TUNNEL SPRING G-E-M RESOURCES AREA

(GRA NO. NV-24)

TECHNICAL REPORT

(WSA NV 050-0166)

Contract YA-553-RFP2-1054

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Final Report

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TABLE OF CONTENTS

Table of Contents cont.

Table of Contents cont.

Table of Contents cont.

EXECUTIVE SUMMARY

The Tunnel Spring Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): NV 050-0166. The GRA is located in eastern Lincoln County, Nevada with its eastern boundary along the Nevada-Utah state border. The geology of the WSA consists entirely of volcanic rocks less than 60 million years old.

There are no known metallic or nonmetallic mineral resources within the WSA, however, there are two reported perlite deposits just outside the WSA but still in the GRA. There are no patented or unpatented mining claims in the GRA. The entire GRA is leased for oil and gas, but there are no geothermal leases.

There is a low favorability for metallic mineral resources beneath the volcanic cover, but with a very low confidence level. There is a low favorability for perlite (nonmetallic resource) in the WSA because of nearby perlite deposits in similar rocks. There is a low favorability with a low confidence level for uranium and very low favorability with a very low confidence level for thorium. There is a moderate favorability for the accumulation of oil and gas but with a very low confidence level, in part because the GRA is within the North American Overthrust Belt. The geologic environment indicates a low favorability for low-temperature geothermal resources with a very low confidence level.

More detailed geology of the WSA is necessary to identify additional perlite and to outline any alteration which could point the way to mineralization.

I. INTRODUCTION

The Tunnel Spring G-E-M Resources Area (GRA No. NV-24) contains approximately 72,000 acres (290 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
Tunnel Spring	NV-050-0166

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°30' north latitude, 114°5' west longitude and includes the following townships:

(Mt. Diablo Meridian)	(Salt Lake Meridian)
T 4 S, R 70,71 E	T 37 S, R 20 W
T 5 S, R 70,71 E	T 38 S, R 20 W
T 6 S, R 70,71 E	T 39 S, R 20 W

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

7.5-minute:

Pine Park	Docs Pass

The nearest town is Caliente which is located approximately twenty miles due west of the western border of the GRA on U.S. Highway 93. Access to the area is via improved secondary roads approaching from the west and north. Access within the area is via both improved and unimproved light duty and dirt roads scattered throughout the GRA and 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 subidivisions 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 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.

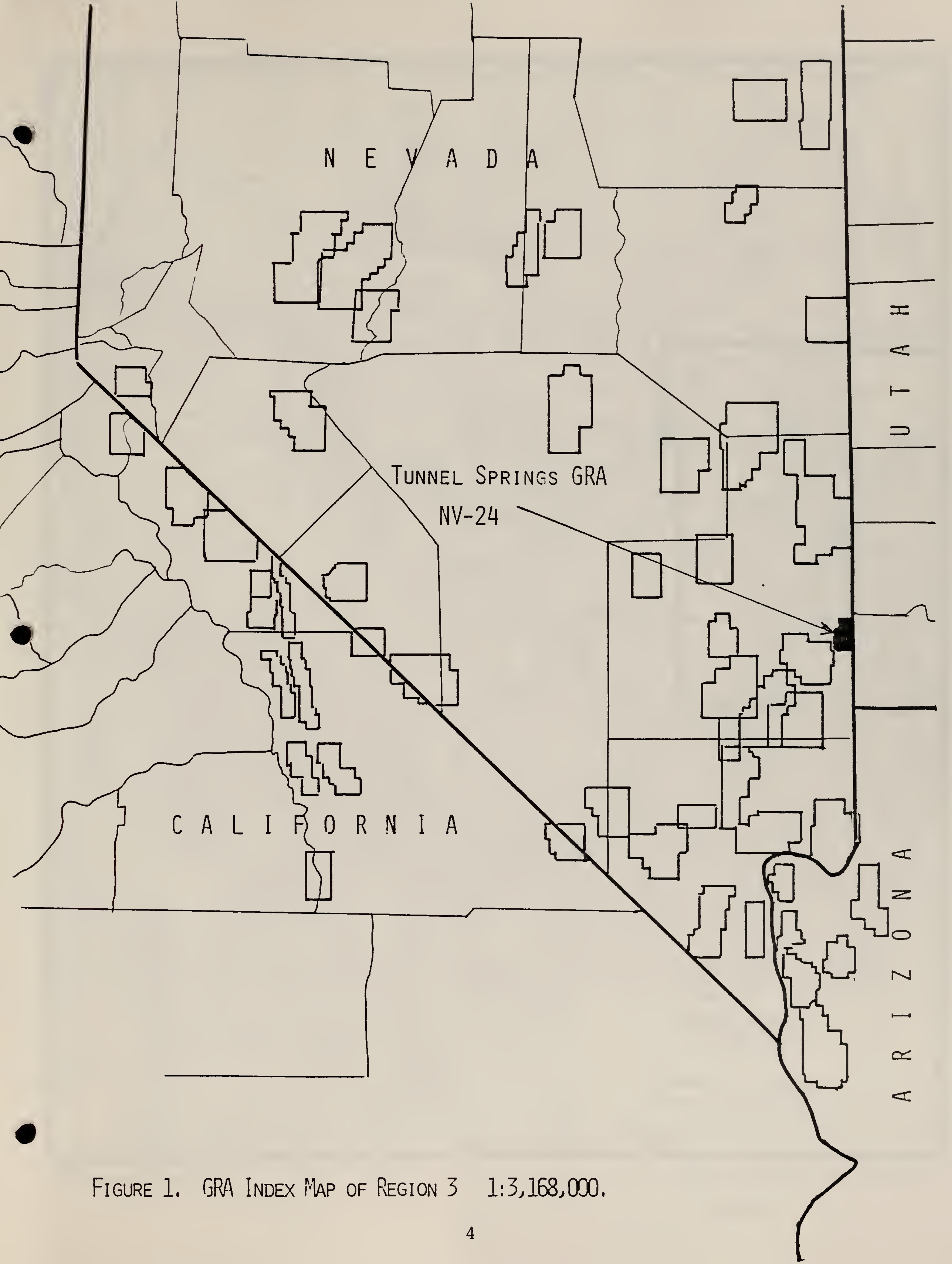
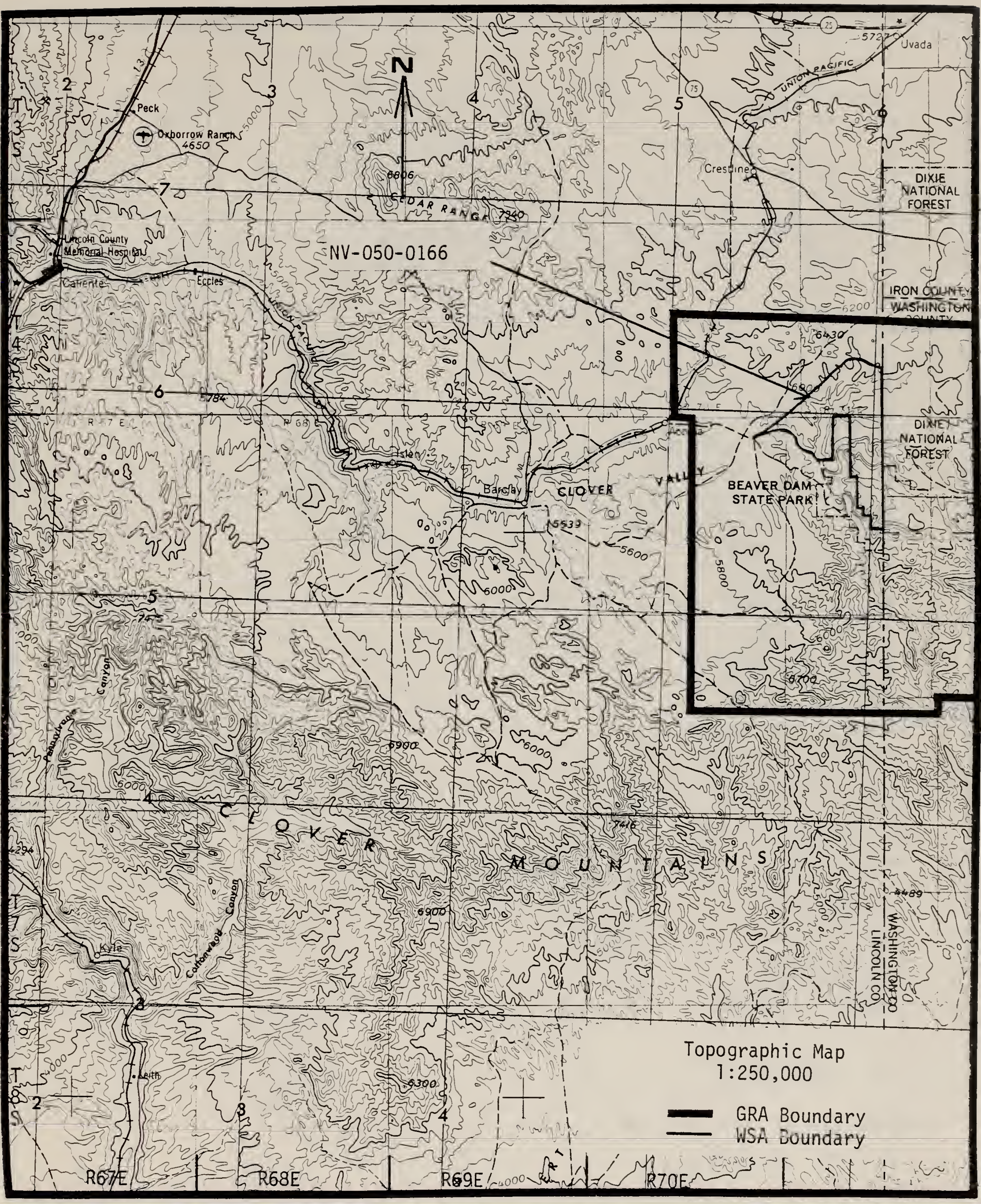


