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Evaluation of the Potential for Uranium and Other Mineral Resources in the Deep Creek Mountains Withdrawal Area, Juab County, Utah

by

R. A. Cadigan, J. T. Nash, R. S. Zech, A.R. Wallace,

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

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SUMMARY

The mineral resource potential of the Deep Creek Mountains Withdrawal Area has been evaluated by the U.S. Geological Survey at the request of the U.S. Bureau of Land Management. Geologic, geochemical, and radioactivity surveys were conducted to assess the potential for undiscovered uranium, thorium, and other mineral deposits. Although many mines have operated in adjacent parts of the Deep Creek Mountains over the past 80 years, there has been no mineral production from the withdrawal area. This study concludes that only a small area on the eastern edge of the withdrawal area possibly may have mineral resource potential.

The Deep Creek Mountains, about 125 mi southwest of Salt Lake City, form a very rugged range with peak elevations in excess of 12,000 ft (3,650 m). The withdrawal area in the central part of the range is underlain primarily by the Ibapah granite of Tertiary age; the granite intrudes Precambrian and Cambrian sedimentary rocks. Alluvium eroded from these rocks forms younger deposits east of the range. Late Tertiary Basin and Range faulting uplifted the mountain range and subsequent erosion created the present steep and angular land forms.

After numerous uranium claims were staked in 1976-1977 in the alluvium east of the withdrawal area, mineral resource interest focused on that commodity. Geologic, geochemical, and radioactivity investigations indicate

that only Tertiary and Quaternary sediments contain notably anomalous amounts of uranium, and the majority of these sediments occur outside the withdrawal area. Accumulations of the uranium- and thorium-bearing heavy minerals--monazite, sphene, and zircon--occur in Tertiary sand and gravel deposits east of the withdrawal area. Wave action of Pleistocene Lake Bonneville reworked the heavy mineral layers and formed richer accumulations on beach terraces at elevations of 5,040 to 5,200 ft. Some more recent stream placers locally contain as much as 642 ppm Th and 168 ppm U. More representative of large volumes of sand is a channel sample that indicated about 47 ppm Th and 7 ppm U. Chemical analyses reveal the presence of high concentrations of zirconium, titanium, and rare earth elements in heavy mineral concentrates made in the laboratory. Because these possible byproduct elements are present and because the mining and beneficiating of heavy mineral sands are relatively inexpensive, the terrace deposits may have economic potential in spite of their seemingly low uranium and thorium content. Further work on large bulk samples obtained by drilling or trenching is required to properly evaluate the economic potential of the placer deposits. The western edge of these deposits, approximately the 5,200-ft contour, is barely within a corner of the withdrawal area, and therefore, evaluation of these deposits is not within the scope of the present study.

Other possible environments for occurrence of uranium and thorium were investigated; these include Precambrian conglomerates, the intrusive contact zone of the Ibapah stock, and veins within the Ibapah stock. No geologic, mineralogic, or geochemical features were observed that would suggest the presence of economic or subeconomic uranium and thorium deposits in the proposed wilderness. Approximately 8 percent of rock samples from granite of the Ibapah stock contain possibly anomalous amounts of uranium (more than

12 ppm), but no other geochemical or petrologic characteristics of these samples suggest nearby concentrations of ore-grade uranium deposits.

Small base-metal veins cut the Ibapah stock; they contain anomalous amounts of silver, bismuth, copper, lead, and zinc. The small size of the veins and lack of appreciable hydrothermal alteration indicate that these veins probably are not sufficiently large to be economic.

Resources of sand and gravel and of granite building stone occur in the eastern part of the withdrawal area. However, the low unit value of these commodities, distance to markets, and availability of other supplies, makes mining unlikely.

INTRODUCTION

The Deep Creek Mountains are in western Utah, about 125 mi (200 km) southwest of Salt Lake City (fig. 1). The withdrawal area, about 42 sq mi (110 sq km), is in the central part of the Deep Creek Mountains, in Juab County. The withdrawal boundaries are shown on plate 1 and figures 2 and 3. The western boundary is the Goshute Indian Reservation, the eastern boundary is drawn approximately at the base of the mountains, and the north and south boundaries are drawn to exclude private and patented lands. The area is dominated by deep canyons and by rugged peaks and ridges. A wide variety of vegetation, ranging from grasses to shrubs and trees covers the area.

Access to the Deep Creek Mountains is by three maintained gravel roads. One heading west from U.S. Highway 6 and 50 at Delta, Utah (about 90 mi or 145 km); another heading north from U.S. 6 and 50 near the Utah-Nevada border; and the third connects to U.S. 90 which joins Interstate 80 at Wendover, Utah (about 80 mi or 130 km). The closest services are in the village of Ibapah, about 30 mi (50 km) by road from most parts of the withdrawal area. Farming settlements of Callao and Trout Creek are about 5 mi (8 km) northeast and

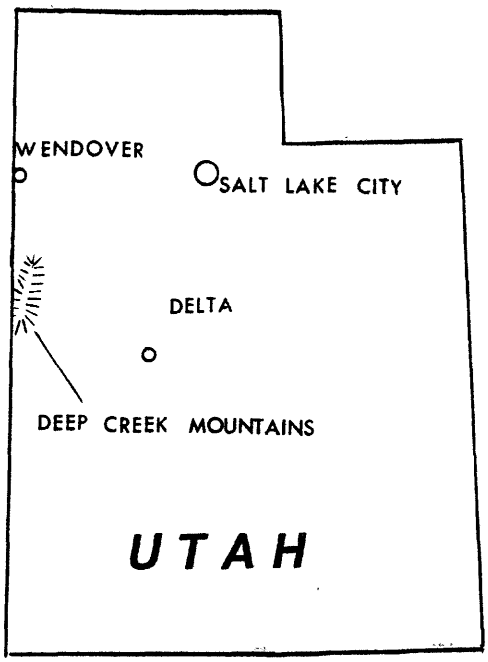

Figure 1.--Location of the Deep Creek Mountains, Utah.

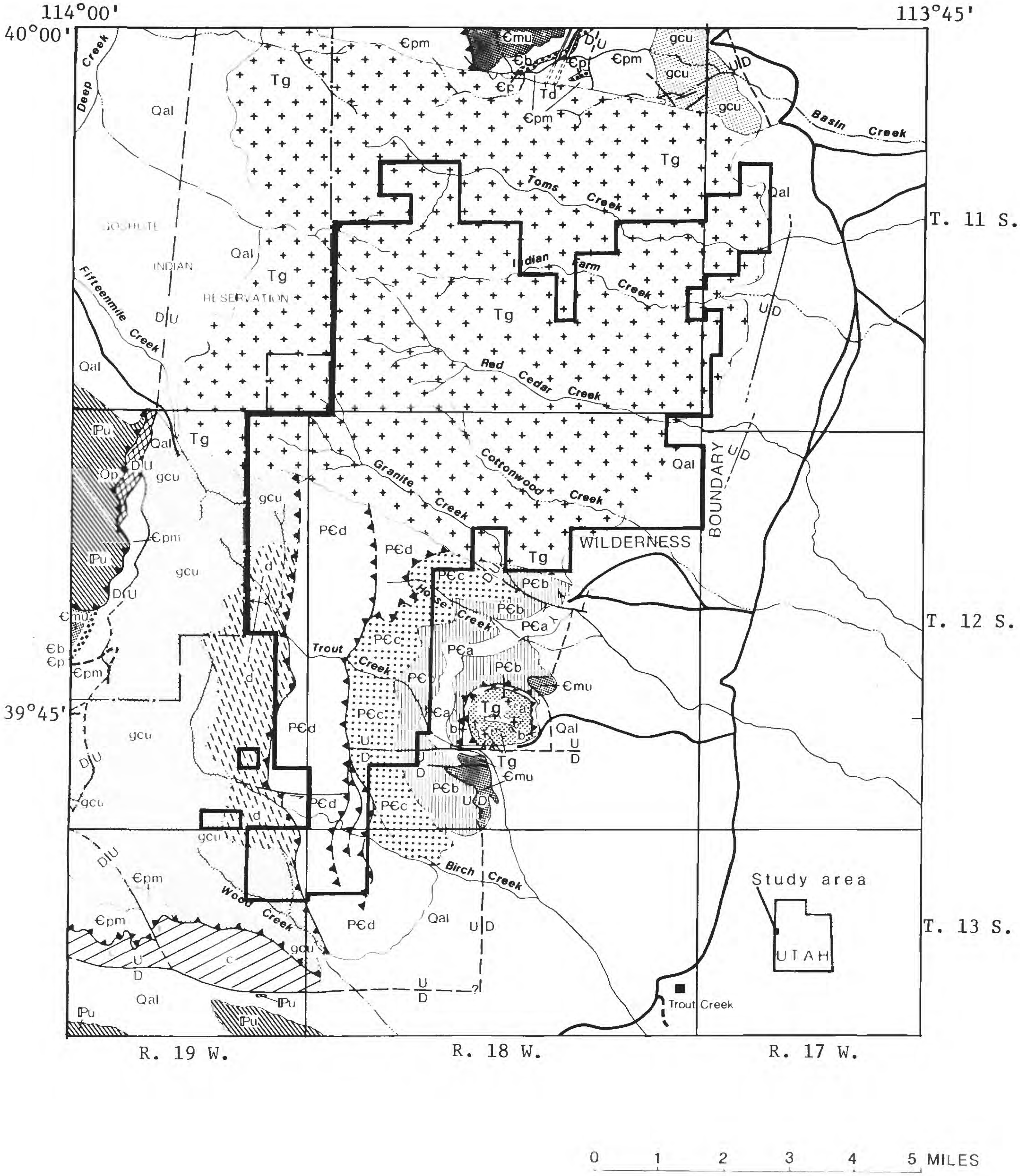

Figure 2.--Geology of the study area (after Bick, 1966) and withdrawal boundaries. Explanation on following page.

EXPLANATION FOR FIGURE 2

Correlation of Map Units

(Modified from Bick, 1966)

Qal	Alluvium	Quaternary
Tg	Granite of Ibapah stock	Tertiary
Td	Aplite dikes	
IPu	Permian-Pennsylvanian rocks, undifferentiated	Permian and Pennsylvanian
Op	Pognip Group & Eureka Quartzite	Ordovician
€mu	Middle & Upper Cambrian rocks, undifferentiated	Cambrian
€b	Busby Quartzite	
€p	Pioche Shale	
€pm	Prospect Mountain Quartzite	
gcu	Goshute Canyon Formation, undivided	Cambrian or Precambrian
d	Formation d	
FAULT CONTACT		
p€d	Horse Canyon Formation member D	Precambrian
p€c	" " " " C	
p€b	" " " " B	
p€a	" " " " A	
FAULT CONTACT		
b	Formation b	Precambrian? (Relations unknown)
FAULT CONTACT		
a	Formation a	
FAULT CONTACT		
c	Formation c	

Contact, dashed where inferred

Normal fault, dashed where inferred

Anticlinal axis

Thrust fault (sawteeth on upper plate)

Transverse fault

Y Adit

Road

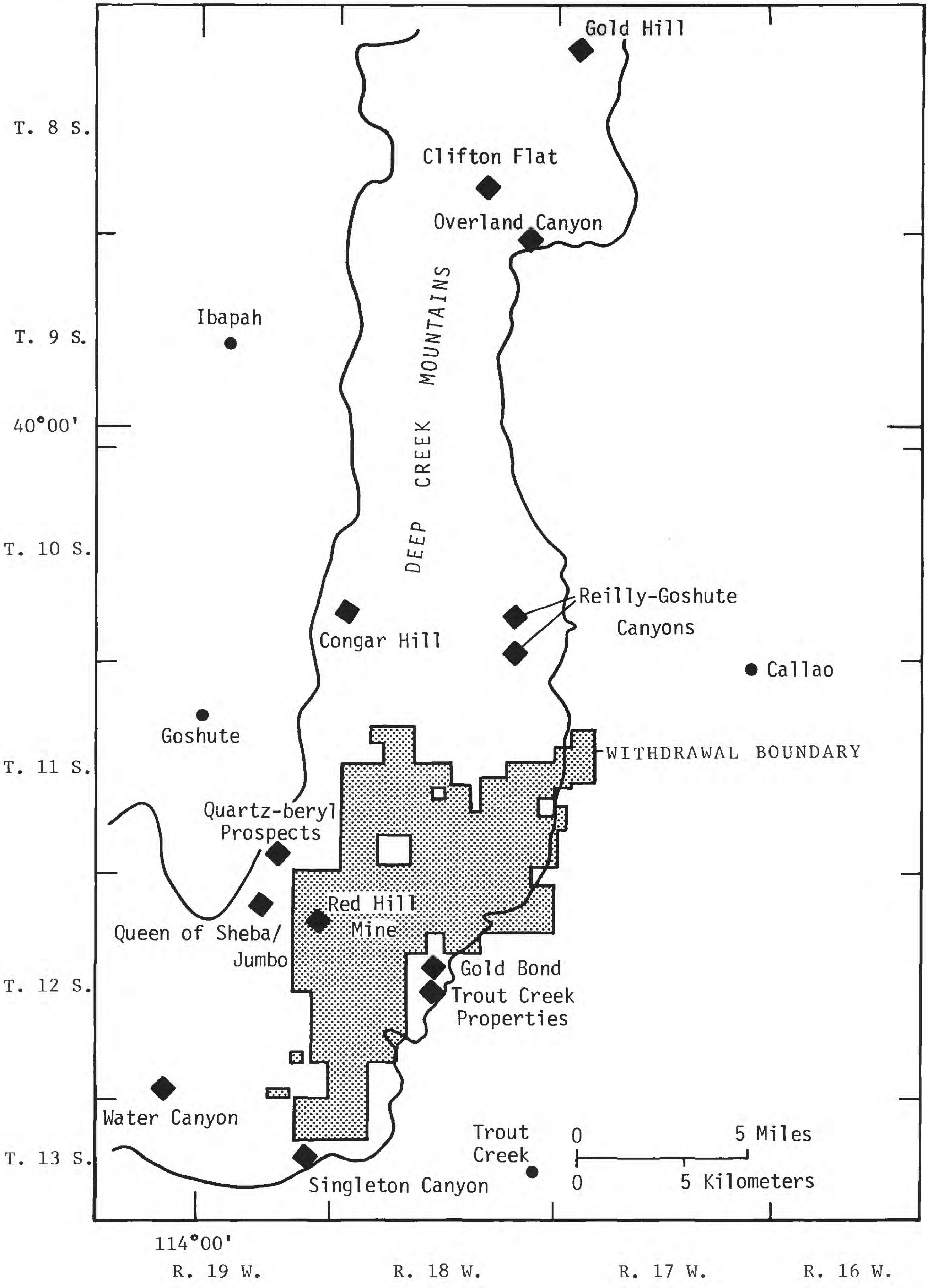

Figure 3.--Location of principal mines and districts, Deep Creek Mountains, Utah.

southeast of the area, respecively. Two jeep roads lead into the withdrawal area from the Callao-Trout Creek road, but neither crosses the range. An old pack trail does cross the area and connects the jeep road in Granite Creek Canyon to a jeep road in Fifteenmile Creek on the Goshute Indian Reservation to the west.

Ridges and peaks of the study area and steep valley walls consist mostly of exposed rock and talus. Frost heaving and large scale fractures in the rocks produce steep slopes and cliffs. Rock slabs and boulders as large as 30 ft (10 m) in diameter have rolled and slumped down the steep slopes. Soil that supports vegetation on higher parts of the range is poorly developed but occurs along fractures and on the flat tops of some upland ridges.

Previous Investigations

The first comprehensive report on the geology and mineral deposits of the Deep Creek Mountains was by Butler and others (1920, p. 469-486). Nolan (1935) studied the Gold Hill (Clifton) mining district at the north end of the range and established the stratigraphic and structural framework upon which all subsequent studies in a large area of eastern Nevada and western Utah have been based. Geologic studies of the central part of the range were done by Bick (1958, 1959, and 1966), and of the southern part by Nelson (1959, 1966). Mineral deposits of the Deep Creek Mountains were described by Thomson (1970, 1973). Other reports that discuss the geologic structure, stratigraphy, and metamorphism of the range include those by Misch, Hazzard, and Turner (1957), Misch (1960), Misch and Hazzard (1962), and Woodward (1965).

For general geologic information and for geologic maps this report draws heavily on the works of these early authors, particularly those of Bick (1966) and Thomson (1970, 1973). Other sources of information were H. T. Morris, U.S. Geological Survey, and J. J. Satkoski, U.S. Bureau of Mines, who worked in the area in 1976.

Present Investigation and Acknowledgements

Field and office studies for this report were made by U.S. Geological Survey personnel over the period from May 1978 to April 1979. Field studies were a group effort in September 1978, at which time a helicopter was employed to expedite traverses and sampling of the rugged area. Approximately 75-man-days, by geologists R. A. Cadigan, F. A. Hills, J. T. Nash, V. J. Suits, A. R. Wallace, and R. S. Zech, were devoted to examination of bedrock geology for indications of mineral resources. During these studies 216 rock samples were collected for chemical analysis and radioactivity was measured. High-resolution color air photos (scale 1:24,000) were studied prior to field investigations, and all color anomalies and lineaments detected on the photos were checked on the ground. In addition, all unusual color and structural features observed during low-altitude helicopter traverses were field checked. Following field studies, 45 rocks were examined with the petrographic microscope, unusual minerals were studied by X-ray diffraction, and heavy minerals in samples were separated and identified.

Stream sediment samples were collected by S. M. Condon, H. C. Day, M. B. Sawyer, and J. J. Stevenson under the direction of Keith Robinson and Clyde Yancey, and assistance in data reduction and map compilation was contributed by L. K. Walker, Clyde Yancey, and Kristin Geer, all of the U.S. Geological Survey. Sediment samples--126 in all--were collected from all major streams and tributaries in the study area. Ten stream water samples were collected where water was available. Water and stream-sediment samples were analyzed by a private laboratory, GEOCO Inc.[1], of Wheatridge, Colo., and additional analyses of the stream sediments for uranium and thorium were made in laboratories of the U.S. Geological Survey.

The study benefited from the use as a base camp of a Bureau of Land Management compound, cabin, and house trailer at Callao. We acknowledge the assistance and cooperation of U.S. Bureau of Land Management personnel, Charles Horsburgh, Mineral Specialist, BLM Richfield (Utah) District, and Thomas Jensen, Manager, House Range Resource Area. We appreciate also the help received from residents of Callao, Utah, and particularly the support extended by Bishop Bagley of the Church of Jesus Christ of Latter Day Saints.

GENERAL GEOLOGY

The withdrawal area, located in the central part of the Basin and Range province, near the Utah-Nevada border, includes the highest part of the Deep Creek Mountains. Thomson (1973) characterizes the mountain range as a horst, bounded by normal faults and tilted to the west. The rocks of the mountainous part of the study area consist of low grade metamorphosed and unmetamorphosed Precambrian and Cambrian sedimentary rocks intruded by the Tertiary Ibapah stock (fig. 2). Flanking the mountains are Quaternary and Tertiary(?) sediments, which were derived by erosion of the Deep Creek Mountains, were deposited as fans and deltas, and were later covered by and partially reworked by waves and longshore currents in Pleistocene Lake Bonneville.

Metamorphism, facies changes, and a complex structural history have made geologic interpretations of the Precambrian and Cambrian rocks difficult. The interpretation and classification of these sedimentary and metasedimentary rocks have varied slightly among authors who have studied the region. The stratigraphic terminology and nomenclature used in this report primarily follows that of Bick (1958, 1966), who has the most detailed map and rock descriptions yet published covering the study area. However, the use of

[1] Use of this company name is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

Bick's stratigraphic nomenclature in this report does not mean that it has been adopted by the U.S. Geological Survey.

Metamorphic and Sedimentary Rocks

Precambrian.[2]--Bick (1966) named his lowest Precambrian unit the Horse Canyon Formation. This unit, metamorphosed in the greenschist facies, may have been a thick accumulation of sandy shales and sandstones. Bick divided the formation into four members, which are equivalent to units 3 through 7 of the Trout Creek sequence of Misch and Hazzard (1962). The lowest unit, member A, is 400 ft (120 m) thick and is composed of a brown to vitreous-white, medium-bedded quartzite. Member B is a pale-red to reddish-gray schistose metaconglomerate with angular to subrounded clasts of granite, gneiss, schist, and quartzite up to 3 ft in diameter. H. T. Morris, U.S. Geological Survey (written commun., 1976) regards this unit as equivalent to the Dutch Peak Tillite of Cohenour (1959). The total thickness of Member B is 1,100 ft (340 m). Member C is a greenish-gray to bluish-gray quartz-muscovite-chlorite-biotite schist with minor magnetite and a few beds of quartzite 10-100 ft (3-30 m) thick. The total thickness of member C is 3,100 ft (950 m). Member D is a pinkish-gray to light-brownish-gray, medium- to thick-bedded, very fine- to medium-grained quartzite with 1- to 2-ft (0.3-0.6 m) interbeds of schist and with beds of conglomerate ranging up to approximately 15 ft (4.5 m) thick. Member D is 3,000 ft (900 m) thick and, along with member C, occupies the same stratigraphic position as the upper part of the Sheeprock Formation

[2] The ages of rocks described here as Precambrian and Precambrian or Cambrian are in dispute. The entire sequence may have been deposited between 500 and 700 million years ago, or it may in part be considerably older. No evidence to establish ages was found during our study, and we leave the dispute unsettled. However, the ages of the rocks appear to be unimportant to considerations of mineral resource potential except possibly in the case of uranium potential of Precambrian quartz-pebble conglomerate, discussed in a later section.

(Cohenour, 1959).

Precambrian or Cambrian.--Formations A, B, and C occur outside of the withdrawal area south of the Ibapah stock and are bounded by faults at one or both contacts. Bick (1966) favors a Cambrian age, but Misch and Hazzard (1962) and Nelson (1959) assigned A and B to the Precambrian Trout Creek sequence and C to the Precambrian formation of Hop Canyon. Formations A and C are gray muscovite-biotite-quartz schists with a few beds of quartzite. Formation B is a light-gray to white, medium-bedded dolomite.

Formation D was proposed by Bick (1966) as an informal name for a sequence consisting of bluish biotite schist, quartzite, and marble. It is in fault contact with the Horse Canyon Formation and overlies the Goshute Canyon Formation; but both formations are overturned, so it is older than the Goshute Canyon Formation. The unit is estimated to be 1,000 to 2,000 ft (300-600 m) thick and is equivalent to the Johnson Pass sequence (Misch and Hazzard, 1962) and the upper member of the Sheeprock Formation (H. T. Morris, U.S. Geological Survey, written commun. 1976).

The Goshute Canyon Formation is approximately 3,200 ft (1,000 m) thick and is divided into four members, but these members have not been mapped in the study area. The undifferentiated Goshute Canyon Formation in the study area consists of dark-gray, red-brown-weathering, sulfide-bearing, phyllitic shale, and locally it contains silty or sandy beds. The absence of faunal and physical evidence makes determination of the age of this unit difficult. Bick assigns a Cambrian or Precambrian age to the Goshute Canyon Formation.

Cambrian.--Lower Cambrian rocks in the Deep Creek Mountains include the Prospect Mountain Quartzite (Lower Cambrian to Precambrian), the Pioche Shale, and the Busby Quartzite. These units occur outside the proposed withdrawal boundary to the south, west, and north (fig. 2).

Undifferentiated Middle and Upper Cambrian rocks in the Deep Creek Mountains (fig. 2) occur east, west, and north of the withdrawal boundary. They include the Abercrombie Formation, Young Peak Dolomite, Trippe Limestone, Lamb Dolomite, Hicks Formation and the Chokecherry Dolomite (Upper Cambrian and Lower Ordovician).

Ordovician.--Rocks of the Pogonip Group and the Eureka Quartzite occur west of the withdrawal boundary. The Pogonip Group is composed of thin-bedded, sand and shale-parted, chert-bearing limestones, and the Eureka Quartzite is a gray to white, vitreous, medium-bedded quartzite.

Pennsylvanian and Permian.--This undifferentiated unit (Arcturus? Formation) outcrops west and south of the withdrawal boundary (fig. 2). It consists of medium- to dark-gray, thick- to thin-bedded sandstone and dolomite.

Tertiary(?) and Quaternary.--Partly consolidated to unconsolidated sedimentary deposits occur in the Deep Creek Mountains at the mouths of narrow canyons and in the basins which flank the mountains to the east and west. Most of the alluvial sediments are of Quaternary age; however, the old dissected pediment surfaces and parts of the fan system predate Lake Bonneville and may be of Tertiary age. The principal deposits in the study area are the coarse, feldspar-rich sands and gravels that extend eastward from the eroded rock slopes and canyons of the Tertiary Ibapah Granite. The resulting alluvial fans coalesced to form a continuous apron (bajada) of sediment extending from the mountain front eastward toward the center of the basin. Several prominent lake terraces and associated lake terrace deposits of reworked fan material are cut into the bajada. Farther east are the remnants of very fine textured lake deposits.

Igneous Rocks

The granite of the Ibapah stock, of Tertiary age, is the main igneous rock in the area of study. It crops out over approximately 52 sq mi (135 km^2), 32 of which (83 km^2) are included within the boundaries of the withdrawal. The granite forms the highest part of the Deep Creek Mountains, including Ibapah and Haystack Peaks. The northern and southern contacts of the granite form relatively straight lines on the map and trend about N. 70° W. Bick (1966) interpreted these contacts as faults, along which the granite was intruded.

The granite generally is medium to light gray and equigranular, with crystals as much as 2 in. (5 cm) in diameter The rock is composed of 40 percent quartz, 25 percent sodic feldspar (oligoclase), 25 percent potassic feldspar, and 10 percent biotite (Bick, 1966). Although, based on composition, this is a biotite quartz monzonite, the term granite is used here in a general sense. Exceptions in the color, texture, or composition of the granite are discussed under geologic investigations.

