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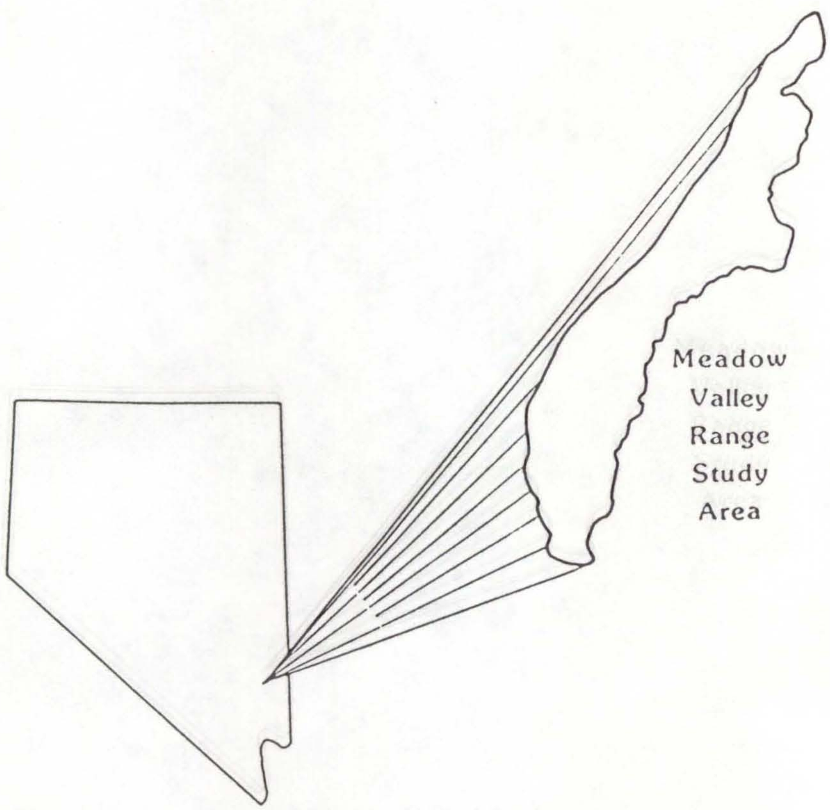
Open File Report

Mineral Resources of the Meadow Valley Range Study Area, Clark and Lincoln Counties, Nevada



BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

MINERAL RESOURCES OF THE MEADOW VALLEY RANGE STUDY AREA, CLARK AND LINCOLN COUNTIES, NEVADA

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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 Management 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 be submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral survey of a portion of the Meadow Valley Range Wilderness Study Area (NV-050-156), Clark and Lincoln Counties, NV.

This 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, E. 360 Third Avenue, Spokane, WA 99202. The report has been edited by members of the Branch of Mineral Land Assessment at the field center and reviewed at the Division of Mineral Land Assessment, Washington, DC.

CONTENTS

ILLUSTRATIONS

TABLES

SUMMARY

In 1984 and 1985, at the request of the U.S. Bureau of Land Management, the U.S. Bureau of Mines studied part of the Meadow Valley Range Wilderness Study Area (NV-050-156) in order to evaluate its identified mineral resources. The study area is located in Clark and Lincoln Counties, NV, about 50 miles northeast of Las Vegas, NV. The Johnston and Fitchett prospect, in the northern part of the study area, has more than 3 million tons of marginal perlite reserves suitable for many commercial uses. A preliminary mining feasibility estimate suggests perlite could be profitably mined from the study area; however, it is unlikely these perlite deposits will be developed in the foreseeable future because of unfavorable market conditions. Zeolite minerals occur in alteration zones adjacent to perlite deposits at the Johnston and Fitchett prospect, but high quality material is closer to potential markets. A metalliferous black shale unit containing 800,000 tons of subeconomic resources may extend into the study area at the Bradshaw vanadium prospect on the northwest boundary. Limestone, stone, sand, and gravel occurrences are wide-spread, but other suitable deposits in the region are more accessible to potential markets.

Seven prospects in and near the study area were examined. The entire study area is leased for oil and gas exploration. A group of perlite placer claims covering more than 480 acres was located in the 1940's in the northern part of the study area. A small group of lode claims was located in the mid 1950's in the southwest part of the study area. No mining claims are currently (1985) held inside the study area. No mineral production is known from within the study area.

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 mineral resource potential of a part of the Meadow Valley Range Wilderness Study Area 1/ 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 study area for inclusion into the

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1/ A Wilderness Study Area is a roadless area or island that has been inventoried and found to have wilderness characteristics as described in section 603 of the Federal Land Policy and Management Act and section 2(c) of the Wilderness Act of 1964 (78 Stat. 891) (U.S. Bureau of Land Management, 1979, p. 32).

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 an adequate and dependable supply of minerals at a reasonable cost.

Setting

In 1984 and 1985, the USBM studied 97,180 acres of the 185,744-acre Meadow Valley Range Wilderness Study Area (NV-050-156). Within this report, these 97,180 acres are referred to as the "study area."

The Meadow Valley Range study area is about 50 mi (miles) northeast of Las Vegas, NV (fig. 1). The study area is elongate, extending about 35 mi in a north-northeast direction and is generally 2 to 6 mi wide. Elevations range from 5,772 ft at an unnamed peak 4 mi southwest of Sunflower Mountain to 2,730 ft at a point on the southern study area boundary (fig. 2). The eastern part of the study area includes a large alluvial apron which slopes gently to Meadow Valley Wash; the western part has rugged peaks and steep canyons. Access to the study area is by unimproved roads from the Kane Springs Valley and Meadow Valley Wash roads. Some washes leading into the study area can be traveled by four-wheel-drive vehicles.

Previous Studies

Tschanz and Pampeyan (1970) described the geology and mineral deposits of the part of the Meadow Valley Range lying in Lincoln County, and Longwell and others (1965) discussed the part in Clark County. Recent published mapping includes a map of Cenozoic rocks by Stewart and Carlson (1976), a geologic map of Tertiary rocks by Ekren and others (1977), and the geologic map of Nevada by Stewart and Carlson (1977), with a discussion by Stewart (1980). A reconnaissance geochemical assessment of the Meadow Valley Range was done by Hoffman and Day (1984). Petroleum potential of the study area was evaluated by Sandberg (1983). Nobel (1968) described the Kane Springs Wash volcanic center. A GEM (geology, energy, and minerals) study of the Meadow Valley Range was prepared by Great Basin GEM Joint Venture (1983).

Present Study

Preliminary work included compilation of available geologic and mineral resource literature, mining claim records, and mine production data within and near the study area. Claimants were sent letters requesting permission to examine their mining claims and to obtain any scientific or historical information they may have.

