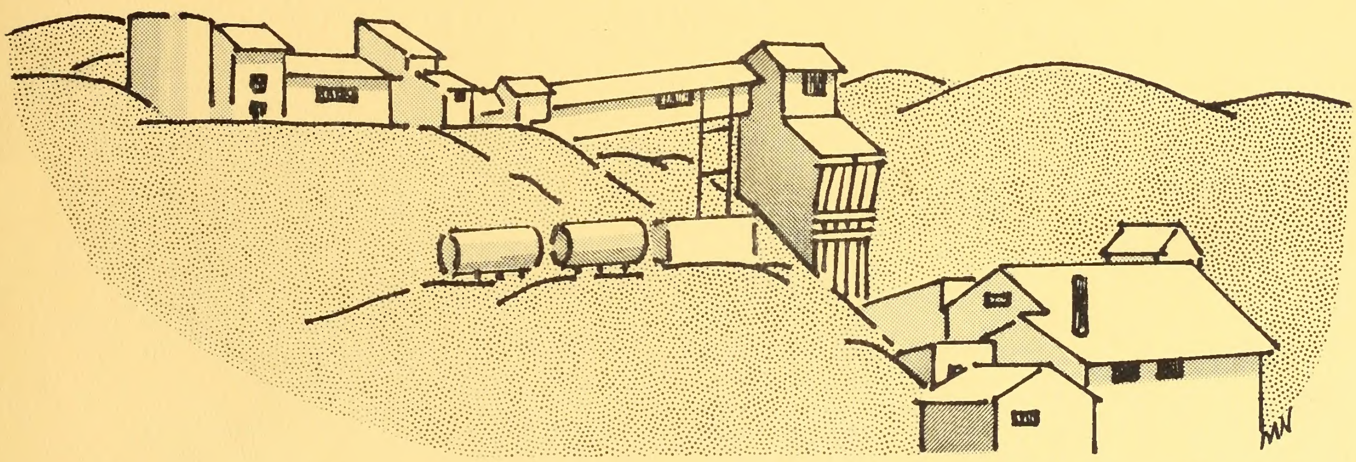
MINERAL IMPACT STUDY OF A 2000 SQUARE MILE AREA OF THE EAST MOJAVE DESERT SAN BERNARDINO COUNTY CALIFORNIA

By
J.R. Evans, Senior Technical Minerals Specialist

Prepared in cooperation with the California Division of Mines and Geology and the California State Mining and Geology Board



Old Sulfide Queen Mill at Mountain Pass

United States
Department of the Interior

Bureau of Land Management
Division of Mineral Resources
California State Office
Sacramento, California

May 1986

BUREAU OF LAND MANAGEMENT SPECIAL MINERAL REPORT

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ABSTRACT

The Mineral Impact Study area consists of about 2,000 square miles (1,280,000 acres) in the east central part of the Mojave Desert, entirely within San Bernardino County. On the northeast corner, the area is bounded by the Nevada-California State line.

In the study area there is a wide variety of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest known Precambrian rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Halloran Springs gives a date of about 400 years.

The distribution and nature of mineral deposits closely relates to the geology of the eastern Mojave Desert and the Minerals Impact Study Area. Therefore, a general understanding of the rock units, structural framework, and types and styles of igneous intrusions with resultant rock alteration that control the formation of mineral deposits is vital for the evaluation of metallic mineral potential.

Most of the nonmetallic minerals occur as, or in, metasedimentary rocks of various geologic ages. Overburden, alteration, weathering, degree of inclimation of rock units, and structural complexity of the geologic environment are critical controls that must be considered when evaluating the mineral potential of nonmetallic deposits.

Land in the Minerals Impact Study Area has been classified into Mineral Resource Zones (MRZ's) with respect to the presence, absence, or likely occurrence of mineral deposits by the California Division of Mines and Geology according to guidelines adopted by the California State Mining and Geology Board (1979, p. 23-27). The State classification is here used because it reflects current knowledge and data and was available through published and unpublished materials for the entire study area.

The eastern Mojave desert and the study area are a repository of a wide variety of mineral resources, formed under a wide range of geologic environments. These environments include deposits formed by magmatic concentration, contact metasomatism, hydrothermal activity, volcanism, sedimentation, and supergene processes. Weathering and metamorphism played a role in the enrichment of many of the deposits to convert them into substances of value, or potential value.

There is no known mineral potential for geothermal resources in the study area, and the oil and gas potential is not known. There is no recorded production of oil and gas, and only 3 wells have been drilled; west and south-southwest of Nipton in the Ivanpah Valley. However, interest in oil and gas in the Study area has been high as shown by the fact that 35 percent of it is covered by oil and gas leases. Interest probably is a result of recent geologic and seismic data that suggest that overthrust belts exist in the Mojave Desert and the study area is similar to those in the Idaho-Wyoming overthrust belt.

ABSTRACT

The Mineral Impact Study area consists of about 1,000 square miles (1,165,000 acres) in the east central part of the Mojave Desert, entirely within San Bernardino County. On the northeast corner, the area is bounded by the Nevada-California State line.

In the study area there is a wide variety of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest known Precambrian rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Kelburn Springs gives a date of about 100 years.

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Land in the Minerals Impact Study [illegible] Resource Zones (MRZ's) with respect to [illegible] ence of mineral deposits by the Californ[illegible] according to guidelines adopted by the [illegible] Board (1978, p. 12-27). The State [illegible] reflects current knowledge and data and [illegible] commodities separately for the entire study area.

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There is no known commercial potential for geothermal [illegible] study area, and the oil and gas potential is not known. There is no recorded production of oil and gas, and only 2 wells have been drilled, along the route southwest of Mitchell in the Ivanpah Valley. However, interest in oil and gas in the study area has been high as shown by the fact that 35 percent of it is covered by oil and gas leases. Interest probably is a result of recent geologic and seismic data that suggest that overthrust belts exist in the Mojave Desert and the study area is similar in nature to the Idaho-Wyoming overthrust belt.

A total of 285 mines and prospects were identified in the area during the course of this study of which 240 are principally valued for their metal content and 45 for their non-metallic content, and used mostly for industrial uses (see Table 2).

The metallic mineral resources include; cerium group rare-earths, gold, silver, copper, lead, zinc, tungsten, molybdenum, iron, antimony, tin and accessory vanadium. The non-metallic mineral resources include; limestone, dolomite, fluorite, barite, gypsum, rare-earth elements, volcanic cinders, sericite, talc, clay, perlite, magnesite, silica, bentonite, and mica.

In 1985 California produced 2.2 billion dollars worth of non-fuel minerals and about 1.2 billion of this came from the California Desert (Bureau of Mines Mineral Industry Surveys-Mineral Industry of California, 1985, and Division of Mines and Geology). Part of this was produced from mines in the study area. In the coming decades, the California Desert and study area should be an even more important source of the mineral commodities that will aid the economy of California and the nation.

It is evident that changes in the current Desert Plan would have major and varied impacts upon future mineral development, existing mining and exploration operations, existing mineral rights holders, private land holders, the State of California, and the BLM. Based upon what has been presented, it is clear that the study area can be characterized as being highly mineralized and generally one of high and moderate mineral potential and that this information will be very helpful for future decision making.

This study was to provide some idea of the overall value and long term supply source of mineral commodities for California and the nation. There are more areas that deserve description that probably conceal a great number of deposits, if analogy can be made with the distribution of those known from the surrounding mountain ranges. However, it is beyond the scope of this report to enter into a lengthy, detailed discussion of each mineral resource area in the study area. The interested reader can find more detailed information in the files and publications of the California Division of Mines and Geology (see Evans, 1971, 1974, and 1975; Greenwood, 1983, 1984, and 1985; Hewett, 1956; Joseph, 1984 and 1985; Kohler, 1984; Wright, 1953).

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the assistance of the California State Board of Mines and Geology who allowed use of unpublished geologic, and mineral data from 4 of the 9 quadrangles involved in this report. The California Division of Mines and Geology provided the above mentioned geologic and mineral data to the BLM in a speedy manner under the tight time constraints of this study. Cooperation of the Division was a vital part in preparing this report and accompanying maps. Special mention is here given to Tom Anderson, Senior Geologist and Ralph Lloyd, Geologist with the Division who were most helpful in the preparation of the report text and accompanying geologic and mineral land classification maps. Much useful information was obtained from the U.S. Geological Survey/Bureau of Mines reports and their background documents.

A total of 295 mines and prospects were identified in the area during the course of this study of which 250 are principally valued for their metal content and 45 for their non-metallic content, and used mostly for industrial uses (see Table 2).

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In the BLM, several staff members provided much needed assistance and support in a short time frame: Ken Aldridge, who compiled data and drafted most of the Plates; Peggy Cranston, who assisted Ken in the early stages of the compilation; Virgil Haven, Rod Bradley and Dale Vinton, who drafted parts of the geologic map and prepared titles and symbols; May Wakabayashi, who prepared the report cover design; and Debbie Becker, who word processed this report.

INTRODUCTION

Purpose of Study

This study was undertaken to gain an understanding of potential impacts upon present and future mineral development. This information will be used to analyze current minerals data and to enhance decision making with respect to the ongoing Desert Plan for the California Desert Conservation Area established by Congress in 1976. The study looks at present claims and leases with particular emphasis on ongoing mining and future potential for mineral development. A selected sample area was chosen which had current minerals data.

This information will be used in decision making by the Bureau of Land Management and Congress on suitable and unsuitable Wilderness Study Areas. The information should also be useful in connection with deliberations on the proposed "California Desert Protection Bill of 1986" (S-2061).

It was not possible with existing time constraints to study the entire Mojave Desert in the manner in which this Mineral Impact Study Area was done. This sample area was selected because current geologic and mineral land classification information was available from the California Division of Mines and Geology. The area is known to be mineralized, and it appears to be typical of the east Mojave Desert area and much of the California Desert Conservation Area.

Background

The Federal Land Policy & Management Act of 1976 directed BLM to prepare a comprehensive multiple-use plan for the California Desert Conservation Area. This plan included an inventory and analysis of minerals and was completed in 1980 with extensive public involvement.

The plan included a process for identification and recommendations of suitable and unsuitable Wilderness Study Areas. This process includes an analysis by U. S. Geological Survey and the Bureau of Mines on areas recommended as suitable for wilderness by the Bureau of Land Management. (Approximately 25 reports have been completed to date.) These reports are being reviewed by the public to provide the Bureau of Land Management important minerals information. A significant amount of new data is also available from the State Division of Mines and Geology. All of this additional information will be used by the public, the Bureau of Land Management, the Department of Interior, and Congress to ultimately make final decisions on Wilderness Study Areas.

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The Federal Land Policy & Management Act of 1976 [illegible] comprehensive multiple-use plan for the California [illegible] This plan included an inventory and analysis of wilderness [illegible] 1980 with extensive public involvement.

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The Desert Plan is an ongoing process which includes an annual review. In addition, there is also an ongoing process to ultimately determine which areas of the desert will be designated as wilderness. It is imperative that these decisions be made with full understanding of ongoing and potential minerals activity. This study serves as a prototype for the type of analysis which could be done to provide the important mineral information to decision makers.

There is also proposed legislation, S-2061, which would significantly alter decisions made in the current Desert Plan. This study and its general application to other desert areas will also provide useful minerals data to the public and decision makers as they address this proposal.

Location and Accessibility

The study area is in the east central part of the Mojave Desert, entirely within San Bernardino County (see Figures 1, and 2). On the northeast the area is bounded by the Nevada-California state line.

Interstate Highway 15 is through the central part of the area. Nevada State Highway 164 connects with Interstate 15 just south of Ivanpah Lake. The remainder of the area is partly accessible by light duty roads with hard or improved surfaces. Much of the area, however, is accessible only on narrow unimproved dirt roads, by 4-wheel drive vehicle, or by foot (see Plate 1).

Physiography and Climate

The Mineral Impact Study Area is generally one of high and remote desert mountains with broad alluviated intermountain valleys. No cities or towns exist only small villages. To the far northeast of the area the Mesquite and Ivanpah Valleys contain lake beds, remnants of Pleistocene lakes. These lakes are Mesquite Lake and Ivanpah Lake. Clark Mountain, north of Mtn. Pass, is nearly 8,000 feet in elevation. The highest peak in the southeast part is in the New York Mountains and about 7,600 feet. In the northwest corner of the area, Kingston Peak is about 7,300 feet. Sand covered lowlands in the Devil's Playground area in the southwest part of the study area are about 1,100 feet in elevation. In the central part of the area is the broad feature called Cima Dome. It is a weathering massif upon underlying granitic rocks that terminates the south end of the Shadow Valley. A study of Plate 1 will show the interested reader the main physiographic features in some detail.

As part of the arid Mojave Desert, the study area is in a region where rainfall is very low, summers are hot, winters cold, and winds locally very strong, as much as 100 miles per hour or more. The daily range of temperatures can be high, with fluctuations during Spring months ranging from 32°F in the morning to nearly 100°F in the afternoon. In the summer, daily temperatures in low areas usually rise to 100°F, and rarely as much as 130°F or more. Below freezing temperatures are common in the high mountain regions during winter.

The Desert Plan is an ongoing process which includes an annual review. In addition, there is also an ongoing process to ultimately determine which areas of the desert will be designated as wilderness. It is imperative that these decisions be made with full understanding of ongoing and potential minerals activity. This study serves as a prototype of the type of analysis which could be done to provide the important mineral information to decision makers.

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Interstate Highway 15 is through the northern [illegible] through the [illegible] with interchanges at [illegible] remainder of the area is poorly accessible [illegible] numerous dirt roads. Much of the area, however, [illegible] unimproved dirt roads by 4-wheel drive vehicles [illegible]

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The Mineral Deposit Study Area is generally [illegible] mountains with broad alluvial intermountain [illegible] exist only small villages. To the northwest [illegible] Ivanpah Valley [illegible] are Ivanpah Lake and Ivanpah [illegible] nearly 8,000 feet in elevation. The highest point [illegible] the New York Mountains are about 7,500 feet. In the [illegible] area, Kingston Peak is about 7,300 feet [illegible] playground area in the southwest part of the [illegible] in elevation. In the central part of the [illegible] Cima Dome. It is a [illegible] generally dome [illegible] symmetrical and [illegible] of the [illegible] The Interstate [illegible] and [illegible]

As part of the Mojave Desert, the study area [illegible] is very low, summers are hot, winters cold, and winds [illegible] as much as 100 miles per hour or more. The daily range of [illegible] can be high, with fluctuations during summer months ranging from 40°F to 50°F according to weather [illegible]. In the summer, daily temperatures in the areas usually climb to 100°F, and rarely as much as 120°F or more. Below freezing temperatures are common in the high mountain regions during winter.

