To Robin

From Hal

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United States Department of the Interior
BUREAU OF LAND MANAGEMENT

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Final Environmental Impact Statement and Proposed Plan

APPENDIX

Volume G

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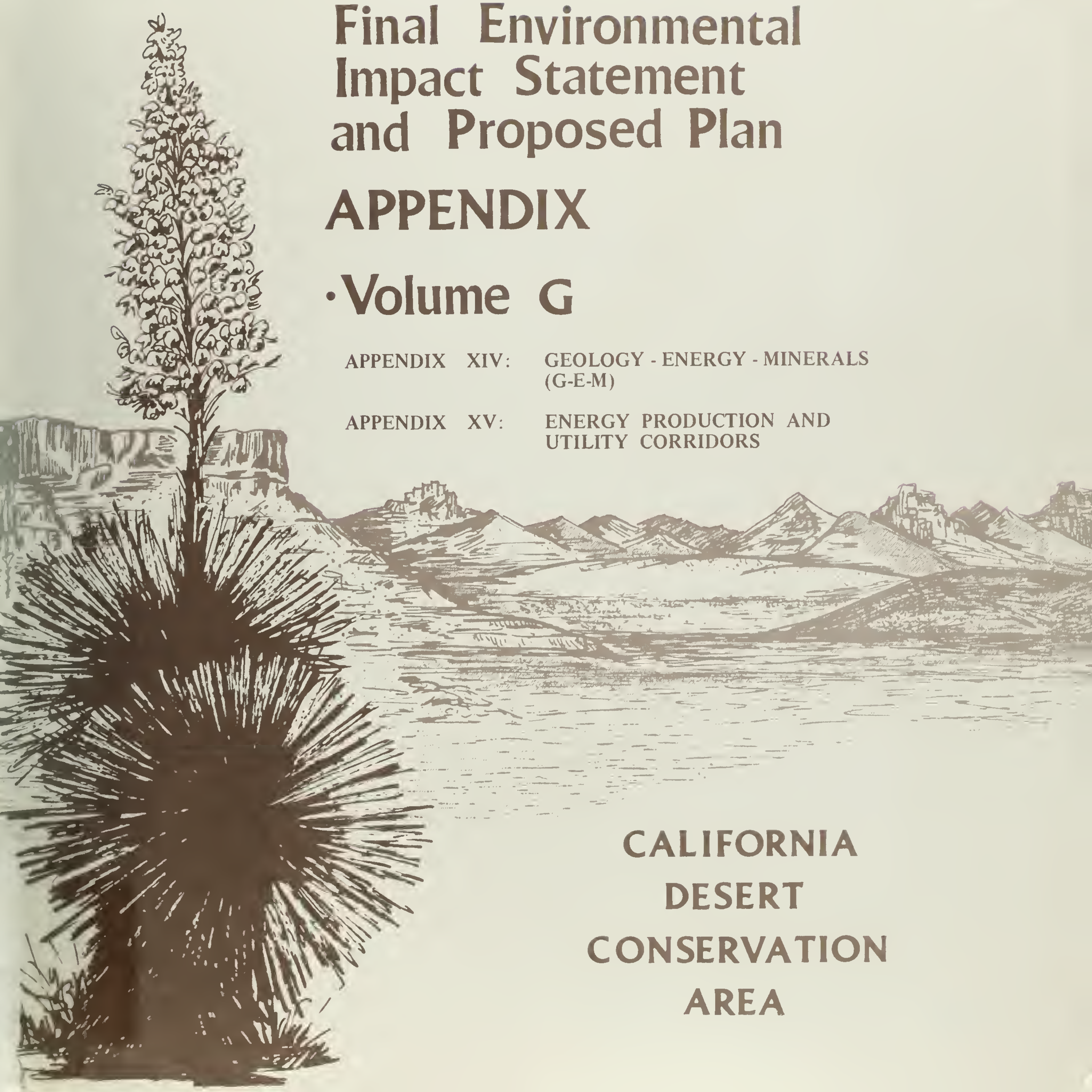
APPENDIX XV: ENERGY PRODUCTION AND UTILITY CORRIDORS



CALIFORNIA DESERT CONSERVATION AREA

APPENDIX XIV

GEOLOGY-ENERGY-MINERALS

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ENERGY PRODUCTION AND UTILITY CORRIDORS

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APPENDIX XIV

GEOLOGY-ENERGY-MINERALS

Part 1

Inventory, Analysis, and Evaluation

METHODOLOGY

A two-phase, modular systems approach program was developed for the inventory of G-E-M resources in the CDCA. The program combined geologic concepts with working hypotheses and with modern methods, all combining for a synergistic result. In Phase 1, methods gave a synoptic view of the geologic environment and its potential for energy and mineral deposits. Results permitted selection of smaller areas within the CDCA where additional, more detailed work was done in Phase 2. A listing of the techniques employed in these two phases follows.

PHASE 1

1. Lineament study of remote-sensed imagery
2. Geostatistical study of mineral endowment
3. Paleontological studies (two)
4. Literature search and compilation (continuous)
5. Lithology/fractures study
6. Field verification of selected areas

PHASE 2

1. Geochemical survey
2. Geophysical survey
3. Tonal anomalies (hydrothermal alteration) survey
4. Literature search and compilation
5. Field verification
6. Industrial minerals study
7. Independent panel evaluation
8. Geostatistical study of mineral endowment
9. Mineral economics study

For full efficiency, phases and most components were to be in sequence, but delays caused some to be done parallel. Time was gained, but efficiency suffered. The work for some of the components was done by outside groups on contract. For instance, in phase one, three components were contracted while three other were done in-house. Brief descriptions of the contracts follow.

PHASE 1 TASKS

1. The Lineament Study is based on the concept that linear structural elements and/or fractures in the Earth's crust could act as conduit for mineralizing solutions and/or locators for certain types of mineral deposits. The relationship between mineral deposits, lithology, and linear structural elements has been observed in many parts in the U.S. and also in the CDCA. To identify linear structures, existing data from different remote sensing surveys were used. They included: Landsat immagery, high and low altitude photography, and CDCA-wide contoured gravity and airborne magnetic data. Lineaments were identified, compared, and weighed for reliability. Different statistical criteria were used to categorize these lineaments; their relationship with known lithology, known mineral deposits, and mineral occurrences was defined and interpreted as mineral resources potentials. The product of this work was a technical report and several CDCA-wide maps. This work was performed for BLM by General Electric Company's Space Division under contract. The General Electric report is available for study in the BLM California Desert District Office, Riverside, California.

2. The Geostatistical Study in Phase I was also based on existing data from a synoptic view. All geologic, geophysical, and mineral occurrence data available in published or unpublished literature were compiled. Data on 3,009 occurrences included location, mineral commodity, name, and in some cases geologic environment and production. Forty geological variables represented on the California Division of Mines and Geology 1:250,000 scale geologic map and one geophysical variable (Bouger gravity) were selected as meaningful from a mineral deposits standpoint. The entire CDCA was divided into 26,810 cells (2 km by 2 km square). The 41 variables were quantified and recorded on a cell by cell basis. Data recorded in this fashion and mineral occurrence data served as bases for statistically classifying the cells according to likelihood of mineral occurrence. Of the several statistical methods tested, the discriminant function analysis (DFA) was chosen as best fitted for this work. The cells were thus classified with respect to occurrences of gold deposits, iron, and manganese, and combined copper, lead, zinc, and silver deposits. Occurrence data on over 40 other mineral commodities including sand and gravel, limestone, carbon dioxide, and geothermal fluid, were tabulated, but were not subjected to statistical analysis because of the small amount of occurrence data. Results were presented in tabular and in map form accompanied by a report. Work was performed for BLM by Terradata Company of San Francisco under contract.

3. The Paleontological Study consisted of two separate studies, one for vertebrate and the other invertebrate fossils, also based on existing data. Their objectives were not only to compile practically all existing significant data, but also to evaluate known and potential site values and to

suggest management guidelines for the resource. Evaluations were made for scientific, educational, and industrial potential of the resource. The results were presented as two separate reports, one for vertebrates and one for invertebrates, and respective maps. The work was performed under contract by professors Murphy (invertebrates) and Woodburn (vertebrates), both at the University of California, Riverside (UCR).

4. The Literature Search was the first task to be undertaken in the G-E-M Resources Program. It is continuous in that up-dating and addition of information takes place at any time. Published and unpublished reports containing geologic, structural, geomorphic, geochemical, geophysical, paleontologic, geothermal, mineralization, mining, and any other similar information in these fields which are directly or indirectly related to the CDCA are continuously sought. Professional papers, bulletins, maps, and any other publications of the U.S. Geological Survey, the U.S. Bureau of Mines, the Department of Energy, the California Division of Mines and Geology (CDMG), County reports California Transportation Department (Caltrans) reports are searched for useful information. For each such report found useful a form is then input to the DPS computer to form the computerized bibliography, the short version of which is also part of this Appendix. Example XIV-1-1 is the G-E-M Resources Bibliography form. Also computerized data banks were searched, for example GEOREF, CRIB, and MAS (MILS). Professional journals, company reports, Master and Ph.D. published and unpublished theses were studied. The literature considered pertinent and useful was either enclosed in the BLM California Desert library, or copies were made and included in the respective file.

Example XIV-1-1

G-E-M RESOURCES BIBLIOGRAPHY FORM

Reference No. ____________________ Author(s) __________________________

Year: _________________ Title: _______________________________________

Source: ____

Country(s) _________________________ State(s) _________________________

County(s): _________________________ BLM District(s): __________________

BLM Res. Area(s): __________________ Plan. Unit(s) _____________________

Region: ____

CATEGORIES:

0. Maps
1. Areal Geology - general
2. Areal Geology - maps & charts
3. Economic Geology - general
4. Economic Geology - leasable
5. Economic Geology - locatable metallic
6. Economic Geology-locatable nonmetallic
7. Economic Geology - salable
8. Energy - coal
9. Energy - general
10. Energy - geothermal
11. Energy - oil, gas, oil shale
12. Energy - nuclear
13. Energy - solar
14. Engineering & Environmental Geology
15. General Geology
16. Geochemistry - applied
17. Geochemistry - theoretical
18. Geochronology
19. Geomorphology
20. Geophysics - applied
21. Geophysics - theoretical
22. Historical Geology
23. History
24. Hydrogeology & Hydrology
25. Mathematical Geology
26. Mineralogy & Crystallography
27. Paleontology - general
28. Paleontology - invertebrate
29. Paleontology - paleobotany
30. Paleontology - vertebrate
31. Petrology - general
32. Petrology - igneous
33. Petrology - metamorphic
34. Petrology - sedimentary
35. Remote Sensing - geophysical
36. Remote Sensing - imagery
37. Stratigraphy
38. Structural Geology
39. Surficial Geology
40. Tectonics

KEYWORDS:

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

5. The Lithology, Structure, and Mineralization Study was to build an understanding of the geologic environment(s) of the known mineral deposits in the CDCA, the relationship between the different types of rocks, the mineralization, and the structural controls. Using the data which was available in the early stages of the program, 1:250,000 geologic map, the mineral occurrence as given in the U.S. Bureau of Mines Computerized Mineral Industry Location System (MILS), and in the CDMG files, and information on types of mineralization, geologic models of mineralization were recognized. Areas with similar geologic and structural characteristics were identified and delineated on a map. Several such models were recognized, as for example, that lead-zinc mineralization which occurs as hydrothermal replacement in carbonate rocks in the vicinity of younger granitic intrusives. In some models the age of the rocks involved is also important. Other examples are the tungsten deposits which are either hypothermal veins in skarn or placer; or the iron deposits are contact metamorphic or podiform in areas of sedimentary rocks intruded by younger igneous masses; or the environment for talc deposits in magnesium-rich carbonate rocks hydrothermally altered in the vicinity of mafic intrusives; or the Pleistocene lava beds as environment for zeolites.

This work was done in the office, and the product was a codified map on which areas of recognized geologic environments were outlined. The results of this study served several purposes, among which was the evaluation of the quality of the available data, the early recognition of different geologic environments, and the selection of areas for field verification.

6. Field Verification was also an in-house, continuous project in both phases which had more than one purpose. In addition to reliable field data being the best geologic information, the field verification was needed to check given geologic and mineral data and to add whatever pertinent data that could be found in the verified area. Another purpose was to verify results from remote sensing surveys and geostatistical predictions. Ideally, all areas defined under 5 above as well as those identified in the paleontologic study, in the remote sensing surveys, and in the geostatistical study should have been verified in the field. However, time and work-force did not permit this, and again areas had to be selected. The selection was based on how much could be covered, where the data were most needed, what type of new data were still needed in a given area, and where more data were needed because of existing or potential conflict(s) with other resources.

Figure XIV-1-1 shows areas where field verification was done. The total acreage of extrapolated field verification was approximately 6 million acres. Using literature data and field verification data (wherever applicable), the Mineral Locality Record form was filled (see Figure XIV-1-2). Data from these forms were input in the DPS computer G-E-M resources data bank.

The results from all projects done in Phase I, were integrated and interpreted. Based on these results, areas and methods for Phase 2 were selected.

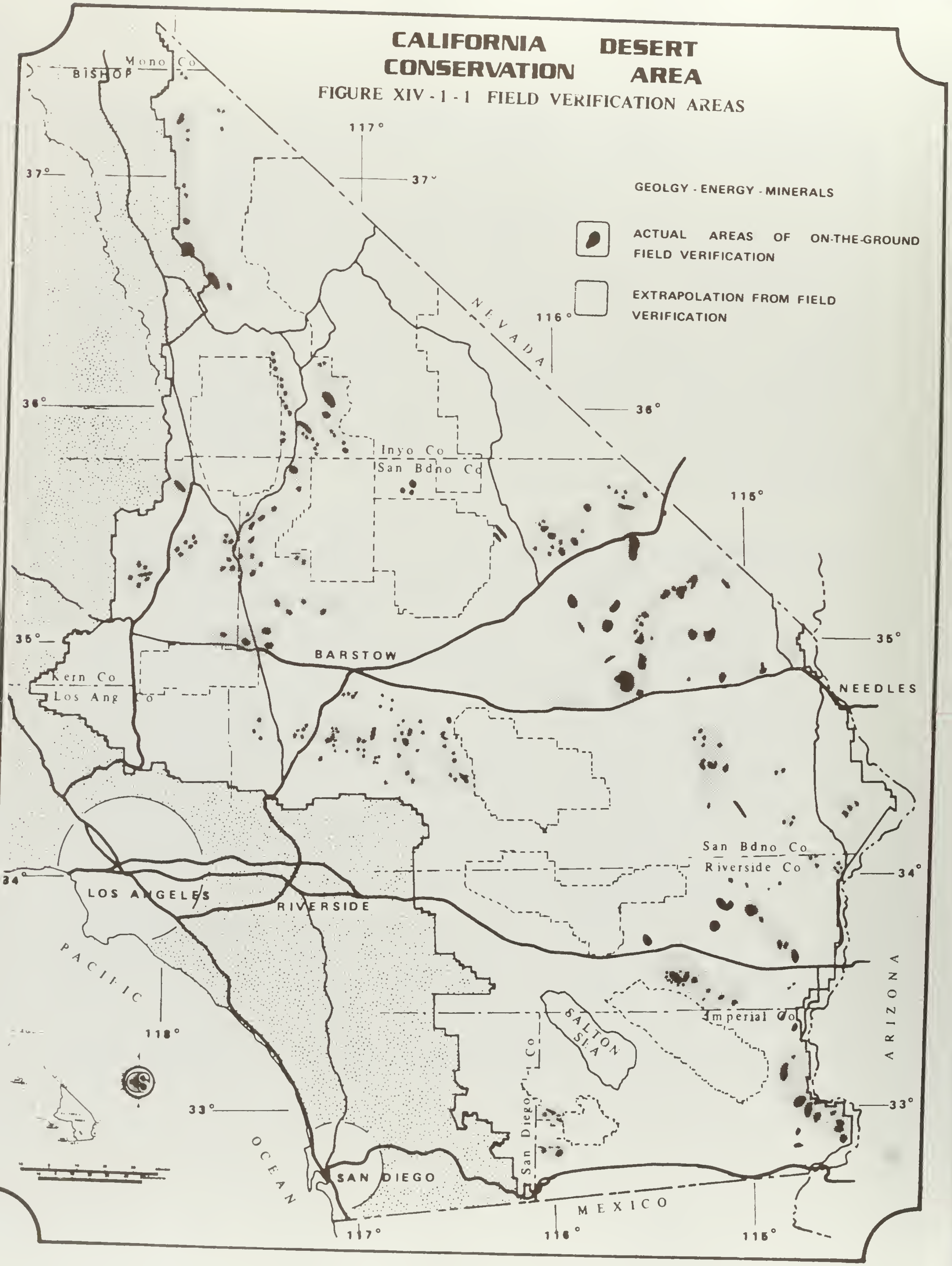

CALIFORNIA DESERT CONSERVATION AREA
FIGURE XIV-1-1 FIELD VERIFICATION AREAS
GEOLGY - ENERGY - MINERALS
ACTUAL AREAS OF ON-THE-GROUND FIELD VERIFICATION
EXTRAPOLATION FROM FIELD VERIFICATION
BISHOP
Mono Co
NEVADA
Inyo Co
San Bdno Co
BARSTOW
Kern Co
Los Ang Co
NEEDLES
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
117°
116°
115°
118°
37°
36°
35°
34°
33°

FIGURE XIV-1-2

BLM - DPS
G-E-M RESOURCES

MINERAL LOCALITY RECORD

State ____
District ____
Res. Area ____
Planning Unit ____
County ____

Site Number ____
Name ____
Action (circle)
change add delete
locatable leasable saleable

LOCATION DATA

Remarks ____

CADASTRAL GRID — UTM — DEG. MIN. SEC.

Twp. ____ N. S. Northing ____ Lat. ____ ____ ____ Field Verified Yes No

Rng. ____ E. W. Easting ____ Long. ____ ____ ____ Recorder ____

Sec. ____ ¼¼ ____ B & M ____ Block ____ Field Note Pages ____

Quad. Name ____ 15' 7.5' Mineral Area ____ Report Yes No Mo ____ Day ____ Yr ____

GEOLOGY and MINERAL DEPOSITS

Remarks ____

Rock Types: Host: ____ 1. ____ 2. ____ 3. ____ 4. ____ 5. ____ 6. Not determined

Commodities (order of abundance)

1. ____ 2. ____ 3. ____

4. ____ 5. ____ 6. Not determined

Ore Minerals (order of abundance)

1. ____ 2. ____ 3. ____

4. ____ 5. ____ 6. Not determined

Gangue Minerals (order of abundance)

1. ____ 2. ____ 3. ____

4. ____ 5. ____ 6. Not determined

Alteration

1 = very weak 3 = moderate
2 = weak 4 = strong

____ Silicic ____ Carbonate
____ Argilic ____ Oxidation
____ Sericitic ____ Weathering
____ Chloritic ____ Other
____ Propylitic ____ None observed

DEPOSIT TYPE
1. Vein (fissure)
2. Vein (replacement)
3. Diseminated
4. Content Metamorphic
5. Evaporite
6. Placer
7. Massive Sulfide
8. Stratiform
9. Volcanic
10. Breccia
11. Marine
12. Other

STATUS EVALUATION
1. Past Producer
2. Producer
3. Potential Producer
4. Raw Prospect
5. Trenched Prospect
6. Underground Prospect
7. Alteration Zone
8. Geochemical Anomaly
9. Geophysical Anomaly
10. Drilled Prospect
11. Gossan
12. Geologic Concept
13. Reconnaissance
14. Occurrence

SHAPE
1. Tabular
2. Lenticular
3. Circular
4. Stockwork
5. Pipe
6. Irregular
7. Other

SIZE (metres)
L ____ W ____ D ____

Attitude ____
Lode ? strike dip

ACTIVITY
Active Inactive

No. of Claims ____
Lode Placer

Claim Name ____

Owner ____

____

SAMPLES

Remarks ____

NO. TYPE ANALYSIS *

1. Stream sediment ____
2. Hvy Mnrl Conc ____
3. Rock ____
4. Chip ____
5. Core ____
6. Dump ____
7. Underground ____
8. Soil ____
9. Water ____
10. Paleontology ____
11. Other ____

* (A = Assay
Q = Quant
R = Reference
S = Semiquant)

Geochem sample taken here ? ____

MAPS

Remarks ____

	Ref.No.		Ref.No.
1. Geologic	____	9. Photogeologic	____
2. Geophysical	____	10. Geophysical (air.	____
3. Geochemical	____	11. Geochemical (air)	____
4. Mineral drilling	____	12. Geologic (satellite)	____
5. Oil & Gas drilling	____	13. Geophysical (satellite)	____
6. Geothermal drilling	____	14. Geochemical (satellite)	____
7. Mineral	____	15. Other	____
8. Property/claim	____		

FIGURE XIV-1-2

WORKINGS

Remarks ______________________

HOW MANY ?	TYPE	HOW MANY ?	OPENINGS	HOW MANY ?	BUILDINGS
______	Drift	______	Adit	______	Mill Foundation
		______	Shaft (vertical)	______	Head Frame
______	Crosscut	______	Shaft (inclined)	______	Loading Chute
______	Level	______	Prospect Pit	______	Other
______	Raise / winze	______	Trench		
		______	Stope to Surface		
		______	Open Pit		
______	Stope	______	Other		

Total length of underground workings (metres) ______________

DUMP: (metres) L ______ W ______ D ______

TAILINGS: (metres) L ______ W ______ D ______

TOTAL DISTURBED AREA: (metres) L ______ W ______ OR AREA ______

PRODUCTION DATA

Remarks ______________________

Year	Unrefined ore amount units	Refined product amount units	material	Reserves	Value

CLASSIFICATION: ______________ Recommendation: 1. Follow up 2. Later review 3. No interest

REFERENCES:

NO.	AUTHOR(S)	YEAR	PAGE(S)	G-E-M BIBLIO. NO.

REMARKS:

____

____

____

PHASE 2 TASKS

1. Reconnaissance Geochemical Surveys were done over four areas, which are shown on Figure XIV-1-3. From all four areas, samples were collected from 1,250 sites by contractors and BLM personnel.

At each site, two samples of drainage sediment were collected. One sample was sieved on-site, and the -80 mesh fraction was collected, bagged, and given an identification number. The second sample was two to three kilograms larger and consisted of drainage sediment scooped from the immediate area of the site. This second sample was taken to the laboratory where, by panning, a heavy mineral concentrate was obtained and the magnetic mineral extracted by hand magnet. This formed the heavy mineral sample. Both the sieved and the heavy mineral samples were sent to the USGS Chemical Laboratory in Denver for semiquantitative spectrographic analyses for 65 elements.

The chemical results and sample locations were digitized and entered in the USGS data bank. Statistical analyses of some of the chemical data were done, and anomalous results plotted and interpreted. Data on the sample and sample location were entered on the form shown as Figure XIV-1-4.

2. Geophysical Surveys were performed under contract on 10 selected areas (Figure XIV-1-5) using a gamma-ray spectrometer and a magnetometer mounted on a DC-3 flying at an ideal altitude of 400 feet above ground level. Different flight-line directions and flight-line spacings were selected on the basis of geologic structural trend and purpose of the survey. Data from a 1975-1976 BLM survey over the East Mojave were available as well. Surveys were performed by Geodata International, Dallas, Texas.

In addition to these BLM surveys, six 1° by 2° quadrangles were also aerially surveyed with gamma-ray spectrometer and magmetometer for the Department of Energy (DOE), National Uranium Resources Evaluation (NURE). Data from these surveys were also obtained and integrated into the CDCA Data Base (Ref. No. 836 through 839 in Appendix XII).

3. Tonal Anomalous Areas were identified on Landsat imagery. The principle behind this project was to identify on especially enhanced Landsat imagery, areas of unusual color tone which could represent hydrothermally-altered areas. Two different approaches were used, both based on enhancement of the data by using ratios of the spectral values of the Multi-Spectral System (MSS) bands. The best combination of three ratios of six possible ratios was combined into color composites to generate images which were photographically enlarged to 1:100,000 scale, for visual interpretation of tonal anomalies.

The tonal anomalies were plotted, correlated with rock units, and interpreted as to their validity as areas hydrothermally altered. This system was used by General Electric, the contractor. Stanford Remote Sensing Laboratory used the same six possible ratios and developed "Matrix Printer Maps" showing spectrally - anomalous areas for the 5/4 ratio and for the 5/4 + 7/6 ratios. The anomalous areas are described, correlated to geology, and interpreted as to their potential for representing hydrothermally altered areas. (BLM Contract No. YA-512-CT8-234). Areas covered by these two studies are shown on Figure XIV-1-6.

CALIFORNIA DESERT CONSERVATION AREA

FIGURE XIV - 1 - 3 GEOCHEMICAL SAMPLING AREAS, 1978

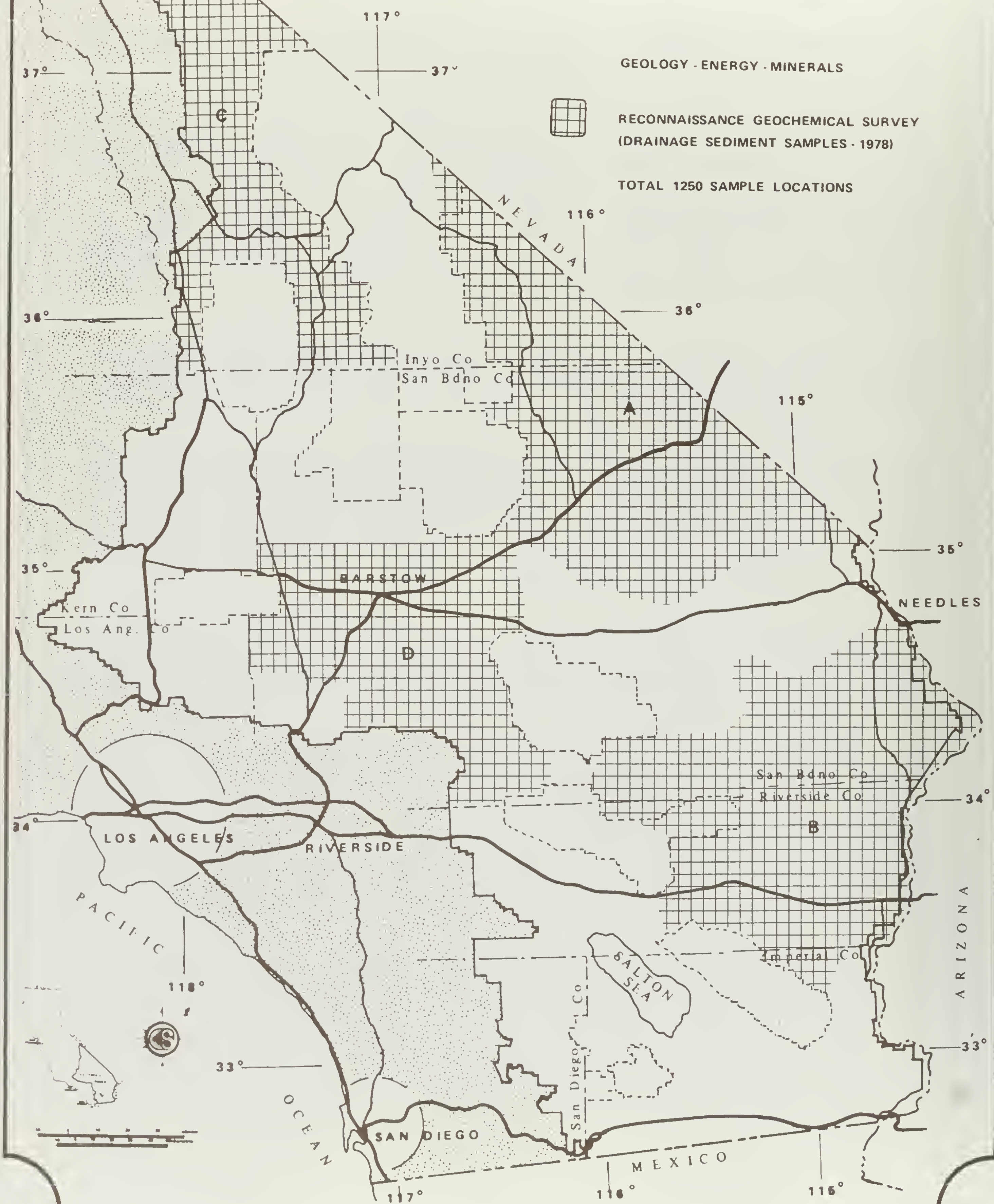


FIGURE XIV-1-4

BLM – DPS G-E-M RESOURCES
DESERTWIDE GEOCHEMICAL SURVEY
SAMPLE SITE RECORD SPRING, 1978

SITE NO. ____
STATE ____
COUNTY ____

DISTRICT ____
RES. AREA ____
PLAN'G UNIT ____

SITE LOCATION

Rmks. ____

Cadastral Grid

Twp. ____ N. ____ S. ____
Rng. ____ E. ____ W. ____
Sec. ____ ¼¼ ____ B&M ____

UTM

Zone ____
Easting ____
Northing ____

Latitude and Longitude

	Deg.	Min.	Sec.
Lat. (N)	____	____	____
Long.(W)	____	____	____

Quad. ____ 15' ____ 7.5' ____ Mineral Area: ____

SAMPLE DATA

Rmks. ____

Date / Mo. ____ Day ____ Yr. ____

Sample Type: 1. 500 μm seived drainage sediment How many ? ____

2. Bulk sample for heavy mineral conc. How many? ____
Black sands taken ? ☐ yes ☐ no

3. Other ____ How many ? ____

Collector : ____
affiliation ____
Recorder : ____
affiliation ____
Hvy. Min. Conc : ____
affiliation ____

SAMPLE ENVIRONMENT

Rmks. ____

Drainage Width (metres): ____ ☐ 1. Dry ☐ 2. Flowing

Drainage Type: ☐ 1. Open Valley ☐ 2. Canyon ☐ 3. Head of fan ☐ 4. Fan or bajada ☐ 5. Intermountain basin ☐ 6. Playa ☐ 7. Other ____

Drainage Pattern: ☐ 1. Dendritic (trunk) ☐ 2. Dendritic (tributary) ☐ 3. Braided ☐ 4. Other ____

Relief: ☐ 1. High ☐ 2. Moderate ☐ 3. Low ☐ 4. Flat

Activity (C= current) (P= past): ☐ 1. Agricultural ☐ 2. Mining ☐ 3. Industrial ☐ 4. Residential ☐ 5. Urban ☐ 6. None ☐ 7. Other ____

Weather: ☐ 1. Clear ☐ 2. Precipitation ☐ 3. Recent precipitation

Vegetation: ☐ 1. Barren ☐ 2. Sparse ☐ 3. Moderate ☐ 4. Heavy

Basin Size (mi ^{2}): ☐ 1. 0-5 ☐ 2. 5-10 ☐ 3. over 10

SEDIMENT CHARACTERISTICS

Rmks. ____

Size: ☐ 1. Boulders ☐ 2. Gravel ☐ 3. Sand and gravel ☐ 4. Sand ☐ 5. Mud (silt and clay)

Color: ☐ 1. Black ☐ 2. Gray ☐ 3. Brown ☐ 4. Dark brown ☐ 5. Red ☐ 6. Red-brown ☐ 7. Yellow ☐ 8. Yellow-brown ☐ 9. Buff ☐ 10. White

Aeolian Sediment Visible ? ☐ yes ☐ no ☐ don't know

Moisture: ☐ 1. Dry ☐ 2. Damp ☐ 3. Wet

Composition (in order of abundance):

Minerals: 1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Clasts: 1. ____ 2. ____ 3. ____
4. ____ 5. ____ 6. Not determined

Outcrop within 100 m ? ☐ yes ☐ no
If yes, lithology

REMARKS: ____

ROCK, MINERAL, COMMODITY CODES

IGNEOUS ROCKS

AG	Agglomerate
AM	(Amygdaloidal)
AD	Andesite
AN	Anorthosite
AP	Aplite (Aplitic)
BA	Basalt
BR	Breccia (Brecciated)
XL	Crystal (Crystalline)
DA	Dacite
DB	Diabase
DI	Diorite
EQ	(Eguigranular)
EX	(Extrusive)
FL	Felsite (Felsic)
GA	Gabbro
GL	Glass (Glassy)
GR	Granite
GD	Granodiorite
HP	Hypabyssal
IN	(Intrusive)
KR	Keratophyre
LA	Lamprophyre
LT	Latite
LI	(Lithic)
MF	(Mafic)
MZ	Monzonite
NR	Norite
OB	Obsidian
PG	Pegmatite (Pegmatitic)
PE	Peridotite
PN	Phonolite
PL	Plutonic
PR	Porphyry (Porphyritic)
QD	Quartz Diorite
QL	Quartz Latite
QM	Quartz Monzonite
RY	Rhyolite (Rhyolitic)
SR	(Seriate)
SI	(Siliceous)
SY	Syenite
TR	Trachyte
TF	Tuff (Tuffaceous)
VO	Volcanic
WT	Welded Tuff

METAMORPHIC ROCKS

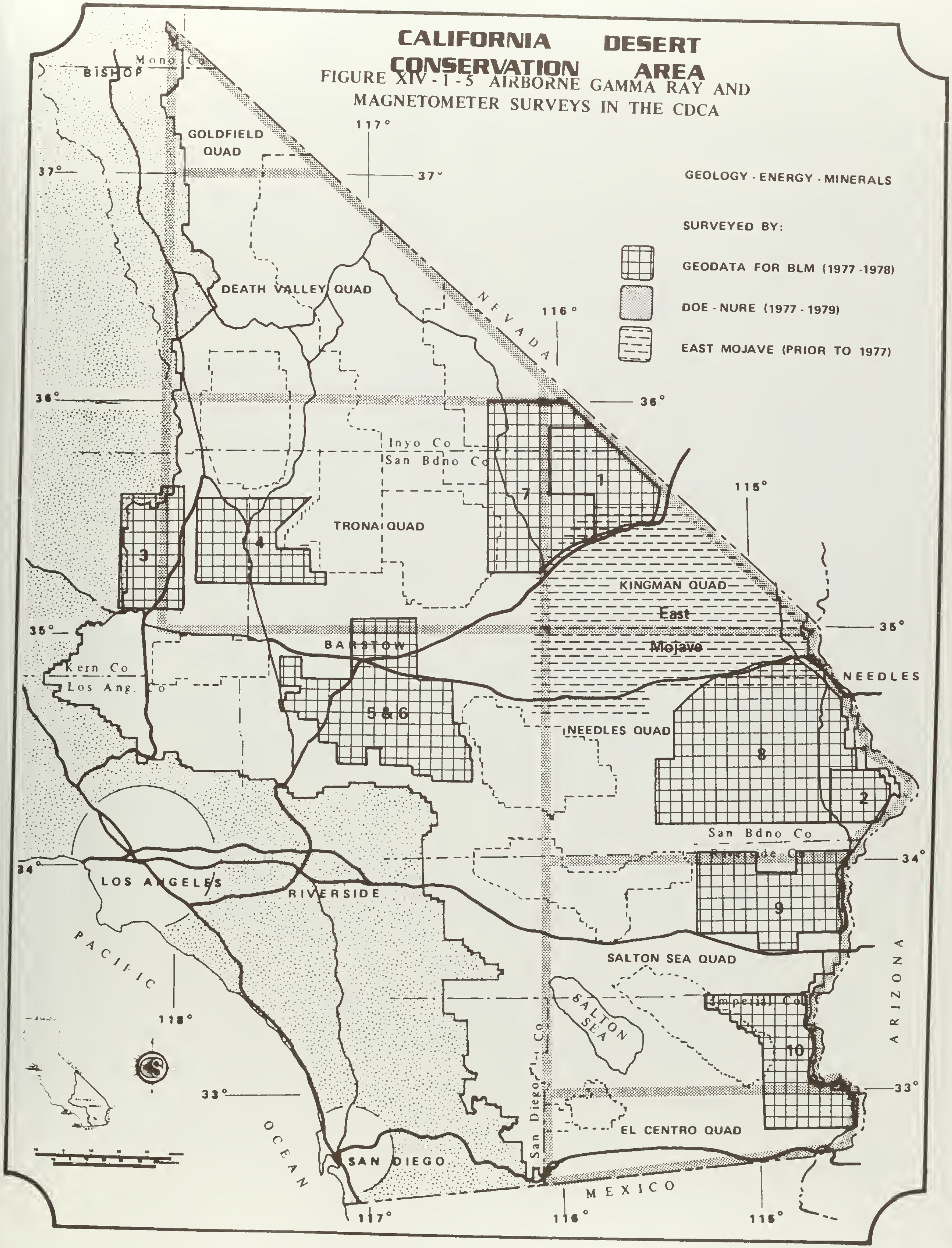
AH	Amphibolite
AS	Augen Gneiss
FL	(Felsic)
GN	Gneiss (Gneissic)
GS	Greenstone
MF	(Mafic)
MA	Marble
MG	Migmatite
MY	Mylonite
OR	(Ortho)
PY	Phyllite (Phyllitic)
QZ	Quartzite
SC	Schist (Schistose)
SE	Serpentinite
SI	(Siliceous)
SK	Skarn
SL	Slate (Slaty)
SO	Soapstone

SEDIMENTARY ROCKS

AV	Alluvium
AT	Anthracite
AR	Argillite (Argillaceous)
AK	Arkose (Arkosic)
BX	Bauxite
BN	Bentonite
BT	(Bituminous)
BR	Breccia (Brecciated)
CL	Caliche
CK	Chalk
CH	Chert (Cherty)
CY	Clay
CS	Claystone
CB	Coal (Carbonaceous)
CG	Conglomerate
CQ	Coquina
DT	Diatomite (Diatomaceous)
DO	Dolomite
EV	Evaporite
FG	Fanglomerate
GW	Graywacke
HM	Hematite (Hematitic)
IR	Ironstone
LG	Lignite
LS	Limestone (Calcareous)
LM	Limonite (Limonitic)
M1	Mica (Micaceous)
MU	Mudstone
OO	Oolite (Oolitic)
PT	Peat
PH	Phosphorite
SS	Sandstone (Sandy)
SH	Shale (Shaly)
ST	Siltstone (Silty)
TL	Till
TI	Tillite
TV	Travertine
TU	Tufa

COMMODITIES AND MINERALS

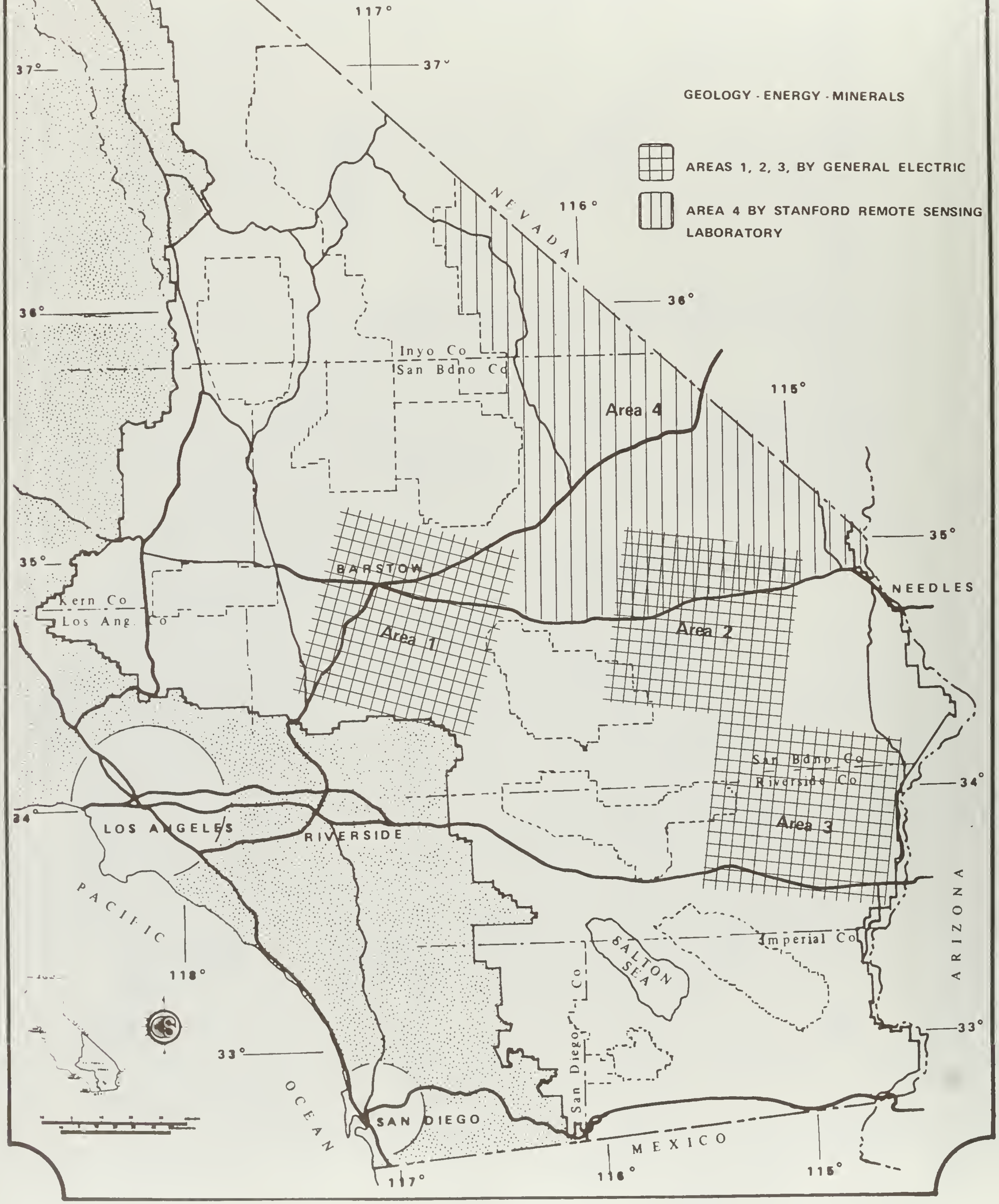
AB	Abrasives
AC	Actinolite
AL	Allanite
AE	Alunite
AM	Amphibole
AD	Andalusite
AN	Anglesite
AH	Anhydrite
AK	Ankerite
SB	Antimony
AP	Apatite
AR	Argentite
AS	Arsenic
AY	Arsenopyrite
AO	Asbestos
AI	Augite
AT	Autunite
AZ	Azurite
BA	Barite
BU	Bauxite
BN	Bentonite
BL	Beryl
BE	Beryllium
BI	Biotite
BO	Borate
BX	Borax
BT	Bornite
BG	Boulangerite
BB	Bournonite
BC	Brucite
CC	Calcite
CA	Carbonate
CS	Cassiterite
CL	Celestite
CG	Cerargyrite
CE	Cerrusite
CQ	Chalcedony
CH	Chalcocite
CP	Chalcopyrite
CT	Chlorite
CM	Chromite
CR	Chromium
CY	Chrysocholla
C1	Cinders
CN	Cinnabar
CX	Clay
CB	Coal
CO	Cobalt
CK	Colemanite
CU	Copper
CD	Corundum
CV	Covellite
CZ	Cuprite
DT	Diatomite
DS	Dimension Stone
DP	Diopside
DO	Dolomite
EN	Enargite
EP	Epidote
FS	Feldspar
FD	Feldspathoid
FL	Fluorite
GA	Galena
GN	Garnet
GM	Gemstone
GT	Geothermal
GL	Glauberite
GO	Goethite
AU	Gold
GP	Graphite
GV	Gravel
GK	Greenockite
GY	Gypsum
HL	Halite
HM	Hematite
HB	Hornblende
ID	Idocrase
1L	Ilmenite
FE	Iron
JR	Jarosite
KL	Kaolinite
KN	Kernite
KY	Kyanite
LT	Laterite
PB	Lead
LS	Limestone
LM	Limonite
LI	Lithium
MG	Magnesite
MT	Magnetite
MC	Malachite
MN	Manganese
MX	Mn Oxide
MR	Marcasite
HG	Mercury
M1	Mica
MB	Molybdenite
MO	Molybdenum
MZ	Monazite
MM	Montmorillonite
MV	Muscovite
NC	Niccolite
NI	Nickel
NT	Nitrate
OV	Olivine
OL	Opal
OP	Orpiment
OR	Orthoclase
OX	Oxide
PR	Perlite
PE	Perthite
PL	Plagioclase
PT	Platinum
PF	Potash Feldspar
KK	Potassium
PW	Powellite
PO	Proustite
PU	Pumice
PG	Pyargyrite
PH	Pyrrhotite
PY	Pyrite
PS	Pyrolusite
pp	Pyrophyllite
PX	Pyroxene
QZ	Quartz
RE	Rare Earth
RL	Realgar
RC	Rhodochrosite
RD	Rhodonite
RK	Rock
RG	Roofing Granules
RU	Rutile
SA	Sand
SG	Sand & Gravel
SH	Scheelite
SC	Sericite
SD	Siderite
SL	Sillimanite
AG	Silver
SM	Smithsonite
NA	Sodium
SP	Sphalerite
SE	Sphene
SO	Staurolite
ST	Steam
S1	Stibnite
SR	Strontianite
SF	Sulfate
SS	Sulfide
SU	Sulfur
TC	Talc
TN	Tennantite
TO	Tenorite
TT	Tetrahedrite
TR	Thorite
TH	Thorium
SN	Tin
TI	Titanium
TZ	Topaz
TL	Tourmaline
TM	Tremolite
TA	Trona
WO	Tungsten
TQ	Turquoise
UX	Ulexite
UN	Uraninite
UR	Uranium
VN	Vanadinite
VA	Vanadium
VM	Vermiculite
WA	Water
WF	Wolframite
WL	Wollastonite
WU	Wulfenite
WZ	Wurtzite
ZL	Zeolite
ZN	Zinc
ZR	Zircon
OM	Other Metallic
ON	Other Nonmetallic
XM	Unknown Metallic
XN	Unknown Nonmetallic



CALIFORNIA DESERT CONSERVATION AREA
FIGURE XIV-1-5 AIRBORNE GAMMA RAY AND MAGNETOMETER SURVEYS IN THE CDCA
GEOLOGY - ENERGY - MINERALS
SURVEYED BY:
GEODATA FOR BLM (1977-1978)
DOE - NURE (1977 - 1979)
EAST MOJAVE (PRIOR TO 1977)
BISHOP
Mono Co
GOLDFIELD QUAD
DEATH VALLEY QUAD
NEVADA
Inyo Co
San Bdno Co
TRONA QUAD
KINGMAN QUAD
East Mojave
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
NEEDLES QUAD
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC OCEAN
SALTON SEA QUAD
SALTON SEA
Imperial Co
ARIZONA
San Diego Co
EL CENTRO QUAD
SAN DIEGO
MEXICO
1
2
3
4
5 & 6
7
8
9
10
117°
116°
115°
118°
37°
36°
35°
34°
33°

CALIFORNIA DESERT CONSERVATION AREA

FIGURE XIV-1-6 TONAL ANOMALIES STUDY AREAS
LOCATION OF FOUR PROJECT AREAS IN THE CDCA



4. and 5. Literature Search and Field Verification have been described under Phase 1. There is no difference except that areas to be field-verified were re-evaluated based on results from projects completed in Phase 1.