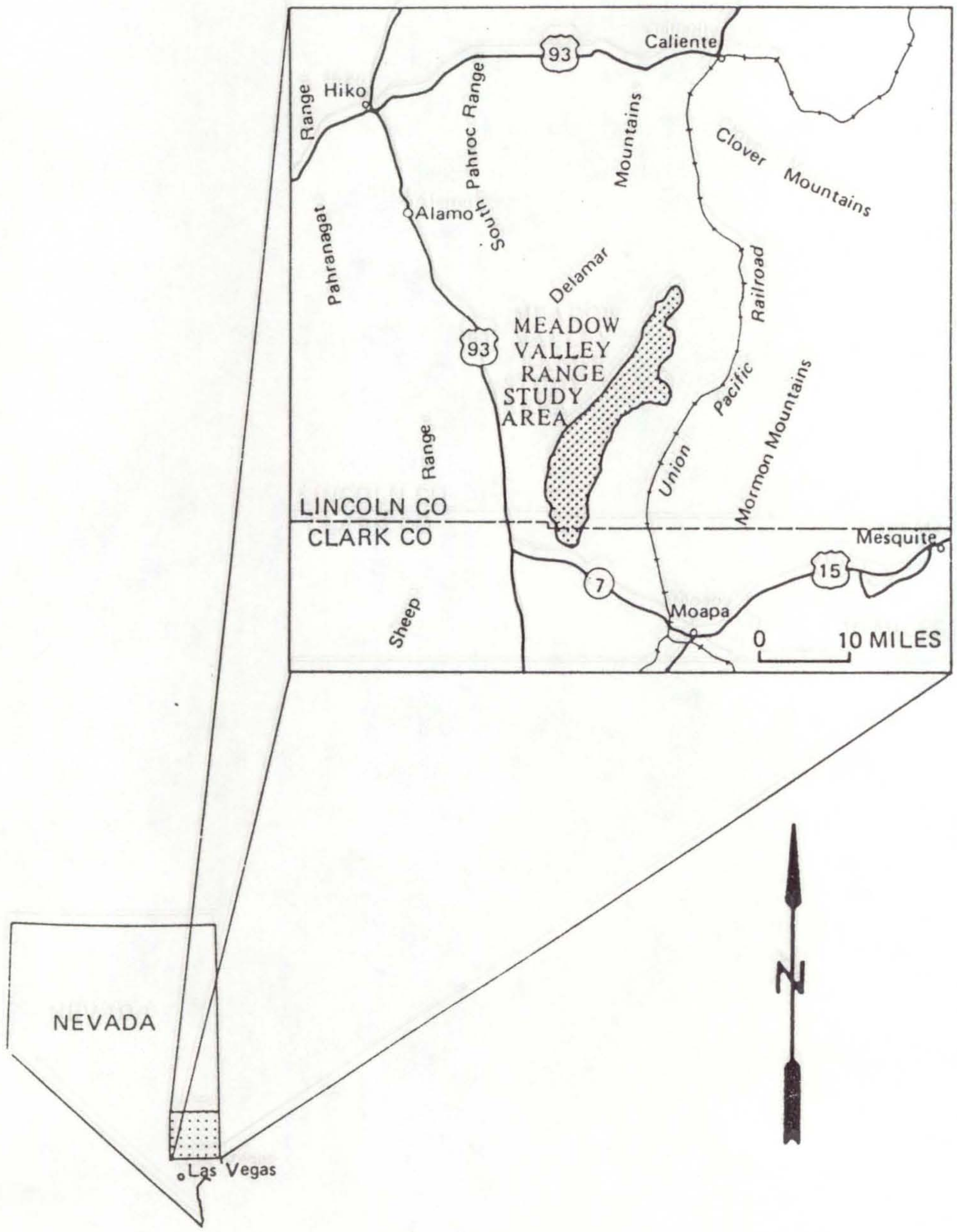

FIGURE 1.– Location of the Meadow Valley Range study area, Clark and Lincoln Counties, NV

