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Reconnaissance Study of Coso Volcanic Field, California, and Pickel Meadow, California

by

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SEPTEMBER 1988

**NAVAL WEAPONS CENTER
CHINA LAKE, CA 93555-6001**



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Naval Weapons Center

FOREWORD

This report documents a geochemical and geophysical reconnaissance study performed by the U.S. Geological Survey for the Naval Weapons Center (NWC) in a continuing attempt to better define the potential for geothermal energy development in two areas: the Coso Volcanic Field on NWC land, and the area surrounding the Marine Corps Mountain Warfare Training Center, Pickel Meadow, California. Three LANDSAT color photographs show the distribution of lithologies and vegetation in the Coso Volcanic Field and environs.

The work was performed from May through December 1986 by the Branch of Geochemistry and the Branch of Geophysics, U.S. Geological Survey, Denver, under contract N68305-86-WR-60041. Special appreciation is due to Margaret Hinkle and Susan Erickson for analytical support. This report is being published by NWC so that the information will be part of the permanent record of the Department of Defense. Any use of trade names is for descriptive purposes only and does not imply endorsement by either the U.S. Geological Survey or NWC.

The report was reviewed for technical accuracy by Carl F. Austin and Jim Whelan.

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<p>(U) The Coso Volcanic Field, California, and the Caldera at Bridgeport, California, of which Pickel Meadow is a part, have great potential for geothermal energy and associated byproduct metals development. This report documents a geochemical and geophysical reconnaissance study performed in 1986 to help determine the extent of those potentials.</p> <p>(U) Samples of soils, rocks, and soil gases were analyzed for minor and trace elements by semi-quantitative spectroscopy and by atomic-absorption spectroscopy. Anomalous element values can be useful in characterizing the geothermal production areas. (Continued)</p>			
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19 ABSTRACT (Cont.)

(U) LANDSAT Multispectral Scanner data enabled us to create spectral maps in the form of color photographs that represent the Coso Volcanic Field and environs. These maps revealed a major circular structure bounding areas of relatively recent volcanic activity. This structure warrants further investigation.

(U) Anomalous soil-gas values for helium, carbon dioxide, and radon in the Coso Volcanic Field invite further investigation. At Pickel Meadow, anomalies of soil gases and of volatile elements in soils were found. Further studies should be undertaken to determine the areal extent and causes of these anomalies.

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INTRODUCTION

This report documents a geochemical and geophysical reconnaissance study performed in 1986 by the U.S. Geological Survey for the Naval Weapons Center. The study was conducted in a continuing effort to better define the potential for geothermal energy and associated byproduct metals development in two areas:

1. The Coso Volcanic Field, including the surface at and adjacent to the Jim Moore and Condy breccia pipes
2. The area surrounding the Marine Corps Mountain Warfare Training Center, Pickel Meadow, California

The reconnaissance study focused principally on the Coso region because of the previously confirmed potential for geothermal energy there. A smaller reconnaissance study was performed at Pickel Meadow. The program at both sites included field mapping and interpretation, geochemical sampling of various media, and chemical analyses and interpretation. The chemical analyses and interpretation included analyses of soil gases, stable-isotope analyses of geothermal gases and thermal waters, and analyses of heavy-mineral concentrates and selected elements in soils. For the Coso region, a LANDSAT study and interpretation were also conducted. Three LANDSAT color photographs show the distribution of lithologies and vegetation in the Coso Volcanic Field and environs.

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Section 1
Geochemical Studies at the Coso Volcanic Field on the
Naval Weapons Center, California

INTRODUCTION

The Naval Weapons Center (NWC) includes within its boundaries the Coso Volcanic Field, an area of recent volcanism and high geothermal potential (Figure 1-1). The Navy, through the Geothermal Program Office at NWC, has an active research program aimed toward a more comprehensive understanding of volcanic processes at Coso and toward delineating areas within the volcanic field that have high potential for geothermal energy and byproduct metals exploitation.

Austin and Durbin (1985) proposed, on the basis of an aerial-photograph interpretation, the existence of two breccia pipes informally termed the Jim Moore and Condy pipes. If these structures exist, they may define important targets in the expanding geothermal energy program at Coso. We studied these areas further, using field mapping and geochemical reconnaissance to evaluate these structures and other features on the geothermal resource at Coso.

Individual sample traverses were conducted over the Jim Moore and Condy pipes, the Wheeler Prospect, and Parcel 20 (Figure 1-2). This geochemical program was designed to broadly evaluate the presence or absence of anomalous element values that might, with further detailed studies, be useful in characterizing the geothermal production areas and the potential for metallic byproducts. Analyses disclosed numerous mercury (Hg) anomalies (Figure 1-3). Notably high concentrations are present at Devils Kitchen; at the Wheeler Prospect, which historically has been worked for Hg; and at the northern end of the arcuate structure that encloses the Condy structure. In addition, localized antimony (Sb) and arsenic (As) anomalies, especially at the Wheeler Prospect, and scattered traces of silver (Ag) and gold (Au) were noted.

Mapping at a scale of approximately 1:10,000 in areas not covered by unconsolidated pyroclastics was done in conjunction with sampling soils, rocks, and soil gases. The soils and rocks were analyzed for minor and trace elements by semi-quantitative spectroscopy and by atomic-absorption spectroscopy. Interstitial helium (He) and carbon dioxide (CO₂) in soils at 1-meter depth were collected by hollow probe and analyzed by mass spectroscopy. Some in situ radon (Rn) measurements were also taken.

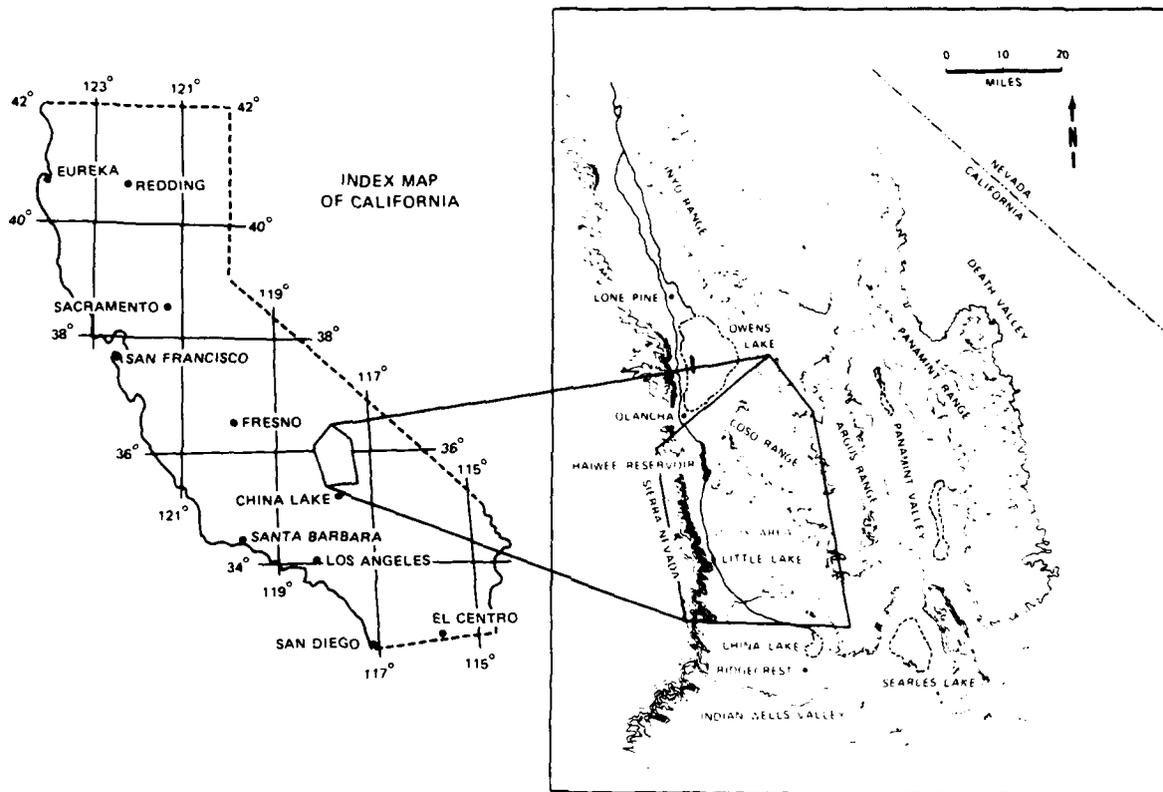
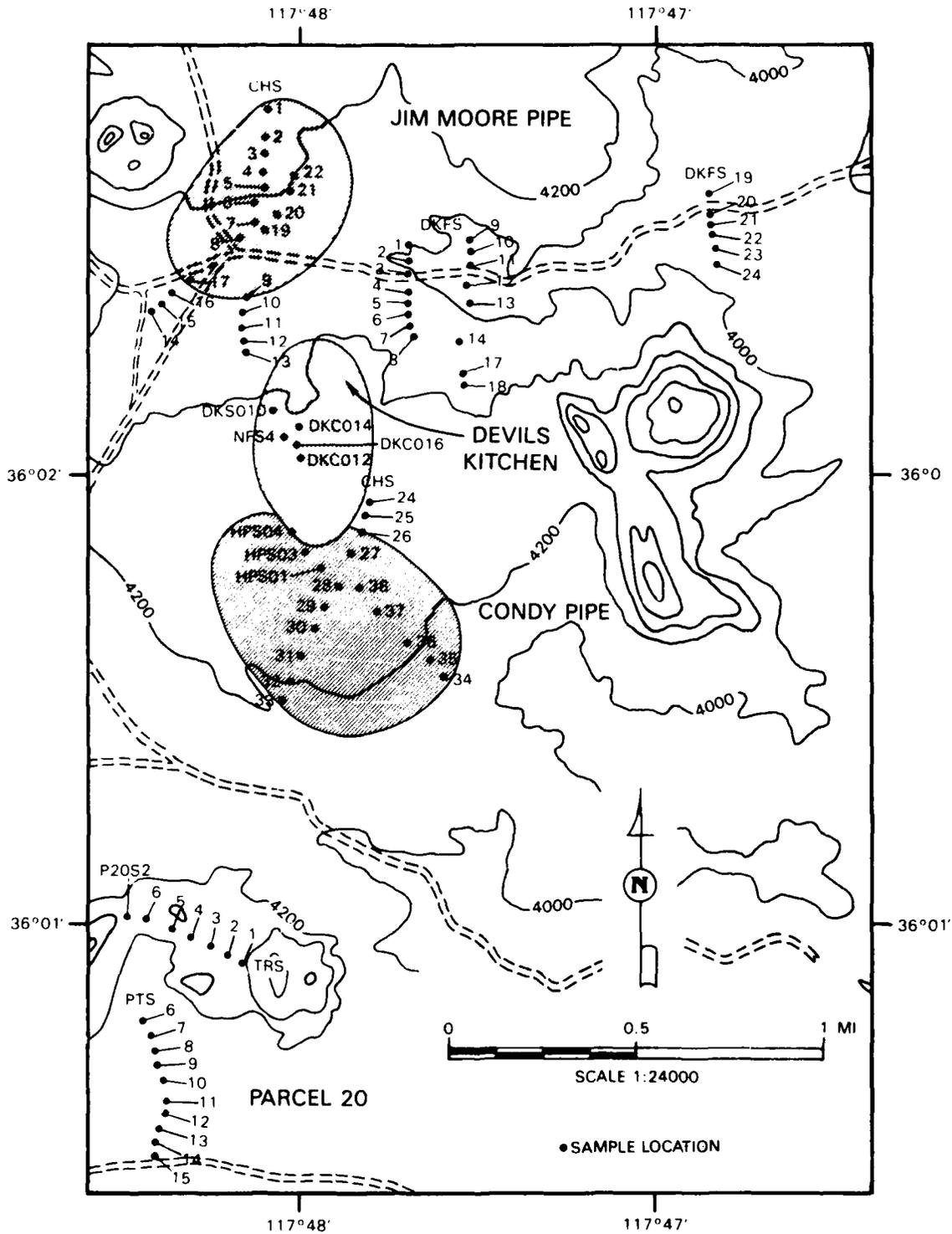
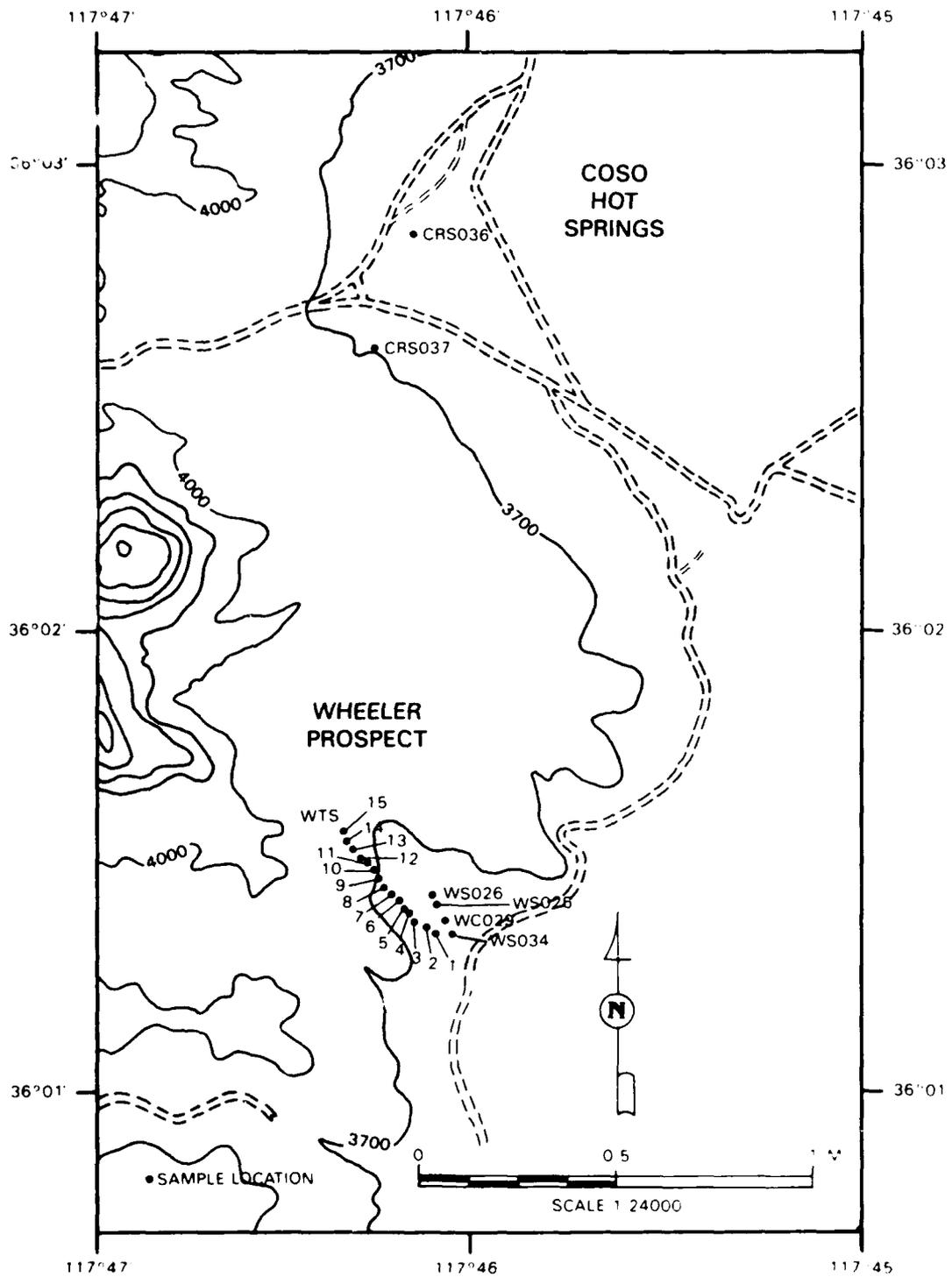


FIGURE 1-1. Location Map of Coso Volcanic Field.



(a) Western region. Shaded areas show approximate extent of the geologic features named.

FIGURE 1-2. Soil Sample Locations in Coso Volcanic Field.



(b) Eastern region.
FIGURE 1-2. (Contd.)

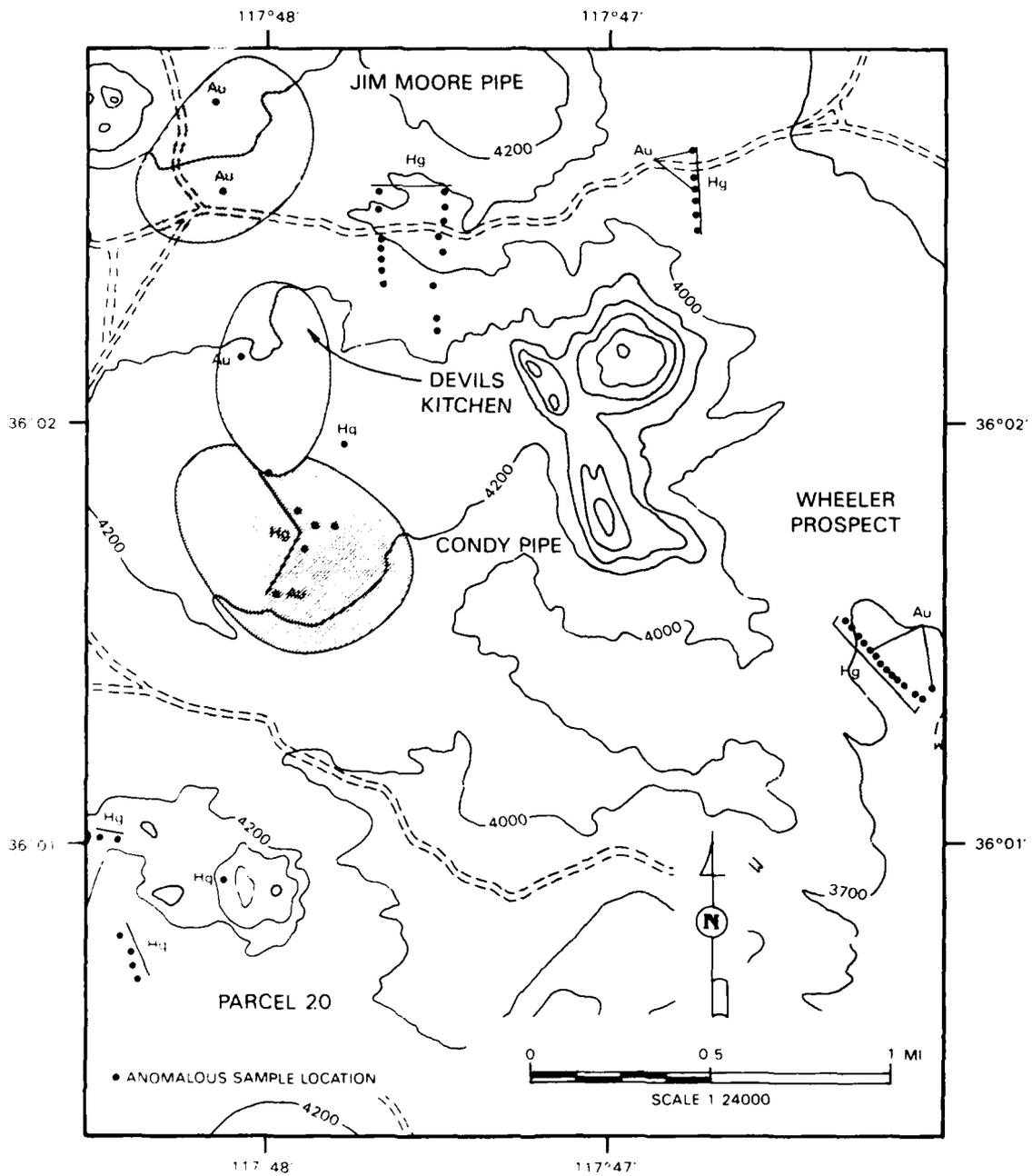


FIGURE 1-3. Locations of Anomalous Amounts of Gold and Mercury in Soil Samples. Shaded areas show approximate extent of the geologic features named.

JIM MOORE AND CONDY PIPES**GEOLOGY**

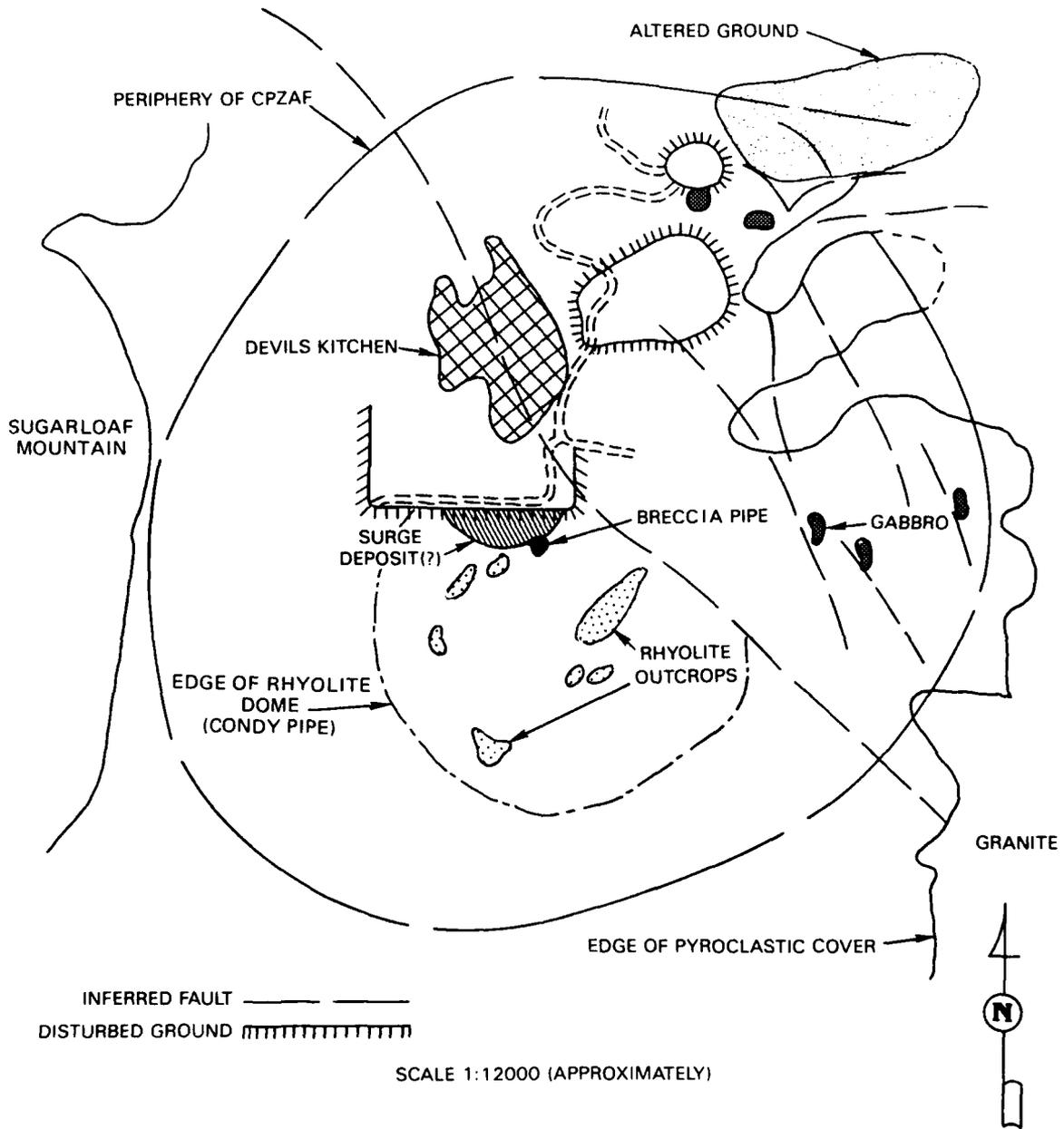
Detailed mapping in the area of the two pipes is shown in Figure 1-4. Mapping in the vicinity of the Condy pipe (as defined by Austin and Durbin, 1985) revealed the circular structure prominent on aerial photographs as a rhyolite dome and an associated apron of explosion breccia. The debris-ring summit appears on the geologic map of Duffield and Bacon (1981), and the pyroclastic apron is composed of unconsolidated ash and pumice lapilli to a thickness of 10 meters. The dome itself is best exposed along two northeast-southwest ridges flanking a central shallow depression representing an erosionally breached crater. The rhyolite varies from phenocryst-poor glass to phenocryst-rich vitrophyre intermingled with devitrified patches. Massive rhyolite zones are separated by thin zones of vesiculated rock throughout which vapor-phase minerals have precipitated.

Within the dome, magma mixing prior to extrusion is indicated by the internal ductile flow structure of basaltic xenoliths, suggesting that the two magmas were hot enough to physically mix without losing their integrity; i.e., the basaltic magma probably cooled quickly to the solidus temperature upon mixing with rhyolite magma. However, the rhyolite also includes small angular and sharply defined fragments of basalt that represent cold xenoliths incorporated within the rhyolite magma during ascent.