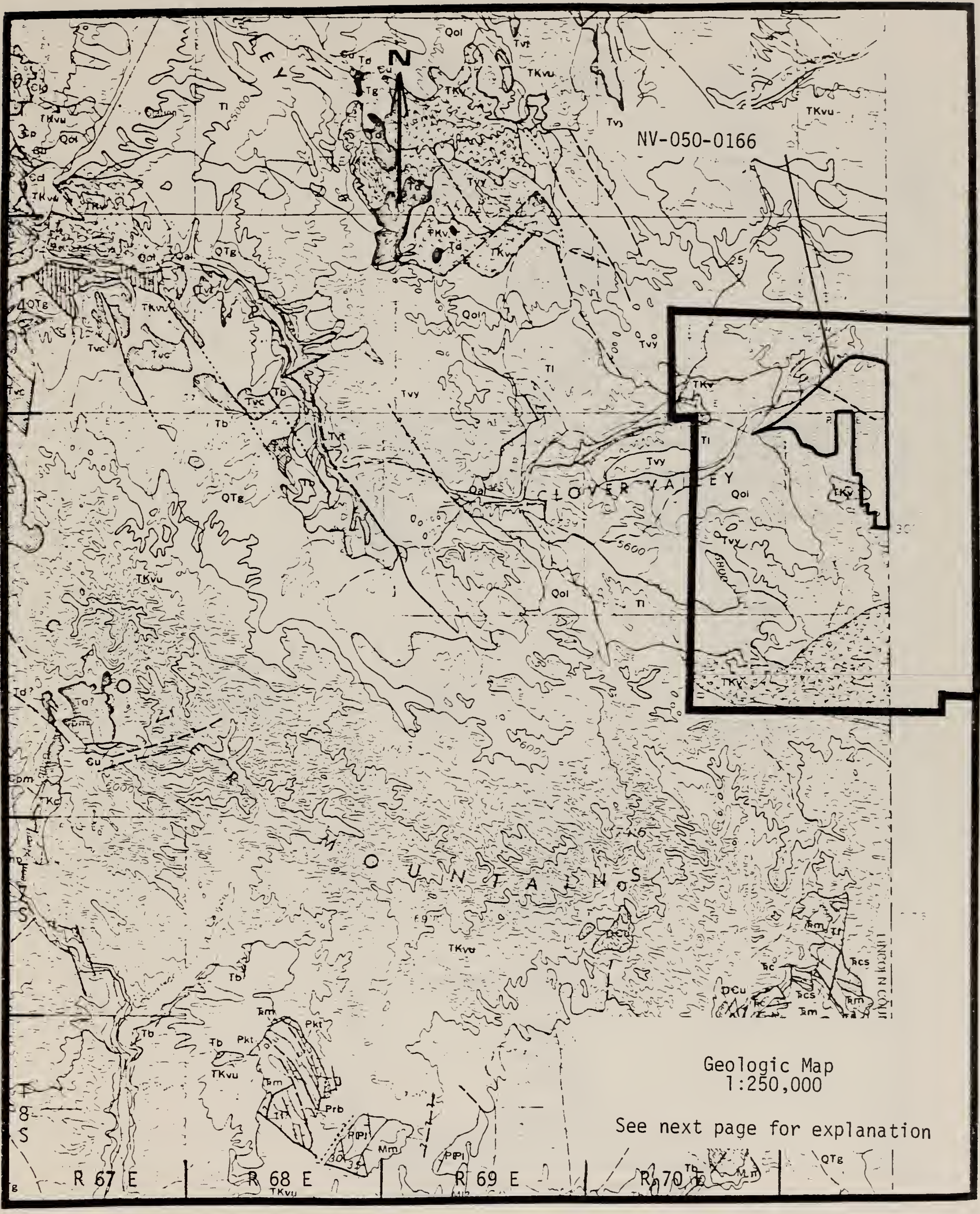
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Caliente Sheet

