ALABAMA G-E-M RESOURCES AREA

(GRA NO. CA-09)

TECHNICAL REPORT

(WSAs CA 010-057, 010-058, and 010-064)

Contract YA-553-RFP2-1054

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Final Report

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EXECUTIVE SUMMARY

The Alabama Geology-Energy-Minerals (G-E-M) Resources Area (GRA) is a few miles west of the town of Lone Pine in Inyo County, California. There are three Wilderness Study Areas (WSAs) in the GRA: WSAs CA 010-057, 010-058 and 010-064.

The oldest rocks in the GRA metamorphosed sedimentary and volcanic rocks somewhat more than 100 million years old that have been intruded by granitic rocks about 90 million years old. These rocks lie at the eastern and western edges of the GRA, and between them is a large expanse in which only very young alluvium -- sands and gravels eroded from the mountains -- is exposed. The WSAs cover almost exclusively the alluvial terrane.

The only known metallic mineral occurrence in the GRA is a small gold vein at the Alabama-Mohawk mine in the Alabama Hills. All three WSAs cover areas that, at the surface, are almost entirely gravels.

There are a few unpatented claims in WSA CA 010-057. There are no oil and gas, sodium and potassium, or geothermal leases in the GRA.

All three WSAs are classified as having low favorability for metallic minerals, uranium, thorium, and geothermal resources, with low to very low levels of confidence; and all three are classified as having moderate favorability for sand and gravel with a moderate level of confidence. There is no favorability for oil and gas, coal, oil shale and tar sands, with a high level of confidence. There is no favorability for sodium and potassium, with a low level of confidence.

No additional work is recommended for the Alabama GRA.

I. INTRODUCTION

The Alabama G-E-M Resources Area (GRA No. CA-09) contains approximately 118,000 acres (478 sq km) and includes the following Wilderness Study Areas (WSA):

WSA Name	WSA Number
Independence Creek	010-057
Wonoga Peak	010-058
Symmes Creek	010-064

The GRA is located in California in the Bureau of Land Management's (BLM) Bishop Resource Area, Bakersfield district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 36°40' north latitude, 118°10' west longitude and includes the following townships:

T 13 S, R 34,35 E	T 15 S, R 34,35 E
T 14 S, R 34,35 E	T 16 S, R 35,36 E

The areas of the WSAs are on the following U. S. Geological Survey topographic maps:

15-minute:

Mt. Whitney	Independence
Lone Pine	

The nearest town is Lone Pine which is located on U.S. Highway 395 in Owens Valley east of the GRA. Access to the area is via U.S. Highway 395. Access within the area is along east-west unimproved roads north and south of the Alabama Hills.

Figure 2 outlines the boundaries of the GRA and the WSAs on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin

and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

None of the WSAs in this GRA were field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the WSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included with the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

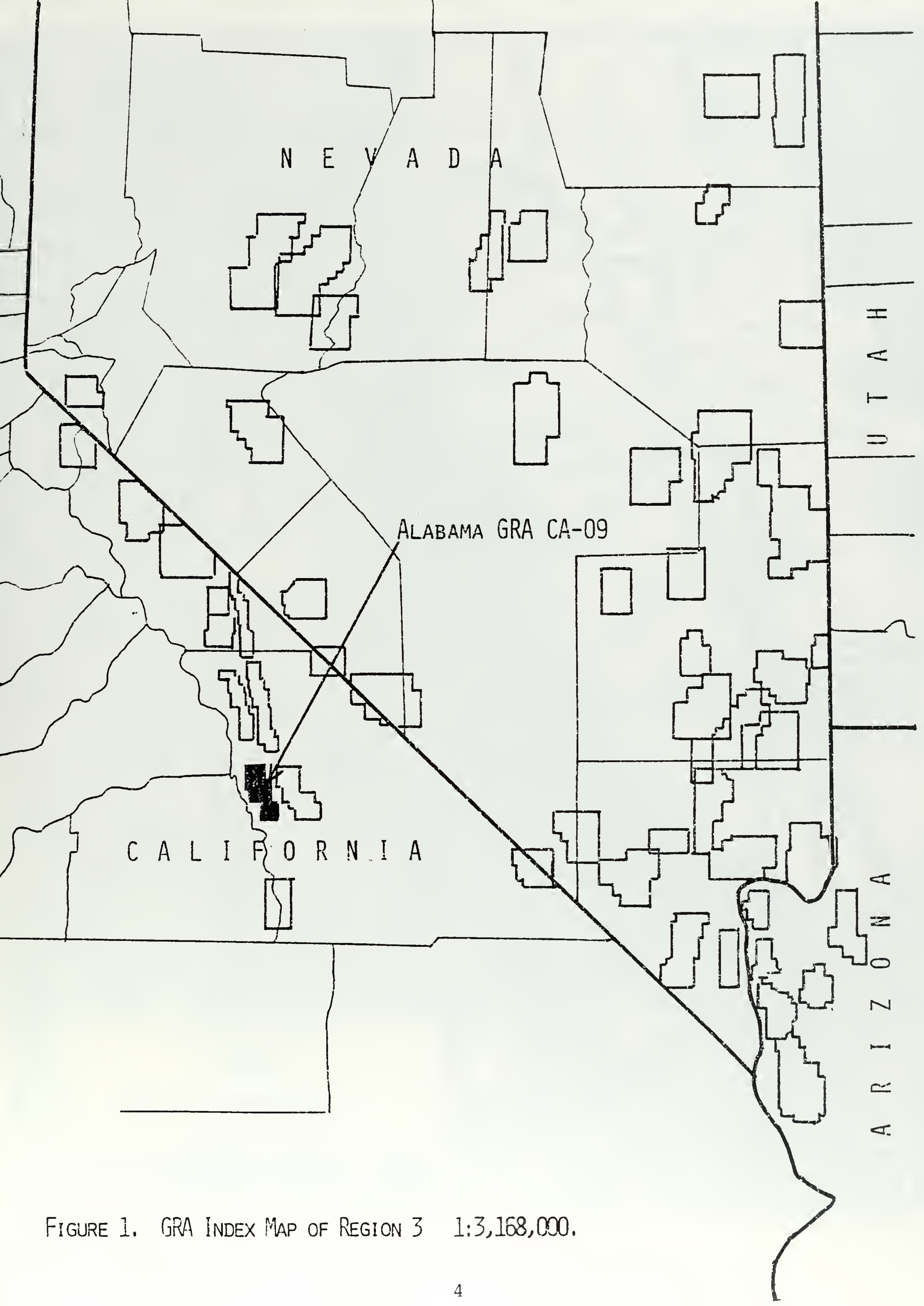
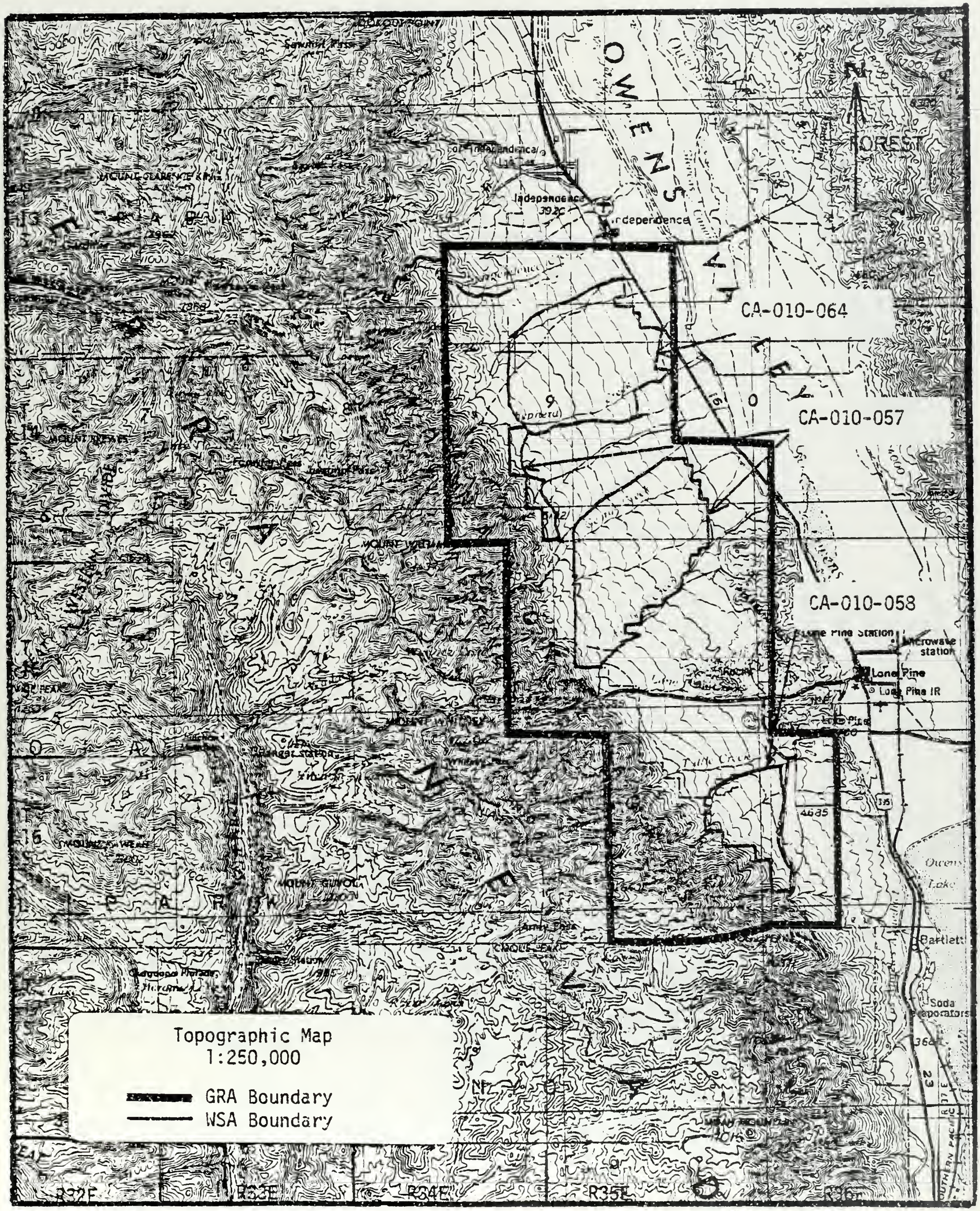


