GJBX-3(78)

PRELIMINARY STUDY OF THE URANIUM FAVORABILITY OF GRANITIC AND CONTACT-METAMORPHIC ROCKS OF THE OWENS VALLEY AREA, INYO AND MONO COUNTIES, CALIFORNIA, AND ESMERALDA AND MINERAL COUNTIES, NEVADA

BENDIX FIELD ENGINEERING CORPORATION
Grand Junction Operations
Grand Junction, Colorado 81501

January 1978

ISSUED BY THE U.S. DEPARTMENT OF ENERGY
GRAND JUNCTION OFFICE
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DISCLAIMER

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SUMMARY

Granitic and contact-metamorphic rocks of the Owens Valley area were sampled to determine their favorability for uranium. Uranium deposits associated with these rocks were examined to determine the mode of occurrence.

A 6½-mi-thick sequence of Precambrian, Paleozoic, and Mesozoic sedimentary and volcanic rocks is exposed in the area. Granitic rocks of two intrusive epochs (75 m.y. to 90 m.y. and 157 m.y. to 184 m.y.) intruded the older rocks. Three batholithic bodies in the area have been described in the literature, but many of the intrusive rock exposures have not been mapped in detail.

Metamorphic rocks near contacts with intrusive rocks include skarns, schists, quartzites, metaconglomerates, hornfels, gneisses, and metavolcanics. The grade of contact metamorphism ranges from slight to intense, depending upon the distance from the intrusive contact. The average U_3O_8 content of the metamorphic rock samples is 3 ppm. Metamorphic rock samples in a roof pendant at the Claw prospect contain as much as 3 percent U_3O_8. Skarn samples from the Birch Creek pluton contain as much as 114 ppm U_3O_8; those from the Santa Rita Flat pluton contain as much as 23 ppm U_3O_8.

Most of the intrusive rocks are granite, quartz monzonite, or monzonite. Granodiorite and diorite are less common, and gabbro is rare. The average U_3O_8 content of the crystalline rock samples is 4 ppm. Samples from a quartz-monzonite pluton east of Lone Pine, California, and quartz monzonite in the Santa Rosa Hills had maximum contents of 28 ppm and 13 ppm U_3O_8, respectively.

Areas of contact metamorphism and metasomatism, such as those at the Claw prospect and Birch Creek pluton, are probably the most favorable sites for uranium deposits. There are many miles of granitic and contact-metamorphic zones in which undiscovered uranium deposits may exist.

Although the overall uranium content of granitic rocks appears to be low, the pluton east of Lone Pine and the Hunter Mountain pluton in the area of the Santa Rosa Hills have sufficient uranium to have acted as uranium and detrital source rocks for uranium deposits that may now be buried in Tertiary sediments in the basins around the plutons. These deposits could have been formed by the leaching of uranium ions from the fractured and weathered granitic rock outcrops above the basins or by ground-water redistribution of uranium ions present in the erosional debris around the flanks of the plutons.

The Claw deposit is the only known uranium deposit of a size and grade to be of possible commercial interest. This deposit may have been formed as the result of contact metamorphism of a pre-existing, low-grade uranium deposit. Heat and minor metasomatic solutions may have remobilized the uranium ions, driving them toward the center of the roof pendant and concentrating the uranium in the remains of the roof pendant while magmatic assimilation reduced it in size.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this study was to determine the uranium favorability of the batholithic and metamorphic rocks of the Owens Valley area. This was accomplished by determining the uranium content of the various rock types and, where possible, the nature and extent of known uranium deposits. The project was conducted by Bendix Field Engineering Corporation (BFEC) under the auspices of the U.S. Energy Research and Development Administration (ERDA).

LOCATION

The project area (Fig. 1) encompasses approximately 5,200 sq mi in Inyo and Mono Counties, California, and adjoining parts of Esmeralda and Mineral Counties, Nevada. Parts of the area are included in the following U.S. Geological Survey 1:250,000 scale maps: Death Valley, Fresno, Goldfield, and Mariposa. Because the outcrops are mainly in mountain ranges, most of the field work was concentrated in the White Mountains, the east edge of the Benton Range, the Inyo Mountains, the east edge of the Sierra Nevada Mountains, the Alabama Hills, Hunter Mountain, the northern part of the Coso Range, and the northeast part of the Argus Range.

PREVIOUS WORK

The study area has been extensively explored. Tungsten, talc, gold, and silver have been mined or are currently being mined. The discovery of commercial uranium deposits in the Coso Range, south of the study area, stimulated uranium exploration efforts in the 1950s. Later discovery of the Claw uranium deposit further stimulated exploration activities. The current increased demand for uranium has brought about renewed interest in the area.

Geologists of the U.S. Geological Survey and others have worked in the area for many years. Pertinent references are listed in the Bibliography. Pakiser and others (1964) described the structure of the Owens Valley area. Kelley and Stevens (1975) described thrust faulting in the Inyo Mountains. Fox (1976) and Hay (1976) described structural development of the area as related to plate-tectonic theories.

PROCEDURES

GEOLOGIC MAP

The geologic map of the area (Pl. 1, simplified from California Div. Mines and Geology) emphasizes the granitic rocks and associated contact zones in the following manner: Precambrian, Paleozoic, and Mesozoic sedimentary and volcanic rocks were grouped as one unit; Mesozoic granitic rocks were grouped

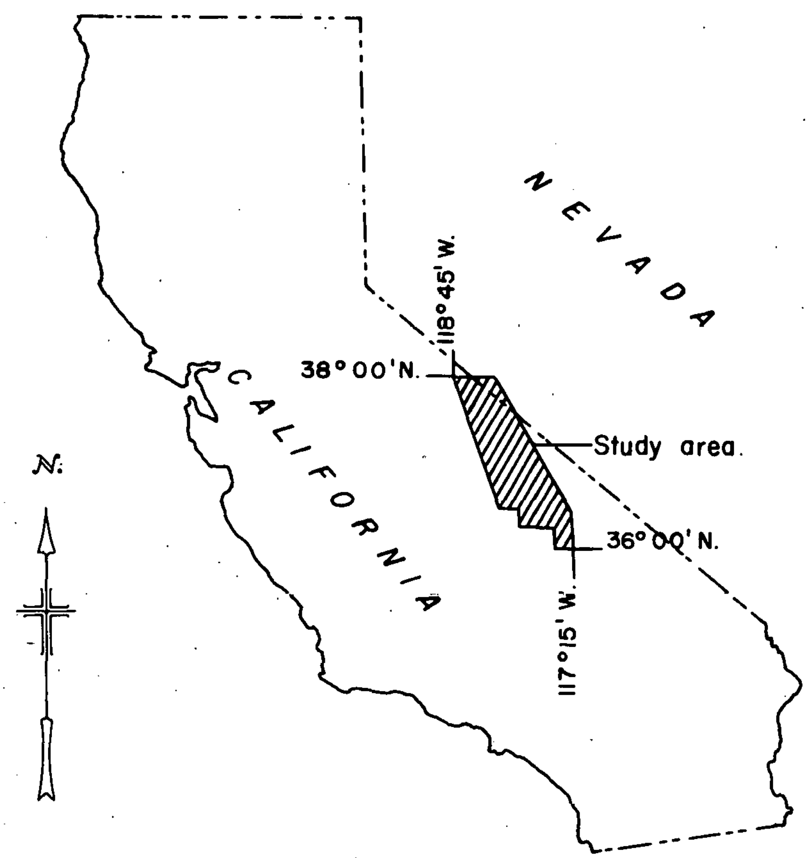

Figure 1. Location map of the Owens Valley granitic rocks project.

as one unit; Tertiary and older Quaternary sedimentary and volcanic rocks were grouped as one unit; and Quaternary alluvium, eolian, and lacustrine rocks, generally unconsolidated, were grouped as one unit. A stratigraphic column (Langenheim and Larson, 1973) is shown as an insert on the geologic map.

