GRAPEVINE SPRING G-E-M RESOURCES AREA

(GRA NO. NV-23)

TECHNICAL REPORT

(WSAs NV 050-0139)

Contract YA-554-RFP2-1054

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Final Report

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EXECUTIVE SUMMARY

The Grapevine Spring Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): WSA NV 050-0139. The GRA is located in southeastern Lincoln County, Nevada. The included WSA encompasses the central part of the Clover Mountains which consist of predominantly volcanic rocks less than 60 million years old. Underlying the volcanics are Paleozoic and Mesozoic rocks which have been partially mineralized.

There are two mining districts in the GRA. The Pennsylvania district on the northwest border of the WSA is an old district and produced somewhere approaching $50,000 worth of gold, silver and copper. The Viola district is on the southern boundary of the WSA and produced somewhat less than $400,000 from the late 1800s until recently, mostly fluorspar.

There are a few patented claims in the GRA but none appear to be in the WSA. There are between 800 and 900 unpatented lode claims in the GRA, approximately 250 of which are inside the WSA. Most of the claims are in the vicinity of the two mining districts, the Pennsylvania and the Viola. The entire GRA and surrounding townships are under lease for oil and gas. There are no geothermal leases in the GRA. A small portion of the extreme eastern edge of the GRA is presently under application for a potassium prospecting permit.

The vast majority of the WSA is considered to have a moderate favorability with moderate confidence for metallic mineral resources because of the proximity of known mining districts, the geological environment, and the interest in the area expressed by some of the major mining companies. The two mining districts on the fringes of the WSA have a high favorability with a high confidence level for metallic mineral resources. The WSA has a low favorability with a low confidence level for uranium resources, a very low favorability with very low confidence for thorium, and a low favorability with a very low confidence level for geothermal resources. The WSA is considered to have a low favorability with a low confidence level for nonmetallic mineral resources in the areas covered by the volcanic rocks, but where the underlying pre-Tertiary carbonates, quartzites and gypsiferous beds are found on the fringes of the WSA the favorability for nonmetallics such as cement, lime, silica and gypsum is moderate with a moderate confidence level. Due to the likelihood of a prospective stratigraphic section, there is a moderate favorability with a very low confidence level for oil and gas. There is a low favorability with a very low confidence level for low-temperature geothermal resources.

Additional work should be done on this area to more adequately evaluate its mineral potential including contacting claimants, detailing the geology, sampling, a more detailed investigation of

the two adjacent mining districts, and further investigation of the potential alunite resources.

I. INTRODUCTION

The Grapevine Spring G-E-M Resources Area (GRA No. NV-23) contains approximately 240,000 acres (980 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
Grapevine Spring	NV-050-0139

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Caliente Resource Area, Las Vegas district. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 37°20' north latitude, 114°20' west longitude and includes the following townships:

T 5 S, R 66-68 E	T 6 S, R 66-70 E
T 7 S, R 66-70 E	T 8 S, R 67-69 E

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

7.5-minute:

Elgin, NE	Ella Mountain
Fife Mountain	Elgin
Leith	Garden Spring
Jacks Mountain	Pine Park
Docs Pass	

The nearest town is Caliente which is located approximately eight miles north of the northern GRA boundary. Access to the area is via the road paralleling the Union Pacific tracks to the north and west. Access within the area is via unimproved dirt roads scattered throughout the GRA peripheral to the WSA.

Figure 2 outlines the boundaries of the GRA and the WSA 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.

The WSA in this GRA was not 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 in 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.

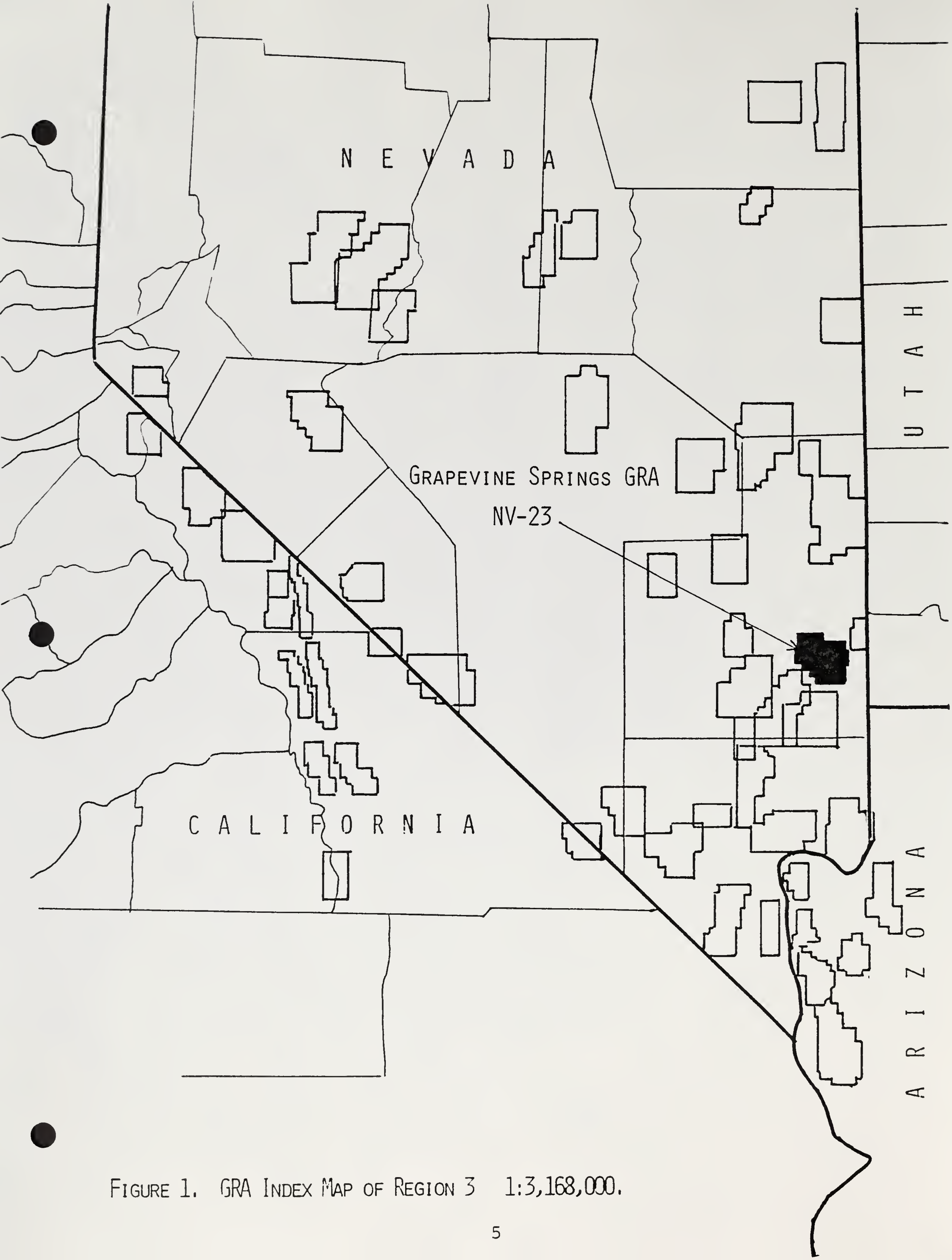
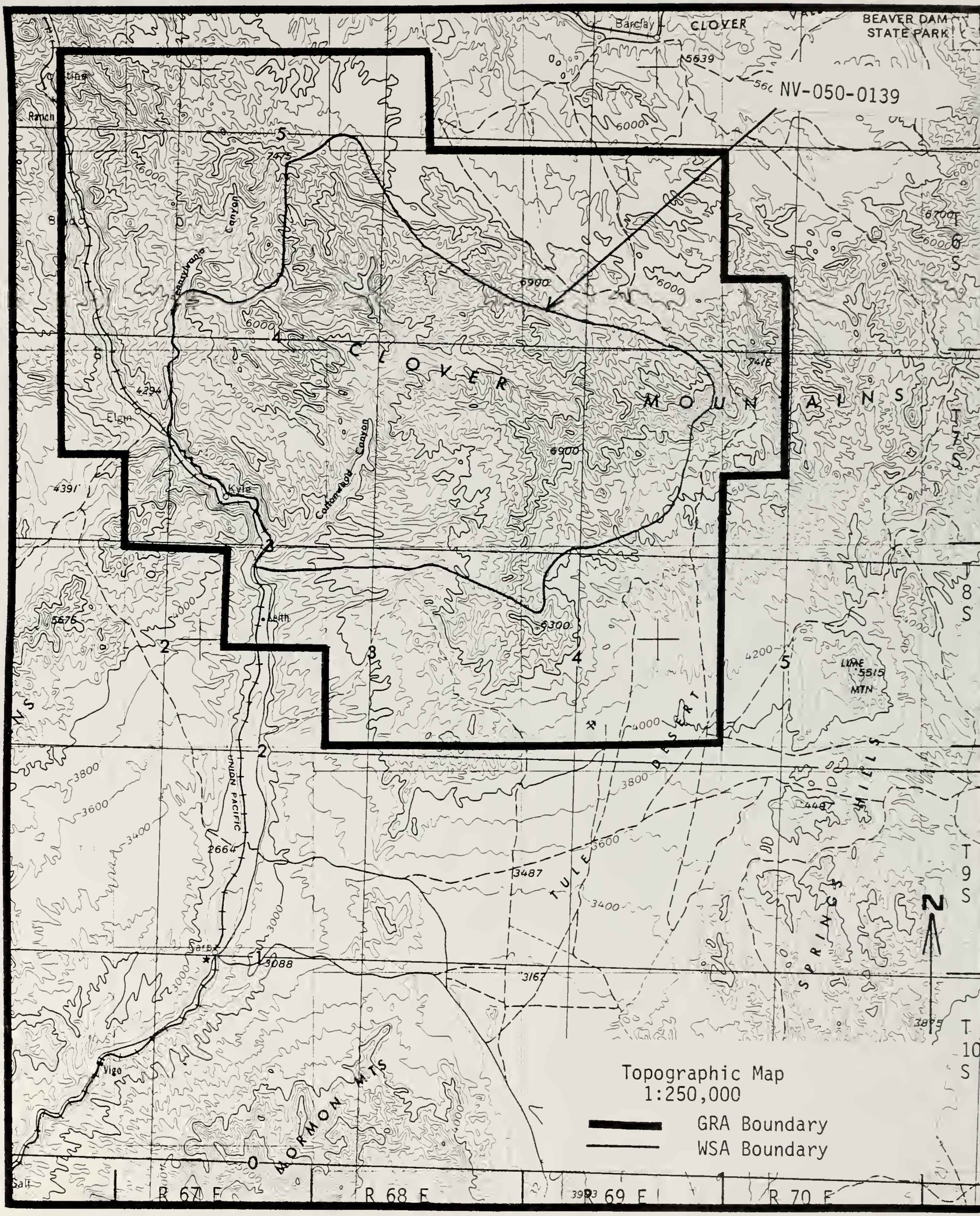


