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GEOCHEMICAL ELEMENT MAPS OF THE HOOVER WILDERNESS AND ADJACENT STUDY AREA, MONO AND TUOLUMNE COUNTIES, CALIFORNIA

By

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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.

INTRODUCTION

The Hoover Wilderness and the adjacent Hoover Extension (East), Hoover Extension (West), and Cherry Creek A Roadless Areas (the adjacent study area) lie along and mostly east of the crest of the Sierra Nevada in Mono and Tuolumne Counties, California. The accompanying series of 11 geochemical maps show the distributions of anomalous concentrations of selected elements in 182 minus-60-mesh (0.25-mm) stream-sediment samples and 180 nonmagnetic heavy-mineral-concentrate samples collected in these areas.

GEOLOGY

The geology of the Hoover Wilderness and adjacent study area is typical of many parts of the Sierra Nevada. A batholithic complex, including plutons of Permian(?) to Late Cretaceous age, has intruded a sequence of Paleozoic and Mesozoic rocks to form what are now metasedimentary, metavolcanic, and metaplutonic roof-pendant rocks and bounding wallrocks. Overlying these units locally are Tertiary volcanic rocks consisting of flows, breccias, lahars, and intrusive dikes and sills (Keith and Seitz, 1981). A generalized geologic map is shown in gray on the geochemical maps. A more detailed geologic map of the entire area is also available (Keith and Seitz, 1981).

SAMPLE COLLECTION, PREPARATION, ANALYSIS, AND EVALUATION

Bulk samples of active stream sediment were collected in 1978. Most of the samples were collected from first-order (unbranched) or 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 sediment collected from several locations within a 50-ft (15-m) radius of the sites shown on the map. A portion of each bulk sample was air dried and sieved. The material passing a screen that has 0.25-mm openings (a 60-mesh screen) was saved and pulverized before analysis. The rest of the sample was processed into a concentrate sample by successively wet panning, separating the heavy minerals by using bromoform, and removing the magnetic part of the heavy-mineral fraction with a hand magnet and a Frantz Isodynamic Separator. 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. The stream-sediment samples were also analyzed for As, Bi, Cd, Sb, and Zn by means of colorimetry or atomic-absorption spectrometry. Further details of the procedures for collecting, preparing, and analyzing of the samples, as well as a complete listing of all of the analyses, are given in Chaffee, Banister, and others (1980).

For each sample medium the threshold value (highest background value) for each selected element was first assigned after a visual inspection of the respective frequency distribution plot (figures 1-2 or 1-3 on sheets 1-11) and map plot (sheets 1-11). 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 geochemical study of the Walker Lake 1° x 2° quadrangle (Chaffee, Hill, and others, 1980), a much larger data base. The final threshold value was assigned based on all of the above information.

Tables 1 and 2 summarize background and anomaly ranges for the analyses of the selected elements in the 182 samples of minus-60-mesh (0.25-mm) stream sediment and the 180 samples of nonmagnetic heavy-mineral concentrate, respectively.

Table 1.--Summary of background and anomaly ranges for selected elements in 182 samples of stream sediment, Hoover Wilderness and adjacent study area, California.

[All concentrations are in parts per million. N means not detected at the lower limit of determination shown in parentheses]

Element	Background samples		Anomalous samples	
	Range of values	Percent of samples	Range of values	Percent of samples
Ag	N(0.5)-<0.5	90	0.5-5	10
Cu	N(5)-50	96	70-200	4
Pb	15-50	95	70-500	5
Zn	20-80	85	90-200	15
Cd	N(0.05)-0.35	90	0.4-2.0	10
As	N(10)-<10	88	10-160	12
Sb	<1-3	95	4-10	5
Bi	N(0.5)-0.5	85	1-5	15
B	N(10)-50	84	70-200	16
Mo	N(5)-7	84	10-20	16
W	N(50)	91	<50-50	9
Ba	200-1,500	94	2,000	6

Table 2.--Summary of background and anomaly ranges for selected elements in 180 samples of nonmagnetic heavy-mineral concentrate, Hoover Wilderness and adjacent study area, California.

