UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geology, geochemistry, and mineral resource potential of the Eighteenmile Wilderness Study Area (ID-43-3), Lemhi County, Idaho

(GEM Phase 2)

by

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EXECUTIVE SUMMARY

The U.S. Bureau of Land Management (BLM) has adopted a multi-phase procedure for the integration of geological, energy, and mineral (GEM) resources data for suitability decisions for wilderness study areas. Phase 1 included the gathering of historical GEM resource data and was carried out by WGM, Inc. (1983). Phase 2 is designed to generate new data to support GEM resource recommendations and was contracted to the U.S. Geological Survey.

This report is the result of a Phase 2 study of the Eighteenmile Wilderness Study Area (WSA) conducted in July of 1983 by personnel from the Central Regional and Exploration Geochemistry Branches of the U.S. Geological Survey. The mineral resource appraisal of the WSA consisted of geologic mapping at a scale of 1:62,500, combined with stream-sediment and rock sampling, and subsequent analysis of the samples.

The Eighteenmile WSA (ID-43-3) covers about 25,000 acres in the central Beaverhead Mountains of east-central Idaho in Lemhi County (fig. 1), and the northern border of the area lies 6 mi southeast of Leadore, Idaho. Parts of the eastern border of the study area lie along the Continental Divide along which peaks rise to more than 11,000 ft. Total maximum relief is about 4,000 ft along the steep western flank of the mountains into which steep valleys and canyons have been carved by Pleistocene alpine glaciers, their meltwaters, and fast-moving steep-gradient streams. Most of these valleys and canyons are now either dry or contain relatively small perennial streams.

Allochthonous marine sedimentary rocks ranging in age from Proterozoic to Permian, and granite and syenite of an Ordovician pluton make up three major thrust plates in the Eighteenmile WSA. Rocks of the thrust plates, emplaced during Late Cretaceous to Paleocene time, are complexly folded and faulted. Two major thrusts, the Hawley Creek and the Fritz Creek, are exposed in the area. The thrust plates have been offset by extension faults ranging in age from early Eocene(?) to Holocene. Autochthonous rocks include Tertiary volcanics and Quaternary glacial and alluvial deposits that lap onto the western flank of the mountains and occupy many of the major valleys and canyons. Landslide deposits of carbonate rocks are common, and one major tectonic slide block extends into the Lemhi Valley.

A total of 173 geochemical samples were collected from within the WSA and surrounding areas. Of these, 34 were sieved sediments, 32 were nonmagnetic heavy mineral concentrates, 79 were rocks, 21 were water samples, and 7 were soil samples. Panned concentrate samples were processed both by heavy liquid and by electro-magnetic separation. The nonmagnetic fraction was analyzed for 31 elements by semiquantitative emission spectrography. Rock samples were crushed and pulverized; sieved-sediment and soil samples were sieved to minus-80 mesh and pulverized, and all were analyzed for 31 elements by semiquantitative emission spectrography. The fine fraction of sieved sediment samples was analyzed for uranium using fluorimetric techniques. Water samples were analyzed for major constituents and for Cu, Mo, and U. In addition, data for 29 stream-sediment, 13 panned concentrate, and 102 rock samples collected in 1981 and 1982 for a mineral resource analysis of the contiguous Italian Peak and Italian Peak Middle Roadless Areas were used in the interpretation of the geochemistry of the WSA.

A wide variety of elements are present in anomalous amounts in samples from the Eighteenmile WSA. Paleozoic rock units and stream sediments derived from them are enriched in Ag, B, Ba, Cr, Mo, Ni, Pb, Mn, Cu, and Zn. One Proterozoic rock sample contained Au. Although sediment samples from streams draining the Proterozoic rocks were enriched in Ag and Cu, among other elements, a Proterozoic source cannot be proven.

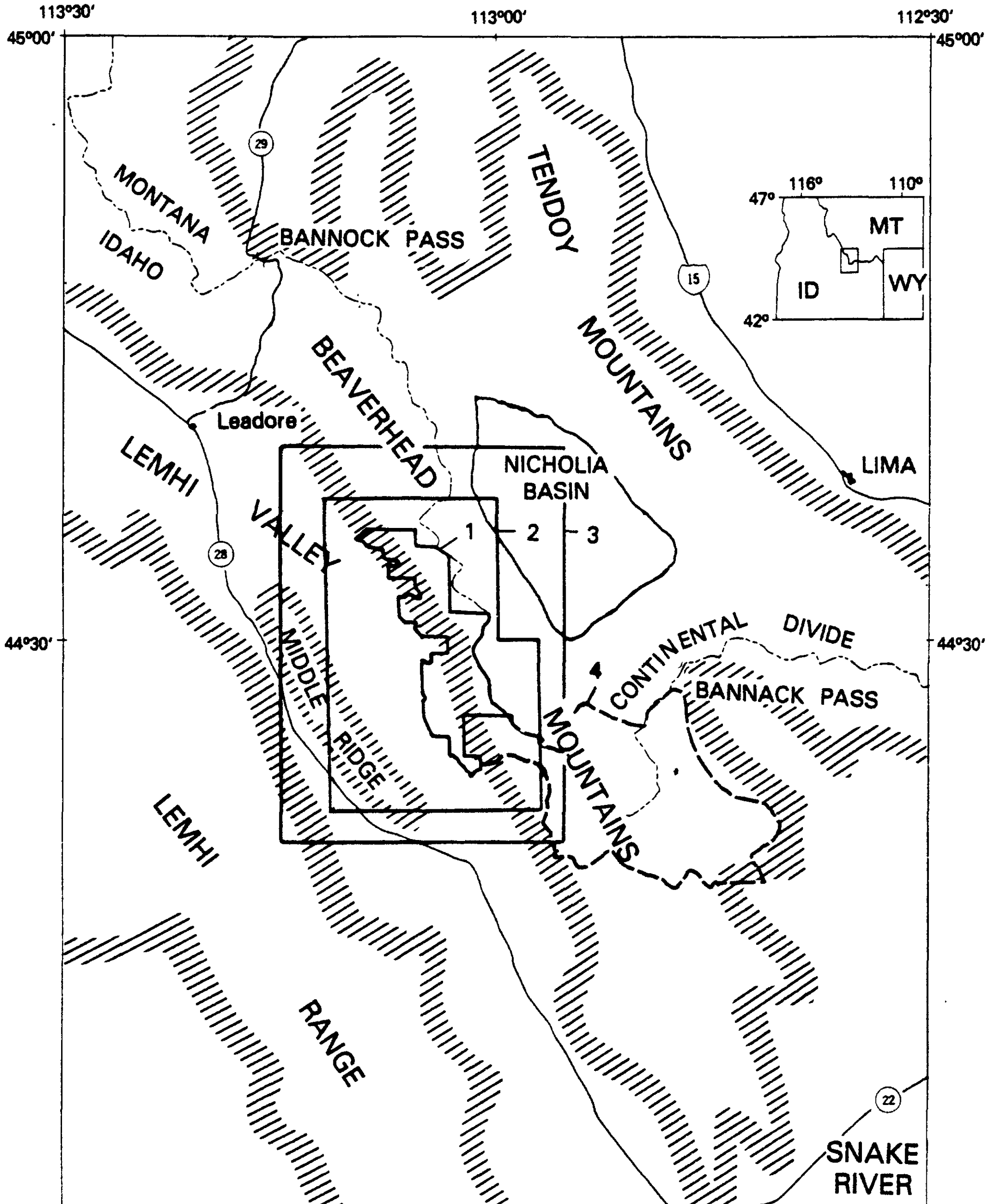


Figure 1.--Index map showing (1) approximate boundary of Eighteenmile Wilderness Study Area, (2) area of Figure 2, (3) area of Figures 3 through 13, and (4) approximate boundary of Italian Peak Roadless Areas.

The Beaverhead Mountains pluton is a geochemically specialized granitoid containing anomalous amounts of B, Be, La, Nb, Mo, Sn, and U, in addition to base and precious metals. Many of the rock samples contain Sn values and Zr/Sn and V/Nb ratios that meet the criteria for recognizing granitoid complexes parent to deposits of rare metals.

Small gypsum deposits are the only known mineral deposits in the Eighteenmile WSA. Gypsum has been mined from the Clear Creek mine one-half mile west of the WSA, and fault-controlled Neogene hydrothermal sulphate and sulphide mineralization extends into the WSA in the area surrounding the mine. Phosphate has been mined from the Phosphoria Formation in the Hawley Creek area north of the WSA, but the Phosphoria Formation is not present in the Eighteenmile area. Lead-silver-zinc stratabound ores were mined from dolomite of the Devonian Jefferson Formation in the northern part of the Birch Creek mining district about two miles southeast of the WSA.

The Clear Creek area has high resource potential for hydrothermal gypsum and associated Ag, Cu, Mo, Pb, and Zn mineralization. Granite of the Beaverhead Mountains pluton has moderate potential for base and precious metal fracture mineralization. Although granite of the pluton is tin rich, a resource potential for tin is low. Concentrations in sediments derived from the granite have a low resource potential for uranium. Paleozoic carbonate rocks have a moderate mineral resource potential for base and precious metals. The resource potential for oil is low for depths below the surface of less than 10,000 ft, and the potential for gas is moderate.

INTRODUCTION

The Wilderness Act of 1964 (PL-577) mandated the withdrawal of major portions of the federal lands in the National Forest System for inclusion into the National Wilderness Preservation System (NWPS). Federal mineral assessments were required to be conducted on lands affected as part of the wilderness land review process.

In 1976, the Federal Land Policy and Management Act (FLPMA, PL94-579) extended the wilderness review program to the lands administered by the U.S. Bureau of Land Management (BLM). Provisions in this act require the Secretary of the Interior to cause mineral surveys to be conducted prior to his making wilderness recommendations to Congress. Natural or Primitive areas formally identified prior to November 1, 1975, were termed Instant Study Areas. Wilderness recommendations for these areas were presented to the President prior to July 1, 1980. The remainder of the BLM lands are under review by the BLM to determine which are suitable as wilderness areas for inclusion into the NWPS. The wilderness land review process is being conducted in three steps: inventory, study, and report.

The inventory of BLM lands meeting wilderness criteria was completed for the state of Idaho in April, 1980, at which time the Wilderness Study Areas were designated. The study step in the wilderness review process includes mineral resource appraisal of the Eighteenmile Wilderness Study Area. The BLM has adopted a multi-phase procedure for the integration of geological, energy, and mineral (GEM) resource data into the suitable/unsuitable decision process on the Wilderness Study Areas. The multi-phase approach allows termination of the mineral resource appraisal at the end of Phase 1, which consists mainly of compilation of existing information. If the data gathered in Phase 1 is not adequate, then Phase 2 would generate new GEM resources data needed to permit an assessment of the potential for GEM resources. This report is the result of a Phase 2 study of the Eighteenmile WSA conducted in July of 1983 by the U.S. Geological Survey.

The Eighteenmile WSA covers about 25,000 acres in the central Beaverhead Mountains in Lemhi County, Idaho (fig. 1). The northern border of the area lies 6 mi southeast of Leadore, Idaho, and much of the eastern border lies along the Continental Divide, which is also the Idaho-Montana State boundary. Lemhi Valley borders the WSA on the west, and Willow Creek and Dry Canyon are the southern and northern boundaries, respectively. Access to the western side of the WSA is provided by gravel roads that exit from paved Idaho State Highways 28 and 29. No maintained trails are present in the WSA.

A mineral resource appraisal of the Eighteenmile WSA was undertaken by the U.S. Geological Survey that utilized geologic mapping at a scale of 1:62,500 with reference to both recent color, and black and white aerial photographs, and stream-sediment and rock sampling with subsequent analysis of the samples.

GEOLOGY

Physiography

The Eighteenmile WSA is comprised of the steep western flank of the central Beaverhead Mountains. The area is about 14 mi long and only 5 mi wide at its widest point. Elevations range from 7,100 ft at the northwest corner to 11,141 ft at Eighteenmile Peak along the Continental Divide in the southeastern part of the WSA. Deep valleys and canyons of the area were sculptured by Pleistocene alpine glaciers, their meltwaters, and steep gradient, fast-moving streams. These valleys and canyons now are either dry or are occupied by intermittent or relatively small perennial streams that reflect the much drier Holocene climate. Peaks along the eastern border of the WSA lie above timberline which is at about 9,600 ft. The western border is flanked by large aprons of alluvial gravels that make up much of the Lemhi Valley.

Description of rock units

More than 9,000 ft of Proterozoic to Permian marine sedimentary rocks and an Ordovician pluton underlie the Eighteenmile WSA. All of these rocks are allochthonous, and were moved from their western places of intrusion or deposition on the outer cratonic platform or shelf margin eastward into the Beaverhead Mountains in Late Cretaceous or early Tertiary time. They make up parts of three major thrust sheets, the Hawley Creek, the Fritz Creek, and the Cabin (fig. 2).

Shallow marine Proterozoic sandstone and minor siliceous mudstone in the WSA form the steep-walled lower canyons of Chamberlain Creek and Horsethief Canyon. A smaller outcrop is present at the mouth of Clear Creek about a mile west of the Eighteenmile WSA boundary. The sandstone is mostly pale red, grayish-green, and light- to dark-gray, fine- to coarse-grained, quartzose, feldspathic or micaceous, and consists of angular to subrounded grains of quartz, altered feldspar, some calcic plagioclase, and lithic fragments including chert, quartzite and gneiss (Scholten and Ramspott, 1968). The sandstone is medium- to thick-bedded, locally crossbedded or laminated, and forms steep cliffs and slopes covered with angular rubble. Shear zones are common.

The shallow marine Middle Ordovician Kinnikinic Quartzite, at least 800 ft thick (Scholten and Ramspott, 1968) consists of light gray to yellowish-gray, medium- to fine-grained, medium- to thick-bedded, pure orthoquartzite composed of subrounded to well-rounded, vitreous quartz grains cemented by authigenic quartz overgrowths. Spotty brown or yellowish-brown limonitic stains and blotches are common. The quartzite is brecciated in much

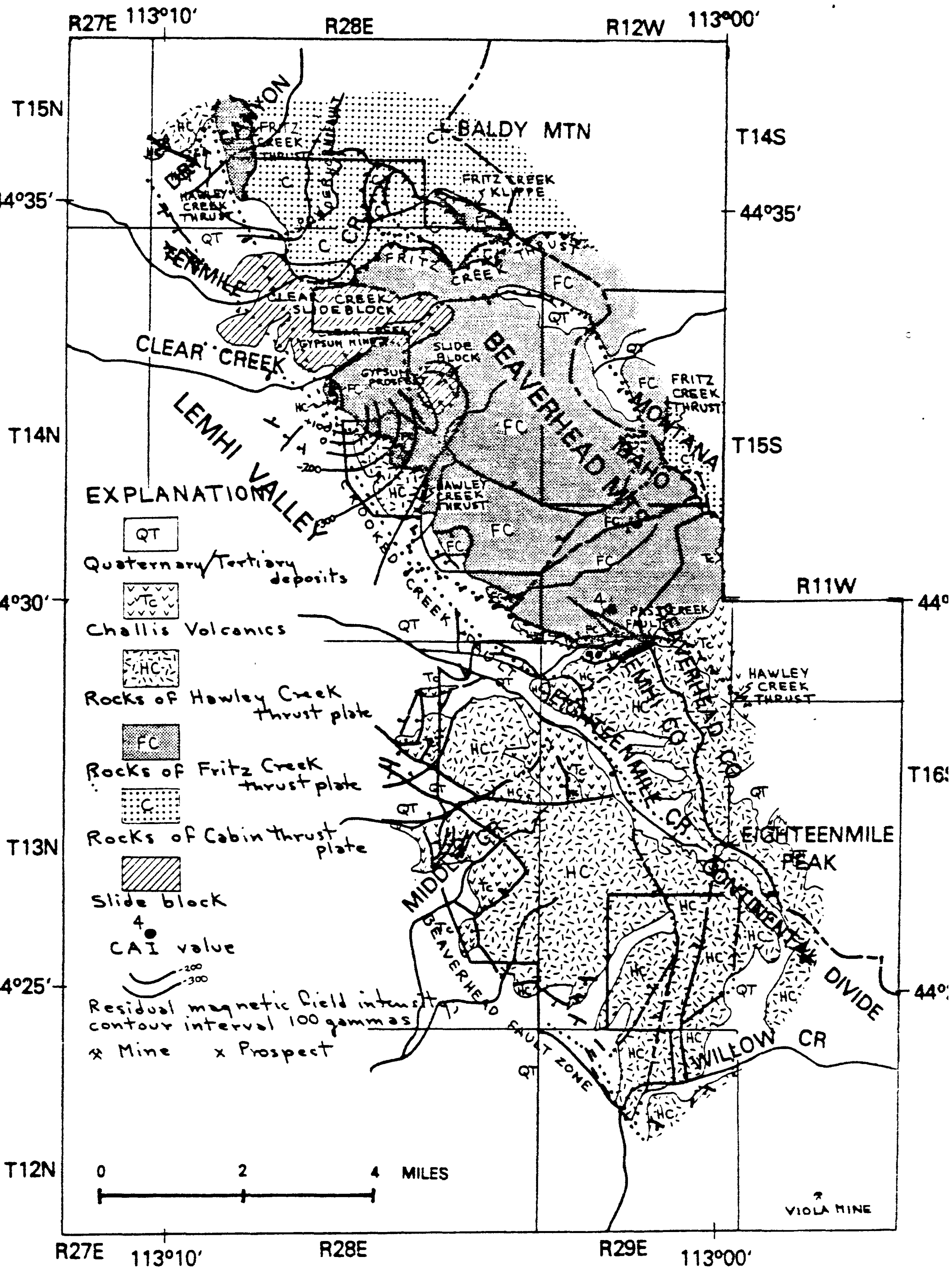


Figure 2.--Geologic sketch map showing location of major structural features, major mines and prospects, conodont color alteration index (CAI) value, and aeromagnetic anomaly (USGS, 1981) in the Eighteenmile WSA and surrounding area

of the outcrop area where it forms cliffs and ledges. In several places in the WSA, the quartzite is overlain unconformably by the Upper Devonian Jefferson Formation.

The Ordovician Beaverhead Mountains pluton consists mostly of granite and minor syenite that intrude the Kinnikinic Quartzite. The granite makes up most of the steep craggy ridges and grus-covered slopes above Eighteenmile Creek. It is grayish-orange to light brown, holocrystalline, medium- to coarse-grained, and consists of both one- and two-feldspar rocks. Unaltered rocks contain more than 23 percent quartz, and 65 percent alkali feldspar; in two-feldspar rock, albite commonly makes up less than one-third total feldspar. Biotite, opaque minerals, zircon, and apatite constitute 5 percent of rock (Ramspott, 1962; Scholten and Ramspott, 1968). Fine-grained, dusky yellow-green chill zone facies are present next to Kinnikinic Quartzite on Eighteenmile Peak. Altered rocks of the pluton are made of quartz, sericite, and magnetite with no relict structures. Syenite or leucosyenite present above Willow Creek in the south end of the WSA is pale red and weathers to shades of brown. The syenite is medium- to coarse-grained, holocrystalline, phaneritic, and is composed of 80-95 percent feldspar, 0-16 percent quartz, less than 5 percent biotite, opaque minerals, zircon, apatite, and as much as 10 percent altered actinolitic amphibole (Ramspott, 1962; Scholten and Ramspott, 1968). Both the granite and syenite are intruded by numerous aplite bodies. Geochemical results based on 40 samples show the granite to be a tin- and niobium-rich granite. This geochemical specialization implies that the granite is a multi-phase granitic complex.

The shallow marine Upper Devonian Jefferson Formation depositionally overlies either Proterozoic sandstone or Kinnikinic Quartzite. Near Pass Creek it is in fault contact with granite. About 100 to 200 ft of dolomite, limestone, limestone-dolomite breccia and a basal conglomeratic sandstone make up the formation. Dolomite is light gray to medium dark gray, finely crystalline, and is thin- to medium-bedded. Medium gray limestone is porous locally with cubic solution cavities filled with a silty limy matrix. Both the angular solution cavities and the limestone-dolomite breccia are evaporite solution features (Poole and others, 1977). Lead-silver-zinc ores from the Viola mine 1 1/2 to 2 mi south of the Eighteenmile WSA boundary (fig. 2) are thought to have been stratabound in dolomite of the Jefferson Formation of the Hawley Creek thrust plate (Skipp and others, 1983). One of four samples of dolomite collected for stratigraphic data contained an anomalous concentration of lead, although the sample presented no outward appearance of alteration or mineralization. This sample came from the Hawley Creek thrust sheet.

