STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

NORTH ABSAROKA WILDERNESS AND VICINITY, PARK COUNTY, WYOMING

GEOLOGICAL SURVEY BULLETIN 1447

Geology and Mineral Resources of the North Absaroka Wilderness and Vicinity, Park County, Wyoming

By WILLIS H. NELSON *and* HAROLD J. PROSTKA, U.S. GEOLOGICAL SURVEY,
and FRANK E. WILLIAMS, U.S. BUREAU OF MINES

With sections on MINERALIZATION OF THE SUNLIGHT MINING REGION
and GEOLOGY AND MINERALIZATION OF THE COOKE CITY MINING DISTRICT
By JAMES E. ELLIOTT, U.S. GEOLOGICAL SURVEY
And a section on AEROMAGNETIC SURVEY
By DONALD L. PETERSON, U.S. GEOLOGICAL SURVEY

STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

GEOLOGICAL SURVEY BULLETIN 1447

An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS

WILDERNESS AREAS

Under the Wilderness Act (Public Law 88-577, Sept. 3, 1964) certain areas within the National forests previously classified as "wilderness," "wild," or "canoe" were incorporated into the National Wilderness Preservation System as wilderness areas. The act provides that the Geological Survey and the Bureau of Mines survey these wilderness areas to determine the mineral values, if any, that may be present. The act also directs that results of such surveys are to be made available to the public and submitted to the President and Congress. This bulletin reports the results of a mineral survey of the North Absaroka Wilderness, Park County, Wyoming, and some adjoining national forest lands that may be considered for wilderness designation.

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GEOLOGY AND MINERAL RESOURCES OF THE NORTH ABSAROKA WILDERNESS, PARK COUNTY, WYOMING

By WILLIS H. NELSON and HAROLD J. PROSTKA, U. S. Geological Survey, and FRANK E. WILLIAMS, U. S. Bureau of Mines

SUMMARY

The North Absaroka Wilderness is approximately 560 square miles (1,450 km^2) of rugged scenic mountainous terrain that adjoins the eastern boundary of Yellowstone National Park in northwestern Wyoming. The area was studied during 1970, 1971, and 1972 by personnel of the U. S. Geological Survey and the U. S. Bureau of Mines to evaluate its mineral-resource potential as required by the Wilderness Act of 1964. This evaluation is based on a search of the literature, courthouse and production records, geologic field mapping, field inspection of claims and prospects, analyses of bedrock and stream-sediment samples, and an aeromagnetic survey.

The North Absaroka Wilderness is underlain almost entirely by andesitic and basaltic volcanic rocks of Eocene age. These volcanics rest on deformed sedimentary rocks of Paleozoic and, locally, of Mesozoic age that are exposed at places along the northern and eastern edges of the wilderness. Dikes and other igneous intrusive bodies cut both the volcanic and sedimentary rocks. A nearly flat detachment fault, the Heart Mountain fault, and a related steep breakaway fault have displaced middle and upper Paleozoic rocks and some of the older part of the volcanic sequence to the southeast. A much greater thickness of volcanic rocks was found to be involved in Heart Mountain faulting than had previously been recognized; however, most of the volcanic rocks and many of the intrusives were emplaced after Heart Mountain faulting. Local folding and high-angle faulting in mid-Eocene time have deformed all but the youngest part of the volcanic sequence in the southeastern part of the wilderness. This deformation is interpreted as the last pulse of Laramide orogeny.

The results of this study indicate that the mineral-resource potential of the wilderness is minimal. Bentonite, petroleum, low-quality coal, and localized deposits of uranium and chromite have been produced in the surrounding region from rocks that underlie the volcanic rocks; but such deposits, if present in the wilderness, would be too deeply buried, too small, or too sporadically distributed to be profitably located and exploited. Copper and gold mines and prospects are present on the fringes of the wilderness, but otherwise the area seems to be devoid of economically valuable concentrations of metallic minerals. No surface evidence of geothermal-energy potential was found.

Known mineral deposits in the vicinity of the North Absaroka Wilderness are associated with intrusive rocks. From the Cooke City mining district, just north of the wilderness, replacement deposits in Upper Cambrian carbonate rocks may extend a short distance into the north edge of the wilderness. In the Sunlight mining region, an enclave nearly surrounded by the wilderness,

mineralization occurs in veins and is disseminated in volcanic and plutonic rocks. Richer concentrations of metallic minerals may occur in carbonate rocks adjacent to intrusive bodies at depth beneath the volcanic rocks in the Sunlight region. A few small intrusive bodies occur in the wilderness, but no significant associated mineralization was detected. Aeromagnetic data indicate that other intrusives not exposed by erosion may occur in the wilderness; however, no significant metamorphism or alteration is evident at the surface to indicate their presence.

Although most of the rocks of the wilderness are of igneous origin, they are all so old (Eocene) that it is unlikely that they retain any original heat. The Pleistocene rhyolitic ash-flow tuffs in the southwestern part of the wilderness were erupted from sources in Yellowstone National Park just to the west; however, in the wilderness these tuffs are too thin to contain any residual heat.

INTRODUCTION

The North Absaroka Wilderness is an extremely rugged and beautiful mountainous region located in Shoshone National Forest, Park County, northwestern Wyoming. It is an irregularly shaped area of about 560 square miles (1,450 km^2) just east of Yellowstone National Park that extends south about 35 miles (56 km) from the Montana-Wyoming State boundary (fig. 1). To the north are the Beartooth Mountains, to the east the Bighorn Basin, and to the south the high peaks of the Washakie Wilderness. The North Absaroka Wilderness ranges in elevation from about 7,000 to over 12,000 feet (2,135 to over 3,660 m); scenic features include high ridges and peaks (fig. 2), cirques, rock glaciers (fig. 3), deep glacial scoured valleys, swift mountain streams, waterfalls (fig. 4), charming meadows, and timbered slopes. The area is the home of numerous elk, deer, moose, bighorn sheep, and bears, including a few grizzlies. Trout abound in the streams.

Good trails penetrate the wilderness along the major streams, but travel along many valley bottoms where there are no trails is extremely difficult, even on foot, and some of the higher parts of the area are accessible only by mountain-climbing techniques.

The principal nearby towns are Cody, Wyo., about 20 miles (32 km) east, and Cooke City, Mont., about 1 mile (1.6 km) north of the wilderness (fig. 1). U.S. Highway 14-20 skirts the south edge of the wilderness, and U.S. Highway 212 is just north of it. From the east, the wilderness can be approached via the Sunlight Basin Road, which joins Wyoming Highway 120 about 15 miles (24 km) north of Cody, and U.S. Highway 212 about 12 miles (19 km) east of Cooke City. An unpaved road leads from Sunlight Basin into the Sunlight mining region via a corridor that has been excluded from the wilderness. Spectacular views of the wilderness may be seen from all these roads.

ACKNOWLEDGMENTS

We thank Jack DeVore, Clarks Fork District Ranger, and Donald Mecklenburg, Wapiti District Ranger, for their helpful advice about local conditions. We are grateful to our helicopter pilots Bert Swainson, Doyle Vaughn, Duane Schmutz, and Sam Buckley, and mechanics Delbert W. Jenkins III and Mike Soiu for their skillful services.

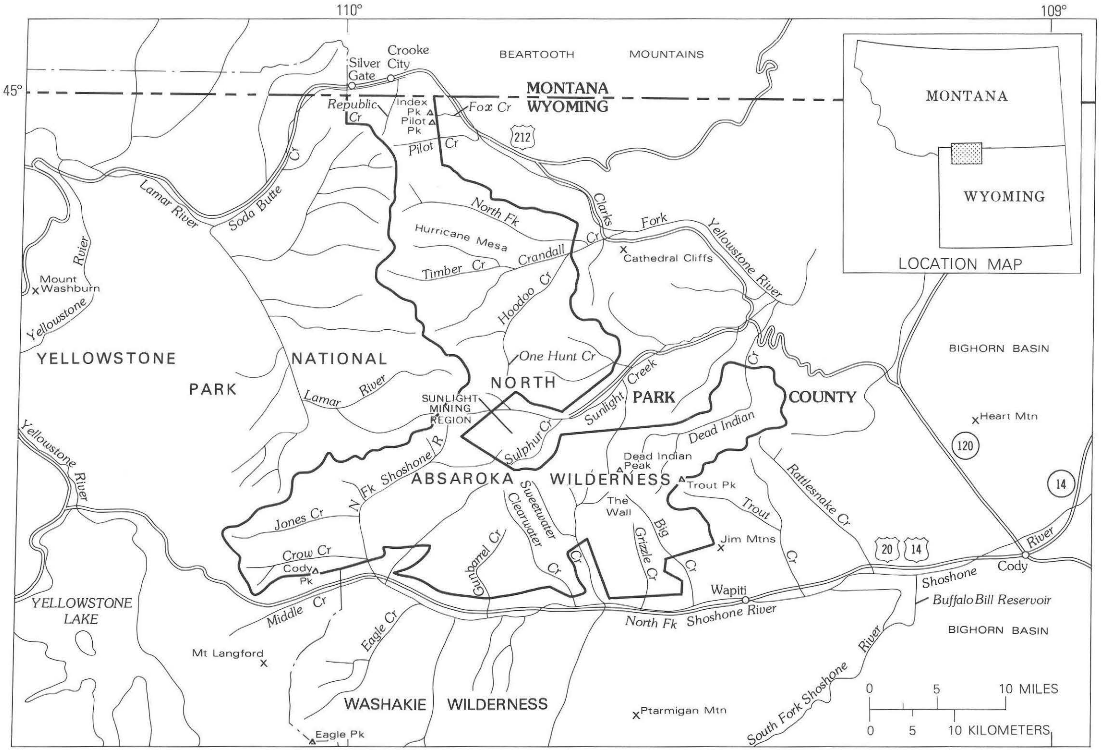

FIGURE 1.—Index map of North Absaroka Wilderness and vicinity.

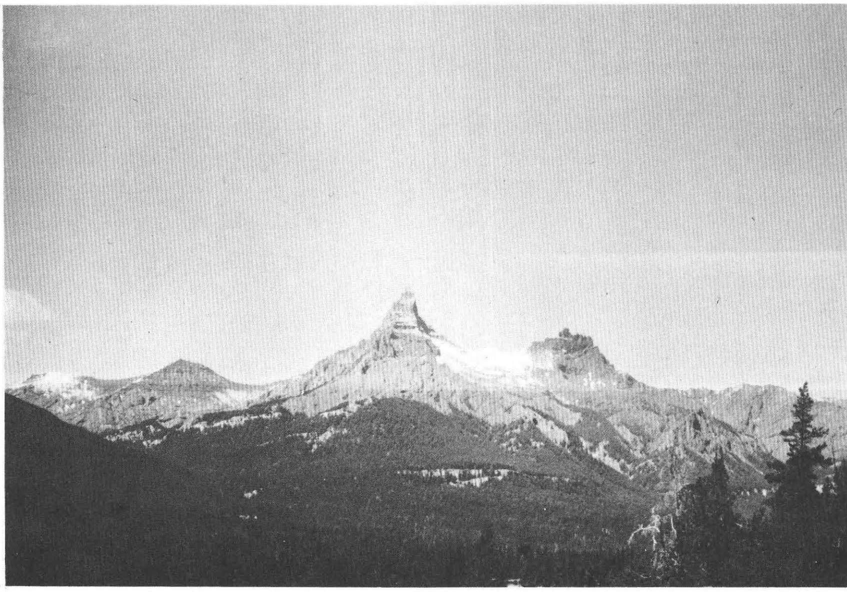

FIGURE 2.—Pilot Peak (left) and Index Peak (right), two prominent landmarks in the North Absaroka Wilderness, as seen from U. S. Highway 212 along the Clarks Fork of the Yellowstone River. View southwest.

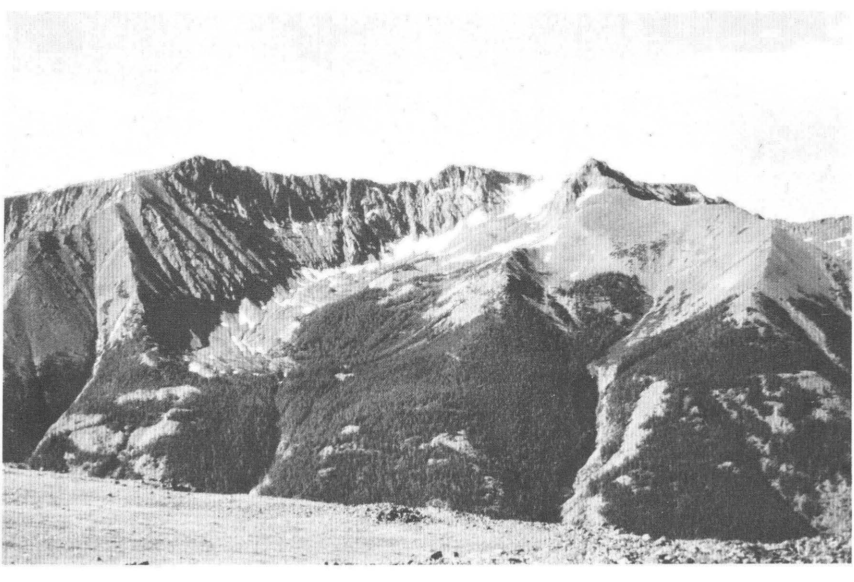

FIGURE 3.—Precipitous north side of Hurricane Mesa. Cirque contains an active rock glacier, one of several in this area.

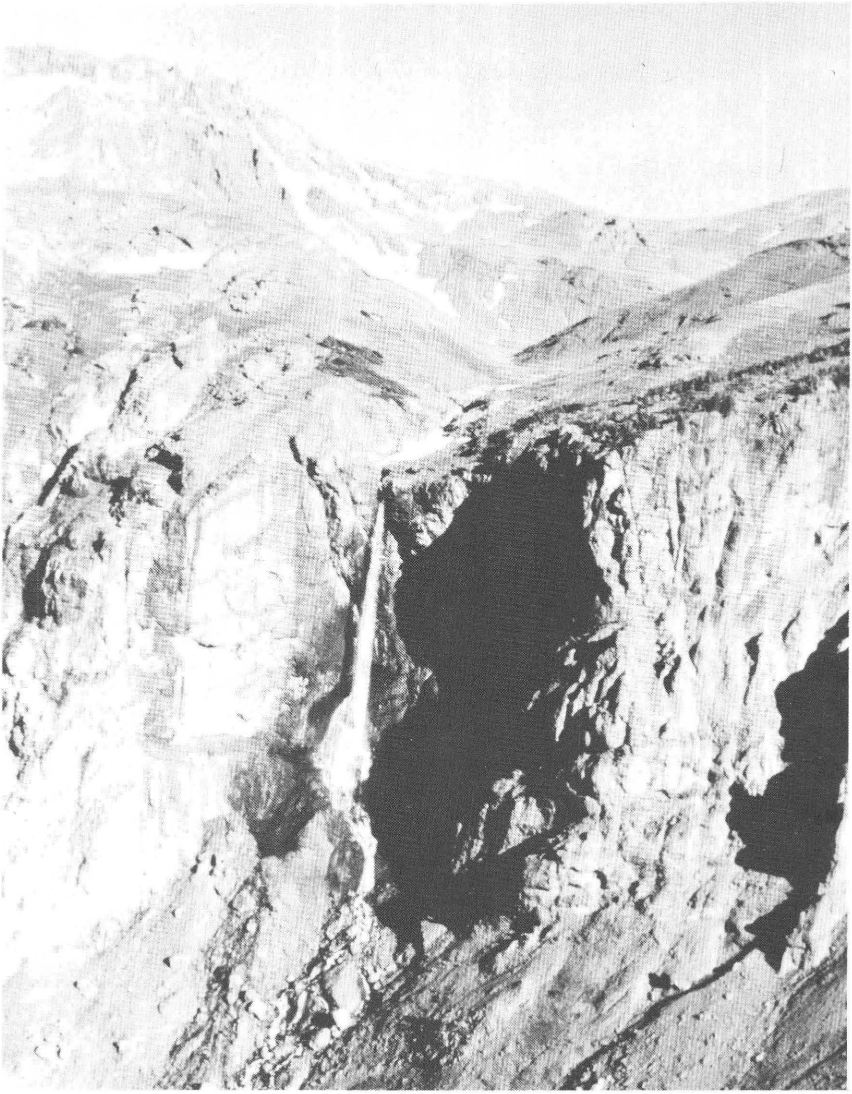

FIGURE 4.—Big Creek Falls, with a drop of more than 350 feet (100 m), is near the headwaters of Big Creek just south of Dead Indian Peak. View north.

We are particularly indebted to W. G. Pierce, not only for allowing us to use his mapping in the eastern and northern parts of the wilderness, but for the many hours that he spent showing and discussing his findings with us, and we thank W. H. Parsons for the many pleasant hours he spent sharing the knowledge that he and his students have of the volcanic rocks of the wilderness.

The U. S. Bureau of Mines acknowledges Messrs. Mike Miller, Roy Colman, and H. E. Thompson, local outfitters in Cody, Wyo., for their helpful assistance in the field. Mr. Will Metz, of Sheridan, Wyo., was extremely cooperative in providing information on mining activity in the Cooke City mining district (Irma Mines, Inc.), near Cooke City, Mont. We are also grateful to Mr. John A. Wells, Timberline Minerals, Inc., for allowing access to parts of the Sunlight mining region.

PREVIOUS STUDIES

The first geologic mapping of the region now designated the North Absaroka Wilderness was done by Hague (1899). Later, T. S. Lovering (1929) studied the geology of the Cooke City (New World) mining district, which included the northern fringe of the wilderness. Rouse (1937) summarized the genesis and structural relationships of a large part of the Absaroka volcanic field, and Parsons (1939) published a description and maps of the geology of the Sunlight Basin and Sunlight mining region. Geologic maps of parts of the wilderness and adjacent areas by Pierce and Nelson (1968, 1971); the U. S. Geological Survey (1972); Prostka, Smedes and Christiansen (1976); Dreier (1967); and Pedersen (1968) were used in compiling the geologic map of the North Absaroka Wilderness (pl. 1). Several other topical studies are cited at appropriate places in the text.

PRESENT INVESTIGATIONS

The objectives of the present study were to map the geology and evaluate the mineral-resource potential of the North Absaroka Wilderness and some adjoining national forest lands. This report is the result of the combined efforts of personnel of the U. S. Geological Survey and the U. S. Bureau of Mines. W. H. Nelson and H. J. Prostka of the U. S. Geological Survey, assisted by M. D. Lewan and J. E. Wade in July and August 1970, and by M. K. Holden and J. L. Nelson in July and August 1971, examined and mapped the geology of the wilderness and collected bedrock and stream-sediment samples for geochemical analyses. Lewan, Wade, Holden, and J. L. Nelson collected most of the stream-sediment samples; W. H. Nelson and Prostka did most of the bedrock sampling and geologic mapping of the volcanic rocks. A helicopter was used almost daily to transport teams to and from the field. Most traverses were made along streams to collect sediment samples and along ridges to collect samples and to make geologic observations. Some traverses were made away from ridges but much of the terrain is too rugged for such traversing to be efficient.

W. G. Pierce of the U. S. Geological Survey mapped most of the Paleozoic and Mesozoic sedimentary rocks and some of the Eocene volcanic rocks in the northern and eastern parts of the wilderness; some of this work was done during the present study, but much of it was done earlier.

J. E. Elliott of the U. S. Geological Survey, who was making a detailed study of the Cooke City mining district, studied the geology and ore deposits of the Sunlight mining region in 1970; he contributed most of the new information on the geology and mineralization in the Sunlight mining region and the Cooke City mining district, just outside the wilderness.

F. E. Williams of the U. S. Bureau of Mines studied the economic aspects of the mineral resources of the North Absaroka Wilderness and some national forest lands and wrote the paragraphs on the history and ore values of claims and prospects in the Sunlight mining region and the Cooke City mining district. In addition, he traversed trails and streams in an effort to find zones of mineralization. Streams were panned for heavy minerals, and specimens were collected for semiquantitative spectrographic analyses. Sixty-six samples were collected for assay from the Sunlight mining region (fig. 1), an area of approximately 20 square miles (5 km^2), which is almost entirely surrounded by the wilderness. Assisting in the field for the U. S. Bureau of Mines were C. L. Bieniewski, W. L. Dare, R. J. Hurt, R. L. Lowrie, B. C. Pollard, Jr., and J. J. Snodgrass.

The records of the U. S. Bureau of Land Management in Cheyenne, Wyo., and those of the U. S. Forest Service in Denver, Colo., were examined to determine locations of patented claims in and near the wilderness. Park County records in Cody were reviewed for information concerning unpatented claims, and Bighorn County records in Basin were examined for data on claims recorded before 1910, the year in which Park County was separated from Bighorn County. Files of the U. S. Bureau of Mines and reports of the Director of the Mint dating from the 1880's were examined for production data on mines in the vicinity of the wilderness. Information relative to mineral leasing was obtained from the Conservation Division, U. S. Geological Survey, Casper, Wyo.

Fieldwork and county courthouse investigations by U. S. Bureau of Mines personnel occupied 45 man-weeks of effort in 1970 and 1971. Fieldwork included evaluating mineralization at patented and identified unpatented claims. Most unpatented claims are so vaguely described in county records that they could not be positively identified in the field.

GEOLOGY

By WILLIS H. NELSON and HAROLD J. PROSTKA, U. S. Geological Survey

The North Absaroka Wilderness is underlain almost entirely by andesitic and basaltic volcanic rocks of Eocene age whose maximum thickness is more than 5,000 feet (1,500 m; pl. 1). These rocks are the remnants of deeply eroded composite stratovolcanoes consisting of laharic breccias, lava flows, flow breccias, and tuffs riddled with dikes and a few larger intrusive bodies. Epiclastic volcanic sediments, chiefly well-sorted breccias, conglomerates, and sandstones, derived by erosion of the volcanic cones and deposited as alluvial plains around the flanks of the cones, occur mainly in the western part of the wilderness.

The volcanic rocks are underlain by a variety of Paleozoic, Mesozoic, and lower Cenozoic sedimentary rocks that were deformed during the Laramide orogeny. The subsurface structure of these strata is largely unknown, but extrapolation of the geology from surrounding areas (Love and others, 1955) suggests that these rocks comprise a generally southwest-dipping sequence, beveled by erosion, with the volcanics resting on lower and middle Paleozoic rocks in the northeastern part of the wilderness and lapping onto progressively younger strata to the southwest.

Along the northeastern part of the wilderness, middle and upper Paleozoic strata and rocks of the older part of the volcanic sequence have been displaced southeastward along a nearly flat detachment fault, the Heart Mountain fault (Pierce, 1957). During this study, a much greater thickness of volcanic rocks was found to be involved in the Heart Mountain faulting than had previously been recognized; however, most of the volcanic rocks and related intrusives in the wilderness area were emplaced after Heart Mountain faulting occurred. Throughout most of the area the volcanic rocks have been only slightly deformed and thus have gentle dips; but in a small area in the southeastern part of the wilderness they were fairly intensely folded and faulted in middle Eocene time.

A few small erosional remnants of rhyolitic ash-flow tuff of Pleistocene age are in the southwestern part of the area; these are outliers of the extensive Yellowstone rhyolite plateau located just west of the wilderness (U. S. Geological Survey, 1972).

PRECAMBRIAN ROCKS

Precambrian metamorphic rocks, chiefly granitic gneisses, are extensively exposed northeast of the wilderness—in some places, less than 1 mile from the boundary (Pierce and Nelson, 1971; Pierce, Nelson, and Prostka, 1973). None were found exposed within the wilderness itself. In the subsurface the top of the Precambrian rocks dips southwestward beneath an increasing thickness of sedimentary and volcanic rocks.

PALEOZOIC AND MESOZOIC ROCKS

Paleozoic and Mesozoic rocks, mostly marine sedimentary strata, are exposed in and along the northeastern part of the wilderness. These rocks are briefly described in table 1. Cambrian rocks compose a narrow belt that lies mostly outside the wilderness except for two localities: one along the lower reaches of Blacktail and Crandall Creeks, and the other along Dead Indian Creek. Ordovician through Mississippian strata are exposed only in

TABLE 1. —*Paleozoic and Mesozoic rocks in and near the North Absaroka Wilderness*
[Modified from Pierce and Nelson, 1968, 1969, 1971]

Age	Formation	Approximate thickness	Description
Late Cretaceous	Cody Shale	1,800-2,200 ft (550-670 m)	Upper part buff sandy shale and thinly laminated buff sandstone; lower part dark-gray thin-bedded shale.
	Frontier Formation	450-500 ft (140-150 m)	Thick lenticular gray sandstone, gray, brown, and carbonaceous shale, and bentonite.
Early Cretaceous	Mowry Shale	400 ft (120 m)	Gray and brown shale, in part siliceous; numerous bentonite beds and abundant fish scales.
	Thermopolis Shale	550-600 ft (170-180 m)	Soft black shale; numerous bentonite beds; Muddy Sandstone Member about 200 ft (60 m) above base.
	Cloverly Formation	600 ft (180 m)	Light-gray sandstone, gray and variegated shale, and lenticular chert conglomerate. So-called Rusty beds at top.
Late Jurassic	Morrison Formation		Dull variegated claystone and gray silty sandstone.
	Sundance Formation	500 ft (150 m)	Green and gray shale, greenish-gray glauconite, limy sandstone, and thin beds of fossiliferous limestone.
Middle Jurassic	Gypsum Spring Formation		Red and gray shale, fossiliferous limestone, and gypsum; gypsum bed at base 50 ft (15 m) or more thick.
Triassic	Chugwater Formation	650-750 ft (200-230 m)	Red siltstone, red shale, and red fine-grained sandstone; gypsiferous.
	Dinwoody Formation	20-50 ft (6-15 m)	Tan, gray, and red siltstone, gypsum, and dolomite.
Permian	Park City Formation	70-110 ft (21-34 m)	Siliceous limestone and dolomite, nodular chert, and tan and gray shale. Formerly called Phosphoria Formation in this area.
Pennsylvanian	Tensleep Sandstone	170-220 ft (52-67 m)	Light-gray well-sorted crossbedded massive sandstone; thin beds of limestone and dolomite in lower part.
Late Mississippian	Amsden Formation	250-300 ft (75-90 m)	Red shale; some dolomitic limestone beds; some chert and hematite nodules; basal part commonly siltstone or sandstone.
Early Mississippian	Madison Limestone	700-900 ft (215-275 m)	Blue-gray massive limestone, dolomitic in part; upper half somewhat thicker bedded and more massive than lower half.
Late Devonian	Three Forks Formation	190-300 ft (58-90 m)	Yellow, greenish-gray, and dark-gray dolomitic siltstone, black fissile shale, and silty dolomite.
	Jefferson Formation		Fetid brown dolomite and light-gray and tan limestone; uppermost part is mottled yellowish-orange dolomite and yellowish-gray siltstone.

TABLE 1.—*Paleozoic and Mesozoic rocks in and near the North Absaroka Wilderness*—Continued

Age	Formation	Approximate thickness	Description
Early Devonian	Beartooth Butte Formation	0-70 ft (0-21 m)	Stream-channel deposit of red calcareous siltstone, red and yellowish-gray silty limestone and siltstone, and some siltstone and limestone conglomerate and breccia.
Late Ordovician	Bighorn Dolomite	400 ft (122 m)	Gray massive cliff-forming dolomite and dolomitic limestone.
Late Cambrian	Snowy Range Formation	340 ft (105 m)	Gray-green shale and green flat-pebble conglomerate. Grove Creek Member at top consists of about 40 ft (12 m) of gray, buff, and orange limestone and dolomite, green shale, and gray-green limestone-pebble conglomerate.
	Pilgrim Limestone	100 ft (30 m)	Massive light-gray mottled oolitic limestone; forms a prominent ledge.
Middle Cambrian	Gros Ventre Formation	740 ft (225 m)	Green micaceous shale, thin-bedded gray limestone, and limestone-pebble conglomerate. A 30- to 50-ft (9-15 m) ledge-forming unit of thin-bedded modular limestone and interbedded green shale 200 feet (60 m) above base is probably equivalent to the Meagher Limestone (Middle Cambrian) in Montana.
	Flathead Sandstone	120-150 ft (37-45 m)	Hard ledge-forming quartzitic sandstone; softer and brown speckled in upper part.

allochthonous Heart Mountain fault blocks throughout the northeastern part of the wilderness. Southeast of Sunlight Basin, however, all the Paleozoic and Mesozoic formations may be found in undisturbed sections (Pierce, 1957; Pierce and Nelson, 1968, 1971; Pierce, Nelson, and Prostka, 1973).

CENOZOIC ROCKS

WILLWOOD FORMATION

The Willwood Formation of early Eocene age is exposed in the extreme southeastern part of the wilderness near the mouth of Big Creek. It consists of varicolored clay, sandstone, shale, and conglomerate and erodes to form badlands. Some of the shale is carbonaceous and contains thin lenses of coal. Less than 100 feet (30 m) of Willwood Formation is exposed in the wilderness, but at least 1,000 feet (300 m) of this unit may extend beneath the thick cover of volcanic rocks to the northwest.

ABSAROKA VOLCANIC SUPERGROUP AND RELATED INTRUSIVE ROCKS

The name Absaroka Volcanic Supergroup and related intrusive bodies collectively refers to the volcanic rocks and volcaniclastic strata, all of

Eocene age, that compose the widespread Absaroka volcanic field of northwestern Wyoming and southwestern Montana (Smedes and Prostka, 1972). The Absaroka Volcanic Supergroup consists of calc-alkalic andesitic, quartz-latitic, and dacitic extrusive rocks, lesser amounts of potassic alkalic mafic lavas, and minor amounts of trachyte to rhyodacite welded ash-flow tuffs. The supergroup consists, in ascending order, of the Washburn Group, the Sunlight Group, and the Thorofare Creek Group. All three groups are composed dominantly of andesitic volcaniclastic rocks. Within the North Absaroka Wilderness the Sunlight Group is by far the thickest and most voluminous. Rocks of the Sunlight Group are darker, more potassic, and less felsic than those of the other groups, and they are separated from them by unconformities. Most of the intrusive bodies in the wilderness are related to vent centers for rocks of the Sunlight Group, but a few dikes in the extreme southwestern corner of the area are related to eruptive centers that were sources for the rocks of the Thorofare Creek Group. Potassium-argon age determinations on samples from near the base and top of the volcanic pile range from 49-42 m.y. (million years) indicating an age of middle to late Eocene (Smedes and Prostka, 1972) for the Absaroka Volcanic Supergroup.

The vent areas for the volcanic rocks were composite stratovolcanoes composed of flow breccias, lava flows, debris-flow deposits, and tuff (fig. 5)—an

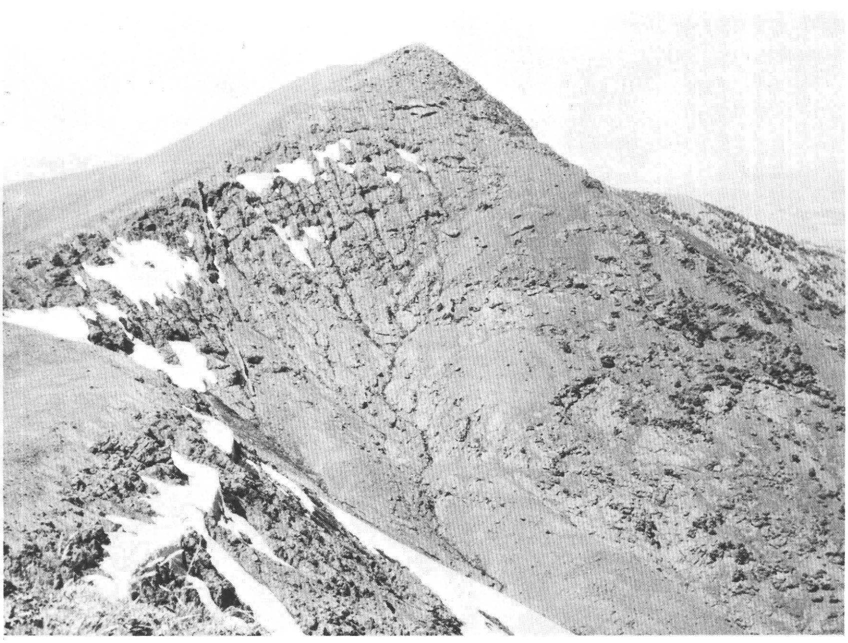

FIGURE 5.—View northward, showing chaotic vent-facies lava-flow breccia, mudflow breccia, and tuff in Wapiti Formation along wilderness boundary at head of One Hunt Creek. Note steeply dipping dike in left half of picture.

assemblage of rocks referred to as "vent facies." Primary dips commonly are steep and locally irregular, though in general the layers dip outward away from the vent centers, many of which also have associated stocks, plugs, and swarms of dikes. Away from the volcanic centers the vent facies rocks interfinger with and grade outward into well-bedded, gently dipping reworked volcanic sediments, mainly volcanic conglomerate and well-sorted breccia (fig. 6), volcanic siltstone and sandstone (fig. 7), and water-laid and air-fall

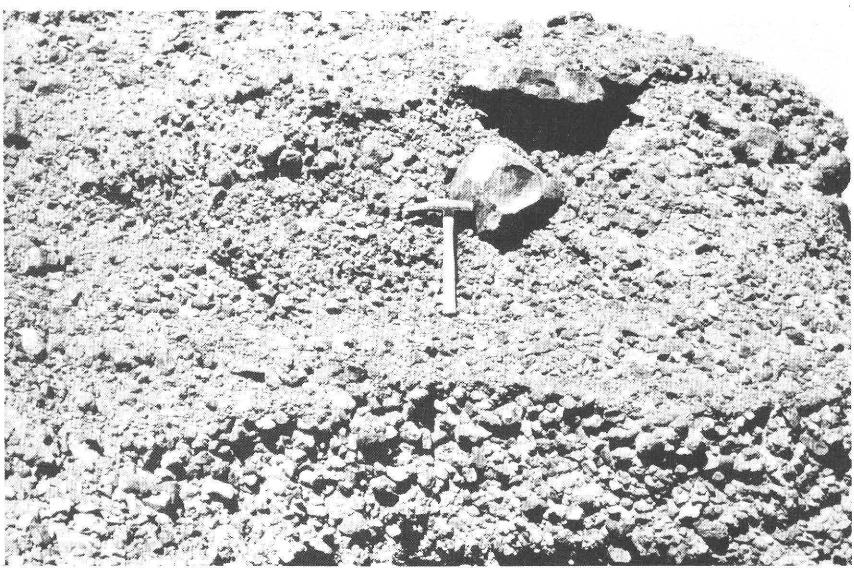

FIGURE 6. —Well-sorted alluvial-facies volcanic breccia and conglomerate in Wapiti Formation along wilderness boundary near head of Timber Creek.

tuffs. These deposits of reworked volcanic debris are referred to as "alluvial facies." Most of the volcanics in the wilderness are vent-facies rocks belonging to the Sunlight Group. Alluvial-facies rocks of all three groups are present, but they are mainly restricted to the northwestern, southwestern, and southeastern fringes of the area. The reconnaissance nature of our mapping did not permit us to show vent facies and alluvial facies as separate map units, but the approximate distribution of these facies is described in the text for each of the mapped formations.

WASHBURN GROUP

The Washburn Group, named after the Washburn Range in north-central Yellowstone National Park, is composed of several laterally gradational, dominantly light colored and dominantly dark colored formations that are the oldest volcanic rocks in the Absaroka volcanic field (Smedes and Prostka, 1972). The light-colored Cathedral Cliffs Formation and the domi-

FIGURE 7.—Well-bedded light-colored volcanic sandstone, tuff, conglomerate, and breccia of Cathedral Cliffs Formation exposed along Fox Creek east of Pilot Peak.

nantly dark-colored Lamar River Formation are the only two formations in the wilderness that belong to the Washburn Group. The Cathedral Cliffs Formation interfingers southwestward with the lower part of the Lamar River Formation; both formations have been extensively disrupted by low-angle Heart Mountain detachment faulting and occur as parts of allochthonous fault masses scattered throughout the northeastern and eastern parts of the wilderness. These fault masses are overlain by rocks of the Sunlight

Group; and west of the wilderness, autochthonous Lamar River Formation is overlain, with slight angular unconformity, by Sunlight Group strata. These relations indicate that the break between the volcanism of the Washburn Group and that of the Sunlight Group was a time of mild tectonism and Heart Mountain faulting.

Cathedral Cliffs Formation

The name Cathedral Cliffs Formation was introduced by Pierce (1963a) to replace "early acid breccia" of Hague, Iddings, and Weed (1896, 1899). In the type section at Cathedral Cliffs, 4 miles (6.4 km) east of the wilderness (pl. 1), the formation, exposed in an allochthonous Heart Mountain fault block, consists of about 500 feet (159 m) of light-gray to yellowish-gray well-bedded, dominantly fine grained volcanic sediments and tuffs. Cathedral Cliffs Formation occurs in several other fault blocks southeast, west, and northwest of the type section; it is autochthonous just west of the northwest corner of the wilderness where it interfingers with the lower 800 feet (244 m) of the Lamar River Formation and pinches out about 5 miles (8 km) southwest of there (U. S. Geological Survey, 1972). Regional facies relations (H. J. Prostka and D. L. Gaskill, unpub. data) indicate that the Cathedral Cliffs Formation was erupted from a line of vents extending from the Cooke City mining district northwest for at least 17 miles (27 km). The vent-facies deposits in this belt grade southwestward into alluvial-facies Cathedral Cliffs strata that, in turn, interfinger with Lamar River Formation still farther to the southwest. The Cathedral Cliffs Formation in the wilderness is dominantly alluvial-facies volcanic sediments (fig. 7) locally intruded by numerous podlike to irregular bodies of autobrecciated andesite (fig. 8) that have also invaded the overlying Lamar River Formation. Prior to Heart Mountain faulting, these intrusive andesites originally were peripheral to the Cooke City mining district and seem to be genetically related to the deeply eroded Cathedral Cliffs vent complex in that area. Emplacement of these intrusives occurred before Heart Mountain faulting, for they are conspicuously present in fault blocks to the southeast, and they are cut by the Heart Mountain breakaway fault just west of the wilderness (Pierce and Nelson, 1971; Prostka and others, 1975).

