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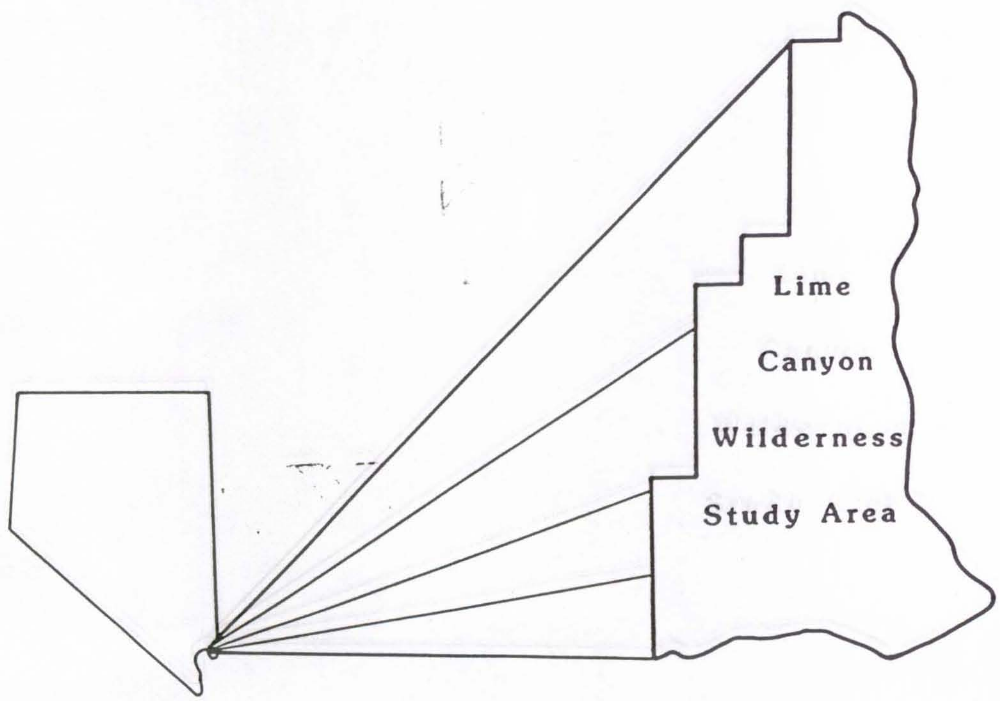
Mineral Land Assessment/1988
Open File Report

Mineral Resources of the Lime Canyon Wilderness Study Area, Clark County, Nevada



BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

MINERAL RESOURCES OF THE LIME CANYON WILDERNESS STUDY AREA, CLARK COUNTY, NEVADA

By
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MLA 40-88

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Spokane, Washington

UNITED STATES DEPARTMENT OF THE INTERIOR
Donald P. Hodel, Secretary

BUREAU OF MINES
T S Ary, Director

PREFACE

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on U.S. Bureau of Land Mangement administered land designated as Wilderness Study Areas ". . . to determine the mineral values, if any, that may be present . . . ." Results must be made available to the public and submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral survey of the Lime Canyon Wilderness Study Area (NV-050-231), Clark County, NV.

The open-file report will be summarized in a joint report published by the U.S. Geological Survey. The data were gathered and interpreted by Bureau of Mines personnel from Western Field Operations Center, East 360 Third Avenue, Spokane, WA 99202. The report has been edited by members of the Branch of Mineral Resource Evaluation at the field center and reviewed at the Division of Mineral Land Assessment, Washington, DC.

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

cps	count per second
yd^3	cubic yard
ft^3	cubic foot
ft	foot
in.	inch
mi	mile
lb	pound
mi^2	square mile
ppm	part per million
ppb	part per billion
%	percent
oz	troy ounce
oz/ton	troy ounce per ton
oz/yd^3	troy ounce per cubic yard

SUMMARY

In 1987, at the request of the U.S. Bureau of Land Management, the U.S. Bureau of Mines studied the 34,680-acre Lime Canyon Wilderness Study Area (NV-050-231) to evaluate its identified mineral resources. The Wilderness Study Area is in Clark County, NV, about 30 air miles southwest of Mesquite, NV. The area studied contains an estimated 44 million tons of indicated subeconomic resources of gypsum, an inferred subeconimic resource of limestone and dolomite, and occurrences of gold, copper, uranium, and zeolite. The Wilderness Study Area is underlain chiefly by carbonate rocks with lesser amounts of sandstone and shale. Metamorphic, granitic, and volcanic rocks also crop out within the area. Large portions of the area are overlain by alluvium.

The Wilderness Study Area is within the Gold Butte mining district. Several gold mines with past production are nearby to the south of the Wilderness Study Area; one mine is reported in operation on a small scale. Several silver-bearing copper and zinc mines with past production are nearby to the east of the Wilderness Study Area.

Seven patented claims (861 acres) cover about 6 mi of the north-trending gypsum beds, some of which have recrystallized to alabaster. Six gold claim groups with workings in alluvium are located in or near the southeast corner of the Wilderness Study Area and were current in 1987. Six uranium claims and many exploration trenches occur in tuffaceous rock in the Wilderness Study Area; none were current in 1987. Three shafts, one adit, and several minor workings in carbonate rock and sandstone are assumed to have been prospected for copper, but were not claimed in 1986. There is an occurrence of zeolite in tuffaceous rock, and an inferred subeconomic resource of sand and gravel occurs in a 16-square-mile area in the western portion of the Wilderness Study Area. Carbonate rocks that crop out over a 20-square-mile area are classified as an inferred subeconomic resource.

The high volume --low-value commodities, such as gypsum, limestone and dolomite, sand and gravel, and zeolites will probably not be mined in the Wilderness Study Area in the near future; the same commodities are available nearer to markets or railways.

The metallic minerals have insufficient grade and/or tonnage to be mined economically.

INTRODUCTION

This report describes the USBM (U.S. Bureau of Mines) portion of a cooperative study with the USGS (U.S. Geological Survey) to evaluate mineral resources and potential of the Lime Canyon Wilderness Study Area at the request of the BLM (U.S. Bureau of Land Management). The USBM examines individual mines, prospects, claims, and mineralized zones, and evaluates identified mineral and energy resources. The USGS evaluates potential for undiscovered resources based on areal geological, geochemical, and geophysical surveys. Results of the investigations will be used to help determine the suitability of the Wilderness Study Area for inclusion into the National Wilderness Preservation System. Although the immediate goal of this and other USBM mineral surveys is to provide data for the President, Congress, government agencies, and the public for land-use decisions, the long-term objective is to ensure the Nation has an adequate and dependable supply of minerals at a reasonable cost.

Setting

The 34,680-acre Lime Canyon WSA (Wilderness Study Area) is about 30 mi southwest of Mesquite, NV (figs. 1 and 2) in the South Virgin Mountains. The southeast corner of the WSA is accessible from U.S. Highway 15, 6 mi west of Mesquite, then south for 28 mi on paved secondary roads, then continuing for 16 mi on a well-graded dirt road. The eastern boundary of the WSA is a four-wheel-drive road.

Elevations range from 4,406 ft south of Lime Canyon to 1,400 ft along the western boundary.

North-trending mountains have cliff-like western faces and more gentle, though steep, eastward slopes. Steep slopes, deep canyons, and abrupt elevation changes typify the area. The western portion has well-developed alluvial fans and large, wide washes.

The WSA is in an arid to semiarid zone with an average annual precipitation of less than 10 in. Precipitation in any given area may vary from year to year because local storms are responsible for most of the rainfall or snow. Mining can be carried on the year round without difficulty (Vanderburg, 1937, p. 5). The sagebrush and low brush and grasses are typical of the southern Nevada desert.

Previous Studies

Geologic mapping of Clark County was accomplished by Bowyer and others (1958). Geologic maps may also be found in Longwell and others 1965 report on geology and mineral deposits of Clark County and Morgan's (1968) thesis. The Precambrian complex (Volborth, 1962) and the overlying Tertiary Formation (Brenner and Glanzman, 1979; and Bohannon, 1984) are discussed in detail. The Sevier orogenic belt, Las Vegas Valley shear zone, and faulting directly affecting the Wilderness Study Area are reported by Armstrong (1968), Fleck (1970), Anderson (1973), Longwell (1974) and Bohannon (1979). The structure and stratigraphy were studied by Morgan (1968). Data on the Gold Butte mining district was published by Hill (1916), Lincoln (1923), Vanderburg (1936), Vanderburg (1937), and Couch and Carpenter (1943). The assessment of geology, energy, and mineral resources by the Great Basin GEM Joint Venture (1983) and a mineral inventory by Smith and Tingley (1983) includes the Wilderness Study Area. Results of radioactive mineral studies are reported by Garside (1973) and the Aero Service Division (1979). Petroleum potential is found in Sandberg (1983).