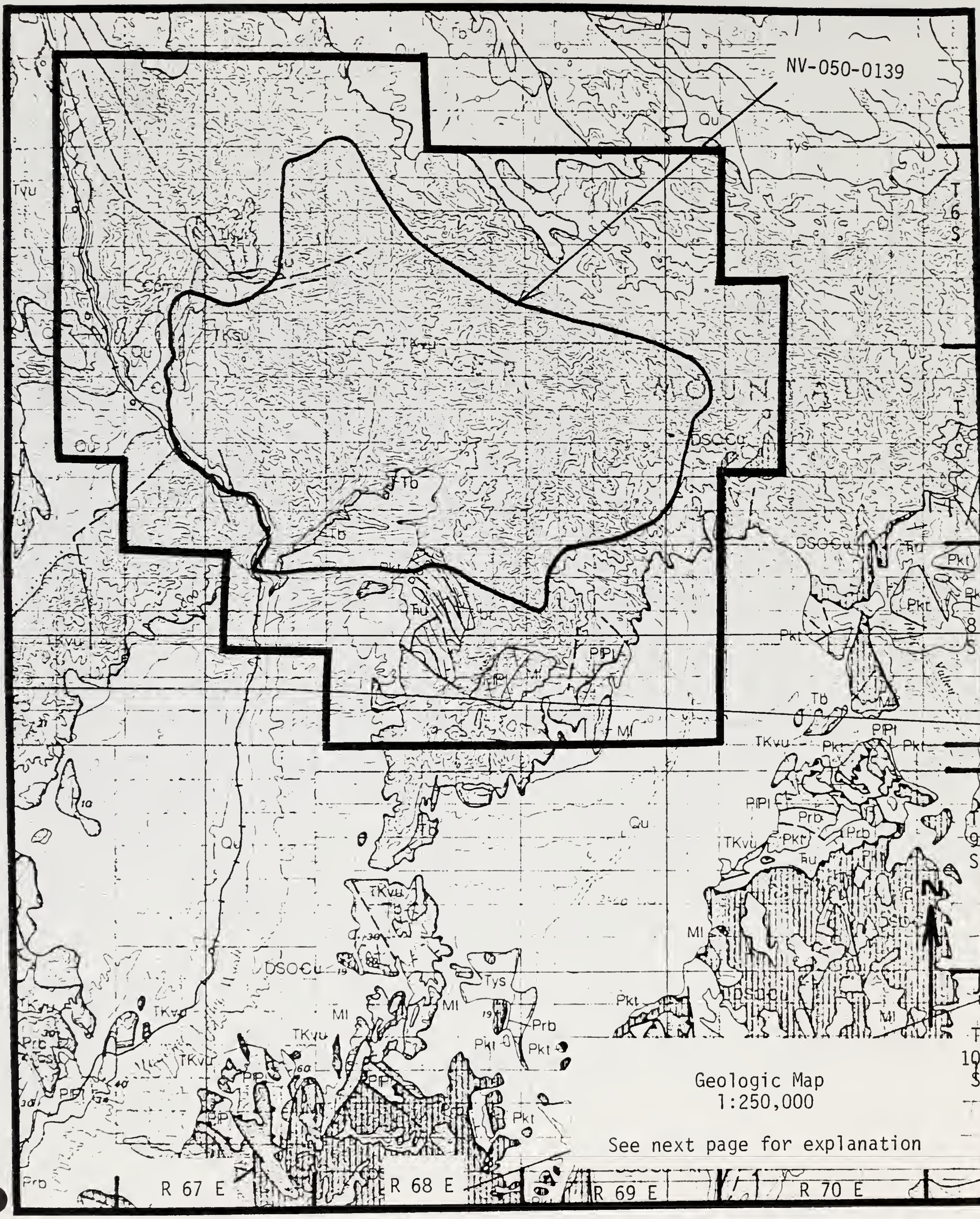
Figure 1. GRA Index Map of Region 3 1:3,168,000.



Caliente Sheet

Grapevine Spring GRA NV-23

Figure 2



Howard (1978)

Grapevine Spring GRA NV-23

Figure 3

Cenozoic Sediments

Quaternary, Undifferentiated (Qu): *Includes all sedimentary rocks and surface exposures of recent playa deposits, dune sands, lake beds, shoreline deposits and younger as well as certain older exposures of gravels and other alluvium associated with pediments and mountain streams.*

Tertiary Younger Sediments (Tys): *Sedimentary rocks of Miocene and Pliocene age including older lake beds of the Muddy Creek Formation and Panaca Formation in Lincoln and Clark Counties; the Muddy Creek Formation in Southwestern Utah; pre-Quaternary sediments in the White River Valley; and sediments associated with ash-flow tuffs near Antelope Summit in White Pine County.*

Tertiary Sediments, Undifferentiated (Tsu): *Primarily Miocene and [illegible] Oligocene deposits including tuffaceous sediments interbedded [illegible] ash flow tuffs, the Horse Camp Formation and various unident[illegible] [illegible], tuffaceous shales and diatomites [illegible] Nye County, intravol[illegible] [illegible] tuffaceous and clastic sedimentary rocks in Lincoln and Nye Counties; and conglomerates and limestones of uncertain age in the Conger-Confusion Ranges and the Cricket Mountains of Utah.*

Tertiary Older Sediments (Tos): *Includes the Sheep Pass Formation in Lincoln and Nye Counties, the Gilmore Gulch Formation in Nye County, [illegible] lacustrine limestones in southern Lincoln County; [illegible] conglomerates, tuffaceous and clastic sedimentary rocks, [illegible] cherts, claystones, silts, carbonaceous shales and oil shales in Elko County; and older limestones of the Illipah area and the Kinsey Canyon Formation of the Schell Creek and Grant Ranges in White Pine County.*

[illegible] Volcanics

[illegible] Basalt (Qb): *Basalt, andesite and latite of Quaternar[illegible] [illegible] in Nye County.*

[illegible] (Tb): *Intermediate and basaltic lavas including the [illegible] Basalt Member of the Muddy Creek Formation in Clark County; [illegible]alt flows, basaltic cinder, tuff and lava cones which are included in parts of the [illegible] Formation and latite flows in Elko County; basalt flows and dikes in Lincoln County; [illegible]esite and basalt flows of various ages in North Central Nevada, and basalt and basaltic andesite flows in Southwestern Utah.*

Tertiary Volcanics, Undifferentiated (Tvu): *Early to late Tertiary volcanic rocks ranging in composition from silicic to intermediate; primarily rhyolites, dacites, quartz latite flows, ignimbrites and pyroclastics of widespread occurrence. These rocks are listed under various subdivisions in Elko, Lincoln, and Nye Counties; North Central Nevada and Southwestern Utah.*

Tertiary Older Volcanics (Tov): *[illegible] Miocene volcanic rocks [illegible] [illegible] similar to Tertiary Volcanics, Undifferentiated (Tvu). Listed [illegible] various subdivisions in Nye County.*

Intrusives (TKJi): *Occurred from mid-Jurassic through late Tertiary. Widespread intrusions ranging in composition from [illegible]itic through [illegible]bbroic and in texture from holocrystalline to porphyrit[illegible].*

Mesozoic Sediments

Tertiary-Cretaceous Sediments (TKsu): *Continental sediments consisting of fanglomerates, clastics, tuffs and limestones. Includes the Gale Hills Formation and the Overton Fanglomerate.*

Cretaceous Sediments (Ks): *Chiefly non-marine siltstone, shale, conglomerate and limestone. Includes lower Gale Hills Formation, Thumb Formation, Baseline Sandstone, Willow Tank and Newark Canyon Formations.*

Jurassic (Ju): *Eolian cross-bedded sandstone in Utah, volcanically derived sediments, ash flows and basic lava flows in northern Elko County. Includes Navajo Sandstone, Aztec Sandstone, Frenchie Creek Formation and Bayer Ranch Formation.*

Jurassic-Triassic (JTRu): *Includes Nugget and Aztec Sandstones and Chinle Formation of southern Nevada.*

Triassic (TRu): *Shallow marine sedimentary rocks including Chinle, Shinarump, Thaynes and Moenkopi Formations in the west and continental to shallow marine sediments in the east.*

Mesozoic Volcanics

Tertiary-Cretaceous Volcanics (TKvu): *Occur in Lincoln County where it covers [illegible] areas of the Clover, Del Mar, Wilson Creek, White Rock and Mahogany Mountains.*

Paleozoic Sediments

Permian, Undifferentiated (Pu): *Shallow marine intertidal and continental sediments. Includes Gerster Formation, Plympton Formation, Kaibab Limestone, Pequop Formation, Coconino Sandstone, Arcturus Formation, Rieptown Formation, Rib Hill Sandstone, Riepe Springs Formation, Carbon Ridge Formation and Loray Limestone. With the exception of parts of White Pine County, local symbols are used to identify all Permian outcrops. In White Pine County, local symbols are used except for the Park City Group which is grouped with the Arcturus [illegible] Sandstones (Par). To avoid confusion, non-standard symbol used [illegible] Permian in Utah has been replaced with the standard "P".*

Pennsylvanian-Permian (PPu): *Marine sandstone and limestone (dolomatized in places). Includes Rib Hill Sandstone, Riepe Spring Limestone and Ferguson Mountain Formation in [illegible]ern Elko County, Strathearn Formation, Buckskin Mountain Formation, Beacon Flat Formation and Carlin Canyon Formation in Eureka County; Pablo Formation in Nye County, and Oquirrh Formation or group in Utah. Local symbols are used where possible.*

Pennsylvanian, Undifferentiated (ℙu): *Includes Ely Limestone, Moleen and Tomera Formations. To avoid confusion, the non-standard symbol used for Pennsylvanian in Utah has been replaced by "ℙ".*