Because of structural complications and numerous irregular bodies of intrusive andesite, it was not feasible to map the Cathedral Cliffs Formation as a separate unit in the northern part of the area, northwest of Jim Smith Peak. In that area Cathedral Cliffs Formation occurs in the stratigraphically lower parts of the volcanic succession mainly interfingered with Lamar River Formation, but locally faulted out. Southeast of Jim Smith Peak the Heart Mountain fault masses are structurally simpler and in that area the Cathedral Cliffs Formation is shown as a separate unit underlying the Lamar River Formation although the contact between them in most places

FIGURE 8. — Autobrecciated intrusive andesite commonly found in Cathedral Cliffs Formation and lower part of Lamar River Formation.

is gradational. The maximum thickness of allochthonous Cathedral Cliffs Formation in the wilderness is 800-900 feet (245-270 m), which is about the same as that of the autochthonous section in northeastern Yellowstone National Park. In the easternmost part of the wilderness, near Dead Indian Creek, the Cathedral Cliffs Formation is thin or missing, and Lamar River Formation and related andesite intrusives lie directly on Paleozoic rocks.

The volcaniclastic strata of the Cathedral Cliffs Formation consist of medium- to light-gray, brown and green fragments of hornblende-pyroxene andesite, hornblende-biotite andesite, and quartz latite in a dacitic to rhyodacitic tuffaceous matrix. Locally, the lower 200 feet (60 m) of the formation contains sparse to abundant pebbles of Precambrian and Paleozoic rocks. Blocks of Madison Limestone, some as much as a fourth of a mile (0.4 km) across, occur at several places at the top of the Cathedral Cliffs Formation. These have been interpreted by Pierce (1963b) to be small fault masses dispersed along a low-angle dêcollement fault, the Reef Creek fault, that was similar to but slightly older and smaller than the Heart Mountain fault.

LAMAR RIVER FORMATION

The Lamar River Formation was named by Smedes and Prostka (1972) for the sequence of medium-brown, locally hornblendic andesitic volcanic and volcaniclastic rocks extensively exposed in the drainage of Lamar River in northeastern Yellowstone National Park. This unit in the type area composes approximately the lower two-thirds of the "early basic breccia" of Hague (1899) and is overlain with slight angular unconformity by the darker, more massive Wapiti Formation, the upper part of the "early basic breccia." Rocks now assigned to the Lamar River Formation were originally included in the Wapiti Formation when the Wapiti Formation was established by Nelson and Pierce (1968) in and near the southeastern part of the wilderness. Throughout most of its extent, the Lamar River Formation consists of well-bedded alluvial facies volcanic breccia, conglomerate, sandstone, and tuffs that interfinger westward with light-colored Sepulcher Formation (Smedes and Prostka, 1972) and northeastward with Cathedral Cliffs Formation. Lateral gradation from the alluvial facies of the type area to vent-facies deposits occurs about 25 mi (40 km) to the southwest toward a major vent source in the southern part of the Washburn Range (Schultz, 1968), 25 mi (40 km) to the north to another source in the Independence area (D. L. Gaskill, oral commun., 1972), and southeastward into the wilderness suggesting still another Lamar River vent located somewhere between Sunlight Creek and Crandall Creek that is now deeply buried beneath Wapiti Formation. Exposures of coarse alluvial facies which may be Lamar River occur beneath Wapiti vent-facies rocks at the mouths of Spring Creek and Jaggar Creek in the Sunlight area. Some of the light-brown, locally hornblendic alluvial-facies strata in the lower part of the Wapiti Formation exposed in the southeastern part of the wilderness may possibly be equivalent to Lamar River Formation. Detailed petrochemical work is needed to confirm that possibility.

The Lamar River Formation is about 2,000 feet (600 m) thick along the western edge of the wilderness west of the Heart Mountain breakaway fault. Southeast of there, the Lamar River Formation occurs as parts of steep-sided Heart Mountain fault blocks surrounded and partly covered by Wapiti Formation and Trout Peak Trachyandesite (pl. 1; fig. 9). South of Hurricane Mesa, Lamar River Formation dips gently and rests depositionally on Cathedral Cliffs Formation or on Paleozoic rocks that slid with the volcanics as a unit. We interpret the hornblende-bearing rocks on either side of Trout Creek and north of the Four Bear ranch in the southeast corner of the area of plate 1 to be Lamar River that are parts of Heart Mountain fault blocks, whereas W. G. Pierce (oral commun., 1972) considers them to be part of the Wapiti Formation deposited on the fault blocks.

North of Hurricane Mesa, many of the masses of Lamar River and Cathedral Cliffs Formations show much internal deformation with bedding dips of as much as 50°. In some places, such as the north side of Republic Mountain, there are excellent exposures of Lamar River Formation in contact with lower Paleozoic rocks upon the tectonically denuded parts of the Heart Mountain fault. Pierce believes that most of these masses of Lamar River Formation lying on the denuded bedding plane of the fault were deposited there, Nelson believes that some of them may have been deposited there, but Prostka thinks all of them are allochthonous masses that were tectonically emplaced. Before Prostka and Smedes established the Lamar River Formation in the area to the west in Yellowstone National Park, where the Wapiti Formation overlies the Lamar River Formation in normal succession (Prostka and others, 1975; Smedes and Prostka, 1972; U. S. Geological Survey, 1972), Nelson included the patches of Lamar River Formation, surrounded by Wapiti Formation east of the breakaway fault, as parts of the Wapiti Formation (Pierce and Nelson, 1968, 1971). During the present study, some of these areas were remapped, and as a result a number of patches of Lamar River Formation that were not shown on previous maps can be shown on plate 1 of this report.

The Lamar River Formation looks very much like the alluvial facies of the Wapiti Formation, and the two are often difficult to distinguish. Contrasted

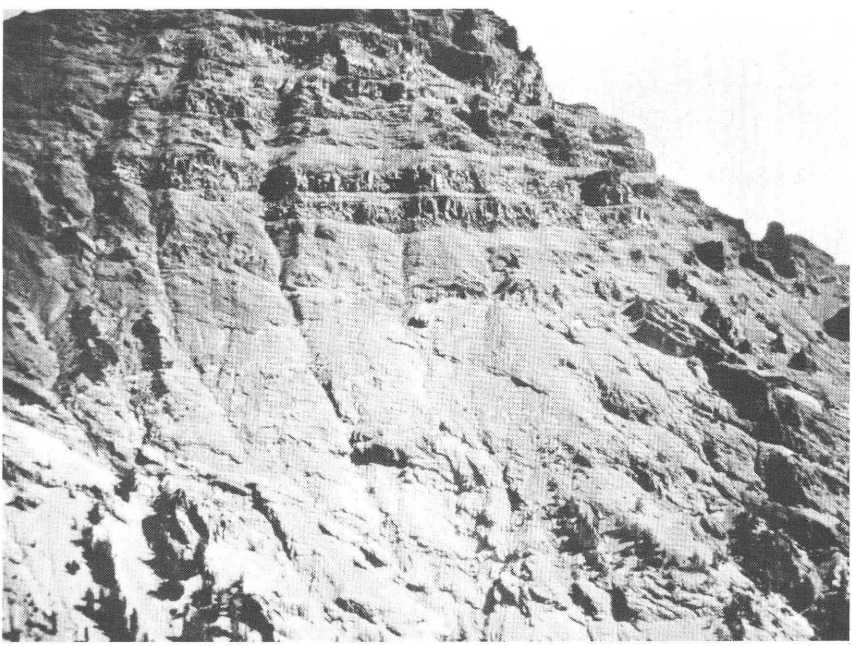

FIGURE 9.—Light-colored Lamar River Formation dipping steeply (50°) to the right is part of an allochthonous fault block. It is unconformably overlain by flat-lying darker colored Wapiti Formation and Trout Peak Trachyandesite, south side of Pilot Peak. Photograph by W. G. Pierce.

with the Wapiti, the Lamar River Formation is generally lighter colored, contains a higher proportion of fine-grained volcanic sediments, typically has volcanic fragments that are of a greater variety of colors, contains abundant petrified wood including large standing tree trunks, is generally more altered looking and breaks across fragments and matrix instead of around fragments, and contains sparse but ubiquitous hornblende. Vent-facies deposits of both formations are even more difficult to tell apart; in general, the lithic fragments in the Wapiti Formation contain larger more conspicuous phenocrysts of plagioclase and clinopyroxene and little, if any, hornblende. Unpublished chemical data on rocks of both formations indicate that the Lamar River Formation is characterized by smaller $K_2O:SiO_2$ ratios; chemical analyses may prove to be the best criteria for distinguishing these formations where megascopic criteria are ambiguous.

SUNLIGHT GROUP

The name Sunlight Group was proposed by Smedes and Prostka (1972) for a sequence of largely dark pyroxene-andesite and shoshonite (trachy-andesite) lava flows and volcaniclastic rocks that compose the stratigraphically middle part of the Absaroka volcanic pile. The group is named after Sunlight Creek which flows through a major vent area—the Sunlight mining region—and through the thickest known accumulation of these rocks. The Sunlight Group in the wilderness area consists of as much as 6,000 feet (1,800 m) of the Wapiti Formation overlain by and partly interfingered with the Trout Peak Trachyandesite. The Wapiti Formation consists dominantly of volcaniclastic rocks of vent and alluvial facies with local, mostly thin, lava flow sequences; the Trout Peak Trachyandesite is dominantly massive mafic lava flows. Toward the vent centers the Trout Peak lavas grade into breccias megascopically indistinguishable from Wapiti breccias; in these areas the two formations are in part laterally equivalent, because the base of the Trout Peak is not a time line but is defined as the bottom of the massive lava-flow sequence (Nelson and Pierce, 1968). In some areas, such as the southwestern part of the wilderness, the contact between these formations is somewhat arbitrary because the Trout Peak contains fairly thick volcaniclastic beds between the lava flows, and the Wapiti Formation contains sizable massive lava flows. Both formations were erupted from the same vent centers, as indicated by the distribution of Wapiti vent and alluvial facies and by the location and geometry of Trout Peak dike swarms and larger intrusive bodies.

WAPITI FORMATION

The Wapiti Formation was defined by Nelson and Pierce (1968) as the sequence of andesitic volcaniclastic rocks and interlayered lava flows of trachyandesite (shoshonite) and andesite extensively exposed on both sides of the valley of the North Fork of the Shoshone River at the southeastern corner of the North Absaroka Wilderness. In the type section it is equivalent to the "early basic breccia" of Hague (1899), but in the northwestern part of the wilderness the lower part of the "early basic breccia" is equivalent to Lamar River Formation. The Lamar River Formation is believed to wedge out southeastward beneath the Wapiti Formation, and in the southeastern part of the wilderness it does not seem to be present except in fault blocks that have slid from the northwest; however, it is possible that the lower part of the Wapiti Formation as presently defined may include rocks equivalent to Lamar River Formation. Light-colored fine-grained volcaniclastic strata, well exposed along Moss Creek, Sweetwater Creek, and at several places just southeast of the wilderness, resemble Lamar River Formation but are included in the Wapiti.

In the area of plate 1 the Wapiti Formation lies in depositional contact on Paleozoic rocks and the Lamar River Formation of Heart Mountain fault blocks and on the tectonically denuded parts of the Heart Mountain fault between fault blocks; west of the breakaway fault it lies on autochthonous Lamar River Formation; and in the southeastern part of the area, at its type section, it lies on Willwood Formation. At the type section it is overlain by massive lava flows of the Trout Peak Trachyandesite. Included within the

FIGURE 10.—View northward up Big Creek from valley of the North Fork of the Shoshone River, showing southeastern part of wilderness, which includes the type section of the Wapiti Formation (Tw), and Dead Indian Peak (1), Trout Peak (2), and Jim Mountain (3). Also shown in the photograph are the Jim Mountain Member (Twj) of the Wapiti, a sequence of lava flows, and the Trout Peak Trachyandesite (Tt), the resistant lava cap on the dissected volcanic plateau. In this area the volcanics overlie lower Eocene Willwood Formation (Twi), here cut by a prominent dike. Photograph by W. B. Hall.

Wapiti is the Jim Mountain Member (Nelson and Pierce, 1968), a sequence of mafic lava flows, chiefly trachyandesite, that resembles the Trout Peak but is much less extensive areally. The Jim Mountain Member (fig. 10) occurs only in the southeastern part of the wilderness and south of Wapiti valley. Westward, the Jim Mountain lavas grade into flow breccias indistinguishable from the vent-facies breccias that constitute most of the Wapiti Formation. The vent-facies rocks below the Jim Mountain Member, however, contain a higher proportion of light-grayish-yellow volcanic ash than the volcaniclastic rocks equivalent to and above the Jim Mountain Member; this difference made it possible for us to map the lower contact of the breccias equivalent to Jim Mountain Member to the west where the lava flows are not present (pl. 1).

Most of the Wapiti Formation in the wilderness is vent-facies flow breccias, mudflow deposits (fig. 5), and thin lenticular lava flows of high-potash pyroxene andesite and, less commonly, hornblende andesite. The fresh rocks are dark gray and brown, but there are extensive areas that have been oxidized and hydrothermally altered to shades of red, purple, green, and yellow. The vent-facies rocks are crudely bedded, have primary dips of as much as 30° that are variable but in general dip outward from the vent centers. Major eruptive centers are recognized by quaquaversal primary dips, facies relations, and presence of large intrusive bodies and radial dike swarms. Much of the wilderness seems to be a complexly overlapping and intertonguing cluster of deeply eroded stratovolcanoes, the exact centers of which would be difficult to reconstruct. A conspicuous spatter cone of pyroxene andesite is present southeast of Trout Peak. A line of eruptive centers seems to have extended from near Index Peak southeast to Sunlight Basin, and another from the Sunlight mining region southeast to Horse Creek. Another center may have been in the Cooke City mining district north of the wilderness.

Alluvial-facies strata are medium- to dark-brown massively bedded well-sorted volcanic breccias and conglomerates and minor volcanic sandstones and siltstones (fig. 6). These strata are thicker in the southwestern and southeastern parts of the wilderness than in the northern and central parts. In the southeastern part of the wilderness, alluvial-facies deposits, only tens of feet thick and interlayered with vent-facies rocks both above and below the Jim Mountain Member, thin and pinch out to the northwest. In the vicinity of Grinnell Creek in the southwestern part of the wilderness, tongues of coarse alluvial-facies strata are as much as 2,000 feet (600 m) thick.

Penecontemporaneous deformation structures characterize much of the lower 800 feet (250 m) or so of the Wapiti Formation in the southeastern part of the wilderness, from Jim Mountain west to Clearwater Creek. The volcanic strata are broadly folded, locally intensely contorted, and faulted. The degree of deformation varies widely and erratically from place to place, but the top of the deformed interval is planar and apparently has been beveled by erosion. Similar structural features have been described in the Wapiti and Pitchfork Formations farther south (Hay, 1954). These features are probably the result of gravity sliding of wet volcaniclastic strata down gentle slopes, which was in part triggered by nearby earthquakes associated with volcanic eruptions.

TROUT PEAK TRACHYANDESITE

The Trout Peak Trachyandesite, named by Nelson and Pierce (1968), is a sequence of alkalic mafic lava flows and associated flow breccia, tuff, and locally interlayered volcanic sediments that overlie and in places interfinger with Wapiti Formation. The base of the Trout Peak Trachyandesite is defined as the base of the massive lava-flow sequence. Because the flows locally grade laterally into breccias indistinguishable from those of the Wapiti Formation, the base of the Trout Peak is a time-transgressive lithologic break. At the type section of Trout Peak in the southeastern part of the wilderness, all the flows seem to be conformable, but from 2-5 miles (3.2-8 km) southwest, in an area west of the area mapped at the time the member was defined, the flows composing the lower part of the formation are folded into a syncline which has been beveled by erosion and which is unconformably overlain by nearly flat lying, generally thicker, flows of the upper part of the formation (fig. 11). The axis of this intraformational syncline trends southeastward approximately along the valley of Big Creek (pl. 1), and the steep southwestern limb dips as much as 40°. To the west and north the fold dies out and all the flows are about parallel. Because the flows above and below the unconformity are petrologically very similar it was not possible to tell whether the flows elsewhere in the wilderness are equivalent to the upper, lower, or both sequences of flows in the type section.

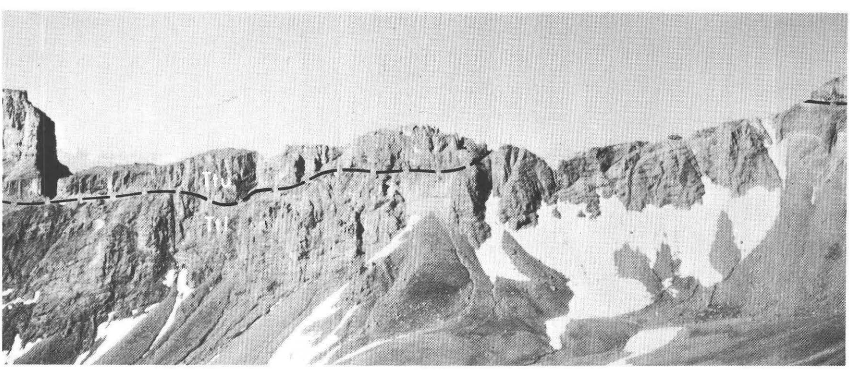

FIGURE 11.—Southwest side of The Wall showing angular intraformational unconformity in Trout Peak Trachyandesite. Thick massive upper lava flows (Ttu) unconformably overlie thinner lower flows (Ttl) that dip moderately to the left.

Throughout all but the southwest corner of the wilderness the Trout Peak Trachyandesite caps most of the higher peaks and is the youngest volcanic unit present. Locally, much of the unit fingers out into Wapiti breccias; in the Sunlight mining region and near Hoodoo Peak, flow breccias rather than lava flows predominate, hence, in these areas most of the Trout Peak equivalent is shown as Wapiti Formation. In the southwest corner of the wilderness, sequences of alluvial facies, volcanic breccias, and conglomerates as much as 500 feet (150 m) thick, and very similar to Wapiti Formation, are interlayered with the Trout Peak lava flows. These alluvial sequences are lenticular and pinch out to the northeast, north, and southwest. In a few places the Trout Peak lavas interfinger with light-colored volcanic sediments of the lower part of the Langford Formation. This interfingering is seem most dramatically to the west in Yellowstone National Park (Smedes and Prostka, 1972), but in the wilderness it occurs in the headwaters region of Bear, Jones, and Crow Creeks, in the upper part of Black Mountain, and just east of the Heart Mountain breakaway fault in the ridge north of Closed Creek (too small to show on plate 1). The maximum thickness of the Trout Peak Trachyandesite in the wilderness is about 1,400 feet (425 m).

The lava flows that compose most of the formation are dark gray to brown, are lenticular, and have scoriaceous brecciated flow tops reddened by oxidation. Individual flows are mostly 30-150 feet (9-45 m) thick and commonly have widely spaced, poorly defined columnar joints. The flows are of trachyandesite (shoshonite and absarokite), characterized by mainly large conspicuous grains of plagioclase, pyroxene, and olivine, in various proportions in different flows, in a potash-rich groundmass composed largely of sanidine, plagioclase, and pyroxene (Iddings, 1895; Hague and others, 1899; Nicholls and Carmichael, 1969; Prostka, 1973). Between some of the lava flows are thin beds of light-gray pumiceous ash. Southwest of the wilderness, a welded rhyodacite ash-flow sheet, the Pacific Creek Tuff Member, is locally interlayered with the uppermost lava flows (Smedes and Prostka, 1972; U. S. Geological Survey, 1972).

The Trout Peak lavas are lava flows that were ponded on the gently sloping flanks of stratovolcanoes. Swarms of dikes, lithologically like the Trout Peak lavas, radiate from the Sunlight mining region, the Hurricane Mesa-Index Peak area, and the Cooke City mining district, thus indicating source vents in these regions. Some of these centers also have larger intrusive bodies of fine- to medium-grained potassium-rich syenogabbro, diorite, dacite porphyry, monzonite, and syenite (Hague, 1899; Lovering, 1929; Parsons, 1939). Contact metamorphism, hydrothermal alteration, and mineralization, locally present in and near the wilderness, are associated mainly with these larger intrusive bodies that will be described in more detail in a later section.

THOROFARE CREEK GROUP

The Thorofare Creek Group is the youngest part of the Absaroka volcanic pile; it mostly overlies, but in a few places interfingers with, rocks of the Sunlight Group (Smedes and Prostka, 1972). It was named for the Thorofare Creek area southeast of Yellowstone National Park (about 25 miles south of the wilderness boundary, fig. 1), and it makes up most of the southern half of the Absaroka volcanic field. Within the North Absaroka Wilderness, rocks of the Thorofare Creek Group are restricted to its southwestern part.

The Thorofare Creek Group is more than 6,000 feet (1,200 m) thick and consists of four formations; however, only the oldest one, the Langford Formation, is in the wilderness.

LANGFORD FORMATION

The Langford Formation is a sequence of dominantly light colored andesitic volcaniclastic rocks of interlayered vent and alluvial facies that overlies and is locally interfingered with the Trout Peak Trachyandesite (Smedes and Prostka, 1972). It is named for Mount Langford (fig. 1) southwest of the wilderness; it includes most of the rocks formerly called "late acid breccia" (Hague and others, 1896, 1899; Hague, 1899). Within the wilderness, it is most extensively exposed on the ridges west of the North Fork of the Shoshone River (pl. 1 and fig. 12) and is a maximum of about 2,000 feet (600 m) thick at the heads of Crow Creek and Jones Creek, where it unconformably overlies Trout Peak Trachyandesite. To the northeast, smaller patches of Langford Formation overlie Wapiti Formation and interfinger with lava flows of Trout Peak Trachyandesite. This interfingering is best seen on Black Mountain where more than 1,200 feet (360 m) of Langford Formation and several Trout Peak lava flows compose the upper part of the mountain.

The Langford Formation consists of interlayered sequences of vent- and alluvial-facies volcaniclastic rocks and minor but conspicuous andesite lava flows (fig. 12). The volcanic fragments are light to dark gray, mainly glassy hornblende and pyroxene andesite in a very light gray ashy matrix that gives the formation an overall light color. Northeast of Cathedral Peak the Langford Formation is entirely of alluvial facies; south of that area, chaotic vent-facies breccias are interlayered with the alluvial-facies strata. The vent-facies sequences thicken southwestward toward vent areas in the Sylvan Pass–Eagle Peak region outside the wilderness (U. S. Geological Survey, 1972). The dike swarms, the larger intrusive bodies, and the associated contact metamorphism in these vent areas are mostly in Yellowstone National Park just outside the southwest corner of the wilderness (pl. 1).

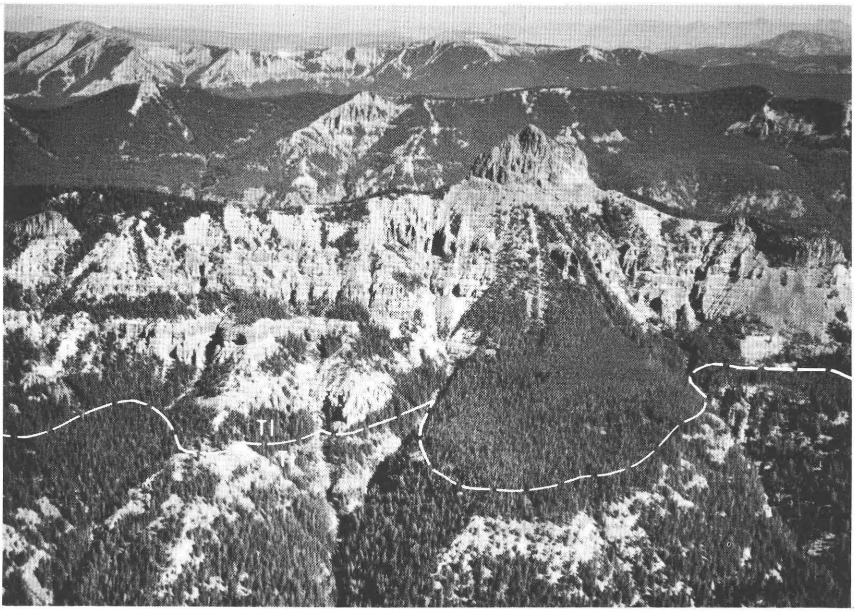

FIGURE 12.—View northward from above valley of Middle Creek in Yellowstone National Park just south of the southwestern part of the wilderness, showing light-colored Langford Formation (Tl) overlying Trout Peak Trachyandesite (Tt). Cody Peak, the prominence just right of center, is one of several craggy peaks carved from thick andesite lava flows in the Langford Formation. Photograph by W. B. Hall.

Andesite lava flows in the Langford Formation are medium pinkish gray to brown, commonly have platy as well as columnar joints, and have associated flow breccias. Individual flows are more than 500 feet (150 m) thick; they are much thicker than Trout Peak lava flows, but unlike them are of very limited lateral extent. Because of their high resistance to weathering they are conspicuously exposed and form spectacular craggy peaks such as Cody Peak, Silvertip Peak, and Giant Castle Mountain.

RELATED INTRUSIVE ROCKS

The intrusive rocks in the North Absaroka Wilderness include numerous dike swarms, some larger irregular bodies of andesite, monzonite, and syenite, and a ring-dike complex of trachyandesite, norite, and diorite. All these intrusive rocks are chemically similar to and are almost certainly genetically related to the lavas of the Wapiti Formation and Trout Peak Trachyandesite; the larger bodies are located close to the centers of vent complexes, and many of the dikes radiate from them.

Most of the dikes average from 5 to 15 feet (1.5–4.6 m) in thickness and are of andesite and trachyandesite. A few of the dikes are more felsic—quartz monzonite, latite, and syenite, but these dikes are close to the larger intrusive bodies and probably are offshoots from them. Most of the dikes dip steeply or are vertical; they occur in swarms that radiate from the Sunlight mining region and from the Hurricane Mesa ring-dike complex. Others occur in parallel swarms; northwest-trending swarms are in the northern part of the wilderness, and also along the wilderness boundary east of Hoodoo Creek. A conspicuous northeast-trending swarm is in the headwaters area of Hoodoo and Timber Creeks. Many more dikes are present than are shown on the map (pl. 1). Time did not permit us to map them in detail; however, the ones shown give a fair idea of their overall trends and abundance from place to place.

The plugs of syenite, monzonite, and andesite in the Sunlight mining region are outside the wilderness and were not studied in detail. Descriptions of them are given by Parsons (1939), Dreier (1967) and Pedersen (1968).

Irregular bodies of diorite and monzonite along and east of Hoodoo Creek (pl. 1) are alined parallel to the dike swarms in those areas and seem to be coarser grained equivalents of the dike rocks.

The Hurricane Mesa ring-dike complex is an oval multiple intrusive as much as 2 miles (3.2 km) in diameter, consisting of a core of fine- to coarse-grained diorite and norite surrounded by a ring of aphanitic porphyritic trachyandesite that locally contains xenoliths of the coarser grained rocks of the core. Contacts with the wall rocks are near vertical, and dikelike offshoots from both the core and the ring are present.

METAMORPHISM AND ALTERATION

Contact metamorphism, hydrothermal alteration and mineralization are locally present in and near the wilderness and are mainly associated with intrusive rocks. The most intense contact metamorphism has affected the country rocks for a distance of more than 2 miles (3.2 km) from the Hurricane Mesa ring-dike complex and from the intrusives of the Sunlight mining region and the Sylvan Pass area. The effects of metamorphism are less intense near the diorite and monzonite intrusives along and east of Hoodoo Creek and still less evident in the country rock of the dike swarms. Compared with the unmetamorphosed volcanics, those affected by contact metamorphism are darker, of gray rather than brownish hues, and are more resistant to weathering. In addition, primary textures are obscured so that close examination is necessary to distinguish breccias, volcanic sediments, and lava flows. Most areas of metamorphosed rocks are associated with exposed intrusives, hence it is unlikely that there are unexposed plutons at shallow depth elsewhere in the wilderness.

Hydrothermal alteration of the kind that is commonly associated with mineralization is most extensive in the Sunlight mining region near the intrusive bodies. Smaller areas of altered rock are near the northwestern border of the Hurricane Mesa ring-dike complex, near the heads of One Hunt and Temple Creeks and on the ridge about 1.3 miles (2 km) east of Jaggar Peak. The larger areas of altered rock are shown on plate 2. A few of these altered areas may be associated with unexposed plutons at depth—this relationship is suggested in a few places by the aeromagnetic data (pl. 2).

No significant mineralization was found to be associated with the altered areas within the wilderness. Samples BBC51, 52, 53, and 245, and BES501, for example, from intensely altered rock in the North Absaroka Wilderness all contain copper, lead, silver, zinc, molybdenum, and gold in amounts no greater than in many unaltered samples from the same stratigraphic units (table 5). Samples BBC51, 52, and 53 are from bleached limonite-stained volcanic rock at the northwest edge of the Hurricane Mesa ring-dike complex. Sample BBC245 is from the wilderness boundary on the south edge of the Sunlight mining region. Sample BES501 is from iron-stained volcaniclastic rock on the boundary between the southwestern part of the wilderness and Yellowstone National Park near the head of Torrent Creek (pl. 2).

Even within the mineralized Sunlight mining region some of the strongly altered rocks, such as those represented by analyzed samples BCM409, 410, 412, 413, and 424 (table 5), contain no abnormal concentrations of metallic minerals. Additional details of the alteration in the Sunlight region are given in the section of this paper by J. E. Elliott on the geology of the Sunlight mining region.

Jasperoid in layers a few feet thick is exposed where limestone has been stripped of its cover of volcanic rocks. The jasperoid seems to have resulted from replacement of the carbonate rocks by silica and iron derived from hot volcanic rocks. Jasperoid is most common in the limestone and basal volcanics of the Pat O'Hara Mountain area (Pierce and Nelson, 1968).

QUATERNARY UNITS

VOLCANIC ROCKS

Remnants of two ash-flow tuffs preserved in the western part of the area shown on plate 1 are parts of the Yellowstone Group (Christiansen and Blank, 1972). Small remnants near ridge tops are probably parts of the older (1.9 m.y.) Huckleberry Ridge Tuff, lower remnants are of the younger (0.6 m.y.) Lava Creek Tuff.

SURFICIAL DEPOSITS

During the Pleistocene Epoch, the North Absaroka Wilderness underwent extensive alpine glaciation which transformed the subdued Absaroka volcanic plateau into the present rugged mountain range with its many cirques, sharp peaks and ridges, and broad U-shaped valleys. The northern and western parts of the wilderness were most intensely sculptured by ice and contain the thickest, most extensive glacial deposits. Most of the morainal deposits are confined to the headward parts of the valleys, but the lower reaches of Pilot Creek, Crandall Creek, and Sunlight Creek valleys all contain till pushed southwestward against and onto the northeastern part of the Absaroka Range by the much more active ice of the Beartooth Mountains that moved down the valley of the Clarks Fork of the Yellowstone River.

In contrast, the valleys in the southeastern part of the wilderness were less intensively glaciated; morainal deposits are largely confined to cirques, and most of the streams flow on bedrock in rugged U-shaped channels. For this reason, stream-sediment samples were much more difficult to collect in this area than in other parts of the wilderness.

A few small rock-choked glaciers still remain, confined to high mostly north-facing cirques on Hurricane Mesa and in the Sunlight mining region.

Subsequent to glaciation, streams deposited alluvial fans and flood plains of sand and gravel in most of the larger valleys.

STRUCTURE AND GEOLOGIC HISTORY

The principal structural features of the North Absaroka Wilderness are the result of Laramide (late Cretaceous-Paleocene) and later deformation. Structural features of Precambrian age in the deeply buried basement rocks may have influenced later structural trends, but to what extent is largely unknown. The Precambrian rocks were eroded to a surface of low relief before the Cambrian sediments were deposited.

The Phanerozoic sequence of Middle Cambrian through Upper Cretaceous marine-shelf and continental sedimentary strata is interrupted by several disconformities (table 1) that indicate recurrent and mild uplift of the craton. Although the missing parts of the stratigraphic succession represent considerable stretches of geologic time, appreciable folding or tilting did not occur.

The Laramide orogeny, lasting from Late Cretaceous to late Paleocene, and locally into Eocene time, was the most profound structural disturbance that affected the area after Precambrian time. The block forming the Beartooth Mountains rose, the Bighorn Basin subsided, and many folds such as the Rattlesnake and Pat O'Hara anticlines formed. In the Bighorn Basin, tightly folded strata as young as Paleocene (Fort Union Formation) are unconformably overlain by the lower Eocene Willwood Formation which is largely post-tectonic.

Low-angle detachment faults, the South Fork and Heart Mountain faults (fig. 13), were formed in mid-Eocene time during the waning stages of folding, at the same time that the voluminous Absaroka volcanic rocks were catastrophically erupted. The South Fork fault is exposed only in the valley of the South Fork of the Shoshone River (fig. 1); however, the fault plane probably extends in under the southern part of the North Absaroka Wilderness. Rocks of Jurassic through early Eocene age (Sundance to Willwood)

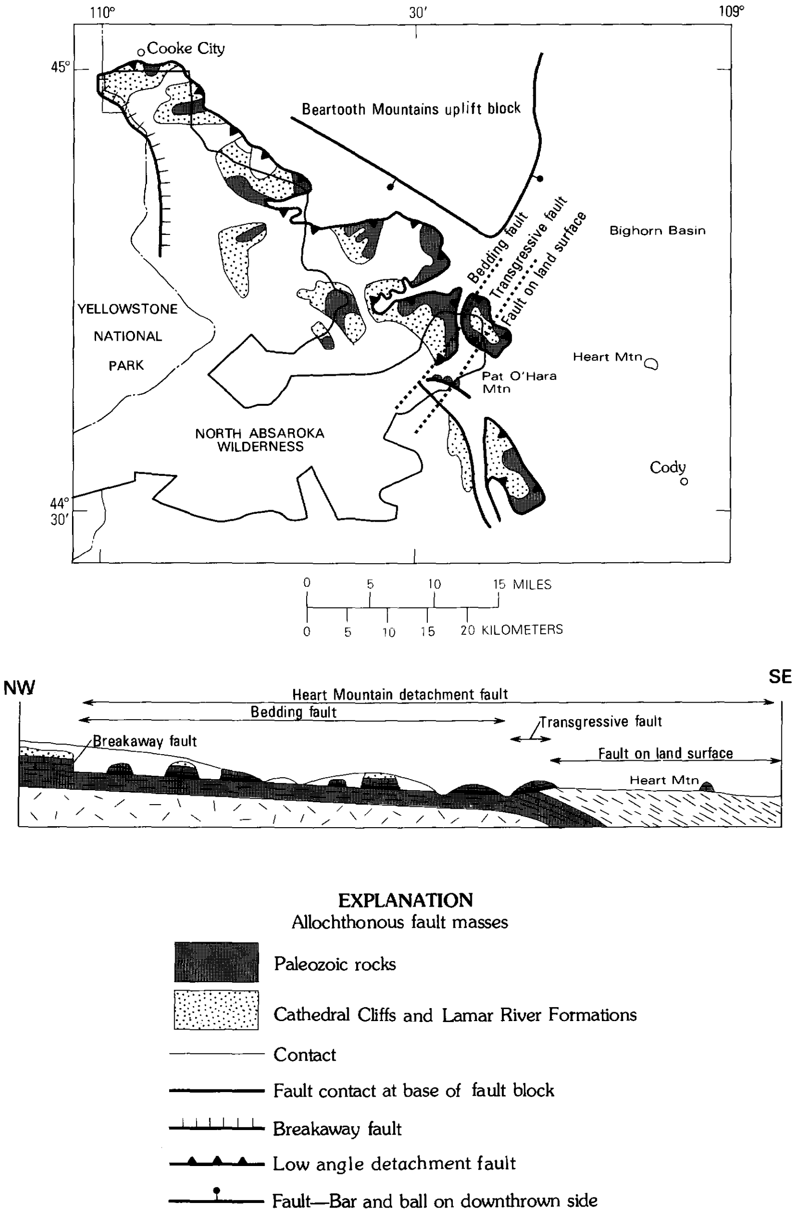

FIGURE 13.—Diagrammatic map and cross section showing extent of Heart Mountain breakaway fault, allochthonous fault masses, and other major structural features in and near the study area. Modified from Pierce (1960) and based in part on the present study.

composing the upper plate of the South Fork fault slid southeastward on a nearly horizontal bedding-plane surface, from an area that includes the southeastern part of the wilderness to the vicinity of the South Fork of the Shoshone River where they piled up in northeast-trending folds and low-angle thrusts (Pierce, 1941; Pierce and Nelson, 1969).

This sliding was soon followed by the formation of the Heart Mountain detachment fault in which Ordovician through Mississippian strata (Bighorn to Madison), the Eocene Crandall Conglomerate, and the overlying volcanics (Cathedral Cliffs and Lamar River Formations) slid southeastward across the northeastern half of the wilderness and broke into scattered blocks. These blocks, the tectonically denuded fault plane between them, and the breakaway scarp were immediately buried by the Wapiti Formation, the Trout Peak Trachyandesite, and, Pierce believes, the youngest part of the Lamar River Formation. The sketch map and cross section (fig. 13), modified from Pierce (1960) and based in part on the present study, show the generalized structural relationships of different parts of the Heart Mountain detachment fault. The Heart Mountain breakaway fault—the steep scarp formed as huge blocks of Paleozoic rocks and Tertiary volcanic rocks slid away to the southeast—follows a south and southeastward trend close to the Yellowstone National Park-North Absaroka Wilderness boundary (pl. 1, fig. 13). This scarp, more than 3,000 feet (915 m) high, formed during the Eocene and was protected from erosion by volcanic rocks deposited or tectonically emplaced against it soon after it was formed. West of the breakaway scarp, the autochthonous Cathedral Cliffs and Lamar River Formations constitute a gently dipping volcanic sequence about 2,000 feet (600 m) thick that rests on the eroded top of the Madison Limestone (Prostka and others, 1975). Southeast of the breakaway fault, these volcanics and the underlying Paleozoic strata down through the Bighorn Dolomite occur as fault blocks, some as much as 9 miles (14.5 km) across; these blocks are scattered along the bedding fault, which is virtually confined to a single bedding plane low in the Bighorn Dolomite. Most of the northern half of the wilderness is in the area of the bedding-plane fault; the southeastern part of the wilderness, however, comprises the transgressive fault and the land-surface part of the Heart Mountain fault where the fault cuts up and across younger beds (fig. 13; Pierce, 1957). The southwestern limit of the area of the bedding fault is not known, but is inferred to extend southwest to a deeply buried southeast-trending tear fault extending approximately from the southern end of the breakaway fault to the vicinity of Dead Indian Peak. The base of the volcanic rocks is believed to step down eastward about 1,500 feet (460 m) from the Madison Limestone to the basal Bighorn Dolomite across this hypothetical buried fault.

