BODIE G-E-M

RESOURCES AREA

(GRA NO. CA-02)

TECHNICAL REPORT

(WSAs CA 010-094, 010-095, 010-099,
010-100, 010-102, and 010-103)

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Geothermal

MINERAL OCCURRENCE AND LAND CLASSIFICATION MAPS (Attached)

Metallic Minerals

Uranium and Thorium

Nonmetallic Minerals

Geothermal

LEVEL OF CONFIDENCE SCHEME

CLASSIFICATION SCHEME

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EXECUTIVE SUMMARY

The town of Bridgeport, Mono County, California, lies in the Bodie GRA, with most of the GRA extending from Bridgeport eastward to the Nevada border. There are six WSAs in the GRA: CA 010-094, CA 010-095, CA 010-099, CA 010-100, CA 010-102, and CA 010-103.

The oldest rocks in the GRA are exposed in a relatively small area of the south-central part of the GRA and in a smaller area in the north around the Masonic mining district. These are Ordovician-Silurian sediments (about 450 million years old) and Triassic volcanics (about 200 million years old) that are metamorphosed and intruded by Cretaceous granitic rocks about 90 million years old. Most of the GRA is covered by Tertiary volcanic rocks 3 million to 10 million years old, and it is apparent that this area was a volcanic center from which many flows and tuffs were extruded during that period.

The Bodie GRA has two mining districts with significant past production: the Masonic district in the northeast part of the GRA which has produced several million dollars in gold, and the Bodie district in the east-central part which has produced more than $30 million in gold. At gold prices in the early 1980's, these would be perhaps $50 million and $300 million. The only other known mineral production is small placer gold from the southwest part of the GRA. There are a few scattered prospects elsewhere in the GRA.

Patented mining claims are only in the established old districts. There are hundreds of unpatented claims, most of them located recently in large groups probably by major mining companies. There are no oil and gas leases, nor sodium and potassium leases. Much of the west central part of the GRA, including virtually all of WSA 010-099 -- is covered by geothermal leases.

The entire GRA is classified as having no indicated favorability for oil and gas and for sodium and potassium. The entire GRA is classified as having low favorability for tungsten (a critical metal) and base metals in the older rocks that are covered by volcanics and alluvium in most of the GRA. The metallic mineral classifications below apply to the volcanic rocks and favorability refers largely to deposits of precious metals.

WSA CA 010-094 has low favorability with low confidence for metals and low favorability with low confidence for nonmetallic minerals, throughout. It has low favorability with low confidence for uranium and has no favorability for thorium, with very low confidence. It has high favorability with high confidence for geothermal resources.

WSA CA 010-095 has low favorability with very low confidence for metals except for a small area in the northeast corner that has high favorability with high confidence. It has low favorability

with low confidence for nonmetallic minerals, for uranium in its entirety, and has no favorability for thorium with very low confidence. For geothermal resources its southwestern half is highly favorable with high confidence and its northeastern half is moderately favorable with moderate confidence.

WSA CA 010-099 is classified for metals as follows: a small area at the south-center edge is highly favorable with moderate confidence; a somewhat larger area in its west-center has low favorability with moderate confidence; and the remainder has low favorability with very low to low confidence. All of the WSA has low favorability with low confidence for nonmetallic minerals and for uranium. The WSA has no favorability for thorium with very low confidence. Almost all of the WSA has high favorability with high confidence for geothermal resources except for a narrow strip along the east edge that has moderate favorability with moderate confidence.

WSA CA 010-100 mostly has moderate favorability with moderate confidence for metals, except for the southernmost part which has low favorability with low confidence. All of it has low favorability with low confidence for nonmetallic minerals and for uranium, and has no favorability for thorium at very low confidence. It has moderate favorability with moderate confidence for geothermal resources.

WSA CA 010-102 mostly has low favorability with very low confidence for metals, except for a small part of the northern tip that has moderate favorability with moderate confidence. A small part has moderate favorability with moderate confidence for sand and gravel, while the remainder has low favorability with low confidence for nonmetallic minerals. All of it has low favorability with low confidence for uranium. Nearly all of it has moderate favorability with moderate confidence for geothermal resources, except for a very narrow strip on the south edge that has high favorability with high confidence. The western part has low favorability for thorium at low confidence, and the eastern part has no favorability for thorium at very low confidence levels.

WSA CA 010-103 has low favorability with very low confidence in its entirety for metals; low favorability with low confidence for nonmetallic minerals and uranium; and moderate favorability with moderate confidence for geothermal resources. Most of the WSA has low favorability for thorium at low confidence levels except for the southwestern tip which has no favorability for thorium at a very low confidence level.

No additional work is recommended for any of the WSAs because anything undertaken would surely duplicate work that has been done by private industry. An effort should be made to get more information from industry.

I. INTRODUCTION

The Bodie G-E-M Resources Area (GRA No. CA-02)) contains approximately 226,700 acres (918 sq km) and includes the following Wilderness Study Areas (WSAs):

WSA Name	WSA Number
Mormon Meadow	010-094
Mount Biedeman	010-095
Bodie Mountain	010-099
Bodie	010-100
Masonic Mountain	010-102
Sweetwater	010-103

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 GRA area is near 38°15' north latitude, 119°15' west longitude and includes all or part of the following townships:

T 3 N, R 25,26,27 E	T 5 N, R 25,26,27 E
T 4 N, R 25,26,27 E	T 6 N, R 25,26, E

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

15-minute:

Bridgeport	Bodie
Trench Canyon	Aurora (NV-CA)

The nearest town is Bridgeport which is located in the west-central part of the GRA at the intersection of U.S. Highway 395 and State route 182. Access to the area is via Nevada Highway 3C to the north, highway 167 to the south, and U.S. Highway 395 to the west. Access within the area is on numerous paved and unimproved roads such as Aurora Canyon, Geiger Grade, Cottonwood Canyon and Bodie Creek Roads.

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.

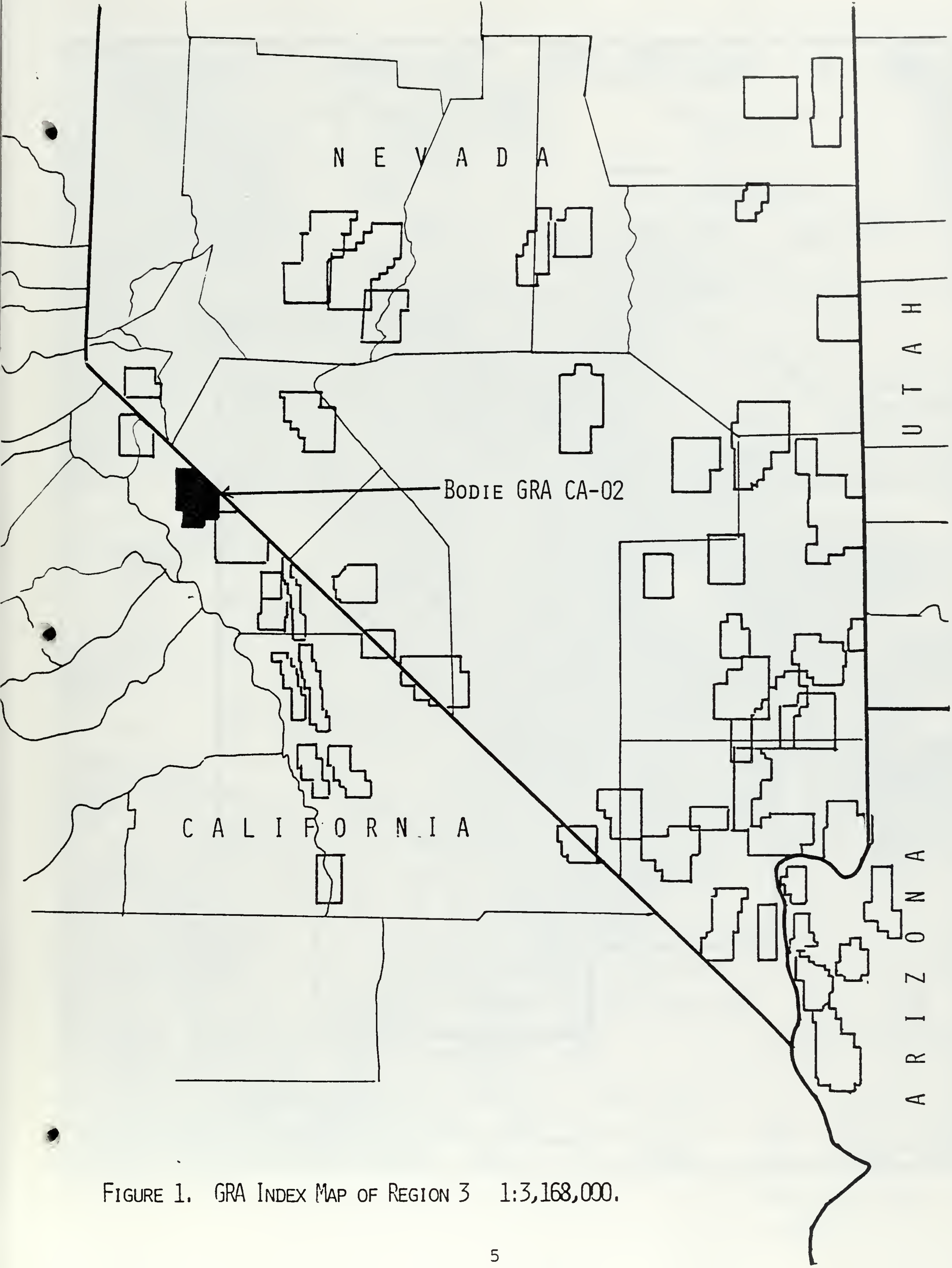
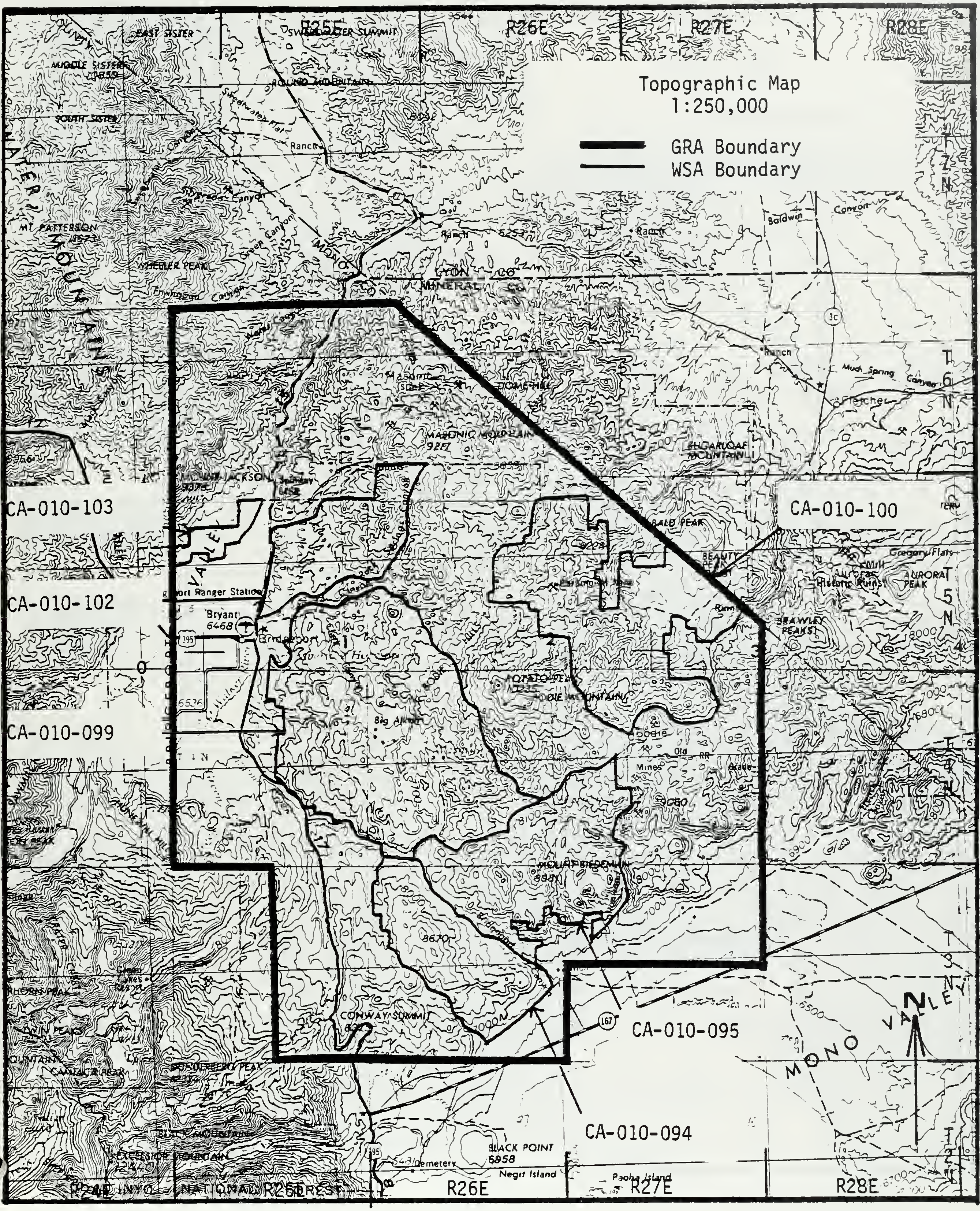