INDEX MAP 1

SHOWING LOCATION OF THE MINERAL IMPACT STUDY AREA, SAN BERNARDINO COUNTY, CALIFORNIA

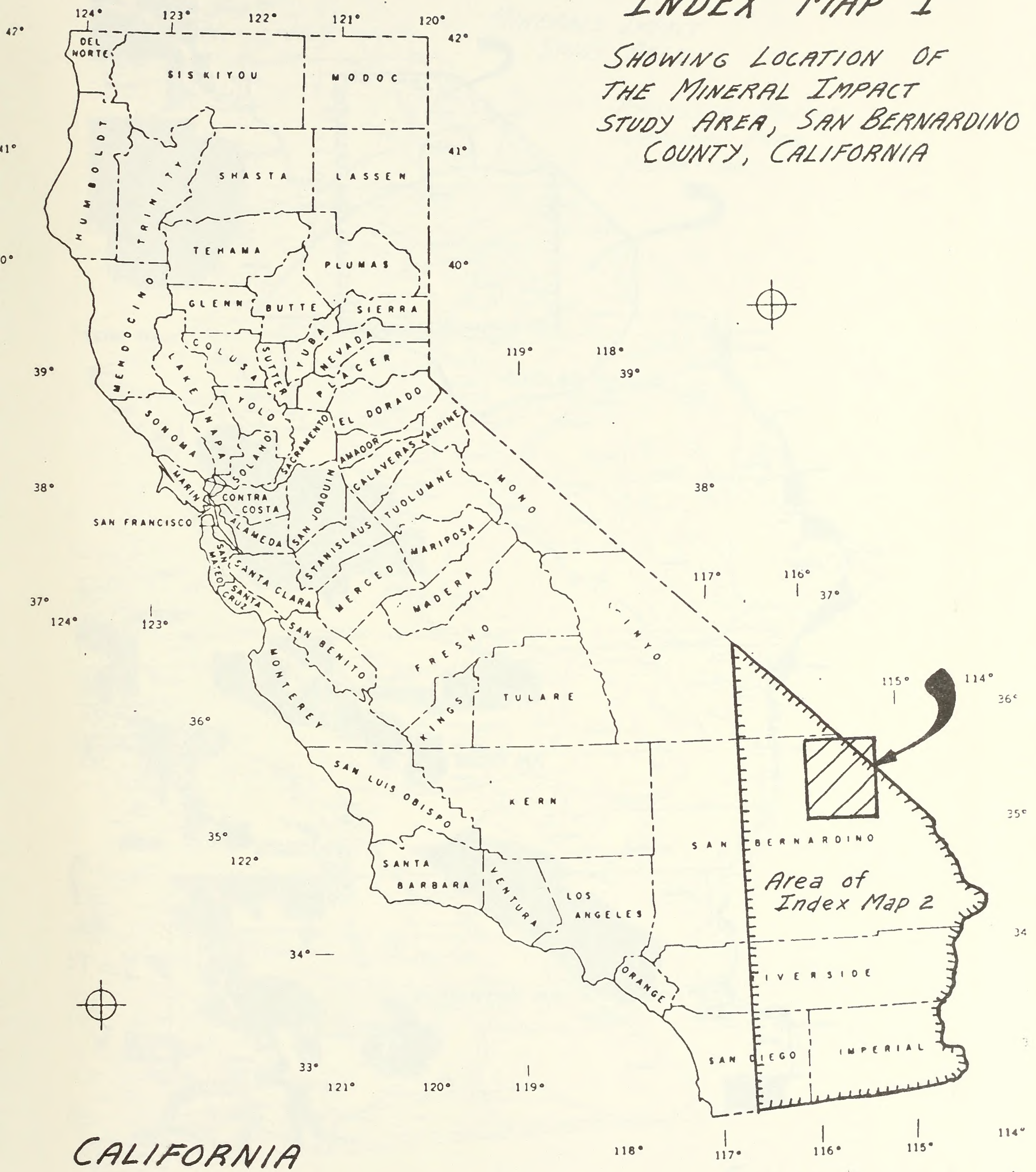

FIGURE 1

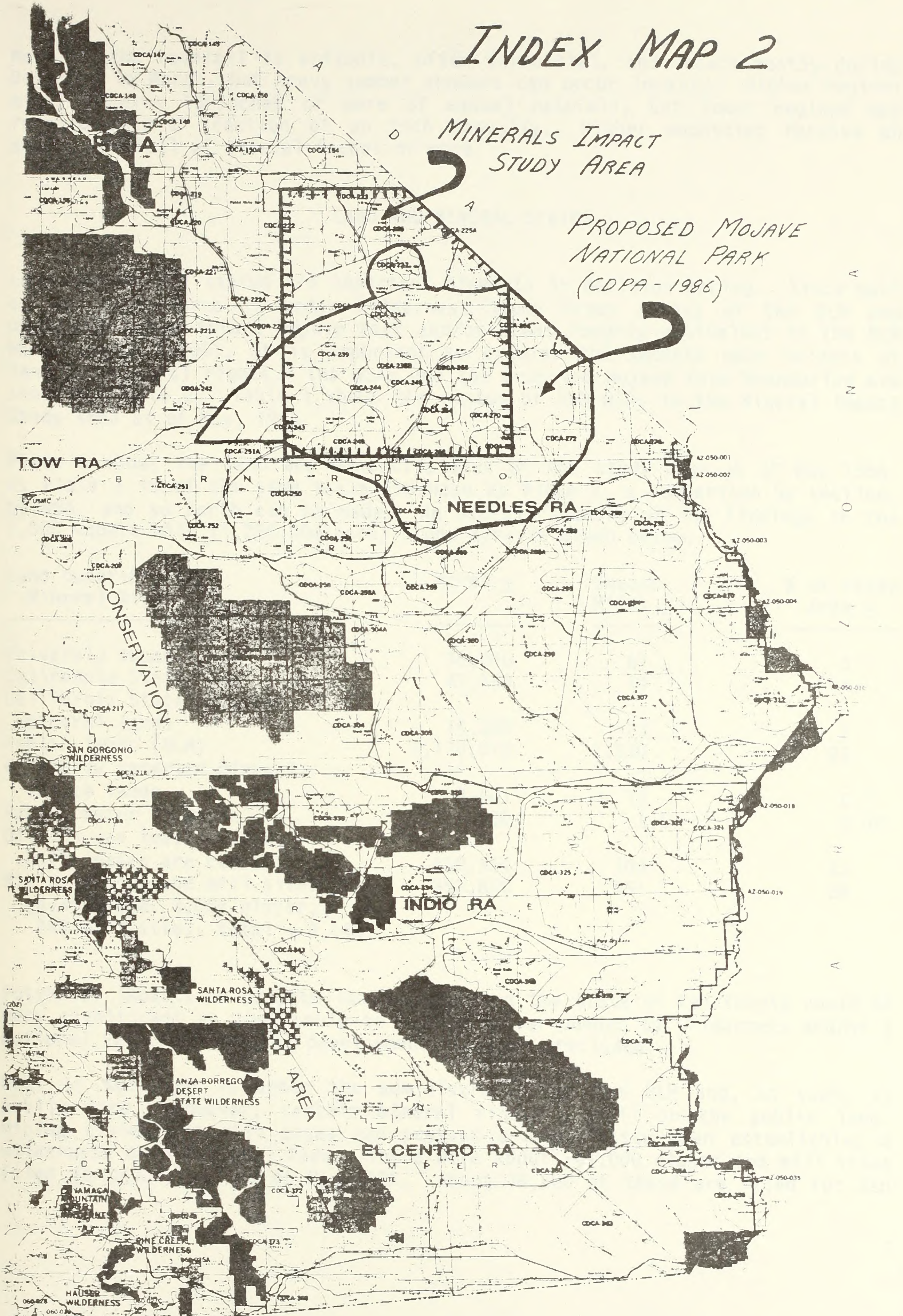
INDEX MAP 2
MINERALS IMPACT STUDY AREA
PROPOSED MOJAVE NATIONAL PARK (CDPA - 1986)
TOW RA
NEEDLES RA
INDIO RA
EL CENTRO RA
CONSERVATION
AREA
SAN GORGONIO WILDERNESS
SANTA ROSA WILDERNESS
ANZA-BORREGO DESERT STATE WILDERNESS
PINE CREEK WILDERNESS
HAUSER WILDERNESS
M E X I C O

FIGURE 2

Must of the rainfall is episodic, often torrential, and occurs mostly during December to March, but heavy summer showers can occur locally. Higher regions might receive 15-inches or more of annual rainfall, but lower regions may receive only a fraction of an inch annually. Higher mountains receive an annual snowfall of several inches or more.

LAND AND MINERAL STATUS

Land and mineral status are important elements in decision making. Since much of the study area is under Wilderness Study Areas (WSAs) of the BLM and proposals for a future Mojave Park and/or areas roughly equivalent to the BLM WSAs, under S-2061, it is important to examine the impacts upon holders of land and mineral rights. The WSAs and the proposed Mojave Park boundaries are shown on Plate 2. Table 1 shows the status of BLM WSAs in the Mineral Impact Study Area as of May, 1986.

Plate 3 shows the land and mineral status of the study area as of May 1986. As Plate 3 is of the same scale and base as Plate 2, a comparison by section, by WSA, and so forth can be made. An overall summary of the findings in the 2,000 square mile (1,280,000 acre) study area is given below.

Land Ownership and Mineral Rights	Acres ±	Square Miles ±	% of Study Area ±
Privately owned lands	39,040	61	3
California State lands	47,153	74	4
California State Reserved mineral lands	14,388	23	1
Public lands (BLM)	1,170,918	1,830	92
Federally reserved mineral estate lands	8,501	13	0.7
Public water reserves	1,000	1.6	0.08
Oil and gas leases - BLM (492 leases are current)	450,554	704	35
Mining claims and mill sites (5,348 lode, 3,056 placer, 242 mill sites; total = 8,646)	352,650	551	28

Potential impacts on private landholders, and the State of California could be very significant as they could be generally surrounded by wilderness and/or a National Park, and mineral development would be precluded.

Most of the land is under the administration of the BLM and, as such, is public land. However, certain mineral rights prevail on the public land. Mining claims and mill sites can present a major issue when establishing a wilderness or a National Park. There were about 149,000 claims and mill sites filed in California as of May 1986. About 38,600 of these are filed for San

Most of the rainfall is cyclonic, often torrential, and occurs mostly during December to March, but heavy summer showers can occur locally. Higher regions might receive 15 inches or more of annual rainfall, but lower regions may receive only a fraction of an inch annually. Higher mountains receive an annual snowfall of several inches or more.

LAND AND MINERAL STATUS

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Plate 3 shows the land and mineral status of [illegible] As Plate 1 is at the same scale and [illegible] by WSA, and as WSAs can be seen. [illegible] 2,000 square mile (1,300,000 acres) study area [illegible]

Land Ownership and Mineral Rights	Acres [illegible]
Privately owned land	[illegible]
California State land	[illegible]
California State reserved mineral lands	[illegible]
Public lands (BLM)	[illegible]
Federally reserved mineral estate lands	[illegible]
Public water reserves	[illegible]
Oil and gas leases - BLM (1980 leases are current)	[illegible]
Mining claims and mill sites (1,368 lode, 2,086 placer, 271 mill sites; total = 8,445)	[illegible]

Potential impact to private landowners [illegible] were classified as WSAs could be generally [illegible] National Park, and potential development would be [illegible]

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TABLE 1 BUREAU OF LAND MANAGEMENT (BLM)

WILDERNESS STUDY AREAS (WSA's) PARTLY OR WHOLLY

IN THE MINERAL INPACT STUDY AREA

NAME	NUMBER	ACRES	NONSUITABLE	SUITABLE
Kingston Range	CDCA-222	256,210	229,677	26,533
No. Mesquite Mtns.	CDCA-223	23,125	23,125	0
Mesquite Mtns.	CDCA-225	44,317	44,317	0
Stateline	CDCA-225A	8,105	8,105	0
Clark Mtn.	CDCA-227	14,107	14,107	0
Hollow Hill	CDCA-228	26,422	26,422	0
Shadow Valley	CDCA-235A	10,452	10,452	0
Magee/Atkins	CDCA-237	11,092	11,092	0
Deer Springs	CDCA-237A	2,560	2,560	0
Valley View	CDCA-237B	3,200	3,200	0
Teutonia Peak	CDCA-238A	2,976	2,976	0
Cima Dome	CDCA-238B	15,333	15,333	0
Cinder Cones	CDCA-239	49,613	9,510	40,103
Old Dad Mtns.	CDCA-243	49,301	49,301	0
Rainbow Week	CDCA-244	16,019	16,019	0
Eight-Mile Tank	CDCA-245	18,714	18,714	0
Kelso Mtns.	CDCA-249	64,273	64,273	0
Kelso Dunes	CDCA-250	150,030	107,180	42,850
No. Providence Mtns.	CDCA-263	54,340	0	54,340
Mid Hills	CDCA-264	13,300	13,300	0
New York Mtns.	CDCA-265	35,583	35,583	0
Castle Peaks	CDCA-266	45,440	3,310	42,130
Table Mtns.	CDCA-270	7,556	7,556	0
Woods Mtns.	CDCA-271	37,758	37,758	0

Bernardino county, or 26 percent of the California State total. Of the 38,600 claims and mill sites, about 10,100 are in the BLM East Mojave National Scenic Area (almost the same area as the proposed Mojave Park), or 26 percent of the San Bernardino County total, and 7 percent of the State total. Of this 10,100, 8,646 are in the Mineral Impact Study Area, about 86 percent of the Scenic Area, 22 percent of the San Bernardino County total, and 6 percent of the California total. It is clear that the study area is one of high mineral interest.

If the "California Desert Protection Act of 1986" (S-2061) is passed into law, about 6,400 of the 8,646 claims and mill sites in the study area would have to be examined by the BLM for validity (and 10,100± for Mojave Park). This is so because about 60 percent of the proposed Mojave Park is within the Mineral Impact Study Area and 6,400 claims and mill sites are within the proposed park (see Figure 2). The Act requires that every unpatented mining claim located within the boundaries of the proposed parks, of which Mojave Park is one, would have to have a validity test completed within two years after passage of the Act. In addition, the estimated cost of purchasing any existing patented mining claims must also be provided Congress within the two-year period.

There is no statement in the Act about fluid and solid mineral leases, but the clear intent is to close out and preclude all forms of mineral development.

Although, there are currently no geothermal leases in the study area, there are 492 oil and gas leases covering about 450,554 acres. These leases, at an annual rent of $1.00 per acre, bring in $450,554 in annual income. Also they cover about 35 percent of the study area.

After a study of the land and mineral status data, it is evident that major and varied impacts would be realized upon future mineral development, existing mining and exploration operations, existing mineral rights holders, private land holders, the State of California, and the BLM.

GEOLOGIC FRAMEWORK

Introduction

The distribution and nature of mineral deposits closely relates to the geology of the eastern Mojave Desert and the Minerals Impact Study Area. Therefore, a general understanding of the rock units, structural framework, and types and styles of igneous intrusions, with resultant rock alteration, that control the formation of mineral deposits, is vital for the evaluation of the metallic mineral potential.

Most of the nonmetallic minerals occur as, or in, metasedimentary rocks of various geologic ages. Overburden, alteration, weathering, degree of inclimation of rock units, and structural complexity of the geologic environment are critical controls that must be considered when evaluating the mineral potential of nonmetallic deposits.

In the study area there is a diversity of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest known Precambrian rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Halloran Springs gives a date of about 400 years.

Bernardino County, or 16 percent of the California State total. Of the 16,300 claims and mill sites, about 10,300 are in the BLM East Mojave National Scenic Area (almost the same area as the proposed Mojave Park), or 26 percent of the San Bernardino County total, and 3 percent of the State total. Of this 10,300, 9,646 are in the Mineral Impact Study Area, about 94 percent of the Scenic Area, 23 percent of the San Bernardino County total, and 4 percent of the California total. It is clear that the study area is one of high mineral interest.

If the "California Desert Protection Act of 1991" (S-2081) is passed into law about 9,400 of the 9,646 claims and mill sites in the study area would have to be examined by the BLM for validity (and 10,100 in the Mojave Park). This is because about 90 percent of the proposed Mojave Park is within the Mineral Impact Study Area and 9,400 claims and mill sites are within the park (see Figure 2). The Act requires that every [illegible] within the boundaries of the proposed park [illegible] would have to have a validity test completed [illegible] the Act. In addition, the estimated cost of [illegible] mining claims must also be provided Congress [illegible]

There is no statement in the Act about [illegible] clear intent is to take and provide [illegible]

Although, there are currently no [illegible] are 192 oil and gas leases covering about [illegible] annual cost of $1.00 per acre, bring in about [illegible] cover about 11 percent of the study area.

After a study of the land and mineral [illegible] and valid leases would be required [illegible] mining and exploration operations, [illegible] land holders, the State of California, [illegible]

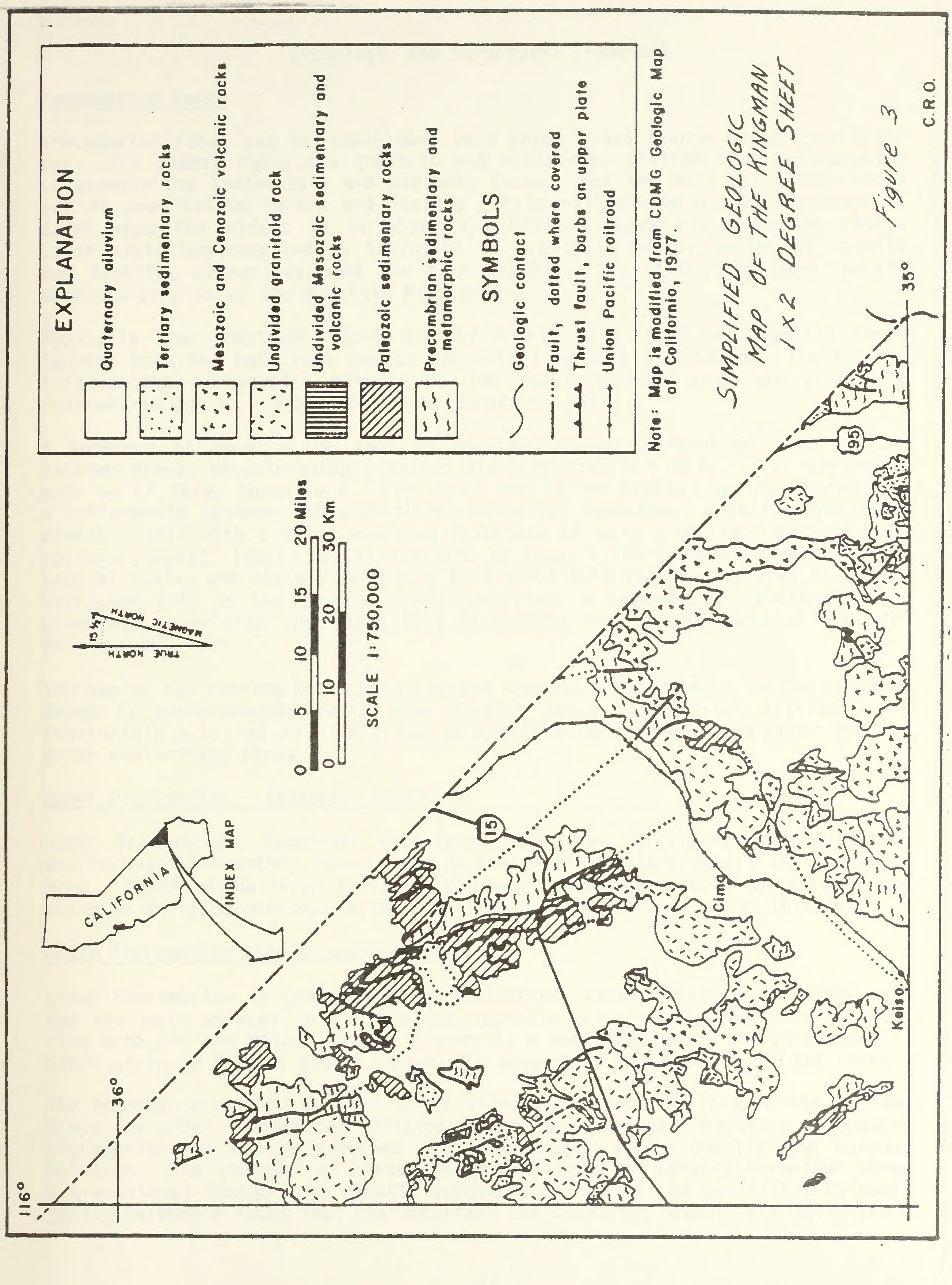
GEOLOGIC FRAMEWORK

Introduction

The distribution and nature of mineral deposits [illegible] of the eastern Mojave Desert and the mineral [illegible] general understanding of the rock units [illegible] styles of igneous intrusion, with particular [illegible] formation of mineral deposits. In effect for the [illegible] mineral potential.

