

Geochemical Results of a Hydrothermally Altered Area at Baker Creek, Blaine County, Idaho

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Contents

Abstract	1
Introduction	1
Acknowledgments	2
Geologic Setting	2
Vegetation	3
Field Methods	3
Upland and Drainage Basin Surveys	3
Sample Media and Collection	3
Plants	3
Soils	4
Stream Sediments	4
Heavy Mineral Concentrates	4
Aquatic Mosses	5
Sample Preparation and Analysis	5
Geochemical Surveys	6
Geochemistry of the Upland	6
Soils	6
Douglas-Fir	6
Big Sagebrush	8
Elk Sedge	8
Summary	8
Geochemistry of the Drainage Basins	8
Stream Sediments	8
Nonmagnetic Heavy Mineral Concentrates	8
Weakly Magnetic Heavy Mineral Concentrates	10
Aquatic Mosses	10
Mineralogy of the Nonmagnetic Concentrates	10
Summary	10
Drill Hole Results	11
Regional Aeromagnetic Trends	12
Conclusions	12
Observations Concerning Sample Media and Techniques	12
Observations Concerning Potentially Mineralized Areas	12
References	14
Appendix	15

Figures

1. Map showing Baker Creek study area	2
2. Geologic map of Baker Creek study area	2
3. Photograph showing view from locality 1 in argillically altered zone	4

4-9. Maps showing:

4. Localities of soil and plant samples from upland geochemical survey.....	5
5. Localities of stream-sediment, heavy mineral concentrate, and aquatic moss samples from drainage basin survey	5
6. Patterns of anomalous elements, upland survey.....	7
7. Patterns of anomalous elements, drainage basin survey	9
8. Distribution of significant ore-related minerals identified in nonmagnetic heavy mineral concentrates, drainage basin survey	11
9. Relationship between aeromagnetic anomalies and alteration in Baker Creek study area and surrounding region	13

Metric Conversion Factors

Multiply	By	To obtain
Miles	1.609	Kilometers
Feet	0.3048	Meters
Inches	2.54	Centimeters
Tons	1.016	Metric tons
Short tons	0.907	Metric tons
Troy ounces	31.103	Grams
Ounces	28.35	Grams

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Abstract

The area immediately east of Baker Creek, Blaine County, Idaho, is underlain by a thick section of mafic to intermediate lava flows of the Eocene Challis Volcanic Group. Widespread propylitic alteration surrounds a zone of argillic alteration and an inner core of phyllic alteration. Silicified breccia is present along an east-trending fault within the zone of phyllic alteration.

As part of a reconnaissance geochemical survey, soils and plants were sampled. Several species of plants (Douglas-fir [*Pseudotsuga menziesii*], mountain big sagebrush [*Artemisia tridentata* ssp. *vaseyana*], and elk sedge [*Carex geyeri*]) were collected from 10 upland localities and stream sediments, panned concentrates, and aquatic mosses were collected from 16 drainage basin localities all of which were generally within the area of alteration.

Geochemical results yielded anomalous concentrations of molybdenum, zinc, silver, and lead in at least half of the seven different sample media and of gold, thallium, arsenic, antimony, manganese, boron, cadmium, bismuth, copper, and beryllium in from one to four of the various media. Part of this suite of elements—silver, gold, arsenic, antimony, thallium, and manganese—suggests that the mineralization in the area is epithermal. Barite and pyrite (commonly botryoidal-framboidal) are widespread throughout the area sampled. Visible gold and pyromorphite (a secondary lead mineral) were identified in only one small drainage basin, but high levels of gold were detected in aquatic mosses over a larger area.

Data from the upland and stream sampling indicate two possible mineralized areas. The first mineralized area was identified by a grab sample from an outcrop of quartz stockwork that contained 50 ppb Au, 1.5 ppm Ag, and 50 ppm Mo. Although the soil and plant species that were sampled in the area indicated mineralized bedrock, the Douglas-fir samples were the best indicators of the silver anomaly. The second possible mineralized area centers on the fault-controlled silicified breccia that is most likely the source of anomalous silver and molybdenum levels identified in the soils; silver, molybdenum, and manganese in stream sediments; thallium in Douglas-fir; bismuth and silver in

concentrates; and gold, silver, arsenic, antimony, and molybdenum and lead in aquatic mosses.

An interpretation of regional aeromagnetic data delineated the subsurface extent of shallow, steeply dipping magnetic sources inferred to be shallower parts of an Eocene batholith thought to underlie much of the Baker Creek area. The Eocene intrusive event(s) may have served as the heat source(s) that caused the hydrothermal alteration.

Examination of core from a 1,530-ft-deep (466 m) hole drilled in 1982 confirmed a bedrock source for the anomalous silver and base-metal suite at the quartz stockwork location, and indicated subeconomic levels of molybdenum.

Introduction

In this report, we summarize geochemical data from a reconnaissance geochemical survey of a hydrothermally altered area located just east of Baker Creek in Blaine County, Idaho, relate these data to the geology and structure, and present results from a 1,530-ft-deep (466 m) drill hole near one of two mineralized areas that we identified. The hole was drilled in 1982 by the Duval Corporation in an attempt to locate a possible porphyry molybdenum deposit.

This reconnaissance survey was conducted by Erdman, July 24–26, 1986, following a brief 1-day tour with D.H. McIntyre (U.S. Geological Survey). McIntyre had studied the volcanic rocks in the summer of 1985 and thought that local conditions were favorable for minable metallic mineral deposits. He suggested that biogeochemistry, more specifically, plant geochemistry, might be more suitable for study of the area than soil geochemistry because of the intense hydrothermal alteration in the area (Hall and McIntyre, 1986) and the possible occurrence of deeply leached soils.

The Baker Creek study area is in the Northern Rocky Mountains physiographic province. It encompasses about 12 mi² (~30 km²) in the northwestern corner of Blaine County and is approximately 10 mi (16 km) northwest of Ketchum (fig. 1). Access to the study area is provided by the unpaved Baker Creek road south of Idaho Highway 75 and by a logging road along the East Fork of Baker Creek.

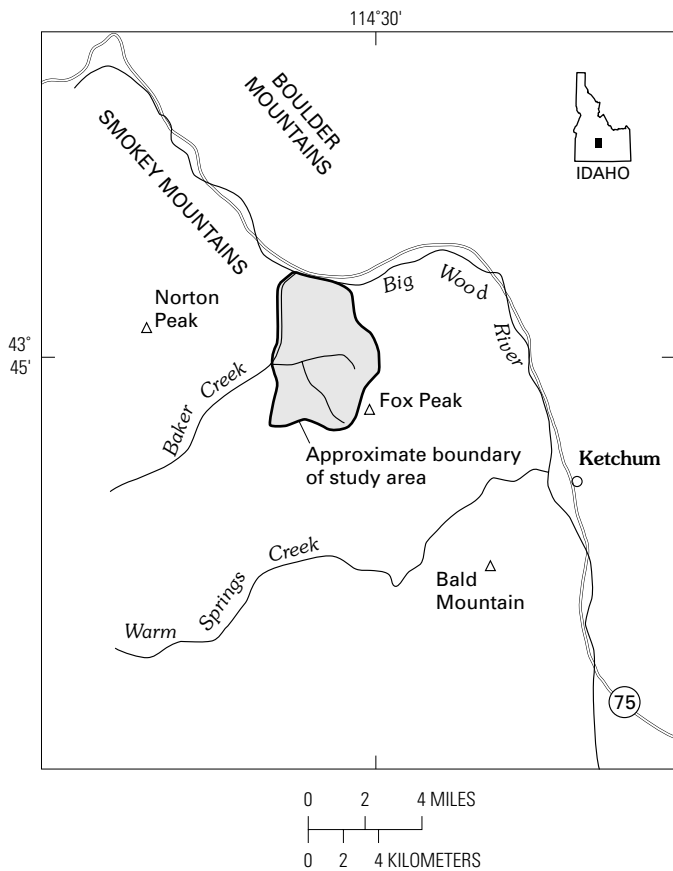


Figure 1. Map showing Baker Creek study area, Blaine County, Idaho.

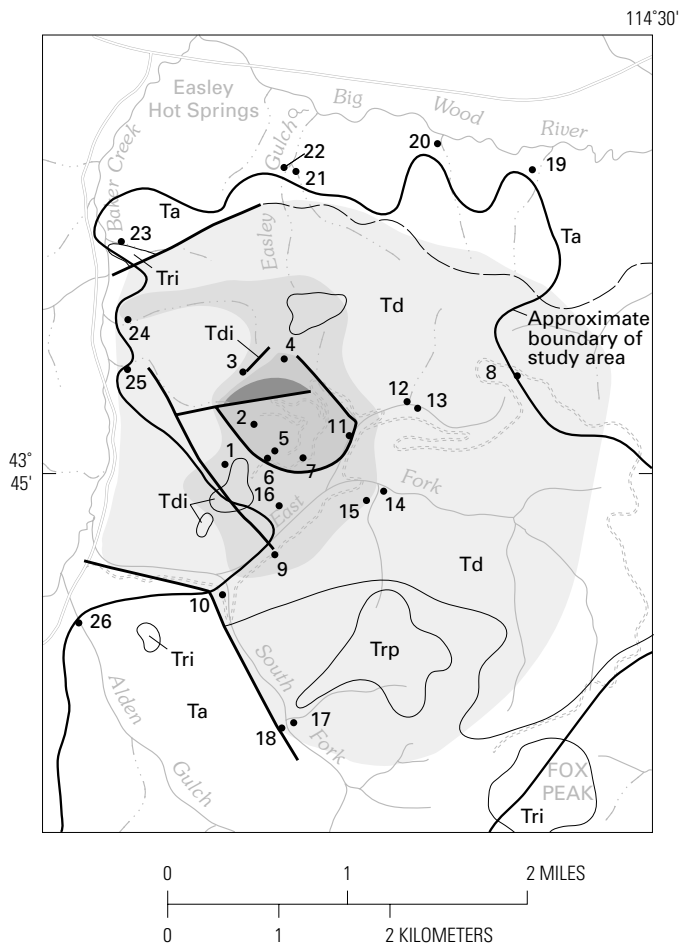


Figure 2. Geologic map of the Baker Creek study area, Idaho, showing sample localities.

