DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
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PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE WEST CLEAR CREEK ROADLESS AREA, YAVAPAI AND COCONINO COUNTIES, ARIZONA

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the West Clear Creek Roadless Area, Coconino National Forest, Yavapai and Coconino Counties, Arizona. The West Clear Creek Roadless Area (03047) was classified as a further planning area during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The mineral resource potential of the West Clear Creek Roadless Area, Ariz., is evaluated as low on the basis of field studies performed by the U. S. Bureau of Mines and the U. S. Geological Survey during 1980. No concentrations of minerals are indicated by geochemical sampling within the roadless area. Evaporite deposits, a manganese deposit, basaltic cinders, and building stone have been mined or quarried near the area. Cinders and sandstone are found in the area but are readily available and more accessible outside the precipitous canyon of West Clear Creek.

INTRODUCTION

During the summer of 1980, the U. S. Bureau of Mines conducted a mineral resource survey of the West Clear Creek Roadless Area. Geologic mapping, an aeromagnetic survey (Davis and Ulrich, in press), and sampling for a geochemical survey were completed by the U. S. Geological Survey during the spring and summer of the same year.

Location, Size, and Geographic Setting

The roadless area includes approximately 53 mi^2 (137 km^2) in Yavapai and Coconino Counties, in central Arizona (fig. 1). Camp Verde, the nearest population center, is approximately 7 mi (11 km) west, and Phoenix is 70 mi (113 km) south of the area.

The roadless area boundary closely follows the rim of the steep-walled canyon cut by the West Clear Creek drainage system into the gently westward-sloping surface of the Colorado Plateau. The mouth of the canyon and the western boundary of the area are near the Mogollon Rim, an escarpment that marks the southwestern margin of the Colorado Plateau. Here the plateau surface falls off sharply to the Verde Valley and West Clear Creek joins the Verde River, the master stream of the region.

Maximum elevation is approximately 7,000 ft (2,134 m) along the canyon rim at the eastern boundary of the area. The lowest elevation is approximately 3,300 ft (990 m) along the West Clear Creek streambed at the western boundary. Topographic relief within the area ranges from a maximum of 1,800 ft (550 m) near Big Spring, to a minimum of approximately 100 ft (30 m) at the head of Long Valley Draw. West Clear Creek, a perennial stream, drops 3,010 ft (917 m) over a distance of 36 mi (57 km) from its head at the juncture of Willow and Clover Creeks to its confluence with the Verde River. Together, with its tributaries, it drains an area of 241 mi^2 (624 km^2).

The rim of West Clear Creek canyon and the boundary of the roadless area are accessible by U.S. Forest Service and logging roads from U.S. Forest Service Highway 3 on the east and by the paved U.S. Forest Service Highway 9 on the south. Access to the north rim of the canyon is gained by generally unimproved U.S. Forest Service roads and by jeep trails from either U.S. Forest Service Highway 3 on the east or U.S. Forest Service Roads 618 and 214 on the west. The western boundary of the area and the mouth