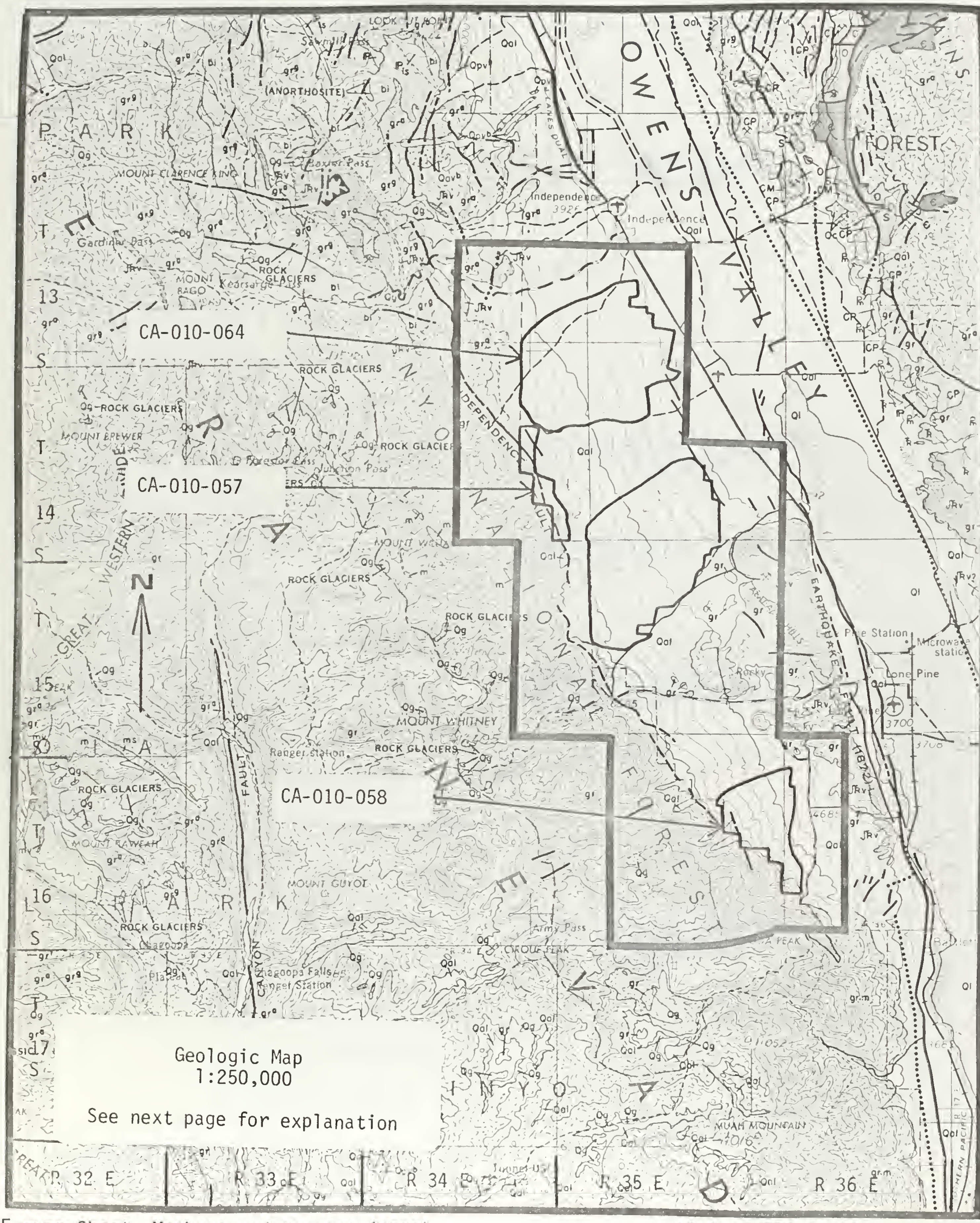
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Fresno Sheet