Near the northern boundary of the dome, a small post-dome breccia pipe about 20 meters in diameter is exposed. The breccia clasts include angular rhyolite identical to the dome and fragments of crystalline basement (granite and diorite) set in a matrix of comminuted and altered rhyolite. Adjacent to and north of the breccia pipe is a 200-meter linear outcrop of poorly consolidated breccia composed of angular to rounded clasts. This deposit may represent a detached base surge associated with the pipe. The northern end of this deposit is obscured by a drill pad, but needs further examination for us to more clearly understand its origin.

Thus, the circular feature called the Condy pipe is an eroded, highly fractured rhyolite dome. However, it lies within a larger arcuate structure approximately 2 kilometers in diameter, as shown in Figure 1-4. The rhyolite dome and the main shallow production area of the Coso Volcanic Field are roughly in the center of this structure, which is located eastward of a series of coalesced rhyolite domes collectively known as Sugarloaf Mountain. Herein, this feature is informally termed the Coso Production Zone Arcuate Feature (CPZAF).

Numerous curved faults occur along the northeast margin of the CPZAF and can clearly be seen on aerial photographs and multispectral satellite composite photographs (see Section 2 of this report). More detailed mapping is required to understand the relation of these faults to the overall arcuate structure, but the faults probably developed in response to a regional inflation of this area. The cause of the doming is presently unknown but may reflect the presence of an upper crustal magma body. The existence of such a body is generally accepted as the heat source for the thermal waters currently being exploited. If correct, then the CPZAF may be considered a manifestation of local resurgence of a much larger system such as the large Coso volcanic feature proposed by Austin and Durbin (1985), or, alternatively, the CPZAF may be a small caldera in its own right.



(a) Geology of proposed CPZAF.
FIGURE 1-4. Portion of Coso Volcanic Field Showing
Coso Production Zone Arcuate Feature (CPZAF).



(b) Delineated are the CPZAF, the Condry pipe, and one of the few perlite domes at the Coso Volcanic Field with an open crater.

FIGURE 1-4. (Contd.)

Associated with the northwestern faults are numerous small, irregular intrusives and dikes (Figure 1-4a). Lithologically, these rocks are distinctly bimodal, consisting of a suite of coarse gabbros cut by aphanitic felsite dikes. The intrusives can be mapped outside of the CPZAF where they cut basement granites and diorites and are clearly aligned along fault traces. Within the CPZAF, unconsolidated ash covers and obscures the intrusive contacts, but we can infer that these small bodies intrude along the arcuate fault system. The genetic relations between the intrusives and the Coso igneous geothermal system is unknown but warrants further study.

GEOCHEMISTRY

Soil Gases

Samples were collected and analyzed for helium (He), carbon dioxide (CO₂) and mercury (Hg). These elements are commonly found in anomalously high concentrations in geothermal areas with high permeability caused by fracturing, faulting, and permeable breccia pipes; the elements are found in anomalously low concentrations where permeability is reduced because of intense alteration. Previous Hg and radon (Rn) surveys were conducted by California Energy Corp. (CEC), Santa Rosa, Calif.

Samples collected over the Jim Moore pipe show interstitial CO₂ values from 0.1 to 4.5% compared to the ambient-air concentration of 0.03% (Table 1-1). The five highest values occur within the boundary of the structure delineated in Austin and Durbin (1985). The He values also are above ambient-air concentrations but do not correlate with high CO₂ values. The He values are constant across and beyond the Jim Moore pipe, suggesting that the overall background values for He in this area are higher than ambient air but are unrelated to specific zones of He leakage to the surface.

Samples collected over the Condy pipe had a narrower range of CO₂ values, from 0.1 to 3.6% (Table 1-2). All elevated values fall within the boundaries of the structure shown in Austin and Durbin (1985). As with the Jim Moore pipe, the He values are above ambient-air concentrations but are not anomalous. The He values do not correlate with CO₂ concentrations.

TABLE 1-1. Helium and Carbon Dioxide Values in Soils, Jim Moore Pipe.

Sample location ^a	He, ppm	CO ₂ , %	Sample location ^a	He, ppm	CO ₂ , %
CHS-1	1.3	1.1	CHS-12	1.4	1.3
CHS-2	1.2	0.7	CHS-13	1.0	0.9
CHS-3	1.4	1.6	CHS-14	1.5	3.9
CHS-4	1.9	0.1	CHS-15	1.3	0.6
CHS-5	1.2	2.3	CHS-19	1.7	3.3
CHS-6	1.1	1.2	CHS-20	1.3	0.5
CHS-7	1.2	No data	CHS-21	2.1	0.8
CHS-8	1.1	4.5	CHS-22	1.6	0.2
CHS-10	0.9	3.6	CHS-23	1.5	1.6
CHS-11	1.4	1.0			

^a Sample locations are shown in Figure 1-2.

**TABLE 1-2. Helium and Carbon Dioxide Values in Soils,
Condy Pipe.**

Sample location ^a	He, ppm	CO ₂ , %	Sample location ^a	He, ppm	CO ₂ , %
CHS-24	1.3	0.3	CHS-32	1.2	1.5
CHS-25	1.4	2.3	CHS-33	1.6	0.4
CHS-26	1.4	1.2	CHS-34	2.0	1.4
CHS-27	1.6	1.7	CHS-35	1.6	No data
CHS-28	1.5	1.4	CHS-36	1.9	3.6
CHS-29	1.1	1.4	CHS-37	1.5	1.8
CHS-30	2.1	1.0	CHS-38	1.9	No data
CHS-31	1.4	No data			

^a Sample locations are shown in Figure 1-2.

Soils and Rocks

Geochemical studies of soils and rocks were undertaken to determine the trace-element signature or characteristics of the rhyolite domes in the Coso Volcanic Field; to establish if, and to what extent, volcanic rocks varied in composition according to relative age; and to target areas of possible high geothermal potential. The database established is presented in Appendix A.

Although more data need to be collected, some preliminary observations can be made. Despite the presence of localized traces of gold (Au), silver (Ag), and molybdenum (Mo), little difference in chemical composition was noted in perlites collected throughout the field (Figure 1-5 and Appendix Tables A2-1 through A2-3). These particular rocks are characterized by extremely low concentrations of iron (Fe), magnesium (Mg), calcium (Ca), and titanium (Ti), and are uniformly enriched in beryllium (Be) and tin (Sn).

RECOMMENDATIONS

Detailed mapping of the entire CPZAF should be undertaken to ascertain various structural elements of this potentially important feature. Attention should be given to the rhyolite and gabbro plugs on the eastern side of this structure, with particular emphasis on their chemistry and petrology. A detailed geochemical survey should be run across the arcuate faults and suspected faults around the perimeter of the structure. Further detailed geochemical surveys should be performed in those areas showing distinct Hg anomalies. An additional soil-gas survey would be helpful in confirming and expanding upon the preliminary findings that anomalous gas concentrations can be detected over this structure and appear to be structurally controlled.

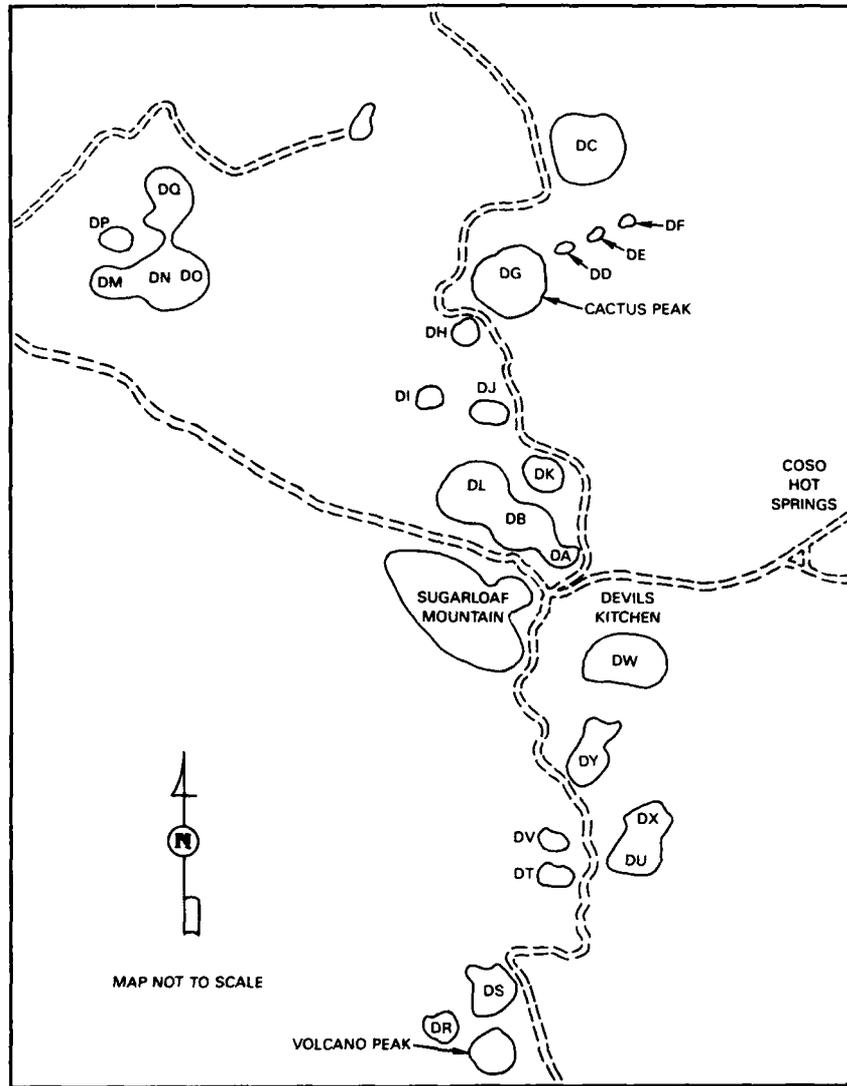


FIGURE 1-5. Young Perlite Domes and Soil Sample Locations.

WHEELER PROSPECT

GEOLOGY

The Wheeler Prospect is approximately 2 miles southeast of Devils Kitchen. The prospect is a 20- by 35-meter pit, situated within old hot-springs deposits consisting of opalized terraces and altered ground. The area was originally prospected for mercury, and traces of cinnabar are readily observed at the surface. Hot ground up to 90°C and minor fumerole activity continue around the pit. The expulsion of hot steam has resulted in argillic alteration, primarily to kaolinite, of the rock around the vents. The area is also mentioned as a gold prospect in early literature, but no record of production exists according to Austin and Durbin (1985).

Brecciated rhyolite plugs, rhyolite dikes, silicified rhyolite, and a diorite plug localized at a fracture intersection all occur within the local vicinity of the prospect (Figure 1-6). These features all represent ongoing volcanic processes and should be studied in more detail.

GEOCHEMISTRY

The Wheeler Prospect was selected for study on the basis of geologic and geothermal associations. Austin and Durbin (1985) identified the fault intersection immediately northwest of the prospect as a possible location for future geothermal drilling. A sample traverse was selected to cross some of the major faults in the area. Rocks and soils were collected from 34 sites and analyzed for a suite of trace elements, and soil gases were analyzed for carbon dioxide (CO₂), helium (He), and radon (Rn) (Table 1-3). The locations for the soil and soil-gas samples are identical (WTS sites, Figure 1-2).

Helium

The He values range from 0.9 to 1.5 ppm. Background He samples measured at a distance from the prospect vary from 0.9 to 1.1 ppm. Thus, most measured values are only marginally above local background. The highest value of 1.5 ppm at site WTS-8 is at the intersection of two faults to the northwest of the pit area. Slightly elevated values occur within or at the edge of the prospect area at sites WTS-3 and WTS-5, and immediately below the fumerole areas at site WTS-1. However, none of these values are remarkably above those in the background samples, and it seems doubtful if large quantities of He are leaking along structures in this region.

Carbon Dioxide

CO₂ values range from 0 to 2.5%. The highest value at site WTS-12 is located on an east-northeast trending fault to the northwest of the prospect. Other high values at sites WTS-1, WTS-3, and WTS-8 are located either in a wash south of the prospect or in a zone of high fracture density. The CO₂ values do not correlate with the higher He values, but it does appear that CO₂ above background concentrations can be correlated with faults in this area.

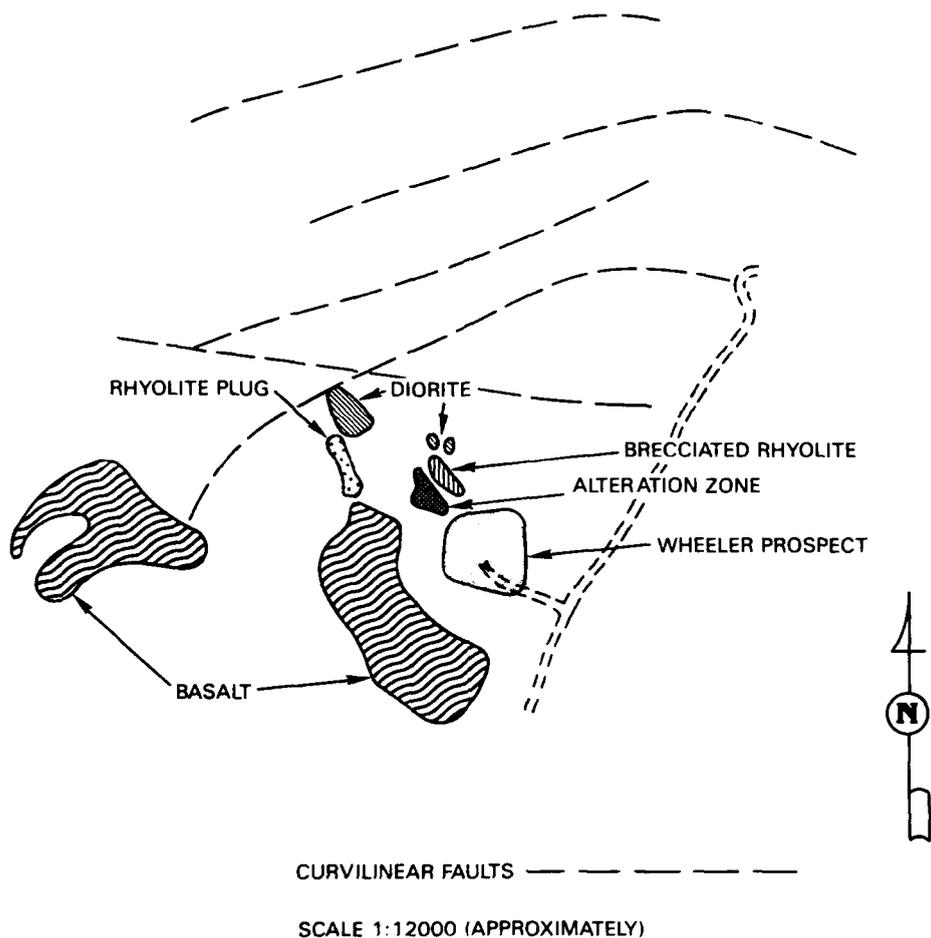


FIGURE 1-6. Generalized Geology in the Area of the Wheeler Prospect.

TABLE 1-3. Helium, Carbon Dioxide, and Radon Values at Wheeler Prospect.

Sample location ^a	He, ppm ^b	CO ₂ , % ^c	Rn, cpm ^d	Sample location ^a	He, ppm ^b	CO ₂ , % ^c	Rn, cpm ^d
WTS-1	+1.4	+1.4	9	WTS-9	+1.3	<0.03	14
WTS-2	+1.1	<0.03	57	WTS-10	+0.9	<0.03	14
WTS-3	+1.1	+1.1	34	WTS-11	+1.2	<0.03	No data
WTS-4	+1.1	+0.89	24	WTS-12	+1.0	+2.5	74
WTS-5	+1.3	<0.03	14	WTS-13	+1.2	+1.3	44
WTS-6	+1.0	<0.03	19	WTS-14	+1.0	+0.10	59
WTS-7	+1.0	<0.03	22	WTS-15	+1.1	+0.13	No data
WTS-8	+1.5	+1.1	29				

^a Sample locations are shown in Figure 1-2.

^b He values are relative to ambient-air concentration of 5.24 parts per million (ppm).

^c CO₂ values are relative to ambient-air concentration of 0.03%.

^d cpm is counts per minute.

Radon

Radon was detected using a Pylon RM-1000 monitor-detector, in which the isotope Rn 222 is measured by scintillation detection of alpha particles emitted during radon disintegration. Measurements were made approximately 12 inches below the surface using a hollow probe inserted into the soil. Values varied from 9 to 71 cpm. Background values for local pyroclastic cover varied from 20 to 40 cpm. The highest value was recorded at site WTS-12, which is close to three faults northwest of the prospect. Other elevated values at sites WTS-13, WTS-14, and WTS-2 are found within the fumarole areas in regions of high fracture density. The Rn values are poorly correlated with CO₂.

RECOMMENDATIONS

The Wheeler Prospect is at the south end of the most interesting areas we investigated in the Coso Volcanic Field. The prospect area itself has had a complex intrusive and extrusive history requiring detailed mapping. The area to the north and west of the prospect, between the southern surface expression of a fault of the Coso Resort and the eastern limit of the CPZAF, should also be mapped in detail to establish the geologic relations between the Coso Resort system, the proposed arcuate structure, and the Wheeler area.

Our orientation study of soil gases suggests that CO₂ gas is venting mainly along faults in this area, the results for He and Rn being largely ambivalent. The He values are close to the local background, whereas a few anomalous Rn values may be associated with faults and fractures. Future soil-gas programs should therefore focus on locating anomalous concentrations of CO₂ and Rn.

PARCEL 20

The area referred to as Parcel 20 is approximately 2.5 kilometers south of Devils Kitchen. This area became a focus of attention after CEC drilled a deep hole with bottom temperatures close to 370°C.

GEOLOGY

The area is largely covered by unconsolidated silicic ash and pumice erupted from nearby rhyolite domes, but basement granite is exposed at the northeast corner. The area is bounded on the west by a young perlite dome displaying pristine morphology and a well-developed central crater. This is one of the few domes at Coso where the central eruptive vent remains preserved (Figure 1-4). The pyroclastic cover severely limits interpretation of the underlying geology. Two major lineations may be recognized from aerial photographs, and are probably fault scarps muted by a veneer of ash. It was on the basis of the presence of these lineations and of mercury (Hg) anomalies in soil samples that led to the drilling in this region.

GEOCHEMISTRY

Two sample traverses were designed to intersect the two lineations (see Figure 1-2). One traverse ran northwest-southeast, and a second ran north-south following the only road in the area. The northwest-southeast traverse (sample sites designated TRS) followed a ridge where the pyroclastic cover was presumed to be thinner, whereas the north-south traverse (sample sites designated PTS) crossed a section where the pyroclastic cover is relatively thick. Data from the samples are shown in Table 1-4.

TABLE 1-4. Helium and Carbon Dioxide Values in Soil Gases, Parcel 20.

Sample location ^a	He, ppm ^b	CO ₂ , % ^c
TRS-1	2.0	1.8
TRS-2	1.0	0.03
TRS-3	2.1	0.0
TRS-4	1.1	0.0
TRS-5	1.7	0.0
TRS-6	2.6	0.0
PTS-6	1.3	0.0
PTS-7	1.2	0.14
PTS-8	0.8	0.13
PTS-9	0.5	0.13
PTS-10	1.0	0.14
PTS-11	1.3	No data
PTS-12	0.6	0.26
PTS-13	0.6	0.30
PTS-14	0.5	0.18
PTS-15	1.3	No data

^a Sample locations are shown in Figure 1-2.

^b He values are relative to ambient air.

^c CO₂ values are relative to ambient air.

Values for He range from 0 to 2.6 ppm relative to ambient air. Background values vary from 0.2 to 1.1 ppm. As expected, the higher values are all along the ridge traverse, suggesting that the pyroclastic cover acts as an effective barrier to the migration of He. However, no correlation exists between He and the observed lineation; the higher He values simply reflect the close proximity of the granitic basement.

The CO₂ values are antithetic to those for He; i.e., low values were observed in the ridge traverse. The highest values are located immediately south of the southernmost lineation and close to the drill site. Thus, CO₂ may provide the most useful gas data in locating structures in this area.

OTHER STRUCTURES

Additional traverses were run across two of the larger faults in the area to test the effectiveness of helium (He), carbon dioxide (CO₂), and mercury (Hg) in detecting subsurface

**TABLE 1-5. Helium, Carbon Dioxide, and Radon in
Soil Traverse Northeast of Devils Kitchen.**

Sample location ^a	He, ppm ^b	CO ₂ , % ^c	Rn, cpm ^d	Sample location ^a	He, ppm ^b	CO ₂ , % ^c	Rn, cpm ^d
DKFS-1	4.1	0.84	88	DKFS-13	0.8	0.0	42
DKFS-2	5.0	0.51	73	DKFS-14	1.2	0.0	61
DKFS-3	2.4	3.3	20	DKFS-15	2.0	0.28	58
DKFS-4	2.3	0.14	113	DKFS-16	1.3	0.63	44
DKFS-5	2.5	0.66	110	DKFS-17	0.8	0.31	91
DKFS-6	2.2	0.92	147	DKFS-18	0.7	0.88	52
DKFS-7	2.7	0.60	67	DKFS-19	1.0	2.32	19
DKFS-8	1.5	0.99	18	DKFS-20	0.9	0.41	16
DKFS-9	0.7	0.84	86	DKFS-21	0.8	1.37	146
DKFS-10	0.8	0.91	42	DKFS-22	1.7	0.0	51
DKFS-11	1.5	0.0	36	DKFS-23	0.9	0.0	38
DKFS-12	1.5	9.3	142	DKFS-24	0.8	0.0	27

^a Sample locations are shown in Figure 1-2.

^b He values are relative to ambient air.

^c CO₂ values are relative to ambient air.

^d cpm is counts per minute.

structures. Figure 1-2 shows the sample locations (DKFS-1 through DKFS-13 and DKFS-19 through DKFS-24). A short traverse was also run across suspected faults and fractures in the northeast part of the CPZAF (DKFS-14 through DKFS-18).

On all four traverses shown in Table 1-5, the radon (Rn) values most closely reflect the structure observed at the surface. In one instance (DKFS-12) the large Rn anomaly is also correlated with a large CO₂ anomaly, but in general the CO₂ and He concentrations are not useful indicators of the underlying structure.

STABLE ISOTOPES

Eleven gas samples were analyzed to determine their overall compositions and their carbon and oxygen isotope values for their methane (CH₄) and carbon dioxide (CO₂) components. Of the eleven samples, four were taken from capped wells, one from Devils Kitchen, and six from the fumerole area at Coso Hot Springs. Steam and other gases were sealed in glass collection bottles.

None of the eleven samples contained appreciable methane, indicating that deep-mantle methane is not leaking to the surface in this region. CO₂ was present in sufficient quantities in eight of the eleven samples to determine the C 12/13 and O 18/16 ratios, expressed as $\delta C13$ and $\delta O18$. These values, together with the measured gas compositions, are shown in Table 1-6. Excepting the values from COSO 5, the $\delta C13$ values are relatively constant, whereas the $\delta O18$ values vary from -8.05 to -15.52 per mil. None of these isotopic compositions approach those of juvenile CO₂ (assuming the latter has a $\delta C13$ of approximately -6.5 per mil and a $\delta O18$ of approximately +7 per mil). Simple exchange of oxygen and carbon between magmatic CO₂ and marine carbonates found in the Paleozoic

TABLE 1-6. Carbon and Oxygen Isotope Composition of Carbon Dioxide Fraction of Gases Collected at Coso Volcanic Field.

Sample location ^a	CO ₂ fraction		Composition of gas received ^b		
	δC13	δO18	Nitrogen (N ₂)	CH ₄	CO ₂
Energy CA-1	-2.65	-15.41	6.26	0.10	93.64
CE 15-8	-2.72	-14.96	5.60	0.11	94.25
CE 75-7	-2.56	-15.52	5.39	0.15	94.44
CE 75A-7	-2.90	-14.70	26.88	0.10	73.02
DKF-1	-3.24	-8.05	97.70	0.02	2.27
COSO 1	Insufficient	Insufficient	99.53	0.02	0.27
COSO 2	Insufficient	Insufficient	98.37	0.02	1.60
COSO 3	Insufficient	Insufficient	98.20	0.02	1.78
COSO 4	-3.94	-11.73	96.51	0.02	3.46
COSO 5	-1.08	-15.39	57.73	0.09	42.18
COSO 5A	-3.11	-13.05	57.16	0.0	42.84

^a Samples CA-1, CE 15-8, CE 75-7, and CE 75A-7 were collected by attaching a half-inch hose and threaded adapter to the bleed valve at the wellhead of four capped California Energy Corp. wells. DKF-1 was collected from an open 1-inch diameter pipe driven into the fumerole area at Devils Kitchen. Samples COSO 1 through 5A are from fumeroles at Coso Hot Springs.

^b Gas compositions do not necessarily represent original compositions.

section (assuming the latter has a δC13 of approximately 0 per mil and a δO18 of approximately +22 per mil) also would not permit the observed isotopic values. In geothermal areas worldwide, CO₂ gas has δC13 values from 0 to -10 per mil, and comparison with local meteoric water frequently suggests that the geothermal waters and steam components are principally or exclusively of meteoric origin. At Coso the geothermal waters are not principally of magmatic origin, and the fluids and gases are largely derived from heating of circulating meteoric water.

