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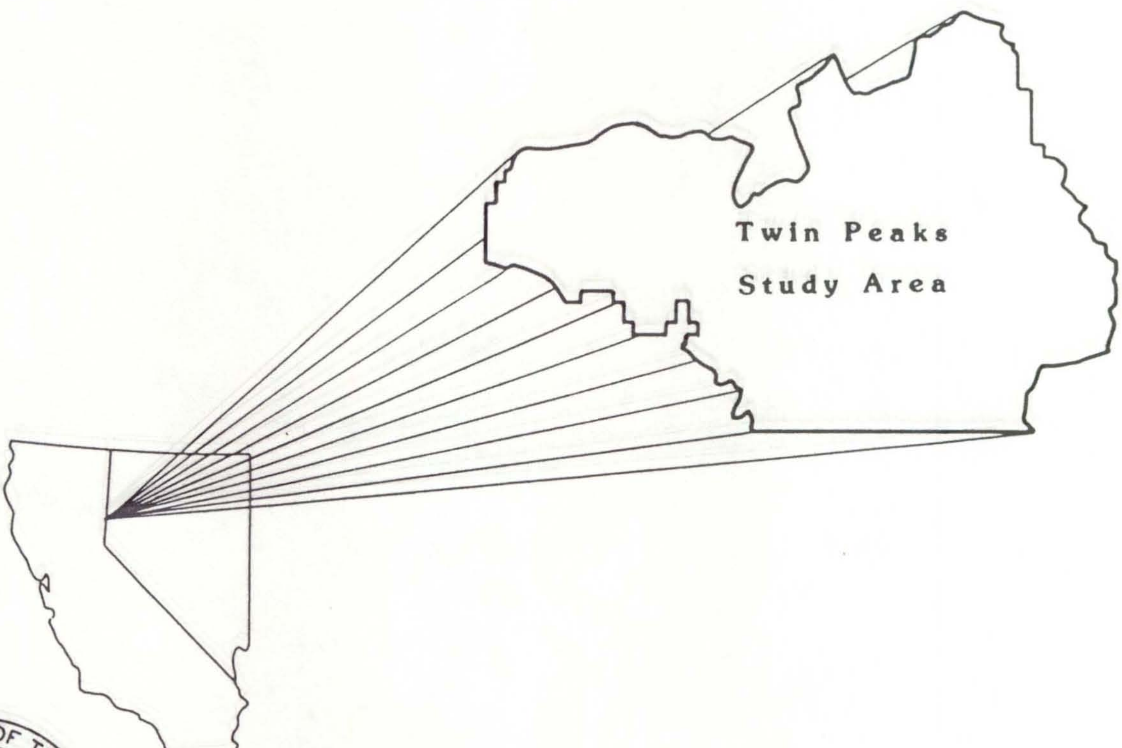
Mineral Land Assessment/1986
Open File Report

Mineral Resources of the Twin Peaks Study Area, Lassen County, California and Washoe County, Nevada



BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

MINERAL RESOURCES OF THE TWIN PEAKS STUDY AREA, LASSEN COUNTY, CALIFORNIA, AND WASHOE COUNTY, NEVADA

By
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MLA 15-87

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

BUREAU OF MINES
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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 Twin Peaks Wilderness Study Area (CA-020-619A), Lassen County, California and Washoe County, Nevada.

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, East 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, D.C.

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SUMMARY

In 1985, at the request of the Bureau of Land Management, the Bureau of Mines studied a 50,570-acre portion of the 90,345-acre Twin Peaks Wilderness Study Area (CA-020-619A) in order to evaluate its identified resources. The area studied is located about 45 miles northeast of Susanville, CA, in Lassen County, CA, and Washoe County, NV. The area is underlain by Tertiary volcanic, volcaniclastic, and intrusive rocks. Quaternary stream, lake, and landslide deposits overlie the older rock.

There are no mines or mining claims in the study area. One mineral resource, pozzolan, was identified. Mining claims, inactive in 1985, have been staked adjacent to or near the northwest corner of, and also southeast of, the study area. Examination and sampling of 17 mineralized sites, delineated mostly by prior geochemical surveys, showed at least 30 million tons of subeconomic pozzolan resources and small or low-grade occurrences of gold, silver, copper, lead, zinc, nickel, molybdenum, zeolites and clay.

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 resource potential of the Twin Peaks 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 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 study area consists of 50,570 acres within the 90,345-acre Twin Peaks Wilderness Study Area in northwestern Nevada and northeastern California, northwest of the Smoke Creek Desert and 45 mi (miles) northeast of Susanville, CA (fig. 1). Access is by the unpaved Smoke Creek road from the south and the Gerlach to Sand Pass Road from the east and by unimproved roads and jeep trails within the study area.

Dominant topographic features are gently rounded peaks and ridges, with some steep and craggy ridges and canyons. Elevation range from 6,592 ft, at Twin Peaks, to approximately 3,880 ft, near Buffalo Slough. All streams are intermittent. Temperatures exceed 100°F in the summer and drop below 30°F in the winter; snow cover on the high peaks and ridges may be several feet deep. Brush, grass, and very sparse deciduous and coniferous trees are the thin vegetative cover.