Alabama GRA CA-09

Figure 2



Fresno Sheet, Mathews and Burnett (1965)

Alabama GRA CA-09

Figure 3

EXPLANATION

SEDIMENTARY AND METASEDIMENTARY ROCKS

CENOZOIC

QUATERNARY

Recent

Qs	Dune sand
Qal	Alluvium
Qsc	Stream channel deposits (GREAT VALLEY)
Qf	Fan deposits (GREAT VALLEY)
Qb	Basin deposits (GREAT VALLEY)
Qsl	Salt deposits
Ql	Quaternary lake deposits
Qg	Glacial deposits
Qt	Quaternary nonmarine terrace deposits

Pleistocene

Qm	Pleistocene marine and marine terrace deposits
Qc	Pleistocene nonmarine
QP	Plio-Pleistocene nonmarine

TERTIARY

Pliocene

Pc	Undivided Pliocene nonmarine
Puc	Upper Pliocene nonmarine
Pu	Upper Pliocene marine
Pmlc	Middle and/or lower Pliocene nonmarine
Pml	Middle and/or lower Pliocene marine

Miocene

Mc	Undivided Miocene nonmarine
Muc	Upper Miocene nonmarine
Mu	Upper Miocene marine
Mmc	Middle Miocene nonmarine
Mm	Middle Miocene marine
Ml	Lower Miocene marine

Oligocene

Φc	Oligocene nonmarine
Φ	Oligocene marine

Eocene

Ec	Eocene nonmarine
E	Eocene marine

Paleocene

Epc	Paleocene nonmarine
Ep	Paleocene marine

IGNEOUS AND META-IGNEOUS ROCKS

Qrv	Recent volcanic: Qrv^r —rhyolite; Qrv^a —andesite; Qrv^b —basalt; Qrv^p —pyroclastic rocks
Qpv	Pleistocene volcanic: Qpv^r —rhyolite; Qpv^a —andesite; Qpv^b —basalt; Qpv^p —pyroclastic rocks
✳	Quaternary and/or Pliocene cinder cones
Pv	Pliocene volcanic: Pv^r —rhyolite; Pv^a —andesite; Pv^b —basalt; Pv^p —pyroclastic rocks
Mv	Miocene volcanic: Mv^r —rhyolite; Mv^a —andesite; Mv^b —basalt; Mv^p —pyroclastic rocks
Φv	Oligocene volcanic: $Φv^r$—rhyolite; $Φv^a$ —andesite; $Φv^b$ —basalt; $Φv^p$—pyroclastic rocks
Ev	Eocene volcanic: Ev^r —rhyolite; Ev^a —andesite; Ev^b —basalt; Ev^p —pyroclastic rocks

EXPLANATION CONT.

Paleocene
- Ep — Paleocene marine

Undivided (Cenozoic)
- QT — Cenozoic nonmarine
- Tc — Tertiary nonmarine
- Tl — Tertiary lake deposits
- Tm — Tertiary marine
- QTv — Cenozoic volcanic: QTvr—rhyolite; QTva—andesite; QTvb—basalt; QTvp—pyroclastic rocks
- Tgr — Tertiary granitic rocks
- Ti — Tertiary intrusive (hypabyssal) rocks: Tir—rhyolite; Tia—andesite; Tib—basalt
- Tv — Tertiary volcanic: Tvr—rhyolite; Tva—andesite; Tvb—basalt; Tvp—pyroclastic rocks

MESOZOIC

CRETACEOUS
- K — Undivided Cretaceous marine
- Ku — Upper Cretaceous marine
- Kl — Lower Cretaceous marine

JURASSIC
- Jk — Knoxville Formation
- Ju — Upper Jurassic marine
- Jml — Middle and/or Lower Jurassic marine

TRIASSIC
- Ћ — Triassic marine

Franciscan Formation
- KJf — Franciscan Formation
- KJfv — Franciscan volcanic and metavolcanic rocks
- gr — Mesozoic granitic rocks: grg-granite and adamellite, grg-granodiorite; grt-tonalite and diorite
- bi — Mesozoic basic intrusive rocks
- ub — Mesozoic ultrabasic intrusive rocks
- JЋv — Jura-Trias metavolcanic rocks

UNDIVIDED
- m, ls — Pre-Cretaceous metamorphic rocks (ls = limestone or dolomite)
- ms — Pre-Cretaceous metasedimentary rocks
- P, ls — Paleozoic marine (ls = limestone or dolomite)
- mv — Pre-Cretaceous metavolcanic rocks
- gr-m — Pre-Cenozoic granitic and metamorphic rocks
- Pv — Paleozoic metavolcanic rocks

PALEOZOIC

PERMIAN
- P — Permian marine
- Pv — Permian metavolcanic rocks

CARBONIFEROUS
- C — Undivided Carboniferous marine
- CP — Pennsylvanian marine
- CM — Mississippian marine
- Cv — Carboniferous metavolcanic rocks

DEVONIAN
- D — Devonian marine
- Dv — Devonian metavolcanic rocks
- Dv? — Devonian and pre-Devonian? metavolcanic rocks

SILURIAN
- S — Silurian marine
- pSs — Pre-Silurian metasedimentary rocks
- pS — Pre-Silurian metamorphic rocks
- pSv — Pre-Silurian metavolcanic rocks

ORDOVICIAN
- O — Ordovician marine

CAMBRIAN
- Є — Cambrian marine
- Є? — Cambrian – Precambrian marine

PRECAMBRIAN
- pЄc — Precambrian igneous and metamorphic rock complex
- pЄ — Undivided Precambrian metamorphic rocks: pЄg = gneiss, pЄs = schist
- pЄg — Undivided Precambrian granitic rocks
- lpЄ — Later Precambrian sedimentary and metamorphic rocks
- pЄan — Precambrian anorthosite
- epЄ — Earlier Precambrian metamorphic rocks

II. GEOLOGY

The Alabama GRA is located at the boundary between the western Basin and Range and the eastern Sierra Nevada geomorphic provinces. The study area includes the eastern escarpment of the Sierra Nevadas and the alluvial fans that slope away from the range front. The northwest portion of the Alabama Hills, which has the only known metal production in this area, is included within the GRA.

The predominant bedrock type in the Alabama GRA consists of a series of unnamed Cretaceous plutons and intrusive bodies ranging in composition from granite in the Sierra Nevada to syenite in the Alabama Hills. Jurassic-Cretaceous metavolcanics are found in the northern portion of the Alabama Hills. Large coalescing alluvial fans between the Sierra Nevada frontal fault and the Alabama Hills, and northward, comprise a large portion of the study area and underlie the WSAs.

1. PHYSIOGRAPHY

The Alabama GRA is located in western Inyo County at the boundary between the Basin and Range and Sierra Nevada geomorphic provinces. The study area includes the steep northwest trending Sierra Nevada escarpment, coalescing alluvial fans that slope away from the Sierras, and the western portion of the Alabama Hills.