The Heart Mountain fault blocks are a few feet to several miles across, have steep sides, and in plan view (pl. 1; fig. 13) show many straight-line segments and right-angle bends. South of Hurricane Mesa they consist of gently dipping Paleozoic strata and the overlying Cathedral Cliffs and (or) Lamar River Formations. Most large blocks contain a complete Ordovician through Mississippian sequence, but in some, considerable thicknesses of the lower part of the sequence are missing (Pierce and Nelson, 1968, 1971). Most of the blocks are cut by many steep faults that terminate downward at the bedding fault; in some blocks the massive carbonates are extensively shattered, but in others the fracturing is minimal.

North of Hurricane Mesa the Heart Mountain fault blocks are structurally more complex. Along North Fork Crandall Creek, Madison Limestone is complexly deformed and rests on the Heart Mountain fault plane. Northeast and southeast of Squaw Peak, the Madison Limestone in one block is cut by low-angle faults and thrust over other Madison Limestone and Cathedral Cliffs Formation (Pierce, 1963a; Pierce and others, 1973). These imbrications, and several disconnected blocks of Madison tectonically emplaced atop the Cathedral Cliffs Formation farther east, have been interpreted by Pierce (1963b) as features indicative of a detachment fault, the Reef Creek fault, that is slightly older and more areally restricted than the otherwise similar Heart Mountain fault.

North of Jim Smith Peak, the Lamar River and Cathedral Cliffs Formations rest directly either on the tectonically denuded part of the Heart Mountain bedding fault or on small scattered blocks of Paleozoic rocks. Bedding attitudes in volcaniclastic rocks in some of these blocks are as steep as 50° (fig. 9), and the basal few tens of feet of the formation resting on the Heart Mountain fault plane locally show the effects of pervasive shearing and shattering. The maximum thickness of Lamar River Formation preserved in these masses is about 2,000 feet (610 m), which closely matches the total thickness of autochthonous Lamar River cut by the breakaway fault. For this and other reasons, Prostka believes that all the Lamar River was deposited before the Heart Mountain faulting and that all the Lamar River lying directly on the tectonically denuded part of the fault plane slid from the area west of the breakaway fault onto that plane as the closing event of the Heart Mountain faulting. Pierce and Nelson (Pierce and others, 1973) think it is possible that some Lamar River Formation was deposited after Heart Mountain faulting; evidence suggesting this includes the occurrence of hornblende-bearing volcanics in apparent depositional contact with the bedding fault and of small Heart Mountain fault blocks mantled with carbonate fault breccia and overlain by Lamar River Formation, and the apparently gradational contact between Lamar River Formation and Wapiti Formation on Jim Smith Peak. The evidence bearing on the question of the precise time of Heart Mountain faulting as related to deposition of the Lamar River Formation is ambiguous; more than one interpretation is possible, and further work will have to be done to resolve this question.

The Black Mountain and Monument Mountain faults (pl. 1), which are high-angle faults, were active after Heart Mountain detachment faulting during Wapiti time; this activity is indicated by thick alluvial-facies deposits that accumulated on the downthrown blocks, but not on the upthrown blocks. Later movement along these faults cut overlying Trout Peak Trachyandesite and Langford Formation.

The southeastern part of the wilderness is unusual in that the volcanics there were strongly folded and faulted along northwest trends during the time the Trout Peak Trachyandesite was being erupted, thus producing a spectacular intraformational unconformity (fig. 11). The folds and faults die out along strike to the northwest or are truncated by northeast-trending faults (pl. 1). The Big Creek syncline is the tightest structural feature, having dips of 40° on its southwest limb. The core of the Sweetwater Creek anticline exposes light-colored hornblendic volcanics that may be Lamar River equivalent; the axial part of the fold contains sulfur deposits and an oil seep, described by Hewett (1913).

These structures are interpreted to be the last pulse of the Laramide orogeny in this area, rather than some kind of volcano-tectonic deformation related to eruption of the Trout Peak Trachyandesite. Evidence for this view is the fact that the structures are confined to only one flank of the Sunlight volcanic center and the intensity of deformation diminishes toward that center. Also, the structures have northwest trends and are geometrically similar to those in the prevolcanic sedimentary rocks that are along strike to the southeast. The folded volcanics are regarded as being part of the belt of Laramide folds that occur all along the southwest side of the Bighorn Basin.

During the last phases of Trout Peak Trachyandesite volcanism and localized structural deformation, volcanism shifted to centers south of the wilderness and eruptions continued there until late Eocene time (Smedes and Prostka, 1972).

In the Cooke City area, north of the wilderness, intrusive activity continued until late Eocene time (J. E. Elliott, written commun., 1971). Intrusives of middle Eocene age are altered and mineralized, thus suggesting that a major hydrothermal event occurred later, in latest Eocene or Oligocene time. In the Sunlight mining region, rocks of the Wapiti Formation are intruded by syenite stocks that are locally altered and mineralized. The mineralization may be late Eocene or younger in this area.

Oligocene through Pliocene was a time of quiescence during which the Absaroka volcanic plateau remained at a low elevation and was slowly eroded. Late Pliocene time marked the beginning of rapid uplift and more vigorous erosion. Welded ash-flow tuffs of early Pleistocene age from the Yellowstone region were deposited in the newly formed valleys and on remnants of the older erosion surface. Uplift has continued to the present, deeply cutting the easily eroded Eocene volcanics into a rugged mountain range. Relative to the Absaroka Range, the Yellowstone plateau to the west subsided, producing numerous young fault scarps (Love, 1961; U. S. Geological Survey, 1972; Keefer, 1972), some of which extend into the wilderness near Cathedral Peak (pl. 1). Several episodes of alpine glaciation have further sculptured the mountains giving them their present extremely rugged form.

AEROMAGNETIC SURVEY

By DONALD L. PETERSON, U. S. Geological Survey

The aeromagnetic data are part of more widespread surveys flown by the U. S. Geological Survey during 1967. North of lat 44°45′N. and west of long 109°45′W. the survey was flown east-west on an average flight-line spacing of 1 mile (1.6 km) and at a barometric elevation of 12,000 feet (3,660 m). The remainder of the survey was flown north-south with an average flight-line spacing of 1 mile (1.6 km) and a barometric elevation of 13,000 feet (3,965 m). Total-intensity magnetic measurements were made with a continuously recording ASQ 10 fluxgate magnetometer installed in a Convair aircraft. Magnetic datum of the survey is 55,090 gammas.

No magnetic properties of rocks were determined during this investigation. F. J. Vine (written commun., 1971; and E. F. Pruss, oral commun., 1972) reported that all the volcanic rocks investigated by them in the area are normally polarized.

The aeromagnetic data are presented as a total-intensity magnetic map (pl. 2). The larger part of the map consists of a complex pattern of anomalies of high amplitude and short wavelength, which are typical of those associated with volcanic provinces elsewhere in the Western United States. These anomalies result mainly from two effects: the contrasting magnetic intensities among the different rock units and the extreme topographic relief of the area. The wilderness lies within a much larger northwest-trending regional magnetic high. The high is probably related mainly to undetermined features of greater depth and extent than concerns the present investigation.

Only those anomalies that seem to be caused by factors other than topography are discussed briefly below.

A positive anomaly (A, pl. 2) that has an amplitude of almost 500 gammas is located over a syenite stock in the Sunlight mining region. The anomaly is approximately circular and about 2-1/2-3 miles (4-4.8 km) in diameter. Four miles (6.5 km) west of anomaly A is a similar anomaly (B) but one that has an amplitude of a little less than 300 gammas. Topography makes an unknown but probably substantial contribution to anomaly B; however, the anomaly may indicate an unexposed shallow intrusive mass.

The Sunlight mining region is one of the higher parts of the area, having several peaks in excess of 11,000 feet (3,355 m). Yet, magnetic intensity in that region is relatively low, probably because of hydrothermal alteration, which occurs throughout the mining region and is locally intense. A negative anomaly (C) near Sunlight Peak may indicate altered rock at depth.

Another negative anomaly (D) occurs over a topographically high area about 3 miles (4.83 km) north of Black Mountain. Only minor hydrothermal alteration was found on the surface in that area.

The Hurricane Mesa ring-dike complex has no well-defined magnetic anomaly associated with it, such as that over the syenite stock in the Sunlight mining region. The magnetic pattern (E) over the intrusive complex and continuing westward for about 7 miles (11 km) consists of sharp irregular anomalies, which, in most part, reflect topography. These anomalies are superimposed on a 15-square-mile (38.8 km^2) area of high magnetic intensity and have the second highest values on the map, at 3,863 gammas. This area of high magnetic intensity may be part of the large regional high caused by basement features or possibly by a large unexposed igneous body underlying the area.

The topographic anomaly over Pilot Peak about 9 miles (14.5 km) to the north has a maximum value of 4,106 gammas, the highest value in the area.

A large equidimensional positive anomaly (F) that has an amplitude of about 200 gammas is located along the southern edge of the area. The anomaly is about 12 square miles (34 km^2) in area and is situated over relatively low topography. No metamorphism or alteration of surface rocks was noted in the area of the anomaly; however, the anomaly is located in an area that may contain an unexposed pluton related to a local vent. North of the anomaly, the dikes trend predominantly northeast and northwest, whereas southeast of the anomaly the dikes trend northwest and curve northward around it. The top of the anomalous source is probably at a relatively shallow depth.

None of the magnetic anomalies in the wilderness (D–F) described above, when viewed in conjunction with the virtual absence of hydrothermal alteration or concentrations of metals, suggest favorable sites for ore deposits.

METALLIC MINERAL DEPOSITS

By Frank E. Williams, U. S. Bureau of Mines

There are four fairly extensively mineralized areas in the Absaroka Range in Wyoming: the Cooke City or New World mining district, which adjoins the North Absaroka Wilderness on the north; the Sunlight mining region, which is nearly surrounded by, but is not part of, the wilderness area; and the Stinkingwater and Kirwin mining districts which are 30 and 40 miles (48 and 65 km) south of the North Absaroka Wilderness. In addition, there has been some prospecting at the Crouch mine at the head of Eagle Creek about 9 miles (14 km) southwest of the wilderness and at several places in the wilderness.

The Cooke City district (Lovering, 1929; Reed, 1950; and Butler, 1965) has produced significant amounts of metal (lead, silver, copper, and gold). The other mining districts have not produced any metal although intermittent prospecting and development work have been done since they were first explored about 80 years ago. The Kirwin district, Cooke City district, and the Sunlight region were the sites of drilling and other exploratory activity at the time of our study. The results of these activities have not been revealed.

The known concentration of metallic minerals in the Absaroka Range are associated with intrusive rocks in volcanic centers. The intrusive bodies in and near the North Absaroka Wilderness are alined in a northwest-trending belt termed the Sunlight intrusives by Hague (1899) and the Eastern Absaroka Belt by Chadwick (1970).

SUNLIGHT MINING REGION

HISTORY

The Sunlight mining region was originally called the Telluride mining region, but it has never been designated a mining district. Access is by road along Sunlight Creek (fig. 1).

Prospecting began in the Sunlight mining region in September 1890 when John R. Painter filed the first claim location notice on his Silvertip Group in Silvertip Basin at the Bighorn County courthouse, Basin, Wyo. This original claim was filed as being "at the head of Stinkingwater River," later called the North Fork of the Shoshone River.

During the next 20 years, 411 location notices were filed. Most of the early prospecting in the region took place in the 6-year period 1903-08. The only recorded ore produced from the region was in 1903 when 100 tons (91 metric tons) containing gold, silver, copper, and probably some lead, was reported to have been mined from the Painter property.

In 1901-02, W. W. McClung put together a group of claims he subsequently sold to the Winona Gold-Copper Mining Co. of Wyoming, which was formed in 1906. The ground explored by the company initially consisted of 31 claims in Sulphur Creek basin at the foot of Stinkingwater Peak. A 763-foot (233-m)-long crosscut adit and a 350-foot (107-m)-long drift were driven. Outcrops on the various claims were tested prior to 1911. No production from this early-day operation was recorded.

Periodic flurries of prospecting have occurred in the region to the present day, as indicated by the data in table 2. Of the 1,100 claim locations recorded in the Sunlight mining region, 38 percent were filed in the two decades between 1890 and 1910. Most of the remaining recordings, including 12 claims filed as being about 3 miles (4.8 km) south of Sunlight Peak, reflect activity during the last 12 years. However, actual exploration at the claim sites seems to have been minor. When the area was visited in mid-1970, only one location notice was found. Most workings were badly caved or obliterated by slide rock and there was little evidence of recent exploration. Two companies were staking an entirely new set of claims and doing required location work.

Figure 14 is a claim map of the Sunlight mining region showing the outlines of 668 claim locations plotted from county records. Patents were

TABLE 2. —*Numbers of claims filed in recorders' offices, Sunlight mining region, by decades*

Year interval	Number of claims	Percent of total
1890–1900[1]	68	6
1901–1910	343	32
1911–1920	87	8
1921–1930	2	—
1931–1940	38	3
1941–1950	42	3
1951–1960	259	24
1961–1971[1]	261	24
Total	1,100	100

[1]11-year interval.

TABLE 3. —*Assays from the Sunlight mining region, Wyoming*

[The description of the sample locality and material sampled is in the text]

Sample No. BCM-	Gold (ounces per ton)	Gold (ppm)	Silver (ounces per ton)	Silver (ppm)	Copper (percent)	Lead (percent)	Zinc (percent)
406	0.01	0.34	0.06	2.06	0.01	0.04	0.02
407	.03	1.03	.17	5.83	.31	.04	.05
408	.02	.69	.08	2.74	.18	.04	.04
409	.02	.69	.48	16.46	.01	.035	.03
410	.02	.69	.18	6.17	Trace	.02	.02
411	.005	.17	Trace	Trace	Trace	.04	.04
412	.02	.69	3.66	125.54	Trace	.03	.04
413	.02	.69	.24	8.23	.01	.05	.04
414	.04	1.37	.50	17.15	Trace	.028	.04
415	.06	2.06	.44	15.09	.05	.04	.03
416	.06	2.06	2.34	80.26	.07	.08	.10
417	.04	1.37	2.32	79.58	.01	.06	.025
418	.01	.34	.53	18.18	.01	.08	.02
419	.005	.17	.20	6.86	.01	.02	.02
421	.01	.34	.45	15.44	.30	.04	.05
422	.005	.17	.46	15.78	.14	.04	.04
423	.03	1.03	.44	15.09	1.16	.045	.05
424	.02	.69	.48	16.46	.04	.04	.09
425	.02	.69	1.18	40.47	Trace	.06	.03
426	.02	.69	.68	23.32	Trace	.16	.03
427	.01	.34	Trace	Trace	.01	1.40	.09
428	.005	.17	1.60	5.49	.16	.04	.04
429	.05	1.72	.05	1.72	.02	8.84	.02
430	.02	.69	24.32	834.18	.05	.76	.30
431	.03	1.03	.57	19.55	.02	.04	.05
432	.01	.34	Trace	Trace	.08	.04	.07
433	.03	1.03	Trace	Trace	.02	.08	.04
434	.02	.69	1.28	43.90	.01	.04	.05
435	.005	.17	.10	3.43	Trace	.04	.05
436	.005	.17	Trace	Trace	Trace	.035	.04
437	.01	.34	.05	1.72	Trace	.10	.10
438	.005	.17	.25	8.58	Trace	.04	.05
439	.01	.34	.09	3.09	.02	.04	.10
440	.005	.17	.10	3.43	Trace	.035	.05

TABLE 3.—*Assays from the Sunlight mining region, Wyoming*—Continued

Sample No. BCM-	Gold (ounces per ton)	Gold (ppm)	Silver (ounces per ton)	Silver (ppm)	Copper (percent)	Lead (percent)	Zinc (percent)
441	0.01	0.34	Trace	Trace	Trace	0.02	0.04
442	.005	.17	0.10	3.43	0.01	.04	.05
443	Trace	Trace	.10	3.43	.01	.04	.04
444	.005	.17	Trace	Trace	Trace	.04	.04
445	.02	.69	Trace	Trace	.01	.02	.05
446	.005	.17	1.50	51.45	Trace	.04	.20
447	.005	.17	.49	16.81	Trace	.035	.05
448	Trace	Trace	Trace	Trace	Trace	.05	.10
449	Trace	Trace	.10	3.43	.01	.20	.08
450	.01	.34	1.19	40.82	.03	.88	.10
451	.01	.34	.29	9.95	.01	.06	.10
452	Trace	Trace	.30	10.29	Trace	.04	.10
453	.005	.17	.48	16.46	Trace	.26	.12
454	.005	.17	.56	19.21	Trace	.20	.05
455	.01	.34	.79	20.10	.01	.04	.10
456	.005	.17	.80	27.44	Trace	.035	.10
457	Trace	Trace	.30	10.29	.01	.02	.07
458	.01	.34	.73	25.04	Trace	.04	.06
459	.005	.17	.30	10.29	Trace	.02	.05
460	.01	.34	.77	26.41	Trace	.03	.04
461	.01	.34	3.19	109.42	.02	.04	.03
462	.005	.17	4.20	144.06	.025	.06	.05
463	.005	.17	.30	10.29	.03	.04	.10
464	.05	1.72	2.45	84.04	2.30	.04	.10
465	.01	.34	.75	25.73	.45	.08	.05
466	.02	.69	1.98	67.91	1.09	.04	.10
467	.01	.34	1.09	37.39	1.25	.04	.06
468	.03	1.03	.47	16.12	.43	.03	.05
469	.005	.17	.58	19.89	.12	.02	.05
470	.06	2.06	1.94	66.54	1.47	.04	.04
471	.07	2.40	3.03	103.93	3.53	.04	.05
472	.005	.17	.49	16.81	.03	.04	.02

granted for 18 of these claims, which totaled 358 acres (145 hectares). Ninety-six were relocations. An additional 420 location notices were poorly described in county records and could not be located or plotted in figure 14.

During the 1970 field season, 66 samples of vein material were taken from 40 locations in the Sunlight mining region. Assay results are shown in table 3 and the description of the sample localities and sampled material are also reported in the text where each working is described. Semiquantative spectrographic analyses of these samples are reported in table 6 at the end of this report. The results of these analyses show consistently minor amounts of gold and locally significant amounts of silver, copper, and lead. All samples were taken from narrow veins or small dumps.

WINONA CLAIMS AND PROSPECTS

Originally, the Winona group of claims consisted of a total of 31 lode claims. The claims were located between June 1901 and October 1910.

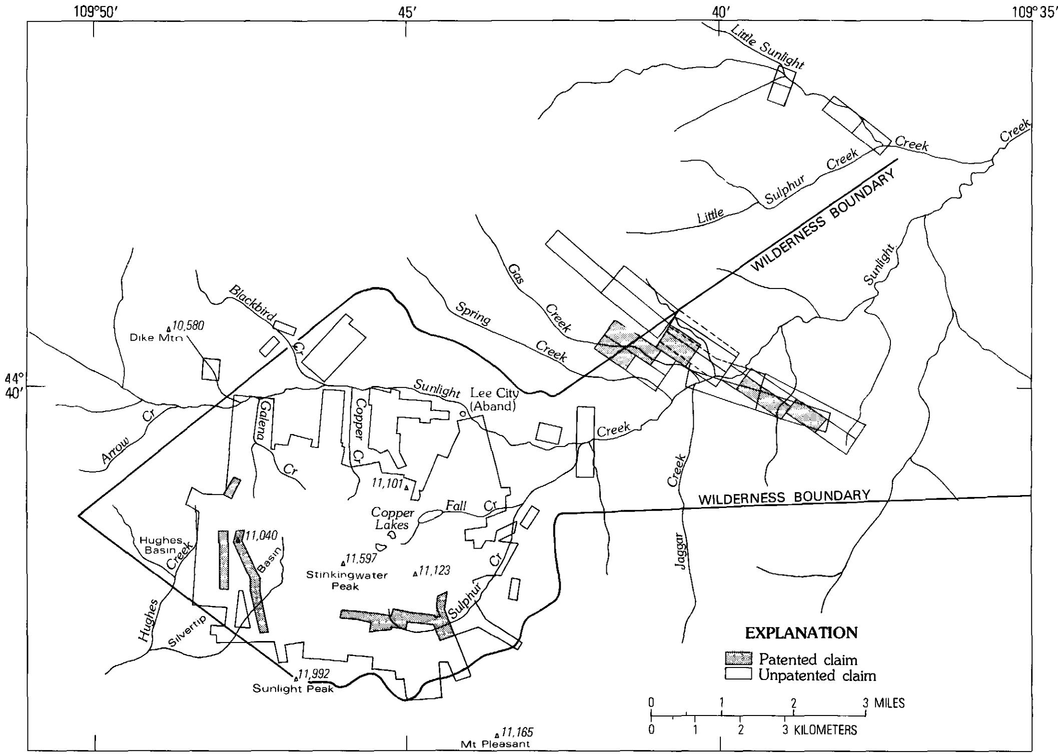

FIGURE 14. —Claim locations, Sunlight mining region.

Patents were issued on nine claims in October 1920 under the ownership of Union Metals Mining Corp., organized in 1920 in Lander, Wyo. These claims, constituting 175.47 acres (70.94 hectares), are Greenhorn, Uncle Frank, Malachite, Copper Queen, Copper King, Mohawk, Copperopolis, Granite Mountain, and Butte. They are now (1973) owned by Mr. Jerry W. Housel of Cody, Wyo.

The Greenhorn claim, located in August 1902, received most of the preliminary exploration. Sometime between 1902 and 1906, the Winona Gold-Copper Mining Co. of Wyoming was founded and a prospectus was issued. In June 1906, an adit was started on the Greenhorn claim to crosscut the vein and during the next five summers 1,135 feet (346 m) of workings were driven, including 350 feet (107 m) of drifting on an unnamed vein. Figure 15 shows the Greenhorn working at the time of patent application survey in 1911.

In its prospectus (circa 1906), the Winona Co. offered seven assays from as many different locales in the claim group, showing gold-silver-copper values ranging from $23.38 to $133.94 per ton. Sample widths or representative tonnages were not reported.

Parsons (1937) reported three assays from claims within the Winona group. He stated that the assays "indicate a relative order of magnitude but the figures are not accurate enough for commercial use." No representative measurements were given with the assays. Parsons' assay of "ore found on the dump" at the Winona mine ran 0.58 ounce gold and 0.88 ounce silver per ton (19.89 ppm gold and 30.18 ppm silver). His assay for an ore sample taken from a dump on the Copper King claim ran 0.04 ounce gold and 0.62 ounce silver per ton (1.37 ppm gold and 21.27 ppm silver) and 3.35 percent copper. His assay for an ore specimen taken from a vein outcrop on the Butte claim ran 0.22 ounce gold and 3.14 ounces silver per ton (7.55 ppm gold and 107.70 ppm silver) and 4.43 percent copper.

East (1911) stated that the Bluff vein of the Winona Gold-Copper Mining Co. was "30 feet wide in andesitic breccia with the sulphides of copper occurring in large bunches with smaller particles disseminated through the entire vein." He also stated that the 750-foot (230-m)-long Winona tunnel cut a 2-foot (0.6-m)-wide vein at 630 feet (195 m) from the portal which had "well defined walls with the sulphides of copper occuring in lens-shaped masses." The 150-foot (46-m) drift reported by East to be on this vein was later found to be 350 feet (122 m), as reported in the land surveyor's 1911 notes.

When the Winona group was examined in mid-1970 only one working was open, a 315-foot (96-m) adit bearing N. 30° W. on the Copper King patent (fig. 16). Others were caved at their portals. Sample BCM407 (table 3) was chipped across a 4.2-foot (1-m)-wide shear zone at the face of the Copper King adit. A second sample (BCM408) was chipped across the 5-foot (1.6-m) back of the drift at a point 185 feet (52.5 m) in from the portal.

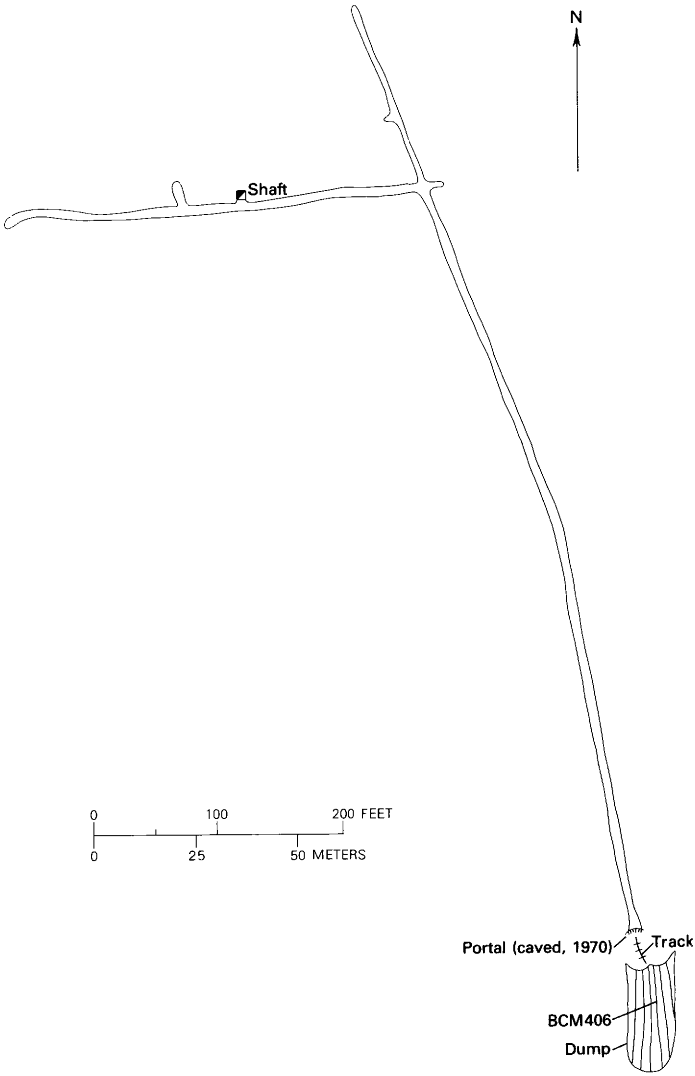

FIGURE 15. — Main Winona adit, Greenhorn claim (patented), Sulphur Creek basin, Sunlight mining region, showing sample locality BCM406. (From Survey No. 460, dated June 1911.)

Sample BCM406 (table 3, fig. 15) was grabbed from the dump at the main Winona adit (Greenhorn claim) on a 20-foot (6.2-m) grid. Determined on an assumption of the 6- by 7-foot (1.8- by 2.1-m) cross section reported in the 1911 survey, an in-place tonnage factor of 12.5 cubic feet per ton, and a probability that no tonnage was shipped, the Winona dump would originally have contained about 4,000 tons (3,628 t).

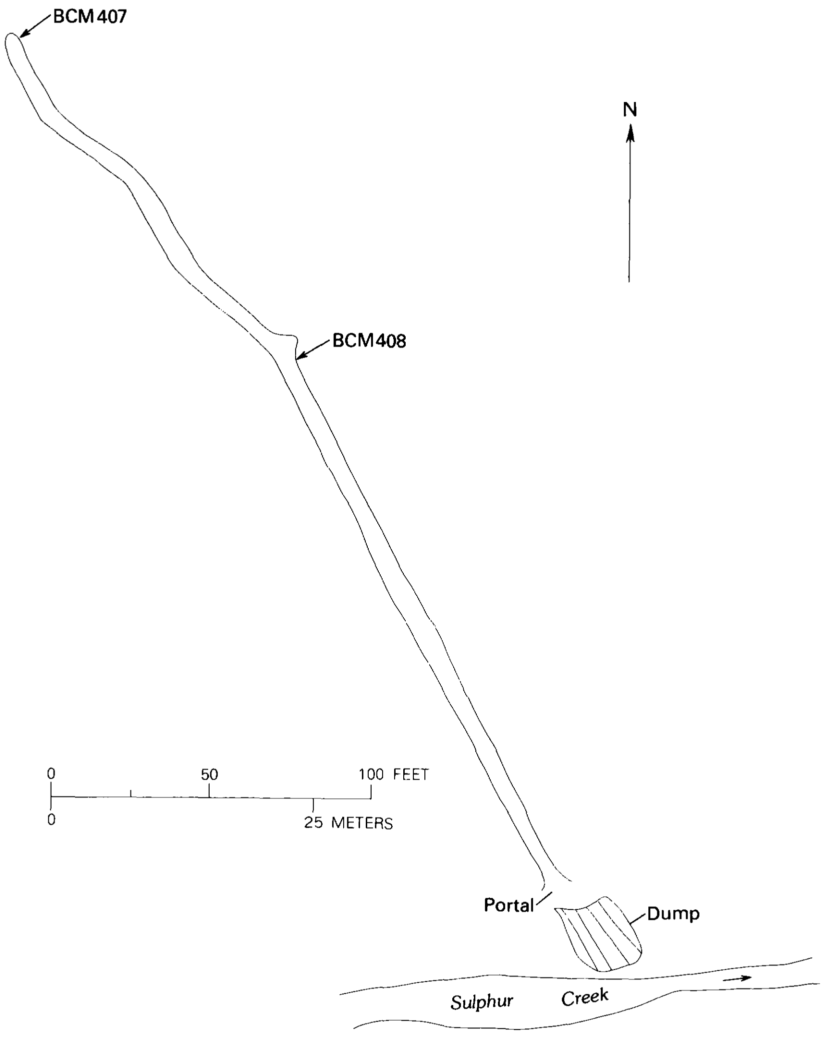

FIGURE 16.—Copper King adit, Winona group, Sulphur Creek basin, Sunlight mining region, showing sample localities BCM407 and BCM408.

Ten prospect-pit dumps were sampled on other claims of the original Winona group. These test pits lie in the upper Sulphur Creek drainage in a cirque just south of a pass leading to the Copper Lakes (pl. 2). Assay data (table 3) showed: gold, 0.005 to 0.03 ounce per ton (0.17–1.03 ppm); silver, trace to 1.18 ounces per ton (trace to 40.47 ppm); copper, as much as 0.30 percent; lead, as much as 1.4 percent; and zinc, less than 0.1 percent. All samples taken were grabbed from the dumps on 4- or 5-foot (1.4- or 1.5-m) centers (samples BCM409–BCM411, BCM421, BCM422, BCM424–BCM427, and BCM433, table 3).

A caved adit about a fourth of a mile (0.4 km) west of the old Winona adit was sampled at its portal. A 2.4-foot (0.74-m) chip sample (BCM412, table 3) was collected across a vertical syenite dike above the portal. A second chip sample was collected (BCM413, table 3) across a 1.1-foot (0.34-m) shear zone of the dike.

COPPER LAKES PROSPECTS

Several caved workings and test pits were examined and sampled in the vicinity of the three Copper Lakes in August 1970. Most of the recorded descriptions are so vague that it is difficult to associate the workings with claim names except for one, the Kodiac claim near the upper or west Copper Lake. The prospects are located on the sample-locality map (pl. 2) and herein are reported by sample number. The results of assays of the samples are shown in table 3.

Sample BCM414 (table 3) is a composite of grab samples taken on a 5-foot (1.5-m) grid pattern from three test-pit dumps along an altered shear zone trending N. 5° E. The structure extends high on the south side of the ridge between upper and middle Copper Lakes. The pits are alined along the structure, one being 175 feet (54 m) south and the other 80 feet (24 m) north of the middle pit.

Sample BCM415 (table 3) is a composite of grab samples on 5-foot (1.5-m) spacings from four test pits just north of those pits represented by sample BCM414. The four pits are 240 feet (74 m), 255 feet (78 m), 465 feet (140 m), and 565 feet (175 m) N. 5° E., from the northernmost pit at sample locality BCM414 and along the same N. 5° E.-trending structure.

Sample BCM416 (table 3) was collected on 5-foot (1.5-m) centers from the dump of a caved adit which contains an estimated 100 tons (91 t) at the southwest end of the main Copper Lake.

Sample BCM417 (table 3) is a composite sample from two dumps of prospect workings high on the slope west of the main Copper Lake and was sampled on 5-foot (1.5-m) centers. The main dump is from a caved adit on a vertical shear zone bearing S. 80° W. in andesite. A small dump of about 100 tons (91 t) on a test pit 140 feet (43 m) (slope distance) west of the main dump is included proportionately in the composite sample.

Sample BCM418 (table 3) was taken at 10-foot (3-m) intervals from a dump estimated to contain 75 tons (68 t). The dump is on the northwest shore of the lower or main Copper Lake and is entirely surrounded by rock talus from peak 11,101. From what could be seen, the adit bears N. 18° W.

Samples BCM430 and BCM431 (table 3) were taken respectively from a small stock pile of cobbed-grade vein material and a small dump located 80 feet (24.5 m) north of the northwest edge of upper or west Copper Lake. The cobbed pile is estimated to contain 1-1/2–2 tons (1.3–1.8 t) and the dump 20 tons (18 t). Sample BCM430 represents selected material from the stockpile. Sample BCM431 was grabbed on 5-foot (1.5-m) intervals from the dump.

This working is the only one in the entire mining region where a location monument complete with location notice was found. From the notice the claim was named Kodiac, and was filed by H. G. Marvin, B. A. Reif, and Margueritte Salinger in August 1937.

Sample BCM432 (table 3) was taken from a 3- by 4- by 5-foot (9.2- by 1.25- by 1.5-m) prospect pit dug on a 4-inch (10-cm) veinlet bearing N. 10° W. in andesite 200 feet (62 m) southwest of the upper Copper Lake. It is a single sample from the full width of the vein.

Samples BCM434 and BCM435 (table 3) were taken from two test adits on the east side of the saddle on the southern slope of peak 11,123. Both adits were probably excavated because of float found in rock talus. The westernmost of the two adits is caved but trends N. 58° E. Sample BCM434 was collected on a 5-foot (1.5-m) grid from the dump of this adit, which is estimated to contain 40 tons (36 t) of rock. The eastern adit, also caved, is 50 feet (15 m) N. 85° E. from the portal where BCM434 was collected. Sample BCM435 was taken from dump "fines" on a 3-foot (0.9-m) grid spacing. The dump contains about 10 tons (9 t) of limonite-stained rock.

Sample BCM436 (table 3) was taken from a quartz veinlet in a 6- by 6- by 6-foot (1.8- by 1.8- by 1.8-m) test pit blasted in massive andesite high on the ridge of peak 11,101, which is just northeast of the saddle between Copper Lakes and Copper Creek. The test pit is caved and practically obliterated by rock talus which masks all outward signs of structure. The quartz veinlet, about 1 inch (2.5 cm) across, was found in a few of the rocks in the test pit. The assay was made on about 2 pounds (0.9 kg) of this material.

Sample BCM437 (table 3) was grabbed from an estimated 25-ton (23-t) dump of a 20-foot (6-m) trench cut at a syenite dike-diorite contact zone about halfway up the slope of peak 11,101 north of the west end of the main Copper Lake. The trench bears N. 33° W. but the lead is completely masked by talus rock.

COPPER CREEK ADIT

An old crosscut adit (fig. 17) was driven into a cliff in Copper Creek basin about 1-1/2 miles (2.4 km) due north of Stinkingwater Peak (pl. 1) and 100 yards (92 m) south of an old cabin. No doubt the adit was at one time covered by a mining claim, but nothing was found on record to establish which claim. The adit bears S. 20° W. for 105 feet (31.5 m), continuing on S. 62° W. for 100 feet (30.5 m) to the face. It was driven in firm andesite to intersect a syenite dike outcrop. The dump contains about 400 tons (363 t). Underground, small shear zones are associated with the dike. Three were sampled. Sample BCM441 (table 3) was chipped from the south wall across a 1.2-foot (0.37-m) vertical shear zone bearing S. 50° E., 8 feet (2.45 m) from the face. At 36 feet (12 m) from the face on the south wall, a 0.7-foot (21.3-cm) vertical shear bearing S. 56° E. was sampled (BCM442, table 3). Sample BCM443 (table 3) was chipped across 1.5 feet (0.45 m) of a parallel shear 47 feet (14.5 m) from the face.

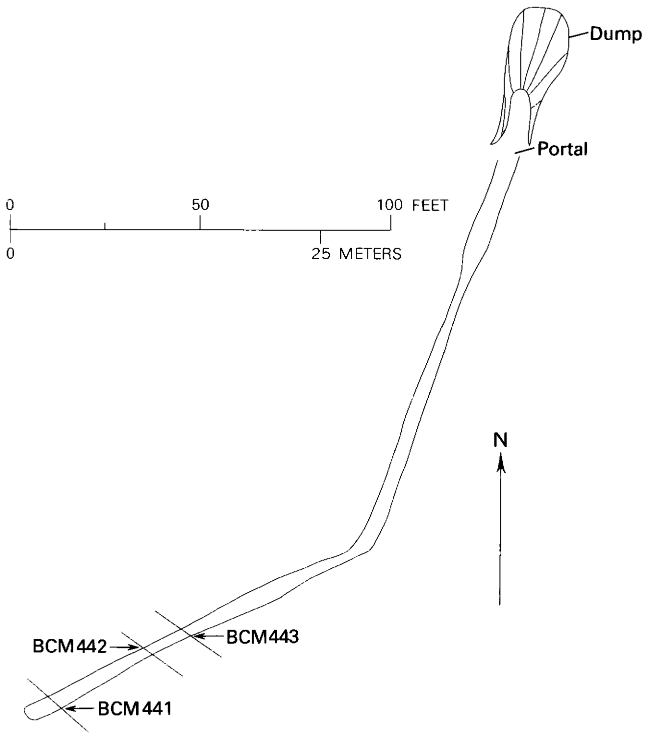

FIGURE 17.—Mine working just south of cabin on upper Copper Creek, Sunlight mining region, showing sample localities BCM441-BCM443.

