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National Uranium Resource Evaluation

JORDAN VALLEY QUADRANGLE OREGON AND IDAHO

MASTER

Bendix Field Engineering Corporation
Grand Junction, Colorado

Issue Date
April 1982

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Nuclear Energy
Grand Junction Area Office, Colorado

This report is a result of work performed by Bendix Field Engineering Corporation, Operating Contractor for the U.S. Department of Energy, as part of the National Uranium Resource Evaluation. NURE is a program of the U.S. Department of Energy's Grand Junction, Colorado, Office to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States.

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NATIONAL URANIUM RESOURCE EVALUATION
JORDAN VALLEY QUADRANGLE
OREGON AND IDAHO

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PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION AREA OFFICE
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EAB

This is the final version of the subject-quadrangle evaluation report to be placed on open file. This report has not been edited. In some instances, reductions in the size of favorable areas on Plate 1 are not reflected in the text.

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ILLUSTRATIONS (continued)

ABSTRACT

The Jordan Valley Quadrangle, Oregon and Idaho, was evaluated to identify and delineate areas favorable for uranium deposits in accordance with criteria developed for the National Uranium Resource Evaluation. Surface radiometric reconnaissance and geochemical sampling were used for overall evaluation of the quadrangle. Detailed rock sampling, geologic mapping, and examination of uranium deposits and occurrences were performed in areas suspected to be favorable.

The northeast part of the McDermitt caldera within the quadrangle is favorable for volcanogenic deposits associated with the ring-fracture zone. The favorable area contains the Aurora uranium deposit, the Bretz mercury mine, and the Cottonwood Creek occurrence. The Triangle Ranch area and the Snake River Plain, both in the northeast part of the quadrangle, have environments that may be favorable for uranium deposits in sandstone but are considered unevaluated due to lack of subsurface data and lack of detailed investigations. Rocks in the remainder of the quadrangle are considered unfavorable for uranium deposits because of low uranium contents, basic to intermediate compositions, or lack of favorable structures.

INTRODUCTION

PURPOSE AND SCOPE

The Jordan Valley Quadrangle (Fig. 1), southeastern Oregon and southwestern Idaho, was evaluated to define areas that have geologic environments favorable for uranium deposits. Favorable environments are those thought to contain deposits of 100 tons or more U_3O_8 at an average grade of at least 100 ppm U_3O_8. Selection of a favorable environment is also based on the similarity of the geologic characteristics to those found in close association with uranium deposits elsewhere (Mickle and Mathews, eds., 1978). The Jordan Valley Quadrangle study was conducted by Bendix Field Engineering Corporation (BFEC) for the National Uranium Resource Evaluation (NURE) program, managed by the Grand Junction, Colorado, office of the U.S. Department of Energy (DOE).

Evaluation began in April 1980 and ended in June 1981. Work included 3 man-months of planning and literature research, 6 man-months of fieldwork, and 7 man-months of data compilation and report preparation. A reconnaissance aerial radiometric and magnetometer survey (ARMS) was conducted over the Jordan Valley Quadrangle by a BFEC subcontractor.

ACKNOWLEDGMENTS

We wish to acknowledge the cooperation of the Placer Amex and Cordex Syndicate companies for permitting geologic mapping and the collection of samples at the Aurora deposit and the Bretz mercury mine, respectively, and for allowing us to examine drill core from the deposits. We are indebted to Mick Roper and Mark Abrams of Placer Amex, Andy Wallace of Cordex Syndicate, and Tak Matsumoto for their discussions of the deposits. We are grateful to James Rytuba of the U.S. Geological Survey and Earl Bennett of the Idaho Bureau of Mines and Geology for their contributions to our work. Petrographic work referred to in this report was done by Mike Dixon and Mike Eatough (BFEC Petrology Group).

PROCEDURES

Fieldwork in the Jordan Valley Quadrangle consisted of radiometric reconnaissance, rock sample collection, evaluation of uranium occurrences, and geologic mapping. Because the quadrangle contains the newly discovered Aurora uranium deposit and the Bretz mercury mine, detailed investigations were conducted at the deposits and in nearby areas. A large-scale geologic map was made of the 22-km^2 area containing the deposits and adjacent areas along the ring-fracture zone in the northeast part of the McDermitt caldera. Four other uranium occurrences associated with the caldera, and an occurrence in the Triangle Ranch area of Idaho, were examined.

A regional-scale aerial radiometric and magnetometer survey (ARMS) was conducted by a BFEC subcontractor for the entire quadrangle. Significant radiometric anomalies indicated by the survey were investigated during the fieldwork. A radiometric contour map of equivalent-uranium data is included in the report (Pl. 3).

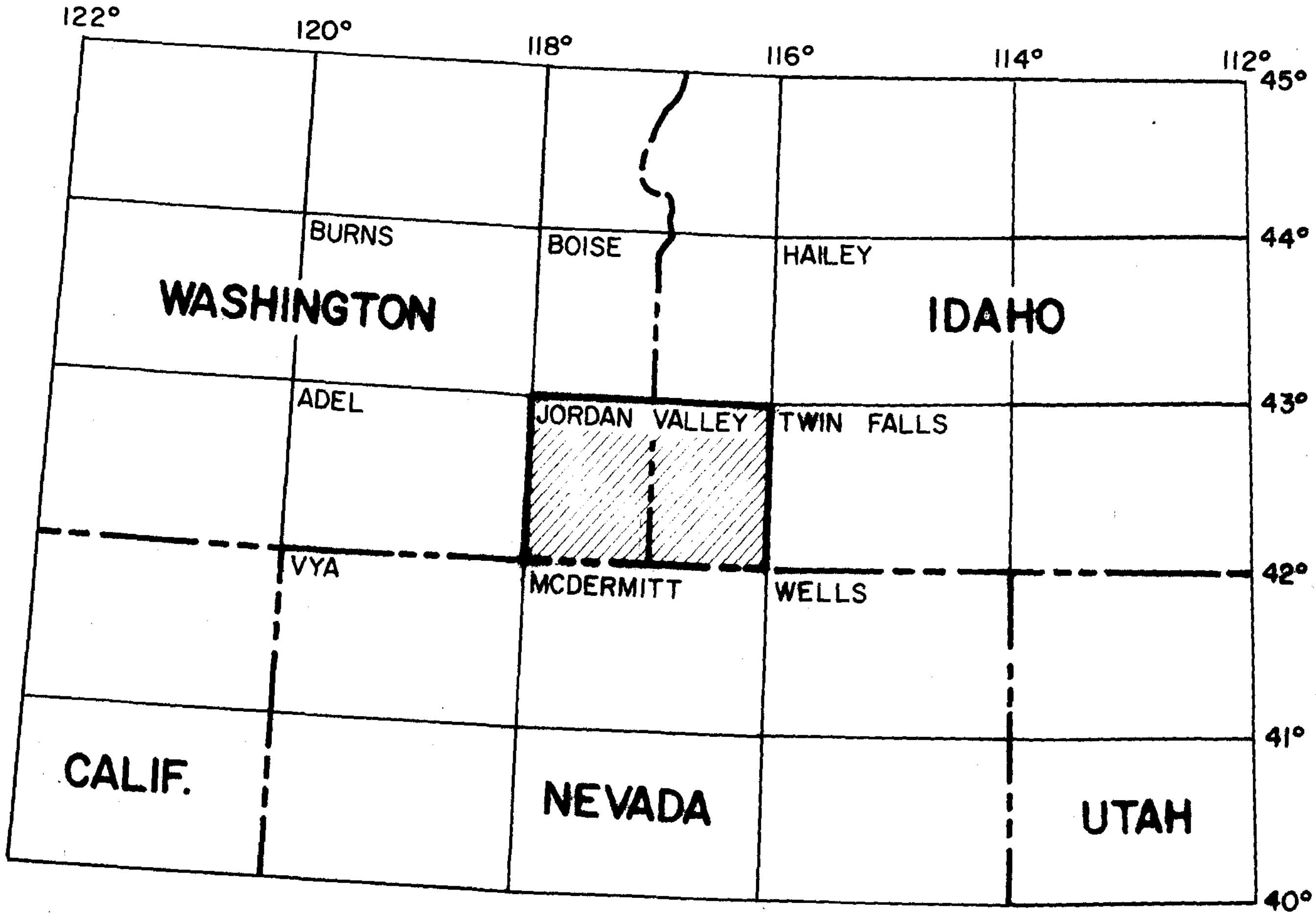

Figure 1. Jordan Valley location map.

Reconnaissance Work

Reconnaissance work in the Jordan Valley Quadrangle consisted of vehicle-borne or man-carried scintillometer surveys and sampling of most rock units. Because of difficult access in many areas of the quadrangle, especially in southwestern Idaho, and time constraints imposed by the project deadline, some mapped rock units were not examined. Emphasis was placed on examination of areas underlain by silicic volcanic rocks. During reconnaissance, 124 rock samples were collected. Analyses of 10 rock samples from a previous study (Marjaniemi and others, 1976), collected from rocks of the Snake River Plain, were also used. All samples collected were analyzed by fluorometry for total U_3O_8. Select samples were submitted for semiquantitative emission spectroscopic analyses for 30 elements; quantitative analyses for trace elements; gamma spectroscopic analyses for potassium and equivalent uranium and thorium; and rapid rock analytical methods for major oxide contents.

Uranium Occurrences

Seven uranium deposits and occurrences were examined in the Jordan Valley Quadrangle (App. A). Uranium-occurrence reports were prepared for all the occurrences. Field examination of the deposits and occurrences consisted of ore-tenor and ore-volume estimates; determination of host-rock environment; and, if possible, determination of ore genesis. Eighty-seven rock samples were collected at the occurrences and were submitted for chemical and spectroscopic analyses, petrographic studies, and radioactive-mineral identification. In addition, 10 water samples were collected at the occurrences and submitted for U_3O_8 analyses.

GEOLOGIC SETTING

The Jordan Valley Quadrangle, Oregon and Idaho, contains parts of the Columbia Intermontane and Basin and Range physiographic provinces (Fig. 2) (Thornbury, 1965). The Columbia Intermontane Province contains parts of two subprovinces: the Owyhee Upland--a plateau and mountainous region that encompasses most of the eastern two-thirds of the quadrangle (Fig. 2) and the High Lava Plains--an area that includes part of the Snake River Basin and the region around Rome, Oregon (Fig. 2). They occupy areas in the northeastern and northwestern parts of the study area, respectively. The Basin and Range Province, a part of the Great Basin section, characterizes the southwest of the quadrangle and that area underlain by the northern part of the McDermitt caldera complex. Most simply, the rocks in the quadrangle can be divided into two broad groups, pre-Cenozoic and Cenozoic, and are described herein as they occur in the two physiographic provinces and associated subprovinces.

Columbia Intermontane Province

Pre-Cenozoic Rocks of the Owyhee Upland. Pre-Tertiary basement, consisting of Paleozoic(?) metamorphic rocks (Neill, 1975) and Mesozoic intrusives, is exposed in the Owyhee Mountains in the north-central part of the quadrangle. Specifically, these rocks underlie parts of the Silver City Range, South Mountain, and the Castle Creek area (Pl. 7).

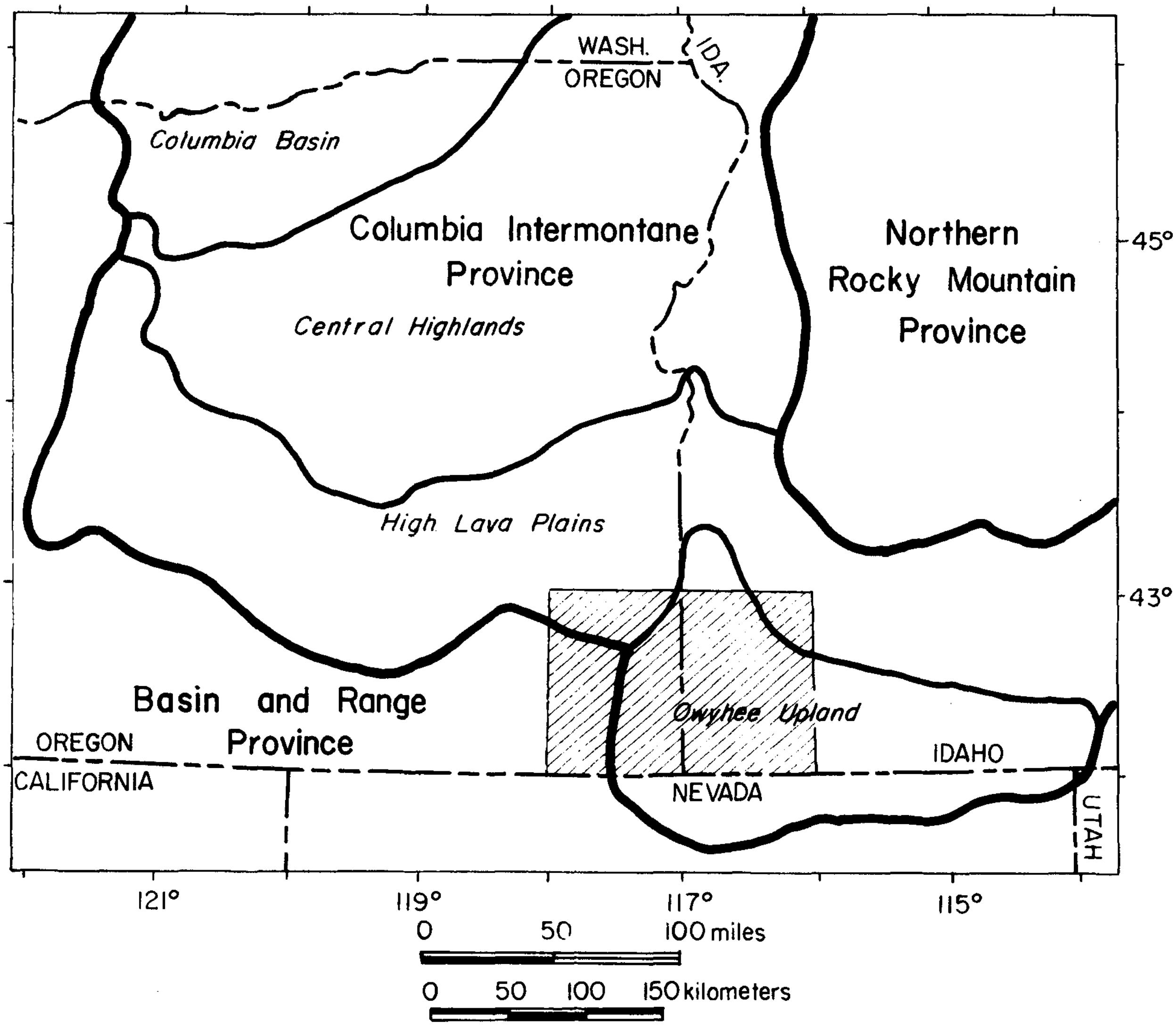

Figure 2. Location of physiographic provinces in the Jordan Valley Quadrangle.

Intrusives in the Silver City Range are predominantly biotite granodiorite and lesser amounts of quartz monzonite, granite, and alaskite (Pansze, 1975). Most of the granodiorite is medium grained, pink to grayish-white, hypidiomorphic-granular to slightly porphyritic rock that has, in places, foliation of K-feldspar phenocrysts. Textural variations to aplite and pegmatite occur locally within the granodiorite (Pansze, 1975). Potassium-argon ages for muscovite from the granodiorite are from 62 to 67 m.y. (Pansze, 1975) and indicate time equivalence between this rock and part of the Idaho batholith to the north. Exposures of Paleozoic(?) metamorphic rocks in the Silver City Range comprise quartz-biotite schist and metaquartzite, the former lithology being prevalent in the Castle Creek canyon area (Neill, 1975). In this area, the metamorphic rocks are cut pervasively by aplite and pegmatite dikes and tabular masses of granodiorite. Although the age of these metamorphic rocks is unknown, a Paleozoic age is implied by Neill (1975) who reported that the metaquartzite may represent deep-sea turbidite sand derived from a stable Paleozoic shelf to the east. Pre-Cenozoic rocks in the South Mountain area comprise a sequence of schists, quartzites, and marbles over 1000 m thick which occur as roof pendants and xenoliths within intrusive rocks. The intrusive rocks, which surround the metamorphic sequence, are mostly gray, structureless to locally gneissic, biotite-hornblende-quartz diorite and granodiorite (Ekren and others, 1978). Also present in the area are aplite and pegmatite dikes, which locally cut the metamorphic-intrusive complex, and a large mass of mostly hornblende gabbro that underlies the south part of South Mountain (Pl. 7). Potassium-argon ages for intrusives in the South Mountain area are from 87 + 3 m.y. (Ekren and others, 1978) to 45.2 + 1.5 m.y. (Armstrong, 1975).

Cenozoic Rocks of the Owyhee Upland. The oldest Tertiary rocks in the Owyhee Upland are the Challis Volcanics of Eocene age, which form an extensive sequence in the Poison Creek-Castle Creek area (Pl. 7). This sequence comprises a compound cooling unit of densely welded rhyodacite tuff up to 300 m thick that unconformably overlies granitic rock. Ash-flow tuffs within the sequence display poorly developed columnar jointing. A rhyolite dike swarm cuts both the Challis Volcanics and the underlying granitic rocks, and flow-layered felsite occurs near the contact with granitics and may be part of the dike swarm (Ekren and others, 1978). A potassium-argon age of 43.6 m.y. was obtained by Neill (1975) for biotite from tuff of that part of the sequence in the Poison Creek area.

During Miocene time, the Owyhee Upland subprovince was the locus of basin-and-range extensional faulting accompanied by rhyolite-basalt bimodal volcanism. These Miocene bimodal volcanic rocks, which form the bulk of the rocks in the Owyhee Upland, are divided into three units: a lower basalt sequence, silicic flows and tuffs erupted from vent areas in the Owyhee Uplands, and an upper basalt sequence that is equivalent to time-transgressive basalt volcanism in the Snake River Plain.

The lower basalt sequence contains latite and basalt flows up to 900 m thick that are exposed around South Mountain and the Silver City Range. These flows unconformably overlie granitic-metamorphic basement rocks. Most of the latite and basalt occurs as thin, interbedded flows, most of which are dense, vesicular, and include porphyries (Ekren and others, 1975). Propylitic alteration is common in the sequence. A potassium-argon age of 16.6 m.y.

(Pansze, 1975) for basalt of this lower sequence in the Silver City area indicates time equivalence between these rocks and the Columbia River Basalt Group. However, rocks of the latter group are of continental tholeiitic affinity, whereas the lower sequence rocks are compositionally much more alkaline (McIntyre, 1971).

The second unit, a sequence of large-volume silicic ash-flow tuffs that underlie most of the Owyhee Upland, was erupted from several vent areas. Probable sources include volcanic centers in the Silver City and Juniper Mountain areas (Pl. 7) and in areas east of the quadrangle.

The oldest rock in the silicic sequence is the Silver City Rhyolite of Miocene age. This rhyolite contains several overlapping cooling units, probably welded tuffs, that were predominately remobilized to a liquid phase prior to final emplacement; densely welded agglutinates occur locally (Ekren and others, 1978). Typically, the rocks vary from phenocryst-poor to aphyric zones alternating with zones containing up to 6 percent phenocrysts. The cooling units have an aggregate thickness of up to 200 m and appear to be closely contemporaneous. Potassium-argon ages of 15.6 to 15.7 m.y. were reported (Pansze, 1975) for five samples from the upper rhyolite in the unit.