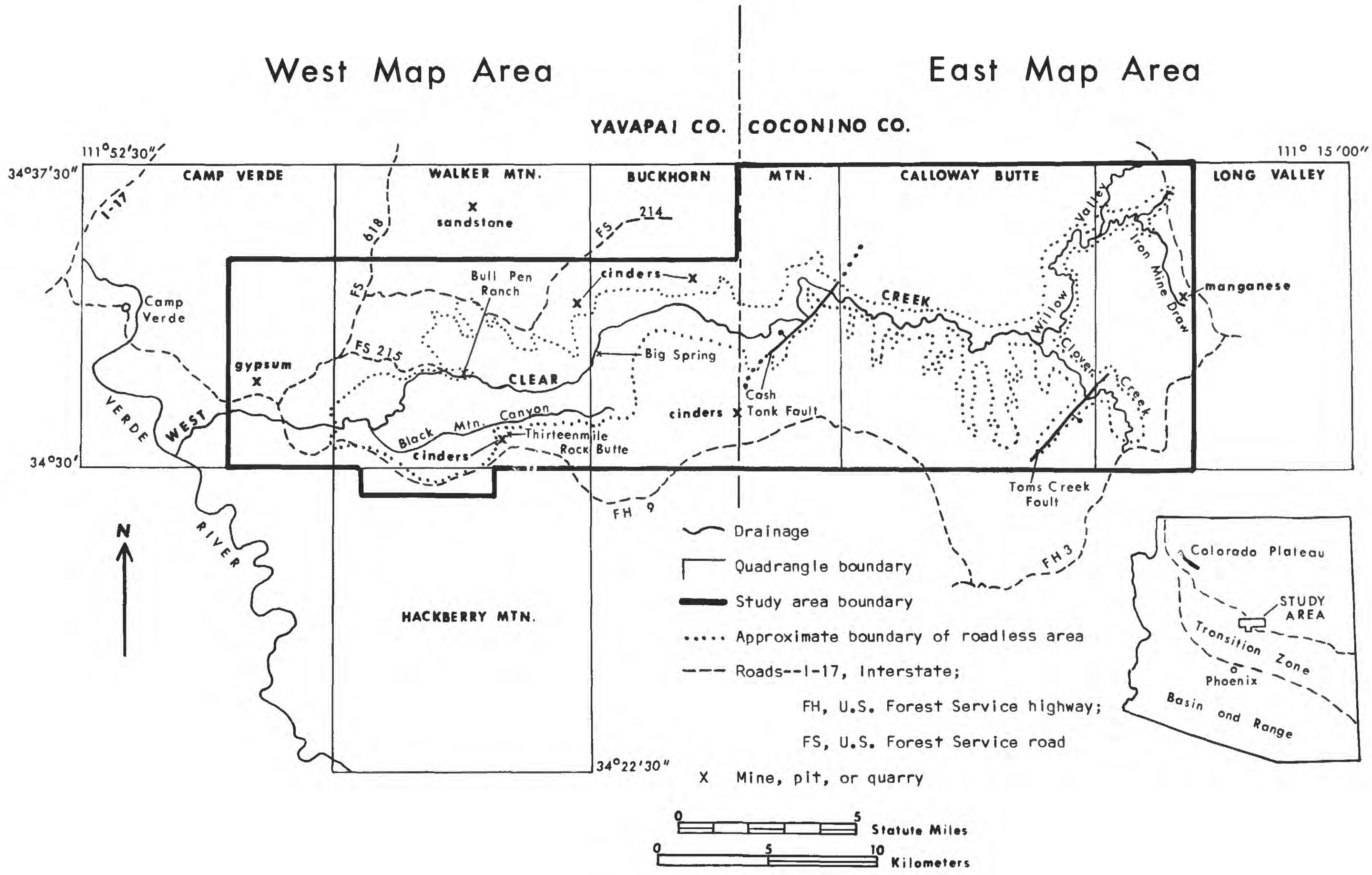

Figure 1.--Index map showing location of the West Clear Creek Roadless Area (03047), developed mineral deposits, access roads, drainages, and area boundaries.

of West Clear Creek canyon can be reached from Camp Verde by Forest Service Roads 618 and 214. The bottom of the canyon is accessible primarily by foot, locally by horse, and in some sections can be traversed only by swimming.

Geologic Setting

The West Clear Creek Roadless Area lies mainly on the southwestern margin of the Colorado Plateau and includes part of the Verde Valley, one of several tectonic basins in the Arizona Transition Zone that separates the Basin and Range and Colorado Plateaus physiographic provinces (fig. 1). The canyon cut by West Clear Creek has very youthful longitudinal and cross-sectional profiles and exposes in its precipitous walls upper Tertiary volcanic rocks, primarily basalts, overlying Lower Permian sedimentary rocks.

The structural setting is one of gentle westward dips in the sedimentary rocks and steeply dipping normal faults. Significant faulting occurred prior to volcanism and probably continued through late Miocene and Pliocene(?) time. The result of the early tectonism was deep downcutting of a broad channel near the Plateau margin and subsequent infilling by coarse fluvial sediments and later volcanic flows and pyroclastic deposits. Fluviolacustrine sediments of the Verde Formation were deposited in the western part of the study area during and following the volcanic activity.