Section 2
A Remote-Sensing Study of the Coso Volcanic Field Using
LANDSAT Multispectral Scanner Data

INTRODUCTION

A remote-sensing investigation of the Coso Geothermal Area and surrounding area was undertaken using LANDSAT Multispectral Scanner (MSS) data. The data were stored on tapes available within the Branch of Geophysics, U.S. Geological Survey, Denver, but required extensive computer processing to produce the spectral maps presented and discussed in this section. The purposes of this study were severalfold:

1. To demonstrate the utility of remotely sensed spectral data in interpreting the complex geology and structure of this region
2. To provide a limonite alteration map of the area, which may have utility in the recognition of geothermal regions
3. To identify areas where further, more complex, remotely sensed data may be useful

LANDSAT MULTISPECTRAL SCANNER DATA

The MSS database is a compilation of radiation reflected from the Earth's surface in four spectral bands:

1. Band 4: 0.5 to 0.6 micrometers
2. Band 5: 0.6 to 0.7 micrometers
3. Band 6: 0.7 to 0.8 micrometers
4. Band 7: 0.8 to 1.1 micrometers

The data have a spatial resolution of 80 meters (that is, the equivalent ground size of each pixel is 80 meters) and allow for the discrimination of surface lithologies and structural features. This method of remote sensing has been found to be a particularly effective method for recognizing and mapping the distribution of limonite that may be produced by the alteration of basalts.

Spectral Properties

Laboratory studies of rocks and minerals have demonstrated that spectral properties in the 0.2- to 2.5-micrometer wavelength region are distinct for a given mineral. The characteristic absorptions can result from electronic or vibrational processes; however, in the wavelength region of the MSS data, only electronic processes are important. Electronic absorption bands are of three types: conduction, charge transfer, and crystal field. Figure 2-1 shows a typical spectrum of hematite and illustrates features resulting from electronic absorptions. The rapid decrease of reflectance at wavelengths shorter than approximately 0.8 micrometer is attributable to a charge-transfer absorption. Absorptions caused by crystal-field effects are mineralogically the most diagnostic; thus, the position, width, and depth of an absorption contain information on the type and chemistry of the mineral or minerals involved in the light interaction.

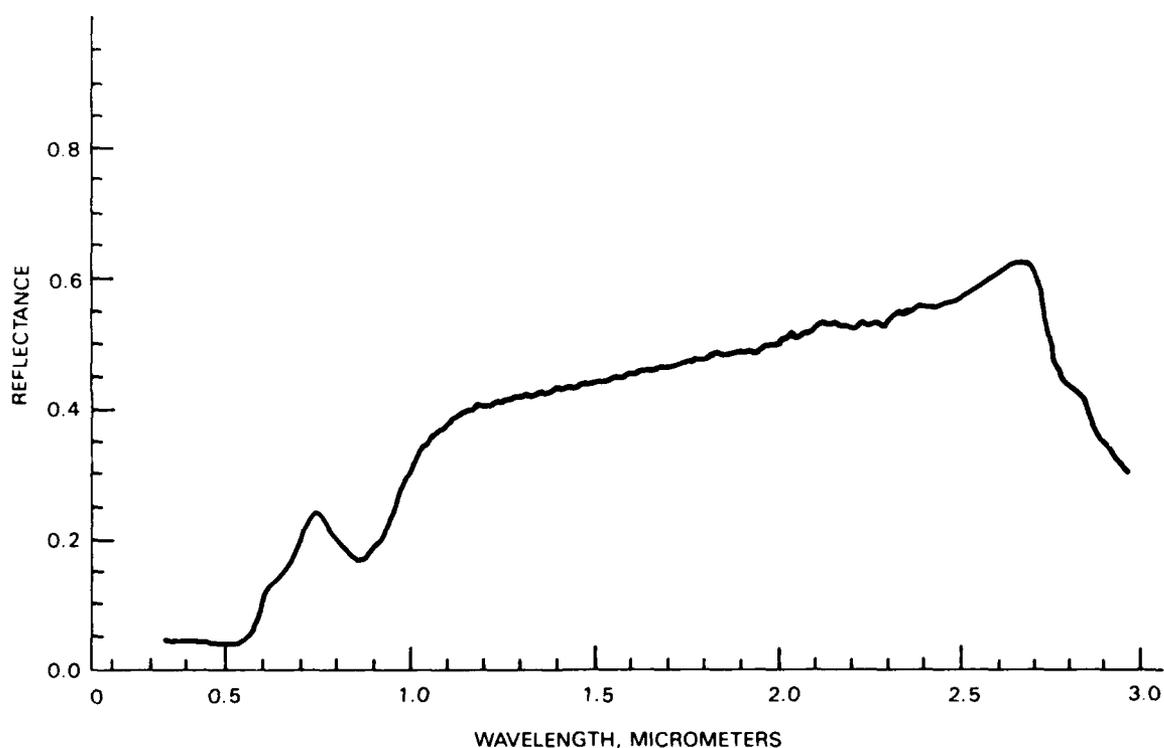


FIGURE 2-1. Visible and Near-Infrared Spectrum of the Mineral Hematite.

Color Composites Used to Present Multispectral Scanner Data

The MSS data can be presented as either single band images or composites of single-band images, or as band-ratio images. Band-ratio images or color-ratio composites (CRCs) often enhance differences between lithologically dissimilar rocks and soil units, moreso than do single-band images. Both color infrared composites and CRC images were used in this study.

The MSS color infrared (CIR) composites are produced by compositing Band 4 in blue, Band 5 in green, and Band 7 in red (Figure 2-2). In Figure 2-2, the CIR composite shows vegetation in shades of red because of the relatively high reflectance of vegetation in the near-infrared (Band 7). Water is shown in black because of the increasing absorption by water of longer wavelengths. Because of the dark reflectance levels, strongly absorbing materials in all bands of the MSS data, such as young, unaltered basalt, also appear dark in CIR images.

COMPOSITES REVEAL LITHOLOGY, HYDROTHERMAL ACTIVITY, AND POSSIBLE MAJOR FAULT

Color in Composites Reveals Lithology

The Pliocene basalts (Duffield et al., 1980) in the southern part of the Coso Volcanic Field are dark gray to black in the CIR image (see Figure 2-2). Comparison of this image with the geologic map of Duffield and Bacon (1981) shows a close correlation between different shades of gray and mapped basalt units of different ages. These color differences are probably resultant from weathering processes, whereby the older units have developed a surface coating of iron oxide and thus appear more greenish than the young, fresher basalts that appear uniformly dark.

The pre-Cenozoic granite and metamorphic basement lithologies that outcrop in the southern part of the Coso region appear blue in the CIR composite image. The CIR color of the basement in the Coso Range south of Wild Horse Mesa is more purplish than that near Volcano Peak because of a cover of vegetation that adds a red component. Possibly such basement lithologies are chemically different, resulting in a surface veneer of vegetation only on certain lithologies. The Mesozoic basement to the north, which is associated with the Pleistocene rhyolite domes and flows, is not as pronounced in the blue as the basement to the south. Again, this may be because of vegetation cover in the north.

The presence of slight vegetation also makes the rhyolite domes appear pinkish in the CIR image (see Figure 2-2). The Pliocene volcanics and intercalated Coso Formation (of Duffield and Bacon, 1981) appear greenish-brown to orange-brown in Figure 2-2 and are easily distinguished from the granitic and metamorphic basement. These brownish colors result from a spectral combination of vegetation and limonite alteration. In Figure 2-3 the distribution of limonite is indicated in red. Although the distribution of limonite is not restricted entirely to the Pliocene volcanics, it is pervasive among the basalts and associated pyroclastics.

Limonite Distribution Indicates Hydrothermal Activity

Limonite can indicate hydrothermal activity because when hydrothermal activity occurs in rocks with sufficient iron, limonite can be a byproduct. During hydrothermal alteration, primary iron-bearing minerals may be converted to pyrite, magnetite, or hematite. During weathering in the near-surface environment, further oxidation may lead to the production of goethite, lepidochrochite, siderite, and jarosite. These secondary iron

minerals, along with poorly crystallized ferric oxide (ferrihydrite) are collectively referred to as the limonite minerals. Thus, although the presence of limonite is not strictly diagnostic of hydrothermal activity, the presence of large areas of limonite on spectral images should prompt closer investigation. Limonite would not be expected in largely rhyolitic terrains.

In the Coso Volcanic Field, the distribution of limonite appears to be influenced both by lithology (basaltic flows and pyroclastics) and by fracture patterns. In Figures 2-2 and 2-3 an arcuate fault pattern can be seen extending from the Coso Basin north towards Silver Peak, then westward dividing Lower and Upper Cactus Flats. West of this structure are a series of north-northeast-trending faults previously mapped by the U.S. Geological Survey. These faults also have prominent limonite staining.

Fracture Systems Indicate Possible Major Fault

In addition to the faults indicated by limonite distribution, another surface expression of a possible major fault can be observed in the southern part of the Coso area; this surface expression defines the northern edge of the basement outcrop and the southern boundary of Airport Lake, and can be followed into the Argus Range. The same system appears to cross the Sierra Nevada frontal fault to the west, but is slightly offset to the south. It is possible that this is a fundamental crustal structure that defines the southernmost extension of geothermal activity, perhaps providing a barrier to subsurface fluid flow.

If the arcuate fault system defined on the CIR image is considered with the fault system to the west mapped by Duffield et al. (1980), it is possible to recognize a roughly circular series of fractures. This circular arrangement is truncated to the south by the aforementioned west-northwest fault, and on the north the scarp appears between Upper and Lower Cactus Flats. Based on this interpretation, all the eruptive vents, rhyolite domes, and flows occur within the bounds of this roughly circular region. Using the CIR images to map this bounding structure on the ground could be instructive because the preliminary data are certainly suggestive of a buried caldera-like structure.

SUMMARY

The MSS data used in this study provided a series of spectral maps previously unavailable for the Coso region. Such maps can be particularly useful in recognizing different lithologies, such as basement versus volcanics; delineating structural features; identifying volcanic units of different ages; and evaluating the spatial distribution of vegetation (Figure 2-4) and limonite alteration. The distribution of limonite alteration includes basaltic flows, pyroclastics, and important faults. The composite maps strikingly show the distribution of major faults and have led to the recognition of a major circular structure bounding the areas of relatively recent volcanic activity. This structure warrants further investigation.

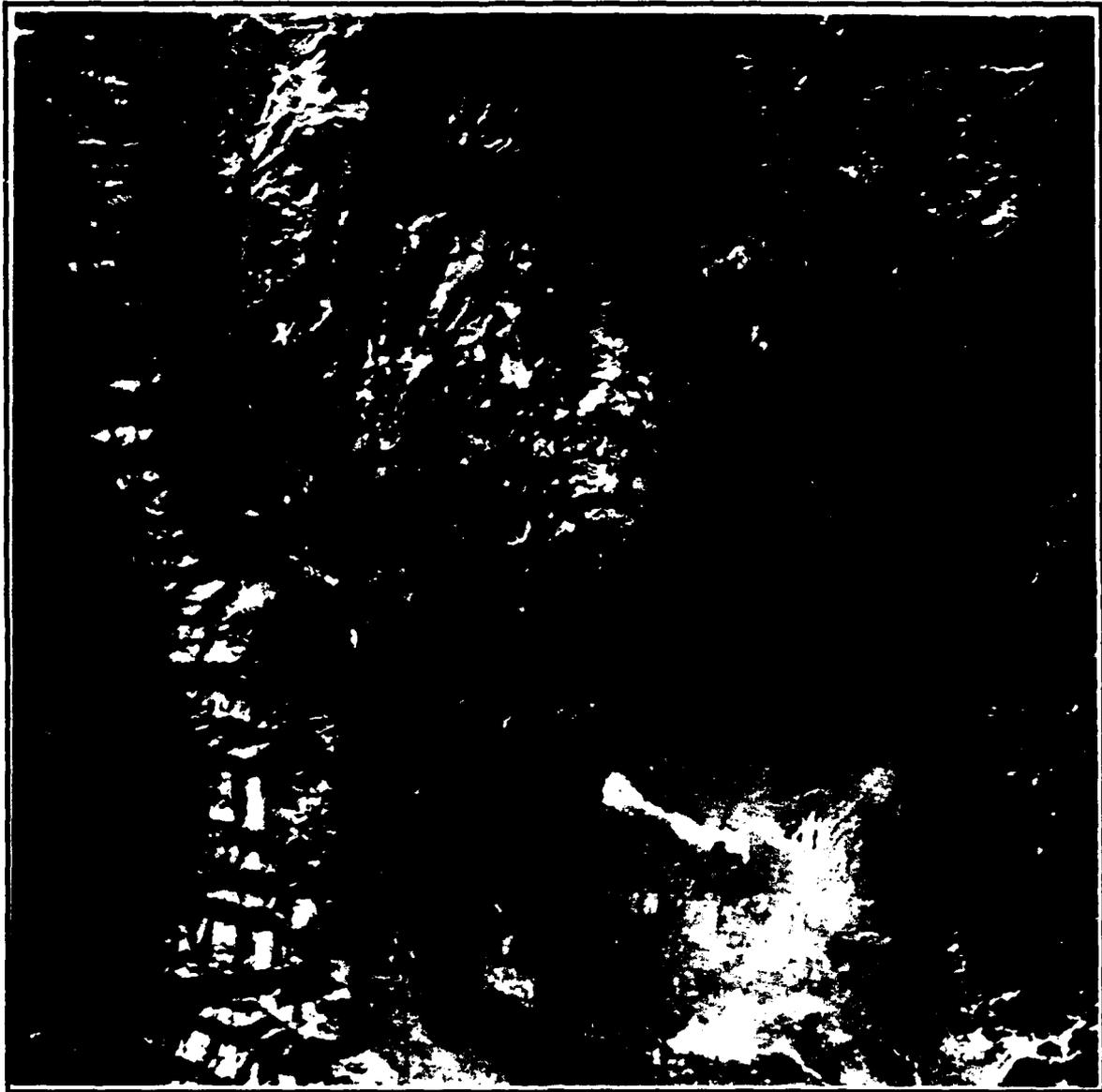


FIGURE 2-2. Color Composite Map of Coso Volcanic Field and Environs. The various mapped lithologies from Duffield and Bacon (1981) are well displayed in this composite spectral map. Foldout on page 33 identifies geologic features.

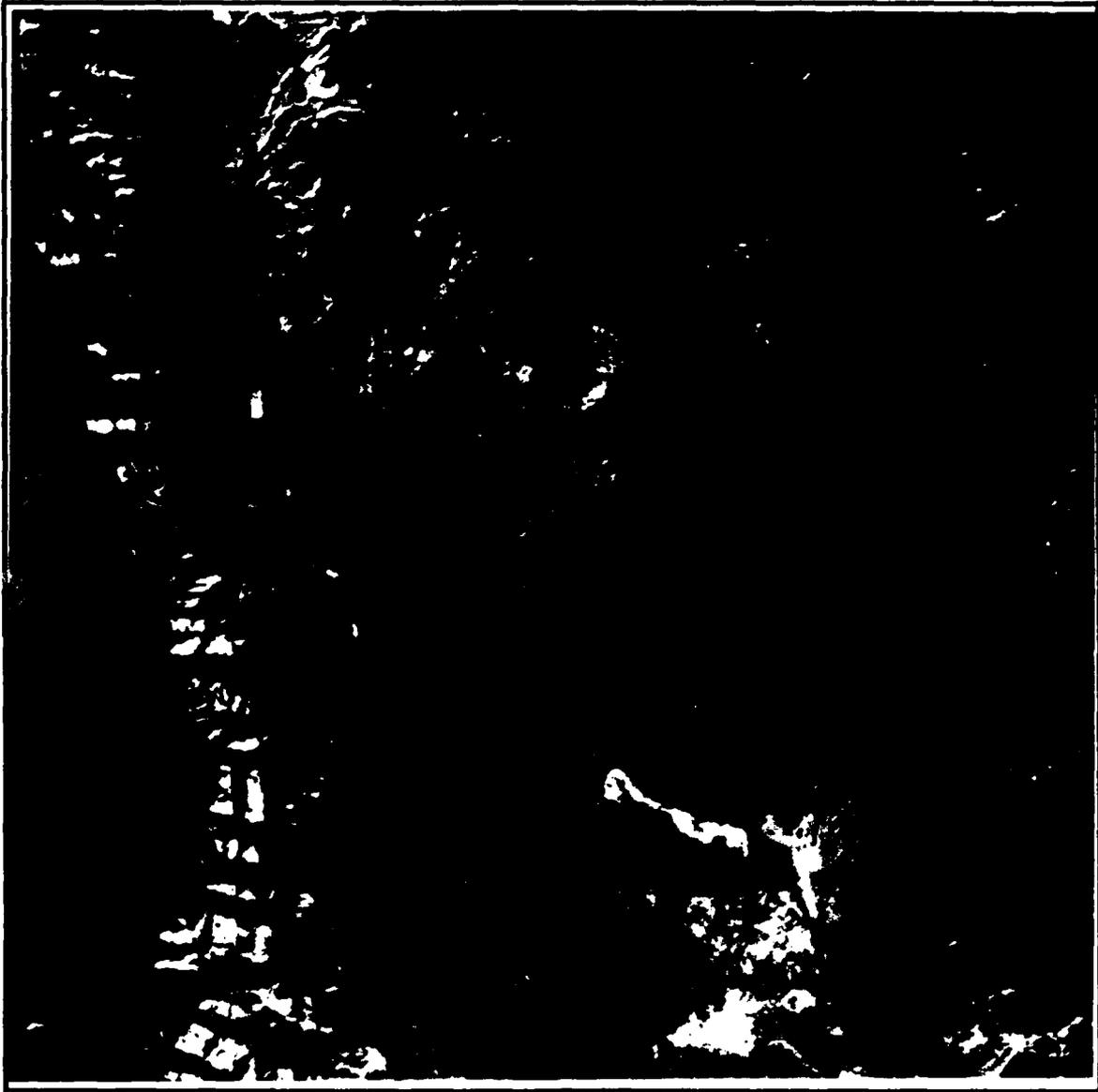
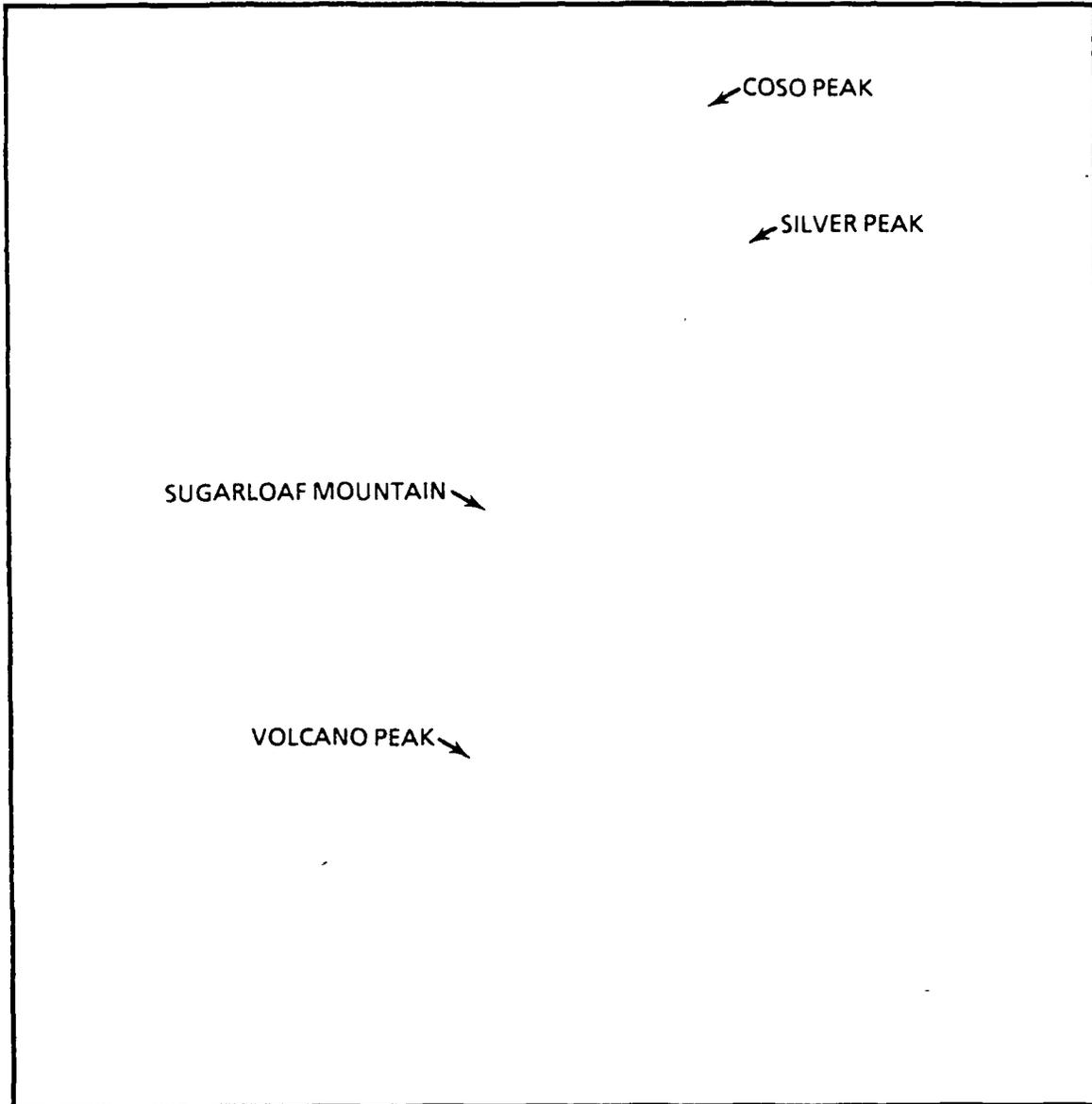


FIGURE 2-3. Distribution of Limonite in Coso Volcanic Field and Environs. Foldout on page 33 identifies geologic features.



FIGURE 2-4. Vegetation Map of Coso Volcanic Field and Environs. The distribution of vegetation (chlorophyll) is indicated by plotting the intensity of Band 7. Foldout on page 33 identifies geologic features.



Fold this oversize page over Figures 2-2 through 2-4 to identify geologic features.

Section 3
Geochemical Reconnaissance of the Marine Corps Mountain Warfare Training Center at Pickel Meadow, California

INTRODUCTION

A reconnaissance geochemical survey was conducted at and contiguous to the Marine Corps Mountain Warfare Training Center (MWTC) in Pickel Meadow, Calif., as an aid to appraising the geothermal potential of the area. Sample media included soil gases, stream sediments, heavy-mineral concentrates, rocks, thermal waters, and hot-spring precipitates. An additional study performed near the family housing unit in Antelope Valley was limited to soil and soil-gas sampling.

The main survey site is located roughly 17 miles northwest of Bridgeport, Calif. (Figure 3-1). California State Highway 108 crosses east-west through Pickel Meadow; other access is limited to dirt roads and trails. Antelope Valley lies 30 miles north of Bridgeport and is bounded by U.S. Forest Service and Bureau of Land Management (BLM)-administered lands. Most of the valley is privately owned, with the family housing unit being several miles north of Coleville, Calif.

GEOLOGY

The oldest known rocks in the area are lower-Jurassic quartz-diorite pebbles and boulders within sediments of Leavitt Meadow. The Sweetwater Range east of Pickel Meadow is underlain by a series of intensely folded and faulted early-Mesozoic sediments intruded by upper-Mesozoic plutons of quartz-gabbro to quartz-diorite compositions. This igneous event was followed by the intrusion of large bodies of granodiorite and quartz monzonite that are widely exposed west of the West Walker River.