[All concentrations are in parts per million except those for Fe, which are in percent. N means not detected at the lower limit of determination shown in parentheses]

Element	Background samples		Anomalous samples	
	Range of values	Percent of samples	Range of values	Percent of samples
Ag	N(1.0)-<1.0	87	1-100	13
Au	N(20)	99	20-70	1
Cu	N(10)-50	93	70-500	7
Pb	N(20)-100	92	150-10,000	8
As	N(500)	93	<500-7,000	7
B	N(20)-300	84	500->5,000	16
Mo	N(10)-30	89	50-150	11
W	N(100)-200	87	300-3,000	13
Sn	N(20)-70	94	100-300	6
Ba	<50-2,000	91	3,000->10,000	9
Th	N(500)-5,000	86	>5,000	14
Fe	0.2-2	72	3-15	28

DISCUSSION OF THE GEOCHEMICAL MAPS

Silver and Gold

Silver was detected in many of the stream-sediment and nonmagnetic heavy-mineral-concentrate samples; however, gold was not detected in any of the stream-sediment samples and was detected in only two of the concentrate samples, mainly because gold commonly occurs in these two types of samples in concentrations that are below the lower limits of determination (10 ppm Au in stream sediment; 20 ppm Au in concentrate) for the spectrographic method used. The two samples containing anomalous gold are located on the map by the symbol "Au" followed by the concentration in parts per million. Because of the erratic dispersed nature of gold in alluvium, this element is often difficult to detect, even when present at a particular location; consequently, anomalous gold may have been present at other sample sites but was either not included in the sample material or was not abundant enough to be detected by the analytical technique used.

Figures 1-3 on sheet 1 show, respectively, the frequency distributions for silver concentrations in the samples of stream-sediment and concentrate and for gold concentrations in the samples of concentrate. Because all three of these data sets contain highly censored populations, the presence of more than one sample population for any of the three cannot be determined.

For the area covered by this report, silver and gold anomalies can be used to locate deposits of base and precious metals (Cu, Pb, Zn, Ag, and Au), molybdenum, and tungsten. Silver anomalies in samples of stream sediment are clustered in the southern part of the overall area sampled, between the Robinson Creek and the Saddlebag Lake-Warren Fork areas. In the Robinson Creek area the silver anomalies all seem to be related to exposures of the Cathedral Peak Granodiorite. South of the Robinson Creek area the silver anomalies are all near exposures of metamorphosed sedimentary and igneous formations of Jurassic to Paleozoic age. These formations represent roof pendants in the Sierra Nevada batholith and locally exhibit the effects of hydrothermal alteration (pyritization and silicification). Many of the samples from these same altered areas also contain anomalous concentrations of other elements (As, B, Ba, Bi, Cd, Cu, Mo, Pb, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these same areas.

Scattered silver anomalies on the west side of the adjacent study area seem to be lithologically related to the granodiorite of Fremont Lake and the Tertiary volcanic formations rather than to past mining activity in the upper Cherry Creek area.

The two concentrate samples containing detectable gold are from sites that are also anomalous for silver in both sample media; thus, as-yet-undetected concentrations of gold may well be present in samples from other localities that are enriched in silver.

Copper

Figures 1 and 2 on sheet 2 show the frequency distributions of copper concentrations in the samples of stream sediment and concentrate. Neither of these figures indicates that more than one population is present.

For the area covered by this report copper anomalies can be used to locate deposits of base and precious metals. Copper anomalies for samples of both stream sediment and concentrate are distributed throughout the area examined. Those anomalies in the Buckeye Creek, Lundy Canyon, and Saddlebag

Lake-Warren Fork areas are all near exposures of the metamorphosed sedimentary and igneous roof-pendant rocks, which are locally hydrothermally altered. Many of the samples from these same altered areas also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Mo, Pb, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these same areas.

Copper anomalies also occur locally near outcrops of the Tertiary volcanic formations in the northern part of the overall area sampled. The sources of these anomalies are not known; they may be related to lithology and only represent locally enriched but normal copper concentrations for the types of rocks exposed.