Just north of the point where Trout Creek debouches from the mountains, alaskite crops out in irregularly shaped masses in a small structural dome in the metamorphic rocks. These masses, which constitute the Trout Creek stock, may be the top of a small stock or plug related to the Ibapah stock. Most of the mining activity in the vicinity of the Ibapah stock has been concentrated around this dome, which, however, is outside of the withdrawal area.

Two large aplite dikes are shown on the geologic map north of the Ibapah stock and outside of the withdrawal area (fig 2). However, during field reconnaissance aplite dikes ranging from an inch to several feet in width were found throughout the granite, and aplitic dikes were also observed in the metasedimentary rocks near the southern contact of the Ibapah stock. In addition, northwesterly trending mafic dikes containing pyroxene, hornblende and plagioclase occur in the eastern and southern portions of the Ibapah stock.

GEOLOGIC STRUCTURE

The mountain ranges of the Basin and Range Province are structurally complex, and the Deep Creek Mountains are typical in this regard. Most of the complex structural development, marked by faulting with associated folding, occurred prior to the intrusion of the Tertiary Ibapah Granite.

Based upon structural features related to ore mineralization in the range, Thomson (1973) divided the Deep Creek Mountains into four structural blocks, each having a distinct structural setting. The two southern blocks, the Spring Creek and Ibapah blocks, underlie the withdrawal area. The Ibapah block is composed entirely of granite of the Ibapah stock. The intrusion of the stock is believed by Thomson (1973) to have been controlled by two preexisting east-west faults. According to Bick (1966) three conjugate sets of joints occur within the stock and are related to igneous emplacement and cooling rather than to later deformation.

The Spring Creek block, the most southerly of the four blocks, includes Precambrian and younger sedimentary and metasedimentary rocks. Two normal fault trends occur within the block, one oriented N. 70° to 80° W. and another, older trend oriented N. 5° to 10° E. (Thomson, 1973). A thrust fault mapped by Nelson (1966) on the east side of the range carried rocks from west to east in the Spring Creek block. Many of the metasedimentary rocks in the block are actually overturned. The anticline or structural dome north of Trout Creek was probably caused by the intrusion of the Trout Creek stock. The Spring Creek block is terminated on the south by the Pleasant Valley fault.

The Deep Creek Mountains are bounded to the east and west by steep normal faults striking N. 5° E. Movement along these faults since late Miocene time has lifted the range into its present position (Bick, 1966). Seismicity in the region suggests that movement along the faults may still be occurring.

MINERAL RESOURCE HISTORY AND PRODUCTION

Introduction

The Deep Creek Mountains have had a history of moderate exploration and mining activity. Simple prospect pits are abundant throughout the mountains, and more than a dozen areas have been exploited. Both metallic and non-metallic deposits have been located, but most interest has been in the metallic deposits. All but one of the known mines (both abandoned and operating) in the range are outside the withdrawal area boundaries; several are within a few kilometers of the boundaries; and several others are tens of kilometers from the area (fig. 3). In addition, mining claims, both inactive and active, are common in the range, and some are within the withdrawal area boundaries.

Precious metals (gold and silver), base metals (copper, lead, and zinc), mercury, beryllium, tungsten, and arsenic, with minor antimony, bismuth, and molybdenum, have been mined from the Deep Creek Mountains. Thomson (1973) proposed a genetic relation of metal deposits to igneous activity in the area. Recently, claims for uranium have been staked on sedimentary deposits east of the mountains.

Nonmetallic and industrial mineral commodities in the range include radio-quality quartz crystal, semiprecious gems, and varieties of sand, gravel, and stone (Thomson, 1973). All have been exploited to some extent, but are not considered to be economic today. None are within the bounds of the withdrawal area.

Mined Areas in and Adjacent to Withdrawal Area

The withdrawal area contains only one mine, the Red Hill gold-silver mine (fig. 3), and it is presently inactive. Eight areas of mineral production (and former production), including one quartz mine, are located within 4 mi (6.5 km) of the withdrawal area boundaries. Based upon the work of Thomson (1973) and upon field work for this study, none of the known deposits adjacent to the withdrawal area appear to extend into the area.

Red Hill Mine.--The Red Hill Mine is located in section 1, T. 12 S., R. 19 W. According to Thomson (1973), a 600-ft (180-m) adit has been developed along a fault contact between two sedimentary rock units. Access is by foot trail. An assay of a channel sample showed only a trace of gold and silver, and no production is recorded.

Gold-silver mines.--Three areas were mined for gold and silver: the Gold Bond property, the Queen of Sheba and Jumbo properties, and the Singleton Canyon area. The Queen of Sheba and Jumbo properties had the largest production; the Gold Bond property was a minor producer. No production is recorded from the Singleton Canyon area.

The Queen of Sheba and Jumbo properties are about 0.6 mi (1 km) west of the withdrawal boundary in sections 2 and 11, T. 12 S., R. 19 W. Ore is localized along fractures in Precambrian rocks. Production from 1900 to 1915 was over 9,500 tons of ore with average grades of 0.52 oz Au/ton and 2.26 oz Ag/ton.

The Gold Bond property is located 1 mi (1.6 km) east of the withdrawal area at the mouth of Granite Creek in section 15, T. 12 S., R. 18 W. Ore occurs along veins and as replacements of limestone of the Precambrian Horse Canyon Formation. Twenty-seven tons of ore was shipped in 1934, with an average assay of 0.71 oz Au/ton. A sample assayed in 1968 contained 0.04 oz

Au/ton and 0.23 oz Ag/ton (Thomson, 1973). No production has been recorded since 1934.

The Singleton Canyon area is located about 0.6 mi (1 km) south of the withdrawal area in section 12, T. 13 S., R. 19 W. Ore occurs along a limonite-stained fracture zone. Assayed samples contain a trace of gold, a trace to 0.12 oz/ton Ag, and up to 0.30 percent copper (Thomson, 1973). No production was recorded.

Base-metal mines.--Two base-metal deposits are located near the withdrawal area: the Reilly-Goshute Canyons area, and the Water Canyon Mine.

The Reilly-Goshute Canyons area is located 2 mi (3.2 km) north of the withdrawal area in a broad area in R. 18 W., T. 10 and 11 S. Ore is localized along discontinuous bifurcating fractures in Cambrian sedimentary rocks. The area produced $699,605 in base- and precious-metal ores from 1934 to 1954, but no production has been recorded since then (Thomson, 1973).

The Water Canyon Mine, 3.5 mi (5.5 km) southwest of the withdrawal area, is in section 32, T. 12 S., R. 19 W. Copper is the only economic element reported from the 200-ft (61-m) -long adit; samples from the mine contain 0 to 1.05 percent copper. No production was recorded (Thomson, 1973).

Tungsten mines.--The Trout Creek properties located 0.5 mi (0.8 km) east of the withdrawal area in sections 21, 22, 27, and 28, T 12 S., R 18 W. were mined primarily for tungsten and for accessory zinc, beryllium, and fluorite. The ore occurs along fractures and faults in the Cambrian or Precambrian metasedimentary rocks near the Tertiary Trout Creek stock, which consists of alaskite. Scheelite (calcium tungstate) was discovered in 1916, and ore was shipped out in 1941 and 1955. Assays on samples range up to 4.5 percent tungsten and 4.46 percent beryllium. No production has been reported since 1956 (Thomson, 1973).

Mercury mines.--The Congar Hill property, in section 30, T 10 S., R 18 W., 4 mi (6.5 km) north of the withdrawal area, was mined for mercury and associated antimony. The ores occur in a dolomite breccia related to a larger thrust fault, which traverses the property. Thomson (1973) reported that mercury was shipped from the mines in the 1940's, but no records exist on production.

Quartz-beryl mines.--Radio-quality quartz crystals and beryl were mined from pegmatite dikes in the southwestern part of the Ibapah stock (Thomson, 1973). The small mines, located 1 mi (1.6 km) west of the withdrawal area in sections 34 and 35, T. 11 S., R. 19 W., have no record of production.

Other Major Areas of Mining in the Deep Creek Mountains

In addition to the mining areas already described, the Deep Creek Mountains contains several more important areas of mining, but these are more than 10 mi (16 km) from the withdrawal area. Among these areas are the districts at the north end of the range, including the Clifton (Gold Hill) district, the Pony Express Canyon-Clifton Flat area, and the Overland Canyon properties. The Clifton district, as a whole, produced more than $2 million in base- and precious-metal ores between 1901 and 1927 (Nolan, 1935). Ores occur in three forms: (1) pipelike deposits; (2) veins; and (3) replacement bodies in upper Paleozoic rocks.

Mining Claims in Withdrawal Area

Mining claims in the Deep Creek Mountains are common, especially in proximity to the mining districts. Although most of the claims are beyond the bounds of the withdrawal area, several active and inactive claims fall within the withdrawal area. No patented claims are in the area. According to D. P. Pendleton, USBLM (1978, written commun.) the only claims with recent assessment work that occur within the withdrawal area are those of Atlas Minerals Company at the mouth of Indian Farm Creek in section 24 and 25, T. 11 S., R 18 W., and sections 18, 19, 30, and 31, T. 11 S., R. 17 W.

H. C. Wilson, USBLM (1977, written commun.) reported 22 claims, in addition to those held by Atlas Minerals Company, that fall wholly or partially within the withdrawal area. Only one claim, located at the edge of section 10, T. 12 S., R. 18 W., in Granite Canyon, had recent assessment work, and according to Pendleton (1978, written commun.) that claim had no assessment work done on it in the ensuing year, suggesting that it has been abandoned.

MINERAL ASSESSMENT STUDIES

Introduction

The uranium resource potential of the Deep Creek Mountains Withdrawal area was known to be of particular interest following the staking of uranium claims along the eastern margin of the area by Atlas Minerals Company in 1976. The U.S. Geological Survey assigned geologists with specialized experience to conduct investigations in the granite, in veins and shear zones, in Precambrian metasedimentary rocks, and in Tertiary and Quaternary sedimentary deposits.

Geologic studies revealed three environments that appeared possibly to be favorable for mineral deposits. One was a broad T-shaped zone of green and red coloration extending along the range front and westward between Indian Farm Creek and Toms Creek, and continuing northwestward beyond the withdrawal boundary. Granite in this area is fractured and sheared and appears to have undergone argillic alteration. It resembles rocks in other regions that contain epithermal base- or precious-metal deposits. Under the microscope these rocks are seen to contain introduced fine-grained silica and minor amounts of chlorite and montmorillonite, but the feldspars are essentially unaltered. Study of thin sections revealed that the granite is extensively crushed and sheared.

The second environment that appeared favorable was Tertiary fluvial sediments and beach terrace deposits that contain visible, radioactive, dark layers rich in heavy minerals. Tertiary sediments exposed discontinuously east of the Deep Creek Mountains contain small but easily visible amounts of dark minerals, often concentrated along bedding planes. Shoreline processes of Pleistocene Lake Bonneville modified the sediments to produce terrace deposits at elevations from 5,040 to 5,200 ft (1535-1585). The reworked sands in terraces are particularly rich in dark minerals, and the dark layers are notably radioactive. The dark layers are placer concentrations of heavy, resistate minerals. Laboratory investigations reveal that the heavy minerals are chiefly magnetite, hematite, monazite, sphene, and zircon, along with lesser amounts of ilmenite, allanite, and hornblende. The same minerals are found in approximately the same order of abundance but in lower concentrations in the Ibapah stock to the west. Therefore, we conclude that the granite is the source for these minerals. This conclusion is further supported by our observation of similar but smaller local concentrations of heavy minerals in first-cycle valley alluvium derived from the Ibapah stock. Locally, the heavy, mineral-rich sands and the alluvium are highly radioactive (500 to 2,000 c.p.s.) and contain as much as 642 ppm Th and 168 ppm U (sample MBQ 738, table 1). These highest values were obtained from a carefully selected black sand layer in the bed of a modern stream that crossed a Bonneville shoreline. While interesting, this carefully selected specimen appears not to be representative of any deposits known to occur in economically significant quantities.

The third possibly favorable environment for uranium mineralization was the Precambrian conglomerate. Member D of Bick's (1966) Horse Canyon Formation is primarily a well sorted, mature orthoquartzite that contains beds and zones of well rounded and well sorted quartzite pebbles.

Conglomeratic zones in member D were examined carefully to determine whether they have any likelihood of containing uranium resources of the Elliot Lake type (Precambrian quartz-pebble conglomerate type). In particular, a careful search was made for placer concentrations of thorium (which might remain in the rock even after uranium has been removed by weathering), for concentrations of pyrite in the matrix of pebble layers, and for highly mature quartz-pebble beds. These features appear to characterize uraniferous Precambrian conglomerates of the Elliot Lake district in Ontario and of the Witwatersrand in South Africa (Roscoe, 1973; Robertson, 1974).

Our search for these features yielded uniformly negative results. The quartzite and conglomerate are everywhere low in radioactivity, and analyses reveal low contents of both thorium and uranium. No pyrite or limonite pseudomorphs of pyrite were found in the conglomerates, and quartz-pebble layers were not encountered (pebbles are mainly of quartzite, rather than of quartz).

Other members of the Horse Canyon Formation contain beds of quartzite, as also does the Goshute Canyon Formation, but no quartz-pebble conglomerates were found, and no anomalous radio-activity or concentrations of pyrite were found in these quartzites. Conglomeratic layers encountered in these other units appeared to be intraformational mud-pebble conglomerates (Goshute Canyon Formation) or were polymictic paraconglomerates (Horse Canyon Formation, member B).

A widely accepted theory on the origin of Precambrian quartz-pebble-conglomerate uranium deposits holds that these deposits formed before the Earth's atmosphere became strongly oxidizing, an event which supposedly occurred approximately 2200 m.y. ago (Roscoe, 1973; Robertson, 1974). Although the precise ages of metamorphic rocks in the Deep Creek Mountains are uncertain, all previous workers on the stratigraphy of this area have assigned these rocks a much younger age, and we have no basis for disputing their assignments. Thus, on the basis of sedimentologic and lithologic characteristics we observed, and of ages assigned by others, these rocks appear to have a very low favorability for uranium deposits of the Elliot Lake type. These rocks will not be discussed further.

Rock Geochemistry

We collected and analyzed 208 samples of bedrock and 8 samples of unconsolidated sand and alluvium. Most of these samples were taken as representing larger areas of exposed rock that, in the field, did not appear altered or mineralized. Other samples were collected specifically to test the geochemistry of veins or altered zones. Locations of sample sites are shown on Plate 1.

Data for 30 elements are reported in table 1. In addition, B, Ce,and Sn were found in many samples and the following is a summary of results:

	B	Ce	Sn
Detection limit (ppm)	10	100	10
Number exceeding limit	34	47	23
Maximum value (ppm)	240	470	140
Sample number, max	MBQ628	MBQ326	MBQ635
Median (ppm)	54	140	22
Mean (ppm)	60	152	29
Standard deviation (ppm)	59	73	27

Other elements that were detected in at least one sample are as follows:

Element	Limit of determination (ppm)	Sample nos.	Content (ppm)
Bi	10	MBQ-553	150
		MBQ-653	1500
		MBQ-676	300
Cd	2.0	MBQ-676	1000
Nb	25	MBQ-326	45
		MBQ-651	77
		MBQ-671	47
		MBQ672	40
		MBQ-674	29
Sb	100	MBQ-667	110
Se	200	MBQ-670	210
Tl	10	MBQ-657	14
		MBQ-662	12
W	100	MBQ-609	110
		MBQ-635	990
		MBQ-674	300
Elements not detected			
As	200		
Au	10 (see atomic absorption results below)		
HG	500		
Re	50		
Te	50		

The following samples were analyzed by atomic absorption for gold and none contained more than 0.05 ppm Au, the determination limit: MBQ-569, 584, 598, 617, 618, 622, 624, 678, 679, 681, 682, 683, 684, 686, 687, 688, 737, 738, 756, and 758.

When interpreting geochemical data such as those in table 1, it is important to consider concentration levels with reference to particular rock types (Levinson, 1974). Radioactivity is normally much higher over granite than over quartzite or phyllite. Variation in uranium and thorium content with rock type is also evident from the chemical analyses (table 1) and from the summary statistics of table 2.

Table 1.--Chemical analyses of rock and sediment samples, Central Deep Creek Mountains, Utah

[L, less than value shown; G, greater than value shown. Direct reading semi-quantitative emission spectrographic analyses by J. G. Crock, Adolph Haubert, B. M. Laughrey, M J. Malcolm, M. L. Retzloff, and J. L. Seeley. Neutron activation analyses for Th and U by M. F. Coughlin, M. W. Solt, R. B. Vaughn, and H. T. Millard, Jr. Th and U analyses reliable to 2 places, other analyses reliable to 1 or 2 places; other zeros generated by computer are not significant]

Tertiary Ibapah Stock and Related Igneous Rocks

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ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
1	MBQ317	33.0000	7.6000	0.7000	0.4600	0.8200	6.2000	2.8000	0.1700	0.0800	360.0000
2	MBQ318	40.0000G	2.8000	0.3400	0.1000L	0.5300	1.2000	1.2000	0.0500	0.0700	220.0000
3	MBQ319	34.0000	9.2000	1.3000	0.9100	1.2000	6.2000	3.5000	0.2800	0.0900	610.0000
4	MBQ320	40.0000G	4.2000	0.3600	0.1100	0.0700	2.5000	3.1000	0.0500	0.0700	200.0000L
5	MBQ321	33.0000	5.7000	0.0500L	0.1000L	0.1900	4.1000	4.2000	0.0700	0.0600	200.0000L
6	MBQ322	36.0000	8.8000	5.9000	1.8000	1.7000	4.3000	4.4000	0.8000	0.1600	1200.0000
7	MBQ323	36.0000	7.3000	0.8000	0.2700	0.7500	6.5000G	5.0000G	0.1200	0.0600	410.0000
8	MBQ324	37.0000	7.5000	0.9200	0.3500	1.1000	5.6000	5.0000G	0.1300	0.0700	330.0000
9	MBQ326	31.0000	9.3000	5.0000	1.5000	0.2800	3.2000	5.0000G	0.8900	0.1000	2800.0000
10	MBQ327	35.0000	7.3000	1.2000	0.3000	1.1000	5.1000	5.0000G	0.1700	0.0600	350.0000
11	MBQ552	37.0000	8.6000	1.1000	0.3100	0.9300	2.9000	4.2000	0.1200	0.0700	440.0000
12	MBQ553	40.0000G	1.3000	2.2000	0.1000L	0.0500L	0.1500L	0.4100	0.0300L	0.0300	200.0000L
13	MBQ554	33.0000	6.2000	0.6200	0.1200	1.4000	2.3000	2.9000	0.0900	0.0500	240.0000
14	MBQ555	40.0000	8.0000	0.9200	0.2700	0.7600	2.9000	3.8000	0.1100	0.0600	350.0000
15	MBQ559	33.0000	8.4000	2.7000	0.7700	1.6000	2.5000	2.7000	0.2900	0.0900	510.0000
16	MBQ561	37.0000	7.2000	0.3600	0.1400	0.7200	3.3000	4.9000	0.0700	0.0600	200.0000L
17	MBQ564	36.0000	8.6000	1.9000	0.7800	1.7000	2.9000	3.9000	0.2400	0.0800	460.0000
18	MBQ565	35.0000	7.1000	1.9000	0.6500	1.5000	2.2000	3.2000	0.2200	0.0700	430.0000
19	MBQ566	33.0000	6.8000	2.1000	0.6600	1.6000	2.5000	3.0000	0.2800	0.0600	470.0000
20	MBQ567	34.0000	6.5000	0.4000	0.1000L	0.3700	2.5000	3.5000	0.0700	0.0500	200.0000
21	MBQ568	34.0000	8.3000	0.9700	0.2800	1.0000	2.7000	4.0000	0.1300	0.0600	360.0000
22	MBQ570	38.0000	7.7000	1.1000	0.3400	0.7900	3.3000	3.7000	0.1500	0.0600	370.0000
23	MBQ575	39.0000	8.4000	0.8900	0.2500	0.8600	3.0000	4.1000	0.1100	0.0700	370.0000
24	MBQ576	36.0000	7.3000	1.4000	0.3500	1.1000	2.5000	3.6000	0.1600	0.0600	430.0000
25	MBQ577	35.0000	7.0000	1.3000	0.3700	0.1700	1.2000	5.0000G	0.1500	0.0600	610.0000
26	MBQ578	37.0000	8.6000	1.3000	0.3800	1.2000	2.8000	3.8000	0.1800	0.0700	420.0000
27	MBQ579	28.0000	9.6000	5.0000	1.7000	3.9000	2.9000	2.5000	0.6300	0.1200	830.0000
28	MBQ580	40.0000G	6.9000	0.7200	0.1600	0.6500	3.3000	4.2000	0.1000	0.0500	400.0000
29	MBQ582	37.0000	7.9000	0.5700	0.1400	0.6200	3.0000	4.4000	0.0600	0.0700	280.0000
30	MBQ583	32.0000	7.9000	1.2000	0.2800	1.1000	2.4000	3.2000	0.1500	0.0600	310.0000
31	MBQ584	32.0000	9.2000	4.0000	1.4000	2.5000	2.8000	1.7000	0.3500	0.1000	950.0000
32	MBQ585	34.0000	8.2000	0.6100	0.1900	0.7900	2.5000	4.1000	0.0900	0.0600	260.0000
33	MBQ587	33.0000	7.0000	1.1000	0.3400	1.1000	2.3000	2.7000	0.1600	0.0500	320.0000
34	MBQ594	38.0000	7.5000	0.8600	0.2700	0.7300	5.2000	5.0000G	0.1300	0.0700	390.0000
35	MBQ595	38.0000	7.2000	1.0000	0.3000	0.8400	5.9000	5.0000G	0.1500	0.0700	430.0000
36	MBQ596	40.0000G	7.2000	1.8000	0.4700	0.8800	5.5000	5.0000G	0.2200	0.0700	600.0000
37	MBQ597	38.0000	7.1000	1.1000	0.3800	0.7400	5.1000	4.9000	0.1400	0.0800	360.0000
38	MBQ598	40.0000G	7.6000	1.4000	0.4800	0.7600	6.5000G	5.0000G	0.2000	0.0700	460.0000
39	MBQ599	39.0000	7.6000	2.0000	0.5900	0.7700	5.9000	5.0000G	0.2200	0.0800	700.0000
40	MBQ600	40.0000G	7.6000	1.5000	0.4900	0.8800	6.0000	5.0000G	0.1600	0.0700	510.0000
41	MBQ601	36.0000	6.7000	0.5700	0.1400	0.4700	5.0000	5.0000G	0.0800	0.0700	430.0000
42	MBQ602	36.0000	7.3000	1.1000	0.2800	0.6400	6.0000	5.0000G	0.1300	0.0800	500.0000
43	MBQ603	39.0000	6.9000	1.1000	0.2900	0.7400	6.5000G	5.0000G	0.1100	0.0700	500.0000
44	MBQ604	37.0000	7.9000	1.4000	0.4300	0.9500	6.5000G	5.0000G	0.1600	0.0800	550.0000
45	MBQ605	34.0000	5.7000	0.1900	0.1000L	0.1900	4.3000	4.6000	0.0600	0.0400	200.0000L
46	MBQ606	39.0000	6.6000	0.2900	0.1000L	0.3400	6.1000	5.0000G	0.0600	0.1000	270.0000
47	MBQ607	39.0000	10.0000	1.1000	0.1900	0.0900	6.5000G	1.4000	0.1300	0.0800	200.0000L
48	MBQ608	37.0000	7.6000	1.3000	0.3300	0.9400	5.0000	5.0000G	0.1600	0.0700	460.0000
49	MBQ609	39.0000	8.2000	1.8000	0.6300	1.2000	6.5000G	5.0000G	0.2200	0.0900	530.0000
50	MBQ610	38.0000	7.9000	2.3000	0.7200	1.3000	4.7000	4.9000	0.2300	0.0700	570.0000

Tertiary Igneous Rocks, cont.