The Upper Devonian Sappington Member of the Three Forks Formation unconformably overlies the Jefferson Formation and consists of 75 to 100 ft of grayish-black to yellowish-brown laminated siltstone and mudstone. Basal dark gray, silty, even-bedded limestone of the Lower Mississippian McGowan Creek Formation unconformably overlies the Sappington Member and contains Kinderhookian conodonts (B. R. Wardlaw, written commun., 1982) with a color alteration index (CAI) value of 4 (Epstein and others, 1977). The limestone is from 150 to 400 ft thick, contains common trace fossils, and is overlain by 150 to 250 ft of siltstone and mudstone that resembles the lithologies of the Sappington Member. These siltstones and mudstones were erroneously assigned to the Upper Mississippian Big Snowy Formation in Scholten and Ramspott (1968). Both siltstone and mudstone units have reported stratabound U and Th anomalies southeast of the WSA (Skipp and others, 1983; Wodzicki and Krason, 1981), but no such anomalies have been found in the study area itself. Three of four samples of mudstones of the McGowan Creek/Three Forks interval collected for stratigraphic data from were found to contain weakly anomalous concentrations of Ag, Mo, and Zn, but presented no visual indication of alteration or mineralization.

The McGowan Creek Formation is overlain gradationally by about 500 ft of medium- to dark-gray, cherty, thin-bedded limestone of the Upper and Lower Mississippian Middle Canyon Formation, the basal formation of the Carboniferous and Lower Permian carbonate bank sequences that make up the Continental Divide and other high peaks of the area. In ascending stratigraphic order, the formations comprising the carbonate bank are the Middle Canyon, Scott Peak, South Creek, Surrett Canyon, Big Snowy, Bluebird Mountain, and Snaky Canyon Formations. The Scott Peak and Surrett Canyon Formations, about 2,000 ft and 100 to 400 ft thick, respectively, consist mostly of medium-dark gray, medium- to thick-bedded, fossiliferous (corals, brachiopods, and mollusks), relatively pure limestone of Late Mississippian age. The South Creek Formation is a thin (200 ft) silty, thin-bedded, Upper Mississippian limestone that separates the Scott Peak from the Surrett Canyon Formation. The Big Snowy Formation, about 800 ft thick, also of Late Mississippian age, contains some sandy limestone and limestone conglomerate beds, but about half the formation is medium-gray and grayish-black mudstone with scattered limestone concretions and calcareous sandstone. The Mississippian-Pennsylvanian boundary is in the Bluebird Mountain Formation that overlies the Big Snowy and consists of 300 to 500 ft of medium-gray, very fine- to medium-grained, thick- to medium-bedded sandstone with minor thin beds of dolomite and limestone (Skipp and others, 1979; Skipp and others, 1981). The Bluebird Mountain Formation is overlain gradationally by the Lower Permian to Lower Pennsylvanian Snaky Canyon Formation, a thick (2,000± ft) sequence of thin- to thick-bedded, light- to dark-gray limestone and dolomite, much of it very sandy.

The Upper to Lower Permian Phosphoria Formation disconformably overlies the Snaky Canyon Formation, and consists of dolomite, sandstone, phosphatic siltstone, and bedded chert (Lucchitta, 1966). The Phosphoria Formation is not present within the WSA.

Moderately anomalous concentrations of Ag, Co, and Cu were identified in 3 of 13 rock samples of the Scott Peak Formation collected for stratigraphic data, and one of the three was from outside the WSA near the Clear Creek gypsum mine. One sample of mudstone and one of limestone from the Big Snowy Formation contained weakly anomalous concentrations of Ag and Co. No anomalous concentrations were noted in 10 samples of the other carbonate bank formations collected for stratigraphic data.

Autochthonous rocks in the WSA include the following: the Middle Eocene intermediate Challis Volcanics consisting of rhyodacite tuff and volcanic breccia, tuffaceous sandstone and conglomerate, and latite flows; intermediate to basic dikes and sills (Chamberlain Canyon Sheet of Scholten and Ramspott, 1968) that may have been feeders to the Challis Volcanics; Quaternary to Tertiary alluvial gravels; Quaternary till and outwash of the Pinedale glaciation; and Quaternary surficial deposits including alluvium, colluvium, landslide deposits, and fan gravels (plate 1; fig. 2). Several landslide deposits consist of semi-coherent debris derived largely from a single stratigraphic unit.

Structure

The Eighteenmile WSA is a part of both the Cordilleran Overthrust and the Basin-Range structural provinces.

Rocks of the Hawley Creek, the Fritz Creek, and the Cabin thrust plates underlie the area (fig. 2). The Hawley Creek thrust, the basal thrust of the structurally highest Hawley Creek plate, was named for exposures immediately north of the WSA (Lucchitta, 1966), and a segment of that thrust extends into the area of plate 1 near Dry Canyon. Two southern segments of this thrust along the western margin of the range from Clear Creek south to Poison Creek were named the Poison Creek thrust by Scholten and Ramspott (1968), but are designated the Hawley Creek Thrust in this report (fig. 2). The Pass Creek fault is interpreted to be a primary tear fault that offsets the Hawley Creek thrust plate to the east, south of Pass Creek. Thus, rocks of the Hawley Creek thrust plate underlie the surface of the WSA south of Pass Creek and are exposed only along the western margin of the Beaverhead Mountains north of Pass Creek. Proterozoic sandstone, the Ordovician Beaverhead Mountains pluton, the Ordovician Kinnikinic Quartzite, and the Devonian Jefferson Formation make up the Hawley Creek plate in the WSA.

Rocks of the Fritz Creek thrust plate below the Hawley Creek plate underlie most of the WSA north of Pass Creek (fig. 2) where they consist of Proterozoic marine sandstone, Devonian carbonates, siltstones and mudstones, the Jefferson and Three Forks Formations, Lower Mississippian limestones and siltstones and mudstones of the McGowan Creek Formation, and Upper Mississippian limestones of the Middle Canyon through Surrett Canyon Formations. The Fritz Creek thrust, named for exposures south of the WSA (Scholten and Ramspott, 1968; Skipp and others, 1983), crops out between Clear and Tenmile Creeks (fig. 2) where folded Upper Mississippian limestones override intensely deformed Upper Mississippian through Permian rocks of the underlying Cabin thrust plate. Part of the Fritz Creek thrust plate has been buried beneath, or extended by, the Clear Creek slide block (fig. 2) that protrudes westward into the Lemhi Valley between Clear and Tenmile Creeks. One smaller slide block is south of Clear Creek (fig. 2). A southern extension of the Fritz Creek thrust tentatively is shown to appear near the Continental Divide at the head of Chamberlain Creek, but mapping in this area is incomplete. A klippe of the Fritz Creek plate is present near the Continental Divide at the head of Clear Creek (fig. 2), and a northern part of the plate is present at the mouth of Dry Canyon.

Rocks of the Cabin thrust plate, named for the Cabin thrust exposed east of Nicholia Basin (fig. 1; Scholten and others, 1955), make up the northern segment of the WSA. Limestones, mudstones, sandstones, and sandy limestones of the Scott Peak through Snaky Canyon Formations crop out on the Cabin plate in the WSA and are folded and thrust faulted. Axes of folds, some overturned, trend east-west to west-northwest, and one thrust appears to be a footwall imbricate of the Fritz Creek thrust. Rocks of the Cabin plate must underlie the entire WSA below the Fritz Creek and Hawley Creek plates.

The stack of thrust plates that make up the central Beaverhead Mountains have been extended by several generations of Tertiary and Quaternary low-angle normal faults (Skipp and Hait, 1984). Within the WSA, prominent Neogene or younger extension faults include the Crooked Creek, the Powderhorn, the enigmatic oval fault zone north of Chamberlain Creek, the north-trending faults in the Beaverhead Mountains pluton, and the Beaverhead fault zone (fig. 2). The southern extension of the Crooked Creek fault in the Italian Peak Roadless Areas (fig. 1) cuts gravels as young as Early Pleistocene (Skipp and Hait, 1984), but in the WSA, the Crooked Creek fault is concealed by gravels of that age, indicating that movement on this segment of the fault ceased earlier in this area than in areas to the south. The westward extension of the Powderhorn fault also is concealed beneath older fan gravels. The oval fault zone formed before emplacement of the Clear Creek slide block, and the Clear Creek slide block seems to have formed after early movements on the major range front fault system. Additional extension of the area probably was accomplished through secondary normal movements on one or more of the thrust faults. The Beaverhead fault zone present in the southwestern corner of the WSA is of Holocene to Pleistocene age (Skipp and Hait, 1984).

The southern part of a large positive aeromagnetic anomaly was identified in the vicinity of Clear Creek by an aeromagnetic study of the Italian Peak and Italian Peak Middle Roadless Areas adjacent on the south (U.S.G.S., 1981). The positive anomaly of more than 500 gammas (fig. 2) probably indicates the presence of a magnetic intrusive body intruded along the range front (Crooked Creek) fault in Neogene time. Such an intrusion probably was the source of heat and mineralizing fluids for the hydrothermal mineralization of the Clear Creek area, and may have "locked" this segment of the Crooked Creek fault.

Geologic History

Proterozoic and Paleozoic rocks presently at the surface of the Eighteenmile WSA were deposited near the Cordilleran hingeline on the outer cratonic platform. Proterozoic-marine sandstones deposited in shallow subtidal environments were uplifted, gently folded and eroded during Late Proterozoic or Cambrian time. In Middle Ordovician time, the clean sands of the Kinnikinic Formation, and, possibly the dolomites of the Fish Haven Formation were deposited across much of the area. In Middle to Late Ordovician time, the existing sedimentary cover was intruded by the granites and syenites of the Beaverhead Mountains pluton, and once again the area was uplifted; the pluton was unroofed, and much of the Ordovician and older sedimentary cover was removed by erosion. In early Late Devonian time shallow seas once again covered the area resulting in the deposition of the Jefferson Formation. Uplift and erosion ensued in Late Devonian time before deposition of the Late Devonian mudstones and siltstones of the Sappington Member of the Three Forks Formation. Much of the Jefferson Formation was removed. The gentle uplift that followed deposition of the Three Forks Formation in latest Devonian time resulted in the removal of parts of that formation. At the close of the Devonian period and the onset of the Mississippian period, western orogenic movements of the Antler highland accompanied the return of the seas to the area. Deeper water limestones and fine terrigenous sediments of the Early Mississippian McGowan Creek Formation were laid down, followed by the deposition of a thick carbonate bank succession in seas that shoaled gradually from Late Mississippian into Lower Permian time. A period of emergence and nondeposition or erosion preceded deposition of the cherts and phosphatic sediments of the Permian Phosphoria Formation. A period of uplift and erosion probably related to the western Sonoma orogeny, closed the Paleozoic Era in the region. In Early Triassic time, shallow seas once again covered the area and fine-grained detrital sediments of the Dinwoody Formation were laid down. The Dinwoody is the last record of Mesozoic sedimentation present in the area. The Cordilleran thrust belt began to form in Middle Jurassic time, and by Late Cretaceous or early Tertiary time, the thrust plates of the Beaverhead Mountains were in place. Thrusting was followed closely by the first phase of extension faulting that preceded extrusion of the middle Eocene Challis Volcanics. Challis volcanism was accompanied and followed by the development of regional continental basins. In middle Miocene time, basin-range extension disrupted former basins, formed new ones, and broke the crust into long, narrow, eastward tilted blocks that evolved in Pleistocene time into the Lost River and Lemhi Ranges, and the Beaverhead

Mountains. Formation of the ranges was accompanied in Miocene and Pliocene time by the downwarping of the Snake River Plain and the extrusion of great volumes of bimodal volcanics, some of which were erupted into the valleys that formed between the tilted crustal blocks far north of the Plain itself. The intrusive body thought to be present at depth in the Clear Creek area probably was a part of the Neogene bimodal magmatism.

GEOCHEMISTRY

Introduction

A geochemical reconnaissance investigation was undertaken in the WSA and vicinity in July, 1983. The chief purpose of this investigation was to provide a geochemical basis for the mineral resource appraisal of the WSA.

A total of 34 sieved-sediment samples (Plate 3), 32 nonmagnetic, heavy-mineral concentrate samples (Plate 3), 79 rock samples (Plate 2), 21 water samples (Plate 4), and 7 soil samples (Plate 4) were collected and analyzed. Analytical data for these samples are presented in the Appendix. Additional data from a recent USGS study of the contiguous Italian Peak Roadless Areas (fig. 1) were used in the interpretation because many of the samples collected in that study came from the Eighteenmile WSA. Plates 2 and 3 show the location of 29 stream-sediment, 13 panned-concentrate, and 102 rock samples. Complete analytical data from that study is presented in Hopkins and others (in press) and interpretations in Antweiler and others (in press). Discussion of the mineral resource potential of the Italian Peak Roadless Areas may be found in Skipp and others (1983).

Sample Collection

Stream-sediment samples

The majority of the alluvial samples were collected from small streams and tributaries in the WSA (Plate 3) for an average density of one sample site per square mile. At most sample sites, two samples were taken. The first sample consisted of about 12 lb of bulk alluvium collected for the purpose of panning a heavy-mineral concentrate. The second sample consisted of about 1 lb of alluvial material collected for the purpose of obtaining a sieved-sediment (fine-grained) fraction. Where possible, the sediment was collected across the full width of the active drainage channel, and as deep and close to underlying bedrock as practicable. If the active sediment channel was more than 1 foot wide, the sample was composited from a series of random sites across the full width. Parts of the stream bed most likely characterized by minimal gravity sorting were preferentially sampled to obtain the maximum variety (widest range of specific gravities) of heavy minerals conveniently obtainable.

Heavy-mineral concentrates. A heavy-mineral concentrate was obtained by panning the bulk alluvial sample either at the sample site or at the nearest convenient stream. Panning is the first of a number of processing steps and is performed for three reasons: first, panning removes the organic, and fine- to clay-sized materials which otherwise might act as a cement to bind the heavy-mineral grains together, or which might act as a coating agent and prevent the identification of the mineral grains. Second, the panning greatly reduces the volume of material that needs to be processed during a subsequent heavy-liquid separation step. Finally and most importantly, panning reduces the proportions of barren material relative to ore-related minerals that generally have a high specific gravity. By physically concentrating those minerals related to mineralization, the metal values obtained are greatly enhanced.

Sieved sediment. A sieved stream-sediment fraction was obtained by collecting about 1 lb of alluvial material from which the larger pebbles were removed. The sieved-sediment sample was taken for two reasons: it may contain fine-grained clastic material from mineralized outcrop; and, it may contain metals adsorbed on silt and clay-sized particles.

Rock samples. Rock samples consisted of grab and composite chip samples collected across the stratigraphic sequence, where appearance or structure indicated the possiblity of detecting mineralization, or for the purpose of determining the suites of elements involved in obviously mineralized rocks. No attempt to systematically sample rocks was made in this reconnaissance study.

Water samples. Water samples were collected at stream-sediment sites where flowing water was present. Two springs also were sampled (NI 015 and 018, Plate 3). At each sample site, a portion of the water was filtered through a 0.45-micron filter and collected into an acid-rinsed polyethylene bottle. This sample was immediately acidified to pH<2 by the addition of a few drops of Ultrex nitric acid. This sample was later used for trace element analysis. A second portion of water was collected untreated into a polyethylene bottle that had been rinsed with the sample water for later analysis of major constituents. Temperature, pH, and specific conductance were measured at each site.

Soil samples. Soil samples were collected from the B horizon at 20-ft intervals perpendicular to structural trends indicated by Scholten and Ramspott (1968) at two localities: ML 009, near Clear Creek, and NI 014, near Eighteenmile Creek. The purpose of this sampling was to detect potential metal leakage from these structures which may have acted as permeable pathways for metal-rich solutions.

Sample Preparation

Sieved-sediment samples. The alluvial material collected for a sieved-sediment sample was air-dried, sieved to <80 mesh using a mechanical sieve shaker and stainless steel sieves, and then analyzed.

Heavy-mineral concentrates. Subsequent to panning, the concentrate samples were further processed by: (1) sieving to <12 mesh, discarding coarse material; (2) bromoform separation, discarding light fraction (specific gravity <2.85); and, (3) electromagnetic separation using a Frantz Isodynamic Separator at 0.1 amp and 1.0 amp (forward setting 25^{o}, side setting 15^{o}). The fraction magnetic at 0.1 amp (largely magnetite) and the fraction magnetic at 1.0 amp (largely ferromagnesian silicates and iron oxides) were stored for possible future analysis.

The nonmagnetic at 1.0-amp (NM-1) sample is a sample where most of the major rock-forming minerals have been removed. In theory, such minerals as sphene, apatite, and zircon are left in unmineralized areas, while in mineralized zones, most of the common, primary and secondary ore minerals are left--sulfides, sulfates, sulfosalts, carbonates, and halides. The NM-1 sample further underwent: a microscopic examination for mineralogy (in general, a brief scan) and assessment of processing quality; pulverization to <200 mesh using an agate mortar and pestle; and, analysis by semiquantitative emission spectrography.

Rock samples. Rock samples were mechanically crushed using steel jaw crushers then pulverized to <150 mesh using ceramic plates.

Water samples. Water samples required no preparation beyond that done in the collection process.

Soil samples. Soil samples were air-dried, sieved to <80 mesh using a mechanical sieve shaker and stainless steel sieves, and pulverized to <150 mesh using ceramic plates.

Analytical Methods

Emission-spectrography analyses

All sediment, rock, and soil samples were analyzed by semiquantitative emission spectrography using the field method of Grimes and Marranzino (1968). Results of these spectrographic analyses for all of the sample media were measured within geometric intervals (for example, boundaries at 1,200, 830, 560, 380, 260, 180, 120, and 83 in ppm) but were reported as the approximate geometric midpoints (1,000, 700, 500, 300, 200, 150, and 100 ppm in the example given above). Thus, the values are reported as a series of six steps per order of magnitude.

Table 1 gives the upper and lower limits of determination for semiquantitative emission spectrographic analyses of rocks, sieved stream sediments, and soils. Both the upper and lower limits of determination of the nonmagnetic fraction of heavy-mineral concentrates are two spectrographic intervals higher than those listed in table 1. These changes are made because the standard weight of 10 mg of sample used in conventional analyses is lowered to 5 mg of heavy-mineral concentrate to reduce spectral interferences inherent to the analysis of heavy-mineral concentrates.

For purposes of geochemical exploration, experience has shown that the analytical precision of semiquantitative emission-spectrographic analysis is well within practical requirements for most of the elements, especially with the enhanced values possible from the analysis of concentrate fractions. The studies of Motooka and Grimes (1976), making use of repeat analyses by a number of analysts and instruments, show that reported values fall within one adjoining report interval 83 percent of the time and within two adjoining report intervals 96 percent of the time for all of the elements.

Uranium analyses.

Fluorometric analyses for uranium were performed on the <80-mesh sediment sample using slightly modified versions of procedures described by Grimaldi and others (1952) and Centanni and others (1956). The detection limit of this method is 0.05 ppm.

Water analyses.

Water temperature, pH, and specific conductance were measured at the sample site, all other determinations were made in the laboratory in Denver, Colo. Alkalinity, chloride, fluoride, nitrate, potassium, sodium, and sulfate were determined using untreated water. Analyses of copper, molybdenum, and uranium were performed using the filtered and acidified sample. The analytical methods used for water analyses are shown in Table 2, detection limits and report parameters are shown in Table 3.

Analysts

Spectrographic analyses were performed by D. E. Detra. Uranium analyses were performed by J. D. Sharkey. Water analyses were performed by W. H. Ficklin, J. R. Hassemer, and J. B. McHugh. Preparation of sieved-sediment, soil, and rock samples was performed under the direction of J. E. Kilburn.

Results

Analytical data from the geochemical survey are presented in the appendix and in figures 3-13. The appendix also contains data for samples collected in nearby mining districts discussed in the Phase I report (WGM, Inc., 1983).

Table 1.--Lower and upper limits of determination for semiquantitative emission spectrographic analyses of rocks, sieved (<80-mesh) stream sediments, and soils.