The Juniper Mountain area has been recognized by Bennett (1976) and Ekren and others (1978) as a major volcanic center in the Owyhee Upland region (Pl. 7). Evidence for this is exposed on U-2 imagery,which shows flow lobes surrounding the mountain, curvilinears that could be vent or ring fractures near the summit, and younger flows forming the mountain tops (Bennett, 1976). Four recognized major rock units were erupted from Juniper Mountain: the Tuff of Swisher Ridge, 0 to 254 m thick; the upper and lower flows of Juniper Mountain, each 0 to 200 m thick; and the Badlands Tuff of Juniper Mountains, 0 to 50 m thick (Ekren and others, 1978). All these units consist of cooling units of densely welded rhyolite tuff, most of which is red. Tuffaceous sandstone, up to 60 m thick, underlies the Tuff of Swisher Ridge in the Poison Creek area, and opalized tuffaceous silt and sandstone, up to 50 m thick, locally underlie flows of the Badlands Tuff. A Miocene age is implied for the Tuff of Swisher Ridge. Neill (1975) reported potassium-argon ages of 11.7 to 13.8 m.y. for sanidine from a correlative unit, by name the rhyolite of Poison Creek.

Flows and tuffs that make up the Juniper Mountain complex show distinct lateral and veritical changes away from the source area. Specifically, away from the extremities of the flows toward the source area, the rocks display an increase in the abundance of crystals in basal vitrophyres, in flow-banding, in crystal size and number, both horizontally and vertically, in the flows, and in lithophysae in upper units (Bennett, 1976). The area, covered by the volcanic units erupted from Juniper Mountain (Fig. 3), includes large portions of the eastern part of the project area (Ekren and others, 1978) and probably includes those regions underlain by ignimbrite west of Juniper Mountain in Oregon (Walder and Repenning, 1966).

Younger silicic flows of Miocene age in the Owyhee Upland region are mostly flow-layered rhyolites and tuffs. These units include the Tuff of Duck Valley, the Rhyolite of Black Mountain, the Tuff of Browns Creek, and the Tuff of Little Jacks Creek (Pl. 7). Exposures of the Tuff of Little Jacks Creek cover large areas in the eastern part of the quadrangle (Fig. 4).

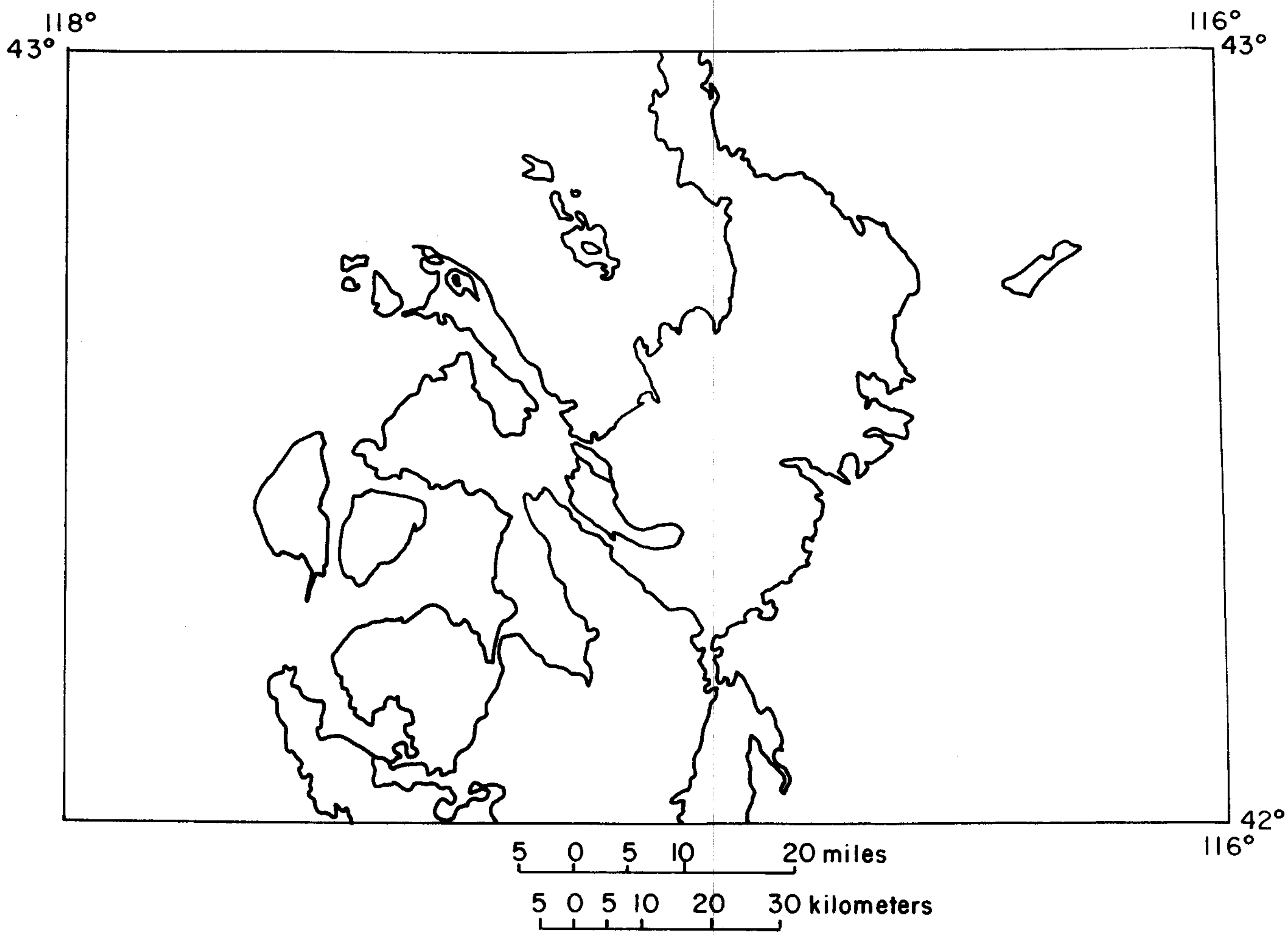

Figure 3. Distribution of ash flow tuffs erupted from Juniper Mountain in the Jordan Valley Quadrangle.

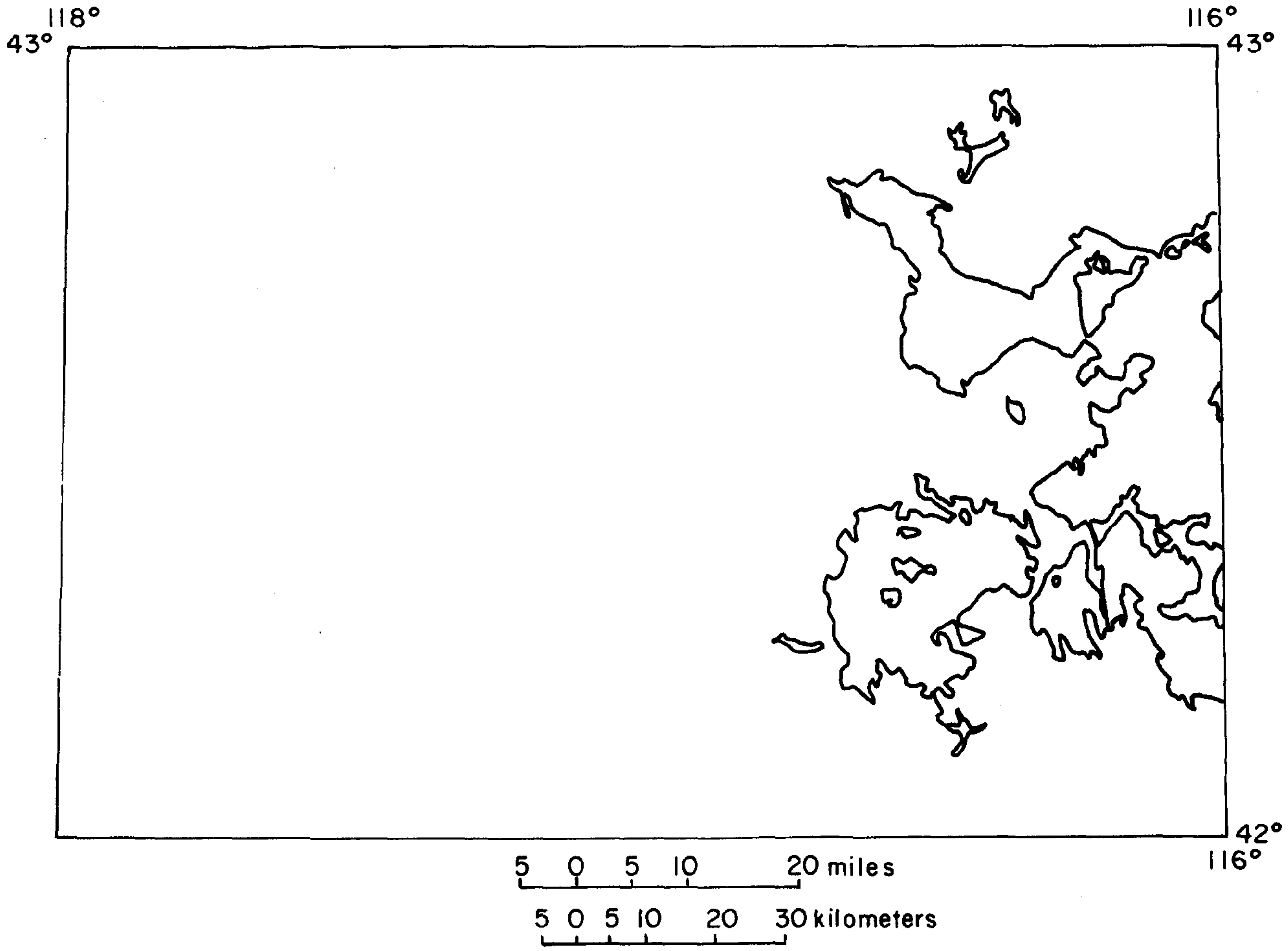

Figure 4. Distributian of the Tuff of the Little Jacks Creek in the Jordan Valley Quadrangle.

Extensive flows of Banbury Basalt compose the upper basalt sequence that overlies silicic flows and tuffs of the Ownyhee Upland. This unit comprises many thin (less than 5 m thick) flows of fine-grained and vesicular, intergranular to ophitic-textured olivine basalt and minor interbeds of stream and lacustrine deposits (Ekren and others, 1978). Some of the sedimentary interbeds are up to 60 m thick and contain variegated basalt clastics, brownish tuffaceous sand, pebble gravel, vitric silicic ash, and local lacustrine diatomite. Potassium-argon dates for Banbury Basalt from nearby exposures to the east and south of the quadrangle are from about 8 to 10.5 m.y. (Armstrong and others, 1975).

Cenozoic Rocks of the High Lava Plains. Sedimentary deposits of the Idaho Group are restricted to the Snake River Plain in the northeastern part of the quadrangle (Pl. 7). Here, these sedimentary rocks are inferred to overlie the Banbury Basalt, for which exposures are commonly lacking, and were deposited during downwarping of the Snake River Plain (Malde and Powers, 1962).

The oldest rocks of the Idaho Group in the quadrangle compose the Chalk Hills Formation of late Miocene and Pliocene age (Malde and Powers, 1962). This formation is up to 100 m thick and contains lacustrine and fluviatile deposits of sand, silt, clay, and diatomite that have thin beds of vitric ash and sparse beds of basaltic tuff. Tuffaceous sand and silt zones within the formation are commonly altered to zeolite and montmorillonite.

Overlying the Chalk Hills Formation is the Glenns Ferry Formation of Pliocene and Pleistocene(?) age (Malde and Powers, 1962). This formation is up to 300 m thick and comprises lacustrine and fluviatile deposits characterized by abrupt lateral changes in facies. The formation consists mostly of thin-bedded ash and tuffaceous sand, silt, and clay, and locally contains thin beds of vitric ash and pebble gravels and clasts of rhyolite, basalt, and granite (Ekren and others, 1978). The basal parts of the formation commonly include fossiliferous oolite up to 30 m thick and massive, unconsolidated, brown, coarse arkosic sand where the oolite is absent. Locally, the basal part of the formation contains brown-pebble conglomerate that has mixed volcanic and granitic clasts and silicified gastropods and pelecypods.

The uppermost unit of Idaho Group rocks in the quadrangle is the Bruneau Formation of Pleistocene age (Malde and Powers, 1962). This formation is up to 110 m thick and comprises white-weathering lacustrine and fluvial silt and clay and minor amounts of sand. The formation includes gravels of the Oreana area (Pl. 7) in the northeastern corner of the quadrangle that are composed of pebbles, cobbles, and boulders of rhyolite and basalt in a tuffaceous sand matrix (Ekren and others, 1978).

The High Lava Plains in the Rome, Oregon, area (Fig. 2) are underlain by tuffaceous sedimentary rocks and olivine-bearing basalt flows that are from late Pliocene to recent in age. Most of the sedimentary rocks are correlative, in part, to those of the above-mentioned Idaho Group in the Snake River Plain (Walker and Repenning, 1966). Lava cones and small shield volcanoes of late Miocene(?) to recent(?) age are common in the area.

Basin and Range Province

Volcanic and sedimentary rocks of Miocene and younger age underlie the northern part of the Basin and Range Province (Fig. 2) in the southwest part of the Jordan Valley Quadrangle. Descriptions of the rock units are divided into two parts on the basis of their association with the McDermitt caldera (Fig. 5).

Cenozoic Rocks Outside of the McDermitt Caldera. Volcanic activity began during the early Miocene in the northern part of the Basin and Range Province. The oldest rocks are a thick sequence of andesite and basalt flows and flow breccias (Tfb, Tbf, and Taf units; Pl. 7), which were erupted from fissure vents (Rytuba, 1976). Exposures of the andesite-basalt sequence are widespread and have a cumulative thickness of over 420 m along the northern margin of the McDermitt caldera (Rytuba and Glanzman, 1979). The rocks are commonly characterized by large plagioclase phenocrysts. They are considered lithologically equivalent to the Steens Basalt, west of the quadrangle, and time correlative to latite and basalt flows which underlie parts of South Mountain and the Silver City Range in the northeast part of the quadrangle (Walker and Repenning, 1966). Potassium-argon ages for andesite from areas around the McDermitt caldera are from 24.6 + 7.0 m.y. to 16.5 + 2.0 m.y. (McKee, 1976).

A series of tuffaceous sediments and ash-flow tuffs (Tts and Ttr units; Pl. 7) of Miocene age unconformably overlie the andesite-basalt sequence. The tuffaceous sediments, which include fine-grained and locally conglomeratic rocks, represent flood-plain or shallow-lake deposits (Walker and Repenning, 1966). The sediments are commonly covered by a widespread, thin veneer of lag and sediment gravels of Pliocene and Pleistocene age. The sedimentary units overlie and are interbedded with the ash-flow tuffs. The tuffs are commonly densely welded and locally contain vitrophyres. Probable source of the tuffs is the McDermitt caldera. Rocks representing silicic vents (QTsv unit, Pl. 7) are present in two localities. According to Walker and Repenning (1966), these rocks grade laterally into the ash-flow tuff units. Basalt flows of Miocene(?) and Pliocene age locally overlie the older rock units. Unconsolidated fluviatile gravel, sand, and silt of Quaternary age occur in lowland areas.

Cenozoic Rocks of the McDermitt Caldera. The McDermitt caldera is a large Miocene eruptive center that lies along the Oregon-Nevada border. Eruption of rhyolitic and peralkaline ash-flow tuffs began about 17.4 m.y. ago and continued for about 1.5 m.y. (McKee, 1976). During this period of silicic eruptions, an area approximately 50 km long and up to 30 km wide collapsed to form the caldera complex. The caldera was subsequently filled with sedimentary and volcanic rocks. The northeastern part of the caldera corresponds to the southern scarp of the Trout Creek Mountains and lies within the quadrangle.

According to Rytuba and Glanzman (1979), five episodes of large-volume rhyolitic and peralkaline ash-flow tuff eruptions resulted in the formation of overlapping and nested calderas (Fig. 6). The northern parts of the Longridge and Washburn calderas occur within the quadrangle. The first three ash-flow

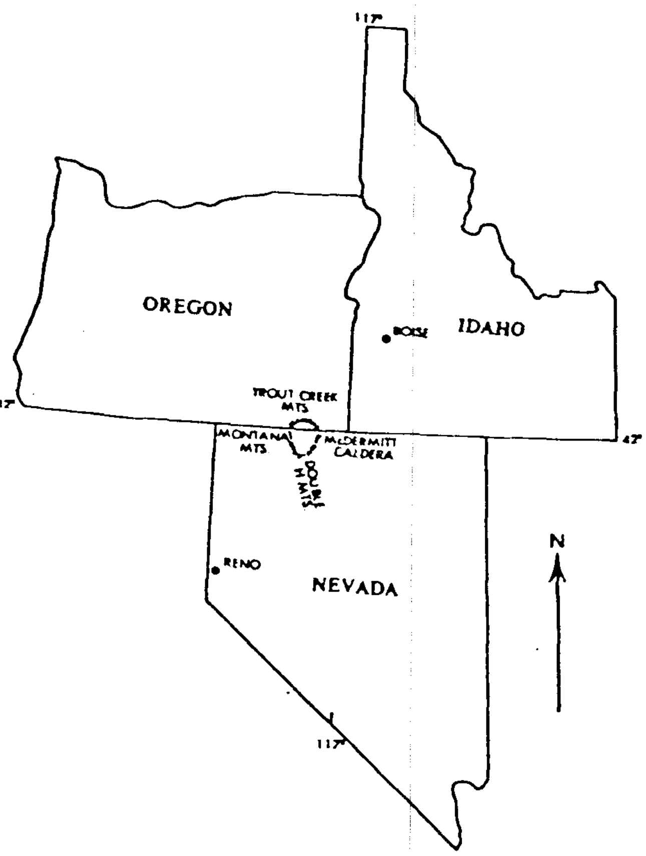

Figure 5. Location of McDermitt caldera (Rytuba, 1976).