Most of the metallic mineral occurrences [illegible] various geologic ages. Therefore, alteration, weathering, degree of [illegible] tion of rock units, and structural complexity of the geology [illegible] critical controls that must be considered when evaluating the mineral potential of metallic deposits.

In the study area there is a diversity of sedimentary, metamorphic and igneous rocks of diverse ages. Radiometric dates show that the oldest Precambrian known rocks are about 1.7 billion years old while the dating of charcoal associated with a young volcanic flow south of Baker Springs gives a date of about 800 years.


EXPLANATION
Quaternary alluvium
Tertiary sedimentary rocks
Mesozoic and Cenozoic volcanic rocks
Undivided granitoid rock
Undivided Mesozoic sedimentary and volcanic rocks
Paleozoic sedimentary rocks
Precambrian sedimentary and metamorphic rocks
SYMBOLS
Geologic contact
Fault, dotted where covered
Thrust fault, barbs on upper plate
Union Pacific railroad
Note: Map is modified from CDMG Geologic Map of California, 1977.
SIMPLIFIED GEOLOGIC MAP OF THE KINGMAN 1 X 2 DEGREE SHEET
Figure 3
C.R.O.
TRUE NORTH
MAGNETIC NORTH
15½°
SCALE 1:750,000
0 5 10 15 20 Miles
0 10 20 30 Km
CALIFORNIA
INDEX MAP
116°
36°
35°
15
95
Cima
Kelso

Lithologic and Structural Framework

Precambrian Rocks

Precambrian rocks can be subdivided into three broad groups based upon their age. The oldest rocks are gneissic and schistose, derived from metamorphism of preexisting sedimentary and plutonic rocks. For the most part these rocks are of amphibolite facies and locally attain silliminite grade. Radiometric dates show the oldest to be about 1.7 billion years old (Lanphere 1964). Later plutonism resulted in intrusion of granitoid rocks, bodies of syenite and diorite, pegmatites, and the rare earth-bearing skonokinite-syenite-carbonatite complex of the Mountain Pass area.

Typically the granitoid rocks display a mild foliation and locally their imprint upon the host rock can be recognized by rock alteration. The shonkinite-syenite carbonatite complex of the Mountain Pass area has yielded a radiometric age of 1.4 billion years (Lanphere, 1964).

A sequence of about 7,000 feet of unmetamorphosed sedimentary rocks of the Pahrump Group, unconformably overlies older Precambrian rocks. The Pahrump is made up of three formations. The basal one is the Crystal Springs Formation, a conformable sequence of quartzites, dolomite, sandstone, arkosic sand and a dioritic sill with a total measured thickness of over 1,900 feet east of Beck Springs (Hewett, 1956). It is overlain by about 1,100 feet of dolomite, minor beds of shale, and shalely sandstone that constitute the Beck Springs Dolomite. Overlying this is the Kingston Peak Formation, a sequence of sandstone, conglomerate, quartzite and shale that altogether have a thickness of approximately 2,000 feet.

The age of the Pahrump Group rocks is not clearly established. In the Panamint Range it unconformably rests upon plutons dated at 1.35-1.4 billion years (Burchfiel, B.C., et al, 1981) and is overlain unconformably by upper Precambrian sedimentary rocks.

Upper Precambrian - Paleozoic Rocks

Upper Precambrian, Cambrian, Ordovician, Devonian, Missippian, Pennsylvanian and Permian sedimentary rocks occur in the eastern Mojave Desert and the study area. North of Halloran Springs Paleozoic sedimentary rocks of unknown age occur in isolated outcrops in an east-west trending belt of about 10 miles.

Upper Precambrian-Middle Cambrian Rocks

Upper Precambrian to Lower Cambrian sedimentary rocks occur in the study area and are well exposed in the Old Dad Mountain area, Clark mountains, Winters Pass area and the Mescal Range. Figure 4, a modification of the stratigraphic chart given by Stewart (1970), shows the sequential relationship of the rocks.

The Noonday Dolomite, a thick cliff forming sequence, lies upon the Pahrump Group and older Precambrian foliated rocks. A conformable sequence of younger Precambrian to Middle Cambrian age sedimentary rocks overlie the Noonday Dolomite. The youngest of these, the Middle Cambrian Cararra Formation shows a gradational change from clastic sequences of shales and quartzites to dominantly carbonate rocks that characterizes the overlying Goodsprings Dolomite.

Lithologic and Structural Framework

Precambrian Rocks

Precambrian rocks can be subdivided into three broad groups based upon their age. The oldest rocks are gneisses and schists, derived from metamorphism of preexisting sedimentary and igneous rocks. [illegible] are of amphibolite facies [illegible]. Radiometric [illegible] later granitic intrusion [illegible] bodies of granite [illegible] and dioritic, pegmatites, [illegible] batholith complex of the [illegible].

Typically the granitic rocks display a [illegible] radiometric age of the [illegible] years [illegible].

A sequence of about 9,000 feet of [illegible] group, unconformably overlies [illegible] made up of three formations. The lower [illegible] a conformable sequence of quartzites, [illegible] with a total measured thickness of [illegible] (Barker, 1969). It is unconformably overlain [illegible] unit of shale, and mainly [illegible] overlying unit is the [illegible] formation, [illegible] glomerate, quartzite and shale that [illegible] nearly 2,000 feet.

The age of the [illegible] group rocks is not known [illegible] is unconformably [illegible] upon [illegible] (Bickford, et al., 1969) and is questionably [illegible] older sedimentary rocks.

Upper Paleozoic - [illegible] Rocks

Upper Paleozoic, [illegible] and [illegible] sedimentary rocks occur in the [illegible] area, [illegible] occur in [illegible].

Upper Precambrian [illegible] Rocks

Upper Precambrian [illegible] and [illegible] Figure 4 [illegible] (1965) [illegible] shows the sequential [illegible].

The [illegible] cliff [illegible] group and [illegible] a [illegible] of [illegible]. The [illegible] that characterizes the [illegible].

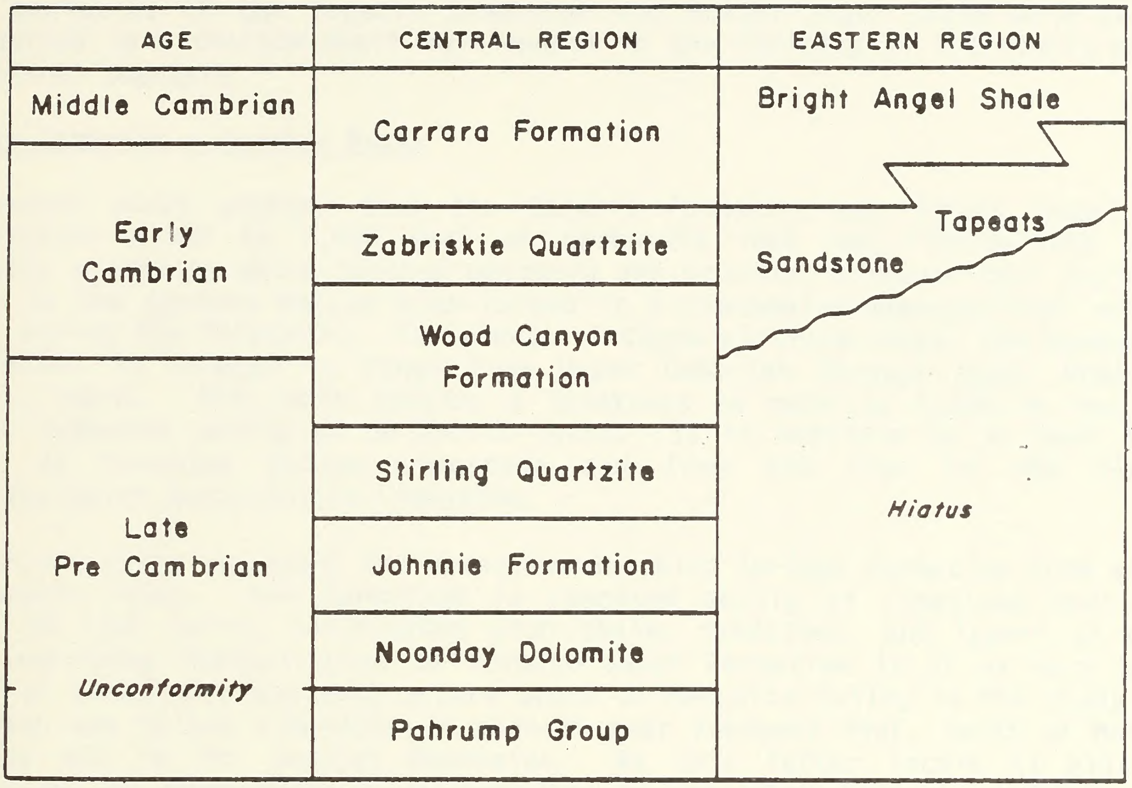


Figure 4. Late Precambrian, Early Cambrian, and Middle Cambrian Sedimentary rocks in the Kingman 1 x 2 degree sheet (modified from Stewart, 1970).

In the Providence Mountains, the Latham Shale, Chambliss Limestone, and Cadiz Formation are correlative with these rocks. The rock sequences shown in Figure 4 under "Central Region" constitute several thousand feet of quartzite, siltstone, conglomerate, dolomite and limestone that thicken to the northwest. They are especially well developed in the western and northern portions of the study area. Tapeats Sandstones and overlying Bright Angel Shale occur in the eastern portion of the study area and are correlative with the Wood Canyon Formation, Zabriskie Quartzite, and Cararra Formation to the west. In the New York Mountains, the Tapeats Sandstone is approximately 300 feet thick; small exposures are present near Mesquite Pass and in the Clark Mountains. The overlying Bright Angel Shale is generally coextensive with Tapeats Sandstone. The sediments of the Tapeats Sandstone and Bright Angel Shale were probably deposited in a shallow shelf environment in the vicinity of a cratonic-miogeosynclinal boundary.

Upper Cambrian - Permian Rocks

Paleozoic rocks younger than the Cararra Formation and Bright Angel Shale constitute 6,000 to 7,000 feet of carbonate rock and fine-grained marine clastic sediments which thicken westward and provides evidence that sedimentation in the eastern Mojave area formed in a cratonal-miogeosynclinal environment during the Paleozoic. The oldest of these platform rocks, the Goodsprings Dolomite, is thought to range from Upper Cambrian through Upper Ordovician (Gans, 1974). This unit attains a thickness as much as 1,500 in the study area, composed mainly of dolomitic rocks. It is overlain by as much as 600 feet of Devonian Sultan Limestone and from 350 feet to 700 feet of Mississippian Monte Cristo Limestone.

An unconformity separates the Pennsylvanian Bird Springs Formation from younger Paleozoic rocks. The formation is composed mostly of limestone beds, less than 20 feet thick, interbedded with shale, sandstone, and layers of chert. The overlying Pennsylvanian to Permian Supai Formation is of as much as 700 feet of sandstone, and only occurs south of Mesquite Valley in the study area. Permian age Kaibab Limestone is present near Kokoweef Peak, south of Mesquite Valley and in the Ivanpah Mountains. At this latter locale it attains a thickness of approximately 400 feet and is separated from overlying Mesozoic rocks by an unconformity.

Mesozoic Sedimentary and Volcanic Rocks

Mesozoic sedimentary and volcanic rocks are sparsely represented in the eastern Mojave Desert and for the most part are of continental origin. Burchfiel and Davis (1981) have interpreted these rocks as having formed in a back arc environment. The oldest is the lower Triassic Moenkopi Formation, a sequence of limestone and minor amounts of shale with a maximum thickness of approximate 500 feet in the study area. It is overlain by as much as 650 feet of sandstone of the Upper Triassic Chinle Formation. The Chinle is overlain by Jurassic Aztec Sandstone, a sequence of about 1,000 feet of cross-bedded sandstone.

Upper Jurassic Mountain Pass Rhyolite (Delfonte Dacite of Hewett) is composed of about 1,200 feet of rhyolitic flows, and overlies the Aztec Sandstone in the Mescal Range (Evans, 1971). Radiometric analyses of tuff from the volcanics has yielded an age of 140 million years (DeWitt, 1982, staff communication, and DeWitt, 1980).

In the Providence Mountains, the Latham Shale, Chambless Limestone, and Cadiz Formation are correlative with these rocks. The rock sequence shown in Figure 4 under "Central Region" constitutes several thousand feet of quartzite, siltstone, conglomerate, dolomite and limestone that thicken to the northwest. They are especially well developed in the western and northern portions of the study area. Tapeats Sandstone and overlying Bright Angel Shale occur in the eastern portion of the study area and are correlative with the Wood Canyon Formation, Zabriskie Quartzite, and Carrara Formation to the west. In the New York Mountains, the Tapeats Sandstone is approximately 400 feet thick; equivalent strata are present both near Ivanpah Lake and in the Clark Mountains. The overlying Bright Angel Shale is generally correlative with Carrara Formation. The sediments of the Tapeats Sandstone and the Bright Angel Shale were probably deposited in a shallow shelf environment in the vicinity of an irregular [illegible] cratonal boundary.

Upper Cambrian - Permian Rocks

Paleozoic rocks younger than the Carrara Formation [illegible] constitute 4,000 to 7,000 feet of carbonate [illegible] clastic sediments which include the [illegible] Thin in the eastern region [illegible] ment during the Paleozoic. The nature of these [illegible] Dolomite, is thought to range from Upper Cambrian [illegible] (Hewett, 1956). This unit attains a thickness [illegible] area, composed mainly of dolomitic facies [illegible] feet of Devonian, Sultan Limestone [illegible] Mississippian Monte Cristo Limestone.

An unconformity separates the Permian [illegible] Paleozoic rocks. The formation is composed [illegible] than 20 feet thick, interbedded with shale [illegible] The overlying formation is Permian [illegible] feet of thickness, and only exposure [illegible] formation and Sultan Limestone. It exposes [illegible] Valley and in the Providence Mountains. At [illegible] thickness of approximately 2,000 feet and it [illegible] rocks by an unconformity.

Mesozoic Sedimentary and Volcanic Rocks

Mesozoic sedimentary and volcanic rocks [illegible] Mojave Desert and for the most part are of [illegible] Hewett (1956) have interpreted these [illegible] environment. The Triassic is the lower [illegible] of limestone and minor amounts of shale [illegible] 500 feet in the study area. It is overlain [illegible] of the Upper Triassic Chinle Formation. [illegible] Aztec Sandstone, a sequence of about 1,500 feet of cross-bedded sandstone.

Upper Jurassic Mountain Pass Rhyolite (Teutonia Adamellite of Hewett) is composed of about 1,500 feet of rhyolitic tuffs and overlies the Aztec Sandstone in the Mescal Range (Hewett, 1956). Radiometric analyses of tuff from the welded unit has yielded an age of 149 million years (Sarna-Wojcicki, 1980, oral communication, and Hewett, 1956).

