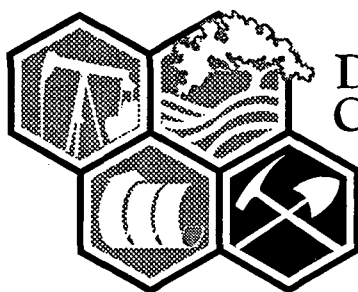


**MINERAL LAND CLASSIFICATION
OF A PART OF SOUTHWESTERN
SAN BERNARDINO COUNTY:
THE BARSTOW-NEWBERRY SPRINGS AREA,
CALIFORNIA**

1997



DEPARTMENT OF
CONSERVATION

Division of
Mines and Geology



DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, *STATE GEOLOGIST*

Copyright © 1997 by the California Department of Conservation, Division of Mines and Geology. All rights reserved. No part of this publication may be reproduced without written consent of the Division of Mines and Geology.

"The Department of Conservation makes no warranties as to the suitability of this product for any particular purpose."

**MINERAL LAND CLASSIFICATION
OF A PART OF
SOUTHWESTERN SAN BERNARDINO COUNTY:
THE BARSTOW-NEWBERRY SPRINGS AREA, CALIFORNIA**

By

Stephen P. Bezore, Associate Geologist
Division of Mines and Geology (DMG)

With Contributions by

Rodger H. Chapman, Senior Geophysicist, DMG, retired
Gordon W. Chase, Associate Geophysicist, DMG, retired
Leslie G. Youngs, Associate Engineering Geologist, DMG
Robert L. Hill, Senior Geologist, DMG
Russell V. Miller, Senior Geologist, DMG
Dinah O. Shumway, Associate Geologist, DMG

OPEN-FILE REPORT 97-16

1997

**CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
801 K STREET, MS 12-30
SACRAMENTO, CA 95814**

PREFACE

The Surface Mining and Reclamation Act of 1975 (SMARA) was enacted to promote the conservation of the State's mineral resources and to ensure adequate reclamation of mined lands. Among other provisions, SMARA requires the State Geologist to classify land in California for mineral resource potential. Presently, mineral land classification studies are being conducted in several areas of the state on a county basis.

Upon completion of each study, the State Geologist submits the mineral land classification report to the State Mining and Geology Board which accepts the report and transmits it to appropriate local governments that maintain jurisdictional authority in mining, reclamation, and related land-use activities. Within 12 months of receiving the mineral information, local governments are required to establish mineral resource management policies to be incorporated into their general plans, which must recognize the information submitted by the State Geologist. Among other considerations, the management policies will emphasize the conservation and development of identified mineral resources.

CONTENTS

	Page
PREFACE	i
EXECUTIVE SUMMARY	vii
Index of Plates	x
PART I - MINERAL LAND CLASSIFICATION PROJECT - BACKGROUND AND SUPPORTING INFORMATION	1
INTRODUCTION	1
Background	1
Scope	4
Fieldwork and Research	4
Geographic Setting	6
REGIONAL GEOLOGY	6
Pre-Mesozoic Rocks	8
Mesozoic Rocks	9
Cenozoic Rocks	10
Late Cenozoic Structure	11
MINING HISTORY	12
Gold and Silver	12
Calico District	12
Ord District	13
Borates	14
Calico Mountains	14
PART II - CALIFORNIA MINERAL LAND CLASSIFICATION SYSTEM	16
MRZ CATEGORIES	16
MINERAL RESOURCE/RESERVE CLASSIFICATION NOMENCLATURE ..	18
CLASSIFICATION CRITERIA	20
PART III - MINERAL LAND CLASSIFICATION OF METALLIC AND INDUSTRIAL MINERAL RESOURCES	21
MRZ NOTATION	22
AREAS CLASSIFIED FOR DEPOSITS FORMED BY HYDROTHERMAL PROCESSES	23
Areas Classified as MRZ-2b ^(h)	23
Calico Silver District, MRZ-2b ^(h-1)	23
Red Hill Deposit, MRZ-2b ^(h-2)	24
Areas Classified as MRZ-3a ^(h)	25
Desert King Mine Area, MRZ-3a ^(h-1)	25

	Page
West Mitchell Range, MRZ-3a ^(h-2)	25
Lead Mountain, MRZ-3a ^(h-3)	25
Harvard Hill, MRZ-3a ^(h-4)	25
Northwestern Cady Mountains, MRZ-3a ^(h-5)	26
Southern Cady Mountains, MRZ-3a ^(h-6)	26
Azucar Mine Area, MRZ-3a ^(h-7)	26
New Deal Mine Area, MRZ-3a ^(h-8)	26
Ord Mountain, MRZ-3a ^(h-9)	26
East Ord Mountain, MRZ-3a ^(h-10)	27
Northwestern Rodman Mountains, MRZ-3a ^(h-11)	28
Lucky Don Juan Mine Area, MRZ-3a ^(h-12)	28
Silver Cliff Mine Area, MRZ-3a ^(h-13)	28
East of Silver Bell Wash, MRZ-3a ^(h-14)	28
West Ord Mountains, MRZ-3a ^(h-15)	28
Pure Quill Mine Area, MRZ-3a ^(h-16)	29
Anita Mine Area, MRZ-3a ^(h-17)	29
Sinbad Mine Area, MRZ-3a ^(h-18)	29
Northern Fry Mountains, MRZ-3a ^(h-19)	29
Red Hills, MRZ-3a ^(h-20)	30
East Lucerne Valley, MRZ-3a ^(h-21)	30
AREAS CLASSIFIED FOR DEPOSITS FORMED BY CONTACT	
METASOMATIC PROCESSES (SKARN)	30
Areas Classified as MRZ-2a ^(s)	30
Morris Lode, MRZ-2a ^(s-1)	30
Areas Classified as MRZ-2b ^(s)	31
Camp Rock Valley, MRZ-2b ^(s-1)	31
Bessemer Mine, MRZ-2b ^(s-2)	31
Areas Classified as MRZ-3a ^(s)	31
White Dollar Mine, MRZ-3a ^(s-1)	31
Copper Strand Mine, MRZ-3a ^(s-2)	31
Ebony Mine, MRZ-3a ^(s-3)	32
New Bessemer Mine, MRZ-3a ^(s-4)	32
AREAS CLASSIFIED FOR DEPOSITS OF PLACER GOLD	32
Areas Classified as MRZ-3a ^(p)	32
Camp Rock Mine, MRZ-3a ^(p-1)	32
AREAS CLASSIFIED FOR INDUSTRIAL MINERALS	32
Areas Classified as MRZ-2a ⁽ⁱ⁾	33
Decorative Rock Quarries, MRZ-2a ^(i-1: specialty stone)	33
Bentonite Quarry Area, MRZ-2a ^(i-2: clay)	33
Hectorite Clay Deposit, MRZ-2a ^(i-3: hectorite)	33
Fort Cady Borate Deposit, MRZ-2a ^(i-4: borates)	35

Pisgah Quarry, MRZ-2a ^(i-5:volcanic cinders)	36
Calspar Quarry, MRZ-2a ^(i-6:feldspar)	36
Red Top Quarry, MRZ-2a ^(i-7:volcanic cinders)	37
Areas Classified as MRZ-2b ⁽ⁱ⁾	37
Calico Silver/Barite District, MRZ-2b ^(i-1:barite)	37
Calspar Bicentennial Group, MRZ-2b ^(i-2:feldspar)	37
Southern Granite Mountains, MRZ-2b ^(i-3:limestone)	37
Areas Classified as MRZ-3a ⁽ⁱ⁾	38
Barstow Formation, MRZ-3a ^(i-1:clay, borates, zeolites, strontium)	38
Mitchell Range, MRZ-3a ^(i-2:barite)	38
Southern Mitchell Range, MRZ-3a ^(i-3:clay)	39
Soldier Mountain, MRZ-3a ^(i-4:pyrophyllite)	39
Farway Pumice Deposit, MRZ-3a ^(i-5:pumice)	39
Afton Canyon Fluorite, MRZ-3a ^(i-6:fluorspar)	39
West Ord Mountains, MRZ-3a ^(i-7:fluorspar)	39
Richter Quarry, MRZ-3a ^(i-8:dolomite)	39
Peterson Quarry, MRZ-3a ^(i-9:limestone)	40
Aztec Sandstone, MRZ-3a ^(i-10:silica)	40
Texas Granite Quarry, MRZ-3a ^(i-11:dimension stone)	40
 CONCLUSIONS	 41
 ACKNOWLEDGMENTS	 43
 REFERENCES CITED	 44
 APPENDIX A: MINE AND PROSPECT DESCRIPTIONS - BARSTOW-NEWBERRY SPRINGS AREA	 A1
 APPENDIX B: GEOPHYSICAL EVALUATIONS OF MINERAL DEPOSITS IN THE CAMP ROCK AREA, SAN BERNARDINO COUNTY, CALIFORNIA	 B1

FIGURES

	Page
Figure 1. Index map of separate reports for the Southwestern San Bernardino County Mineral Land Classification Study	2
Figure 2. Index map of U.S. Geological Survey 15-minute and 7.5-minute quadrangle maps	3
Figure 3. Index of geologic maps used in the compilation of Plate 1: Geology of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area, California	5
Figure 4. General location map of the study area showing major geographic features	7
Figure 5. California Mineral Land Classification Diagram: Diagrammatic relationship of mineral resource zone categories to the resource/reserve classification system. Adapted from U.S. Bureau of Mines/U.S. Geological Survey (1980)	17

TABLES

Table 1. Classes of mineral deposits (adapted from Bates, 1960)	22
Table 2. Areas classified MRZ-2a and MRZ-2b, with commodity and square miles	42

PLATES

- Plate 1. Geology of a Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area, California (scale 1:62,500).
- Plate 2. Mineral Land Classification Map of a Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Composite MRZ-2s showing all mines and prospects (scale 1:62,500).
- Plate 3. Mineral Land Classification Map of a Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Metallic mineral deposits formed by hydrothermal, contact metasomatic, and placer processes, and associated mines and prospects (scale 1:62,500).
- Plate 4. Mineral Land Classification Map of a Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Industrial minerals and associated mines and prospects (scale 1:62,500).
- Plate 5. Total intensity aeromagnetic map of the Camp Rock area showing anomaly designations, faults, and locations of detailed surveys and lines.
- Plate 6. Complete Bouguer gravity map of the Camp Rock area.
- Plate 7. Total intensity ground magnetic contour map of the Morris Lode area.

EXECUTIVE SUMMARY

The California Surface Mining and Reclamation Act of 1975 (SMARA) requires the State Geologist to classify land into Mineral Resource Zones (MRZs), according to the known or inferred mineral potential of that land. The process is based solely on geology, without regard to existing land use or land ownership. The primary goal of mineral land classification is to ensure that the mineral resource potential of land is recognized by local government decision-makers and considered before land-use decisions, which could preclude mining, are made.

Areas subject to California Mineral Land Classification studies are divided into MRZ categories that reflect varying degrees of mineral potential:

- MRZ-1: Areas of no mineral resource significance
- MRZ-2: Areas of identified mineral resource significance
- MRZ-3: Areas of undetermined mineral resource significance
- MRZ-4: Areas of unknown mineral resource significance

Two of the categories (MRZ-2 and MRZ-3) are divided into two subcategories. Expanded definitions of the MRZ categories can be found in Part II.

With the concurrence of the California State Mining and Geology Board (SMGB), the State Geologist has initiated mineral land classification studies in southwestern San Bernardino County. The area includes the region from Kramer east to Newberry Springs, south to the Morongo Valley and west to the city of Ontario, and has been divided into five areas covered by six Open-File Reports by the California Department of Conservation's Division of Mines and Geology (DMG): OFR 92-06, OFR 94-04, OFR 94-06, OFR 94-07, OFR 94-08, and OFR 97-16 (Figure 1). This report, OFR 97-16 discusses the northeast part of the study area - the Barstow-Newberry Springs area, and includes all of the Daggett, Newberry Springs, Ord Mountains, and Rodman Mountains 15-minute quadrangles, and portions of the Cady Mountains and Lavic 15-minute quadrangles. This report covers all of 20 7.5-minute quadrangles and parts of four 7.5-minute quadrangles that comprise the 15-minute quadrangles listed above.

This report covers all mineral resources except aggregate; aggregate resources are classified in OFR 92-06: Mineral Land Classification of Concrete Aggregate Resources in the Barstow-Victorville Area, California (Miller, 1993).

This report includes a geologic map of the area (Plate 1, Geology of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area, California); a composite map of the areas classified as MRZ-2 with mines and prospects of the area (Plate 2, Mineral Land Classification Map of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Composite MRZ-2s

showing all mines and prospects); a map of areas classified for minerals of hydrothermal, contact metasomatic, and placer origin, with the associated mines and prospects (Plate 3, Mineral Land Classification Map of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Metallic Mineral Deposits formed by hydrothermal, contact metasomatic, and placer processes, and associated mines and prospects); and a map of areas classified for industrial minerals with the associated mines and prospects (Plate 4, Mineral Land Classification Map of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs Area: Industrial minerals and associated mines and prospects). A listing of the mines and prospects examined in connection with this study is included as Appendix A. Appendix B includes results of geophysical evaluations of mineral deposits in the Camp Rock area. Geophysical surveys are presented on Plates 5-7 (Plate 5, Total intensity aeromagnetic map of the Camp Rock area showing anomaly designations, faults, and locations of detailed surveys and lines; Plate 6, Complete Bouguer gravity map of the Camp Rock area; Plate 7, Total intensity ground magnetic contour map of the Morris Lode area). An index map of Plates 1-7 is shown on page x.

Major findings of this study are:

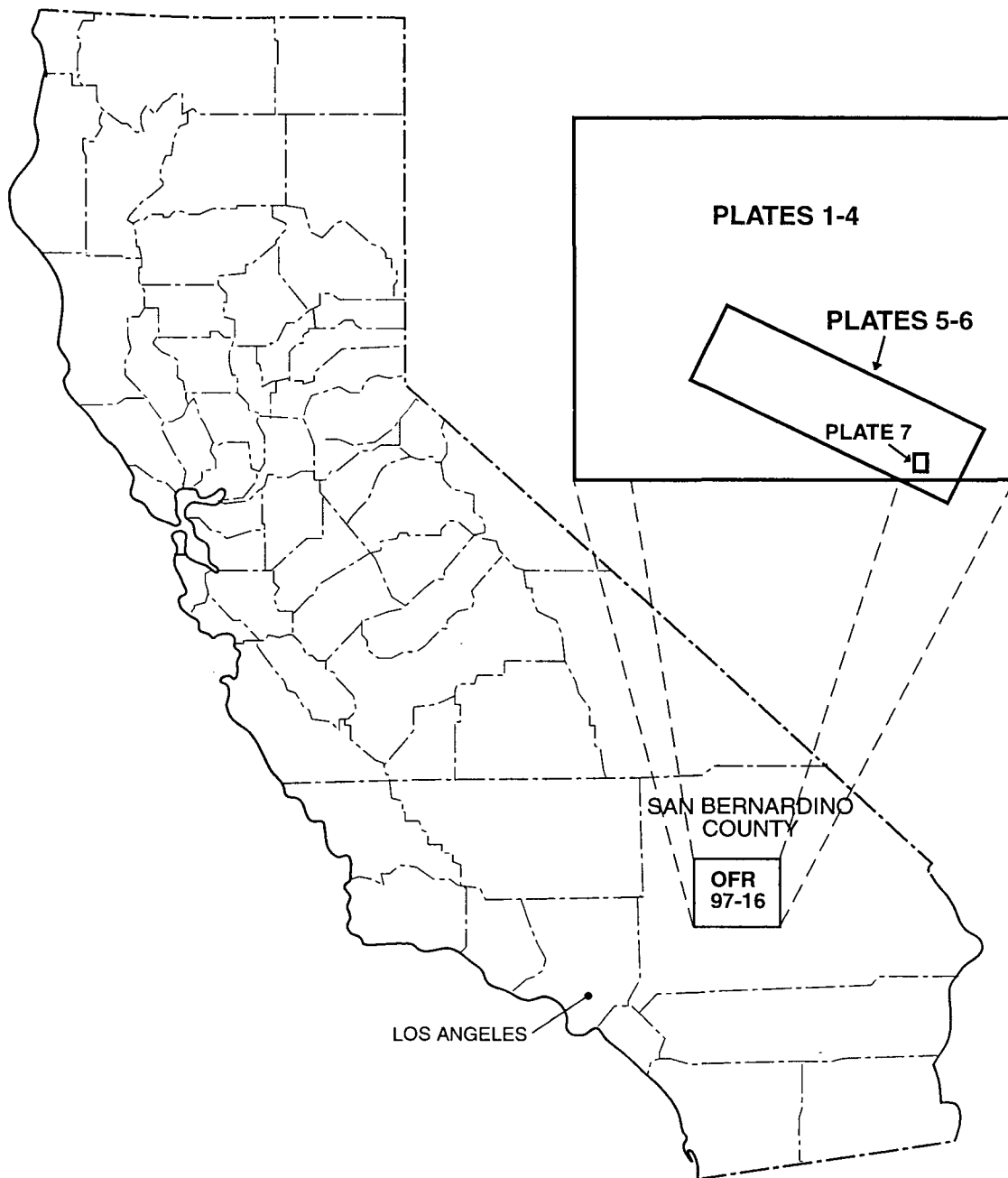
- The industrial minerals, clay, volcanic cinders, specialty stone (decorative rock), limestone, borates, barite, and feldspar are the most economically important mineral resources in the study area.
- Twelve areas are classified MRZ-2a (MRZs that contain known significant mineral deposits) These areas include active mines that produce hectorite clay, borates, decorative rock, volcanic cinders, bentonite clay, and feldspar. One area classified MRZ-2a for iron contains a known significant deposit which is not currently mined.
- Eight areas are classified MRZ-2b (MRZs that contain inferred or subeconomic significant mineral deposits) for barite, iron, silver, copper/molybdenum, limestone, and feldspar.
- The study area covers 1,300 square miles; the MRZs classified as MRZ-2a or MRZ-2b cover an area totaling 14.10 square miles.
- Areas underlain by the Barstow Formation contain known resources of bentonite clay, zeolites, and borates that have been mined but are not depleted. These areas are classified MRZ-3a.
- The Ord Mountains and Rodman Mountains have considerable potential for economic gold mineralization. There is also potential for buried porphyry

copper/molybdenum deposits and associated silver in the Ord Mountains - Rodman Mountains area.

- There are 12 principal active mines in the study area (excluding aggregate mines): seven decorative rock quarries, one hectorite (specialty clay) mine, one volcanic cinder quarry, one bentonite clay deposit, one deposit of quartz-feldspar rock, and one subsurface deposit of calcium borate (colemanite) mined by in situ leaching.

MINERAL LAND CLASSIFICATION OF A PART OF SOUTHWESTERN SAN BERNARDINO COUNTY: THE BARSTOW-NEWBERRY SPRINGS AREA

OPEN FILE REPORT 97-16
1997



Index map of Plates 1-7

PART I - MINERAL LAND CLASSIFICATION PROJECT - BACKGROUND AND SUPPORTING INFORMATION

INTRODUCTION

This is the sixth of six reports on the mineral land classification of southwestern San Bernardino County (Department of Conservation, Division of Mines and Geology [DMG] Open-File Reports 92-06, 94-04, 94-06, 94-07, 94-08, and 97-16). Southwestern San Bernardino County is one of many geographical regions in California to be selected for Surface Mining and Reclamation Act (SMARA) mineral land classification studies. This report, OFR 97-16, covers all mineral resources except aggregate. Aggregate resources are classified in OFR 92-06 (Miller, 1993). OFR 97-16 complements and does not supersede OFR 92-06.

The study area of this report is in the western Mojave Desert about 100 miles northeast of Los Angeles (Figure 1). Included within the study are the eastern part of the city of Barstow and the communities of Daggett, Yermo, and Newberry Springs. This report includes the western two-thirds of the Newberry Springs 1/2° by 1° Quadrangle, covering the northeastern part of the southwestern San Bernardino County study area. The study area covers over 1,300 square miles and includes all or part of six U.S. Geological Survey 15-minute quadrangles and all or part of 24 U.S. Geological Survey 7.5-minute quadrangles (Figure 2).

Background

Local, state, and federal agencies are faced with difficult land-use decisions as competition for land for a variety of purposes increases. Known mineral deposits underlie a very small percentage of the land area, yet these mineral resources are vital to our future economic well being. Ore deposits are where they are, not where we would like them to be, thus it is essential that land use planning in areas underlain by mineral resources be undertaken with full knowledge of the importance of these materials, and that every encouragement be offered to develop or reserve these areas for their mineral potential.

The California Surface Mining and Reclamation Act of 1975 (SMARA) requires the State Geologist to classify land according to the presence or absence of significant mineral deposits in priority areas of the state. These classification studies are carried out under guidelines adopted by the California State Mining and Geology Board (SMGB) in 1983. As these studies are completed, SMGB transmits the mineral land classification reports to appropriate lead agencies that are required to incorporate the information in their general plans and to use it in their land-use decision process.

MINERAL LAND CLASSIFICATION OF A PART OF SOUTHWESTERN SAN BERNARDINO COUNTY: THE BARSTOW-NEWBERRY SPRINGS AREA

OPEN FILE REPORT 97-16
1997

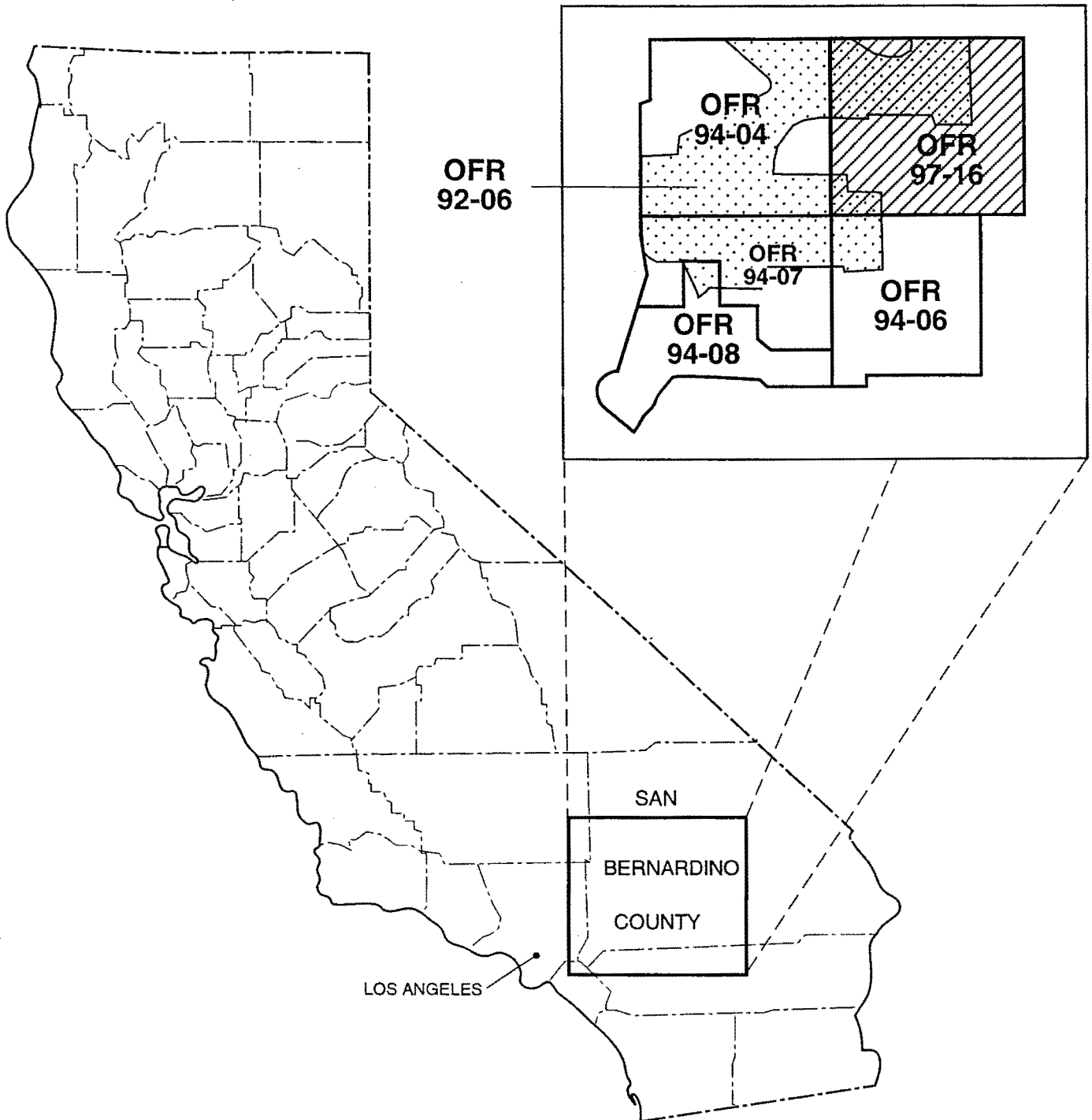
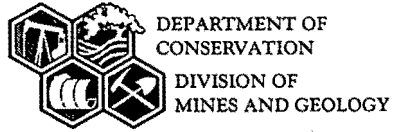


Figure 1. Index map of separate reports for the Southwestern San Bernardino County Mineral Land Classification Study.

MINERAL LAND CLASSIFICATION OF SOUTHWESTERN SAN BERNARDINO COUNTY: THE BARSTOW-NEWBERRY SPRINGS AREA

OPEN-FILE REPORT 97-16
1997

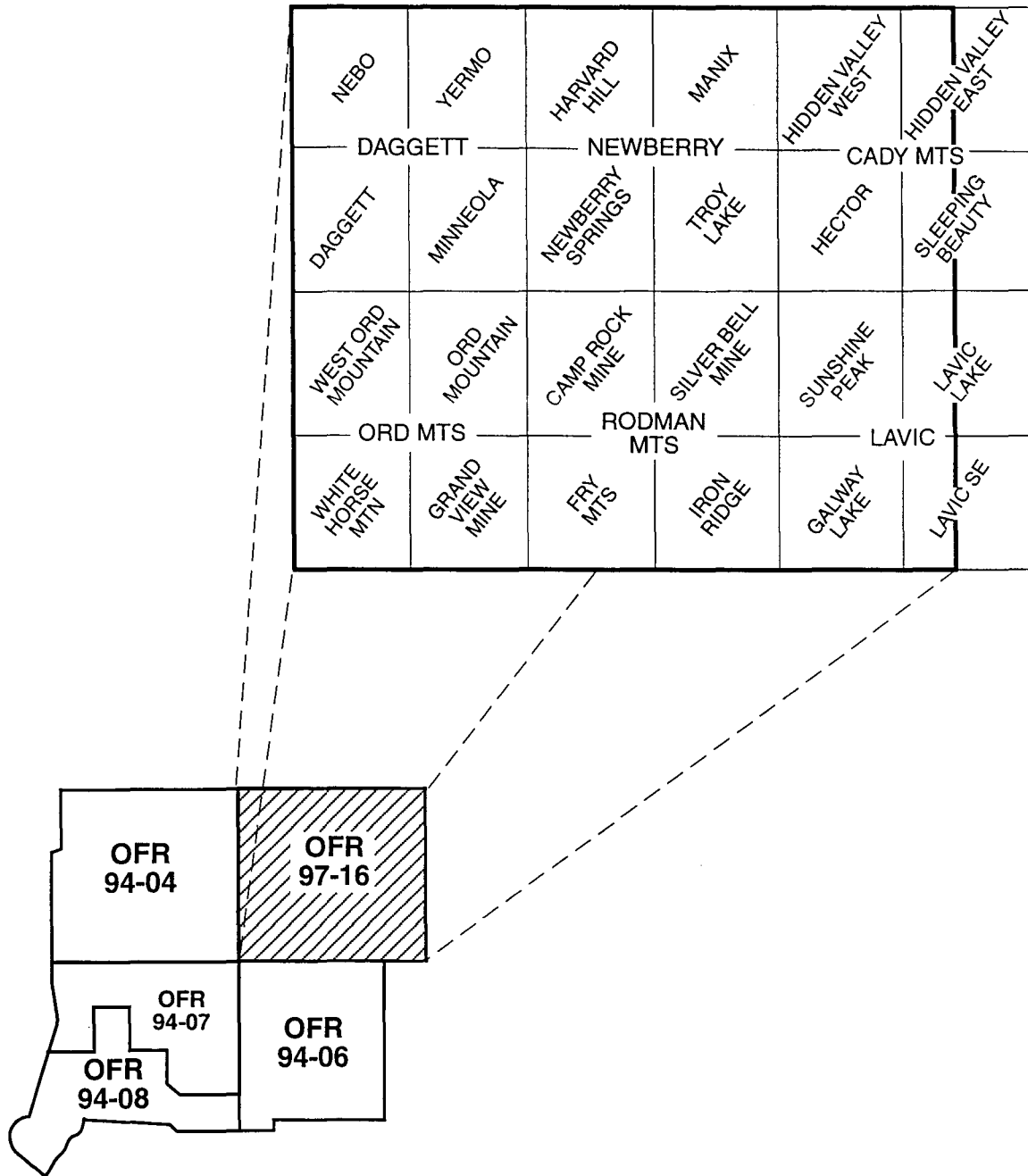


Figure 2. Index map of U.S. Geological Survey 15-minute and 7.5-minute quadrangle maps.

Scope

This mineral land classification study addresses the overall mineral potential of land through the identification of local and regional geologic factors that control or influence the formation of mineral deposits. Within the study area, only mineral deposits formed by hydrothermal processes, contact metasomatic processes, placer processes, and industrial minerals formed by diverse processes are classified. Construction aggregate resources are not addressed in this report. Refer to DMG's Open-File Report 92-06 *Mineral Land Classification of Concrete Aggregate Resources in the Barstow-Victorville Area* by R.V. Miller (1993), for a discussion of construction aggregate resources in the study area.

Fieldwork and Research

The mineral land classification study of the Barstow-Newberry Springs area, San Bernardino County was conducted from January 1987 to May 1990. The study involved research of geologic and mining related literature. Because an understanding of the geologic environment is fundamental to an understanding of the occurrence of ore deposits, a geologic map was compiled from publications of DMG and the U.S. Geological Survey (USGS), and unpublished mapping by USGS investigators and other geologists (Figure 3). The plotting of reported mines and prospects used data from DMG, the USGS, the U.S. Bureau of Mines (USBM), and the U.S. Bureau of Land Management (BLM). The study included fieldwork which involved general field observations, site investigations, and interviews with operators of active mines. Limited sampling of rocks for fire assay and X-ray diffraction analysis was done, and the data were assessed to identify resources and/or the geologic factors that control or influence mineralization.

The field and analytical data were integrated and evaluated for assigning Mineral Resource Zones (MRZs) in accordance with Mineral Land Classification guidelines adopted by the SMGB (1983). In addition to the geologic map (scale 1:62,500, Plate 1) Mineral Land Classification maps (scale 1:62,500, Plates 2-4) were prepared and are included in this report. The plates also show mine and prospect locations. Mine and prospect descriptions are in Appendix A. A detailed aeromagnetic map of the Camp Rock area was obtained from the U.S. Diversified Group, a Division of USX Corporation. Ground geophysical surveys including magnetic, gravity, and one resistivity-induced potential profile were conducted to evaluate magnetic anomalies identified in the aeromagnetic map. The results of these surveys are presented in Appendix B.

MINERAL LAND CLASSIFICATION OF A PART OF
SOUTHWESTERN SAN BERNARDINO COUNTY:
THE BARSTOW-NEWBERRY SPRINGS AREA

OPEN FILE REPORT 97-16
1997

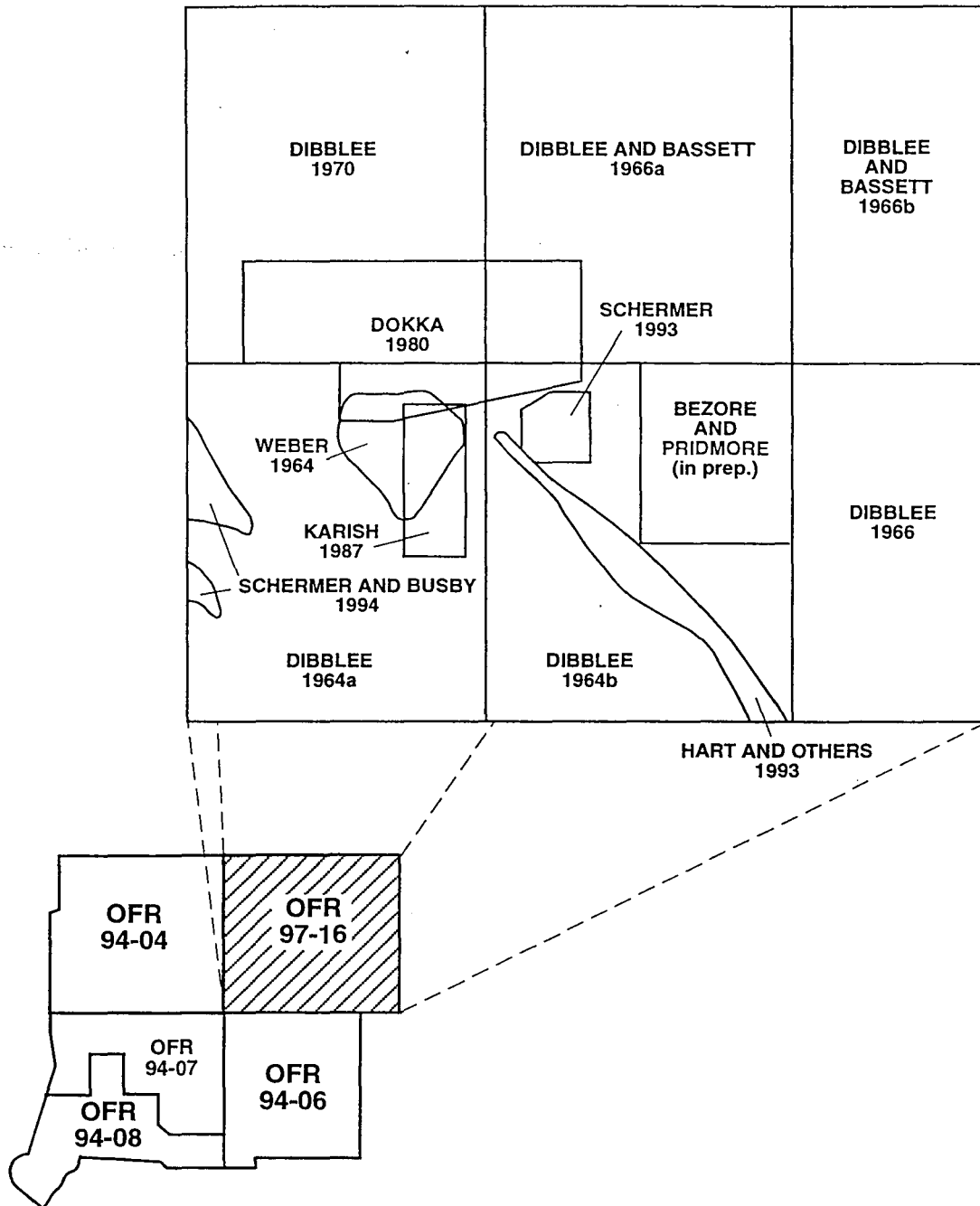


Figure 3. Index of geologic maps used in the compilation of Plate 1: Geology of Part of Southwestern San Bernardino County: The Barstow-Newberry Springs area, California.

Geographic Setting

The study area is in the Mojave Desert region of San Bernardino County. Mojave Valley, through which flows the Mojave River, lies in the northern part of the area (Figure 4). Most of the population in the study area resides in the communities of Daggett, Yermo, and Newberry Springs. The city of Barstow lies on the western edge of the area. The community of Lucerne Valley lies just south of the study area. Many ranchettes are in the valley in the southwestern corner of the study area.

Northwest-trending mountain ranges separated by internally drained valleys characterize most of the study area. The Ord Mountains, Newberry Mountains, and Rodman Mountains are in the central part of the area. The Calico Mountains lie in the north. The easternmost Cady Mountains are in the northeast corner of the area. Drainage from the ranges flows into normally dry playas. Lucerne Lake is in the southwest. Soggy Lake and Melville Lake lie south of the area. Galway Lake is in the southeast. Troy Lake is in the Mojave Valley west of the Cady Mountains. The Mojave River flows into Soda Lake near Baker, 30 miles northeast of the study area.

Elevation ranges from 1,600 feet on the Mojave River to 6,309 feet at Ord Mountain. Relief ranges from very low in the Mojave Valley to 2,000 feet over a distance of two miles in the Ord Mountains. The temperature range is extreme, from average daytime temperatures in summer of about 105° to nighttime lows of well below freezing in winter.

Primary access into the area is by Interstate 15 and Interstate 40, which cross the northern half of the study area. State Highway 247 (Barstow Road) between Barstow and Lucerne Valley lies along the western edge of the area. There are numerous secondary roads primarily in the populated areas of Mojave Valley and Lucerne Valley. The more important roads are Fort Irwin Road in the northwestern part of the area, Calico and Mule Canyon roads in the Calico Mountains, and Camp Rock Road between I-40 at Daggett and Lucerne Valley. Bessemer Mine Road provides access from Highway 247 east of Lucerne Valley into the southeastern part of the area. Powerline and pipeline maintenance roads, mine roads, and other unmaintained roads provide additional access into remote areas. There are numerous off-road vehicle trails in the south part of the area within the Johnson Valley Off-Highway Vehicle Area.

REGIONAL GEOLOGY

Knowledge of the geology and geologic history of the area is fundamental to the evaluation of the mineral resource potential and the classification of the MRZs. Important mineral resources in the study area include lithologically related industrial mineral resources, such as limestone, and time/event-related hydrothermal or

MINERAL LAND CLASSIFICATION OF A PART OF SOUTHWESTERN SAN BERNARDINO COUNTY: THE BARSTOW-NEWBERRY SPRINGS AREA

OPEN-FILE REPORT 97-16
1997

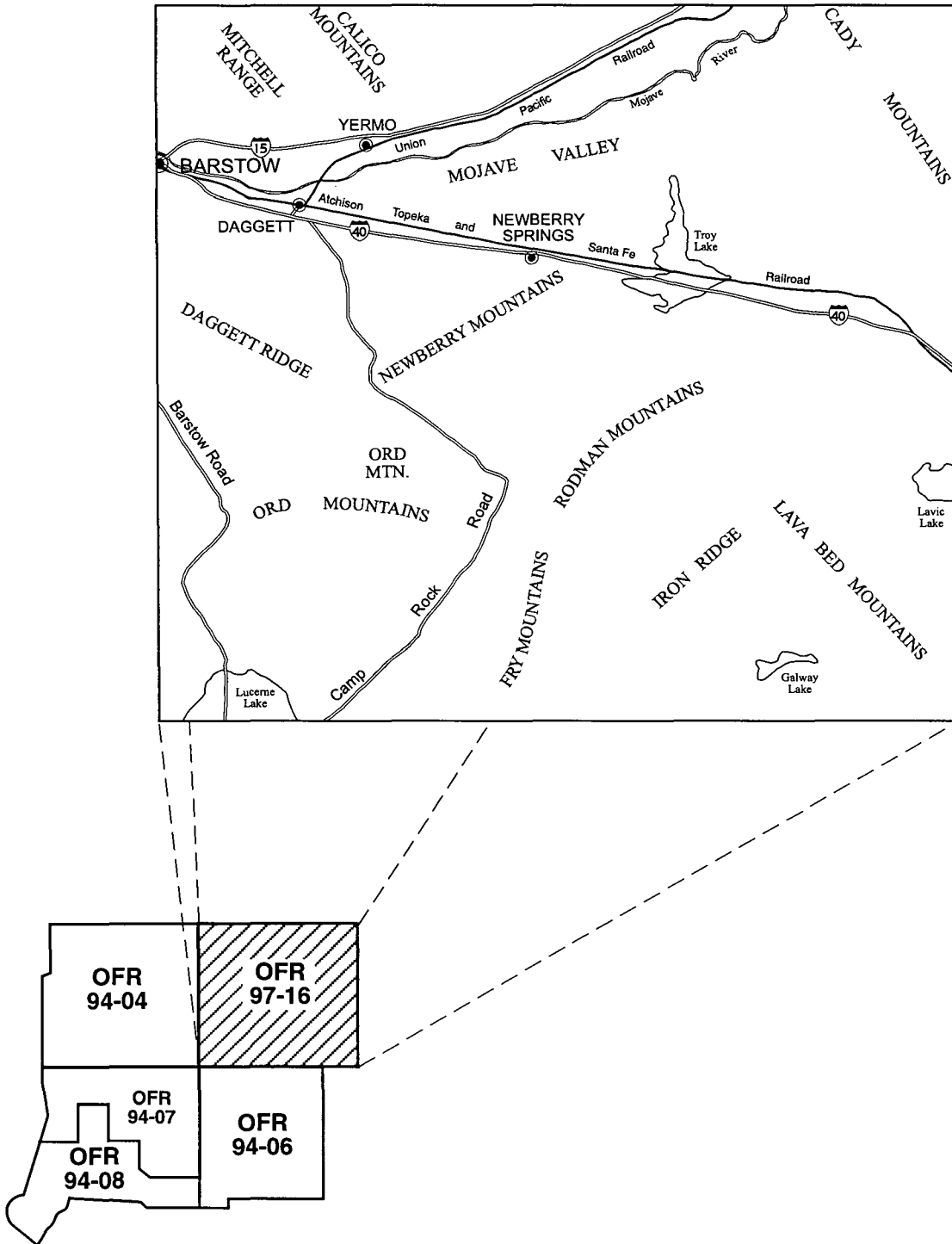


Figure 4. General location map of the study area showing major geomorphic features.

metasomatic deposits of precious and base metals, such as gold, silver, copper, or tungsten.

The first geologic report of the area by Lindgren (1887) describes the geology and silver mineralization of the Calico District. Gardner (1940) produced a geologic map that covers most of the study area, at a scale of 1 inch equals approximately 4 miles. The entire area was mapped by Dibblee (1964a, 1964b, 1966, and 1970) and Dibblee and Bassett (1966a and 1966b) at a scale of 1:62,500. Dibblee's mapping was used extensively in the compilation of the San Bernardino Sheet (1:250,000) (Rogers, 1967; Bortugno and Spittler, 1986) and in the compilation of the geologic map that accompanies this report (Plate 1).

Other geologic maps cover limited areas or are topical studies. They include McCulloh (1965) in the Nebo and Yermo 7.5' quadrangles; Weber (1964) and Karish (1983) in the Ord Mountains; Nason (1978) and Dokka (1980) in the Newberry Mountains; Sanner (1985) in the Box Canyon area; Lambert (1987) and Cox and Wilshire (1993) in the southern Mitchell Range; Ross (1995) in the eastern Cady Mountains; Karish and others (1987) in the Fry Mountains; Miller and Carr (1978), Schermer (1993), and Schermer and Busby (1994) on the Mesozoic rocks in the Rodman Mountains; and Glazner and others (1988, 1989), Dokka (1989), and Bartley and others (1990) on Tertiary extensional faulting. (See References Cited for detailed geology of the study area.)

The following discussion of the geologic history of the area briefly relates the geology to the various mineral deposits in the area.

Pre-Mesozoic Rocks

Precambrian and Paleozoic rocks occur as scattered roof pendants within the study area. Quartzo-feldspathic augen gneiss is exposed in the western Ord Mountains, in Kane Wash, and in the northern Iron Ridge. Martin and Walker (1992) report U-Pb ages of 1.3 billion years for the gneiss in Kane Wash and 1.8 billion years for the gneiss in Stoddard Valley just west of the study area. These rocks represent the basement on which late Precambrian and Paleozoic miogeoclinal and cratonal facies rocks were deposited.