The oldest Tertiary volcanic rocks are of upper-Eocene age and are exposed as several small flow remnants of welded-rhyolite tuff between the West Walker River and Mill Creek, and between Mill Creek and Lost Canyon Creek. The most widespread Tertiary volcanics are the mid-Pliocene andesites of the West Walker River drainage basin, which outcrop as flows, sills, dikes, and lahars overlain by latitic flows and tuffs. Mid-Pliocene andesitic and rhyolitic

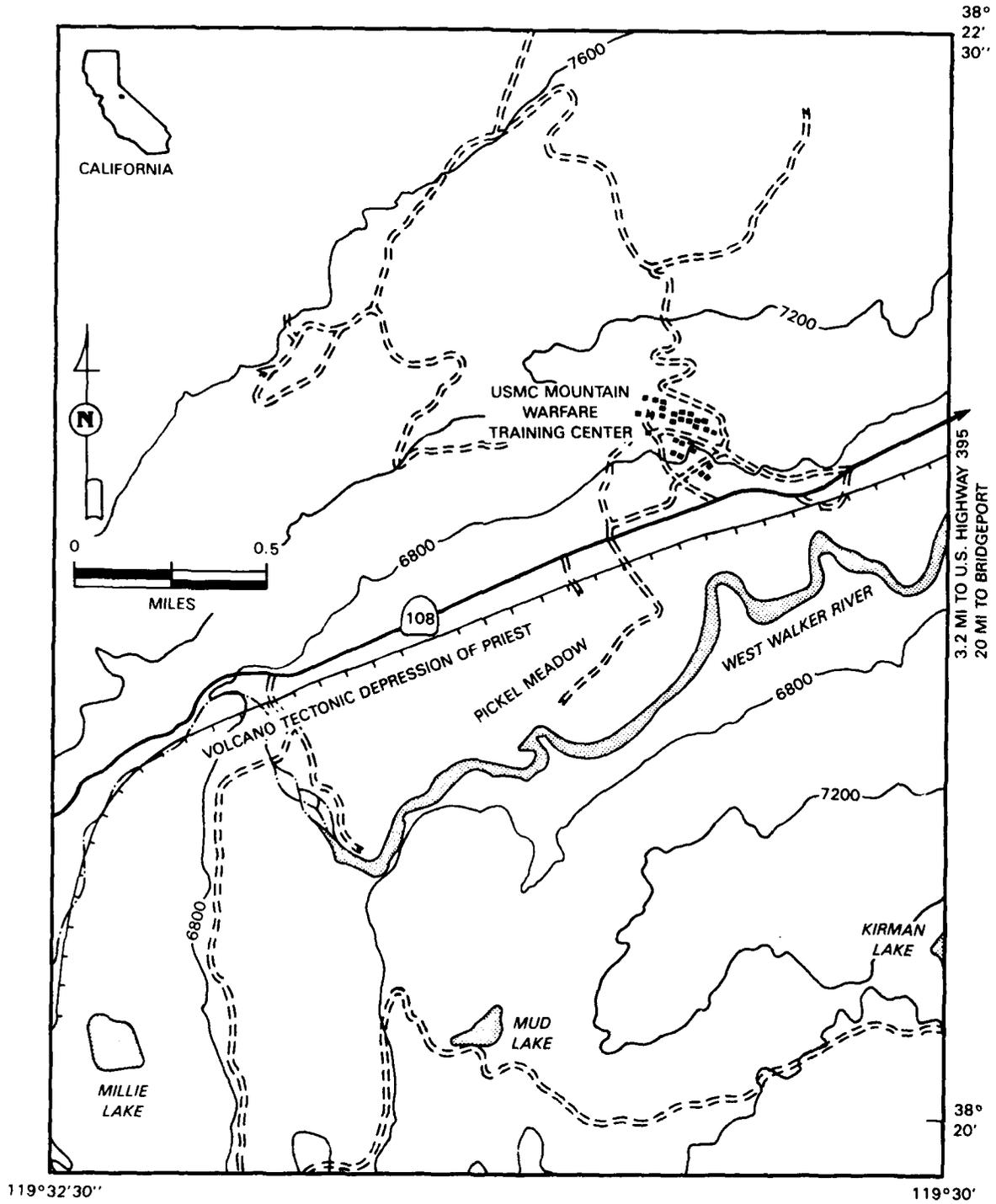


FIGURE 3-1. Location Map of Marine Corps Mountain Warfare Training Center at Pickel Meadow.

flows and intrusives are exposed south of Antelope Valley and north of Leavitt Meadow. Outcrops of late-Pliocene olivine basalts occur as small domes, intrusives, and flow remnants, particularly in the Sweetwater Range. Although Pickel Meadow is covered by alluvium and glacial debris, Quaternary basaltic andesites occur locally in the Fales Hot Springs region.

The Leavitt Meadow-Slinkards Valley fault marks a division in the structural province within this area. The fault block pattern of the Basin and Range is found east of the fault, whereas to the west the structural style of the Sierra Nevada is more evident. The present-day physiographic features are largely resultant from Pleistocene faulting east of the Sierra Nevada crest. Antelope Valley is a graben confined on the west by the West Walker River-Antelope Valley fault and to the east by the Wellington Hill Fault. Pickel Meadow is a typical U-shaped valley formed in part by glaciers of the Tioga, Tahoe, and Sherwin stages.

SAMPLE ANALYSIS

Soils, rocks, heavy-mineral concentrates, sediments, and hot-spring precipitates were analyzed by a six-step semi-quantitative spectroscopic method. The elements analyzed and the analytical results are presented in Appendix B, Tables B1-1 through B5-1. Soil gases were analyzed for helium (He) using a modified mass spectrometer at the U.S. Geological Survey, Denver, and for carbon dioxide (CO₂) using a method developed at the U.S. Geological Survey. The spectrographic determinations for silver (Ag), arsenic (As), gold (Au), cadmium (Cd), antimony (Sb), and zinc (Zn) in stream sediments, for Au, Cd, and Zn in heavy-mineral concentrates, and for Au in rocks were all below the detection limit. In the Appendix B tables the columns for these elements have been deleted.

SOIL GASES

Appendix Table B6-1 shows the He and CO₂ values. These data were collected in an effort to delineate structural features that may serve as conduits for migrating thermal fluids and gases. Duplicate soil-gas samples were collected at 75 sample sites. Of these, 54 sites are located in the vicinity of the main encampment of the MWTC at Pickel Meadow and 18 sites are situated immediately east of the family housing unit in Antelope Valley. Three background samples were collected along California State Highway 108 between Sardine and Leavitt Meadow.

The Pickel Meadow samples were collected in a square grid (Figure 3-2). The Antelope Valley samples were collected within a rectangular grid along two east-west traverses across the valley along Topaz and Cunningham Lanes. The east-west traverses are linked by two north-south traverses along California State Highway 395 and Eastside Lane (Figure 3-3).

Pickel Meadow samples analyzed for He contained less He than that of ambient air, which had 5.24 ppm. This difference suggests solution of He in a fluid phase within the soil. The samples ranged from 4.69 to 5.1 ppm with a mean and standard deviation of 4.85 ± 0.16 ppm (Appendix Table B6-1). Distinct He anomalies occur along a well-defined elongate zone between and parallel to the West Walker River and California State Highway 108. A solitary anomaly is found northeast of the MWTC. The intensity of the He

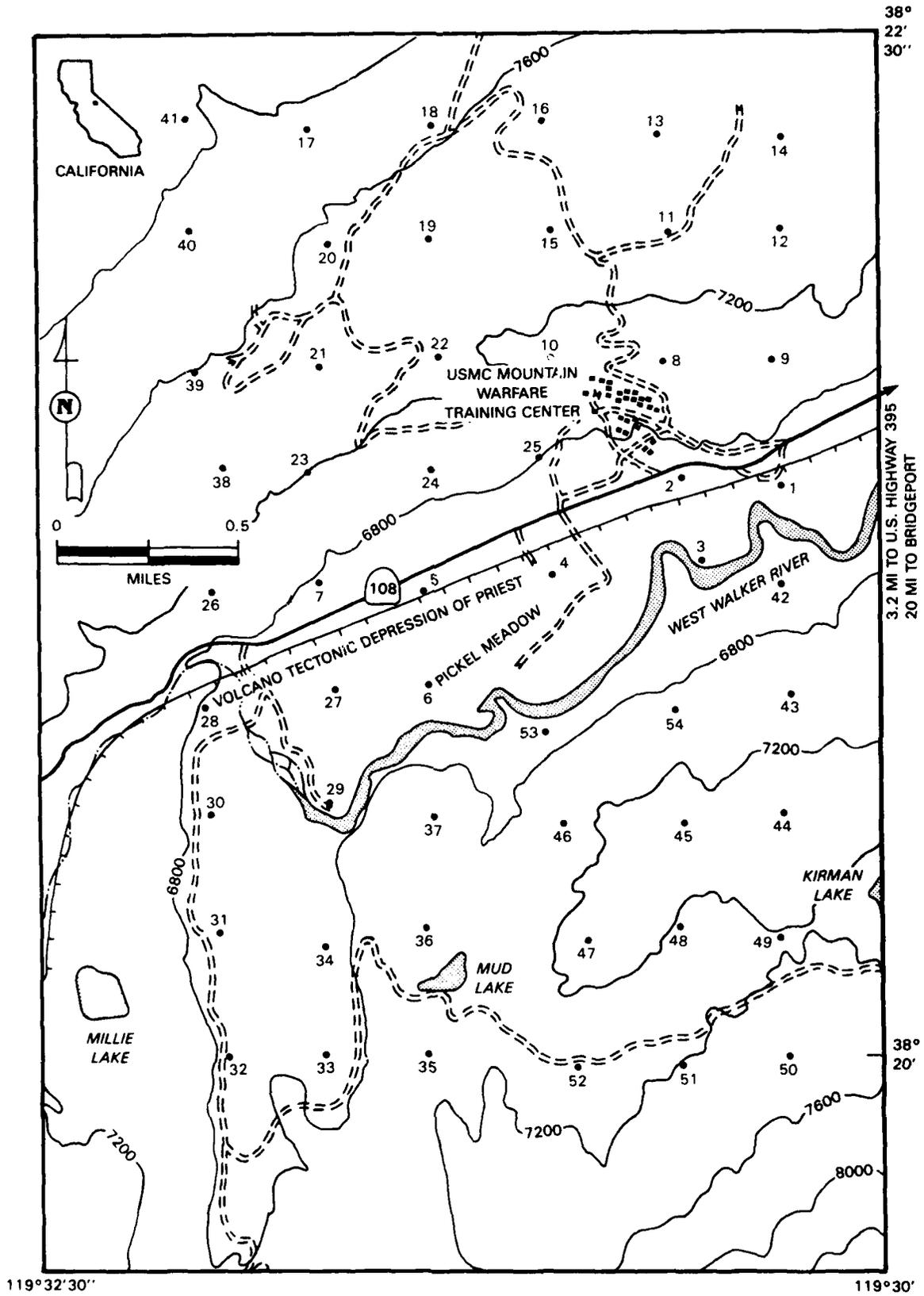


FIGURE 3-2. Soil-Gas Sample Locations at Pickel Meadow. Samples were collected in a grid with approximately one-half mile spacing.

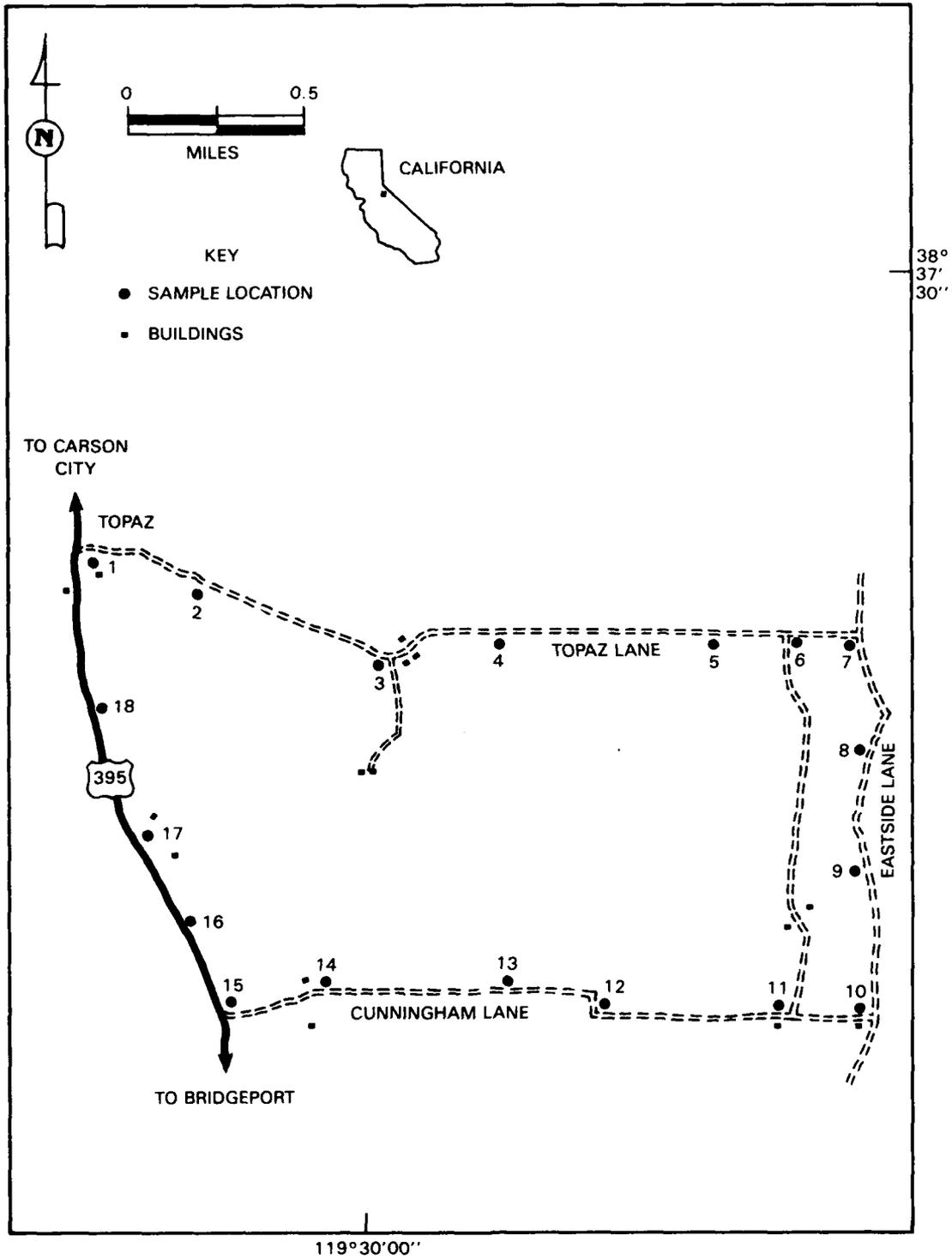


FIGURE 3-3. Soil-Gas Sample Locations at Antelope Valley Facility. Lack of access to private land limited the sampling program to areas near major highways.

anomaly decreases in a symmetrical pattern away from the anomalous sites and is easily contoured (Figure 3-4).

Concentrations of CO₂ range from 0.14 to 2.91%. Prominent anomalies coincide with He anomalies north of the West Walker River (Figure 3-5). Lesser concentrations, although appearing in groups, are not concentrically distributed in contrast to the He values. The presence of coinciding He and CO₂ anomalies is significant, and it seems reasonable that some sort of structural feature underlies this part of Pickel Meadow. The presence of such a feature would be consistent with, but does not prove, the contention made by Priest in 1979 that a "volcano-tectonic depression" passes across this segment of the valley (see Figures 3-4 and 3-5). Follow-up studies are needed to further evaluate the gas data, but it is encouraging to see the correspondence between both He and CO₂ data for this area, in contrast to the Coso region where little correspondence could be detected.

The soil-gas data for Antelope Valley should be interpreted with some caution. Farms and private property severely limited access, which resulted in a very restricted sampling scheme. Also, contamination close to highways is always likely and renders the integrity of the samples suspect. Consequently, although we present the data, we have made no attempt to interpret the results.

SOILS

Soil samples were collected concurrent with the soil-gas samples at Pickel Meadow to determine if local geothermal activity could be recognized through key elements in the soils. Mercury (Hg), arsenic (As), antimony (Sb), and bismuth (Bi) are often associated with geothermal fields and constituted the focal point of the soil survey. However, this reconnaissance study did not attempt to differentiate soil types nor to sample specific soil horizons.

Chemical analyses were unable to detect Bi, only one sample contained detectable Sb, and seven samples contained detectable As (Appendix Table B5-1). Nevertheless, the samples mildly enriched in Hg, As, and Sb relative to local background roughly correspond to the He and CO₂ anomalies in the area north of the West Walker River (Figures 3-6 and 3-7).

The soil data were augmented by spectrographic data (Appendix Table B1-1) aimed at estimating the trace-element composition of the soils to provide a soil-chemistry database. The elemental composition of the soils is determined by chemistry of local rock units and the specific weathering and soil-building processes acting on these rocks. The soil data, when compared to similar information from the local rocks (Appendix Table B3-1), demonstrate that soil chemistry in this area can be used to estimate the composition of local rocks in areas of poor rock outcrop.

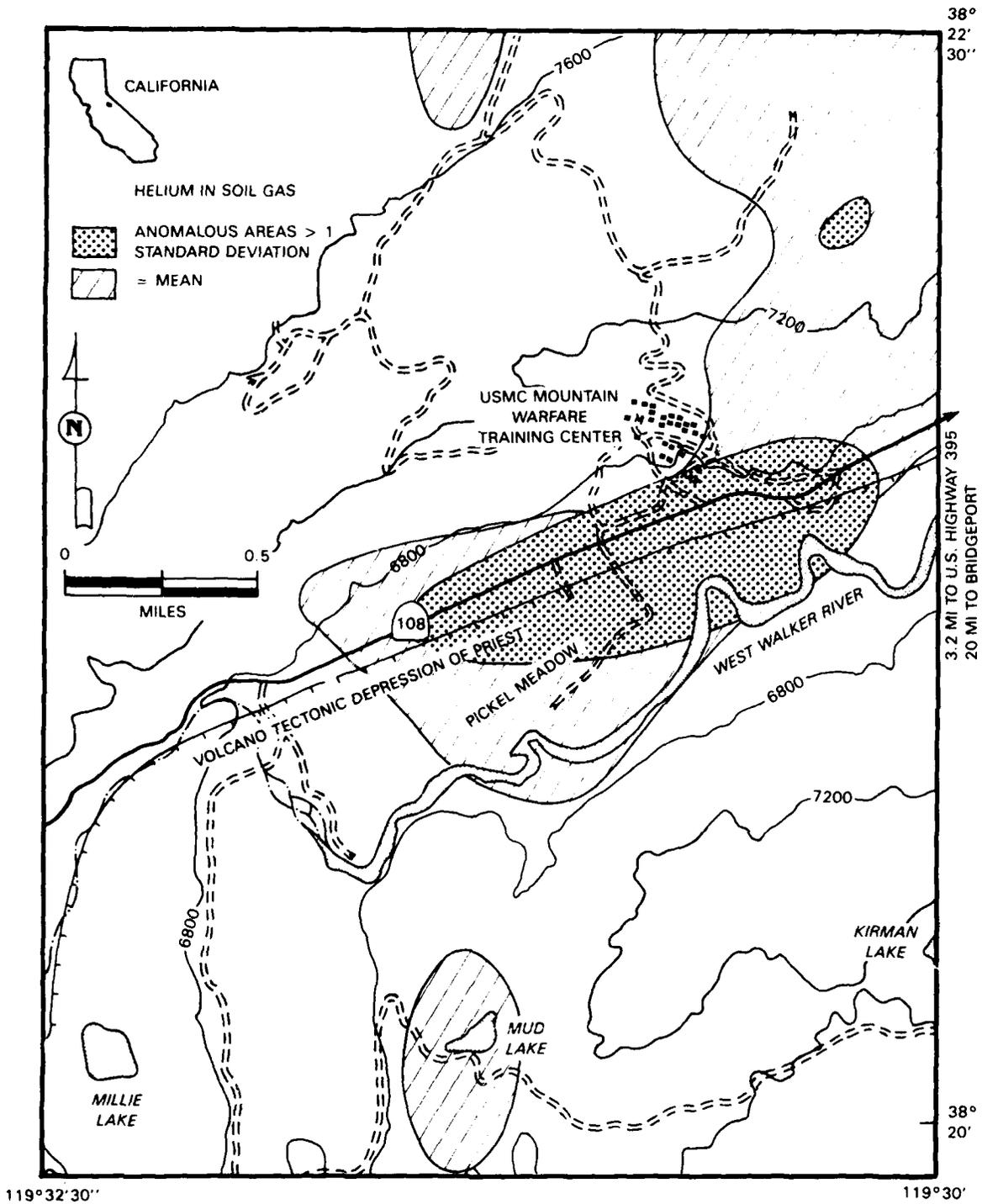


FIGURE 3-4. Distribution of Helium (He) in Soil Gas, Expressed as Anomalous Values (Defined as Greater Than One Standard Deviation From the Mean Value). Note that the areas having anomalous values are coincident with the limit of an inferred volcano-tectonic depression.

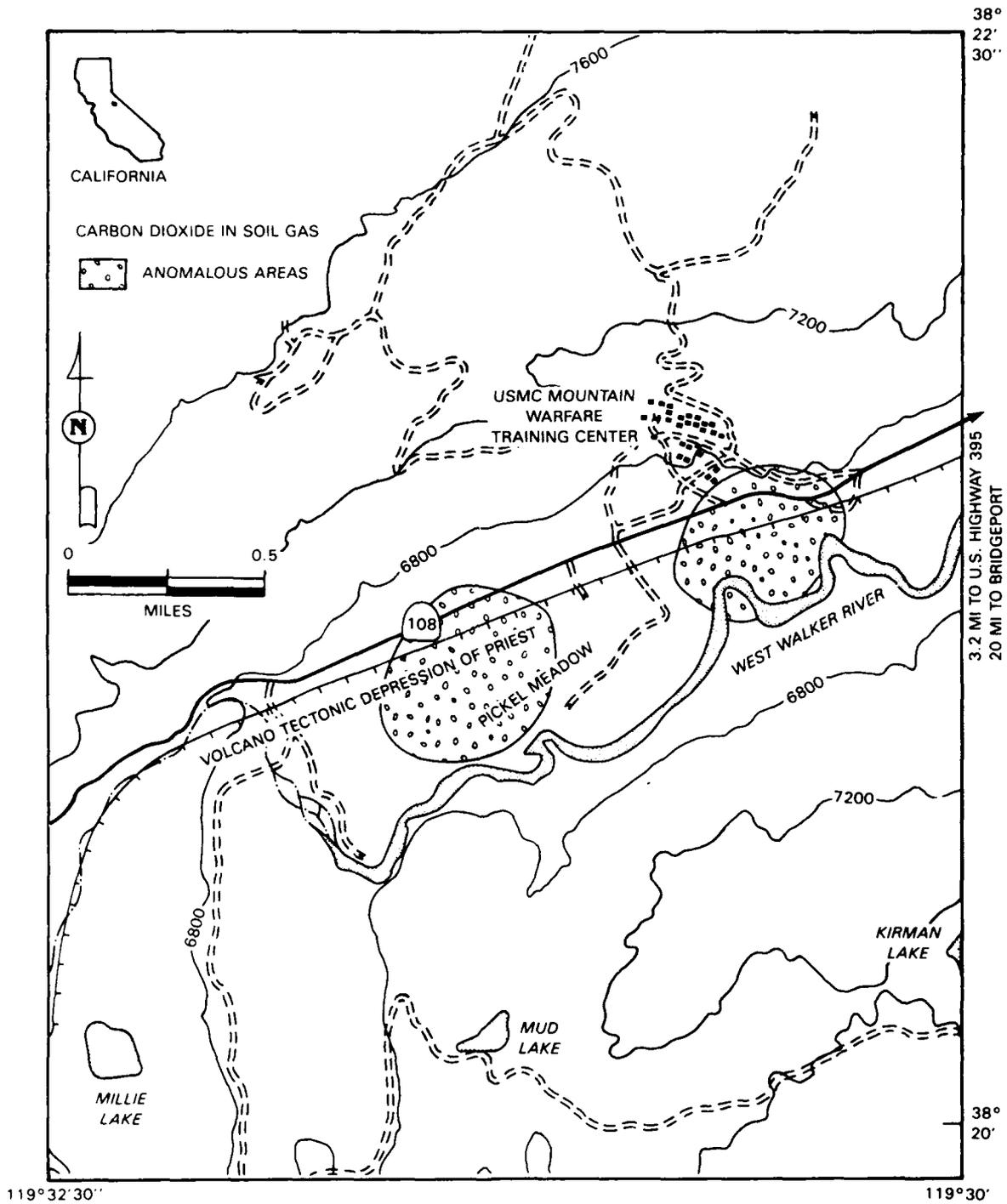


FIGURE 3-5. Distribution of Carbon Dioxide (CO₂) in Soil Gas, Expressed as Anomalous Values (Defined as Greater Than One Standard Deviation From the Mean Value). Note that the areas having anomalous values are coincident with the limit of an inferred volcano-tectonic depression.