FIELD INVESTIGATIONS

Field work consisted principally of collecting rock samples for geochemical analysis (App. A). Sample localities (Pl. 2) were selected from geologic maps published by the California Division of Mines and Geology (scale 1:250,000). Fifteen-minute quadrangle topographic maps, published by the U.S. Geological Survey, were used in the field to record sample localities.

Approximately one rock sample was collected for every two radiometric readings. An attempt was made to collect a sufficient number of rock samples and radiometric readings from each pluton and from adjacent metamorphic sequences to determine the overall uranium content of the rocks. The radiometric readings (Pl. 3) were used to determine the continuity of uranium content between samples. Coverage and sample density were limited by access and time restrictions.

Some granitic and metamorphic samples and radiometric readings were taken from exposures too small to be shown in the plates. Therefore, some sample localities of one rock type may appear to be within the boundaries, as shown on the geologic map, of another rock type. Samples were collected after scanning the outcrop with a Mt. Sopris Model 131-A Scintillometer.

ANALYTICAL PROCEDURES

Samples were analyzed for uranium by fluorometric methods and for equivalent potassium, uranium, and thorium (eTh, eU, and eK) by gamma-ray spectroscopy. Selected samples were submitted for thin-section analysis, emission spectroscopy analysis, full rapid-rock analysis, organic-carbon content, mineral identification, scanning electron-microscope evaluation, and quantitative modal analysis. All analytical work was performed at the ERDA Grand Junction, Colorado, Laboratories, operated by the Bendix Field Engineering Corporation. Analytical data is listed in Appendix Tables A-1 through A-5.

GEOLOGY

STRATIGRAPHY

Prebatholithic Rocks

A 34,250-ft-thick sequence of Precambrian, Paleozoic, and Mesozoic sedimentary, metamorphic, and volcanic rocks (Pls. 1, 2, 3) is exposed in the White Mountains and Inyo Mountains areas (Langenheim and Larson, 1973). Approximately 50 percent of the stratigraphic section is composed of limestone and dolomite; 40 percent is composed of mudstone, shale, conglomerate, siltstone, and sandstone; and the remaining 10 percent is composed of basalt and andesite flows.

Rocks of this sequence were deposited prior to the emplacement of the intrusive rocks that form the cores of most of the mountain ranges in the area. Contact metamorphism ranges from none to intense. Little regional metamorphism is evident other than that related to the batholithic intrusions.

Batholithic Rocks

Intrusive rocks emplaced during Mesozoic time are exposed over much of the study area. Evernden and Kistler (1970) grouped these intrusive rocks into two intrusive epochs. The youngest rocks, emplaced during the Cathedral Range intrusive epoch, are from 75 m.y. to 90 m.y. in age. Most of the Sierra Nevada Range within the study area, the Alabama Hills, the Papoose Flat pluton, and the Coso Range (Berry, 1976, p. 9) are composed of these rocks. The oldest rocks, emplaced during the Inyo Mountains intrusive epoch, are from 157 m.y. to 184 m.y. in age and form most of the Inyo and White Mountains, Hunter Mountain, the Argus Range, and a small part of the Sierra Nevada Mountains within the study area.

Ross (1969) described three granitic bodies of batholithic proportions in the Inyo Mountains; the Paiute Monument quartz monzonite, the Tinemaha granodiorite, and the Hunter Mountain quartz monzonite. Rocks in these plutons range in composition from granitic to gabbroic, depending in part on the amount of wall-rock contamination (Ross, 1969). Many of the intrusive rock exposures outside of the plutons were mapped by geologists of the California Division of Mines and Geology as "undifferentiated."

Postbatholithic Rocks

Tertiary and Quaternary rocks in the study area have not been mapped in detail. The Coso Formation and Bishop Tuff are the only formations described in the literature (Toohey and Cupp, 1976; Pakiser and others, 1964). Most of the Tertiary-Quaternary units are alluvium, eolian, lacustrine, or volcanic deposits and are generally found within valleys. These rocks were not examined as part of this project.

STRUCTURE

The Owens Valley area is on the western margin of the Basin and Range province, which is dominated by north-trending normal faults. Several thrust faults have been described in the Inyo Mountains (Kelley and Stevens, 1975) and may extend northward into the White Mountains. Anticlinal, synclinal, monoclinal, and recumbent folds are found throughout the area in the prebatholithic rocks. These folds are associated with faults, intrusive events, and regional compression.

Dikes and Sills

Basaltic dikes are common in the southern Inyo Mountains. Granitic dikes are less common but occur throughout the study area. Granitic sills are most common in the southern part of the White Mountains but also occur throughout the area; in many cases, they form a lit-par-lit relationship with the country rocks. Pegmatite dikes are rare and are generally found near contact zones.

EVIDENCES OF URANIUM FAVORABILITY

URANIUM IN ROCK SAMPLES

Prebatholithic Rocks

The average uranium content of 34 metamorphic rock samples (App. A) is 3 ppm U_3O_8. Samples that contained more then 50 ppm U_3O_8 were not used to calculate the average. Metamorphic rock samples from the Claw prospect contain 52 ppm to 3400 ppm U_3O_8 (samples 20606, 20607, 20926, 20927, and 20930) [see section on Claw prospect]. (Use of data on samples collected from the Claw prospect is by permission of Pioneer Uravan, Inc.)

Sample 20892 from the western edge of the Birch Creek pluton, SW¼SW¼ sec. 22, T. 6 S., R. 35 E., contains 114 ppm U_3O_8. The rock sampled is epidote skarn with minor amounts of fluorite and beryl. The skarn, found as small roof pendants less than 100 ft in maximum dimension is a metamorphosed marble (sample 20891) that contains 2 ppm U_3O_8. Sample 20890, from the granite that intruded the marble unit, contains 4 ppm U_3O_8.

Sample 20951 from a skarn found along Birch Creek in sec. 7, T. 7 S., R. 36 E., contains 11 ppm U_3O_8. The skarn grades into marble (sample 20889) that contains 2 ppm U_3O_8.

Samples 20936 and 20939, from two small skarns found as roof pendants in Santa Rita Flat, secs. 24 and 25, T. 12 S., R. 35 E., contain 18 ppm U_3O_8 and 23 ppm U_3O_8, respectively. Sample 20936 is marble with traces of disseminated chrysocolla. Sample 20939 is garnet skarn. The quartz monzonite that intruded these skarns was assigned to the Tinemaha granodiorite by Ross (1969), and samples of it contain 3 to 7 ppm U_3O_8 (Pl. 2). Sample 20936 has an organic carbon content of 0.41 percent, which is high for the area (Table A-4).

Batholithic Rocks

The average uranium content of 168 samples of intrusive rocks (App. A) is 4 ppm U_3O_8. Samples containing more than 50 ppm U_3O_8 were not used to calculate the average.

Two granitic rock samples were collected at the Claw prospect. Sample 20928, from a small granite dike in the metamorphic rocks near the adit, contains 35 ppm U_3O_8. Most of the uranium is probably of secondary origin. Sample 20932, from a granite prophyry outcrop 50 ft north of the adit, contains 4 ppm U_3O_8.