The Waterman Gneiss is a name that is applied to a suite of mylonitic metasedimentary and metagneous gneisses in the Mitchell Range. The gneissic complex was first named by Bowen (1954). The metasedimentary rocks are considered to be late Precambrian to Paleozoic (Kiser, 1981). The metagneous rocks were mapped as Precambrian. Although they may be Precambrian in part, it is now thought they are largely Mesozoic plutonic rocks (Walker and others, 1990). The mylonitic fabric

of these rocks is the result of ductile deformation during early Miocene extension (Glazner and others, 1988).

Paleozoic metasediments occur as small, isolated pendants primarily at Iron Ridge, near Galway Lake, and in the southeastern Granite Mountains northwest of Lucerne Valley. These rocks are in part converted to epidote-garnet-diopside-quartz tactites and are the host of large magnetite skarn deposits near Galway Lake, at Iron Ridge, and in the subsurface southwest of the Rodman Mountains along the Camp Rock and Emerson faults.

Mesozoic Rocks

The oldest Mesozoic rocks in the area are a sequence of quartzites, calc-silicate rocks, carbonates, and volcanic-clast conglomerates that occur as roof pendants in the Fry Mountains and southern Rodman Mountains. The quartzites have been correlated with the Jurassic Aztec Sandstone (Miller and Carr, 1978). At the Copper Strand Mine the quartzites grade upsection into interbedded calc-silicate rocks and quartzite. These rocks laterally interfinger with and are overlain by an interval of rocks dominated by limestone and silty limestone with interlayers of calc-silicate rock. The limestone hosts the copper-bearing skarn at the Copper Strand Mine.

Middle Jurassic volcanic rocks underlie much of Sidewinder Mountain and Stoddard Ridge and extend into the western edge of the area. These rocks were named the Sidewinder volcanic series by Bowen (1954). Recent work by Schermer and Busby (1994) identifies four ignimbrites, in what is termed the lower Sidewinder volcanic series, that were formed by major caldera-forming eruptive events. The first, from oldest to youngest, is a crystal-poor rhyolite which overlies andesitic lava flows and hypabyssal intrusions and is overlain by andesitic lava flows, tuffs, and sedimentary rocks. The second is a crystal-rich rhyolite to dacite ignimbrite. The third is a crystal-rich biotite dacite ignimbrite and tuff breccia. The fourth is a lithic- and pumice-lapilli dacite ignimbrite. The age of these rocks is constrained by a date of 170 million years at the base of the sequence (Graubard and others, 1988) and ages of around 166 million years in the upper part of the sequence (Glazner and others, 1994). In the southern Rodman Mountains, a crystal-rich ignimbrite is correlated with the second ignimbrite of the Sidewinder series (Schermer and Busby, 1994).

Metavolcanic rocks of similar age in the Ord and northern Rodman Mountains were named the Ord volcanic series by Gardner (1940). Karish (1983), Schermer (1993), and Schermer and Busby (1994) identify two distinct sequences of volcanic rocks: a thick monotonous sequence of welded latite ignimbrite overlain unconformably by basalt or basaltic andesite lavas. Mesozoic metavolcanic rocks also occur in the western Cady Mountains.

Normal faulting, tilting, and erosion followed the period of explosive volcanism represented by the Sidewinder volcanic series, and was broadly contemporaneous with intrusion of granitic plutons. These plutons, common throughout the region, are generally porphyritic and heterogeneous in texture and composition. Quartz monzonite and granite are the common rock types with smaller bodies of hornblende diorite and gabbro. These plutons range in age from 166 to 171 million years (Karish and others, 1987).

During Late Jurassic time (148 million years ago) felsic and mafic dikes intruded the older Mesozoic rocks. These rocks have been correlated with the Independence dike swarm (James, 1989). The dikes apparently fed rhyolite flows and domes of the upper Sidewinder volcanic series (Schermer and Busby, 1994) in the Black Mountain area northeast of Victorville. Karish (1983) and Schermer and Busby (1994) correlate the basalt or basaltic andesite with the dikes. A white siliceous felsite intrudes the basalt, ignimbrite, and Jurassic quartz monzonite in the Rodman Mountains and at the Calspar Mine in the Ord Mountains. Metavolcanic rocks of the east Ord Mountains have been described as a volcanic vent complex that intrudes lower Sidewinder volcanic rocks and Jurassic quartz monzonite (Dibblee, 1964a; Karish, 1983; Karish and others, 1987; and Schermer and Busby, 1994).

Cretaceous plutons in the area were intruded around 70-75 million years ago (Miller and Morton, 1980). These rocks are biotite quartz monzonite or monzogranites that are typically more homogeneous than Jurassic plutons and exhibit spheroidal weathering.

Cenozoic Rocks

There are no early Cenozoic rock outcrops within the study area. Hewett (1954) hypothesized that the area probably was uplifted during the early Tertiary and that those highlands provided sediments to the surrounding basins. Late Cretaceous through Paleocene sediments survive only as remnants on the margins of the Mojave Desert and none survive within the study area.

During the early Miocene, 22-24 million years ago, volcanic rocks were erupted in the Mojave Desert. The volcanism, which was a combination of calc-alkaline andesites, basalts, and rhyolites (Glazner and Bartley, 1984; Woodburne, 1991), was accompanied by extensional faulting. The volcanic rocks and intercalated epiclastic rocks, which accumulated in extensional basins, are tilted to the southeast along northwest-striking normal faults. The early Miocene rocks are exposed in the Calico Mountains, Mitchell Range, Cady Mountains, Newberry Mountains, and Box Canyon area of the northern Rodman Mountains.

The major structural feature of Miocene extension in the study area is the Waterman Hills Detachment Fault exposed in the Mitchell Range. The detachment fault is a major, low-angle, normal fault that places the brittlely deformed Pickhandle Formation on ductilely and cataclastically deformed Waterman Gneiss (Dokka and Woodburne, 1986; Glazner and others, 1988). The footwall rocks (Waterman Gneiss) are intensely chloritized near the detachment fault. In the Newberry Mountains and at Daggett Ridge, a major low angle fault, the Newberry Mountains Detachment Fault, separates tilted Miocene and upper plate crystalline rocks from cataclastically deformed lower plate rocks (Dokka, 1980).

By the time of the eruption of the Peach Springs Tuff (18.5 million years ago), extension had ceased in the central Mojave Desert. In Kane Springs Wash, a flat-lying tuff that is correlated with the Peach Springs Tuff (Glazner and others, 1986) overlies with angular unconformity, tilted early Miocene beds. The Peach Springs tuff is also exposed at Daggett Ridge and in the Cady Mountains.

The Barstow Formation—middle Miocene lacustrine, fluvial, and alluvial fan sediments—was deposited in an east-west-trending basin in the northern part of the study area. The lacustrine deposits – primarily tuffaceous mudstone and shale interbedded with limestone, tuff, and sandstone – contain deposits of borates, celestite, zeolites, and bentonite (Link, 1980).

Late Cenozoic volcanism in the area consists of isolated basalt flows and cinder cones. Pisgah cinder cone and an associated lava flow lie near the eastern edge of the area along Interstate 40. Malpais (Pipkin) cinder cone lies in the Rodman Mountains. The associated lava flow extends down into Mojave Valley southeast of Newberry Springs. Both cinder cones are mined for volcanic cinders.

An estimated 50% of the study area is covered by Late Cenozoic (Quaternary) alluvium (areas labeled "Q" on the geologic map, Plate 1). Thickness of the Quaternary alluvium and underlying Tertiary volcanic and sedimentary rocks is greater than 0.62 mile in the deepest basins in the northwestern and north central parts of the study area (U.S. Geological Survey, 1992). Mineralized areas not covered by alluvium can be expected to extend laterally beneath the alluvium in some areas. Mineral deposits are also likely to occur in Tertiary and older rocks in areas obscured by the alluvium. These areas remain largely unexplored and may host a variety of metallic and nonmetallic mineral deposits like those identified in outcrop and by exploration drilling in other parts of the study area.

Late Cenozoic Structure

The pervasive structural fabric of the central and western Mojave Desert, including the study area, is northwest-southeast striking. The present-day topography is

the result of regional tectonics that began during the Miocene and continues to dominate modern tectonics. Major faults are high-angle, right-lateral, strike-slip faults. Within the study area, the important faults are the Lenwood, Johnson Valley, Camp Rock, Harper Lake, Emerson, Calico, Rodman, Pisgah, and Galway Lake. During the 1992 Landers earthquake there was major fault rupture on the Emerson and Camp Rock faults in the study area. Near the southern edge of the area 15 to 20 feet of right-lateral displacement occurred (Hart and others, 1993).

No economic mineralization is known to be associated with these high-angle faults. However, they are significant in that they displace Miocene and older geologic structures and mineral deposits. The most significant example is the iron deposits in Camp Rock Valley. The Man deposit on the west side of the Emerson Fault is 1.5 miles northwest of the Ord deposit which is bound by the Emerson Fault on the west and the Camp Rock Fault on the east. A fault-bound sliver of the same iron deposit is displaced 2 miles to the southeast. The Bessemer Mine iron deposit on the east side of the Camp Rock Fault lies 4 miles farther to the southeast. These iron deposits are likely a single deposit or a closely spaced cluster of deposits that has been displaced a total of approximately 7.5 miles along the Camp Rock and Emerson faults.

MINING HISTORY

The study area is in southwestern San Bernardino County and includes many mining areas with histories of activities dating from the mid to late 1800s. The early mining ventures were in the quest for silver and gold. Later mining operations included the extraction of other minerals, such as borates, copper, iron, tungsten, barite, and clay, which supported an advancing industrial technology and expanding population. Present-day mining centers around industrial minerals, especially volcanic cinders, decorative rock, feldspar, and bentonite clay.

Gold and Silver

The largest mining district within the study area is the Calico District, in the northwestern part of the study area in the Calico Mountains. The Ord District comprises gold and silver mines in the Ord Mountains, Fry Mountains, and Rodman Mountains.

Calico District

Development of the Calico District began on April 6, 1881 when S.C. Warden, Hues Thomas, and John C. King located claims which they began to develop as the Silver King Mine (Weber, 1966). By the spring of 1882 about 100 people were reported to be living in Calico and mining was underway. At the beginning of 1883 the active mines included the Silver King, Oriental, Burning Moscow, Garfield, Odessa, Bismark, and Blackfoot.

Ore from the Silver King Mine was first hauled to Oro Grande, 40 miles away for processing, but in 1882 a ten-stamp mill was erected near the Mojave River at Daggett. In 1887 a narrow gauge railroad was built to bring ore from the Waterloo and Silver King mines to the mill. Ore from the Cuba Mine and from the mines of the Silver Odessa Mining Company were milled at Hayley's Mill at Camp Cady. Between 1883 and 1885 ore from the Garfield Mine was processed at Barber's Mill northwest of the mouth of Mule Canyon. The Odessa, Oriental, and Occidental mines processed their ore at the mill owned by the Silver King Mining Company of London, England, between the mouths of Wall Street and Odessa canyons.

Production peaked in 1884-1885; the Silver King Mine produced \$1 million in bullion during that time. In subsequent years production declined as silver prices dropped and the highest grade ores were mined out. In 1892 the Waterloo Mine closed. By 1896 most other mines were inactive. Total production of silver is estimated to have been between 13 and \$20 million (Weber, 1966).

Between 1896 and 1963 there were only small and intermittent mining operations for silver in the district. Around 1917 cyanide was used to recover silver from the Silver King Mine dumps (Vredenburgh and others, 1981). In 1926 the Zenda Company acquired the assets of the Waterloo Mining Company and began an exploration and development program. Before operations ceased in 1930 two shafts were sunk to depths of 550 and 350 feet but did not develop any significant mineralization (Weber, 1966).

The town of Calico was abandoned in 1930 and remained so until 1950 when it was purchased by Walter Knott, owner of Knotts Berry Farm in Buena Park. The ghost town was converted into a tourist attraction. The town was deeded to San Bernardino in 1966 and is currently operated as a county park.

In 1963 American Smelting and Refining Company (ASARCO) began a drilling project in the Waterloo Mine area. An ore body of about 30 million tons was identified (Weber, 1980). The company proceeded with plans to develop the mine, including construction of a mill and tailings pond. It was estimated that 6,000 tons of ore a day would be mined, producing 12,000 to 15,000 ounces of silver with barite as a coproduct. A permit to mine was issued by San Bernardino County in May 1981. However, the mine was never developed.

Ord District

The first mining claims in the Ord District were located in 1876 by Sandie Lochery, who named them the Ord Group (Weber, 1964). Nine of the original claims were patented in 1882 by Mr. Andrew of the Painesville Company. He sold the claims,

with the exception of the Painesville claim, a few years later to J.L. Osborne of Daggett. Production from the Ord Group was never large. DeGroot (1890) stated that "Ord has not produced much bullion, only one small mill having ever been erected there; nor has the population ever been large." In 1908 and 1909 about 500 tons of gold-silver ore was shipped. In 1917 several hundred tons of copper-gold-silver ore was produced from the nearby Gold Banner Mine. During 1942, H.J. Stevenson produced about 1,000 tons of copper-gold-silver ore from the Rio Vista and Brilliant claims of the Ord Group.

In the Fry Mountains the Gold Peak, Cumberland, and Elsie mines were worked in the early 1900s. Ore from the Gold Peak and Cumberland was milled at Old Woman Springs. Production at the Gold Peak was over \$40,000 prior to 1914 (Cloudman and others, 1919).

In the 1930s several of the mines in the district were in production. Ore was produced from the Elsie and Cumberland mines. A 40-ton mill operated at the Gold Belt Mine in the West Ord Mountains. The Grand View Mine was in operation with a three-stamp mill on the property. A washing and screening plant was erected on the Camp Rock Placer in 1932 and operated until September 1933 (Wright and others, 1953).

Borates

Calico Mountains

The discovery of colemanite in Mule Canyon in 1882 led to a rush to stake claims in the Calico Mountains. William T. Coleman, the namesake of the mineral, purchased many of the claims and began working the deposits. After the failure of Coleman's company, Francis Marion (Borax) Smith and his Pacific Coast Borax Company acquired the properties in 1890. Twelve tons of colemanite a day were produced from three deep shafts. The colemanite was hauled to the railroad at Daggett by mule team and shipped to Alameda for refining (Hensher and Vredenburg, 1991; Zeitelhack and La Barge, 1976).

In 1898 an 11-mile narrow-gauge railroad was built to haul the colemanite ore to Daggett. A calcining plant was constructed at Marion, 4 miles north of Daggett, to roast low-grade calcium borate ore. In August 1907 the Tonapah & Tidewater Railroad reached the newly opened Lila C. Mine near Death Valley Junction. In December 1907 the Calico mines, with the easily recoverable reserves of colemanite ore nearly depleted, were closed and the operations of Pacific Coast Borax were moved to the Lila C. Mine. Total production from the Pacific Coast Borax mines at Calico was over \$9 million (Cloudman and others, 1919).

Other borate operations in the area at the time included the American Borax Company which produced from their mine near Lead Mountain from 1904 to 1907, the

Columbus Borax Company mine about 4 miles south of Daggett, the Palm Borate Company mine in the Calico Mountains, and the Western Mineral Company mine near the town of Calico.

PART II - CALIFORNIA MINERAL LAND CLASSIFICATION SYSTEM

Areas subject to California Mineral Land Classification studies are divided by the State Geologist into various MRZ categories that reflect varying degrees of mineral potential. The MRZ nomenclature and criteria adopted by SMGB (1983) are graphically portrayed on what is referred to as the California Mineral Land Classification Diagram (Figure 5). Definitions of terms used in the diagram are included in this section. The diagram is a modification of a mineral resource classification scheme developed by the USBM and the USGS (1980) that presents a relationship between mineral resource occurrence and economic significance. The horizontal axis of the diagram represents the degree of knowledge about mineral occurrence, and the vertical axis portrays economic characteristics of mineral deposits (grade and size). The diagram may be divided into four parts for the purpose of presenting basic information regarding mineral resource potential of land:

- 1) Areas of No Mineral Resource Significance**
- 2) Areas of Identified Mineral Resource Significance**
- 3) Areas of Undetermined Mineral Resource Significance**
- 4) Areas of Unknown Mineral Resource Significance**

MRZ CATEGORIES

As shown on Figure 5, each of the above four divisions relates directly to and incorporates one of the four basic MRZ categories established through law and/or SMGB policy. The specific definitions of each MRZ category are given below. Note in both Figure 5 and in the MRZ definitions below that two of the categories (MRZ-2 and MRZ-3) are divided into two subcategories.

- MRZ-1:** Areas where available geologic information indicates there is little likelihood for the presence of significant mineral resources.
- MRZ-2a:** Areas underlain by mineral deposits where geologic data indicate that significant measured or indicated resources are present. As shown on the California Mineral Land Classification Diagram, MRZ-2 is divided on the basis of both degree of knowledge and economic factors. Areas classified MRZ-2a contain discovered mineral deposits that are either measured or indicated reserves as determined by such evidence as drilling records, sample analysis, surface exposure, and mine information.

**MINERAL LAND CLASSIFICATION OF A PART OF
SOUTHWESTERN SAN BERNARDINO COUNTY:
THE BARSTOW-NEWBERRY SPRINGS AREA**

**OPEN-FILE REPORT 97-16
1997**



CALIFORNIA MINERAL LAND CLASSIFICATION DIAGRAM

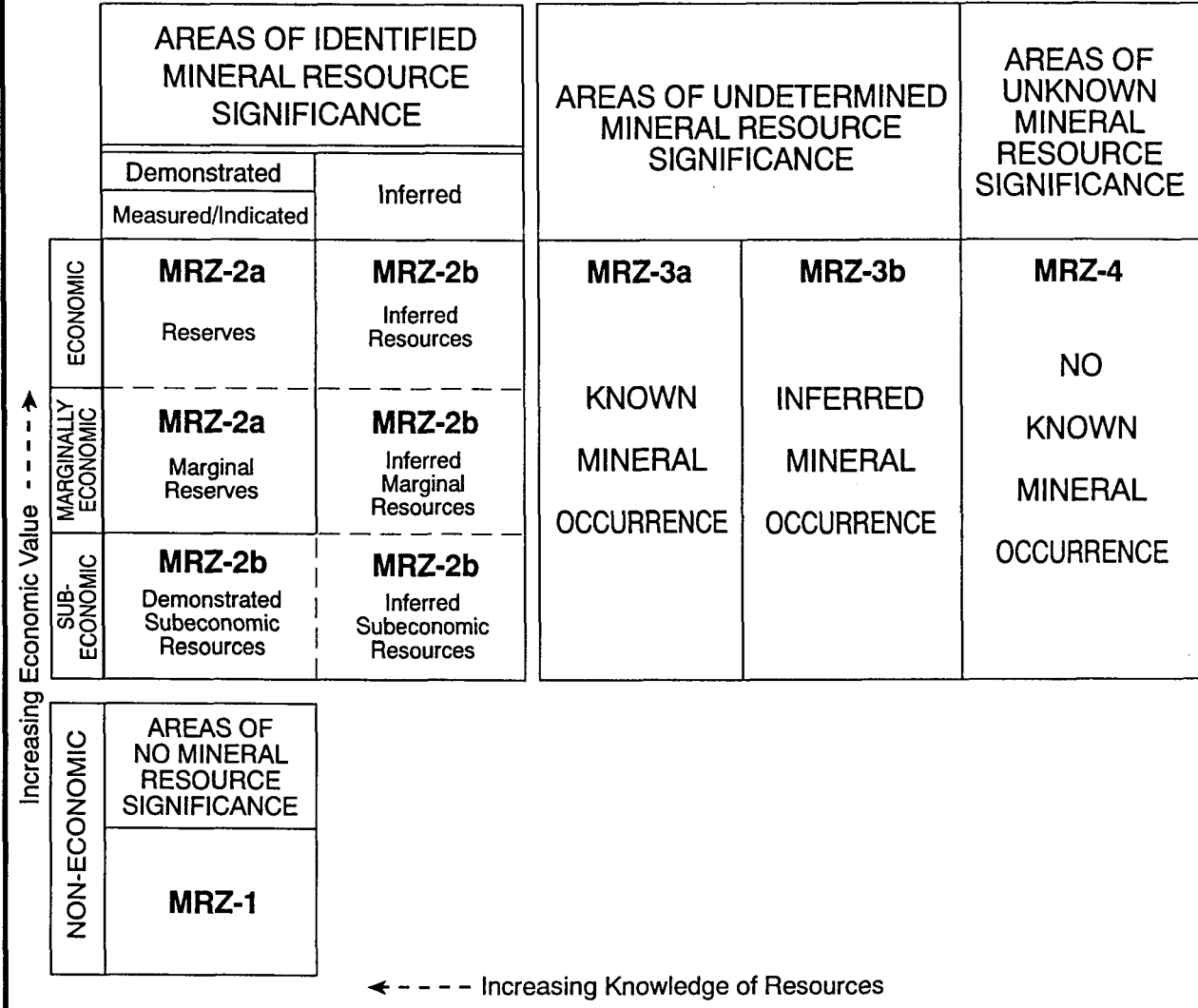


Figure 5. California Mineral Land Classification Diagram: Diagrammatic relationship of mineral resource zone categories to the resource/reserve classification system. Adapted from U.S. Bureau of Mines/U.S. Geological Survey (1980).

Land included in the MRZ-2a category is of prime importance because it contains known economic mineral deposits.

MRZ-2b: Areas underlain by mineral deposits where geologic information indicates that significant inferred resources are present. Areas classified MRZ-2b contain discovered mineral deposits that are either inferred resources as determined by limited sample analysis, exposure, and past mining history or are deposits that presently are sub-economic. Further exploration work and/or changes in technology or economics could result in upgrading areas classified MRZ-2b to MRZ-2a.

MRZ-3a: Areas containing known mineral occurrences of undetermined mineral resource significance. Further exploration work within these areas could result in the reclassification of specific localities into MRZ-2a or MRZ-2b categories. As shown on the California Mineral Land Classification Diagram, MRZ-3 is divided on the basis of knowledge of economic characteristics of the resources.

MRZ-3b: Areas containing inferred mineral occurrences of undetermined mineral resource significance. Land classified MRZ-3b represents areas in geologic settings that appear to be favorable environments for the occurrence of specific mineral deposits. Further exploration could result in the reclassification of all or part of these areas into the MRZ-3a category or specific localities into MRZ-2a or MRZ-2b categories.

MRZ-4: Areas of no known mineral occurrences where geologic information does not rule out either the presence or absence of significant mineral resources.

The distinction between the MRZ-1 and MRZ-4 categories is important for land-use considerations. It must be emphasized that MRZ-4 classification does not imply that there is little likelihood for the presence of mineral resources, but rather there is a lack of knowledge regarding mineral occurrence. Further exploration could well result in the reclassification of land in MRZ-4 areas to MRZ-3 or MRZ-2 categories.

MINERAL RESOURCE/RESERVE CLASSIFICATION NOMENCLATURE

Following are definitions of the nomenclature associated with the California Mineral Land Classification Diagram. It is important to refer to these definitions when studying the different resource categories shown on the California Mineral Land Classification Diagram. Particular attention should be given to the distinction between a mineral deposit and a resource and to how a mineral deposit may relate to resources.

MINERAL DEPOSIT: A mass of naturally occurring mineral material, e.g. metal ores or nonmetallic minerals, usually of economic value, without regard to mode of origin. The mineral material may be of value for its chemical and/or physical characteristics.

MINERAL OCCURRENCE: Any ore or economic mineral in any concentration found in bedrock or as float; especially a valuable mineral in sufficient concentration to suggest further exploration.

ECONOMIC: This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

MINERAL RESOURCE: A concentration of naturally occurring solid, liquid, or gaseous material in or on the earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible. The terms resource and mineral resource are synonymous in this report.

RESERVES: That part of the resource base that could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative.

IDENTIFIED MINERAL RESOURCES: Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified mineral resources include economic, marginally economic, and subeconomic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into demonstrated and inferred.

DEMONSTRATED: A term for the sum of measured plus indicated.

MEASURED: Quantity is computed from dimensions revealed in outcrops, trench workings, or drill holes; grade and/or quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

INDICATED: Quantity and grade and/or quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are

farther apart or otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

INFERRED: Estimates are based on an assumed continuity beyond measured and/or indicated resources, for which there is geologic evidence. Inferred resources may or may not be supported by samples or measurements.

MARGINAL RESERVES: That part of the demonstrated reserve base that, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technologic factors.

MARGINAL RESOURCES: That part of the inferred resource base that, at the time of determination, would be economically producible, given postulated changes in economic or technologic factors.

SUBECONOMIC RESOURCES: The part of identified resources that does not meet the economic criteria of marginal reserves and marginal resources.

CLASSIFICATION CRITERIA

To be considered significant for the purpose of Mineral Land Classification, a mineral deposit, or a group of mineral deposits that can be mined as a unit, must meet marketability and threshold value criteria adopted by SMGB (1983). The criteria vary for different minerals depending on 1) whether they are strategic or non-strategic minerals; 2) their uniqueness or rarity; and 3) their commodity-type category (metallic minerals, industrial minerals, or construction minerals). For example, to be considered significant, the threshold value of the first marketable product for a metallic ore deposit is 500,000 in 1978 dollars, 1,000,000 in 1978 dollars for an industrial mineral deposit, and 5,000,000 in 1978 dollars for a construction aggregate deposit (multiply 1978 dollars by 2.35 to calculate threshold value in 1997 dollars).

PART III - MINERAL LAND CLASSIFICATION OF METALLIC AND INDUSTRIAL MINERAL RESOURCES

The land within the study area (Figure 1) has been classified for the presence or likely occurrence of industrial and metallic mineral resources, one exception being the classification for aggregate resources, which has been done previously in DMG OFR 92-06 (Miller, 1993). Consideration is given to all non-fuel minerals of economic importance by determining what genetic classes of mineral deposits (Table 1) are likely to exist in the area.

Mineral land classification is based on recognition and delineation of geologic environments present in an area and determination of those genetic types of mineral deposits likely to be hosted in those environments. In all, nine distinct genetic types of mineral deposits are recognized. In addition, industrial mineral deposits and construction aggregate deposits are both classified as groups rather than on a genetic basis (Table 1).

Only those genetic classes for which direct or indirect evidence indicates the presence or likely presence of significant mineral occurrences are addressed in this mineral land classification report. However other types of mineral occurrences may exist which, because of lack of evidence, are not presently recognized.

Of the 11 classes of mineral deposits (nine genetic classes, the industrial minerals group, and the construction aggregate group) listed in Table 1, only category 2 - deposits formed by contact metasomatism, category 3 - deposits formed by hydrothermal processes, category 8 - deposits formed by residual and mechanical concentrations (placer processes), category 10 - industrial mineral deposits formed by diverse processes, and category 11 - construction aggregate deposits formed by diverse processes, apply to the study area. Descriptions of areas classified for mineral resources in categories 2, 3, 8, and 10 are presented in this section; areas classified for construction aggregate (category 11) are discussed in DMG OFR 92-06 (Miller, 1993).

Mineral deposits in genetic category 2, those formed by contact metasomatic processes (skarns), commonly form within sedimentary or metasedimentary rocks at the borders of felsic igneous bodies. In genetic category 2, two types of alteration are recognized: 1) recrystallization to coarser grains of the same mineral or new mineral assemblages; and 2) metasomatism resulting from the introduction of new materials such as silica or metals, most commonly iron. Ore minerals commonly hosted by skarn deposits are lead, zinc, iron, copper, and tungsten.

Ore deposits of genetic category 3, those formed by hydrothermal processes, are a major source of metallic mineral resources and include gold, silver, lead, zinc, copper, mercury, antimony, tin, tungsten, molybdenum, vanadium, and minor elements.

These deposits form when hot, metal-enriched fluids travel away from the heat source and precipitate minerals in the fractures, faults, vugs or interstices between mineral grains as they travel through the rocks. New minerals also replace preexisting minerals in the host rock as the preexisting minerals react with the metal-rich fluids. The host rock becomes physically and chemically altered as it reacts with the hot fluids. Alteration zones are often used in identifying hydrothermal ore deposits, and the minerals in alteration zones may have additional resource value.

Mineral deposits in category 8, those formed by mechanical processes, include placer gold, the only type of placer deposit identified in the study area.

Industrial minerals, those in genetic category 10, are naturally occurring earth materials exclusive of metallic ores or fuels. These materials have economic value because of the physical and/or chemical characteristics which they possess. In the study area, the industrial minerals of economic importance include clays, volcanic cinders, feldspar, borate, barite, limestone, and decorative rock.

Table 1. Classes of mineral deposits (adapted from Bates, 1960).

<ol style="list-style-type: none">1. Magmatic concentration deposits* 2. Contact metasomatic deposits* 3. Hydrothermal mineral deposits (exclusive of volcanogenic deposits)4. Exhalative volcanic deposits (volcanogenic)5. Deposits formed by sedimentation6. Deposits of bacteriogenic origin7. Evaporites* 8. Residual and mechanical concentrations9. Deposits formed by regional metamorphism* 10. Industrial mineral deposits formed by diverse processes11. Construction aggregate deposits formed by diverse processes <p>* Classified in this report.</p>

MRZ NOTATION

MRZs are delineated on the accompanying Plates 2-4. Zone assignments are denoted by MRZ categories defined on the California Mineral Land Classification Diagram (Figure 5). Genetic affinities of the MRZs are denoted by superscript notations loosely based on the genetic classifications of Bates (1960) (Table 1).

For example, the MRZ

MRZ-3a^(h)

refers to an area classified MRZ-3a for hydrothermal processes.

Individual MRZs are assigned a geographic reference number that follows the genetic notation. For example, the MRZ number

MRZ-2b⁽ⁱ⁻²⁾

refers to a specific area (area 2) classified MRZ-2b for an industrial mineral. The geographic reference numbers proceed from west to east and from north to south.

MRZs for industrial minerals are further classified by the commodity. These follow the geographic reference number in the notation. For example, the MRZ number

MRZ-2a^(i-2:limestone)

refers to an area classified MRZ-2a for the industrial mineral limestone.

AREAS CLASSIFIED FOR DEPOSITS FORMED BY HYDROTHERMAL PROCESSES

Areas Classified as MRZ-2b^(h)

Calico Silver District, MRZ-2b^(h-1)

Between 1882 and 1896 the Calico Silver District produced silver ore with an estimated value of 13 to \$20 million. The mines produced the ore from zones of secondary enrichment; with principal ore minerals being embolite (silver chlorobromide) and cerargyrite (silver chloride). The average grade of ore was 10 to 20 ounces of silver per ton (Weber, 1966).

The Calico Mountains are underlain by the early Miocene Pickhandle Formation and the mid-late Miocene Barstow Formation. The Pickhandle Formation consists of intercalated pyroclastics, volcanic flows, and volcanoclastic sedimentary beds. The Barstow Formation is interbedded shales, siltstones, and sandstones with minor fresh water limestone. Both units host the silver mineralization.

Silver ore occurs in three types of deposits in the district. In the central area the ore occurs in northwest-striking veins of barite and jasperoid in the Pickhandle Formation. The most extensive vein systems lie along Wall Street Canyon in a broad

zone of propylitic alteration. Mines in this zone include the Silver King, Oriental, Sioux, Falls, and St. Louis Consolidated.

In the eastern area, silver was mined from barite veins and from impregnations of embolite and cerargyrite in a porous tuff breccia that overlies the Pickhandle Formation. Some of the richest ores of the district occur as shallow irregular pockets in the tuff. Mines include the Odessa, Humbug, Carbonate, and Alabama. Drilling by Dusty Mac Mines, Ltd. in the 1980s identified four major zones of shallow low-grade silver mineralization containing 17 to 20 million tons averaging between 1.0 and 2.1 ounces per ton silver (Payne and Glass, 1987).

The Waterloo and Langtry deposits in the western area are distinct from those to the east. Silver mineralization occurs in epithermally silicified and baritized siltstone and sandstone beds of the Barstow Formation. The primary silver minerals are acanthite (silver sulphide) and native silver. Drilling by ASARCO, which began in 1963, identified reserves in these two deposits of 27 million tons averaging 3.1 ounces per ton silver and 11.8% barite and 15 million tons averaging 2.5 ounces per ton silver and 6% barite (Fletcher, 1986).

Red Hill Deposit, MRZ-2b^(h-2)

The U.S. Geological Survey (1992) identified "permissive terrane" for Jurassic porphyry copper systems in the Ord Mountains - Rodman Mountains area. One known deposit of this type is the Red Hill Deposit on the southern flank of the Ord Mountains, approximately 2 miles south of Ord Mountain itself (N1/2, Section 6, T6N, R2E and S1/2, Section 31, T7N, R2E). The mineralized system was explored in 1960 by a number of drill holes put down by Western Gold and Uranium, Inc., and it was also drilled during a subsequent round of exploration by American Exploration and Mining Co. during 1968. As a result of these exploration activities, two nearly vertical shear zones near the contact of a largely non-porphyrific, alkalic quartz monzonite were found to contain an indicated sulfide reserve of 4 million tons averaging 0.305 weight % copper and 0.155 weight % molybdenum and a somewhat deeper "prospective" sulfide reserve of 2,600,000 tons averaging 0.262 weight % copper and 0.117 weight % molybdenum below a depth of approximately 660 feet. Combined oxide reserves in the two mineralized shear zones reportedly include 489,000 tons that average 0.4 weight % copper and 0.07 weight % molybdenum. Nine of 31 rock samples analyzed from the exposed parts of the Red Hill system reportedly contain detectable concentrations of silver, that is, greater than 0.1 part per million, and all of the samples that contain detectable silver show highly elevated abundances of both copper and molybdenum. Silver reportedly would constitute an important byproduct from the Red Hill system if it were ever put into production.

Areas Classified as MRZ-3a^(h)

Desert King Mine Area, MRZ-3a^(h-1)

In the northern Mitchell Range, the Waterman Hills Detachment Fault is mineralized with a light blue tourmaline which locally contains gold-bearing thin quartz veins. The area was first worked around the turn of the century and again in the 1930s. In 1988 an exploratory drilling program was conducted by Pegasus Gold Corporation in the area. Two grab samples collected by DMG for assay contain 0.016 and 0.049 ounces per ton gold. The gold mineralization is apparently confined to a narrow zone along the detachment fault.

West Mitchell Range, MRZ-3a^(h-2)

This area is an extension of MRZ 3a^(h-11) in the adjacent study area to the west (Bezore and Shumway, 1994). A northwest-striking, argillized fracture zone in Waterman Gneiss is exposed discontinuously for over a mile. Within the fracture zone are quartz-barite veins that range from 1 inch to 3 feet thick. Mineralogy includes vuggy quartz, coarse barite, galena, and pyrite. One DMG sample collected along the vein assayed 12.46 ounces per ton silver and 0.014 ounces per ton gold. In the southeast part of the area northwest-striking barite-quartz veins are developed by two short adits.

Lead Mountain, MRZ-3a^(h-3)

The Lead Mountain Mine was originally worked for silver prior to 1896. Barite was produced in the 1930s. At the mine, a mineralized northwest-striking fault zone in Miocene tuff contains barite, quartz, calcite, galena, lead carbonate, and silver chloride. The zone dips 40° northeast. In the footwall there is a broad zone of intensely altered tuff, diabase, freshwater limestone, and conglomerate overlying quartz monzonite that is intensely altered and cut by numerous thin barite veins.

Harvard Hill, MRZ-3a^(h-4)

Harvard Hill is underlain by Miocene lacustrine limestone, tuffaceous sandstone, and clay. Secondary uranium minerals occur as coatings on fractures and bedding surfaces in the limestone. Exploration includes shallow prospect pits, a caved shaft, and drill holes. One sample collected by the USGS contained 0.025% uranium, and another sample assayed by the U.S. Atomic Energy Commission contained 0.085% uranium (Walker and others, 1956).

Northwestern Cady Mountains, MRZ-3a^(h-5)

In the northwestern Cady Mountains, the granitic and Jurassic metavolcanic rocks are cut by scattered north- to northwest-striking quartz veins. The veins contain pyrite and chalcopyrite. DMG samples collected from these veins range from 0.008 to 0.066 ounces per ton gold.

Southern Cady Mountains, MRZ-3a^(h-6)

Manganese ore was produced from the Black Butte and Logan mines in the southern Cady Mountains. The ore consists of psilomelane and pyrolusite (manganese oxide) and occurs in northwest-trending fracture zones in Miocene volcanic rocks.

Azucar Mine Area, MRZ-3a^(h-7)

In 1941, 6 ounces of gold were recovered from the Azucar Mine (Wright and others, 1953). The ore was probably produced from a 1-foot-thick quartz vein, which was developed by two trenches. No significant mineralization was observed at either the 135-foot inclined shaft or adit on the property. Three samples of the vein collected by USBM contained 0.017-0.082 ounces per ton gold and 0.046-0.151 ounces per ton silver (Sabine, 1985).

New Deal Mine Area, MRZ-3a^(h-8)

A northwest-striking shear zone contains iron-stained quartz veins in argillized quartz monzonite. One DMG sample contains 0.041 ounces per ton gold and 0.05 ounces per ton silver. To the southeast, 4,000 feet, roughly on strike with the New Deal Mine vein, a massive quartz vein is explored by shallow prospects. These veins are similar to other veins in the area which have produced gold and silver.

Ord Mountain, MRZ-3a^(h-9)

Ord Mountain is underlain by Jurassic metavolcanic rocks intruded by Jurassic quartz monzonite. The Jurassic metavolcanic rocks consist of a thick monotonous sequence of welded latite ash-flow tuff. The tuff is overlain unconformably by basaltic andesite flows. Both the metavolcanic rocks and the Jurassic quartz monzonite are intruded by felsic dikes of the Independence Dike Swarm. On the south side of Ord Mountain and at Willis Well on the east side, the Jurassic rocks are intruded by Cretaceous quartz monzonite plutons.

Three episodes of hydrothermal mineralization occurred in the area. The youngest mineralization is represented by quartz veins in the northern and southern parts of the area. The veins typically strike east-west, contain wall rocks intensely

argillized, and are usually vuggy with euhedral quartz crystals. Fluorite and chalcedony occur in some veins. Ore minerals include chalcopyrite, pyrite, galena, and sphalerite. Mines and prospects that develop these veins include the Gold Banner (east), Martha, Tao, and Red Hill. In the study area this type of vein is observed to cut all Mesozoic rocks including Cretaceous quartz monzonite.

The next youngest mineralization is represented by the Ord Mountain Mine system of veins. The veins strike roughly north-south and extend from the Brilliant Claim on the north to the Moly Prospect on the south where the veins disappear in an irregular area of fractured and mineralized metavolcanic rock. Gangue minerals include quartz and barite, and ore minerals are chalcopyrite and bornite. The veins are crudely banded. Mines on the vein system produced copper and gold. These veins and other similar veins in the study area cut all Jurassic rocks but not Cretaceous plutons. In the northern Fry Mountains (MRZ 3a^(h-19)) similar veins are cut by a Cretaceous quartz monzonite porphyry dike.

The oldest hydrothermal mineralization is an irregular area of silicified and pyritized ash flow tuff on the east side of Ord Mountain, south of the White Dollar Mine. No mines or prospects explore this hydrothermal mineralization. Similar mineralization occurs at East Ord Mountain and is cut by felsic dikes of the Independence Dike Swarm.

East Ord Mountain, MRZ-3a^(h-10)

Geologically, East Ord Mountain is similar to Ord Mountain. The principal difference is a large area underlain by a vent complex of rhyolite or latite breccia (Dibblee, 1964a). These breccias are thought to be equivalent in age to Independence Dike Swarm (Karish and others, 1987).

East-west-striking quartz veins are developed at the Maumee and Active Bee mines. One north-south vein of barite, quartz, and galena was prospected by an open cut on the west side of East Ord Mountain. More significant in this area are the large irregular areas of silicified and pyritized latite ash flow tuff and vent breccia on the southern and, to a lesser extent, the northern flanks of East Ord Mountain. The mineralization also occurs along the margin of felsic dikes of the Independence Dike Swarm that intrude Jurassic quartz monzonite, ash flow tuff, and vent breccia. Mines that produced from along the margin of these altered areas include the Ord Belt, Ford, and Grand View. Of 14 DMG samples collected for assay in the vicinity of the Ord Belt Mine, three contain between 0.004 and 2.230 ounces per ton gold. The rest contain no significant values of gold.

Northwestern Rodman Mountains, MRZ-3a^(h-11)

The geology and mineralization of the northwestern Rodman Mountains is essentially the same as at Ord Mountain. North-south-striking veins of quartz or quartz and barite are developed at the L. and L. Mine and several prospects. One northeast-striking quartz vein similar to the east-west veins at Ord Mountain is worked at the Burning Bush Mine. A small area of silicified and pyritized ash flow tuff occurs in the southeastern part of the MRZ, north of the Camp Rock Mine.

At the Camp Rock Mine, placer gold in Quaternary alluvial fan deposits may be residual or derived from a nearby source (see Camp Rock Mine, MRZ-3a^(p-1), page 31). A negative magnetic anomaly occurs over the alluvium near the mine. This anomaly may be the result of hydrothermal alteration of the bedrock under the mine (Cox and others, 1987; and Appendix B, this report). The USBM collected samples from two shear zones exposed in a 295-foot-long adit driven in quartz monzonite near the placer mine. One sample contained 1.96 ounces per ton gold and 0.1 ounces per ton silver. The other sample contained 0.01 ounces per ton gold and 1.3 ounces per ton silver.

Lucky Don Juan Mine Area, MRZ-3a^(h-12)

East-west-striking quartz veins occur in an inlier of Jurassic metavolcanic rock, Jurassic quartz monzonite, and Precambrian gneiss surrounded by Miocene volcanic and sedimentary rocks. The quartz veins contain pyrite and galena. One DMG sample contains 71.75 ounces per ton silver and 0.519 ounces per ton gold.

Silver Cliff Mine Area, MRZ-3a^(h-13)

The Silver Cliff Mine produced from a northwest-striking fault zone in Miocene basalt. At the surface, the fault zone is marked by a vein of black-stained calcite 3 to 5 feet thick. The ore produced at the mine is barite vein material cemented by calcite and drizzly quartz. Values of silver and lead reportedly occur in the breccia.

East of Silver Bell Wash, MRZ-3a^(h-14)

An east-west-striking quartz vein in an argillized fault zone in Cretaceous quartz monzonite is mineralized. The fault zone is intruded by a Tertiary andesite dike. The vein is similar to other veins in the area that have produced gold and silver. One DMG sample contains 0.248 ounces per ton gold and 7.09 ounces per ton silver.

West Ord Mountains, MRZ-3a^(h-15)

The West Ord Mountains are underlain by Precambrian gneiss that is intruded by Jurassic hornblende diorite and quartz monzonite. Mines and prospects in the area,

including the Gold Belt, One Ton, Goat Spring, Green Hornet (fluorspar), and McKinney (fluorspar), are developed on east-west-striking quartz veins. The quartz veins are usually vuggy with euhedral quartz crystals. Fluorite and chalcedony occur in some veins. Ore minerals include chalcopyrite, pyrite, galena, and sphalerite. The Gold Belt Mine is the largest gold mine in the study area. A 40-ton mill operated during 1930-32.

Pure Quill Mine Area, MRZ-3a^(h-16)

A zone of weakly altered Precambrian gneiss with thin, irregular quartz veins extends approximately 1,000 feet in a north-south direction. Scheelite is disseminated in the quartz veins and in the adjacent amphibolite gneiss. Tungsten was produced from the mine in 1951-1952 from 225 feet of drifts along the mineralized zone (Wright and others, 1953).