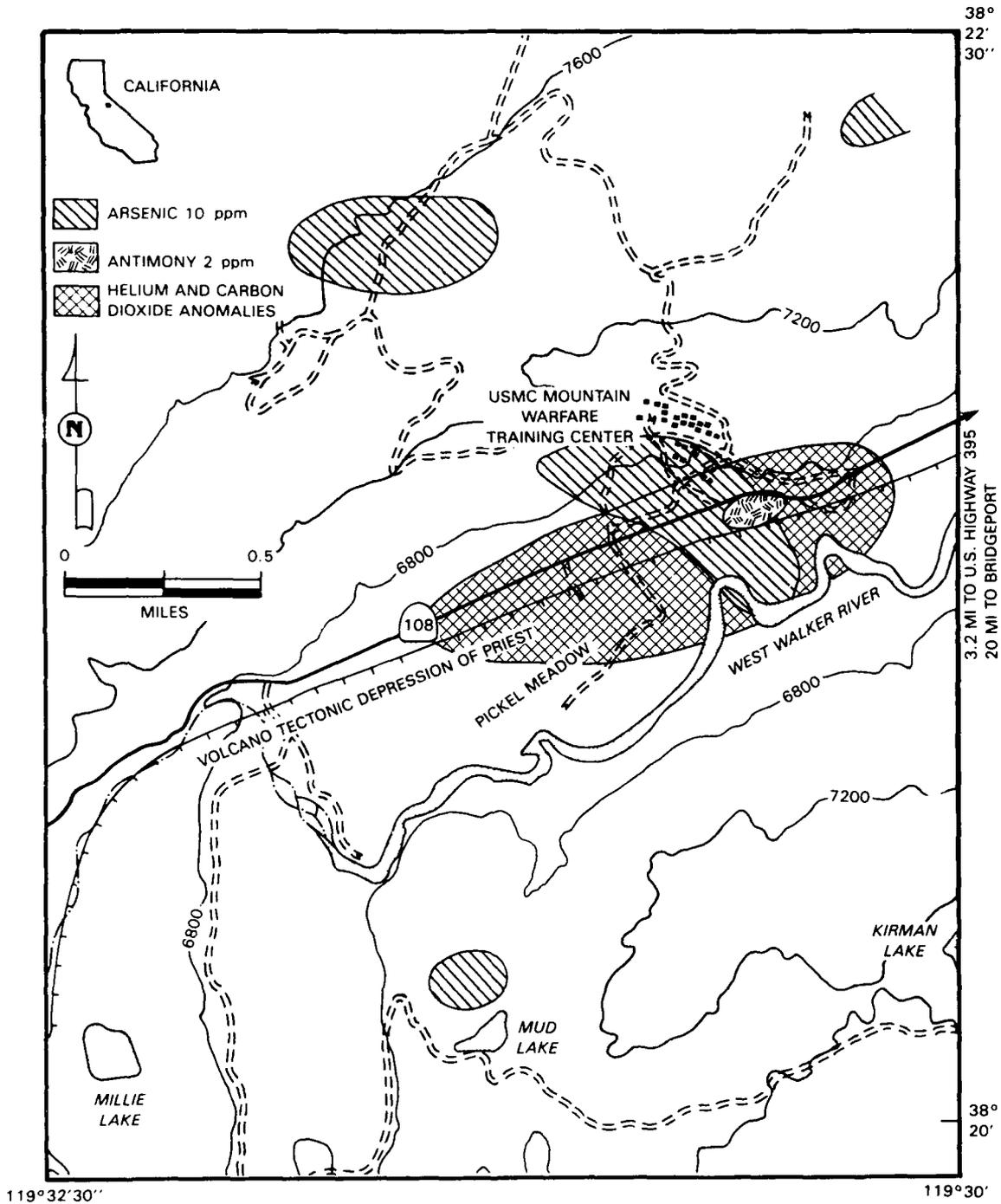


FIGURE 3-6. Anomalous Concentrations of Arsenic, Antimony, Helium, and Carbon Dioxide in Soil Samples From Pickel Meadow.

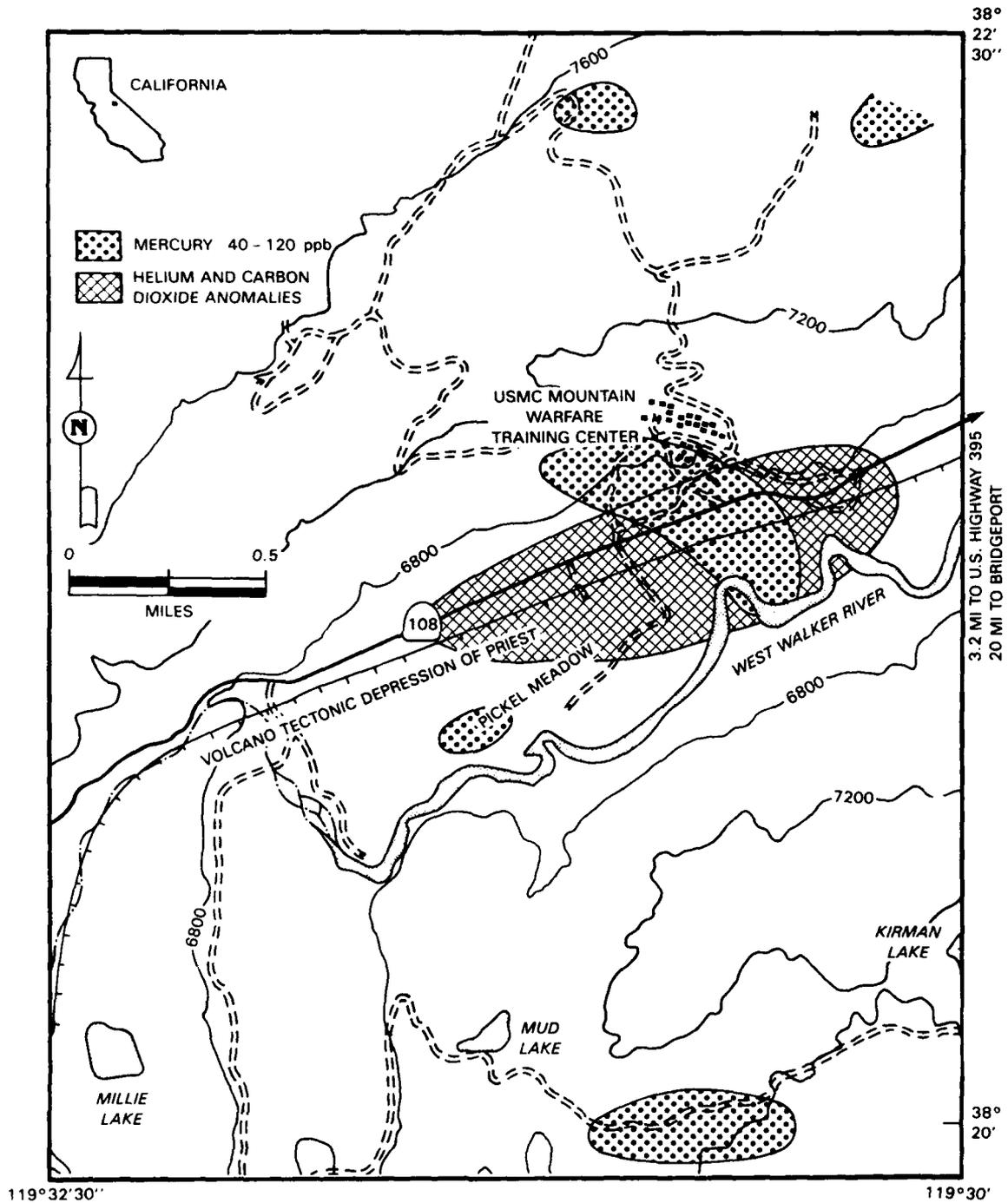


FIGURE 3-7. Anomalous Concentrations of Mercury, Helium, and Carbon Dioxide in Soil Samples From Pickel Meadow.

ROCKS, STREAM SEDIMENTS, AND HEAVY-MINERAL CONCENTRATES

Rocks and stream sediments were collected to determine the trace-element signature of the various rock types at Pickel Meadow, and to target areas of possible mineralization associated with near-surface solutions or hot springs. Sixteen rocks were collected from the Relief Peak Formation south of the West Walker River (Figure 3-8). This formation is the major rock unit in the area and is composed primarily of andesite flows and lahars, minor basalt flows, and minor volcanoclastic sandstones and conglomerates.

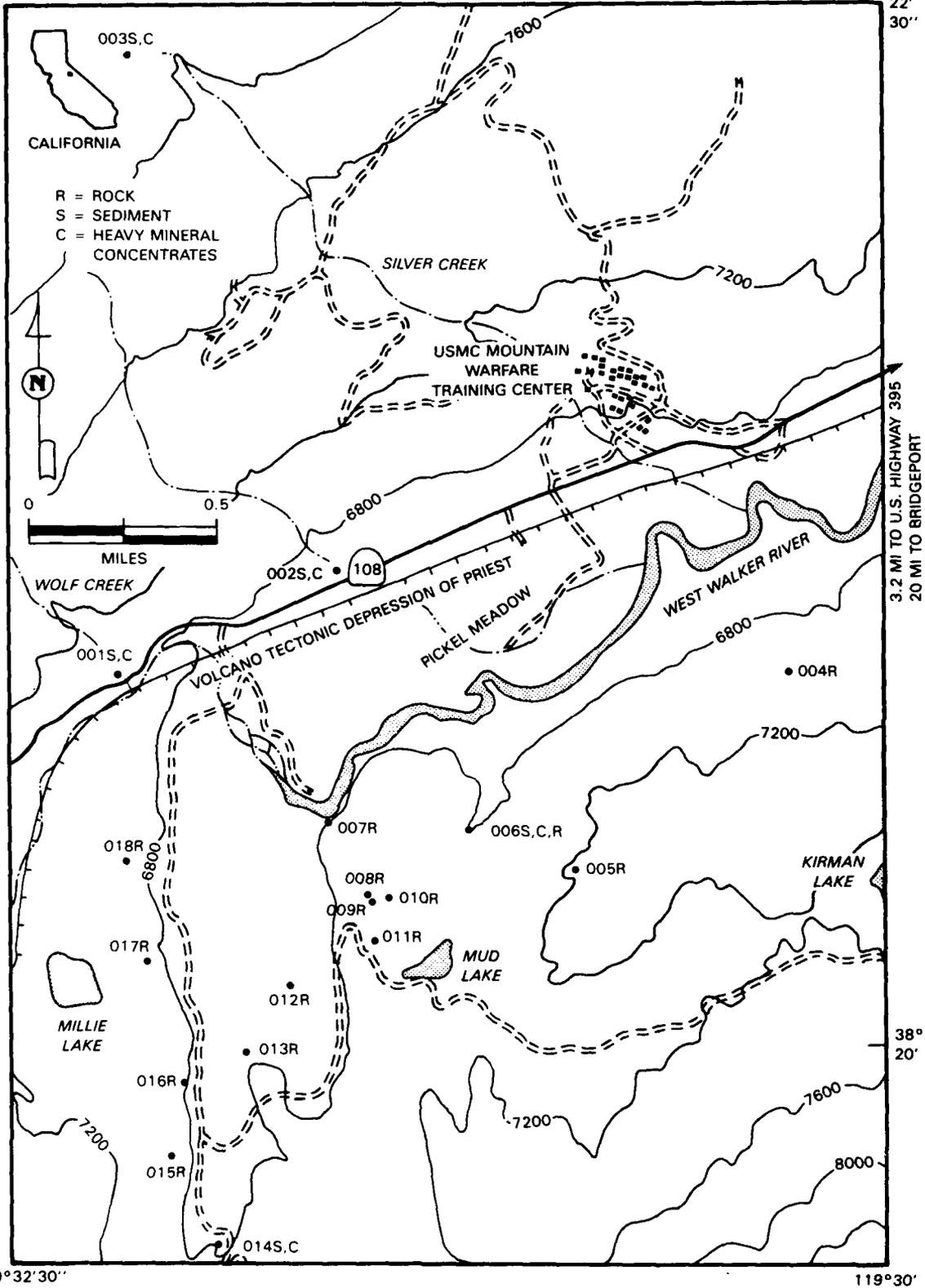
Two stream sediments were composited from active alluvium at five sample sites. The first sample, referred to as the stream sediment, was sieved and the fine fraction retained for analysis. This sample provided a good geochemical representation of the transplanted components of a stream or drainage. The second sample was a panned concentrate that provided a sample of the sediments' heavy minerals.

The data on these samples are shown in Appendix Tables B2-1 and B3-1. Within these data some geochemical anomalies exist that are potentially interesting. The mineral concentrates of most interest were collected near the mouth of Wolf Creek (site 001) and the small drainage between Wolf Creek and Silver Creek (site 002) (see Figure 3-8). Anomalous barium (Ba), strontium (Sr), and tungsten (W) values were observed at site 001. Traces of silver (Ag) were noted at both locations, and site 002 is slightly enriched in mercury. What makes these samples intriguing is the admixture of exotic minerals identified both by optical microscope and X-ray diffraction. The sample from site 001 is especially enriched in barite, to a lesser extent in marcasite and pyrite, and contains minor scheelite and tourmaline. The sample from site 002 contained cinnabar, marcasite, pyrite, scheelite, and barite. The observed anomalies and mineral assemblages may serve as subtle indications of a weakly developed hydrothermal system, because cinnabar is universally linked to near-surface and hot-springs deposits and in such environments is commonly associated with barite, pyrite, and marcasite. However, these latter minerals may also occur in other geological environments, thus precluding a definitive interpretation of the data from sites 001 and 002.

HOT-SPRING WATERS AND PRECIPITATES

Thermal waters from hot springs were sampled to estimate water sources from hydrogen isotope compositions. Corresponding hot-spring precipitates or encrustations were also collected to gain some insight into what material may be dissolved within heated water circulating at depth and then precipitated during surface discharge.

Thermal springs are unknown at Pickel Meadow; therefore, three samples were collected from the closest documented thermal-spring locations near Bridgeport. These locations are Travertine Hot Springs (W-1), The Hot Springs (W-2), and Buckeye Hot Springs (W-3) (Figure 3-9). A fourth sample was collected at Fales Hot Springs (W-4), just east of Pickel Meadow.



119°32'30"

119°30'

FIGURE 3-8. Sample Locations for Rock (R), Sediment (S), and Heavy-Mineral Concentrates (C) at Pickel Meadow. Sampling locations were chosen by the position of rock outcrops and the location of streams.

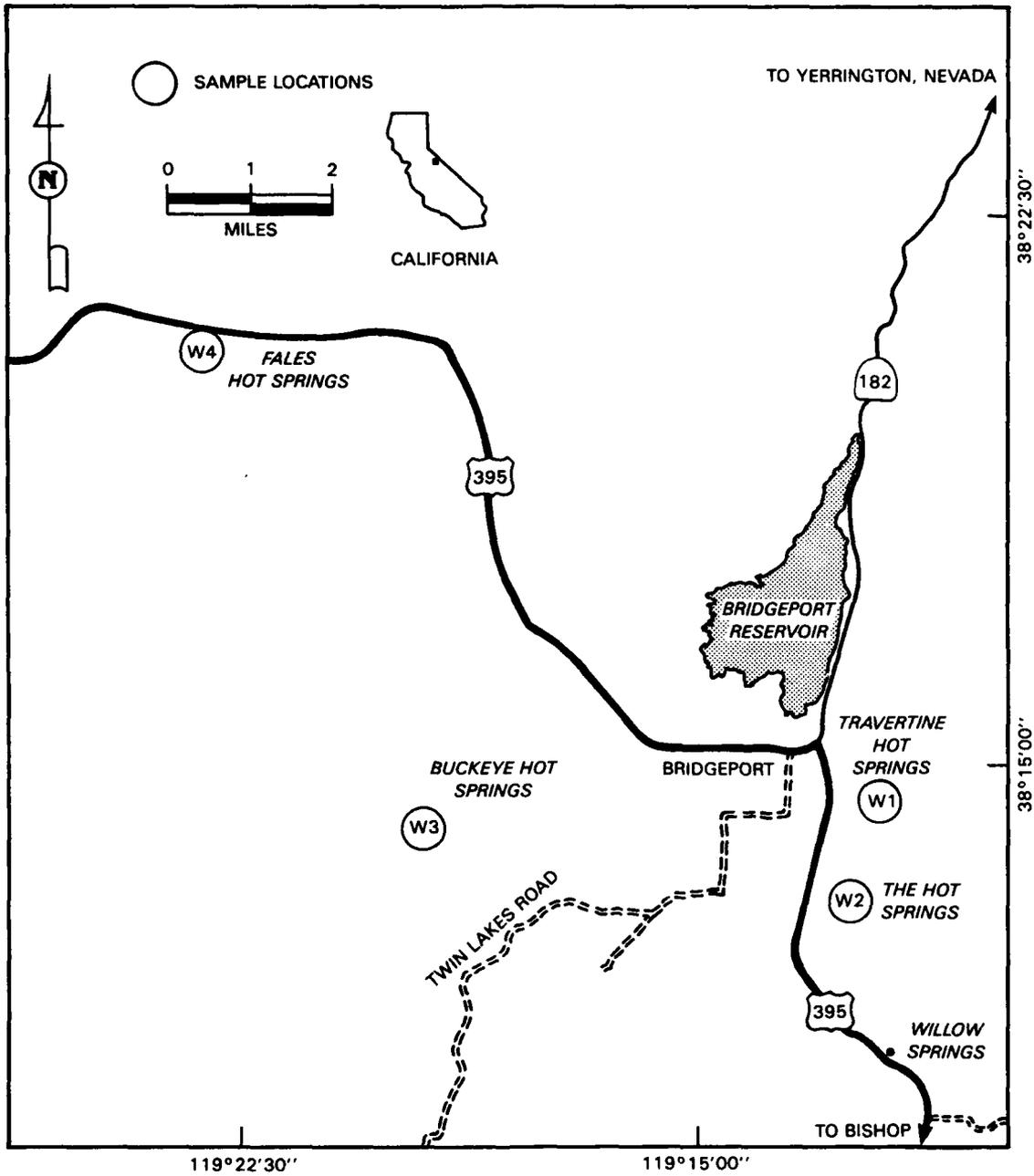


FIGURE 3-9. Hot-Spring Sample Locations for Fluid and Precipitate Studies. These locations are the closest sites to Pickel Meadow of known surface expressions of thermal waters.

Deuterium/hydrogen ratios are shown in Table 3-1. Variation within the sample set is insignificant (-136 to -140), but the values are very light compared to previous compilations of modern meteoric water from this region (-110 to -120*). No compelling evidence for a large magmatic component (-50 to -80) shows in any of these samples.

TABLE 3-1. Deuterium Analyses of Thermal Waters From Hot Springs Near Pickel Meadow.

Deuterium values are expressed as per mil deviations from Standard Mean Ocean Water (SMOW).

Sample no.	Deuterium value
W1	-139
W2	-140
W3	-130
W4	-136

The relatively light isotopic conditions could result from any one of or a combination of the following factors, in decreasing order of merit:

1. The thermal springs tap a source of Pleistocene water, not modern meteoric water. In this scenario the light isotopic composition is partly caused by deuterium fractionation into ice, leaving subsurface waters enriched in hydrogen, and partly caused by lower mean annual air temperature.
2. A fractionation of hydrogen from deuterium occurs at depth where hydrogen is preferentially incorporated into a vapor phase. The vapor phase then condenses in the near-surface environment as a component of the surficial groundwater.

The precipitates are principally calcium carbonate, specifically calcite and aragonite. Considerable strontium (Sr) has substituted for calcium (Ca), as indicated by the spectrographic results (Appendix Table B4-1). The precipitates also contain anomalously high quantities of mercury (Hg), arsenic (As), antimony (Sb), bismuth (Bi), and beryllium (Be). This collective assemblage is common to many high-temperature geothermal systems (Moore et al., 1983, and Boyle, 1974). Although beyond the scope of the present study, but of environmental interest, are the large amounts of Hg and As noted in several samples.

* Irving Friedman, personal communication with W. I. Ridley, 1987.

SUMMARY

1. Helium (He) and carbon dioxide (CO₂) soil-gas anomalies were identified at Pickel Meadow. Overlapping anomalies suggest that these gases may be leaking along a buried structure.

2. Soil samples mildly enriched in mercury (Hg), arsenic (As), and antimony (Sb) above local background values correspond to some gas anomalies in the area north of the West Walker River.

3. Given the reconnaissance nature of the study, it is encouraging that some geochemical anomalies can be recognized, albeit not precisely defined. That the anomalies are soil gases and volatile elements suggests that they may be controlled by subsurface fractures, which may also be important in controlling subsurface fluid flow.

4. Future studies should attempt to determine the areal extent and causes of He and CO₂ anomalies at Pickel Meadow. Such a study should include detailed geological mapping and further soil and soil-gas analyses. This study should cover the Leavitt Meadow-Fales Hot Springs area as well as Pickel Meadow.

5. If geochemistry at Antelope Valley is determined to be important, then it is essential to design a program in cooperation with local private landowners.

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Appendix A
SPECTROGRAPHIC AND CHEMICAL ANALYSES OF SAMPLES COLLECTED
FROM THE COSO VOLCANIC FIELD

TABLE A1-1. Spectrographic and Chemical Analyses of Soil Samples Collected From the Coso Volcanic Field. Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected. < means detected but below the limit of determination shown, > means determined to be greater than the value shown.

Sample location	Latitude (degrees, minutes, seconds)		Longitude (degrees, minutes, seconds)		Element, ppm												
	Fe	Mg	Ca	Ti	V/n	Ag	As	Au	B	Ba	Be	B	Co	Cr	Cu	La	Mu
DKC012	0.5	N	<0.05	0.3	N	N	N	N	N	500	N	N	N	50	20	50	N
DKC014	1.5	<0.02	0.10	0.5	15	<0.5	N	N	N	1500	N	N	N	30	70	20	<5
DKC016	1.0	0.02	0.07	0.2	<10	N	N	N	N	300	<1.0	N	N	30	20	30	N
DKS019	0.5	<0.2	<0.05	>1.0	10	N	N	N	N	2000	<1.0	N	N	15	10	<20	5
WS025	3.0	0.20	1.50	0.5	150	N	N	N	N	500	1.5	N	5	50	15	20	N
WS026	3.0	0.20	0.15	0.7	150	N	N	N	N	300	1.5	N	7	50	30	<20	N
WS027	3.0	1.00	1.50	0.7	700	N	N	N	N	300	2.0	N	20	50	30	20	N
WS028	3.0	0.70	0.15	1.0	500	N	N	N	N	200	30.0	N	15	30	<20	N	N
WC029	0.7	0.07	0.05	1.0	50	N	N	N	N	200	<1.0	N	15	30	<20	N	N
WS034	3.0	1.00	1.50	0.5	700	N	N	N	N	300	2.0	N	15	100	30	30	N
CRS036	3.0	1.00	1.00	0.3	500	N	N	N	N	500	2.0	N	10	50	30	20	N
CRS037	2.0	2.00	0.30	0.5	500	N	N	N	N	1000	1.5	N	5	15	70	20	N
CHS2	3.0	0.70	1.50	0.3	500	N	N	N	N	300	2.0	N	10	30	30	20	N
CHS3	2.0	0.70	1.50	0.3	500	N	N	N	N	300	3.0	N	10	30	30	<20	N
CHS4	2.0	0.70	1.50	0.3	500	N	N	N	N	300	3.0	N	10	30	20	<20	N
CHS5	3.0	0.70	1.50	0.3	700	N	N	N	N	300	3.0	N	15	30	30	20	N
CHS7	3.0	0.70	1.00	0.2	700	N	N	N	N	300	3.0	N	10	30	20	<20	N
CHS8	3.0	0.70	1.50	0.3	500	N	N	N	N	300	3.0	N	10	50	20	20	N
CHS10	2.0	0.70	1.00	0.3	700	N	N	N	N	200	3.0	N	7	30	20	20	N
CHS11	3.0	1.00	1.50	0.3	700	N	N	N	N	300	3.0	N	15	50	30	20	N
CHS12	3.0	0.70	1.50	0.3	700	N	N	N	N	300	3.0	N	10	30	20	20	N
CHS13	2.0	0.70	1.00	0.2	500	N	N	N	N	300	3.0	N	10	30	20	20	N
CHS16	3.0	0.70	1.50	0.3	700	N	N	N	N	300	3.0	N	15	30	30	20	N
CHS17	3.0	0.70	1.50	0.5	700	N	N	N	N	300	3.0	N	15	50	30	20	N
CHS19	3.0	0.70	1.50	0.2	700	N	N	N	N	300	5.0	N	10	20	20	<20	N
CHS21	3.0	0.70	1.50	0.3	700	N	N	N	N	200	5.0	N	10	30	30	<20	N
CHS25	2.0	0.50	1.00	0.2	500	N	N	N	N	200	5.0	N	7	20	20	20	N
CHS26	3.0	0.70	1.50	0.3	700	N	N	N	N	300	5.0	N	10	30	20	20	N
CHS27	3.0	0.70	1.00	0.3	500	N	N	N	N	300	5.0	N	7	20	20	20	N
CHS30	3.0	0.70	1.50	0.3	700	N	N	N	N	300	5.0	N	10	30	30	20	N
CHS32	3.0	0.70	1.50	0.3	700	N	N	N	N	200	5.0	N	10	20	30	<20	N
CHS35	3.0	0.70	1.50	0.3	700	N	N	N	N	300	5.0	N	10	30	30	20	N
CHS36	3.0	0.70	1.50	0.3	700	N	N	N	N	300	5.0	N	15	30	30	20	N
CHS37	2.0	0.70	1.00	0.2	700	N	N	N	N	300	5.0	N	10	20	20	20	N
CHS34	2.0	0.70	1.50	0.3	500	N	N	N	N	300	3.0	N	10	30	20	20	N
CHS38	3.0	0.70	1.50	0.3	700	N	N	N	N	200	5.0	N	10	20	30	<20	N
CHS29	2.0	0.70	1.50	0.5	500	N	N	N	N	200	5.0	N	10	30	30	20	N
CHS15	3.0	0.70	1.50	0.5	700	N	N	N	N	300	5.0	N	7	20	30	20	N
CHS33	3.0	0.70	1.50	0.5	500	N	N	N	N	300	5.0	N	15	50	30	20	N
CHS9	3.0	0.70	1.50	0.3	700	N	N	N	N	300	3.0	N	10	30	30	20	N
CHS24	3.0	0.70	1.00	0.3	500	N	N	N	N	300	5.0	N	15	30	30	20	N
CHS28	2.0	0.50	1.00	0.3	500	N	N	N	N	300	5.0	N	10	30	30	20	N
CHS1	6.0	0.70	1.50	0.3	500	N	N	N	N	300	5.0	N	10	30	20	20	N
CHS5	2.0	0.70	1.50	0.3	500	N	N	N	N	300	5.0	N	10	20	30	20	N
HPS01	3.0	0.70	1.00	0.3	500	N	N	N	N	300	5.0	N	10	20	20	20	N

TABLE A1-1. (Contd.)

