trends about N 45 degrees E and is approximately parallel to the southeastern boundary of the monzonite porphyry stock. All the major ore deposits are in the quartz diorite gneiss close to the monzonite porphyry. (Auth)(MBW)

<254>

Gill, J.R., and G.W. Moore; USGS, Washington, DC

Carnotite-Bearing Sandstone in Cedar Canyon, Slim Buttes, Harding County, South Dakota. USGS Bulletin 1009-I, (pp. 249-264). (1955)

Carnotite-bearing sandstone and claystone have been found in the Chadron formation of the White River group of Oligocene age in the southern part of the Slim Buttes area, Harding County, South Dakota. The carnotite is an efflorescent yellow coating on lenticular silicified sandstone. Locally, the mineralized sandstone contains 0.23 percent uranium. The uranium and vanadium ions are believed to have been derived from the overlying mildly radioactive tuffaceous rocks of the Arikaree formation of Miocene age. Analyses of water from 26 springs issuing from the Chadron and Arikaree formations along the margins of Slim Buttes show uranium contents of as much as 200 ppb. Meteoric water percolating through tuffaceous rocks is thought to have brought uranium and other ions into environments in the Chadron formation that were physically and chemically favorable for the deposition of carnotite. (Auth)

<255>

Freeman, V.L., and L.S. Hilpert; USGS, Washington, DC

Stratigraphy of the Morrison Formation in Part of Northwestern New Mexico. USGS Bulletin 1030-J, (pp. 309-334). (1956)

While investigating the uranium resources of northwestern New Mexico, it was discovered that the stratigraphic nomenclature of the Morrison formation in use in the Laguna area was not consistent with that in use elsewhere in the region. A review of the literature led to the agreement that the nomenclature currently in use elsewhere in the area, such as near Grants, is satisfactory. This usage divides the Morrison formation into three members; in ascending order they are the Recapture, the Westwater Canyon, and the Brushy Basin members. These members may be recognized and have been correlated throughout northwestern New Mexico. In the Laguna area the Recapture, Westwater Canyon, and most of the Brushy Basin members, are present in the stratigraphic interval that has previously been considered as Recapture. The sandstone previously considered as Westwater Canyon is at the top of the Brushy Basin. This sandstone is of economic importance and is informally called the Jackpile ore-bearing bed. (Auth)(MBW)

<256>

Moxham, R.M.; USGS, Washington, DC

Airborne Radioactivity Surveys for Phosphate in Florida. USGS Circular 230, 4 pp. (1954)

Airborne radioactivity surveys totaling 5,600 traverse miles were made in 10 areas in Florida, which were thought to be geologically favorable for deposits of uraniferous phosphate. Abnormal radioactivity was recorded in 8 of 10 areas surveyed. The anomalies are located in Bradford, Clay, Columbia, DeSoto, Dixie, Lake, Marion, Orange, Sumter, Taylor, and Union Counties. Two of the anomalies were investigated briefly on the ground. One resulted from a deposit of river-pebble phosphate in the Peace River valley; the river-pebble samples contain an average of 0.013 percent equivalent uranium. The other anomaly resulted from outcrops of leached phosphatic rock containing as much as 0.016 percent equivalent uranium. Several anomalies in other areas were recorded at or near localities where phosphate deposits have been reported. (Auth)

<257>

Kittleman, L.R., Jr., and W.L. Chenoweth; AEC, Exploration Division, Grand Junction, CO

Uranium Occurrences on the Goodner Lease Sandoval County, New Mexico. TM-184, 14 pp. (1957, July 15)

The Goodner Lease, located on the Ojo del Espiritu Santo Grant, Sandoval County, New Mexico, contains the only known occurrences of visible uranium minerals in the Morrison Formation of the Nacimiento Mountains. Weak mineralization occurs at sandstone-claystone contacts and in thin zones within sandstone beds in the Brushy Basin and Westwater Canyon Members. An unusual color change in the sandstones occurs in the area and is believed to be related to the uranium mineralization. (Auth)

<258>

Eargle, D.H.; USGS, Austin, TX

Uranium in Texas. Houston Geological Society Bulletin, 13(2), 18-27. (1970)

Uranium deposits are known in five Texas geographical areas but are poorly explored. These geographical areas are the Trans-Pecos, Panhandle, Red River region, Llano uplift, and the South Texas Coastal Plain. The nature of the uranium mineralization and potentials for uranium production are discussed. (PAG)

<259>

Eargle, D.H., K.A. Dickinson, and B.O. Davis; USGS, Denver, CO; USGS, Austin, TX

South Texas Uranium Deposits. American Association of Petroleum Geologists Bulletin, 776-779. (1975)

The uranium deposits of South Texas are in tuffaceous, zeolitic sandstone and mudstone beds that strike northeastward and dip gently southeastward. These host rocks are included in the Whitsett Formation of late Eocene age, Frio Clay of Oligocene age, Catahoula Tuff and Oakville Sandstone of Miocene age, and Goliad Sand of Pliocene age. Marine-beach sandstone of the Whitsett Formation is the primary host rock in the Karnes area, but some ore has been taken from crosscutting fluvial channels also in the Whitsett. This ore is in a down-dropped block between the Falls City fault on the northwest and the Fashing and Hobson faults on the southeast. The ore in this area is divided between a belt of updip oxidized deposits within a few feet of the surface and a belt of downdip unoxidized deposits, for the most part at a depth of 80 to 100 ft (24 to 30 m). The unoxidized deposits are mainly in ore rolls. Most of the ore in the Live Oak mining area is in unoxidized ore rolls in the Oakville Sandstone. One oxidized deposit in this area was found in the Frio Clay (Oligocene). The ore in the Duval area is found principally in unoxidized ore rolls in sandstone parts of the Catahoula Tuff. One exceptional deposit is in the Goliad Sand that lies above Palangana salt dome. The Catahoula Tuff is believed by many authors to be the principal source rock for uranium and other elements in the deposits. The uranium apparently was leached from this rock during periods of dry-climate weathering, transported through permeable rocks in aqueous solution, and deposited in a chemically reducing environment. The reducing agents were probably hydrogen sulfide or methane gas that seeped from accumulations of petroleum in the subsurface, and carbonaceous material that is found in some of the rocks. (Auth)(PAG)

<260>

Anderson, E.C.; New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Occurrences of Uranium Ores in New Mexico. New Mexico Bureau of Mines and Mineral Resources Circular 29, 38 pp. (1955)

The publication is a directory of the uranium mines and prospects in New Mexico. The names, location, and ownership of the various mines and prospects are given, and the lithology and host formation are indicated. The mines and prospects are indicated by spots on a map of New Mexico at a scale of about 1:2,500,000. Occurrences in a number of counties are reported, and uranium minerals and guides to ore are listed. (Auth)

<261>

Argall, G.O., Jr.; Colorado School of Mines, Golden, CO

The Occurrences and Production of Vanadium. Colorado School of Mines Quarterly, 38(4), 56. (1943)

The paper is a brief but comprehensive study of vanadium, with particular reference to the vanadium deposits of the Colorado Plateau. It describes the history, uses, production, occurrence, mining, and milling of vanadium and its ores. Because carnotite, one of the major vanadium minerals in the vanadium deposits on the Colorado Plateau, also contains uranium, this report refers in part to uranium. The deposits occur mostly in sandstone in the Shinarump conglomerate of Triassic age and the Entrada and Morrison formations of Jurassic age. The ore bodies are extremely spotty and form irregularly tabular masses that lie essentially parallel to the sandstone beds, but do not follow the beds in detail. The ore occurs in lenses, flat tabular bodies, in well-defined channels, in rolls, and as zones of ore surrounding trees that have been replaced by silica and or calcite. The vanadium is recovered from carnotite by roasting the crushed ore with common salt, which converts the vanadium to a water-soluble vanadate, leaching the calcine with water, and precipitating the vanadium by adjusting the pH. Variations of this process are used for different types of sandstone ore. If the ore contains more than six percent lime, the lime is neutralized with acid before roasting. An extensive bibliography on vanadium is included. (Auth)(MBW)

<262>

Bain, G.W.: Amherst College, Amherst, MA

Uranium in the Dirty Devil Shinarump Channel Deposit. RMO-66, 40 pp. (1952)

Uranium occurs in the Shinarump conglomerate of Triassic age at the Dirty Devil No. 6 mine, Emery County, Utah. The deposit is in conglomeratic sediments which fill a channel cut into the underlying Moenkopi formation of Triassic age. Although carnotite and tyuyamunite are present, hydrocarbons apparently contain most of the uranium. Base-metal sulfides also are present. It is suggested that the uranium in the deposit was derived from jasperoid pebbles in the Triassic river gravels, and that the pebbles were derived from a pre-existing leptothermal uranium deposit. (Auth)

<263>

Bales, W.E., H. Bell, and V.R. Wilmarth; USGS, Denver, CO

Uranium - Vanadium Deposits Near Edgemont, Fall River County, South Dakota. Geological Society of America Bulletin, 64(12), 1540. (1953)

Vanadium-uranium deposits have been found in the Lakota and Fall River sandstones of the Inyan Kara group of Early Cretaceous age in the southern part of the Black Hills near Edgemont. Uranium occurrences are also reported from the Deadwood formation of Cambrian age, the Minnelusa sandstone of Pennsylvanian age, and from the Pierre shale of Late Cretaceous age. Most high-grade deposits are in an area of approximately 20 square miles on the gently dipping southwest flank of the Black Hills uplift. Minor northward-trending anticlines lie east and west of the known mineralized area. These folds may be related to northward-trending shear zones of complex structure in the Precambrian rocks that crop out about 10 miles to the north. The ore bodies apparently were localized by (1) thin bedding rather than massiveness of the sandstone beds, (2) local changes in dip, (3) minor faults, and (4) fracture zones. The ore minerals are carnotite, tyuyamunite, rauvite, hewettite, metahewettite, autunite, and other unidentified uranium minerals. They form fracture fillings and disseminations through sandstones and shales, with a gangue of calcite, gypsum, and limonite. Geologic guides useful in prospecting for uranium in the Edgemont area are (1) a brick-red staining of the sandstones near deposits of uranium and vanadium minerals, (2) abrupt, local changes of dip, (3) thin-bedded rather than thick-bedded sandstone, (4) abundant organic material in sedimentary rocks, and (5) proximity to northward-trending fracture zones. (Auth)

<264>

Behre, C.H., Jr., and P.B. Barton, Jr.; AEC, Washington, DC; Columbia University, New York, NY

Interpretation and Valuation of Uranium Occurrences in the Bird Spring and Adjacent Mining Districts, Nevada: Progress Report. RME-3057, 7 pp. (1953, August 31)

Uranium mineralization in the Bird Spring and Spring Mountain Ranges, Clark County Nevada, are regionally and structurally of three types: (1)

along fractures in sandy zone in the Kaibab formation of Permian age; (2) in fractures and cement of Tertiary lavas, tuffs, and gravels and the immediately underlying Paleozoic rocks; and (3) in the oxidized parts of cupriferous and ferruginous fissure veins and replacement deposits. None of these occurrences are economically important. (Auth)(MBW)

<265>

Curran, T.F.V.; Not given

Carnotite. Engineering Mining Journal, 96(25), 1165-1167. (1913)

The history of the carnotite industry on the Colorado Plateau to 1913 is described. Carnotite ore bodies occur in a series of thin-bedded sandstones and shales (Morrison formation of Jurassic age). The best deposits are in western Montrose County, but the carnotite field covers an area of several thousand square miles in western Colorado and eastern Utah. In the second part of the report, the production, refining, and uses of uranium and radium are discussed. (Auth)

<266>

Adams, J.W., A.J. Gude, 3rd, and E.P. Beroni; USGS, Washington, DC

Uranium Occurrences in the Golden Gate Canyon and Ralston Creek Areas, Jefferson County, Colorado. USGS Circular 320, 16 pp. (1953)

Pitchblende, associated with base-metal sulfides, has been found at nine localities in the northern part of Jefferson County, Colorado, in shear zones that cut pre-Cambrian metamorphic and igneous rocks, chiefly hornblende gneiss, biotite schist, and granite pegmatite. The known deposits are in the vicinity of Ralston Creek and Golden Gate Canyon, in the foothills of the Colorado Front Range and about 15 miles east of the pitchblende-producing area of the Central City district. The pitchblende deposits, with one exception, are in major shear zones that contain veinlike bodies of carbonate-rich breccia that ranges from 1 to 5 feet in thickness. The breccias probably are related to the Laramide faults, or "breccia reefs" of similar trend. The breccias are composed of fragments of bleached and iron-stained wall rock, usually hornblende gneiss, that have been cut by veins and cemented by carbonate minerals, quartz, and orthoclase. Pitchblende and associated ore minerals, chiefly copper sulfides, occur in and along the margins of the breccias and apparently were introduced at a late stage of the carbonate deposition. At one deposit, the Buckman, the pitchblende is in narrow shear zones not closely related to any large breccia bodies. Secondary uranium minerals are subordinate except at the Schwartzwalder mine, where torbernite and metatorbernite are common. Some alteration of pitchblende to nonopaque materials, believed to be hydrated oxides, has been noted in ore from two of the deposits. (Auth)(MBW)

<267>

Fischer, R.P.; USGS, Washington, DC

Simplified Geologic Map of the Vanadium Region of Southwestern Colorado and Southeastern Utah. USGS Strategic Minerals Investigations Preliminary Map 3-226. (1944)

The uranium-vanadium deposits in this area that are in the Morrison formation of Jurassic age are indicated on the map by spots; the larger mines and groups of mines are named. The deposits in the northern part of the area are in a sandstone unit near the middle of the Morrison; the ore-bearing horizon is progressively lower in the section to the south. The ore bodies are irregularly tabular masses that lie essentially parallel to the sandstone beds, but they do not follow the beds in detail. The vanadium and uranium minerals impregnate the sandstone; shale pebbles, clay layers, and fossil plants in or near the ore bodies may be richly mineralized (Auth)

<268>

Fischer, R.P.; USGS, Washington, DC

Vanadium Deposits of Colorado and Utah, A Preliminary Report. USGS Bulletin 936-P, (pp. 363-394). (1942)

Deposits of vanadium-bearing sandstone are widely distributed in western Colorado and eastern Utah and have been the principal domestic source of vanadium, uranium, and radium. Most of the deposits are in the Morrison formation, but there are two important deposits in the Entrada sandstone and several small deposits in the Shinarump conglomerate. Recent X-ray studies indicate that the principal vanadium mineral, roscoelite, belongs to the hydrous mica group of clay minerals. This mineral, along with other vanadium minerals of minor importance, impregnates sandstone. Shale pebbles and clay films on bedding planes in ore-bearing sandstone are rich in absorbed vanadium, and fossil plants in and adjacent to ore bodies are richly mineralized with vanadium and uranium in places. The vanadium-bearing hydrous mica is in part uniformly disseminated through the sandstone and in part concentrated along bedding planes and in thin zones that cut across bedding. The ore bodies are spotty and form irregularly tabular masses that lie essentially parallel to the sandstone beds, but they do not follow the beds in detail. They range in content from a few tons of ore to many thousand tons. The trend of many elongate bodies is indicated by the orientation of the rolls within the ore, and this trend also suggests the probable alinement of any adjacent ore bodies; mapping of ore bodies and rolls is therefore an aid to prospecting and development. The ore bodies do not appear to have been localized by such geologic structures as fractures or folds, but within limited areas they are restricted to certain stratigraphic zones. (Auth)(MBW)

<269>

Finch, W.I.; USGS, Washington, DC

Geologic Aspects of the Resource Appraisal of Uranium Deposits in Pre-Morrison Formations of the Colorado Plateau: An Interim Report. TEI-328A, 35 pp. (1953, May)

In December 1951 a reconnaissance resource appraisal was begun of uranium deposits in pre-Morrison formations, particularly the Shinarump conglomerate, the Moenkopi and Chinle formations. The Triassic formations, particularly the Shinarump conglomerate, and the Jurassic Morrison formation contain most of the uranium deposits on the Colorado Plateau. The Lower Triassic Moenkopi formation consists of pale reddish-brown siltstone and sandstone which are horizontally- and ripple-laminated. The formation ranges from a knife-edge to about 1,000 feet in thickness, and in general it thickens to the west. Channel scours, filled with Shinarump conglomerate, have been cut into the upper Moenkopi surface. Alteration of 1 foot or more of the Moenkopi is prevalent immediately below the overlying Shinarump; in places this zone contains uranium and copper minerals near deposits in the Shinarump. The Upper Triassic Shinarump conglomerate consists mainly of channel fillings of light-colored sandstone and conglomerate. The Shinarump although absent in places generally thickens southward. The continuous sandstone beds pinch out north of the junction of the Green and Colorado Rivers. The majority of the uranium deposits are found in the Shinarump conglomerate near the edges of these facies changes. The Upper Triassic Chinle formation consists dominantly of pale-red and variegated claystone and siltstone, with some gray limestone and sandstone beds. The formation ranges from a knife-edge to about 1,200 feet in thickness. Uranium deposits are found in the Chinle in several places, notably in the Cameron-Holbrook area, Arizona, and in the Silver Reef district, Utah. Most of the uranium deposits are tabular bodies, irregular in plan, in which the ore minerals impregnate the rock. Carbonaceous material is commonly associated with ore. The deposits range in size from a few tons to many thousand tons. (Auth)(PAG)

<270>

Lovering, T.G.; USGS, Washington, DC

Radioactive Deposits of Nevada. USGS Bulletin 1009-C, (pp. 63-106). (1954)

Uranium deposits in Nevada that were known prior to 1952 are described. Those which can be classed as sandstone-type deposits are included in the annotation. All known occurrences of this type are of low grade, and all are thought to have been deposited by ground waters. Carnotite, associated with calcite and manganese oxide, forms fracture coatings and small veinlets in a rhyolite porphyry a few miles south of Sloan. Near Sutor and Goodsprings, carnotite, associated with manganese oxide, calcite, and celestite, forms joint and fracture coatings in sandstone of Permian age. Secondary uranium minerals occur as caliche in alluvium of Quaternary age between Erie and Arden. These four occurrences are in Clark County southwest of Las Vegas. Discontinuous layers of uraniferous opal occur in vitric tuff and ash beds in the Virgin Valley opal district in northwestern Nevada. Carnotite occurs locally as fine coatings on parting planes and fractures in the opal. (Auth)

<271>

Gruner, J.W.; University of Minnesota, Department of Geology and Mineralogy, Minneapolis, MN

The Origin of the Uranium Deposits of the Colorado Plateau and Adjacent Regions. Mines Magazine, 44(3), 53-56. (1954, March)

The uranium deposits on the Colorado Plateau are in essentially flat-lying sedimentary rocks that range in age from Permian to Tertiary, but most are in Triassic and Jurassic rocks. The uranium is found in universal association with plant remains. The normally red rocks are bleached to gray near the uranium deposits, presumably due to the same solutions which concentrated the uranium. The rocks containing the ores are flood-plain deposits. Interstratified with them are thick volcanic ash beds, now mudstones and silts. The volcanic ash presumably contained a small percentage of uranium which was easily leached by ground-water. During the Laramide Revolution tilting and doming of strata caused important changes in ground-water flow. At this stage much of the uranium was precipitated by the plant and hydrocarbon materials. The oxidation of the black ores to yellow is related to the present surface. (Auth)

<272>

Rasor, C.A.; AEC, Colorado Raw Materials Office, Grand Junction, CO

Uraninite from the Grey Dawn Mine, San Juan County, Utah. Science, 116(3004), 89-90. (1952, July 25)

Massive chunks of primary uraninite have been found intimately associated with carnotite-bearing ores from the Grey Dawn Mine, which is on a small tributary of La Sal Creek near the southeast flank of the La Sal Mountains, San Juan County, Utah. The host rock is a gently dipping sandstone bed in the Salt Wash member of the Morrison formation of Jurassic age. About a thousand pounds of ore containing 64 percent U3O8 were found. This is the first discovery of uraninite in the Salt Wash sandstone. The deposit is otherwise similar to other carnotite deposits in the Salt Wash sandstone. The presence of uraninite may modify the present concept of the origin of these ores. (Auth)

<273>

Thomas, H.D.; University of Wyoming, Department of Geology, Laramie, WY

Uranium in Wyoming. Mines Magazine, 44(3), 81-82. (1954, March)

Uranium deposits in Wyoming occur in sedimentary rocks that range in age from Cambrian to Recent. The deposits in the Black Hills are in the Lakota sandstone, Fuson shale, and Fall River sandstone, all of Cretaceous age. Carnotite fills small fractures and interstitial spaces in medium- to coarse-grained sandstone which contains abundant carbonaceous material. Deposits of carnotite and uranophane occur in sandstone in the Wasatch formation of Early Eocene age in the Pumpkin Buttes area. In the Miller Hill area, a uraniferous limestone occurs in a series of several hundred feet of mildly radioactive tuffaceous rocks of Tertiary age. Most of the uranium deposits in the Gas Hills are in sandstone in the Wind River formation of Lower Eocene age. The uranium deposits in the McComb area are in rocks of Middle or Late Eocene age; those in the Saratoga area are in the North Park formation of Pliocene age; deposits near Mayoworth are in limestone of the Sundance formation of Jurassic age. In the Red Desert area, schroeckingerite occurs in the Wasatch formation and in younger alluvial material. The deposits near Baggs are in Tertiary sandstones. (Auth)

<274>

Beroni, E.P., and F.A. McKeown; USGS, Washington, DC

Reconnaissance for Uraniferous Rocks in Northwestern Colorado, Southwestern Wyoming, and Northeastern Utah.
TEI-308A, 41 pp. (1952, July)

No deposits commercially exploitable under present conditions were found during the Green River and Uinta Basin reconnaissance of 1950. Samples of coal from the Bear River formation at Sage, Wyoming, assayed 0.004 to 0.013 percent uranium in the ash; in the old Uteland copper mine in Uintah County, Utah, 0.007 to 0.017 percent uranium; in a freshwater limestone, Duchesne County, Utah, as much as 0.019 percent uranium; and in the Mesaverde formation at the Snow and Bonniebell claims near Jensen, Uintah County, Utah, 0.003 to 0.090 percent uranium. Maps were made and samples were taken at the Skull Creek carnotite deposits in Moffat County, Colorado (0.006 to 0.16 percent uranium); at the Fair-U claims in Routt County, Colorado (0.002 to 0.040 percent uranium); and at the Lucky Strike claims near Kremmling in Grand County, Colorado (0.006 to 0.018 percent uranium). (Auth)(PAG)

<275>

Adams, J.A.S.; University of Wisconsin, Department of Chemistry, Madison, WI

Uranium and Thorium Contents of Volcanic Rocks. In Faul, H. (Ed.), Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York, (pp. 89-98), 414 pp. (1954)

The Lassen Volcanic National Park, California, the obsidian from Obsidian Cliff in Yellowstone National Park and other unweathered obsidians and volcanic glasses were evaluated for the uranium and thorium concentrations. The less abundant acidic volcanics have long been known to have higher uranium concentrations than the basic ones. The average uranium concentration for acidic volcanics was determined to be 5.6 ppm. The average uranium content of basic lavas is between 0.6 and 1.1 ppm. At Lassen differentiation produced dacitic lavas with 4 times as much uranium as the most basic lava analyzed, and differentiation can be expected to produce acidic volcanic rocks with at least 6 times as much uranium as the average basic lavas. Obsidians with 15 ppm are known, and extreme differentiates may have even higher concentrations of uranium. Present data indicate that thorium is about 3 times more abundant than uranium in unweathered volcanic rocks and that this ratio probably holds constant during differentiation. (PAG)

<276>

Finch, W.I.; USGS, Washington, DC

Preliminary Geologic Map Showing the Distribution of Uranium Deposits and Principal Ore-Bearing Formations of the Colorado Plateau Region. USGS Map MF 16, (1955)

The locations of nearly 3,000 uranium deposits and occurrences on the Colorado Plateau are indicated on this map by spots; those from which more than 1,000 tons of ore have been produced are distinguished by color. The history of production, the general geology, the major uranium-bearing formations, and the ore deposits are described in the text. The uranium is commonly associated with vanadium or copper and with carbonaceous material in rather well-defined, irregular-shaped bodies. The ore minerals normally impregnate the host rock. The major uranium-bearing formations are the Shinarump and Chinle formations of Triassic age, and the Entrada, Todilto, and Morrison formations of Jurassic age. Except for those in the Todilto limestone, most of the deposits are in light-colored sandstones. (Auth)

<277>

Denson, N.M., H.D. Zeller, and J.G. Stephens; USGS, Washington, DC

Water Sampling as a Guide in the Search for Uranium Deposits and Its Use in Evaluating Widespread Volcanic Units as Potential Source Beds for Uranium. In USGS Professional Paper 300, (pp. 673-680), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 794-800), 825 pp. (1956)

During the investigations of the occurrence and emplacement of uranium in coal and related carbonaceous materials in the Western United States, several thousand samples of water issuing from the various widespread volcanic rock units of Tertiary age and many samples of water from the underlying sedimentary rocks were analyzed for uranium. These analyses have proved a useful guide in delimiting areas where uranium deposits are likely to occur. Largely on the basis of the uranium content of their waters, areas previously not thought favorable for the occurrence of uranium have been recommended for ground and airborne radiometric surveying, and subsequently found to contain commercial deposits of uranium. Most ground water contains less than 2 ppb uranium. However, water from seeps and springs in volcanic and tuffaceous sedimentary terranes and water from areas of known uranium deposits may contain as much as 10 to 250 ppb. These analyses have served to delimit areas where the abnormally high uranium content of water reflects present-day leaching of hidden ore deposits and to help evaluate the relative potentialities of various volcanic units as source beds for uranium. Volcanic rocks ranging from Late Cretaceous to Pliocene in age were examined in detail in the Rocky Mountain and Great Plains provinces and samples of water issuing from them were collected for chemical analyses. Although many of the volcanic rocks of Tertiary age contain appreciable amounts of uranium, not all of the units make the uranium available to the ground water system in equal amounts. The units of Oligocene and Miocene age, irrespective of their geographic location, were notable for the significantly high uranium content in ground water issuing from them. The investigations here reported are primarily concerned with uranium carried in ground water, and secondarily with that in surface water. Brief consideration is given to trace-metal suites determined by chemical analyses of residues obtained by evaporation of bulk samples of water from the better-known and more widely distributed Tertiary volcanic units. Regional variation in the uranium content of water as influenced by the presence of uranium deposits or volcanic rocks are discussed and shown on geologic maps. (Auth)

<278>

Fischer, R.P.; USGS, Washington, DC; Colorado Mining Association, Denver, CO

Federal Exploration for Carnotite Ore. USGS Special Publication, 14 pp. (1949)

A brief description of the carnotite deposits is given, with particular reference to the geologic features that are useful in guiding exploration. Most deposits are in lenticular sandstone beds, mainly in or near the thicker, central parts of the lenses, where the sandstone is medium-grained and rather thickly though somewhat irregularly bedded. Thin-bedded and fine-grained sandstone on the thinning edges of the lenses is less favorable for ore. It is suggested that ground-water solutions, from which the ore minerals probably were precipitated, circulated along the central parts of the sandstone lenses, and in doing so influenced the rock color, which is a useful guide in recognizing ground favorable for ore deposits. Most of the known deposits are in light yellowish-brown sandstone with associated mudstone or argillaceous material that has been altered from red to gray. (Auth)(MBW)

<279>

Fischer, R.P., J.C. Haff, and J.F. Rominger; USGS, Denver, CO

Vanadium Deposits Near Placerville, San Miguel County, Colorado. Colorado Science Society Proceedings, 15(3), 115-134. (1947)

The vanadium deposits near Placerville, discovered about 1900, occur in two belts in the Entrada sandstone of Upper Jurassic age. The formations in the area are nearly horizontal sedimentary rocks of Permian to Cretaceous age which have been intruded by Tertiary igneous rocks and cut by numerous faults. The vanadium deposits seem to be older than the faults and intrusive rocks and thus not genetically related to them. The ore is sandstone impregnated with vanadium minerals. The vanadium-bearing rock forms a wavy layer within the upper 25 feet of the Entrada sandstone. The vanadium-bearing layer is nearly continuous and lies nearly parallel to the bedding but does not follow the bedding in detail. The layer averages a few inches in thickness, but locally it forms minable ore bodies one foot to 20 feet thick. The ore bodies seem to be irregularly distributed and are either elongate or roughly circular in plan. Most of the elongate bodies occur where the vanadium-bearing layer cuts rather sharply across the bedding to form what are called rolls. The mineralization is believed to have taken place at a water table that existed prior to igneous activity and deformation. The genetic and structural conditions that controlled the localization of the ore bodies have not been definitely determined, and the exact locations of ore bodies cannot be predicted. A number of mines and prospects in the area are described. (Auth)

<280>

Fleck, H., and W.G. Haldane; Colorado Bureau of Mines, Denver, CO

A Study of the Uranium and Vanadium Belts of Southern Colorado. Report of the Colorado State Bureau of Mines 1905-1906, (pp. 47-115). (1907)

The geology of the uranium and vanadium deposits in southwestern Colorado, the metallurgy of the ores, and the uses of the metals are discussed. Little is known of the geology of the deposits. They are in sandstone beds in a series of sandstone, shale, and conglomerate above the Entrada Sandstone (La Plata formation) of Jurassic age, and were formed subsequent to the deposition of the sandstone beds. It has been suggested that the deposits formed recently near the present surface as local concentrations of material already in the sandstone, but the authors suggest that the deposits may be much older. A number of mines and prospects in the region are described. (Auth)

<281>

Gale, H.S.; USGS, Washington, DC

Carnotite in Rio Blanco County, Colorado. USGS Bulletin 315-C, (pp. 110-117). (1906)

Carnotite deposits about 15 miles northeast of Meeker in Rio Blanco County are in sandstone of the Dakota sandstone of Cretaceous age. The carnotite coats fractures in the sandstone and is associated with fossil wood. The deposits are probably superf...l. (Auth)

<282>

Griggs, R.L.; USGS, Washington, DC

A Reconnaissance for Uranium in New Mexico. USGS Circular 354, 9 pp. (1953)

A reconnaissance for uranium was conducted in the Datil area in Catron and Socorro Counties, the Cerrillos and the Glorieta Mining districts in Santa Fe County, the Las Vegas area and the Tecolote Mining district in San Miguel County, and an area in Colfax County, all in New Mexico. Possibly significant uranium deposits were found only in the Datil area, where one sample contained 0.056 percent U3O8. In this area, yellow uranium minerals associated with carbonaceous material and limonite occur in the Mesaverde formation of Cretaceous age at the base of sandstone beds which overlie shale. (Auth)

<283>

Merritt, P.L.; AEC, Washington, DC

Uranium Exploration in the United States. Rocks and Minerals, 25(7-8), 363-370; Canadian Mining and Metals Bulletin, 43(460), 438-443; Mines Magazine, 40(6), 36, 51-52. (1950)

Generalized geologic descriptions of the types of environments in which uranium has been found in the United States are given. The uranium deposits on the Colorado Plateau are mostly in continental sandstone formations of Triassic and Jurassic age. The most important producing formation is the Salt Wash member of the MOrrison formation of Jurassic age. The deposits are roughly tabular, irregular in outline, and, in general, conform to the beddings, although in detail they may cross the bedding. The most important mineral is carnotite; it is usually associated with fossil organic material. Pitchblende deposits in the Colorado Front Range, in the Coeur d'Alene district in Idaho, at Marysvale, Utah, and in Upper Michigan, and uraniferous phosphorite and black shale deposits also are described. (Auth)(MBW)

<284>

Miller, L.J.; AEC, Grand Junction, CO

Drilling in the Happy Jack Mine Area, White Caynon, San Juan County, Utah. RME-4039, 14 pp. (1952)

Diamond drilling in the Happy Jack mine area was done to locate copper-uranium deposits in the Shinarump conglomerate of Triassic age and to outline channels cut into the underlying Moenkopi formation of Triassic age. Eleven of twenty-six holes penetrated ore, and the Sunrise, Gonaway, and Happy Jack channels were outlined. The ore occurs in the Shinarump conglomerate at or near the base of the channels and is characteristically in porous, coarse-grained sandstone which rests on dense mudstone. The principal uranium mineral, pitchblende, is associated with carbonaceous material, and in places replaces wood. The host rock is erratically cemented with gypsum, calcite, and silica. (Auth)

<285>

Hess, F.L.; USGS, Washington, DC

Uranium-Bearing Asphaltite Sediments of Utah. Engineering Mining Journal, 144(7), 272-276. (1922)

Uranium and vanadium minerals occur in and are associated with asphaltite in the Shinarump conglomerate of Triassic age at Temple Mountain, Emery County, Utah, on the southeast flank of the San Rafael Swell. Fossil vegetal material is abundant. The asphaltite grains are detrital and are deformed around other sand grains. The metal-bearing asphaltite is notably harder and blacker than is asphaltite that contains no metals. Brightly colored uranium and vanadium minerals are conspicuous on the outcrop; they become markedly rarer a few feet from the surface, but never disappear. Ore shoots have an irregular ellipsoidal form, probably due to weathering. The feature on part of Temple Mountain called the "flopover" may be due to the action of sulfurous hot springs. Normally red or brown sediments are bleached to white; the structure is jumbled, and asphaltite is absent. Small masses of uranium ore occur in the "flopover" in the Wingate sandstone of Jurassic age. The metals were probably leached from the asphaltite and redeposited; the volatile products were lost. It is suggested that the uranium and vanadium were picked up by the asphaltite grains before or during deposition of the surrounding sediments. The position, size, and shape of the ore shoots is thought to be fortuitous and modified by weathering. The possibility also exists that the metals were derived from the hot springs. (Auth)

<286>

Hewett, D.F.; Not given

Carnotite in Southern Nevada. Engineering Mining Journal, 115(5), 232-235. (1923)

Small, non-commercial carnotite deposits have been found in three areas in Clark County, Nevada, southwest of Las Vegas. Near Sloan, the carnotite occurs in vertical joints in a Tertiary rhyolite flow. The occurrences near Sutor are in a sandstone bed that immediately underlies the lowest Permian limestone bed, and those near Goodsprings are in a sandstone bed that overlies the lowest Permian limestone bed. The deposits probably were emplaced relatively recently by surface waters. (Auth)

<287>

Hewett, D.F.; Not given

Carnotite Near Aguila, Arizona. Engineering Mining Journal, 120(1), 19. (1925)

Small, non-commercial carnotite deposits occur in a lacustrine bentonitic tuff bed that is faulted, tilted, and intruded by dikes. The tuff beds overlie Precambrian granite and are overlain by basalt flows. The carnotite replaces clay blebs near poorly defined fractures in the tuffs. The deposits probably formed recently by circulating ground water. (Auth)

<288>

Hewett, D.F.; Not given

Central Arizona Holds Deposits of Carnotite. Arizona Mining Journal, 9(7), 49-50. (1925)

Carnotite occurs as small patches along minor crosscutting fractures in drab thin-bedded Tertiary tuffs near Aguila, Maricopa County, Arizona. The tuffs are now largely bentonitic clays that aggregate over 200 feet in thickness. They are overlain by several hundred feet of vesicular basalt. The rocks are faulted, and they dip 10-25 degrees S. The carnotite probably has been deposited recently by circulating ground water. (Auth)

<289>

Hillebrand, W.F., and F.L. Ransome; USGS, Washington, DC

On Carnotite and Associated Vanadiferous Minerals in Western Colorado. USGS Bulletin 262, (pp. 9-31); American Journal of Sciences, 10(56), 120-144. (1905)

The first part of the report describes some of the vanadium-uranium deposits in western Colorado, and the second part describes chemical analyses of the ores. Vanadium deposits with minor amounts of uranium occur in the La Plata sandstone (Entrada sandstone) of Jurassic age near Placerville, Colorado. Roscoelite impregnates fine-grained sandstone and may replace calcite cement. The vanadiferous material is fairly continuous over about 2,000 feet of outcrop but has no constant thickness; it locally splits into two or more layers. A thin, discontinuous seam of sandstone impregnated with carnotite occurs near the base of the vanadiferous material. The deposits at La Sal Creek are in massive, nearly white sandstone in the McElmo formation (Morrison formation) of Jurassic age. Carnotite impregnates the sandstone along bedding planes and minor fractures. The deposits are small, discontinuous, and superficial. The deposits of carnotite and roscoelite were formed subsequent to the deposition of the host rocks. The origin of the roscoelite deposits is not clear, but the carnotite deposits are thought to have been formed at the present surface of the ground by evaporation of uraniferous groundwater. The metals were originally disseminated in the mass of the host formations. (Auth)(PAG)

The report was also published in the American Journal of Sciences, 10(56), 120-144 in 1900.

<290>

Hilpert, L.S., and V.L. Freeman; USGS, Washington, DC

Guides to Uranium Deposits in the Morrison Formation, Gallup-Laguna Area, New Mexico. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 346-349), 825 pp.; In USGS Professional Paper 300, (pp. 299-302), 739 pp. (1956)

Uranium ore production from New Mexico constitutes a significant part of the total production from the Colorado Plateau. About 90 percent of the ore from New Mexico has come from the area that extends from Gallup to Laguna, in McKinley and Valencia Counties; and over 95 percent of the area's production has come from the Todilto limestone and Morrison formation of Jurassic age. Although the area's first production came from the Todilto limestone, the production from the Morrison rose rapidly from 1951 to 1954, and by September 1954 it exceeded that from the Todilto. In September 1954 the reserves in the Morrison in the Gallup-Laguna area constituted most of the reserves in New Mexico and an important part of the reserves of the Colorado Plateau. Until recently the deposits in the Morrison formation were believed to be distributed almost equally through the three members of the formation in the area. From base to top, these are the Recapture, Westwater Canyon, and Brushy Basin members. Recent work shows, however, that most of the deposits in the Morrison-in fact, all the larger deposits-are in the Brushy Basin member. The Brushy Basin generally consists of claystone with subordinate amounts of sandstone, conglomerate, and some relatively thin limestone lenses; it ranges from a knife edge to about 375 feet in thickness. Preliminary work shows that the larger deposits in the Brushy Basin member generally occur in coarse-grained sandstone units where the units are thicker. Preliminary ore guides and methods of prospecting have been developed for two of these sandstones, the so-called Poison Canyon and so-called Jackpile sandstone units. Because of their relatively great uranium potential, these units and others of the same type in the Brushy Basin member perhaps should be primary exploration targets in the search for uranium in the Gallup-Laguna area. (Auth)

The Conference paper was entitled "Guides to Uranium Deposits in the Gallup-Laguna Area".