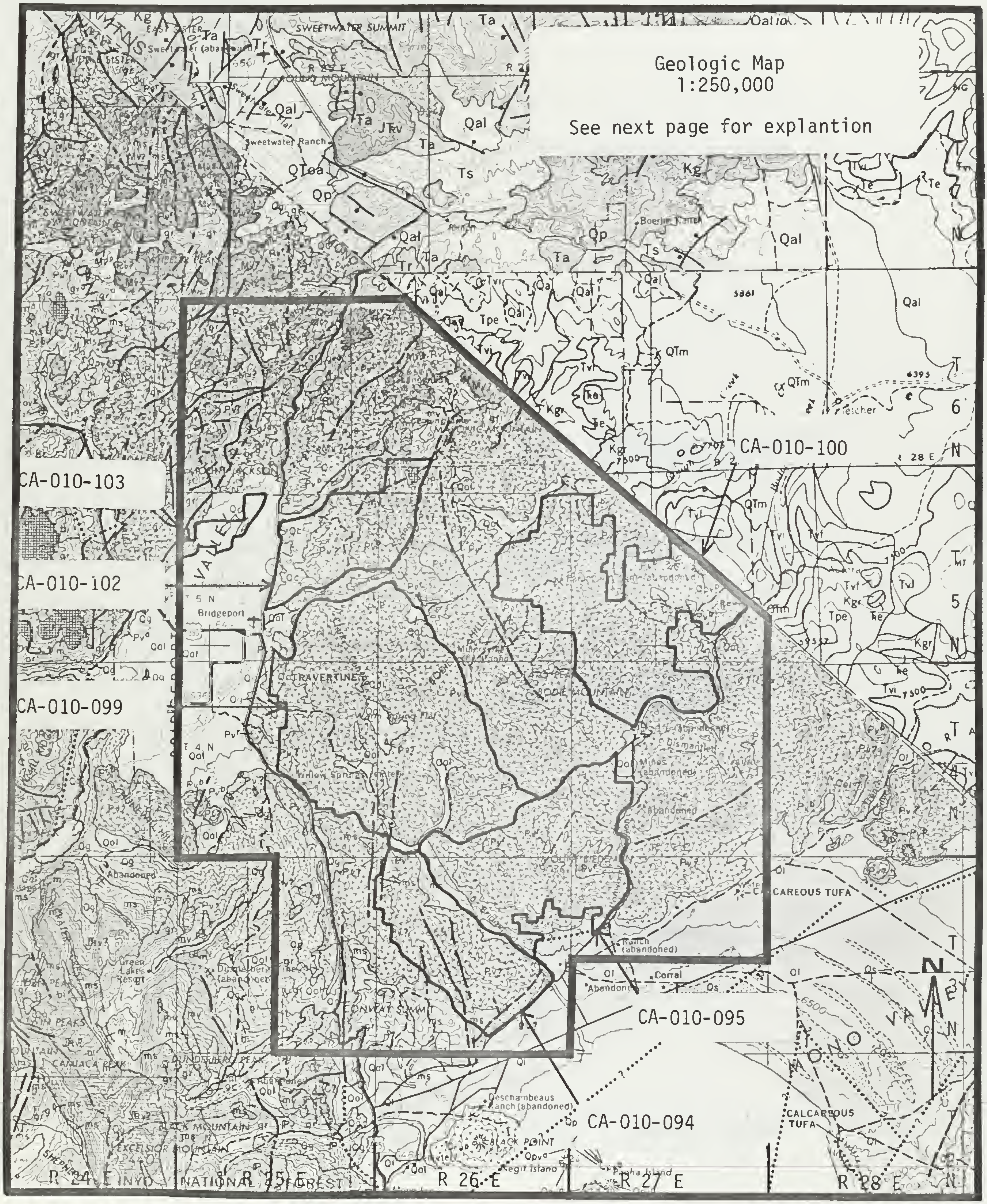
Figure 1. GRA Index Map of Region 3 1:3,168,000.



Walker Lake Sheet

Bodie GRA CA-02

Figure 2



Walker Lake Sheet, Koenig (1963); Lion County Geologic Map, Moore (1969); Mineral County Geologic Map, Ross (1961)

Bodie GRA CA-02

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)
Qst	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.

	Pal.	Ep	Paleocene marine		
	Undivided	CT	Cenozoic nonmarine	QTv	Cenozoic volcanic: QTv^r—rhyolite; QTv^a—andesite; QTv^b—basalt; QTv^p—pyroclastic rocks
	Undivided	Tc	Tertiary nonmarine	Tgr	Tertiary granitic rocks
	Undivided	T	Tertiary lake deposits	Ti	Tertiary intrusive (hypabyssal) rocks: Ti^r—rhyolite; Ti^a—andesite; Ti^b—basalt
	Undivided	Tm	Tertiary marine	Tv	Tertiary volcanic: Tv^r—rhyolite; Tv^a—andesite; Tv^b—basalt; Tv^p—pyroclastic rocks
MESOZOIC	CRETACEOUS	K	Undivided Cretaceous marine		
MESOZOIC	CRETACEOUS	Ku	Upper Cretaceous marine	KJf (Franciscan Formation)	
MESOZOIC	CRETACEOUS	Kl	Lower Cretaceous marine	KJfv	Franciscan volcanic and metavolcanic rocks
MESOZOIC	JURASSIC	Jk	Knoxville Formation	gr	Mesozoic granitic rocks: gr^a-granite and adamellite; gr^g-granodiorite; gr^t-tonalite and diorite
MESOZOIC	JURASSIC	Ju	Upper Jurassic marine	bi	Mesozoic basic intrusive rocks
MESOZOIC	JURASSIC	Jml	Middle and/or Lower Jurassic marine	ub	Mesozoic ultrabasic intrusive rocks
MESOZOIC	TRIASSIC	Ћ	Triassic marine	JЋv	Jura-Trias metavolcanic rocks
	UNDIVIDED	m / ls	Pre-Cretaceous metamorphic rocks (ls = limestone or dolomite)	mv	Pre-Cretaceous metavolcanic rocks
	UNDIVIDED	ms	Pre-Cretaceous metasedimentary rocks	gr-m	Pre-Cenozoic granitic and metamorphic rocks
PALEOZOIC	UNDIVIDED	Pz / ls	Paleozoic marine (ls = limestone or dolomite	Pzv	Paleozoic metavolcanic rocks
PALEOZOIC	PERMIAN	P	Permian marine	Pv	Permian metavolcanic rocks
PALEOZOIC	CARBONIFEROUS	C	Undivided Carboniferous marine	Cv	Carboniferous metavolcanic rocks
PALEOZOIC	CARBONIFEROUS	CP	Pennsylvanian marine		
PALEOZOIC	CARBONIFEROUS	CM	Mississippian marine		
PALEOZOIC	DEVONIAN	D	Devonian marine	Dv	Devonian metavolcanic rocks
PALEOZOIC				Dv?	Devonian and pre-Devonian? metavolcanic rocks
PALEOZOIC	SILURIAN	S	Silurian marine		
PALEOZOIC		pSs	Pre-Silurian metasedimentary rocks	pS	Pre-Silurian metamorphic rocks
PALEOZOIC				pSv	Pre-Silurian metavolcanic rocks
PALEOZOIC	ORDOVICIAN	O	Ordovician marine		
PALEOZOIC	CAMBRIAN	Є	Cambrian marine		
		Є?	Cambrian – Precambrian marine	pЄc	Precambrian igneous and metamorphic rock complex
PRECAMBRIAN		pЄ	Undivided Precambrian metamorphic rocks pЄg = gneiss, pЄs = schist	pЄg	Undivided Precambrian granitic rocks
PRECAMBRIAN		lpЄ	Later Precambrian sedimentary and metamorphic rocks	pЄan	Precambrian anorthosite
PRECAMBRIAN		epЄ	Earlier Precambrian metamorphic		

II. GEOLOGY

The Bodie GRA, located directly north of Mono Lake, encompasses a broad gently rolling Cenozoic volcanic terrane through which are exposed patches of older Paleozoic metasediments, Mesozoic metavolcanics, and Cretaceous granitic intrusions.