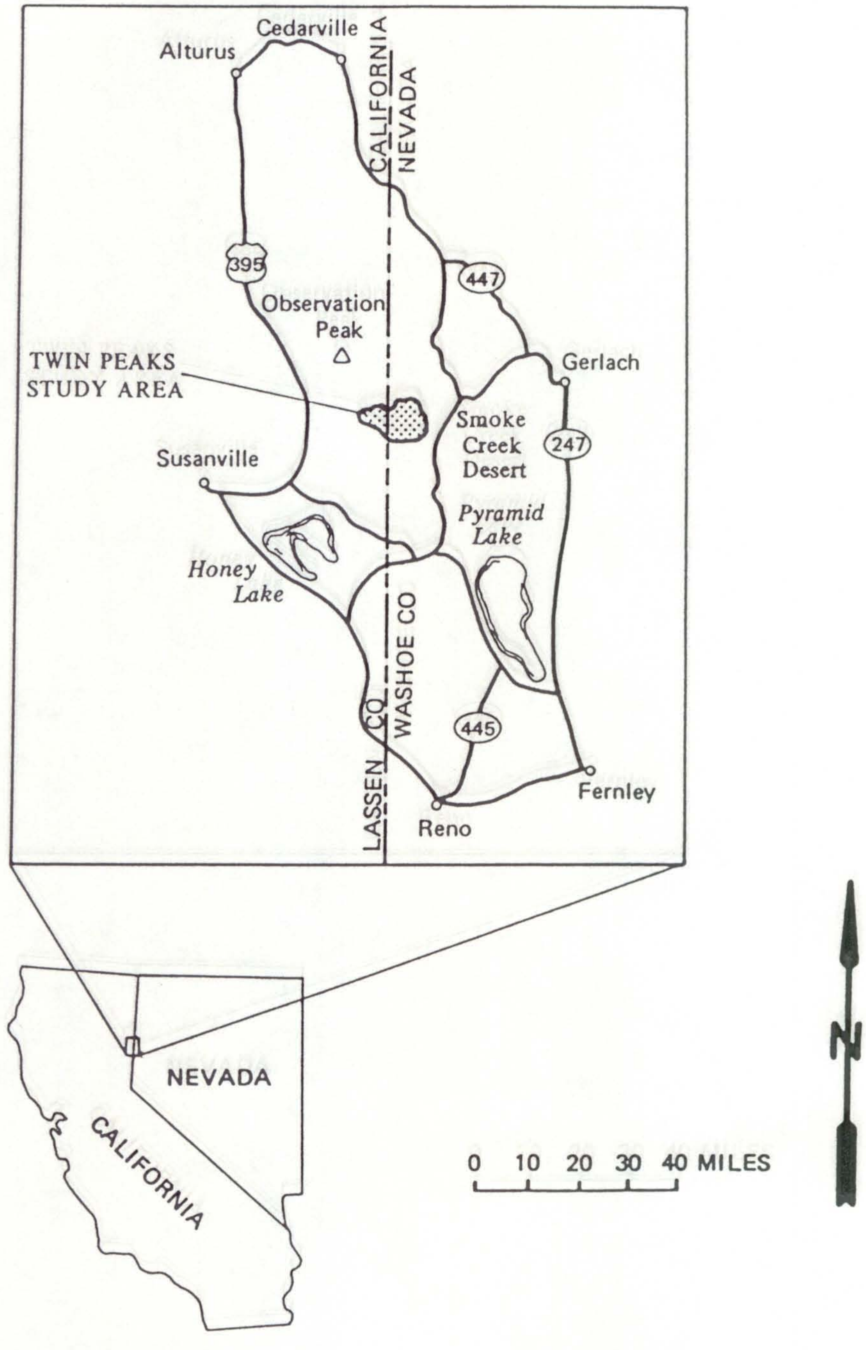

FIGURE 1.– Location of the Twin Peaks study area, Lassen County, CA and Washoe County, NV

Previous Studies

Descriptions of general geology are in Russell (1885), Webb and Wilson (1962), Norris and Webb (1976), Bailey (1966), MacDonald (1966), Oakeshott (1976), Stewart and Carlson (1976), and Bingler (1978).

Discussions of pertinent mineral economics are in Russell (1885), Hill (1915), Phalen (1919), Lincoln (1923), Overton (1947), Smith (1956), Faick (1963), Horton (1964), Gay, Jr. (1966), Bonham and Papke (1969), U.S. Bureau of Mines (1969), Papke (1970), Elevatorski (1973), Cupp and others (1977), and Karfunkel (1983).

Geophysical and geochemical surveys are reported in Lawrence Livermore Laboratory (1976), Qualheim (1979), Aero Services Division (1981), Berry and others (1982), and Conners and others (1985).

Present Study

The Bureau of Mines investigation was conducted by personnel from Western Field Operations Center, Spokane, WA, and consisted of pre-field research, field work, and report preparation during 1985 and 1986. Pre-field studies included a literature search and an examination of Lassen and Washoe County mining claim records, U.S. Bureau of Land Management mining claim and mineral lease records, and U.S. Bureau of Mines production records. Field studies in June 1983 included a search for all mineralized sites within the study area. Sites found were examined, and mapped and sampled if warranted. Mineralized zones close to the study area were also studied to determine if they extended into the study area, and to better understand mineral deposits. Ground and air reconnaissance was done to find extensions of known mineral occurrences.