Anita Mine Area, MRZ-3a^(h-17)

The Anita Mine area is underlain by Jurassic hornblende diorite and quartz monzonite which are intruded by Jurassic felsic dikes. The active Lenwood Fault is the southwestern boundary. An irregular zone of hydrothermal alteration is explored by shallow shafts, pits, and branching drift adits. One DMG sample assayed 0.089 ounces per ton gold and 0.25 ounces per ton silver.

Sinbad Mine Area, MRZ-3a^(h-18)

An east-west-trending zone of argillized Cretaceous quartz monzonite is exposed over a distance of 4,500 feet. Within the zone are scattered copper-stained, chalcopyrite-bearing quartz veins. Of four DMG samples collected for assay, two contain 0.004 ounces per ton gold. The quartz veins are similar to other veins in the study area which have produced gold and silver.

Northern Fry Mountains, MRZ-3a^(h-19)

Gold mines in the northern Fry Mountains include the Cumberland, Elsie, and Gold Peak. These mines produced from north-south-striking quartz veins. The veins contain chalcopyrite, pyrite, and, reportedly, free gold. Selected DMG samples collected at the mines assayed 0.408 to 1.730 ounces per ton gold. The veins cut Jurassic quartz monzonite and dikes of the Independence Dike Swarm. A northeast-striking quartz monzonite porphyry dike, probably related to the Cretaceous plutons in the area, cuts the veins.

Red Hills, MRZ-3a^(h-20)

The Red Hills are underlain by Aztec Sandstone intruded by Jurassic quartz monzonite and basaltic and rhyolitic dikes of the Independence Dike Swarm. A north-south-striking shear zone dips 55° east. The shear zone contains thin vuggy quartz veins with minor pyrite and is developed by an inclined shaft. Spotty gold values reportedly occur in the veins (Tucker and Sampson, 1940).

East Lucerne Valley, MRZ-3a^(h-21)

An east-west-striking quartz vein in Cretaceous quartz monzonite (Sections 20,21, T5N, R2E) is developed by a 50-foot inclined shaft. The hanging wall is intensely argillized. The vein contains chalcopyrite and secondary copper minerals. It is similar to other veins in the study area which have produced gold and silver. One DMG sample assayed 0.008 ounces per ton gold and 2.27 ounces per ton silver. This area and the adjacent area to the south classified by Taylor (1994) contains many small prospects/mines that for the most part apparently developed small discontinuous quartz veins and/or iron oxide stained shear zones in granitic rock.

AREAS CLASSIFIED FOR DEPOSITS FORMED BY CONTACT METASOMATIC PROCESSES (SKARN)

Areas Classified as MRZ-2a^(s)

Morris Lode, MRZ-2a^(s-1)

The Morris Lode area contains a large subsurface magnetite skarn deposit. The ore consists of magnetite, with small proportions of pyrite and hematite, in a brecciated silicated rock containing diopside and minor calcite and epidote. Exposures of magnetite occur on two hills 1,100 feet apart. These small deposits were mined in 1949-1950 for use in portland cement manufacturing. In early 1944, USBM discovered a large magnetic anomaly in the alluvium-covered area between the hills. The anomaly involves an area 1,500 x 1,000 feet. In 1944 and 1955 a diamond drilling program was conducted to explore the anomaly (Wiebelt, 1947). Of nine holes drilled, eight penetrated an ore zone with a thickness from 87 to 921 feet. Analysis of the ore encountered averaged 37.32% iron. The deepest hole, 955 feet deep, bottomed in ore. Geophysical modeling by Chapman and others (Appendix B, page B19, this report) suggests the Morris Lode contains as much as 100 million tons of low-grade iron ore.

Areas Classified as MRZ-2b^(s)

Camp Rock Valley, MRZ-2b^(s-1)

Three large deposits of magnetite skarn were discovered in Camp Rock Valley by an aeromagnetic survey conducted in 1958 (Plate 5). The aeromagnetic data were obtained from USX Corporation. The two largest deposits, the Man and the Ord, were explored by 25 deep drill holes. Except for a small, isolated outcrop of limestone and magnetite-bearing skarn there are no surface exposures of the skarn deposits (Moore, 1971). The Man and Ord deposits are discussed by Chapman and others (Appendix B, pages B22 and B26, this report).

Bessemer Mine, MRZ-2b^(s-2)

The Bessemer Mine produced 28,000 tons of iron ore between 1945 and 1951. Magnetite-bearing skarn occurs in 14 bodies ranging in surface area from 2,500 to 50,000 square feet. More significant than the exposed ore bodies is the large magnetic anomaly just south of the mine beneath the alluvium. USBM drilled one hole in the anomaly and found iron ore from 61 to 102 feet, averaging 48% iron (Wiebelt, 1947). Drilling during 1954 intersected a bed of iron ore too narrow to be of economic interest. However, the size of the magnetic anomaly indicates that more magnetite mineralization is present than the 1954 drilling indicated (Moore, 1971). Also see the Bessemer Deposit, Appendix B, page 22, this report.

Areas Classified as MRZ-3a^(s)

White Dollar Mine, MRZ-3a^(s-1)

A few hundred tons of scheelite-bearing ore were produced from the White Dollar Mine in 1951 and 1952. Scheelite is disseminated in brecciated garnet-epidote tactite along two northwest-striking shear zones. The ore mined in 1951 averaged 0.3% tungsten trioxide, and the ore mined in 1952 is said to have assayed as high as 1.4% tungsten trioxide. (Weber, 1964).

Copper Strand Mine, MRZ-3a^(s-2)

The Copper Strand Mine area is underlain by a sedimentary sequence of cross-bedded orthoquartzites overlain by interstratified calc-silicate rocks, quartzite, and limestone. The quartzite is correlated with the Jurassic Aztec Sandstone (Miller and Carr, 1978). To the west and north, near the contact with Jurassic quartz monzonite, the calc-silicates and limestones are converted to a garnet-epidote tactite. Copper mineralization in the tactite occurs along a northwest-striking fault and is mainly secondary malachite, azurite, and chrysocolla. Chalcopyrite and pyrite is reported, but

was not observed. The tactite is bordered on the east by the Emerson Fault which ruptured during the Landers M7.5 earthquake of 1992. An extension of the deposit may be displaced to the southeast under the alluvium in sections 10 and 15.

Ebony Mine, MRZ-3a^(s-3)

Magnetite skarn occurs along the margin of a dolomite pendant in Jurassic quartz monzonite. The more prominent ore body is 10 to 25 feet thick. It was mined from an open cut 200 feet long, 25 feet wide, and about 75 feet deep. A second ore body lies 100 feet to the southeast. It was mined from an open pit 50 feet across and 30 feet deep. Before mining, the resources were estimated to be 100,000 tons of ore containing 40-50% iron (Lamey, 1948; Moore, 1971). The Ebony Mine lies outside the aeromagnetic map, Plate 5.

New Bessemer Mine, MRZ-3a^(s-4)

The New Bessemer Mine area contains a small iron-bearing skarn deposit. In 1949, about 4,000 tons of iron ore were produced from the New Bessemer Mine. The deposit is a magnetite-bearing skarn along the margin of a dolomite marble pendant (Wright and others, 1953; Dibblee, 1964b). The aeromagnetic map (Plate 5) indicates that the deposit is relatively small.

AREAS CLASSIFIED FOR DEPOSITS OF PLACER GOLD

Areas Classified as MRZ-3a^(p)

Camp Rock Mine, MRZ-3a^(p-1)

At the Camp Rock Mine, gold occurs in Quaternary alluvial fan deposits that range in thickness from 2 to 33 feet. The property has been worked intermittently since 1905. More than 300 ounces of gold and 20 ounces of silver were produced between 1907 and 1960 (Kuizon, 1985; Sampson, 1932; Tucker and Sampson, 1930, 1931, 1940; Wright and others, 1953). The gold may be residual or derived from nearby sources (see Northwestern Rodman Mountains, MRZ-3a^(h-11), page 26; also see Camp Rock Mine Area, Appendix B, page B14, this report).

AREAS CLASSIFIED FOR INDUSTRIAL MINERALS

Although resources of sodium, potassium, carbonate, and borate compounds are known to be present in the bedded crystalline deposits and also in the brines at Lucerne (dry) Lake and Troy (dry) Lake (U.S. Geological Survey, 1992), these saline

resources are not classified in this report because of insufficient knowledge of the deposits. Lucerne Lake reportedly contains relatively dilute brines ($\leq 100,000$ ppm total dissolved salts) in thin (≤ 148 feet) lacustrine sequences. "Concentrated" brines reportedly are present at Troy Lake.

Areas Classified as MRZ-2a⁽¹⁾

Decorative Rock Quarries, MRZ-2a^(i-1: specialty stone)

Five areas that include seven quarries are classified MRZ-2a for specialty stone. The quarries, operated by Brubaker-Mann, Inc. and Calico Rock Milling, Inc., produce colored rock for roofing and landscaping. Except for the Birdseye Granite Quarry the decorative rock quarries mine Miocene volcanic rocks.

Bentonite Quarry Area, MRZ-2a^(i-2: clay)

Brubaker-Mann, Inc. produces bentonite from an altered tuff bed in the southern Mitchell Range. The tuff bed overlies dacite flows and is overlain by lacustrine limestone of Miocene age. The area classified MRZ-2a includes the permitted area of the mine and the continuous exposures of the tuff outside the permitted area.

Hectorite Clay Deposit, MRZ-2a^(i-3: hectorite)

The RHEOX, Inc. Hector Mine, 32 miles east of Barstow, California, near Hector siding along the Santa Fe Railroad that parallels Interstate Highway 40, is a world-class source of hectorite, a thixotropic magnesium lithium silicate clay that formed when lithium and fluorine were introduced into fine lacustrine volcanic sediments through hot springs activity during the Pliocene. A thixotropic clay displays the property of changing from a gel to a sol when shaken, and increases in strength upon standing. Hectorite is used in cosmetics, household cleaners, plastics, rubber, paints, paint strippers, coatings, greases, adhesives, paper, and inks. This deposit has been supplying the highest grade thixotropic clay to the coatings industry continuously for over 50 years and contains reserves to support mining well into the next century. The following information on geology and historic development of the hectorite deposit, and nature and origin of the hectorite clay is from Willette (1995).

Hectorite's morphological mineral structure consists of wide flat trioctahedral sheets that develop very strong thixotropic bonding between the sheets. Sheets are composed of an octahedral layer sandwiched between two silica tetrahedral layers. Magnesium and minor lithium replace all the aluminum sites while some of the hydroxyl sites are replaced by fluorine. The sheets form a stacked mesh in water or select organic fluid to form gels. Energy imparted to a clay suspension results in a gel failure

that reforms quickly after the shearing energy is removed. This thixotropic property is important in the coatings industry. At least three times as much bentonite is required to develop a gel consistency equivalent to that of hectorite, but without the thixotropic property of hectorite.

At the mine site drilling has revealed a porphyritic andesite with a thick (20-35 feet) weathered, cobble surface overlain by 330-410 feet of Pliocene lakebeds composed of calcareous and tuffaceous bentonite clays with numerous impure zeolitic bands. Travertine from hot springs activity, and associated hectorite clay are found within the lakebeds. The lakebeds and the hot springs deposits are intensely deformed. Deformation occurred prior to burial of the lakebeds beneath a 35-100 feet thick Holocene-age olivine basalt that unconformably overlies the lakebeds. This Holocene lava and associated flow structures dominate the volcanic landscape in the area around the Hector Mine.

During the Pliocene, uplift along the Pisgah Fault interrupted the drainage between the Barstow and Bristol troughs, thus developing a large shallow lake that collected fine volcanic sediment and airborne ash. Meteoric waters circulating along the Pisgah Fault became heated and carried soluble ions including lithium and fluorine to thermal springs at the eastern margin of the lake. An accumulation of travertine developed into a ridge that diverted sediments around its extremities causing bars to build out into the lake. A marginal lagoon formed behind the bars.

A regulated flow developed between the marginal lagoon and the main body of the shallow lake. Magnesium-rich alkaline lake waters slowly washed over the bar to mix with the lithium and fluorine supplied by the hot springs. The finer volcanic glass and tuff were selectively winnowed from the bars into the marginal lagoon and altered to hectorite clay. Because of the high pH, alumina and silica remained in solution and decanted out into the lake.

During periods of extended quiescence the hot spring vents welded shut. With renewed thermal activity, pressures built within the geyser chambers causing explosive brecciation that ejected fragments into the air. Continuing hot springs activity contributed additional carbonate that welded the brecciated heap. Eventually the fumarole activity stopped. Continued basin subsidence resulted in burial by calcium bentonites and later by coarser sediments.

The area containing and surrounding the hectorite deposit was staked during 1931 to 1934 by investors who had successfully promoted and sold a group of bentonite properties northwest of the area. Key hectorite property leases changed hands several times during 1937 and 1938 prior to development. In 1944 that portion acquired by the F.S. Schundler Eyrte Company was sold to the National Lead Mining Company, which had acquired the North Group bentonite claims the previous year. The

other major player, the Inerto Company, was already in business having acquired leases in 1941. By 1948 the North Group bentonites were depleted and National Lead Company, which became NL Chemicals and finally RHEOX, Inc., maintained a vigorous competition with the Inerto Company. The former company took over the Aquagel paint market while the Inerto Company developed Tansul, a product used to clarify most beers and ales in the world.

The two companies had been mining underground on opposite sides of the same ore body but joined workings during 1961 to develop a safe ventilation system. Within months of the joining of workings, a flash flood entered the Inerto shaft and flooded out the Inerto and National Lead workings. Having just begun a small open pit, National Lead Company was able to supply its customers -- Inerto could not, and was forced to sell. Since that time mining has continued with truck and loader open-pit methods. RHEOX Inc., 31763 Mountain View Road, Newberry Springs, California, is the current operator.

Fort Cady Borate Deposit, MRZ-2a^(i-4:borates)

The Fort Cady Minerals Corp.'s Fort Cady in situ borate-mining project, about 33 miles east of Barstow, California, near Hector siding along the Santa Fe Railroad that parallels Interstate Highway 40, involves recovering boron from a calcium borate (primarily colemanite) deposit more than 1,300 feet below the ground surface. The recovery method is a new in situ mining technology that uses weak acid solution injected directly into the ore body. Information on process, geology, and historical development is from Hartman (1996; and personal communication, September 19, 1997).

Duval began evaluating the possibility of in situ leaching the Fort Cady deposit in 1981 after it was determined that underground mining of the colemanite ore would not be feasible due to depth and poor ground condition. Open-pit recovery was ruled out due to the depth of the ore body. Initial favorable results indicated that in situ leaching might be successful. Additional work was done at Fort Cady during 1983-84 and 1987-88. Based on successful results, Fort Cady Minerals Corp. was chartered in 1989 to commercially develop the property. Five steps were necessary for a successful production facility: permitting, small-scale production operation, marketing, large facility design and construction, and long-term production.

Environmental applications were first submitted in April 1990 and the final permit was issued in March 1995. Of the three above-ground chemical processes proposed -- evaporation, liquid solvent extraction, and precipitation -- precipitation was accepted by all environmental agencies.

A small-scale production facility was commissioned in May 1995 to produce material for market trial and to test technical design and economic feasibility projections. The current production facility (demonstration plant) consists of six unit operation circuits: well field, purification, product precipitation, solids-liquid separation, drying, and packaging.

Calcium borate (synthetic colemanite) was selected as the product as indicated by the permitting process, and design of a larger facility was begun in November 1995. The larger facility was designed initially to increase production 10-fold over the current demonstration plant. This equates to a production increase to 30,000 tons per year, with flexibility to expand to 60,000 tons per year and finally to 90,000 tons per year. Once the larger facility is on line, production is expected to continue into the next century. Industrial Minerals (1989) reported a reserve of 147 million tons of colemanite ore averaging 6.4% boric oxide (B_2O_3).

Pisgah Quarry, MRZ-2a^(i-5:volcanic cinders)

At the Pisgah volcanic cinder deposit about 12 miles west of Ludlow and 2 miles east of Pisgah, a siding on the Santa Fe Railroad that parallels Interstate Highway 40, volcanic cinders have been mined for lightweight aggregate sporadically from the Mt. Pisgah cone. Mt. Pisgah rises about 300 feet above the surrounding lava-covered desert. The cone is composed of basaltic cinders and minor proportions of volcanic bombs. The cinders are scoriaceous, black to reddish-black, and range from 1/4 to 4 inches diameter. Cinder mining has been limited to the west side of the cone. There has been recent interest in developing the aggregate potential of these cinder deposits.

Calspar Quarry, MRZ-2a^(i-6:feldspar)

A white quartz-feldspar rock has been mined from a quarry near Willis Well since 1974 and marketed under the name "Calspar." The product is used in the manufacture of various types of ceramics such as sanitary ware, dishes, pottery, and insulators. Approximately 750,000 tons of milling-grade rock is estimated to occur in the saddle of the ridge behind the quarry, with additional resources under the alluvium south of the mine. The mine is currently operated by Pacific Coast Minerals.

The rock has been described as a feldspathic quartzite (Weber, 1964; Clark, 1977). However, the rock is an intrusive siliceous felsite as mapped by Dibblee (1964a). Alteration of the felsite, at least in part due to the intrusion of a Cretaceous quartz monzonite pluton north of the quarry, has obscured any igneous texture. Similar, but less altered felsite intrusions occur in the Rodman Mountains to the east.

Red Top Quarry, MRZ-2a^(i-7:volcanic cinders)

Volcanic cinders are produced from Malpais Crater, also known as Pipkin Cone. The deposit is a basaltic cinder cone of Pleistocene age which is composed of red and black volcanic bombs and scoriaceous fragments in layers that dip away from the crater. The cone is approximately 2,000 feet in diameter at the base and 300 feet high. Cinders were first produced by the Lucerne Valley Cinder Company in the 1950s. Sierra Aggregate Company has operated a quarry on the south face of the cone since 1981. Estimated reserves are 12 million tons of volcanic cinders suitable for lightweight aggregate and soil conditioner (Kuizon, 1985).

Areas Classified as MRZ-2b⁽ⁱ⁾

Calico Silver/Barite District, MRZ-2b^(i-1:barite)

In the early 1980s, ASARCO had planned to mine silver and recover associated barite along the west slope of the Calico Mountains (see Part III; Areas Classified for Deposits Formed by Hydrothermal Processes; Calico Silver District, MRZ-2b^(h-1)). Mining was to be by open-pit methods with estimated daily production of 6,000 tons of ore and 4,000 tons of waste rock. The ore was expected to yield approximately 12,000 to 15,000 ounces of silver and 500 tons of barite daily. During the estimated 25 years of production, ASARCO planned to extract a total of more than 30 million tons of ore (Harthrong, 1983). The ASARCO property has not gone into production.

Calspar Bicentennial Group, MRZ-2b^(i-2:feldspar)

White siliceous felsite similar to that mined at the Calspar Quarry near Willis Well (page 35, this report) is exposed along the Camp Rock Fault and in a dike complex that extends almost 2 miles to the northeast from the fault. Calspar Corporation explored the deposit by bulldozing cuts along the fault and stockpiling material for testing. The felsite has been crushed by movement along the fault. Testing of the material showed it to be essentially the same as that mined at Willis Well. An EIR and reclamation plan for mining were filed with San Bernardino County in 1977.

Southern Granite Mountains, MRZ-2b^(i-3:limestone)

Near the southwestern corner of the study area, a ridge underlain by Paleozoic limestone projects southeastward from the Granite Mountains into Lucerne Valley. The ridge is 4,000 feet long by 2,000 feet wide and rises 600 feet above the valley floor. The limestone has been recrystallized to white to gray marble that has been isoclinally folded and refolded. The marble is highly siliceous with chert nodules and silicate minerals (epidote, wollastonite, others). Howard Brown (personal communication, September 9, 1997) has tentatively assigned this unit to the Bird Spring Formation

(Paleozoic). This deposit is undeveloped except for a small quarry on the southern side that was inactive in 1987 when fieldwork for this project was performed. The highly siliceous nature of the deposit precludes its use in many products; however, it might have applications in specialty cement products.

Areas Classified as MRZ-3a⁽ⁱ⁾

Barstow Formation, MRZ-3a^(i-1:clay, borates, zeolites, strontium)

Areas underlain by lacustrine beds of the Barstow Formation are classified MRZ-3a for clay, borates, zeolites, and strontium. Diagenetic alteration of tuff beds by alkaline and saline lake waters have produced deposits of bentonite clays and zeolites. Bentonite clay has been mined at the North Group claims, Gunn Mine, Stacsite Mine and several other localities in the Barstow Formation. Zeolites, most commonly clinoptilolite, have been identified at a number of localities in the Barstow Formation (Stinson, 1988). While no zeolites have been mined in the study area, about 2,000 tons of clinoptilolite was produced from the Mud Hills Mine about 1 mile north of the northwest corner of the study area.

Borate deposits in the Barstow Formation, primarily colemanite and colemanite-rich shale, were mined from 1884-1907 in the Calico Mountains, near Lead Mountain (American Borax), and at Daggett Ridge (Columbus Mine). The Fort Cady deposit (MRZ-2a^(i-4: borates)) occurs in subsurface Barstow Formation. The borate deposits are probably a result of spring emissions within the Miocene lakes and later ground water and evaporitic concentration of the borate minerals (Link, 1980).

Within the study area, celestite (strontium sulphate) and strontianite (strontium carbonate) are found associated with borate deposits of the Barstow Formation in the Calico Mountains, at the American Borax Mine, and at the Fort Cady borate deposit (Madsen, 1970). No large deposits are known in the study area. However, at the Argos deposit in the southern Cady Mountains 3 miles east of the study area, Durrell (1953) estimates reserves of 1.5 to 2.5 million tons of celestite. The Solomon and Ross strontianite deposits lie in the Mud Hills northwest of the study area.

Mitchell Range, MRZ-3a^(i-2:barite)

The northeastern Mitchell Range contains numerous northwest-striking barite veins. The veins occur in Miocene mylonites below the Waterman Hills Detachment Fault and in Miocene sedimentary and volcanic rocks above the detachment fault. The largest veins are at the Barium Queen Mine, which was worked in 1915-1916 and 1930, and at the Lead Mountain Mine. At the Big Medicine prospect, barite occurs as thin veins and replacement zones in lacustrine limestone and shale.

Southern Mitchell Range, MRZ-3a^(i-3:clay)

Beds of altered Miocene tuff underlying and interbedded with lacustrine limestone have been mined for bentonite clay in the southern Mitchell Range. Bentonite was produced from the Grottoes and Soapstone mines. The tuffs, at least in part, are stratigraphically equivalent to the tuff bed mined by Brubaker-Mann to the north (MRZ-2a^(i-2:clay)).

Soldier Mountain, MRZ-3a^(i-4:pyrophyllite)

Small deposits of white pyrophyllite- and sericite-quartz schist occur on the southern flank of Soldier Mountain. The exposed deposits are relatively small and are likely derived by the hydrothermal alteration of Jurassic volcanic rock. A small amount of material was probably produced from the deposit in the northwest 1/4 of section 29.

Farway Pumice Deposit, MRZ-3a^(i-5:pumice)

A 10-foot-thick bed of white pumice tuff strikes northwest and dips 25° southeast. The bed is exposed discontinuously 3,000 feet along strike. The pumice was mined from shallow pits.

Afton Canyon Fluorite, MRZ-3a^(i-6:fluorspar)

North- to northeast-striking veins in Miocene volcanic rock and Mesozoic granite contain fluorite, calcite, and quartz. Several shipments of fluorite were made in 1918 (Tucker and Sampson, 1943).

West Ord Mountains, MRZ-3a^(i-7:fluorspar)

Fluorite occurs in east-west-striking quartz veins. The veins are identical to veins in the study area that have produced gold and silver except for the abundance of fluorite. These fluorite-bearing veins are developed at the Green Hornet and McKinney mines.

Richter Quarry, MRZ-3a^(i-8:dolomite)

The Richter Quarry occupies an isolated hill surrounded by alluvium in Lucerne Valley. The property was first worked for magnesite in the early 1940s. About 1946, brucite marble was produced from the quarry and marketed under the trade name "Lucernite" or "Brucite Marble Flour" for use in special types of filler. The brucite marble is exposed over a length of about 500 feet and averages about 200 feet in width. It was formed by contact metamorphism of dolomite with at least some magnesium

metasomatism (Campbell, 1948). Tucker and Sampson (1943) estimate the deposit contains 1.2 million tons of "commercial dolomite."

Peterson Quarry, MRZ-3a^(i-9:limestone)

A body of white to gray, medium- to coarse-grained, limestone marble is exposed over an area 1,500 feet long and up to 300 feet wide. Within the limestone body are bands of white high-calcium limestone 50-75 feet wide and several 100 feet long. The deposit has been core drilled to a depth of at least 90 feet (Gray, 1965). The quarry was opened in 1944 by Marter Mining Company and was active intermittently into the 1960s.

Aztec Sandstone, MRZ-3a^(i-10:silica)

Undeveloped exposures of Aztec Sandstone occur near the Copper Strand Mine and on the southwest flank of Rodman Mountain. The sandstone is a cross-bedded orthoquartzite containing 90-95% well-rounded quartz grains with minor sericite and pyrite (Miller and Carr, 1978; Ver Planck, 1966).

Texas Granite Quarry, MRZ-3a^(i-11:dimension stone)

This area and the area to the south, classified by Taylor (1994), encompasses a series of small granitic outcrops that historically have been quarried for use as dimension stone. The quarries were opened during the 1930s and reportedly operated on an intermittent basis up to the 1950s. Material produced is a biotite-rich, quartz monzonite that grades from a pale gray to yellowish gray, medium grained, and devoid of planar or linear features. Weathering has commonly produced concentric iron oxide bands parallel to jointing; this stone has been marketed as "golden vein" granite. Quarrying was confined to relatively fresh blocks that were split parallel to a prominent joint set. However, in all probability, these prominent joint sets led to the demise of this operation as jointing made it difficult for the operators to remove large blocks of material that were suitable for resawing.

CONCLUSIONS

Within the Barstow-Newberry Springs area, lands classified MRZ-2a and MRZ-2b contain resources for iron, silver, and industrial minerals (Table 2). The most important commodities mined at present in the study area are hectorite, volcanic cinders, specialty stone (decorative rock), bentonite clay, feldspar, and borates.

Areas which are classified MRZ-2a include a deposit of hectorite mined by RHEOX, Inc.; seven decorative rock quarries operated by Brubaker-Mann, Inc. and Calico Rock Milling, Inc.; two volcanic cinders deposits at Pisgah Crater and Malpais Crater (Pipkin Cone); a deposit of bentonite clay mined by Brubaker-Mann, Inc.; a subsurface deposit of borates being developed by Fort Cady Minerals Corporation; and a deposit of quartz-feldspar rock at Willis Well mined by Pacific Coast Minerals. A large undeveloped deposit of magnetite (iron oxide) skarn near Galway Lake (Morris Lode) is also classified MRZ-2a.

Areas which are classified as MRZ-2b include important resources for silver, iron, copper/molybdenum, feldspar, barite, and limestone. Large low-grade silver deposits with associated barite occur in the Calico Mountains. Subsurface deposits of iron ore are located in Camp Rock Valley and at the Bessemer Mine. Quartz-feldspar rock like that mined at Willis Well occurs in the Rodman Mountains. Paleozoic limestone crops out in the southern Granite Mountains.

In addition to iron and silver, past mining activities have included the mining of gold, copper, and tungsten; however, no areas are classified higher than MRZ-3a for these metal resources. The Ord Mountain and East Ord Mountain Area (MRZ 3a^(h-9) and MRZ 3a^(h-10)), has considerable potential for economic gold and silver mineralization. Placer gold has been mined intermittently at the Camp Rock Mine in the northwestern Rodman Mountains (MRZ-3a^(p-1)). The gold may be residual or derived from a nearby source. The negative magnetic anomaly over the alluvium in the mine area may be the result of hydrothermal alteration of potentially mineralized bedrock underlying the alluvium. The Ord Mountains - Rodman Mountains area also has potential for porphyry copper/molybdenum deposits.

Although not classified because of insufficient knowledge of these deposits, resources of sodium, potassium, carbonate, and borate compounds reportedly are present in the bedded crystalline deposits and in the brines at Lucerne and Troy (dry) lakes.

Table 2. Areas classified MRZ-2a and MRZ-2b, with commodity and square miles.

AREA NAME	MRZ	COMMODITY	SQUARE MILES	PAGE
Morris Lode	2a ^(s-1)	iron	.41	29
Decorative rock quarries	2a ⁽ⁱ⁻¹⁾	decorative rock	.57	31
Bentonite Quarry	2a ⁽ⁱ⁻²⁾	bentonite clay	.38	31
Hectorite clay deposit	2a ⁽ⁱ⁻³⁾	hectorite	1.41	31
Fort Cady borate deposit	2a ⁽ⁱ⁻⁴⁾	borates	.79	33
Pisgah Quarry	2a ⁽ⁱ⁻⁵⁾	volcanic cinders	.12	34
Calspar Quarry	2a ⁽ⁱ⁻⁶⁾	feldspar	.12	34
Red Top Quarry	2a ⁽ⁱ⁻⁷⁾	volcanic cinders	.21	34
Calico Silver District*	2b ^(h-1)	silver	6.82	22
Calico Silver/Barite District*	2b ⁽ⁱ⁻¹⁾	barite		35
Red Hill deposit	2b ^(h-2)	copper, molybdenum	.80	23
Camp Rock Valley	2b ^(s-1)	iron	1.36	29
Bessemer Mine	2b ^(s-2)	iron	.62	29
Calspar Bicentennial Group	2b ⁽ⁱ⁻²⁾	feldspar	.22	35
Southern Granite Mountains	2b ⁽ⁱ⁻³⁾	limestone	.27	36
Total Square Miles			14.10	mi ²

* The Calico Silver District and the Calico Silver/Barite District cover the same geographic area.

ACKNOWLEDGMENTS

The Division of Mines and Geology gratefully acknowledges the cooperation of local government agencies, organizations, consultants, and especially the producers, all of whom provided information during the course of this study. Special thanks is extended to Bill Mann and Julie Mann of Brubaker-Mann, Inc.; Jane Nielson and Bret Cox of the USGS, Las Vegas; Liz Schermer of Western Washington University; George J. Hartman of Fort Cady Minerals Corporation; Mike R. McGath, Joyce Pulliam-Fitzgerald, and Richard Willett of RHEOX Corporation; Ken Schulte of the USBLM, Barstow; and Cindy Pridmore and Ron Churchill of the Division of Mines and Geology.

REFERENCES CITED

- Ames, L.L., Sand, L.B., and Goldich, S.S., 1958, A contribution on the Hector, California, bentonite deposit: *Economic Geology*, v. 53, p. 22-37.
- Aubury, L.E., 1908, The copper resources of California: California State Mining Bureau Bulletin 50, 366 p.
- Bartley, J.M., Fletcher, J.M., and Glazner, A.F., 1990, Tertiary extension and contraction of lower-plate rocks in the central Mojave metamorphic core complex, southern California: *Tectonics*, v. 9, no. 3, p. 521-534.
- Bates, R.L., 1960, *Geology of the industrial rocks and minerals*: Harper and Brothers, New York, 441 p.
- Bezore, S.P. and Pridmore, C.L., in preparation, *Geology of the Silver Bell Quadrangle, San Bernardino County, California*: California Department of Conservation, Division of Mines and Geology, scale 1:24,000.
- Bezore, S.P. and Shumway, D.O., 1994, Mineral land classification of a part of southwestern San Bernardino County: the Barstow-Victorville area, California: California Department of Conservation, Division of Mines and Geology Open-File Report 94-04, 62 p.
- Bortugno, E.J., and Splittler, T.E., 1986, San Bernardino Quadrangle, California Department of Conservation Division of Mines and Geology Regional Geologic Map Series, Map No. 3A (Geology), scale 1:250,000.
- Bowen, O.E., Jr., 1954, *Geology of the Barstow Quadrangle, California*: California State Division of Mines Bulletin 165, 208 p.
- Bradley, W.W., 1930, Barite in California: California Division of Mines Report 26, p. 45-57.
- California State Mining and Geology Board, 1983, *California surface mining and reclamation policies and procedures*: California Division of Mines and Geology Special Publication 51, second revision, 38 p.
- Campbell, Ian, 1948, *Magnesium metasomatism in dolomite from Lucerne Valley, California*: Publications of the Division of the Geological Sciences, California Institute of Technology, Pasadena, California, Contribution No. 511, 8 p.
- Chesterman, C.W., 1956, Pumice, pumicite, and volcanic cinders in California: California Division of Mines Bulletin 174, 119 p.
- Clark, W.B., 1977, Feldspar deposit in the Ord Mountains, San Bernardino County, California: *California Geology*, v. 30, no. 4, p. 81-85.
- Cloudman, H.C., Huguenin, E., and Merrill, F.G.H., 1919, San Bernardino County: California State Mining Bureau Report 15, p. 771-899.
- Cox, B.F., Griscomm, Andrew, Kilburn, J.E., Raines, G.L., Knepper, D.H., Jr., Sabine, Charles, and Kuizon, Lucia, 1987, Mineral resources of the Newberry Mountains and Rodman Mountains Wilderness Study Areas, San Bernardino County, California: U.S. Geological Survey Bulletin 1712, 28 p.
- Cox, B.F. and Wilshire, H.G., 1993, Geologic map of the area around the Nebo Annex, Marine Corps Logistics Base, Barstow, California: U.S. Geological Survey Open-File Report 93-568, 36 p.
- Crawford, J.H., 1894, *Mines and mining products of California*: California State Mining Bureau Report 12, p. 21-411.
- Crawford, J.H., 1896, California State Mining Bureau Report 13, 726 p.
- Crosby, J.W., III and Hoffman, S.R., 1951, Fluorspar in California: *California Journal of Mines and Geology*, v. 47, p. 619-638.
- DeGroot, Henry, 1890, San Bernardino County--its mountains, plains and valleys: California State Mining Bureau Report 10, p. 518-539.
- Dibblee, T.W., Jr., 1964a, Geologic map of the Ord Mountains Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-427, scale 1:62,500.
- Dibblee, T.W., Jr., 1964b, Geologic map of the Rodman Mountains Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-430, scale 1:62,500.
- Dibblee, T.W., Jr., 1966, Geologic Map of the Lavic Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-472, scale 1:62,500.
- Dibblee, T.W., Jr., 1970, Geologic map of the Daggett Quadrangle, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-592, scale 1:62,500.
- Dibblee, T.W., Jr. and Bassett, A.M., 1966a, Geologic map of the Newberry Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-461, scale 1:62,500.
- Dibblee, T.W., Jr. and Bassett, A.M., 1966b, Geologic map of the Cady Mountains Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-467, scale 1:62,500.
- Dokka, R.K., 1980, Late Cenozoic tectonics of the central Mojave Desert, California: University of Southern California, unpublished Ph.D. dissertation, 193 p.
- Dokka, R.K., 1989, The Mojave extensional belt of southern California: *Tectonics*, v. 8, p. 363-390.
- Dokka, R.K. and Woodburne, M.O., 1986, Mid-Tertiary extensional tectonics and sedimentation, central Mojave Desert, California: Louisiana State University Publications in Geological and Geophysical, Tectonics and Sedimentation, v. 1, 55 p.
- Durrell, Cordell, 1953, *Geological investigations of strontium deposits in southern California*: California Division of Mines Special Report 32, 48 p.
- Durrell, Cordell, 1954, Barite deposits near Barstow, San Bernardino County, California: California Division Of Mines Special Report 39, 8 p.
- Erwin, H.D. and Gardner, D.L., 1940, Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California: California Division of Mines Report 36, p. 293-304.
- Fletcher, D.I., 1986, *Geology and genesis of the the Waterloo and Langtry silver barite deposits, California*: Unpublished Ph.D.

- dissertation, Stanford University, 158 p.
- Gardner, D.L., 1940, Geology of the Newberry and Ord mountains, San Bernardino County California: California Journal of Mines and Geology, v. 36, p. 257-292.
- Glazner, A.F. and Bartley, J.M., 1984, Timing and tectonic setting of Tertiary low-angle faulting and associated magmatism in the southwestern United States: Tectonics, v. 3, p. 385-396.
- Glazner, A.F., Bartley, J.M., and Walker, J.D., 1988, Geology of the Waterman Hills detachment fault, central Mojave Desert, California, in Weide, D.L., and Faber, M.L., editors: This extended land, geological journeys in the southern Basin and Range: Field trip guidebook for the Geological Society of America, Cordilleran Section Meeting, Las Vegas, p. 225-237.
- Glazner, A.F., Bartley, J.M., and Walker, J.D., 1989, Magnitude and significance of Miocene crustal extension in the central Mojave Desert, California: Geology, v. 17, p. 50-53.
- Glazner, A.F., Nielson, J.E., Howard, K.A., and Miller, D.M., 1986, Correlations of the Peach Springs Tuff, a large-volume Miocene ignimbrite sheet in California and Arizona: in Cenozoic stratigraphy, structure and mineralization in the Mojave Desert, prepared for the 82nd annual meeting of the Cordilleran Section of the Geological Society of America, Los Angeles, March 25-28, 1986, p. 65-68.
- Glazner, A.F., Walker, J.D., Bartley, J.M., Martin, M.M., Schermer, E.R., Boettcher, S.S., Miller, J.S., Fillmore, R.P., and Linn, J.K., 1994, Reconstruction of the Mojave Block, in McGill, S.F., and Ross, T.M., editors: Geological Investigations of an Active Margin, Geological Society of America Cordilleran Section Guidebook, 27th Annual Meeting San Bernardino, California.
- Goodyear, W.A., 1888, San Bernardino County: California Mining Bureau Report 8, 504-411.
- Graubard, C.M., Mattinson, J.M., and Busby-Spera, C.J., 1988, Age of the lower Sidewinder volcanics and reconstruction of the early Mesozoic arc in the Mojave Desert: Geological Society of America Abstracts with Programs, v. 20, p. A274.
- Gray, C.H., Jr., 1965, Limestone and dolomite resources of the Mojave Desert Province: California Division of Mines and Geology unpublished report.
- Hart, E.W., Bryant, W.A., and Trieman, J.A., 1993, Surface faulting associated with the June 1992 Landers earthquake, California: California Geology, v. 46, no. 1, p. 10-16.
- Harthrong, D.S., 1983, Renewed mining activity in the Calico Mountains: California Division of Mines and Geology, v. 36, no. 10, p. 216-225.
- Hartman, G.J., 1996, Fort Cady: developing an in situ borate mine: Mining Engineering, v. 48, no. 8, p. 48-50.
- Henderson, G.V., 1980, Geology of the Leviathan barite-silver mine, Calico Mountains, California, in Fife, D.L., and Brown, A.R., editors, Geology and mineral wealth of the California Desert: South Coast Geological Society, p. 346-348.
- Hensher, Alan and Vredenburg, Larry, 1991, Ghost towns of the Mojave Desert, a concise and illustrated guide: California Classic Books, Los Angeles, 63 p.
- Hewett, D.F., 1954, General geology of the Mojave Desert region, California: California Division of Mines and Geology Bulletin 170, ch. 2, p. 5-20.
- Hewett, D.F. and Glass, J.J., 1953, Two uranium-bearing pegmatite bodies in San Bernardino County, California: American Mineralogist, v. 38, nos. 11-12, p. 1040-1050.
- Industrial Minerals, 1989, Corona controls Fort Cady borate: Industrial Minerals, no. 260, p. 15-16
- Irelan, William, Jr., 1888, Eighth annual report of the State Mineralogist: California State Mining Bureau, p. 490-512.
- James, E.W., 1989, Southern extension of the Independence dike swarm of eastern California: Geology, v. 17, p. 587-590.
- Jenkins, O.P., 1942, Tabulation of tungsten deposits in California to accompany Economic Mineral Map No.4: California Journal of Mines and Geology, v. 38, p. 303-364.
- Jessy, D.R., 1988, Silver-barite mineralization of the Calico Mining District, in Gaskin, L., compiler, Geologic excursions in the eastern Mojave Desert, prepared for the spring conference of the Far Western Section, National Association of Geology Teachers, April 15-17, 1988, p. 43-55.
- Karish, C.R., 1983, Mesozoic geology of the Ord Mountains, Mojave Desert: structure, igneous petrology, and radiometric dating of a failed incipient intra-arc rift: Stanford University, unpublished M.S. thesis, 112 p.
- Karish, C.R., Miller, E.L., and Sutter, J.F., 1987, Mesozoic tectonic and magmatic history of the central Mojave Desert: Arizona Geological Society Digest, v. 18, p. 15-32.
- Kerr, P.F., 1946, Tungsten mineralization in the United States: Geological Society of America Memoir 15, 241 p.
- Kiser, N.L., 1981, Stratigraphy, structure, and metamorphism in the Hinkley Hills, Barstow, California: Stanford University, unpublished M.S. thesis, 70 p.
- Kuizon, Lucia, 1985, Mineral resources of the Rodman Mountains Wilderness Study Area (BLM No. CDCA-207), San Bernardino County, California: U.S. Bureau of Mines Mineral Lands Assessment Report MLA 36-85, 14 p.
- Lamey, C.A., 1948, Iron Mountain iron-ore deposits, Lava Bed District, San Bernardino County, California: California Division of Mines Bulletin 129, p. 39-58.
- Lambert, J.R., 1987, Middle Tertiary structure and stratigraphy of the southern Mitchell Range, San Bernardino County, California: Louisiana State University, Baton Rouge, unpublished M.S. thesis, 119 p.
- Lindgren, Waldemar, 1887, The silver mines of Calico, California: Transactions of the American Institute of Mining Engineers, v. 15, p. 717-734.
- Link, M.H., 1980, Sedimentary facies and mineral deposits of the Miocene Barstow Formation, in Fife, D.L., and Brown, A.R., editors, Geology and mineral wealth of the California Desert: South Coast Geological Society, p. 191-203.
- Logan, C.A., 1947, Limestone in California: California Journal of Mines and Geology, v. 43, p. 175-357.
- Madsen, B.M., 1970, Core logs of three test holes in Cenozoic lake deposits near Hector, California: U.S. Geological Survey Bulletin 1296, 43 p.
- Martin, M.W. and Walker, J.D., 1992, Extending the western North American Protozoic and Paleozoic

