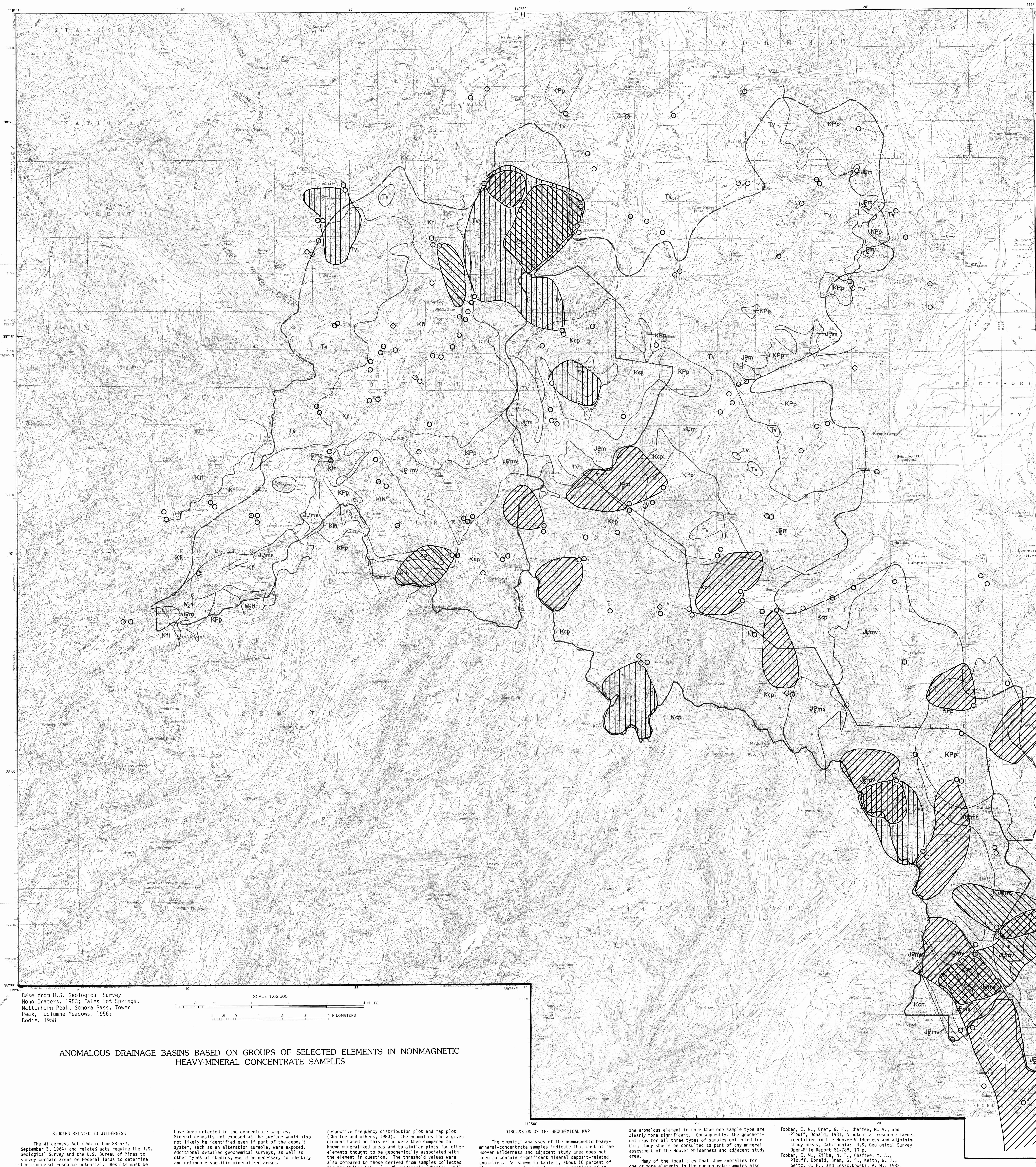
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY



LIST OF MAP UNITS

Tv VOLCANIC FLOWS, BRECCIAS, AND LAHARS VARYING IN COMPOSITION FROM RHYOLITE TO BASALT (TERTIARY)--Includes Disaster Peak Formation of Slemmons (1966), Stanislaus Group, Relief Peak Formation of Slemmons (1966), Valley Springs Formation, and intrusive andesite

Kcp CATHEDRAL PEAK GRANODIORITE (CRETACEOUS)

Ktl GRANODIORITE OF TOPAZ LAKE (CRETACEOUS)

Kfl GRANODIORITE OF FREMONT LAKE (CRETACEOUS)

Klh GRANODIORITE OF LAKE HARRIET (CRETACEOUS)