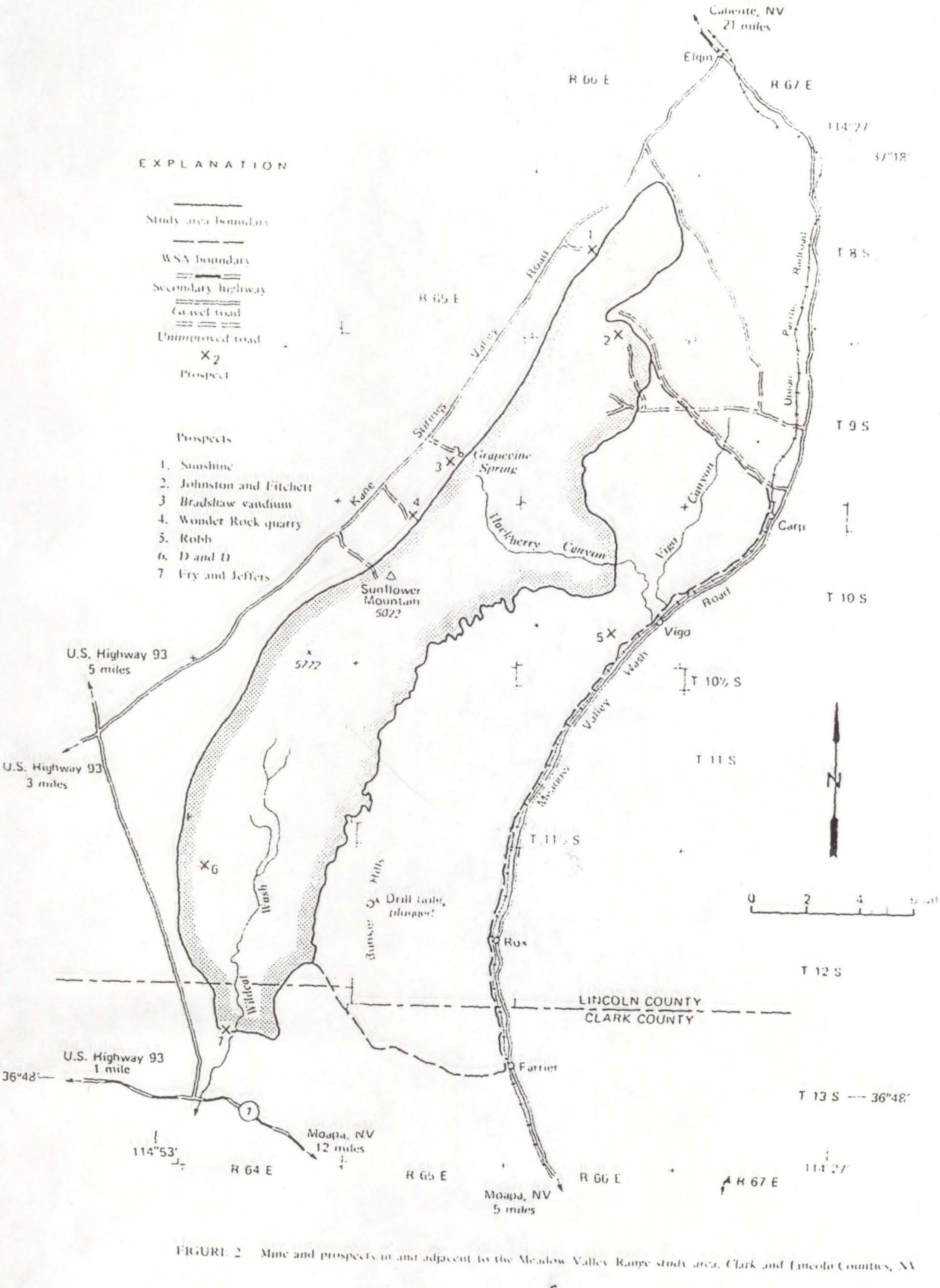

FIGURE 2. Mine and prospects in and adjacent to the Meadow Valley Range study area, Clark and Lincoln Counties, NV

Field work was conducted during October and November 1984 and April and May 1985. All known claims and prospects in or near the study area were sampled, and if warranted, mapped; 44 rock samples were taken from these sites. Chip samples were collected from mineralized structures and grab samples were taken from float or outcrop. All rock samples, except perlite and zeolite, were pulverized and analyzed by fire assay and atomic absorption or inductively coupled plasma methods. At least one sample from each location was analyzed for 40 elements 2/ by semiquantitative spectrography to check for significant concentrations of unsuspected elements. Analyses were performed at the USBM Reno Research Center, Reno, NV.

Petrographic examination was performed on 21 perlite samples to: 1) determine if refractive indices were within the range of commercially acceptable perlite (between 1.495 and 1.500; Kadey, 1963, p. 334), 2) find the percentage of non-perlitic impurities, and 3) examine textural relationships. After this preliminary screening, five chip samples of perlite were selected for shipment to the New Mexico Bureau of Mines and Mineral Resources, Socorro, NM, for preliminary laboratory-scale evaluation.

Thirteen grab samples of zeolite-bearing material were taken from 10 sites. All samples were sent to the USBM Reno Research Center, Reno, NV, for determination of the semiquantitative abundance of zeolite minerals by x-ray diffraction methods. These zeolite samples were also analyzed to determine the ammonium cation exchange capacity.

Complete results of sample analyses are available from the USBM Western Field Operations Center, Spokane, WA.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the cooperation of James Bradshaw of Caliente, NV, for generously providing information concerning the Bradshaw vanadium prospect. BLM geologist, Richard Gundry, is thanked for the valuable assistance he provided concerning access to study area mineral localities. USBM geologists, Terry Neumann, Richard Rains, and Clayton Rumsey ably assisted the author in the field.

2/ Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, gallium, gold, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, palladium, phosphorus, potassium, platinum, scandium, silicon, silver, sodium, strontium, tantalum, tellurium, tin, titanium, vanadium, yttrium, zinc, and zirconium.

GEOLOGIC SETTING

The Meadow Valley Range is in the Basin and Range physiographic province, adjacent to the westernmost part of the Colorado Plateau. The province is characterized by a series of generally north-trending mountain ranges separated by broad alluvial valleys. Much of the central and southern part of the study area is underlain by Paleozoic and Mesozoic shale, limestone, and quartzite. Tertiary rhyolitic rocks cover most of the northern part of the study area and overlie some of the older rocks in the central and southern section of the range. The Kane Spring Wash volcanic center, whch was the source of most of the Tertiary volcanic rocks in the study area, was displaced at least 5 mi southward relative to present outcrops by left-lateral movement along the Kane Spring Wash fault (Ekren and others, 1977, map). Basin and Range normal faults have tilted and displaced the rock units. Much of the eastern side of the study area is covered by an extensive alluvial apron.

MINING HISTORY

There are no mining districts in or adjacent to the study area. No mining claims were held in the study area in 1985; however, the entire study area was leased for oil and gas exploration. Placer claims were located inside the study area when the region was prospected for perlite beginning in 1945. Gypsum claims were located west and north of Carp, NV, and east of the study area. Texaco Inc. completed a well east of the study area in 1972 (fig. 2) (Garside and others, 1977, p. 10). Several major mining companies examined a vanadium prospect at the west boundary of the study area beginning in 1979. A small quantity of stone was mined near the study area from the Wonder Rock quarry, located in 1962, southwest of Grapevine Spring.

COMMODITY HIGHLIGHTS

Vanadium

"Vanadium is classified as a strategic and critical material because of its significant import dependence and essential use in equipment for defense, energy, and transportation" (Kuck, 1985, p. 908). The chief use of vanadium in 1985 was as an alloying agent for iron and steel. It is also important for the production of titanium alloys and as a catalyst for production of sulfuric acid. Annual domestic vanadium production for 1984 was 3.2 million pounds of vanadium content with a net import reliance of 54 percent. Import sources (1981-84) were Republic of South Africa, 38 percent; European Communities, 25 percent; Canada, 16 percent; Finland, 6 percent; others, 15 percent. Average price of vanadium was $3.50 per pound of V_2O_5 in 1985. (See Kuck, 1986, p. 172).

Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, and uraniferous sandstones and siltstones where it constitutes less than 2 percent of the host rock. Significant amounts are also in bauxite and carboniferous materials such as crude oil, coal, oil shale, and tar sands. Vanadium is generally recovered as a byproduct or coproduct of another element, such as iron, uranium, or phosphorus; therefore, available supplies are often dependant upon market conditions of other commodities. (See Kuck, 1986, p. 173). More than one-half of the vanadium mined in the United States is recovered as a coproduct with uranium from sandstones mined on the Colorado Plateau (Kuck, 1985, p. 904). In 1985, coproduction of uranium and vanadium from sandstone ore was stopped on the Colorado Plateau by the lowest spot market prices for U_3O_8 in more than a decade. While domestic resources are adequate to supply current domestic needs, a substantial part of United States demand is currently met by foreign material because of price advantages. The United States vanadium industry consisted of 12 firms in 1985. Raw materials included Idaho ferrophosphorus slags, Arkansas clay, petroleum residues, utility ash, spent catalysts, and imported iron slags. Total demonstrated domestic resources are estimated at 30 million tons of contained vanadium. Only 35,000 tons can be recovered for the vanadium content alone. (See Kuck, 1986, p. 172, 173).

