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GEOLOGICAL SURVEY

Assessment of Mineral Resources in the Muggins Mountains Bureau of Land Management Wilderness Study Area (AZ-050-53A), Yuma County, Arizona

by

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CONTENTS

ILLUSTRATIONS

TABLES

APPENDICES

EXECUTIVE SUMMARY

Geologically, the Muggins Mountains are located within the Basin-and-Range Province of southwest Arizona, some 25 miles (40 km) east-northeast of Yuma, Arizona. The Muggins Mountains Wilderness Study Area (WSA) encompasses some 25 square miles (16,000 acres) in the southwest part of the range.

The oldest rocks in the WSA are marble, micaceous quartzite, and monzogranite which are all thought to be Precambrian in age. The Miocene Kinter Formation, composed of two members, unconformably overlies these rocks. The lower member of the Kinter Formation is made up of sandstone and siltstone interstratified with white tuff having a K-Ar age of 22.5 m.y. (early Miocene). This lower member is intruded by a rhyolite dome. Coarse fanglomerate and minor sandstone of the upper member of the Kinter Formation are interbedded with silicic volcanic flows, domes, and minor tuffs. Unconformably overlying these Miocene sedimentary and volcanic rocks and the Precambrian(?) rocks are several units of late Tertiary(?) and Quaternary deposits of gravel, sand, and silt.

Exploration activity within the WSA has involved gold and uranium. Minor gold placers occur south of Klothos Temple and Muggins Peak. The Red Knob uranium prospect is located within the WSA near the eastern boundary, and other small uranium prospects are located just east of the WSA.

Based on the recently concluded geochemical survey, geologic mapping, and past exploration activity, three small areas (figure 6) in the east and southeast portions of the WSA are classified (see table 5 in text) as having moderate potential (3-C classification) for uranium and thorium resources. The remainder of the WSA is classified as having low potential (2-C classification) for metallic minerals, uranium and thorium, nonmetallic minerals, and leasable resources.

INTRODUCTION

The Muggins Mountains Wilderness Study Area (WSA) is located approximately 25 miles (40 km) east-northeast of Yuma, Arizona, and covers approximately 25 square miles (16,000 acres) (fig. 1). Maximum relief is approximately 1,470 feet (448 meters), with elevations ranging from about 200 feet (61 meters) near the southern and western boundaries to 1,666 feet (508 meters) at the summit of Klothos Temple. Intermittent streams have dissected the area into an intricate pattern of rounded hills, flat mesas, and deep, steep-walled arroyos. Virtually all streams within the WSA flow southward into the Gila River. The mean annual precipitation in Yuma for the period 1931-60 was only 3 inches (7.6 centimeters) and in the adjacent mountains, 4-6 inches (10-15 centimeters) (Hely and Peck, 1964). Access to the WSA is mostly over gravel and unimproved roads, many of which can be traveled only by four-wheel-drive vehicles.

Geologic mapping and a geochemical study was undertaken in the Muggins Mountains WSA in November 1983 as a Phase II contribution to the Bureau of Land Management's Geology, Energy, and Minerals (GEM) process (Beikman and others, 1983). This report presents the results of these studies.

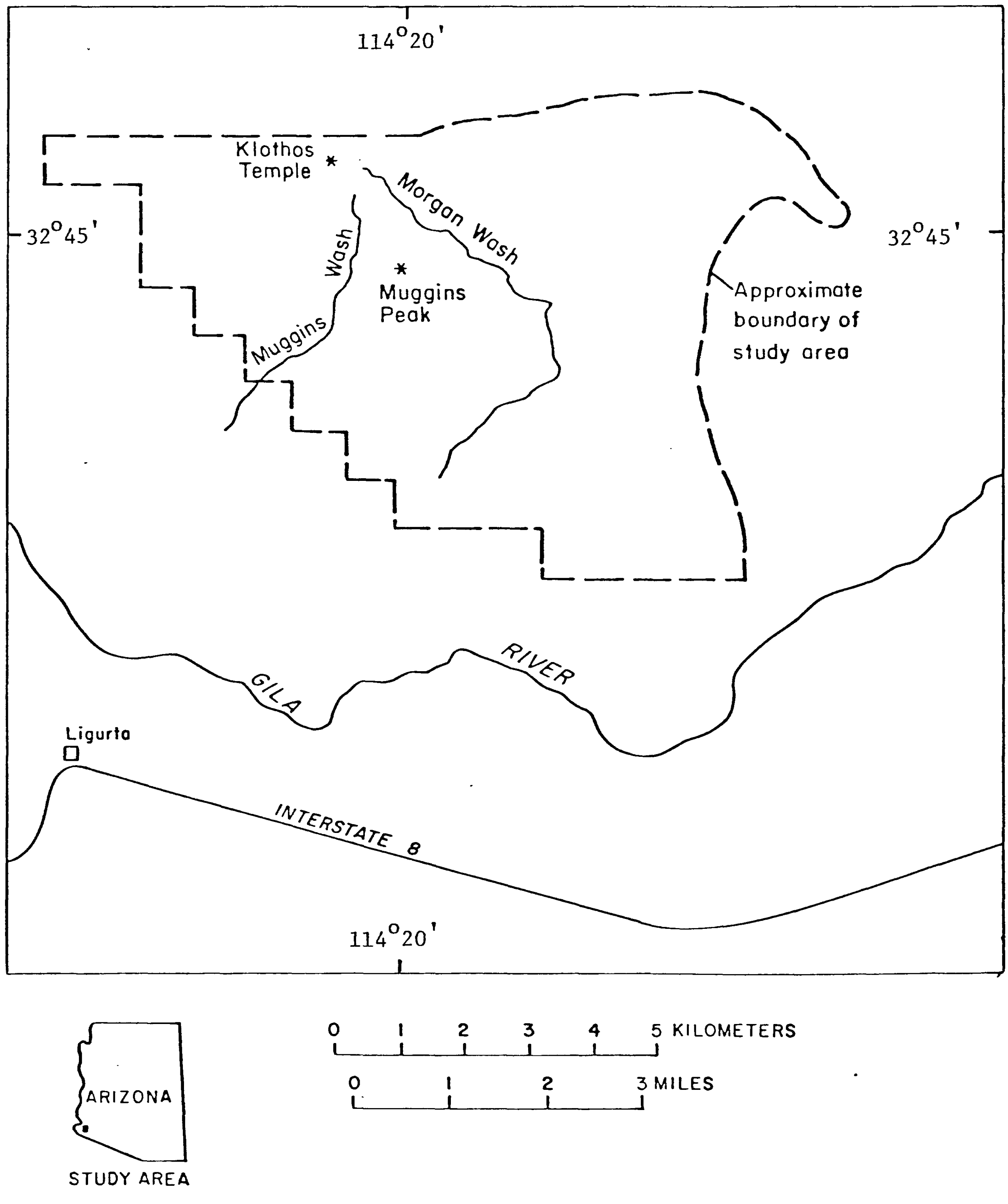

Figure 1. Location of Muggins Mountains WSA.

GEOCHEMICAL STUDY

Sample Collection

Stream sediments were chosen as the primary sample medium for this study because they represent a composite of rock and soil exposed in the drainage basin upstream from the sample site. Chemical analysis of sediments provides information useful in identifying those basins which contain concentrations of elements that may be related to mineral deposits.

We collected samples at 48 sites in, what were at the time, dry stream channels (fig. 2). Two stream-sediment samples were collected at each site. Each sample consisted of the most recently active alluvium collected from first-order (unbranched) and second-order (below the junction of two first-order) streams as shown on USGS topographic maps (scales = 1:24,000 and 1:62,500). Each sample was composited from several localities within an area that may extend as much as 100 feet (30 meters) from the site plotted on the map.

One stream-sediment sample was sieved through an 80-mesh (0.18-mm) screen and the fine fraction saved for analysis. The other sediment sample was passed through a 10-mesh (2.0-mm) screen to remove the coarse material. Approximately 10-15 pounds of the sediment passing through the 10-mesh screen were panned until most of the quartz, feldspar, organic materials, and clay-sized material was removed. The panned concentrate was separated into light and heavy fractions using a bromoform (heavy liquid, specific gravity 2.8) separation. The light fraction was discarded. The material of specific gravity greater than 2.8 was further separated magnetically into three fractions (highly magnetic, weakly magnetic, and nonmagnetic) using a modified Frantz Isodynamic Separator. The nonmagnetic fraction (containing common ore-forming sulfide and oxide minerals, barite, zircon, sphene, apatite, native gold, etc.) was hand ground for analysis.

In addition to the stream-sediment samples, 8 rock samples were collected from outcrops in the vicinity of the plotted site locations (fig. 2). Some of these samples were taken to provide information on geochemical background values while others were taken to determine suites of elements related to observed alteration. Table 1 gives a brief description of each rock sample. The rocks were crushed and then ground to minus 0.15 mm using a pulverizer equipped with ceramic plates.

Sample Analysis

The stream-sediment, heavy-mineral-concentrate, and rock samples were analyzed for 31 elements using a semiquantitative, direct-current arc emission spectrographic method (Grimes and Marranzino, 1968). Spectrographic results were obtained by visual comparison of spectra derived from the sample against spectra obtained from standards made from pure oxides and carbonates. Standard concentrations are geometrically spaced over any given order of magnitude of concentration as follows: 100, 50, 20, 10, and so forth. Samples whose concentrations are estimated to fall between those values are assigned values of 70, 30, 15, etc. The precision of the analytical method is approximately plus or minus one reporting interval at the 83 percent confidence level (Motooka and Grimes, 1976). Values determined for the major elements (iron, magnesium, calcium, and titanium) are given in weight percent; all others are given in parts per million (micrograms/gram) (table 2).