Elements	Lower determination limit	Upper determination limit
	Percent	Percent
Iron (Fe)	0.05	20
Magnesium (Mg)	.02	10
Calcium (Ca)	.05	20
Titanium (Ti)	.002	1
	Parts per million	Parts per million
Manganese (Mn)	10	5,000
Silver (Ag)	0.5	5,000
Arsenic (As)	200	10,000
Gold (Au)	10	500
Boron (B)	10	2,000
Barium (Ba)	20	5,000
Beryllium (Be)	1	1,000
Bismuth (Bi)	10	1,000
Cadmium (Cd)	20	500
Cobalt (Co)	5	2,000
Chromium (Cr)	10	5,000
Copper (Cu)	5	20,000
Lanthanum (La)	20	1,000
Molybdenum (Mo)	5	2,000
Niobium (Nb)	20	2,000
Nickel (Ni)	5	5,000
Lead (Pb)	10	20,000
Antimony (Sb)	100	10,000
Scandium (Sc)	5	100
Tin (Sn)	10	1,000
Strontium (Sr)	100	5,000
Vanadium (V)	10	10,000
Tungsten (W)	50	10,000
Yttrium (Y)	10	2,000
Zinc (Zn)	200	10,000
Zirconium (Zr)	10	1,000
Thorium (Th)	100	2,000

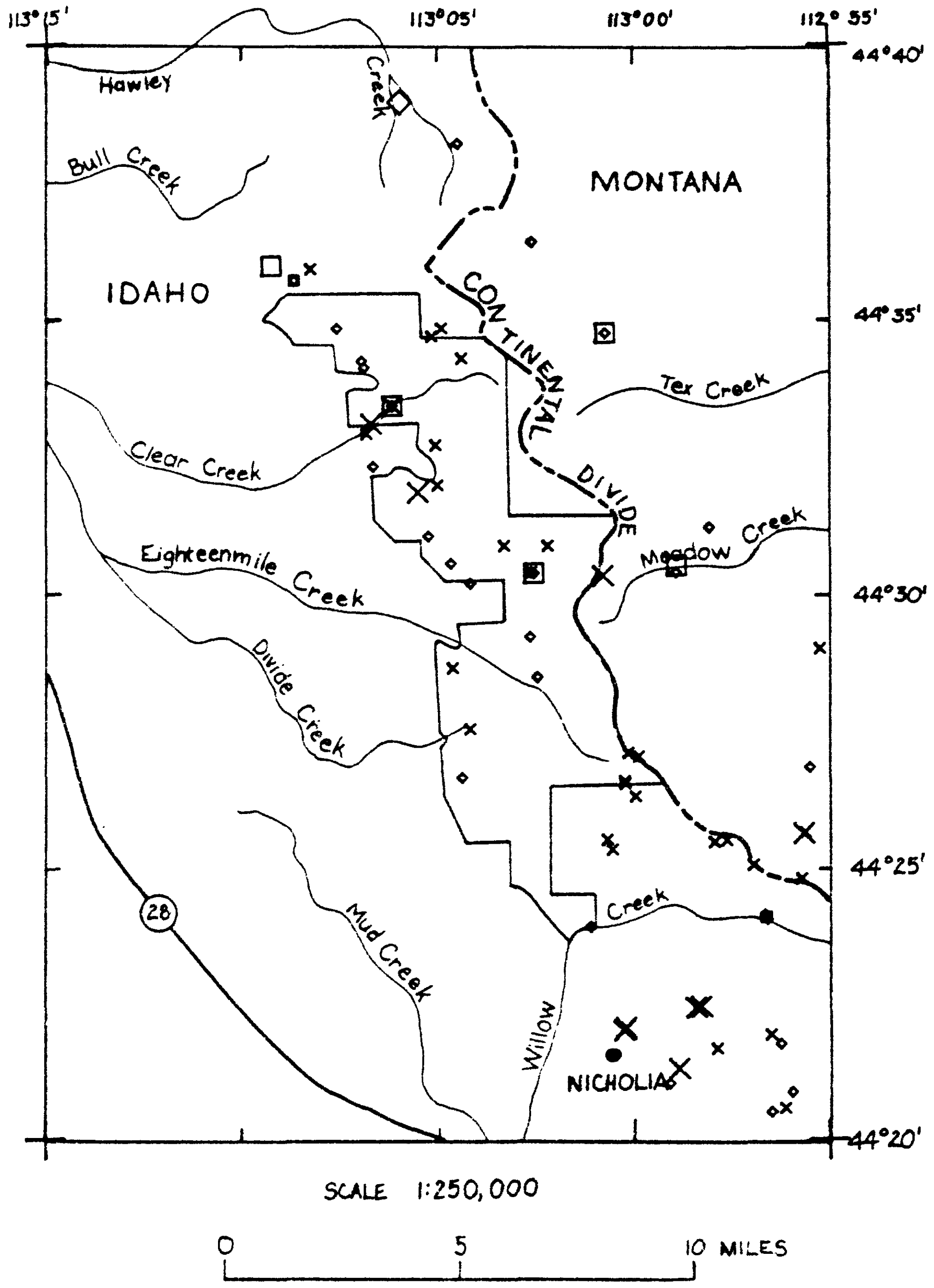
Table 2.--Analytical methods used for water analyses

Property	Method	Reference
Alkalinity	Gran's plot titration with sulfuric acid	Orion Research, Inc. (1978)
Chloride, Fluoride, Nitrate, and Sulfate	Ion chromatography	Fishman and Pyen (1979)
Calcium, Magnesium, Potassium, and Sodium	Flame atomic-absorption spectrophotometry	Fishman and Downs (1966)
Copper	Flameless atomic-absorption spectrophotometry	Perkin-Elmer Corp. (1977)
Molybdenum	Flameless atomic-absorption spectrophotometry	(a)
Uranium	Laser-excitation fluorescence	Ward and Bondar (1979)
Specific conductance	Conductivity bridge	Brown and others (1970)
pH	pH meter	Brown and others (1970)
Temperature	Thermometer	Brown and others (1970)

(a) specific method undocumented, but is a modification of procedures as described by the Perkin-Elmer Corp. (1977).

Table 3.--Detection limits and report parameters for water samples

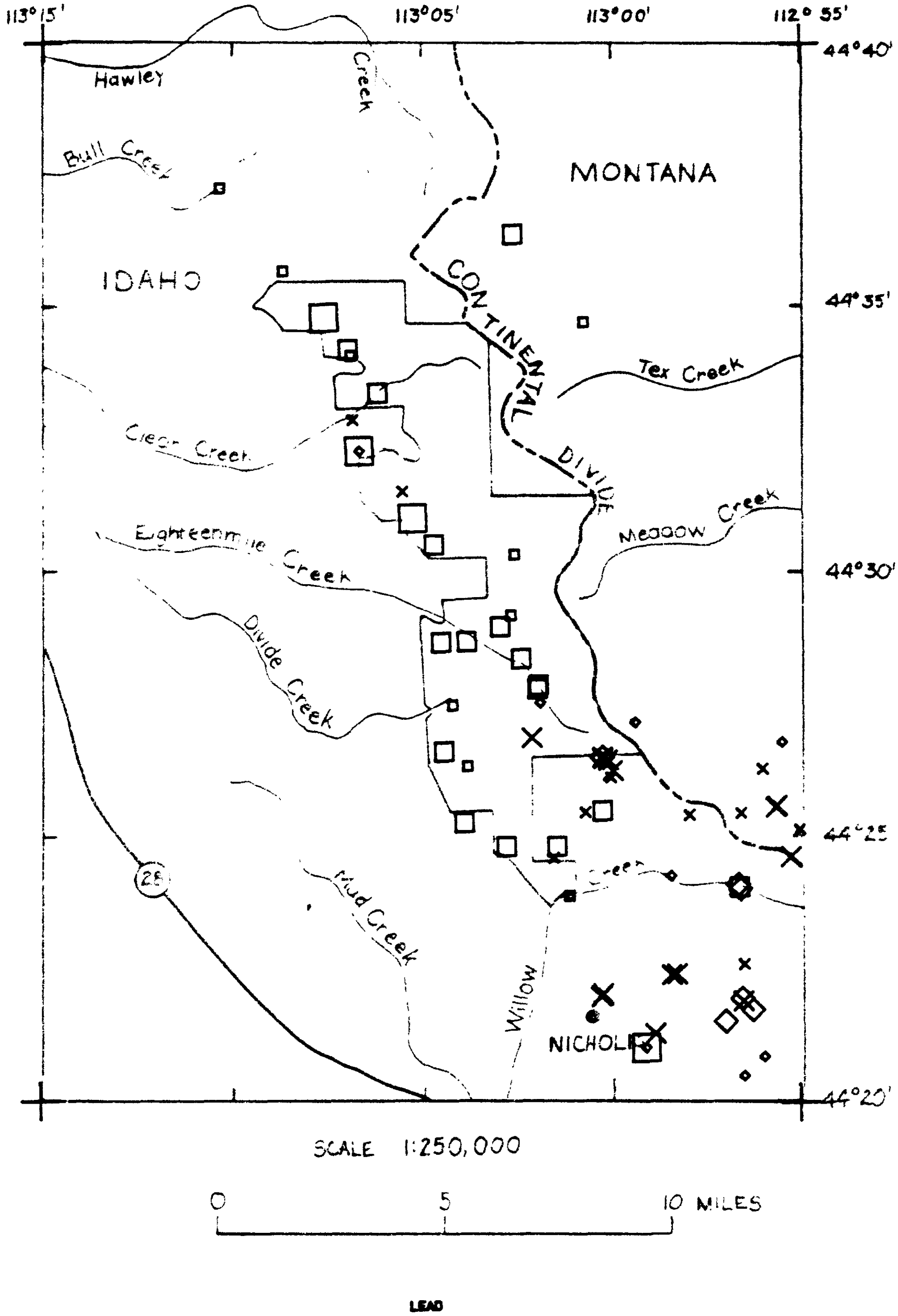
Constituent (Detection Limit)	Report parameter	Comments
Calcium (0.1), Chloride (0.1), Fluoride (0.1), Magnesium (0.1) Nitrate (0.1), Potassium (0.1) Sodium (0.1)	milligrams per liter (ppm)	
Alkalinity (10)	do.	Reported as bicarbonate (HCO_3)
pH	pH units	
Specific conductance (10)	microSiemans	
Temperature	degrees Celsius	
Copper (1), Molybdenum (1), and Uranium (0.01)	micrograms per liter (ppb)	



SILVER

Sieved-sediments	Heavy-mineral concentrates	Rocks
◇ 0.5–2 ppm	▫ 1–2 ppm	× 0.5–2 ppm
◇ ≥2 ppm	□ ≥2 ppm	X ≥2 ppm

Figure 3. Distribution of anomalous silver values in the Eighteenmile WSA and surrounding areas.

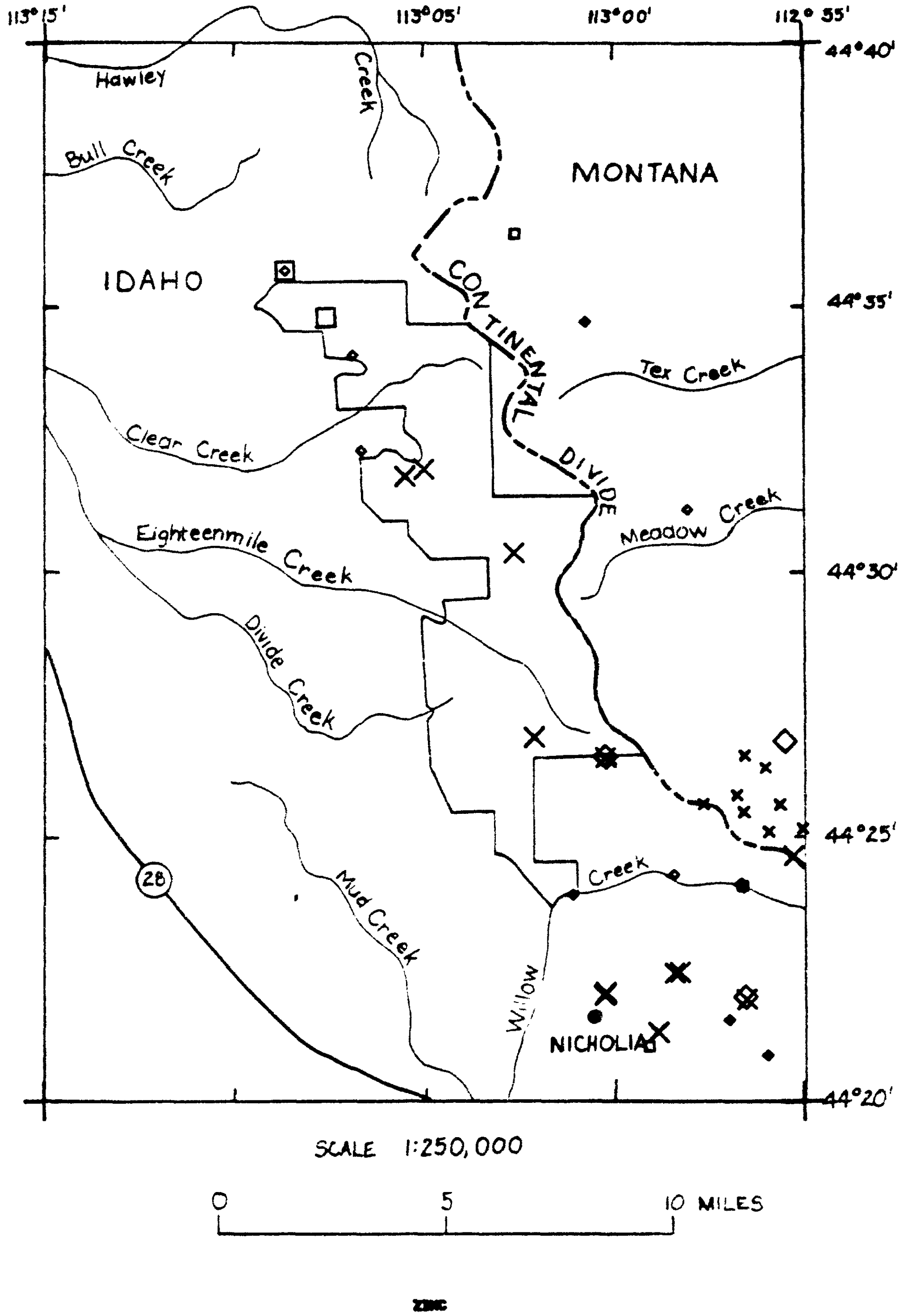


Sieved-sediments
- ◇ 50–100 ppm
- ◇ ≥100 ppm

Heavy-mineral concentrates
- □ 150–500 ppm
- □ 500–5000 ppm
- □ ≥5000 ppm

Rocks
- × 50–100 ppm
- × ≥100 ppm

Figure 4. Distribution of anomalous lead values in the Eighteenmile WSA and surrounding areas.

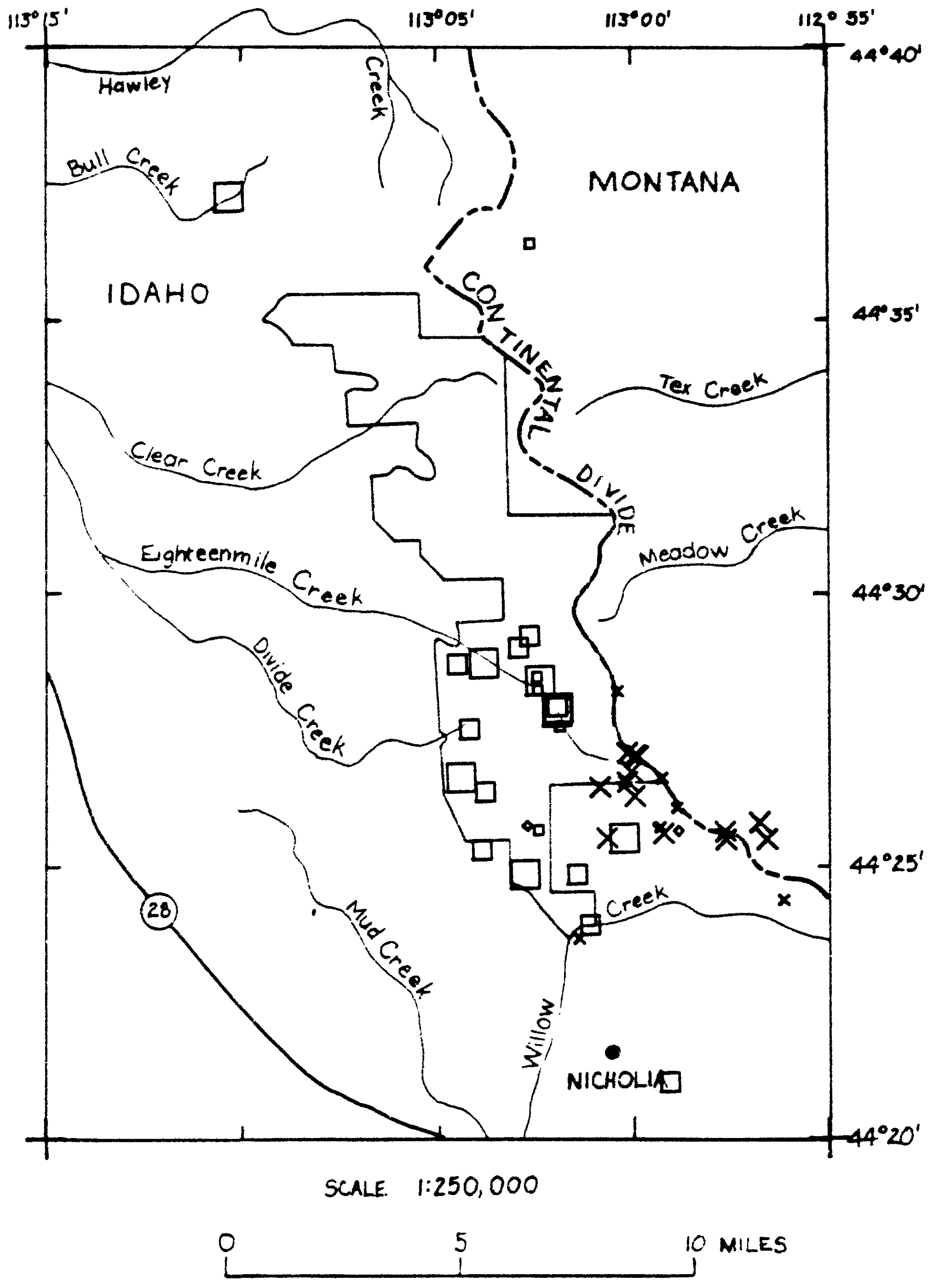


Sieved-sediments
◇ 200–500 ppm
◇ ≥500 ppm

Heavy-mineral concentrates
□ 500–1000 ppm
□ ≥1000 ppm

Rocks
× 200–500 ppm
× ≥500 ppm

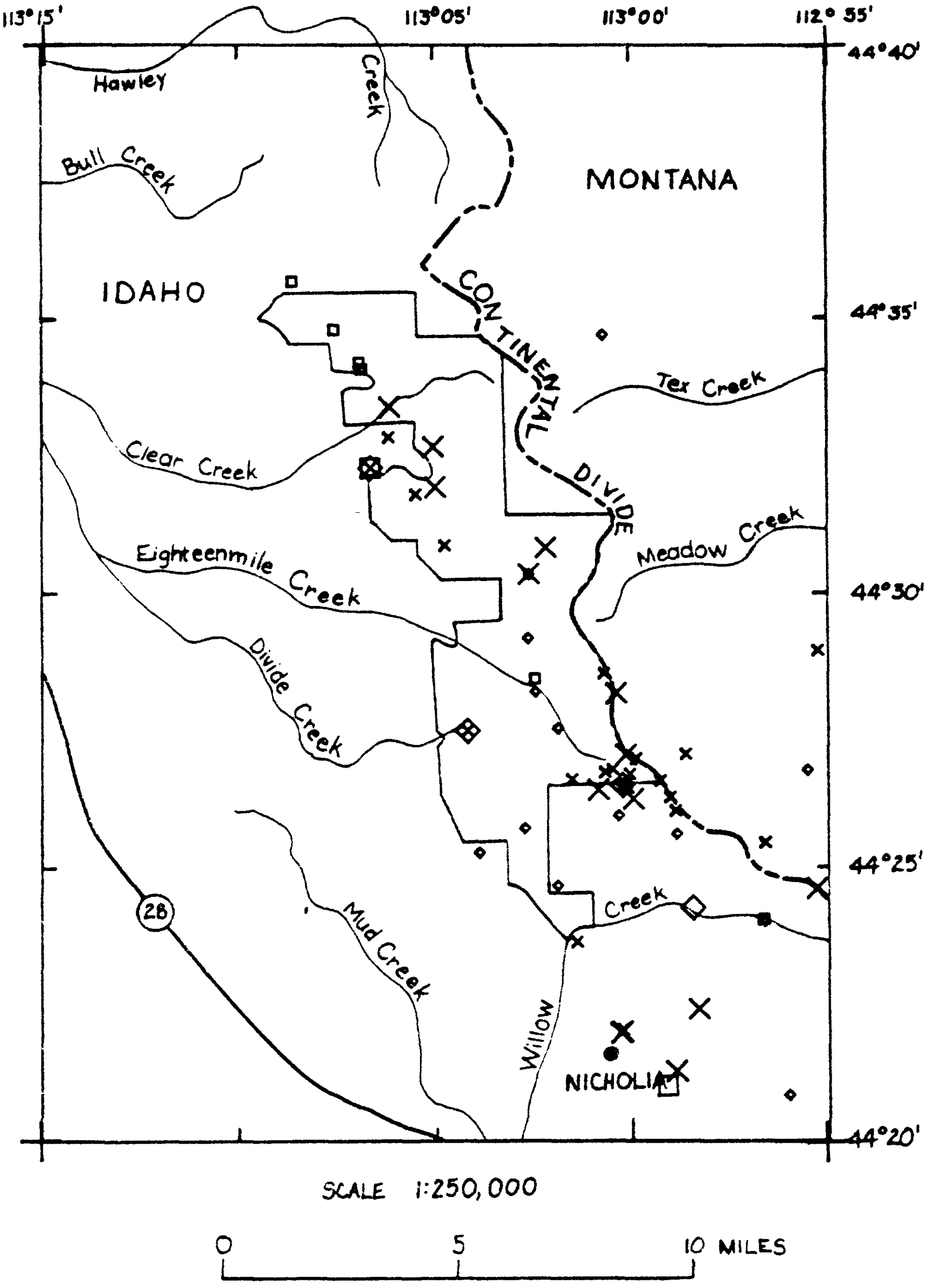
Figure 5. Distribution of anomalous zinc values in the Eighteenmile WSA and surrounding areas.