About 200 yards (185 m) due north of this adit is another adit which is obliterated by slide rock. Remnants of timber sets indicate that it was driven about N. 80° E. into the hillside. A grab dump sample (BCM444, table 3) was taken on a 5-foot (1.5-m) grid from the dump, which contains an estimated 120 tons (109 t).

Also on the Copper Creek drainage are two more prospects, both unnamed. One is a caved adit at 10,000-foot (3,050-m) elevation on the steep west wall of the basin about half a mile (0.8 km) north of the summit of Stinkingwater Peak. This adit was driven on a 4-foot (1.2-m)-wide syenite dike striking S. 72° W. and dipping 78° NW. in andesite near a gabbro intrusive. The dump is nearly obliterated by talus rock. A grab sample (BCM439, table 3) of minus-2-inch (52-mm) material which made up 50 percent of the surface of the 75-ton (68-t) dump was taken on a 10-foot (3-m) grid pattern. The other prospect pit is about 300 yards (270 m) northeast of the site of sample BCM439. This pit, some 200 feet (60 m) lower than the other, has been blasted to expose an 80-foot (24.5-m)-wide irregular syenite sill, which crops out over the Galena Creek-Copper Creek divide in a N. 60° W. direction. A random grab sample (BCM440, table 3) was taken from the estimated 30-ton (27-t) dump.

GALENA CREEK BASIN PROSPECTS

Cursory examinations were made of several syenite dikes in the upper reaches of Galena Creek. Contact zones of the dikes with adjacent andesite host rocks were of particular interest to prospectors. Seven samples were collected from six prospects in the upper cirque and on the crest of the Galena Creek-Copper Creek ridge.

Two short adits about 150 yards (140 m) apart were driven into the west-facing slope high in the Galena Creek cirque. One, 8 feet (2.4 m) long, explored a 4-inch (10-cm) veinlet on the footwall of a 2-foot (0.6-m) syenite dike striking N. 61° E. and dipping 83° NW. Sample BCM451 (table 3) was chipped across the veinlet at the face. The second adit, northwest of the 8-foot (2.5-m) adit, was driven 30 feet (9.2 m) S. 70° E. along an andesite-gabbro contact. It does not expose fracture, shear zone, dike, or mineralization.

Sample BCM452 (table 3) is a hand-picked specimen from a test pit high on the Galena Creek-Copper Creek divide about 1 mile (1.6 km) south of Sunlight Creek. The 6-foot (2.8-m)-wide zone of alteration, with some silicification exposed in the pit, was sampled. The pit bears S. 30° E. and is 3-4 feet (0.92-1.2 m) wide, 3 feet (0.9 m) deep, and 20 feet (6 m) long.

Sample BCM453 (table 3) was taken at a prospect pit about 50 feet (15 m) from the crest of the same ridge on the west-facing slope of a cirque overlooking upper Galena Creek. The pit is in a highly altered zone trending N. 20° W. near a gabbro intrusive in andesite. The cut is 12 feet (3.7 m) long by 8 feet (2.5 m) wide and has a 6-foot (1.85-m)-high face. The sample was taken on 4-foot (1.2-m) centers from the dump.

About 100 feet (30 m) lower than the site of sample BCM453, three samples were chipped from a prospect cut trending N. 38° E. in a highly altered zone in andesite. The cut is 4 feet (1.2 m) wide by 10 feet (3 m) long ending at a 10-foot (3-m)-high face. Sample BCM454 (table 3) is a chip sample across a 0.7-foot (21-cm) quartz stringer exposed at the northeast end of the cut. Sample BCM455 (table 3) was chipped from a 0.6-foot (18-cm)-wide quartz stringer in the southwest end of the cut. Sample BCM456 (table 3) was chipped across a 10-foot (3-m)-wide alteration zone containing a 1-inch (2.5-cm) stringer about 2 feet (0.6 m) southeast of sample BCM455.

Some 300 feet (92 m) lower than the test pit represented by samples BCM454-BCM456 an adit was driven 76 feet (23 m) N. 62° E. and then 19 feet (6 m) S. 66° E. in firm andesite. At 66 feet (20 m) from the portal a 10-foot (3.2-m) crosscut bears N. 20° W. Two thin, barren syenite dikes and a shear zone were intersected by the main adit. A 6-inch (15-cm) chip sample

(BCM457, table 3) was taken from the shear zone at 20 feet (6 m) from the portal. The shear zone bears N. 74°W., and is vertical; it is highly altered with limonitic gouge.

NOVELTY CLAIM

The Novelty claim (20.66 acres; 8.4 hectares) was recorded originally in 1899, amended and surveyed in the fall of 1904, and patented in June 1908 by The Sunlight Copper Mining Co. It is presently owned by H. A. Weaver and E. P. Heald. The Novelty dump is at an elevation of 9,204 feet (2,807 m) on the west fork of Galena Creek near the base of Galena glacier just off a newly bulldozed road at the head of Galena basin and adjacent to a trail that winds up to the Galena Creek-Hughes Creek saddle. The structural feature that was prospected trends S. 24° W. and dips 82° SE. This structure follows the general course of a syenite dike in andesite host rock. Although the portal of the Novelty adit was partially caved when it was visited in August 1970, entrance was easy. The working was surveyed by compass and tape, and samples were taken from shear zones (fig. 18). At the time of the early survey two short adits had been driven. The upper adit was driven 36 feet (11 m) S. 13° W. and a lower adit 39 feet (10.5 m) S. 66° W. Neither bearing correlates with the bearing from the portal of the present adit. No doubt the original work has been obliterated by the Galena glacier.

One grab sample from the dump and five chip samples from the crosscuts were collected and assayed (table 3). Sample BCM445 is a random grab on a 10-foot (3-m) grid across the dump. Sample BCM446 was chipped across a 0.1-foot (3-cm) veinlet that strikes N. 8° E. and dips 72° E.; the veinlet was intersected 4 feet (1.3 m) from the face on the north wall in the main adit. Sample BCM450 was chipped from the east wall 100 feet (31 m) from the portal, across a 0.8-foot (24-cm) vertical vein striking N. 2° E.

The other chip samples were collected from the shorter crosscut (fig. 18). Sample BCM447 (table 3) was chipped from the north wall across three 0.1-foot (3-cm) stringers 1-1/2, 3, and 5 feet (0.5 m, 0.9 m, and 1.5 m) from the face. These stringers are within a shear zone that strikes N. 5° W. and dips 73° E. Sample BCM448 was taken from a 0.2-foot (6-cm) veinlet where two smaller veinlets merge on the south wall of the shorter crosscut 31 feet (10 m) from the face. One veinlet strikes N. 32° W. and dips 52° NE.; the other N. 25° E. and 48° SE. Sample BCM449 (table 3) was chipped from the north wall across a 0.5-foot (15-cm) vertical veinlet that strikes N. 31° W. at 8 feet (2.5 m) from the junction of the two crosscuts.

MORNING STAR CLAIM

The Morning Star claim, 16.87 acres (6.8 hectares) in area, was located originally in September 1904, and was patented in November 1910. It is now owned by H. A. Weaver and E. P. Heald. The claim is at an elevation of about 10,650 feet (3,248 m) on the northeast wall of Hughes Basin just south of the saddle between Hughes and Galena Creeks. Access to the claim

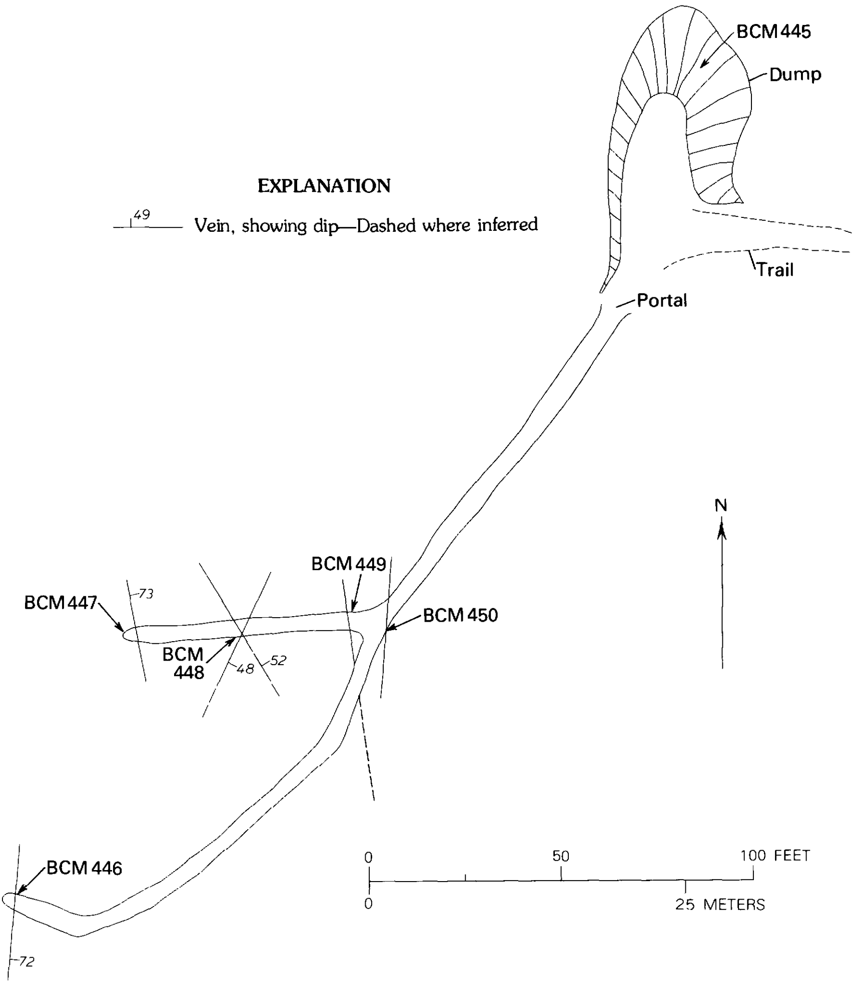

FIGURE 18.—Novelty adit, Galena basin, Sunlight mining region, showing sample localities BCM445-BCM450.

from the Hughes-Galena saddle is along half a mile (0.8 km) of foot trail that crosses slide rock. The course of the claim conforms to the ridgeline along a mineralized syenite dike in firm andesite. The dike strikes N. 10°-15° W. and dips 83° E. at its outcrop. A 273-foot (85-m) adit (fig. 19) driven due east intersects the dike at 254 feet (77 m). The adit extends 13 feet (4 m) N. 13° W. and 44 feet (13 m) S. 14° E. Two chip samples were cut from the face of the north drift. Sample BCM458 (table 3) was chipped across a 1.3-foot (0.4-m) shear zone on the left side of the face. Sample BCM459 was chipped across 1.2 feet (0.3 m) of gouge material on the right side of the face. A third sample (BCM460, table 3) was chipped

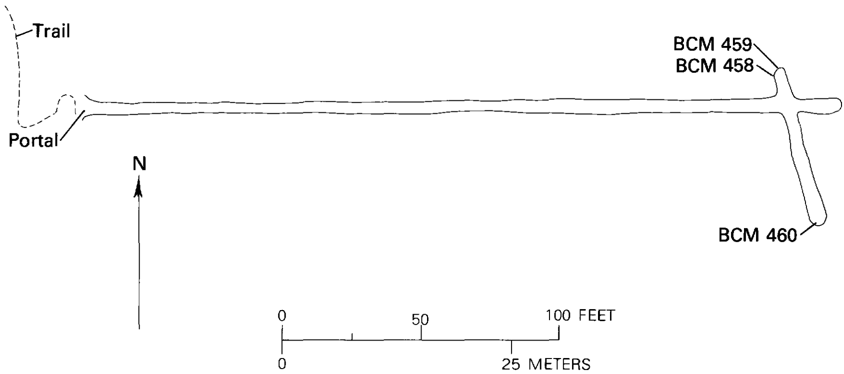

FIGURE 19. —Morning Star adit, Hughes Basin, Sunlight mining region, showing sample localities BCM458-BCM460.

across a 1.2-foot (0.3-m)-wide shear zone in the middle of the face of the south drift. The dump has been obliterated by talus. However, an estimated 825 tons (748 t) of ore has been removed from the prospect, as estimated from its 5-by-6-foot (1.5-by-1.8-m) cross sections.

EVENING STAR CLAIM

The Evening Star and the Katherina claims, totaling 41.32 acres (16.74 hectares), were located in September 1890 and were patented in October 1906 by The Sunlight Copper Mining Co. They are now owned by H. A. Weaver and E. P. Heald. The claims are on the south ridge of peak 11,040 in the saddle between Hughes and Silvertip Basins.

The Evening Star joins the patented Morning Star to the north and the Katherina to the south. Elevation on the ridge is about 10,600 feet (3,233 m). The claim is on the same trail as that to the Morning Star but is about a fourth of a mile (0.4 km) farther south. According to early survey notes the property was prospected by a 30-foot (9.2-m)-deep shaft, two nearly parallel adits bearing N. 20°-23° E., 80 and 200 feet (25 and 60 m) long driven on the same level, and 350 feet (108 m) of drift (fig. 20). The drift bears N. 10° W., which almost coincides with the N. 10°-15° W. strike of the shear zone exposed on the Morning Star claim about 1,500 feet (52.5 m) to the north; it thus presumably follows the same syenite dike in andesite host rock.

Parsons (1937) reported an assay of a "sample taken from the ore vein outcrop" at the Evening Star property to be 0.02 ounce (7 ppm) gold and 91.44 ounces (3,136 ppm) silver per ton, 1.40 percent copper, and 1.30 percent lead. Inasmuch as its silver content was high, this was probably a selected sample.

All the workings were caved at their entrances when the area was visited in mid-1970 and no vein material was visible on the dumps. Grab samples were

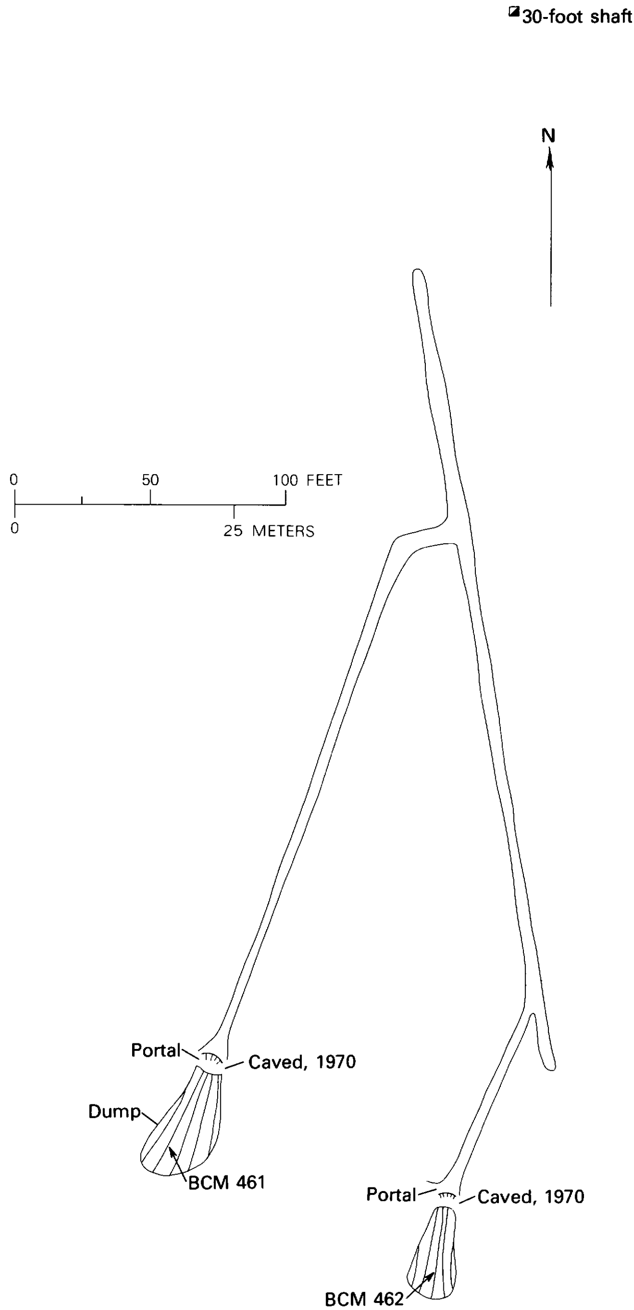

FIGURE 20.—Evening Star workings, Hughes Basin, Sunlight mining region, showing sample localities BCM461 and BCM462. (From survey No. 305, dated September 1904.)

taken on 10-foot (3-m) centers across the two dumps near the portals of the adits. One from the west dump (BCM461, table 3), which contains about 500 tons (450 t), was from the longer adit. Sample BCM462 (table 3) from the east dump, which contains about 950 tons (920 t) was trammed from the shorter adit.

PAINTER MINE

This property, locally known as the Painter mine, comprises five claims dating from 1890. The Silvertip, Boston, New York, Pilgrim, and Rainbow claims were amended in 1903, surveyed in 1904, and patented in October 1907. In all, the Silvertip group consists of 103.31 acres (41.8 hectares). Originally controlled by Sunlight Copper Mining Co., they are now owned by H. A. Weaver and E. P. Heald.

The Painter mine is on the west flank of upper Silvertip Basin just to the east and below the Evening Star patent. The adit of the mine is at 9,370-foot (2,858-m) elevation, but the claim group extends in a northerly trend to the top of peak 11,040 (approximate elevation) (3,367 m). Access to the mine is either by a precipitous 4-wheel-drive vehicle trail from the Hughes-Silvertip saddle or by a horse trail from lower Silvertip Basin.

In 1903, about 100 tons (91 t) of ore was sold by the Sunlight Mining Co. Most came from the Painter mine. Its gross dollar value is unknown, but presumably most of its values were in silver and copper.

Before the original survey for patent application, 10 test pits or cuts had been made on the New York, Boston, Pilgrim, and Rainbow lodes. This work consisted of a 94-foot (28-m)-long upper adit and an 806-foot (250-m)-long lower adit, both driven to explore the Painter vein which trends from N. 20° W. to N. 15° E. (fig. 21).

From the mine-working dimensions given in the 1904 survey notes and from an in-place tonnage factor of 12.5 cubic feet per ton, 2,430 tons (2,200 t) were trammed to the dumps during the exploration of this deposit. The calculated dump tonnage, based on volume measurements taken during the present investigation and a tonnage conversion of 15 cubic feet per ton, corroborates this tonnage, implying little if any work after 1904.

Seven grab samples (BCM464-BCM470, table 3) were taken on 10-foot (3-m) centers across three main dumps and five lesser dumps or stockpiles. An eighth grab sample (BCM471) was taken on 4-foot (1.2-m) centers across a small stockpile (about 2 tons; 1.8 t) of obviously higher grade material. A 1-pound (454-g) sample of gouge material taken from a 1-foot (0.3-m)-wide mineralized zone exposed in the face of the 806-foot (250-m) drift was supplied for assay by Timberline Minerals, Inc. This company had leased the mine from the owners and had opened the mine in mid-August 1971. The assay showed 0.005 ounce gold and 0.20 ounce silver per ton (0.17 ppm gold and 6.86 ppm silver).

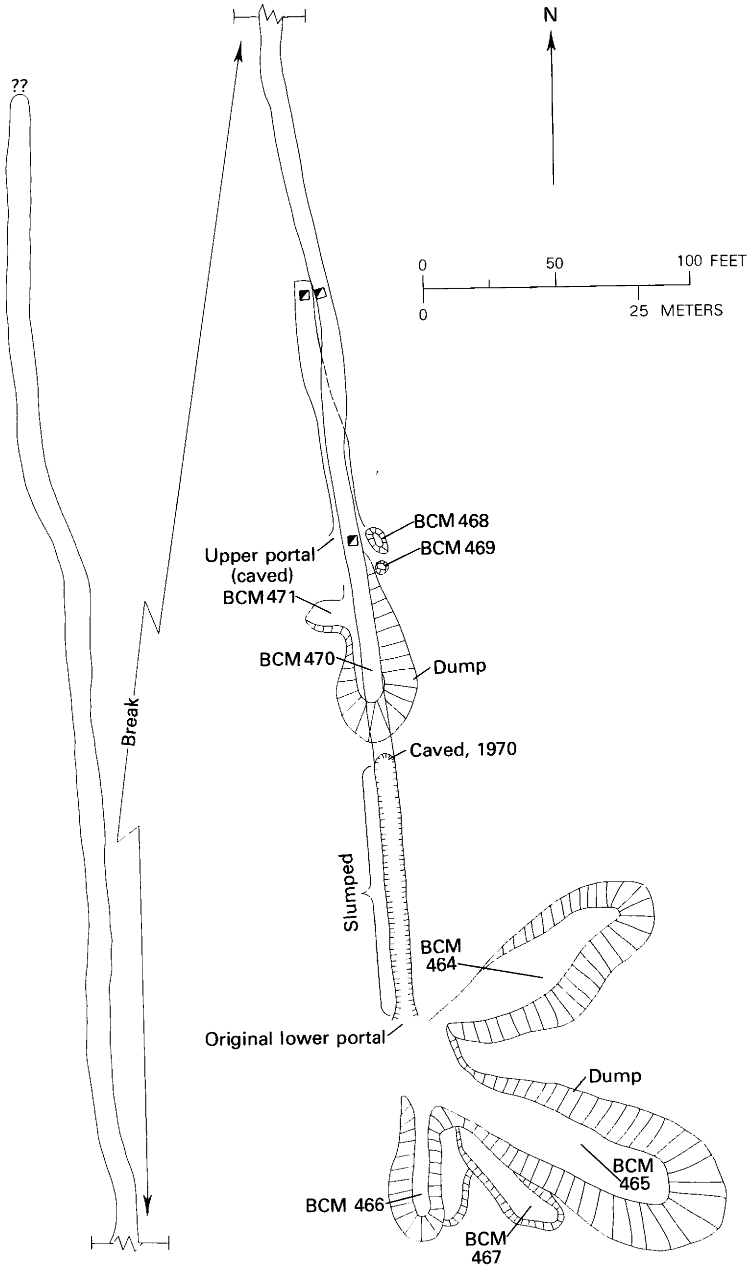

FIGURE 21.—Painter mine, Silvertip Basin, Sunlight mining region, showing sample localities, BCM464–BCM470. (Underground workings from survey No. 306, dated 1903.)

NEWTON PROSPECT

The Newton prospect dump is on the east side of Silvertip Basin at an elevation of 9,266 feet (2,826 m) and is about 1 mile (1.6 km) south of the Painter mine. The prospect consists of a 67-foot (21-m) adit, of which the first 25 feet (7.8 m) was cribbed through slide rock which now is badly caved. The adit is along a vertical shear zone that strikes N. 85° E. in andesite porphyry. No production is recorded. A grab sample (BCM472, table 3) was taken on a 10-foot (3.1-m) grid from an estimated 130-ton (118-t) dump.

UPPER SILVERTIP BASIN PROSPECT

At an elevation of 10,000 feet (3,050 m) in the upper end and on the east side of Silvertip Basin is an adit which is now badly caved. The adit is 52 feet (16 m) long and bears S. 85° E. in blocky andesite. There is no indication of alteration or mineralization. The dump contains an estimated 100 tons (91 t). Sample BCM463 (table 3) was selected from slightly altered material on the dump.

LEE CITY PROSPECT

An abandoned adit bearing S. 20° W., obviously caved for many years, was found at Lee City, an early mining camp on Sunlight Creek about 2 miles (3.2 km) upstream from its confluence with Sulphur Creek. There is no known production or record of work done here. A grab sample (BCM419, table 3) was collected on 10-foot (3.1-m) centers from the estimated 150-ton (136-t) dump.

MINERALIZATION OF THE SUNLIGHT MINING REGION

By JAMES E. ELLIOTT, U. S. Geological Survey

In the Sunlight mining region the concentrations of ore minerals occur in vein-filled fissures and disseminated in andesitic volcanic rocks near intrusive stocks of syenite and monzonite. The veins may be classed as barren and mineralized. Barren veins consist of quartz-pyrite, pyrite, magnetite, and carbonate. Minor amounts of copper and copper minerals are present in most of the pyrite- and magnetite-bearing veins (Dreier, 1967, p. 76). Barren carbonate veins are common as extensions of lead-silver-bearing veins and may carry trace amounts of these metals (Parsons, 1937, p. 849).

Most of the mineralized veins can be classed as one of two types: copper-bearing or lead-silver-bearing. Economically, the copper-bearing veins have the greater potential. The common ore mineral is chalcopyrite, but small amounts of pyrite, bornite, tetrahedrite, native gold, sphalerite, and galena are present. Weathering and minor supergene enrichment have given rise to limonite, malachite, covellite, and chalcocite. Common gangue minerals are quartz, adularia, and carbonates.

Lead- and silver-bearing veins contain galena and tetrahedrite as the principal ore minerals and stromeyerite, chalcopyrite, and native silver in lesser amounts. Benjaminite, a copper-lead-silver sulfosalt, has been described from this type of vein in this region (Dreier, 1967, p. 77). The main gangue minerals are the carbonates calcite, ankerite, siderite, and barite.

Other ore minerals that have been described from various veins in the Sunlight area are sylvanite, famatinite, wolframite, proustite, bournonite, anglesite, cerussite, and cerargyrite (Parsons, 1937). These occur only in minor or trace amounts in a few deposits.

Disseminated deposits consist of (1) pyrite in altered zones in all rock types, (2) magnetite and chalcopyrite in intrusive rocks, and (3) stockworks consisting of a network of copper-bearing veins and veinlets. The widespread mineralization, chiefly pyrite, in all rock types as well as the sparse disseminated chalcopyrite and magnetite in intrusive rocks does not seem to be economically important. The stockwork mineralization in the syenite stock at the headwaters of Sulphur Creek, however, could be economically important. The mineralization consists of a network of veins and veinlets from 1-16 mm wide that compose 5-8 percent of the rock. The veins and veinlets also contain chalcopyrite, bornite, covellite, and chalcocite, along with quartz and calcite as gangue (Dreier, 1967, pp. 73-75).

Widespread and locally intense alteration is conspicuous in the Sunlight mining region. The alteration has been described in terms of intensity (Dreier, 1967) and facies (Pedersen, 1968). The intensity varies with proximity to intrusives, composition and consolidation of the host rocks, and proximity to quartz-pyrite veins. Three alteration facies are recognized: propylitic, argillic, and potassic. Each of the facies can be correlated with intensity of alteration. The most extensive type is a widespread background alteration, principally propylitic facies, that is more intense near intrusives. Potassic facies alteration is restricted to intensely altered zones near intrusive bodies or adjacent to veins. The least abundant type is argillic facies alteration that occurs sporadically with other types in the outer parts of intensely altered zones.

The primary controls of mineralization were intrusive bodies and fracture systems. Disseminated mineralization is localized in and around intrusives; veins are more numerous and better developed adjacent to intrusives. Veins are controlled by joint sets, shear zones, and intersections of joints and dikes. Veins occur in all orientations but northwesterly trending ones predominate.

Lithology is not recognized as an important control of mineralization in this area but may be important at depth below the present level of exposure. Replacement deposits are not known in the Sunlight area, except perhaps on a very minor scale, but in the Cooke City mining district to the north, where erosion has exposed Paleozoic and Precambrian rocks that underlie the volcanic rocks, replacement deposits that have yielded most copper, gold and some lead-silver ores occur in Cambrian limestones and shales. Favorable loci for replacement ore deposits in the Sunlight mining region would be where intrusives, such as syenite stocks exposed at the head of Sulphur Creek and Copper Lakes (pl. 1), are in contact with Paleozoic carbonate rocks.

In the Sunlight mining region all the carbonate rocks, especially the Cambrian rocks that contain replacement deposits in the Cooke City mining district, are deeply buried beneath volcanic rocks. The Sunlight mining region is probably on or southwest of the inferred buried scarp bounding the southwest side of the area that was tectonically denuded by the Heart Mountain fault, and the carbonate rocks of Ordovician, Devonian, and Carboniferous age, which might be favorable hosts for metalliferous replacement deposits, may be present at depth. If replacement deposits in carbonate rocks comparable to those in the Cooke City mining district are present in the Sunlight area, a combination of deep burial and small size of intrusive bodies would make locating and exploiting these deposits very difficult and costly.

The mineralization of the Sunlight area is hydrothermal in origin and should be classed as epithermal to mesothermal (Parsons, 1937, p. 852; Pedersen, 1968, p. 48). The mineralized rocks have banded, crustiform, and vuggy textures, which indicate shallow emplacement (Parsons, 1937, p. 852; Dreier, 1967, p. 77). The deposits are probably related to the magma that formed the syenite stocks. In many aspects the mineralization is similar to that in the Cooke City mining district and in the San Juan Mountains in southwestern Colorado.

Geologic evidence indicates that the most promising mineralization is in the southern and eastern parts of the Sunlight mining region. Much of the most favorable mineralization is localized in or adjacent to syenite intrusives exposed at the head of Sulphur Creek and at Copper Lakes (pl. 1).

Deposits having anomalous copper and gold values (table 6) are clustered mainly in the southern and eastern parts of the district. Deposits having anomalously high silver and lead values are distributed farther north and west as well as in the areas having high values in gold and copper. The results of sampling indicate an essentially copper-gold zone localized in and around the syenite stocks in the south and east. Adjoining this zone to the north and east is a silver-lead zone. This zonation is similar to that at Cooke City where pyritic gold-copper deposits near the center of the district give way to lead-silver-zinc deposits on the fringes of the district. A vertical zonation of metals has also been described for the district by Parsons (1937, p. 849) as well as a regionwide zonation of ore minerals by Dreier (1967, p. 61).

COOKE CITY MINING DISTRICT

HISTORY

By FRANK E. WILLIAMS, U. S. Bureau of Mines

The Cooke City mining district, which is more correctly but less widely known as the New World mining district, is for the most part north of the North Absaroka Wilderness in Montana. However, 22 claims in the district lie wholly or partly in Wyoming and are thus in the wilderness; 3 mines are very near the wilderness boundary. All these workings are less than 2 miles (3.2 km) south of Cooke City. The mines are the Republic, Irma, and Mohawk; the Republic was taken over by Irma Mines, Inc., and the merged workings are presently known as the Irma-Republic Mines and the workings penetrate the wilderness underground a short distance. Figure 22 shows the location of those claims.

According to Lovering (1929), rumors of rich gold, silver, and lead ores in the Cooke City area date from 1868. The first furnace was built in 1875 to smelt ore from Miller Mountain north of Cooke City. In 1878, the Nez Perce Indians stole the lead, probably for shot. A smelter was built in 1883, operating first in 1884. The next year the smelter was enlarged by the construction of a roaster section. In 1886, however, smelter operations were abandoned. The population of Cooke City in those days was about 2,000 persons as compared to the present-day 30 or so permanent residents.

Activity has been intermittent in the district; several properties were worked on a small scale until about 1940 when the McLaren mine 3 miles (5 km) north of Cooke City became a consistent producer of gold-copper ore

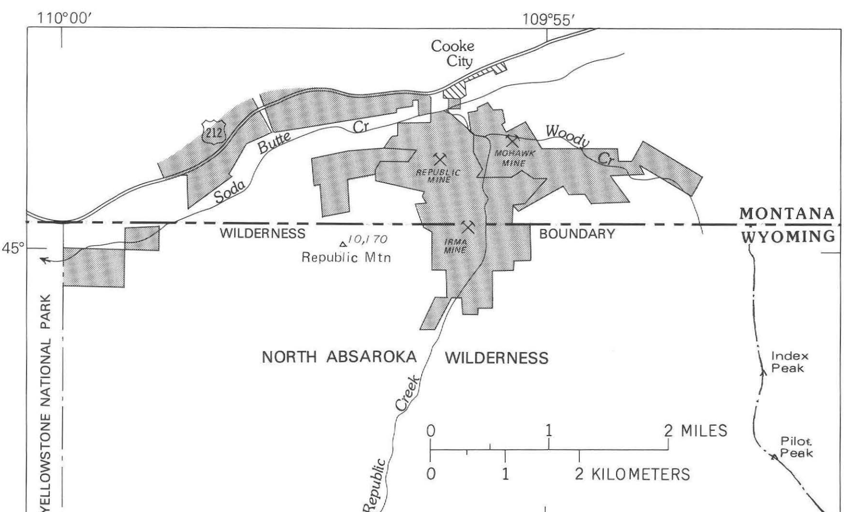

FIGURE 22. — Partial claim map, Cooke City (New World) mining district.

with annual production approaching 40,000 tons (36,280 t) (Reed, 1950, p. 44). This operation ceased in 1953 and activity in the district since has been limited. Currently (1972), at least three companies are actively exploring the area. Although records are incomplete, available information indicates that the district has produced ore valued at $4–$5 million since its discovery.

Although no exploration has taken place in the area south of Cooke City in recent years, knowledge of the past production in this vicinity may attract new interest. Because the workings of most of the mines were either caved or extremely dangerous to enter when visited in mid-1970, we took most of the following information about the workings from the literature.

REPUBLIC MINE

The Republic mine is on the northeast slope of Republic Mountain about three-fourths of a mile (1.2 km) southwest of Cooke City (fig. 22) near the North Absaroka Wilderness. It is at an elevation of 8,250 feet (2,516 m) along an extensive exposure of the Pilgrim Limestone, readily seen from Cooke City.

According to Lovering (1929), the Republic property was actively exploited in the late 1880's, again in 1906, and in the 3-year period 1918–20. The ore occurs as a series of fracture fillings and replacements in the oolitic beds of the Pilgrim Limestone. There were about 3,000 feet (915 m) of workings in about 250 vertical feet (76 m). Most of the work was done by opencut methods along the cliff exposed on the mountainside. However, an adit was used for entry to a series of stopes cut on intersecting fractures. Lovering reported a 200-foot (61-m) adit near the base of the mountain. He also said that oxides in some of the stopes ran as high as 1,000 ounces (3.43 percent) silver per ton. Without some indication of volume, however, such an assay is not truly representative of the potential of the mine.

The main workings of the Republic mine of Irma Mines, Inc., were dangerously caving at the time of the present investigation; no samples suitable for assay could be obtained.

IRMA MINE

The Irma mine occupies parts of 34 lode and 3 millsite claims in secs. 35 and 36, T. 9 S., R. 14 E., Montana, and in unsurveyed T. 58 N., R. 108 W., Wyoming. The claims in Montana include the site of the old Republic mine. Ten whole claims and parts of two others are in Wyoming within the boundary of the North Absaroka Wilderness (fig. 22).

The old mining camp and the shaft collar on the main Irma mine are at an elevation of 8,180 feet (2,495 m), some 200 feet (60 m) above the west bank of Republic Creek about 1 mile (1.6 km) south of Cooke City. The shaft is on the Snowslide claim in Wyoming, but most of the connecting workings are on the Blackrock claim in Montana.

Recorded production was 18,400 tons (16,689 t) of concentrates which contained gold, silver, copper, lead, and zinc. This production was intermittent from 1922 through 1959 with sustained yearly production from 1936 through 1950. The total gross value of this production, mostly in silver and lead, amounted to about $600,000, as based on annual average metal prices.

The Irma mine consists of a 250-foot (76-m) shaft connecting with several hundred feet of workings including a 700-foot (213-m) drainage adit that empties into Republic Creek. The shaft and much of the interworkings were caved in 1970 and could not be entered. The drainage tunnel was intact and permitted access to the lower part of the mine. No ore minerals were exposed, however, in these accessible areas and no samples for assay were obtained.

MARTIN CLAIM

On the Martin claim, a shaft (now caved) and a connecting adit, at an elevation of about 8,000 feet (2,440 m), were cut to explore for ore along a fissure system between the old Republic mine and the main Irma mine. No ore was seen at this locale even though much of the working was accessible in 1970 and was mapped. The Martin portal is about 250 yards (230 m) N. 35° W. from the portal of the drainage adit of the main Irma working.

MOHAWK-WARRIOR MINE

The Mohawk-Warrior mine is about half a mile (0.8 km) southeast of Cooke City along Woody Creek. Most of the text concerning the Mohawk mine is taken from Lovering (1929). In 1922-23, the Mohawk Mining Co. began exploring along a silver-bearing vein. A 110-foot (36-m) shaft was sunk and a 100-foot (33-m) drift was driven from the bottom along a mineralized sheeted zone trending N. 20° W. and dipping at a high angle to the northeast. Ore occurs in numerous thin parallel veinlets within a 1- to 3-foot (0.3- to 0.9-m)-wide zone. Most seams are less than 4 inches (10 cm) across. The veinlets are quartz containing coarse-grained galena, sphalerite, minor tetrahedrite, and secondary silver minerals. The sheeted zone is in the glauconitic upper sandstone member of the Flathead Sandstone, about 75 feet (23 m) above Precambrian granitic gneiss. The shaft collar is in the shale of the Gros Ventre Formation.

WOODY CREEK ADIT

A short adit into the hillside on Woody Creek at an elevation of 7,750 feet (2,360 m) is cut in andesite. When the mine was visited in 1970 the adit was open only to its connection with the shaft.

Eight lode claims filed in 1934 are in the extreme northwest corner of the wilderness (fig. 22). When the vicinity of the claims was examined in 1970 no sign of mining activity could be found and no ore minerals were visible. Stream-sediment samples taken in the vicinity of the claims were spectrographically evaluated but showed no significant metal values.

GEOLOGY AND MINERALIZATION OF THE COOKE CITY MINING DISTRICT

By JAMES E. ELLIOTT, U. S. Geological Survey

Like the Sunlight mining region, the Cooke City mining district is located in one of the eruptive centers along the eastern Absaroka belt. However, uplift and erosion has exposed a deeper level of the volcanic and intrusive complex at Cooke City than at other places in the Absaroka volcanic field. The volcanic cover is preserved only in the western and southern parts of the district; Precambrian gneiss, Paleozoic rocks, and Tertiary intrusive rocks, which range in composition from diorite to syenite, are exposed throughout the rest of the district. The most comprehensive reports on the geology and ore deposits of the area are those by Lovering (1929) and Reed (1950). Several more recent reports (student theses) have been done for the area; one of these pertinent to the present report is by Butler (1965) on the Irma and Republic mines.