Acknowledgments

We especially thank D.H. McIntyre for sharing his field observations and suggestions on the Baker Creek area. G.S. Plumlee shared his expertise on the role of botryoidal and frambooidal pyrite in low-temperature hydrothermal systems. Battle Mountain Exploration Company provided extensive geochemical data from an earlier study of the area. Chemical analyses were performed in the USGS laboratories by Betty Bailey, R.H. Hill, T.A. Roemer, and R.M. O'Leary. Molybdenum and thallium were determined in Douglas-fir samples on an acid digestion of the ash from 30-g aliquots of dry material using inductively coupled plasma emission spectroscopy by Geochemical Services, Inc., Sparks, Nev.

Geologic Setting

The Baker Creek area is underlain by a thick section of mafic to intermediate lava flows and tuff breccias of the Eocene Challis Volcanic Group. Andesitic to dacitic volcanic rocks crop out discontinuously (fig. 2), reflecting their original deposition on an irregular topographic surface. Volcanic rocks have been intruded by a number of small intrusions, ranging from dacite to alkali rhyolite in composition. These were emplaced at shallow levels; for example, the rhyolite at Fox Peak vented to the surface to form a pyroclastic carapace.





2 Geochemical Results of a Hydrothermally Altered Area at Baker Creek, Blaine County, Idaho

EXPLANATION

Tertiary lithologies

Trp	Rhyolite ash-flow tuff of Fox Peak
Tri	Porphyritic rhyolite intrusion
Tdi	Dacite porphyry intrusion
Td	Dacite lava
Ta	Andesite lava

Alteration

	Silicified breccia
	Phyllic alteration
	Argillic alteration
	Propylitic alteration

— Contact—Dashed where approximately located

— Fault

• 2 Sample locality and number

The basal andesite lava flows and tuff breccias range in composition from basic andesite containing clinopyroxene as the dominant phenocryst to silica-rich andesite that has a phenocryst assemblage of hornblende, plagioclase, and clinopyroxene. Dacite is dominantly of lava flow origin and typically is strongly porphyritic, containing as much as 30 percent phenocrysts of varied proportions of hornblende, biotite, and plagioclase; clinopyroxene may be present in minor amounts. Dacite also is present as small intrusive bodies that can be distinguished from lava flows only by contact relations. Rhyolite is present as two distinct compositional and genetic types. In a shallow flow-dome complex at Fox Peak, rhyolite is strongly porphyritic, containing as much as 40 percent phenocrysts of sanidine, quartz, plagioclase, biotite, and minor hornblende. Ages of 49.61 ± 19 Ma (biotite) and 48.3 ± 15 Ma (sanidine) were determined by $^{40}\text{Ar}/^{39}\text{Ar}$ dating. Other rhyolite intrusive rocks, such as the small plug east of Alden Gulch (fig. 2, unit Tri), are alkali rhyolite characterized by coarse, pink potassium feldspar in a fine-grained groundmass. A similar intrusion 2 mi (3.2 km) to the southeast yielded an $^{40}\text{Ar}/^{39}\text{Ar}$ age of 47.89 ± 0.14 Ma (sanidine).

Hydrothermal alteration has affected an area about 5 sq mi (13 sq km) in the study area. A well-developed concentric alteration zone comprises a broad marginal zone of propylitic alteration and a core zone of argillic, phyllic, and silicic alteration. Propylitic alteration has affected all volcanic rock types and is widespread and generally indistinguishable from deuteric alteration in the mafic and intermediate rocks. Argillic alteration has affected mainly dacite intrusive and volcanic rocks and is confined to an area in which there are several small dacite intrusive bodies (fig. 2). For this reason, we believe that alteration is closely related to emplacement of the dacite intrusions. Intense phyllic alteration is present in a central core defined by localities 2, 4, 5, 7, and 11 (fig. 2). Within this core there are variably developed quartz-stockwork and silicified zones, and the most intense stockwork zones are proximal to silicified breccia zones. Sulfide minerals are concentrated primarily in the phyllic zone and in silicified breccia and stockwork, although minor amounts of sulfide minerals are present in the weak argillic and propylitic zones. In the weak argillic and propylitic zones, pyrite is the only sulfide mineral and makes up less than 1 percent of the rock. In the phyllic zone and silicified breccia and stockwork, pyrite, molybdenite, chalcocopyrite, galena, and tetrahedrite are the principal sulfide minerals; pyrite is the most abundant.

Vegetation

The terrain in the study area is typically steep and ranges in elevation from about 6,600 ft (2,012 m) along the Big Wood River to 9,160 ft (2,790 m) at Fox Peak (fig. 1). Because of the high relief, the abundant perennial streams that drain the area have a high flow rate that tends to scour fine sediments from the active channels. Aquatic mosses, which were found to be responsive to mineralization in similarly steep terrain in the Idaho cobalt belt (Erdman and Modreski, 1984), are quite common and provide an alternative to sampling the missing fine sediments.

Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) dominates the forested parts of this landscape (fig. 3), but the open slopes are covered by mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana* [Rydberg] Beetle), a subspecies that is present throughout the upper foothill and mountain areas of much of the western interior of the United States. Elk sedge (*Carex geyerii* Boott.) is an herbaceous plant common to the area and is easily recognized.

Large blocks of slopes have been clear cut during logging operations; these areas support a vegetation rich in herbaceous and shrubby species and in young conifers.

Field Methods

Upland and Drainage Basin Surveys

One part of the study consisted of sampling soils, Douglas-fir, sagebrush, and sedge from 10 upland localities (fig. 4), mainly in the argillically and phyllically altered zones. Douglas-fir was selected for its unusual ability to concentrate arsenic (Warren and others, 1968) and gold (Erdman and others, 1985); sagebrush was chosen because of its demonstrated response to gold (Erdman and others, 1988) and base metals (Lovering and Heddal, 1983); and sedge was collected because of its ability to accumulate molybdenum (Erdman and others, 1985, p. 148). Gold, silver, and molybdenum are of particular interest because a rock sample from a stockwork-veined outcrop contains 50 ppb Au, 1.5 ppm Ag, and 50 ppm Mo.

The purpose of this upland sampling was to determine which of these three common and quite different plant species is most useful in detecting possible metallization in the underlying soils and bedrock and to ascertain how they compare with soils as a prospecting medium. As Dunn (1986) expressed so well, "The biogeochemical method has the advantage that it may give a more representative indication of [in Dunn's case] gold in the environment than a spot soil sample."

In a second part of the study, stream sediments, panned concentrates, and aquatic mosses were sampled from 16 drainage basin localities (fig. 5) generally in the identified alteration zones. Boyle (1979, p. 472) reported that it is often useful to sample moss where it abounds along stream courses, especially where spring flooding occurs, because moss tends to mechanically collect fine (skim) gold, which can be determined chemically in the ash. Shacklette (1984) and Smith (1986) detailed the advantages of using aquatic mosses in mineral exploration surveys.

Sample Media and Collection

Plants

At most of the 10 upland localities, plant samples were collected from two sites about 10 m apart because of high local chemical variability commonly encountered with plants. Cohen and others (1987, p. 66–68) gave the best accounting of this



Figure 3. View from locality 1, Baker Creek study area, Idaho, in the argillically altered zone showing highly altered dacites in foreground and mosaic of Douglas-fir forest and sagebrush-dominated clearings. Heavy mineral concentrates at the mouth of the drainage in the immediate foreground contained visible gold and the lead phosphate mineral pyromorphite. Location of locality 1 is shown in figure 2.

problem in a biogeochemical study at the Hemlo gold deposit. In the present study, the outermost 15 cm (5.9 in.) of branches from a single Douglas-fir tree were sampled at each site for all localities except locality 6 for a total of 17 samples, and the twigs and needles were placed in cloth sample bags. Fifteen samples of sagebrush collected at all localities, except localities 6 and 9, consisted of new growth, including the inflorescence, composited from several adjacent shrubs. The above-ground portion of several clumps of sedge at all localities was combined into a composite sample for a total of 18 samples. Only a single set of samples was collected at locality 5, a small stand of Douglas-fir at the base of a silicified outcrop. Sedge was sampled at locality 6, a site encrusted with manganese and iron oxides at a small spring.

Soils

Soil samples were collected from shallow pits at all upland localities except locality 6. The 18 samples were taken from a depth just below 2 in. (5 cm), sieved to a minus 10-mesh (<2 mm) fraction, and composited. This fraction was later sieved into two size fractions, <30 to >80 mesh (<0.6 mm to >0.17 mm) and <80 mesh.

4 Geochemical Results of a Hydrothermally Altered Area at Baker Creek, Blaine County, Idaho

Stream Sediments

Stream-sediment samples were analyzed to determine the chemistry of rock material eroded from the drainage basin upstream from selected sample localities. This information is useful in identifying basins that contain concentrations of elements that may be related to mineral deposits. The 16 stream-sediment samples consisted of active alluvium collected, with few exceptions, from the mouths of unbranched streams. Each sample was composited from several sites at the locality plotted on figure 2.

Heavy Mineral Concentrates

Heavy mineral concentrate samples were collected from the same active alluvium as the stream-sediment samples. The nonmagnetic fraction of a concentrate sample is useful in detecting mineralized areas because primary and secondary ore minerals are commonly in this fraction. This is particularly true for uncommon minerals such as gold and cinnabar (mercury sulfide). The concentrations of ore and ore-related minerals in

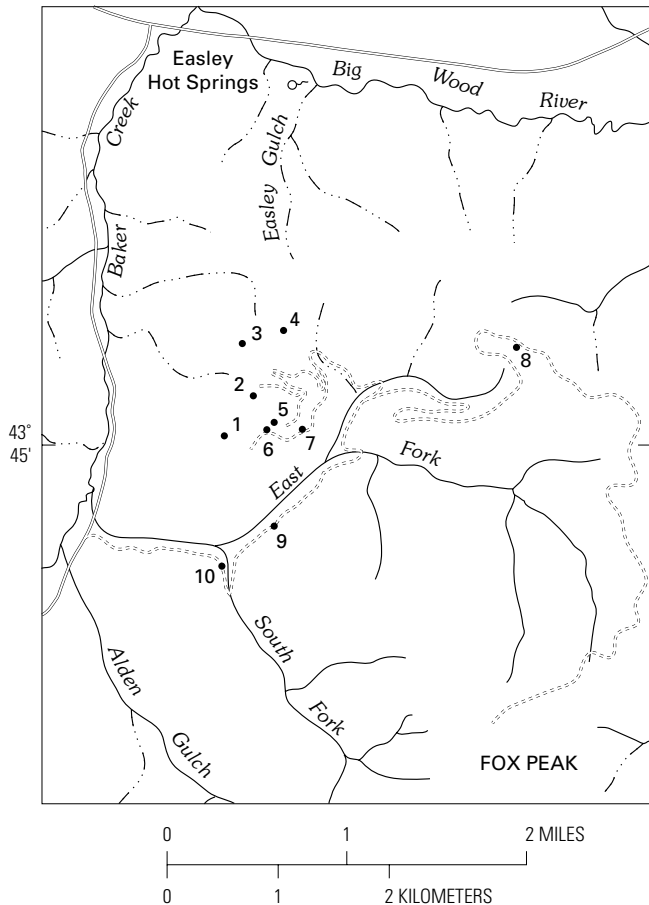


Figure 4. Soil and plant sample localities, Baker Creek study area, Idaho.

these concentrate samples facilitate determination of elements not easily detected in bulk stream sediments. The contrast in metal content between geochemical anomalies and normal background is greatly expanded so that anomalies that are fairly subtle in stream sediments are easily recognized in the concentrate fraction. Each of the 16 bulk sediment samples was screened with a 10-mesh sieve to remove the coarse material. The <10-mesh fraction was panned in the field until most of the quartz, feldspar, clay, and organic matter were removed. This panned concentrate was then placed in paper bags for further processing in the laboratory.