TIN

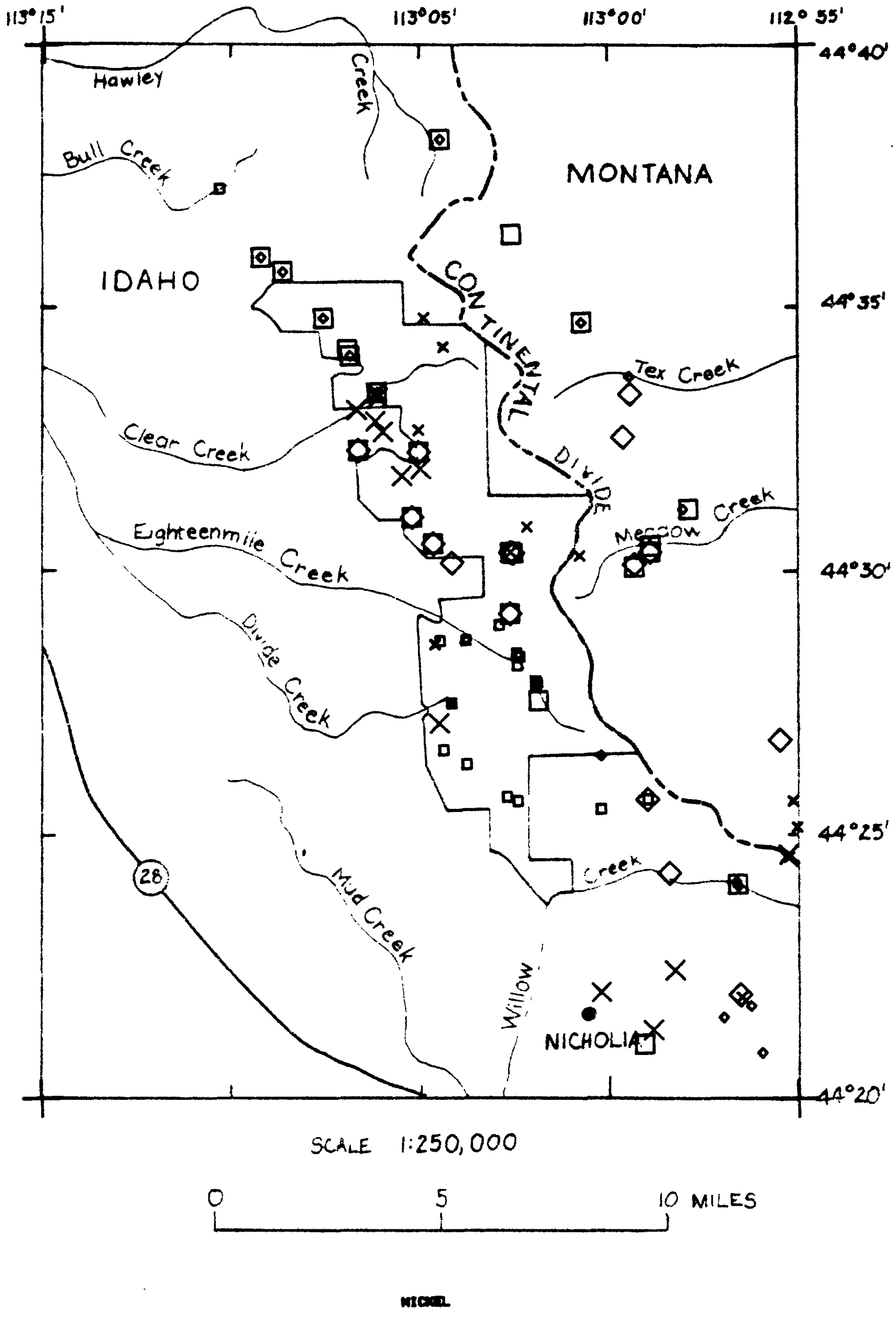
Sieved-sediments	Heavy-mineral concentrates	Rocks
⋄ 10-15 ppm	▫ 20-100 ppm	× 10-15 ppm
◇ ≥15 ppm	□ 100-1000 ppm	✕ ≥15 ppm
	□ ≥1000 ppm	

Figure 6. Distribution of anomalous tin values in the Eighteenmile WSA and surrounding areas.



Sieved-sediments	Heavy-mineral concentrates	Rocks
◦ 5–20 ppm	▫ 10–20 ppm	× 5–20 ppm
◇ ≥20 ppm	□ ≥20 ppm	✕ ≥20 ppm

Figure 7. Distribution of anomalous molybdenum values in the Eighteenmile WSA and surrounding areas.

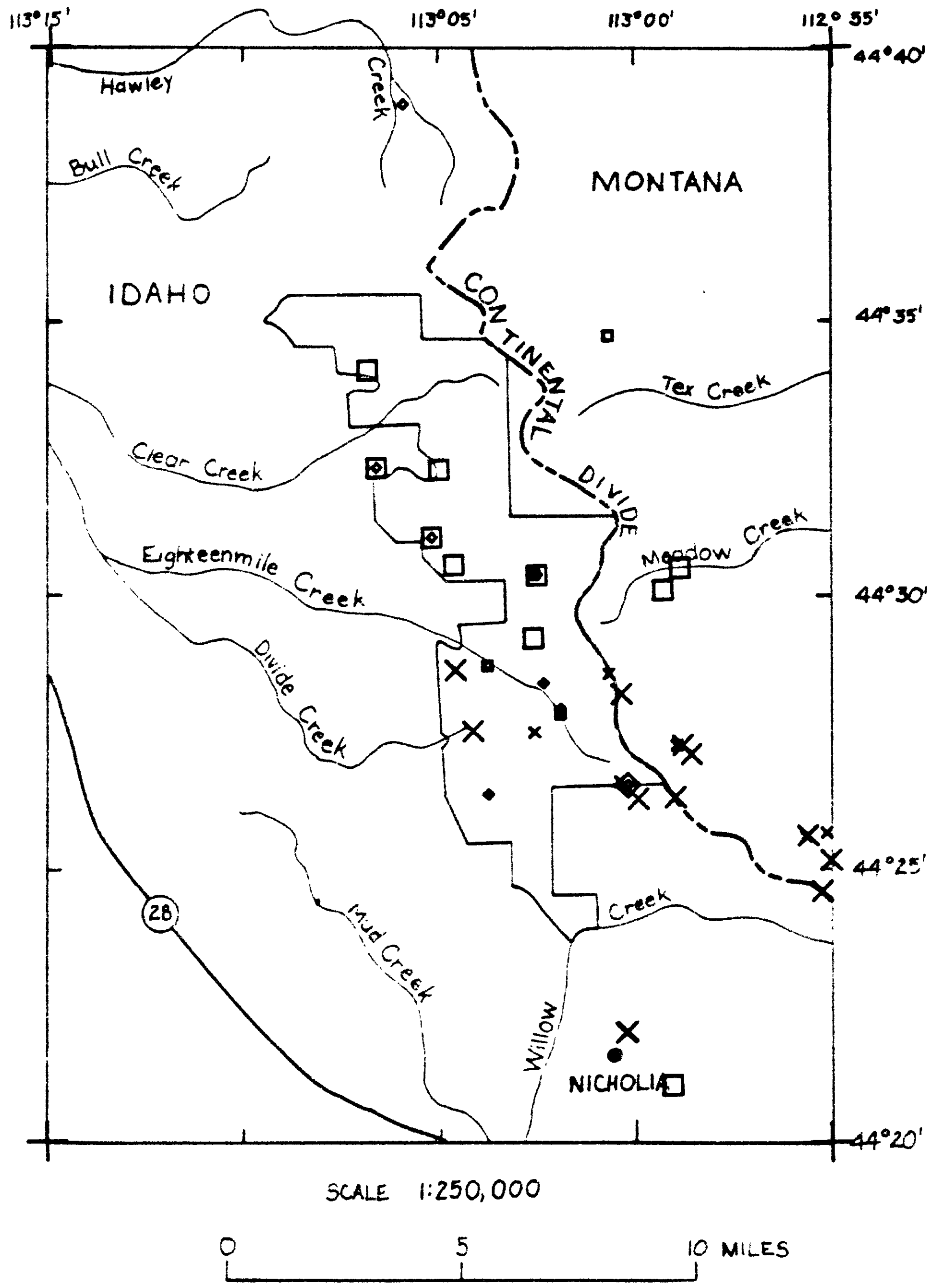


Sieved-sediments
∘ 50-100 ppm
◇ ≥150 ppm

Heavy-mineral concentrates
▫ 10-50 ppm
□ ≥50 ppm

Rocks
× 50-150 ppm
X ≥150 ppm

Figure 8. Distribution of anomalous nickel values in the Eighteenmile WSA and surrounding areas.

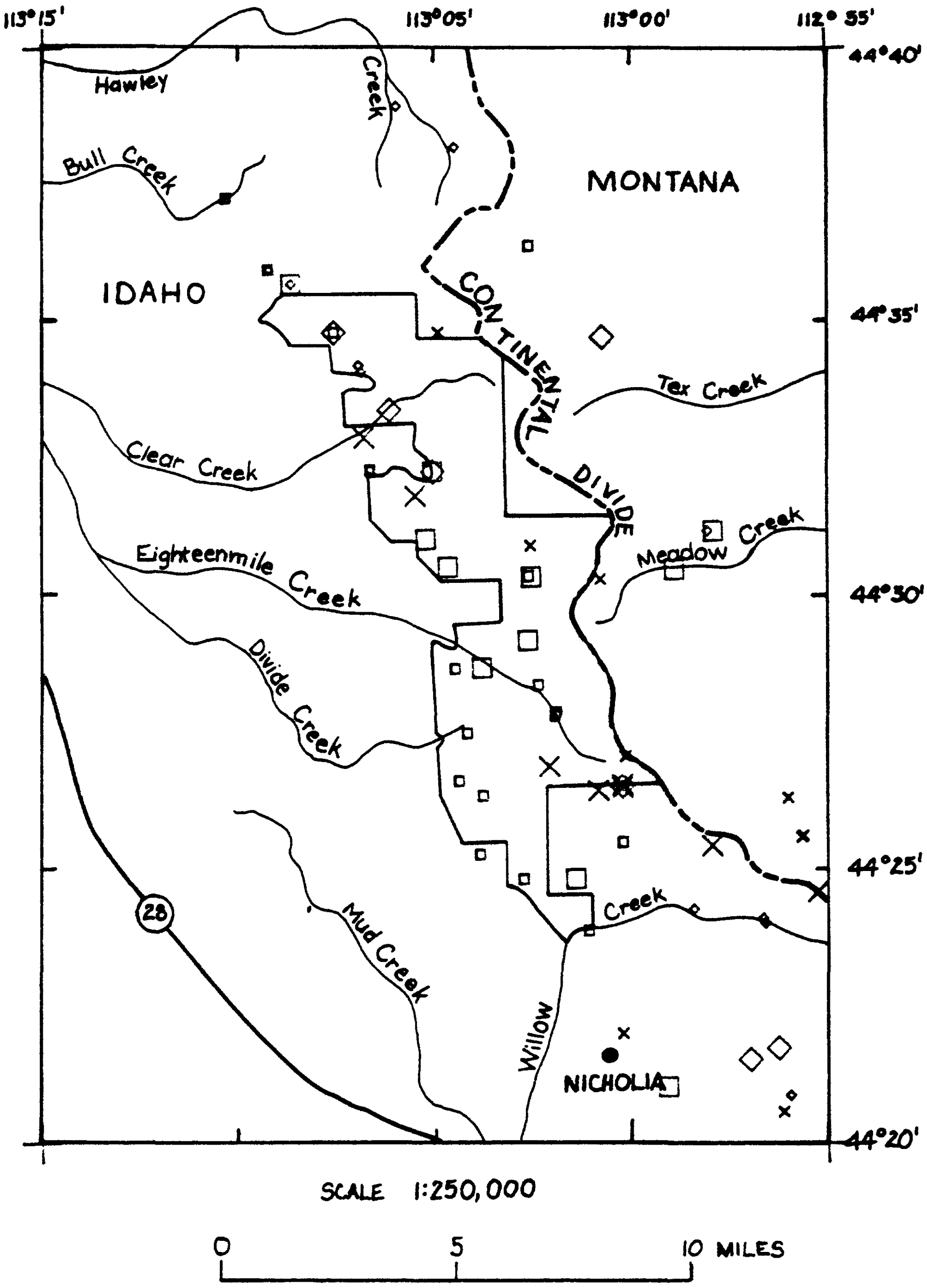


Sieved-sediments
∘ 1000-2000 ppm
◇ >2000 ppm

Heavy-mineral concentrates
▫ 5000-10000 ppm
□ >10000 ppm

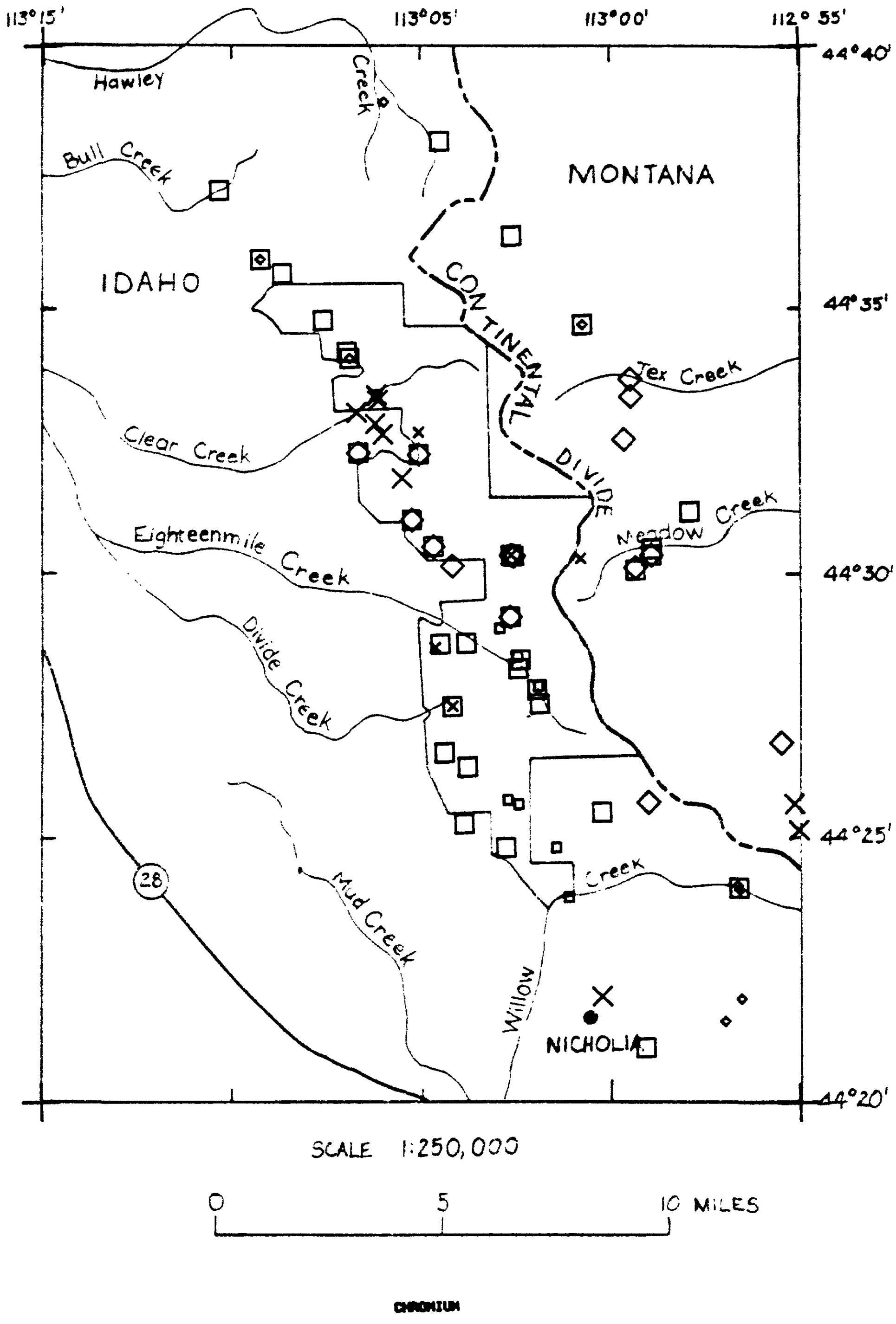
Rocks
× 1000-2000 ppm
X >2000 ppm

Figure 9. Distribution of anomalous barium values in the Eighteenmile WSA and surrounding areas.



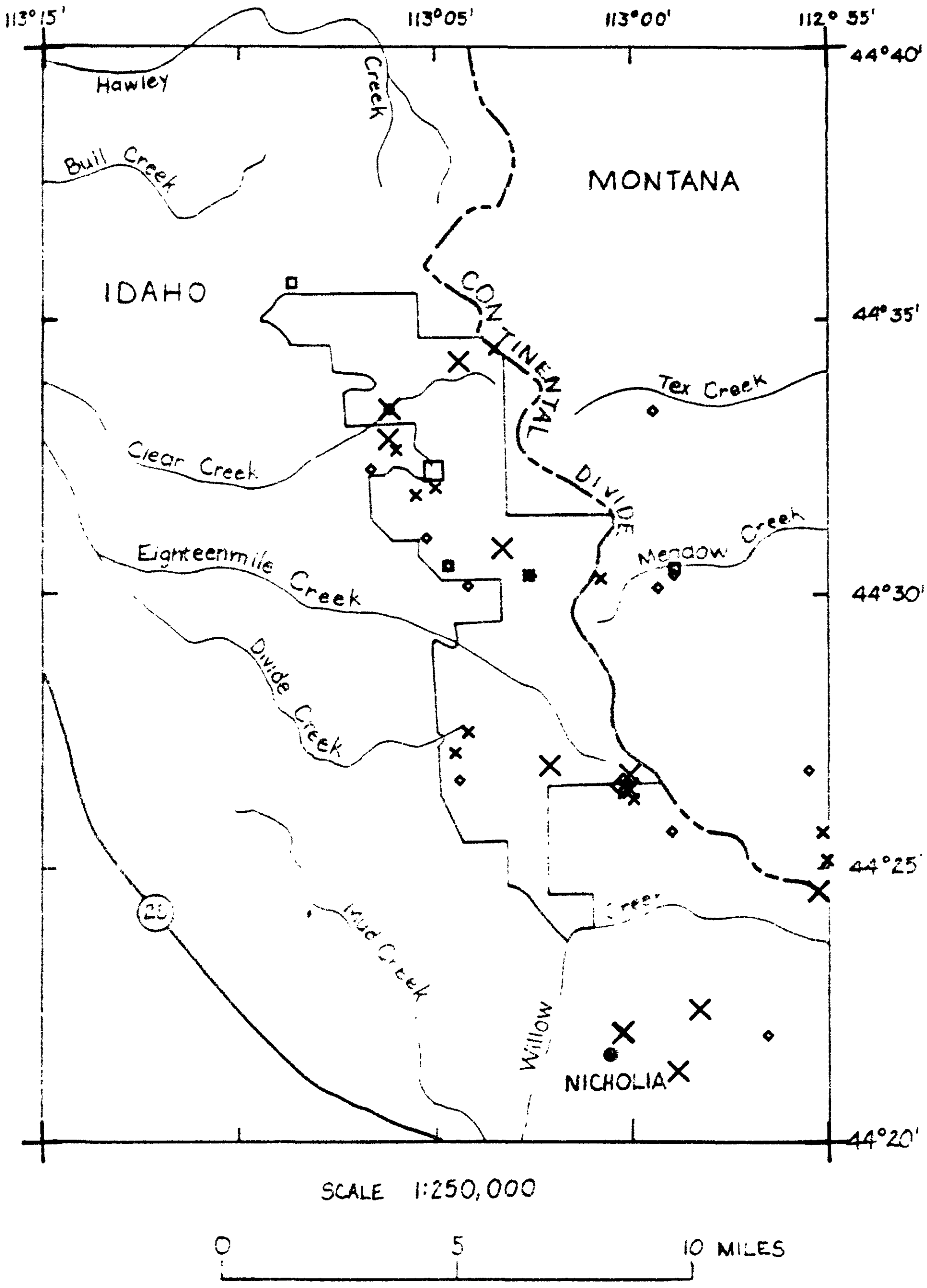
Sieved-sediments	Heavy-mineral concentrates	Rocks
◇ 100-200 ppm	□ 100-300 ppm	× 100-200 ppm
◇ ≥200 ppm	□ ≥300 ppm	× ≥200 ppm

Figure 10. Distribution of anomalous boron values in the Eighteenmile WSA and surrounding areas.