Perlite

Perlite, by commercial definition, is any naturally occurring glass of igneous origin, that when heated rapidly to its softening point, expands or "pops" into a white, porous, lightweight material. The term "perlite" is also applied to the expanded product. Most commercial perlite deposits are of rhyolitic composition and are restricted to locations in the western United States. The United States has a perlite reserve base of 200 million tons (Meisinger, 1986, p. 115). There are sufficient domestic perlite resources for the foreseeable future (Kadey, 1983, p. 1006). Estimated 1986 domestic production of processed perlite was 520,000 tons. Processed perlite produced in 1985 had an estimated value of $34 per ton, f.o.b. mine. Crude ore production in 1985 came from 12 mines operated by 10 companies in 6 western states. The leading five companies supplied 92 percent of domestic production. New Mexico, with 87 percent of domestic crude ore mined, was the leading producing state. Processed ore was expanded at 65 plants in 32 states. (See Meisinger, 1986, p. 114-115). Generally, perlite expansion plants are located near market areas because of the high freight costs for the lightweight and bulky expanded perlite.

Perlite is mainly mined by open-pit methods. Some ore is friable enough to be loosened by bulldozers equipped with rippers, although much ore requires blasting. The variable nature of perlite deposits often requires selective mining techniques to avoid clay seams, obsidian, and other nonperlitic areas. (See Kadey, 1983, p. 1008). Crude perlite is usually crushed and sized at or near the point of use. Processing generally consists of drying, preheating, and expansion. Crude perlite ore has no commercial application except in foundry uses. Compared with natural pumice, perlite has the advantage of being shippable to consumption centers in the form of crude, heavy rock at low freight rates and then expanded to a finished form. Perlite can be made in a variety of densities; it is relatively chemically inert, flame-proof, mildew-proof, does not disintegrate when wet, and has excellent heat and sound insulating properties. (See Benton, 1984, p. 3). Principal end uses in 1985 were building construction products, 67 percent, and filter aids, 15 percent (Meisinger, 1986, p. 114).

Zeolite

Zeolite is a generic term for a large group of hydrous aluminosilicate minerals having a framework structure that encloses interconnected cavities occupied by relatively large cations and water molecules (Sheppard, 1973, p. 689). These cavities constitute between 15 and 50 percent of the total volume depending upon the type of zeolite mineral. In general, zeolites are formed by the reaction of pore water with materials such as volcanic glass. More than 35 distinct species of zeolites occur naturally, and more than 150 synthetic zeolites have been manufactured (Harben and Bates, 1984, p. 311). Industrial applications of zeolites utilize its properties of ion-exchange, absorption and molecular-sieve phenomena, dehydration and rehydration, and siliceous composition. Major uses of natural zeolites include paper filler, pozzolanic cement, and lightweight aggregate for concrete. (See Mumpton, 1983, p. 1419-1420). Uses for synthetic zeolites are mainly as catalysts, selective sorbents, and desiccants. Natural domestic zeolite production in 1985 was about 13,000 tons (U.S. Bureau of Mines, 1985, p. 8); however, natural zeolites have only limited use in the United States as most of the zeolites used are synthetic. Despite the relative cheapness of natural zeolites as compared to synthetic zeolites, they have not made substantial inroads upon the use of higher-priced synthetic zeolites (Olson, 1983, p. 1391).

Principal markets for natural zeolites are specialty chemical applications (pollution control), radioactive waste disposal, and deodorizers (animal waste absorbants). Other potential domestic markets include slow release encapsulants for pesticides and nutrients, animal feeds, and soil stabilizers (Stinson, 1984, p. 3-4). Value of natural zeolites ranges from $70 to $200 per ton, depending upon the end use and quality (R. L. Virta, USBM commodity specialist, oral commun., 1986). Numerous, large-tonnage zeolite deposits of high purity are known in the western United States and Gulf Coastal Plain. Total domestic zeolite resources are estimated at 10 trillion tons. (See Sheppard, 1973, p. 693)

Zeolites can usually be mined by open-pit methods. Most deposits have little overburden and can easily be mined with a bulldozer. Many commercial deposits are monomineralic or nearly so. Beneficiation consists of crushing and screening to remove fines and to obtain the correct particle size (Stinson, 1984, p. 18).

PROSPECTS

Evidence of prospecting activity was found at seven prospects in or near the study area (fig. 2). Two of these prospects have identified resources and are described in the following narrative. The appendix contains a brief description of all prospects examined by USBM during this study, including the five other prospects considered to be less significant. Conclusions are presented and discussed in the appraisal of mineral resources section.

Bradshaw Vanadium Prospect

The Bradshaw vanadium prospect (fig. 2, no. 3) near Grapevine Spring is mostly outside the study area boundary; however, a few of the claims in the group did extend into the area. The prospect is approximately 1.5 mi^2 (square mile) in areal extent and is located along the low-lying hills of the western Meadow Valley Range front. The prospect is in portions of unsurveyed secs. 14, 22, 23, 26-28, and 32-34, T. 9 S., R. 65 E. and secs. 4 and 5, T. 10 S., R. 65 E., Mount Diablo Baseline and Meridian. From Elgin, NV, the prospect is reached by traveling 19 mi southwest via the Kane Springs Valley Road and then going 1 mi east by unimproved road to Grapevine Spring.

James Bradshaw discovered the metalliferous Chainman Shale outcrops in 1978 and located 14 lode claims extending about 3 mi along the length of the deposit (fig. 3). He also dug six prospect pits, which exposed unweathered portions of the shale. In 1979, Newmont Mining Co., Noranda Exploration Inc., and Cominco American Inc. examined the prospect. Newmont located 36 additional adjoining claims in 1979, but dropped them in 1980. Wayne Cole of Pioche, NV, acting as agent for Mr. Bradshaw, relocated the 36 Newmont claims in 1981. From 1979 through 1981, Cominco conducted an examination of the prospect that included reconnaissance sampling, geologic mapping, core drilling, geophysical surveys, and geochemical work. (See Heston, 1982b, p. 4). Information gathered by Cominco was included in a masters thesis prepared by Deborah Heston (1982a) of Colorado State University. Cominco terminated its evaluation of the prospect and cancelled an option to purchase the property in September 1981 because the deposit was deemed smaller than preliminary examination indicated (Heston, 1982b, p. 4). Mr. Bradshaw abandoned his claims in 1982; the prospect was unclaimed in 1985.