Lead

Figures 1 and 2 on sheet 3 show the frequency distributions of lead concentrations in the samples of stream sediment and concentrate. Both of these figures show a single population.

For the area covered by this report lead anomalies can be used to locate deposits of base and precious metals. Lead anomalies in samples of both stream sediment and concentrate are scattered throughout the area examined; however, the most significant lead anomalies are present in the southern part, between Green Creek and the Saddlebag Lake-Warren Fork area. These anomalies are all near exposures of the metamorphosed sedimentary and igneous roof-pendant rocks, which locally exhibit the effects of hydrothermal alteration (pyritization and silicification). Many of the samples from these same altered areas also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Mo, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these same areas.

The scattered lead anomalies in the concentrate samples from the northern part of the area sampled are not reflected in the stream-sediment analyses and are mostly associated with the Tertiary volcanic formations. The sources of these lead anomalies are not known. Except for barium no other hydrothermally-associated anomalies were detected in any of these same scattered localities, suggesting that these volcanic units may locally have a relatively enriched but normal content of lead.

Zinc and Cadmium

Figures 1 and 2 on sheet 4 show the frequency distributions for zinc and cadmium concentrations in the samples of stream sediment. Both of these figures seem to show only a single population, although a weak second, overlapping population may be present at the higher concentration levels for both elements.

For the area covered by this report zinc and cadmium anomalies can be used to locate deposits of base and precious metals, molybdenum, and tungsten. Zinc anomalies in samples of stream sediment are scattered throughout the area examined but are mainly concentrated in the metamorphosed sedimentary and igneous formations of Jurassic to Paleozoic age in the Lundy Canyon and Saddlebag Lake-Warren Fork areas; in the Cathedral Peak Granodiorite in the Robinson Creek area; and in the granodiorite of Fremont Lake, the granodiorite of Topaz Lake, and the Tertiary volcanic formations, all in the upper West Walker River and(or) upper Cherry Creek drainages. The extensive zinc anomaly in the West Walker River area is not related to anomalies of other elements studied or to any known mineralization and thus may only represent locally enriched but normal zinc concentrations for the types of rocks in that area. The metamorphosed sedimentary and igneous rocks in the southern part of the area sampled locally exhibit exposures of hydrothermally altered (pyritized and silicified) rock. High concentrations of zinc are commonly associated with many types of mineral deposits. However, none of the stream-sediment samples collected for this study had zinc in concentrations exceeding 200 ppm, suggesting that zinc is not significantly enriched anywhere in the Hoover Wilderness or adjacent study area in spite of its association with localities of known altered and mineralized rocks.

Anomalies for cadmium in samples of stream sediment are also present throughout the area examined and are associated with a variety of rock types. Although cadmium is normally associated with zinc minerals, very few of the sites with zinc anomalies are also anomalous for cadmium. The best clustering of both zinc and cadmium anomalies is in the southern part of the Hoover Wilderness, in the metamorphic rocks in the Lundy Canyon and Saddlebag Lake-Warren Fork areas. In addition to containing anomalous concentrations of zinc and(or) cadmium, many of the samples in these two drainage basins also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cu, Mo, Pb, Sb, Sn, and(or) W). Numerous mines and prospects are present in many of these areas.

Arsenic

Figures 1 and 2 on sheet 5 show the frequency distributions for arsenic concentrations in the samples of stream sediment and concentrate. Because the analyses for both sample types are highly censored, the presence of more than one population in each data set cannot be determined.

For the area covered by this report arsenic anomalies can be used to locate deposits of base and precious metals. Arsenic anomalies in samples of both stream sediment and concentrate are clustered mainly in the central and southern parts of the area examined. In general, no coincidence of arsenic anomalies exists for most sites for the two types of samples, suggesting that arsenic occurs in two different minerals, one of which predominates in each sample medium. Neither mineral has as yet been identified.