<291>

Hinckley, D.N., and J.H. Volgamore; AEC, Grand Junction, CO

Reconnaissance of Little Wild Horse Mesa, Green River Desert, Emery

County, Utah. RME-43, 14 pp. (1953)

Uranium occurrences on Little Wild Horse Mesa are in medium- to coarse-grained, cross-bedded sandstone near the middle of the Salt Wash member of the Morrison formation of Jurassic age. Two of the three mineralized localities may have some economic importance. (Auth)

<292>

Hunt, C.B., P. Averitt, and R.L. Miller; USGS, Washington, DC

Geology and Geography of the Henry Mountains Regions, Utah. USGS Professional Paper 228, 234 pp. (1953)

The Henry Mountains are situated in a structural basin; exposed sedimentary rocks aggregate about 8,000 feet in thickness and include rocks of Permian, Triassic, Jurassic, Upper Cretaceous, and Quaternary age. More than 80 percent of the pre-Cretaceous rocks are of continental origin; most of the Upper Cretaceous rocks are marine. Faults are generally uncommon. Each of the Henry Mountains is a structural dome produced by the injection of stocks and laccolithic masses. The report includes geologic and structural maps of the region at a scale of about 1:125,000, and geologic maps of Mount Hillers, of Mount Holmes and Mount Ellsworth, and of Mount Ellen and Mount Pennell, all at the scale of 1:31,680. Vanadium- and uranium-bearing minerals locally impregnate the sandstone and replace fossil plant remains in the lower part of the Morrison formation of Jurassic age on the east side of the Henry Mountains. Similar deposits, some of which contain copper, occur in the Shinarump conglomerate of Triassic age in areas adjacent to this region. (Auth)

<293>

Huttl, J.B.; Not given

New Mexico Uranium. Engineering Mining Journal, 155(8), 96-99. (1954)

The report deals mainly with the uranium mining and milling operations of the Anaconda Copper Mining Company in the Grants district, New Mexico. The Anaconda's Section 9 mine, near Grants, is in the Todilto limestone of Jurassic age, and the Jackpile mine, also an Anaconda property, is in the Westwater Canyon member of the Morrison formation of Jurassic age. The carnotite orebody at the Jackpile mine is cut by a diabase sill. (Auth)

<294>

Isachsen, Y.W.; AEC, Grand Junction, CO

Uranium Deposits, Big Indian Wash-Lisbon Valley Area, San Juan County, Utah. Economic Geology, 49(7), 804; Geological Society of America Bulletin, 65(12), 1267-1268. (1954)

Extensive bedded uranium deposits have been discovered along the southwest limb of the Lisbon Valley salt anticline. The major ore bodies are confined to the lower portion of the Triassic Chinle formation which unconformably overlies the Permian Cutler formation. Arkosic, gray to black sandstone with intercalated lenses of gray-green mudstone and mudstone pebble conglomerate contain uraninite which has replaced carbonaceous material and calcite cement. Locally, solid masses of pure uraninite result from replacement of organic material. Montroseite occurs with uraninite in the major deposits discovered to date. Tyuyamunite frequently forms surface coatings along fractures. Thickness of ore in the area is generally sufficient to permit mining with little or no waste rock. In several areas known to contain ore bodies, the gray-green color of the lower Chinle formation extends upwards into the overlying red Chinle mudstones in the manner of an alteration halo. About 100 feet beneath the Chinle ore horizon are arkosic lenses in the Cutler formation which contain, in some instances, low grade uranium mineralization. The ore minerals, carnotite and becquerelite, are disseminated in the arkose with greatest concentration adjacent to fractures. The oxidized state of these minerals coupled with the concentration near fractures suggests that the Cutler mineralization is due to leaching from uraninite ore bodies in the Chinle formation. (Auth)

<295>

Stokes, W.L. (Ed.); Utah Geological and Mineralogical Survey, Salt Lake City, UT

Uranium Deposits and General Geology of Southeastern Utah. *Guidebook to the Geology of Utah*, No. 9, 115 pp. (1954)

The report is divided into several supplementary parts. Two sections are devoted to the history of the vanadium-uranium-radium industry on the Colorado Plateau. In another section the uranium mineralogy of the region is described; mineral tables are included. The stratigraphy and structure of the region are discussed separately and the uranium deposits of the Thompson area, Grand County, and the Big Indian Wash-Lisbon Valley area, San Juan County, are described separately. (Auth)

<296>

Stokes, W.L., and C.M. Mobley;
University of Utah, Salt Lake City, UT;
USGS, Washington, DC

Geology and Uranium Deposits of the Thompson Area, Grand County, Utah. In Stokes, W.L. (Ed.), Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 78-94), 115 pp. (1954)

Uranium-vanadium deposits in the Thompson area occur in fluvial sandstones in the Salt Wash member of the Morrison formation of Jurassic age. Rocks in the area dip at low angles to the northeast away from the Salt Valley anticline. Carnotite and tyuyamunite replace fossil plant material and are disseminated in the surrounding sandstone. Corvusite and a micaceous vanadium mineral are disseminated in the sandstone also, but they do not always occur with the uranium minerals. The deposits may be tabular or lenticular in shape, with their long axes parallel to the bedding, or they may be curved zones, called "rolls", of mineralized material that cross bedding planes. The sandstone enclosing most of the ore bodies is dominantly light-gray to white rather than the usual red, and the mudstone interbedded with the sandstone near the ore bodies is gray rather than the normal red-brown. The ore appears to be confined mainly to the thicker, more continuous sandstone lenses, and the larger ore deposits are in the central part of the lenses. (Auth)

<297>

Isachsen, Y.W.; AEC, Grand Junction, CO

Ore Deposits of the Big Indian Wash-Lisbon Valley Area. In Stokes, W.L. (Ed.), Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 95-106), 115 pp. (1954)

Uranium deposits in the Big Indian Wash-Lisbon Valley area are mostly in the Chinle formation of Triassic age, but small deposits occur in the Cutler formation of Permian age. The uranium-producing area is on the southwest flank of the faulted, northwest-trending Lisbon Valley anticline, which is probably a salt structure. In the deposits in the Chinle formation, uraninite and montroseite replace calcite cement, and uraninite also replaces coalified logs and carbonaceous debris. Pyrite is fairly abundant. The deposits are all in the lower part of the formation, sometimes directly on the underlying Cutler formation. Ore does not follow the host rock uniformly, nor does it follow primary textures in detail. Host rock lithologies include siltstone, fine- to coarse-grained arkosic sandstone, and conglomerate. The most favorable host rock is gray-green fine- to coarse-grained arkosic sandstone cemented with calcite. The deposits in the Cutler formation consist of carnotite and becquerelite disseminated in streaks, pods, and patches in fluvial arkose lenses. (Auth)

<298>

Kaiser, E.P.; USGS, Washington, DC

Uraniferous Quartzite, Red Bluff Prospect, Gila County, Arizona. USGS Circular 137, 10 pp. (1951)

Radioactivity is present in two zones in the silty upper part of the Dripping Spring quartzite of Precambrian age at the Red Bluff prospect, Gila County, Arizona. An unidentified uranium mineral, possibly pitchblende, is rather evenly disseminated through most of the rock in the deposits, but black streaks and fractures within the deposits contain a higher percentage of uranium. Stratigraphic control of the radioactive zones is indicated by the restriction of the zones to two layers, each about 20 feet thick. The rock in the radioactive zones has been bleached and partly recrystallized. The uranium deposits are epigenetic and probably of hydrothermal origin. (Auth)

<299>

Reyner, M.L.; AEC, Grand Junction, CO

Preliminary Report on Some Uranium Deposits Along the West Side of the San Rafael Swell, Emery County, Utah.
RMO-673, 31 pp. (1950)

Twelve uranium deposits along the western flank of the San Rafael Swell were examined. The deposits are lenticular or tabular bodies of mineralized sandstone, conglomerate, or shale, and all are near the base of the Shinarump conglomerate of Triassic age. The uranium is intimately associated with blebs and seams of asphalt, and with small bits of carbonized wood. Brightly colored secondary uranium minerals are present at the outcrop. The claims and groups of claims reported on are: Lone Tree, Hard Pan, Dalton, Dexter, Wickiup, Dolly, South Fork, Pay Day, Green Vein, Brown Throne and Dirty Devil groups, and the Clifford Smith, Hertz No. 1, and Gardell Snow claims. (Auth)

<300>

Rogers, K.J.; AEC, Grand Junction, CO

Reconnaissance of the Lower Chinle Along the Colorado River Between the Moab and Dewey Bridges, Grand County, Utah. RME-70, 17 pp. (1954)

One small radioactivity anomaly was located as a result of a reconnaissance for uranium deposits in the lower part of the Chinle formation of Traissic age in an area north of Moab along the Colorado River. The lower Chinle in this area is apparently unfavorable for the occurrence of uranium deposits. (Auth)

<301>

Schnabel, R.W.; USGS, Washington, DC

The Uranium Deposits of the United States. USGS Mineral Investigations Resource Appraisals Map MR 2. (1955)

The map shows the location of the more important uranium deposits in the United States. The deposits are classed by their geologic environment. These classes include the deposits in sandstone mainly on the Colorado Plateau but also in South Dakota, Wyoming, and other states, deposits in phosphorite in Florida, South Carolina, and in the northwest, deposits in lignite mainly in South Dakota, North Dakota, and Wyoming, uraniferous black shale deposits mainly in Tennessee, Kentucky, Alabama, and Georgia, placer deposits of monazite in the southeastern United States and in Idaho, and deposits in igneous rocks, pegmatites, limestone, and other rocks. The geology of each class of occurrence is briefly summarized. (Auth)

<302>

Miller, R.D.; AEC, Salt Lake City, UT

Reconnaissance for Uranium in the Hualapai Indian Reservation Area, Mohave and Coconino Counties, Arizona.
RME-2007, 18 pp. (1954)

The only known occurrence of uranium in the Hualapai Indian Reservation is at the Ridenour mine. The workings are in bleached fine-grained sandstone members of the normally red Supai formation of Permian age. Copper minerals occur in a vein and breccia zone with pyrite and limonite. Vein quartz is absent, and uranium and vanadium are minor. Consolidated sedimentary rocks in the area range in age from Cambrian to Permian. Precambrian crystalline rocks are exposed in the deeper canyons. Major faults are prominent. The sedimentary rocks are either horizontal or gently dipping. The Supai formation and the Hermit shale, both of Permian age, appear to be the most favorable host rocks in the area for uranium deposits localized by stratigraphic control. (Auth)

<303>

Moore, R.B., and K.L. Kithil; US Bureau of Mines, Washington, DC

A Preliminary Report of Uranium, Radium, and Vanadium. US Bureau of Mines Bulletin 70, 101 pp. (1913)

Topics d'cussed in this report are: the carnotite deposits of Colorado and Utah, the pitchblende deposits of the world, the vanadium deposits in the United States and Peru, methods of analysis of ore, methods of ore treatment, and uses of the metals. Carnotite deposits in the Green River and Thompsons districts in Utah, and at Skull Creek, Coal Creek, and the Paradox Valley region in Colorado are described. The deposits are commonly associated with carbonaceous material in sandstone beds. Variable quantities of vanadium minerals may be present. The deposits in the Paradox Valley region are in a light-colored sandstone of the McElmo formation (Morrison formation) of Jurassic age. The most typical ore is sandstone impregnated with carnotite and containing small brown kidneys of vanadium-rich sandy clay. The deposits are invariably in pockets and are associated with gypsum, carbonaceous material, and red, brown, blue, and black vanadium minerals. Some of the mine workings are described as of 1912. The authors suggest that the uranium was disseminated in the sandstone country rock and has been concentrated in ore bodies by the action of water. (Auth)

<304>

Muilenburg, G.A.; Missouri Geological Survey and Water Resources, Jefferson City, MO

Notes on Uranium. Missouri Geological Survey and Water Resources Information Circular No. 5, 18 pp. (1949)

The circular briefly describes uranium minerals and methods of identifying them different types of uranium deposits, and uranium occurrences in Missouri. Only specimen quantities of uranium minerals have been found in Missouri. Meta-torbernite has been found in a fire-clay in Franklin County, and carnotite has been found on a joint surface in limestone at a quarry near Ste. Genevieve. Several other localities are known. (Auth)

<305>

Carithers, L.W., and N.J. Clinton; AEC, Grand Junction, CO

Uranium in Shoreline Sandstones of Terrestrial and Marine Origin, Colorado Plateau. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 383-386). 825 pp. (1956)

At Black Mesa, Arizona, and in the San Juan Basin of New Mexico, uranium minerals occur in sandstones deposited in marginal marine or near-shore terrestrial environment in the Curtis formation of Jurassic age and in some members of the Mesaverde group of Late Cretaceous age. The occurrences are associated with local facies changes and with accumulations of carbonaceous material; all are in or near regions of post-Cretaceous tectonic disturbances. (Auth)

<306>

Cater, F.W., Jr.; USGS, Washington, DC

Geology of the Bull Canyon Quadrangle, Colorado. USGS Map GQ 33. (1954)

The map area is underlain by sedimentary rocks that range in age from Late Paleozoic to Quaternary except in the northeastern part where crystalline Precambrian rocks crop out along the flanks of the Uncompahgre Plateau. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The uranium-vanadium deposits are mostly restricted to the upper layer of sandstone lenses in the Salt Wash member of the Morrison formation of Jurassic age. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals, but rich concentrations are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. The ore bodies range from small irregular masses that contain a few tons of ore to large tabular masses containing many thousands of tons; most ore bodies are relatively small and contain only a few hundred tons. Margins of ore bodies may be vaguely or sharply defined. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts of sandstone lenses and commonly near the base of the lenses. The trend of the long direction of the deposits and the trend of the rolls in the sandstone are roughly parallel to the trend of the fossil logs in the sandstone and to the average or resultant dip of the cross-bedding in the sandstone. (Auth)(PAG)

<307>

Cater, F.W., Jr.; USGS, Washington, DC

Geology of the Gateway Quadrangle, Colorado. USGS Map GQ 55. (1955)

The map area is underlain by sedimentary rocks that range in age from Late Paleozoic to Quaternary except in the northeastern part where crystalline Precambrian rocks crop out along the flanks of the Uncompahgre Plateau. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The uranium-vanadium deposits are mostly restricted to the upper layer of sandstone lenses in the Salt Wash member of the Morrison formation of Jurassic age. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals, but rich concentrations are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. The ore bodies range from small irregular masses that contain a few tons of ore to large tabular masses containing many thousands of tons; most ore bodies are relatively small and contain only a few hundred tons. Margins of ore bodies may be vaguely or sharply defined. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts of sandstone lenses and commonly near the base of the lenses. The trend of the long direction of the deposits and the trend of the rolls in the sandstone are roughly parallel to the trend of the fossil logs in the sandstone and to the average or resultant dip of the cross-bedding in the sandstone. (Auth)(PAG)

<308>

Cater, F.W., Jr.; USGS, Washington, DC

Geology of the Pine Mountain Quadrangle, Colorado. USGS Map GQ 60. (1955)

The map area is underlain by sedimentary rocks that range in age from Late Paleozoic to Quaternary except in the northeastern part where crystalline Precambrian rocks crop out along the flanks of the Uncompahgre Plateau. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The uranium-vanadium deposits are mostly restricted to the upper layer of sandstone lenses in the Salt Wash member of the Morrison formation of Jurassic age. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals, but rich concentrations are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. The ore bodies range from small irregular masses that contain a few tons of ore to large tabular masses containing many thousands of tons; most ore bodies are relatively small and contain only a few hundred tons. Margins of ore bodies may be vaguely or sharply defined. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts of sandstone lenses and commonly near the base of the lenses. The trend of the long direction of the deposits and the trend of the fossil logs in the sandstone and to the average or resultant dip of the cross-bedding in the sandstone. (Auth)(PAG)

<309>

Chase, G.W. Oklahoma Geological Survey, Norman, OK

Occurrence of Radioactive Material in Sandstone Lenses of Southwestern Oklahoma. Oklahoma Geological Survey Mineral Report No. 26. (1954)

Sandstone lenses of Permian age containing radioactive bituminous material occur locally beneath a gray cross-bedded bituminous sandstone in the southern part of Jefferson and Cotton Counties, Oklahoma. The sandstones are probably near the base of the Garber sandstone. (Auth)

<310>

Coffin, R.C.; Colorado Geological Survey, Denver, CO

Radium, Uranium, and Vanadium

Deposits of Southwestern Colorado. Colorado Geological Survey Bulletin 16. 231 pp. (1921)

The paper is the report of a study of the carnotite region of southwestern Colorado includes descriptions of several claims and groups of claims within the carnotite region. Separate chapters are devoted to geography, stratigraphy, structure, economic geology of the carnotite deposits, description of selected areas, and miscellaneous economic materials. Most of the carnotite deposits occur in one of two zones in the lower half of the McElmo formation of Jurassic age (redefined in part as the Morrison formation). The lower zone is from 60 to 125 feet above the base of the formation, and the more productive upper zone is from 275 to 325 feet above the base. The host rock is generally a light-colored massive cross-bedded sandstone, and the ore is frequently underlain by beds of clay. Carnotite usually impregnates the sandstone and cements the sands grains, but it may also replace fossil wood or fill fractures and vugs. The carnotite deposits occur in the sandstone as lenses, seams, and irregular pockets whose long dimensions follow in general the bedding of the sandstone. The deposits are irregular in plan. Cylindrical masses of ore called "trees" or "logs" are sometimes within the deposits. (Auth)(PAG)

<311>

Hall, R.B.; Not given

Recent Uranium Developments in the Black Hills. Mines Magazine, 45(3), 60, 122-123. (1955)

The Black Hills is a relatively flat, domal uplift, elliptical in shape, and trends northwesterly. Crystalline Precambrian rocks are exposed in the core, and sedimentary rocks of Cambrian to Cretaceous age form a series of cuestas and hogbacks around the core. In the Edgemont district, Fall River County, South Dakota, the regional dip is to the southwest; the regional dip is interrupted by two major south-plunging anticlines and other minor structural features. Uranium deposits in the Edgemont district, first discovered in 1951, are for the most part confined to the Inyan Kara group of Lower Cretaceous age. Most of the deposits and all of the major producing mines are in areas where the rocks dip less than 5 degrees, and they are often where there is a sharp change in dip. The Gould ore body, the largest producer in the Black Hills, is in the basal part of the Fall River sandstone, which, in the vicinity of the mine, is a buff to brown, coarse- to very coarse-grained sandstone. The principal ore mineral, carnotite, occurs as interstitial fillings. It is thought that lithologic controls combined with structural controls were instrumental in localizing the ore bodies. An electrical resistivity survey in the drilling area demonstrated that a resistivity anomaly exists over the ore body. Resistivity techniques may be successful in delimiting favorable ground. (Auth)

<312>

Hatfield, K.G., and C.R. Maise; AEC, Grand Junction, CO

Geologic Reconnaissance of the Defiance Uplift, Apache County, Arizona. RME-71. 14 pp. (1954)

A reconnaissance investigation for uranium deposits in the Defiance uplift was concentrated on the Chinle formation of Triassic age. No large deposits were found. A number of mineralized localities in the Chinle were associated with small concretions and carbonized logs. The deposits are surrounded by a zone in which the normal blue or purple color has been altered to gray or brownish-orange. Small uranium deposits may occur in formations other than the Chinle. The Defiance uplift is a broad structural feature in which formations that range in age from Precambrian to Tertiary are exposed. (Auth)

<313>

Hess, F.L.; USGS, Washington, DC

Carnotite Near Green River, Utah. USGS Bulletin 530-K, (pp. 161-164). (1913)

The carnotite deposits near Green River occur in coarse-grained, cross-bedded sandstone of the Flaming Gorge formation (redefined in part as the Morrison formation) of Jurassic age. The carnotite impregnates the sandstone, coats fractures, and fills small irregular cavities. The mineral is associated with iron oxide stains and abundant fossil plant material. (Auth)

<314>

Hess, F.L.; USGS, Washington, DC

Notes on the Vanadium Deposits Near Placerville, Colorado. USGS Bulletin 530-K, (pp. 142-156). (1913)

The vanadium mineral roscoelite occurs in a dark-colored fine-grained sandstone in the La Plata formation (redefined in part as the Entrada sandstone) of Jurassic age. The mineral locally impregnates the sandstone at about the same stratigraphic horizon along several miles of outcrop. The individual deposits are tabular and have an outcrop length of as much as 700 feet. Carnotite is minor to roscoelite and occurs locally along joints in the vanadium deposits. Mariposite, a green chromium mineral, is disseminated in sandstone and nearly envelopes the vanadium deposits. (Auth)

<315>

Hess, F.L.; USGS, Washington, DC

Uranium and Vanadium. USGS Mineral Resources, 1912, Part I, (pp. 1003-1007). (1913)

The report is a brief study of the uranium and vanadium industry of the United States and the world in 1912 and a survey of the geology of deposits of uranium and vanadium. The deposits discussed are in southwestern Colorado, Gilpin County, Colorado, and several other minor localities in the United States, and in Central Europe, England, Australia, Sweden, Norway, Portugal, France, Russia, East Africa, and Madagascar. The uranium and vanadium minerals in the deposits in southwestern Colorado occur as interstitial fillings in sandstone. There are two types of deposits: carnotite and roscoelite. The roscoelite deposits contain a negligible percentage of uranium. (Auth)

<316>

Stugard, F., Jr.; USGS, Washington, DC

Uranium Resources in the Silver Reef (Harrisburg) District, Washington County, Utah. TEM-214, 33 pp. (1951)

Uranium deposits occur in the Silver Reef district near Leeds, Utah in the Tecumseh sandstone member of the Chinle formation of Triassic age. The major structural feature of the area is the northeast-trending and plunging Virgin anticline, which has been thrust-faulted and breached by erosion. Hogbacks, or "reefs" dipping as much as 36 degrees are developed on resistant sandstone beds. The ore occurs in thinly-bedded and cross-bedded fluviatile lenses of shale and sandstone and is apparently associated with carbonized plant material. Vanadium-uranium ore has been shipped from the Chloride Chief and Silver Point Claims. The ore contains several times as much vanadium as uranium, some copper, and traces of silver. (Auth)(MBW)

<317>

Not given; USGS, Washington, DC

Wamsutter (Red Desert) Area, Wyoming, Progress Report. TEM-96A, 2 pp. (1951)

The report concerns the preliminary results of field work done during 1949 on the schroeckingerite deposits at Lost Creek near Wamsutter, Sweetwater County, Wyoming. The schroeckingerite occurs as a caliche deposit along a fault zone. The uranium may have been derived from uraniferous lignite cut by the fault zone at a depth of about 500 feet. It is suggested that similar deposits may occur along other fault zones that cut uraniferous lignite. (Auth)

<318>

Stephens, J.G.; USGS, Washington, DC

Crooks Gap Area, Fremont County, Wyoming. TEI-490, (pp. 120-122); In Geologic Investigations of Radioactive Deposits, Semiannual Progress Report, June 1 to November 30, 1954, (pp. 120-122). (1954)

In the Crooks Gap area, uranium occurs both in the arkosic sandstones of the Wasatch formation of Eocene age, and in ferruginous limestone and shale of Cambrian age mainly along a thrust-fault zone. No ore-grade deposits have been discovered in the Cambrian rocks. The Wasatch formation consists of iron stained, coarse arkose that contains thin lenses of carbonaceous sandy shale and mudstone, and interbeds of giant-boulder conglomerate. The uranium deposits are in the lower part of the formation and are associated with fine-grained carbonaceous beds and with red and brownish-yellow iron stained sandstone. Uranophane is the principal uranium mineral. (Auth)

<319>

Stokes, W.L., and D.A. Phoenix; USGS, Washington, DC

Geology of the Egnar-Gypsum Valley Area, San Miguel and Montrose Counties, Colorado. USGS Oil and Gas Investigation Preliminary Map 93 (with text). (1948)

The stratigraphy and structure of the area are described. Exposed sedimentary rocks range in age from Pennsylvanian to Quaternary; no igneous rocks are present. Most of the Permian, Triassic, and Jurassic rocks are of continental origin. The structural trend is northwest-southeast; the gentle regional folding dates in part to Paleozoic time. From south to north, the structures include the Dolores anticline, the Disappointment syncline, and the Gypsum Valley anticline. The Dolores anticline may be due to the intrusion of salt, and the Gypsum Valley anticline certainly is. The crest of the Gypsum Valley anticline is extensively faulted and collapsed. (Auth)

<320>

Stokes, W.L., R.T. Russell, R.P. Fischer, and A.P. Butler, Jr.; USGS, Washington, DC

Geologic Map of the Gateway Area, Mesa County, Colorado, and the Adjoining Part of Grand County, Utah. USGS Strategic Minerals Investigations Preliminary Map 3-173 (with text). (1945)

The vanadium-uranium deposits in the Gateway area are in a bench-forming sandstone unit near the top of the lower part of the Morrison formatiom of Jurassic age. The sandstone in the deposits is partly or wholly impregnated with carnotite and other vanadium minerals, and some plant material is richly mineralized. The ore bodies are irregular in shape; the larger ones are tabular bodies that lie essentially parallel to the bedding but cut the bedding in detail. Locally the ore bodies have a roughly cylindrical shape; these are called rolls by the miners. The rolls and the mineralized logs have a northeasterly orientation. A belt in which the ore bodies are relatively closely spaced trends northwestward through the area. The deposits are indicated on the map by spots. (Auth)

<320>

MAPPING, SURVEYING, AND LOCATION OF DEPOSITS

<320>

Stokes, W.L., R.T. Russell, R.P. Fischer, and A.P. Butler, Jr.; USGS, Washington, DC

Geologic Map of the Gateway Area, Mesa County, Colorado, and the Adjoining Part of Grand County, Utah. USGS Strategic Minerals Investigations Preliminary Map 3-173 (with text). (1945)

The vanadium-uranium deposits in the Gateway area are in a bench-forming sandstone unit near the top of the lower part of the Morrison formatiom of Jurassic age. The sandstone in the deposits is partly or wholly impregnated with carnotite and other vanadium minerals, and some plant material is richly mineralized. The ore bodies are irregular in shape; the larger ones are tabular bodies that lie essentially parallel to the bedding but cut the bedding in detail. Locally the ore bodies have a roughly cylindrical shape; these are called rolls by the miners. The rolls and the mineralized logs have a northeasterly orientation. A belt in which the ore bodies are relatively closely spaced trends northwestward through the area. The deposits are indicated on the map by spots. (Auth)

CHEMICAL ANALYSIS AND GEOCHEMISTRY

<321>

Tatsumoto, M., C.E. Hedge, and A.E.J. Engel; USGS, Denver, CO; University of California, La Jolla, CA

Potassium, Rubidium, Strontium, Thorium, Uranium, and the Ratio of Strontium 87 to Strontium 86 in Oceanic Tholeiitic Basalt. Science, 150, 886-888. (1965, November)

The average concentrations of potassium, rubidium, strontium, thorium, and uranium in oceanic tholeiitic basalt are (in parts per million) potassium, 1400; rubidium, 1.2; strontium, 120; thorium 0.2; and uranium, 0.1. The ratio of strontium 87 to strontium 86 is about 0.702, that of potassium to uranium is 1.4 X 10(E+4), and thorium to uranium is 1.8. These amounts of potassium, thorium, uranium, and radiogenic strontium 87 are less than in other common igneous rocks. The ratios of thorium to uranium and strontium 87 to strontium 86 suggest that the source region of the oceanic tholeiites was differentiated from the original mantle material some time in the geologic past. (Auth)

<322>

Ritchie, J.C., and G.L. Plummer; University of Georgia, Department of Botany, Athens, GA

Natural Gamma Radiation in Northeast and East Central Georgia. Bulletin of the Georgia Academy of Science, 27(4), 173-194. (1969, September)

Soil samples from northeastern and east central Georgia contained thorium, uranium, potassium, beryllium 7, cesium 137, ruthenium 106, cerium 144, antimony 125, zirconium, niobium 95 and manganese 54. Thorium concentrations ranged from 3 to 70 ppm with an average concentration of 15.8 ppm. Uranium concentrations varied from 1 to 10 ppm with an average of 3.7 ppm. The average thorium to uranium ratio was 4.3:1. Total potassium ranged from non detectable levels to 4.8 percent with an average of 1.08 percent. Distribution of thorium, uranium and potassium followed broad geologic patterns. Concentrations of these elements were lowest in the sandy materials of the Coastal Plain and highest in the basic igneous metamorphic material of the Piedmont. Distribution of thorium, uranium and potassium in four soil series was best related to geologic parent material. The Piedmont soils, Appling, Madison and Cecil had higher concentrations than sandy Norfolk soils of the Coastal Plain. A high correlation (r=0.88) was found between aerial gamma radioactivity and dose rates indicating that gamma aeroradioactivity maps can be used to delineate areas with different background radiation. (RRB)

<323>

Rogers, J.J.W., J.A.S. Adams, and B. Catlin; Rice University, Department of Geology, Houston, TX

Distribution of Thorium, Uranium, and Potassium in Three Cores from the Conway Granite, New Hampshire, USA. American Journal of Science, 263, 817-822. (1965)

Thorium, uranium, and potassium concentrations have been measured in 1051 samples from three cores with a total length of 2700 feet in the Conway granite of New Hampshire. Thorium and potassium concentrations are generally uniform and probably represent a primary distribution developed during crystallization of the batholith. Uranium, however, is clearly less abundant in surface and near-surface rocks than at depth and has presumably been leached during weathering. These results cast some doubt on the use of outcrop samples for the determination of total radioactivity of large volumes of rock. (Auth)

<324>

Baranov, V.I., and L.A. Khristianova; Vernadskii Institute of Geochemistry and

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Analytical Chemistry, Academy of Sciences, Moscow, USSR

Radioactivity of Ocean Deposits.
Chemistry of the Earth's Crust, 1, 425-432. (1966)

The mechanism of penetration of radioactive elements into marine sediments is explained by radiochemical studies and granulometric analysis of terrigenous, *biogenic, and polygenic sediments.* Determinations were made of uranium, sodium, ionium, radium, and also iron, mangenese, authigenous SiO2, calcium carbonate, and organic carbon, which can act as coprecipitators of radioisotopes or as indicators of their path of penetration. Concentrations of these elements except uranium, seem to be determined by the granulometric composition of the sediments and uranium penetration by the mode of occurrence. (PAG)

<325>

Gladney, E.S., J.W. Owens, and J.W. Starner; Los Alamos Scientific Laboratory, Los Alamos, NM

Determination of Uranium in Natural Waters by Neutron Activation Analysis. Analytical Chemistry, 48, 973-975. (1976, June)

A rapid procedure has been developed for the measurement of uranium in natural waters using thermal neutron activation and anion-exchange separation of radio-uranium from ethanol/HCl solvent mixtures. Detection limits of 0.05 ppb have been achieved with analytical precisions of plus or minus 10-30%. Results of uranium analyses by this procedure and by fluorometry are compared for natural water samples from Alaska and New Mexico. (Auth)

<326>

Coles, D.G., J.W.T. Meadows, and C.L. Lindeken; University of California, Lawrence Livermore Laboratory, Radiochemistry Division, Livermore, CA; University of California, Lawrence Livermore Laboratory, Hazards Control Department, Livermore, CA

The Direct Measurement of ppm Levels of Uranium in Soils Using High-Resolution Ge(Li) Gamma-Ray Spectroscopy. The Science of the Total Environment, 5, 171-179. (1976, March)

The direct determination of uranium 238 in various soil samples was done by measuring the 63.3 keV transition from the decay of the first daughter thorium 234. Potential errors resulting from the *chemical non-equilibrium of* uranium 238 with its daughters are thus avoided. The method sensitivity is 1 ppm compared to the 35 ppm obtainable by employing the 1001-keV gamma ray. A Ge(Li) gamma-ray spectrometer is the only analytical tool required. Examples are offered that demonstrate the usefulness of the technique for routine, inexpensive environmental monitoring of uranium. The technique also has the capability of providing information on the uranium 238 uranium 235 isotopic ratio. (Auth)

<327>

Ritchie, J.C., P.H. Hawks, and J.R. McHenry; US Department of Agriculture, Sedimentation Laboratory, Oxford, MS

Thorium, Uranium, and Potassium in Upper Cretaceous, Paleocene and Eocene Sediments of the Little Tallahatchie River Watershed in Northern Mississippi.
Southeastern Geology, 14, 221-232. (1972, December)

Gamma-ray spectrometric analyses were made of 129 samples collected from outcrops of ten geologic formations in north Mississippi. Thorium, uranium and potassium-40 concentrations were determined. Thorium concentrations ranged from 0.9 to 29.9 ppm, uranium from 0.3 to 10.9 ppm and potassium from nondetectable to 2.43 percent. Low concentrations of these elements were found in the sands of Kosciusko and Meridian Formations (Upper Cretaceous). Concentrations were three to five times greater in the fine-textured formations. (Auth)

<328>

Dyck, W.; Canada Geological Survey, Ottawa, Ontario, Canada

Geochemistry Applied to Uranium Exploration. Canadian Mining Journal, 96(4), 58-62. (1975, April)

The main radiochemical and geochemical principles that enable detection of uranium in the natural environment are described in the report. The detection methods of helium tracers, track-etch technique, well water surveys, and hydrogeochemical analyses are presented. (PAG)

<329>

Larsen, E.S., and D. Gottfried; USGS, Washington, DC

Uranium and Thorium in Selected Suites of Igneous Rocks. American Journal of Science, 258-A, 151-169. (1960)

The uranium and thorium contents of 199 igneous rocks from a variety of petrographic provinces is summarized. Data are given for the Mesozoic calc-alkalic batholiths of the western United States, volcanic and hypabyssal rocks of the tholeiitic magma type from Hawaii and Virginia, and effusive calc-alkalic, alkalic, and subsilic-alkalic rocks from the western United States and Hawaii. The batholitic rocks show an increase of both uranium and thorium from gabbro to quartz - monzonite and granite. The more extreme differentiates, chiefly muscovite - quartz monzonites, contain considerably less uranium and thorium than the quartz monzonites and granites, although the Th U ratios are nearly the same. The volcanic and hypabyssal rocks show a similar increase in both thorium and uranium toward the more felsic members. The alkali basalts of the Honolulu volcanic series show an anomalous decrease in uranium and thorium toward the right on a variation diagram. The data show no increasing loss of uranium relative to thorium from the magma during the later stages of crystallization. (Auth)(PAG)

<330>

Judson, S., and J.K. Osmond; University of Wisconsin, Department of Geology, Madison, WI

Radioactivity in Ground and Surface Water. American Journal of Science, 253, 104-116. (1955)

Values for the uranium content and total radioactivity of some underground and surface waters are presented for samples from 77 localities, largely in the United States. The uranium content for these samples ranges between 0.02 ppb and 460 ppb. The uranium content and total radioactivity of water from carnotite-bearing beds in the Grand Junction, Colorado area are spectacularly high when contrasted with values for water from non-mineralized beds. Uranium content and total radioactivity was determined from residues obtained by evaporation of water samples. The total radioactivity of these residues is shown to change through time. (Auth)

<331>

Bate, G.L., and J.R. Huizenga; Argonne National Laboratory, Argonne, IL

Abundances of Ruthenium, Osmium and Uranium in Some Cosmic and Terrestrial Sources. Geochimica et Cosmochimica Acta, 27, 345-360. (1963)

Determinations of ruthenium and osmium in ten chondrites by neutron activation analysis give average concentrations of 0.89 X 10(E-6)g Ru g meteorite and 0.91 X 10(E-6)g Os g meteorite. With proper assumptions these values lead in turn to cosmic abundances (per 10(E+6) atoms) of 1.3 for Ru and 0.73 for Os. The averages cited include Ru and Os concentrations for a carbonaceous chondrite, which, though below average, fall within the range of concentrations found for the non-carbonaceous chondrites. The isotopic ratio Os 184 Os 190 for osmium in meteorites agrees with that in terrestrial material to about 1 percent, within the limits of experimental error. The experimental uncertainty in determining the ratio Ru 96 Ru 102 is greater, and as a consequence the agreement of Ru 96 Ru 102 for ruthenium in meteorite and terrestrial sources cannot be established to much better than 2-3 percent. With these limits of experimental accuracy, no conclusive evidence for anomalous isotopic composition of ruthenium or osmium has been found in the samples analysed in this work. Two achondrites, a tektite and several terrestrial samples are found to have ruthenium and osmium concentrations 2-3 orders of magnitude below those in chondrites, giving evidence of the marked depletion of these elements in differentiated silicate matter. For samples in which the uranium concentration approaches that of ruthenium, the corrections necessary to account for fission-produced ruthenium permit incidentally the measurement of the uranium present. Uranium concentrations determined in this manner are reported for a few samples including the standard rocks G-1 and W-1. (Auth)(PAG)

<332>

Lopatkina, A.P.; Not given

Characteristics of Migration of Uranium in the Natural Waters of Humid Regions and Their Use in the Determination of the Geochemical Background for Uranium.
Geochemistry International, 788-795.
(1964)

Compilation of analytical data indicates consistent relationships among content of U in waters, total salinity of waters, and content of U in rocks through which the waters are flowing. The relationships hold only for humid climates and do not apply to areas of abundant evaporites or other anomalous rock types. Quantitative relations between U and total salinity and U and HCO3, are useful in interpreting radiogeochemical data. (PT)

<333>

Holland, H.D., and J.L. Kulp; Columbia University, Lamont Geological Observatory, Palisades, NY

The Transport and Deposition of Uranium, Ionium and Radium in Rivers, Oceans and Ocean Sediments. Geochimica et Cosmochimica Acta, 5(5), 197-213.
(1954, May)

The important factors controlling the concentration of the radioelements in the oceans are the influx, the rate of radioactive decay, and the rate at which the radioelements are removed by sedimentation. With such data as are available for the concentration of uranium and radium in ocean water, their rates of influx, and their rates of deposition, it is possible to estimate the concentration of ionium in sea water and the amount of ionium annually transported into the oceans. It may be further concluded that in the geochemistry of uranium, influx and deposition in shallow water are of major importance while in the case of ionium, influx and deep water deposition seem most important and in the case of radium, the production by radioactive decay of ionium, the disintegration of radium itself, and deep water deposition are important factors. Ionium is not in equilibrium with uranium in ocean water. (Auth)

<334>

Harriss, R.C., and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

Geochemical and Mineralogical Studies on the Weathering of Granitic Rocks.
American Journal of Science, 264, 146-173. (1966, February)

Chemical, mineralogical, and autoradiographic techniques have been applied to the study of five weathering profiles developed on granite rocks. Two profiles from the Tishomingo granite, Oklahoma, two profiles from the Mount Scott granite, Oklahoma, and a single profile from the Elberton granodiorite, Georgia, were investigated. The relative mineral stabilities in the three granites under investigation generally follow the expected sequence: plagioclase feldspar, biotite, potassium feldspar, quartz, from least to most stable respectively. This relative stability sequence is consistently observed regardless of climatic and/or local physiochemical variations. Kaolinite is the predominant clay mineral present in the Elberton profile from Georgia. Illite and kaolinite are both present as major constituents in the four Oklahoma profiles. The largest physical and chemical changes occur in the transition from the C-horizon (weathered rock) to the B-horizon (soil). Mineralogy is the predominant factor controlling the relative mobility of calcium, sodium, potassium, rubidium, and thorium during weathering. Calcium and sodium are concentrated in the plagioclase feldspars and mafic minerals and are released and mobilized during the early stages of weathering. Potassium and rubidium are concentrated in the relatively stable orthoclase feldspars and thorium in the resistate minerals. These three elements are mobilized only in the intermediate and final stages of weathering. Lithium, copper, manganese, and zinc are generally enriched in the soil portion of the weathered mantle as a result of adsorption and surface exchange with clay minerals. Stability diagrams indicate that the natural surface waters of east-central Georgia are in equilibrium with kaolinite, the major clay mineral present in the soils. In contrast, the surface waters of southern Oklahoma are in equilibrium with kaolinite and montmorillonite but not illite which is a major constituent of the Oklahoma soils. Combined field and theoretical evidence indicates that the Georgia soils have reached maturity and are probably the result of extensive weathering early in the postglacial period. The Oklahoma soils are very immature and are presently undergoing active alteration. (Auth)

<335>

Heier, K.S.; Australian National University, Department of Geophysics, Canberra, Australia

Uranium, Thorium and Potassium in Eclogitic Rocks. Geochimica et Cosmochimica Acta, 27, 849-860. (1963)

Radiometric determinations of Th, U, and K, in 6 eclogites from metamorphic environments, and in 13 eclogitic rocks from volcanic environments are given. Good agreement is found between radiometrically determined potassium contents. The most important conclusions made from this study are: (a) the Th/U ratio in eclogitic rocks is comparable to tholeiitic basalts of orogenic type; (b) eclogites are derived from the upper portion of the mantle; (c) the data indicate a more complex history of formation of the examined eclogites from metamorphic environments as compared with those from volcanic environments. (Auth)

<336>

Leonova, L.L., and O.S. Renne; Vernadskii Institute of Geochemistry and Analytical Chemistry, Academy of Sciences, Moscow, USSR

Distribution of Uranium, Thorium and Potassium in Homogeneous Granites. Geochemistry International, 775-781. (1964)

The concentrations of uranium, thorium and potassium in the Khantaus intrusive granite are uniformly distributed throughout the massif. Fifty percent of the total uranium and 36% of the thorium is in the essential minerals, about 20% of the total uranium and thorium is in the dark minerals. The remainder is in the accessory minerals of which uranothorite is the only important concentrator of thorium. (DRW)

<337>

Smith, W.L., M.L. Franck, and A.M. Sherwood; USGS, Washington, DC

Uranium and Thorium in the Accessory Allanite of Igneous Rocks. American Mineralogist, 42, 367-378. (1957)

Accessory allanite was separated from phanerocrystalline igneous rocks and its optical properties and radioactive components were compared. The indices of refraction of these allanite samples are higher than those from the pegmatites that are usually described in geologic literature. The birefringence was found to range from 0.015 to 0.021, the alpha-index of refraction from 1.690 to 1.775. The allanite content ranges from 0.005 to 0.25 percent by weight in the rocks studied. The mineral is confined largely to the more siliceous phanerites. The uranium content is highest in the allanite from the granites sampled, ranging from 0.35 to 2.33 percent. Allanite was found to be otherwise of exceptionally uniform composition. (Auth)

<338>

Pliler, R., and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

The Distribution of Thorium and Uranium in a Pennsylvanian Weathering Profile. Geochimica et Cosmochimica Acta, 26, 1137-1146. (1962)

Eleven samples representing a pre-Pennsylvanian weathering profile on the Boulder Creek granodiorite near Boulder, Colorado, have been analysed for thorium and uranium by gamma-ray spectrometric and chemical methods. In an effort to determine the possible sites of thorium and uranium in these samples, a study of their leachability in hot 2 N hydrochloric acid was undertaken. The fresh granodiorite was found to contain 9.3 ppm thorium and 2.5 ppm uranium. The first stages of weathering resulted in an apparent removal of 25 per cent of the thorium and 60 per cent of the uranium present in the original granodiorite. The leaching study of the fresh granodiorite demonstrated that as much as 90 per cent of the thorium and 60 per cent of the uranium could be removed by an acid leach solution. This seems to indicate that most of the thorium and uranium in the fresh rock is situated in acid soluble minerals or in interstitial materials. After the initial drop of the concentration in the lowest part of the weathered mantle, the total uranium and thorium content of the weathered rock increases by a factory of at least 4 in the uppermost, most-weathered rock material. Leaching studies of the weathered rock indicate that uranium is present largely in the primary resistates, such as zircon, xenotime, and apatite, and thorium occurs mainly in or on clays or in the secondary resistates-minerals formed during weathering. (Auth)

<339>

Rogers, J.J.W., and K.A. Richardson; Rice University, Department of Geology, Houston, TX

Thorium and Uranium Contents of Some Sandstones. Geochimica et Cosmochimica Acta. 28, 2005-2011. (1964, July)

Average values have been obtained by gamma-ray spectrometry for the thorium and uranium contents of some orthoquartzites and graywackes. The Atoka and Jackfork quartz sandstones of western Arkansas average approximately 4 ppm thorium and 1 ppm uranium. The Umpqua and Tyee graywackes of western Oregon average approximately 7 ppm thorium and 2 ppm uranium. Weighted average concentrations for all sandstones are 5.5 ppm thorium and 1.7 uranium. Much of the radioactivity, particularly in the graywackes, is carried by heavy minerals such as biotite and zircon. The average concentrations in sand-sized material are, therefore, lower and may be estimated as 3 ppm thorium and 1 ppm uranium. Sand-sized quartz and other minerals deposited in hydraulic equilibrium probably have average concentrations in the neighborhood of those of the Atoka and Jackfork orthoquartzites, namely: 4 ppm thorium and 1 ppm uranium. (Auth)

<340>

Bivens, H.M., G.W. Smith, D.H. Jensen, E.L. Jacobs, and L.G. Rice; Sandia Laboratories, Albuquerque, NM

Pulsed Neutron Uranium Borehole Logging with Epithermal Neutron Dieaway. CONF-760316-1; In Proceedings of a Symposium on Exploration of Uranium Ore Deposits, held in Vienna, Austria, March 29-April 2, 1976. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 745-755), 806 pp.; SAND 75-5991, 16 pp.; IAEA-SM 208-48, (pp. 745-755), 806 pp. (1976)

Both prompt fission neutrons and delayed fission neutrons can be used for logging uranium boreholes. The paper describes a uranium logging system, using a pulsed neutron generator, which detects and assays uranium by the measurement of prompt fission neutrons. The system development began with a feasibility study which included experimental measurements in uranium test pits at Grand Junction, Colorado, and computer calculations of the epithermal neutron return in the presence of uranium. A Monte Carlo neutron transport code and a 21 group, one-dimension, time-dependent, discrete-ordinates neutron transport code have been used to calculate the effects of borehole geometry and rock matrix parameters on the epithermal neutron dieaway. Some experimental and analytical results are described. A prototype logging probe, 70 mm in diameter, was built and field evaluation began in January 1976. The physical and operational characteristics of the probe and the uphole equipment are described. Some logging results are shown which were obtained in an area in which disequilibrium is known to exist. Although the field experience with the probe has been brief, the results have been significant. They imply that a relatively accurate assay of low-grade uranium ore can be obtained with this method provided that proper calibration factors are determined, and a neutron output of about 10(E+10) n/s is used. A neutron tube is being developed for uranium logging that will generate 10(E+10) n/s when operated at 100 pulses per second. (Auth)