The major rock types are Cretaceous granitic intrusives of the Sierra Nevada batholith and Jurassic-Triassic metavolcanic rocks.

Elevations exceed 10,000 feet on the eastern slopes of Mt. Whitney and Mt. William, located to the west of the Sierra Nevada escarpment. Streams dissect the alluvial fans sloping away from the Sierra Nevadas and drain eastward toward the Owens River at an elevation of about 4,000 feet.

2. ROCK UNITS

The oldest rocks in the Alabama GRA are metavolcanics. The unnamed unit is composed of meta-rhyolite tuffs, interbedded metasediments, quartz metaporphyry, and lamprophyre and metaandesites dikes (Richardson, 1975). The age of these rocks is Triassic to early Cretaceous.

The Sierra Nevadas are comprised of Cretaceous age interlocking plutons ranging in composition from granite to diorite. The Sierra Nevada intrusions within the study area are described as granite on the Fresno sheet of the Geologic Map of California (Matthews and Burnett, 1965).

The predominant rock type in the Alabama Hills consists of a series of unnamed intrusive rocks. The intrusives were emplaced in order of increasing silica and are composed of quartz monzonite, alaskite, and syenite dikes (Knopf and Kirk, 1918). Aplite and pegmatite dikes were formed along contacts between the metavolcanics and the igneous rocks. The last of the intrusives were intruded at the close of the Cretaceous.

Glacial deposits and recent alluvium are the youngest rocks in this area. Fine lateral moraines containing poorly sorted, blocky sediments are exposed along the Diaz Creek and Lone Pine Creek Canyons. The moraines were deposited during various Pleistocene glacial epochs (Knopf, 1918). Recent Quaternary deposits comprise the alluviated slope from the base of the Sierra escarpment to the Alabama Hills and nearly all the area of the WSAs is on these Quaternary deposits.

3. STRUCTURAL GEOLOGY AND TECTONICS

The oldest structural features in the Alabama GRA are associated with the metavolcanics in the Alabama Hills. These rocks contain crossbedding in the metasediments and bedding plane between the volcanic and clastic layers. Metamorphic structures include cleavage and shearing (Mayo,1941). The age of these features is Triassic to Cretaceous.

Within the granitic rocks, well developed joint patterns were formed as the plutons were cooling. Parallel fracture systems mimic the original flow structure of the liquid intrusives. Dikes and pegmatites are consistent with this northeast trend. These structures formed by the end of the Cretaceous.

The Sierra Frontal fault is represented by the steep northwest-trending escarpment in the western portion of the GRA. The eastern escarpment of the Alabama Hills was produced by the Central Owens Valley faults. Associated with these boundary faults are numerous east-west lateral faults located north and south of the Alabama Hills. The Central Owens Valley fault, active as recently as 1872, may be older than the Pliocene-Pleistocene uplift along the Sierra Frontal fault (Oliver, 1956).

4. PALEONTOLOGY

Dominant lithologies within the Alabama GRA either preclude occurrence of paleontological resources (pre-Cretaceous granitic rocks) or have a very low potential (Quaternary alluvium, principally fanglomerates and coarse sands).

5. HISTORICAL GEOLOGY

Active volcanism in the southern Sierra Nevada region occurred during the middle to late Triassic. These early volcanics were intruded by dikes and sills composed of basic and rhyolite to andesite material. A layer of sediments was deposited over the subsequent erosional surface and are capped by rhyolite tuff. Regional metamorphism of these sediments occurred prior to the intrusion of the Sierra Nevada batholith.

The metamorphic sequence was intruded by a series of plutons during the late Jurassic to Cretaceous. The granitics were emplaced during four separate events (Richardson, 1975). Dikes and veins filled fractures in the cooling intrusives. Contact metamorphism occurred locally along the metavolcanic and intrusive contact and at some places in the region major tungsten deposits were formed.

During the late Miocene and early Pliocene, the Sierra Nevadas were uplifted along northwest-trending normal faults and tilted west. The Pliocene-Pleistocene movement along these faults formed the present escarpment and the resulting erosion produced the extensive alluvial fans.

The Alabama Hills were uplifted along the Central Owens Valley fault prior to the most recent movement along the Sierra frontal faults and as recently as 1872.

Pleistocene glaciers in the Sierras deposited moraines evidenced in Diaz Creek and Lone Pine Creek Canyons (Knopf and Kirk, 1918).

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

Gold is the only commodity that has been produced in the Alabama GRA. The Alabama-Mohawk Mine (Sec. 11, T 35 E, R 15 S) produced an unknown quantity of gold from a narrow quartz vein associated with an andesite dike in micro-granite. This vein has been developed by an adit and a shallow shaft. No specific production or geologic data concerning this property is readily available (Tucker, 1938).

2. Known Prospects, Mineral Occurrences and Mineralized Areas

With the exclusion of the known gold deposit described in the previous section, no prospects or mineral occurrences have been identified.

A northwest trending zone of sericitic, chloritic, and argillic alteration along a fault which passes through the Alabama-Mohave mine has been identified by Richardson (1975). This zone extends for several miles cutting through undifferentiated Jurassic-Cretaceous metamorphic rocks in the southeast and microgranite in the northwest. The age of this hydrothermal alteration is dated by Richardson as having occurred sometime during the Tertiary.

3. Mining Claims

There are no patented claims in the GRA area.

A few lode and placer unpatented mining claims are located in the area around the Alabama-Mohawk mine in the northwestern portion of the Alabama Hills. Placer and lode unpatented claims have been located on the alluvial fans between the Alabama Hills and the Sierra Nevada. Some of these are in WSA CA 010-057. No prospects have been identified in this area and it is unknown what commodity is being explored for. Sec. 15 of T 16 S, R 36 E contains an isolated unpatented millsite claim, presumably for processing gold ore from small mines in the Alabama Hills.

4. Mineral Deposit Types

The only known mineral deposit located within the GRA is the Alabama-Mohawk mine in the northwest portion of the Alabama Hills. This mine developed a narrow auriferous quartz filled fault zone along an andesite dike which cuts Cretaceous microgranite. The gold is associated with pyrite and copper minerals indicating a mesothermal type depositional environment. A northwest trending zone of hydrothermal alteration passes through this area and may be related to the mineralization; Richardson (1975) dates the alteration as Tertiary.

Judging by the gravity data that Pakiser, and others, (1964) present, bedrock lies at no great depth beneath the surface of the WSAs in the Alabama GRA. At many places along the eastern front of the Sierra Nevada there are deposits of tungsten in pyrometasomatic zones along contacts between Paleozoic calcareous metasediments and intrusive rocks. In and near the Alabama GRA no calcareous metasediments are exposed, which suggests there is little expectation for tungsten deposits under the WSAs.

5. Mineral Economics

The Alabama GRA possesses only minor potential for additional gold production from the narrow auriferous quartz veins in the Alabama Hills. These veins are located outside of the WSAs boundaries. Unpatented lode and placer claims have been located in two sections on the alluvium within WSA 010-057, but, the commodity being explored for has not been identified.