In the area of the Irma and Republic mines, Paleozoic sandstone, shale, and carbonate rocks are overlain by a thick sequence of andesitic volcanic rocks of the Absaroka Volcanic Supergroup. The Paleozoic rocks have been intruded by dikes and sills of andesite and dacite porphyry related to the volcanic rock.

The Irma-Republic ores are localized in a nearly vertical vein system that strikes N. 20°-40° W. The silver-lead-zinc ores have been mined from fissure-replacement type deposits occurring in the upper part of the Pilgrim Limestone. The ore shoots and ore bodies are best developed at intersections of fractures and sheeted zones (Reed, 1950, p. 42; Lovering, 1929, p. 78).

Ore minerals are galena, sphalerite, pyrargyrite, proustite, chalcopyrite, polybasite, anglesite, cerussite, silver, freibergite, and argentite. Gangue minerals are quartz, calcite, rhodochrosite, dolomite, ankerite, arsenopyrite, pyrite, marcasite, pyrolusite, psilomelane, and various iron oxides (Butler, 1965, p. 25; Lovering, 1929, p. 80-83; Reed, 1950, p. 42). Alteration at the Irma-Republic mines is silicification and dolomitization along veins and fracture systems; it is locally intense adjacent to veins.

The mineralogy, alteration, and replacement nature of the Irma-Republic ore deposits are characteristically mesothermal. Genetically the deposits are probably related to the Cooke City intrusive center, 2-3 miles (3-5 km) north of Cooke City, and were produced by the action of hydrothermal fluids moving along fractured zones in response to temperature, pressure, and chemical gradients. In the Cooke City district, there is a rough zonal arrangement of ores centered on Henderson Mountain, approximately 4 miles (6.5 km) north of the Irma and Republic mines. The Irma-Republic area is part of the outer zone of complex lead-silver-zinc deposits. Successive inner zones contain pyritic copper-lead and pyritic gold-copper deposits (Lovering, 1929, p. 49).

A geochemical soil-sampling study has been done in the area of the Irma and Republic mines (Butler, 1965). Samples were collected at closely spaced sites along east-west and north-south traverses and were analyzed for cold-extractable heavy metals. Results of this study were largely inconclusive because of the preponderance of transported overburden relative to residual soils. Rock sampling in this area, conducted during 1969–71, was also hampered by the scarcity of outcrops. Anomalous values were mostly restricted to the immediate mine area and areas outside the wilderness boundary.

GEOCHEMICAL SAMPLES AND ANALYSES

The bedrock and stream sediments in and near the North Absaroka Wilderness were systematically sampled and analyzed in a search for anomalous concentrations of elements that might indicate the presence of mineral deposits. Semiquantitative spectrographic analyses of these samples were made in the field by R. N. Babcock, E. F. Cooley, G. W. Day, J. A. Domenico, J. G. Frisken, R. T. Hopkins, J. M. Mitchell, and J. H. Reynolds, and atomic-absorption analyses for gold were made by J. G. Frisken, J. Hassemer, J. D. Hoffman, J. M. Mitchell, and J. H. Reynolds. The significance of these analyses for selected elements is discussed later in this report. The results of the selected analyses are presented in tables 4, 5, and 6 at the end of this report. In table 4 are data on stream-sediment samples, in table 5 are data on bedrock samples from the wilderness, and in table 6 are data on bedrock samples from the Sunlight mining region. Only analyses showing significant amounts of selected elements are published in this report.

Tables 4 and 5 are divided into five parts, each reporting on samples collected from large contiguous areas; these areas are arranged in the tables by geographic position roughly from northwest to southeast, and the samples are listed in rows from west to east in successive rows from north to south to facilitate locating them on plate 2. The sample numbers in the table are those on record with the U. S. Geological Survey; the first two letters of these numbers are not necessary to identify the samples within the study area, and they are omitted from plate 2 for brevity. Spectrographic analyses for 30 elements were made on all samples by the method described by Ward and others (1963), and atomic-absorption analyses for gold were made on all the samples from the wilderness by the method described by Ward and others (1969).

Anomalous values for most of the elements listed in tables 4, 5, and 6 were statistically determined. These determinations were made on the analytical results of samples subdivided by sample type—rock and stream sediment—and by the geographic distribution of the samples. An anomalous value is defined as a value greater than threshold which, in turn, is arbitrarily chosen as twice the geometric mean value of an element in the various sample subdivisions mentioned above. Only a few samples contained tungsten, molybdenum, silver, gold, or tin in amounts greater than the lower detection limit of the analytical method. In these cases, statistical determinations of anomalous values were not possible, and any detectable amount of these elements was considered anomalous.

The evaluation of anomalies is problematic. Clusters of anomalous values may indicate areas of possible economic significance, or merely reflect a high background amount of an element(s) in particular rock types. An isolated anomalous value is most likely spurious, but it could indicate a mineral deposit. In either case, we attempted to locate the source of the anomalies.

MINERAL POTENTIAL

COPPER

The abundance of copper in the samples of rock and stream sediments from within the North Absaroka Wilderness ranged from less than 5 ppm (parts per million), the lower limit of detection, to a maximum of 200 ppm; specimens containing 200 ppm copper were common. Nearly all the higher concentrations of copper are in samples from trachyandesite lava flows and streams draining areas surmounted by trachyandesite flows; other than this there do not seem to be any regional anomalous concentrations of copper in the wilderness. Exceptions to this generalization for stream sediments are samples BEJ141, BEJ142, and BEJ143, which are from near the head of the North Fork of the Shoshone River a short distance downstream from the mineralized area in Silvertip Basin, which is part of the Sunlight mining region. Except in these three samples, there are no anomalously high concentrations of copper or lead in stream sediment samples from near the Sunlight mining region. This indicates that analysis of stream sediments probably would not reveal the presence of other unexposed or poorly exposed deposits of copper or lead that might be present in the wilderness. It is possible, however, that analysis of water or a concentrate of some fraction of the sediments other than those that were analyzed might reveal concentrations of copper and lead derived from the Sunlight mining district, as well as from other unexposed or poorly exposed mineralized areas if such areas are present. Perhaps the copper- and lead-bearing minerals from the shallow, oxidized parts of mineral deposits have been removed by ground-water solution, whereas the copper in trachyandesite flows occurs in more insoluble form in the lattice of the mafic minerals where the copper and lead are retained even after the flow rocks have broken down and the detritus from them incorporated in stream sediments.

Two companies were actively drilling and otherwise exploring the most promising parts of the Sunlight mining region for concentrations of copper and associated metals in 1971, and the outcome of these efforts will probably have important implications for the metal-producing potential of the surrounding wilderness area.

TABLE 4.—*Analyses of stream-sediment samples*

[Samples analyzed by semiquantitative spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1 which represent approximate midpoints of group data on a geometric scale. All samples were analyzed for Fe(0.05), Ca(0.05), and Mg(0.02), but the quantities found are considered normal for the rocks of the region, and, therefore, they are not presented here. Analyses for Sn revealed no significant values, and no determinations are shown. Samples containing amounts equal to or greater than the lower spectrographic detection limits for the As(200), Au(10), Bi(10), Cd(20), and Sb(100) are shown in footnotes. Atomic absorption detection analyses for gold are

Sample	Semiquantitative spectrographic analyses												
	(percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Stream sediments							
			Northern part of area including Pilot and Onemile Creeks										
BBC028	0.3	1,000	N	L	700	L	20	300	10	N	N	N	70
BBC029	.3	1,000	N	L	700	L	20	200	10	N	N	N	70
BBC045	.3	700	N	L	1,000	L	30	300	15	20	N	N	70
BBC046	.5	1,000	N	L	700	L	30	300	10	N	N	N	70
BBC047	.5	1,000	N	L	700	L	30	300	15	N	N	N	70
BBC048	.5	1,000	N	L	1,000	L	50	700	20	20	N	N	100
BBC049	.5	1,000	N	L	1,000	L	30	500	15	20	N	N	70
BBC043	.5	1,000	N	L	1,000	L	30	700	20	20	N	N	100
BBC044	.5	1,000	N	L	1,000	L	30	300	20	N	N	N	70
BBC042	.3	700	N	L	700	L	15	300	10	20	N	N	70
BBC041	.3	700	N	L	700	L	30	300	20	N	N	N	70
BBC040	.3	700	N	L	700	L	20	500	15	N	N	N	70
BBC039	.5	700	N	L	700	L	30	500	15	N	N	N	70
BBC038	.3	700	N	L	700	L	20	300	15	N	N	N	70
BBC037	.5	700	N	L	700	L	30	500	15	N	N	N	100
BBC036	.3	700	N	L	700	L	20	700	10	N	N	N	100
BBC035	.3	700	N	L	700	L	30	1,000	10	20	N	N	100
BBC034	.2	700	N	L	700	L	20	200	5	N	N	N	70
BBC033	.3	700	N	L	700	L	30	300	20	N	N	N	50
BBC032	.5	1,000	N	L	1,000	L	30	200	30	20	N	N	50
BBC031	.3	1,000	N	L	700	L	30	300	10	N	N	N	70
BBC030	.5	700	N	L	700	L	30	500	10	N	N	N	100
Gm	.37	823			772		27	378	14				75
						Crandall Creek drainage							
BBC108	.5	1,000	N	10	700	L	20	1,500	15	20	N	N	100
BBC109	.3	1,000	N	L	700	L	10	200	15	20	N	N	20
BBC110	.5	1,000	N	L	700	L	15	300	15	20	N	N	20
BBC111	.2	1,000	N	L	1,500	N	10	300	20	20	N	N	20
BBC112	.5	700	N	L	1,500	N	20	300	30	20	30	N	100
BBC113	.5	1,000	N	10	1,500	N	20	700	20	L	N	N	50
BBC114	.5	700	N	10	700	N	15	500	15	L	N	N	30
BBC115	.5	700	N	10	1,000	L	20	200	15	20	N	N	20
BBC116	.5	700	N	10	1,000	L	20	300	50	20	N	N	50
BBC117	.5	700	N	10	700	L	20	300	15	20	N	N	50
BBC060	.5	1,000	N	L	700	L	20	200	15	L	N	N	20
BBC061	.3	1,000	N	L	700	L	30	100	30	L	N	N	30
BBC062	.5	1,000	N	L	700	L	30	300	20	L	N	N	30
BBC063	.5	1,000	N	L	1,000	L	30	200	20	20	N	N	50
BBC064	.3	1,000	N	L	700	L	20	200	20	L	N	N	30
BBC065	.3	700	N	L	700	L	20	70	15	L	N	N	20
BBC066	.3	1,000	N	L	700	L	20	200	15	20	N	N	50
BBC306	.3	300	N	10	700	L	10	150	10	20	N	N	30
BBC104	.3	500	N	L	700	L	10	300	10	20	N	N	50
BBC105	.3	500	N	10	700	L	15	200	20	20	N	N	30

from the North Absaroka Wilderness, Wyoming

labeled AA. Symbols used are: N, looked for but not found; G, the amount of the element present is greater than the sensitivity limit; L, an undetermined amount of the element is present below the sensitivity limit; ---, no data given; Gm, geometric mean. Analysts: R. N. Babcock, E. F. Cooley, G. W. Day, J. A. Domenico, J. G. Frisken, R. T. Hopkins, J. M. Mitchell, and J. H. Reynolds (spectrographic analyses); J. G. Frisken, J. Hassemer, J. D. Hoffman, J. M. Mitchell, and J. H. Reynolds (atomic absorption, Au)].

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
							Stream sediments		
				Northern part of area including Pilot and Onemile Creeks					
BBC028	10	20	700	150	N	15	N	50	L(0.02)
BBC029	10	15	700	100	N	10	N	70	L(.02)
BBC045	10	20	1,000	200	N	15	N	100	L(.02)
BBC046	15	20	1,000	200	N	15	N	100	L(.02)
BBC047	15	15	700	150	N	15	N	100	L(.02)
BBC048	10	20	1,000	150	N	15	N	100	L(.02)
BBC049	10	20	1,000	150	N	15	N	100	L(.02)
BBC043	15	20	1,000	100	N	20	N	100	L(.02)
BBC044	10	30	1,500	150	N	20	N	100	L(.02)
BBC042	10	10	700	100	N	15	N	70	L(.02)
BBC041	10	20	700	100	N	15	N	70	L(.02)
BBC040	10	15	700	100	N	15	N	70	L(.02)
BBC039	10	15	700	100	N	15	N	70	L(.02)
BBC038	10	15	700	100	N	15	N	70	L(.02)
BBC037	10	15	700	100	N	15	N	70	L(.02)
BBC036	10	15	700	100	N	15	N	70	L(.02)
BBC035	10	20	700	100	N	15	N	70	L(.02)
BBC034	10	10	700	70	N	10	N	50	L(.02)
BBC033	10	15	1,000	100	N	15	N	70	L(.02)
BBC032	15	15	1,000	100	N	15	N	70	L(.02)
BBC031	10	15	700	100	N	15	N	70	L(.02)
BBC030	10	20	700	150	N	15	N	70	L(.02)
Gm	11	17	812	117		15		76	
							Crandall Creek drainage		
BBC108	10	20	500	150	N	20	N	30	L(.02)
BBC109	10	15	700	150	N	15	N	30	L(.02)
BBC110	10	20	1,000	200	N	20	L	50	L(.02)
BBC111	20	15	1,500	70	N	15	N	30	L(.02)
BBC112	15	20	1,500	200	N	20	N	70	L(.02)
BBC113	15	30	1,500	100	N	20	N	70	L(.02)
BBC114	10	30	1,000	200	N	20	N	70	L(.02)
BBC115	15	20	1,000	100	N	20	N	100	L(.02)
BBC116	15	30	1,500	100	N	20	N	70	L(.02)
BBC117	15	30	1,000	100	N	20	N	100	L(.02)
BBC060	15	15	1,000	150	N	15	N	70	L(.02)
BBC061	15	15	1,000	100	N	15	N	70	L(.02)
BBC062	10	20	700	150	N	15	N	70	L(.02)
BBC063	10	20	1,000	150	N	15	N	70	L(.02)
BBC064	10	15	700	100	N	15	N	70	L(.02)
BBC065	10	10	700	100	N	15	N	70	L(.02)
BBC066	10	20	700	150	N	15	N	50	L(.02)
BBC306	10	15	700	100	N	15	N	70	L(.02)
BBC104	15	10	700	100	N	15	N	70	L(.02)
BBC105	15	15	700	100	N	20	N	70	L(.02)

TABLE 4.—*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Stream sediments--Continued							
						Crandall Creek drainage--Continued							
BBC106	0.3	500	N	L	700	L	10	200	15	20	N	N	15
BBC107	.3	300	N	10	700	L	10	300	10	20	10	N	70
BBC137	.2	500	N	L	700	L	20	300	15	20	N	N	50
BBC138	.5	500	N	L	700	L	30	500	15	L	N	N	50
BBC139	.5	500	N	10	700	L	30	300	15	20	N	N	50
BBC140	.2	300	N	N	700	L	10	150	10	20	N	N	20
BBC054	.5	1,000	N	L	500	L	30	200	15	L	N	N	50
BBC055	.3	1,000	N	L	700	L	30	150	15	N	N	N	50
BBC056	.5	1,000	N	L	700	L	30	200	15	L	N	N	50
BBC057	.5	1,000	N	L	700	L	50	300	15	L	N	N	50
BBC007	.5	1,000	N	L	700	L	50	200	20	20	N	N	20
BBC008	.5	1,000	N	L	700	L	50	300	20	20	N	N	30
BBC058	.5	1,000	N	L	700	L	30	300	15	L	N	N	50
BBC059	.3	1,000	N	N	700	L	20	200	20	L	N	N	30
BBC206	.5	500	N	10	300	L	30	200	20	20	N	N	30
BBC089	.5	1,000	N	L	1,500	N	20	700	30	N	N	N	30
BBC090	.3	1,000	N	L	1,500	N	30	200	20	N	N	N	50
BBC091	.2	700	N	L	700	N	15	500	15	N	N	N	30
BBC092	.3	1,000	N	L	1,000	N	20	300	20	N	N	N	70
BBC093	.5	1,000	N	L	1,000	N	30	300	20	N	N	N	70
BBC094	.2	500	N	L	700	L	15	150	15	20	N	N	30
BBC095	.3	1,000	N	L	700	L	20	300	15	N	N	N	50
BBC097	.3	700	N	L	700	L	15	300	15	N	N	N	30
BBC096	.5	1,000	N	10	1,000	L	30	200	30	30	N	N	50
BBC099	.5	1,000	N	10	700	L	30	500	15	20	N	N	30
BBC100	.2	700	N	L	700	L	10	200	10	20	N	N	30
BBC101	.5	1,500	N	10	1,000	L	15	300	15	20	N	N	20
BBC102	.5	1,000	N	10	700	L	30	300	20	20	N	N	30
BBC103	.5	1,000	N	10	700	L	20	200	20	30	N	N	20
BBC098	.3	1,000	N	L	700	L	10	200	10	20	N	N	20
BBC133	.3	700	N	L	700	L	20	200	20	20	N	N	50
BBC134	.2	700	N	L	700	L	30	150	15	L	N	N	30
BBC135	.5	500	N	L	700	L	30	300	10	20	N	N	50
BBC136	.3	500	N	L	700	L	30	300	15	20	N	N	50
BBC142	.2	500	N	L	700	L	10	200	10	20	N	N	30
BBC143	.3	300	N	L	700	L	10	200	10	20	N	N	30
BBC190	.5	500	N	L	500	L	15	100	20	20	N	N	50
BBC193	.5	700	N	L	500	L	10	200	20	20	N	N	70
BBC192	.2	500	N	N	300	L	10	70	15	20	N	N	30
BBC191	.2	500	N	N	300	L	10	70	15	20	N	N	30
BBC195	.3	500	N	L	300	L	10	150	15	20	N	N	50
BBC194	.2	700	N	L	300	L	20	100	20	20	N	N	70
BBC196	.5	500	N	L	300	L	20	100	15	20	N	N	50
BBC197	.5	700	N	L	300	L	20	100	20	20	N	N	70
BBC198	.5	700	N	L	500	L	20	150	20	20	N	N	70
BBC188	.5	700	N	L	500	N	10	150	15	20	N	N	50
BBC189	.5	500	N	L	300	L	15	100	30	20	N	N	50
BBC187	.5	1,000	N	L	500	N	10	200	30	20	N	N	70
BBC186	.3	1,000	N	L	300	N	10	150	20	N	N	N	30
BBC183	.5	700	N	L	700	L	15	150	15	20	N	N	30
BBC182	.3	700	N	L	700	L	15	200	15	20	N	N	30
BBC184	.5	700	N	L	500	L	15	100	15	20	N	N	20
BBC185	.5	700	N	L	700	L	20	300	15	20	N	N	30
BBC181	.3	700	N	L	700	L	15	150	10	20	N	N	30
BBC180	.3	700	N	L	700	L	20	200	15	20	N	N	30

the North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Crandall Creek drainage--Continued				
BBC106	10	15	700	70	N	20	N	50	L(0.04)
BBC107	10	10	700	100	N	20	N	70	L(.02)
BBC137	15	15	700	100	N	20	N	70	L(.02)
BBC138	L	20	700	200	N	15	N	50	L(.02)
BBC139	10	20	700	150	N	20	N	70	L(.02)
BBC140	10	10	700	70	N	10	N	50	L(.02)
BBC054	10	20	700	150	N	20	N	70	L(.02)
BBC055	10	15	700	150	N	15	N	70	L(.02)
BBC056	10	20	700	150	N	15	N	70	L(.02)
BBC057	L	30	700	200	N	15	L	50	L(.02)
BBC007	10	15	1,500	150	N	20	N	100	L(.02)
BBC008	20	20	1,500	150	N	20	N	70	L(.02)
BBC058	10	30	700	150	N	15	N	70	L(.02)
BBC059	15	15	700	100	N	15	N	70	L(.02)
BBC206	10	30	700	200	N	20	N	30	L(.02)
BBC089	10	20	1,500	200	N	20	N	50	L(.02)
BBC090	15	20	1,500	150	N	20	N	70	L(.02)
BBC091	15	15	1,000	100	N	10	N	30	.08
BBC092	15	15	700	100	N	15	N	50	L(.02)
BBC093	10	20	1,000	200	N	15	N	30	L(.02)
BBC094	10	10	700	100	N	15	N	70	L(.02)
BBC095	15	15	1,000	150	N	15	N	70	L(.02)
BBC097	15	20	500	100	N	20	N	70	L(.02)
BBC096	15	20	1,500	150	N	20	N	100	L(.02)
BBC099	10	20	700	150	N	20	N	70	L(.02)
BBC100	15	15	700	100	N	20	N	70	L(.02)
BBC101	15	20	1,000	100	N	20	N	70	L(.02)
BBC102	20	20	700	100	N	20	N	70	L(.02)
BBC103	20	15	700	100	N	20	N	100	L(.02)
BBC098	10	15	700	70	N	20	N	70	L(.02)
BBC133	10	15	700	100	N	15	N	70	L(.02)
BBC134	20	15	700	100	N	10	N	50	L(.02)
BBC135	10	20	1,000	200	N	20	N	70	L(.02)
BBC136	10	15	700	100	N	20	N	70	L(.02)
BBC142	L	15	700	100	N	15	N	30	L(.02)
BBC143	L	15	700	100	N	20	N	70	L(.02)
BBC190	15	15	700	100	N	15	N	100	L(.02)
BBC193	10	15	500	200	N	15	N	50	L(.02)
BBC192	10	10	500	100	N	10	N	70	L(.02)
BBC191	10	10	700	70	N	10	N	50	L(.02)
BBC195	15	20	700	100	N	15	N	50	L(.02)
BBC194	15	15	500	100	N	15	N	50	L(.02)
BBC196	15	15	500	100	N	15	N	50	L(.02)
BBC197	15	10	500	100	N	15	N	50	L(.02)
BBC198	15	20	700	100	N	20	N	70	L(.02)
BBC188	L	20	700	150	N	15	N	70	L(.02)
BBC189	10	15	500	100	N	15	N	100	L(.02)
BBC187	L	30	700	150	N	15	N	70	L(.02)
BBC186	L	30	700	200	N	15	N	50	L(.02)
BBC183	10	20	700	150	N	15	N	50	L(.02)
BBC182	10	20	700	100	N	15	N	30	L(.02)
BBC184	10	20	700	150	N	15	N	50	L(.02)
BBC185	10	20	700	200	N	15	N	30	L(.02)
BBC181	10	15	700	100	N	15	N	50	L(.02)
BBC180	10	20	700	100	N	15	N	50	L(.02)

TABLE 4.—*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Stream sediments--Continued							
						Crandall Creek drainage--Continued							
BBC178	0.2	700	N	L	700	L	10	150	15	20	N	N	30
BBC179	.3	700	N	L	700	L	10	100	15	20	N	N	30
BBC177	.3	700	N	L	700	L	10	200	10	20	N	N	30
BBC176	.3	700	N	L	700	L	30	100	20	20	N	N	70
BBC175	.5	700	N	L	700	L	15	200	10	20	N	N	30
BBC199	.2	500	N	L	300	L	15	70	15	20	N	N	50
Gm	.36	721			662		18	208	16	19			37
						Southwestern part of area							
BEJ132	.7	1,000	N	L	2,000	L	30	300	70	20	N	N	50
BEJ133	1	2,000	N	L	2,000	L	50	300	70	20	N	N	50
BEJ131	.7	2,000	N	L	2,000	L	30	300	50	20	N	N	30
BEJ130	1	2,000	N	L	5,000	L	30	700	100	70	N	10	100
BEJ129	1	2,000	N	L	2,000	L	30	150	70	20	N	N	30
BEJ128	1	1,500	N	L	2,000	L	30	500	100	20	7	N	50
BEJ127	.7	1,500	0.5	L	2,000	L	30	200	100	20	N	N	50
BEJ135	1	1,000	N	L	2,000	L	50	700	70	20	N	10	100
BEJ256	.7	1,000	N	L	1,500	N	30	700	70	20	N	N	100
BEJ255	.5	700	N	L	1,000	N	30	700	50	20	N	N	30
BEJ136	1	1,000	N	L	2,000	L	30	500	70	20	N	N	50
BEJ134	1	2,000	N	L	2,000	L	50	1,000	70	20	N	N	50
BEJ137	1	1,000	N	L	2,000	L	30	500	70	20	N	N	50
BEJ138	1	2,000	N	L	2,000	L	30	200	70	20	N	N	30
BEJ139	.7	1,000	N	L	1,000	L	30	150	70	20	N	N	30
BEJ140	1	2,000	N	L	2,000	L	50	500	50	20	N	N	50
BEJ141	1	2,000	N	L	2,000	L	30	500	50	20	N	N	50
BEJ142	.7	1,000	N	L	2,000	L	50	500	200	30	5	N	50
BEJ143	.7	2,000	N	10	1,000	L	50	1,000	200	20	N	N	100
BEJ144	.7	1,000	N	L	2,000	L	50	500	100	30	5	N	100
BEJ145	.7	1,000	N	10	5,000	L	30	500	70	30	N	10	100
BES515	.3	1,000	N	L	700	L	20	200	50	30	N	N	70
BES516	.3	1,000	N	L	700	L	20	300	30	30	N	N	70
BES517	.5	1,000	N	L	1,000	L	20	300	50	30	N	N	70
BES518	.5	700	N	L	700	L	20	300	30	30	N	N	50
BES519	.3	700	N	L	700	1	20	300	30	30	N	N	50
BES520	.5	1,000	N	L	700	N	30	500	50	30	N	N	100
BES521	.3	700	N	L	1,000	1	20	200	50	30	N	N	50
BES522	.5	700	N	L	1,000	1	20	300	30	30	N	N	50
BES523	.5	700	N	L	1,000	L	20	200	30	30	N	N	50
BES524	.3	700	N	L	1,000	L	20	150	50	30	N	N	50
BEJ126	.7	2,000	N	10	5,000	L	30	1,000	70	20	N	N	150
BEJ125	.7	2,000	N	10	3,000	L	30	1,000	100	20	N	N	150
BEJ124	.7	1,500	N	10	2,000	L	30	1,000	100	20	5	N	150
BEJ123	.5	1,000	3	10	2,000	L	30	700	100	20	N	N	100
BEJ122	.5	1,000	N	L	2,000	L	20	500	50	20	7	N	70
BEJ121	.5	1,000	N	L	1,500	L	30	500	50	20	N	N	100
BEJ120	.5	1,000	N	L	2,000	L	30	500	50	30	N	N	100
BEJ119	.7	2,000	N	10	2,000	L	50	1,000	70	20	N	N	150
BEJ118	1	1,500	N	10	5,000	L	30	700	70	30	N	N	70
BEJ117	1	1,500	N	10	5,000	L	50	700	70	30	N	N	70
BEJ116	.7	1,500	N	10	5,000	L	30	700	100	30	7	N	70
BEJ115	.5	1,000	N	L	2,000	L	20	500	100	30	N	N	50
BEJ114	.5	1,000	N	L	3,000	L	30	500	70	30	7	N	100
BEJ113	.7	1,000	N	L	2,000	L	30	700	70	30	10	N	50

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Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Crandall Creek drainage--Continued				
BBC178	10	20	700	100	N	20	N	50	L(0.02)
BBC179	10	15	700	100	N	15	N	50	L(.02)
BBC177	10	30	700	200	N	20	N	30	L(.02)
BBC176	10	15	500	100	N	15	N	70	L(.02)
BBC175	L	30	700	200	N	15	N	50	L(.02)
BBC199	10	15	500	100	N	15	N	50	L(.02)
Gm	11	18	770	122		16		59	
					Southwestern part of area				
BEJ132	10	30	1,000	300	N	15	N	200	L(.02)
BEJ133	20	30	2,000	500	100	20	N	200	L(.02)
BEJ131	20	50	2,000	300	N	15	N	100	L(.02)
BEJ130	20	70	5,000	500	N	30	N	300	L(.02)
BEJ129	20	30	5,000	500	50	20	N	200	L(.02)
BEJ128	30	50	2,000	500	200	15	N	100	L(.02)
BEJ127	20	50	2,000	200	100	15	N	100	L(.02)
BEJ135	20	50	1,000	500	50	20	N	200	L(.02)
BEJ256	15	50	2,000	500	N	20	N	100	L(.02)
BEJ255	15	50	700	500	N	10	N	50	---
BEJ136	20	70	1,500	500	N	20	N	100	L(.05)
BEJ134	10	70	1,000	500	N	20	N	100	L(.05)
BEJ137	15	70	1,500	500	N	20	N	200	L(.05)
BEJ138	20	30	2,000	500	100	20	N	200	L(.02)
BEJ139	20	30	1,500	300	N	15	N	100	L(.02)
BEJ140	20	50	2,000	500	N	20	N	200	L(.02)
BEJ141	15	50	2,000	500	100	20	N	100	L(.02)
BEJ142	20	50	2,000	500	200	20	N	200	L(.02)
BEJ143	20	100	1,000	500	N	20	N	50	L(.02)
BEJ144	20	50	2,000	500	50	20	N	200	L(.02)
BEJ145	70	30	1,500	300	N	20	N	300	L(.05)
BES515	20	15	700	150	N	10	N	100	L(.02)
BES516	10	20	700	150	N	10	N	100	L(.02)
BES517	20	20	700	150	N	15	N	100	L(.02)
BES518	10	15	700	100	N	10	N	100	L(.02)
BES519	10	20	700	100	N	10	N	100	L(.02)
BES520	10	30	700	150	N	15	N	100	L(.02)
BES521	30	15	700	100	N	15	N	200	L(.02)
BES522	20	15	700	100	N	15	N	200	L(.02)
BES523	20	15	700	150	N	15	N	150	L(.02)
BES524	20	15	700	150	N	15	N	200	L(.02)
BEJ126	50	30	2,000	300	70	20	N	200	L(.02)
BEJ125	15	50	2,000	200	N	20	N	200	L(.02)
BEJ124	20	50	1,000	300	N	15	N	100	L(.02)
BEJ123	20	30	1,000	200	50	20	N	200	L(.02)
BEJ122	20	20	1,000	200	100	15	N	200	L(.02)
BEJ121	20	30	1,000	200	70	15	N	200	L(.02)
BEJ120	30	30	1,000	200	N	15	N	300	L(.02)
BEJ119	10	70	1,500	500	150	20	N	100	L(.02)
BEJ118	20	50	2,000	500	N	20	N	500	.06
BEJ117	20	50	2,000	500	N	20	N	200	L(.02)
BEJ116	20	70	2,000	500	N	20	N	200	L(.02)
BEJ115	30	30	1,500	300	70	15	N	300	L(.02)
BEJ114	20	30	1,500	200	200	20	N	200	L(.02)
BEJ113	20	50	1,000	500	100	20	N	100	L(.02)

TABLE 4.—*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
					Stream sediments--Continued								
					Southwestern part of area--Continued								
BEJ112	0.7	1,000	N	L	3,000	L	30	700	70	20	N	N	50
BEJ111	.7	1,000	N	L	2,000	L	30	700	70	20	N	N	50
BEJ110	1	1,000	N	L	3,000	L	30	700	70	20	10	N	50
BET031	.5	1,000	N	L	1,000	N	20	300	20	30	N	N	30
BET030	1	1,000	N	10	1,000	N	20	200	20	30	N	N	30
BET032	1	1,000	N	10	700	N	20	300	20	30	N	N	30
BET033	.5	1,000	N	L	1,000	N	20	200	20	30	N	N	30
BET029	1	1,000	N	10	1,000	N	20	200	20	30	N	N	30
BET028	.7	1,000	N	L	1,000	N	20	100	50	30	N	N	30
BET026	.5	1,000	N	L	1,000	N	30	200	30	30	N	N	30
BET027	1	1,500	N	10	700	N	30	300	30	30	N	N	30
BEJ109	.7	1,000	N	10	2,000	L	30	700	50	30	N	N	100
BEJ108	.5	1,000	N	L	2,000	L	30	700	70	20	N	N	100
BEJ107	.7	2,000	N	10	1,500	L	50	1,500	70	20	N	N	150
BEJ106	.5	1,000	N	L	2,000	L	30	700	70	20	N	N	100
BEJ105	.7	1,500	N	10	2,000	L	50	1,000	50	20	N	N	150
BEJ104	1	2,000	N	10	3,000	L	30	1,000	50	70	N	N	100
BEJ103	.7	1,500	N	L	3,000	1	30	700	70	20	N	N	150
BEJ102	.7	1,000	N	L	2,000	L	30	700	50	20	N	N	150
BEJ101	.7	1,000	1	10	5,000	1	20	500	100	70	7	10	50
BEJ100	1	2,000	N	10	3,000	L	30	1,000	100	30	N	10	100
BEJ099	1	2,000	N	10	3,000	N	100	1,500	70	20	N	N	150
BEJ098	1	2,000	N	10	2,000	L	50	1,000	70	30	N	N	150
BEJ097	1	2,000	N	10	2,000	L	30	700	70	30	N	10	70
BEJ096	1	1,000	N	L	2,000	L	30	700	50	30	N	10	100
BEJ095	1G	2,000	N	10	2,000	N	70	1,000	50	20	N	N	150
BEJ094	1	1,500	N	10	5,000	L	30	700	100	50	7	10	100
BEJ093	1	1,500	N	L	5,000	L	30	1,000	100	30	N	10	50
BEJ092	1G	2,000	N	10	1,500	L	100	1,000	100	N	N	N	150
BEJ091	.5	1,000	N	10	1,500	1	20	2,000	50	20	N	10	50
BEJ090	1	1,000	N	L	3,000	L	30	700	100	20	N	N	50
BEJ089	1	1,000	N	10	5,000	L	30	700	100	20	7	10	50
BEJ088	.7	1,000	N	10	3,000	L	30	500	100	50	N	10	50
BEJ087	1	1,500	N	L	2,000	L	70	1,000	150	20	N	N	150
BEJ086	.7	1,500	N	L	5,000	L	30	200	70	30	N	N	30
BEJ085	.7	1,500	N	L	2,000	L	50	700	50	30	N	N	150
BEJ084	1	1,000	N	L	2,000	L	30	500	70	50	N	10	100
BEJ083	1	1,500	N	L	5,000	L	30	500	70	50	N	10	50
BEJ082	.7	1,000	N	L	2,000	L	30	500	70	30	5	10	70
BEJ081	1	1,000	N	L	2,000	L	30	700	70	50	N	10	100
BEJ080	.7	1,000	N	L	2,000	L	30	500	20	50	N	N	100
BEJ079	.7	1,000	N	L	2,000	L	20	200	70	50	N	N	50
BEJ229	.5	1,000	N	L	1,500	L	30	200	70	20	N	N	30
BEJ230	.5	1,000	N	L	1,500	N	30	200	70	20	N	N	30
BEJ231	.5	1,000	N	L	2,000	L	30	200	70	20	N	N	30
BEJ232	.7	1,000	N	L	1,000	N	30	700	50	N	N	N	30
BEJ233	.7	1,000	N	L	2,000	L	30	1,000	70	20	N	N	70
BEJ234	.5	1,000	N	L	1,000	N	30	700	50	N	N	N	30
BEJ235	.7	1,000	N	L	2,000	N	50	700	50	20	N	N	50
BEJ209	.5	700	N	N	1,000	N	30	500	50	20	N	N	30
BEJ210	.5	700	N	N	1,500	N	30	500	70	20	N	N	50
BEJ211	.5	700	N	N	1,000	N	30	500	30	20	N	N	30
BEJ212	.5	700	N	N	1,000	N	30	500	20	20	N	N	30
BEJ213	1	1,000	N	N	2,000	L	50	700	30	30	N	N	50
BEJ214	.5	1,000	N	N	1,500	N	30	300	20	20	N	N	30

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Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Southwestern part of area--Continued				
BEJ112	20	70	2,000	700	N	20	N	100	L(0.05)
BEJ111	15	70	2,000	500	N	20	N	100	L(.02)
BEJ110	20	70	2,000	500	150	20	N	200	L(.02)
BET031	20	20	700	100	N	10	N	100	L(.02)
BET030	15	30	700	300	N	10	N	70	L(.02)
BET032	15	30	700	300	N	15	N	50	L(.02)
BET033	15	30	700	200	N	15	N	50	L(.02)
BET029	15	30	700	200	N	10	N	100	L(.02)
BET028	20	20	700	200	N	10	N	100	L(.02)
BET026	15	20	700	100	L	15	N	100	L(.02)
BET027	15	30	700	500	100	10	N	50	L(.02)
BEJ109	15	50	1,000	500	N	20	N	200	L(.02)
BEJ108	15	30	1,000	500	N	15	N	200	L(.02)
BEJ107	10	70	700	500	N	15	N	100	L(.02)
BEJ106	30	30	1,000	200	N	15	N	200	L(.02)
BEJ105	20	30	1,000	300	N	15	N	200	L(.02)
BEJ104	30	30	2,000	500	100	20	N	200	L(.02)
BEJ103	20	20	1,000	200	N	15	N	200	L(.02)
BEJ102	15	30	1,000	200	200	20	N	200	L(.02)
BEJ101	50	30	2,000	300	100	50	N	500	L(.02)
BEJ100	20	50	2,000	700	200	20	N	100	L(.02)
BEJ099	10	50	2,000	500	N	20	N	100	L(.02)
BEJ098	15	50	2,000	500	N	20	N	100	L(.02)
BEJ097	50	30	1,000	500	N	20	N	500	L(.02)
BEJ096	15	50	2,000	300	N	30	N	300	L(.02)
BEJ095	10	50	2,000	700	N	20	N	200	L(.02)
BEJ094	20	50	5,000	500	50	30	N	200	---
BEJ093	50	30	2,000	300	N	20	N	200	L(.02)
BEJ092	20	50	1,500	700	N	20	N	200	L(.02)
BEJ091	50	20	1,000	200	50	20	N	300	L(.02)
BEJ090	20	30	2,000	500	N	15	N	200	L(.02)
BEJ089	50	30	2,000	500	200	20	N	300	L(.02)
BEJ088	50	20	1,000	500	N	20	N	500	L(.02)
BEJ087	20	50	1,000	500	50	15	N	100	L(.02)
BEJ086	50	30	5,000	500	N	20	N	200	L(.02)
BEJ085	10	30	1,000	500	100	15	N	200	L(.02)
BEJ084	20	30	1,500	300	150	20	N	200	L(.02)
BEJ083	20	70	2,000	300	N	20	N	200	L(.02)
BEJ082	20	50	1,500	300	200	20	N	100	L(.02)
BEJ081	20	30	1,500	300	N	20	N	200	L(.02)
BEJ080	20	30	1,500	200	N	15	N	200	L(.02)
BEJ079	20	30	1,500	200	N	15	N	200	L(.02)
BEJ229	15	30	1,000	300	N	10	L	70	L(.04)
BEJ230	15	30	700	300	N	10	L	70	L(.02)
BEJ231	15	30	700	300	N	10	L	100	L(.02)
BEJ232	10	50	500	500	N	10	L	30	L(.04)
BEJ233	15	50	1,000	500	N	20	L	200	L(.04)
BEJ234	10	30	300	500	N	10	L	30	L(.04)
BEJ235	10	70	1,000	500	N	20	L	70	L(.02)
BEJ209	20	30	1,000	200	N	15	N	70	L(.02)
BEJ210	10	50	1,000	300	N	20	N	70	L(.02)
BEJ211	15	50	1,000	300	N	15	N	70	L(.02)
BEJ212	15	30	1,000	200	N	15	L	100	L(.02)
BEJ213	10	50	1,500	500	N	20	L	100	L(.02)
BEJ214	15	30	1,000	200	N	10	N	100	.04