- continental crust through the Mojave Desert: *Geology*, v. 20, p. 753-756.
- McCulloh, T.W., 1965, Geologic map of Nebo and Yermo quadrangles, San Bernardino County, California: U.S. Geological Survey Open File Map 65-107, scale 1:24,000.
- Miller, E.L. and Carr, M.D., 1978, Recognition of Possible Aztec-equivalent sandstones and associated Mesozoic metasedimentary deposits within the Mesozoic magmatic arc in the southwestern Mojave Desert, California, in Howell, D.G. and McDougall, K.A., editors, *Mesozoic paleogeography of the western United States, Pacific Coast Paleogeography Symposium 2: Pacific Section Society of Economic Paleontologists and Mineralogists*, p. 283-289.
- Miller, F.K. and Morton, D.M., 1980, Potassium-argon geochronology of the eastern Transverse Ranges and southern Mojave Desert, southern California: U.S. Geological Survey Professional Paper 1152, 30 p.
- Miller, R.V., 1993, Mineral land classification of concrete aggregate resources in the Barstow-Victorville area, California: California Department of Conservation, Division of Mines and Geology Open-File Report 92-06.
- Moller, W.P., 1963a, "Sulfur Hole" Part 1: *The Mineralogist*, v. 31, no. 3, p. 12-16.
- Moller, W.P., 1963b, "Sulfur Hole" Part 2: *The Mineralogist*, v. 31, no. 4, p. 10-14.
- Moore, L., 1971, Economic evaluation of California-Nevada iron resources and iron ore markets: U.S. Bureau of Mines Information Circular 8511, 207 p.
- Nason, G.W., 1978, Geology of a portion of the northern Newberry Mountains, San Bernardino County, California: California State University, Los Angeles, unpublished M.S. thesis, 70 p.
- Payne, J.G. and Glass, J.R., 1987, Geology and silver deposits of the Calico district, San Bernardino County, California, in Johnson, J.L., editor, *Bulk mineable precious metal deposits of the western United States, Guidebook and Symposium volume*, Geological Society of Nevada, p. 31-44.
- Rogers, T.H., 1967, San Bernardino Sheet: Geologic Map of California, California Division of Mines and Geology, Geologic Atlas Series, scale 1:250,000.
- Ross, T.M., 1995, North-south-directed extension and timing of extension and vertical-axis rotation in the southwest Cady Mountains, Mojave Desert, California: *Geological Society of America Bulletin*, v. 107, p. 793-811.
- Sabine, Charles, 1985, Mineral resources of the Newberry Mountains Wilderness Study Area (BLM No. CDCA-206), San Bernardino County, California: U.S. Bureau of Mines Mineral Lands Assessment Report MLA 27-85, 11 p.
- Sampson, R.J., 1932, Placers of southern California: California Division of Mines Report 28, p. 254.
- Sanner, W.K., 1985, Tectonic significance of early Miocene basin formation in the Box Canyon area, Mojave Desert, California: University of North Carolina, Chapel Hill, unpublished M.S. thesis, 67 p.
- Schermer, E.R., 1993, Mesozoic structural evolution of the west-central Mojave Desert, in G. Dunne and K.A. McDougall, editors, *Mesozoic Paleogeography of the Western United States II: Society of Paleontologists and Mineralogists, Pacific Section*, p. 307-322.
- Schermer, E.R. and Busby, C.J., 1994, Characteristics of Jurassic magmatism, central Mojave Desert; implications for arc paleogeography and preservation of continental volcanic sequences: *Geological Society of America Bulletin*, p. 767-790.
- Silva, M.A. and Eyde, D.T., 1990, Mineral commodity report, bentonite and fuller's earth: California Department of Conservation, Division of Mines and Geology Special Publication 107, 37 p.
- Southern Pacific Company, 1964, Minerals for industry, southern California, volume III, summary of geological survey of 1955-1961: California Department of Conservation, Division of Mines and Geology, re-released with permission as Special Publication 95 (1987), 242 p.
- Stinson, M.C., 1988, Zeolites in California, California Department of Conservation, Division of Mines and Geology Bulletin 208, 74 p.
- Storms, W.H., 1893, San Bernardino County: California State Mining Bureau Report 11, p. 337-367.
- Taylor, G.C., 1994, Mineral Land Classification of a part of southwestern San Bernardino County: the Big Bear Lake-Lucerne Valley area, California: California Department of Conservation, Division of Mines and Geology Open-File Report 94-06, 79 p.
- Trask, P.D., 1950, Geologic description of the manganese deposits of California: California Division of Mines Bulletin 152, 378 p.
- Tucker, W.B., 1921, San Bernardino County: California State Mining Bureau Report 17, p. 333-374.
- Tucker, W.B., 1924, San Bernardino County: California State Mining Bureau Report 20, p. 196-200.
- Tucker, W.B. and Sampson, R.J., 1930, San Bernardino County: California State Division of Mines Report 26, p. 221-260.
- Tucker, W.B. and Sampson, R.J., 1931, San Bernardino County: California State Division of Mines Report 27, p. 262-401.
- Tucker, W.B. and Sampson, R.J., 1940, Current mining activity in southern California: California State Division of Mines Report 36, p. 9-82.
- Tucker, W.B. and Sampson, R.J., 1943, Mineral resources of San Bernardino County: California State Division of Mines Report 39, p. 427-549.
- U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a resource/reserve classification for minerals: U.S. Geological Survey Circular 831, 5 p.
- U.S. Geological Survey, 1992, Evaluation of selected metallic and nonmetallic mineral resources, West Mojave Management Area, southern California: U.S. Geological Survey Open-File Report 92-595, 89 p.
- Ver Plank, W.E., 1966, Quartzite in California: California Division Of Mines and Geology Bulletin 187, 58 p.
- Vredenburg, L.M., Shumway, G.L., and Hartill, R.D., 1981, *Desert Fever--an overview of mining in the California desert*: Living West Press, Canoga Park, California, 323 p.
- Walker, G.W., Lovering, T.S., and Stephens, H.G., 1956, Radioactive deposits in California: California Division of Mines Special Report, 49, 38 p.
- Walker, J.D., Bartley, J.M., and Glazner, A.F., 1990, Large-magnitude extension in the central Mojave Desert; implications for Paleozoic to Tertiary paleogeography and

- tectonics: *Journal of Geophysical Research*, v. 95, no. B1, p. 557-569.
- Weber, F.H., Jr., 1964, *Geology of the Ord Mountain District, San Bernardino County, California*: California Division of Mines and Geology Special Report 77, 45 p.
- Weber, F.H., Jr., 1965, *Reconnaissance of silver and barite deposits of the Barstow region, San Bernardino County, California*: California Division of Mines and Geology Open File Maps.
- Weber, F.H., Jr., 1966, *Silver mining in old Calico*: Mineral Information Service, v. 19, no. 5, p. 71-80.
- Weber, F.H., Jr., 1980, *Calico silver District, San Bernardino County California - update* in Fife, D.L. and Brown, A.R., editors, *Geology and mineral wealth of the California Desert*: South Coast Geological Society, p. 339-345.
- Wiebelt, F.J., 1947, *Bessemer iron project, San Bernardino County, California*: U.S. Bureau of Mines Report Investigation 4478, 7 p.
- Willette, R.D., 1995, *Geology of the Hector Mine deposit* in Tabilio, M. and Dupras, D.L., editors, 29th forum on the geology of industrial minerals: proceedings: California Department of Conservation, Division of Mines and Geology Special Publication 110, p. 189-194.
- Woodburne, M.O., 1991, *The Mojave Desert Province* in M.O. Woodburne, R.E. Reynolds, and D.P. Whistler, editors, *Inland Southern California; The last 70 Million Years*, San Bernardino County Museum Association Quarterly, v. 38, nos. 3 and 4.
- Wright, L.A., Stewart, R.M., Gay, T.E, Jr., and Hazenbush, G.C., 1953, *Mines and mineral deposits of San Bernardino County, California*: California Journal of Mines and Geology, v. 49, p. 49-259.
- Zeitelhack, June and La Barge, J.Z., 1976, *Operations of the Pacific Coast Borax Company 1883-1907, Daggett, Marion, Borate, and the Borate-Daggett Railroad* in Keeling, P.J., editor, *Once upon a desert, a bicentennial project: Mojave River Valley Museum Association, Barstow, California*, p. 96-104.

APPENDIX A

MINE AND PROSPECT DESCRIPTIONS - BARSTOW-NEWBERRY SPRINGS AREA

NOTE: References presented in the following pages are listed in the REFERENCES CITED section at the end of the text of the report, page 44.

CONTENTS

APPENDIX A*

	Page
Metallic Mineral Commodities	A3
Copper	A3
Gold (lode)	A8
Gold (placer)	A23
Iron	A24
Manganese	A26
Molybdenum	A28
Silver	A29
Tungsten	A41
Uranium	A43
Industrial Mineral Commodities	A44
Barite	A44
Borates	A46
Clay	A49
Dolomite	A53
Feldspar	A54
Fluorspar	A55
Limestone	A57
Pumice	A58
Pyrophyllite	A59
Silica	A60
Specialty Stone	A61
Sulfur	A63
Volcanic Cinders	A64
Zeolites	A65

- * Mines and prospects are described in the Appendix in numerical order (**APPENDIX NO.**). Mine and prospect localities are numbered on Plate 1 (**MAP NO.**). Each **APPENDIX NO.** has a corresponding **MAP NO.**

COMMODITY: COPPER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
1	Brilliant	Ord Mountain 7.5 T7N R1E Sec 12 SE 1/4	3a(h-9)	Northernmost workings of the Ord Mountain Mine. See Ord Mountain Mine.	120
2	Copper Strand	Camp Rock Mine 7.5 T6N R3E Sec 9 NE 1/4	3a(s-2)	NW-trending, SW-dipping shear zone in garnet-epidote tectite contains copper mineralization. Development consists of an inclined shaft 500 feet in depth and a cross cut tunnel driven 600 feet west. To the NW the shear zone is explored by open cuts, a shallow shaft, and an adit driven SE. Observed mineralization consists of secondary copper minerals. Chalcopyrite and pyrite reported. Property was first operated in 1900. Ore was processed at mill and leaching tanks on site. Tucker and Sampson, 1943, p. 432; Wright and others, 1953, Tabulated List of Mines, p. 7-8.	192
3	Greenback prospect	Ord Mountain 7.5 T7N R1E Sec 12 NE 1/4	3a(h-9)	Two shafts, each about 50 feet deep, develop a copper-stained shear zone in a metamorphosed greenstone pendant. The near-vertical shear zone is about 5 feet wide and trends N30°E. Mineralogy: secondary iron and copper minerals, chalcopyrite, scheelite, quartz, and epidote. The prospect was worked first in 1898 and again in 1939 and in the 1950s. Weber, 1964, p. 29; Wright and others, 1953, Tabulated List of Mines, p. 11.	119
4	L. and L.	Camp Rock Mine 7.5 T7N R3E Sec 17 N 1/2	3a(h-11)	An inclined shaft, now caved or filled, was sunk on northwest-striking quartz veins that dipped 50°W. The veins reportedly contain malachite, azurite, bornite, and chalcopyrite. Northwest of the shaft a crosscut tunnel was driven 469 feet N70°E. On the ridge north of the shaft a mineralized shear zone with quartz, chalcopyrite, and chrysocolla strikes N10°W and dips 65°W. It is developed by a shallow shaft and a crosscut tunnel driven east 400 feet. One sample contains 0.110 oz/ton gold and 0.28 oz/ton silver. Dibblee, 1964b; Tucker and Sampson, 1930, p. 215; 1931, p. 274; 1940, p. 237; Wright and others, 1953, Tabulated List of Mines, p. 14.	147

COMMODITY: COPPER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
5	Moly Prospect	Ord Mountain 7.5 T7N R2E Sec 30 W 1/2	3a(h-9)	Adit driven N10°E 150 feet in Jurassic quartz monzonite and metavolcanic rocks. A mineralized zone striking N17°W and containing values of gold and silver is said to occur 100 feet from the portal at the contact between the two rock types. Mineralogy: chalcopyrite, pyrite, chrysocolla, and copper oxides. The prospect is at the south end of the Ord Mountain vein system. In the vicinity of the adit, mainly in the W 1/2 Section 30, are irregular areas of fractured, hydrothermally altered rock with disseminated chalcopyrite. Samples collected by Weber (1964) contained up to 0.05% copper. Dibblee, 1964a; Weber, 1964, p. 31.	139
6	Ord Mountain	Ord Mountain 7.5 T7N R1E Sec 13 E 1/2	3a(h-9)	Group of patented claims on the west side of Ord Mountain that extends roughly 2 miles in a N-S direction. From north to south the claims include the Brilliant, Modesto, Copper Junction, Belgium, Josephine, Tehachapi, Last Chance, Coupon, Central, and Rio Vista. Workings include a 182-ft. shaft on the Brilliant claim with level workings at the 100- and 182-ft. levels, two drift adits on the Copper Junction claim, the western adit driven 392 ft. with a winze to the 140 ft. level, two cross cut adits, and several open cuts and shafts on the Coupon claim. Aubury, 1908, p. 336; Cloudman and others, 1919, p.789; Crawford, 1894, p. 234; 1896, p. 61 and 326; DeGroot, 1890, p. 528; Tucker and Sampson, 1930, p. 217-218; 1931, p. 276-278; 1940, p. 239; 1943, p. 133, 435, 436; Weber, 1964, p. 31-40; Wright and others, 1953, p. 195.	122
7	Unknown	West Ord Mountain 7.5 T7N R1E Sec 31 SW 1/2	3a(h-15)	8-foot pit in sheared, copper-stained hornblende diorite, with thin pegmatite and quartz veins.	129

COMMODITY: COPPER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
8	Unknown	Camp Rock Mine 7.5 T7N R2E Sec 12 S 1/2	3a(h-11)	A copper prospect is described by Dibblee (1964b) as a fault zone, 1-3 feet wide, which contains chrysocolla, malachite, azurite, and hematite. The zone was developed by an adit driven east 50 feet. More recent work, which obliterated the adit, includes bulldozer cuts and roads to drill sites on and around a north-trending iron-stained ridge. Drill core samples left on the site are mostly metatuff with disseminated chalcopyrite along fine fractures. Dibblee, 1964b.	134
9	Unknown	Camp Rock Mine 7.5 T7N R2E Sec 14 SW 1/4	3a(h-10)	Copper-stained shear zone in Jurassic metavolcanic rock strikes north-south and dips 65°W. Developed by a 15-foot inclined shaft. Mineralogy: quartz, chrysocolla, malachite, limonite, and chalcopyrite.	137
10	Unknown	Ord Mountain 7.5 T7N R2E Sec 19 NW 1/4	3a(h-9)	Quartz-barite veins up to 10 inches thick strike N65°E and dip 75°N. The veins contain secondary copper mineralization and are vuggy with euhedral quartz crystals. Development consists of prospect pits on the veins and a crosscut adit driven northwest. The adit is caved at the portal.	138
11	Unknown	Camp Rock Mine 7.5 T7N R2E Sec 26 NW 1/4	3a(h-10)	Two prospect pits on thin marble pendants in quartz monzonite. At the southern prospect the marble is 3 feet thick, trends north, and is near vertical. Minor copper staining occurs on fractures. At the second prospect, 1,600 feet to the N, the marble is 2 feet thick.	141
12	Unknown	Camp Rock Mine 7.5 T7N R2E Sec 25 SW 1/4	4	A 15-foot shaft in fine-grained aplite. Specular hematite occurs along fractures in the aplite. Dibblee (1964a) reports that an iron-stained shear zone with a few malachite stains is explored by open pits at this location. Dibblee, 1964a.	142

COMMODITY: COPPER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
13	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 17 SW 1/4	3a(h-11)	Copper-stained fracture zone, 2 feet wide, in metabasalt is developed by a 25-foot shaft and a 30-foot crosscutting adit driven east. Mineralogy: thin calcite and quartz veins with chalcopyrite. Trend N10°E, dip 80°W.	148
14	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 17 SE 1/4	3a(h-11)	Shear zone in metavolcanic rock is developed by a 6-foot prospect pit. Trend N10°W, dip 65°W. Vuggy quartz veins and quartz-barite veins from 1 to 10 inches thick occur in the zone. Mineralogy: quartz, barite, chalcopyrite, specular hematite, and secondary copper minerals.	149
15	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 20 NW 1/4	3a(h-11)	Inclined shaft of undetermined depth on 1-foot fracture zone in metabasalt. Trend N10°E, dip 75°W. The zone is copper-stained with thin calcite veins and a trace of pyrite. Sample collected on dump contains no significant values of gold or silver.	151
16	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 20 E 1/2	3a(h-11)	Barite veins in metavolcanic rocks are developed by an inclined shaft and a shallow prospect pit. Trend N10°E, dip 60°W. Host rock is brecciated with barite and quartz filling interstices. Mineralogy: quartz, barite, chalcopyrite, galena, and secondary copper minerals. Dibblee, 1964a.	152
17	Unknown	West Ord Mountain 7.5 T6N R1E Sec 6 NW 1/4	3a(h-15)	Thirty-foot shaft in argillized shear zone in hornblende diorite. Minor copper staining.	167
18	Unknown	Silver Bell Mine 7.5 T6N R4E Sec 6 E 1/2	4	Small tactite bodies with magnetite, copper staining, and serpentine in quartz monzonite. Developed by shallow prospect pits. Dibblee, 1964b.	195

COMMODITY: COPPER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
19	Unknown	Fry Mountains 7.5 T5N R2E Sec 24 NW 1/4	3a(h-21)	A 20-foot-wide silicated zone in a schistose metavolcanic pendant in quartz monzonite is developed by a 15-foot shaft, two southwesterly driven crosscutting adits, and open cuts. The silicated zone is cut by NW-trending spherulitic rhyolite dikes, which in turn are cut by a N-S shear zone. Mineralogy includes quartz, chalcopyrite, and secondary copper minerals. An assayed sample yielded .005 oz/ton gold and .12 oz/ton silver. To the southeast 1,500 feet a shallow cut exposes a garnet-epidote-diopside-quartz tactite.	205

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
20	Active Bee	Ord Mountain 7.5 T6N R2E Sec 8 NE 1/4	3a(h-10)	Vertical shaft and drift adit develop an argillized shear zone in quartz monzonite. A 1-foot-thick quartz vein contains chalcopyrite and copper staining. Strike N40°E, vertical. One sample contains 0.031 oz/ton gold and 1.09 oz/ton silver.	176
21	Anita	West Ord Mountain 7.5 T7N R1E Sec 21 SE 1/4	3a(h-17)	Two shallow shafts, a 12 x 20-foot pit 6 feet deep, and a branching drift adit. Adjacent to the Lenwood Fault, the quartz monzonite and rhyolite dikes at the mine are heavily sheared. Mineralogy: limonite, sparse copper staining, and boxworks in quartz. One sample contains 0.089 oz/ton gold and 0.25 oz/ton silver.	123
22	Azucar	Minneola 7.5 T8N R2E Sec 19 NW 1/4	3a(h-7)	Quartz vein, 1-foot thick, along the contact between quartz monzonite and diorite explored by two trenches. Three samples collected by the U. S. Bureau of Mines contained 0.017-0.082 oz/ton gold and 0.046-0.151 oz/ton silver. Additional workings include an inclined shaft, 135 feet deep with 120 feet of drifts, and an adit that is caved 55 feet from the portal. No significant mineralization was observed at the shaft or adit. In 1941, 6 ounces of gold was recovered from 20 tons of ore. Sabine, 1985, p. 12; Wright and others, 1953, Tabulated List of Mines, p. 24.	100
23	Burning Bush	Camp Rock Mine 7.5 T7N R3E Sec 6 NE 1/4	3a(h-11)	A 4-foot-thick shear zone developed by an inclined shaft. Strike N45°E, dip 55°S. Mineralogy: quartz, calcite, chrysocolla, and limonite. Boxworks and free gold observed in thin quartz veins collected on the dump.	145

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
24	Cumberland	Fry Mountains 7.5 T6N R2E Sec 25 SE 1/4	3a(h-19)	<p>Two shafts 200 feet apart, shallow prospect pits, and a drift adit develop a N25°E-trending vein that dips 85°W. Mineralogy: quartz, pyrite, chalcopyrite, and secondary copper minerals. Ore produced in 1939. Two arrastres near the shafts and a mill site 1/4 mile SW. A sample collected from the dump contains 0.429 oz/ton gold and 0.33 oz/ton silver.</p> <p>Tucker and Sampson, 1940, p. 63; 1943, p. 447; Wright and others, 1953, Tabulated List of Mines, p. 31.</p>	185
25	Desert King	Nebo 7.5 T10N R1W Sec 16 N 1/2	3a(h-1)	<p>Gold deposit in the northern Mitchel Range. The gold mineralization occurs along the Waterman Hills Detachment Fault. At the principal workings a 200-foot-wide and 700-foot-long zone of argillized mylonite is bound on both sides by light blue tourmalinized rock. The zone strikes northeast-southwest. Thin quartz veins in the tourmalinized rock contain pyrite. The deposit was probably first worked around the turn of the century. In the early 1930s it was explored by sample trenches and open cuts. An adit was driven southwest 56 feet connecting with a 50-foot shaft. To the west 3,500 feet a shaft was driven 200 feet in chloritized Waterman Gneiss. Two samples contain 0.016-0.049 oz/ton gold. In 1988 an exploratory drilling program was conducted by Pegasus Gold Corporation in the area.</p> <p>Tucker and Sampson, 1930, p. 324; 1940, p. 234.</p>	1

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
26	Elsie	Fry Mountains 7.5 T6N R2E Sec 36 N 1/2	3a(h-19)	<p>Two shafts 500 feet apart develop quartz veins in quartz monzonite. The veins are on trend with those of the Cumberland Mine and lie along the west side of a quartz monzonite porphyry dike that trends slightly more easterly. Active in early 1900s; output probably appreciable. Small production in 1935 and 1940. A sample collected from the dump contains 1.730 oz/ton gold and 0.30 oz/ton silver. Additional workings include two shallow shafts between the main shafts, an adit, shafts, and prospect pits that explore the porphyry dike for 2,000 feet, and two shafts east of the dike along mineralized shear zones.</p> <p>Tucker and Sampson, 1940, p. 235; Wright and others, 1953, Tabulated List of Mines, p. 33.</p>	187
27	Ford (Hoover)	Grand View Mine 7.5 T6N R2E Sec 10 SW 1/4	3a(h-10)	<p>A group of workings on the southern slope of the East Ord Mountains. On the west, an adit was driven westerly in a limonite-stained zone adjacent to a rhyolitic dike. Approximately 400 feet to the NE is a partially collapsed shaft with a drift to the SW. The shaft is in a shear zone that trends N50°E and dips 65°N. 1,000 feet NE of the shaft an adit was driven N20°E in sheared quartz monzonite. No evidence of mineralization was observed at this adit. A sample collected from a small stock pile contains 0.239 oz/ton gold and 0.13 oz/ton silver. The ore is a siliceous rock with thin stringers of quartz, pyrite, and limonite after pyrite.</p> <p>Tucker and Sampson, 1940, p. 237; Wright and others, 1953, Tabulated List of Mines, p. 43.</p>	179
28	Galena claim	Ord Mountain 7.5 T6N R2E Sec 4 NW 1/4	3a(h-10)	<p>Quartz vein, 1 to 2 feet thick, in a small tactite zone in metamorphosed volcanic breccia near the contact with quartz monzonite. Vein strikes N15°E. Developed by a 10-foot shaft, a 20-foot drift adit, and a crosscutting tunnel about 50 feet long driven east toward the vein. Mineralization: quartz, garnet, epidote, albite, fluorite, chalcopyrite, scheelite, and galena. One sample contains 0.002 oz/ton gold and 1.16 oz/ton silver.</p> <p>Dibblee, 1964a.</p>	175

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
29	Goat Spring	West Ord Mountain 7.5 T7N R1E Sec 30 NW 1/4	3a(h-15)	Two E-W-trending, iron- and copper-stained, argillized breccia zones with thin chalcopyrite-bearing quartz veins and opal cementing the breccia. The eastern zone is developed by a 40-foot vertical shaft and shallow prospects to the east. The western zone is developed by a 40-foot shaft and a short adit to the west. A second adit is driven S40°W about 40 feet in a shear zone SW of the shafts. One sample contains 0.659 oz/ton gold and 9.78 oz/ton silver. A mill site foundation at Goat Spring is dated 1934.	125
30	Gold Banner (East)	Ord Mountain 7.5 T7N R2E Sec 7 SW 1/4	3a(h-9)	Six-foot-wide vein developed by a drift adit driven N45°E. Reportedly the adit and appended level workings total about 250 feet. The vein is prospected for a distance of 1,500 feet to the northeast by several shafts; the deepest is approximately 40 feet. Mineralogy: vuggy quartz, pyrite, chalcopyrite, and secondary copper minerals. One sample collected for assay contains 0.041 oz/ton gold and 1.05 oz/ton silver. Tucker and Sampson, 1943, p. 434; Weber, 1964, p. 29; Wright and others, 1953, Tabulated List of Mines, p. 10.	131
31	Gold Banner (West)	Ord Mountain 7.5 T7N R1E Sec 12 SE 1/4	3a(h-9)	Inclined shaft approximately 100 feet deep along a rhyolitic dike in quartz monzonite. The dike, about 4 feet wide, trends N25°W and dips 75°W. An east-west-striking fault cuts the dike at the shaft. To the south a shaft or stope follows the dike for 25 feet along strike and to an undetermined depth. North of the shaft a tunnel was driven S10°W. No copper mineralization was observed. The ore produced is apparently a bleached zone with minor boxworks in the hanging wall of the dike. One sample collected from the dump contains no significant values of gold or silver. Weber, 1964, p. 29.	121

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
32	Gold Belt	West Ord Mountain 7.5 T7N R1E Sec 30 SW 1/4	3a(h-15)	<p>Fracture zone in hornblende diorite, 2-to-7 feet wide, with quartz-calcite veins containing pyrite and chalcopyrite. Trend N50°E. Developed through a 275-foot vertical range by a shaft with level workings at 50, 100, and 240 feet and an 820-foot haulage tunnel connecting with shaft. Levels also connected by a 270-foot raise to surface from haulage tunnel and by other intermediate raises. In 1930 a 40-stamp mill was installed. Operated until 1932.</p> <p>Tucker and Sampson, 1930, p. 236; 1931, p. 296-297; 1940, p. 235-236; 1943, p. 448-449; Wright and others, 1953, Tabulated List of Mines, p. 36.</p>	126
33	Gold Peak	Fry Mountains 7.5 T6N R3E Sec 31 W 1/2	3a(h-19)	<p>North-trending shear zone with thin pyrite-bearing quartz veins in quartz monzonite, 2,000 feet long. At the northern end are a 120-foot collapsed shaft with drifts at the 50-foot and 100-foot level, a stope to the surface, a drift adit driven N, and a crosscut adit driven N75°E. At the southern end are two drift adits driven N. Over \$40,000 in gold was produced by Gold Peak Mining Company prior to 1914. Two samples contain 1.466 oz/ton gold, 0.31 oz/ton silver and 0.408 oz/ton gold, 0.09 oz/ton silver from the northern and southern ends of the zone respectively.</p> <p>Cloudman and others, 1919, p. 810; Tucker and Sampson, 1940, p. 236; Wright and others, 1953, Tabulated List of Mines, p. 38.</p>	194

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
34	Grand View	Grand View Mine 7.5 T6N R2E Sec 10 SE 1/4	3a(h-10)	<p>Two-compartment inclined shaft sunk on a shear zone that trends N40°E and dips 65°N. There is a 70-foot drift to the NE at the 38-foot level and 75 feet of drifting at the 98-foot level. Several shallow prospect pits explore the shear zone to the SW. The shaft is at the intersection of the shear zone with a spherulitic rhyolite dike intruding quartz monzonite and metatuff. Mineralization: boxworks with free gold in a silicified host rock. Similar silicified and pyritized rock extends into the footwall along the east side of the dike. A selected sample collected from the dump contains 0.416 oz/ton gold and 0.38 oz/ton silver.</p> <p>Tucker and Sampson, 1930, p. 339-240; 1931, p. 299; Wright and others, 1953, Tabulated List of Mines, p. 40.</p>	180
35	Johnson	Fry Mountains 7.5 T6N R2E Sec 36 E 1/2	3a(h-19)	<p>Shear zone in quartz monzonite. Strike N25°E, near vertical. Development: 15-foot shaft in the shear zone and a crosscut tunnel driven 400 feet S70°E with drifts 250 feet to the north and 250 feet to the south. Several small lenses of iron-stained quartz were reportedly developed in the north drift. Active in the 1930s.</p> <p>Tucker and Sampson, 1930, p. 242; 1931, p. 302-303; 1940, p. 68; Wright and others, 1953, Tabulated List of Mines, p. 44-45.</p>	188
36	Mary Etta (T.K.T.)	Ord Mountain 7.5 T6N R2E Sec 6 NW 1/4	3a(h-9)	<p>A 50-foot shaft in dark-gray rhyolite on the west side of a north-trending ridge. On the east side of the ridge a short adit was driven in sheared quartz monzonite. No significant mineralization was observed. Dibblee reports a vein made mostly of quartz stringers with chalcopyrite and pyrite at the adit.</p> <p>Dibblee, 1964a; Weber, 1964, p. 31.</p>	174

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
37	Maumee	Ord Mountain 7.5 T7N R2E Sec 34 NE 1/4	3a(h-10)	Three-foot-wide fault zone in Jurassic quartz monzonite and metabasalt with thin vuggy quartz veins. Strike N80°W, vertical. Mineralogy: euhedral quartz crystals, chalcedony, pyrite, minor copper staining. Developed by a 30-foot shaft at the portal of an adit driven west. West of the adit is a 40-foot shaft inclined 60°. One sample contains 0.126 oz/ton gold and 0.13 oz/ton silver. Dibblee, 1964a.	144
38	New Deal	West Ord Mountain 7.5 T7N R1W Sec 12 NW 1/4	3a(h-8)	Shear zone in quartz monzonite intruded by a basalt dike. Trend N45°W, vertical. Developed by a 25-foot shaft with drift and a 20-foot drift adit on the SE. Mineralogy: limonite-stained quartz veins in argillized quartz monzonite. One sample contains 0.041 oz/ton gold and 0.05 oz/ton silver. 4,000 feet to the southeast a massive quartz vein is explored by shallow prospect pits.	113
39	Olony Lode	Fry Mountains 7.5 T6N R2E Sec 35 SE 1/4	3a(h-19)	Chloritic shear zone in quartz monzonite strikes N20°E and is exposed for a length of 50 feet. The zone contains quartz veins up to 6 inches thick with minor chalcopryrite, limonite, and secondary copper mineralization. It is developed by a shallow pit. Southern Pacific Company, 1964, p. 114.	186
40	One Ton	White Horse Mountain 7.5 T6N R1W Sec 12 NW 1/4	3a(h-15)	A 20-foot shaft and adit driven on an E-W-trending, near-vertical fault zone in diorite. Vuggy quartz veins, 1 to 12 inches thick contain pyrite, chalcopryrite, galena, chrysocolla, limonite, and manganese oxides. Development in 1987 consists of bulldozer cuts west of the shaft that expose additional thin quartz veins. 800 feet SW of the shaft an adit is driven west on a quartz vein in an argillized shear zone in gneiss. One sample contains 0.023 oz/ton gold and 115.61 oz/ton silver.	163

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
41	Ord Belt	Ord Mountain 7.5 T6N R2E Sec 10 NE 1/4	3a(h-10)	<p>Four adits in metatuff intruded by rhyolite dikes. The southernmost adit was driven S30°E 35 feet then SW. Reportedly, at about 250 feet a raise went up about 30 feet on a 5-foot-wide zone of quartz and brecciated wall rock carrying sulfides. 50 feet, in a N50°W direction beyond the raise, a 12-inch mineralized zone trending NS was encountered. NW of this adit, 500 feet, two adits were driven on a shear zone that trends N70°E. A sample of silicified wall rock with boxworks collected from the margin of a rhyolite dike above the portal of the westernmost adit, contains 2.230 oz/ton gold and 0.62 oz/ton silver. East of these two adits, about 700 feet, a cross-cut tunnel was driven N70°W to intersect the shear zone. A sample of silicified and pyritized rock from the dump contains 0.004 oz/ton gold. Just north of the workings is an irregular area roughly 4,500-by-1,000 feet of partially to intensely silicified and pyritized rock, mostly rhyolite breccia. Of 12 samples collected in the area, one, in which free gold was observed, contains 0.027 oz/ton gold. The rest contained no significant values of gold or silver.</p> <p>Tucker and Sampson, 1930, p. 247; 1931, p. 307-308; 1940, p. 238-239; Wright and others, 1953, Tabulated List of Mines, p. 51.</p>	178
42	Overlook	Hidden Valley West 7.5 T10N R5E Sec 16 S 1/2	3a(h-5)	<p>Short adits, pits, and bulldozer cuts lie along a northwest-trending zone for a distance of 4,000 feet. Reportedly, minor galena and malachite occurs in auriferous quartz veins along the zone. One sample contains 0.052 oz/ton gold.</p> <p>Southern Pacific Company, 1964, p. 124.</p>	78

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
43	Painesville	Ord Mountain 7.5 T7N R1E Sec 24 SE 1/4	3a(h-9)	<p>This is the southernmost mine on the Ord Group vein system. A 12-foot-wide vein with Sidewinder metavolcanic rock in the hanging wall and Jurassic quartz monzonite in the footwall strikes N10°W and dips 65°E. Developed by a 25-foot drift adit driven south and a 50-foot inclined shaft in the footwall. Mineralogy: barite, quartz, chalcopyrite, and secondary copper minerals.</p> <p>Cloudman and others, 1919, p. 808-809; DeGroot, 1890, p. 528-529; Tucker and Sampson, 1930, p. 249; 1931, p. 329-331; 1940, p. 239; Weber, 1964, p. 40-41; Wright and others, 1953, Tabulated List of Mines, p. 53.</p>	124
44	Red Hills	Fry Mountains 7.5 T6N R3E Sec 7 SW 1/2	3a(h-20)	<p>Shaft at the base of a NW-trending ridge 60 feet deep, inclined 55°E, in quartz monzonite adjacent to a quartzite pendant. At the top of the ridge, 500 feet to the SE, a partly caved shaft explores a N-trending shear zone that dips 55°E. The hanging wall is argillized quartz monzonite and the footwall is a quartzite pendant. Fragments of thin vuggy quartz veins with minor pyrite occur on the dump. 500 feet to the south is a shaft 30 feet deep in copper stained metabasalt and an adit driven south 200 feet on a N-trending, vertical fault zone in quartz monzonite. Gold is reported to occur in vuggy quartz veins along a rhyolite dike.</p> <p>Tucker and Sampson, 1940, p. 240; Wright and others, 1953, Tabulated List of Mines, p. 54-55.</p>	191
45	Riley	Grand View Mine 7.5 T6N R2E Sec 16 SW 1/4	3a(h-10)	<p>Shear zone in quartz monzonite intruded by northwest-striking rhyolite dikes. Trend N70°E, dip 65°N. A vertical shaft was sunk on the zone. Fragments of silicified and pyritized rhyolite or wall rock with thin stringers of quartz occur on the dump. One sample contains 0.27 oz/ton silver and no significant gold.</p>	181

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
46	Sinbad	Grand View Mine 7.5 T6N R2E Sec 19 W 1/2	3a(h-18)	Argillized zone exposed for approximately 4,500 feet in quartz monzonite with small metamorphic pendants. Copper-stained quartz veins with chalcopyrite are developed by small pits and a 25-foot vertical shaft. Of four samples collected for assay, two contain 0.004 oz/ton gold. 1,000 feet to the SE of the shaft an adit was driven S20°E into quartz monzonite and metamorphic rock. Minor copper staining occurs in a shear zone that strikes N70°W and dips 65°S. Dibblee, 1964a.	182
47	Tao	Ord Mountain 7.5 T7N R1E Sec 12 NW 1/4	3a(h-9)	Quartz vein in quartz monzonite with pyrite, chalcopyrite, galena, chrysocolla, malachite, and limonite. The vein strikes N30°E and dips 75°N. Exploration on the vein in 1992 consisted of a 50-foot drift adit and an inclined shaft 42 feet deep.	118
48	Unknown	Hidden Valley West 7.5 T10N R5E Sec 3 SW 1/4	3a(h-5)	Chloritized shear zones in granite explored by open cuts, presumably for gold. The zones are stained with iron and manganese oxides and contain minor chalcedony. In the northernmost open cut the shear zone is 15 feet thick, strikes N20°W, and dips 40°E.	75
49	Unknown	Hidden Valley West 7.5 T10N R5E Sec 11 SW 1/4	3a(h-5)	Quartz vein in 12-foot-wide chloritized shear zone in granite strikes north-south and dips 40°W. The vein is developed by a 115-foot inclined shaft and a 100-foot adit driven south. Mineralogy: quartz with minor pyrite, chalcopyrite, and secondary copper staining. One sample contains 0.008 oz/ton gold. Southern Pacific Company, 1964, p. 124.	76
50	Unknown	Hidden Valley West 7.5 T10N R5E Sec 12 NW 1/4	3a(h-5)	Shallow bulldozer cut, 75 feet long, exposes a quartz vein in granite. The vein strikes N70°W and dips steeply north. A basalt dike intrudes the granite parallel to the vein.	77

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
51	Unknown	Hidden Valley West 7.5 T11N R5E Sec 35 S 1/2	3a(h-5)	Shaft driven S70°W on a 60° incline 30 feet. Thin stringers of quartz in granite and a quartz vein up to 2 feet thick contain chalcopyrite, chrysocolla, limonite, and calcite. One sample contains 0.066 oz/ton gold and 0.13 oz/ton silver. Southern Pacific Company, 1964, p. 125.	79
52	Unknown	Daggett 7.5 T8N R1W Sec 11 SE 1/4	4	Vertical shaft in Tertiary mudflow breccia. The shaft was driven through the volcanic rocks and a detachment fault into metavolcanic rocks. No mineralization observed.	95
53	Unknown	Daggett 7.5 T8N R1E Sec 16 N 1/2	4	Shaft 25 feet deep, inclined 40° S65°W, in granite beneath a N-S striking basalt dike. The dike is cut by an E-W-trending, steeply-north-dipping fault at the shaft. No mineralization observed. Southern Pacific Company describes a small gold-bearing quartz vein in granite in the SE 1/4 of Section 9. No prospect pit was located in that part of the section underlain by granite. Southern Pacific Company, 1964, p. 120.	99
54	Unknown	Minneola 7.5 T8N R2E Sec 30 NW 1/4	4	Twenty-foot vertical shaft in gray andesite. No evidence of mineralization. Sabine, 1985, p. 12.	102
55	Unknown	West Ord Mountain 7.5 T7N R1E Sec 28 SW 1/4	4	Vertical shaft 50 feet deep in Precambrian gneiss. 1,200 feet to the west an adit driven S10°W in gneiss intruded by a mafic dike. A 2-foot-wide quartz vein is exposed in a prospect pit between the shaft and adit.	127
56	Unknown	Ord Mountain 7.5 T7N R2E Sec 7 SE 1/4	3a(h-9)	Shallow shaft and crosscut adit explore a brecciated quartz vein. No metallic mineralization observed other than minor secondary copper and iron staining. The quartz vein is an eastward extension of the vein at the Gold Banner (East) Mine.	133

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
57	Unknown	Ord Mountain 7.5 T7N R2E Sec 27 SE 1/4	3a(h-10)	Inclined shaft in a vertical, 2-foot-wide shear zone that strikes N-S. Mineralogy: quartz in thin discontinuous veins, chalcopyrite, secondary iron and copper minerals. To the west a 20-foot shaft explores a N65°E-striking shear zone.	140
58	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 8 NE 1/4	3a(h-11)	Shear zone in metabasalt strikes N-S and dips 80°W. The zone contains thin, vuggy quartz veins with euhedral quartz crystals, minor chalcopyrite, and secondary copper staining. Development consists of a vertical shaft 40 feet deep.	146
59	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 19 NE 1/4	3a(h-11)	A 15-foot shaft in altered metatuff cut by a porphyritic dike. At the north edge of the shaft is a small body of hematite-stained, gray, siliceous, pyritized rock.	150
60	Unknown	Camp Rock Mine 7.5 T7N R3E Sec 31 NE 1/4	4	Open cut in Jurassic metavolcanic rock intruded by quartz monzonite. Thin quartz veins, 2-3 inches thick, strike NW.	155
61	Unknown	Silver Bell Mine 7.5 T7N R4E Sec 31 SE 1/4	4	Shear zone in quartz monzonite explored by shallow dozer cuts. Copper-stained fragments of quartz vein with minor chalcopyrite are scattered about the prospect. A circular body of tactite on the knoll east of the prospect reportedly contains 10% garnet. Southern Pacific Company, 1964, p. 160.	158
62	Unknown	Sunshine Peak 7.5 T7N R5E Sec 19 W 1/2	3a(h-14)	Quartz vein in an argillized fault zone in quartz monzonite. The fault strikes N70°E, dips 85°S, and is intruded by an andesite dike. The vein is developed by a 50-foot drift adit, with a 15-foot pit at the portal, and several small prospect pits along strike. Southwest of the adit a 50-foot shaft is driven in quartz monzonite.	160
63	Unknown	West Ord Mountain 7.5 T6N R1W Sec 1 SE 1/4	3a(h-15)	Shallow prospect pit in 10-foot-wide shear zone with quartz veins. Trend: N30°W, dip 65°E. Mineralogy: quartz, pyrite, limonite, and jarosite. Sample contains no significant amounts of gold or silver.	162

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
64	Unknown	West Ord Mountain 7.5 T6N R1W Sec 12 NW 1/4	3a(h-15)	Eight-foot-wide argillized zone in gneiss and quartz monzonite containing 2 1/2-foot-wide quartz vein. Trend: N80°W, vertical. Development consists of an open cut, an 80-foot inclined shaft, and a 20-foot vertical shaft along the zone. Sample of vein contains 0.044 oz/ton gold and 1.40 oz/ton silver. Sample of wall rock contains 0.17 oz/ton silver and no detected gold. Dibblee (1964a) identifies this site as a uranium prospect with small amounts of autinite in the vein. No radioactive minerals were detected in the current study. Dibblee, 1964a.	164
65	Unknown	White Horse Mountain 7.5 T6N R1W Sec 24 N 1/2	4	An adit driven N65°E approximately 50 feet and a partially collapsed shaft 500 feet to the SE, develop zones of iron-stained quartz-sericite schist in Precambrian gneiss intruded by small bodies of quartz monzonite. Mineralogy: quartz, white and light green mica, and hematite. A sample collected for assay yielded 0.002 oz/ton gold and 0.27 oz/ton silver.	166
66	Unknown	West Ord Mountain 7.5 T6N R1E Sec 6 SW 1/4	3a(h-15)	Shallow prospect pit in brecciated zone with thin quartz veins. Mineralogy: quartz, trace of chalcopryrite, malachite, limonite, and pyrolusite. Trend: N70°W, dip 75°N. A selected sample has no significant values of gold or silver.	168
67	Unknown	White Horse Mountain 7.5 T6N R1E Sec 17 SE 1/4	3a(h-15)	Adit driven west about 75 feet along basalt dike and 3-foot-wide shear zone. Four-inch-thick fractured quartz veins contain minor pyrite altered to limonite. Sample of vein contains 0.006 oz/ton gold and 0.73 oz/ton silver.	172
68	Unknown	White Horse Mountain 7.5 T6N R1E Sec 21 NW 1/4	3a(h-15)	Adit driven 30 feet S30°W along a 3-foot-wide argillized shear zone in Precambrian gneiss. Mineralogy: quartz in a 2-foot-wide vein, limonite, and minor pyrite. Trend N30°E, dip 65°E. Sample of vein contains 0.003 oz/ton gold.	173

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
69	Unknown	Fry Mountains 7.5 T6N R2E Sec 26 NE 1/4	3a(h-19)	A 75-foot incline driven south develops an argillized shear zone in quartz monzonite. The shear zone is near vertical and strikes N10°E. Mineralogy: vuggy quartz veins with boxworks and minor secondary copper staining. Southern Pacific Company, 1964, p. 114.	183
70	Unknown	Fry Mountains 7.5 T6N R2E Sec 25 NE 1/4	3a(h-19)	A shallow shaft, now filled, develops an limonite-stained, argillized shear zone in Jurassic quartz monzonite. The zone strikes N65°E and is exposed for a total length of 500 feet on either side of the shaft. Mineralization includes quartz with minor boxworks. Southern Pacific Company (1964) reports a trace of gold and 0.2 oz/ton silver in an assayed sample. Southern Pacific Company, 1964, p. 114.	184
71	Unknown	Fry Mountains 7.5 T6N R2E Sec 36 SW 1/4	3a(h-19)	A drift adit on the south side of an east-west-trending ridge is driven N30°E along a pyrite-bearing quartz vein in Jurassic quartz monzonite. The vein is cut by a quartz monzonite porphyry dike that strikes N20°E. The adit turns more northerly to follow the dike. North of the adit, on the north side of ridge, an open cut, 10 feet deep and 40 feet long exposes a mineralized shear zone adjacent to porphyry dike.	189
72	Unknown	Grand View Mine 7.5 T5N R2E Sec 20 E 1/2	3a(h-21)	East-west-striking shear zone in quartz monzonite developed by a 50-foot shaft inclined 60°S. Mineralogy: chalcopyrite, chrysocolla, malachite, and limonite in a 2-foot-thick quartz vein. The hanging wall is intensely argillized. One sample yielded 0.008 oz/ton gold and 2.27 oz/ton silver. Dibblee, 1964a, p. 5.	204