The major use of gold is for storing wealth. It is no longer used for coinage because of monetary problems, but many gold "coins" are struck each year for sale simply as known quantities of gold that the buyer can keep or dispose of relatively easily. The greatest other use of gold is in jewelry, another form of stored wealth. In recent years industrial applications have become increasingly important, especially as a conductor in electronic instrumentation. In the United States and some other countries gold is measured in troy ounces that weigh 31.1 grams -- twelve of which make one troy pound. Annual world production is about 40 million ounces per year, of which the United States produces somewhat more than one million ounces, less than one-fourth of its consumption, while the Republic of South Africa is by far the largest producer at more than 20 million ounces per year. World production is expected to increase through the 1980s. For many years the price was fixed by the United States at $35 per ounce, but after deregulation the price rose to a high of more than $800 per ounce and then dropped to the

neighborhood of $400 per ounce. At the end of 1982 the price was $460.50 per ounce.

More than half of all tungsten used is in the form of tungsten carbide, a hard and durable material used in cutting tools, wear-resistant surfaces and hard-faced welding rods. Lesser quantities are used in alloy steels, in light bulb filaments, and in chemicals. World production of tungsten is nearly 100 million pounds annually, of which the United States produces somewhat more than six million pounds, while using more than 23 million pounds. The shortfall is imported from Canada, Bolivia, Thailand and Mainland China, as well as other countries. Tungsten is a strategic and critical metal. United States demand is projected to about double by the year 2000, and most of the additional supply will probably be imported, because large reserves are in countries in which profitability is not a factor -- they need foreign exchange, and therefore sell at a price that few domestic mines can match. Tungsten prices F.O.B. mine are quoted for "short ton units", which are the equivalent of 20 pounds of contained tungsten. At the end of 1982 the price of tungsten was about $80 per short ton unit.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

No nonmetallic mineral deposits are known in the Alabama GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Area

No nonmetallic mineral prospects are known in the GRA. The Quaternary alluvial fans that make up the surficial material on all the WSAs are by definition sand and gravel, with unknown admixtures of coarser cobbles and boulders.

3. Mining Claims, Leases and Material Sites

Unpatented claims in the western part of the southern segment of WSA CA 010-057 may have been located for nonmetallic minerals. They are staked on alluvium more than a mile from any bedrock outcrops. Alternatively, they may be placer locations for gold.

No material sites are known within the WSAs.

4. Mineral Deposit Types

There are no known nonmetallic mineral deposits to be described.

5. Mineral Economics

There are no known nonmetallic mineral deposits to be considered. In general, nonmetallic deposits in this region are burdened by the cost of the long haul to major market areas in the vicinity of Los Angeles.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are no known uranium or thorium deposits within or near the WSAs or the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Radioactive occurrences are indicated on the Uranium Land Classification and Mineral Occurrence Map included at the back of the report.

There are no known uranium or thorium prospects or occurrences within or near the WSAs or the GRA. There is a uranium occurrence on the east side of Owens Valley, east of the GRA. This occurrence is in Mesozoic granite and may be from the same stock as the Cretaceous granites in the GRA.

3. Mining Claims

No uranium or thorium claims or leases are listed for the WSAs or the GRA.

4. Mineral Deposit Types

Uranium and thorium deposit types are not known as no occurrences have been found.

5. Mineral Economics

Uranium and thorium would appear to have no economic value for the area as there are no known radicactive mineral occurrences within the GRA.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States is the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was forecast in the late 1980s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mines and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Thorium is used in the manufacture of incandescent gas mantles, welding rods, refractories, as fuel for nuclear power reactors and as an alloying agent. The principal source of thorium is monazite which is recovered as a byproduct of titanium, zirconium and rare earth recovery from beach sands. Although monazite is produced from Florida beach sands, thorium products are not produced from monazite in the United States. Consequently, thorium products used in the United States come from imports, primarily from France and Canada, and industry and government stocks. Estimated United States consumption of thorium in 1980 was 33 tons, most of which was used in incandescent lamp mantles and refractories (Kirk, 1980b). Use of thorium as nuclear fuel is relatively small at present, because only two commercial thorium-fueled reactors are in operation. Annual United States demand for thorium is projected at 155 tons by 2000 (Kirk, 1980a). Most of this growth is forecast to occur in nuclear power reactor usage, assuming that six to ten thorium-fueled reactors are on line by that time. The United States and the rest of the world are in a favorable position with regard to adequacy of thorium reserves. The United States has reserves estimated at 218,000 tons of ThO_2 in stream and beach placers, veins and carbonatite deposits (Kirk, 1982); and probable cumulative demand in the United States as of 1000 is estimated at only 1800 tons (Kirk, 1980b). The price of thorium oxide at the end of 1981 was $16.45 per pound.

Oil and Gas Resources

There are no oil and gas fields, hydrocarbon shows in wells, or surface seeps in the region; nor are there any Federal oil and gas leases in the immediate region. The rocks underlying the GRA are the granitic Sierran batholith, normally with a thin veneer of Cenozoic sediments, but there are no petroleum source rocks.

There is no oil and gas lease map or oil and gas occurrences and land classification map for this report.

Geothermal Resources

1. Known Geothermal Deposits

   There are no known geothermal deposits within the Alabama GRA, or in its immediate vicinity.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

   There is no direct evidence of prospects, occurrences, or thermal manifestations within the GRA. Ten miles to the southwest, not directly on structural trend, is Kern Hot Spring (43°C, flowing 950 mg/l water at 15 l/min) (NOAA, 1980). Part of the GRA is situated within the alluvial fan environment on the western side of the Owens Valley which hosts geothermal prospects geographically distant but in the same general geological setting. The Kern Hot Spring is shown on the Geothermal Occurrence and Land Classification Map at the back of the report.

3. Geothermal Leases

   There are no recorded Federal geothermal leases or lease applications within the GRA, or in its vicinity. There is no geothermal lease map in this report.

4. Geothermal Deposit Types

   If there were geothermal deposits present, they would be expected to be deep-circulation types associated with major Basin and Range normal faulting.

5. Geothermal Economics

   Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The

fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystallization (266°F), and drying of diatomaceous earth (338°F).

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGICAL RESOURCES

There are no known other geological resources. There is no potential for coal, oil shale or tar sands.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981-March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

There is low potential for tungsten a strategic and critical metals in the Alabama WSAs of the GRA. Tungsten deposits are known in the general region, and the geology beneath the extensive alluvial cover may be suitable for such deposits.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES POTENTIAL

There is no detailed geologic mapping for most of the GRA. However, for the part covered by the WSAs this lack is of little importance, since it is clear from the generalized mapping that they lie almost entirely on Quaternary alluvium. It is unlikely that more detailed mapping of the alluvium, without extensive pitting to evaluate gravel qualities, would provide more information than does the generalized mapping. Therefore, the quantity and quality of geologic work in most of the WSAs is ample for the purpose of this report. Small areas at the west edges of WSAs CA 010-057 and 010-058 extend into areas of bedrock exposure at the foot of the Sierra Nevada. The existing mapping indicates that these are entirely granitic rocks, and the quality and quantity and quality of the mapping appears sufficient for the purpose of this report.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g. M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

Land classifications have been made here only for the areas that encompass segments of WSA CA 010-057, CA 010-058, and CA 010-064. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report. The classification areas are based on a geologic map of 1:250,000 and therefore are generalized, so they have not been transferred to 1:62,500 scale topographic maps for the GRA file.