Mztl GABBRO OF TWIN LAKES (MESOZOIC)

KPp PLUTONIC ROCKS, UNDIVIDED, OF PREDOMINANTLY GRANITIC TO GRANODIORITIC COMPOSITION (CRETACEOUS TO PERMIAN?)--Includes granite of Eagle Creek, granodiorite of Buckeye Creek, granodiorite of Green Creek, granodiorite of Long Canyon, alaskite of Grace Meadow, granite of upper Twin Lakes, granodiorite of Bond Pass, granodiorite of Mono Dome, granite of Dorothy Lake, granodiorite of Log Cabin Creek, granite of Devils Gate, gabbro of Mount Warren, and quartz diorite of Odell Lake (Keith and Seitz, 1981)

JPzms METASEDIMENTARY ROCKS, UNDIVIDED (JURASSIC TO PALEOZOIC)--Represent roof-pendant material in the Sierra Nevada batholith

JPzmv METAVOLCANIC AND METAPLUTONIC ROCKS, UNDIVIDED (JURASSIC TO PALEOZOIC)--Represent roof-pendant material in the Sierra Nevada batholith

JPzm METASEDIMENTARY, METAVOLCANIC, AND METAPLUTONIC ROCKS, UNDIVIDED (JURASSIC TO PALEOZOIC)--Represent roof-pendant material in the Sierra Nevada batholith

ANOMALOUS DRAINAGE BASINS BASED ON GROUPS OF SELECTED ELEMENTS IN NONMAGNETIC HEAVY-MINERAL CONCENTRATE SAMPLES

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geochemical survey of the Hoover Wilderness (NF-036) and adjacent Hoover Extension (East) (E-4662), Hoover Extension (West) (W-4662), and Cherry Creek A (5662) Roadless Areas in the Inyo, Stanislaus, and Toiyabe National Forests, Mono and Tuolumne Counties, California. The Hoover Wilderness was established by Public Law 88-577, September 3, 1964. The Hoover Extension (East) was classified as a further planning area and the Hoover Extension (West) and Cherry Creek A were classified as wilderness areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

SAMPLING DESIGN

This summary geochemical map shows the distributions of anomalous concentrations of 11 selected elements in 180 samples of nonmagnetic heavy-mineral-concentrate samples processed from bulk sediment collected during 1978 in the Hoover Wilderness and adjacent study area. Concentrate samples were processed from the same active alluvium used to make minus-60-mesh (0.25-mm) stream-sediment samples. The concentrate samples were prepared to provide information about the elements in a limited number of minerals present in rock material eroded from the drainage basin upstream from each sample locality. Removal most of the quartz, feldspars, clay minerals, and highly magnetic minerals concentrates other minerals that are commonly associated with mineral deposits. The selective concentration of ore-related minerals permits determination of some elements that are not easily detected in stream-sediment samples by emission spectroscopy. The analytical composition of a concentrate may also indicate specific minerals. For example, the barium content in a stream-sediment sample is predominantly the sum of barium in the mineral barite, plus barium substituted in feldspars, clay minerals, and possibly other minerals, whereas the barium in a concentrate sample is essentially all in barite.

Because the sampling program was designed and executed on a reconnaissance scale, some small but exposed areas of chemically anomalous rock may not have been detected in the concentrate samples. Mineral deposits not exposed at the surface would also not likely be identified even if part of the deposit system, such as an alteration aureole, were exposed. Additional detailed geochemical surveys, as well as other types of studies, would be necessary to identify and delineate specific mineralized areas.

SAMPLE COLLECTION, PREPARATION, ANALYSIS, AND EVALUATION

Bulk samples of active stream sediment were collected primarily from first-order (unbranched) and second-order (below the junction of two first-order) streams as shown on 1:62,500-scale topographic maps. Each bulk sample was composited from active alluvium collected from several localities within a 50-ft (15-m) radius of the locality plotted on the map. Each concentrate sample was derived by, successively, wet panning, separating the heavy-minerals by using bromoform, and removing the magnetic fraction of the heavy-mineral fraction with a hand magnet and a Frantz Isodynamic Separator[1] set at 0.6 amperes with a 15° forward setting and a 15° side setting. The remaining nonmagnetic heavy-mineral fraction was then ground before analysis.

All of the samples were analyzed for 31 elements (Ag, As, Au, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, Mo, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Th, Ti, V, W, Y, Zn, and Zr) using a six-step semiquantitative emission spectrographic method. Further details of the procedures for collecting, preparing, and analyzing the samples, as well as a complete listing of all of the analyses, are given in Chaffee, Banister, and others (1980).