Mississippian Upper (Mu): *Includes Diamond Peak and Bird Spring Formations, Callville Limestone, Scotty Wash Formation, Ochre Mountain Limestone and Manning Canyon Shale in parts of Clark County. Chainman Shale is combined with Diamond Peak Formation in some parts of Utah.*

Mississippian, Chainman Shale (Mc): *Includes Mountain City Formation in Elko County and Eleana Formation in Nye County.*

Mississippian, Lower (Ml): *Includes Monte Cristo and Rogers Spring Limestones in Clark County; Joana, Mercury and Bristol Pass Limestones in Lincoln County; and Joana Limestone elsewhere.*

Mississippian-Devonian, Undfiferentiated (MDu): *Includes Rogers Spring Limestone and Muddy Peak Limestone in parts of Clark County. Joana Limestone and Pilot Shale in Elko County, Pilot Shale, Joana Limestone, Chainman Shale and Diamond Peak Formation in Eureka and White Pine Counties.*

Mississippian-Devonian, Pilot Shale (MDp): *Shown in combination with other Mississippian Formations in Clark, Elko, parts of Lincoln, Eureka and White Pine Counties.*

Devonian-Cambrian, Undifferentiated (DSO€u): *Undivided limestone and dolomite occurring in Lincoln County.*

Devonian-Ordovician, Undifferentiated (DSOu): *Dolomites in Elko and Nye Counties.*

Devonian, Upper (Du): *Primarily Devils Gate and Guilmette Formations. Also includes Sevy and Simonson dolomites in parts of White Pine County. Contains Guilmette, Devils Gate, Simonson and Sevy in Elko County under the heading of* Dgd. *Local symbols used where possible.*

Simonson Dolomite (Dsi): *Alternating light to dark gray fine to coarse grained dolomite. Included with other Silurian and Devonian sediments in North Central Nevada and parts of Utah. Grouped with Sevy Dolomite in parts of Clark, Elko, Eureka, Nye, and White Pine Counties.*

Sevy Dolomite (Dse): *Very light colored, dense, distinctly bedded unfossiliferous dolomite. Combined with other Devonian and Silurian sediments in parts of North Central Nevada and Utah and with the Simonson Dolomite in parts of Clark, Elko, Eureka, Nye and White Pine Counties.*

Sevy and Simonson Dolomites, combined (Dun): *Also includes the Sultan and Muddy Peak Limestones in Clark County; Nevada Formation in Elko County; Devils Gate Formation in Eureka County; Nevada Formation, Woodpecker Limestone, Oxyolk Canyon Sandstone and Rabbit Hill Formation in Nye County; Nevada Formation and Devils Gate Formation in Eureka County and the Nevada Formation in White Pine County. Local symbols are used where possible.*

Devonian, Western Facies (Dw): *A portion of the western allochthonous assemblage. Includes Woodruff Formation and Slavern Chert in Elko County and silicious siltstone in the Cockalorum Wash area of Nye County.*

Silurian, Undifferentiated (Su): *Includes Lone Mountain and Laketown Dolomites throughout the mapping area, the Elder Sandstone and Fourmile Canyon formation in Eureka County, and the Roberts Mountain formation in Nye County. In White Pine County, the Silurian deposits are grouped with the upper Ordovician sediments under the heading of Silurian-Ordovician, Undifferentiated (SOu).*

Upper Ordovician, Undifferentiated ( ): *Includes Ely Springs and Fish Haven Dolomites and the Hanson Creek Formation. Local symbols are used where possible. Listed as Ordovician, Undifferentiated (Ou) in parts of North Central Nevada. In Clark County, Ely Springs Dolomite has been divided from the rest of* Oep *by the author. The Eureka Quartzite and Pogonip Group are grouped with Silurian sediments under the heading Silurian-Ordovician, Undifferentiated (SOu) in Elko County.*

Ordovician, Eureka Quartzite (Oe): *Light colored vitreous quartzite and hard sandstone. Also includes the Swan Peak Quartzite in parts of Utah. In Clark County, the Eureka Quartzite has been separated from* Oep *by the author. In parts of North Central Nevada, the Eureka Quartzite has been grouped with other Ordovician sediments under the heading of* Ou. *In White Pine County, the Eureka Quartzite has been grouped with the Pogonip Group under the heading of*

Ordovician, Pogonip Group (Op): *Limestone, silty limestone shale and interformational conglomerates. In Clark County, the Pogonip Group has been separated from* Oep *by the author. Includes the Garden City Limestone in parts of Utah. In White Pine County, the Pogonip Group is grouped the Eureka Quartzite under the heading of* Ol.

Ordovician, Undifferentiated (Ou): *Includes the Pogonip Group, Ely Springs Dolomite, Eureka Quartzite and Comus Formation in North Central Nevada.*

Ordovician, Vinini Formation (Ovi): *Part of the western allochthonous assemblage. Includes Valmi Formation in parts of North Central Nevada. Local symbols are used where possible.*

Cambrian-Ordovician, Undifferentiated (O€u): *Occurs in Elko, Eureka, Nye and White Pine Counties as shale and limestone and is usually so identified when metamorphosed to phyllite. Includes the Tennessee Mountain Formation in Elko County, Board Canyon, Sequence in North Central Nevada, Windfall Formation in Nye County and the lower Ordovician and post-Dunderberg Shale in the Schell Creek Range of White Pine County. In some parts of Nye County,* O€u *is metamorphosed to slate and marble instead of phyllite*

Cambrian, Upper and Middle (€u): *Primarily limestones, dolomites, shales and quartzites. Includes Edgemont and Peak Limestones in Elko County; Highland Peak formation, Patterson Pass Shale, Pole Canyon Limestone, Chisholm Shale and Lyndon Limestone member of the Chisholm Shale in Lincoln County; Harmony Formation, Preble Formation, Pioche Shale, Eldorado Dolomitee, Geddes Limestone, Secret Canyon, Hamberg, Dole and Dunderberg Shales, Windfall Formation, and Scott Canyon Formation in North Central Nevada, Windfall Formation, Dunderberg Shale, Tybo Shale and Lincoln Peak Formation in Nye County; Notch Peak Formation, Dunderberg Shale, Orr Formation, Weeks Formation, Marjum Formation, Wheeler Shale, Swasey Formation, Whirlwind Formation, Dome Limestone, Howell Formation and Tatow Formation in Utah; and Corset Spring Shale, Notch Peak Limestone, Dunderberg Shale and Windfall Limestone in White Pine County. Metamorphosed to schist in Elko County*

Cambrian, Lower (€pmp). *Primarily Prospect Mountain Dolomite and Pioche Shale. Also includes Tapeats Sandstone, Wood Canyon Formation, Lyndon Limestone, Chisholm Shale and Carrera Formation in Clark County; Sterling Quartzite and Wood Canyon Formation in parts of Lincoln County, Busby Quartzite in the Gold Hill area of Utah and the Stella Lake Quartzite in White Pine County.*

Precambrian

Precambrian Sediments (p€s): *Includes the Johnnie Formation, Sterling Quartzite and some metamorphics in Clark County; Johnnie Formation and lower units of Prospect Mountain Quartzite in Lincoln County; McCoy Creek Group in Elko County; and the McCoy Creek Group excluding the Stella Lake Quartzite in White Pine County.*

Precambrian Intrusives (p€i): *Includes the Gold Butte Granite in Clark County and other undifferentiated igneous and metamorphic rocks, primarily granites and pegmatites.*

II. GEOLOGY

The Grapevine Spring GRA lies within the Basin and Range province in eastern Lincoln County, Nevada. WSA 050-0139 encompasses much of the western portion of the Clover Mountains, which trend east-west and are somewhat arcuate to the north.

The Clover Mountains are composed of Tertiary volcanics which mask much of the pre-Basin and Range structure (see Figure 3). A few small areas of pre-Tertiary sedimentary rocks that were complexly faulted before the Mid-Tertiary volcanism, have been exposed in scattered fault blocks.

Tertiary age intrusive rocks are present which led to metallic mineralization from the late fluids to their cooling stage which then migrated along a structurally favorable conduit to favorable host rocks or depositional environments.

Basin and Range normal faults generally trend northwest and cut the Tertiary volcanic sequences. Two major subparallel normal faults transect the Miocene-Pliocene volcanics.

Most of the following geological description is taken from Tschanz and Pampeyan (1970). Greater detail in the volcanic rocks in the area is indicated on the map by Stewart and Carlson (1976).

1. PHYSIOGRAPHY

The Grapevine Spring GRA lies within the Basin and Range province in eastern Lincoln County, Nevada. The study area contains the western portion of the Clover Mountains which generally trend east-west and are arcuate to the north.

The Clover Mountains are composed of Tertiary volcanics except for a few small areas of pre-Tertiary sedimentary rocks that were complexly faulted before the mid-Tertiary volcanic activity.

Northwest-trending Basin and Range normal faults cut the Tertiary sediments in the northwest portion of the study area. A window of Late Paleozoic-Early Mesozoic sediments in the southern part of the GRA has also been intersected by pre-volcanic normal faults.

The topography of the Clover Mountains is rugged with elevations along the crest of the range averaging about 6,000 feet, while to the east Meadow Valley Wash is near 3,000 feet. Drainage of the area is predominantly into the Meadow Valley Wash which discharges into the Colorado River.

2. ROCK UNITS

The oldest rock units exposed in the study area are Cambrian marine sediments which crop out in the vicinity of Pennsylvania Canyon. The Prospect Mountain Quartzite, consisting chiefly of thin-bedded to massive reddish-brown to white quartzite, is overlain by the Pioche Shale and undifferentiated Cambrian limestones and dolomites. The Upper Cambrian Highland Peak Formation, composed of alternating layers of light and dark-gray limestone and dolomite, was deposited next.

Undivided Lower Mississippian limestone, Monte Cristo Limestone and undivided Pennsylvania limestone and sandstone, the next youngest sediments, are exposed in two fault blocks in the southern portion of the GRA.

Red beds overlain by the Kaibab limestone and Toroweap Formation were deposited next during the Lower Permian. The Toroweap, consisting of mudstone and limestone, and the overlying Kaibab limestone commonly form a conspicuous double cliff. These units are unconformably overlain by the Triassic Moenkopi Formation which is composed of marine limestone with tongues of red beds. These Permian through Triassic sediments crop out in a fault block to the east of Leith Station and host the gold and silver mineralization in the Cherokee mine area (Tschanz and Pampeyan, 1970).