Sieved-sediments	Heavy-mineral concentrates	Rocks
◦ 150-300 ppm	▫ 50-150 ppm	× 150-300 ppm
◇ ≥300 ppm	□ ≥150 ppm	✕ ≥300 ppm

Figure 11. Distribution of anomalous chromium values in the Eighteenmile WSA and surrounding areas.

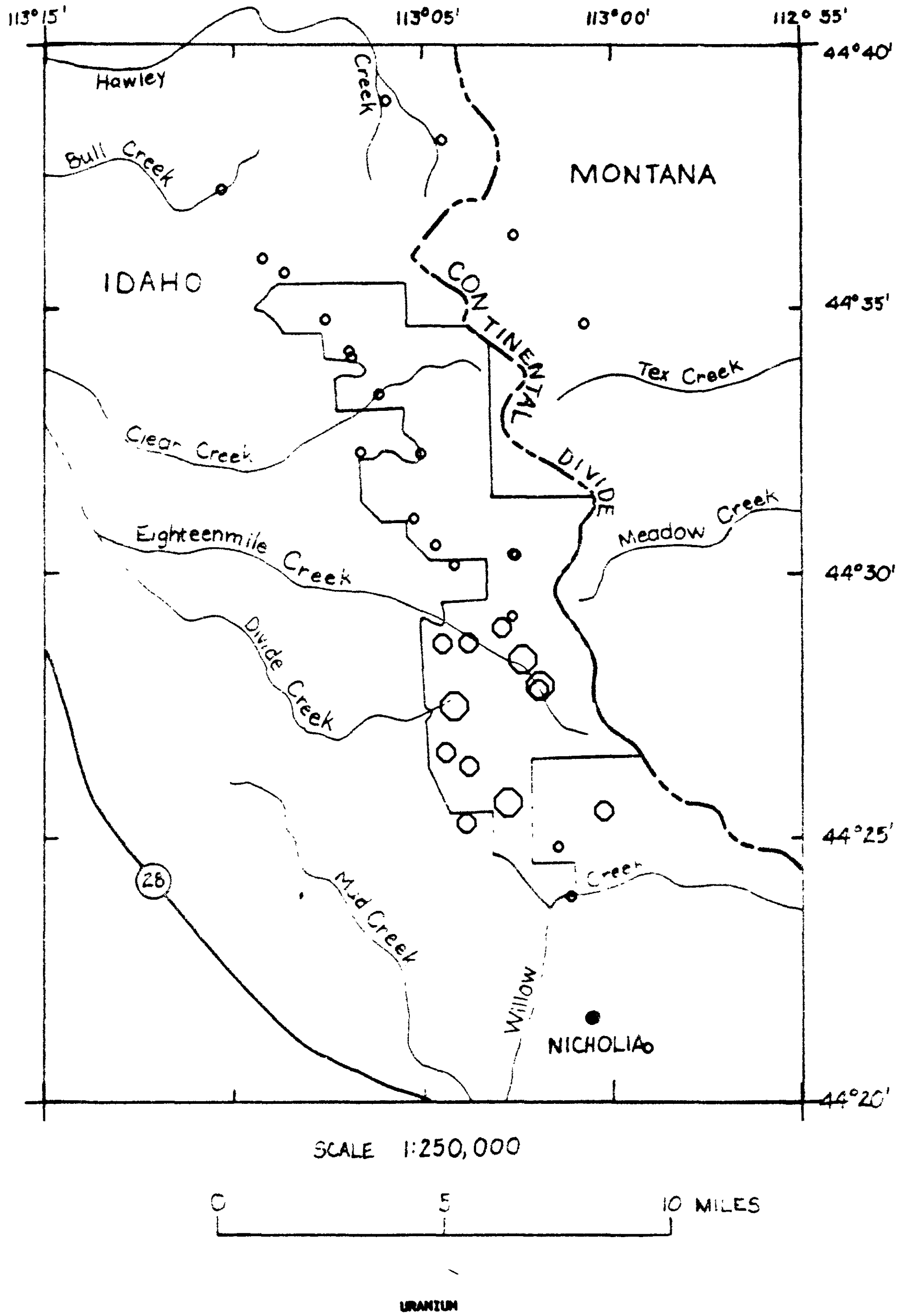


Sieved-sediments
∘ 50-100 ppm
◇ ≥100 ppm

Heavy-mineral concentrates
▫ 150-500 ppm
□ ≥500 ppm

Rocks
× 50-100 ppm
╳ ≥100 ppm

Figure 12. Distribution of anomalous copper values in the Eighteenmile WSA and surrounding areas.



Sieved-sediments
- 0-5 ppm
- 5-20 ppm
- ≥20 ppm

Figure 13. Distribution of uranium values in the Eighteenmile WSA and surrounding areas.

Data from both this report and from Hopkins and others (in press) are presented in the figures (see also plates 2 and 3). Except for figure 13, uranium, only those sample sites considered anomalous are shown on figures 3-13. Table 4 lists the threshold values for the elements presented in these figures and, for the convenience of the reader, lists average elemental abundances for the main rock types found in the WSA. The small size of the WSA and the concomitant small data set preclude statistical treatment of the data.

As a general observation, the entire WSA appears to be enriched in a wide variety of elements resulting from several geochemical processes.

The Paleozoic rock units and the stream sediments derived from them are enriched in Ag, B, Ba, Cr, Cu, Mn, Mo, Ni, Pb, and Zn. The structural complexities present in outcrop areas of the Paleozoic rock units and the reconnaissance nature of the geochemical data combine to create considerable uncertainties in the interpretations. For example, the highest Ag value in a rock sample, 10 ppm (excluding samples from known mining districts), was obtained from a siltstone. Siltstones were found to be anomalous in a number of elements in several localities. These data suggest the siltstones may have been solution pathways for fluids that subsequently caused the mineralization that occurs in the Paleozoic carbonate rocks. The metal content of the mineralizing fluids could be derived from several sources: hydrothermal fluids or enriched ground waters, both of which may have used the siltstones as the most permeable units; and formation brines where the siltstones and sandstones were the source of the metal-rich fluids. If such solutions were fluids derived from formation brines (that is sedimentary or sedimentary-exhalative fluids), then the genetic model for such mineralization would be similar to models proposed for a number of stratabound Pb-Zn deposits and a model which has been proposed for the Nicholia district (Lambeth and Mayerle, 1983). However, the highest Mo value, 300 ppm, occurred in an altered and highly brecciated carbonate rock found in a tributary of Chamberlain Canyon suggesting that mineralization is related to faulting and, because of age relationships, is a result of hydrothermal fluid movement along these structures. Supporting evidence of a hydrothermal genetic model is the spatial association of faults and mineralized rocks throughout the WSA and an apparent tendency towards increased mineralization at structural intersections. However, because of the reconnaissance nature of the geochemical survey, such structures were preferentially sampled and the spatial association may only reflect sampling bias and secondary redistribution of pre-existing metal enrichment.

The presence of very high Cr and Ni values in many of the rock and stream-sediment samples may be interpreted as further evidence of hydrothermal activity. Altered limestones and dolomites frequently have much higher contents of Cr and Ni than samples of the mafic dikes of probable Eocene age.

A further complication in the interpretation of the geochemical data is the near-certain presence of a subsurface pluton emplaced along the range front fault. Whether or not this body is the source of the anomalous elements is not clear. At the very least, this body acted either as a source for hydrothermal fluids or as a heat pump for cells of circulating, heated meteoric waters. This activity resulted in the formation of the gypsum deposits in the Clear Creek area and probably caused considerable redistribution of elements locally.

The presence of a subsurface igneous body and anomalous Mo values does lead to speculation on the possibilities of porphyry molybdenum mineralization. The data, however, are sufficient only for speculation. Age

Table 4.--Threshold Values and Average Elemental Abundances

Element	Threshold values (ppm) for anomalous concentrations (Weakly Anomalous, Moderate-to-Strongly Anomalous)			Average Elemental Abundances (ppm) (Rose, Hawkes, and Webb, 1979)					
	Stream Sediment	Nonmagnetic Heavy-Mineral Concentrate	Rock	Mafic Rocks	Granite	Limestone	Sandstone	Shale	Soil
Manganese (Mn)	1500, 2000	1500, 3000	1500, 2000	1500	390	1100	X0	850	320
Silver (Ag)	0.5*, 2	1*, 2	0.5*, 2	0.1	0.037	0.1	0.25	0.19	--
Boron (B)	100, 200	100, 300	100, 200	5	10	20	35	100	29
Barium (Ba)	1000, 2000	5000, 10,000	1000, 2000	330	840	92	170	550	300
Chromium (Cr)	150, 300	50, 150	150, 300	170	4.1	11	35	90	43
Copper (Cu)	50, 100	150, 500	50, 100	72	12	5	10	42	15
Molybdenum (Mo)	5*, 20	10*, 20	5*, 20	1.5	1.3	0.4	0.2	2.6	2.5
Niobium (Nb)	30, 100	50*, 200	30, 100	20	20	--	--	20	15
Nickel (Ni)	50, 150	10, 50	50, 150	130	4.5	20	2	68	17
Lead (Pb)	50, 100	150, 500	50, 100	4	18	5	10	25	17
Tin (Sn)	10*, 15	20*, 100	10*, 15	1.5	3.0	0.X	0.6	6	10
Zinc (Zn)	200*, 500	500*, 1000	200*, 500	94	51	21	40	100	36
Uranium (U)	5, 20	--	--	0.53	3.9	2.2	1.7	3.7	1

*, Lower detection limit; --, no data; and X, significant figure is not known, only the order of magnitude

relationships indicate the subsurface body is Mid to Late Tertiary and most porphyry molybdenum systems in Idaho and Montana are considered Early Tertiary or Late Cretaceous (Armstrong and others, 1978). If emanations from the intrusive body are the source of the high Cr and Ni contents in the rocks and stream sediments, such data would suggest a body of basaltic composition. Samples of Eocene dikes did contain weakly anomalous Mo values, but this may have resulted from metal leakage along the contact. If the dike rocks or the Mo values are related to a porphyry molybdenum system, it has been beheaded by the thrust faulting because there is no evidence of another subsurface body indicated by the geophysical data. As further negative evidence for a porphyry molybdenum system, a visual search was made of the nonmagnetic concentrate samples for fluorite, a mineral commonly associated with porphyry molybdenite systems, but only trace amounts were found. In most samples no fluorite was observed.

Many of the nonmagnetic concentrate samples collected between Dry Canyon and Pass Creek, however, did contain large amounts of phosphatic material which indicates that there are phosphate-bearing beds in Paleozoic rocks other than the Phosphoria Formation. The Phosphoria Formation does not occur within the WSA and thus cannot be the source of this material.

Three Proterozoic rock samples were analyzed, one of which contained 30 ppm gold. This was the only sample of any type from the Eighteenmile WSA in which gold was found. Although sediments from streams draining Proterozoic rocks were enriched in Ag and Cu, among other elements, a Proterozoic source cannot be established because those streams also drain Paleozoic rocks.

The Beaverhead pluton is a geochemically specialized granitoid containing anamolous amounts of B, Be, La, Nb, Mo, Sn, and U, in addition to base and precious metals. Many of the rock samples (data from Hopkins and others, in press) contain Sn values and Zr/Sn and V/Nb ratios that meet the criteria for recognizing granitoid complexes parent to deposits of rare metals (Beus and Grigorian, 1977, tables 20 and 21). The base and precious metal values show a close relation to fault systems in the granite, while Sn-rich rock samples tend not to be enriched in either base or precious metals. These indications of separate mineralizing systems suggest that the base and precious metal mineralization may not be genetically related to the granite, but rather a later, superimposed mineralization.

High U values (figure 13) are definitely associated with the Beaverhead pluton; however, none of 30 rock samples analyzed for U contained as much as 5 ppm U (Hopkins and others, in press). The source for the high U values in the sediments remains unknown. The cause is probably precipitation of uranium on organic matter in small localized boggy areas in the stream drainages.

A few, selected, magnetic at one-amp (M-1), heavy-mineral concentrates were also analyzed by semiquantitative emission spectrography. This concentrate fraction contains mafic minerals and iron and manganese oxides. Results of the analyses yielded essentially the same interpretations as the other sample types, although one sample site, NI 010, contained high values of La, Y, and Th suggesting the possibility of fine-grained thorite inclusions in hematite grains. Hematite-thorite mineralization occurs in the Lemhi Pass disrict (Staatz, 1972; 1979) and at a thorite prospect (Staatz and others, 1972a) at Bull Canyon just north of the WSA (see site ML001, plate 3 and Appendix). These deposits also contain significant amounts of rare earth elements (Staatz and others, 1972b). The data suggest that analysis of the M-1 fraction and analyses for rare earth elements might prove fruitful.

ENERGY AND MINERAL DEPOSITS

Known mineral deposits

Gypsum constitutes the only known mineral deposit in the Eighteenmile WSA. Gypsum has been mined from the Clear Creek gypsum mine in Clear Creek about one-half mile west of the WSA (fig. 2), and small gypsum deposits have been prospected north and south of the Clear Creek mine in the WSA.

Phosphate has been mined from the Phosphoria Formation north of the WSA (Oberlindacher and Hovland, 1979), but no Phosphoria Formation is present in the WSA.

Silver-lead-zinc ores from the Viola mine in the Nicholia mining district two miles south of the WSA (fig. 2) are thought to have been stratabound in dolomite of the Devonian Jefferson Formation of the Hawley Creek thrust plate (Skipp and others, 1983; Lambeth and Mayerle, 1983). No similar deposits have been identified in the WSA.

Known prospects, mineralized areas, and mineral occurrences

Several prospects are present in the vicinity of the Clear Creek gypsum mine (WGM, Inc., 1983). All other known prospects and mineral occurrences are outside the WSA.

Mining claims and leases

Information on mining claims and leases within the Eighteenmile WSA was obtained from the Phase 1 GEM report on the WSA (WGM, Inc., 1983). As indicated in that report, six mining claims, one of them patented, the gypsum prospect shown on figure 2, are present in the WSA in the general vicinity of the Clear Creek gypsum mine as of June 30, 1982. A phosphate prospecting permit application extends into the northern part of the WSA (WGM, Inc., 1983, fig. 13). As of August 12, 1982, about 60 percent of the WSA was covered by oil and gas leases or lease applications. The southern part and northwestern edge of the WSA are completely leased.

Mineral resource types

Four mineral resource types are present in the Eighteenmile WSA: gypsum and base, precious, and rare metals associated with hydrothermal mineralization in the Clear Creek area; base and precious metals in fractures in granite of the Ordovician Beaverhead Mountains pluton; rare metals and uranium in granite of the pluton and sediments derived therefrom; and stratabound or replacement precious, base, and rare metals in Paleozoic siltstones and carbonate rocks.

Gypsum deposits are present in the WSA near the Clear Creek gypsum mine, and geochemical sampling shows most samples from this area are anomalous in Ag, Cu, and Mo. Fault-controlled hydrothermal mineralization probably resulted from heat and metal ions provided by a buried Neogene intrusive emplaced along the Crooked Creek fault near the mouth of Clear Creek. A recent aeromagnetic map (USGS, 1981) identifies the southern part of a large positive magnetic anomaly in this area (fig. 2).

Mineralization in the Clear Creek area is of hydrothermal origin as suggested by E. T. Ruppel (*in* Withington, 1964), rather than stratabound origins as concluded in the Phase 1 report (WGM, Inc., 1983). Mineralized zones are not confined to a single stratigraphic unit or tectonic block, but are present in the Mississippian Scott Peak and McGowan Creek Formations and Eocene(?) dikes of the Fritz Creek thrust plate and the Clear Creek slide block (fig. 2).

Fractures in granite of the Ordovician Beaverhead Mountains pluton are enriched in Ag, Cu, Pb, and Zn. Granite of the pluton is rich in Sn and Nb. Sediments derived from the granite contain weakly to moderately anomalous U.

Siltstones and mudstones of the Devonian Three Forks Formation and the Mississippian McGowan Creek and Big Snowy Formations are preferentially enriched in Ag and Mo. These strata may have acted as conduits for mineralizing fluids.

Dolomite of the Devonian Jefferson Formation is the host for stratabound Ag-Pb-Zn ores in the Nicholia mining district south of the WSA (Lambeth and Mayerle, 1983; Skipp and others, 1983). Weakly anomalous concentrations of Ag and Pb were noted in samples of Devonian dolomite from the WSA. Scattered samples of Mississippian carbonate rocks are enriched in Pb, Cu, and Mo.

Mineral economics

Mineral resource types found in the Eighteenmile WSA are primarily hydrothermal gypsum and associated base, precious, and rare metals in the Clear Creek area; base and precious metals in fractures in granite of the Beaverhead Mountains granite; uranium in sediments derived from the granite; stratabound precious metals in Devonian and Mississippian siltstones and mudstones; and stratabound base and precious metals in Devonian and Mississippian dolomites and limestones. Access, transportation, grade, recovery volume, extraction methods, and market value affect the economics of mining the various deposits. The gypsum deposits and related base and precious metal deposits in the Clear Creek area have a moderate to high economic potential although the grades are incompletely known. All other mineralized areas in the WSA have unknown economic potential because of lack of data.

Land classification

Land classification decisions were made on the basis of field investigations, geochemical study, historical research, and a partial aeromagnetic survey. The classification scheme used by the Bureau of Land Management is given in table 5, and the land classification decisions are presented in table 6.

The Clear Creek area has high resource potential for hydrothermal gypsum and a moderate resource potential for associated Ag, Cu, Mo, Pb, and Zn mineralization. Gypsum already has been produced from the Clear Creek mine adjacent to the WSA, and several prospects, one of them patented, are present in an area that probably is underlain by a Neogene intrusive as a possible source for heat and metals prerequisite to hydrothermal ore deposits. The area is easily accessible along an improved gravel road that exits east from Idaho State Highway 28. More detailed mapping, geochemical studies, a gravity survey, and a magnetic survey would be necessary to assess the full potential of the area.

Base and precious metal fracture mineralization in granite of the Beaverhead Mountains pluton appears to be generally localized and of low grade. These factors suggest moderate potential for this resource. Although granite of the pluton is Sn-rich, concentrations are low, and a resource potential for Sn is low. Sediments derived from the granite contain moderately anomalous concentrations of U, but the resource potential is considered low.

Moderately anomalous concentrations of precious and rare metals, present in siltstones and mudstones of the Devonian Three Forks and the Mississippian McGowan Creek and Big Snowy Formations, are not considered a resource themselves, but they may indicate the presence of metal-rich fluids.