6. An Industrial Mineral Study was initiated with help from BLM geologists and mining engineers from resource areas or districts within the CDCA, forming a team under the immediate supervision of a BLM specialist in industrial minerals from the Denver Service Center. The basis of the study was existing data gathered from published reports, BLM files, and mining companies willing to release such data. Data were plotted and compiled as a map at 1:250,000 scale. Together with the geologic data, the industrial mineral data was interpreted, and the potential was inferred.

7. The Independent Panel Evaluation Project was accomplished by contract with Terradata, which assembled a panel of ten experts, prepared the material to be evaluated, and then prepared the report and maps from the panel's evaluation. Five mineral resource potential maps were prepared: nationally important industrial minerals, regionally important industrial minerals, metals, uranium, and saline minerals. This project was done through BLM Contract No. YA-512-CT9-66; the report and maps are available for study in the California Desert District Office, Riverside, California.

8. The Geostatistical Study in Phase 2 is similar to that in Phase 1, but it is more complete as new data became available. The CDCA was geostatically classified as to the potential for gold, iron, manganese, tungsten, combined copper, lead, zinc, silver, and combined metal deposits. Results are presented in tabular form and in map form. Work was done by Terradata, San Francisco, under Contract No. YA-512-CT9-66.

9. The Mineral Economics Study started after all other data from in-house and contracts were gathered. A team concentrating on the mineral economics studied industrial minerals. The report is included in this Appendix.

THE ANALYSIS AND INTERPRETATION OF THE DATA BASE

The GRA Files

The CDCA was subdivided into 92 G-E-M resource areas (GRAs) on the basis of geologic environment and mineral or administrative units. 17 of the GRAs are in National Parks or areas managed by the military. The other 75 GRAs fall within the rest of the CDCA. Figure XIV-1-7 shows the 75 GRAs, and names are given in Table XIV-1-1.

After the GRAs were delineated, a file was created for each, and all pertinent data were extracted from the data base and organized. In each GRA file the data are in written and/or map form. The written material consists of copies of technical articles, lists of known mineral occurrences, lists of geochemical and/or geophysical data, description of field-verified areas, description of field-verified tonal anomalies, county reclamation plans, internally-generated technical reports, copies of public comment, and other information pertinent to the respective GRA. Example XIV-1-2 shows a form within each GRA file listing useful material.

CALIFORNIA DESERT

FIGURE XIV-1-7

G-E-M RESOURCES AREAS

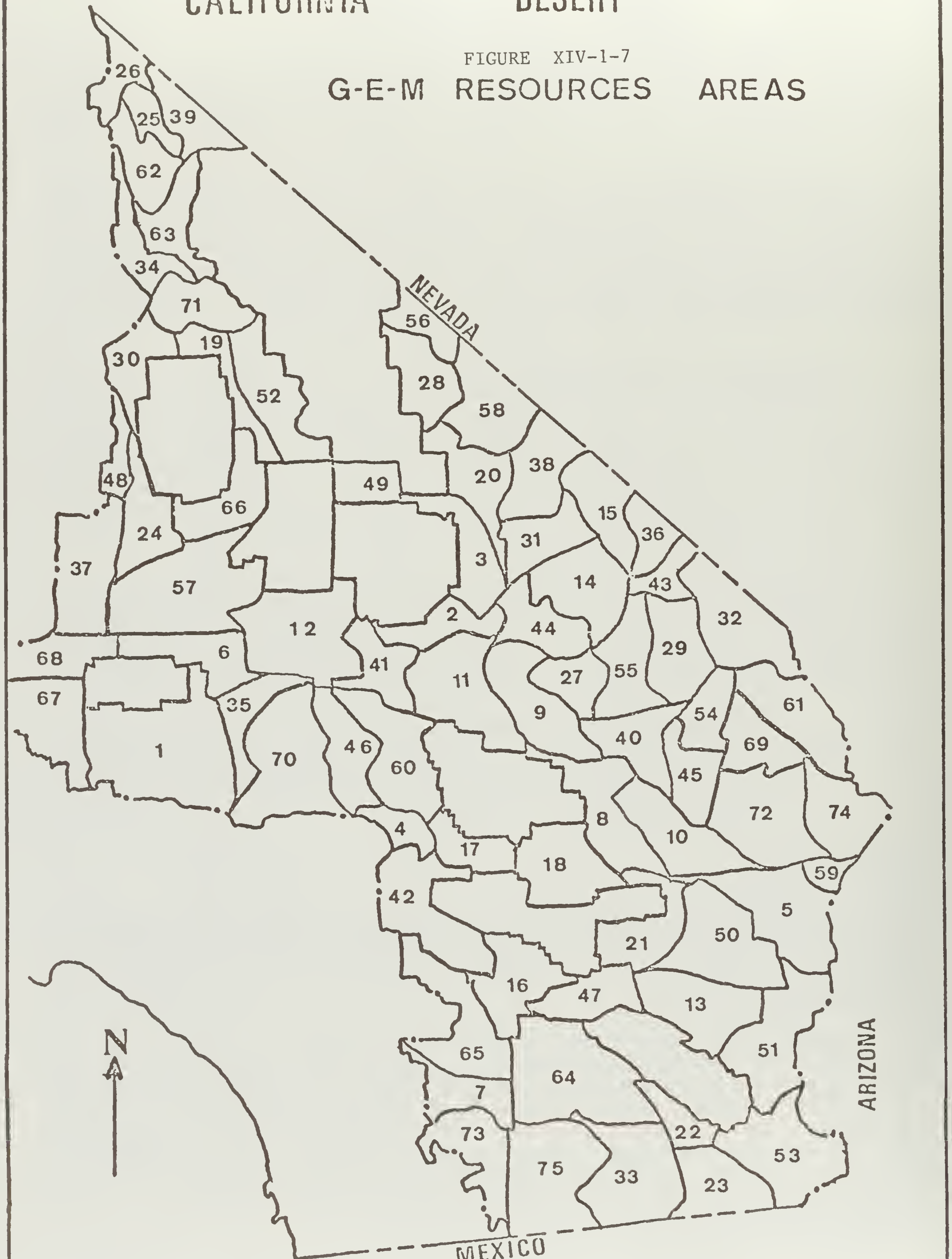


Table XIV-1-1

LIST OF G-E-M RESOURCE AREAS

NO.	AREA	NO.	AREA	NO.	AREA
1.	Adobe Mountain	*26.	Fish Lake Valley	51.	Palo Verde Mountains
2.	Alvord Mountain	27.	Granite Mountains	*52.	Panamint
3.	Avawatz Mountain	28.	Greenwater Range	*53.	Picacho
4.	Bighorn Mountains	*29.	Hackberry	54.	Piute Mountains
*5.	Big Maria Mountains	30.	Haiwee Reservoir	55.	Providence Mountains
6.	Boron	*31.	Halloran	*56.	Pyramid Peak
7.	Borrego Springs	*32.	Homer Mountain	57.	Red Mountain
8.	Bristol Lake	33.	Imperial Valley	*58.	Resting Spring Range
*9.	Bristol Mountains	*34.	Inyo Mountains	*59.	Riverside Mountains
10.	Cadiz/Danby Lake	35.	Iron Mountain	*60.	Rodman Mountains
*11.	Cady Mountains	36.	Ivanpah Valley	61.	Sacramento Mountains
*12.	Calico Mountains	37.	Jawbone Canyon	*62.	Saline Range
*13.	Chuckwalla Mountains	38.	Kingston Range	*63.	Saline Valley
14.	Cima Dome	*39.	Last Chance Range	64.	Salton Sea
*15.	Clark Mountain	40.	Marble Mountains	65.	Santa Rosa Mountains
16.	Coachella	41.	Mojave Valleyles	*66.	Searles
17.	Copper Mountain	42.	Morongo Valley	67.	Sierra Pelona
18.	Dale Lake	43.	New York Mountains	68.	Soledad/Rosamond
*19.	Darwin/Slate Range	*44.	Old Dad Mountain	69.	Stepladder Mountains
*20.	Dumont Dunes	45.	Old Woman Mountains	70.	Stoddard
21.	Eagle Mountain	46.	Ord Mountain	*71.	Talc City Hills
22.	East Mesa-North	7.	Orocopia Mountains	72.	Turtle Mountains
23.	East Mesa-South	48.	Owens Peak	73.	Vallecito Mountains
24.	El Paso Mountains	*49.	Owlshead Mountains	*74.	Whipple Mountains
*25.	Eureka Valley	*50.	Palen/McCoy Mountains	75.	Yuha Basin

*GRAs analyzed: (7,596,160 acres)

Example XIV-1-2

Date__________________

MAPS AND OVERLAYS______________________________GEM RESOURCE AREA

Items marked X are not in this file. Circled numbers indicate maps and overlays most useful in interpreting potential.

NUMBER TITLE ADDITIONAL MAPS/OVERLAYS

1. Topographic Base
2. Geologic Map
3. Land Nets
4. Field Verification
5. Known Occurrences
    a. Metallics (Terradata)
    b. Industrial Minerals
6. Geostatistics
    a. Gold
    b. Cu-Pb-Ag-Zn
    c. Iron
    d. Manganese
    e. Tungsten
    f. Combined Metals
7. Expert Panel Classification
    a. Metals
    b. Uranium
    c. Ind. Mnrls - National
    d. Ind. Mnrls - Reg., Loc.
    e. Salines
8. Lineament Study
    a. Lineaments
    b. Metals Potential - Total Scores
    c. Metals Potential - Components
9. Geochemistry
    a. Sample Locations
    b. One Sample - One St. Dev.
    c. Two Samples - Two St. Dev.
10. Geophysics
    a. Gamma-ray - Uranium
    b. Gamma-ray - Thorium
    c. Gamma-ray - K^{40}
    d. Magnetic Anomalies
    e. Bouguer Anomaly
    f. Tonal Anomaly

11. Economics
12. Lands Status - Minerals
    a. Segregations and Withdrawals
    b. Wilderness Study Areas
13. Claims and Leases
    a. Claims
    b. Leases
14. Mineral Potential
    a. Metals
    b. Industrial Mnrls (Loc)
    c. Uranium-Thorium
    d. Geothermal
    e. Oil and Gas
    f. Sodium/Potassium
    g. Salables
15. Leasables (USGS Classif.)
    a. Sodium/Potassium
    b. Oil and Gas
    c. Geothermal
16. Salables
17. Paleontology

Analysis and Interpretation.

With the data filed, analysis and interpretation started. Example XIV-1-3 shows the standard working outline for the GRA Report.

Example XIV-1-3

GEOLOGY-ENERGY-MINERAL RESOURCE AREA REPORT

I. Introduction

II. General Geology

A. Physiography
B. Rock Units
C. Structure and Tectonics
D. Paleontology
E. Description of mineral deposits and energy resources

III. Evaluation and Classification of potential

A. Locatable Minerals
1. Metallic
2. Uranium/Thorium
3. Nonmetallic
B. Leasable
1. Oil and Gas
2. Geothermal
3. Sodium and potassium
C. Salable minerals

IV. Recommendations for additional work
V. References cited

Since practically no GRAs were analyzed by the time the Draft Plan was sent to the public for review in February 1980, a CDCA-wide preliminary analysis and classification was completed for the Draft Plan alternatives.

For the Proposed Plan, time allowed analysis and interpretation of 29 GRAs. The selection of the 29 was based on WSA ranking. The GRAs analyzed are identified in Table XIV-1-1. For the rest of the CDCA, the preliminary analysis and interpreation was used and so indicated on the maps presented in the plan. Continuation of the analysis and interpretation of the other 46 GRAs is expected to start as soon as preparation of the Proposed Plan is finished in September 1980. It is estimated that with the work force that will be available for this work, all GRAs will be completed and classified by April 1, 1981.

As an example, the Clark Mountain GRA Report and copies of selected overlays are attached at the end of this part of Appendix XIV.

THE EVALUATION AND CLASSIFICATION FOR POTENTIAL

As the staff began analysis of GRAs, the classification system initially developed was tested. Although the system was initially designed for locatable minerals, it was adapted for use with leasable, salable, and energy resources. (See Table XIV-1-2.)

In evaluating and classifying each GRA, the analyzed and interpreted data were used as direct or indirect evidence. Although not always the same, the reported occurrences, geochemical anomalies, gamma-ray uranium and/or thorium anomalies, classification by USGS and/or CDMG, past and/or present production, and mineral economic data were used as direct evidence. Gamma-ray potassium anomalies, lineaments, Bouguer gravity anomalies, tonal anomalies, and others were most often considered as indirect evidence. However, combination, correlation, and coincidence may change the importance given to certain data. This was left to the professional judgment of the Geology Staff. Although there were often similarities, no two GRAs were alike. Similarly, information found to be useful in one GRA was less useful in another.

As evaluation proceeded, overlay maps were prepared for locatable metallic minerals, locatable non-metallic minerals, uranium, thorium, leasable minerals including geothermal, oil and gas, and sodium and/or potassium, and salable minerals. These overlays are all identified as the "14" series with a letter identifier for each overlay.

As each map was developed, a narrative rationale was prepared for each classified area. The rationale describes the evidence used and the significance.

As GRAs were completed, the classification maps were combined into a two-piece (north and south half) 1:250,000 scale CDCA map. A simplified map consolidated the 11 classes into 5 for locatable minerals. Using the simplified classification, a new map was developed for each of the resource groups: locatables, leasables, salables, and energy. The description of the simplified classification is provided in the legend of maps attached to the plan as well as in the Glossary in the Appendix.

A copy of the Clark Mountain GRA Report accompanied by copies of selected overlays follows.

EVALUATION OF CLARK MOUNTAIN G-E-M RESOURCE AREA

The Clark Mountain GRA is located in eastern San Bernardino County on the eastern edge of the CDCA. The northeastern border of the GRA is the Nevada State Line. The area includes from north to south: Mesquite Mountains and Mesquite Valley, Clark Mountain Range, Mohawk Hill, Mescal Range, and the

Table XIV-1-2
MINERAL POTENTIAL CLASSIFICATION

class	LOCATABLE	LEASABLE			SALABLE
		GEOTHERMAL	OIL & GAS	SODIUM/POTASSIUM	
1a	Present or intermittent producer or active development of any locatable mineral, and associated favorable geologic environment. Development means that an ore body has been defined, and work is continuing.	Present producer or development and associated geologic environment.	Same as Geothermal.	Same as Geothermal.	Present producer or development.
1b	Past producers and/or reserves of any category I minerals and associated favorable geologic environment.	KGRA - favorable for plant siting.	KGS - past producer and/or reserves.	Valuable for Na/K or K reserve, past producer and reserves.	(does not apply)
1c	Past producers and/or identified resources of any category I minerals and associated favorable geologic environment	KGRA - less favorable for plant siting.	KGS - past producer and/or resources.	Valuable for Na/K or K reserve, past producer & resources.	(does not apply)
2a	Past producers and/or reserves of any category II minerals and associated favorable geologic environment. Does not apply to uranium.	PGRA - favorable for plant siting.	Prospectively Valuable: in Overthrust Belt, or has shows from wells.	Prospectively Valuable for Na and/or K, salines known present.	Reserves.
2b	Past Producers and/or identified resources of any category II minerals and associated favorable geologic environment. Does not apply to uranium.	PGRA - less favorable for plant siting.	Prospectively Valuable: other potentially favorable areas.	Prospectively Valuable for Na and/or K, salines not known to be present.	Past Producers.
2c	Occurrences (nonproducers) or direct evidence for occurrence of any category I minerals and associated favorable geologic environment.	Direct evidence for geothermal energy, not in PGRA or KGRA.	Direct evidence for oil and/or gas, not classified by USGS.	Direct evidence for Na and/or K, not classified by USGS.	(does not apply)
3a	Occurrences (nonproducers) or direct evidence for occurrence of any category II minerals and associated favorable geologic environment.	(does not apply)	(does not apply)	(does not apply)	Favorable geologic environment, may be economic in forseeable future.
3b	Favorable geologic environment for occurrence of any locatable mineral.	Favorable geologic environment based on indirect evidence, not in PGRA or KGRA.	Favorable geologic environment based on indirect evidence, not classified by USGS.	Same as oil & gas.	Favorable geologic environment, not economic in near future.
4a	Data insufficient to classify.	Same as locatables.	Same as locatables.	Same as locatables.	Same as locatables.
4b	Lithologies exposed at surface are unfavorable for locatable mineral occurrence.	Insufficient data, probably unfavorable.	Same as geothermal.	Same as geothermal.	Same as geothermal.
4c	Data insufficient to classify, but potentially favorable lithologies may be present.	Same as locatables.	Same as locatables	Same as locatables.	Potentially favorable environment. Poor access. May be important in the future.

Ivanpah Mountains. Adjacent GRAs include: Kingston Range, Halloran, Cima Dome, and Ivanpah Valley.

Interstate 15 cuts through the GRA in an east-west direction at Mountain Pass. Access to the area from the freeway is by Valley Wells, Mountain Pass, Nipton Road, Yates Well, and State Line off-ramps. The major secondary roads include Cima Road south and Excelsior Mine Road north from the Valley Wells Road. These two roads mark the western, boundary of the GRA. Principal unpaved roads that lead into the upland areas are the Winters Pass Road, Mesquite Pass Road, Keany Pass Road, State Line Pass Road, the Cima-Ivanpah Valley Road, Piute Valley Road, and Kokoweef Road. Numerous mine roads provide access to most of the mines and prospected areas.

Mountain Pass is the only town within the GRA; services such as food, water, and gasoline may be available to travelers. Baker is 35 miles west of Mountain Pass and Las Vegas is about 50 miles to the northeast.

The principal sources of geologic information covering the GRA are Hewett (1956), Clary (1967), Dobbs (1960), Evans (1971), and Olson et al. (1954). The complete references to these and other works are appended to this report.

General Geology

The Clark Mountain GRA is composed of eight major distinct physiographic features: Mesquite Mountains, Clark Mountain, Northeastern Clark Mountain Range, Mohawk Hill, Mescal Range, Striped Mountain, Ivanpah Mountains, and Mesquite Valley. The various ranges taken as a composite, form a northwest trending upoland which is bounded by Mesquite, Shadow, and Ivanpah valleys. Clark Mountain (7,929 feet, 2,425 m) dominates the physiography of the area and is visible as the major topographic feature for many miles.

The drainage patterns of the area are principally two. At Clark Mountain the pattern is slightly modified radial, with individual drainages being very steep, sharply defined, and relatively straight. Such features characterize a juvenile drainage pattern. The remainder of the upland area of the GRA has essentially a linear to rectilinear pattern with local dendritic modifications. In general, the hills and drainages are less steep and the topography noticeably more rounded than at Clark Mountain. The pattern is somewhat more mature and reflects influence in many areas by the locally dominant structural grain of the ranges. North of the freeway the dominant trend is NNW with a subsidiary NE trend of faults, contacts, and drainages. South of the freeway the principal faults mapped (Hewett) are N to NNW trending features that cut through the central part of the upland at right angles to the dominantly E-W drainages of the Mescal Range and Ivanpah Mountains.

The drainage patterns suggest a recent period of warping and or fault block tilting such that: (1) the northeastern Clark Mountains were tilted down toward Mesquite Valley; (2) the Mesquite Mountains were tilted away from Mesquite Valley; and (3) the Mescal Range-Striped Mountain area and the Ivanpah Mountains were warped synformally on a N-S axis, such that the western and eastern edges of the upland developed linear drainages away from the warp axis.

Lithologically and structurally the Clark Mountain GRA is a very complex area, but this complexity is highly favorable for development of mineral deposits. The following is abstracted from Hewett's (1956) 1:125,000 scale map of the Ivanpah quadrangle. Details of stratigraphic features may be found in his report.

The oldest rocks known in the area are found in the granitic and granite gneiss complex exposed in the Clark and Ivanpah Mountains. The age of these units is not well known and has been placed, somewhat vaguely, in the Lower Precambrian by Hewett. In the main, these rocks form the stable base upon which younger rocks were deposited and over which many units have been thrust. In part, the granitics have also been caught up in thrust slices (by some of the deepest and most pervasive tectonic events of the area). Most, if not all, of the contacts with other units are faulted or intrusive except in the northwestern part of the Mesquite Range where a major unconformity separates the Nopah Formation and Prospect Mountain Quartzite from the Precambrian gneisses. Also, in the central Ivanpah Mountains small areas of Tapeats Sandstone and Goodsprings Dolomite unconformably overlie the Precambrian gneisses.

The Cambrian section includes Noonday Dolomite, Prospect Mountain Quartzite, Pioche Shale as the so-called western facies and the Tapeats Sandstone and Bright Angel Shale of the eastern facies. The top of the Cambrian is represented by the Goodsprings Dolomite which reportedly ranges from Cambrian to Devonian in age and may properly be divided into as many as five mapable litho-stratigraphic units.

The Goodsprings Dolomite is the most widespread and most abundant sedimentary rock unit mapped by Hewett in the GRA. It extends from the south-central Ivanpah Mountains north to the northeastern tip of the Mesquite Mountains near Winters Pass.

Younger Paleozoic units begin with the Sultan Limestone (Devonian) and continue upwards through the Monte Cristo Limestone (Mississippian), the Bird Spring Formation (Pennsylvanian dolomite with sandstone, shale, and limestone), the Supai Formation (Pennsylvanian to Permian sandstone with shale), and finally the Kaibab Limestone (Permian).

Triassic and Jurassic sedimentary rocks crop out in only two small parts of the GRA, five miles west of State Line Pass and on the east side of the Mescal Range. These units include the Moenkopi Formation (limestone, dolomite, and shale), the Shinarump conglomerate and Chinle Formation (sandstone and shale with chert and limestone) all of Triassic age. Above the Chinle lies the Aztec Sandstone of Jurassic age and a dacite flow-breccia, the Delfonte(?) Volcanics (or Mountain Pass rhyolite of Evans, 1971), also of Jurassic ages.

Cretaceous intrusive bodies of the Teutonia quartz nomzonite are exposed in the southern and central Ivanpah Mountains and the southeastern Mescal Range.

Small exposures of the Teutonia quartz monzonite also occur at Mohawk Hill and on the southern edge of Clark Mountain. It is suspected that some of the non-foliated granitic rocks mapped as Precambrian gneiss and granite may actually be Mesozoic in age. The rhyolitic breccia pipe at the Colosseum Mine is reported to be 100 million years old (Sharp, 1980). Much of Clark Mountain is probably underlain by Mesozoic granitic intrusives at relatively shallow depth.

Quaternary sediments fill all the surrounding valleys and various drainages in the upland area. Extensive lake bed (playa) deposits occur in Mesquite Valley and in the vicinity of the Old Copper World smelter. The debris shed from the granitic terrane in the southern Ivanpah Mountains tends to be very sandy. Elsewhere the alluvial fans are composed of angular broken rock (much of it sedimentary and metamorphic).

The structural history of this GRA is very complex and poorly understood, although progress has bee made in recent years. Of primary importance are the large- scale normal and overthrust faults. Hewett (1956), Clary (1967), Evans (1971), and Olson et al. (1954) mapped and/or discussed many structural features of the region; however, the field guide by Burchfiel and Davis(1971) is the definitive work on the configuration of the overthrusts.

Burchfiel and Davis describe a thrust complex composed of three major plates which have a minimum total displacement of 40 to 50 miles to the east and northeast. These plates are (from the lowest and eastern-most to the highest): Keystone, Mesquite Pass, and Winters Pass. Motion on these faults has been determined to have occurred during the following periods. Mesquite Pass basal thrust (greater than or equal to 190 to 200 m.y.), Winters Pass thrust (no younger than 92 m.y.) and Keystone thrust (85 to 94 m.y.).

The Keystone and Mesquite Pass plates are composed principally of Paleozoic marine sedimentary units. The Winters Pass plate is composed dominantly of Cambrian and Precambrian sedimentary and metamorphic rocks.

Evans (1971) also maps, without discussion, several thrusts in the Mescal Range and Striped Mountain area. Unfortunately, his nomenclature and mapped positions do not correspond with those of Burchfiel and Davis, making direct correlation difficult. In both mappings, the internal structural detail of the thrust plates has been simplified and/or eliminated. Each of the major thrust plates may, in fact, be composed of a series of several imbricate thrusts of lesser extent or magnitude. Burchfiel and Davis show some of these faults--those sufficiently important to warrant naming on their 1:62,500 scale sketch map.

Recent work (Sharp, 1980) indicates that in the vicinity of the Colosseum Mine, localized gravity sliding may have occurred on the Keystone decollement after the cessation of thrusting. The east-to-west sliding is interpreted to have occurred in response to local structural doming that resulted from the intrusion of the felsite breccia pipe complex at the Colosseum Mine.

The principal normal faults exposed in the area are the Ivanpah, the Clark Mountain, and the State Line. Although each of these faults is a major structural feature, little is said in the literature regarding their offsets. Clary (1967) indicates 10,000 feet of displacement on the Ivanpah fault, and Hewett (1956) shows a value of 18,000 feet on the Ivanpah at a location that the gravity data suggest little density contrast. If the fault displacements are true, the material east of the fault in northern Ivanpah Valley must not have much alluvium covering Precambrian terrane below. Hewett shows the Ivanpah fault to die out (down to 1500' offset) in the New York Mountains south of the Ivanpah Valley.

North of the Clark Mountains, the Ivanpah fault is not mapped; however, physiographic and structural studies of the Mesquite Mountains and Mesquite Valley strongly suggest several thousand feet of normal faulting along a northward projection of the Ivanpah fault. The development of this valley probably was a recent event (Late Cenozoic) and, as such, probably is not related to the tectonic regime which created the Ivanpah fault. However, the localization of the western boundary of Mesquite Valley may have resulted from the presence of this pre-existing zone of weakness.

Hewett (1956) suggests 1,200 feet of throw on the State Line fault, down on the west. Two other unnamed faults located between the State Line and Ivanpah faults are shown by Hewett to have 1,200 and 3,000 feet of throw. The former is a minor thrust with the thrust plane dipping west, and the second fault is a west-dipping normal fault (down on the west). Both of these faults occur in the northeastern arm of the Clark Mountain Range.

The Clark Mountain fault (probably the same structure as that called the Kokoweef fault by Burchfiel and Davis), a southeast trending normal fault, cuts across the Ivanpah Mountains from a point about 2 miles southwest of Mountain Pass to Ivanpah Valley. This feature forms the southwestern outcrop boundary of the early Precambrian terrane in the Ivanpah Mountains, and the vertical offset of several thousand feet is "up" on the northeast side. As shown on the CDMG Kingman map sheet, the fault is projected across Ivanpah Valley to and across the New York Mountains. The surface trace geometry is sinuous and rather extraordinary for a simple normal fault. It appears probable that if the fault does cut across Ivanpah Valley then the Clark Mountain fault has been deformed or cut by a buried northeast-trending structure, with a net left-lateral offset on the order of two to three miles.

Finally, gravity data for the region suggest the existence of a buried, N-S trending normal fault on the west side of the northeastern Ivanpah Valley. This inferred fault trends south from the junction of the Nevada stateline and the I-15 freeway. A vertical offset of a few thousand feet is suggested by the anomaly.

None of the major normal faults appears to have played a significant role in the localization of identified ore deposits.

Paleontologic Resources

Fossil invertebrates are reported (Murphy) to occur at three localities in the northeastern Clark Mountains and at one locality each in the southern Mesquite Range, the Mescal Range, and at Striped Mountain. The fossil types include corals, brachiopods, "bivalves" (assumed to be pelecypods), gastropods, and Bryozoa.

The potential for fossil vertebrate localities is considered (Woodburne) to be high at the Shadow Valley playa (Valley Wells), in the southeastern part of the Mescal Range and at two localities in the Ivanpah Mountains. Moderate potential for sites occurs at the Mesquite playa, and all of the older Quaternary alluvium is considered low potential.

The dinosaur trackway site at the southeastern Mescal Range is adjacent to the dimension stone quarry and this site has been proposed as an ACEC to protect the valuable paleontologic resources. The other areas of resource are relatively protected by their remote locations, the lack of publicity about the sites, and, in some cases, the ruggedness of the topography. Should public interest in collection (or vandalism) at these sites increase dramatically, some management action may be needed to protect the most significant of these resources.

Mineral Potential - Overview

This GRA may be the most mineralized area of its size in the CDCA. The potential for future discoveries and/or reactivation of old workings is extraordinarily high. The area has well over 60 mines or mining districts and the workings and prospects number in the hundreds. Production of metallic commodities (Au, Ag, Pb, Zn, Cu, W, Sn, Sb, REE), energy materials (U, Th), nonmetallic minerals (fluorite, gypsum, barite, magnesite, limestone, dolomite, silica), gemstones (azurite, malachite), and salable materials (dimension stone, slate, sand, and gravel) has been recorded. The potential for renewed extraction of these and other commodities such as saline minerals (sodium, potassium, lithium, and strontium) and oil and gas is considered highly favorable. The rare-earth elements have been included with the metals in the following analysis.

Estimates of the value of production plus potential production have been made for the following materials in the GRA: rare-earth elements, thorium, limestone-dolomite, gypsum, gold, copper, silver, tin, tungsten, lead, sand, and gravel. The total estimated value for these commodities at the known deposits exceeds $19.99 billion (in 1978 dollars). The potential for discovery of additional values in new deposits is excellent.

Also, several mines are currently in operation. The Mountain Pass rare-earth deposit is the principal major operation in the GRA. The production from this mine supplies about 97 percent of the domestic demand for rare-earth elements; it is the world's largest producer of these metals. Both the Morning Star and New Trail mines have been reactivated in recent months. The Copper World currently is being worked intermittently as a supply of semiprecious gem quality azurite and malachite. Recent exploration of the Colosseum and Shire properties show extensive reserves. There is renewed interest and exploration in the Old Ivanpah district and at the Carbonate King, Benson, and Umberci mines.

Mineral Potential

Locatable Metallic - Class 1a. Area 1 (Map 14a) has the world's largest production of rare-earth elements (REE) and supplies about 97 percent of the U.S. domestic consumption. Reserves are large and should last for many decades at current rate of production. The area includes the principal auxilliary known deposits of REE in the region (not currently in production). The potential is high for continued production of thorium and barite from the Mountain Pass mine and throughout the mineralized area. Additional supporting evidence of mineralization is available in the form of: (1) at least 355 unpatented mining claims (as shown by BLM 12/12/79) in and adjacent to the area classified 1a; (2) 18 patented mining claims; (3) strong geochemical anomalies in REE, Ba, Ag, Cu, Mo, W, Th, and other elements; (4) extensive coverage of the area by Landsat tonal anomalies; and (5) the presence of uranium and thorium anomalies in the gamma-ray data.

An extension to the southeast of area 1 is labeled area "A1" on map 14a and is classified 2c. Apparently, drilling by Moly Corporation has resulted in discovery of substantial reserves of rare-earth and thorium mineralization in this area. Although not shown on the BLM file as of December 12, 1979, much of the area labeled "A1" is under claim by Molycorp.

Area 2 (Map 14a), the Colosseum mine area, has recently been explored for additional reserves of gold mineralization. Approximately 20 million tons of ore averaging 0.07 ounces per ton have been delineated to date. The total gold content is about 1.4 million ounces which is worth $700 million (at $500/ounce gold). Essentially the entire area shown is under claim. At least two claims are patented. Various geochemical anomalies (Ag, W, REE, etc.) occur on drainages in this area. The structural setting and existence of several remotely-sensed lineaments in the area and immediate vicinity also add emphasis to the classification of this area as 1a. Additionally, Terradata classified the area as about 75 percent probability for gold, and the expert panel classified the area favorable for metals.

Areas 3 and 4 (Map 14a) have been classified 1a because within the past few months, two old mines have gone back into production. In area 3, the Morning Star Mine produced 500,000 tons of ore which averaged about .2 to .3 ounces of gold per ton (at $500 per ounce, equal to more than $50 million). Reserves of 28,000 ounces contained gold are reported. Vanderbilt Gold Corporation reports 400,000 tons of ore to be processed at a rate of 60,000 tons per year for the next 7 years. In area 4, the New Trail mine intermittently produced gold, silver, copper, lead, zinc, and magnesite

MAP 14 a

CLARK MOUNTAIN:

MINERAL POTENTIAL FOR LOCATABLE METALLICS AND RARE EARTH ELEMENTS

during the period 1916-1950. The current or design rates of production at New Trail operation are not known.

Additional supporting evidence for mineralization includes: (1) major northwest-trending lineaments adjacent to the New Trail mine; (2) nearby anomalous geochemical values in silver, copper, tin and rare-earth elements; (3) coincidence of Landsat tonal anomalies, airborne gamma-ray anomalies (uranium, thorium and potassium) at area 3 and a tonal anomaly only for area 4; (4) the "expert panel" rated the areas as favorable and very favorable for deposits of metallic minerals.

<u>Locatable Metallic - Class 1c</u>. Areas 5, 6, 7, 8, 9, 10, 11, 12, and 13 (Map 14a) are all classified 1c on the basis of past production of group 1 metals, favorable environment, and other factors.

Area 5 has produced major amounts of copper, lead, zinc, as well as some gold and silver. The Copper World, with production exceeding 2.4 million pounds, is one of the largest copper mines in the desert. Additionally, 3.15 million pounds of lead, 1.1 million pounds of zinc, 153,676 ounces of silver and 323 ounces of of gold are reported to have been produced from Copper World, Mohawk, and Keiper mines. These are minimum values for the area. At least 10 separate mines are known in area 5. At least five mining claims at Mohawk Hill are patented.

The area is underlain by lithologies highly favorable for deposition of ore bodies. The Paleozoic carbonate rocks have been faulted, folded, thrust over the older terrane, and intruded by monzonite of Cretaceous age. These contact zones have been highly mineralized with base and precious metal deposits. The contact zone at depth beneath Clark Mountain is believed thoroughly mineralized, and the potential for existence of a porphyry copper deposit is considered very high.

Ancilliary supportive data include major east-west lineaments through the Mohawk Hill area. Terradata maps show 75 percent probability of occurrence of copper-lead-zinc-silver mineralization, and the expert panel determined the central part of area 5 to be very favorable and most of the rest of the area favorable for metallic mineralization.

In area 6, the Carbonate King mine produced 5.5 million pounds of zinc, 170 pounds of lead, and 58,000 ounces of silver from 1941-51. Additional production of 370,000 pounds of lead has been reported at the Piute mine also in area 6. The Carbonate King is patented land.

The geologic environment is similar to that of area 4 (adjacent) and the potential is excellent for discovery of additional reserves. Supporting evidence includes: area 6 lies in the same tonal anomaly as area 4 lies along the same lineaments, and has a partially coincident magnetic anomaly. Terradata gives it 75 percent probability of occurrence for copper-lead-silver-zinc mineralization, and the panel classified the area as favorable and in part very favorable for metallic deposits.

Area 7 includes the Old Ivanpah district which produced 3-5 million ounces of silver. The area has been explored recently and is under claim (part of a block of at least 591 claims in BLM records as of 12/12/79). Four patented mining claims are adjacent to the unpatented claims. Past mining activity has resulted in many mines and prospects, besides the more than 100 being developed in the district.

The area is cut by northwest and east-west trending lineaments. Anomalous geochem values of silver, tungsten, and rare-earth elements occur in the area. Terradata score for combined metals is 75 percent and the expert panel classified the area favorable for metals.

Area 8 is technically outside the GRA; however, it is geologically associated with the Ivanpah Mountains mineralization. Production from the Teutonia mine was approximately 12,000 ounces of silver and several thousand pounds of lead.

The geology is similar to that of several mines in the Ivanpah Mountains, and the area is in a thorium gamma-ray anomaly.

Area 9 has the only known tin mine in the CDCA. Production records are vague; however, the property was mined during the years 1939 to 1944 and produced tin, tungsten, and copper. The area is currently under claim. The deposit occurs in a contact zone between Goodsprings Dolomite and Teutonia Quartz Monzonite.

Coincident tonal, uranium, thorium, and potassium anomalies occur immediately adjacent to area 9. The expert panel classified the area as favorable for metallic minerals.

Area 10 has produced unknown, probably small quantities of tungsten, copper, silver, gold, zinc, and lead. The geologic environment, the contact zone of Sultan Limestone and Goodsprings Dolomite with the Teutonia Quartz Monzonite, is exceptionally favorable for deposits of tungsten and other base metals.

The quartz monzonite adjacent to the mineralized area shows up as a tonal anomaly, and most of the area is rated by Terradata as having 75 percent probability of occurrence of copper-lead-silver-zinc.

Area 11 - Unknown quantities of gold, copper, lead, and silver ores were removed from a minimum of 11 mines in this area. Mineralization occurs in quartz veins in Paleozoic limestones and dolomites, as well as in the Teutonia Quartz Monzonite. A nearby geochem sample is anomalous in silver, rare-earth elements, and others. The area is covered by a large tonal anomaly and partially included in uranium, thorium, and potassium gamma-ray anomalies.

Area 12 - The Mollusc, Blue Buzzard, and Iron Horse mines produced thousands of pounds of lead. Recorded mine production includes, gold, silver, copper, and zinc. Most of the area is currently under claim, and the Mollusc mine is patented.

The area has anomalous geochemical values in silver, lead, and zinc, is magnetically high, is adjacent to tonal anomalies, and is rated 75 percent by Terradata. The expert panel said it is a favorable area.

Area 13 - Past production of lead, zinc, silver, and copper is reported from the Umberci and Kalley mines in the northeastern Clark Mountains. The area is currently under claim, the lithology similar to that at other base metal deposits, and part of the area is magnetically high.

Locatable Metallic - Classes 2 and 3. Area 14 (Map 14a), classified 2b, produced unknown amounts of stibnite with barite in veins cutting a schistose granite. The area is in the major zone of tonal anomalies adjacent to the major northwest-trending lineaments of the GRA. The workings were not examined underground, but a small pile of ore material at the mine indicates the probable presence of antimony mineralization that was not removed during mining. Terradata classified the area 75 percent for gold and for copper-lead-silver-zinc mineralization. The expert panel map indicates a favorable area for metals.

Area 15 (Map 14a) is classified 3a for the presence of the Green's and Benson mines and several other prospects. Tungsten and copper (?) mineralization is reported at these mines. The area is largely under claim and most of it falls in the tonal anomalies of the northern Clark Mountains. Located at the intersection of northwest and east-west-trending lineaments and having anomalous tungsten, rare-earth, and silver geochemical values suggests a very favorable environment for mineralization. Terradata computed a 75 percent score for copper-lead-silver-zinc, and the expert panel rated the area favorable for metals.

Area 16 is classified 3a. The Ivanpah Mammoth mine explored copper-silver-gold mineralization on the southern end of the area. Possibly 60 unpatented claims have been recorded on BLM files as of December 12, 1979. Tonal and uranium gamma-ray anomalies cover much of the area. Anomalous geochemical values in copper, molybdenum, silver, lead, and rare-earth elements occur thoughout the area. The west-central part of the area is magnetically high, and northwest-trending lineaments cut the western part. Terradata rated the area high for gold and copper-lead-silver-zinc mineralization; the expert panel rated the area favorable and very favorable for metals.

Area 17 is classified 3a. Past production of copper, gold, silver, lead, and zinc is recorded from the Allured mine. Part of the area may be under claim, both patented and unpatented. Other small parts of the area have tonal and potassium gamma-ray anomalies. Silver, copper, and tin(?) are anomalous in the geochemical sample taken downstream. The area lies between two major northwest-trending lineaments. Terradata gave the area 75 percent score for copper-lead-silver-zinc, and the expert panel rated the area favorable and very favorable for metals.

Area 18 and 19 are classified 3b because the lithologies are considered favorable. There are numerous mining claims in the area. Additional data exists in the form of scattered tonal anomalies, uranium-thorium gamma-ray anomalies, potassium gamma-ray anomalies, and magnetic anomalies. Portions of these areas rate high (75%) for gold and copper-lead-silver-zinc mineralization (Terradata), and the expert panel classified the entire area as favorable or intermediate for metals.

<u>Locatable Nonmetallic</u> (Map 14b)

Huge areas in this GRA have good to excellent potential for deposits of several nonmetallic commodities. Specifically, limestone, dolomite, and mixed limestone-dolomite deposits in the area represent large resources.

Desposits of other nonmetallic minerals of importance or potential importance include barite, fluorite, gypsum, semiprecious gem stones, magnesite, and silica.

Limestone and/or dolomite deposits occur in all areas labeled 1, 4, 6, 8, 10 and 11. Known resources in areas 4 and 10 (both classed 1c) are huge (on the order of 1 billion dollars each at 1978 prices). Area 4 (Striped Mountain) has reserves of 100,000,000 short tons and resources of an additional 300 million short tons. Area 10 (Kikoweef) is possibly of comparable size. All areas labeled "8" have limestone or dolomite mineral localities cited in the literature and are classed "2c" for this evaluation. The geologic terrane is highly favorable for occurrence of extensive and potentially important deposits of limestone in each of the three areas (Mescal-Mohawk-Clark, northeasten Clark Mountains, Mesquite Range).

Area 1 is classified 1c on the basis of past production of fluorite. The potential of this area for carbonate rock deposits alone would be classified 2c, similar to the adjacent area 8.

Also, seven separate areas are labeled "11" on the Locatable Nonmetallic Minerals map. The Goodsprings Dolomite crops out in each of these areas, and this represents potentially valuable resources of limestone and/or dolomite. However, no deposits of economic significance have been specifically identified in these areas. Therefore, these seven areas are classified 3b.

Gypsum is known to occur in area 2 (classified 2b), and the value (in 1978 dollars) is estimated at $618 million, in place. The area is under claim (unpatented).

Fluorite was mined at the Douglass #1 and 2 and Juniper (Korfist) sites in area 1, which is classified 1c on the basis of past production, resources visibly present, and favorable geologic terrane. Production apparently was curtailed after a court decided the mine was being operated in trespass on State lands. The fluorite deposit in the southern Ivanpah Mountains (area 5) is classified 3a as a known occurrence, but the geologic environment and surface evidence suggests the area is not particularly well suited for large, extensive deposits.

Barite is being mined at the Mountain Pass operation; however, it is not yet known if the mill circuit is set up to recover barite so mined. The area has

MAP 14 b

CLARK MOUNTAIN:

CLASSIFICATION OF POTENTIAL FOR LOCATABLE NONMETALLIC MINERALS

been classified 1a on the assumption that the barite is being produced; however, it is certain that if no other values were present (e.g., REE), the barite content would be insufficient to support the costs of mining and milling to recover it. Production can only occur as a by-product at this time and with current production economics.

Several hundred tons magnesite has been mined in area 7 at the New Trail mine. However, the quantity remaining is not known. The area is classified 2b on past production only.

In recent years, portions of the Copper World mine have been worked intermittently to recover semi-precious gemstones: azurite and malachite. The quantity produced is unknown; however, the quality appears high. The area is classified 2a.

Finally, substantial areas (all labeled "9" on the map) of this GRA have potential and/or identified deposits of quartzite sufficiently pure to be used in various silica applications. Three identified deposits occur in widely separated outcroppings of Prospect Mountain Quartzite; therefore, all areas of Prospect Mountain Quartzite (as mapped by Hewett) are shown as having potential for sources of silica materials. Another identified occurrence is located in the earlier Precambrian granite gneiss complex of the southeastern part of the GRA. The deposit is listed as having silica, mica, and feldspar; therefore, it is assumed to be a granite pegmatite. The size and quality have not been estimated. Each of the areas labeled "9" has been classified 3a.

<u>Uranium-Thorium</u> (Map 14c)

Several types of data available for the Clark Mountain GRA suggest the potential for deposits containing uranium and/or thorium. These data are: current recovery from an operating mine, gamma-ray anomalies (uranium and thorium), geochemical anomalies (thorium), reported occurrences, expert panel evaluation, claims, and favorable geologic environment.

Area 1 (Map 14c) is classified 1a because <u>all</u> of the above types of data are available and define the potential (and actual recovery) for thorium.

Areas 2 through 6 are all in the same geologic terrane as area 1 and therefore favorable. Area 2 also has gamma-ray (uranium) and geochemical (thorium) analyses, known occurrences, and claims. Area 3 is defined principally on the basis of known mineralization discovered by core drilling in the area. The evaluated in-place worth of the thorium resource of areas 1, 2, and 3 combined exceeds 6.3 billion dollars (1978 prices). The potential for presence of uranium mineralization in these areas is not as well documented; however, the presence of gamma-ray uranium anomalies and reported occurrence at the Mountain Pass mine suggest substantial potential.

Areas 4, 5, and 6 are considered favorable terrane for uranium and/or thorium mineralization because the country rock is similar to that in areas 1, 2, and 3. Also, at least one uranium occurrence is reported in area 6.

MAP 14 c

CLARK MOUNTAIN:

CLASSIFICATION OF POTENTIAL FOR URANIUM AND THORIUM

Areas 7, 8, and 9 are classified 3b on the basis of uranium and/or thorium gamma-ray anomalies. Areas 7 and 8 are underlain by the Teutonia Quartz Monzonite and alluvial debris derived therefrom. The anomalies could reasonably be expected to relate to mineralization (uranium and/or thorium) in the area. However, in area 9 the anomaly is in a Quaternary playa that is virtually surrounded by sedimentary rocks of Paleozoic to Precambrian ages.

In area 10, occurrences of uranium are reported at the Mohawk mine and adjacent workings. The significance of the occurrences is not known; however, potential for a large deposit of uranium mineralization is not considered high. This area is patented land.

The rest of the GRA is classified 4a because of the lack of relevant data.

Oil and Gas (Map 14e)[1]

The potential for discovery of oil and gas resources in the Clark Mountain GRA is considered to be moderately high, based on geologic inference. However, the Overthrust Belt, wherein intense exploration activity has taken place during the past two years in other states, is known to persist into this GRA. The units of most interest are the Paleozoic sedimentary rocks similar to those exposed in the various thrust sheets found in the Clark Mountain area.

Areas 1, 2, and 3 (Map 14e) are classified 3b due to the presence of the Paleozoic units of the Overthrust Belt. Additionally, areas 1 and 3 have been classified by the U S G S as basins prospectively valuable for oil and gas discoveries. The potential for discovery of such resources in areas 1, 2, and/or 3 is considered to be moderately high. Active exploration is currently underway in area 1 and portions of area 2, as well as in adjacent valleys (Pahrump and Ivanpah).

Areas 4 and 5 are considered unfavorable for discovery of oil and gas because of surficial geology (Precambrian granitic and metamorphic rocks and Mesozoic granitic intrusives) is incompatible with generation and/or retention of such deposits.

Information concerning area 6 is insufficient, at this time, to classify as to potential for hydrocarbon resources.