Sample location	Element, ppm																				
	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b	Te ^b
DKC012	50	N	150	N	<5	20	300	150	N	20	N	150	N	...	N	N	N	N	N	<0.001	0.03
DKC014	70	N	70	N	<5	50	200	30	N	30	N	700	N	...	N	N	N	N	N	<0.001	0.02
DKC016	20	N	70	N	<5	15	300	70	N	15	50	50	N	...	N	N	N	N	N	<0.001	<0.02
DKS019	200	N	50	N	<5	100	N	50	N	70	N	>1000	N	...	N	N	N	N	N	0.002	0.10
WS025	<20	7	15	100	7	N	200	100	N	10	N	150	N	...	N	N	N	28	20	<0.001	0.22
WS026	<20	7	20	200	7	N	100	70	N	N	N	150	N	...	10	N	N	74	20	<0.001	0.13
WS027	<20	20	20	20	10	N	300	100	N	20	N	200	N	...	10	N	N	15	70	<0.001	<0.02
WS028	<20	15	<10	150	10	N	100	50	N	15	N	100	N	...	...	N	N	...	...	...	...
WCO29	<20	<5	50	150	20	N	150	100	N	N	N	150	N	...	N	N	N	8	5	0.004	...
WS034	<20	20	20	N	10	N	500	100	N	20	N	150	N	...	N	N	N	2	55	<0.001	<0.02
CRS036	N	15	30	N	10	<10	100	70	N	15	N	150	N	...	N	N	N	N	50	<0.001	<0.02
CRS037	<20	5	300	N	5	N	500	70	N	15	N	200	N	...	N	N	N	N	75	<0.001	<0.02
CHS2	N	15	20	N	7	N	300	70	N	20	N	150	N	...	N	N	N	N	40	0.001	<0.02
CHS3	<20	15	20	N	7	N	300	70	N	20	N	150	N	...	N	N	N	N	30	<0.001	<0.02
CHS4	<20	15	20	N	7	N	300	70	N	20	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS6	<20	15	20	N	7	N	300	100	N	20	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS7	<20	15	30	N	7	<10	300	70	N	20	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS8	20	15	30	N	7	<10	300	100	N	30	N	150	N	...	N	N	N	N	30	<0.001	<0.02
CHS10	N	10	20	N	7	N	300	70	N	30	N	100	N	...	N	N	N	N	35	<0.001	<0.02
CHS11	<20	15	20	N	7	N	300	100	N	30	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS12	<20	10	20	N	7	N	300	70	N	20	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS13	N	10	20	N	7	N	300	50	N	20	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS16	N	15	20	N	10	N	300	100	N	30	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS17	N	20	30	N	10	<10	300	100	N	30	N	200	N	...	N	N	N	N	45	<0.001	<0.02
CHS19	<20	15	30	N	7	N	300	100	N	20	N	100	N	...	N	N	N	N	25	0.002	<0.02
CHS21	N	15	30	N	10	N	300	100	N	20	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS25	<20	15	30	N	7	<10	200	70	N	20	N	150	N	...	N	N	N	N	20	<0.001	<0.02
CHS26	<20	15	30	N	7	<10	300	70	N	30	N	100	N	...	N	N	N	N	25	<0.001	<0.02
CHS27	<20	15	30	N	7	<10	300	70	N	20	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS30	<20	20	30	N	10	<10	300	70	N	30	N	150	N	...	N	N	N	N	20	<0.001	<0.02
CHS32	N	15	30	N	7	<10	300	70	N	20	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS35	<20	15	30	N	7	<10	300	70	N	20	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS36	<20	15	30	N	7	<10	300	70	N	30	N	70	N	...	N	N	N	N	20	<0.001	<0.02
CHS37	<20	15	30	N	7	<10	300	70	N	30	N	150	N	...	N	N	N	N	20	<0.001	<0.02
CHS34	<20	15	30	N	7	<10	300	70	N	30	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS38	<20	20	30	N	7	<10	300	70	N	30	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS29	N	15	30	N	7	N	200	70	N	30	N	200	N	...	N	N	N	N	35	<0.001	<0.02
CHS15	N	20	20	N	10	N	300	100	N	30	N	150	N	...	10	N	N	N	40	<0.001	0.04
CHS33	<20	20	30	N	7	N	300	100	N	30	N	150	N	...	N	N	N	N	35	<0.001	<0.02
CHS9	N	15	30	N	7	N	300	100	N	30	N	200	N	...	N	N	N	N	40	<0.001	<0.02
CHS24	<20	20	30	N	7	<10	300	100	N	30	N	300	N	...	N	N	N	N	25	<0.001	0.02
CHS28	N	15	30	N	7	<10	300	70	N	30	N	150	N	...	N	N	N	N	25	<0.001	<0.02
CHS1	N	15	30	N	7	<10	300	70	N	30	N	150	N	...	N	N	N	N	45	<0.001	<0.02
CHS5	N	15	30	N	7	N	300	70	N	30	N	150	N	...	N	N	N	N	40	<0.001	<0.02
HP501	<20	20	30	N	7	N	300	100	N	30	N	150	N	...	N	N	N	N	30	<0.001	<0.02

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE A1-2. Spectrographic and Chemical Analyses of Soil Samples Collected From the Coso Volcanic Field. Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected; < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Element, %							Element, ppm										
			Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo
HPS03	36 1 52	117 47 59	3.0	0.70	1.00	0.3	500	N	N	N	50	300	5.0	N	N	10	30	30	N	N
HPS04	36 1 54	117 48 2	3.0	0.70	1.00	0.3	500	N	N	N	100	200	5.0	N	N	10	15	30	20	N
PTS12	36 0 34	117 48 20	3.0	0.70	1.50	0.5	500	N	N	N	300	300	5.0	N	N	15	30	30	20	N
WTS4	36 1 24	117 46 10	3.0	0.70	1.50	0.5	500	N	N	N	15	300	3.0	N	N	15	50	30	20	N
TRS3	36 0 56	117 48 11	3.0	0.70	1.50	0.5	500	N	N	N	30	300	5.0	N	N	15	20	30	20	N
TRS4	36 0 59	117 48 14	3.0	0.70	1.50	0.5	500	N	N	N	30	300	5.0	N	N	10	50	30	20	N
DKFS5	36 2 22	117 47 40	3.0	0.70	1.50	0.3	500	N	N	N	30	500	3.0	N	N	10	30	20	20	N
DKFS14	36 2 18	117 47 30	2.0	0.50	0.70	0.3	500	N	N	N	30	200	5.0	N	N	10	20	20	20	N
DKFS10	36 2 28	117 47 28	2.0	0.70	1.00	0.3	500	N	N	N	30	200	5.0	N	N	10	20	20	20	N
DKFS2	36 2 28	117 47 40	3.0	0.70	1.50	0.3	500	N	N	N	20	300	3.0	N	N	10	30	20	20	N
PTS9	36 0 43	117 48 20	3.0	0.70	1.50	0.3	500	N	N	N	30	300	5.0	N	N	10	50	30	20	N
WTS1	36 1 20	117 46 7	3.0	1.00	1.50	0.3	700	N	N	N	15	500	1.5	N	N	15	50	30	20	N
WTS3	36 1 23	117 46 9	3.0	1.00	1.50	0.5	700	N	N	N	15	300	2.0	N	N	15	50	30	20	N
PTS10	36 0 40	117 48 18	2.0	0.70	1.50	0.3	500	N	N	N	30	300	5.0	N	N	10	30	20	20	N
PTS11	36 0 38	117 48 18	2.0	0.70	1.50	0.3	500	N	N	N	30	300	5.0	N	N	10	30	20	20	N
WTS8	36 1 28	117 46 15	3.0	1.50	3.00	0.7	1000	N	N	N	10	500	<1.0	N	N	30	50	50	20	N
WTS10	36 1 30	117 46 17	5.0	1.50	3.00	0.7	700	N	N	N	<10	700	<1.0	N	N	50	50	50	20	N
WTS9	36 1 28	117 46 16	3.0	1.00	3.00	0.5	1500	N	N	N	<20	700	<1.0	N	N	30	20	30	20	N
WTS5	36 1 24	117 46 12	5.0	1.00	2.00	0.5	700	N	N	N	30	500	1.0	N	N	30	50	30	20	N
PTS6	36 0 48	117 48 22	3.0	0.70	1.50	0.5	700	N	N	N	30	300	3.0	N	N	20	50	30	20	N
WTS2	36 1 22	117 46 8	3.0	0.70	1.50	0.3	700	N	N	N	N	500	1.5	N	N	20	30	30	20	N
WTS14	36 1 32	117 46 20	3.0	1.50	2.00	0.5	700	N	N	N	N	500	<1.0	N	N	30	100	50	20	N
WTS12	36 1 30	117 46 20	5.0	1.50	2.00	0.5	700	N	N	N	N	500	1.0	N	N	30	100	50	20	N
WTS11	36 1 29	117 46 18	5.0	1.50	2.00	0.7	700	N	N	N	N	500	1.0	N	N	30	70	50	20	N
WTS15	36 1 33	117 46 21	5.0	1.50	3.00	0.5	700	N	N	N	N	300	<1.0	N	N	20	100	30	20	N
P2052	36 1 3	117 48 25	3.0	0.70	1.50	0.5	500	N	N	N	50	300	3.0	N	N	10	50	30	20	N
NFS4	36 2 5	117 47 58	1.5	0.30	0.50	0.2	200	N	N	N	30	300	3.0	N	N	5	30	20	20	N
TRS2	36 0 57	117 48 8	2.0	0.70	1.50	0.3	500	N	N	N	30	300	5.0	N	N	10	30	30	20	N
DKFS17	36 2 14	117 47 32	2.0	0.70	1.00	0.3	500	N	N	N	30	300	7.0	N	N	10	30	20	20	N
DKFS24	36 2 27	117 46 47	3.0	1.00	1.50	0.5	700	N	N	N	30	500	3.0	N	N	15	50	30	20	N
DKFS22	36 2 32	117 46 48	3.0	1.00	1.50	0.3	700	N	N	N	30	300	2.0	N	N	15	100	30	20	N
DKFS23	36 2 30	117 46 47	3.0	1.00	1.50	0.3	1000	N	N	N	20	500	2.0	N	N	15	100	30	20	N
DKFS6	36 2 22	117 47 40	3.0	0.70	1.50	0.3	700	N	N	N	30	500	5.0	N	N	15	50	30	20	N
DKFS19	36 2 38	117 46 49	3.0	1.00	1.50	0.5	700	N	N	N	20	500	1.0	N	N	20	50	30	30	N
DKFS1	36 2 31	117 47 40	3.0	1.00	1.50	0.5	700	N	N	N	20	300	3.0	N	N	20	50	30	20	N
DKFS21	36 2 34	117 46 48	3.0	1.00	1.50	0.5	700	N	N	N	20	500	3.0	N	N	20	70	30	20	N
DKFS12	36 2 25	117 47 28	3.0	1.00	1.50	0.5	700	N	N	N	20	300	2.0	N	N	15	30	30	20	N
DKFS18	36 2 12	117 47 30	3.0	0.70	1.00	0.3	700	N	N	N	30	300	5.0	N	N	10	50	30	20	N
DKFS7	36 2 18	117 47 38	3.0	0.70	1.50	0.5	700	N	N	N	15	300	3.0	N	N	20	70	30	20	N
DKFS20	36 2 36	117 46 48	3.0	0.70	1.50	0.3	700	N	N	N	15	300	3.0	N	N	20	50	30	20	N
DKFS9	36 2 30	117 47 28	3.0	0.70	1.50	0.5	700	N	N	N	20	300	3.0	N	N	15	30	30	20	N
DKFS13	36 2 22	117 47 28	0.7	0.07	0.05	0.3	100	N	N	N	20	200	3.0	N	N	N	20	15	20	N
PTS7	36 0 46	117 48 20	2.0	0.70	1.50	0.3	500	N	N	N	20	300	3.0	N	N	15	50	30	20	N
WTS5	36 1 25	117 46 15	3.0	1.00	1.50	0.5	700	N	N	N	20	300	2.0	N	N	20	70	30	30	N
PTS 5	36 0 30	117 48 20	3.0	0.70	1.50	0.3	700	N	N	N	30	300	5.0	N	N	15	30	30	20	N

TABLE A1-2. (Contd.)

Sample Location	Element, ppm																					
	Ne	N	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	B ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b	T ^b	
HPS03	<20	20	30	N	7	<10	300	100	N	30	N	200	N	N	10	N	N	N	2	35	<0.001	<0.02
HPS04	<20	20	30	N	7	<10	300	70	N	30	N	150	N	0.44	30	N	N	N	2	45	<0.001	<0.02
PTS12	<20	20	30	N	10	N	300	100	N	30	N	150	N	0.06	10	N	N	N	N	40	<0.001	<0.02
WFS4	N	20	30	N	10	N	500	100	N	30	N	200	N	1.70	10	N	N	N	N	60	<0.001	0.04
TRS3	N	20	30	N	10	N	300	100	N	30	N	200	N	0.04	N	N	N	N	N	30	<0.001	<0.02
TRS4	N	20	30	N	10	N	300	100	N	30	N	150	N	0.10	N	N	N	N	N	40	<0.001	<0.02
DKFS5	<20	15	30	N	10	N	300	100	N	30	N	150	N	0.62	N	N	N	N	N	35	<0.001	0.05
DKFS14	<20	15	30	N	7	<10	200	100	N	20	N	200	N	1.50	N	N	N	N	N	25	<0.001	<0.02
DKFS10	<20	15	30	N	7	<10	200	70	N	20	N	150	N	5.30	N	N	N	N	N	30	<0.001	<0.02
DKFS2	N	15	20	N	7	N	300	100	N	20	N	150	N	0.40	N	N	N	N	N	40	<0.001	0.02
PTS9	<20	20	30	N	10	<10	300	100	N	30	N	150	N	0.14	N	N	N	N	N	30	0.005	<0.02
WFS1	N	20	15	N	10	N	500	100	N	20	N	150	N	1.90	N	N	N	N	N	70	<0.001	0.02
WFS3	N	20	20	N	10	N	500	100	N	20	N	100	N	5.40	<10	N	0.1	2	70	<0.001	0.02	
PTS10	<20	15	30	N	7	N	300	70	N	20	N	150	N	0.08	N	N	N	N	30	<0.001	<0.02	
PTS11	N	15	30	N	7	<10	300	100	N	20	N	200	N	0.10	N	N	N	N	30	<0.001	<0.02	
WFS8	N	50	20	N	10	N	500	200	N	20	N	150	N	2.40	N	N	N	N	N	95	<0.001	0.06
WFS10	N	50	20	N	10	N	500	200	N	20	N	200	N	0.30	10	N	N	N	N	85	<0.001	<0.02
WFS9	N	10	20	N	10	N	500	150	N	20	N	100	N	0.98	N	N	N	N	N	95	0.001	<0.02
WFS5	<20	30	20	N	10	N	500	150	N	20	N	200	N	0.16	<10	N	0.1	2	60	<0.001	0.08	
PTS6	N	20	30	N	10	<10	300	100	N	20	N	150	N	0.16	N	N	N	N	40	<0.001	0.02	
WFS2	N	20	20	N	7	N	300	150	N	20	N	150	N	4.50	<10	N	N	N	N	65	<0.001	0.04
WFS14	N	50	20	N	15	N	500	150	N	20	N	150	N	0.12	N	N	0.1	N	N	80	<0.001	<0.02
WFS12	N	50	20	N	15	N	500	150	N	20	N	150	N	0.72	N	N	N	N	N	70	<0.001	0.02
WFS11	N	50	30	N	15	N	500	150	N	30	N	200	N	0.38	N	N	N	N	N	90	<0.001	0.05
WFS15	N	50	20	N	15	N	500	200	N	20	N	150	N	0.12	N	N	0.1	N	N	75	<0.001	<0.02
P2052	<20	20	20	N	10	<10	300	100	N	20	N	150	N	1.30	N	N	N	N	N	30	<0.001	0.02
NFS4	N	7	20	N	5	N	200	70	N	15	N	150	N	>16.00	N	N	N	N	N	10	0.007	<0.02
TRS2	<20	20	30	N	10	N	300	100	N	20	N	200	N	0.10	N	N	0.1	N	N	35	<0.001	0.02
DKFS17	<20	15	30	N	7	N	300	100	N	20	N	150	N	0.54	N	N	N	N	N	30	<0.001	0.04
DKFS24	N	30	20	N	10	N	500	100	N	30	N	150	N	0.16	N	N	N	N	N	50	<0.001	0.04
DKFS22	N	50	20	N	10	N	500	100	N	20	N	150	N	0.22	N	N	N	N	N	45	<0.001	0.02
DKFS23	N	50	20	N	10	N	500	100	N	30	N	150	N	0.28	N	N	N	N	N	40	<0.001	0.06
DKFS6	<20	20	30	N	10	<10	300	100	N	30	N	200	N	0.30	N	N	N	N	N	30	<0.001	<0.02
DKFS19	<20	30	20	N	10	N	500	100	N	30	N	150	N	0.28	N	N	N	N	N	50	0.002	<0.02
DKFS1	N	30	20	N	10	N	500	100	N	30	N	150	N	0.20	N	N	0.1	N	N	45	<0.001	<0.02
DKFS21	N	30	20	N	10	N	500	150	N	30	N	200	N	3.40	N	N	N	N	N	35	0.001	<0.02
DKFS12	<20	20	30	N	10	N	500	100	N	30	N	150	N	7.20	N	N	N	N	N	35	<0.001	<0.02
DKFS18	N	20	30	N	7	N	300	70	N	30	N	150	N	0.22	N	N	N	N	N	30	<0.001	<0.02
DKFS7	20	20	30	N	10	<10	300	100	N	30	N	150	N	0.40	N	N	0.1	N	N	25	<0.001	<0.02
DKFS20	<20	20	20	N	10	N	500	100	N	20	N	150	N	9.40	N	N	N	N	N	40	<0.001	<0.02
DKFS9	<20	20	20	N	5	N	300	100	N	30	N	150	N	0.26	N	N	N	N	N	40	<0.001	0.02
DKFS13	<20	<5	20	N	10	N	300	70	N	15	N	150	N	>16.00	N	N	N	N	N	5	<0.001	<0.02
PTS7	<20	15	30	N	7	N	300	70	N	20	N	150	N	0.20	N	N	0.1	N	N	40	<0.001	<0.02
WFS5	N	30	20	N	10	N	500	100	N	30	N	100	N	11.00	<10	N	N	N	2	50	<0.001	<0.02
PTS15	<20	20	30	N	7	N	300	70	N	30	N	150	N	0.06	N	N	N	N	N	30	<0.001	<0.02

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE A2-1. Spectrographic and Chemical Analyses of Rock Samples Collected From the Coso Volcanic Field. Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected. < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Element, %				Element, ppm													
			Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo
B41	35 57 62	117 50 5	3.00	1.50	3.00	1.00	700	N	N	N	N	N	N	N	N	20	30	30	20	N
B42	35 57 52	117 50 35	5.00	2.00	3.00	1.00	1000	N	N	N	N	N	N	N	N	30	30	30	<20	N
B43	35 57 52	117 50 35	5.00	2.00	3.00	1.00	1000	N	N	N	N	N	N	N	N	30	50	30	<20	N
D41	36 2 45	117 48 24	0.70	0.03	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	<5	<20	<5	N
D42	36 2 45	117 48 30	0.70	0.07	0.30	0.02	150	N	N	N	N	N	N	N	N	10	10	<5	<20	N
D43	36 2 40	117 48 25	0.70	0.05	0.20	0.03	300	N	N	N	N	N	N	N	N	10	10	<5	N	N
D44	36 2 40	117 48 35	0.70	<0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	N
D45	36 2 48	117 48 32	0.70	<0.02	0.15	0.03	150	N	N	N	N	N	N	N	N	10	10	<20	N	N
D46	36 2 46	117 48 55	0.70	<0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D47	36 2 56	117 48 59	0.70	0.03	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D48	36 2 53	117 48 36	0.70	0.03	0.15	0.02	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D49	36 2 53	117 48 36	1.00	0.05	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D50	36 3 2	117 48 48	0.70	<0.02	0.20	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D51	36 6 2	117 48 12	0.71	0.03	0.15	0.02	150	N	N	N	N	N	N	N	N	<10	15	N	N	N
D52	36 6 22	117 48 27	0.70	0.05	0.20	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	<5
D53	36 6 22	117 48 27	0.70	<0.02	0.20	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	<5
D54	36 6 13	117 48 45	0.70	0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	<5
D55	36 6 13	117 48 45	0.70	<0.02	0.15	0.02	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D56	36 5 54	117 48 38	0.70	0.02	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	7	N	N	N
D57	36 5 3	117 48 38	0.70	0.10	0.20	0.03	150	N	N	N	N	N	N	N	N	10	30	<20	N	N
D58	36 5 4	117 48 31	0.70	0.07	0.15	0.03	150	N	N	N	N	N	N	N	N	10	10	<5	<20	N
D59	36 5 4	117 48 24	0.70	0.07	0.15	0.03	200	N	N	N	N	N	N	N	N	10	10	<5	<20	N
D60	36 5 9	117 48 25	0.70	0.03	0.20	0.03	150	N	N	N	N	N	N	N	N	10	10	<5	<20	N
D61	36 5 12	117 48 5	0.70	0.07	0.20	0.03	150	0.7	N	N	N	N	N	N	N	<10	5	N	N	N
D62	36 5 16	117 48 8	0.70	0.15	0.30	0.03	200	N	N	N	N	N	N	N	N	N	<5	<20	N	N
D63	36 5 3	117 48 48	0.50	<0.02	0.10	0.02	150	N	N	N	N	N	N	N	N	<10	N	<20	N	N
D64	36 4 42	117 48 47	0.70	<0.02	0.10	0.03	150	N	N	N	N	N	N	N	N	<10	N	<20	N	N
D65	36 4 32	117 49 13	0.70	0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	N
D66	36 4 32	117 49 13	0.70	<0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D67	36 4 54	117 49 12	0.70	<0.02	0.10	0.03	150	N	N	N	N	N	N	N	N	10	<5	N	N	N
D68	36 4 26	117 49 10	0.70	0.02	0.10	0.03	150	N	N	N	N	N	N	N	N	<10	<5	N	N	N
D69	36 4 26	117 49 10	0.70	0.03	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	N
D70	36 4 28	117 49 18	0.70	0.2	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	N	N	N
D71	36 4 18	117 49 23	0.70	0.05	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	15	<20	N	N
D72	36 4 17	117 49 12	0.70	0.02	0.15	0.03	200	N	N	N	N	N	N	N	N	N	5	N	N	N
D73	36 3 52	117 49 50	0.70	<0.02	0.10	0.03	200	N	N	N	N	N	N	N	N	N	<5	<20	N	N
D74	36 3 57	117 49 42	0.70	0.03	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D75	36 3 54	117 49 38	0.70	0.07	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D76	36 3 54	117 49 38	0.70	0.07	0.15	0.03	200	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D77	36 3 45	117 49 46	0.70	0.03	0.15	0.03	200	0.5	N	N	N	N	N	N	N	<10	<5	<20	N	N
D78	36 3 51	117 49 11	0.70	<0.02	0.10	0.03	150	N	N	N	N	N	N	N	N	N	<5	N	N	N
D79	36 3 41	117 49 14	0.70	0.03	0.10	0.03	200	N	N	N	N	N	N	N	N	<10	5	N	N	N
D80	36 3 41	117 49 3	0.70	<0.02	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N
D81	36 3 50	117 49 2	0.70	0.03	0.15	0.03	200	N	N	N	N	N	N	N	N	10	<5	<20	N	N
D82	36 3 50	117 49 2	0.70	0.02	0.15	0.03	150	N	N	N	N	N	N	N	N	<10	<5	<20	N	N

TABLE A2-1. (Contd.)