COMMODITY: GOLD (LODE)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
73	Unknown	Iron Ridge 7.5 T5N R4E Sec 5 SE 1/4	4	Prospect pit in an iron-stained siliceous zone 35 feet long and up to 10 feet thick that strikes northwest and dips southwest. The zone lies in the contact between quartz monzonite and metasedimentary rock. Mineralogy: pyrite and, reportedly, arsenopyrite. Selected sample collected by Southern Pacific Company assayed 0.05 oz/ton gold. Southern Pacific Company, 1964, p. 157.	208
74	Unknown	Iron Ridge 7.5 T5N R4E Sec 16 NE 1/4	4	Twenty-foot shaft in quartz monzonite intruded by an aplite dike. No metallic mineralization observed. Southeast of the shaft, shallow prospect pits explore a small body of metamorphic rock with hematite, quartz, and calcite. In S 1/2 Sec 15 shallow dozer cuts expose pegmatite dikes in diorite.	211

COMMODITY: GOLD (PLACER)

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
75	Camp Rock Mine	Camp Rock Mine 7.5 T7N R3E Sec 28 SW 1/4	3a(p-1)	Gold occurs in Quaternary alluvial fan deposits that range from 2 to 33 feet thick. The property has been worked intermittently since 1905. More than 300 ounces of gold and 20 ounces of silver were produced between 1907 and 1960. Kuizon, 1985, p. 12; Sampson, 1932, p, 254; Tucker and Sampson, 1930, p. 230-231; 1931, p. 291; 1940, p. 233; 1943, p. 443-444; Wright and others, 1953, Tabulated List of Mines, p. 29.	154
76	Gem Placer	Minneola 7.5 T8N R1E Sec 10 NW 1/4	4	Adit driven SW about 75 feet in fanglomerate. Tucker and Sampson, 1940, p. 235.	97
77	Unknown	West Ord Mountain 7.5 T7N R1E Sec 4 NW 1/4	4	Circular shaft 4 feet in diameter and about 50 feet deep in red-stained older alluvium.	114
78	Unknown	West Ord Mountain 7.5 T7N R1E Sec 4 SE 1/4	4	Bulldozer cuts in Tertiary fanglomerate.	115
79	Unknown	Camp Rock Mine 7.5 T6N R3E Sec 10 NW 1/4	4	Vertical shaft approximately 100 feet deep in alluvium at the edge of a wash. The shaft is 3 x 4 feet with cribbing in place, but partly caved as a result of the M7.4 Landers earthquake of June 28, 1992. The Emerson Fault, which ruptured during the earthquake, enters the wash west of the shaft.	193

COMMODITY: IRON

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
80	Bessemer	Iron Ridge 7.5 T6N R4E Sec 28 SE 1/4	2b(s-2)	<p>Podlike bodies of magnetite developed by open pits, shallow shafts, and tunnels. The ore bodies occur in irregular pendants of dolomite intruded by quartz monzonite. Fourteen ore bodies are exposed in an area roughly 3,000 feet long and 1,500 feet wide. Production: 2,000 tons in 1945 and 26,000 tons in 1951.</p> <p>Lamey, 1948, p. 25-38; Moore, 1971, p. 92-93; Wiebelt, 1947; Wright and others, 1953, p. 91.</p>	197
81	Camp Rock prospect	Camp Rock Mine 7.5 T6N R3E Sec 4 NW 1/4	2b(s-1)	<p>A small body of garnet-epidote tactite containing magnetite at the contact of quartz monzonite and marble was explored in the mid-1950s by shallow dozer cuts.</p> <p>Dibblee, 1964a.</p>	190
82	Ebony	Iron Ridge 7.5 T6N R4E Sec 15 SW 1/2	3a(s-3)	<p>Two garnet-epidote tactite bodies in a dolomitic marble pendant. The ore occurs along quartz monzonite-dolomite contacts. The larger deposit is 10 to 25 feet thick, dips steeply NW and is composed of 75% magnetite and 25% hematite. Fifteen feet of coarse garnet, epidote, and calcite separates the magnetite from the quartz monzonite. Ore was mined by an open pit 25 feet wide, 200 feet long, and 75 feet deep. The second ore body, developed by open cuts, lies 100 feet to the southeast.</p> <p>Lamey, 1948, p. 34-35; Moore, 1971, p. 94.</p>	196

COMMODITY: IRON

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
83	Morris Lode	Iron Ridge 7.5 T5N R4E Sec 12 E 1/2	2a(s-1)	<p>Contact zone between dolomite and quartz monzonite developed by two open pits approximately 800 feet apart. Mineralogy: magnetite and hematite with minor pyrite in a gangue of pyroxene, garnet, and epidote. Production: 17,500 tons in 1949-50 for use in cement manufacturing and a few thousand tons in 1957 for use as open hearth lump. A large magnetic anomaly approximately 1,000 feet wide and 1,500 feet long was identified in 1944 by the U.S. Bureau of Mines. Nine holes were drilled of which eight intersected 120 to 921 feet of iron ore with an average grade of 37.323% iron. In 1954 Kaiser Steel Corp. sunk a 55-foot shaft to obtain bulk samples for metallurgical testing. Ore bodies were explored by shallow pits and scraping away of overburden in 1955-58.</p> <p>Lamey, 1948, p. 27-28; Moore, 1971, p. 93-94; Tucker and Sampson, 1943, p. 471-473; Wright and others, 1953, p. 97-98.</p>	210
84	New Bessemer (Alarm)	Iron Ridge 7.5 T5N R4E Sec 1 NE 1/4	3a(s-4)	<p>Irregular body of magnetite-bearing tactite developed by a shallow open pit. Most of the magnetite observed is disseminated in a white mica schist and serpentine-bearing rock. About 4,000 tons of ore was quarried in 1949.</p> <p>Dibblee, 1964b; Wright and others, 1953, Tabulated list of Mines, p. 68.</p>	209
85	Ord Mountain Iron Prospect	Ord Mountain 7.5 T7N R2E Sec 5 SW 1/4	4	<p>Small magnetite skarn deposit on the northeast flank of Ord Mountain. Not visited.</p> <p>Weber, 1964, p. 41-42.</p>	130
86	Unknown	Galway Lake 7.5 T6N R5E Sec 32 NE 1/4	4	<p>Northwest-striking veins of specular hematite and quartz in quartz monzonite. The quartz monzonite is intruded by basalt dikes. The veins are explored by two short adits and shallow pits.</p> <p>Southern Pacific Company, 1964, p. 133.</p>	198

COMMODITY: MANGANESE

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
87	Black Butte	Sleeping Beauty 7.5 T8N R6E Sec 10 NW 1/4	3a(h-6)	<p>The mine originally produced from two adits driven north along a N10°W fault zone that dips 80°W. Psilomelane and pyrolusite occur in the hanging wall in a zone of brecciated andesite 4-6 feet thick. The footwall has a smooth polished red jasperoid surface that resembles polished dimension stone. One hundred tons of ore was shipped from the mine in 1918. The site of the adits is now an open cut, 30 feet wide and 500 feet long. In 1942, 100 tons of ore was produced from an open pit on the pediment surface 1,500 feet to the south. The ore occurs in a zone of brecciated andesite 25 feet wide and 100 feet long.</p> <p>Southern Pacific Company, 1964, p. 138; Trask, 1950, p. 188-191; Tucker and Sampson, 1940, p. 241; 1943, p. 492-493; Wright and others, 1953, p. 114-115.</p>	111
88	Black Raven	Newberry Springs 7.5 T8N R3E Sec 5 NE 1/4	4	<p>Stringers and narrow veinlets of black calcite enclose narrow, discontinuous bodies of psilomelane along a shear zone in Miocene rhyolite.</p> <p>Trask, 1950, p. 193-194.</p>	103
89	Logan	Sleeping Beauty 7.5 T9N R6E Sec 28 SW 1/4	3a(h-6)	<p>Veins of psilomelane, pyrolusite, and calcite occur in a 20-foot-wide brecciated fault zone in Miocene andesite. The veins strike northwest and dip northeast. The mine was worked from an open pit 400 feet long and up to 20 feet deep. Ore was shipped from the mine in 1934, 1942, and 1943.</p> <p>Southern Pacific Company, 1964, p. 138; Trask, 1950, p. 200-201; Tucker and Sampson, 1943, p. 495; Wright and others, 1953, p. 115-116.</p>	93
90	Read Ridge	Sleeping Beauty 7.5 T9N R6E Sec 34 NW 1/4	3a(h-6)	<p>Lenses of manganese oxides and calcite occur along a fault zone that is 1-3 feet wide and 200 feet long. The fault strikes northwest and dips 55° northeast. The property is developed by a 30-foot adit and shallow pits.</p> <p>Southern Pacific Company, 1964, p. 139.</p>	94

COMMODITY: MANGANESE

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
91	Unknown	Hidden Valley West 7.5 T11N R6E Sec 31 SW 1/4	4	An irregular outcrop of manganese oxide, 6 feet in diameter and 8 feet tall in fault zone between Miocene volcanic rock and granite is explored by open cut. Southern Pacific Company, 1964, p. 141.	82
92	Unknown	Silver Bell Mine 7.5 T7N R4E Sec 13 NE 1/4	4	Calcite vein, stained black with pyrolusite. Strike north-south, dip 75°E. The vein, up to 3 feet thick and 500 feet long, occurs in a fault zone that cuts red-stained conglomerate and sandstone. At the southern exposure the vein is developed by a 60-foot-long trench. To the north a 50-foot cut and drift adit exposes the vein. To the northeast, 800 feet, an adit is driven S20°W about 30 feet on an argillized fault zone in basalt.	157

COMMODITY: MOLYBDENUM

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
93	Red Hill prospect	Ord Mountain 7.5 T7N R2E Sec 31 SE 1/4	2b(h-2)	<p>The Red Hill prospect was first worked for gold and copper perhaps as early as 1896. An adit was driven N45°E along a 2-foot-wide quartz vein. There is also a shaft, presently about 50 feet deep. The vein contains chalcopyrite, chrysocolla, and chalcocite. In 1962, exploratory work was done for molybdenum. Included in this work are numerous trenches and drill holes. One hole was core-drilled 490 feet. Molybdenite and its alteration product powellite occur in silicified zones along rhyolite dikes that strike N20°E.</p> <p>Dibblee, 1964a; Weber, 1964, p. 41.</p>	143

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
94	Alabama	Yermo 7.5 T10N R1E Sec 14 SW 1/4	2b(h-1)	Short adits and shallow shafts develop silver mineralization in tuff and tuff breccia on the west side of Odessa Canyon south of Odessa Mine. Tucker and Sampson, 1940, p. 242; Wright and others, 1953, Tabulated list of Mines, p. 96.	45
95	Argentum	Yermo 7.5 T10N R1E Sec 15 NE 1/4	2b(h-1)	The Argentum claims lie west of the Thunderer claims and south of the Occidental and Bismark claims. The workings are mostly in sandy tuff and tuff breccia. A nearly vertical shaft with a large dump lies just southeast of the Humbug Mine. Tucker and Sampson, 1940, p. 242.	36
96	Baltic	Yermo 7.5 T10N R1E Sec 14 S 1/2	2b(h-1)	Shallow workings south of Alabama Mine develop silver mineralization in tuff and tuff breccia.	46
97	Bismark and Humbug	Yermo 7.5 T10N R1E Sec 15 NE 1/4	2b(h-1)	Nearly flat-lying tuff and tuff breccia overlying red dacite or andesite breccia was worked by open pits, drifts, and shallow shafts (Humbug Mine). Ore occurs as impregnations of embolite and cerargyrite along fractures in the tuff. On the west side of the deposit a fault that strikes N35°W and dips 50°W is the site of the Bismark Mine. The ore occurred as barite-rich masses up to 8 inches thick along this fault with red volcanic breccia on the hanging wall and buff-colored tuff on the footwall. To the north of the Bismark Mine a 3-foot-wide vein of coarse barite, striking N and dipping 60°E, was worked by a 20-foot drift. Crawford, 1896, p. 607; Erwin and Gardner, 1940, p. 301; Irean, 1888, p. 497; Wright and others, 1953, p. 131.	34

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
98	Blackfoot	Yermo 7.5 T10N R1E Sec 14 SE 1/4	2b(h-1)	<p>A number of small workings on the east side of Odessa Canyon developed thin jasperoid veins in breccia and tuff breccia. Cerargyrite and embolite occur with minor barite, chalcedony, and lead carbonate.</p> <p>Erwin and Gardner, 1940, p. 302; Tucker and Sampson, 1930, p. 269; 1931, p. 342; 1940, p. 242; Wright and others, 1953, p. 131.</p>	47
99	Burcham (Total Wreck)	Nebo 7.5 T10N R1E Sec 21 NE 1/4	2b(h-1)	<p>Two ore zones are developed by the mine. The southern zone (Burcham Vein) strikes N70°W and dips 65°SW; width is 3 to 10 feet. Gold is reportedly disseminated in iron-stained quartz with lead carbonates, silver chlorides, and small irregularly distributed bunches of galena and sphalerite. The vein is wholly within lacustrine sediments and is truncated by a thrust fault 250 feet below the crosscut tunnel. The northern zone (Mulcahy Vein) strikes N45°W and dips 65°S; width is 4 to 30 feet. The ore deposit lies along a fault that separates lacustrine sediments on the south from volcanic breccia on the north. Gold is disseminated in iron-stained brecciated quartz. Development consists of a crosscut tunnel driven from the south which intersects the Burcham Vein 104 feet and the Mulcahy Vein 410 feet from the portal. Drifts on the Burcham Vein were run for 640 feet northwest and 200 feet southeast with three winzes about 200 feet apart put down to 250 feet below the tunnel level. The Mulcahy Vein was explored for 500 feet to the northwest and 240 feet to the southeast.</p> <p>Erwin and Gardner, 1940, p. 302-303; Tucker, 1921, p. 351; Tucker and Sampson, 1930, p. 285-286; 1931, p. 358-359; 1940, p. 242; 1943, p. 475-476; Wright and others, 1953, p. 132-133.</p>	49
100	Burning Moscow	Yermo 7.5 T10N R1E Sec 15 SW 1/4	2b(h-1)	<p>The Burning Moscow claim lies high on the east wall of Wall Street Canyon, north of Oriental Mine. Workings include an open pit, a shaft of undetermined depth, two short adits driven south, and an inclined shaft. About 50 feet above the canyon floor a NW-trending vein was trenched for about 75 feet across a wash. The deposit is part of the system of veins in altered tuff breccia that extends from the Sioux Mine to the Silver King and Oriental mines.</p>	37

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
101	Carbonate	Yermo 7.5 T10N R1E Sec 23 NW 1/4	2b(h-1)	Shallow surface cuts and short adits developed silver-impregnated tuffs near the junction of Bismark and Odessa canyons. Picked ore had as much as 25 ozs./ton silver, 0.187 oz/ton gold, and 19% lead. Wright and others, 1953, Tabulated List of Mines, p. 98.	52
102	Cisco	Nebo 7.5 T10N R1E Sec 8 SW 1/4	2b(h-1)	Shallow workings in lacustrine sediments along the Calico Fault Zone. Weber, 1965.	21
103	Dietzman group	Yermo 7.5 T10N R1E Sec 23 NE 1/4	2b(h-1)	Short adits, open cuts, and shallow shafts develop silver mineralization in a cream-colored tuff breccia. Tucker and Sampson, 1940, p. 244; Wright and others, 1953, Tabulated List of Mines, p. 99.	53
104	Gale group	Yermo 7.5 T10N R1E Sec 9 SE 1/4	2b(h-1)	An inclined shaft driven S70°W at 65° to an undetermined depth, developed a 4-foot-thick barite vein. Smaller veins on the property are developed by shallow shafts, short adits, and open cuts.	24
105	Galena King	Nebo 7.5 T10N R1E Sec 5 SW 1/4	2b(h-1)	Two shafts and a prospect pit develop a northwest-striking, near vertical vein containing barite, jasper, chalcedony, hematite, and galena. The vein is up to 8 feet wide and is cut off by a northeast-striking fault just north of the shafts. Wright and others, 1953, Tabulated List of Mines, p. 100.	16

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
106	Garfield	Yermo 7.5 T10N R1E Sec 14 NW 1/4	2b(h-1)	The principal workings of the Garfield Mine are two tunnels driven westerly, one 100 feet above the other. The lower tunnel was driven 4,000 feet and the upper tunnel 2,500 feet. Large chambers of ore were developed in these tunnel, about 300 feet long x 40 feet wide. Tucker, 1921, p. 362; Tucker and Sampson, 1930, p. 271; 1931, p. 344; 1940, p. 243-244; 1943, p. 477; Wright and others, 1953, p. 130-131.	43
107	Grant	Nebo 7.5 T10N R1E Sec 16 SW 1/4	2b(h-1)	Small workings along the Calico Fault northwest of the Waterloo Mine. Weber, 1965.	28
108	Lamar	Nebo 7.5 T10N R1E Sec 17 NE 1/4	2b(h-1)	Shallow workings along the Calico Fault Zone. Wright and others, 1953, p. 132.	27
109	Langtry	Nebo 7.5 T10N R1E Sec 7 NE 1/4	2b(h-1)	Near-vertical fractures in silicified Miocene sediments are developed by a shaft and adit. The fracture zone contains veins of barite and quartz that strike N20°W. About 200 tons of ore was produced containing 6-22 oz/ton of silver. Crawford, 1896, p. 607; Storms, 1893, p. 343; Wright and others, 1953, p. 131-132.	19
110	Le Montain	Nebo 7.5 T10N R1E Sec 5 SE 1/4	2b(h-1)	Northwest-striking barite vein worked by an open cut, drift adit, and two shallow shafts in the 1950s. Dibblee, 1970, p. 5; Weber, 1966, p. 79.	18

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
111	Lead Mountain	Nebo 7.5 T10N R1W Sec 36 N 1/2	3a(h-3)	<p>Mineralized fault zone in Miocene tuff. The fault strikes northwest and dips 40° northeast. Mineralogy: barite, quartz, calcite, galena, lead carbonate, and silver chloride. The hanging wall tuff is silicified and cut by barite veins. Near the eastern end of the fault these barite veins are up to 30 feet thick and more than 400 feet in length. There is intense hydrothermal alteration of tuff, diabase, limestone, and conglomerate with numerous thin barite veins in the footwall. The mine was originally worked for silver prior to 1896. Barite was produced in the early 1930s. Workings include a series of open cuts and tunnels along the strike of the fault zone for 500 feet, a 75-foot crosscut tunnel driven north with a 100-foot drift to the NW, and a 210-foot inclined shaft. On the north side of Lead Mountain a 1,300-foot tunnel driven south and a 240-foot raise connect to the inclined shaft.</p> <p>Durrell, 1954, p. 7-8; Tucker, 1924, p. 199-200; Tucker and Sampson, 1930, p. 279, 298; 1931, p. 351-352, 372; 1940, p. 245; 1943, p. 484; Wright and others, 1953, Tabulated List of Mines, p. 79.</p>	12
112	Lone Star Group	Yermo 7.5 T10N R1E Sec 15 SW 1/4	2b(h-1)	The workings lie southeast of the St. Louis Group on the east side of Wall Street Canyon near the mouth.	39
113	Lucky Don Juan	Newberry Springs 7.5 T8N R3E Sec 28 SW 1/4	3a(h-12)	East-west-striking shear zone, 15 feet wide, in Jurassic volcanic rock. The zone is intensely argillized and contains quartz veins with pyrite and galena. One sample collected for assay contains 71.75 oz/ton silver and 0.519 oz/ton gold. The property is developed by a drift incline with a vertical shaft at the portal and a shallow shaft to the east in the bottom of a wash.	106

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
114	Martha prospect	Ord Mountain 7.5 T7N R1E Sec 11 S 1/2	3a(h-9)	Argillized shear zone in quartz monzonite with a quartz vein up to 4 feet thick. Trend EW, dip 75°S. Mineralogy: galena, sphalerite, pyrite, and marcasite in vuggy quartz. Developed by a shallow shaft and a 20-foot trench in 1953. A sample of the vein is reported to have assayed 9% lead and 33 oz/ton silver. Dibblee, 1964a, p. 4; Weber, 1964, p. 29-31.	117
115	Mulcahy Group	Nebo 7.5 T10N R1E Sec 5 SW 1/4	2b(h-1)	Barite veins in a N25°W-striking fracture zone are developed by open cuts and two short adits. The property was located in 1925. In 1934, 200 tons of ore was shipped. Wright and others, 1953, Tabulated List of Mines, p. 103.	15
116	Occidental	Yermo 7.5 T10N R1E Sec 15 NE 1/4	2b(h-1)	The workings consist of open pits, shafts, tunnels, and large open stopes on the hillside east of the Humbug Mine. Embolite and cerargyrite occur along fractures in brecciated and sheared dark gray dacite with barite and minor copper staining. Crawford, 1896, p. 608; Goodyear, 1888, p. 511; Irelan, 1888, p. 497; Storms, 1893, p. 344; Wright and others, 1953, Tabulated List of Mines, p. 104.	35
117	Odessa	Yermo 7.5 T10N R1E Sec 14 SW 1/4	2b(h-1)	The main development is a tunnel driven 600 feet northwest along a minor fault and two smaller tunnels on the west side of Odessa Canyon. The ore, which consists of cerargyrite and embolite with minor copper staining, occurs as impregnations and rich pockets in fractured tuff and tuff breccia. Crawford, 1896, p. 608; Tucker, 1921, p. 363; Tucker and Sampson, 1930, p. 271-272; 1931, p. 344-345; 1940, p. 244; 1943, p. 477; Wright and others, 1953, p. 130.	44

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
118	Old Oriental	Yermo 7.5 T10N R1E Sec 15 N 1/2	2b(h-1)	The Old Oriental claim lies near the top of the ridge east of Wall Street Canyon. Workings include a vertical shaft and an open cut 100 feet long, 6 feet wide, and 30 feet deep in the northern part of the claim and a shaft on the east side of the ridge in the southern part of the claim.	33
119	Oriental	Yermo 7.5 T10N R1E Sec 15 S 1/2	2b(h-1)	The Oriental group includes the Wall Street, Oregon, Red Jacket, and Red Cloud claims on the southwest side of King Mountain north of the town of Calico. The mine workings, which are the most extensive in the area, were made mostly through tunnels entering the mountain from Wall Street Canyon. The Oriental vein system strikes northwest and dips 70° southwest. At the Red Cloud and Red Jacket claims the altered tuff and tuff breccia is intensely fractured with barite and jasper forming a stockwork of small veins in a zone 30 feet wide. Crawford, 1896, p. 608; Erwin and Gardner, 1940, p. 301; Goodyear, 1888, p. 509-511; Irelan, 1888, p. 497; Tucker, 1921, p. 363-364; Tucker and Sampson, 1930, p. 289-290; 1931, p. 362-363; Wright and others, 1953, p. 129.	40
120	Possibility Group	Nebo 7.5 T10N R1E Sec 17 NE 1/4	2b(h-1)	Shallow workings in lacustrine Barstow Formation along the Calico Fault Zone. Wright and others, 1953, p. 132.	26
121	Revier	Nebo 7.5 T10N R1E Sec 5 SW 1/4	2b(h-1)	The mine explored the southeast extension of the Galena King Vein by a shallow shaft and open cuts.	17
122	Silver Bell	Silver Bell Mine 7.5 T7N R4E Sec 12 S 1/2	4	Crosscut adit driven S35°W, 1,050 feet in Miocene basalt. A small mill was built on the site. No significant mineralization observed. Tucker and Sampson, 1930, p. 282-283; 1931, p. 355-356; 1940, p. 246; 1943, p. 487; Wright and others, 1953, Tabulated List of Mines, p. 83.	156

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
123	Silver Bow	Nebo 7.5 T10N R1E Sec 9 W 1/2	2b(h-1)	<p>A 3-foot-wide barite vein developed by a 230-foot inclined shaft and 500 feet of drifting. Minor production of ore prior to 1925, reported to average 100 oz/ton silver.</p> <p>Wright and others, 1953, Tabulated List of Mines, p. 106.</p>	23
124	Silver Cliffs	Sunshine Peak 7.5 T7N R5E Sec 18 NW 1/4	3a(h-13)	<p>Mineralized fault zone in Miocene basalt strikes N60°W. Development consists of a 376-foot shaft with tunnels at four levels, a 150-foot shaft sunk on a 75° incline, and an 80-foot shaft. A small mill was erected on the property. Mineralization is calcite, mostly stained black, with minor chalcedony. The ore reportedly carried values of lead and silver, but this was not verified.</p> <p>Tucker and Sampson, 1930, p. 283-284; 1931, p. 356-357; 1943, p. 487-489.</p>	159
125	Silver Contact	Nebo 7.5 T10N R1E Sec 9 NE 1/4	2b(h-1)	<p>The property is developed by two shafts 600 feet apart. The northern shaft followed bedding in tuff breccia on an incline of 55° for 65 feet. The southern shaft, more than 150 feet deep, explored a barite vein.</p> <p>Wright and others, 1953, Tabulated List of Mines, p. 106.</p>	22
126	Silver King	Yermo 7.5 T10N R1E Sec 15 S 1/2	2b(h-1)	<p>The Silver King Vein lies northeast of the Oriental Vein and intersects it at the southeast corner of the Silver King claim. The original development of the vein was by an inclined shaft 500 feet deep. Additional development was by crosscut tunnels from the Oriental Mine.</p> <p>Tucker, 1921, p. 365; Tucker and Sampson, 1930, p. 289-290; 1931, p. 362-363.</p>	41

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
127	Silver Monument	Yermo 7.5 T10N R1E Sec 22 N 1/2	2b(h-1)	An open pit 65 feet deep and a tunnel at the north end of the Calico townsite produced a large amount of ore. The ore consists of light-colored tuff impregnated with ceragyrite and embolite. Crawford, 1896, p. 609; Irelan, 1888, p. 497.	50
128	Silverado	Nebo 7.5 T10N R1E Sec 5 W 1/2	2b(h-1)	North-south-striking veins, 1-3 feet wide, in a 15-foot-wide shear zone are developed by a 50-foot vertical shaft, an adit below the shaft leading to a stope, and shallow pits. The veins dip 65°E and contain coarsely crystalline barite and euhedral quartz crystals. Weber, 1965.	14
129	Sioux and Falls	Yermo 7.5 T10N R1E Sec 15 NW 1/4	2b(h-1)	Several northwest-striking veins were extensively worked by shafts, drifts, adits, and open cuts at the head of Wall Street Canyon. The larger veins are banded with barite, which commonly exhibits a comb structure, and jasper. The host rock is a light green altered tuff breccia. The presence of chlorite, epidote, and calcite indicate propylitic alteration. This zone is about 1,500 feet wide and extends southeast along Wall Street Canyon to the Silver King and Oriental mines area. Jessy, 1988, p. 50.	32
130	Snowbird	Yermo 7.5 T10N R1E Sec 14 SE 1/4	2b(h-1)	A group of shallow workings, short adits, shafts, and open cuts, develop silver mineralization in a cream-colored to light green, waterlain tuff and tuff breccia. Mineralization occurs as impregnations in tuff and as thin veins of hematite, manganese oxide, barite, and drizzly quartz. The workings, along with those of the Dietzman group to the southwest, trend in a northeasterly direction roughly 1/2 mile along strike of the tuff which dips gently to the southeast. The Barstow Formation overlies the tuff to the south.	48

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
131	St. Louis Consolidated	Yermo 7.5 T10N R1E Sec 15 SW 1/4	2b(h-1)	A group of barite veins in slightly to intensely altered tuff breccia above Wall Street Canyon on the west side were worked by several adits and two shallow shafts. The barite veins strike N30°W and are near vertical or dip steeply east. The larger veins occur in hematite-stained fracture zones up to 20 feet wide. Wright and others, 1953, p. 130.	38
132	Thunderer	Yermo 7.5 T10N R1E Sec 14 NW 1/4	2b(h-1)	The Thunderer claims lie on the ridge between Bismark and Odessa Canyon. Short adits develop irregular ore bodies in fractured dacite breccia. Silver occurs with barite, chalcedony, and minor copper staining. Erwin and Gardner, 1940, p. 243; Irelan, 1888, p. 497; Tucker and Sampson, 1943, p. 477; Wright and others, 1953, p. 130-131.	42
133	Union	Nebo 7.5 T10N R1E Sec 16 SW 1/4	2b(h-1)	Located north of the Waterloo Mine. A tunnel was driven N45°E in tuff breccia 400 feet to intersect a mineralized shear zone. The zone strikes N50°W and dips 50° southwest, flattening at depth. The ore occurs as iron-stained brecciated wall rock with minor quartz that reportedly carried values in gold, silver, and lead. A winze was sunk on the zone to a depth of 100 feet. Erwin and Gardner, 1940, p. 303; Tucker and Sampson, 1940, p. 246; 1943, p. 489; Wright and others, 1953, p. 132.	31
134	Unknown	Nebo 7.5 T10N R1E Sec 6 NW 1/4	2b(h-1)	Prospect pit in Miocene dacite breccia, 8 feet wide, 15 feet long, and 10 feet deep. A smooth vertical fault surface, which strikes N30°W, is exposed on the east side of the pit. Within the pit is an irregular zone of brecciated veins of jasper, barite, and chalcedony.	13
135	Unknown	Yermo 7.5 T10N R1E Sec 25 SE 1/4	4	Adit driven approximately 50 feet east into fanglomerate with volcanic and metavolcanic clasts. Above the adit, two shallow prospect pits expose barite veins in irregular breccia zones cemented by calcite and limonite.	57

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
136	Unknown	Yermo 7.5 T10N R2E Sec 9 NE 1/4	4	Two partly collapsed shafts develop a 30-foot shear zone in intensely fractured granite. Quartz veins up to 2 feet thick dip to the west at the surface then steepen and dip to the east at depth. The veins are very fractured and contain pyrite. One sample contains 1.86 oz/ton silver. Southern Pacific Company, 1964, p. 148.	58
137	Unknown	Ord Mountain 7.5 T6N R2E Sec 9 NW 1/4	3a(h-10)	Two veins, 1 to 2 feet thick and 10 feet apart, in dark gray intrusive rhyolite developed by open cut 10 feet wide and 60 feet long. Mineralogy: barite, quartz, galena, and minor copper staining. One sample contains 0.58 oz/ton silver. Dibblee, 1964a, p. 6.	177
138	Voca	Nebo 7.5 T10N R1E Sec 16 SW 1/4	2b(h-1)	Development of this mine consists of shafts and tunnels that were driven in an attempt to locate an eastward extension of the Waterloo deposit. During its active period, mostly before 1888, the mine yielded 10 to 15 tons of ore averaging 40 ounces of silver per ton, but the total output was small. The ore occurred as small irregular bodies with a silicious gangue and little barite. Irelan, 1888, p. 498-499; Wright and others, 1953, p. 132.	30

COMMODITY: SILVER

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
139	Waterloo	Nebo 7.5 T10N R1E Sec 16 SW 1/4	2b(h-1)	<p>The Waterloo Mine is the largest mine in the west group of the Calico District. The ore bodies lie along the Calico Fault which separates volcanic breccia on the northeast from lacustrine sediments on the southwest. The fault strikes northwest and dips about 40° southwest. The ore bodies are irregular masses that extend along the fault for 1,100 feet. The silver occurs as embolite and cerargyrite in a gangue of barite and jasper. The mine was worked from 1881 to 1896. Development includes a 350-foot shaft with seven levels at 50-foot intervals and two crosscut tunnels, the lower one 2,330 feet long at the seventh level and the upper one 600 feet long intersecting the shaft at the fourth level. The total underground development was approximately 10,000 feet. In 1950 the seventh level was extended northwest to intersect the principal vein of the Union Mine.</p> <p>Erwin and Gardner, 1940, p. 303; Irelan, 1888, p. 492-495; Tucker and Sampson, 1930, p. 286-287; 1931, p. 359-360; 1940, p. 246-247; 1943, p. 488-490; Wright and others, 1953, p. 132.</p>	29

COMMODITY: TUNGSTEN

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
140	Kane Wash prospect	Camp Rock Mine 7.5 T8N R3E Sec 33 NE 1/4	4	Small pendant of marble and tactite in quartz monzonite developed by a 22-foot adit, a 25-foot-deep inclined shaft, an open cut, and shallow pits. The tactite reportedly contains sheelite. Kuizon, 1985, p. 15; Southern Pacific Company, 1964, p. 154.	107
141	Pure Quill	West Ord Mountain 7.5 T6N R1E Sec 4 NW 1/4	3a(h-16)	A northerly-trending zone of irregular quartz veins in amphibolite gneiss is exposed by shallow cuts and pits for 500 feet. Scheelite is disseminated in the quartz and adjacent amphibolite. Minor chalcopyrite and copper staining is also present. A tunnel was driven N70°W 200 feet, intersecting the zone at 170 feet. The zone was followed by drifts 138 feet north and 87 feet south. Wright and others, 1953, p. 150-151.	169
142	Stardust Group	White Horse Mountain 7.5 T5N R1W Sec 12 W 1/2	4	Shallow prospect pits, and short adits explore small garnet-epidote tactite bodies and talc-bearing silicated zones in a marble pendant intruded by hornblende diorite. Disseminated scheelite is reported. Jenkins, 1942, p. 352; Kerr, 1946, p. 165; Wright and others, 1953, Tabulated List of Mines, p. 126.	201
143	Unknown	White Horse Mountain 7.5 T5N R1W Sec 11 NW 1/4	4	Small tactite bodies up to 20 feet long at the contact between marble and diorite are explored by shallow prospect pits. Mineralogy: epidote, garnet, calcite, quartz, actinolite, and traces of chalcopyrite and secondary copper minerals. Shallow prospect pits on the ridge to the east were dug in hornblende diorite with abundant metamorphic inclusions. The similarity and proximity of this deposit to those of the Star Dust Group suggest that it was prospected for tungsten.	199
144	Unknown	Fry Mountains 7.5 T5N R3E Sec 18 NW 1/4	4	Adit driven northeast in tactite along contact between quartz monzonite and a small pendant of marble. The pendant is 1,000 feet long and 200 feet wide. Mineralogy: garnet, epidote, quartz, and calcite. No metallic mineralization observed.	206

COMMODITY: TUNGSTEN

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
145	White Dollar (May Day)	Ord Mountain 7.5 T7N R2E Sec 7 SE 1/4	3a(s-1)	<p>Two shear zones in a metavolcanic pendant carry skarn mineralization. The eastern zone, approximately 1,700 feet long, strikes N15-25°E and dips 65°W. Near the southern end of the zone is a 30-foot inclined shaft with a drift driven 75 feet northward. To the north the zone is explored by open cuts. A 30-foot shaft was sunk on the western zone. Mineralogy: quartz, epidote, garnet, calcite, fluorite, scheelite, and pyrite. The tactite is brecciated and sheared to form a friable, chloritic gouge and breccia zone a few feet thick. A few hundred tons of ore was produced in 1951 and 1952 which reportedly assayed up to 1.4% W₃.</p> <p>Tucker and Sampson, 1943, p. 504; Weber, 1964, p. 43-44; Wright and others, 1953, p. 153.</p>	132

COMMODITY: URANIUM

METALLIC MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
146	Harvard Hill	Harvard Hill 7.5 T10N R3E Sec 21 SE 1/2	3a(h-4)	Secondary uranium minerals occur as coatings on fractures and bedding surfaces in Miocene limestones and cherts interbedded with tuffaceous sandstones and clays. Exploration includes several shallow prospect pits, a caved shaft, and drill holes in the northern portion of Harvard Hill. One sample assayed by the U.S. Geological Survey contained 0.025% uranium; another sample, assayed by the U.S. Atomic Energy Commission, contained 0.085% uranium. Walker and others, 1956, p. 20-21.	69
147	Hoerner-Ross	Sleeping Beauty 7.5 T9N R6E Sec 16 SW 1/4	4	Betafite, strueverite, and cyrtolite occur in biotite-magnetite segregations in a pegmatite dike. The pegmatite was prospected by excavation of a shallow pit. Hewett and Glass, 1953, p. 1040-1050; Southern Pacific Company, 1964, p. 155; Walker and others 1956, p. 21.	92
148	Urano-Thor claims	West Ord Mountain 7.5 T6N R1E Sec 7 SW 1/4	4	Uranium prospect developed by two adits driven in Precambrian gneiss. The upper, northern, adit is driven N45°E, 300 feet and the lower adit is driven N35°W, 250 feet. No significant uranium mineralization observed.	170

COMMODITY: BARITE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
149	Barium Queen	Nebo 7.5 T10N R1W Sec 27 NW 1/4	3a(i-2)	<p>A series of parallel barite veins in Waterman Gneiss. The longest vein can be traced for 6,200 feet. Workings on the veins are primarily shallow shafts and open cuts. On the easternmost and largest vein, a drift adit was driven 310 feet. The mine was first worked about 1915-1916. In 1930, 20 carloads of material was shipped for oil-well drilling mud.</p> <p>Bradley, 1930, p. 54; Cloudman and others, 1919, p. 853; Durrell, 1954, p. 4-5; Tucker, 1921, p. 334, Tucker and Sampson, 1930, p. 297; 1931, p. 371; 1940, p. 249; 1943, p. 509; Wright and others, 1953, Tabulated List of Mines, p. 133.</p>	7
150	Big Medicine	Nebo 7.5 T10N R1W Sec 35 NW 1/4	3a(i-2)	<p>Barite occurs as thin veins and replacement zones in gently folded Miocene limestone and shale. Explored by open cuts and drill holes.</p> <p>Tucker and Sampson, 1930, p. 297, 371; 1940, p. 249; 1943, p. 509; Wright and others, 1953, Tabulated List of Mines, p. 133.</p>	10
151	Hope	Nebo 7.5 T10N R1W Sec 35 NE 1/4	3a(i-2)	<p>Barite veins in Miocene limestone and diabase. Mineralogy: barite, calcite, galena, and minor copper staining. Developed by an inclined shaft and open cuts.</p> <p>Dibblee, 1970, p. 6.</p>	11
152	Leviathan	Nebo 7.5 T10N R1E Sec 8 NE 1/4	2b(i-1)	<p>Barite-jasper vein over 2,000 feet long and up to 50 feet wide. The vein was originally worked for silver by four adit levels having 1,500 feet of workings and by shafts over 100 feet deep. From 1957 to 1961 Oil Base, Inc. mined 50,000 tons of drilling-mud-grade barite from an open cut along the vein.</p> <p>Henderson, 1980, p. 346-348; Wright and others, 1953, Tabulated List of Mines, p. 102.</p>	20

COMMODITY: BARITE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
153	Penny prospect	Nebo 7.5 T10N R1W Sec 23 NW 1/4	3a(i-2)	Irregular veins of barite with chalcopyrite and minor copper staining in volcanic breccia just above the Waterman Hills Detachment surface. Prospected in 1964 from an open pit. One sample contains 0.05 oz/ton silver. Dibblee, 1970, p. 6.	3
154	T.K.T.	Ord Mountain 7.5 T7N R1E Sec 25 SE 1/4	4	A 2-foot-wide barite vein in Jurassic quartz monzonite strikes N17°W. Developed by a 6-foot adit and several drill holes. Not located during this study. Dibblee, 1964a, p. 6.	128
155	Unknown	Nebo 7.5 T10N R1W Sec 22 NE 1/4	3a(i-2)	A group of shallow shafts and open cuts develop small barite veins in Waterman Gneiss.	2
156	Unknown	Nebo 7.5 T10N R1W Sec 28 SW 1/4	4	Northwest-striking mineralized zone in Waterman Gneiss with barite and quartz in thin veins up to 1 foot thick. Explored by two adits, one driven N20°W about 20 feet and the other driven N25°E about 75 feet. A third adit to the south is driven in unmineralized gneiss.	4

COMMODITY: BORATES

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
157	American Borax	Nebo 7.5 T10N R1W Sec 25 NE 1/4	3a(i-1)	Borate shale in the Calico Formation north of Lead Mountain was mined from 1900 to 1907. The shale beds were reportedly 15-20 feet thick and contained 8 to 14% anhydrous boric acid. The deposit was worked from an inclined shaft 400 feet long with 1,000 feet of horizontal drifts. The workings are now caved. Dibblee, 1970, p. 6; Wright and others, 1953, p. 225.	8
158	Centennial	Yermo 7.5 T10N R2E Sec 29 W 1/2	3a(i-1)	Colemanite was produced from an exposure of thin-bedded black shales on a southeast-trending ridge on the south slope of the Calico Mountains. The shale strikes N65°E and dips 35° to 50°W. The colemanite occurs in a zone approximately 5 feet thick as thin layers along bedding planes and irregular lumps enclosed in powdery white howlite. Workings consist of a series of cuts, declines, and drifts for 250 feet along the strike of the black shale. The workings are largely caved and buried by talus. Below the southernmost exposure a haulage tunnel was driven N35°W and a second tunnel was started at wash level to the north. The mine produced 600 to 700 tons of colemanite. Southern Pacific Company, 1964, p. 162; Wright and others, p. 224.	66
159	Columbus (Gem)	Minneola 7.5 T8N R1E Sec 10 NW 1/4	3a(i-1)	Borate-bearing shale beds were first mined here in 1897 or 1898. The beds strike N75°E, dip 65°S, and are overturned to the north. Most of the borate shale mined probably contained from 8 to 18% anhydrous boric acid, although some carload shipments are said to have contained as much as 30%. The main workings consist of a 150-foot shaft, now caved, with drifts at the 50-foot and 100-foot levels. Dibblee, 1970, p. 6; Wright and others, 1953, p. 225.	98

COMMODITY: BORATES

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
160	Fort Cady	Hector 7.5 T8N R5E Sec 25 SW 1/4	2a(i-4)	The Fort Cady borate deposit is more than 1,300 feet below the surface and has an average thickness of 118 feet. Its areal extent is 273 acres. Fort Cady Minerals Corporation plans to recover the calcium borate (colmanite) by in situ solution recovery methods. The final permit for mining was issued in 1995 and plans are to begin production in the summer of 1997. Hartman, 1996, p. 48-50.	110
161	Pacific Coast Borax Co.	Yermo 7.5 T10N R2E Sec 19 N 1/2	3a(i-1)	The Pacific Coast Borate Company mined colemanite in the Calico Mountains from 1884-1907. The workings, now caved, consist of numerous inclined shafts, drifts, and crosscuts that honey-combed the colemanite bearing shales along a belt about 1.5 miles long in the northern half of Section 19. The deepest workings were said to extend 500 feet below the surface. In 1919 and 1920 Union Borax Company drove a 640-foot shaft in andesite near the east end of the Pacific Coast Borate Company workings. A north-trending crosscut was driven into shale containing colemanite and howlite. Wright and others, 1953, p. 224.	63
162	Palm	Yermo 7.5 T10N R2E Sec 29 C	3a(i-1)	Workings of the Palm Borate Company lie near the center of Section 29 and on the section line between Sections 19 and 20 just north of the section corner. Borate shale was produced from inclined shafts, now largely caved, that follow the dip of the shale beds. The shale is a light to dark gray, thin-bedded lacustrine shale of the Barstow Formation. It contains thin stringers and nodules of colemanite. A plant to leach borate from the shale with sulfuric acid and recover the borate in evaporating vats was constructed in 1907. The plant site is at the foot of the Calico Mountains approximately 1/2 mile north of the agricultural inspection station on Interstate 15. The plant operated for 10 days before it was closed and the company liquidated. Wright and others, 1953, p. 224.	67