Sodium and POtassium (Map 14f)

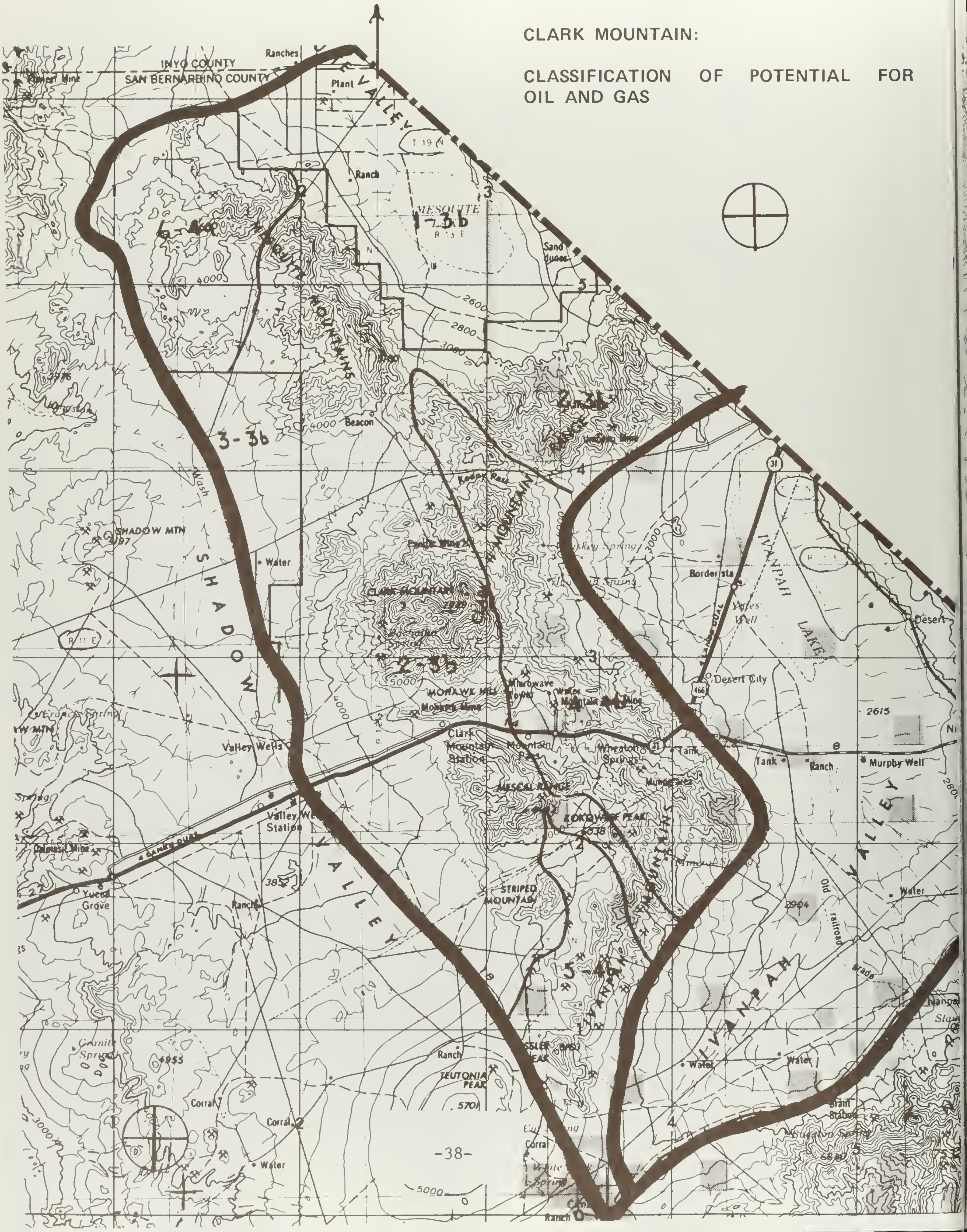
The potential for discovery of economic deposits of sodium and/or potassium minerals cannot be critically evaluated on the basis of available data. However, the playa at Valley Wells (area 1) has been determined by the U S G S to be prospectively valuable for sodium, and the playa in Mesquite Valley (area 2) is considered to be geologically favorable for such deposits (Map 14f). The favorability of Mesquite Valley playa is somewhat decreased by the absence (at least on the California side) of good source rocks for sodium and/or potassium. Both area 1 and area 2 are herein classified 3b as having speculative potential for these saline materials.

[1] Note: These are selective maps; no map 14d is included herein.

MAP 14 e

CLARK MOUNTAIN:

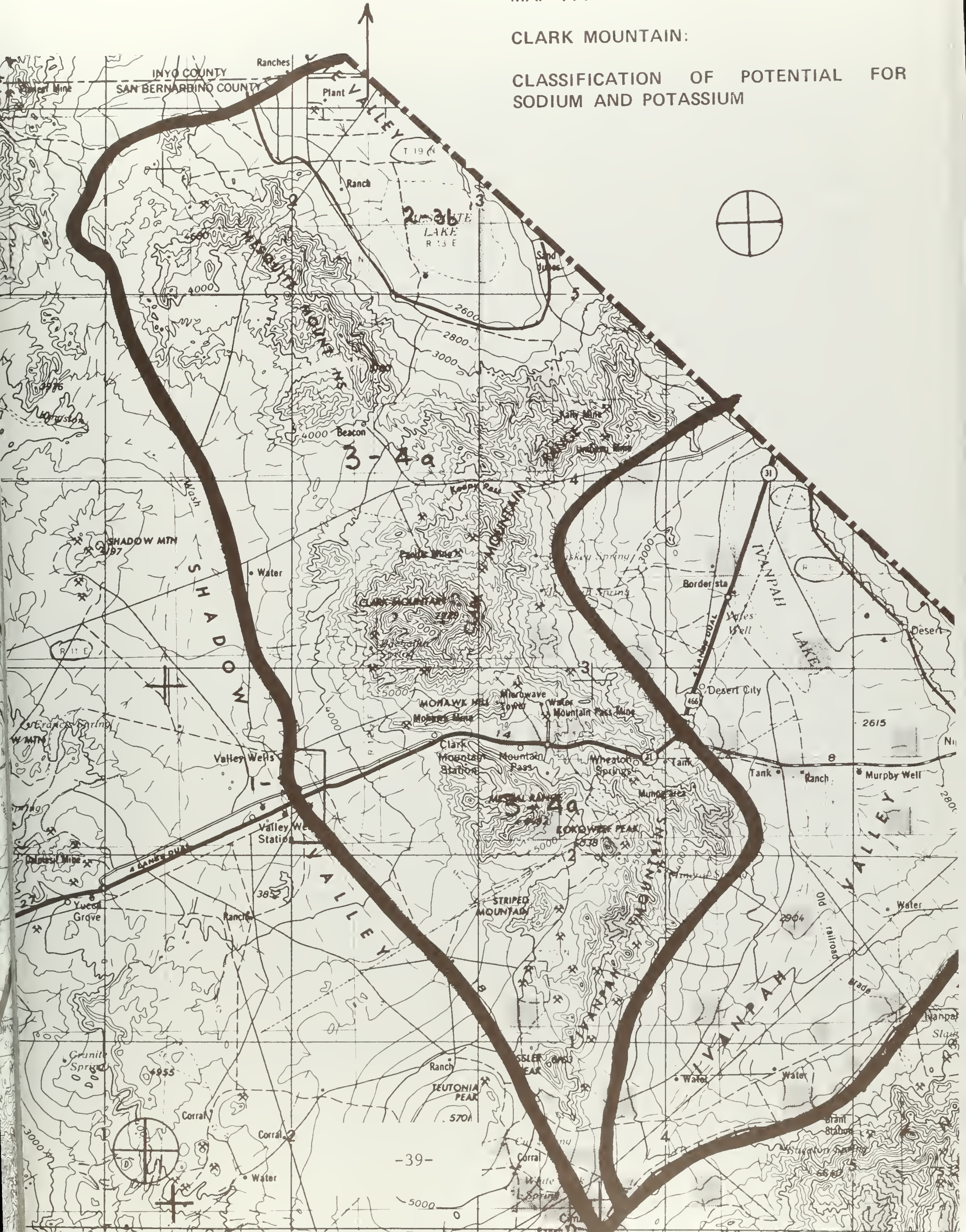
CLASSIFICATION OF POTENTIAL FOR OIL AND GAS



MAP 14 f

CLARK MOUNTAIN:

CLASSIFICATION OF POTENTIAL FOR SODIUM AND POTASSIUM



The remainder of the GRA (area 3) is not well enough known to specify areas of greater or lesser potential for sodium and potassium minerals; therefore, the area has been classified 4a. However, throughout most of this area the surficial geology does not appear favorable.

Salable Commodities (Map 14g)

Deposits of sand and gravel, dimension stone, slate, and roofing granules have been exploited at various locations in the GRA (Map 14g). Three areas (seven deposits) in which deposits of sand and gravel have been developed are located adjacent to Interstate 15. Each of these areas (1, 2, and 3) is classified 2b. Several other areas have potential for the presence of good quality deposits of sand and gravel and are classified 3a and 3b. The two areas labeled 3a were identified from the landform analysis contract as having potential for sand and gravel deposits.

The dimension stone quarry is located in area 4 on the southeastern side of Mescal Range. The slate quarry is in area 5 on the west side of Striped Mountain, and the roofing granules sites is located in area 6 in the west central part of the Ivanpah Mountains. Each of these areas has been classified 2b with potential for future production.

The remainder of the GRA is classified 4c because virtually any geologic material may potentially be exploited for saleable commodities; however, the distance may make economic development unfavorable.

Recommendations for Additional Study

1. A copper porphyry deposit has been postulated to occur at depth beneath Clark Mountain. The potential for such could be evaluated in part by a detailed geochemical survey, mapping of alteration zones, and geophysical surveys (detailed potassium, gamma-ray, electromagnetic, and induced polarization surveys) of the area. This work should be undertaken to evaluate mineral potential before final consideration is given to the proposals for ACEC and Wilderness in the area.

2. Data concerning mineral potential are particularly sparse in the Mesquite Mountains area. However, the same mineralized geologic terranes that are exposed in the rest of the GRA extend into the Mesquite Mountains (or may reasonably be expected to persist in the subsurface). In an effort to determine more precisely the mineral potential of the northern quarter of the GRA three surveys should be undertaken: (1) semi-detailed geochemical survey for metallic and nonmetallic elements; (2) geologic traverses to find and map alteration zones, mineralized areas, and evidence of presence of nonmetallic mineral deposits; (3) geophysical surveys (particularly airborne electromagnetic) to evaluate the presence or absence of conductive zones (altered and/or mineralized) in the subsurface.

3. The U S G S should be coaxed into surface sampling and deep drilling of the Mesquite Valley playa. The purpose would be to evaluate the potential for presence of economic deposits of calcium, sodium, and/or potassium salts,

MAP 14 g

CLARK MOUNTAIN:

CLASSIFICATION OF POTENTIAL FOR SALABLE COMMODITIES

lithium clays or brines, and/or uranium mineralization. The geo-hydrologic regime of the valley does not appear to be particularly favorable for development of such deposits, but, the possibility should be evaluated. The presence of a uranium gamma-ray anomaly in the lowest part of the valley suggests potential for the unexpected.

4. The large areas of uranium and thorium gamma-ray anomalies occur in the southern Ivanpah Mountains and the Cima Dome area (shown as areas 7 and 8 on map 14c). These anomalies should be evaluated by several ground traverses with gamma-ray spectrometer and magnetometer instrumentation. Geologic notes should be taken along each traverse with particular attention being paid to areas of high gamma-ray readings and areas of pegmatities.

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Part 2

Preliminary Analysis of Economic Geology, Minerals Commodities, and Related Socioeconomics of the California Desert Conservation Area

ECONOMIC GEOLOGY AND MINERAL COMMODITIES

INTRODUCTION

An investigation of the economic geology, mineral commodities and mineral economics of the California Desert Conservation Area (CDCA) was carried out between December, 1979, and July, 1980. Its purpose was to establish a preliminary appraisal of the CDCA for its mineral resources and to obtain a preliminary feeling for the mineral activities on the desert in terms of past, present, and future conditions.

It is expected when the California Desert Plan is implemented in 1980, that this preliminary analysis will be expanded and completed during the first five years. Then a more comprehensive overview of the mineral resources and economic potential of the California Desert Conservation Area will be obtained.

Of the 46 known mineral commodities in the CDCA, 25 were chosen for analysis and documentation. These commodities were chosen on the basis of four criteria of significance: (1) the commodity is on the official strategic minerals list and is critical to national security; (2) the United States imports 50% or more of this commondity for domestic consumption; (3) the United States is a major exporter of this commodity which therefore contributes to the balance of payments in our nonfuel foreign trade; (4) the commodity is of economic importance in the local (California) or regional (U.S.) markets.

For each commodity a separate report has been prepared from U.S. Bureau of Mines and Department of Energy publications giving the commodity's uses, domestic consumption, projected supply and demand trends, production (U.S., California, and CDCA), substitutes, and 1978 prices. The location, production, reserve and resources figures for each commodity in the CDCA were compiled. A list of sources is included with each commodity report. Due to incomplete records and the limited amount of time available to complete this analysis, the report is considered a minimum approximation of the in-place values of these commodities. The analysis of the remaining 19 commodities that time did not allow us to consider would add additional valuation for mineral resources in the CDCA.

To compare in-place mineral values of different areas mixed at different periods in the history of the CDCA, the cumulative past production quantities of each commodity were valued in dollars based on the average 1978 price for each commodity. The 1978 average dollar value were taken from the Engineering and Mining Journal, February, 1979. The geothermal values are given as a potential for utilization, either for electric generating or non-electrical uses.

The oil and gas potentials are based on a geologic appraisal of the area, and the sand and gravel values are based on their 1978 Federal royalty value of $0.25 per cubic yard from areas of known past and present extraction.

The CDCA has produced, or is capable of producing from known deposits, an approximate 1978 value of $648 billion. Approximately $105 billion is in past production, $326 billion is available as reserves, and $217 billion is available as reserves, and $217 billion is potentially available as resources.

A series of mylar overlays at a scale of 1:250,000 has been prepared with each mineral deposit or mining district encircled. The quantity of each commodity, as a total of past production, known reserves, and resources is recorded next to the ellipse. The ellipse boundaries are conservatively drawn, reflecting the area distribution of known, measured, or reasonably inferred limits of deposit or district boundaries. No attempt has been made to predict or forecast undiscovered deposits, because of time limitations. Such a need is obvious for economic and land management purposes.

With each commodity report is a table listing the deposits, geographic locations in the CDCA, its GEM Reserve Area (GRA), and its 1978 dollar values. Except for zeolites and geothermal, a graph has been prepared for each commodity showing the market behavior of that commodity from 1966 to 1979. The 1979 figures are official estimates from the U.S. Bureau of Mines. Each graph shows the U.S. domestic consumption, domestic production, and world production (less U.S. production) for that commodity. All graphs were compiled from official statistics published by the U.S. Bureau of Mines and the U.S. Department of Energy.

All reserve measurements given in this report are demonstrated reserves. The resources are combined measured and indicated resources for that commodity. Part 4 of this appendix contains a listing of the definitions of units and reserves as used in this report.

COMMODITY GROUPS

Group I -- Strategic Minerals

These commodities form the basis for the U.S. to defend itself in times of war or national emergency. Most are imported because of a shortage of domestic supplies and because sources of foreign supply are vulnerable to disruption by adversaries. Table XIV-2-1 displays Group I commodities in the

CDCA and American dependence upon them from foreign sources as of March 31, 1979.

Table XIV-2-1 demonstrates that at present only three commodities require stockpiling for defense purposes. The CDCA has produced all three in the past and has an excellent potential for future production of lead and zinc from sulphide, oxide, and carbonate ores and of copper from porphyry-type copper deposits.

The CDCA was a major producer of silver, tungsten, and talc. The CDCA is currently producing talc, is about to produce more silver, and has large reserves of tungsten which are currently being reexamined by industry for imminent mining. Kerr McGee is producing tungsten from brine at Searles Lake on a pilot plant basis. The project has been successful to date.

One of three new molybdenum deposits will produce soon; one area is favorable for tin (skarn deposits), and thorium is present in rare earth deposits and in granites.

Of the known areas of mineralization in the CDCA for strategic minerals, the areas of present or probable future production are listed in Table XIV-2-2.

Table XIV-2-1
GROUP I COMMODITIES - STRATEGIC MINERALS

COMMODITY	Unit	Stock Goal	Inventory	Stock Short %	Import Reliance 1978 %	Import Reliance 1979 %	Foreign Source
Copper	Short ton	1,299,000	24,717	98.1	20	13	Canada, Africa, South America
Lead	Short ton	865,000	601,056	30.5	9	8	Canada, Australia, South America
Molybdenum	Pounds of Mo	0	0	0	Net Exp.		Canada, Chile
Silver	Troy Ounce	0	0	0	48	45	Canada, Mexico, Peru, England
Talc (Steatite)	Short ton	104	1,092	0	Net Exp.		Italy, Canada, France
Thorium Nitrate	Pounds	1,800,000	7,156,996	0	NA		France, Canada, Netherl.
Tin	Long ton	32,499	200,480	0	79	81	SE Asia, Bolivia
Tungsten	Pounds of W	8,823,000	96,405,162	0	56	59	Canada, Bolivia, Korea
Zinc	Short ton	1,313,000	374,091	71.5	66	62	Canada; Central, South America; Europe

Table XIV-2-2

PAST, PRESENT, FUTURE STRATEGIC MINERAL PRODUCERS IN THE CDCA

LOCATION	Copper	Lead	Molybdenum	Silver	Talc	Thorium Nitrate	Tin	Tungsten	Zinc
Ivanpah	PP[1]	PP		PP		FP	PP	PP	PP
Clark	FP[2]	FP		FP		FP		FP	CP
Mts.	CP[3]								
New York		PP	FP						PP
Mts.									
Nopah	PP	PP		PP					PP
Mts.	FP	FP		FP					FP
Darwin	PP			PP				PP	PP
Hills	FP			FP				FP	FP
Inyo	PP	PP		PP	PP				PP
Mts.	FP	FP		FP	CP				FP
Panamint				PP					PP
Mts.				FP					FP
Argus				PP					
Range	FP			FP					
Atolia-				PP				PP	
Red Mts.				FP				FP	
Calico				PP					
Mts.				FP					

[1]PP--Past Producer
[2]FP--Future Producer
[3]CP--Current Producer

Table XIV-2-2 (Continued)
PAST, PRESENT, FUTURE STRATEGIC MINERAL PRODUCERS IN THE CDCA

LOCATION	Copper	Lead	Molybdenum	Silver	Talc	Thorium Nitrate	Tin	Tungsten	Zinc
Waterman Hills				PP FP					
Providence Mts.		PP FP		PP FP					
Silurian Hills				PP CP	PP FP				
Hollow Hills					PP				
Alexander Hills					PP				
Saddle Peak Hills					PP				
Avawatz Mts.					PP				
Kingston Range					PP				
Ord Mts.			FP						
Last Chance Mts.			FP						
Owens Peak								PP	
Old Woman Mts.								PP	
Shadow Mts.								PP	
Slate Range								PP	
Searles								CP	

Table XIV-2-2 (Continued)
PAST, PRESENT, FUTURE STRATEGIC MINERAL PRODUCERS IN THE CDCA

LOCATION	Copper	Lead	Molybde-num	Silver	Talc	Thorium Nitrate	Tin	Tungsten	Zinc
Lake									
Whipple Mts.	FP								
Vontrig-ger Hills	PP								

It should be remembered that although the U.S. is presently short on only copper, lead, and zinc, in times of national crisis other strategic imported commodities must come from domestic sources. If international supply lines are disrupted and stockpiles are drained, those commodities will be needed at once. Again the CDCA may be called upon to produce additional talc, tungsten, silver, lead, zinc, molybdenum, and copper.

Group II -- Import Reliance of 50% or More

Two commodities fall into this category, gold and strontium. Domestic consumption is greater than domestic production of these two commodities by 50% or more. We import 100% of our strontium requirements from Mexico and Spain, and in 1979, 56% of U.S. gold requirements came mostly from Canada, South Africa and the USSR.

The CDCA was once a major gold producer and is currently producing from several deposits. Large reserves and resources of strontium are known to exist within the CDCA, but present economic conditions make them impractical because of the lower cost of Mexican strontium. However, future marketing conditions may change the situation. Table 3 lists known deposits of gold and strontium in the CDCA. With the current upswing in gold prices, all of these areas are being reevaluated for further production by the mining industry.

Table XIV-2-3
GOLD AND STRONTIUM PRODUCTION IN THE CDCA

LOCATION	Deposit	Gold	Strontium
Cargo Muchacho Mts.	Tumco District	PP FP	
Picacho Mts.	Picacho Mine	PP FP	
Soledad Mts.	Golden Queen Mine	PP FP	
Rand Mts.	Yellow Astre Mine	PP FP	
Bullion Mts.	Bagdad Chase Mine	CP	
Pinto Mts.	Supply Mine	CP	
Ivanpah-Clark Mts.	Colisseum Mine	PP FP	
Ivanpah Mts.	Morning Star Mine	CP	
Nopah Range	Tecopa Mine	PP FP	
Panamint Mts.	Panamint Mts.	PP FP	
Fish Creek Mts.	Ocotillo		FP
Bristol Dry Lake	Bristol Dry Lake		?
Avawatz Mts.	Avawatz Mts.		?
Mud Hills	Solomon		PP FP
Mud Hills	Ross		PP PP
Cady Mts.	Ludlow		FP

PP -- Past Producer
CP -- Current Producer
FP -- Future Producer
? -- Insufficient Information

Group III -- Minerals Exported to the World Market

Six commodities: borates, lithium, rare earths, uranium, kyanite, and sodium carbonate (soda ash) are produced in the United States in large quantities. The United States produces more than 50 percent of the world supplies of borates, lithium, rare earths, and uranium and maintains a commanding economic position in the four items.

The CDCA is the sole source of the U.S. borate supply and 95 percent of the domestic rare earth supply. Lithium was produced by Kerr McGee until 1978 from brines at Searles Lake. There is record of small past uranium production from the Coso area, and present exploration activities are heavy in the CDCA. Soda ash is currently being produced by Kerr McGee. Its plant expanded by 40 percent in 1978 to process 1.3 million tons of soda ash per year. Kyanite was produced in Imperial County, and large resources are still present in the Cargo Muchacho Mountains.

Table XIV-2-4 displays location and production history of the six commodities. Table XIV-2-5 shows the position of the six commodities in the 1978 world market.

Table XIV-2-4
MAJOR EXPORT COMMODITIES IN THE CDCA

DEPOSIT	Location	Kyanite	Soda Ash	Lithium	Borates	Rare Earths	Uranium[1]
Bluebird Mine	Cargo Muchacho Mts.	PP FP					
Searles Lake	Trona		CP	PP FP	CP		
Mountain Pass	Mountain Pass					CP	
Boron	Boron				CP		
Ryan	Greenwater Mts.				CP		
Shoshone	Resting Spring Range				FP		
Coso	Haiwee Reservoir						FP PP
Owens Valley							?
	McCoy Mts.						PP
	Eastern Sierra Mts.						?
	Big Maria Mts.						?
Rosamond	Willow Springs						?
Niland	Salton Sea			FP			
Cadiz Dry Lake				FP			

PP -- Past Producer
CP -- Current Producer
FP -- Future Producer
? -- Insufficient data

[1]Preliminary appraisal, subject to change

Table XIV-2-4 (Continued)
MAJOR EXPORT COMMODITIES IN THE CDCA

DEPOSIT	Location	Kyanite	Soda Ash	Lithium	Borates	Rare Earths	Uranium[1]
Bristol Dry Lake				PP-FP			
Franklin Lake Playa				?			
Eureka Valley				FP			
Death Valley Borate				?	PP FP		
Kramer Borate	Kramer Junction			?	FP		

Table XIV-2-5
WORLD MARKET RANKING OF MAJOR UNITED STATES EXPORT COMMODITIES

COMMODITY	Percent Exported (1979)	Percent of World Market	Dollar Values of Export 1978
Borates	64%	48.6%	126,630,000
Kyanite	45%[1]	20.1%	19,000,000[1]
Lithium	58.8%[1]	75.8%	5,000,000
Rare Earths[2]	0.57%	0.39%	98,000
Soda Ash	9.4%	81.2%[1]	47,519,000
Uranium	36.8%	28.6%[1]	529,000,000

[1] Estimates
[2] Raw ore only, does not include finished products.

Group IV -- Mineral Commodities of Local and Regional Economic Significance

Eight commodities are items of major economic significance to southern California local economy or to national domestic economy. The "local" commodities are iron, sand and gravel, geothermal energy, gypsum, and limestone. These commodities support local industries that employ thousands of people in southern California, generate millions of dollars in wages and taxes, and support other industries, (i.e. construction, agriculture, chemical plants).

The "regional" commodities are oil and gas, zeolites, and specialty clays. The significance of oil and gas is obvious; zeolites and specialty clays are mined in the CDCA and are marketed in the eastern United States where they are used in pollution control systems, chemical refining, ceramics, drill muds, and specialty chemical research.

In the "local" category, iron has been and is being mined in the CDCA. The iron feeds Kaiser Steel's Fontana plant and is used by the local cement industry in ferro-concrete manufacturing. Sand and gravel is mined in the CDCA and is used in concrete manufacturing, road construction, and irrigation drain systems. Geothermal energy is currently being produced (23.5 MWe) in the CDCA, and more (138 MWe) is currently under development. The CDCA has the capacity to produce 7500 MWe, enough geothermal power by the year 2000 to supply most of the Los Angeles-San Diego region, lessening dependence on fossil fuel or nuclear plants. This is based on a 10 percent recovery factor of hot water in a reservoir. Gypsum is currently mined in the CDCA to produce wall board for housing construction and calcium sulphate for agricultural purposes. Limestone is currently produced in the CDCA for the manufacture of cement, paint pigments, chemical reagents and sulphur dioxide control units on fossil-fuel power plants.

Of the regional items, oil and gas exploration is active along the California, Nevada, and Arizona borders since the discovery of favorable geologic environments extending into this area from the Montana-Wyoming overthrust belt. Natural gas exploration is active in the Coachella and Imperial Valleys. Oil exploration occurs in the Antelope Valley near the San Bernardino Mountains. Zeolites are beng produced in the CDCA in the Ryan-Shoshone area, which is a major supplier of the U.S. domestic market. Production will be increasing by additional demands for pollution control and waste treatment systems. Quantities of specialty clays, mainly varieties of bentonites and ball (ceramic) clays are now mined at four locations in the CDCA. Major uses are for specialty ceramics, porcelains, cosmetics, and drilling muds for the oil, gas, and geothermal industries. Based on projected demands, production should increase.

Table XIV-2-6
PRODUCTION OF MINERAL COMMODITIES OF LOCAL ECONOMIC SIGNIFICANCE IN THE CDCA

DEPOSITS	Location	Iron	Geo-Thermal	Gypsum	Lime-Stone	Sand & Gravel
Whittiker Mine	Argus Range	CP			CP	
Westend Quarry	Argus Range					
Kaiser Steel	Eagle Mts.	CP				
Iron Mt.	Avawatz Mts.	CP		PP		
	Old Dad Mts.	PP				
Cave Canyon	Cave Mt.	PP CP				
Vulcan Mine	Ship Mts.	PP				
Iron Hat Mine	Marble Mts.	PP		FP		
	Kingston Mts.	CP				
	Kelso Dunes	FP				
	Fish Creek Mts.			CP	CP	
	Coyote Mts.			FP	FP PP	
	Little Maria Mts.			CP	FP	
	Big Maria Mts.			FP	FP	
	Palen Mts.			FP		
	Riverside Mts.			FP		
Shire Deposit	Ivanpah Range			FP		
	Bristol Dry Lake			PP		
	Danby Dry Lake			PP		
	Koehn Dry Lake			PP		
	San Bernardino Mts.				CP	
	Lee Flat				FP	
	Darwin Hills				FP	
	Talc Hills				FP	
	Piute Mts.				CP	
	San Jacinto Mts.				FP	

PP -- Past Producer
CP -- Current Producer
FP -- Future Producer

Table XIV-2-6 (Continued)
PRODUCTION OF MINERAL COMMODITIES OF LOCAL ECONOMIC SIGNIFICANCE
IN THE CDCA

DEPOSITS	Location	Iron	Geo-Thermal	Gypsum	Lime-Stone	Sand & Gravel
	Shadow Mts.				PP	
	Alvord Mt.				FP	
	Marble Mts.				FP	
	Tehachapi Mts.				FP	
	New York Mts.				FP	
Coso KGRA	Coso Hot Springs		FP			
Randsburg KGRA	Alvord Mts.		FP			
Salton Sea KGRA	Niland		CP			
Heber KGRA	Heber		CP			
Brawley KGRA	Brawley		CP			
East Mesa KGRA	East Mesa		CP			
Westmoreland	Westmoreland		FP			
Glamis KGRA	Glamis		FP			
Dunes KGRA	East Mesa		FP			
East Brawley	Brawley		FP			
Saline Valley KGRA	Saline Valley		FP			
Tecopa	Tecopa Hot Springs		FP			
Ford Dry Lake KGRA	Ford Dry Lake		FP			
Yuha Basin	West Mesa		FP			
Salton City	Salton City		FP			
Amboy Crater	Amboy		FP			
Pisgah Crater	Hector		FP			
	CDCA Wide					CP

Table XIV-2-7

PRODUCTION OF MINERAL COMMODITIES OF REGIONAL ECONOMIC SIGNIFICANCE IN THE CDCA

DEPOSITS	Location	Oil & Gas	Zeolites	Specialty Clay
Ash Meadows	Death Valley Junction		CP	CP
Rest	Shoshone		FP	FP
Shoshone West	Shoshone		FP	FP
Hector	Hector		CP	CP
Mud Hills	Mud Hills		FP	FP
Hart	Castle Mts.			CP
Olancha	Olancha			CP
Tecopa	Tecopa			PP
El Paso				CP
Sharpe	Dead Mts.			FP
	Fremont Valley	?		
	Antelope Valley	FP		
	Victorville Basin	?		
	Lucerne Valley	?		
	Landers Basin	?		
	Pahrump-Ivanpah Valley	FP		
	Piute Valley	FP		
	Coachella Valley	FP		
	West Coast -- Salton Sea	FP		
	East Coast -- Salton Sea	?		
	Yuha Basin	?		
	Milpitas Basin	?		

PP __ Past Producer
CP -- Current Producer
FP -- Future Producer
? -- Insufficient Information

Table XIV-2-8 displays the mineral commodity group in the CDCA and lists them in place values (as a total of past production and reserves and resources), quantities (past production and reserves and resources), U.S. domestic market conditions relating to the mineral commodities, annual projected rate of increased demand, and 1980 production status in the CDCA.

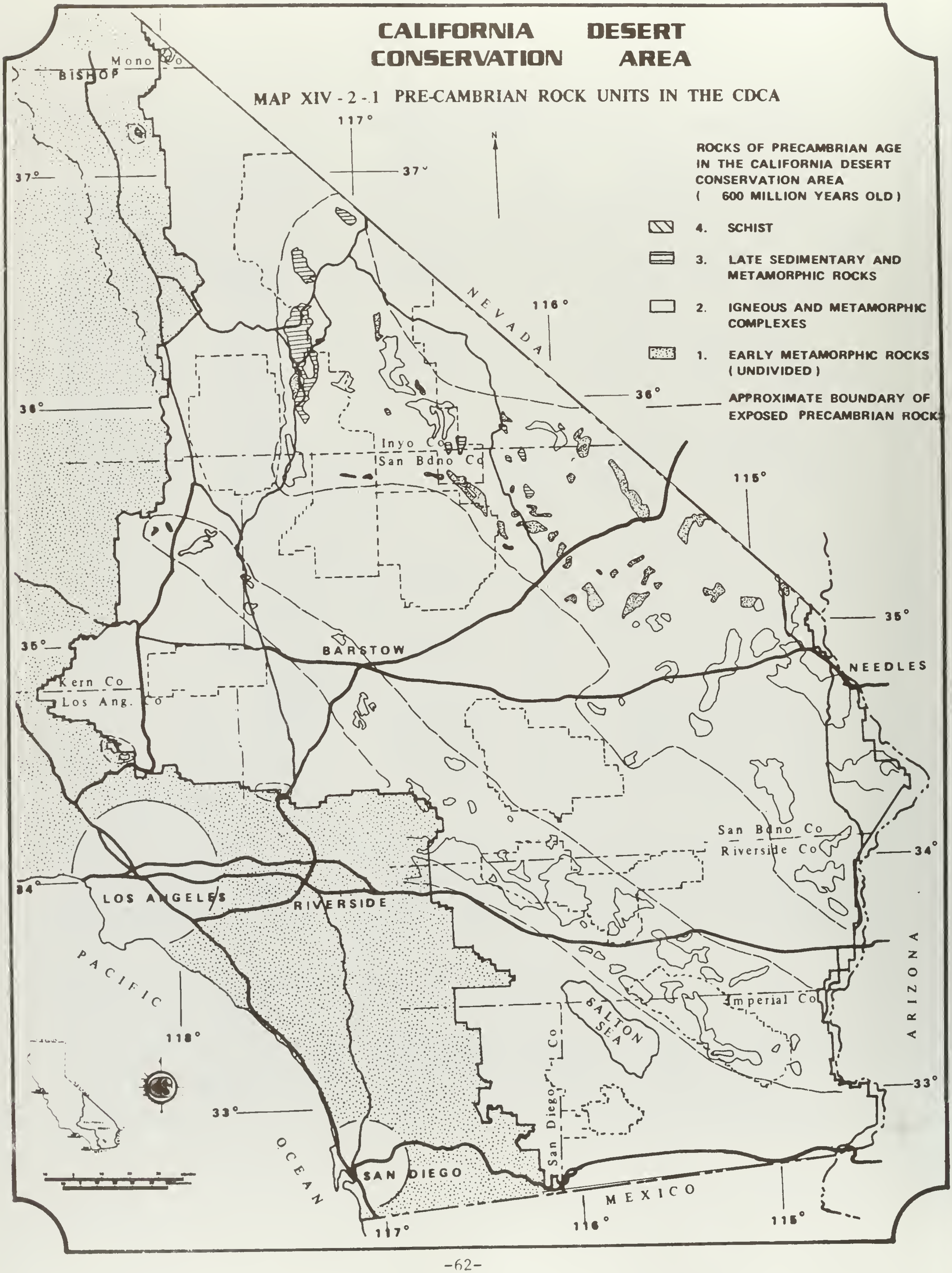
REGIONAL ECONOMIC GEOLOGY OF THE CDCA PRECAMBRIAN (600 Million Years Old or Older)

The CDCA has undergone a long and complex geologic evaluation since middle Precambrian (see Map XIV-2-1). Exposed Precambrian rocks (see Table XIV-2-9) in the CDCA are composed of igneous and metamorphic suites that also contain large areas of metasedimentary gneisses and schists of uncertain depositional origin. Igneous rocks are represented by primary granitic rocks, anatectic

Table XIV-2-8

MINERAL STATUS IN THE CDCA AND MARKET STATUS
OF THESE COMMODITIES AS A FUNCTION OF THE U.S. ECONOMY

COMMODITY	CDCA In Place $ Value (000,000)	CDCA In-Place Volumes	U.S. Domestic Consumption (1978) Percent Of Net Import	Net Export	$ Value Of Net Import (000,000)	Export (000,000)	(To 1985) Projected Rate Of Annual Demand	1980 Production Status In CDCA
GROUP I								
Copper	599.52	906,870,295 lb	20	---	768.33	---	1.0%	Dormant
Lead	85.74	254,793,165 lb	9	---	271.75	---	2.0%	Dormant
Molybdenum	15,659.80	3,170,000,000 lb	--	52	---	329.59	5.0%	None
Silver	1,318.64	244,191,856 oz	48	---	287.28	---	3.0%	Active
TAlc	409.96	5,945,201 st	--	21	---	18.69	4.0%	Active
Thorium	44.96	42,416,000 lb	100	---	0.50	---	1.0%	None
Tin	0.30	48,000 lb	79	---	703.46	---	1.0%	None
Tungsten	1,251.68	9,628,327 st	56	---	57.75	---	10.0%	Active
Zinc	30.11	97,234,996 lb	66	---	497.07	---	2.0%	Active
TOTAL GROUP I	19,395.38				2,586.14	348.28	3.2%	
Group II								
Gold	662.48	3,416,071 oz	53	---	907.23	---	3.0%	Active
Strontium	1,045.11	22,680,500 st	100	---	0.93	---	3.0%	None
TOTAL GROUP II	1,704.79				908.16	0.0	3.0%	
Group III								
Borates	37,996.62	106,822,088 st	--	74	---	45.57	4.0%	Active
Kyanite	236.94	3,761,000 st	--	45	---	19.00	6.0%	None
Lithium	3,956.17	1,939,300 st	--	59	---	60.00	10.0%	Dormant
Rare Earths	14,119.29	9,289,010 st	--	0.57	---	0.10	6.0%	Active
Soda Ash	67,569.70	1,107,700,000 st	--	9	---	47.03	2.0%	Active
Uranium	8,517.60	113,400 st	--	37	---	588.00	5.0%	None
TOTAL GROUP III	132,396.32				0.00	759.70	4.1%	
Group IV								
Geothermal	---	7,494 MWe	--	---	---	---	5.0%	Active
Gypsum	19,439.60	3,120,321,890 st	32	---	51.76	---	3.0%	Active
Iron	440,913.00	200,415,000 lt	29	---	739.20	---	2.0%	Active
Limestone	7,659.80	3,195,600,000 st	3	---	1.83	---	5.0%	Active
Oil and Gas	---		45	---	46,932.20	---	5.0%	None
Sand and Gravel	1,170.00		--	0.36	---	8.21	2.0%	Active
Spec. Clay	21,068.08	522,775,000 st	--	5.0	---	103.34	6.0%	Active
Zeolite	4,562.50	29,725,000 st	--	---	---	---	3.0%	Active
TOTAL GROUP IV	494,812.98				47,724.99	111.55	3.9%	
GRAND TOTAL	648,314.80				51,219.29	1,219.53	3.6%	



CALIFORNIA DESERT CONSERVATION AREA
MAP XIV - 2 - 1 PRE-CAMBRIAN ROCK UNITS IN THE CDCA
ROCKS OF PRECAMBRIAN AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (600 MILLION YEARS OLD)
4. SCHIST
3. LATE SEDIMENTARY AND METAMORPHIC ROCKS
2. IGNEOUS AND METAMORPHIC COMPLEXES
1. EARLY METAMORPHIC ROCKS (UNDIVIDED)
APPROXIMATE BOUNDARY OF EXPOSED PRECAMBRIAN ROCKS
BISHOP
Mono
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
LOS ANGELES
RIVERSIDE
San Bdno Co
Riverside Co
Imperial Co
SALTON SEA
San Diego Co
SAN DIEGO
PACIFIC
OCEAN
MEXICO
ARIZONA
117°
37°
116°
36°
115°
35°
34°
118°
33°

TABLE 14-2-9
RELATIVE GEOLOGIC TIME

ERA	Period	Epoch	Millions of Years Before Present
Cenozoic	Quaternary	Holocene	
			0.011
		Pleistocene	
			1.5-2
	Tertiary	Pliocene	
			5 - 7
		Miocene	
			23-26
		Oligocene	
			37-38
		Eocene	
			53-54
		Paleocene	
			65
Mesozoic	Cretaceous		
			136
	Jurassic		
			190-195
	Triassic		
			225
Paleozoic	Permian		
			280
	Pennsylvanian		
			320
	Mississippian		
			345
	Devonian		
			395
	Silurian		
			430-440
	Ordovician		
			500
	Cambrian		
			570
Precambrian	Late		
		Approx.	1,000
	Early		4,500

gneisses and granites, and in the East Mojave area, by carbonatite intrusive, especially at Mountain Pass.

Two rectangular blocks of Precambrian rocks are present in the CDCA. The northern block enters the CDCA from Nevada and Arizona, trends northwestward, and is terminated by faulting in the Panamint Mountains. This northern belt appears to be an extension of the Precambrian mineral belt currently defined in northern Arizona and southern Nevada. A large proportion of the metallic and precious metal deposits in the CDCA are associated with this belt, as are the known rare earth deposits (see Map XIV-2-5). Although most of the mineralizing events in this northern belt can be associated with more recent events, it appears that this Precambrian belt, acting as a basement complex, could be the source of these metals.

A southern belt of Precambrian rocks enters the CDCA from Arizona into Imperial County and trends northwestward (see Map XIV-2-1) to the San Bernardino Mountains and on to the Tehachapi Mountains. In the vicinity of Yucca Valley a bifurcation of this belt occurs with one arm continuing onto the Tehachapi Mountains. The other one trends north-northwest through Barstow, terminating in the El Paso Mountains, probably because of the uplift and dislocation caused by the implacement of the Sierra Nevada Batholith.

There is no apparent association of mineral deposits with the southern Precambrian belt. It may be because major exploration of the CDCA has focused on the northern belt and also because large portions of the southern belt are in National Park or military withdrawals.

Paleozoic (600 to 225 Million Years Ago)

Paleozoic rock units of the CDCA can be divided into two major groups (see Map XIV-2-2). In the northern and eastern CDCA, Paleozoic rocks are essentially unmetamorphosed, sedimentary units of marine origin. In the southern CDCA, a series of pre-Cretaceous metasedimentary gneisses and schists are presumed to be of Paleozoic age; but the majority of these units have not as yet been age-dated by modern radiometric methods, and their ages are subject to reinterpretation.

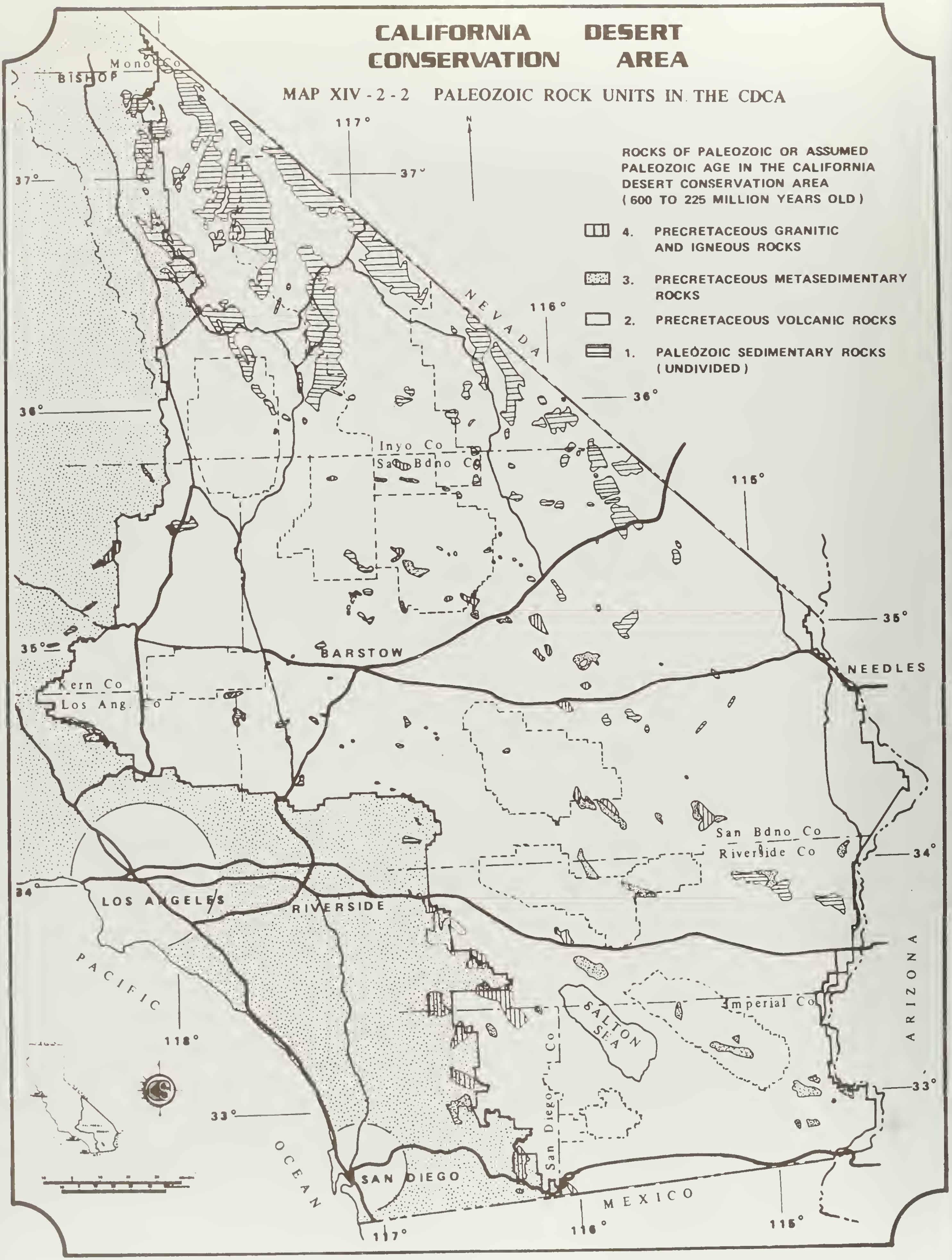
The Paleozoic units of the northern and eastern CDCA are major sources (see Map XIV-2-5) of limestone, gypsum, and some potential sources of strontium. These units are also hosts to a variety of contact metasomatic deposits, replacement deposits, and talc deposits. However, the mineralization of these last deposits is younger, ranging from Mesozoic to middle Tertiary in age.

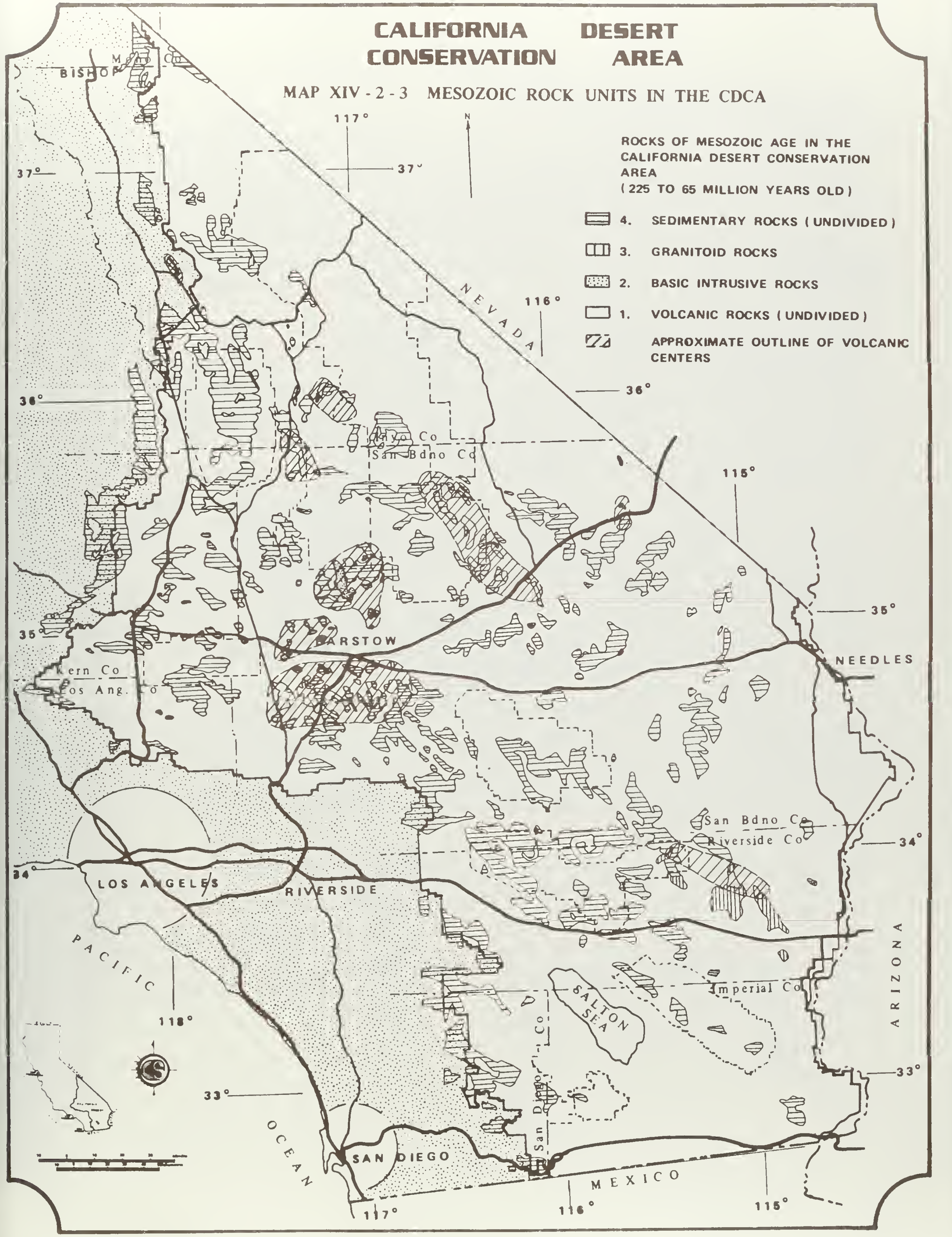
Mesozoic (225 to 65 Million Years Ago)

The Mesozoic Era in the CDCA was one of intense tectonic activity (see Map XIV-2-3). Triassic rocks of marine origin occur sporadically in the Ivanpah Mountains, Panamint Mountains, and in the southern Inyo Mountains. Metasedimentary units (schists and gneisses) of Jurassic Age have been radiometrically dated in the Orocopia, Palen, and McCoy Mountains.