Mining Activity

No mining activity has been conducted within the West Clear Creek Roadless Area. Manganese minerals have been mined on a small scale near Iron Mine Draw 1-3 mi (1.6-4.8 km) east of the area. One mile (1.6 km) west of the area, claims have been staked for gypsum and other evaporites. Approximately 2 mi (3 km) west of the boundary, a gypsum mine is presently in operation (1983). Small pits in cinder cones are scattered about the area periphery; these have been sources of road material and were not being actively mined at the time they were mapped. Minor quarries in Coconino Sandstone are 2.5 mi (4 km) north of the west end of the area and are inactive. The sandstone was presumably used as building or decorative stone. Figure 1 shows the locations of these deposits.

GEOLOGY

The rocks of the West Clear Creek Roadless Area include cumulative exposures of approximately 1,700 ft (522 m) of upper Paleozoic sedimentary strata that are overlain by a thin basaltic cover (approximately 100 ft; 30 m thick) east of the Cash Tank fault and by more than 1,475 ft (450 m) of volcanic rocks ranging from basalt to rhyolite west of the fault (fig. 2). Tertiary sedimentary rocks are both older and younger than the Miocene to Pliocene(?) volcanism, and in adjacent areas (Elston and others, 1974; E. W. Wolfe, unpub. data, 1980) they are interbedded with the volcanic rocks.

Paleozoic rocks include, in ascending order, the upper one-third of the Supai Formation (650 ft; 200 m), the Coconino Sandstone (700 ft; 215 m), and the Kaibab Formation (350 ft; 107 m). An erosional remnant of the Triassic Moenkopi Formation is found in the northeast corner of the mapped area. Extensive prevolcanic erosion removed more than 1,300 ft (about 400 m) of the upper Paleozoic strata from the area west of the Cash Tank fault, creating a broad valley about 6.5 mi (10 km) wide that marked the edge of the Colorado Plateau at that time. Subsequently, coarse conglomerates were deposited on the valley floor to a maximum thickness of 300 ft (90 m); these contain clasts mainly of local sedimentary rocks, but additional scattered clasts of lower Paleozoic and Precambrian rocks suggest distant sources as well, or in some cases reworked rim gravels as proposed by Peirce and others (1979).

The volcanic rocks are mainly alkali-olivine basalt flows, one or two flows thick in the eastern map area, with a dramatic increase in number and thickness west of the Cash Tank fault. The thick western volcanic pile overlies the Tertiary conglomerates and the eroded Supai Formation and Coconino Sandstone and includes, in addition to basalt flows, a few andesite plugs and dikes, silicic ash flows (mainly dacite) derived from local buried vents and from the Hackberry Mountain silicic center south of the area (R. E. Lewis, unpub. data, 1981), and abundant basaltic dikes and pyroclastic vent deposits. Potassium-Argon ages reported by Peirce and others (1979) for a basalt flow and dike in the lower part of the pile near Bull Pen Ranch are 10.6 ± 0.3 and 9.7 ± 0.4 m.y. respectively, placing the beginning of volcanism in late Miocene time and the formation and partial sedimentary filling of the large paleovalley at or before late Miocene time.

The Verde Formation at the western edge of the roadless area consists of conglomerate and lacustrine facies unconformably overlying the volcanic rocks; in adjacent areas the conglomerate facies is interbedded with lava flows and ash-flow tuffs. Evaporites (mainly gypsum) are present within the lacustrine facies west of the area. Although a Pleistocene age for the upper part of the Verde Formation has been established in the northern part of the Verde Valley (Nations, 1974), rocks younger than Pliocene are not believed to be present within the mapped area.

The sedimentary rocks of the West Clear Creek area dip gently westward on the southwestern flank of the Mormon Mountain anticline of Twenter and Metzger (1963). The age of folding has not been documented but is inferred to be Laramide by analogy with nearby structures in the Colorado Plateau. Structural lowering from east to west due to westward dip and faulting combined is approximately 2,200 ft (670 m). Most of the faults are normal, have small throws, and trend north to northwest. Two faults, which are anomalous in their northeasterly strikes and traceable distances (greater than 3 mi; 5 km) are the Cash Tank and Toms Creek faults. The Cash Tank fault is also notable in its large throw (240-360 ft; 73-110 m) and its reflection in the gravity and aeromagnetic data (see "Geophysics"). The Toms Creek fault parallels the aeromagnetic contours in the area and lies on a trend that, if extended to the northeast, would coincide with the breccia zone described by Jones and Ransome (1920) in the Last Chance mine area.