Tunnel Spring GRA NV-24

Figure 2



Geologic Map
1:250,000

See next page for explanation

Tschanz and Pampeyan, 1970

Figure 3

EXPLANATION

EXPLANATION

QUATERNARY

Recent

Qp Recent playa deposits

Qs Dune sand

Qal Younger alluvium

Pleistocene(?)

Ql Younger lake beds

Qol Older alluvium

TERTIARY(?) AND QUATERNARY(?)

Pliocene(?) and Pleistocene(?)

QTl Intermediate lake beds

QTg Older gravels

UNCONFORMITY

TERTIARY

Pliocene

Tl Older lake beds

Muddy Creek Formation, Panaca Formation, and lake beds in White River Valley

Tb Basalt

Includes some older basalt flows and basalt dikes of several ages

ANGULAR UNCONFORMITY

Eocene(?), Oligocene, Miocene, and Pliocene

Tvy **p** **Tva** **Tvb** **Tvc** **Tvd** **Tvr** **Tvt**

Younger volcanic rocks

Tvy, *younger volcanic rocks, undivided, including intravolcanic sedimentary rocks* (Ts) *and perlite* (p)

Tva, *andesite*

Tvb, *spheroidal-weathering ignimbrite*

Tvc, *rhyolitic unit*

Tvd, *biotite dacite*

Tvr, *rhyolite complex*

Tvt, *tuffs and tuffaceous sediments*

Tg ... **Tgp** ... **Tgd** ... **Tqm** ... **Td** **T**

Intrusive rocks

Tg, *granite stocks and dikes*

Tr, *rhyolite and microgranite dikes*

Tgp, *granite porphyry*

Tgd, *granodiorite*

Tqm, *quartz monzonite or quartz diorite*

Td, *diorite*

Tdi, *diabase*

Tvn, *andesitic volcanic neck*

Tf Lacustrine limestone

Tsp Sheep Pass Formation

Cretaceous(?) or Eocene or Oligocene

TKvu Volcanic rocks, undifferentiated

ANGULAR UNCONFORMITY

CRETACEOUS(?) OR TERTIARY

TKv Older volcanic rocks

TKc Older clastic rocks

UNCONFORMITY

TRIASSIC

Upper Triassic

Ŧc **Ŧcs**

Chinle Formation

Ŧcs, *Shinarump Member*

UNCONFORMITY (?)

Lower and Middle(?) Triassic

Ŧm Moenkopi Formation

EROSIONAL UNCONFORMITY

PERMIAN

Lower Permian

Pkt Kaibab Limestone and Toroweap Formation, undivided

Prb Red beds

PENNSYLVANIAN

Lower, Middle, and Upper Pennsylvanian

PPl **Pl** **Ps** **Pl**

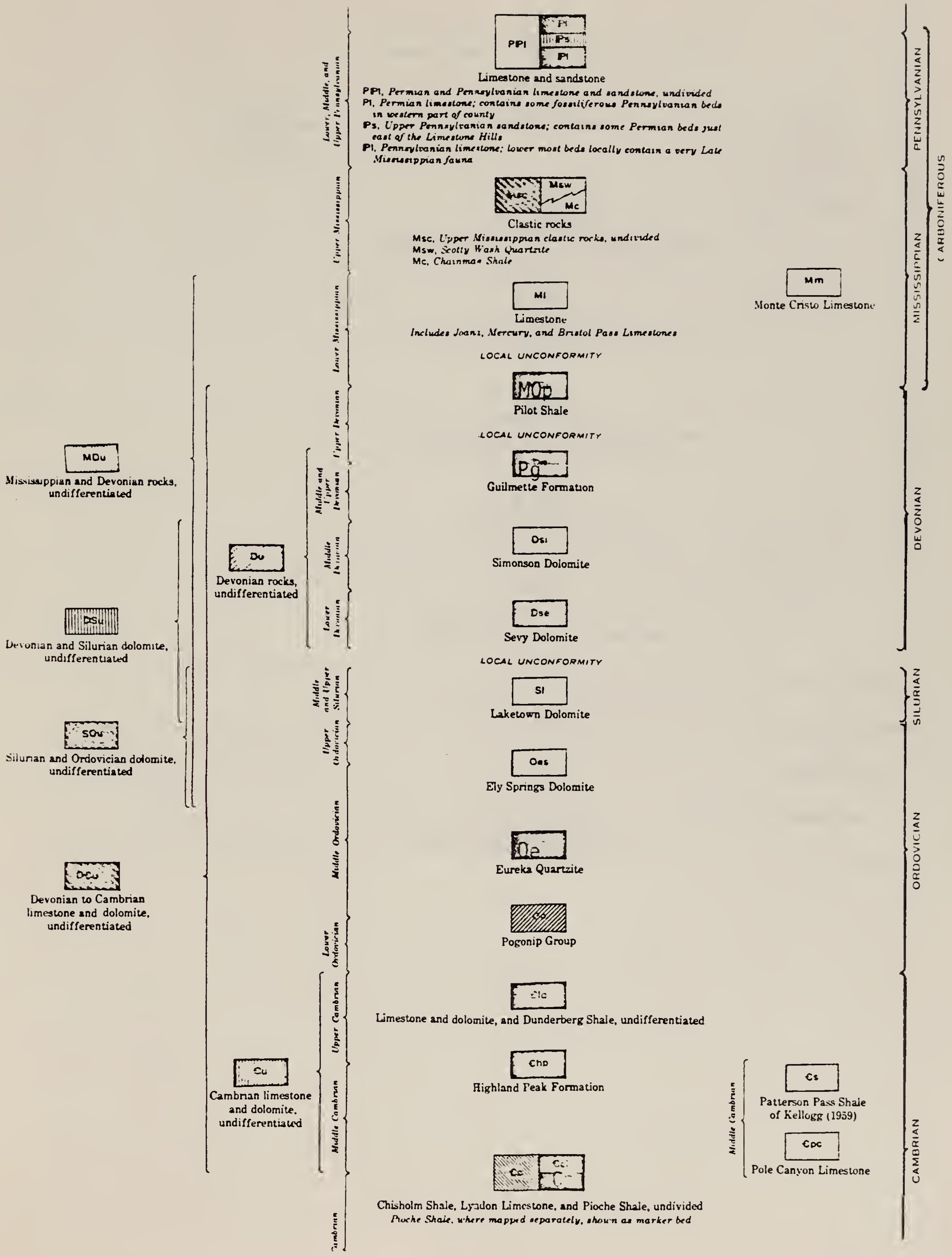
Limestone and sandstone

PPl, *Permian and Pennsylvanian limestone and sandstone, undivided*

Pl, *Permian limestone; contains some fossiliferous Pennsylvanian beds in western part of county*