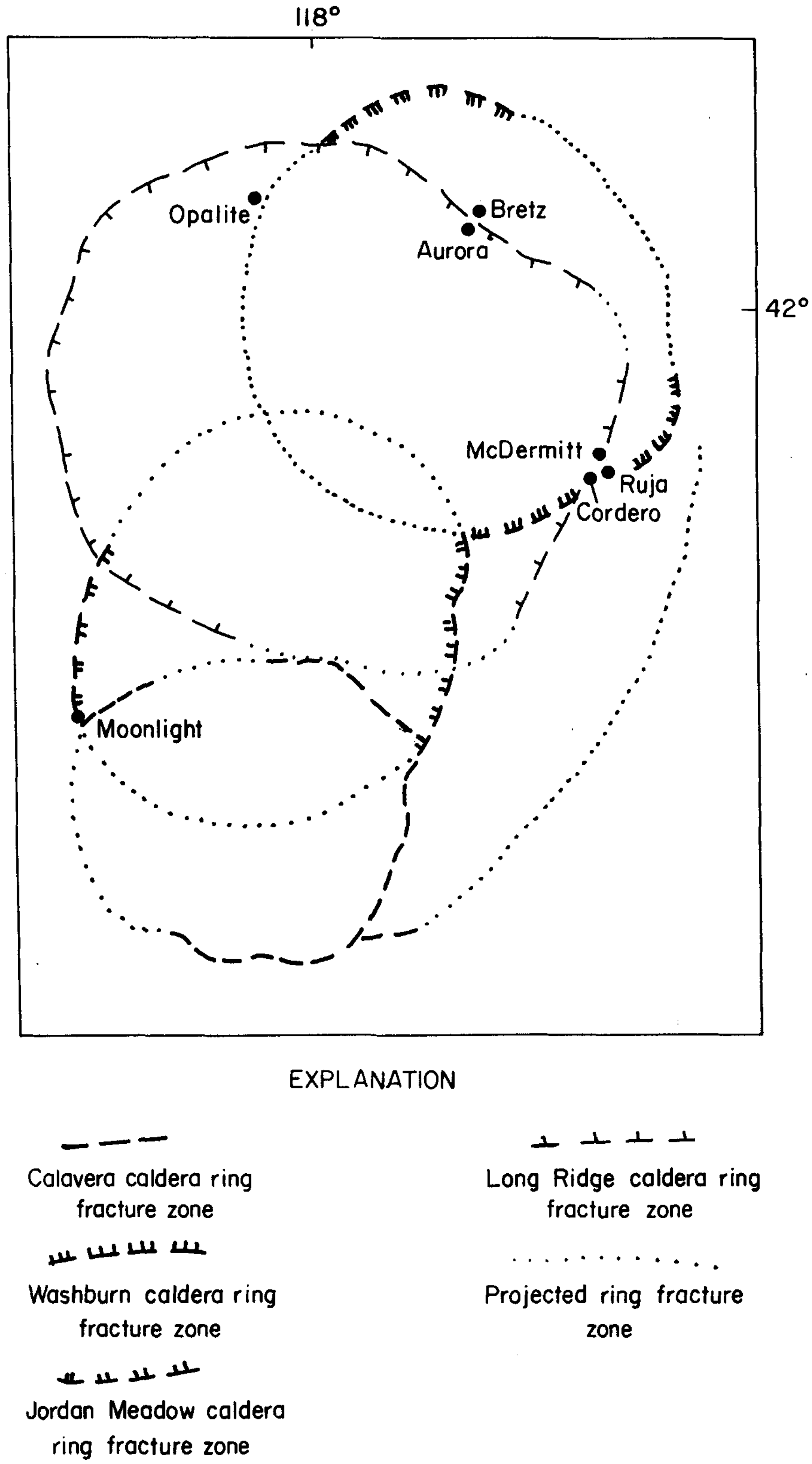

Figure 6. Distribution of calderas within the McDermitt caldera complex (Rytuba and Glanzman, 1978).

tuffs are restricted to the southern part of the caldera, presumably near their source area. Ash-flow tuffs 4 and 5 (Fig. 7) are mostly restricted to the northern part of the caldera as outflow-facies rocks.

The well defined ring-fracture zone of the Longridge caldera (Fig. 6) separates volcanic rocks that form the caldera wall from intracaldera volcanic and sedimentary rocks in the moat and resurgent highland of the caldera. The caldera-wall rocks, which consist of a series of ash-flow tuffs and intermediate flow rocks, appear to be repeated by ring-fracture faulting in the caldera wall. The oldest exposed rocks are ash-flow tuffs and intermediate to mafic flow rocks (Tri unit, Pl. 11). The ash-flow tuffs of this unit have rhyolitic to intermediate compositions and contain several vitrophyres. The rock is poorly defined but may correlate with ash-flow tuffs in the moat of the caldera. The intermediate to mafic flow rocks of this unit include icelandite and trachyte flows. The icelandite flows, described by Wallace and others (1980), are defined as a complex series of intermediate lava flows that are characterized by large amounts of iron, alkalis, and intermediate silica. The flows may correlate with the Aurora lava series, of similar composition, in the moat part of the caldera. The flows are exposed both in the lower part and upper parts of the caldera wall.

Ash-flow tuffs 4 and 5 (Fig. 7) of Rytuba and Glanzman (1979) form much of the caldera wall. Ash-flow tuff 4 (Tt unit; Pl. 11) is a peralkaline ash-flow tuff up to 30 m thick. The rock is characterized by sparse to moderately abundant lath-shaped feldspar crystals in granophyric to aphanitic groundmass. The tuff overlies the intermediate to mafic lava flows (Tri unit) and has a basal 1-m-thick crystal-rich welded tuff (aenigmatite-bearing pantellerite of Wallace and others, 1980). Ash-flow tuff 5 (Tta unit; Pl. 11) is a peralkaline ash-flow tuff that has an exposed thickness of 90 m (Rytuba and Glanzman, 1979). The tuff has a granophyric groundmass and contains a thin basal vitrophyre. The unit caps the top of the Trout Creek Mountains and locally appears to drape the caldera rim fault of the ring-fracture zone.

Intracaldera rocks include volcanic and sedimentary rocks in the moat of the caldera and volcanic rocks of the resurgent highlands. Rocks in the moat part of the caldera are associated with structures along the northwest-trending ring-fracture zone. These rocks include rhyolitic flow rocks, lava flows of the Aurora series, and tuffaceous sedimentary rocks. Important structures along the ring-fracture zone (Fig. 8) have been described by Roper and Wallace (1981). The oldest tuffs and flows (Tr unit; Pl. 11) appear to represent both intrusive and extrusive phases of the caldera. These rocks form the Aurora structure (Fig. 6) of Roper and Wallace (1981). The Aurora structure is an elongate anticlinal feature striking northwest, dipping gently southwest, and paralleling the ring-fracture zone. It is unclear whether exposures of the rhyolite of McDermitt Creek (Tmr unit; Pl. 11) (Green, 1976) are part of the moat rhyolites or part of the resurgent highlands. Lava flows of the Aurora series (Ta unit; Pl. 11) overlie the rhyolitic rocks. The Aurora series has been defined as a complex sequence of intermediate lava flows of icelandite (Wallace and others, 1980). The Aurora flows commonly consist of massive central zones with vesicular to scoriaceous flow tops and locally brecciated flow layers (Roper and Wallace, 1981). The massive central zones are unaltered dense black icelandite that has sparse plagioclase phenocrysts. Individual flows range in thickness from 6 to 15 m and have a

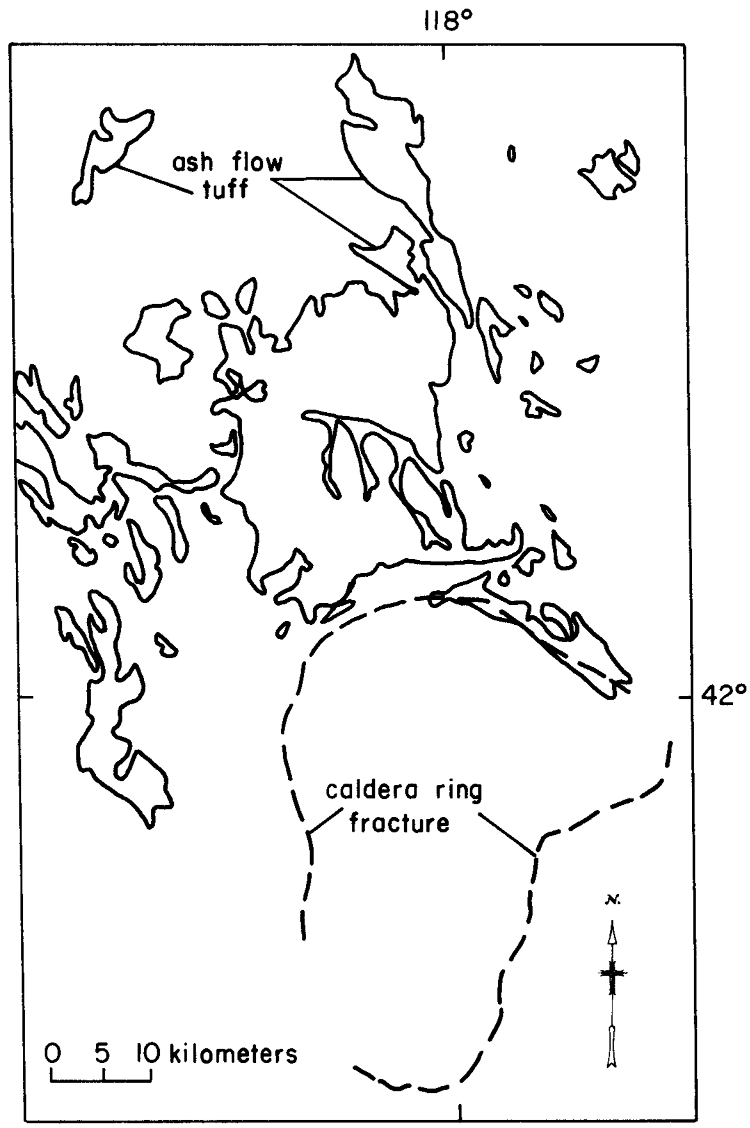

Figure 7. Distribution of ash flow tuff units 4 and 5 of the McDermitt caldera (Rytuba, Conrad, and Glanzman, 1979).

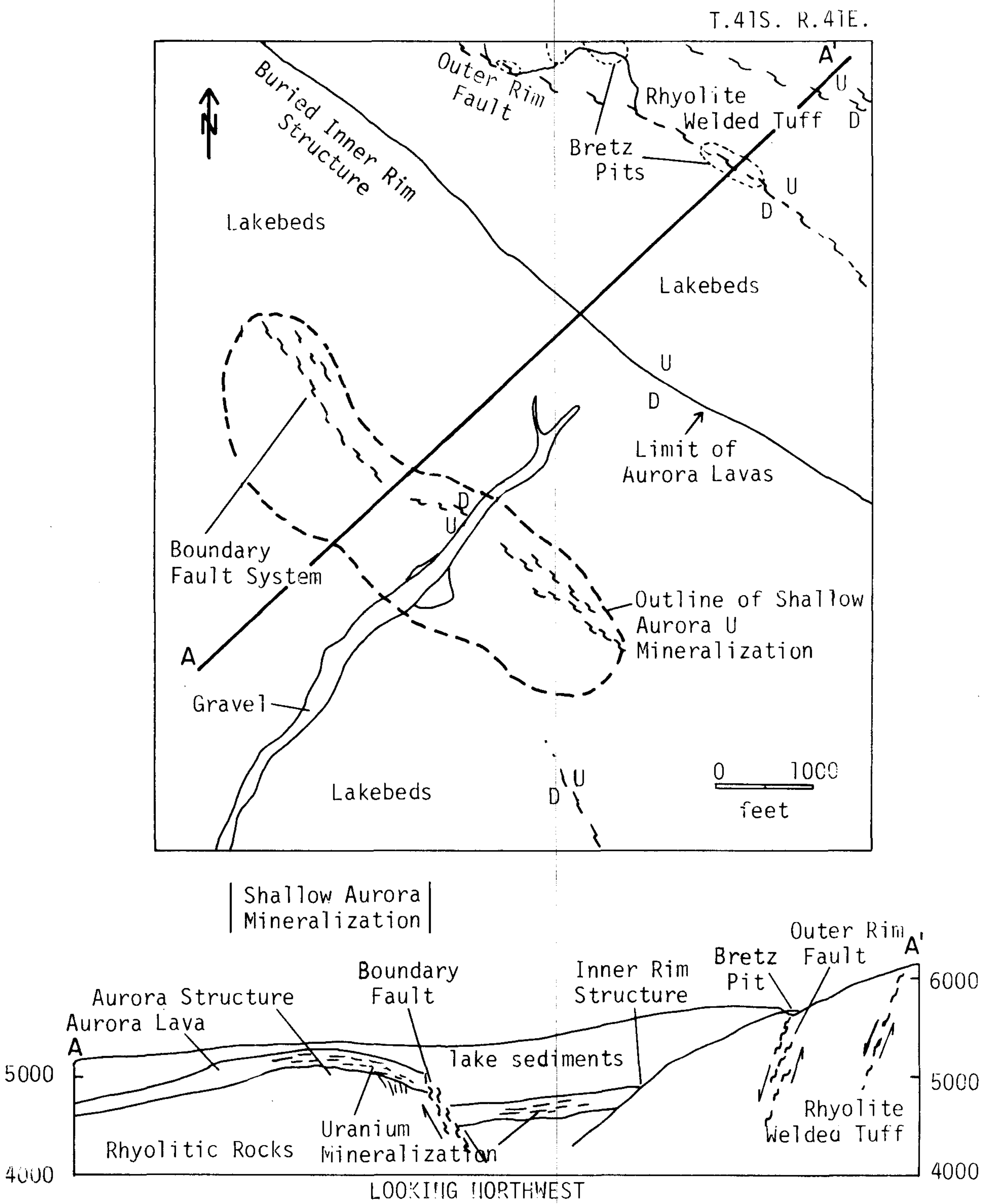

Figure 8. Generalized geologic map and stratigraphic - structural section of the mineralized area of the Aurora and Bretz uranium prospects (after Roper and Wallace, 1981).

cumulative thickness of about 100 m (Roper and Wallace, 1981). Exposures of the Aurora lava west of the quadrangle include flows that have abundant glass.

A thick sequence of tuffaceous sediments overlies flows of the Aurora lava series and, locally, rhyolitic rocks (Fig. 8). The thickest accumulation of the sediments is along the ring-fracture zone. A more detailed explanation of the lithology of the sediments and their relationship with structures of the ring-fracture zone is presented in the section "Favorable Environments."

Rocks that form the resurgent highland of the caldera within the quadrangle include a series of ash-flow tuffs and flows of rhyolitic to rhyodacitic composition. Mapping by Greene (1976) to the south indicates that at least part of these rocks are the alkali rhyolite of Jordan Meadow.

ENVIRONMENTS FAVORABLE FOR URANIUM DEPOSITS

SUMMARY

The Jordan Valley Quadrangle contains favorable environments for hydrothermal volcanogenic deposits in the northeast part of the McDermitt caldera, Oregon (Area A, Pl. 1). The area is favorable because it contains the Aurora deposit and the Bretz mercury mine, which have proven reserves of over 23 million pounds U_3O_8, and the Cottonwood Creek occurrence with significant low-grade reserves of U_3O_8. The Aurora, the Bretz, and two other minor occurrences meet some recognition criteria for pneumatogenic uranium deposits (Class 520, Pilcher, 1978), but differ in that uranium deposition is related in part to hot-spring activity rather than fumeroles. The Cottonwood Creek occurrence meets some recognition criteria for hydroallogenic uranium deposits (Class 540, Pilcher, 1978), but differs in that uranium mineralization was introduced syngenetically with deposition of tuffaceous lacustrine (moat) sediments rather than by descending fluids. All occurrences of uranium are along or near the northwest-trending ring-fracture zone of the caldera. Host lithologies include intermediate lava flows, tuffaceous sediments, and peralkaline ash-flow tuffs; all of which are Miocene in age. The Hot Spring occurrence, which lies outside the favorable area of the caldera complex, is underlain by caldera outflow-facies rock and contains thorium anomalies.

URANIUM DEPOSITS AND OCCURRENCES

Uranium occurrences in the northeast part of the McDermitt caldera are all considered to be of hydrothermal origin. However, the occurrences can be divided into two groups on the basis of ore controls. The Aurora, Bretz, Indian Creek, and LeBret occurrences were formed by hypogene solutions during hot-spring activity related to ring-fracture structures. The Cottonwood Creek occurrence is related to the same hydrothermal activity, but the uranium is stratabound and appears to have been deposited during deposition of lacustrine moat sediments.

Aurora Deposit

Approximately 17 million pounds of 0.05% grade U_3O_8 have been outlined by drilling at the Placer Amex Aurora deposit (occurrence 1; App. A). According to Roper and Wallace (1981), shallow uranium mineralization occurs along flow tops and breccia layers in the Aurora lava series in a zone 1500 m long by nearly 500 m wide and up to 100 m thick (Fig. 8). The long axis of the deposit is subparallel to the northwest-trending caldera rim fault, which passes through the Bretz mine pits less than 1 km to the northeast. Higher grade mineralization occurs along steeply dipping fractures that cut the north part of the shallow mineralized zone. The Cordex Syndicate Bretz property, which includes the Bretz mercury mine, is adjacent to the Aurora deposit on the northeast. Approximately 6 million pounds of 0.05% to 0.075% grade U_3O_8 have been identified by drilling on the Cordex property in a northwest-trending zone 1800 m long and up to 600 m wide (The Northern Miner, 1979). Part of the ore reserves at the Cordex property is an extension of the Aurora deposit.

Most uranium at the Aurora deposit is in Aurora lava flows, but some mineralization occurs in underlying rhyolitic rocks and in the lower part of a section of tuffaceous moat sediments overliying the lava flows (Pl. 11). The Aurora lava series is defined as a complex sequence of intermediate lava flows of icelandite (Wallace and others, 1980). Chemically, the lava flows contain high iron and alkalis and intermediate silica. However, whole-rock chemical analyses of drill-core samples from the deposit indicate that flows and ash flows of dacitic to rhyolitic composition are also present in the lava series (MLE 563 and 569; App. F). The Aurora flows commonly consist of massive central zones having vesicular to scoriaceous flow tops and locally brecciated flow layers (Roper and Wallace, 1981). The massive central zones are unaltered dense black icelandite that has sparse plagioclase phenocrysts. The brecciated flow layers include flow breccia, laharic breccia, and pyroclastic breccia (Roper and Wallace, 1981). Individual flows are from 6 to 15 m thick and have a cumulative thickness of about 100 m (Roper and Wallace, 1981). Exposures of Aurora lava may be widespread in the caldera, but they are poorly defined because of the lack of detailed mapping.

According to Roper and Wallace (1981), uranium occurs as very fine-grained uraninite and coffinite in fine-grained coatings around and between framboidal pyrite and as minute grains sparsely dispersed in leucoxene. Sooty coatings of uraninite and coffinite are associated with pyrite along the steeply dipping fracture zones. Roper and Wallace also tentatively identified phosphuranylite, umohoite, and autunite. Our petrographic work indicates the presence of uraniferous titanium oxides, uranophane(?) associated with leucoxene and pyrite, and a uranyl phosphate mineral replacing rutile and forming pseudomorphs after uraninite(?) in mineralized Aurora lava drill core from the deposit (App. G). We were not able to verify the presence of uraninite or coffinite in high-grade unoxidized ore, even with the use of a scanning electron microscope-energy dispersive analysis system (SEM/EDS).

U_3O_8 content of select drill-core samples of altered Aurora lava from the deposit is from 0.09% to 0.3% (MLE 561-662, 564, 566, 568; App. B). Less altered Aurora lava drill-core samples from massive central zones in the flow contain between 2 and 101 ppm U_3O_8 (MLE 563, 567, MES 551; App. B). The discovery outcrop at the deposition in the Bretz gulch contains a section of altered, mineralized Aurora lava overlain by about 9 m of uranium-enriched tuffaceous sediments. The altered Aurora lava in the area contains up to 0.04% U_3O_8 (MLE 501, 707; App. B) and the tuffaceous sediments up to 0.02% U_3O_8 (MLE 704-706; App. B). Small fossil sinter mounts in tuffaceous sediments southeast of the deposit contain up to 60 ppm U_3O_8 (MLE 720, 759; App. B) and probably represent hot-spring activity associated with the deposit. A drill-core sample of rhyolitic ash-flow tuff, which underlies mineralized Aurora lava, has pyrite on fracture surfaces and contains 18 ppm U_3O_8 (MLE 565; App. B). Altered Aurora lava in the Cottonwood Creek drainage to the west of the deposit contains up to 70 ppm U_3O_8 (MLE 520, 536; App. B) and appears to mark the western limit of uranium enrichment of the deposit. Mineralized Aurora lava at the deposit has an epithermal trace-element suite consisting of anomalous As, F, Hg, Li, Mo, Sb, Zn, and W (App. D and E). Uraniferous sediments overlying the Aurora lavas at the deposit have similar associated trace elements (MLE 704 and 706; App. D and E).