The Jurassic period was a time of volcanism in the central and northern CDCA. The remnants of this activity are exposed as areas of basic intrussive (root of volcanic centers), pyroclastics, and flow units and are concentrated in recognizable centers of previous activity. These centers are located in the areas of the McCoy-Palen-Coxcomb Mountains, Ord Mountains-Helendale, Calico-Lane Mountains, Soda-Avawatz Mountains, Mescal Mountains, Slate Range, southern Panamint Mountains, southern Inyo Mountains, and a possible center in the vicinity of Hinkley. Many of these volcanic centers contain precious metals and various industrial minerals.

The Cretaceous period was one of essentially continuous magmatic activity with plutons and batholiths of granitic rocks being emplaced all over the CDCA. The tungsten mineralization of the CDCA appears to be related to this phase of igneous activity. Base and precious metal deposition is associated with the Cretaceous event in the Cargo Muchacho Mountains, Dale District, Clark Mountain and possibly at Randsburg and the southern Panamint Mountains. Several of the contact metamorphic iron deposits in the CDCA were implaced then.


CALIFORNIA DESERT CONSERVATION AREA
MAP XIV-2-2 PALEOZOIC ROCK UNITS IN THE CDCA
ROCKS OF PALEOZOIC OR ASSUMED PALEOZOIC AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (600 TO 225 MILLION YEARS OLD)
4. PRECRETACEOUS GRANITIC AND IGNEOUS ROCKS
3. PRECRETACEOUS METASEDIMENTARY ROCKS
2. PRECRETACEOUS VOLCANIC ROCKS
1. PALEOZOIC SEDIMENTARY ROCKS (UNDIVIDED)
N
Mono Co
BISHOP
117°
37°
116°
36°
115°
35°
34°
33°
118°
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
LOS ANGELES
RIVERSIDE
San Bdno Co
Riverside Co
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA



CALIFORNIA DESERT CONSERVATION AREA
MAP XIV-2-3 MESOZOIC ROCK UNITS IN THE CDCA
ROCKS OF MESOZOIC AGE IN THE CALIFORNIA DESERT CONSERVATION AREA
(225 TO 65 MILLION YEARS OLD)
4. SEDIMENTARY ROCKS (UNDIVIDED)
3. GRANITOID ROCKS
2. BASIC INTRUSIVE ROCKS
1. VOLCANIC ROCKS (UNDIVIDED)
APPROXIMATE OUTLINE OF VOLCANIC CENTERS
BISHOP
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
117°
116°
115°
118°
37°
36°
35°
34°
33°
N

Tertiary (65 to 2 Million Years Ago)

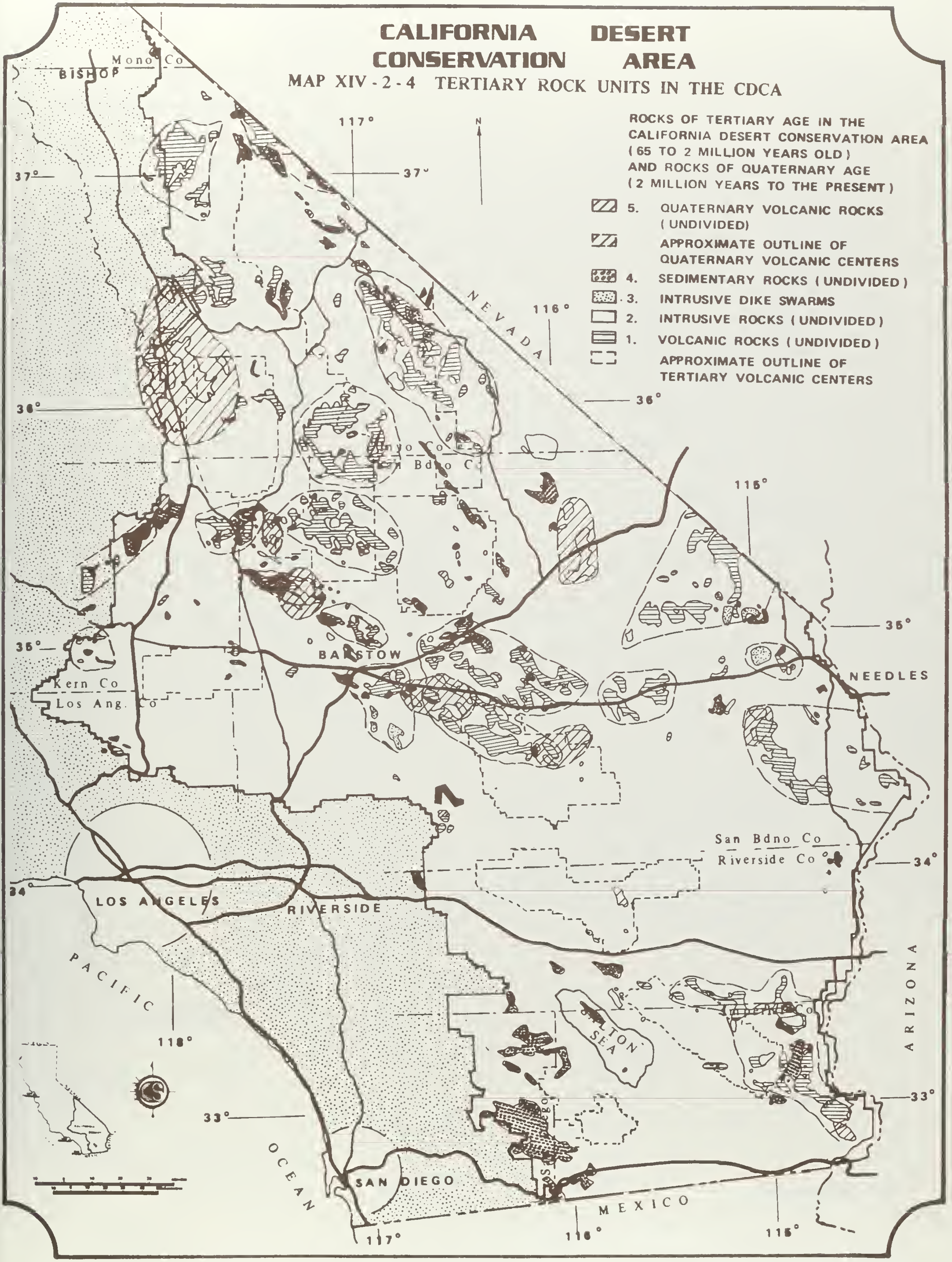
The Tertiary in the CDCA was a time of active tectonism and crustal instability that continued from the late Mesozoic. Plate tectonic stresses caused the Basin and Range topography to form and crustal thinning and fracturing produced an increase in volcanism. The ocean occupied the western and southern CDCA until the beginning of the Pliocene Epoch when crustal uplift along the major fault zones finally expelled the Pacific Ocean. Continental and lacustrine sedimentation has been the depositional regimen since the Pliocene in the CDCA.

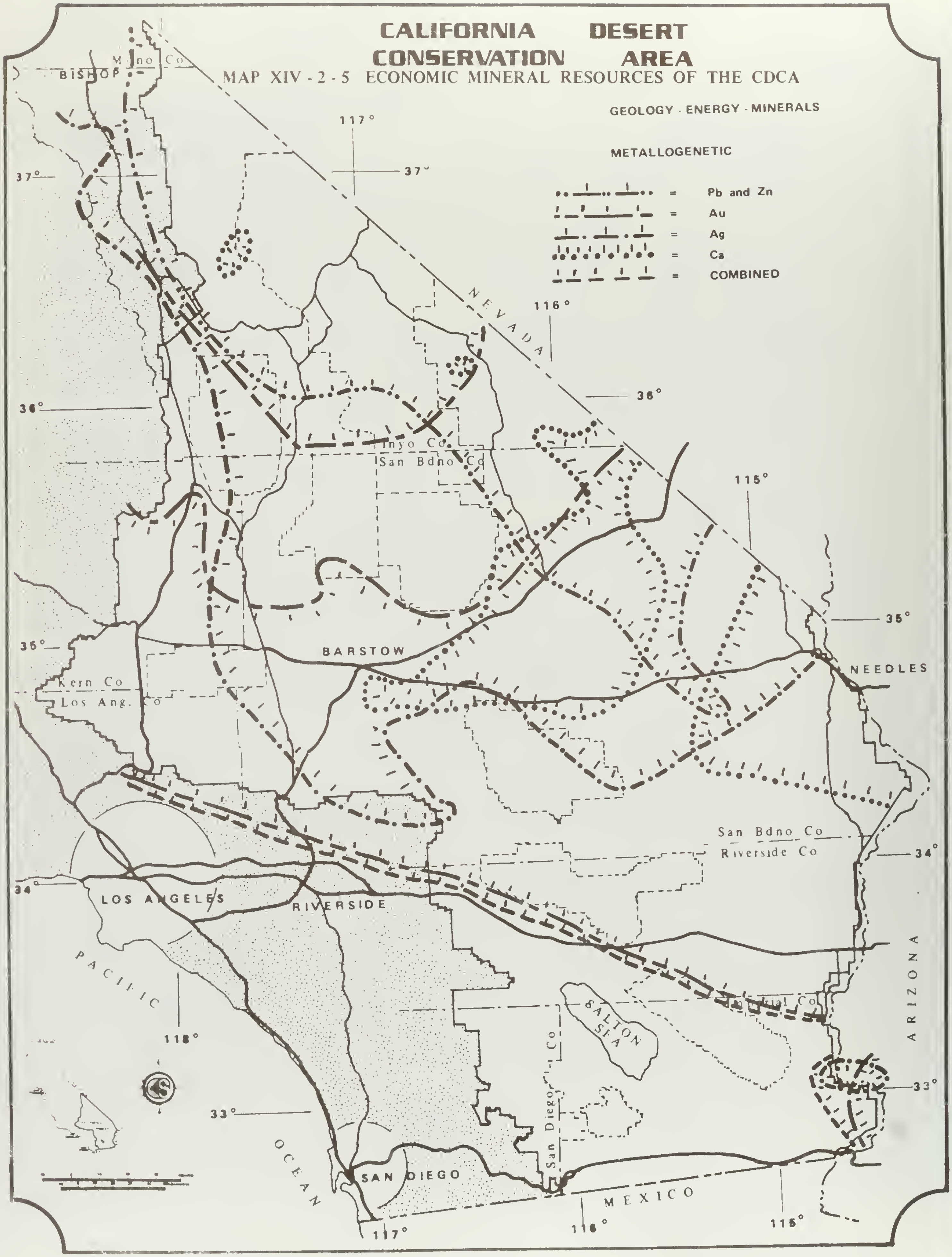
Numerous centers of volcanism formed during the early Tertiary (see Map XIV-2-4) and several have continued eruptive activity until historic times. Centers of Tertiary volcanic activity are located in the areas of the Picacho-Chuckwalla Mountains, Whipple-Turtle Mountains, New York-Homer Mountains, Providence-Marble Mountains, Greenwater-Funeral Mountains, Saline Range, Darwin Hills, southern Panamint Range, Red-Dome Mountains, Pilot Knob Valley-Granite Mountains, Black Mountain, Calico Mountains, Ord-Newberry Mountains, Rodman-Cady-Bristol Mountains, Jawbone Canyon, Soledad Mountain, and the Kramer Hills.

Many Tertiary volcanic centers are continuations of the Jurassic-Cretaceous volcanic centers and are therefore regions of long term hydrothermal activity. This is well displayed by the mineralization histories of the Panamints, Darwin, Randsburg, Calico, New York Mountains, and the Ord Mountains. The activity also produced dike swarms that are related to porphyry, copper, and molybdenum occurrences, especially in the Ord Mountains (see Map XIV-2-5). A deposit of porphyry molybdenum mineralization in the New York Mountains is probably related to this activity.

The remainder of the iron deposits and precious metals deposits in the CDCA were emplaced during the early to middle Tertiary. By Miocene time, borates were being deposited in lacustrine sediments, and zeolites were being generated under the Palen Mountains. The occurrence of the porphyry molybdenum and copper deposits opens up a large new geologic environment for the exploratory geologist to consider, as porphyry deposits occur in belts or clusters, rarely alone.

Renewed tungsten and uranium exploration will uncover new deposits. Reported discoveries of sedimentary copper and deposits of cobalt in the Shoshone area indicate that two new, previously unsuspected geologic environments for minerals exist in that portion of the CDCA. Disseminated deposits of various metals and industrial minerals will be located beneath the old mining districts in the CDCA, which will cause these districts to be reactivated and their utility to be extended, to the economic benefit of the counties and people in the CDCA.


CALIFORNIA DESERT CONSERVATION AREA
MAP XIV-2-4 TERTIARY ROCK UNITS IN THE CDCA
ROCKS OF TERTIARY AGE IN THE CALIFORNIA DESERT CONSERVATION AREA (65 TO 2 MILLION YEARS OLD) AND ROCKS OF QUATERNARY AGE (2 MILLION YEARS TO THE PRESENT)
5. QUATERNARY VOLCANIC ROCKS (UNDIVIDED)
APPROXIMATE OUTLINE OF QUATERNARY VOLCANIC CENTERS
4. SEDIMENTARY ROCKS (UNDIVIDED)
3. INTRUSIVE DIKE SWARMS
2. INTRUSIVE ROCKS (UNDIVIDED)
1. VOLCANIC ROCKS (UNDIVIDED)
APPROXIMATE OUTLINE OF TERTIARY VOLCANIC CENTERS
Mono Co
BISHOP
N
117°
37°
116°
36°
115°
35°
34°
33°
118°
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
SAN DIEGO
MEXICO
ARIZONA


CALIFORNIA DESERT
CONSERVATION AREA
MAP XIV - 2 - 5 ECONOMIC MINERAL RESOURCES OF THE CDCA
GEOLOGY - ENERGY - MINERALS
METALLOGENETIC
= Pb and Zn
= Au
= Ag
= Ca
= COMBINED
BISHOP
Mono Co
NEVADA
Inyo Co
San Bdno Co
BARSTOW
NEEDLES
Kern Co
Los Ang. Co
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
37°
36°
35°
34°
33°
117°
116°
115°
118°

COMMODITY REPORTS

The following section contains individual reports on each of the 25 commodities selected for study. Each report has a commodity summary, abstracted from the Bureau of Mines, 1980, Mineral Commodity Summaries, with pertinent data for the CDCA added. A table lists the deposits inventoried, locations, amounts (past production, reserves, and resources), and the value in terms of 1978 prices. A graph for each commodity, except for geothermal and zeolites, of the activity from 1966 to 1979 in terms of World production (less U.S. production), the U.S. production, and U.S. domestic consumption, follows. See Figures XIV-2-1 - XIV-2-24 and Tables XIV-2-10 through XIV-2-33. All data used are on file at the California Desert District Office of the Bureau of Land Management, Riverside, California, and are available for inspection upon request at that office.

GROUP I
Strategic Mineral Commodities

COPPER (Cu)

Uses: The major uses of copper metal are: electrical 58%, construction 18%, industrial machinery 9%, transportation 9%, other uses 6%.

Consumption: The U.S. consumed 4,521,000 metric tons of copper metal, both from primary mining and secondary recycling of copper scrap.

Trends: The consumption of copper should be constant through 1985.

Production: U.S. mining production in 1978 was 1,358,000 metric tons; recycling of scrap produced an additional 143,000 metric tons of copper metal; the U.S. imported 532,000 metric tons in 1978, or 20% of its domestic requirements.

Copper production in the U.S. came mainly from five states: Arizona 65%, Utah 13%, New Mexico 12%, Montana 5%, and Michigan 3%.

The CDCA has produced copper metal as a by-product of gold and silver mining activities. Centers were the Ivanpah Mts., Vontrigger Hills, Darwin District, Tecopa Mine and Santa Rosa Mine. Several areas of large tonnage, low-grade copper deposits have been inferred or located in the past five years in the CDCA. These are at Clark Mt., Copper Basin, Ord Mountains, and the Argus Mountains. The potential is considered excellent.

Substitutes: Copper can be substituted for in many applications by materials such as aluminum for electrical uses, steel for shell casings, and plastics for plumbing.

Reserves: Up-to-date figures on copper reserves in the CDCA are lacking. Past-producing areas have an excellent potential for future production according to geologic comparisons with similar districts in Montana, Arizona, Nevada, and Utah.

TABLE XIV-2-10
COPPER PRODUCTION IN THE CDCA

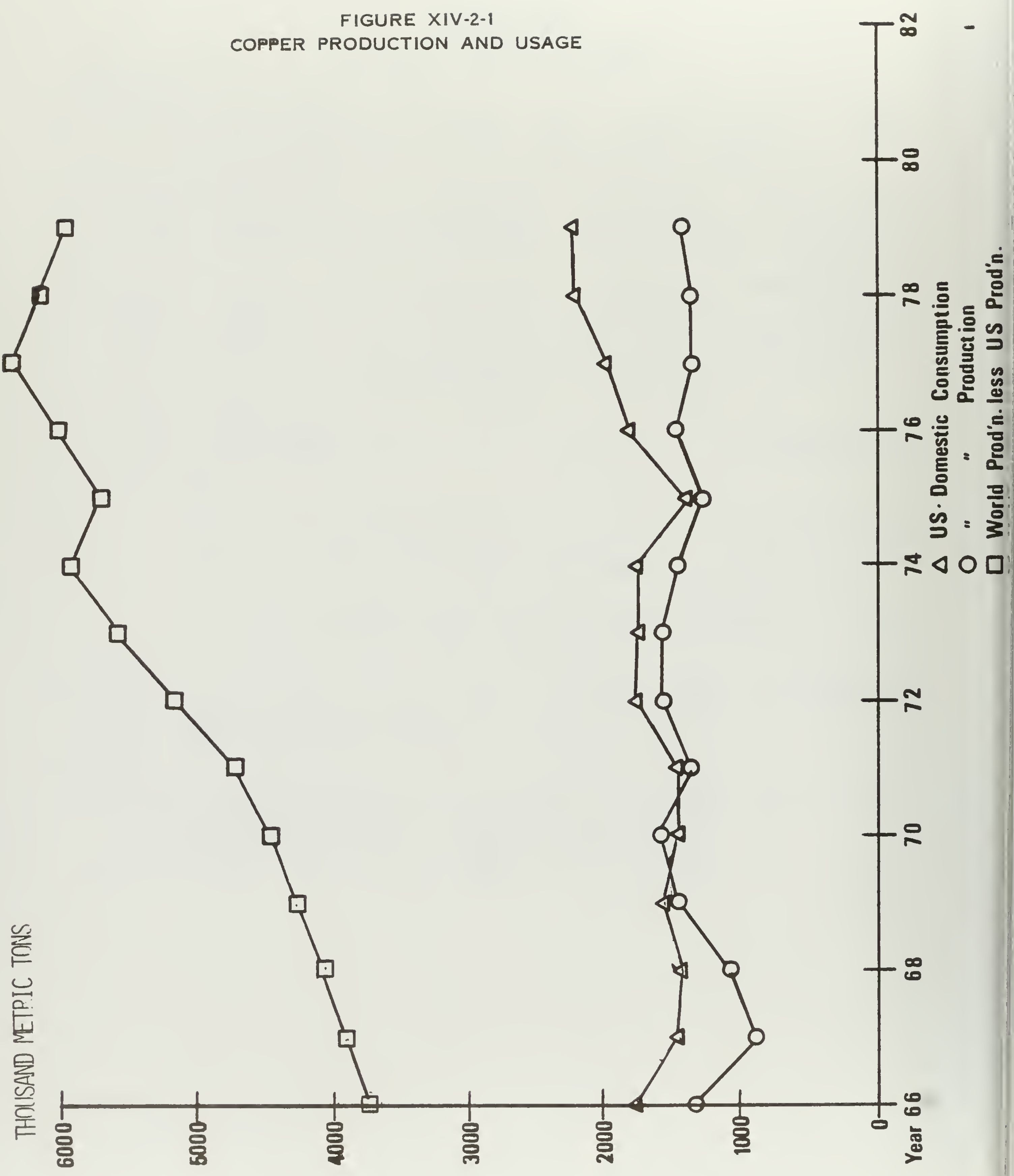
DEPOSIT	Location	GRA	Resource(lb)	($ x 10^6) Value
Ivanpah District	Ivanpah Mts.	Clark Mt.	3,551,755[1]	2.33
Copper Basin	Whipple Mts.	Whipple Mts.	134,973,200[2]	88.42
New American Eagle Mine	Whipple Mts.	Whipple Mts.	122,194[1]	0.08
California Mine	Vontrigger Hls	Homer Mt.	440,000[1]	0.29
Echo Canyon	Funeral Mts.	Dunn-Black Mts.	3,955,950[2]	2.59
Santa Rosa Mine	Inyo Mts.	Inyo Mts.	487,000[1]	0.32
Darwin District	Darwin Hills	Talc City Hills	1,489,396[1]	0.98
Tecopa Mine	Nopah Mts.	Resting Spring Range	140,000[1]	0.02
Red Hill	Ord Mts.	Ord Mt.	770,000,000[2]	504.43
TOTAL PRODUCTION[3]			6,230,345	4.08
TOTAL RESERVES			900,639,950	595.47

[1]Past Production
[2]Reserves
[3]Minimum values only: incomplete production records.

Price: 1978: $0.65510 per pound of copper metal.

Information Sources:
1) Mineral Commodities Summary, U.S. Bureau of Mines 1978, 1979, 1980.
2) Economic Geology of the Darwin Quadrangle Inyo County, California Special Report 51, California Division of Mines & Geology 1958.
3) Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada U.S. Geological Survey Professional Paper 275, U.S. Geological Survey 1956.
4) Confidential data supplied by various mining companies.
5) Lead and Zinc in California, California Journal of Mines and Geology, Vol 53, 3-4. 1957.

FIGURE XIV-2-1
COPPER PRODUCTION AND USAGE



LEAD (Pb)

Uses: Batteries 61%, gasoline additives 12%, paints 6%, ammunition 4%, construction 3%, electrical 2%, others 12%.

Consumption: The U.S. consumed 1,350,000 metric tons of lead in 1978 of which 291,000 metric tons were imported.

Trends: From a 1976 base year, the domestic demand for lead is expected to increase at an annual rate of 1.8%.

Production: The U.S. produced 1,867,000 metric tons of lead in 1978, from both primary and secondary (recycled) sources. The U.S. imported 291,000 metric tons (9%) and exported 161,000 metric tons for net import reliance of 9% in 1978.

Fifteen mines produce 79% of the domestic production. Missouri produced 89%, Idaho 9%, Colorado 1%, and other states 1% of the 1978 domestic production.

Historically, the CDCA has been a producer of lead, mostly from the Darwin District, Ivanpah-Clark Mts., Providence Mts., Cerro Gordo District, Shoshone District, and Santa Rosa Mines. Production came from lead-zinc-silver ores. As the re-evaluation of these mines and districts continues, future production of silver will also require extraction of lead and zinc.

Substitutes: Plastics can be substituted in buildings, cable coverings, and in cans and containers. Lead competes with zinc-nickel, zinc-chlorine, and lithium-sulphur mixtures in batteries.

Reserves: Past production has yielded 333,480,670 pounds (151,582 metric tons) from the CDCA. The renewed activity in silver mining in the CDCA will cause more lead to be produced in the future.

Table XIV-2-11
LEAD PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (lbs)	($x10^6) Value
Cerro Gordo Dist.	Inyo Mts.	Inyo Mts.	73,128,860[1]	24.61
Santa Rosa Mine	Inyo Mts.	Inyo Mts.	11,990,792[1]	4.04
Darwin District	Darwin Hills	Talc City Hills	40,091,258[1]	13.49
Ivanpah District	Ivanpah Mts.	Clark Mt.	4,457,255[1]	1.50
Shoshone District	Nopah Mts.	Resting Springs Range	125,000,000[1]	42.06
Death Valley Mine	New York Mts.	New York Mts.	50,000[1]	0.02
Mitchell Mine	Providence Mts.	Providence Mts.	75,000[1]	0.03
TOTAL PRODUCTION*			254,793,165	85.74

[1]Past production
*Minimum values only: incomplete records

Price: 1978: $0.33653 per pound.

References:
1) Mineral Commodities Summaries. 1980. Bureau of Mines.
2) Mines and Mineral Deposits of San Bernardino County. California. California Journal of Mines and Geology. Vol. 49, No. 1, 2. 1953.
3) Mines and Mineral Resources of Kern County. County Report No. 1, California Division of Mines and Geology. 1962.
4) Mines and Mineral Resources of Inyo County. California Journal of Geology. Vol 47, No. 1. 1950.
5) Economic Geology of the Darwin Quadrangle. Inyo County, California. Special Report 51, California Division of Mines and Geology. 1958.
6) Geology and Mineral Resources of the Ivanpah Quadrange. California and Nevada. U.S. Geological Survey Professional Paper 275. USGS 1956.
7) Lead and Zinc in California. California Journal of Mines and Geology. Vol 53, No. 3, 4. 1957.

FIGURE XIV-2-2

LEAD PRODUCTION AND USAGE

MOLYBDENUM (Mo)

Uses:	Molybdenum is a steel-hardening agent, and molybdenum sulphide (MoS_2) is a dry lubricant. Used in iron and steel alloys 75%. Of the remaining 25%, the usage is: machinery 32%, transportation 22%, oil and gas industry 17%, chemicals 13%, electrical 8%, others 8%.
Consumption:	The U.S. consumed 67,724,000 pounds of molybdenum metal and exported an additional 69,150,000 pounds in 1978.
Trends:	From a 1977 base, demand for molybdenum will increase annually at a rate of 5% thru 1985. However, in 1978 and 1979 demand exceeded production, and the annual rate may rise to 10%.
Production:	In 1978, the U.S. mined 131,843,000 pounds of molybdenum metal. The major mines are located in Colorado, New Mexico, and Arizona. A new mine in Nevada will be in operation by 1981. Three deposits of molybdenum have been discovered in the CDCA since 1978. Major mining companies are currently evaluating.
Substitutes:	There is no substitute for molybdenum in alloying of metals. It is a hardening agent in tool and machine steels.
Reserves:	Three major deposits have been identified in the CDCA since 1978. As molybdenum deposits cluster in "belts," the potential for future deposits in the same areas is high.

Table XIV-2-12
MOLYBDENUM PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resources(lbs)	($x10[6]) Value
Big Hunch	New York Mts	New York Mts	800,000,000[1]	3952.00
Red Hill	Ord Mts	Ord Mts	770,000,000[2]	3803.80
State Line Deposit	Last Chance Mts	Last Chance Mts	1,600,000,000[1]	7904.00
TOTAL RESERVES			770,000,000	3803.80
TOTAL RESOURCES			2,400,000,000	11856.00

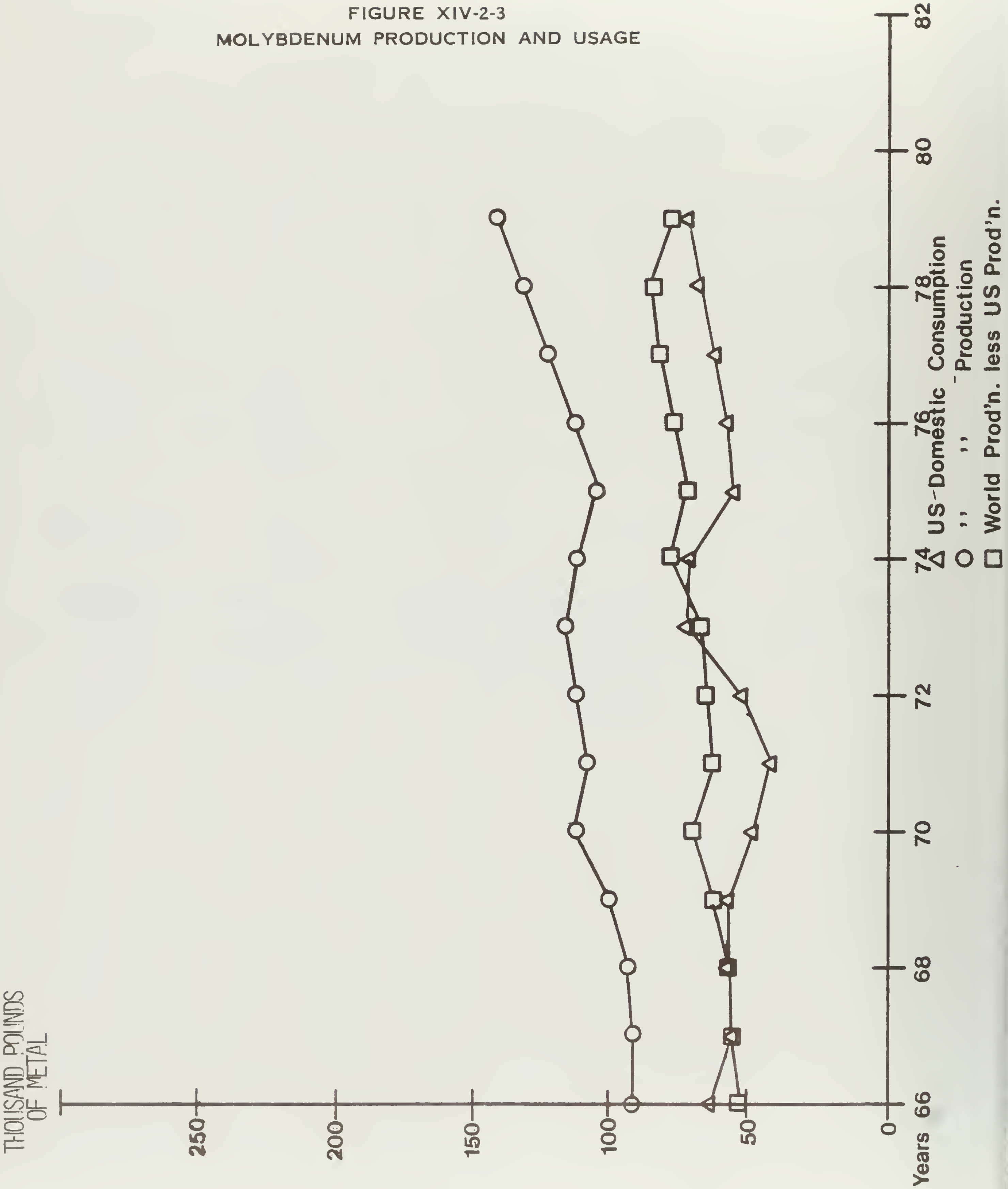
[1]Resources
[2]Reserves

Price: 1978: $4.94 per pound MoS_2 concentrate.

References:

1) Mineral Commodity Summaries. U.S. Bureau of Mines. 1977, 1978, 1979, 1980.
2) Mineral Industry Surveys. U.S. Bureau of Mines. 1978, 1979, 1980.
3) Confidential Data supplied by various mining companies.

FIGURE XIV-2-3
MOLYBDENUM PRODUCTION AND USAGE



SILVER (Ag)

Uses: Photography 39%, electrical and electronic components 25%, sterling ware and electroplated ware 15%, brazing alloys and solders 8%, others 13%.

Consumption: The U.S. consumed 148,100,000 troy ounces of silver in 1978. Imports amounted to 75,600,000 troy ounces (48%).

Trends: From a 1976 base year, domestic consumption of silver is expected to increase at an annual rate of 2.5% through 1985.

Production: The U.S. produced 39,400,000 troy ounces in 1978. About 66% of the silver was recovered as a by-product of copper and lead-zinc mining. Domestic production: Idaho 48%; Arizona 19%; Colorado 8%; Utah, Montana and Missouri 20%; others 5%. California produced 58,000 troy ounces (0.15%) in 1978.

Silver mining in the CDCA has been historically a major activity. Currently one mine is active in the Silurian Hills, and several in the Ivanpah, Providence, Calico, and Inyo Mountains are being reactivated because of recent increases in the price of silver.

Table XIV-2-13

SILVER PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource(oz)	(\$x10^{6}) Value
Darwin District	Darwin Hills	Talc City Hills	7,630,497[1]	41.21
Santa Rosa Mine	Inyo Mts.	Inyo Mts.	426,534[1]	2.30
Panamint City Dist.	Panamint Mts.	Panamint	1,717,687[1]	9.28
Modoc District	Argus Mts.	Darwin-Slate Rge	2,037,888[1]	11.01
Cerro Gordo Mine	Inyo Mts.	Inyo Mts.	4,581,937[1]	24.74
Randsburg Dist.	Red Mt.	Red Mt.	18,176,310[1]	98.15
Calico District	Calico Mts.	Calico Mts.	1,828,691[1] 175,000,000[2]	9.88 945.00
Waterman Mine	Waterman Hills	Calico Mts.	1,593,252[1]	8.60
Tecopa Silver Mine	Nopah Range	Resting Spring Range	950,000[1]	5.13
Ivanpah District	Ivanpah Mts.	Clark Mt.	10,894,182[1]	58.83
Bonanza King Mine	Providence Mts.	Providence Mts.	1,554,878[1]	8.40
Riggs Mine	Silurian Hills	Halloran	200,000[1]	1.08
Sentinel Peak Mine	Panamint Range	Panamint	17,600,000[2]	95.04
TOTAL PRODUCTION[3]			51,591,856	278.60
TOTAL RESERVES[3]			192,600,000	1040.04

[1]Past production
[2]Reserves
[3]Minimum amounts only: incomplete records

Price: 1978: \$5.40 per troy ounce of silver.

References: 1) Mineral Commodity Summaries. U.S. Bureau of Mines. 1980.

2) Mineral Industry Survey of California. U.S. Bureau of Mines. 1979.

3) Mines and Mineral Deposits of San Bernardino County, California. California Journal of Mines and Geology. Vol 49, No. 1, 2. 1953

4) Mines and Mineral Resources of Kern County. County Report No. 1, California Division of Mines and Geology. 1962.

5) Mines and Mineral Resources of Inyo County. California Journal of Mines and Geology. Vol 47, No. 1. 1950.

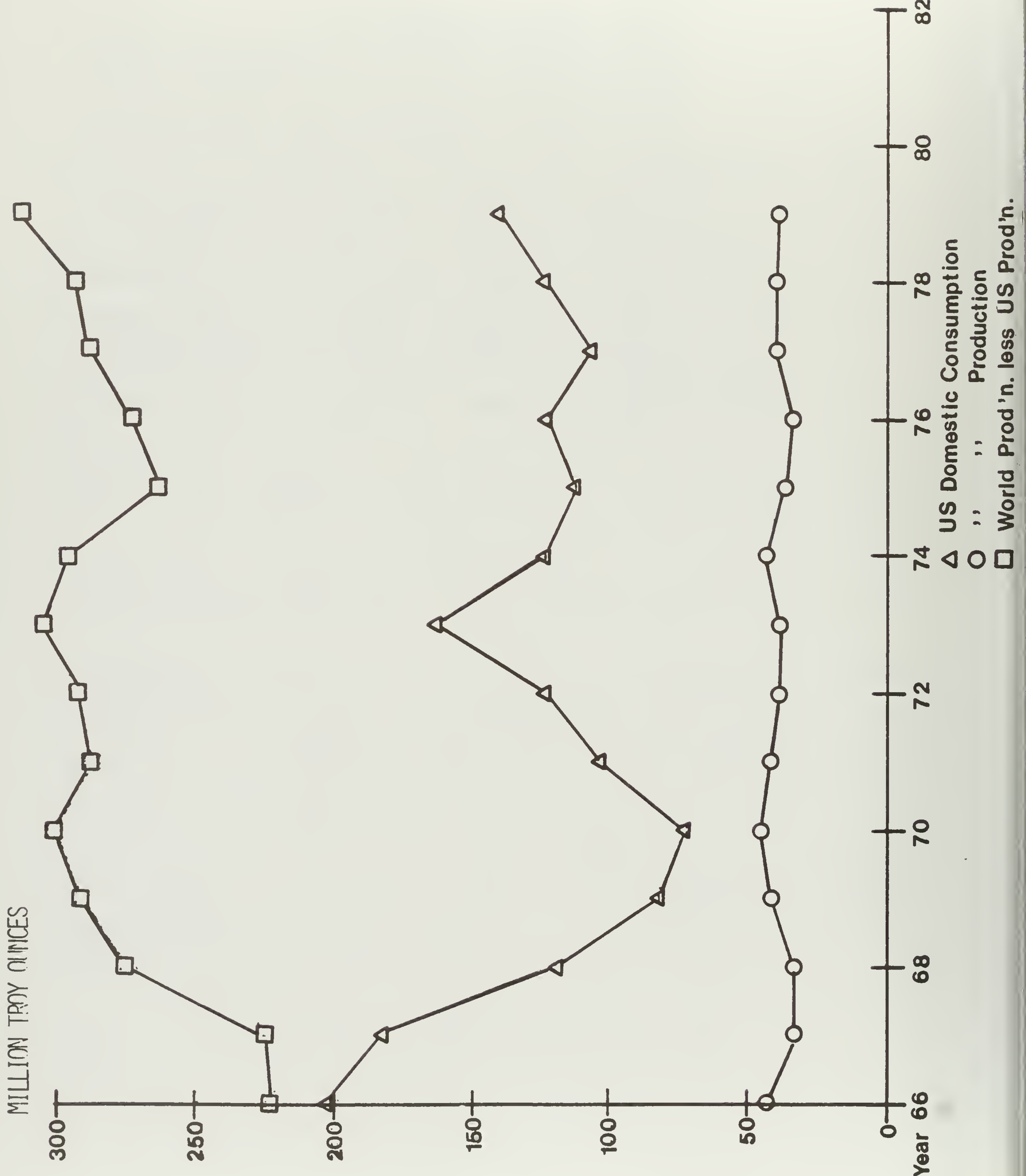
6) Economic Geology of the Darwin Quadrangle, Inyo County, California. Special Report 51. California Division of Mines and Geology. 1958.

7) Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada. U.S. Geological Survey Professional Paper 275. U.S. Geological Survey. 1956.

8) Confidential data supplied by various mining companies.

FIGURE XIV-2-4

SILVER PRODUCTION AND USAGE



TALC - $Mg_3Si_4O_{10}(OH)_2$

Uses: Talc is used domestically in the manufacture of ceramics 28%, paints 21%, plastics 16%, cosmetics 8%, paper 9%, rubber 4%, roofing 2%, misc. 12%.

Consumption: In 1978, the U.S. consumed 957,000 short tons of talc and exported 267,000 short tons.

Trends: From a 1977 base year, U.S. talc consumption will increase at an annual rate of 4% through 1985. Export shipments will increase at an annual rate of about 10% through 1985.

Production: Twelve states, including California, are talc producers. More than 90% of domestic production comes from Vermont, Montana, New York, and Texas. Most California talc comes from the CDCA in Inyo County. Small amounts were produced in San Bernardino county. Production in Inyo County continues in the Darwin and Tecopa areas of Inyo County, and in the Silurian Hills of San Bernardino County.

Total U.S. production in 1978 was 1,384,000 short tons, of which 267,000 short tons (19%) were exported. The production figures in the CDCA are not known but would be in the 10-20,000 short ton range.

Substitutes: Talc competes with kaolin, Fuller's earth and other inorganic fillers, feldspar for ceramics, and mica for plastics.

Reserves: The CDCA has produced a large amount of talc since the 1920's. Marketing conditions influence mining feasibility. Geologic criteria indicate moderate reserves of talc in the CDCA and future production is reasonable. Nine areas of Inyo and San Bernardino counties have been production centers.

Table XIV-2-14
TALC PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (short tons)	($x10⁶) Value
Silver Lake Mine	Hollow Hills	Halloran	230,000[1]	16.10
Talc City Hills	Inyo Mts.	Talc City Hills	280,000[1]	14.00
Alexander Hills	Alexander Hills	Dumont Dunes	346,050[1]	24.22
Ibex Hills	Ibex Hills	Dumont Dunes	217,780[1]	15.24
Avawatz Mts.	Avawatz Mts.	Avawatz Mts.	20,000[1]	1.40
Kingston Range	Kingston Range	Kingston Range	93,500[1]	6.55
Saddle Peak Hills	Saddle Pk Hills	Dumont Dunes	20,700[1]	1.45
Silurian Hills	Silurian Hills	Halloran	5,000[1]	0.35
Northern Inyo Mts.	Inyo Mts.	Inyo Mts.	30,000[1]	1.50
Death Valley National Monument		DVNM-Confidence Hills	609,171[1] 1,084,000[2] 3,009,000[3]	42.64 75.88 210.63
TOTAL PRODUCTION[4]			1,852,201	123.45
TOTAL RESERVES[4]			1,084,000	75.88
TOTAL RESOURCES[4]			3,009,000	210.63

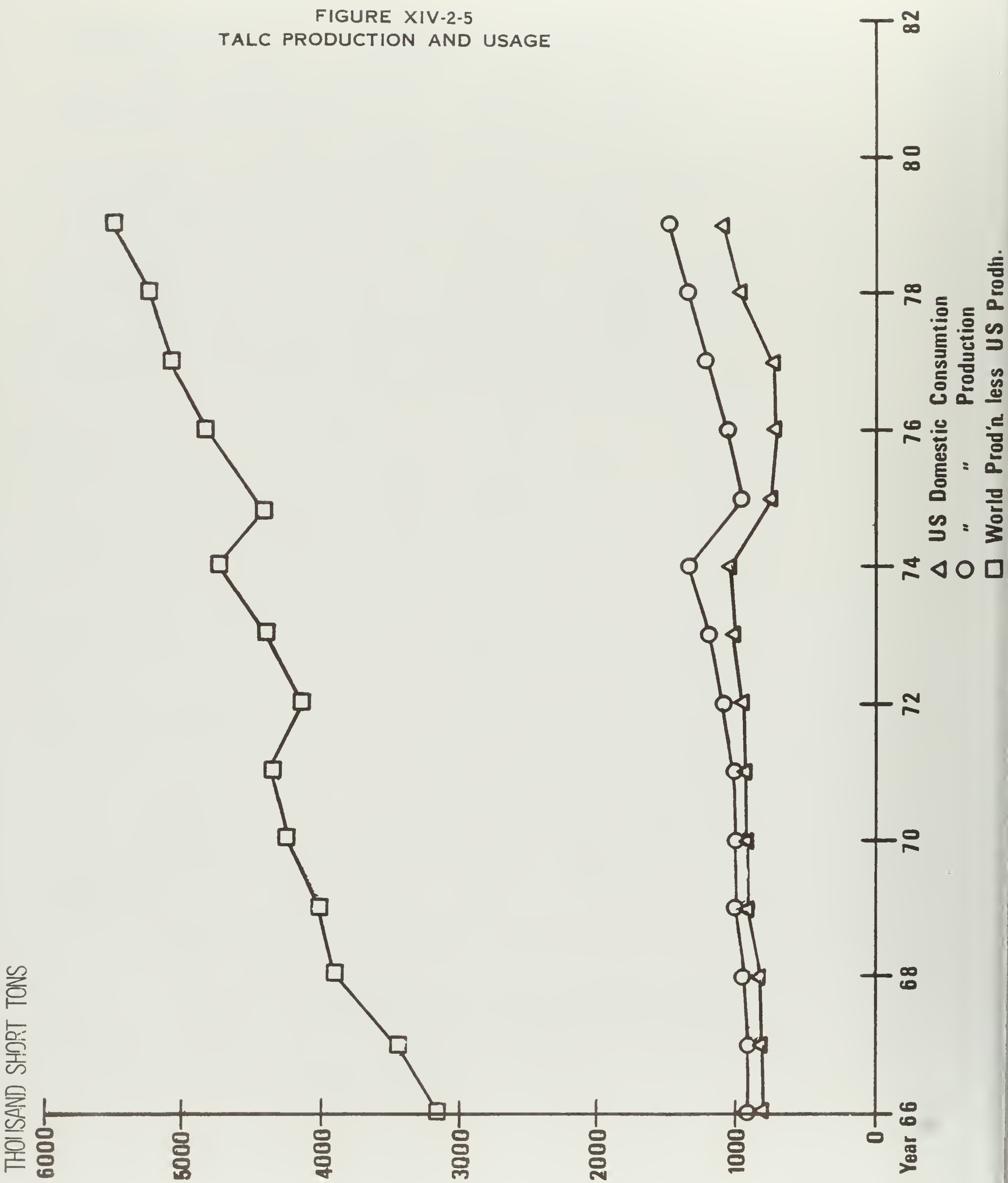
[1]Past production
[2]Reserves
[3]Resources
[4]Minimum figures only due to incomplete records.

Price: 1978: $50.00 per short ton of steatite grade.
$70.00 per short ton of standard grade.

References: 1) Mineral Commodities Summary, 1978, 1979, 1980, U.S. Bureau of Mines.

2) Talc Deposits of the Southern Death Valley-Kingston Range Region, California. Special Report 95. California Division of Mines and Geology. 1968.
3) Economic Geology of the Darwin Quadrangle, Inyo County, California. Special Report 51. California Division of Mines and Geology. 1958.
4) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
5) Talc Deposits of Steatite Grade, Inyo County, California. Special Report 8. California Division of Mines and Geology. 1951.
6) Geology of the Silver Lake Talc Deposits, San Bernardino County, California. Special Report 38. California Division of Mines and Geology. 1954.
7) Mines and mineral deposits in Death Valley National Monument, California. Special Report 125. California Division of Mines and Geology. 1976.

FIGURE XIV-2-5
TALC PRODUCTION AND USAGE



THORIUM (ThO_2)

Uses: Electrical generation in nuclear reactors, mantles in incandescent lamps, magnesium-thorium alloys, and in refractories.