Ps, *Upper Pennsylvanian sandstone; contains some Permian beds just east of the Limestone Hills*

Pl, *Pennsylvanian limestone; lower most beds locally contain a very Late Mississippian fauna*



Limestone and sandstone

PℙI, Permian and Pennsylvanian limestone and sandstone, undivided

Pl, Permian limestone; contains some fossiliferous Pennsylvanian beds in western part of county

ℙs, Upper Pennsylvanian sandstone; contains some Permian beds just east of the Limestone Hills

ℙl, Pennsylvanian limestone; lower most beds locally contain a very Late Mississippian fauna

Clastic rocks

Msc, *Upper Mississippian clastic rocks, undivided*
Msw, *Scotty Wash Quartzite*
Mc, *Chainman Shale*

Limestone

Includes Joana, Mercury, and Bristol Pass Limestones

LOCAL UNCONFORMITY

Pilot Shale

LOCAL UNCONFORMITY

Guilmette Formation

Simonson Dolomite

Sevy Dolomite

LOCAL UNCONFORMITY

Laketown Dolomite

Ely Springs Dolomite

Eureka Quartzite

Pogonip Group

Limestone and dolomite, and Dunderberg Shale, undifferentiated

Highland Peak Formation

Chisholm Shale, Lyndon Limestone, and Pioche Shale, undivided

Pioche Shale, where mapped separately, shown as marker bed

Monte Cristo Limestone

Patterson Pass Shale of Kellogg (1959)

Pole Canyon Limestone

Mississippian and Devonian rocks, undifferentiated

Devonian rocks, undifferentiated

Devonian and Silurian dolomite, undifferentiated

Silurian and Ordovician dolomite, undifferentiated

Devonian to Cambrian limestone and dolomite, undifferentiated

Cambrian limestone and dolomite, undifferentiated

EXPLANATION CONT.

Ꞓu

Cambrian limestone and dolomite, undifferentiated

Upper Cambrian

Middle Cambrian

Lower Cambrian

Ꞓld

Limestone and dolomite, and Dunderberg Shale, undifferentiated

Ꞓhp

Highland Peak Formation

Ꞓc **Ꞓcl** **Ꞓp**

Chisholm Shale, Lyndon Limestone, and Pioche Shale, undivided

Pioche Shale, where mapped separately, shown as marker bed

Ꞓpm

Prospect Mountain Quartzite

Includes Wood Canyon Formation and Stirling Quartzite in the Desert Range

pCj

pꞒj

Johnnie Formation

Mapped only in the Desert Range. Equivalent beds may be included in Prospect Mountain Quartzite in the Groom Range

UNCONFORMITY

pꞒm

Igneous and metamorphic rocks

Middle Cambrian

Ꞓs

Patterson Pass Shale of Kellogg (1959)

Ꞓpc

Pole Canyon Limestone

CAMBRIAN

PRECAMBRIAN

j

Jasperoid

Highest beach or strand line, or wave-cut terrace

Fault breccia

Anticline

Syncline

Overturned syncline

Showing trace of axial plane and direction of plunge of axis. Dashed where approximately located

Contact

Dashed where approximately located, dotted where generalized or inferred

U

D

Fault, showing dip

Dashed where approximately located, dotted where concealed; queried indicates probable or inferred fault. U, upthrown side; D, downthrown side. Arrows show relative horizontal movement

Thrust fault

Dashed where approximately located, dotted where concealed; queried where probable or inferred. Sawteeth on upper plate

Strike and dip of beds

Strike and dip of overturned beds

Strike of vertical beds

Horizontal beds

Strike of vertical joints

II. GEOLOGY

The Tunnel Spring GRA lies within the Basin and Range province in east-central Lincoln County, Nevada, bounding on Utah to the east and Beaver Dam State Park to the south and west.

The study area is located in low relief foothills of Tertiary volcanics which have been incised by the Beaver Dam Wash (see Figure 3). Pre-Tertiary structure has been masked by Tertiary volcanic sequences. A northwest-trending normal fault cuts the younger mid-Tertiary volcanics in the northern part of WSA 050-0166. The area has not been mapped in detail, and may be more complex structurally and lithologically than indicated in available research material.

Most of the following geological description is taken from Tschanz and Pampeyan, 1970.

1. PHYSIOGRAPHY

The Tunnel Spring GRA lies within the Basin and Range province in east-central Linclon County, Nevada. WSA 050-0166 is located north of Beaver Dam State Park, adjacent to the Utah State line, in foothills composed of undivided Tertiary volcanic rocks.

A northwest-trending fault cuts the volcanics in the northern part of the WSA. The topography of the study area is moderate, with elevations averaging about 6,000 feet. Beaver Dam Wash occupies a steep canyon incised into the volcanics.

Drainage of the area is predominantly into Beaver Dam Wash which flows south into the Virgin River, a tributary of the Colorado River.

2. ROCK UNITS

The oldest rock units in the area are undifferentiated Cretaceous(?)-Early Tertiary volcanics. This unit consists chiefly of flows, mud flows, breccias and tuffs, which are andesitic in appearance but may be latitic or dacitic in composition. These rocks crop out in Beaver Dam Wash and in the Bunker Peak area in the southern portion of the GRA.

Unconformably overlying these older volcanics are undivided Miocene-Pliocene sequences of ignimbrites that consist of welded vitric and crystal tuffs, pumice, tuff breccias, flows and perlitic rocks. These volcanics cover much of the study area masking older structures and rock units.

The youngest rocks exposed in the study area are Late Pliocene lacustrine deposits of the Muddy Creek Formation. These rocks are largely silt and clay shale and crop out in Clover Valley to the west.