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ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
1	MBQ317	1.0000L	530.0000	6.8000	4.2000	15.0000	2.7000	18.0000	57.0000	57.0000	10.0000L
2	MBQ318	1.0000L	190.0000	2.6000	1.0000L	10.0000L	2.3000	13.0000	20.0000L	50.0000L	10.0000L
3	MBQ319	1.0000L	800.0000	5.8000	7.3000	19.0000	3.5000	22.0000	71.0000	50.0000L	10.0000L
4	MBQ320	1.0000L	320.0000	2.8000	2.7000	10.0000L	8.7000	20.0000	26.0000	50.0000L	10.0000L
5	MBQ321	1.0000L	520.0000	2.9000	1.0000L	10.0000L	2.3000	13.0000	53.0000	50.0000L	10.0000L
6	MBQ322	1.0000L	920.0000	5.5000	17.0000	59.0000	24.0000	28.0000	140.0000	91.0000	10.0000L
7	MBQ323	1.0000L	810.0000	5.0000	2.4000	10.0000L	2.6000	27.0000	39.0000	320.0000	10.0000L
8	MBQ324	1.0000L	1400.0000	3.5000	3.4000	12.0000	2.6000	23.0000	46.0000	130.0000	10.0000L
9	MBQ326	1.0000L	480.0000	7.7000	21.0000	83.0000	5.7000	73.0000	290.0000	1100.0000	10.0000L
10	MBQ327	1.0000L	1100.0000	3.1000	2.6000	14.0000	79.0000	20.0000	58.0000	50.0000L	10.0000L
11	MBQ552	1.0000L	610.0000	5.2000	2.4000	10.0000L	3.6000	26.0000	37.0000	170.0000	10.0000L
12	MBQ553	1.0000L	84.0000	18.0000	1.0000L	10.0000L	12.0000	10.0000L	20.0000L	50.0000L	36.0000
13	MBQ554	1.0000L	960.0000	3.5000	1.0000L	10.0000L	2.5000	12.0000	31.0000	50.0000L	10.0000L
14	MBQ555	1.0000L	500.0000	4.9000	1.0000L	10.0000L	2.7000	21.0000	32.0000	50.0000L	10.0000L
15	MBQ559	1.0000L	990.0000	4.3000	5.3000	22.0000	5.4000	22.0000	75.0000	50.0000L	10.0000L
16	MBQ561	1.0000L	680.0000	5.1000	1.0000L	10.0000L	1.9000	21.0000	25.0000	50.0000L	10.0000L
17	MBQ564	1.0000L	860.0000	5.6000	5.1000	38.0000	4.5000	22.0000	61.0000	61.0000	10.0000L
18	MBQ565	1.0000L	740.0000	5.8000	1.2000	22.0000	8.3000	19.0000	47.0000	50.0000L	10.0000L
19	MBQ566	1.0000L	860.0000	3.1000	4.4000	17.0000	6.2000	19.0000	97.0000	50.0000L	10.0000L
20	MBQ567	1.0000L	700.0000	3.0000	1.0000L	10.0000L	1.9000	14.0000	21.0000	50.0000L	10.0000L
21	MBQ568	1.0000L	830.0000	6.1000	1.0000L	10.0000L	3.5000	20.0000	36.0000	67.0000	10.0000L
22	MBQ570	1.0000L	630.0000	4.7000	1.2000	11.0000	55.0000	15.0000	45.0000	50.0000L	10.0000L
23	MBQ575	1.0000L	650.0000	5.1000	1.0000L	10.0000L	61.0000	21.0000	40.0000	81.0000	10.0000L
24	MBQ576	1.0000L	720.0000	4.6000	1.6000	11.0000	98.0000	18.0000	51.0000	54.0000	10.0000L
25	MBQ577	1.0000L	910.0000	1.9000	1.3000	12.0000	6.3000	12.0000	47.0000	50.0000L	10.0000L
26	MBQ578	1.0000L	920.0000	6.9000	1.9000	12.0000	6.2000	21.0000	76.0000	50.0000L	10.0000L
27	MBQ579	1.0000L	1300.0000	2.4000	17.0000	20.0000	21.0000	24.0000	83.0000	50.0000L	10.0000L
28	MBQ580	1.0000L	360.0000	3.1000	1.0000L	10.0000L	2.0000	15.0000	43.0000	50.0000L	10.0000L
29	MBQ582	1.0000L	550.0000	6.6000	1.0000L	10.0000L	9.6000	24.0000	20.0000L	94.0000	10.0000L
30	MBQ583	1.0000L	950.0000	5.8000	1.0000L	10.0000L	2.5000	17.0000	38.0000	54.0000	10.0000L
31	MBQ584	1.0000L	1000.0000	13.0000	12.0000	46.0000	5.8000	28.0000	71.0000	300.0000	10.0000L
32	MBQ585	1.0000L	840.0000	3.9000	1.0000L	10.0000L	2.1000	20.0000	25.0000	65.0000	10.0000L
33	MBQ587	1.0000L	720.0000	2.8000	1.0000L	11.0000	2.0000	18.0000	65.0000	50.0000L	10.0000L
34	MBQ594	1.0000L	750.0000	4.3000	2.0000	10.0000L	3.2000	26.0000	44.0000	140.0000	10.0000L
35	MBQ595	1.0000L	680.0000	4.2000	1.4000	10.0000L	2.5000	25.0000	43.0000	200.0000	10.0000L
36	MBQ596	1.0000L	850.0000	5.4000	4.5000	13.0000	5.0000	28.0000	46.0000	220.0000	10.0000L
37	MBQ597	1.0000L	870.0000	4.4000	3.6000	13.0000	3.1000	23.0000	29.0000	55.0000	10.0000L
38	MBQ598	1.0000L	900.0000	5.6000	4.6000	12.0000	3.5000	24.0000	31.0000	57.0000	10.0000L
39	MBQ599	1.0000L	1000.0000	4.9000	5.4000	13.0000	3.6000	30.0000	36.0000	430.0000	10.0000L
40	MBQ600	1.0000L	1000.0000	5.3000	4.4000	13.0000	3.9000	26.0000	25.0000	240.0000	10.0000L
41	MBQ601	1.0000L	520.0000	4.9000	1.0000L	10.0000L	2.1000	28.0000	20.0000L	190.0000	10.0000L
42	MBQ602	1.0000L	530.0000	19.0000	1.6000	10.0000L	2.1000	31.0000	40.0000	410.0000	10.0000L
43	MBQ603	1.0000L	550.0000	6.0000	2.4000	10.0000L	3.2000	28.0000	45.0000	330.0000	10.0000L
44	MBQ604	1.0000L	880.0000	4.4000	3.3000	12.0000	3.4000	31.0000	45.0000	260.0000	10.0000L
45	MBQ605	1.0000L	680.0000	3.5000	1.0000L	10.0000L	1.9000	18.0000	20.0000L	50.0000L	10.0000L
46	MBQ606	1.0000L	230.0000	5.2000	1.0000L	10.0000L	2.3000	36.0000	20.0000L	200.0000	10.0000L
47	MBQ607	1.0000L	120.0000	4.1000	1.0000L	12.0000	2.0000	29.0000	38.0000	50.0000L	10.0000L
48	MBQ608	1.0000L	870.0000	5.1000	1.9000	12.0000	2.9000	27.0000	48.0000	250.0000	10.0000L
49	MBQ609	1.0000L	1000.0000	5.5000	5.6000	16.0000	62.0000	25.0000	49.0000	76.0000	10.0000L
50	MBQ610	1.0000L	930.0000	5.3000	5.2000	16.0000	2.6000	23.0000	110.0000	71.0000	10.0000L

Tertiary Igneous Rocks, cont.

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ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
1	MBQ317	9.0000	10.0000L	10.0000L	310.0000	42.0000	21.0000	50.0000L	10.0000L	32.1000	5.9200
2	MBQ318	5.8000	50.0000	10.0000L	150.0000	42.0000	10.0000L	50.0000L	10.0000L	8.3600	2.3700
3	MBQ319	13.0000	10.0000L	10.0000L	380.0000	41.0000	27.0000	50.0000L	10.0000L	32.7000	6.2900
4	MBQ320	4.7000	30.0000	10.0000L	81.0000	13.0000	10.0000L	50.0000L	10.0000L	17.1000	2.6300
5	MBQ321	3.5000	10.0000L	10.0000L	160.0000	16.0000	10.0000L	50.0000L	10.0000L	27.4000	2.9300
6	MBQ322	39.0000	10.0000L	15.0000	380.0000	120.0000	57.0000	84.0000	490.0000	26.1000	5.2600
7	MBQ323	5.2000	44.0000	10.0000L	210.0000	26.0000	34.0000	50.0000L	10.0000L	5.2000L	16.2000
8	MBQ324	7.6000	29.0000	10.0000L	320.0000	30.0000	15.0000	50.0000L	11.0000	19.9000	3.6900
9	MBQ326	42.0000	10.0000L	34.0000	120.0000	150.0000	140.0000	210.0000	340.0000	189.0000	32.4000
10	MBQ327	7.4000	34.0000	10.0000L	270.0000	35.0000	12.0000	50.0000L	80.0000	28.0000	5.0400
11	MBQ552	3.9000	23.0000	10.0000L	190.0000	16.0000	34.0000	50.0000L	26.0000	29.1000	5.9600
12	MBQ553	1.6000	10.0000L	10.0000L	10.0000L	10.0000L	10.0000L	50.0000L	20.0000L	3.6000L	7.5300
13	MBQ554	3.8000	27.0000	10.0000L	220.0000	10.0000L	16.0000	50.0000L	26.0000	22.2000	4.6500
14	MBQ555	3.9000	37.0000	10.0000L	210.0000	12.0000	27.0000	50.0000L	64.0000	24.1000	8.7400
15	MBQ559	9.7000	10.0000L	10.0000L	370.0000	56.0000	22.0000	50.0000	83.0000	24.9000	3.8500
16	MBQ561	1.8000	54.0000	10.0000L	210.0000	10.0000L	20.0000	50.0000L	20.0000L	20.3000	4.3600
17	MBQ564	18.0000	26.0000	10.0000L	360.0000	41.0000	29.0000	50.0000L	46.0000	21.8000	4.5500
18	MBQ565	9.8000	25.0000	10.0000L	350.0000	40.0000	24.0000	50.0000L	51.0000	17.3000	12.7000
19	MBQ566	9.3000	10.0000L	10.0000L	290.0000	46.0000	30.0000	52.0000	53.0000	28.0000	3.4200
20	MBQ567	1.9000	19.0000	10.0000L	140.0000	10.0000L	18.0000	50.0000L	20.0000L	15.7000	3.3700
21	MBQ568	3.8000	29.0000	10.0000L	230.0000	16.0000	23.0000	50.0000L	37.0000	28.6000	4.6900
22	MBQ570	4.6000	28.0000	10.0000L	190.0000	18.0000	21.0000	83.0000	35.0000	27.2000	6.2900
23	MBQ575	3.7000	29.0000	10.0000L	200.0000	16.0000	29.0000	50.0000L	20.0000L	17.8000	16.3000
24	MBQ576	5.4000	39.0000	10.0000L	220.0000	25.0000	24.0000	150.0000	48.0000	36.1000	10.9000
25	MBQ577	6.3000	120.0000	10.0000L	360.0000	19.0000	20.0000	110.0000	20.0000L	37.6000	9.7500
26	MBQ578	6.3000	15.0000	10.0000L	300.0000	29.0000	23.0000	50.0000L	76.0000	35.6000	9.7500
27	MBQ579	20.0000	10.0000L	15.0000	700.0000	150.0000	28.0000	97.0000	310.0000	18.7000	3.6400
28	MBQ580	2.9000	30.0000	10.0000L	83.0000	10.0000L	10.0000L	50.0000L	20.0000L	43.8000	6.5700
29	MBQ582	2.3000	35.0000	10.0000L	170.0000	10.0000L	19.0000	50.0000L	20.0000L	12.9000	8.0100
30	MBQ583	2.4000	22.0000	10.0000L	300.0000	16.0000	16.0000	50.0000L	33.0000	20.9000	2.6400
31	MBQ584	28.0000	10.0000L	11.0000	490.0000	80.0000	20.0000	90.0000	72.0000	20.4000	5.4900
32	MBQ585	2.5000	39.0000	10.0000L	210.0000	10.0000L	24.0000	50.0000L	20.0000L	19.5000	3.5900
33	MBQ587	5.0000	13.0000	10.0000L	230.0000	32.0000	21.0000	50.0000L	77.0000	30.9000	7.3200
34	MBQ594	5.7000	34.0000	10.0000L	200.0000	23.0000	28.0000	50.0000L	10.0000L	9.6000L	44.8000
35	MBQ595	5.0000	32.0000	10.0000L	190.0000	20.0000	33.0000	50.0000L	10.0000L	32.6000	10.6000
36	MBQ596	8.4000	25.0000	10.0000L	190.0000	39.0000	22.0000	50.0000L	22.0000	23.1000	8.5300
37	MBQ597	7.7000	25.0000	10.0000L	240.0000	34.0000	20.0000	50.0000L	58.0000	24.4000	4.4000
38	MBQ598	8.0000	36.0000	10.0000L	260.0000	35.0000	16.0000	50.0000L	10.0000L	26.2000	4.9000
39	MBQ599	9.4000	24.0000	11.0000	230.0000	40.0000	26.0000	55.0000	42.0000	37.6000	4.0300
40	MBQ600	8.4000	35.0000	10.0000L	230.0000	37.0000	16.0000	50.0000L	10.0000L	30.6000	7.6200
41	MBQ601	2.7000	22.0000	10.0000L	150.0000	12.0000	19.0000	50.0000L	10.0000L	16.7000	3.5500
42	MBQ602	4.6000	18.0000	10.0000L	160.0000	18.0000	28.0000	50.0000L	10.0000L	24.6000	11.5000
43	MBQ603	5.4000	29.0000	10.0000L	180.0000	25.0000	21.0000	50.0000L	11.0000	6.5000L	23.6000
44	MBQ604	6.9000	28.0000	10.0000L	220.0000	31.0000	22.0000	50.0000L	10.0000L	30.6000	3.7800
45	MBQ605	2.6000	18.0000	10.0000L	180.0000	10.0000L	12.0000	50.0000L	10.0000L	19.1000	2.2600
46	MBQ606	3.5000	18.0000	10.0000L	76.0000	13.0000	15.0000	50.0000L	10.0000L	8.6800	6.3500
47	MBQ607	3.6000	12.0000	10.0000L	210.0000	16.0000	18.0000	50.0000L	24.0000	42.1000	13.1000
48	MBQ608	5.8000	48.0000	10.0000L	240.0000	29.0000	21.0000	50.0000L	10.0000L	28.5000	9.5000
49	MBQ609	10.0000	26.0000	10.0000L	370.0000	44.0000	26.0000	70.0000	76.0000	32.8000	5.7100
50	MBQ610	10.0000	16.0000	10.0000L	280.0000	47.0000	21.0000	50.0000L	57.0000	27.8000	9.0700

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ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
51	MBQ612	35.0000	7.6000	3.1000	0.8900	0.9000	3.7000	5.0000G	0.3000	0.1000	740.0000
52	MBQ613	38.0000	8.8000	2.8000	1.4000	1.9000	5.6000	5.0000G	0.3100	0.1000	560.0000
53	MBQ614	40.0000G	8.1000	1.2000	0.3600	0.7600	3.4000	5.0000G	0.1700	0.0700	310.0000
54	MBQ615	38.0000	6.9000	0.8500	0.2700	0.6800	4.4000	5.0000G	0.1300	0.0600	330.0000
55	MBQ616	40.0000G	6.8000	0.2000	0.1000L	0.3900	6.5000G	5.0000G	0.0400	0.0700	200.0000
56	MBQ617	38.0000	7.2000	0.5400	0.1500	0.5600	6.1000	5.0000G	0.0800	0.0700	200.0000
57	MBQ618	40.0000G	7.0000	1.0000	0.3000	1.2000	5.0000	4.2000	0.1500	0.0600	330.0000
58	MBQ619	37.0000	6.8000	0.6900	0.2300	0.6700	4.5000	5.0000G	0.1100	0.0500	240.0000
59	MBQ621	40.0000G	8.3000	0.9000	0.3400	0.9000	5.2000	5.0000G	0.1600	0.0700	310.0000
60	MBQ622	38.0000	7.7000	1.5000	0.3800	1.1000	5.5000	4.5000	0.1800	0.0800	450.0000
61	MBQ623	39.0000	7.4000	1.3000	0.3300	0.8800	2.7000	5.0000G	0.1600	0.0800	360.0000
62	MBQ676	35.0000	7.5000	1.2000	0.3800	1.1000	3.3000	4.7000	0.1400	0.0600	430.0000
63	MBQ677	34.0000	7.7000	1.7000	0.5400	1.4000	2.6000	3.6000	0.2000	0.0600	440.0000
64	MBQ678	36.0000	7.0000	0.6900	0.1700	0.6800	4.2000	4.7000	0.0900	0.0600	220.0000
65	MBQ679	27.0000	10.0000	1.9000	0.6200	1.9000	5.5000	4.8000	0.2700	0.0700	540.0000
66	MBQ680	34.0000	7.1000	1.9000	0.5600	1.4000	3.0000	4.1000	0.1900	0.0700	440.0000
67	MBQ683	33.0000	7.5000	1.4000	0.4600	1.4000	2.5000	3.9000	0.2000	0.0500	360.0000
68	MBQ685	32.0000	8.2000	1.6000	0.5300	1.6000	3.2000	4.4000	0.2100	0.0700	360.0000
69	MBQ686	34.0000	6.9000	0.6800	0.2300	1.1000	3.6000	2.3000	0.1000	0.0500	280.0000
70	MBQ689	37.0000	8.4000	1.7000	0.1800	0.1200	1.8000	4.9000	0.0700	0.0700	200.0000
71	MBQ691	35.0000	7.2000	0.4900	0.1400	0.1200	3.2000	3.9000	0.0800	0.0500	500.0000
72	MBQ692	34.0000	7.3000	1.4000	0.3500	0.8700	3.0000	3.2000	0.1400	0.0600	460.0000
73	MBQ694	38.0000	7.7000	1.0000	0.2900	0.1000	0.1500L	4.0000	0.1200	0.0700	1200.0000
74	MBQ695	37.0000	6.8000	0.3100	0.1000L	0.4400	4.1000	5.0000G	0.0500	0.0500	270.0000
75	MBQ696	38.0000	7.1000	0.9200	0.2400	0.7700	3.2000	4.6000	0.1100	0.0600	370.0000
76	MBQ697	33.0000	6.6000	0.7200	0.2000	0.7800	3.0000	4.1000	0.0900	0.0600	330.0000
77	MBQ698	37.0000	8.1000	1.1000	0.3300	0.9400	5.9000	3.8000	0.1300	0.0900	450.0000
78	MBQ697	39.0000	6.9000	0.7600	0.2100	0.6500	2.7000	4.3000	0.1100	0.0500	370.0000
79	MBQ700	37.0000	7.1000	1.1000	0.2600	0.5000	2.5000	4.2000	0.1200	0.0600	380.0000
80	MBQ702	36.0000	6.9000	0.1600	0.1000L	0.4300	1.8000	3.1000	0.0300	0.0500	290.0000
81	MBQ703	37.0000	6.5000	1.1000	0.2500	0.4700	2.9000	5.0000G	0.1200	0.0600	320.0000
82	MBQ704	37.0000	8.6000	1.6000	0.3900	1.1000	3.6000	5.0000G	0.1700	0.0700	430.0000
83	MBQ706	36.0000	7.3000	2.1000	0.4200	1.4000	2.3000	3.4000	0.1900	0.0700	560.0000
84	MBQ707	34.0000	7.8000	2.1000	0.4400	2.3000	3.2000	4.0000	0.2100	0.0800	540.0000
85	MBQ708	33.0000	8.8000	3.0000	1.1000	2.3000	3.3000	3.3000	0.3000	0.0800	750.0000
86	MBQ709	35.0000	7.8000	1.5000	0.4200	0.8900	3.0000	5.0000G	0.1500	0.0800	370.0000
87	MBQ711	35.0000	9.4000	3.9000	1.2000	2.2000	4.9000	2.2000	0.3800	0.1200	930.0000
88	MBQ713	36.0000	8.0000	1.2000	0.3600	1.2000	3.7000	4.8000	0.1300	0.0700	390.0000
89	MBQ714	39.0000	7.0000	1.9000	0.4800	1.7000	2.9000	2.2000	0.2000	0.0700	430.0000
90	MBQ716	36.0000	8.5000	1.9000	0.5300	1.5000	3.1000	3.9000	0.2300	0.0800	430.0000
91	MBQ717	40.0000G	7.8000	2.3000	0.6700	1.8000	4.0000	3.9000	0.2300	0.0900	500.0000
92	MBQ718	36.0000	8.4000	2.0000	0.5800	1.7000	3.3000	4.7000	0.2700	0.0900	460.0000
93	MBQ719	35.0000	8.1000	1.7000	0.4900	1.3000	3.1000	3.4000	0.2100	0.0800	420.0000
94	MBQ721	33.0000	7.1000	0.6300	0.1900	0.2700	2.8000	4.3000	0.1000	0.0400	250.0000
95	MBQ722	40.0000G	1.1000	0.0500L	0.1000L	0.0600	0.1500L	0.4900	0.0300L	0.0400	200.0000
96	MBQ723	39.0000	4.8000	0.7000	0.2400	0.1400	0.1500L	2.5000	0.0700	0.0400	350.0000
97	MBQ724	33.0000	7.2000	0.3700	0.1300	0.2200	2.8000	5.0000G	0.0700	0.0400	200.0000
98	MBQ726	35.0000	7.7000	0.7800	0.2400	0.6600	2.9000	4.6000	0.1200	0.0500	330.0000
99	MBQ727	33.0000	7.1000	1.3000	0.3800	0.8300	2.5000	4.1000	0.1800	0.0500	390.0000
100	MBQ728	34.0000	8.3000	1.1000	0.4600	0.8100	2.9000	4.3000	0.1500	0.0600	500.0000

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ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
51	MBQ612	1.0000L	1400.0000	5.3000	7.6000	21.0000	4.6000	27.0000	68.0000	190.0000	10.0000L
52	MBQ613	1.0000L	1300.0000	5.2000	11.0000	69.0000	6.9000	26.0000	25.0000	130.0000	10.0000L
53	MBQ614	1.0000L	920.0000	6.0000	2.3000	11.0000	2.7000	24.0000	48.0000	130.0000	10.0000L
54	MBQ615	1.0000L	800.0000	5.0000	1.9000	10.0000L	2.4000	25.0000	22.0000	56.0000	10.0000L
55	MBQ616	1.0000L	74.0000	6.7000	1.0000L	10.0000L	3.0000	33.0000	20.0000L	50.0000L	10.0000L
56	MBQ617	1.0000L	790.0000	4.5000	1.0000L	10.0000L	3.1000	28.0000	51.0000	70.0000	10.0000L
57	MBQ618	1.0000L	790.0000	4.3000	2.1000	11.0000	3.2000	18.0000	59.0000	50.0000L	10.0000L
58	MBQ619	1.0000L	1500.0000	3.1000	1.7000	10.0000L	2.7000	20.0000	20.0000L	50.0000L	10.0000L
59	MBQ621	1.0000L	1700.0000	3.8000	2.8000	11.0000	2.8000	23.0000	33.0000	50.0000L	10.0000L
60	MBQ622	1.0000L	760.0000	5.7000	2.4000	12.0000	3.2000	21.0000	81.0000	50.0000L	10.0000L
61	MBQ623	1.0000L	850.0000	4.2000	2.6000	11.0000	4.9000	27.0000	86.0000	50.0000L	10.0000L
62	MBQ676	1.0000L	960.0000	4.1000	3.1000	13.0000	4.0000	21.0000	78.0000	57.0000	10.0000L
63	MBQ677	1.0000L	900.0000	4.1000	3.8000	15.0000	3.4000	18.0000	54.0000	50.0000L	10.0000L
64	MBQ678	1.0000L	970.0000	4.8000	1.0000L	10.0000L	2.1000	24.0000	67.0000	60.0000	10.0000L
65	MBQ679	1.0000L	1300.0000	3.0000	3.3000	17.0000	2.4000	24.0000	86.0000	50.0000L	10.0000L
66	MBQ680	1.0000L	1100.0000	3.5000	4.7000	18.0000	6.6000	19.0000	83.0000	50.0000L	10.0000L
67	MBQ683	1.0000L	1100.0000	3.2000	2.3000	14.0000	3.0000	16.0000	110.0000	50.0000L	10.0000L
68	MBQ685	1.0000L	1300.0000	3.2000	3.4000	16.0000	4.1000	19.0000	78.0000	50.0000L	10.0000L
69	MBQ686	1.0000L	530.0000	4.5000	1.0000L	10.0000L	13.0000	16.0000	35.0000	50.0000L	10.0000L
70	MBQ689	1.0000L	600.0000	6.6000	1.0000L	10.0000L	2.5000	31.0000	27.0000	50.0000L	10.0000L
71	MBQ691	1.0000L	500.0000	6.2000	1.0000L	10.0000L	5.0000	22.0000	21.0000	50.0000L	10.0000L
72	MBQ692	1.0000L	490.0000	5.3000	1.8000	11.0000	2.9000	22.0000	31.0000	57.0000	10.0000L
73	MBQ694	1.0000L	370.0000	7.6000	1.0000L	10.0000L	28.0000	23.0000	57.0000	50.0000L	10.0000L
74	MBQ695	1.0000L	110.0000	2.7000	1.0000L	10.0000L	1.8000	21.0000	20.0000L	50.0000L	10.0000L
75	MBQ696	1.0000L	770.0000	5.9000	1.0000L	10.0000L	3.1000	23.0000	34.0000	50.0000L	10.0000L
76	MBQ697	1.0000L	650.0000	4.7000	1.0000L	10.0000L	2.7000	20.0000	27.0000	50.0000L	10.0000L
77	MBQ698	1.0000L	450.0000	11.0000	1.7000	11.0000	26.0000	28.0000	20.0000L	50.0000L	10.0000L
78	MBQ697	1.0000L	1100.0000	2.7000	1.0000L	10.0000L	12.0000	15.0000	63.0000	50.0000L	10.0000L
79	MBQ700	1.0000L	1100.0000	2.5000	1.0000L	10.0000L	12.0000	15.0000	77.0000	50.0000L	10.0000L
80	MBQ702	1.0000L	170.0000	6.5000	1.0000L	10.0000L	3.3000	23.0000	20.0000L	50.0000L	10.0000L
81	MBQ703	1.0000L	1100.0000	3.2000	1.2000	10.0000L	4.4000	17.0000	73.0000	50.0000L	10.0000L
82	MBQ704	1.0000L	1400.0000	3.9000	1.9000	17.0000	2.4000	21.0000	60.0000	50.0000L	10.0000L
83	MBQ706	1.0000L	2100.0000	5.7000	6.2000	15.0000	8.2000	15.0000	60.0000	50.0000L	10.0000L
84	MBQ707	1.0000L	1000.0000	3.8000	4.2000	16.0000	3.6000	27.0000	100.0000	50.0000L	10.0000L
85	MBQ708	1.0000L	790.0000	4.6000	7.4000	25.0000	3.8000	26.0000	56.0000	65.0000	10.0000L
86	MBQ709	1.0000L	1800.0000	3.0000	2.7000	14.0000	4.5000	19.0000	35.0000	50.0000L	10.0000L
87	MBQ711	1.0000L	350.0000	5.8000	11.0000	39.0000	3.7000	32.0000	63.0000	220.0000	10.0000L
88	MBQ713	1.0000L	1100.0000	3.7000	2.3000	12.0000	2.8000	24.0000	45.0000	50.0000L	10.0000L
89	MBQ714	1.0000L	500.0000	4.3000	3.9000	16.0000	3.7000	21.0000	68.0000	50.0000L	10.0000L
90	MBQ716	1.0000L	1200.0000	3.9000	3.7000	15.0000	4.2000	20.0000	63.0000	50.0000L	10.0000L
91	MBQ717	1.0000L	990.0000	4.1000	6.2000	16.0000	9.5000	25.0000	120.0000	50.0000L	10.0000L
92	MBQ718	1.0000L	1400.0000	3.4000	4.7000	17.0000	4.0000	24.0000	98.0000	50.0000L	10.0000L
93	MBQ719	1.0000L	1000.0000	3.8000	2.8000	14.0000	3.2000	18.0000	62.0000	50.0000L	10.0000L
94	MBQ721	1.0000L	850.0000	3.0000	1.0000L	10.0000L	2.2000	14.0000	44.0000	50.0000L	10.0000L
95	MBQ722	1.0000L	140.0000	1.5000	1.0000L	10.0000L	2.4000	10.0000L	20.0000L	50.0000L	10.0000L
96	MBQ723	1.0000L	440.0000	4.4000	1.0000L	10.0000L	4.1000	13.0000	25.0000	50.0000L	10.0000L
97	MBQ724	1.0000L	1100.0000	2.3000	1.0000L	10.0000L	2.0000	13.0000	27.0000	50.0000L	10.0000L
98	MBQ726	1.0000L	1200.0000	3.3000	1.4000	11.0000	2.7000	14.0000	48.0000	50.0000L	10.0000L
99	MBQ727	1.0000L	950.0000	3.5000	2.8000	15.0000	2.4000	16.0000	53.0000	50.0000L	10.0000L
100	MBQ728	1.0000L	1300.0000	2.6000	2.6000	15.0000	2.4000	15.0000	55.0000	50.0000L	10.0000L