Cretaceous-Tertiary clastic rocks in largely cobble conglomerate, which crop out along Pennsylvania Canyon were deposited next.

Unconformably overlying the Paleozoic and Mesozoic rocks is an Early Miocene unnamed lacustrine limestone which consists of thin lenses of massive or laminated dense limestone. This formation has tentatively been identified in one of the fault blocks in the southern part of the study area.

Tertiary volcanic rocks cover the majority of the Clover Mountains. The composition of these units range from rhyolite to basalt and consist mainly of several series of ignimbrites. These volcanics were apparently deposited conformably over the lacustrine limestone and unconformably over the Paleozoic and Mesozoic rocks. These volcanic units are a thick sequence of ash from numerous volcanic centers in the region. The west portion of the GRA is part of the Caliente caldera complex. The area is currently under study by researchers attempting to understand the nature of the downward-flat-curving faults that may have occurred during the development of the caldera structure (Gundry, 1983).

Two mid-Tertiary age dioritic stocks(?) have tentatively been identified by Tschanz and Pampeyan (1970) near the head of Pennsylvania Canyon. Copper, silver and gold mineralization in the Pennsylvania mining district is presumably related to the intrusion of the diorite.

During the Pliocene basalt was extruded over the older formations marking the end of volcanism. Small outcrops of this basalt are found along the southern fringes of the Clover Mountains.

Thick accumulations of gravel and alluvium derived from the erosion of nearby mountains were deposited in Meadow Valley Wash and adjacent valleys during the Pleistocene.

3. STRUCTURAL GEOLOGY AND TECTONICS

Much of the pre-Basin and Range structure in the study area has been masked by the extensive coverage of Tertiary volcanics. The manifestation of these earlier structures is therefore limited to the scattered fault blocks which expose Paleozoic and Mesozoic sediments.

Faults cutting the Paleozoic and Mesozoic sediments generally trend northwest, as do the Basin and Range faults. These older normal faults may be an earlier pulsation of the Basin and Range tectonic forces which formed the numerous post-volcanic Miocene-Pliocene normal faults in the area.

Post-volcanic Basin and Range faults generally trend northwest. Two major subparallel normal faults over ten miles long cut the Tertiary volcanics in the northwest corner of the study area.

4. PALEONTOLOGY

The dominant lithology of the Grapevine Springs GRA is not suitable for the preservation of paleontological resources, and none are recorded from this area.

5. GEOLOGICAL HISTORY

During the Paleozoic era marine carbonate miogenosynclinal formations were deposited. Toward the end of the Paleozoic red beds were formed indicating deltaic conditions prevailed. Mesozoic carbonate and clastic rocks were deposited over the area; however, most of these sediments was eroded during the Laramide orogeny that began with uplift in Late Triassic time and culminated in Cretaceous age thrusting.

Continental conditions existed in Early Tertiary times as evidenced by Early Miocene age lacustrine deposits.

Post-Laramide normal faulting of the Paleozoic and Mesozoic sediments occurred sometime before the extrusion of the extensive Miocene ignimbrite series.

Contemporaneous with the volcansim, intrusive bodies of diorite were emplaced. Copper, silver and gold mineralization in the Pennsylvania mining district is probably associated with the cooling intrusives. Most of the Basin and Range normal faulting occurred after the major mid-Tertiary volcanism during Miocene-Pliocene times.

Subsequent to the formation of the Basin and Range topography, the newly formed highlands were eroded during the Pleistocene to form thick deposits of alluvium and gravel in the adjacent valleys and isolated lake beds.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are two mining districts in the GRA, the Pennsylvania and the Viola which are shown on the Metallics Land Classification and Mineral Occurrence Map.

The Pennsylvania district is in T 6 S, R 67 E adjacent to the northwest edge of the WSA. It is reported by Tschanz and Pampeyan (1970) to be an old district with probably less than $50,000 total production of gold, silver and copper. The district is found in a window of the Tertiary volcanics and is composed of Cambrian quartzite, shale and limestone which has been intruded by a Tertiary diorite stock(?). The Pennsylvania quartz vein, three to fifteen feet thick, can be traced for approximately 3,000 feet, strikes N 20° W and dips 20°E. It contains the ore deposits in the district.

The Viola district is northwest of the Tule Desert along the south edge of the Clover Mountains along the southern edge of the WSA. Tschanz and Pampeyan (1970) indicate little is known about the history of the district, but that total metallic production was small. Most of the production came from fluorspar which was mined later. The deposits occur in three isolated areas of pre-Tertiary rocks surrounded by Tertiary volcanics. The properties involved are the Cherokee, Johnnie, Crystal and Pittsburg. The pre-Tertiary rocks consist predominantly of limestones which host the mineralization in the district, usually near the base of the overlying volcanic rock. There are large masses of jasperoid capping many of the hills in the area which are believed to have been formed beneath the altered volcanic rock. Silver is known to have been produced in limited quantities from vein deposits, with some copper and mercury production also a possibility.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

The areas around the above two mining districts are the only known mineralized areas in the GRA. At the Pennsylvania district contact silicates, copper carbonates and sulfides are present along shear zones in limestone near the diorite stock. The mineralization is probably related to the intrusion of the diorite.

In the Viola district the silver in part came from argentiferous lead-zinc-copper deposits. Also some deposits contained appreciable amounts of cadmium, antimony and molybdenum. Manganese has also been reported from near where the fluorite was mined in a fault zone that separates limestone and volcanic rock.

To the west of the WSA, in the same volcanic units, alteration is prevalent in places which may indicate the presence of mineralization. It is unknown, however, if similar alteration is present in the volcanics in the WSA.

In the very eastern portion of the GRA, in altered volcanic rocks, Earth Sciences, Inc. of Golden, Colorado currently has applied for potassium prospecting permits for alunite. Alunite is a hydrothermal alteration product of these volcanic rocks and is rich in potassium and aluminum. Reportedly the company is interested in the aluminum rather than the potassium, therefore, we have included this occurrence under the metallics section. It is unknown whether the alunite alteration is present in the WSA.

3. Mining Claims

There are abundant claims in the GRA and the WSA. In the Pennsylvania district there are parts of an eight square mile area claimed by predominantly Lincoln Exploration. Some of these claims overlap into the WSA.

In the Viola district there are even more claims, mostly staked by either Amax or Paul Klippel. These claims cover parts of at least seventeen sections in and around the district. Amoco has a group of claims in Section 8 of T 8 S, R 68 E near the Cherokee mine. All these claims appear to be outside the proposed WSA boundary.

In T 7 S, R 68 E Houston International Minerals Corporation has close to 150 lode claims covering parts of nine sections within the WSA. These claims were staked in 1980 for molybdenum potentia and have been subsequently dropped. According to the geologic map all this area is underlain by Tertiary volcanic rocks (Wagoner, 1983).

The Caliente caldera encompasses a portion of the Clover Mountains, and recent exploration concepts link certain caldera characteristics with precious metal mineralization. This is probably the reason for the major interest in this whole region.

Most patented claims in the GRA are in the Viola district south of the WSA, or near the east boundary of the GRA outside the WSA.

4. Mineral Deposit Types

The Pennsylvania district hosts most of its mineralization of gold, silver and copper along one quartz vein. Contact silicates, copper carbonates, and sulfides are present along shear zones in limestone near its contact with a diorite stock.

The Viola district mineralization is found in vein deposits in limestone. There is also an abundance of jasperoid capping many of the surrounding hills. The silver mineralization is from argentiferous lead-zinc-copper deposits which indicate high-temperature environments, while the gold, mercury, fluorspar and jasperoid indicate a low-temperature environment. Perhaps there is a zonation in the district but at this level of study that cannot be ascertained.

The overall geology and known mineralization are very suggestive of a potential for large, disseminated precious metal deposits. The nearness of the Caliente caldera alone is encouraging. The presence of Tertiary intrusives is demonstrated in the Pennsylvanian. Potential large mineralization is demonstrated by the silicified limestones of the Viola district and limestones are probably widespread beneath the volcanic cover. The location of the silicification -- just beneath the volcanics -- suggests a regional ore localizing feature. Alteration in the volcanics noted west of the WSA may offer targets at depth if not at the surface. This line of thinking is probably responsible for the interest in the area shown by some major mining companies.

5. Mineral Economics

Underground, narrow vein-type deposits are generally not of great interest to most major mining companies. However, if the vein is sufficiently wide (the Pennsylvania quartz vein has been reported to attain widths of 15 feet) and the grade is adequate, underground mining is feasible.

The description of the mineralization in the Viola district as being in limestones and associated with widespread jasperoids, indicates there may be low-grade disseminated mineralization in the vicinity. There is interest in the area since some of the major mining companies have claims in the vicinity.

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 byproduct 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 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 copper industry weaken its competitive capability on the work market. At the end of 1982 the price of copper was 73 cents per pound.

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 amount -- 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 use 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 lead is in electrical storage batteries, and the second being a gasoline antiknock additive. It has many other uses, however, including radiation shielding, solders, numerous chemical applications, and in construction. About four million metric tons of lead are produced in the world annually. the United States produces about half a million tons per year, and recovers about the same amount from scrap -- much of it through the recycling of old batteries. It imports about one-quarter of a million tons. Lead is classified as a strategic mineral. Demand is projected to increase somewhat in the next couple of decades, but environmental concerns will limit the increase. The United States has large ore reserves that are expected to last well beyond the end of this century at current production rates even without major new discoveries. At the end of 1982 the price was about 22 cents per pound.

The major uses of zinc are in galvanizing, brass and bronze products, castings, rolled zinc and in pigments or other chemicals. About six million metric tons are produced annually, with the United States producing somewhat less than a quarter of a million tons. Domestic production has decreased dramatically over the past five years, largely as the result of closing down of most zinc smelters because of environmental problems. Imports into the United States are about one million tons per year. Zinc is listed as a strategic and critical metal. Both world-wide and domestic consumption are expected to increase at a moderate rate over the next twenty years. At the end of 1982 the price of zonc was about 38 cents per pound.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

Fluorspar was mined from the Wells Cargo deposit in the Viola district near the southern border of the GRA. Production was approximately 11,000 tons of 70% CaF in 1958. The fluorite occurred as replacement deposits in limestone, which in turn has been partially replaced by jasperoid.