Based on the results of this study, none of the rocks within the roadless area are known to be mineralized.

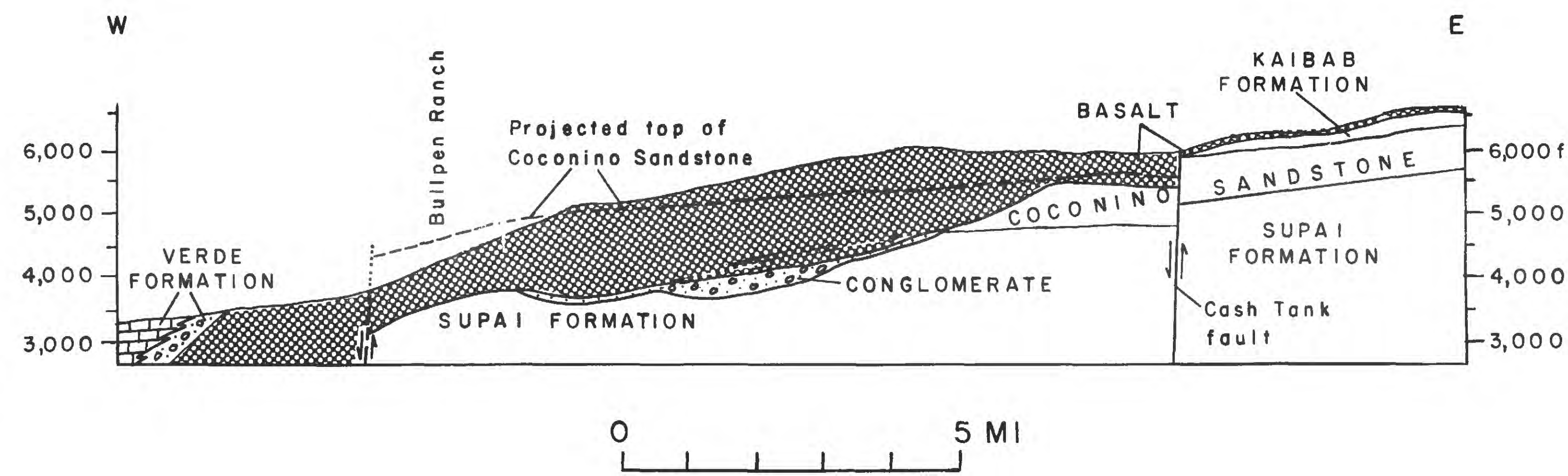

Figure 2.--Generalized longitudinal cross section of West Clear Creek canyon.

GEOCHEMISTRY

Stream-sediment and rock samples were collected for chemical analysis and evaluation of typical and anomalous values that might indicate potential mineral resources in the region.

Sampling Strategy and Analytical Techniques

Five stream-sediment and 58 rock samples were collected within the mapped area for semiquantitative spectrographic analysis for trace elements and for neutron activation analysis for uranium and thorium. The stream-sediment samples were processed in the field by sieving and heavy-mineral panning of alluvium. Sediment samples for panning were collected (1) at the lower ends of tributaries to West Clear Creek, (2) in West Clear Creek canyon above the highest outcrop of the Supai Formation, and (3) at the lower end of the West Clear Creek drainage. These locations (fig. 3) were selected to discriminate possible source areas of anomalous concentrations. Rock samples were selected to represent the various facies of the sedimentary formations and the lithologic variety of the volcanic suite. Table 1 lists the 24 samples that have anomalous trace element concentrations and figure 3 shows their locations. Determination of background values for each of the elements was made by visual comparison of the data and selection of a maximum common value as the "background" level for all samples. Elements considered to be anomalous are those that have concentrations generally at least twice as high as the average value for the rock type or stream-sediment group. A complete listing of major and trace element analyses for the area is available as an open-file report (Ulrich, 1983).

Evaluation of Analytical Data

The most significant geochemical anomaly is based on analyses of two samples of the Kaibab Formation taken from the Last Chance mine in the Long Valley manganese district, 1-3 mi (1.6-4.8 km) east of the roadless area east of Willow Valley. High values of manganese, arsenic, cobalt, copper, molybdenum, and tungsten and above-background amounts of silver and beryllium are found in one or both samples (75A and B, table 1). Arsenic and tungsten were found in no other samples and no comparable anomalies were identified anywhere within the roadless area.