<341>

Brodzinski, R.L., and N.A. Wogman;
Battelle, Pacific Northwest Laboratories, Richland, WA

Californium-252 IN SITU Activation and Photon Detection Techniques for Uranium Ore Deposit Evaluation. CONF-760316: In Proceedings of a Symposium on Exploration of Uranium Ore Deposits, held in Vienna, Austria, March 29-April 2, 1976. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 757-763), 806 pp.; IAEA-SM-208 50, (pp. 757-763), 806 pp.; BNWL-SA-5561, 11 pp. (1976, March)

Four different techniques are evaluated for borehole analysis of uranium and thorium ores. Methods involving detection of fission product photons following Cf 252 activation, detection of low energy uranium and thorium gamma-rays, direct measurement of the 1001 keV photon from Pa 234, a progeny of U 238 and isotopic excitation X-ray fluorescence spectroscopy are evaluated. The first two techniques are found too unsuitable for most low grade ores. The third is found to be suitable for the in situ analysis of uranium ores only, and the fourth method is shown to be a superior, cost effective method for both uranium and thorium ore analysis. (Auth)

<342>

D'Silva, A., and V.A. Fassel; ERDA, Ames Laboratory, Ames, IA; Iowa State University, Department of Chemistry, Ames, IA

Direct Determination of Uranium Ores by an X-Ray Excited Optical Luminescence Technique. IS-M-47, 4 pp. (1976)

X-ray excited optical luminescence (XEOL) has emerged as a highly sensitive analytical technique for the determination of trace level rare earth impurities in nuclear materials, high purity rare earth oxides, and impurities in rare gases. This communication discusses the application of this technique to the direct determination of uranium in ores. (Auth)

<343>

Murray, E.G., and J.A.S. Adams; Rice University, Houston, TX

Thorium, Uranium and Potassium in Some Sandstones. Geochimica et Cosmochimica Acta, 13, 260-269. (1958)

Thorium, uranium, and potassium concentrations have been determined in nineteen sands and sandstones by gamma-ray spectrometry, fluorometric uranium analysis, and alpha-counting. The samples were selected so that both common and extreme thorium and uranium ratios would be represented. The average and nearly uniform values found in orthoquartzitic, clay-free sands were potassium (0.64 plus or minus 0.04 percent), thorium (1.7 plus or minus 0.1 ppm), and uranium (0.45 plus or minus 0.05 ppm), giving a Th U ratio of 3.8 plus or minus 0.8. The Th U ratio found is very near to that of average igneous rocks and may represent an independent determination of the average crustal Th U ratio. Heavy mineral separations on some of the ordinary sands indicate that very little of the thorium, uranium and potassium in a common sand is associated with the heavy detrital grains. Neglecting a very minor feldspar content, the radioactivity of the common sandstones studied is contained almost entirely in the quartz, where it appears to be largely related to microscopic and submicroscopic inclusions. The heavy detrital minerals do not begin to affect the Th U ratio or concentration ratios until they occur in large quantities as in placer sands. Within experimental error, the modern beach sands studied were in radioactive equilibrium. These preliminary data provide some independent and experimental comparisons for the average thorium and uranium content of sandstones calculated from geochemical balances. The data are also helpful in constructing models of the changes in thorium and uranium ratios that might be observed in moving from a beach line through shallow water sediments to deep-water sediments. (Auth)

<344>

Ahrens, L.H.; University of Cape Town, Department of Geochemistry, Cape Town, South Africa

Some Observations on the Uranium and Thorium Distributions in Accessory Zircon from Granitic Rocks. Geochimica et Cosmochimica Acta, 29, 711-716. (1965, January)

The uranium and thorium distributions in seventy-two specimens of accessory zircon from granitic rocks have been examined. Frequency distributions of both elements are positively skewed and the distributions approximated lognormality. The dispersion of the thorium concentration is distinctly greater than that of uranium; ionic radii differences may be the cause. The ratio Th/U is also positively skewed and whereas the average ratio is 0.47, the modal (most frequent) value is 0.35. Though not well-developed there appears to be a distinct correlation between uranium and thorium in the zircon under consideration. (Auth)

<345>

Heier, K.S., and J.A.S. Adams; Australian National University, Department of Geophysics, Canberra, Australia; Rice University, Department of Geology, Houston, TX

Concentration of Radioactive Elements in Deep Crustal Material. Geochimica et Cosmochimica Acta, 29, 53-61. (1965, January)

Th, U and K have been determined in paragneisses of different metamorphic grade. Both Th and U concentrations are lower in granulite facies rocks than in more low-grade metamorphic rocks of equivalent nature. Thus geological processes operating in the crust must result in an upward concentration of these elements. The Th/U ratio of the paragneisses shows a widely variation which is related to the oxidation of U. Some evidence exists for a decrease of the Th/U ratios with metamorphic grade. (Auth)

<346>

Rogers, J.J.W., and P.C. Ragland; Rice University, Department of Geology, Houston, TX

Variation of Thorium and Uranium in Selected Granitic Rocks. Geochimica et Cosmochimica Acta, 25, 99-109. (1961)

A selected suite of granitic rocks representing both individual differentiation sequences and a broad sampling of granites from North America have been analysed for thorium, uranium, and potassium by gamma-ray, spectrometry. In the White Mountain and Oliverian series of New Hampshire both the thorium and uranium contents and the Th/U ratio tend to increase with igneous evolution. In the Southern California batholith the thorium and uranium contents increase during differentiation, but the Th/U ratio is constant. The general tendency for the Th/U ratio to increase with petrogenetic evolution is shown by a comparison of the Th/U ratio with the ratio of potassium feldspar to plagioclase for a broad sampling of granitic rocks. This increase is probably caused by oxidation during magmatic differentiation. (Auth)

<347>

Pliler, R., and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

The Distribution of Thorium, Uranium, and Potassium in the Mancos Shale. **Geochimica et Cosmochimica Acta, 26,** 1115-1135. (1962)

Over 135 samples of the upper Cretaceous Mancos shale have been analyzed for uranium, thorium, and potassium by chemical and radiometric means. These samples were collected from 16 localities in Colorado, Utah, Arizona, and New Mexico. The average concentrations found in the Mancos shale samples are 10.2 ppm thorium, 3.7 ppm uranium, and 1.9 percent potassium as metal. The average Th/U ratio is 3.1. For the most part, the variations in the thorium, uranium and potassium concentrations are gradual and take place over large distances. Thorium, Th/U ratio and potassium tend to decrease and uranium tends to increase with distance from the upper Cretaceous shoreline. The K/Th ratio in the shale, including sandy intertongues, shows remarkedly little variation on a regional basis. Laboratory studies indicate that the uranium in the Mancos shale is present largely in the fine-grained primary resistate minerals, and the thorium occurs in the fine-grained secondary resistates or fixed in or on clays. (Auth)

<348>

Miller, D.S., and J.L. Kulp; Columbia University, Lamont Geological Observatory, Palisades, NY

Isotopic Study of Some Colorado Plateau Ores. Economic Geology, 53(8), 937-948. (1958, December)

A number of selected uranium ore specimens from several localities have been analyzed for uranium and lead in both pitchblende and galena phases by isotope dilution techniques and the lead isotopic abundance determined. It is shown that the hypothesis of hydrothermal deposition of uranium accompanied by old radiogenic lead from the basement at one time about 60 m.y. ago does not satisfy the isotopic data. A new hypothesis is presented which requires local sources with high U Th and U Pb ratios, variable radon leakage, suitable ground water movement, and deposition at the site of H2S production at low temperature. This hypothesis can explain the age discordances and the lead isotope abundances in galena. It is possible from the isotopic data to have all deposition occurring within the last five million years but it does not preclude other periods of deposition such as in Laramide time. The isotopic ages are apparent ages only and bear no direct relation to the time of deposition. The isotopic ratios, however, provide information which may be used to restrict theories of origin. (Auth)

<349>

Foyn, E., B. Karlik, H. Pettersson, and E. Rona; Borno Station, Sweden

Radioactivity of Sea Water. Nature, 143, 275-276. (1939, January)

The radioactive elements of uranium, radium, and thorium have been measured in sea water. Uranium was measured by its fluorescence in beads of sodium fluoride excited with ultra-violet radiation. Results showed that uranium is a constant component of sea water, varying in proportion with the total salinity. Radium, more difficult to measure, was precipitated as sulfate but results varied due to an unknown factor. Thorium was precipitated using ammonia and ferric chloride added to large quantities of sea water, to which ammonium chloride had been previously added. (PAG)

<350>

Smith, A.R., and H.A. Wollenberg; University of California, Lawrence Berkeley Laboratory, Berkeley, CA

Geology and Natural Terrestrial Dose Rates. In McLaughlin, J.E. (Ed.). Workshop on Natural Radiation Environment, held in New York City, March, 1972, (pp. 8-11), 80 pp.; HASL-269, (pp. 8-11), 80 pp. (1972, August)

The natural terrestrial gamma radioactivity is due mainly to the uranium, thorium, and potassium contents of the rock and soil. The west to east increase in radioactivity in the Sierra Nevada batholith matches an increasing K2O SiO2 ratio, which suggests emplacement of magmas of increasing alkalinity. With the exception of the carbonate rocks, potassium and thorium individually contribute more to the total natural gamma-ray dose rate than does uranium. (PAG)

<351>

Anspaugh, L.R., P.L. Phelps, G.W. Huckaby, P.H. Gudiksen, and C.L. Lindeken; University of California, Lawrence Livermore Laboratory, Bio-Medical Division, Livermore, CA; University of California, Lawrence Livermore Laboratory, Hazards Control Department, Livermore, CA

Methods for the IN SITU Measurement of Radionuclides in Soil. In McLaughlin, J.E. (Ed.). Workshop on Natural Radiation Environment, held in New York City, March, 1972, (pp. 12-30), 80 pp.; HASL-269, (pp. 12-30), 80 pp. (1972, August)

A Ge Li spectrometer in the field which converts counting rates into units of soil activity was the method studied. A generalized computer code has been developed for application to a variety of detector geometries and source distributions. Small differences, for example 2% for potassium 40, was noted in radioactivity levels for the natural occurring radionuclides as measured by the in situ method and laboratory analysis. A larger discrepancy in results for cesium 137 was probably related to inadequate soil sampling over too small an area. (PAG)

<352>

Lovering, J.F., and J.W. Morgan;
Australian National University,
Department of Geophysics, Canberra,
Australia

Uranium and Thorium Abundances in Possible Upper Mantle Materials. Nature, 197(4863), 138-140. (1963, January 12)

The report documents a study concerning neutron activation analyses of uranium and thorium abundances in eclogites. This method is the most appropriate technique for the determination of the relatively low levels predicted for eclogite rocks from the mantle. Eclogitic rocks occur in two main environments. The pipe eclogites occur along with ultra-basic and granulitic rocks as inclusions in kimberlite and basic igneous pipes. Crustal eclogites occur as lenses or discontinuous masses often associated with peridotite and garnet peridotite masses in orogenic zones. Results of the analyses of the 5 pipe eclogite samples and 4 crustal eclogite samples are discussed. Very briefly, eclogites from the continental upper mantle have very similar uranium (range 0.04-0.07 ppm) and thorium (range 0.15-0.29ppm) abundances with mean values of 0.052 ppm uranium and 0.22 ppm thorium. The thorium/uranium ratios from the continental upper mantle samples range from 3.5 to 5.8, with a mean value of 4.2. The crustal eclogites had uranium contents between 0.018 ppm and 0.24 ppm, thorium contents between 0.015 ppm and 0.60 ppm, and thorium/uranium ratios between 0.6 and 4.8. (MBW)

<353>

Otton, J.K.; USGS, Lakewood, CO

Uranium and Trace Elements in Stream Sediments as an Exploration Tool. USGS Open File Report, 76-220, 19 pp. (1976)

More than 45 trace elements have been reported in anomalous amounts in the uranium ores. The specific suite of elements associated with any one uranium deposit varies according to deposit type and geologic province. The primary geochemical halo of uranium and associated trace elements in the host rock, together with secondary dispersion halo in soils and alluvium, offers a potential geochemical exploration target. Sediment from streams near low-grade uranium occurrences in arkosic sandstone of the Denver Basin, Colorado, and sediment from streams in the igneous and metamorphic terrane near the Midnite mine of eastern Washington have been analyzed for acid-extractable U, Cu, Pb, Zn, Ni, Co, Fe, Mn, Mo, Cd, Cr, Ag, V, and Se, and for total Fe, Mn, Hg, As, and organic C. The -80 mesh fraction of the alluvium downstream from a small uraniferous limonite occurrence in the Denver basin shows anomalous concentrations of U, Pb, As, Ni, Mo, V, Zn, and Se. Anomalous concentrations of U persist farther downstream (as much as 1,000 m) than any of the trace elements. In another stream system southeast of Denver, above-ground levels of U, Pb, As, Zn, V, Fe, and Mn occur near a uranium anomaly which has no surface mineralization. In the Midnite mine area, sediments of streams draining prospect areas showed anomalous concentrations of uranium, but no accompanying anomalous trace-element concentrations, although analyses of Midnite mine ores show that a broad suite of trace elements are associated with uranium. (Auth)

<354>

Cohen, P., and O.J. Loeltz; USGS,
Washington, DC

Evaluation of Hydrogeology and Hydrogeochemistry of Truckee Meadows Area, Washoe County, Nevada. USGS Paper No. 1779-S, 63 pp. (1964)

Practically all the ground water in the Truckee Meadows area, an alluviated intermontane basin in western Nevada, is in the valley fill, which consists of unconsolidated and partially consolidated sedimentary deposits. The Mesozoic and Cenozoic consolidated rocks of the mountains bordering the valley contain some water in fractures and other openings, but they have virtually no interstitial permeability. The permeability of the valley fill is extremely variable. The study stresses the aspects of the ground water system that bears directly on the hydrologic problems. The geology of the area and an intensive water-quality study was undertaken. Water from wells and streams was analyzed for uranium, chloride, carbonates, iron, sodium, potassium and other minerals. (Auth)(PAG)

<355>

McCauley, J.F.; Pennsylvania Geological Survey, Department of Internal Affairs, Harrisburg, PA

Uranium in Pennsylvania. M43, 71 pp. (1961)

Forty-three uranium occurrences were studied primarily within the Commonwealth of Pennsylvania. The great majority are in the Catskill Formation of Devonian age and are of the "sandstone type". Similar occurrences are present in rocks of Mississippian and Triassic ages. The occurrences are in gray to green zones within red bed formations of continental origin.
Mineralization is commonly associated with carbonaceous material in the form of plant fragments. Pyrite, bornite, chalcopyrite, galena, digenite, chalcocite and covellite have been identified from the Devonian occurrences along with the secondary *uranium minerals, uranospinite* and metazeunerite. No primary uranium minerals could be identified and it is believed the primary uranium occurs either as a urano-organic compound or as an oxide, very finely disseminated throughout the carbon. X-ray spectrographic analysis shows that uranium, vanadium, iron, copper, lead, zinc, barium and arsenic are present in varying quantities in the majority of the sandstone occurrences. Uranium is the most abundant element in the Triassic occurrences, while the Mississippian are characterized by uranium and vanadium, and the Devonian by copper and uranium. (Auth)

<356>

Haji-Vassilious, A., and P.F. Kerr;
Columbia University, New York, NY

Uranium-Organic Matter Association at La Bajada, New Mexico. Economic Geology, 67, 41-54. (1972)

Urano-organic matter at La Bajada is associated with sulfide mineralization along a fault in an altered tuff-breccia (Oligocene). The deposit is believed to be hydrothermal and probably represents an aftermath of igneous activity. Underlying coal- and oil-burning units (Mesa Verde) are believed to have provided the organic fractions in the urano-organic matter.
Physico-chemical evidence indicates that petroleum was the major source. Geological features and mineral associations suggest that petroleum derivatives escaped to the place of deposition soon after the fracturing of the rocks and were then followed by the uranium-bearing hydrothermal solutions. Although specific uranium minerals have not been identified in the ore, preliminary data suggest that most of the uranium is associated with submicroscopic mineral matter disseminated through the organic components. (Auth)

<357>

Holland, H.D., G.G. Witter, Jr., W.B. Heak, III, and R.W. Petti; Princeton University, Princeton, NJ

The Use of Leachable Uranium in Geochemical Prospecting on the Colorado Plateau, The Distribution of Leachable Uranium in Surface Samples in the Vicinity of Ore Bodies. Economic Geology, 53(2), 190-209. (1958, March)

Determinations were made of the leachable uranium content of soil and rock samples from the vicinity of the Standard-Lisbon-Cal Uranium ore body, Big Indian Wash, Utah, the new Monument No. 2 ore body, Oljetoh, Arizona, a Shinarump and a Chinle deposit near Cameron, Arizona, and the Freedom No. 1 and No. 2 ore bodies near Marysvale, Utah. In the sedimentary uranium deposits studied the presence of uranium mineralization can be detected at considerable horizontal distances from ore, but surface samples at vertical distances of more than about 30 feet from ore gave no indication of the presence of ore at depth. At Marysvale uranium was found to penetrate no farther than alteration visible in hand-specimen into the quartz monzonite wall rock of a uraninite-fluorite vein. Analysis of surface samples indicate that mineralization at the base of late Tertiary rhyolite can be detected at the surface through a fair thickness of rhyolite. The data as a whole suggest that in areas in which uranium ore is present at shallow depths leachable uranium analyses can serve as a useful tool in exploration. (Auth)

<358>

Gross, E.B., A.S. Corey, R.S. Mitchell, and K. Walenta; AEC, Grand Junction, CO; University of Virginia, Charlottesville, VA; Institut fur Mineralogie und Kristallchemie, Stuttgart, Germany

Heinrichite and Metaheinrichite, Hydrated Barium Uranyl Arsenate Minerals. American Mineralogist, 43, 1134-1143. (1958, November)

Heinrichite, Ba(UO2)2 (AsO4)2 10-12H2O, and metaheinrichite,. Ba(UO2)2 (AsO4)2 8H2O occur as tabular, yellow to green, fluorescent, transparent to transluscent crystals belonging in the tetragonal system. Optically the uranium minerals are uniaxial (-), sometimes anomalously biaxial with 2V up to 20 degrees. The refractive indices of heinrichite and metaheinrichite are given. The calculated specific gravity of metaheinrichite is 4.09 and the measured specific gravity is 4.04. The minerals have thus far been found near Lakeview, Oregon and in the Black Forest of Germany. (Auth)(MBW)

<359>

De Abeledo, M.J., M.R. De Benyacar, and E.E. Galloni; Comision Nacional de Energia Atomica, Buenos Aires, Argentina

Ranquilite, A Calcium Uranyl Silicate. American Mineralogist, 45, 1078-1086. (1960, September)

A new uranium mineral, named ranquilite, has been found in Mendoza Province, Argentina. The probable formula is 1.5 CaO(2UO3) 5(SiO2)-12H2O. Values for the orthorhoml · unit cell are given, as well values for Z and G and 3.32, respectively). Samples heated to 110-120 degrees and to 130-140 degrees Centigrade show certain changes in the x-ray powder pattern suggesting two lower hydrates. After exposure to the air, the original pattern is again obtained. (Auth)(MBW)

<360>

Anderson, P.L.; Alaska Department of Natural Resources, Division of Geological Survey, College, AK

Semi-Quantitative Uranium Analysis by X-Ray Spectrography. Alaska Department of Natural Resources Laboratory Notes No. 10, 3 pp. (1969)

A new method of per se uranium determination by X-ray spectrography was investigated. Data were collected at a wavelength of 0.910 angstroms. The detectability limit was estimated to be between 0.01 and 0.005% U and the precision of this method was 27% of the value at 0.066% U, an acceptable precision. The method incorporates some matrix correction by using the peak to background intensity ratios rather than simply peak intensity. (PAG)

<361>

Evans, R.D., and C. Goodman; Massachusetts Institute of Technology, Department of Physics, Cambridge, MA

Radioactivity of Rocks. Bulletin of the Geological Society of America, 52, 459-490. (1941, April 1)

In the study of the radioactivity of terrestrial materials, a systematic program of standardization, calibration, and interchecking has been followed throughout. As part of an international intercalibration among the various workers in this field and a general program of helium age research, several hundred radioactivity measurements have been made. These results represent the most reliable collection of radioactivity determinations which have yet been made within the range of concentrations involved. By combining these newer measurements with the limited number of well-authenticated earlier analyses available, average values have been obtained as follows: 1.37 plus or minus 0.17 X 10(E-12)g Ra/g for 43 acidic igneous rocks, 0.51 plus or minus 0.05 X 10(E-12)g Ra/g for 7 intermediate igneous rocks, 0.38 plus or minus 0.03 X 10(E-12) g Ra/g for 54 basic igneous rocks, and 0.57 plus or minus 0.08 X 10(E-12)g Ra/g for 28 sedimentary rocks; 3.0 plus or minus 0.3 X 10(E-6)g U/g, 13 plus or minus 2.0 X 10(E-6)g Th/g, and a Th/U ratio of 5.0 for 26 acidic igneous rocks; 1.4 plus or minus 0.2 X 10(E-6)g U/g, 4.4 plus or minus 1.2 X 10(E-6)g Th/g, and a Th/U ratio of 2.6 for 6 intermediate igneous rocks; 0.96 plus or minus 0.11 X 10(E-6)g U/g, 3.9 plus or minus 0.6 X 10(E-6)g Th/g, and a Th/U ratio of 4.0 for 34 basic igneous rocks. These values are substantially lower than those obtained by Jeffreys in a compilation of most of the measurements reported prior to 1936. The present averages show a more marked decrease of radioactivity with increasing basicity, the Th U ratios are considerably greater than those compiled by Jeffreys and are in better agreement with those to be expected from geochemical considerations. Two ultrabasic rocks were found to have radioactivities comparable to the low values for iron meteorites. Specific inaccuracies in earlier investigations have been discovered. Estimates are made of the rate of production of heat by radioactive decay based on the above average values for the different rock types. (Auth)

<362>

Burwash, R.A., and G.L. Cumming; Not given

Uranium and Thorium in the Precambrian Basement of Western Canada. Canadian Journal of Earth Sciences. 13(2). 284-293. (1976, February)

Delayed neutron activation analyses of 182 core samples from the basement of the western Canada sedimentary basin give mean values of 4.13 ppm U and 21.1 ppm Th. These values are almost twice the published values for the Shield as a whole. Replicate analyses of a composite sample of all cores indicates an analytical precision of plus or minus 1% for uranium and plus or minus 7% for thorium. Histograms of number of samples vs. U and Th values indicate a negatively skewed frequency distribution. Analysis of composite samples prepared from a large number of hand specimens may tend to conceal this skewed nature. Mean abundance values will also be influenced by the form of the U and Th frequency distributions. Trend surface analysis, with smoothing to reduce the effect of high or low single sample values, indicates two 'highs' common to both U and Th. The helium-producing area around Swift Current, Saskatchewan is associated with a high U-Th plutonic complex. A linear belt trending northeast from Edmonton appears to be a Hudsonian metamorphic belt in which U and Th have been concentrated. Several local concentrations of U or Th are found in the Peace River Arch of northern Alberta. (Auth)

<363>

Dooley, J.R., Jr., E.N. Harshman, and J.N. Rosholt; USGS, Denver, CO

Uranium-Lead Ages of the Uranium Deposits of the Gas Hills and Shirley Basin, Wyoming. Economic Geology. 69(4). 527-531. (1974, June)

The uranium-lead ages for two massive uraninite samples from two deposits, one each in the Gas Hills and Shirley Basin districts, are both 22 plus or minus 3 m.y. as determined by Pb 206 U 238 and Pb 207 U 235. These are sufficiently concordant to confirm an early Miocene time of mineralization for both deposits. Uranium-lead ages for several ore-grade samples from an upper sandstone layer of the Shirley Basin indicate 24 plus or minus 5 m.y. The ore samples show less concordancy in age than the massive uraninite samples and are believed to give a less reliable age because of a large common lead correction. Radioactive secular equilibrium between U 238 and U 234 was determined by alpha spectrometry to be greater than 99 percent for the massive uraninite samples; equilibrium between U 238 and Th 230 (ionium) was established by a direct method of isotopic mass ratios. A method of indexing the common lead correction using Pb 208 is used with these young samples which contain negligible Th 232. Both the Gas Hills and Shirley Basin uranium deposits, located about 85 miles (137 km) apart, are in the Wind River Formation. The radioactive equilibrium found in the massive uraninite samples supports the reliability of the age found for these two samples. The loss of equilibrium in the ore-grade samples, along with the less reliable lead age, indicates that some local migration of elements occurred surrounding the roll at the Shirley Basin. Apparently this has not affected the lead-uranium system sufficiently to invalidate a date of 22 m.y. for the emplacement of both deposits and the conclusion that ore deposition stopped at about that time. (Auth)

<364>

Cowart, J.B., and J.K. Osmond; Florida State University, Tallahassee, FL

Uranium 234 and Uranium 238 in the Carrizo Sandstone Aquifer of South Texas. IAEA-SM-182 35. (pp. 131-149).

(1974)

The waters of the Carrizo Sand Formation of South Texas exhibit a pattern of uranium isotopic disequilibrium, described in terms of U 234 U 238 activity ratio ("A.R.") and uranium concentration, which may be a function of geochemical factors and the hydrologic history of the area. In terms of uranium, two regimes seem to exist. The first, including outcrop and near outcrop sample locations, has waters with relatively high concentration and low A.R. Somewhat downdip, the uranium concentration decreases sharply at the downdip limit of the oxidation environment, a zone of uranium precipitation. Recoil of daughter products from the precipitated uranium causes an increase of A.R. of the water. Water of low uranium concentration and high A.R. is found throughout the downdip regime. If a constant input of U 234 through time is assumed, the downdip decrease in A.R. after the initial introduction of U 234 into the water may be ascribed to radioactive decay of U 234. However, this assumption leads to the calculation of a water flow rate one twentieth that determined by other means. Alternatively, this pattern may be an artifact of a change of climate from 20,000 years to 10,000 years ago. In this case, the decrease in A.R. downdip is a function of a varying input of U 234 as well as decay. (Auth)

<365>

Files, F.G.; University of California, Graduate Division, Berkeley, CA

Geology and Alteration Associated with Wyoming Uranium Deposits. Ph.D. Dissertation, University of California, 132 pp.; GJO-936-1, 132 pp. (1970)

The paper deals with roll-type uranium ore bodies at three deposits in Wyoming, namely Crooks Gap, Gas Hills and Shirley Basin. The study was aimed at establishing the physical and chemical factors responsible for roll formation and migration. Rolls in the Gas Hills and Shirley Basin were found to resemble each other closely in important morphological characteristics such as size, shape, lateral continuity, occurrence below the permanent water table and relation of the alteration ton···s to the paleotopography of the underlying form...ions. Crooks Gap rolls differ by being smaller and higher grade and lacking continuity as a result of rapidly changing lithofacies in the host rocks. M.neralogical variations across the roll-front were investigated microscopically · polished thin-sections and heavy minera· ·parates. Bulk chemical analyses show that al...ed and unaltered ground differ little from each other in content of the major components SiO2, Al2O3, and K2O, which comprise 90-95 percent of the host rocks. Roll formation and migration is apparently in response to generation of an "acid wave" in the vicinity of the roll-front caused by oxidation of pyrite by invading oxygenated waters. The observed mineralogical reactions in roll-front formation and migration generally consist of minerals dissolving and being redeposited farther down-dip in response to changing chemical conditions in the pore solution, rather than of minerals altering in place to other phases. (Auth)(MBW)

<366>

Sackett, W.M., T. Mo, R.F. Spalding, and M.E. Exner; Texas A & M University, Department of Oceanography, College Station, TX

A Revaluation of the Marine Geochemistry of Uranium. In Radioactive Contamination of the Marine Environment. International Atomic Energy Agency, Vienna, Austria, 1973, (pp. 757-769); IAEA-SM-158 51, (pp. 757-769). (1973)

Approximately 10(E+15) micrograms year of dissolved uranium are being removed from the ocean by each of the generally accepted significant sinks for uranium-carbonate deposits and deep anoxic basin sediments. However, these sinks account for only 10 percent of the estimated present-day input of uranium. Possible explanations for this discrepancy are: (1) contemporary input values are too high owing to a significant contribution from man's effects, such as uranium input via phosphate fertilizers or world-wide cultivation leading to premature leaching of uranium from soils, or (2) there are other important uranium sinks such as the abundant siliceous oozes or continental shelf anoxic sediments. (Auth)

<367>

Spalding, R.F., W.M. Sackett, and W.R. Bryant, Texas A & M University, Department of Oceanography, College Station, TX

Paleogeochemistry of Uranium in the Gulf of Mexico. Earth Research, 2, 35-42. (1974)

The paper describes the relationship between uranium concentrations and other parameters in sediments recovered from hole 94 at the northern edge of the continental slope of the Yucatan platform, which was drilled by the Glomar Challenger. Twenty-five samples from different time intervals of the core material were analyzed for uranium. Uranium concentrations were determined by the nondestructive delayed neutron technique. Nine of these samples were also analyzed for percent calcium carbonate. Eleven core intervals were analyzed for acid soluble phosphate. The aluminosilicate fractions for uranium concentrations had from 2-6 ppm uranium with a mean of about 3.5 ppm. For the calcareous fraction of Gulf sediments, uranium ranged from 0.15 ppm in foraminifera to about 2 ppm in pteropods to almost 5 ppm in some corals and calcareous algae. For the Oligocene and Eocene sediments recovered, the uranium concentrations ranged from about 0.1 to 1 ppm. For the same type sediments deposited in the Pleistocene, Pliocene, and Miocene, however, uranium values are approximately five times higher than those just mentioned. Two possibilities for this may be responsible; a secondary enrichment process associated with lateral or upward vertical migration and/or a process associated with Gulf coast Miocene tectonic activity. (Auth)(MBW)

<368>

Mo, T., A.D. Suttle, and W.M. Sackett; Texas A & M University, College Station, TX

Uranium Concentrations in Marine Sediments. Geochimica et Cosmochimica Acta, 37, 35-51. (1973)

Uranium concentrations in a large number of marine sediment samples of different types with world-wide spatial distribution have been determined using the rapid, precise and nondestructive technique of counting the delayed neutrons emitted during U 235 fission induced with thermal neutrons. Several interesting relationships were apparent. (1) A direct proportionality was observed between percentage of organic carbon and uranium in sediments deposited in an anoxic environment in the Pettaquamscutt River in Rhode Island with concentrations ranging from 7 percent organic carbon and 7 ppm uranium to 14 percent organic carbon and 30 ppm uranium. A similar relationship was found in cores of sediments deposited on the Sigsbee Knolls in the Gulf of Mexico. (2) For manganese nodules a direct relationship can be seen between uranium and calcium concentrations and both decrease with increasing depth of deposition. For nodules from 4500 m in the Pacific, concentrations are 3 ppm uranium and 0.3 percent calcium compared with 14 ppm uranium and 1.5 percent calcium at 1000 m. (3) Relatively high uranium concentrations were observed in carbonates deposited in the deepest parts of the Gulf of Mexico, with the greater than 88 micron carbonate fraction in Sigsbee Knoll cores having as much as 1.20 ppm. A model to explain the observed variations must include uranium enrichments in near shore environments via an anoxic pathway, followed by redeposition in a deep ocean environment with dilution either by low-uranium-bearing foraminiferal or siliceous oozes or, along the continental margins, dilution with high-uranium-bearing carbonate sands. (Auth)

<369>

Spalding, R.F., and W.M. Sackett; Texas A & M University, Department of Oceanography, College Station, TX

Uranium in Runoff from the Gulf of Mexico Distributive Province: Anomalous Concentrations. Science, 175, 629-631. (1972, February 11)

Uranium concentrations in North American rivers are higher than those reported 20 years ago. The increase is attributed to applications to agricultural land of larger amounts of phosphate fertilizer containing appreciable concentrations of uranium. Experiments showing a constant phosphorous-uranium ratio for various types of fertilizers and for the easily solubilized fraction of 0-46-0 fertilizers support this view. (Auth)

<370>

Barker, F.B., J.O. Johnson, K.W. Edwards, and B.P. Robinson; USGS, Washington, DC

Determination of Uranium in Natural Waters. USGS Water-Supply Paper 1696-C, 25 pp. (1965)

A method is described for the determination of very low concentrations of uranium in water. The method is based on the fluorescence of uranium in a pad prepared by fusion of the dried solids from the water sample with a flux of 10 percent NaF, 45.5 percent Na_2Co_3, and 45.5 percent K_2CO_3. This flux permits use of a low fusion temperature and yields pads which are easily removed from the platinum fusion dishes for fluorescence measurements. Uranium concentrations of less than 1 microgram per liter can be determined on a sample of 10 milliliters, or less. The sensitivity and accuracy of the method are dependent primarily on the purity of reagents used, the stability and linearity of the fluorimeter, and the concentration of quenching elements in the water residue. A purification step is recommended when the fluorescence is quenched by more than 30 percent. Equations are given for the calculation of standard deviations of analyses by this method. Graphs of error functions and representative data are also included. (Auth)

<371>

Scott, R.C., and F.B. Barker; USGS, Washington, DC

Data on Uranium and Radium in Ground Water in the United States, 1954 to 1957. USGS Professional Paper 426, 115 pp. (1962)

The report is one of a series resulting from a study by the U.S. Geological Survey to determine the occurrence and distribution of naturally radioactive substances in water. From 1954-57 uranium and radium concentrations were determined in 561 samples, mainly of ground water, having wide geologic and geographic distribution. These concentrations, together with data on the hydrologic and geologic environment, the beta-gamma activity, and the chemical characteristics of each sample, are tabulated by states. The conterminous United States was subdivided into 10 geotectonic regions to facilitate statistical interpretation of the occurrence of uranium and radium in fresh water in approximately homogeneous geologic provinces. For each geotectonic region, the range and median were determined for the concentrations of radium and uranium; for regions from which sufficient data were available, log-normal frequency distribution curves were calculated and superimposed on histograms of radium and uranium concentrations in the samples. An "anomaly threshold" is suggested for both radioelements for each region analyzed statistically. The western stable region had the greatest median and highest "anomaly threshold" for uranium. This region also had the highest "anomaly threshold" for radium, but the largest median for radium was found for samples collected in the Ozark-Ouachita system. The median concentration for uranium was lowest for the Atlantic and Gulf Coastal Plain and the Pacific orogenic belt. This latter region also had the lowest median-radium content. (Auth)

<372>

De Nault, K.J.; Stanford University, Department of Geology, Stanford, CA

Origin of Sandstone Type Uranium Deposits in Wyoming. Ph.D. Dissertation, Stanford University, 352 pp. (1974, May)

An examination of a uranium roll in the Red Desert, Wyoming, has shown the following outstanding mineralogic differences between fresh and altered ground: 1) Hornblende, pyrite, and zircon are removed from altered ground. 2) Hornblende crystals in fresh ground show pronounced solution features and they are uraniferous. 3) Pyrite is found in three morphologic varieties in fresh ground, octahedra, framboids, and small massive grains, all of which are uraniferous. In mineralized ground, framboidal pyrite has grown and is the dominant form. Framboids in both fresh and mineralized ground are composed of small discrete tetrahedra. 4) Anatase replaces ilmenite in mineralized and altered ground. In order for a roll to form, a host sand must contain sufficient pyrite, methane, and other constituents to lower the Eh of influxing groundwater so that pyrite, uraninite, and selenium precipitate. The zonation of calcite, pyrite, uraninite, and selenium represents a serial increase in Eh and a modest drop in pH across a roll. (Auth)(MBW)

<373>

Scott, J.H., and J.J. Daniels; USGS, Denver, CO

Non-Radiometric Borehole Geophysical Detection of Geochemical Halos Surrounding Sedimentary Uranium Deposits. USGS Open File Report 76-228, 16 pp.; IAEA SM 208-16, 16 pp. (1976)

Roll-type uranium deposits are formed by the concentration of uranium by ground water in geochemical cells. Non-uranium minerals having different solubilities may be deposited ahead of or behind the uranium minerals, forming halos that surround the ore. In addition, oxidizing and reducing environmental conditions may cause zones of mineral alteration to develop beyond the limits of the uranium deposit. Certain physical property anomalies that are commonly associated with halos can be detected by relatively fast and inexpensive borehole geophysical measurements made either in individual holes, or between two adjacent holes. Borehole measurements that have been found to be useful include electrical resistivity, induced polarization, and magnetic susceptibility. Electrical resistivity is increased by the presence of calcite and other cementing minerals that sometimes create permeability barriers in the neighborhood of uranium deposits. Induced polarization (IP) response is increased by sulfide and clay minerals that are commonly found in anomalous concentrations near roll-type deposits. Magnetic susceptibility is usually decreased by the oxidation of magnetite to hematite or limonite in the zone of chemical alteration that is left as a trail behind roll fronts. Borehole measurements of electrical resistivity, induced polarization and magnetic susceptibility were made in the vicinity of a uranium roll-type deposit in south Texas. Results indicate that mineral halos can be detected by borehole measurements made in wide-spaced drill holes, and that the total amount of drilling needed to find a deposit can be reduced substantially by this exploration approach. (Auth)

<374>

Cheney, E.S., and J.W. Trammell; University of Washington, Department of Geological Sciences, Seattle, WA

Isotopic Evidence for Inorganic Precipitation of Uranium Roll Ore Bodies. American Association of Petroleum Geologists Bulletin, 57(2), 1297-1303. (1973, July)

Uranium roll ore bodies form below the water table predominantly in arkosic sandstones. Exterior barren ground (EBG) outside of the crescentic roll may retain mafic detrital minerals or may be hematitic or pyritic. Pyritic EBG commonly contains coalified wood and calcite. Roll ore bodies generally grade into pyritic EBG, have sharper boundaries with interior barren ground (IBG), and are discontinuous along strike. IBG usually is devoid of pyrite, calcite, organic materials, and fresh feldspars. A disequilibrium mineralogic assemblage (or transitional zone) of variable width is present between roll ore and IBG in some deposits. During the past decade, a bacterial origin for roll ore bodies has been more popular than other theories of origin. However, largely on the basis of laboratory experiments Granger and Warren suggested that the roll ore bodies may form inorganically. According to their model, incursion of groundwater may cause the oxidation of biogenic or other sulfides to sulfite; because sulfite disproportionates into SO4- and HS-, inorganic HS- rather than bacteriogenic H2S may be responsible for the precipitation of pyrite and uranium minerals. Isotopic data that seem to support the new hypothesis in the Gas Hills district of Wyoming include the following: (1) the lack of C 12 enriched (i.e., methane-derived) calcite, (2) the variable and extreme enrichment of S 32 in pyrite within transitional IBG and in pyrite associated with jordisite on the leading edge of some rolls, and (3) the greater enrichment of S 34 in the present groundwater sulfate than in the epigenetic sulfides that generate this sulfate. The unusual occurrence of roll ore bodies between EBG and IBG that contain almost no pyrite or calcite would be difficult to attribute to a bacterial origin. The diagenetic formation of bacterial sulfides in sandstones can be viewed as ground preparation for the later and genetically unrelated formation of roll ore bodies. Accordingly, other factors being equal, wide ore zones should exist adjacent to pyritic EBG, and rolls should be absent or narrow next to nonpyritic EBG. (Auth)

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Osmond, J.K., L.I. Briel, J.B. Cowart, and M.I. Kaufman; Florida State University,

Department of Geology, Tallahassee, FL

Analysis of Ground-Water Regimes by Use of Natural Uranium Isotope Variations. PB-240-267, 123 pp. (1974)

The concentrations in natural waters of U 238 and U 234 vary greatly both in absolute terms and relative to each other. This isotopic phenomenon, which is due to processes related to the radiogenic origin of U 234 by way of intermediate daughters from U 238, can be used to study ground-water regimes in two ways: (1) as isotopic fingerprints of water masses, so that mixing volumes of diverse sources can be computed, and (2) as indicators of water-aquifer interactions through time, whereby the isotopic parameters are changed. Examples of the first kind of study include mixing volumes and sources of major Florida springs, and ground-water contributions to a Florida karstic river. Examples of the second kind of study include analysis of circulation patterns of the Carrizo aquifer of Texas and of the Floridan aquifer of south Florida. The analytical techniques are designed for low concentration-large volume samples, and include the use of an artificial yield tracer, U 232, and simple procedures for co-precipitation, ion-exchange, electrodeposition, and alpha energy pulse height analysis. (Auth)

<376>

Stieff, L.R., T.W. Stern, and R.G. Milkey; USGS, Washington, DC

A Preliminary Determination of the Age of Some Uranium Ores of the Colorado Plateaus by the Lead-Uranium Method. USGS Circular 271, 19 pp. (1953)

Treatment of the data for 41 ore samples containing more than 0.1 percent uranium gives an average Pb 206/U age of approximately 71 million years, an average Pb 207/U 235 age of about 82 million years, and an average Pb 207/Pb 206 ratio equivalent to an age of 425 million years. At least part of the large discrepancy between the mean lead-uranium ages and the much less reliable Pb 207/Pb 206 ages is due to small systematic mass spectrometric errors. The extreme sensitivity of the Pb 207/Pb 206 ratio to small mass spectrometric errors invalidates not only the Pb 207/Pb 206 ages but also the corrections for the presence of old radiogenic lead and the selective loss of radon which must be based in part on precise determinations of the Pb 207 Pb 206 ratio. Errors in the chemical analyses for lead and uranium introduce uncertainties in the mean Pb 206 U age of approximately plus or minus 3 million years. The small systematic mass spectrometric errors should not increase the mean Pb 206 U age by more than 3 million years. Better corrections for common lead and additional corrections for selective loss of uranium and the presence of old radiogenic lead should lower the mean Pb 206 U age by approximately 10 million years. The data suggest that the calculated ages are close to the true age of the ores. From these calculated ages it is reasonable to assume that the uranium was introduced into the sediments not later than the late Cretaceous or early Tertiary (55 to 80 million years ago). This assumption differs markedly from the assumption that the present uranium deposits were formed in the Late Triassic and Late Jurassic sediments of the Colorado Plateaus (152 and 127 million years ago), during or soon after deposition of the sediments. (Auth)

<377>

Rogers, J.J.W., and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

Autoradiography of Volcanic Rocks of Mount Lassen. Science, 125, 1150. (1957, March 18)

The Mount Lassen volcanic rocks studied consisted of phenocrysts of plagioclase and one or more ferromagnesian minerals (and rarely quartz) in a groundmass of glass or aphanitic material. The determined ratios (percentage alpha tracks from mineral/percentage of mineral in the rock) are close to 1 for most minerals, including glass, in each sample. Apparently no mineral is either enriched or impoverished in thorium and uranium, and the distribution of alpha-emitting elements seems to be uniform. (PAG)

<378>

Stewart, D.C., and W.C. Bentley; Argonne National Laboratory, Lemont, IL

Analysis of Uranium in Sea Water. Science, 120, 50-51. (1954, July)

The uranium concentration of water collected from the Pacific Ocean and the Great Salt Lake was determined by extracting the uranium directly from the water into an organic solvent containing di-butyl-orthophosphoric acid in CCl4. The solution was transferred in toto to a platinum counting plate and dried. The U 235 present was estimated by fission-fragment counting in the Argonne heavy-water reactor. This method is accurate for volumes of 1 ml or less, with volumes of 20 ml being the routine sample size. (PAG)

<379>

Hamilton, E.; Not given

The Uranium Content of the Differentiated Skaergaard Intrusion Together with the Distribution of the Alpha Particle Radioactivity in the Various Rocks and Minerals as Recorded by Nuclear Emulsion Studies. Meddelelser Om Gronland, 162(7), 1-39. (1959)

The distribution of radioactivity and uranium in the Skaergaard intrusion (East Greenland) is traced in detail by means of quantitative nuclear emulsion techniques, radioactivation and fluorimetric analyses. It has been shown that in the rocks formed by differentiation of a basaltic magma there is *no* preferential increase of radioactivity from the major minerals, the olivine being the least and the quartz the most radioactive of the major minerals. Of the accessory minerals apatite, zircon, sphene, epidote, and hydrated iron oxides showed a preferential increase in radioactivity. (Auth)

<380>

Wollenberg, H.A., and F.C.W. Dodge; University of California, Lawrence Berkeley Laboratory, Berkeley, CA; USGS, Washington, DC

Radioelement and Trace-Element Content of the Ione Formation, Central California. USGS Bulletin 1382-B, 17 pp. (1973)

Radioactivity and content of uranium plus thorium in 77 samples of sandstones and clays from the Eocene Ione Formation of central California correlate with abundance of titanium, zirconium, and lanthanum, suggesting a general correspondence between the radioelements and heavy minerals. There is no apparent correlation between the content of gold and radioelements. Of 77 samples of Eocene rocks, gold was detected in less than one-third; there is little probability that the element exists in exploitable amounts in the Ione Formation. Sandstones of the Ione Formation in the Ione-Buena Vista area are characterized by low potassium content as compared with their northern counterparts and with samples from the Eocene Tesla and Domengine Formations of the west side of the Great Valley. Sandstones from all areas sampled are similar in uranium and thorium contents. Processes associated with transportation and deposition rather than composition of source materials alone may have significantly affected radioelement concentrations in the Ione. (Auth)

<381>

Trites, A.F., Jr., and E.W. Tooker; USGS, Washington, DC

Uranium and Thorium Deposits in East-Central Idaho, Southwestern Montana. USGS Bulletin 988-H, (pp. 157-209). (1953)

Thirty-nine mines and prospects in east-central Idaho and southwestern Montana were examined radiometrically to determine the grade, reserves, and mode of occurrence of uranium and thorium. The region is underlain by granite gneiss of pre-Cambrian age; metasedimentary rocks of younger pre-Cambrian age; limestone, dolomite, quartzite, sandstone, shale, and phosphate rock of Paleozoic and Mesozoic age; and shale, sandstone, and unconsolidated deposits of Tertiary age. The igneous rocks, which vary widely in composition, comprise pre-Cambrian and Cretaceous or Tertiary dikes, late Mesozoic batholiths, and Tertiary to Recent lavas. The rocks have been folded by pre-Cambrain, Laramide, and post-Miocene deformation and displaced by many thrust and normal faults. Uranium occurs principally in gold, lead, copper, and quartz-hematite veins that cut pre-Cambrian quartzite and phyllite of the Belt series and Paleozoic limestone and shale. The uranium minerals that have been identified, torbernite and autunite, are associated with pyrite, galena, malachite, and hydrous iron oxides. These deposits are estimated to contain 0.02 to 0.1 percent uranium. Known reserves are small.