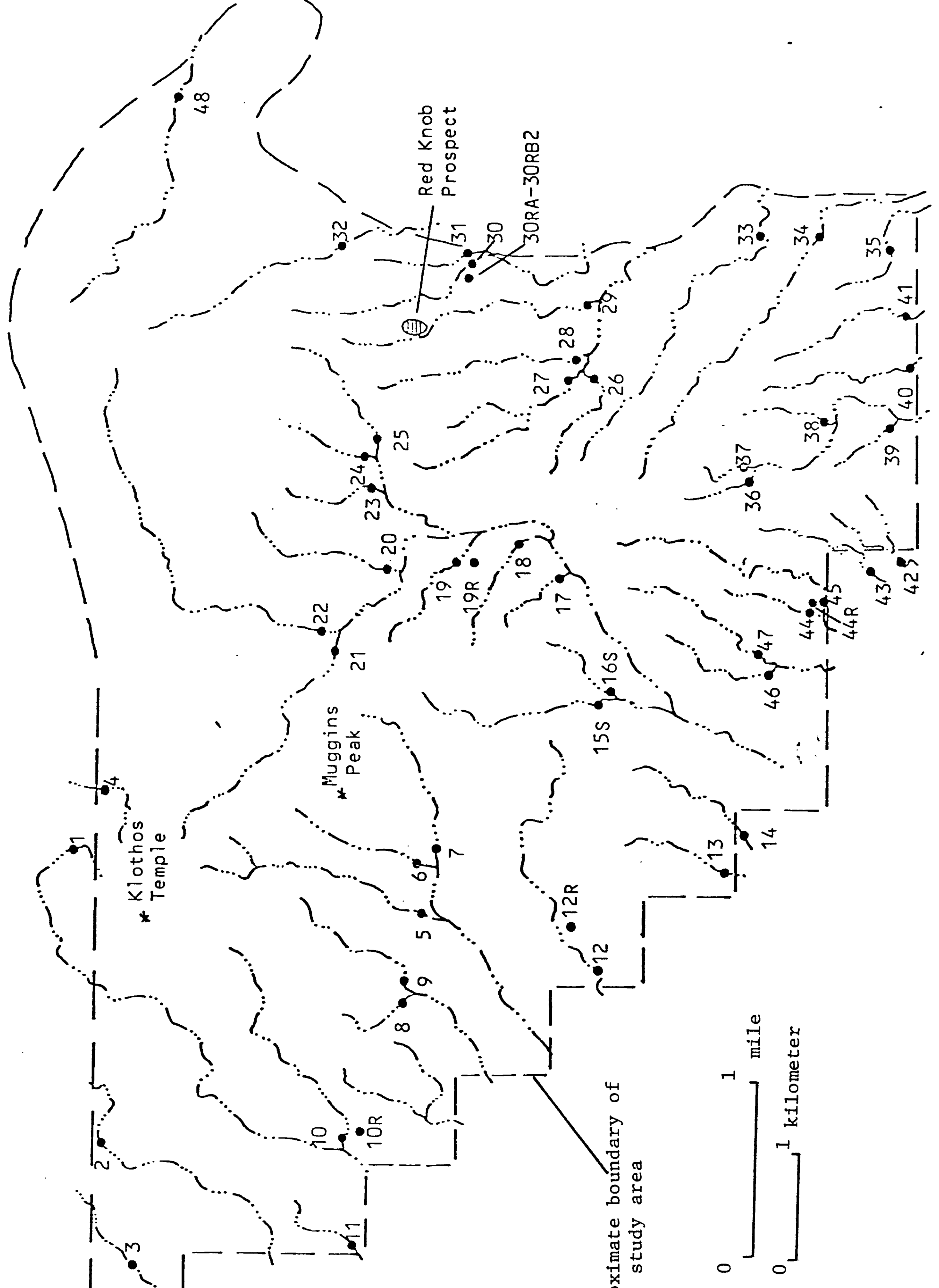

Figure 2. Sample locality map.
˙18: -80-mesh stream-sediment and heavy-mineral concentrate at same site; ˙16S: -80-mesh sediment only; ˙12R: Rock sample.

TABLE 1.--**Description of rock samples**

Sample Number	Description
MM-010R	Granitic(?) porphyry--collected from large boulder in gravel/fanglomerate deposit.
MM-012R	Latite flow, celadonite in fractures.
MM-019R	Vitrophyre.
MM-030RA MM-030RB MM-0030RBI MM-030RB2	Silicified, tuffaceous, lake sediments: scintillometer reading twice background.
MM-044R	Calcite-quartz veinlets.

In addition to emission spectrographic analysis, other chemical analyses were performed on rock samples and -80-mesh stream sediments as shown in table 3.

GEOLOGIC SETTING

Geologically, the nearly elliptical Muggins Mountains are located within the Basin-and-Range Province of southwest Arizona. The Muggins Mountains Wilderness Study Area (WSA) is located in the southwest part of the range. Figure 3 is a geologic map of the WSA and a summary of the geology is given below.

The oldest rocks exposed in the WSA are monzogranite, marble, and micaceous quartzite. As the marble and micaceous quartzite form part of a Precambrian or Mesozoic mylonite zone, their original stratigraphic relation to the enclosing monzogranite is unknown. In the nearby Gila Mountains, located some 6 miles (10 km) to the west, a similar unit of marble and quartzite is intruded by granitic rocks of probable Precambrian age (Wilson, 1933). Thus, by correlation, both the monzogranite and the marble and quartzite are also assumed to be of Precambrian age. To the north of the area in the northern Muggins Mountains, augen gneiss has yielded a Precambrian zircon age (L. T. Silver, in Dillon, 1975).

Sandstone, siltstone, and fanglomerate of early Miocene age unconformably overlie the Precambrian(?) and Mesozoic(?) crystalline rocks. In the eastern part of the WSA, this sequence has been named the Kinter Formation (Olmstead and others, 1973). Lower Miocene fossil camel bones have been found in the lower member of the Kinter Formation (Lance and Wood, 1958). A tuff in the lower member of the Kinter Formation has yielded an early Miocene age of 22.5 m.y. (Shafiqullah and others, 1980).

TABLE 2.--Limits of determination for the spectrographic analysis of stream sediments, based on a 10-mg sample

[The spectrographic limits of determination for heavy-mineral-concentrate samples are based on a 5-mg sample, and are therefore two reporting intervals higher than the limits given for stream sediments]

Elements	Lower determination limit	Upper determination limit
	Percent	
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

TABLE 3.--**Chemical methods used**

Sample Type	Element Determined	Analytical Method[1]	Determination Limit (ppm)	Reference
Rocks and -80-mesh sediments	As	AA	5	Modification of Viets, 1978.
	Sb	AA	2	Modification of Viets, 1978.
	Zn	AA	5	Modification of Viets 1978.
Rocks	Bi	AA	1	Modification of Viets, 1978.
	Cd	AA	0.1	Modification of Viets, 1978.
	Au	AA	0.05	Thompson and others, 1968.
	Hg	Ins.	0.02	Modification of McNerney and others, 1972, and Vaughn and McCarthy, 1964.
	F	SE	100	Hopkins, 1977.
	W	Sp	0.5	Welsch, 1983.
	U	DN	0.1	Millard, 1976.
	Th	DN	5	Millard, 1976.

[1]AA = Atomic Absorption; Ins. = Instrumental Technique; SE = Selective ion Electrode; Sp = Spectrophotometry; DN = Delayed Neutron

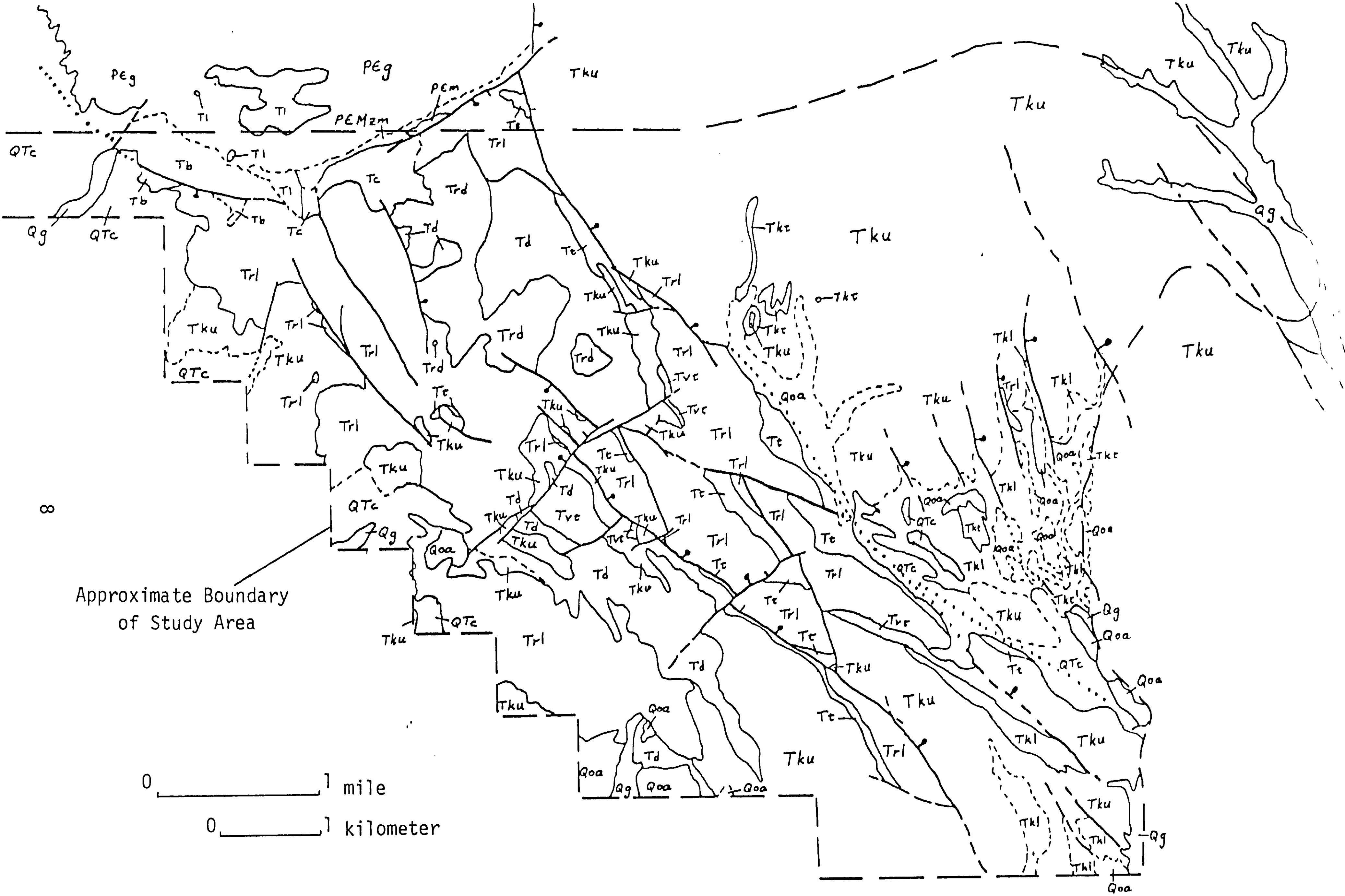

Figure 3. Geologic map of the Muggins Mountains Wilderness Study Area. (Geology mapped by R. M. Tosdal, 1983.)