TABLE 4.—*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Stream sediments--Continued							
						Southwestern part of area--Continued							
BEJ215	0.7	1,000	N	N	2,000	L	50	500	50	30	N	N	50
BEJ216	1	2,000	N	N	1,000	L	50	1,000	20	30	N	N	100
BEJ009	.5	1,000	N	L	1,500	L	50	150	70	30	N	N	30
BEJ008	.3	300	N	L	700	N	30	200	20	20	N	N	30
BEJ007	.2	300	N	L	500	N	10	200	20	N	N	N	30
BEJ006	.3	500	N	10	1,000	N	20	100	30	30	N	N	30
BEJ005	.3	700	N	L	700	N	10	150	50	20	N	N	20
BEJ004	.3	1,000	N	L	700	N	20	150	70	20	N	N	30
Gm		1,131			1.752		31	468	57	25	1		59
						Sunlight Creek drainage area							
BBC207	.2	300	N	L	300	L	10	70	10	20	N	N	20
BBC208	.2	500	N	N	500	L	10	20	15	20	N	N	50
BBC209	.3	700	N	L	700	L	20	100	15	20	N	N	30
BBC210	.3	700	N	L	700	L	20	70	20	20	N	N	30
BBC211	.3	500	N	L	700	L	20	200	15	20	N	N	30
BBC212	.3	500	N	10	700	L	20	70	15	20	N	N	30
BBC213	.3	500	N	L	700	L	20	150	15	20	N	N	30
BBC214	.3	500	N	10	700	1	15	200	20	20	N	N	50
BBC215	.5	700	N	L	700	L	15	150	15	20	N	N	30
BBC216	.3	700	N	L	700	L	20	200	15	20	N	N	50
BBC217	.3	700	N	L	700	L	20	200	15	20	N	N	30
BBC218	.3	500	N	L	700	L	10	70	10	20	N	N	20
BBC219	.2	500	N	L	700	L	10	150	10	20	N	N	20
BBC205	.2	500	N	10	700	1	10	150	20	20	N	N	30
BBC220	.2	500	N	L	700	1.5	20	300	50	20	N	N	100
BBC221	.2	500	N	10	1,000	1	10	150	15	30	N	N	30
BBC222	.15	500	N	L	700	1	10	200	10	20	N	N	30
BBC223	.3	500	N	L	700	L	20	300	10	20	N	N	30
BBC224	.3	500	N	L	1,000	L	20	200	30	30	N	N	70
BBC225	.3	500	N	L	700	L	20	150	15	20	N	N	30
BBC226	.3	300	N	L	700	L	10	100	10	20	N	N	30
BBC227	.5	500	N	L	700	L	20	150	15	20	N	N	30
BBC228	.3	500	N	L	700	L	10	70	10	20	N	N	30
BBC229	.3	500	N	L	700	L	10	150	15	20	N	N	50
BEJ302	1	2,000	N	10	5,000G	L	50	1,000	100	70	N	10	100
BEJ293	.7	1,500	N	10	3,000	L	50	700	100	30	N	N	50
BEJ294	.5	700	N	L	2,000	L	50	300	70	30	N	N	50
BEJ295	.7	700	N	L	5,000	L	50	500	100	50	N	10	100
BEJ296	.7	1,000	N	L	5,000	L	50	700	100	70	N	10	100
BEJ297	.7	700	N	L	3,000	N	50	700	70	50	N	N	50
BEJ298	.7	2,000	N	10	5,000	L	50	700	100	70	N	N	50
BEJ299	.7	2,000	N	10	5,000G	L	50	700	100	30	N	N	150
BEJ300	.7	2,000	N	10	5,000G	L	50	700	100	30	N	N	70
BEJ301	.7	1,000	N	L	3,000	N	30	700	70	50	10	N	50
BBC230	.2	1,000	N	L	700	1	10	70	200	50	N	L	20
BBC231	.2	1,500	N	L	500	L	20	100	50	20	N	N	50
BBC232	.2	1,000	N	L	300	L	10	100	15	20	N	N	50
BBC233	.3	1,000	N	L	500	L	10	200	15	20	N	N	30
BBC234	.5	700	N	10	500	L	10	150	15	20	N	N	30
BBC235	.3	500	N	10	700	L	10	150	10	20	N	N	30
BBC164	.3	1,000	N	L	700	L	20	150	10	20	N	N	30
BBC165	.2	700	N	N	700	L	10	70	10	20	N	N	20
BBC166	.5	700	N	L	700	L	30	200	15	20	N	N	30
BBC167	.5	700	N	L	700	L	30	300	10	20	N	N	30
BEJ280	.5	1,000	N	N	1,500	N	30	700	70	20	N	N	50

the North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Southwestern part of area--Continued				
BEJ215	15	50	1,500	200	N	20	L	100	L(0.02)
BEJ216	10	70	1,000	500	N	20	L	30	L(.02)
BEJ009	20	30	1,500	200	N	15	N	100	L(.02)
BEJ008	10	30	500	200	N	10	N	30	L(.02)
BEJ007	10	20	300	100	N	N	N	20	L(.02)
BEJ006	20	15	1,000	100	N	15	N	100	L(.02)
BEJ005	10	20	500	200	N	10	N	30	L(.02)
BEJ004	10	30	700	200	N	10	N	70	L(.02)
Gm	18	36	1,207	309	17	16		131	
					Sunlight Creek drainage area				
BBC207	10	15	500	100	N	15	N	50	L(.02)
BBC208	L	20	700	100	N	15	N	50	L(.02)
BBC209	10	15	700	100	N	15	N	70	L(.02)
BBC210	10	15	700	100	N	15	N	70	L(.02)
BBC211	15	20	700	100	N	15	N	50	L(.02)
BBC212	15	15	700	100	N	15	N	70	L(.02)
BBC213	10	20	700	100	N	15	N	50	L(.02)
BBC214	30	15	700	100	N	15	N	100	L(.02)
BBC215	15	15	700	200	N	15	N	50	L(.02)
BBC216	10	20	700	100	N	15	N	50	L(.02)
BBC217	10	30	700	200	N	15	N	30	L(.02)
BBC218	15	15	700	100	N	15	N	50	L(.02)
BBC219	10	20	700	100	N	15	N	30	L(.02)
BBC205	30	10	700	100	N	15	N	100	L(.02)
BBC220	30	15	500	70	N	15	N	70	L(.02)
BBC221	20	15	700	100	N	15	N	70	L(.02)
BBC222	15	10	700	100	N	15	N	30	L(.02)
BBC223	L	30	700	200	N	15	N	30	L(.02)
BBC224	20	15	700	100	N	20	N	100	L(.02)
BBC225	10	20	700	100	N	15	N	70	L(.02)
BBC226	N	20	700	100	N	15	N	70	L(.10)
BBC227	15	30	700	150	N	20	N	50	L(.02)
BBC228	15	15	700	100	N	15	N	70	L(.02)
BBC229	10	20	700	200	N	15	N	70	L(.02)
BEJ302	15	50	5,000	500	50	20	N	200	L(.02)
BEJ293	15	30	1,000	300	50	15	N	100	L(.02)
BEJ294	15	30	1,000	300	N	15	N	100	L(.02)
BEJ295	20	30	1,000	300	N	15	N	200	L(.02)
BEJ296	20	50	5,000	300	N	20	N	200	L(.02)
BEJ297	20	30	1,500	300	N	15	N	200	L(.02)
BEJ298	15	50	5,000	300	N	20	N	200	L(.02)
BEJ299	20	50	5,000	300	N	15	N	200	L(.02)
BEJ300	20	50	5,000	500	N	20	N	200	L(.02)
BEJ301	20	30	2,000	300	100	20	N	200	L(.02)
BBC230	30	7	700	100	N	15	N	100	L(.02)
BBC231	10	15	700	100	N	15	N	70	L(.02)
BBC232	10	10	700	70	N	10	N	30	L(.02)
BBC233	L	20	700	150	N	15	N	70	L(.02)
BBC234	10	15	700	200	N	15	N	70	L(.02)
BBC235	10	15	700	100	N	15	N	100	L(.02)
BBC164	10	20	700	200	N	15	N	50	L(.02)
BBC165	15	15	700	100	N	10	N	50	L(.02)
BBC166	15	20	700	200	N	15	N	30	L(.02)
BBC167	L	20	700	200	N	15	N	50	L(.02)
BEJ280	10	50	2,000	200	N	15	L	70	L(.02)

TABLE 4. —*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Stream sediments--Continued							
						Sunlight Creek drainage area--Continued							
BEJ281[1]	0.5	1,000	N	N	1,000	N	30	500	50	20	N	N	30
BEJ282	.5	1,000	N	N	2,000	L	30	700	70	20	N	N	100
BEJ283	.7	1,000	N	N	3,000	N	30	700	70	50	N	10	50
BEJ284	.7	1,000	N	N	2,000	N	30	500	70	30	N	N	50
BEJ285	.5	1,000	N	N	1,500	N	30	200	70	20	N	N	30
BEJ286	.7	1,000	N	N	3,000	N	30	700	70	50	N	N	30
BEJ287	.5	1,000	N	N	2,000	N	30	500	70	20	N	N	50
BEJ288	.5	1,000	N	N	2,000	L	30	700	70	20	N	N	50
BEJ289	.7	1,500	N	N	2,000	L	30	700	70	20	N	N	50
BEJ290	.7	1,500	N	N	3,000	L	30	500	70	20	N	N	30
BEJ291	.7	1,000	N	N	2,000	N	30	500	70	20	N	N	50
BEJ292	.7	1,000	N	N	2,000	L	50	500	70	20	N	N	50
BBC202	.3	700	N	L	300	L	30	50	20	20	N	N	30
BBC203	.5	700	N	10	500	L	30	100	15	20	N	N	50
BBC204	.7	500	N	10	300	L	50	300	20	20	N	N	50
BBC200	.3	500	N	L	500	L	15	300	20	20	N	N	50
BBC201	.5	700	N	N	300	L	15	500	15	20	N	N	50
BET023	.7	700	N	L	1,000	N	30	300	30	30	N	N	30
BET024	.7	700	N	10	1,000	N	20	200	30	30	N	N	30
BET025	.5	700	N	L	1,000	N	30	200	20	30	N	N	30
BBC168	.5	700	N	L	700	L	10	200	15	20	N	N	30
BBC169	.5	700	N	10	700	L	30	200	20	20	N	N	70
BBC170	.5	500	N	L	700	L	15	100	15	20	N	N	15
BBC171	.5	700	N	L	700	L	15	70	15	20	N	N	15
BBC172	.5	700	N	L	700	L	15	150	15	20	N	N	15
BBC173	.5	700	N	L	500	L	20	200	15	20	N	N	30
BEJ252	.5	1,000	N	L	2,000	L	50	700	70	20	N	N	200
BEJ253	.7	1,000	N	L	2,000	L	30	500	70	20	N	N	100
BEJ254	.5	1,000	N	L	1,500	N	30	700	50	20	N	N	100
BET022	.7	1,000	N	L	1,000	N	30	100	20	30	N	N	20
BET021	.7	1,000	N	L	1,000	N	30	200	50	30	N	N	30
BET020	.7	700	N	L	1,000	N	30	200	50	30	N	N	30
BET019	1	1,000	N	10	1,000	N	30	300	50	30	N	N	30
BET018	.5	700	N	L	1,000	N	20	200	20	30	N	N	30
BET015	.5	1,000	N	L	1,000	N	30	300	50	30	N	N	30
BET016	.5	500	N	10	1,000	N	30	100	30	30	N	N	50
BET017	.5	700	N	10	1,000	N	20	200	20	30	N	N	50
BET014	.3	700	N	10	1,000	N	30	70	50	30	L	N	20
BET013	.5	700	N	10	1,000	N	30	150	30	30	N	N	30
Gm	.4	758					22	225	29	25			39
						Southern part of area							
BEJ217	.5	1,000	N	L	1,000	L	30	700	70	20	N	N	50
BEJ218	.7	1,000	N	L	1,500	L	30	700	70	20	N	N	100
BEJ219	.5	1,000	N	L	1,500	L	30	700	70	N	N	N	70
BEJ220	1	1,500	N	L	1,500	N	30	1,000	70	N	N	N	100
BEJ221	1	1,500	N	L	2,000	N	30	500	70	20	N	N	30
BEJ222	.7	1,000	N	L	1,500	N	30	500	70	20	N	N	30
BEJ223	.5	700	N	L	1,500	N	30	700	50	N	N	N	50
BEJ224	.5	1,000	N	L	2,000	N	20	300	70	20	N	N	30
BEJ204	.5	1,000	N	N	2,000	L	30	100	70	30	N	N	30
BEJ203	.7	1,000	N	N	1,500	L	30	500	50	30	N	N	30

[1]BEJ281, Au detected spectrographically.

the North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Sunlight Creek drainage area--Continued				
BEJ281	10	30	1,000	200	N	10	L	70	L(0.02)
BEJ282	15	30	1,000	300	N	15	L	100	L(.02)
BEJ283	20	30	1,500	300	N	20	N	200	L(.02)
BEJ284	15	30	1,500	300	N	15	L	100	L(.02)
BEJ285	10	30	1,000	300	N	15	L	100	L(.02)
BEJ286	15	30	1,000	500	N	15	L	100	L(.02)
BEJ287	15	30	1,000	300	N	15	L	100	L(.02)
BEJ288	20	30	1,500	300	N	15	L	100	L(.02)
BEJ289	10	50	1,500	500	N	15	L	50	L(.02)
BEJ290	20	50	2,000	500	N	15	L	100	L(.02)
BEJ291	10	30	1,500	300	N	15	L	100	L(.02)
BEJ292	15	30	1,000	500	N	15	L	100	L(.02)
BBC202	10	10	700	100	N	15	N	70	L(.02)
BBC203	L	15	700	100	N	15	N	70	L(.02)
BBC204	L	20	500	200	N	15	N	30	L(.02)
BBC200	10	20	500	100	N	15	N	50	L(.02)
BBC201	L	30	500	100	N	15	N	30	L(.02)
BET023	15	20	700	150	100	10	N	100	L(.02)
BET024	20	30	700	100	100	15	N	100	L(.02)
BET025	15	30	700	100	N	15	N	100	L(.02)
BBC168	10	15	700	200	N	10	N	30	L(.02)
BBC169	10	20	700	200	N	15	N	50	L(.02)
BBC170	10	20	700	200	N	15	N	70	L(.02)
BBC171	10	20	700	200	N	15	N	30	L(.02)
BBC172	10	15	700	200	N	15	N	50	L(.02)
BBC173	L	20	700	200	N	15	N	50	L(.02)
BEJ252	20	30	1,000	500	N	15	N	100	L(.04)
BEJ253	15	50	1,000	500	N	20	N	100	L(.02)
BEJ254	15	50	1,000	500	N	15	N	30	L(.02)
BET022	20	20	700	150	L	15	N	50	L(.02)
BET021	15	30	700	200	N	10	N	50	L(.02)
BET020	15	30	700	200	50	15	N	50	L(.02)
BET019	15	30	700	200	L	15	N	100	L(.02)
BET018	15	20	700	100	L	10	N	70	L(.02)
BET015	20	30	700	200	70	15	N	30	L(.02)
BET016	20	15	700	100	N	15	N	100	L(.02)
BET017	20	15	500	100	N	15	N	150	L(.02)
BET014	20	15	700	100	100	10	N	70	L(.02)
BET013	20	20	700	100	100	15	N	100	L(.02)
Gm	13	22	886	174	8	15		72	
					Southern part of area				
BEJ217	20	30	700	300	N	10	L	100	L(.02)
BEJ218	15	30	1,000	500	N	10	L	100	L(.02)
BEJ219	15	30	1,000	500	N	10	L	70	L(.02)
BEJ220	15	50	1,000	700	N	10	L	100	L(.02)
BEJ221	15	50	1,500	500	N	20	L	100	---
BEJ222	15	30	1,000	500	N	10	L	100	L(.02)
BEJ223	15	30	700	500	N	10	L	70	L(.02)
BEJ224	15	30	1,000	500	N	15	L	100	L(.02)
BEJ204	15	30	1,000	200	N	20	N	100	L(.02)
BEJ203	15	50	1,000	200	N	20	N	100	.04

TABLE 4. —*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
	Stream sediments--Continued												
	Southern part of area--Continued												
BEJ205	0.5	1,000	N	N	1,500	L	50	300	50	30	N	N	30
BEJ206	1	700	N	N	1,500	L	50	700	50	70	N	N	50
BEJ207	.7	1,000	N	N	2,000	L	30	200	70	20	N	N	30
BEJ208	.7	1,000	N	N	1,500	L	30	500	20	20	N	N	30
BEJ202	.7	700	N	N	1,000	N	30	700	20	20	N	N	30
BEJ201	1	1,000	N	N	1,500	L	50	1,000	50	20	N	N	100
BEJ200	.7	700	N	N	1,500	L	30	700	20	20	N	N	50
BEJ199	.5	700	N	N	1,500	L	30	700	20	20	N	N	50
BEJ198	1	1,000	N	N	2,000	L	30	700	50	30	N	N	50
BEJ197	.5	1,000	N	N	1,500	L	30	300	20	30	N	N	30
BEJ196	.5	1,000	N	N	1,500	L	30	500	20	30	N	N	30
BEJ236	.3	700	N	L	1,000	N	30	500	50	N	N	N	30
BEJ237	.5	700	N	L	1,000	N	30	500	20	20	N	N	30
BEJ238	.5	1,000	N	L	2,000	N	50	1,500	70	20	N	N	300
BEJ239	.7	1,000	N	L	2,000	N	50	700	70	20	N	N	50
BEJ240	.7	1,000	N	L	2,000	N	30	700	70	N	N	N	30
BEJ241	.7	1,000	N	L	1,500	N	30	300	50	N	N	N	30
BEJ242	.7	1,000	N	L	1,500	N	30	700	30	N	N	N	30
BEJ243	.5	700	N	L	1,000	N	30	200	30	N	N	N	30
BEJ244	.7	1,000	N	L	1,500	N	30	700	50	20	N	N	30
BEJ245	.5	1,000	N	L	5,000	N	70	1,000	70	20	N	N	500
BEJ246	1	1,500	N	L	1,500	N	30	1,000	70	20	N	N	100
BEJ188	.5	1,000	N	L	1,500	N	30	500	100	20	N	N	50
BEJ189	1	2,000	N	L	5,000	N	50	1,500	100	20	N	N	150
BEJ190	.7	1,500	N	L	2,000	N	30	200	50	20	N	N	20
BEJ001	.3	1,000	N	L	1,000	N	30	100	70	N	N	N	30
BEJ002	.3	300	N	L	700	N	10	150	50	N	N	N	30
BEJ003	.3	300	N	L	700	N	20	500	30	20	N	N	30
BEJ153	.7	1,000	N	L	1,500	L	50	500	70	20	N	N	30
BEJ154	1	2,000	N	L	1,500	L	50	700	70	20	7	N	30
BEJ155	.7	1,500	N	L	1,500	L	50	500	100	20	5	N	30
BEJ156	.7	1,000	N	L	1,500	L	50	300	70	20	N	N	30
BEJ157	.7	1,500	N	L	1,500	L	50	300	70	20	5	N	30
BEJ158	.7	1,000	N	L	1,500	L	50	700	70	20	N	N	50
BEJ159	.7	1,500	N	L	2,000	L	30	700	70	20	5	N	30
BEJ160	1	2,000	N	10	2,000	L	30	700	70	20	N	N	50
BEJ161	.7	2,000	N	L	2,000	L	50	700	100	20	N	N	50
BEJ167	1	2,000	N	10	5,000	L	30	1,000	70	20	N	N	70
BEJ168	1	1,000	N	L	5,000	L	30	700	70	20	N	N	30
BEJ169	.7	1,500	N	L	2,000	N	50	700	100	20	N	N	70
BEJ170	.7	1,500	N	L	2,000	N	50	700	100	20	N	N	50
BEJ171	.7	1,500	N	L	2,000	N	30	300	70	20	N	N	50
BEJ172	1	1,500	N	L	2,000	N	50	1,000	100	20	N	N	70
BEJ173	1	1,500	N	L	3,000	N	30	700	70	20	N	N	50
BEJ162	.7	1,500	N	L	2,000	L	50	700	100	20	N	N	100
BEJ163	.7	1,500	N	L	1,500	L	50	500	200	20	N	N	70
BEJ164	.7	1,500	N	L	1,500	L	50	1,000	100	20	N	N	150
BEJ165	.5	1,000	N	L	1,500	L	30	500	70	20	5	N	70
BEJ166	.7	1,000	N	L	1,500	L	30	700	70	20	N	N	70
BEJ020	.3	500	N	L	1,000	N	10	150	50	N	N	N	20
BEJ021	.2	300	N	L	1,000	N	10	200	50	N	N	N	30
BEJ022	.7	1,500	N	L	1,000	N	30	1,000	70	20	N	N	50
BEJ023	1	1,500	N	L	1,500	N	30	1,000	70	20	N	N	50
BEJ024	.7	1,500	N	L	1,000	N	30	700	20	20	N	N	50
BEJ025	.7	1,500	N	10	1,000	N	30	1,000	50	20	N	N	50

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Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Southern part of area--Continued				
BEJ205	15	30	1,000	200	N	20	N	100	L(0.02)
BEJ206	10	50	1,000	500	N	20	N	100	L(.02)
BEJ207	20	30	1,000	200	N	15	N	100	L(.02)
BEJ208	15	50	2,000	300	N	20	N	100	L(.02)
BEJ202	10	50	500	200	N	10	N	70	L(.02)
BEJ201	N	70	1,000	700	N	15	N	100	L(.02)
BEJ200	N	50	500	200	N	15	N	100	L(.02)
BEJ199	10	30	500	200	N	15	N	100	L(.04)
BEJ198	10	50	2,000	300	N	20	N	100	L(.02)
BEJ197	20	50	1,000	200	N	15	N	100	L(.02)
BEJ196	10	50	1,000	200	N	10	N	100	L(.02)
BEJ236	15	30	1,000	200	N	10	N	50	L(.02)
BEJ237	15	30	1,000	200	N	10	N	30	L(.02)
BEJ238	15	30	700	200	N	15	N	100	L(.02)
BEJ239	10	50	700	500	N	15	N	100	L(.02)
BEJ240	15	30	2,000	500	N	15	N	100	L(.02)
BEJ241	15	30	1,500	500	N	15	N	70	L(.02)
BEJ242	15	50	1,500	500	N	15	N	70	L(.02)
BEJ243	15	30	1,000	300	N	15	N	100	L(.02)
BEJ244	15	50	1,000	500	N	15	N	100	L(.02)
BEJ245	10	30	1,500	300	N	15	N	100	L(.02)
BEJ246	10	70	1,500	1,000	N	20	L	70	L(.02)
BEJ188	15	50	1,000	500	N	15	N	100	L(.02)
BEJ189	15	100	1,500	700	N	20	N	200	L(.02)
BEJ190	20	30	1,500	500	N	20	N	100	L(.02)
BEJ001	10	20	1,000	100	N	10	N	70	L(.02)
BEJ002	10	15	500	100	N	10	N	50	L(.02)
BEJ003	10	20	500	300	N	10	N	50	L(.02)
BEJ153	15	50	2,000	500	50	20	N	100	L(.02)
BEJ154	10	70	2,000	500	50	20	N	100	L(.02)
BEJ155	20	50	1,500	500	N	20	N	50	L(.02)
BEJ156	15	50	1,500	500	N	20	N	50	L(.02)
BEJ157	20	50	2,000	500	N	20	N	50	L(.02)
BEJ158	10	50	1,000	500	N	20	N	100	L(.02)
BEJ159	20	50	2,000	500	200	20	N	100	L(.02)
BEJ160	10	100	5,000	1,000	100	30	N	100	L(.02)
BEJ161	15	50	2,000	1,000	N	20	N	100	L(.02)
BEJ167	15	100	5,000	1,000	100	30	N	200	L(.02)
BEJ168	20	50	5,000	700	N	30	N	200	L(.02)
BEJ169	20	50	1,500	500	N	15	N	100	L(.02)
BEJ170	20	50	1,500	500	N	15	N	100	L(.02)
BEJ171	20	50	1,500	500	70	15	N	100	L(.02)
BEJ172	15	70	1,500	500	N	20	N	100	L(.02)
BEJ173	15	70	3,000	500	50	20	N	100	L(.02)
BEJ162	15	50	2,000	500	N	20	N	100	L(.02)
BEJ163	20	50	1,000	500	N	20	N	100	L(.02)
BEJ164	15	50	1,000	500	70	20	N	100	L(.05)
BEJ165	10	50	1,000	500	70	20	N	100	L(.02)
BEJ166	15	50	1,000	700	N	20	N	70	L(.02)
BEJ020	10	20	700	100	N	10	N	50	L(.02)
BEJ021	10	15	700	100	N	10	N	30	---
BEJ022	10	70	700	300	N	10	N	30	L(.05)
BEJ023	10	70	1,000	300	N	20	N	70	L(.02)
BEJ024	10	70	1,000	300	N	20	N	50	L(.02)
BEJ025	10	50	1,000	500	N	15	N	30	L(.02)

TABLE 4.—*Analyses of stream-sediment samples from*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
					Stream sediments--Continued								
					Southern part of area--Continued								
BEJ174	0.7	1,000	N	L	2,000	N	30	700	200	30	N	N	100
BEJ175	.7	1,500	N	L	2,000	N	30	700	100	30	N	N	70
BEJ176	.7	1,500	N	L	3,000	N	30	500	100	20	N	N	50
BEJ225	.7	1,000	N	L	2,000	N	50	1,000	70	20	N	N	100
BEJ226	.5	1,000	N	L	5,000	N	30	700	70	20	N	N	100
BEJ227	.5	1,000	N	L	3,000	N	30	700	70	30	N	N	70
BEJ228	.5	1,000	N	L	2,000	N	30	1,000	70	30	N	N	70
BEJ191	.7	1,500	N	L	5,000	N	50	1,000	150	50	N	N	100
BEJ192	.7	1,500	N	L	2,000	N	30	700	150	20	N	N	100
BEJ193	1	1,500	N	L	5,000	N	30	1,500	150	20	N	N	100
BEJ194	1	1,500	N	L	2,000	N	30	1,000	200	20	N	N	100
BEJ195	.7	1,000	N	L	1,500	N	30	500	200	20	N	N	100
BEJ010	.3	300	N	L	500	N	10	150	50	N	N	N	30
BEJ011	.3	300	N	L	500	N	20	150	50	20	N	N	20
BEJ012	.3	1,000	N	L	1,000	L	20	150	50	30	N	N	30
BEJ013	.3	500	N	L	700	N	10	200	50	N	N	N	20
BEJ177	.7	1,500	N	L	2,000	N	50	700	200	20	N	N	100
BEJ178	.7	1,000	N	L	1,500	N	50	500	100	20	N	N	100
BEJ179	.7	1,500	N	L	2,000	N	30	200	70	20	7	N	50
BEJ180	1	2,000	N	L	2,000	N	30	500	70	20	N	N	50
BEJ181	1	2,000	N	L	2,000	N	50	700	70	20	N	N	100
BEJ182	.7	1,500	N	L	1,500	N	30	500	70	20	N	N	50
BEJ183	.7	1,000	N	L	1,500	N	50	500	200	20	N	N	70
BEJ184	1 .	2,000	N	L	3,000	N	30	500	70	20	15	N	70
BEJ185	.7	1,500	N	L	2,000	N	30	500	70	20	N	N	70
BEJ186	.7	1,500	N	L	2,000	N	30	200	70	20	N	N	70
BEJ187	.5	1,500	N	L	1,500	N	30	200	70	20	N	N	50
BEJ018	.3	500	N	L	1,000	N	30	200	70	20	N	N	30
BEJ019	.3	700	N	L	1,000	N	20	200	50	20	N	N	20
BEJ250	.7	1,000	N	L	3,000	N	50	1,000	100	20	N	N	100
BEJ249	.7	1,000	N	L	2,000	N	30	200	50	20	N	N	30
BEJ248	.7	1,000	N	L	2,000	N	30	700	70	20	N	N	50
BEJ014	.5	700	N	L	1,000	N	30	200	70	20	N	N	30
BEJ015	.3	500	N	L	700	N	10	150	20	20	N	N	20
BEJ016	.3	700	N	L	700	N	30	200	50	20	N	N	30
BEJ017	.3	300	N	L	700	N	10	500	20	N	N	N	20
BEJ247	.7	1,000	N	L	2,000	N	30	200	50	20	N	N	30
Gm	.6	1,042			1,626		31	490	64				49

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Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)
					Stream sediments--Continued				
					Southern part of area--Continued				
BEJ174	20	50	1,500	500	N	20	N	200	L(0.02)
BEJ175	20	50	1,500	500	100	20	N	100	L(.02)
BEJ176	20	70	2,000	500	N	20	N	100	L(.02)
BEJ225	15	50	700	700	N	15	L	70	L(.04)
BEJ226	20	30	1,000	500	N	15	L	100	L(.02)
BEJ227	20	30	1,000	500	N	10	L	100	L(.02)
BEJ228	15	30	1,000	300	N	10	L	100	L(.02)
BEJ191	20	70	1,500	500	N	20	N	100	L(.02)
BEJ192	20	50	1,500	500	N	20	N	100	L(.02)
BEJ193	20	70	1,500	700	N	20	N	100	L(.02)
BEJ194	20	50	1,500	700	N	20	N	100	L(.02)
BEJ195	20	50	1,500	500	N	20	N	100	L(.02)
BEJ010	10	20	500	100	N	10	N	30	L(.02)
BEJ011	10	20	500	100	N	10	N	30	L(.02)
BEJ012	10	30	1,500	200	N	15	N	100	L(.02)
BEJ013	10	30	500	200	N	10	N	70	L(.02)
BEJ177	30	70	1,500	500	N	20	N	100	L(.02)
BEJ178	20	50	1,500	700	N	15	N	100	L(.02)
BEJ179	20	30	2,000	500	500	15	N	100	L(.02)
BEJ180	20	50	2,000	500	50	20	N	200	L(.02)
BEJ181	20	70	1,500	700	200	20	N	100	L(.02)
BEJ182	15	50	1,500	500	N	20	N	100	L(.02)
BEJ183	20	70	1,000	500	N	15	N	100	L(.02)
BEJ184	15	70	3,000	700	200	20	N	200	L(.02)
BEJ185	20	50	1,500	500	100	20	N	100	L(.02)
BEJ186	15	50	1,500	500	N	20	N	100	L(.02)
BEJ187	20	30	1,500	500	N	15	N	100	L(.02)
BEJ018	20	20	500	100	N	10	N	50	.12
BEJ019	10	30	700	200	N	10	N	50	L(.02)
BEJ250	15	50	1,500	500	N	20	N	100	L(.02)
BEJ249	15	30	1,500	500	N	15	N	100	L(.02)
BEJ248	10	50	1,500	500	N	20	N	70	L(.02)
BEJ014	20	30	1,000	200	N	10	N	70	L(.02)
BEJ015	10	15	500	100	N	10	N	70	L(.02)
BEJ016	10	30	500	200	N	10	N	70	L(.02)
BEJ017	10	20	300	100	N	10	N	30	L(.02)
BEJ247	15	30	2,000	500	N	15	N	100	L(.02)
Gm	14	42	1,176	377	6	16		85	

TABLE 5. —*Analyses of bedrock samples from*

[Samples analyzed by semiquantitative spectrographic analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1 which represent approximate midpoints of group data on a geometric scale. All samples were analyzed for Fe(0.05), Ca(0.05), and Mg(0.02), but the quantities found are considered normal for the rocks of the region, and, therefore, they are not presented here. Analyses for Sn revealed no significant values, and no determinations are shown. Samples containing amounts equal to or greater than the lower spectrographic detection limits for the As(200), Au(10), Bi(10), Cd(20), and Sb(100) are shown in footnotes. Atomic absorption detection analyses for gold are

Sample	Semiquantitative spectrographic analyses												
	(percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
					Bedrock samples								
					Pilot Creek watershed and north								
BBC304	0.2	200	N	L	700	L	5	50	7	20	N	N	20
BBC018	.2	700	N	N	1,000	L	10	150	5	20	N	N	70
BBC016	.5	700	N	20	1,000	1	10	50	15	70	N	10	15
BBC017	.5	1,000	N	N	700	L	30	200	20	20	N	N	100
BBC019	.5	500	N	N	1,000	L	50	200	20	20	N	N	100
BBC021	.5	500	N	L	1,000	L	50	300	5	20	N	N	150
BBC020	.5	1,000	N	L	1,000	L	30	200	15	20	N	N	70
BBC126	.3	200	N	10	1,000	L	20	200	15	20	N	N	100
BBC131	.5	500	N	10	1,000	1	20	70	50	20	N	N	20
BBC024	.5	700	N	L	700	L	30	70	30	20	N	N	50
BBC002	.2	500	N	N	2,000	L	10	150	10	20	N	N	70
BBC023	.3	700	N	N	1,000	L	10	20	5	20	N	N	10
BBC127	.5	1,000	N	10	1,000	L	30	100	15	50	N	N	50
BBC130	.3	500	N	10	1,000	L	30	700	20	20	N	N	150
BBC001	.5	1,000	N	N	700	L	20	100	20	N	N	N	20
BBC003	.2	200	N	N	700	L	15	200	10	N	N	N	100
BBC025	.5	500	N	L	3,000	L	50	500	20	150	N	N	150
BBC022	.5	1,000	N	L	1,000	L	20	100	15	20	N	N	30
BBC120	.5	300	N	10	1,000	L	20	700	50	20	N	N	150
BBC146	.2	300	N	L	700	L	10	50	10	20	N	N	30
BBC145	.2	500	N	L	700	L	10	70	15	20	N	N	30
BBC144	.5	300	N	10	700	L	20	70	70	70	N	N	50
BBC147	.2	500	N	L	700	L	20	300	20	20	N	N	70
BBC148	.5	200	N	L	1,000	L	10	30	50	70	N	N	20
Gm	.4	492		6	943		19	127	17				51
					Crandall Creek watershed								
BBC269	.5	200	N	L	1,000	L	10	50	30	20	N	N	20
BBC270	.5	300	N	L	1,000	L	10	70	10	20	N	N	20
BBC268	.3	500	N	10	1,000	L	15	200	50	20	N	N	70
BBC118	.3	700	N	L	700	L	20	300	30	N	N	N	100
BBC151	.5	1,000	N	L	700	L	30	150	100	70	N	N	50
BBC152	.2	150	N	L	1,000	1	5	30	10	20	N	N	7
BBC267	.3	200	N	L	700	L	15	70	20	20	N	N	15
BBC161	.1	150	N	L	500	L	5	30	10	L	N	N	30
BBC313	.1	150	N	L	500	L	5	70	5	20	N	N	20
BBC264	.2	500	N	10	1,000	L	20	500	20	20	N	N	100
BBC162	.2	200	N	L	300	L	10	70	10	20	N	N	30
BBC149	.2	150	N	L	700	L	10	100	10	20	N	N	70
BBC150	.2	150	N	L	1,000	L	10	200	10	20	N	N	70
BBC163	.2	500	N	10	500	L	10	150	30	20	N	N	50
BBC265	.2	300	N	L	1,000	L	10	150	15	20	N	N	70
BBC266	.2	500	N	L	1,000	1	10	30	15	70	N	N	15
BBC308	.2	300	N	L	500	L	10	20	10	20	N	N	10
BBC307	.2	300	N	L	700	L	15	70	20	20	N	N	20
BBC330	.5	700	N	L	1,000	L	20	70	20	20	N	N	50
BBC331	.5	700	N	10	700	L	20	200	50	20	N	N	50

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labeled AA. Symbols used are: N, looked for but not found; G, the amount of the element present is greater than the sensitivity limit; L, an undetermined amount of the element is present below the sensitivity limit; ---, no data given; Gm, geometric mean. Analysts: R. N. Babcock, E. F. Cooley, G. W. Day, J. A. Domenico, J. G. Frisken, R. T. Hopkins, J. M. Mitchell, and J. H. Reynolds (spectrographic analyses); J. G. Frisken, J. Hassemer, J. D. Hoffman, J. M. Mitchell, and J. H. Reynolds (atomic absorption, Au)]

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples					
					Pilot Creek watershed and north					
BBC304	10	10	700	70	N	15	N	70	L(0.02)	Volcaniclastic
BBC018	15	5	1,500	70	N	10	N	100	L(.02)	Intrusive
BBC016	20	5	700	70	N	20	N	150	L(.02)	Volcaniclastic
BBC017	15	15	700	100	N	20	N	100	L(.02)	Flow
BBC019	10	15	700	100	N	20	N	70	L(.02)	Do.
BBC021	10	10	1,000	100	N	20	N	100	L(.02)	Volcaniclastic
BBC020	20	15	1,000	100	N	20	N	100	L(.02)	Do.
BBC126	15	10	1,000	70	N	10	N	100	L(.02)	Do.
BBC131	20	10	700	100	N	20	N	100	L(.02)	Flow
BBC024	10	15	500	100	N	20	N	150	L(.02)	Do.
BBC002	20	7	1,500	70	N	10	N	100	L(.02)	Volcaniclastic
BBC023	10	7	1,000	100	N	10	N	100	L(.02)	Do.
BBC127	15	15	700	100	N	20	N	100	L(.02)	Do.
BBC130	20	15	700	100	N	10	N	100	L(.02)	Do.
BBC001	N	20	1,000	150	N	10	N	70	L(.02)	Do.
BBC003	L	7	1,000	70	N	10	N	100	L(.02)	Do.
BBC025	50	15	2,000	100	N	20	N	100	L(.02)	Do.
BBC022	10	15	1,000	100	N	20	N	100	L(.02)	Do.
BBC120	15	20	700	100	N	20	N	100	L(.02)	Flow
BBC146	15	7	700	70	N	15	N	70	L(.02)	Volcaniclastic
BBC145	10	10	700	70	N	15	N	70	L(.02)	Do.
BBC144	30	15	500	100	N	20	N	100	L(.02)	Flow
BBC147	15	15	700	70	N	15	N	30	L(.02)	Do.
BBC148	20	10	1,000	100	N	20	N	100	L(.02)	Do.
Gm	14	11	853	89		16		91		
					Crandall Creek watershed					
BBC269	20	10	300	100	N	20	N	100	L(.02)	Do.
BBC270	20	10	700	100	N	15	N	70	L(.02)	Volcaniclastic
BBC268	20	10	500	100	N	15	N	100	L(.02)	Flow
BBC118	30	20	500	100	N	20	N	70	L(.02)	Volcaniclastic
BBC151	20	15	500	100	N	20	N	70	L(.02)	Do.
BBC152	10	7	1,000	70	N	15	N	50	L(.02)	Do.
BBC267	10	10	500	100	N	15	N	70	L(.02)	Do.
BBC161	15	5	500	30	N	10	N	50	L(.02)	Do.
BBC313	15	7	500	70	N	10	N	50	L(.02)	Do.
BBC264	10	15	500	100	N	20	N	100	L(.02)	Do.
BBC162	L	10	300	70	N	15	N	50	L(.02)	Do.
BBC149	15	7	700	70	N	10	N	70	L(.02)	Do.
BBC150	15	7	500	70	N	15	N	70	L(.02)	Do.
BBC163	15	15	500	70	N	15	N	50	L(.02)	Flow
BBC265	15	7	300	70	N	10	N	100	L(.02)	Volcaniclastic
BBC266	20	10	700	100	N	15	N	100	L(.02)	Do.
BBC308	10	10	500	100	N	15	N	70	L(.02)	Do.
BBC307	10	15	700	100	N	15	N	50	L(.02)	Do.
BBC330	20	15	700	100	N	20	N	100	L(.02)	Do.
BBC331	30	15	1,000	100	N	15	N	100	L(.02)	Do.