Consumption: The U.S. consumed 36 short tons of thorium in 1978, of which 6 short tons went into nuclear reactors (breeder types).

Trends: Using 1977 as a base year, an annual rate of increase of 1% through 1985 is forecast.

Production: Thorium residues from monazite concentrates are stockpiled in Tennessee but are not refined in the U.S. The U.S. imports its thorium metal from Europe.

Substitutes: There are no substitutes for the nonenergy uses of thorium.

Reserves: Only two areas in the CDCA are known to contain thorium reserves.

Table XIV-2-15

THORIUM PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource(lbs)	($x10⁶) Value
Molycorp	Mountain Pass	Clark Mt.	19,500,000[2]	20.67
			19,500,000[3]	20.67
South Ivanpah	Ivanpah Mt.	Clark Mt.	416,000[2]	0.44
			3,000,000[3]	3.18
TOTAL RESERVES			19,916,000	21.11
TOTAL RESOURCES			22,500,000	23.85

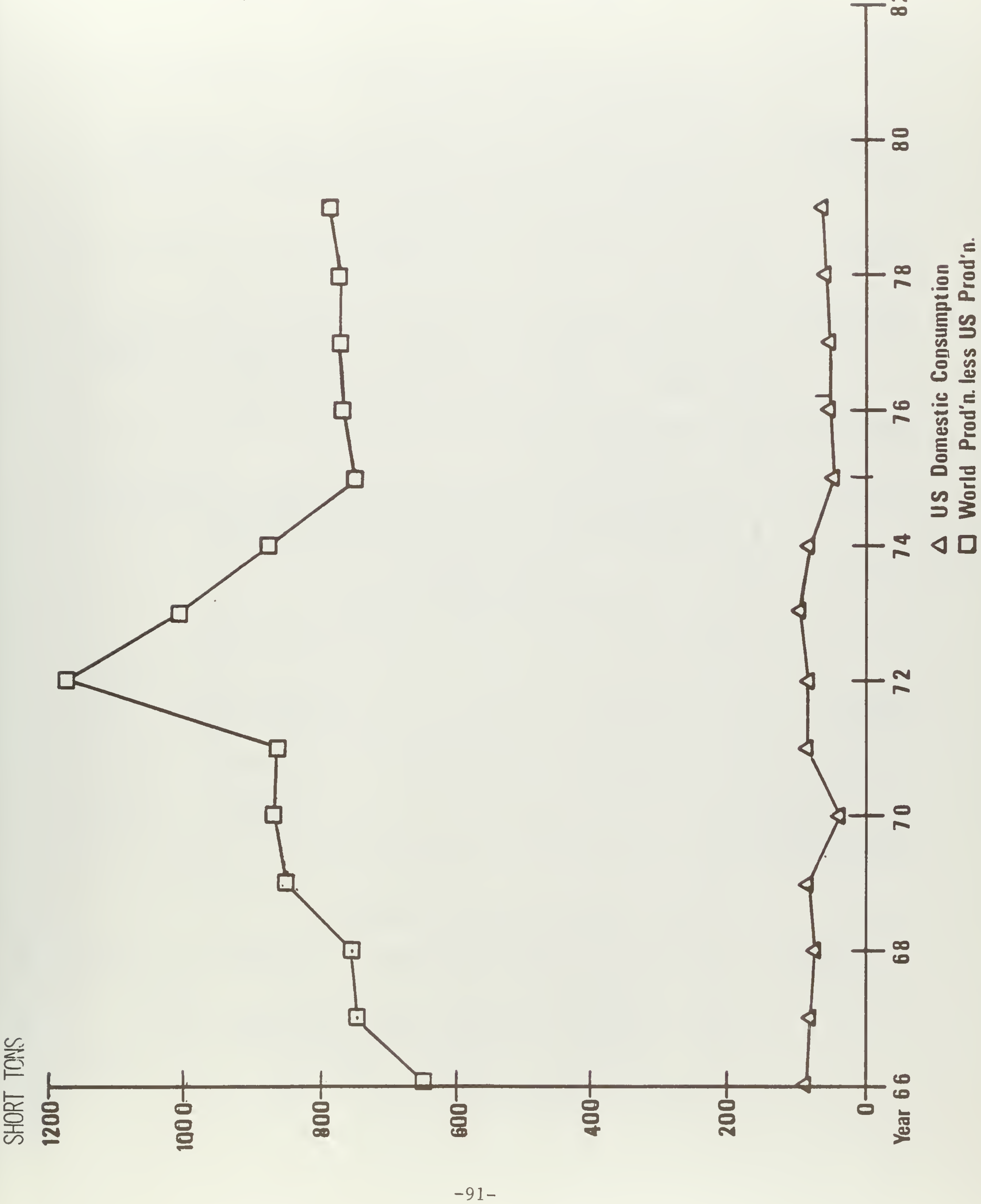
[2]Reserves (at $30.00 per pound ThO_2).
[3]Resources (at $30.00 per pound ThO_2).

Prices: 1978: $1.06 per pound of contained ThO_2 per ton.

References:

1) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
2) Mineral Commodities Report for Rare Earths. 1976, 1977, 1978, 1979. U.S. Bureau of Mines.
3) Mineral Commodity Summary. 1978, 1979, 1980. U.S. Bureau of Mines.
4) Mineral Commodity Profiles for Rare Earths. 1979. U.S. Bureau of Mines.
5) Principal thorium resources in the U.S. U.S. Geological Survey Circular 805. 1979.

FIGURE XIV-2-6
THORIUM PRODUCTION AND USAGE



TIN (Sn)

Uses: Cans and containers 31%, electrical 15%, construction 15%, transportation 12%, other 27%.

Consumption: The U.S. produced small amounts of tin as a by-product of molybdenum mining at Climax, Colorado. Total domestic consumption in 1978 was 63,913,000 metric tons of tin metal, of which 79% was imported.

Trends: From a 1976 base year, the demand for tin is expected to increase at an annual rate of 1% through 1985.

Production: Domestic production was less than 1,000 metric tons of tin metal in 1978, all mined at Climax. Three areas in California: Gorman, Temescal, and Striped Mt. (Mescal Range), produced small amounts of tin before 1945.

Substitutes: Various metals and plastics can be substituted for tin in some applications.

Reserves: The Evening Star Mine in the Mescal Range is the only known producer of tin in the CDCA. The area around the mine is still considered favorable for further deposits.

Table XIV-2-16
TIN PRODUCTION IN THE CDCA

DEPOSIT	Location	Gra	Resource(lbs)	($x10³) Value
Evening Star Mine	Striped Mt.	Clark Mt.	48,000[1]	301.92
TOTAL PRODUCTION			48,000	301.92

[1]Past production

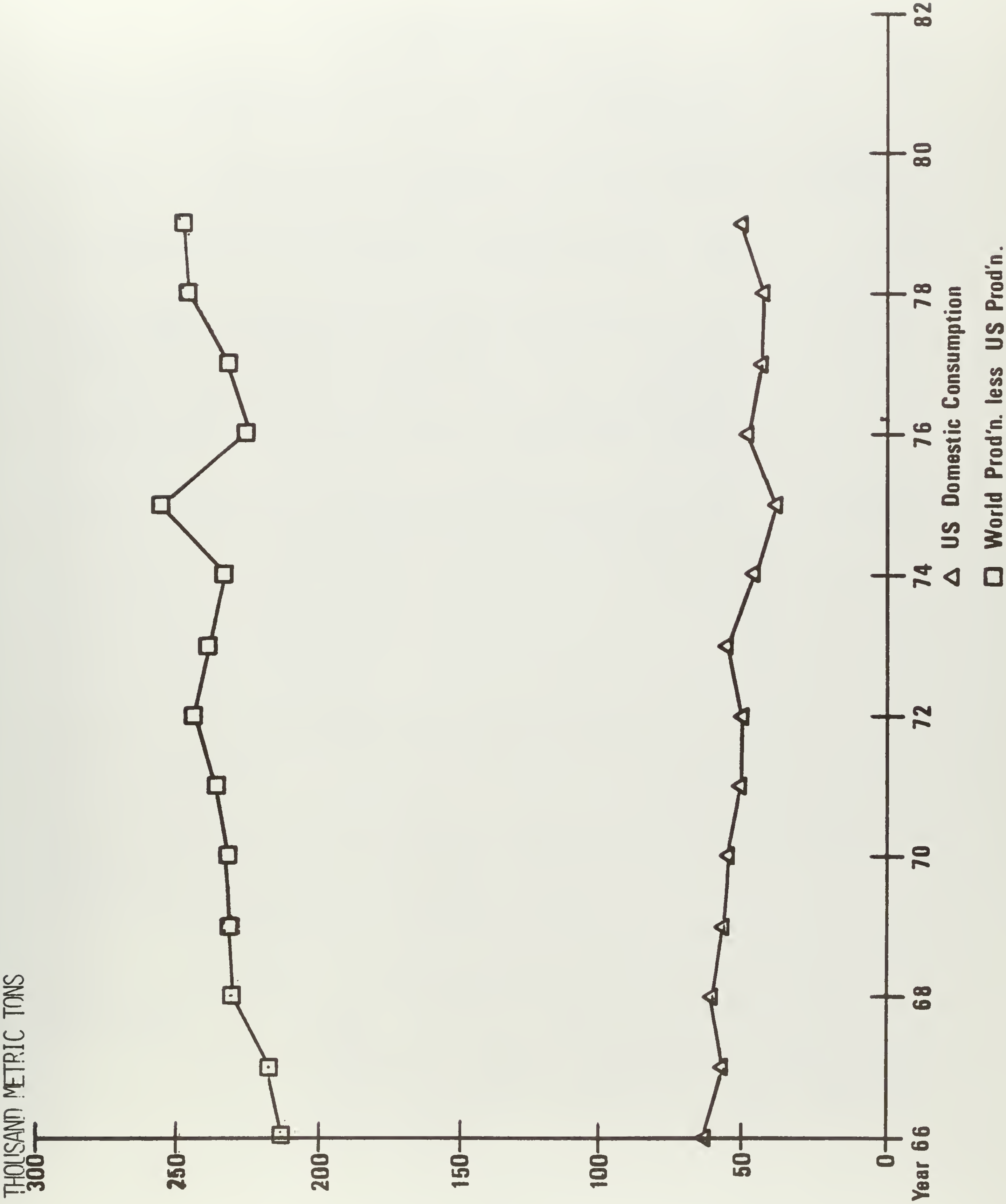
Price: 1978: $6.29 per pound of tin metal.

References:

1) Mineral Commodities Summary. 1979, 1980. U.S. Bureau of Mines.
2) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
3) Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada. U.S. Geological Survey Professional Paper 275. USGS 1956.

FIGURE XIV-2-7

TIN PRODUCTION AND USAGE



TUNGSTEN (W)

<u>Uses</u>: Metal working and machinery construction 77%; transportation 10%, lamps and lighting 6%, electrical 4%, other 3%.

<u>Consumption</u>: The U.S. consumed 22,514,000 pounds of tungsten metal in 1978, of which 9,138,000 pounds was imported.

<u>Trends</u>: The demand for tungsten is increasing at an annual rate of 10%. Demand is currently 8% higher than existing supply.

<u>Production</u>: In 1978, about 97% of domestic production came from four mines located in California, Colorado, and Nevada. The U.S. produced 6,901,000 pounds of tungsten that year. Imports were 9,138,000 pounds, and exports 1,853,000 pounds. Net import reliance is 56% of consumption. The CDCA has been a major past producer of tungsten and the geologic potential is considered excellent.

<u>Reserves</u>: Nine areas have produced in the past, and Kerr-McGee began production in 1980 at Searles Dry Lake.

Table XIV-2-17
TUNGSTEN PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (short tons)	($x10⁶) Value
Darwin District	Darwin Hills	Talc City Hills	55,940[1] Large[2]	7.27 ---
Hi Peak Mine	Owens Peak	Owens Peak	4,000[1]	0.52
Atolia District	Red Mt.	Red Mt.	1,000,000[1] 70,157[2]	130.00 9.12
Hidden Value Mine	Old Woman Mts.	Old Woman Mts.	500[1]	4.23
Just Tungsten Quarries	Shadow Mts.	Adobe Mt.	1,750[1]	0.23
"76" Mine	Slate Range	Darwin-Slate Rng.	43,290[1]	5.62
Kerr McGee	Searles Lake	Searles	8,500,000[2]	1,105.00
Mojave Mine	Ivanpah Mts.	Clark Mt.	1,924[1]	0.25
Star Bright Mine	Lane Mt.	Calico Mts.	20,000[1]	2.60
Howe Mine	Old Woman Mts.	Old Woman Mts.	923[1]	0.12
TOTAL PRODUCTION[3]			1,128,327	146.68
TOTAL RESERVES[3]			8,500,000+	1,105.00+

[1]Past production
[2]Reserves
[3]Minimum amounts only due to incomplete records.

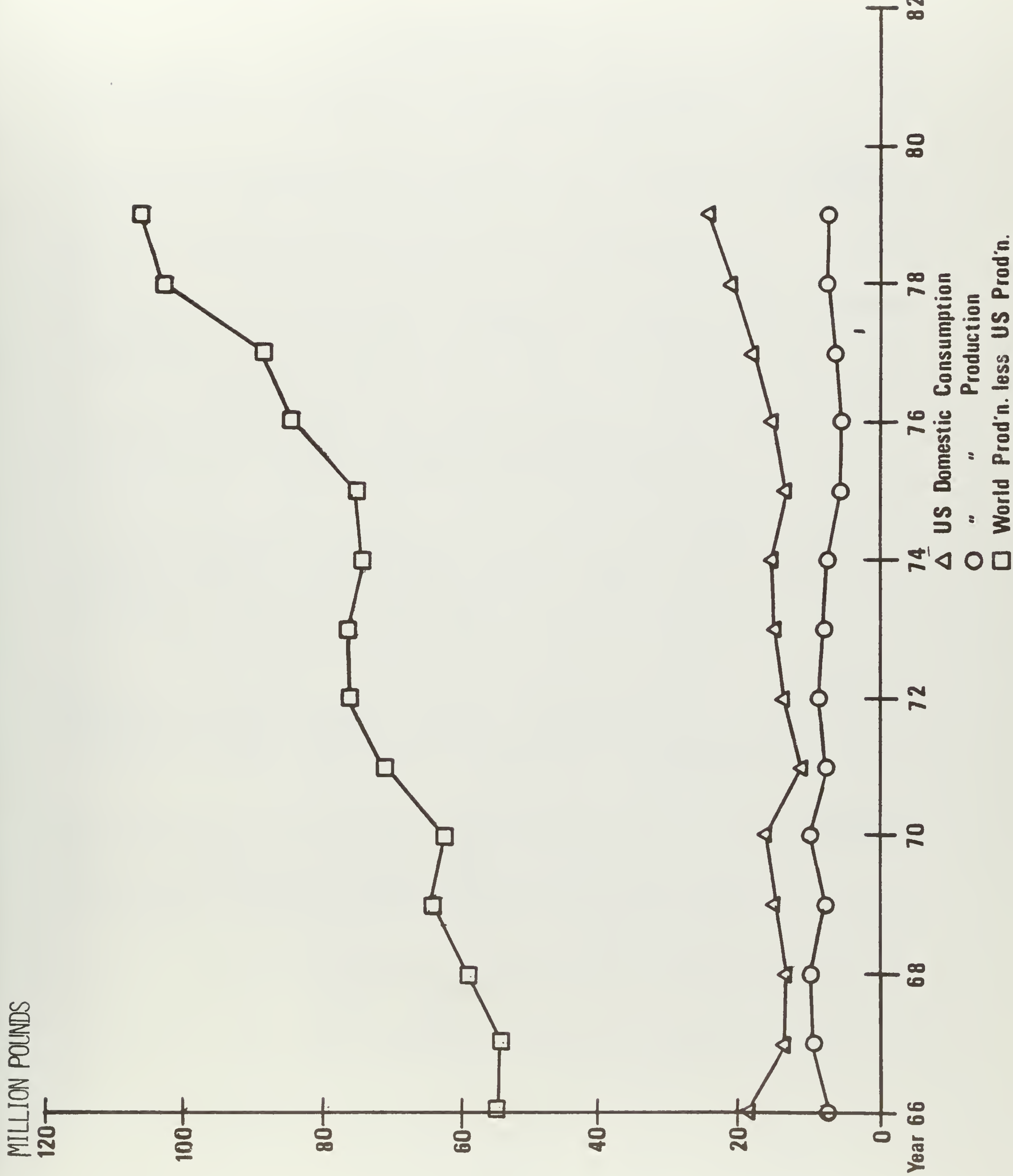
Price: 1978: $130.00 per short ton unit of contained WO_3.

References:

1) Mineral Commodity Summary. U.S. Bureau of Mines. 1980.
2) Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada. U.S. Geological Survey Professional Paper 275. U.S. Geological Survey. 1956.

3) Mines and Mineral Resources of Kern County, California. County Report 1. California Division of Mines and Geology. 1962.
4) Mines and Mineral Deposits of San Bernardino County, California. California Journal of Mines and Geology. Vol 49, No. 1, 2. California Division of Mines and Geology. 1953.

FIGURE XIV-2-8
TUNGSTEN PRODUCTION AND USAGE



ZINC (Zn)

Uses: Construction materials 40%, transportation equipment 26%, electrical equipment 12%, machinery and chemicals 10%, others 12%.

Consumption: In 1978 the U.S. consumed 1,119,000 metric tons of zinc metal of which 728,000 metric tons (66%) were imported.

Trends: From a 1976 base year, domestic demand for zinc is expected to increase at an annual rate of 2% through 1985.

Production: The U.S. produces 745,000 metric tons of zinc from primary (mining) and secondary (recycling) sources in 1978. An additional 728,000 metric tons were imported and 22,000 metric tons were exported in 1978. Net import reliance in 1978 was 65% of apparent consumption.

About 95% of domestic production comes from 2.5 mines, with 5 producing 55% of U.S. output. Major producing states are Tennessee 31%, Missouri 23%, New Jersey 12%, Idaho 12%, others 22%.

The CDCA has been a zinc producer from various lead-zinc-silver mines in the Darwin District, Ivanpah District, Cerro Gordo District, Santa Rosa Mine, Shoshone District, and several smaller operations. As the recent upsurge in silver activity is expected to continue in the CDCA, the future for zinc production in the CDCA is excellent.

Substitutes: Aluminum and magnesium are the major substitutes for zinc in die casting. Plastics, paints, cadmium, and special steels can replace zinc in corrosion control. Aluminum, magnesium, titanium, and zirconium compete with zinc in chemicals and paints.

Reserves: The CDCA has been a past producer of zinc, and because of its association with silver can be expected to be a producer in the future. Recent discoveries of zinc carbonate ores in the Panamint Mountains and in the Darwin District indicate a good future for zinc production in those areas.

Table XIV-2-18
ZINC PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource(lbs)	($x10⁶) Value
Cerro Gordo Dist.	Inyo Mts.	Inyo Mts.	23,966,020	7.42
Darwin District	Darwin Hills	Talc City Hills	46,679,612[1]	14.46
Panamint Range	Panamint Range	Panamint	550,000[1]	0.17
Ivanpah District	Ivanpah Mts.	Clark Mts.	10,009,364[1]	3.10
Shoshone District	Nopah Mts.	Resting Spring Range	16,000,000[1]	4.96
Death Valley Mine	New York Mts.	New York Mts.	30,000[1]	0.01
TOTAL PRODUCTION[2]			97,234,996	30.11

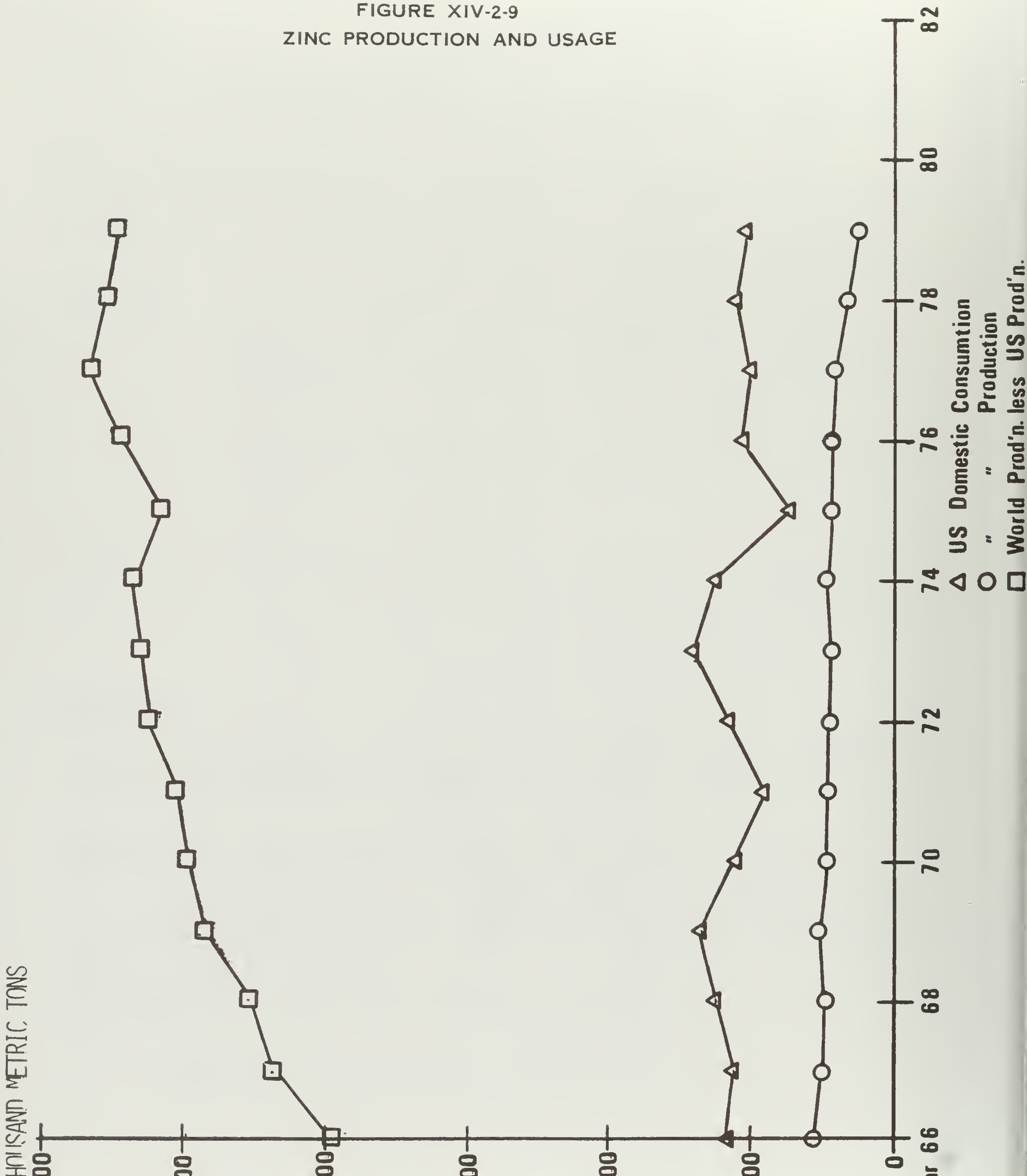
[1]Past production
[2]Minimum values only: Incomplete data

Price: 1978: $0.30971 per pound of zinc metal.

References:

1) Mineral Commodities Summaries. U.S. Bureau of Mines. 1980.
2) Mines and Mineral Deposits of San Bernardino County, California. California Journal of Mines and Geology. Vol 49, Nos. 1, 2. 1953.
3) Mines and Mineral Resources of Inyo County, California. California Journal of Mines and Geology. Vol 47, 1. 1950.
4) Economic Geology of the Darwin Quadrangle, Inyo County, California. Division of Mines and Geology. 1958.
5) Geology and Mineral Resources of the Ivanpah Quadrangle, California and Nevada. U.S. Geological Survey Professional Paper 275. U.S. Geological Survey. 1956.
6) Lead and Zinc in California. California Journal of Mines and Geology. Vol 53, Nos. 3, 4. 1957.

FIGURE XIV-2-9
ZINC PRODUCTION AND USAGE



GROUP II

Mineral Commodities With a Net Import Reliance of 50% or More

GOLD (Au)

Uses: Jewelry and arts 58%, electronics 28%, dental 13%, small bars for investment 1%.

Consumption: In 1978, U.S. domestic consumption was 5,100,000 troy ounces. About 4,690,000 troy ounces was imported and 5,510,000 exported.

Trends: From a 1978 base, domestic gold demand is expected to increase at an annual rate of 3% through 1985.

Production: The U.S. produced 1,000,000 troy ounces in 1978 and recycled 4,780,000 troy ounces. The U.S. had a net import reliance of 53% in 1978, measured against apparent domestic consumption. The gold was produced from 175 mines in the USA, but three of these account for 65% of the total output. About 49% of gold produced is recovered as a by-product of base metal (Cu-Pb-Zn) mining operations. California produced 7,480 troy ounces in 1978, mostly from the Mother Lode area.

Production of gold in the CDCA is still continuing for small operations. The current increase of gold prices to over $500 per troy ounce is causing many old mines to reactivate.

Substitutes: The reserves of gold in the CDCA are inferred to be high. The CDCA was a major producer from high grade vein systems and is now being actively explored by companies for large tonnage, low grade deposits. Several have been located in the Panamint Mts., Clark Mt., and Randsburg areas. Past producing areas will be producing again due to improved prices and technology for handling low grade ores. Ten areas of past and present production are known.

Table XIV-2-19
GOLD PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource(oz)	($x10⁶) Value
Tumco District	Cargo Muchacho Mts	Picacho	167,500[1]	33.24
Picacho Mine	Picacho Mts.	Picacho	100,000[1]	19.34
Golden Queen Mine	Soledad Mt	Soledad/Rosemond	250,000[1]	48.36
Yellow Astre Mine	Rand Mts.	Red Mt.	541,000[1]	105.50
Bagdad Chase Mine	Bullion Mts.	Cady Mt.	260,000[1]	50.28
Supply Mine	Pinto Mts.	Dale Lake	62,666[1]	12.12
OBJ Mine	Panamint Mts.	Panamint	14,474[1]	2.80
Panamint Mts.	Panamint Mts.	Panamint	85,030[1] 415,000[2]	16.45 80.28
Colesseum Mine	Clark Mt.	Clark Mt.	1,400,000[2]	270.82
Morning Star Mine	Ivanpah Mts.	Clark Mt.	28,000[2]	5.42
Tecopa Mine	Nopah Range	Resting Spring Range	7,300[1]	1.41
Skidoo District	Tuki Mt.	DVNM-Tuki Mt.	75,000[1] 10,101[2]	14.51 1.95
TOTAL PRODUCTION[3]			1,562,970	304.01
TOTAL RESERVES[3]			1,853,101	358.47

[1]Past production
[2]Reserves
[3]Minimum values only: incomplete records

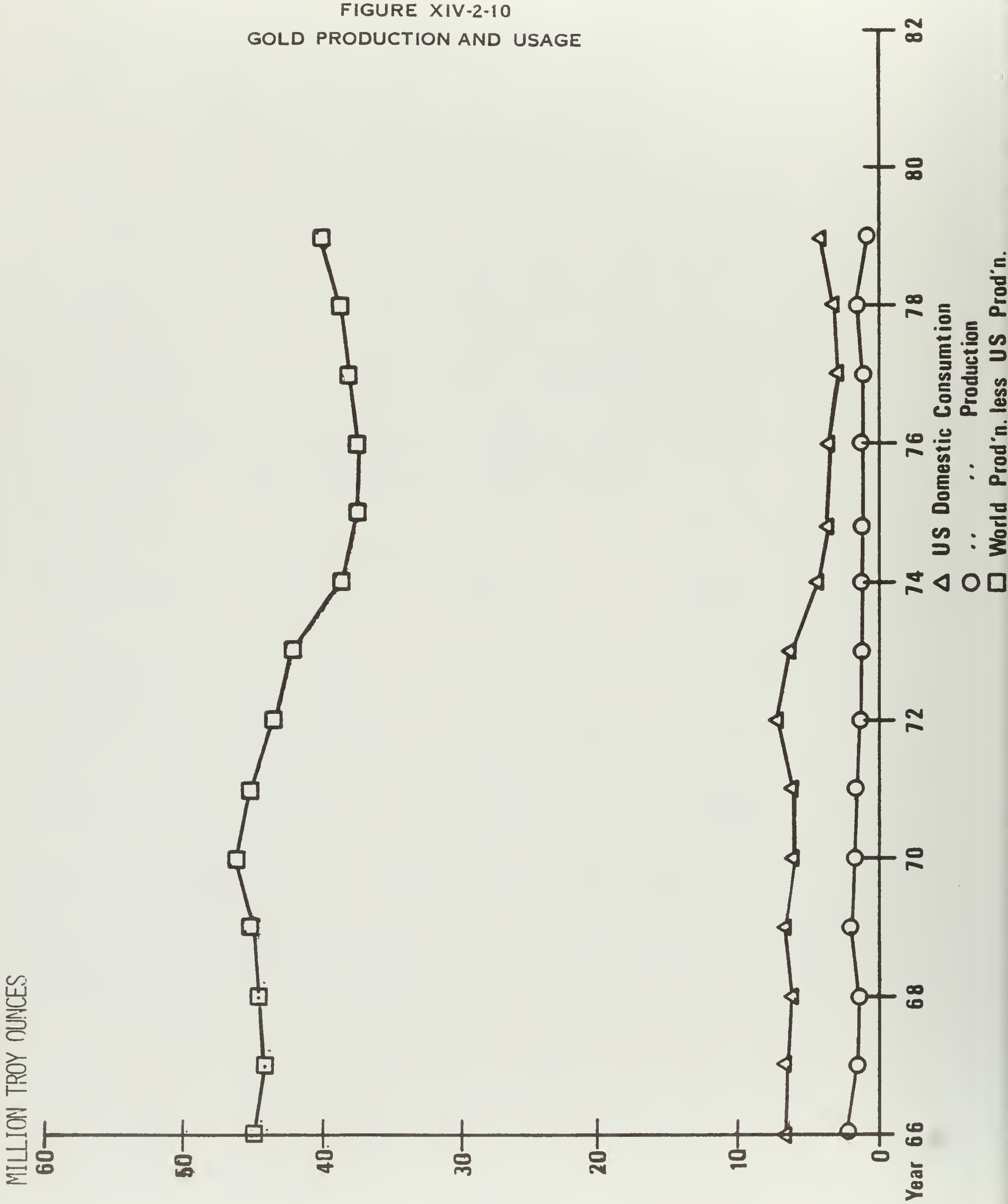
Price: 1978: $193.44 per troy ounce.

References: 1) Mineral Commodity Summary. 1979, 1980. U.S. Bureau of Mines.

2) Mineral Industry Surveys. The Mineral Industry of California in 1979. U.S. Bureau of Mines.
3) Geology and Mineral Resources of Imperial County, California. County Report 7, California Division of Mines and Geology. 1978.
4) Mines and Mineral Deposits of San Bernardino County, California. California Journal of Mines and Geology. Vol 49, 1, 2. 1953.
5) Mines and Mineral Deposit Resources of Kern County, California. County Report 1, California Division of Mines and Geology. 1962.
6) Mines and Mineral Resources of Inyo County. California Journal of Mines and Geology, Vol 37, 1. 1950.
7) Confidential data supplied by various mining companies.
8) Lead and Zinc in California. California Journal of Mines and Geology, Vol 53, No. 3, 4. 1957.
9) Mines and mineral deposits in Death Valley National Monument, California. Special Report 125. California Division of Mines and Geology. 1976.

FIGURE XIV-2-10

GOLD PRODUCTION AND USAGE



STRONTIUM (Sr)

<u>Uses</u>: Manufacture of color TV tubes 65%, pyrotechnics and signals 15%, ferrite ceramic permanent magnets 5%, other 15%.

<u>Consumption</u>: In 1978, the U.S. consumed 20,400 short tons of strontium, all imported.

<u>Trends</u>: Consumption is expected to increase at an annual rate of 3% through 1985, using a 1977 base year.

<u>Production</u>: The U.S. produces no strontium domestically. All of our strontium is imported from Mexico (79%) and West Germany (21%). Two U.S. companies process strontium compounds, one in California and the other in Georgia.

<u>Reserves</u>: Six areas in the CDCA are known to contain strontium reserves or resources.

Table XIV-2-20
STRONTIUM PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource(oz)	($x10^6) Value
Ocotillo	Fish Creek Mts.	Yuha Basin	18,000[2]	0.83
Bristol Dry Lake	Bristol Dry Lake	Bristol Lake	10,000[2] 10,000,000[3]	0.46 460.80
Avawatz	Avawatz Mts.	Avawatz Mts.	222,000[3]	10.23
Solomon	Mud Hills	Calico Mts.	500[1] 290,000	0.02 13.36
Ross	Mud Hills	Calico Mts.	140,000[2]	6.45
Ludlow	Cady Mts.	Cady Mts.	2,000,000[2] 10,000,000[3]	92.16 460.80
TOTAL PRODUCTION			500	0.02
TOTAL RESERVES			2,458,000	113.26
TOTAL RESOURCES			20,222,000	931.83

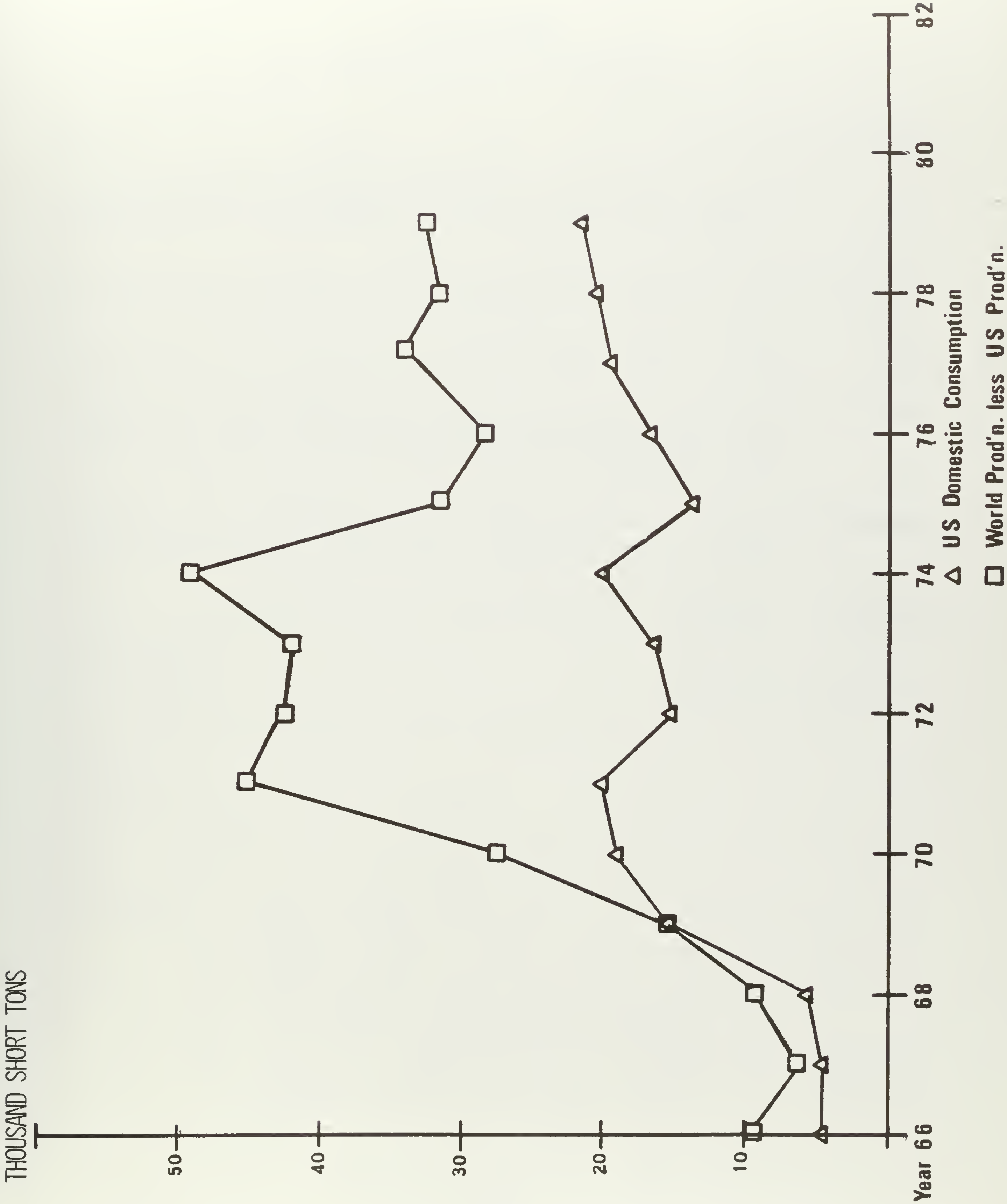
[1]Past Production
[2]Reserves
[3]Resources

Price: 1978: \$46.08 per ton of contained strontium.

References:
1) Geological Investigation of Strontium Deposits in southern California. Special Report 32 California Division of Mines and Geology 1953.
2) Mineral Commodity Summaries 1974, 1979, 1980. U.S. Bureau U.S. Bureau of Mines.
3) Mineral Commodities of California Bulletin 176. California Division of Mines and Geology 1957.

FIGURE XIV-2-11

STRONTIUM PRODUCTION AND USAGE



GROUP III

Major Export Commodities on the World Market

BORATES (B_2O_3)

Uses: Glass manufacture 50%, chemical fire retardants 15% in soap and detergents 10%, vitreous enamel 5%, agricultural-biological uses 5%, nuclear and metallurgical applications 2%.

Consumption: In 1978 the U.S. consumed 128,000 short tons of borates and exported 356,000 short tons of borates and boric acid.

Trends: From a 1977 base, the demand for U.S. borates will be at 4% anually through 1985.

Production: Most of free world borates are mined at three sites in the CDCA: Boron, Searles Lake, and southern Death Valley-Ryan area. The total borate production in the U.S. in 1978, all from the CDCA, was 1,554,000 short tons.

Substitutes: Borates are essential components of thermal-shock-resistant glasses. Some substitutes are possible in soaps, detergents, paints, and agriculture.

Reserves: In the CDCA, six areas are known to contain significant reserves of borates.

Table XIV-2-21
BORATE PRODUCTION IN THE CDCA

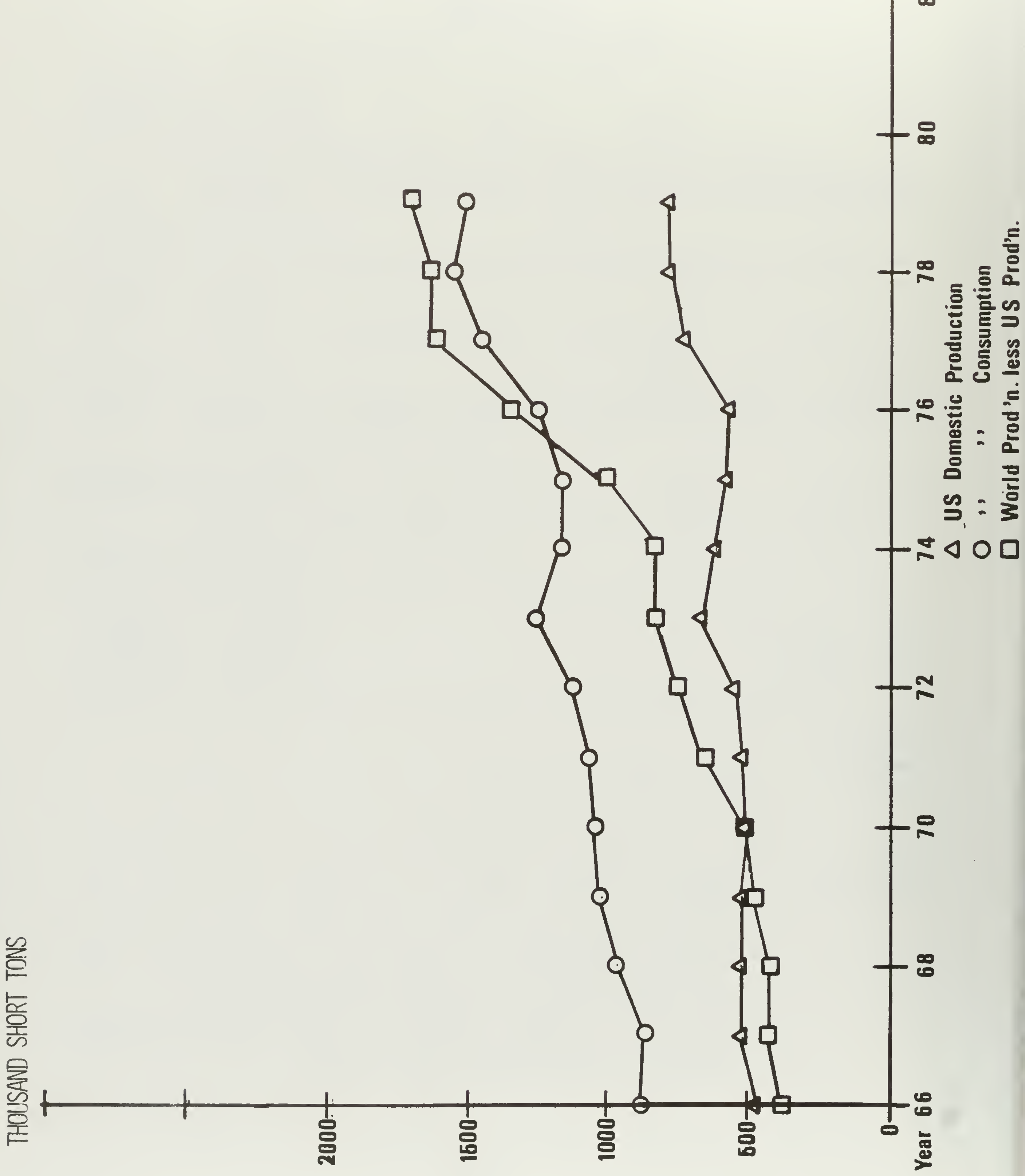
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
American Borax Co. - U.S. Borax		DVNM-Black Mts	180,706[1]	64.28
			2,041,200[2]	726.05
			14,759,000[3]	5,249.78
Ryan Area	Ryan	Greenwater Range	1,956,700[2]	696.00
			824,000	293.10
Death Valley Junction	Death Valley Junction	Pyramid Peak	1,000[2]	0.36
			350,000[3]	124.50
Shoshone	Shoshone	Resting Spring Range	89,628[2]	31.88
			485,000[3]	172.51
Kerr McGee	Trona	Searles	4,000,000[1]	1,422.80
			25,000,000[2]	8,892.50
U.S. Borax	Boron	Boron	21,794,850[1]	7,752.43
			25,000,000[2]	8,892.50
			10,340,000[3]	3,677.94
TOTAL PRODUCTION[4]			25,975,556	9,239.51
TOTAL RESERVES			54,088,528	19,239.29
TOTAL RESOURCES			26,758,000	9,517.82

[1]Past Production
[2]Reserves
[3]Resources
[4]Minimum values only; records incomplete

Price: 1978: $355.70 per short ton B_2O_3.

References:
1) Mineral Commodity Summaries. 1978, 1979, and 1980. U.S. Bureau of Mines.
2) Minerals Commodity Profile for Boron. U.S. Bureau of Mines. 1979.
3) Mineral Commodities of California. Bulletin 176. 1957. California Division of Mines and Geology. 1975.
4) Proprietary data from various mining companies.
5) Mines and mineral deposits in Death Valley National Monument, California. Special Report 125. California Division of Mines and Geology. 1976.

FIGURE XIV-2-12
BORATE PRODUCTION AND USAGE



KYANITE (Al_2O_5)

Uses: Major uses in refractories, smelting, glassmaking, and furnace linings.

Consumption: Estimated to be 25,000 short tons per year. The U.S. is a net exporter of kyanite.

Trends: The demand for kyanite and synthetic mullite is expected to increase by 6% per year thru 1985. Export demand is expected to be higher.

Production: All kyanite in the U.S. is mined in Virginia and Georgia. Past production in the CDCA was from the Cargo Muchacho Mountains in Imperial County between 1925 and 1956. A total of 31,000 short tons was produced in that time.

Substitutes: Bauxite, kaolin, other clays, and silica sand can be used in place of kyanite. Sythetic mullite can be replaced by high alumina materials or super duty fire clays.

Reserves: An estimated 3,730,000 short tons of kyanite are contained in three deposits in the Cargo Muchacho Mountains.

Table XIV-2-22
KYANITE PRODUCTION IN THE CDCA

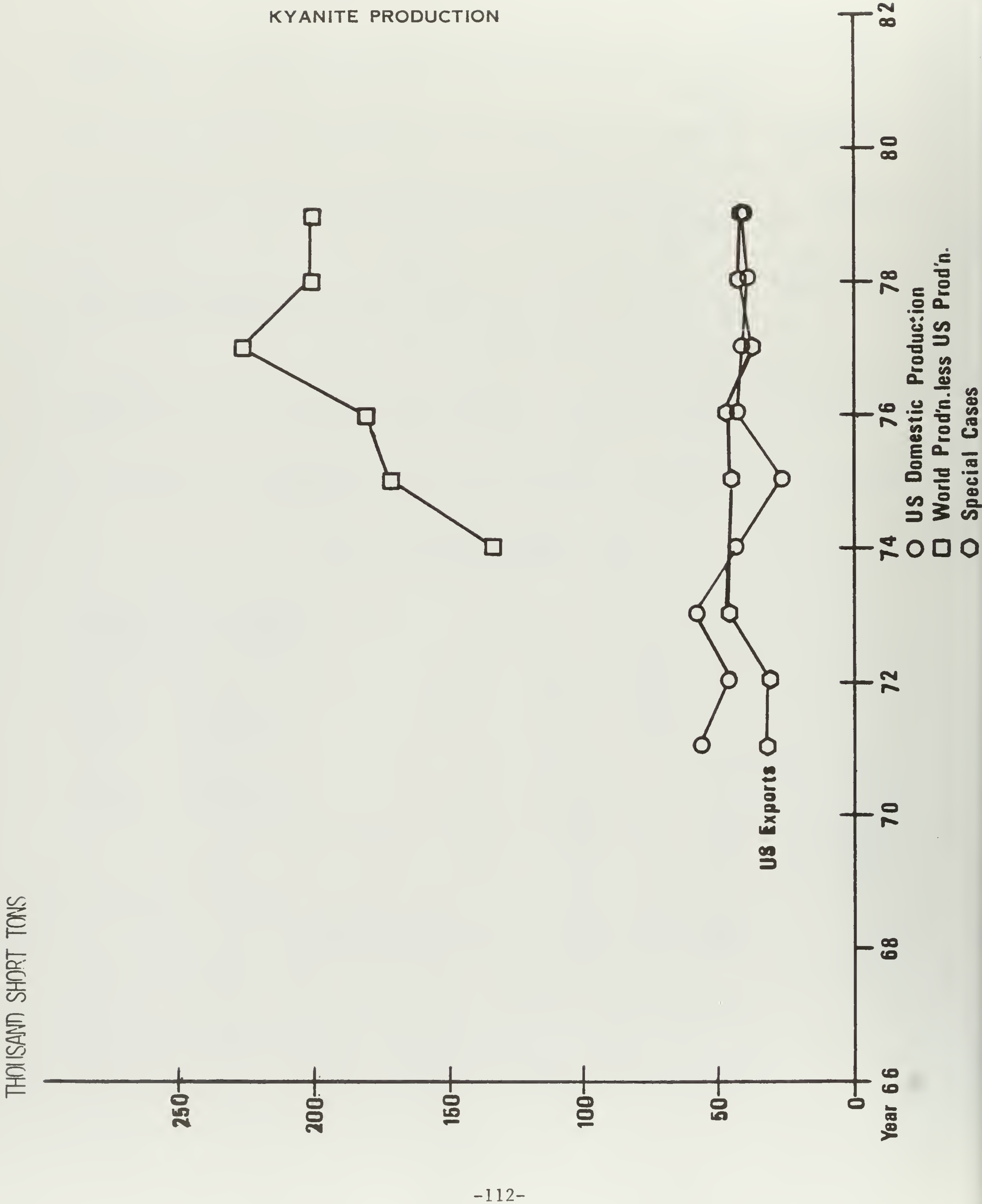
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6$) Value
Cargo Muchacho	Cargo Muchacho Mts.	Picacho	31,000[1] 3,730,000[3]	1.95 234.99
TOTAL PRODUCTION			31,000	1.95
TOTAL RESOURCES			3,730,000	234.99

[1]Past Production
[2]Reserves
[3]Resources

Price: 1978: \$63.00 to \$117.00 per short ton of kyanite. \$139.00 to \$810.00 per short ton of synthetic mullite.