Some alunite production has been reported from a deposit in altered volcanic rock on the east side of Meadow Valley Wash in the northwest corner of the GRA, but well outside the WSA. It is reported by Hewett and others (1936) that the deposit is an eight-foot thick lens of massive pink and white alunite which is approximately 100 feet long. The material was shipped and used for fertilizer.

Clay has also been mined in this same area. The deposit is located in the vicinity of Section 2, T 6 S, R 66 E. It is described as a 25-foot thick lens of hard white altered rhyolite. It is reported by Callaghan to have been mined between 1920 and 1930.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

The only other reported nonmetallic mineral occurrence in the GRA is gypsum in the Viola district to the south of the WSA where the Permian Red Beds are found, but nothing more is known about these occurrences and a barite occurrence in the Wells Cargo fluorite deposit.

3. Mining Claims, Leases and Material Sites

Wells Cargo owns lode claims in parts of two sections covering their fluorspar mine near the southern border of the GRA. The remainder of the claims in the GRA are probably staked for metallic mineral resources, but some may be for nonmetallic commodities.

The only patented claim suspected of being on a nonmetallic mineral commodity is in the northwest edge of the GRA outside the WSA in the vicinity of the clay and alunite.

There is a potassium prospecting permit application for alunite in altered volcanics along the eastern border of the GRA. Reportedly the commodity under investigation is the aluminum in the mineral. This was discussed under metallics.

The alluvium in the GRA could undoubtedly be used for construction applications.

4. Mineral Deposit Types

The fluorspar is found as replacement deposits in limestone. The alunite and clay deposits in the same proximity in the northwest part of the GRA are both hydrothermal alteration products of volcanic rocks. The gypsum is a bedded evaporite deposit. The sand and gravel in the alluvium is the result of erosion of the various bedrock units and subsequent redeposition.

5. Mineral Economics

The fluorspar was mined in 1958. If similar high-grade underground deposits are still present in the area, a small mining operation may be able to develop additional deposits, but not enough is known of the deposit to determine that.

The alunite and clay deposits, as described, appear to be very small. If larger reserves could be found in this area however, mining could possibly be feasible.

The sand and gravel of the alluvium could possibly be used in local construction applications, if they were to develop some time in the future.

By far the greatest use of fluorite (or fluorspar) is in the production of hydrofluoric acid, which has many industrial applications. Other uses are in steelmaking, welding rods, refining of a number of metals, and in the production of certain glasses. World production fluorine, the principal component of fluorite, is about 2.5 million tons annually, of which the United States produces less than 100 thousand tons, nearly half of this being in the form of fluorsilicic acid that is a byproduct of phosphate production. United States consumption is about 700 thousand tons annually, with more than half of the shortfall imported from Mexico, and the remainder mostly from South Africa, Spain and Italy. Fluorite is a strategic and critical mineral. United States demand for fluorite is expected to increase by about 50% by the year 2000, and probably all of the increase will be imported. In 1980 the price of fluorite was about $65 to $85 per ton, depending upon the quality.

By far the greatest use of gypsum is in prefabricated products, mostly wallboard, which account for nearly three-fourths of all usage. Most of the remainder is used in cement, as an agricultural soil conditioner, and in plaster. The United States consumes about 20 million tons of gypsum annually, about two-thirds of it produced domestically. Gypsum is a relatively common mineral and occurs in large deposits, and the United States has practically unlimited reserves. However, although its commonness makes it a low priced material, some plants on the eastern seaboard use imported raw material that can be transported by ship at low cost and these account for the imports of gypsum. United States consumption is forecast to nearly double by the year 2000, with domestic production keeping up with demand except in those special situations where imported material can compete. The price for gypsum is about $7 per short ton.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

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

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There is one known radioactive occurrence in the GRA (see Uranium Land Classification and Mineral Occurrence Map). Anomalous radioactivity was discovered in altered volcanic rocks in or near the rim of the Caliente caldera (Lackey, 1983), northeast of the Pennsylvania mining district in Meadow Valley Wash.

3. Mining Claims

There are no known current uranium or thorium claims or leases in the GRA. An area in Meadow Valley Wash near the rim of the Caliente caldera was staked by Noranda for uranium, but the claims have since been dropped (Lackey, 1983).

4. Mineral Deposit Types

The types of uranium or thorium deposits present in the area cannot be discussed due to the lack of known deposits in the GRA.

5. Mineral Economics

The lack of known uranium or thorium occurrences in the area appears to indicate that these elements are of little economic value in 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 was responsible for about 30 percent of this total, making the United States 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 1970s, because the number of new reactors scheduled for construction has delcined 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 over production in the industry have resulted in the losures 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.

Oil and Gas Resources

1. Known Oil and Gas Deposits

   There are no known oil and gas deposits in the GRA or the immediate region.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

   There are no oil seeps, nor have there been any exploratory wells drilled in the GRA. The GRA is situated in the petroliferous Paleozoic miogeosyncline portion of Nevada and Utah.

3. Oil and Gas Leases

   The GRA and adjacent townships are entirely covered by oil and gas leases.

4. Oil and Gas Deposit Types

   Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also the Tertiary section.

   The reservoirs at the Trap Spring and Eagle Springs oil fields in Railroad Valley are the Oligocene Garrett Ranch volcanics or equivalent, which produce from fracture porosity; or the Eocene Sheep Pass Formation, a freshwater limestone. Minor production has been recorded from the Ely(?) Formation of Pennsylvanian age at Eagle Springs. It may be that production also comes from other units in the Tertiary or Paleozoic sections in the Blackburn oil field in Pine Valley or the Currant and Bacon Flat oil fields in Railroad Valley.

   The GRA is within or close to the North American Overthrust Belt which has good oil and gas production in Wyoming/Utah, Mexico and Canada (Oil and Gas Jour., May 12, 1980). The Federal leases in Nevada are for rank wildcat acreage, and surficial stratigraphic units do not necessarily have a direct bearing on possible drilling objectives at depth, considering overthrust structural implications.

   Recent seismic surveys (e.g., Seisdata Services, 1981;

Geophysical Service Inc., 1981; GeoData, 1981: Index maps in GRA File) indicate, in part, the general area of industry interest. This and certain other data may be purchased, but deep exploratory test data are not readily available. Published maps of the Overthrust Belt in Nevada are very generalized, and are not necessarily in agreement because exploration is at an early stage (Oil and Gas Jourl, May 12, 1980; Western Oil Reporter, June, 1980; Keith, 1979: Index maps in GRA File).

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluctuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; enviornmental constraints; willingness or ability of a refiner to take certain types of oil; and of course, the price to the producer, which is tied to regional, national and international prices.

Geothermal Resources

1. Known Geothermal Deposits

There are no known geothermal deposits in the GRA, but according to Schilling and Garside (1979), about 10 miles north of the GRA is Caliente Hot Springs. This thermal area has shallow waters of 104° to 145°F.

2. Known Prospects, Geothermal occurrences, and Geothermal Areas

There are no known prospects or occurrences in or immediately adjacent to the GRA.

3. Geothermal Leases

There are no geothermal leases in the GRA or the surrounding region.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam which occur in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

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, as well as the end use, 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 cyrstallization (266°F), and drying of diatomaceous earth (338°F). These are only a few examples.

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 other known unique geological resources in the GRA. Coal is not known in the GRA, and there is no known potential for coal.

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 the report.

The Stockpile Report to the Congress, October 1981-March 1981, 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.

Strategic and critical minerals that have been produced from the GRA are flourspar, silver, copper and mercury. Flourspar was the most prevalent with production of approximately 11,000 tons of 70 percent CaF in 1958 from the Wells Cargo mine near the southern border of the GRA.

Other strategic and critical minerals reported to occur in the mining districts in the GRA are antimony, cadmium, lead, zinc and manganese.

None of these above strategic and critical minerals is known to occur or to have been produced from within the WSA.

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

The geologic maps which cover this WSA include Tschanz and Pampeyan (1970) and Howard (1978) both at a scale of 1;250,000 and both essentially the same for this GRA. The scale of these maps is too small to show a great deal of geological detail other than gross lithologies. Structural details, veining or alteration, if present, are not shown. The vast majority of this WSA in both the above references is mapped as undivided volcanic rocks, therefore, hardly any geologic detail is available. Stewart and Carlson's (1978) Geologic Map of Nevada at a scale of 1:500,000 is much more detailed for this GRA as it subdivides the volcanic units. None of these maps are adequate for evaluating mineral resources. The data on mineral resources comes principally from Tschanz and Pampeyan (1970) and is not detailed. Overall the quantity of data concerning mineral resources is low, but the quality and level of confidence in that data is high.

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 the WSA has been used in establishing a classification area within the 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 mylars or the prints of those that accompany each copy of 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 hve 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

WSA NV 050-0139

M1-4D. This classification area of high favorability with a high confidence level borders the northwest boundary of the WSA and includes the Pennsylvania mining district. It is an old district that produced less than $50,000 in gold, silver and copper. The area includes the pre-Tertiary rocks exposed in a window of the overlying volcanics. Mineralization is found in these older rocks. The 4D classification is because of known past production, geologic environment and present claims and exploration activity.

M2-4D. This classification area of high favorability with a high confidence level borders the southern boundary of the WSA and includes the Viola mining district. Metallic production is reported to have been small, but some gold, silver, copper, mercury and lead production probably occurred. The area includes another pre-Tertiary outcrop area exposed in a window of the overlying volcanics. The mineralization in the district is found in these pre-Tertiary rocks. The 4D classification is due to reported past production, geologic environment and present claims and exploration activity.

M3-2B. This classification area of low favorability with a low confidence level includes the remaining exposures of pre-Tertiary rocks along the western edge of the WSA just south of the Pennsylvania district. The 2B or low favorability classification is applicable since there is evidently no obvious mineralization or alteration present and no claims covering this area; but it is in close proximity to a known mineralized area, the Pennsylvania district.

M4-3B. This classification area of moderate favorability with a low confidence level includes all the remaining Tertiary volcanic outcrop area of the WSA. This classification area covers at least 90 per cent of the WSA. This area is considered to have a moderate potential for metallic resources.

