UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Mineral Resource Potential of Parts of the Cloud Peak Contiguous, Little Goose, and Rock Creek Roadless Areas, Big Horn, Johnson, and Sheridan Counties, Wyoming

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Open-File Report 83-469

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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1983

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of parts of the Rock Creek, Little Goose, and Cloud Peak Contiguous Roadless Areas, Bighorn National Forest, Big Horn, Johnson, and Sheridan Counties, Wyoming. The Cloud Peak Contiguous (02030), Little Goose (02031), and Rock Creek (02032) Roadless Areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, April 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The results of geologic, geochemical, and mine prospect investigations of parts of the Cloud Peak Contiguous, Little Goose, and Rock Creek Roadless Areas parallel the results of previous investigations concerning the Cloud Peak Primitive Area, indicating no evidence of a potential for metallic mineral resources. A low resource potential for copper exists outside of the study areas to the northwest. Nonmetallic commodities, such as feldspar, limestone, building stone, clay, sand, and gravel are more readily available in areas nearby. The geologic setting of the Bighorn Mountains precludes the existence of extensive deposits of organic fuels.

INTRODUCTION

Three roadless areas, the Cloud Peak Contiguous, Little Goose, and Rock Creek Roadless Areas, had their boundaries redrawn in April 1979 and were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service. The U.S. Geological Survey and the U.S. Bureau of Mines previously conducted field studies of the Cloud Peak Primitive Area and proposed extensions to the Primitive Area during 1970 and 1972 (Kiilsgaard and others, 1972; Segerstrom and others, 1976). The areas examined under these two previous investigations included approximately 80 percent of the three roadless areas, the Cloud Peak Primitive Area, the Seven Brothers RARE II Recommendation Area, and the Piney Creek Roadless Area. Field studies for this report during 1980 and 1981 concentrated on those parts of the further planning areas not previously examined (fig. 1). In this report, those parts not previously investigated, when grouped together, are referred to as the study areas.

The three roadless areas lie in the Bighorn National Forest in Big Horn, Johnson, and Sheridan Counties, north-central Wyoming (fig. 1). The acreages of the three roadless areas are Cloud Peak Contiguous, 151,410; Little Goose,