COMMODITY: BORATES

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
163	Unknown	Yermo 7.5 T10N R1E Sec 25 NW 1/4	3a(i-1)	Shallow pits in Barstow Formation. Samples collected in 1956 ranged from 7.2-24.1% anhydrous boric acid. Southern Pacific Company, 1964, p. 161.	56
164	Unknown	Yermo 7.5 T10N R2E Sec 30 NW 1/4	3a(i-1)	Partly collapsed shaft in Barstow Formation lakebeds, 10 x 10 feet, with drift to northwest. The large dumps at the site indicate the workings are more extensive than is evident at the surface. The lakebeds strike northwest, dip 60° northeast, and are overlain by andesite breccia to the northeast.	65
165	Western	Yermo 7.5 T10N R1E Sec 22 E 1/2	3a(i-1)	The Western Mineral Company mine in the Calico Mountains lies near the mouth of Odessa Canyon, southeast of Calico Ghost Town. At the site of the mine are 400 feet of open cuts and drifts on the northwest side and just above the floor of the canyon. When active, there was a 200-foot inclined shaft, now caved, with drifts at 50-foot intervals. The mine produced borate shale which was said to average 10% anhydrous boric acid and to contain stringers of howlite, celestite, and gypsum. The borate shales are in lacustrine beds of the Barstow Formation that strike to the northeast and dip to the northwest. Not more than 500 tons of 95% boric acid was produced before the mine and processing plant were shut down in 1907. Wright and others, 1953, p. 224-225.	51

COMMODITY: CLAY

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
166	Bentonite Pit	Nebo 7.5 T9N R1W Sec 1 E 1/2	2a(i-2)	Gray-white, bentonitic clay is quarried from open cuts by Brubaker-Mann, Inc. The material is derived from the alteration of Miocene tuff. It is used as a trace mineral carrier for animal feed supplements. Silva and Eyde, 1990, p. 26.	86
167	Big Dee	Manix 7.5 T9N R4E Sec 11 NW 1/4	4	Dozer cut, 30 feet wide, 100 feet long, 10 feet deep in light gray tuff and claystone cut by quartz and chalcedony veins.	89
168	Bomber Moon	Yermo 7.5 T10N R2E Sec 17 SE 1/4	3a(i-1)	A bed of bentonite clay 1 to 5 feet thick and 4,000 to 5,000 feet in exposed length in lacustrine beds of the Barstow Formation. Workings consist of a 40-foot shaft, now collapsed, and a small open pit. Wright and others, 1953, Tabulated List of Mines, p. 176.	61
169	Grottoes	Nebo 7.5 T9N R1W Sec 2 SE 1/4	3a(i-3)	Altered Miocene tuff overlain by limestone, mined for bentonite clay. Workings consist of three adits and a large open cut. Southern Pacific Company, 1964, p. 83; Silva and Eyde, 1990, p. 25.	85
170	Gunn	Yermo 7.5 T10N R2E Sec 22 NW 1/4	3a(i-1)	Quarry in horizontal Barstow Formation lakebeds capped by older alluvium. Small tonnage quarried before 1950; several thousand tons quarried and stockpiled in 1963-64. The quarry is currently withdrawn by U.S. Bureau of Land Management to protect the Calico Early Man site. Dibblee, 1970, p. 6; Southern Pacific Company, 1964, p. 68.	64

COMMODITY: CLAY

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
171	Hector	Hector 7.5 T8N R5E Sec 26 SW 1/4	2a(i-3)	<p>The Hectorite clay deposit was first mined for its unusual clay in 1931. The deposit is now being mined from an open pit by RHEOX, Inc. The hectorite bed is overlain by Pliocene gravel and mud, which is capped by a basalt flow from nearby Mt. Pisgah. The hectorite occurs along the northeast side of a major northwest-trending fault.</p> <p>Ames and others, 1958, p. 22-37; Tucker and Sampson, 1930, p. 306; 1931, p. 380-381; 1940, p. 81-82 and 250-253; 1943, p. 509-510; Willette, 1995, p. 189-194; Wright and others, 1953, p. 157-161.</p>	109
172	North Group (bentonite)	Troy Lake 7.5 T8N R4E Sec 1 NE 1/4	3a(i-1)	<p>Also known as the "Talc Mine," the North Group was mined by California Talc Company, then a subsidiary of National Lead Company (now RHEOX, Inc.) before operations were moved to the South Group (Hector Mine). Bentonitic clay occurs in Miocene lacustrine sediments locally covered by older alluvium. The clay was produced from shallow shafts and pits.</p> <p>Ames and others, 1958, p. 22-37; Dibblee and Bassett, 1966a; Tucker and Sampson, 1940, p. 250-253; 1943, p. 509-510; Wright and others, 1953, p. 157-160.</p>	108
173	Soapstone Mine	Nebo 7.5 T9N R1W Sec 12 E 1/2	3a(i-3)	<p>White bentonite clay derived from the alteration of Miocene tuff. Several hundred tons were mined from two shallow shafts and open pits, probably in the 1930s.</p> <p>Dibblee, 1970, p. 6; Southern Pacific Company, 1964, p. 72.</p>	88

COMMODITY: CLAY

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
174	Stacsite	Manix 7.5 T10N R4E Sec 20 SE 1/2	3a(i-1)	<p>Large roughly "Y" shaped quarry 800 feet long and up to 60 feet deep. The NW arm of the "Y" is the haulage road. Most of the material exposed in the walls of the quarry is a terrace beach sand deposit indicating that the quarry originally produced sand. At the bottom and on the west side near the center of the "Y" a pink clay derived from the alteration of a tuff is exposed. A stockpile of clay 150 feet long and up to 75 feet wide and 25 feet high remains adjacent to the haulage road.</p> <p>Dibblee and Bassett, 1966a, p. 3; Southern Pacific Company, 1964, p. 168.</p>	71
175	Unknown	Harvard Hill 7.5 T10N R2E Sec 14 SE 1/4	3a(i-1)	<p>Bentonite layer 4 feet thick in Barstow Formation tuffaceous lakebeds overlain by older alluvium. Strike north-south, dip 20°E. Developed by bulldozer cuts, 20-foot vertical shaft, and 30-foot adit driven N60°E, partly caved.</p> <p>Southern Pacific Company, 1964, p. 167; Wright and others, 1953, Tabulated list of Mines, p. 139.</p>	62
176	Unknown	Harvard Hill 7.5 T10N R2E Sec 25 W 1/2	3a(i-1)	<p>A low east-west-trending ridge just north of Interstate 15 is underlain by lacustrine claystone, tuff, and sandstone of the Barstow Formation. On the east end of the ridge two adits, a small quarry 50 feet in diameter, and a shallow cut develop bentonitic clay beds. On the west end (NE 1/4 Section 26) the clay was mined by open cuts 250 feet along the strike of the beds. Of four samples of tuff collected by Stinson (1988) three contain between 50 and 75% clinoptilolite, and one contains mordenite.</p> <p>Southern Pacific Company, 1964, p. 168; Stinson, 1988, p. 53, 57.</p>	68
177	Unknown	Harvard Hill 7.5 T10N R3E Sec 28 NE 1/2	3a(i-1)	<p>White to light green clay interbedded with limestone, chert, and pink sandy claystone. Strike N70°W, dip 80°S. Developed by an open cut 400 feet long, 15 to 20 feet wide, and 20 feet deep. At the west end of the cut is a 6- by 8-foot shaft at least 20 feet deep.</p>	70

COMMODITY: CLAY

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
178	Unknown	Manix 7.5 T10N R4E Sec 33 SE 1/4	4	Shallow cut at the base of a Tertiary andesite mudflow breccia exposes impure clay.	74
179	Unknown	Daggett 7.5 T8N R1E Sec 9 NW 1/4	3a(i-1)	A 30-foot-thick bed of brown clay in the Barstow Formation is developed by a 100-foot-long cut on the east side of a wash. The bed strikes N70°W and dips 65°N. It overlies pink to white tuff and is overlain by sandstone and siltstone.	96

COMMODITY: DOLOMITE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
180	Richter Quarry	White Horse Mountain 7.5 T6N R1W Sec 15 SE 1/4	3a(i-8)	<p>Quarry on the north end of an isolated hill of dolomitic marble surrounded by alluvium. A quartz monzonite dike, striking N60°W, is exposed in the quarry. The property was originally mined for magnesite. Magnesite occurs as veins up to 18 inches thick. About 60 tons of magnesite were produced in the early 1940s. In the late 1940s dolomite was mined by Marter Mining Company. The dolomite, which contains up to 44% brucite, was marketed under the trade name "Lucenite" or "Brucite Marble" for specialized filler.</p> <p>Campbell, 1948; Gray, 1965; Logan, 1947, p. 294-295; Tucker and Sampson, 1943, p. 524, 534-535; Wright and others, 1953, Tabulated list of Mines, p. 155, 160.</p>	165

COMMODITY: FELDSPAR

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
181	Calspar	Ord Mountain 7.5 T7N R2E Sec 16 SE 1/4	2a(i-6)	Quarry near Willis Well produces quartz-feldspar rock for ceramics, which is marketed under the trade name of "Calspar." The rock is an altered rhyolitic intrusion which is intruded by a Cretaceous quartz monzonite pluton on the north. The mine has been active intermittently since 1974. Clark, 1977, p. 81-85; Tucker and Sampson, 1930, p. 305; 1931, p. 379, 445; 1943, p. 543; Weber, 1964, p. 44; Wright and others, 1953, Tabulated List of Mines, p. 144.	135
182	Calspar Bicentennial Group	Camp Rock Mine 7.5 T7N R2E Sec 14 E 1/2	2b(i-2)	Bulldozer cuts along the Camp Rock Fault develop exposures of white siliceous felsite identical to that mined at the Calspar Mine near Willis Well. The material is extensively crushed by movement along the fault. Additional cuts explore the same siliceous felsite in the SE 1/4 of Section 12.	136

COMMODITY: FLUORSPAR

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
183	Afton Canyon	Hidden Valley West 7.5 T11N R6E Sec 31 NE 1/4	3a(i-6)	<p>Partly caved vertical shaft, 150 feet deep, develops northeast-striking fluorite veins in brecciated granite. A northwest-striking fault at the shaft offsets Miocene basalt on the north against granite on the south. Mineralogy: fluorite, quartz, hematite, and jasper. Siderite is reported but not verified. Approximately 1,000 feet to the west, veins of green fluorite, up to 3 inches thick, in pink granite are explored by shallow prospect pits. The veins strike N40°E and are near-vertical. Several shipments of fluorite were made in 1918.</p> <p>Crosby and Hoffman, 1951, p. 633-636; Southern Pacific Company, 1964, p. 173; Tucker, 1921, p. 343; Tucker and Sampson, 1930, p. 301-302; 1931, p. 375-376; 1943, p. 513-514; Wright and others, 1953, Tabulated List of Mines, p. 145.</p>	81
184	Big Horn	Hidden Valley East 7.5 T10N R6E Sec 4 S 1/2	3a(i-6)	<p>A north-south-striking fault zone cuts Miocene volcanic rock. The fault dips 55° east and contains fluorite, black and white calcite, and small euhedral quartz crystals in cavities in the fluorite. The hanging wall is basalt and the footwall is tuff breccia. A 30-foot adit driven south and shallow pits develop the fluorite vein. To the west, 200 feet, a second fault zone, containing red jasper, chalcedony, and fluorite is explored by shallow prospect pits.</p> <p>Crosby and Hoffman, 1951, p. 633-636; Southern Pacific Company, 1964, p. 172; Tucker, 1921, p. 343; Tucker and Sampson, 1930, p. 301-302; 1931, p. 375-376; 1943, p. 513-514; Wright and others, 1953, Tabulated List of Mines, p. 145.</p>	80

COMMODITY: FLUORSPAR

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
185	Green Hornet	West Ord Mountain 7.5 T6N R1E Sec 8 W 1/2	3a(i-7)	<p>A group of east-west-striking quartz and fluorite veins in Precambrian gneiss are developed by a series of shafts from the northern edge of the section to just above the southern edge. The main shaft, located in the SW 1/4 of the SW 1/4 of section 8, is reportedly 80 feet deep with a 125-foot drift to the east. A 40-foot northerly drift intersects a second vein. A thousand feet to the southeast, a 30-foot inclined shaft was driven on a 6-foot shear zone with quartz veins up to 1 foot thick. Mineralogy: quartz, fluorite, chalcopyrite, and minor copper staining. A sample of the vein contains 0.009 oz/ton gold and 2.08 oz/ton silver. At the north edge of section 8 a shaft was sunk on a 6-foot-wide shear zone. The shaft was flooded to about 20 feet below the surface when visited. Fragments of vuggy quartz and fluorite veins up to 2 inches thick occur on the dump. A thousand feet south, a 20-foot inclined shaft was driven on a 6-inch quartz vein with pyrite, calcite, and minor galena. Strike N30°E, dip 45°E. A sample of the vein contains 0.112 oz/ton gold and 1.15 oz/ton silver. Other workings include a 25-foot adit along a diabase dike in the SE 1/4 of the NW 1/4 of section 8, and an inclined shaft along a 2-inch-thick quartz vein along the margin of a diabase dike in the NE 1/4 of the SW 1/4 of section 8. Strike N30°E, dip 65°S.</p> <p>Crosby and Hoffman, 1951, p. 636; Tucker and Sampson, 1943, p. 514; Wright and others, Tabulated List of Mines, p. 146.</p>	171
186	McKinney	West Ord Mountain 7.5 T6N R1W Sec 1 S 1/2	3a(i-7)	<p>Four-foot-wide shear zone with veins of quartz and fluorite. Strike N80°E, vertical. Developed by an inclined shaft driven S80°W and a shallow prospect pit. A second vein is reported 1/4-mile to the south.</p> <p>Crosby and Hoffman, 1951, p. 637; Tucker and Sampson, 1943, p. 514; Wright and others, 1953, Tabulated List of Mines, p. 147.</p>	161

COMMODITY: LIMESTONE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
187	Allied Desert Products Quarry	White Horse Mountain 7.5 T5N R1W Sec 15 SW 1/4	4	White wollastonite-bearing marble was produced from a small quarry on the south side of an isolated knoll 125 feet in diameter. Quarried by Allied Desert Products in 1957 for roofing rock. Gray, 1965.	202
188	Peterson	White Horse Mountain 7.5 T5N R1W Sec 12 NW 1/4	3a(i-9)	High-calcium marble was produced in the mid-1940s from a quarry on the north end of Peterman Hill. The quarry, 50 feet wide and 300 feet long, is in a pendant of marble and schist intruded by hornblende diorite. Logan, 1947, p. 294; Wright and others, 1953, Tabulated List of Mines, p. 155.	200
189	Unknown	White Horse Mountain 7.5 T5N R1W Sec 21 NW 1/4	2b(i-3)	White calcite and dolomite marble explored by a shallow 15 x 30 foot cut.	203

COMMODITY: PUMICE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
190	Farway	Hector 7.5 T9N R5E Sec 14 SW 1/4	3a(i-5)	A 10-foot-thick bed of white pumice tuff worked by shallow pits. The bed strikes northwest and dips 25° southwest. Southern Pacific Company, 1964, p. 181.	90

COMMODITY: PYROPHYLLITE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
191	Unknown	Manix 7.5 T10N R4E Sec 29 E 1/2	3a(i-4)	Deposit of pyrophyllite and sericite schist derived from the hydrothermal alteration of metavolcanic rock. Development consists of an open pit 80 feet across in the bottom of a wash. On the southeast side of the pit a 30-foot adit is driven S55°E and a short drift is driven N65°E. X-ray analysis of the material in the pit indicates that it is pyrophyllite and quartz. The material in the adits is illite and quartz. Upstream from the pit an adit is driven 40 feet S70°E then 20 feet S. At the portal a partially filled shaft 15 feet deep was sunk in sericite schist.	72
192	Unknown	Manix 7.5 T10N R4E Sec 28 W 1/2	3a(i-4)	Five shallow prospect pits in pyrophyllite or sericite schist. The schist occurs as irregular, northeast-trending zones in metavolcanic breccia.	73

COMMODITY: SILICA

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
193	Unknown	Fry Mountains 7.5 T5N R3E Sec 18 SW 1/4	4	Shallow dozer cuts in iron-stained quartzite.	207

COMMODITY: SPECIALTY STONE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
194	Birdseye Granite Quarry	Nebo 7.5 T9N R1W Sec 4 NE 1/4	2a(i-1)	Granite quarried for decorative rock by Brubaker-Mann, Inc.	83
195	Brown-Gold-Lilac	Nebo 7.5 T9N R1W Sec 1 SW 1/4	2a(i-1)	Miocene dacite or rhyolite quarried for decorative rock by Brubaker-Mann, Inc.	87
196	Brubaker-Mann Beige Rock	Nebo 7.5 T10N R1E Sec 30 W 1/2	2a(i-1)	Miocene dacite quarried for decorative rock by Brubaker-Mann, Inc.	54
197	Calico Rock Beige Rock Quarry	Nebo 7.5 T10N R1E Sec 30 SW 1/4	2a(i-1)	Miocene dacite quarried for decorative rock by Calico Rock Milling, Inc.	55
198	Dusty Rose Quarry	Nebo 7.5 T10N R1W Sec 33 NW 1/4	4	Quarry in Miocene volcanic dacite. The dacite was quarried for decorative rock by Calico Rock Milling, Inc.	9
199	Gold-Lilac-Bark Group	Nebo 7.5 T9N R1W Sec 2 NE 1/4	2a(i-1)	Miocene dacite or rhyolite quarried for decorative rock by Calico Rock Milling, Inc.	84
200	Pink Rock Quarry	Nebo 7.5 T10N R1W Sec 28 SW 1/4	4	Quarry in Miocene dacite. The dacite was quarried for decorative rock by Brubaker-Mann, Inc.	5
201	Unknown	Nebo 7.5 T10N R1W Sec 28 SW 1/4	4	Exposure of Waterman marble developed by a small quarry. The marble was probably mined for roofing granules or decorative rock during the early 1960s. May have been mined by Rainbow Rock, Barstow. Gray, 1965.	6
202	Unknown	Yermo 7.5 T10N R1E Sec 12 NE 1/4	4	A single-bench quarry in rhyolite tuff at the base of a low hill. The quarry is 250 feet long with a 10-foot-high free face. Subhorizontal parting yields 1- to 5-inch-thick slabs. The tuff was probably quarried for flagstone. There is a smaller quarry at the top of the hill and prospects in the tuff to the southeast.	25

COMMODITY: SPECIALTY STONE

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
203	Unknown	Yermo 7.5 T10N R2E Sec 18 SE 1/4	4	Quarry in Miocene rhyolite tuff. The tuff, which splits into 2- to 6-inch slabs, was probably quarried for decorative rock or flagstone.	60
204	Unknown	Minneola 7.5 T8N R2E Sec 19 NE 1/4	4	Two veins of brecciated travertine in andesite. One vein is 300 feet long and 10-40 feet thick with an exposure relief of 80 feet; the other is 150 feet long and 5-35 feet thick with a relief of 50 feet. Strike N25°W. Developed by a cut at the lower end of the larger vein. Sabine, 1985, p. 12.	101
205	Unknown	Ord Mountain 7.5 T7N R1E Sec 3 SE 1/4	4	Travertine deposit several feet thick. The travertine is exposed for several hundred feet along a northwest trend. Prospected by shallow pits and trenches. Dibblee, 1964a, p. 6; Weber, 1964, p. 44.	116
206	Wine Quarry	Newberry Springs 7.5 T8N R3E Sec 9 NE 1/4	2a(i-1)	Quarry in a Miocene rhyolite intrusion. The red rhyolite is mined for decorative rock by Calico Rock Milling, Inc.	105
207	Wine Red Quarry	Newberry Springs 7.5 T8N R3E Sec 4 SE 1/4	2a(i-1)	Red Miocene rhyolite is quarried for decorative rock by Brubaker-Mann, Inc.	104

COMMODITY: SULFUR

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
208	Sulfur Hole	Yermo 7.5 T10N R2E Sec 18 SE 1/4	3a(i-1)	Shallow excavation in the side of the wash just north of the Pacific Coast Borax Company's mines. The site was originally prospected for sulfur, but the yellow mineral thought to be sulfur is instead copiapite, a hydrous iron sulphate. More recent excavations at the site have been for mineral specimens. Sulfate minerals found include alunite, fibroferrite, coquimbite, krausite, and jarosite. Moller, 1963a, p. 12-16; 1963b, p. 10-14.	59

COMMODITY: VOLCANIC CINDERS

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
209	Pisgah	Sunshine Peak 7.5 T8N R6E Sec 32 NW 1/4	2a(i-5)	<p>At the Pisgah volcanic cinder deposit about 12 miles west of Ludlow and 2 miles east of Pisgah, a siding on the Santa Fe Railroad that parallels Interstate Highway 40, volcanic cinders have been mined for lightweight aggregate sporadically from the Mt. Pisgah cone. Mt. Pisgah rises about 300 feet above the surrounding lava-covered desert. The cone is composed of basaltic cinders and minor proportions of volcanic bombs. The cinders are scoriaceous, black to reddish-black, and range from 1/4 to 4 inches diameter. Cinder mining has been limited to the west side of the cone. There has been recent interest in developing the aggregate potential of these cinder deposits.</p> <p>Chesterman, 1956, p. 87; Southern Pacific Company, 1964, p. 181; Wright and others, 1953, p. 188.</p>	112
210	Red Top	Silver Bell Mine 7.5 T7N R3E Sec 24 N 1/2	2a(i-7)	<p>Quaternary basalt cinder cone mined for volcanic cinders since the 1950s. Sierra Aggregate Company has operated the quarry since 1981.</p> <p>Kuizon, 1985, p. 11.</p>	153

COMMODITY: ZEOLITES

INDUSTRIAL MINERALS

APPENDIX NO.	NAME	LOCATION	MRZ	COMMENTS AND SELECTED REFERENCES	MAP NO.
211	North Group (zeolite)	Troy Lake 7.5 T9N R5E Sec 31 SW 1/4	3a(i-1)	<p>Zeolitized tuff bed in Miocene lacustrine sediments strikes east-west and dips 10°-15° south. The bed is approximately 5 feet thick and is exposed for a length of 3,000 feet. The tuff is largely altered to clinoptilolite. Lying within the North Group of claims of RHEOX, Inc., the tuff bed was explored with bulldozer cuts and drill holes by the company.</p> <p>Dibblee and Bassett, 1966a; Stinson, 1988, p. 52-53.</p>	91

APPENDIX B

**GEOPHYSICAL EVALUATIONS OF MINERAL DEPOSITS IN THE CAMP ROCK
AREA, SAN BERNARDINO COUNTY, CALIFORNIA**

by

Rodger H. Chapman, Gordon W. Chase, and Leslie G. Youngs

**CONTENTS
APPENDIX B**

	Page
INTRODUCTION	B5
GEOLOGY AND MINERAL RESOURCES	B7
GEOPHYSICAL DATA	B8
Magnetic Susceptibility and Density Measurements	B8
Density Measurements	B8
Measurements of magnetic properties	B10
Aeromagnetic Survey	B12
Ground Geophysical Surveys	B13
INTERPRETATION OF DATA	B14
Camp Rock Mine Area	B14
The Morris Lode	B19
The Bessemer Deposit	B22
The Man Prospect	B22
The Ord Prospect	B25
Section 13 Anomaly	B29
The New Bessemer Deposit	B32
The Ebony Deposit	B32
Faults in the Camp Rock Area	B32
DISCUSSION	B37
ACKNOWLEDGMENTS	B41
REFERENCES CITED	B42

FIGURES

	Page
Figure B-1. Map showing the location of the Camp Rock area	B6
Figure B-2. Ground magnetometer profiles A-A' and B-B', Camp Rock Mine area ..	B15
Figure B-3. Dipole-dipole electrical resistivity pseudosection, Camp Rock Mine area (coincides with magnetic line A-A')	B16
Figure B-4. Dipole-dipole induced potential pseudosection (frequency effect), Camp Rock Mine area	B17
Figure B-5. Possible model for source of electrical resistivity and induced potential anomalies, Camp Rock Mine area	B18
Figure B-6. Observed and calculated gravity anomalies and model, line O-O', Morris Lode area	B21
Figure B-7. Ground magnetometer profiles C-C' and D-D', Bessemer Mine area ..	B23
Figure B-8. Ground magnetometer profile C-C' and model, Bessemer Mine area ..	B24
Figure B-9. Ground magnetometer profiles E-E', F-F', and G-G', Man Anomaly area	B26
Figure B-10. Possible model for source of magnetic anomaly on profile G-G', Man Anomaly area	B27
Figure B-11. Ground magnetometer profile H-H', Ord Anomaly area.	B28
Figure B-12. Ground magnetometer profiles I-I' and J-J', Ord Anomaly area	B30
Figure B-13. Observed and calculated aeromagnetic anomalies and model, profile K-K' Ord Anomaly area	B31
Figure B-14. Ground magnetometer profile L-L', Section 13 Anomaly area	B33
Figure B-15. Ground magnetometer profile M-M' and gravity profile, Section 13 Anomaly area	B34
Figure B-16. Ground magnetometer profile M-M' and interpreted model, Section 13 Anomaly area	B35

Figure B-17. Ground magnetometer profile N-N' over Camp Rock Fault B38

Figure B-18. Ground magnetometer profiles P-P', Q-Q', and R-R', over Camp Rock
Fault B39

TABLES

Table B-1. Rock density data B9

Table B-2. Rock magnetic properties B11

PLATES (in Pocket)

Plate 5. Total intensity aeromagnetic map of the Camp Rock area showing anomaly designations, faults and proposed faults, and locations of detailed surveys and lines.

Plate 6. Complete Bouguer gravity map of the Camp Rock area.

Plate 7. Total intensity ground magnetic contour map of the Morris Lode area.

INTRODUCTION

The Camp Rock area is about 35 miles southeast of Barstow in San Bernardino County (Figure B-1). The area extends in a northwesterly direction from the vicinity of Galway Lake in T5N, R5E, on the southeast, to the Camp Rock Road just east of East Ord Mountain in T7N, R2E, following the general trend of the Camp Rock Fault. This area, which is about 22 miles long in a northwest-southeast direction and an average of about 3 miles wide, is mostly covered by a detailed helicopter aeromagnetic survey (Plate 5). This aeromagnetic survey, which was recently obtained by DMG from U.S. Diversified Group, a Division of USX Corporation, was flown in 1958.

The Camp Rock area is almost entirely within the Rodman Mountains 15' Quadrangle, except for a small part at the southeastern edge which is in the Lavic 15' Quadrangle. The area consists largely of an alluvial-covered valley area bordered on the northeast by the Rodman Mountains and Iron Ridge, and on the southwest by the Fry Mountains, Red Hill, and other unnamed low hills southeast of Red Hill.

The known and potential mineral resources of the Camp Rock area and vicinity have been discussed by Vredenburg (1980) and by Cox and others (1987). The area includes the iron deposits of the Lava Bed District as described by Lamey (1948), as well as several more recently discovered iron prospects that are about 4 to 8 miles northwest of the Lava Bed District. The area also includes a copper prospect (Copper Strand Mine) (Wright and others, 1953), and a placer gold prospect (Camp Rock Mine; also known as the Flying M Association claim group) (Wright and others, 1953, mine list; Cox and others, 1987). These properties are currently inactive.

The purpose of this study is to help evaluate the Camp Rock area for potential economic mineral deposits by using both the aeromagnetic data and new ground geophysical data. During the study the largest magnetic anomalies were checked on the ground with magnetic and gravity measurements. An electrical resistivity-induced potential survey was also conducted in the Camp Rock Mine area. The geophysical data together with information from surface exposures and, in some cases, information from drill holes was used to construct possible models for the mineralized zones.

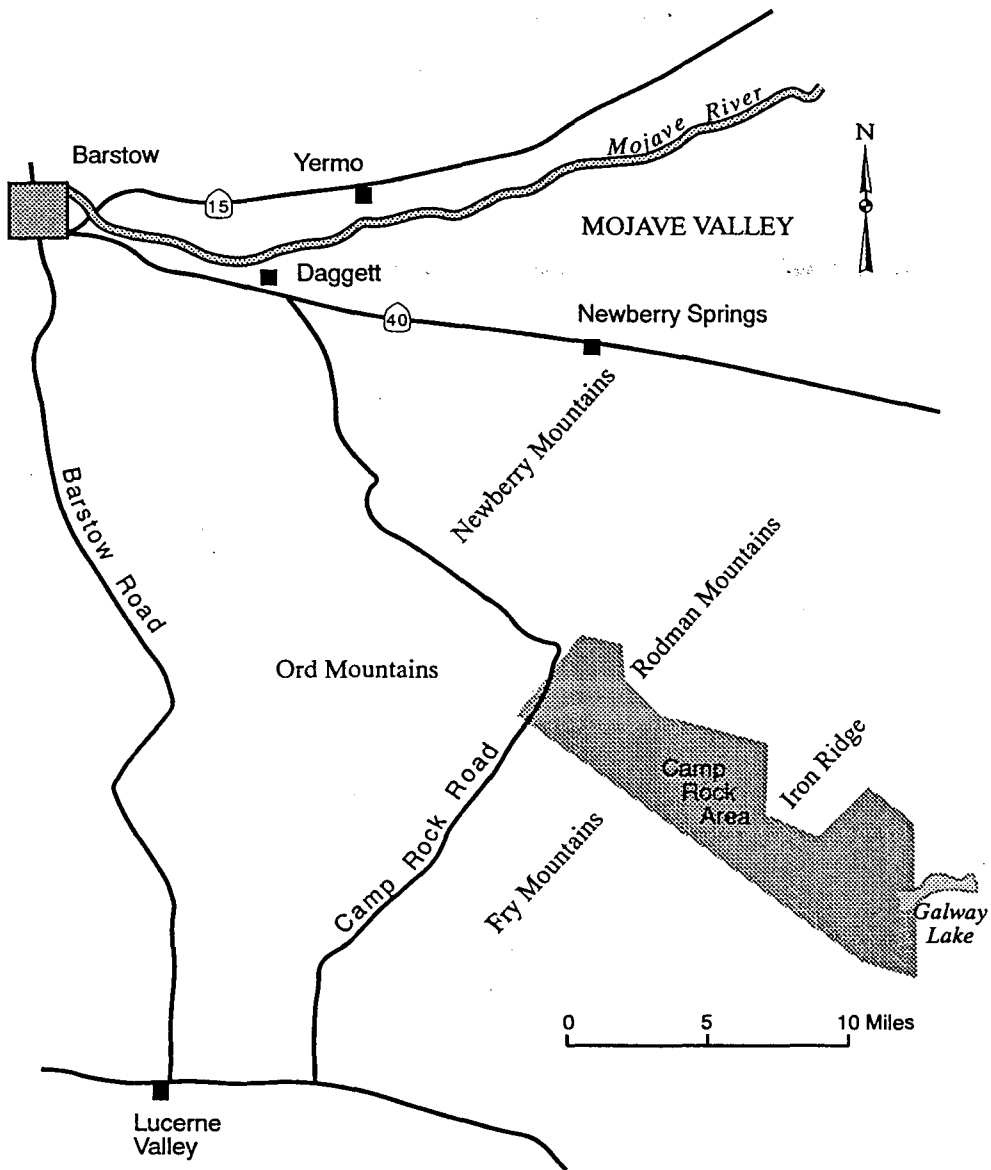


Figure B-1. Map showing the location of the Camp Rock area.

GEOLOGY AND MINERAL RESOURCES

The geologic units that have been mapped in the Camp Rock area consist chiefly of metasedimentary rocks of possible Paleozoic age, metasedimentary, metavolcanic, and intrusive igneous rocks of Mesozoic age, and unconsolidated alluvium of Quaternary age (Dibblee, 1964). The metasedimentary rocks include metaconglomerate, marble (limestone and dolomite), and quartzite. The intrusive igneous rocks are mostly varieties of quartz monzonite, but they range from granite to granodiorite and diorite.

The metasedimentary rocks were intruded by, and in some places engulfed by, the younger igneous rocks. Skarns are found near the contacts between limestone and dolomitic marble and quartz monzonite. The skarns usually consist of magnetite with some hematite, pyrite, marble (limestone and dolomite), mica, garnet, diopside, and epidote (Wiebelt, 1947; Lamey, 1948; Dibblee, 1964). Some iron deposits in the Camp Rock area consist of massive, nearly pure, magnetite, but these deposits are usually relatively small.

The Camp Rock Mine, located in Section 28, T7N, R3E, has produced a small amount of gold from alluvial fan deposits overlying granite and quartz monzonite (Wright and others, 1953). Chip samples of shear zones in an adit at this property are reported to show some gold, silver, and copper (Cox and others, 1987). The Camp Rock Mine and vicinity were included by Cox and others (1987) with three other prospects within 2 miles to the east and northeast, in a zone of moderate mineral resource potential for gold, silver, and copper. A small amount of copper has been produced at the Copper Strand Mine in Section 9, T6N, R3E, from shear zones in skarn (Wright and others, 1953; Dibblee, 1964).

Prior to the mid 1950s, exploration, in some cases including drilling, was done at some of the known iron prospects in the Camp Rock area, including the Morris Lode deposit in Section 12, T5N, R4E, and Section 7, T5N, R5E; the Bessemer Mine (also called "Iron Ridge deposit") in Sections 27 and 28, T6N, R4E; the New Bessemer property in Section 36, T6N, R4E, and Section 1, T5N, R4E; and at the Ebony prospect in Section 15, T6N, R4E. Except for the Ebony prospect, which is not within the boundaries of the magnetic survey on Plate 5, these deposits are all represented by large magnetic anomalies. Lamey (1948) estimated that before any mining had been done the reserves at Iron Ridge consisted of 1.8 million tons of ore of grades ranging from 30 to 65% iron, although some of this is in small deposits scattered over an area of about 80 acres. A ground magnetic survey and drilling at the Morris Lode deposit also indicated a possible large tonnage of iron ore averaging about 37% iron (Wiebelt, 1947). More recently, Vredenburgh (1980) estimated that approximately 51,000 tons of iron ore had been mined from these properties up until 1951 and that demonstrated reserves amount to a total of at least 3,650,000 tons. In addition to the iron-ore

prospects near Galway Lake and Iron Ridge, significant prospects a few miles to the northwest in the Camp Rock area have been briefly described by Dibblee (1964), Moore (1971), and Vredenburg (1980).

The Camp Rock area includes three known active faults: the Camp Rock, Emerson, and Galway Lake (Plate 5). The Camp Rock and Emerson faults both trend generally northwest and pass through much of the Camp Rock area (Dibblee, 1964; Hart and others, 1993). The Galway Lake Fault trends just west of north and is near the southeastern edge of the Camp Rock area west of Galway Lake (Hill and Beeby, 1977).

GEOPHYSICAL DATA

Magnetic Susceptibility and Density Measurements

Density Measurements

Measurements of density (specific gravity) were made for a number of samples of rocks from the Camp Rock area using the weight in air-weight in water method (Table B-1). Nine samples of one of the most common types of rock in the area, quartz monzonite, were found to range in density from 2.60 g/cm³ to 2.72 g/cm³ with an average of 2.64 g/cm³. The highest value was measured for a sample of relatively unweathered quartz monzonite from a drill core. The other samples were from surface outcrops and probably were affected to some degree by weathering. Therefore, the average value of density for quartz monzonite from these measurements may be somewhat lower than it should be for unweathered rock.

One sample of granite from the Camp Rock Mine area was found to have a density of 2.61 g/cm³, two samples of limestone (marble) were each found to have densities of 2.82 g/cm³, and samples of skarn composed chiefly of garnet, diopside, and epidote, with very little magnetite, were found to have densities in the range of 3.10 g/cm³ to 3.59 g/cm³. Skarn containing appreciable magnetite (up to 75% or more) ranged from 3.10 g/cm³ to 4.58 g/cm³.

Some types of rocks in the immediate area of the survey were not sampled. These include quartzite, felsite, some types of quartz monzonite, hornblende diorite from near Galway Lake, and unconsolidated Quaternary-age rocks. In order to construct models for gravity anomalies caused by the magnetite-bearing skarn, it is necessary to make some assumptions regarding the probable average density contrast of the anomalous mass. This contrast depends on the percentage of magnetite and other relatively dense minerals present and also on the type of rocks that surround the mineralized zone. Therefore, it is likely that only a range of values can be assumed.

Table B-1. Rock density data

Sample No.	Location	Source	Rock type	Density(g/cm ³)
1	S5,T6N,R3E	outcrop	quartz monzonite	2.60
2	" " "	"	" "	2.67
3	" " "	"	" "	2.64
4	S12,T5N,R4E	"	" "	2.60
5	" " "	"	" "	2.62
6	S32,T7N,R3E	"	" "	2.62
7	" " "	"	" "	2.60
8	S28,T6N,R4E	"	" "	2.66
9	S4,T6N,R3E	core	" "	2.72
10	S28,T7N,R3E	outcrop	granite	2.61
11	S12,T5N,R4E	"	marble	2.82
12	" " "	"	"	2.82
13	" " "	"	skarn (epidote)	3.16
14	" " "	"	skarn (garnet)	3.59
15	" " "	"	skarn (actinolite)	3.06
16	" " "	"	" "	3.17
17	" " "	"	skarn with magnetite	3.10
18	S28,T6N,R4E	"	magnetite	4.18
19	S4,T6N,R3E	core	"	4.11
20	S12,T5N,R4E	outcrop	magnetite with hematite	4.33
21	" " "	"	" " "	4.26
22	" " "	"	" " "	4.58
23	" " "	"	" " "	4.28

Measurements of magnetic properties

Tests of hand samples of various rocks in the Camp Rock area indicated that the only types of rocks in the immediate area that have appreciable magnetic properties are some of the igneous rocks (primarily quartz monzonite) and magnetite-bearing skarn. Of these rocks, the magnetite-bearing skarn is by far the most magnetic.

A few samples of igneous rocks (quartz monzonite and granite) and of magnetite-bearing skarn were tested by means of a Soiltest magnetic susceptibility bridge and the results are given in Table B-2. The values of magnetic susceptibility in the International System of units (SI) for samples of quartz monzonite and granite range from very low values (near zero) to moderate values (more than 4×10^{-2} units). Samples of magnetite-bearing skarn (with a high percentage of magnetite) have very high values, ranging in the samples tested from about 0.88 units to about 3.14 units. Clearly, the magnetite-bearing skarn is far more magnetic than the known igneous rocks in the area. If sufficient volumes of the skarn are present, this type of rock could cause large magnetic anomalies. Zablocki (1962) measured electrical resistivity, induced polarization, and magnetic susceptibility in five drill holes in a magnetite deposit in this part of the Mojave Desert. He reported magnetic susceptibilities that ranged in value from 0.04 emu units (0.50 SI units) to 0.30 emu units (3.77 SI units) and averaged 0.18 emu units (2.26 SI units) in the magnetite body. Also, quartz monzonite in the drill holes was found to have an average value of 0.01 emu units (0.126 SI units), which is distinctly higher than the values we measured in the Camp Rock area (Table B-2).

The magnetic susceptibilities of the magnetite-bearing skarn samples were also measured with a vertical-intensity magnetometer, using the method described by Parasnis (1975). This method also yields values of the remanent magnetization of the samples but not the direction of this magnetization unless the samples are oriented. Although this method is approximate, as shown in Table B-2 the results of the magnetic susceptibility measurements are roughly similar to the bridge measurements. Estimates of the values of remanent magnetization are given in Table B-2 as the ratio of remanent to induced magnetization (the Koenigsberger ratio-Q). The values of Q for the magnetite samples tested apparently range from more than 8 to 23, which are very large values (Table B-2). If these high values of Q are correct, it seems that remanent magnetism is much more important than induced magnetism in these samples.

To be accurate, the high values of magnetic susceptibility given in Table B-2 require a correction for the demagnetization effect. This is also true for values of remanent magnetization. Samples having susceptibility values of about 0.12 SI units or less are not affected appreciably by this correction, but higher measured values are actually much lower than the true figures. The demagnetization factor depends on the shape of the sample. The corrected values in Table B-2 were obtained by using the expression developed by Werner (1945) for specimens having a cylindrical shape.

Table B-2. Rock magnetic properties

Sample	Magnetic susceptibility (k) magnetometer method SI units ¹	Magnetic susceptibility (k) bridge method SI units ²	Q ³
1) skarn with magnetite (core) (S4,T6N,R3E)	2.953 (5.04) ⁴	3.142 (5.60) ⁴	23
2) " " "	1.395 (1.73)	1.885 (2.56)	23
3) " " "	1.068 (1.26)	0.880 (1.01)	8.4
4) " " "	2.312 (3.42)	2.011 (2.79)	8.3
5) " " "	1.382 (1.71)	1.759 (2.34)	18
6) quartz monzonite (core) (S4,T6N,R3E)	-- --	0.0441	
7) quartz monzonite (S32,T7N,R3E)	-- --	0.000528	
8) " " "	-- --	0.000528	
9) " " " (S12,T5N,R4E)	-- --	0.01621	
10) granite (S28,T7N,R3E)	-- --	0.000415	

1) Obtained by means of a vertical-intensity magnetometer using the method described by Parasnis (1975).

2) Obtained by using a Soiltest magnetic susceptibility bridge

3) Q (Koenigsberger ratio) is the ratio of the intensity of magnetization due to remanent magnetism (J_r) over that due to induced magnetism (J_i).

4) Magnetic susceptibility values in parentheses have been corrected for the demagnetization effect.

As seen in Table B-2, the highest values of susceptibility (about 3.0 SI units) become nearly twice as large when this correction is taken into account. The importance of the demagnetization factor for practical purposes in magnetic anomaly modeling is reduced by the fact that this effect also reduces the effective magnetic susceptibility of the actual mineralized mass, depending somewhat on the shape of this body (Parasnis, 1975). Thus, the measured magnetic susceptibility (and remanent magnetism) of samples may still be useful for approximate purposes in modeling.

The direction or directions of the large apparent values of remanent magnetism of samples from the Camp Rock area are not known, so quantitative interpretation of the magnetic anomalies without more information may be subject to a high degree of uncertainty. However, the samples tested were pieces of drill core and it is possible that the drilling process itself has caused an increase in the remanent magnetization (Cornwall, 1975).

Despite the possibly difficult problems that may be associated with magnetic properties discussed above, explorationists who have worked on iron deposits in the Mojave Desert, such as those in the Camp Rock area, report that they have had reasonably good results in modeling magnetite ore zones simply by using values of magnetic susceptibility of between 0.10 and 0.15 emu units (1.26 and 1.88 SI units) for the iron mineralization and assuming the normal earth's field. The model studies in this report have been done by using values in this general range. Whether or not these models provide reasonable approximations of the actual ore zones in the Camp Rock area is not known. Of course, when more information on the magnetic properties of these rocks is known it should be possible to improve these models.