EXPLANATION FOR FIGURE 3

Qal ALLUVIUM (QUATERNARY)--Pale-brown, unconsolidated silt and fine sand; forms floodplain deposits of the Gila River

Qg GRAVELS (QUATERNARY)--Unconsolidated gravel, sand, and minor silt; forms floors of modern washes and alluvial fans

Qoa OLDER ALLUVIUM (QUATERNARY)--Unconsolidated gravel, sand, and silt; forms terraces as much as 10 m above alluvium (unit Qal) and gravels (unit Qg)

QTc CONGLOMERATE (QUATERNARY AND TERTIARY(?))--Poorly consolidated, poorly sorted, tan conglomerate and minor sandstone; strata are subhorizontal; unconformably overlies older rock units; forms topographically highest and moderately incised terraces

Ti LATITE (MIOCENE)--Orange-brown weathering, banded, gray biotite latite; intrudes monzogranite (unit P€g), rhyolite and quartz latite (unit Trl), and breccia (unit Tb)

Tk KINTER FORMATION (MIOCENE)--Conglomerate, sandstone, and minor siltstone and tuff; composed of two members that are interbedded along contact; upper member is intercalated with silicic volcanic flows (unit Td and Trl); lower member contains fossil camel bones of lower Miocene age; white tuff in lower member has a K-Ar age of 22.5 m.y. (Shafiqullah and others, 1980); tuff beds are mapped separately

Tku Upper member--Poorly to moderately sorted, poorly to moderately bedded fanglomerate and minor coarse-grained sandstone; grades down into lower member; interbedded with lower member in southern part of map area; interstratified with white tuff (unit Tkt); clasts are almost exclusively Precambrian augen gneiss but, locally, rhyolite clasts (unit Trl) are present; clasts range from pebbles to blocks as large as 10 m in longest dimension, degree of clast sorting and bedding increases from the north towards the south; average size of clasts diminishes from the north towards the south

Tkl Lower member--Well-bedded, well-sorted, tan, fine- to medium-grained sandstone and siltstone; interstratified with white tuff (unit Tkt); clastic rocks become more coarse-grained upward in the member; intruded by a rhyolite dome (unit Trl)

Tkt Tuff--White, biotite-bearing, vitric tuff; maximum thickness is 3 m; composes at least one stratigraphic horizon in the upper member and the lower member

Tvt VITROPHYRE AND TUFF (MIOCENE)--Flow-banded, black rhyolite vitrophyre, well-bedded, white and yellow lithic-lapilli tuff, and minor tuffaceous sandstone; conformably overlies and interfingers with rhyolite and quartz latite flows (unit Trl)

Trl RHYOLITE AND QUARTZ LATITE (MIOCENE)--Red, brown, and locally black, flow banded, platey-weathering rhyolite and quartz latite flows, domes, and plugs and minor yellow tuff and tuff breccia; exposures are characterized by a cavernous appearance; intruded lower member of Miocene Kinter Formation (unit Tkl), and is interbedded with the upper member; black vitrophyre is present at the base of some flows; phenocrysts are plagioclase, less abundant quartz, and rare biotite

Trd RHYODACITE (MIOCENE)--Red-brown, gray and black platey-weathering rhyodacite and underlying tan and yellow tuffaceous conglomerate; clasts in conglomerate are composed of black rhyodacite vitrophyre; phenocrysts are quartz as much as 50 mm in diameter, biotite, and plagioclase

Td DACITE (MIOCENE)--Gray and red-brown weathering, gray clinopyroxene dacite, agglomerate, and local tuff breccia; forms recessive weathering slopes; composed of a complex series of flows and domes

Tt TUFF (MIOCENE)--Pale-gray, white, pink and yellow lithic-lapilli tuff, ash-flow tuff, and tuffaceous sandstone; unit occupies several stratigraphic horizons; phenocrysts are biotite, plagioclase, and quartz

Tc CONGLOMERATE AND SANDSTONE (MIOCENE)--Brown conglomerate, sandstone, and breccia and less abundant orange tuff breccia, tuffaceous sandstone, and white tuff; may be a stratigraphic equivalent to the lower member of Kinter Formation (unit Tkl); clastic strata are poorly sorted and composed of pebbles to boulders of monzogranite (unit P€g), mylonite (unit P€Mzm), and rare tuff

Tb BRECCIA (MIOCENE OR OLIGOCENE)--fragments of monzogranite (unit P€g) and less abundant biotite schist (probably the metamorphic equivalent of unit P€g); unit grades from essentially intact but completely shattered rock to a crudely bedded deposit with a coarse sand matrix

P€Mzm MYLONITE (PRECAMBRIAN(?) OR MESOZOIC(?))--Quartz-feldspathic mylonite, chloritic schist, and local boudins of monzogranite and pegmatite; derived from monzogranite (unit P€g)

P€g MONZOGRANITE (PRECAMBRIAN(?))--Gray, fine- to medium-grained biotite monzogranite and less abundant diabase dikes; monzogranite contains rare alkali feldspar phenocrysts as much as 1 cm in longest dimension

P€m MARBLE AND QUARTZITE (PRECAMBRIAN(?))--Orange, blue-gray, and white marble, and less abundant micaceous quartzite; forms part of mylonite zone (unit P€Mzm); similar rocks in the northern Gila Mountains located some 10 km to west are intruded by Precambrian(?) granitic rocks (Wilson, 1933)

CONTACT--dashed where approximately located

FAULT--showing dip of fault when known; ball on down thrown block, dashed where approximately located, dotted where inferred.

Coarse fanglomerate and minor sandstone of the upper member of the Kinter Formation are interbedded with silicic volcanic flows, domes, and minor tuffs. These volcanic rocks are probably equivalent to the upper part of the much larger volcanic field located some 37 miles (60 km) to the northwest in the Picacho area, southeast California (Crowe, 1978). The fanglomerates of the upper member of the Kinter Formation were derived almost exclusively from the Precambrian augen gneiss exposed to the north of the WSA.

Coincident with and following this volcanism was a period of active tectonism and generation of considerable relief. This phenomenon is well recognized throughout southwest Arizona and is related to late Oligocene and early Miocene regional extension and development of low-angle normal faults (Crittenden and others, 1980; Frost and Martin, 1982). A northwest-trending set of high-angle normal faults of small displacements, which, in general, have the downdropped block on the northeast side, are the obvious structural manifestation of this period of extensional tectonics. These faults postdate the volcanism. A set of smaller, northeast-trending faults offset the former and either are part of the same episode of faulting or are of late Miocene or younger age and related to formation of the nearby Gila Trough (Eberly and Stanley, 1978).

Subtle evidence for major low-angle normal faults is provided by the breccia exposed in the northwest corner of the WSA. The breccia is similar to those present along low-angle normal faults in the northern Mohawk Mountains, some 28 miles (45 km) to the east (Muellar and others, 1982). Stratigraphic relations between the breccia and the volcanic rocks suggest that movement along low-angle normal faults preceded the volcanism in early Miocene times. Regeneration of relief expressed by the coarse fanglomerates of the upper member of the Kinter Formation may also be related to low-angle fault displacements to the north of the wilderness area. Similar fanglomerates are related to low-angle normal faults in the Baker Peaks area, Arizona, located some 16 miles (25 km) to the southeast (Pridmore and Craig, 1982). Thus, silicic volcanism may have been contemporaneous with extensional tectonics.

Unconformably overlying the Miocene sedimentary and volcanic rocks and Precambrian(?) and Mesozoic(?) crystalline rocks are several units of late Tertiary(?) and Quaternary gravel, sand, and silt. The youngest deposits are composed of silts deposited in the floodplain of the Gila River, and gravels in washes graded to the Gila River. Successively older deposits form progressively higher geomorphic features.

ENERGY AND MINERAL RESOURCES

Known mineral deposits

There are no known mineral deposits (valuable or useful material in sufficiently large concentration that extraction at a profit may be feasible under current or future conditions) in the Muggins Mountains WSA.