Dominant structural features within the study area are arcuate volcanic collapse structures within complex vent areas, and associated warping.

Basin and Range normal faulting trends predominantly to the northwest and is an important environment for precious metal deposition in the Bodie and Masonic mining districts.

1. PHYSIOGRAPHY

The study area is in Mono County, California with the eastern boundary following the Nevada-California state line. The area of study is within the Basin and Range Province near its western boundary with the Sierra Nevada Province.

The rugged Sierra peaks, 10 miles to the west with elevations towering above 12,000 feet, contrast greatly with the rolling topography and 7,500-10,000 foot elevations of the Bodie Hills area. Volcanic vent areas form the topographic highs. A radiating drainage pattern originates from the Bodie Peak area. The north-flowing East Walker River fills the Bridgeport Reservoir in the northwest corner of the study area.

The two volcanic structures which dominate the volcanic scene are the Big Alkali collapse caldera in the Bodie Hills area, and the Mt. Biedeman dome in the southern portion of the study area.

Both normal and reverse faults occur in the area; however, maximum displacement is reportedly only several hundred feet. A north-northwest trend paralleling the regional trend is the predominant orientation of faults in the study area. A conjugate system of northeast trending faults is also present; these faults are the dominant structures in the southeast corner of the study area and occur also in the Bodie mining district.

2. ROCK UNITS

The oldest rock are in the south central portion of the Bodie GRA where a sequence of thin-bedded Silurian-Ordovician (Chesterman and Gray, 1975) hornfels and quartzite of the Log Cabin pendant outcrop. To the southwest of these meta-sediments are Triassic(?) weakly metamorphosed volcanics

tentatively correlated with the Excelsior Formation in west-central Nevada (Muller and Ferguson, 1939). Similar volcanic rocks crop out at Masonic.

The next oldest rock-type persists as outcrops of biotite granite, which was emplaced during the Cretaceous. The Rattlesnake Gulch granites crop out in the southwest portion of the study area, and an unnamed granitic stock crops out in the Masonic Mountain area in the north. K-Ar determinations give ages of about 90 million years for all the granitic rocks (Chesterman and Gray, 1975).

Cenozoic rocks predominate in the study area and include lavas, pyroclastic deposits, domes and plugs. These range in composition from rhyolite through dacite, latite and andesite to basalt, and K-Ar dates range from 3 million to 9.5 million years.

The oldest Cenozoic rocks are the Silver Hills volcanic series which were deposited during the Miocene/Pliocene over an unconformity. This series consists of flows and intrusive bodies of dacite and rhyodacite and pyroclastic deposits. It is the host for the ore deposits of Bodie.

The next oldest Cenozoic unit in the area is the 1,000 feet thick Rancheria Tuff Breccia which consists largely of pyroclastic deposits but includes dikes, flows, and plugs of basalt, rhyolite, andesite and dacite.

Unconformably overlying the Rancheria Tuff Breccia are rocks of the Miocene/Pliocene Murphy Spring Tuff Breccia. This 900 foot thick sequence consists principally of pyroclastics, but also includes flows and intrusive bodies of dacite, rhyolite, and basalt.

The Murphy Spring Tuff is unconformably overlain by the Willow Springs Formation which crops out around the Big Alkali Caldera. This formation, 1000' thick, consists of flows and intrusives of dacite, rhyodacite, rhyolite, with some pyroclastics.

The Mt. Biedeman Formation unconformably overlies these rocks. This formation contains more mafic flows and intrusive bodies consisting of andesite, basalt and dacite.

The next youngest rocks are those in the Potato Peak Formation. This unit is predominantly lava flows and pyroclastic deposits of dacite, rhyolite and tuff breccia. These rocks have been intensely hydrothermally altered in many areas, where they are currently the subject of intense mineral exploration.

Although all of these Tertiary volcanic rocks have potassium-argon dates very close to 9 million years (Chesterman and Gray, 1975), some of them are younger than mineralization and

serve as cover over possibly-mineralized other volcanic units (Blakestad, 1982). It is possible that there were several episodes of mineralization during eruption of the volcanic sequence, so that a unit may be post-mineral cover in some areas while it is mineralized elsewhere.

In the Pliocene the andesite of the Cedar Hill-Trench Canyon Formation (3 million years old) was deposited in the southeastern corner of the study area. During the Pliocene in the Beauty Peak area on the eastern border of the study area, basalt-andesite flows and pyroclastics were deposited (this is the youngest volcanic formation within the study area).

Pleistocene lacustrine deposits and tufa are found along the border of Mono Lake in the southern part of the Bodie GRA. Late Pleistocene terrace deposits in the study area are generally unsorted and poorly bedded. Unconformably overlying these terrace deposits is recent alluvium.

3. STRUCTURAL GEOLOGY AND TECTONICS

Chesterman (1968, Fig 2), using gravity data, defines a major northeast-trending graben, with Bodie near its south edge and Masonic near its north edge. On a smaller scale than this, the major structural features in the study area are constructional upland features developed on the sites of volcanic vents and intrusive complexes of Tertiary age. The terrane has been modified by Basin and Range normal faulting which probably predates the Pliocene basaltic andesite volcano of Beauty Peak.

Basin and Range faults in the Bodie Hills trend mostly north-northwest and are clustered in some localities such as Bodie. Easterly striking divergent faults occur at Bodie and at Masonic, both major mining districts. Both northwest and northeast trending faults in the Bodie district contain precious metal mineralization.

Arcuate faulting delineates circular collapse calderas at Mount Beauty, Big Alkali Caldera and the southwest flank of Potato Peak. These collapse features provided zones of weakness along which plugs and dikes have later intruded, forming discrete composite eruptive centers. These composite centers are found at Mount Biedeman and Mount Hicks (Chesterman and Gray, 1975).

Potato Peak and Bodie Mountain represent a major complex volcano composed of dacite to andesitic lava and tuff breccia intruded by dikes and plugs of andesite and rhyolite. The Bodie mining district lies near the east edge of Potato Peak Center in dacitic rocks.

A broad gentle upwarp associated with volcanism of probably

early or middle Pleistocene age underlies the Bodie Hills, as defined by Al-Rawi (1970) from regional gravity data.

4. PALEONTOLOGY

Lithologic units within the Bodie GRA are, in order of abundance, Pliocene volcanics (Pv), pre-Cretaceous metasediments (ms), and metavolcanics (mv), Quaternary alluvium (Qal), lake deposits (Ql), Pleistocene nonmarine sediments (Qc), and Mesozoic granitic rocks. No fossil localities are known to occur within this GRA. Highest potential for paleontological resources would be in the Quaternary lake deposits (Ql), which are exposed in the southernmost part of WSA CA-010-095. It is possible that fossiliferous lacustrine or fluviatile sediments may be intercalated within units mapped as Pv, as this is known to be the case elsewhere in the Mono Lake area.

5. HISTORICAL GEOLOGY

During the early Paleozoic marine sediments were deposited in the region of the Bodie GRA. A period of erosion of unknown length interrupted deposition until the Triassic when volcanics of the Excelsior Formation(?) were laid down. Another period of non-deposition followed, during which granitic intrusions were emplaced during the Cretaceous.

There are few exposures of these older rocks in the GRA, which elsewhere in the region they contain important base metal and tungsten deposits genetically related to the Cretaceous intrusions.

During the Cenozoic several sequences of thick volcanics were deposited unconformably one upon the other. Volcanism during the Miocene was a calc-alkalic suite, and the younger Pliocene-Pleistocene volcanics deposited are representative of an alkalic-calcic suite.

Basin and Range faulting occurred during the Cenozoic volcanism and probably predates the Pliocene basalts and andesites of the younger volcanic suite. These faults were mineralized in the Bodie and Masonic areas with "bonanza zones" occuring near intrusive andesite bodies.

Volcanism continued in the area subsequent to the Bodie-Masonic mineralization epoch with the emplacement of dikes and plugs along older collapse features, lava extrusion and pyroclastic accumulation, and hot spring activity with accompanying hydrothermal alteration and perhaps mineralization. This activity continued until approximately several thousand years ago.

During the Pleistocene, lacustrine deposits and tufa were formed in the Mono Lake area.

Late Pleistocene erosion formed unsorted terrace deposits along several of the larger canyons. These older terraces were then unconformably overlain by recent alluvium.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

Most of the known mineral deposits are concentrated in the two major mining districts of the GRA, Bodie and Masonic. In Bodie, Sampson (1940) lists more than 100 properties, while Clark (1970) names seven with production ranging from $122,000+ to $18 million+ each and estimates total district production at slightly more than $30 million, which would be close to $500 million at gold prices in the early 1980s. In Masonic Sampson (1940) lists 14 properties while Clark (1980) lists eight with production ranging from unstated to as high as $700,000 each; no estimate of total Masonic production is available. Both districts produced principally gold.

Outside these two districts, Sampson lists the following productive mining property:

Rancheria Placer, Sec. 29-30, T 3 N, R 26 E, a large cut yielded over $80,000. The description fits a property known to A. Baker III (an author of the present report) as Sinnamon Cut; west of the cut at Mono Diggings occurrences of coarse rounded gold in narrow stream channels on granitic bedrock have been mined.

The Wedertz Quicksilver mine is listed by Sampson (1940) as in Sec. 25, T 4 N, R 25 E but is probably the prospect symbol on the Bodie topographic quadrangle in Sec. 19, T 4 N, R 25 E. Sampson lists no production here. Blakestad (1982) refers to it as the Cal-Mono mine and says it produced a few flasks of mercury in the early 1900's. Blakestad also says there is massive stibnite present on the surface, as well as some cinnabar and traces of gold.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Conroy Ranch Placer, Sec. 2, T 2 N, R 26 E. Sampson (1940) comments that 400 patented acres on the north shore of Mono Lake average 25 cents per yard.

Little Bodie Mining Company, Sec. 18, T 3 N, R 26 E. Sampson (1940), says there is a quartz vein with 175' shaft. The Bodie topographic quadrangle shows the Little Bodie Mine in Sec. 1, T 3 N, R 25 E.

Paramount Mine, Sec. 24, T 5 N, R 26 E, shown on the Walker Lake AMS sheet with the notation "abandoned".

Unnamed prospect, Sec. 34, T 5 N, R 26 E. Mentioned as having mercury and gold in pyrite, by Chesterman and Gray (1975).

Large altered areas, one mile to three miles west of Big Alkali Flat and a mine four miles south of Big Alkali Flat, are shown on Chesterman and Gray (1975).

An area extending a mile or two southwest from the Paramount mine in Sec. 24, T 5 N, R 26 E has been drilled by Homestake Mining Company in the past couple of years; this encountered significant amounts of gold and the drilling program is currently (late 1982) being continued (Blakestad, 1982).