Alteration of Aurora lavas is commonly coincident with uranium concentration and is mostly restricted to porous and permeable zones along flow tops and breccia layers. Our petrographic analyses indicate that the groundmass of the altered rock consists mostly of variable amounts of potash feldspar, quartz, and clay. Cristobalite occurs less commonly as groundmass material. Plagioclase phenocrysts are commonly altered to clay, and vesicles are commonly filled with jarosite or spherulitic siderite and clay. The potash feldspar and cristobalite may be primary or devitrification minerals in the lava flows. According to Roper and Wallace (1981), mineralized rock is almost completely altered to nearly sectile claylike minerals and contains about 18% water by weight. They have identified montmorillonite, chlorite, clinoptilolite, leucoxene, and silica gel as the dominant alteration minerals.

Pyrite is commonly abundant in mineralized rock and occurs as fine disseminations of framboidal aggregates. Other minerals associated with alteration include iron oxides, rutile, ilmenite, marcasite, arsenopyrite, sphalerite, galena, calcite, gypsum, fluorite, apatite, and barite.

Uranium mineralization at the deposit appears to be controlled, in part, by four major structures (Fig. 8) identified by Roper and Wallace (1981). These include the outer rim fault, the inner rim structure, the boundary fault, and the Aurora structure.

The outer rim fault is a steeply southwest-dipping normal fault that has less than 15 m of displacement, and in most places it marks the contact between moat sediments and caldera rim rocks. It is the innermost exposed ring-fracture fault along the caldera rim. The fault strikes northwest through the pits at the Bretz mine and appears to have acted as an ore control for opalite-type mineralization at the Bretz mine.

The inner rim structure is a feature that marks the northern boundary of the Aurora lava series. Locally, the inner rim structure resembles a relatively steep normal fault; elsewhere, in many places, it is a gently dipping feature resembling sedimentary or volcanic overlap on an erosion surface.

The boundary fault, an arcuate zone of normal faults, marks the northern limit of relatively shallow mineralized Aurora lavas. The fault strikes northwest and has produced a basinlike graben between itself and the caldera rim fault. The basin is filled with as much as 200 m of tuffaceous sediments and is underlain, in part, by Aurora lava. The structure is probably composed of a series of en echelon faults with a total offset of 60 to 90 m. However, the structure may be the steep outer wall of an elongate flow dome or series of ash-flow tuffs in the caldera.

The Aurora structure is an elongate, assymetric anticlinal feature consisting of a series of the above-mentioned intrusive and extrusive rhyolitic rocks that strike northwest and dip gently southwest. The structure is bounded on the northeast by the steeply dipping boundary fault. The axis or crest of the structure passes through the center of the shallow mineralized Aurora lavas, and the margin of the structure commonly coincides with the extent of shallow uranium ore. It is unclear whether the contact between the rhyolitic rock and the overlying Aurora lava represents an unconformity or was the result of resurgent doming. The structure does appear, however, to be related to the formation of uranium ore at the deposit.

Other faults at the deposit include a variety of lesser normal faults with scissorlike offset and a northeast-trending normal fault, with appears to limit the eastern extent of Aurora lavas (Roper and Wallace, 1981).

The trace-element chemistry, alteration mineralogy, and structural ore controls at the deposit support a hydrothermal origin for uranium mineralization. Roper and Wallace (1981) suggest uranium mineralization is associated with a final period of hydrothermal activity in the caldera, perhaps related to the events that formed the boundary fault. They believe that hypogene solutions introduced uranium into the lava flows and ground-water movement spread uranium along more permeable layers in the lava sequence. Hypogene mineralization is represented by uranium associated with pyrite along steeply dipping fractures. Roper and Wallace (1981) suggest that uranium was introduced in slightly acidic hydrothermal solutions as uranyl carbonate or sulfate complexes and precipitated by a combination of fixing agents, conductive chemical environments, and physical traps. These include clay minerals and various oxides, such as leucoxene, which prohibit the migration of hexavalent uranium ions, as well as H_2S gas, which was detected in some drill holes.

Bretz Mercury Mine

Uranium mineralization at the Bretz mine (occurrence 2, App. A) occurs mostly in large siliceous masses and in argillized tuffaceous sediments and ash-flow tuff along the outer rim fault of the ring-fracture zone. The overall geometry of the siliceous masses is probably similar to the southwest-dipping faults of the ring-fracture zone, but exposures of individual masses are irregular (Pl. 11). Surface uranium mineralization occurs intermittently for approximately 3800 m along the ring-fracture zone; width is between 200 and 500 m. Uranium mineralization is coextensive with mercury mineralization in pits at the mine. Over 14,000 flasks of mercury were produced at the Bretz mine from 161,326 tons of ore-grade material between the years 1930 and 1961 from relatively shallow (30 m) orebodies (Brooks, 1963). Cinnabar is the dominant mercury mineral.

Host lithologies for uranium in the Bretz mine area are tuffaceous sediments, ranging in texture from tuffaceous shale to sedimentary breccia; peralkaline ash-flow tuffs, which form the caldera wall rocks; and vesicular flow rocks of intermediate composition (Pl. 11).

According to Glanzman and Rytuba (1979), over 60 m of volcaniclastic sediments are present in the Bretz mine area. The sediments overlie an irregular surface of vesicular, altered, intermediate flow rock, which may be correlative to the Aurora lava series. Glanzman and Rytuba have divided the sedimentary section into three distinct stratigraphic units. These include: a lower tuffaceous sandstone, about 19 m thick, which contains minor interbedded mudstone and silicified layers; a medial mudstone, from 19 to 61 m, which has minor sandstone and opaline and chalcedonic silica nodules and lenses in the upper part of the unit; and an upper tuffaceous sandstone, above 61 m, which has minor mudstone and a persistant pertrified wood horizon. Adjacent to the ring-fracture faults, the tuffaceous sediments contain abundant silicified masses of conglomerate, talus, and sedimentary breccia. Moderate to intense brecciation is common in all lithologies adjacent to ring-fracture faults.

Peralkaline ash-flow tuff, which hosts some mineral concentration in the Bretz mine area, consists mainly of gray, aphyric, faint to strongly flow-banded rhyolite (Pl. 11). The tuff has microgranular texture and is commonly greenish gray. The tuff corresponds to ash-flow tuff 5 of Rytuba and Glanzman (1978). The unit appears to drape, in part, over the caldera rim fault of the ring-fracture zone. The tuff is intensely silicified along ring-fracture faults but becomes distinctly less silicified upward onto the caldera wall.

Vesicular flow rock of intermediate composition is exposed in open pits in the west area workings at the mine (Pl. 11). The unit is extensively altered and silicified; the vesicular, porphyritic rock ranges in color from light brown to black. Feldspar phenocrysts are altered to cristobalite, opal, feldspar, and clay and contains abundant microlites. Abundant gypsum occurs in the altered rock. Concentric banding in the unit, highlighted by bands of limonitic material, may be representative of fossil hot springs or fumeroles. The rock may correlate with the Aurora lava series, but it is probably part of an older series of icelandite flow rock in the caldera wall (Wallace and Roper, 1981).

Alteration in the Bretz mine area consists mostly of silicification and argillization. Silicification is commonly in the form of microcrystalline to macrocrystalline quartz. Quartz veins, although not abundant, occur locally, and drusy quartz commonly lines cavities in rocks. Silicification affects all lithologies, especially the tuffaceous sediments and ash-flow tuff, and masks characteristic textures. According to Rytuba and Glanzman (1979), alteration at the Bretz mine is concentrated along the ring-fracture zone. They suggest that silicification by quartz increases toward the center of the deposit, with a corresponding decrease in the crystallinity and amount of cristobalite, and that a zeolite and clay-mineral alteration halo around the deposit indicates hydrothermal alteration was imposed after diagenesis. According to the above, the tuffaceous rocks show lateral and vertical zeolitic alteration from almost fresh glass away from the deposit, through a clinoptilolite zone, a mordenite-erionite zone, an analcime-potassium feldspar zone, and finally to potassium feldspar at the center of the deposit, which represents the center of a hydrothermal cell. However, Wallace and Roper (1981) believe that alteration of the tuffaceous sediments is not concentric, that the lower part of the tuffaceous section is everywhere altered intensely, and that it is exposed in the Bretz pits.

Uranium in the Bretz mine area probably occurs as extremely fine-grained uranium minerals disseminated in silica, adsorbed on limonite, or associated with sulfides and mercury ore. The BFEC petrology group could not identify any dominant uranium minerals, even with the use of a scanning electron microscope. However, they were able to identify trace amounts of primary zircon and xenotime in samples of siliceous breccia (MLE 554, 703; App. G). Minerals associated with uraniferous rock include limonite, jarosite, leucoxene, rutile, and, in one sample of altered tuffaceous sediment, fine-grained aggregates of barite (MLE 550; App. 6). Sulfides, mostly pyrite and trace amounts of chalcopyrite, galena, marcasite, mercury sulfide, and Sb-Fe-Cu sulfide, were also identified petrographically in mineralized rock (App. G).

Surface exposures of radioactive rock contain uranium concentrations from less than 0.01% to over 0.02% U_3O_8. However, a sample of altered limonitic rock from a drill hole that probably intersects a ring-fracture fault contains nearly 0.1% U_3O_8 (MLE 710; App. A). Samples of rock having around 100 ppm U_3O_8 commonly have high mercury contents (up to 1.6%). Other anomalous trace elements associated with uraniferous rock include As, F, Mo, Sb, and Zr. Moderately anomalous amounts of Ba, Pb, Zn, and W are also present (App. D and E).

The mineralogy and trace-element chemistry, and the association of uranium with silicification and potassic alteration, indicate a shallow hydrothermal origin for the deposit. Both the mercury and the uranium mineralization appears to have been associated with epithermal hot-spring systems along the ring-fracture zone. Tectonic breccia along the ring fracture, and sedimentary breccia adjacent to it, provided permeable hosts for the metal-bearing solutions. Higher grade mineralization (up to 0.1% U_3O_8), at depth along the ring-fracture faults, may be similar to hypogene mineralization along steeply dipping fractures at the nearby Aurora deposit.

Cottonwood Creek Occurrence

Stratabound uranium at the Cottonwood Creek occurrence (occurrence 3; App. A) is in a single horizon in tuffaceous moat sediments. The uraniferous horizon "marker bed" of Wallace and Roper (1981) is 0.3 to 1.0 m thick and occurs 15 to 25 m above the contact with underlying Aurora lava series. It has large areal extent, occurring in an area about 4000 m long by 500 to 1500 m wide. The area, elongate to the northwest, is bounded on the north by the outer ring-fracture fault. The uraniferous horizon overlies and is coextensive with the Aurora deposit, but is more extensive, extending well into the Cottonwood drainage to the west.

According to Wallace (pers. comm., 1981), grade and thickness of the marker bed increases toward the Bretz mine, but the bed is unmineralized or pinches out at the caldera rim fault. In exposures along Cottonwood Creek, the thickness and radioactivity of the marker bed also appears to decrease southward.

The marker bed consists of two brown, opalized, thin-bedded shale units separated by a greenish-gray, altered air-fall tuff. A distinctive black chalcedony bed, 10 to 20 cm thick, occurs beneath the marker bed. The chalcedony bed contains abundant sulfide, but has low uranium content. There has been a tentative petrographic identification of organic compounds in a sample of the chalcedony bed from the Cottonwood Creek drainage (MLE 714; App. G). Freshly exposed surfaces of this rock west of the Cottonwood Creek area commonly have a distinct petroleum odor.

Although no uranium minerals have been identified, it appears that uranium is intimately associated with opal and clay minerals. Uranium contents of the marker bed are from about 0.01% to over 0.02% U_3O_8 (MLE 713, 716, 751-752; App. B). Uraniferous rock has a trace-element suite somewhat similar to that at both the Aurora and Bretz deposits. It contains high As, F, Hg, Li, Mo, and Sb (App. D and E).

The spatial relationship between the marker bed and the Aurora and Bretz deposits, along with similarity between trace-element suites of the deposits, suggests a genetic connection between hydrothermal activity at the Aurora and Bretz deposits and the marker bed. Wallace and Roper (1981) suggest that uraniferous hot springs along the ring fracture or within the moat of the caldera introduced uraniferous solutions during lacustrine sedimentation. Therefore, the marker bed can be considered of hydrothermal-syngenetic origin.

Indian Creek Occurrence

The Indian Creek occurrence (occurrence 4; App. A) is along a nearly east-trending fault within the ring-fracture zone approximately 6 km west of the Bretz mine. Low-grade uranium concentration (MES 761; App. B) of less than 0.01% U_3O_8 occurs in a small area of gray to buff, silicified tuffaceous sediment. Thinly laminated bedding in the sediment is complexly folded at the occurrence, probably the result of soft-sediment deformation by faulting. Anomalous As, Hg, Li, Mo, and Sb are associated with uraniferous rock (App. D and E). Uranium and silicification appear to have been introduced by hot-spring activity along the fault.

LeBret Occurrence

The LeBret occurrence (occurrence 5; App. A) is along the caldera rim fault of the ring-fracture zone, approximately 7 km southeast of the Bretz mine. Uranium is associated with large areas of moderately to intensely silicified aphyric ash-flow tuff. The tuff corresponds to ash-flow tuff 5 of Rytuba and Glanzman (1978). Uranium content of anomalously radioactive rock is from 10 to 129 ppm U_3O_8 (MLE 658, 660, 662; App. B). Anomalous amounts of As, Mo, and Sb are associated with both radioactive and background rocks (occurrence 4). The presence of a fossil hot spring at the occurrence indicates the area was the locus of surface hydrothermal activity. Rocks representing the fossil hot spring consist of altered, vuggy, siliceous rock cut by 7- to 10-cm silicic veins, abundant limonitic material, siliceous sinter, and acicular siliceous aggregates. A bleached alteration halo occurs for several meters around the fossil system. However, anomalous radioactivity, associated with silicified rock, decreases toward the center of the fossil system. Structures at the occurrence include a steeply southwest-dipping, northwest-trending fault and a series of steeply dipping northeast- and northwest-striking fracture systems.

Hot Spring Occurrence

The Hot Spring occurrence (occurrence 6; App. A) is about 12 km northeast of the Bretz mine. Although the occurrence lies outside the favorable area of the McDermitt caldera complex, it is discussed here because rocks in the area of the occurrence probably represent caldera outflow facies. Radioactive anomalies at the occurrence are in a talus slope along the scarp of a north-trending basin and range fault. The fault dips steeply to the west and has several meters of offset. Rock underlying the scarp at the site of the radioactive anomalies is a bluish-gray to green, peralkaline, ash-flow tuff. Exposures of the tuff above the anomalies, and elsewhere along the upper part of the scarp, are often brecciated and locally contain quartz veinlets. The groundmass of the tuff is altered to quartz and potassium feldspar and has finely mottled granular to spherulitic texture. Alteration appears to be a result of devitrification. Minor constituents in the rock include limonite, rutile, and riebeckite(?). Elongate vugs are common, and some are lined with clay, riebeckite, and tourmaline(?) (App. G). Samples of the ash-flow tuff (MLE 534, 535, and 623; App. B) contain 1 to 10 ppm U_3O_8.

Three soil samples (MLE 678-680; App. B), taken at the site of the radioactive anomalies, contain 10 to 24 ppm U_3O_8 and up to 0.05% eTh. A contour map of the radiometric data (occurrence 6) indicates east-trending radioactive anomalies, possibly controlled by fractures that have similar orientations.

An active hot spring, associated with sinter material, is along the fault about 1 km south of the occurrence; a fossil hot spring has been tentatively identified in an east-trending valley about 2 km southwest of the anomalies. However, no anomalous radioactivity is associated with either system.

Because the thorium anomalies at the occurrence are not associated with silicification and hydrothermal alteration, it is not known whether the radioactivity is associated with a hydrothermal system.

LAND STATUS AND ACCESSIBILITY

Most land within the Jordan Valley Quadrangle is owned and managed by the Bureau of Land Management (BLM). Private property consists of ranch land and is commonly restricted to areas that have water resources.

Accessibility in the McDermitt caldera favorable area is good during dry weather; no point in the area is more than a few kilometers from either a BLM, ranch, or mining road. However, vehicle access is restricted during wet weather because those roads not covered with gravel or those without proper ditches have a tendency to wash out. Access in other parts of the west half of the quadrangle is generally good during dry weather on BLM or ranch roads. Access is impaired in many places in the east half of the quadrangle because many road beds are formed on basalt or rhyolite bed rock and are difficult to maintain. The Owyhee River, which crosses the entire width of the quadrangle and generally forms a deep gorge, can be crossed in a few locations; however, only one crossing is located in the eastern half of the quadrangle.

ENVIRONMENTS UNFAVORABLE FOR URANIUM DEPOSITS

SUMMARY

Favorability for uranium deposits in the Jordan Valley Quadrangle is associated with Miocene volcanic rocks of peralkaline affinities and tuffaceous sediments along the ring-fracture zone of the McDermitt caldera. Except for some sediments that have not been thoroughly evaluated in the northeast part of the quadrangle, all rocks outside of the favorable area are considered unfavorable. Rocks in unfavorable environments can be divided into three groups on the basis of their geologic setting within the physiographic provinces (Fig. 2).

ROCKS IN THE BASIN AND RANGE PROVINCE

These rocks include basalt and andesite flows (Tfb, Tbf, and Taf units; Pl. 7); tuffaceous sediments, tuffs, and silicic flows (Ttf, Tts, and Ttr units; Pl. 7); and basalt flows (Tb unit; Pl. 7). In the Basin and Range Province, the basalt and andesite flows (Tfb, Tbf, and Taf units) are the oldest rocks. They are unfavorable because of their basic compositions and their low uranium contents.

The tuffaceous sediments, tuffs, and silicic flows (Ttf, Tts, and Ttr units) overlie the basalt and andesite flows. Although the uranium content of these rocks varies (App. B) and the ash-flow tuffs (Ttr unit) are mostly outflow facies rocks of the McDermitt caldera (Fig. 5), all are considered unfavorable because they do not lie along any known or inferred caldera structures (e.g., the ring-fracture zone of the McDermitt caldera). Included in the latter group of rocks are those of silicic vent areas (QTsv unit, Pl. 7). These rocks grade into ash-flow tuffs and silicic flows of the Ttr unit (Walker and Repenning, 1966) and are considered unfavorable for the same reasons.

Basalt flows (Tb unit; Pl. 7) of Miocene(?) and Pliocene age are unfavorable because of their low radioactivity.

ROCKS IN THE COLUMBIA INTERMONTANE PROVINCE

High Lava Plains Subprovince

Rocks within the High Plains subprovince (Fig. 2) are Pliocene and younger basalt flows and sedimentary rocks in the northwest part of the quadrangle. Tuffaceous sediments, tuffs, and interbedded basalt and andesite flows (Tsb, Tst, and Tob units; Pl. 7) are the oldest of these rocks.

All are considered unfavorable for uranium deposits because of their low uranium contents, their basic compositions, or the absence of known or inferred caldera structures. However, a thick sequence of tuffaceous sediments (Tst unit; Pl. 7) in the Rome, Oregon, area contains anomalous concentrations of uranium (MLE 541-543; App. B). The sediments were deposited in a large saline basin and contain near-commercial deposits of zeolites and authigenic fluorite (Ellison, 1968; Sheppard and Gude, 1969). The area of zeolite and fluorite enrichment was the loci of ARMS-defined anomalies. It is presumed that the anomalous concentration of uranium is associated with fluorite and zeolitic enrichment. The area, however, does not meet criteria for NURE-defined uranium deposits.

Owyhee Upland Subprovince

Paleozoic(?) Metasediments and Cretaceous-Tertiary Granitic Rocks. Interbedded schist, quartzite, and marble of Paleozoic(?) age, in part intruded by masses of granodiorite (TKg unit; Pl. 7), and hornblende gabbro (Khg unit; Pl. 7) in the South Mountain area, are unfavorable for uranium deposits because of the intermediate to basic composition of the intrusive rocks and the low uranium contents of the other rocks. Granodiorite, granite, and quartz monzonite in the Silver City Range and the Castle Creek areas (Kg unit; Pl. 7) are also considered unfavorable for uranium deposits because of their low radioactivity or low uranium contents.