Aquatic Mosses

Aquatic mosses are an ideal alternative sampling medium where steep terrain and the attendant high flow rate of streams make it difficult to obtain adequate sediment samples. Heavy rain and sleet at the time of collecting made sampling the stream sediments very difficult, but mosses were generally abundant and easily collected. No attempt was made to identify the moss species because previous studies indicate that element contents

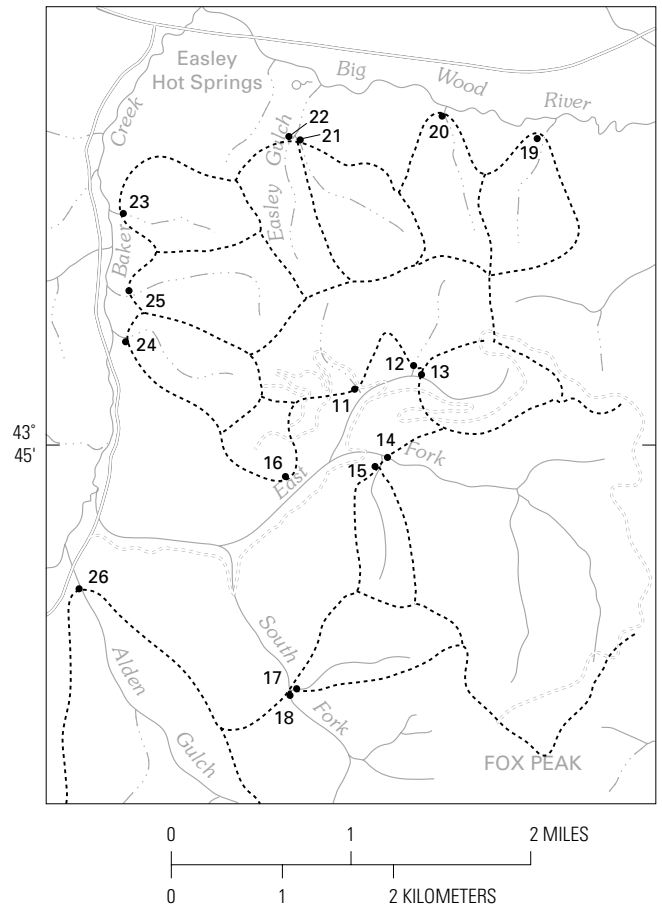


Figure 5. Stream-sediment, heavy mineral concentrate, and aquatic moss sample localities, Baker Creek study area, Idaho. Dashed lines indicate approximate limits of drainage basins associated with sample localities.

between different species collected at the same site differ little (Shacklette and Erdman, 1982, p. 235; Erdman and Modreski, 1984, p. 75; Smith, 1986, p. 345). The 16 samples were rinsed of silt as thoroughly as possible in the stream water, squeezed to remove most of the water, and placed in sealed plastic bags.

Sample Preparation and Analysis

The plant samples were washed, oven dried at 40°C, pulverized in a mill to pass a 2-mm screen, and then ashed in an electric muffle furnace at 450°C. The heating and cooling cycle was 24 hours.

Gold determinations were made on 500 mg samples of ash (250 mg samples of moss) by a modified graphite-furnace atomic absorption method of Meier (1980), as detailed in Erdman and others (1988). Nine ore-related elements—Ag, As, Bi, Cu, Cd, Mo, Pb, Sb, and Zn—were determined in 250 mg aliquots for Douglas-fir, sedge, and moss (500 mg aliquots for sagebrush) by flame atomic absorption spectrophotometry (O'Leary and Viets, 1986). Bismuth and antimony were not detected in any of the plant samples at a lower limit of

determination of 4 and 8 ppm, respectively (2 and 4 ppm for sagebrush), and so are not listed in the tables of analytical results given in the appendix tables.

The soil and stream-sediment samples were air dried, then sieved using 30- and 80-mesh stainless-steel sieves. The portion of the sediment passing through the sieves was saved for analysis; two size fractions, <30- to >80-mesh and <80-mesh, of the soils were analyzed, whereas only the finer fraction of the sediments was retained for analysis.

Samples that had been panned in the field were air dried and sieved to <35 mesh; the light minerals remaining in the <35-mesh fraction were removed by heavy liquid flotation (bromoform, specific gravity 2.85). The heavy mineral concentrate samples were then separated into magnetic, weakly (para-) magnetic, and nonmagnetic fractions by placing the sample in contact with the face of a large electromagnet (in this case a modified Frantz Isodynamic Separator). The most magnetic material (removed at a setting of 0.25 amperes), primarily magnetite, was not analyzed. The second fraction (removed at a setting of 1.75 amperes), mostly ferromagnesian silicate minerals and iron and manganese oxide minerals, was saved for analysis, because this paramagnetic fraction might contain limonite and manganese oxide minerals which in turn might contain high trace-metal values related to mineral deposits. The third fraction (the nonmagnetic material, which might include nonmagnetic ore minerals) was split using a Jones splitter. These magnetic separates are the same separates that would be produced by using a Frantz Isodynamic Separator set at a slope of 15° and a tilt of 10° with a current of 0.2 amperes to remove the magnetite and ilmenite and a current of 0.6 amperes to split the remainder of the sample into paramagnetic and nonmagnetic fractions.

The nonmagnetic fractions were examined visually at low magnification (10-30×) to identify the minerals present. Nonmagnetic and weakly magnetic fractions were pulverized for chemical analysis, and the magnetic fraction was archived.

As with the heavy mineral concentrates, the soil and stream-sediment samples were first pulverized to approximately 200 mesh (75 μ) before being analyzed for 31 elements using semiquantitative, direct-current-arc emission spectroscopy. The analyses of heavy mineral concentrate samples were performed using the method of Grimes and Marranzino (1968). Gold analyses were conducted by graphite furnace atomic absorption spectrophotometry on 10 g aliquots of soil samples only.

Geochemical Surveys

Figures 6–8 show the *patterns* of elements whose concentrations in various sample media were anomalous based on visual inspection of the data and experience, not the *concentrations* themselves. Analytical results for these samples are given in appendix tables 1–7. The concentrations given in the text that refer to plant samples are expressed on an ash basis.

Geochemistry of the Upland

Soils

Only the soils from localities in the zones of phyllic and argillic alteration contain anomalous levels of silver, molybdenum, lead, and zinc (figs. 2, 6A; appendix table 1). Some of the soil samples contain detectable gold at background levels of 2 ppb, but the distribution of these samples is widely scattered and forms no pattern that corresponds to the mineralized areas identified using other evidence.

The molybdenum, lead, and zinc element suite at locality 7 reflects the molybdenum-silver-gold anomaly in the nearby stockwork-veined outcrop sampled by D. L. McIntyre in the summer of 1985. Both the coarse and fine fractions of the soil from locality 7 contain the highest concentrations of molybdenum, lead, and zinc (15, 150, and 200 ppm, respectively; appendix table 1).

In contrast to the above base-metal suite, silver was detected only in soils from localities 3 and 4, just north of the east-trending fault and associated silicified breccia (fig. 2). Silver values range from 1 to 2 ppm in both coarse and fine fractions. The two fractions from locality 4 also contain 7 and 10 ppm Mo, respectively.

Douglas-Fir

Analytical results for Douglas-fir samples (appendix table 2) generally reveal anomalies (fig. 6B) that are subtle; concentrations are about twice background. Such subtle anomalies were also observed with the other two plant species. Results for silver, arsenic, and thallium are exceptions, however.

Concentrations of silver in Douglas-fir from the two sites at locality 7 are 3.2 and 3.8 ppm, well above the concentrations of ~0.2 ppm at most other localities. Samples of both trees from locality 7 also contain anomalous levels of zinc, as compared to background levels of ~400 ppm, and of molybdenum, as compared to <1 ppm elsewhere. Only one sample of Douglas-fir from locality 7 yielded an anomalous concentration of cadmium, 5.6 ppm as compared to ~2 ppm in other samples.

Arsenic (160–400 ppm) was detected in the four samples of Douglas-fir from localities 9 and 10 (fig. 6B) where the bedrock contains fresh disseminated pyrite. Arsenic levels in Douglas-fir samples from the other localities are less than the 40 ppm limit of determination.