Mesozoic Plutonic Rocks and the Laramide Orogeny

Mesozoic plutonic rocks are widely distributed throughout the study area and include a variety of granitoid bodies that range from granitic to dioritic in composition and are cut by felsic and mafic dikes. These rocks yield radiometric ages that range from 54 to 200 million years, representing a time span from Late Triassic through early Cenozoic for their emplacement. The oldest currently recognized rock is granodiorite from the Clark Mountain area which is 195 and 200.3 m.y. old according to K/Ar whole rock analyses (Sutter, 1968). Radiometric dates of granitic rocks at a few locales have yielded ages in the 126-168 m.y. range. However, the majority of ages cluster in the 54-110 m.y. range with the mean being 84 million years. These dates indicate major plutonic emplacement began in early Cretaceous time and had generally waned during early Tertiary time.

Laramide Orogeny

The Laramide orogeny involves a period of widespread folding, faulting and emplacement of plutons related to mountain building in the Cordilleran region of North America during Late Cretaceous to early Tertiary time. In the study area, radiometric dates show that plutonic emplacement began in Late Triassic and continued into late Miocene, representing a time span which extends beyond the Laramide. However, most of the plutonic bodies in the area were emplaced during upper Cretaceous and early Tertiary time, and thus conforms to the generally accepted time span for the orogeny (approximately 90-58 m.y.).

Field studies coupled with evaluation of Hewett's (1956) interpretation of structural events in the study area lead to the following interpretation:

1. Initial folding of the area
2. Development of the Mescal thrust
3. Clark Mountain normal faulting
4. Mesquite overthrusting together with minor folding and faulting
5. Winters overthrust involving folding and thrust faulting
6. Major plutonic activity
7. Early normal faults
8. Dolomitization and other alteration of limestone
9. Mineralization to form most of the ore deposits present in the eastern Mojave Desert.

Cenozoic Rocks

As mentioned previously, the youngest plutonic activity associated with the Laramide orogeny in the study area is dated at 54 million years, which indicates magma emplacement continued into Late Paleocene - Early Eocene

Mesozoic Plutonic Rocks and the Laramide Orogeny

Mesozoic plutonic rocks are widely distributed throughout the study area and include a variety of granitoid bodies that range from granitic to dioritic in composition and are cut by felsic and mafic dikes. These rocks yield radiometric ages that range from 64 to 200 million years, representing a time span from Late Triassic through early Cenozoic (or Tertiary) emplacement. The oldest currently recognized rock is granodiorite from the Clark Mountain area which is 153 and 200 ± m.y. old according to U/Pb zircon rock analysis (Sutter, 1968). Radiometric dates of [illegible] the same [illegible] locality have [illegible] in the 135-150 m.y. range. However, the majority of dates cluster in the 64-110 m.y. range with the mean being 84 million years. These dates indicate major plutonic emplacement during late Cretaceous time and [illegible] during early Tertiary time.

Laramide Orogeny

The Laramide orogeny involves a period of [illegible] emplacement of plutons related to [illegible] of North America during late Cretaceous to [illegible] area, radiometric dates show that plutonic [illegible] and continued into late Eocene, representing [illegible] the Laramide. However, most of the plutonic [illegible] during upper Cretaceous and early Tertiary time [illegible] generally accepted time span for the orogeny [illegible].

Field studies coupled with evaluation of [illegible] structural events in the study area lead to the [illegible]:

1. Initial folding of the area
2. Development of the Keystone thrust
3. Clark Mountain normal faulting
4. Mesozoic granite-quartz monzonite with minor [illegible]
5. Mineral development [illegible] faulting [illegible]
6. Major plutonic activity
7. Early normal faults
8. Metamorphism and other alteration of [illegible]
9. Mineralization [illegible] in the area [illegible] of the [illegible] Mojave Desert

Cenozoic Rocks

As mentioned previously, the youngest plutonic activity associated with the Laramide orogeny in the study area is dated at 64 million years, which indicates magma emplacement continued into late Paleocene or early Eocene time. However, monzonite porphyry in the Kingston Range has yielded a radiometric age of 18.2-18.6 million years (Sutter, 1968) which indicates it was emplaced during middle Miocene.

There are no known early Tertiary sedimentary or volcanic rocks in the vicinity of the study area that suggest erosion was taking place then. Miocene sedimentary, pyroclastic, and other volcanic rocks are, however, widely distributed throughout the eastern Mojave Desert and are separated from older rocks by an unconformity. Thick sequences of Tertiary clastic flows, and related hypabyssal bodies are well exposed within the Hackberry, Castle, Shadow, New York and Providence Mountains, and at other locales. These rocks have been folded or faulted locally.

During late Tertiary, tectonic activity imposed regional effects upon the eastern Mojave Desert whereby middle Tertiary sedimentary and volcanic rocks were folded and faulted. Evidence of thrusting during late Tertiary can be found in the Kingston Range, Shadow Mountains and Old Dad Mountains.

<u>Quaternary Rocks and Alluvial Deposits</u>

Sedimentary Rocks:

A thick succession of limey sandstone, conglomerate and pumice, which according to Hewett (1956) is at least 1,000 feet thick, occurs as scattered remnants in the Shadow Mountains and a few miles north of the Kingston Range. This succession, the Resting Springs Formation, is separated from older rock by an unconformity and is probably Pleistocene age.

Older Alluvium:

At numerous places in the study area, there are deposits of sand and gravel which based upon their degree of induration, composition and relationship to other nearby alluvium, indicate they had been deposited during an earlier period of alluviation. Deposits of this type are especially prominent east of Old Dad Mountain, south of the New York Mountains, along the northern boundary of the Shadow Mountains, and south of the Pahrump Valley.

Lake Beds:

Pleistocene age lake beds occur at Mesquite Lake, presently covering about 12 square miles, at Ivanpah Lake, at least 15 square miles, at Valley Wells, about 3 square miles, and at the south end of the Piute Range, about 1 square mile.

Eolian Sand:

Eolian sand is especially prominent west of Old Dad Mountain and in the area surrounding the Cowhole Mountains, and in Mesquite Valley. Elsewhere, windblown sand is present at scattered locales where it extends for considerable distances up mountain slopes.

Volcanic Rock:

Quaternary basaltic flows cover an area of roughly 40 square miles northeast of Old Dad Mountain. Included within this field are about 30 cinder cones. Volcanism began there about 10 million years ago (Katz and Boetcher, 1980) time. However, monzonite porphyry in the Kingston Range has yielded a radiometric age of 10.2-10.6 million years (Sutter, 1968) which indicates it was emplaced during middle Miocene.

There are no known early Tertiary sedimentary or volcanic rocks in the vicinity of the study area that suggest erosion was taking place then. Miocene sedimentary, pyroclastic, and other volcanic rocks are, however, widely distributed throughout the eastern Mojave Desert and are separated from older rocks by an unconformity. Thick sequences of Tertiary clastic flows, and related hypabyssal bodies are well exposed within the Hackberry, Castle, Granite, New York and Providence Mountains, and at other locales. These rocks have been folded and faulted locally.

During late Tertiary, tectonic activity imposed regional effects upon the eastern Mojave Desert whereby middle Tertiary sedimentary and volcanic rocks were folded and faulted. Evidence of thrusting during late Tertiary can be found in the Kingston Range, Shadow Mountains and Old Dad Mountains.

Quaternary Rocks and Alluvial Deposits

Sedimentary Rocks:

A thick succession of flaggy sandstone, conglomerate and [illegible] to Hewett (1956) is at least 1,000 feet thick, [illegible] the Shadow Mountain and a few miles north of the [illegible] region, the Resting Springs Formation, is [illegible] unconformable and is probably Pleistocene age.

Older Alluvium

At numerous places in the study area, there are [illegible] which based upon their degree of induration, [illegible] older gravels, alluvium, indicate they had been [illegible] period of alluviation. Deposits of this type are al[illegible] Old Dad Mountain, south of the New York Mountains, [illegible] of the Shadow Mountains, and southwest the Halloran [illegible]

Lake Beds:

Pleistocene age lake beds occur at Mesquite [illegible] square miles, at Ivanpah Lake, it [illegible] about 4 square miles, and at the south end of [illegible] Hills.

Eolian Sand:

Eolian sand is especially prominent west of Old Dad Mountains and in the area surrounding the Granite Mountains, and in Devils Playground. Windblown sand is present at scattered locales where it extends for considerable distances up mountain slopes.

Volcanic Rock:

Quaternary basaltic flows cover an area of roughly 60 square miles northwest of Old Dad Mountain. Includes within this field are about 30 cinder cones. Potassium argon, there about 10 million years ago (Dibblee and Bortugno, 1960) and has continued into recent time. Katz and Boetcher (1980) report a carbon age of 330-480 years from a piece of charcoal collected from the base of one of the flows.

RELATIONSHIP OF THE MINERAL RESOURCES TO THE GEOLOGIC FRAMEWORK

As discussed earlier, the concentration and distribution of mineral resources are intimately related to the geologic framework in which mineralization occurs. An important element of this study was to record these relationships in order to identify those areas where important mineral resources occur and to provide insight where other significant resources may exist that have not yet been recognized or discovered. The discussion which follows is to show some of the relationships that relate the mineral deposits in the eastern Mojave Desert, and the study area, to the geologic framework.

The oldest known mineralization within the area formed during the Precambrian, about 1.4 billion years ago, with the emplacement of the carbonatite complex in the Mountain Pass area. Here Union Molycorp mines cerium group rare-earth elements. The copper-gold mineralization north of the Mountain Pass rare-earth deposit and the hydrothermal gold deposit in the Vanderbilt mine area may also have formed during the Precambrian. As yet evidence has not been obtained to firmly establish the age of mineralization.

From the Precambrian through the close of the Paleozoic the eastern Mojave area was subjected to an environment in which fine grain clastic and carbonate sediments were being deposited in a miogeosynclinal environment. The style of sedimentation changed from one wherein clastic sediments predominated to one in which chemical precipitation of carbonate sediments occurred punctuated by brief interval of non-deposition or erosion. The overall pattern of deposition was one in which sedimentation occurred in a shallow marine shelf environment that deepened to the northwest. The deposition of clastic sediments occurred in an environment in which chemically resistant quartz-rich sediments survived stream transport to form the quartzites that are of possible economic importance in the desert area.

Sea water exchange reactions in shelf environment during the late Precambrian and Paleozoic brought about precipitation of calcium and magnesium carbonates to form bodies of dolomite and limestone that are of economic significance.

During the Late Mesozoic into early Tertiary time the Laramide Orogeny was a period of mountain building characterized by thrust faulting, normal faulting and invasion of magmatic bodies. The introduction of the magmas allowed ore forming fluid to react with Paleozoic age carbonate rock to form skarn deposits of copper, tungsten, tin, and iron with accessory gold and silver. With the introduction of heat from magmatic activity, ore forming fluids were introduced into fractures, faults, open pore spaces and other rock openings to bring about formation of hydrothermal deposits containing molybdenum, tungsten, copper, gold, silver, lead, zinc, antimony and fluorite.

and has continued into recent time. Fife and Bachman (1980) report a carbon age of 510-460 years from a piece of charcoal collected from the base of one of the flows.

RELATIONSHIP OF THE MINERAL RESOURCES TO THE GEOLOGIC FRAMEWORK

As discussed earlier, the concentration and distribution of mineral resources are intimately related to the geologic framework in which mineralization occurs. An important element of this study was to record these relationships in order to identify those areas where important mineral resources occur and to provide insights where other significant resources may exist that have not yet been recognized or discovered. The discussion below [illegible] to show some of the relationships that relate the mineral deposits of the [illegible] Mojave Desert, and the study area, to the geologic framework.

The oldest known mineralization within the area [illegible] about 1.4 billion years ago, with the emplacement [illegible] in the Mountain Pass area. Rare [illegible] elements. The copper-gold mineralization [illegible] deposits and the hydrothermal gold deposit [illegible] have formed during the Precambrian. As yet [illegible] firmly establish the age of mineralization.

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The major tectonic [illegible] and Paleozoic [illegible] to form skarns of [illegible]

During the late Mesozoic [illegible] period of magmatic activity characterized [illegible] and intrusion of granitic bodies. [illegible] of copper, tungsten, [illegible] introduction of most [illegible] magmatic activity [illegible] into [illegible] which formed [illegible] of hydrothermal deposits containing molybdenum, tungsten, copper, gold, silver, lead, zinc, antimony and fluorite.

Deposits of magnesite occurring in carbonate rock are spatially related to intrusion of plutonic rocks in the area and probably formed through metasomitism of the carbonate host rock. Sericite in the New York Mountains occurs in altered Mesozoic rocks and is thought to have formed through alteration by magmatic activity.

In the Old Dad Mountain area there is a possibility that hydrothermal gold mineralization is younger than the Laramide related mineralization. Gold mineralization in the Old Dad area had been localized along the Playground thrust zone. The Old Dad fault however juxtaposes Miocene-Pliocene fanglomerate against older rock and cuts the Playground thrust. Although direct evidence is not at hand, the possibility exists that gold mineralization here has been introduced along the Old Dad fault and subsequently mineralized the Playground thrust system as well, implying that gold mineralization occurred no later than the Miocene.

Volcanism extending back to Cretaceous time played an important role in the formation of low temperature hydrothermal mineral deposits. Gold mineralization in the Clark Mountains at the Colosseum mine is hosted by rhyolite in a former vent zone. In the Woods Mountain area rhyolitic rock of Miocene age hosts low temperature gold mineralization and perlite deposits. Bentonite deposits formed in old lake beds where fine grain tuffs deposited from volcanism were later altered to bentonite. South of Halloran Springs cinder cones are formed on volcanic flows. Several of these cones have been, or are now being mined.

MINERAL LAND CLASSIFICATION SYSTEM

Land in the Minerals Impact Study Area has been classified into Mineral Resource Zones (MRZ's) with respect to the presence, absence, or likely occurrence of significant mineral deposits by the California Division of Mines and Geology according to guidelines adopted by the California State Mining and Geology Board (1979, p. 23-27). The State classification is here used because it reflects current knowledge and data and was available through published and unpublished materials for the entire study area.

The classification scheme used on Plate 5 is given below.

- MRZ-1 Areas where available geologic information indicates there is little likelihood for the presence of mineral resources.
- MRZ-2a Areas that contain known significant mineral deposits.
- MRZ-2b Areas where there is a high likelihood that significant mineral deposits are present.
- MRZ-3a Areas that have a moderate potential for the presence of significant mineral deposits.

Deposits of magnesite occurring in carbonate rock are spatially related to intrusion of plutonic rocks in the area and probably formed through metasomatism of the carbonate host rock. Sericite in the New York Mountains occurs in altered Mesozoic rocks and is thought to have formed through alteration by magmatic activity.

In the Old Dad Mountain area there is a possibility that hydrothermal gold mineralization is younger than the Laramide related mineralization. Gold mineralization in the Old Dad area has been localized along the Playground thrust zone. The Old Dad fault however juxtaposes Miocene-Pliocene fanglomerate against older rock and cuts the Playground thrust. Although direct evidence is not at hand, the possibility exists that gold mineralization here has been introduced along the Old Dad fault and subsequently mineralized the Playground thrust system as well, implying that gold mineralization occurred no later than the Miocene.

Volcanism extending back to Cretaceous time played an important role in the formation of low temperature hydrothermal mineral deposits. Gold mineralization in the Clark Mountains at the Colosseum mine is hosted in [illegible] of a former vent zone. In the Woods Mountain area rhyolitic [illegible] hosts low temperature gold mineralization and perlite deposits. Bentonite deposits formed in old lake beds where fine grain tuffs [illegible] from volcanism were later altered to bentonite. [illegible] zones are formed on volcanic flows. Several of these [illegible] are now being mined.

MINERAL LAND CLASSIFICATION SYSTEM

LUMA in the Minerals Issues Study area has been [illegible] Mineral Resource Zones (MRZ) [illegible] the presence or absence of significant mineral deposits as the California Division of Mines and Geology according to guidelines adopted by the California State Mining and Geology Board (1979, p. 52-?). The State classification [illegible] it reflects current knowledge and data and was available [illegible] for the entire study area.

The classification scheme used on Plate 9 is given below.

MRZ-1 Areas where available geologic information shows that there is little likelihood for the presence of mineral resources.

MRZ-2a Areas that contain known significant mineral deposits.

MRZ-2b Areas where there is a high likelihood that significant mineral deposits are present.

MRZ-3a Areas that have a moderate potential for the presence of significant mineral deposits.

MR2-3b Areas where it is plausible that significant mineral deposits are present.

MR2-4 Areas with unknown mineral potential.

As defined in State Guidelines (Cal. St. Min. and Geol. Bd., p. 25-27) classification is the process of identification of lands containing significant mineral deposits. A significant mineral deposit must meet certain criteria for marketability and threshold value.

For marketability mineral deposits are divided into two categories; strategic and non-strategic. Non-strategic mineral commodities are those which are available domestically and of which the United States imports less than 65 percent of its needs, as reported annually by the Bureau of Mines. Mineral deposits in this category must be minable, processible, and marketable under the technologic and economic conditions that exist at present or which can be estimated to exist in the foreseeable future (a time span of about 50 years). Strategic mineral commodities are defined as those that are in short domestic supply and important for national defense or the well-being of the domestic economy. For purposes of State classification they are those mineral commodities of which the United States imports more than 65 percent of its needs, as reported annually by the Bureau of Mines. They are judged to be minable, processible, and marketable in the foreseeable future.