The Bradshaw vanadium prospect is located on a metal- and phosphate-enriched zone in the upper part of the Mississippian Chainman Shale. The Chainman Shale is included in a 1,500 ft stratigraphic section in this area which strikes N. 10° E. and dips 25° SE., and is unconformably overlain by Tertiary lacustrine limestone and rhyolitic ash flow tuffs. The mineralized upper unit of the Chainman Shale is a black, fine-grained shale with laminated bedding; thin beds of limestone are

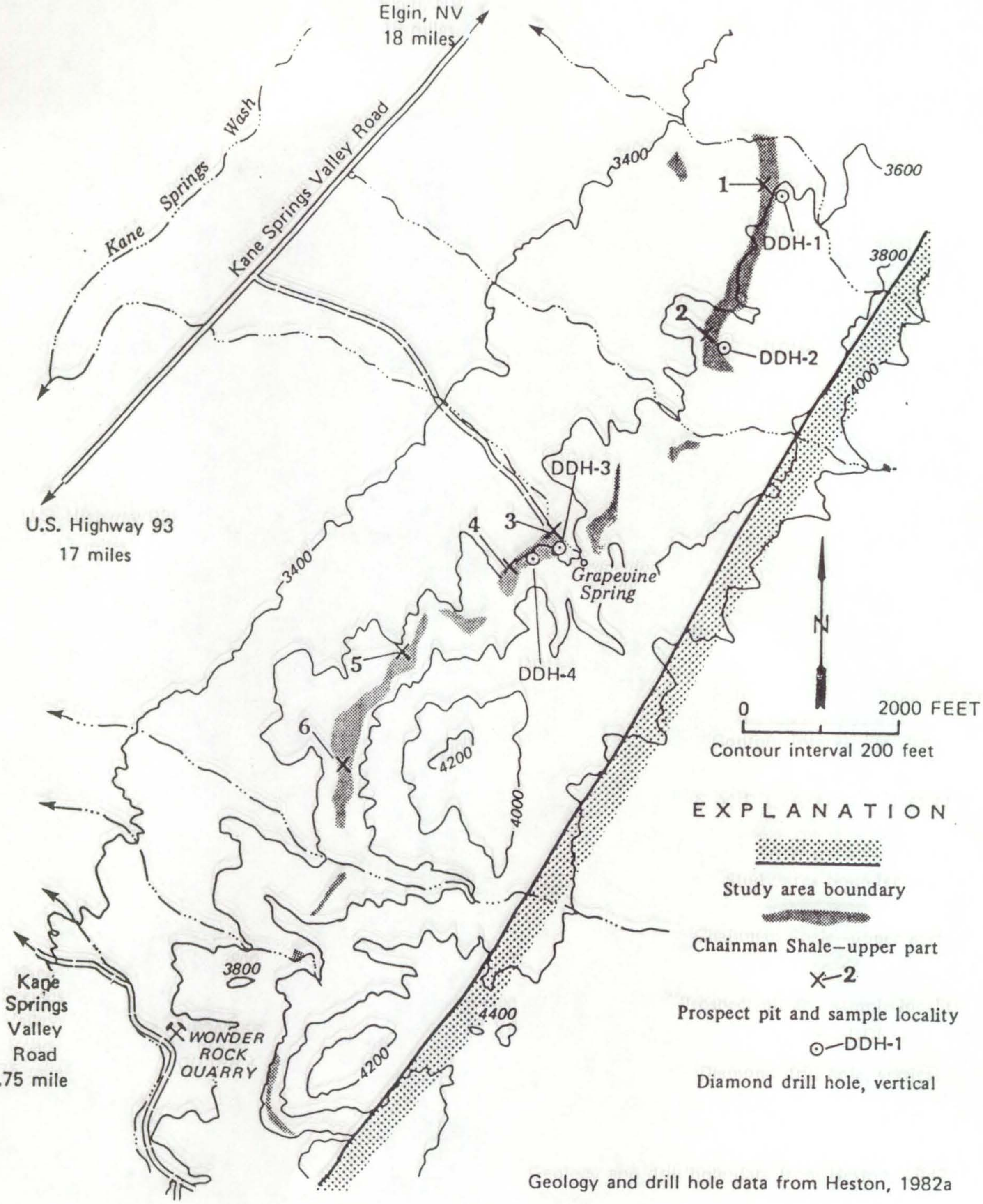

FIGURE 3.– Bradshaw vanadium prospect and vicinity

Table 1.--Sample results, Bradshaw vanadium prospect

Sample								
No.	Type	Length (ft)	Description	Silver (oz/ton)	Vanadium (ppm)	Zinc (ppm)	P_2O_5 (%)	Ni (ppm)
1*	Channel	0.5	Across black, fine-grained Mississippian Chainman Shale----------------------------	1.23	1033	2006	1.75	288
2*	do-----	.5	do--	.38	2214	2630	5.59	43
3	Chip---	5.0	do--	.57	3800	2400	5.3	50
4	do-----	3.0	do--	.49	3000	3800	4.7	59
5	do-----	2.0	do--	.14	180	560	2.4	20
6	do-----	1.5	do--	.46	3200	1900	5.8	51

*Samples taken by Cominco American Inc. (Heston, 1982b, p. 21) intercalated with the shale. (See Heston, 1982a, p. 12-13). Complex folding and faulting has disrupted the shale and caused large- and small-scale fracturing. Petrologic and scanning electron microscope work indicates that all the metals in the black shale are dispersed in ionic form (Heston, 1982a, p. 68).

Analyses of two channel and four chip samples taken from six prospect pits are shown in table 1, accompanying figure 3. Four diamond drill holes (fig. 3, DDH-1 to 4) totaling 632 ft were completed during 1981 by Cominco. Results of analyses of drill core samples gave low values; however DDH-3 and DDH-4 had enriched metal values in the position possibly equivalent to the mineralized zone exposed at the surface. (See Heston, 1982b, p. 19, 22).

An estimated 800,000 tons of subeconomic resources (U.S. Bureau of Mines and U.S. Geological Survey, 1980, p. 2) are inferred outside the study area boundary in the mineralized zone of the Chainman Shale. The average grade of this zone is 0.62 oz/ton (ounce per ton) silver, 0.27 percent vanadium, 4.8 percent P_2O_5 (phosphorous pentoxide), 0.01 percent molybdenum, 0.19 percent zinc, and 0.04 percent nickel (Heston, 1982a, p. 88). The tabular mineralized zone in the black shale has a length of about 15,000 ft, a width of about 12 ft, and extends down dip at least 50 ft (Heston, 1982a, p. 54). Resource estimates are based on data collected by Cominco and includes geologic maps, drill holes, and results of sample analyses. A tonnage factor of 12 ft^3/ton was used.