Although the only strong multielement anomaly detected in Douglas-fir is at locality 7, high thallium concentrations in samples from both sites at locality 2 present a curious anomaly that is supported by other evidence, including proximity to the silicified breccias (fig. 2). Concentrations of 1.8 and 2.1 ppm Tl from the Douglas-fir at locality 2 are anomalous as compared to most other samples in which thallium was detected in only trace amounts (appendix table 2). Boyle (1979, p. 132) reported that,

Thallium is a trace constituent of most gold deposits containing sulphides and sulphosalts * * * It should also be mentioned that thallium shows a marked coherence

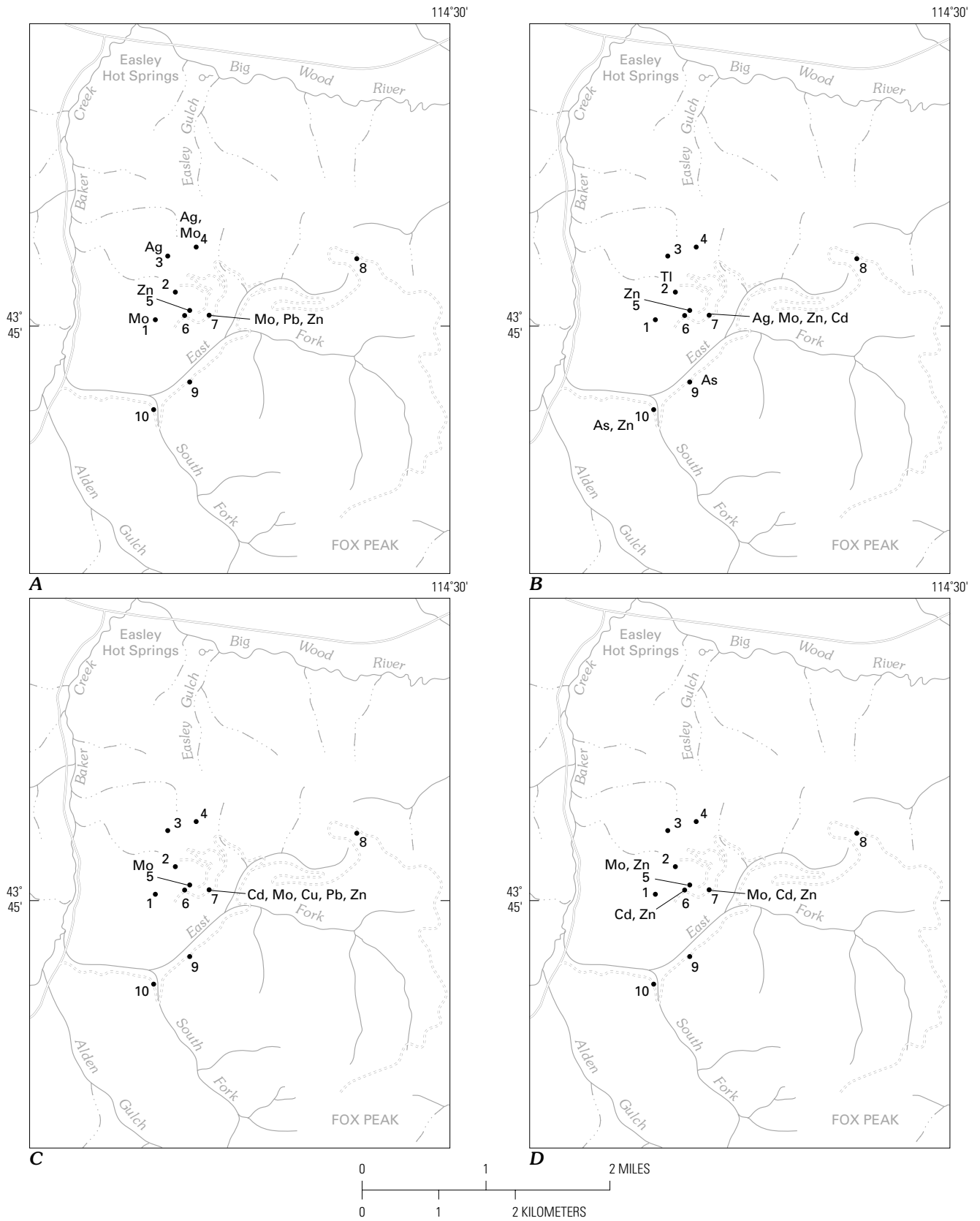


Figure 6. Patterns of anomalous elements, Baker Creek study area, Idaho. *A*, Soils. No sample collected at locality 6. *B*, Douglas-fir. No sample collected at locality 6. *C*, Sagebrush. No samples collected at localities 6 and 9. *D*, Sedge.

with silver and lead * * * Thallium tends to be concentrated in medium and low temperature deposits * * * and is enriched in some present day gold-bearing precipitates from hot springs.

Warren and Horsky (1986) described the role of thallium in plants as a pathfinder for gold. According to Boyle (1979), thallium is highly mobile under both acidic and alkaline conditions and therefore is easily dispersed into the water regime. Such mobility might account for the strong anomaly in Douglas-fir.

A rock-chip sample of outcrop from locality 2 contains 6 ppm W; it is one of the few rock samples collected by Duval Corporation in 1980 (unpublished data) that contained anomalous tungsten. The sample also contained 3.5 ppm Ag.

Big Sagebrush

Only samples of sagebrush from localities 5 and 7 are anomalous (fig. 6C). Molybdenum levels in the three samples from both localities range from 20 to 72 ppm and are considerably higher than levels of 4–12 ppm in sagebrush samples from the other localities (appendix table 3). Locality 7 is again the focal point and has a strong base-metal signature of cadmium-molybdenum-copper-lead-zinc. Sagebrush from the two sites at this locality contains 26 and 40 ppm Cd, far above the levels of 0.4–5.0 obtained elsewhere. This represents an anomaly to background contrast of about 10.

Marked cadmium anomalies in plants from mineralized environments where cadmium is enriched should be expected. Unlike most other elements, cadmium is readily taken up in proportion to its concentration in the soil solution (Kabata-Pendias and Pendias, 1984). A similarly strong contrast was found in sagebrush associated with an active hot-springs system in Nevada where peak levels approached those found at Baker Creek (Erdman and others, 1988). The same two sagebrush samples from locality 7 contain the only detectable lead (10 and 20 ppm) and about twice background concentrations of copper and zinc (appendix table 3).

Elk Sedge

The anomaly pattern for the sedge samples (fig. 6D) mirrors that of sagebrush and, to some degree, that of Douglas-fir. The molybdenum values of 24–56 ppm at localities 5 and 7 are strong outliers as compared to molybdenum concentrations of generally 8–12 ppm in the other samples (appendix table 4). The anomaly to background contrast of 2 to 1 for cadmium is considerably less than that for sagebrush; concentrations in sedge samples from localities 6 and 7 range from 5.2 to 7.6, and are clearly higher than the range of 0.8–3.2 in samples from the other localities. Anomalous zinc levels range from 880 ppm at locality 5 to >2,000 ppm in the sedge from the mineralized seep at locality 6; background concentrations in sedge are ~200–400 ppm.

Summary

The results from the upland survey identify locality 7 as indicating potential for base-metal mineralization, with some potential for silver. The silver-molybdenum anomalies in the soils from localities 3 and 4 (and the thallium anomaly in Douglas-fir from locality 2) reveal another possible precious-metal mineralized area: the silicified breccia about 0.5 km to the north.

Results of the admittedly limited soil geochemistry tentatively define two areas with potential for mineralization that differ geochemically and, perhaps, structurally.

Geochemistry of the Drainage Basins

Stream Sediments

Stream-sediment samples in 5 of the 16 drainage basins sampled—localities 11, 15, 16, 24, and 25—have anomalous metal values (fig. 7A, appendix table 5). The only convincing silver anomaly, 1.5 ppm, is from sample locality 11, whose west fork drains the east-trending fault and associated silicified breccia (fig. 2). This sediment sample also contains the highest manganese and molybdenum concentrations, >5,000 and 10 ppm, respectively. Other molybdenum anomalies (7 ppm) were detected in samples from basin localities 24 and 25, whose sediments are derived, in part, from the western end of the same fault.

At the East Fork of Baker Creek (fig. 7A), the sediment sample from locality 16 yielded the only clear lead anomaly (150 ppm), the highest concentration of zinc (700 ppm), and 2,000 ppm Mn. This sample reflects the anomalies associated with upland localities 5, 6, and 7, described earlier. The sediment from locality 15 also contains anomalous levels of manganese and zinc, >5,000 and 200 ppm, respectively; the close proximity of this locality to locality 16 suggests a broad mineralized system having similar characteristics.

Nonmagnetic Heavy Mineral Concentrates

The nonmagnetic fraction of the concentrates from 7 of the 16 drainages sampled have anomalous metal values (fig. 7B). The lead and copper anomalies from localities 21 and 22 are unsupported by results from other sample media and therefore most likely reflect metal contamination from nearby cabins. The bismuth anomalies at localities 11, 24, and 25, however, coincide with the molybdenum anomalies in the stream sediments and strongly suggest that bismuth is enriched in the east-trending fault or its associated breccia. Bismuth concentrations range from 70 ppm at locality 11 to 1,000 ppm at locality 25 (appendix table 6).

Although bismuth commonly indicates high-temperature mineralization, it can be associated with arsenic and antimony in low-temperature hydrothermal conditions (G.S. Plumlee, oral commun., 1990). For example, in a reconnaissance-scale geochemical survey of geothermal fields, Zhu and others (1989)