From the 31 elements determined in the concentrate samples, 11 were selected as those most likely to be related to hydrothermal alteration and(or) mineralization; anomaly maps for these elements have been made (Chaffee and others, 1983). Table 1 summarizes, for the 11 selected elements, the background and anomaly ranges used in constructing this summary map. The percent of samples in the background range is also given for each element so that differences between the elements can be compared.

For the concentrate samples the threshold value (highest background value) for each selected element was first assigned after a visual inspection of the respective frequency distribution plot and map plot (Chaffee and others, 1983). The anomalies for a given element based on this value were then compared to known mineralized areas and to similar plots for other elements thought to be geochemically associated with the element in question. The threshold values were also compared to those derived from samples collected for the Walker Lake 1° x 2° quadrangle (Chaffee, Hill, and others, 1980), a much larger data base. The final threshold value was assigned after studying all of the above information.

On the basis of their observed associations, each of the 11 selected elements was assigned to one of three groups. Group 1 consists of those elements (Ag, As, Au, Cu, Pb, and W) that are thought to be most likely related to mineralization in the overall area examined. Group 2 consists of those elements (B, Mo, and Sn) whose concentrations are likely to vary with rock type, but which locally may be a result of mineralization. Group 3 consists of those elements (Ba and Fe) that seem to indicate the presence of hydrothermally altered rock, which may or may not be related to mineralization. Barium in concentrate samples is predominantly the mineral barite and iron in concentrate samples is predominantly the mineral pyrite. Both of these minerals are commonly associated with hydrothermal alteration in the region in and around the overall area examined.

Within each of these three groups the anomalously high concentrations for each element were assigned to one of three concentration-range categories. The dividing concentrations between the first and second categories and between the second and third categories were, generally, the 95th and 97th percentiles, respectively. All concentrations falling in category 1 were given a weighting or "anomaly score" of 1; those concentrations in categories 2 and 3 were assigned anomaly scores of 2 and 3, respectively. The anomaly scores for the element suites in each of the three groups were then added for each sample locality to produce a number for each group called a SCORESUM (Chaffee, 1983). In general, the higher the SCORESUM for a site, the more significant is that site in terms of mineral potential. Cross-hatched areas on the map outline drainage basins for sites with SCORESUMS of ≥3 for each of the three groups of elements. These three minimum values seem to identify best the important anomalies while removing most of the anomalies based on only one element that may only be related to rock type.

[1]The use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

DISCUSSION OF THE GEOCHEMICAL MAP

The chemical analyses of the nonmagnetic heavy-mineral-concentrate samples indicate that most of the Hoover Wilderness and adjacent study area does not seem to contain significant mineral deposit-related anomalies. As shown in table 1, about 10 percent of the samples contain anomalous concentrations of at least one element.

In terms of mineral resource potential, significant geochemical anomalies are present in several localities. Significant Group 1 anomalies are scattered throughout the entire area sampled. Those anomalies north of Robinson Creek are mainly associated with high concentrations of arsenic, copper, and tungsten, and are predominantly in drainage basins containing outcrops of the Cathedral Peak Granodiorite. Those Group 1 anomalies south of Robinson Creek are mostly associated with high concentrations of copper, lead, silver, and gold, and are predominantly in drainage basins containing outcrops of metamorphosed sedimentary and igneous roof-pendant rocks. Hydrothermally altered (mainly silicified and pyritized) outcrops are present locally in these formations. Numerous mines and prospects are known in this general area (Tooker and others, 1983).

Anomalies for Group 2 elements are well scattered. The most significant anomaly is probably that in the Lundy Canyon area, where Group 1 anomalies and altered metamorphic roof-pendant rocks are present. The anomalous area west of Mount Emma is based on high (>5,000 ppm) concentrations of boron associated with the Tertiary volcanic rocks. This area also contains high concentrations of the Group 3 elements. These boron anomalies may be related to hot-spring activity or to hydrothermal alteration possibly associated with buried mineralization in the region around Mount Emma (Tooker and others, 1981).

Group 3 anomalies are also scattered throughout the area examined. The most significant anomaly is that west of Mount Emma. Areas of hydrothermally altered, bleached, argillized, and pyritized Tertiary volcanic formations are present in the vicinity of this anomaly (Tooker and others, 1981). Other Group 3 anomalies are present in the upper parts of the Robinson Creek and Green Creek drainage basins, respectively, and also in parts of the Little Walker Creek and Leavitt Creek drainage basins. Several different rock types are associated with these anomalies; consequently, further studies would be necessary to determine the sources of these anomalies.