3. STRUCTURAL GEOLOGY AND TECTONICS

Pre-Tertiary structures that may occur in the study area have been masked by overlying volcanic sequences. A northwest-trending normal fault, slightly over two miles in length, cuts the younger volcanic rocks in the northern part of WSA 050-0166. This area has not been mapped in detail, which may account for the simplistic geology recorded in available research material.

4. PALENTOLOGY

The only potential for paleontological resources within the Tunnel Spring GRA is from lacustrine sediments (?Miocene) interbedded with volcanics, and discrete lake beds of the Panaca formation or its equivalent. However, no fossil localities are recorded from within this GRA.

5. HISTORICAL GEOLOGY

Throughout the Paleozoic era marine sediments of the Cordilleran miogeosyncline were deposited throughout the region. These sediments were deformed by the Laramide orogeny during the Cretaceous period.

Volcanism followed during the early and mid-Tertiary with the extrusion of thick sequences of intermediate volcanics and ignimbrites. Basin and Range faulting occurred during the Late Miocene-Pliocene.

Lake deposits of the Muddy Creek Formation were deposited in Clover Valley in Late Pliocene time.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are no known metallic mineral deposits located within the Tunnel Spring GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Based on available information, there are no metallic minerals prospects, occurrences or mineralized areas located within the study area.

3. Mining Claims

There are no patented or unpatented claims located within the study area.

4. Mineral Deposit Types

Since there are no occurrences a discussion of known deposit types is not applicable.

5. Mineral Economics

Due to the apparent lack of metallic mineralization in the Tunnel Spring GRA lack of industry interest and lack of mineralization pathfinders, it is doubtful that this area would be of current interest to prospectors or mining companies exploring for metallic deposits.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

The only reported nonmetallic mineral deposits reported in the GRA are perlite deposits outside the WSA to the southwest and located in sections 22 and 23 of T 5 S, R 70 E and known as the Acoma and Boykin deposits, respectively (see Nonmetallics Land Classification and Mineral Occurrence Map). The Acoma deposit is described by Cochran (1951) as a deposit that lies on and partly under a dark reddish andesite, contains both "onion skin" and "sugar loaf" perlite, and is over 5,000 feet long, 2,600 feet wide and 30 feet thick. The Boykin deposit is believed to be an extension of the Acoma deposit.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no other reported nonmetallic mineral occurrences or prospects known to be in the GRA.

3. Mining Claims, Leases and Material Sites

There are no patented or unpatented mining claims for nonmetallics in the GRA or the WSA. There are no known material sites or sales in the WSA.

4. Mineral Deposit Types

The perlite deposits are volcanic in origin, but it is unknown whether it is part of a flow or air-fall deposit. These deposits were not field checked.

5. Mineral Economics

The perlite reserves in the GRA are large and may be exploitable. However, the economics of putting a perlite deposit into production involves not only the size and grade of the deposit, but more importantly, a market. A perlite deposit in a remote area such as in this GRA would have to compete with perlites that are much closer to the market. The perlite deposits are, however, within five miles of the Union Pacific Railroad at Acoma which would provide low cost transportation to distant markets.

Perlite is a glassy volcanic rock that has the unusual property of expanding to about 20 times its original volume when heated to the proper temperature. Almost all of it is used in the expanded form. The largest use of perlite, accounting for more than half of United States consumption, is in construction where it is used as lightweight and insulating aggregate in concrete, alone as an insulator, as an aggregate in fireproof plastic mixes for structural steel and in other applications. About 15 percent of usage is as a filter aid in many food and beverage applications. Less than 10 percent is used in agruculture as a soil conditioner, and a great variety of other applications consumes the remainder. The United States uses about 600,000 short tons annually and produces this much, plus a little more that is exported. Consumption is forecast to about double by the year 2000, with production keeping up with demand. The price of crude perlite is about $25 per short ton.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

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

2. Known Prospect, Mineral Occurrences and Mineralized Areas

There are no known uranium, thorium or radioactive occurrences within or near the GRA.

3. Mining Claims, Leases and Material Sites

There are no known uranium or thorium claims or leases in the GRA.

4. Mineral Deposit Types

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

5. Mineral Economics

Uranium and thorium appear to be of no economic value in the GRA due to the lack of known occurrences of these elements in the area.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufactrue 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 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.

Oil and Gas

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 known 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 Pennyslvanian 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 In.c, 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 Jour., 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 fluxuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; environmental 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 20 miles west (off map) 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 unique or unusual geological resources known to exist 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 this report.

The Stockpile Report to the Congress, October 1981-March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.There are no strategic and critical mineral resources known to exist in the GRA.

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

Tschanz and Pampeyan's (1970) geologic map of Lincoln County and Howard's (1978) map, both at a 1:250,000 scale provide the only coverage of the GRA. The Geologic Map of Nevada at a 1:500,000 scale by Stewart and Carlson (1978) differentiates some of the volcanic rocks to the west of the WSA, but otherwise is the same. There is very limited information on mineral deposits because perlite is the only commodity known. There is no information on possible alteration in the area. Overall the quantity of geological mapping is limited, as it is at a very small scale, for adequate use in the evaluation of mineral resources. The level of confidence in that data available however is high. The quantity of data concerning mineral resources is very limited but the level of confidence in that information however 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 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

WSA NV 050-0166

M1-2A. This classification area of low favorability with a very low confidence level includes the entire WSA which is entirely composed of Tertiary volcanic rocks. There are no metallic mineral resources known to occur in these rocks in this area and no alteration has been reported. The classification 2 indicates a low favorability however, because the nature of the underlying Paleozoic rocks are unknown, and because there is abundant metallic mineralization in many of the Paleozoic rocks throughout eastern Nevada, the possibility exists for a buried ore deposit. Also to the west in similar rocks in the Clover Mountains which are part of the Caliente caldera there is present interest in precious metals associated with the caldera complex. The confidence level of A is because there is no available evidence to suggest that there are metallic mineral resources either at depth in the Paleozoics or in the overlying volcanics at this location.

b. Uranium and Thorium

WSA NV 050-0166

U1-2B. This land classification covers virtually all of the WSA and most of the GRA except for two areas on the western edge of the GRA. The area is covered by late Cretaceous to Tertiary volcanic rocks including flows, breccias and tuffs. The area has low favorability at a low level of confidence for uranium as fracture-filled deposits providing that the volcanic rocks are a source for uranium.

The area has very low favorability, with very low confidence for thorium because there are no known suitable source rocks such as pegmatites present in the area.