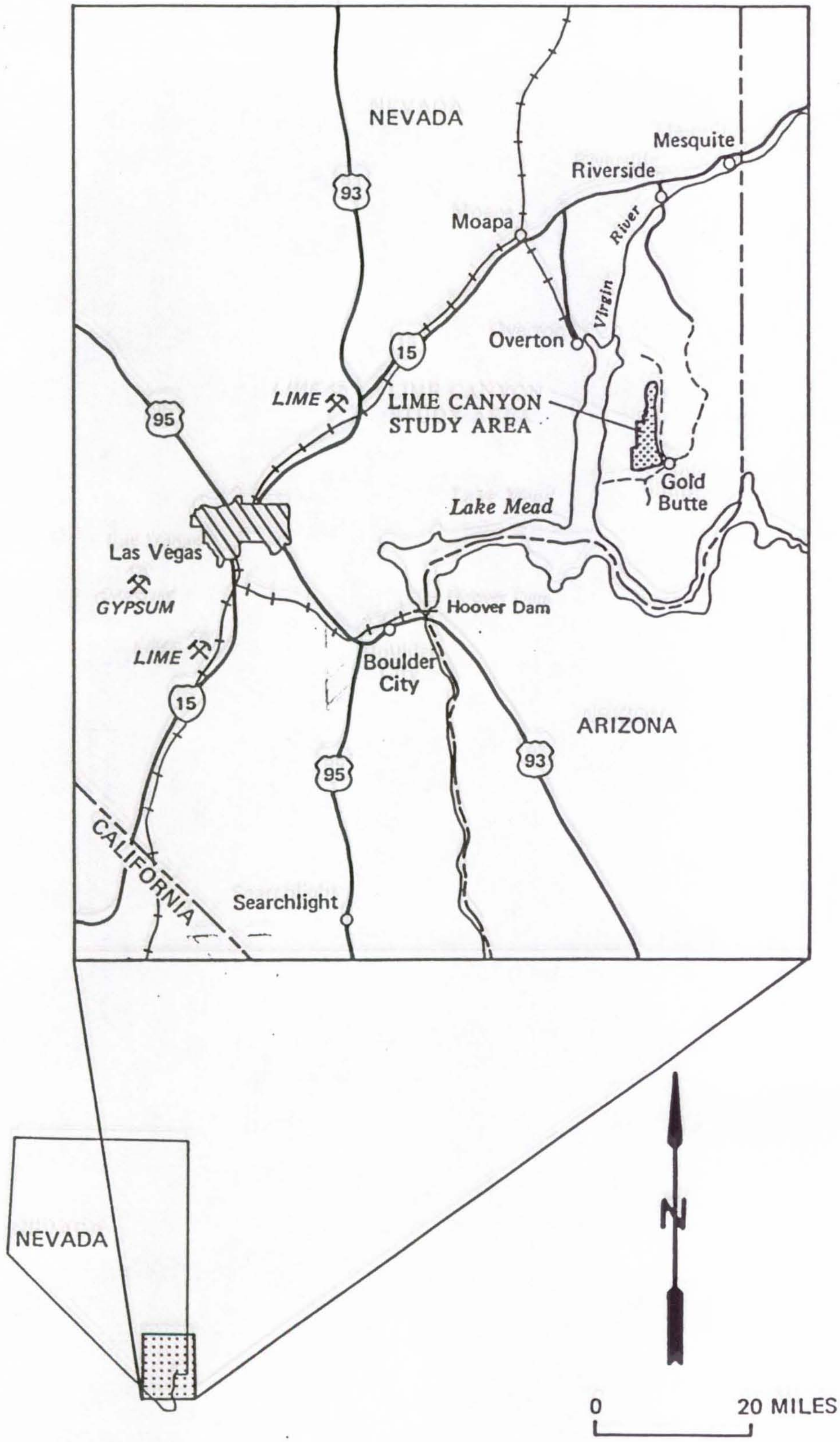

FIGURE 1.– Location of the Lime Canyon Wilderness Study Area, Clark County, NV

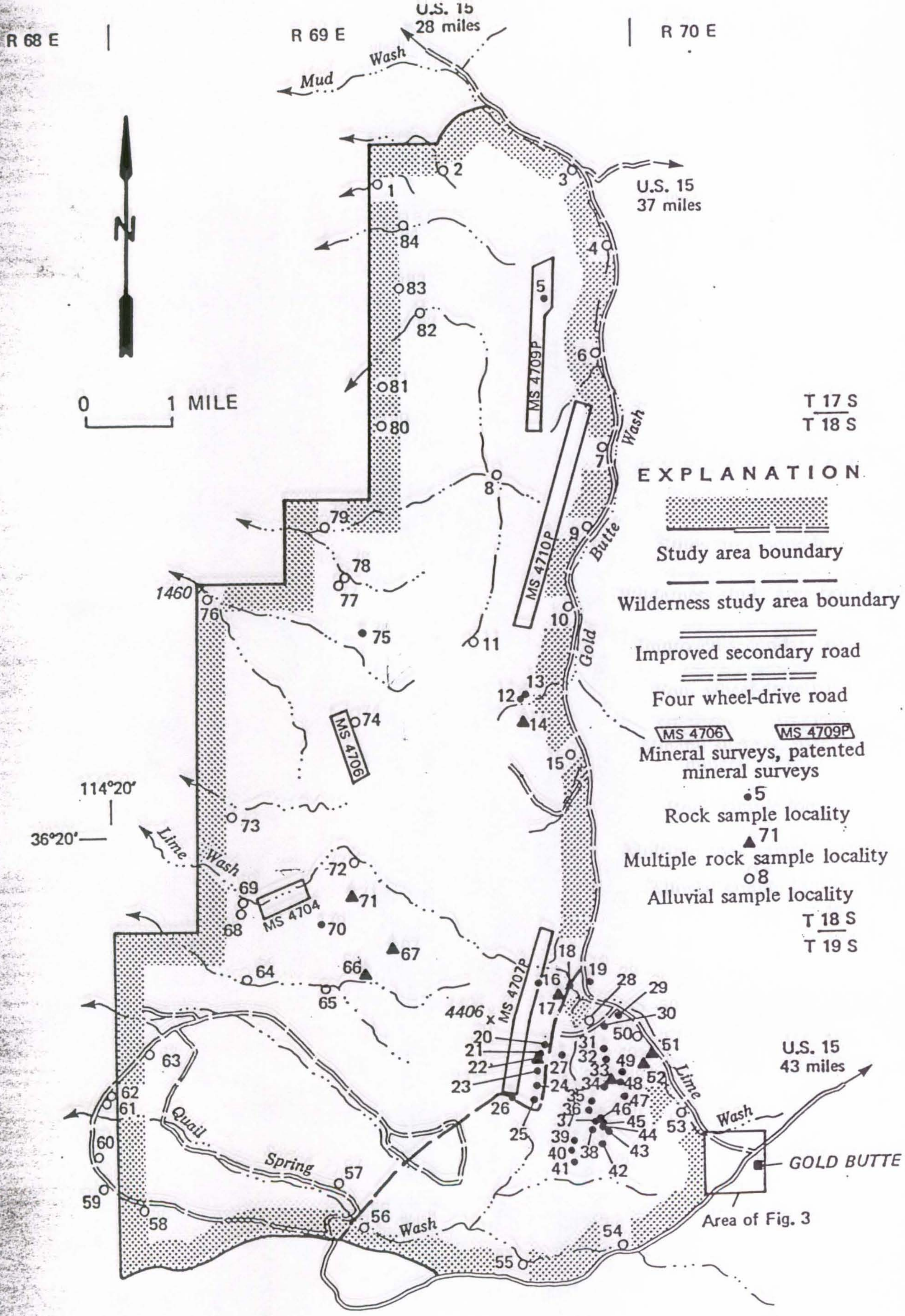

FIGURE 2.– Sample localities in and near the Lime Canyon Wilderness Study Area, Clark County, NV

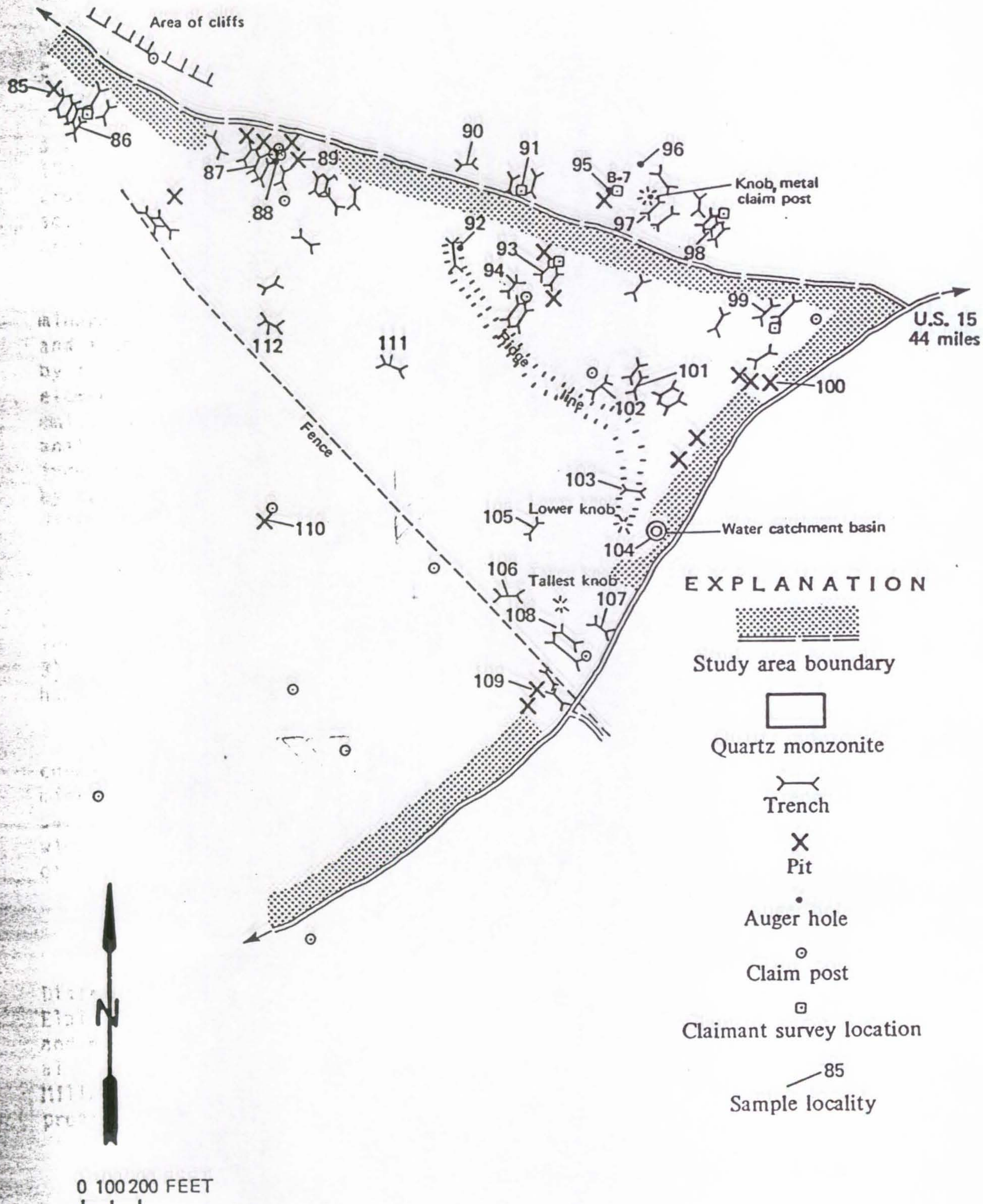

FIGURE 3.– Sample localities in and near the southeast corner of the Lime Canyon Wilderness Study Area, Clark County, NV

Present Study

Prefield studies included research at the USBM, Spokane, WA, library and examination of Clark County and BLM mining, lease, claim, and land status records. These data were used to study the geologic setting, mining history, possible mineral commodities, mining claim ownership, claim locations, and access. USBM and State mineral production records were examined. Aerial photographs were used to aid in the search for mine workings, for access, to check the extent of the gypsum beds, and as a reference for drafting cross-sections. Field studies in the spring of 1987, 36 man days, involved searches for and sampling of mines, prospects, claims, or mineralized geologic structures. Gamma ray scintillometer readings were monitored throughout the Wilderness Study Area.

Eighty rock and 59 alluvial samples were collected to evaluate the mineral resources of the WSA. All samples were checked for radioactivity and fluoresence. Forty-nine of the rock samples were analyzed for gold by fire assay and atomic absorption spectrophotometry and for multiple elements (appendixes D and E) by inductively coupled plasma atomic emission spectroscopy. Of the remaining 31 rock samples, 12 were analyzed for gypsum (table 1), and 4 for limestone (table 2) by inductively coupled plasma atomic emission spectroscopy, 12 for uranium by neutron activiation analysis, 2 for zeolites and 1 for clay by x-ray diffraction, and 1 for alabaster by petrographic evaluation.

The following rock sample types were collected: 1) chip - a continuous series of rock chips taken across the measured thickness of a vein, structure, or bed; 2) random chip - rock chips taken at random intervals, over a given area of an apparently homogeneous exposure; 3) grab - an unselected assortment of rock fragments; 4) select - hand-picked chips of the highest grade rock available.

The alluvial samples, consisting of two level 14-in. panfuls, were concentrated by a laboratory-sized Wilfley table and inspected for microscopic gold and other valuable minerals. Alluvial material was sampled throughout the WSA in order to evaluate for placer gold since a wide range of gold occurrences have been reported associated with rocks of the same type and age as those in the WSA (Phillips, 1985).

ACKNOWLEDGEMENTS

The author wishes to thank Brent Bestram of the BLM Las Vegas District Office for his cooperation and the use of aerial photographs, Elaine Hoyle of the BLM Nevada State Office for her compilation of oil and gas lease application data, Bruce Wynne for his evaluation of alabaster, and William Hale, Andrew Leszcykowski, Mitchell Linne, Michael Miller, and Steven Schmauch of the WFOC who rearranged their schedules to provide the necessary field assistance.