Known prospects, mineral occurrences, and mineralized areas

Known exploration activity within the WSA has involved two commodities--gold and uranium. Minor gold placers occur south of Klothos Temple and Muggins Peak (fig. 4) where the bedrock is coarse-grained cemented gravel,

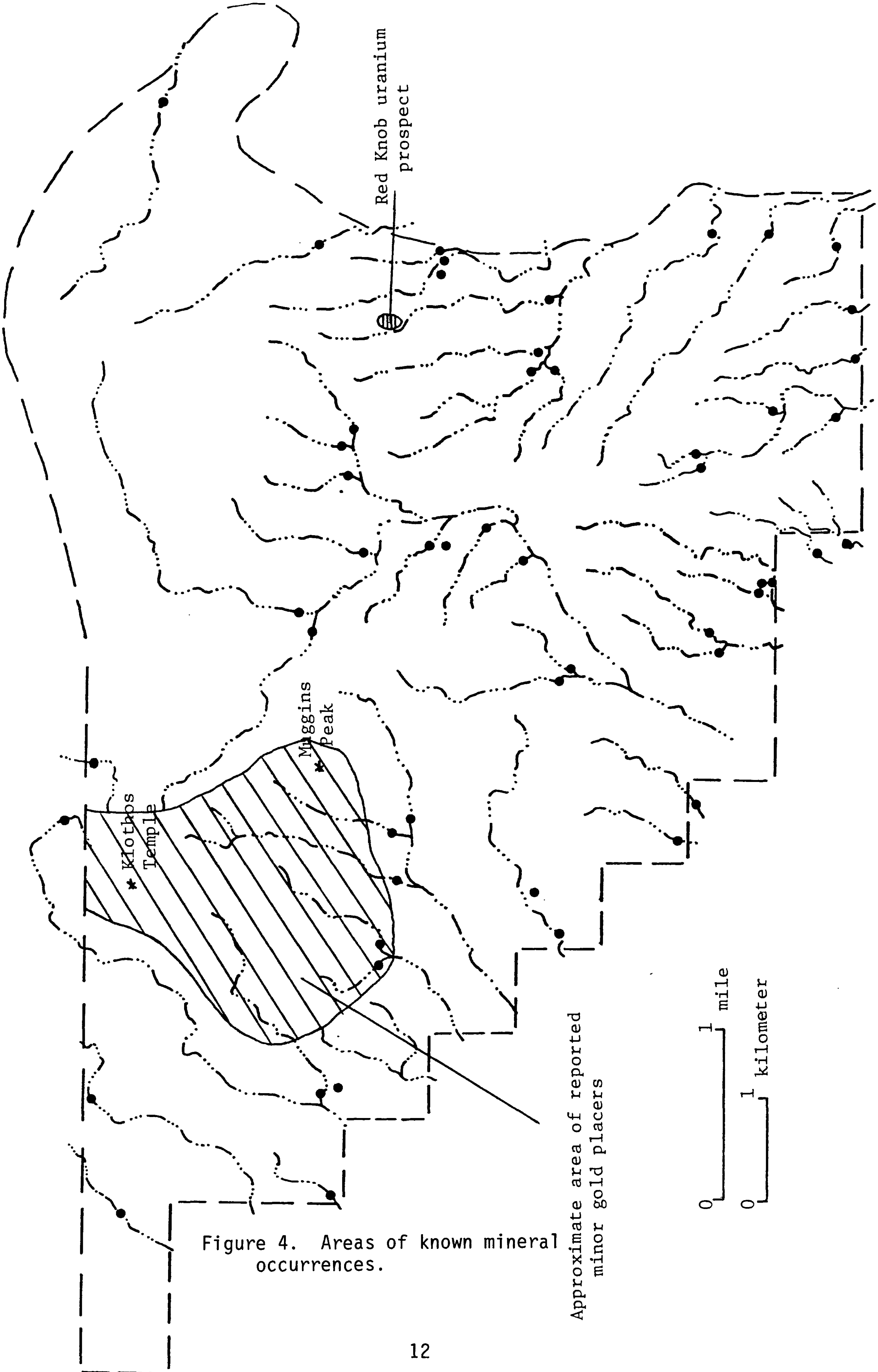

Figure 4. Areas of known mineral occurrences.

older than part of the lavas, and possibly derived from quartz veins in gneiss and schist exposed to the north of the WSA (Wilson, 1933; Johnson, 1972).

Exploration for uranium in the Muggins Mountains has been intermittently active since the early 1950's. Uranium occurs in the Muggins Mountains as pods and disseminations in silicified mudstones adjacent to northwesterly trending faults; in interlacing quartz stringers within dikes or sills; as disseminations in volcanics, mudstones, and sandstones; in association with copper carbonates and silicified wood fragments along mudstone beds; and in loosely consolidated, angular conglomerates or talus (Reyner and Ashwill, 1955). Most of the known uranium prospects in the Muggins Mountains occur to the east of the WSA. The one prospect known to occur within the WSA has been called the Red Knob Claims by Reyner and Ashwill (1955). It is shown in Fig. 4. This prospect occurs in the lower member of the Kinter Formation near an intruded rhyolite dome. Uranophane, calcite, vanadinite, and chalcedony occur within a highly silicified mudstone bed, one to three feet thick, along the north side of a normal fault which trends N30W. Examination of chemical analyses on rocks from this prospect (table 4) shows that the suite of elements characteristic of this type of mineralization is U-Pb-Mo-V-Zn.

Mineral deposit types possible in the WSA

The mineral deposit types discussed briefly below are based on three categories of mineral occurrences: (1) the type of mineral occurrence known to occur in the WSA; (2) types of occurrences that are found in the region near the WSA; and (3) types of occurrences that may be found in the geological environments recognized in the WSA based on geological inference but were not recognized in or around the WSA.

(1) Placer gold deposits--These deposits may occur in alluvium of any age. The primary requirement is that the river or stream which deposited the alluvium contained a source of particulate gold in its drainage basin.

(2) Precious- and base-metal epithermal deposits--These deposits are found in areas characterized by thick andesitic to rhyolitic Tertiary volcanics (Barton and others, 1982). The ore minerals (native gold + pyrite ± tetrahedrite ± arsenopyrite ± galena ± sphalerite) are generally found in vuggy quartz veins associated with through-going, anastomosing fracture systems (Berger, 1982). These deposits give a geochemical signature consisting of some combination of Au, Ag, As, Sb, Cu, Pb, and Zn, depending on the depth in the system.

(3) Volcanogenic uranium--These deposits are generally found in high-silica, alkali rhyolites (Nash and others, 1981). Uranium mineralization is found in veins comprised of quartz, fluorite, and sulfides of iron, arsenic, and molybdenum. The veining may be associated with caldera systems. Anomalously high As, Sb, F, Mo, W, and Hg may occur near and with the ore.

TABLE 4.--**Chemical analyses of rocks from the Red Knob Claims**
(C. S. Bromfield, unpublished data)

[N = Not detected at limit of detection]

Sample Number	012	013	014	015
U (ppm)	94.3	253	120	257
Ag (ppm)	1.5	1.5	15	3
B (ppm)	200	150	300	150
Ba (ppm)	150	300	300	150
Cu (ppm)	5	20	30	7
Mn (ppm)	300	700	70	70
Mo (ppm)	N	3	500	70
Pb (ppm)	N	20	2,000	300
Sr (ppm)	200	500	70	70
V (ppm)	15	150	300	70
Zn (ppm)	N	N	700	300

(4) Uranium in volcaniclastic sediments--This type of deposit is similar to that found at the Anderson Mine in southwestern Arizona as discussed by Sherborne and others (1979). Uranium occurs in organic-rich mudstones, the organic material acting as a reductant to precipitate uranium from solution in ground water. The source of uranium is postulated to be tuffaceous lake sediments from which connate water and uranium were squeezed out during compaction. Molybdenum commonly occurs in high concentrations with uranium in this type of deposit.

LAND CLASSIFICATION FOR GEM RESOURCE POTENTIAL

The purpose of this Phase II investigation of the Muggins Mountains WSA was to accumulate a body of geological and geochemical data on the area and provide an interpretation of that data as it applies to the evaluation of mineral resource potential. The geologic map is shown in Figure 3 and Appendices I, II, and III show complete analytical data for -80-mesh stream sediments, nonmagnetic heavy-mineral concentrates, and rock samples, respectively. Anomalous values, as discussed below, were chosen by inspection of the overall data set.

Analysis of the nonmagnetic fraction of the heavy-mineral concentrates proved to be the most useful in evaluating the WSA. This medium gives greatly enhanced anomaly patterns because the more common rock-forming minerals (quartz and feldspar) have been removed. Figure 5 shows anomalous concentrations of elements in the concentrates. Table 5 summarizes the system used for classifying the resource potential of the WSA.

1. Locatable resources

Locatable resources are those defined as locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, nonmetallic minerals such as asbestos, barite, zeolite, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, clay, magnesite, silica sand, etc. (Maley, 1983).

a. Metallic minerals

The entire WSA is classified 2-C for metallic minerals. Wilson (1933) and Johnson (1972) reported minor placer gold activity in the area near Klothos Temple and Muggins Peak from gravel beds older than some of the volcanic rocks. This old, currently inactive alluvium was not directly sampled, but there was no geochemical indication of these deposits from analysis of currently active alluvium. The small size of these placer occurrences indicates they probably cannot be regarded as a resource.

The possibility of precious- and base-metal epithermal deposits in the WSA was discussed earlier, but there was no indication from the geochemical data of their existence. The minor tin and tungsten anomalies shown in Figure 5 are believed to reflect usual background variations seen in nonmagnetic heavy-mineral concentrates collected from streams draining silicic volcanic rocks and are not indicative of metallic mineral deposits.