References:
1) Mineral Commodities Summaries. U.S. Bureau of Mines. 1980.
2) Geology and Mineral Resources of Imperial County, California. County Report 7. Paul K. Morton. California Division of Mines and Geology. 1977.

FIGURE XIV-2-13
KYANITE PRODUCTION



LITHIUM (Li)

Uses: About 33% of domestic production was consumed in aluminum potlines (smelting of aluminum ores) and 40% in the manufacture of class, ceramics, and specialty greases.

Trends: Using 1978 as a base year, over-all demand for lithium chemicals is expected to increase at an annual rate of 10% to 1985.

Production: All U.S. production of lithium is produced by two companies, one in Nevada, the other in North Carolina. The estimated U.S. production in 1978 was 5,385,000 short tons of contained lithium. The Kerr-McGee facility at Searles Lake produced lithium until 1978 when it phased out lithium operations because of economic considerations.

Substitutes: Other materials can be used in place of lithium in glasses, ceramics, greases, and batteries. These include sodium and potassium in glasses and ceramics, calcium and aluminum in soaps and greases, and zinc, magnesium, calcium, and mercury as anode material in primary batteries.

Reserves: In the CDCA, eight areas are known to contain reserves or resources of potentially extractable lithium.

Table XIV-2-23

LITHIUM PRODUCTION IN THE CDCA

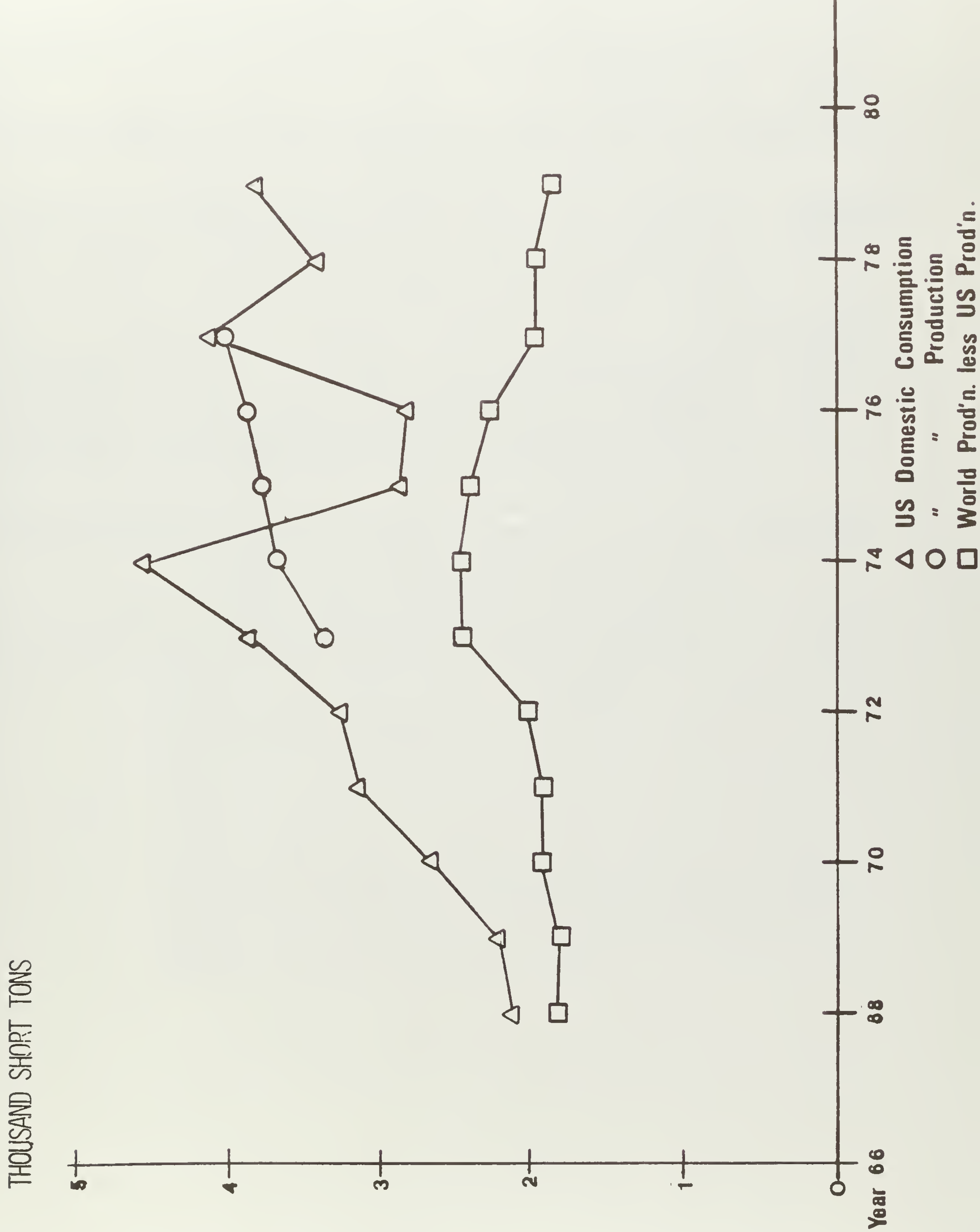
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
Kerr McGee	Trona	Searles	22,600[1] 62,500[2]	46.10 127.50
Niland	Salton Sea	Salton Sea	1,800,000[3]	3,672.00
Cadiz Dry Lake	Cadiz Dry Lake	Cadiz/Danby Lake	6,000[3]	12.24
Bristol Dry Lake	Bristol Dry Lake	Bristol Lake	6,000[3]	12.24
Franklin Dry Lake Lake	Franklin Dry Lake	Pyramid Peak	15,600[3]	31.82
Eureka Dry Lake	Eureka	Eureka Valley	15,600[3]	31.82
Death Valley	Black Mts.	DVNM-Black Mts.	5,500[3]	11.22
Kramer	Kramer	Boron	5,500[3]	11.22
TOTAL PRODUCTION[4]			22,600	46.10
TOTAL RESERVES			62,500	127.50
TOTAL RESOURCES			1,854,200	3,782.57

[1]Past Production
[2]Reserves
[3]Resources
[4]Minimum value only; incomplete records

Price: 1978: \$1.02 per pound Li_2CO_3
\$1.40 per pound LIOH
\$15.00 per pound Li metal
\$125.00 per short ton sponumene, LiA1 (SiO_3)

References:
1) Mineral Industry Surveys. 1976, 1977, 1978. U.S. Bureau of Mines.
2) Mineral Commodities in California. Bulletin 176. California Division of Mines and Geology. 1975.
3) Mineral Commodity Summaries. 1978, 1979. Bureau of Mines.
4) Leasable Mineral Resources of the California Desert Conservation Area. J. P. Calzia et al. U.S. Geological Survey. 1979.
5) A Classification of Lithium Deposits and Anomalies. James Vine. U.S. Geological Survey. 1979.

FIGURE XIV-2-14
LITHIUM PRODUCTION AND USAGE



RARE EARTH OXIDES (REOs), (CeF)CO_3

Uses: Petroleum catalysts 38%, steel making 38%, ceramic and glass 19%, other 5% (electrical, nuclear, super alloys, magnets, and color TV tubes).

Consumption: The apparent domestic consumption of REOs in 1978 was 18,500 short tons. About 100 short tons were exported in 1978 and 6,309 short tons were imported.

Trends: From a 1977 base year, domestic consumption is expected to increase at an annual rate of 6% through 1985. Foreign imports will increase due to a major U.S. producer of monazite closing its Florida operations in April 1979.

Production: The worlds major producer of REOs from basnaestite is Molycorp Inc., at Mountain Pass, California. The U.S. imports monazite ores (6,309 short tons in 1978) from Australia, Malaysia, and Thailand. However, the monazite ores do not contain the entire suite of rare earth elements, the deficiency must be extracted from the basnaestite ores of Mountain Pass. The 1978 production in the U.S. was approximately 9,000 short tons of REOs.

Substitutes: In major use categories, there are no suitable substitutes now known. In minor use areas, substitutes are available, but are less effective than the rare earth elements.

Reserves: The present U.S. reserves are located at Mountain Pass, California. The pit area contains 5,080,000 short tons of REOs.

Table XIV-2-24
RARE EARTH OXIDES PRODUCTION IN THE CDCA

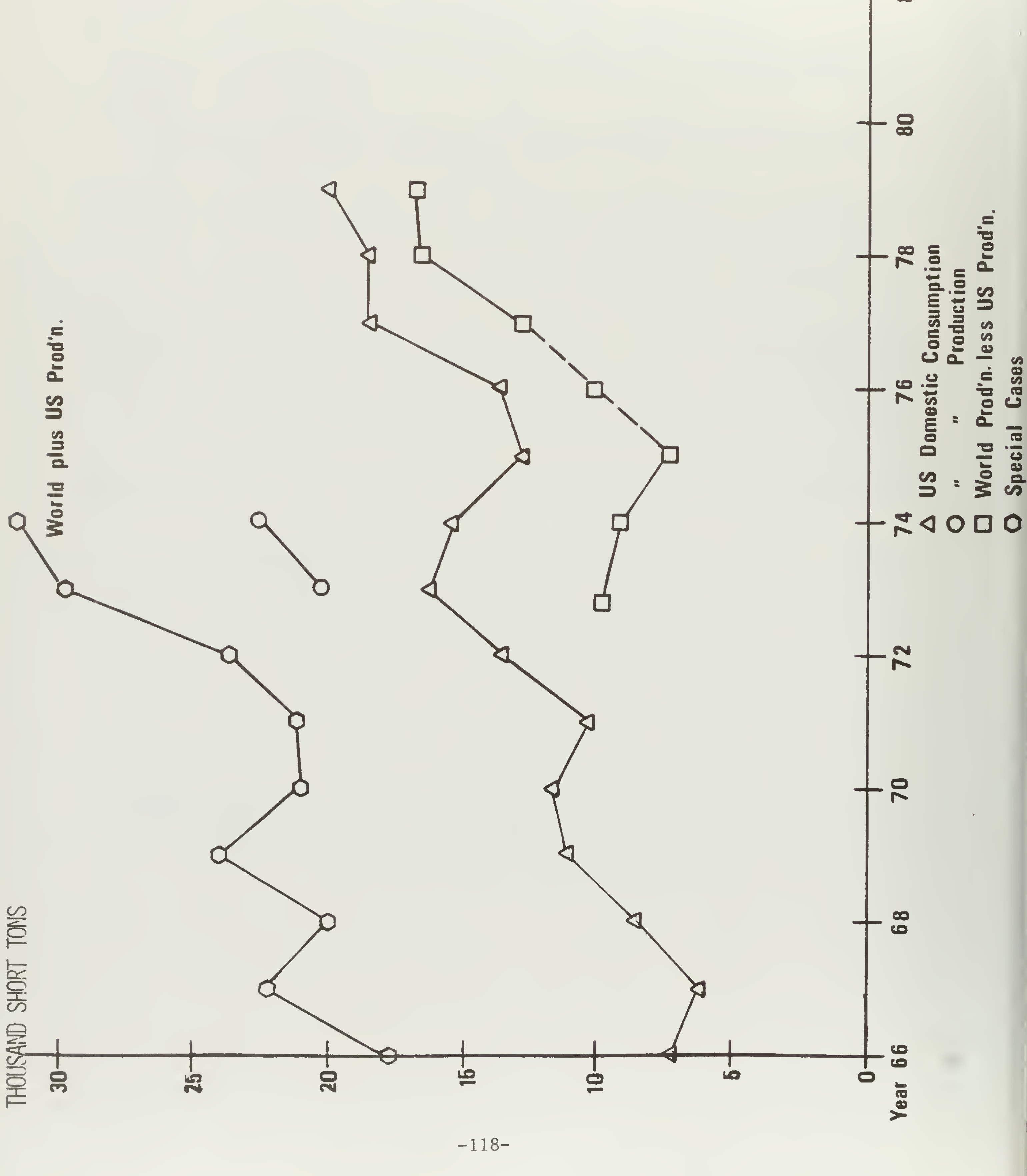
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
Molycorp Inc.	Mountain Pass	Clark Mt.	4,200,000[1]	6,384.00
			2,540,000[2]	3,860.80
			2,540,000[3]	3,860.80
South of Mountain Pass	Ivanpah Mt.s	Clark Mt	1,819[2]	2.75
			7,200[3]	20.94
TOTAL PRODUCTION[4]			4,200,000	6,384.00
TOTAL RESERVES			2,541,810	3,863.55
TOTAL RESOURCES			2,547,200	3,871.74

[1]Past Production
[2]Reserves
[3]Resources
[4]Minimum value only; records incomplete

Prices: 1978: $0.76 per pound of contained REO in basnaestite.
$0.20 per pound of contained REO in monazite.

References:
1) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
2) Mineral Commodity Reports. Rare Earths. 1976, 1977, 1978. U.S. Bureau of Mines.
3) Mineral Commodity Summaries. 1978, 1979. U.S. Bureau of Mines.
4) Mineral Commodity Profiles. Rare Earths. U.S. Bureau of Mines. 1979.
5) Rare-Earth Mineral Deposits of the Mountain Pass District, San Bernardino County, California. U.S. Geological Survey Professional Paper 261. U.S. Geological Survey. 1954.
6) Principal thorium resources in the United States. U.S. Geological Survey Circular 805. 1979.

FIGURE XIV-2-15
RARE EARTH OXIDES PRODUCTION AND USAGE



SODIUM CARBONATE (Na_2CO_3)

Uses: About 55% of domestically consumed soda ash was used in glass manufacturing; Chemical reagents 23%, detergents 5%, pulp to paper 3%, water treatment 3%, others 11%. About 9% was exported.

Consumption: The U.S. consumes 7,515,000 short tons of Na_2CO_3 per year and exports 730,000 short tons annually.

Trends: The demand for soda ash, based on 1977 projections, is to increase by 1.8% per year thru 1985.

Production: The national production of soda ash in 1979 was 8,235,295 tons. The CDCA produced 17% of that, or 1,400,000 tons, from the Kerr-McGee plant at Trona, California.

Substitutes: Caustic soda can be substituted for soda ash but at a higher cost.

Reserves: The reserves at Searles Lake are large and are estimated to have a production life of 770 years at the present annual rate of 1,400,000 short tons.

Table XIV-2-25
SODIUM CARBONATE PRODUCTION IN THE CDCA

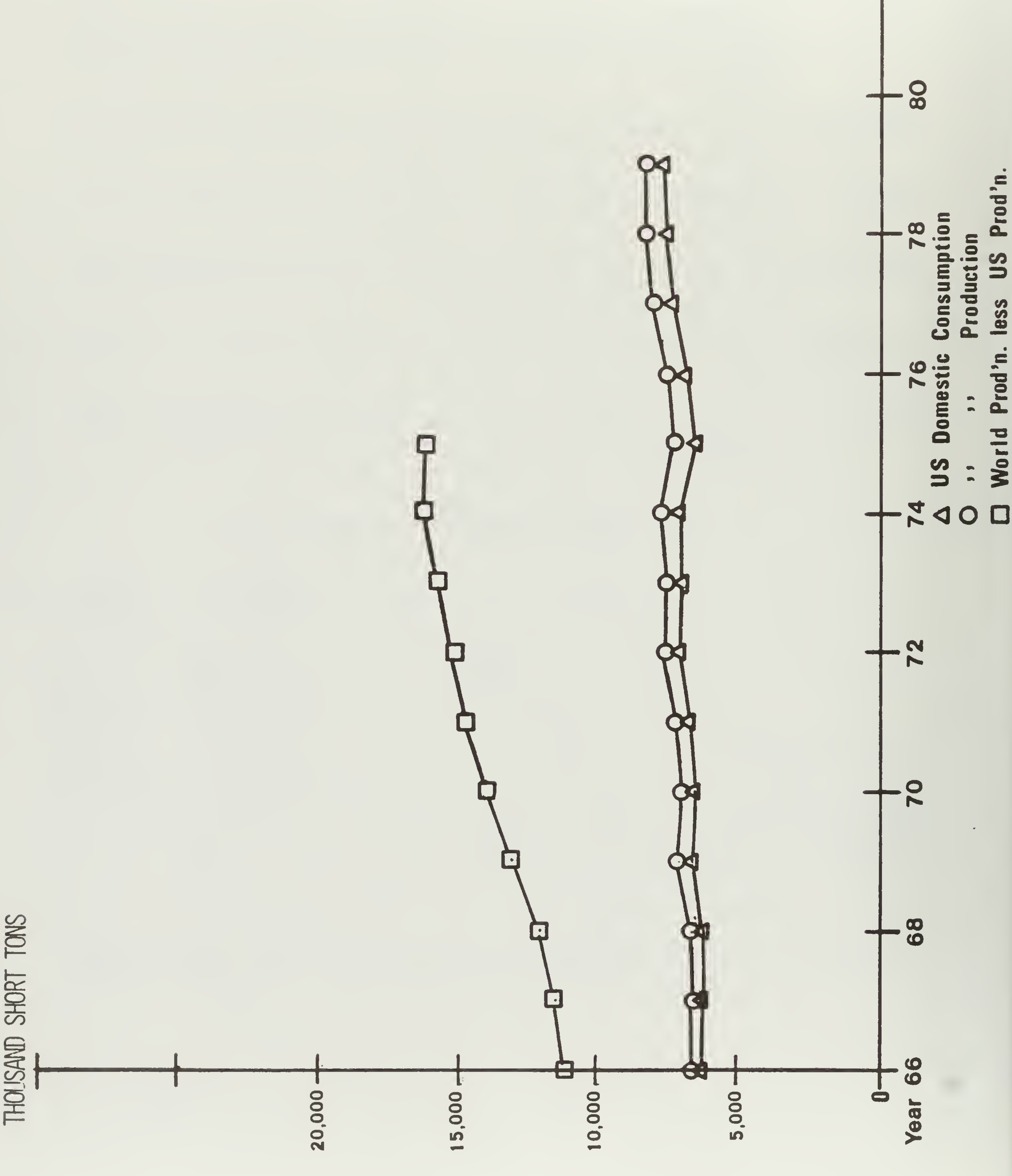
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
Kerr McGee	Trona	Searles	29,700,000[1]	1,811.70
			1,078,000,000[2]	65,758.00
TOTAL PRODUCTION[3]			29,700,000	1,816.70
TOTAL RESERVES			1,078,000,000	65,758.00

[1]Past Production
[2]Reserves
[3]Minimum Values only: incomplete records

Price: 1978: $61 a short ton.

References:
1) Mineral Commodity Summaries. U.S. Bureau of Mines. 1980.
2) Mineral Commodity Profiles-Soda ash. U.S. Bureau of Mines. 1979.

FIGURE XIV-2-16
SODIUM CARBONATE PRODUCTION AND USAGE



URANIUM (U), (U_3O_8)

<u>Uses</u>: The major uses of uranium are as a nuclear fuel in generating electrical power and in weapons manufacture for the military. Small amounts are used in pure research. Depleted uranium is used for armor-piercing shells, containers for radioactive waste, radiation shielding, and aircraft counterweights, ballast, and research.

<u>Consumption</u>: The consumption in 1978 is estimated at 20,000 short tons of U_3O_8 and 5,500 short tons of depleted uranium metal.

<u>Trends</u>: It is expected that domestic demand will increase at an annual rate of 5% through 1985, using 1978 as a base year.

<u>Production</u>: The U.S. produced approximately 16,700 short tons of U_3O_8 and 25,000 short tons of depleted uranium metal in 1978. There is no current production in the CDCA. Most of the U.S. production comes from New Mexico, Arizona, Wyoming, Colorado, and Nevada.

<u>Substitutes</u>: For reactors and weapons, thorium or plutonium may be substituted. However, plutonium is produced from uranium. Depleted uranium can be replaced by lead, tungsten, or other dense metals.

<u>Reserves</u>: No proven reserves are known to exist in CDCA. However, six areas of potential uranium resources have been identified.

Table XIV-2-26
URANIUM PRODUCTION IN THE CDCA

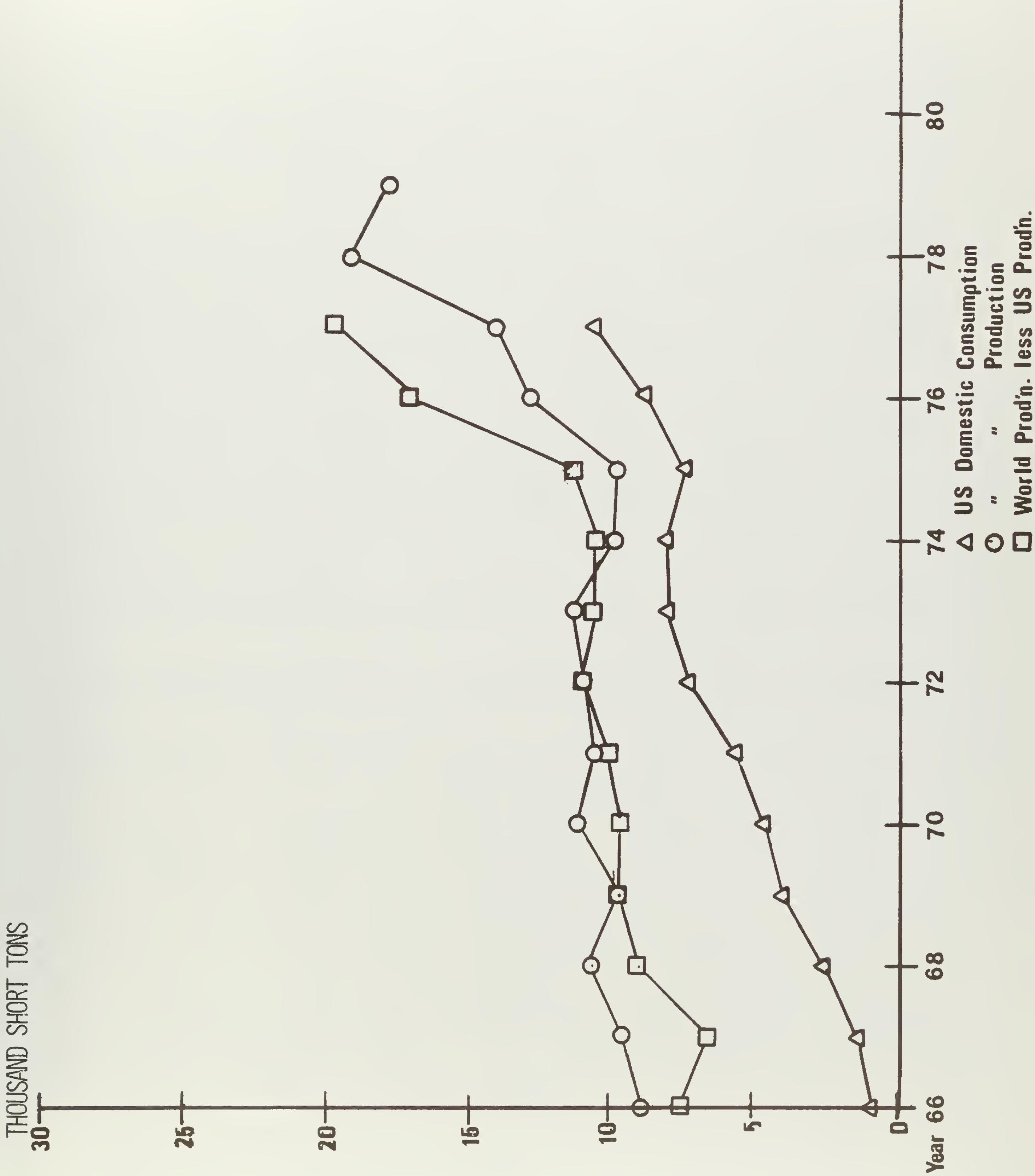
DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
Coso	Haiwee Res.	Haiwee Res.	50,800[1]	4,267.20
Owens Valley	Owens Lake South Shore	Haiwee Res.	12,000[1]	1,008.00
McCoy Mts.	McCoy Mts.	Palen/McCoy Mts.	600[1]	50.40
Eastern Sierra Nevada Mts.	Eastern Sierra Nevada Mts.	Owens Peak	26,000[1]	2,184.00
Big Maria Mts.	Big Maria Mts.	Big Maria Mts.	2,000[1]	158.00
Rosemond	Willow Springs	Soledad/Rosemond	10,000[1]	840.00
TOTAL RESOURCES[2]			101,400	8,517.60

[1]Resources
[2]Approximately 35,000 short tons are speculative based on airborne geophysical surveys and geologic interpretation.

Price: 1978: $42.00 per pound uranium (nuclear)
$ 2.50 per pound uranium (depleted)

References:
1) Mineral Commodity Summaries. 1978, 1979. U.S. Bureau of Mines.
2) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
3) Statistical Data of the Uranium Industry. U.S. Department of Energy. 1978.
4) Uranium in California. John S. Rapp. California Division of Mines and Geology. 1976.

FIGURE XIV-2-17
URANIUM PRODUCTION AND USAGE



GROUP IV

Commodities of Local and Regional Economic Significance

GEOTHERMAL

Uses: Geothermal products (hot water and steam) have two major uses. One is for electric power generation and the other is for direct heat application such as space heating, hydrophonics, and industrial requirements for process heating.

Consumption: The U.S. is--or will be--generating electrical power from geothermal reservoirs in Utah, New Mexico, and California. Power generation is currently being produced only in California.

Trends: The recent technological breakthrough in noncorroding alloys and in plant design will allow geothermal power plants to be rapidly placed on line once a reservoir is proven.

Production: Electrical power is currently being generated at the Geysers in northern California and at East Mesa in Imperial County, California. Additional power will be generated in the Imperial Valley at Brawley (1980), Heber, (1981), and East Mesa (1981)). California currently generates 650 MWe of electric power from geothermal sources. By 1985 this figure will rise to at least 1500 MWe.

Substitutes: Coal, oil, gas, or nuclear fuels may be substituted for geothermal power, but they are harder to control environmentally.

Reserves: The CDCA has 18 geothermal areas that are capable of either electrical generation or direct heat utilization.

Table XIV-2-27
GEOTHERMAL PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Temp.	Potential
Coso KGRA	Coso Hot Springs	Haiwee Res	220[1]	650 MWe[2]
Randsburg KGRA	Randsburg	Red Mt.	172	84 MWe
Salton Sea	Niland	Salton Sea	323	3,400 MWe
Heber KGRA	Heber	Imperial Valley	175	650 MWe
Brawley KGRA	Brawley	Imperial Valley	253	640 MWe
East Mesa KGRA	East Mesa	East Mesa South	182	360 MWe
Westmoreland	Westmoreland	Imperial Valley	217	1,710 MWe
Glamis KGRA	Glamis	East Mesa North	132[3]	Good
Dunes KGRA	East Mesa	East Mesa South	132[3]	Good
East Brawley	Brawley	Imperial Valley	132[3]	Good
Saline Valley KGRA	Saline Valley	Saline Valley	89	Dir. Heat
Tecopa Hot Spt Springs	Tecopa	Dumont Dunes	126	Dir. Heat
Ford Dry Lake KGRA	Ford Dry Lake	Palen/McCoy Mts	?	Good
Yuha Basin	Yuha Basin	Yuha Basin	?	Good
Pisgah Crater	Pisgah Crater	Lady Mts.	?	Unknown
Amboy Area	Amboy Crater	Bristol Mts.	?	Moderate
Truckhaven	Salton City	Salton Sea	?	Good
Searles Lake	Searles Lake	Searles	L100	Moderate

[1]Temperature in degrees celsius
[2]MWe = Megawatts of electric power
[3]Estimated from temperature gradient surveys
L = Less than

Price: 1978: $5,000 per Megawatt of output in tax revenues to the county of origin.

References:
1) Assessment of the Geothermal Resources of the U.S. 1978. Circular 790. U.S. Geological Survey. 1979.
2) Company sponsored data.

GYPSUM (Ca SO_4 $2H_2O$)

<u>Uses</u>: Plaster-of-Paris, cement, agricultural soil conditioning, gypsum for building construction.

<u>Consumption</u>: In 1978, the U.S. consumed 22,609,000 short tons of gypsum of which 8,308,000 short tons (38 percent) were imported.

<u>Trends</u>: From 1977 base year, the annual demand is expected to increase at 2.7 percent through 1985.

<u>Production</u>: In 1978 the U.S. produced 14,891,000 short tons of gypsum. The leading producing states are Michigan, Texas, Iowa, California, Oklahoma, and Nevada. In 1978, California produced 1,578,000 short tons, 11% of the U.S. production. A major portion was from Imperial and Riverside county areas of the CDCA.

<u>Substitutes</u>: Other construction materials may replace gypsum except in cement.

<u>Reserves</u>: The CDCA has produced significant amounts of gypsum in the past and is currently producing large amounts from the Fish Creek Mountains in Imperial County. A new mine in the Little Maria Mountains is currently in development.

Table XIV-2-28
GYPSUM PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (short tons)	($x10⁶) Value
Fish Creek Mts.	Fish Creek Mts.	Yuha Basin	17,000,000[1] 271,546,753	105.91 1,691.74
Coyote Mts.	Coyote Mts.	Yuha Basin	22,220,017[2]	138.43
Little Maria Mts.	Little Maria Mts.	Big Maria Mts.	1,487,864[1] 1,409,449,762[2]	9.27 8,780.87
Big Maria Mts.	Big Maria Mts.	Big Maria Mts.	67,981,355[2]	423.52
Palen Mts.	Palen Mts.	Palen/McCoy	284,384,537[2]	4,263.72
Riverside Mts.	Riverside Mts.	Riverside Mts.	102,513,590[2]	638.66
Shire	Clark Mt.	Clark Mt.	99,237,529[1]	618.25
Avawatz Mts.	Avawatz Mts.	Avawatz Mts.	435,160,305[2]	2,711.05
TOTAL PRODUCTION[3]			18,491,210	115.20
TOTAL RESOURCES			3,101,830,640	19,324.40

[1]Past production
[2]Resource
[3]Minimum value only, due to incomplete records.

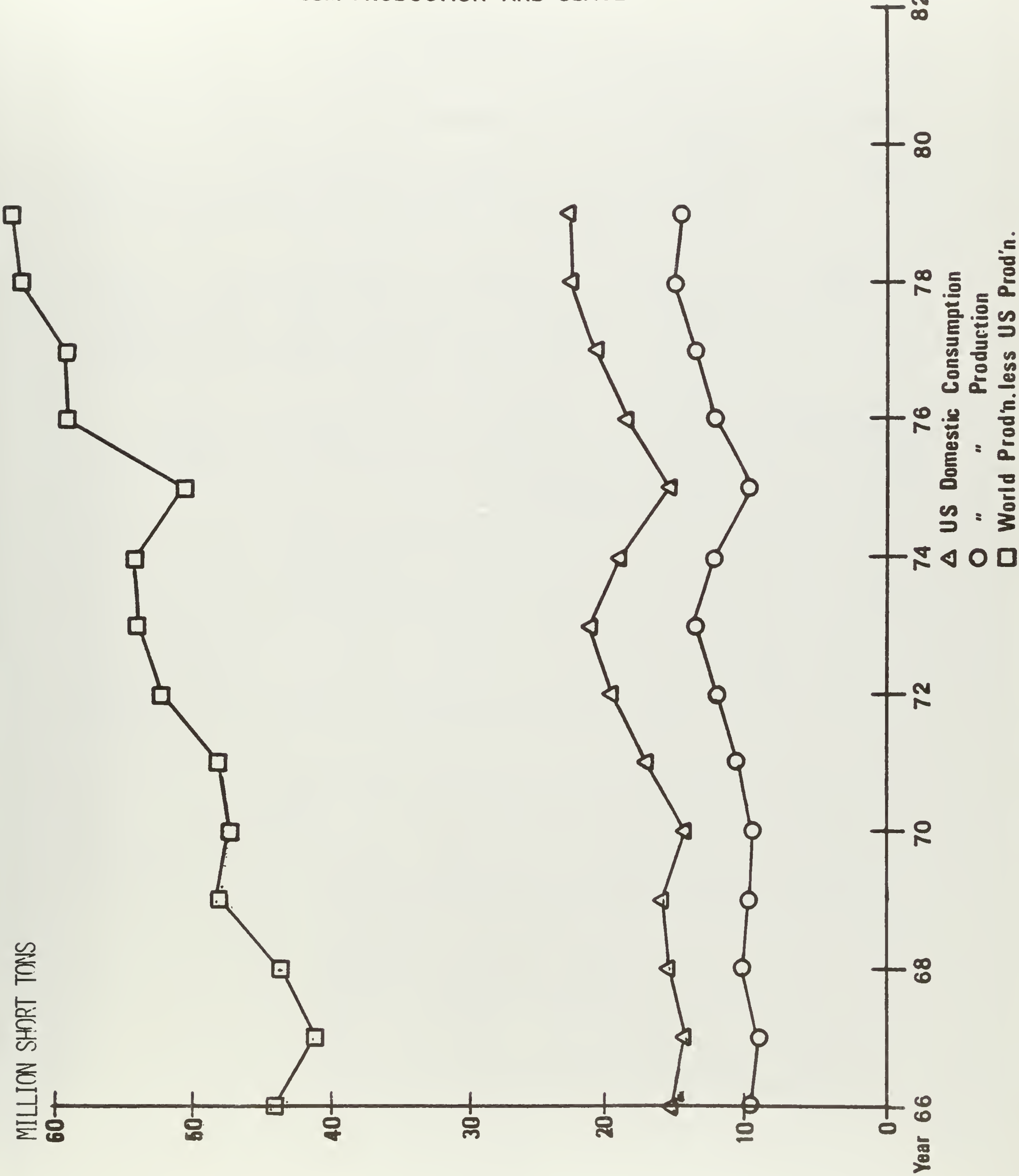
Price: 1978: $6.23 per short ton, FOB at the mine site.

References:

1. Mineral Commodity Summaries. U.S. Bureau of Mines. 1980.
2. Gypsum in California. Bulletin 163. California Division of Mines and Geology. 1952.
3. Geology and Mineral Resources of Imperial County, California. County Report 7. California Division of Mines and Geology. 1978.

FIGURE XIV-2-18

GYPSUM PRODUCTION AND USAGE



IRON (Fe)

Uses: The major use of iron is in the production of various types and alloys of iron, steel and cement.

Consumption: The United States consumed 125,000,000 long tons of iron in 1978.

Trends: The annual demand for iron ore in the United States is expected to increase at a rate of 2% through 1985, using 1976 as a base year.

Production: The United States produced 81,500,000 long tons in 1978, and imported an additional 33,600,000. There are several producing iron mines in the CDCA of which Kaiser Steel's operation at Eagle Mountain is the largest. Others produce iron ore for the cement industry in southern California. Small amounts are shipped to Japan.

Substitutes: There are no substitutes for the major uses of iron.

Reserves: There are 10 iron ore deposits in the CDCA with known calculated reserves.

Table XIV-2-29
IRON PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (long ton)	($x10^6) Value
Whittaker Mine	Argus Mts.	Darwin/Slate Rge	20,000,000[1]	44,000
Eagle Mt.	Eagle Mt.	Eagle Mt.	43,000,000[1]	94,600
Iron Mt.	Avawatz Mt.	Avawatz Mts.	10,100,000[1]	22,220
Old Dad Mt.	Old Dad Mts.	Bristol Mts.	450,000[1]	990
Cave Canyon	Cave Mt.	Cady Mts.	12,000,000[1]	26,400
Iron Hat Mine	Marble Mts.	Marble Mts.	185,000[1]	407
Ship Mt.	Ship Mt.	Marble Mts.	8,680,000[1]	19,096
Kingston Mt.	Kingston Range	Kingston Range	6,000,000[1]	13,200
Kelso Dunes	Kelso Dunes	Old Dad Mt	100,000,000[2]	22,000
TOTAL RESERVES			100,415,000	220,913
TOTAL RESOURCES			100,000,000	220,000

[1]Reserves
[2]Resources

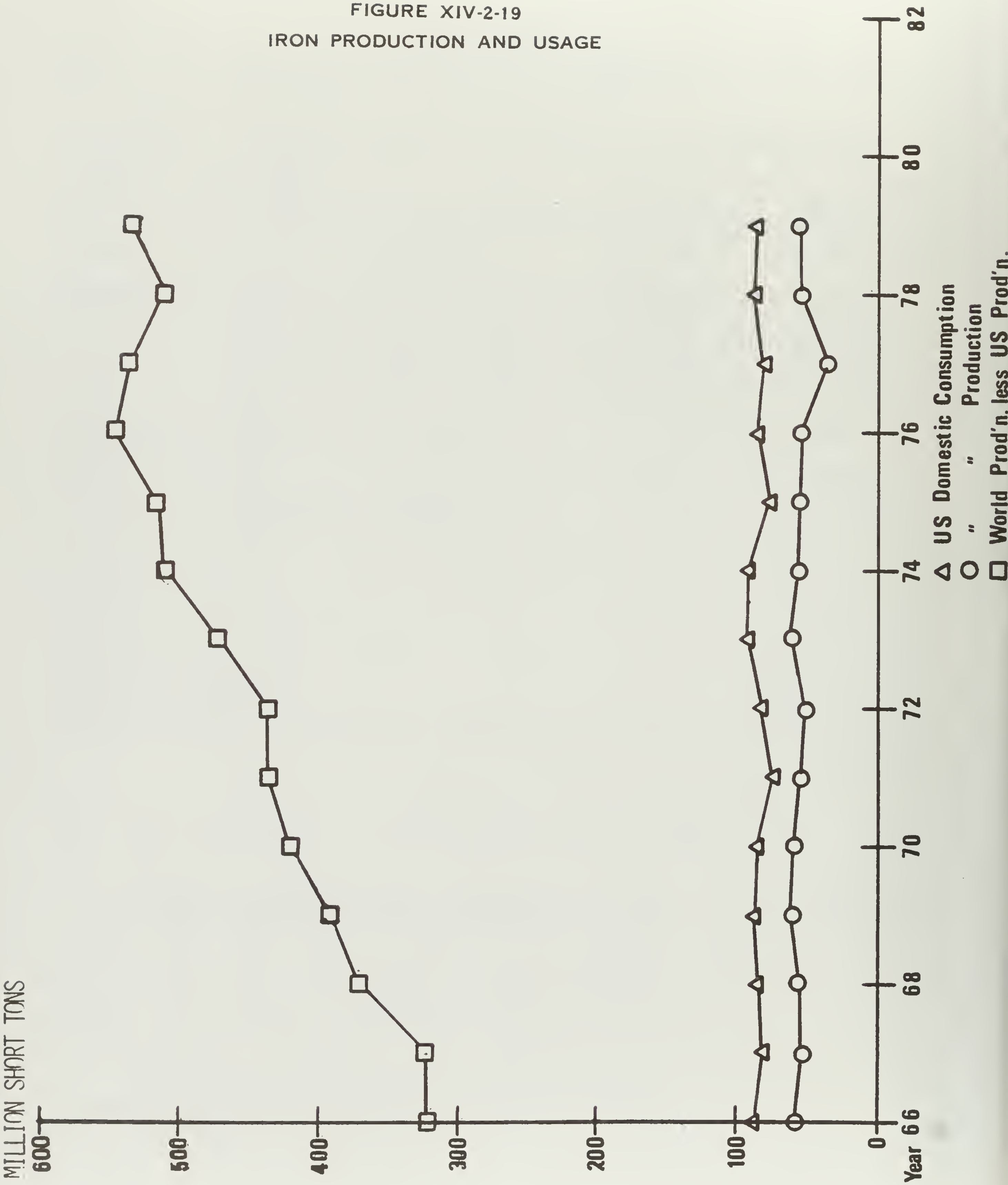
Price: 1978: $22.00 per long ton unit (50-60% Fe_2O_3), FOB at the mine.

References:

1) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
2) Mineral Commodity Summary. 1978, 1979. U.S. Bureau of Mines.
3) Commodity Reports for Iron. 1975, 1976, 1977, 1978, 1979. U.S. Bureau of Mines.
4) Mineral Commodity Profiles for Iron Ore. U.S. Bureau of Mines. 1978.
5) Iron Resources of California. Bulletin 129. California Division of Mines and Geology. 1948.
6) Proprietary data supplied by various mining companies.

FIGURE XIV-2-19

IRON PRODUCTION AND USAGE



LIMESTONE, LIME, CEMENT ($CaCO_3$, $CaMgCO_3$)

<u>Uses</u>: Manufacture of various cements and lime products; chemical, agricultural, and soil conditioning; production of carbon dioxide, metallurgical fluxes, and as sulfur dioxide scrubbers in fossil-fueled power plants.

<u>Consumption</u>: The U.S. consumption of lime in 1978 was 21,008,000 short tons.

<u>Trends</u>: Cement consumption is expected to increase at 3% annually nationwide and at 5% in southern California. The western U.S. imported 800,000 tons of cement clinker in 1978; imports are expected to continue in the short term. Lime is expected to increase in demand at an annual rate of 4% through 1985. In 1978 the United States imported 535,000 short tons of lime.

<u>Production</u>: The U.S. total production in 1978 was 20,443,000 short tons of lime products and cement. About 610,000 short tons were imported. There are several producers in the CDCA who mine limestone deposits in the CDCA. Limestone mines in the CDCA will begin to increase in 1985, and by 2000, all of the current cement producers in southern California will be obtaining limestone in the CDCA, because of depletion of deposits outside the CDCA.

In southern California, current production of limestone for cement is 12,000,000 short tons; an additional 1,000,000 short tons are mined for lime products annually.

<u>Substitutes</u>: Limestone can be supplanted by calcined gypsum in lime products and by metals, wood, fiberglass, stone and clay products in cement.

<u>Reserves</u>: Eleven areas of limestone deposits are known in the CDCA.

Table XIV-2-30
LIMESTONE PRODUCTION IN THE CDCA

DEPOSIT	Location	Gra	Resource(st)	($x10⁶) Value
Fish Creek Canyon	Fish Creek Mt.	Yuha Basin	100,000,000[1] 300,000,000[2]	300.00 900.00
Coyote Mts.	Coyote Mt.	Yuha Basin	150,000,000[2]	450.00
Cushenbury	San Bernardino Mts.	Stoddard	100,000,000[1] 300,000,000[2]	300.00 900.00
Marble Mts.	Marble Mts.	Marble Mts.	50,000,000[2]	150.00
New York Mts.	New York Mts.	New York Mts.	42,000,000[2]	128.00
Black Mt.	Victorville	Stoddard	35,000,000[2]	105.00
Black Mt.	Victorville	Stoddard	20,600,000[2]	62.00
Alvord Mts.	Alvord Mts.	Alvord Mt.	25,000,000[2]	75.00
Cave Canyon	Afton Canyon	Cady Mts.	30,000,000[2]	150.00
Gamble Spring Cyn.	Tehacapi Mts.	Soledad/Rosemound	100,000,000[2]	300.00
Bryant	Shadow Mts.	Adobe Mt.	50,000,000[2]	150.00
Lee Flat	Darwin	Talc City Hills	50,000,000[2]	150.00
Darwin	Darwin	Talc City Hills	150,000,000[2]	450.00
Talc Hills	Darwin	Talc City Hills	10,000,000[1] 50,000,000[2]	30.00 150.00

[1]Reserves
[2]Resources

Table XIV-2-30 (Cont'd)
LIMESTONE PRODUCTION IN THE CDCA

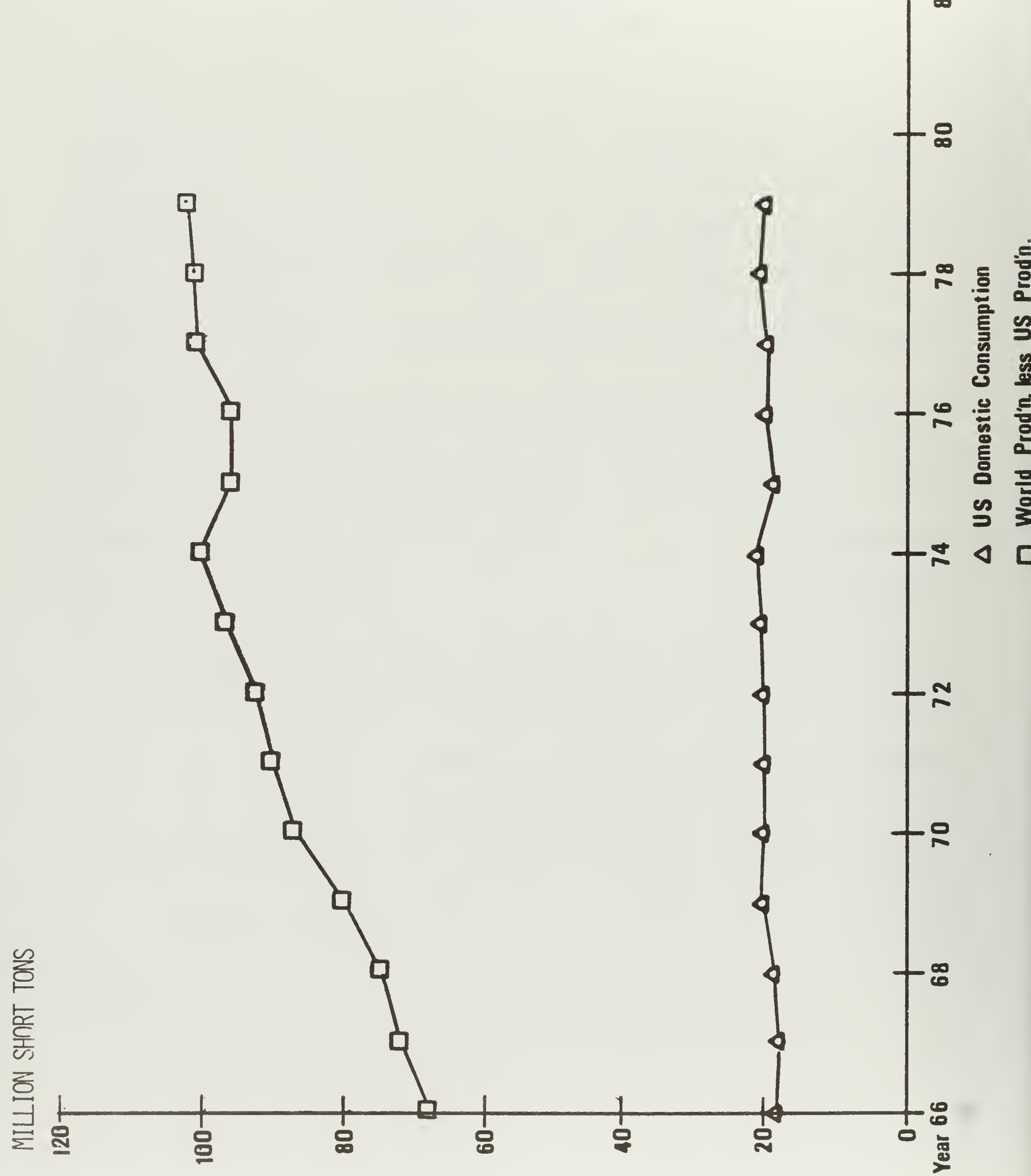
DEPOSIT	Location	GRA	Resource(st)	($x10^6 Value
Piute Mts.	Piute Mts.	Piute Mt.	100,000,000[1]	300.00
			300,000,000[2]	900.00
San Jacinto Mts.	Banning Pass	Morongo Valley	100,000,000[1]	300.00
			200,000,000[2]	600.00
Striped Mt.	Ivanpah Mts.	Clark Mt.	100,000,000[1]	300.00
			300,000,000[2]	900.00
Big & Little Maria Mts.	Big & Little Maria Mts.	Big Maria Mts.	100,000,000[1]	300.00
			300,000,000[2]	900.00
Westend Quarry	Argus Mts.	Darwin/Slate Rge.	33,000,000[1]	99.00
			100,000,000[2]	300.00
TOTAL RESERVES			643,000,000	1,929.00
TOTAL RESOURCES			2,552,600,000	7,657.80

Prices: 1978: $3.00 per short ton FOB minesite for cement grade.
$8.31 per short ton FOB minesite for industrial limestone

References:

1) Mineral Commodity Summary. 1978, 1979. U.S. Bureau of Mines.
2) Mineral Industry Surveys. Limestone. 1975, 1976, 1977, 1978, 1979. U.S. Bureau of Mines.
3) Mineral Economics of the Carbonate Rocks. Bulletin 194. California Division of Mines and Geology. 1973.
4) Proprietory company data from various companies.