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
Bedrock samples--Continued													
Crandall Creek watershed--Continued													
BBC012	0.5	1,000	N	N	1,000	L	20	70	15	20	N	N	15
BBC128	.3	500	N	L	1,000	L	20	70	15	20	N	N	30
BBC119	.5	500	N	L	700	L	10	70	15	L	N	N	20
BBC132	.3	300	N	15	1,000	1	10	150	30	70	N	10	20
BBC129	.3	200	N	15	1,000	1	10	50	15	70	N	10	10
BBC004	.5	1,000	N	N	1,500	L	20	20	50	30	N	N	10
BBC005	.5	1,000	N	L	700	L	30	50	30	20	N	N	50
BBC006	.5	1,000	N	10	1,000	1.5	20	100	100	70	N	N	70
BBC301	.2	200	N	10	500	L	10	20	20	30	N	N	15
BBC302	.2	300	N	10	700	L	15	20	10	30	N	N	15
BBC051	.5	1,000	N	L	1,000	L	30	70	15	70	N	N	50
BBC052	.5	500	N	20	1,000	L	30	50	10	50	7	N	30
BBC053	.5	150	L	15	1,500	L	5	70	15	20	N	N	5
BBC026	.3	500	N	L	700	1	30	30	20	20	N	N	20
BBC027	.5	500	N	L	1,000	L	5	70	15	30	5	N	5
BBC014	.5	1,000	N	L	1,000	L	15	70	20	50	N	N	5
BBC278	.2	500	N	10	1,000	1	15	30	20	30	N	N	20
BBC013	.2	700	N	N	1,000	1	10	70	20	20	N	N	20
BBC050	.5	5,000	N	15	700	L	30	200	15	50	N	N	70
BBC305	.2	300	N	10	700	L	30	100	10	20	N	N	50
BBC015	.5	1,000	N	L	700	L	50	200	20	20	N	N	50
BBC277	.15	200	N	10	1,000	L	5	70	15	20	N	N	30
BBC303	.2	300	N	L	500	L	20	200	10	20	N	N	100
BBC274	.3	500	N	L	700	L	15	70	15	20	N	N	30
BBC276	.3	500	N	10	700	L	15	L	20	30	N	N	5
BBC275	.3	500	N	L	700	L	20	50	20	20	N	N	20
BBC315	.1	150	N	L	700	L	10	100	5	20	N	N	50
BBC299	.2	300	N	L	700	L	15	200	100	20	N	N	100
BBC319	.3	700	N	15	1,000	1	15	50	50	30	N	N	20
BBC320	.5	500	N	L	700	L	20	150	20	20	N	N	50
BBC316	.2	150	N	10	300	L	5	10	10	20	N	N	5
BBC011	.5	1,000	N	L	1,000	L	10	10	10	50	N	N	5
BBC009	.5	150	N	L	700	1	5	20	50	70	N	N	5
BBC010	.5	1,000	N	10	1,000	1	50	100	20	50	N	N	20
BBC296	.2	500	N	L	700	L	20	70	10	20	N	N	30
BBC300	.15	200	N	L	700	L	10	100	5	20	N	N	50
BBC121	.7	500	N	10	700	L	15	200	50	20	N	N	20
BBC122	.7	700	N	10	1,000	L	20	200	50	50	N	N	50
BBC125	.5	700	N	10	1,000	L	20	70	15	70	N	N	15
BBC124	.5	1,000	N	10	700	N	20	100	10	20	N	N	20
BBC123	.5	500	N	10	1,500	L	20	20	20	50	N	N	15
BBC153	.3	1,000	N	10	700	L	20	50	20	50	N	N	20
BBC309	.2	200	N	L	700	L	10	50	10	20	N	N	20
BBC160	.3	500	N	L	300	L	20	150	20	L	N	N	50
BBC297	.2	200	N	L	500	L	15	70	5	20	N	N	50
BBC273	.2	500	N	L	1,000	L	20	200	15	20	N	N	70
BBC310	.2	200	N	L	500	L	20	70	15	20	N	N	20
BBC154	.3	200	N	L	500	L	20	100	15	20	N	N	20
BBC155	.2	500	N	L	500	L	10	30	5	20	N	N	20
BBC156	.2	500	N	L	1,500	L	10	100	10	20	N	N	50
BBC157	.2	300	N	L	500	L	10	70	10	20	N	N	50
BBC298	.2	200	N	L	500	L	15	200	5	20	N	N	100
BBC158	.3	1,000	N	L	500	L	20	70	15	20	N	N	30
BBC159	.3	700	N	L	300	L	15	100	20	L	N	N	50
BBC311	.1	200	N	L	700	L	5	70	5	20	N	N	50

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples--Continued					
					Crandall Creek watershed--Continued					
BBC012	10	15	1,000	200	N	20	N	70	L(0.02)	Volcaniclastic
BBC128	15	15	1,000	100	N	20	N	70	L(.02)	Flow
BBC119	15	20	700	100	N	20	N	100	L(.02)	Do.
BBC132	20	15	1,000	70	N	20	N	100	L(.02)	Do.
BBC129	20	10	700	70	N	20	N	150	L(.02)	Do.
BBC004	10	15	1,500	100	N	20	N	100	L(.02)	Volcaniclastic
BBC005	N	15	1,000	100	N	20	N	100	L(.02)	Do.
BBC006	30	10	1,000	100	N	20	N	150	L(.02)	Do.
BBC301	10	7	500	70	N	15	N	70	L(.02)	Intrusive
BBC302	20	10	700	70	N	15	N	70	L(.02)	Do.
BBC051	15	15	1,000	150	N	20	N	150	L(.02)	Altered flow
BBC052	15	10	700	150	N	15	N	100	L(.02)	Do.
BBC053	50	10	700	150	N	15	N	100	L(.02)	Do.
BBC026	30	10	700	100	N	15	N	100	L(.02)	Intrusive
BBC027	30	10	700	150	N	15	N	150	L(.02)	Do.
BBC014	20	15	1,500	150	N	20	N	100	L(.02)	Do.
BBC278	30	10	700	100	N	15	N	100	L(.02)	Do.
BBC013	15	5	1,000	70	N	10	N	100	L(.02)	Do.
BBC050	15	15	700	150	N	15	N	100	L(.02)	Do.
BBC305	10	15	700	100	N	15	N	100	L(.02)	Volcaniclastic
BBC015	10	20	1,000	100	N	20	N	70	L(.02)	Intrusive
BBC277	30	5	300	70	N	10	N	100	L(.02)	Do.
BBC303	15	10	700	70	N	10	N	50	L(.02)	Volcaniclastic
BBC274	15	10	500	100	N	15	N	70	L(.02)	Volcaniclastic, hornfelsed
BBC276	20	15	700	100	N	15	N	70	L(.02)	Flow, hornfelsed
BBC275	15	15	500	100	N	15	N	70	L(.02)	Do.
BBC315	15	7	500	50	N	10	N	50	L(.02)	Volcaniclastic
BBC299	20	10	300	70	N	15	N	100	L(.02)	Flow
BBC319	30	15	700	100	N	15	N	100	L(.02)	Intrusive
BBC320	20	20	700	100	N	15	N	100	L(.02)	Volcaniclastic
BBC316	10	7	300	70	N	15	N	50	L(.02)	Do.
BBC011	10	7	1,000	100	N	20	N	100	L(.02)	Do.
BBC009	30	5	1,000	50	N	20	N	150	L(.02)	Do.
BBC010	15	15	1,000	150	N	20	N	150	L(.02)	Do.
BBC296	15	15	500	100	N	15	N	100	L(.02)	Do.
BBC300	15	7	500	70	N	10	N	70	L(.02)	Do.
BBC121	15	20	700	100	N	20	N	70	L(.02)	Do.
BBC122	15	20	700	100	N	20	N	70	L(.02)	Do.
BBC125	20	15	1,000	100	N	20	N	100	L(.02)	Do.
BBC124	10	15	1,000	100	N	20	L	70	L(.02)	Do.
BBC123	20	15	1,000	100	N	20	N	70	L(.02)	Flow
BBC153	20	15	700	100	N	15	N	70	L(.02)	Do.
BBC309	10	10	500	100	N	15	N	100	L(.02)	Volcaniclastic
BBC160	N	15	300	100	N	20	N	50	L(.02)	Flow
BBC297	15	10	500	70	N	15	N	70	L(.02)	Volcaniclastic
BBC273	15	10	500	100	N	15	N	70	L(.02)	Do.
BBC310	L	10	500	100	N	20	N	100	L(.02)	Do.
BBC154	10	15	700	100	N	15	N	30	L(.02)	Do.
BBC155	15	10	700	70	N	15	N	70	L(.02)	Do.
BBC156	15	15	700	100	N	15	N	50	L(.02)	Do.
BBC157	15	10	700	70	N	10	N	50	L(.02)	Do.
BBC298	15	7	500	70	N	10	N	70	L(.02)	Do.
BBC158	15	15	700	100	N	20	N	70	L(.02)	Do.
BBC159	N	15	700	100	N	15	N	50	L(.02)	Do.
BBC311	15	7	300	50	N	10	N	50	L(.02)	Do.

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses												
	(percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
Bedrock samples--Continued													
Crandall Creek watershed--Continued													
BBC312	0.2	150	N	L	700	L	10	70	10	20	N	N	20
BBC314	.2	300	N	L	500	L	10	30	10	20	N	N	15
BBC321	.3	500	N	L	700	L	15	100	10	20	N	N	30
BBC328	.5	500	N	10	1,000	L	20	50	50	50	N	N	20
BBC326	.5	500	N	10	1,000	L	20	100	50	50	N	N	30
BBC327	.2	500	N	10	1,000	L	15	70	10	20	N	N	20
BBC324	.2	500	N	10	1,000	1	15	100	30	20	N	N	30
BBC322	.5	500	N	10	1,000	L	20	200	15	30	N	N	50
BBC323	.5	500	N	L	1,000	L	15	200	15	20	N	N	50
BBC325	.2	500	N	10	700	L	15	150	20	20	N	N	30
BBC329	.5	700	N	10	1,000	L	20	200	50	20	N	N	50
BBC271	.3	200	N	10	700	L	15	70	10	20	N	N	15
Gm	.3	415		7	759	0.5	14	74	17				27
Southwestern part of area													
BEJ274	.7	700	N	L	2,000	L	30	500	50	50	N	10	50
BES507	.7	2,000	N	L	5,000	N	20	100	70	70	N	N	30
BEJ275	.5	700	N	L	5,000	L	10	30	100	70	N	10	15
BEJ276	.5	700	N	10	5,000	L	20	200	100	50	N	N	30
BEJ277	.5	700	N	L	1,000	L	30	500	70	20	N	N	50
BEJ278	.5	700	N	L	1,500	L	30	200	50	20	N	N	30
BEJ279	.7	700	N	L	5,000	L	10	10	100	70	N	10	7
BES532	.2	20	N	L	700	N	5	10	70	N	N	N	5
BBC239	.3	500	N	10	700	L	20	50	20	20	N	N	30
BBC282	.3	500	N	10	1,500	L	10	30	30	70	N	N	10
BBC283	.2	200	N	10	700	L	10	20	70	20	N	N	20
BBC284	.3	500	N	L	1,500	1	5	L	10	50	N	N	L
BES485	.5	700	N	L	2,000	L	7	N	50	100	N	N	5
BBC285	.3	500	N	10	1,500	L	10	70	50	30	N	N	30
BBC286	.2	500	N	L	500	L	10	20	20	20	N	N	15
BEJ266	.5	700	N	L	1,500	L	30	150	50	30	N	N	20
BES503	1	1,000	N	L	1,500	L	20	70	70	100	N	N	20
BES504	.7	1,000	N	L	1,000	N	20	50	50	70	N	N	10
BES501	1	10	N	L	2,000	N	5	10	30	N	N	10	5
BES502	1	1,000	N	10	1,000	L	20	70	70	70	N	N	20
BES500	.7	1,000	N	L	2,000	L	20	70	100	100	N	N	30
BES499	.7	1,000	N	L	1,000	L	20	200	70	50	N	N	30
BES505	.5	1,000	N	L	1,500	N	20	150	50	100	N	N	50
BES506	.5	1,000	N	L	1,000	N	20	70	70	30	N	N	30
BEJ309	.7	1,000	N	L	5,000G	L	30	100	20	100	N	10	20
BEJ313	.7	1,000	N	10	5,000G	L	30	700	200	70	N	N	150
BEJ310	.7	1,000	N	10	5,000	L	30	200	50	70	N	N	20
BEJ311	.7	700	N	L	5,000G	N	30	700	20	70	N	N	150
BEJ270	.3	700	N	L	2,000	L	15	300	20	50	N	10	30
BEJ312	.7	1,000	N	10	5,000G	L	20	70	20	70	N	N	10
BEJ314	.7	1,000	N	L	2,000	N	30	20	15	30	N	N	10
BES472	.3	700	N	L	1,000	L	10	15	50	50	N	N	20
BES473	.5	500	N	L	1,500	L	10	300	30	70	N	N	50
BES474	.5	700	N	L	1,500	L	10	70	30	50	N	N	30
BES475	.3	500	N	10	2,000	1	10	70	30	50	N	N	20
BES476	.5	500	N	L	2,000	L	15	20	20	70	N	N	10
BES477	.5	500	N	L	1,500	L	15	50	30	70	N	N	10
BES478	.5	700	N	L	1,500	L	15	50	50	70	N	N	10
BES479	.7	1,000	N	L	5,000	L	15	70	100	70	N	N	10
BES480	.5	1,000	N	L	2,000	L	20	70	100	70	N	N	30

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples--Continued					
					Crandall Creek watershed--Continued					
BBC312	10	7	300	70	N	20	N	100	L(0.02)	Volcaniclastic
BBC314	15	10	500	70	N	10	N	50	L(.02)	Do.
BBC321	15	15	700	100	N	15	N	100	L(.02)	Do.
BBC328	15	15	1,000	100	N	20	N	150	L(.02)	Do.
BBC326	20	15	700	100	N	20	N	150	L(.02)	Flow
BBC327	20	15	700	70	N	15	N	100	L(.02)	Volcaniclastic
BBC324	20	15	700	70	N	15	N	100	.02	Flow
BBC322	20	20	1,000	100	N	20	N	100	L(.02)	Volcaniclastic, hornfelsed
BBC323	15	20	700	100	N	15	N	100	L(.02)	Do.
BBC325	15	15	700	100	N	15	N	100	L(.02)	Flow
BBC329	15	20	700	100	N	20	N	150	L(.02)	Volcaniclastic
BBC271	15	15	700	100	N	15	N	70	L(.02)	Flow
Gm	16	12	645	91		16		82		
					Southwestern part of area					
BEJ274	15	30	1,000	200	N	20	N	100	L(.02)	Volcaniclastic
BES507	30	30	1,000	200	N	20	N	100	L(.02)	Do.
BEJ275	50	15	1,000	200	N	20	N	200	L(.02)	Do.
BEJ276	30	20	2,000	200	N	20	N	100	L(.02)	Andesitic dike
BEJ277	15	50	1,000	200	N	15	N	100	L(.02)	Volcaniclastic
BEJ278	10	20	1,000	200	N	15	N	100	L(.02)	Do.
BEJ279	50	10	2,000	200	N	15	N	200	L(.02)	Andesitic dike
BES532	20	5	200	20	N	N	N	70	L(.02)	Sulfur depost
BBC239	10	15	700	100	N	15	N	70	L(.02)	Flow
BBC282	10	10	700	100	N	20	N	100	L(.02)	Do.
BBC283	15	7	500	70	N	10	N	100	L(.02)	Do.
BBC284	30	7	700	70	N	20	N	150	L(.02)	Do.
BES485	50	15	1,500	100	N	30	N	200	L(.02)	Volcaniclastic
BBC285	30	7	1,000	100	N	15	N	100	L(.02)	Do.
BBC286	10	15	500	100	N	15	N	70	L(.02)	Volcaniclastic, altered
BEJ266	15	30	1,000	200	N	20	N	100	L(.02)	Flow
BES503	30	30	1,000	200	N	20	N	150	L(.02)	Volcaniclastic
BES504	30	30	1,000	200	N	20	N	150	L(.02)	Do.
BES501	10	10	1,000	100	N	L	N	150	L(.02)	Volcaniclastic, altered
BES502	30	30	1,000	200	N	20	N	150	L(.02)	Volcaniclastic
BES500	50	20	1,000	200	N	15	N	150	L(.02)	Do.
BES499	30	20	700	150	N	15	N	150	L(.02)	Do.
BES505	30	15	700	150	N	20	N	150	L(.02)	Do.
BES506	30	20	700	150	N	15	N	100	L(.02)	Do.
BEJ309	50	20	5,000	300	N	20	N	300	L(.02)	Do.
BEJ313	15	30	2,000	300	N	15	N	300	L(.02)	Do.
BEJ310	20	30	1,500	500	N	20	N	300	L(.02)	Do.
BEJ311	30	20	2,000	300	N	10	N	300	L(.02)	Flow
BEJ270	15	20	1,000	200	N	10	N	100	L(.02)	Volcaniclastic, hornfelsed
BEJ312	30	20	2,000	200	N	15	N	300	L(.02)	Volcaniclastic
BEJ314	20	20	700	200	N	20	N	300	L(.02)	Do.
BES472	30	10	700	150	N	10	N	100	L(.02)	Do.
BES473	30	15	700	150	N	20	N	100	L(.02)	Do.
BES474	30	15	700	150	N	10	N	100	L(.02)	Do.
BES475	30	15	700	100	N	15	N	100	L(.02)	Do.
BES476	30	10	1,000	150	N	10	N	100	L(.02)	Do.
BES477	30	15	700	150	N	10	N	100	L(.02)	Do.
BES478	30	15	700	200	N	15	N	100	L(.02)	Do.
BES479	50	15	700	200	N	20	N	100	L(.02)	Do.
BES480	30	15	1,000	200	N	20	N	70	L(.02)	Flow

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
Bedrock samples--Continued													
Southwestern part of area--Continued													
BES482	0.3	500	N	L	1,500	L	10	100	50	70	N	N	30
BEJ272[1]	.1	1,000	N	L	500	5	7	N	10	70	5	100	L
BEJ308	.7	1,000	N	L	5,000G	L	30	200	50	100	N	10	30
BEJ307	1	1,000	N	50	5,000G	L	30	70	150	70	5	10	20
BES483	.3	700	N	L	1,500	L	10	10	50	70	N	N	5
BES469	.5	500	N	L	1,000	L	10	100	70	70	N	N	50
BES470	.5	700	N	L	1,000	L	10	100	50	70	N	N	30
BES471	.5	1,000	N	L	1,000	L	10	70	30	50	N	N	10
BES481	.3	700	N	L	1,500	L	10	15	100	70	N	N	7
BEJ268[1]	.1	300	N	L	500	3	5	N	10	70	5	100	5
BEJ267	.5	700	N	L	1,000	1	50	150	100	30	N	10	50
BEJ303	1	1,000	N	10	5,000G	L	30	200	100	70	N	N	30
BEJ273	.7	1,000	N	10	3,000	L	20	30	100	70	N	10	15
BEJ304	.7	1,000	N	L	5,000G	N	50	300	70	70	N	10	50
BEJ269	.7	500	N	10	5,000	L	20	200	70	70	N	10	30
BEJ264	.5	700	N	L	2,000	L	15	30	70	70	N	10	30
BEJ265	.7	700	N	L	2,000	L	30	200	70	70	N	N	30
BEJ260	1	700	N	L	5,000	L	10	15	70	70	N	10	15
BBC291	.2	300	N	L	700	L	10	100	20	20	N	N	70
BEJ261	.7	700	N	L	2,000	L	20	500	70	70	N	10	100
BEJ262	.7	700	N	L	5,000	L	30	70	70	100	N	10	30
BEJ263	.5	700	N	L	1,500	N	20	100	10	20	N	N	10
BEJ306	1	2,000	N	10	5,000G	L	50	700	70	100	N	10	30
BEJ305	.7	2,000	N	L	5,000G	L	30	150	100	70	N	10	30
BBC251	.3	700	N	10	700	L	20	50	50	20	N	N	20
BBC252	.2	700	N	L	1,000	L	10	30	20	20	N	N	20
BBC253	.3	700	N	L	1,000	L	10	50	20	20	N	N	30
BBC254	.5	700	N	N	1,000	L	10	100	20	20	N	N	30
BEJ056	.7	1,000	N	L	5,000	L	30	200	70	100	N	10	50
BEJ149	.7	1,500	N	L	5,000	L	30	300	70	30	10	N	30
BBC250	.5	500	N	10	1,500	1	15	30	70	50	N	N	15
BEJ259	.7	1,000	N	L	2,000	L	30	150	100	30	N	10	30
BES484	.5	700	N	L	1,500	L	10	100	100	70	N	N	20
BBC262	.5	500	N	10	1,000	L	30	30	50	20	N	N	100
BEJ257	.7	700	N	L	1,500	N	30	500	70	50	N	N	30
BES487	.5	700	N	L	1,500	L	10	100	50	50	N	N	10
BEJ258	.7	700	N	L	2,000	N	30	500	100	50	N	N	100
BBC261	.3	500	N	10	1,000	L	20	70	50	20	N	N	30
BBC260	.2	200	N	L	700	L	10	70	15	20	N	N	20
BBC263	.5	500	N	10	700	L	10	30	15	20	N	N	15
BBC258	.5	500	N	L	700	L	20	200	15	20	N	N	50
BBC259	.3	500	N	L	700	L	10	70	15	20	N	N	30
BBC257	.5	500	N	L	1,000	L	10	30	10	20	N	N	10
BBC255	.3	1,000	N	10	1,000	L	15	70	20	20	N	N	20
BBC256	.3	200	N	L	2,000	1	10	50	50	70	N	N	30
BEJ055	.7	1,000	N	20	2,000	L	70	1,500	70	50	N	10	700
BBC290	.3	150	N	10	1,000	L	10	10	70	30	N	N	20
BEJ053	.7	300	N	10	2,000	L	10	200	20	70	15	10	30
BEJ033	.5	1,000	N	L	1,500	N	30	200	70	20	N	N	30
Gm	.5	634					16	75	45	46			23

[1]10 ppm Sn.

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
				Bedrock samples--Continued						
				Southwestern part of area--Continued						
BES482	30	15	700	100	N	10	N	150	L(0.02)	Volcaniclastic
BEJ272	70	L	N	L	N	30	N	500	L(.02)	Volcanic tuff
BEJ308	20	30	5,000	300	N	20	N	300	L(.02)	Volcaniclastic
BEJ307	50	20	5,000	200	N	30	N	200	L(.02)	Flow
BES483	30	10	700	70	N	15	N	150	L(.02)	Do.
BES469	30	15	700	100	N	15	N	150	L(.02)	Do.
BES470	30	15	700	150	N	15	N	100	L(.02)	Volcaniclastic
BES471	30	15	700	150	N	15	N	100	L(.02)	Do.
BES481	50	10	1,000	100	N	10	N	100	L(.02)	Flow
BEJ268	30	L	N	L	N	30	N	500	L(.02)	Do.
BEJ267	15	20	1,000	70	N	10	N	200	L(.02)	Volcaniclastic
BEJ303	20	30	5,000	500	N	30	N	200	L(.02)	Do.
BEJ273	15	30	500	200	N	20	N	200	L(.02)	Flow
BEJ304	30	50	2,000	500	N	20	N	200	L(.02)	Volcaniclastic
BEJ269	50	20	2,000	200	N	20	N	200	L(.02)	Volcanic tuff
BEJ264	20	10	1,500	100	N	10	N	200	L(.02)	Do.
BEJ265	30	20	1,500	200	N	20	N	200	L(.02)	Flow
BEJ260	70	20	1,500	200	N	20	N	200	L(.02)	Do.
BBC291	15	10	700	70	N	15	N	100	L(.02)	Do.
BEJ261	20	30	1,500	200	N	20	N	200	L(.02)	Do.
BEJ262	20	20	1,000	200	N	20	N	200	L(.02)	Do.
BEJ263	15	30	700	200	N	20	N	100	L(.02)	Do.
BEJ306	20	70	5,000	500	N	30	N	200	L(.02)	Volcaniclastic
BEJ305	20	30	2,000	300	N	20	N	200	L(.02)	Do.
BBC251	10	15	700	150	N	15	N	70	L(.02)	Flow
BBC252	15	15	700	100	N	10	N	100	L(.02)	Do.
BBC253	15	15	1,000	100	N	15	N	100	L(.02)	Volcaniclastic
BBC254	15	20	1,000	150	N	10	N	100	L(.02)	Do.
BEJ056	50	20	2,000	200	50	20	N	200	L(.02)	Flow
BEJ149	20	50	2,000	500	150	20	N	200	L(.02)	Volcaniclastic
BBC250	20	10	1,000	100	N	20	N	100	L(.02)	Flow
BEJ259	20	30	700	200	N	20	N	150	L(.02)	Do.
BES484	30	20	700	200	N	20	N	70	L(.02)	Volcaniclastic
BBC262	20	20	700	100	N	20	N	100	L(.02)	Flow
BEJ257	70	30	1,000	500	N	15	N	100	L(.02)	Do.
BES487	30	15	700	200	N	15	N	100	L(.02)	Volcaniclastic
BEJ258	50	30	1,000	500	N	15	N	150	L(.02)	Flow
BBC261	15	20	700	100	N	20	N	100	L(.02)	Do.
BBC260	15	15	500	70	N	15	N	30	L(.02)	Do.
BBC263	L	15	500	100	N	20	N	70	L(.02)	Volcaniclastic
BBC258	L	20	500	100	N	20	N	70	L(.02)	Flow
BBC259	20	10	700	100	N	15	N	100	L(.02)	Do.
BBC257	15	15	700	100	N	15	N	100	L(.02)	Volcaniclastic
BBC255	15	15	1,000	100	N	20	N	100	L(.02)	Do.
BBC256	20	10	700	100	N	20	N	150	L(.02)	Flow
BEJ055	15	50	1,000	200	N	15	N	200	L(.02)	Do.
BBC290	30	7	500	100	N	15	N	100	L(.02)	Do.
BEJ053	50	30	700	200	N	30	N	300	L(.02)	Do.
BEJ033	15	30	1,000	200	N	15	N	100	L(.02)	Do.
Gm	24	18	937	149		17		135		

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses (percent)	Semiquantitative spectrographic analyses (ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
					Bedrock samples--Continued								
					Southeastern part of area								
BET009	0.5	1,000	N	L	500	N	30	300	50	30	N	N	70
BES510	.7	1,000	N	L	1,000	N	30	200	100	50	N	N	50
BET010	.3	500	N	L	1,000	N	10	N	L	30	N	N	5
BES511	.5	1,000	N	L	1,000	N	20	200	50	30	N	N	50
BET008	.5	500	N	L	1,500	N	20	300	20	30	N	N	70
BES513	.5	700	N	L	1,000	L	20	70	70	70	N	N	20
BES509	.5	700	N	L	1,500	L	20	100	50	50	N	N	30
BBC238	.3	500	N	10	700	1.5	10	100	50	70	N	10	30
BBC281	.2	500	N	10	700	L	20	30	20	20	N	N	10
BBC280	.3	500	N	10	700	L	30	100	30	20	N	N	20
BBC237	.3	300	N	10	700	L	10	50	15	20	N	N	15
BES512	.5	1,000	N	L	1,500	N	20	70	50	50	N	N	30
BET006	.5	700	N	L	1,000	N	20	100	20	30	N	N	30
BET007	1	700	N	L	1,000	N	20	70	30	30	N	N	20
BET011	1	1,000	N	10	1,000	N	20	100	50	30	N	N	30
BES514	.5	700	N	L	1,000	L	20	150	50	30	N	N	30
BBC240	.5	500	N	10	500	L	20	70	15	20	N	N	30
BBC241	.3	500	N	10	1,000	L	20	100	5	20	N	N	30
BBC236	.3	700	N	10	700	L	20	70	15	20	N	N	15
BBC279	.3	500	N	L	700	L	30	200	20	20	N	N	70
BET012	.1	10	N	L	700	N	N	N	10	N	N	N	N
BBC293	.2	200	N	L	500	L	5	30	7	20	N	N	15
BBC292	.2	500	N	10	700	L	30	300	50	20	N	N	70
BES498	.7	700	N	L	1,000	L	20	30	50	50	N	N	15
BES497	.7	700	N	L	1,000	N	30	150	70	50	N	N	50
BES496	.7	700	N	L	1,500	L	20	70	50	70	N	N	20
BES494	.5	700	N	L	1,500	L	20	70	50	50	N	N	30
BES495	.5	500	N	L	1,000	L	20	N	20	50	N	N	5
BEJ330	1	1,000	N	L	5,000	L	50	700	70	30	N	N	100
BES493	.5	500	N	L	1,000	L	20	70	50	30	N	N	30
BEJ328	1	700	N	L	5,000G	L	30	300	20	70	N	N	50
BEJ329	1	1,000	N	L	5,000G	L	30	200	50	70	N	N	50
BEJ327	.7	1,000	N	L	5,000G	L	10	20	10	70	N	N	5
BEJ326	.5	1,000	N	L	3,000	L	30	700	50	20	N	N	200
BES492	.02	200	N	L	L	N	N	10	L	N	N	N	N
BEJ325	.05	50	5	L	70	N	5	50	10	N	N	N	20
BES490[2]	.2	200	N	10	700	L	10	100	50	30	20	N	50
BES491	.01	70	N	L	N	N	N	N	5	N	N	N	N
BEJ322[3]	.1	200	N	20	5,000G	N	5	200	70	N	N	N	10
BEJ323	.01	50	N	N	200	N	N	10	5	N	N	N	N
BEJ324	.7	1,000	N	L	5,000	N	50	200	50	20	N	N	50
BES488	.01	70	N	L	L	N	N	10	5	N	N	N	L
BES489[4]	.05	200	N	L	300	N	5	10	20	N	N	N	10
BEJ321	.007	50	N	20	20	N	N	10	5	N	N	N	L
BEJ320	.7	700	N	L	5,000	L	30	700	20	50	N	N	150
BEJ331	1	1,000	N	L	5,000	N	50	500	70	70	N	N	30
BBC248	.5	500	N	10	1,000	L	30	70	50	20	N	N	50
BBC249	.3	500	L	L	700	1	5	L	30	30	N	N	5
BEJ146	.7	500	N	L	5,000	1	10	10	100	70	N	10	5
BEJ052	.5	500	N	L	2,000	L	7	L	20	70	7	10	5
BEJ050	.7	2,000	N	L	1,500	1	30	200	50	20	N	N	30
BBC247	.5	500	N	10	1,500	1	30	200	50	20	N	N	70
BEJ051	.5	700	N	L	1,500	1	15	70	50	50	N	10	20
BEJ148	.5	1,000	N	10	1,500	1	10	50	50	100	N	20	20
BEJ147	1	2,000	N	L	5,000G	1	7	10	50	100	10	10	5

[2]200 ppm As.
[3]3,000 ppm As.
[4]1,500 ppm As.

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples--Continued					
					Southeastern part of area					
BET009	10	20	700	150	70	15	N	50	L(0.02)	Volcanoclastic
BES510	30	30	1,000	200	N	20	N	150	L(.02)	Do.
BET010	30	7	700	70	N	15	N	150	L(.02)	Do.
BES511	15	30	700	200	N	20	N	100	L(.02)	Flow
BET008	30	15	700	70	N	15	N	100	L(.02)	Volcaniclastic
BES513	30	15	700	150	N	15	N	200	L(.02)	Andesitic dike
BES509	30	20	1,000	200	N	15	N	150	L(.02)	Volcaniclastic
BBC238	15	15	700	100	N	20	N	100	L(.02)	Do.
BBC281	15	15	500	100	N	15	N	70	L(.02)	Do.
BBC280	10	20	500	100	N	15	N	70	L(.02)	Flow
BBC237	15	15	700	100	N	15	N	70	L(.02)	Do.
BES512	30	20	700	200	N	20	N	100	L(.02)	Volcaniclastic
BET006	50	20	700	100	N	15	N	100	L(.02)	Do.
BET007	20	20	700	100	N	15	N	100	L(.02)	Do.
BET011	20	30	1,000	100	N	20	N	100	L(.02)	Do.
BES514	20	30	700	200	N	20	N	100	L(.02)	Do.
BBC240	10	15	700	100	N	15	N	70	L(.02)	Do.
BBC241	10	15	700	100	N	15	N	70	L(.02)	Do.
BBC236	10	20	700	200	N	15	N	50	L(.02)	Do.
BBC279	15	15	700	100	N	15	N	100	L(.02)	Flow
BET012	10	N	100	10	N	N	N	30	L(.02)	Sulfur deposit
BBC293	15	7	500	70	N	15	N	70	L(.02)	Volcaniclastic
BBC292	15	15	500	100	N	15	N	70	L(.02)	Flow
BES498	20	20	700	200	N	20	N	150	L(.02)	Volcaniclastic
BES497	20	30	700	150	N	15	N	150	L(.02)	Do.
BES496	30	20	1,000	200	N	20	N	150	L(.02)	Do.
BES494	30	15	700	150	N	15	N	100	L(.02)	Do.
BES495	30	10	1,000	150	N	15	N	150	L(.02)	Do.
BEJ330	20	50	2,000	300	50	30	N	200	L(.02)	Do.
BES493	30	15	700	150	N	10	N	100	L(.02)	Do.
BEJ328	30	30	5,000	200	N	20	N	300	L(.02)	Do.
BEJ329	30	30	2,000	200	100	30	N	300	L(.02)	Do.
BEJ327	50	10	2,000	100	50	20	N	500	L(.02)	Do.
BEJ326	20	30	2,000	200	N	10	N	200	L(.02)	Do.
BES492	L	N	200	10	N	N	N	N	L(.02)	Limestone
BEJ325	15	N	300	30	N	10	N	10	L(.02)	Do.
BES490	10	10	N	100	N	20	L	70	L(.02)	Jasperoid
BES491	L	N	150	10	N	10	N	N	L(.02)	Limestone
BEJ322	N	50	500	300	N	N	N	30	.04	Jasperoid
BEJ323	L	N	150	L	N	N	N	N	L(.02)	Limestone
BEJ324	20	50	2,000	300	150	20	L	200	L(.02)	Flow
BES488	L	N	100	10	N	N	N	10	L(.02)	Limestone
BES489	N	L	N	70	N	L	N	15	L(.02)	Jasperoid
BEJ321	10	N	N	L	N	N	N	N	L(.02)	Limestone
BEJ320	50	50	2,000	300	N	20	N	200	L(.02)	Volcaniclastic
BEJ331	30	50	1,000	500	N	30	N	200	L(.02)	Limestone
BBC248	10	20	700	100	N	20	N	70	L(.02)	Volcaniclastic, altered
BBC249	100	5	700	70	N	15	N	70	L(.02)	Altered dike
BEJ146	50	10	1,500	200	N	20	N	300	L(.02)	Flow
BEJ052	20	7	1,000	100	70	15	N	200	L(.02)	Volcaniclastic
BEJ050	15	30	1,000	300	N	20	N	100	L(.02)	Flow
BBC247	20	15	700	100	N	20	N	70	L(.02)	Flow, altered
BEJ051	20	20	1,000	200	N	15	N	200	L(.02)	Flow
BEJ148	100	5	500	50	N	20	N	700	L(.02)	Do.
BEJ147	50	15	5,000	100	N	30	N	300	L(.02)	Do.