Seventy-four samples were taken from 17 mineralized sites in the study area (fig. 2), and included 15 placer and 59 rock samples. Three of the rock samples were examined petrographically. Samples were of three types: 1) chip - a regular series of rock fragments taken in a continuous line across a mineralized outcrop; 2) channel - rock or alluvium from a measured cut; 3) grab - rock pieces, alluvium or soil taken unsystematically from loose material. All placer (alluvial) samples were grab or channel samples of surficial sand and gravel.

Gold and silver analyses were by combined fire assay-ICP (inductively coupled plasma analysis); other elements were analyzed by atomic absorption, colorimetry, radiometry, or X-ray fluorescence. Representative samples were analyzed for 40 elements 2/ by semi-quantitative emission spectrophotometry to detect unsuspected element concentrations. X-ray diffraction was used to screen selected samples for zeolite and clay minerals.

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.

Nine samples of lake sediment material were screened for pozzolan suitability by analyzing oxide content for whole-rock composition (ICP) and loss on ignition. Suitable samples contained sufficient combined Al_2O_3, Fe_2O_3, and SiO_2 to meet ASTM (American Society for Testing and Materials, 1985) standards for a combined minimum of 70 percent. The percentage of SO_3 and loss on ignition were compared to ASTM standard maximums of 4 percent and 10 percent, respectively.

Two samples were analyzed for pozzolan suitability by the U.S. Army Corps of Engineers, Vicksburg, MS. ASTM standard specifications are: water requirement, maximum 115 percent; compressive strength, percent of control, minimum 75 percent.

Placer (alluvial) samples were panned in the field and later concentrated on a laboratory-sized Wilfley table. Resulting heavy mineral fractions were examined with a binocular microscope. When free gold was detected, larger particles were hand-picked and weighed along with fine gold recovered by amalgamation. Concentrates were also checked for radioactivity and fluorescence. Detailed sample data is available from Bureau of Mines Western Field Operations Center, E. 360 Third Avenue, Spokane, WA, 99202.

ACKNOWLEDGEMENTS

Bureau of Mines personnel who assisted the author in the field were J. Mitchell Linne and William N. Hale of Western Field Operations Center.

GEOLOGIC SETTING

Basalt, andesite, and rhyolite flows, volcanic breccias, and dikes crop out extensively and form both plateau flows and cone structures. Water-laid tuffaceous sediments which crop out mainly at lower elevations appear to be generally younger than plateau basalts but may underlie flows east of Smoke Creek Ranch (fig. 2). Alluvial deposits and landslides occur locally throughout the area.

Mineralization was in or near dikes, in altered volcanic clastics (including diatremes), and in alluvial deposits.

Gold, silver, copper, lead, zinc, nickel and molybdenum were concentrated in small amounts in or near dikes, which are steep-dipping, a few tens of feet thick, and have strike lengths of several hundred or thousand feet. Mineralization was mainly at or near contacts, which may be sheared, brecciated, and argillized. Fine-grained chilled zones occur at some intrusive contacts.

Small amounts of the same metals also were in some tuffaceous pyroclastics where argillization and silicification have been extensive and clinoptilolitic zeolites formed. Kaolinization was intense at a