FIGURE XIV-2-20
LIMESTONE PRODUCTION AND USAGE



OIL, GAS

Uses: Petroleum products are used as fuels, in producing organic compounds and plastics, and as lubricants.

Consumption: In 1978, the U.S. consumed 6.83 billion barrels of oil and 22.28 trillion cubic feet of gas.

Trends: The demand for oil and gas will continue at the present level of consumption. As conservation measures take effect, consumption will level off but is not expected to decline by 1985.

Production: In 1978, the U.S. produced 3.76 billion barrels of oil and 21.3 trillion cubic feet of gas. The U.S. imported in 1978 a total of 3.07 billion barrels of oil and 0.97 trillion cubic feet of gas. In 1978, California produced 0.35 billion barrels of oil (9.3% of domestic production) and 0.38 trillion cubic feet of gas (1.8% of domestic production).

Substitutes: Coal, nuclear fuels, oil shales, tar sands, and geothermal reservoirs can be substituted for electrical power generation facilities. Automobile fuels are still based on oil, and there are few substitutes for petrochemicals in industrial applications.

Reserves: Only one area in the CDCA, the Imperial Valley, has produced gas as carbon dioxide. The Sevier Overthrust Belt, a prolific producing belt that extends from Alberta to Baja, extends into the CDCA. This covers the area from the Pahrump, to the Vidal Valleys. Recent activity suggests it may extend down to the Big Maria Mountains before it enters Arizona. The flanks of the Imperial Valley are good gas prospects, based on historical drilling information.

Table XIV-2-31
OIL AND GAS PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Potential
Sevier Overthrust Belt	Pahrump-Ivanpah-Mesquite-Piute-Chemehuevi-Vidal Valleys	Kingston Range, Clark Mt., Homer Mt., Sacramento Mts., Stepladder Mts., Whipple Mts., Turtle Riverside Mts.	Excellent
Coachella - Imperial Valleys	Coachella-Imperial Valleys	Salton Sea, Yuha Basin	Moderate
Fremont Valley	Fremont Valley	Red Mt.	Poor
Antelope Valley	Antelope Valley	Sierra Pelona, Adobe Mt.	Good
Lucerne Valley	Lucerne Valley	Ord Mts. Bighorn Mts.	Moderate
Johnson Valley	Johnson Valley	Rodman Mts.	Poor
Milpitas Wash Area	Milpitas Wash	Palo Verde Mt.	Poor

Price: 1978: $15.00 per barrel of oil (42 gallons)
$ 0.91 per thousand cubic feet of gas

References:

1) Leasable Mineral Resources of the California Desert Conservation Area. J. P. Calzin et al. USGS. 1979.
2) A Geostatistical Study for G-E-M Resources in the California Desert. Terradata Inc. 1979.
3) Natural Gas Production and Consumption-1978. Energy Data Reports. DOE. October 12, 1979.
4) Supply, Disposition and Stocks of All Oil by PAD District and Imports into the United States, by Country, Final 1978. Energy Data Reports. DOE. January 7, 1980.
5) Crude Petroleum, Petroleum Products, and Natural Gas Liquid. Energy Data Reports. DOE. Jan. 1978-Dec. 1978.

FIGURE XIV-2-21
NATURAL GAS PRODUCTION AND USAGE

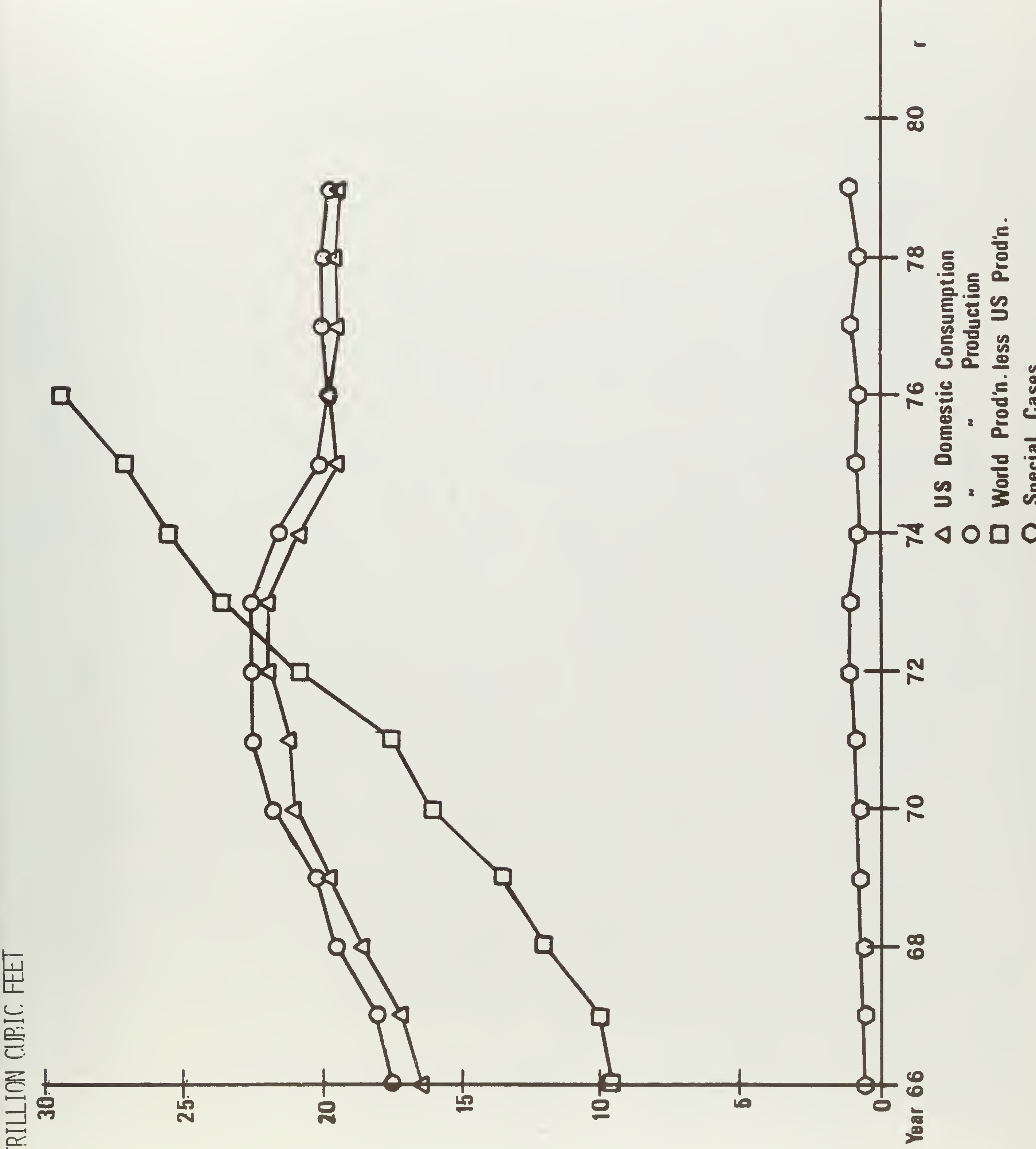
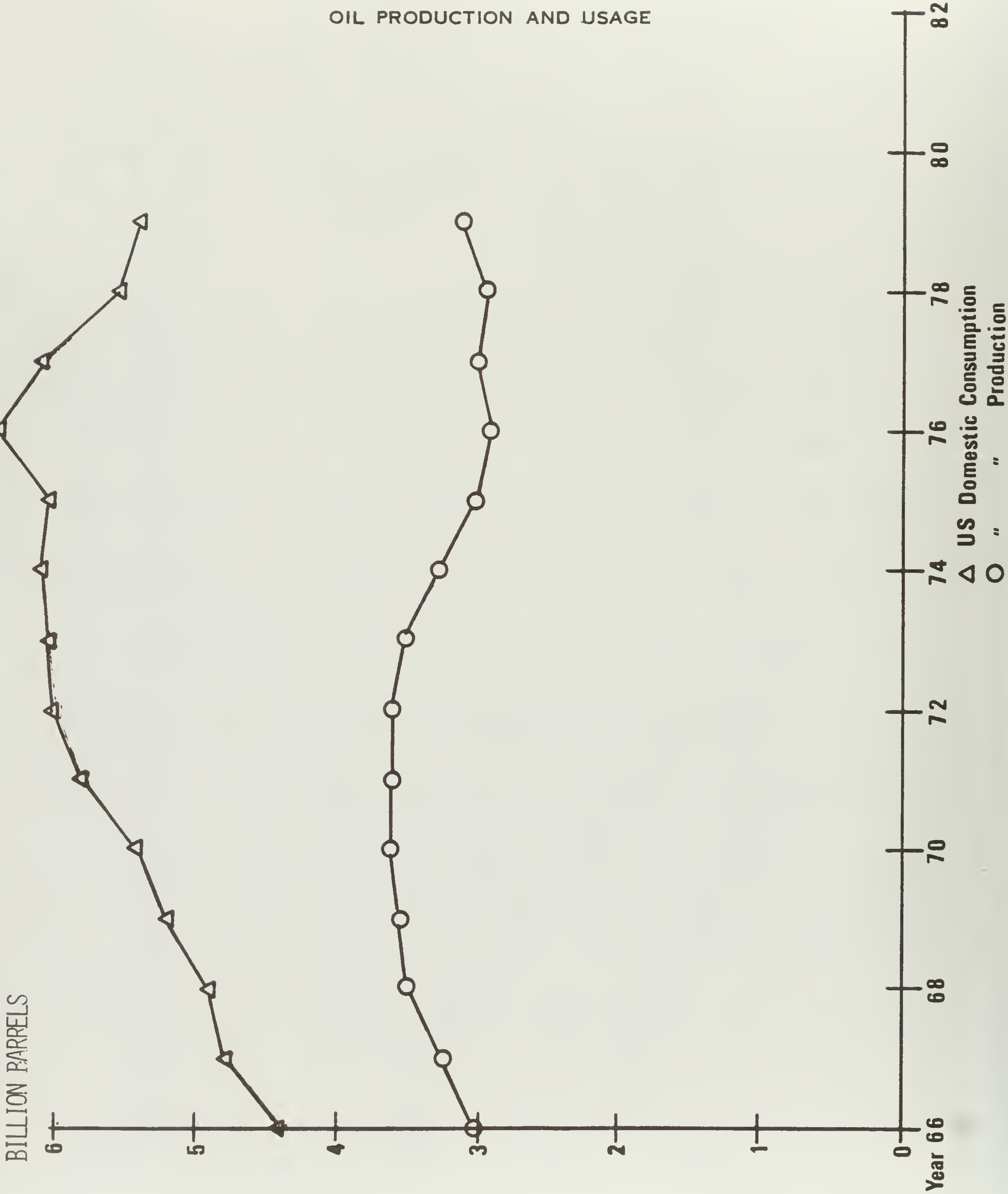


FIGURE XIV-2-22
OIL PRODUCTION AND USAGE



SAND AND GRAVEL

Uses: Construction aggregate (concrete) 43%, road bases and coverings 22%, fill material 17%, asphaltic aggregate 15%, and railroad ballast 3%.

Consumption: The U.S. consumed 988,000,000 short tons of sand and gravel in 1978 and exported an additional 4,225,000 short tons.

Trends: From a base year of 1976, the demand for sand and gravel is expected to increase at an annual rate of 1.6% through 1985.

Production: The U.S. produced 991,700,000 short tons of sand and gravel in 1978 with the major share (34%) coming from California, Alaska, Texas, Ohio and Michigan. California produced 115,100,000 short tons (12%) in 1978. The CDCA produced 9,208,000 short tons in 1978 with about 25%, or 2,302,000 short tons, being transported into the Los Angeles-San Diego metropolitan areas for construction.

Substitutes: Crushed stone can be used in place of gravel but quarries are harder to reclaim than gravel pits. High purity sands for iron casting cannot be easily supplanted.

Reserves: The CDCA has seemingly inexhaustable reserves of sand and gravel. However, the economics of sand and gravel require that the deposits be located close to the source of consumption. The major cost of concrete and aggregate is in transportation from pits to manufacturer. Based on data from the San Bernardino County Tax Assessor's Office, the per capita consumption of sand and gravel is 7.5 tons per person. That escalates to a requirement for 4,3000,000 short tons per year in 1985 and 5,800,000 short tons per year in the year 2000. Requirements of sand and gravel from the CDCA from 1980 to 2000 would total 99,400,000 short tons.

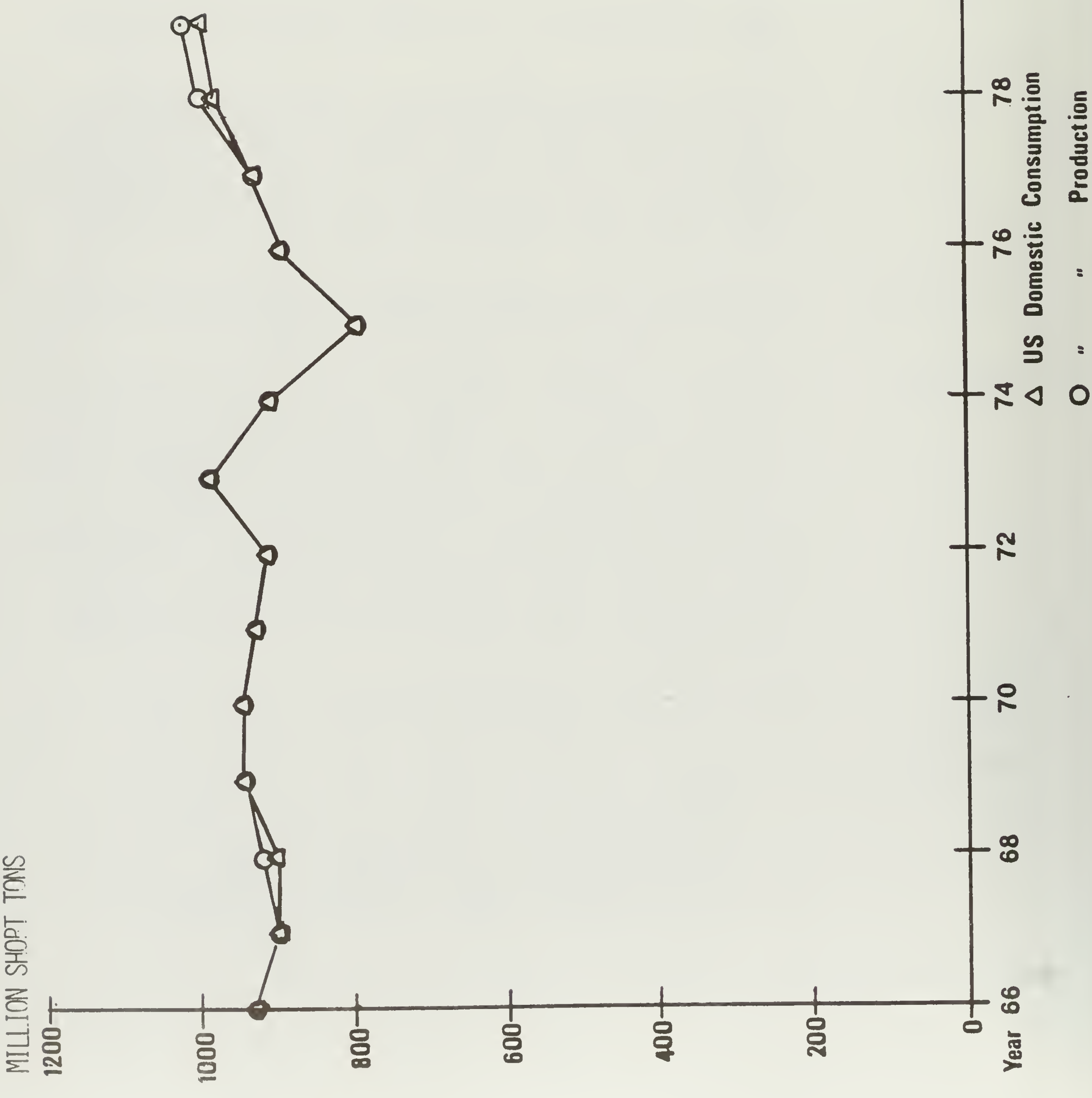
Price: 1978: \$0.25 per ton federal royalty.
\$2.50 per ton FOB at the mine commercially.

References:

1) Mineral Commodity Summaries. U.S. Bureau of Mines. 1980.
2) Mineral Industry Survey. The Mineral Industry of California in 1979. U.S. Bureau of Mines.
3) Future Demographic and Economic Trends in the California Desert. SRI International. October, 1978.
4) County Assessor's Office. San Bernardino County.

FIGURE XIV-2-23

SAND AND GRAVEL PRODUCTION AND USAGE



SPECIALTY CLAYS

<u>Uses</u>: Specialty clays are utilized in the manufacture of ceramics, drilling mud, iron production, cosmetics, fillers in wood products, and in steel casting. Ball clays are used in procelains; bentonites in drilling and steel casting; other clays are involved in construction applications.

<u>Consumption</u>: In 1978, the U.S. consumed 54,467,000 short tons of clays and exported an additional 2,665,000 short tons.

<u>Trends</u>: An annual rate of increase of 6% in consumption is forecast through 1985, using a 1977 base year.

<u>Production</u>: Clays are produced in most states of the U.S. Total domestic production of all clays in the 1978 was 57,107,000 short tons. Four areas in the CDCA are currently producing clays, three of these produce bentonites: Hector, Death Valley Junction, and the Snow White Mine in the El Paso Mountains. Production figures are not available.

<u>Substitutes</u>: In limited uses, talc, whiting, and other commodities can be substituted for clays used as fillers or extenders. There are no substitutes for ceramic, casting, or drilling and clays.

<u>Reserves</u>: Eight areas in the CDCA are known to contain reserves and resources of specialty clays.

Table XIV-2-32
SPECIALTY CLAY PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (short tons)	($x10⁶) Value
National Lead Inc. (H)	Hector	Cady Mt.	33,000,000[1]	1,331.55
Death Valley Junction (H)	Armargosa Valley	Pyramid Peak	33,000,000[1] 33,000,000[2]	1,331.55 1,331.55
Hart (M)	Hart	Homer Mt.	250,000[1] 500,000[2]	3.45 6.90
Olancha (M)	Olancha	Haiwee Reservoir	45,000[1] 180,000[2]	0.62 4.48
Tecopa (B)	Tecopa	Resting Spring Range	2,500,000[2]	100.87
Shoshone (B)	Shoshone	Resting Spring Range	5,600,000[2]	225.96
El Paso (B)	El Paso Mts.	El Paso	1,700,000[2]	68.60
Dead Mts. (B)	Dead Mts.	Homer Mt.	413,000,000[2]	16,664.55
TOTAL RESERVES			66,295,000	2,667.17
TOTAL RESOURCES			456,480,000	18,400.91

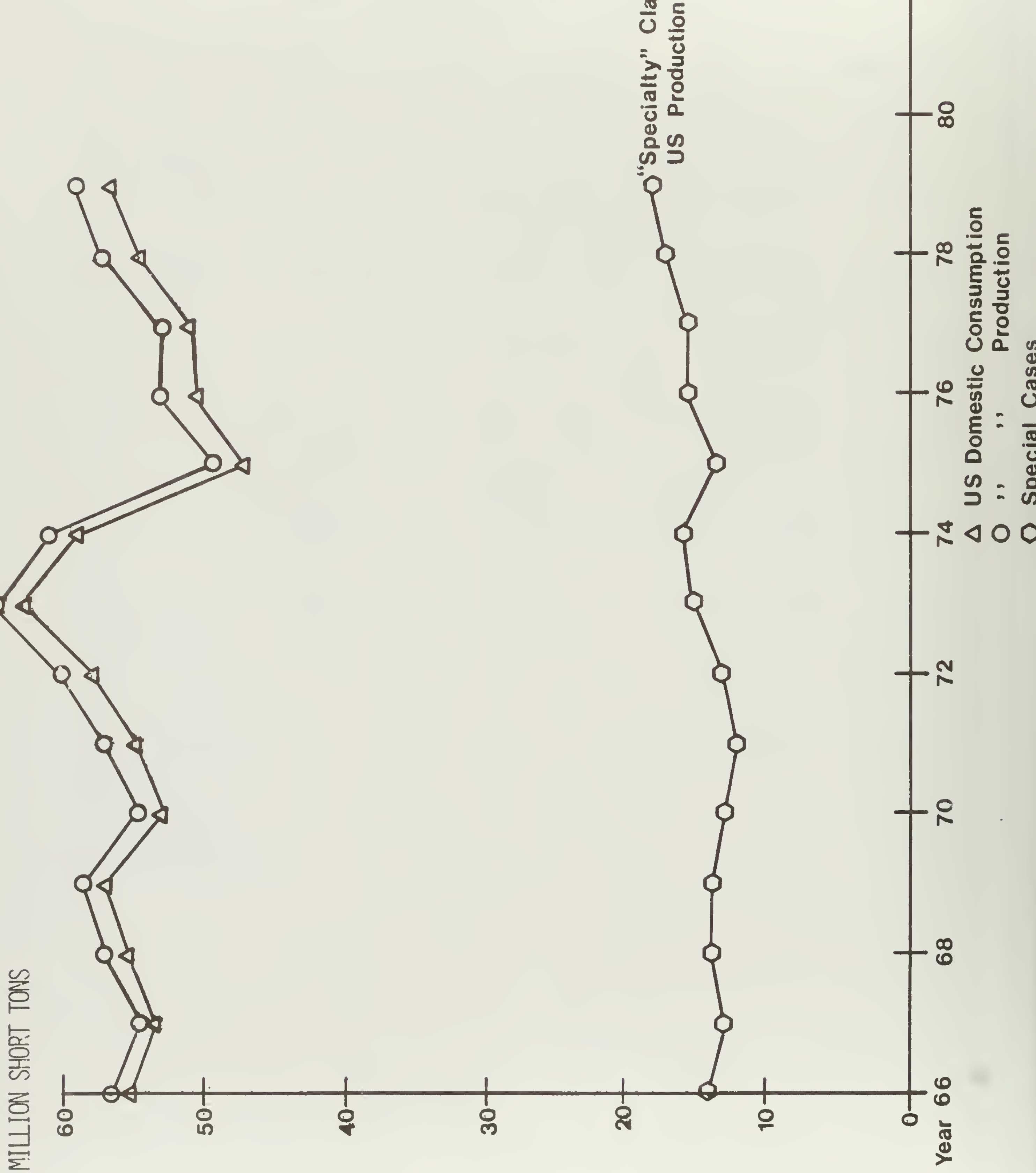
[1]Reserves
[2]Resources
H = Hectorite
B = Bentonite
M = Montmorillinite

Prices: 1978: \$40.35 per ton bentonite
\$13.79 per ton ball clay
\$12.48 per ton misc. clays.

References:

1) Mineral Commodity Summaries. 1978, 1979, 1980. U.S. Bureau of Mines.
2) Mineral Commodity Profile for Clay. U.S. Bureau of Mines. 1979.
3) Mineral Commodities of California. Bulletin 176. California Division of Mines and Geology. 1957.
4) Mineral Commodity Reports. 1975, 1976, 1977. U.S. Bureau of Mines.
5) Confidential data from various mining companies.

FIGURE XIV-2-24
CLAY PRODUCTION AND USAGE



ZEOLITES

<u>Uses</u>: The principal uses of zeolites are for molecular sieves and ion exchange applications in waste treatment facilities and in pollution control devices.

<u>Consumption</u>: The U.S. consumes about 500 short tons of zeolites per year.

<u>Trends</u>: The demand for zeolites is expected to increase rapidly in the next decade because of increasing requirements for environmental protection equipment for air and water quality control.

<u>Production</u>: Zeolites are currently produced by two major companies, both mining zeolites in the CDCA: Anaconda at Ash Meadows and National Lead at Hector. Actual production figures are not available at this time.

<u>Substitutes</u>: There are no known naturally occurring substitutes for zeolites. Man-made zeolites are currently being used in ion exchange applications.

<u>Reserves</u>: Five locations in the CDCA are known to contain zeolites.

Table XIV-2-33
ZEOLITE PRODUCTION IN THE CDCA

DEPOSIT	Location	GRA	Resource (short tons)	($x10^6) Value
Ash Meadows (C)	Death Valley Junction	Pyramid Peak	20,000,000[1]	2,000.00
Rest (P)	Shoshone	Resting Spring Range	300,000[1]	300.00
Shoshone (E)	Shoshone	Resting Spring Range	300,000[2]	---
(P)			1,500,000[1]	1,500.00
Hector (C)	Hector	Cady Mts.	1,000,000[1]	100.00
(C)			1,000,000[2]	100.00
Mud Hills (C)	Mud Hills	Calico Mts.	625,000[1]	62.50
(C)			5,000,000[2]	500.00
TOTAL RESERVES			23,425,000	3,962.50
TOTAL RESOURCES			6,300,000	600.00

[1]Reserves
[2]Resources

KEY: C = Clinoptolite
P = Phillipsite
E = Erionite

Prices: 1978: $ 100.00 per short ton clinoptolite
$1000.00 per short ton phillipsite
$1000.00 per short ton erionite

References:
1) Confidential data supplied by various mining companies.
2) Anaconda Copper Company report. May, 1980.

MINERAL INDUSTRY EMPLOYMENT IN THE CDCA

This section describes the extent of the mineral industry direct employment in the CDCA. Mineral industry is defined as firms which explore for, mine, or process mineral materials. People whose livelihood may be related to the mineral industry such as contract truckers, builders, wholesale and retail sellers are not directly employed in the mineral industry and are not counted in the standard data sources as part of it. They are counted in the indirect employment effects in economic analyses. The direct plus indirect employment is total employment attributable to the mineral industry in the CDCA. The impact is usually estimated through an input-output or economic base study as the conduct of such studies was beyond the capabilities of the CDCA planning effort, only rough estimates of indirect employment are given.

In some cases employment at plants outside of the CDCA is based on minerals mined inside the CDCA. Some such cases of substantial related employment are identified but not included in the total employment in the CDCA by the mineral industry.

The basic data source on employment is the reports of the State of California Employment Development (EDD) for 1979. The mining sector reported by EDD covers most of the mineral industry in the CDCA except cement manufacturing and calcining of gypsum. Employment in the latter categories has been estimated using data obtained by telephone from processing firms located in the CDCA. Sand and gravel employment is included in the mining sector statistics reported by EDD, so it is not identified separately.

Employment is shown by county as much as possible from the data. Though EDD data is reported for whole counties, no counties fall entirely within the CDCA. As a result, the following rationale has been used to determine whether to use whole county data. San Bernardino and Riverside counties are aggregated because that is how they are reported by EDD. The cement manufacturing industry employment was estimated by counting the number of firms operating in the CDCA portion of each county and multiplying by the number of employees at a typical cement plant.

Kern, Imperial and San Diego County mineral employment was estimated by major mineral industry firms in those counties for personnel figures.

Table XIV-2-32 shows the estimated mineral industry employment in the CDCA. The total 7,932, is 4.1 percent of the estimated employment in the CDCA for 1979.

It is reported that the California Mining Association (CMA) in 1976 listed 23,906 employees in six counties within the CDCA (San Bernardino Economic Development Department, May 15, 1980). Conversations with CMA representative Ray Hunter, June 25, 1980, confirmed such estimates but did not produce documentation of methodology. The data sources were said to approximate those used in this report, though for an earlier period. The difference may be the exclusion of oil and gas extraction employment in this study. Oil and gas employment occurs prominently in Los Angeles and Kern Counties, outside of the CDCA. Also, though the CMA estimate is said to have omitted sand and gravel it must have been included if EDD estimates were used. EDD reports do include sand and gravel employment as part of mining under SIC 14 (Mining), (OMB, Standard Industrial Classification Manual).

Table XIV-2-32 shows mineral industry employment is most concentrated in the San Bernardino County portion of the CDCA. It has been estimated that in the Victorville area 13 percent of all employees, and 36 percent of total private sector employment, are in the minerals industry. (County of San Bernardino, Economic Development Department, June 24, 1980.)

While San Bernardino County has the largest employment in the mineral industry, Inyo County has the greatest dependence on mineral industry employment. Surveys of desert residents reflect this with residents of the eastern half of the desert, including Inyo County, being most opposed to controls over the use of the desert. Part of the concern in this area stems from the controversy over continuing borate mining within Death Valley National Monument.

Table XIV-2-34
CDCA MINERAL INDUSTRY EMPLOYMENT
AS A PERCENT OF TOTAL CDCA EMPLOYMENT (1979)

COUNTIES[1]	CDCA Employment	Mineral Industry	Percent
San Bernardino	42,400	4,696	4.6
Riverside	59,900	4,696	4.6
Los Angeles	32,500	1,300	4.0
Inyo	1,100	124	11.3
Kern	20,300	1,512	7.4
Imperial	35,250	300	0.9
San Diego	650	0	0
TOTAL	192,100	7,932	4.1%

[1]Total employment for CDCA portions is taken from SRI, Future Demographic and Economic Trends in the California Desert, October 1978.

INDEPENDENT MINES IN THE CDCA

The independent miner is a person who works part or full-time prospecting for minerals, or operating mines but is not employed by one of the large corporate mineral firms. Typically the independent miner is self-employed or works for a firm employing five or fewer people.

A separate section is devoted to these people for three reasons: independent miners are reported to be responsible for finding most major mineral deposits which have been developed; theirs is a distinct life style in addition to providing employment and income; these people are not reported in standard employment statistics, because they usually are not covered by employment compensation insurance.

Since there is little hard statistical data on independent miners, estimates of their numbers are necessarily imprecise. It is estimated that there are 300 to 500 independent miners in the CDCA. The number of mineral producers in the CDCA counties has been conservatively estimated at 318 (San Bernardino County, June 30, 1980).

The key ingredient for the continuation of this life style is the opportunity to prospect over large areas having mineral potential and to capitalize on the results by obtaining title to valuable deposits thus located. This opportunity is provided largely by the Mining Law of 1872 applying to public lands not withdrawn from mineral entry.

The independent miners are motivated in part by an affinity for desert living with its freedom from urban interference, and partly by the hope of some day finding a valuable deposit. The latter motivation is currently being fueled by the rapid escalation of worldwide mineral prices. Deposits which were uneconomical to develop at past prices may become operable as mineral prices escalate. Old gold and silver mines in the CDCA are reported being considered for renewed production.

Independent miners generally feel threatened by the current trend of increased Federal, State and local regulation of mining activities. The effect of these regulations is to increase the cost of exploration and mining. Another perceived Federal threat is the potential establishment of wilderness areas. The first step, designation of wilderness study areas, limits the production of existing mines and substantially increases the paperwork required for intensive exploration and development of new finds. The next step, Congressional designation of wilderness, is perceived as being particularly threatening because it may permanently prevent production from unpatented claims which miners have been actively working. The independent miner's tie to the major mineral producing firms is through the sale of mining claims. Usually the independent miner lacks the capital to fully explore and develop deposits. If the market looks healthy, large firms frequently buy the more promising claims for selected minerals in a region and carry out an intensive program of exploration resulting in the opening of a new major production site.

MINERAL INDUSTRY IN THE CDCA - SIGNIFICANCE

This section is concerned with the linkage between the mineral industry in the CDCA and the rest of California, the United States economy, and the world. Only the most prominent linkages are cited; for a more complete commodity-by-commodity discussion the reader is referred to the preceding mineral economics portion of this report.

Kaiser Steel

The nation's largest steel mill west of the Mississippi River is located at Fontana, in western San Bernardino County. Though this mill is outside the CDCA, it is completely dependent upon the supply of raw materials from the CDCA for its operation. The raw materials involved are iron ore from the Eagle Mountain mine in the Riverside County portion of the CDCA, and smelter grade limestone from the Cushenbury Springs area, San Bernardino County in the CDCA. Employment at the mines has been counted in the CDCA employment data, while an additional 7,600 people are employed at the mill in Fontana. The main competitor with this plant is steel imported from Japan.

Union Oil - Molycorp

Located at Mountain Pass in eastern San Bernardino County, the mine and plant supplies almost all of the world's supply of rare-earth minerals. These minerals are used throughout the United States in the production of petroleum (catalysts), iron and steel (including pyrophoric alloys), ceramics and glass, and electronics (color TV tubes and X-ray screen intensifiers).

U.S. Borax

The mine and plant located at Boron in eastern Kern County is the world's largest producer of boron minerals. It employs about 1,250 people, and further expansion is expected in the near future. Most of this product is used in the north-central and eastern states to manufacture glass, soap and detergents, and other chemical derivatives. Its use in high temperature glass cannot be substituted without significant reduction in quality. This company is probably the largest non-government employer in the CDCA.

Kerr-McGee

The nation's second largest producer of boron products also produces sodium carbonate products. The location is Searles Lake in eastern San Bernardino County. The mineral source is the brines taken from the lake. A great variety of products are produced from a highly integrated plant. The brines in this lake constitute the nation's largest reserve of tungsten, now an additional product of the plant. The market for this plant's varied products is nationwide.

U.S. Gypsum

The quarry and processing plant are located in western Imperial County. Calcined gypsum produced there is used for wallboard, plaster, and in the production of cement. The market is primarily the building industry throughout the western states. Approximately 300 people are employed at the plant.

Cement Manufacturing

Essential to the building industry, cement is manufactured by eight firms in the CDCA. These firms quarry limestone and process it for sale as lime, limestone, and cement. Part of the production from these facilities goes to the Kerr-McGee plant at Searles Lake where it is used to produce CO_2. Another major mineral producer dependent upon these quarries is Kaiser Steel which obtains the lime necessary for its smelters at Fontana. The market for these products is principally southern California. At this time some cement is being imported to the Port of Los Angeles from foreign sources because of increasing costs of domestically produced cement. The CDCA will have to be the source of most of the cement used for future building in southern California. A large new limestone quarry and cement plant is expected to be opened soon in western Imperial County. Current CDCA employment in the industry is estimated to be 2400 people.

Existing Major Mineral Producers in the CDCA

American Borate -- Boron minerals from the Billie Mine in Death Valley National Monument, Inyo Co., and the Maria deposit outside of the Monument.

Pfizer -- Talc from a mine in Death Valley National Monument and a mine east in Inyo County.

Cyprus -- Talc from a mine in Death Valley National Monument; all of the talc mines send mineral to be milled at a plant between Barstow and Baker.

Creal -- Cement and limestone near Mojave in Kern County; California Portland Cement Co.

Victorville -- Cement, gypsum, limestone, stone from Riverside Cement Co., Southwestern Portland Cement Co., Pfizer Co. at Victorville, San Bernardino Co.

Cushenbury Springs -- Area contains four plants supplied primarily from limestone quarries in the San Bernardino National Forest; Pluess - Staufer, Pfizer, Kaiser, Partin Limestone.

Westend Quarry -- Argus Range; limestone source for Kerr-McGee's Searles Lake plant.

INDUSTRY-PROPOSED MAJOR NEW MINERAL PRODUCERS IN THE CDCA

Plaster City, Imperial Co. -- Large cement plant and mine to be constructed by Texas Industries; expected employment, 200.

Piute Limestone-Pleuss-Staufer Inc. -- Soon to develop a limestone quarry near Essex; may be processed at existing plant site in Lucerne Valley.

Calico -- Barite and silver source, begins operation in 1983 (possibly) by ASARCO, $100 million to build mill.

Barstow -- Occidental Minerals proposes to develop a zeolite deposit; area has been drilled, would be an open pit operation.

Ash Meadows -- Anaconda is producing and plans to produce zeolites from a new mine southeast of Death Valley Junction.

Areas of High Probability for Production

Yellow Aster Mine -- Randsburg, high probability of being reopened by ASARCO.

Kelly-Rand Silver MIne -- in Red Mountain, underground exploration continuing in existing tunnels.

Red Hill -- Molybdenum deposit in Ord Mts. southeast of Barstow, being explored by B&B Mining (subsidiary of Noranda).

Northeast of Last Chance Mt. -- Molybdenum deposit being explored by Marathon Oil and Amoco Minerals Company; four test holes were drilled by Amoco.

Clark Mountain -- Colisseum Mine being explored by Draco Co. to confirm size of gold deposit; will probably evolve into an open pit mine.

Sentinel Peak Mine -- Panamint Range deposit of uranium and silver being explored by Lacana Joint Venture.

Coso -- Uranium deposit just outside of NWC being explored by several companies: Rocky Mountain Energy, Federal Resources Corp., Phillips Uranium Corp.

Copper Basin Deposit-Whipple Mountains -- Relatively small copper deposit compared to deposits in Arizona; ore grade rock at current prices; Louisiana Land and Minerals has delineated the deposit.

Gerstley Mine-U.S. Borax -- Borate mine northeast of Shoshone; ore body delineated; intermittent production for last 60 years, in Inyo Co.

REFERENCES

Labor Market Newsletter and Annual Planning Information. State of California. Employment Development Department.

Department of the Interior. Mineral Commodity Summaries. Bureau of Mines. 1978.

Cooperation 79-Cooperative Economic Development Planning. San Bernardino County. Economic Development Commission. 1978.

Letter dated May 15, 1980.

Letter dated June 24, 1980.

Letter dated June 30, 1980.

Demographic and Economic Trends in the California Desert. SRI International. May 1978.

Future Demographic and Economic Trends in the California Desert. October, 1978.

Part 3

GEM Resources

This report is intended to document the present state of mining-related surface disturbance in the CDCA, to project the estimated additional surface disturbance over the twenty-year life of the Plan, and to explain via appropriate scenarios the type of mineral activities that have or will occur in the CDCA. These scenarios were put together by several Bureau mineral specialists and by a contract to Omniplan Corporation (contract number YA-512-CT9-289, June, 1980), which evaluated the potential impacts of six selected mining operations in three different ecosystems of the CDCA. These scenarios are intended to serve as reference material for the assessment of the effects of these operations on the environment.

Mining activities have been present in the CDCA since the 1980's and are still active today. In 1974 the U.S. Bureau of Mines (ref. 852) published statistics, by state, of all lands disturbed and reclaimed by surface mining activities. This report formed the baseline for the following analysis of the effects of mining in the CDCA. In addition, the Soils Staff of the Desert Plan Staff, using recent (1973-77) aerial photography, compiled a preliminary inventory of areas disturbed by mining operations, exclusive of the roads into these operations. These two sets of data are given in Table XIV-3-1.

Table XIV-3-1 presents the mining disturbance projections in two columns labelled "High" and "Low". Column "High" contains the calculations derived from the U.S. Bureau of Mines baseline data and formed the data base of the Desert Plan Staff to analyze the effects of mining in the CDCA. The "Low" column was calculated using the aerial photo data as a constant base in 1980 and was projected to the year 2000. These two columns, therefore, define the expected range of surface disturbance that is anticipated in the CDCA over the next twenty years. Based on the aerial photo inventory, the CDCA has lagged behind the state as a whole by about 24 percent in acreage disturbed by surface mining activities. The CDCA has not had the same level of mineral development as the rest of the state.

The reclamation data is derived from the baseline data only, as the staff has no reclamation data solely for the CDCA. Only statewide totals are available. The State Mining and Reclamation Act of 1975 and the Federal Surface Mining and Reclamation Act of 1977 require ongoing reclamation of mined lands. The rate of reclamation has increased markedly since these acts went into effect. However, statistics are not yet available for projection. Therefore, projected reclamation figures in Table XIV-3-1 are minimum values. The actual acreage reclaimed will be higher.

In Table XIV-3-1 "High" column, the acreage disturbed by mining to 1980 amounts to 0.27 percent of the 18,031,000 acres available for mining in the CDCA. The projected additional percentage is 0.14 percent for the interval 1980 to 2000, or a cumulative total of 0.41 percent of the CDCA open to mining since the 1860's. It should also be noted, by reference to the Geology Energy Minerals Element, that of the 18,031,000 acres, 64 percent is administered by the Bureau. The rest is state or private. It is impossible to separate the areas of potential effects from mining by land ownership. Therefore, this analysis covers the CDCA as a unit and considers all lands jointly.

Table XIV-3-2 gives the location of the major mining operations in the CDCA by commodity, style of mining, and acres disturbed. Data were compiled from the aerial photo inventory.

The three largest operations are at Boron (open pit for borates), Eagle Mountain (open pit for iron), and Searles Lake (solution mining for saline minerals). On a Desert-wide basis, the limestone, gypsum, and sand and gravel operations are the most consumptive of the surface disturbing mining operations.

The following scenarios will give the reader a good perspective of the types of mining activities that occur within the CDCA and the details of the internal workings of these operations. The previously mentioned report by Omniplan Corporation should also be read for a fuller understanding of the effects of mining operations in the CDCA. Table XIV-3-3 is a summary of the surface disturbing effects as outlined in the Omniplan report and the effects of exploration, development, and reclamation activities in the CDCA.

Table XIV-3-1

CALCULATIONS FOR PROJECTED MINING DISTURBANCE IN THE CDCA[1]

UNIT OF CALCULATION	PROJECTION HIGH	PROJECTION LOW
State of California, total acreage	100,207,000	100,207,000
Acreage in the CDCA open to mining	18,031,000	18,031,000
Percent of the State of California which is in the CDCA and open to mining	17.99	17.99
Past Disturbance		
Total acreage disturbed by mining in California to 1971 (1930-1971, 42 years)	227,000	227,000
Total acreage disturbance calculated to 1980 (227,000/42) (50)	270,238	270,238
Calculated disturbance expected in the CDCA in 1980 (270,238) (0.1799)	48,616	
Actual disturbance compiled from aerial photographs to 1980 (includes 20% inflation for roads and missed mines)		37,031
Difference between calculated and actual acres (CDCA)	11,585	
percent	23.83	
Projected Disturbance		
Calculated annual disturbed acreage in California from 1980-2000		
(270,238 acres/50 yrs) (0.1799)	972	
(270,238 acres/50 yrs) (0.1799) (0.7617)		741
Calculated total mining disturbance in the CDCA from 1980-2000		
(972 acres) (20 years)	19,446	
(741 acres) (20 years)		14,812
Additional roads at 10%	1,945	1,481
TOTAL	21,391	16,293
Expected rate of increase in mining activity is 13%	2,781	2,118
	======	======
Total projected disturbance	24,172	18,411

Table XIV-3-1 (Continued)
CALCULATIONS FOR PROJECTED MINING DISTURBANCE IN THE CDCA[1]

UNIT OF CALCULATION	PROJECTION HIGH	PROJECTION LOW
Reclamation[2]		
Reclamation in California from 1930-1971 (42 years)	43,900	43,900
Reclamation acreage calculated to 1980 (50 years)	52,262	52,262
Calculated acreage reclaimed in the CDCA to 1980	9,402	7,161
Calculated annual rate of reclamation to 1980	188	143
Projected acreage to be reclaimed from 1980-2000[2]	3,760	2,864

[1]Baseline period, 1930-1971 is 42 years, (Paone, Morning, Giorgetti. Land Utilization and Reclamation in the Mining Industry, 1930-71 U.S. Bureau of Mines Information Circular IC 8642 1974).
[2]The projected reclamation acreage does not consider Bureau's surface management regulations (43 CFR 3802 & 3809) or Class guidelines. Actual reclaimed acreage will be more.