There are two known mining districts at opposite ends of the WSA, both of which are in mineralized windows of the volcanic cover. The inference is that since the exposed pre-Tertiary rocks in the area are mineralized then the same units underlying the volcanics may also likely contain mineralization. There are intrusives in the exposed windows also, which are a further evidence for potential mineralization. This entire area is of current interest to some of the major mining companies and abundant recent mining claims have been staked. Alteration is present in some of the volcanic rocks. Houston International staked a block of 150 lode claims inside the WSA in 1980. The Clover Mountains form part of the Caliente caldera, and some of its features may indicate the presence of potential disseminated precious metal mineralization. Hence the 3B classification.

In addition there currently are prospecting permit applications to the immediate east of the WSA in these same rocks for alunite, a hydrothermal alteration product of these volcanic rocks. Aluminum is the reported commodity of interest.

M5-3B. This classification area of moderate favorability with a low confidence level covers only the alluvium in the southern portion of the WSA, adjacent to the known mineralized Viola district. The nature of the bedrock beneath the alluvium is unknown, but it is directly adjacent to mineraliation in outcrop; therefore, additional mineralization may be buried under the alluvium. The same arguments are valid here as in M4-3C described above except that a lower confidence level is indicated because there is no direct evidence to support a moderate favorability.

b. Uranium and Thorium

WSA NV 050-0139

U1-2B. This land classification covers the majority of the WSA. The area is covered mostly by Tertiary flows and tuffs ranging in composition from basalt to rhyolite. Early Paleozoic sedimentary rocks and two small Tertiary diorite intrusions occur near the northwest margin of the WSA in the area. The classification indicates a low uranium favorability for the area, with a low confidence level.

Uranium could have been deposited as fracture fillings in the volcanics or sediments in conjunction with emplacement of the diorite intrusives, or during development of the Kane Springs Wash or Caliente calderas, which are located southwest and northwest, respectively, of the WSA (Stewart and Carlson, 1976). Anomalous radioactivity has been discovered near the rim of the Caliente caldera in the northwestern part of the GRA indicating that there is some potential for caldera-related uranium deposits in the area.

The area for thorium has no favorability and very low confidence level due to an apparent lack of thorium source rocks such as granites or pegmatites in the area.

U2-2B. This land classification covers an area in the southwest part of the WSA and small areas in the northern, southwestern and eastern parts of the GRA, which are covered by Quaternary gravels and alluvial deposits. These areas have low uranium favorabiltiy with a low level of confidence for epigenetic sandstone-type deposits. Ground water leaching of uranium from silicic tuffs and lavas in the highlands, and redeposition in reduced zones in the alluvium in adjacent basins may have occurred to produce this type of deposit.

The area has very low favorability with a very low confidence level for thorium due to an apparent lack of suitable thorium source rocks in the area.

c. Nonmetallic Minerals

WSA NV 050-0139

N1-4D. This classification area of high favorability with a high confidence level is outside the WSA to the south in the Viola district. It is a fluorite deposit which has shown considerable production in the past.

N2-3C. This classification area is one of moderate favorability with a moderate confidence level, and includes the area of is a gypsum occurrence in Permian Red Beds. Gypsum is common in this unit throughout southern Nevada. This area again is outside the WSA.

N3-3C. This classification area of moderate favorability with a moderate confidence level includes the carbonate units which are exposed in windows through the volcanic rocks. Most are outside the WSA to the south. These units could probably be utilized in cement or lime manufacture.

N4-3B. This classification area of moderate favorability with a low confidence level includes the Prospect Mountain Quartzite which is exposed in a window of the volcanics along the west boundary of the WSA. This unit could possibly be utilized for silica sand, however, no accurate description is available of the unit at this location, hence the classification level of B.

N5-2B. This classification area of low favorability with a low confidence level covers the majority of the WSA which consists of Tertiary volcanic rocks at the surface. The area shows low favorability for the accumulation of nonmetallic mineral resources. These undivided volcanic rocks often have perlite as is evidenced in similar volcanic rocks throughout southeastern Nevada. There are applications for potassium prospecting permits for alunite in these rocks to the east of the WSA. It is unknown, however, if similar alteration is present in the WSA. The presence of nometallics in windows through the volcanics in adjacent areas (fluorspar and gypsum) suggests that these same pre-Tertiary rocks underlying the volcanics may have similar mineralization, though it is highly unlikely that a gypsum deposit would be economically viable under those circumstances. At any rate, the 2B classification can be supported because all rocks can be used for construction purposes and any mineral material can become an economic nonmetallic mineral if a use can be developed for its potential chemical or physical properties.

N6-3C. This classification area of moderate favorability with a moderate confidence level covers the area in the southern portion of the WSA composed of alluvium. This material could possibly be utilized for local construction purposes as sand and gravel.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA 050-1039

OG1-3A. The WSA is covered by Upper Cretaceous and Lower Tertiary volcanics, except for some relatively small outcroppings of similar age sediments, and some Paleozoics. Outcrops of Upper Paleozoic rocks are present throughout the immediate region, as well as within the GRA.

The intense leasing is indicitive of two separate drilling plays. The first is the normal Upper Paleozoic and Tertiary section, which hosts oil production in Railroad and Pine Valleys. The second is the Overthurst Belt which has been found to be so productive in Wyoming/Utah, Canada and Mexico.

b. Geothermal

WSA NV 050-0139

G1-2A. The WSA is in a region of low-temperature resources which are relatively widely scattered, as compared with the northwestern part of the state. There are some faults present in the WSA which are similar to those that host thermal waters elsewhere. The favorability is considered to be very low.

c. Sodium and Potassium

WSA NV 050-0139

S1-2B. This classification area of low favorability with a low confidence level applies to all the volcanic rocks in the WSA. The presence of alunite has been indicated to the west and possibly the east of the GRA in similar volcanic rocks. Alunite is a hydrothermal alteration product, high in potassium. Very little is known concerning these occurrences, however, and more information is necessary.

3. SALEABLE RESOURCES

Saleable resources, sand and gravel, have been addressed above under nonmetallics and are included in classification N6-3C.

The alunite has been discussed previously both under metallics (for its reported aluminum content) and under nonmetallics. There is no classification map for this commodity designation.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

This WSA is believed to have one of the highest potentials for metallic mineral resources of any of the areas studied in southeast Nevada. This area was not field checked however, because of existing snow conditions making access and verification unreasonably difficult.

1. Many of the mining companies with claims in the area have been contacted, but few have responded. Their input would be very helpful in further evaluating this area.

2. Additional mapping of the region is also necessary to more adequately evaluate mineral potential, with emphasis on structure and alteration in possible association with the nearby Caliente caldera complex.

3. A comprehensive stream sediment geochemical sampling program would identify potential anomalous metallic sites.

4. The two mining districts on the outskirts of the WSA need detailed study to determine if similar mineralization could be found within the WSA.

5. The potassium prospecting permit applications covering purported alunite occurrences need further study to determine if there is an aluminum, potassium or clay potential, and to see if similar alteration may be present in the WSA.