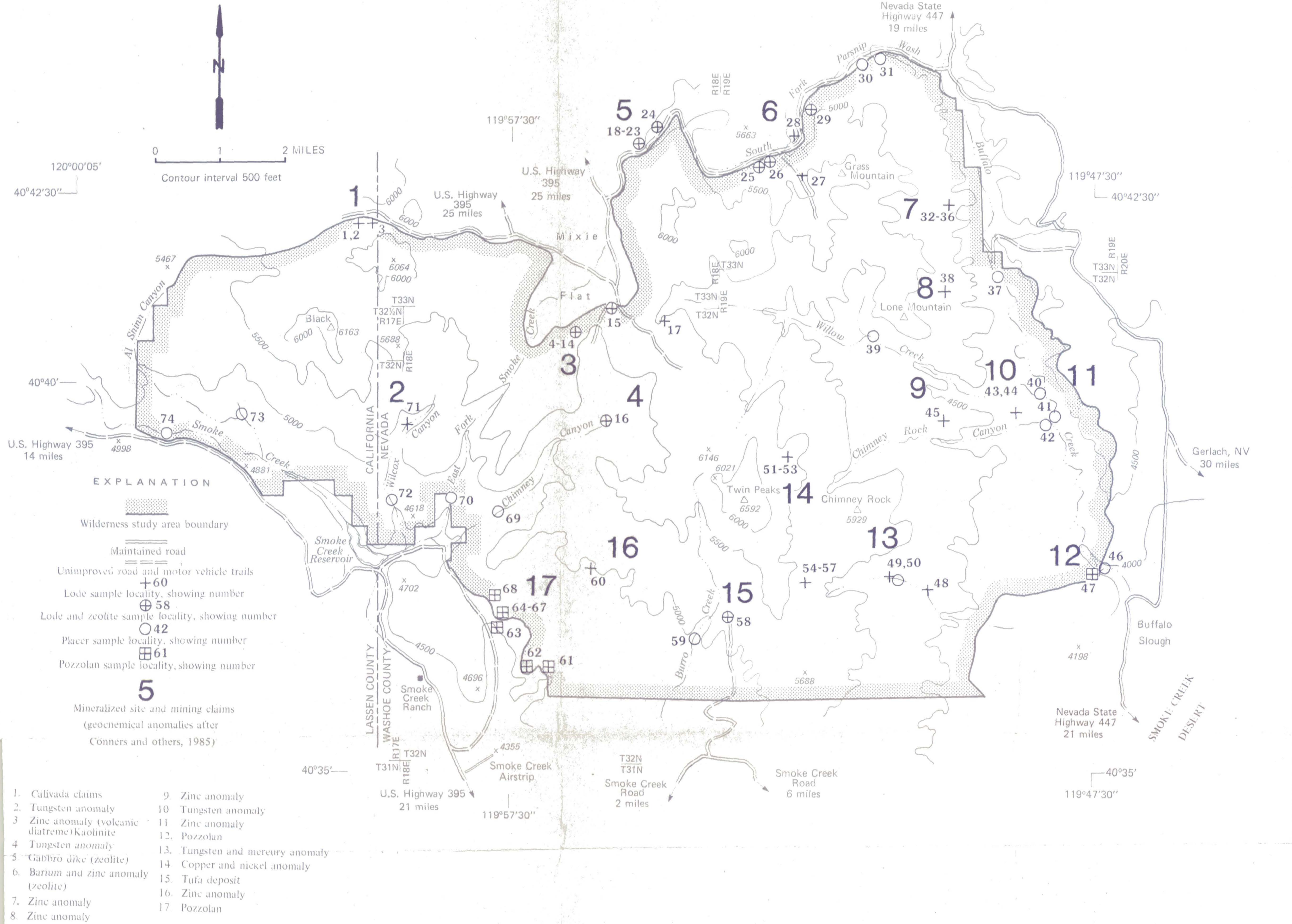

FIGURE 2 – Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV

volcanic diatreme. Some tuffaceous sediments are pozzolanic. The fine-grained water-laid tuffaceous sedimentary rocks are white to gray, nearly flat-laying, and laminose to massive. Glassy pumiceous fragments are abundant in some layers; some layers contain at least 40 percent diatoms.

Gravels along the intermittent streams contain very low grade placer gold, probably derived by weathering of weakly mineralized volcanic rocks in the study area. The gold is extremely fine-grained.

MINING HISTORY

At least 30 mining claims were staked in 1911 and in the 1930's northwest of Mixie Flats, outside the study area near the state boundary. Two other claims were staked in 1946 about 2 mi southeast of the area for diatomite in the tuffaceous lake sediments. Salt and other evaporites were produced on a small scale in the late 1800's and early 1900's a few miles southeast of the study area in the Smoke Creek Desert (Russell, 1885, p. 232-233; Phalen, 1919, p. 145-146). In 1985, there were no active claims or mining activity within or near the study area.

MINES, MINING CLAIMS, AND MINERALIZED SITES

No mines or mining claims exist in the study area. However, mineral bearing sites contain small or low-grade concentrations of gold, silver, copper, lead, zinc, nickel, tungsten, zeolite and clay and at least 30 million tons of subeconomic pozzolan resources. Mining claims and mineralized sites are described in Appendix A. Sample analytical results are given in Appendices B, C, and D.

APPRAISAL OF MINERAL RESOURCES

One mineral resource, pozzolan, was identified (U.S. Bureau of Mines and U.S. Geological Survey, 1980) in the study area. Gold, silver, copper, lead, zinc, molybdenum, nickel, zeolite and clay occurrences are low grade, of small size, have poor marketability, or are distant from foreseeable markets.

No metallic minerals were visible at the sites of metallic geochemical anomalies of Conners and others (1985). The amount of lead, zinc, silver, and copper in several Bureau of Mines samples, particularly those from a diatreme at Mixie Flat (fig. 2, nos. 10-13), confirmed anomalies of Conners and others and indicate possible hydrothermal mineralization systems in or near the study area. Gold, silver, copper, lead, zinc, and nickel content of samples taken by the Bureau of Mines were a tenth to a hundredth of concentrations needed to be economic in today's economy. Zeolite concentrations were lower than in typical deposits by a factor of about ten, and the kaolinite deposit at the diatreme south of Mixie Flat (fig. 2, no. 10-13) is too small for economic consideration. No volumes or tonnages of these materials were estimated.

At least 30 million tons of pozzolan crops out in and near the study area (fig. 2, mineralized sites no. 12, 17). Pozzolans are siliceous material found in many volcanic tuffs, in diatomaceous earth, and in the ash wastes from coal-fired power plants. Pozzolans can be finely ground and combined with portland cement and used in concrete admixtures. Coal ash is widely used as pozzolan as a means of disposing of coal-fired power plant wastes (Toy Poole, U.S. Army Corps of Engineers, Vicksburg, Mississippi, oral communication, 1986). What is probably the only domestic natural pozzolan source being mined in 1985 is the extensive deposit of Lassenite Industries, Doyle, CA. These pozzolans are at a railhead. Mining, exploration, and transportation costs (for July 1986, using methods of Benjamin and Gale, 1984) for a 1 million ton deposit mined at 500 tons per day with a 1:1 stripping ratio are estimated to be about $12.50 per ton, including truck transportation for 1 mi. Competition from coal ash, and transportation and other costs will probably continue to prevent mining the study area pozzolans. Although coal ash furnishes most current domestic pozzolan requirements, transportation costs could make natural pozzolans (as more prospects are identified) preferable to ash wastes at future local construction projects. Concrete dam, canal, or road construction nearby would make mining the pozzolan more likely. Decrease in coal ash production by coal powered plants could also improve markets for natural pozzolans.