Three rock samples were taken at an unnamed hill east of Lone Pine, California, in secs. 19, 29, and 30, T. 15 S., R. 37 E., on the west flank of the Inyo Mountains. Samples 20609 and 20612 are from the east side of the hill where the rocks sampled intruded granite rock included in Ross' (1969) Hunter Mountain quartz monzonite. Both samples, taken at the intrusive contact, are blastomylonitic gneisses equivalent in composition to quartz monzonite. The samples contain 20 ppm (sample 20609) and 28 ppm (sample 20612) U_3O_8. Sample 20611, from quartz monzonite on the western edge of the hill contains 11 ppm U_3O_8. The granite intruded by the quartz monzonite, sample 20610, contains 3 ppm U_3O_8. Uranium leachability analyses of samples 20609, 20611, and 20612 determined that the samples contain 8 ppm, 8 ppm, and 19 ppm leachable U_3O_8, respectively.

Sample analyses and radiometric readings of the Hunter Mountain quartz monzonite east of Lee Flat and on the southeast end of the Santa Rosa Hills, Tps. 17 and 18 S., Rs. 40 and 41 E., indicate a greater-than-average uranium content. Samples 21933, 21938, 21940, and 21941 were taken from granite and monzonite in this area; U_3O_8 contents ranged from 3 ppm (sample 21933) to 13 ppm (sample 21941).

Postbatholithic Rocks

The postbatholithic rocks were not investigated during this study, but it should be noted that volcanic rocks of this sequence may have played an important role in the area's geologic and uranium mineralization history. Because of the close proximity of the Mono cauldron, the Long Valley cauldron (Pakiser and others, 1964), the Coso ring-fracture system (Duffield, 1975), and the volcanic deposits north, east, and south of the study area, it is probable that the area was once covered by tuffs and lavas ranging from basalts to rhyolites in composition. The presence of stilbite (zeolite found as fracture filling in granite in sec. 27, T. 19 S., R. 40 E.; sample 21962) may be evidence of the postulated volcanic cover.

Dikes and Sills

Dikes and sills are common in the area but little uranium was found associated with them. A single grain of uraninite, ½ in. in diameter was found in a pegmatite dike in a migmatite zone in Buffalo Canyon, sec. 35, T. 1 N., R. 32 E. (sample 20999). All other pegmatite dikes examined, however, appeared barren of uranium.

URANIUM DEPOSITS

Because of time restraints and access limitations, only four of the sixteen uranium deposits described in the U.S. Atomic Energy Commission's preliminary reconnaissance reports on the area were found (Table 1). The deposits are associated with skarn zones, roof pendants, pegmatitic migmatite zones, and fractures in granitic rock. Most of them are of low grade and limited extent.

TABLE 1. URANIUM PROSPECTS IN STUDY AREA DESCRIBED BY U.S. ATOMIC ENERGY COMMISSION'S PRELIMINARY RECONNAISSANCE REPORTS

Name and AEC file number	Location	Found or not
Big Horn C-114	sec. 19, T. 15 S., R. 37 E.	Found
Claw R-108	sec. 32, T. 2 S., R. 33 E.	Found
Darwin Mine - None	secs. 14 and 23, T. 19 S., R. 40 E.	Found but posted
Golden Nugget SC-SL-134	sec. 13, T. 19 S., R. 41 E.	Looked for but not found
Green Gold R-120	sec. 2, T. 4 S., R. 35 E.	Looked for but not found
Jackson No. 1 C-101	sec. 29?, T. 15 S., R. 36 E.	Looked for but not found
Little Peep R-185	sec. 10, T. 4 S., R. 35 E.	Looked for but not found
Lucky Strike C-103	sec. 19, T. 15 S., R. 37 E.	Found
Lucky Susan No. 1 R-16	sec. 35, T. 1 N., R. 32 E.	Looked for but not found
Lucky Tom C-102	sec. 5, T. 12 N., R. 37 E.	Looked for but not found
Milmar Mng. NC-LC-30	sec. 25?, T. 5 S., R. 36 E.	Looked for but not found
Minerva SC-SL-135	sec. 12, T. 16 S., R. 40 E.	Looked for but not found
San Antonio R-12	sec. 30?. T. 5 S., R. 36 E.	Looked for but not found
Scintiscope C-97	sec. 10, T. 13 S., R. 36 E.	Not found, road chained and posted

TABLE 1. (continued)

Name and AEC file number	Location	Found or not
Surprise Uranium No. 1 C-152	sec. 14, T. 15 S., R. 40 E.	Found
Ubehebe and Lippincott Lead Mines - None	sec. 13, T. 15 S., R. 40 E.	Found but posted

Claw Prospect

The Claw prospect is the only uranium deposit examined during this study that may be of economic size and grade. The deposit is in limestone intruded by granite. Samples collected by Mallory and Richards (1956) contained from 0.007 to 3.00 percent U_3O_8. Uranium minerals reported by Mallory and Richards were uraninite, meta-autunite, cherkinite, beta-uranotile, and beta-uranophane. The prospect was explored by an adit 13 ft long.

Data gathered during this study indicate that the uranium mineralization is in a roof pendant of metasedimentary rocks that is approximately 900 ft long and 5 to 20 ft wide. Beds in a roof pendant strike north and dip 55° W. The roof pendant is on near-vertical cliff faces and could not be examined in detail.

Metamorphic rock samples 20606, 20607, 20926, 20927, 20929, 20930, 20931, and 20933 were collected within the roof pendant. Granitic rock sample 20932 was collected within the roof pendant from what appeared to be a small, irregular-shaped dike. Granitic rock sample 20928 was collected approximately 50 ft north of the roof pendant. All samples were collected within 50 ft of the 13 ft adit near the center and in the widest portion of the roof pendant. Other small roof pendants were observed on the shear canyon walls around the prospect, but were not sampled.

Metamorphic rock types found in the roof pendant included banded marble, magnetite schist, actinolite schist, and biotite schist. The uranium content of samples of these rock types are banded marble (20606), 418 ppm U_3O_8; banded marble (20607), 3400 ppm U_3O_8; magnetite schist (20926), 3400 ppm U_3O_8; actinolite schist (20927), 500 ppm U_3O_8; and biotite schist (20930), 52 ppm U_3O_8.

Petrographic samples contain beta-uranophane, uraninite, relict pyrite, magnetite, and secondary quartz; trace amounts of chalcopyrite and ilmenite; and hematite in minor amounts. These minerals were found in open fractures and vugs (beta-uranophane), which are finely disseminated throughout the sample, or were concentrated along mineral bands.

Uraninite was found as microscopic euhedral crystals disseminated along opaque and calc-silicate bands in the marble and irregularly throughout the schist. The crystals show an automorphic replacement type of growth. In several samples, magnetite and quartz replaced uraninite, which indicates that the uraninite crystals formed first. No mineral relationships were noted with other accessory minerals.

CONCLUSIONS

PREBATHOLITHIC ROCKS

Rocks of the prebatholithic sequence have low uranium contents, except in areas along the intrusive and contact-metamorphic zones. Contact-metamorphic zones, such as at the Claw prospect, and contact-metasomatic areas (indicated by the presence of epidote, fluorite, beryl, and garnet), such as those at the Birch Creek pluton and the Santa Rita Flat pluton, are probably the most favorable sites for uranium deposits. Most of the skarns examined contained little more uranium than did the unaltered parent rocks, but there are many miles of granitic and contact-metamorphic zones that were not examined in which uranium deposits may be found.