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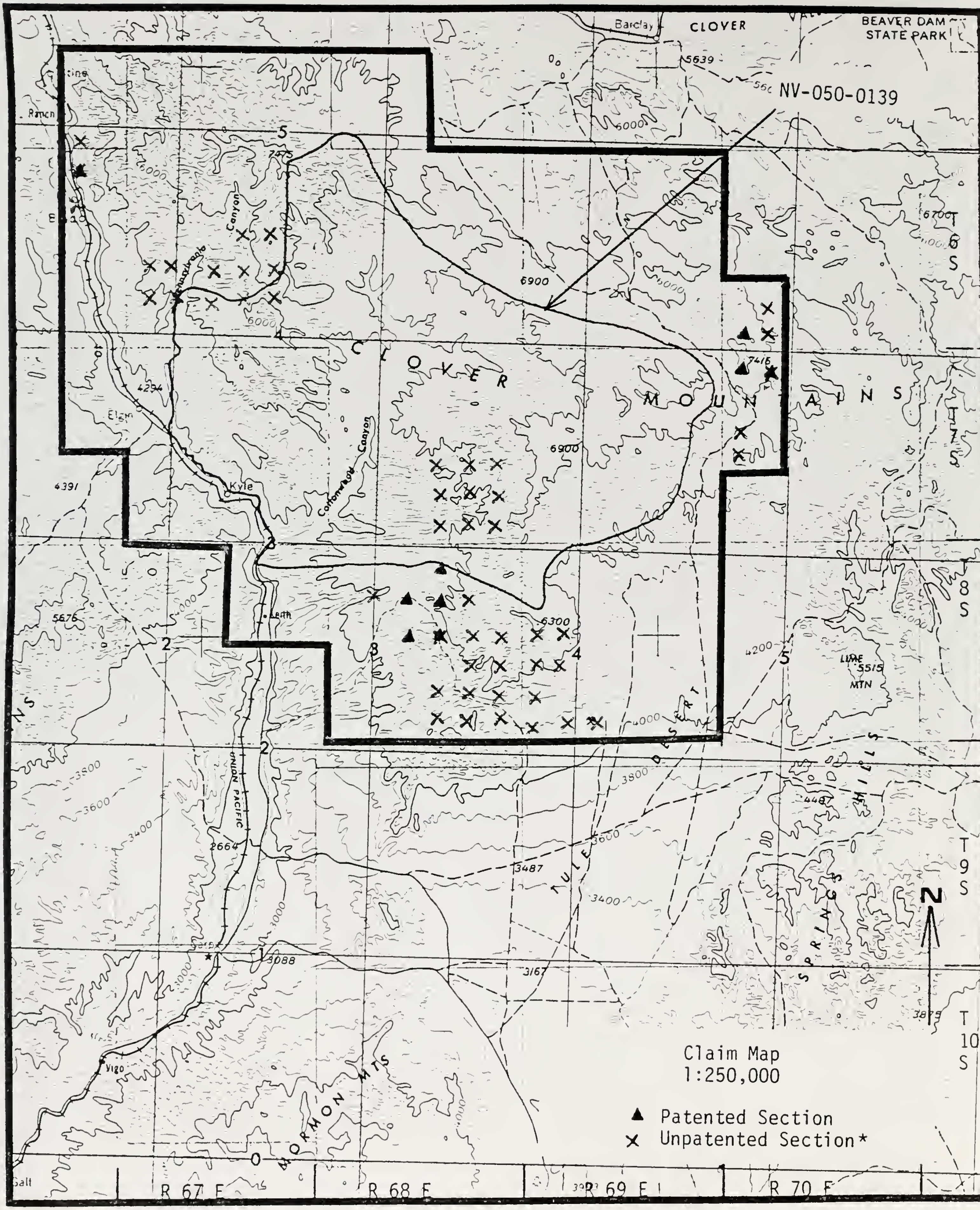
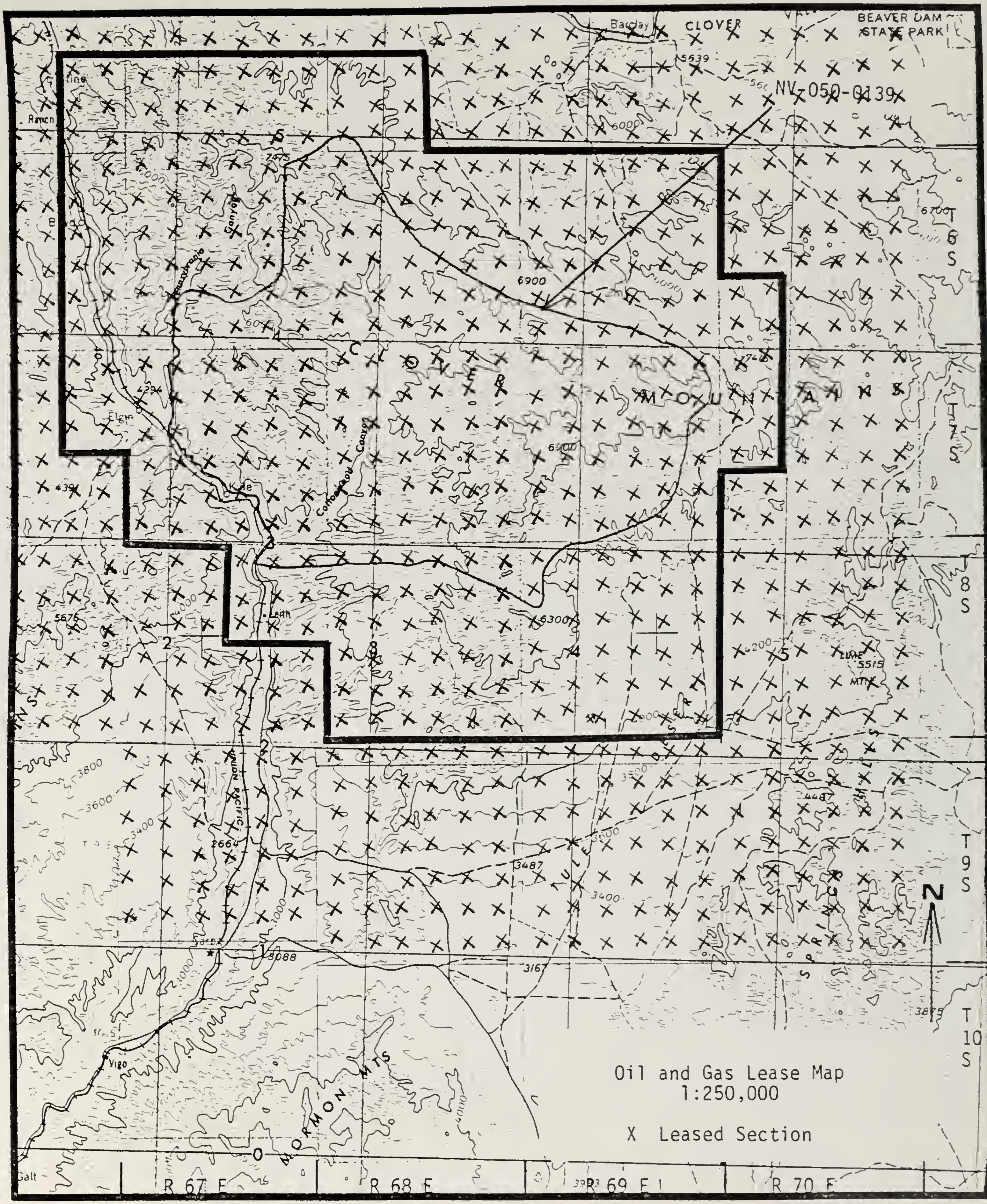


*X denotes one or more claims per section

Grapevine Spring GRA NV-23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CLOVER
Barclay
NV-050-0139
CLOVER MOUNTAINS
MORMON MTS
Elgin
Vigo
Galt
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T 6 S
T 7 S
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Oil and Gas Lease Map
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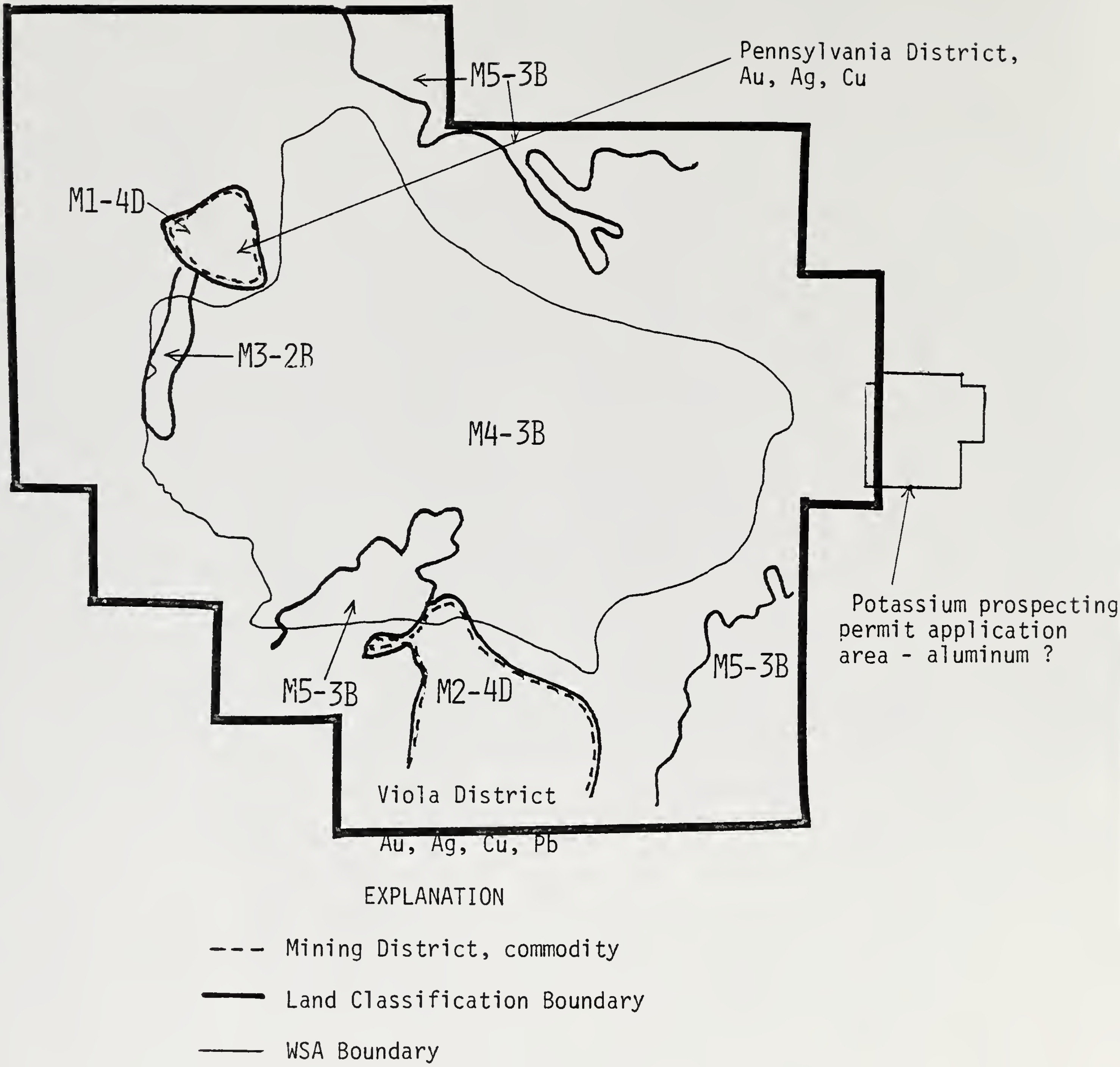
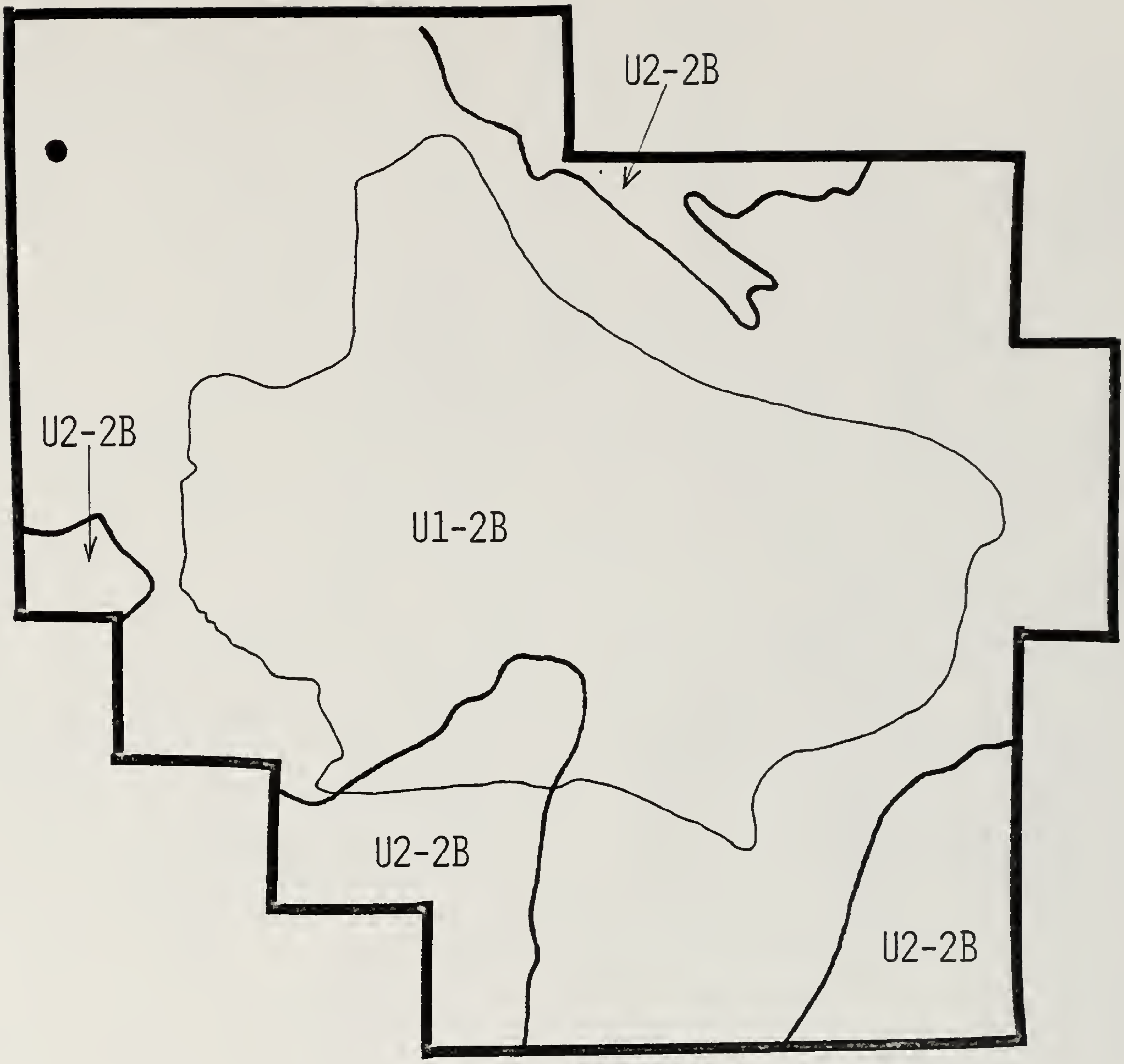