Aeromagnetic Survey

The helicopter total intensity aeromagnetic survey map (Plate 5) was compiled from aeromagnetic profiles spaced approximately 800 feet apart, trending northeast, and flown with the measuring instrument about 125 feet above the ground. The contour interval is 20 nanoteslas (nT) (gammas) except in areas of high magnetic gradient. A fixed value has been subtracted from the data to simplify contour numbering, but no reference magnetic field has been removed.

Plate 5 shows prominent magnetic anomalies associated with the known iron deposits in the Camp Rock area. There is a large anomaly over the Morris Lode deposit in Section 12, T5N, R4E, and Section 7, T5N, R5E. Smaller anomalies are associated with the Bessemer deposit in Section 28, T6N, R4E, and the New Bessemer deposit in the southeastern quarter of Section 36, T6N, R4E, and Section 1, T5N, R4E. Other large magnetic anomalies shown on Plate 5 represent concealed iron deposits. One located in Sections 4 and 5, T6N, R3E, and Sections 32 and 33, T7N, R3E and another in Sections 10 and 11, T6N, R3E are known as the "Man" and "Ord" prospects,

respectively. They were tested by drilling during a private exploration program (Dibblee, 1964; Moore, 1971; Vredenburg, 1980). The locations of some of these drill holes are shown on Plate 5. Another magnetic anomaly on Plate 5, which probably represents a concealed iron deposit, is located in Section 13, T6N, R3E. This deposit is not known to have been investigated by drilling.

In addition to the large anomalies, there are numerous smaller anomalies in the area. These could be caused either by small magnetite skarn deposits or by variations in magnetite content in igneous rocks. Curiously, the largest exposed skarn in the area, located largely in Section 9, T6N, R3E, in the vicinity of the Copper Strand Mine, evidently contains little magnetite because there is no noticeable anomaly in this area (Plate 5). Specimens of this rock confirm this observation.

Ground Geophysical Surveys

A number of ground magnetometer profiles were obtained during this study to check the locations and characteristics of some of the major aeromagnetic anomalies and to help evaluate them. Some gravity profiles and regional gravity data were also obtained and a gravity map prepared. Also, an electrical resistivity-induced potential profile was done in one area to check a possible mineralized zone. Plate 5 shows the locations of the ground geophysical surveys with respect to the aeromagnetic anomalies. Most of the magnetic data were obtained with Geometrics proton-precession magnetometers. The gravity data were obtained with LaCoste and Romberg and Worden gravity meters. The electrical resistivity-induced potential data were obtained using a Geotronics FT-4 transmitter with an output rated at 3.2 KVA, a power source consisting of a Geometrics B-2 engine generator, and a Geomite receiver.

Gravity data for the Camp Rock area were obtained from Tang and Ponce (1982), Andrew Griscom (personal communication), and new stations obtained by DMG during this study. Plate 6 is a contour map of the gravity data. The gravity data of Plate 6 are based on the Woollard and Rose (1963) datum and the 1930 ellipsoid, reduced to complete Bouguer anomalies using a density of 2.67 g/cm³.

Plate 6 and the regional gravity map by Biehler and others (1988) show that there is no distinct regional gravity trend in the immediate Camp Rock area. One semi-regional feature is a fairly large positive gravity anomaly in the southeastern part of the Camp Rock map area. This anomaly is shown more clearly on the regional map by Biehler and others (1988). The anomaly which has an amplitude of about 30 milligals (mGals) is centered southeast of the Camp Rock area near Emerson Lake where it may be associated with numerous outcrops of "hornblende diorite and minor gabbro" shown on the geologic map by Bortugno and Spittler (1986). Also shown on Plate 6 is a northwest-trending negative anomaly with an amplitude of about 4 mGals, located

generally between the Camp Rock and Emerson faults south of the Rodman Mountains. This anomaly may be related to a graben between these two faults.

At least two local positive gravity anomalies on Plate 6 are associated with positive magnetic anomalies that mark the locations of magnetite deposits. At other such deposits there is insufficient gravity data to provide detailed information.

INTERPRETATION OF DATA

Camp Rock Mine Area

The Camp Rock Mine area is in Section 28, T7N, R3E, in the northwestern part of the Camp Rock area (Camp Rock Mine, MRZ-3a^(p-1), page 31, this report). A negative aeromagnetic anomaly with an amplitude of about 250 nT marks the area near the location of the mine (Plate 5). The anomaly is centered over alluvium just southeast of the main mine workings. The negative magnetic anomaly was noted on another aeromagnetic map (Cox and others, 1987). Those authors suggested that the anomaly might be caused by hydrothermal alteration that has removed magnetite from the igneous rocks in this immediate area. It is also possible that the magnetic "low" represents a type of rock, perhaps granite or some other rock that has a very low magnetite content compared to the surrounding quartz monzonites. Geophysical survey work done here includes two ground magnetometer lines (A-A' and B-B') and an electrical resistivity-induced potential line to test this anomaly (Plate 5, Figures B-2 to B-5). Each of the ground magnetometer profiles shows a local negative magnetic anomaly with an amplitude of about 400 nT (Figure B-2). The anomaly is centered over alluvium, but intrusive quartz monzonite and granite are exposed just to the north and northwest (Dibblee, 1964). A limited amount of gold has been mined in the area just to the west and north of the center of this magnetic anomaly from Quaternary age alluvium, which is from 2 to 33 feet thick (Cox and others, 1987).

The electrical resistivity-induced potential survey line was done to test this magnetic anomaly for possible rock alteration and/or mineralization containing sulfides. The survey was run at the location of the magnetic anomaly along the same line as magnetometer line A-A'. A dipole-dipole electrode configuration was used with an n-spacing of 400 feet. The resulting resistivity and induced potential pseudosections are given in Figures B-3 and B-4, respectively. Because of time constraints, these electrical sections are not as complete as would be desirable. However, the electrical resistivity section (Figure B-3) might be interpreted as representing resistive bedrock beneath alluvium that becomes shallower toward the northeast (where quartz monzonite and granite are exposed). It might also be interpreted as a zone of relatively high resistivity in the bedrock (Figure B-5). There is no evidence of a low resistivity zone that would correlate with the magnetic low. The induced potential section (Figure B-4) shows some

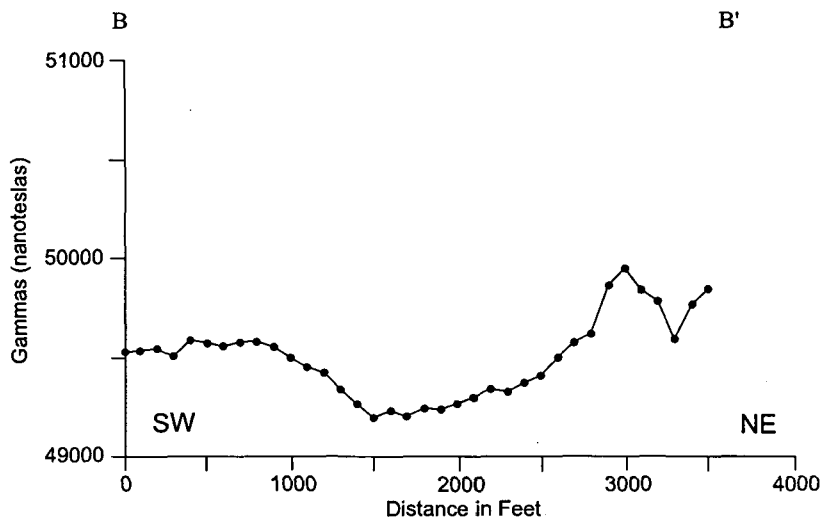
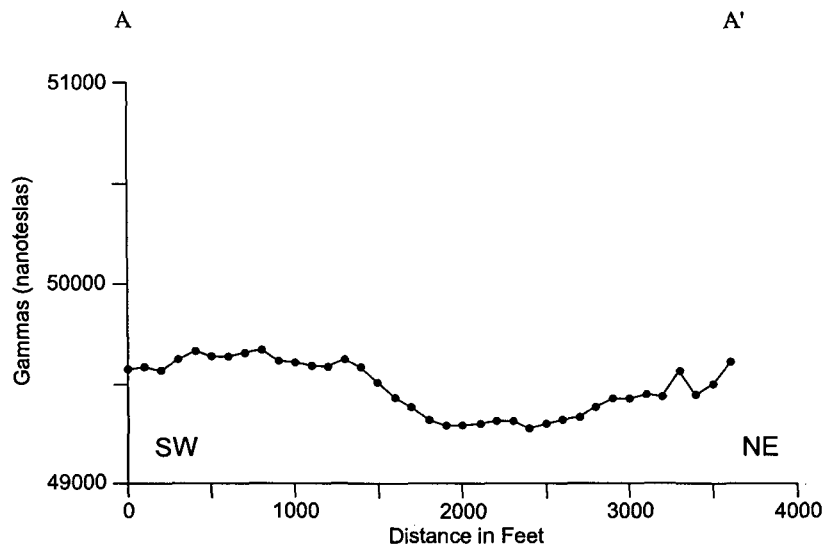


Figure B-2 . Ground magnetometer profiles A-A' and B-B', Camp Rock Mine area.

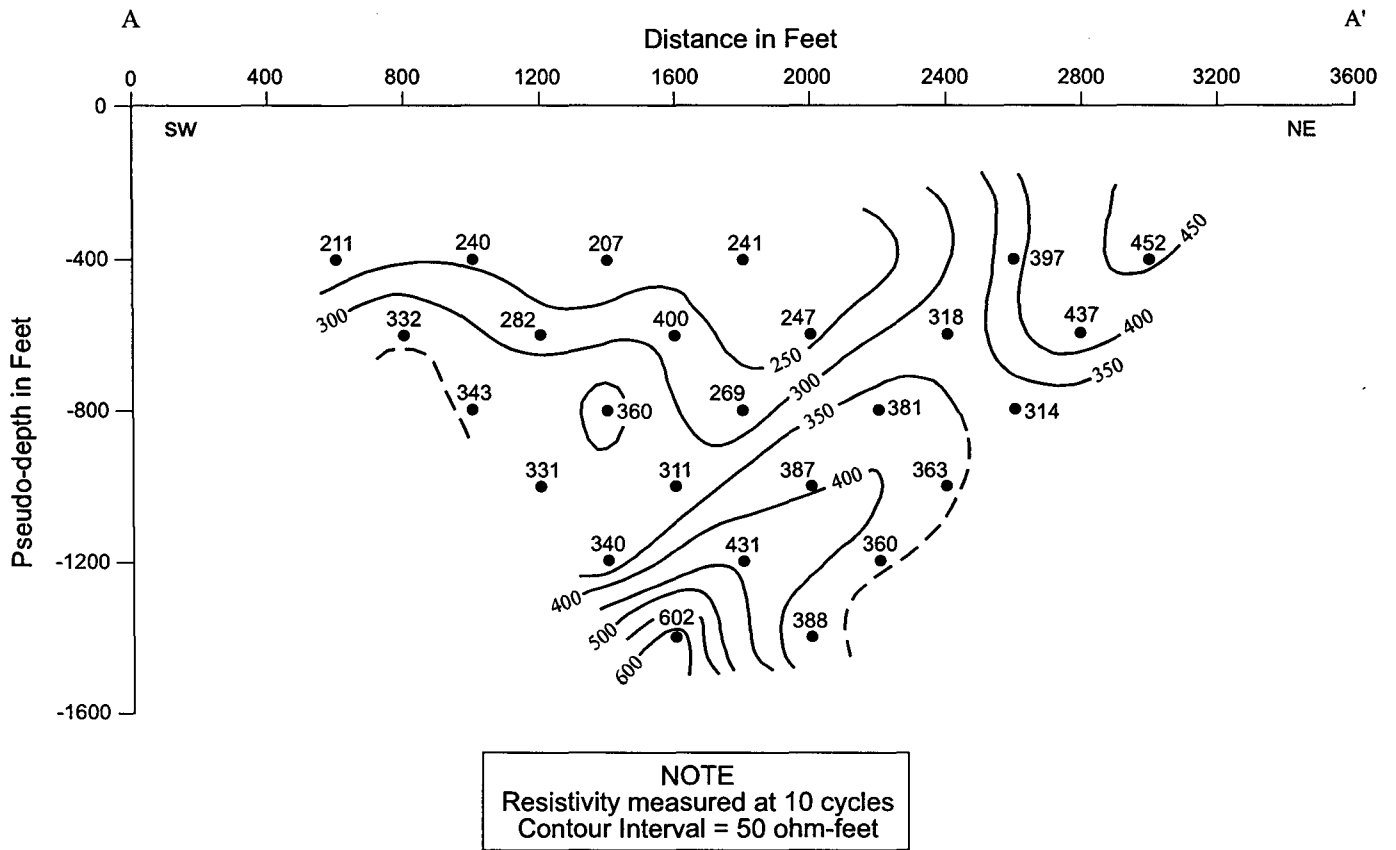


Figure B-3. Dipole-dipole electrical resistivity pseudosection, Camp Rock Mine area (coincides with magnetic line A-A').

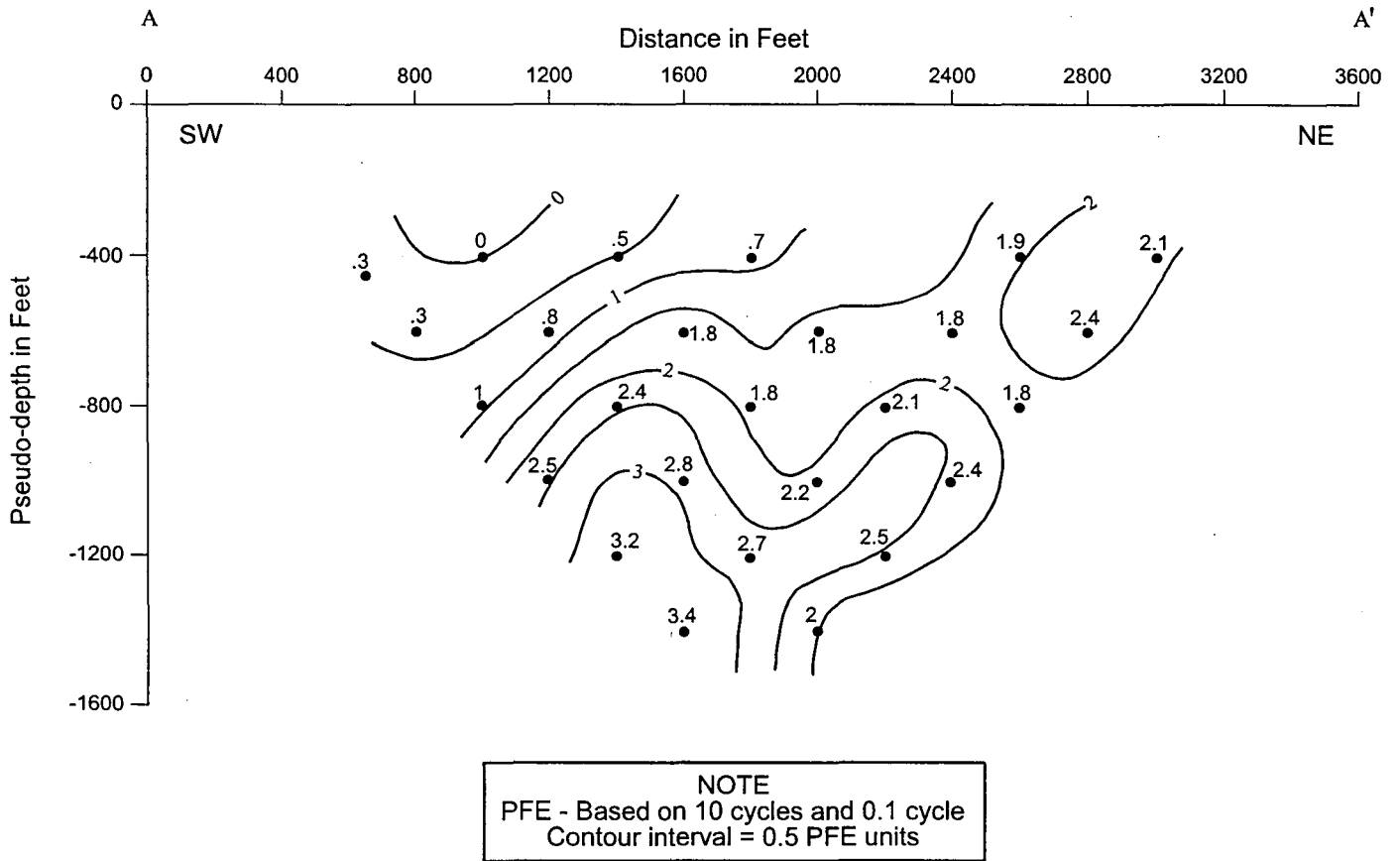


Figure B-4. Dipole-dipole induced potential pseudosection (frequency effect), Camp Rock Mine area.

values as high as about 3% frequency effect. This percentage is usually considered only borderline in significance, but it could represent low-grade sulfide mineralization (Figure B-5).

The Morris Lode

The magnetic anomaly having the highest amplitude on the aeromagnetic map (Plate 5), more than 20,000 nT, is in Section 12, T5N, R4E and Section 7, T5N, R5E, just west of Galway Lake. Some exposures of magnetite are present in the vicinity of the southern end of the anomaly, but the main anomaly is over alluvium. The anomaly is evidently associated with the Morris Lode prospect where some exploration has been done by USBM and by private companies (Wiebelt, 1947; Moore, 1971; see Morris Lode, MRZ-2a^(s-1), page 29, this report). This work included a ground magnetometer survey and a total of nine drill holes by USBM (Wiebelt, 1947). According to Moore (1971), 17,500 tons of ore were mined from this deposit in 1949-50 for use in cement manufacturing and in 1957 a few thousand tons were mined for use as open hearth lump ore.

The ground magnetometer survey done by USBM in 1944-1945 was a detailed vertical-intensity survey of the central or highest part of the Morris anomaly. This part of the anomaly was found to be 1,000 feet wide and 1,500 feet long (Wiebelt, 1947). The diamond drill holes on the anomaly ranged in depth from 182 to 955 feet. The alluvium over the mineralized zone averaged about 30 feet in thickness. Eight of these drill holes intersected from 87 feet to 921 feet of iron ore with an average grade of about 37% iron (Wiebelt, 1947). One of these holes was drilled to a depth of 955 feet and was still in iron mineralization. The other drill holes did not reach this depth, but some of these were still in skarn minerals or dolomite when the drilling was stopped. Additional magnetite mineralization might be present below the greatest depths reached in some of these drill holes.

During the present study, the area around the Morris Lode magnetic anomaly was investigated on the ground by 12 east-west and four north-south magnetometer profiles and one gravity profile (Plate 5, Plate 7). This magnetometer survey covers a larger area and shows a more complete overall picture of the mineralized area, but with less detail, than does the original survey by USBM. Because of the very steep magnetic gradients in a small area near the central part of the anomaly, it was not possible to obtain accurate measurements in all places with the proton-precession magnetometers used. In this area, aeromagnetic data were used to help fill the gap. Thus, the depiction of the anomaly in Plate 7, a contour map consisting of all the ground magnetic data and a small component of aeromagnetic data, probably is not entirely accurate in the area near the highest part of the anomaly.

Both the aeromagnetic and ground magnetic data shown in Plate 5 and Plate 7, respectively, indicate that the Morris Lode anomaly has a north trend and that it consists of two parts: a large elliptically-shaped northern part and a narrower southern extension, or tail. The southern extension of the anomaly is composed of a few separate small magnetic closures over exposures of pods and veins of magnetite in the low hills south of the main anomaly. Most of the iron ore produced at this property has come from these exposures. The main anomaly is centered largely in an alluvial-covered wash between hills on both the north and south sides.

The shape of the main Morris Lode magnetic anomaly suggests that the anomaly source may dip or plunge toward the north at a low or moderate angle. It is also possible that there is a fault near line 500 N that has caused the northern portion of the anomaly source to be displaced downward (Plate 7). Both the drilling results and the magnetic and gravity anomalies indicate a large depth extent for the iron mineralization. The magnetic anomaly also suggests that the mineralization extends northward beyond line 20N (Plate 7), but at an increasing depth in this direction. Therefore, the main magnetic anomaly has a total length of at least 2,500 feet. A northwest-trending negative magnetic anomaly centered just northeast of the main positive anomaly in Section 6, T5N, R5E, probably represents the buried north magnetic pole of the magnetite zone.

Attempts at producing a reasonable model for the mineralized zone using either the ground magnetic data or the aeromagnetic data were not very successful. In the case of the ground magnetic data, the problem may be the lack of accurate values in critical areas near the center of the anomaly. The aeromagnetic data, however, were recorded on flight lines that are oriented at a small angle to the trend of the mineralized zone. As a result, we do not have an accurate aeromagnetic profile across the trend of the mineralized zone.

The one gravity profile that was obtained along line "0-0", over the central part of the magnetic anomaly is believed to be accurate and useful for modeling (Figure B-6). The residual gravity anomaly on this profile is centered at about the same location as the magnetic anomaly and has an amplitude of about 5.9 mGals. An assumption was made that the ore consists of about 50% magnetite based on the average grade (37% iron) found by Wiebelt (1947) including a small percentage of pyrite. The remaining 50% was assumed to consist of various proportions of gangue minerals, including calcite, dolomite, diopside, epidote, garnet, mica, and some quartz monzonite. The density contrast between the surrounding dolomite and quartz monzonite and the ore mineralization probably would be between 1.0 g/cm³ and 1.5 g/cm³, depending on the composition of the mineralization. The model in Figure B-6 assumes a simple parallelogram in cross section for the ore zone, tilted slightly toward the west, with a width of 950 feet, a depth extent of 1,400 feet below a 100 foot thickness of alluvium and low grade ore, and a strike length of 1,000 feet in both directions from the profile.

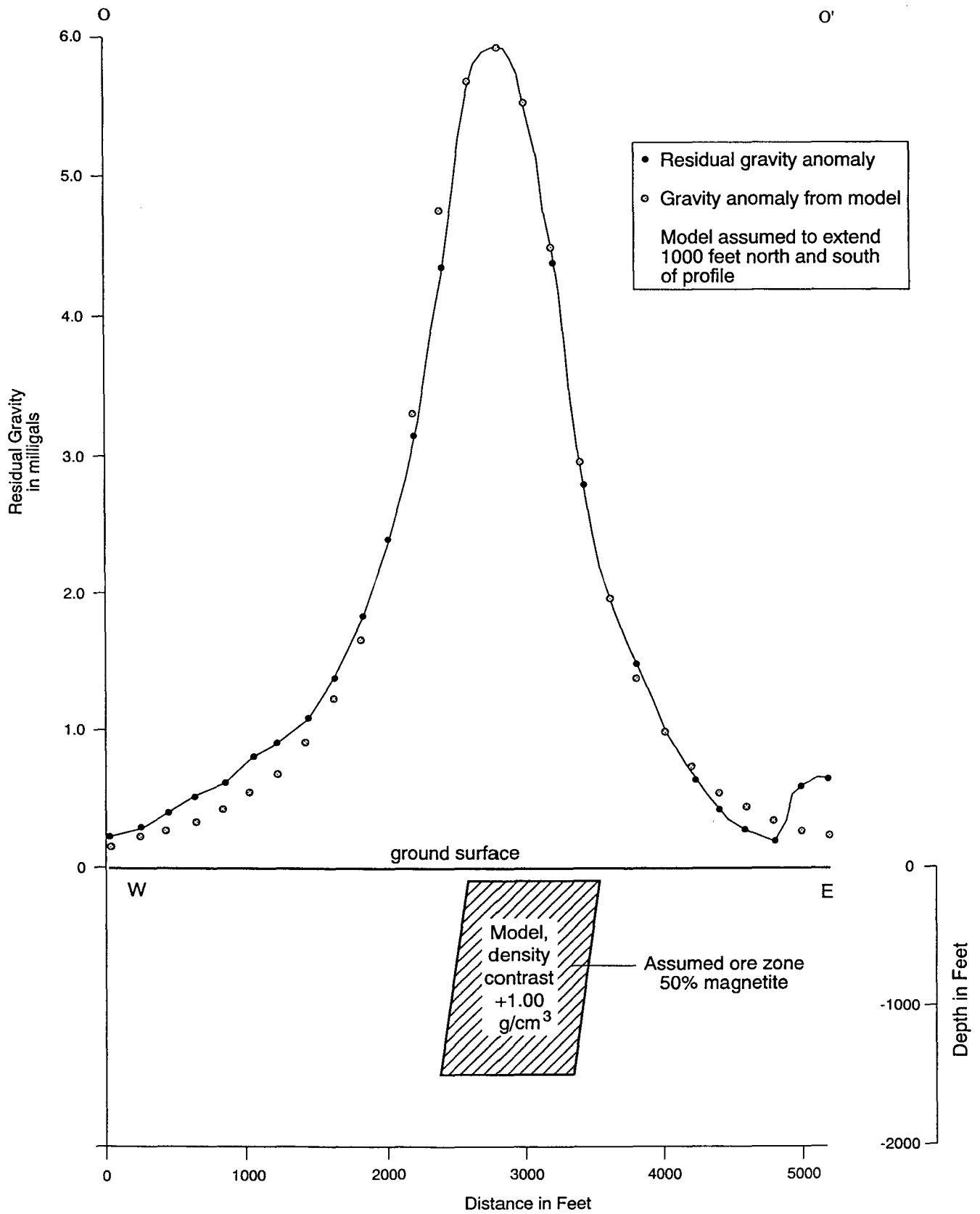


Figure B-6. Observed and calculated gravity anomalies and model, line O-O', Morris Lode area.

Using this model it was found that a density contrast of about 1.00 g/cm³ was necessary to produce a reasonably good agreement with the observed gravity anomaly. If the total length of the mineralized zone is taken to be 2,500 feet, the model suggests a very substantial amount of low grade iron ore, possibly as much as 100,000,000 tons. A part of this may be too deep to exploit by open-pit methods, however.

The Bessemer Deposit

The Bessemer deposit, also called the Iron Mountain deposit, located in Sections 27 and 28, T6N, R4E, has been described by Lamey (1948), Wright and others (1953), Dibblee (1964), and Moore (1971), (see Bessemer Mine, MRZ-2b^(s-2), page 30, this report). The deposit is at the southwestern end of Iron Ridge, an area of fairly high and irregular topography. Numerous, relatively small high-grade magnetite deposits exposed in the hillside above the valley were mined from about 1945 to 1957. The greatest part of the iron ore production from the Lava Bed District has come from these deposits.

Because of the high topography of Iron Ridge, the helicopter aeromagnetic map of Plate 5 does not cover the complete deposit. The largest magnetic anomaly in the mine area is under alluvium, south of the exposures in the hillside (Plate 5). The results of one drill hole by USBM to test this anomaly were described by Wiebelt (1947). This drill hole found iron ore from 61 to 102 feet, averaging about 48% iron. Moore (1971) states that drilling in 1954 on this anomaly found that this mineralized zone was too narrow to be of economic interest. Figure B-7 shows both an east-west ground magnetic profile (C-C') and a north-south profile (D-D') that cross the anomaly. Figure B-8 shows a possible model of a magnetite-bearing skarn zone that is based on magnetic profile C-C'. Although this model may not be a reasonable representation of the actual mineralized body, it suggests that there may be more magnetite mineralization present in this deposit than is suggested by the reports on the drilling.

The Man Prospect

The complex magnetic anomaly in Sections 32 and 33, T7N, R3E, and Sections 4 and 5, T6N, R3E, represents the "Man" iron prospect (Dibblee, 1964; Moore, 1971; Vredenburg, 1980; see Camp Rock Valley, MRZ-2b^(s-1), page 29, this report). The anomaly has a somewhat arcuate shape; it extends from the maximum value in Section 5 northeastward into Section 33, and southeastward toward the southeastern corner of Section 4. On the northeastern side, the mineralization represented by this anomaly may be bound by both the Emerson Fault and the Camp Rock Fault (Hart and others, 1993). The only exposures of skarn and magnetite in this area are on a small limestone hill near the center of Section 4. This occurrence is marked by three small magnetic closures which are superimposed on the main anomaly (Plate 5).

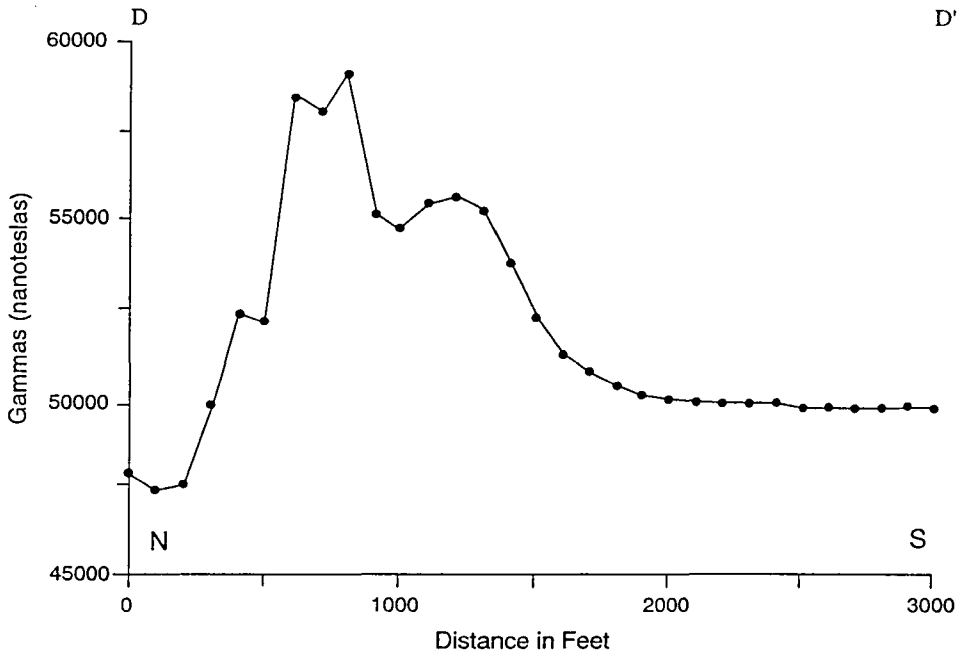
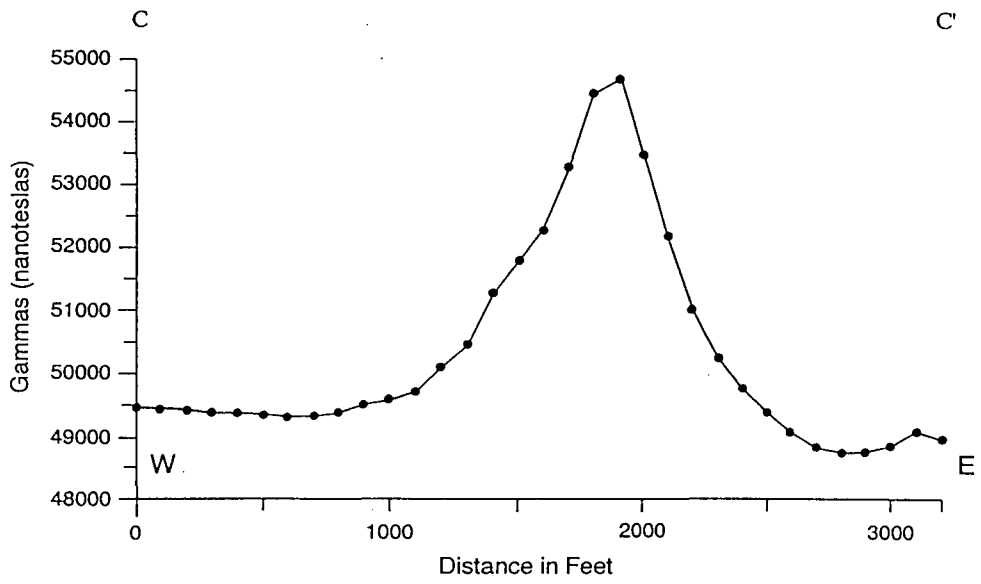


Figure B-7. Ground magnetometer profiles C-C' and D-D', Bessemer Mine area.

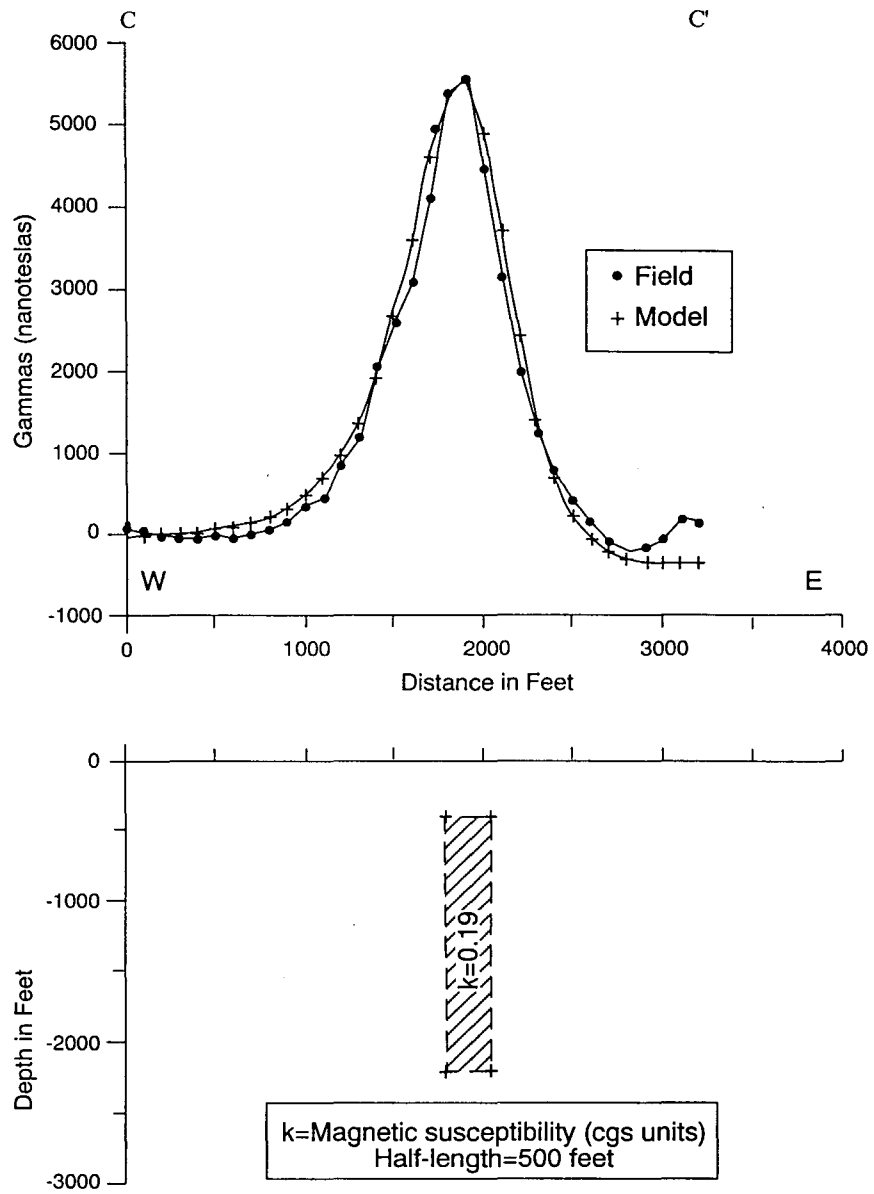


Figure B-8. Ground magnetometer profile C-C' and model, Bessemer Mine area.

The main magnetic anomaly associated with the Man prospect has an amplitude of about 2,500 nT on the aeromagnetic map of Plate 5. Figure B-9 shows three ground magnetic profiles E-E', F-F', and G-G' that were on this anomaly (Plate 5). The amplitude of the anomaly near its center on profile G-G' is about 3,000 nT. A few exploration holes were drilled on this anomaly in Sections 4 and 32 by a private mining company during the 1950s (Dibblee, 1964). Skarn and magnetite mineralization were reportedly encountered at depths of a few hundred feet below the surface, and this extends to depths of more than 3,000 feet. Although no drill holes have been reported in Section 5 near the highest part of the anomaly the mineralization probably would be found closer to the surface there.

A possible model based on an east-west-trending ground magnetometer profile G-G' is given in Figure B-10. The model is not intended to represent a unique solution, only to indicate the possible size of the mineralized mass, considering the drill hole information and an assumed effective magnetic susceptibility of 0.042 cgs units (5.28 SI units). Based on the model, it is clear that this is a very large skarn deposit, although it may be low in overall grade. Much of the deposit evidently is quite deep and probably could not be mined by open-pit methods.

A few gravity stations shown on Plate 6, located on and near the magnetic anomaly, indicate a local positive anomaly. This anomaly may have the same cause as the magnetic anomaly because the magnetite-bearing skarn has both a high magnetic susceptibility and a high density (Tables B-1 and B-2).

The Ord Prospect

The Ord prospect is represented by two positive magnetic anomaly closures in Sections 10 and 11, T6N, R3E, just southwest of the Rodman Mountains (see Camp Rock Valley, MRZ-2b^(s-1), page 29, this report). A negative aeromagnetic anomaly is also located in this area near the southeastern corner of Section 9, T6N, R3E. The largest of the positive anomalies, which has an amplitude of about 2000 nT, is centered on the eastern section line of Section 10, just southwest of the active trace of the Camp Rock Fault (Manson, 1986). There are no outcrops of magnetite-bearing skarn in Sections 10 and 11.

The small negative aeromagnetic anomaly, which has an amplitude of about 100 gammas and a northeast trend, was checked on the ground by means of one magnetometer profile (profile H-H', Figure B-11). The ground profile shows an anomaly of about 200 nT. The cause of this anomaly is uncertain; it could be caused by an alteration zone, but more likely it is related to a felsite dike exposed in outcrops just to the northwest of the anomaly (Dibblee, 1964).

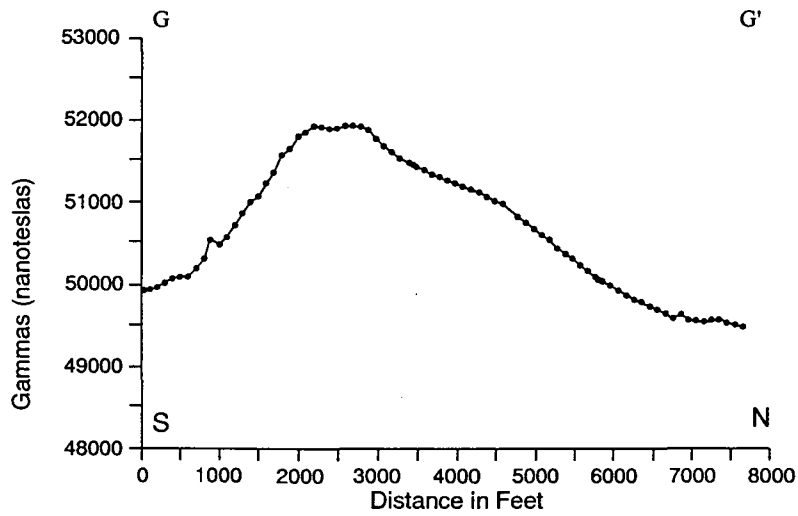
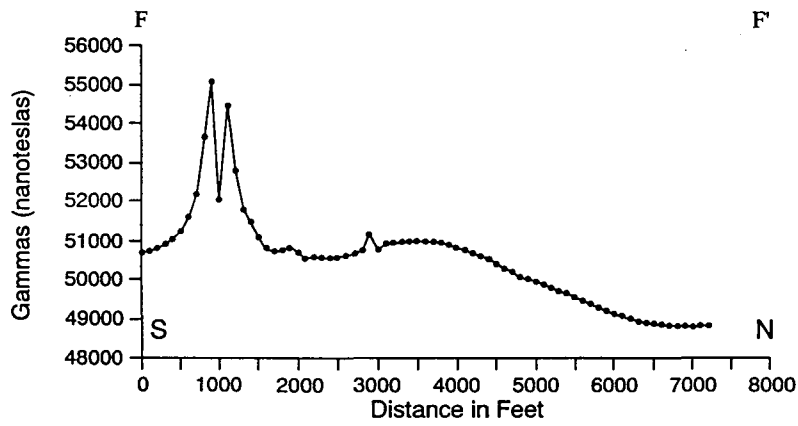
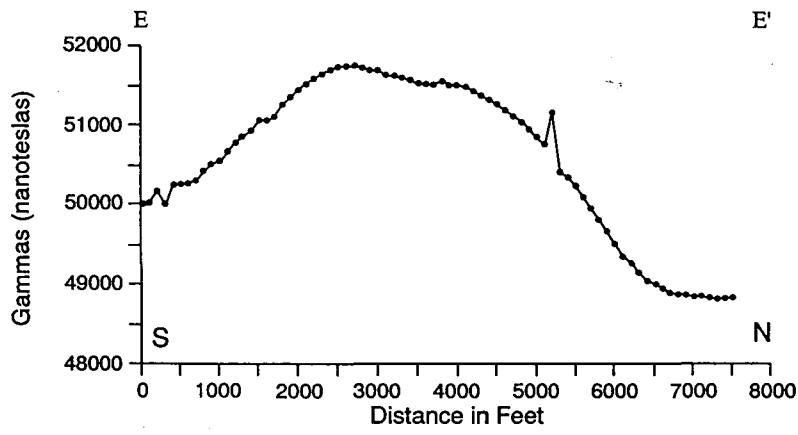


Figure B-9. Ground magnetometer profiles E-E', F-F', and G-G', Man Anomaly area.

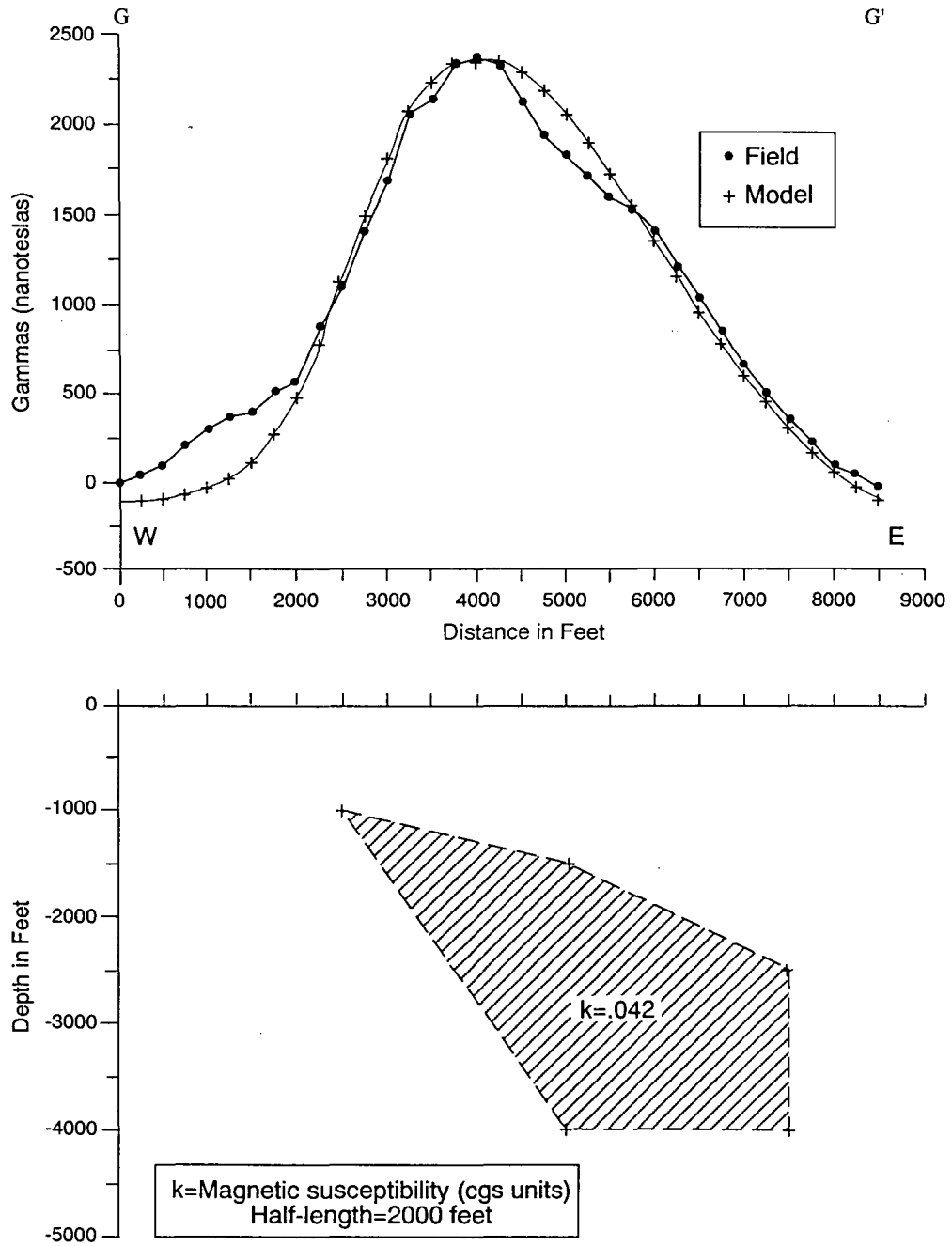


Figure B-10. Possible model for source of magnetic anomaly on profile G-G', Man Anomaly area.