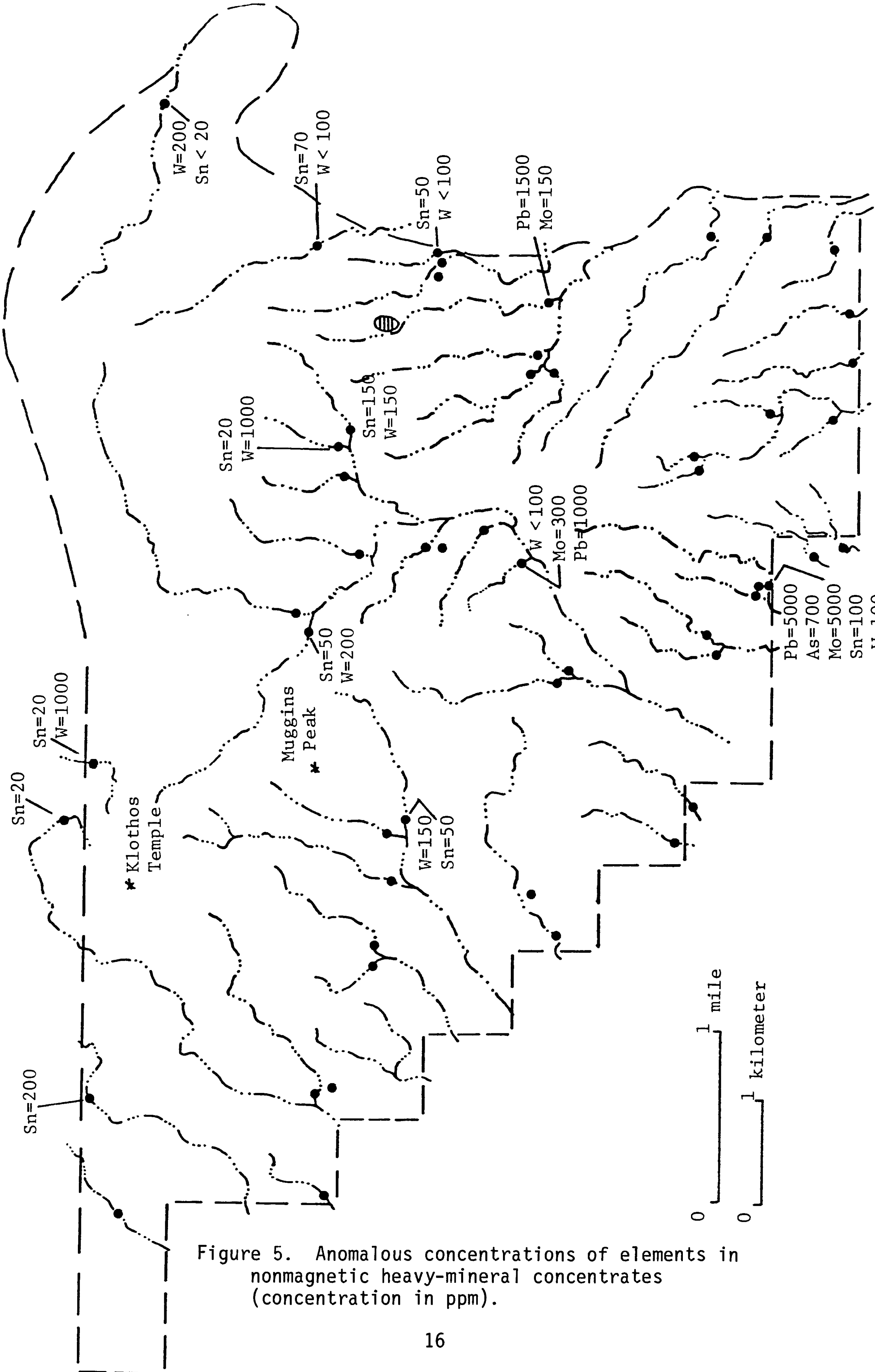

Figure 5. Anomalous concentrations of elements in nonmagnetic heavy-mineral concentrates (concentration in ppm).

TABLE 5.--**BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES**

CLASSIFICATION SCHEME	
1.	The geologic environment and the inferred geologic processes do not indicate a favorability for accumulation of mineral resources.
2.	The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3.	The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4.	The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.
LEVELS OF CONFIDENCE	
A.	The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.
B.	The available data provide indirect evidence to support or refute the possible existence of mineral resources.
C.	The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.
D.	The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

b. Uranium and thorium

Three small areas in the east and southeast portions of the WSA are classified 3-C for uranium and thorium resource potential (fig. 6). This classification is based on known prospects within and adjacent to the WSA in the Kinter Formation and on the existence of lead and molybdenum anomalies in nonmagnetic heavy-mineral concentrates. As discussed earlier, rocks collected from the Red Knob Claims showed high concentrations of U, Pb, Mo, Zn, and V. Downstream from these claims (sample site 29) the nonmagnetic heavy-mineral concentrates were anomalously high in Pb and Mo (fig. 5). Two other sample sites in the southeastern part of the WSA showed similar anomalies. Site 17 had high Mo and Pb; and site 45 had high Mo, Pb, and As. This may be an indication that these drainage basins contain uranium occurrences similar to the Red Knob prospect or prospects in the Muggins Mountains east of the WSA. The remainder of the WSA is classified 2-C for uranium and thorium potential because of the lack of geochemical anomalies and known prospects.

c. Nonmetallic minerals

The entire WSA is classified 2-C for locatable nonmetallic mineral resources.

2. Leasable and saleable resources

The only evidence for the possible existence of a leasable resource (geothermal) is the presence of a group of thermal springs on the northern bank of the Gila River near the southeastern margin of the Muggins Mountains (Wilson, 1933), well outside the WSA. No evidence of geothermal activity is known inside the WSA. Therefore, the entire WSA is classified 2-C for all leasable and saleable resources including geothermal, oil and gas, sodium and potassium, etc.

RECOMMENDATIONS FOR ADDITIONAL WORK

Additional work on placer gold deposits might involve mapping gravel beds whose source was north of the WSA in areas of gneiss and schist that contain quartz veins. Beneficial work concerning uranium deposits might involve determining the potential for reductants such as organic material occurring in basin-fill sediments and lake beds in the eastern part of the WSA. Such reductants are necessary to remove uranium from solution in ground water.

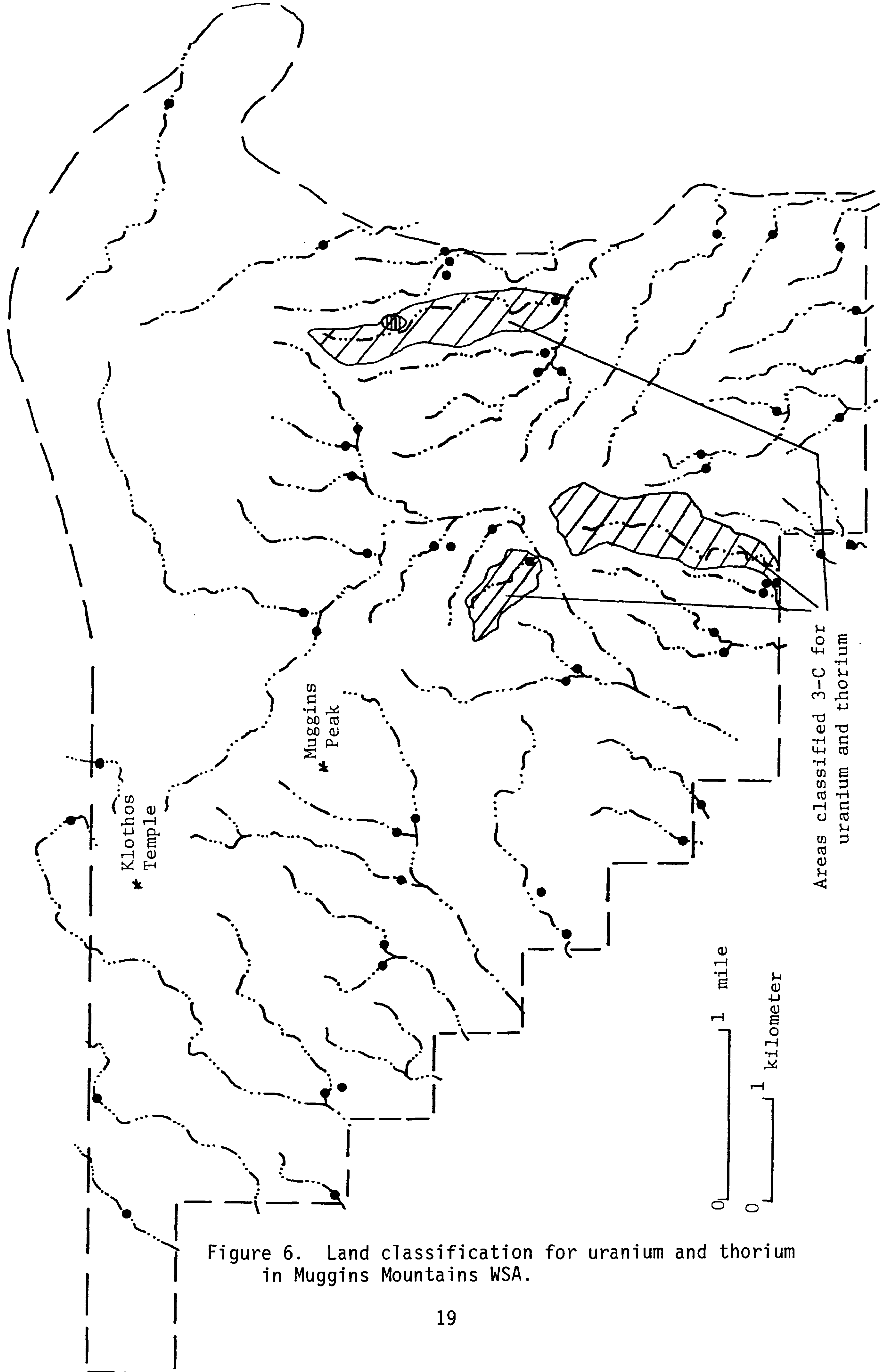

Figure 6. Land classification for uranium and thorium in Muggins Mountains WSA.