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ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
51	MBQ612	13.0000	19.0000	10.0000L	310.0000	64.0000	25.0000	88.0000	21.0000	19.7000	0.0000B
52	MBQ613	30.0000	28.0000	10.0000L	490.0000	78.0000	23.0000	50.0000L	53.0000	21.4000	4.7000
53	MBQ614	6.9000	21.0000	10.0000L	250.0000	33.0000	27.0000	50.0000L	140.0000	32.7000	9.0600
54	MBQ615	5.7000	38.0000	10.0000L	220.0000	20.0000	33.0000	50.0000L	15.0000	20.2000	4.4700
55	MBQ616	2.4000	23.0000	10.0000L	50.0000	10.0000L	18.0000	50.0000L	10.0000L	6.4100	4.8000
56	MBQ617	2.7000	29.0000	10.0000L	190.0000	11.0000	11.0000	50.0000L	20.0000	26.3000	6.2900
57	MBQ618	6.2000	33.0000	10.0000L	280.0000	24.0000	21.0000	74.0000	120.0000	23.6000	7.5900
58	MBQ619	5.1000	34.0000	10.0000L	280.0000	23.0000	16.0000	50.0000L	10.0000L	18.5000	4.7800
59	MBQ621	6.1000	28.0000	10.0000L	310.0000	31.0000	20.0000	50.0000L	10.0000L	31.5000	7.2100
60	MBQ622	6.7000	20.0000	10.0000L	260.0000	28.0000	19.0000	50.0000L	88.0000	31.6000	7.9600
61	MBQ623	6.5000	14.0000	10.0000L	190.0000	42.0000	20.0000	50.0000L	110.0000	26.0000	5.2600
62	MBQ676	6.6000	10.0000	10.0000L	290.0000	31.0000	30.0000	50.0000L	20.0000L	25.5000	8.0000
63	MBQ677	8.8000	10.0000L	10.0000L	320.0000	40.0000	25.0000	50.0000L	38.0000	25.6000	6.4500
64	MBQ678	3.6000	25.0000	10.0000L	280.0000	14.0000	14.0000	50.0000L	51.0000	31.8000	7.2800
65	MBQ679	8.1000	31.0000	10.0000L	440.0000	48.0000	28.0000	50.0000L	120.0000	33.6000	9.8300
66	MBQ680	10.0000	10.0000L	10.0000L	390.0000	46.0000	25.0000	50.0000L	56.0000	34.4000	5.9200
67	MBQ683	7.2000	10.0000L	10.0000L	340.0000	37.0000	23.0000	50.0000L	140.0000	28.9000	5.9800
68	MBQ685	9.2000	10.0000L	10.0000L	410.0000	43.0000	24.0000	50.0000L	140.0000	26.4000	4.3800
69	MBQ686	4.7000	11.0000	10.0000L	270.0000	16.0000	19.0000	50.0000L	68.0000	19.2000	7.6300
70	MBQ689	2.6000	10.0000L	10.0000L	130.0000	17.0000	20.0000	50.0000L	20.0000L	15.0000	11.5000
71	MBQ691	2.1000	90.0000	10.0000L	160.0000	12.0000	19.0000	81.0000	20.0000L	20.5000	16.8000
72	MBQ692	5.7000	10.0000L	10.0000L	220.0000	21.0000	23.0000	50.0000L	52.0000	37.1000	7.5700
73	MBQ694	4.4000	160.0000	10.0000L	18.0000	21.0000	19.0000	71.0000	47.0000	27.8000	13.4000
74	MBQ695	2.5000	89.0000	10.0000L	71.0000	10.0000	12.0000	50.0000L	20.0000L	16.2000	10.8000
75	MBQ696	6.3000	38.0000	10.0000L	210.0000	17.0000	14.0000	50.0000L	300.0000	24.1000	2.9700
76	MBQ697	3.7000	27.0000	10.0000L	190.0000	13.0000	18.0000	50.0000L	20.0000L	24.1000	4.5500
77	MBQ698	5.3000	18.0000	10.0000L	160.0000	24.0000	24.0000	50.0000L	22.0000	6.3000L	21.0000
78	MBQ697	4.5000	81.0000	10.0000L	180.0000	17.0000	16.0000	50.0000L	83.0000	28.8000	6.5400
79	MBQ700	4.4000	34.0000	10.0000L	160.0000	13.0000	23.0000	50.0000L	110.0000	30.8000	5.0400
80	MBQ702	1.0000L	10.0000L	10.0000L	48.0000	10.0000L	10.0000L	50.0000L	10.0000L	2.4000	0.8000
81	MBQ703	5.3000	52.0000	10.0000L	180.0000	17.0000	17.0000	55.0000	87.0000	33.9000	5.3400
82	MBQ704	7.6000	24.0000	10.0000L	240.0000	27.0000	20.0000	50.0000L	140.0000	23.7000	5.4300
83	MBQ706	7.8000	92.0000	10.0000L	390.0000	42.0000	26.0000	64.0000	150.0000	20.2000	6.9300
84	MBQ707	8.7000	14.0000	10.0000L	410.0000	66.0000	30.0000	50.0000L	110.0000	30.9000	7.5300
85	MBQ708	15.0000	10.0000L	18.0000	360.0000	74.0000	24.0000	85.0000	140.0000	27.0000	5.3500
86	MBQ709	7.1000	10.0000L	10.0000L	400.0000	34.0000	18.0000	50.0000L	63.0000	18.8000	4.1000
87	MBQ711	25.0000	10.0000L	14.0000	270.0000	95.0000	25.0000	94.0000	110.0000	21.8000	4.0600
88	MBQ713	6.3000	17.0000	10.0000L	300.0000	28.0000	11.0000	50.0000L	74.0000	37.0000	6.1500
89	MBQ714	9.6000	10.0000L	10.0000L	290.0000	41.0000	24.0000	50.0000L	150.0000	36.5000	5.9700
90	MBQ716	8.8000	13.0000	10.0000L	360.0000	45.0000	21.0000	50.0000L	170.0000	28.5000	5.7500
91	MBQ717	12.0000	10.0000L	10.0000L	360.0000	53.0000	33.0000	50.0000L	180.0000	28.1000	3.6000
92	MBQ718	9.8000	10.0000L	10.0000L	390.0000	51.0000	31.0000	50.0000L	100.0000	27.4000	4.0800
93	MBQ719	7.6000	10.0000L	10.0000L	340.0000	32.0000	26.0000	50.0000L	110.0000	29.9000	6.8500
94	MBQ721	2.9000	20.0000	10.0000L	210.0000	14.0000	16.0000	50.0000L	20.0000L	25.8000	3.8400
95	MBQ722	3.6000	10.0000L	10.0000L	10.0000L	13.0000	10.0000L	50.0000L	20.0000L	4.4100	1.0100
96	MBQ723	3.4000	10.0000L	10.0000L	11.0000	19.0000	11.0000	50.0000L	20.0000L	16.8000	2.4100
97	MBQ724	1.8000	18.0000	10.0000L	250.0000	11.0000	10.0000L	50.0000L	20.0000L	15.3000	3.1500
98	MBQ726	4.6000	13.0000	10.0000L	260.0000	24.0000	19.0000	50.0000L	20.0000L	16.4000	7.8200
99	MBQ727	6.7000	16.0000	10.0000L	270.0000	38.0000	22.0000	50.0000L	20.0000L	28.9000	7.9000
100	MBQ728	6.5000	10.0000L	10.0000L	220.0000	25.0000	19.0000	50.0000L	20.0000L	25.0000	4.0600

Tertiary Igneous Rocks, cont.

DATE 5/ 8/79

ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
101	MBQ729	35.0000	8.2000	1.4000	0.5000	1.2000	2.9000	3.2000	0.2000	0.0600	410.0000
102	MBQ731	32.0000	8.2000	1.8000	0.6400	1.3000	3.0000	3.3000	0.2300	0.0600	530.0000
103	MBQ732	40.0000G	3.2000	0.6900	0.1000L	1.4000	0.9100	0.7500	0.0600	0.0300	200.0000L
104	MBQ734	35.0000	7.1000	1.7000	0.4800	1.2000	2.8000	2.6000	0.2000	0.0700	450.0000
105	MBQ735	36.0000	7.1000	0.6700	0.1000L	0.5400	2.6000	4.2000	0.1100	0.0500	200.0000L
106	MBQ736	33.0000	7.1000	1.3000	0.3600	0.9700	2.8000	3.6000	0.1600	0.0600	360.0000
107	MBQ739	34.0000	8.5000	2.5000	0.7700	2.0000	2.6000	2.9000	0.2900	0.0800	550.0000
108	MBQ740	27.0000	11.0000	2.4000	0.5700	3.5000	5.3000	5.0000G	0.2400	0.0900	640.0000
109	MBQ742	35.0000	7.4000	0.6700	0.1700	0.7700	2.9000	4.0000	0.0900	0.0600	320.0000
110	MBQ744	34.0000	6.9000	1.9000	0.3600	0.9600	2.2000	2.4000	0.1700	0.0700	450.0000
111	MBQ745	33.0000	7.1000	1.4000	0.2900	0.9200	2.3000	2.9000	0.1400	0.0600	360.0000
112	MBQ747	36.0000	8.4000	0.7700	0.2600	0.8300	4.0000	5.0000G	0.1000	0.0600	410.0000
113	MBQ748	35.0000	7.0000	0.7500	0.2400	0.7100	2.8000	4.5000	0.1000	0.0500	310.0000
114	MBQ750	35.0000	7.2000	0.9100	0.2200	0.7300	2.9000	4.7000	0.1000	0.0600	490.0000
115	MBQ752	36.0000	6.9000	1.2000	0.3100	0.7900	3.4000	4.3000	0.1300	0.0500	460.0000
116	MBQ754	40.0000	6.3000	1.2000	0.2800	0.6600	2.4000	4.0000	0.1300	0.0600	370.0000
117	MBQ755	37.0000	7.9000	0.9700	0.2100	0.7900	4.4000	4.6000	0.1100	0.0600	310.0000
118	MBQ758	38.0000	4.6000	0.5500	0.1900	0.7000	1.8000	3.2000	0.0900	0.0400	270.0000
119	MBQ648	39.0000	6.7000	0.7900	0.1500	0.4000	2.3000	4.4000	0.1000	0.0400	290.0000
120	MBQ659	32.0000	7.2000	0.6900	0.1600	0.8600	2.7000	2.7000	0.0600	0.0500	200.0000L
121	MBQ330	39.0000	9.7000	2.8000	0.5200	2.4000	4.8000	5.0000G	0.3500	0.1000	570.0000
122	MBQ331	36.0000	8.5000	1.6000	0.3200	1.2000	4.4000	5.0000G	0.1600	0.0600	210.0000
123	MBQ332	38.0000	7.7000	1.6000	0.4800	2.1000	3.3000	5.0000G	0.1500	0.0600	480.0000
124	MBQ333	35.0000	7.8000	1.6000	0.2800	1.1000	3.4000	5.0000G	0.1500	0.0600	200.0000L
125	MBQ334	37.0000	7.1000	1.4000	0.3600	2.4000	3.1000	5.0000G	0.1200	0.0700	400.0000
126	MBQ560	29.0000	8.8000	8.3000	1.6000	2.0000	2.7000	3.4000	0.5700	0.1600	1300.0000

Tertiary Igneous Rocks, cont.

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ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
101	MBQ729	1.0000L	760.0000	5.1000	2.7000	13.0000	3.8000	18.0000	72.0000	50.0000L	10.0000L
102	MBQ731	1.0000L	760.0000	5.9000	4.2000	16.0000	3.3000	17.0000	70.0000	50.0000L	10.0000L
103	MBQ732	1.0000L	270.0000	1.9000	1.0000L	10.0000L	2.4000	12.0000	24.0000	50.0000L	10.0000L
104	MBQ734	1.0000L	790.0000	4.4000	3.1000	14.0000	4.4000	17.0000	57.0000	50.0000L	10.0000L
105	MBQ735	1.0000L	840.0000	3.1000	1.0000L	10.0000L	3.0000	15.0000	48.0000	50.0000L	10.0000L
106	MBQ736	1.0000L	920.0000	3.7000	2.2000	12.0000	5.9000	17.0000	45.0000	50.0000L	10.0000L
107	MBQ739	1.0000L	1000.0000	3.5000	5.9000	19.0000	8.8000	20.0000	110.0000	50.0000L	10.0000L
108	MBQ740	1.0000L	1700.0000	2.6000	4.4000	18.0000	2.4000	28.0000	110.0000	50.0000L	10.0000L
109	MBQ742	1.0000L	570.0000	4.7000	1.0000L	10.0000L	2.0000	20.0000	41.0000	50.0000L	10.0000L
110	MBQ744	1.0000L	290.0000	5.6000	1.8000	12.0000	3.9000	24.0000	61.0000	71.0000	10.0000L
111	MBQ745	1.0000L	600.0000	5.8000	1.0000L	10.0000	2.4000	23.0000	39.0000	68.0000	10.0000L
112	MBQ747	1.0000L	810.0000	3.8000	1.7000	10.0000L	2.2000	26.0000	41.0000	50.0000L	10.0000L
113	MBQ748	1.0000L	730.0000	4.1000	1.0000L	10.0000L	2.5000	19.0000	41.0000	50.0000L	10.0000L
114	MBQ750	1.0000L	760.0000	4.6000	1.0000L	11.0000	2.2000	20.0000	70.0000	50.0000L	10.0000L
115	MBQ752	1.0000L	650.0000	4.0000	2.3000	13.0000	3.1000	22.0000	56.0000	50.0000L	10.0000L
116	MBQ754	1.0000L	590.0000	3.5000	2.1000	12.0000	2.4000	18.0000	50.0000	55.0000	10.0000L
117	MBQ755	1.0000L	910.0000	6.4000	1.3000	10.0000L	3.8000	26.0000	50.0000	60.0000	10.0000L
118	MBQ758	1.0000L	580.0000	2.2000	1.3000	10.0000L	4.7000	13.0000	33.0000	50.0000L	10.0000L
119	MBQ648	1.0000L	760.0000	4.5000	1.0000L	10.0000L	7.6000	19.0000	26.0000	50.0000L	10.0000L
120	MBQ659	1.0000L	1400.0000	2.3000	1.0000L	10.0000L	1.3000	25.0000	20.0000L	50.0000L	10.0000L
121	MBQ330	1.0000L	2100.0000	4.8000	4.8000	10.0000L	35.0000	23.0000	80.0000	50.0000L	10.0000L
122	MBQ331	1.0000L	1800.0000	3.6000	1.6000	10.0000L	6.9000	19.0000	93.0000	50.0000L	10.0000L
123	MBQ332	1.0000L	1500.0000	4.1000	2.2000	10.0000L	3.9000	17.0000	82.0000	50.0000L	10.0000L
124	MBQ333	1.0000L	1900.0000	3.5000	1.0000L	10.0000L	3.5000	18.0000	99.0000	50.0000L	10.0000L
125	MBQ334	1.0000L	1600.0000	4.1000	3.5000	10.0000L	4.1000	20.0000	100.0000	50.0000L	10.0000L
126	MBQ560	1.0000L	480.0000	5.5000	14.0000	42.0000	14.0000	33.0000	100.0000	190.0000	10.0000L

Tertiary Igneous Rocks, cont.

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ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
101	MBQ729	6.6000	12.0000	10.0000L	290.0000	33.0000	23.0000	50.0000L	20.0000L	27.0000	8.7200
102	MBQ731	8.8000	10.0000L	10.0000L	340.0000	41.0000	28.0000	50.0000L	41.0000	35.0000	4.7200
103	MBQ732	2.8000	10.0000L	10.0000L	200.0000	31.0000	10.0000L	50.0000L	20.0000L	6.8400	3.8500
104	MBQ734	7.6000	15.0000	10.0000L	280.0000	30.0000	25.0000	58.0000	65.0000	24.3000	6.2000
105	MBQ735	3.6000	32.0000	10.0000L	160.0000	16.0000	17.0000	50.0000L	20.0000L	25.2000	2.7000
106	MBQ736	5.8000	15.0000	10.0000L	250.0000	29.0000	19.0000	50.0000L	20.0000L	22.0000	4.1000
107	MBQ739	11.0000	12.0000	10.0000L	360.0000	59.0000	31.0000	60.0000	130.0000	30.6000	3.7100
108	MBQ740	9.1000	46.0000	10.0000L	450.0000	66.0000	28.0000	66.0000	120.0000	38.7000	8.2300
109	MBQ742	3.1000	24.0000	10.0000L	160.0000	14.0000	29.0000	50.0000L	20.0000L	22.4000	5.8300
110	MBQ744	6.4000	25.0000	10.0000L	160.0000	20.0000	41.0000	76.0000	180.0000	38.8000	10.3000
111	MBQ745	4.4000	30.0000	10.0000L	180.0000	13.0000	38.0000	50.0000L	43.0000	33.5000	11.1000
112	MBQ747	4.7000	34.0000	10.0000L	240.0000	24.0000	19.0000	50.0000L	20.0000L	21.1000	3.7900
113	MBQ748	3.9000	24.0000	10.0000L	200.0000	18.0000	18.0000	50.0000L	20.0000L	26.2000	3.3500
114	MBQ750	4.2000	21.0000	10.0000L	220.0000	21.0000	22.0000	50.0000L	37.0000	31.6000	2.9900
115	MBQ752	5.8000	14.0000	10.0000L	220.0000	29.0000	22.0000	50.0000L	20.0000L	31.2000	3.7300
116	MBQ754	5.7000	17.0000	10.0000L	170.0000	28.0000	27.0000	50.0000L	26.0000	29.2000	5.5300
117	MBQ755	3.0000	35.0000	10.0000L	290.0000	15.0000	10.0000	50.0000L	27.0000	25.0000	8.5100
118	MBQ758	4.8000	10.0000L	10.0000L	160.0000	22.0000	14.0000	50.0000L	58.0000	16.6000	6.0100
119	MBQ648	2.3000	26.0000	10.0000L	110.0000	10.0000L	28.0000	50.0000L	58.0000	26.3000	9.4900
120	MBQ659	1.3000	17.0000	10.0000L	470.0000	10.0000L	14.0000	50.0000L	37.0000	8.4400	2.5900
121	MBQ330	7.7000	33.0000	10.0000L	600.0000	38.0000	41.0000	50.0000L	480.0000	30.8000	6.7900
122	MBQ331	4.3000	22.0000	10.0000L	320.0000	13.0000	26.0000	50.0000L	200.0000	35.9000	7.1800
123	MBQ332	5.5000	31.0000	10.0000L	330.0000	16.0000	29.0000	50.0000L	180.0000	36.9000	7.8200
124	MBQ333	4.0000	31.0000	10.0000L	300.0000	10.0000L	24.0000	50.0000L	230.0000	33.1000	7.2300
125	MBQ334	7.8000	25.0000	10.0000L	330.0000	23.0000	32.0000	50.0000L	280.0000	36.0000	7.5800
126	MBQ560	24.0000	10.0000L	17.0000	230.0000	140.0000	58.0000	140.0000	280.0000	122.0000	13.1000

Precambrian Metasedimentary Rocks

DATE 5/ 8/79

ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
156	MBQ560	29.0000	8.8000	8.3000	1.6000	2.0000	2.7000	3.4000	0.5700	0.1600	1300.0000
157	MBQ571	33.0000	6.3000	0.4300	0.1400	0.6900	2.0000	3.9000	0.0800	0.0500	200.0000L
158	MBQ572	40.0000G	4.4000	2.5000	0.5500	0.1100	0.6700	1.6000	0.2500	0.0500	740.0000
159	MBQ574	39.0000	8.3000	3.9000	0.7600	0.2400	0.7200	2.7000	0.2700	0.0600	480.0000
160	MBQ581	40.0000G	0.8200	0.1900	0.1000L	0.0500L	0.1500L	0.2600	0.0400	0.0300	200.0000L
161	MBQ588	32.0000	7.0000	1.4000	0.4200	1.2000	2.4000	2.8000	0.1800	0.0500	330.0000
162	MBQ589	40.0000G	6.1000	3.0000	0.7800	0.1500	0.4400	2.7000	0.3200	0.0600	680.0000
163	MBQ591	33.0000	9.8000	9.4000	2.6000	0.3400	2.3000	2.2000	0.3200	0.0900	1400.0000
164	MBQ592	31.0000	10.0000	4.2000	1.0000	0.2800	1.4000	4.3000	0.3800	0.0900	450.0000
165	MBQ611	32.0000	11.0000	6.8000	1.1000	0.1300	1.0000	4.7000	0.4500	0.1400	650.0000
166	MBQ626	31.0000	11.0000	3.9000	1.0000	0.1300	0.2600	3.9000	0.4700	0.0700	350.0000
167	MBQ627	40.0000G	5.6000	1.8000	2.7000	3.8000	1.1000	2.4000	0.1700	0.0400	1900.0000
168	MBQ629	40.0000G	3.7000	1.9000	0.5500	0.4200	0.5000	2.0000	0.2000	0.0400	430.0000
169	MBQ630	40.0000G	1.7000	1.3000	0.2000	0.0800	0.1500L	1.0000	0.0500	0.0300	200.0000L
170	MBQ631	40.0000G	1.0000	0.2900	0.1000L	0.0700	0.1500L	0.5500	0.0500	0.0500	200.0000L
171	MBQ632	40.0000G	0.8900	0.0500L	0.1000L	0.0900	0.1500L	0.7200	0.0300	0.0300	200.0000L
172	MBQ633	33.0000	11.0000	6.0000	1.4000	0.2700	1.1000	3.4000	0.4700	0.0800	750.0000
173	MBQ634	32.0000	10.0000	5.4000	1.4000	0.4400	1.4000	2.9000	0.3800	0.0700	580.0000
174	MBQ636	40.0000G	2.7000	0.1600	0.1100	0.0500L	0.5600	1.9000	0.2000	0.0400	200.0000L
175	MBQ638	31.0000	10.0000	3.0000	1.0000	0.0600	0.8200	5.0000G	0.5600	0.0600	450.0000
176	MBQ639	35.0000	8.9000	4.3000	1.3000	0.1300	1.0000	2.5000	0.4100	0.0600	730.0000
177	MBQ640	31.0000	11.0000	3.1000	0.7800	0.1600	1.2000	3.1000	0.4100	0.0700	370.0000
178	MBQ641	35.0000	10.0000	2.9000	1.5000	6.0000	0.2800	1.3000	0.3600	0.0700	680.0000
179	MBQ642	31.0000	11.0000	4.6000	1.2000	0.2700	1.1000	3.3000	0.4800	0.0800	570.0000
180	MBQ643	30.0000	11.0000	3.8000	1.2000	0.2200	1.1000	3.9000	0.5400	0.0700	480.0000
181	MBQ644	30.0000	12.0000G	3.7000	1.1000	0.2000	1.7000	4.0000	0.4800	0.0800	510.0000
182	MBQ645	31.0000	11.0000	3.1000	1.3000	0.2700	1.1000	4.2000	0.4800	0.0700	390.0000
183	MBQ646	40.0000G	1.4000	0.0700	0.1400	0.2400	0.2000	0.8600	0.0400	0.0300	440.0000
184	MBQ647	35.0000	10.0000	5.5000	1.6000	0.4000	1.6000	4.7000	0.6300	0.0800	980.0000
185	MBQ649	24.0000	11.0000	14.0000	2.6000	0.2800	0.5600	4.2000	0.7200	0.1200	1500.0000
186	MBQ650	32.0000	9.6000	8.7000	1.9000	0.3400	1.5000	3.5000	0.5400	0.1000	670.0000
187	MBQ651	33.0000	7.8000	5.9000	1.4000	1.9000	2.0000	2.7000	0.6900	0.1400	1100.0000
188	MBQ652	40.0000G	6.0000	3.2000	0.7400	0.1300	0.8200	2.5000	0.2100	0.0500	660.0000
189	MBQ653	40.0000G	2.8000	4.1000	0.6000	0.3500	0.4000	0.3500	0.0500	0.0400	4700.0000
190	MBQ654	40.0000G	6.0000	4.1000	0.7300	0.1800	0.8900	2.7000	0.2900	0.0600	640.0000
191	MBQ656	30.0000	11.0000	2.8000	1.2000	0.4400	1.2000	4.0000	0.4300	0.0700	220.0000
192	MBQ658	25.0000	12.0000G	6.5000	1.8000	0.2800	1.0000	4.8000	0.5400	0.1100	500.0000
193	MBQ660	31.0000	8.9000	6.3000	1.3000	0.2600	0.8000	2.7000	0.2300	0.0800	620.0000
194	MBQ661	30.0000	11.0000	4.7000	1.2000	0.2700	1.3000	3.0000	0.3500	0.0800	530.0000
195	MBQ662	10.0000L	2.3000	0.6500	0.2800	20.0000G	0.1500L	0.7600	0.0800	0.0300	280.0000
196	MBQ663	40.0000G	2.7000	0.2000	0.1000L	0.0800	0.1500L	2.4000	0.1000	0.0400	200.0000L
197	MBQ664	32.0000	9.6000	5.6000	1.3000	0.3800	1.3000	3.8000	0.5600	0.0900	760.0000
198	MBQ665	28.0000	9.4000	4.6000	1.1000	0.2400	0.9500	2.3000	0.4400	0.0500	590.0000
199	MBQ666	40.0000G	1.0000	0.1300	0.1000L	0.0800	0.1500L	0.6100	0.0300	0.0500	200.0000L
200	MBQ667	40.0000G	0.8200	0.0500L	0.1000L	0.0500L	0.1500L	0.5500	0.0400	0.0300	200.0000L

Metasedimentary Rocks, cont.