Eocene volcanic rocks. Rhyodacite tuffs of the Challis Volcanics (Tcv unit, Pl. 7) in the Poison Creek-Castle Creek area are considered unfavorable for uranium deposits because of their intermediate composition and low uranium contents. A dike swarm (Tro unit, Pl. 7), which cuts the Challis Volcanics, and an adjacent mass of Eocene(?) quartz-biotite tuff (Tqb unit, Pl. 7) are also considered unfavorable because of their low radioactivity.

Miocene ash-flow tuffs. These rocks include ash-flow tuffs erupted from the Juniper Mountain volcanic center (Tsr, Tjl, Tju, and Tjub units; Pl. 7), the Silver City rhyolite (Tsc unit, Pl. 7), the tuff of Little Jacks Creek (Tlj unit, Pl. 7), and a few other ash-flow tuff units outlined in the "Geologic Setting" section of this report. All are considered unfavorable for uranium deposits. Although Juniper Mountain and parts of the Silver City Range are inferred to be volcanic centers (Bennett, 1976; Ekren and others, 1978), reconnaissance work during this project in these areas did not indicate the presence of favorable structures such as those along the ring-fracture zone of the McDermitt caldera. Uranium contents of the ash-flow tuffs from these areas varies, but whole-rock chemical analyses indicate the rocks have peraluminous chemistries compared with the peralkaline affinities of extrusive rocks of the McDermitt caldera. According to Pilcher (1978), peralkaline chemistry of volcanic rocks is an important criterion for uranium deposits in volcanogenic terranes. The tuff of Little Jacks Creek is a widespread unit in the eastern part of the quadrangle. The ARMS survey indicates this unit has the highest overall equivalent uranium of any unit within the quadrangle. Although the rock contains near-anomalous background concentrations of uranium, it is considered unfavorable for uranium deposits because of its peraluminous chemistry and the absence of favorable caldera structures. Other Miocene ash-flow tuff units in the eastern part of the quadrangle are unfavorable because of their low radioactivity.

UNEVALUATED ENVIRONMENTS

SUMMARY

Two areas in the northeast part of the quadrangle have environments that may be favorable for sandstone uranium deposits (Subclass 241, Austin and D'Andrea, 1978) but are considered unevaluated in this report. The areas include the Triangle Ranch area (Area A, Pl. 1B) and the Snake River Plain (Area B, Pl. 1B). The areas are considered unevaluated because of the lack of subsurface data, lack of detailed geologic mapping, and lack of time imposed by the project deadline did not allow time for evaluation.

TRIANGLE RANCH AREA

Sedimentary rocks of Tertiary(?) age in the Triangle Ranch area in the northeast-central part of the quadrangle (Area A, Pl. 1B) are unevaluated for sandstone uranium deposits (Class 240, Austin and D'Andrea, 1978). The area is considered unevaluated because of the lack of subsurface data and geologic mapping; also, time constraints of the project did not allow time for adequate evaluation.

The Triangle Ranch area is an intermontane basin at the southern end of the Silver City Range in the Owyhee Mountains, Idaho. The basin is underlain by arkosic and volcaniclastic sediments of Miocene(?) or younger age, which host several occurrences of stratabound uranium. All surface occurrences are along the 5,100- to 5,200-ft contour interval in sediments in the southern part of the basin (occurrence 7). Uranium occurs in fine-grained minerals associated with the fluorapatite or phosphate-clay matrix of an exposed arkosic sandstone and conglomerate and an overlying tuffaceous claystone. Locally, uranium concentration occurs in an unconsolidated sandstone of younger age.

Limited stratigraphic work indicates the cumulative thickness of sediments in the southern part of the basin is from 30 to 80 m. The variability of the cumulative thickness of the sediments is the result of sedimentary deposition on an irregular ridge-type surface of Miocene ash-flow tuffs. The bedrock tuffs include the tuff of Swisher Ridge (Tsr, Pl. 7) and the tuff of Little Jacks Creek (Tlj, Pl. 7). Granitic rocks and Miocene basalt flows and ash-flow tuffs (KTg, Tlb, and Tsc, respectively; Pl. 7) form highlands of the Silver City Range on the north end of the basin. All these rocks may have provided detritus for sediments in the basin, especially the arkosic sediments.

Uranium content of the arkosic sandstone and tuffaceous claystone of the mineralized interval is from about 0.01% to over 0.03% U_3O_8. At the main occurrence in S1/2 sec. 12, T. 7 S., R. 3 W., the mineralized interval is about 2 m thick and extends intermittently for about 700 m. Local exposures of the mineralized interval occur sporadically to the north and west of the main occurrence. Uraniferous rock has a trace-element suite that shows anomalous Ca, F, and P_2O_5. This corresponds to the fluorapatite or phosphate matrix of the radioactive rock.

Sediments in the basin are cut by west-trending normal (listric) faults, dipping to the south. Northwest-trending linears, possibly related to the structural grain of the bedrock ash-flow tuffs, appear on airphotos to locally offset or are offset by the west-trending faults. A maar, tentatively identified on airphotos, is about 3 km northeast of the occurrence (occurrence 7).

Source of the uranium and the associated fluorapatite and phosphate in the sediments is speculative. Water samples taken from several recent drill holes at the occurrence indicate that present ground water carries no more than 4 ppm U_3O_8 (occurrence 7). However, possible source rocks could include the bedrock tuffs, which average between 5 and 8 ppm U_3O_8, and the Silver City rhyolite, which contains up to 9 ppm U_3O_8. A gray, glassy air-fall tuff, another possible source, is exposed in pits at the main occurrence and overlies the mineralized tuffaceous claystone (occurrence 7). The tuff contains 8 ppm U_3O_8, 0.1% F, and anomalous Hg; it could represent much thicker accumulations of tuff that were leached and subsequently eroded.

The anomalous Hg contents of samples of uraniferous tuffaceous sandstone (occurrence 7), the tuff (occurrence 7), and the presence of a maar (occurrence 7) near the main occurrence may indicate some hydrothermal system was active in the basin. However, the distinct lack of silicification and the trace-element suite of uraniferous samples do not support a hydrothermal origin for the deposit. The limited stratigraphic work and the lack of both subsurface data and detailed geologic mapping preclude any favorable designation for the basin.

SNAKE RIVER PLAIN

Sedimentary rocks of late Tertiary age, which underlie that part of the Snake River Plain in the northeasternmost part of the quadrangle (Area B, Pl. 1B), are unevaluated for sandstone uranium deposits (Class 240, Austin and D'Andrea, 1978). The area is considered unevaluated because of the lack of subsurface data and detailed geologic mapping; in addition, time constraints of the project did not allow time for adequate evaluation. However, part of the area was considered to be favorable for sandstone uranium deposits by previous workers (Marjaniemi and others, 1976); this evaluation is based on the high percentages of sandstone in the sedimentary units, high mean equivalent-uranium content of rock samples, and anomalous trace-element content of rock samples.

The western Snake River Plain is part of a broad depression, probably a rift zone (Warner, 1975), that is part of the eastern High Lava Plains subprovince (Fig. 2). The part of the Snake River Plain within the quadrangle is underlain by upper Miocene to Pleistocene sediments of the Idaho Group (Malde and Powers, 1962; Ekren and others, 1978). The Idaho Group sediments have a cumulative thickness of about 1000 m. Recognized rock units of this group are the late Miocene-Pliocene Chalk Hills Formation, the Pliocene-Pleistocene Glenns Ferry Formation, and the Pleistocene Brunneau Formation, which includes gravels in the Oreana area. The sediments of the Idaho Group were probably deposited as a result of subsidence along faults that bound the basin (Malde and Powers, 1962). The sediments are inferred to overlie the Miocene Banbury Basalt, although exposures of the basalt are lacking in the unevaluated area. For general descriptions of the lithologic units, see the "Geologic Setting" section of this report.

Because time constraints of this project permitted only minor reconnaissance work in the unevaluated area, the results of the study by Marjaniemi and others (1976) were used as the basis for the unevaluated designation.

Results of their study indicate that the Murphy-Chalk Hills subarea had the greatest favorability for uranium deposits, based on favorable lithologic, stratigraphic, and chemical criteria. Favorable lithologic and stratigraphic criteria include the presence of thick beds and sequences of sandstone and conglomerate units, evidence of fluvial origin and present or original permeability, and the presence of feldspar, iron staining, and carbonaceous material. Favorable chemical characteristics are the high mean equivalent-urannium content (5.4 ppm) of rock samples, and the statistically high elemental concentrations of B, Cr, Li, P, and V in rock samples. Uranium content of four reconnaissance rock samples collected during this study from the Chalk Hills and Glenns Ferry Formations was commonly low. Three of the samples contain 4 or less ppm U_3O_8, but one sample from the Glenns Ferry Formation contains 11 ppm U_3O_8 (App. B; Pl. 5). The presence of potential source rocks in the area is speculative. The uranium contents of granitic rocks and silicic volcanic rocks (Kg, Tcv, and Tcv units; Pl. 7) in the surrounding highlands are commonly less than 3 ppm U_3O_8 (App. B; Pl. 5). However, the tuff of Little Jacks Creek (Tlj unit, Pl. 7), exposed along the southern part of the unevaluated area, has a mean uranium content of nearly 8 ppm U_3O_8 (App. B, Pl. 5).

At the present time, no data are available on the uranium content of ground water in the unevaluated area. Three ARMS-defined radioactivity anomalies are present within the area. However, it was determined during fieldwork that radioactivity was commonly associated with sediments containing abundant clasts of the tuff of Little Jacks Creek.

Although there is no reported uranium occurrence in the area, the lithologic, stratigraphic, and chemical characteristics outlined by Marjaniemi and others (1976) can be considered as favorable criteria for sandstone uranium deposits. For these reasons the area is considered unevaluated.

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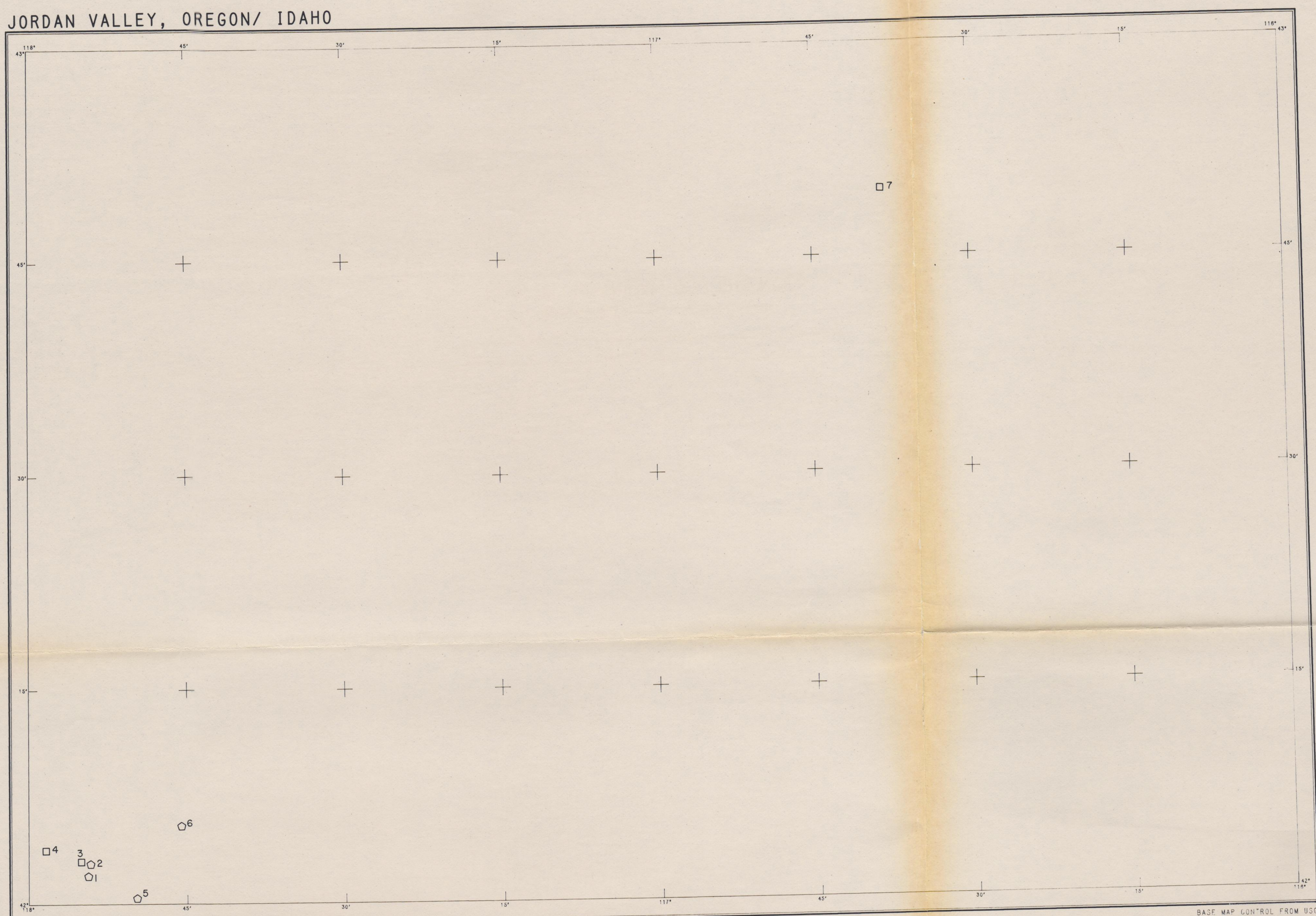


URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

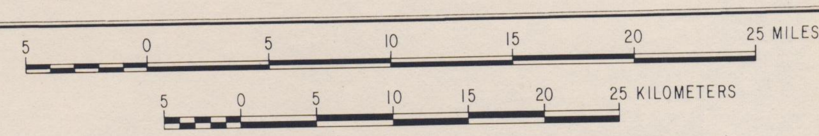
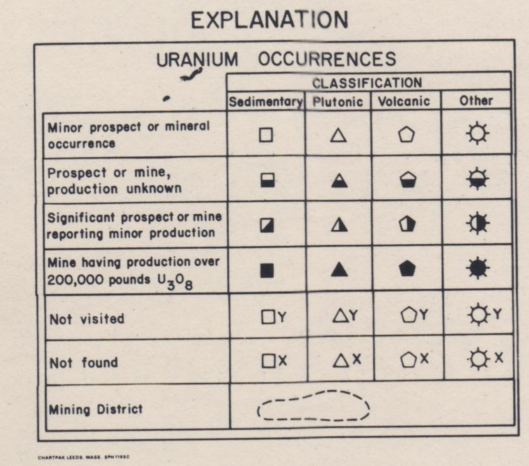


Plate 2. URANIUM OCCURRENCES



June 1981

Plate 2.

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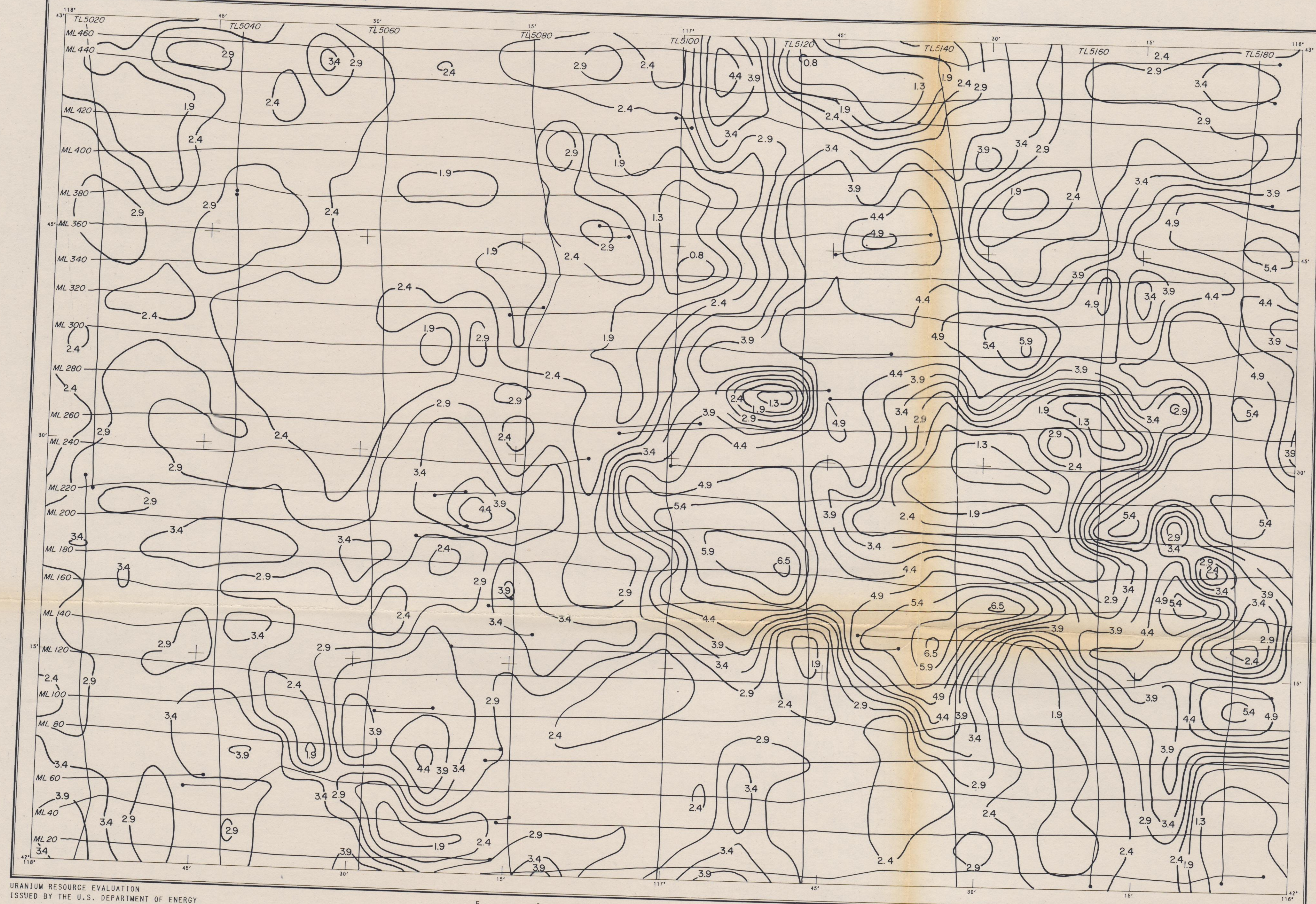

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate 3. INTERPRETATION OF AERIAL RADIOMETRIC DATA

EXPLANATION

AERIAL RADIOMETRIC DATA

ML 20 — Flightline

2.9 — Computer contour interval of equivalent uranium (ppm).

June 1981

Plate 3.