Threshold value is considered by the State to be the projected value (gross selling price) of the first marketable product from mineral deposits, and figured in terms of 1978 equivalent dollars. There are four basic categories which follow:

1. Construction materials (minimum value $5,000,000).

2. Industrial and chemical mineral materials (minimum value $1,000,000).

3. Metallic and rare minerals (minimum value $500,000).

4. Non-fluid mineral fuels (minimum value $1,000,000).

METALLIC AND NON-METALLIC MINERAL RESOURCES

Introduction

The eastern Mojave desert and the study area are a repository of a wide variety of mineral resources, formed under a wide range of geologic environments. These environments include deposits formed by magmatic concentration, contact metasomatism, hydrothermal activity, volcanism, sedimentation, and supergene processes. Weathering and metamorphism played a role in the enrichment of many of the deposits to convert them into substances of value, or potential value.

A total of 285 mines were identified in the area during the course of this study which includes 240 deposits of interest principally for their metal content and 45 non-metallic deposits of interest for their industrial uses (see Table 2).

MRZ-3b: Areas where it is possible that significant mineral deposits are present.

MRZ-4: Areas with unknown mineral potential.

As defined in state guidelines [illegible] classification is the process of identifying lands or areas containing significant mineral deposits. A significant mineral deposit must meet certain criteria for marketability and threshold value.

For marketability, mineral deposits are divided into two categories: strategic and non-strategic. Non-strategic mineral commodities are those which are available domestically and of which the United States does not import more than 50 percent of its needs, or supplied domestically as [illegible]. Mineral deposits in this category must be minable, processible, and marketable under the technologic and economic conditions that exist at the time of classification or that are estimated to exist in the reasonably foreseeable future. Strategic mineral commodities are [illegible] supply and important for national defense or [illegible] economy. For purposes of state classification [illegible] list of which the United States imports more [illegible] reported annually by the Bureau of Mines. [illegible] processible, and marketable in the foreseeable future.

Threshold value is considered to be the [illegible] selling value) of the first marketable product [illegible] figures in terms of 1978 equivalent dollars. [illegible] which follow:

1. Construction materials (minimum value [illegible]
2. Industrial and chemical mineral materials [illegible]
3. Metallic and rare minerals (minimum value [illegible]
4. Nonfluid mineral fuels (minimum value [illegible]

MINERALS AND MINERAL [illegible]

INTRODUCTION

The Distant Hills Desert Area (study area) has a long history [illegible] of mineral discoveries. Formed under a wide range of [illegible] these environments include deposits formed by magmatic [illegible] metamorphism, hydrothermal activity, volcanic [illegible] processes. Weathering and erosion have played a [illegible] in the enrichment of many of the deposits to concentrations sufficient to be of economic value.

A total of 288 mines were identified in the area during the course of this study which included 162 deposits of [illegible] principally for their metal content and 95 nonmetallic deposits of [illegible] for their industrial uses (see Table 2).

TABLE 2

LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

CLARK MOUNTAIN AND ROACH LAKE 15' QUADRANGLES

MINE NAME	LOCATION T.	R.	S.
Gold			
Colosseum Mine	17	13	10
Conquistador #2	17	12	36
Fay's Claim	17	13	25 & 26
Franks Claim	17	13	25
Ivanpah Springs	17	13	24
Pearl	17	13	26
White Hat	17	14	11
Unknown C	17	13	5
Unknown C #2	17	13	5
Unknown #1	19	12	31
Unknown #2	18	12	29
Mesquite Lake Mine	18	13	4 & 5
Silver			
Allie	17	13	9
Beatrice	17	13	8 & 9
Lizzie Bullock	17	13	9
Monitor	17	13	8 & 9
Stonewall	17	13	9
Lead-Zinc-Silver			
Carbonate King (DeWitts)-Umberci	17	14	6 & 8
Kalley	17	14	5
Keiper	17	12	25
Lime Canyon	17	13	30
Stateline	17	14	7
Tungsten Springs (Silver)	17	13	23
Clark Mountain Mine	17	13	27
Copper			
Benson	17	13	23
Calarivada	17	14	6
Copper Commander	16	13	5
Copper World	16	13	5
Dewey	16	13	5
Mammoth	17	12	14
Unknown C #1	17	13	5
Tungsten			
Mojave Tungsten #1 (Green)	17	13	15
Mojave Tungsten #2	17	13	26
New Benson	17	13	22 & 27
Unknown M	17	13	22
Tungsten Springs	17	13	23
Antimony			
Wade	16	14	19
Fluorite			
Curtis #2	17	13	8
Korfist	17	13	22
Pacific Fluroite Deposit	17	13	16
Taylor	17	13	9
Valley View	17	13	5
#59758	17	13	8
Unknown A	17	13	5
Unknown B	17	13	5
Unknown G	17	13	8
Unknown N	17	13	21
Barite			
Unknown H	19	11	13 & 24
Gypsum			
Shire	17	14	6

HALLORAN SPRINGS 15' QUANDRANGLE

MINE NAME	LOCATION T.	R.	S.
Gold			
Little Dove and Dove Mill Site	14	10	36
Raw Silver Cone No. 1	14	11	5
Jumbo Mine	15	9	25
Hillside #1	15	10	4
Wanderer Ext. #3	15	10	5
Wander Mine	15	10	7
Arrowhead Mine	15	10	16
Robin Lee	15	10	18
Unnamed Shaft	15	10	18
Lost Lead Claim Group	15	11	9
Utah Claim Group	15	11	15
Telegraph Mine	15	11	16 & 17 & 20
Unnamed Shaft	15	11	19
Ruby - S - Mines	16	10	25
Unnamed Prospect	16	11	33
Copper			
Unnamed Prospect	15	11	11
West Camp Area (formerly Toltec Mine) (copper-turquoise)	16	10	31
Middle Camp Area (formerly Himalaya Mine)(copper-turquoise)	16	10	32 & 33
Tiffany Mine (turquoise)	16	11	33
East Camp Area (formerly Stone Hammer Mine)(copper-turquoise)	16	11	32 & 33
Unnamed Shaft	15	11	9
Unnamed Shafts	16	11	33
Talc			
Calmosil Mine	15	11	3
Yucca Mine	16	10	28
Yucca Grove Mine (?)	16	11	9
Huber Claim Group No. 1-41	16	11	22
Unnamed Shafts	16	11	31
Unnamed Shafts	16	11	31
Great Wanamingo Mine	16	11	31
Yucca Mine (formerly Pomona Mine)	16	11	33
Tungsten			
Unnamed Prospect	16	11	31

TABLE 2

LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

IVANPAH 15' QUANDRANGLE

MINE NAME	LOCATION T.	R.	S.
Gold			
Kokoweef Caverns	15	14	4
Uknow #1	15	14	9
Morning Star	15	14	21 & 28
Kewanee	15	14	28 & 33
Vanderbilt	14	16	3 & 4
Blue Crystal	15 1/2	16	24
Oro Belle	14	17	13 & 24
Mountain Top	14	17	24
Hart Consolidated	14	17	24
Valley View	14	17	24
Big Chief	14	17	24
Lead-Zinc-Silver			
Carbonate King Zinc Mine	15	14	4
Mineral Spring	15	14	2
Bullion	15	14	10 & 15
Don's Claim	15	16	22
Copper			
Oroweef	15	14	4
Revenue Copper	15	14	9
New Trail	15	14	9
Unknown #2	15	14	15
Allured	15	14	22
Sunnyside	15	14	28
Trio Group	14	16	21
Copper Queen	14	16	30
Tungsten			
Garvanza	14	15	23
Live Oak	14	16	30
Dorr Tungsten	14	15	36
Giant Ledge	14	16	31
Sagamore	14	16	32
Molybdenum			
Big Hunch	14	15	35
Limestone			
Meevint Claims	14	16	9
Sericite			
Rose Property	14	16	29
Magnesite			
New Trail Deposit	15	14	15
Rare Earth Elements			
Mineral Hill Deposit	15 1/2	14	28 & 33
Clay			
C-1 Clay	14	17	13 & 24
P.S. Hart Clay	14	17	24
Huntingtop Tile	14	17	24 & 25
Turtle Back	14	17	12 & 13
Hart Peak #5	15	18	31
Perlite			
Erin (Morelite Deposit)	15	18	19
Cedar Top	15	18	30

KELSO 15' QUANDRANGLE

MINE NAME	LOCATION T.	R.	S.
Gold			
Gold Standard (formerly Minden Mine)	12	12	9
Unnamed Prospect	13	12	27
Blue Quail #1 (formerly Jackpot Mine?)	12	12	1
Unnamed Prospect	12	12	12
Morning Dove #1 (former Rainbow Wells)	13	12	13
Morning Dove #2	13	12	24
Rainbow Wells Prospect	13	12	13
Unnamed Prospect	13	12	13
Marl Spring	13	12	36
Unnamed Prospect	13	12	36
Unnamed Prospect	11	12	15
Tourman-Alto Lode #1	11	12	15
Unnamed Prospect	11	12	15
Unnamed Prospects	11	12	10
Unnamed Prospect	11	12	11
Unnamed Prospect	11	12	11
Unnamed Prospects	11	12	11
Unnamed Prospect	12	14	30
Unnamed Prospect	12	14	29
BAN 1-20 and Lucky Larry #1 (formerly Okaw Group)	11	13	11 & 12
CAN 1-11 (formerly Jo Je Mine)	11	13	23
Unnamed Prospects	11	13	23
Unnamed Prospect	11	14	17
Iron			
Speculor	11	12	15
Tungsten			
Owl #1 (formerly Bright Outlook Mine)	13	13	28
Base Metals			
DAN #1 and #2	11	14	30
Tough Nut Mine	11	14	30
FAN Claim Group #1-5	11	14	19
Unnamed Prospects	11	14	17
Volcanic Cinders			
WMK Builders Products	13	12	5 6 8

TABLE 2

LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

KINGSTON PEAK 15' QUADRANGLE

MINE NAME	LOCATION T.	R.	S.
Gold			
Dan Henry Mine	17	11	15
Unknown	17	11	16
Lead-Zinc-Silver			
Eastern Star Mine	17	10	17
Gold Hill Mine	17	11	9 & 16
Golden Shadow #1 Mine	17	10	23
Shadow Mountain Load (sic)	17	11	21
Unknown	17	11	20
Unknown	17	10	26
Unknown	17	10	26
Unknown	17	10	7 & 13
Unknown	19	11	33
Copper			
Grey Copper	17	11	16
Iron Cap	19	10	34
Shadow Mountain Mine	17	11	21
Unknown	19	10	26
Unknown	18	9	24
Clay			
Kingston Wash Mine	18	9	26
White Clay Mine	17	10	28
Gypsum			
Red Canyon	17	10	16
Talc			
Johnson	19	10	25 & 26
Mica			
Unknown	19	11	11 & 14

MESCAL RANGE 15' QUADRANGLE

MINE NAME	LOCATION T.	R.	S.
Gold			
Sulfide Queen	16	13	12
New Era	15	14	29
New Era #3	15	14	20
Billy Bob	14	14	17
Teutonia	14	13	11
Lead-Silver-Zinc			
Ginn Mine	15	14	29
Wilshire	16	13	7
Mohawk	16	13	7
Yucca Queen	16	13	17
Henry	16	13	17
Budget	16	13	20
Mollusk	16	13	24
Blue Buzzard	16	13	25
Iron Horse	16	13	36
Silverado	15	14	18
Agnes	16	13	27
Ross	16	13	26
Unnamed #1	15	14	32
G.A. Foyle	16	13	12
Copper			
Standard #1	15	14	18
Standard #2	15	14	30
Johnny	15	14	30
Suzanna R.	15	13	25
Copper King	15	13	25
Lucky Find	15	13	25
Tungsten			
Silver Star	15	14	7
Tungstite	15	14	18
Standard #1	15	14	30
Hartmann	15	13	25
Tin			
Evening Star	15	13	25
Apex	15	13	25
Limestone			
Georgia Marble	15	14	18
Volcanic Cinders			
Cima Cinders	14	12	20
Rare Earth Elements			
Mountain Pass	16	13	13
Blue Moon	16	14	31
Bullsnake	16	13	13
Horsehoe Group	16	14	30
Lucky Strike	16	13	12
Simon-Ray Mine	15 1/2	14	19
Cake & Candy #3	16	13	11

TABLE 2

LIST OF MINES IN THE MINERAL IMPACT STUDY AREA

MID HILLS 15' QUADRANGLE

MINE NAME	LOCATION T.	LOCATION R.	LOCATION S.
Gold			
Barnett Mine (Mary Creed)	12	15	11
Blue Jay #1	11	14	10
Butcher Knife Mine	13	15	5
Columbia Mine	11	14	3
Deneb Claim	11	14	3
GAN #3 (Frisco Claim Group?)	11	14	9
Globe Mine	11	14	9
Golden Quail Claim Group ? (Gold Chief?)	13	16	18
Gold Quartz #9	11	14	16
Gold Valley Mine	11	15	6
Good Hope Mine	11	14	21
HML #6	11	14	4
K & S Mine (Beverly Glen?)	12	15	14
Lost Burro Mine ?	12	15	31
Peso Plata #1	12	14	35
Polaris Claim Group ?	13	16	18
Silver Buddy Claim Group (Six Claims Group)	11	14	3
Silver Buddy Claim Group	11	14	2
Star Mine (?)	11	14	9
Unnamed	11	14	2
Unnamed	11	14	3
Unnamed	11	14	4
Unnamed	11	14	4
Unnamed	11	14	8
Unnamed	11	14	9
Unnamed	11	14	10
Unnamed	11	15	6
Unnamed	11	15	31
Unnamed	12	14	21
Unnamed	12	14	22
Unnamed	12	14	23
Unnamed	12	14	23
Unnamed	12	14	27
Unnamed	12	14	27
Unnamed	12	14	28
Unnamed	12	14	33
Unnamed	12	14	34
Unnamed	12	14	35
Unnamed	12	15	1
Unnamed	12	15	17
Unnamed	12	15	17
Unknown	12	15	17
Unnamed	12	15	18
Unnamed	12	15	31
Unnamed	13	14	3
Unnamed	13	14	3
Unnamed	13	14	10
Unnamed	13	14	11
Unnamed	13	14	12
Unnamed	13	14	14
Unnamed	13	14	15
Unnamed	13	14	15
Unnamed	13	15	3
Unnamed	14	15	34
Unnamed	14	16	31
Unnamed	14	16	31
Valley View Claim	11	14	4
Vega	12	14	34
Silver			
Death Valley Mine (Dolly Varden)	13	14	11
JAN No. 2 (Providence Mine ?)	11	14	16
Red Rock (Perseverence ?)	11	14	28
New York Mountains Claim Group	13	16	4
Copper			
Confidence Mine (Blue Rock Claims, Pat Claims?)	11	14	4
Francis Mine	11	14	4
Iron			
Unnamed	13	15	17
Molydbenum			
Summit Spring Claim Group	11	14	8 & 9 & 17
Corbonate Rock			
Schiedel	12	14	11
Snow White	14	16	31 & 32

OLD DAD MOUNTAIN 15' QUADRANGLE

MINE NAME	LOCATION T.	LOCATION R.	LOCATION S.
Gold-Silver-Copper-Lead-Molybdenum			
Big Horn	13	10	35
Brannigon	13	10	26
Lucky	12	10	11
Comet	13	10	26
Oro Fino	13	10	23
Paymaster	13	10	23
Rainy Day	13	11	21
Sweet	12	10	2
Unnamed Prospect	13	11	8
Unnamed Prospect	13	11	8
Copper-Lead-Iron			
Little Cowhole Mtn	13	9	35
Iron King	11	11	5
Old Dad	12	10	13
Unnamed Prospect	12	9	13

The metallic mineral resources include; cerium group rare-earth elements, gold, silver, copper, lead, zinc, tungsten, molybdenum, iron, antimony, tin and accessory vanadium. The non-metallic mineral resources include; limestone, dolomite, fluorite, barite, gypsum, volcanic cinders, sericite, talc, clay, perlite, magnesite, silica, bentonite, and mica.

In 1985 California produced 2.2 billion dollars worth of non-fuel minerals and about 1.2 billion of this came from the California Desert (Bureau of Mines Mineral Industry Surveys-Mineral Industry of California, 1985, and Tom Anderson (CDMG, Phone Conversation, 5-21-86)). Part of this latter amount was produced from mines in the study area. In the coming decades the California Desert and study area should be an important source of the mineral commodities that will aid the economy of California and the nation.

The following discussion highlights the occurrence and potential of these mineral resources (see Plate 5).