1. LOCATABLE MINERALS

a. Metallic Minerals

WSA CA 010-057

M1-2A. This classification area covers all of the WSA except for very small tips along the western edge. In it only Quaternary alluvium is mapped, and this completely obscures the bedrock geology. Elsewhere in and along the eastern edge of the Sierra Nevada metamorphosed Paleozoic sedimentary rocks contain important deposits of tungsten, a strategic and critical metal, close to intrusive bodies. The classification of low favorability for metallic minerals is based on this potentiality, while the level of confidence in this classification is very low because it is based entirely upon geological reasoning.

M2-1B. This classification area covers small tips along the western edge of the WSA. In and adjacent to it Cretaceous granitic rocks are mapped with no known mineral occurrences. Intrusive rocks as such are generally unfavorable for metallic deposits, and here where they are exposed at the edge of the valley, easily accessible for prospecting, it is to be expected that evidence of mineralization would have been found if it were present. These are the reasons for the classification as having no indication of favorability for metallic minerals, and the low level of confidence in this classification.

WSA CA 010-058

M1-2A. This classification area covers most of the WSA. The rationale for the classification and the level of confidence is given above under WSA CA 010-057.

M2-1B. This classification area covers small tips along the western edge of the WSA. The rationale for the classification and the level of confidence is given above under WSA CA 010-057.

WSA CA 010-064

M1-2A. This classification area covers all of the WSA. The rationale for the classification and then level of confidence are given above under WSA CA 010-057.

b. Uranium and Thorium

WSAs CA 010-064, 010-057, 010-058

U1-2B. This land classification area covers all of WSA CA 010-064 and most of WSA CA 010-057 and WSA CA 010-058. The area has low favorability at a low confidence level for epigenetic sandstone type uranium deposits. The uranium could be leached by ground water from the granitic rocks of the Sierra Nevada to the west, carried down into the Quaternary alluvium, and precipitated in permeable horizons, particularly in the presence of a reducing agent such as organic matter.

Thorium and uranium have very low favorability at a very low confidence level for concentration in the area as resistate mineral deposits. Radioactive minerals weathering out of the granites and pegmatites of the Sierra Nevada could be deposited along stream beds in the alluvium. However, it is doubtful that sufficient reworking of the sediments has taken place to allow concentration of the heavy resistate minerals.

WSAs CA 010-057, 010-058

U2-2B. This land classification area, indicating low uranium and thorium favorability at a low confidence level, covers parts of the western borders of the WSAs where they include the cretaceous granitic rocks of the Sierra Nevada. The granites are a potential source of uranium and mineral concentrations could occur along fractures and in veins in the area.

Thorium and uranium could also occur in small concentrations in pegmatites of the Cretaceous intrusive, though it is not known whether there are pegmatities present along the eastern edge of the Sierra Nevada within the WSAs.

c. Nonmetallic Minerals

WSAs CA 010-057, CA 010-058, CA 010-064

N1-3C. The Quaternary alluvium that makes up the surficial cover of nearly all the WSAs is by definition sand, gravel, cobbles and boulders of various sizes. Thus, sand and gravel deposits are known to occur throughout the WSAs, although none is known to have been mined from the WSAs. The quality of the sand and gravel is unknown, hence the only moderate confidence level.

2. LEASABLE RESOURCES

a. Oil and Gas

WSAs CA 010-064, CA 010-057, and CA 010-058

OG1-1D. There has been no serious oil and gas exploration, nor are there any recorded occurrences of oil and gas in this westernmost sector of the Basin and Range province where it meets the Sierra Nevadas. The entire WSA area is within the thin Quaternary covering of a pediment of the Sierran granitic batholith which has no source rock potential for oil or gas.

b. Geothermal

WSAs CA 010-064, CA 010-057, and CA 010-058

G1-2B A low favorability classification is based largely on the fact that the Alabama GRA is regionally on trend with major proven and lesser geothermal deposits, where the Basin and Range province meets the eastern flank of the Sierra Nevada Mountains. The site is probably underlain by a partially fractured fault block of the Sierran granite batholith, within the western half of the Owens Valley fault zone. There are no recorded thermal manifestations in the immediate region and no Cenozoic volcanics present in outcrop.

c. Sodium and Potassium

S1-1A. This classification applies to the entire WSA. There is no indication of favorability for the accumulation of tungsten, a sodium and potassium. No map is presented for sodium and potassium.

3. SALEABLE RESOURCES

Saleable resources have been covered in consideration of nonmetallic resources.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

No additional work is recommended for the Alabama GRA.