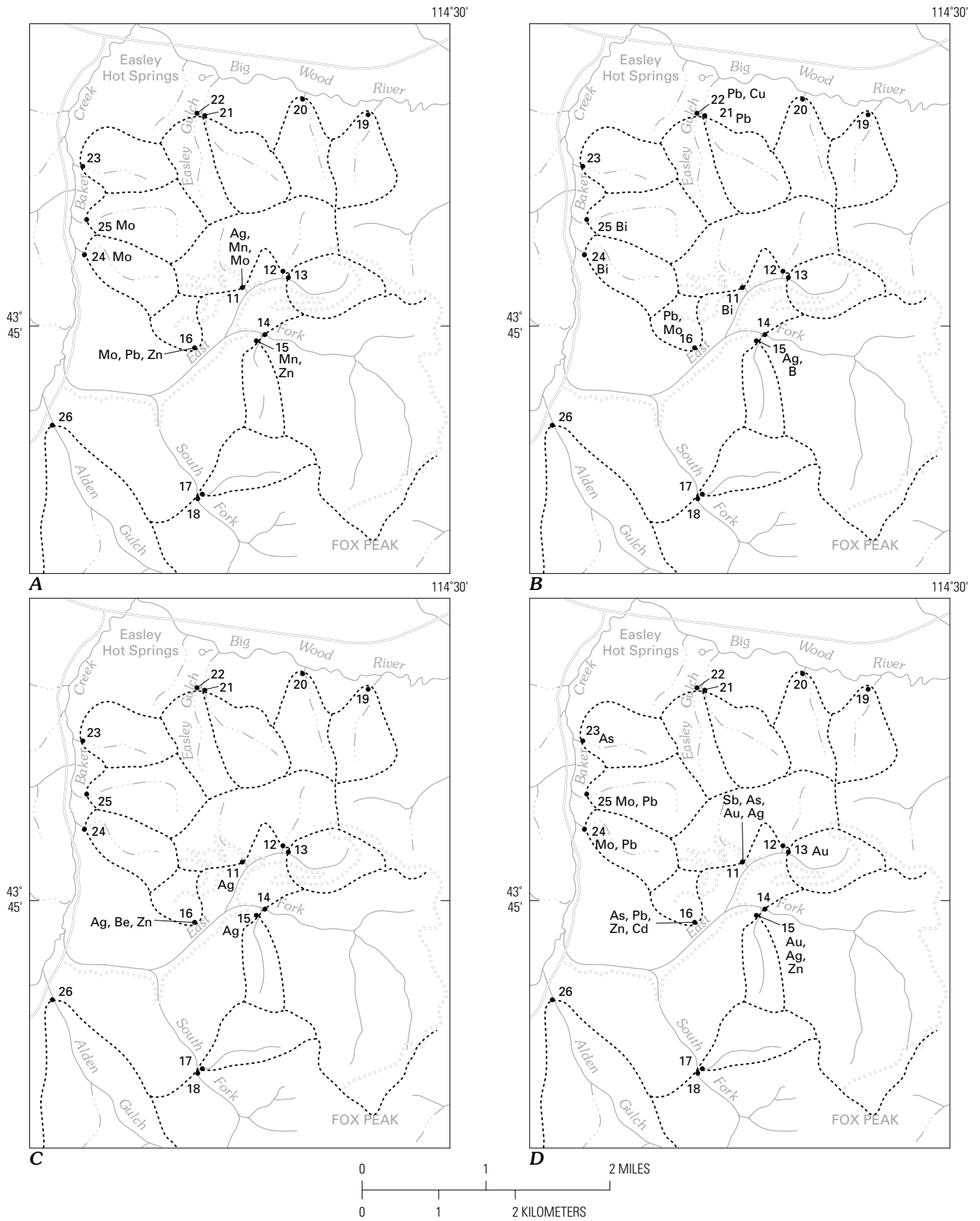


Figure 7. Anomalous elements detected in drainage basins in Baker Creek study area, Idaho. *A*, Stream sediments. *B*, Nonmagnetic heavy mineral concentrates. *C*, Weakly magnetic heavy mineral concentrates. *D*, Aquatic mosses.

found that higher bismuth concentrations in soils tend to coincide with near-surface thermal waters from drill holes in the geothermal fields.

The concentrate from locality 16 contains extremely anomalous amounts of molybdenum and lead: 70 ppm Mo, as compared to <10 ppm in the other 16 samples, and 3,000 ppm Pb, as compared to normal concentrations of <20 to 50 at all other localities except 21 and 22. Also, as shown on figure 7A, the sediment from this locality 16 contains anomalous amounts of zinc.

The concentrate from nearby locality 15 contains anomalous amounts of silver and boron. The sample contains 2 ppm Ag and 500 ppm B, as compared to <1 ppm Ag and <20 to 50 ppm B in the concentrates from the other 15 localities.

Barium levels in most of the samples exceed the 10,000 ppm upper limit of determination (appendix table 6). Such levels are significant in that they indicate the presence of barite. In this terrace, the only source of barite is hydrothermal.

Weakly Magnetic Heavy Mineral Concentrates

We found metal anomalies in this weakly magnetic fraction of concentrates from only localities 11, 15, and 16 (fig. 7C). Concentrations of silver are anomalous at all three localities and range from 1 ppm at localities 15 and 16 to 2 ppm at locality 11; silver is below the 1 ppm limit of determination in all other samples. The beryllium content of concentrate from locality 16 is 15 ppm, well above the <2–5 ppm levels in the other samples. The zinc concentration in this sample is 1,000 ppm.

Aquatic Mosses

The analytical results for the moss samples are given in appendix table 7. The anomalous patterns (fig. 7D) to some extent mirror those for the stream sediments. The following anomalies were observed in both media: molybdenum at localities 24 and 25, lead and zinc at locality 16; silver at locality 11, and zinc at locality 15.

Analytical methods used for sediment samples will not detect low-level gold, arsenic, and antimony, so a comparison of the relative merits of the two media is somewhat biased. However, the antimony-gold-silver-arsenic anomaly in the moss at locality 11 is far more significant than the anomalies in the stream sediments and two fractions of concentrates shown in figure 7A–C. Antimony was detected in only this sample, and the 72 ppm value far exceeds the 8 ppm limit of determination. The silver value of 3.2 ppm is the second highest observed, well above the <0.2 ppm levels found in most other samples. The gold value of 64 ppb matches that of the sample from locality 15 and far exceeds the gold concentrations in most of the other samples (appendix table 7). Arsenic, antimony, and silver are low-temperature “mobile” elements that are commonly characteristic of late stages or fringes of epithermal systems (Plumlee and Rye, 1989). Although samples having gold values of 48 ppb or higher are fairly widespread, the gold concentrations at localities 11 and 15 are high enough to warrant closer study of those localities.

Anomalous metallic elements in the moss sample from locality 15 include gold, the highest concentration of silver (5.2 ppm), and 1,500 ppm Zn. Finally, anomalous metallic elements in the moss sample from locality 16 suggest base-metal potential: 160 ppm Pb, >2,000 ppm Zn, 20 ppm Cd, and detectible arsenic. The cadmium anomaly in the moss sample from locality 16 (as shown in appendix table 7) may relate to the occurrence of pyromorphite in the nonmagnetic concentrate (described below) from locality 16. Boyle (1979, p. 126) observed:

“Where supergene * * * lead minerals such as * * * pyromorphite are present cadmium may be significantly enriched.”

Analytical results for the aquatic moss samples complement those of the concentrates and may be more informative than results for the stream sediments. In retrospect, we probably could have combined the advantages of both sediments and mosses by simply using the fines entrapped by the moss, as has been suggested by Smith (1976) and Boyle (1979). In his work with aquatic bryophytes (mostly mosses), Smith (1986) analyzed the plants but maintained that rigorous cleaning actually detracts from this plant’s effectiveness as a sample medium.

Mineralogy of the Nonmagnetic Concentrates

Barite and pyrite are the most common and widespread of the ore-related minerals identified in the nonmagnetic heavy mineral concentrates. Because barite was identified in samples from all 16 drainage basin localities, its distribution is not shown in figure 8. Barite was either dominant or abundant at all localities except 15 and 19. Botryoidal-framboidal pyrite was identified in 8 of the 12 samples in which pyrite was identified. The source of framboidal pyrite is commonly metalliferous black shale. Although such black shale is common east of the study area (Hall and others, 1978; Hall, 1985), it does not crop out in any of the basins drained by Baker Creek and therefore most likely is not the source of the pyrite at Baker Creek. The botryoidal-framboidal pyrite in the concentrates at Baker Creek may have formed under low-temperature hot-springs conditions. Because low-temperature pyrite can break down relatively rapidly in the weathering environment, it must be continuously eroding from exposed hydrothermally altered outcrops. Both botryoidal pyrite and barite tend to be present in the late, waning stages or low-temperature (<200°C) fringes of hydrothermal systems (Plumlee and Rye, 1989).

Visible gold and pyromorphite were identified in the nonmagnetic concentrate only from locality 16 (fig. 8). A single, extremely small flake of gold in this sample is the only visible gold observed in the study. Pyromorphite is a typical secondary mineral in the oxidized zone of lead deposits. The presence of these ore-related minerals requires that the bedrock source be exposed in the watershed above locality 16.

Summary

Results of the drainage basin survey, like those of the upland survey, provide evidence of two areas with potential for

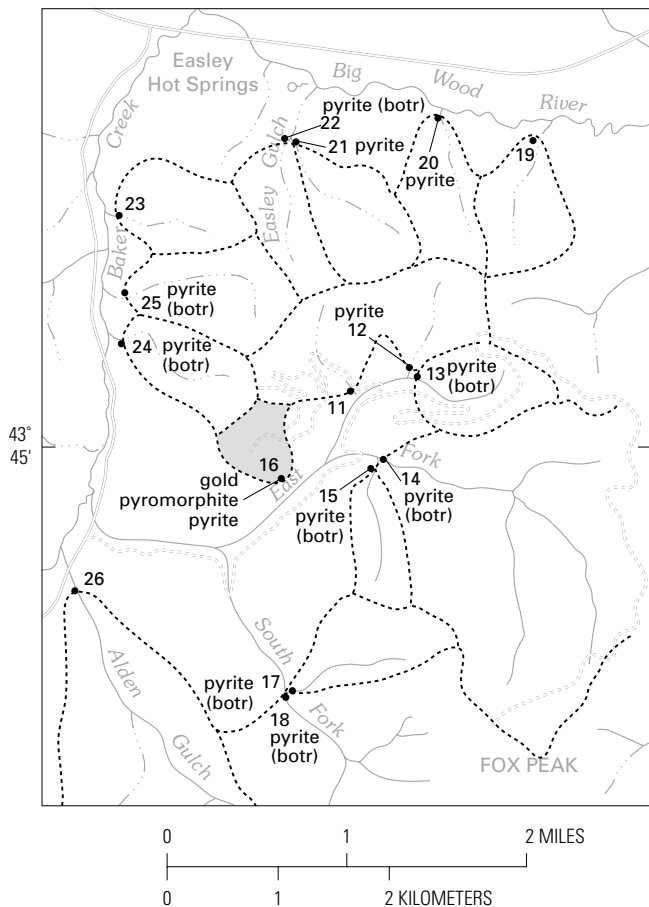


Figure 8. Distribution of significant ore-related minerals identified in nonmagnetic heavy mineral concentrates, Baker Creek study area, Idaho. Dashed lines indicate drainage basins associated with sample localities. Screened pattern indicates drainage basin associated with sample containing visible gold. Pyrite (botr), botryoidal-framboidal pyrite.

as-yet unrecognized mineralization. One area centers on locality 16, but includes the basin above locality 15 just across the East Fork of Baker Creek. The focal point of the second area is the east-trending fault and associated breccia delineated by localities 11, 24, and 25.

Drill Hole Results

During 1982, Duval Corp. completed a 1,530 ft (466 m) diamond drill hole just east of locality 5 (fig. 2). The purpose of the drilling was to test for porphyry molybdenum mineralized rock beneath a zone of phyllically altered intrusive dacite and local quartz stockwork. The hole was also placed to test a coincident factor analysis anomaly correlating log molybdenum and log fluorine with inverse strontium and log zinc as well to test a molybdenum-silver geochemical anomaly based on rock chip and soil grid sampling. The resulting drill core was megascopically logged and split on alternate 10-foot (3.05-m) intervals for assay except in zones of visible mineralized rock where each

10-foot zone was split and assayed. Twenty-one thin sections stained for potassium feldspar were petrographically examined to quantify rock type and alteration.