Northern Providence Mountains

The northern Providence Mountains and their extension into the Mid Hills have a high concentration of mineralized areas which are spatially related to the Providence Mountains fault system. The deposits occur in open cavity fillings along faults and fractures in Precambrian gneiss and quartz monzonite. Mineral deposits that have been identified include; 18 gold deposits, 1 silver deposit, a copper deposit and a porphry molybdenum system. The overall pervasive nature of the Providence Mountains fault system, strongly suggests that a district wide structurally controlled mineralized system is present through the Providence Mountains, into the Mid Hills and beyond. Therefore, the system as a whole should be regarded of importance for its mineral potential. Active mineral exploration is currently in progress in this area.

Old Dad Mountain Area

In the northern Old Dad Mountain Area there are several gold bearing deposits that consist of vein quartz with native gold and accessory chalcopyrite in faults and fractures in Precambrian rock. Past gold production has been realized from the district and because of the extensive nature of the vein system it is likely that additional gold resources remain. Mineralization is probably of Laramide age because of the presence of quartz monzonite in close proximity to the mineralization beneath the Precambrian cover.

In the Central Old Dad Mountain area significant gold mineralization is associated with the Playground Thrust system, a major structural feature. In this area mineralization includes native gold with accessory copper occurring with quartz along with well-developed hydrothermal alternation. Elsewhere along the thrust there are a number of zones displaying hydrothermal

The metallic mineral resources include, cerium group rare-earth elements, gold, silver, copper, lead, zinc, tungsten, molybdenum, iron, antimony, tin and secondary vanadium. The non-metallic mineral resources include limestone, dolomite, fluorite, barite, gypsum, volcanic cinders, perlite, talc, clay, perlite, magnesite, silica, bentonite and mica.

In 1983 California produced 2.2 billion dollars worth of non-fuel minerals and about 1.2 billion of this came from the California Desert (Bureau of Mines Mineral Industry Surveys-Mineral Industry of California, 1983, and Tom Anderson (CDMG, Phone Conversation, 4-21-84)). Part of this latter amount was produced from mines in the study area. In the coming decades the California Desert and study area should be an important source of the mineral commodities that will aid the economy of California and the nation.

The following discussion highlights the geology and [illegible] of these mineral resources (see Plate 5).

Northern Providence Mountains

The northern Providence Mountains are [illegible] a high concentration of mineralized areas within [illegible] Providence Mountains fault system. The deposits [illegible] along faults and fractures in Precambrian gneiss [illegible] deposits that have been identified include [illegible] deposits, a copper deposit and a [illegible] peculiar nature of the Providence Mountains [illegible] that a district wide structurally controlled [illegible] through the Providence Mountains. This and [illegible] the [illegible] as a whole should be regarded as [illegible] potential. Active mineral exploration is currently [illegible]

Old Dad Mountain [illegible]

In the northern Old Dad Mountain Area there are [illegible] that consist of vein quartz with native gold and [illegible] faults and fractures in Precambrian rocks [illegible] realized from the district and because of its [illegible] system it is likely that additional gold deposits [illegible] probably be [illegible] because of the presence of [illegible] proximity to the mineralization beneath the [illegible]

In the [illegible] Old Dad Mountain area, high [illegible] associated with the Playground Thrust System a [illegible] this area mineralization includes native gold with [illegible] with quartz along with well-developed [illegible] along the thrust there are a number of [illegible] alternation and transported hydrated iron oxides suggesting that mineralization may be pervasively developed along the fault. Localization of gold mineralization along the Playground Thrust, past production of high grade gold from the Lucky mine which is situated in the thrust zone, existence of known gold resources at the Lucky mine, well developed hydrothermal alternation and the pervasive nature of the thrust provide evidence that a significant gold resource exists in the central Old Dad Mountain area.

The Old Dad vein deposit is in a canyon about a mile and half south of the Lucky mine in a skarn in Paleozoic carbonate rock. The deposit consists of magnetite and hematite with accessory pyrite and chalcopyrite near its western contact with carbonate rock. The deposit includes two main bodies of iron and several small ones that in total occupy a zone of about 700 feet of length and 250 feet of width. Laney (1954) provides a minimum inferred resource of 400,000 tons for the deposit. It is probable that the actual tonnage is much larger because the deposit maintains a reasonable degree of continuity at depth. Its proximity to a railroad a few miles to the south provides additional interest for the deposit.

Elsewhere in the central Old Dad Mountain area and the nearby Cowhole Mountains there are Paleozoic age carbonate rocks and quartzite with possible significant resource value.

New York Mountains

There are several mineralized areas in the central New York Mountains which include deposits of molybdenum, copper, tungsten, silver, lead, zinc, fluorite, carbonate rock and sericite.

The most prominent of these is a porphyry molybdenum deposit which includes a zone containing noteable development of stockwork quartz rock that carries molybdenite, pyrite and chacopyrite enclosed by hydrothermally altered Laramide age quartz monzonite. The area is laced with a number of quartz veins that contain varying amounts of copper, lead, zinc, fluorite and accessory gold and silver.

On the northeast side of the New York Mountains a deposit of sericite is held by Pfizer, Inc., that has yielded production in recent time. The deposit occurs in a northeast trending series of altered metavolcanic rock.

Limestone and dolomite occur in the Sagamore mine area in the eastern New York Mountains, in Paleozoic age carbonate rock. According to test data provided by the owner, Pluess-Staufer, Inc., this deposit is of sufficient quality to be used as a raw material for the chemical and plastics industry.

Halloran Summit Area

Two significant mineral areas occur in the Halloran Summit area, including a gold and talc deposits.

alternation and transported hydrated iron oxides, suggesting that mineralization may be pervasively developed along the fault. Localization of gold mineralization along the [illegible] fault, past production of high grade gold from the Lucky mine which is situated in the thrust zone, existence of known gold resources at the Lucky mine, well developed hydrothermal alternation and the pervasive nature of the thrust provides evidence that a significant gold resource exists in the [illegible] area.

The [illegible] vein deposit is in a canyon about 2 miles [illegible] of the Lucky mine in a [illegible] in Paleozoic carbonate rock. The deposit consists of magnetite and hematite with secondary pyrite and chalcopyrite near the [illegible] contact with carbonate rock. The deposit includes two main [illegible] bodies and several small ones that in outcrop occupy a zone of about [illegible] feet of length and 250 feet of width. [illegible] (1955) provides an estimate [illegible] of 400,000 tons for the deposit. It is probable that the deposit is [illegible] target because the deposit [illegible] at depth. Its proximity to a railroad a few miles [illegible] additional interest for the deposit.

Elsewhere in the central [illegible] Mountains also [illegible] Rocks are Paleozoic and Cenozoic [illegible] significant minerals noted.

New York Mountains

There are several mineralized areas in the [illegible] include deposits of molybdenum, copper, [illegible] and [illegible].

The most prominent of these is [illegible] which contains [illegible] porphyry [illegible] and [illegible]. The [illegible] contains [illegible] of [illegible] with [illegible].

In the northeast [illegible] of the New York Mountains [illegible] by [illegible], 1962 [illegible] to a northeast trending [illegible].

Limestone and dolomite occur in the [illegible] Mountains, in [illegible] and [illegible] by the [illegible], [illegible], Inc., 1979. [illegible] be used as a raw material for the cement and glass industry.

[illegible] Area

Two significant mineral areas occur in the following [illegible] area, including gold and talc deposits.

The gold bearing area includes the Telegraph mine, the Lost Lead claim group and other nearby mine workings. Mineralization include 2 parallel stockwork veins in silicified quartz monzonite, that follow a northeast trend. During the period 1932 to 1948 the deposit yielded over 2,800 ounces of gold, Recent drilling by Cascade Energy and Minerals Corporation show that significant tonnages of gold-bearing vein matter remain in the mine area. Additional mineralized ground extends beyond the area for which gold resources have been established.

Talc deposits are about 2.5 miles northeast of the Telegraph mine and include the Yucca Grove Mine. They consist of two roughly parallel massive, blocky beds of tremolitic talc. Where exposed, the talc trends N 55 W and can be traced for about 2,000 feet. Data submitted by the mine operator coupled with field study of the area indicate that a significant body of talc is available.

Cima Volcanic Field

The Cima Volcanic field, is in the east central part of the study area, is about a 40 square mile area of basaltic lava beds and attendant cinder cones. Cinders from the cones are currently being mined and several of the remaining cones contain similar material. The overall tonnage available at the site where mining is active constitutes a significant resource of this material.

Mescal Range

The Mescal Range is the locus of the most important skarn system in the east Mojave desert. In addition, significant undeveloped carbonate rocks occur in the range.

The Mescal Range skarn system can be traced for a linear distance of at least 10 miles along its northerly trend on the west side of the range. Deposits contain tungsten, copper and tin bearing minerals along with magnetite, epidote, garnet, serpentine, pyroxine, chlorite and quartz. Skarn occurs in Paleozoic carbonate rock adjacent to its contact with quartz monzonite. To the north and west of the main skarn zone is an area in which there are at least 9 silver-lead-zinc deposit with accessory copper that are considered to be skarn related because they possess some of characteristics of mineral assemblages that typify both skarns and hydrothermal deposits. The main skarn system includes 16 individual mineralized locales and has a history of past production, overall continuity, and the presence of inferred resources. The Mohawk mine area has a history of past production and known resources of significance remaining. In addition, based upon the geology of the area there is a fair chance that lateral extensions of known mineralization extends to the north beneath the alluvium.

A magnetometer survey of the main skarn system that was conducted with the field study by California Division of Mines and Geology showed a strong magnetitic anomaly extending for a distance in excess of a 1,000 feet beyond the skarn that could be directly correlated with one of the mines from which production had been realized in the past.

The gold bearing area includes the Telegraph mine, the Lost Load claim group and other nearby mine workings. Mineralization include 2 parallel stockwork veins in silicified quartz monzonite, that follow a northeast trend. During the period 1932 to 1942 the deposit yielded over 7,000 ounces of gold. Recent drilling by Cascade Energy and Minerals Corporation show that significant tonnages of gold-bearing vein matter remain in the mine area. Additional mineralized ground extends beyond the area for which gold resources have been established.

Talc deposits are about 2.5 miles northeast of the Telegraph mine and include the Yucca Grove Mine. They consist of two roughly parallel lenslike, blocky beds of tremolitic talc. Where exposed, the talc trends N 55 W and can be traced for about 2,000 feet. Data submitted by the mine operator together with field study of the area indicate that a significant body of talc is available.

Cima Volcanic Field

The Cima volcanic field, is in the east central part of the [illegible] about a 40 square mile area of basaltic lava beds and [illegible] Cinders from the cones are currently being mined and [illegible] cones contain similar material. The overall tonnage [illegible] where mining is active constitutes a significant resource [illegible]

Mescal Range

The Mescal Range is the locus of the most important strategic [illegible] Mojave Desert. In addition, significant undeveloped [illegible] the range.

The Mescal Range skarn system can be traced for [illegible] 10 miles along the northerly trend on the west side of the range. [illegible] contain tungsten, copper and tin bearing minerals [illegible] epidote, garnet, serpentine, pyroxene, chlorite [illegible] Paleozoic carbonate rock adjacent to its contact with [illegible] the north end west of the main skarn zone is an area [illegible] least 3 silver-lead-zinc deposit with [illegible] be skarn related because they contain some of [illegible] assemblages that typify both skarns and [illegible]. The main skarn system includes 15 individual mineralized bodies [illegible] production, overall continuity, and the presence of [illegible]. The Bonanza mine area has a history of gold production and known reserves of significance remaining. In addition, based upon the geology of the area there is a fair chance that lateral extensions of known mineralization extends to the north beneath the alluvium.

A magnetometer survey of the main skarn system that was conducted with the field study by California Division of Mines and Geology showed a strong magnetic anomaly extending for a distance in excess of 4,500 feet beyond the skarn that could be directly correlated with one of the mines from which production had been realized in the past.

A significant carbonate rock deposit held by Georgia Marble Company occurs on the east slopes of Striped Mountain a short distance south of the Mescal Range. The deposit is Paleozoic carbonate rocks of the Goodsprings Dolomite, Sultan Limestone and Monte Criste Limestone, and extends for a distance of about 2 miles along a northern trend and averages approximately 0.5 miles in width. Data provided by the Georgia Marble Company indicates the deposit contains high quality limestone and dolomite. Because of the extensive size of the deposit, its local high quality and overall continuity it is regarded as an important deposit.

Elsewhere in the Mescal Range there are local hydrothermal gold and silver-lead-zinc deposits that occupy faults in quartz monzonite, however, information is not available to determine if any are significant. In addition to these deposits, there are wide expanses of Paleozoic carbonate rock that may represent significant mineral resources. However, there is insufficient sample and test data to determine their significance.

Clark Mountain Area

The Clark Mountain area is a highly mineralized and hosts deposits of cerium group rare-earth elements, gold, silver, antimony, lead, silver, zinc, copper, fluorite, silica, gypsum and limestone.

Without doubt the most well known mineralization in the eastern Mojave Desert is the rare-earth element mineral deposit in the Mountain Pass area at the south end of the Clark Mountain. In April 1949, a vein containing bastnaesite ($REFCO_3$), a fluocarbonate of cerium group rare-earths, was discovered near the Sulphide Queen gold mine. Subsequent prospecting led to the discovery of numerous veins, dikes, sills and a main body of carbonatite in Precambrian gneiss and schist in a northwestward-trending belt about 7 miles long and a mile wide. The veins and main carbonatite body are characterized by barite, strontianite, calcite, quartz, galena, bastnaesite, fluorite, crocidolite, and other minerals. The main carbonatite body is a north trending sill with a maximum dimension of 700 feet (Evans, 1966). Production by Union Molycorp, Inc., from this ore body represents a major contribution to the world supply of cerium group rare-earth elements. The deposit which is the largest known one of its kind in the world has sufficient reserves to continue to be a global supplier of rare-earths for a considerable time into the future.

In a number of areas around Mountain Pass there are exposures of fenitized (sodium and potassium metasomatised) country rock representing a characteristic type of alternation associated with carbonatities. Areas in which fenitized rocks occur provide indirect evidence that additional rare-earth element mineralization may be present.

Approximately 6 miles northeast of the Mountain Pass deposit is another important mineral resource area, the site of the Colosseum mine. The deposit consists of two hydrothermally altered Mesozoic age rhyolite breccia pipes. The pipes are approximately 500 feet wide by 700 feet in length and connect at depth. The breccia pipe contains disseminated gold and altered fragments of a variety of older rock types. The deposit consists of several million tons of gold bearing rock comparable in grade to other deposits being mined elsewhere in the western United States.

A significant carbonate rock deposit held by [illegible] Marble Company occurs on the east slopes of Striped Mountain a short distance south of the Mescal Range. The deposit is Paleozoic carbonate rocks of the Goodsprings Dolomite, Sultan Limestone and Monte Cristo Limestone, and extends for a distance of about 2 miles along a northern trend and averages approximately 0.4 miles in width. Data provided by the [illegible] Marble Company indicates the deposit contains high quality limestone and dolomite. Because of the extensive size of the deposit, its local high quality and overall continuity it is regarded as an important deposit.

Elsewhere in the Mescal Range there are small hypothermal gold and silver-lead-zinc deposits that occupy faults in quartz monzonite. However, information is not available to determine if any are significant. In addition to these deposits, there are wide expanses of Paleozoic carbonate rock that may represent significant mineral resources. However, further [illegible] sample and test data is required to determine their significance.

Clark Mountain Area

The Clark Mountain area is a highly mineralized area [illegible] rare-earth elements, gold, silver, antimony, [illegible] fluorite, silica, gypsum and limestone.

Without doubt the most well known mineralization [illegible] is the rare-earth element mineral deposit [illegible] south end of the Clark Mountains [illegible] (MR[illegible]) [illegible] the Sulphide Queen gold mine [illegible] [illegible] [illegible] mile wide [illegible] [illegible] [illegible] [illegible] of [illegible] rare-earth elements [illegible] one of the [illegible] global supplier of rare-earths for a wide [illegible]

In a number of areas around Mountain Pass [illegible] and [illegible] metamorphic [illegible] characteristic type of alteration [illegible] which [illegible] rare-earth element mineralization may be present.

Approximately 4 miles northwest of the Mountain Pass deposit is [illegible] mineral resource area [illegible] the Colosseum mine. The deposit consists of [illegible] The pipe is approximately 500 feet wide by 300 feet [illegible] The [illegible] gold [illegible] The deposit [illegible] is comparable in [illegible] being mined [illegible] in the western United States.

Kingston Wash

A high quality bentonite deposit is currently being mined by American Colloid Company about one-half mile south of Kingston Wash near the western boundary of the study area. The deposit occurs in Tertiary lake beds that trend east-west and dip about 25° north. Sufficient bentonite of high quality exists in the deposit to be considered a significant resource.