Sample location	Element, ppm																				
	Nb	Ni	Pb	Sb	Sc	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cdb	Sbb ^b	Znb	Aub	Teb ^b	
BA1	15	<10	N	15	15	300	150	N	20	N	100	N	...	N	N	N	N	N	85	<0.001	<0.02
BA2	20	<10	N	20	20	300	150	N	20	N	150	N	...	N	N	N	N	N	80	<0.001	<0.02
BA3	N	30	N	N	20	300	200	N	20	N	150	N	...	N	N	N	N	N	80	<0.001	<0.02
DA1	20	<5	30	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	5	<0.001	<0.02	
DA2	20	<5	50	N	15	N	<10	N	30	N	50	N	...	N	N	N	N	5	<0.001	<0.02	
DA3	20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02	
DA4	<20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	<5	<0.001	<0.02
DA5	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DB1	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DB2	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<5	<0.001	<0.02
DB3	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	0.001	0.001	<0.02
DB4	<20	<5	50	N	15	N	<10	N	50	N	50	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DB5	20	<5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DC1	20	<5	50	N	20	N	<10	N	70	N	100	N	...	N	N	N	N	<5	<0.001	<0.02	
DC2	30	<5	50	N	20	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02	
DC3	30	<5	50	N	20	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DC4	50	<5	70	N	20	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DC5	30	<5	50	N	20	N	<10	N	70	N	100	N	...	N	N	N	N	5	<0.001	<0.02	
DC6	50	5	70	N	30	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DD1	20	5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DD2	20	5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DE1	20	<5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DE2	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DF1	20	5	30	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DF2	20	<5	30	N	10	N	<10	N	30	N	150	N	...	N	N	N	N	N	0.001	0.001	<0.02
DG1	<20	<5	30	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DG2	20	<5	30	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DG3	20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DG4	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DG5	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DH1	20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DH2	20	5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DH3	20	5	30	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	<5	<0.001	<0.02	
DH4	20	<5	50	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	5	<0.001	<0.02	
DH5	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.001	<0.02
DI1	20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DI2	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
DI3	20	<5	50	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02	
DI4	20	<5	50	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DI5	20	<5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DJ1	20	<5	50	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DJ2	20	<5	50	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DJ3	20	5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DJ4	20	<5	50	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	
DJ5	20	<5	30	N	15	N	<10	N	30	N	150	N	...	N	N	N	N	<5	<0.001	<0.02	

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE A2-2. Spectrographic and Chemical Analyses of Rock Samples Collected From the Coso Volcanic Field. Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected; < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Latitude (degrees, minutes, seconds)		Longitude (degrees, minutes, seconds)		Element %							Element ppm										
					Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo
DK1	36 3 30	117 48 45	0.30	0.02	0.07	0.02	0.02	150	N	N	N	50	N	N	7.0	N	N	N	<10	30	N	N
DK2	36 3 20	117 48 45	0.70	0.02	0.10	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DK3	36 3 22	117 48 37	0.70	0.03	0.15	0.03	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DK4	37 3 15	117 48 49	0.70	0.02	0.15	0.03	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DK5	36 3 20	117 48 56	0.70	<0.02	0.10	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DL1	36 2 58	117 49 7	0.70	0.02	0.15	0.03	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DL2	36 3 1	117 49 8	0.70	0.07	0.15	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DL3	36 3 0	117 49 35	0.70	0.02	0.10	0.02	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DM1	36 4 37	117 51 32	0.70	0.02	0.15	0.03	150	N	1.0	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DM2	36 4 42	117 51 36	0.70	0.05	0.20	0.03	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DN1	36 4 55	117 51 12	0.70	0.07	0.15	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DN2	36 4 39	117 51 11	0.70	0.10	0.30	0.03	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DO1	36 4 48	117 51 3	1.00	0.05	0.15	0.03	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DO2	36 4 43	117 50 57	0.70	<0.02	0.15	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DP1	36 5 4	117 51 35	0.70	<0.02	0.10	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DP2	36 5 7	117 51 35	1.00	<0.02	0.07	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DP3	36 5 5	117 51 44	0.70	0.02	0.07	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DP4	36 5 5	117 51 44	1.00	<0.02	0.07	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DP5	36 5 11	117 51 37	0.70	0.03	0.07	0.02	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DQ1	36 5 23	117 51 21	0.70	0.03	0.15	0.02	150	N	N	N	50	N	N	7.0	N	N	N	<10	5	N	N	<5
DQ2	36 5 27	117 51 8	0.70	0.07	0.30	0.02	150	N	N	N	50	N	N	7.0	N	N	N	<10	<5	<20	N	N
DQ3	36 5 32	117 51 12	0.70	0.03	0.15	0.02	150	N	N	N	50	N	N	7.0	N	N	N	<10	<5	<20	N	N
DQ4	36 5 28	117 51 19	0.70	<0.02	0.15	0.02	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DQ5	36 5 28	117 51 19	0.70	0.05	0.15	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DR1	35 57 36	117 50 24	0.50	0.03	0.15	0.15	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DR2	35 57 34	117 50 41	0.70	0.03	0.15	0.02	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DR3	35 57 43	117 50 47	0.70	0.02	0.10	0.02	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DR4	35 57 50	117 50 31	0.70	0.02	0.15	0.03	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DR5	35 57 50	117 50 31	0.70	<0.02	0.10	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DS1	35 58 15	117 49 58	0.70	0.10	0.15	0.03	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DS2	35 58 16	117 50 5	0.70	0.05	0.20	0.03	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DT1	35 59 28	117 48 55	0.70	0.05	0.15	0.03	150	N	N	N	50	N	N	7.0	N	N	N	<10	<5	<20	N	N
DT2	35 59 22	117 48 53	0.70	0.05	0.15	0.03	150	N	N	N	50	N	N	7.0	N	N	N	<10	<5	<20	N	N
DU1	35 59 45	117 48 33	0.70	0.02	0.10	0.03	150	N	N	N	50	N	N	7.0	N	N	N	<10	<5	<20	N	N
DU2	35 59 55	117 48 5	0.70	0.02	0.15	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DV1	35 59 53	117 49 7	0.50	0.02	0.05	0.01	150	N	N	N	70	N	N	5.0	N	N	N	<10	<5	<20	N	N
DV2	35 59 40	117 49 1	0.70	<0.02	0.07	0.02	150	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DW1	36 1 53	117 47 52	0.70	0.03	0.15	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DW2	36 1 48	117 47 48	0.70	0.02	0.15	0.03	200	N	N	N	70	N	N	10.0	N	N	N	<10	<5	<20	N	N
DX1	36 0 21	117 47 38	0.70	0.02	0.10	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DX2	36 0 20	117 48 5	0.70	0.02	0.15	0.03	150	N	N	N	50	N	N	7.0	N	N	N	<10	20	<20	N	N
DY1	36 0 38	117 48 52	0.70	0.02	0.15	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DY2	36 0 51	117 48 54	0.70	<0.02	0.10	0.02	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DA6	36 2 48	117 48 32	0.70	0.07	0.20	0.03	150	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N
DB6	36 3 2	117 48 46	0.70	0.05	0.15	0.03	200	N	N	N	70	N	N	7.0	N	N	N	<10	<5	<20	N	N

TABLE A2-2. (Contd.)

Sample location	Element, ppm																		
	Nb	Ni	Pb	Sb	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	B ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b	Te ^b
DK1	<20	<5	30	N	N	<10	N	30	N	50	N	...	N	N	N	N	N	<0.001	<0.02
DK2	20	5	30	N	N	<10	N	30	N	100	N	...	N	N	N	N	N	<0.001	<0.02
DK3	20	<5	30	N	N	<10	N	50	N	150	N	...	N	N	N	N	N	<0.002	<0.02
DK4	20	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	N	<0.001	<0.02
DK5	20	<5	30	N	N	<10	N	50	N	100	N	...	N	N	N	N	N	<0.001	<0.02
DL1	30	<5	50	N	N	<10	N	50	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DL2	30	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	10	<0.001	<0.02
DL3	20	<5	50	N	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DM1	20	<5	30	N	N	<10	N	70	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DM2	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DN1	30	5	50	N	N	<10	N	50	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DN2	30	<5	50	N	N	<10	N	70	N	100	N	...	N	N	N	N	5	<0.001	<0.02
DO1	20	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DO2	30	<5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DP1	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DP2	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DP3	30	<5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DP4	30	<5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DP5	20	5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DO1	30	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DO2	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DO3	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DO4	20	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DO5	20	<5	50	N	N	<10	N	100	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DR1	<20	<5	50	N	N	<10	N	30	N	70	N	...	N	N	N	N	N	<0.001	<0.02
DR2	<20	<5	50	N	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DR3	20	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DR4	<20	<5	50	N	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DR5	<20	<5	50	N	N	<10	N	150	N	150	N	...	N	N	N	N	N	<0.001	<0.02
DS1	30	5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	N	<0.001	<0.02
DS2	30	<5	50	N	N	<10	N	70	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DT1	20	<5	50	N	N	<10	N	30	N	150	N	...	N	N	N	N	N	<0.001	<0.02
DT2	20	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	N	<0.001	<0.02
DU1	<20	<5	50	N	N	<10	N	30	N	150	N	...	N	N	N	N	5	<0.001	<0.02
DU2	20	<5	50	N	N	<10	N	50	N	100	N	...	N	N	N	N	N	<0.001	<0.02
DV1	<20	5	50	N	N	<10	N	20	N	30	N	...	N	N	N	N	<5	<0.001	<0.02
DV2	20	<5	50	N	N	<10	N	50	N	50	N	...	N	N	N	N	<5	<0.001	<0.02
DW1	30	<5	70	N	N	<10	N	70	N	150	N	...	N	N	N	N	10	<0.001	<0.02
DW2	30	<5	50	N	N	<10	N	50	N	70	N	...	N	N	N	N	15	<0.001	<0.02
DX1	<20	<5	50	N	N	<10	N	50	N	100	N	...	N	N	N	N	N	<0.001	<0.02
DX2	<20	<5	30	N	N	<10	N	30	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DY1	<20	5	30	N	N	<10	N	50	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DY2	20	<5	50	N	N	<10	N	30	N	100	N	...	N	N	N	N	<5	<0.001	<0.02
DA6	<20	<5	50	N	N	<10	N	50	N	150	N	...	N	N	N	N	<5	<0.001	<0.02
DB6	<20	<5	50	N	N	<10	N	50	N	100	N	...	N	N	N	N	<5	<0.001	<0.02

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE A2-3. Spectrographic and Chemical Analyses of Rock Samples Collected From the Coso Volcanic Field. Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected, < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Element, %						Element, ppm											
			Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo
DC7	36 5 54	117 48 38	0.70	0.02	0.10	0.02	150	N	N	70	N	10.0	N	N	N	<10	N	N	N	
DG6	36 4 54	117 49 12	0.70	<0.02	0.10	0.03	150	N	N	70	7.0	N	N	N	<10	N	N	N	N	
DH6	36 4 17	117 49 12	1.00	0.02	0.15	0.03	150	N	N	70	7.0	N	N	N	<10	<5	<20	N	N	
D16	36 3 45	117 49 46	0.70	0.03	0.10	0.03	150	N	N	70	7.0	N	N	N	<10	<5	<20	N	N	
D16	36 3 50	117 49 2	0.70	<0.02	0.15	0.03	150	N	N	70	7.0	N	N	N	<10	<5	<20	N	N	
DK6	36 3 20	117 48 56	1.00	0.03	0.15	0.03	200	N	N	70	7.0	N	N	N	<10	<5	<20	N	N	
DL4	36 3 0	117 49 35	0.70	<0.02	0.15	0.02	150	N	N	70	7.0	N	N	N	<10	<5	<20	N	N	
DP6	36 5 11	117 51 37	0.70	<0.02	0.15	0.02	150	N	N	70	10.0	N	N	N	<10	<5	<20	N	N	
DQ6	36 5 28	117 51 19	0.70	<0.02	0.15	0.02	150	N	N	70	10.0	N	N	N	<10	<5	<20	N	<5	
DR6	35 57 50	117 50 31	0.70	<0.02	0.10	0.02	200	N	N	70	7.0	N	N	N	<10	N	N	N	N	
DU3	35 59 55	117 48 5	0.70	<0.02	0.15	0.03	150	N	N	50	7.0	N	N	N	<10	<5	<20	N	<5	
DW3	36 1 48	117 47 48	0.70	0.05	0.20	0.03	300	N	N	70	10.0	N	N	N	<10	<5	<20	N	N	
DKR010	36 2 3	117 47 1	0.05	<0.02	<0.05	0.10	<10	N	N	N	300	N	N	N	20	5	20	N	N	
DKR017	36 2 2	117 47 55	0.10	<0.02	<0.05	0.20	<10	N	N	N	300	N	N	N	10	<5	20	N	N	
DKR018	36 2 5	117 48 4	0.20	<0.02	<0.05	0.10	15	N	N	15	1.5	N	N	N	15	7	20	N	N	
DKR020	36 2 9	117 47 59	0.70	<0.02	<0.05	0.20	<10	N	N	N	<1.0	N	N	N	10	10	30	N	N	
DKR021	36 2 9	117 47 53	0.05	0.02	<0.05	0.15	70	N	N	70	3.0	N	N	N	20	<5	N	N	N	
WR024	36 1 25	117 46 5	0.30	0.02	<0.05	0.07	<10	N	N	30	5.0	N	N	N	<10	5	N	N	N	
WR030	36 1 18	117 46 4	0.50	0.07	0.07	0.05	500	N	N	70	7.0	N	N	N	<10	7	<20	N	N	
WR031	36 1 19	117 46 5	0.07	<0.02	<0.05	0.03	15	N	N	100	<20	N	N	N	10	<5	N	N	N	
WR032	36 1 20	117 46 10	0.50	0.10	<0.05	0.07	70	N	N	10	7.0	N	N	N	N	<5	N	N	N	
WR033	36 1 22	117 46 3	0.07	<0.02	<0.05	0.07	20	N	N	300	5.0	N	N	N	<10	<5	N	N	N	
NR035	36 2 25	117 47 28	0.07	0.05	0.05	0.70	15	N	N	30	1000	N	N	N	N	20	<20	N	N	
MA5	36 2 35	117 49 56	0.70	0.05	0.15	0.03	200	N	N	50	10.0	N	N	N	<10	<5	<20	N	N	
MA2	36 1 50	117 49 12	0.70	0.05	0.20	0.03	200	N	N	50	10.0	N	N	N	<10	<5	20	N	N	
MA1	36 2 17	117 48 48	10.00	2.00	3.00	>1.00	1000	N	N	N	<1.0	N	N	N	50	30	20	N	N	
MA3	36 2 5	117 49 12	0.70	0.03	0.15	0.05	200	N	N	50	7.0	N	N	N	10	N	<20	N	N	
MA4	36 1 55	117 50 28	1.00	0.02	0.15	0.03	200	N	N	50	10.0	N	N	N	10	N	<20	N	N	
MA6	36 1 55	117 48 35	0.70	0.03	0.15	0.05	200	N	N	70	10.0	N	N	N	<10	<5	20	N	5	
MA7	36 2 25	117 48 49	1.00	0.10	0.30	0.05	200	N	N	70	10.0	N	N	N	N	5	20	N	5	
HPR2	36 1 45	117 48 10	1.00	0.03	0.20	0.07	300	N	N	70	10.0	N	N	N	<10	5	20	N	N	
HPR02	36 1 49	117 47 55	0.70	0.05	0.15	0.03	300	N	N	70	15.0	N	N	N	<10	7	<20	N	N	
DFR13	36 2 23	117 47 28	0.07	<0.02	<0.05	0.03	10	N	N	N	3.0	N	N	N	<10	7	<20	N	N	
WTR1	36 1 20	117 46 8	0.70	0.05	0.30	0.03	200	N	N	N	2.0	N	N	N	10	N	N	N	N	
WTR4	36 1 24	117 46 12	0.30	0.02	0.20	0.03	300	N	N	N	1.0	N	N	N	N	5	N	N	N	

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TABLE A2-3. (Contd.)

Sample location	Element, ppm																					
	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cdb	Sbb	Znb	Aub	Te ^b	
DC7	30	<5	50	N	N	15	N	<10	N	70	N	100	N	...	N	N	N	N	N	5	<0.001	<0.02
DG6	20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DH6	20	5	50	N	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	N	<5	<0.001	<0.02
Di6	<20	<5	50	N	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	<5	<0.001	<0.02
D16	20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	<5	<0.001	<0.02
DK6	20	<5	50	N	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
DL4	20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	<5	<0.001	<0.02
DP6	20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DO6	30	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	<5	<0.001	<0.02
DR6	20	<5	50	N	N	15	N	<10	N	30	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
DU3	<20	<5	30	N	N	10	N	<10	N	30	N	150	N	...	N	N	N	N	N	5	<0.001	<0.02
DW3	20	5	50	N	N	20	N	<10	N	50	N	100	N	...	N	N	N	N	N	15	<0.001	<0.02
DKR010	<20	<5	30	N	N	<5	N	20	N	30	N	300	N	...	N	N	N	N	N	N	0.004	0.02
DKR017	30	<5	500	N	N	15	N	15	N	<10	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
DKR018	<20	<5	50	N	N	<10	N	10	N	10	N	50	N	...	N	N	N	N	N	N	<0.001	<0.02
DKR020	30	<5	50	N	N	15	N	<10	N	N	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
DKR021	<20	<5	<10	N	N	<10	N	<10	N	<10	N	150	N	...	N	N	N	N	N	...	...	...
WR024	<20	<5	<10	N	N	<10	N	20	N	15	N	10	N	...	N	N	N	N	N	...	...	...
WR030	N	5	<10	N	N	N	N	20	N	15	N	10	N	...	N	N	N	N	N	10	<0.001	<0.02
WR031	N	<5	N	N	N	N	N	<10	N	N	N	<10	N	...	N	N	N	N	N	2	<0.001	<0.02
WR032	N	5	N	N	N	N	N	10	N	N	N	10	N	...	N	N	N	N	N	24	<0.001	<0.02
WR033	N	<5	N	N	N	N	N	10	N	N	N	30	N	...	N	N	N	N	N	6	<0.001	<0.02
WR035	<20	<5	15	N	N	10	N	20	N	15	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
MA5	20	<5	50	N	N	10	N	<10	N	30	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
MA2	20	<5	50	N	N	15	N	<10	N	50	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
MA1	<20	30	10	N	N	N	N	200	N	50	N	200	N	...	N	N	N	N	N	120	<0.001	<0.02
MA3	<20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
MA4	20	<5	50	N	N	15	N	<10	N	50	N	100	N	...	N	N	N	N	N	N	<0.001	<0.02
MA6	20	<5	50	N	N	20	N	<10	N	50	N	150	N	...	N	N	N	N	N	N	<0.001	<0.02
MA7	20	5	50	N	N	20	N	<10	N	50	N	150	N	...	N	N	N	N	N	N	0.001	<0.02
HPR2	50	<5	50	N	N	30	N	<10	N	70	N	150	N	...	N	N	N	N	N	10	<0.001	<0.02
HPR02	50	<5	70	N	N	30	N	<10	N	70	N	150	N	...	N	N	N	N	N	15	<0.001	<0.02
DFR13	<20	<5	15	N	N	N	N	<10	N	N	N	50	N	...	N	N	N	N	N	N	<0.001	0.02
WTR1	N	<5	30	N	N	N	N	<10	N	N	N	30	N	...	N	N	N	N	N	N	<0.001	<0.02
WTR4	N	<5	30	N	N	N	N	<10	N	N	N	30	N	...	N	N	N	N	N	N	<0.001	<0.02

^a Measured by mercury instrument.
^b Measured by atomic absorption.

Appendix B
SPECTROGRAPHIC AND CHEMICAL ANALYSES OF SAMPLES COLLECTED
FROM PICKEL MEADOW

TABLE B1-1. Spectrographic and Chemical Analyses of Soil Samples Collected From Pickel Meadow.

Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected, < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample locator	Element, %							Element, ppm												
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb	Ni
PV1	5.0	1.0	2.0	1.00	700	N	N	N	50	1000	1.0	N	N	15	50	30	50	N	N	30
PV2	3.0	1.0	1.5	0.50	500	N	N	N	50	500	1.5	N	N	15	30	20	50	N	N	20
PV3	3.0	1.0	2.0	0.70	500	N	N	N	50	700	1.5	N	N	15	50	30	70	N	N	30
PV4	5.0	1.0	1.5	1.00	700	N	N	N	50	700	1.5	N	N	15	30	30	70	N	N	15
PV5	5.0	1.5	2.0	1.00	700	N	N	N	50	700	1.0	N	N	20	100	20	50	N	N	20
PV6	0.2	0.2	0.5	0.05	50	N	N	N	50	100	<1.0	N	N	N	N	7	N	N	N	<5
PV7	7.0	2.0	2.0	1.00	1000	N	N	N	30	1000	1.0	N	N	20	50	70	30	N	N	20
PV8	7.0	1.0	2.0	0.50	700	N	N	N	50	700	1.0	N	N	15	100	50	50	N	N	20
PV9	7.0	1.0	2.0	1.00	1000	N	N	N	100	1000	1.5	N	N	15	70	50	50	N	N	20
PV10	7.0	1.0	2.0	1.00	1000	N	N	N	30	1000	1.0	N	N	15	70	30	50	N	N	20
PV11	7.0	1.0	2.0	1.00	700	N	N	N	30	1000	1.5	N	N	20	100	50	70	N	N	50
PV12	7.0	1.0	2.0	1.00	700	N	N	N	30	1000	1.5	N	N	20	100	50	50	N	N	50
PV13	10.0	2.0	2.0	1.00	1000	N	N	N	50	1000	1.5	N	N	30	150	50	70	N	N	50
PV14	5.0	1.0	2.0	0.70	1000	N	N	N	50	700	1.5	N	N	20	70	50	70	N	N	30
PV15	3.0	1.5	1.5	1.00	1000	N	N	N	50	1000	1.5	N	N	15	100	50	50	N	N	30
PV16	5.0	1.5	2.0	1.00	1000	N	N	N	50	1000	1.5	N	N	20	100	50	50	N	N	30
PV17	5.0	1.0	2.0	1.00	1000	N	N	N	50	1000	1.5	N	N	15	100	50	30	N	N	30
PV18	7.0	1.5	2.0	1.00	1000	N	N	N	50	1000	1.5	N	N	20	100	50	70	N	N	50
PV19	5.0	1.0	2.0	1.00	700	N	N	N	70	700	1.5	N	N	10	100	30	50	N	N	30
PV20	5.0	1.5	2.0	0.70	1000	N	N	N	50	1000	1.0	N	N	20	150	50	50	N	N	50
PV21	2.0	1.0	1.5	0.50	700	N	N	N	50	500	1.0	N	N	10	30	20	50	N	N	20
PV22	3.0	1.0	2.0	1.00	500	N	N	N	50	700	1.0	N	N	15	50	15	50	N	N	20
PV23	3.0	1.0	2.0	1.00	700	N	N	N	10	700	1.0	N	N	20	50	20	50	N	N	30
PV24	5.0	1.0	3.0	1.00	1000	N	N	N	50	1000	1.0	N	N	20	100	15	50	N	N	20
PV25	5.0	1.0	2.0	0.70	70	N	N	N	70	700	1.0	N	N	15	150	30	50	N	N	30
PV26	3.0	1.0	1.5	0.70	500	N	N	N	20	500	1.0	N	N	10	50	20	30	N	N	20
PV27	5.0	1.5	2.0	1.00	700	N	N	N	30	500	1.0	N	N	20	100	50	50	N	N	50
PV28	3.0	1.0	2.0	0.70	500	N	N	N	20	500	1.0	N	N	20	100	15	50	N	N	20
PV29	7.0	2.0	3.0	<1.00	1000	N	N	N	50	1000	1.0	N	N	10	150	50	100	N	N	30
PV30	3.0	1.0	1.5	0.70	700	N	N	N	50	700	1.0	N	N	20	50	50	30	N	N	20
PV31	3.0	1.0	2.0	0.50	700	N	N	N	50	500	1.0	N	N	15	50	50	50	N	N	15
PV32	5.0	2.0	2.0	1.00	700	N	N	N	20	500	1.0	N	N	15	70	70	50	N	N	20
PV33	5.0	1.0	2.0	0.70	1000	N	N	N	30	700	1.0	N	N	20	70	70	50	N	N	15
PV34	3.0	1.0	2.0	0.70	1000	N	N	N	30	1000	1.0	N	N	20	20	30	50	N	N	15
PV35	5.0	1.0	2.0	0.50	1000	N	N	N	50	700	1.0	N	N	10	50	50	50	N	N	20
PV36	3.0	1.0	1.5	0.70	1000	N	N	N	30	1000	1.0	N	N	15	30	30	50	N	N	7
PV37	5.0	1.5	2.0	0.70	1000	N	N	N	30	1000	1.0	N	N	10	30	50	70	N	N	7
PV38	5.0	1.5	1.5	0.70	700	N	N	N	50	700	1.0	N	N	10	50	30	30	N	N	20
PV39	2.0	0.5	2.0	0.30	500	N	N	N	50	500	1.5	N	N	5	50	20	30	N	N	7
PV40	5.0	1.5	2.0	1.00	700	N	N	N	30	700	1.5	N	N	20	100	50	50	N	N	20
PV41	7.0	1.0	2.0	1.00	700	N	N	N	30	700	1.5	N	N	15	100	15	100	N	N	15
PV42	3.0	1.0	2.0	0.70	700	N	N	N	30	500	1.0	N	N	10	50	50	50	N	N	15
PV43	5.0	2.0	2.0	1.00	700	N	N	N	50	1000	1.0	N	N	20	70	70	100	N	N	20
PV44	3.0	0.7	2.0	0.70	700	N	N	N	50	1000	1.0	N	N	10	30	50	70	N	N	7
PV45	5.0	1.0	2.0	1.00	700	N	N	N	50	1000	1.5	N	N	15	70	50	70	N	N	15

TABLE B1-1. (Contd.)