The most significant arsenic anomalies in the samples of stream sediment are those in the southern part of the Hoover Wilderness, in the Green Creek, Lundy Canyon, and Saddlebag Lake-Warren Fork areas. All three of these areas are near exposures of the metamorphosed sedimentary and igneous roof-pendant rocks, which are locally hydrothermally altered. Many of the samples from these same altered areas also contain anomalous concentrations of other metals (Ag, Au, B, Ba, Bi, Cd, Cu, Mo, Pb, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these same areas.

Other arsenic anomalies in samples of stream sediment are scattered throughout the overall area sampled. These anomalies are associated with several different rock types, and the significance, if any, of these anomalies is not known.

The arsenic anomalies in samples of concentrate are present mainly in the center of the area examined and are associated with the Cathedral Peak Granodiorite. These anomalies probably represent locally enriched but normal concentrations of arsenic in this rock unit.

Antimony and Bismuth

Figures 1 and 2 on sheet 6 show the frequency distributions for antimony and bismuth concentrations in the samples of stream sediment. Both figures show the presence of only one population.

For the area covered by this report antimony and bismuth anomalies can be used to locate deposits of base and precious metals and possibly those of molybdenum and tungsten. The most significant antimony anomaly in samples of stream sediment is in the Lundy Canyon area near exposures of the locally altered and metamorphosed roof-pendant rocks. Many of the samples from the Lundy Canyon area also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Mo, Pb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these areas. Widely scattered antimony anomalies are also present in samples from other localities in the area examined. These anomalies are near outcrops of many different rock types; the significance of these anomalies is not known.

Samples of stream sediment containing anomalous concentrations of bismuth are also present throughout much of the area sampled. Probably the most important of these anomalies are those in the Lundy Canyon, Robinson Creek, and Buckeye Creek drainage basins. All of these anomalies are associated with the metamorphic rocks. Many of the samples from these areas are also anomalous for one or more of the group of elements listed above. Most of the other bismuth anomalies are probably nonsignificant as a result of a decision to consider the reported values of 1.0 ppm Bi anomalous (fig. 2 on sheet 6). Because exclusion of the 1.0 ppm values left too few samples in the anomalous portion of the analytical data set in relation to the number of samples included for the rest of the elements studied (Table 1), the samples with these values were added. The histogram for bismuth (fig. 2 on sheet 6) suggests that this value is probably part of the background population.

Boron

Figures 1 and 2 on sheet 7 show the frequency distributions for boron concentrations in the samples of stream sediment and concentrate. Figure 1 is probably a single population; figure 2 seems to indicate two overlapping populations.

Boron is found commonly as a constituent in late-stage hydrothermal accessory minerals, such as tourmaline or biotite, and thus boron may be associated with deposits of other elements that might be of economic interest; consequently, boron anomalies might indicate the presence of undiscovered deposits of such elements. Boron anomalies are present in samples of both stream sediment and concentrate, primarily in two areas. In the northern part of the area examined boron anomalies are present near exposures of the granodiorite of Lake Harriet, the granodiorite of Fremont Lake, as well as, locally, the Tertiary volcanic formations, the metamorphosed sedimentary and igneous formations of Jurassic to Paleozoic age, and some of the other Cretaceous to Paleozoic plutons.

The other major location of boron anomalies is in the southern part of the Hoover Wilderness, where anomalies are near exposures of the locally altered metamorphic rocks in the Lundy Canyon and Saddlebag Lake-Warren Fork drainage basins. Many of the samples from these two areas also contain anomalous concentrations of other elements (Ag, As, Au, Ba, Bi, Cd, Cu, Mo, Pb, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in many of these same areas.

Molybdenum

Figures 1 and 2 on sheet 8 show the frequency distributions for molybdenum concentrations in the samples of stream sediment and concentrate. Both figures seem to show only a single population.