Table 5.--Favorability/Resource Potential Classification for BLM Mineral Resource Reports

Level of Favorability	Level of Certainty
Resource potential cannot be classified	
0. Favorability unknown; information on the likelihood of of presence of mineral resources is inadequate for classification; equates with UNKNOWN potential.	A. The available data are not sufficient for determination of the degree of favorability for the occurrence of mineral resources.
Resource potential can be classified	
1. The nature of the geologic environment, and, the geologic processes that have acted in the area, indicate no favorability for the presence of mineral resources; equated with NO resource potential.	B. The available data are adequate to give an indication of the degree of favorability, but lack key evidence that would help define geologic environments or activity of resource-forming processes.
2. The nature of the geologic environment, and, the geologic processes that have acted in the area, indicate low favorability for the presence of mineral resources; the data define a geologic environment permissive for the presence of mineral resources but there is no evidence of the action of processes of resource accumulation; equates with LOW resource potential.	C. The available data provide a good indication of the degree of favorability, but are minimal in terms of definition of degree of activity of possible resource-forming processes, and the nature of geologic environment.
3. The nature of the geologic environment, and, the geologic processes that have acted in the area, indicate moderate favorability for the presence of mineral resources; the data define a geologic environment favorable for the presence of mineral resources; evidence is present of the action of processes likely to form resources; equates with MODERATE resource potential.	D. The available data define the geologic environment and the degree of activity of possible resource-forming processes with considerable certainty; key evidence to interpretation of the presence or absence of appropriate ore deposit types is available.
4. The nature of the geologic environment, and, the geologic processes that have acted in the area, indicate high favorability for the presence of mineral resources; the data define a geologic environment highly favorable for the presence of mineral resources, and strongly support the interpretation that resources are probably present; evidence is compelling for the activity of processes likely to form resources; equates with HIGH resource potential.	
Reserves have been discovered	
5. Reserves have been discovered	E. The available information is adequate to identify reserves, and to specify to varying degrees of certainty, the quantity and grade of valuable minerals in a well-defined area

Table 6. Land classification of the Eighteenmile WSA

Resource	Classification	Comments
METALS		
Precious (Au, Ag)	3C	Ag fracture mineralization associated with granite of the Beaverhead Mountains pluton
	2C	Ag mineralization associated with siltstone and mudstone of Devonian Three Forks, and Mississippian McGowan Creek and Big Snowy Formations
	3B	Ag mineralization in Devonian and Mississippian carbonate rocks associated with Tertiary hydrothermal systems
	3B	Ag mineralization stratabound in dolomite of the Devonian Jefferson Formation
Base (Cu, Pb, Zn)	3C	Cu-Pb-Zn fracture mineralization associated with granite of the Beaverhead Mountains pluton
	3B	Cu-Pb-Zn mineralization associated with Paleozoic carbonate rocks
Rare (Mo, Sn, Nb)	2C	Sn-Nb mineralization associated with granite of the Beaverhead Mountains pluton
	2C	Mo mineralization in siltstone and mudstone of Devonian Three Forks and Mississippian McGowan Creek Formations (by-product associated with possible base or precious metal mineralization)
	3B	Mo mineralization in Mississippian carbonate rocks (a by-product as above)
	2C	Mo porphyry at depth
URANIUM-THORIUM	2C	U-Th mineralization associated with granite of the Beaverhead Mountains pluton
NONMETALLIC MINERALS		
Phosphate	1D	WSA lacks Phosphoria Formation, and phosphate-rich zones in other Paleozoic formations are of low grade
Gypsum	4C	Gypsum mineralization associated with hydrothermal systems related to buried Neogene intrusive
OIL AND GAS	2D	Oil at depths less than 10,000 ft
	3B	Gas at depths less than 10,000 ft
GEOTHERMAL	2B	WSA lacks evidence of Holocene heat-providing bodies

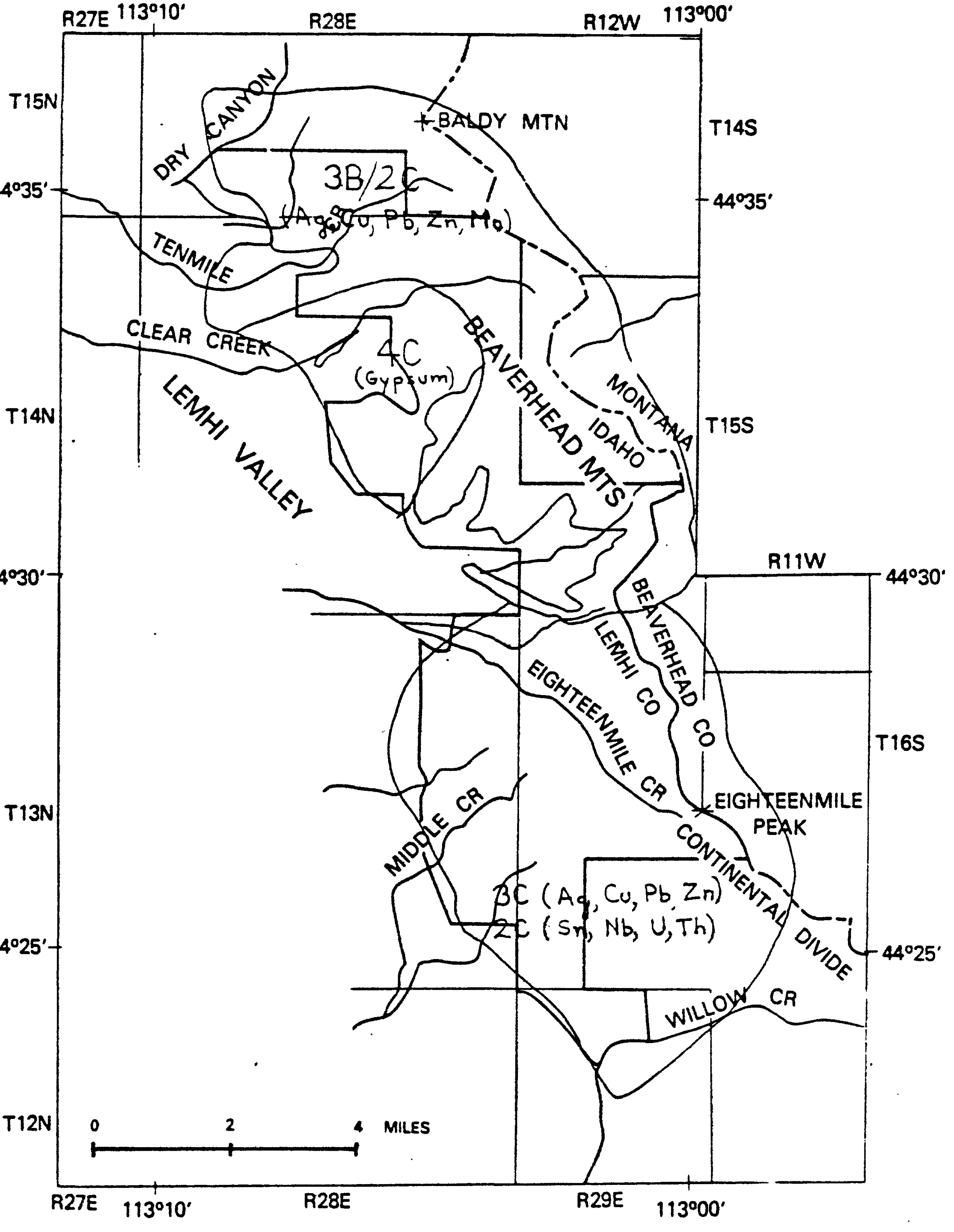


Figure 14.--Map showing land classification of the Eighteenmile Wilderness Study Area, Lemhi County, Idaho

Base and precious metal geochemical anomalies in dolomites of the Jefferson Formation are weak where sampled for this study. The resource potential is considered moderate in the WSA.

Scattered anomalous concentrations of base and rare metals were found in samples of Mississippian carbonate rocks, but little is known about the extent or cause of the mineralization. This resource is classed as having a moderate potential until more is known.

The potential for oil and gas in the WSA above a depth of 10,000 ft is classified as low to moderate. One, two, or all three of the thrust plates present (fig. 2) underlie the entire area of the WSA to depths of at least 10,000 ft. What lies beneath these thrust sheets remains speculative. Borehole and seismic information south and east of the WSA indicate that regional basement is deep, perhaps near 30,000 ft (Perry and others, 1981; Perry and others, 1983; Skipp and Hait, 1977), so there may be room for one or more thrust sheets below 10,000 ft depths that may be composed of rocks deposited on the inner craton margin.

One conodont color alteration index (CAI) value from McGowan Creek Formation on the Fritz Creek thrust plate just north of Pass Creek is 4 (fig. 2), indicating that these rocks have been subjected to temperatures in excess of 190^{o}C (Epstein and others, 1977). Other CAI values from limestones of the Fritz Creek thrust plate south of the WSA are similar (Skipp and others, 1983). Any hydrocarbons present in rocks of the Fritz Creek plate would be in a state of late postmature thermal maturity, and dry gas would be the only possible resource (Perry and others, 1981). Similar CAI values have been obtained from limestones of the Cabin plate southeast of the WSA. No information on the thermal history of the rocks on the Cabin plate is available in the WSA, but if the thermal history is similar to that of the Fritz Creek plate, dry gas once again is the only possible resource. For these reasons, the oil potential for rocks at depths less than 10,000 ft is low, and the gas potential is moderate. It is, however, very difficult to identify structures that might contain gas in a terrane like that of the WSA, where dense carbonate and intrusive rocks lie at the surface.

RECOMMENDATIONS FOR FURTHER WORK

The Clear Creek area containing the Clear Creek gypsum mine appears to be underlain by a Neogene magnetic intrusive that furnished the heat and metal-rich solutions for extensive fault-controlled hydrothermal mineralization that extends into the WSA. More detailed geologic mapping of faults, fold axes, and areas of altered rocks is needed in this area, along with more detailed geochemical sampling, a gravity survey, and an aeromagnetic or ground magnetic survey to define the northern limits of the magnetic anomaly. A gravity survey would furnish information on the the relative density of the inferred Neogene magnetic intrusive body. Eventually, the area probably should be tested by drilling or less expensive specialized geophysical techniques. Evaluation of the true potential for base and precious metals in fractures of the granite of the Ordovician pluton would involve very detailed geologic mapping and sampling of that body, neither of which are recommended at this time because of the extremely localized nature of the mineralization. Detailed field mapping and geochemical sampling to delineate in three dimensions the different phases of the granite would be necessary to further evaluate the Sn potential of the Beaverhead Mountains pluton (Taylor, 1979, p. 96). These are not recommended at this time largely because no other tin deposits are known in the region.

Specialized sampling of Devonian dolomites and siltstones and Mississippian siltstones and limestones that have yielded anomalous concentrations of precious, base and rare metals would allow evaluation of the validity of the model of stratabound mineralization in this area, and might provide the information needed to explain and identify the scattered mineralized zones in Mississippian carbonate rocks.

Because of the numerous oil and gas leases in the WSA, it is recommended that a few more conodont color alteration index (CAI) values be obtained for carbonate rocks in the WSA, and that vitrinite reflectance and thermal alteration index (TAI) values be obtained for mudstones of the Mississippian Big Snowy and McGowan Creek Formations to determine the thermal maturity of particulate organic matter in the fine-grained detrital rocks of the Cabin and Fritz Creek thrust plates in the WSA. This information would allow evaluation of the oil and gas potential of the WSA on the basis of local, rather than regional, data.

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Appendix 1. Explanation of data tables

The column listings in appendices 2-6 are arranged so that column 1 contains the sample identifiers. The first two numbers of the sample identifier designate the year the sample was collected. The next 1 or 2 letters indicate the 7.5- or 15-minute U.S. Geological Survey topograhic quadrangle in which the sample was collected. The letter abbreviation and corresponding quadrangles are as follows: ML, Morrison Lake; NI, Nicholia; and SP, Scott Peak. Samples collected from mining districts outside the Eighteenmile GRA include LE, Leadore; GI, Gilmore; LP, Lemhi Pass; SA, Salmon; BM, Blackbird Mountain; and PA, Patterson.

The three numbers following letter abbreviations are the unique identification of the sample site. Letter suffixes or a blank space at the end of the sample number have the following meanings: NM, nonmagnetic (NM-1) heavy-mineral concentrate; R, rock sample; (no suffix), <80-mesh stream sediment; W, water sample; and S, soil sample.

Rock samples collected by B. Skipp have a single letter, S, and the year is indicated by the last two numbers.

The latitude north and longitude west for each sample locality is shown in degrees, minutes, and seconds in columns 2 and 3. The remaining columns list the elements for which data are available.

The following examples illustrate the column headings for the data:

Fe-pct.	U-ppm	SO_4-ppm	Cu-ppb
s	i	ic	aa

The headings in this example indicate iron in percent, uranium in parts per million, sulfate in parts per million, and copper in parts per billion, respectively. The subheading "s" in the iron example indicates a semiquantitative emission-spectrographic analysis; "i", "ic", and "aa" indicate instrumental, ion chromatographic, and atomic-absorption spectroscopic analyses respectively.

Data qualified (censoring) codes are used with some reported values. Symbols used are N, not detected; <, detected, but below the value shown; >, greater than the value shown; --, no data available.

The results given in tables should be considered as having only two significant figures. Instrument readouts frequently give three or more digits, especially if the data are internally processed before the readout. Additionally, when a number such as "1200" occurs in the same column as a number such as "3.5," the computer printout will be "1200.0," indicating a false precision.

Appendix 2. Analytical data for nonmagnetic heavy-mineral concentrates. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
ML001NM1	44 37 16	113 10 20	5.0	1.00	10.0	>2.0	100	N	N	N	200	700
ML002NM1	44 35 58	113 9 15	3.0	1.00	50.0	1.5	1,000	7	N	N	150	2,000
ML003NM1	44 35 42	113 8 40	10.0	5.00	30.0	>2.0	1,000	1	N	N	500	300
ML004NM1	44 34 49	113 7 35	7.0	5.00	50.0	1.5	1,000	N	N	N	200	500
ML005NM1	44 34 13	113 6 57	2.0	1.50	>50.0	.2	700	N	N	N	50	1,500
ML006NM1	44 34 6	113 6 53	2.0	1.50	>50.0	.5	700	N	N	N	50	>10,000
ML008NM1	44 33 24	113 6 10	5.0	.20	>50.0	.2	100	3	N	N	30	1,000
ML011NM1	44 32 16	113 5 3	3.0	7.00	30.0	>2.0	700	N	N	N	>5,000	>10,000
ML013NM1	44 32 18	113 6 39	2.0	2.00	50.0	.5	700	N	N	N	200	>10,000
ML014NM1	44 31 2	113 5 14	3.0	2.00	20.0	>2.0	500	N	N	N	300	>10,000
ML015NM1	44 30 21	113 2 33	5.0	7.00	30.0	>2.0	700	2	N	N	1,000	>10,000
ML016NM1	44 30 22	113 2 37	5.0	1.50	20.0	>2.0	500	N	N	N	150	5,000
ML017NM1	44 30 32	113 4 40	5.0	5.00	>50.0	2.0	1,500	N	N	N	1,500	>10,000
ML019NM1	44 34 44	113 0 44	2.0	1.00	>50.0	.5	700	10	N	N	50	3,000
ML020NM1	44 36 24	113 2 36	5.0	1.00	30.0	>2.0	500	N	N	N	100	300
ML021NM1	44 38 12	113 4 30	.7	15.00	50.0	1.5	150	N	N	N	20	200
NI001NM1	44 28 59	113 2 55	1.5	.70	2.0	>2.0	500	N	N	N	70	200
NI002NM1	44 29 12	113 2 38	5.0	7.00	50.0	>2.0	1,500	N	N	N	300	>10,000
NI003NM1	44 28 23	113 2 22	7.0	2.00	2.0	>2.0	500	N	N	N	200	2,000
NI004NM1	44 27 53	113 1 54	3.0	.70	1.0	>2.0	300	N	N	N	200	1,000
NI005NM1	44 27 49	113 1 56	3.0	2.00	7.0	>2.0	500	N	N	N	200	5,000
NI006NM1	44 28 42	113 3 48	5.0	2.00	7.0	>2.0	500	N	N	N	300	5,000
NI007NM1	44 24 50	113 1 25	2.0	1.50	10.0	>2.0	1,500	N	N	N	300	1,500
NI008NM1	44 24 50	113 2 45	2.0	1.00	2.0	>2.0	100	N	N	N	100	300
NI009NM1	44 25 30	113 0 13	3.0	1.50	20.0	>2.0	500	N	N	N	200	300
NI010NM1	44 26 37	113 4 23	2.0	1.00	2.0	>2.0	300	N	N	N	150	500
NI012NM1	44 27 30	113 4 10	2.0	1.00	3.0	>2.0	700	N	N	N	150	300
NI013NM1	44 26 41	113 4 29	3.0	1.50	2.0	>2.0	200	N	N	N	100	200
NI016NM1	44 26 21	113 3 46	2.0	.70	1.0	>2.0	300	N	N	N	100	150
NI017NM1	44 25 17	113 3 51	3.0	1.00	7.0	>2.0	200	N	N	N	100	300
NI019NM1	44 23 54	113 1 5	2.0	1.50	1.5	>2.0	700	N	N	N	150	200
SP001NM1	44 21 2	112 59 4	2.0	1.00	5.0	>2.0	200	N	N	N	300	7,000
Samples collected in mining districts outside the Eighteenmile GRA												
GI001NM1	44 27 6	113 17 0	7.0	20.00	20.0	>2.0	5,000	300	N	N	2,000	5,000
LE002NM1	44 46 24	113 18 27	3.0	2.00	2.0	>2.0	1,000	50	N	200	200	>10,000
LP001NM1	44 58 23	113 28 45	3.0	1.00	30.0	>2.0	2,000	70	500	100	200	>10,000
LP004NM1	44 56 52	113 27 23	2.0	1.00	20.0	>2.0	700	N	N	50	200	2,000
SA001NM1	45 4 32	113 51 39	10.0	.70	20.0	>2.0	300	70	<500	N	20	>10,000
BM002NM1	45 6 31	114 18 36	15.0	.05	10.0	.2	100	30	>20,000	1,000	<20	1,500
PA001NM1	44 31 35	113 41 58	>50.0	.50	50.0	.2	2,000	1,500	500	N	50	3,000

Appendix 2. Analytical data for nonmagnetic heavy-mineral concentrates. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho. (Continued)

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
ML001NM1	5	N	N	N	700	N	1,000	N	500	20	200
ML002NM1	<2	N	N	15	1,500	70	1,000	N	N	150	100
ML003NM1	<2	N	N	30	3,000	150	500	15	150	500	150
ML004NM1	2	N	N	20	500	30	500	10	<50	100	20,000
ML005NM1	2	N	N	10	500	20	1,500	10	N	100	2,000
ML006NM1	2	N	N	10	1,000	50	500	10	<50	100	150
ML008NM1	<2	N	N	70	100	50	150	N	N	200	700
ML011NM1	<2	N	N	20	1,500	700	300	N	300	100	30
ML013NM1	<2	N	N	20	700	30	1,000	70	N	100	15,000
ML014NM1	<2	N	N	30	500	100	300	N	300	150	15,000
ML015NM1	<2	N	N	70	1,500	70	200	N	70	200	200
ML016NM1	<2	N	N	20	300	20	300	N	70	100	<20
ML017NM1	<2	1,500	N	20	1,000	150	1,500	N	<50	200	2,000
ML019NM1	2	N	N	10	200	30	1,000	N	N	50	150
ML020NM1	<2	100	N	70	500	N	500	N	50	70	500
ML021NM1	<2	N	N	N	200	<10	100	N	<50	50	70
NI001NM1	10	N	N	N	100	N	300	N	1,000	10	500
NI002NM1	<2	N	N	30	700	70	700	N	300	200	150
NI003NM1	15	N	N	N	300	N	1,000	N	1,500	10	700
NI004NM1	15	N	N	N	100	N	500	N	1,000	<10	500
NI005NM1	10	N	N	N	500	10	1,500	N	700	20	700
NI006NM1	3	N	N	N	700	N	1,000	N	2,000	20	1,500
NI007NM1	3	N	N	N	100	N	1,500	N	700	N	1,000
NI008NM1	<2	N	N	30	200	N	1,000	N	2,000	N	500
NI009NM1	<2	N	N	20	1,000	N	1,500	N	700	20	500
NI010NM1	5	N	N	N	300	N	2,000	N	1,500	15	500
NI012NM1	7	N	N	10	200	<10	1,000	N	700	30	300
NI013NM1	<2	N	N	N	500	<10	1,000	N	2,000	15	500
NI016NM1	3	N	N	N	200	N	500	N	1,000	10	300
NI017NM1	<2	N	N	20	700	<10	200	N	700	N	500
NI019NM1	N	N	N	10	50	<10	700	N	1,000	N	300
SP001NM1	2	N	N	N	500	100	500	70	700	50	>50,000
Samples collected in mining districts outside the Eighteenmile GRA											
GI001NM1	<2	N	N	30	700	1,500	200	20	50	70	>50,000
LE002NM1	3	N	N	N	500	200	1,000	50	1,500	20	>50,000
LP001NM1	N	2,000	N	70	700	10,000	500	2,000	200	30	>50,000
LP004NM1	N	N	N	30	300	100	500	N	300	N	1,000
SA001NM1	3	>2,000	N	100	150	>50,000	200	N	<50	50	>50,000
BM002NM1	<2	>2,000	N	>5,000	30	20,000	150	20	50	5,000	300
FA001NM1	3	1,000	300	1,000	50	20,000	200	>5,000	70	100	50,000

Appendix 2. Analytical data for nonmagnetic heavy-mineral concentrates. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho. (Continued)