Perspective View

This brief excursion through some of the more important known mineral resource areas of the study area was to provide some idea on its overall value as a long term supply source of mineral commodities for California and the nation. There are many more areas here that probably conceal a great number of deposits, if analogy can be made with the distribution of those known from the surrounding mountain ranges. However, it is beyond the scope of this report to enter into a lengthy, detailed discussion of each mineral resource area. The interested reader can find more detailed information in the files and publications of the California Division of Mines and Geology (see Evans, 1971, 1974, and 1975; Greenwood, 1984, 1984, and 1985; Hewett, 1956; Joseph, 1984, and 1985; Kohler, 1984; Wright, 1953). However, based upon what has been presented it is clear that the study area can be characterized as highly mineralized and one that contains many areas of high and moderate mineral potential.

FLUID MINERAL RESOURCES

There is no known potential for geothermal resources. An examination of recent geothermal maps of California show no hot springs on areas of abnormal heat flow within the Mineral Impact Study Area (Higgins and Martin, 1980, and Majmundar, 1983).

Oil and gas potential is not known. There is no recorded production, and only 3 oil and gas wells have been drilled in the study area (California Division of Oil and Gas, Well Summary Reports, 1970). These wells are in the Ivanpah Valley west and south southwest of Nipton. They are:

Ramseyer 1-35; TD 3,500'; S. 35, T. 16 N., R. 15 E.; OG shows reported
Ivanpah 1-23; TD 2,440'; S. 23, T., 15½ N., R. 15 E.; OG shows reported
Ivanpah 13; TD 6,502'; S. 5, T., 15 N., R. 16 E.

In the Ivanpah Valley, however, seismic refraction, gravity and magnetic measurements show as much as 8,000 feet of fine to medium grained clastic rocks in an asymmetrical graben (Carlisle and others, 1980).

Interest in oil and gas by individuals and by oil and gas companies in the Mineral Impact Study ARea has been high as shown by the fact that 35 percent of it is covered by oil and gas leases. Interest probably is a result of recent geologic and seismic data that suggest that overthrust belts similar to those in the Idaho-Wyoming overthrust belt exist in the Mojave Desert and the study area (Calzia and others, U.S. Geological Survey, unpublished administrative report, 1981).

Kingston Wash

A high quality bentonite deposit is currently being mined by Americ[illegible] Colloid Company about one-half mile south of Kingston Wash near the eastern boundary of the study area. The deposit occurs in Tertiary [illegible] beds that trend northwest and dip about 45° north. Sufficient [illegible] and high quality [illegible] in the deposit to be considered a significant resource.

Perspective View

This brief excursion through some of the more important [illegible] areas of the study area was to provide some idea of the [illegible] long term supply source of mineral commodities for California [illegible]. There are many more areas here that probably contain [illegible] deposits, if analogy can be made with the [illegible] surrounding mountain ranges. However, it is beyond [illegible] to enter into a lengthy, detailed discourse [illegible]. The interested reader can find more details in [illegible] publications of the California Division of Mines and Geology [illegible] 1914, and 1919; [illegible], 1980, 1984, and [illegible] and 1985; [illegible], 1988; Wright, 1953). [illegible] presented it is clear that the study area [illegible] mineralized and one that contains many [illegible] potential.

Fluid Mineral Resources

There is no known potential for geothermal resources [illegible] recent geothermal maps of California show no [illegible] heat flow within the mineral [illegible] (Higgins?, 1980).

Oil and gas potential is not known [illegible] 3 oil and gas wells have been drilled in the [illegible] of oil and gas well [illegible] (1980) [illegible] Valley well and south [illegible] of [illegible]:

- [illegible] 1-32; T9 [illegible]
- [illegible] 1-24; T8 [illegible]
- [illegible] #3; T9 [illegible]

In the [illegible] Valley, however, [illegible] measurements show [illegible] depth of 4,000 [illegible] to an asymmetrical graben (Griscom and others, 1980).

Interest in oil and gas by [illegible] leasing by oil and gas companies [illegible] mineral impact [illegible] has been shown by the [illegible] of it is covered by oil and gas leases. Interest apparently is a result [illegible] recent geologic and seismic data that suggest that [illegible] traps [illegible] some of the [illegible] overthrust belt exist in the [illegible] and the study area (Grijalva and others, U.S. Geological Survey, [illegible] [illegible] report, 1983).

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MESQUITE LAKE, CALIFORNIA–NEVADA
30X60 MINUTE SERIES (TOPOGRAPHIC)
PLATE 1
MAP SHOWING
TOPOGRAPHY
IN THE
MINERAL IMPACT
STUDY AREA
San Bernardino County, California
1986
EXPLANATION
Mineral Impact Study Area Boundary
Proposed Mojave Park Boundary
116° 00'
Roach Lake
35° 45'
Kingston Peak
Clark Mtn
NEV.
CALIF.
Halloran Springs
Mescal Range
Ivanpah
Old Dad Mtn
Kelso
Mid Hills
35° 00'
115° 15'
INDEX MAP
For Minerals Impact Study Area
by U.S. Geological Survey Quadrangle
Topographic Map Symbols
EAST MOJAVE
NATIONAL SCENIC AREA
Produced by the United States Geological Survey
MESQUITE LAKE
Compiled from USGS 1:62 500-scale topographic maps dated 1955-1960. Planimetry revised from aerial photographs taken 1976 and other source data. Revised information not field checked. Map edited 1985
IVANPAH
Compiled from USGS 1:24 000-scale topographic maps dated 1983-1984. Planimetry revised from aerial photographs taken 1980 and other source data. Revised information not field checked. Map edited 1985
Projection and 10 000-meter grid, zone 11,
Universal Transverse Mercator
25 000-foot grid ticks based on California coordinate system, zone 5 and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 3 meters north and 76 meters east
There may be private inholdings within the boundaries of the National or State reservations shown on this map


EAST MOJAVE
NATIONAL SCENIC AREA
Compiled from USGS 1:62 500-scale topographic maps dated 1955-1960. Planimetry revised from aerial photographs taken 1976 and other source data. Revised information not field checked. Map edited 1985
IVANPAH
Compiled from USGS 1:24 000-scale topographic maps dated 1983-1984. Planimetry revised from aerial photographs taken 1980 and other source data. Revised information not field checked. Map edited 1985
Projection and 10 000-meter grid, zone 11, Universal Transverse Mercator
25 000-foot grid ticks based on California coordinate system, zone 5 and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 3 meters north and 76 meters east
There may be private inholdings within the boundaries of the National or State reservations shown on this map
IVANPAH VALLEY
NEW YORK MOUNTAINS
LANFAIR VALLEY
PIUTE VALLEY
PIUTE RANGE
CINDER CONE LAVA BEDS
Cima Dome
Mescal Range
Kelso Mountains
Providence Mountains
DEVILS PLAYGROUND
SAND
SCALE 1:100 000
1 CENTIMETER ON THE MAP REPRESENTS 1 KILOMETER ON THE GROUND
CONTOUR INTERVAL 50 METERS
IVANPAH, CALIFORNIA—NEVADA
35115-A1-TM-100
1985


PLATE 2
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MESQUITE LAKE, NEV.—CALIF.
1978
MESQUITE LAKE QUADRANGLE
NEVADA—CALIFORNIA
1:100 000-SCALE SERIES (PLANIMETRIC)
MAP SHOWING CALIFORNIA
DESERT CONSERVATION AREA
WILDERNESS STUDY AREA
BOUNDARIES AND NUMBERS
FOR THE
MINERAL IMPACT STUDY
AREA
San Bernardino County, California
1986
Assembled By J. R. Evans, Senior Technical Minerals Specialist
K. C. Aldridge, Division of Operations
Graphics By P. Cranston, Division of Resources
K. C. Aldridge, Division of Operations
EXPLANATION
Mineral Impact Study Area Boundary
Proposed Mojave Park Boundary
California Desert District Wilderness Study Area Boundaries and Numbers
"California Desert Protection Act of 1986" Boundaries
INDEX MAP
For Minerals Impact Study Area by U.S. Geological Survey Quadrangle
Kingston Peak
Clark Mtn
NEV. CALIF.
Halloran Springs
Mescal Range
Ivanpah
Old Dad Mtn.
Kelso
Mid Hills
Roach Lake
116° 00'
35° 45'
35° 00'
115° 15'
STATE BURRO SANCTUARY
KINGSTON RANGE WSA CDCA 222
N. MESQUITE MTNS WSA CDCA 223
MESQUITE MTNS WSA CDCA 225
STATE LINE WSA CDCA 225A
CLARK MTN WSA CDCA 227
Mesquite Lake
INYO CO
SAN BERNARDINO CO
CLARK CO
INYO CO
MESQUITE
VALLEY
RANGE
SHADOW
VALLEY
SPRING
MOUNTAINS
IVANPAH
MC CULLOUGH
ELDORADO
RANGE
VALLEY
HIGHLAND RANGE
BIGHORN
SHEEP AREA
Pahrump
Valley
California
Valley
KINGSTON
Mescal
Range
NEVADA
CALIFORNIA
VON SCHMIDT LINE (1873)
RED ROCK CANYON RECREATION LANDS

Produced by the Geological Survey
in cooperation with the Bureau of Land Management

Compiled from USGS 1:62 500-scale topographic maps dated 1955–56
Planimetry revised from aerial photographs taken 1975
and other source data. Revised information not field checked
Map edited 1979

Projection and 10 000-meter grid, zone 11,
Universal Transverse Mercator
50 000-foot grid ticks based on California coordinate system,
zone 5, and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move
the projection lines 3 meters north and 76 meters east

Dashed gray lines indicate protracted land lines

There may be private inholdings within the boundaries of
the National or State reservations shown on this map

INDEX TO 1:62 500-SCALE MAPS

SCALE 1:100 000

ELEVATIONS SHOWN IN METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by 0.3048

This map complies with national map accuracy standards
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

LEGEND

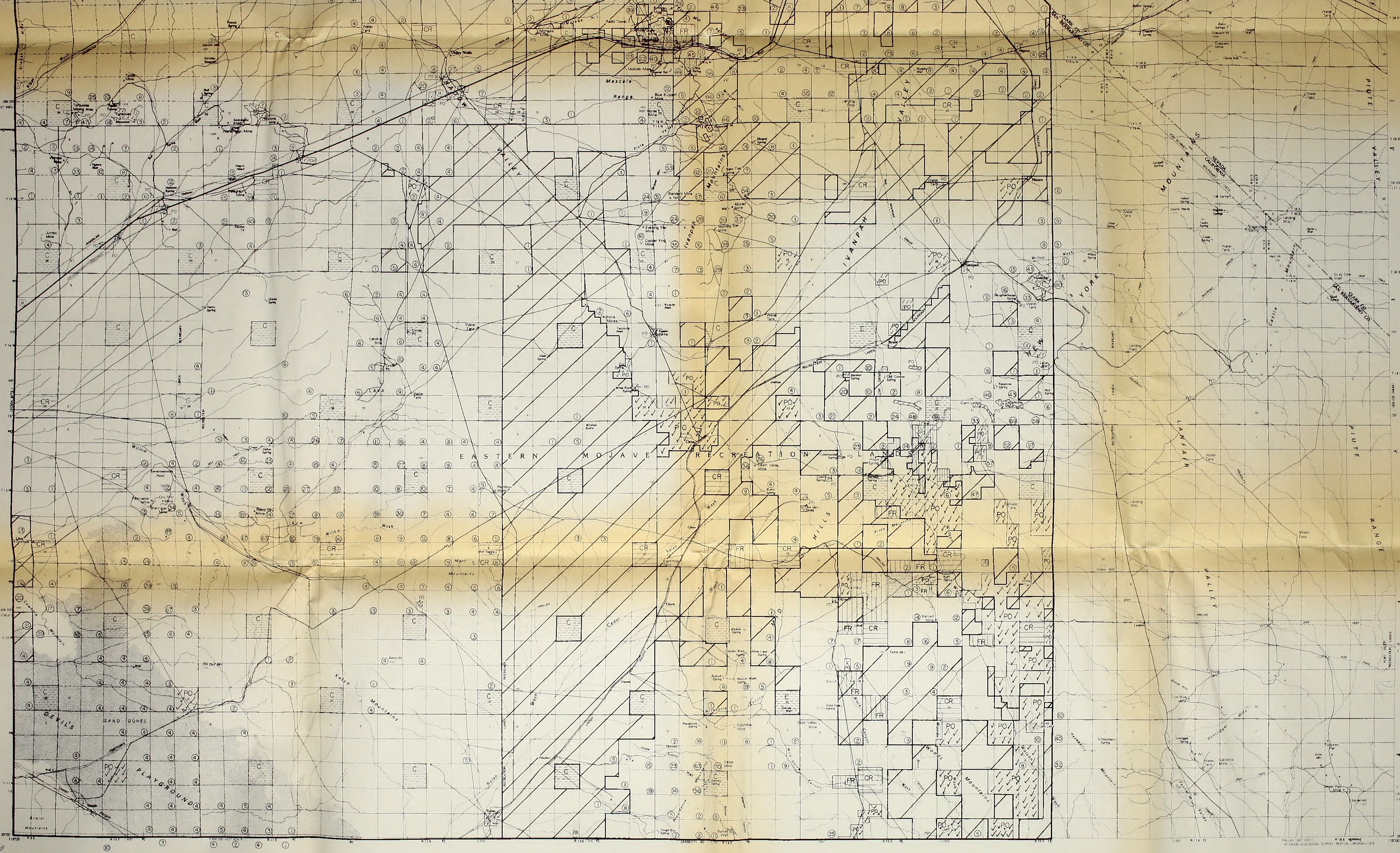
- Village or locality
- Landmark building
- Perennial stream, lake
- Intermittent stream, lake

ROAD CLASSIFICATION

- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Street or other road
- Trail
- Interstate route · U.S. route · State route

IVANPAH, CALIF.–NEV.
SW/4 KINGMAN (NI 11-3) 1:250 000-SCALE MAP
N3500–W11500/30x60
1979


PLATE 3
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MESQUITE LAKE, NEV.—CALIF.
N3530—W11500/30X60
1978
MESQUITE LAKE QUADRANGLE
NEVADA—CALIFORNIA
1:100 000-SCALE SERIES (PLANIMETRIC)
MAP SHOWING
SURFACE-MINERAL MANAGEMENT
STATUS IN THE MINERAL IMPACT
STUDY AREA
San Bernardino County, California
1986
EXPLANATION
Privately Owned Lands
California State Lands
California State Reserved Mineral Lands
Public Lands
Federally Reserved Mineral Estate Lands
Public Water Reserves
Oil & Gas Leases
Mining Claims (No. per section)
Mineral Impact Study Area Boundary
DATA SUMMARY (approximate)
39,040 ac.; 61 sq. mi.; 3%
47,153 ac.; 74 sq. mi.; 4%
14,388 ac.; 23 sq. mi.; 1%
1,170,918 ac.; 1830 sq. mi.; 92%
8501 ac.; 13 sq. mi.; 0.7%
1000 ac.; 1.6 sq. mi.; 0.08%
450,554 ac.; 704 sq. mi.; 492 leases; 35%
352,650 ac.; 551 sq. mi.; 8646 claims; 28% (figures include lode/placer claims and mill sites)
1,280,000 ac.; 2000 sq. mi.
Prepared By J. R. Evans, Senior Technical Minerals Specialist
Data Analysis and Graphics By K.C. Aldridge, Division of Operations
Data Assembled By P. Cranston, Division of Resources
R. Fairbanks, Chief, Locatable Minerals
B. Gaulhier-Warinner, Land Law Examiner
INDEX MAP
For Minerals Impact Study Area by U.S. Geological Survey Quadrangle
Kingston Peak
Clark Mtn
NEV. CALIF.
Halloran Springs
Mescal Range
Ivanpah
Old Dad Mtn
Kelso
Mid Hills
Roach Lake
STATE BURRO SANCTUARY
HIGHLAND RANGE BIGHORN SHEEP AREA
MESQUITE VALLEY
SHADOW VALLEY
CLARK MOUNTAIN RANGE
IVANPAH VALLEY
SPRING MOUNTAINS
Mesquite Lake
Roach Lake



Produced by the Geological Survey
in cooperation with the Bureau of Land Management

Compiled from USGS 1:62 500-scale topographic maps dated 1955–56
Planimetry revised from aerial photographs taken 1975
and other source data. Revised information not field checked
Map edited 1979

Projection and 10 000-meter grid, zone 11,
Universal Transverse Mercator
50 000-foot grid ticks based on California coordinate system, zone 5, and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move the projection lines 3 meters north and 76 meters east

Dashed gray lines indicate protracted land lines

There may be private inholdings within the boundaries of the National or State reservations shown on this map

INDEX TO 1:62 500-SCALE MAPS

1 Halloran Spring - 1956
2 Mescal Range - 1955
3 Ivanpah - 1956
4 Crescent Peak - 1956
5 Old Dad Mtn. - 1956
6 Kelso - 1955
7 Mid Hills - 1955
8 Lanfair Valley - 1956

UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:100 000

KILOMETERS

MILES

FEET

ELEVATIONS SHOWN IN METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by 0.3048

QUADRANGLE LOCATION

LEGEND

- Village or locality
- Landmark building
- Perennial stream, lake
- Intermittent stream, lake

ROAD CLASSIFICATION

- Primary highway, hard surface
- Secondary highway, hard surface
- Light-duty road, hard or improved surface
- Street or other road
- Trail
- Interstate route
- U.S. route
- State route

This map complies with national map accuracy standards
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

IVANPAH, CALIF.–NEV.