BATHOLITHIC ROCKS

None of the granitic rocks sampled during this study contained sufficient uranium to warrant mining in the foreseeable future. The quartz-monzonite intrusives east of Lone Pine and in the Santa Rosa Hills, contain sufficient uranium to have served as source rocks for supergene uranium deposits that may be present in Tertiary sediments buried in the basins around the mountain ranges. Sand and gravel, derived from the erosion and weathering of the intrusive rocks, form some of the Tertiary sediments that may now be buried around the flanks of the plutons. Ground water moving through these sediments could leach the contained uranium and redeposit it farther out in the basin.

The quantity of leachable uranium in samples from the Lone Pine area, 8 ppm to 19 ppm U_3O_8, is large. Because leachable uranium is still present in the rock, it is possible none has been removed. If this is the case, erosional debris from these rocks will have carried uranium into environments more conducive to leaching, such as alluvial fans. It is also possible that the leachable uranium is of supergene origin.

POSTBATHOLITHIC ROCKS

The study area was probably once blanketed by tuffs of intermediate to silicic composition, and they must be considered as a possible source for at least part of the uranium in the area. During weathering and erosion of these volcanic deposits, large quantities of uranium ions would have been released into the ground- and surface-water systems of the area. This may have been the source of uranium for the small, fracture-controlled uranium deposits scattered throughout the area.

DIKES AND SILLS

Dikes, sills, and other structurally controlled igneous features examined were barren of uranium. However, the uraninite grain in sample 20999 indicates that there are minor amounts of uranium in some of the pegmatite dikes. Uraniferous pegmatites, related to migmatite zones, may be rare.

URANIUM DEPOSITS

Most of the known uranium deposits in the area are too low in grade and extent to be of more than academic interest. The single exception is the Claw deposit. Development of this deposit will depend on the depth of the roots of the roof pendant. If the roof pendant is shallow then the quantity of ore will be small.

Data gathered during this study indicates that the Claw deposit was a pre-existing uranium deposit that was remobilized as the result of contact metamorphism. During metamorphism, uraninite crystals replaced pre-existing rock minerals without disturbing the rock fabric. The uraninite crystals were in turn partially replaced by quartz and magnetite. Most of the minerals present in the pendant could have been formed by the metamorphism of siliceous shales and limestones without the introduction of new ions. Minerals normally found in metasomatic deposits, such as garnet, diopside, and fluorite, are absent at the Claw prospect. The absence of metasomatic solutions is further supported by the absence of quartz veins or pegmatite dikes in the vicinity of the deposit. Uranium to thorium ratios (7:1 and 24:1, Table A-1) are much higher than the 1:3.5 to 1:4.0 ratios commonly found in metasomatic uranium deposits (Nishimori and others, 1977, p. 66; Walker and others, 1956, p. 23-24).

The Claw deposit probably formed after a granitic melt intruded a shaley limestone and isolated the roof pendant in which the deposit is found. The rocks of the pendant contained a low-grade uranium deposit before the intrusive activity. The lower roots of the pendant were surrounded and heated by magma. As the edges of the pendant were assimilated, the uranium ions were driven inward, and possibly upward, which reconcentrated the uranium within the interior of the roof pendant and formed a type of autometasomatic uranium deposit. Unmetamorphosed low-grade uranium deposits, such as the Claw deposit may once have been, may exist in the 6½ mi of stratagraphic section now exposed in the White and Inyo Mountains.

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APPENDIX A

TABULATIONS OF SAMPLE ANALYSES

TABLE A-1. TABULATION OF SAMPLE ANALYSES

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY			CHEMICAL URANIUM (ppm)
			EQUIVALENT THORIUM (ppm)	EQUIVALENT POTASSIUM (percent)	EQUIVALENT URANIUM (ppm)	
20602	intrusive	275	18	3.6	4	5
20603	meta.	112	0	0	2	4
20604	intrusive	112	9	3.7	2	3
20605	intrusive	175	11	3.6	3	4
20606	meta.	350	14	0	334	418
20607	meta.	2950	-	-	-	3400
20608	meta.	23	0	0	1	2
20609	intrusive	355	75	2.8	14	20
20610	intrusive	152	7	3.3	1	3
20611	intrusive	295	34	3.6	9	11
20612	intrusive	500	90	2.8	26	28
20876	intrusive	215	22	4.7	5	2
20877	meta.	128	1	0	2	<2
20878	intrusive	148	10	4.1	2	2
20879	intrusive	152	11	3.6	3	3
20880	meta.	82	0	0	0	2
20881	intrusive	176	7	3.9	3	<2
20882	intrusive	180	10	4.1	2	<2
20883	intrusive	225	16	4.7	3	2
20884	intrusive	184	8	3.9	3	<2
20885	meta.	170	5	3.2	2	<2
20886	intrusive	160	6	5.7	1	<2
20887	intrusive	150	8	4.2	1	2
20888	intrusive	160	8	3.8	1	2
20889	meta.	160	8	1.6	2	2
20890	intrusive	120	9	3.5	1	4
20891	meta.	60	3	0.2	2	2
20892	meta.	600	3	1.4	116	114
20893	intrusive	170	13	3.3	3	7
20894	intrusive	124	7	3.4	2	<2
20895	intrusive	180	11	4.3	5	5
20896	intrusive	140	9	3.8	2	3

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-1. (continued)

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY			CHEMICAL URANIUM (ppm)
			EQUIVALENT THORIUM (ppm)	EQUIVALENT POTASSIUM (percent)	EQUIVALENT URANIUM (ppm)	
20897	intrusive	295	53	5.0	9	8
20898	meta.	164	18	4.8	5	< 2
20899	meta.	126	8	6.1	3	2
20900	meta.	72	14	2.7	3	4
20901	intrusive	118	8	4.0	2	< 2
20902	intrusive	122	10	4.1	3	3
20903	intrusive	117	9	3.4	2	< 2
20904	intrusive	120	11	3.4	1	< 2
20905	intrusive	114	7	3.0	1	< 2
20906	intrusive	110	8	3.3	2	< 2
20907	intrusive	124	12	3.1	1	1
20908	intrusive	112	11	3.1	1	< 2
20909	intrusive	118	12	2.8	1	< 2
20910	meta.	118	9	3.5	2	3
20911	intrusive	110	13	3.2	3	< 2
20912	intrusive	98	8	3.4	2	< 2
20913	meta.	128	14	4.5	3	< 2
20914	intrusive	108	16	2.4	3	< 2
20915	meta.	55	1	0	1	2
20916	meta.	132	21	3.7	4	< 2
20917	intrusive	112	1	0	0	< 2
20918	intrusive	118	14	3.3	1	1
20919	meta.	88	10	3.3	1	< 2
20920	intrusive	94	3	0.3	1	< 2
20921	intrusive	100	10	2.9	2	< 2
20922	intrusive	176	10	3.3	2	5
20923	intrusive	150	16	3.3	5	< 2
20924	intrusive	150	9	4.5	2	< 2
20925	intrusive	170	7	4.0	2	< 2
20926	meta.	10,000+	-	-	-	3400
20927	meta.	10,000+	44	0.7	342	500
20928	intrusive	2500	18	0.5	20	35
20929	meta.	-	-	-	-	-

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-1. (continued)