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
ML001NM1	N	--	1,000	N	150	N	>5,000	N	>2,000	300
ML002NM1	N	--	N	1,000	300	N	1,000	N	>2,000	N
ML003NM1	N	--	N	500	500	N	300	3,000	>2,000	N
ML004NM1	N	--	N	1,000	200	N	700	2,000	>2,000	N
ML005NM1	N	--	N	2,000	300	N	1,500	N	2,000	N
ML006NM1	N	--	N	2,000	1,000	N	700	N	>2,000	N
ML008NM1	N	--	N	2,000	50	N	200	N	2,000	N
ML011NM1	N	--	N	1,500	200	N	200	N	>2,000	N
ML013NM1	N	--	N	1,500	300	N	300	N	1,500	N
ML014NM1	N	--	N	2,000	300	N	200	N	>2,000	N
ML015NM1	N	--	N	3,000	200	N	200	N	1,500	N
ML016NM1	N	--	N	1,000	500	N	200	N	>2,000	N
ML017NM1	N	--	N	3,000	200	N	300	N	>2,000	N
ML019NM1	N	--	N	2,000	100	N	1,500	N	>2,000	N
ML020NM1	N	--	<20	200	200	N	1,000	500	>2,000	N
ML021NM1	N	--	N	N	50	N	200	N	>2,000	N
NI001NM1	N	--	700	N	50	N	>5,000	N	>2,000	200
NI002NM1	N	--	100	>10,000	200	N	500	N	>2,000	N
NI003NM1	N	--	>2,000	N	100	N	>5,000	N	>2,000	N
NI004NM1	N	--	1,000	N	30	N	2,000	N	>2,000	N
NI005NM1	N	--	2,000	N	200	N	3,000	N	>2,000	N
NI006NM1	N	--	2,000	200	300	N	3,000	N	>2,000	N
NI007NM1	N	--	500	N	300	N	2,000	N	>2,000	N
NI008NM1	N	--	1,000	N	200	N	1,000	N	>2,000	N
NI009NM1	N	--	1,000	N	200	N	1,000	N	>2,000	N
NI010NM1	N	--	>2,000	N	200	N	1,500	N	>2,000	N
NI012NM1	N	--	300	N	200	N	1,000	N	>2,000	N
NI013NM1	N	--	500	N	100	N	1,500	N	>2,000	N
NI016NM1	N	--	700	N	150	N	1,000	N	>2,000	N
NI017NM1	N	--	500	N	150	N	1,000	N	>2,000	N
NI019NM1	N	--	200	N	300	N	1,000	N	>2,000	N
SP001NM1	N	--	200	700	700	N	2,000	700	>2,000	200
Samples collected in mining districts outside the Eighteenmile GRA										
GI001NM1	1,000	--	N	200	15,000	N	200	1,500	>2,000	N
LE002NM1	N	--	500	N	1,000	N	1,500	N	>2,000	N
LP001NM1	N	--	>2,000	2,000	150	500	1,000	2,000	>2,000	2,000
LP004NM1	N	--	200	N	200	300	1,000	N	>2,000	1,500
SA001NM1	5,000	--	200	2,000	50	N	500	N	>2,000	N
BM002NM1	1,000	--	200	N	500	N	150	N	>2,000	N
PA001NM1	3,000	--	150	N	<20	10,000	500	15,000	>2,000	N

Appendix 3. Analytical data for sieved stream-sediments. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
ML001	44 37 16	113 10 20	3.0	.50	.30	.5	200	N	N	N	100	300
ML002	44 35 58	113 9 15	3.0	.70	.70	.7	1,000	N	N	N	150	700
ML003	44 35 42	113 8 40	3.0	1.00	2.00	.5	1,000	.5	N	N	100	500
ML004	44 34 49	113 7 35	1.5	.50	2.00	.7	300	<.5	N	N	200	200
ML005	44 34 13	113 6 57	.7	.10	.50	.2	200	<.5	N	N	100	100
ML006	44 34 6	113 6 53	5.0	1.00	5.00	.7	100	1.0	N	N	150	500
ML008	44 33 24	113 6 10	5.0	1.00	1.50	.7	1,000	.5	N	N	500	300
ML011	44 32 16	113 5 3	7.0	7.00	7.00	1.0	1,500	N	N	N	200	500
ML013	44 32 18	113 6 39	5.0	5.00	10.00	.7	1,000	.7	N	N	150	1,000
ML014	44 31 2	113 5 14	10.0	10.00	3.00	>1.0	1,500	1.0	N	N	50	1,000
ML015	44 30 21	113 2 33	10.0	10.00	5.00	>1.0	1,500	<.5	N	N	70	1,000
ML016	44 30 22	113 2 37	10.0	5.00	5.00	>1.0	1,500	.7	N	N	70	700
ML017	44 30 32	113 4 40	7.0	7.00	5.00	1.0	1,500	.5	N	N	50	700
ML018	44 30 10	113 4 10	15.0	10.00	5.00	>1.0	1,500	.5	N	N	50	700
ML019	44 34 44	113 0 44	5.0	.70	3.00	.7	1,500	1.0	N	N	200	300
ML020	44 36 24	113 2 36	1.5	.70	.30	.5	500	<.5	N	N	70	300
ML021	44 38 12	113 4 30	1.0	1.00	2.00	.5	300	<.5	N	N	100	500
ML022	44 38 57	113 5 59	2.0	2.00	5.00	.5	2,000	5.0	N	N	100	1,000
NI001	44 28 59	113 2 55	5.0	.20	.50	>1.0	2,000	N	N	N	50	700
NI002	44 29 12	113 2 38	7.0	5.00	1.50	>1.0	1,000	1.0	N	N	50	700
NI003	44 28 23	113 2 22	2.0	.50	.70	.5	1,500	N	N	N	50	1,000
NI004	44 27 53	113 1 54	2.0	.15	.15	.5	300	N	N	N	50	300
NI005	44 27 49	113 1 56	2.0	.70	1.00	.7	1,000	N	N	N	50	500
NI006	44 28 42	113 3 48	5.0	1.00	1.50	.5	1,500	N	N	N	30	1,000
NI007	44 24 50	113 1 25	3.0	.50	.20	.7	1,000	N	N	N	50	500
NI008	44 25 40	113 2 45	1.5	.10	.30	.3	500	N	N	N	30	300
NI009	44 25 30	113 0 13	2.0	.30	.20	.5	700	N	N	N	70	700
NI010	44 26 37	113 4 23	3.0	.50	.50	.5	1,500	.5	N	N	50	700
NI012	44 27 30	113 4 10	2.0	.70	1.50	.5	700	N	N	N	30	700
NI013	44 28 41	113 4 29	3.0	.50	.20	.5	700	N	N	N	70	500
NI016	44 26 21	113 3 46	3.0	.70	1.00	1.0	1,500	N	N	N	50	1,000
NI017	44 25 17	113 3 51	5.0	.50	.30	>1.0	1,000	N	N	N	50	500
NI019	44 23 54	113 1 5	2.0	.30	.50	.5	2,000	<.5	N	N	50	700
SP001	44 21 2	112 59 4	1.0	.30	.50	.3	1,000	<.5	N	N	30	300

Samples collected in mining districts outside of the Eighteenmile GRA.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
GI001	44 27 6	113 17 0	2.0	7.00	7.00	.2	2,000	2.0	N	N	70	200
LE002	44 46 24	113 18 27	2.0	3.00	5.00	.7	700	3.0	N	N	100	700
LP001	44 58 23	113 28 45	2.0	.50	.50	.7	1,000	1.5	N	N	70	700
LP004	44 56 52	113 27 23	5.0	.50	.30	>1.0	700	N	N	N	200	500
SA001	45 4 32	113 51 39	3.0	.30	.50	.5	500	<.5	N	N	50	1,500
BM001	45 6 16	114 18 11	3.0	.50	1.00	.5	2,000	N	N	N	100	1,500
BM002	45 6 31	114 18 36	7.0	.50	.30	.5	300	<.5	3,000	N	500	700
PA001	44 31 35	113 41 58	3.0	.50	1.00	.5	>5,000	15.0	N	N	50	500

Appendix 3. Analytical data for sieved stream-sediments. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.(Continued)

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s	Sb-ppm s
ML001	2.0	N	N	10	50	10	100	N	30	20	N	N
ML002	1.5	N	N	10	150	15	50	N	<20	70	10	N
ML003	1.5	N	N	10	100	20	50	N	<20	70	30	N
ML004	1.0	N	N	7	100	10	50	N	N	50	10	N
ML005	1.5	N	N	N	70	15	20	N	N	20	10	N
ML006	2.0	N	N	20	200	30	70	15	<20	100	20	N
ML008	2.0	N	N	20	200	50	70	N	N	100	20	N
ML011	1.0	N	N	30	1,500	30	100	N	30	500	15	N
ML013	1.0	N	N	30	1,500	70	30	30	<20	500	70	N
ML014	1.5	N	N	50	3,000	70	100	N	50	500	10	N
ML015	1.0	N	N	50	1,500	70	100	N	50	700	10	N
ML016	1.0	N	N	50	2,000	50	20	10	20	500	10	N
ML017	1.5	N	N	20	700	70	70	N	20	200	15	N
ML018	1.0	N	N	50	1,500	50	70	N	30	500	20	N
ML019	3.0	N	N	10	150	20	20	5	N	100	30	N
ML020	1.0	N	N	5	100	20	N	N	N	30	20	N
ML021	1.0	N	N	5	100	10	N	N	N	50	10	N
ML022	1.5	N	N	10	150	15	30	N	N	30	20	N
NI001	5.0	N	N	5	50	7	100	N	100	15	10	N
NI002	1.5	N	N	30	700	30	70	7	30	200	20	N
NI003	3.0	N	N	5	50	10	150	N	50	20	20	N
NI004	3.0	N	N	N	20	<5	100	N	70	5	N	N
NI005	2.0	N	N	15	70	15	200	N	70	20	20	N
NI006	3.0	N	N	30	100	30	50	N	<20	50	10	N
NI007	3.0	N	N	5	30	20	70	N	50	15	30	N
NI008	3.0	N	N	N	20	10	150	N	50	10	10	N
NI009	2.0	N	N	5	50	10	70	N	50	10	20	N
NI010	5.0	N	N	20	70	50	150	N	30	30	30	N
NI012	2.0	N	N	20	50	20	50	30	20	30	10	N
NI013	3.0	N	N	10	50	20	100	N	50	20	10	N
NI016	2.0	N	N	20	70	20	200	N	20	20	10	N
NI017	2.0	N	N	20	70	20	100	7	50	15	20	N
NI019	1.5	N	N	15	50	30	70	N	20	20	70	N
SP001	2.0	N	N	N	50	20	30	N	<20	20	50	N
Samples collected in mining districts outside of the Eighteenmile GRA.												
GI001	1.0	N	N	10	100	20	20	N	N	20	500	N
LE002	1.5	N	N	10	50	20	50	N	20	20	700	N
LP001	2.0	N	N	10	50	1,000	30	N	<20	20	70	N
LP004	2.0	N	N	10	70	30	50	N	<20	20	10	N
SA001	2.0	N	N	10	50	1,000	50	N	N	20	15	N
BM001	2.0	N	N	30	70	70	100	N	N	20	30	N
BM002	1.0	700	N	>2,000	50	5,000	70	N	N	70	10	N
PA001	5.0	100	N	15	50	500	20	300	50	15	1,000	N

Appendix 3. Analytical data for sieved stream-sediments. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho. (Continued)

Sample	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s	U-ppm i
ML001	--	N	100	70	N	50	N	300	N	3.20
ML002	--	N	100	100	N	30	N	500	N	.60
ML003	--	N	200	100	N	30	200	500	N	1.20
ML004	--	N	N	100	N	30	N	500	N	1.80
ML005	--	N	N	70	N	20	N	70	N	1.50
ML006	--	N	100	200	N	30	<200	200	N	.90
ML008	--	N	200	200	N	50	N	150	N	1.30
ML011	--	N	200	200	N	30	N	200	N	.95
ML013	--	N	300	300	N	30	300	100	N	2.70
ML014	--	N	100	200	N	70	N	150	N	.70
ML015	--	N	100	300	N	50	N	150	N	.90
ML016	--	N	100	300	N	30	N	300	N	.70
ML017	--	N	100	150	N	30	N	100	N	1.40
ML018	--	N	100	200	N	30	N	100	N	1.40
ML019	--	N	200	200	N	30	200	200	N	1.50
ML020	--	N	N	70	N	20	N	300	N	.85
ML021	--	N	N	100	N	15	N	500	N	1.90
ML022	--	N	300	70	N	20	N	150	N	1.60
NI001	--	N	100	50	N	100	N	>1,000	N	16.00
NI002	--	N	200	200	N	30	N	200	N	3.50
NI003	--	N	100	50	N	70	N	>1,000	N	41.00
NI004	--	N	N	20	N	70	N	700	N	58.00
NI005	--	N	100	50	N	100	N	1,000	N	14.00
NI006	--	N	500	100	N	30	N	100	N	5.80
NI007	--	N	N	50	N	50	N	1,000	N	1.90
NI008	--	N	N	20	N	70	N	500	N	27.00
NI009	--	N	N	30	N	30	N	300	N	6.30
NI010	--	N	100	50	N	70	N	200	N	19.00
NI012	--	N	300	70	N	20	N	100	N	23.00
NI013	--	N	100	50	N	50	N	500	N	5.30
NI016	--	N	300	100	N	50	N	500	N	5.30
NI017	--	N	N	50	N	70	N	>1,000	N	11.00
NI019	--	N	100	50	N	20	300	700	N	1.60
SP001	--	N	N	70	N	15	N	100	N	.75
Samples collected in mining districts outside of the Eighteenmile GRA.										
GI001	--	N	N	50	N	10	N	70	N	.35
LE002	--	N	100	50	N	70	N	300	N	.65
LP001	--	N	100	70	N	30	N	500	N	6.20
LP004	--	N	100	70	N	50	N	>1,000	N	3.50
SA001	--	N	100	50	N	20	N	500	N	1.40
BM001	--	N	100	70	N	30	N	150	N	2.00
BM002	--	N	N	20	N	100	N	700	N	2.70
PA001	--	N	N	30	3,000	50	700	500	N	6.70

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
5S83	44 27 29	113 2 36	5.00	1.00	2.00	.500	700	N	N	N	50	1,000
14S83	44 30 51	113 3 18	10.00	5.00	1.50	>1.000	700	<.5	N	N	30	300
28S83	44 31 28	113 4 17	3.00	10.00	20.00	.100	2,000	N	N	N	10	70
29S83	44 30 53	113 4 45	1.00	10.00	15.00	.050	200	N	N	N	10	30
31S83	44 34 49	113 4 55	7.00	1.00	.50	.500	500	<.5	N	N	150	150
32S83	44 34 52	113 4 48	.30	.30	20.00	.010	200	N	N	N	N	N
33S83	44 34 50	113 4 47	N	.50	20.00	.005	100	N	N	N	N	N
35S83	44 34 40	113 5 10	3.00	.30	10.00	.200	1,500	<.5	N	N	70	50
40S83	44 33 43	113 7 24	N	.15	10.00	<.002	20	N	N	N	N	N
41S83	44 33 26	113 8 36	N	.20	15.00	<.002	20	N	N	N	N	N
47S83	44 34 49	113 6 10	.10	.10	15.00	.002	70	N	N	N	N	N
49S831	44 32 38	113 6 57	.20	10.00	15.00	.002	150	N	N	N	<10	N
49S832	44 32 38	113 6 57	<.05	.20	.30	.002	20	N	N	N	<10	30
50S831	44 32 53	113 6 49	2.00	>10.00	15.00	.070	700	<.5	N	N	10	200
50S832	44 32 53	113 6 49	1.00	.30	.20	.150	30	N	N	N	200	700
52S83	44 32 51	113 6 12	7.00	3.00	5.00	1.000	1,500	N	N	N	15	300
53S83	44 33 4	113 6 42	3.00	.20	5.00	1.000	500	2.0	N	N	15	200
55S83	44 33 18	113 6 8	10.00	7.00	5.00	>1.000	1,000	N	N	N	10	100
59S83	44 33 57	113 4 21	.05	.70	>20.00	.010	50	N	N	N	N	N
60S83	44 32 24	113 5 30	.07	.20	20.00	.010	200	N	N	N	10	N
63S83	44 33 14	113 3 30	.05	.20	20.00	.007	70	N	N	N	N	N
66S83	44 32 45	113 4 55	.10	.20	>20.00	.010	100	N	N	N	<10	N
68S83	44 32 0	113 5 24	.20	.50	20.00	.020	500	N	N	N	N	100
69S83	44 31 49	113 5 30	3.00	.50	7.00	.200	300	10.0	N	N	200	500
70S83	44 31 35	113 5 28	.20	.50	20.00	.050	700	N	N	N	N	50
71S83	44 31 32	113 5 30	1.00	10.00	15.00	.030	500	N	N	N	20	N
75S83	44 30 18	113 0 47	.50	.30	2.00	.150	200	2.0	N	N	150	500
82S83	44 34 30	113 3 30	.15	.70	>20.00	.015	100	N	N	N	<10	N
87S83	44 34 16	113 4 24	>20.00	1.50	1.00	.100	2,000	1.0	N	N	30	70
89S83	44 30 51	113 2 11	.70	.10	.70	.070	150	<.5	N	N	50	200
90S83	44 30 55	113 2 34	1.50	.50	.10	.200	100	N	N	N	100	70
91S83	44 36 0	113 5 17	.15	1.00	15.00	.070	100	N	N	N	50	20
92S83	44 35 55	113 5 37	N	.50	2.00	.030	70	N	N	N	10	30
93S83	44 35 47	113 6 17	<.05	<.02	1.00	.010	100	N	N	N	10	50
94S83	44 35 36	113 6 36	.70	.30	20.00	.050	200	N	N	N	15	<20
95S83	44 34 59	113 6 41	.15	.07	10.00	.100	150	N	N	N	50	150
97S83	44 34 38	113 7 49	<.05	.10	15.00	.007	50	N	N	N	10	20
99S83	44 36 18	113 6 56	.10	.20	15.00	.015	70	N	N	N	15	30
100S83	44 36 34	113 7 39	N	.50	15.00	<.002	30	N	N	N	N	N
101S83	44 35 54	113 8 15	.50	7.00	7.00	.150	150	<.5	N	N	70	70
102S83	44 35 44	113 8 39	<.05	.20	20.00	.005	70	N	N	N	N	N
103S83	44 35 39	113 8 46	N	.20	20.00	<.002	70	N	N	N	N	N
4S83	44 26 53	113 2 5	7.00	.07	.15	.100	700	N	N	N	500	150
ML003R	44 35 42	113 8 40	N	.10	15.00	.020	50	N	N	N	N	N
ML007R1	44 33 24	113 6 10	5.00	2.00	.50	>1.000	150	3.0	N	N	20	700
ML007R2	44 33 24	113 6 10	5.00	2.00	1.50	>1.000	150	5.0	N	N	20	700
ML007R3	44 33 24	113 6 10	7.00	5.00	.70	>1.000	300	1.0	N	N	15	300
ML007R4	44 33 24	113 6 10	1.00	3.00	10.00	.100	700	<.5	N	N	<10	70
ML007R5	44 33 24	113 6 10	N	<.02	10.00	<.002	N	N	N	N	N	<20

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.
(Continued)

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
5S83	2.0	N	N	20	70	20	100	N	<20	20	30
14S83	1.5	N	N	50	<10	100	100	N	20	20	10
28S83	<1.0	N	N	N	30	15	N	N	N	30	10
29S83	<1.0	N	N	N	20	5	N	10	N	10	30
31S83	5.0	N	N	30	100	20	100	N	N	100	10
32S83	N	N	N	N	10	7	N	N	N	10	N
33S83	N	N	N	N	15	N	N	N	N	5	N
35S83	<1.0	N	N	N	70	7	20	N	N	20	<10
40S83	<1.0	N	N	N	<10	N	N	N	N	7	N
41S83	N	N	N	N	<10	N	N	N	N	N	N
47S83	<1.0	N	N	N	<10	N	N	N	N	10	N
49S831	<1.0	N	N	N	<10	N	N	N	N	5	N
49S832	N	N	N	N	<10	N	N	N	N	N	N
50S831	<1.0	N	N	15	50	30	N	N	N	15	70
50S832	1.5	N	N	N	15	5	N	N	N	5	N
52S83	<1.0	N	N	50	500	100	50	<5	20	300	10
53S83	<1.0	N	N	20	500	30	50	N	20	200	N
55S83	<1.0	N	N	30	700	<5	100	N	30	300	10
59S83	N	N	N	N	20	N	N	N	N	5	N
60S83	N	N	N	N	30	<5	N	N	N	7	N
63S83	N	N	N	N	20	N	N	N	N	10	N
66S83	N	N	N	N	<10	<5	N	N	N	10	N
68S83	<1.0	N	N	N	50	5	N	N	N	7	N
69S83	3.0	N	N	5	700	70	150	10	N	150	N
70S83	N	N	N	N	70	<5	N	N	N	15	N
71S83	N	N	N	N	20	<5	N	N	N	5	50
75S83	1.0	N	N	7	150	50	30	N	N	70	N
82S83	<1.0	N	N	N	20	70	N	N	N	10	N
87S83	1.0	N	N	30	70	200	20	N	N	70	30
89S83	1.0	N	N	N	30	30	N	30	N	50	N
90S83	3.0	N	N	N	30	N	30	N	N	10	N
91S83	N	N	N	N	30	N	20	N	N	7	N
92S83	N	N	N	N	<10	N	20	N	N	5	N
93S83	N	N	N	N	<10	7	N	N	N	7	N
94S83	N	N	N	N	50	5	N	N	N	10	N
95S83	<1.0	N	N	N	30	<5	N	N	N	5	N
97S83	<1.0	N	N	N	50	N	N	N	N	N	N
99S83	<1.0	N	N	N	50	5	N	N	N	15	20
100S83	N	N	N	N	N	<5	N	N	N	N	N
101S83	<1.0	N	N	N	100	7	N	N	N	15	20
102S83	<1.0	N	N	N	10	N	N	N	N	N	N
103S83	N	N	N	N	<10	N	N	N	N	N	N
4S83	7.0	N	N	10	15	300	150	N	20	15	150
ML003R	N	N	N	N	N	<5	N	N	N	N	N
ML007R1	<1.0	N	N	30	1,500	70	N	30	50	1,000	10
ML007R2	<1.0	N	N	30	1,500	100	30	50	70	1,500	30
ML007R3	1.0	N	N	50	2,000	100	100	5	50	2,000	20
ML007R4	<1.0	N	N	5	100	20	N	N	N	50	N
ML007R5	N	N	N	N	N	N	N	N	N	5	N