Three of the panned stream-sediment samples contained 500 parts per million or more of zirconium and one produced above-background values for cobalt, chromium, copper, and nickel. These values are interpreted as detrital concentrates derived from primarily basaltic sources upstream from the sample localities.

The volcanic rock suite, mostly basaltic and generally olivine-rich, contains expected high concentrations of cobalt, chromium, and nickel. Other elements that are locally found in concentrations above background include beryllium, copper, lead, and scandium. Uranium and thorium concentrations are locally high, especially in two basalt dikes (samples 10A and 14). Silver values of 2-7 ppm appear to be anomalous in two silicic tuff samples (13 and 32), one basaltic tuff (37), a pyroxenite clast within the conglomerate facies of the Verde Formation (4), and eight samples from the Kaibab Formation and Coconino Sandstone. These values were rechecked and confirmed by D. E. Detra (unpub. data, 1982). Silver in the Kaibab and Coconino might be due to lateral migration in ground water from pre-existing Precambrian highlands to the south.

GEOPHYSICS

As shown by the Bouguer map of Arizona (West and Sumner, 1973) the west half of the West Clear Creek Roadless Area has a regional gravity slope that strikes north-south and dips eastward and has a 25 mgal drop at the approximate position of the Cash Tank fault. East of that point the gradient flattens.

An aeromagnetic map prepared from data collected at an average altitude of 1,000 ft (300 m) above the ground (Davis and Ulrich, in press) shows an irregular pattern of small high-gradient anomalies reflecting the thick section of volcanic rocks in the western and central parts of the area. Low magnetic relief in the eastern part is explained by the thin to absent volcanic cover over relatively undisturbed sedimentary rocks.

MINING DISTRICTS AND MINERALIZED AREAS

The West Clear Creek Roadless Area is not part of an organized mining district. Records at the Coconino and Yavapai County Courthouses and at the U.S. Bureau of Land Management State Office contained no mining claims located within the area. Mineralized areas, mining claims, and mining activities are limited to the Long Valley manganese district, which is east of the area near Iron Mine Draw, and to the gypsum deposits in the Verde Valley, west of the area. Small pits and quarries in cinders and sandstone are also scattered outside the area (fig. 1).

The Long Valley manganese district is centered at the Last Chance mine, near the head of Iron Mine Draw. The district has been the subject of manganese resource studies by Bell (1940), Bromfield (1952), Duncan and Byers (1942), Farnham and Stewart (1959), Harrer (1964), Hunt and Johnson (1940), Jones and Ransome (1920), Soulé (1952), and Wilson and Butler (1930). Mining claims in the Long Valley district were recorded as early as 1917. Since then other claims and relocations were filed sporadically until 1976. From 1945 to 1960, several claim blocks were legally surveyed, and parts of these blocks were patented. Some of the patents were reconveyed to the government in 1978.

Manganese is concentrated in a northeast trending, locally brecciated, zone through the Last Chance mine area described in some of the above reports. The trend is similar to that of the Toms Creek fault projected to the northeast through the mineralized area. The relationship of the Toms Creek fault to the manganese mineralization is unknown because the fault cannot be traced on the ground beyond its mapped extent.

Psilomelane and pyrolusite, the most abundant manganese minerals, occur with limonite and calcite as fracture fillings, nodules, and irregular masses in limestone, conglomerate, and soil. Detrital fragments of resistant varieties of manganese minerals form alluvial placer deposits along the water course of Iron Mine Draw.