Johnston and Fitchett Prospect

The Johnston and Fitchett prospect is inside the study area in the unsurveyed secs. 14-16, 20-23, 27-29, and 31-34, T. 8 S., R. 66 E., and secs. 2-9, T. 9 S., R. 66 E., Mount Diablo Baseline and Meridan (fig. 4). The prospect is about 12 mi by unimproved road from the railroad siding at Carp, NV, in Meadow Valley Wash.

In December 1945, Samuel Johnston and O. E. Fitchett of Carp NV, began locating placer claims on perlite deposits in the Meadow Valley Range. Only limited discovery work was done on the claim group. Mr. K. L. Cochran, a geologist of the Union Pacific Railroad Company, performed a mineral survey of the prospect, which was published in 1949 (Cochran, 1951, p. 1). The prospect was unclaimed during this study.

Perlite deposits in the study area are associated with a thick accumulation of tuffs and flows erupted from the rhyolitic Kane Springs Wash volcanic center which was active about 13 to 14 million years ago (Novak, 1984, p. 8603). Perlite occurs in flows or as irregular bodies in alteration zones. Individual perlite flows range in thickness from a few feet to several tens of feet, and some flows cover several square miles. Perlite flows are dark gray or black and contain phenocrysts of feldspar and/or quartz which compose 1 to 20 percent of the rock.

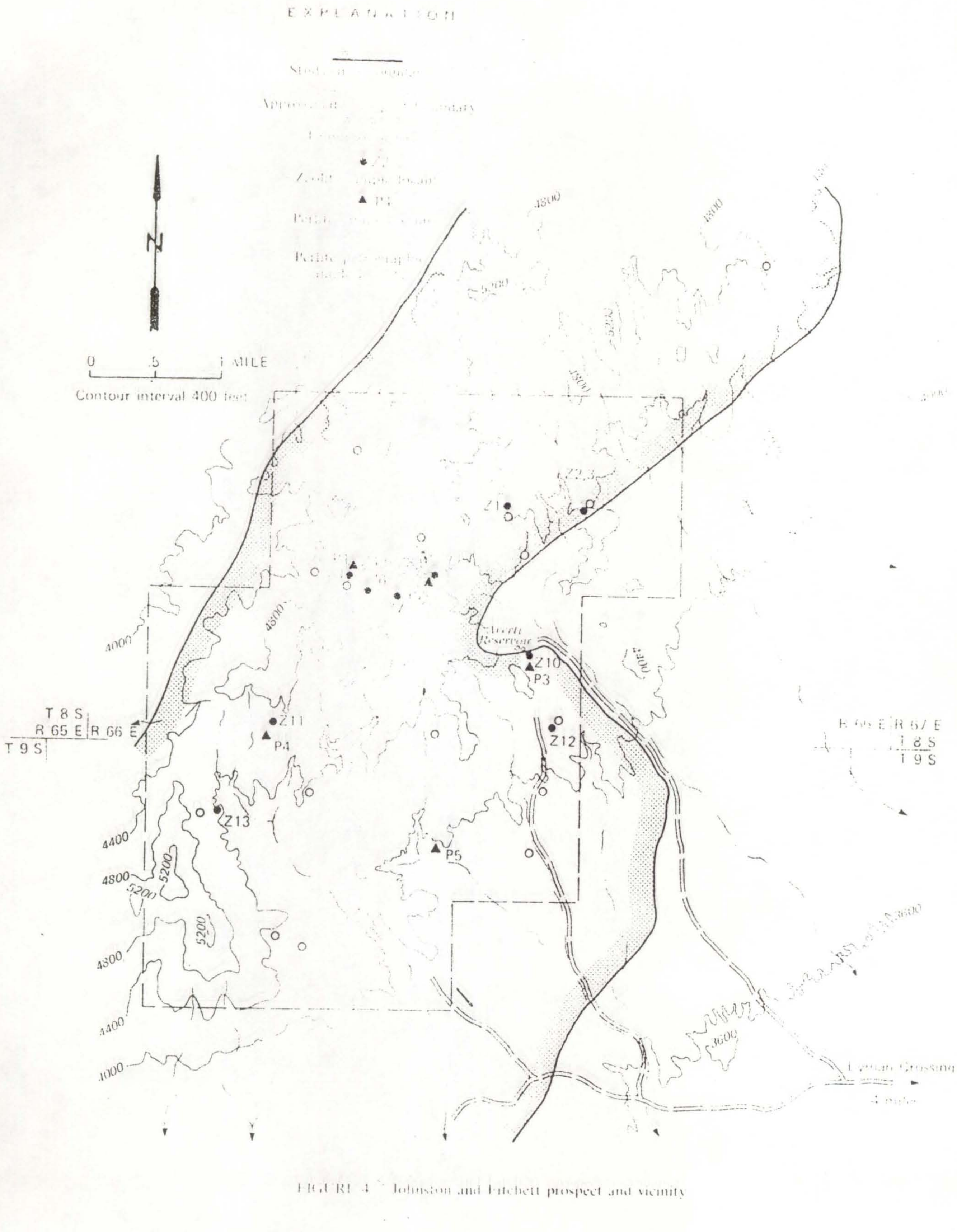

FIGURE 4 — Johnston and Fitchett prospect and vicinity

Perlite is also in irregular to lenticular zones near the margins of perlite flows as remnant glassy zones in altered rocks. These bodies and lenses range from less than 1 ft to more than 50 ft in thickness and are up to 1,000 ft in length. Lenticular perlite commonly exhibits gradational contacts with clay and/or zeolitic altered rocks. Zeolitic zones are green, yellow, or buff with an earthy texture and have relict glass, quartz, and feldspar. These conspicuously colored alteration zones crop out near most perlite exposures. Nodules, lithophysae 3/, seams, and crusts of red chalcedony and/or felsite are common in most perlite outcrops. Many nodules are filled with banded agate or have opaline cores. Marekanite nodules (Apache tears) are locally abundant, especially near weathered outcrops of "onionskin" textured perlite. Faulting has displaced many perlite units. Some units are exposed on the flanks and crests of cuestas 4/.

Representative perlite and zeolite samples were taken and submitted for preliminary testing. Results of testing of 5 perlite and 13 zeolite samples are shown in tables 2 and 3, respectively.