JORDAN VALLEY, OREGON/ IDAHO

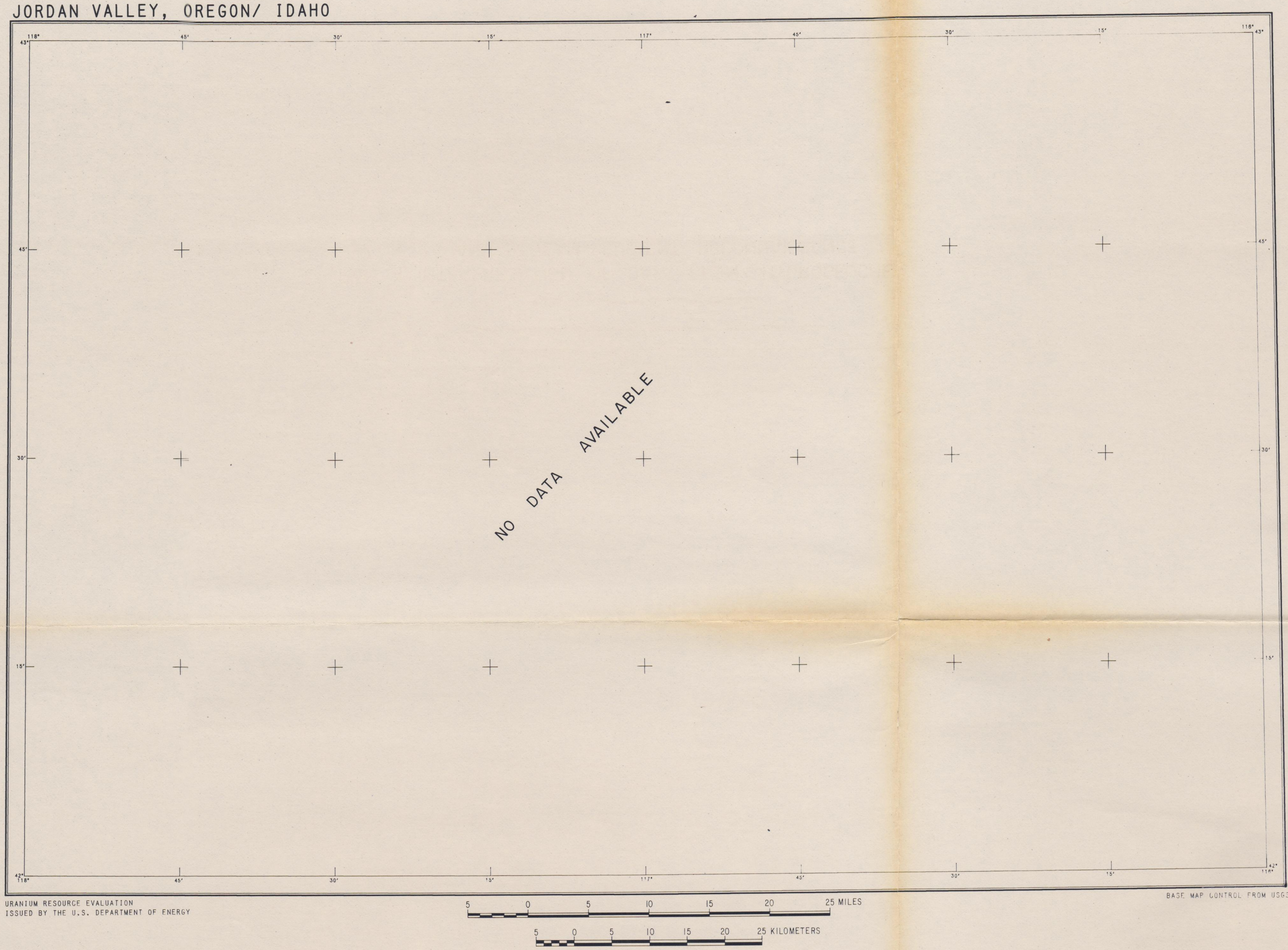

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Plate 4. INTERPRETATION OF DATA FROM HYDROGEOCHEMICAL AND STREAM-SEDIMENT RECONNAISSANCE

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Plate 4.

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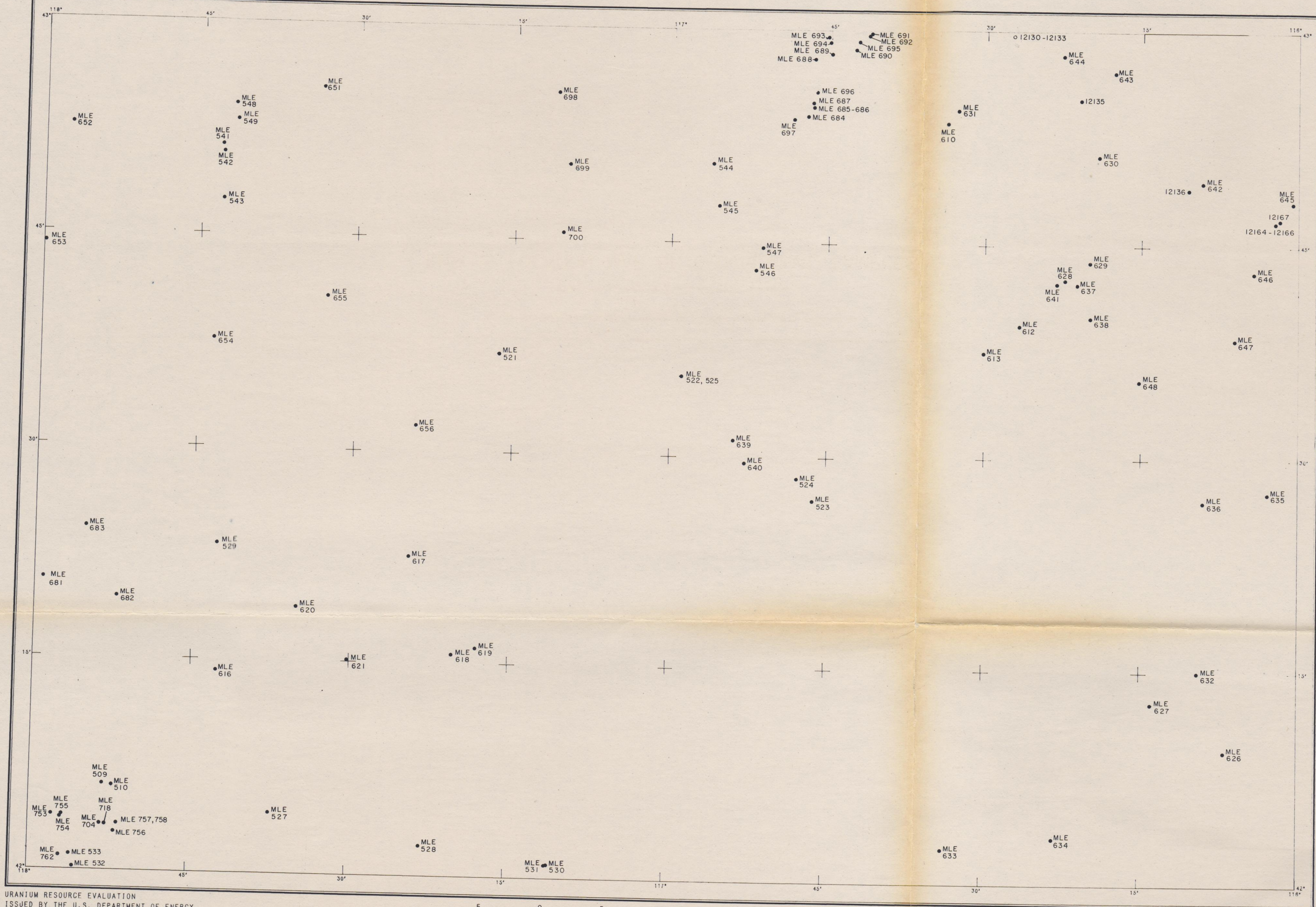

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

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5 0 5 10 15 20 25 KILOMETERS

Plate 5. LOCATION MAP OF GEOCHEMICAL SAMPLES

June 1981

Plate 5.

JORDAN VALLEY, OREGON/ IDAHO

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

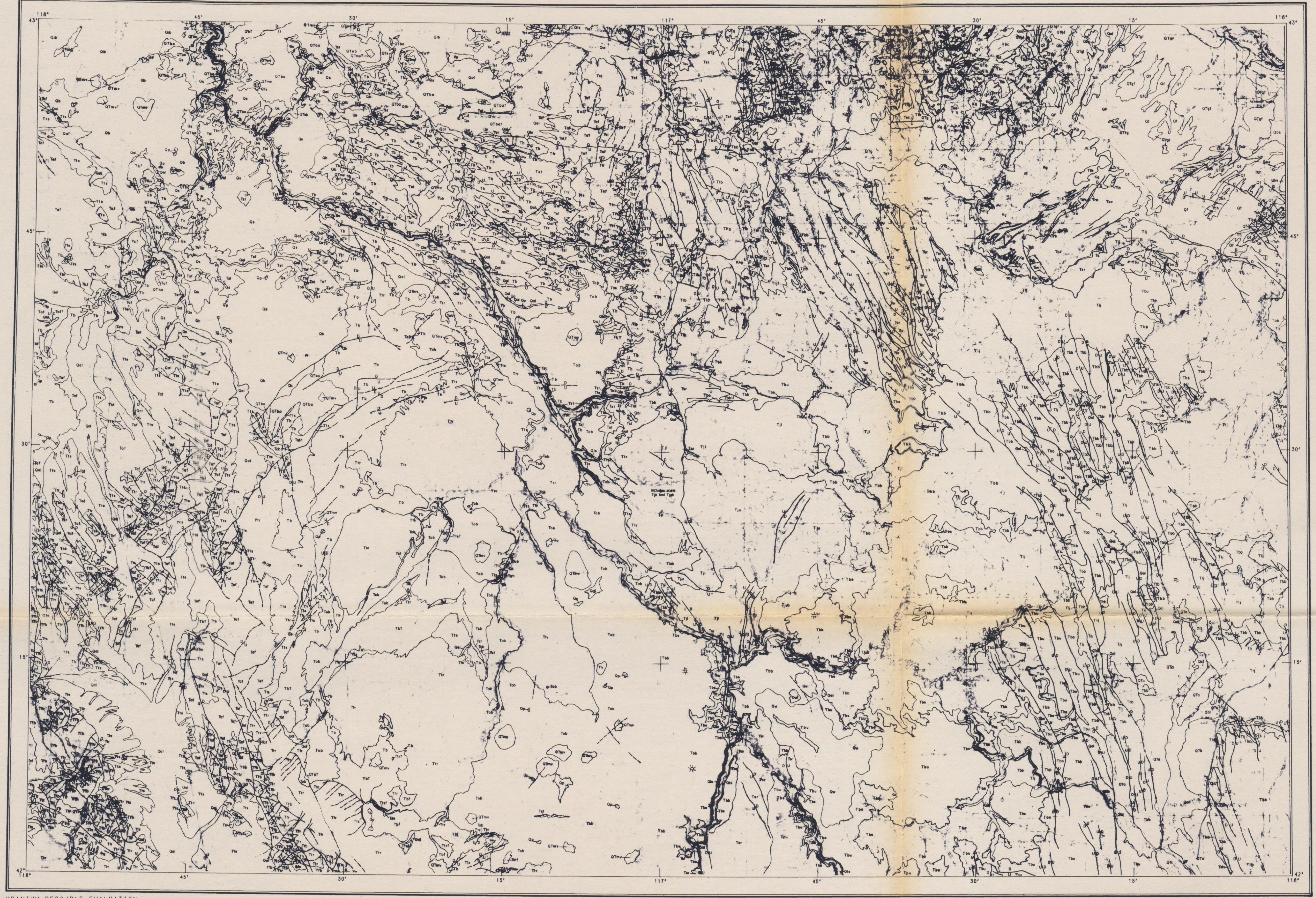
5 0 5 10 15 20 25 KILOMETERS

Plate 6. DRAINAGE

June 1981

Plate 6.

JORDAN VALLEY, OREGON/ IDAHO



URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS
Data source: Idaho Bureau of Mines and Geology, June, 1979

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate 7a. GEOLOGIC MAP

June 1981

Plate 7a.

JORDAN VALLEY, OREGON/ IDAHO

EXPLANATION

CENOZOIC — QUATERNARY — Pleistocene and Holocene

Sedimentary

Oregon

Qls Landslide debris

Qp Playa deposits

Qal Alluvium

Qs / Qb Sedimentary rocks and interbedded basalt flows
- **Qs** *semiconsolidated tuffaceous sediments and unconsolidated clay, sand, silt, and gravel*
- **Qb** *feldspathic, olivine-bearing basalt*

QTsb / QTba / QTs Tuffaceous sedimentary rocks, palagonite breccia and tuff, and mafic flows
- **QTsb** *lacustrine and fluviatile sedimentary rocks and interbedded basalt and andesite flows*
- **QTba** *diktytaxitic, olivine bearing basalt flows*
- **QTs** *tuffaceous, lacustrine sedimentary rocks*

Idaho — Owyhee Mountains

Qls / Qal / QTg / QTa
- **Qls** Landslide deposits
- **Qal** Alluvium
- **QTg** Terrace gravels *fan and other terrace gravels, undifferentiated*
- **QTa** Older alluvium

Idaho — Snake River Plain

Qal / Qw / Qf / Qbg / Qbs
- **Qal** Alluvium
- **Qw** Wind blown sand and silt
- **Qf** Fan alluvium and fanglomerate
- **Qbg** Gravels in the Oreana area
- **Qbs** Bruneau Formation *lacustrine and fluvial silt and clay*

QTgf Glenns Ferry Formation *lake and stream deposits of ash, tuffaceous sand, silt, and clay*

Igneous

Oregon

Qlb Thin basalt flows, correlate with Snake River Group

QTm Mafic intrusive rocks

QTp Pyroclastic rocks of basaltic cinder cones

QTsv Rocks of silicic vents *plugs, domes, and related flows and flow breccias of rhyodacite composition*

QTmv Rocks of mafic vents *basaltic and andesitic breccia, scoria, and flows*

Idaho — Owyhee Mountains

Metamorphic

Pliocene

Tch Chalk Hills Formation *lake and stream deposits of sand, silt, clay, and diatomite, with minor vitric ash and basaltic tuff*

TERTIARY — Miocene

Tsb / Tst / Tob Tuffaceous sedimentary rocks, tuffs, and interbedded basaltic and andesitic flows
- **Tsb** *tuffaceous sediments and interbedded basalt or andesite flows*
- **Tst** *semiconsolidated lacustrine tuffaceous sediments*
- **Tob** *thin, diktytaxitic basalt flows*

Tas Arkosic sedimentary rocks

Tb Basalt

Tbb / Tbu / Tbs Banbury Basalt
- **Tbb** *olivine basalt and minor interbedded stream and lake deposits*
- **Tbu** upper basalt *mesa-forming sequence of thin basalt flows*
- **Tbs** *volcaniclastic sediments and local diatomite*

Tlj / Tbc / Tbm
- **Tlj** Tuff of Little Jacks Creek *extremely densely welded, flow-layered rhyolite tuff*
- **Tbc** Tuff of Browns Creek *densely welded, flow-layered rhyolite tuff*
- **Tbm** Rhyolite of Black Mountain

Ttf / Tts / Ttr Tuffaceous sedimentary rocks, tuffs, and silicic flows
- **Ttf** *tuff of rhyolitic and dacitic composition, tuffaceous sedimentary rocks, and rhyodacite flows*
- **Tts** *fine grained tuffaceous sedimentary rocks representing flood plain and shallow lake deposits*
- **Ttr** *partly to densely welded tuffs and rhyolite or dacite flows*

Tdv (?) / Tjub / Tjs / Tju / Tjl / Tsr / Ts
- **Tdv** Tuff of Duck Valley *red, densely welded flow-layered rhyolite tuff*
- **Tjub** Badlands tuff of Juniper Mountain *pink to red, flow-layered, densely welded rhyolite tuff*
- **Tjs** Tuffaceous sedimentary rocks
- **Tju** Upper flows of Juniper Mountain *red, densely welded rhyolite tuff*
- **Tjl** Lower flows of Juniper Mountain *red, densely welded rhyolitic tuff, largely remobilized to viscous lava*
- **Tsr** Tuff of Swisher Ridge *densely welded rhyolite tuff with minor vitrophyres and nonwelded tuff*
- **Ts** Sedimentary rocks beneath the tuff of Swisher Ridge *tuffaceous sandstone*

Tsu Sucker Creek Formation *altered, nonwelded, bedded tuff, arkose, volcanic sandstone and granite cobble conglomerate*

Tfb / Tbf / Taf Flows and flow breccias
- **Tfb** *basalt and andesite flows and flow breccias*
- **Tbf** *massive basalt flows with minor interbeds of tuff and scoria*
- **Taf** *andesite flows, with minor basalt and interbedded tuff and tuffaceous sediments*

Tsc / Tql / Tr
- **Tsc** Silver City Rhyolite
- **Tql** Quartz latite flows
- **Tr** Rhyolite dikes and plugs

Tlb Latite and basalt flows undivided

Miocene(?)

Tro Rhyolite dikes

Eocene(?)

Tqb (?) Quartz biotite tuff

Eocene

Tcv Challis Volcanics *rhyodacitic tuff and felsite*

MESOZOIC — CRETACEOUS

Tkg / Kg / Khg
- **Tkg** Granitic rocks of South Mountain *quartz diorite and granodiorite*
- **Kg** Granitic rocks undivided *granodiorite, granite, and quartz monzonite*
- **Khg** Hornblende gabbro of South Mountain

PRE-CRETACEOUS

m Metamorphic rocks *interbedded schist, quartzite and marble age unknown*

SYMBOLS

- Contact: dashed where approximately located.
- U/D Dip-slip fault: U--upthrown block; D--downthrown block, where known. Dashed where inferred; dotted where concealed
- Volcanic vent

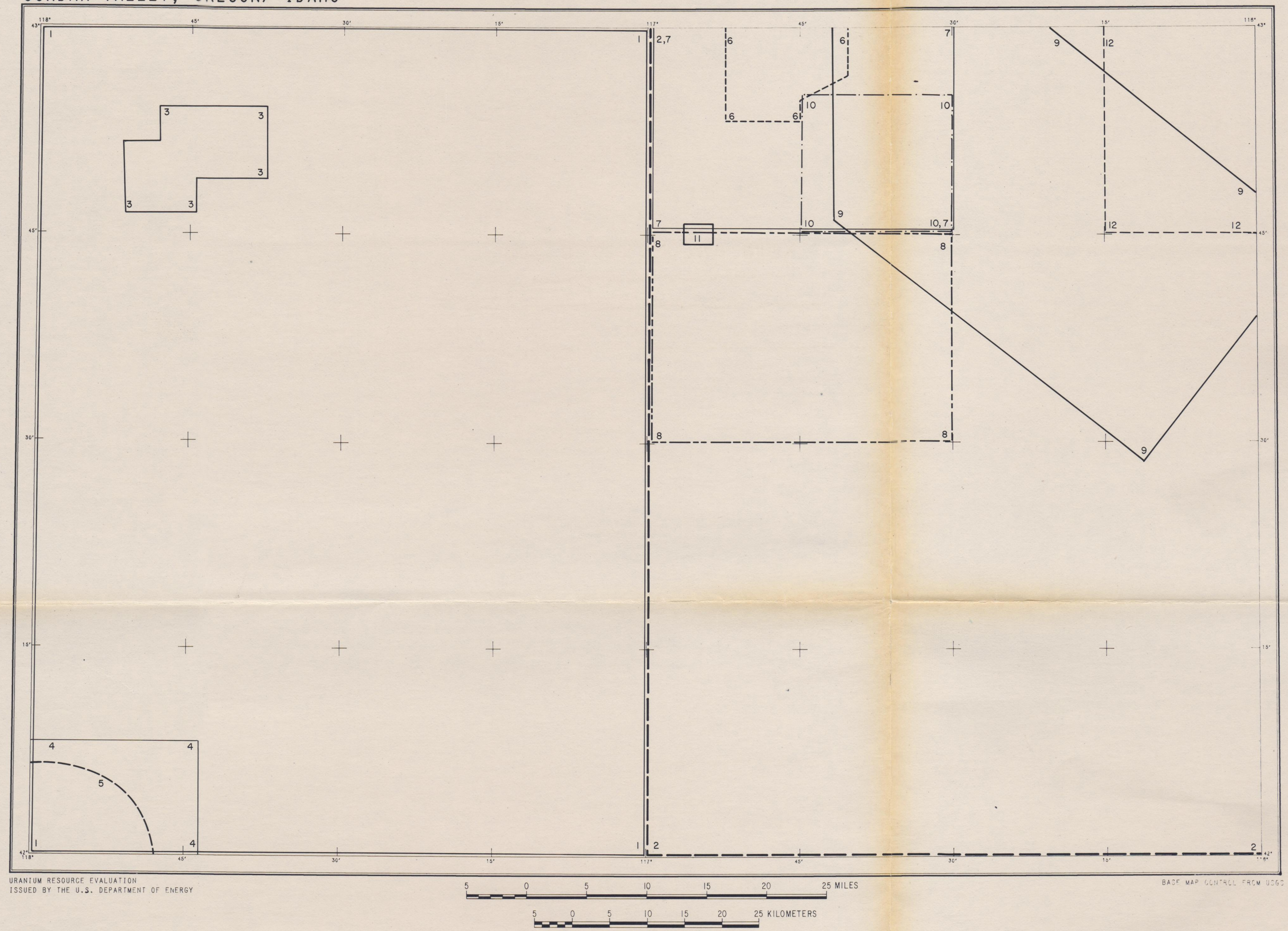
NOTES

The legend for this map is divided into two parts, one for Idaho and one for Oregon, because both parts are taken from two main sources Idaho--Ekren and others, 1978; Oregon--Walker and Repenning, 1966. However, in some areas along the border, the rocks have not been correlated formally between states. The stratigraphic equivalents shown in the legend are probably correct. The welded tuff unit (Ttr) in Oregon does contain both lower flows of Juniper Mountain (Tju) and the Tuff of Swisher Ridge (Tsr). This welded tuff unit in Oregon probably also contains some ash flows from the McDermitt caldera or other sources. In most places in Oregon the basalt units Tob and Tb are correlative with the Banbury Basalt (Tbb) in Idaho.