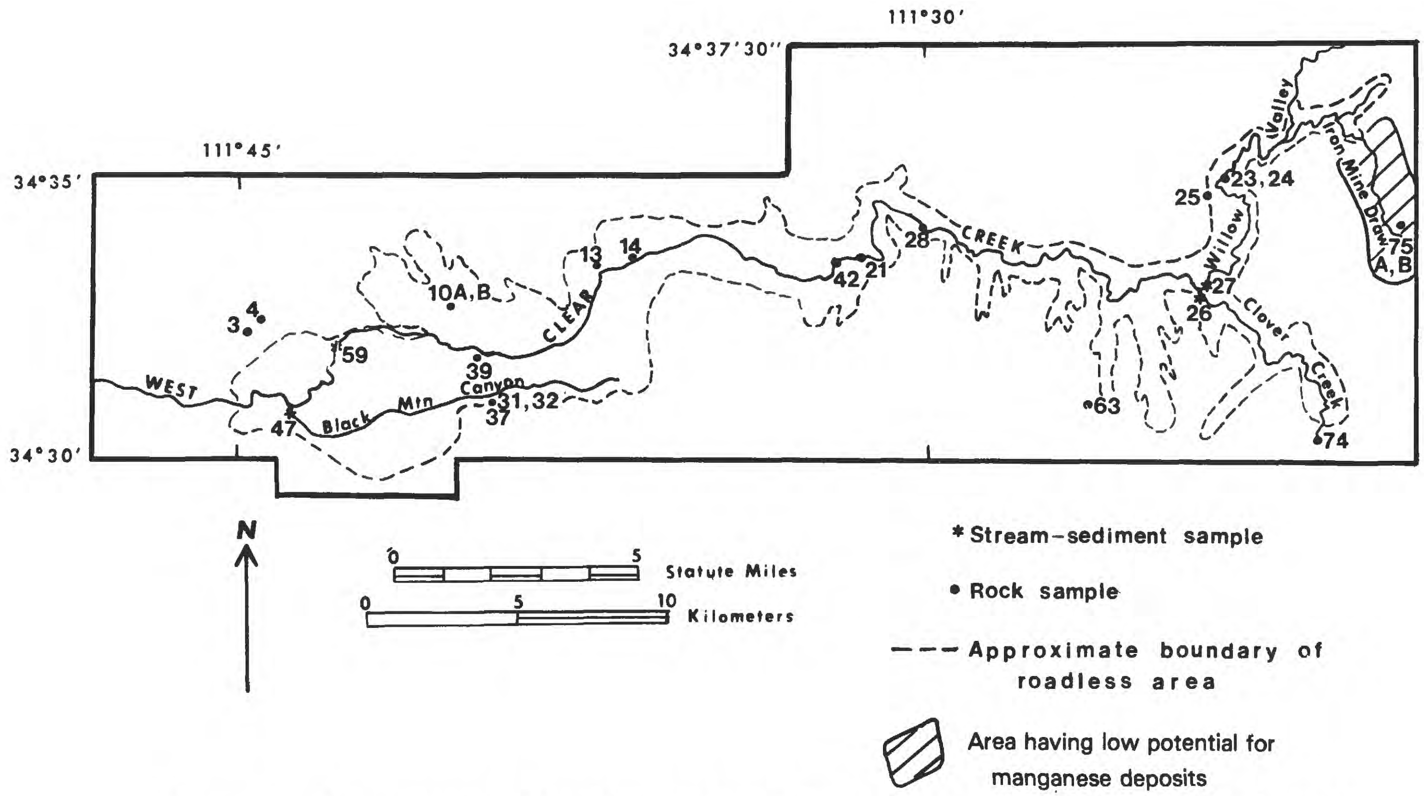

Figure 3.--Map showing locations of samples having anomalous trace-element concentrations and area having low potential for manganese deposits.

Table 1.--Anomalous Trace Element Values from West Clear Creek Roadless Area
[All values are in parts per million; - - -, indicates concentration at or below background level]