WSA NV 050-0166

U2-2B. This land classification covers a small area in the northwest portions of the WSA and two areas in the western part of the GRA. The areas are covered by Quaternary alluvium and Tertiary lake deposits of the Muddy Creek Formation. The area has low favorability for sandstone-type uranium deposits with a low level of confidence. Uranium, contained in silicic volcanic rocks in surrounding highlands or within tuffaceous units in the lake sediments, may have been leached by ground water

and deposited in reduced areas in alluvium or lake sediments. The Muddy Creek Formation contains uranium mineralization at several locations in southern Nevada (Garside, 1973).

The area has very low favorability for thorium at a very low confidence level due to a lack of known source rocks.

c. Nonmetallic Minerals

WSA NV 050-0166

N1-2B. This classification area of low favorability with a low confidence level includes the entire area encompassing the WSA which is entirely made up of Tertiary volcanic rocks. The classification is 2B because perlite deposits are present in similar volcanic rocks within the GRA, approximately three miles southwest of the WSA boundary. There is a possibility that similar perlite exists within the WSA and this could be determined by reconnaissance and more detailed mapping. Also to reinforce the 2B classification, this rock could at least be used for limited construction purposes.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA NV 050-0166

OG1-3A. Younger and older Tertiary (and Cretaceous?) volcanic rocks cover the entire WSA and are the main rock types throughout the region. Twelve miles due south Cambrian to Permian and Triassic sedimentary rocks crop out at the surface.

The entire WSA is under lease, together with all of the adjacent townships. The WSA is within the prospective Paleozoic miogeosyncline, and the Overthrust Belt, which extends southward from Canada into this part of Nevada, and beyond into Mexico.

b. Geothermal

WSA NV 050-0166

G1-2A. The WSA is in a region of sparsely scattered low-temperature resources associated with regional, normal faults, one of which is in the WSA. The favorability is considered to be very low. Caliente Hot Springs deposit is only 20 miles to the west (off map).

c. Sodium and Potassium

WSA NV 050-0166

S1-1D. This classification applies to the entire WSA. There is no indication of favorability for the accumulation of resources of sodium and potassium.

3. SALEABLE RESOURCES

The saleable mineral resources in the form of sand and gravel are not discussed in this report as there is no alluvium mapped within the WSA. Most materials, however, can be utilized for sand and gravel applications if a nearby need justifies it and these volcanic rocks could be quarried and crushed to size. The saleable resources therefore would be included above under the nonmetallic classification N1-2B.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

Since the WSA has not been mapped in detail a detailed mapping program could be undertaken which would help in recognizing mineral resources potential. Of special interest would be any alteration which may be associated with buried mineralization. A more detailed minimum effort mapping program of the WSA would most likely identify any additional perlite resources if present.