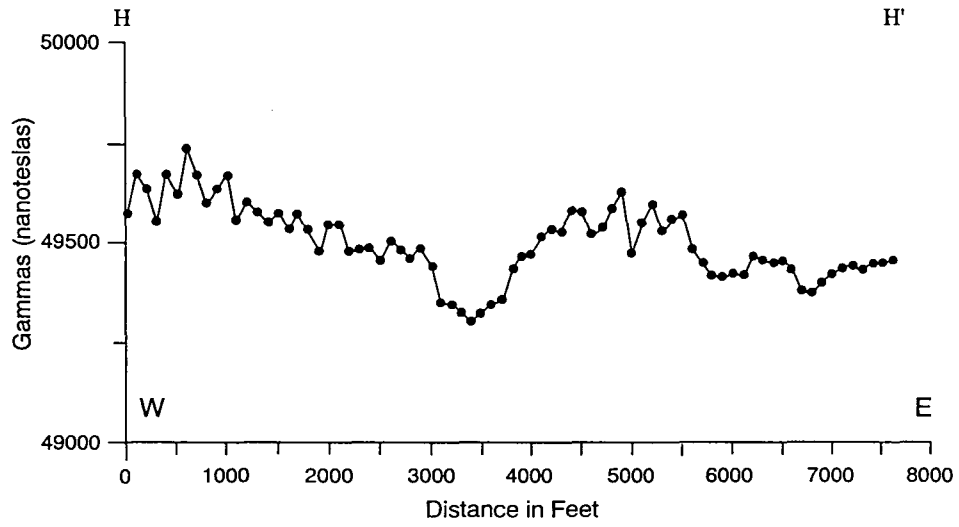


Figure B-11. Ground magnetometer profile H-H', Ord Anomaly area.

The two positive magnetic closures in Sections 10 and 11, T6N, R3E, have together a general east-west trend, but an extension also appears to turn northwest into Section 4 where it joins the large magnetic anomaly associated with the Man prospect. However, the possible magnetite mineralization is either relatively weak or absent in the area between the Man and the Ord anomalies because there is a saddle or gap in the anomaly trend. This apparent break between the two anomalies is approximately in the location of the Emerson Fault (Hart and others, 1993).

Two ground magnetometer profiles (Profiles I-I' and J-J') on this anomaly are given in Figure B-12. An estimate of the depth to the top of the anomalous mass for the largest (northeasternmost) anomaly is about 900 feet (Figure B-13). A hole drilled northeast of the peak of this anomaly (Plate 5) is believed to have encountered mineralization at about this depth. A possible model for the source of this anomaly is given in Figure B-13 (profile K-K'), based on one of the aeromagnetic anomaly profiles (Plate 5). A magnetic regional trend, rising toward the northeast, was assumed based on ground vertical and total intensity magnetic measurements. This gradient may be caused by the quartz monzonite exposed northeast of the Camp Rock Fault which evidently is more magnetic than the metasedimentary rocks thought to be present southwest of the fault in this area (Table B-2).

The model in Figure B-13 matches the observed anomaly fairly well and suggests that the mineralized body may be a tabular zone that dips steeply toward the northeast. The Camp Rock Fault, the surface trace of which is near the change in slope of the topographic profile in Figure B-13, probably represents the northeast, or hanging wall, boundary of the mineralized zone. The model used assumes the direction of the normal magnetic field and a magnetic susceptibility of 0.09 cgs units (1.13 SI units). If the direction of the total magnetization of the mineralization in the Camp Rock area is not the same as that of the normal magnetic field, the model shown in Figure B-13 could be greatly in error.

Section 13 Anomaly

The magnetic anomaly in the northern part of Section 13, T6N, R3E is designated here as the "Section 13 Anomaly" (Plate 5; see Camp Rock Valley, MRZ-2b^(s-1), page 29, this report). This anomaly has an amplitude of about 1,000 nT and it is centered between two power lines, about 1/2 mile southwest of the junction of these two lines. This anomaly, which is nearly circular in plan, is just north of the Camp Rock Fault and about 8,000-9,000 feet (2.4-2.7 km) southeast of the magnetic anomaly that represents the Ord prospect. Although it has not been tested by drilling to our knowledge, this anomaly probably represents magnetite-bearing skarn. There are no outcrops of this possible mineralization in the vicinity. Estimates of the depth to the top of this anomalous mass from the magnetic data are in the range of 800 to 1,000 feet.

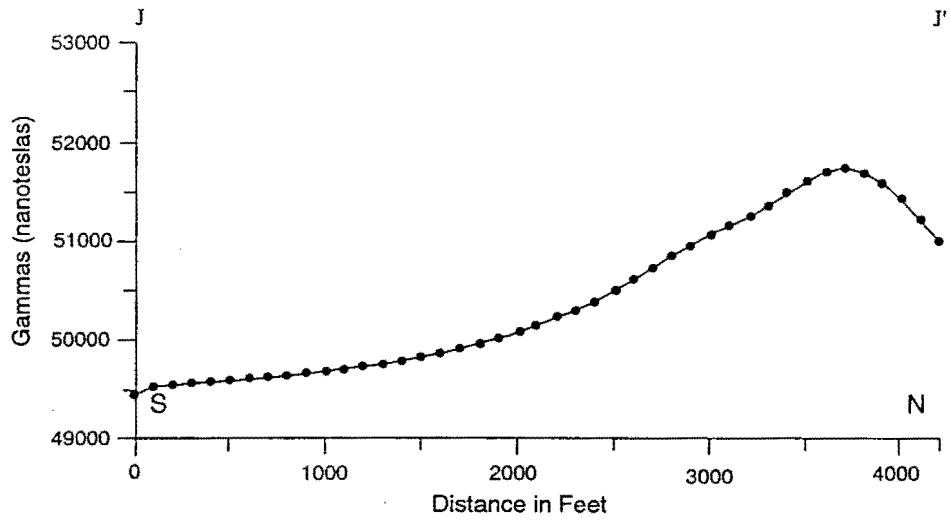
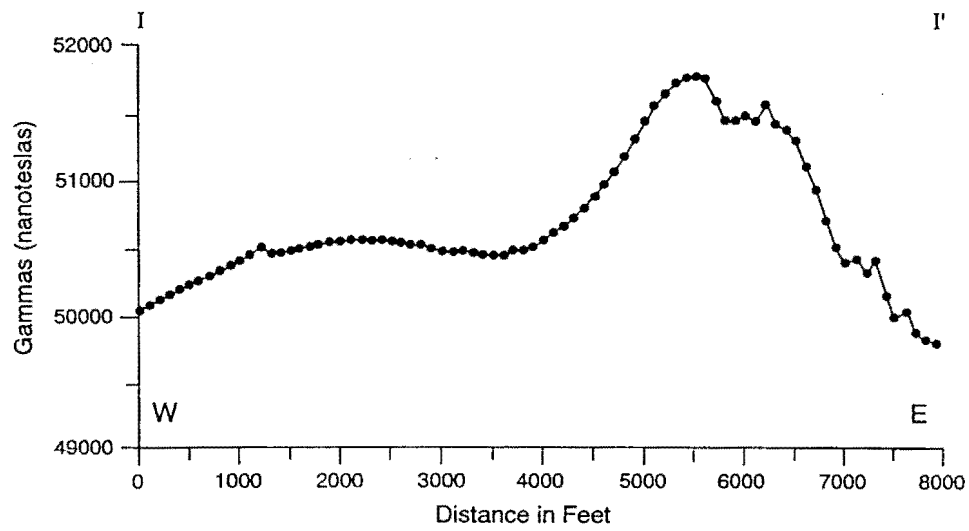


Figure B-12. Ground magnetometer profiles I-I' and J-J', Ord Anomaly area.

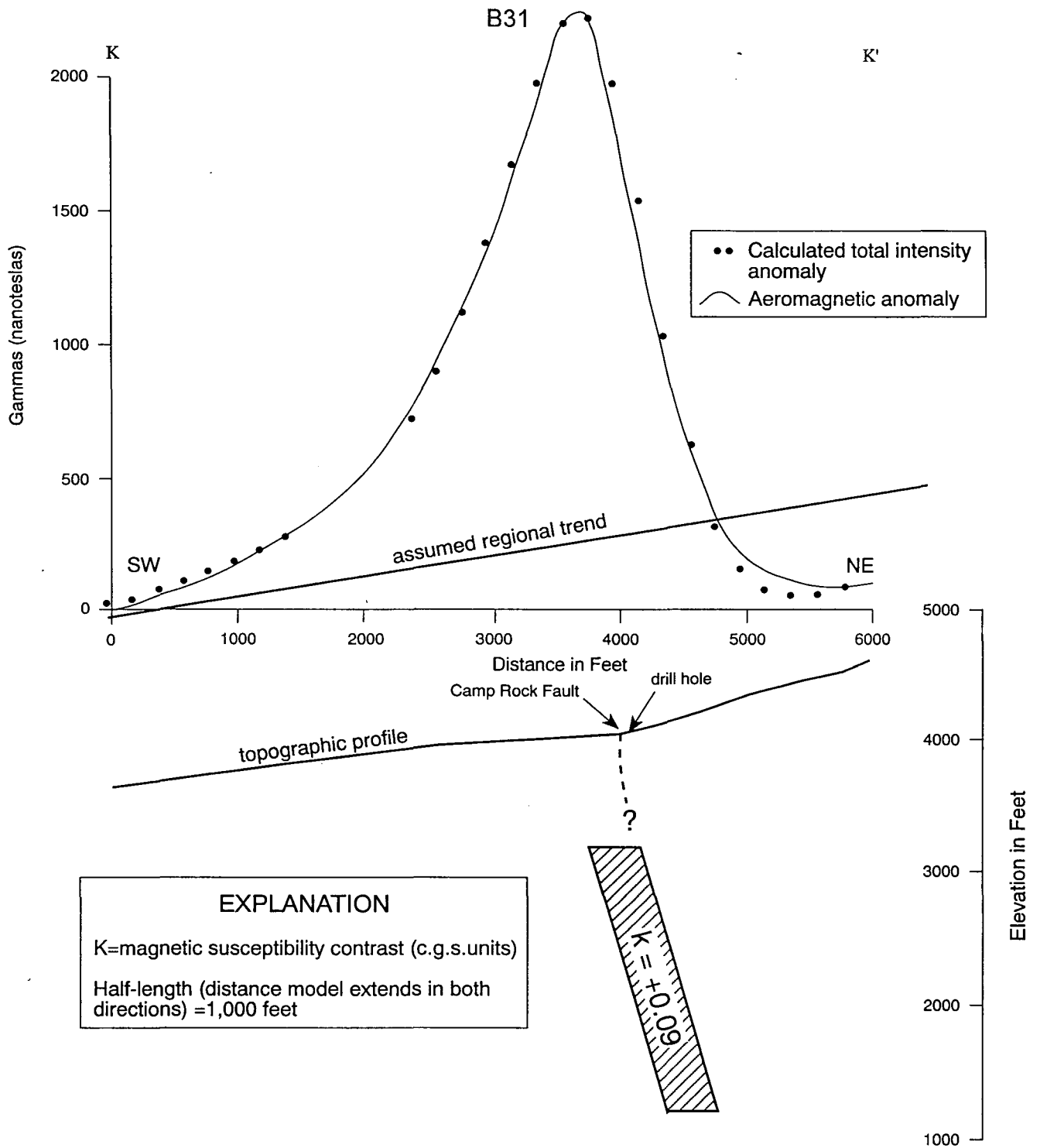


Figure B-13. Observed and calculated aeromagnetic anomalies and model, profile K-K' Ord Anomaly area.

This anomaly probably represents some of the same mineralization that is present at the Ord prospect to the northwest that has been displaced by movement on the Camp Rock Fault (see discussion on page B26).

Ground magnetic profiles on the Section 13 anomaly show an anomaly of about 1,800 nT in amplitude (Plate 5; Profiles L-L' and M-M', Figures B-14 and B-15). Figure B-15 (profile M-M') shows both magnetic and gravity anomalies on this line. Figure B-16 shows magnetic profile M-M' and a possible model for the assumed magnetite-bearing skarn zone based on the magnetic data. The anomaly caused by a mass shaped approximately like a buried sphere with a radius of 500 feet and a magnetic susceptibility of 0.10 cgs units (1.3 SI units) appears to fit the observed data fairly well. The gravity profile on this same line shows a local anomaly with an amplitude of about 1.2 mGals that is in the same location as the magnetic anomaly.

The New Bessemer Deposit

An aeromagnetic anomaly with an amplitude of about 5,500 nT that covers a small area in the southeastern part of Section 36, T6N, R4E, and the northern part of Section 1, T5N, R4E, is about 1 mile north of the Morris Lode anomaly (Plate 5; see New Bessemer Mine, MRZ-3a^(s-4), page 31, this report). This anomaly is associated with an iron deposit known as the "New Bessemer" property. This deposit evidently is a relatively small one (Wright and others, 1953, mine list). Some iron ore was mined here during 1949 (Dibblee, 1964). Also, a magnetic closure with an amplitude of about 400 nT may represent an even smaller iron deposit in the southwestern part of the same Section 36. These anomalies have not been investigated in detail during this study.

The Ebony Deposit

The Ebony deposit is in Section 15, T6N, R4E, on Iron Ridge, north of the aeromagnetic survey in Plate 5 (see Ebony Mine, MRZ-3a^(s-3), page 30, this report). This is a small magnetite deposit that has been explored by several open cuts (Wright and others, 1953, mine list; Dibblee, 1964; Moore, 1971). Lamey (1948) estimated that before mining this deposit might contain about 100,000 tons of iron ore with a grade of between 40% and 50% iron. An unknown amount of iron ore has been produced from this deposit. The Ebony deposit was not investigated during this study.

Faults in the Camp Rock Area

The northwest-trending Camp Rock and Emerson faults pass through much of the Camp Rock area in Plate 5 (Dibblee, 1964; Manson, 1986; Hart and others, 1993). Right lateral movement was recorded on both of these faults as a result of the Landers earthquake on June 28, 1992 (Hart and others, 1993; Irvine and Hill, 1993). The north-trending Galway Lake Fault, just west of Galway Lake and apparently just east of

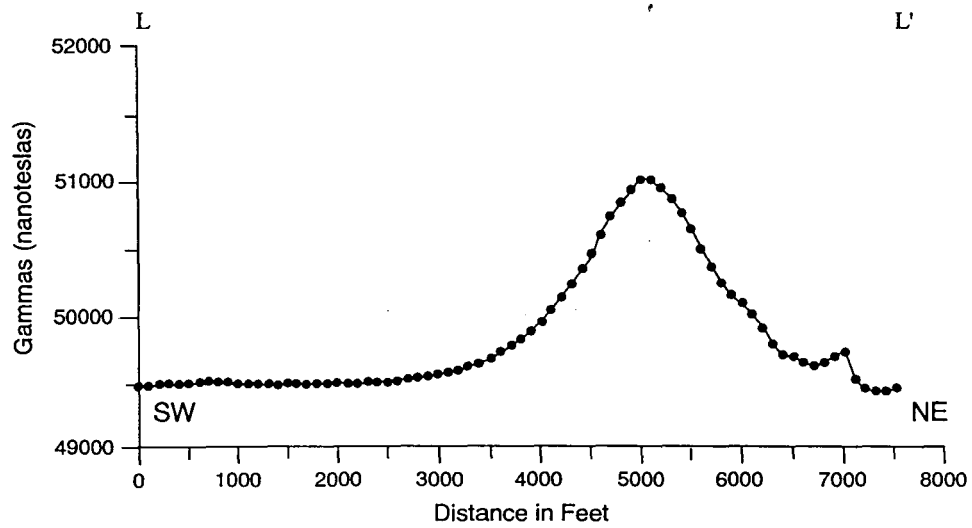


Figure B-14. Ground magnetometer profile L-L', Section 13 Anomaly area.

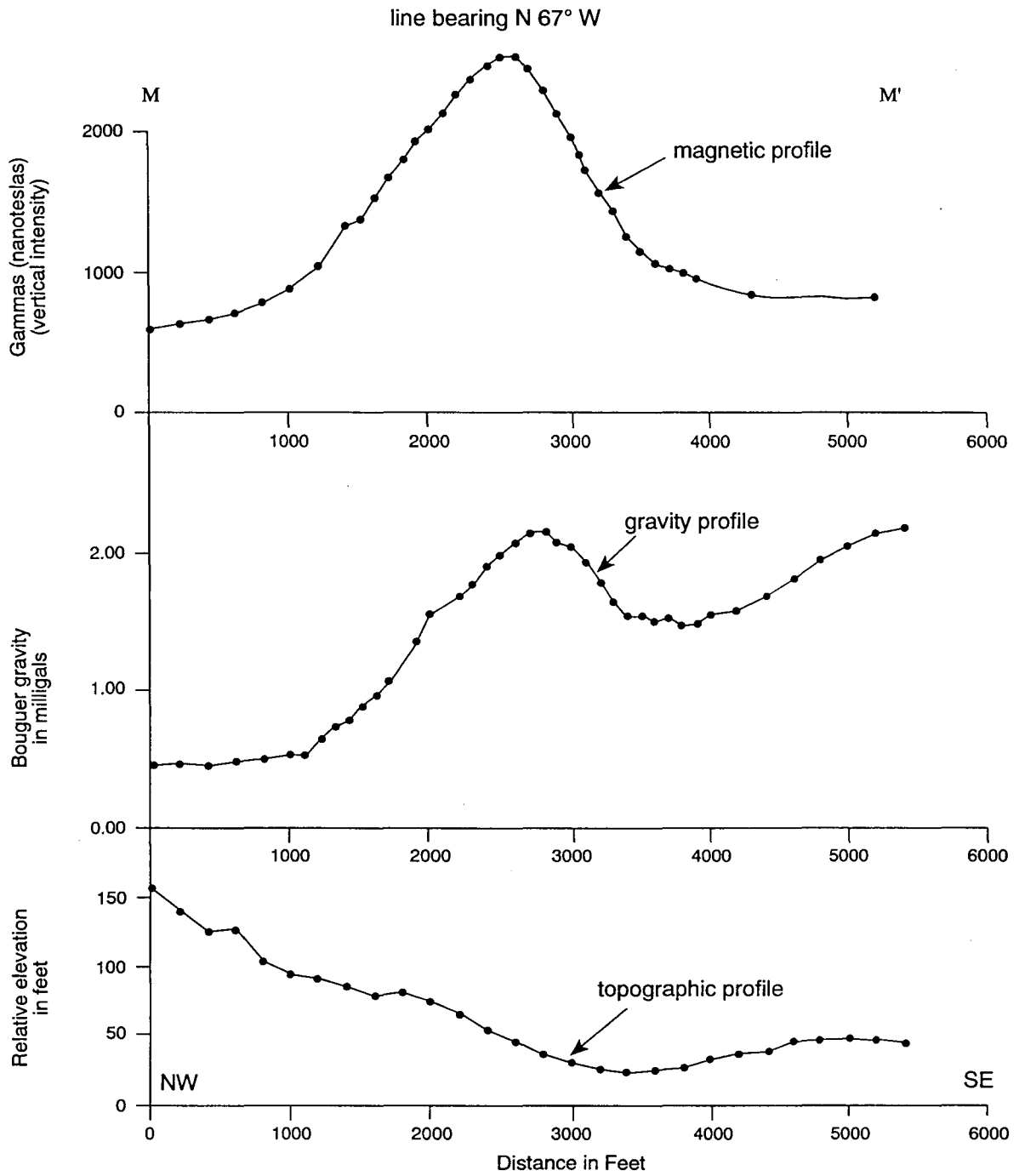


Figure B-15. Ground magnetometer profile M-M' and gravity profile, Section 13 Anomaly area.

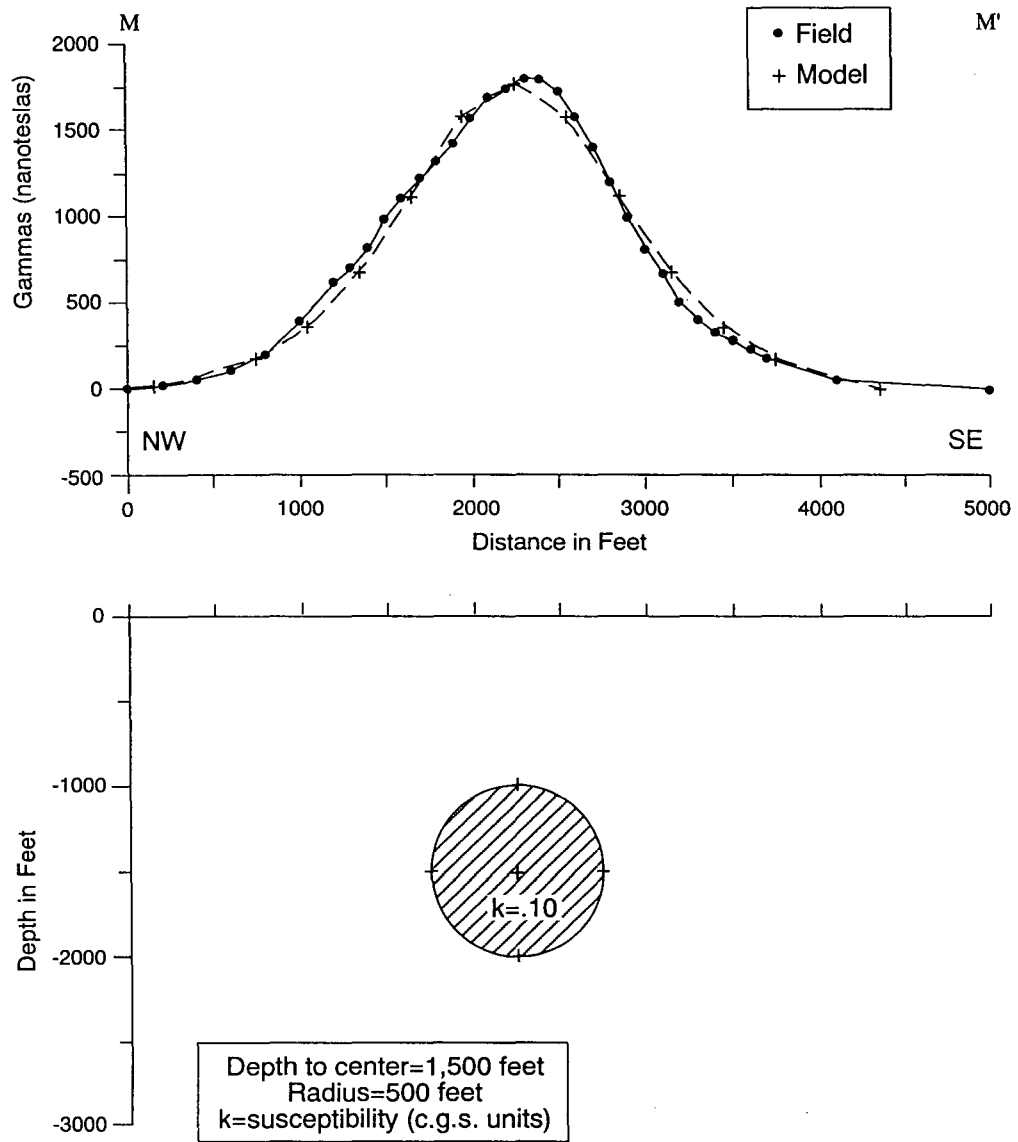


Figure B-16. Ground magnetometer profile M-M' and interpreted model, Section 13 Anomaly area.

the Morris Lode deposit, is also known to be an active fault (Hill and Beeby, 1977). Field observations and aftershock data following an earthquake on this fault in 1975 indicate that the fault is vertical and that it had a small right lateral offset.

Dibblee (1964) shows the Camp Rock Fault to be vertical or near vertical in his cross sections, and to have both right lateral and vertical displacement with the southwest side down in this area. He also shows that the Emerson Fault is vertical in cross section and has both right lateral and vertical displacement with the northeast side down. The effect of vertical displacements on the Camp Rock and Emerson faults has resulted in a graben between the two faults in the Camp Rock area (Dibblee, 1964; Manson, 1986).

Estimates of the total amount of offset on the Camp Rock and Emerson faults vary from about 0.75 km to 10 km (Hawkins, 1976; Miller, 1980; Dokka, 1983). These estimates are summarized by Manson (1986). Also, Cox and others (1987) have estimated a right lateral displacement of 2.4 to 2.8 miles on the Camp Rock Fault on the basis of apparent displacements of gravity and magnetic anomalies, northwest of the Camp Rock area.

Most of the iron deposits in the Camp Rock area are near one of the three faults mentioned above. The Bessemer deposit, and possibly the Morris Lode deposit, are on the north side of the Camp Rock Fault and a possible southeastern extension of this fault. The iron deposits near the western end of the Camp Rock area (the Man and Ord deposits) are apparently south of the Camp Rock Fault and near the northwestern end of the Emerson Fault. Displacement along the Emerson Fault is apparently responsible for the separation between the Man and Ord deposits.

The deposit represented by the Section 13 anomaly is apparently bound by two splays of the Camp Rock Fault. Right lateral displacement on the Camp Rock Fault has likely offset what was once one continuous deposit and produced two separate ones, the Ord and Section 13 deposits. Because movement on the Emerson Fault caused the present separation between the Man and Ord deposits, all three of these deposits may have been a part of one original mass. If the mineralization represented by anomalies associated with the Ord and Section 13 deposits was once continuous, the apparent offset is about 8,000-9,000 feet. This estimate of fault displacement is somewhat less than that obtained by Dokka (1983) and Cox and others (1987) (between 2.4 and 2.8 miles) along the fault northwest of this area.

Southeast of the Section 13 anomaly to the end of the Camp Rock Fault as shown by Dibblee (1964) and Manson (1986), in Section 29, T6N, R4E, the magnetic anomaly pattern on Plate 5 shows a distinct change from one side of the fault to the other. Northeast of the fault where igneous rocks (quartz monzonite) are exposed, the magnetic map is characterized by numerous small magnetic anomalies. Southwest of

the fault the anomaly pattern is much smoother, which indicates either a change in the type of rock or a greater depth to the source of the anomalies. Ground profiles show this clearly in some areas. For example, a short profile (N-N', Figure B-17) that crosses the location of the Camp Rock Fault southeast of the Section 13 anomaly (Plate 5), shows a distinct change from somewhat irregular anomalies with amplitudes of a few 10s of nT northeast of the fault to a very smooth profile southwest of the fault. There is also a small negative anomaly or dip near the fault. Figure B-18 shows ground magnetic profiles P-P' and Q-Q' in Sections 28 and 33, just west of the Bessemer Mine, and profile R-R' in Sections 33 and 34, southeast of the Bessemer Mine. The first two profiles are just southeast of the mapped end of the Camp Rock Fault as shown by Dibblee (1964). Magnetic observations on profile P-P' are somewhat obscured by magnetite in the alluvium that originated upslope at the Bessemer Mine, but profile Q-Q' shows a very pronounced change from one side of the projected fault to the other and a small negative anomaly at about the location of the fault. Northeast of the fault, the profile shows irregular anomalies of up to a few hundred nanoteslas. On the southwest side of the fault the profile is smooth.

Southeast of the Bessemer Mine, a change in anomaly patterns from one side of the projected trend of the Camp Rock Fault to the other can also be seen on Plate 5. The ground magnetic profile (R-R') that crosses the southern parts of Sections 33 and 34, T6N, R4E, shows this in somewhat more detail (Figure B-18). The fault may be present near station 7600, close to the locations of a small negative anomaly and the steep magnetic gradient shown on the profile and on the aeromagnetic map in this area. The magnetic anomalies tend to be somewhat smoother in this area, possibly because of a greater thickness of alluvium. From southeast of Section 34, T6N, R4E, to the vicinity of the Galway Lake Fault, in Sections 18 and 19, T5N, R5E, one can draw a line that separates a smooth magnetic field on the southwest from a more detailed and complex field on the northeast (Plate 5). This suggests that the Camp Rock Fault may continue southeastward and either intersect or merge with the Galway Lake Fault. However, if the Camp Rock Fault does continue this far, the Morris Lode prospect may be in the acute angle between the Camp Rock and the Galway Lake faults.

Two of the ground magnetic profiles (Q-Q' and R-R') cross the location of the Emerson Fault in Sections 33, T6N, R4E, and Section 4, T5N, R4E, respectively (Figure B-18). There is no apparent anomaly associated with the fault on either of these ground profiles. Because the mapped Emerson Fault follows close to the border of the aeromagnetic map, there is insufficient aeromagnetic data to determine whether or not anomalies mark the fault in other places.

DISCUSSION

An aeromagnetic survey, ground geophysical studies, and the results of drilling and other exploratory work show that the Camp Rock area is a major mineralized area

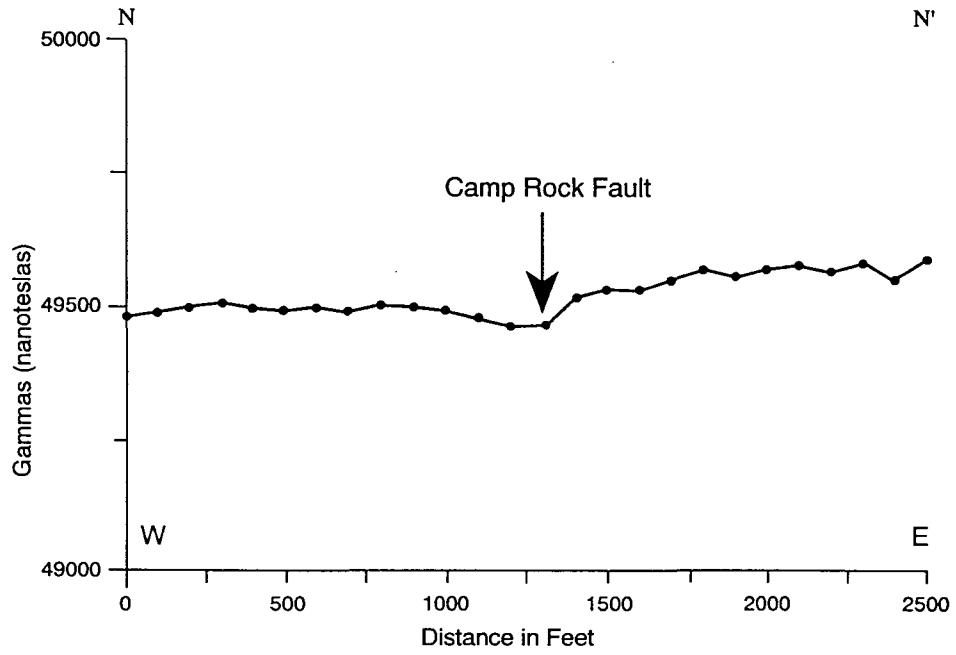


Figure B-17. Ground magnetometer profile N-N' over Camp Rock Fault.

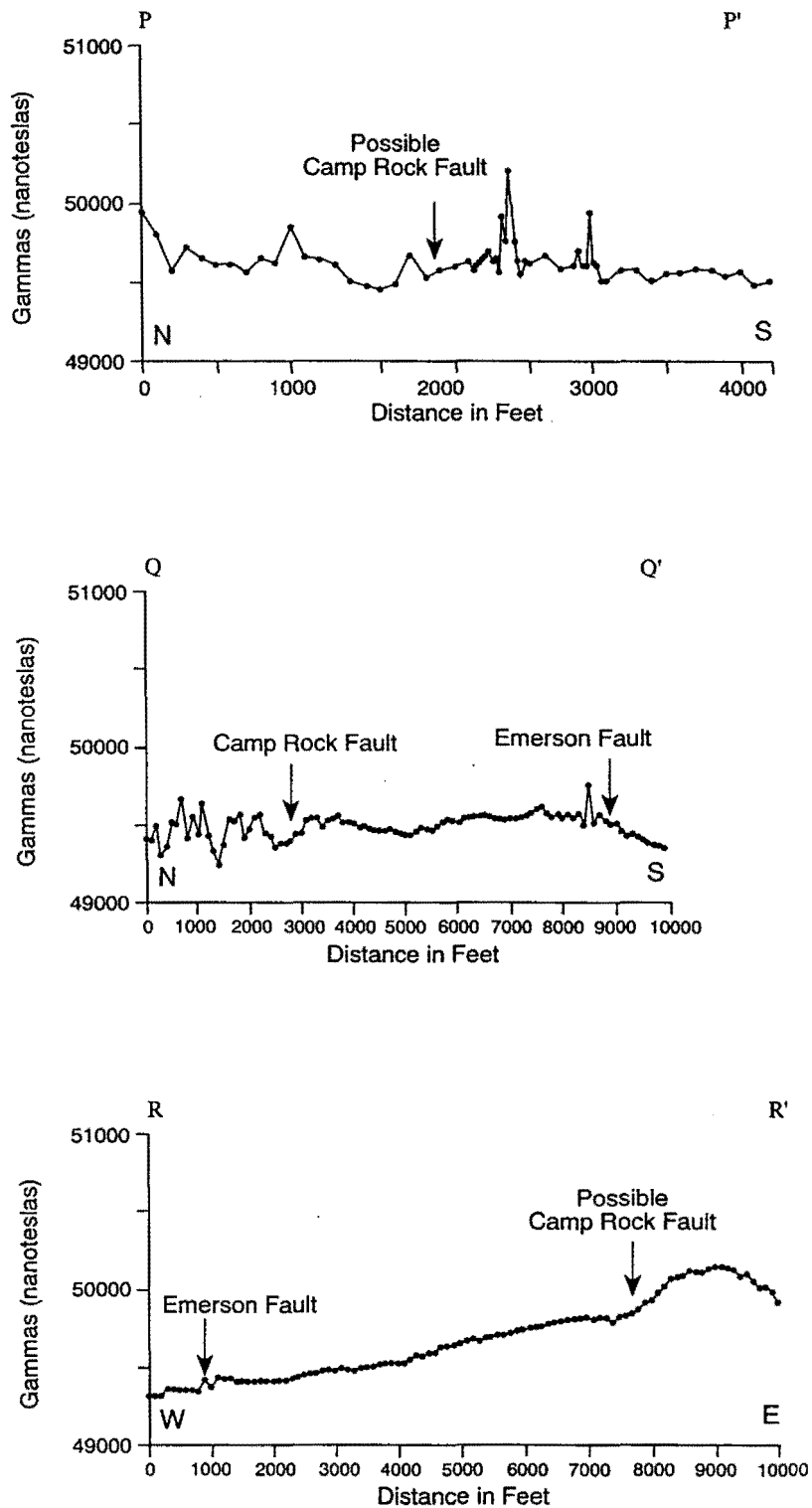


Figure B-18. Ground magnetometer profiles P-P', Q-Q', and R-R', over Camp Rock Fault.

that includes at least five important magnetite-bearing skarn deposits of possible economic interest. The limited exposures of some of the magnetite-bearing skarn zones do not provide a useful indication of the size of the resources actually present. The largest exposed area of skarn, in the area near the Copper Strand Mine, contains little or no magnetite, however, and it is not marked by a magnetic anomaly. Limited ground magnetic and gravity data were used to help evaluate the major positive aeromagnetic anomalies and two negative anomalies, and to help map some of the faults in the area. The negative anomaly at the Camp Rock Mine was also investigated by means of an electrical resistivity-induced potential profile, but the results were not conclusive.

Models have been made for the sources of most of the major magnetic and one of the gravity anomalies in the Camp Rock area. These models are not unique and can be duplicated assuming different parameters of size, depth, and physical properties. However, because most of them are constrained by at least some geologic and drilling data, they do serve to provide a reasonably good idea of the physical dimensions and location of the source of the anomaly in each case.

Analyses of the magnetic and gravity anomalies indicate large tonnages of possible iron ore at all five of the major anomalies that were investigated during this study. However, the grades of these deposits are hard to estimate. Based on known drilling results, parts of the anomalous zones probably are low in grade, and other parts are relatively high in grade. It appears that none of the deposits represented by these anomalies has been adequately explored by drilling. Judging from the models, however, it is possible that both the Man deposit, near the northwestern end of the map area, and the Morris Lode deposit, near Galway Lake, may each contain at least 1 million tons of relatively high-grade iron ore. The Morris Lode deposit is partly exposed on the surface but probably extends to a considerable depth. The mineralization at the Man deposit is not exposed on the surface, and the top probably is a few hundred feet below the surface. Therefore, it is not likely that either of these deposits could be mined entirely by open-pit methods. Three other deposits, the Ord, Section 13, and the Bessemer, may also contain significant amounts of mineralization. Of these three, only the Bessemer is close to the surface.

Other types of mineral deposits, including non magnetic skarn deposits, could be found in the Camp Rock area. Because the skarn at the Copper Strand Mine is not magnetic, it is possible that other such deposits are present. These types of skarn deposits could contain deposits of copper, gold, or other minerals of possible economic interest. Although the electrical geophysical work at the Camp Rock Mine was inconclusive, the negative magnetic anomaly here may represent a favorable location for exploration for sulfide deposits or gold. There may be other such negative anomalies in the map area. The magnetic data may also include other anomalies, both positive and negative, that could lead to the discovery of different kinds of mineral resources.

ACKNOWLEDGMENTS

We thank Andrew Griscom of the U. S. Geological Survey for providing us with his unpublished gravity data in the Camp Rock area and vicinity. Elise Mattison of DMG assisted both in the fieldwork and in preparation of the computer drawn maps.

REFERENCES CITED APPENDIX B

- Biehler, Shawn, Tang, R.W., Ponce, D.A., and Oliver, H.W., 1988, Bouguer gravity map of the San Bernardino Quadrangle, California: California Department of Conservation, Division of Mines and Geology Regional Geologic Map Series, Map no. 3B, scale 1:250,000.
- Bortugno, E. J. and Spittler, T. E., 1986, Geologic Map of the San Bernardino quadrangle: California Department of Conservation, Division of Mines and Geology Regional Geologic Map Series, Map no. 3A, scale 1:250,000.
- Cornwall, J. D., 1975, The magnetization and densities of Precambrian rocks and iron-ores of northern Sweden: *Geoexploration*, v. 13, p. 201-214.
- Cox, B. F., Griscom, Andrew, Kilburn, J.E., Raines, G.L., Knepper, Jr., D.H., Sabine, Charles, and Kuizon, Lucia, 1987, Mineral resources of the Newberry Mountains and Rodman Mountains Wilderness Study Areas, San Bernardino County, California: U.S. Geological Survey Bulletin 1712 A, 28 p.
- Dibblee, T. W., Jr., 1964, Geological map of the Rodman Mountains Quadrangle, San Bernardino County, California: U.S. Geological Survey Miscellaneous Geologic Investigations, Map I-430, scale 1:62,500.
- Dokka, R. K., 1983, Displacements on Late Cenozoic strike-slip faults of the central Mojave Desert, California: *Geology*, v. 11, p. 305-308.
- Hart, E. W., Bryant, W. A., and Treiman, J. A., 1993, Surface faulting associated with the June 1992 Landers earthquake, California: *California Geology*, v. 46, no. 1, p. 10-16.
- Hawkins, H. G., 1976, Strike-slip displacement on the Camp Rock Fault, central Mojave Desert, San Bernardino County, California: University of California, Los Angeles, unpublished M.S. thesis, 62 p.
- Hill, R. L. and Beeby, D. J., 1977, Surface faulting associated with the 5.2 magnitude Galway Lake earthquake of May 31, 1975: *Geological Society of America Bulletin*, v. 88, no. 10, p. 1378-1384.
- Irvine, P. J. and Hill, R. L., 1993, Surface rupture along a portion of the Emerson Fault: *California Geology*, v. 46, no. 1, p. 23-26.
- Lamey, C. A., 1948, Iron Mountain iron-ore deposits, Lava Bed District, San Bernardino County, California, in Olaf P. Jenkins, editor, *Iron resources of California*: California Division of Mines Bulletin 129, p. 25-38.
- Manson, M. W., 1986, Fault evaluation report FER-183, Camp Rock, Emerson, Galway Lake, Homestead Valley (north end), and associated faults, San Bernardino County, California: California Department of Conservation, Division of Mines and Geology FER-183, 15 p.
- Miller, S. T., 1980, Geology and mammalian biostratigraphy of a part of the northern Cady Mountains, Mojave Desert, California: U.S. Geological Survey Open-File Report 80-878, 122 p.
- Moore, Lyman, 1971, Economic evaluation of California-Nevada iron resources and iron ore markets: U.S. Bureau of Mines Information Circular 8511, 207 p.
- Parasnis, D. S., 1975, Mining geophysics, second edition, v. 3 in *Methods in Geochemistry and Geophysics*: Elsevier Publishing Company, New York, 395 p.
- Tang, R. W. and Ponce, D. A., 1982, Principal facts, accuracies, sources, and base station descriptions for 4915 gravity stations on the San Bernardino one degree by two degrees quadrangle, California: U.S. Department of Commerce, National Technical Information Service, Report PB82-200312, 99p.
- Vredenburgh, L. M., 1980, Rodman Mountains geology-energy-mineral resource area report: U.S. Bureau of Land Management, unpublished report, 13 p., on file at U. S. Bureau of Land Management, California District Office, Riverside, California.
- Werner, Sture, 1945, Determination of the magnetic susceptibility of ores and rocks from Swedish iron ore deposits: *Sveriges Geologiska Undersokning, Arsbok 39*, 79 p.
- Wiebelt, F. J., 1947, Bessemer iron project, San Bernardino County, California: U.S. Bureau of Mines Report of Investigations 4066, 13 p.
- Woollard, G. P. and Rose, J. C., 1963, International gravity measurements: Society of Exploration Geophysicists, Tulsa, Oklahoma, 518 p.
- Wright, L. A., Stewart, R.M., Gay, T.E., Jr., and Hazenbush, G.C., 1953, Mines and mineral deposits of San Bernardino County, California: *California Journal of Mines and Geology*, v. 49, p. 49-259, with tabulated mine list, 192 p.
- Zablocki, C. J., 1962, Electrical and magnetic properties of a replacement-type magnetite deposit in San Bernardino County, California: U.S. Geological Survey Professional Paper 450 D, p. 103-104.