Cochran (1951, p. 23) estimated 2.68 million tons of indicated and 1 million tons of inferred perlite reserves at the Johnston and Fitchett prospect. USBM field observations indicate perlite tonnages are actually higher than this estimate. For example, more than 3 million tons of marginal reserves (U.S. Bureau of Mines and U.S. Geological Survey, 1980, p. 2, 5, figure 1) of perlite is inferred at sample site P5 (fig. 4); this site has 52 acres of perlite about 20 ft thick with little or no overburden. In addition, large tonnages are present at several other sites. Perlite tests show that samples have physical properties falling within the range of commercial deposits. A tonnage factor of 13.9 ft^3/ton was used for perlite resource estimates. Zeolitic zones crop out extensively in the study area. Zeolite tests indicate that the zeolite minerals clinoptilolite and mordenite are in alteration zones adjacent to perlite occurrences.

3/ Lithophysae are hollow bubblelike structures composed of concentric shells of felsite.

4/ A hill or ridge with a gentle slope on one side and a steep slope on the other.

TABLE 2.--Results of perlite testing, Johnston and Fitchett prospect

[Analytical work by New Mexico Bureau of Mines and Mineral Resources]

Sample no. (fig. 4)	Expanded density (lb/ft^3)	Furnace yield (%)	Sinkers (%)	Compaction resistance (lb/in^2) 1 & 2 in.	Furnace temperature (°F)	Expansion
P1	9.9	79	6.7	49 & 315	1,350	15X
P1*	13.0	83	17.0	18 & 144	1,450	11X
P2	6.1	84	3.3	37 & 167	1,350	24X
P2*	9.0	85	25.0	35 & 222	1,450	16X
P3	11.6	91	8.5	245 & 527	1,350	13X
P3*	11.7	95	22.0	133 & 516	1,450	13X
P4	6.51	91	2.0	42 & 861	1,320	22X
P5	16.8	95	34.0	1/	1,320	9X

1/ Too dense to test.
*Rerun of a split of this sample.

TABLE 3.--Results of zeolite testing, Johnston and Fitchett prospect

[ND, not detected]

Sample no. (fig. 4)	Zeolites Clinoptilolite (%) 1/	NH_4+ Cation exchange capacity (meq/g) 4/	Contaminants 2/3/
Z1	69	0.60	Major Am; minor Crs---------
Z2	69	.75	do--------------------------
Z3	62	.86	do--------------------------
Z4	45	.61	Major Am; minor Fls, Crs; trace Qtz------------------
Z5	54	.62	do--------------------------
Z6	27	.84	Major Am; trace Mnt, Qtz----
Z7	72	.75	Minor Am, Crs---------------
Z8	70	1.1	Major Am; minor Crs; trace Qtz-----------------------
Z9	64	.81	Major Am; minor Crs---------
Z10	ND 5/	.66	Major Am; minor Fls, Qtz----
Z11	62	.94	Major Am; minor Crs---------
Z12	55	.97	Major Am; minor Crs; trace Fls-----------------------
Z13	28	.29	Major Am, Fls; minor Crs, Qtz-----------------------

1/ Quantitative estimate in wt. %, accuracy approximately ± 25% of amount present.
2/ Major-approximately 30% to 100%; minor-approximately 10% to 30%; trace-approximately 1% to 10%.
3/ Mineral abbreviation key: Am - amorphous glass, Crs - cristobalite, Fls - feldspars, Mnt - montmorillonite, Qtz - quartz.
4/ Milliequivalents per gram
5/ Sample Z10 had 50% mordenite.

APPRAISAL OF MINERAL RESOURCES

Vanadium

A mineralized zone in Paleozoic black shale contains relatively high concentrations of vanadium, silver, nickel, copper, phosphate, and molybdenum that may extend into the study area. About 800,000 tons of subeconomic metalliferous shale resources are inferred at the Bradshaw prospect. This deposit has many characteristics which are similar to large syngenetic metal-rich black shale deposits in the western United States (Desborough and Poole, 1983, p. 99-109). Although considerable exploratory work was done at the prospect, the character and extent of the deposit is still uncertain.

Complex faulting and folding makes prediction of the lateral extent of the mineralized zone in the Chainman Shale difficult without subsurface data, but the 25° SE. dip of the associated strata suggests the mineralized zone probably extends into the study area beneath Tertiary rocks. The nearest known outcrop is about 600 ft west of the boundary (fig. 3). Plastic deformation of the incompetent shale bed caused by faulting and folding may have thickened the mineralized zone or caused lateral discontinuities. Chainman Shale crops out in the eastern part of the Meadow Valley Range, but is reportedly thinner (Tschanz and Pampeyan, 1970, p. 106, plate 2). A visual reconnaissance by helicopter and two scintillometer traverses performed by hiking perpendicular to strike failed to identify any mineralization in poorly exposed and weathered shale units.

Recovery of vanadium from black shales is technologically feasible (Brooks and Potter, 1974; Hyashi and others, 1985); however, the process to date is not economic (Kuck, 1985, p. 902). These black shales are fine grained, and metals in the shale are ionically bound to other elements. This makes physical separation and extraction difficult. (See Desborough and Poole, 1983, p. 100). Production of vanadium from black shales may become economic when combined with the recovery of other valuable metals (Kuck, 1985, p. 902).

Information needed to evaluate the full extent of the resources at the prospect includes: 1) the age of mineralization, 2) the degree to which faulting and folding have affected the deposit, 3) the relative importance of diagenetic versus epigenetic processes to the mineralization of the shale, and 4) a suitable method of economic recovery. Until this deposit is better understood, it remains a favorable target for further mineral resource evaluation.

Perlite

Perlite is abundant inside the study area at the Johnston and Fitchett prospect and vicinity. At least 3 million tons of marginal reserves of perlite, with little or no overburden, are identified. Expansion tests in a laboratory-scale furnace suggest this perlite compares favorably with commerical perlite ores and is suitable for several commercial applications. Perlite is a highly differentiated, use-specific commodity; therefore, less-than-maximum values of expanded density can be profitable provided a market exists or can be developed (Barker and Hingtgen, 1985, p. 1).

To determine the minability of perlite from the study area, a hypothetical mining and processing operation was designed. Costs were based on the STRAAM Engineers, Inc., cost estimating system (Clement and others, 1979) using a 100 ton/day open-pit method of mining for 250 day/year. Overall production costs of the hypothetical operation are estimated as follows:

		Production Cost 5/
Mine Operating Cost 6/		$13/ton
Capital Costs		7/ton
	Total Costs	$20/ton

This preliminary feasibility estimate suggests that perlite could be mined, processed, and transported to Carp, NV, for roughly $20/ton. The estimated average value of perlite (f.o.b. mine) in 1985 was $34/ton (Meisinger, 1986, p. 114). Selective mining techniques would be necessary to avoid nonperlitic inclusions and areas of low quality. Although this estimate suggests perlite could be mined profitably from the study area, it is unlikely that these perlite deposits will be mined in the foreseeable future because higher quality deposits of large size are already developed. For example, the Mackie mine, 30 mi northwest of the study area, has about 1 million tons of perlite reserves and supplies regional demand for perlite (Neumann, 1986, p. 13, 16).