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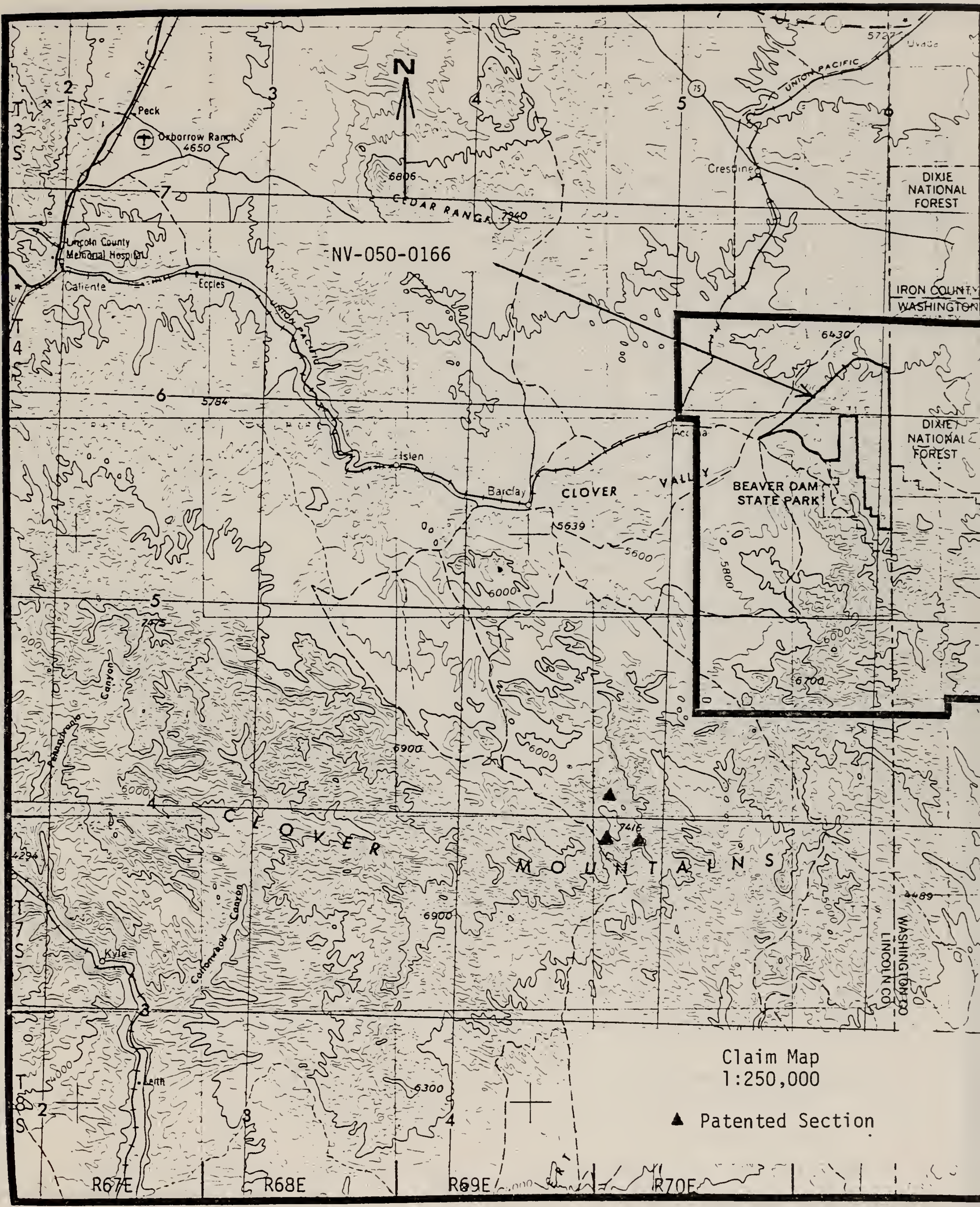
N
NV-050-0166
Claim Map
1:250,000
▲ Patented Section
Peck
Oxborrow Ranch
4650
Lincoln County
Memorial Hospital
Caliente
Eccles
Islen
Barclay
Acoma
Crestline
CEDAR RANGE
7940
6806
UNION PACIFIC
DIXIE
NATIONAL
FOREST
IRON COUNTY
WASHINGTON
BEAVER DAM
STATE PARK
CLOVER VALLEY
CLOVER MOUNTAINS
Pahroc Canyon
Canyon
Cottonwood Canyon
Kyle
Leith
5639
5600
6000
6430
5800
6700
6900
7416
6300
5784
7475
4294
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LINCOLN CO
WASHINGTON CO
T 3 S
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T 8 S
R67E
R68E
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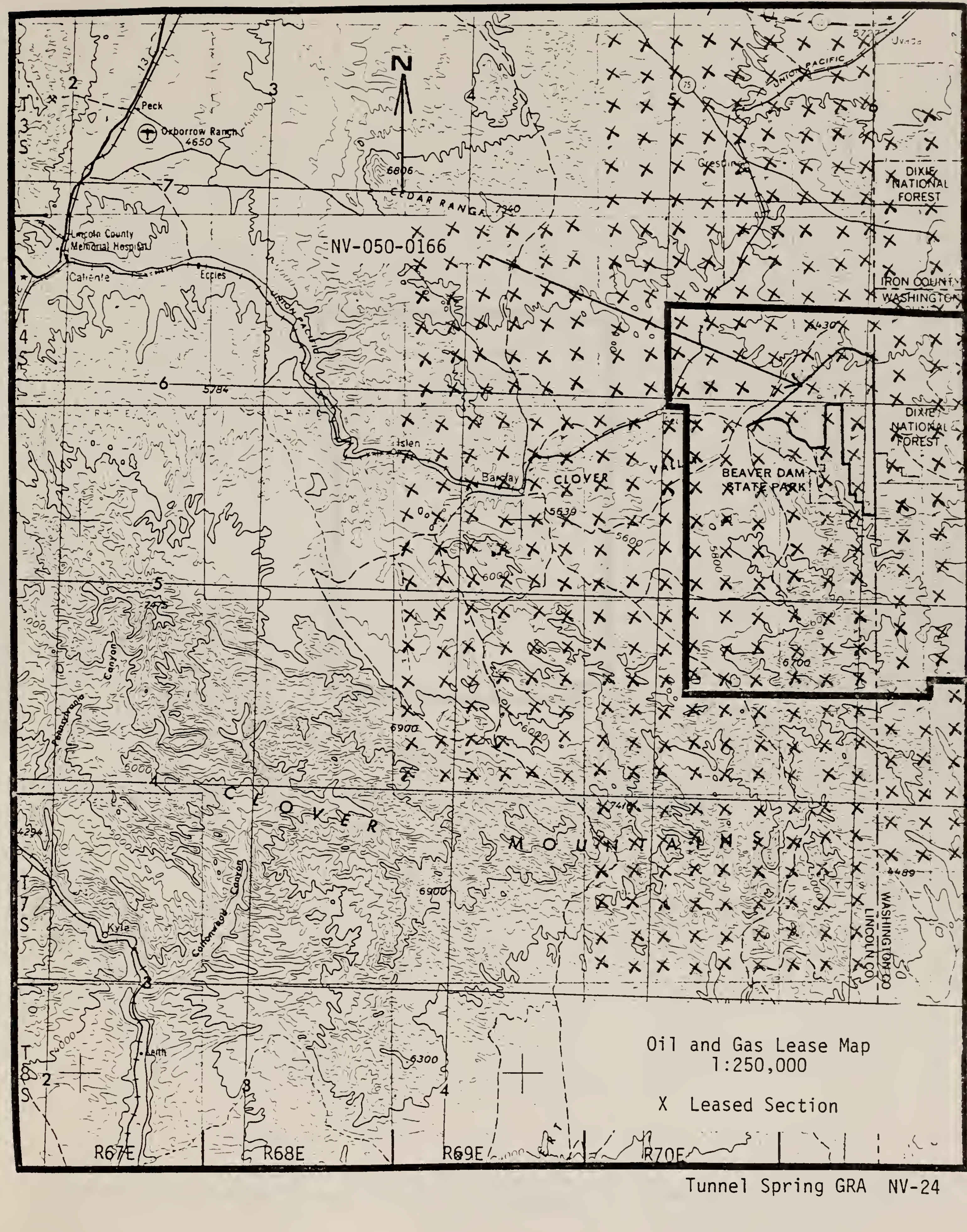
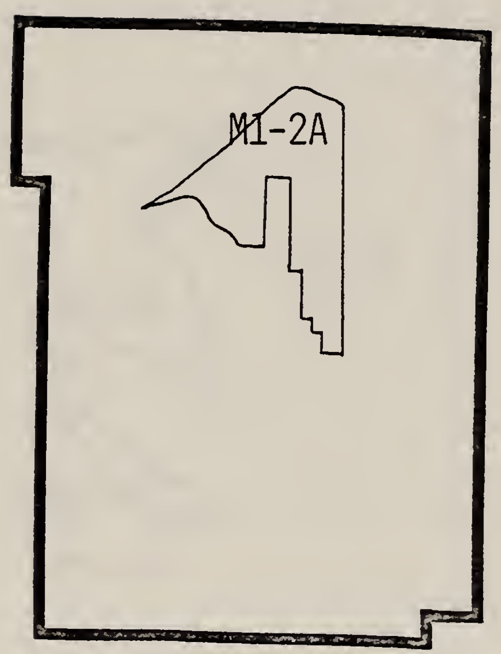
R70E