Sample location	Element, ppm																	
	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b
P1	20	N	15	N	500	100	N	20	<200	100	N	0.02	N	N	0.2	N	65	N
PV2	70	N	10	N	300	100	N	15	<200	100	N	0.06	N	N	1.0	2	140	0.002
PV3	50	N	10	N	500	100	N	15	<200	100	N	0.04	10	N	0.4	N	90	0.002
PV4	50	N	10	N	500	150	N	20	<200	200	N	0.02	N	N	0.3	N	80	N
PV5	30	N	10	N	700	150	N	15	<200	100	N	N	N	N	0.2	N	65	N
PV6	<10	N	5	N	<100	20	N	N	<200	10	N	0.06	N	N	N	N	N	N
PV7	30	N	15	N	700	150	N	20	<200	100	N	N	N	N	0.1	N	80	N
PV8	50	N	10	N	700	100	N	20	<200	100	N	N	N	N	0.2	N	50	N
PV9	30	N	10	N	700	100	N	20	<200	150	N	N	N	N	0.2	N	70	N
PV10	30	N	10	N	700	100	N	20	<200	150	N	N	N	N	0.2	N	50	N
PV11	30	N	5	N	700	100	N	20	<200	150	N	N	N	N	0.2	N	85	0.002
PV12	30	N	15	N	1000	100	N	20	<200	150	N	0.02	N	N	0.2	N	85	N
PV13	30	N	20	N	1000	150	N	20	<200	200	N	0.02	N	N	N	N	55	N
PV14	20	N	10	N	700	150	N	20	<200	150	N	0.10	10	N	0.3	N	60	N
PV15	30	N	10	N	700	150	N	20	<200	200	N	N	N	N	0.2	N	65	N
PV16	30	N	15	N	500	150	N	20	<200	200	N	0.12	N	N	0.3	N	60	N
PV17	30	N	10	N	500	150	N	20	<200	200	N	N	N	N	0.4	N	60	N
PV18	50	N	15	N	500	150	N	20	<200	200	N	N	N	N	0.3	N	60	N
PV19	20	N	10	N	500	100	N	20	<200	150	N	N	10	N	0.2	N	60	N
PV20	50	N	15	N	500	150	N	20	<200	100	N	0.02	10	N	0.2	N	65	N
PV21	50	N	10	N	500	100	N	15	<200	300	N	0.02	N	N	0.3	N	75	N
PV22	50	N	15	N	700	100	N	15	<200	100	N	N	N	N	0.2	N	40	N
PV23	30	N	15	N	700	150	N	15	<200	150	N	0.02	N	N	0.1	N	55	N
PV24	50	N	15	N	1000	150	N	20	<200	150	N	0.02	N	N	0.2	N	55	N
PV25	50	N	15	N	500	150	N	20	<200	150	300	0.04	10	N	0.1	N	50	N
PV26	20	N	10	N	500	150	N	20	<200	150	N	N	N	N	0.2	N	85	N
PV27	50	N	15	N	500	150	N	15	<200	100	N	0.02	N	N	0.2	N	85	N
PV28	20	N	15	N	500	150	N	15	<200	100	N	0.02	N	N	0.1	N	65	N
PV29	50	N	15	N	700	200	N	20	<200	200	N	N	N	N	0.1	N	70	0.002
PV30	50	N	10	N	500	100	N	15	<200	150	N	N	N	N	0.3	N	70	N
PV31	30	N	10	N	500	100	N	15	<200	100	N	<0.02	N	N	0.2	N	75	N
PV32	30	N	15	N	500	150	N	20	<200	150	N	<0.02	N	N	0.2	N	75	N
PV33	50	N	15	N	500	100	N	15	<200	150	N	0.02	N	N	0.3	N	120	N
PV34	50	N	10	N	500	100	N	15	<200	150	N	<0.02	N	N	0.2	N	75	N
PV35	50	N	10	N	500	100	N	15	<200	150	N	0.02	N	N	0.2	N	75	N
PV36	30	N	15	N	500	100	N	20	<200	150	N	<0.02	10	N	0.2	N	75	N
PV37	50	N	15	N	700	100	N	15	<200	150	N	N	N	N	0.2	N	80	N
PV38	20	N	15	N	500	100	N	15	<200	200	N	<0.02	N	N	0.2	N	60	N
PV39	20	N	7	N	500	100	N	15	<200	500	N	<0.02	N	N	0.4	N	85	N
PV40	50	N	15	N	500	100	N	20	<200	200	N	N	N	N	0.2	N	55	N
PV41	50	N	15	N	500	150	N	30	<200	1000	N	N	N	N	0.1	N	40	0.036
PV42	30	N	10	N	700	100	N	15	<200	150	N	<0.02	N	N	0.2	N	60	N
PV43	50	N	15	N	700	150	N	20	<200	100	N	N	N	N	0.1	N	85	0.002
PV44	30	N	10	N	700	100	N	20	<200	300	N	0.02	N	N	0.2	N	75	N
PV45	50	N	15	N	500	200	N	30	<200	200	N	N	N	N	0.2	N	100	N

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE B1-2. Spectrographic and Chemical Analyses of Soil Samples Collected From Pickel Meadow.

Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected; < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Element, %										Element, ppm									
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb	Ni
PV46	5.0	1.0	2.0	1.00	700	N	N	N	20	1500	1.0	N	N	20	50	50	70	N	N	20
PV47	5.0	1.5	2.0	0.70	700	<0.5	N	N	20	1000	1.0	N	N	20	20	70	70	N	N	10
PV48	5.0	1.0	1.5	0.50	500	N	N	N	50	1000	1.0	N	N	7	20	30	50	N	N	10
PV49	0.7	0.2	1.5	0.15	100	N	N	N	30	300	1.0	N	N	N	N	10	N	<5	N	<5
PV50	3.0	1.0	2.0	0.70	700	N	N	N	50	1000	1.0	N	N	15	20	30	50	5	N	7
PV51	2.0	0.7	1.5	0.30	700	N	N	N	30	700	1.5	N	N	7	20	20	<20	5	N	7
PV52	5.0	1.0	1.5	1.00	1000	N	N	N	30	1000	1.5	N	N	15	30	50	50	N	N	10
PV53	5.0	1.0	2.0	1.00	1000	N	N	N	30	1000	1.5	N	N	20	50	30	70	N	N	15
PV54	7.0	1.5	3.0	>1.00	700	N	N	N	15	1000	1.0	N	N	30	100	50	50	N	N	30
BC1	5.0	1.0	1.0	0.70	1000	N	N	N	50	700	1.0	N	N	20	100	20	50	<5	N	20
BC2	5.0	1.0	1.0	1.00	1000	N	N	N	50	1000	1.0	N	N	15	70	30	70	N	<20	30
BC3	5.0	1.0	1.0	1.00	1000	N	N	N	50	700	1.0	N	N	15	50	30	70	N	N	20
AV1	3.0	1.5	2.0	1.00	700	N	N	N	20	500	1.5	N	N	15	20	20	100	N	<20	7
AV2	5.0	2.0	3.0	1.00	700	N	N	N	70	700	1.0	N	N	20	50	70	30	N	N	15
AV3	5.0	2.0	2.0	1.00	700	N	N	N	50	700	1.0	N	N	20	70	100	30	N	<20	20
AV4	3.0	2.0	3.0	0.70	700	N	N	N	70	700	1.0	N	N	10	70	50	30	<5	N	10
AV5	5.0	1.5	2.0	0.50	700	N	N	N	50	700	1.0	N	N	15	50	50	50	N	N	10
AV6	5.0	2.0	2.0	0.70	700	N	N	N	50	700	1.0	N	N	15	50	70	30	N	N	15
AV7	3.0	2.0	2.0	0.50	700	N	N	N	50	700	1.0	N	N	15	30	70	30	N	N	10
AV8	3.0	2.0	2.0	0.50	500	N	N	N	70	500	1.0	N	N	15	50	50	30	<5	N	10
AB9	5.0	1.5	2.0	0.70	700	N	N	N	100	700	1.0	N	N	15	70	50	30	N	N	10
AV10	5.0	2.0	5.0	0.50	700	N	N	N	70	500	1.0	N	N	10	30	30	30	N	N	7
AV11	5.0	1.5	2.0	0.70	700	N	N	N	50	500	1.0	N	N	15	30	50	50	N	<20	10
AV12	3.0	1.0	2.0	1.00	1000	N	N	N	50	500	1.0	N	N	10	50	20	50	N	<20	7
AV13	5.0	2.0	3.0	0.50	1000	N	N	N	50	700	1.5	N	N	20	100	70	70	N	N	15
AV14	5.0	2.0	3.0	0.70	700	N	N	N	70	700	1.5	N	N	20	50	70	50	N	N	15
AV15	5.0	2.0	3.0	1.00	1500	1.0	N	N	100	700	1.0	N	N	15	30	20	70	N	<20	7
AV16	3.0	1.5	1.5	0.70	700	N	N	N	50	700	1.0	N	N	15	30	20	50	N	N	7
AV17	5.0	1.5	2.0	1.00	700	N	N	N	50	500	1.0	N	N	10	20	15	70	N	N	5
AV18	5.0	2.0	2.0	1.00	1000	1.0	N	N	50	500	1.0	N	N	15	20	15	100	N	<20	7

TABLE B1-2. (Contd.)

Sample location	Element, ppm																	
	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b
PV46	30	N	15	N	1000	150	N	20	<200	150	N	<0.02	N	N	0.1	N	80	0.002
PV47	70	N	15	N	700	100	N	20	<200	150	N	<0.02	N	N	N	N	60	0.002
PV48	50	N	10	N	500	100	N	15	<200	200	N	N	N	N	0.2	N	60	N
PV49	10	N	5	N	700	30	N	10	<200	70	N	<0.02	N	N	0.4	N	60	N
PV50	20	N	10	N	700	100	N	20	<200	200	N	N	N	N	0.2	N	55	N
PV51	20	N	7	N	500	50	N	15	<200	100	N	0.06	N	N	0.3	N	80	N
PV52	50	N	10	N	500	100	N	20	<200	150	N	0.04	N	N	0.3	N	70	N
PV53	30	N	15	N	700	100	N	20	<200	150	N	<0.02	N	N	0.2	N	75	N
PV54	30	N	20	N	700	200	N	20	<200	150	N	N	N	N	0.1	N	80	N
BC1	30	N	15	N	500	100	N	20	<200	150	N	N	10	N	0.3	N	75	N
BC2	50	N	15	N	500	100	N	20	<200	150	N	0.04	N	N	0.2	N	55	0.002
BC3	50	N	10	N	500	100	N	20	<200	150	N	N	N	N	0.2	N	70	0.002
AV1	100	N	15	N	500	100	N	30	<200	200	N	0.02	N	2	0.4	N	100	N
AV2	20	N	20	N	500	150	N	30	<200	150	N	<0.02	N	N	0.1	N	45	0.002
AV3	50	N	30	N	500	150	N	30	<200	300	N	N	N	N	0.1	N	45	N
AV4	50	N	15	N	500	100	N	15	<200	70	N	N	N	N	0.1	N	50	N
AV5	30	N	20	N	500	150	N	20	<200	150	N	<0.02	N	N	0.1	N	40	N
AV6	50	N	20	N	500	150	N	30	<200	300	N	<0.02	N	N	0.1	N	45	N
AV7	50	N	20	N	500	100	N	20	<200	100	N	N	N	N	0.1	N	45	N
AV8	50	N	20	N	500	100	N	20	<200	150	N	N	10	N	0.2	N	45	N
AB9	30	N	20	N	500	100	N	20	<200	150	N	0.04	N	N	0.3	N	40	0.002
AV10	30	N	15	N	300	100	N	15	<200	100	N	0.04	N	5	0.6	N	65	N
AV11	20	N	15	N	300	100	N	20	<200	200	N	0.02	N	1	0.2	N	50	0.002
AV12	30	N	15	N	500	70	N	30	<200	200	N	0.02	N	4	0.4	N	70	0.002
AV13	30	N	20	N	500	150	N	20	<200	100	N	0.02	N	N	0.1	N	45	N
AV14	30	N	20	N	500	150	N	30	<200	150	N	<0.02	N	N	0.1	N	45	N
AV15	300	N	20	N	300	100	N	30	300	150	N	N	20	N	2.7	6	250	N
AV16	100	N	15	N	300	100	N	15	<200	100	N	0.02	N	N	1.5	N	130	0.004
AV17	70	N	10	N	300	100	N	20	<200	500	N	0.04	N	N	1.4	N	180	0.002
AV18	200	N	15	N	500	100	N	20	300	200	N	0.02	N	N	2.6	4	300	0.002

^a Measured by mercury instrument.

^b Measured by atomic absorption.

TABLE B2-1. Spectrographic and Chemical Analyses of Sediment Samples Collected From Pickel Meadow.
 Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected; < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Element, %										Element, ppm													
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb					
PV001S	7	2.0	5.0	1.0	1000	N	N	N	70	700	1	N	N	15	200	50	30	N	N					
PV002S	3	1.0	2.0	1.0	700	N	N	N	50	500	1	N	N	7	50	20	30	N	N					
PC003S	20	1.0	2.0	>1.0	1500	N	N	N	50	300	1	N	N	20	100	50	300	<5	20					
PC006S	2	1.0	2.0	0.7	700	N	N	N	50	1000	1	N	N	10	20	20	50	N	N					
PV014S	3	1.5	1.5	1.0	700	N	N	N	50	1000	1	N	N	10	30	30	50	N	N					

Sample location	Element, ppm																		
	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b
PV001S	30	30	N	20	N	1000	150	N	30	N	500	N	0.02	N	N	N	N	65	0.004
PV002S	7	15	N	10	N	500	100	N	20	N	200	N	0.06	N	N	N	N	70	N
PC003S	15	20	N	20	N	300	200	N	70	N	>1000	<100	0.04	10	N	N	N	75	0.110
PC006S	7	50	N	15	N	700	100	N	20	N	300	N	0.04	N	N	N	N	75	0.010
PV014S	7	50	N	15	N	700	100	N	15	N	200	N	0.04	10	N	N	N	85	0.008

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE B3-1. Spectrographic and Chemical Analyses of Rock Samples Collected From Pickel Meadow.
 Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected;
 < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Element, %										Element, ppm									
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb	
PV004R	5.0	1.0	7	1.0	2000	N	N	N	30	2000	1.5	N	N	15	30	50	50	<5	N	
PV005R	3.0	1.5	5	1.0	700	N	N	N	50	1500	1.5	N	N	15	20	50	100	<5	N	
PV006R	3.0	1.0	2	0.7	500	N	N	N	20	1000	1.5	N	N	10	15	30	70	<5	N	
PV007R	5.0	2.0	3	0.7	700	N	N	N	30	1000	1.0	N	N	20	20	50	50	<5	N	
PV008R	5.0	3.0	2	1.0	500	N	N	N	10	1000	1.0	N	N	20	15	30	50	<5	...	
PV009RA	1.5	1.0	1	0.2	300	N	N	N	10	1000	2.0	N	N	<5	10	15	70	<5	<20	
PV009RB	7.0	2.0	2	1.0	1000	N	N	N	15	700	1.0	N	N	15	10	30	30	<5	N	
PV009RC	2.0	1.5	2	0.2	300	N	N	N	20	1500	2.0	N	N	<5	10	7	100	<5	N	
PV010R	5.0	2.0	5	1.0	1500	N	N	N	20	1500	1.0	N	N	20	30	70	50	<5	N	
PV011R	2.0	0.3	1	0.3	300	N	N	N	30	2000	1.5	N	N	<5	10	<5	70	<5	N	
PV012R	3.0	1.0	5	1.0	500	N	N	N	50	1000	1.5	N	N	15	50	50	70	<5	N	
PV013R	3.0	2.0	7	1.0	500	N	N	N	20	1000	1.5	N	N	20	10	50	50	<5	N	
PV015R	5.0	2.0	2	0.7	700	N	N	N	30	1000	1.5	N	N	15	10	50	50	<5	N	
PV016R	5.0	2.0	3	1.0	700	N	N	N	20	1000	1.5	N	N	20	20	70	70	<5	N	
PV017R	3.0	2.0	2	0.7	700	N	N	N	30	1500	1.5	N	N	10	10	50	100	<5	N	
PV018R	5.0	5.0	5	1.0	700	N	N	N	20	1500	1.0	N	N	15	15	70	70	<5	N	

TABLE B3-1. (Contd.)

Sample location	Element, ppm																		
	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b
PV004R	7	30	N	15	N	1000	150	N	20	<200	100	N	0.08	N	N	N	N	65	N
PV005R	7	30	N	15	N	1500	150	N	30	<200	200	N	0.04	N	N	N	N	40	N
PV006R	5	50	N	15	N	1000	100	N	20	<200	200	N	0.04	N	N	N	N	60	N
PV007R	15	20	N	15	N	700	150	N	15	<200	100	N	0.08	N	N	N	N	55	N
PV008R	10	15	N	5	N	1000	150	N	20	<200	100	N	0.02	N	N	N	N	100	N
PV009RA	5	30	N	10	N	700	50	N	15	<200	300	N	<0.02	N	N	N	N	55	N
PV009RB	10	10	N	7	N	1000	100	N	15	<200	100	N	<0.02	N	N	N	N	90	N
PV009RC	5	50	N	15	N	1000	30	N	20	<200	150	N	N	N	N	N	N	40	N
PV010R	15	30	N	7	N	1500	150	N	20	<200	200	N	N	N	N	N	N	70	N
PV011R	<5	50	N	15	N	500	30	N	15	<200	300	N	<0.02	N	N	N	N	55	N
PV012R	20	50	N	15	N	1000	150	N	20	<200	150	N	<0.02	N	N	N	N	60	N
PV013R	10	30	N	15	N	1500	150	N	15	<200	100	N	0.04	N	N	N	N	65	N
PV015R	10	30	N	15	N	1000	150	N	20	<200	150	N	<0.02	N	N	N	N	80	N
PV016R	15	20	N	15	N	1500	150	N	20	<200	150	N	<0.02	N	N	N	N	80	N
PV017R	7	30	N	15	N	1000	100	N	20	<200	200	N	N	N	N	N	N	70	N
PV018R	7	30	N	15	N	1000	150	N	15	<200	100	N	<0.02	N	N	N	N	70	N

^a Measured by mercury instrument.

^b Measured by atomic absorption.

TABLE B4-1. Spectrographic Analysis of Heavy-Mineral-Concentrate Samples Collected From Pickel Meadow. Measuring device used was a spectrometer. Under element measurement, N means not detected; < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Element, %													Element, ppm												
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La									
PV001C	5.0	0.2	5	>2	500	<1	N	N	30	> 10,000	<2	N	N	10	30	150	200									
PV002C	1.0	0.7	15	>2	1500	<1	N	N	50	1000	<2	N	N	<10	50	15	1000									
PC003C	0.7	0.2	10	>2	1000	2	N	N	50	500	<2	N	N	10	30	15	1500									
PC006C	1.5	0.7	50	>2	1000	<1	N	N	20	> 10,000	<2	N	N	N	70	15	2000									
PV041C	0.7	0.5	50	>2	700	<1	N	N	30	1500	<2	N	N	<10	100	10	1500									

Sample location	Element, ppm													
	Mo	Nb	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th
PV001C	<10	70	30	<20	N	15	<20	3000	100	200	700	<500	>2000	500
PV002C	<10	100	20	<20	N	<10	<20	300	200	N	500	<500	>2000	500
PC003C	20	150	20	70	N	<10	N	300	200	300	500	<500	>2000	3000
PC006C	<10	70	<10	50	N	<10	N	5000	300	N	700	<500	>2000	200
PV041C	<10	100	<10	20	N	<10	N	2000	200	N	500	<500	>2000	<200

TABLE B5-1. Spectrographic and Chemical Analyses of Hot-Springs Precipitates Collected From Pickel Meadow.
 Measuring device used was a spectrometer except where otherwise noted. Under element measurement, N means not detected;
 < means detected but below the limit of determination shown; > means determined to be greater than the value shown.

Sample location	Element, %										Element, ppm													
	Fe	Mg	Ca	Ti	Mn	Ag	As	Au	B	Ba	Be	Bi	Cd	Co	Cr	Cu	La	Mo	Nb					
W1	0.1	2.0	>20	0.007	50	N	N	N	150	200	20	N	N	N	<10	<5	N	N	N					
W2	2.0	1.5	>20	0.010	500	N	N	N	150	150	20	N	N	N	<10	<5	N	N	N					
W3	0.7	1.5	>20	0.050	700	N	N	N	10	300	10	N	N	N	<10	5	N	N	N					
W4	5.0	1.0	>20	0.010	>5000	N	N	N	20	500	70	N	N	5	<10	7	N	N	N					

Sample location	Element, ppm																			
	Ni	Pb	Sb	Sc	Sn	Sr	V	W	Y	Zn	Zr	Th	Hg ^a	As ^b	Bi ^b	Cd ^b	Sb ^b	Zn ^b	Au ^b	
W1	<5	<10	N	<5	N	<5000	10	N	N	N	N	N	0.02	200	N	N	N	N	15	0.004
W2	<5	<10	N	<5	N	<5000	10	N	N	N	N	N	0.04	>2000	N	N	N	10	10	N
W3	<5	<10	N	5	N	<5000	15	N	10	N	<10	N	7.00	80	6	N	N	2	15	N
W4	<5	20	N	5	N	<5000	15	N	<10	N	N	N	0.12	>2000	N	N	N	14	160	N

^a Measured by mercury instrument.
^b Measured by atomic absorption.

TABLE B6-1. Concentrations of He and CO₂ in Soil-Gas Samples Collected From Pickel Meadow.

Sample location	CO ₂ , %	He, ppm	Sample location	CO ₂ , %	He, ppm
PV 1	0.21	5.06	PV 29	0.17	4.69
2	1.93	5.01	29 (second sample)	0.28	4.77
3	2.90	5.10			
4	0.30	5.10	30	0.28	4.73
5	2.41	5.06	31	0.29	4.84
6	0.59	4.91	32	0.22	4.84
7	0.25	4.86	33	0.23	4.84
8	0.16	4.86	34	0.23	4.84
9	0.23	4.86			
10	0.23	4.82	35	0.23	4.88
11	0.28	4.77	36	0.24	4.88
12	0.27	5.01	37	0.26	4.8
13	0.22	4.86	38	0.24	4.73
14	0.27	4.91	39	0.16	4.8
15	0.17	4.82	40	0.19	4.77
16	0.20	4.77	41	0.24	4.69
17	0.21	4.73	42	0.18	4.77
18	0.18	4.91	43	0.30	4.69
19	0.19	4.84	44	0.22	4.77
20	0.27	4.77	45	0.22	4.77
21	0.30	4.77	46	0.19	4.77
22	0.21	4.84	47	0.22	4.8
23	0.25	4.84	48	0.20	4.77
24	0.25	4.8	49	0.25	4.69
25	0.24	4.84	50	0.34	4.77
26	0.14	4.84	51	0.26	4.73
27	0.19	4.84	52	0.25	4.77
28	0.21	4.73	53	0.23	4.88
			54	0.17	4.69

TABLE B7-1. Concentrations of He and CO₂ in Soil-Gas Samples Collected From Antelope Valley and Bridgeport.

Sample location	CO ₂ , %	He, ppm
AV ^a 1	0.28	4.71
2	0.28	4.71
3	0.25	4.64
4	0.26	4.71
5	0.27	4.67
6	0.26	4.64
7	0.28	4.71
8	0.24	4.83
9	0.23	4.64
10	0.21	4.86
11	0.19	4.83
12	0.22	4.79
13	0.25	4.67
14	0.20	4.79
15	0.22	4.86
16	0.22	4.83
17	0.25	4.83
18	0.24	4.71
BG ^b 1	0.25	4.75
2	0.26	4.79
3	0.22	4.75

^a AV = Antelope Valley.

^b BG = Bridgeport.

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- 5 Naval Civil Engineering Laboratory, Port Hueneme
 - Commanding Officer (1)
 - L70 (1)
 - L70PM (1)
 - L72, D. Holmes (1)
 - Technical Library (1)
- 2 Naval Energy and Environmental Support Activity, Port Hueneme
 - Code 1101 (1)
 - Code 111A (1)
- 1 Naval Postgraduate School, Monterey (Library)
- 1 Naval War College, Newport (Library)
- 1 Navy Energy and Natural Resources Research and Development Office
- 1 Chief of Engineers (DAEN-RDM)
- 1 Headquarters, U. S. Air Force (AF/LEYSF)
- 2 Air Force Academy, Colorado Springs
 - Code LGSF (1)
 - Library (1)
- 1 Civil Engineering Center, Tyndall Air Force Base (DEB)

- 12 Defense Technical Information Center, Alexandria
- 1 Department of Energy, San Francisco Operations, Oakland, CA (J. Crawford)
- 1 Los Alamos National Laboratory, Los Alamos, NM (Reports Library)
- 1 Oak Ridge National Laboratory, Oak Ridge, TN (Energy Division)
- 5 United States Geological Survey, Denver, CO (W. I. Ridley)
- 1 United States Geological Survey, Menlo Park, CA (Library)
- 1 Associated Universities, Incorporated, Upton, NY (Brookhaven National Laboratory)
- 2 California Energy Company, Incorporated, Santa Rosa, CA
 - A. K. Carter (1)
 - J. L. Moore (1)
- 1 Lawrence Berkeley Laboratory, Berkeley, CA
- 1 The Johns Hopkins University, Applied Physics Laboratory, Laurel, MD
- 1 University of Utah, Salt Lake City, UT (Department of Geology, Dr. J. A. Whelan)
- 1 University of Utah Research Institute, Salt Lake City, UT (Earth Sciences Group)