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APPENDICES

Description of Appendices I, II, and III

Appendices I, II, and III list the chemical analyses for samples of minus-80-mesh stream sediment, nonmagnetic heavy-mineral concentrates, and rocks, respectively. For the three sample sets, the data are arranged so that column 1 contains the U.S.G.S. assigned sample numbers. These numbers, excluding the "MM" prefix, coincide with the numbers on the sample locality map (figure 2). Columns 2 and 3 list the latitudes (north) and longitudes (west) for the sample sites in degrees, minutes, and seconds.

Abbreviations used on the element columns are as follows:

pct - percent

ppm - parts per million

s - semiquantitative emission spectrographic analysis

aa - atomic absorption

inst - instrumental

cm - colorimetry

SI - specific ion electrode

N - not detected at limit of detection

< - less than lower limit of determination

> - greater than upper limit of determination

Appendix 1. Analytical data for -80-mesh stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
MM01	32 45 59	114 15 25	2	.7	1.0	.5	1,500	N	N	N	70	500	2.0
MM02	32 45 53	114 17 5	2	.7	1.0	.5	1,000	N	N	N	100	500	2.0
MM03	32 45 43	114 17 48	2	1.0	2.0	.5	1,500	N	N	N	150	500	2.0
MM04	32 45 34	114 15 4	5	1.0	1.5	.5	700	N	N	N	100	700	3.0
MM05	32 44 18	114 15 47	7	2.0	2.0	.5	1,000	N	N	N	70	1,000	3.0
MM06	32 44 18	114 15 30	10	2.0	2.0	1.0	1,000	N	N	N	100	1,000	2.0
MM07	32 44 16	114 15 26	10	1.0	1.5	1.0	1,500	N	N	N	50	1,000	2.0
MM08	32 44 25	114 16 17	7	2.0	2.0	.5	1,000	N	N	N	50	1,000	3.0
MM09	32 44 25	114 16 11	15	2.0	2.0	1.0	1,500	N	N	N	50	2,000	1.5
MM10	32 44 42	114 17 3	5	1.0	2.0	.5	1,000	N	N	N	70	1,000	3.0
MM11	32 44 39	114 17 42	7	.7	1.5	1.0	1,000	N	N	N	100	1,000	2.0
MM12	32 43 41	114 15 55	10	1.5	1.5	.7	2,000	N	N	N	70	1,500	2.0
MM13	32 42 54	114 15 32	7	1.0	2.0	.5	1,500	N	N	N	100	1,000	2.0
MM14	32 42 50	114 15 18	7	1.0	1.5	.5	1,500	N	N	N	100	1,000	3.0
MM15	32 43 30	114 14 31	5	2.0	1.5	.5	1,000	N	N	N	100	1,000	2.0
MM16	32 43 28	114 14 28	10	2.0	1.5	.5	1,000	N	N	N	100	700	2.0
MM17	32 43 40	114 13 46	3	1.0	1.5	.5	2,000	N	N	N	100	1,000	2.0
MM18	32 43 54	114 13 38	7	1.0	1.5	.5	700	N	N	N	100	1,000	2.0
MM19	32 44 12	114 13 45	7	1.5	2.0	.7	1,500	N	N	N	70	1,500	3.0
MM20	32 44 30	114 13 47	7	1.0	1.5	.5	1,000	N	N	N	50	1,000	3.0
MM21	32 44 47	114 14 17	7	1.5	2.0	.7	1,500	<.5	N	N	50	700	2.0
MM22	32 44 49	114 14 8	10	1.0	2.0	1.0	1,000	N	N	N	70	700	2.0
MM23	32 44 34	114 13 19	10	1.5	2.0	.5	1,000	N	N	N	70	700	2.0
MM24	32 44 36	114 13 8	10	1.5	2.0	.7	1,500	.5	N	N	150	700	2.0
MM25	32 44 34	114 13 3	5	1.0	2.0	.5	1,500	N	N	N	100	700	2.0
MM26	32 43 32	114 12 40	10	1.0	2.0	1.0	2,000	N	N	N	100	2,000	3.0
MM27	32 43 38	114 12 39	5	.7	2.0	1.0	1,500	N	N	N	100	1,000	3.0
MM28	32 43 39	114 12 35	3	.7	1.5	.3	1,000	N	N	N	150	1,000	3.0
MM29	32 43 33	114 12 13	5	1.0	2.0	.5	2,000	N	N	N	100	1,500	5.0
MM30	32 44 5	114 11 58	5	1.0	1.5	.5	1,000	N	N	N	100	700	3.0
MM31	32 44 4	114 11 56	3	.7	1.5	.5	1,000	N	N	N	100	1,000	3.0
MM32	32 44 45	114 11 54	5	.7	2.0	1.0	1,500	N	N	N	100	700	3.0
MM33	32 42 45	114 11 51	3	1.0	1.5	.5	1,000	N	N	N	150	700	2.0
MM34	32 42 29	114 11 54	7	.7	1.5	1.0	1,500	N	N	N	70	700	2.0
MM35	32 42 7	114 11 56	15	.7	1.5	1.0	2,000	N	N	N	100	700	2.0
MM36	32 42 47	114 13 14	7	1.0	1.5	.5	1,500	N	N	N	100	700	2.0
MM37	32 42 49	114 13 10	5	1.0	2.0	.5	1,000	N	N	N	150	700	2.0
MM38	32 42 27	114 12 54	5	1.0	2.0	.5	1,500	N	N	N	100	500	2.0
MM39	32 42 5	114 12 53	10	1.0	1.5	.7	2,000	N	N	N	70	700	2.0
MM40	32 42 1	114 12 36	7	1.0	1.5	.5	1,000	N	N	N	100	500	2.0
MM41	32 42 1	114 12 18	7	.7	1.5	.5	1,500	N	N	N	50	700	2.0
MM42	32 42 4	114 13 42	15	1.5	2.0	1.0	2,000	N	N	N	50	500	2.0
MM43	32 42 12	114 13 48	5	1.0	2.0	.7	1,000	N	N	N	100	700	1.5
MM44	32 42 31	114 14 1	10	1.5	2.0	1.0	2,000	N	N	N	100	1,000	1.5
MM45	32 42 27	114 14 0	20	1.0	1.5	1.0	3,000	N	N	N	50	1,000	2.0

Appendix 1. Analytical data for -80-mesh stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
MM01	N	N	15	70	70	50	N	<20	10	50	N	15
MM02	N	N	10	70	30	50	N	<20	10	30	N	10
MM03	N	N	15	70	70	70	N	<20	30	50	N	10
MM04	N	N	10	50	20	50	N	N	20	15	N	15
MM05	N	N	15	150	20	70	N	N	70	10	N	15
MM06	N	N	20	150	30	70	N	N	100	10	N	20
MM07	N	N	20	100	30	50	N	<20	50	20	N	20
MM08	N	N	20	200	50	100	N	N	100	30	N	20
MM09	N	N	30	150	70	50	5	30	100	20	N	30
MM10	N	N	10	50	20	50	N	N	20	10	N	15
MM11	N	N	10	50	20	50	N	N	20	10	N	10
MM12	N	N	15	100	30	50	N	<20	50	20	N	15
MM13	N	N	15	70	30	50	N	N	30	15	N	15
MM14	N	N	15	100	30	50	N	N	20	15	N	10
MM15	N	N	20	150	50	50	N	<20	100	50	N	15
MM16	N	N	20	150	50	50	N	N	100	15	N	15
MM17	N	N	10	50	50	50	N	N	30	100	N	10
MM18	N	N	10	50	15	50	N	N	30	10	N	10
MM19	N	N	15	100	20	100	N	N	30	20	N	15
MM20	N	N	15	50	30	50	N	N	30	10	N	20
MM21	N	N	15	150	20	70	N	N	50	15	N	20
MM22	N	N	20	50	50	50	N	20	30	10	N	20
MM23	N	N	15	70	50	50	N	N	30	10	N	20
MM24	N	N	15	70	50	50	N	N	50	10	N	20
MM25	N	N	15	70	30	50	<5	N	30	10	N	10
MM26	N	N	15	50	30	100	5	N	30	20	N	20
MM27	N	N	10	50	30	70	5	N	20	50	N	15
MM28	N	N	10	20	20	50	5	N	20	15	N	7
MM29	N	N	10	20	20	50	5	N	20	30	N	10
MM30	N	N	10	30	30	50	<5	N	20	20	N	15
MM31	N	N	10	50	20	50	<5	N	20	50	N	10
MM32	N	N	15	50	50	70	5	<20	20	50	N	15
MM33	N	N	15	70	30	50	N	N	30	10	N	15
MM34	N	N	15	100	30	70	<5	20	30	70	N	20
MM35	N	N	15	100	30	100	N	20	30	30	N	20
MM36	N	N	10	100	30	50	N	N	20	50	N	10
MM37	N	N	15	50	30	50	N	N	30	15	N	10
MM38	N	N	15	70	30	70	N	N	30	20	N	15
MM39	N	N	10	100	15	70	<5	N	30	20	N	15
MM40	N	N	15	150	30	50	N	N	30	20	N	10
MM41	N	N	10	50	20	50	5	N	30	20	N	10
MM42	N	N	20	150	30	70	<5	<20	70	15	N	20
MM43	N	N	10	70	20	50	<5	N	50	15	N	10
MM44	N	N	20	150	20	50	N	N	70	15	N	15
MM45	N	N	15	150	50	70	7	<20	30	50	N	20