East of the Paramount mine Homestake has found widespread occurrences of gold, in geochemical chip sampling of bedrock (Blakestad, 1982).

At the Bluebird prospect, in Secs. 21, 22, 27, 28, T 5 N, R 26 E, an extensive area of quartz-alunite alteration with traces of gold is reported by Blakestad (1982).

In Sec. 31, T 6 N, R 26 E there is a copper show in metasediments (Blakestad, 1982).

In Secs. 25 and 26, T 6 N, R 26 E molybdenite occurs as large flakes, associated with some copper, in intrusive rocks (Blakestad, 1982).

3. Mining Claims

Patented claims in the GRA are all in either the Bodie or the Masonic mining districts -- six sections in both of the districts each have at least one patented claim. At least one Bodie patented claim plots as being in WSA 010-095.

The several sections of both the Bodie and Masonic districts have many unpatented claims, and it is likely that the central parts are completely covered and that the fringes of the Masonic district have at least partial coverage for a mile or more beyond the central part. Dense claim staking about Bodie extends at least a mile into WSA 101-095. Another area of dense staking covering half a township centers around the Paramount Mine, about midway between Bodie and Masonic; much of this staked area is within WSA 010-100.

Westward from the Paramount Mine to Highway 395 there are numerous unpatented claims, with several sections that appear to be almost completely covered -- at least, there are claims in all four quarters of them. Many of these claimed areas, including half a dozen of the sections that

appear completely staked, are in WSA 010-099. Homestake Mining Company's claim map of the Bodie region (shown to A. Baker III, an author), presumably more up-to-date than our BLM files, shows the southwestern part of 010-099 even more completely covered with claims. There are a few claims in the eastern part of WSA 010-102.

In the southern part of the GRA there are scattered claims, a very few of which plot as being just within the boundaries of WSA 010-094 and a couple of which lie well within WSA 010-095.

The only WSA in the GRA that does not have any mining claims is 010-103.

4. Mineral Deposit Types

Most of the rocks exposed in the Bodie GRA are part of a very large expanse of Tertiary volcanics that, overall, extend from about the latitude of Lake Tahoe to Bishop, in a band twenty to thirty miles wide. In the northern and southwestern parts of the GRA there are exposures of Paleozoic sediments and the Mesozoic intrusives into them, but these older rocks are not seen for ten miles or more to the east and south of the GRA. The aggregate thickness of the volcanics is on the order of 6,000 feet, though between non-deposition and erosion, the actual thickness of volcanics at any given place is probably much less than this. In the GRA gold ore occurs in the Tertiary rocks and gold placers have been mined. Elsewhere in the region major tungsten deposits occur in Paleozoic sediments and Mesozoic intrusives.

There are no published modern descriptions of the known metallic ore deposits and occurrences in the GRA; almost all are described as gold-bearing quartz veins. Bodie, the most productive district, is in volcanics about nine million years old, and therefore certainly belongs in the epithermal category. It is very likely from the old published descriptions that Masonic, the other important district, also is epithermal. Scattered other gold-quartz occurrences, some of which evidently have made limited production, probably also are epithermal whether they are in Tertiary rocks or in the older basement rocks.

Many of the unpatented claims in the GRA were located very recently, probably covering areas in which there is evidence of hydrothermal alteration or hot spring activity. Such areas are considered prime targets for exploration for open-pittable low-grade gold deposits such as Homestake's McLaughlin Mine in Napa County. All of the known altered areas are covered by unpatented claims.

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At least two occurrences of mercury have been prospected in the GRA. Both are in the Tertiary volcanic rocks.

The relatively small outcrop areas in the GRA of older, pre-Tertiary, rocks have only minor occurrences of mineralization except at Masonic. It is entirely possible that under the extensive cover of the Tertiary rocks there are ore deposits related to the granitic bodies that were intruded 80 million to 95 million years ago. The most likely kinds of deposits are contact metamorphic tungsten bodies (a critical metal) in the Paleozoic rocks, similar to those at Black Rock and Pine Creek 30 and 60 miles to the south, or porphyry copper deposits in the granitic rocks, similar to Yerington, Nevada, 60 miles to the north.

In the southwest corner of the GRA small placer deposits have been hand- worked along Virginia Creek and at Mono Diggings, and by hydraulicing at Sinnamon Cut. The origin of the gold in these deposits is unknown; some speculate that it is of the same origin as the major placer deposits on the west side of the Sierra Nevada: from Tertiary channels that have long since been eroded away on the east side of the Sierras. We found no indication that placer gold has been mined near Masonic or Bodie. The descriptions of their gold, as being very fine-grained, suggest that it would not form good placers. There is little likelihood of important placer deposits in the GRA.

5. Mineral Economics

For most mining and mineral processing techniques the deposits in the Bodie GRA would pose no particular problems. It is close enough to existing towns and cities that a labor force can be housed and equipment and supplies can be purchased. Heavy snowfalls in the winter will cause some difficulties in access but for an operating mine these can be easily overcome. One popular technique, heap leaching, cannot be used to full effectiveness because of freezing during the long, cold winters. Probably the season for heap leaching is only seven or eight months per year.

When the veins at Bodie and Masonic were mined, mostly before 1932 with gold at about $20 per ounce, a cutoff grade of about 0.3 oz Au/ton was probably used, and the average grade mined was above 0.5 oz Au/ton. Although the price of gold is now around $400 per ounce and seems likely to stay at least that high, costs have risen similarly, so if new veins are discovered it is likely that they will be mined also to a cutoff of about 0.3 oz Au/ton. It is unlikely that any of the large mining concerns would explore for or mine vein deposits because the gross profit from the relatively small tonnages of ore

is too small for them to bother with. However, there are plenty of smaller companies that are happy to mine anything that offers a profit; these are the ones that will mine veins if any are found in the GRA.

Large disseminated deposits of gold are another matter, however. If they lie at reasonably shallow depth they can be mined at relatively low cost with open pit techniques. Such deposits are likely to use a cutoff well below 0.1 oz Au/ton, with an average grade perhaps not greatly above 0.1 oz Au/ton. It is known that Homestake Mining Company has staked claims in a number of areas in the GRA, and other major mining companies also have staked there -- open pittable gold is definitely of interest to the large companies.

Mineral deposits in the pre-Tertiary rocks, buried as they are beneath hundreds or thousands of feet of volcanic rocks, are difficult or impossible to find with present-day techniques. It is likely, however, that within the next twenty years techniques will be developed that will permit exploration through such thick cover at a reasonable cost. Deposits that are found will almost certainly have to be mined by underground methods. By the time they can be found, it is likely that newer mining techniques will have lowered underground costs enough that they can be mined if they have a reasonable grade -- perhaps something above 0.5% WO_3 , in the case of tungsten.

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.

The major uses of silver are in photographic film,

sterlingware, and increasingly in electrical contacts and conductors. It is also widely used for storage of wealth in the form of jewelry, "coins" or bullion. Like gold it is commonly measured in troy ounces, which weigh 31.1 grand grams, twelve of which make one troy pound. World production is about 350 million ounces per year, of which the United States produces about one-tenth, while it uses more than one-third of world production. About two-thirds of all silver is produced as a by-product in the mining of other metals, so the supply cannot readily adjust to demand. It is a strategic metal. Demand is expected to increase in the next decades because of growing industrial use. At the end of 1982 the price of silver was $11.70 per ounce.

The principal use for mercury is in the manufacture of alkalies and chlorine, in which the mercury does not become a part of the final product but is used as an electrical conductor and a sealant. Thus, it theoretically is not consumed but in fact some is lost during the process so some renewal is constantly required. The start-up of a single alkali- or chlorine-producing plant calls for very large quantities of mercury for the initial installation. Electrical applications, including mercury batteries, lamps, rectifiers and switches account for nearly one-third of consumption, and paints, agricultural chemicals and dental amalgam require substantial quantities. Mercury is measured in units of flasks, one flask being 76 pounds of mercury. The United States consumes nearly 50,000 flasks per year and produces about one-half this much -- most of it from the McDermitt mine in northwestern Nevada. The principal world producers are Italy, U.S.S.R., Spain, Algeria and China. Italy and Spain are considered to control the world market because their deposits are large and rich. Numerous mines in the western United States, most of them small, have produced mercury in the past but in general they cannot compete on the world market today. Mercury is listed as a strategic metal. United States demand for mercury is forecast to remain at about its present level to the year 2000 (principally because toxic effects of the metal discourage uses in any but the most essential applications), while domestic production is expected to drop to essentially zero when the McDermitt deposit is exhausted. The price for mercury at the end of 1982 was $360 per flask.

The largest use for copper is in electrical equipment and supplies and in smaller-guage wire where its electrical conductivity is essential. It is also used in large quantities in applications where its corrosion resistance is important -- in housing, brass and bronze, sea-water corrosion resistant alloys and others. It is used also in ammunition, many chemicals, and in applications where its conductivity of heat is important. World production is

about 7.5 million metric tons annually, of which the United States produces about 1.5 million tons, nearly sufficient to satisfy domestic demand. Copper is a strategic metal. There are large reserves of copper ore in the world, and the United States has greater reserves and greater resources than any other country. United States demand is expected to nearly double by the year 2000, but reserves are thought to be sufficient to meet the demand. However, environmental problems of smelting copper may hinder production, and in times of low prices foreign producers tend to maintain full production for political reasons, while domestic producers tend to restrict production for economic reasons. These pressures on the domestic copper industry weaken its competitive capability on the world market. At the end of 1982 the price of copper was 73 cents per pound.

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 FOB 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

The Bridgeport Travertine Deposits, are one mile southeast of Bridgeport. A carload of the material was shipped in 1926.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Some of the altered rocks in the southwest corner of T 4 N, R 26 E are very white. Because of this color they have been desultorily prospected as a potential source of material to be ground for use as an inert filler in plastics and other compounds (personal communication, A.

Baker III).

3. Mining Claims, Leases and Material Sites

We could not identify any claims as pertaining to nonmetallic minerals. We did not find any leases for nonmetallic minerals, nor any material sites within the WSAs of the GRA.

4. Mineral Deposit Types

Sampson (1940) briefly describes the Bridgeport Travertine Deposits, about a mile southeast of Bridgeport, as apparently having fairly good quality and fairly substantial quantities.

5. Mineral Economics

Industrial minerals in the GRA, such as the known travertine deposits and the known altered material that might be usable as a filler, suffer from their geographic location -- they are 300 miles from the major consuming center in the Los Angeles area. Only some very highly prized characteristic would make them competitive with other sources of similar materials, and no such characteristic is known.

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

Known radioactive occurrences are indicated on the Uranium Land Classification and Mineral Occurrence Map included in the back of the report.