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY			CHEMICAL URANIUM (ppm)
			EQUIVALENT THORIUM (ppm)	EQUIVALENT POTASSIUM (percent)	EQUIVALENT URANIUM (ppm)	
20930	meta.	10,000+	55	3.7	69	52
20931	meta.	7,000	-	-	-	-
20932	intrusive	250	17	4.6	5	4
20933	meta.	-	-	-	-	-
20934	intrusive	106	7	3.3	2	2
20935	intrusive	116	10	3.0	2	2
20936	meta.	118	3	0.6	17	18
20937	intrusive	134	14	3.7	4	3
20938	intrusive	160	27	3.7	6	4
20939	meta.	138	1	0	18	23
20941	intrusive	146	21	4.0	6	4
20942	intrusive	178	15	3.3	4	7
20943	intrusive	230	20	3.7	8	5
20944	intrusive	230	9	2.9	1	3
20945	intrusive	192	23	3.9	5	4
20946	intrusive	195	22	3.5	5	3
20947	intrusive	174	19	3.4	5	5
20948	intrusive	154	21	3.7	5	4
20949	meta.	182	22	2.6	7	7
20950	meta.	250	45	1.7	7	4
20951	meta.	200	21	0	10	11
20987	intrusive	80	2	1.2	1	2
20989	intrusive	138	12	3.2	3	3
20990	intrusive	138	14	3.3	3	3
20991	meta.	50	1	0.1	3	3
20992	intrusive	124	9	3.9	2	2
20993	intrusive	118	9	3.7	2	<2
20994	intrusive	142	18	4.5	4	4
20995	intrusive	130	15	3.2	4	3
20996	intrusive	178	14	3.7	6	4
20997	intrusive	140	17	2.8	5	6
20998	meta.	190	23	2.5	7	5
20999	-	-	-	-	-	-
21000	intrusive	166	18	3.3	5	5

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-1. (continued)

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY			CHEMICAL URANIUM (ppm)
			EQUIVALENT THORIUM (ppm)	EQUIVALENT POTASSIUM (percent)	EQUIVALENT URANIUM (ppm)	
21001	intrusive	146	7	3.8	1	3
21002	intrusive	170	10	4.7	3	3
21003	intrusive	168	9	4.7	5	4
21004	intrusive	220	15	2.9	5	6
21005	meta.	110	6	2.7	7	7
21006	intrusive	180	9	4.0	3	3
21007	meta.	110	2	0.3	3	3
21008	intrusive	156	9	3.3	3	3
21009	meta.	150	1	0	8	6
21010	intrusive	180	8	3.8	3	2
21011	intrusive	240	21	3.0	5	4
21012	meta.	190	8	0.9	4	2
21013	intrusive	176	32	1.6	2	< 2
21014	meta.	100	2	0.1	1	< 2
21015	intrusive	200	22	4.1	2	3
21016	intrusive	250	22	4.6	3	3
21017	meta.	160	9	1.5	2	< 2
21018	intrusive	198	19	3.3	3	4
21019	intrusive	290	30	3.5	6	4
21772	intrusive	182	19	3.1	4	5
21773	intrusive	215	23	4.5	5	5
21774	intrusive	152	19	3.1	5	4
21775	intrusive	162	19	3.4	5	6
21776	intrusive	182	18	3.4	5	5
21777	intrusive	162	20	3.0	5	5
21778	intrusive	194	22	3.9	3	5
21779	intrusive	186	21	3.5	6	6
21780	intrusive	166	19	3.2	4	4
21781	intrusive	144	18	3.4	4	4
21782	intrusive	235	46	1.4	6	6
21783	intrusive	160	21	3.6	5	4
21784	intrusive	180	17	3.5	5	6

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-1. (continued)

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY EQUIVALENT THORIUM (ppm)	EQUIVALENT POTASSIUM (percent)	EQUIVALENT URANIUM (ppm)	CHEMICAL URANIUM (ppm)
21785	intrusive	135	35	4.5	7	6
21786	intrusive	146	14	3.5	4	3
21787	meta.	98	8	1.8	2	3
21788	intrusive	110	12	3.4	3	3
21789	meta.	50	0	0	0	< 2
21790	intrusive	130	11	3.2	3	5
21791	intrusive	150	11	4.4	3	5
21792	meta.	88	2	0	5	5
21793	meta.	88	1	0	1	2
21794	intrusive	180	18	3.9	4	4
21795	intrusive	235	26	4.0	5	4
21912	intrusive	195	19	3.9	4	5
21913	intrusive	205	16	3.9	3	3
21914	intrusive	136	9	3.6	2	3
21915	intrusive	138	13	3.8	1	< 2
21916	intrusive	132	13	3.8	2	3
21917	intrusive	132	9	3.8	1	< 2
21918	intrusive	154	12	3.8	2	2
21919	intrusive	122	12	4.0	1	1
21920	intrusive	122	14	3.6	2	2
21921	intrusive	120	13	4.1	1	2
21922	intrusive	168	17	3.4	3	3
21923	intrusive	142	12	4.6	2	3
21924	intrusive	120	7	2.7	3	< 2
21925	meta.	118	7	0	7	7
21926	intrusive	164	15	4.6	2	2
21927	intrusive	250	29	3.9	5	5
21928	intrusive	148	17	3.6	3	4
21929	intrusive	118	5	1.0	1	< 2
21930	intrusive	122	10	2.3	1	< 2
21931	intrusive	210	21	4.0	4	5
21932	intrusive	144	8	3.4	3	3

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-1. (continued)

SAMPLE NUMBER	ROCK UNIT	FIELD RADIOMETRIC VALUE (C.P.S.)*	GAMMA SPECTROSCOPY EQUIVALENT THORIUM (ppm)	GAMMA SPECTROSCOPY EQUIVALENT POTASSIUM (percent)	GAMMA SPECTROSCOPY EQUIVALENT URANIUM (ppm)	CHEMICAL URANIUM (ppm)
21933	intrusive	225	23	5.0	3	3
21934	intrusive	150	8	3.3	2	2
21935	intrusive	275	34	4.1	8	4
21936	intrusive	210	17	3.7	5	5
21937	meta.	68	1	0	1	< 2
21938	intrusive	340	28	3.8	9	9
21939	intrusive	150	11	4.1	1	< 2
21940	intrusive	215	29	5.1	2	3
21941	intrusive	325	40	4.7	9	13
21942	intrusive	225	24	2.8	6	9
21943	intrusive	210	14	3.8	2	2
21944	intrusive	156	11	3.8	1	< 2
21945	intrusive	200	24	4.0	3	3
21946	intrusive	250	21	3.8	5	5
21947	intrusive	110	8	1.3	1	< 2
21948	intrusive	190	14	3.8	3	3
21949	intrusive	61	2	0.1	0	< 2
21950	intrusive	112	11	3.2	1	< 2
21951	intrusive	164	11	4.4	2	3
21952	intrusive	126	10	2.2	1	1
21953	intrusive	134	13	3.4	1	< 2
21954	intrusive	114	12	2.5	2	< 2
21955	intrusive	146	14	4.0	3	4
21956	intrusive	110	5	3.5	2	< 2
21957	intrusive	112	7	4.0	2	3
21958	intrusive	230	46	4.4	4	4
21959	intrusive	118	15	3.5	2	3
21960	intrusive	120	14	3.7	3	3
21961	intrusive	114	–	–	–	< 2

* COUNTS PER SECOND, MOUNT SOPRIS 131-A SCINTILLOMETER.

TABLE A-2. COMPLETE SEMIQUANTITATIVE MODAL ANALYSES (QUANTITIES IN PERCENTAGES).