Appendix 1. Analytical data for -80-mesh stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Sb-ppm aa
MM01	N	500	150	N	50	N	500	N	N	50	N
MM02	N	300	150	N	20	N	500	N	N	60	N
MM03	N	300	150	N	30	N	200	N	N	50	N
MM04	N	200	100	N	50	N	300	N	<10	60	2
MM05	N	300	100	N	30	N	300	N	N	45	2
MM06	N	200	150	N	30	N	300	N	N	50	2
MM07	N	200	100	N	50	N	700	N	N	60	2
MM08	N	500	100	N	30	N	300	N	N	80	2
MM09	50	300	200	N	70	N	1,000	N	N	50	2
MM10	N	300	70	N	30	N	500	N	N	55	2
MM11	N	200	100	N	30	N	300	N	N	55	2
MM12	N	200	100	N	30	N	500	N	N	60	2
MM13	N	200	100	N	50	N	500	N	N	55	N
MM14	N	200	100	N	30	N	500	N	N	55	<2
MM15	N	200	100	N	30	N	300	N	N	80	2
MM16	N	200	100	N	20	N	500	N	N	70	2
MM17	N	200	100	N	30	N	500	N	N	55	2
MM18	N	200	70	N	20	N	300	N	N	55	2
MM19	N	300	150	N	50	N	500	N	N	60	2
MM20	N	200	150	N	50	N	500	N	N	65	2
MM21	N	300	150	N	50	N	500	N	N	60	<2
MM22	N	150	100	N	50	N	1,000	N	N	80	<2
MM23	N	200	150	N	50	N	1,000	N	N	70	N
MM24	N	200	100	N	50	N	300	N	N	75	<2
MM25	N	200	100	N	30	N	500	N	N	70	<2
MM26	N	300	150	N	200	N	500	N	N	65	2
MM27	N	300	100	N	50	N	500	N	N	55	<2
MM28	N	200	70	N	30	N	200	N	N	70	<2
MM29	N	700	70	N	50	<200	150	N	N	80	N
MM30	N	200	100	N	50	N	300	N	N	80	N
MM31	N	200	70	N	50	N	300	N	N	75	N
MM32	N	200	100	N	50	N	500	N	N	90	N
MM33	N	200	100	N	30	N	500	N	N	75	N
MM34	N	200	200	N	70	N	500	N	<10	75	2
MM35	N	200	300	N	70	N	>1,000	N	N	65	2
MM36	N	200	100	N	20	N	500	N	N	65	<2
MM37	N	200	70	N	30	N	300	N	N	80	<2
MM38	N	200	100	N	30	N	500	N	N	65	<2
MM39	N	200	150	N	30	N	1,000	N	N	65	<2
MM40	N	200	100	N	30	N	300	N	N	75	<2
MM41	N	200	100	N	30	N	500	N	N	65	<2
MM42	N	300	200	N	30	N	500	N	N	80	<2
MM43	N	200	100	N	50	N	500	N	N	75	N
MM44	N	200	200	N	30	N	300	N	N	65	<2
MM45	N	200	300	N	30	N	1,000	N	<10	80	2

Appendix 1. Analytical data for -80-mesh stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.--continued

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s	Be-ppm s
MM46	32 42 42	114 14 22	7	1.5	2.0	.5	1,000	N	N	N	100	1,000	2.0
MM47	32 42 43	114 14 18	10	2.0	2.0	.5	1,500	N	N	N	70	1,000	2.0
MM48	32 45 28	114 10 55	10	1.0	1.5	.5	1,500	.5	N	N	100	1,000	2.0

Sample	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s	Sc-ppm s
MM46	N	N	15	150	30	50	N	N	50	15	N	10
MM47	N	N	15	100	30	70	<5	N	100	10	N	15
MM48	N	N	10	70	50	50	N	N	30	20	N	15

Sample	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	As-ppm aa	Zn-ppm aa	Sb-ppm aa
MM46	N	200	150	N	30	N	700	N	N	65	<2
MM47	N	300	150	N	20	N	500	N	N	65	<2
MM48	N	200	100	N	30	N	700	N	N	90	<2

Appendix II. Analytical data for heavy-mineral concentrates from stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
MM01C	32 45 59	114 15 25	.5	.15	2	>2	300	N	N	N	20	>10,000
MM02C	32 45 53	114 17 5	2.0	1.00	5	>2	1,500	N	N	N	200	5,000
MM03C	32 45 43	114 17 48	.5	.20	5	>2	300	N	N	N	300	>10,000
MM04C	32 45 54	114 15 4	.5	.30	3	>2	700	N	N	N	200	3,000
MM05C	32 44 13	114 15 47	5.0	2.00	3	>2	3,000	N	N	N	1,000	5,000
MM06C	32 44 13	114 15 30	7.0	2.00	3	>2	3,000	N	N	N	1,000	2,000
MM07C	32 44 16	114 15 26	2.0	1.00	5	>2	2,000	N	N	N	500	10,000
MM08C	32 44 25	114 16 17	.7	.50	5	>2	1,000	N	N	N	50	>10,000
MM09C	32 44 25	114 16 11	7.0	2.00	3	>2	5,000	N	N	N	300	>10,000
MM10C	32 44 42	114 17 3	10.0	2.00	3	>2	5,000	N	N	N	200	>10,000
MM11C	32 44 39	114 17 42	15.0	1.00	3	>2	3,000	N	N	N	500	5,000
MM12C	32 43 41	114 15 55	2.0	.50	5	>2	1,500	N	N	N	100	>10,000
MM13C	32 42 54	114 15 32	1.5	.50	5	>2	2,000	N	N	N	500	>10,000
MM14C	32 42 50	114 15 18	.3	.20	3	>2	700	N	N	N	100	>10,000
MM17C	32 43 40	114 13 48	.3	.30	5	>2	700	N	N	N	20	>10,000
MM18C	32 43 54	114 13 38	5.0	2.00	3	>2	3,000	N	N	N	1,000	>10,000
MM19C	32 44 12	114 13 45	1.5	.50	3	>2	1,000	N	N	N	500	>10,000
MM20C	32 44 30	114 13 47	.5	.50	3	2	700	N	N	N	200	3,000
MM21C	32 44 47	114 14 17	1.0	.50	5	>2	1,000	N	N	N	300	2,000
MM22C	32 44 49	114 14 8	1.0	.20	3	>2	1,000	N	N	N	100	3,000
MM23C	32 44 34	114 13 19	.2	.20	2	2	200	N	N	N	100	1,500
MM24C	32 44 36	114 13 8	.7	.30	5	>2	1,000	N	N	N	100	5,000
MM25C	32 44 34	114 13 3	1.5	.30	5	>2	1,000	N	N	N	700	2,000
MM26C	32 43 32	114 12 40	1.0	.20	3	>2	1,000	N	N	N	200	>10,000
MM27C	32 43 36	114 12 39	.5	.15	3	>2	1,000	N	N	N	200	>10,000
MM28C	32 43 39	114 12 35	.7	.15	5	>2	1,000	N	N	N	300	>10,000
MM29C	32 43 33	114 12 13	.5	.15	3	>2	1,000	N	N	N	100	>10,000
MM30C	32 44 5	114 11 58	1.5	.30	5	>2	1,000	N	N	N	200	7,000
MM31C	32 44 4	114 11 56	.5	.20	5	>2	1,000	N	N	N	150	>10,000
MM32C	32 44 45	114 11 54	2.0	.50	5	>2	2,000	N	N	N	100	5,000
MM33C	32 42 45	114 11 51	.7	.30	5	>2	1,000	N	N	N	150	10,000
MM34C	32 42 29	114 11 54	1.0	.30	5	>2	1,000	N	N	N	300	5,000
MM35C	32 42 7	114 11 56	.3	.10	3	>2	500	N	N	N	100	3,000
MM36C	32 42 47	114 13 14	1.5	.50	5	>2	1,500	N	N	N	300	3,000
MM37C	32 42 49	114 13 10	3.0	.70	5	>2	2,000	N	N	N	500	3,000
MM38C	32 42 27	114 12 54	.5	.30	3	>2	700	N	N	N	300	3,000
MM39C	32 42 5	114 12 53	.5	.20	5	>2	1,000	N	N	N	70	3,000
MM40C	32 42 1	114 12 36	.3	.30	2	>2	1,000	N	N	N	200	1,000
MM41C	32 42 1	114 12 18	3.0	1.00	5	>2	2,000	N	N	N	700	10,000
MM42C	32 42 4	114 13 42	.5	.30	5	>2	1,000	N	N	N	100	7,000
MM43C	32 42 12	114 13 48	2.0	1.00	5	>2	2,000	N	N	N	300	3,000
MM44C	32 42 31	114 14 1	1.0	.50	5	>2	1,000	N	N	N	100	10,000
MM45C	32 42 27	114 14 0	1.5	.50	3	>2	1,500	N	700	N	300	5,000
MM46C	32 42 42	114 14 22	.2	.15	3	>2	500	N	N	N	70	>10,000
MM47C	32 42 43	114 14 18	.7	.20	3	>2	1,000	N	N	N	70	5,000