There is a radiocative anomaly in rhyolite tuff at the Relich Claim at the northeastern corner of the GRA, Sec. 26, T 5 N, R 27 E (Garside, 1973). No other uranium or thorium occurrences are known within the GRA.

3. Mining Claims

There are a number of claims and leases within the GRA but it is not known if any of these are for uranium or thorium.

4. Mineral Deposit Types

Uranium and thorium deposit types cannot be discussed as there are no known deposits within the GRA.

5. Mineral Economics

Uranium and thorium would appear to have low economic value within the GRA due to the lack of occurrences.

Uranium in its enriched form is used primarily as fuel for nucelar 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 was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metalic 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 1970s, 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 2000 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. There are igneous intrusive and extrusive rocks underlying nearly all of the GRA, and no indication of the presence of petroleum source beds. There is no oil and gas lease map, nor is there an oil and gas occurrence and land classification map.

Geothermal Resources

1. Known Geothermal Deposits
   In the GRA and within WSA CA 010-099 at Bridgeport is a north-south linear area known or inferred to be underlain at shallow depth (less than 1000 m) by thermal water of sufficient temperature for direct heat applications. At the north end of the known thermal zone is Travertine (or Marble Quarry) Hot Springs (82°C at 50 l/min and a salinity of 4320 mg/l). At the south end is located the Hot Springs (45°C at 100 l/min and a salinity of 4390 mg/l). The total dissolved solids of the two springs strongly supports a common thermal aquifer. Magma Power Company drilled a 300 meter offset to the latter spring and recorded a temperature of 51°C (NOAA, 1980).

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

   Five miles to the southeast of the Bridgeport thermal deposit, the 27°C Warm Spring flows at 2 l/min. Continuing on structural trend ten miles to the south, the Bodie GRA overlaps with the Mono KGRA in Mono Valley

(Geothermal Occurrence and Land Classification Map). This is the northern edge of an area known or inferred to be underlain at shallow depth (less than 1000 m) by thermal water of sufficient temperature for direct heat applications. The area adjacent to and near the Bodie GRA is delineated by (NOAA, 1980):

Well/Spring	Temp.	Flow (l/min)	Salinity (mg/l)	Depth
Dechambeau's Well	66°C	228	1490	287m
Unnamed Spring	54°C	---	1600	---
State PRC 4572.1 Well	57°C	---	----	743
Warm Springs	31°C	95	1930	---
Unnamed Springs	86°C	100	25,000	---

The area is also defined by means of known or inferred geologic and hydrologic conditions.

3. Geothermal Leases

Federally administered geothermal leases or lease applications are present in two distinct areas of the GRA (see Geothermal Lease Map). One is a 10 square mile area within the Bodie Hills from Bridgeport to the southeast. The second is in California and Nevada from the Bald Peak area continuing eastward to the Aurora mining district, covering an area of 50 square miles.

4. Geothermal Deposit Types

The geothermal resources in both major areas are believed to be hot-water hydrothermal convection systems of 90° to 150°C based on geothermometry (Muffler, 1979).

5. Geothermal Economics

An indicated measure of the geothermal systems' size and heat content has been estimated by the U. S. Geological Survey in Circular 290 (Muffler, 1979):

(1) Travertine Hot Springs area
(2) North Shore Mono Lake (Black Rock Point Hot Spring)

(1)	(2)	Characteristics
87°-137°C	85°-122°C	Estimates of reservoir temperature
111°±10°C	100°±8°C	Mean reservoir temperature
3.3±0.9	3.3±0.9	Mean reservoir volume (km^3)
0.87±0.26	0.77±0.23	Mean reservoir thermal energy (10^{18}J)
0.22	0.193	Wellhead thermal energy (10^{18} J)
0.52	0.046	Beneficial heat (10^{18}J)

The boundaries of the resource and the values indicated will undoubtedly change with additional drilling and other exploratory work.

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

Some parts of the GRA, and perhaps of some WSAs, have mineral or rock collecting sites used by rockhounds.

E. CRITICAL AND STRATEGIC 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 an 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.

Small quantities of silver, as a byproduct of gold mining, and of mercury have been produced in the GRA. Both are strategic metals. Future production of silver from this area is highly likely. It is also possible there will be mercury production.

IV. LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

The published geologic map of the Bodie quadrangle (Chesterman and Gray, 1975) provides excellent exploration-scale geologic coverage, including alteration, of about the southwest one-fourth of the Bodie GRA. The remainder of the GRA has either generalized geological coverage in the published literature or detailed coverage of some areas in theses; we were not able to examine all of the potentially-available coverage. Information from Blakestad (1982) and Mahon (1980) provided valuable supplements to the published material, particularly as regards alteration and geochemistry. Overall, geological coverage ranges from excellent to fair, and coverage of mineralization/alteration is good. Our level of confidence in the basic information is moderate.

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.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 scale mylars in the original report and the prints of the mylars in each copy of this report. Metallic mineral classification areas are shown on 1:62,500 topographic maps in the GRA files.

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.

1. LOCATABLE RESOURCES

a. Metallic Minerals

Following are descriptions of two general land classification areas for metallic minerals, presented here and to be referred to briefly in connection with the individual WSAs.

Ml-2A classification area covers the entire GRA, including those parts of it that also are covered by other classification areas of higher or lower favorability for mineral resources. This dual classification is required because there is potential for two entirely separate kinds of mineralization that differ in genesis, host rocks, nature of occurrence, and expected mineral commodities. One of these kinds of potential mineralization is that related to and results from the young Tertiary volcanic activity of the area; mineralization of this kind is mostly likely to be gold, silver or mercury. It can occur in any of the rocks in the GRA though it is most likely in the Tertiary rocks. It is likely to be relatively close to the surface, and alteration or other features in the outcropping rocks will serve as guides to finding it. All of the classification areas for the GRA are concerned with this kind of mineralization except for Ml-2A classification area described here. The Ml-2A classification area pertains to the other kind of potential mineralization that is related to and results from the granitic intrusions of about 90 million years ago; mineralization of this kind is most likely to be copper, tungsten or other base metals. It can occur only in the Paleozoic or Mesozoic rocks that were intruded by the granitic bodies long before Tertiary time, except where these older rocks crop out, it is likely to be one thousand or several thousand feet below the present surface, and none of the features seen in exposed Tertiary rocks or Quaternary alluvium cannot serve as guides to finding it.

The reason for establishing classification area Ml-2A is that the Paleozoic rocks throughout the Basin and Range province are hosts to major mineral deposits, many of them related to late Cretaceous intrusives. A mental scan of the major metal mining districts of the Basin and Range suggests that virtually all of its very large metal production other than gold or silver came from such deposits. The copper district of Yerington, 50 miles north of Bodie, and the tungsten deposits of Pine Creek, 60 miles south, are the nearest major examples.

Since the classification is established solely on geological reasoning, the favorability must be considered low with the criteria being used, and since there is no evidence at all as to the presence or absence of mineral

resources in these rocks, the level of confidence must be very low.

All other classification areas for the Bodie GRA are concerned with mineralization potential related to the young Tertiary intrusive bodies. They are established on the basis of geological features observable in the exposed rocks. Thus, every area of the Bodie GRA has been assigned a double-barrelled classification: it has low favorability for mineral potential in the underlying older rocks, and other favorability classification for mineral potential in the younger rocks.

M2-2A. This classification area, which is concerned with the mineralization potential related to the young Tertiary intrusive bodies, covers all of the GRA that is not covered by other classification areas except for M1-2A. It might seem that M1-2A serves the same purpose, but logic demands that, since M1-2A is concerned exclusively with the older rocks, then some classification must be provided for the Tertiary rocks that are not otherwise classified. That is the function of M2-2A. Classification area M2-2A is largely covered with Tertiary volcanic rocks and has many indications -- in the form of calderas, plugs, volcanic necks and hot springs -- that it overlies the former magma chamber that supplied mineralizing solutions in the region. Some of the volcanic rocks are known to be younger than some of the volcanic-related mineral deposits and therefore can mask them. These are the reasons for the classification of low favorability. The lack of information pertaining to mineralization or alteration in the area is the reason for the very low confidence level in this classification.

WSA CA 010-094

M1-2A and M2-2A cover the WSA entirely. We do not define any other classification areas within this WSA. Unpatented mining claims that plot within the WSA in the northeast and southeast corners probably actually lie outside it.

WSA CA 010-095

M1-2A covers this WSA entirely and M2-2A covers most of it.

M3-4D extends into a small part of the northeast corner of the WSA. This area includes the productive center of the Bodie district and a densely-staked area that surrounds it, which is the reason for the highly favorable classification and the high level of confidence in that classification.

WSA CA 010-099

M1-2A covers all of this WSA and M2-2A covers those parts not covered by the classification areas listed below.

M4-3C. This classification area covers much of the west-central part of the WSA. It encompasses the large altered area west of the Big Alkali caldera, including Homestake's prospect in Hot Spring Canyon, where there is at least some gold associated with alunite. The classification is as moderate favorability because of this known gold occurrence in the altered area. The confidence rating is moderate on the basis of the one prospect, plus the widespread alteration.

M5-4C. This classification area covers the altered area south of the Big Alkali caldera, with its productive mercury mine which is the reason for the high favorability classification. The confidence level is only C because the Cal-Mono is the only known productive mine in the relatively large area.

M6-2B. This classification area covers much of the remaining part of the WSA. It is classified as having low favorability on the basis of its proximity to the Big Alkali caldera, the areas of higher favorability east and west of it, and the interest expressed by the companies that have located claims over large parts of it. The confidence level if low because all the evidence to back it up is indirect.

WSA CA 010-100

M1-2A covers all of the WSA and M2-2A covers those parts not covered by the classification areas listed below.

M7-4C. This classification area covers most of WSA 010-100. It is classified as moderately favorable on the basis of the presence of the Paramount Mine and the Wedertz prospect, Homestake's nearby drilling, Homestake's findings of gold in outcrops east of the Paramount Mine, and the Bluebird prospect. The same indications account for the moderately high confidence level.

WSA CA 010-102.

M1-2A covers all of the WSA and M2-2A covers those parts not covered by the classification areas listed below.

M6-2B. This classification area, described above, covers part of the southwestern curve of the WSA.

M8-3C. This classification area includes the Masonic district and the densely-staked area surrounding it. Although Masonic has made large gold production, the classification is lower than this would justify because while some production has come from close to the WSA, none came from the part of the classification area that covers the WSA. The level of confidence is only moderate for the same reason.