GEOLOGIC SETTING

The Lime Canyon Wilderness Study Area is in the Basin and Range physiographic province, although this portion of Nevada has external drainage by the Colorado River. The South Virgin Mountains are divided by the Gold Butte fault into north and south segments which differ considerably in their geology (fig 4). The northern segment consists of a series of linear, north-striking ridges and valleys formed along steeply east-dipping beds. The rocks in this area range in age from Precambrian to Tertiary and are chiefly carbonate in composition with lesser amounts of sandstone and shale. The southern segment is a deeply dissected mass of Precambrian metamorphic and granitic rocks. The Wilderness Study Area is in the northern segment with some outcrops of the metamorphic and granitic rocks found in the southern segment. The ridges in the Wilderness Study Area are steep, generally bare, separated by deep ravines and are composed almost entirely of exposed bedrock. These ridges reflect tilting along north-trending faults, with resultant duplication of formations in adjacent ridges. The area has undergone several periods of deformation including the Cretaceous Sevier orogeny and later movement, up to 11 mi locally, along the Gold Butte and Lime Ridge left lateral-slip faults (Armstrong, 1968 p. 436; Longwell, 1974, p. 988; and Bohannon, 1979, p. 131).

MINING HISTORY

The Wilderness Study Area is within the Gold Butte mining district. Mining activity in this district began in 1873 with Daniel Bonelli's discovery of mica deposits a short distance east of Gold Butte. Prior to 1900 Bonelli made several shipments of sheet mica totaling an estimated 5 tons. In 1908, Frank Allsop made a shipment of 2,500 lb of sheet mica from the same area. Later, ultramafic rocks in the vicinity were developed for vermiculite.

Metal mining began about 1905 when gold was discovered in veins in the metamorphic and granitic rocks south of Gold Butte by Frank Burgess and associates. In 1907, replacement deposits of silver-bearing copper and zinc ore were found in Paleozoic limestone north of Gold Butte (east of the Wilderness Study Area) by Messrs. Bonelli, Burgess, Syphus, and Gentry. The discovery was the cause of a small boom in 1908 at which time the camp of Gold Butte was established. Small shipments of copper and zinc ore were reported from these areas from 1912 to 1918 (Longwell and others, 1965, p. 126).

Since 1918 gold-bearing quartz veins in the granitic rocks have been the most valuable of the metallic ore deposits. Longwell (1965 p. 128) and Couch and Carpenter (1943) show metallic production figures. Longwell's data spans the years 1905 through 1962. Apparently total production was less than $100,000 (2,857 oz gold at $35 per oz). One of these gold properties continues in small-scale operation today (1987) by the Bounsall family.

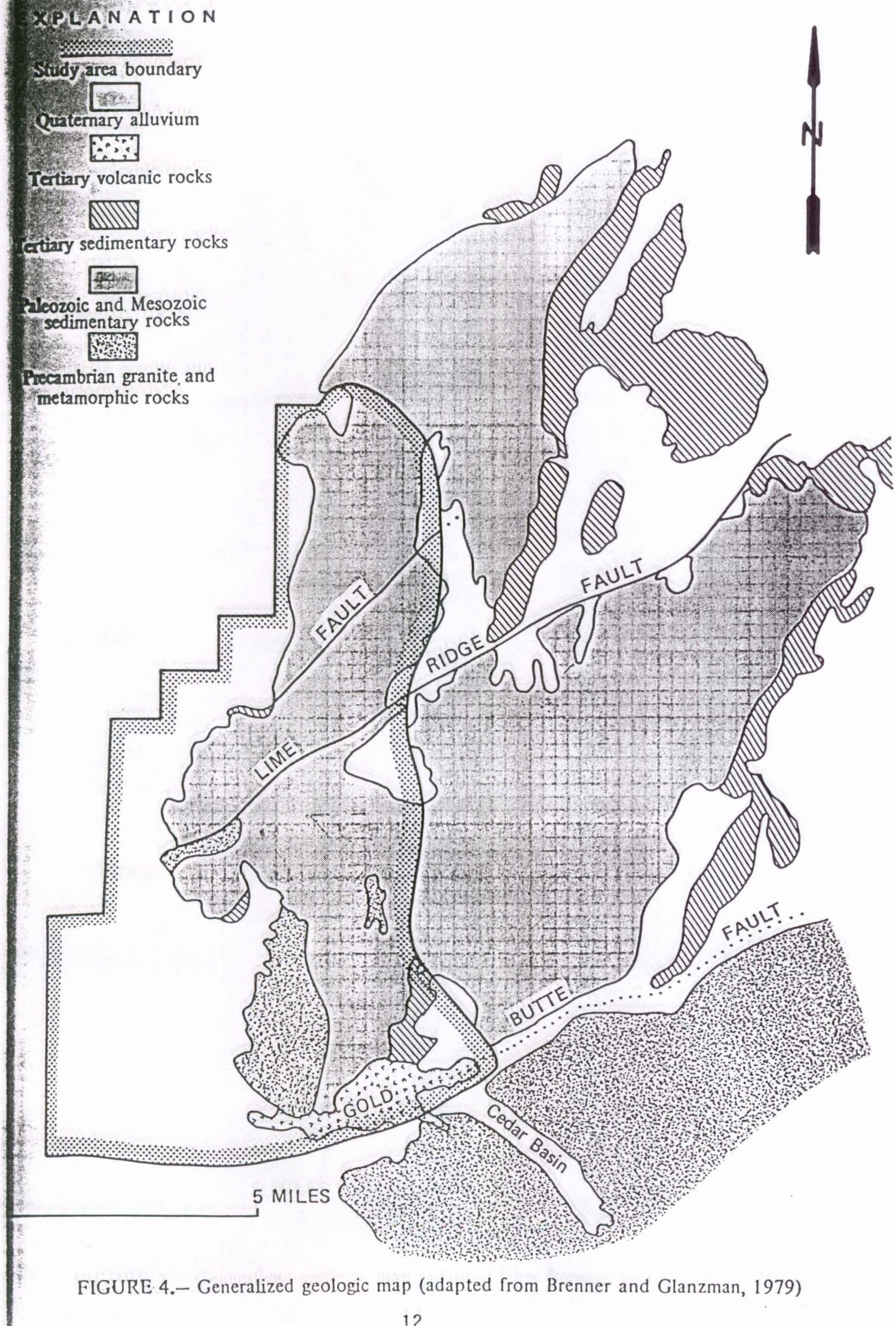

FIGURE 4.– Generalized geologic map (adapted from Brenner and Glanzman, 1979)

This mining has been conducted south of the Wilderness Study Area in the Precambrian rocks and east of the Wilderness Study Area in the same Paleozoic formations that exist in the Wilderness Study Area. In the Wilderness Study Area, the 1987 field examination found: a) three shafts, one adit, and other minor workings in carbonates and redbeds, b) seven patented gypsum claims, c) numerous uranium exploration trenches in the Tertiary sediments, and d) current gold claims with minor workings in alluvium adjacent to Gold Butte. These gold claims appear to correspond with the operations referred to by Vanderburg (1936, p. 63) and Longwell (1965, p. 127). "Small-scale placer operations have been carried on intermittently since about 1926 in gravels near Gold Butte but the production has been slight." Unpatented mineral surveys MS4704 and MS4706 (fig. 2) were examined. No workings or commodities were noted during the field examination. There is a small volume of gypsum near the northwestern portion of MS4706. This outcrop is very steep, deeply weathered and very unstable. No samples were taken.

Longwell and others (1965, p. 209-210) reports that flagstone and molding sand have been mined in the region from Permian redbeds elsewhere near the market place or near available transportation. Permian redbeds occur within the Wilderness Study Area in several locations due to the complex fault sets. They are generally a sandstone or sandy shale and are usually exposed on the flank of carbonate ridges.

At one time, 56 percent of the Wilderness Study Area was under lease or lease application for oil and gas. As of March 1987, 37 percent of the Wilderness Study Area was still under lease or application. No known drilling has occurred in the Wilderness Study Area; however, drilling has occurred north and east of the Wilderness Study Area.

INDUSTRIAL MINERALS

Clay

One 2-ft chip sample was taken from clayey textured layers interbedded with carbonate rocks for x-ray diffraction analysis (fig. 2, locality 27). This sample contains significant dolomite, lesser quartz and possibly very minor amounts of kaolinite and illite. No clay deposits were found during the field work.

Gypsum is a widely distributed mineral consisting of hydrous calcium sulfate. It is the commonest sulfate mineral, and is frequently associated with halite and anhydrite in evaporates forming thick extensive beds interstratified with limestone, shale, and clay, especially in rocks of Permian and Triassic age. It occurs massive (alabaster), fibrous (satin spar), or in monoclinic crystals (selenite).

Seven patented claims, 861 acres, cover about 6 mi of outcropping of north-trending gypsum beds (fig. 2). The beds are generally 75 to 100 ft thick, swell and thin, and locally dip 35^{o} to 45^{o} easterly. The gypsiferous beds are less resistant than the bounding limestone members of the Toroweap and Kaibab Formations.

The seven gypsum claims were located in 1924, recorded in 1928, and patented in 1933 as the McDonald Mines Company by eight members of the McDonald family of Overton, NV. From north to south, they are the: Legion Nos. 1 and 2, MS (mineral survey) No. 4709; Leeway Nos. 3, 4 and 5, MS 4710; and Boulder Nos. 1 and 2, MS 4707. A discrepancy in location of the Boulder property was found during field work. The gypsum beds, claim markers, claim papers and exploration works for MS 4707 (Boulder claims) occur about 2,000 ft east of and parallel to the location described in the record of patent and the location shown on the Clark County master title plat. The southern portion of this eastern location was claimed in 1968 as the Blue Ridge Nos. 2 and 3 by ten members of the Hafen family.

Longwell and others (1965, p. 152) reports that the gypsum in the Virgin Mountains associated with the Toroweap and Kaibab Formations commonly passes into anhydrite from 10 to 150 ft beneath the surface outcrops.

In 1937 (p. 67) Vanderburg wrote: "There are large reserves of gypsum on the east side of the Virgin River. Although the fact that these deposits were there has been known for many years, they have not been mined due to their inaccessibility and distance from market."