Juniper Mountain is known to be a major source area. The upper flows of Juniper Mountain, the lower flows of Juniper Mountain, and the Tuff of Swisher Ridge were erupted from this center. The source area for the Silver City rhyolite appears to be rhyolite domes in the vicinity of Silver City. The source area for the Tuff of Little Jacks Creek is believed to be just east of the map boundary.

Plate 7b. EXPLANATION FOR GEOLOGIC MAP

JORDAN VALLEY, OREGON/ IDAHO



URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 8. GEOLOGIC-MAP INDEX

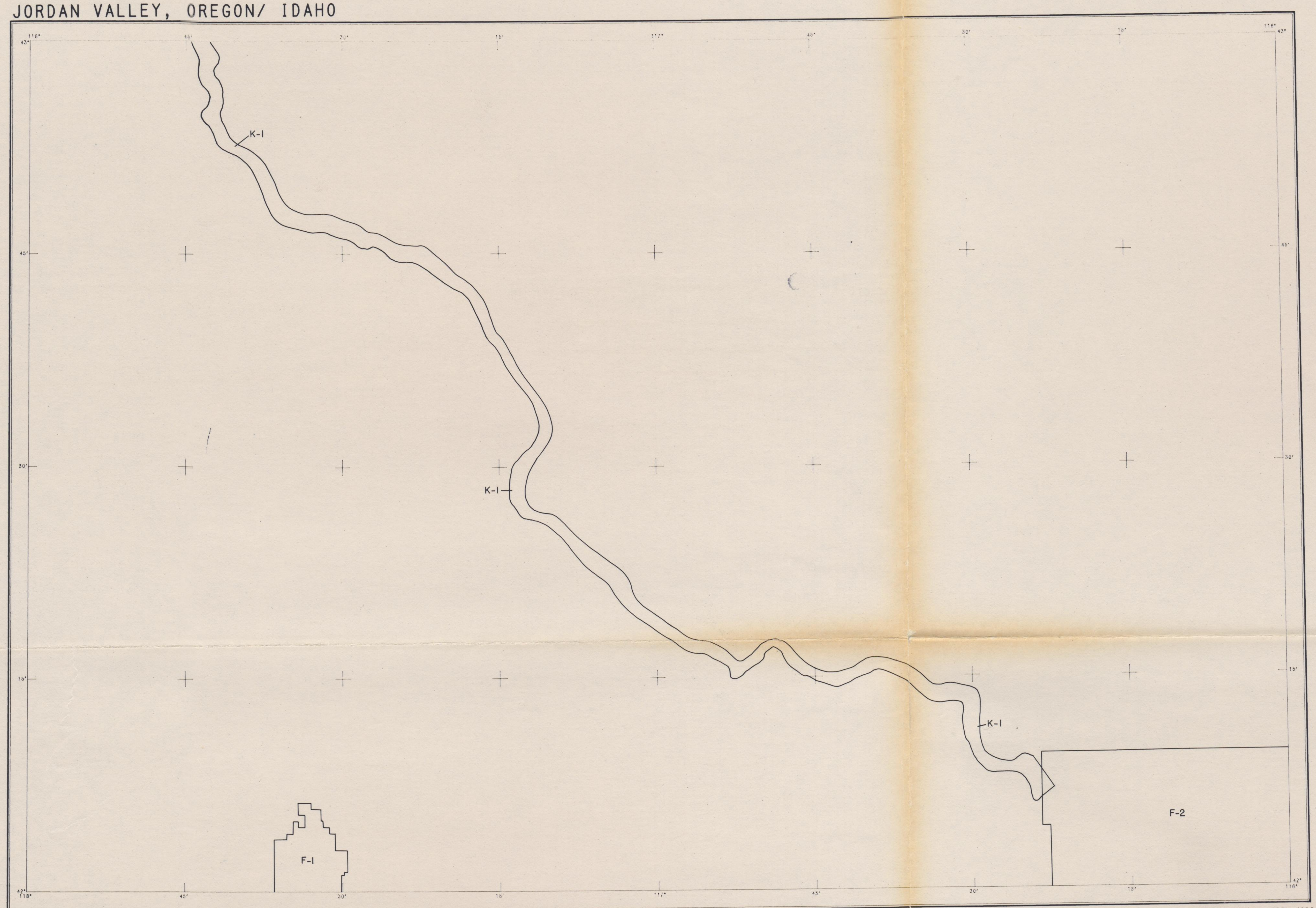
INDEX

1. Walker and Repenning, 1963, scale 1:250,000.
2. Ekren, McIntyre, and Bennett, 1978, scale 1:125,000,
3. Ellison, 1968, scale 1:31, 680.
4. Rytuba, 1976, scale 1:250,000.
5. Yates, 1942, scale 1:62,500.
6. Pansze, 1975, scale 1:36,200.
7. Bennett and Galbraith, 1975, scale 1:62,500.
8. Bennett, 1976, scale 1:62,500.
9. Neill, 1975, scale 1:125,000.
10. Sharp and Warner, 1969, scale 1:125,000.
11. Sorenson, 1927, scale 1:18,400.
12. Littleton and Crosthwaite, 1957, scale 1:125,000.

June 1981

Plate 8.

JORDAN VALLEY, OREGON/ IDAHO



URANIUM RESOURCE EVALUATION
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BASE MAP CONTROL FROM USGS

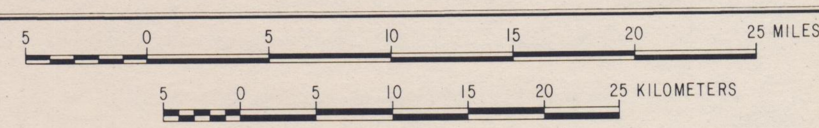


Plate 9. GENERALIZED LAND STATUS MAP

INDEX

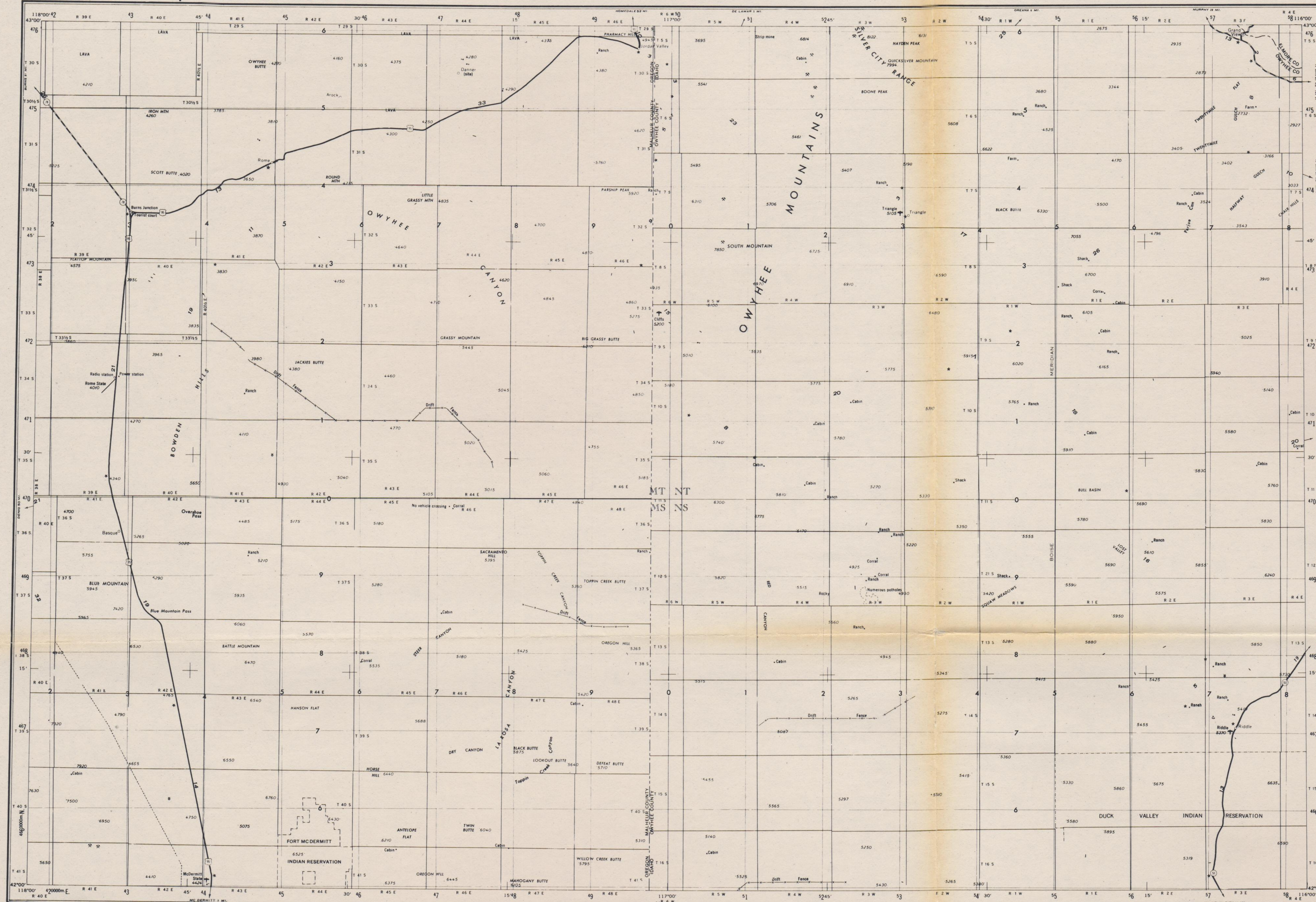
F. Indian Lands
- F-1 Fort McDermitt Indian Reservation
- F-2 Duck Valley Indian Reservation

K. Wild and Scenic Rivers
- K-1 Owyhee River (proposed)

June 1981

Plate 9.

JORDAN VALLEY, OREGON/ IDAHO



URANIUM RESOURCE EVALUATION
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BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

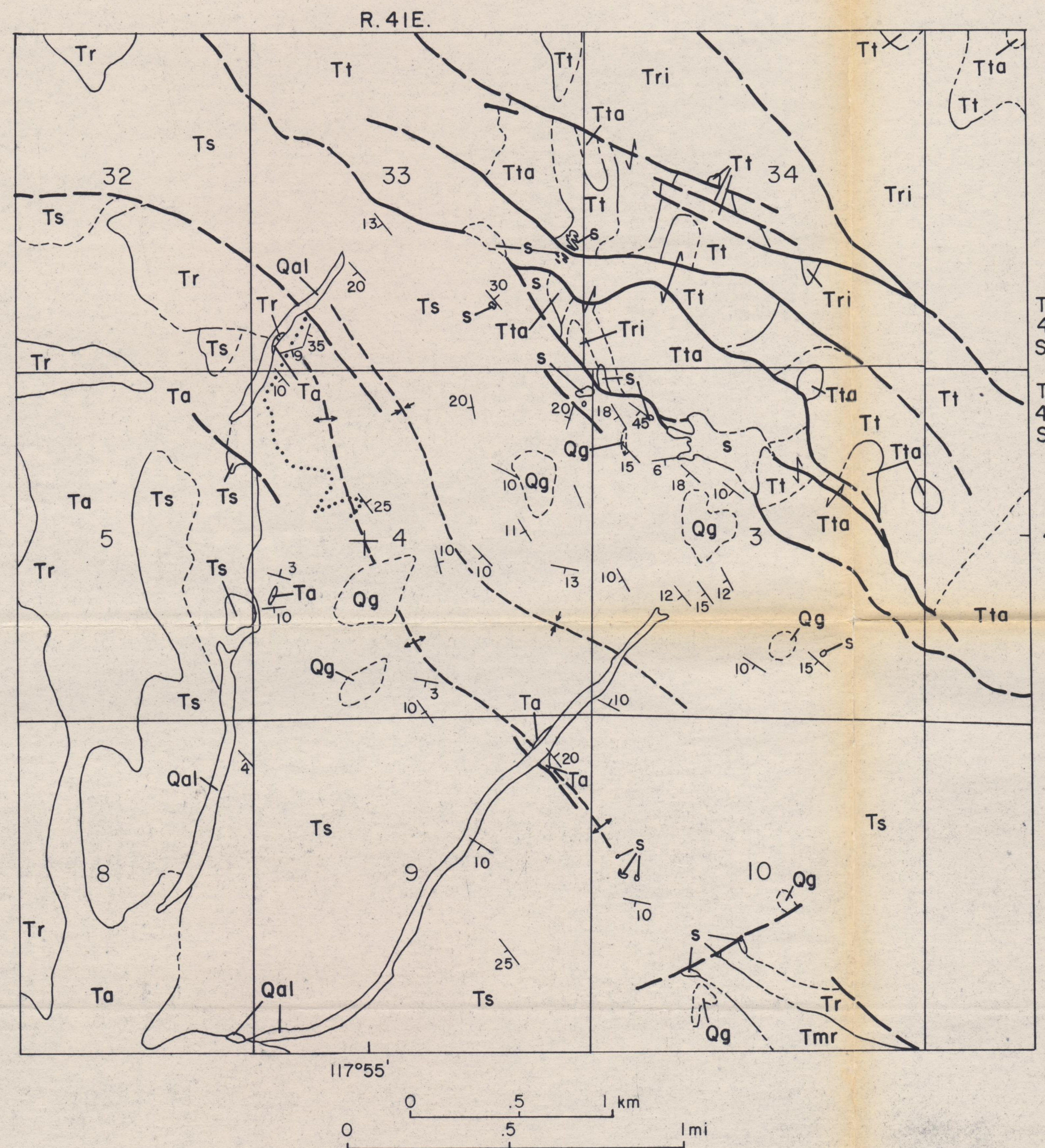
5 0 5 10 15 20 25 KILOMETERS

Plate 10. CULTURE

June 1981

Plate 10.

JORDAN VALLEY, OREGON/ IDAHO



EXPLANATION

RECENT

Qal	Recent alluvium

PLEISTOCENE

Qg	Perched alluvial gravels of Pleistocene(?) age

MIOCENE

S	Silicified rock. Finely crystalline quartz, chalcedony, and opal. Mostly replaces moat sediments, but also replaces caldera wall rocks along the main ring fracture.

CALDERA FLOOR ROCKS

Ts	Moat sediments. Consist mainly of tuffaceous sedimentary rock and airfall tuffs. Adjacent to ring fracture contains abundant conglomerate and sedimentary breccia. Silicified layers and petrified wood are present locally. Diatomite and limey layers are present near the base of the section.
Ta	Aurora series. Mostly consists of vesicular buff to black icelandite flow rock with sparse feldspar phenocrysts. Contains dark gray ash flow tuffs at depth.
Tmr	Rhyolite of McDermitt Creek (Greene, 1976). Olive green to brown crystal-rich flow rock of quartz latitic composition.
Tr	Siliceous gray to buff aphyric rhyolitic flow rock ash flow tuff; faintly to distinctly flow-layered. Probably correlative with Tta.

CALDERA WALL ROCKS

Tta	Peralkaline ash flow tuffs; generally aphyric. Green where altered. Has granophyric texture and faint to strong flow-layering. Black apache tears occur in a thin basal vitrophyre. (Ash flow tuff number 5 of Rytuba and Glanzman, 1978).
Tt	Peralkaline ash flow tuff with sparse to moderately abundant lath-shaped feldspar crystals in a granophyric to aphanitic matrix with well developed flow-layering. Green, purple, and reddish-brown in color. (Ash flow tuff number 4 of Rytuba and Glanzman, 1978). At the base of unit is a 1 m thick crystal-rich welded tuff (aenigmatite-bearing pantellerite of Wallace and others, 1980).
Tri	Rhyolitic to intermediate volcanic rocks. Includes incelandite and trachyte flows, and rhyolitic to intermediate ash flow tuffs. The unit is characterized by gray, brown, and black colors, and the presence of block-shaped feldspar phenocrysts and crystals. It contains locally abundant vesicular flow rock. Several vitrophyre units are present, and a frothy vitrophyre occurs at the top of the sequence in places. The most mafic rock appears to occur near the top of the section.

Geologic contact

Anticlinal structure

Synclinal structure

Fault

Uraniferous marker bed in the Cottonwood Creek drainage

10 Strike and dip

Plate II. GEOLOGIC MAP OF PART OF THE MCDERMITT CALDERA FAVORABLE AREA

June 1981
Plate II.