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ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
156	MBQ560	1.0000L	480.0000	5.5000	14.0000	42.0000	14.0000	33.0000	100.0000	190.0000	10.0000L
157	MBQ571	1.0000L	890.0000	3.5000	1.0000L	10.0000L	1.5000	15.0000	25.0000	50.0000L	10.0000L
158	MBQ572	1.0000L	450.0000	1.9000	7.8000	22.0000	26.0000	10.0000L	23.0000	50.0000L	10.0000L
159	MBQ574	1.0000L	540.0000	3.6000	12.0000	46.0000	30.0000	21.0000	20.0000L	50.0000L	10.0000L
160	MBQ581	1.0000L	55.0000	1.8000	1.0000L	10.0000L	3.8000	10.0000L	20.0000L	50.0000L	10.0000L
161	MBQ588	1.0000L	930.0000	3.1000	1.3000	12.0000	1.8000	13.0000	63.0000	50.0000L	10.0000L
162	MBQ589	1.0000L	700.0000	2.6000	7.3000	31.0000	11.0000	15.0000	31.0000	50.0000L	10.0000L
163	MBQ591	1.0000L	150.0000	6.5000	19.0000	59.0000	23.0000	28.0000	45.0000	200.0000	10.0000L
164	MBQ592	1.0000L	740.0000	4.2000	12.0000	77.0000	35.0000	30.0000	52.0000	61.0000	10.0000L
165	MBQ611	1.0000L	790.0000	5.2000	10.0000	67.0000	53.0000	22.0000	64.0000	190.0000	10.0000L
166	MBQ626	1.0000L	660.0000	4.0000	6.0000	71.0000	27.0000	27.0000	51.0000	50.0000L	10.0000L
167	MBQ627	1.0000L	800.0000	2.7000	12.0000	22.0000	200.0000	13.0000	21.0000	50.0000L	10.0000L
168	MBQ629	1.0000L	940.0000	3.8000	7.7000	23.0000	16.0000	10.0000L	20.0000L	61.0000	10.0000L
169	MBQ630	1.0000L	230.0000	1.3000	12.0000	11.0000	2.6000	10.0000L	20.0000L	50.0000L	10.0000L
170	MBQ631	1.0000L	220.0000	1.7000	3.0000	12.0000	32.0000	10.0000L	20.0000L	50.0000L	10.0000L
171	MBQ632	1.0000L	280.0000	1.0000L	1.0000L	10.0000L	1.9000	10.0000L	20.0000L	50.0000L	10.0000L
172	MBQ633	1.0000L	600.0000	6.9000	15.0000	68.0000	28.0000	32.0000	66.0000	260.0000	10.0000L
173	MBQ634	1.0000L	470.0000	4.0000	14.0000	60.0000	25.0000	27.0000	55.0000	180.0000	10.0000L
174	MBQ636	1.0000L	670.0000	1.4000	1.2000	17.0000	6.6000	10.0000L	20.0000L	50.0000L	10.0000L
175	MBQ638	1.0000L	1200.0000	6.6000	6.7000	68.0000	18.0000	25.0000	44.0000	57.0000	10.0000L
176	MBQ639	1.0000L	430.0000	3.6000	12.0000	59.0000	28.0000	23.0000	40.0000	96.0000	10.0000L
177	MBQ640	1.0000L	610.0000	4.7000	6.8000	73.0000	38.0000	25.0000	20.0000L	50.0000L	10.0000L
178	MBQ641	1.0000L	250.0000	3.6000	11.0000	55.0000	13.0000	27.0000	37.0000	190.0000	10.0000L
179	MBQ642	1.0000L	540.0000	4.0000	16.0000	90.0000	28.0000	25.0000	60.0000	67.0000	10.0000L
180	MBQ643	1.0000L	650.0000	4.3000	4.3000	85.0000	27.0000	28.0000	62.0000	58.0000	10.0000L
181	MBQ644	1.0000L	750.0000	4.8000	4.5000	100.0000	24.0000	30.0000	74.0000	100.0000	10.0000L
182	MBQ645	1.0000L	890.0000	4.4000	2.4000	90.0000	19.0000	30.0000	45.0000	90.0000	10.0000L
183	MBQ646	1.0000L	1400.0000	1.1000	1.3000	10.0000L	2.6000	10.0000L	20.0000L	50.0000L	10.0000L
184	MBQ647	1.0000L	870.0000	4.4000	24.0000	110.0000	16.0000	29.0000	61.0000	170.0000	10.0000L
185	MBQ649	1.0000L	560.0000	6.1000	40.0000	150.0000	24.0000	38.0000	73.0000	580.0000	10.0000L
186	MBQ650	1.0000L	660.0000	4.4000	17.0000	71.0000	30.0000	29.0000	60.0000	77.0000	10.0000L
187	MBQ651	1.0000L	910.0000	4.8000	17.0000	55.0000	20.0000	24.0000	130.0000	88.0000	10.0000L
188	MBQ652	1.0000L	730.0000	2.3000	3.9000	27.0000	30.0000	16.0000	20.0000L	50.0000L	10.0000L
189	MBQ653	1.0000L	87.0000	1.9000	5.7000	10.0000L	38.0000	10.0000L	20.0000L	50.0000L	10.0000L
190	MBQ654	1.0000L	820.0000	2.6000	16.0000	33.0000	33.0000	18.0000	27.0000	50.0000L	10.0000L
191	MBQ656	1.0000L	970.0000	5.2000	2.7000	79.0000	7.0000	22.0000	20.0000L	61.0000	10.0000L
192	MBQ658	1.0000L	890.0000	4.4000	20.0000	95.0000	3.7000	32.0000	46.0000	120.0000	10.0000L
193	MBQ660	1.0000L	640.0000	3.7000	9.1000	56.0000	19.0000	28.0000	21.0000	110.0000	10.0000L
194	MBQ661	1.0000L	710.0000	4.8000	4.2000	81.0000	13.0000	32.0000	30.0000	100.0000	10.0000L
195	MBQ662	1.0000L	310.0000	1.2000	8.4000	21.0000	8.3000	10.0000L	70.0000	86.0000	10.0000L
196	MBQ663	1.0000L	440.0000	1.4000	2.2000	20.0000	9.7000	10.0000L	20.0000L	50.0000L	10.0000L
197	MBQ664	1.0000L	910.0000	4.0000	22.0000	89.0000	16.0000	22.0000	58.0000	110.0000	10.0000L
198	MBQ665	1.0000L	440.0000	5.4000	12.0000	54.0000	25.0000	25.0000	36.0000	64.0000	10.0000L
199	MBQ666	1.0000L	660.0000	1.5000	1.0000L	11.0000	4.1000	10.0000L	20.0000L	50.0000L	10.0000L
200	MBQ667	1.0000L	190.0000	1.0000L	1.0000L	10.0000L	1.7000	10.0000L	20.0000L	50.0000L	10.0000L

Metasedimentary Rocks, cont.

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ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
156	MBQ560	24.0000	10.0000L	17.0000	230.0000	140.0000	58.0000	140.0000	280.0000	122.0000	13.1000
157	MBQ571	2.4000	17.0000	10.0000L	200.0000	10.0000L	14.0000	50.0000L	14.0000	22.7000	2.9600
158	MBQ572	16.0000	10.0000L	10.0000L	56.0000	30.0000	30.0000	50.0000L	350.0000	6.0400	2.5300
159	MBQ574	28.0000	10.0000L	15.0000	73.0000	83.0000	30.0000	79.0000	160.0000	9.6700	3.4100
160	MBQ581	2.4000	10.0000L	10.0000L	10.0000L	10.0000L	12.0000	50.0000L	57.0000	2.1000	0.7500
161	MBQ588	6.1000	10.0000L	10.0000L	240.0000	26.0000	24.0000	50.0000L	130.0000	27.9000	5.7300
162	MBQ589	18.0000	10.0000L	10.0000L	66.0000	57.0000	36.0000	51.0000	320.0000	7.7400	3.1000
163	MBQ591	42.0000	50.0000	17.0000	160.0000	90.0000	38.0000	200.0000	180.0000	12.8000	0.0000B
164	MBQ592	26.0000	10.0000L	21.0000	130.0000	150.0000	40.0000	68.0000	150.0000	17.4000	3.8500
165	MBQ611	34.0000	210.0000	22.0000	100.0000	110.0000	41.0000	100.0000	320.0000	13.2000	4.7200
166	MBQ626	16.0000	10.0000L	21.0000	73.0000	100.0000	51.0000	50.0000L	220.0000	15.6000	3.9400
167	MBQ627	23.0000	10.0000L	10.0000L	160.0000	48.0000	21.0000	50.0000L	87.0000	6.4300	2.0400
168	MBQ629	19.0000	84.0000	10.0000L	95.0000	36.0000	21.0000	50.0000L	150.0000	4.4100	2.0000
169	MBQ630	21.0000	10.0000L	10.0000L	58.0000	15.0000	11.0000	50.0000L	10.0000L	2.3000	0.9200
170	MBQ631	6.3000	19.0000	10.0000L	24.0000	14.0000	17.0000	50.0000L	32.0000	3.3400	0.5500
171	MBQ632	3.5000	10.0000L	10.0000L	32.0000	10.0000L	10.0000L	50.0000L	10.0000L	2.0000	0.4100
172	MBQ633	33.0000	10.0000L	21.0000	110.0000	110.0000	55.0000	50.0000L	210.0000	24.6000	5.7400
173	MBQ634	32.0000	10.0000L	21.0000	130.0000	87.0000	54.0000	50.0000L	270.0000	18.7000	4.4200
174	MBQ636	5.7000	180.0000	10.0000L	38.0000	13.0000	22.0000	83.0000	320.0000	6.5600	2.0700
175	MBQ638	17.0000	10.0000L	15.0000	52.0000	110.0000	53.0000	110.0000	170.0000	18.6000	4.4700
176	MBQ639	19.0000	10.0000L	15.0000	100.0000	91.0000	52.0000	52.0000	170.0000	11.3000	4.5400
177	MBQ640	13.0000	10.0000L	18.0000	130.0000	120.0000	13.0000	50.0000L	130.0000	12.1000	3.7900
178	MBQ641	23.0000	42.0000	17.0000	1200.0000	180.0000	29.0000	50.0000L	91.0000	10.2000	4.4400
179	MBQ642	32.0000	10.0000L	20.0000	110.0000	120.0000	54.0000	110.0000	190.0000	21.9000	4.8800
180	MBQ643	7.6000	10.0000L	21.0000	160.0000	140.0000	52.0000	50.0000L	160.0000	17.3000	3.8600
181	MBQ644	8.4000	10.0000L	22.0000	200.0000	150.0000	52.0000	58.0000	150.0000	19.7000	4.8400
182	MBQ645	5.1000	10.0000L	20.0000	200.0000	160.0000	44.0000	50.0000L	130.0000	16.2000	3.1400
183	MBQ646	4.8000	10.0000L	10.0000L	92.0000	13.0000	11.0000	50.0000L	10.0000L	1.6000	0.5300
184	MBQ647	50.0000	10.0000L	20.0000	130.0000	150.0000	46.0000	50.0000L	240.0000	15.3000	4.1300
185	MBQ649	79.0000	10.0000L	30.0000	53.0000	170.0000	50.0000	110.0000	410.0000	24.9000	4.5500
186	MBQ650	23.0000	10.0000L	25.0000	170.0000	120.0000	43.0000	94.0000	350.0000	15.4000	3.4600
187	MBQ651	36.0000	10.0000L	16.0000	310.0000	92.0000	53.0000	130.0000	670.0000	17.0000	4.5200
188	MBQ652	11.0000	10.0000L	10.0000L	77.0000	46.0000	31.0000	50.0000L	280.0000	6.8500	2.7500
189	MBQ653	8.3000	10.0000L	10.0000L	95.0000	10.0000L	24.0000	62.0000	34.0000	1.5000L	0.9700
190	MBQ654	24.0000	10.0000L	10.0000L	99.0000	46.0000	35.0000	54.0000	440.0000	5.5300	2.7300
191	MBQ656	8.5000	10.0000L	22.0000	310.0000	210.0000	22.0000	66.0000	180.0000	16.6000	4.8700
192	MBQ658	61.0000	10.0000L	29.0000	120.0000	110.0000	41.0000	100.0000	240.0000	19.4000	4.8200
193	MBQ660	19.0000	11.0000	17.0000	70.0000	84.0000	26.0000	120.0000	270.0000	13.9000	2.9600
194	MBQ661	8.0000	17.0000	21.0000	190.0000	120.0000	31.0000	100.0000	190.0000	14.2000	3.6800
195	MBQ662	18.0000	24.0000	10.0000L	2800.0000G	31.0000	18.0000	240.0000	180.0000	3.9000	2.6200
196	MBQ663	9.3000	10.0000L	10.0000L	190.0000	10.0000L	14.0000	50.0000L	160.0000	3.1000	1.5900
197	MBQ664	46.0000	10.0000L	20.0000	95.0000	120.0000	41.0000	86.0000	360.0000	16.2000	4.1400
198	MBQ665	29.0000	10.0000L	16.0000	75.0000	99.0000	40.0000	50.0000L	180.0000	28.9000	5.8300
199	MBQ666	4.5000	10.0000L	10.0000L	61.0000	10.0000L	12.0000	50.0000L	33.0000	1.4000L	0.7100
200	MBQ667	3.0000	10.0000L	10.0000L	18.0000	10.0000L	10.0000L	50.0000L	10.0000L	2.6000	0.4700

Precambrian Metasedimentary Rocks

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ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
201	MBQ668	40.0000G	1.0000	0.0500L	0.1000L	0.1100	0.1500L	0.6100	0.0300	0.0300	430.0000
202	MBQ669	26.0000	10.0000	9.4000	2.0000	0.2000	0.8700	2.7000	0.4700	0.1000	670.0000
203	MBQ670	29.0000	11.0000	7.8000	2.0000	0.3100	1.3000	3.5000	0.6600	0.1100	760.0000
204	MBQ671	34.0000	8.7000	4.7000	1.8000	1.0000	1.4000	3.7000	0.5700	0.1300	550.0000
205	MBQ672	40.0000G	7.6000	4.8000	1.3000	1.6000	1.6000	2.9000	0.5600	0.1500	690.0000
206	MBQ673	40.0000G	8.1000	6.9000	1.2000	0.6700	0.8100	2.7000	0.4200	0.0900	720.0000
207	MBQ674	37.0000	6.6000	3.1000	0.6100	0.1600	0.9900	1.6000	0.2200	0.0400	320.0000
208	MBQ675	31.0000	11.0000	3.1000	0.8000	0.3100	1.2000	3.2000	0.4700	0.0900	200.0000L
209	MBQ701	10.0000L	0.2500L	0.0500L	13.0000	19.0000	0.1500L	0.0800L	0.0300	0.0200L	520.0000
210	MBQ702	36.0000	6.9000	0.1600	0.1000L	0.4300	1.8000	3.1000	0.0300	0.0500	290.0000
211	MBQ725	34.0000	6.0000	0.0500L	0.1000L	0.3600	3.0000	3.9000	0.0300	0.0400	200.0000L
212	MBQ733	36.0000	7.6000	1.4000	0.3700	1.7000	2.8000	2.6000	0.1800	0.0600	430.0000

ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
201	MBQ668	1.0000L	750.0000	1.0000L	1.0000L	10.0000L	6.8000	10.0000L	20.0000L	50.0000L	10.0000L
202	MBQ669	1.0000L	700.0000	3.3000	13.0000	81.0000	53.0000	30.0000	59.0000	58.0000	10.0000L
203	MBQ670	1.0000L	840.0000	4.9000	13.0000	100.0000	27.0000	28.0000	72.0000	69.0000	10.0000L
204	MBQ671	1.0000L	960.0000	4.6000	14.0000	46.0000	32.0000	22.0000	110.0000	170.0000	10.0000L
205	MBQ672	1.0000L	1000.0000	4.7000	14.0000	46.0000	21.0000	16.0000	86.0000	110.0000	10.0000L
206	MBQ673	1.0000L	790.0000	3.2000	20.0000	67.0000	32.0000	18.0000	36.0000	160.0000	10.0000L
207	MBQ674	1.0000L	370.0000	2.8000	3.4000	26.0000	31.0000	17.0000	20.0000L	50.0000L	10.0000L
208	MBQ675	1.0000L	690.0000	3.6000	4.2000	74.0000	27.0000	25.0000	55.0000	50.0000L	10.0000L
209	MBQ701	1.0000L	20.0000L	1.0000L	5.7000	11.0000	2.5000	10.0000L	39.0000	50.0000L	10.0000L
210	MBQ702	1.0000L	170.0000	6.5000	1.0000L	10.0000L	3.3000	23.0000	20.0000L	50.0000L	10.0000L
211	MBQ725	1.0000L	49.0000	8.1000	1.0000L	10.0000L	1.2000	19.0000	20.0000L	50.0000L	10.0000L
212	MBQ733	1.0000L	780.0000	4.8000	2.5000	13.0000	2.6000	18.0000	88.0000	50.0000L	10.0000L

ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
201	MBQ668	2.0000	10.0000L	10.0000L	51.0000	10.0000L	10.0000L	50.0000L	10.0000L	1.3000L	0.4400
202	MBQ669	58.0000	10.0000L	22.0000	65.0000	100.0000	41.0000	120.0000	310.0000	15.1000	3.9000
203	MBQ670	23.0000	10.0000L	28.0000	110.0000	160.0000	47.0000	100.0000	420.0000	19.2000	4.9400
204	MBQ671	27.0000	10.0000L	16.0000	200.0000	91.0000	50.0000	93.0000	500.0000	22.0000	5.1500
205	MBQ672	25.0000	10.0000L	15.0000	260.0000	85.0000	49.0000	110.0000	420.0000	16.2000	4.1500
206	MBQ673	29.0000	26.0000	17.0000	96.0000	100.0000	37.0000	86.0000	290.0000	10.9000	3.6500
207	MBQ674	10.0000	10.0000L	12.0000	72.0000	52.0000	39.0000	64.0000	350.0000	7.6800	2.5300
208	MBQ675	11.0000	16.0000	22.0000	160.0000	120.0000	50.0000	54.0000	220.0000	17.9000	4.0900
209	MBQ701	10.0000	53.0000	10.0000L	160.0000	11.0000	10.0000L	63.0000	10.0000L	1.4000L	0.1300L
210	MBQ702	1.0000L	10.0000L	10.0000L	48.0000	10.0000L	10.0000L	50.0000L	10.0000L	2.4000	0.8000
211	MBQ725	1.1000	57.0000	10.0000L	29.0000	10.0000L	10.0000	50.0000L	20.0000L	14.2000	9.7000
212	MBQ733	6.6000	14.0000	10.0000L	330.0000	38.0000	22.0000	50.0000L	40.0000	22.6000	4.6500

Mafic and Andesitic Dikes

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ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
127	MBQ328	30.0000	7.4000	2.7000	0.9500	2.3000	1.3000	3.8000	0.2900	0.1100	330.0000
128	MBQ329	30.0000	7.5000	2.5000	1.2000	2.7000	1.2000	2.2000	0.3300	0.0900	500.0000
129	MBQ557	30.0000	9.6000	6.6000	2.2000	2.3000	2.2000	2.1000	0.5800	0.1400	1000.0000
130	MBQ562	23.0000	9.1000	12.0000	4.1000	6.7000	2.1000	0.4300	1.0000	0.1300	1700.0000
131	MBQ573	25.0000	7.6000	14.0000	2.5000	4.4000	2.8000	0.3500	1.5000G	0.1400	2100.0000
132	MBQ730	29.0000	8.4000	3.4000	2.6000	1.4000	2.4000	2.6000	0.4500	0.0600	860.0000
133	MBQ749	34.0000	9.8000	2.5000	0.8200	2.1000	3.3000	3.6000	0.2900	0.0800	630.0000

ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
127	MBQ328	1.0000L	1600.0000	3.6000	7.2000	14.0000	5.5000	15.0000	61.0000	50.0000L	10.0000L
128	MBQ329	1.0000L	750.0000	3.6000	9.1000	11.0000	6.1000	14.0000	68.0000	150.0000	10.0000L
129	MBQ557	1.0000L	1000.0000	2.2000	22.0000	34.0000	29.0000	23.0000	70.0000	260.0000	10.0000L
130	MBQ562	1.0000L	250.0000	1.6000	49.0000	69.0000	120.0000	27.0000	30.0000	50.0000	10.0000L
131	MBQ573	1.0000L	68.0000	1.7000	44.0000	10.0000L	42.0000	31.0000	41.0000	59.0000	10.0000L
132	MBQ730	1.0000L	710.0000	4.1000	16.0000	200.0000	7.4000	21.0000	62.0000	50.0000L	10.0000L
133	MBQ749	1.0000L	1100.0000	5.3000	6.8000	16.0000	11.0000	22.0000	68.0000	50.0000L	10.0000L

ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
127	MBQ328	7.9000	31.0000	10.0000L	970.0000	53.0000	28.0000	62.0000	290.0000	21.4000	6.2900
128	MBQ329	8.8000	31.0000	10.0000L	1900.0000	67.0000	30.0000	65.0000	360.0000	21.0000	3.4100
129	MBQ557	24.0000	20.0000	22.0000	600.0000	170.0000	38.0000	100.0000	350.0000	13.7000	2.7500
130	MBQ562	140.0000	10.0000L	31.0000	500.0000	290.0000	32.0000	84.0000	130.0000	1.5000L	0.5200
131	MBQ573	23.0000	10.0000L	44.0000	700.0000	410.0000	51.0000	150.0000	270.0000	2.5000	1.0400
132	MBQ730	89.0000	10.0000L	12.0000	290.0000	95.0000	24.0000	76.0000	120.0000	15.7000	6.8700
133	MBQ749	9.9000	21.0000	10.0000L	470.0000	63.0000	22.0000	51.0000	73.0000	17.5000	6.9600

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ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
1	MBQ335	16.0000	4.3000	1.5000	1.2000	16.0000	3.3000	1.6000	0.1900	0.0500	360.0000
2	MBQ681	31.0000	8.5000	1.8000	0.7700	2.4000	2.8000	4.0000	0.1900	0.0600	540.0000
3	MBQ682	35.0000	7.8000	4.6000	0.4000	2.0000	3.6000	4.7000	0.2200	0.0600	570.0000
4	MBQ684	36.0000	6.7000	1.9000	0.1800	0.5500	2.2000	4.1000	0.1100	0.0600	320.0000
5	MBQ687	29.0000	5.6000	20.0000G	0.2800	2.3000	2.3000	4.2000	0.4800	0.0700	1400.0000
6	MBQ688	19.0000	3.8000	20.0000G	0.1700	0.8000	2.1000	3.0000	0.8500	0.1100	2400.0000
7	MBQ737	33.0000	8.5000	8.1000	0.4800	3.6000	3.0000	3.8000	0.3400	0.0700	630.0000
8	MBQ738	18.0000	3.4000	20.0000G	0.2000	1.1000	1.4000	1.9000	0.7500	0.0700	1800.0000
9	MBQ756	37.0000	6.4000	0.2400	0.2100	1.0000	2.5000	4.6000	0.0700	0.0400	200.0000L

ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
1	MBQ335	1.0000L	930.0000	1.9000	9.1000	26.0000	16.0000	12.0000	75.0000	180.0000	10.0000L
2	MBQ681	1.0000L	880.0000	4.8000	3.7000	19.0000	5.8000	18.0000	74.0000	50.0000L	10.0000L
3	MBQ682	1.0000L	900.0000	4.0000	4.6000	40.0000	5.4000	20.0000	380.0000	50.0000L	10.0000L
4	MBQ684	1.0000L	770.0000	4.2000	2.1000	17.0000	3.4000	19.0000	57.0000	50.0000L	10.0000L
5	MBQ687	1.0000L	880.0000	3.7000	14.0000	170.0000	9.1000	33.0000	480.0000	50.0000L	10.0000L
6	MBQ688	1.0000L	440.0000	5.3000	26.0000	240.0000	12.0000	48.0000	580.0000	50.0000L	0.0000H
7	MBQ737	1.0000L	870.0000	4.6000	6.2000	59.0000	7.3000	25.0000	380.0000	50.0000L	10.0000L
8	MBQ738	1.0000L	330.0000	3.6000	22.0000	250.0000	10.0000	43.0000	980.0000	50.0000L	0.0000H
9	MBQ756	1.0000L	1100.0000	2.5000	1.0000L	10.0000L	2.5000	11.0000	21.0000	50.0000L	10.0000L

ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
1	MBQ335	20.0000	21.0000	10.0000L	1900.0000	68.0000	29.0000	50.0000L	160.0000	15.7000	7.6100
2	MBQ681	9.4000	11.0000	10.0000L	360.0000	38.0000	27.0000	50.0000L	93.0000	33.5000	5.0200
3	MBQ682	9.6000	10.0000L	10.0000L	340.0000	97.0000	33.0000	50.0000L	81.0000	158.0000	16.9000
4	MBQ684	6.0000	10.0000L	10.0000L	220.0000	37.0000	22.0000	50.0000L	20.0000L	46.7000	6.7700
5	MBQ687	23.0000	10.0000L	12.0000	320.0000	310.0000	85.0000	50.0000L	370.0000	328.0000	87.9000
6	MBQ688	42.0000	10.0000L	20.0000	170.0000	320.0000	88.0000	0.0000H	950.0000	583.0000	149.0000
7	MBQ737	13.0000	29.0000	10.0000L	340.0000	140.0000	52.0000	50.0000L	240.0000	233.0000	27.5000
8	MBQ738	37.0000	19.0000	18.0000	110.0000	480.0000	120.0000	0.0000H	560.0000	642.0000	168.0000
9	MBQ756	3.2000	12.0000	10.0000L	250.0000	14.0000	12.0000	50.0000L	20.0000L	14.1000	2.3700

Quartz-Sulfide Veins.