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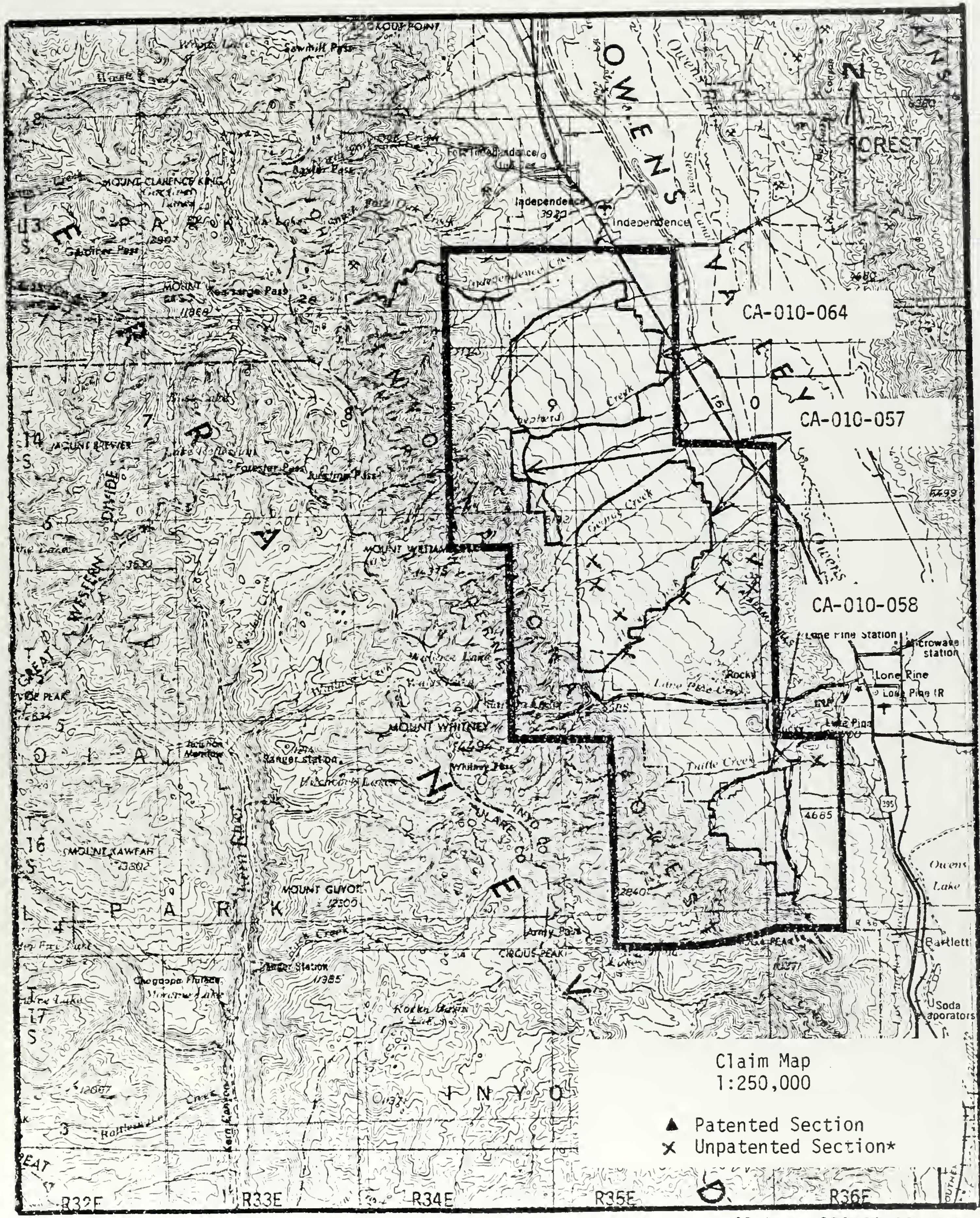
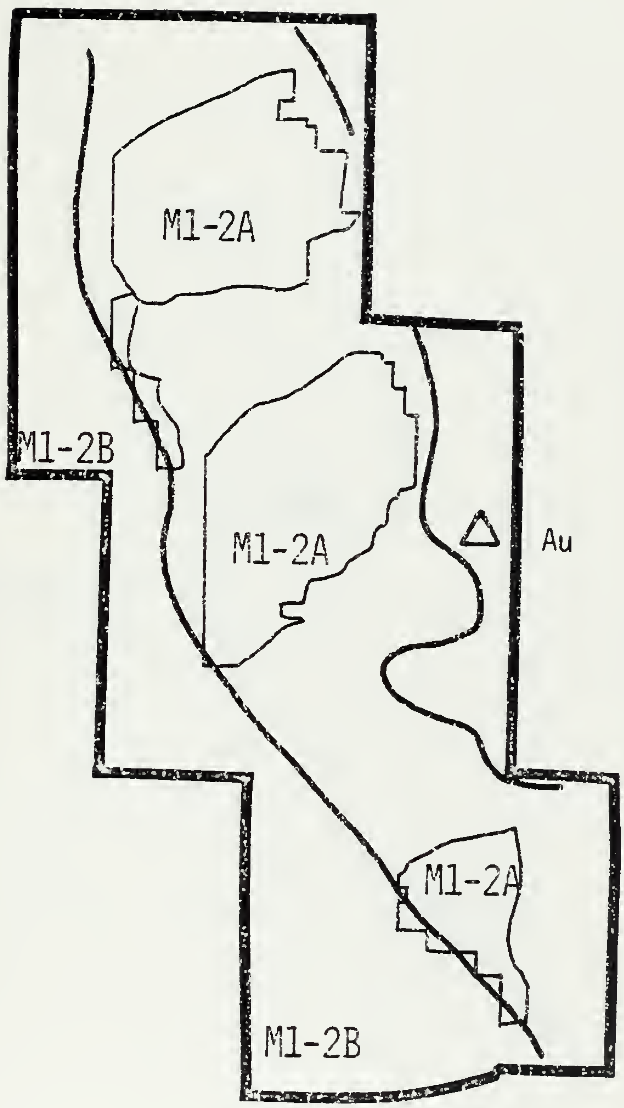