Gypsum companies near Las Vegas have extensively developed the Harrisburg gypsiferous member of the Kaibab Formation. Locally it contains nearly pure gypsum (Longwell and others, 1965, p. 37). This member is not present in the Wilderness Study Area. Pabco Gypsum Incorporated, near Las Vegas, estimates a 500-year reserve at the present rate of mining (personal commununication with Pabco).

not in Paleozoic rx

Georgia-Pacific has plans for mining and processing gypsum near Interstate Highway 15 about midway between Las Vegas and Mesquite (personal commununication Brent Bestram, BLM, Las Vegas).

already in prod @ ~200,000 tpy

Ten of the 11 samples taken from the patented properties (fig. 2, localities 5, 17, 18, 20-25) contained from 85 to 99 percent gypsum (table 1). The other sample contained 59 percent gypsum (locality 20). Appleyard (1983, p. 775) states that gypsum when pure has the following composition: lime (CaO) 32.6 percent, sulfur trioxide 46.5 percent, and combined water 20.9 percent, and that most mine production of gypsum will range between 85 and 95 percent pure. According to the American Society for Testing and Materials (ASTM) Standards (1986), no material may be considered gypsum that contains less than 70.0 weight percent

TABLE 1.--Analysis of gypsum samples in the Lime Canyon Wilderness Study Area, Clark County, NV

[<, less than; n/a, not analyzed]

Sample locality fig. 2	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	LOI	TOTAL %	CO_2 %	H_2O+ %	H_2O- %	S %	Cl ppm
5	0.51	0.16	0.09	0.77	31.59	0.03	0.30	<0.01	0.03	<0.01	21.73	55.24	1.56	2.19	18.28	18.000	n/a
17a	0.05	0.18	0.49	0.54	31.14	0.11	5.10	0.01	0.19	<0.01	21.34	59.17	1.06	2.26	18.58	18.900	n/a
17b	0.16	0.12	0.37	0.46	31.13	0.08	3.70	<0.01	0.16	<0.01	21.34	57.55	0.95	1.77	19.04	17.400	n/a
18	<0.01	0.03	0.09	0.41	33.13	0.02	0.60	<0.01	0.04	<0.01	21.34	55.70	0.74	1.76	18.94	19.000	61.
20	1.92	0.35	0.56	10.49	30.13	0.10	3.90	0.01	0.26	0.01	34.72	82.46	26.00	1.32	7.88	8.560	n/a
21	0.37	0.17	0.40	0.31	31.93	0.09	4.00	0.01	0.16	<0.01	21.05	58.51	0.35	1.46	18.81	18.500	n/a
22a	0.49	0.15	0.35	0.21	32.23	0.07	3.30	0.01	0.15	<0.01	21.42	58.40	1.34	2.18	18.54	18.200	n/a
22b	1.33	0.22	0.23	0.60	31.23	0.06	2.10	0.01	0.09	<0.01	21.30	57.19	1.31	1.56	18.44	17.700	n/a
23	0.80	0.11	0.12	0.76	31.49	0.03	0.70	<0.01	0.03	<0.01	21.74	55.81	2.65	1.95	18.26	17.500	n/a
24	0.45	0.09	0.08	0.62	31.17	0.03	0.50	<0.01	0.03	<0.01	21.71	54.71	0.81	1.42	18.62	18.000	n/a
25	4.63	0.35	0.19	2.44	30.30	0.06	0.70	0.02	0.07	<0.01	23.44	62.22	5.89	1.33	15.59	15.700	n/a
35	32.52	6.29	2.45	2.26	17.82	1.08	7.50	0.27	0.37	0.05	16.27	86.95	2.94	1.81	9.03	8.310	n/a

Sample locality 35 is from a gypsiferous bed in the Horse Springs Formation, not from the patented gypsum deposits.

$CaSO_4.2H_2O$. A 75-pound block of compact gypsum, creamy-white with pink banding, was evaluated for alabaster 1/ properties by a stone carver and judged to be of good quality. A sample from locality 17 was chosen for petrographic study. The analysis showed that this sample consists of 96 percent gypsum, 3 percent carbonate, and 1 percent quartz and that the process of recrystallization to a fine grained gypsum (alabaster) is well developed. The Haines Gypsum Company of British Columbia, Canada, has shown some interest in these patented properties for the mining of alabaster (personal commununication with Brent Bestram, BLM, Las Vegas).

An estimated 44 million tons of indicated subeconomic resources of gypsum occurs in the Wilderness Study Area. This amount was derived by using the combined measured strike lengths of 29,460 ft, the 75-ft thickness of Morgan (1968, p. 23), an arbitary distance downdip of 300 ft (increasing overburden), and a tonnage factor of 13.9 ft^3/ton. Field observation revealed that portions of the deposit in MS 4707 were interlayered with carbonates of varying thicknesses. The volume for this 5,000-ft segment was calculated using an estimated 40-ft thickness of gypsum.

Limestone and Dolomite

More than 20 mi^2, about 40 percent, of the Wilderness Study Area are covered by 12 rock-stratigraphic units containing limestone or dolomite (fig. 5) spanning a time-frame from the Cambrian to the Tertiary (Morgan, 1968). These units and the facies within the units reflect a variety of depositional environments and diagenesis. They include interlayered, interfingered, or gradational compositional changes of limestone, dolomite, shale, sandstone, siltstone, claystone, gypsum, conglomerate and tuff. Carr and Rooney (1983, p. 835-836) state;

> "Environment of deposition is significant to the economic geologist because it determines the size, shape, purity, and other economically significant characteristics of the carbonate rock deposit. Limestones that form in high-energy zones generally contain little noncarbonate material and hence may be the source of high-purity carbonate material. Micrite, which accumulates in zones of low-energy, is more likely to be diluted by clay and silt-size noncarbonate material. Carbonate sediments are highly susceptible to postdepositional alteration and modification. The origin of dolomite is especially significant to the economic geologist."

1/ Alabaster is a compact, very fine grained variety of rock gypsum prized by sculptors for its uniform workability under the chisel, and occasionaly is found within commercial deposits (Appleyard, 1983, p. 776).

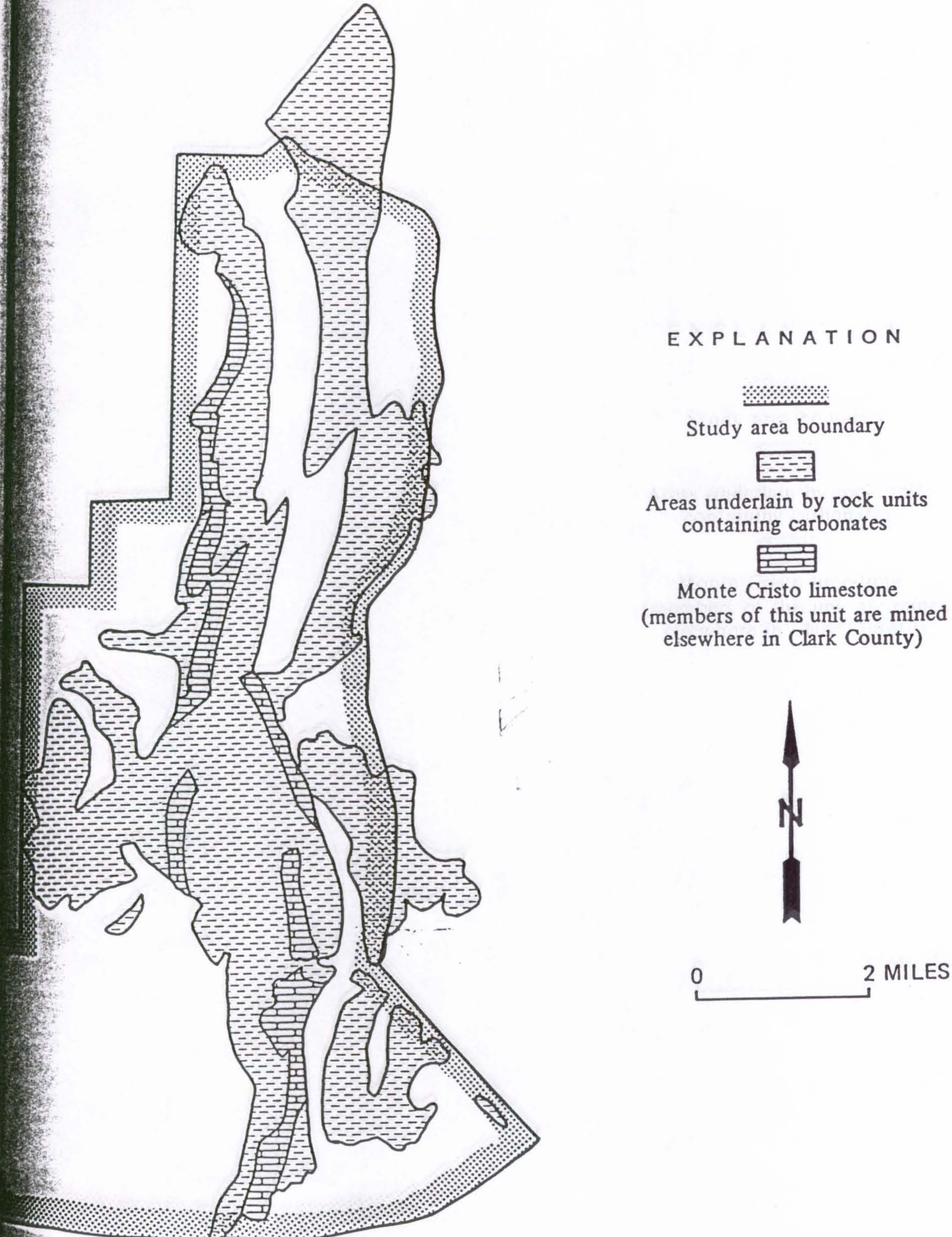

FIGURE 5.– Generalized map showing areas underlain by 12 rock-stratigraphic units containing carbonates(adapted from Longwell, 1965 and Morgan, 1968)

The depth of study and detailed sampling required to determine the purity and volume of carbonates in the many carbonate units in the Wilderness Study Area is beyond the scope of this evaluation. Mineability and mining methods cannot be addressed until the position of stratum relative to one another is known. For example, the limestone may be a surface expression, may be capped by dolomite, or may be at some intermediate position in a several-hundred-foot-thick unit. Until these studies have been completed the carbonates are classified as an inferred subeconomic resource.

Longwell and others (1965, p. 156) reports that the only carbonate deposits which have been extensively developed in Clark County are primarily from the Crystal Pass Member of the Sultan Limestone (Devonian in age), and the Dawn and Bullion Member of the Monte Cristo Limestone (Mississippian in age). The deposits currently being developed are near railroads and close to the market. These deposits are adequate to meet the demand for many years with unpatented claim groups held in reserve (personal communications with production managers of Genstar Lime Company and Pabco Gypsum Incorporated). Approximately 3 mi^2 of the Monte Cristo Limestone occurs in the Wilderness Study Area (Morgan, 1968).

Sample localities 29, 51, 52 (fig. 2) were bounded by rock cairns. Locality 52 is known as Jumbo 2. No workings or structures were found. Three samples were taken of country rock. The analyses (table 2) show a high-calcium limestone suitable for cement (Harben and Bates, 1984, p. 159). These three samples taken from a relatively small limestone outcrop of the multimembered Horse Springs Formation are not representative of the several limestone units in the Wilderness Study Area. These samples also contained lead ranging from 12 to 14 ppm, zinc ranging from 6 to 26 ppm, and arsenic as much as 10 ppm.

Analysis of a 7-ft chip sample across a vuggy brecciated zone with pods of pink to yellow coloration at locality 26 (fig. 2) contained 1 ppm silver, 15 ppm copper, and 56 ppm zinc. A portion of the host rock chosen for petrographic study showed 99 percent dolomite.

Sand and Gravel

About 16 mi^2 of the western portion of the Wilderness Study Area is covered by Quarternary alluvial fans containing millions of tons of sand and gravel consisting of an aggregate of metamorphic and carbonate rocks with minor amounts of basalt. Appropriate testing is required of this deposit to determine its applicable uses. Until such tests are completed this deposit is classified as an inferred subeconomic resource.

Longwell and others (1965, p. 166) reports that deposits of stone, sand, and gravel for use as construction and building material have been developed near Las Vegas, Nellis Air Force Base, Boulder City, and Davis Dam. The phenomenal growth of Las Vegas in addition to demands of nearby military installations has accelerated the demand for both new and known deposits.