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ROWNO	SAMPLE	21 Ni ppm-S	22 Pb ppm-S	23 Sc ppm-S	24 Sr ppm-S	25 V ppm-S	26 Y ppm-S	27 Zn ppm-S	28 Zr ppm-S	29 Th ppm	30 U ppm
143	MBQ628	39.0000	7.9000	1.9000	0.5400	0.1000	1.4000	5.0000G	0.1800	0.0500	730.0000
144	MBQ635	40.0000G	0.7400	0.7000	0.1000L	0.0700	0.1500L	0.4000	0.0600	0.0300	200.0000L
145	MBQ637	10.0000L	0.2500L	9.2000	0.1000L	20.0000G	6.5000G	0.0900	0.0300L	0.0900	3600.0000
146	MBQ655	40.0000G	1.8000	11.0000	0.1000L	0.1300	0.1500L	0.2600	0.0400	0.1200	430.0000
147	MBQ551	37.0000	2.0000	20.0000G	0.1300	0.0600	0.1500L	0.9600	0.0300L	0.0200L	300.0000
148	MBQ556	40.0000G	0.9000	0.4600	0.1000L	0.0500L	0.1500L	0.3700	0.0300L	0.0300	200.0000L
149	MBQ569	39.0000	5.8000	0.0500L	0.1000L	0.2300	2.3000	4.3000	0.0400	0.0400	200.0000L
150	MBQ590	40.0000G	1.6000	4.3000	0.1200	0.0800	0.1500L	0.6800	0.0400	0.0800	220.0000
151	MBQ593	40.0000G	3.0000	2.2000	0.1900	0.0900	0.1700	1.2000	0.1700	0.0400	200.0000L
152	MBQ624	36.0000	6.4000	1.1000	0.2900	0.7400	4.4000	4.0000	0.1300	0.0700	250.0000
153	MBQ625	40.0000G	2.8000	0.4700	0.1000L	1.1000	0.8300	0.7100	0.0300	0.0400	230.0000
154	MBQ693	40.0000G	0.3100	0.7800	0.1000L	0.0500L	0.1500L	0.0800L	0.0300L	0.0400	200.0000L
155	MBQ746	40.0000G	5.1000	1.9000	0.2400	0.0900	0.1500L	2.6000	0.0800	0.0500	910.0000

ROWNO	SAMPLE	11 Ag ppm-S	12 Ba ppm-S	13 Be ppm-S	14 Co ppm-S	15 Cr ppm-S	16 Cu ppm-S	17 Ga ppm-S	18 La ppm-S	19 Li ppm-S	20 Mo ppm-S
143	MBQ628	1.0000L	1700.0000	10.0000	6.8000	20.0000	8.4000	24.0000	20.0000L	810.0000	10.0000L
144	MBQ635	700.0000	100.0000	1.3000	1.0000L	10.0000L	210.0000	10.0000L	20.0000L	50.0000L	10.0000L
145	MBQ637	50.0000	20.0000L	1.0000L	50.0000	10.0000	70.0000	10.0000L	41.0000	50.0000L	10.0000L
146	MBQ655	1.0000L	75.0000	3.7000	23.0000	11.0000	32.0000	10.0000L	20.0000L	50.0000L	10.0000L
147	MBQ551	1.0000L	71.0000	3.3000	14.0000	10.0000L	15.0000	21.0000	20.0000L	50.0000L	10.0000L
148	MBQ556	9.5000	73.0000	1.0000	1.0000L	10.0000L	45.0000	10.0000L	20.0000L	50.0000L	60.0000
149	MBQ569	1.0000L	170.0000	2.8000	1.0000L	10.0000L	2.5000	14.0000	20.0000L	50.0000L	10.0000L
150	MBQ590	1.0000L	140.0000	2.7000	10.0000	14.0000	19.0000	10.0000L	20.0000L	50.0000L	10.0000L
151	MBQ593	1.0000L	260.0000	1.6000	1.0000L	21.0000	16.0000	10.0000L	20.0000L	50.0000L	10.0000L
152	MBQ624	1.0000L	730.0000	3.5000	1.8000	10.0000L	1.8000	16.0000	28.0000	50.0000L	10.0000L
153	MBQ625	1.0000L	140.0000	2.5000	1.0000L	10.0000L	1.9000	16.0000	20.0000L	50.0000L	10.0000L
154	MBQ693	37.0000	36.0000	1.0000L	1.0000L	10.0000L	190.0000	10.0000L	20.0000L	50.0000L	15.0000
155	MBQ746	1.0000L	420.0000	5.0000	2.6000	10.0000L	3.4000	21.0000	20.0000L	50.0000L	10.0000L

ROWNO	SAMPLE	1 Si%-S	2 Al%-S	3 Fe%-S	4 Mg%-S	5 Ca%-S	6 Na%-S	7 K%-S	8 Ti%-S	9 P%-S	10 Mn ppm-S
143	MBQ628	26.0000	10.0000L	10.0000L	70.0000	42.0000	27.0000	50.0000L	250.0000	8.2100	2.9200
144	MBQ635	3.3000	5000.0000G	10.0000L	57.0000	23.0000	10.0000L	270.0000	65.0000	1.7000L	2.0200
145	MBQ637	27.0000	500.0000	10.0000L	57.0000	12.0000	27.0000	10000.0000G	11.0000	20.9000	0.2500
146	MBQ655	180.0000	10.0000L	10.0000L	10.0000L	10.0000L	68.0000	130.0000	10.0000L	5.5800	1.7200
147	MBQ551	12.0000	46.0000	10.0000L	10.0000L	10.0000L	10.0000L	50.0000L	20.0000L	6.4000L	22.0000
148	MBQ556	1.5000	11000.0000	10.0000L	10.0000L	10.0000L	10.0000L	130.0000	20.0000L	2.1000L	2.0700
149	MBQ569	1.0000L	52.0000	10.0000L	68.0000	10.0000L	10.0000L	50.0000L	20.0000L	20.0000	4.5000
150	MBQ590	30.0000	20.0000	10.0000L	24.0000	23.0000	26.0000	50.0000	10.0000L	1.5000L	0.6300
151	MBQ593	4.3000	10.0000L	10.0000L	32.0000	38.0000	14.0000	50.0000L	42.0000	4.7600	1.0400
152	MBQ624	5.7000	18.0000	10.0000L	230.0000	24.0000	13.0000	50.0000L	83.0000	4.7300	1.7000
153	MBQ625	3.6000	120.0000	10.0000L	92.0000	29.0000	10.0000L	50.0000L	10.0000L	6.2900	1.4100
154	MBQ693	2.6000	20000.0000G	10.0000L	21.0000	10.0000L	10.0000L	50.0000L	20.0000L	2.6000L	4.8100
155	MBQ746	3.7000	170.0000	10.0000L	29.0000	10.0000L	18.0000	110.0000	28.0000	20.4000	6.5600

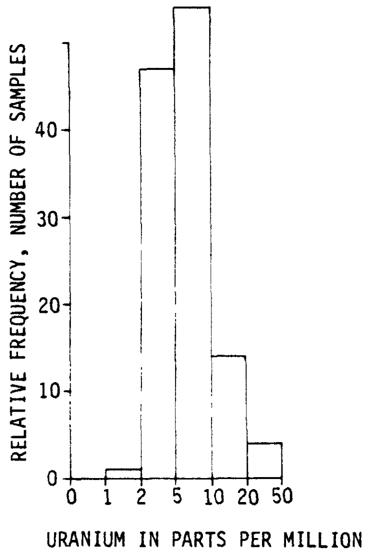
Mean concentrations of uranium and thorium in Precambrian metasedimentary rocks are within the range commonly observed for unmineralized sedimentary and metasedimentary rocks elsewhere (Adams and others, 1959). Likewise, the concentrations of uranium and thorium in andesitic and mafic dikes is in the range normally found in these rock types (Adams and others, 1959). Concentrations of uranium and thorium in samples of granitic Ibapah stock are in the upper part of the range reported for granitic rocks (Adams and others, 1959) and require discussion.

The uranium content of the Ibapah stock ranges from 1 to 45 ppm (table 2). The mean content, 6.03 ppm, is not unusual compared to granites and quartz monzonites elsewhere (Adams and others, 1959) but is higher than the 4.4 ppm uranium reported by Marjaniemi and Basler (1972) for 116 samples collected throughout the western United States. Many uranium geologists consider values greater than 10 ppm to be of special interest--this abundance is about twice the world average for granitic rocks. Fifteen percent of the samples from the Ibapah stock contain more than 10 ppm uranium. A break in the slope of the cumulative frequency curve, at an abundance of 12 ppm uranium, (fig. 4) indicates that a uranium-rich variant of the Ibapah Granite may be present. Based on figure 4, eight percent of the samples, containing greater than 12 ppm uranium, may belong to the uranium-rich variant. However, the uranium-rich samples are not lithologically distinct in the field or under the microscope, and, more importantly, no radioactive zones were observed near them.

It is well known that uranium can be leached from rocks by weathering (Stuckless and others, 1977); hence, surveys based on surface samples can severely underestimate the uranium content of rocks at depth. However, most of the granite samples collected are not heavily weathered, and they can be

Table 2.--Summary Statistics for U and Th in rock samples.

Rock Type	Number of samples	Thorium (ppm)				Uranium (ppm)				Th/U	
		Min.	Max.	Mean	St. dev.	Min.	Max.	Mean	St. dev.	Mean	St. dev.
Granite (all)	120	4.4	47	24.0	8.64	1	45	6.0	6.94	4.4	0.77
Altered granites	34	3.6	42	25.9	8.10	1	17	6.7	3.06	4.2	1.39
Metamorphic rocks (all)	53	1.4	27	11.9	7.46	<1	9.5	3.2	1.58	3.6	1.55
Mafic Dikes	5	1.5	18	10.2	7.59	<1	7	3.7	3.11	3.0	1.29
Quartz Veins	11	1.5	20	8.8	7.70	<1	22	2.5	1.98	3.6	0.73



Geometric Mean = 6.03 ppm
Geometric Deviation = 1.74
Median = 5.91 ppm
Mode = 5 - 10 ppm
Range = 1.01 - 44.8 ppm
Number of samples = 120

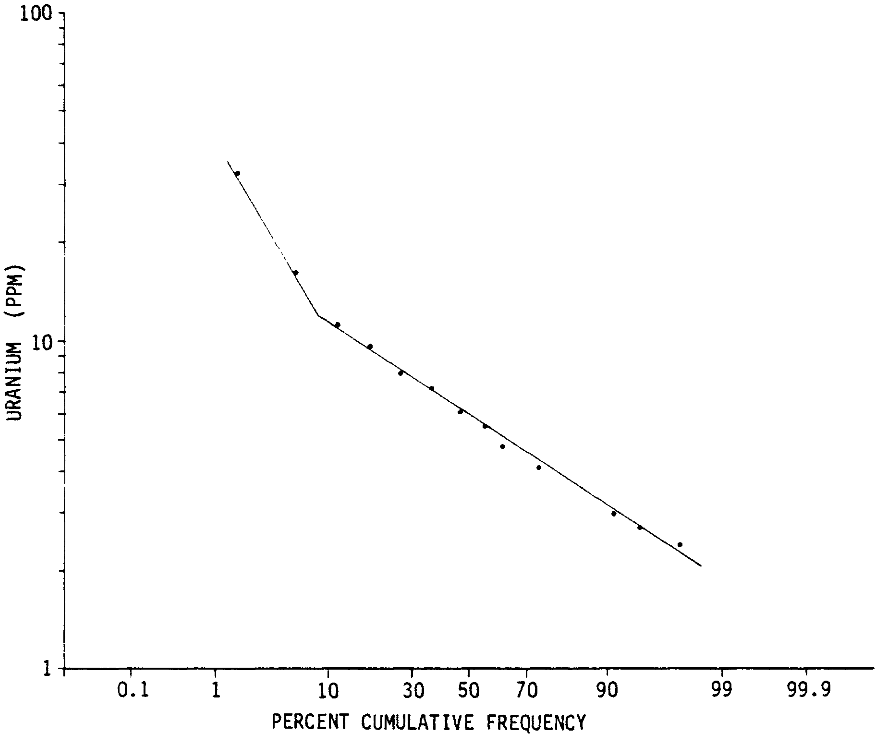
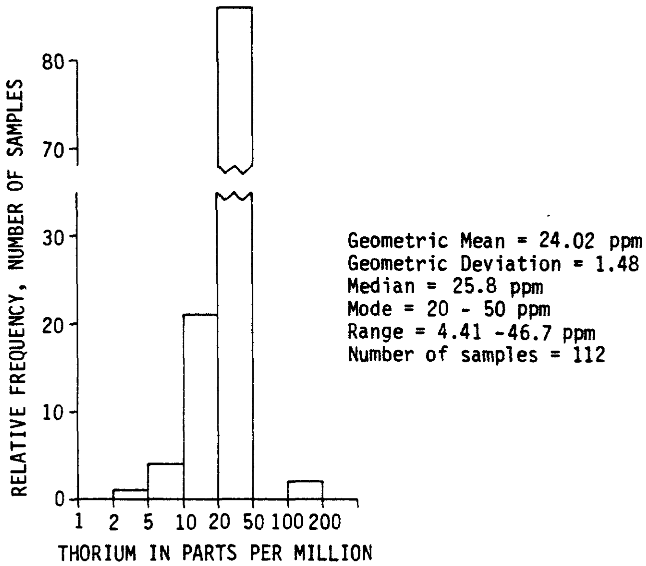


Figure 4.--Histogram and cumulative frequency distribution of uranium in Ibapah stock, Deep Creek Mountains, Utah.

compared with similar surface samples of granite. This comparison should be reliable for establishing the amount of uranium relative to other fresh surface samples (Nash, 1979). Although we cannot establish the subsurface uranium content of granite of the Ibapah stock without a drilling program, the surface samples indicate that this granite contains about 2 ppm more uranium than most granites (including quartz monzonites) in the western United States, but it contains distinctly less than granites with associated uranium deposits. The mean surface-sample uranium content of granites with associated uranium deposits is greater than 14 ppm (Nash, 1979; Leroy, 1978), and thus it seems unlikely that uranium deposits occur in or associated with the Ibapah stock.

Thorium content of the Ibapah stock ranges from less than 3.6 to 47.0 ppm, and the mean content is 24.0 ppm (Table 2). Thorium content of the Ibapah falls in the range normally observed for granites (Adams and others, 1959). The distribution of thorium (fig. 5) appears to closely resemble that of uranium, as shown by the consistency of Th/U near 4 and a correlation coefficient of 0.64 that is significant at the 99-percent level of confidence.

Petrographically, granite of the Ibapah stock resembles many granites that have genetically related uranium deposits (Nash, 1979; Cuney, 1978). The central part of the stock contains both muscovite and biotite and thus is a two-mica granite. This variety of granite is considered by many geologists to be favorable for uranium deposits (e.g. Nash, 1977; Cuney, 1978). However, because most of the uranium in the Ibapah appears to be carried in refractory minerals such as zircon, sphene, and monazite, most of the uranium in the rock is not leachable, which makes formation of uranium deposits unlikely.
Leaching of uranium by ground water or by hydrothermal fluids is considered necessary to form uranium deposits, and there is no evidence that this



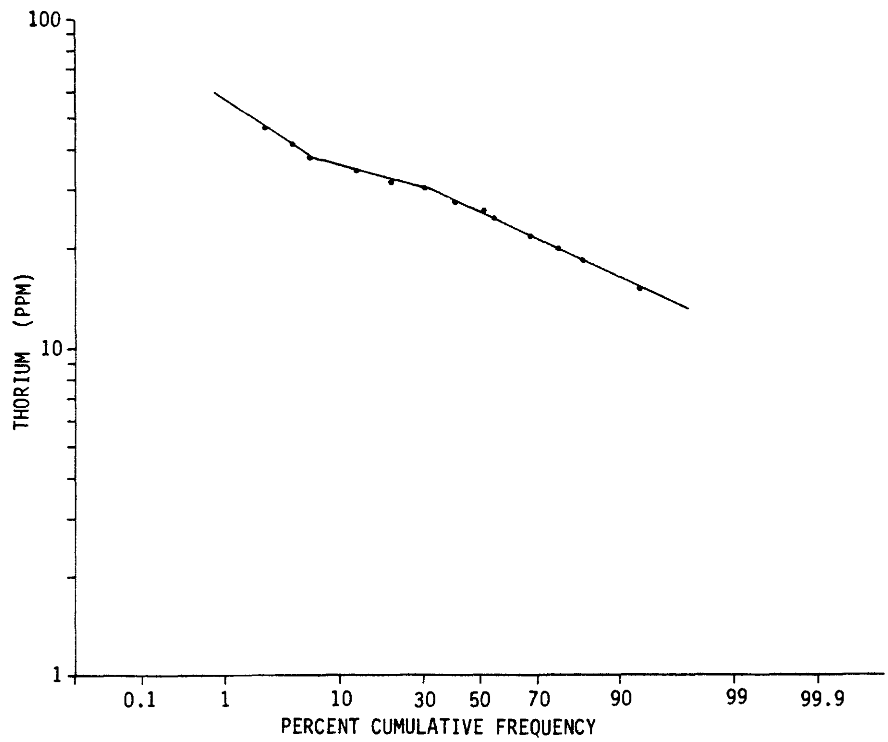


Figure 5.--Histogram and cumulative frequency distribution of thorium in Ibapah stock, Deep Creek Mountains, Utah.

happened in granite of the Ibapah stock.

Samples of metamorphic rocks and granite contain normal amounts of base and precious metals, even in alteration zones. (Some vein samples contain anomalous amounts of silver, lead, zinc, and copper, but these appear to be minor occurrences, and they will be discussed later.)

It is evident from the data in Table 1 that concentrations of some elements, such as Co, Cr, Ni, Pb, and Zn, are much higher in metasedimentary rocks than in granites. This pattern is normal (Turekian and Wedepohl, 1961). Hence, values of even 100 ppm Cr, Ni, Pb, or Zn, although they are anomalous with respect to the local sample population do not constititute exploration targets.

Twenty rock and sediment samples (table 1) were analyzed by fire assay-atomic absorption for gold, and none contained more than the detection limit, 0.05 ppm Au.

Geochemical Survey of Stream Sediments

A survey of stream sediments was undertaken to assist in the mineral resource evaluation. The stream sediment survey is an efficient method of checking for unknown or unexposed mineral deposits, because the sediments in streams reflect the chemistry of both rock and water in the basin above the sample site. A total of 126 stream sediment samples and 10 stream water samples were collected. The sediments were obtained from the beds of actively flowing streams and dry streams. Most of the samples are composites of material collected within a 100-ft (30-m) stretch of stream bed. Replicate samples were collected at several localities to test reproducibility of sampling and chemical analysis.

All stream sediments were air dried and sieved to obtain a less-than-170 mesh (88-micron) fraction. Studies in similar terranes have shown that this size fraction is optimum, because it reduces dilution of potentially interesting metals by major rock-forming elements. The less-than-170-mesh fraction of all stream sediment samples was routinely analyzed for 34 elements using a 6-step, DC-arc, semiquantitative emission spectrographic method, and uranium and thorium were analyzed by the delayed neutron method. Water samples were analyzed for uranium by an extraction fluorimetry method. The distribution and relative abundance of uranium in stream sediments collected in the central part of the Deep Creek Mountains is shown on plate 1. Class intervals, represented by symbols of different sizes, were chosen from cumulative logarithmic probability plots of uranium.

Uranium and thorium contents of stream sediments are shown on figures 6 and 7. The frequency distributions of uranium and thorium are bimodal, indicating that two populations were sampled. The histograms suggest that the two sediment populations have approximately 2-5 ppm and 20-50 ppm uranium respectively, and 10-20 ppm and 100-200 ppm thorium respectively (table 3). The two breaks on the cumulative frequency diagrams (figs. 6 and 7) suggest (1) a population of stream sediments containing generally less than 5.7 ppm U and 15.5 ppm Th, (2) a population of stream sediments containing more than 16 ppm U and more than 100 ppm Th, and (3) a mixed population of sediments with intermediate values. This can be explained by a metasedimentary source for the low U-Th population and a granitic source for the high U-Th population. All of the sediment samples with uranium and thorium values of less than 5.7 and 15.5 ppm, respectively, are geographically clustered in the north and south parts of the study area, where they were derived from metasedimentary rocks. All sediment samples with uranium and thorium values greater than 16 and 100 ppm, respectively, are clustered in the central part of the study area and are interpreted as being derived from granite of the Ibapah stock.

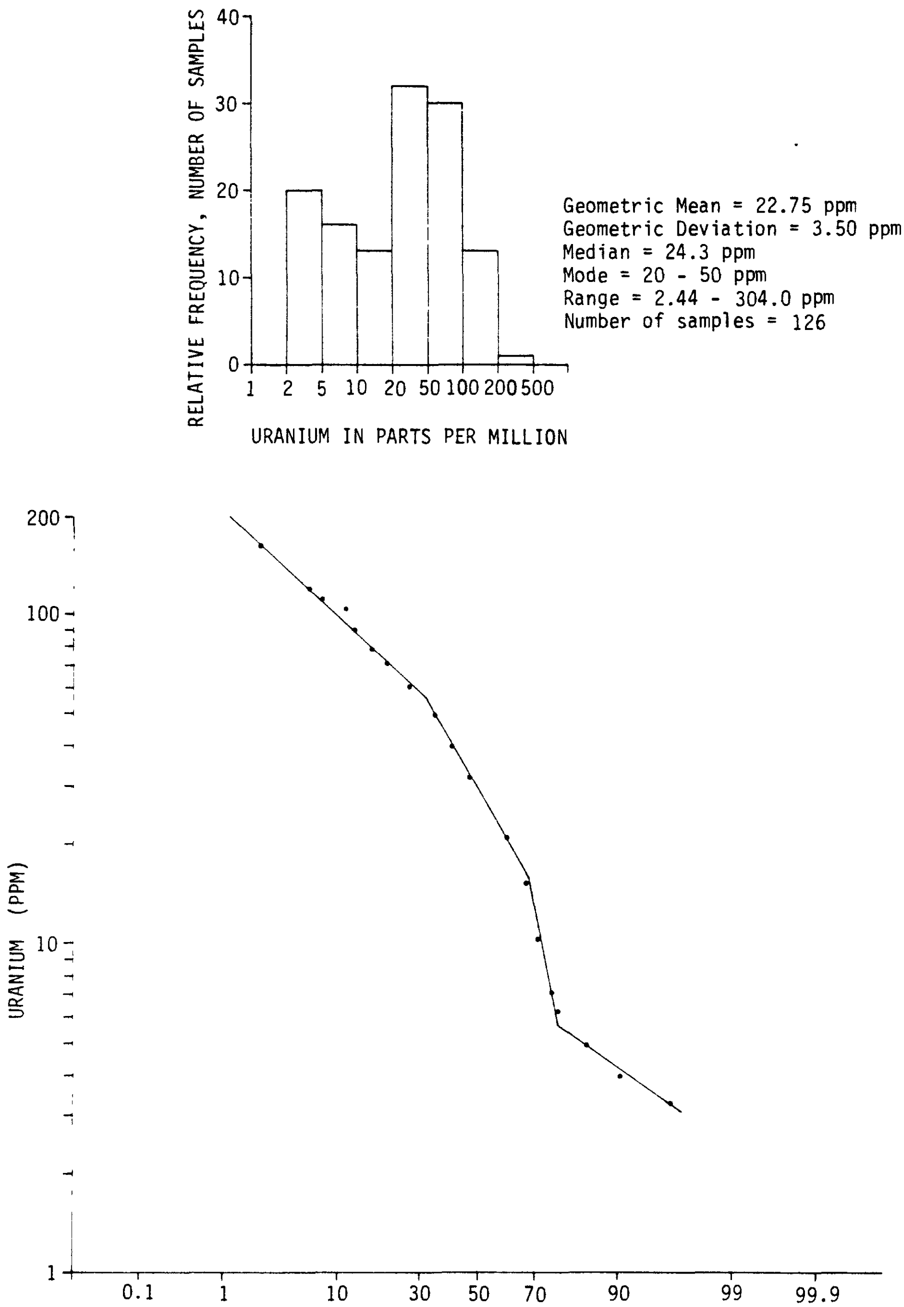


Figure 6.--Histogram and cumulative frequency distribution of uranium in stream sediment samples, Deep Creek Mountains, Utah.