RECOMMENDATIONS FOR FURTHER STUDY

Additional mapping, sampling, and testing of pozzolans is recommended. Market studies and detailed cost analyses are needed.

Geochemical sampling to determine extent and grade of hydrothermal mineralization is recommended. Some dikes, faults, and pyroclastics contain small concentrations of at least one metal. The volcanic diatreme south of Mixie Flat is intensely argillized and contains small concentrations of lead, zinc, and copper.

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APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA, and Washoe County, NV.

APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV

[Asterisk (*), wholly or partly outside study area boundary]

Mineralized site (fig. 2)	Sample no. (fig. 2)	Description 1/	Sample analyses 2,3/
1 *	1-3, 73, 74	Calivada claim area. Basalt flows and dikes contain some 0.03-ft feldspar phenocrysts, scoriaceous zones, sheet jointing, and limonitic weathering.	Three rock samples contained no significant concentrations 2/. The two placer samples contained about $0.01 gold per cu yd 3/.
2	71, 72	Tungsten anomaly. Basalt, with zeolites or feldspar in vesicles.	Rock sample 71 contained no significant concentrations 2/. The placer sample contained no gold.
3	4-15, 17, 70	Zinc anomaly. Samples 4-14 were of a volcanic diatreme breccia in porphyritic gray volcanic rock; the diatreme, a 300- by 500-ft outcrop was intensely altered and contained massive clay (mainly kaolinite). Some of the breccia is silicified, limonitic, and stained by manganese oxides. Some fragments are rounded and polished. Sample 15 was from a nearby vesicular porphyritic basalt and 17 from a coarse gabbroic dike in red pyroclastics.	None of the 13 rock samples contained significant concentrations 2/. The placer sample, 70, contained about $0.01 gold per cubic yard 3/. No diamonds, pyrope garnets, or chromian diopside were found in the outcrops of the diatreme.
4	16, 69	Tungsten anomaly. A basalt dike with 10% feldspar phenocrysts and fine-grained magnetite, pyrite or both cuts N. 20° W. (dips 85° SW.) through a scoriaceous to sheet-jointed basalt flow.	The rock sample contained no significant concentrations 2/; the placer sample contained no free gold.

APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV--Continued

Mineralized site (fig. 2)	Sample no. (fig. 2)	Description 1/	Sample analyses 2,3/
5 *	18-24	Coarse, gabbroic dike striking N. 5-10° E. and dipping vertically is about twice as radioactive, 60 cps (counts per second) 1/, as surrounding tuffaceous pyroclastic rock.	Seven rock samples contained no significant metal concentrations 2/ and up to 8% clinoptilolite.
6 *	25-31	Barium and zinc anomalies. Samples 25 and 26 were biotite feldspar pyroclastic rhyolite; 27 was fine- to medium-grained porphyritic rhyolite; 28 was an argillized limonitic contact between pyroclastic rhyolite and a vertical, N. 37° W trending andesite dike; sample 29 was of white to yellow altered pyroclastic rhyolite.	Five rock samples (25 through 29) contained no significant concentrations 2/, and, at most, about 5% clinoptilolite. Two placer samples (30 and 31) contain $0.04 and $0.02 gold per cu yd 3/, respectively.
7	32-36	Zinc anomaly. Yellow to gray or black vitreous to fine-grained rhyolitic welded limonite tuff strikes N. 50° W. and dips 90°; slickensides at surrounding basalt contacts.	Five rock samples contained no significant concentrations 2/.
8	37, 38	Zinc anomaly. White to gray flow-banded rhyolitic welded limonitic biotite tuff.	The rock sample contained no significant concentrations 2/; the placer sample contained no gold.
9	45	Zinc anomaly. Red, sandy, fine- to medium-grained tuff.	The rock sample contained no significant concentrations 2/.

APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV--Continued

Mineralized site (fig. 2)	Sample no. (fig. 2)	Description 1/	Sample analyses 2,3/
10	43, 44	Tungsten anomaly. A red, sandy, fine- to medium-grained tuff, with about 30% rounded basalt granules, and a porphyritic vesicular limonite-stained basalt.	Two rock samples contained no significant concentrations 2/.
11 *	40-42, 46	Zinc anomaly. Basalt and pyroclastic rhyolite crop out.	Four placer samples contained $0.01, $0.005, $0.02 and $0.0 gold per cu yd 3/.
12	47	Pozzolan-bearing material. Occurrence of silty, sandy, white to brown horizontal lake deposits cover at least 212 acres. Contains about 40% diatoms.	The pozzolan sample had a specific gravity of 2.26, a water requirement of 112, and a compressive strength (cement/pozzolan blend) of 3,920 lb per sq in.
13	48-50, 54-57	Tungsten and mercury anomalies. Sample 48 was argillized limonitic rhyolite dike; 49 was gray to green volcanic breccia; 54 through 57 were a basalt porphyry dike, strike N. 40° E., dip 85° NW., and contact zones. The basalt dike has 0.04-ft feldspar laths, some scoria, abundant magnetite, light limonite stains and chilled margins.	None of six rock samples contained significant concentrations 2/. The placer sample (no. 50) contained $0.02 gold per cu yd 3/.

APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV--Continued

Mineralized site (fig. 2)	Sample no. (fig. 2)	Description 1/	Sample analyses 2,3/
14	51-53, 39	Copper/nickel anomaly. A porphyritic basalt dike strikes N. 10° W., dips 90° and cuts basalt flows; contacts are glassy and locally limonitic; local sheet jointing.	None of the three rock samples contained significant concentrations 2/; the placer sample contained no gold.
15	58, 59	Tufa deposit. Green to gray volcanic breccia.	A rock sample contained no significant concentrations 2/, and a placer sample, 59, contained 0.005 gold per cu yd 3/.
16	60	Zinc anomaly. A basalt dike cuts a basalt flow breccia	The rock sample contained no significant concentrations 2/.

APPENDIX A.--Mining claims and mineralized sites in or near the Twin Peaks study area, Lassen County, CA and Washoe County, NV--Continued

Mineralized site (fig. 2)	Sample no. (fig. 2)	Description 1/	Sample analyses 2,3/
17*	61-68	Pozzolan-bearing material. Occurrences of white to brown, fissile to blocky, bedded, pumiceous, silty, sandy lake beds crop out over at least 360 acres. A pumiceous, glass-shard rich zone has radioactivity of 70-90 cps 1/. Pozzolanic material crops out in the study area over a length of about 16,000 ft, a width of about 600 ft, and through a depth of 50 ft. At least 30 million tons of pozzolan, based on one sample analysis, is inferred (U.S. Bureau of Mines and U.S. Geological Survey, 1980, p. 2).	Eight rock samples. A 28.5-ft-long section had a specific gravity of 2.42, a water requirement of 109, and a compressive strength (cement/pozzolan blend) of 4540 lb per sq in.

1/ A geometrics model GR-101A scintillometer was used for radiometry in the field; no endorsement intended.
2/ "No significant concentrations" means analytical contents too low for the material to be mined economically in the forseeable future.
3/ Gold value $400 per troy oz. Placer gold assumed 1000 fine. Gravel assumed to expand 25 percent on excavation.

APPENDIX B.--ROCK SAMPLE ANALYTICAL RESULTS, METALLIC ELEMENTS

APPENDIX B.--Rock sample analytical results, metallic elements

[N, none detected; --, not analyzed; NA, not applicable; ppm, parts per million; *, wholly or partly outside study area]

Sample no. (fig. 2)	Sample Type	Sample Length (feet)	Sample Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
1	Grab	NA	Red soil along basalt dike----------------------	N	N	--	--	--
2	Chip	14.0	Gray to green basalt dike strikes N. 30° W., dips 90°; 0.03-ft feldspar phenocrysts and a few scoria zones----------------------------	N	N	--	--	--
3	Chip	11.0	Similar to dike at site 2; sheet jointing trends N. 27° W., dips 62° SW-----------------	N	N	--	--	--
4	Grab	NA	Petrographic sample of gray porphyritic mafic volcanic rock; 80% to 90% feldspar laths are aligned--	--	--	--	--	--
5	Grab	NA	Yellow to red subvitreous siliceous rock; earthy yellow-weathering, some black staining, and shearing----------------------------------	0.075	N	47	31	200
6	Chip	0.7	Pale yellow to gray argillic volcanic breccia with some rounded fragments-------------------	N	N	70	N	75
7	do--	2.3	Gray to blue or purple argillic volcanic breccia--	N	N	130	N	92
8	do--	2.0	do--	N	N	130	N	200

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample								
Sample no. (fig. 2)	Type	Length (feet)	Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
9	Chip	6.0	Yellow and gray argillic, weathered volcanic breccia--	N	N	74	N	75
10	do--	2.9	White to gray, blocky, argillic volcanic flow--	N	N	32	N	87
11	do--	1.5	Same as 10; intense kaolinitization-----------	N	N	36	N	180
12	do--	6.0	do---	N	N	70	N	83
13	Grab	NA	White, blocky, clay-rich volcanic breccia------	--	--	--	--	--
14	Chip	7.0	White to gray, blocky, argillic volcanic breccia; intense kaolinitization-------------	N	N	70	N	100
15	Grab	NA	Brown vesicular basalt; colluvial fragments----	N	0.370	43	N	130
16	Chip	28.0	Basalt dike trends N. 20° W., dip 85° SW.; 10% feldspar phenocrysts, and possible trace pyrite or magnetite--------------------	N	N	52	13	13
17	do--	4.0	Yellow to brown argillic volcanic breccia------	N	N	13	N	87
18 *	do--	11.0	Coarse gray to green gabbroic dike trends N. 5° to 10° E., dip 90°; 60 cps 1/ compared to 10 to 30 cps in red, volcaniclastic country rocks-----------------	N	N	50	N	92

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample no. (fig. 2)	Type	Length (feet)	Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
19 *	Chip	6.0	Basaltic to andesitic argillic pyroclastic rocks, possibly water-lain; cut by small volcanic dikes or joint-controlled rocks that weather to 5-ft-thick ridges------------	N	N	45	N	130
20 *	do--	3.0	do---	N	N	42	N	130
21 *	do--	3.5	Coarse gray to green gabbro dike trends N. 5° to 10° E., dip 90°; 60 cps 1/ compared to 10 to 30 cps in red, volcaniclastic country rocks---------------------------------	N	N	50	N	110
22 *	do--	4.0	do---	N	N	54	N	130
23 *	Grab	NA	do (petrographic sample)----------------------	--	--	--	--	--
24 *	Chip	1.0	Yellow to gray porous blocky pumiceous pyroclastic rocks---------------------------	N	N	13	N	120
25	Grab	NA	Red, blocky, pyroclastic rocks----------------	N	N	16	N	94
26	Chip	4.5	Gray banded pyroclastic rhyolite with coarse biotite(?), plagioclase grains, and 8% clinoptilolite-------------------------------	N	N	46	N	92