Thorium occurs in significant amounts in three copper-bearing veins and in at least nine quartz-hematite veins. One copper-bearing vein is in pre-Cambrian hornblende gneiss; the other veins cut argillite, sandstone, quartzite, and schist of the Belt series. The thorium occurs principally as thorite and as hydrothorite. The thorite is in very small, altered, red-brown, prismatic crystals associated with hematite, hydrous iron oxides, and barite. The hydrothorite is believed to occur in the mixture of hydrous iron oxides. Minor quantities of monazite and allanite are found in some of the deposits, but they are not considered significant sources of thorium. These deposits are believed to contain 0.1 to 1.2 percent thoria (ThO_2). (Auth)

<382>

Gott, G.B., and J.W. Hill; USGS, Washington, DC

Radioactivity in Some Oil Fields of Southeastern Kansas. USGS Bulletin 988-E, (pp. 69-122). (1953)

Radium-bearing precipitates derived from oil-well fluids have been found in more than 60 oil and gas fields in Cowley, Butler, Marion, Sedgwick, and Greenwood Counties of southeastern Kansas. The abnormal radioactivity of these precipitates has been studied by means of gamma-ray and sample logs; by radiometric, chemical, petrographic, and spectrographic analyses of the precipitates and drill samples; and by chemical analyses of brines collected from oil wells in the areas of high radioactivity. The most radioactive precipitates were collected from a narrow belt, roughly marginal to the Nemaha anticline, that extends from the southern part of Marion County southward to near the Kansas-Oklahoma boundary. Most of the formations in this area have no higher concentration of radioactive constituents than is normally found in rocks of similar lithology elsewhere, but in a few wells the drill samples from beds just below the eroded top of the Arbuckle group and from some limestones in the Kansas City group have an abnormally high radium content. The highest radioactivity caused by radium in any of the rocks from this area that have been radiometrically analyzed is equivalent to that of 0.26 percent uranium oxide. This analysis indicates as much radium as would be found in equilibrium with about 0.5 percent uranium. The radioactivity of the precipitates ranges from 0.000 to 10.85 percent equivalent uranium oxide, and the uranium oxide content ranges from 0.000 to 0.006 percent. Radium determinations have shown that radium is the element that causes most of the radioactivity. Brines, collected from oil wells where radium-bearing precipitates have formed, contain as much as 0.2 ppm of uranium. (Auth)

<383>

Thompson, M.E.; USGS, Washington, DC

Further Studies of the Distribution of Uranium in Rich Phosphate Beds of the Phosphoria Formation. USGS Bulletin 1009-D, (pp. 107-123). (1954)

Five sets of "close" samples (narrow and contiguous samples across a lithologic unit) from beds of high phosphate content of the Phosphoria formation in Idaho, Utah, and Wyoming were analyzed chemically for F and CO_2. Very good correlations between F, CO_2, and P_2O_5 were found in several of the samples. The size of phosphate pellets was measured in thin sections of two sets of close samples. Frequency histograms and cumulative curves were plotted from these size measurements, but when compared with uranium concentration for each sample, no significant correlation between size and uranium concentration was discovered. In two sets of samples a good correlation was found between equivalent uranium and each of the other components. The samples in these two sets have a uranium content that is relatively high for the Phosphoria formation, and they show considerable range in P_2O_5 content. (Auth)

<384>

Kaspar, J., and V. Hejl; Institute of Experimental Mineralogy and Geochemistry, Prague, Czechoslovakia

Thermodynamic Conditions of the Origin of Uraninites. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 301-314), 386 pp.; IAEA-PL-391/6, (pp. 301-314), 386 pp. (1970, October)

The dependence of the origin of UO_2, UO_3 and U_3O_8 on temperature (300-900 degrees K) and pressure (1-10000 atm) was studied. Calculations of values of free enthalpies at 1 atm show that values of delta G are predominantly negative. Therefore, in theory, the oxides could exist in nature. At the same time, the absolute values of delta G are most favorable for the formation of UO_3 which, however, has not been encountered in nature. The reason why UO_3 formation is most favored is because the experimental reactions occur in an environment with a surplus of oxygen. The oxides under study form a series according to the decreasing value of delta G, namely UO_3 U_3O_8 and UO_2. In nature, however, the origin of uraninite (in pegmatites as well as in hydrothermal veins) occurs under a lack of oxygen and the above sequence is the reverse, the only oxide originating in nature being therefore UO_2. On the whole, calculations show that the existence of UO_2, UO_3 and U_3O_8 is possible under high pressures up to 10000 atm. However, increasing pressure influences unfavorably the value delta G, in other words the formation of the uranium oxides is less probable. From the results obtained, it is clear that temperature is more important than pressure for the formation of uraninites. Another important factor is the chemical character of the environment in which uraninite originates. The reducing atmosphere supports the origin of UO_2, whereas an oxidizing medium suppresses its origin. The calculated values were checked against experimental results of hydrothermal synthesis of uraninites in autoclaves. Uraninites in nature may originate in pegmatites as well as in the zone of hypergenesis. At the same time, according to the different content of U^{6+}, uraninites may be classified as alpha, beta or gamma uraninite or uraninite I, II and III. Chemically, it is a question of the variable amount of UO_3 in the structure of UO_2, which causes the change in the unit cell dimensions in the range between 5.38 and 5.49 angstroms. (Auth)

<385>

Gabelman, J.W.; AEC, Division of Raw Materials, Washington, DC

Speculations on the Uranium Ore Fluid. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency publications, Vienna, Austria, (pp. 315-330), 386 pp.; IAEA-PL-391 21, (pp. 315-330), 386 pp. (1970, October

Lateral secretion by fresh meteoric groundwater is a popular theory for uranium mineralization in sedimentary rocks. However, field evidence indicates that presently migrating fresh groundwater does not mineralize its aquifers, and that uranium, copper and vanadium deposits are formed by fluids which were corrosive enough to pervade and alter relatively impermeable rocks. Further, uranium mineralization occurred in geographically restricted areas and not in any hydrodynamic system with suitable source and reservoir rocks. Uranium districts are concentrated along the forelands of mobile belts whereas the best source rocks are in the hinterlands. Districts in regionally extensive preferred formations are localized in relation to broad tectonic features rather than the topographic surface, stratigraphy, local structures, or local hydrodynamic systems. The areally uniform uranium content presently found in the most uraniferous source rocks - granite, rhyolitic tuff and carbonaceous shale - indicates its resistance to leaching by ordinary water. A portion of this uranium is removable by acid leaching. Uranium deposits also contain a family of minor elements in quantities up to several orders of magnitude times their level in source rocks. Some of these are not easily leached. The patterns of altered rock that invariably accompany uranium deposits do not reflect fresh-water flow but are restricted, selective among similar chemical traps, and locally transgressive, indicating a limited supply of fluid. The difficulties in concentrating a sufficient volume of ions by diffusion or water by flow to create an ore deposit invite consideration of a concentrated fluid. Freshwater analyses show contents of the family of uranium deposit elements many times less than the levels in source rocks, whereas brines have concentrations many times more, even approaching the concentration in ores. Fluid-gas inclusions in calcite in sandstone uranium deposits appear to be brines trapped at 45 to 65 degrees C. Recent isotopic studies show many brines to be meteoric water enriched in mineral ions by percolation through heated environments. The uranium ore fluid must have corrosiveness, penetrability, concentration and selectivity; qualities which fresh groundwater does not possess. The ore fluid could be a brine composed of originally meteoric water mixed with magmatic, connate, or rock crystallization fluids and mineral ions from any source. This fluid could migrate and mineralize in response to temperature zoning. (Auth)

<386>

Miller, M.R.; Montana Bureau of Mines and Geology, Hydrology Division, Butte, MT

Hydrogeochemical Investigation of Selected Watersheds in Southwestern Montana. PB-238 348, 25 pp.; MUJWRRC Report No. 60, 25 pp.; OWRT A-029 MONT, 25 pp. (1974, December)

A two-year study was conducted (1969-1971) to delineate the geological factors that influence the water quality of selected watersheds in southwestern Montana. Secondary objectives included investigation of parameters or group of constituents to see which are the best indicators of geologic environment and examination of the effects of seasonal variations on water chemistry. Seven small watersheds were studied, each containing one predominant rock group. The watersheds range in size from 2 to 9 square miles, and most are along the flanks and foothills of several mountain ranges. An attempt was made to select watersheds where man's activities are minimal. Findings of the study indicate that bedrock geology does influence the water chemistry of watersheds; waters issuing from watersheds in metamorphic and in plutonic terrains seem to be similar in composition and concentration; carbonate, sandstone, shale and volcanic terrains seem to influence the water chemistry the most; concentrations of major constituents vary inversely with stream discharge; concentrations of trace metals seem to remain almost constant regardless of discharge; in general trace-metals concentrations were too low to be significant, suggesting that stream sediments may be more useful than stream water as a geochemical exploration tool. (Auth)

<387>

Hill, J.W.; Oklahoma Geological Survey, Norman, OK

Uranium Bearing Carbonaceous Nodules of Southwestern Oklahoma. Oklahoma Geological Survey Mineral Report 33, 6 pp. (1957)

Uranium-bearing carbonaceous nodules have been found along the north flank of the Wichita uplift in southwestern Oklahoma. The carbonaceous nodules are black, hard, brittle, highly lustrous, and largely insoluble in carbon disulfide or benzene. One specimen by analysis had approximately 42 percent carbon and 3 percent hydrogen. The uranium, vanadium, cobalt, arsenic, nickel, lead, and iron contents each range between 1 and 10 percent. It is concluded that the carbonaceous nodules are epigenetic and that the organic and inorganic constituents were derived from mobile solutions. (Auth)

<388>

Ward, F.N., and A.P. Marranzino; USGS, Washington, DC

Field Determination of Uranium in Natural Waters. USGS Bulletin 1036-J, (pp. 181-192). (1957)

A simple and moderately accurate method for determining traces of uranium in natural waters has been devised to facilitate the development of hydrogeochemical prospecting techniques. The procedure eliminates the present practice of transporting bulky water samples from field to laboratory and the time-consuming evaporation of samples, preliminary to analysis. Under field conditions the uranium is separated from a water sample by means of a phosphate collector, and, after a paper-chromatographic separation, is determined by its reaction with ferrocyanide. The lower limit of the method is 2 ppb and without modification it can be used to determine as high as 200 ppb of uranium in natural waters. Recoveries of 2, 30, and 10 micrograms of uranium added to 500 ml portions of a water sample are respectively 1, 5, and 7 micrograms. The analyses of 7 different binary mixtures prepared from natural water samples compare favorably with the values calculated from the mixture composition and the known uranium contents of the components. Five repeat determinations on a water sample containing 5 ppb agree within 1 ppb of the mean; similar determinations on a sample containing 30 ppb agree within 4 ppb of the mean; similar determinations on a sample containing 5 ppb agree within 4 ppb of the mean. Results by the proposed method on samples containing from 2 to 30 ppb of uranium compare reasonably well with the fluorimetric results obtained by another laboratory. (Auth)

<389>

Robinson, C.S., and J.N. Rosholt, Jr.: USGS, Denver, CO

Uranium Migration and Geochemistry of Uranium Deposits in Sandstone Above, At, and Below the Water Table: Part II - Relationship of Uranium Migration Dates, Geology, and Chemistry of the Uranium Deposits. Economic Geology, 56(8), 1404-1420. (1961)

The time of uranium migration in deposits in sandstone can be determined by correlating apparent age calculations, based on radiochemical analyses, with the geology of a particular deposit. Data were obtained from uranium ore samples representing deposits above the water table, deposits just above and below perched water tables, and deposits at least 250 feet below the water table in the Hulett Creek area, Wyoming. The first uranium deposition occurred more than 250,000 years ago for the deposits now at or above the water table. Approximately 60,000 to 80,000 years ago these deposits were oxidized, leached, and locally enriched. Accumulation of uranium in the deposits below the water table probably did not start before 180,000 years ago and has continued to the present. (Auth)

<390>

Rosholt, J.N., A.P. Butler, E.L. Garner, and W.R. Shields; USGS, Denver, CO; National Bureau of Standards, Washington, DC

Isotopic Fractionation of Uranium in Sandstone, Powder River Basin, Wyoming, and Slick Rock District, Colorado. Economic Geology, 60(2), 199-213. (1965)

Considerable isotope fractionation of uranium has been found in sandstone-type deposits in the Powder River Basin, Wyoming. Uranium deposits, protected from surface weathering and only partly oxidized occur in roll ore bodies in the zone of oxidation above the water table. U 234 deficiencies of 40 to 60 percent are found in ore, and slight U 234 excess is found in samples directly below ore. The large magnitude of isotope fractionation appears to be the result of the slightly oxidizing environment. The roll ore body in the Slick Rock district occurs below the zone of oxidation, and the uranium ore is varied only from that which is 5 percent deficient in U 234 to that which is 2 percent in excess of U 234. Of the roll ore bodies below the zone of oxidation and studied for isotopic fractionation of uranium, the Slick Rock roll has the least amount of fractionation. The relative lack of preferential leaching of U 234 is attributed to the high reducing potential of the environment. (Auth)

<391>

Moxham, R.M.; USGS, Washington, DC

Radioelement Dispersion in a Sedimentary Environment and Its Effect on Uranium Exploration. Economic Geology, 59(2), 309-321. (1964)

The radioelement content of the major part of the southeast Texas Coastal Plain sedimentary sequence falls within a range common for sandstones and shales. Exceptions to the normal limit are mainly in small, widely scattered areas. One anomalous area, however, covers several tens of square miles and contains most of the important uranium deposits. Both mechanical and chemical dispersion of radioelements takes place in the immediate vicinity of the ore deposits, though no attempt is made to extend this local dispersion model to the large, regional gamma radiation anomaly. It is suggested that the point-source concept for sedimentary uranium deposits is unrealistic and that conventional aeroradiometric survey grid spacing can be substantially enlarged without seriously reducing efficiency in uranium exploration. (Auth)

<392>

Miller, L.J.; Ecstall Mining Company, Limited, Toronto, Ontario

The Chemical Environment of Pitchblende. Economic Geology, 53(5), 521-545. (1958)

Several uranium complex ions were found to be stable over a wide range of pH, temperature, and pressure. At 25 degrees C and in neutral solutions uranyl complexes of carbonate, fluoride, and hydroxide remain in solution at concentration values between 10(E-5) M and 10(E-3) M. At elevated temperatures (215 degrees C) the solubility of these ions at pH 7 is still above 10(E-5) M. At 25 degrees C the above mentioned ions will react with a reducing agent (H2S) at pH 7 to form pitchblende of small crystallite size. A similar reaction proceeds at elevated temperatures (215 degrees C) and pH 7, but the pitchblende precipitates with larger crystallite dimensions. The uranous complex ions are relatively unstable. Solutions of uranous hydroxide precipitate a small amount of pitchblende at 25 degrees C. At elevated temperatures (215 degrees C) all of the uranium in solutions converts to well crystallized pitchblende. (Auth)

<393>

Rosholt, J.N., M. Tatsumoto, and J.R. Dooley, Jr.; USGS, Denver, CO

Radioactive Disequilibrium Studies in Sandstone, Powder River Basin, Wyoming, and Slick Rock District, Colorado. Economic Geology, 60(3), 477-484. (1965)

Radiochemical analyses of Th 230 and Pa 231 were made by use of an alpha spectrometer of two suites of samples from roll ore bodies in the Powder River Basin, Wyoming, and in the Burro No. 7 mine, San Miguel County, Colorado. The isotopic abundances thus determined are compared with those of the parent U 234 and U 235 isotopes previously determined by use of a mass spectrometer. In both ore bodies the amount of Th 230 and Pa 231 ranges from being in excess to being deficient of that required for radioactive equilibrium with U 234 and U 235. The relationships between these daughters and the parent uranium isotopes indicate that uranium has migrated from the concave boundary toward the convex boundary in both rolls. Very low Th 230/Pa 231 ratios in the ore from the Powder River basin roll indicate that U 234 has been preferentially leached from the ore for a period of at least 100,000 years rather than leached only during the last few thousand years. (Auth)

<394>

Bates, T.F.; Pennsylvania State University, Division of Mineralogy, School of Mineral Industries, State College, PA

Mineralogy of the Chattanooga Shale. Geological Society of America Bulletin, 64, 1529. (1953)

Mineralogical studies, both qualitative and quantitative, of the Chattanooga shale are in progress. Problems of separation and analysis of mineral and organic components are difficult because the rock is fine-grained. However, the application of light and electron microscopy, x-ray diffraction, differential-thermal analysis, and other methods has provided data of interest. In thin section the rock is seen to consist of grains of quartz and feldspar in a matrix of yellow to red-brown organic material which incorporates shreds of mica and probably clay particles and is dotted by small clusters of pyrite. Larger organic fragments with associated pyrite are common and take various forms. Individual mineral particles range from pyrite cubes less than 0.15 micron on a side to quartz and feldspar grains as large as 0.25 mm. Certain heavy minerals are characteristic of the sediment, and x-ray study shows several types of clay minerals present. Investigations of the radioactivity involve the use of counting, fluorimetric, and autoradiographic techniques. The latter have been particularly fruitful in attempts to discover the nature and occurrence of the uranium in the rock. Quantitative studies of the minerals are being made by a combination of chemical and mineralogical methods. (Auth)

<395>

Hutton, C.O.; Stanford University, School of Mineral Sciences, Stanford, CA

Uranoan Thorite and Thorian Monazite from Blacksand Paystreaks, San Mateo County, California. Geological Society of America Bulletin, 62, 1518. (1951)

Small quantities of uranoan thorite (UO2 = 6.95%) and thorian monazite (ThO2 = 4.22%) have been found in blacksand paystreaks distributed in thin sheets and narrow lenses, repeated many times in depth, on the backshore zone of some San Mateo County, California, beaches. These minerals are usually associated with green, brown, red-brown hornblendes, various orthorhombic and clinopyroxenes, chromian spinel, a range of garnets, and zircon, although diamond, in grains of octahedral habit and fragments with pronounced conchoidal fractures, is a noteworthy constituent of the finest grade size of one sample. Pyrite, monazite, clinozoisite-epidote are locally abundant, whereas xenotime, dufrenite, chrysoberyl, pumpellyite, and cassiterite are rare but of considerable mineralogical interest. The thorite is metamict with n = 1.846 plus or minus 0.002 in most instances, although a range of 1.843-1.851 was observed. Density (at 26 degrees C) = 6.27. Color is very pale green to brown. Heating induces the production of patchy anisotropism, an increase in refractive index (1.847 - 1.878 after being held at 680 degrees C for 2 1 2 hours), a marked transformation in color, but insignificant density changes. Employing the logarithmic formula of Holmes an age of 24.7 x 10(E+6) years has been obtained from the Pb ratio. The associated thorian monazite is found as slightly worn anhedra of pale yellow color; alpha = 1.787, gamma = 1.840. Pure fractions of thorite and monazite have been fractionated from the sands and then analyzed completely. (Auth)

<396>

Bates, T.F., and E.O. Strahl; Pennsylvania State University, Department of Mineralogy, University Park, PA

Regional Study of the Mineralogy and Petrology of the Chattanooga Shale.
Geological Society of America Bulletin, 67, 1669. (1956)

A detailed mineralogic and petrographic investigation of the Gassaway member of the Chattanooga formation covering the area from northern Tennessee to Alabama has established the dependence of the uranium concentration on the composition of this shale. The variation in the areal distribution of uranium is a reflection of the regional variation in the major shale constituents. There is no association between uranium and quartz grain size, orientation of micaceous minerals, or bedding except as these textural features vary in response to change in composition. Bivariate correlation coefficients calculated from the mineralogical and chemical analyses of 136 samples from nine drill cores show the uranium to be directly correlated with carbon, inversely correlated with the silicate minerals, and independent of the pyrite. These simple relationships are complicated by a direct pyrite-carbon correlation. The absence of high correlation coefficients indicates that no one constituent is the source of or host for the uranium, but rather that the element was precipitated from a sea which varied little in uranium concentration throughout Gassaway time. Multiple and partial correlation statistics indicate that, in the Chattanooga sea, the environment conducive to the accumulation and preservation of carbon also led to the precipitation of uranium, the retention of the silicate minerals, and the authigenic growth of pyrite. The very presence of pyrite, however, appears to have inhibited the precipitation of uranium, whereas the silicates acted only as a diluent. (Auth)

<397>

Deul, M.; USGS, Washington, DC

Mode of Occurrence of Uranium in the Chattanooga Shale. Geological Society of America Bulletin, 66, 1549. (1955)

The Chattanooga shale, an abnormally uraniferous marine carbonaceous shale of Late Devonian age, has been studied to determine the relationship of uranium to gross organic and mineral constituents. Mineral-rich, organic-rich, and uranium-rich fractions have been obtained mechanically from a shale sample containing 0.009 percent uranium and 13.7 percent carbon. Separation of shale components after ball-mill grinding in a mixture of water and kerosene for several hundred hours yielded a mineral concentrate containing 0.0035 percent uranium and 4.7 percent carbon, an organic concentrate containing 0.0038 percent uranium and 39.8 percent carbon, and a middlings fraction, consisting of the finest particles, assaying 0.019 percent uranium and 9.1 percent carbon. With increased grinding time more uranium has been liberated from the shale components. The middlings fraction from a sample milled for 1361 hours contained 0.031 percent uranium and 26.7 percent carbon. This fraction, consisting of less than 8 percent of the total material, contained more than 24 percent of the uranium. These experimental data indicate that uranium in the Chattanooga shale exists largely as a colloidal phase dispersed through the organic matrix and that most of the uranium is not now combined with the organic material or with the minerals. The conclusions are confirmed by other experiments where colloidal fractions markedly enriched in uranium were obtained by air elutriation of air-jet pulverized shale and by dialysis of a hydrosol of shale. (Auth)

<398>

Brimhall, W.H., and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

Concentration Changes of Thorium, Uranium and Other Metals in Hydrothermally Altered Conway Granite, New Hampshire. Geochimica et Cosmochimica Acta, 33, 1308-1311. (1969)

Concentrations of Th, U, K, Mg, Ca, Mn, Fe, Zn, Co, and Cu are significantly different in two sections of a 1000 foot core sample of Conway granite. The differences attributable to the action of weak hydrothermal fluids, indicate that the fluids, though weak, caused effective redistribution of these elements. (Auth)

<399>

Ahrens, L.H., R.D. Cherry, and A.J. Erlank; University of Cape Town, Department of Geochemistry, Cape Town, South Africa; University of Cape Town, Department of Physics, Cape Town, South Africa

Observations on the Th-U Relationship in Zircons from Granitic Rocks and from Kimberlites. Geochimica et Cosmochimica Acta, 31, 2379-2387. (1967

Existing data for thorium and uranium in zircons from granitic rocks are discussed, and new data for thorium and uranium in zircons from kimberlites are presented. The new data show that thorium and uranium are at very low levels (from 1.8 to 7.2 ppm for thorium, and from 7.0 to 28.0 ppm for uranium) in kimberlitic zircons, but that the Th:U ratio is just as low (from 0.23 to 0.70) as for granitic zircons. The Th:U ratio in zircons is compared with the ratio in igneous rocks, and possible reasons for the low ratio in zircons are suggested. (Auth)

<400>

Rosholt, J.N., E.N. Harshman, W.R. Shields, and E.L. Garner; USGS, Denver, CO; National Bureau of Standards, Washington, DC

Isotopic Fractionation of Uranium Related to Roll Features in Sandstone, Shirley Basin, Wyoming. Economic Geology, 59(4), 570-585. (1964)

Significant isotope fractionation of uranium has been found in sandstone-type deposits in the Shirley Basin, Wyoming. Uranium deposits occur in unaltered sand adjacent to altered sand and the isotope fractionation appears to have taken place near this contact. Ratios of U 234 U 235 approaching radioactive equilibrium occur in unaltered sand above and below the ore, whereas U 234 deficiencies of 7 to 22 percent are found in ore. U 234 excess of as much as 70 percent is found in the altered sand tongue near the ore. In the mechanism of isotope fractionation, it is considered that U 234 is contributed to the environment in two ways: some of the U 234 atoms are mixed, transported, or precipitated with U 238 and U 235 and subsequent changes in their isotopic ratios caused primarily by radioactive decay of U 234, and the remaining U 234 atoms are generated IN SITU from the radioactive disintegration of precursors, Th 234 and Pa 234, and thus are subject to differential migration with respect to the U 238 from which they were derived. (Auth)

<401>

Adams, J.A.S., and C.E. Weaver; Rice University, Department of Geology, Houston, TX; Shell Oil Company, Technical Services Division, Houston, TX

Thorium-To-Uranium Ratios as Indicators of Sedimentary Processes: Example of Concept of Geochemical Facies. American Association of Petroleum Geologists Bulletin, 42(2), 387-430. (1958)

Because of analytical difficulties, few data are available on the thorium and uranium contents of sedimentary rocks. More than 200 new thorium and uranium determinations have been made by a gamma-ray spectral technique and by an alpha activity-fluorometric uranium technique. Together these two independent techniques can be used as an experimental test of secular radioactive equilibrium. Only rarely in this study have fresh samples of ancient sedimentary rocks been found out of radioactive equilibrium. The accuracy of the thorium-to-uranium ratio determinations is more than sufficient for many geologic studies. The thorium-to-uranium ratios in sedimentary rocks range from less than 0.02 to more than 21. Ratios in many oxidized continental deposits are above 7, whereas most marine deposits have ratios much below 7. Thus, the thorium-to-uranium ratio varies with sedimentary processing and depositional environment. A cyclothem and several other sedimentary sequences illustrate the use of this ratio to distinguish environments and processes. The thorium content of shales varies much less than the uranium content. By mineral and trace-element analysis an attempt has been made to evaluate the resistate, hydrolyzate, clay, and precipitate (evaporite) contributions to the thorium and uranium contents of sedimentary rocks. These data also provide some insight into the details of the mobilization, transportation, and fixation of thorium and uranium in the sedimentary cycle. Field tests indicate that quantitative potassium, uranium, and thorium determinations can be made with a spectral gamma-ray logging instrument. Logs obtained with such instruments may provide an important additional means for subsurface interpretations. (Auth)

<402>

Gott, G.B., and R.L. Erickson; USGS, Washington, DC

Reconnaissance of Uranium and Copper Deposits in Parts of New Mexico, Colorado, Utah, Idaho, and Wyoming.
USGS Circular 219. 16 pp. (1952)

Because of the common association of uranium and copper in several of the commercial uranium deposits in the Colorado Plateau province, a reconnaissance study was made of several known deposits of copper disseminated through sandstone to determine whether they might be a source of uranium. In order to obtain additional information regarding the relationship between copper, uranium, and carbonaceous materials, some of the uraniferous asphaltite deposits in the Shinarump conglomerate along the west flank of the San Rafael Swell were also investigated briefly. During this reconnaissance 18 deposits were examined in New Mexico, 8 in Utah, 2 in Idaho, and 1 each in Wyoming and Colorado. Commercial grade uranium is not associated with the copper deposits that were examined. The uraniferous asphaltites in the Shinarump conglomerate of Triassic age on the west flank of the San Rafael Swell, however, are promising sources of commercial uranium. Spectrographic analyses of crude oil, asphalt, and bituminous shales show a rather consistent suite of trace metals including vanadium, uranium, nickel, copper, cobalt, chromium, lead, zinc, and molybdenum. The similarity of the metal assemblage in the San Rafael Swell asphaltites to the metal assemblage in crude oil and other bituminous materials suggests that these metals were concentrated in the asphaltites from petroleum. However, it is possible that uranium minerals were already present before the hydrocarbons were introduced and that some kind of replacement of uranium minerals by carbon compounds was effected after the petroleum migrated into the uranium deposit. The widespread association of uranium with asphaltic material suggests that it also may have been concentrated by some agency connected with the formation of petroleum. The problem of the association of uranium and other trace metals with hydrocarbons should be further studied both in the field and in the laboratory. (Auth)

<403>

Weeks, A.D., and M.E. Thompson; USGS, Washington, DC

Identification and Occurrence of Uranium and Vanadium Minerals from the Colorado Plateaus. USGS Bulletin 1009-B. (pp. 13-62). (1954)

The report, designed to make available to field geologists and others information obtained in recent investigations by the Geological Survey on identification and occurrence of uranium minerals of the Colorado Plateau, contains descriptions of the physical properties, X-ray data, and in some instances results of chemical and spectrographic analysis of 48 uranium and vanadium minerals. Also included is a list of locations of mines from which the minerals have been identified. (Auth)

<404>

Gindler, J.E.; Argonne National Laboratory, Argonne, IL; National Academy of Sciences - National Research Council, Committee on Nuclear Science, Subcommittee on Radiochemistry, Washington, DC

The Radiochemistry of Uranium. NAS-NS-3050, 350 pp. (1972)

The volume, one of many monographs issued by the Subcommittee on Radiochemistry, deals with the radiochemistry of uranium. A review of the nuclear and chemical features of uranium, particularly uranium compounds, metallic uranium characteristics, the separation of uranium, uranium determination, the chemistry of uranium in solution, and a discussion of sample dissolution problems, is covered. A general review of the radiochemistry of uranium, as well as a table of uranium isotopes, a collection of radiochemical procedures for uranium as found in the literature, and a general summary of inorganic and analytical chemistry of uranium, is also included. (MBW)

<405>

Perricos, D.C., and E.P. Belkas; Nuclear Research Center "Democritos", Chemistry Division, Athens, Greece

Determination of Uranium in Uraniferous Coal. Talanta, 16, 745-748. (1969)

The uranium content of uraniferous coal was determined by neutron-activation analysis. Carrier-free Np 239 was separated quantitatively and selectively by column extraction chromatography with glass powder as support and thenoyltrifluroacetone in xylene as stationary phase. Only one purification step was involved. (Auth)

<406>

Butler, A.P.; USGS, Denver, CO

Ground Water as Related to the Origin and Search for Uranium Deposits in Sandstone. Contributions to Geology, 8(2), 81-86. (1969)

Slightly alkaline bicarbonate sulfate ground water generally similar to the modern ground water is thought to have been the agent that formed the uranium deposits in fluviatile sandstone in Wyoming. Such water has the general characteristics of the aqueous solution which investigations indicate could transport uranium at low temperatures and from which it could be precipitated. Lack of evidence for any conduits in underlying rocks and the absence of igneous rocks near deposits in some areas suggest that deposits were not formed by juvenile thermal water. The large volume of mildly oxidized rock to which the deposits are marginal suggest that oxygen-poor connate water was not the agent that formed the deposits. Modern ground water moves downward from higher to lower elevations in the same general direction as associated surface drainage; the ancient water which formed the deposits undoubtedly moved in a similar way with respect to the paleodrainage. In addition to being the agent for emplacement of the deposits, ground water may be a guide to general areas in which deposits occur, although its utility as a guide to unoxidized deposits below the water table is not clearly established. (Auth)

<407>

Rosholt, J.N., Jr.; USGS, Denver, CO

Uranium Migration and Geochemistry of Uranium Deposits in Sandstone Above, At, and Below the Water Table: Part I - Calculation of Apparent Dates of Uranium Migration in Deposits Above and At the Water Table. Economic Geology, 56(8), 1392-1403. (1961)

The migration of uranium may be studied by the distribution of the radioactive daughter products, which serve as natural tracers in the migration of uranium. The distribution of the daughter products is determined by radiochemical analyses of samples from ore deposits in sandstone, and the apparent minimum and maximum dates of uranium introduction or redistribution may be calculated from the Pa 231/Th 230 ratio. The primary assumption required is that the protactinium and thorium do not migrate in measurable quantities from the place where they were produced by the decay of the parent uranium isotopes. The upper limit of age determination is about 250,000 years, based on the half-lives of Pa 231 and Th 230. The difference in the half-lives of these isotopes is reflected in their differential rates of growth and decay corresponding to migrations of the parent uranium during the time range used to determine the apparent date of uranium migration. Calculations based on analyses of samples from the Hulett Creek area, Wyoming, illustrate the results for typical sandstone ore deposits that are above and at the water table. (Auth)

<408>

Zeller, H.D., and J.M. Schopf; USGS, Washington, DC

Core Drilling for Uranium-Bearing Lignite in Harding and Perkins Counties, South Dakota, and Bowman County, North Dakota. USGS Bulletin 1055-C, (pp. 59-95), 315 pp. (1959)

Twenty core holes having a total footage of 1,907 feet were drilled and from them 94 feet of lignite were taken for analyses for uranium during part of the summers of 1951 and 1952 in northwestern South Dakota and southwestern North Dakota. About 9 million tons of lignite averaging 0.01 percent uranium are estimated to be present in the areas covered by this report. The results of 191 chemical determinations for uranium show that generally the greatest concentrations of uranium are in the upper parts of uranium-bearing lignite beds 3 feet or more in thickness and that the uranium content decreases downward to near the vanishing point in succeeding lower beds. The results of 191 semiquantitative spectrographic analyses of the ash from the lignite cores reveal that molybdenum closely parallels uranium in distribution and concentration and may possibly be significant as an indicator element in prospecting for uranium. (Auth)

<409>

Dar, K.K.; India Department of Atomic Energy, New Delhi, India

On the Possibility of Formation of Sedimentary Uranium Deposits by Groundwater in India. In Mithal, R.S. and Singhal, B.B.S. (Eds.), Proceedings of the Symposium on Groundwater Studies in Arid and Semi-Arid Regions, held in Roorkee, India, October 27-30, 1966. University of Roorkee and Geological Society of India, (pp. 359-370). (1969)

Enrichment of ore by supergene action is well known, but formation of ore concentrations by lateral movement of groundwater has received little attention in India. Some of the world's richest uranium deposits are in sedimentary rocks and their formation is ascribed to lateral transport of uranium by groundwaters which take it in solution in an oxidative environment and from which it is precipitated in a reducing environment in suitable lithological horizons or along sedimentary structures. The influence of geochemical conditions, pH and Eh levels, lithofacies, sedimentary features, paleohydrodynamics, geomorphology and paleoclimate on the formation of uranium deposits by groundwater action is briefly reviewed and applied to the evaluation of favorability factors in the Vindhyan, Gondwana and Tertiary rocks laid down in the main sedimentary basins of peninsular India. Account is taken of the fact that granites, which contain 4 ppm uranium of which about 40 per cent is leachable, can provide enough metal for the formation of large and rich deposits. The writer believes that in many cases surface data by themselves are not a desirable guide in sub-surface exploration of ore, whether primary or secondary, because many potential areas may be discarded on the basis of poor or negative results. He suggests that other techniques need to be employed in such exploration. One of these is the geochemical method which, in addition to the aforesaid investigations, must also take into account trace element distribution, particularly of uranium, in groundwaters, soils, and in the surrounding granitic highlands. It is also suggested that this method is likely to be applicable in exploration for ores of Cu, Pb, Zn, Co, Ni, Mo, etc., which may have been formed under similar conditions and are concealed beneath superincumbent strata. (Auth)

<410>

Weeks, A.D., and D.H. Eargle; USGS, Washington, DC; USGS, Austin, TX

Relation of Diagenetic Alteration and Soil-Forming Processes to the Uranium Deposits of the Southeast Texas Coastal Plain. In Ingerson, E. (Ed.). Clays and Clay Minerals. MacMillan Company, New

York. (pp. 23-41). (1963)

The Upper Eocene Jackson Group is the chief host rock of the uranium deposits in the Karnes area of the southeast Texas Coastal Plain. It is highly tuffaceous and the uranium deposits are within approximately 100 feet of the unconformity with the overlying Catahoula Tuff (Miocene). Glass shards, fragments of sanidine and plagioclase, grains of fine-grained volcanic rocks, and biotite and other minerals in these sediments were highly reactive chemically, causing complex diagenetic alteration and the development of alkaline carbonate pore water. Extensive caliche development and silica induration associated with a recent hotter, drier climate favored the concentration of uranium. The origin of these shallow uranium deposits is believed to have been controlled by the complex diagenesis of the highly reactive volcanic detritus, by development of a "built-in" solvent for uranium (the alkaline carbonate pore water), and by climatic, structural, and permeability conditions that allowed concentration and deposition of uranium rather than dilution and dispersal. The tuffaceous rocks are considered to have been the source of the uranium and associated molybdenum, phosphorus, and arsenic. (Auth)

<411>

Rosholt, J.N., Jr.; USGS, Washington, DC

Natural Radioactive Disequilibrium of the Uranium Series. USGS Bulletin 1084-A, (pp. 1-30). (1959)

Many radioactive samples show radioactive disequilibrium because of the numerous geochemical processes affecting ore deposits. As it is difficlt to interpret disequilibria by simply comparing radiometric and chemical assay values of uranium, analyses should be made of Pa 231, Th 230, Ra 226, Rn 222, and Pb 210. Uranium-series disequilibria, as shown by radiochemical studies of samples representing a cross section of most of the significant present-day radioactive deposits in the United States, can be classified according to six basic types. Interpretations of the geochemical history of these types indicate that it may be possible to date uranium deposition within a theoretical range of 2,000 to 200,000 years. Ages ranging between 6,000 and 30,000 years have been calculated for several specific samples. (Auth)

<412>

Frondel, C.; USGS, Washington, DC

Systematic Mineralogy of Uranium and Thorium. USGS Bulletin 1064, 400 pp. (1958)

Uranium and thorium minerals, together with a few rare-earth minerals containing uranium and thorium as nonessential constituents, are systematically and comprehensively described in the volume. The classification of the minerals included here is chemical. It is based on the nature of the anion, giving rise to the following broad categories: oxides, carbonates, sulfates, molybdates, phosphates and arsenates, vanadates, silicates, and the niobate-tantalate-titanates or, more properly, multiple oxides. The phosphates and arsenates are described together because in general they are isostructural and form partial or complete solid-solution series. Within each category, minerals of analogous chemical composition and crystal structure are grouped together, such as the torbernite group of minerals within the phosphates in general. No formal distinction is made in the classification between anhydrous species and those containing water or hydroxyl. Almost all of the minerals described are hydrated. Each mineral species is described according to its synonymy, composition, crystallography and crystal habit, physical properties, optical properties, synthesis, identification, natural formation, and occurrence. The descriptive mineralogy is followed by determinative tables in which the mineral species are arranged according to their X-ray diffraction interplanar spacings, chemical composition, optical properties, color, specific gravity, and fluorescence. (Auth)(MBW)