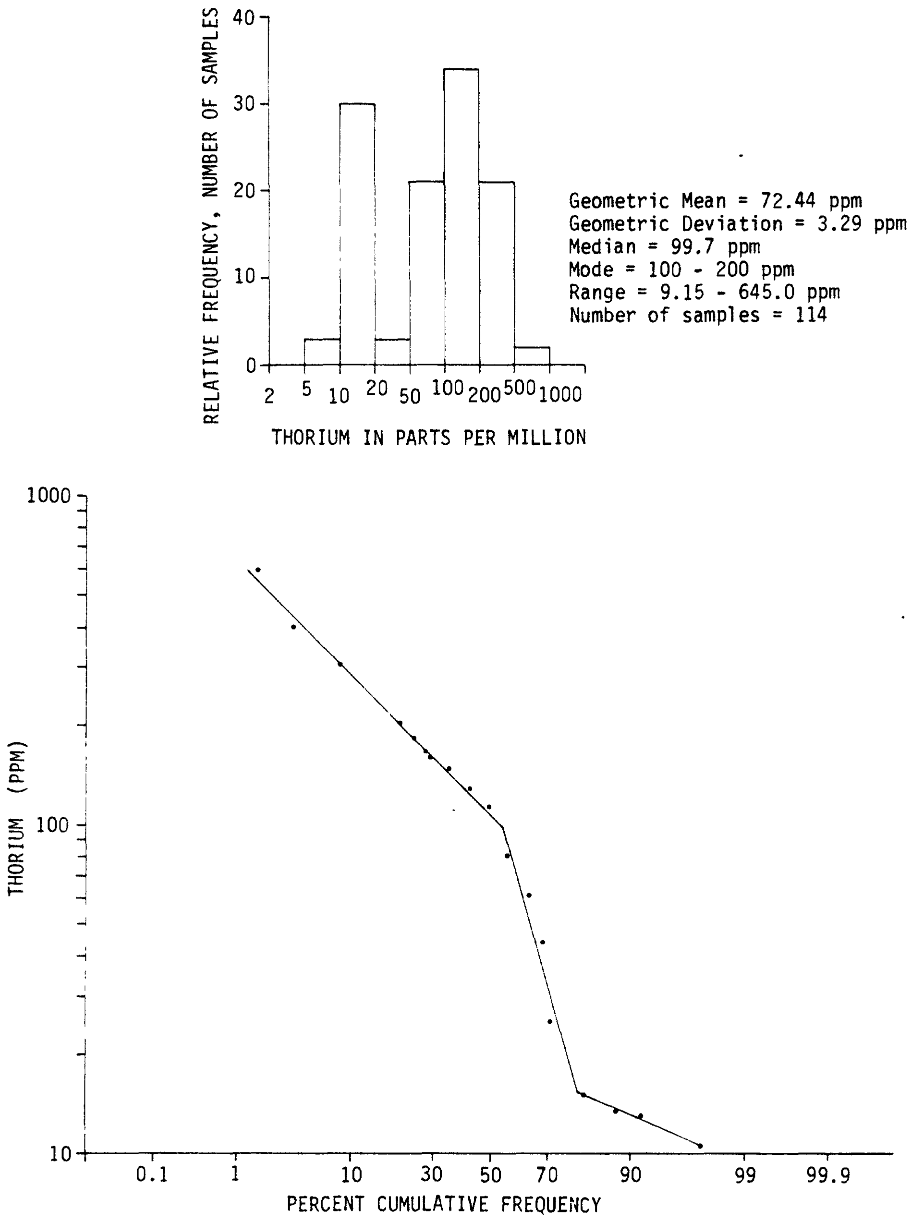


Figure 7.--Histogram and cumulative frequency distribution of thorium in stream sediment samples, Deep Creek Mountains, Utah.

Table 3.--Summary statistics for U and Th in stream sediment samples.

Uranium			
	All stream sediments	Stream sediments <16 ppm U	Stream sediments >16 ppm U
Geometric mean (ppm)	22.8	5.4	0.43
Geometric deviation (ppm)	3.50	1.7	1.7
Median (ppm)	24.3	5.0	55
Mode (ppm)	20-50	2-5	20 -50
Range (ppm)	2.4-210	2.4-15	16-210
Number samples	125	43	82

Thorium			
	All Stream Sediments	Stream Sediments <55 ppm Th	Stream Sediments >55 ppm Th
Geometric mean (ppm)	72.4	16.4	156.0
Geometric deviation (ppm)	3.29	1.59	1.73
Median (ppm)	99.7	14.3	153
Mode (ppm)	100-200	10-20	100-200
Range (ppm)	9.21-645	9.21-54	58-645
Number samples	114	39	75

Sediment samples with values of uranium ranging from 5.7 to 16 ppm and thorium ranging from 15.5 to 100 ppm are considered to be mixtures derived from metasediments and Ibapah stock.

Uranium in stream sediments behaves very similarly to thorium, as shown by a correlation coefficient of 0.81 that is significant at the 99 percent confidence level. The Th/U ratio of most uranium- and thorium-rich stream sediments is between 3 and 4, very similar to that of the granite source rocks. Therefore, uranium and thorium in stream sediments derived from granite is probably carried in the resistate minerals zircon, monazite, and sphene, as observed in alluvium.

Analytical data for 25 other elements in stream sediments is summarized in table 4. The ranges and median values appear normal, and no mineralization is suggested. The following elements were sought in chemical analyses but no samples contained more than the limit of detection (in parentheses):

Au (10 ppm), Mo (5 ppm), Cd (20 ppm),
As (200 ppm), Sb (100 ppm), Bi (10 ppm),
Li (100 ppm), and W (50 ppm)

As discussed previously for uranium and thorium, stream sediment geochemistry reflects source-rock character. For example, copper content is higher in stream sediments derived from metasedimentary rocks than in those derived from the Ibapah stock. The break in slope on the cumulative frequency diagram (fig. 8) suggests the likelihood of two source-rock populations. The geographic distribution of samples indicates that most stream sediment samples containing more than 25 ppm copper came from streams draining metasedimentary rocks and most containing less than 25 ppm copper came from streams in the Ibapah stock.

Table 4.--Summary of element concentrations in less-than-170-mesh (88-micron) stream sediment samples from the central part of the Deep Creek Range, Utah.

Element	Minimum	Maximum	Median	Mode	Number of samples
		Data in percent			
Fe	1.0	7.0	2.0	2.0	126
Mg	0.3	3.0	0.7	0.5	126
Ca	0.5	15.0	2.0	1.5	126
Ti	0.15	1.0	0.3	0.3	126
Na	1.0	5.0	2.0	2.0	126
Al	4.0	10.0	7.0	7.0	126
		Data in parts per million			
Ag	N(0.5)	2	L(0.5)	L(0.5)	126
Cu	7	100	20	20	126
Pb	L(10)	300	50	50	126
Zn	L(5)	50	15	15	116
Ni	L(5)	50	15	15	126
Co	5	30	10	10	126
Cr	20	150	70	5	126
Mn	200	1,000	300	300	126
V	15	200	30	30	126
Sn	N(10)	30	10	10	126
Zr	200	G(1,000)	700	G(1,000)	126
B	N(10)	100	10	10	126
Ba	70	1,000	700	700	126
Be	3	70	20	30	126
La	20	500	150	150	126
Nb	10	100	30	20	126
Sc	5	30	15	15	126
Sr	100	700	300	300	126
Y	10	200	70	70	126

N--not detected at the lower limit of determination, in parentheses.
L--detected, but below the lower limit of determination, in parentheses.
G--detected, but at a value greater than the upper limit of determination, in parentheses.

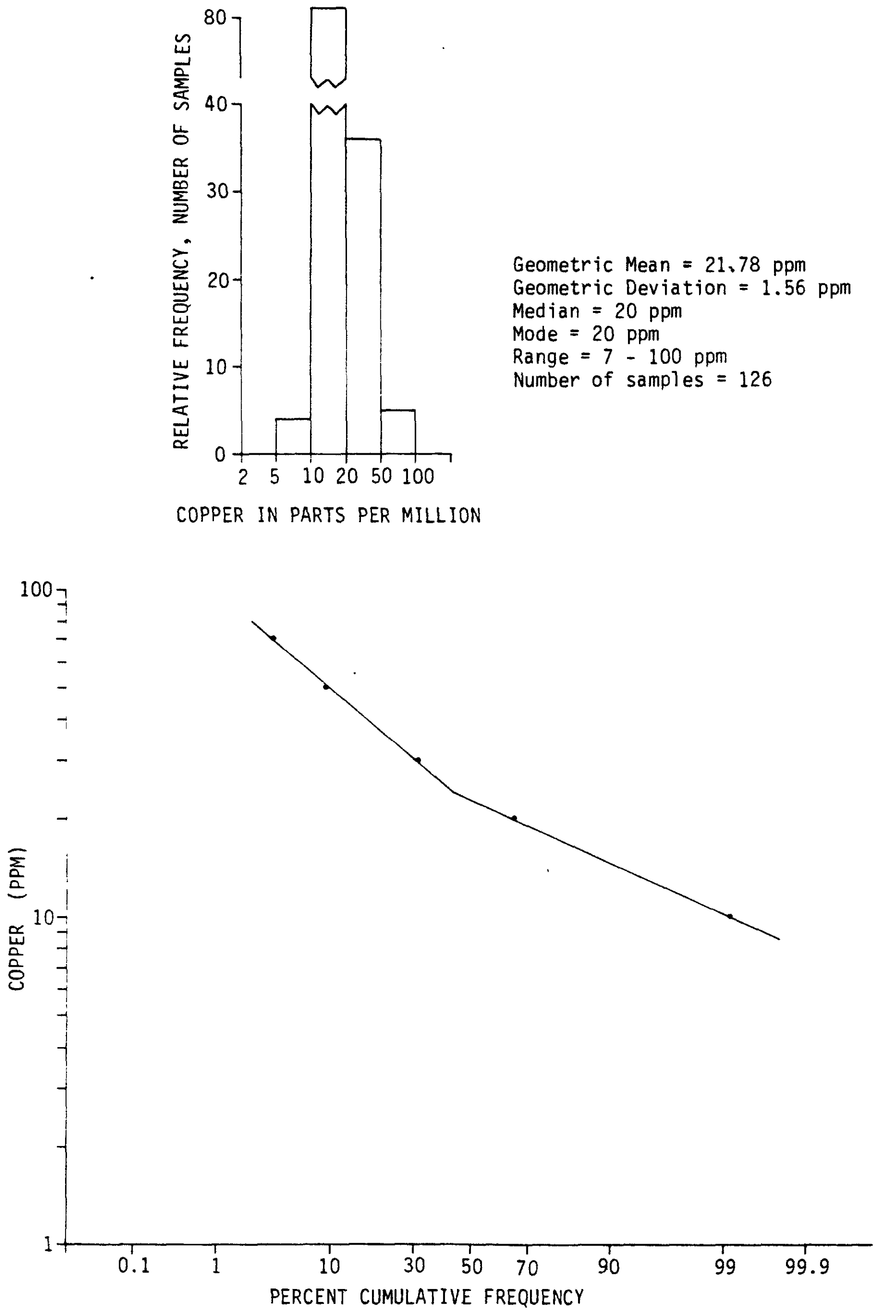


Figure 8.--Histogram and cumulative frequency distribution of copper in stream sediment samples, Deep Creek Mountains, Utah.

Radiation Surveys

Each group of geologists working together in the field carried at least one scintillometer with which the gamma radiation intensity was constantly monitored. At irregular intervals, and whenever possibly significant changes in the gamma radiation intensity were detected, the count rate, in counts per second (cps), was recorded. Traverses over the Tertiary Ibapah stock totaled approximately 60 mi (100 km). Traverses over the Precambrian metasedimentary rocks, which consisted principally of quartzite and phyllite, totaled approximately 27 mi (45 km). All scintillometers used were of the same brand and model (Geometrics Model GR101A)[1], and all gave comparable results. These scintillometers measure the flux rate of all gamma rays with energies above the detection limit of the instrument, regardless of the sources of the gamma rays. They cannot distinguish among gamma rays produced by cosmic rays, by potassium (^{40}K), by radioactive daughter isotopes of uranium, and by radioactive daughter isotopes of thorium. They measure the total of gamma rays from all sources, and, therefore, data obtained from these instruments are described as total-gamma data.

A more sophisticated instrument, the gamma spectrometer, is capable not only of counting gamma rays but also of distinguishing between gamma rays having different energies. Data from one of these instruments, (Scintrex Model GAD-4)[1] was used to calculate approximate uranium, thorium, and potassium contents of rocks and soil.

The traverses studied and the total-gamma activity data collected using scintillometers and the gamma spectrometer are plotted on Plate 2. Because the scintillometers and the gamma spectrometer used have different counting

[1]Use of brand names is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

characteristics (mainly the result of different detector crystal volumes), raw data from the two types of instruments are not directly comparable. Therefore, to facilitate comparison, a linear correction formula has been applied to the scintillometer data plotted on Plate 2. The correction formula raised all scintillometer readings by 24 percent.

Highest corrected total-count measurements are in the Ibapah stock, where 300 to 350 cps was typical. The median of total-gamma measurements for Precambrian phyllites is 134 cps, but most of the gammas are emitted by potassium rather than by uranium. The quartzites, with a median of 60 cps, showed unusually low gamma radiation.

The gamma spectrometer was used for five systematic gamma radiation traverses, four of which crossed parts of the withdrawal area (Plate 2). Each recording station, by number, and the total gamma count at each location are shown for each traverse. On five of the systematic gamma radiation traverses, total gamma count and counts for thorium, uranium, and potassium were recorded at each station. The gamma spectrometer used was calibrated with the Department of Energy standards at Grand Junction, Colorado. Using the calibration data, the gamma counts for uranium, thorium, and potassium were converted by conventional methods to equivalent compositional values in parts per million or percent, designated as equivalent thorium (eTh), equivalent uaniuim (eU), and potassium (K). These values are presented graphically along with distances and elevations in figures 9-13.

Mean values of uranium and thorium (13 ppm eU and 60 ppm eTh) derived from the gamma spectrometer survey are significantly higher than mean values (6.0 ppm U and 24 ppm Th) derived from the delayed neutron analyses of rock samples. The discrepancy is approximately a factor of two, but careful comparison of the data obtained by the two techniques indicates that the

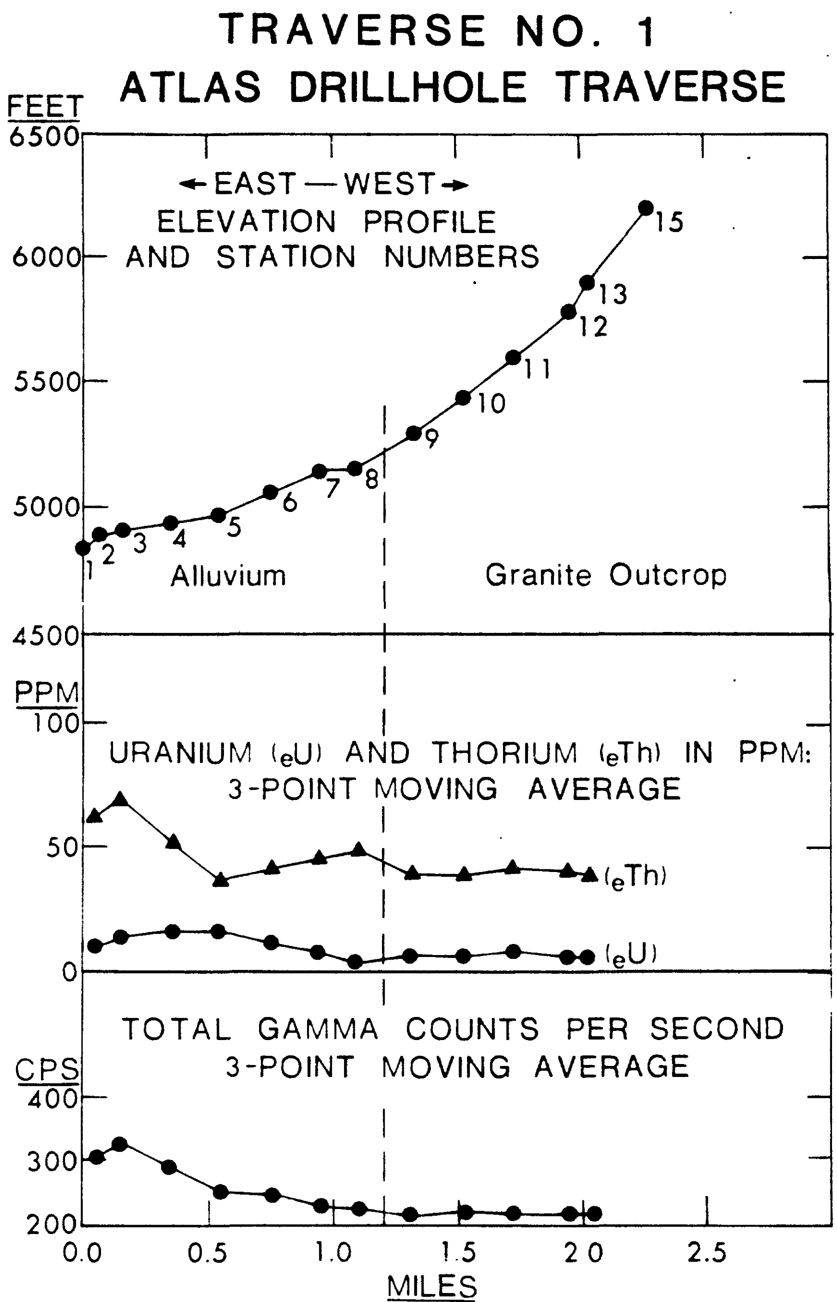


Figure 9.--Radiometric profile of Traverse No. 1, Atlas Drillhole Traverse.

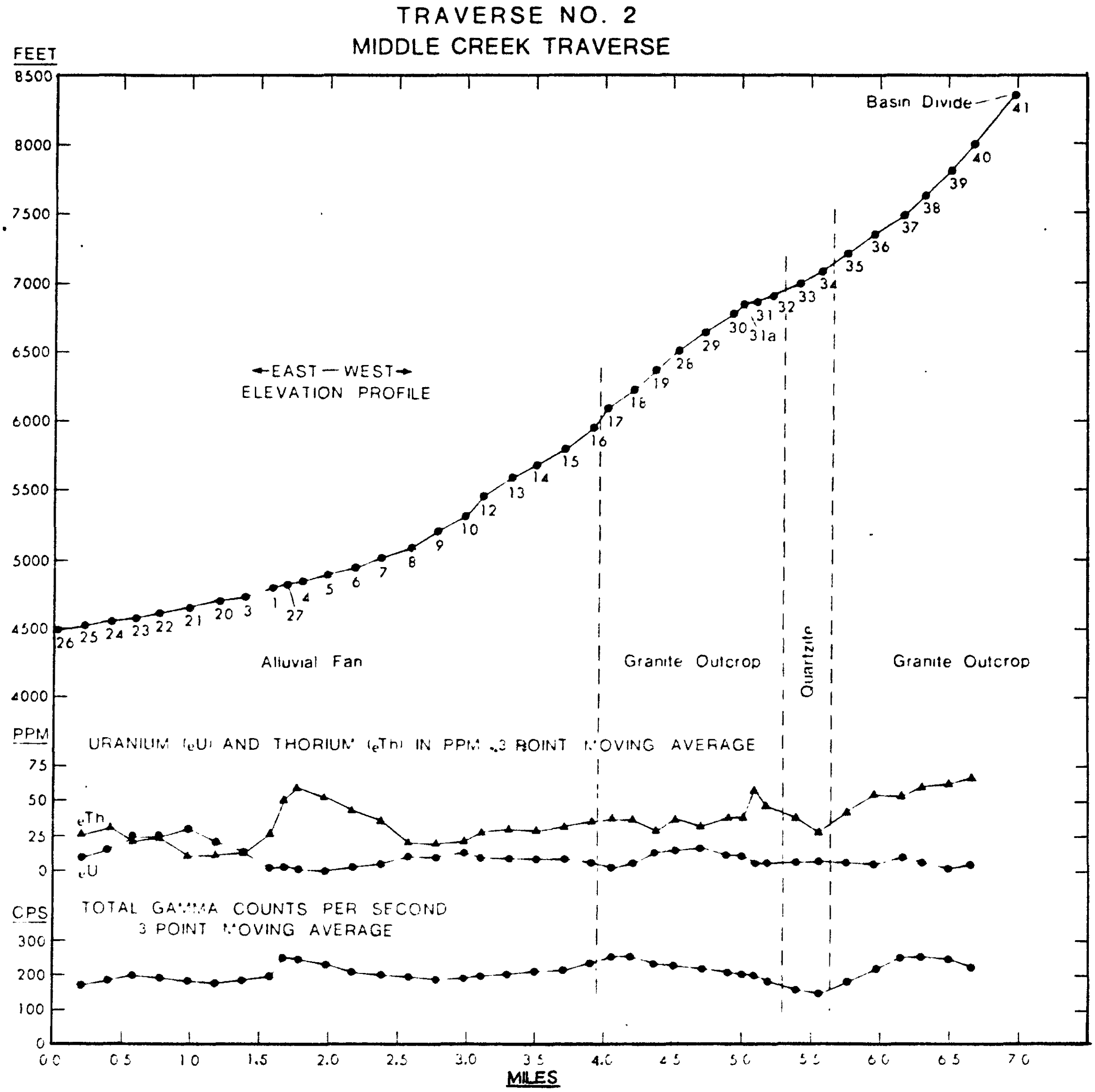


Figure 10.--Radiometric profile of Traverse No. 2, Middle Creek Traverse.

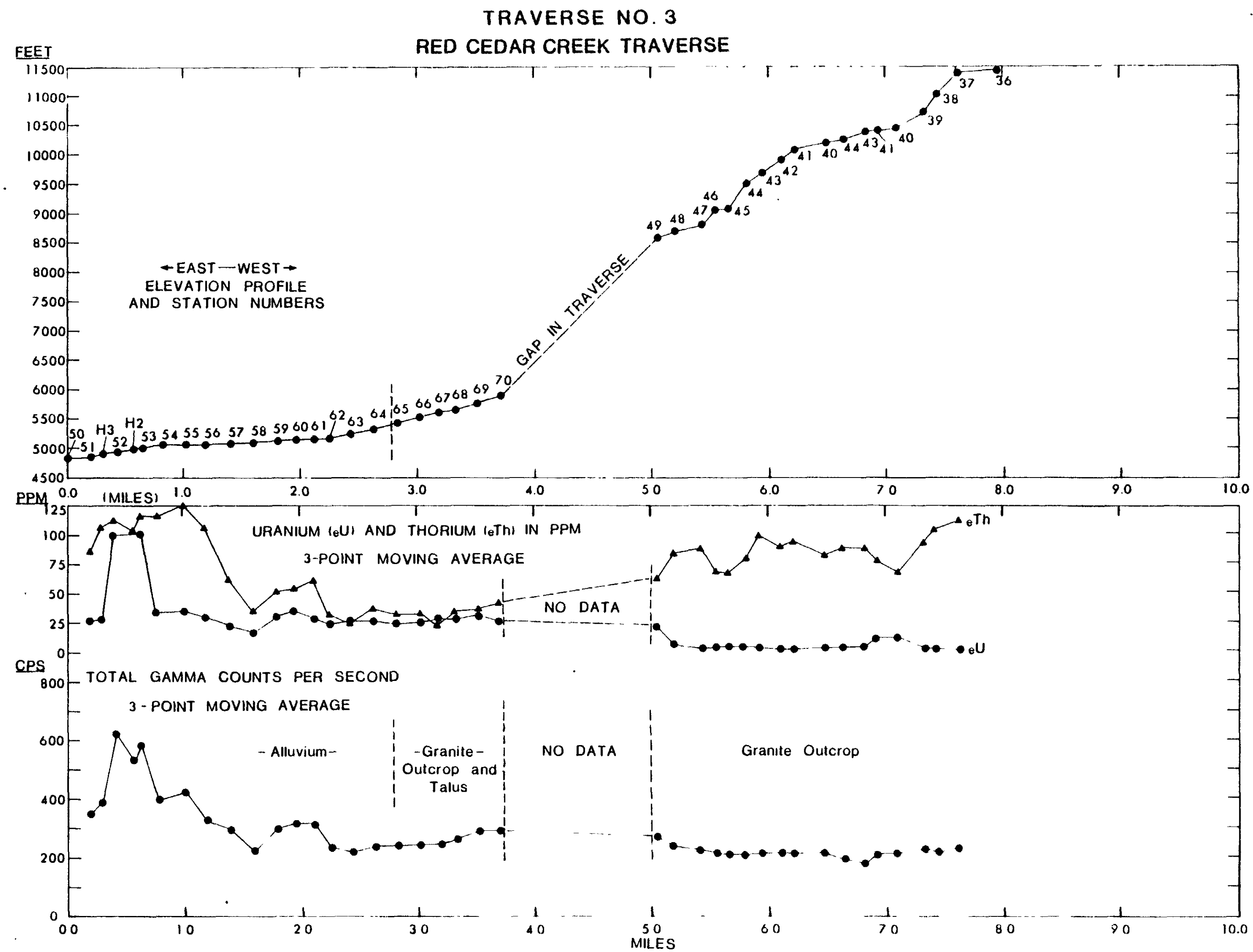


Figure 11.--Radiometric profile of Traverse No. 3, Red Cedar Creek Traverse.