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/ actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
20602	granite	30	45	25						tr	tr	tr	tr										
20604	quartz monzonite	40	30	20			5			1	tr	tr		3									
20605	quartz monzonite	40	35	20						tr			3										
20606	banded marble				55	43	tr	tr		2													
20607	banded marble	23			40	30	1	tr	3	3													
20608	marble				99					tr											tr		
20609	blastomylonitic gneiss	40	30	25			2			tr		tr	3										
20610	granite	40	30	20			5			tr	tr	tr		3									
20611	quartz monzonite	30	30	40						tr		tr								tr			
20612	blastomylonitic gneiss	40	30	25						tr		tr	3		tr								
20876	granite porphyry	24	49	23			3			tr	tr		tr										
20878	monzonite porphyry	7	47	34			5	tr		1	1	tr	tr	4	tr	tr							
20879	monzonite	8	37	46			4	tr		1	tr	tr	tr	3	tr	tr							
20883	granite	28	48	21			2	tr		tr		tr	1										

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/ actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
20886	granite	27	48	22			1			tr	tr		1										
20890	mylonite	25	35	25			5			tr			tr										
20892	epidote skarn						tr			tr					1	97	2						
20893	diorite	6	18	42			14			1	tr			4	tr								12
20895	quartz monzonite	28	45	32			2		tr	1			1										
20897	granite	34	42	18			3	tr	tr	1			1										
20898	andesite porphyry		45	50			4			1		tr											
20899	andesite		5	50						tr					45								
20901	mylonite	35	30	30						2			3										
20904	granodiorite	18	22	47			4	tr		1			6	1	tr	1							
20907	mylonite	29	31	27			6	tr		2			3			tr							
20910	spotted hornfel	10			35					15			40										
20911	mylonite	30	45	20			3			tr			2			tr							
20921	quartz monzonite porphyry	38	29	26			4	tr		1			1		tr								

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
20925	quartz monzonite porphyry	17	36	26			8			tr	tr	tr		6	1	tr							
20926	magnetite (93%) schist	2			3	3	tr											tr					
20927	actinolite schist	10			15	55				tr	tr								20				
20928	granite	15	45	20	2		3			tr	tr	tr		5									
20929	actinolite schist	2			5	92		1		tr	tr	tr											
20930	biotite schist	55	5			tr	40	1		tr		tr											
20931	actinolite schist				45	35		2	3	tr					15								
20932	granite porphyry	30	49	5						tr	tr			3	10	2							
20933	actinolite schist	8			80	10		2		tr													
20935	quartz monzonite porphyry	23	32	37			6			1			tr										
20936	marble	1			95					1													
20939	garnet skarn	1																		99			
20943	quartz monzonite	14	37	24			14	tr	tr	1	1			8	tr	tr							
20948	diorite	8	18	54			7	tr		2	1	tr		9	tr	tr							

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/ actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
20949	siltstone	54	1	2			38			4		tr	1										
20950	siltstone	60	5				35	tr		tr		tr			tr								
20951	garnet skarn	tr						tr		tr					tr	tr				97		tr	
20989	quartz monzonite	40	25	28			5			tr	tr	tr			tr	2							
20993	granite	35	40	20			2			tr	tr		tr		2	tr							
20995	quartz monzonite	36	30	25			4			tr				4	tr								
21000	blastomylonitic gneiss	40	35	20			5			tr	tr				tr	1							
21004	blastomylonitic gneiss	35	45	30						tr			tr										
21005	siltstone-slate	30								70													
21006	quartz monzonite	38	30	26	tr		1			tr	tr	tr		5									
21008	quartz monzonite	35	32	25	tr		3			tr	tr			tr	tr	5							
21010	granite	35	45	17			1			tr			2										
21013	granite	55	25	13	3		tr		tr	tr			4		tr								
21015	quartz monzonite	50	28	25			tr			tr													

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
21016	granite	35	40	20			4		tr	tr	tr				tr								
21018	quartz monzonite	35	40	24			tr			tr													
21019	quartz monzonite	25	35	30			10			tr						tr							
21772	granite	21	46	22			4	tr		tr	tr	tr		6	tr	tr							
21774	quartz monzonite	23	41	28			4	tr		1	tr	tr			2	tr							
21777	granite	25	48	17			2	tr		1	tr	tr		4	2	tr							
21779	granite	23	50	19			1	tr		1		tr		5	tr	tr							
21782	micrographic granite	34	59	5			tr			1		tr											
21784	granite	12	57	15			tr	tr		2	tr	tr		10	tr	3							
21785	granite	30	61	6			tr			tr	tr	tr	tr		1	1							
21786	quartz monzonite	17	45	33			tr	tr		1	tr	tr			2	1							
21788	andesite porphyry			87			5							3	5								
21790	granodiorite	10	22	60	tr		tr	tr		tr	1			2	3	1							
21791	monzonite	4	44	39			tr	tr		1	2	tr		9	tr								

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/ actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
21792	chlorite skarn	23						tr		16					60								
21794	quartz monzonite	10	44	37			tr	tr		tr	1	tr		7	tr								
21795	quartz monzonite	18	40	30			tr	tr		1	tr	tr		10	tr	tr							
21912	quartz monzonite	25	42	24			tr	tr		1	tr	tr	tr	7		tr							
21914	granite	22	40	16			tr	tr		2	tr	tr		11	tr	tr							
21916	quartz monzonite	22	38	28			9	tr		1	tr	tr	tr		tr	1							
21919	quartz monzonite	21	47	29			2	tr	tr	tr	tr		tr		tr	tr							
21922	quartz monzonite	27	29	37	tr		tr	tr		tr	tr	tr	tr	3	tr	3							
21925	skarn	4		tr	20					32					tr					17	26		tr
21928	quartz monzonite	25	37	29			tr	tr		tr	tr	tr	tr	4	2	2							
21929	diorite	4		50			tr	tr		1			tr	37	1	4							2
21931	granite	14	56	26				tr		tr	tr	tr		3		tr							
21932	monzonite	9	39	34			tr	tr		2	1	tr		14	tr								
21933	granite	27	49	21			tr	tr		1		tr	1										

TABLE A-2. (continued)

SAMPLE NUMBER	ROCK NAME	quartz	k-feldspar	plagioclase	calcite	tremolite/actinolite	biotite	apatite	tourmaline	opaques	sphene	zircon	muscovite	hornblende	chlorite	epidote	fluorite	pyrite	phlogopite	garnet	clay	amphibole	pyroxene
21935	granite	16	55	19			3	tr		tr	tr	tr		6	tr								
21938	monzonite	2	42	38			6	tr		3				3	tr								5
21941	granite	17	57	21			2	tr	tr	tr		tr		tr	2	tr							
21945	quartz monzonite	25	47	27			tr	tr		tr	tr		tr		tr	tr							
21948	quartz	34	19	33			7	tr	tr	tr	tr	tr		6	tr	tr							
21949	diorite			28	3			tr		tr				30	17	21							
21953	quartz monzonite	24	33	34			4	tr	tr	1		tr	tr	3	tr	tr							
21955	quartz monzonite	22	40	30			tr	tr		1	tr		tr	2	3	1							
21957	quartz monzonite	30	39	26						tr	tr	tr	4							tr			
21960	quartz monzonite	24	23	45			3	tr		tr	tr	tr	tr	4	tr	tr							
21961	granodiorite	24	16	46			5	tr	tr	1	tr	tr	tr	7	tr								

TABLE A-3. MINERAL IDENTIFICATIONS

Sample Number	Mineral Name
20607	beta-uranophane, uraninite
20926	uraninite
20927	uraninite
20929	beta-uranophane
20949	beryl
20999	uraninite
21962	stilbite

TABLE A-4. FULL RAPID-ROCK ANALYSIS (QUANTITIES GIVEN IN PERCENTAGES)