<413>

Breger, I.A., M. Deul, and S. Rubinstein; USGS, Washington, DC

Geochemistry and Mineralogy of a Uraniferous Lignite. Economic Geology, 50(2), 206-226. (1955, March)

Detailed studies have been carried out on a uraniferous lignite from the Mendenhall strip mine, Harding County, South Dakota. By means of heavy-liquid separations, a mineral-free concentrate of the lignite was obtained that contained 13.8 percent ash and 0.31 percent uranium in the ash. The minerals (gypsum-69 percent, jarosite-10 percent, quartz-2 percent, kaolinite and clay minerals-19 percent, and calcite-trace) contain only 7 percent of the uranium in the original coal, indicating an association of the uranium with the organic components of the lignite. Batch extractions show that 88.5 percent of the uranium can be extracted from the lignite by two consecutive treatments with boiling 1 N hydrochloric acid. Continuous extraction with hot 6 N hydrochloric acid removes 98.6 percent of the uranium. Columns of coal were treated with water, 1 N hydrochloric acid, 6 N hydrochloric acid, and a solution of lanthanum nitrate. The experiment with lanthanum nitrate indicated that only 1.2 percent of the uranium in the coal is held by ion exchange. The elutriation experiments showed that the uranium is held in the coal as an organo-uranium compound or complex that is soluble at a pH of less than 2.18. A geochemical mechanism by which the uranium may have been introduced into and retained by the lignite is discussed. (Auth)

<414>

Breger, I.A., and J.C. Chandler; USGS, Washington, DC

Extractability of Humic Acid from Coalified Logs as a Guide to Temperatures in Colorado Plateau Sediments. Economic Geology, 55(5), 1039-1047. (1960, August)

Coalified logs in Triassic and Jurassic sediments of the Colorado Plateau have been exposed to alkaline ground water. Extraction of humic acids under such conditions is temperature dependent. Study of residual humic acids in a suite of coalified logs has indicated that temperatures up to but not over 120 degrees C prevailed in the sediments. This maximum temperature corresponds with that to be expected from geothermal gradient and estimated from mineralogic evidence. (Auth)

<415>

Dooley, J.R., Jr., M. Tatsumoto, and J.N. Rosholt; USGS, Denver, CO

Radioactive Disequilibrium Studies of Roll Features, Shirley Basin, Wyoming. Economic Geology, 59(4), 586-595. (1964, June)

Radiochemical analyses of Th 230 and Pa 231 using an alpha spectrometer were made on three suites of samples from roll features in the Shirley Basin, Wyoming. These isotopic abundances are compared with those of the parent U 234 and U 235 isotopes previously determined with a mass spectrometer. Unaltered sand above and below uranium ore has a low Th 230/Pa 231 ratio compared to a U 234/U 235 ratio which is near the normal reference ratio. Altered sand has a higher Th 230/Pa 231 ratio than ore samples or unaltered sand. Uranium ore contains both Th 230 and Pa 231 in excess of the amount required for equilibrium with U 234 and U 235. The excess Th 230 and Pa 231 in ore indicates the presence, in the water-saturated sandstone, of pore water containing anomalously large amounts of uranium in solution. (Auth)

<416>

Rogers, J.J.W., and T.W. Donnelly; Rice University, Department of Geology, Houston, TX

Radiometric Evidence for the Origin of Eugeosynclinal Materials. Tulane Studies in Geology, 4, 133-138. (1966)

Thorium and uranium contents of eugeosynclinal graywackes and associated volcanic rocks are similar and are in the range of 1-2 ppm thorium and 0.5-1 ppm uranium. These values are much lower than average concentrations in the continental crust and apparently indicate derivation of orogenic material directly from the upper mantle without contribution from the craton. (Auth)

<417>

Spears, D.A.; University of Sheffield, Department of Geology, Yorkshire, England, United Kingdom

The Distribution of Alpha Radioactivity in a Specimen of Shap Granite. Geological

Magazine, 48, 483-487. (1961)

The distribution of alpha radioactivity in thin sections of Shap granite is discussed and more than 95 per cent of the activity is shown to be concentrated in the accessory minerals. The results of this study are compared with those obtained for the Adamello granodiorite using similar techniques. (Auth)

<418>

Scott, R.H., A. Strasheim, and M.L. Kokot; National Physical Research Laboratory, Pretoria, South Africa; Transterra Mining Limited, Johannesburg, South Africa

The Determination of Uranium in Rocks by *Inductively Coupled Plasma-Optical Emission Spectrometry*. Analytica Chimica Acta, 82, 67-77. (1976)

A method for the determination of uranium in rock samples by emission spectrometry is presented. The rock is dissolved and the uranium content determined by nebulizing the solution into an inductively coupled-plasma optical excitation source. Various spectral lines were investigated. The uranium emission at 378.28 nm was chosen because of its relative freedom from matrix element spectral interferences. For this emission, a practical detection limit of 0.1 p.p.m. in solution was achieved by optimizing source parameters (power, flow-rate, observation height). Results are compared with those obtained by a number of other techniques. (Auth)

<419>

Adams, J.A.S.; Rice University, Department of Geology, Houston, TX

The Uranium Geochemistry of Lassen Volcanic National Park, California. Geochimica et Cosmochimica Acta, 8, 74-85. (1955, July)

The uranium contents and relative alpha-particle activities have been determined on thirty-nine samples from Lassen Volcanic National Park. Sodium and potassium were also determined on nineteen of the samples. Secular radioactive equilibrium to within sampling and analytical error was found between the uranium values and the radium values of other workers. The K2O U ratio was found to be constant over a fourfold variation in uranium. The relative alpha-particle activity to uranium ratio was also found to be constant in the main Lassen sequence. There is some evidence that zircon crystals contain a proportion of the uranium in the Lassen volcanic rocks. (Auth)

<420>

Whitfield, J.M., J.J.W. Rogers, and J.A.S. Adams; Rice University, Department of Geology, Houston, TX

***The Relationship Between the Petrology* and the Thorium and Uranium Contents of Some Granitic Rocks.** Geochimica et Cosmochimica, 17, 249-271. (1959)

Thorium and uranium contents of granitic rocks are intimately related to model compositions and general petrologic features. Correlations are quite distinct between thorium content and common indices of general petrogenetic evolution, such as amount of dark minerals, percentage of anorthite in plagioclase, and ratio of potassium fledspar to plagioclase. Thorium content increases regularly toward the more acidic rocks, and the increase is most pronounced in the most highly alkalic samples. Uranium content generally shows little, if any, relationship to modal composition or other petrologic features, and the increase in abundance of uranium toward the more acidic rocks is irregular. The greater petrogenetic control of thorium than of uranium content may be explained on the basis of oxidation and repeated loss of uranium from magmas during the later stages of their differentiation. Such an explanation assumes that magmas are originally derived from a relatively homogeneous source; remobilization, however, of different types of sedimentary or other rocks might provide granitic magmas of widely different initial thorium and uranium contents. The possibility that thorium is added hydrothermally to granites is partly supported by unusually high abundance of thorium in some red, porphyritic, allanite-bearing rocks, but the general petrologic control of thorium abundances argues against major secondary addition of material. (Auth)

<421>

Heier, K.S., and J.J.W. Rogers; Rice University, Department of Geology, Houston, TX

Radiometri: Determination of Thorium, Uranium, and Potassium in Basalts and in Two Magmatic Differentiation Series. Geochimica et Cosmochimica Acta, 27(2), 137-154. (1963)

Thorium, uranium and potassium contents of basalts and other basic rocks have been measured by gamma-ray spectrometry. The ratios of Th K, U K and Th U are constant within one order of magnitude in a wide variety of rock types. The averages for basalts are: Th K x 10(E+4) = 2.8, U K x 10(E+4) = 0.60 and Th U = 4.8. Some tendency exists, however, for increase in these ratios with igneous differentiation, as shown by investigations of the Duluth and Southern California intrusive sequences. The Th U ratios are particularly low in tholeiites (1.6) from the orogenically active Japanese area and is also lower in the basic rocks of the Duluth and Southern California sequences than in most basalts. Apparently the process which leads to the formation of magma in orogenic areas causes removal of thorium, potassium and to a lesser extent, uranium from source materials before intrusion or eruption. Close relationship between potassium content and Th U ratio in basic rocks from widely separated, areas, however, suggests that the subcrust in which basic magmas originate is compositionally uniform and differences between the compositions of primary basalt magmas are probably the result of local processes. (Auth)

<422>

Rosholt, J.N., C. Emiliani, J. Geiss, F.F. Koczy, and P.J. Wangersky; University of Miami, Marine Laboratory, Miami, FL

Absolute Dating of Deep-Sea Cores by the Pa 231/Th 230 Method. Journal of Geology, 69, 162-185. (1961)

Oxygen isotopic analysis of Globigerina-ooze cores from the Atlantic and adjacent seas showed that surface ocean temperatures underwent numerous, apparently periodical, variations during the past few hundred thousand years. C 14 dating showed that the last temperature minimum of the deep-sea cores was synchronous with the last major glaciation, the Main Wurm. Pa 231 Th 230 dating of two deep-sea cores from the Caribbean, about 600 km apart, has given a set of dates which are internally consistent; identical, within the limits of error, in stratigraphically equivalent levels of the two cores; and coincident with the C 14 chronology. This set of dates is believed to provide a reliable, absolute time scale, extending from the present to about 175,000 years ago. Pa 231 Th 230 and C 14 measurements on deep-sea cores, and correlation of the temperature record of the deep-sea cores with continental events provide the following ages for Pleistocene stages. postglacial, 0-10,000 years; Late and Main Wurm, 10,000-30,000 years; Main Wurm-Early Wurm interval, 30,000-50,000 years; Early Wurm, 50,000-65,000 years; Riss Wurm interglacial, 65,000-100,000 years; Riss, 100,000-130,000 years; and Mindel Riss interglacial, 130,000-175,000 years. These ages are very close to or identical with the ages given by Emiliani. Correlation between temperature variations of the deep-sea cores and continental stages preceding the last interglacial, however, is only tentative. The apparent identity of the C 14 and Pa 231 Th 230 chronologies over the entire range of the C 14 method indicates that the cosmic-ray flux did not change by more than a factor of 2 during the past 60,000 years. Pa 231 Th 230 dating of a deep-sea core from the North Atlantic gave ages which are consistently about 30,000 years greater than the Pa 231 Th 230 ages obtained from the two Caribbean cores and the C 14 chronology. This is believed to result from contamination by reworked clay, an effect which may actually exist in most deep-sea cores. Rates of sedimentation of the carbonate fraction larger than 62 micron, the carbonate fraction smaller than 62 micron, and the non-carbonate fraction, calculated for the intervals between selected dated levels, appear not to have changed markedly when averaged over time intervals of some tens of thousands of years. The rates of sedimentation during the last 11,000 years, however, were lower than during previous time intervals. A generalized temperature curve, calibrated in terms of the C 14-Pa 231 Th 230 chronology, is presented. (Auth)(PAG)

<423>

Lindsey, D.A.; USGS, Lakewood, CO

A Reconnaissance Survey of Mineralogy and Trace Element Content of Some

Upper Tertiary and Quaternary Waterlaid Tuffs and Tuffaceous Sediments in the Basin-and-Range Province, Western United States. PB-236 067, 33 pp. (1974)

The report summarizes the results of mineralogical and trace element studies of tuffaceous rocks at 13 localities in the Basin and Range province of the western United States, with emphasis on Tertiary age mineralized tuff. These tuffaceous rocks show potential for uranium and other metals in the Miocene and Pliocene Siebert Tuff at Tonopah, Nevada, for lithium in the Miocene and Pliocene Muddy Creek Formation of southern Nevada and in Miocene lakebeds of the Opalite mercury district of Oregon, and for beryllium in the unnamed tuff in Hamblin Valley, Utah. In addition, tuffaceous rocks of the Mojave Desert region possess potential for a wide variety of mineral deposits. The existence of extensive trace element anomalies in tuff adjacent to the Spor Mountain beryllium-fluorspar district suggests that geochemical studies should be a good method for evaluating other tuffaceous rocks for mineral potential. (Auth)

<424>

Doe, B.R.; USGS, Isotope Geology Branch, Washington, DC

Distribution and Composition of Sulfide Minerals at Balmat, New York. Geological Society of America Bulletin, 73, 833-854. (1962, July)

In the Balmat area in northern New York, tabular deposits of sulfide minerals parallel the layering in folded, siliceous magnesian marbles of a metamorphic complex commonly referred to as the Precambrian Grenville Series. Sphalerite, pyrite, and, locally, pyrrhotite and galena have replaced the carbonate minerals in parts of the marble units. The contacts between ore and marble are, in general, ill-defined; scattered grains of sulfides are present from several inches to hundreds of feet from the massive portions of ore. Cobalt and nickel concentrations in pyrite from grains disseminated in the metasedimentary rocks away from the ore bodies are each greater than 200 ppm. Most samples of pyritic from the ore bodies contain less than 50 ppm each of cobalt and nickel. It is believed unlikely that the pyrite of the ores is genetically related to the pyrite in the metasedimentary rocks. Textural relationships suggest that pyrrhotite formed after most of the sphalerite, which in turn formed after most of the pyrite in the ore bodies. By use of the experimentally determined systems FeS-ZnS and FeS-FeS2, it is inferred from the amounts of iron in sphalerite and sulfur in pyrrhotite that the bulk of the sulfide minerals formed above 320 degrees C. The absolute temperature of formation of pyrrhotite indicated by the FeS-ZnS system is about 150 degrees higher than that indicated by the FeS-FeS2 system. The former system probably gives the more reliable estimate. The concentrations of individual minor elements, including minor concentrations of uranium minerals in sphalerite and pyrite range considerably among specimens of the same sulfide mineral from the same level and ore body. The ratio of the concentrations of minor elements between sphalerite-pyrite pairs varies considerably also. This variation probably indicates that exchange of minor elements between pyrite and sphalerite during the formation of the ores was very slow and incomplete. (Auth)(PAG)

<425>

Dyck, W., and A.Y. Smith; Canada Geological Survey, Department of Energy, Mines and Resources, Ottawa, Ontario, Canada

Use of Radon 222 in Surface Waters for Uranium Geochemical Prospecting. Canadian Mining Journal, 89(4), 100-103. (1968, April)

Radon 222, the sixth disintegration product in the uranium 238 series, being a gas and electrically neutral, is mobile and able to enter the water phase. The concentration of radon in the water is a measure of the concentration of uranium decay products in the sediments and thus a strong indicator of uranium in the surrounding area. Radon 222 concentrations in 59 surface water samples of lakes and streams in the Bancroft, Ontario area were compared with 78 samples from the Hull, Quebec area. High radon content was noted in the samples from the Bancroft area and the Gatineau hills near Hull, Quebec where uranium minerals are known to occur. (PAG)

<426>

Phair, G., and H. Levine; USGS, Washington, DC

Notes on the Differential Leaching of Uranium, Radium, and Lead from Pitchblende in H2SO4 Solutions.
Economic Geology, 48(5), 358-369. (1953, August)

Two 5-pound samples from the "hot spot" of the pyritic dump of the Wood mine, a past producer of pitchblende near Central City, Colorado, showed Ra U ratios that were abnormally high but nearly constant at about 150 times the equilibrium value for both samples in spite of a sevenfold difference in uranium contents. Analyses of oxidized but still black pitchblende from Katanga, in the Belgian Congo, before and after leaching in very dilute, dilute, and concentrated sulfuric acid solutions showed that: (1) UO2 is preferentially leached with respect to UO2, Ra, and Pb in all three solutions, (2) the resulting residual concentration of both radium and lead effected in the process is proportional to the total amount of uranium leached except in concentrated H2SO4, and (3) after a sample has been leached in concentrated H2SO4 the resulting increase in radium content relative to lead is much lower, as might be expected. Under similar leaching conditions, unaltered pitchblende from Great Bear Lake, in Northwest Territory, Canada, lost only 1 10 to 1 15 as much uranium as the UO2-rich Katanga ore. Both laboratory and field results point to the same conclusion; in an oxidizing, highly acid environment uranium is rapidly leached and both radium and lead tend to be fixed about proportionally in the process. These results help to explain (1) why UO2-rich uranium minerals tend to give maximal Pb U ages and (2) why the search for high-grade uranium ore in and around abandoned sulfide mines known to have produced pitchblende in the past has been consistently disappointing. (Auth)

<427>

Faul, H. (Ed.); USGS, Denver, CO

Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. **John Wiley and Sons, New York, 414 pp.** (1954)

The symposium on nuclear phenomena in the earth sciences is a text covering the field between geology and nuclear physics. The first chapter is an introduction to nuclear physics followed by an outline of some techniques used in the study of radioactivity and isotopes. The next three chapters discuss the natural occurrence of radioactive elements. The thermal, physical, and chemical effects of radioactivity and nuclear methods of geophysical exploration and well logging are considered, and techniques and results of absolute age determinations are discussed in detail. The last chapter discusses the origin of the Earth. (Auth)

<428>

Larsen, E.S., Jr., G. Phair, J.A.S. Adams, K.G. Bell, H. Pettersson, and F.F. Koczy; USGS, Washington, DC; University of Wisconsin, Department of Chemistry, Madison, WI; Oceanografiska Institutet, Goteborg, Sweden

Uranium and Thorium. In Faul, H. (Ed.), Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York, (pp. 75-127), 414 pp. (1954)

The chapter discusses the problems of sampling, interpretation and analysis of uranium and thorium in igneous rocks, volcanic rocks, and sedimentary rocks. Included are sections on radioactive elements, specifically radium, in ocean waters and sediments and detection techniques. (PAG)

<429>

Larsen, E.S., Jr., and G. Phair; USGS, Washington, DC

The Distribution of Uranium and Thorium in Igenous Rocks. In Faul, H. (Ed.), Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York, (pp. 75-89), 414 pp. (1954)

The chapter describes the present state of sampling, analysis and interpretation of uranium and thorium in igneous rocks. Work has pointed up the variability of the different igneous rock groups. Most of the fresh igneous rocks have uranium contents lower than 7 ppm, some radioactive samples contain as much as 200 ppm uranium and 500 ppm thorium. High contents of uranium and thorium can be correlated with other compositional peculiarities. (PAG)

<430>

Bell, K.G.; USGS, Washington, DC

Uranium and Thorium in Sedimentary Rocks. In Faul, H. (Ed.). Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York. (pp. 98-114). 414 pp. (1954)

Uranium occurs in igneous rocks, in part as discrete uranium minerals, and to a greater extent in minerals in isomorphous substitution for elements such as calcium and the rare earths. Some uranium exists in extremely thin intergranular films formed by solidification of the last residual traces of magmatic fluid, or by supergene enrichment. Most of the thorium contained in the earth is believed to be present in the upper lithosphere and preferentially concentrated in acidic rocks. It occurs in igneous rocks in part as discrete thorium minerals and in part in isomorphous substitution for calcium, the rare earths, and possibly other elements. The chapter summarizes the vast literature on uranium and thorium in sedimentary rocks and discusses the sediments where uranium accumulates. (PAG)

<431>

Pettersson, H.; Oceanografiska Institutet, Goteborg, Sweden

Radioactive Elements in Ocean Waters and Sediments. In Faul, H. (Ed.). Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York. (pp. 115-119). 414 pp. (1954)

Of the radioactive elements present in ocean waters and recent marine sediments, radium alone has been accessible to direct measurements since the early years of the present century. The uranium content in sea water could be measured only after the development of the fluorescence method in the early thirties, and it is now fairly well known. The relative scarcity of radium in sea water and the excess of the same element in the surface layers of deep sea deposits led to the assumption that the intervening element, thorium 230 precipitates on to the sea bottom, especially at great depths and there gives rise to thorium 230-supported radium. (Auth)

<432>

Johnson, D.H., H. Faul, and C.W. Tittle; USGS, Denver, CO

Geophysical Exploration by Nuclear Methods. In Faul, H. (Ed.). Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York. (pp. 219-255). 414 pp. (1954)

The chapter reviews the various techniques and problems in the application of Geiger-Muller and scintillation counters to geophysical prospecting, the use of gamma-ray and neutron logs by the petroleum industry, and the nuclear logging of drill holes for mineral exploration and soil studies. (PAG)

<433>

Johnson, D.H.; USGS, Denver, CO

Radiometric Prospecting and Assaying. In Faul, H. (Ed.), Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York. (pp. 219-241). 414 pp. (1954)

Calibration and standardization of the Geiger-Muller and scintillation counters utilized for geophysical prospecting and the geometrical interferences of (1) solid-angle effects; (2) absorption by rocks; (3) absorption by air; (4) radioactive elements; and (5) contamination are discussed. The counters are utilized in radiometric assaying, geologic mapping, and in exploration for new sources of petroleum. (PAG)

<434>

Faul, H.; USGS, Denver, CO

Nuclear Logging of Drill Holes for

Mineral Exploration and Soil Studies. In Faul, H. (Ed.). Nuclear Geology: A Symposium on Nuclear Phenomena in the Earth Sciences. John Wiley and Sons, New York, (pp. 250-255), 414 pp. (1954)

The scintillation logging apparatus, with its increased sensitivity, offers particular promise for geologic logging of exploratory drill holes where radioactive ore is not expected. Contacts, fissures, and general rock types can be identified from the gamma-ray log, in a manner analogous to the procedure in petroleum exploration. The limitations encountered in neutron logging apply here as well, except that the measurements can be carried out with greater accuracy, owing to the absence of interfering factors such as well fluid and casing. The nuclear methods of soil-density and moisture-content determination are more accurate and much simpler than previously used standard sampling techniques. (Auth)(PAG)

<435>

Erickson, R.L., A.T. Myers, and C.A. Horr; USGS, Denver, CO

Association of Uranium and Other Metals with Crude Oil, Asphalt, and Petroliferous Rock. American Association of Petroleum Geologists Bulletin, 38(10), 2200-2218, (1954)

Some crude oil, natural asphalt, and petroliferous rock are appreciable radioactive, but little is known about the actual uranium content and the chemical nature of the uranium compound or compounds in these materials. Semiquantitative spectrographic analyses of the ash of 29 samples of crude oil, 22 samples of natural asphalt, and 27 samples of oil extracted from petroliferous rock indicate that metals such as vanadium, nickel, copper, cobalt, molybdenum, lead, chromium, manganese, and arsenic are consistently present - at some places in exceptionally high concentrations - in this type of organic matter. The chemical analyses show that the uranium content of crude oil is consistently much lower than the uranium content of the natural asphalt and oil extracted from petroliferous rock. The association of uranium with organic materials may have a direct bearing on the genesis of some types of uranium deposits. Many uranium deposits, such as those in the San Rafael Swell, Emery County, Circle Cliffs, Garfield County, and Capitol Reef, Wayne County, Utah, occur on the flanks of breached anticlinal structures that have served as traps for the accumulation of petroleum during geologic time. (Auth)

<436>

Lovering, T.G.; USGS, Denver, CO

Progress in Radioactive Iron Oxides Investigations. Economic Geology, 50(2), 186-195, (1955)

Many uranium and thorium deposits in the western United States are closely associated with zones of secondary radioactive iron minerals. As a result of a study of these radioactive "limonites", it was concluded that uranium minerals in an oxidizing sulfide environment go into solution in acid sulfate waters as uranyl sulfate in the presence of ferric sulfate. When these acid waters are neutralized, ferric sulfate hydrolyzes to form colloidal ferric oxide hydrate. This absorbs the uranyl ion and thus removes most of the uranium from solution. As the colloidal ferric oxide hydrate ages, it crystallizes to form goethite and in this process most of the uranium is expelled to form particles of secondary uranium minerals in the resulting limonite. Most thorium minerals are resistant to weathering and remain in their original form in thorian limonites. (Auth)

<437>

Lovering, T.S., H.W. Lakin, F.N. Ward, and F.C. Canney; USGS, Washington, DC

The Use of Geochemical Techniques and Methods in Prospecting for Uranium. In USGS Professional Paper 300, (pp. 659-665), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 782-787), 825 pp. (1956)

The art of successfully applying the fundamental principles of geochemical dispersion of the elements to the practical problem of finding hidden ore bodies depends on establishing diagnostic patterns of dispersed metals in the vicinity of ore deposits.

The techniques of using variation in trace amounts of metals to delineate such patterns or anomalies is being used in the search for uranium and thorium. The anomalies most commonly investigated in geochemical prospecting are those formed at the earth's surface by agents of weathering, erosion, or surficial transportation. Analysis of soil derived from the direct weathering of rock in place gives the most reliable and consistent indication of ore lying immediately beneath the soil. Attention also is being given to primary anomalies found in bedrock, and several studies have indicated the presence of dispersion halos adjoining and overlying some blind ore bodies - dispersions that are apparently related to the ore depositing process. Owing to the varying mobilities of different elements, some of these diagnostic halos, both primary and secondary, extend over a large area and form broad targets which are useful in general reconnaissance; others, which are restricted to the vicinity of the ore body itself, are more useful for detailed studies. (Auth)

<438>

Huff, L.C.; USGS, Washington, DC

Preliminary Geochemical Studies in the Capitol Reef Area, Wayne County, Utah. USGS Bulletin 1015-H, (pp. 247-256). (1955)

A bleached zone at the base of the Chinle formation near the Oyler mine, Wayne County, Utah, was studied to establish whether there was a chemical relationship between bleaching in the Chinle and uranium mineralization in the Shinarump conglomerate. The preliminary results suggest that the bleaching was accompanied by a slightly reducing acid solution which deposited zinc and copper but no uranium in the bleached zone. A field test for heavy metals which has been devised for geochemical prospecting appears to be satisfactory for detecting and tracing such mineralization effects. It is hypothesized that the solution which bleached the Chinle also deposited uranium in the Shinarump, but more work is needed to clarify this relationship. (Auth)

<439>

Joubin, F.R.; Not given

Widespread Occurrence and Character of Uraninite in the Triassic and Jurassic Sediments of the Colorado Plateau - A Discussion. Economic Geology, 50(2), 233-234. (1955)

The paper is a short comment on the paper of the same name by Rosenzweig, Gruner, and Gardiner (1954). It is sugested that the agent active in the precipitation of uranium is not elemental carbon but rather the hydrocarbon fraction (resin) once present. (Auth)

<440>

Rankama, K., and T.G. Sahama; Not given

Geochemistry. In Geochemistry. University of Chicago Press, Chicago, (pp. 632-639), 912 pp. (1950)

The geochemistry of uranium is discussed. Uranium is a member of the actinide series of rare-earth elements and has a large ionic radius. The most important uranium mineral is the oxide, UO_2, found as uraninite and pitchblende. Other uranium minerals include hydroxides, phosphates, arsenates, vanadates, uranates, carbonates, silicates, and sulfates; these minerals are usually derived from the alteration or decomposition of uraninite and pitchblende. Uranium never occurs in the natural state and never forms sulfides, arsenides, or tellurides. During the crystallization of a magma, uranium does not enter the crystal lattice of the rock-forming minerals due to its large ionic radius, and it is therefore enriched in residual solutions. It may crystallize in pegmatites or it may enter pneumatolytic and hydrothermal veins. Uranium is also concentrated, notably in the presence of vanadium, in minerals precipitated from ground waters; such uranium deposits are sometimes found in sandstones. The cycle of uranium and the biogeochemistry of uranium are discussed. Uranium is absorbed by biological substances. Some petroleum and associated brines contain uranium, and marine carbonaceous shales are definitely higher in uranium than other sedimentary rocks. Some coals have a high uranium content. The largest and most important uranium deposits are in the vicinity of Great Bear Lake in Canada, in Katanga in the Belgian Congo in West Africa, and in Czechoslovakia. They are all associated with hydrothermal veins. Important deposits also occur in continental sandstones in the western United States. (Auth)

<441>

Notestein, F.B.; Not given

Some Chemical Experiments Bearing on the Origin of Certain Uranium-Vanadium Ores. Economic Geology, 13(1), 50-64. (1918)

The carnotite deposits of the Colorado Plateau occur as small lenticular bodies of mineralized light-colored sandstone within hard, ledge-forming, cross-bedded sandstones of the McElmo formation (Morrison formation) of Jurassic age. The deposits generally conform to the bedding. Nearly all of the ore-bearing beds are rich in fossil carbonaceous material, and most also contain calcite and gypsum. Three hypotheses of origin have been advocated; they are summarized as follows: 1. Widely disseminated uranium and vanadium minerals have been dissolved from overlying rocks and transported by ground water; the metals were reprecipitated at the position where now found through some agency such as calcite or organic material or through oxidation near outcrops. Recency is implied. 2. The minerals carrying vanadium and uranium were concentrated by ordinary processes of sedimentation at or near the present position, and the carnotite is an oxidation product of such minerals. 3. The uranium and vanadium were precipitated from sea water by the reducing action of decaying vegetable matter; carnotite is an oxidation product, nearly in place, of such precipitated salts. The author suggests that descending sulfate waters dissolved disseminated uranium and vanadium minerals and carried the metals down in solution. The metals precipitated when a calcitic bed was reached, and gypsum and carbon dioxide formed. The carbon dioxide in solution would form calcium bicarbonate which would redissolve the uranium and part of the vanadium, and the dissolved salts would be transported to and deposited at an outcrop or some other place where carbon dioxide could escape. (Auth)(MBW)

<442>

Stieff, L.R., and T.W. Stern; USGS, Washington, DC

Identification and Lead-Uranium Ages of Massive Uraninites from the Shinarump Conglomerate, Utah. Science, 115(3000), 706-708. (1952)

Age determinations were made on massive uraninites from the Happy Jack Mine, White Canyon, San Juan County, Utah, and the Shinarump No. 1 claim, Seven Mile Canyon, Grand County, Utah, both in the Shinarump conglomerate of Triassic age. The ages, as determined from the Pb 206/U 238 and the Pb 207/U 235 ratios, range from 65 to 75 million years. If the ages calculated are close to the true ages of these ores, then these minerals were probably formed in Late Mesozoic or Early Tertiary time. This interpretation differs from an earlier conclusion that the ore bodies were formed during or soon after deposition of the host rocks in Late Triassic time. (Auth)

<443>

Stieff, L.R., and T.W. Stern; USGS, Washington, DC

Interpretation of the Discordant Age Sequence of Uranium Ores. In USGS Professional Paper 300, (pp. 549-555), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 540-546), 825 pp. (1956)

Several recent reports on the calculated ages of uranium ores have consistently shown the following discordant age sequence: The Pb 206/U 238 age is less than the Pb 207/U 235 which is much less than the Pb 207/Pb 206. Five hypotheses have been proposed to explain these discrepancies: the loss of radon, loss of lead or uranium, presence of original radiogenetic lead, and reworking of uranium deposits or multiple periods of deposition or both. The choice of one of these hypotheses will determine which of the three ages is believed to approximate most nearly the "true age" of the ore. None of these five hypotheses has been satisfactorily established by detailed mineralogic or isotopic studies nor have the chosen ages been confirmed by stratigraphic or paleontologic evidence. Agreement between the calculated Pb

206/Pb 210 and Pb 206/U 238 ages of uranium ores with much higher calculated Pb 207/Pb 206 ages strongly suggests that radon loss is not the major reason for the discrepancies. Loss of lead can not account for Pb 207/Pb 206 ages being appreciably more than stratigraphers' "best" estimates of the age of the uranium ores or the enclosing rocks. Some investigators believe that the presence of original radiogenic lead does not account for the observed differences in the radiogenic lead content of the galena within uraninite specimens and free galena, both from the same deposits. One of the most important problems at the present time in determining the age of uranium ores is to recognize the geologic process or processes that result in the Pb 206/U 238 is less than Pb 207/U 235 is much less than Pb 207/Pb 206 age sequence. Until this problem has been clarified, caution should be used in assuming the cause of the discrepancy and in selecting one age from the sequence when the necessary geologic, mineralogic, and analytical data are not available. (Auth)

PROSPECTING

<444>

Dennison, J.M.; University of North Carolina, Department of Geology, Chapel Hill, NC

Possibilities for Uranium, Vanadium, Copper, and Silver in the Pennsylvanian System in West Virginia. Proceedings of the West Virginia Academy of Science, 45, 294-296. (1973)

Most United States commercial deposits of uranium are associated with feldspathic fluvial sandstones as a result of geochemical cell concentration from groundwater circulation. Sedimentary and stratigraphic criteria are presented which lead to the conclusion that the Pottsville Group, Allegheny Formation, and Conemaugh and Monongahela Groups in West Virginia have moderate potential for uranium. The Dunkard Group is highly favorable for uranium prospecting. Geochemical cells can concentrate other elements besides uranium, including vanadium, copper, and silver. Geochemical sampling should be done for these elements, especially associated with the red shales and siltstones of the Dunkard, Monongahela, and Conemaugh Groups and Allegheny Formation. (Auth)

<445>

Wogman, N.A., R.L. Brodzinski, and L. Van Middlesworth; Battelle, Pacific Northwest Laboratories, Richland, WA; University of Tennessee, Department of Physiology and Biophysics, Memphis, TN

Radium Accumulation in Animal Thyroid Glands-A Possible Method for Uranium and Thorium Prospecting. BNWL-SA-5560, 14 pp. (1976)

A method of prospecting for uranium and thorium is proposed based on uptake of their radioactive daughters, Ra 226 and Ra 228, by plants, the collection of plant material by herbivores, the concentration of the radioactive species by specific animal tissues, and the subsequent gamma-ray analysis of the tissues. (Auth)

<446>

White, D.J.; Oregon Department of Geology and Mineral Industries, Portland, OR

Radioactive Minerals the Prospector Should Know. Oregon Department of Geology and Mineral Industries Short Paper No. 18, 11 pp. (1976)

The introduction to prospecting and uranium minerals includes a chart of minerals found in combination with uranium deposits. There is also a summary of uranium mines in Oregon and basic information for the novice prospector. (PAG)

<447>

Collins, G.E., and T.S. Nye; AEC, Division of Raw Materials, Albuquerque, NM

Exploration Drilling for Uranium in the Scholle Area, Torrance County, New Mexico. DAO-4-TM-9, 23 pp. (1957, December)

Uranium and copper minerals occur in a conglomerate and sandstone zone in the Permian Abo Formation which outcrops on the east side of Priest Canyon north of Scholle, Torrance County, New Mexico. A drilling program was carried out to evaluate the uranium potential of the area. The results of the drilling indicate that scattered and weak uranium and copper mineralization, associated with carbonaceous plant material, occurs in a broad, meandering paleostream channel. (Auth)

<448>

Eakins, G.R.; Alaska Department of Natural Resources, Division of Geological

and Geophysical Surveys, College, AK

Investigation of Alaska's Uranium Potential, Part I. CJO-1627, Part I, 437 pp. (1975, June 1)

Various geographical regions in Alaska were examined in an exhaustive literary search for the possibility of uranium, either vein type or sedimentary. Six offer encouragement: the Copper River Basin, the alkaline intrusive belt of west-central Alaska and Selawik Basin area, the Seward Perinsula, the Susitna Lowland, the coal-bearing basins of the north flank of the Alaska Range, the Precambrian gneisses of the USGS 1:250,000 Goodnews quadrangle, and southeastern Alaska, which has the sole operating uranium mine in the state. Other areas that may be favorable for the presence of uranium include the Yukon Flats area, the Cook Inlet Basin, and the Galena Basin. (Auth)

<449>

Councill, R.J.; North Carolina Department of Conservation and Development, Division of Mineral Resources, Raleigh, NC

An Introduction to Radioactive Minerals in North Carolina. North Carolina Department of Conservation and Development Information Circular 14, 21 pp. (1955)

The general physical and chemical properties, mode of occurrence, and the general distribution of radioactive minerals in North Carolina are presented. Mineral rights and permits to prospect on private, state, and federal lands are discussed. (PAG)

<450>

Cannon, H.L.; USGS, Washington, DC

The Development of Botanical Methods of Prospecting for Uranium on the Colorado Plateau. USGS Bulletin 1085-A, (pp. 1-50). (1960)

Detailed investigation has shown that a relation exists between the distribution of mineralized ground and of specific herbaceous plants. The distribution of these plants is controlled by the presence of selenium, sulfur, and other trace elements available in the environment of the uranium deposit. Investigation also has shown that the uranium content of trees rooted in ore is significantly higher than that of trees rooted in barren ground. On the flat-lying sediments at lower altitudes of the Colorado Plateau there is a definite correlation between major plant zones and stratigraphic units. Chemical differences that occur in a mineralized area within a formation produce, on the other hand, recognizable changes in the plant societies, which may be useful as indicators in prospecting. Information concerning the availability of ions in an ore environment and the absorption of these ions by plant species is important in the development of botanical prospecting techniques. Plants that act as indicators of uranium ore on the Colorado Plateau are controlled by the increased availability of selenium, sulfur, calcium, or phosphorus in the vicinity of ore deposits. The most useful plant species is ASTRAGALUS PATTERSONI; the distribution of this plant has led to the discovery of ore deposits in several districts. Prospecting by mapping the distribution of indicator plants is most effective at altitudes below about 7,000 feet where the ore horizon is less than 40 feet below the surface and where the ore contains 0.001 percent or more selenium. Plants of the mustard family excel in the absorption of uranium but are not as useful in prospecting by plant analysis as coniferous species of deep-root habit and wide distribution. The average uranium content of coniferous trees growing in barren areas is 0.5 ppm compared to 1.5 ppm in mineralized ground. Tree samples may be collected on a grid pattern, analyzed for uranium content by a recently devised chromatographic field test or the older fluorimetric laboratory method, and the values contoured to indicate mineralized ground. The method is applicable in areas of thick forest cover where the ore horizon is at a depth of 70 feet. (Auth)

<451>

Not given; International Atomic Energy Agency, Vienna, Austria

Uranium Exploration Geology. IAEA-PL-391, 386 pp.; Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970.

International Atomic Energy Agency
Publications, Vienna, Austria, 386 pp. (1970, October)

A panel of uranium geologists representing expertise on different phases of uranium geology in various sectors of the world met in Vienna April 13-17, 1970 to present a review of geologic favorability criteria and formulate guidelines for exploration. The papers, summaries of the discussions, and conclusions are included in the publication. (PAG)

Papers presented at the meeting are abstracted and input as individual records.