TABLE 2.--Analysis of carbonate samples in the Lime Canyon Wilderness Study Area, Clark County, NV

[<, less than]

Sample locality fig.2	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	MnO %	LOI %	TOTAL
26	0.40	0.05	0.24	18.97	29.59	0.02	0.40	<0.01	0.15	0.01	46.54	96.39
29	1.30	0.32	0.19	0.47	55.62	0.04	0.70	0.01	0.07	0.01	42.98	101.72
51	1.41	0.28	0.22	0.21	53.61	0.04	0.80	0.01	0.04	0.02	42.88	99.53
52	1.01	0.35	0.45	0.24	52.68	0.09	3.40	0.01	0.16	0.02	43.06	101.48

The material principally mined for sand and gravel is alluvium and alluvial fans of Quarternary Age which occur in the Las Vegas Valley. The State of Nevada Department of Transportation has access to sufficient material sites to support the maintenance of Interstate 15 for several years (Chris Cocking, personnal communications, 1988).

The deposits in the Wilderness Study Area are similar to those in the Las Vegas Valley and along Interstate 15.

Zeolite

Bohannon and others (1982, p. 4) report zeolite minerals in mint-green-colored tuff beds in the Horse Springs Formation (Tertiary in age) in the Muddy Mountains east of the Wilderness Study Area. The green beds occur only at locality 70 (fig. 2) in the Wilderness Study Area. A chip sample across a 1-ft-thick bed showed no zeolites; however, a chip sample across a 3.5-ft-thick bed contained the zeolite species clinoptilolite. The green beds are continuous for about 3,900 ft striking N. 75^{o} E. and dipping 50^{o} SE. The downdip extent is unknown. The entire Tertiary exposure is only about 3,900 ft long by 900 ft wide and is part of a multiple fault system juxtaposing relatively narrow exposures of a variety of rock types of various geologic ages.

METALLIC MINERALS

Copper

One grab sample from the dump of a 50- to 60-ft-deep shaft in gypsiferous sandstone with loosely cemented conglomerate contained 0.24 percent copper, 3 ppm silver, 5 ppm lead, and 10 ppm zinc. This is the Pink Lady claim (locality 13, fig. 2).

One select sample from the dump of a 6-ft-deep shaft in silty sandstone with blebs and bands of malachite contained 1.8 percent copper, 7.5 ppm silver, 5 ppm lead, and 36 ppm zinc. This is the Green Monster claim (locality 12, fig. 2).

Three samples were collected from a 32-ft-long adit in limestone (locality 14, fig. 2); the claim name is unknown. A 1-ft chip sample across a shear zone containing brecciated limestone with thin stringers of calcite and malachite and some chalcopyrite contained 0.25 percent copper, 1 ppm silver, 30 ppm lead, and 244 ppm zinc. A select sample from the dump of malachite stained clasts and limonitic breccia containing black sulfides contained 1.48 percent copper, 2 ppm silver, 165 ppm lead, and 488 ppm zinc. One 1.5-ft chip sample across a shear zone in a brecciated limestone with pyrite contained 0.17 percent copper, 1.5 ppm silver, 120 ppm lead and 620 ppm zinc.

Workings on the Red Dot (1955) claim consist of a 50-ft-deep shaft, a 10-ft open cut into limestone, a 35-ft shallow trench, and a 25-ft shallow trench (fig. 2, locality 66). In 1954 this was the Flow claim. A 2.3-ft chip sample of sheared greenish-blue stained limestone and limonite contained 24 ppm copper, 0.5 ppm silver, 5 ppm lead, and 12 ppm zinc. An 11-ft chip sample of extensively weathered sheared limestone with reddish-purple and green staining contained 9 ppm copper, 1 ppm silver, 5 ppm lead, and 6 ppm zinc. A select sample of iron and manganese stained brecciated limestone with minor brecciated quartz from the dump contained 151 ppm copper, 0.5 ppm silver, 175 ppm lead, and 195 ppm zinc.

Four samples were collected from four shallow workings in sheared limestone (fig. 2, locality 67) about 2,500 ft northeast of the Red Dot claim. Copper ranged from 1 to 104 ppm, silver was constant at 0.2 ppm, lead ranged from 14 to 950 ppm, and zinc ranged from 12 to 1,575 ppm.

Gold

Lode gold was detected in two areas--the Yellow Ten uranium claim (fig. 2, locality 33) and in the southeastern corner of the Wilderness Study Area (fig. 3, localities 104, 105, 107, 109, 110). The three samples collected from the Yellow Ten claim of fractured tuffaceous rock contained 10, 10, and 20 ppb gold, 24, 58, and 18 ppm zinc, and one contained 30 ppm uranium.

Nine rock and 19 alluvial samples were collected from the southeastern corner of the Wilderness Study Area (fig. 3). One select sample of vein quartz with limonite (fig. 3, locality 104) was collected from a 60-ft shallow circular scraping, assumed to be a water catchment basin, contained 0.201 oz/ton gold. Four rock samples (fig. 3, localities 105, 107, 109, 110) collected from outcrops with thin quartz veins contained gold ranging from 0.0017 to 0.012 oz/ton. None of the alluvial samples contained gold.

The five samples containing gold were collected from the Golden claim group. The relatively flat alluvium-covered area around Gold Butte (fig. 1) is covered by the Golden, Golden Hawk, Golden Charlie and Rapakivi lode claim groups, and the Gold Butte Wash and Golden Cross placer claim groups.

Outcrops are few and small. The many workings are shallow trenches and pits in pea-sized gravel, sand, and grus. The workings were made by bulldozers, backhoes, and auger.

Production of gold from this vicinity, the Gold Butte mining district, came from quartz veins in the granite complex south of the Wilderness Study Area. Longwell (1965 p. 127) reports that small-scale placer operations have been carried on intermittently since about 1926 in the gravels near Gold Butte and that production was slight. Vanderburg (1936, p. 63-64) discusses the 1930's operation where the overburden was removed by a team and scraper, and the material directly above bedrock was treated in a portable washing plant. The source of water for washing the gravel was Granite Well about 0.5 mi away. Granite Springs and a well are shown on Volborth's (1962) and Morgan's (1968) maps to be very near Gold Butte. Both of these maps show the granite complex extending into the gold claim area. Longwell's (1965) map shows the same area as alluvium.

Vanderburg (1936, p. 64) reports the placer deposits,

> "have been formed by the erosion of the veins in the surrounding hills. The depth of gravel varies from 2 to 20 feet, and some angular and rounded boulders are present. For several feet above bedrock the gravel may run up to $2.50 per cubic yard (gold at $35.00 per troy ounce). The gold is invariably fine, and no piece larger than a pinhead has been found ... The bedrock is altered granite."

The accumulation of sediments in this area may have diminished after a Quaternary (Morgan, 1968) basalt flow dammed the north-flowing stream in Cedar Basin (Volborth, 1962, p. 820) (fig. 3).

Forty alluvial samples were collected to evaluate for placer gold from drainages throughout the Wilderness Study Area, not including the alluvial samples taken from the workings shown on figure 3. The sample taken at locality 2 (fig. 2) contained 0.00083 oz/yd^3. Eleven other samples contained gold ranging from 0.0000097 to 0.00017 oz/yd^3 (localites 1, 3, 7, 10, 64, 65, 69, 73, 81, 82, 84). Based on gold at $450/oz, the value at locality 2 equates to $0.37/yd^3. The remaining values range from less than $0.01 to $0.08/yd^3. The lowest cost domestic placer gold mine known to have operated in recent times (to 1984) had a total unit production cost of $3.95 per cubic yard at a production rate of about 170,000 yd^3 per year (Schumacher, 1985).

The source of the gold may be the Permian to Triassic sedimentary rocks in the Wilderness Study Area. Phillips, 1985 (p. 37), reports the occurrence of gold in a wide range of sedimentary rocks across a great span of geologic time, crossing many depositional environments. Part of the rock stratigraphic sequence of Phillips' report occur in the Wilderness Study Area.

Uranium and Thorium

The Aero Services Division states that the Tertiary Horse Springs Formation is also considered a favorable environment for uranium.

Interpretation of the Aero Services Division (1979), airborne gamma-ray spectrometer data shows no uranium or thorium anomalies in the Wilderness Study Area. Uranium anomalies do exist in the Horse Springs Formation 3 to 6 mi east of the Wilderness Study Area. In the Wilderness Study Area in the Horse Springs Formation, Garside (1973, p. 21) describes the Yellow Queen prospect as bulldozer cuts in calcareous green and white clays, tuffaceous sediments, and red sandstone containing the uranium mineral tyuyamunite(?). This prospect and numerous other bulldozer cuts were found in the same sediments registering 30 to 33 cps. Thirty counts per second was established as a background reading for the area. Six samples were collected from the Yellow Queen claims (fig. 1, localities 34, 35, 36, 39, 40, 41). Sample 34 contains 10 ppm uranium; the remaining 5 samples contain less than 10 ppm. One of three samples collected from the Yellow Ten claim (locality 33) contains 30 ppm uranium, and all three contained gold (10, 10, and 20 ppb). The sample collected from a claim of unknown name (locality 37) contains 10 ppm uranium. All other samples collected from workings in these sediments contain less than 10 ppm uranium. The Betty L. 6 (locality 32), Betty L. 7 (locality 31), Dee-Dee 1 (locality 42) and Matilda 2 (locality 43) claims were identified by claim notices on site.

The Horse Springs Formation also outcrops in two locations in the western portion of the Wilderness Study Area. One chip sample taken across a 5-ft bed of dull white tuff, striking S. 75° W., dipping 50° SE., and emitting 115 cps, contained 26.1 ppm uranium (fig. 2, locality 70).

Two chip samples across 12 ft of a silty tuff bed in a shallow trench contained 6.8 and 7.2 ppm uranium (fig. 2, locality 71). Nearby an 800-ft-long bulldozer workings exposed 8 lithofacies of the tuff bed. The 8 chip samples collected ranged from 3.1 to 16.0 ppm uranium (locality 71). One 1.5-ft chip sample collected from a dull white tuff bed, striking N. 72° W. and dipping 46° NE. contains 20.1 ppm uranium (fig. 2, locality 75).

The Aero Services Division (1979) report states ". . . the thorium anomalies appear to be related to the Precambrian gneisses and granites." During the 1987 field survey, scintillometer readings reached 170 cps in a very local area just outside the Wilderness Study Area over a small granite outcrop (fig. 2, locality 19).

APPRAISAL OF MINERAL RESOURCES

An estimated 44 million tons of indicated subeconomic resources of gypsum occurs in the Wilderness Study Area, some of which has recrystallized to alabaster. Appleyard (1983 p. 788) emphasizes,

> "The single most important factor in the evaluation of a gypsum deposit is its location with respect to markets . . . a local market demand will make nearby deposits more valuable even though they may not be as pure nor as easily mined as more remote deposits. Thus, the factor which more often than any other determines the value of one deposit as against another is the cost of transportation from the mine to the major market areas."

At the present time it would be difficult for the deposit in the Wilderness Study Area to compete with gypsum companies in the Las Vegas area, one of which reports a 500-year reserve at the present rate of mining, and another plans to begin gypsum production near U.S. Highway 15 east of Las Vegas.

The USBM Mineral Commodity Summaries show an 11 percent increase in gypsum production in 1986 over 1985 with a projection of doubling the production by the year 2000 (Appendix C).

Gypsum is mined both from open pit and underground. Cross-sections constructed from field observations and aerial photographs indicate a ratio of overburden to gypsum unacceptable to open pit mining. Morgan's (1968) map and cross-sections shows complex fault sets that illustrate the off-setting of the various formations with increasing dips, whereas in other localities the strata are folded upward positioning the gypsum-bearing stratum near surface. The area of the two northern properties (MS 4709 and MS 4710) has not been geologically mapped in detail. The feasibility of mining this deposit and the choice of underground mining methods cannot be determined until the nature of the overburden is known and the relationship of the deposit to other geologic units and the surface is established.