A locality with only one anomalous element in one type of sample may be significant as a mineral deposit indicator; however, those localities with more than one anomalous element in more than one sample type are clearly more significant. Consequently, the geochemical maps for all three types of samples collected for this study should be consulted as part of any mineral assessment of the Hoover Wilderness and adjacent study area.

Many of the localities that show anomalies for one or more elements in the concentrate samples also show anomalies for elements in one or both of the other two sample types used in this study. Most significant are those localities in and south of the Robinson Creek drainage basin, which show common anomalies at many sites for both sediment and concentrate samples and, locally, also for rock samples.

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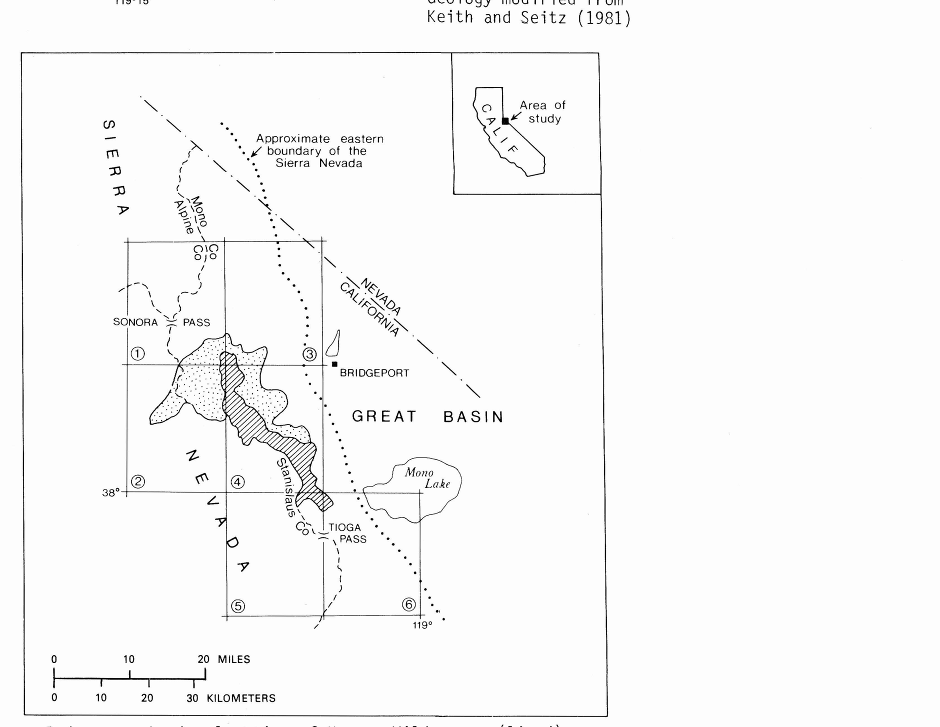
Table 1.--Summary of background and anomaly ranges for 11 selected elements in 180 samples of nonmagnetic heavy-mineral concentrate, Hoover Wilderness and adjacent study area, Mono and Tuolumne Counties, California

[All analyses are spectrographic. All concentrations are in parts per million except those for Fe, which are in percent. N = not detected at lower limit of determination shown in parentheses. Leaders (--) indicate no samples in that category]

Element	Background samples: Range of values	Background samples: Percent of samples	Anomalous samples: Anomaly score = 1	Anomalous samples: Anomaly score = 2	Anomalous samples: Anomaly score = 3
Group 1 (probably mineralization related)					
Ag	N(0.1)-<1.0	87	1-7	10-15	20-100
As	N(500)	93	<500-500	700-1,000	1,500-7,000
Au	N(20)	99	--	--	20-70
Cu	N(10)-50	93	70	100	150-500
Pb	N(20)-100	92	150-200	300	2,000-10,000
W	N(100)-200	87	300-500	700-1,000	1,500-3,000
Group 2 (possibly mineralization related)					
B	N(20)-300	84	500-1,000	1,500-2,000	5,000->5,000
Mo	N(10)-30	89	50	70	150
Sn	N(20)-70	94	100	150	300
Group 3 (hydrothermal alteration related)					
Ba	<50-2,000	91	3,000	5,000	7,000->10,000
Fe	0.2-2.0	72	3	5	7-15



Index map showing location of Hoover Wilderness (lined) and adjacent study area (stippled), California. Numbers indicate 15-minute quadrangles: (1) Sonora Pass, (2) Tower Peak, (3) Fales Hot Springs, (4) Matterhorn Peak, (5) Tuolumne Meadows, and (6) Mono Craters.

SUMMARY GEOCHEMICAL MAPS, HOOVER WILDERNESS AND ADJACENT STUDY AREA, MONO AND TUOLUMNE COUNTIES, CALIFORNIA

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