PGJ/F-132(82)

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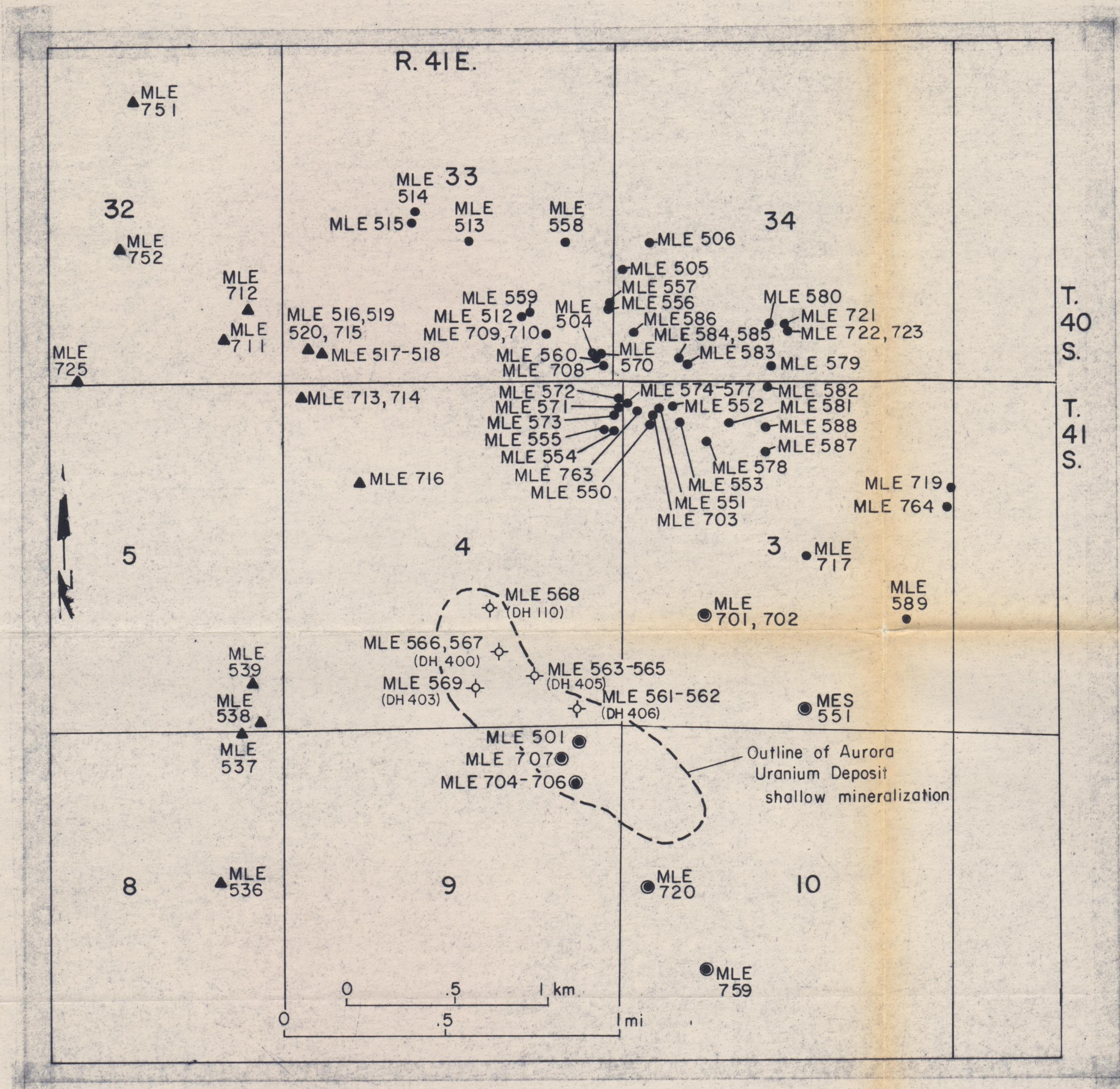


EXPLANATION

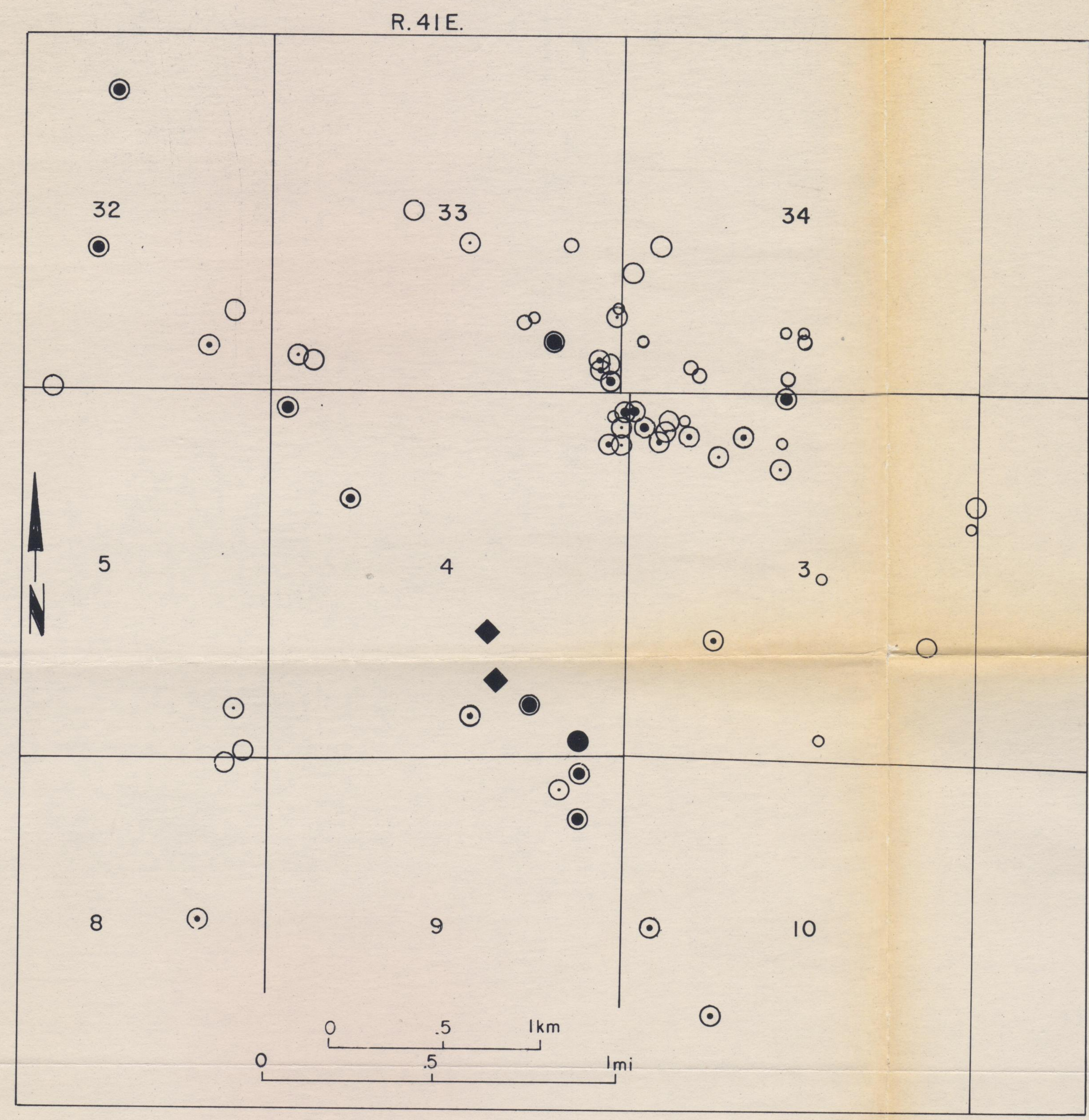
● MLE 505	Rock samples from the Bretz mercury mine
▲ MLE 725	Rock samples from the Cottonwood Creek occurrence
◉ MLE 720	Rock samples from the Aurora deposit
✧ MLE 568	Drill hole core samples from the Aurora deposit

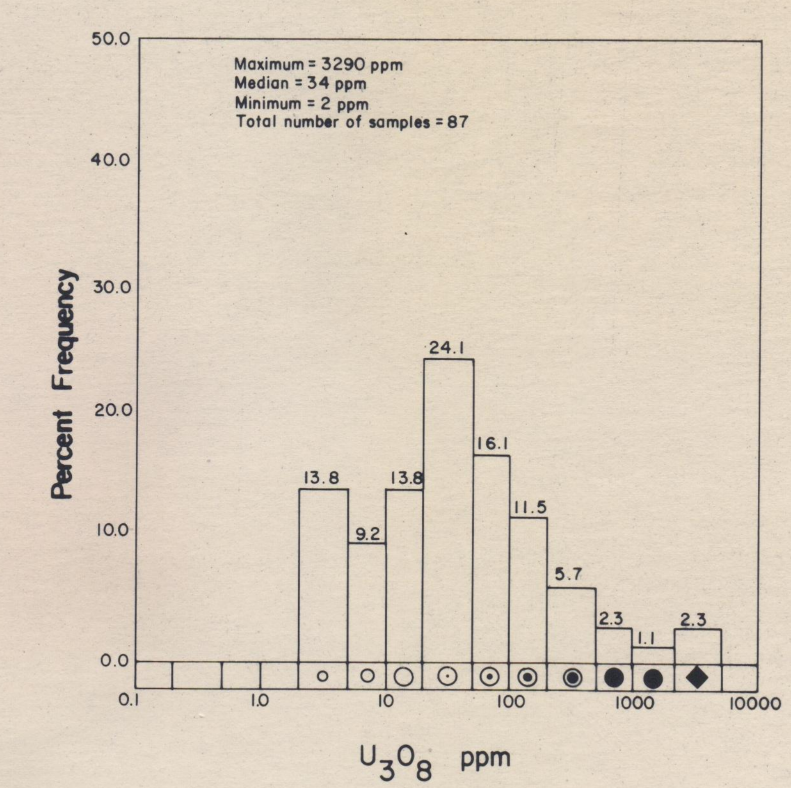
Plate 12. LOCATION MAP OF GEOCHEMICAL SAMPLES FROM PART OF THE MCDERMITT CALDERA FAVORABLE AREA

PGJ/F-132(82)

June 1981

Plate 12.





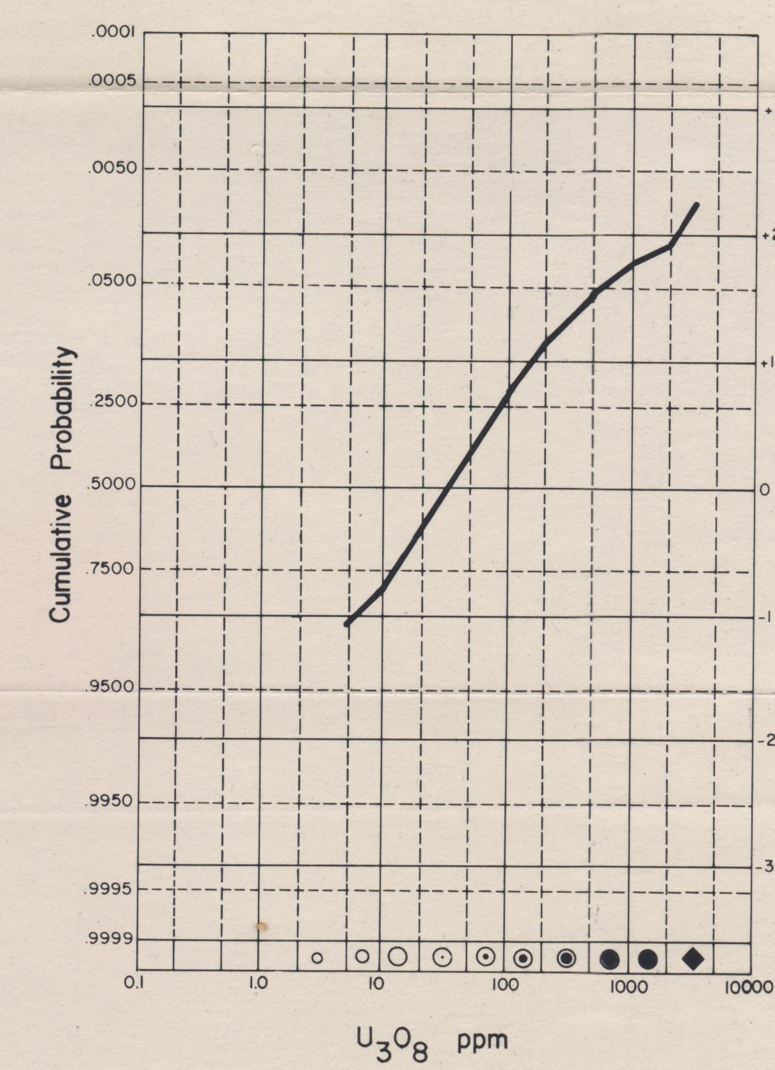


Plate 13. URANIUM CONTENT OF GEOCHEMICAL SAMPLES FROM PART OF THE MCDERMITT CALDERA FAVORABLE AREA

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Plate 13.

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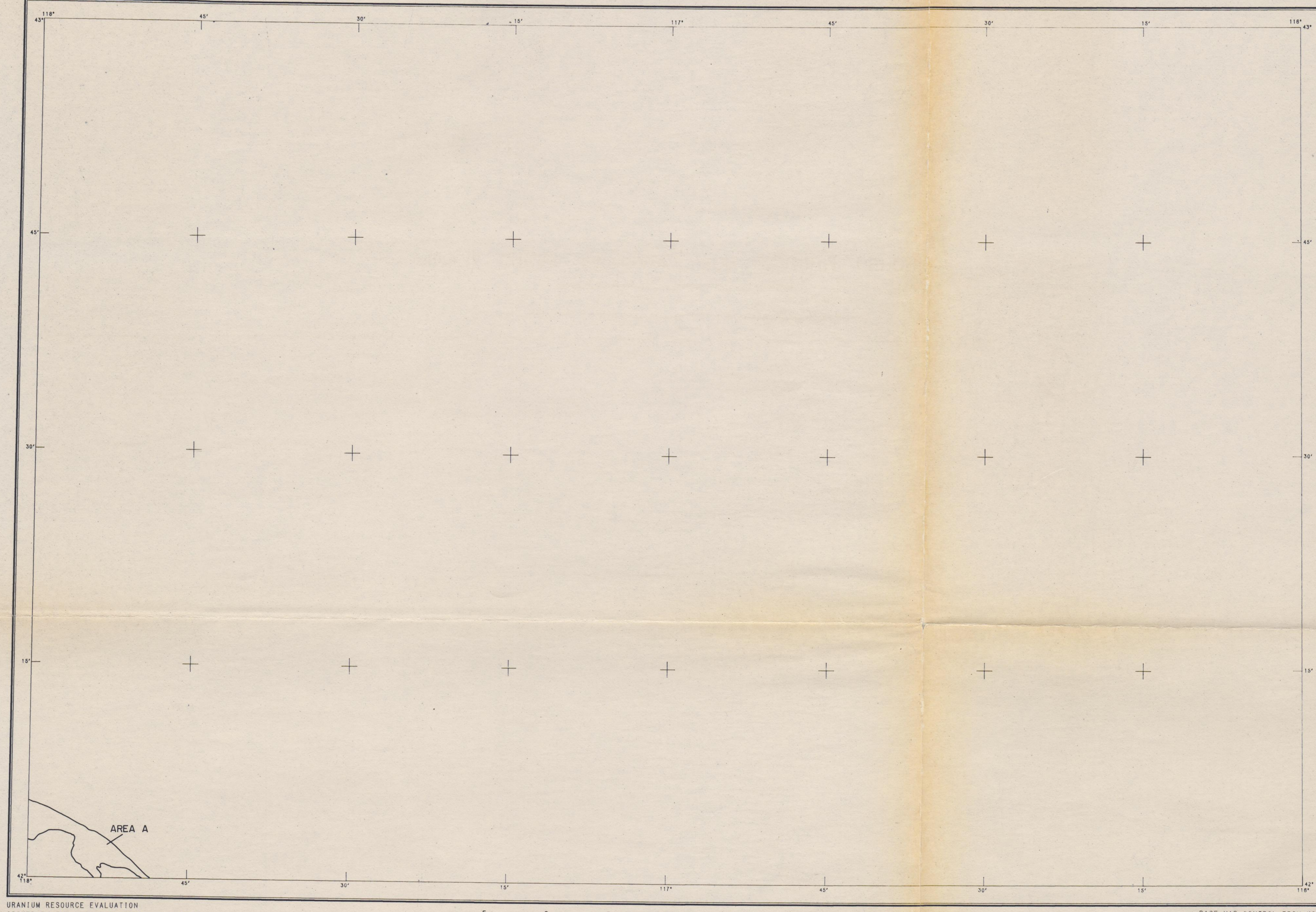

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate Ia. AREAS FAVORABLE FOR URANIUM DEPOSITS

June 1981

Plate Ia.

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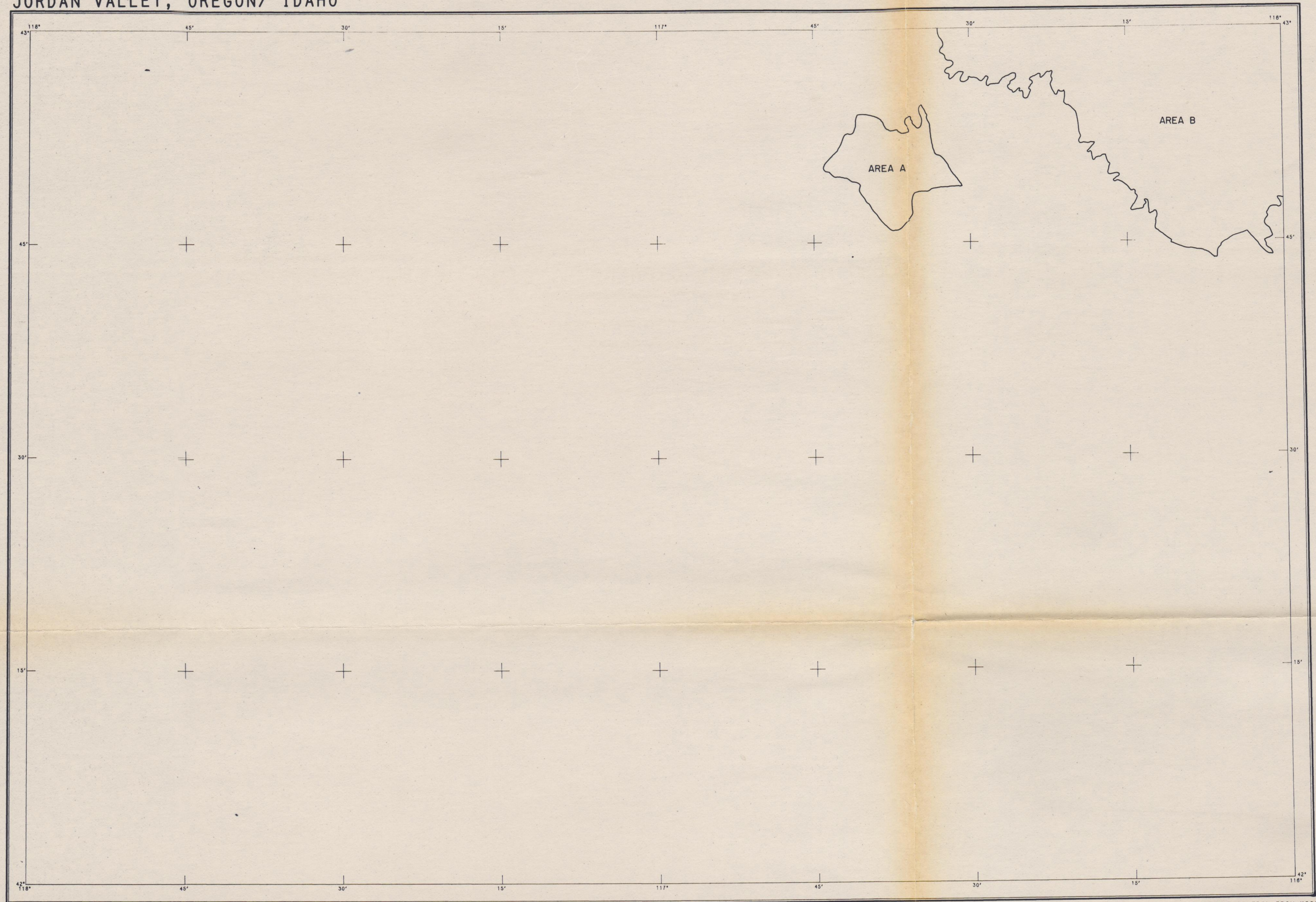

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate Ib. AREAS UNEVALUATED FOR URANIUM DEPOSITS

June 1981

Plate Ib.