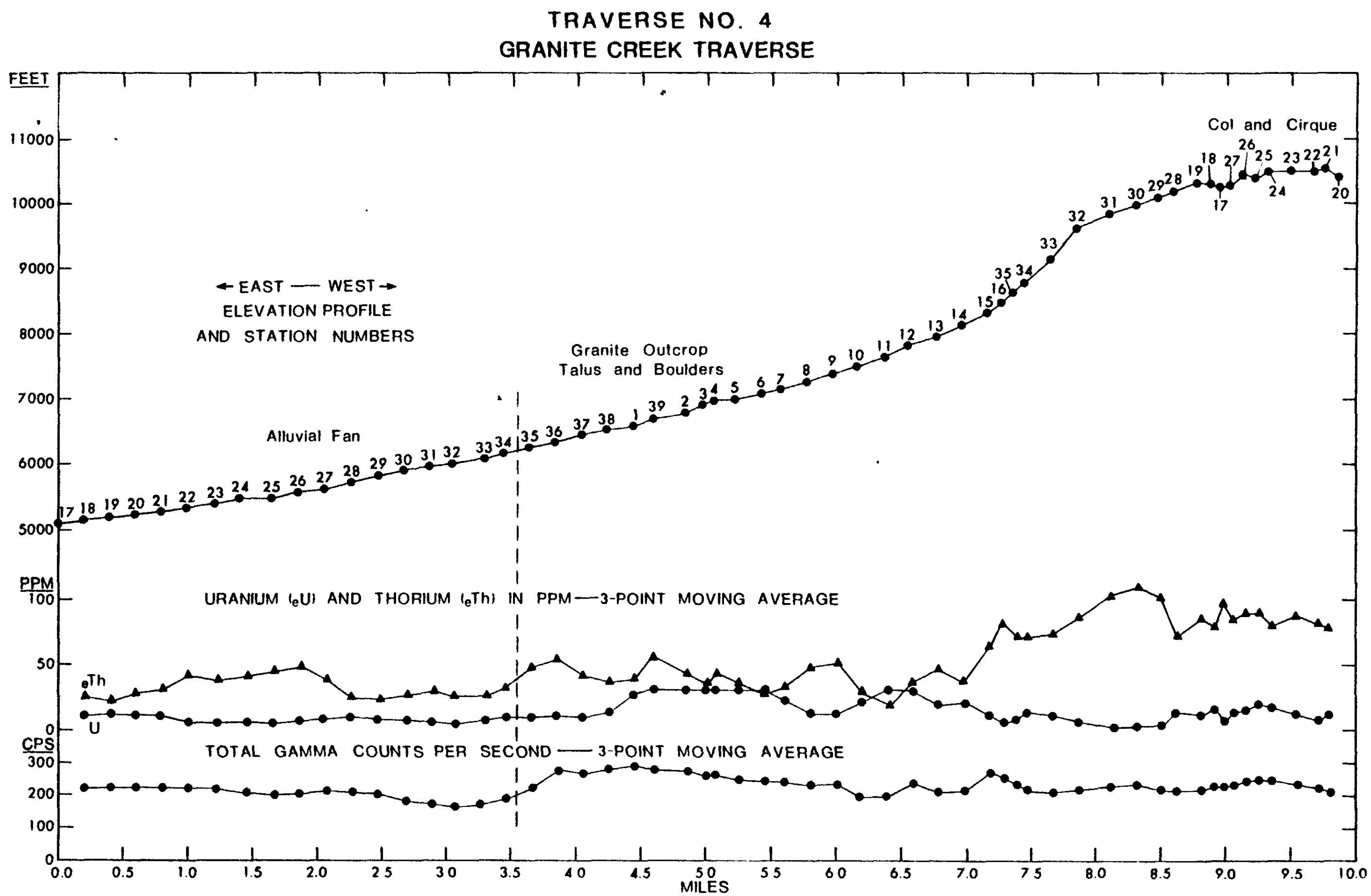


Figure 12.--Radiometric profile of Traverse No. 4, Granite Creek Traverse.

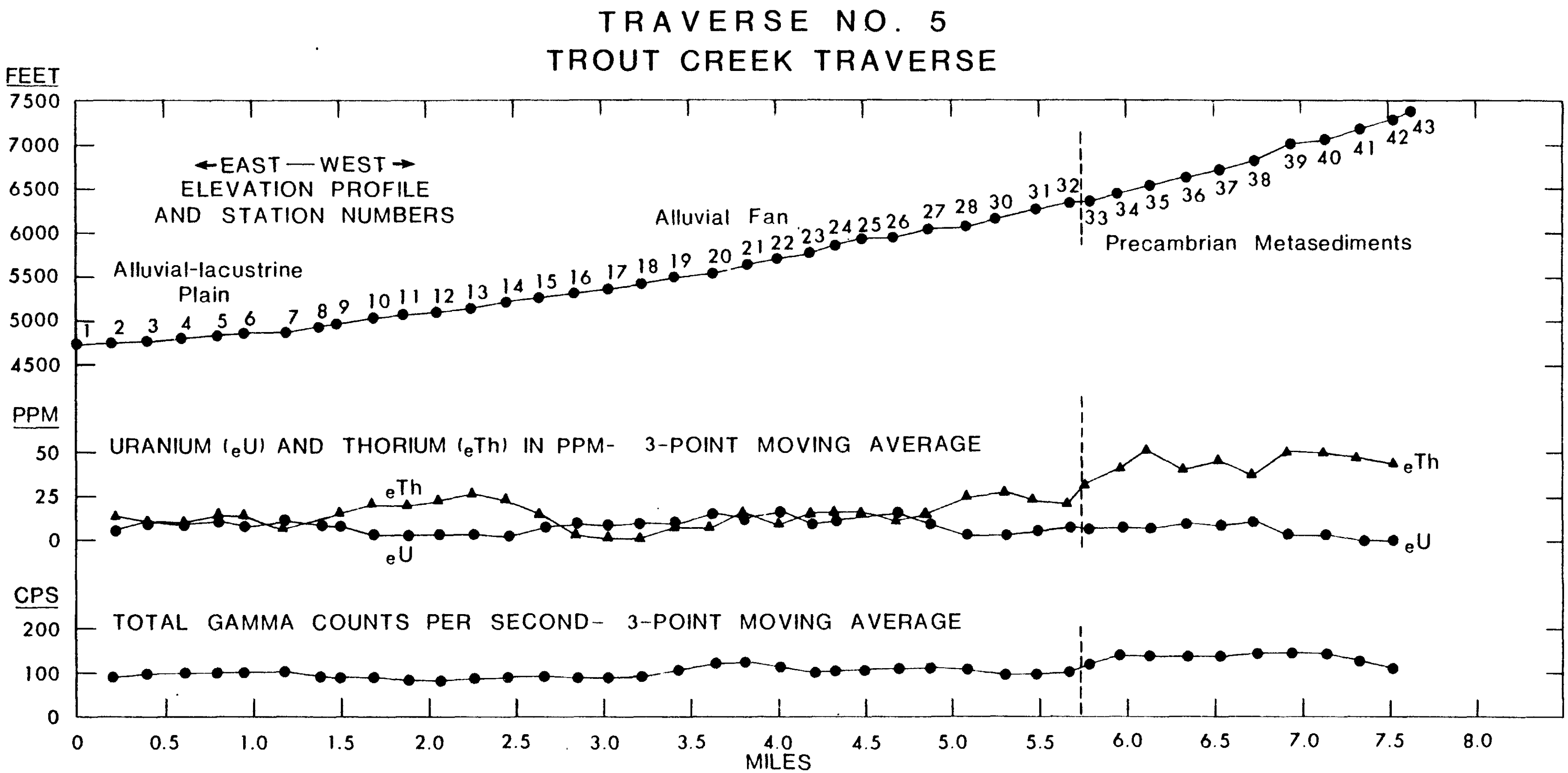


Figure 13.--Radiometric profile of Traverse No. 5, Trout Creek Traverse.

discrepancy is not a constant factor; it varies proportionately with the uranium concentration. The discrepancy probably results from error in calibrating the gamma spectrometer.

Each measurement made with the gamma spectrometer used in our radiometric traverses samples a circular slice of the ground 6 ft (2 m) in diameter and about 1 ft (30 cm) thick. Material directly below the measuring instrument exerted a greater influence on the value measured than did material along the perimeter of the circular slice.

Typically in such a survey, rocks with minor amounts of radioactive elements, such as most limestones or pure quartzites, may yield about 50 total-gamma counts per second or less, depending on the gamma spectrometer used. Granites containing greater amounts of potassium feldspars and other radioactive minerals may yield 200 total-gamma counts per second (cps) or more.

The average total-gamma radiation measurement at base camp in Callao, Utah, using the gamma spectrometer was approximately 70 cps. In much of the study area the average total gamma count measured was significantly higher. A summary of the values measured on the east-west oriented systematic gamma spectrometer traverses across the granitic Ibapah stock is shown below (93 stations):

	Total Gamma (cps)	eU (ppm)	eTh (ppm)	K (%)
Mean	231	13	60	4
Median	232	10	61	3
Maximum	308*	46*	138*	12
Minimum	99	1	9	1

Measured in a stream bed that probably contained placer mineral concentrations.

The parts of the gamma spectrometer traverses derived from the granite yielded the values shown t

	Total Gamma (cps)	eU (ppm)	eTh (ppm)	K (%)
Mean..........	224	17	44	4
Median........	225	13	38	4
Maximum.......	887*	236*	203*	6
Minimum........	148	1	1	1

*Measured in a shallow dry wash; heavy mineral placer concentrations present.

Part of the gamma spectrometer traverse which (Traverse No. 5, fig. 13) passes through Precambria values determined for the metasediments (11 statior

	Total Gamma (cps)	eU (ppm)	eTh (ppm)	K (%)
Mean...........	131	6	44	2
Median.........	135	2	44	2
Maximum........	153	24	74	3
Minimum.........	99	1	1	1

The part of traverse No. 5 that crossed alluvi detritus derived from the Precambrian metasedimentad the following values:

	Total Gamma (cps)	eU (ppm)	eTh (ppm)	K (%)
Mean............	98	9	16	2
Median..........	97	6	17	1
Maximum........	127	24	50	5
Minimum.........	57	1	1	1

On the basis of the statistical values, the Ibapah stock appears to contain two to five times as much uranium as the Precambrian rocks south of the Ibapah. Some Precambrian rocks show an average radiation of about twice that of the lake bed terrane of Callao, and the Ibapah stock shows an average radiation of more than three times the Callao radiation.

Alluvium derived mostly from the granite stock appears to contain on the average twice as much uranium as alluvium derived from the Precambrian rocks. Maximum values for eU and eTh are six times higher in the alluvium derived from granite than in the alluvium derived from metasedimentary rock.

Traverse number 6, fig. 14, is a traverse from the settlement of Callao, Utah to the settlement of Trout Creek, Utah. Orientation of the traverse was from north to south along the Callao-Trout Creek road. Only total-gamma counts were measured at 0.1-mi (0.16-km) intervals.

The graph of total-gamma counts shows a definite rise in values in the part of the traverse that passes through the sediments derived from the Ibapah. Variation in total count from station to station is high in the sediments derived from the Ibapah, which suggests the presence of local variations in the concentration of radioactive minerals. In order to smooth out local variations and detect trends, a three-point moving average was used to plot the total-count data. The result was the appearance of high and low ranges of total-gamma radiation, which can be correlated with the location of distributary and main-stem stream channelways in the alluvium. These are the most likely locations of radioactive mineral placers.

Using data from all 181 stations, the maximum measured total-gamma radiation was 459 cps at station 42 (4.2 mi or 6.5 km south of Callao). The minimum measured was 74 cps at station 175 (17.5 mi or 20.8 km south of Callao). The median value is 170 cps. The range of values is, thus, six

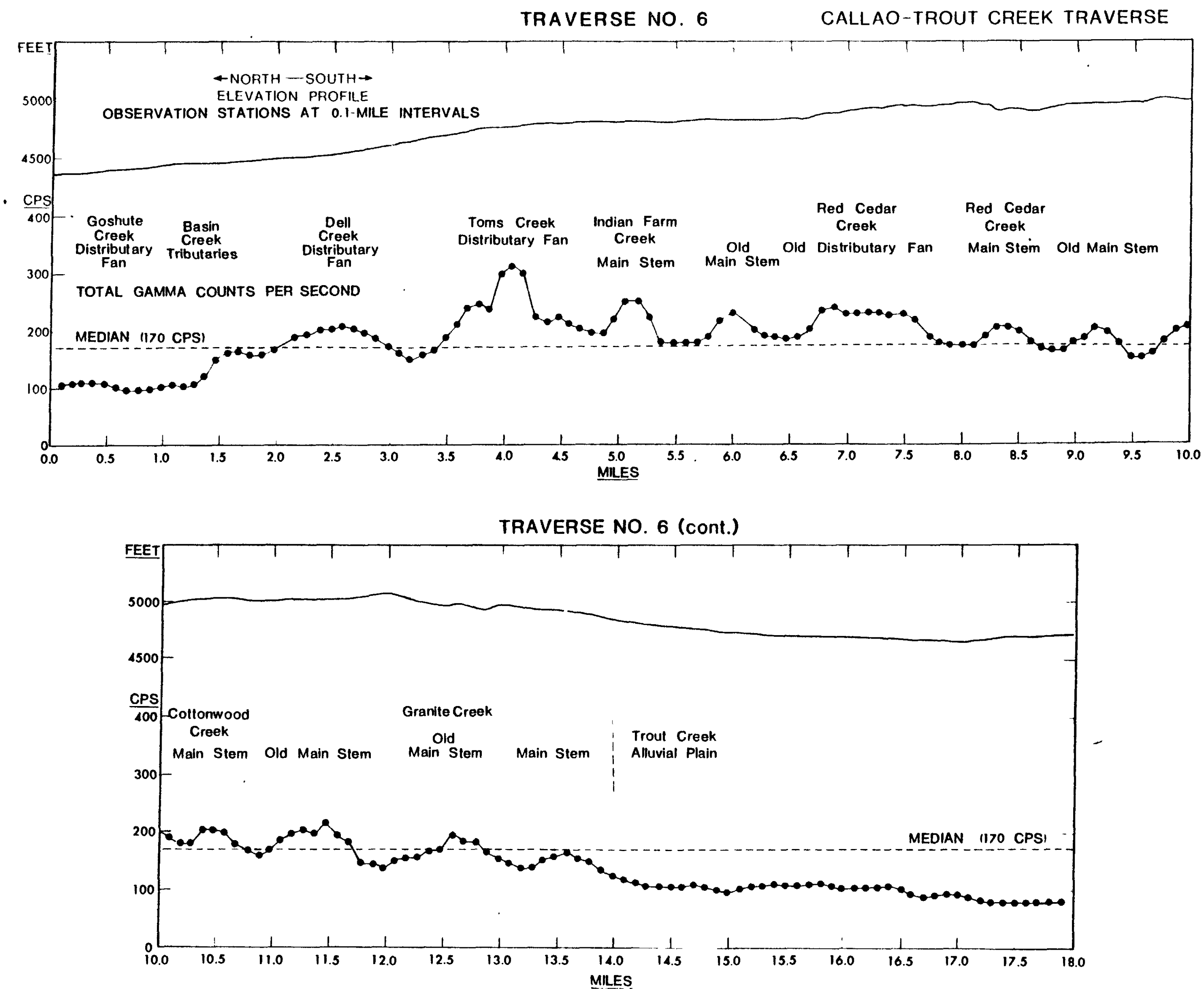


Figure 14.--Radiometric profile of Traverse No. 6, Callao-Trout Creek Traverse.

times the minimum value. The mean or average of the 130 measurements made in alluvium derived mostly from the granite is 188 cps. The mean for the 51 measurements made on alluvium derived mostly from the Cambrian and Precambrian rocks is 99 cps. The average sediment from the Ibapah granite stock yields twice the radiation of the average sediment from the Cambrian and Precambrian rocks.

Recorded measurements of total-gamma radiation for all traverses in the rocks of the study area range from 50-90 cps in relatively pure quartzites and limestones to 100-150 cps in phyllites and to 200-400 cps in granite. Highest measurements of total radiation were found in concentrations of radioactive minerals in sediments (lake beach or strandline sediments, alluvium, and active stream sediments), and these measurements fall into the general range of 400-1,200 cps.

Semiquantitative values for eU, eTh, and K in rocks computed from gamma spectrometer data range from approximately 1 to 50 ppm for eU, 1 to 150 ppm for eTh, and 1 to 15 percent for K. Wider ranges of values for eU and eTh are present in the sediment and alluvium derived from the granitic stock, owing to the localized concentration of uranium-bearing heavy minerals. These ranges are estimated to be 1 to 400 ppm eU and 1 to 500 ppm eTh. However, the extreme high values were recorded over quantitatively minor black-sand concentrates in modern stream beds.

With the possible exception of the high gamma counts found to occur over Tertiary and Quaternary sedimentary deposits east of the withdrawal area, no radiation anomalies were found that are of sufficient magnitude to suggest the presence of economic concentrations of uranium.

Evaluation of Potential Mineral Resources

Uranium Deposits.--Prior to undertaking the field and geochemical studies, environments were considered to be possibly favorable for uranium deposits, based on the general geologic character of the Deep Creek Mountains: (1) quartz-pebble conglomerate in Precambrian units; (2) veins within the granitic Ibapah stock, and (3) deposits in Tertiary and Quaternary sand and gravel. Based on geologic observations and geochemical results, only the last environment, deposits in sand and gravel, seems favorable.

Important uranium deposits occur in Precambrian conglomerate in Ontario, Canada, and in South Africa. We conclude that the Precambrian strata in the Deep Creek Mountains are not favorable for this type deposit for the following reasons: (1) Precambrian rocks of the Deep Creek Mountains are probably too young; (2) no significant uranium and thorium anomalies were found, and (3) although some conglomerates have appropriate texture and grain size, quartzite pebbles rather than quartz pebbles predominate, and the diagnostic mineral pyrite was not observed. Hence, conglomerates of the Deep Creek Mountains are unlike productive conglomerates elsewhere.

Uranium deposits occur in intrusive contact zones, similar to those of the Ibapah stock of the Deep Creek Mountains, in several places in the world, most notably at the Midnite Mine, Washington. Several features observed in the withdrawal area compare favorably with those at the Midnite Mine, chiefly the presence of sulfidic phyllite intruded by somewhat radioactive granite. However, other important features make us conclude that contact zone uranium deposits are unlikely: (1) the exposed contact is steeply dipping and does not occur at the top of the intrusion; (2) the area has youthful topography, which makes supergene enrichment unlikely; (3) there are no indications of uranium mobility in the pluton; and (4) no uranium anomalies were found near the contact.

Vein-type deposits of uranium occur in many places around the world and are best known in France (Cuney, 1978). As mentioned previously, the lithology of the granitic Ibapah stock is generally similar to that associated with uranium veins in France (Cuney, 1978). However, other attributes, well known from the French examples (Cuney, 1978), were not observed in the Ibapah stock: (1) no radioactive veins or faults were observed; (2) mean uranium content of the granite is only slightly higher than that of normal granites that contain no uranium deposits; (3) no episyenite alteration was observed; and (4) uranium in the Ibapah stock appears to be contained in refractory minerals such as zircon, sphene, monazite, and allanite, rather than in the soluble mineral uraninite, found in the French examples. Episyenite alteration produces red-brown color in granite and an unusual porous texture, partially the result of removal, by leaching, of quartz. These characteristics were not observed on our traverses. In summary, we found no evidence to suggest that intragranitic vein deposits of uranium are present. A geochemical coherence of uranium and thorium in samples of fresh and altered granite, as well as in sand and gravel derived from the granite, is an important observation in this study. Mineralogical studies of samples of granite and alluvium indicate that the probable explanation for uranium and thorium coherence is their mutual residence in the resistate minerals zircon, monazite, and sphene. These minerals are not easily dissolved during hydrothermal alteration, weathering, or stream transport, which explains the unusually uniform Th/U ratios. If uranium were present in a soluble mineral, such as uraninite, it would tend to dissolve more readily than thorium, and the Th/U ratio would be variable and tend to be high in altered rocks and sediments. This inferred insolubility of uranium in the Ibapah stock explains the absence of uranium anomalies in fractures and veins associated with the granite.

To test our inference, chemical tests of uranium solubility were made by F. N. Ward (USGS, oral commun., 1979), who measured the amount of uranium dissolved from rocks and sediments in acid (4 N HNO_3) at 94°C for 1 hr. For five samples of granite from the Ibapah stock the average amount of uranium dissolved was 22 percent of the amount present (range 12 to 30 percent). In two samples of sediment (samples MBQ688 and 738), 17 and 12 percent of total uranium content dissolved. These analyses are consistent with our interpretation that most uranium in the Ibapah, and in sediments derived from the Ibapah, is held in refactory minerals.

Several types of uranium deposits occur in sandstone in the United States. The Tertiary sediments east of the Ibapah stock have the general character of the fluvial sandstones that host uranium deposits in Wyoming. However, Wyoming-type sandstone deposits probably would occur east of the withdrawal boundary, if the occur at all.

Uranium deposits can also occur in sandstones as mechanical concentrations of refractory minerals called placer deposits. Dark, radioactive heavy-mineral layers are present in the Tertiary sand and gravel deposits and especially in Quaternary beach terraces where Pleistocene Lake Bonneville reworked the sediments.

As described earlier, numerous radioactivity and geochemical anomalies are caused by the black heavy-mineral concentrations. It is important to emphasize that analyses such as MBQ 688 (583 ppm Th and 149 ppm U) and MBQ 738 (642 ppm Th and 168 ppm U) are not representative of large volumes; rather, they are samples that were selected with care from beds less than an inch thick. More representative of large deposits is sample MBQ 684, a channel sample across a 5 ft thick section of sediment exposed in an arroyo; the concentrations of thorium and uranium, 46.7 and 6.77 ppm respectively, may be approximately representative of terrace deposits between 5,200 and 5,040 ft (1585 and 1535 m) in elevation. Because heavy minerals consitute approximately 5 percent of the channel sample, and because heavy minerals can be beneficiated rather inexpensively, these deposits may have economic potential in spite of their seemingly very low uranium and thorium content. Chemical analyses reveal the presence of high concentrations of thorium, zirconium, titanium, cerium, lanthanum, yttrium, ytterbium, and some niobium in heavy mineral concentrates made in the laboratory from seven samples of granite and alluvium (table 5). These possible byproducts add to the potential value of the placer deposits. Drilling or trenching and analyses of large bulk samples are required to properly evaluate the economic potential of the placer deposits.

Essentially all of the possibly economic placer deposits occur outside of the withdrawal boundary. The western limit of the terrace deposits is approximately the 5,200-ft (1585-m) contour, which barely cuts a corner of the withdrawal area. Sands within the withdrawal area appear to contain lower concentrations of heavy minerals and smaller zones of placer concentrates than the beach terraces to the east.

Table 5.--General mineral and chemical description of heavy-mineral concentrates from granite and alluvium.

[Chemical analyses in weight percent. N.d., not detected. Semi-quantitative emission spectrographic analyses by Molly Jane Malcolm. Range of values of 34 analyses of heavy minerals concentrated in the laboratory from samples MBQ 680, 682, 684, 687, 688, 737, 757]

Fraction	Major minerals	U	Th	Ti	Zr	Ce	La	Y	Yb	Nb
Nonmagnetic	Zircon	0.3-2.0	2.0-10	>2	>2	0.1-0.5	0.01-0.05	0.1-0.5	0.05	N.d.
Moderately magnetic	Monazite, sphene	0.1-1.5	0.5-2.0	>2	0.2-0.7	0.5->2	0.5->2	0.2-2.0	0.2-2.0	0.1-0.15
Highly magnetic	Magnetite, ilmenite, hematite	<0.1	0.05-1.0	>2	0.1-0.2	0.3-0.7	0.2-1.0	0.05-0.7	0.005-0.02	N.d.

Base-metal deposits--The geologic setting of the Deep Creek Mountains is favorable for base-metal sulfide veins, and indeed there has been production of lead, zinc, copper, and silver at Gold Hill to the north. In our geologic traverses, relatively few veins were encountered, and only four contain anomalous amounts of silver, bismuth, copper, lead, and zinc (sample localities MBQ 556, 635, 637, and 693 on Plate 1). Of particular interest are the silver values in the range about 1 to 20 oz/ton (37 to 700 ppm). The geology of the anomalous sites, however, does not suggest the presence of large deposits, as the faults are small, the veins are thin and short, and hydrothermal alteration is not intense. Sample sites MBQ 635 and 637 are from a mine dump and a prospect pit on patented land east of the withdrawal boundary and near the contact of metasedimentary rocks and alaskite, north of Trout Creek.

Granite of the Ibapah stock is distinctly finer grained in the bowl between Ibapah Peak and Haystack Peak, a texture resembling some igneous rocks that contain copper and molybdenum deposits of the porphyry type. However, in this area we observed no veins or brecciation, no alteration, and no rusty coloration as are observed at porphyry deposits. Also, no anomalous metal concentrations were observed in rocks or stream sediments to suggest the presence of porphyry-type deposits in the finer grained central facies of the Ibapah stock.

Precious metal deposits.--Gold has been produced elsewhere in western Utah from rocks similar to those in the withdrawal. Because gold of economic tenor generally is not visible in rocks and veins, we checked for the presence of gold in samples of quartz veins and silicified granite. Fire assay and atomic absorption analysis of 20 samples (table 1) revealed no gold in bedrock samples and none in stream sediments and alluvium, where gold might be expected to accumulate along with placer concentrations of other heavy minerals. Although the geology of the area is generally favorable for gold-bearing veins, the absence of any geochemical anomalies suggests that significant gold deposits are not present within the study area.

Nonmetallic mineral resources.--Sand and gravel deposits occur in the eastern part of the withdrawal area. However, the low unit value of the deposits, distance to markets, and availability of other supplies makes it unlikely that these deposits would be mined.

Several areas of the granitic Ibapah stock have unusually wide-spaced joints and fractures. This unfractured granite might become a source of dimension stone. It has uniform color and texture, and its light gray color with phenocrysts of feldspar would make it an attractive ornamental stone. An area north of the mouth of Red Cedar Canyon, where cliffy exposures of unfractured granite occur, is possibly the most favorable site for quarrying dimension stone.

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