High volume - low value commodities, such as gypsum, limestone and dolomite, sand and gravel, and zeolites will probably not be mined in the Wilderness Study Area in the near future due to a combination of high haulage costs from this relatively remote area and the same commodities being available in quantity and quality near the market or railways. Vanderburg (1937, p. 67) commented on the feasibility of transport by barges on Lake Mead to the Union Pacific Railroad at Boulder City (fig. 1). As demands increase for these commodities, barging to the railroad near Overton, a much shorter distance, may be considered.

The occurrences of gold, copper, and uranium have insufficient grade and/or tonnage to be mined economically.

An index map of Nevada showing petroleum provinces indicates a low to zero potential for oil and gas (Sandberg, 1983).

RECOMMENDATIONS

All of the gypsum samples were taken with rock hammers and chisels which were found to be inadequate to penetrate more than 12 to 18 in. into the deeply weathered portion of the outcrop. There is a tendency for enrichment of salts near exposed surfaces in arid environments. A possibility exists that the high degree of purity of the samples is due to this process and is not representative of the whole deposit. As a minimum the use of long pry bars should be employed to remove the weathered portion and permit the sampling of fresh rock. Another factor that must be considered is the relationship of gypsum to anhydrite. The anhydrous form of gypsum is of little economic value. Appleyard (1983, p. 778 and 787) states,

> "Most commercial gypsum deposits are believed to have resulted from the action of surface and ground waters upon anhydrite . . . the degree of hydration can vary widely, with corresponding reduction in the amount of available reserves, and increase in the cost of mining. In all cases, . . . it is well advised to thoroughly explore and understand the anhydrite-gypsum relationship prior to development of a mine . . . . Even though the extent of gypsum can be mapped from surface outcrops, drilling is necessary to predict the amount and regularity of hydration, i.e., how much of the calcium sulfate is gypsum, and how much is either only partially hydrated or is anhydrite."

A drilling program would also define the gypsum deposit and its relationship to other geologic units and structures. To develop the Wilderness Study Area gypsum deposit the overlying limestone of the Kaibab Formation may have to be removed, at least in part, and may itself be of commercial value.

The three samples of limestone collected at random on two claims from a single limestone formation is not indicative of the carbonates throughout the Wilderness Study Area. A possibility exists that mineable limestone occurs in sufficient tonnages for a variety of uses. A detailed mapping and sampling program of selected carbonate units is required prior to reclassification from the inferred subeconomic resource category.

The Kaibab Formation is one of the twelve rock-stratigraphic units in the Wilderness Study Area containing limestone. The paraphrasing of Gregory's (1950, p. 53) studies of the Kaibab Formation is offered to illustrate how a formation may change over distance and time. Studies of scores of localities reveal the formation as a composite of limestone, sandstone, shale, gypsum, travertine, breccia, and conglomerate, which in composition and stratigraphic sequence varies much from place to place. Nearly all the limestone beds are arenaceous. They reveal much replacement, and the upper beds in particular are dolomitized. Beds with as much as 70 percent combined dolomite and calcite are rare, and few of them have value in making cement. In Utah some of these limestones are nearly pure.

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APPENDIX A.--RESOURCE DEFINITIONS

Gypsum resource estimates, in tons, were calculated by determining the volume of rock, within set limits, and dividing by a tonnage factor of 13.9 ft^3/ton. Lateral continuation along strike was determined by field observation and measured on aerial photographs. Thickness and dip measured in the field fell within the range of published data of 75+ ft to 100+ ft thick and 35° to 40° easterly dip (Longwell and others, 1965, and Morgan, 1968). The lower limit of 75 ft was used to ensure a conservative value for tonnage due to faulting, deep dissection in portions of the deposit, observed thinning along strike in some areas, and the unknown anhydrite factor. A thickness of 40 ft was used for the Boulder-Blue Ridge claim area (MS 4707) due to interbeds of sandstone and carbonate rocks. These non-gypsum rocks may be a veneer of the Hermit Formation with uninterrupted gypsum below. The distance downdip was limited to 300 ft.

Resources have been classified according to the definitions in U.S. Geological Survey Circular 831:

RESOURCE.--A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

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

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

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

INDICATED.--Quantity and grade and (or) quality are computed from information similiar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

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

APPENDIX B.--Sample description in and near the Lime Canyon Wilderness Study Area, Clark County, Nevada

Locality no. (fig. 2)	Sample description	Workings	Sample type and analysis
5	A 75+ ft-thick gypsum deposit.	Blocks of gypsum have been displaced probably by pry bars to access fresh material.	A 1.5-ft chip sample of deeply weathered material contained 95.8% gypsum.
12	Malachite blebs, bands, surface staining, and crustations in a silty sandstone. Thin bands of sulfides.	Shaft, 8 ft by 8 ft by 6 ft deep.	Select sample from dump contained 1.8% copper, 7.5 ppm silver, 5 ppm lead, and 36 ppm zinc.
13	Minor malachite staining and thin bands of sulfides in a gypsiferous sandstone with loosely cemented conglomerate.	Shaft, 60 to 70 ft deep.	Select sample from dump contained 0.24% copper, 3 ppm silver, 5 ppm lead, and 10 ppm zinc.
14a	Stringers of malachite and calcite in a brecciated shear zone in limestone, striking N. 60° W., dipping 85° SW. Zone pinches out.	Adit, 32 ft long.	A 1-ft-chip sample across the shear zone contained 0.25% copper, 1 ppm silver, 30 ppm lead, and 244 ppm zinc.
14b	Sulfides in a limonitic malachite-stained breccia.	Dump of 32-ft adit.	Select sample contained 1.48% copper, 2 ppm silver, 165 ppm lead, and 448 ppm zinc.
14c	Sheared limonite-stained brecciated limestone with pyrite and thin bands of sulfides.	Short open cut into a shear zone 62 ft north of and subparallel to 32-ft adit shear zone.	A 1.5-ft chip sample across shear zone contained 0.17% copper, 1.5 ppm silver, 120 ppm lead, and 620 ppm zinc.
16	Red to pink sandstone with stringers of an unknown green material.	None.	A 60-ft random chip sample contained no economic minerals.
17a	A 75-ft-thick fine to medium-grained gypsum deposit.	Discovery pit, 10 ft wide, 10 ft deep. Probably opened by displacing large blocks downslope with pry bars.	A 0.5-ft chip sample contained 96.9% gypsum.
17b	do-------------------------------------	do--------------------------	A 5.7-ft chip sample contained 93.6% gypsum.
18	do-------------------------------------	Trench, 56 ft long, 5 to 10 ft wide, 5 to 10 ft deep.	A 2-ft chip sample in moist deeply weathered material contained 99.5% gypsum.
19	Coarse-grained granitic rock with some pegmatite. Gamma ray scintillometer read 170 cps.	None.	No economic mineraled were detected in a 1-ft chip sample.
20	A 75-ft-thick gypsum exposure along an erosional embayment into the deposit.	None.	A 1.5-ft chip sample 1 ft into the outcrop contained 59.4% gypsum.

APPENDIX B.--Sample description in and near the Lime Canyon Wilderness Study Area, Clark County, Nevada--Continued

Locality no. (fig. 2)	Sample description	Workings	Sample type and analysis
21	A massive white gypsum outcrop.	None.	An 0.8-ft chip sample 8 in. into the outcrop contained 96.9% gypsum.
22a	A compact pink to buff, thinly banded white gypsum outcrop.	None.	A 0.8-ft chip sample 8 in. into the outcrop contained 96.2% gypsum.
22b	A compact buff to tan thinly banded gypsum outcrop.	None.	A 10-ft chip sample, 10 in. into the outcrop contained 93.98% gypsum.
23	Interbedded 5- to 10-ft-thick gypsum beds with sandstone and limestone.	Three minor workings of displaced blocks.	A 2-ft chip sample contained 93.4% gypsum.
24	Five to 10-ft-thick gray gypsum beds interbedded with sandstone and limestone. Entire unit may be a 40- to 50-ft-thick slump block.	Minor displacement of gypsum blocks.	A 1.2-ft chip sample contained 94.7% gypsum.
25	A 20-ft-thick bed of white gypsum with pink to red pods. Some interbedding of limestone and sandstone.	None.	A 17-ft chip sample contained 85% gypsum.
26	Vuggy brecciated dolomite with minor silicification and lenses of pink and yellow discoloration.	None.	A 7-ft chip sample contained 1 ppm silver, 15 ppm copper, 5 ppm lead, and 56 ppm zinc.
27	Ten- to 30-ft-thick beds of friable, waxy, green to brown shale interbedded with limestone.	None.	A 2-ft chip sample contained a very minor percentage of kaolinite and illite.
29	Massive limestone with limonite-lined vugs. Stone claim cairns.	None.	A random chip sample contained no economic minerals.
30	Dull white compact tuff, with small silica nodules and thin silica coatings.	Shallow 100 ft by 10 ft trench.	A grab sample contained no economic minerals.
31	Homogeneous, red sandy limestone.	Shallow 83 ft by 10 ft trench.	A grab sample contained no economic minerals.
32	do--	None.	A grab sample contained no economic minerals.
33	An outcrop of dark gray ash and tuff. Yellow mineral coatings on fracture surfaces.	Shallow bulldozer scrapping.	A select sample contained 30 ppm uranium and 20 ppb gold. A 1-ft chip sample contained less than 10 ppm uranium and 10 ppb gold. A 6-ft chip sample contained less than 10 ppm uranium and 10 ppb gold.
34	White to gray ash underlying a red limestone.	Shallow trench and very minor pits.	A 2-ft chip sample contained 10 ppm uranium.

APPENDIX B.--Sample description in and near the Lime Canyon Wilderness Study Area, Clark County, Nevada--Continued

Locality no. (fig. 2)	Sample description	Workings	Sample type and analysis
35	Greenish-blue gypsiferous outcrop with lenses of brown earthy material.	Shallow trench.	A 2.3-ft chip sample contained less than 10 ppm uranium.
36	Gypsiferous limy outcrop with a green and brown earthy material.	Shallow 50 ft by 10 ft trench.	A 2-ft chip sample contained less than 10 ppm uranium.
37	Dull white to pink, limy gypsiferous bed in sandy, shaly redbeds.	Trench, 105 ft long, 10-ft-wide, 4-ft-deep.	A grab sample contained 10 ppm uranium.
38	Dull white earthy friable limestone.	Trench, 120 ft by 15 ft.	A grab sample contained less than 10 ppm uranium.
39	Red limestone and clay.	Shallow trench	A random chip sample contained less than 10 ppm uranium.
40	One-foot-thick siliceous zone in limestone.	Shallow trench	do-----------------------------------
41	Extensively weathered red limestone.	Shallow trench	do-----------------------------------
42	Dull white earthy material in a weathered limestone.	Trench, 120 ft long, 10 ft wide, 2 ft deep.	A grab sample contained less than 10 ppm uranium.
43	A limy dull white, iron stained earthy material.	Shallow trench, 65 ft long, 10 ft wide.	do-----------------------------------
44	A limy dull white earthy material with minor iron staining.	Trench, 73 ft long, 10 ft wide, 2 ft deep.	A random chip sample contained less than 10 ppm uranium.
45	Limestone with minor iron staining.	Trench, 76 ft long, 10 ft wide, 3 ft deep.	A grab sample contained less than 10 ppm uranium.
46	Limestone with pale pink weathered surfaces, thin calcite coatings and minor gypsum.	Trench, 250 ft long, 10 ft wide benched into steep slope.	A select sample contained less than 10 ppm uranium.
47	No outcrop. Scattered clasts consist of pegmatite, schist with small garnets, basalt, minor calcite coatings.	Shallow trench, 56 ft long, 10 ft wide.	A grab sample contained no economic minerals.
48	No outcrop. Clasts of pink to white limestone with minor iron staining.	Shallow trench, 140 ft long, 15 ft wide.	do-----------------------------------
49	Pink to white limestone with interbeds of redbeds. Minor gypsum.	Trench, 135 ft long, 15 ft wide, 2 ft deep	A random chip sample contained no economic minerals.