Table XIV-3-2
MAJOR MINING DISTURBANCES IN THE CDCA

COMMODITY	Location	Mining Style	Acres Used
Borates	Boron	Open Pit	2,320
	Ryan Area	Open Pit	120
			2,440
Iron	Eagle Mountain	Open Pit	4,630
Limestone and Gypsum	Black Mountain	Open Pit	320
	Oro Grande	Open Pit	920
	Victorville Area	Open Pit	150
	San Bernardino Mts.	Open Pit	1,270
	Tehachapi Mountains	Open Pit	490
	Big and Little Marias	Open Pit	555
			3,705
Rare Earths	Mountain Pass	Open Pit	660
Talc	Kingston Mountain	Open Pit	195
	Ibex Hills	Underground	45
			240
Clay	Hart Mine	Open Pit	130
Sand and Gravel	CDCA Wide	Open Pit	6,700
Saline Minerals	Searles Lake	Solution Mining	6,415
	Koehn Dry Lake	Solution Mining	130
	Bristol Dry Lake	Solution Mining	2,130
	Danby Dry Lake	Solution Mining	250
	Cadiz Dry Lake	Solution Mining	290
	Dale Lake	Solution Mining	310
			9,525

Table XIV-3-2 (Continued)
MAJOR MINING DISTURBANCES IN THE CDCA

COMMODITY	Location	Mining Style	Acres Used
Base and Precious Metals (Au,Ag,W, Cu,Pb,Zn)	Johannesburg Area	Open Pit	1,120
	Red Mountain Area	Underground	350
	Randsburg Area	Underground	185
	Summit Range	Underground	33
	Revenue Canyon	Open Pit	35
	Whipple Mountains	Open Pit	270
	Savahia Peak	Underground	19
	Ivanpah Mountains	Underground	66
	Vanderbuilt Mine	Underground	54
	Calico Area	Underground	407
	Darwin Area	Underground	90
			2,629
Total Acreage Inventoried			30,659

Table XIV-3-3
ESTIMATED DISTURBANCE AND RECLAMATION COSTS OF MINING ACTIVITIES IN THE CDCA

ACTIVITY	Limestone Quarry I	Pb-Zn-Ag Mine II	Clay Pit Bentonite III	Open Pit Copper IV	Solution Mining Uranium V	Solution Mining Brines VI
EXPLORATION[1]						
Cost[3]	$.1	$2	$1	$15	$10	$10
Roads (acres)	1-3	1-2	5	5	1-3	1-3
Pads (acres)	3-5	1-3	3-5	4-5	2-3	2-3
DEVELOPMENT[1]						
Roads (acres)	121	30	181	15	121	121
Powerlines(acres)	87	15	58	8	87	87
Mine Site (acres)	1,500	---	200	1,500	200	200
Mill Site (acres)	---	200	---	---	5	5
Tailings (acres)	1,500	100	100	1,500	200	200
Mill Cap. (tons)	20,000	1,000	3,000	25,000	1,000	1,000
Water Use (gals)	40,000	10,000	6,000	250,000	large	large
Mine Life (yrs)	10-20	20	10	20-40	10	20
Employment	100±	200±	100±	500±	150±	150±
Acres Used	3,200	345	540	3,000	613	513
Capital Cost[3]	$6.1	$14	$9.1	$60	$20	$25
RECLAMATION[2]						
Cost Per Acre	$1500-2000	$200	$4,000	$1000-6000	$1,000	$1,000
Company Cost[3]	$4.8 to $6.4	$.069	$ 2.16	$ 3 to $18	$ .613	$ .513
Total Project[3]	$10.4 to $12.5	$14.069	$11.26	$63 to $78	$20.613	$25.513

[1]Omni-Plan 1980.
[2]National Academy of Sciences, 1979.
[3]Dollar amounts expressed in millions in 1979 dollars.

LOCATABLE MINERALS SCENARIO

Locatable minerals activity in the California desert includes numerous small lode operations (subsurface, on veins) for gold and other metallics perhaps some larger subsurface operations for disseminated metallics and industrial minerals, numerous small to moderately large (to 50 acres) open pit operations for industrial minerals and metallics, a few large, open pit operations on the order of 500 acres or more, and numerous smaller placer gold operations. Operational life can vary from a few intermittent months, for small placer and lode operations, to 5 to 30 years or more. Different mineral occurrences may require particular methods of detection and exploitation. With all these variables there are still some common environmental effects from activities during the progressive stages of mining.

Tables XIV-3-4 through XIV-3-7 summarize activities and extent of operations involved in the exploration, development, extraction, and reclamation phases of hardrock mining. A more detailed discussion follows the tables.

Table XIV-3-4
EXPLORATION: HARDROCK MINING

TECHNIQUES[1]	Duration	Area Involved	Access Needs	Air/Water Impacts
Geologic (outcrops), geophysical, geochemical prospecting of broad areas.	Several weeks to one year.	Broad areas, intensity comparable to recreation use (hiking).	Existing access.	Negligible
Trenches, pits, exploration headings (adits, shafts) on a narrowed target area.	Several weeks to a few months.	Less than 10 acres. The intensive use of working and waste dumps.	Existing access and minor additional developed access for light vehicles.	Minor, intermittent dust.
Drilling of a target area.	Several weeks to several months.	A few drill sites within 20-1,000 acre target area.	Existing access and development of light to heavy vehicle access.	Minor, intermittent dust. Possible drilling fluid residues.

[1]Activities are listed sequentially. Some steps may be omitted by early discovery of mineralization.

Table XIV-3-5
DEVELOPMENT: HARDROCK MINING

TECHNIQUES, ACTIVITIES	Duration	Area Involved	Air/Water Impacts
Development drilling	5 to 10 months (overlaps and continues exploration drilling).	Drill sites and their access within 20 to 500 acres.	Minor, intermittent dust. Possible drill fluid residues.
Surface Mining:			
Removal, placement of overburden.	Several months to 2 years.	Several hundred acres.	Dust, intermittent
Initial development of pit working faces (a series of benches).	Several weeks to a year.	Within above area.	Dust, intermittent
Subsurface Mining:			
Development of underground access preparing to extract, haul, hoist ore and waste.	Less than 1 year to 2 years.	Small portal area.	Minor dust. Possible water discharge from subsurface workings.
Construction of surface plant (to crush, grind, upgrade ore).	1 to 2 years, (concurrent with above).	5 to 100 acres	Dust
Construction of surface access (roads, railroads, overland conveyors).	A few months to 1 year (concurrent).	Perhaps 5 to 10 miles, 5 to 6 acres per mile.	Dust
Utilities Development: Water (wells, reservoirs, pipelines). Electricity (transmission lines, pipelines).	Several months to 1 year (concurrent).	Together with access roads.	Dust

Table XIV-3-6
EXTRACTION: HARDROCK MINING

TECHNIQUES, ACTIVITIES	Duration	Area Involved	Air/Water Impacts
Surface Mining:			
Open pit, advancing downward on a series of benches. Pit slopes to about 40° - 50°.	5 to 30 years or more.	Up to 500 acres or more, to perhaps 2,000 feet deep.	Dust
Subsurface:			
Vein mining to block caving of large, low-grade deposits.	5 to 30 years or more.	None additional, (see mine waste disposal below).	Possible water discharge.
Milling operations.	Mine life	5 - 100 acres for the mill area.	Fluid and gaseous effluents.
Mine waste disposal (may involve heap leaching of low-grade ore).	Mine life	5 - 500 acres	Dust, Leaching fluids.
Mill tailings disposal.	Mine life	5 - 2,000 acres	Mill fluid residues.

TABLE XIV-3-7
RECLAMATION: HARDROCK MINING

TECHNIQUES, ACTIVITIES	Duration	Residual Effects
Dismantling, salvage of surface plant.	Several months to one year.	Compacted areas, concreted area.
Reduction, and/or fencing of dangerous pit slopes.	Several months.	Some degree of hazard may remain.
Blocking or sealing underground access.	A few weeks to several months.	Few effects at portals. Subsidence at block-caved areas.
Neutralization, removal, containment of toxic residues.	Several weeks to months. Periodic monitoring.	Reduced vegetative productivity.
Grading, shaping of waste dumps, mill tailings to blend into surrounding terrain.	Several months.	Degraded visual aspect as a permanent effect.
Development of lakes, ponds from pit areas where practicable.	Several months.	Most pit areas remain as a permanent effect.
Revegetation as practicable.	Short operations within a one to two year period.	Probable reduced productivity.

Lode Mining

Exploration. Initial on-the-ground exploration techniques include geoligic surveys (examination of outcrops) and various geophysical and geochemical surveys, most involving light vehicle access or foot traverses and portable equipment. The activity covers broad areas with use intensity and effects comparable to recreational touring and hiking.

If anomalies or mineral showings are found, exploration proceeds with increasing intensity involving three dimensional physical access. For a vein deposit, this might involve surface cuts, then short adits, and/or shafts in conjunction with a few drill holes. For large, low grade metallic or industrial minerals, the work might consist of trenching and successive drilling patterns aimed at identifying and outlining the deposit. Exploration headings (adits, shafts) may be driven on drill holes or independently, to confirm drill-hole sampling and to develop bulk samples for metallurgical (ore processing) testing. If or when the evaluation determines economic feasibility of mining, development begins.

A series of minor surface trenches, pits, and cuts can be completed within a few weeks. Adits and shafts can take up to several months to complete (perhaps 5-10 feet of advance per day). The areas affected are the actual surface exposures of the workings and their dumps, perhaps averaging 20 by 30 feet (0.01 acres each) and their access (about 2 acres per mile) so that surface effects would rarely exceed 5-10 acres within the several-hundred-acre target area.

Surface effects from drilling involve access for drills on medium to heavy duty trucks (about 2.5 acres per mile) and drill pads of from 15 by 15 to 30 by 30 feet (0.005 to 0.02 acres each)). For example, drilling 640 acres on a 500 foot grid would involve less than 1 or 2 acres in drill pads and about 15 to 20 acres in access. If water is used to raise drill cuttings, alkaline mud conditioners (dispersants such as sodium tetraphosphate) may be used. Small amounts of petroleum may be used to lubricate the drill column. Drilling rates would vary from about 35 feet per day for diamond drilling in hard rock to several hundred feet per day with rotary drilling in sediments. The duration of the drilling program would be from a few weeks to several months, using several crews.

Activities would produce minor intermittent dust from vehicle travel and other surface activities. While these activities are more or less sequential, some of them may be omitted or short circuited by discovery of an ore deposit at an early stage.

<u>Development</u>. A drilling program would continue into development within the existing drilling grid to refine information on the deposit for design of the mining (and possibly milling) program. Drill pattern and intensity would depend upon homogeneity of the ore. Erratic mineralization would require closer sampling intervals. For the 640-acre example, filling in the 500 foot drilling grid to a 100-foot grid would increase the access area an additional 20 acres to a total of 30 to 40 acres, and drill pad areas to a total of 15 to 20 acres. Drilling may involve use of alkaline drilling muds and petroleum lubricant for the drill column. Duration may be from several weeks to several months.

Surface development (open pit) would involve stripping the overburden and development of initial benches or working faces. The materials may be stacked nearby or used to construct tailings ponds if milling is involved, or stacked on impervious pads for leaching of mineral values. Removal of overburden may require up to two years for the large copper mines. Development of pit benches may take a few weeks to a year for large pits. Areas involved are the pit design limits as of the current mining plan, perhaps 20 to 50 acres to upwards of 500 acres, the same area involved in target drilling efforts. The operations would produce moderate to high intermittent dust from stripping and blasting.

A subsurface development in vein mining or large scale subsurface methods such as block caving involves development of subsurface access and facilities for extraction, storage, and hoisting of ore and waste. Development may take less than a year to two years depending upon mine size and mining method. Surface effects would be limited to the small areas of access to subsurface workings and the initial waste dumps. Pumping and water discharge problems would be minor in desert areas.

Surface facilities may consist of offices, assay, or testing labs, warehouses, maintenance shops, and possibly a mill. Mills are crushing and grinding facilities for the separation and upgrading of ore by washing and sorting, gravity methods (jigs and tables), heavy media separation, air flotation, cyanidation, or combinations. Surface facilities can vary from a few acres in small vein mines to 20 to 30 acres for larger mines to 100 acres for a large, open pit mine.

Surface access within the mine area would occupy fractional areas within intensive use areas. Access to the mine may require extending existing access by as much as 5 to 10 miles. Construction of paved roads or rail access could take several months to a year. Utilities (water, power, gas) would likely follow the same access route during the same construction period. Access and utilities may occupy up to 6 acres per mile depending upon terrain (rough country would produce widened cut and fill areas). Water storage reservoirs may occupy one to several acres near the surface facilities. There would be intermittent, moderate generation of dust during activities of surface development and construction.

Extraction. Open pit mining involves advancing downward on a series of benches from the perimeter, steepening the average pit slope (through benches) as the final pit limit is reached. Final pit slopes may range from 25 to 50 degrees depending upon competency of the rock. Duration of mining could be from about 5 to 30 years or more, covering the surface area previously involved in target exploration and development activities: a few acres to 50 to 500 acres or more for a large open pit mine. The effects would be intensive: cycles of blasting, loading, and hauling with accompanying dust and gases.

Subsurface mining effects could be minimal, with intensive use at portal areas. Block caving effects may vary from nothing for deeper deposits to subsidence and funneling of surface materials into the center of the caved area. This would be the area already subjected to intensive exploration and development.

Effects from milling operations may rande from minor dust to residues and gases from flotation and cyanidation processes. Flotation involves the use of water and several pounds of various organic and mineral oils, mineral acids, and alkalies, and various flocculants such as calgon. These are consumed to some extent and are contained within ore concentrates and as residues in the tailings. Cyanidation is used to recover gold, and sometimes silver, by dissolving a weak solution (about one pound per ton of water) of solium or calcium cyanide, with solutions recirculated for reuse. Tailings are given a final fresh water wash to extract greatest possible values but may still contain minor cyanide residue.

Mine waste may be spread over disposal areas, or used to construct tailings dams, or in the case of copper, gold, and silver ores (and possibly uranium) may be leached by stacking on impervious pads (asphalt or butyl plastic). Leaching is accomplished by weak acids (for copper and uranium) or cyanide solutions (for gold and silver). Waste dumps may vary from less than 5 acres for small mines to 500 acres or more for a large open pit mine.

Mill tailings are dispersed as a series of tailings settlement ponds behind dams. As the materials dry they may be subject to dusting in winds. The tailings may contain residues of alkaline flotation reagents or sodium cyanide. Tailings areas may range from a few acres for small vein mines to as much as 2,000 acres for large open pit mines.

Reclamation. At the end of the mining operation, the affected areas are rehabilitated and reclaimed for hazard abatement and the restoration of productivity to the disturbed lands. Surface facilities can be dismantled and salvaged, over a period of several months to a year. Residual effects may be left in areas which are graded, compacted, or concreted over.

For surface mines, hazardous slopes may be reduced (not practicable in hard rock open pits) or fenced at their crest. Larger pits would remain as a residual effect.

Access to subsurface workings would be blocked and sealed over a period of weeks or months. For small mines there may be few residual effects, largely confined to portal areas. For block caved areas, subsidence would be a residual effect.

Mine waste and tailings can be graded and shaped to blend more naturally into the surrounding terrain. Mine tailings can be neutralized and revegetation attempted. Residual effects would be degraded visual aspect and probable reduced vegetative productivity. Many aspects of rehabilitation can be accomplished during mining: by the mining plan, by planned waste and tailings placement, and by commencing rehabilitation on abandoned areas during the life of the mine.

Placer Gold Mining

Operations would be generally small, 5 to 10 acres or less with a few larger operations on low grade deposits such as residual, colluvial, or floodplain deposits (as at Glamis), perhaps 30 to 50 acres.

Exploration would involve effects of direct physical sampling through test pits, cribbed shafts, and auger or drill holes and would require temporary access. Net areas affected would be quite small, usually less than one or two acres.

Development and mining tend to merge in smaller placer operations. Mining may commence with bulk sampling and then proceed. The most efficient separation requires water, a problem in most desert areas. Dry processes have poorer gold recovery and may generate considerable dust. The areas mined might range from a few acres to 10 acres perhaps 20 feet deep to 50 acres of 30 or more feet in depth.

Placer mining has potential for restoration as mining proceeds. Mined gravels can be replaced, graded, and revegetated with little loss in productivity.

Gold Mining

Because of the expected continuation of high gold prices, prospecting efforts are again being seen in all areas where gold may be found. The CDCA has a long history of gold mining and can expect its share of activity.

Large gold mines are possible in the CDCA, both open pit and underground. Small mines should be much more numerous. Large company exploration programs may find ore bodies too small to interest them, though profitable to the small investor. Independent prospectors may make new finds, although this should be rare in the well-prospected CDCA. Old mines of known history, shut down during WW II and low gold prices, may reopen. Prospects without production history may be re-examined by government and private exploration, and some should prove capable of profitable production.

Small gold-bearing veins are not uncommon in the geologic settings found in the CDCA, and although their values excite amateur gold seekers, the amount of gold is usually small compared to the quantity of barren rock mined to extract gold-bearing material on a continuing basis. Also, few amateur miners have the time, money, or knowledge needed to properly sample ahead of their mining, and cannot anticipate when the gold veins they are attempting to follow may come to an end. Historically, these uncertainties have not discouraged prospectors from wanting to "strike it rich", and so the greatest threat of impact from gold mining may be the "gold fever" urge to rush out to the desert and start digging. In such instances, access roads and poorly planned bulldozing and trenching could severely tax BLM's ability to monitor these activities and keep them within reasonable and constructive bounds. Areas of the desert which once were blanketed with mining claims may see revived flurries of claim staking.

Underground mining methods generally require little surface disturbance, and some mining methods utilize waste material to fill in the voids created by mining, so that surface waste dumps are small. A typical mine could occupy less than five acres. An additional 10 acres to 40 acres could be occupied by ore heaps used for leaching methods of gold recovery.

Large operations today use leaching methods for recovery wherever possible, they require up to several hundred acres for dumps to handle waste rock, and for water-recovery systems. Leaching in place (in situ) does not require crushing and grinding the ore. Heap leaching on the surface may require crushing but not fine grinding. Recovery of low unit values in large operations usually require fine grinding in a mill, with additional steps for dissolving and recovering gold and other associated mineral values.

The common chemical agent for gold recovery is cyanide, a poisonous substance which must be carefully controlled. Cyanide is usually precipitated as a sodium-zinc compound which is recycled or as an iron compound which is disposable. Iron cyanide is not considered hazardous, but its disposal is carefully controlled by Federal and State regulations. Hydrogen sulphide can also be produced during the chemical processes for recovery of dissolved gold from cyanide solutions. Barren mill waste, similar to very fine sand, can be used as fill in underground mines or spread in waste dumps. For large operations, waste dumps can occupy more than 100 acres.

Surface facilities for small mines are simple and require little land; for large facilities, improved roads, electric power supply, etc., can require substantial land. If large electric earth moving equipment is needed for stripping overburden, up to 35 MW of electric power for each large machine may be required.

Surface facilities for underground mines are usually not affected by the underground workings and can be designed with more flexibility than can surface mines. Open pits and their processing and waste disposal facilities must crowd together to minimize distances for transporting materials of all kinds. Large areas may be needed for waste disposal and ore storage near the extraction area. Surface mining methods generally apply to such ores as iron, disseminated copper and gold, limestone, boron, gypsum, clays, and rare earths; underground methods are more often used for all vein deposits and for such commodities as silver, gold, tungsten, lead, and zinc.

Uranium

Uranium exploration is typical of most locatable minerals and requires selection of a favorable area, field reconnaissance, land acquisition, target definition, and evaluation. The last items involve drilling and excavation and are done after land acquisition because of the significant increase of exploration costs in later stages. If the land cannot be acquired and access assured, exploration cannot be justified beyond preliminary stages.

Preliminary investigations include study of remote sensing data. Geologic features such as lineaments and alteration zones can be observed from satellite images. Lower level data, including photography and radar, can identify smaller features and more subtle differences in color and texture of rock units. Very low level airborne geophysical investigations of gamma ray emission, gravity, and magnetism complete the indirect methods leading toward selection of favorable prospecting areas. Ground-based studies of geochemistry, geophysics, and geologic mapping may be required for site selection and may overlap into the field reconnaissance stage of exploration.

Field studies may include soil and water sampling, radiometric investigations, and studies of electrical and physical charactersitics of localities and specific targets. These studies may include some drilling and downhole logging.

After property acquisition, further site-specific exploration programs, primarily involving drilling, lead to design of mining operations. Surface disturbance because of access by off-road vehicles and trucks during the later stages of exploration would normally be where subsequent mining operations take place. Problems could be minimized by careful selection of routes and drill sites and by appropriate clean-up after tests are completed.

Uranium ore may be mined by either open pit or underground methods. Where the ore zones extend below the water table, removal of water may change the chemical conditions and result in toxic elements being dissolved in the mine water when it is pumped to the surface for disposal. Extensive treatment of mine waters may be required as a component of proper mine design.

Air quality underground and adjacent to uranium mines may be adversely affected by radon decay products. Dust from haulage trucks or from other handling of radioactive ore may concentrate emissions where the dust accumulates. Waste rock from uranium mines can release toxic and radioactive materials which can, in time, enter into ground water.

Uranium ore is not now being produced in the CDCA. Production would require bringing facilities to the desert for doing at least some of the concentration of ores now done out-of-state only.

In-situ leaching, i.e., dissolving uranium from ore deposits in place, is a technique finding wider application in the uranium industry. There are methods for controlling the spread of chemicals into adjacent soil or ground water. Solutions derived from leaching operations must be stripped of their values at the place of production.

The Nuclear Regulatory Commission licenses uranium production and requires environmental reports with detailed consideration of the many issues. (Ref: Rouse, J. V., Environmental Considerations of Uranium Mining and Milling, Mining Engineering, October 1978).

MATERIAL SALES ACTIVITY SCENARIO

This scenario was developed from a study of the "average" material sales contract, normally for 10,000 cubic yards of total material for quarried rock aggregate. Table XIV-3-8 summarizes surface acreage disturbance by stages and by cumulative total.

Material sales activities on Federal lands are authorized by the Materials Act of July 31, 1947, as amended. Surface management control of these Activities and reclamation are provided by the Act and its subsequent regulations codified under 43 CFR 23 and 43 CFR 3600. The State of California also regulates material sales operations under the State Mining and Reclamation Act (SMRA) of 1975.

Under Title 23 USC (Interstate and Defense Highway System), a State highway department (i.e., Caltrans) may apply for exclusive material sales right of ways on Federal lands for highway construction and maintenance programs. It is handled through the Secretary of Transportation and bypasses the Bureau material sales system. The material sales sites are in the form of exclusive grants to the State and are not subject to the normal BLM procedures or planning system. This has particular implications for the Desert Plan, especially in Class L.

The major aspects of typical sand and gravel operations are a pit or trench covering 0.74 to 1.0 acres to a depth of approximately 10 feet. Deposits are of predomonently sand or gravel and are located in physiographic areas where erosion and weathering have reworked sediments into deposits of predominently one particular size. These areas are normally washes, riverbeds, shorelines, and alluvial fans.

Sites are located as close to use areas as possible because of transportation costs. Typical equipment used are front-end loaders, dump trucks, water trucks, and personal vehicles. The processing equipment, portable and moved from site to site, consists of conveyor belts, sizing screens, and occassionally drying kilns. Equipment is normally set up in the pit itself to minimize handling costs.

Surface reclamation requires that pit slopes or trench slopes be left stable and re-contoured at 3:1 to 6:1 (horizontal: vertical). Past experience has shown that vegetation and wildlife return to the reclaimed site within two years after activity ceases.

A rock quarry operation entails hard rock mining in a small open pit, using explosives to break the rock. Quarry size is 1-2 acres in area and vertical extent is variable, depending on topography. Cliff faces or ledges are preferred for easier access to rock and easier removal. Equipment and operational methods are the same as sand and gravel operations.

Table XIV-3-8

SURFACE DISTURBANCE FROM MATERIAL SALES SITES

STAGE	Roads	Pit/Quarry	Cumulative Acreage Used
Exploration	0.50	None	0.50
Development/ Production	0.25	1.5	2.25
Reclamation	0.0	0.0	2.75

SALINE MINERALS ACTIVITY SCENARIO

This scenario was developed from contacts with active saline minerals extraction operations presently active on several dry lake beds in the CDCA. Table XIV-3-9 summarizes surface acreage disturbance by stages and cumulative totals.

Table XIV-3-9

SURFACE DISTURBANCE ASSOCIATED WITH SALINE MINING OPERATIONS

STAGE	Roads	Drill Pads	Pipe-lines	Ponds	Plant	Stage Total	Cumulative Total
Exploration	4.33	0.2	0.0	0.0	0.0	4.53	4.53
Development/ Production	8.71	10.0	294.0	1100.00	140.00	1631.1	1635.63
Close Down	0.0	0.0	0.0	0.0	0.0	0.0	1635.63
Residual							140.00

Saline minerals exploration and production on Federal lands is authorized by the Mineral Leasing Act of February 25, 1920, as amended (41 Statute 437). Surface management control is provided by the National Environmental Policy Act of 1969 (42 USG 4332). Regulations codified under 43 CFR 3500 and various cooperative agreements between the U.S. Geological Survey, the Bureau of Land Management, the Forest Service, and the U.S. Fish and Wildlife

Service provide for strict surface management controls of a lessee's operations.

A typical saline program begins with the issuance of a prospecting permit which carries a preference right to lease if an economic discovery is made. Exploratory activities concentrate on drilling the dry lake beds proper, using a track road and placing a drill truck on a 30 x 30-foot open site.

If a discovery is made and development proceeds, a series of wells are drilled into the brine using a 50 x 50-foot pad which is reclaimed to 25 x 25 feet after the well is completed. Well spacing is variable, depending on the size of the brine pool encountered, but averages one well per 80 acres.

Brines are conveyed via 10 to 12-inch pipelines to evaporation ponds where the salt is removed by precipitation and the brines are further concentrated. A 20 to 24-inch pipeline carries the brines from the ponds to the chemical plant for processing. A road net connects the wells to each other and the pipelines follow the roads. All installations except the plant are located on the dry lake bed. The salt crust will not support the weight of the plant.

Reclamation is easily accomplished. The winter rains raise the brines to the surface, and each new layer of salt is laid down (up to 8 vertical inches per year). This causes all roads and drill pads to be filled in, and the dry lake bed is restored to a homogenous surface again. The lessee is faced with re-establishing his roads every year. Once the evaporation ponds are backfilled and smoothed over, all traces of the operation will be removed by natural processes within one year.

GEOTHERMAL ACTIVITY SCENARIO

This scenario was developed from the official documentation of the history of Magma Electric Company's 10 MW geothermal power plant on the East Mesa of Imperial County, California. It is the only completely documented geothermal power system on the California Desert currently in operation. Table XIV-3-10 summarizes the surface disturbance by stages and by cumulative total. Map XIV-3-1 indicates major units of the plant in relation to its site along the East Highline Canal.

Table XIV-3-10
SURFACE DISTURBANCE (ACRES) ASSOCIATED WITH GEOTHERMAL OPERATIONS

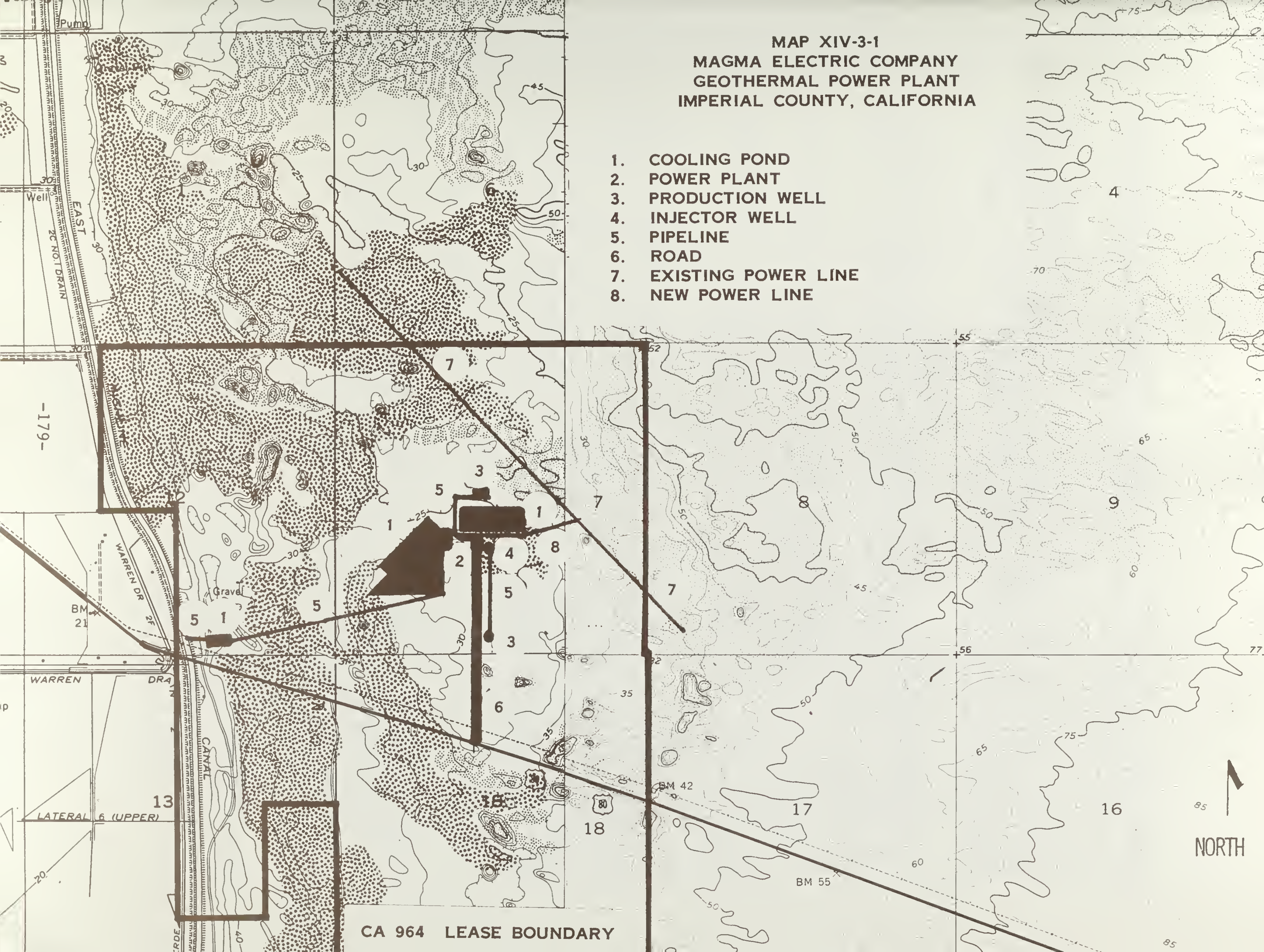
STAGE	Roads	Drill Pads	Pipe-lines	Ponds	Power Plant	Power Lines	Stage Total	Cumula-tive Total	% of Lease
Initial Exploration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Preliminary Exploration	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geophysical Surveys	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exploration Drilling	2.05	3.45	0.0	0.62[1]	0.0	0.0	5.50	0.0	0.29
Field Development	0.33	4.83[2]	2.05	37.19[3]	0.92	0.92	42.79	48.29	2.29
Production and Operation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.29	2.29
Close Down and Reclamation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.29	2.29

[1]Included in Pad Area.
[2]1.38 is the actual additional disturbance after exploration drilling.
[3]Does not contain the 0.62 acres of temporary drill sumps on the pads.

Geothermal operations on Federal lands are authorized by the Geothermal Steam Act of December 24, 1970 (PL 91-5810). Strict surface management control of all geothermal activities is provided by the Act and its subsequent regulations codified under 30 CFR 270 and 271, 43 CFR 3200, and the Geothermal Resource Operations Orders (GRO's) issued by the U.S. Geological Survey. All lessees and operators must comply with its provisions or face punitive action, up to and including lease termination in severe noncompliance. GRO #4 is solely concerned with the environmental controls and safeguards on Federal geothermal leases.

Magma is a model of regulated maximum development with minimum environmental surface disturbance.

Problems involved designing the road and drill pad net to be reused for development if the initial exploratory drilling were successful. The five production wells were drilled from two pads of 1.61 acres each -- three wells


MAP XIV-3-1
MAGMA ELECTRIC COMPANY
GEOTHERMAL POWER PLANT
IMPERIAL COUNTY, CALIFORNIA
1. COOLING POND
2. POWER PLANT
3. PRODUCTION WELL
4. INJECTOR WELL
5. PIPELINE
6. ROAD
7. EXISTING POWER LINE
8. NEW POWER LINE
CA 964 LEASE BOUNDARY
NORTH
EAST
2C NO.1 DRAIN
WARREN DR
WARREN
CANAL
LATERAL 6 (UPPER)
Gravel
BM 21
BM 42
BM 55
Pump
Well

from one pad, two from the other. The three injection wells were likewise all drilled from one 1.61 acre pad. This minimized drill pad proliferation and surface disturbance.

Pipelines and power lines were placed along the road shoulders, and the pipelines were elevated on concrete pedastals to at least one foot to allow for wildlife mobility and thermal expansion. All pipelines are insulated with two inches of fiberglass insulation to prevent heat loss and safety hazards. All power lines are constructed so as to prevent electrocution of raptors and other large birds.

The power plant operates on a closed cycle system and does not emit any gases to the outside atmosphere, as all production fluids are re-injected into the reservoir. The cooling ponds contain fresh water obtained from the nearby East Highline Canal, and spent cooling water is discharged into the nearby Warren Drain (see Map XIV-3-1).

All noise levels are mandated to be no greater than 65 dBA at a distance of 1,500 feet from their source or the lease boundary, whichever is the closer.

The power plant was operating during the 6.4 magnitude earthquake of October 15, 1979, and suffered no noticeable damage to any of its facilities, despite being only five miles from the earthquake's epicenter.

The area contains sensitive wildlife and botanical species, as well as numerous cultural resources sites. All wildlife and botanical mitigation for the operation was approved by the Bureau of Land Management, U.S. Fish and Wildlife Service, and California Department of Fish and Game. The cultural resources mitigation was approved by the State Historic Preservation Offices. A detailed, general discussion of the stages and activities involved in the development of geothermal resources, along with diagrams and drawings, is available for study at the BLM California Desert District Office, 1695 Spruce St., Riverside, California, 92507.

Part 4

Glossary

Units of Measurement

kilogram (kg) -- 2.2046 pounds

metric ton (mt) -- 1,000 kg: 2,2046 pounds

short ton (st) -- 2,000 pounds

long ton (lt) -- 2,240 pounds

short ton unit (stu) -- 1% of a short ton: 20 pounds

long ton unit (ltu) -- 1% of a long ton: 22.4 pounds

troy ounces -- 1.09714 ounces avoirdupois

barrel (bbl) -- 42 gallons

cubic foot (ft^3) -- 1 ft^3

ounce and pound -- U.S. avoirdupois (16 oz/lb)

Category I Mineral Commodities -- (a) A strategic mineral commodity found in significant quantities in the CDCA: or (b) mineral commodity of which 50% or more of the U.S. consumption is imported; or (c) mineral commodity sold in regional or local markets, in high demand, with relatively few known regional economic occurrences, which would increase in price if regional or local sources were made unavailable; or (d) mineral commodity in which the U.S. approaches self-sufficiency but depends on production from the CDCA; or (f) mineral commodity which could be obtained from the CDCA, and if so, would considerable reduce the U.S. burden of importing it.

Category II MIneral Commodities -- (a) Low demand mineral commodities found in the CDCA; or (b) mineral commodities that may be strategic or of which 50% or more of the consumption is imported, but so far not known to occur in significant[1] quantities in the CDCA: or (c) non-strategic mineral commodities of which less than 50% of the U.S. consumption is imported;

[1]The expression "significant quantities in the CDCA" means that somewhere in the CDCA at least one occurrence of a given commodity may now be economic, or there is a strong probability that at least one occurrence would be economic if enough were known about it. Therefore, each occurrence or deposit of a commodity need not be significant to make that commodity significant.

or (d) mineral commodities which, although found in significant quantities in the CDCA, probably will not support new production unless current producers become exhausted or there is a dramatic increase in demand.[1]

direct evidence -- Unambiguous information which relates directly to the occurrence of a given mineral or commodity. Verified or reported known occurrences, production or economic data; e.g., geochemical anomalies, gamma ray uranium anomalies, gamma ray thorium anomalies, and magnetic anomalies.

economic -- Capable of profitable production or extraction under reasonable investment assumptions, or assumed with reasonable certainty or analytically demonstrated for the commodity under consideration.

favorable geologic environment -- Areas where the geologic setting, i.e., lithology (rock types), structure, location, mineral occurrences, and/or any other forms of direct or indirect evidence, indicates potential for mineral deposition. The classification system makes a distinction between mineral occurrences from favorable geologic environments without known occurrences.

indirect evidence -- Information about a geologic environment which does not directly relate to the occurrence of any specific mineral commodity. The information includes indicators of mineralization, such as geostatistical maps, expert panel maps, lineament maps, gamma ray potassium amomalies, Bouguer anomalies, tonal anomalies, claims, and potentially favorable lithologies (lithologies similar to those hosting mineralization in other areas).

intermittent producer -- Removal of minerals or energy resources on a non-continuous basis; operations at which removals occurred at lease once within the past two years.

Known Geothermal Resource Area (KGRA) as classified by the USGS -- ". . . an area in which the geology, nearby discoveries, competitive interests or other factors would" . . . engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose." Code of Federal Regulations (CFR), Title 43, Group 3200.0-5 (cited as: 43 CFR 3200-5).

[1]Because technology, geology, planning, and economics are all dynamic processes, a commodity that is now (July, 1980) in one category may in the future fall under the other category if required by technical advances, discoveries, new shortages, etc.

Known Geologic Structure (KGS) -- "A known geologic structure is technically the trap in which an accumulation of oil or gas has been discovered by drilling and (is) determined to be productive, the limits of which include all acreage that is presumptively productive." (CFR 43, 3100.0-5).

leasables -- Mineral and energy resources for which lands can be leased. These commodities are defined and regulated by U.S. laws, 43 CFR Groups 3100, 3200, 3500, and other regulations. Oil, gas, geothermal, and all sodium and/or potassium compounds are among examples of leasable resources found in the CDCA.

locatables -- Minerals subject to General Mining Law of May 10, 1872, as amended. Metallic minerals and many nonmetallic minerals, such as zeolites or barite, are locatable; 43 CFR 3800 pertains to locatable minerals.

mineral deposit -- A natural concentration of a mineral, minerals or chemical element (i.e., gold) in sufficient quantities and of such quality as to permit inferring profitable extraction.

net export -- Export of a commodity in excess of import.

ore deposit -- A mineral deposit which is currently mined or which has been well defined, tested, and on which a feasibility study indicates that profitable extraction is possible at present or in the immediate future.

Potential Geothermal Resource Area (PGRA) -- Equivalent to "prospectively valuable" as classified by USGS.

prospectively valuable -- USGS classification of leasable mineral commodity. Areas which are geologically similar to currently producing deposits" . . . inference being that similar deposits are probably present" in prospectively valuable areas. This designation includes known occurrences where the extent and quality "cannot be ascertained."

resource[1] -- Concentration of naturally occurring solids, liquids 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. Modifiers below are listed in ascending order of geologic assurance.

inferred -- Estimates based on an assumed continuity from measured and/or indicated resources for which there is geologic evidence.

[1]All definitions of resources and reserves are adapted from Mineral Commodity Summaries 1980, U.S. Bureau of Mines.

indicated -- Quantity, grade, and/or quality computed from information similar to that used for measured resources, but sites for inspection, sampling, and measurement are farther apart or less adequately spaces; degree of assurance, although lower than that for measured resources, is high enough for continuity between points of observation to be assumed.

measured -- Quantity, grade, and/or quality computed from dimensions revealed in outcrops, trenches, workings or drill holes, and geologic character is so well defined that size, shape, depth, and mineral content of a resource body are well established.

demonstrated -- Term for the sum of <u>measured</u> and <u>indicated</u>.

reserves -- Part of resource which could be economically extracted or produced at time of determination; term <u>reserves</u> need not signify that extraction facilitates are in place and operative.

marginal reserves -- Portion of the reserves which, at the time of determination, borders on being economically producible; essential characteristic is economic uncertainty. Included are resources that would be producible, given project changes in economic or technologic factors.

salables -- Mineral materials as covered by and defined in 43 CFR 3600: sand, gravel, pumice, cinders, roofing granules, and crushed rock and examples of salable materials found in the CDCA.

strategic minerals -- Mineral resources included on a list of minerals and other commodities stockpiled by the gederal Government. The list is compiled annually by the Federal Emergency Management Agency.

USGS -- United States Geological Survey.

valuable -- Same as USGS classification "known valuable"; deposits of known extent and quality, and deposits about which the extent and quality can "be reasonably inferred from the geologic information available."

APPENDIX XV

ENERGY PRODUCTION AND UTILITY CORRIDORS

APPENDIX XV

ENERGY PRODUCTION AND UTILITY CORRIDORS

Contingent Corridors
Corridors with Potential for Future Use

CORRIDOR INDENTIFICATION

Sixteen utility planning corridors are identified in the Energy Production and Utility Corridors Element of the Proposed Plan. Additionally, nine more corridors (P, Q, R, S, T, AA, W, Y, Z) have been identified as having some potential for use in the future, should project status associated with the proposed 16 corridors change. These nine are referred to as "contingent corridors" and are described in Table XV-1 and shown on the map in this appendix. These corridors are not shown on the Proposed Plan. Contingent corridors may be brought forward into the Plan after simultaneous Plan amendment and environmental impact statements on an identified project have been prepared.

Contingent corridors were identified because of the level of uncertainty associated with any power plant and utility proposal. Therefore, the reasons for placing Corridors P, Q, R, S, T, W, Y, Z and AA in a contingency status are described below.

TABLE XV-1
CONTINGENT CORRIDORS

CORRIDOR	Width	Identified Use
P	2 miles	2/115-kv power lines 12-in. pipeline Coaxial cable
Q	5 miles	Coaxial cable
R	2 miles	Telephone line
S	2-5 miles	None
	5 miles	None
T	2 miles	12-in. pipeline
W	2 miles	500-kV power line 2/230-kV power line
Y	2 miles	Aqueduct Telephone line
Z	2 miles	92-kV power line
AA	4 miles	2/500-kV power lines

CORRIDOR P

Corridor P contains existing facilities. The anticipated additional use of this corridor is predicated upon new energy sources being located north of or in the northerly sector of the California Desert Conservation Area.

CORRIDOR Q

This corridor is seen as a contingency corridor for the transmission of energy from eastern generating sites. While this corridor is not specifically associated with any particular project, it could be utilized in connection with the Allen-Warner Valley Energy System or other generating facilities currently under study.

CORRIDOR R

There are existing electric transmission facilities within this corridor. It is an alternate corridor for the Allen-Warner Valley Energy System presently being reviewed by the California Public Utilities Commission. This corridor could prove to be invaluable for other transmission facilities which would be associated with future projects.

CORRIDOR S

Corridor S provides one of the few viable alternatives to the critical corridor through the Banning Pass area. There are existing transmission facilities within portions of this corridor.

CORRIDOR T

Corridor T is an alternative for the transmission of energy generated by either geothermal or conventional power plants. This corridor, which is an alternative to Corridor Z, is improved with existing electric transmission facilities.

CORRIDOR Z

This Corridor may be useful in transmitting energy from geothermal and possible solar generators associated with the Salton Sea if these become viable sources in the future.

CORRIDOR AA

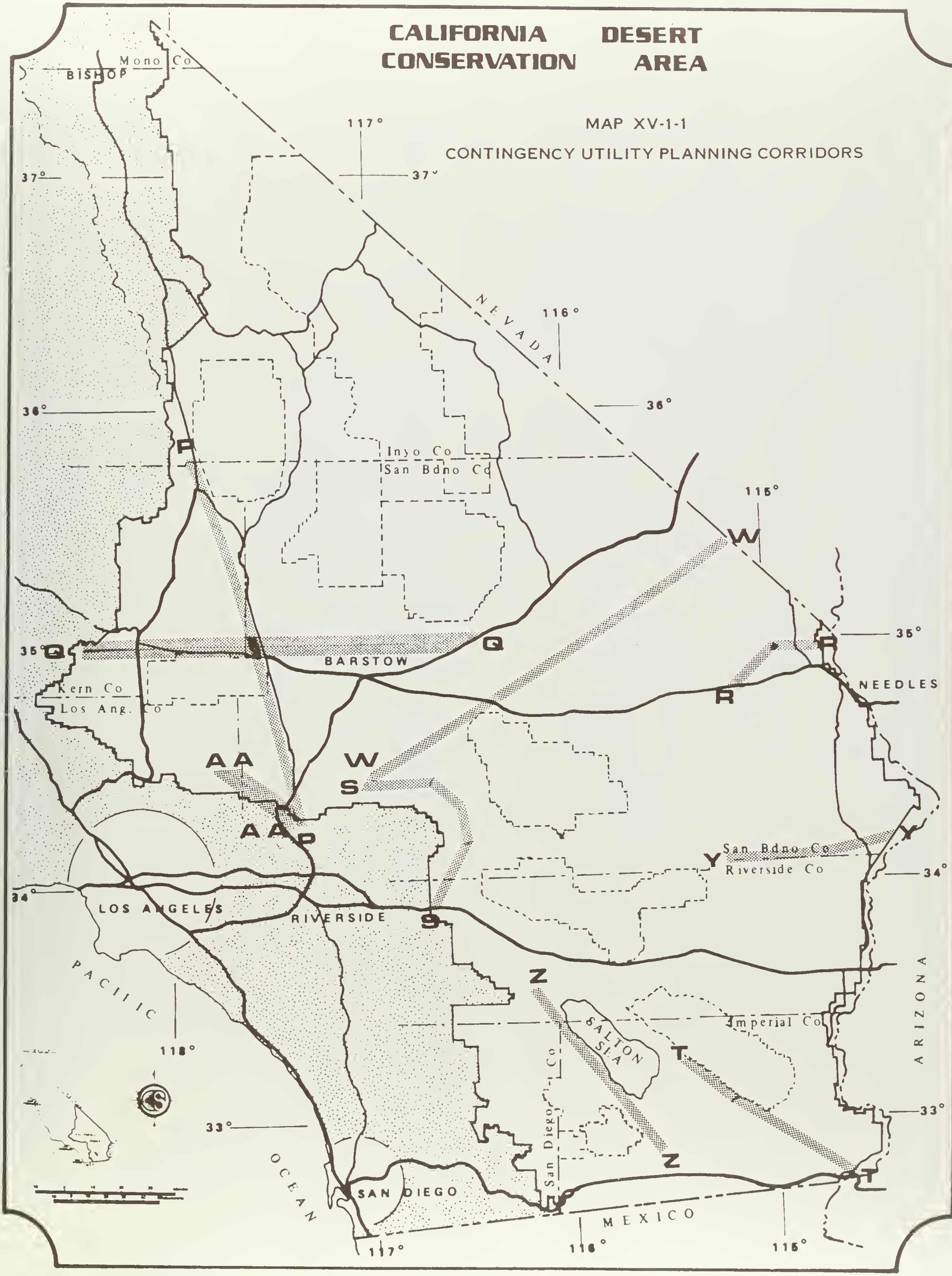
This corridor, which contains existing electric transmission facilities, is almost totally within private lands. Corridor AA completes an important link in the network of transmission corridors.

CORRIDOR W

Southern California Edison Company and the Public Utilities Commission are considering this corridor. Edison is proceeding with plans to build a power plant in Lucerne Valley. Corridor W would serve the site as a means for delivering electricity to customers in the Los Angeles basin.

CORRIDOR Y

Southern California Edison Company and the California Public Utilities Commission requested this corridor since it would serve the Rice Site of the California Coal Project currently under review by the Energy Commission.


CALIFORNIA DESERT CONSERVATION AREA
MAP XV-1-1
CONTINGENCY UTILITY PLANNING CORRIDORS
BISHOP
Mono Co
NEVADA
Inyo Co
San Bdno Co
BARSTOW
Kern Co
Los Ang. Co
NEEDLES
San Bdno Co
Riverside Co
LOS ANGELES
RIVERSIDE
PACIFIC
OCEAN
SALTON SEA
Imperial Co
San Diego Co
SAN DIEGO
MEXICO
ARIZONA
P
Q
W
R
AA
S
Y
Z
T
37°
36°
35°
34°
33°
118°
117°
116°
115°

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