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample no. (fig. 2)	Type	Length (feet)	Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
27	Grab	NA	Gray massive, fine- to medium-grained rhyolite; phenocrysts up to 0.02 ft----------	N	N	N	N	83
28 *	Grab	NA	Red-weathering contact zone between andesite dike and a pyroclastic flow, trends N. 37° W., dips 90°; partly sheared, about 5% clinoptilolite-------------------------------	N	N	N	N	110
29	Grab	NA	White to yellow tuffaceous pyroclastic flow.	N	0.380	N	N	120
32	Chip	28.0	Yellow to gray, vitreous to fine-grained welded rhyolite tuff; silicified with jasper, limonite, and slickensides; contains 18 ppm molybdenum and no detectable nickel or tungsten------------------------	N	N	N	26	90
33	do--	4.0	Vuggy, yellow to gray partly devitrified welded rhyolite tuff beneath no. 32; vuggy, minor biotite and limonite; contains 24 ppm molybdenum and no detectable mercury or nickel----------------------------------	N	N	N	32	94
34	do--	23.0	Yellow to gray vitreous to fine-grained welded rhyolite tuff; minor limonite stains; contains 16 ppm molybdenum and no detectable mercury or nickel-------------------------	N	N	N	20	76

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample no. (fig. 2)	Type	Length (feet)	Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
35	Chip	8.0	Brown to gray, partly devitrified welded rhyolite tuff; minor biotite(?) and limonite stains. Contains 25 ppm molybdenum and no detectable nickel or tungsten----------------	N	N	N	33	100
36	Grab	NA	Brecciated black vitrophyre at base of silicic rhyolite flow. Contains 18 ppm molybdenum and no detectable nickel or tungsten----------	N	N	N	20	81
38	Chip	9.0	White to gray welded rhyolite tuff; 5% to 10% biotite or ilmenite phenocrysts, rough and vuggy with minor limonite stains; strike N. 65° W., dip 5° NE; joints trend N. 40° E., dip 90°; contains 34 ppm nickel and no detectable tungsten-------------------	N	N	N	16	70
43	do--	2.0	Red, sandy, fine- to medium-grained tuff; 30% well-rounded, fine-pebble-sized fragments; contains 34 ppm nickel and no detectable tungsten-------------------------	N	N	78	N	120
44	do--	8.0	Gray to black basalt; 10% to 20% feldspar phenocrysts, some vesicular zones and limonite stains; contains 11 ppm nickel and no detectable tungsten-----------------------	N	N	99	14	140
45	Grab	NA	Red, sandy, fine- to medium-grained tuff. Contains 9.1 ppm nickel and no detectable tungsten--------------------------------------	N	N	80	21	130

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample no. (fig. 2)	Sample: Type	Sample: Length (feet)	Sample: Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
48	Chip	10.0	Rhyolite dike; partly argillic, slightly sheared and limonitic; trends N. 60° W.; contains no detectable nickel or tungsten-----	N	N	6.1	27	14
49	Grab	NA	Gray to green volcanic flows; fragments (some rounded) average 0.06-ft-long; contains 3.1 ppm nickel and no detectable mercury or tungsten--------------------------	N	N	19	19	120
51	Chip	4.0	Gray basalt dike; 20% feldspar laths to 0.8-ft-long; trends N. 10° W., dips 90°; contains 17 ppm nickel and no detectable tungsten--	N	N	57	17	130
52	do--	19.0	Gray porphyritic rhyolite dike; local irregular sheet jointing; contains 16 ppm nickel and no detectable tungsten------------	N	N	60	15	130
53	do--	2.5	Gray basalt dike; 20% feldspar laths to 0.8-ft-long; trends N. 10° W., dips 90°; contains 16 ppm nickel and no detectable tungsten--	N	N	57	17	130
54	do--	6.0	Basalt dike; abundant magnetite and some scoria and glass; 20% phenocrysts of dark feldspar to 0.04-ft-long; traces of limonite stain; contains 29 ppm nickel, no detectable mercury or tungsten--------------------------	N	N	90	16	130

APPENDIX B.--Rock sample analytical results, metallic elements--Continued

Sample no. (fig. 2)	Type	Length (feet)	Description	Gold (ppm)	Silver (ppm)	Copper (ppm)	Lead (ppm)	Zinc (ppm)
55	Grab	NA	Yellow to brown, argillic contact zone of dike (sample no. 54); contains 15 ppm nickel, no detectable mercury or tungsten-------------	N	N	55	18	140
56	do--	NA	Black scoriaceous contact zone of dike (sample no. 54) contains 16 ppm nickel, no detectable mercury or tungsten----------------	N	N	160	14	150
57	do--	NA	Black chilled contact of dike (sample no. 54); partly glass, and partly granular; 20% feldspar laths to 0.04-ft-long----------------	N	N	180	13	150
58	Chip	8.0	Green to gray volcanic breccia at spring-------	N	N	21	N	100
60	do--	4.0	Basalt dike adjacent to flow breccia; contains 4.6 ppm nickel----------------------	N	N	N	19	99
71	do--	8.5	Vesicular basalt strikes N. 20° E., dips 5° NW. Minor feldspar and zeolite amygdules; no detectable mercury, 19 ppm molybdenum, and 86 ppm nickel-----------------------------	N	N	79	N	120

1/ A Geometrics model GR-101A scintillometer was used for radiometry in the field; no endorsement intended.