Locality no. (fig. 2)	Sample description	Workings	Sample type and analysis
51	Massive limestone. Stone claim cairns.	None	A random chip sample contained no economic minerals.
52	do-----------------------------------	do-----------------------	do---------------------------------------
66	Sheared limestone with thick limonite coating and manganese staining. Some limestone breccia. Minor quartz.	Fifty-ft-deep shaft, 10-ft-long open cut, 35-ft- and 25-ft-long shallow trenches.	A 2.3-ft chip sample contained 24 ppm copper, 0.5 ppm silver, 5 ppm lead and 12 ppm zinc. An 11-ft chip sample contained 9 ppm copper, 1 ppm silver, 5 ppm lead, and 6 ppm zinc. A select sample contained 151 ppm copper, 0.5 ppm silver, 175 ppm lead, and 195 ppm zinc.
67	Limestone breccia in a shear zone with minor malachite staining and limonite.	Open cut 10 ft long, 4 ft wide, and 10 ft deep. Three small pits.	A 1-ft chip sample in the open cut contained 104 ppm copper, 950 ppm lead, 1575 ppm zinc, and 39.5 ppm cadimum. Two chip and 1 grab samples from the pits contained very minor amounts of copper, lead and zinc.
70	Pale green tuff beds.	None	A 3.5-ft chip sample contained clinoptilolite. A 1 ft chip sample across an overlying bed contained no zeolites.
70	Dull white tuff bed, 5 ft thick overlies the zeolite bed.	do-----------------------	A 5-ft chip sample contained 26.1 ppm uranium.
71	Eight lithofacies of a tuff deposit ranging from loosely consolidated to compact. White to light brown and green beds.	Trench, 12 ft long, and an 800-ft-long bench cut into slope.	Ten chip samples ranged from 3.1 to 16.0 ppm uranium.
75	Small outcrop of dull white tuff.	None	A 1.5-ft chip sample contained 20.1 ppm uranium.
97	One foot quartz vein in granite.	Shallow trench	A 3.5-ft chip sample contained no economic minerals.
103	Granitic outcrop.	Shallow trench	A 1-ft chip sample contained no economic minerals.
104	Fragments of vein quartz with limonite.	Forty to 60 ft circular bulldozer scrape.	Select sample contained 0.201 oz/ton gold.
105	Granite outcrop with quartz veinlets.	Shallow trench	Random chip of the quartz contained 0.012 oz/ton gold.
106	Ouartz veins as much as 0.25 ft thick in manganese stained granite.	do-----------------------	A 10.2-ft chip sample contained no economic minerals.

APPENDIX B.--Sample description in and near the Lime Canyon Wilderness Study Area, Clark County, Nevada--Continued

Locality no. (fig. 2)	Sample description	Workings	Sample type and analysis
107	Minor quartz veins in manganese stained granite.	Shallow trench.	Random chip sample contained 0.002 oz/ton gold.
108	Minor quartz veins in granite.	do------------------------	Sample contained no economic minerals.
109	Quartz veins less than 0.08 ft thick in granite.	Shallow pit.	A 6.25-ft chip sample contained 0.0017 oz/ gold.
110	Three quartz veins about 0.08 ft thick in granite.	Shallow trench------------	A 4-ft chip sample contained 0.007 oz/ton gold.

APPENDIX C.--Commodity highlights

Commodity	United States 1986 consumption 1/	Domestic 1987 production 1/	Main uses	Import sources	Resources in United States	1987 dollar value	Anticipated demand
Gypsum	26,100,000	15,800,000	Wallboard, plastics, retarders, fillers, soil conditioners	Canada Mexico Spain	Reserves are conservatively estimated at 800 million tons (Davis, 1988, p. 67)	$6.50 per ton crude $19.00 per ton calcined	1987 production followed the continued high activity of the construction and housing industries. Production is projected to nearly double by the year 2000 (Pressler, 1985, p. 354).
Lime	15,363,000	15,200,000	Cement, lime, building stone, fluxes, glass, refractories, fillers, extenders, abrasives, chemicals, soil conditioners, aggregates	Canada Mexico	Adequate for the foreseeable future (Pelham, 1988, p. 91)	$51.91 per ton	Estimated at 15.1 million tons in 1988. Projected by year 2000: one to 2.5 million short tons for dimension stone, a growth rate of 1.4%; 1.2 to 2.4 billion short tons for crushed stone, a growth rate of 2.2%. The actual demand is dependent on several variables (Carr and Rooney, 1983, p. 833).
Zeolite	Consumption and production figures are unreliable, but it is estimated that the annual output is less than one half million tons worldwide 2/		Detergents (growing application), catalysts, absorbants, desiccants, dimension stone 3/	The major sources are Japan, USA, Hungary, Bulgaria, with smaller tonnages in W. Germany, Cuba, New Zealand, Ireland, and Italy	Olson (1983, p. 1399) identifies 66 locations of the zeolite "clinoptilolite" in the United States chiefly in the western states derived from alteration of volcanic rocks.		Although commercial products of natural zeolites is growing, the rate is only modest. Synthetic zeolites are well established in many of the more lucrative markets and the ability of natural zeolites to penetrate these areas will dictate future production levels 2/.

1/ Estimated short tons
2/ Harbin and Bates, 1984, p. 315
3/ Griffiths, 1987, p. 19 and 33.

APPENDIX D.--Analysis of rock samples for 33 elements in and near the Lime Canyon Wilderness Study Area, Clark County, NV

[<, less than; >, more than]

Sample locality fig-2,3	Au ppb	Al %	As ppm	Ba ppm	Bi ppm	Ca %	Co ppm	Cr ppm	Cu ppm	Fe %	K %	La ppm	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	Se ppm	Sr ppm	Ti %	U ppm	V ppm	Zn ppm
16		0.52	5.	130	<2.	2.76	<1.	48	<1	0.6	0.29	<10.	1.39	122	2.	<0.01	5.	170.	12.	10.	19.	<0.01	<10.	13.	20.
19		1.05	5.	80	<2.	0.11	11.	113	11	2.57	0.8	90.	0.58	241	5.	0.03	7.	160.	6.	10.	6.	0.17	<10.	46.	62.
29		0.04	5.	20	4.	>15.00	<1.	7	1	0.07	0.01	<10.	0.22	85	<1.	<0.01	3.	80.	12.	10.	110.	<0.01	<10.	2.	6.
30		0.39	5.	90	2.	>15.00	<1.	17	2	0.31	0.19	<10.	2.42	270	1.	0.03	2.	210.	6.	10.	479.	0.01	<10.	8.	8.
31		0.61	<5.	90	2.	>15.00	<1.	31	3	0.61	0.29	<10.	1.87	171	1.	0.01	5.	200.	10.	20.	141.	0.01	<10.	12.	18.
32		0.54	5.	210	2.	>15.00	<1.	28	8	0.68	0.16	<10.	1.57	203	1.	0.01	1.	210.	12.	20.	169.	0.01	<10.	14.	12.
33a	20	1.21	35.	170	<2.	>15.00	9.	9	4	0.53	0.29	<10.	7.6	177	<1.	0.19	3.	150.	12.	40.	1320.	0.02	30.	32.	18.
33b	10	4.57	60.	350	<2.	3.79	10.	17	11	1.4	0.62	10.	3.86	161	<1.	0.36	12.	330.	<2.	20.	465.	0.05	<10.	92.	58.
33c	10	1.32	50.	170	<2.	>15.00	10.	11	5	0.66	0.33	<10.	7.21	173	<1.	0.16	3.	200.	10.	20.	999.	0.03	<10.	33.	24.
34		1.4	30.	240	<2.	12.60	10.	10	6	0.77	0.38	<10.	6.71	200	<1.	0.16	5.	210.	8.	20.	994.	0.02	10.	17.	26.
35		1.38	20.	230	2.	12.50	10.	53	11	1.05	0.34	<10.	1.17	307	5.	0.31	9.	310.	1540.	10.	3080.	0.01	<10.	57.	28.
36		0.74	5.	110	2.	>15.00	<1.	11	8	0.67	0.3	<10.	0.63	213	<1.	0.01	6.	250.	4.	10.	2190.	0.01	<10.	20.	18.
37		0.14	55.	160	2.	>15.00	<1.	4	1	0.18	0.08	<10.	0.55	65	<1.	0.04	2.	90.	4.	20.	1990.	<0.01	10.	6.	44.
38		0.54	15.	290	4.	>15.00	<1.	8	3	0.32	0.19	<10.	1.27	82	<1.	0.04	6.	130.	10.	20.	5330.	0.01	<10.	11.	22.
39		0.69	5.	20	2.	>15.00	<1.	35	5	0.56	0.29	<10.	0.9	183	<1.	0.01	4.	160.	12.	10.	94.	0.01	<10.	9.	14.
40		0.01	<5.	10	<2.	1.38	<1.	316	3	0.27	<0.01	<10.	0.05	43	21.	<0.01	4.	10.	8.	<10.	25.	<0.01	<10.	2.	<2.
41		0.47	5.	20	2.	>15.00	<1.	16	4	0.62	0.26	<10.	1.3	253	<1.	0.01	3.	150.	18.	20.	75.	0.01	<10.	9.	12.
42		0.26	20.	450	4.	>15.00	<1.	5	3	0.3	0.08	<10.	0.84	89	<1.	0.03	5.	200.	8.	10.	479.	<0.01	<10.	13.	48.
43		0.2	15.	640	4.	>15.00	<1.	7	2	0.27	0.06	<10.	0.7	78	<1.	0.02	5.	150.	4.	20.	443.	<0.01	<10.	12.	50.
44		0.68	10.	310	2.	>15.00	9.	36	6	1.05	0.22	<10.	2.15	121	<1.	0.02	9.	230.	4.	20.	425.	0.03	<10.	37.	18.
45		0.34	60.	140	4.	>15.00	<1.	6	3	0.38	0.13	<10.	0.43	125	1.	0.03	<1.	160.	4.	10.	5720.	0.01	<10.	10.	12.
46		0.52	130.	80	2.	>15.00	<1.	7	6	0.53	0.33	<10.	0.88	125	1.	0.02	3.	180.	8.	10.	2830.	0.01	<10.	16.	24.
47		0.66	<5.	50	<2.	1.98	9.	125	9	1.53	0.17	10.	0.38	249	7.	0.04	17.	370.	2.	<10.	37.	0.07	<10.	33.	18.
48		0.11	35.	40	2.	>15.00	<1.	3	1	0.17	0.04	<10.	0.2	57	1.	0.01	6.	140.	6.	20.	1210.	<0.01	<10.	3.	14.
49		0.18	50.	150	4.	>15.00	<1.	2	2	0.15	0.07	<10.	0.51	51	<1.	0.02	2.	80.	8.	10.	4520.	<0.01	<10.	4.	8.
51		0.03	<5.	90	6.	>15.00	<1.	2	1	0.06	0.01	<10.	0.09	181	<1.	<0.01	3.	110.	14.	20.	164.	<0.01	<10.	1.	26.
52		0.05	10.	10	6.	>15.00	<1.	2	1	0.07	0.02	<10.	0.09	100	<1.	<0.01	5.	90.	14.	10.	135.	<0.01	<10.	1.	24.
67a		0.07	25.	<10	<2.	>15.00	10.	7	104	0.2	0.03	<10.	9.56	171	<1.	0.01	2.	<10.	950.	60.	50.	<0.01	<10.	14.	1575.
67b		0.06	<5.	30	<2.	>15.00	<1.	6	6	0.18	0.03	<10.	7.97	82	<1.	0.01	<1.	40.	30.	40.	117.	<0.01	<10.	8.	52.
67c		0.27	15.	30	<2.	>15.00	9.	8	4	0.23	0.16	<10.	9.54	79	<1.	0.02	2.	60.	26.	40.	180.	<0.01	<10.	12.	46.
67d		0.14	<5.	20	<2.	>15.00	4.	7	1	0.16	0.07	<10.	9.29	44	<1.	0.01	1.	50.	14.	40.	126.	<0.01	<10.	2.	12.
97		0.55	<5.	30	<2.	1.25	8.	60	6	2.2	0.15	110.	0.2	265	4.	0.03	8.	620.	<2.	<10.	22.	0.05	<10.	25.	40.
103		0.7	5.	110	<2.	4.65	7.	83	5	1.71	0.37	40.	0.31	397	6.	0.03	3.	540.	16.	10.	48.	0.15	<10.	21.	66.
104	>10000	0.2	<5.	40	2.	0.07	<1.	197	3	1.48	0.1	20.	0.05	65	63.	0.02	1.	150.	10.	<10.	22.	<0.01	<10.	11.	12.
105	430	0.74	<5.	60	2.	0.58	12.	106	1	3.64	0.32	180.	0.23	250	9.	0.03	3.	960.	8.	10.	17.	0.04	<10.	39.	38.
106		0.68	5.	60	<2.	1.04	9.	111	1	2.29	0.17	100.	0.32	433	9.	0.04	2.	570.	<2.	<10.	12.	0.03	<10.	22.	40.
107	95	0.49	<5.	40	<2.	0.43	8.	142	2	2.11	0.14	50.	0.18	214	10.	0.04	3.	560.	12.	10.	7.	0.04	<10.	26.	66.
108		0.66	5.	50	<2.	0.59	8.	134	1	2.08	0.18	100.	0.26	302	10.	0.04	2.	540.	8.	<10.	12.	0.02	<10.	24.	52.
109	60	0.72	<5.	130	<2.	1.36	7.	100	1	1.72	0.36	80.	0.2	228	7.	0.03	3.	680.	22.	<10.	33.	0.05	<10.	20.	50.
110	230	0.68	5.	80	2.	1.13	9.	122	2	1.99	0.33	110.	0.26	249	9.	0.03	2.	670.	4.	<10.	18.	0.02	<10.	19.	34.