In summary, the corehole penetrated variably altered and mineralized dacite porphyry cut by dikes of rhyolite porphyry and quartz latite porphyry. The dacite porphyry shows little textural or mineralogic variation downhole and is a gray to green to brownish-tan porphyry composed of clear to milky white plagioclase laths as long as 5 cm in an aphanitic groundmass of quartz, hornblende, and potassium feldspar. The rhyolite porphyry dikes are a distinctive light-pinkish-white intrusive rock that clearly cuts the dacite porphyry and consists of greasy, greenish plagioclase phenocrysts, sparse large quartz "eyes," and abundant biotite laths in an aphanitic, pinkish groundmass of potassium feldspar and quartz. The only quartz latite dike encountered was also distinctive; it is a cream-white porphyry composed of small (1-3 cm), clear quartz phenocrysts, sparse white plagioclase phenocrysts, and salmon-colored potassium feldspar phenocrysts in a hard, dense, microcrystalline groundmass of quartz and potassium feldspar.

Strong phyllic alteration and local quartz stockworks development and silica groundmass flooding were logged from the collar to 350 ft and (0–107 m) from 950 to 1,200 ft (290–366 m). These zones range from a uniform gray color to tan brown; the brown coloration is due to biotization. The phyllically altered zones are separated by short intervals of argillic alteration. Broad zones of propylitic alteration were logged from 450 to 850 ft (137–259 m) and from 1,300 to 1,532 ft (396–467 m).

The alteration mineralogy based on thin section petrography is similar to that mapped on the surface and is summarized in the following paragraphs.

Intense phyllic alteration: Quartz+serite+pyrite±clay±calcite. This alteration involves almost total obliteration of the original rock textures that yields a light-gray, fractured, and brecciated aggregate of sericitized feldspar and introduced silica cut by quartz stockworks containing as much as 5 percent pyrite.

Phyllic alteration: Quartz+pyrite±serite±biotite±clay±calcite. This alteration involves partial to total alteration of feldspar and generally total alteration of mafic rocks. Ragged biotite is locally developed as felty aggregates in the groundmass as well as larger phenocrysts visible to the eye. Original rock textures are generally preserved, and color ranges from gray to brown in biotite-rich zones.

Argillic alteration: Clay±quartz±pyrite±sericite. This alteration involves argillization of feldspar and general preservation of rock texture.

Propylitic alteration: Calcite+chlorite+pyrite±clays±epidote. This alteration involves partial to almost total alteration of plagioclase and mafic minerals and patchy alteration of groundmass. Propylitically altered rock has a distinctly greenish cast and reacts with dilute HCl.

In addition to pyrite, which varies from less than 1 percent to 5 percent in the most intensely altered zones, three zones of lead-zinc-silver-copper mineralized rock were intercepted in the drill hole. These zones consist of galena, sphalerite, pyrite, and local chalcopyrite associated with pods and veinlets of actinolite, chlorite, calcite, and local gypsum. Also, from 150 to

190 ft (46-58 m), traces of molybdenite were logged in zones of strong phyllic alteration.

A summary of the drill hole geochemistry includes the following groupings:

0-300 ft (0-91 m):	39 ppm Mo
	2,650 ppm F
660-710 ft (201-216 m):	3,000 ppm Pb
820-880 ft (250-268 m):	7,000 ppm Pb
	500 ppm Zn
	1,450 ppm Cu
890-920 ft (271-280 m):	870 ppm Pb
	5.9 ppm Ag
980-1,350 ft (299-411 m):	36 ppm Mo
	1,333 ppm F

The highest values obtained were 10 ft (3.05 m) of 1.20 percent Pb from 810 to 820 ft (247–250 m), 10 ft of 0.29 percent Cu from the same interval, and 10 ft of 80 ppm Mo from 1,010 to 1,020 ft (308–311 m).

Regional Aeromagnetic Trends

Regional aeromagnetic data from the study area were extracted and interpreted from a regional data set compiled as part of a larger project (McCafferty, 1992). The data originated from surveys flown north-south with 1 mi (1.6 km) flightline spacing at 11,000–12,000 ft (3,353–3,658 m) barometric elevation. The original data have been filtered to simulate the magnetic field as if it were measured at a constant elevation of 1,000 ft (305 m) above ground. This representation is shown as a contour map on figure 9.

A combination of magnetic highs and lows is present over the Baker Creek area. Magnetization boundaries were inferred (Cordell and Grauch, 1985; Blakely and Simpson, 1986) on figure 9. The boundaries represent abrupt lateral changes in the magnetic properties of rocks and are inferred to be steep or near-vertical geologic contacts.

Two such boundaries coincide with the Wood River graben (fig. 9, loc. A). A magnetic high over the graben suggests that the faults may have played a role in the emplacement of Tertiary intrusions. Alternatively, it may reflect shallower exposures of an Eocene granitic batholith that Hall and McIntyre (1986) felt underlies much of the area northwest of Ketchum. Preliminary studies of rock magnetization in the surrounding area (J.W. Cady, oral commun., 1988) indicate that the Eocene granite has relatively high magnetization values as compared to rocks of Challis Volcanic Group of similar age.

Similar pairs of parallel northeast-trending magnetization boundaries are directly to the northwest and southeast of the hydrothermally altered area (fig. 9, locs. B, C). The presence of magnetic highs over these areas suggests a similar relationship to the Eocene batholith as in the Wood River graben. These boundary features may represent major structural features that played a role in alteration and mineralization at Baker Creek by

localization of intrusive and hydrothermal activity. These structures may also control the path for the heated meteoric water at Easley Hot Springs just to the north of the Baker Creek altered area (see fig. 2).

Conclusions

Observations Concerning Sample Media and Techniques

Results of a geochemical survey of a hydrothermally altered area at Baker Creek, Blaine County, Idaho, indicate that soils are more useful than expected, generally more so than the plants, in delineating possible areas of mineralized rock. Silver and molybdenum contrasts were about the same in both media, but the soil anomalies were more extensive. The better response of Douglas-fir to silver, as compared to that of the other two plant species sampled, suggests that it is an ideal plant medium in precious-metal exploration.

Aquatic mosses are a preferred sample medium, as compared to stream sediments, and results for mosses complement results for heavy mineral concentrates. Mineral identification in concentrates defined only a single, narrow target based on single grains of visible gold and pyromorphite, a secondary lead mineral, in the nonmagnetic concentrate from one locality.

Aeromagnetic data for the area define magnetization boundaries that coincide with structural and lithologic contacts that may play a role in controlling the hydrothermal activity in the Baker Creek Area.

Observations Concerning Potentially Mineralized Areas

Two broad areas with potential for as-yet unrecognized mineralization were defined by the geochemical results. One area centers on drainage basin locality 16, where visible gold and pyromorphite were identified in the nonmagnetic heavy mineral concentrate. Locality 15, nearby, may be part of this area and warrants more detailed study. Anomalous amounts of base-metals characterize this area more strongly than they do the other area, and the inferred mineralization at localities 15 and 16 may reflect a deeply buried, higher temperature porphyry system. The second area focuses on silicified breccia along a fault zone. The geochemical signature of this latter area—antimony, arsenic, silver, bismuth, thallium, and tungsten—is suggestive of a low-temperature system.

Results of a drill hole in the area indicate subeconomic mineralization in bedrock underlying the base-metal surface geochemical anomaly. Unfortunately, the drilling effort did not intersect molybdenum mineralized rock as had been anticipated. The geochemical, geologic, and aeromagnetic results, however, support further studies in the area.