Sample Number	SiO_2	Al_2O_3	TiO_2	MnO	MgO	Na_2O	K_2O	CaO	CO_2	P_2O_5	S	SO_4	FeO	Fe_2O_3	LOI	organic carbon
20606	18.84	0.50	0.07	1.65	10.15	0.18	0.04	29.67	0.28	0.18	0.21	0.09	5.75	4.03	26.0	-
20607	32.09	1.16	0.38	0.63	0.82	0.68	0.11	27.97	2	2.05	0.045	0.039	3.69	2.23	20.55	-
20892	36.88	20.64	0.15	0.34	2.72	0.73	1.67	17.86	0.86	0.13	0.002	0.02	1.28	10.8	2.14	0.072
20926	13.61	1.16	0.46	0.16	3.00	0.30	0.39	3.87	0.75	0.48	0.03	0.03	23.6	49.1	gain	0.08
20927	44.57	5.82	0.49	0.61	8.34	1.76	1.03	17.57	2.42	0.78	0.01	0.02	5.78	2.35	9.07	<0.002
20928	61.71	17.47	0.96	0.09	1.39	8.49	0.71	3.75	1.46	0.23	0.004	0.03	1.46	0.51	1.81	0.20
20930	55.86	13.65	0.80	0.15	9.03	3.07	4.62	2.08	0.11	0.75	0.01	0.04	4.70	1.73	1.14	0.002
20932	61.06	17.81	1.01	0.08	1.22	4.83	4.79	2.77	-	0.23	0.008	0.003	1.87	2.21	0.41	0.03
20936	39.51	2.83	0.27	0.17	1.28	0.42	0.64	24.77	18.6	0.22	0.04	0.13	0.34	3.91	20.8	0.41
20939	46.24	0.83	0.12	0.32	0.09	0.16	0.11	23.04	0.31	0.17	0.01	0.04	0.54	24.9	0.73	0.10
20949	68.23	12.65	1.97	0.04	2.19	2.94	2.85	0.46	0.063	0.23	0.004	0.03	4.33	1.52	0.89	0.05
20950	71.76	10.65	1.99	0.08	1.53	2.42	1.64	1.10	0.031	0.30	0.02	0.03	3.90	0.57	0.49	0.05
20951	38.31	10.34	1.01	0.84	2.30	0.20	0.11	27.36	0.99	0.16	0.006	0.03	1.61	9.85	4.23	<0.002

TABLE A-5. TOTAL-SPECTRUM EMISSION SPECTROSCOPY (QUANTITIES GIVEN IN PERCENTAGES)

Sample Number / Element	20606	20607	20608	20892	20926	20927	20928	20930	20932	20936	20937	20939	20949	20950	20951	21005
Ag	.0001			<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	.0003	<.0001	.0005	<.0001	<.0001	<.0001	
Al	.3000	1.0000	.0200	> 10	.8000	4.0000	> 10	10.000	> 10	.8000	9.000	.4000	8.000	7.000	10.000	1.000
As																.0500
B	.0001			<.0001	<.0001	.0010	.0010	.0010	.0010	.0020	.0020		.0050	.0060	.0010	.0010
Ba				<.0005	.0300	.0100	.0400	.1000	.1500	.1000	.0900		.0200	.0300	.0100	1.000
Be	.0030	.0040		.0010	.0008	.0030	.0007	.0010	.0006	.0001	.0003		.0002	.0001	.0001	.0003
Ca	> 10	> 10	> 10	> 10	> 10	7.000	> 10	3.000	5.000	> 10	7.000	> 10	1.000	2.000	> 10	> 10
Co				.0040	.0020	<.0005	<.0005	.0030	.0010	.0010	.0010		<.0005	<.0005	<.0005	
Cr				<.005	<.005	<.005	<.005	<.005	.0020	.0070	<.005	.0030	.0040	.0100	<.005	.0050
Cu	.0070	.0040	.0004	.0080	.0003	.0004	.0003	.0003	.0003	.6000	.0010	.7000	.0100	.0020	.0020	.0050
Fe	5.000	2.500	.1000	8.0000	10.000	5.000	.7000	2.400	1.500	.5000	2.000	8.000	2.500	2.000	5.000	1.000
Ga				.0020	.0001	.0001	.0001	.0001	.0001	<.0001	.0001		.0001	<.0001	.0001	
K	.1000	.3000	.0500	.7000	.3000	.3000	.4000	1.000	1.000	.8000	1.500	.0300	.8000	.5000	.2000	1.500
Li				.0030	<.0001	<.0001	<.0001	<.0001	<.0001	.0010	.0001		.0001	.0001	<.0001	.0002
Mg	4.500	1.500	5.000	2.0000	.8000	4.000	.5000	3.000	.4000	.3000	1.000	.2000	1.000	.7000	1.000	.2000
Mn	.9000	.3000	.0100	1.0000	.0600	1.000	.0400	.1000	.0300	.0300	.1000	.2500	.0300	.0500	> 1	.0500
Mo	.0003			<.0005	.0050	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	.0006	<.0005	<.0005	.0010	
Na		.2000		.2000	.1000	1.500	.3000	.3000	.5000	.2000	1.500	.0500	.2000	.2000	.1000	.0500
Nb				<.001	.0010	<.001	<.001	.0010	<.001	<.001	<.001		<.001	<.001	<.001	
Ni	.0030	.0030		.0010	.0200	.0060	.0020	.0080	.0030	.0020	.0020	.0010	.0030	.0030	.0020	.0060
P		> 1		<.05	<.05	.2500	.1000	.5000	.1000	.0800	.1000	.0500	.1000	.1000	<.05	1.000
Pb	.0010	.0007		.0010	.0070	.0008	.0001	.0003	.0004	.0001	.0005	.0008	.0004	.0003	.0020	.0030
Sc				<.001	.0010	.0020	.0010	.0010	<.001	<.001	.0010	.0010	.0010	.0010	<.001	
Si	> 10	> 10	1.000	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10	> 10
Sr	.0050	.0300		.1000	<.001	.0050	.0200	<.001	.0500	.0400	.0800		.0050	.0080	.0300	.0050
Ti	.0030	.0800	.0001	.0600	.1500	.2500	.7000	.7000	.9000	.0400	.8000	.0070	1.000	1.000	.7000	.1500
V	.0300	.0300	.0020	.0100	.2000	.0400	.0080	.0300	.0050	.0020	.0060	.0200	.0080	.0100	.0200	.0300
Y	.0090	.0030		.0030	.0080	.0040	.0020	.0030	.0020	<.001	.0020	.0020	.0070	.0050	.0040	.0010
Yb	.0003	.0001		<.0001	.0020	.0001	<.0001	.0001	.0001	<.0001	<.0001		.0001	.0002	.0001	
Zn				.0100	.0100	.0100	.0100	.0100	.0100	<.01	<.01		.0100	.0200	.0100	.0300
Zr	<.001	<.001	<.001	.0050	.0060	.0300	.0700	.0300	.0500	<.001	.0100	.0005	.0300	.0900	.0100	.0005