<452>

White, M.G.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Vicinity of Teller and Cape Nome, Seward Peninsula, Alaska, 1946-47, Part I: Reconnaissance in the Vicinity of Teller, 1946. In USGS Circular 244, (pp. 1-4), 8 pp. (1953)

Placer-mining areas and bedrock exposures near Teller on the Seward Peninsula, Alaska, were investigated in June and July, 1946, for possible sources of radioactive materials. The areas that were investigated are: Dese Creek, southeast of Teller; Bluestone River basin, south and southeast of Teller; Sunset Creek and other small streams flowing south into Grantley Harbor, northeast of Teller; and, also northeast of Teller, Swanson Creek and its tributaries, which flow north into the Agiapuk River basin. No significant amount of radioactive material was found, either in the stream gravels or in the bedrock of any of the areas. A heavy-mineral fraction obtained from a granite boulder probably derived from a bench gravel on Gold Run contains 0.017 percent equivalent uranium, but the radioactivity is due to allanite and zircon. The types of bedrock tested include schist, slate, and greenstone. Readings on fresh surfaces of rock were the same as, or only slightly above the background count. The maximum radioactivity in stream concentrates is 0.004 percent equivalent uranium in a sluice concentrate from Sunset Creek. (Auth)

<453>

White, M.G., and P.L. Killeen; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Lower Yukon-Kuskokwim Highlands Region, Alaska, 1947, Chapter B: Radioactivity and Mineralogy of Concentrates from the Placers of Julian, Moore, and Candle Creeks, and the Cripple Creek Mountains. In USGS Circular 255, (pp. 16-18), 18 pp. (1953)

Radiometric and mineralogic study of 10 concentrate samples from the placers of Julian, Moore, and Candle Creeks, and the Cripple Creek Mountains, Lower Yukon-Kuskokwim Highlands region, Alaska, failed to reveal any significant amounts of uranium. Only the sample from Julian Creek shows an appreciable amount of radioactivity (0.03 percent equivalent uranium), but this is attributed entirely to thorium in monazite. (Auth)

<454>

Moxham, R.M.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in South-Central Alaska, 1947-49, Part I: Reconnaissance for Radioactive Deposits in Areas Adjacent to Highways in South-Central Alaska During 1947. In USGS Circular 184, (pp. 1-6), 14 pp. (1952)

A radiometric reconnaissance of the areas adjacent to the principal highways and secondary roads of south-central Alaska was carried out during the summer of 1947. The investigation included the examination of nine gold-placer workings, five gold lodes, a gypsum mine, and a copper prospect. Nearly all types of rock cropping out in the highway belt were tested. No significant amounts of radioactive material were found. (Auth)

<455>

White, M.G.; USGS, Washington, DC

Radioactivity of Selected Rocks and Placer Concentrates from Northeastern Alaska. USGS Circular 195, 12 pp. (1952)

Radiometric examinations of nearly 30 samples of placer concentrates and specified rocks from the Mount Michelson area and Wiseman and Chandalar Districts reveals the presence of radioactive materials. The report discusses the radioactivity and mineralogy data of these three regions. The radioactive minerals found, monazite, thorianite, and biotite, to name a few, are nearly always associated in the placers with hematite and a few metallic sulfides, and may be a potential future source of uranium deposits. (MBW)

<456>

Gault, H.R., P.L. Killeen, W.S. West, R.F. Black, J.B. Lyons, M.G. White, and J.J. Matzko; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951. USGS Circular 250, 31 pp. (1953)

Five locations in the northeastern part of the Seward Peninsula, Alaska were investigated during a reconnaissance for radioactive deposits from 1945-47, and in 1951. The Sweepstakes Creek and Candle Creek areas were scanned in 1945, the South Fork of Quartz Creek was studied in 1946, Buckland-Kiwalik District was examined in 1947, and the headwaters of the Peace River were surveyed in 1951. The five chapters included in the report summarize the radioactivity investigations and mineralogic data of each area. (MBW)

<457>

Wells, J.D., and J.E. Harrison; USGS, Washington, DC

Radioactivity Reconnaissance of Part of North-Central Clear Creek County, Colorado. USGS Circular 345, 9 pp. (1954)

A radioactivity reconnaissance of 334 localities in north-central Clear Creek County, Colorado was made in 1951 and 1952. This reconnaissance, made with a portable scintillation counter and a portable survey meter with a 6-inch gamma-beta Geiger tube, disclosed that seven of the localities contain sufficient uranium to warrant some physical exploration. Within the area studied, the localities containing chalcopyrite have the highest grade and highest percent of occurrences of significant abnormal radioactivity. Zones of galena-sphalerite veins have approximately the same rate of occurrence of significant abnormal radioactivity as zones of galena-sphalerite with chalcopyrite. Any locality or zone containing pyritic-type veins without chalcopyrite is considered unlikely to contain a uranium deposit. (Auth)

<458>

Moxham, R.M., and A.E. Nelson; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Southern Cook Inlet Region, Alaska, 1949, Part 1: Iliamna Lake-Lake Clark Region. In USGS Circular 207, (pp. 1-4), 7 pp. (1952)

Reconnaissance for radioactive deposits in Iliamna Lake-Lake Clark region undertaken in 1949 included the examination of two silver-lead occurrences and five copper deposits, one of which had been reported earlier to contain uranium; the radiometric testing of numerous concentrates from gravels of streams draining the more inaccessible areas; and about 310 miles of radiometric traversing with portable survey meters. The maximum equivalent uranium content of any material tested did not exceed 0.009 percent. (Auth)

<459>

Moxham, R.M., and A.E. Nelson; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Southern Cook Inlet Region, Alaska, 1949, Part 2: Jakolof Bay Area. In USGS Circular 207, (pp. 5-7), 7 pp. (1952)

The Geological Survey conducted a brief investigation in the vicinity of Jakolof Bay on the Kenai Peninsula in southern Alaska. No radioactive material was found. Possibly a chromite stock pile in this locality was mistaken for pitchblende. (Auth)(MBW)

<460>

Wedow, H., Jr.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Eagle-Nation Area, East-Central Alaska, 1948. USGS Circular 316, 9 pp. (1954)

Reconnaissance of radioactive deposits in sedimentary rocks of Proterozoic and Paleozoic age, and granite of Mesozoic age together with its Tertiary sedimentary derivatives, was conducted in the Eagle-Nation area, east-central Alaska, in 1948. None of the rocks examined contains more than 0.003 percent equivalent uranium except for black shale beds in the upper Mississippian Calico Bluff formation and in granite of Mesozoic age and its sedimentary derivatives. Two units near the base of the formation appear to be persistent in the area: Radioactive unit A, with an average thickness of 6.6 feet, contains an average of 0.007 percent equivalent uranium and 0.004 percent uranium; radioactive unit B, with an average thickness of 5.2 feet, contains an average of 0.006 percent equivalent uranium and 0.003 percent uranium. Phosphatic pellets from unit B at one locality contain 0.022 percent equivalent uranium, 0.019 percent uranium, and 15 percent P2O5. Samples of the granite of Mesozoic age and its Tertiary sedimentary derivatives average 0.005 and 0.004 percent equivalent uranium, respectively. Biotite is the chief radioactive mineral in the granite and its radioactivity is ascribed to the presence of uranium and thorium, which occur either as impurities or in minute inclusions of other, as yet unidentified, minerals. Traces of uranium and thorium in zircon, sphene, and monazite also contribute to the total radioactivity of the granite. Zircon and monazite are the major uranium- and thorium-bearing minerals of the Tertiary sedimentary rocks derived from the granite. (Auth)(MBW)

<461>

Hail, W.J., Jr., and J.R. Gill; USGS, Washington, DC

Results of Reconnaissance for Uraniferous Coal, Lignite, and Carbonaceous Shale in Western Montana. USGS Circular 251, 9 pp. (1953)

A reconnaissance search for uraniferous lignite and carbonaceous shale was made in western Montana and adjacent parts of Idaho during the summer of 1951. Particular emphasis in the examination was placed on coal and carbonaceous shale associated with volcanic rocks, as volcanic rocks in many areas appear to have released uranium to circulating ground water from which it was concentrated in carbonaceous material.
Twenty-two areas in Montana and one area in Idaho were examined. The coal in five of these areas is of Cretaceous age. The coal and carbonaceous shale in the remaining 18 areas occur in Tertiary "lake-bed" deposits of Oligocene and younger age. Both the Cretaceous and Tertiary coal and carbonaceous shale are associated with contemporaneous or younger volcanic rocks and pyroclastic sequences. A sample of carbonaceous shale from the Prickly Pear Valley northeast of Helena, Montana, contained 0.013 percent uranium. A sample of carbonaceous shale from the Flint Creek Valley southwest of Drummond, Montana, contained 0.006 percent uranium. All other samples of both Cretaceous and Tertiary coal and carbonaceous shale were essentially nonradioactive. (Auth)

<462>

Wedow, H., Jr., J.M. Stevens, and G.E. Tolbert; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in East-Central Alaska, 1949, Chapter A: Fairbanks and Livengood Quadrangles. In USGS Circular 335, (pp. 1-3), 22 pp. (1954)

In the summer of 1949, several mines and prospects in the Fairbanks and Livengood quadrangles, east-central Alaska, were examined for the possible presence of radioactive materials. Also tested were metamorphic and sedimentary rocks of pre-Cambrian and Paleozoic age crossed by the Elliott Highway. Nuggets consisting chiefly of native bismuth and containing as much as 0.1 percent equivalent uranium had been found previously in a placer on Fish Creek several miles downstream from the reported bismuth-bearing lode on Melba Creek, but none of the lodes tested in 1949 exhibited radioactivity in excess of 0.003 percent equivalent uranium. The greatest radioactivity found in the rocks along the Elliott Highway was in an iron-stained pre-Cambrian schist and in a carbonaceous shale of middle Devonian or Carboniferous age. Respective samples of these rocks contain 0.003 and 0.004

percent equivalent uranium. A possible local bedrock source for the euxenite-polycrase mineral found in a placer concentrate containing about 0.04 percent equivalent uranium was sought in the watershed of Goodluck Creek, near Livengood. The bedrock source of this mineral could not be located and it is believed that the source could be outside of the Goodluck watershed because drainage changes during Quaternary time may well have introduced gravels from nearby areas. (Auth)(MBW)

<463>

White, M.G., and G.E. Tolbert; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in East-Central Alaska, 1949, Chapter B: Miller House-Circle Hot Springs Area. In USGS Circular 335, (pp. 4-6), 22 pp. (1954)

Granite of Mesozoic age in the Miller House-Circle Hot Springs area, east-central Alaska, contains 0.005 to 0.007 percent equivalent uranium. The radioactivity is mostly caused by uranium in such primary accessory minerals of the granite as allanite, garnet, scheelite, sphene, and zircon. However, the presence of metallic sulfides, cassiterite, and uraniferous fluorite, malachite, and topaz in the granite or associated placers suggests the possibility of a post-emplacement or late-stage mineralization of the granite, presumably of hydrothermal origin, as a source for at least part of the uranium. Additional reconnaissance in the area to determine the presence or absence of hydrothermal uraniferous deposits of commerical grade appears warranted. (Auth)

<464>

Wedow, H., Jr., and G.E. Tolbert; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in East-Central Alaska, 1949, Chapter C: Copper Creek Copper Lode Prospect, Eagle District. In USGS Circular 335, (pp. 7-9), 22 pp. (1954)

Investigation of radioactivity anomalies at the Copper Creek copper lode prospect, Eagle district, east-central Alaska, during 1949 disclosed that the radioactivity is associated with copper mineralization in highly metamorphosed sedimentary rocks. These rocks are a roof pendant in the "Charley River" batholith of Mesozoic age. The radioactivity is probably due almost entirely to uranium associated with bornite and malachite. (Auth)

<465>

White, M.G.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in East-Central Alaska, 1949, Chapter D: Placer Concentrates from the Fortymile District. In USGS Circular 335, (pp. 10-12), 22 pp. (1954)

Studies of 24 placer-concentrate samples from the Fortymile district of east-central Alaska revealed only two samples containing significant amounts of radioactivity. Both samples are from Atwater Bar on the South Fork of the Fortymile River, a short distance below the confluence of Mosquito and Dennison Forks. The radioactivity is due to traces of uranium-bearing thorianite, which occurs as minute black cubes and fragments. No data are available as to the source of the thorianite. (Auth)

<466>

Wedow, H., Jr., and G.E. Tolbert; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in East-Central Alaska, 1949, Chapter E: Wilson Creek, My Creek, Ben Creek, and Chicken Areas, Fortymile District. In USGS Circular 335, (pp. 13-22), 22 pp. (1954)

A reconnaissance was conducted in the Wilson Creek, My Creek, and Ben Creek areas, Fortymile district, east-central Alaska, in 1949 in an attempt to locate three occurrences of high-grade uranium ores reported by prospectors. The search was unsuccessful. A maximum of 0.005 percent equivalent uranium was found in felsic igneous rocks of the Wilson Creek and Ben Creek areas. The radioactivity of these rocks in the Wilson Creek area is probably due to traces of radioactive elements in the common accessory minerals of the igneous rocks; in the Ben Creek area it is probably due chiefly to thorium in monazite and allanite, which were identified in concentrates from gravels of streams draining areas underlain by the igneous rocks. Radioactivity tests of Tertiary sedimentary rocks in the vicinity of Chicken show that a sulfide-bearing montmorillonite-type clay contains as much as 0.005 percent equivalent uranium and that coked coal and ash from a burned coal bed contain as much as 0.003 percent equivalent uranium. A concentrate submitted by a prospector from a gold-placer deposit at Atwater Bar, a short distance east of Chicken, contains traces of uranothorianite and monazite and has an equivalent uranium content of 0.027 percent. (Auth)

<467>

Nelson, A.E., W.S. West, and J.J. Matzko; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in Eastern Alaska, 1952. USGS Circular 348, 21 pp. (1954)

Reconnaissance for radioactive deposits was conducted in selected areas of eastern Alaska during 1952. Examination of copper, silver, and molybdenum occurrences and of a reported nickel prospect in the Slana-Nabesna and Chisana districts in the eastern Alaska Range revealed a maximum radioactivity of about 0.003 percent equivalent uranium. No appreciable radioactivity anomalies were indicated by aerial and foot traverses in the area. Reconnaissance for possible lode concentrations of uranium minerals in the vicinity of reported fluorite occurrences in the Hope Creek and Miller House-Circle Hot Springs areas of the Circle quadrangle and in the Fortymile district revealed a maximum of 0.055 percent equivalent uranium in a float fragment of ferruginous breccia in the Hope Creek area; analysis of samples obtained in the vicinity of the other fluorite occurrences showed a maximum of only 0.005 percent equivalent uranium. No uraniferous lodes were discovered in the Koyukuk-Chandalar region, nor was the source of the monazite, previously reported in the placer concentrates from the Chandalar mining district, located. The source of the uranothorianite in the placers at Gold Bench on the South Fork of the Koyukuk River was not found during a brief reconnaissance, but a placer concentrate containing 0.18 percent equivalent uranium was obtained. This concentrate is about 10 times more radioactive than concentrates previously available from the area. (Auth)

<468>

Barrett, D.C.; AEC, Salt Lake City, UT

Preliminary Report of Reconnaissance in the Bighorn Basin, North-Central Wyoming and South-Central Montana. RME-4027, 19 pp. (1953)

Airborne and ground reconnaissance for uranium was conducted in the Bighorn Basin. No occurrences of economic importance were found. Sedimentary rocks ranging in age from Cambrian to Lower Tertiary are exposed in the structural and topographic Bighorn Basin. Small occurrences of uranium were found in the Flathead sandstone of Cambrian age, the Chugwater formation of Triassic age, the Morrison and Cloverly formations of Jurassic and Cretaceous age, the Frontier and Mesaverde formations of Cretaceous age, and in the Wasatch formation of Eocene age. (Auth)

<469>

Miller, T.P., and O.J. Ferrians, Jr.; USGS, Washington, DC

Suggested Areas for Prospecting in the Central Koyukuk River Region, Alaska. USGS Circular 570, 12 pp. (1968)

Anomalous amounts of copper, lead, zinc, silver, and gold in stream-sediment samples and mineralized outcrops define seven areas favorable for prospecting in the central Koyukuk River region, west-central Alaska. These areas, listed with their metals of interest, are (1) Indian Mountain: silver, lead, copper, and gold, (2) Sun Mountain: lead, copper, and silver, (3) Dakli: copper, (4) Clear Creek: gold, (5) Caribou Mountain: uranium and thorium, (6) Hawk River: lead and silver, and (7) Purcell Mountain: gold. Mineralization at all these localities is closely related to granitic plutons of Late Cretaceous age. These plutons are intrusive into volcanic rocks ranging in composition from quartz latite to andesite and in age from possibly Late Jurassic to Early Cretaceous. (Auth)

<470>

Davidson, D.F.; USGS, Washington, DC

Reconnaissance for Uranium in the Powder River Basin, Wyoming. TEM-677, 32 pp (1953)

A reconnaissance was made of a large part of the Powder River Basin, Wyoming, to search for uranium deposits in parts of the basin other than the Pumpkin Buttes area. No uranium deposits of economic interest were found, but some rocks of the Tertiary Fort Union formation and the Cretaceous Inyan Kara group were found to be sufficiently uraniferous to justify further search in these formations. (Auth)

<471>

Proctor, P.D.; Utah Geological and Mineralogical Survey, Salt Lake City, UT

Uranium: Where It Is and How to Find It. Eagle Rock Publishers, Salt Lake City, UT, 85 pp. (1954)

The publication is a non-technical guide to prospecting for uranium. Included is information on uranium minerals and deposits, areas of known deposits, equipment, and other topics of interest to a uranium prospector. (Auth)

<472>

Page, L.R.; USGS, Washington, DC

Geologic Prospecting for Uranium and Thorium. In USGS Professional Paper 300, (pp. 627-631), 739 pp.; In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York, (pp. 688-691), 825 pp. (1956)

The search for uranium and thorium in the United States has emphasized the value of geologic guides in prospecting. The application of these guides in conjunction with radiometric, geochemical, botanical, panning, and geophysical techniques has greatly increased the rate of discovery. Prospecting for new districts is based on very general criteria; prospecting for individual ore deposits in new or old districts requires specific guides. Geologic guides to ore deposits vary for each major uranium and thorium district; many of these guides are discussed. (Auth)

<473>

Cannon, H.L.; USGS, Denver, CO

Botanical Methods of Prospecting for Uranium. Mining Engineering, 6(2), 217-220. (1954)

Botanical methods of prospecting for metalliferous ores are based on the premise that deposits at depth may affect surface vegetation. This may be manifested as unusual concentrations of the metals within the bodies of the plants growing on or near the deposits, or as the presence of particular plants which flourish in the anomalous geochemical environment. Both may be used in botanical prospecting for uranium. A plant may be used as an indicator in botanical prospecting if its distribution is controlled by any factor related to the chemistry of the ore deposit. Since some uranium deposits contain unusual concentrations of selenium and sulfur, selenium- and sulfur-indicator plants may be used as a guide to these ore deposits. Botanical prospecting for uranium is useful wherever deposits are less than 70 feet from the surface and where selenium and uranium are readily available to plant roots. (Auth)

<474>

Stugard, F., Jr.; USGS, Washington, DC

Physical Exploration for Uranium During 1951 in the Silver Reef District, Washington County, Utah. TEI-254, 59 pp. (1953)

The Silver Reef district in southwestern Utah lies on the northeastward trending and plunging Virgin anticline which has been breached by erosion leaving hogbacks of resistant Chinle sandstone beds which are locally repeated by thrust faulting. Thirteen diamond drill holes, ten of which were located around Pumpkin Point, were drilled in 1951; no ore-grade mineralization was encountered. Carnotite and volborthite are present in surface exposures in mined areas. Small lenticular ore bodies in the Chinle formation have been mined; no ore remains in sight. The chances of discovering significant uranium deposits in the Silver Reef district are poor because of highly variable lithology, closely faulted structure, and obliteration of shallow uranium-bearing lenses by previous silver mining. The report includes descriptions of several mines and prospects in the area. (Auth)

<475>

Holder, B.E.; University of California, Lawrence Livermore Laboratory, Livermore, CA

LLL Uranium Hydrogeochemical Survey Project Highlights for July, 1975.
UCID-16883, 7 pp. (1975, August)

Status of the LLL hydrogeochemical survey of Winnemucca Lake, Smoke Creek Desert, Cave Valley, and Roach Lake basins in Nevada is reported. A reconnaissance sampling of Winnemucca Lake was made to determine its accessibility by four wheel drive vehicles and to test hand augering as a means of collecting samples. About 100 sediment samples were taken from alluvial fans and dry stream channels of Walker Basin. Preliminary survey analyses were performed on 24 samples from Walker River and its tributaries. (GRA)

<476>

MacDonald, J.A.; Eldorado Mining and Refining Limited, Ottawa, Canada

Lake Water, A Guide to Uranium.
Canadian Mining Journal, 89(4), 89-90, 99-100. (1968, April)

The hydrochemical survey in the Beaverlodge area of Canada indicates that zones of secondary uranium mineralization can readily be delineated by lake water sampling. Because the secondary migration of uranium is greatly enhanced in a carbonate-rich environment, pH and bicarbonate determinations provide necessary criteria for establishing the significance of uranium assay results. The specific conductance of surface waters can provide a useful though indirect, guide to areas of mineralization. (Auth)(PAG)

<477>

Nichols, C.E., V.E. Kane, S.C. Minkin, and G.W. Cagle; Union Carbide, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN

National Uranium Resource Evaluation Program, Hydrogeochemical and Stream, Sediment Pilot Survey of Llano Area, Texas. K-TL-602, 155 pp. (1976, June 30)

The objective of the Hydrogeochemical and Stream Sediment Reconnaissance Survey is to perform a reconnaissance of the nation's surface waters, groundwater, and stream and lake sediment in regions selected according to geologic favorability which will aid in the identification of the best areas for uranium exploration. A pilot geochemical survey of the Llano, Texas area was conducted during February and March 1976 to prepare for a subsequent reconnaissance geochemical survey of uranium in Central Texas. Stream sediment, stream water, well water, and plant ash from five geologic areas were analyzed in the laboratory for approximately 25 parameters. Examples of anomalous values in stream sediment and stream water indicate the usefulness of both sample types in identifying anomalies at a regional reconnaissance-scale station spacing of approximately 5 km (3 mi). Anomalies in San Saba County are associated with the Marble Falls-Smithwick Formations and the Strawn Series (Pennsylvanian), the Houy Formation (Devonian and lower Mississippian), and the Hickory Sandstone Member of the Riley Formation (Cambrian). In Burnet County anomalous values are due to the influence of the Valley Spring Formation (Precambrian); and in Blanco County anomalies are found associated with the Riley Formation (Cambrian). (Auth)(PAG)

<478>

Moxham, R.M., and W.S. West; USGS, Washington, DC

Radioactivity Investigations in the Serpentine-Kougarok Area Seward Peninsula Alaska, 1946. USGS Circular 265, 11 pp. (1953)

Radioactive minerals in small quantities were found in the bedrock and alluvium within the outcrop area of granite at the head of Serpentine River. Tests of radioactivity at outcrops of the granite indicate that small amounts of radioactive material is disseminated throughout the mass. Four variants of the normal granite have been recognized: early and late differentiates, and pegmatitic and fine-grained facies. All variants except the early differentiates show radioactivity in excess of the normal granite. The average equivalent uranium content of 29 samples of the granitic variants is 0.008 percent. The heavy-mineral portions of these samples average 0.034 percent equivalent uranium. The radioactivity of the placer material and bedrock is attributable to zircon, sphene, allanite, hydrogoethite, and two unidentified secondary minerals. (Auth)

<479>

Boberg, W.W., and D.D. Runnells;
University of Colorado, Department of Geological Sciences, Boulder, CO;
Conoco, Uranium Exploration, Casper, WY

Reconnaissance Study of Uranium in the South Platte River, Colorado. Economic Geology, 66, 435-450. (1971)

The South Platte River in Colorado drains areas of crystalline and sedimentary rocks. The water is a sodium-calcium-sulfate-chloride type throughout its length of flow in Colorado. The concentration of uranium in the water of the South Platte during the winter of 1969-1970 ranged from 5 ppb to 67 ppb, making it anomalously rich in uranium in comparison with most other rivers of the world. The concentration of uranium increases downstream, in contrast to the decrease in uranium concentration observed in other rivers that drain areas with known deposits of uranium. The South Platte contains a higher concentration of uranium than either the Colorado or North Platte rivers, despite the fact that the latter two rivers drain ore-producing areas of the United States. It is likely that most of the uranium in the South Platte is contributed by uraniferous coal seams in the Cretaceous Laramie Formation and by uranium-rich black shales in the Cretaceous Pierre Formations. The possibility that undiscovered deposits of uranium ore are present in the drainage basin of the South Platte cannot be excluded, but no major deposits are known. Use of the parameter "incremental areal uranium-load" permits certain portions of the drainage basin to be recognized as contributors of anomalously large amounts of uranium to the river. In the headwaters of the South Platte the incremental areal uranium-load is a low 0.00018 kg U day km2, whereas for the increment of drainage between Weldona and Balzac, Colorado, the incremental areal uranium-load is 0.016 kg U day km2. This parameter may be useful for hydrogeochemical prospecting for uranium ore in other areas. The concentration of uranium in the interstitial water of the alluvium in cutoff meanders varies seasonally, but there is no clear-cut evidence for precipitation of uranium minerals. Measurements of Eh, pH, and total vanadium in interstitial waters indicate that neither uraninite, coffinite, nor carnotite is stable. (Auth)

<480>

Way, J.H., Jr., and G.M. Friedman;
Rensselaer Polytechnic Institute, Troy, NY

U, K, and Th Concentrations in Devonian Sedimentary Rocks of the Catskill Mountain Area and Their Interpretation. GJO-7404, 72 pp. (1971, May 14)

Rocks of the Catskill Mountain area were investigated as possible host rocks for uranium. Analytical data, U, K, and Th concentrations, derived from samples collected under careful stratigraphic and environmental control were analyzed by statistical methods. Stepwise discriminant function analysis showed that there was not enough variability in the data nor enough change from one measured section to another to effect a separation of sections at any statistically significant level. Using linear regression and correlation analysis, potassium and thorium show a dependency on each other to a greater degree than either potassium versus uranium or thorium versus uranium. No definite conclusions were reached in attempting to explain why uranium concentrations throughout the area were so low. (Auth)

<481>

Marjaniemi, D.K., and A.L. Basler; Lucius Pitkin Incorporated, Geology Division, Grand Junction, CO

Geochemical Investigations of Plutonic

Rocks in the Western United States for the Purpose of Determining Favorability for Vein-Type Uranium Deposits.
GJO-912-16, 181 pp. (1972, December 15)

Reconnaissance geochemical investigations of plutonic rocks in the western United States were undertaken for the purpose of determining geochemical guides and favorable areas for vein-type uranium deposits. Gamma ray spectrometric analyses for uranium, thorium, and potassium and semiquantitative emission spectrographic analyses were obtained on approximately 500 samples collected from throughout the western U.S. Quantitative major-element analyses were obtained on selected samples. The regional variations of uranium, thorium, and potassium concentrations in plutonic rocks were investigated on the basis of average values for one-degree latitude-longitude quadrilaterals and average values and frequency distributions for geologic subdivisions. The results in both cases indicate a general decrease in the concentrations of the three elements from the continental interior to the continental margin. Possible geochemical guides for vein-type uranium deposits were determined from comparisons of chemical data for samples from plutonic bodies associated with known deposits and all samples from the western U.S. or selected groups of samples. The results indicate that plutonic bodies associated with known vein deposits are characterized by very high silicon, high aluminum, potassium, rubidium and Nockolds-Allen differentiation index, a limited range of values of the ferric to total iron ratio, low sodium, calcium, titanium, manganese, and phosphorus, very low iron and vanadium, and a high range of values of the uranium-potassium ratio. Uranium and thorium concentrations and the uranium-thorium ratio are commonly but not always higher in the plutonic bodies associated with vein deposits. (Auth)(PAG)

<482>

Rose, A.W., M.L. Keith, and N.H. Suhr; Pennsylvania State University, Department of Geosciences, University Park, PA

Geochemical Drainage Surveys for Uranium: Sampling and Analytical Methods Based on Trial Surveys in Pennsylvania. GJO-1645-1, 55 pp. (1976, June 8)

Geochemical surveys near sandstone-type uranium prospects in northeastern and north-central Pennsylvania show that the deposits can be detected by carefully planned stream sediment surveys, but not by stream water surveys. Stream waters at single sites changed in U content by x10-50 during the 18 months of the study, and even near known prospects, contain less than 0.2 ppb U most of the time. Uranium extractable from stream sediment by acetic acid-H_2O_2 provides useful contrast between mineralized and non-mineralized drainages of a square mile or less; total U content in sediment does not. High organic material results in increased U content of sediments and must be corrected. Changes in U content of sediment with time reach a maximum of x3 and appear to be of short duration. As, Mn, Pb, and V are enriched in the mineralized zones, and perhaps in surrounding halo zones, but do not appear to be pathfinder elements useful for reconnaissance exploration. (Auth)

<483>

Illsley, C.T.; AEC, Production Evaluation Division, Grand Junction, CO

Hydrogeochemical Reconnaissance for Uranium in the Stanley Area, South-Central Idaho. RME-140, 23 pp. (1961, July)

Geochemical data obtained from the analyses of 73 water samples collected in the Stanley area, Idaho, demonstrate the applicability of hydrogeochemical techniques to uranium exploration. Uranium concentrations in surface waters of the area ranged from 0.2 to 22.0 ppb U_3O_8. The geometric mean for 27 samples from the Basin Creek mining area was 3.9 ppb U_3O_8, and the geometric mean for the remainder of the Stanley area was 1.1 ppb U_3O_8 (39 samples). Samples from seven hot springs averaged 0.3 ppb U_3O_8. The conductivity of the surface waters ranged from 45 to 350 micromhos, with the higher conductivities generally found in water from areas underlain by sedimentary rock. The pH of the surface waters varied only slightly from the average value of 7.4. Twelve of the most highly anomalous uranium concentrations in the Basin Creek district were found from 0.15 to 2 miles downstream from known uranium deposits.

Outside Basin Creek district 2 of the 3 highest concentrations are from areas immediately adjacent to Basin Creek district; and of 4 other possible anomalies, one is along the strike of structural trends which may mark an extension of the mineralized area, and the other 3 are presumably influenced by higher conductivity of water from areas of sedimentary rocks. Hot springs waters are geochemically distinct from the surface waters of the uranium district, and apparently are neither contributing unusual amounts of uranium nor dissolving significant amounts of uranium from the surrounding rock. (Auth)

<484>

Forbes, R.B.; Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, College, AK

Investigation of Alaska's Uranium Potential, Part 2. GJO-1627, Part 2, 267 pp. (1975, June 1)

The report provides information necessary in estimating the uranium potential of Alaska and serves as a practical guide to exploration. A 1:1,000,000 scale map of the felsic rocks, analytical data, and age determinations are included in the report. (PAG)

<485>

Reimer, G.M.; USGS, Lakewood, CO

Helium Detection as a Guide for Uranium Exploration. USGS Open-File Report 76-240, 14 pp. (1976)

Helium, a byproduct of radioactive decay, may prove to be a valuable indicator of the presence and distribution of uranium deposits. Recent technological advances permit the development of instrumentation not previously adapted for this purpose. A truck-mounted mass spectrometer, tuned for He 4, permits immediate adjustment or modification of sampling patterns in response to accumulating data. The inlet system of the spectrometer has been designed to allow flexibility in gas analyses from various sample types - soil gas, atmosphere, or gases in water. Sensitivity of the instrument is better than 50 parts of helium per 10(E+9) parts of gas. Investigations can be performed on a qualitative, relative basis, or on a quantitative basis by comparison to calibrated helium standards. Preliminary field testing includes studies of the responses to variations in wind speed, temperature, barometric pressure, moisture and sampling depth over extended time periods, as well as studies of geologic controls on the helium content in soil gas. Surveys over known uranium occurrences reveal some anomalous helium distributions. (Auth)(MBW)

<486>

Gault, H.R.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951, Chapter B: Candle Creek Area, 1945. In USGS Circular 250, (pp. 11-14), 31 pp. (1953)

A black cubic mineral, questionably identified as uraninite, is abundant in one of two significantly radioactive placer samples obtained prior to 1945 from the Candle Creek area on the Seward Peninsula. Only 4 of the 16 concentrate samples collected during the field season of 1945 from this area contain more than 0.01 percent equivalent uranium. Although mineralogical study of the samples collected in 1945 failed to isolate the radioactive mineral grains, additional search of the Candle Creek area for the uraninite may be warranted. (Auth)

<487>

White, M.G.; USGS, Washington, DC

Radioactivity of Selected Rocks and Placer Concentrates from Northeastern Alaska, Part I: Radioactivity in Gneissic Granite of the Mount Michelson Area, Northeastern Alaska. In USGS Circular 195, (pp. 1-7), 12 pp. (1952)

Radiometric examination of 13 samples collected in the Mount Michelson area, northeastern Alaska, in 1948, shows that four samples of gneissic granite contain an average of 0.007 percent equivalent uranium. The heavy-mineral fractions from three of these four samples contain an average 0.052 percent equivalent uranium and 0.03 percent uranium. The heavy-mineral fractions from three of these four samples contain an average 0.052 percent equivalent uranium and 0.03 percent uranium. The heavy-mineral fractions of panned concentrates from gravels of streams draining relatively large areas of granitic rock, contain an average of 0.028 percent equivalent uranium, whereas similar heavy fractions of panned concentrates from streams that drain areas other than those largely underlain by granitic rock contain an average of only 0.005 percent equivalent uranium. Mineralogic study of all heavy-mineral fractions having more than 0.01 percent equivalent uranium indicates that the radioactive material apparently is confined to biotite, which in one sample contains 1.19 percent uranium. Fluorite, hematite, zircon, sphene, galena, and molybdenite, commonly associated elsewhere with uranium, apparently are disseminated in the granite with the biotite. The presence of uranium in the biotite of the granite and, of other minerals associated with uranium elsewhere, suggests that this area should be considered in relation to others in Alaska as a possible locality to search for high-grade uranium deposits. (Auth)

<488>

White, M.G.; USGS, Washington, DC

Radioactivity of Selected Rocks and Placer Concentrates from Northeastern Alaska, Part II: Radioactivity and Mineralogy of Placer Concentrates from the Wiseman and Chandalar Districts. In USGS Circular 195, (pp. 8-12), 12 pp. (1952)

Radiometric and mineralogic study of 19 placer concentrates revealed the presence of monazite on Rye Creek in the Wiseman district and on several creeks northeast of Chandalar Lake in the Chandalar district, upper Yukon region, northeastern Alaska. Uranium-bearing thorianite occurs on the South Fork of the Koyukuk River at Gold Bench and vicinity in the Wiseman district. The radioactive minerals are almost always associated in the placers with hematite and several of the metallic sulfides. Such association may indicate the possible occurrence of primary uranium ores with hematitic alteration within the drainage basins of the streams where the radioactive minerals are found. Selected areas in the vicinity of the radioactive mineral occurrences in the Wiseman and Chandalar districts might contain primary uraniferous deposits. (Auth)

<489>

Illsley, C.T.; AEC, Division of Raw Materials, Denver, CO

Hydrogeochemical Exploration for Uranium in the Mt. Spokane Area, Washington. Geological Society of America Bulletin, 76, 1750. (1965)

The applicability of the hydrogeochemical method of uranium exploration in eastern Washington has been tested. The geochemistry of the waters and the rock environment associated with the waters were considered. Chemically the waters are of the carbonate type and divided into three groups according to the amount of total dissolved material. These three groups correspond to an arbitrarily selected grouping of geologic environments: intensely decomposed granitic rock; fresh granitic rock; and sedimentary lake-bed deposits overlain by Columbia River lavas. The areal-background analysis for uranium in surface waters was determined to be approximately 1.5 ppb as compared with the regional background of 0.2 ppb. The area background for spring waters was found to be about 4.5 ppb. Several springs in the area are radioactive and can be easily detected with a hand scintillation counter. Anomalies in the amount of 100 ppb were detected. Comparisons of uranium with the pH and bicarbonate content of surface waters showed that uranium occurs in anomalous concentrations only where the bicarbonate content is greater than 25 ppm and the pH is greater than 6.5. Limitations of the hydrogeochemical method in the Mt. Spokane area are similar to those encountered elsewhere. Not all waters with abnormally high uranium indicate the presence of uranium ore deposits. The major factor of distance between an ore deposit and the surface openings of adjacent springs needs further evaluation. Other significant limitations are the presence of intermittent and discontinuous surface drainage, and variations that may occur in the composition of waters caused by climatic changes. (Auth)

<490>

McClernan, H.G.; Montana Bureau of Mines, School of Mines, Butte, MT

Geochemical Exploration of the Stemple Pass Area, Lewis and Clark County, Montana. Montana Bureau of Mines Special Publication 64. 7 pp. (1974, June)

Geochemical soil sampling for copper and molybdenum over two granitic intrusive bodies in the Stemple Pass area of Lewis and Clark County, Montana, indicates the presence of disseminated mineral deposits within and adjacent to the granitic rocks. Although the economic importance of the deposits is not yet known, the sampling results do indicate an area worthy of further geological and geochemical investigation. (Auth)

<491>

Davis, W.E.; USGS, Washington, DC

Electrical Resistivity Investigations of Carnotite Deposits in the Colorado Plateau. TEM-232. 25 pp. (1951, April)

Investigations of the use of geophysical methods in prospecting for carnotite deposits on the Colorado Plateau indicate that electrical resistivity methods combined with other geologic data can be used successfully to locate areas favorable for drilling. Broad positive resistivity anomalies of small magnitude were observed over most of the deposits investigated, all of which are in the Salt Wash member of the Morrison formation of Jurassic age. The anomalies are related to thickening of the ore-bearing sandstone; mineralized ground in most places is also associated with this thickening. Electrical resistivity measurements can be successfully made at depths of as much as 400 feet. The investigations were conducted on Calamity and Outlaw Mesas, Mesa County, and Long Park, Montrose County, Colorado. (Auth)

<492>

Comstock, S.S.; AEC, Grand Junction, CO

Scintillation Drill-Hole Logging. In Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 6, Geology of Uranium and Thorium, held in Geneva, Switzerland, August 8-20, 1955. United Nations, New York. (pp. 722-725), 825 pp. (1956)

Scintillation type drill hole logging units are now part of the uranium exploration drilling program. The scintillation logging unit, designed for efficient one-man operation, is mounted in a four-wheel drive Jeep station wagon. Gamma ray pulses detected by a subsurface probe are recorded on a paper chart. These gamma ray curves are used to obtain geological information and semi-quantitative radiometric analysis of the mineralized zones. (Auth)

<493>

Cook, K.L., and C.K. Moss; USGS, Washington, DC

Geophysical Observations in Parts of the Grants District, McKinley County, New Mexico. TEI-244. 16 pp. (1952)

Geophysical observations near Haystack Mesa in the Grants district had the dual objective of investigating the unusual occurrence of negative aeromagnetic anomalies in close association with airborne radioactivity anomalies and of investigating other geophysical methods which might assist in the search for uranium ores in the Grants district. Ground magnetometer tests indicate that the apparent correlation shown in the airborne data is fortuitous and cannot be attributed to a genetic relationship between uranium mineralization and the intrusion of dikes or the extrusion of the basaltic lava flow. (Auth)

<494>

Not given; US Department of the Interior, Bureau of Indian Affairs, Albuquerque Area Office and Ute Mountain Ute Agency, Albuquerque, NM

Final Environmental Statement of the Approval by the Department of the Interior of a Lease of the Ute Mountain Ute Tribal Lands for Uranium Exploration and Possible Mining. FES-75-94, 190 pp. (1975)

The Department of the Interior has approved this project, leased by the Ute Mountain Ute Tribal lands, for the purpose of exploring and possibly mining uranium and related minerals. The project will consist of a four-year development phase and an appropriate twelve years of mining and possible processing. The entire project is based on the assumption that exploration will reveal commercial ore bodies that will be mined by underground methods. Radon gas will be one of the air pollutants. Surface erosion in selected areas will occur. The biological community will be affected and the aesthetics of the area will be noticeably impacted adversely. (Auth)

<495>

Dennison, J.M., and W.H. Wheeler;
University of North Carolina, Department of Geology, Chapel Hill, NC

Precambrian Through Cretaceous Strata of Probable Fluvial Origin in Southeastern United States and Their Potential as Uranium Host Rocks.
GJO-4168-1, 268 pp.; Southeastern Geology, Special Publication No. 5, 210 pp. (1972, February 1)

The report furnishes information that will provide a basis for evaluating the fluvial sandstones of the southeastern United States as a possible source of uranium. The report is based on literature review supplemented by the writers' field experience. Roughly a thousand geologic documents were examined, and 376 are specifically cited in the discussion of 25 stratigraphic units which are or may be nonmarine fluvial and deltaic in origin. Maps are presented showing the outcrop pattern of each unit, with thickness and other information. A summary description is given of the stratigraphic occurrence, petrography, provenance, and sedimentary structures including indication of current vectors. Factors affecting ground water circulation, past or present, are evaluated in an effort to locate conditions favorable for uranium ore development. Redbeds may serve as indicators of oxidizing facies and are therefore important. The boundary between oxidizing (red or drab) and reduzate (gray, greenish, or black coloration) facies are delimited where possible. One aim of the report is to locate the counties in which each stratigraphic unit appears to be most favorable for uranium on the basis of host rock characteristics. This should facilitate field examination of the rocks for more specific indications of uranium deposits. (Auth)(PAG)

Southeastern Geology Special Publication No. 5, published in July, 1975, is entitled "Stratigraphy of Precambrian Through Cretaceous Strata of Probable Fluvial Origin in Southeastern United States and Their Potential as Uranium Host Rocks".

<496>

Sears, R.S., D.K. Marjaniemi, and J.T. Blomquist; Lucius Pitkin Incorporated, Geology Division, Grand Junction, CO

A Study of the Morrison Formation in the San Juan Basin, New Mexico and Colorado. GJO-912-20, 102 pp. (1974, January)

The objective of the study was to analyze relative favorability of the members of the Morrison Formation and to delineate areas of optimum favorability for uranium accumulation and concentration. Stratigraphic units studied were the Todilto Limestone, Summerville Formation, Bluff Junction Creek Sandstone, Morrison Formation and Burro Canyon Formation. Emphasis was placed on the Salt Wash, Recapture, Westwater Canyon and Brushy Basin Members of the Morrison Formation. Analyses of these units included measuring and sampling of surface sections, chemical and mineralogical sample analyses, and examination of petroleum test well cutting samples and electric and gamma ray logs. The Westwater Canyon Member has the highest overall favorability and the Recapture Member has a slightly lower favorability. The Brushy Basin Member and Burro Canyon Formation are not considered of sufficient potential to warrant further evaluation. (Auth)(PAG)

<497>

Bowie, S.H.U.; Institute of Geological Sciences, London, United Kingdom

Some Geological Concepts for Consideration in the Search for Uranium Provinces and Major Uranium Deposits. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 285-300). 386 pp.; IAEA-PL-391 27, (pp. 285-300). 386 pp.

(1970, October

The discovery of the major uranium ore provinces of the world has depended more on the application of geological knowledge than on the use of the wide range of electronic appliances at the disposal of the prospector or mining company. This does not mean, however, that such instruments have not been - and still are - of immense value in the specific location of uranium ore bodies. Isotope ratio studies have shown that the ore-forming processes extended in many instances over hundreds of millions of years and this, together with mineragraphic (ore microscopy) evidence, suggests that uranium is epigenetic in the case of most major peneconcordant deposits. The most favorable environments for the discovery of new uranium provinces and major uranium deposits are considered to be intracratonic sediments, miogeosynclinal sediments, and sediments in intermontane basins in uranium provinces, particularly if there are associated acid igneous intrusive or eruptive rocks. (Auth)

<498>

Sorensen, H.; University of Copenhagen, Institute of Petrology, Copenhagen, Denmark

Occurrence of Uranium in Alkaline Igneous Rocks. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 161-168), 386 pp.; IAEA-PL-391/23, (pp. 161-168), 386 pp. (1970, October)

The major types of uranium mineralization associated with alkaline rocks are briefly reviewed: (1) disseminated mineralization in alkali granite, nepheline syenite and alkali trachyte and related vein deposits; (2) nepheline syenite pegmatites in which radioactive minerals are associated with late zeolitization and albitization; and (3) hydrothermal and metasomatic deposits occurring as veins and impregnations in and around alkaline rocks. The chances of finding uranium deposits are considered best in and around agpaitic nepheline syenites and peralkaline syenites and granites rich in Zr, rare earths and Nb minerals. (Auth)

<499>

Zeller, E.J., E.A. Dreschhoff, K. Holdoway, W. Hakes, G. Jayaprakash, K. Crisler, and D.F. Saunders; University of Kansas, Radiation Physics Laboratory, Space Technology Center, Lawrence, KS; Texas Instruments Incorporated, Dallas, TX

Potential Uranium Host Rocks and Structures in the Central Great Plains. GJO-1642-1, 97 pp. (1975, November 15)

A new method of utilizing petroleum exploration gamma-ray well log data was tested in the western Kansas portion of the survey area. Gamma activities in the Dakota and Morrison formations were computer-processed by trend surface analysis, statistically analyzed, and the anomalies were compared with regional geomorphic lineaments derived from satellite imagery as well as regional geology, to draw conclusions as to their origin and significance. Conclusions are: possible uraniferous provinces have been outlined in the subsurface of western Kansas; the new well log data approach can be used to define potential uraniferous provinces in any well-explored petroleum region; the close spatial correlation between anomalies and regional geomorphic lineaments provides strong support for the concept that the lineaments represent vertical fracture zones which can act as preferred pathways for vertical fluid migration; and the location of the strongest anomalies over impervious salt bodies indicates that any uranium-bearing mineralizers must have moved down through the geologic section rather than upward. Recommendations are made to extend the application of the well-log approach, to do drilling and sampling to prove whether the anomalies are really due to uranium, and to add geobotanical and emanometric measurements during future studies. (Auth)(MBW)

<500>

West, W.S., and J.J. Matzko; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Vicinity of Teller and Cape Nome, Seward Peninsula, Alaska, 1946-47, Part 2: Reconnaissance in the Vicinity of Cape Nome, 1947. In USGS Circular 244, (pp.