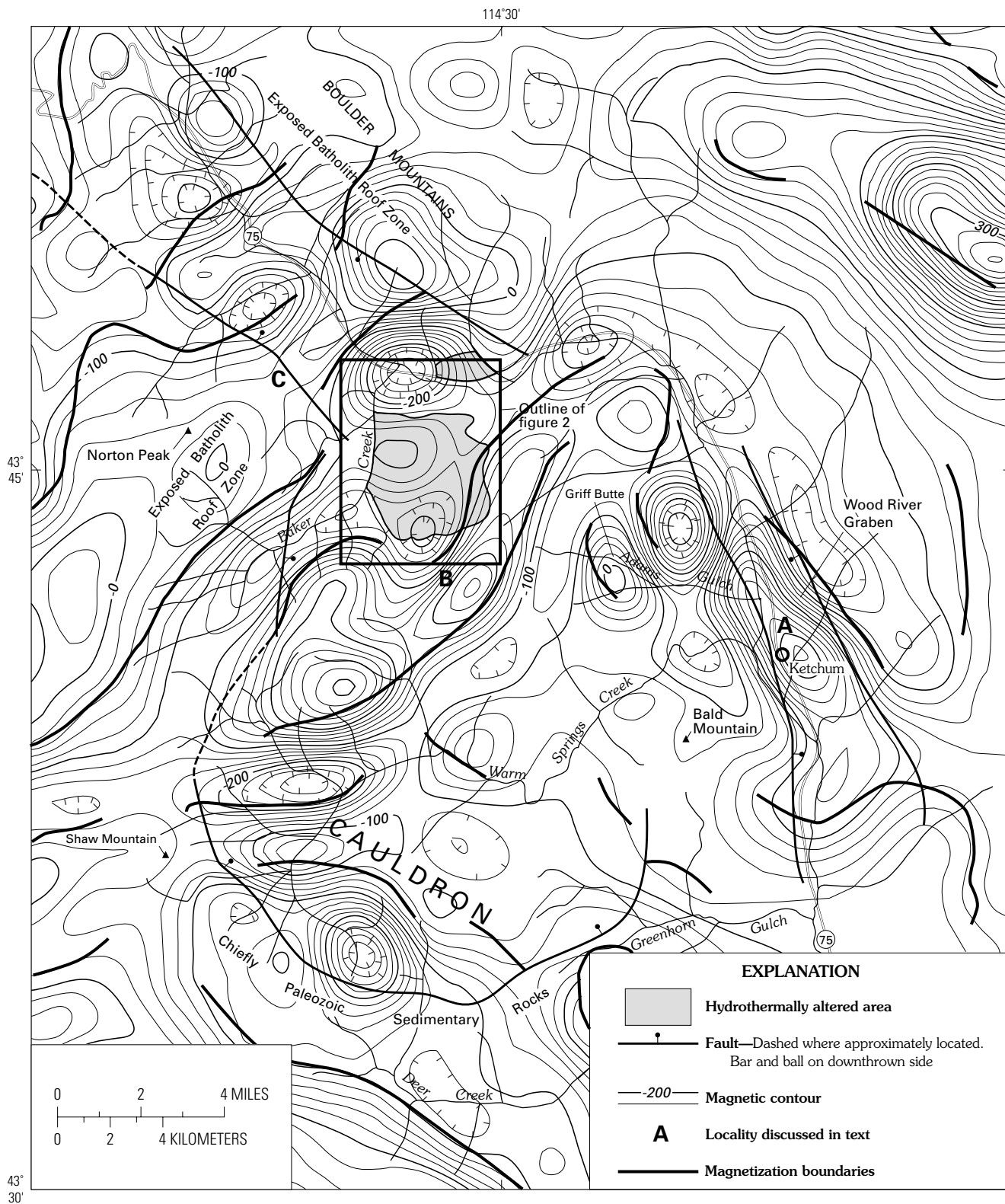


Figure 9. Relationship between aeromagnetic anomalies and alteration in Baker Creek study area and surrounding region, Idaho. Aeromagnetic anomaly map from surveys flown at 1-mi (1.6 km) spacing. Data have been filtered to simulate the magnetic field at 1,000 ft (305 m) above terrain. Magnetization boundaries (heavy lines) were inferred from the horizontal gradient method. Hachures indicate areas of magnetic lows. Contour interval 20 nanoteslas.

References

- Blakely, R.J., and Simpson, R.W., 1986, Locating edges of source bodies from magnetic or gravity anomalies: *Geophysics*, v. 51, p. 1494–1498.
- Boyle, R.W., 1979, The geochemistry of gold and its deposits (together with a chapter on geochemical prospecting for the element): *Canadian Geological Survey Bulletin* 280, 584 p.
- Cohen, D.R., Hoffman, E.L., and Nichol, I., 1987, Biogeochemistry—A geochemical method for gold exploration in the Canadian Shield, in Garrett, R.G., ed., *Geochemical exploration 1985, Part II: Journal of Geochemical Exploration*, v. 29, p. 49–73.
- Cordell, Lindrith, and Grauch, V.J.S., 1985, Mapping basement magnetization zones from aeromagnetic data in the San Juan Basin, New Mexico, in Hinze, W.J., ed., *The utility of regional gravity and magnetic anomaly maps: Society of Exploration Geophysicists*, p. 181–197.
- Dunn, C.E., 1986, Biogeochemistry as an aid to exploration for gold, platinum, and palladium in the northern forests of Saskatchewan: Canada: *Journal of Geochemical Exploration*, v. 25, p. 21–40.
- Erdman, J.A., Cookro, T.M., O'Leary, R.M., and Harms, T.F., 1988, Gold and other metals in big sagebrush (*Artemisia tridentata* Nutt.) as an exploration tool, Gold Run district, Humboldt County, Nevada: *Journal of Geochemical Exploration*, v. 30, p. 287–308.
- Erdman, J.A., Leonard, B.F., and McKown, D.M., 1985, A case for plants in exploration—Gold in Douglas-fir at the Red Mountain stockwork, Yellow Pine district, Idaho, in McIntyre, D.H., ed., *Symposium on the geology and mineral deposits in the Challis 1°×2° quadrangle, Idaho: U.S. Geological Survey Bulletin* 1658-L, p. 141–152.
- Erdman, J.A., and Modreski, P.J., 1984, Copper and cobalt in aquatic mosses and stream sediments from the Idaho cobalt belt: *Journal of Geochemical Exploration*, v. 20, p. 75–84.
- Grimes, D.J., and Marranzino, A.P., 1968, Direct-current arc and alternating-current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: *U.S. Geological Survey Circular* 591, 6 p.
- Hall, W.E., 1985, Stratigraphy of and mineral deposits in middle and upper Paleozoic rocks of the black-shale mineral belt, central Idaho, in McIntyre, D.H., ed., *Symposium on the geology and mineral deposits in the Challis 1°×2° quadrangle, Idaho: U.S. Geological Survey Bulletin* 1658-J, p. 117–131.
- Hall, W.E., and McIntyre, D.H., 1986, Eocene cauldron, batholith, and hydrothermal alteration west of Ketchum, Idaho: *U.S. Geological Survey Open-File Report* 86-0122, 5 p.
- Hall, W.E., Rye, R.O., and Doe, B.R., 1978, Wood River mining district, Idaho—Intrusion-related lead-silver deposits derived from country rock source: *U.S. Geological Survey Journal of Research*, v. 6, p. 579–592.
- Kabata-Pendias, Alina, and Pendias, Henryk, 1984, *Trace elements in soils and plants*: Boca Raton, Florida, CRC Press, 315 p.
- Lovering, T.G., and Heddal, J.A., 1983, The use of sagebrush (*Artemisia*) as a biogeochemical indicator of base-metal deposits in Precambrian rocks of west-central Colorado: *Journal of Geochemical Exploration*, v. 18, p. 205–230.
- McCafferty, A.E., 1992, Magnetic maps and terrane magnetization map for Idaho mineral initiative study, Idaho and vicinity: *U.S. Geological Survey Geophysical Investigations Map* GP-994, scale 1:1,000,000.
- Meier, A.L., 1980, Flameless atomic-absorption determination of gold in geological materials: *Journal of Geochemical Exploration*, v. 13, p. 77–85.
- O'Leary, R.M., and Viets, J.G., 1986, Determination of antimony, arsenic, bismuth, cadmium, copper, lead, molybdenum, silver, and zinc in geologic materials by atomic absorption spectrometry using a hydrochloric acid-hydrogen peroxide digestion: *Atomic Spectroscopy*, v. 7, p. 4–8.
- Plumlee, G.S., and Rye, R.O., 1989, Mineralization in the waning Creede epithermal system, and similar behavior in other systems: *U.S. Geological Survey Open-File Report* 89-95, 30 p.
- Shacklette, H.T., 1984, The use of aquatic bryophytes in prospecting: *Journal of Geochemical Exploration*, v. 21, p. 89–93.
- Shacklette, H.T., and Erdman, J.A., 1982, Uranium in spring water and bryophytes at Basin Creek in central Idaho: *Journal of Geochemical Exploration*, v. 17, p. 221–236.
- Smith, D.C., 1976, Storvatnet and Rettbekken—Moss-trapped stream sediment material as a prospecting medium: *Journal of Geochemical Exploration*, v. 5, p. 338–341.
- Smith, S.C., 1986, Base metals and mercury in bryophytes and stream sediments from a geochemical reconnaissance survey of the Chandalar quadrangle, Alaska: *Journal of Geochemical Exploration*, v. 25, p. 345–365.
- Warren, H.V., Delavault, R.E., and Barakso, J., 1968, The arsenic content of douglas fir as a guide to some gold, silver, and base metal deposits: *Canadian Institute of Mining and Metallurgy Bulletin*, v. 61, p. 860–867.
- Warren, H.V., and Horsky, S.J., 1986, Thallium, a biogeochemical prospecting tool for gold: *Journal of Geochemical Exploration*, v. 26, p. 215–221.
- Zhu, B., Zhu, L., Shi, C., Yu, H., and Wang, G., 1989, Application of geochemical methods in the search for geothermal fields, in Xie Xuejing and Jenness, S.E., eds., *Geochemical exploration in China: Journal of Geochemical Exploration*, v. 33, p. 171–183.

APPENDIX

Appendix table 1. Analytical results for selected elements in soils from upland localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million except for gold, which is in parts per billion. Sample localities shown on figure 2; suffixes C and F in sample numbers indicate powdered coarse (<30 to <80 mesh) and fine (<80 mesh) fractions of soils, respectively. Analyses for Ag, Mo, Pb, and Zn by optical emission spectroscopy and for Au by graphite furnace atomic absorption. < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected; Anomalous values are shown in italics]

Sample No.	Au (2)	Ag (0.5)	Mo (5)	Pb (10)	Zn (200)
H01-C	N	<	7	30	N
H01-F	N	N	<	20	N
H02-C	N	N	N	10	N
H02-F	N	N	N	<	N
H03-C	N	2	<	30	N
H03-F	2	2	5	30	N
H04-C	2	<i>1</i>	7	30	N
H04-F	N	<i>1.5</i>	<i>10</i>	50	N
H05-C	N	<	N	70	<i>200</i>
H05-F	N	N	N	50	<i>200</i>
H07-C	N	<	<i>15</i>	<i>150</i>	<i>200</i>
H07-F	N	<	<i>15</i>	<i>150</i>	<i>200</i>
H08-C	2	N	N	10	N
H08-F	N	N	N	10	N
H09-C	N	N	N	30	N
H09-F	2	N	N	20	N
H10-C	N	N	N	15	N
H10-F	N	N	<	10	N

Appendix table 2. Analytical results for selected elements in ash of Douglas-fir branches (stems and needles combined) from upland localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million except for gold, which is in parts per billion. Sample localities shown on figure 2. < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Analyses for Mo and Tl were on an acid digestion of the ash from 30-g samples of dry material by inductively coupled plasma emission spectroscopy at the laboratory of Geochemical Services, Inc., Rocklin, Calif. Anomalous values are shown in italics]

Sample No.	Au (8)	Ag (0.2)	As (40)	Cd (0.2)	Cu (20)	Mo (20)	Pb	Tl (~0.6)	Zn (20)
H01-P1	<	N	N	2.8	60	0.67	<	<	600
H01-P2	N	0.8	N	2.0	40	0.57	<	<	480
H02-P1	<	0.2	N	2.4	40	0.57	<	<i>2.1</i>	360
H02-P2	8	N	N	0.8	40	0.61	20	<i>1.8</i>	240
H03-P1	<	0.6	N	0.4	40	0.52	<	0.7	400
H03-P2	8	0.2	<	0.8	80	0.90	20	<	480
H04-P1	N	N	N	2.4	40	0.55	<	<	400
H04-P2	16	0.4	N	1.2	60	0.74	<	<	440
H05-P	<	0.2	N	3.6	60	1.10	20	<	<i>1,000</i>
H07-P1	8	3.2	N	5.6	60	<i>1.80</i>	<	<	<i>1,000</i>
H07-P2	<	<i>3.8</i>	N	2.4	60	<i>4.00</i>	<	0.6	<i>800</i>
H08-P1	16	N	N	2.4	80	0.76	<	<	440
H08-P2	N	0.6	N	1.6	40	0.51	<	1.2	360
H09-P1	8	0.4	<i>200</i>	0.8	60	0.97	<	<	520
H09-P2	<	<	<i>400</i>	0.8	60	0.68	<	<	640
H10-P1	<	N	<i>160</i>	2.0	60	0.67	N	<	680
H10-P2	<	0.4	<i>240</i>	2.8	60	0.83	N	<	<i>800</i>