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
Bedrock samples--Continued													
Southeastern part of area--Continued													
BBC246	0.5	500	N	10	1,500	1	20	70	50	50	N	N	50
BBC242	.5	500	N	10	1,000	L	20	150	15	20	N	N	50
BBC243	.3	700	N	10	1,000	1	50	1,000	50	20	N	N	200
BBC244	.5	700	N	10	1,500	1	20	70	70	30	N	N	30
BBC245	.3	50	N	15	1,000	1	50	30	50	30	N	N	5
BBC288	.2	500	N	10	700	L	30	500	30	20	N	N	150
BBC289	.3	300	N	L	1,500	L	10	L	70	30	N	N	7
BEJ049	.7	1,000	N	L	1,000	N	30	150	100	50	N	N	30
BEJ048	1	1,000	N	10	2,000	N	30	100	100	100	5	10	30
BEJ045	1	1,000	N	L	1,500	N	30	200	70	70	N	10	30
BEJ047	1	1,000	N	10	5,000	N	30	300	100	100	N	10	50
BEJ057	.5	1,000	N	L	5,000	L	30	150	70	150	N	10	30
BBC318	.3	700	L	10	700	L	15	50	20	20	N	N	10
BEJ046	.7	1,000	N	10	1,500	N	20	100	70	70	N	10	20
BEJ058	.5	1,500	N	L	2,000	L	30	100	50	30	N	N	20
BEJ030	.5	1,000	N	L	1,000	N	20	150	50	30	N	N	30
BEJ029	.5	1,000	N	L	1,500	N	20	150	20	30	N	N	20
BBC295	.2	700	N	L	700	L	20	50	20	20	N	N	15
BEJ150	.5	700	N	L	5,000G	L	5	L	50	100	N	10	L
BEJ151	1	1,000	N	L	3,000	L	30	200	50	30	N	N	20
BEJ152	.7	1,000	N	L	3,000	L	50	500	50	20	N	N	30
BEJ078	.7	1,000	N	L	2,000	L	30	150	70	50	N	10	50
BEJ054	1	1,000	N	L	5,000	1	20	150	100	100	N	10	30
BES486	.5	700	N	L	1,000	L	20	70	50	50	N	N	20
BEJ318	1	1,000	N	10	5,000	L	30	300	70	30	N	N	30
BEJ316	.7	1,000	N	L	3,000	N	30	700	70	20	N	N	50
BEJ317	.7	2,000	N	L	5,000	N	50	300	70	30	N	N	50
BEJ271	.5	700	N	L	1,000	L	30	500	70	20	N	N	30
BEJ044	1	1,000	N	10	2,000	N	30	700	70	70	N	N	50
BEJ076	1	1,000	N	L	1,500	L	30	200	70	30	N	N	70
BEJ077	1	1,000	N	L	5,000	L	30	100	100	100	N	N	20
BEJ059	.5	1,000	N	L	2,000	L	30	700	70	50	N	N	200
BEJ035	.7	1,000	N	10	5,000	N	20	150	50	70	N	N	20
BEJ036	.5	700	N	10	2,000	N	20	200	70	70	N	N	50
BEJ066	1	1,000	N	L	2,000	L	30	200	100	50	N	10	30
BEJ034	.7	1,000	N	10	5,000	N	15	200	70	50	N	N	30
BEJ027	.7	1,000	N	10	2,000	N	30	1,000	70	30	N	N	200
BEJ028	.5	1,000	N	L	1,500	N	30	1,000	50	20	N	N	200
BEJ074	1	1,000	N	10	5,000G	L	30	500	100	100	N	10	100
BEJ072	.7	1,000	N	L	2,000	L	30	200	50	70	N	N	50
BEJ071	1	1,000	N	L	2,000	L	50	700	100	100	N	10	150
BEJ073	.7	1,000	N	L	2,000	L	30	150	70	50	N	N	30
BEJ026	.7	1,000	N	L	1,000	N	20	200	50	20	N	N	30
BEJ043	.7	1,000	N	L	1,000	N	30	500	70	20	N	N	30
BEJ075	.7	1,500	N	L	5,000	L	50	1,500	100	50	N	10	700
BEJ041	.5	700	N	10	1,000	N	20	100	30	20	L	N	20
BEJ042	.5	1,000	N	L	1,000	N	30	500	70	30	5	N	50
BEJ319	.7	700	N	L	2,000	N	30	300	70	20	N	N	30
BEJ068	1	1,000	N	10	2,000	L	30	200	100	100	N	10	50
BEJ069	1	1,500	N	L	5,000	L	30	200	70	100	N	10	30
BEJ039	.5	700	N	L	1,000	N	15	100	50	50	N	N	20
BEJ065	.7	1,000	N	L	2,000	L	30	200	100	70	N	10	50
BEJ040	.5	700	N	10	1,500	N	15	100	50	50	7	N	20
BEJ038	.3	700	N	L	700	N	15	200	70	20	N	N	30
BEJ063	.5	700	N	L	1,000	L	20	30	20	50	N	N	20

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples--Continued					
					Southeastern part of area--Continued					
BBC246	30	10	700	100	N	15	N	70	L(0.02)	Flow
BBC242	10	15	700	100	N	15	N	70	L(.02)	Volcaniclastic
BBC243	10	20	700	100	N	15	N	70	L(.02)	Dike
BBC244	20	10	700	100	N	15	L	70	L(.02)	Volcaniclastic, altered
BBC245	15	7	1,500	100	N	15	N	70	L(.02)	Do.
BBC288	10	15	500	100	N	15	N	70	L(.02)	Flow
BBC289	30	7	700	70	N	15	N	70	L(.02)	Volcaniclastic
BEJ049	15	30	1,000	200	N	20	N	100	L(.02)	Flow
BEJ048	30	30	1,500	500	100	20	N	200	L(.02)	Do.
BEJ045	20	30	2,000	200	N	20	N	200	L(.02)	Do.
BEJ047	50	30	5,000	500	N	30	N	200	L(.02)	Volcaniclastic
BEJ057	50	30	2,000	200	N	15	N	200	L(.02)	Flow
BBC318	20	20	1,000	100	N	15	N	100	L(.02)	Do.
BEJ046	20	30	2,000	300	N	20	N	200	L(.02)	Do.
BEJ058	15	30	700	200	150	15	N	100	L(.02)	Do.
BEJ030	15	20	1,000	200	N	10	N	100	L(.02)	Do.
BEJ029	15	30	1,000	200	N	15	N	100	L(.02)	Do.
BBC295	10	15	300	100	N	15	N	30	L(.02)	Do.
BEJ150	100	10	1,000	50	70	50	N	500	L(.02)	Do.
BEJ151	15	50	2,000	500	N	30	N	100	L(.02)	Do.
BEJ152	20	50	2,000	500	N	20	N	100	L(.02)	Volcaniclastic
BEJ078	20	30	1,500	200	N	20	N	200	L(.02)	Do.
BEJ054	50	30	2,000	500	N	20	N	200	L(.02)	Do.
BES486	30	15	700	200	N	15	N	100	L(.02)	Do.
BEJ318	15	50	1,500	500	N	30	N	100	L(.02)	Do.
BEJ316	15	50	1,500	500	N	30	N	200	L(.02)	Flow
BEJ317	15	50	1,500	500	50	30	N	100	L(.02)	Volcaniclastic
BEJ271	15	30	1,000	200	N	10	N	50	L(.02)	Flow
BEJ044	20	50	2,000	500	N	20	N	200	L(.02)	Do.
BEJ076	15	70	1,500	200	N	20	N	200	L(.02)	Volcaniclastic
BEJ077	20	50	2,000	300	N	30	N	200	L(.02)	Do.
BEJ059	30	20	1,000	200	50	15	N	200	L(.02)	Do.
BEJ035	20	30	2,000	200	N	20	N	100	L(.02)	Flow
BEJ036	20	30	1,500	200	N	20	N	100	L(.02)	Do.
BEJ066	20	50	2,000	500	70	30	N	200	L(.02)	Do.
BEJ034	20	20	1,000	200	N	15	N	100	L(.02)	Volcaniclastic
BEJ027	20	50	1,000	200	N	20	N	100	L(.02)	Flow
BEJ028	20	30	700	100	N	10	N	70	L(.02)	Do.
BEJ074	20	50	2,000	200	70	20	N	200	L(.02)	Do.
BEJ072	20	30	1,500	300	N	20	N	100	L(.02)	Do.
BEJ071	20	50	1,500	200	70	20	N	200	L(.02)	Do.
BEJ073	15	50	1,500	300	70	20	N	100	L(.02)	Do.
BEJ026	20	30	1,000	200	N	15	N	150	L(.02)	Volcaniclastic
BEJ043	15	30	700	300	N	15	N	100	L(.02)	Flow
BEJ075	20	70	1,500	200	N	15	N	100	L(.02)	Do.
BEJ041	15	30	1,000	200	50	15	N	100	L(.02)	Do.
BEJ042	15	30	500	200	N	20	N	100	L(.02)	Do.
BEJ319	15	50	1,000	300	N	20	N	100	L(.02)	Do.
BEJ068	20	30	1,500	200	N	30	N	300	L(.02)	Do.
BEJ069	30	70	2,000	300	100	30	N	300	L(.02)	Volcaniclastic
BEJ039	20	20	1,000	200	N	15	N	70	L(.02)	Do.
BEJ065	20	30	1,000	200	N	20	N	200	L(.02)	Flow
BEJ040	20	30	1,000	200	N	15	N	100	L(.02)	Do.
BEJ038	20	20	500	200	N	15	N	50	L(.02)	Do.
BEJ063	20	30	1,000	200	N	15	N	100	L(.02)	Do.

TABLE 5.—*Analyses of bedrock samples from the*

Sample	Semiquantitative spectrographic analyses (percent)	(ppm)											
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)	Ni (5)
						Bedrock samples--Continued							
						Southeastern part of area--Continued							
BEJ064	0.7	1,500	N	L	2,000	L	30	500	100	50	N	N	70
BEJ037	.7	1,000	N	L	1,500	N	20	30	70	30	N	N	10
BEJ315	.7	700	N	10	5,000G	L	30	200	50	70	N	N	50
BEJ062	.5	700	N	L	2,000	L	20	30	70	70	N	N	20
BEJ031	.5	700	N	L	1,500	N	20	70	70	70	N	N	20
BEJ032	.5	1,000	N	10	1,500	N	30	150	70	70	N	N	30
BEJ070	1	700	N	L	5,000	L	30	500	70	100	N	10	100
BEJ060	.5	700	N	L	2,000	L	20	70	50	50	5	N	30
BEJ061	.2	700	N	L	1,000	L	15	50	50	50	N	N	30
BEJ067	.7	700	N	L	2,000	L	30	200	70	70	N	N	30
BET034	.5	500	N	L	1,000	N	15	70	20	30	N	N	20
Gm	.4	637		7		0.5	20	105	41	38		6	27

North Absaroka Wilderness, Wyoming—Continued

Sample	Semiquantitative spectrographic analyses (ppm)--Continued								Atomic absorption (ppm)	
	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Au (0.02)	Sample description
					Bedrock samples--Continued					
					Southeastern part of area--Continued					
BEJ064	20	50	1,000	200	100	20	N	100	L(0.02)	Flow
BEJ037	20	30	1,000	200	N	20	N	100	L(.02)	Do.
BEJ315	50	30	2,000	300	50	30	N	500	L(.02)	Do.
BEJ062	20	15	2,000	100	70	15	N	200	L(.02)	Do.
BEJ031	15	20	1,000	200	N	15	N	150	L(.02)	Do.
BEJ032	15	30	1,000	200	N	15	N	100	L(.02)	Do.
BEJ070	30	30	1,500	200	N	20	N	200	L(.02)	Do.
BEJ060	15	20	1,000	200	50	15	N	200	L(.02)	Volcaniclastic
BEJ061	15	15	700	100	N	10	N	100	L(.02)	Do.
BEJ067	15	50	1,500	300	N	20	N	100	L(.02)	Do.
BET034	20	15	700	100	N	10	N	100	L(.02)	Do.
Gm	19	20	895	149	14	17		104		

TABLE 6.—*Semiquantitative spectrographic analyses of*

[Analyses are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1 which represent approximate midpoints of group data on a geometric scale. All samples were analyzed for Fe(0.05), Ca(0.05), and Mg(0.02), but the quantitites found are considered normal for the rocks of the region, and, therefore, they are not presented here. Analyses for Sn revealed no significant values, and no determinations are shown. Samples containing amounts equal to or greater than the lower

Sample	(percent)	(ppm)										
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)
BBC287	0.2	200	N	L	700	L	5	L	20	30	N	N
BCM445	.3	2,000	0.5	10	1,500	1	70	100	50	30	7	N
BCM446	.3	2,000	N	L	5,000G	1	50	100	20	50	N	N
BCM447	.3	1,500	.5	L	1,500	1.5	20	15	30	30	10	N
BCM448	.2	500	.5	L	1,000	2	15	L	10	20	N	10
BCM449	.5	300	.7	10	1,500	2	70	70	100	50	7	10
BCM450[1, 2]	.2	5,000G	50	10	700	2	70	70	3,000	N	70	N
BCM458[2]	.5	2,000	20	50	3,000	1.5	70	70	150	70	5	N
BCM459	.3	2,000	5	70	2,000	3	70	70	150	20	N	N
BCM460[3]	.3	1,500	5	70	3,000	3	50	70	150	20	N	N
BCM461[2]	.3	1,500	100	20	5,000G	2	50	150	700	50	N	N
BCM462	.5	2,000	100	30	5,000G	1.5	70	500	300	70	N	N
BCM452	.1	500	.5	L	700	1	7	70	30	20	7	10
BCM457	.3	700	.5	L	1,500	1.5	7	20	20	30	5	10
BCM453	.5	1,000	1.5	10	2,000	1.5	20	70	70	70	30	10
BCM454[4]	.2	5,000	20	10	5,000	1.5	30	20	150	20	15	10
BCM455	.2	2,000	7	10	5,000	1.5	10	15	100	20	7	10
BCM456	.3	2,000	10	10	3,000	1.5	20	70	100	50	10	10
BCM451	.3	1,500	3	30	200	2	15	150	150	20	30	N
BCM439	.3	700	N	L	2,000	1.5	50	70	7	150	N	10
BBC294	.2	500	N	L	1,000	L	10	20	30	30	N	N
BCM464[5]	.15	5,000G	30	L	1,000	1.5	30	20	20,000G	20	70	N
BCM465[6, 3]	.3	5,000G	20	10	1,500	1.5	30	70	5,000	30	30	N
BCM466[7, 8]	.1	5,000G	50	10	5,000G	1.5	30	15	20,000	20	70	N
BCM467[6, 9]	.2	5,000G	50	10	3,000	1.5	70	50	20,000	20	70	N
BCM468[3]	.2	5,000G	10	10	1,500	1.5	50	L	2,000	20	70	10
BCM469[3]	.3	5,000G	50	10	2,000	1.5	70	50	1,500	30	70	N
BCM470[10, 11]	.1	5,000G	50	10	1,500	1.5	20	15	20,000G	20	30	10
BCM471[10, 11]	.1	5,000G	100	15	700	2	30	15	20,000G	20	30	N
BCM463	.3	1,500	.7	L	2,000	1.5	20	15	50	70	N	N
BCM472	.3	1,000	1.5	L	1,000	1	70	150	200	50	N	N
BCM444	.3	1,000	N	L	2,000	1	30	70	20	50	N	10
BCM441	.3	700	N	L	1,500	2	5	70	100	70	N	10
BCM442	.3	700	.5	L	2,000	2	15	70	20	100	N	10
BCM443[6]	.2	150	1	L	2,000	1.5	30	L	700	30	N	20
BCM440	.15	150	.7	L	2,000	1.5	5	L	20	20	N	10
BCM436	.2	3,000	N	L	2,000	5	70	70	150	100	30	30
BCM432[6]	.3	700	7	L	5,000	1	70	300	2,000	50	N	N
BCM434	.2	700	100	L	2,000	1	15	100	150	20	10	10
BCM433	.3	700	1.5	L	2,000	1	20	100	150	50	N	10
BCM422	.3	700	1	L	1,500	1	15	50	1,000	30	N	10
BCM423	.3	300	3	L	2,000	L	7	10	15,000	50	10	10
BCM421	.3	200	3	L	1,500	1	10	10	3,000	70	70	10
BCM437	.2	200	.5	15	1,500	1.5	5	15	30	50	30	10
BCM430[12]	.2	300	700	10	5,000G	1	10	70	1,500	20	100	10
BCM431[2]	.3	700	20	L	2,000	1.5	20	70	200	30	50	10
BCM415[6, 5]	.2	500	20	L	1,500	1	10	70	200	30	70	10
BCM414[2]	.2	500	7	L	1,000	1	7	50	100	20	50	10
BCM435	.3	500	1.5	L	2,000	1	10	20	30	50	10	20
BCM425	.3	2,000	5	20	2,000	1	30	100	100	70	15	10
BCM426[6]	.3	1,500	5	20	2,000	1	20	100	150	70	7	10
BCM427	.3	2,000	2	L	1,500	1	30	70	150	70	N	10
BCM428[3]	.1	5,000G	50	L	1,500	1	30	100	2,000	30	10	10
BCM429	.3	700	N	L	1,500	1.5	70	150	200	20	N	10
BCM411	.5	1,000	N	L	1,500	1	15	70	100	30	7	10

See footnotes at end of table.

bedrock samples from the Sunlight mining region, Wyoming

spectrographic detection limits for the As(200), Au(10), Bi(10), Cd(20), and Sb(100) are shown in footnotes. Symbols used are: N, looked for but not found; G, the amount of the element present is greater than the sensitivity limit; L, an undetermined amount of the element is present below the sensitivity limit; ---, no data given; Gm, geometric mean. Analysts: R. N. Babcock, G. W. Day, and R. T. Hopkins]

Sample	(ppm)--Continued									
	Ni (5)	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Sample description
BBC287	5	15	7	700	70	N	15	N	100	Flow
BCM445	30	70	15	700	150	N	20	N	150	Adit dump
BCM446	20	30	20	1,000	150	L	30	N	100	Vein
BCM447	7	30	10	1,000	150	N	20	N	150	Shear zone
BCM448	7	30	10	700	100	N	15	N	150	Vein
BCM449	50	70	15	1,000	150	L	20	N	150	Do.
BCM450	50	3,000	10	500	300	N	20	1,000	50	Do.
BCM458	30	1,500	15	700	200	N	20	L	150	Shear zone
BCM459	30	1,000	15	700	150	N	15	L	100	Gouge material
BCM460	30	100	15	700	150	N	15	L	100	Shear zone
BCM461	70	2,000	15	1,500	200	N	20	L	150	Adit dump
BCM462	150	700	15	1,000	100	N	20	L	150	Do.
BCM452	30	70	5	500	150	N	10	N	150	Prospect pit dump
BCM457	5	30	7	700	200	N	15	300	150	Limonitic gouge zone
BCM453	20	100	10	5,000G	50	N	20	N	150	Altered rock
BCM454	30	5,000	5	500	50	N	10	2,000	100	Altered andesite
BCM455	10	5,000	5	500	100	N	10	2,000	100	Quartz vein
BCM456	20	300	10	500	100	N	15	2,000	150	Altered rock
BCM451	50	15,00	15	700	20	N	15	N	150	Vein
BCM439	20	30	15	1,000	200	N	20	N	150	Adit dump
BBC294	10	30	7	1,000	70	N	15	N	100	Altered rock
BCM464	30	200	5	500	100	N	10	200	150	Adit dump
BCM465	30	150	7	500	50	N	20	N	150	Do.
BCM466	20	5,000	5	500	100	N	15	500	100	Do.
BCM467	20	3,000	7	300	100	N	15	300	150	Do.
BCM468	10	150	5	200	200	50	15	200	150	Do.
BCM469	30	200	15	500	50	N	20	200	150	Do.
BCM470	7	500	L	200	50	N	10	L	150	Do.
BCM471	20	500	L	100	50	N	10	300	100	Selected mineralized rock
BCM463	7	500	7	1,500	50	N	20	L	150	Adit dump
BCM472	50	30	15	700	30	N	20	N	150	Do.
BCM444	30	30	15	1,000	150	N	20	N	150	Do.
BCM441	10	10	15	2,000	200	N	20	N	150	Shear zone
BCM442	20	20	15	2,000	150	N	30	N	150	Do.
BCM443	5	10	5	1,000	70	N	10	N	150	Do.
BCM440	5	10	5	700	70	N	10	N	150	Prospect pit dump
BCM436	70	100	5	1,000	70	N	20	300	150	Quartz veinlet
BCM432	50	500	15	700	150	L	15	N	150	Vein
BCM434	30	2,000	7	700	100	L	15	700	150	Adit dump
BCM433	30	500	10	700	150	N	20	L	150	Prospect pit dump
BCM422	20	20	7	1,000	150	N	15	N	150	Do.
BCM423	7	50	5	700	70	N	15	N	150	Do.
BCM421	7	20	7	1,000	150	N	20	N	150	Do.
BCM437	5	30	5	1,000	100	N	15	N	150	Prospect trench dump
BCM430	20	20,00 G	5	700	100	70	10	10,00 G	100	Select vein material
BCM431	10	10,00	15	700	150	50	15	700	150	Prospect dump
BCM415	20	200	5	1,000	100	N	15	700	100	Prospect pit dumps
BCM414	20	100	5	500	70	N	N	L	150	Do.
BCM435	7	70	7	700	100	N	20	N	150	Adit dump
BCM425	100	1,500	15	700	100	N	15	N	150	Prospect pit dump
BCM426	50	3,000	10	700	100	N	15	N	150	Do.
BCM427	30	5,000	10	700	100	N	15	N	150	Do.
BCM428	30	20,00 G	5	500	100	N	15	L	100	Do.
BCM429	30	70	15	700	200	N	20	N	150	Do.
BCM411	30	20	15	700	200	N	20	N	150	Do.

TABLE 6. —*Semiquantitative spectrographic analyses of bedrock*

Sample	(percent)	(ppm)										
	Ti (0.002)	Mn (10)	Ag (0.5)	B (10)	Ba (20)	Be (1)	Co (5)	Cr (10)	Cu (5)	La (20)	Mo (5)	Nb (10)
BCM410	0.5	500	0.5	L	1,500	L	20	70	30	70	7	10
BCM409	.5	1,000	.5	L	2,000	1	50	70	150	70	N	10
BCM424	.2	500	.5	L	1,500	1	10	15	150	50	50	10
BCM407	.3	500	1.5	L	2,000	1	10	15	3,000	70	7	10
BCM408	.2	300	.7	L	1,500	1	10	150	1,500	30	7	10
BCM406	.3	1,000	.5	L	2,000	1	30	70	150	70	N	N
BCM412	.5	1,000	N	L	1,500	1	30	50	30	70	N	10
BCM413	.3	1,000	.5	L	1,500	2	20	50	150	70	N	10
BCM419	.5	1,000	N	L	1,500	1	20	15	30	70	30	10
BCM438	.2	2,000	.7	10	700	2	50	70	100	70	N	10
BCM418	.3	1,000	.5	L	1,500	2	20	70	150	50	N	10
BCM417	.2	300	.7	10	1,500	3	10	70	30	50	7	20
BCM416[6, 13]	.2	700	70	10	1,500	1	30	15	1,500	50	30	10
Gm	.3		2.3			1	23	44		39	7	9

[1]70 ppm Bi.
[2]150 ppm Sb.
[3]100 ppm Sb.
[4]20 ppm Cd.
[5]300 ppm Sb.
[6]Bi present below sensitivity limit (10 ppm).
[7]20 ppm Bi.

samples from the Sunlight mining region, Wyoming—Continued

Sample	(ppm)--Continued									
	Ni (5)	Pb (10)	Sc (5)	Sr (100)	V (10)	W (50)	Y (10)	Zn (200)	Zr (10)	Sample description
BCM410	20	20	10	700	200	N	20	N	200	Prospect pit dump
BCM409	30	20	15	1,000	200	N	20	N	200	Do.
BCM424	7	30	5	700	50	70	10	N	150	Do.
BCM407	70	70	5	1,500	150	N	20	N	150	Shear zone
BCM408	30	30	5	1,000	100	N	10	N	100	Altered rock
BCM406	30	20	15	1,500	150	N	20	N	150	Adit dump
BCM412	30	10	15	1,500	200	N	30	N	150	Syenite dike
BCM413	30	10	15	1,500	200	N	20	N	150	Shear zone
BCM419	7	30	10	700	150	150	20	N	150	Adit dump
BCM438	30	30	10	300	100	N	15	300	150	Syenite
BCM418	20	30	7	2,000	100	N	15	N	150	Adit dump
BCM417	30	30	5	700	100	N	10	N	150	Do.
BCM416	10	500	5	1,000	100	N	10	300	150	Do.
Gm	20		9		108		16		138	

[8] 200 ppm Sb.
[9] 3,000 ppm Sb.
[10] 50 ppm Bi
[11] 500 ppm Sb
[12] 1,500 ppm As, 500 ppm Cd, 5,000 ppm Sb.
[13] 700 ppm As, 700 ppm Bi, and 15 ppm Au detected spectrographically.

SILVER AND GOLD

Very few of the analyzed specimens from the wilderness contained gold or silver in amounts exceeding the lower limit of detection, 0.5 ppm. Silver content was determined by semiquantitative spectrographic analyses, and gold content was determined by atomic absorption, which has a sensitivity of 0.02-0.05 ppm, depending on the sample size.

Only one bedrock specimen contained a measurable amount of silver, this was BEJ325, with 5 ppm silver, from limestone north of Pat O'Hara Mountain. There is no perceptible alteration in this limestone and no evidence of any intrusive rocks in the vicinity; however, the limestone here was probably at one time not far below volcanic rocks which have been removed by erosion and which may have contributed the silver. Three other bedrock specimens, BBC053, BBC249, and BBC318, contained low, but detectable, concentrations of silver.

Three stream-sediment samples from scattered localities in the southwestern part of the area contained measurable amounts of silver; these were BEJ101 from Crow Creek, BEJ123 from Jones Creek, and BEJ127 from Bear Creek, which contained 1, 3, and 0.5 ppm silver.

Two bedrock samples contained measurable amounts of gold; one, sample BBC324, with 0.02 ppm gold, was from a ridge east of Hoodoo Creek in Crandall Creek drainage, and one, BEJ324, with 0.04 ppm gold, was in jasperoid, which formed at the contact between limestone and volcanic rock near the top of Pat O'Hara Mountain.

Measurable traces of gold were found in five widely scattered stream-sediment samples. These were BEJ018 from Libby Creek at the south edge of the wilderness with 0.12 ppm gold, BBC091 from near the head of Timber Creek with 0.08 ppm gold, BEJ118 from Jones Creek with 0.06 ppm gold, BEJ203 and BEJ214 from Libby Creek and Grinnell Meadows, respectively, with 0.04 ppm gold each.

In contrast with bedrock samples from the wilderness, samples from veins and mine dumps taken in the Sunlight mining region contain large amounts of silver and gold. One sample (BCM430, table 6) contained 700 ppm silver and four (BCM434, BCM461, BCM462, and BCM471) contained 100 ppm silver, and one (BCM416) contained 15 ppm gold. No atomic-absorption determinations for gold were made on the samples from the mining region.

MOLYBDENUM

Few of the analyzed samples contained more than 5 ppm molybdenum, which is the limit of detection. Samples containing detectable amounts of molybdenum were taken from widely spaced areas throughout the wilderness, which indicates that small amounts of molybdenum are widely distributed in the rocks of the area.

The maximum concentration of 30 ppm molybdenum in samples from the wilderness, and the maximum of 100 ppm in a sample of mineralized rock from the Sunlight mining region are well below economically significant values.

Two bedrock samples from near the top of Hurricane Mesa in the northern part of the wilderness (C27 and C52) contained at least 5 ppm molybdenum (table 5); one of these was taken from a limonitic alteration zone. Five bedrock samples from the southwestern part (J53, J149, J268, J272, and J307) have detectable amounts of molybdenum. Seven specimens from scattered localities in the southeastern part have detectable amounts of molybdenum; two of these, J52 and J147, are near the Sunlight mining region; one, S490, with 20 ppm molybdenum, is a jasperoid which developed where volcanic rocks came to rest on limestone about 1 mile (1.6 km) west of Pat O'Hara Mountain in the eastern part of the wilderness.

One stream-sediment sample, C112, from upper North Fork of Crandall Creek has 30 ppm molybdenum (table 4), and one, C107, from Tepee Creek has 10 ppm. Several stream-sediment samples from the southwestern part of the area contained 5–10 ppm molybdenum. Seven stream-sediment samples from near the southern edge of the wilderness contained detectable amounts of molybdenum, from 7 to 15 ppm (table 4).

Of all the samples from the North Absaroka Wilderness that contain detectable amounts of molybdenum only those from Jones and Crow Creeks in the western part of the area are clustered in a way that suggests a local concentration of molybdenum. Of the bedrock samples from this vicinity only one, J304, from an unaltered lava flow in the Langford Formation, contains a detectable amount of molybdenum. This suggests that the weak concentration of molybdenum in the nearby stream sediments may have been derived from the Langford Formation, possibly from the lava flows of that formation, which have been mostly removed in this locality by erosion. The molybdenum in these sediments, however, may be from glacial debris from outside the immediate area.

LEAD

The lead content of analyzed samples from the North Absaroka Wilderness ranges from less than 10 ppm (the lower limit of detection) to 100 ppm. Samples with the greater quantities of lead are not localized in small areas nor are they associated with altered rock; therefore, they probably are not genetically related to subsurface intrusive bodies or to any other mineralized structural feature.

ZINC

Zinc, which is commonly associated with copper and lead, was not detected in any of the specimens from the North Absaroka Wilderness. The lower limit of detection for zinc is 200 ppm.

CHROMIUM

Chromium has been produced from the Precambrian Stillwater Complex, a body of layered mafic and ultramafic igneous rocks about 20 miles (32 km) north of the North Absaroka Wilderness. This layered intrusive body makes up a very small part of the Precambrian rocks exposed in this part of the Rocky Mountains, and no similar intrusives are indicated to be deeply buried beneath the volcanic and sedimentary rocks in the North Absaroka Wilderness. It is noteworthy that the chromite in the Stillwater Complex contains too much iron for the chromium to be extracted profitably on the bases of present technology and prices.

In the North Absaroka Wilderness, no high concentrations of chromium were found; the highest values were 2,000 ppm in stream-sediment samples and 1,000 ppm in bedrock samples. Chromium of these values was found locally throughout the southern and southeastern parts of the wilderness and seems to be related to the chromium of local high background value in dikes and lava flows of the Trout Peak Trachyandesite rather than to be indicative of mineralization.

URANIUM

Thirty-six samples taken throughout the wilderness and representing all types of rocks in the wilderness were analyzed for equivalent uranium (eU). Values of 30-70 ppm were found; values of this magnitude are commonplace in rocks and are not of economic interest. All the Rocky Mountain area was prospected for radioactive minerals shortly after World War II, but no claims were filed for radioactive minerals in the North Absaroka Wilderness indicating that concentrations of radioactive minerals are lacking in surface rocks in the wilderness.

BARIUM

Barium of high value was found unevenly distributed throughout the wilderness. All but one of the bedrock samples that contained more than 5,000 ppm barium were samples in an east-northeast trending zone from the extreme western end of the wilderness, at the heads of Crow Creek and Jones Creek, through the Sunlight mining region, to Dead Indian Hill. Barium of high value does not seem to be related to a specific lithology, formation, or alteration, and that of high value is interspersed with that of low value.

TUNGSTEN

Tungsten is present in samples from the southern half of the wilderness in concentrations of as much as 500 ppm in stream-sediment samples and 150 ppm in bedrock samples. The highest bedrock values were found in the same zone in which high barium concentrations occurred but they are interspersed with many more low values than are the barium and do not make a clearly defined anomaly.

The relatively high values of barium and tungsten in the southern part of the area may be of regional geochemical significance but they do not seem to indicate locally significant deposits.

Many of the stream-sediment samples containing tungsten are from Crow, Jones, and Bear Creeks in the western part of the wilderness, in the area which yielded the largest number of stream-sediment samples with detectable amounts of molybdenum. None of the bedrock samples from the area adjoining these creeks had detectable amounts of tungsten which suggests that the tungsten is associated with morainal material, probably from outside the wilderness, which makes up much of the sediments here.

PETROLEUM

Paleozoic and Mesozoic rocks with structural features similar to those of the petroleum-producing Bighorn Basin to the east are probably present under the volcanic rocks of the wilderness, and a small oil seep was reported on Sweetwater Creek (Hewett, 1913). However, the possibility of economic recovery of petroleum in the wilderness is diminished by the following factors:

(1) Heat from the abundant dikes and other intrusives in the wilderness probably was sufficient to drive out or decompose any petroleum that the Paleozoic and Mesozoic rocks may have contained.

(2) Test wells in the valley of the North Fork of the Shoshone River, on the southeastern fringe of the wilderness, have not revealed recoverable amounts of petroleum.

(3) In most of the northeastern half of the wilderness all the middle and upper Paleozoic sedimentary rocks have been dislocated, broken into blocks, and shattered by the Heart Mountain faulting. This breaking and dislocation would have tended to allow petroleum that may have been present in these rocks to escape.

(4) The volcanic rocks in the wilderness are so thick, and the terrain so rugged, that exploration of the underlying rocks for petroleum would be difficult and costly.

COAL

Coal of rather low quality is common in Cretaceous rocks (Pierce and Andrews, 1941, p. 170), which extend beneath the volcanics in the southern part of the North Absaroka Wilderness, but these beds probably would be too deeply buried to be mined economically.

BENTONITE

Bentonite is widespread in Cretaceous and Tertiary rocks that extend beneath the volcanics in the southern part of the wilderness (Osterwald and Osterwald, 1952, p. 10; Pierce and Andrews, 1941, p. 175), but the bentonite probably would be too deeply buried to be mined economically.

SULFUR

Sulfur is deposited at several places in the vicinity of the Sunlight mining region, and 63 claims for sulfur are on file in the county records. Six of these totaling 518 acres (210 hectares), were patented. Most of these claims are outside the North Absaroka Wilderness, but some do extend into the Wilderness.

These sulfur deposits attracted attention shortly after 1900 when major prospecting activity was initiated in the Sunlight mining region to the west.

Hewett (1913) wrote that "*** sulphur occurs in two forms—cementing surface debris and incrusting irregular open fractures in the lava." He also said that the "*** sulphur deposits *** formed through the decomposition of hydrogen sulphide rising through irregular fractures." This gas, emitted through small vents, oxidized to form water and native sulfur. According to Hewett these fumarolic sulfur zones probably are not more than 15 feet (4.6 m) thick and are of small areal extent.

These conclusions by Hewett were corroborated in 1951. Wideman (1957) wrote that "*** four of the largest deposits were explored by auger drilling and bulldozer trenching. A limited amount of core drilling was accomplished on two other deposits ***. The drilling indicated that most of the sulfur lies within 6 feet (2 m) of the surface, except in one deposit, where it is associated with sedimentary rocks." Samples from two of the sulfur deposits (BES532 and BET012) were analyzed and found to be devoid of concentrations of valuable metallic elements.

No production has been reported from these sulfur deposits in the Sunlight mining region, except for a few carloads of ore used for metallurgical testing.

Two specimens from other sulfur deposits, BES532, from One Hunt Creek north of the Sunlight mining region, and BET12, from Company Creek south of the Sunlight mining region, were analyzed and no concentrations of valuable metallic elements were found.

GEOTHERMAL ENERGY

All the igneous activity within the North Absaroka Wilderness occurred before Oligocene time, 37 m.y. ago, and no fumarolic or hot spring activity now occurs to suggest that any abnormal source of heat remains beneath the surface. The small erosional remnants of Huckleberry Ridge Tuff of Quaternary age, which were emplaced as airborne tuff from sources to the west in Yellowstone National Park, are too thin to contain any residual heat. These factors indicate that the potential for geothermal energy is low.

CONCLUSIONS

We conclude that the North Absaroka Wilderness, except possibly its northernmost fringe, does not contain concentrations of metallic minerals that can be profitably extracted given the economic conditions and technology that exist now or in the foreseeable future. Our reasons for this conclusion are as follows:

1. No exploitable mineral deposits have been found by prospectors in the area during the last 80 years.
2. We found no mineral deposits or indications of mineral deposits during our 2 years of intensive mapping and geochemical sampling in the wilderness.
3. Known deposits of copper, chromium, molybdenum, and other metals adjacent to the wilderness have been too small to be profitably expolited, except along the northern fringe of the wilderness, which is part of the Cooke City mining district.
4. Rocks that might contain bentonite, coal, and petroleum, are so deeply buried that extraction of these commodities, if they were present, would be costly.
5. Petroleum that may have been present in rocks beneath the wilderness is likely to have been largely dispersed or decomposed by heat from the intrusive rocks, especially the stocks but also the numerous dikes. The oil seep reported on Sweetwater Creek just outside the southern border of the wilderness, however, suggests that trace amounts of petroleum may still be present locally in rocks beneath the wilderness.
6. No evidence of geothermal energy resources exists.

Underground mine workings and mineralization of the Irma and Republic mines, on the southern margin of the Cooke City mining district, extend a short distance into the northern edge of the North Absaroka Wilderness. These mines have the longest history of activity of any in the district. Accurate records of their total production are not available, but yield is reported to be substantial. The mineralization in these mines is in Cambrian shale, sandstone, and carbonate strata, which are beneath a thick cover of volcanic rocks. Access to this mineralization has been by workings that begin in deep valleys outside the wilderness; continued mining from these workings probably would not have any effect at the surface in the wilderness. Comparable nearby deposits, if present, would be difficult targets because of the thick cover of volcanic rocks.

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