*X denotes one or more claims per section

Alabama GRA CA-09



EXPLANATION

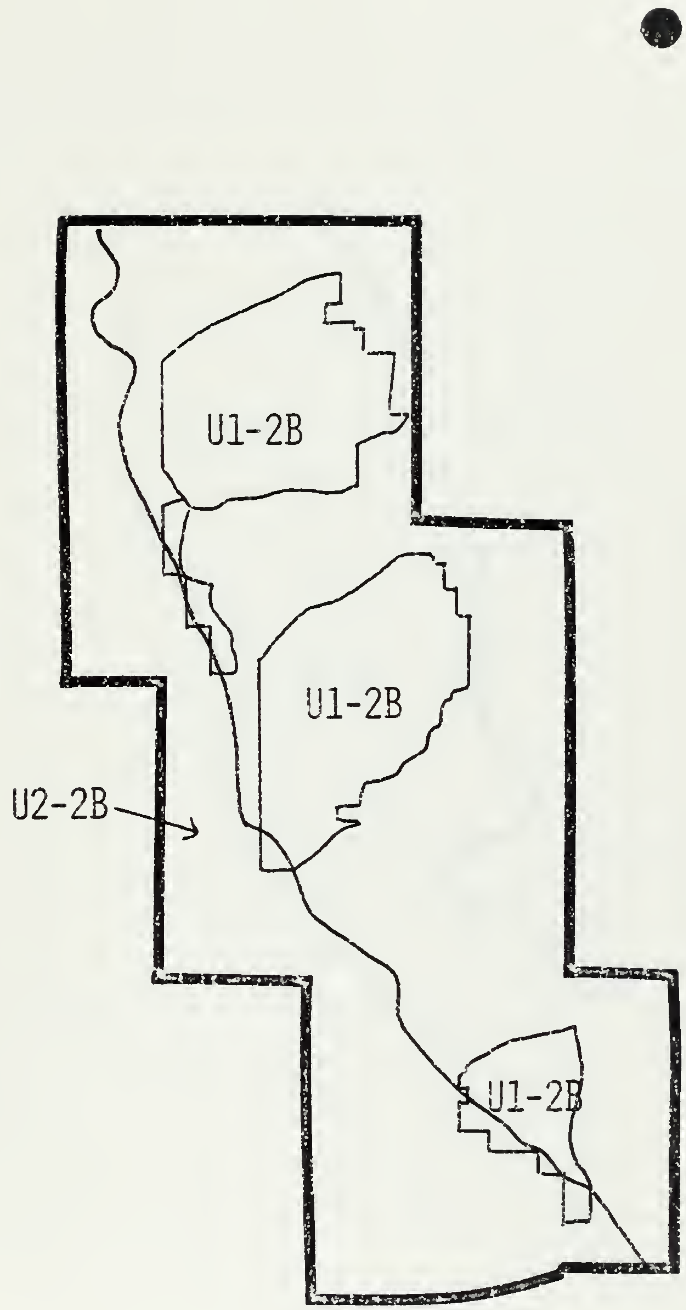
△ Mine, Commodity

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Metallics

Alabama GRA CA-09
Scale 1:250,000



EXPLANATION

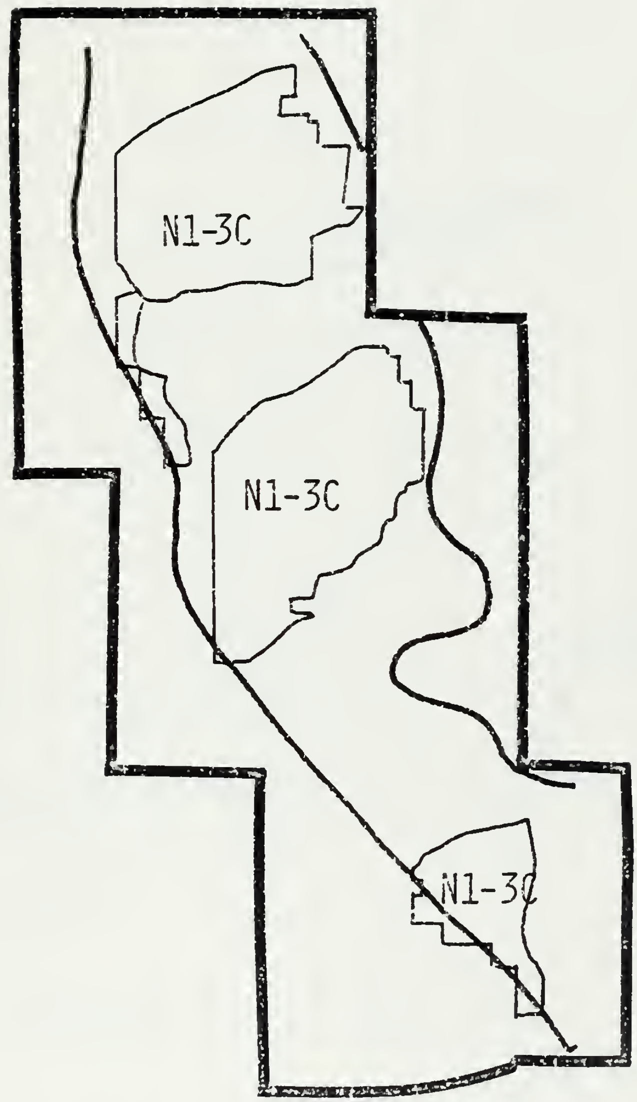
Uranium Occurrence

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Uranium

Alabama GRA CA-09
Scale 1:250,000

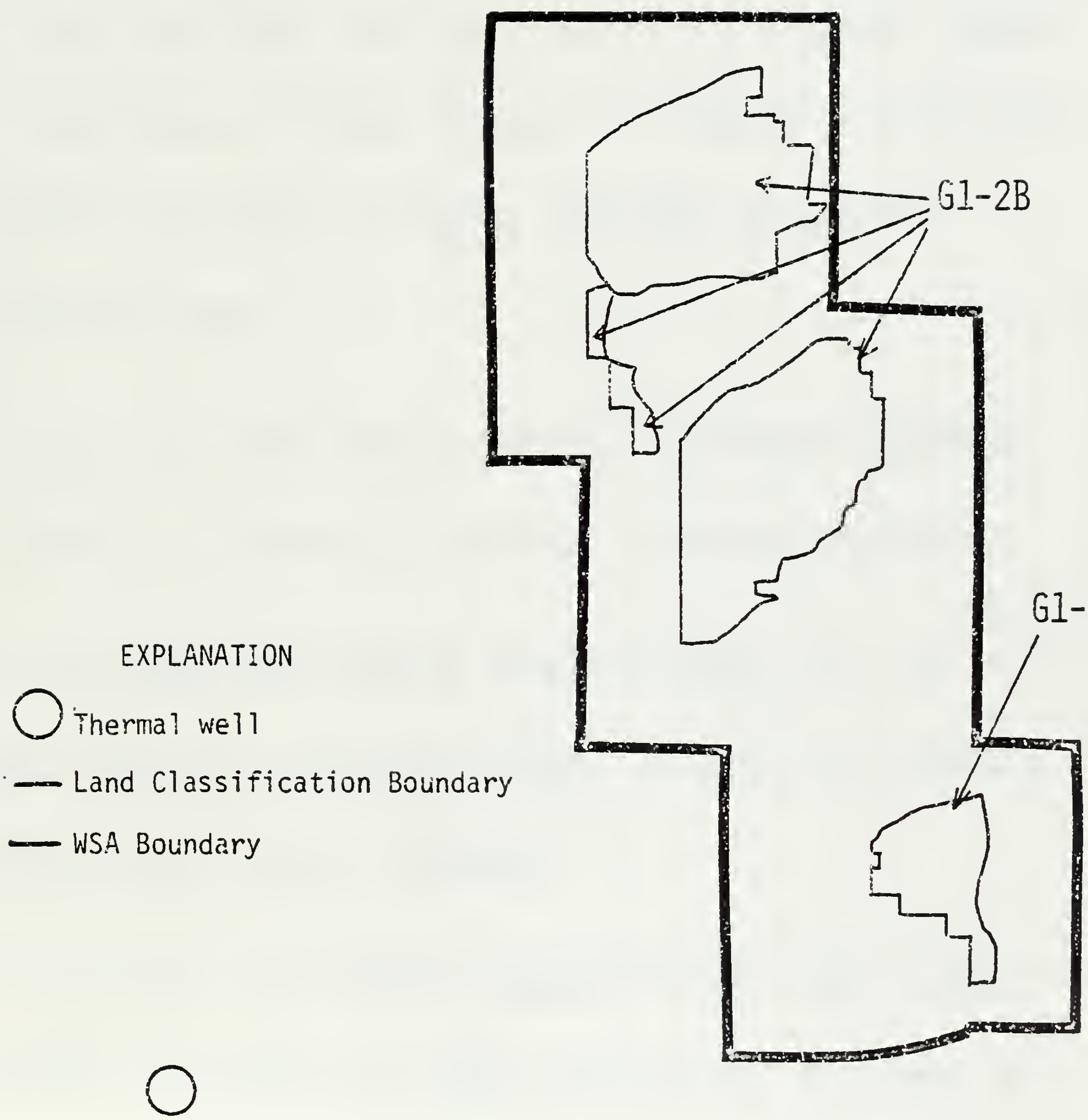


EXPLANATION

Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Nonmetallics Alabama GRA CA-09
Scale 1:250,000



Land Classification - Mineral Occurrence Map/Geothermal

Alabama GRA CA-09
Scale 1:250,000

LEVEL OF CONFIDENCE SCHEME

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 TO 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.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE 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.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary	Holocene	
		Pleistocene	2-3 [1]
	Tertiary	Pliocene	12 [1]
		Miocene	26 [2]
		Oligocene	37-38
		Eocene	53-54
		Paleocene	65
Mesozoic	Cretaceous [4]	Upper (Late) Lower (Early)	136
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems: Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
	Carboniferous Systems: Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

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[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970