Appendix table 3. Analytical results for selected elements in ash of big sagebrush new growth (stems and leaves combined) from upland localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million except for gold which is in parts per billion. Sample localities shown on figure 2. < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Anomalous values are shown in italics]

Sample No.	Au (8)	Ag (0.1)	As (20)	Cd (0.2)	Cu (10)	Mo (2)	Pb (10)	Zn (10)
H01-A1	16	0.1	N	2.6	160	8	N	480
H01-A2	<	N	N	3.0	380	6	N	360
H02-A1	8	N	N	1.0	340	6	N	300
H02-A2	24	N	N	1.0	340	12	N	320
H03-A1	8	0.1	N	1.6	320	8	N	380
H03-A2	8	N	N	1.2	380	6	N	360
H04-A1	<	N	N	4.2	460	10	N	400
H04-A2	48	N	N	2.8	400	4	N	420
H05-A	<	N	N	5.0	440	20	N	520
H07-A1	<	0.1	N	26	520	20	20	620
H07-A2	8	<	N	40	520	72	10	720
H08-A1	<	N	N	3.6	360	6	N	360
H08-A2	8	N	N	1.8	360	10	N	400
H10-A1	<	N	N	3.2	310	8	<	380
H10-A2	<	N	N	0.4	440	8	<	320

Appendix table 4. Analytical results for selected elements in ash of elk sedge (above ground parts) from the upland localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million except for gold which is in parts per billion. Sample localities shown on figure 2. < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Anomalous values are shown in italics]

Sample No.	Au (8)	Ag (0.2)	As (40)	Cd (0.2)	Cu (20)	Mo (4)	Pb (20)	Zn (20)
H01-C1	<	0.2	N	2.0	60	12	N	480
H01-C2	24	0.4	N	1.6	80	12	N	480
H02-C1	<	0.4	N	1.6	40	4	N	360
H02-C2	N	0.4	N	1.6	40	20	N	400
H03-C1	8	1.4	N	0.8	60	16	N	360
H03-C2	N	0.4	N	1.2	40	12	N	360
H04-C1	N	2.0	N	3.2	60	20	N	600
H04-C2	<	0.4	N	2.4	80	8	N	560
H05-C	<	N	N	1.6	40	28	N	880
H06-C	20	1.2	N	5.2	100	8	N	>2,000
H07-C1	N	N	N	5.2	100	24	N	1,200
H07-C2	<	0.8	N	7.6	60	56	N	1,400
H08-C1	N	N	N	1.2	40	8	N	280
H08-C2	8	N	N	1.2	60	8	N	560
H09-C1	16	N	N	0.8	20	4	N	160
H09-C2	8	0.2	N	0.8	20	4	N	180
H10-C1	N	0.4	N	2.0	60	12	N	400
H10-C2	N	0.8	N	1.2	40	8	N	300

Appendix table 5. Analytical results of selected elements in stream sediments from drainage basin localities in the Baker Creek area.

[In parts per million. Sample localities shown on figure 2. Analyses made on <80-mesh (<180- μ m) fraction by optical emission spectroscopy; <, indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Anomalous values are shown in italics]

Sample No.	Ag ppm (0.5)	Mn ppm (10)	Mo ppm (5)	Pb ppm (10)	Zn ppm (200)
H11-SS	<i>1.5</i>	<i>>5,000</i>	<i>10</i>	50	<
H12-SS	N	700	N	20	N
H13-SS	<	500	<	30	N
H14-SS	N	500	N	30	N
H15-SS	0.5	<i>>5,000</i>	<	30	<i>200</i>
H16-SS	0.5	<i>2,000</i>	5	<i>150</i>	<i>700</i>
H17-SS	N	500	N	20	N
H18-SS	N	300	N	30	N
H19-SS	N	150	N	10	N
H20-SS	N	100	N	<	N
H21-SS	N	150	N	15	N
H22-SS	N	500	N	<	N
H23-SS	N	1,000	N	10	N
H24-SS	0.5	300	7	30	N
H25-SS	N	300	7	20	N
H26-SS	N	150	N	15	N

Appendix table 6. Analytical results of selected elements in the nonmagnetic and weakly magnetic fractions of heavy mineral concentrates collected from drainage basin localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million. Sample localities shown in figure 2. Analyses of powdered <80-mesh fractions by optical emission spectroscopy; < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Anomalous values are shown in italics]

Sample No.	Ag (1)	B (20)	Ba (50)	Be (2)	Bi (20)
Nonmagnetic (C3) fraction					
H11-H	N	20	>10,000	N	70
H12-H	N	20	>10,000	N	N
H13-H	N	<	>10,000	N	N
H14-H	N	20	>10,000	N	N
H15-H	2	500	10,000	N	N
H16-H	N	20	>10,000	N	20
H17-H	N	20	>10,000	N	N
H18-H	N	<	7,000	2	N
H19-H	N	20	700	N	N
H20-H	N	20	3,000	N	N
H21-H	N	50	>10,000	<	N
H22-H	N	20	>10,000	N	N
H23-H	N	50	7,000	<	N
H24-H	N	50	2,000	N	100
H25-H	N	50	>10,000	N	1,000
H26-H	N	30	2,000	<	30
Weakly magnetic (C2) fraction					
H11-H	2	<	3,000	5	N
H12-H	N	<	700	<	N
H13-H	<	<	500	<	N
H14-H	<	<	1,000	<	N
H15-H	1	<	1,000	3	N
H16-H	1	<	1,000	15	N
H17-H	N	<	200	N	N
H18-H	N	<	200	N	N
H19-H	N	<	200	N	N
H20-H	N	<	200	N	N
H21-H	<	<	150	2	N
H22-H	N	<	500	2	N
H23-H	N	<	150	<	N
H24-H	<	<	150	2	N
H25-H	N	<	700	3	N
H26-H	N	<	200	N	N

Appendix table 6—Continued. Analytical results of selected elements in the nonmagnetic and weakly magnetic fractions of heavy mineral concentrates collected from drainage basin localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million. Sample localities shown in figure 2. Analyses of powdered <80-mesh fractions by optical emission spectroscopy; < indicates trace but less than the lower limit of determination shown in parentheses; N indicates not detected. Anomalous values are shown in italics]

Sample No.	Cu (10)	Mo (10)	Pb (20)	Sr (200)	Zn (500)
Nonmagnetic (C3) fraction					
H11-H	<	N	<	<3,000	N
H12-H	<	N	N	3,000	N
H13-H	<	N	N	5,000	N
H14-H	<	N	20	3,000	N
H15-H	<	N	50	500	N
H16-H	<	<i>70</i>	<i>3,000</i>	2,000	N
H17-H	N	N	50	700	N
H18-H	<	N	<	<	N
H19-H	N	N	N	<	N
H20-H	<	N	30	200	N
H21-H	<	N	<i>700</i>	500	N
H22-H	<i>300</i>	N	<i>300</i>	1,000	N
H23-H	10	N	30	500	N
H24-H	<	N	30	N	N
H25-H	<	N	20	1,500	N
H26-H	N	N	30	200	N
Weakly magnetic (C2) fraction					
H11-H	100	15	30	<	500
H12-H	70	N	<	<	<
H13-H	100	N	50	<	<
H14-H	70	10	70	<	<
H15-H	100	15	100	<	500
H16-H	100	<	200	200	<i>1,000</i>
H17-H	70	N	50	N	N
H18-H	10	N	<	N	N
H19-H	20	N	50	<	N
H20-H	70	N	50	<	N
H21-H	100	10	50	N	N
H22-H	70	N	20	200	<
H23-H	10	N	20	300	N
H24-H	20	N	100	500	N
H25-H	70	20	70	300	<
H26-H	15	N	30	N	N

Appendix table 7. Analytical results, including ash yield, for aquatic mosses from drainage basin localities in the Baker Creek study area, Blaine County, Idaho.

[In parts per million except for gold which is in parts per billion. Sample localities shown on figure 2. < indicates detected but below the limit of determination shown in parentheses; N indicates not detected; leaders (--), no data. Anomalous values are shown in italics]

Sample No.	Au (16)	Ag (0.2)	As (40)	Sb (8)	Mo (4)
H11-M	<i>64</i>	3.2	<	72	8
H12-M			Insufficient sample, no data		
H13-M	48	N	N	N	8
H14-M	16	N	N	N	4
H15-M	<i>64</i>	5.2	N	N	8
H16-M	16	1.6	<i>40</i>	N	8
H17-M	--	N	N	N	8
H18-M	16	N	N	N	N
H19-M	<	N	N	N	N
H20-M	<	N	N	N	4
H21-M			Insufficient sample, no data		
H22-M	<	0.4	N	N	4
H23-M	<	0.6	<i>40</i>	N	4
H24-M	--	2.2	N	N	<i>20</i>
H25-M	16	0.6	N	N	<i>16</i>
H26-M	--	N	N	N	4

Sample No.	Cu (20)	Pb (20)	Zn (20)	Cd (0.2)	Ash %
H11-M	100	60	720	2.8	15.5
H12-M			Insufficient sample, no data		
H13-M	60	20	380	1.2	16.8
H14-M	40	20	240	0.8	32.0
H15-M	140	40	<i>1,500</i>	5.6	16.1
H16-M	120	<i>160</i>	<i>>2,000</i>	<i>20</i>	21.4
H17-M	60	<	380	1.6	12.6
H18-M	20	<	360	0.4	56.5
H19-M	80	40	180	1.2	32.3
H20-M	40	<	160	0.8	17.8
H21-M			Insufficient sample, no data		
H22-M	80	20	300	1.6	17.5
H23-M	80	20	320	1.6	14.3
H24-M	100	<i>100</i>	360	4.4	23.3
H25-M	60	<i>100</i>	180	2.4	38.2
H26-M	60	<	260	0.8	20.2