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.
(Continued)

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
5S83	N	--	N	500	100	N	20	N	200	N
14S83	N	--	N	300	200	N	50	N	150	N
28S83	N	--	N	200	20	N	15	N	10	N
29S83	N	--	N	N	15	N	N	N	<10	N
31S83	N	--	N	200	150	N	70	N	100	N
32S83	N	--	N	300	50	N	N	N	N	N
33S83	N	--	N	500	10	N	N	N	N	N
35S83	N	--	N	200	30	N	20	N	150	N
40S83	N	--	N	100	10	N	N	N	N	N
41S83	N	--	N	100	10	N	N	N	N	N
47S83	N	--	N	500	15	N	10	N	N	N
49S831	N	--	N	N	10	N	N	N	N	N
49S832	N	--	N	N	<10	N	N	N	10	N
50S831	N	--	N	200	10	N	10	N	20	N
50S832	N	--	N	N	30	N	10	N	100	N
52S83	N	--	N	100	100	N	20	N	70	N
53S83	N	--	N	N	100	N	15	N	70	N
55S83	N	--	N	200	150	N	15	N	100	N
59S83	N	--	N	300	10	N	N	N	N	N
60S83	N	--	N	200	<10	N	10	N	<10	N
63S83	N	--	N	300	20	N	N	N	N	N
66S83	N	--	N	700	10	N	10	N	N	N
68S83	N	--	N	700	20	N	10	N	<10	N
69S83	N	--	N	500	300	N	100	500	50	N
70S83	N	--	N	200	10	N	10	N	N	N
71S83	N	--	N	100	10	N	10	N	10	N
75S83	N	--	N	100	100	N	30	N	50	N
82S83	N	--	N	1,000	<10	N	10	N	N	N
87S83	N	--	N	100	50	N	70	N	30	N
89S83	N	--	N	N	1,000	N	15	N	20	N
90S83	N	--	N	N	70	N	20	N	150	N
91S83	N	--	N	N	15	N	10	N	100	N
92S83	N	--	N	N	10	N	N	N	100	N
93S83	N	--	N	N	10	N	N	N	20	N
94S83	N	--	N	500	15	N	15	N	20	N
95S83	N	--	N	100	30	N	10	N	200	N
97S83	N	--	N	100	10	N	N	N	<10	N
99S83	N	--	N	N	10	N	10	N	10	N
100S83	N	--	N	100	<10	N	N	N	N	N
101S83	N	--	N	N	30	N	15	N	100	N
102S83	N	--	N	200	10	N	N	N	N	N
103S83	N	--	N	200	<10	N	N	N	N	N
4S83	N	--	N	N	150	N	30	500	150	N
ML003R	N	--	N	300	<10	N	10	N	N	N
ML007R1	N	--	N	N	300	N	20	N	70	N
ML007R2	N	--	N	100	300	N	30	N	100	N
ML007R3	N	--	N	100	300	N	30	N	70	N
ML007R4	N	--	N	500	50	N	10	N	N	N
ML007R5	N	--	N	2,000	<10	N	N	N	N	N

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.--continued
(Continued)

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
ML010R1	44 32 41	113 5 3	.70	1.00	10.00	.150	200	1.5	N	N	N	50
ML010R2	44 32 41	113 5 3	.50	.70	15.00	.030	500	N	N	N	N	N
ML012R1	44 31 57	113 5 0	.07	.02	.30	.100	10	<.5	N	N	20	200
ML012R2	44 31 57	113 5 0	.20	1.00	20.00	.030	100	N	N	N	10	100
ML012R3	44 31 57	113 5 0	5.00	.05	1.00	.050	50	.5	700	N	10	300
ML013R	44 32 18	113 6 39	1.00	.10	.70	.070	70	N	N	N	10	200
ML015R	44 30 21	113 2 33	.20	.05	<.05	.007	150	N	N	30	50	200
ML016R1	44 30 22	113 2 37	2.00	.05	.20	.070	2,000	.5	N	N	30	700
ML016R2	44 30 22	113 2 37	7.00	7.00	10.00	1.000	1,500	N	N	N	50	500
NI011R1	44 27 7	113 4 30	10.00	5.00	7.00	>1.000	2,000	N	N	N	10	700
NI011R2	44 27 7	113 4 30	.50	.50	>20.00	.050	500	N	N	N	N	100
NI012R1	44 27 30	113 4 10	3.00	.10	.10	.300	1,500	<.5	N	N	50	500
NI012R2	44 27 30	113 4 10	10.00	3.00	5.00	.700	1,000	N	N	N	30	2,000
NI014R1	44 28 37	113 4 37	10.00	2.00	3.00	1.000	700	<.5	N	N	50	3,000
NI014R2	44 28 37	113 4 37	7.00	1.50	5.00	.700	500	<.5	N	N	20	2,000
NI019R1	44 23 54	113 1 5	1.50	.07	<.05	1.000	70	N	N	N	20	500
NI019R2	44 23 54	113 1 5	N	<.02	N	.007	10	N	N	N	10	<20
SP001R	44 21 6	112 59 1	<.05	<.02	.10	.005	20	N	N	N	10	30
SP002R1	44 21 18	112 58 50	>20.00	.02	.05	.020	200	<.5	700	N	N	<20
SP002R2	44 21 18	112 58 50	>20.00	<.02	.05	.002	100	1.5	1,000	N	N	N
SP002R3	44 21 18	112 58 50	>20.00	.30	1.50	.100	150	3.0	N	N	50	100
SP002R4	44 21 18	112 58 50	1.00	10.00	10.00	.002	300	N	N	N	N	N
SP003R1	44 22 0	113 0 15	>20.00	1.50	5.00	.030	3,000	30.0	500	N	20	>5,000
SP003R2	44 22 3	113 0 12	1.00	10.00	15.00	.005	200	1.0	N	N	N	100
SP003R3	44 22 3	113 0 12	5.00	7.00	10.00	.002	>5,000	7.0	500	N	N	N
SP003R4	44 22 1	113 0 13	7.00	.03	.20	.010	1,000	30.0	700	N	<10	50
SP003R5	44 22 1	113 0 13	.50	2.00	20.00	.007	200	N	N	N	N	70
SP003R6	44 22 1	113 0 13	2.00	1.00	15.00	.150	300	10.0	N	N	150	100
SP003R7	44 22 1	113 0 13	7.00	5.00	5.00	.500	1,500	N	N	N	20	2,000

Samples collected in mining districts outside the Eighteenmile GRA

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
LE001R1	44 46 22	113 18 26	1.50	.02	.05	.100	15	20.0	N	N	10	100
LE001R2	44 46 22	113 18 26	20.00	.30	.07	.030	3,000	10.0	<200	N	30	300
LE001R3	44 46 22	113 18 26	20.00	.10	.05	.020	150	5.0	300	N	10	300
GI002R	44 26 56	113 17 10	3.00	.50	15.00	.050	>5,000	5.0	N	N	150	3,000
GI003R	44 27 28	113 17 13	20.00	.50	5.00	<.002	>5,000	10.0	500	N	10	5,000

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.--continued
(Continued)

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
ML010R1	<1.0	N	N	7	150	20	N	50	N	70	N
ML010R2	<1.0	N	N	N	150	<5	N	30	N	15	N
ML012R1	1.0	N	N	N	30	N	N	<5	N	5	N
ML012R2	N	N	N	N	30	5	N	N	N	10	N
ML012R3	1.5	N	N	5	30	50	30	30	N	300	N
ML013R	1.0	N	N	N	10	7	N	10	N	30	20
ML015R	<1.0	N	N	N	10	7	1,000	N	N	5	N
ML016R1	2.0	N	N	50	30	50	N	300	N	1,000	N
ML016R2	<1.0	N	N	30	1,500	50	30	5	<20	500	N
NI011R1	<1.0	N	N	50	100	50	20	N	N	200	10
NI011R2	1.0	N	N	5	20	<5	N	N	N	10	N
NI012R1	1.5	N	N	15	10	10	150	10	150	15	10
NI012R2	1.5	N	N	30	200	50	100	N	<20	100	30
NI014R1	1.5	N	N	30	150	30	150	N	<20	70	20
NI014R2	1.5	N	N	30	150	15	70	N	N	70	20
NI019R1	1.0	N	N	N	<10	30	200	N	70	10	30
NI019R2	<1.0	N	N	N	<10	N	N	N	N	5	N
SP001R	<1.0	N	N	N	<10	N	N	N	N	N	N
SP002R1	30.0	N	N	N	20	20	N	100	N	20	200
SP002R2	20.0	N	N	N	10	15	N	20	N	7	3,000
SP002R3	1.0	N	N	30	100	300	30	200	N	500	2,000
SP002R4	<1.0	N	N	N	N	7	N	N	N	5	100
SP003R1	<1.0	N	N	N	50	200	20	700	N	10	>20,000
SP003R2	N	N	N	N	50	5	N	10	N	10	7,000
SP003R3	1.0	N	>500	5	<10	10	N	7	N	20	10,000
SP003R4	<1.0	N	20	N	<10	200	N	20	N	5	>20,000
SP003R5	N	N	N	N	50	15	N	N	N	5	5,000
SP003R6	1.0	N	N	7	300	30	20	N	N	200	1,000
SP003R7	2.0	N	N	30	700	50	30	N	<20	100	700
Samples collected in mining districts outside the Eighteenmile GRA											
LE001R1	1.0	N	N	N	30	5	200	10	N	N	1,000
LE001R2	2.0	N	N	5	100	30	150	5	N	15	7,000
LE001R3	1.0	N	N	N	50	50	150	20	N	20	7,000
GI002R	1.0	N	N	N	20	15	N	5	N	20	5,000
GI003R	<1.0	N	<20	N	10	20	N	10	N	5	3,000

Appendix 4. Analytical data for rocks. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.--continued
(Continued)

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
ML010R1	N	--	N	2,000	70	N	N	N	<10	N
ML010R2	N	--	N	1,500	30	N	N	N	N	N
ML012R1	N	--	N	N	50	N	N	N	50	N
ML012R2	N	--	N	1,000	15	N	10	N	N	N
ML012R3	N	--	N	100	100	N	20	700	20	N
ML013R	N	--	N	N	50	N	10	N	20	N
ML015R	N	--	N	100	10	N	15	N	20	N
ML016R1	N	--	N	N	2,000	N	30	2,000	20	N
ML016R2	N	--	N	300	200	N	20	N	70	N
NI011R1	N	--	N	300	300	N	50	N	100	N
NI011R2	N	--	N	200	15	N	10	N	20	N
NI012R1	N	--	N	100	10	N	50	N	500	N
NI012R2	N	--	N	500	150	N	30	N	300	N
NI014R1	N	--	N	700	150	N	30	N	200	N
NI014R2	N	--	N	700	150	N	20	N	200	N
NI019R1	N	--	N	N	15	N	50	N	700	N
NI019R2	N	--	N	N	<10	N	N	N	30	N
SP001R	N	--	N	N	<10	N	N	N	<10	N
SP002R1	N	--	N	N	200	N	30	1,000	<10	N
SP002R2	N	--	N	N	10	N	N	<200	N	N
SP002R3	N	--	N	N	1,000	N	20	7,000	50	N
SP002R4	N	--	N	N	10	N	N	N	N	N
SP003R1	300	--	N	N	50	N	N	>10,000	20	N
SP003R2	N	--	N	N	<10	N	10	N	N	N
SP003R3	N	--	N	N	<10	N	N	>10,000	N	N
SP003R4	300	--	N	N	10	N	30	>10,000	N	N
SP003R5	N	--	N	N	<10	N	N	200	N	N
SP003R6	N	--	N	N	100	N	30	200	50	N
SP003R7	N	--	N	N	150	N	20	200	150	N
Samples collected in mining districts outside the Eighteenmile GRA										
LE001R1	N	--	N	N	10	N	N	N	50	N
LE001R2	N	--	N	N	30	N	20	<200	20	N
LE001R3	300	--	N	N	10	N	10	N	10	N
GI002R	N	--	N	N	50	N	20	300	30	N
GI003R	200	--	N	N	50	N	<10	5,000	N	N

Appendix 5. Analytical data for water. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.

Sample	Latitude	Longitude	Ca-ppm aa	K-ppm aa	Mg-ppm aa	Na-ppm aa	HCO3-ppm tit	Cl-ppm ic	F-ppm ic
ML001W	44 37 16	113 10 20	13.0	.9	4.7	1.6	56	.6	.09
ML008W	44 33 24	113 6 10	34.0	1.1	3.4	1.3	115	.6	.05
ML011W	44 32 16	113 5 3	35.0	.5	3.3	1.6	110	.5	.05
ML013W	44 32 18	113 6 39	45.0	.9	25.0	3.4	200	1.8	.10
ML015W	44 30 21	113 2 33	37.0	.6	6.6	2.4	150	.5	.08
ML019W	44 34 44	113 0 44	50.0	.5	11.0	1.3	140	.7	.40
ML021W	44 38 12	113 4 30	44.0	.4	13.0	2.0	210	.9	.10
NI001W	44 28 59	113 2 55	10.0	.3	2.0	2.2	38	.7	.40
NI002W	44 29 12	113 2 38	23.0	.3	8.3	1.6	100	.5	.30
NI003W	44 28 23	113 2 22	6.6	.2	1.1	1.6	24	.4	.20
NI004W	44 27 53	113 1 54	4.1	.3	.9	.9	13	.3	.10
NI005W	44 27 49	113 1 56	4.2	4.0	1.2	.8	13	.3	.09
NI007W	44 24 50	113 1 25	2.7	.2	.5	1.3	10	.4	.06
NI008W	44 25 40	113 2 45	3.7	4.0	1.0	1.2	17	.4	.09
NI009W	44 25 30	113 0 13	3.9	.6	.9	.5	13	.2	.05
NI012W	44 27 30	113 4 10	9.4	.6	2.4	2.5	43	.7	.50
NI013W	44 28 41	113 4 29	5.1	.7	1.2	2.0	24	.8	.10
NI015W	44 25 42	113 4 24	18.0	.7	4.7	4.1	84	2.8	.40
NI016W	44 26 21	113 3 46	9.7	.9	2.4	3.1	48	1.1	.09
NI017W	44 25 17	113 3 51	14.0	1.2	3.6	3.3	61	1.5	.10
NI018W	44 24 42	113 2 36	14.0	.9	4.0	3.8	76	1.4	.20
Samples collected in mining districts outside the Eighteenmile GRA									
LP004W	44 56 52	113 27 23	4.9	1.6	1.4	1.8	27	.6	.06
BM002W	45 6 31	114 18 36	17.0	3.7	4.3	2.6	<1	1.9	.20
PA001W	44 31 35	113 41 58	7.3	1.0	4.6	1.2	49	.4	.10

Appendix 5. Analytical data for water. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho. (Continued)

Sample	NO3-ppm ic	SO4-ppm ic	COND- S i	pH-units i	TEMP- C i	Cu-ppb aa	Mo-ppb aa	U-ppb i
ML001W	<.1	6.7	85	7.8	11.0	2.9	<1.0	.20
ML008W	<.1	5.9	170	7.5	6.0	<1.0	1.2	.90
ML011W	<.1	5.9	140	8.2	7.5	<1.0	<1.0	.60
ML013W	<.1	40.0	340	7.9	12.0	<1.0	37.0	5.80
ML015W	<.1	12.0	150	8.3	6.0	<1.0	1.6	.32
ML019W	<.1	4.5	240	6.2	7.5	<1.0	5.2	1.60
ML021W	<.1	16.0	240	8.4	8.0	<1.0	17.0	2.80
NI001W	<.1	4.5	65	7.8	10.5	<1.0	<1.0	.38
NI002W	<.1	7.7	140	7.7	11.5	<1.0	23.0	2.40
NI003W	<.1	1.1	40	7.6	10.5	<1.0	<1.0	.24
NI004W	.8	1.3	20	7.5	5.0	<1.0	<1.0	.16
NI005W	.6	2.9	25	7.2	7.5	<1.0	<1.0	.18
NI007W	<.1	1.2	18	7.4	6.0	<1.0	<1.0	.14
NI008W	<.1	1.6	24	7.3	6.0	<1.0	<1.0	.16
NI009W	.6	1.4	22	7.3	5.0	<1.0	<1.0	.12
NI012W	<.1	3.0	80	7.9	10.0	<1.0	<1.0	.20
NI013W	<.1	1.3	41	7.6	17.0	<1.0	<1.0	.18
NI015W	<.1	5.0	130	7.5	10.0	<1.0	<1.0	1.10
NI016W	<.1	3.2	85	7.8	16.0	<1.0	<1.0	.24
NI017W	<.1	6.2	110	8.0	21.0	<1.0	3.1	.76
NI018W	<.1	3.2	110	7.4	--	<1.0	<1.0	.80
Samples collected in mining districts outside the Eighteenmile GRA								
LP004W	<.1	1.3	38	7.9	8.5	<1.0	<1.0	.18
BM002W	<.1	97.0	110	6.6	13.5	<1.0	<1.0	.20
PA001W	<.1	4.2	70	7.5	10.0	<1.0	1.3	.40

Appendix 6. Analytical data for soils. Samples collected in the Eighteenmile GRA, Lemhi County, Idaho.

Sample	Latitude	Longitude	Fe-pct. s	Mg-pct. s	Ca-pct. s	Ti-pct. s	Mn-ppm s	Ag-ppm s	As-ppm s	Au-ppm s	B-ppm s	Ba-ppm s
ML009S1	44 32 39	113 6 0	3.0	1.5	1.0	1.0	1,000	2.0	N	N	50	500
ML009S2	44 32 39	113 6 0	5.0	3.0	2.0	1.0	1,000	.7	N	N	50	700
ML009S3	44 32 39	113 6 0	5.0	2.0	1.5	1.0	1,000	.7	N	N	30	700
ML009S4	44 32 39	113 6 0	7.0	3.0	1.5	>1.0	1,000	<.5	N	N	30	700
NI014S1	44 28 37	113 4 37	1.5	.2	.3	.5	500	N	N	N	50	300
NI014S2	44 28 37	113 4 37	2.0	.3	.5	.7	700	N	N	N	50	500
NI014S3	44 28 37	113 4 37	3.0	.3	.5	.7	500	N	N	N	50	700

Sample	Be-ppm s	Bi-ppm s	Cd-ppm s	Co-ppm s	Cr-ppm s	Cu-ppm s	La-ppm s	Mo-ppm s	Nb-ppm s	Ni-ppm s	Pb-ppm s
ML009S1	1.5	N	N	30	500	50	100	5	50	200	20
ML009S2	1.5	N	N	30	700	70	100	7	50	300	30
ML009S3	1.5	N	N	30	500	50	100	<5	<20	200	20
ML009S4	1.5	N	N	30	700	70	100	N	50	300	20
NI014S1	2.0	N	N	7	50	20	50	N	<20	20	20
NI014S2	3.0	N	N	10	70	20	70	N	<20	20	20
NI014S3	2.0	N	N	10	50	30	70	N	<20	30	20

Sample	Sb-ppm s	Sc-ppm s	Sn-ppm s	Sr-ppm s	V-ppm s	W-ppm s	Y-ppm s	Zn-ppm s	Zr-ppm s	Th-ppm s
ML009S1	N	--	N	200	150	N	30	N	100	N
ML009S2	N	--	N	200	200	N	50	N	100	N
ML009S3	N	--	N	200	150	N	30	N	100	N
ML009S4	N	--	N	200	150	N	30	N	100	N
NI014S1	N	--	N	200	50	N	30	N	150	N
NI014S2	N	--	N	200	70	N	30	N	150	N
NI014S3	N	--	N	200	70	N	30	N	200	N