For the area covered by this report molybdenum anomalies can be used to locate deposits of molybdenum, copper, and tungsten. Molybdenum anomalies for samples of both stream sediment and concentrate are distributed throughout the area examined. Those anomalies in the southern part, in the Green Creek, Lundy Canyon, and Saddlebag Lake-Warren Fork drainage basins, and possibly some of those near Cherry Creek, to the west, are all near exposures of the metamorphosed sedimentary and igneous roof-pendant rocks, which locally exhibit the effects of hydrothermal alteration (pyritization and silicification). Many of the samples from these same altered areas also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Pb, Sb, Sn, W, and(or) Zn). Numerous mines and prospects are present in these same areas.

A stream-sediment anomaly is present in Molybdenite Creek below an old molybdenite prospect in outcrops of the Cathedral Peak Granodiorite. In addition, extensive molybdenum anomalies are present in the central and northern parts of the Hoover Wilderness and adjacent study area. Most of these anomalies are associated either with the metamorphosed rock units described above or with intrusive rock units of the Sierra Nevada batholith, including the Cathedral Peak Granodiorite, the granodiorite of Fremont Lake, the granodiorite of Lake Harriet, and possibly some of the other plutonic units included in the Cretaceous to Paleozoic, undivided, unit. The metamorphic units in these areas are known to have been prospected locally for tungsten in the past. Many of the molybdenum anomalies associated with the Cretaceous intrusive formations, on the other hand, may be associated with scattered quartz veins and thus are probably the result of high but normal concentrations of molybdenum for these rock types. A few molybdenum anomalies are also present in streams draining the Tertiary volcanic formations at the northern end of the entire area sampled. The source of this molybdenum is not known.

Tungsten and Tin

Tungsten and tin commonly occur in samples of stream sediment in concentrations that are below the lower limits of determination for the emission spectrographic method of analysis used by the U.S. Geological Survey. Both of these elements were detected in a significant number of the nonmagnetic heavy-mineral-concentrate samples. Figures 1-2 on sheet 9 show the frequency distributions for tungsten and tin concentrations in the samples of concentrate. These figures indicate that both of these elements may have overlapping populations.

In the area covered for this report both tungsten and tin may be associated with deposits of other elements, such as molybdenum, that might be of economic interest; thus, anomalies of either tungsten or tin might indicate the presence of undiscovered deposits of molybdenum. Tungsten may also indicate the presence of tungsten deposits, a number of which are already known in the area of the Sierra Nevada batholith.

Sites with tungsten anomalies in samples of concentrate are present in the extreme upper West Walker River, Little Walker River, Buckeye Creek, Robinson Creek, Green Creek, and Lundy Canyon areas. In the southern part of the overall area examined, the tungsten anomalies are near altered outcrops of the metamorphosed sedimentary and igneous formations. Many of the samples from these same altered areas also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Mo, Pb, Sb, Sn, and(or) Zn).

In the central and northern parts of the area sampled tungsten anomalies are mainly associated with exposures of the Cathedral Peak Granodiorite, the granodiorite of Lake Harriet, the Tertiary volcanic formations, and(or) the metamorphic formations. The metamorphic rocks in these areas are known to have been prospected locally for tungsten in the past. The sources of tungsten anomalies in the plutonic rocks are not known; the tungsten may occur locally in quartz veins.

The tin anomalies in the samples of concentrate are less widespread than those of tungsten. Tin anomalies are present in the extreme upper West Walker River drainage and in the Lundy Canyon and Saddlebag Lake areas. The anomalies in the upper West Walker River area are mainly associated with the granodiorite of Lake Harriet or with the Cathedral Peak Granodiorite. Many of the tin anomalies associated with these granodioritic intrusive formations probably only represent locally enriched but normal tin concentrations for these rock types. Tin is probably present in the mineral cassiterite. Many of the granodiorites in the study area are enriched in sphene; thus, this mineral may be another possible source for much of the tin.

The tin anomalies in the Lundy Canyon and the Saddlebag Lake areas are associated with the locally altered roof-pendant rocks. The samples that have the highest tin concentrations are those in Lundy Canyon. Many of the samples from these two areas also contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Mo, Pb, Sb, W, and(or) Zn). Numerous mines and prospects are present in these areas.

Barium

Figures 1 and 2 on sheet 10 show the frequency distributions of barium concentrations in the samples of stream sediment and concentrate. Figure 1 shows only one population; however, figure 2 indicates that two overlapping populations of barium may be present in the concentrate samples.