Zeolite

Reconnaissance rock samples taken from the Johnston and Fitchett prospect inside the study area contained the zeolite minerals clinoptilolite and mordenite in alteration zones adjacent to perlite deposits. Information is not sufficient to determine the quantity and quality of these zeolite occurrences. Commercial development of zeolite

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5/ Costs are as of July 1985.

6/ Perlite trucked to railroad siding at Carp, NV.

deposits will depend upon the expansion of markets for natural zeolites, especially for low quality, agricultural grade zeolite. Because the zeolite occurrences are closely associated with perlite, these two commodities could potentially be developed jointly. However, development of zeolite deposits in the study area is unlikely because many high quality zeolite deposits are located closer to potential markets.

Other Mineral Occurrences

Gypsum is in a Permian red bed at the Robb prospect (fig. 2, no. 5) east of the study area. No evidence of gypsum resources extending into the study area was identified. Slight radioactivity associated with black Paleozoic limestone (fig. 2, no. 7) near the southern boundary of the study area is not significant. Ornamental stone (fig. 2, no. 4) which was quarried west of the study area, does not extend into the study area. Sand and gravel, and other stone, such as limestone and quartzite, are abundant in the southern part of the study area, but other suitable deposits are closer to potential markets. A labradorite 7/ occurrence of possible interest to mineral collectors is at the D and D prospect (fig. 2, no. 6). Banded agate, opaline rock, and Apache tears, also of interest to collectors, occur at the Johnston and Fitchett prospect (fig. 2, no. 2).

Sandberg (1983, p. H8) assigned a medium petroleum potential to the Meadow Valley Range based upon the presence of adequate source rocks and favorable indications in wells drilled nearby. No evidence of geothermal energy resources or other energy resources was found.

RECOMMENDATIONS FOR FURTHER STUDY

Surface and subsurface characteristics of the perlite and zeolite occurrences at the Johnston and Fitchett prospect need to be established. Lateral extent and continuity can be determined by taking closely spaced samples and by core drilling. Detailed geologic mapping is also required.

Additional study is needed at the Bradshaw vanadium prospect to evaluate the size and quality of the mineralized zone in the Palezoic black shale bed. Core drilling, trenching, geologic mapping, and geochemical and geophysical work is needed.

7/ A blue feldspar mineral showing a beautiful play of colors.

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APPENDIX.--Mines and prospects in and adjacent to the Meadow Valley Range study area, Clark and Lincoln Counties, NV

Appendix.--Mine and prospects in and adjacent to the Meadow Valley Range study area

[* (asterisk) indicates outside the study area; ** indicates prospect straddling the study area boundary]

Map no. (fig. 2)	Name	Summary	Workings	Sample and resource data
1**	Sunshine prospect	A rhyolite flow striking N. 5° E., with a vertical dip, is about 8 ft thick. Yellow devitrified volcanic glass about 0.5 ft wide is along the margin of the flow.	Bulldozer cut about 20 ft by 30 ft by 6 ft deep.	A chip sample across the margin of the rhyolite flow contained no gold or silver.
2	Johnston and Fitchett prospect	Perlite occurs in flows or irregular bodies associated with thick accumulations of Tertiary rhyolitic volcanic rocks which cover several square miles. Zeolite minerals are in alteration zones associated with perlite occurrences. Apache tears and banded agate are abundant near weathered perlite outcrops.	None.	Twenty-one perlite and 13 zeolite samples were taken. It is inferred that more than 3 million tons of perlite resources are inside the study area. Results of extensive testing of 5 perlite samples suggests these deposits have properties falling within the range of commercial deposits. The zeolite mineral clinoptilolite was detected in 12 samples, and 1 sample had mordenite. Apache tears and agate may be of interest to mineral collectors.
3**	Bradshaw vanadium	A mineralized zone in the Mississippian Chainman Shale contains concentrations of several metals and phosphate. The shale unit strikes about N. 10° E. and dips 25° SE. and is composed of black shale intercalated with limestone beds. The mineralized zone averages about 12 ft thick over a 3 mi strike length.	Six prospect pits.	Four samples were taken. An estimated 800,000 tons of subeconomic resources are outside the study area. Average grade of resources is 0.62 oz/ton silver, 0.27% vanadium, 4.8% P_2O_5, 0.010% molybdenum, 0.19% zinc, and 0.04% nickel (Heston, 1982a, p. 88).
4*	Wonder Rock quarry	A Paleozoic sandstone has yellow, orange, red, and purple liesegang banding. Small amounts of ornamental stone were quarried.	A quarry 100 ft by 20 ft and 2 prospect pits about 0.5 mi SSE of the quarry.	This bed does not extend into the study area.
5*	Robb prospect	Gypsum is in a Permian red-bed unit. The deposit is about 2,600 ft long and 1,000 ft wide. Gypsum beds dip about 60° NW. and range in thickness from a few inches to 20 ft.	None.	A 3-ft chip sample across a gypsum bed contained 92.6% $CaSO_4 \cdot xH_2O$; 0.12% free H_2O, 19.10% combined H_2O, 90.7% $CaSO_4 \cdot 2H_2O$, and 1.9% $CaSO_4 \cdot 1/2H_2O$.

Appendix.--Mine and prospects in and adjacent to the Meadow Valley Range study area--Continued

Map no. (fig. 2)	Name	Summary	Workings	Sample and resource data
6	D and D prospect	Silicified, iron-stained limestone is in a contact zone beneath a partially eroded, thick, canyon-filling rhyolite flow. Quartz veinlets are in silicified limestone. The margin of the rhyolite flow near the contact contains blue labradorite crystals up to 0.5 inch long.	None.	Two samples were taken. A 6-ft chip sample across the rhyolite flow margin and a grab sample of silicified limestone contained 0.01 and 0.02 oz/ton silver, respectively. No gold was detected. Labradorite may be of interest to mineral collectors.
7**	Fry and Jeffers prospect	Slight radioactivity is associated with black Paleozoic limestone. No veins or geologic structure is associated with the occurrence (Atomic Energy Commission, 1954).	None.	Two soil samples from top and base of range front had 0.009% and 0.011% cU_3O_8, respectively. Highest scale reading was 100 counts per second (background was 60 counts per second) on a Halrass scintillometer (Atomic Energy Commission, 1954).