PLATE I

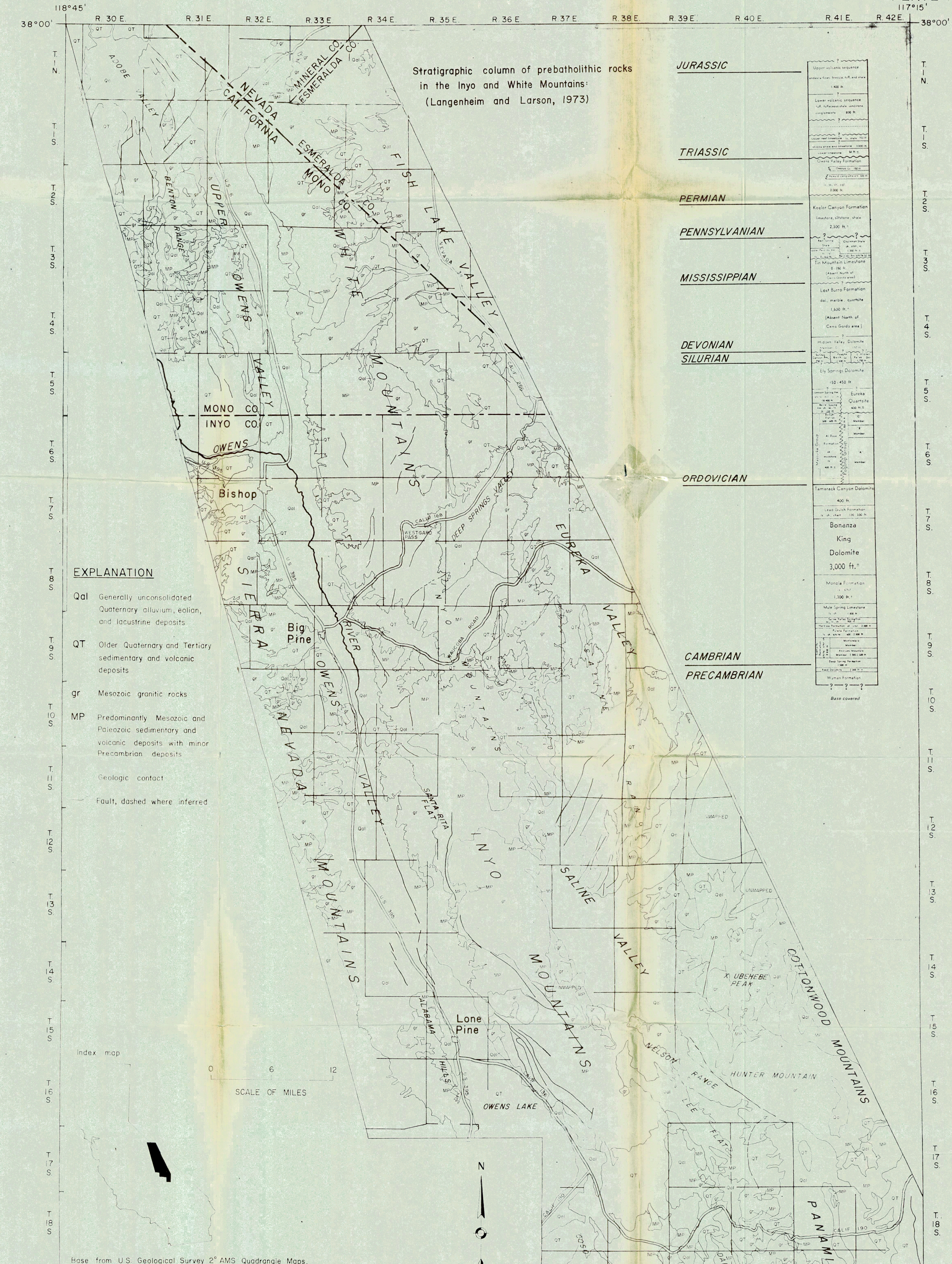

PLATE I
GEOLOGIC MAP, OWENS VALLEY AREA,
INYO AND MONO COUNTIES, CALIFORNIA, AND
ESMERALDA AND MINERAL COUNTIES, NEVADA

PLATE 2

LOCATION MAP OF SAMPLES COLLECTED, OWENS VALLEY AREA, INYO AND MONO COUNTIES, CALIFORNIA, AND ESMERALDA AND MINERAL COUNTIES, NEVADA

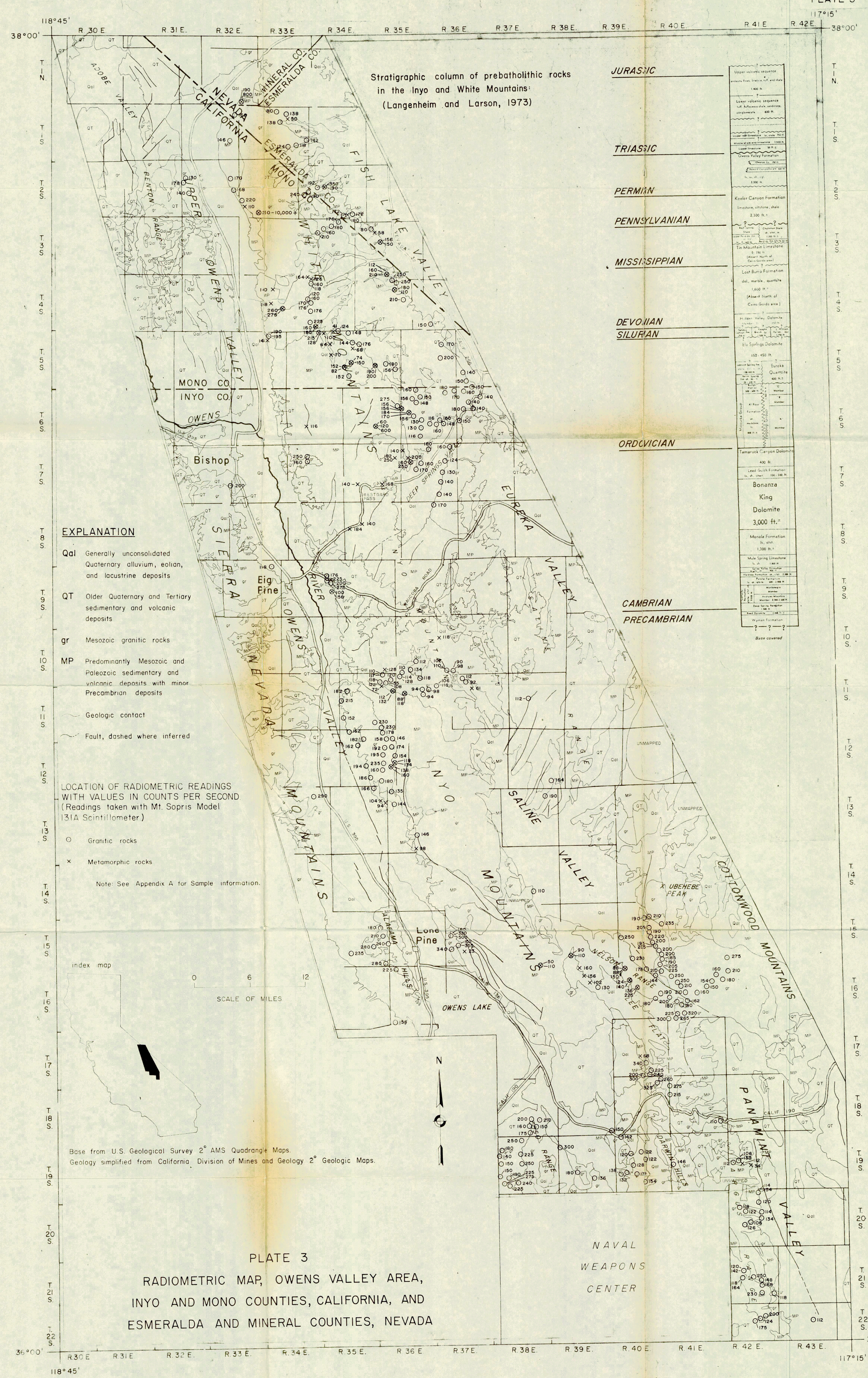

PLATE 3

RADIOMETRIC MAP, OWENS VALLEY AREA, INYO AND MONO COUNTIES, CALIFORNIA, AND ESMERALDA AND MINERAL COUNTIES, NEVADA