Appendix II. Analytical data for heavy-mineral concentrates from stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
MM01C	7	N	N	N	<20	<10	<50	N	N	30	50
MM02C	7	N	N	15	200	20	700	N	100	30	70
MM03C	5	N	N	N	<20	<10	200	N	N	20	700
MM04C	5	N	N	N	N	<10	100	N	150	30	50
MM05C	5	N	N	20	500	10	500	N	150	50	50
MM06C	5	N	N	20	500	15	500	N	200	70	150
MM07C	5	N	N	15	200	15	500	N	200	30	150
MM08C	2	N	N	N	50	10	300	N	100	15	N
MM09C	3	N	N	20	300	15	500	<10	200	50	50
MM10C	2	N	N	20	200	20	300	N	200	50	50
MM11C	3	N	N	20	300	20	700	N	150	50	50
MM12C	3	N	N	N	50	<10	500	N	300	20	300
MM13C	<2	N	N	N	100	30	500	<10	200	20	<20
MM14C	2	N	N	N	50	20	150	N	150	20	100
MM17C	2	N	N	N	N	N	150	300	150	15	1,000
MM18C	2	N	N	10	200	30	500	<10	300	50	150
MM19C	3	N	N	N	100	N	500	N	200	30	70
MM20C	<2	N	N	N	20	<10	150	N	70	N	70
MM21C	5	N	N	N	50	<10	200	N	200	30	50
MM22C	5	N	N	N	<20	<10	100	N	150	20	50
MM23C	3	N	N	N	<20	<10	200	N	50	N	N
MM24C	3	N	N	N	20	10	150	N	200	20	50
MM25C	3	N	N	N	20	10	200	N	200	15	50
MM26C	<2	N	N	N	20	<10	200	10	300	20	700
MM27C	2	N	N	N	20	10	300	20	300	20	700
MM28C	2	N	N	N	20	10	500	N	200	20	150
MM29C	2	N	N	N	20	10	200	150	200	20	1,500
MM30C	3	N	N	N	50	10	200	<10	300	20	70
MM31C	3	N	N	N	20	10	300	15	200	20	500
MM32C	2	N	N	N	70	20	300	10	500	20	700
MM33C	2	N	N	N	50	<10	300	<10	200	15	100
MM34C	3	N	N	N	50	10	500	N	200	30	200
MM35C	3	N	N	N	<20	N	150	N	50	20	150
MM36C	3	N	N	N	50	<10	500	10	200	15	1,500
MM37C	2	N	N	N	100	10	500	<10	300	20	500
MM38C	3	N	N	N	50	10	300	N	100	20	70
MM39C	2	N	N	N	<20	N	200	N	150	20	30
MM40C	2	N	N	N	<20	<10	300	<10	100	<10	200
MM41C	2	N	N	N	70	10	700	N	300	20	700
MM42C	2	N	N	N	<20	N	500	<10	300	15	<20
MM43C	2	N	N	N	50	10	500	<10	200	50	70
MM44C	2	N	N	N	20	<10	300	15	200	30	100
MM45C	2	N	N	N	50	50	300	5,000	200	30	5,000
MM46C	5	N	N	N	<20	N	100	N	100	20	70
MM47C	2	N	N	N	<20	N	300	<10	500	20	50

Appendix II. Analytical data for heavy-mineral concentrates from stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
MM01C	N	70	20	1,000	100	N	1,000	N	>2,000	<200
MM02C	N	50	200	N	300	N	2,000	N	>2,000	2,000
MM03C	N	10	N	10,000	150	N	700	N	>2,000	N
MM04C	N	70	20	1,000	200	1,000	1,500	N	>2,000	200
MM05C	N	100	N	500	300	N	700	N	>2,000	<200
MM06C	N	70	N	<200	700	N	1,000	N	>2,000	300
MM07C	N	50	50	500	500	150	1,500	N	>2,000	700
MM08C	N	<10	N	>10,000	150	N	1,000	N	>2,000	N
MM09C	N	30	N	1,500	500	N	1,000	N	>2,000	300
MM10C	N	30	20	700	500	N	1,000	N	>2,000	N
MM11C	N	100	<20	500	500	N	1,500	N	>2,000	300
MM12C	N	20	100	2,000	300	N	1,500	N	>2,000	<200
MM13C	N	20	N	1,000	300	N	1,000	N	>2,000	N
MM14C	N	30	N	1,000	500	N	1,500	N	>2,000	200
MM17C	N	<10	N	1,000	300	<100	1,000	N	>2,000	N
MM18C	N	<10	150	1,000	500	N	1,000	N	>2,000	200
MM19C	N	20	N	1,500	500	N	2,000	N	>2,000	200
MM20C	N	30	<20	700	50	N	500	N	>2,000	<200
MM21C	N	100	50	<200	200	200	2,000	N	>2,000	500
MM22C	N	70	20	<200	150	N	1,000	N	>2,000	200
MM23C	N	10	20	200	70	N	500	N	>2,000	N
MM24C	N	20	20	<200	200	1,000	1,000	N	>2,000	<200
MM25C	N	50	150	<200	200	150	1,000	N	>2,000	500
MM26C	N	<10	20	2,000	300	N	700	N	>2,000	<200
MM27C	N	30	20	1,000	500	N	2,000	N	>2,000	700
MM28C	N	30	20	1,000	200	N	2,000	N	>2,000	200
MM29C	N	20	20	>10,000	300	N	1,500	N	>2,000	<200
MM30C	N	30	50	1,000	200	<100	1,500	N	>2,000	N
MM31C	N	20	30	2,000	500	N	2,000	N	>2,000	<200
MM32C	N	20	70	1,000	300	<100	2,000	N	>2,000	200
MM33C	N	20	20	N	300	N	700	N	>2,000	<200
MM34C	N	50	<20	500	500	N	2,000	N	>2,000	700
MM35C	N	100	N	N	200	N	1,000	N	>2,000	1,000
MM36C	N	50	N	N	700	N	1,000	N	>2,000	700
MM37C	N	20	<20	N	500	N	1,500	N	>2,000	700
MM38C	N	30	N	<200	500	N	1,500	N	>2,000	500
MM39C	N	20	30	1,500	500	N	1,000	N	>2,000	200
MM40C	N	20	<20	200	200	N	500	N	>2,000	200
MM41C	N	20	20	700	700	N	1,500	N	>2,000	700
MM42C	N	20	20	700	500	N	1,500	N	>2,000	500
MM43C	N	20	20	<200	500	N	1,000	N	>2,000	300
MM44C	N	20	<20	N	300	N	1,000	N	>2,000	1,500
MM45C	N	20	100	N	1,000	100	1,000	N	>2,000	1,000
MM46C	N	30	20	1,000	200	N	1,000	N	>2,000	500
MM47C	N	<10	<20	500	500	N	1,000	N	>2,000	700

Appendix II. Analytical data for heavy-mineral concentrates from stream sediments from the Muggins Mountains Wilderness Study Area, Arizona.--continued

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
MM48C	32 45 28	114 10 55	2.0	.30	5	>2	1,500	N	N	N	100	10,000

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
MM48C	2	N	N	N	<20	10	200	N	200	20	70

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
MM48C	N	20	<20	>10,000	200	200	1,500	N	>2,000	500

Appendix III. Analytical data for rocks from the Muggins Mountains Wilderness Study Area, Arizona.

Sample	Latitude	Longitude	Fe-pct.	Mg-pct.	Ca-pct.	Ti-pct.	Mn-ppm	Ag-ppm	As-ppm	Au-ppm	B-ppm	Ba-ppm
			s	s	s	s	s	s	s	s	s	s
MM10R	32 44 41	114 17 2	5.00	.50	.5	.30	700	N	N	N	50	1,500
MM12R	32 43 38	114 15 50	3.00	.30	.7	.50	300	<.5	N	N	100	1,500
MM19R	32 44 7	114 13 44	1.00	.15	.3	.07	1,000	.5	N	N	150	700
MM30RA	32 44 5	114 11 58	1.00	.70	.7	.15	200	<.5	N	N	50	300
MM30RB	32 44 5	114 11 58	.15	.20	10.0	.02	1,000	1.5	N	N	500	100
MM30RB1	32 44 5	114 11 58	.10	.50	10.0	.02	2,000	N	N	N	150	150
MM30RB2	32 44 5	114 11 58	.20	.50	15.0	.03	5,000	2.0	N	N	200	500
MM44R	32 42 31	114 14 1	.70	.70	20.0	.03	2,000	N	N	N	150	300

Sample	Be-ppm	Bi-ppm	Cd-ppm	Co-ppm	Cr-ppm	Cu-ppm	La-ppm	Mo-ppm	Nb-ppm	Ni-ppm	Pb-ppm
	s	s	s	s	s	s	s	s	s	s	s
MM10R	5.0	N	N	7	<10	15	50	N	N	7	20
MM12R	3.0	N	N	5	<10	15	70	N	<20	5	30
MM19R	7.0	N	N	N	N	<5	70	5	<20	5	70
MM30RA	10.0	N	N	N	<10	10	50	N	<20	7	20
MM30RB	1.5	N	N	N	50	10	N	N	N	N	300
MM30RB1	N	N	N	N	N	7	N	N	N	5	70
MM30RB2	1.5	N	N	N	<10	50	<20	N	N	5	1,000
MM44R	N	N	N	N	10	5	N	N	N	50	N

Sample	Sb-ppm	Sc-ppm	Sn-ppm	Sr-ppm	V-ppm	W-ppm	Y-ppm	Zn-ppm	Zr-ppm	Th-ppm	Au-ppm
	s	s	s	s	s	s	s	s	s	s	aa
MM10R	N	7	N	200	50	N	30	<200	100	N	N
MM12R	N	7	N	300	50	N	30	N	300	N	N
MM19R	N	<5	N	150	10	N	30	N	200	N	N
MM30RA	N	5	N	1,000	20	N	15	200	150	N	N
MM30RB	N	N	N	200	50	N	N	<200	10	N	N
MM30RB1	N	N	N	100	15	N	N	N	N	N	N
MM30RB2	N	N	N	300	50	N	10	<200	100	N	N
MM44R	N	N	N	100	30	N	N	N	<10	N	N

Sample	Hg-ppm	As-ppm	Zn-ppm	Cd-ppm	Bi-ppm	Sb-ppm	W-ppm	SI-F	U-ppm	TH-ppm
	inst	aa	aa	aa	aa	aa	cm			
MM10R	N	N	60	N	N	N	N	400	1.62	11.5
MM12R	N	N	55	N	N	<2	N	400	4.40	11.4
MM19R	N	N	20	N	N	N	2.0	300	5.96	17.5
MM30RA	N	N	130	N	N	N	1.0	800	19.50	<11.0
MM30RB	.34	<10	50	.6	N	N	2.0	1,600	83.30	<23.0
MM30RB1	.04	10	25	.4	N	N	2.0	1,600	35.70	<13.0
MM30RB2	.10	N	85	.8	N	N	2.0	1,100	57.50	<17.0
MM44R	.02	N	10	2.8	N	N	6.0	300	10.40	<6.1