WSA 010-103

M1-2A and M2-2A cover the WSA entirely. We do not define any other classification areas within this WSA, which is all covered by alluvium.

b. Uranium and Thorium

WSA CA 010-103

U1-2B. This land classification area covers most of the WSA and is composed mainly of Quaternary alluvial sediments. There is a low favorability at a low level of confidence for epigenetic sandstone- type uranium deposits within the study area. Uranium could be carried in groundwater from the Cretaceous granitic rocks of Mount Jackson to the northwest or Masonic Mountain to the northeast, or from the surrounding Tertiary rhyolites and tuffs. The uranium would be precipitated from the groundwater in a favorable reducing environment within the WSA (e.g. permeable alluvial sands containing organic matter).

Thorium also has low favorability at a low level of confidence for concentration within the WSA. It could occur as concentrations of monazite sands weathered from the surrounding Cretaceous granitic rocks.

U2-2B. This land classification indicating low potential at a low confidence level for uranium covers the southwestern tip of the WSA. It is composed primarily of Tertiary volcanic rocks such as rhyolites, andesites, and tuffs. Cretaceous granitic rocks also crop out in the northern quarter of the GRA, though not within the WSA. Fracture fill uranium deposits are prospective in the area, particularly in alteration zones. Uranium may also be prospective in gold-bearing quartz veins in the volcanics though no such uranium occurrences have been mentioned within the GRA. An aerial radiometric uranium anomaly just west of the WSA (Durham and Felmlee, 1980) slightly increases the favorability for a uranium occurrence in this area of the WSA.

Thorium has a low favorability at a low confidence level for concentration in pegmatites of the granite intrusive just north of the WSAs.

WSA CA 010-102

U1-2B. This land classification covers the western edge of the WSA and indicates that the area has low favorability at a low confidence level for uranium and thorium concentration in the Quaternary alluvium as discussed under WSA CA 010-103.

U2-2B. This land classification covers the WSA and indicates low favorability for uranium and no favorability for thorium concentration in the Tertiary volcanics which cover the area as discussed under WSA CA 010-103. An aerial radiometric uranium anomaly to the north of the WSA (Durham and Felmlee, 1980) is over Tertiary volcanics, metavolcanics, and Cretaceous granitic rocks. This adjacent anomaly slightly increases the favorability for uranium within the WSA.

WSA CA 010-099

U2-2B. This land classification area covers the entire WSA and indicates that uranium has low favorability at a low confidence level for concentration in the Tertiary volcanics which cover the area as discussed under WSA CA 010-103.

A collapse caldera structure in the vicinity of Big Alkalai (Warm Spring Flat) slightly increases the favorability for uranium concentration within the WSA. Large uranium deposits have been found in tuffs and rhyolitic volcanics surrounding calderas as at McDermitt caldera, Nevada. A second caldera has been noted on the southwest flank of Potato Peak on the eastern border of the WSA.

The area has no favorability at a very low level of confidence for thorium deposits due to lack of suitable source rocks.

WSA CA 101-100

U2-2B. This land classification area covers the entire WSA and indicates low favorability for uranium concentration at a low level of confidence in the Tertiary volcanics which cover the area as discussed under WSA CA 010-103. An aerial radiometric uranium anomaly in the northern part of the WSA (Durham and Felmlee, 1980), a collapse caldera at Beauty Peak on the northeastern

border, and a radiocative anomaly in rhyolite tuff northeast of the WSA (Sec. 26, T 5 N, R 27 E) make the northern and northeastern sections of the WSA slightly more prospective for uranium concentration.

The area has no favorability for thorium deposits at a very low level of confidence due to a lack of suitable source rocks.

WSA CA 101-095

U2-2B. This land classification area covers essentially all of the WSA and indicates low favorability for uranium at a low confidence level and no favorability for thorium concentration at a very low confidence level in the Tertiary volcanics which cover the area as discussed under WSA CA 010-103.

U3-2B. This land classification covers a small section along the southern boundary of the WSA and is composed of Quaternary alluvium. The area has low favorability at a low confidence level for epigenetic sandstone type uranium deposits deposited from ground waters flowing down from the Tertiary rhyolitic volcanics of the mountains to the north and west. A stream sediment sample showing between 10 and 20 ppm uranium (Durham and Fermlee, 1980) southeast of the area indicates that the Tertiary volcanics of the mountains may indeed provide a uranium source.

The area is not favorable for thorium concentration at a very low confidence level.

WSA CA 101-094

U2-2B. This land classification covers essentially all of the WSA and indicates that the area has low favorability for uranium and no favorability for thorium concentration in the Tertiary volcanics which cover the area as discussed under WSA CA 010-103.

c. Nonmetallic Minerals

WSAs CA 010-094, 010-095, 010-099, and 010-100

N1-2B. This classification area covers most of the GRA and virtually all of the above-listed WSAs; minor parts of some of the WSAs (see Nonmetallic Mineral Occurrences and Classification Map) are covered by classification area N2-3C, and the distinction is not considered important here for these small parts. Classification area N1-2B is the area in which bedrock is mapped, as distinguished from alluvium. The only known nonmetallic mines or prospects

are the travertine deposit just south of Bridgeport from which minimal production has been made, and the altered area in T 4 N, R 26 E that has been prospected because of the whiteness of some of the material. However, any rock is usable for construction purposes, and any rock can become a higher-priced nonmetallic mineral if an entrepreneur can develop a market that makes use of whatever chemical or physical properties the rock has. These potentialities are the reason for the classification of low favorability for nonmetallic mineral resources, and the low level of confidence in this classification.

WSA CA 010-102

N1-2B. This classification area covers most of the WSA except for about the westernmost one-fifth. The rationale for the classification and the level of confidence are presented immediately above.

N2-3C. This classification area covers the remainder of the WSA. In it is mapped Quaternary alluvium, which by definition is largely sand and gravel. This known presence of sand and gravel, with no known production, is the reason for classification as moderately favorable for deposits of this commodity, while lack of knowledge of the quality of the sand and gravel at any point is the reason for the only moderate level of confidence in this classification.

WSA CA 010-103

N1-2B. This classification area covers a small part of the western tip of the WSA. The rationale for the classification and level of confidence is given above.

N2-3C. This classification area covers all the remainder of the WSA. The rationale for the classification and level of confidence is given above.

2. LEASABLE RESOURCES

a. Oil and Gas

WSAs CA 010-094, CA 010-095, CA 010-099, CA 010-102, and CA 010-103.

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 GRA is underlain by a thick and widespread cover of Pliocene volcanics which are believed to overlie pre-Cretaceous metasedimentary rocks and the Sierra Nevada granitic batholith. There are no source rocks in the area. These are the reasons for the classification of no known favorability for oil and gas, and the high level of confidence in the classification. No map is presented for oil and gas.

b. Geothermal

WSAs CA 010-099, CA 010-102, CA 010-094, and CA 010-095

G1-4C. The abundance of hot springs and wells, and the inferred continuity of these favorable thermal deposits, prospects, and occurrences, together with the geologic evidence, is strong evidence leading to this classification. Existing geothermal reservoirs tested and studied by both private companies and the U. S. Geological Survey show this area to be highly prospective for direct use and for electrical power generation.

WSAs CA 010-095, CA 010-099, CA 010-100, CA 010-102, and CA 010-103

G2-3C. This area has excellent geological continuity with that area given the 4D classification. Three miles west of the GRA, on the faulted west edge of Bridgeport Valley, Buckeye Hot Springs (60°C flowing 400 l/min; salinity 1230 mg/l) is apparently on a fault that extends into the northwestern quarter of the GRA (NOAA, 1980). The Travertine Hot Springs structure also probably extends both north and south of its known limits. The eastern part of this area is partially under lease and is currently being assessed by the leasees whose leaseholds extend almost continuously from Bridgeport to Aurora in Nevada.

c. Sodium and Potassium

S1-1D. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of sodium and potassium resources.

3. SALEABLE RESOURCES

Saleable resources have been addressed in the section on nonmetallic minerals, above.

V. RECOMMENDATIONS FOR FURTHER WORK

The GRA is currently being intensively explored by several mining companies, and at least the gist of their findings will eventually become public knowledge -- perhaps in future hearings concerning the WSAs in the GRA. Further work at this time would be essentially duplicating this private-sector effort.