The barium content of a sample of stream sediment is predominantly the sum of barium substituting for other elements in feldspars and other rock-forming minerals and of barium in the mineral barite. This barite may be either hydrothermal in origin or a result of chemical precipitation during the formation of a sedimentary rock unit. In contrast, the barium content of a nonmagnetic heavy-mineral concentrate is essentially all related to the mineral barite. Hydrothermal barite may be associated with deposits of other elements that might be of economic interest; thus, barium anomalies, particularly those in concentrate samples, might indicate the presence of undiscovered deposits of such elements.

Most of the barium anomalies in the samples of both stream sediment and concentrate, including those anomalies with the highest barium values, are clustered in the northern part of the area examined in the vicinity of the Tertiary volcanic formations associated with the Mount Emma volcanic center. The sources of these anomalies are not entirely known. Hydrothermal barium in this area may be related either to hot spring activity associated with the waning phases of volcanism around the Mount Emma center or possibly to an unknown, deeply buried source of mineralization. Hydrothermally altered volcanic and plutonic rocks are present locally in that area. Samples of stream sediment in the Robinson Creek area also contain anomalous concentrations of barium. The source of this anomaly is also not known.

A barium anomaly based on concentrate samples is present in the Warren Fork drainage at the southern end of the Hoover Wilderness. This anomaly is near locally altered exposures of the metamorphosed roof-pendant formations. Samples from this same area also contain anomalous concentrations of other elements (Ag, As, Cd, Cu, Mo, and(or) Zn).

Thorium and Iron

Thorium, which normally occurs in samples of stream sediment in concentrations that are below the lower limit of determination for the emission spectrographic method used by the U.S. Geological Survey, was determined in a significant number of the concentrate samples collected for this study.

The total iron content of stream-sediment samples may result from iron that occurs in a variety of minerals, only a few of which may be related to any mineral deposits that may be present. As a result of the mineral separation techniques used, the iron analyses of the heavy-mineral concentrates prepared for this study are thought to be predominantly a measure of the pyrite content of the sample, and thus may indicate areas that have been hydrothermally altered.

Figures 1 and 2 on sheet 11 show the frequency distributions of thorium and iron concentrations in the samples of concentrate. The distributions suggest that two, or possibly three, overlapping populations may be present for both elements.

Within the Hoover Wilderness and adjacent study area the distribution of thorium anomalies does not coincide with those of other elements that might be associated with mineral deposits. Nearly all of the samples with anomalous thorium are from drainages that include outcrops of either the Cathedral Peak Granodiorite or the granodiorite of Fremont Lake; thus, a strong lithologic control exists for thorium. The high thorium concentrations are probably only normal amounts for these two rock units. Most of the thorium is probably present in accessory minerals, such as zircon and sphene. Sphene, in particular, is abundant in both of the granodiorites cited above.

Iron (pyrite(?)) anomalies are scattered throughout the area examined. These anomalies in the north--in the West Walker River, Little Walker River, Buckeye Creek, and Eagle Creek drainages--are mainly associated with outcrops of the Tertiary volcanic formations, and to a lesser extent, with outcrops of the metamorphosed sedimentary and igneous formations. No prospects or mines are known in the vicinity of these anomalies; however, hydrothermally altered (pyritized and silicified) outcrops are present locally in some of these drainage areas.

Extensive iron anomalies are also present in the southern part of the area examined, in all of the major drainages south of Robinson Creek. These anomalies are confined almost entirely to the locally altered and metamorphosed sedimentary and (especially) igneous roof-pendant rocks. Many of the samples from this part of the area examined contain anomalous concentrations of other elements (Ag, As, Au, B, Ba, Bi, Cd, Cu, Mo, Pb, Sb, Sn, W, and(or) Zn). The high iron concentrations in the concentrate samples consequently provide a good correlation with these areas of known pyrite and thus help to identify mineralized areas. Numerous mines and prospects are present in many of these same drainage basins.

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