Land Classification and Mineral Occurrence Map/ Metallics
Grapevine Spring GRA NV-23
Scale 1:250,000



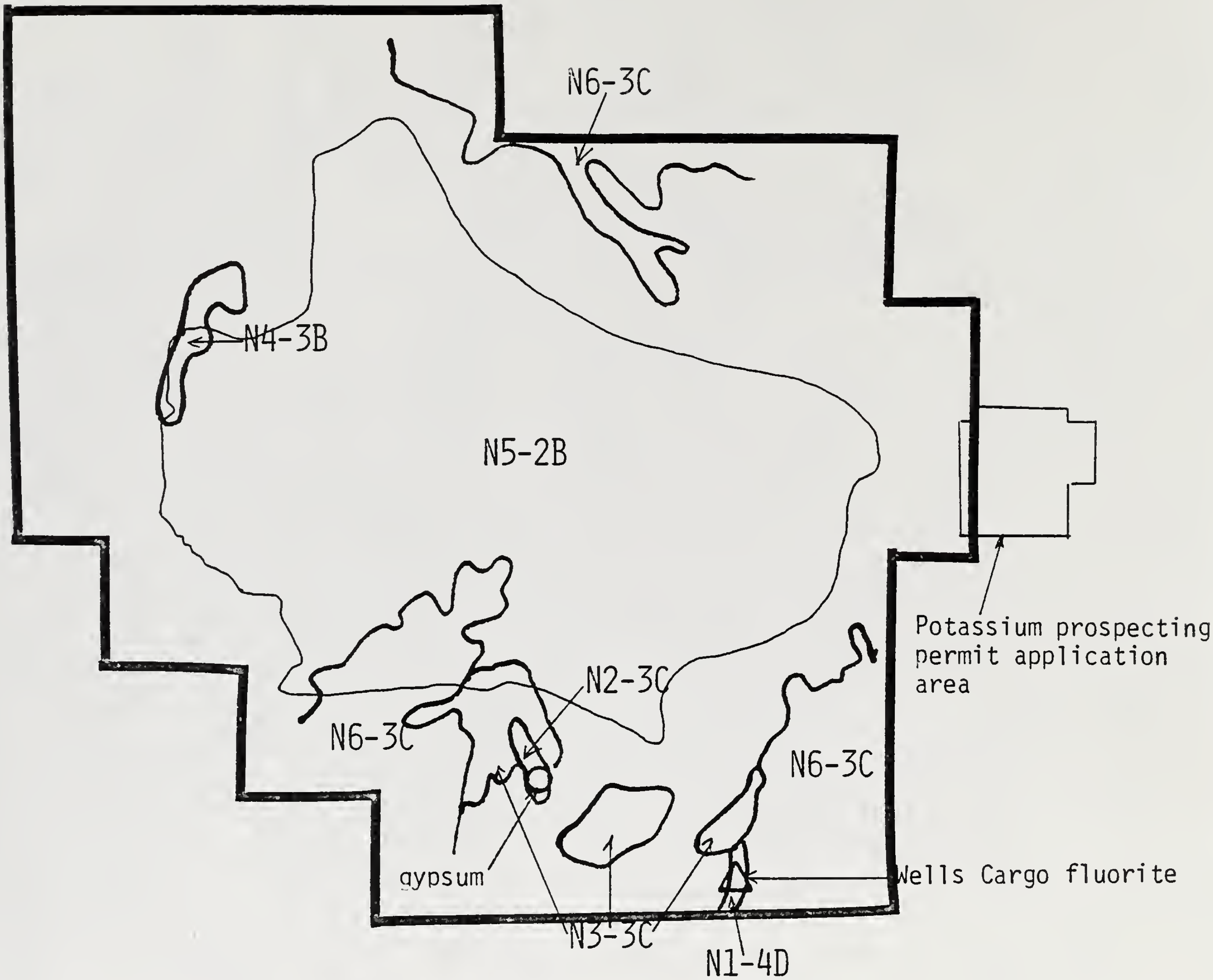
EXPLANATION

Land Classification Boundary

WSA Boundary

Uranium Occurrence

Land Classification and Mineral Occurrence Map/Uranium Grapevine Spring GRA NV-23
Scale 1:250,000



EXPLANATION

△ Mine, commodity

○ Occurrence, commodity

▬ Land Classification Boundary

— WSA Boundary

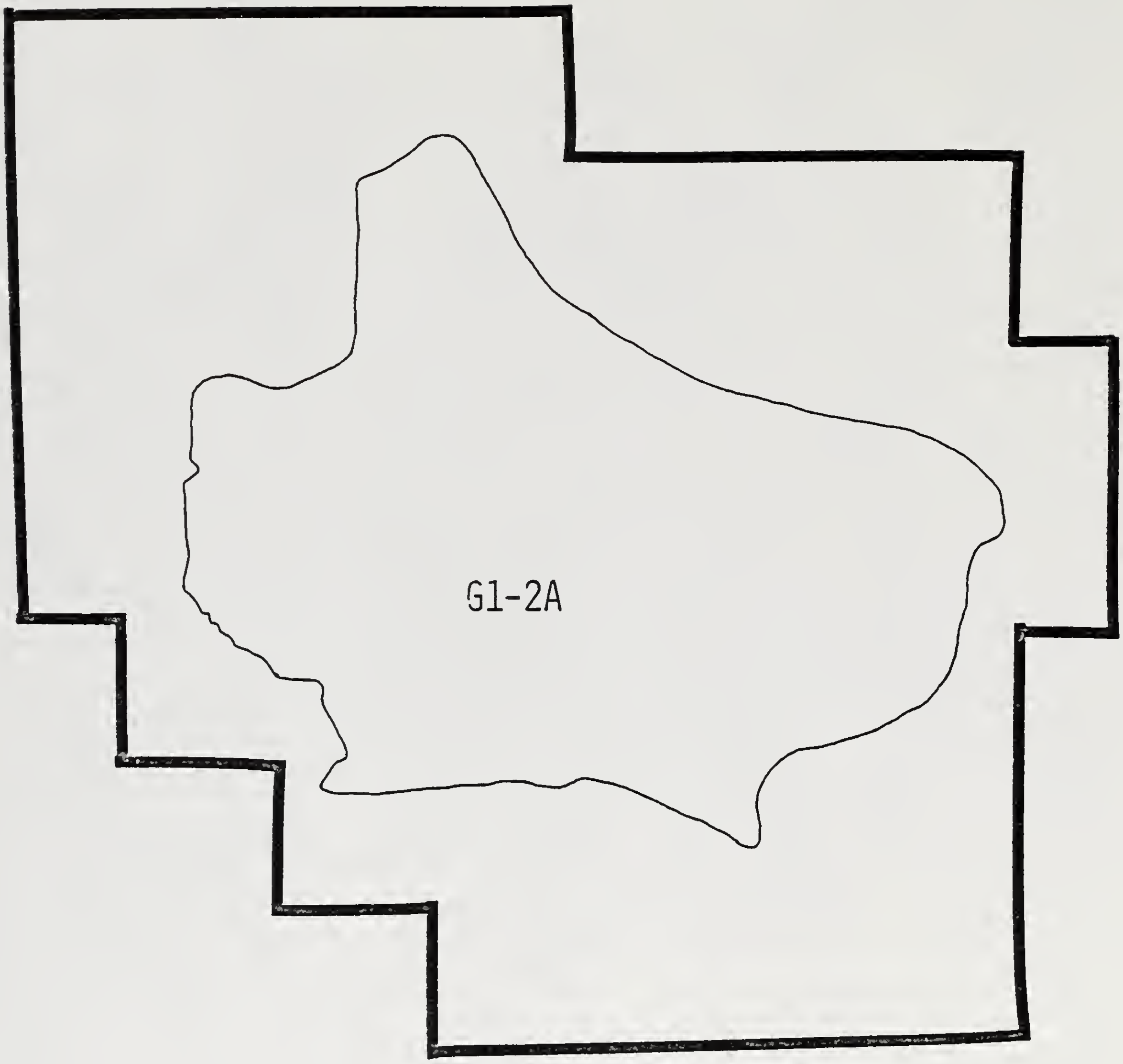
Land Classification and Mineral Occurrence Map/Nonmetallics
Grapevine Spring GRA NV-23
Scale 1:250,000

EXPLANATION

—— WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/ Oil and Gas

Grapevine Spring GRA NV-23
Scale 1:250,000



EXPLANATION

—— WSA and Land Classification Boundary

Grapevine Spring GRA NV-23
Scale 1:250,000

Land Classification - Mineral Occurrence Map/Geothermal

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]

[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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