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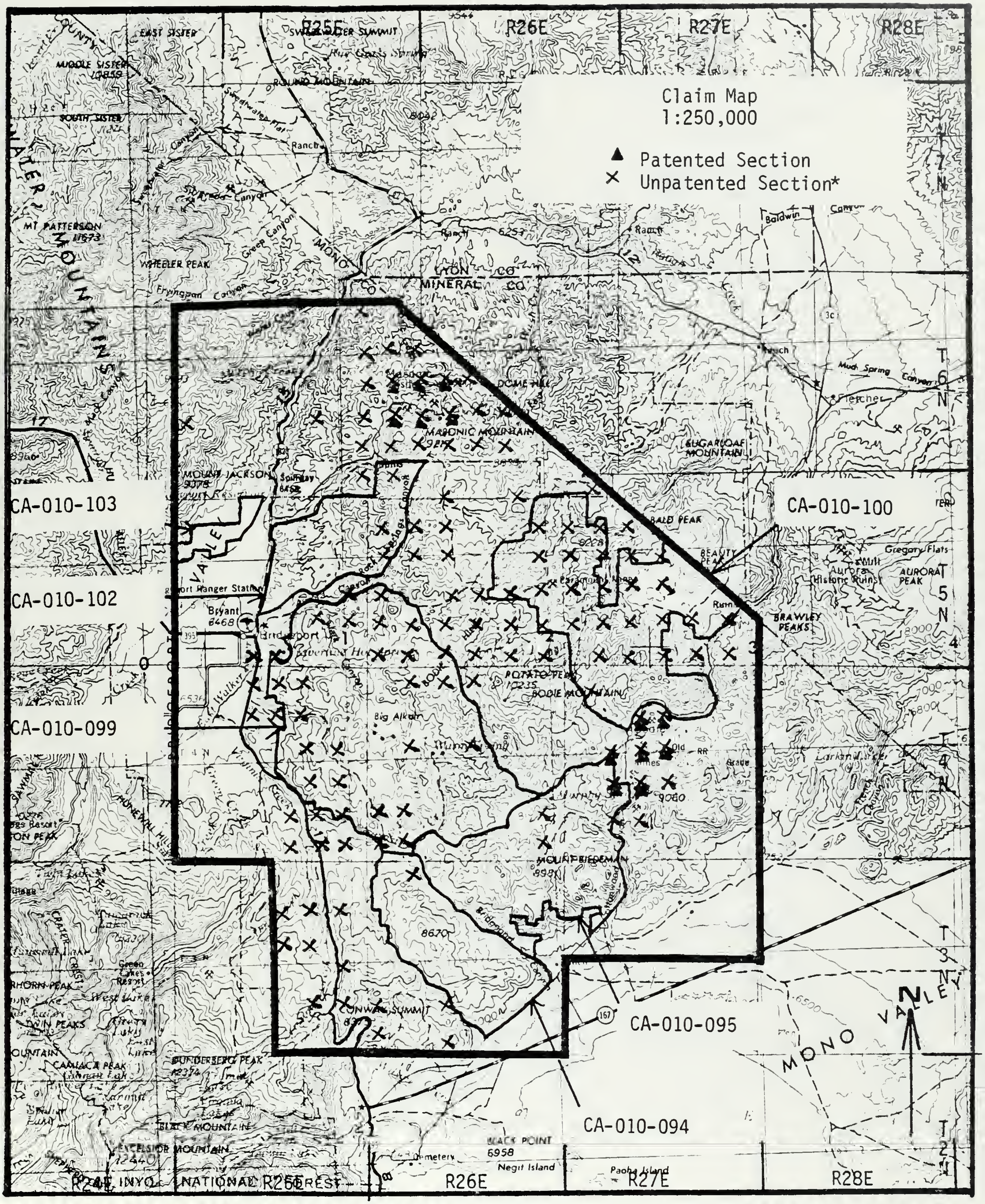
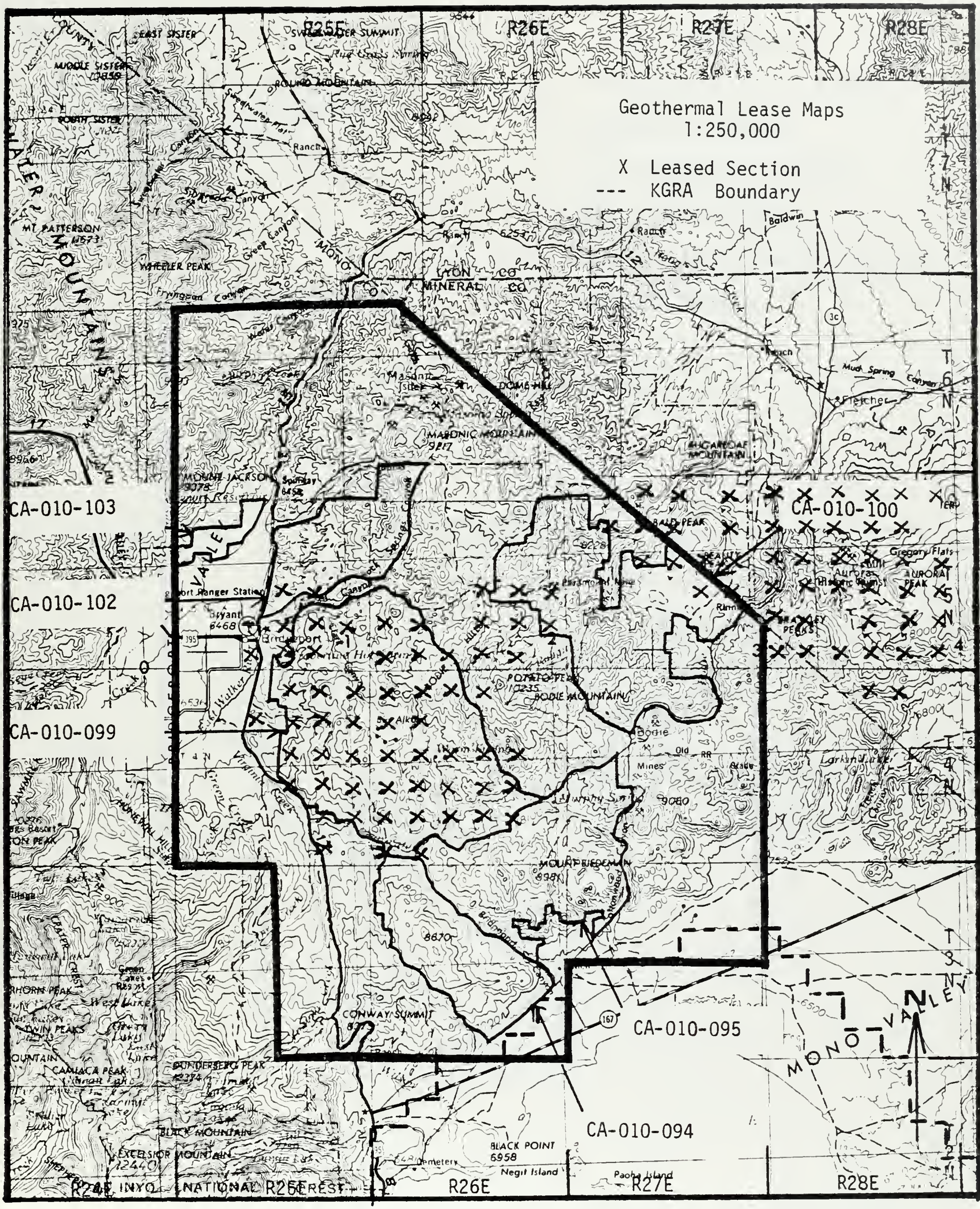


*X denotes one or more claims per section

Bodie GRA CA-02



Bodie GRA CA-02

M1-2A includes entire GRA classification of pre-Tertiary rocks for metal deposits related to 90-million year old intrusives