Sample No.	Material	Mn	Ag	As	Be	Co	Cr	Cu	Mo	Ni	Pb	Sc	W	Zr	U	Th
	Lower limit of detection	10	0.5	200	1	5	10	5	5	5	10	5	50	10	1	0.1
	Background level	<3000	0	0	<3	<60	<1000	<200	0	<200	<80	<60	0	<300	<4	<15
		Concentrations														
3	Basalt vent..........................	- - -	- - -	- - -	- - -	70	1500	- - -	- - -	500	- - -	- - -	- - -	- - -	- - -	- - -
4	Pyroxenite clast.....................	- - -	2	- - -	- - -	- - -	5000	- - -	- - -	- - -	- - -	100	- - -	- - -	- - -	- - -
10A	Basalt dike..........................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	4.9	24.0
10B	Basalt dike..........................	- - -	- - -	- - -	- - -	- - -	- - -	500	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
13	Silicic tuff.........................	- - -	5	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
14	Basalt dike..........................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	7.5	25.2
21	Coconino Sandstone...................	- - -	3	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
23	Kaibab Formation, calcarenite........	- - -	3	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
24	Coconino Sandstone...................	- - -	5	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
25	Basalt vent..........................	- - -	- - -	- - -	- - -	100	1500	- - -	- - -	1000	- - -	- - -	- - -	- - -	- - -	- - -
26	Stream sediment......................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	>1000	- - -	- - -
27	Stream sediment......................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	500	- - -	- - -
28	Coconino Sandstone...................	- - -	7	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
31	Silicic tuff.........................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	200	- - -	- - -	- - -	- - -	- - -
32	Silicic tuff.........................	- - -	3	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
37	Basaltic tuff........................	- - -	3	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
39	Basalt flow..........................	- - -	- - -	- - -	5	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
42	Coconino Sandstone...................	- - -	7	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
47	Stream sediment......................	- - -	- - -	- - -	- - -	50	1500	100	- - -	200	- - -	- - -	- - -	- - -	- - -	- - -
59	Stream sediment......................	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1000	- - -	- - -
63	Kaibab Formation, sandstone..........	- - -	2	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
74	Coconino Sandstone...................	- - -	2	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
75A	Kaibab Formation (mineralized).......	>5000	2	1000	5	300	- - -	700	500	- - -	- - -	- - -	50	- - -	- - -	- - -
75B	Kaibab Formation (mineralized).......	>5000	0.5	2000	5	- - -	- - -	- - -	50	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Deposits are discontinuous and generally yield a few tons of ore. Mineralized rock is commonly located near the surface, but may extend to a depth of 50 ft (15 m). Because of the erratic nature of the ore zones, development has been by shallow pits, shafts, opencuts, trenches, and short adits.

Information from U. S. Bureau of Mines sources (Soulé, 1952; Farnham and Stewart, 1958; and U. S. Bureau of Mines production records 1954-1959) indicate that between 6,000 and 6,300 long tons (6096 and 6400 metric tons) of manganese ore were shipped between 1918 and 1959. Production was greatest during World War I and from World War II to the late 1950's.

Many of the workings in the district have been reclaimed and exposures of the deposits are limited. At the time of the field examination (May 1980), the Last Chance mine area was being used as a warehouse-shop facility by Southwest Forest Industries which has interests in timber resources of the region.

During the field examination, a 30-inch (76 cm) -long-channel sample, taken from a trench across the bedding of the Kaibab Formation having manganese-mineralized seams as much as 2 in. (5 cm) thick, assayed 3.4 percent manganese. A specimen from a stockpile near a small pit assayed 4.4 percent manganese. The trench is about .75 mi (1.2 km) and the pit about 1 mi (1.6 km) from the roadless area.

Claims staked in the Verde Valley as close as 1 mile (1.6 km) outside the west boundary of the area are associated with gypsum and other evaporites within the Verde Formation. Active mining of gypsum occurs 2.1 mi (3.4 km) west of the area. The Verde Formation occurs at the western margin of the roadless area, but no evaporites were recognized during the geologic mapping.

Cinder pits in basaltic vents are scattered outside the perimeter of the area. Small quarries in the Coconino Sandstone are located 2.5 mi (4.0 km) north of the western end of the area. The cinders and sandstone were probably used locally for road metal and building stone, respectively.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The mineral resource potential of the West Clear Creek Roadless Area is low. Deposits of manganese minerals trend northeast in an elongate zone from the Last Chance mine area. The zone is east of and does not intersect the roadless area, although it may reflect an extension of the Toms Creek fault from within the area. Alluvial placer deposits of manganese minerals do not continue along Iron Mine Draw to the area boundary. The Verde Formation (conglomerate facies) is at the western extremity of the roadless area, but does not contain evaporite deposits there. Basalt and basaltic cinder deposits along the canyon rim have a potential for road metal, concrete aggregate, riprap, and cinder blocks, and the Coconino Sandstone exposed in the canyon may be used as building stone and flagstone, but similar construction materials are more readily available outside the area.

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