APPENDIX C.--ROCK SAMPLE ANALYTICAL RESULTS, POZZOLAN

APPENDIX C.--Rock sample analytical results, pozzolan

(Astrisk (*), wholly or partly outside study area boundary)

[--, not determined; <, less than]

Sample				Analysis 2/											
Sample no. (fig. 2)	Type	Length (feet)	Description 1/	Al_2O_3 (%)	CaO (%)	Fe_2O_3 (%)	K_2O (%)	MgO (%)	MnO (%)	Na_2O (%)	SO_3 (%)	P_2O_5 (%)	SiO_2 (%)	TiO_2 (%)	L.O.I. (%)
47 *	Chip	11.6	White, fissile, silty sand with some tuff------------------------------------	13.8	3.5	4.5	4.1	1.6	0.12	1.8	3.52	0.2	65.6	0.57	6.63
61	do--	1.25	White to brown silty sand with possible tuff------------------------------------	13.3	3.4	6.0	1.7	1.5	.039	2.6	.01	.23	53.5	.87	15.10
62	do--	1.0	White, friable lake sediments------------	13.8	3.7	4.9	3.8	1.9	.1	2.0	--	.19	65.3	.61	5.80
63 *	do--	17.0	Gray to green fine-grained laminose shale.	19.9	3.5	8.7	1.8	1.4	.13	1.5	--	.28	54.0	1.2	9.95
64	do--	2.7	White, pumiceous lake sediments----------	13.7	3.4	4.2	5.0	1.6	.09	2.0	--	.15	67.5	.55	6.63
65	do--	2.7	do--------------------------------------	13.6	3.2	4.2	4.8	1.6	.089	2.0	--	.17	68.1	.55	6.43
66	do--	3.3	Pumiceous lake sediments; 70-90 cps------	12.2	1.2	2.4	9.2	.29	.046	1.7	--	.029	73.7	.29	5.64
67	do--	.7	Glassy, pumiceous sediments--------------	11.8	.73	2.1	9.7	.14	.044	1.8	--	<.01	72.0	.26	4.92
68	do--	5.0	White to gray, partly pumiceous, laminated friable lake sediments--------	13.9	3.4	4.6	4.7	1.7	.1	2.0	--	.18	66.0	.58	6.66

1/ A Geometrics model GR-101A scintillometer was used for radiometry in the field; no endorsement intended
2/ H_2O not determined; SO_3 not determined except for 47 and 61.

APPENDIX D.--Placer sample analytical results, gold

APPENDIX D.--Placer sample analytical results, gold

[Astrisk (*), wholly or partly outside study area boundary]

Sample				Estimated $ cubic yard 1/
No. (fig. 2)	Type	Size (ft^3)	Description	
30 *	Pan	0.2	Recent gravel composed mainly of subrounded volcanic sand, cobbles, and pebbles; bright and angular flour gold (0.01-0.05 mm)----------	0.04
31	do--	.2	Same as sample no. 30; bright, flat flour gold flake (0.01-0.05 mm)----	.02
37	do--	.3	Recent gravel containing no gold----	0.0
39	do--	.23	Sand on rough, volcanic breccia bedrock in intermittent stream channel; no gold------------------	0.0
40	do--	.27	Recent gravel under boulder; bright and subangular flour gold (0.01-0.05 mm)--------------------------	.01
41	do--	.3	Sandy pebbly bench gravel; bright and subangular flour gold (0.01-0.05 mm)--------------------------	.005
42	do--	.2	Recent gravel containing bright, subangular flour gold (0.01-0.05 mm)	.02
46 *	do--	.325	Recent gravel on silty bar containing no gold----------------------------	0.0
50	do--	.2	Recent gravel composed mainly of basalt sand and pebbles; bright and angular flour gold (0.01-0.05 mm)-------------------------------	.02
59	do--	.3	Recent silt, pebbles, and cobbles from low bench; bright, subrounded to rounded flour gold (0.01-0.05 mm)	.005
69	do--	.1	Fine granular gravel; no gold-------	0.0
70 *	do--	.1	Same; gold bright, subangular flour gold (0.01-0.05 mm)----------------	.01

APPENDIX D.--Placer sample analytical results, gold--Continued

Sample				Estimated $ cubic yard 1/
No. (fig. 2)	Type	Size (ft^3)	Description	
72	Placer	0.1	Organic rich silty sand; no gold----	0.0
73	do--	.25	Recent silt, sand, and cobbles; bright, subangular flour gold (0.01-0.05 mm)--------------------	.01
74	do--	.25	Recent limonitic silt and sand from beneath a boulder contained bright, subrounded flour gold (0.01-0.05 mm)	.01

1/ Gold assumed 1000 fine, gravel volume assumed to expand 25 percent on excavation, and gold price about $400 per troy ounce.