5-8). 8 pp. (1953)

An early report on the Cape Nome, Seward Peninsula, Alaska, stated that granitic rocks there contain allanite as a common accessory mineral. Results of studies in 1947 indicate that very little allanite is present, and that the slight amount of radioactivity of the granitic complex is attributable to the accessory minerals zircon and sphene. (Auth)

<501>

White, M.G., and P.L. Killeen; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Lower Yukon-Kuskokwim Highlands Region, Alaska, 1947, Chapter A: Radioactivity Investigations in the Vicinity of Flat. In USGS Circular 255, (pp. 1-15). 18 pp. (1953

Investigations in 1947 in the Lower Yukon-Kuskokwim region, Alaska found that previously reported radioactivity in the vicinity of Flat is due to uraniferous zircon, an accessory mineral in monzonite. The monzonite intrudes mafic igneous and Upper Cretaceous sedimentary rocks. The maximum equivalent-uranium content of the zircon is 0.14 percent, and the average content is probably near 0.13 percent. Chemical analysis of one sample of the most radioactive zircon indicates approximately 0.12 percent uranium and 0.03 percent thoria. The radioactive elements apparently are most commonly associated with reddish-brown inclusions within the zircon crystals. Tests of sulfide-bearing veins, black shales, and other rock types in the area around Flat showed no significant amount of radioactive material. (Auth)(MBW)

<502>

Johnson, H.S., Jr.; USGS, Washington, DC

Uranium Resources of the Cedar Mountain Area, Emery County, Utah, A Regional Synthesis. USGS Bulletin 1087-B, (pp. 23-58). (1959)

The results of field reconnaissance and office study of the Cedar Mountain area, Emery County, Utah, suggest that the Chinle and Morrison formations and possibly the Cedar Mountain formation have further potential for sandstone-type uranium deposits in the area. Appraisals of unexposed units are based on the premise that primary sedimentary features are the major control of favorable ground. The Monitor Butte member and the Moss Back member of the Chinle formation are both considered generally favorable for uranium deposits. The Salt Wash member of the Morrison formation has been the source of about 90 percent of all uranium ore mined in the Cedar Mountain area but has not been found to contain deposits larger than a few hundred tons in size. Minor uranium occurrences also are known in the Brushy Basin member of the Morrison formation and in the upper shale member of the Cedar Mountain formation. Uranium in these deposits is associated with carbonaceous material in siltstone or claystone, and ore grades are commonly submarginal. These units may, however, contain fairly large tonnages of low-grade uranium-bearing rock. (Auth)(MBW)

<503>

Moxham, R.M.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Manley Hot Springs - Rampart District, East-Central Alaska, 1948. USGS Circular 317, 6 pp. (1954)

The occurrence of cobalt in lead-silver deposits near Manley Hot Springs, Alaska, is mentioned in several of the earlier publications of the Geological Survey; additional mineralogic data are sparse. In 1945 and 1947 radioactivity and mineralogic studies of Alaskan placer samples disclosed the presence of five radioactive minerals-eschynite, ellsworthite, columbite, monazite, and zircon-tin association with extensive gold-tin placer deposits in the Tofty area, a few miles north of the lead-silver deposits. On the basis of the mineral associations and the geographic relationship between the two types of deposits, field studies seemed warranted and were undertaken in 1948. Field work failed to disclose the bedrock source of the radioactive minerals in the gold-tin placers. None of the material collected from the lead-silver deposits showed any radioactivity, although the granite country rock has an average equivalent uranium content of 0.003 percent which is attributed mostly to disseminated monazite. No field evidence could be found to establish a geomorphic relationship between the two types of deposits. A few concentrates from gold-placer mines in the Eureka area northeast of Manley Hot Springs contain small amounts of monazite and radioactive zircon. Granitic rocks at nearby Elephant Mountain are also slightly radioactive due to monazite and are probably the ultimate source of the radioactive minerals in the placers of the Eureka area. (Auth)

<504>

West, W.S.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Darby Mountains, Seward Peninsula, Alaska, 1948. USGS Circular 300, 7 pp. (1953)

Radioactivity in the southern and eastern parts of the Darby Mountains, Seward Peninsula, Alaska, appears to be directly related to the occurrence of granite. Concentrates from placers derived from areas containing granite are more radioactive than concentrates from placers not derived from the granite and, generally, contain from 0.01 to 0.05 percent equivalent uranium. The radioactivity of these concentrates is largely due to radioactive elements in common accessory minerals in granite, such as sphene, allanite, zircon, and, locally, monazite. Locally, in the Clear Creek-Vulcan Creek area, the headwaters of the Kwiniuk River, and on Golovnin Bay near McKinley Creek, concentrates from placers derived from granitic terrain contain as much as 0.1 percent equivalent uranium. The higher radioactivity of the concentrates from the Clear Creek area and on Golovnin Bay is due chiefly to an unidentified uranium-titanium niobate, whereas the higher radioactivity at the headwaters of the Kwiniuk River is due to thorianite. (Auth)

<505>

White, M.G., W.S. West, and J.J. Matzko; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Vicinity of Teller and Cape Nome, Seward Peninsula, Alaska, 1946-47. USGS Circular 244, 8 pp. (1953)

Reconnaissance for radioactive deposits occurred in 1946-1947 near the Teller and Cape Nome areas on Seward Peninsula, Alaska. The report discusses the geology and radioactivity investigations of each region. No significant amounts of radioactive material were found in either area; however, zircon, sphene, and allanite contribute minor concentrations. (MBW)

<506>

White, M.G., and P.L. Killeen; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Lower Yukon-Kuskokwim Highlands Region, Alaska, 1947. USGS Circular 255, 18 pp. (1953)

Reconnaissance for radioactive deposits took place in 1947 in the Lower Yukon-Kuskokwim Highlands Region, Alaska. The areas investigated were Flat, Julian Creek, Moore Creek, Candle Creek, and Cripple Creek Mountains. The report examines the geology, geography, and radioactivity of each area. Uraniferous zircon, averaging 0.13 percent equivalent uranium was discovered in the Flat vicinity. Julian Creek was the only placer deposit which contained appreciable radioactivity; 0.03 percent equivalent uranium, which was attributed to thorium in monazite. (MBW)

<507>

De Vergie, P.C.; AEC, Grand Junction, CO

Preliminary Drilling at the Nash Car Area, White Canyon District, San Juan County, Utah. RME-4032, 13 pp. (1953)

Copper-uranium deposits in the Nash Car area occur in the Shinarump conglomerate of Triassic age in gray sandstone and conglomerate at or near the base of channels cut into the underlying Moenkopi formation of Triassic age. This unit is as much as 10 feet thick, is about 100 to 150 feet wide, and has an unknown length. Chalcopyrite and pyrite replace carbonaceous material and are disseminated in the surrounding sandstone. Secondary copper minerals and limonite appear on the weathered outcrop. No uranium minerals are visible although the rock locally contains ore-grade quantities of uranium. The report includes a map of the drilling and sections compiled from the logs of core. (Auth)

<508>

Reinhardt, E.V.: AEC, Grand Junction, CO

Practical Guides to Uranium Ores on the Colorado Plateau. RME-1027, 13 pp. (1952)

This report presents and discusses a list of guides to uranium ore. Items 1 through 4 are syngenetic features, and items 5 through 11 are epigenetic. They are not necessarily listed in order of importance. 1. Presence of fossil stream channels. 2. Thickening of sandstone lenses. 3. Interfingering of mudstone and sandstone lenses. 4. Presence of carbonaceous material. 5. Proximity of ore. 6. Relation to mountain masses and large folds. 7. Bleaching of sandstone. 8. Bleaching of mudstone adjacent to sandstone lenses. 9. Presence of yellow iron-oxide stains. 10. Presence of bleached mudstone pebbles in the sandstone lenses. 11. Etched and corroded sand grains. (Auth)

<509>

Reinhardt, E.V.: AEC, Grand Junction, CO

Reconnaissance of Henry Mountains Area, Wayne and Garfield Counties, Utah. RMO-753, 7 pp. (1951)

Uranium ore deposits occur in sandstone of the Salt Wash member of the Morrison formation of Jurassic age in a strip about three miles wide along the east flank of the Henry Mountains. Tertiary laccolithic intrusives in a structural basin form the core of the Henry Mountains. The uranium deposits are found in three districts: the North Wash, the Trachyte, and the Little Rockies districts, from north to South. The deposits are of good grade and apparently are quite extensive, but many are thin. Development and production have been limited mostly by the long distance to shipping points and buying stations. (Auth)

<510>

Malan, R.C.: AEC, Resource Division, Geologic Branch, Grand Junction, CO

Summary Report-Distribution of Uranium and Thorium in the Precambrian of the Western United States. AEC-RD-12, 59 pp. (1972, March)

An investigation of the distribution of uranium and thorium in Precambrian rocks in the western United States was made to assess the possibilities for the existence of economically exploitable uranium deposits similar to the major deposits of Precambrian age in the Canadian Shield and compare and evaluate the distribution of uranium and thorium in the Precambrian to the distribution of major uranium deposits in Mesozoic and Cenozoic sedimentary rocks in the western United States. Thorium, and to a lesser extent uranium each correlate positively with potassium because of the strong petrographic control on radioelement distributions in igneous rocks. Regional averages of radioelements in Precambrian igneous rocks are greatest in Colorado, Wyoming, and southern California-southern Nevada. The Th K and U K ratios also are anomalously high in these enriched regions. Variations in radioelement contents in the igneous rocks do not appear to be related to the age of the rocks. The distributions of major uranium deposits in Mesozoic and Cenozoic sandstones of the Cordilleran foreland platform (Mesozoic and Colorado Plateau) and in basins within the Rocky Mountain foldbelt (Tertiary of Wyoming) are spatially related to patterns of radioelement enrichment in Precambrian rocks. The Precambrian appears to be the source of the uranium in the major Mesozoic and Cenozoic deposits either through "granite-leach", "tuff-leach", or both. Recognition of regional pattern of uranium enrichment in Precambrian rocks as indicated in the study should be useful as regional exploration guides. (Auth)(PAG)

<511>

Malan, R.C., and D.A. Sterling: AEC, Resource Division, Geologic Branch, Grand Junction, CO

A Geologic Study of Uranium Resources in Precambrian Rocks of the Western United States, Distribution of Uranium and Thorium in the Precambrian of the West-Central and Northwest United

States. AEC-RD-11. 64 pp. (1970, May)

The study of the distribution of uranium and thorium in lithologic, geochronologic, and geographic subdivisions of Precambrian rocks includes data on Colorado, Utah, Wyoming, South Dakota, Montana, Idaho, and Washington. Reconnaissance sampling indicated 19 locations with greater than 8 ppm U and/or 50 ppm Th including seven in Colorado, 11 in Wyoming, and one in Montana. All are believed to be igneous or metaigneous and nearly all are quartz monzonitic or granitic in composition. Additional sampling in the localities of the anomalous reconnaissance samples indicates that the mean value of 57 ppm Th in the southern half of the Longs Peak-St. Vrain Batholith in the central portion of the Front Range, Colorado and the mean value of 7.0 ppm U in the Cotopaxi-Texas Creek batholith in the northern Wet Mountains, Colorado are the highest of all mean values in large areas of exposed Precambrian terrane in the west-central and northwest United States. The four mountain ranges in which the mean uranium content of all Precambrian rocks combined is greater than 4 ppm include the Seminoe-Shirley Mountains, the Granite Mountains, the Owl Creek Mountains, all in central Wyoming and the Front Range in Colorado. The strongest determinant of the average uranium and thorium in various ranges is the aerial extent of silicic igneous rocks relative to other rocks. The silicic igneous rocks characteristically contain about twice as much uranium and thorium as intermediate igneous rocks and metamorphic rocks. (Auth)(PAG)

<512>

Malan, R.C., and D.A. Sterling; AEC, Resource Division, Geologic Branch, Grand Junction, CO

A Geologic Study of Uranium Resources in Precambrian Rocks of the Western United States, an Introduction to the Distribution of Uranium and Thorium in Precambrian Rocks Including the Results of Preliminary Studies in the Southwestern United States. AEC-RD-9. 54 pp. (1969, January)

The study of the Precambrian in the southwestern United States attempts to determine if there are exploitable uranium resources of Precambrian age and if there are time-space-facies patterns of uranium and thorium enrichment in the Precambrian that are related to the major stratiform uranium deposits in Mesozoic and Cenozoic continental clastic sediments. From the east in New Mexico to the west in southeastern California, the mean uranium and thorium contents increase significantly in igneous and in metamorphic rocks. Nearly all of the 21 bulk samples that contain statistically anomalous amounts of uranium and/or thorium are from west of the 112 degree meridian near Phoenix. These regional variations may be related to more felsic, higher-energy sedimentary facies with an inferred nearby continental provenance in the western portion in contrast to lower-energy geosynclinal facies in the central and eastern portions of the presently exposed Precambrian in the southwestern United States. (Auth)(PAG)

<513>

Malan, R.C., and D.A. Sterling; AEC, Resource Division, Geologic Branch, Grand Junction, CO

A Geologic Study of Uranium Resources in Precambrian Rocks of the Western United States, Distribution of Uranium and Thorium in Precambrian Rocks of the Western Great Lakes Region. AEC-RD-10. 25 pp. (1969, July)

In Wisconsin and in upper Michigan, Lower, Middle, and Upper Precambrian silicic and hyperalkalic plutonic rocks contain anomalous amounts of disseminated radioactive minerals. Limited sampling indicates that masses of silicic igneous rocks in northeastern Wisconsin may contain 50 to 100 parts per million uranium oxide. In upper Michigan, Middle Precambrian metasediments of the Animikie Series contain uranium veins in slate, monazite placers in conglomerate and irregular concentrations of uranium in iron formations adjacent to slate. A potentially great resource of thorium may exist in the monazite placers in conglomerates of the Goodrich Quartzite (Animikie Series) near Palmer in upper Michigan, but the uranium content is very low. Anomalous amounts of uranium in sparse outcrops of other conglomeratic quartzites of the Animikie warrant additional study. (Auth)(PAG)

<514>

Kleinhampl, F.J.; USGS, Washington, DC

Botanical Prospecting for Uranium on South Elk Ridge, San Juan County, Utah. USGS Bulletin 1085-D, (pp. 105-188). (1962)

The plant-analysis prospecting method was used to search for uranium deposits in rocks of the lowest 40 feet of the Chinle formation of Late Triassic age on South Elk Ridge, San Juan County, Utah. Collection of plant samples was generally restricted to trees growing in a single line along steep slopes and canyon walls, because only here were trees sufficiently close to the ore-bearing strata to permit successful prospecting. For optimum prospecting results, sampled evergreens should grow no more than 20 feet above the ore zone. By inference, this depth restriction is probably applicable wherever similar ecology prevails. A sample interval of 50 to 60 feet appears to be adequate for delimiting the lateral extent of botanical anomalies. Branch-tip samples, the type generally used in plant-analysis prospecting for uranium, are representative of the trees, and thus are satisfactory in plant-analysis prospecting programs. Plant-analysis prospecting along 30 linear miles of basal strata of the Chinle formation found 110 localities that are probably mineralized. Based on geologic criteria at the localities, at least 55 could contain minable quantities of uranium. According to the more realistic of two interpretations of drill tests, plant-analysis prospecting is about twice as successful as random drilling in locating mineralized material. Closely spaced drilling at botanical anomalies is slightly less successful than similar drilling at geologically selected channel-fillings. Drill tests indicate that amounts of uranium in the rooting medium as small as 10 to 20 ppm locally suffice for trees to absorb unusually large amounts. Because of this and complicating environmental factors, it is impossible to predict reliably the grade and precise extent of deposits. (Auth)(PAG)

<515>

Kleinhampl, F.J., and C. Koteff; USGS, Washington, DC

Botanical Prospecting for Uranium in the Circle Cliffs Area, Garfield County, Utah. USGS Bulletin 1085-C, (pp. 85-104). (1960)

The plant-analysis method of botanical prospecting may be used to locate uranium deposits in the Circle Cliffs area where the deposits lie as much as 70 feet beneath the surface of benches developed on the Shinarump member of the Chinle formation. The Shinarump underlying the benches is thicker than 70 feet at many places, however, and thus restricts the use of the plant-analysis prospecting method. The plants ASTRAGALUS PATTERSONI and STANLEYA PINNATA broadly define some uraniferous localities adjacent to the contact of the Moenkopi formation and the Shinarump member of the Chinle formation, but the general paucity of ASTRAGALUS in the Circle Cliffs area limits the usefulness of this genus. ASTRAGALUS PATTERSONI, STANLEYA PINNATA, and ASTER VENUSTUS may serve as guides to mineralized parts of the Salt Wash sandstone member of the Morrison formation in the Circle Cliffs area. Thick and thin units of sandstone of the Shinarump member generally can be distinguished by studies of the ratios of pinyons to junipers. These studies may supplement drilling to define channel-fill sandstone, which is associated with ore deposits in the Circle Cliffs area. Ratio studies appear to be applicable to other areas throughout the Colorado Plateau where similar geologic and ecologic conditions exist. (Auth)

<516>

Froelich, A.J., and F.J. Kleinhampl; USGS, Washington, DC

Botanical Prospecting for Uranium in the Deer Flat Area, White Canyon District, San Juan County, Utah. USGS Bulletin 1085-B, (pp. 51-84). (1960)

The plant-analysis method of botanical prospecting for concealed uranium deposits was employed from May to July 1953, in the Deer Flat area, White Canyon district, San Juan County, Utah. About 2,000 samples of tips of branches from as many junipers and pinyons were systematically collected along about 27 miles of outcrop of the Shinarump member of the Chinle formation of Triassic age or of laterally equivalent units and were analyzed in the laboratory for uranium content. Anomalously large amounts of uranium absorbed by trees imply a nearby source, which may be an ore deposit. The indicator-plant method of prospecting di^d not prove very useful in the Deer Flat area. Botanically defined anomalies occur at all major known deposits at Deer Flat. Other botanically defined anomalies may reflect previously unknown mineralized parts of the Shinarump member. The distribution of botanical anomalies suggests that the south half of the Deer Flat area is much more favorable for concealed uranium deposits than the north half. Additional physical exploration is recommended at Deer Flat to test the validity of the plant-analysis method of prospecting for uranium. The finding of mineralized ground at botanical anomalies would verify the reliability of the botanical-prospecting method for defining mineralized areas. (Auth)

<517>

Little, H.W.; Canada Geological Survey, Ottawa, Ontario, Canada

Distribution of Types of Uranium Deposits and Favorable Environments for Uranium Exploration. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Agency Publications, Vienna, Austria, (pp. 35-48), 386 pp.; IAEA-PL-391/2, (pp. 35-48), 386 pp. (1970, October)

Productive uranium deposits in Canada are of four types: conglomeratic, hydrothermal veins and disseminations with simple mineralogy, hydrothermal veins and disseminations with complex mineral associations, and pegmatitic. All occur in the Canadian Shield near its edge. Extensions of known deposits and new orebodies adjacent to known ones have been outlined recently, notably at Elliot Lake, Bancroft and Beaverlodge. In addition, promising indications of deposits in new districts, both of the types above and of new types not previously reported in Canada have been uncovered in several parts of the country. Mineralization has been reported in the Cypress Hills of Saskatchewan and at Padlei and Baker Lake in District of Keewatin, but little exploratory drilling has been done in Keewatin. More promising discoveries have been made at Rabbit Lake in Saskatchewan, Makkovik-Kaipokok area in Labrador, and at some other localities from which information is not yet available for publication. New discoveries have confirmed some predictions of favorable environments for certain types of uranium deposits: for example pyritiferous conglomerates of Early Proterozoic age wherever found are in varying degrees uraniferous, but similar conglomerates of Late Proterozoic age are not. Lignitic uranium deposits are being drilled in Oligocene beds predicted to be favorable. In the Canadian Shield new discoveries have been made of pegmatitic and of vein and replacement deposits in areas that had previously been pointed out to be lithologically and/or structurally favorable. (Auth)

<518>

Wedow, H., Jr., W.S. West, A.E. Nelson, J.J. Matzko, J.R. Houston, R.S. Velikanje, R.G. Bates, P.L. Killeen, F.A. Stejer, and A. Grantz; USGS, Washington, DC

Preliminary Summary of Reconnaissance for Uranium and Thorium in Alaska, 1952. USGS Circular 248, 15 pp. (1953)

Reconnaissance for uranium and thorium in Alaska during 1952 was centered chiefly in parts of the lower Yukon-Kuskokwim region and northeastern, east-central, south-central, and southeastern Alaska. Reconnaissance in the northern part of Prince of Wales Island and parts of adjacent islands in southeastern Alaska found that the radioactive carbonate hematite veins in the vicinity of Salmon Bay are probably limited in areal extent to the Prince of Wales Island coast from near Exchange Cove to Point Colpoys. The veins seem to be almost entirely thorium-bearing at the surface and range from less than 1 inch to about 2 feet in thickness. They contain a maximum of about 0.1 percent equivalent uranium and an average of about 0.03 percent equivalent uranium. Investigations in the Hyder area and the Taku Harbor-Point Astley district failed to locate significant concentrations of uranium minerals. No uraniferous lodes were discovered in the Koyukuk-Chandalar region, nor was the source of the monazite, previously reported in the placer concentrates from the Chandalar mining district, located. The source of the uranothorianite in the placers at Gold Bench on the South Fork of the Koyukuk River was not found during a brief reconnaissance, but a placer concentrate was obtained that contains 0.18 percent equivalent uranium. It is about ten times more radioactive than concentrates previously available from the area. Reconnaissance for possible lode concentrations of uranium minerals in the vicinity of reported fluorite occurrences in the Hope Creek and Miller House-Circle Hot Springs areas of the Circle Quadrangle and in the Fortymile district, east-central Alaska, found 0.055 percent equivalent uranium in a float fragment of ferruginous breccia in the Hope Creek area; analysis of samples obtained in the vicinity of the other fluorite occurrences showed a maximum of only 0.005 percent equivalent uranium. Examination of silver-lead and molybdenum occurrences and of a reported nickel prospect in the eastern Alaska range revealed no radioactivity in excess of 0.004 percent equivalent uranium. Samples taken during radiometric reconnaissances at a zeunerite-bearing copper lode in the Russian Mountains and two molybdenum lodes along the lower Yukon River in the lower Yukon-Kuskokwim region contain no more than 0.004 percent equivalent uranium. Radiometric tests in the Nelchina area and Prince William Sound, south-central Alaska, and in the York tin district, Seward Peninsula, by Geological Survey parties conducting other investigations found no new occurrences of rocks or ore deposits containing significant quantities of radioactive minerals. (Auth)

<519>

Gault, H.R., R.F. Black, and J.B. Lyons; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951, Chapter A: Sweepstakes Creek Area, 1945. In USGS Circular 250, (pp. 1-10), 31 pp. (1953)

Field investigations with a Geiger-Mueller counter were made of the creek gravels and the placer-gold paystreak on the bench ground of Sweepstakes Creek and its tributaries, the syenite stock of Granite Mountain to the north of Sweepstakes Creek, and the creek gravels of Rube and Anzac Creeks which are tributaries of the Peace River east of the syenite stock. The content of radioactive minerals in the gravels and in the placer-gold "paystreak" was found to be disappointingly low. Where concentration ratios were between 45 and 169 to 1, the content of concentrates from the creek gravels was only 0.001 to 0.016 percent equivalent uranium. The average content of the creek gravels in place is computed as 0.0001 percent equivalent uranium. The placer-gold paystreak was not accessible in place, but the content was computed as 0.0003 percent equivalent uranium from the sluice-box concentrates and tailings at Winder's open-cut, the only active placer mine in the area in 1945. Crushed syenite samples from 14 localities show a content of radioactive material ranging from 0.001 to 0.013 percent equivalent uranium. Two radioactive minerals have been recognized from the photographic effects obtained on alpha-ray plates, and are tentatively identified as uraninite-thorianite and hydrothorite. The content of radioactive minerals in the placer deposits is believed to be too low for them to be significant as sources of uranium. (Auth)(MBW)

<520>

Killeen, P.L., and M.G. White; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951, Chapter C: South Fork of Quartz Creek, 1946. In USGS Circular 250, (pp. 15-20), 31 pp. (1953)

Two uranium-bearing minerals, uranothorianite and thorite, were found in the stream gravels of the main branch of the South Fork of Quartz Creek, a tributary of the Kiwalik River. Although the bedrock source of the minerals was not located, the radioactive material was traced in slope wash well above the stream gravel. A detailed investigation of the area with more sensitive portable survey meters might reveal the source of the minerals and localities where the minerals are sufficiently concentrated to be minable. (Auth)

<521>

West, W.S.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Northeastern Part of the Seward Peninsula, Alaska, 1945-47 and 1951, Chapter E: Headwaters of the Peace River. In USGS Circular 250, (pp. 28-31), 31 pp. (1953)

Reconnaissance in 1947 found uranothorianite and gummite associated with copper sulfides, iron oxides, molybdenite, gold, silver, bismuth, and thorite in placers of a headwater tributary of the Peace River in the eastern part of the Seward Peninsula, Alaska. The concentrates from these placers contain as much as about 0.8 percent equivalent uranium, or about ten times the equivalent uranium content of the average uranothorianite-bearing concentrates from other placers in the eastern Seward Peninsula. Brief radiometric reconnaissance early in the summer of 1952 failed to locate the bedrock source of the radioactive minerals at the head of the Peace River, primarily because of the shielding-effect of widespread tundra cover. The samples obtained in 1952 indicate the presence of galena, sphalerite pyrrhotite, covellite, and fluorite in addition to the minerals reported in the results of the 1947 reconnaissance. In these samples the intimate association of pyrite, sphalerite, chalcopyrite, and galena in discrete grains in the placers, but not in the granite country rock, indicates a possible lode source for the sulfides. Gummite, believed to be a decomposition product of the uranothorianite, occurs in mineral grains with tetradymite, galena, and pyrite; this also suggests that the uranium minerals occur along with the sulfides in a lode deposit, possibly a vein, which is located somewhere in an area of about one-half square mile lying upstream from the topographically highest placer sample. (Auth)

<522>

Keller, G.V.; USGS, Washington, DC

Directional Resistivity Measurements in Exploration for Uranium Deposits of the Colorado Plateau. USGS Bulletin 1083-B, (pp. 37-72). (1959)

A study of the electrical properties of the Morrison formation in the Uravan mineral belt of the Colorado Plateau province indicated that there is a significant correlation between electrical resistivity and the relative favorability for occurrence of ore. The differences in resistivity were not large enough to provide a recognizable target for standard resistivity field methods, especially where the ore-bearing sandstone member is more than a few hundred feet deep. Measurement of resistivity trends by placing one electrode in a drill hole and spreading the others out radially on the surface seemed to offer a means of exploiting the resistivity-favorability correlation. Field tests of such directional-resistivity measurements were made in the Spud Patch area in San Miguel County, Colorado, and the White Canyon district, San Juan County, Utah. A comparison of the resistivity trends thus determined with the favorability estimated from geologic indexes indicated that directional-resistivity methods could predict the location of favorable areas at distances of 600-1,000 feet with a high degree of success. In the White Canyon district directional-resistivity measurements were made on the assumption that the conglomerate which is found in many channels filled with the Shinarump member of the Chinle formation has a high resistivity. The measurements were successful in tracing the channel conglomerate where surface conditions were favorable. (Auth)(MBW)

<523>

Granger, H.C., and R.B. Raup; USGS, Washington, DC

Reconnaissance Study of Uranium Deposits in Arizona. USGS Bulletin 1147-A, (pp. 1-54). (1962)

Between 1950 and 1954 a large number of deposits in Arizona were examined in search of uranium-bearing minerals in minable concentrations. Five of the localities are of particular interest, either because uranium is produced from them or because of their unusual geologic setting. The deposit of the Orphan claim, in Coconino County, contains material equivalent in radioactivity to as much as 12.5 percent uranium in a pipelike body, and the deposit exposed in Hack's mine in Mohave County is in a somewhat similar pipe. The deposits in the Dripping Spring quartzite of Precambrian age in Gila County are unusual in that they appear to be genetically related to diabase. A considerable quantity of uraninite-bearing ore has been produced from several of the many deposits in siltstone, and siltstone metamorphosed to hornfels, within the Dripping Spring. The economic possibilities of the Annie Laurie prospect in Santa Cruz County could be evaluated by exploratory drilling to the east of the eastward-dipping fault zone. Specimens of uranium ore found on the dumps of the Abe Lincoln mine in Yavapai County may indicate the presence of small but rich pockets of ore in the mine, but the workings are inaccessible because of caving and flooding. (Auth)(MBW)

<524>

Weis, P.L., F.C. Armstrong, and S. Rosenblum; USGS, Washington, DC

Reconnaissance for Radioactive Minerals in Washington, Idaho, and Western Montana, 1952-1955. USGS Bulletin 1074-B, (pp. 7-48). (1958)

About 50 occurrences of radioactive minerals and nearly 50 properties not abnormally radioactive were examined during geologic reconnaissance for radioactive minerals in Idaho, Washington, and western Montana during the period July 1952 to June 1955. The most important uranium deposits are in or near granitic to quartz monzonitic intrusions of probable Cretaceous age in central and northern Idaho, westernmost Montana, and northeastern Washington. These areas are considered to be most favorable for prospecting. Margins of granitic intrusive bodies in central Montana and western Washington may also be favorable. Uranium-bearing pegmatites associated with granitic intrusive rocks are considered too small and too low grade to be potential sources of uranium. Some placer deposits in southern and central Idaho contain sufficient concentrations of uranium minerals to be of interest as a source of uranium. Known thorite-bearing veins are confined to Precambrian rocks of the Belt series in northern and east-central Idaho and southwestern Montana. Monazite-rich layers in metamorphic rocks in east-central Idaho do not seem large enough and continuous enough to permit profitable mining. (Auth)

<525>

White, M.G., and J.M. Stevens; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Ruby-Poorman and Nixon Fork Districts, West-Central Alaska, 1949, Chapter A: Ruby-Poorman District. In USGS Circular 279, (pp. 1-9), 19 pp. (1953)

Reconnaissance for radioactive deposits in the Ruby-Poorman district, Ruby quadrangle, central Alaska during July 1949 showed that two small bodies of granite in the Long area, contain an average of 0.005 percent equivalent uranium. This radioactivity is due chiefly to a uraniferous thorium silicate, tentatively identified as uranothorite, which is disseminated in the granite. Other minerals, such as sphene, allanite, and zircon, that contain radioactive elements as impurities, however, also contribute to the total radioactivity of the granite. The uranothorite contains about 57 percent thorium and 8 percent uranium. Search for the bedrock source of a radioactive mineral of the spinel group which occurs in placers on upper Solomon Creek in the Poorman area was unsuccessful. Radiometric traversing indicated no anomalous radiation at a silver-bearing galena deposit on New York Creek in the Ruby area. Although it is believed that there is little possibility of commercial deposits of uranium in the Ruby-Poorman district, it should be noted that the heavy cover of vegetation and alluvium prevents complete coverage of the district by radiometric surveying. (Auth)

<526>

White, M.G., and J.M. Stevens; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Ruby-Poorman and Nixon Fork Districts, West-Central Alaska, 1949, Chapter B: Nixon Fork District. In USGS Circular 279, (pp. 10-19), 19 pp. (1953)

Reconnaissance for radioactive deposits in the Nixon Fork mining district, Medfra quadrangle, central Alaska, in 1949 disclosed the occurrence of allanite in samples containing as much as 0.05 percent equivalent uranium from the dump of the Whalen mine; the presence of radioactive parisite (a rare-earth fluocarbonate) in a highly altered limestone containing about 0.025 percent equivalent uranium near the Whalen shaft, and radioactive idocrase in samples of altered garnet rock with about 0.025 percent equivalent uranium, from the Crystal shaft of the Nixon Fork mine. This radioactivity is due mostly to thorium rather than uranium. Placer concentrates from Ruby and Eagle Creeks contain 0.078 and 0.26 percent equivalent uranium respectively, in which the radioactivity is due chiefly to uraniferous thorianite. The bedrock source of the uraniferous thorianite was not located primarily because much of the area is overlain by a relatively thick mantle of vegetation (mostly moss) which limited the effectiveness of radiometric surveying. The uraniferous thorianite is believed to occur in a restricted zone or zones at or near the contact of limestone with monzonite similar to the gold-copper ores of the district and the deposits of radioactive parisite and garnet rock at the Whalen and Crystal shafts respectively. (Auth)

<527>

Moxham, R.M., and A.E. Nelson; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in South-Central Alaska, 1947-49, Part 2: Radioactive Pegmatite Minerals in the Willow Creek Mining District. In USGS Circular 184, (pp. 7-10), 14 pp. (1952)

During the summer of 1948 radioactive pegmatite float was found in the Willow Creek mining district. Laboratory examination showed a small amount of uraninite and thorite to be primarily responsible for the radioactivity. A brief field examination was made by the Geological Survey in 1949. Representative channel samples of 11 pegmatites average 0.004 percent equivalent uranium; the heavy-mineral fractions of the samples average 0.332 percent equivalent uranium. None of the pegmatites are of such dimensions as to be mined profitably. Dikes and veins in the area, although genetically related to the pegmatites, do not contain radioactive minerals. (Auth)

<528>

Moxham, R.M.; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in South-Central Alaska, 1947-49, Part 3: Radioactive Minerals in the Yakataga Beach Placers. In USGS Circular 184, (pp. 11-14), 14 pp. (1952)

The radioactivity of nine samples of beach placer deposits in the Yakataga area, southern Alaska, was studied in 1948. The heavy-mineral fractions from the concentrates average 0.044 percent equivalent uranium. Three minerals, all members of the zircon group, contain the radioactive material in the sample; one mineral is uranium-bearing, the other two are thorium-bearing. (Auth)

<529>

McKay, E.J.; USGS, Washington, DC

Criteria for Outlining Areas Favorable for Uranium Deposits in Parts of Colorado and Utah. USGS Bulletin 1009-J, (pp. 265-282). (1955)

Most of the uranium deposits in the Uravan and Gateway mining districts are in the persistent upper sandstone stratum of the Salt Wash member of the Morrison formation. Areas in which this stratum is predominantly lenticular have been differentiated from areas in which the stratum is predominantly nonlenticular. The most favorable ground for uranium deposits is in areas of lenticular sandstone where the stratum is underlain by continuous altered greenish-gray mudstone. Ore is localized in scour-and-fill sandstone beds within favorable areas of lenticular sandstone. Regional control of the movement of ore-bearing solutions in the principal ore-bearing sandstone zone is indicated by belts of discontinuously altered mudstone transitional in a northerly and southerly direction from an area of unaltered mudstone to areas of continuously altered mudstone; and an area of unaltered mudstone in which no ore deposits are found and an increase in size, number, and grade of ore deposits from areas of discontinuously altered to continuously altered mudstone. Discrete regional patterns of ore deposits and altered mudstone are associated with Tertiary structures; where these structures and favorable host rocks occur in juxtaposition, regional controls appear to have localized ore deposits. (Auth)

<530>

McKelvey, V.E.; USGS, Washington, DC

Search for Uranium in the United States. USGS Bulletin 1030-A, (pp. 1-64). (1955)

The search for uranium in the United States is the most intensive ever made for any metal during our history. The largest part of this search has been concentrated in the Western States. No vein deposit of major importance by world standards has been discovered, but the search has led to the discovery of important minable deposits in sandstones on the Colorado Plateau, Wyoming, and South Dakota and in coals in South Dakota; of large, low-grade deposits of uranium in phosphates in both the western and Florida fields, in black shales in Tennessee, and in coals in the Dakotas, Wyoming, Idaho, and New Mexico; and of some promising occurrences of uranium in vein deposits. Despite the fact that many of the districts considered favorable for deposits of uranium have already been examined, the outlook for future discoveries is bright, particularly for uranium in sandstone and vein deposits in the Rocky Mountain States. (Auth)(MBW)

<531>

Moxham, R.M., and A.E. Nelson; USGS, Washington, DC

Reconnaissance for Radioactive Deposits in the Southern Cook Inlet Region, Alaska, 1949. USGS Circular 207, 7 pp. (1952)

Reconnaissance for radioactive deposits took place in two Alaskan areas within the Southern Cook Inlet during 1949: the Iliamna Lake-Lake Clark Region, and the Jakolof Bay Region. The report discusses the radioactivity investigations of each. Two silver-lead prospects and five copper deposits were examined in the Iliamna Lake-Lake Clark region. The maximum equivalent uranium content found there did not exceed 0.009 percent. No radioactive material was discovered in the Jakolof Bay region. (MBW)

<532>

Tourtelot, H.A.; USGS, Washington, DC

Reconnaissance for Uraniferous Rocks in Northeastern Wind River Basin, Wyoming. TEM-445, 14 pp. (1952, August)

A reconnaissance search for uraniferous rocks in the northeastern part of the Wind River Basin was made in July and August 1951. In addition to Tertiary tuffs and associated lignite, coal, and carbonaceous rocks, some radioactivity anomalies, chiefly in granite, which had been detected by airborne equipment in November 1950, were checked on the ground. A tuff of middle or late Eocene age containing 0.003 percent uranium was as high in uranium as any rock found. One sample of granite also contained 0.003 percent uranium. The equivalent uranium content of the granite was two to five times as large as the uranium content, presumably due to the presence of thorium. Further investigations in the northeastern part of the basin do not seem to be warranted at the present time, but more reconnaissance testing will be done whenever work on other materials is undertaken there. (Auth)

<533>

Huleatt, W.P., S.W. Hazen, Jr., and W.M. Traver, Jr.; US Bureau of Mines, Washington, DC

Exploration of Vanadium Region of Western Colorado and Eastern Utah. US Bureau of Mines Report of Investigation 3930, 30 pp. (1946)

Core-drilling by the Bureau of Mines on the Colorado Plateau from May to December 1943, was done to stimulate wartime production of vanadium ore. Eight hundred ninety-five core-drill holes with an aggregate depth of 38,510 feet were distributed between 46 areas. Small maps and short descriptions of each of these areas together with assay data are included in the report. The deposits explored are carnotite ore bodies in the Morrison formation of Jurassic age. The ore bodies are tabular, irregular in shape, and generally conform to the bedding. The uranium and vanadium minerals impregnate the sandstone and locally may replace fossil wood. (Auth)

<534>

Kelley, D.R.; AEC, Grand Junction, CO

Drilling in the North Point No. 6 and Horn Channels, White Canyon, San Juan County, Utah. RME-63, 33 pp. (1954)

The Shinarump conglomerate of Triassic age in the North Point No. 6 and Horn channels was explored by 52 diamond-drill holes, two of which penetrated ore-grade material. No economic ore bodies were found. Uranium silicates and secondary copper minerals are locally present in the channels. It is thought that the sediments contain too little carbonaceous material and that the sandstone is too fine-grained to be a suitable host rock. (Auth)

<535>

Redmond, R.L., and J.P. Kellogg; AEC, Grand Junction, CO

Drilling at Polar Mesa, Grand County, Utah, and Review of Favorability Criteria Used. RME-22 (Part 1). 30 pp. (1954)

Vanadium-uranium deposits on Polar Mesa occur in a sandstone unit of the Salt Wash member of the Morrison formation of Jurassic age. This unit, called the "Payoff sand", is a massive, cross-bedded, medium- to fine-grained, yellow-brown sandstone that ranges from 10 to 70 feet in thickness. The base of the ore-bearing zone is about 270 feet above the easily recognizable Entrada-Summerville contact. Carnotite and roscoelite are associated with fossil trees and carbonaceous trash. The ore bodies are generally tabular and irregularly shaped and contain as much as 10,000 tons. A drilling program was conducted in an area near the northeast rim of the mesa. The "Payoff sand" was correlated between holes on the basis of regional dip. A favorability map of this zone was successfully constructed to guide further drilling. Factors considered favorable for uranium ore are the presence of: equal amounts of sandstone and mudstones; more sandstone than mudstones; more yellow-brown than gray sandstone; or blue-green mudstones. (Auth)

<536>

Poehlmann, E.J., and E.N. King; AEC, Salt Lake City, UT

Report on Wagon Drilling for Uranium in the Silver Reef (Harrisburg) District, Washington County, Utah. RME-2004. 24 pp. (1953)

An exploratory wagon-drilling program revealed two new uranium ore bodies in the Silver Reef district. The uranium deposits in the Silver Reef district are near the faulted north-plunging nose of the Virgin anticline. Silver, uranium, vanadium, and copper minerals occur in five carbonaceous, sandy shale zones of the Leeds and Tecumseh members of the Chinle formation of Triassic age. The most important uraniferous zone is a carbonaceous, cross-bedded, sandy shale which lies in the upper part of the Leeds sandstone. Mineralization has favored areas where relatively close-spaced normal faults of very small displacement cut the favorable beds. (Auth)

<537>

Jupiter, C., and H. Wollenberg; EG&G, Incorporated, Las Vegas, NV

Interim Status of the Texas Uranium Survey Experiment. EGG-1183-1630. 34 pp. (1974, April 26)

The Texas uranium survey field experiment began on June 13, 1973 employing a Martin-404 aircraft to fly gamma ray recording equipment at 500 feet altitude over two areas in southeast Texas. The areas surveyed are referred to as the Dubose area and the Clay West area. The objective of the experiment was to evaluate an improved method for prospecting for uranium by determining correlations among geologic analysis, soil sample radiochemical analysis, aerial radiometric data, aerial infrared scans, and aerophotographic data. The document briefly summarizes the work which has been done, describes the kind and quality of calibrations and data analysis carried out thus far and outlines recommended additional work which would bring the experiment to some degree of completion, providing a basis for evaluating the techniques. (PAG)

REMOTE SENSING

<538>

Salmon, B.C., and W.W. Pillars;
Environmental Research Institute of
Michigan, Infrared and Optics Division,
Ann Arbor, MI

Multispectral Processing of ERTS-A (LANDSAT) Data for Uranium Exploration in the Wind River Basin, Wyoming: A Visual Region Ratio to Enhance Surface Alteration Associated with Roll-Type Uranium Deposits. Report 110400-2-F. 129 pp.; GJO-1635-1. 129 pp. (1975, August)

The purpose of the report is to document possible detection capabilities of the LANDSAT multispectral scanner data for use in exploration for uranium roll-type deposits. Spectral reflectivity, mineralogy, iron content, and color parameters were measured for twenty natural surface samples collected from a semiarid region. The relationships of these properties to LANDSAT response-weighted reflectances and to reflectance ratios are discussed. It was found that the single ratio technique of multispectral processing is likely to be sensitive enough to separate hematitic stain, but not limonitic. A combination of the LANDSAT R5,4 and R7,6 ratios, and a processing technique sensitive to vegetative cover is recommended for detecting areas of limonitic stain. Digital level slicing of LANDSAT R5,4 over the Wind River Basin, after geometric correction, resulted in adequate enhancement of Triassic redbeds and lighter red materials, but not for limonitic areas. No recommendations for prospects in the area were made. Information pertaining to techniques of evaluating laboratory reflectance spectra for remote sensing applications, ratio processing, and planimetric correction of LANDSAT data is presented qualitatively. (Auth)