EXPLANATION

Mining District, commodity

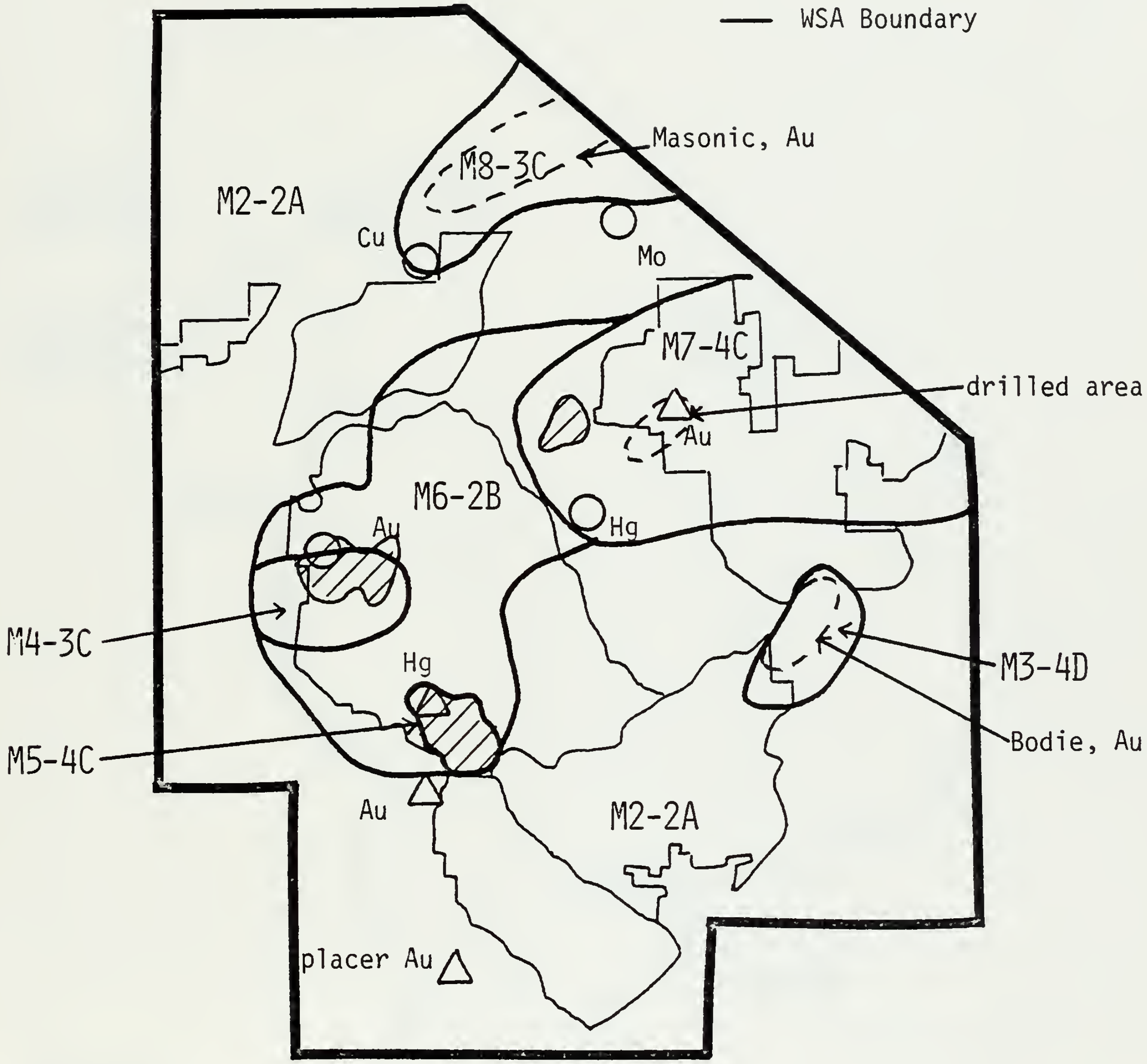
Mine, commodity

Occurrence, commodity

Alteration zone

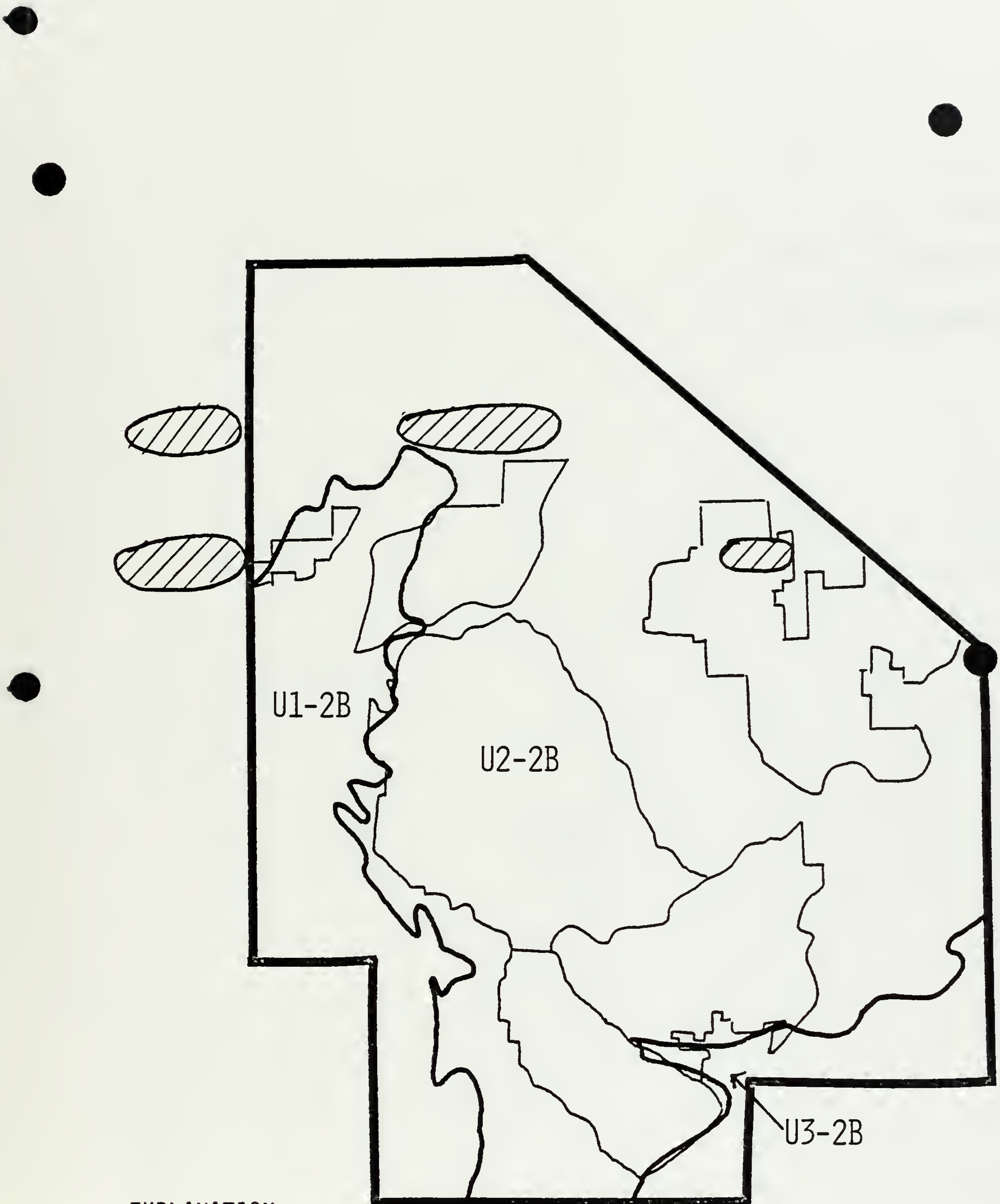
Land Classification Boundary

WSA Boundary



Land Classification - Mineral Occurrence Map/Metallics

Bodie GRA CA-02
Scale 1:250,000



EXPLANATION

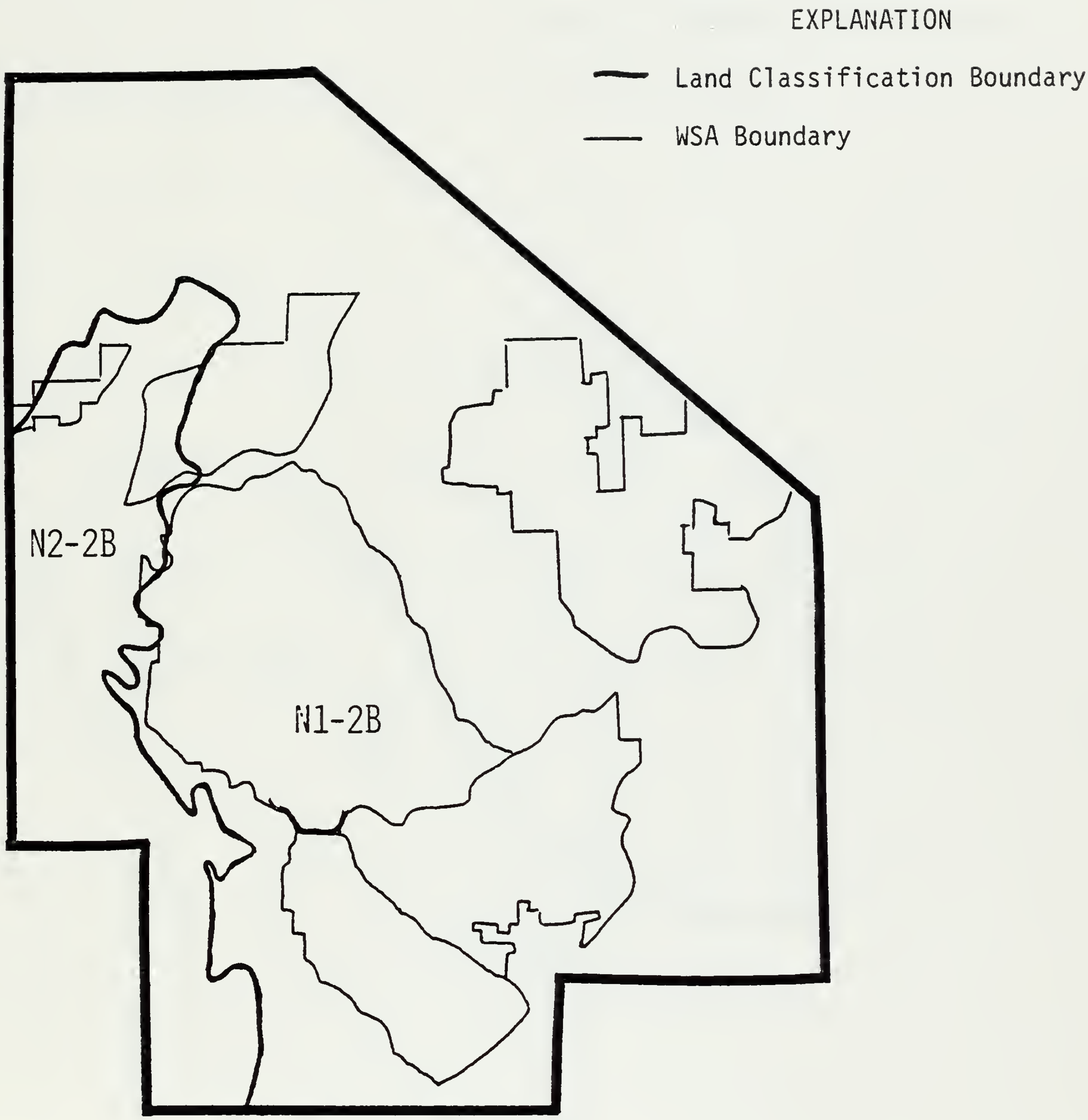
Uranium Occurrence

Aerial radiometric uranium anomaly

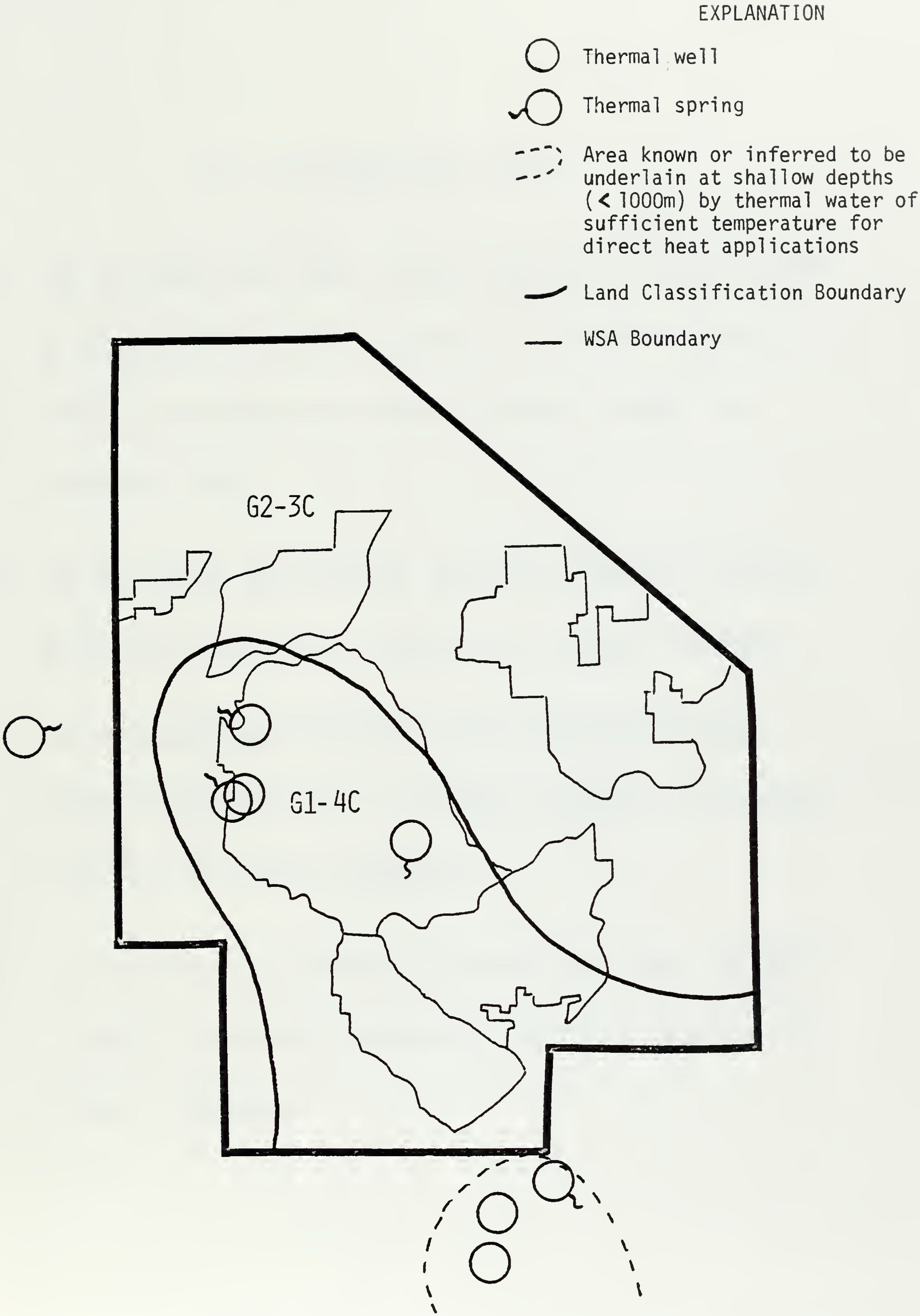
Land Classification Boundary

WSA Boundary

Land Classification - Mineral Occurrence Map/Uranium Bodie GRA CA-02
Scale 1:250,000



Land Classification - Mineral Occurrence Map/Nonmetallics Bodie GRA CA-02
Scale 1:250,000



Land Classification - Mineral Occurrence Map/Geothermal

Bodie GRA CA-02
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 [4]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600 + [3]

[1] Holmes, Arthur, 1965, Principles of physical geology: 2d ed., New York, Ronald Press, p. 360-361, for the Pleistocene and Pliocene, and Obradovich, J. D., 1965, Age of marine Pleistocene of California: Am. Assoc. Petroleum Geologists, v. 49, no. 7, p. 1087, for the Pleistocene of southern California.

[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.

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