Oil and Gas Lease Map
1:250,000

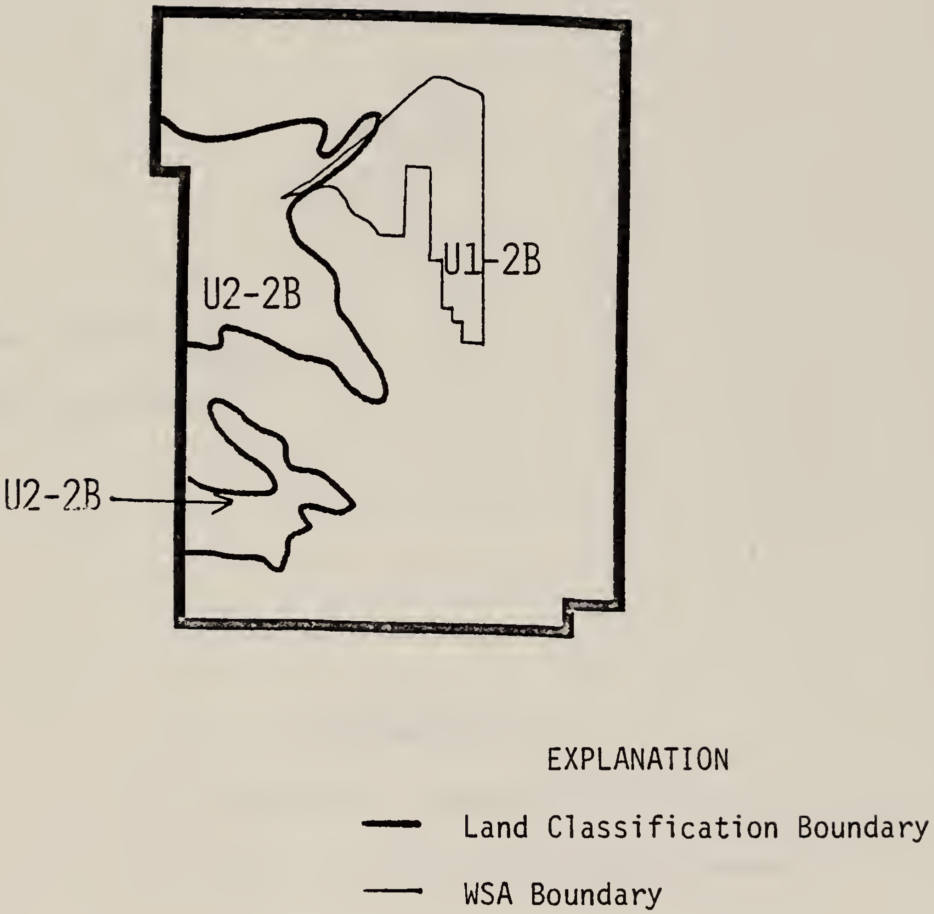
X Leased Section



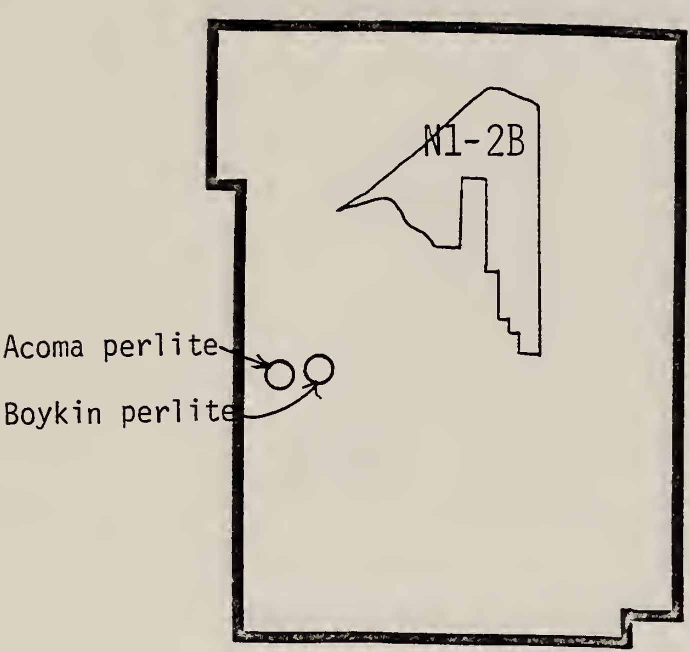
EXPLANATION

—— Land Classification and WSA Boundary

Land Classification and Mineral Occurrence Map/Metallics Tunnel Spring GRA NV-24
Scale 1:250,000



Land Classification and Mineral Occurrence Map/Uranium Tunnel Spring GRA NV-24
Scale 1:250,000



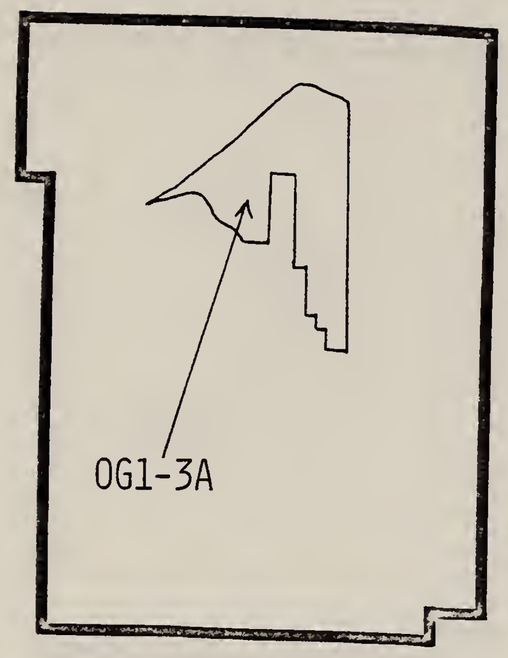
EXPLANATION

○ Occurrence, commodity

— Land Classification and WSA Boundary

Land Classification and Mineral Occurrence Map/Nonmetallics

Tunnel Spring GRA NV-24
Scale 1:250,000

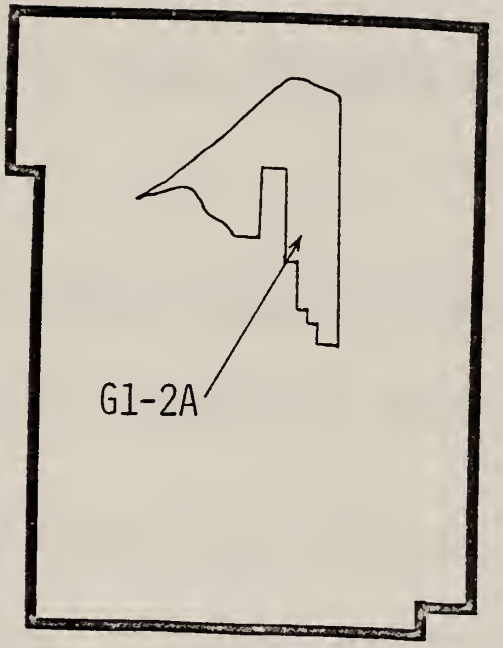


EXPLANATION

—— WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/
Oil and Gas

Tunnel Spring GRA NV-24
Scale 1:250,000



EXPLANATION

—— WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/
Geothermal

Tunnel Spring GRA NV-24
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)	
		Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian		Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]		Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]		Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]		Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]			Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600+ [3]

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

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

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

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

GEOLOGIC NAMES COMMITTEE, 1970