ll unlisted gold values are <5 ppb.

ll samples contain: 0.2 ppm silver except no. 34 at 0.6 ppm, 0.5 ppm or less beryllium, 0.5 ppm or less cadmium except no. 28 at 39.5 ppm and no. 29 at 1 ppm, <10 ppm gallium, <1 ppm mercury, 5 ppm mercury, 5 ppm or less antimony, <10 ppm thallium, and 5 ppm or less tungsten except no. 35 at 10 ppm.

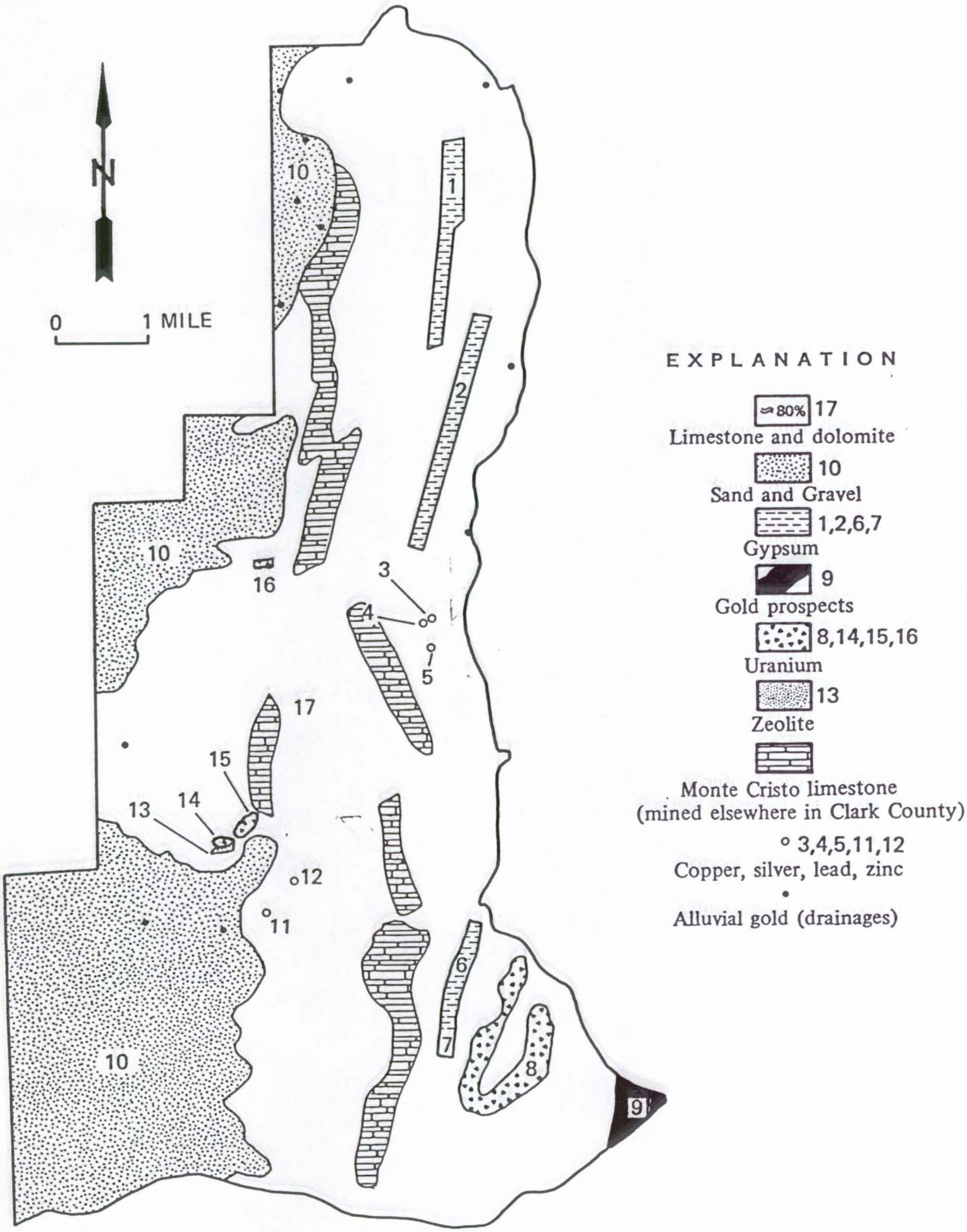
ire assay of sample locality 104 yielded 0.201 troy oz/ton gold.

APPENDIX E.--Analysis of rock samples for 25 elements in the [illegible]

[<, less than; >, more than]

Sample locality fig.2	Al %	Ag ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	K %	Mg %	Mn ppm	Mo ppm	Na %	Ni ppm	P ppm	Pb ppm	Sr ppm	Ti %	V ppm	Zn ppm
12	1.86	7.5	416.	<0.5	<2.	0.16	2.0	35.	67.	>10000.	0.12	1.61	0.13	11	4.	0.03	45	<10	5.	68.	0.06	37.	36.
13	1.64	3.0	151.	<0.5	<2.	10.50	1.5	24.	27.	2357.	0.40	1.44	1.13	67	14.	0.13	9	170.	5.	361.	0.08	24.	10.
14a	0.09	1.0	10.	<0.5	<2.	>25.00	8.0	<1.	23.	2501.	0.32	0.05	0.25	117.	1.	0.05	5	710.	30.	164.	<0.01	15.	244.
14b	0.51	2.0	33.	<0.5	<2.	>25.00	8.0	11.	117.	>10000.	2.39	0.33	2.29	198.	18.	0.07	29	4320.	165.	135.	0.02	97.	488.
14c	0.31	1.5	20.	<0.5	<2.	20.97	10.0	<1.	94.	1750.	1.66	0.20	0.86	111.	10.	0.02	12	650.	120.	88.	0.01	18.	620.
26	0.09	1.0	64.	<0.5	2.	23.50	2.5	<1.	12.	15.	0.17	0.03	5.49	116.	<1.	0.02	10	240.	5.	132.	<0.01	6.	56.
66a	3.75	0.5	255.	1.5	2.	7.57	1.5	13.	60.	24.	2.40	3.77	3.82	156.	2.	0.09	8	1300.	5.	78.	0.16	29.	12.
66b	3.23	1.0	180.	3.0	4.	6.29	2.0	13.	57.	9.	3.97	3.18	3.41	136.	1.	0.04	10	2040.	5.	65.	0.14	36.	6.
66c	0.94	0.5	290.	<0.5	6.	10.04	1.5	<1.	18.	151.	>20.00	0.27	3.93	146.	49.	0.01	14	220	175.	52.	0.04	10.	195.

All gold values are <5 ppb.
All tungsten values are <10 ppm.
Reassay of sample 12 (>10,000 ppm) yielded 1.8% copper.
Reassay of sample 14b (>10,000 ppm) yielded 1.48% copper.



Appendix F–Location of prospects and mineralized outcrops in the Lime Canyon Wilderness Study Area, Clark County, NV (Numbers refer to appendix G)

APPENDIX G.--Identified mineral resources and occurrences in the Lime Canyon Wilderness Study Area, Clark County, Nevada

Map no. (fig.)	Property name	Quantity	Resource classification	Commodity
		Industrial mineral deposits		
1	Legion Nos. 1 and 2	Estimated 44 million tons	Indicated subeconomic resources	Gypsum
2	Leeway Nos. 3, 4, and 5			
6	Boulder Nos. 1 and 2			
7	Blue Ridge Nos. 1 and 2			
10	Deposit	About 16 mi^2 containing millions of tons	Inferred subeconomic resources	Sand and gravel
17	Deposit	More than 20 mi^2 containing millions of tons	Inferred subeconomic resources	Limestone and dolomite
13	Outcrop	---	Occurrence	Zeolite
		Precious and base metals		
3	Pink Lady	---	Occurrence	Copper, silver, lead, zinc
4	Green Monster	---	Occurrence	Copper, silver, lead, zinc
5	Prospect	---	Occurrence	Copper, silver, lead, zinc
11	Red Dot	---	Occurrence	Copper, silver, lead, zinc

APPENDIX G.--Identified mineral resources and occurrences in the Lime Canyon Wilderness Study Area, Clark County, Nevada--Continued

Map no. (fig.)	Property name	Quantity	Resource classification	Commodity
		Precious and base metals--Continued		
12	Prospect	---	Occurrence	Copper, lead, zinc
9	Golden	---	Occurrence	Gold
8	Yellow Queen and numerous prospects	---	Occurrence	Uranium
13	Outcrop	---	Occurrence	Uranium
15	Prospect	---	Occurrence	Uranium
16	Outcrop	---	Occurrence	Uranium