SW/4 KINGMAN (NI 11-3) 1:250 000-SCALE MAP
N3500–W11500/30x60

1979


PLATE 4
MESQUITE LAKE QUADRANGLE
NEVADA—CALIFORNIA
1:100 000-SCALE SERIES (PLANIMETRIC)
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MESQUITE LAKE, NEV.—CALIF.
1978
GEOLOGIC MAP
OF THE
MINERAL IMPACT STUDY
AREA
San Bernardino County, California
1986
Compiled and simplified by J. R. Evans, Senior Technical Minerals Specialist
Graphics by K. C. Aldridge, R. M. Bradley and D. E. Vinton, Division of Operations
Compiled from published and unpublished geologic maps prepared and/or compiled by the California Division of Mines and Geology. (Unpublished data subject to revision.)
SEDIMENTARY AND METAMORPHIC ROCKS
CENOZOIC
Qa Alluvium, dune sand, and older alluvium
Ql Quaternary lake bed deposits
Tfcm Fanglomerate; monolithic carbonate megabreccia
Tlb Tertiary lake bed deposits
Td Dolomite
MESOZOIC
Ja Aztec Sandstone
Trm Chinle (sandstone) and Moenkopi (limestone) Formations
PALEOZOIC
Pk Kaibab Limestone
Pms Supai Formation (limestone, gypsum, and shale)
Pb Bird Spring Formation (carbonate rock and quartzite)
Єm Monte Cristo Limestone
Ds Sultan Limestone
DЄg Goodsprings Dolomite
Єn Nopah Formation (dolomite)
Єbk Bonanza King Formation (limestone and dolomite)
Єc Carrara Formation (siltstone, shale, quartzite and dolomite)
Єba Bright Angel Shale
Єp Pioche Shale
Єz Zabriskie Quartzite
Єt Tapeats Sandstone
Єwc Woods Canyon Formation (quartzite, siltstone, and dolomite)
Pzls Undivided Paleozoic limestone
Єsu Undivided Cambrian sedimentary rocks
ЄPЄsu Undivided Paleozoic and Upper Precambrian sedimentary rocks
PЄsu Undivided Upper Precambrian sedimentary rocks
PRECAMBRIAN
PЄsq Stirling Quartzite
PЄJ Johnie Formation (quartzite, siltstone, and dolomite)
PЄn Noonday Dolomite
PЄkp Kingston Peak Formation (sandstone, siltstone, mudstone, conglomerate)
PЄbs Beck Springs Dolomite
PЄcs Crystal Springs Formation (metaclastic rocks, carbonate rocks, chert)
PЄr Precambrian rocks (granitic gneiss, sillimanite gneiss, augen gneiss, hornblende gneiss, amphiblite, quartzite, quartz mica schist, marble; pegmatite
VOLCANIC ROCKS
CENOZOIC
QTVb & QTvc Quaternary and Late Tertiary basalt flows and associated cinder cones
Tvr Tertiary volcanics including basalt, rhyolite, and andesite, flows of Miocene age; interbedded high-silica alkali rhyolite flows and lithic airfall tuffs, three high silica alkali rhyolite and interbedded lithic airfall tuffs, and rhyolitic airfall tuffs with several interbedded rhyolite flows and local epiclastic sediments
MESOZOIC
Kr Rhyolite breccia pipes
Jmr Mountain Pass Rhyolite (Delfonte Dacite of Hewitt)
Mvru Undivided Mesozoic volcanic and metavolcanic rocks
INTRUSIVE ROCKS
CENOZOIC
Ti Undivided Tertiary rocks including andesite, basalt, dacite, felsic hypabyssal rocks, hypabyssal high-silica alkali rhyolite, and endogeneous porphyritic dacite domes
MESOZOIC
Kti Tuetonia Quartz monzonite, and other porphyritic quartz monzonites
Kg Porphyritic gabbro
Mzgr Undivided Mesozoic granitic rocks
PRECAMBRIAN
PЄdb Diabase
PЄsh Biotite - rich syenite, and shonkinite
PЄcs Carbonatite, syenite, and granite
MAP SYMBOLS
Geologic contact (dashed where inferred)
Fault trace (dashed where approximated or inferred, dotted where concealed)
Thrust fault-barb on upper plate (dashed where approximated, dotted where concealed)
10 Attitude of bedding
15 Attitude of foliation
Volcanic vent
Tertiary (?) quartz stockwork veins
INDEX MAP
For Minerals Impact Study Area by U.S. Geological Survey Quadrangle
Roach Lake
Kingston Peak
Clark Mtn
NEV. CALIF.
Halloran Springs
Mescal Range
Ivanpah
Old Dad Mtn.
Kelso
Mid Hills
116° 00'
115° 15'
35° 45'
35° 00'
STATE BURRO SANCTUARY
Pahrump Valley
California Valley
KINGSTON RANGE
MESQUITE VALLEY
Mesquite Lake
SHADOW MOUNTAINS
SHADOW VALLEY
IVANPAH VALLEY
Ivanpah Lake
Roach Lake
VON SCHMIDT LINE (1873)
CLARK CO
INYO CO
SAN BERNARDINO CO
ELDORADO VALLEY
Piute Valley
Highland Range
HIGHLAND RANGE BIGHORN SHEEP AREA
McCullough Range
Valjean Valley

Produced by the Geological Survey
In cooperation with the Bureau of Land Management

Compiled from USGS 1:62 500-scale topographic maps dated 1955–56
Planimetry revised from aerial photographs taken 1975
and other source data. Revised information not field checked
Map edited 1979

Projection and 10 000-meter grid, zone 11,
Universal Transverse Mercator
50 000-foot grid ticks based on California coordinate system,
zone 5, and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move
the projection lines 3 meters north and 76 meters east

Dashed gray lines indicate protracted land lines

There may be private inholdings within the boundaries of
the National or State reservations shown on this map

INDEX TO 1:62 500-SCALE MAPS

1	2	3	4
5	6	7	8

1 Halloran Spring—1956
2 Mescal Range—1955
3 Ivanpah—1956
4 Crescent Peak—1956
5 Old Dad Mtn—1956
6 Kelso—1955
7 Mid Hills—1955
8 Lanfair Valley—1956

SCALE 1:100 000

KILOMETERS 1 0 1 2 3 4 5 6 7 8 9 10

MILES 1 0 1 2 3 4 5

FEET 5000 0 5000 10000 15000 20000 25000

ELEVATIONS SHOWN IN METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by 0.3048

This map complies with national map accuracy standards

FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

LEGEND

Village or locality	
Landmark building	
Perennial stream, lake	
Intermittent stream, lake	

ROAD CLASSIFICATION

Primary highway, hard surface	
Secondary highway, hard surface	
Light-duty road, hard or improved surface	
Street or other road	
Trail	

Interstate route U.S. route State route

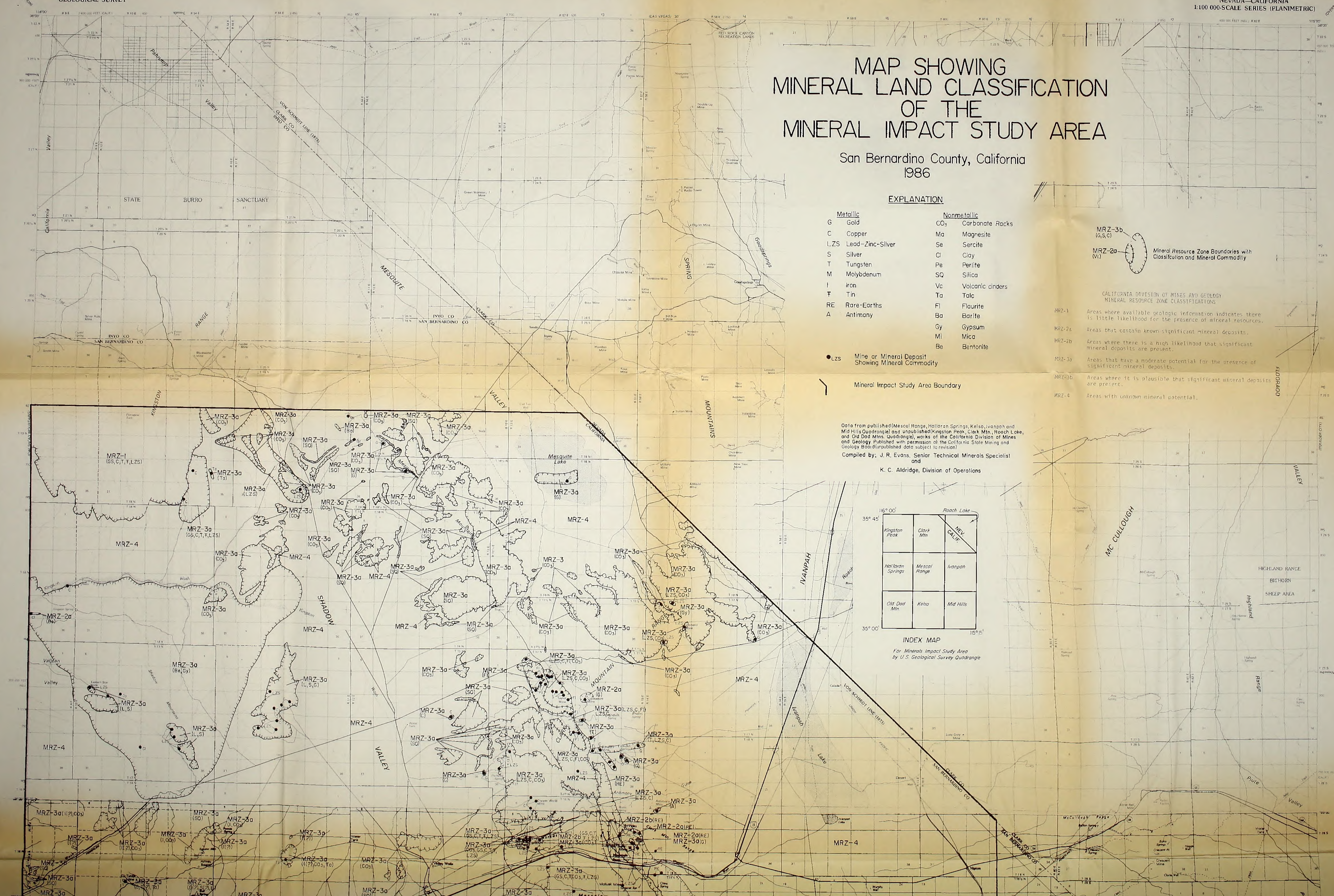
IVANPAH, CALIF.–NEV.
SW/4 KINGMAN (NI 11-3) 1:250 000-SCALE MAP
N3500–W11500/30x60
1979

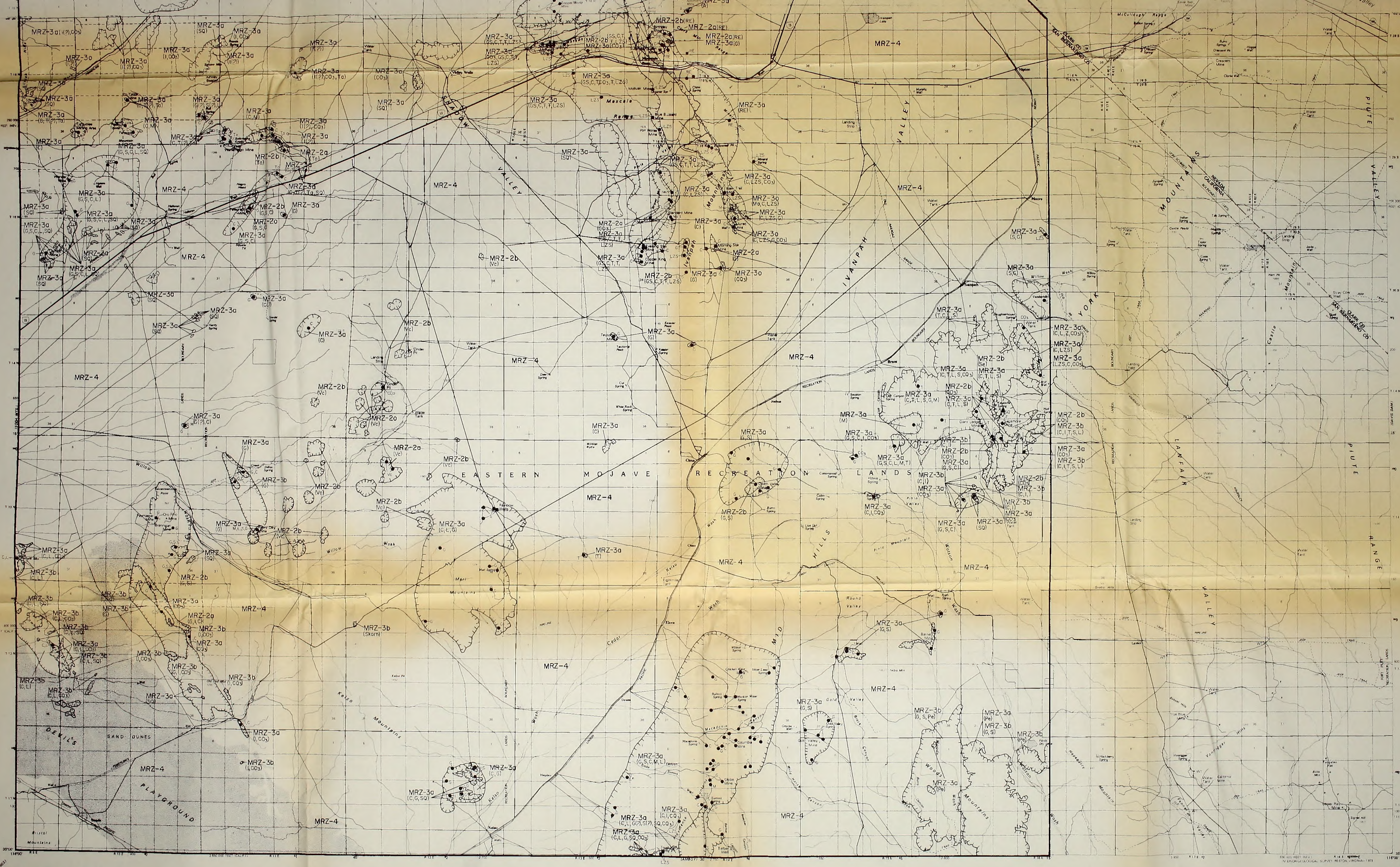
PLATE 5

MESQUITE LAKE, NEV.—CALIF.
1978

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MESQUITE LAKE QUADRANGLE
NEVADA—CALIFORNIA
1:100 000-SCALE SERIES (PLANIMETRIC)





Produced by the Geological Survey
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Compiled from USGS 1:62 500-scale topographic maps dated 1955–56
Planimetry revised from aerial photographs taken 1975
and other source data. Revised information not field checked
Map edited 1979

Projection and 10 000-meter grid, zone 11,
Universal Transverse Mercator
50 000-foot grid ticks based on California coordinate system,
zone 5, and Nevada coordinate system, east zone
1927 North American Datum
To place on the predicted North American Datum 1983 move
the projection lines 3 meters north and 76 meters east

Dashed gray lines indicate protracted land lines

There may be private inholdings within the boundaries of
the National or State reservations shown on this map

INDEX TO 1:62 500-SCALE MAPS

1 Halloran Springs
2 Mescal Range
3 Ivanpah - 1956
4 Crescent Peak
5 Old Dad Mtn
6 Kelso - 1955
7 Mid Hills - 1955
8 Lanfair Valley

SCALE 1:100 000

KILOMETERS

MILES

FEET

ELEVATIONS SHOWN IN METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
To convert meters to feet multiply by 3.2808
To convert feet to meters multiply by 0.3048

This map complies with national map accuracy standards
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

LEGEND

Village or locality
Landmark building
Perennial stream, lake
Intermittent stream, lake

ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Street or other road
Trail
Interstate route
U.S. route
State route

IVANPAH, CALIF. – NEV.

SW/4 KINGMAN (NI 11-3) 1:250 000-SCALE MAP
N3500 – W11500/30x60

1979

Wright, L.A., Troxel, B.W., Williams, E.G., Roberts, M.T., Diehl, P.E., 1976, Precambrian sedimentary environments of the Death Valley Region, eastern California, in Geologic features Death Valley, California: California Division of Mines and Geology Special Report 106, p. 7-15.

Yeend, W., Dohrenwend, J.C., Smith, R.S.U., Goldfarb, R., Simpson, R.W., Jr., and Munts, S.R., 1984, Mineral resources and mineral resource potential of the Kelso Dunes Wilderness Study Area (CDCA-250), San Bernardino County, California: U.S. Geological Survey Open-File Report 84-647, 19 p.