<539>

Schwarzer, T.F., and J.A.S. Adams; Esso Production Research Company, Houston, TX; Rice University, Houston, TX

Rock and Soil Discrimination by Low Altitude Airborne Gamma Ray Spectrometry in Payne County, Oklahoma. Economic Geology, 68, 1297-1312. (1973, December)

The ability to identify and discriminate rock and soil types from the air using gamma-ray spectrometry was investigated in Payne County, Oklahoma. The data, which were reduced to concentration values for K, U, and Th, were obtained from a helicopter at an average altitude of 75 feet above the ground. The area investigated was underlain by a variety of sedimentary rocks which encompassed a transitional sequence from continental deltaic deposits through marine sediments. Because of the shallow depths sensed aeroradiometrically (about one foot), the data were first related to the pedology of the area considering the regolith independent of underlying bedrock. However, it was soon discovered that in situ soils could only be distinguished to the extent that their parent lithologies could be discriminated. Concentrations of K, U, and Th determined from the air suggest that the "signatures" of these elements in underlying bedrock are largely preserved in in situ soils allowing the identification of lithologies and the discrimination of lithologic contacts from the air. Transported soils were generally distinguishable from in situ soils and hence, common lithologies of the area. A sequence of sedimentary formations was established on the basis of shale content. Quantitative estimates of percent clay were made using thorium contents as an indicator of clay (shale content) and an attempt was made to relate clay content to soil engineering properties. In an effort to find new improved means of aeroradiometric data presentation, a multivariate technique, cluster analysis, was used. This technique merged the K, U, and Th data and produced lihtologically significant groupings of rock formations. Such an approach might be used as a step toward generating a single "lithologic" map directly as opposed to the traditional individual element, multi-map technique currently used. The study emphasized that spectral data converted to concentration units (ppm or %) are superior to qualitative count rates (cps) or total radioactivity for the discrimination and identification of lithologies. Ratioed spectral data in the study area were relatively insensitive to

lithologic changes and suggest that anomalies may be enhanced by such a ratioing procedure. (Auth)

<540>

Tavelli, J.A.; AEC, Grand Junction, CO

Review of Airborne Radioactivity Survey Techniques in the Colorado Plateau.
RMO-697, 12 pp. (1951)

An airborne technique for rapidly prospecting for surface exposures of uranium deposits is being developed. It has been found that uranium concentrations of commercial grade can be detected from low flying fixed-wing aircraft, using simple instrumentation. Flight elevations of 50 feet at air speeds of about 60 miles per hour have produced successful results with commercially available scintillation equipment. The technique is applicable only to exposed deposits and does not eliminate the need for additional ground prospecting. (Auth)

ENVIRONMENTAL EFFECTS

<541>

Douglas, R.L., and J.M. Hans, Jr.; EPA, Office of Radiation Programs, Las Vegas, NV

Gamma Radiation Surveys at Inactive Uranium Mill Sites. ORP LV-75-5, 88 pp. (1975, August)

The report presents the results of gamma radiation surveys conducted by the Office of Radiation Programs-Las Vegas Facility of the U.S. Environmental Protection Agency at twenty inactive uranium mill sites in the Western United States. The purpose of these surveys was to measure the extent to which radioactive material had been spread into the environment from the sites by the action of wind and or water erosion, and by milling activities. The results indicate that hundreds of acres of land exclusive of the tailings piles have been contaminated to above-background levels. Some of the contaminated land is private, off-site property. Survey techniques were developed to locate the spread of radioactive materials and to estimate the gamma exposure rates resulting from them. These measurements were complicated by the presence of direct gamma radiation from the tailings piles. Iso-exposure rate lines were located around each site and plotted on site maps to facilitate site decontamination decisions. These lines, corresponding to post-cleanup exposure rates of background, 10 microroentgens per hour and 40 microroentgens per hour, were selected to correspond to current ORP criteria for decontamination of inactive uranium mill sites. (Auth)

URANIUM INDUSTRY

<542>

Not given; ERDA, Grand Junction, CO

Statistical Data of the Uranium Industry. GJO-100(76), 87 pp. (1976, January)

The report is an annual compilation of historical facts and figures on the United States uranium industry from 1947 to 1975. The report covers subjects such as production, resources, exploration, land holdings, employment, and uranium concentrate commitments and requirements. The statistics contained in the report have been compiled annually since January 1, 1968, by the Grand Junction Office for the use* of goverment and industry. (RRB)

<543>

Not given; ERDA, Division of Nuclear Fuel Cycle and Production, Office of Assistant Director for Raw Materials, Washington, DC

Survey of United States Uranium Marketing Activity. ERDA 76-46, 28 pp.; UC-51, 28 pp. (1976, April)

Information for the survey was rece.ved from 70 utilities with nuclear reactor projects, 33 present or potential uranium producers, and 5 reactor manufacturers. These companies represent virtually all the principal companies involved in uranium marketing activity. A list of participants is presented in an attachment of the report. The 1976 survey requested data on uranium purchase commitments, uranium imports and exports, unfilled reactor fuel requirements, inventories of domestic and foreign uranium, and prices for domestic buyers. The report covers 210 nuclear power reactors in operation, under construction, or for which orders have been placed, having a total rated capacity of 207,000 megawatts electric. (Auth)(MBW)

<544>

Johnson, W.E.; AEC, Washington, DC

United States Uranium Policy. S.A. Mining & Engineering Journal, 84(4065), 25-33. (1972, February)

The United States policies of boosting the domestic uranium market and selling government surplus stocks over a number of years are reviewed. Market prospects could be strengthened by new mining and milling capacities and more exploratory work. The regulated sale of government stockpiles, foreign uranium purchases and enrichment of uranium are policies considered by the United States Atomic Energy Commission to boost the U.S. domestic uranium market. (PAG)

<545>

Kaufmann, R.F., G.G. Eadie, and C.R. Russell; EPA, Office of Radiation Programs, Las Vegas, NV

Summary of Ground-Water Quality Impacts of Uranium Mining and Milling in the Grants Mineral Belt, New Mexico. ORP LV-75-4, 70 pp. (1975, August)

Waste discharges from uranium mining and milling were studied to determine if they comply with all applicable regulations, standards, permits, and licenses, and to determine their impact on surface waters and ground waters of the Grants Mineral Belt. Radium, selenium, and nitrate were of most value as indicators of contamination. Potable waters at uranium mines were tested for composition and company monitoring networks, self-monitoring data, analytical procedures and reporting requirements were evaluated for adequacy. (PAG)

<546>

Manger, G.E., G.L. Gates, and R.A. Cadigan; USGS, Lakewood, CO

Physical Properties of Uranium Host Rocks and Experimental Drilling at Long

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Park, Montrose County, Colorado.
BP-241 576, 53 pp.; USGS-GD-75-005, 53 pp. (1975)

A core-drilling study in uranium host rocks of the Jurassic Morrison formation in southwestern Colorado attempted to obtain samples of host rock in its natural state. Three holes were drilled; the holes and core were logged for radioactivity and electrical properties. Samples were analyzed for physical and chemical properties. Drilling results suggest that drilling with dried air yields core with least contamination at least cost. Drilling with oil results in maximum core recovery but also maximum cost and significant core contamination. Drilling with water results in contamination and loss of original pore water. A factor group of variables present are: those positively related to uranium mineralization are poor sorting, percent-by-weight clay, percent of pore space containing water; and negatively related variables are median grain size (mm), electrical resistivity, and permeability. Optimum depth to locate ore seems to be at the top of the pore water capillary circulation zone, below the dehydrated no-capillary-circulation zone. (Auth)

<547>

Coffin, R.C.; Stanolind Oil and Gas Company

History of Radium-Uranium Mining in the Plateau Province. In Stokes, W.L. (Ed.). Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 1-7). 115 pp. (1954)

The history of the mining activity of uranium and its associated metals, radium and vanadium, followed closely the advances in scientific discoveries of the behavior of radioactive materials. These periods of maximum mining activity, following new discoveries, were tempered by competition from richer ores from foreign countries. Three stages can be recognized in the development of the Plateau Province as a source of radioactive materials. During World War I the demand for radium as a source of luminous paint and the interest in its uses in the treatment of cancer created the first "high point". This stage began about 1912 and reached a maximum in 1921. Following this period a salvage operation, recovering vanadium from ore left in the mines, on dumps and in new development, gave a limited revival in Plateau mining. The discovery of fissionable material and its applications has brought on a new surge of prospecting that extends well beyond the limits of the Plateau. (Auth)(PAG)

<548>

Not given; Not given

Summary of Events in the Colorado Plateau Since 1924. In Stokes, W.L. (Ed.). Uranium Deposits and General Geology of Southeastern Utah: Guidebook to the Geology of Utah, No. 9. Utah Geological Society, Salt Lake City, (pp. 8-15). 115 pp. (1954)

The historical aspects of uranium mining and development on the Colorado Plateau which began in 1948 when the AEC began purchasing ore and providing funds for exploration are presented. The period was preceded by several years of periodic vanadium mining. (PAG)

<549>

Renoux, A., J.Y. Barzic, and G. Madelaine; Faculte des Sciences, Laboratoire de Physique des Aerosols et de Radioactivite Atmospherique, Brest-Cedex, France; Laboratoire de Physique de l'Atmosphere, Departement de Protection, Fontenay-Aux-Roses, France

Comparison Entre La Repartition Granulometrique En Masse Poussieres Et L'Activite Alpha, Au Cours De Differentes Phases De Travauz Dans Une Mine D'Uranium. Chemosphere, 3, 173-176. (1976)

A seven stage Andersen impacter was used to determine the dust content of the air in the Margnac uranium mine, located in the Division of Crouzille, France. A comparison between the granulometric distribution of the dusts and the distribution of the alpha radioactivity was conducted and determined to be dependent upon the grain size and nature of the work phase. Only during excavation is there good agreement between the granulometric distribution by weight and that of alpha activity. (PAG)

<550>

Argall, G.O., Jr.; Not given

Why Anaconda's Uranium Mines are Unique. Mining World, 16(10), 54-59. (1954)

The report outlines the exploration and mining procedures used by the Anaconda Copper Mining Company in its uranium operations in the Grants district, New Mexico. The ore body at the Jackpile mine is in the Westwater Canyon member of the Morrison formation of Jurassic age. The ore body is partly overlain by, and partly cut by, a post-ore diabase sill that is from 3 to 7 feet thick. The deposit is being mined by open-pit methods. The uranium deposit at the Woodrow mine occurs in the Morrison formation in a "ring fault" or "breccia pipe". The structure has the shape of an upright but slightly tilted cone with a diameter of about 30 feet at the surface. The central part has apparently dropped about 15 feet. The ore minerals are mostly uraninite and coffinite associated with pyrite and asphaltic material. (Auth)

BIBLIOGRAPHIES AND INDICES

<551>

Not given; AEC, Washington, DC

Selected Bibliography on Radioactive Occurrences in the Central United States (Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, Oklahoma, Texas). TID-26261, 11 pp. (1972, November)

One hundred fifteen references on radioactive minerals are included in the bibliography. Citations include articles published between 1950 and 1972. (RRB)

<552>

Not given; AEC, Division of Production and Materials Management, Washington, DC

Selected Bibliography on Radioactive Occurrences in Colorado. TID-26256, 17 pp. (1972, December)

The bibliography contains 185 references concerning radioactive minerals published between 1951 and 1972. (RRB)

<553>

Not given; AEC, Division of Production and Materials Management, Washington, DC

Selected Bibliography on Radioactive Occurrences in California, Nevada, Oregon, and Washington. TID-26255, 10 pp. (1972, December)

The bibliography consists of 108 references concerning radioactive minerals published between 1950 and 1972. (RRB)

<554>

Not given; AEC, Division of Production and Materials Management, Washington, DC

Selected Bibliography on Radioactive Occurrences in the Northeast and Central United States (Illinois, Indiana, Michigan, Minnesota, New England, New Jersey, New York, Ohio, Pennsylvania and Wisconsin). TID-26262, 7 pp. (1972, December)

The bibliography contains 65 references on radioactive minerals published between 1935 and 1972. (RRB)

<555>

Corcoran, R.R. (Comp.); Oregon Department of Geology and Mineral Industries, Portland, OR

Index to Published Geologic Mapping in Oregon, 1898-1967. Oregon Department of Geology and Mineral Industries Miscellaneous Paper No. 12, 20 pp. (1968)

Geologic maps published in The ORE BIN, ground-water and engineering maps, geophysical survey maps, geologic quadrangle maps, and miscellaneous geologic maps of Oregon are indexed. Also included is an index to topographic quadrangle maps, Army Map Service sheets, and geomorphic divisions. (PAG)

<556>

Mussotto, N.T. (Comp.), M.C. (Comp.) Lewis, and C.S. (Comp.) Brookhyser; Oregon Department of Geology and Mineral Industries, Portland, OR

Index to The ORE BIN, 19[illegible].

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Oregon Department of Geology and Mineral Industries Miscellaneous Paper No. 13, 50 pp. (1975)

The index to The ORE BIN in Oregon covers entries from 1950 to 1974 on related geological surveys and mineral resources. Each entry in the author index and subject index includes date and page numbers of publications. (PAG)

<557>

Allen, J.E. (Comp.), E. (Comp.) Kinsley, H. (Comp.) Quasdorf, and R.C. (Comp.) Treasher; Oregon Department of Geology and Mineral Industries, Portland, OR

Bibliography of the Geology and Mineral Resources of Oregon, July 1, 1936 to December 31, 1945. Oregon Department of Geology and Mineral Industries *Bulletin* No. 33, 108 pp. (1947)

The bibliography includes references to geological and mining subjects in Oregon with many references from Washington, Idaho, and California. It is divided into an author index and a subject index which is subdivided according to divisions of geological sciences. (PAG)

<558>

Steere, M.L. (Comp.), and L.F. (Comp.) Owen; Oregon Department of Geology and Mineral Industries, Portland, OR

Bibliography of the Geology and Mineral Resources of Oregon, January 1, 1951 to December 31, 1955. Oregon Department of Geology and Mineral Industries Bulletin No. 53, 97 pp. (1962)

The bibliography includes references to geological and mining subjects in Oregon. It is divided into an author index and a subject index with cross references. (PAG)

<559>

Steere, M.L. (Comp.); Oregon Department of Geology and Mineral Industries, Portland, OR

Bibliography of the Geology and Mineral Resources of Oregon, January 1, 1946 to December 31, 1950. Oregon Department of Geology and Mineral Industries *Bulletin* No. 44, 61 pp. (1953)

The bibliography includes references to geological and mining subjects in Oregon. It is divided into an author index and a subject index with cross references. (PAG)

<560>

Roberts, M.S. (Comp.), M.L. (Comp.) Steere, and C.S. (Comp.) Brookhyser; Oregon Department of Geology and Mineral Industries, Portland, OR

Bibliography of the Geology and Mineral Resources of Oregon, January 1, 1961 to December 1, 1970. Oregon Department of Geology and Mineral Industries Bulletin No. 78, 199 pp. (1973)

The bibliography contains reports and publications on the geology and mineral resources of Oregon. An alphabetical listing by author of all citations, complete with publication date and subject index is included. (PAG)

<561>

Frondel, J.W., and M. Fleischer; USGS, Washington, DC

A Glossary of Uranium and Thorium Bearing Minerals, Fourth Edition. USGS Bulletin 1250, 69 pp. (1967)

The glossary is a collection of data pertaining to uranium and thorium minerals and to those minerals that contain traces or more of uranium and thorium. There are 534 entries in the index which represents 260 species of which 185 are in the group of minerals containing uranium and thorium as major constituents 55 are in the group of minerals that might show uranium or thorium content if investigated by modern analytical methods, and 20 are in the group that has been reported to contain impurities or intergrowths of uranium, thorium, or rare-earth minerals. Structural formulas are given for most of the minerals and oxide formulas are given where good data are not available. Identities and group relations are also indicated. (PAG)

<562>

Not given; ERDA, Office of Public Affairs, Technical Information Center, Oak Ridge, TN

Nuclear Raw Materials: A Selected Bibliography. TID-3257, 44 pp. (1976, January)

Two hundred and seventy-three reports open filed the Grand Junction, Colorado Office (DOE) are listed in the bibliography on nuclear raw materials. The abstracts section has been subdivided into three categories: a) reserves, b) exploration, and c) feed processing. Corporate author, author, subject, and report number indices are also included. The dates of the reports range from 1943 to 1974. (MBW)

<563>

Finch, W.I., J.C. Wright, and M.W. Sullivan; USGS, Lakewood, CO

Selected Bibliography Pertaining to Uranium Occurrence in Eastern New Mexico and West Texas and Nearby Parts of Colorado, Oklahoma, and Kansas.
USGS-GD-75-003, 98 pp.; PB-241 629, 98 pp.; Report 101109, 98 pp. (1975)

Nearly 500 selected references to uranium and to stratigraphy, structure, and groundwater geology related to uranium-bearing formations in eastern New Mexico and west Texas and nearby parts of Colorado, Kansas, and Oklahoma are indexed topically and geographically. The list is nearly complete through 1972 and contains some references with later dates. (Auth)

<564>

Friebele, C.D.; USGS, Water Resources Division, Austin, TX

Bibliography of United States Geological Survey Reports on the Geology and Water Resources of Texas, 1887-1974.

PB-248 926, 174 pp.;
USGS WRD-76 002, 174 pp.;
USGS WRI-20-75, 174 pp. (1975, October)

The report contains a bibliographic list of reports prepared by the U.S. Geological Survey on the geology and water resources of Texas. In addition to the bibliographic list, the reports are indexed by county, hydrologic area, and subject matter. (Auth)

RESOURCE UTILIZATION AND RESERVES

<565>

Not given; ERDA, Grand Junction, CO

National Uranium Resource Evaluation, Preliminary Report. GJO-111(76), 135 pp. (1976, June)

The first section of the two part report summarizes estimates of uranium ore reserves and potential resources at production cost cutoffs of $10, $15, and $30 per pound of uranium oxide, the standard measure. The estimate of reserves in all categories up to the $30 cost level is 640,000 tons of uranium oxide. In addition, uranium recoverable as a by-product of phosphate and copper production is estimated at 140,000 tons during the period of 1976 to 2000. Potential resources are estimated to be 1,060,000 tons of uranium oxide in the probable category, 1,270,000 tons in the possible category, and 590,000 tons in the speculative category. The major producing regions of the United States are the Colorado Plateau, Wyoming Basins and Coastal Plain of Texas which contain 94 percent of the $30 reserves and approximately 80 percent of the probable, 66 percent of the possible and 28 percent of the speculative potential resources. Essentially all of the resources in these regions are in stratiform or roll front deposits in strata of Mesozoic and Tertiary age. The report says it is likely that estimates of resources in conventional sandstone type deposits will increase as a result of current and future investigations. In addition, the opportunity exists for the discovery of uranium deposits of other types similar to those in Australia, Canada, and South Africa, although only limited parts of the United States may be geologically favorable for such deposits. The report emphasizes that prompt and vigorous exploration and development will be required to make new discoveries and to convert potential resources to reserves at a rate adequate to support projected nuclear power expansion. (PM)

<566>

Boyden, T.A.; Nuclear Exchange Corporation, Menlo Park, CA

Uranium Resources of the United States. Transactions of the American Nuclear Society, 21, 244-245. (1975)

Conventional uranium resources are those found chiefly in sandstone, and total an estimated 2,200,000 tons of uranium oxide recoverable at costs up to $30.00/lb. These resources make up about 98% of all resources producible at $30.00 or less per pound with the remaining 2% occurring in vein deposits. A total of 2,700,000 tons of uranium oxide in nonconventional resources, those occurring in low grade concentrations in various rock types and as by-products related to other industries, are recoverable at costs up to $100 lb. An estimated 2,500,000 tons of uranium oxide could be recovered from the Chattanooga Shale Formation located throughout much of central Tennessee. The average grade of the formation is 0.007% uranium oxide, or about 1 lb/10.2 tons of shale at 70% recovery. Another 30,000 tons of uranium oxide is recoverable by ion exchange and solvent extraction at a cost of $6 to $10/lb from leach solutions originating at the western U.S. copper mining operations and 160,000 tons is recoverable from marine phosphorites in Florida at a cost of $10/lb. Other nonconventional resources include marine phosphorites in Idaho, coal, monazite, granites, and seawater. (PAG)

<567>

Kenward, M.; Not given

How Much Uranium. New Scientist, 69, 686-687. (1976, March)

Reports on world uranium resources from the OECD's Nuclear Energy Agency and the UN's International Atomic Energy Agency are reviewed with doubts about the validity of assumptions made in these studies. Also included is a chart of future demands and supplies of uranium. (PAG)

<568>

Williams, R.M.; Canada Department of Energy Mines and Resources, Mineral Development Sector, Canada

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Uranium to 2000-An Exploration Challenge. Canadian Mining Journal, 96(4), 29-32. (1975, April)

Projections of installed nuclear capacity translate into requirements for uranium of 30,000 tons of uranium oxide in 1975; 70,000-80,000 tons in 1980; and 40,000-490,000 tons in the year 2000. In gross cumulative terms, over the next 15 years, new uranium reserves totaling some 2.6 million tons of uranium ore are required. If uranium is to be discovered and developed for production at a rate sufficient to meet demand, an accelerating expansion of exploration effort is needed. Once exploration is redirected toward sources of uranium with grades lower than 0.1 percent U3O8, substantial resources will probably be identified. New methods of foreign, nonequity financing will evolve for the uranium exploration and development effort. (Auth)

<569>

Searl, M.F.; Electric Power Research Institute, Palo Alto, CA

Uranium Resources to Meet Long Term Uranium Requirements - Summary. EPRI-SR-5, 21 pp.; Combustion, 46(11), 13-17. (1974, November)

The uncertainty about United States uranium resources and future levels of uranium consumption is explored to help determine the proper rate for fast breeder reactor development. Various breeder introduction dates and a relatively slow rate of commercial breeder growth are assumed. Projections of uranium resources are based on the estimated physical relationships and the cutoff cost of the highest cost quantities subsequently calculated. In the cost analysis, costs are biased upward so that more confident statements can be made about the quantity of the resource; costs could be significantly lower. (Auth)

COMBUSTION journal article was published in May 1975.

<570>

Alexander, F.M.; Tennessee Department of Conservation, Division of Geology, Nashville, TN

The Chattanooga Black Shale, A Possible Future Source of Uranium. Tennessee Department of Conservation Circular No. 1, 3 pp. (1953)

Deposited under marine conditions, the black shale of the Chattanooga Shale Formation in Middle Tennessee is a promising source of potential uranium reserves. The uranium content is low and ranges between 0.001 and 0.03 percent and probably contains less than 0.2 pounds of uranium per ton of shale. The AEC has begun studies on the geology of the formation and long range plans to determine economic processes of uranium extraction. (PAG)

<571>

Chenoweth, W.L.; ERDA, Grand Junction, CO

Uranium Resources of New Mexico. In New Mexico Geological Society Special Publication No. 6, (pp. 138-143). (1976)

Uranium deposits in New Mexico occur in rocks of many geologic ages and lithologic types. Bedded deposits in continental, fluvial sandstones of the Morrison Formation of Jurassic age are the most important. A cluster of large deposits in McKinley and Valencia Counties comprises the Grants mineral belt, the largest uranium area in the United States. During the period 1948-1975, 52,250,000 tons of ore with an average grade of 0.22 percent U3O8 and containing 112,684 tons of uranium oxide have been produced in New Mexico, almost entirely from the Grants mineral belt. This amounts to 40 percent of the total United States uranium ore production. The discovered ore reserves and the undiscovered potential resources of the State are expected to maintain New Mexico's position as the nation's principal source of uranium for years to come. (Auth)

<572>

Silver, J.M., and W.J. Wright; Australian Atomic Energy Commission, Canberra, Australia

Uranium Resources and Requirements. AAEC/IPS, 13 pp. (1975, August)

About 3.5 million tons of uranium is estimated to be available to the Western World in deposits which could be recovered for present day costs of less than $A30 per kilogram. This amount is believed to be sufficient to meet the nuclear power program until the turn of the century. There are good prospects for the discovery of further deposits (particularly in Africa, Canada, South America and Australia) which could extend these resources. If the Fast Breeder Reactor is introduced by about 1990, it could ultimately decrease the demand for uranium from about 2020 onwards. The total amount of uranium required to support the Light Water Reactor power program until this happens would be about 7 million tons. On present evidence, this could be available from high grade deposits, together with some low grade deposits and by-product sources at costs less than $A60 per kilogram. If the Fast Breeder Reactor is not introduced as expected, the demand for uranium will continue to increase and it could be necessary to recover uranium from black shales or ultimately from sea water at costs ranging up to $A300 per kilogram. Australia has about 19% of the reasonably assured resources of uranium in the Western World recoverable at costs of less than $A20 per kilogram, or about 9% of the resources (reasonably assured and estimated additional) recoverable at costs of less than $A30 per kilogram. (Auth)(PAG)

<573>

Ellis, J.R., D.P. Harris, and N.H. VanWie; ERDA, Grand Junction, CO; University of Arizona, Department of Mining and Geological Engineering, Tucson, AZ;
Union Carbide Corporation, Nuclear
Division, Computer Sciences Division,
Oak Ridge, TN

A Subjective Probability Appraisal of Uranium Resources in the State of New Mexico. GJO-110(76), 97 pp. (1975, December)

Undiscovered uranium resources in New Mexico are estimated to be 226,681,000 tons of material containing 455,480 tons U3O8. The basis for this estimate was a survey of expectations of 36 geologists, in terms of subjective probabilities of number of deposits, ore tonnage, and grade. Weighting of the geologists' estimates to derive a mean value used a self-appraisal index of their knowledge within the field. Detailed estimates are presented for the state, for each of 62 subdivisions (cells), and for an aggregation of eight cells encompassing the San Juan Basin, which is estimated to contain 92 percent of the undiscovered uranium resources in New Mexico. Ore-body attributes stated as probability distributions enabled the application of Monte Carlo methods to the analysis of the data. Sampling of estimates of material and contained U3O8 which are provided as probability distributions indicates a 10 percent probability of there being at least 600,000 tons U3O8 remaining undiscovered in deposits virtually certain to number between 500 and 565. An indicated probability of 99.5 percent that the ore grade is greater than 0.12 percent U3O8 suggests that this survey may not provide reliable estimates of the abundance of material in very low-grade categories. Extrapolation to examine the potential for such deposits indicates more than 1,000,000 tons U3O8 may be available down to a grade of 0.05 percent U3O8. Supplemental point estimates of ore depth and thickness allowed derivative estimates of cost of development, extraction, and milling. Eighty percent of the U3O8 is estimated to be available at a cost less than $15/lb (1974) and about 98 percent at less than $30 lb. (Auth)

<574>

Mutschler, P.H., J.J. Hill, and B.B. Williams; US Bureau of Mines, Eastern Field Operation Center, Field and
Environmental Activities, Pittsburgh, PA

Uranium from the Chattanooga Shale, Some Problems Involved in Development. US Bureau of Mines Information Circular 8700, 85 pp.; PB-251 986, 85 pp. (1976, February)

The Bureau of Mines studied the Chattanooga Shale to determine the quantity and quality of the uranium resources present and to assess specific environmental effects of mining the shale. Geologic data and chemical analyses, mainly concerning a 12-county area of Tennessee, were compiled from previous published and unpublished reports. Uranium resources in the Gassaway Member of the Chattanooga Shale in this 12-county area were estimated to be between 4.2 and 5.1 million tons, contained in 76 to 91 billion tons of shale. These figures represent inground tonnages and do not allow for mining or processing losses. Depending upon efficiency of mining and processing systems, enough uranium could be available to satisfy a large part of the cumulative domestic and world demand through the year 2000. A model was developed which assesses the total tons or acres of shale to be mined if the Cassaway Member were to satisfy 1 percent of the United States demand for uranium in 1991. This partially demonstrates the environmental impact of mining the shale and is easily factorable to any specified demand. (Auth)

<575>

Nininger, R.D.; AEC, Division of Raw Materials, Washington, DC

Uranium Reserves, Future Demand and the Extent of the Exploration Problem. In Proceedings of a Panel on Uranium Exploration Geology, held in Vienna, Austria, April 13-17, 1970. International Atomic Energy Publications, Vienna, Austria, (pp. 3-19), 386 pp.; IAEA-PL-391/17, (pp. 3-19), 386 pp. (1970, October)

Known world low-cost reserves, that is, reserves which can be exploited and delivered to the world market, excluding the USSR, Eastern Europe and Mainland China, at prices of $10 or less per pound are approximately one third of the estimated requirements through the remainder of this century. Four countries, Canada, South Africa, the United States and France, control 85 to 90% of the known low-cost uranium reserves, and 13 other countries have the remainder. Since the ultimate uranium requirements are of more importance than the immediate supply and demand situation, we should be concerned with the large number of developing countries which will not have large requirements for uranium and which have not been adequately explored. These could become important suppliers of uranium over the next 30 years while at the same time greatly improving their own economic position and standard of living. Uranium geology is now at a stage in which a flood of details about specific types of deposits is available but has not been sufficiently well digested and assimilated to bring some cohesiveness to the various concepts of regional, tectonic, lithologic and geochemical distribution of uranium. A meeting of this kind can be instrumental in integrating some of these ideas into meaningful criteria that will help guide exploration anywhere in the world. (Auth)

<576>

Not given; Organization for Economic Co-Operation and Development, Paris, France

Is There Enough Uranium. OECD Observer, 79, 33-36. (1976, January)

Physical availability, economic factors, and political factors will influence the future supplies of uranium. Low cost uranium reserves at present definitely identified will be adequate for approximately fifteen years, but new supplies must be found to provide for future demand. (PAG)

<577>

Not given; Organization for Economic Co-operation and Development/Nuclear Energy Agency, Paris, France; International Atomic Energy Agency, Vienna, Austria

Uranium Resources, Production and Demand, Including Other Nuclear Fuel Cycle Data. OECD/NEA-IAEA Report, 78 pp. (1975, December)

The report, compiled by OECD/NEA and IAEA, deals with the uranium resources and demands of its member countries around the globe. The current situation in uranium resources, the availability of uranium reserves, the exploration activities, and the uranium production and inventories are discussed. Subjects also included and reviewed are the recent price trends in the uranium market, the long term uranium resources situation, and future uranium requirements. An expanded feature of the report is the addition of an annex, containing information on other fuel cycle capacities and requirements, such as uranium conversion, fuel element fabrication and reprocessing of spent fuel. (MBW)

<578>

Hilpert, L.S.; USGS, Washington, DC

Uranium Resources of Northwestern New Mexico. USGS Professional Paper 603, 16C pp. (1969)

Uranium deposits in northwestern New Mexico occur in about 30 formational units that range in age from Precambrian to Quaternary. The most economically important deposits are peneconcordant and occur in sandstone, limestone, shale, and coal. Less economically important vein deposits occur in metamorphic, igneous, and miscellaneous sedimentary rocks. Of the peneconcordant deposits, the most economically important ones occur in sandstone in the Morrison Formation; others occur in limestone beds of the Todilto Limestone and in sandstone beds of the Dakota Sandstone. About two-thirds of the uranium output was from the Ambrosia Lake district and nearly a third was from the Laguna district. During the 1956-64 period, production was 42 percent of the national output. More than 95 percent of the ore came from sandstone, 4 percent came from limestone, and less than 1 percent came from carbonaceous shale, coal, and igneous rocks. More than 99 percent of the output was from rocks of Jurassic age; the remainder came from rocks that range in age from Pennsylvanian to Tertiary. As of January 1966, mine reserves totaled 29.7 million tons of material that averaged 0.23 percent U3O8. About 60 percent of these reserves was in the Ambrosia Lake district, in the Morrison Formation. Undiscovered or potential reserves probably are several times the combined production and mine reserves estimated as of January, 1966 and may amount to as much as 200 million tons of material, expected to average about 0.25 percent U3O8. These resources are expected to be almost entirely peneconcordant deposits, principally in large ones in sandstone lenses in the Morrison Formation, but important deposits also are anticipated in sandstone lenses in the Dakota Sandstone and in limestone beds in the Todilto Limestone. Structural data and general age relations of the deposits indicate that the source of the uranium was the adjacent highland areas and the host rocks. Uranium probably was leached from these rocks, carried basinward in dilute solutions through unconsolidated sediments, and precipitated by the reduction of carbonaceous debris and by other unknown means. No evidence is convincing that magmatic fluids played any significant part in the emplacement of the peneconcordant deposits. (Auth)(MBW)

<579>

Gustafson, J.K.; Not given

Uranium Resources. Nucleonics, 4(5), 23-28. (1949)

The occurrence of uranium in nature, the potential supply of uranium, and the uranium procurement policy of the AEC are discussed. Uranium deposits are divided into four main types: (1) igneous rocks, (2) hydrothermal vein deposits, (3) sedimentary rocks, and (4) deposits of doubtful and perhaps complex origin. Within the fourth group are the carnotite-type uranium deposits of the Colorado Plateau. Tabular or lenticular bodies of carnotite-impregnated sandstone are found in certain parts of the Morrison and Entrada formations of Jurassic age and in the Shinarump conglomerate of Triassic age. The carnotite is commonly associated with other vanadium minerals and fossil plant material. (Auth)

RESEARCH PROGRAMS

<580>

Cannon, R.S., Jr.; USGS, Denver, CO

Geological Survey's Work on Isotope Geology of Uranium and Thorium and Their Decay Products. TEI-209, 12 pp. (1952)

A program of research on the isotope geology of the uranium and thorium series is being carried on by the Geological Survey. Work is in progress on uranium-lead relationships in uranium ores of the Colorado Plateau region, on uranium-thorium-lead relationships in granite, on geologic variations in the isotopic composition of lead, and on radon and helium in natural gas. A continuing program of systematic studies will try to establish methods in this field on a surer footing, and to apply the methods to the solution of important geologic and mineral-resource problems. (Auth)

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GEOGRAPHIC LOCATION INDEX

All geographic locations in the United States are indexed by state, and may be followed by county, city, township, range, section, and $7^{1}/_{2}$ or 15 minute quadrangle or combinations of the above. The following illustration shows township, range, section, and $7^{1}/_{2}$ and 15 minute quadrangles.

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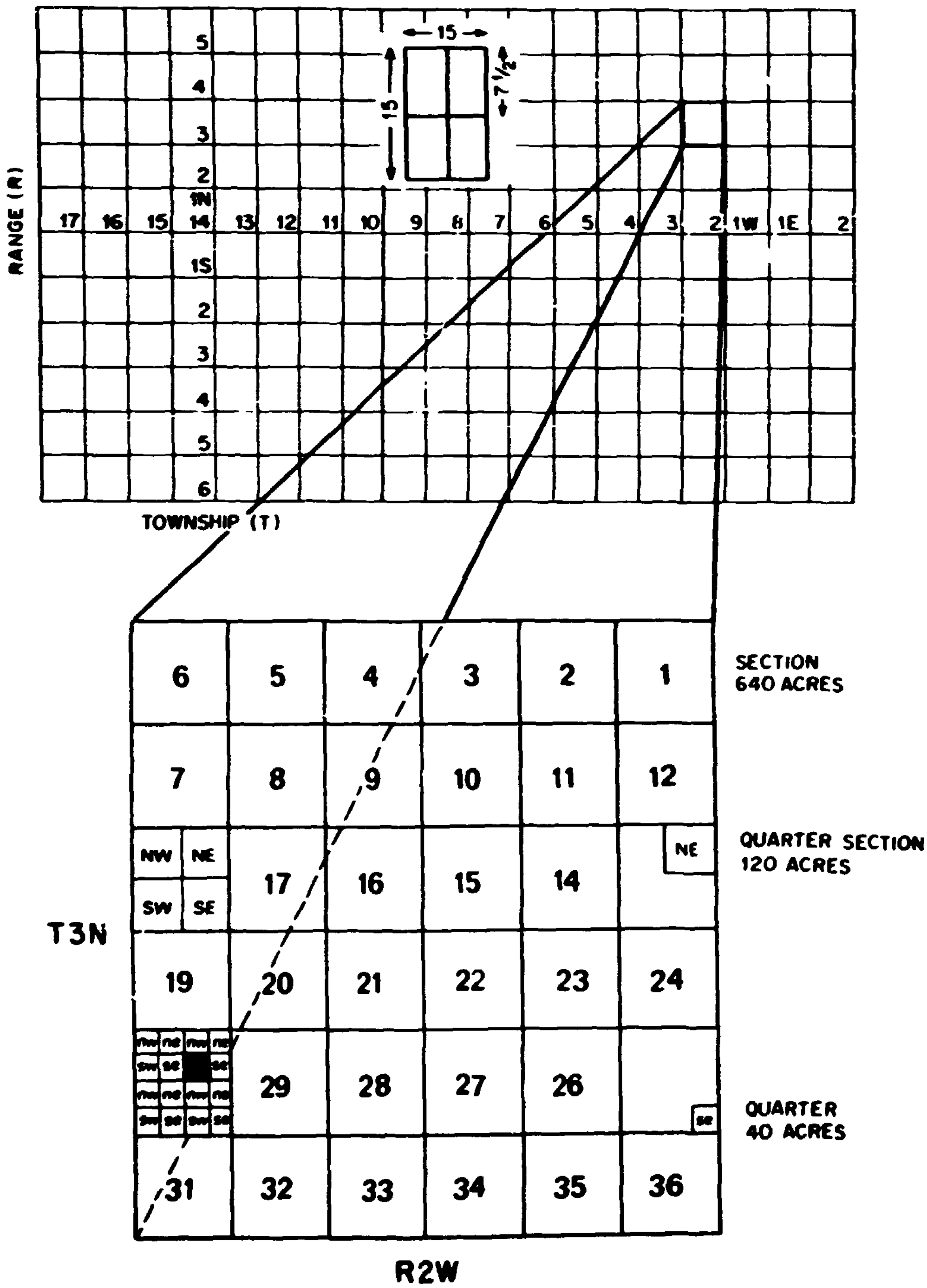

THE SHADED AREA IS IDENTIFIED AS:
T3N, R2W, SEC. 30, NE 1/4, SW 1/4

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QUADRANGLE NAME INDEX

The one degree by two degree National Topographic Map Series (NTMS) quadrangles are indexed. The following map shows the quadrangles of the continental United States.

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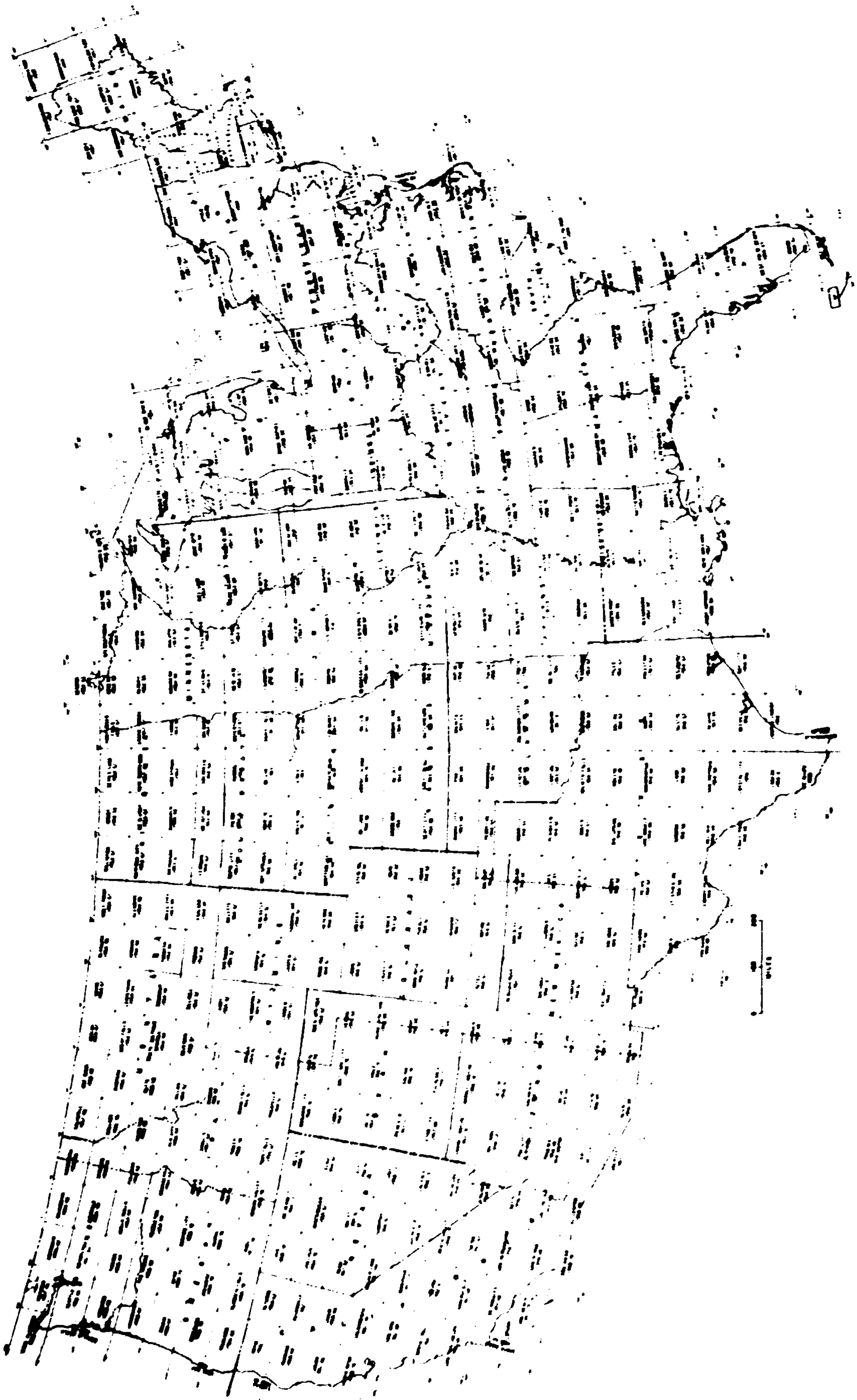

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GEOFORMATIONAL FEATURES INDEX

Geologic formations, mines, claims, districts, lakes, rivers, mountains, and other regional structures presented in the reports are indexed.

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