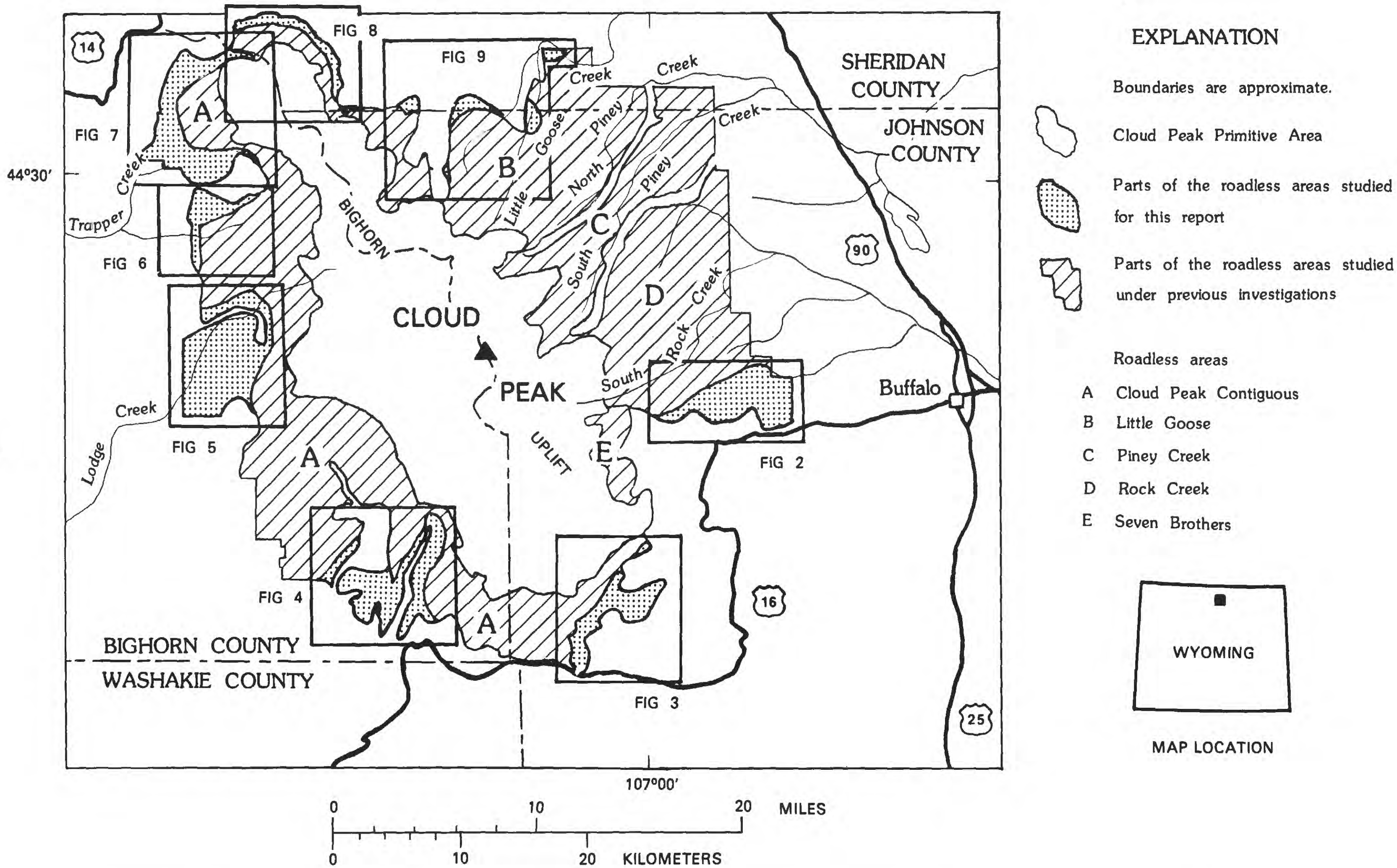


Figure 1.--Index map of the Cloud Peak Primitive Area showing contiguous roadless areas, study areas of this report, and areas covered by figures 2-9.

37,760; and Rock Creek, 51,200. All but approximately 55,000 acres of the total 263,900 acres were included in previous studies. The remaining acreage reported here consists of five major and several smaller separate study areas surrounding the Cloud Peak Primitive Area (fig. 1).

The areas studied are within the Bighorn Mountains and have a variety of terrain ranging from grass prairie to flat, wooded land and marshes, to steep and rugged mountains above timberline. Altitudes range from 6,000 to 11,000 ft.

The study areas are accessible by paved highways, U.S. Highway 14 to the north and U.S. Highway 16 to the south. From these and other major routes, numerous gravel roads and jeep trails go near and (or) into the study areas.

GEOLOGY

The Bighorn uplift (fig. 1), the easternmost of several Laramide uplifts in northern Wyoming, consists of a core of Precambrian rocks flanked by Paleozoic and Mesozoic sedimentary rocks, which in the study areas dip steeply eastward and gently westward away from the core (figs. 2-9).

Rocks found within the study areas are largely Precambrian and in this report have been divided into two groups. The older group consists primarily of gneiss (pЄg) and granite (pЄgr) of felsitic to intermediate composition. The most common foliated rock, gray biotite quartz feldspar gneiss, is well exposed in the Rock Creek Roadless Area (fig. 2) and is generally uniform in composition. The granitic rocks in the study areas range in composition from granite through quartz monzonite and quartz diorite to diorite. The granite is most abundant in the northern study areas (figs. 6-9). Foliated rocks in the southern part of the Cloud Peak Primitive Area grade into more massive rocks in the northern part, as has been reported by Heimlich and Banks (1968), Kiilsgaard and others (1972), and Segerstrom, Weisner, and Jackson (1976). Other older Precambrian rocks are migmatite (mapped with gneiss, pЄg), amphibolite-schist (pЄas), and gabbro (pЄgb). Outcrops of migmatite, associated with gneiss, are sparse in most parts of the study areas though the migmatite is noticably exposed in South Piney Creek north of the Rock Creek Roadless Area. Amphibolite-schist is very rare, and gabbro crops out only in the Rock Creek Roadless Area. Quartz veins in and near the study areas are associated with the older Precambrian rocks.

The younger group of Precambrian age rocks consists of mafic quartz dolerite dikes, both metamorphosed and unmetamorphosed, that have holocrystalline to porphyritic textures. The dark-colored, erosion-resistant dikes generally form bold outcrops which contrast starkly with the light-colored, weathered rocks they intrude. Exposures of mafic dikes are generally more abundant within the Cloud Peak Primitive Area near the core of the range and are less conspicuous in the study areas.

Paleozoic rocks form a marine sedimentary sequence of which six map units have been designated in the study areas (figs. 2-9). On both sides of the Bighorn Mountains the formations dip away from the Precambrian core so that, progressing outward from the range, successively younger beds are exposed.

The Flathead Sandstone (Єf) of early Middle Cambrian age (Howell and others, 1944) is the oldest sedimentary rock in the study areas. It consists of about 220 ft of yellow-brown to light-gray sandstone and silty shale that unconformably overlie the Precambrian crystalline rocks. The basal part of the Flathead is a conglomerate consisting of well-rounded pebbles of massive

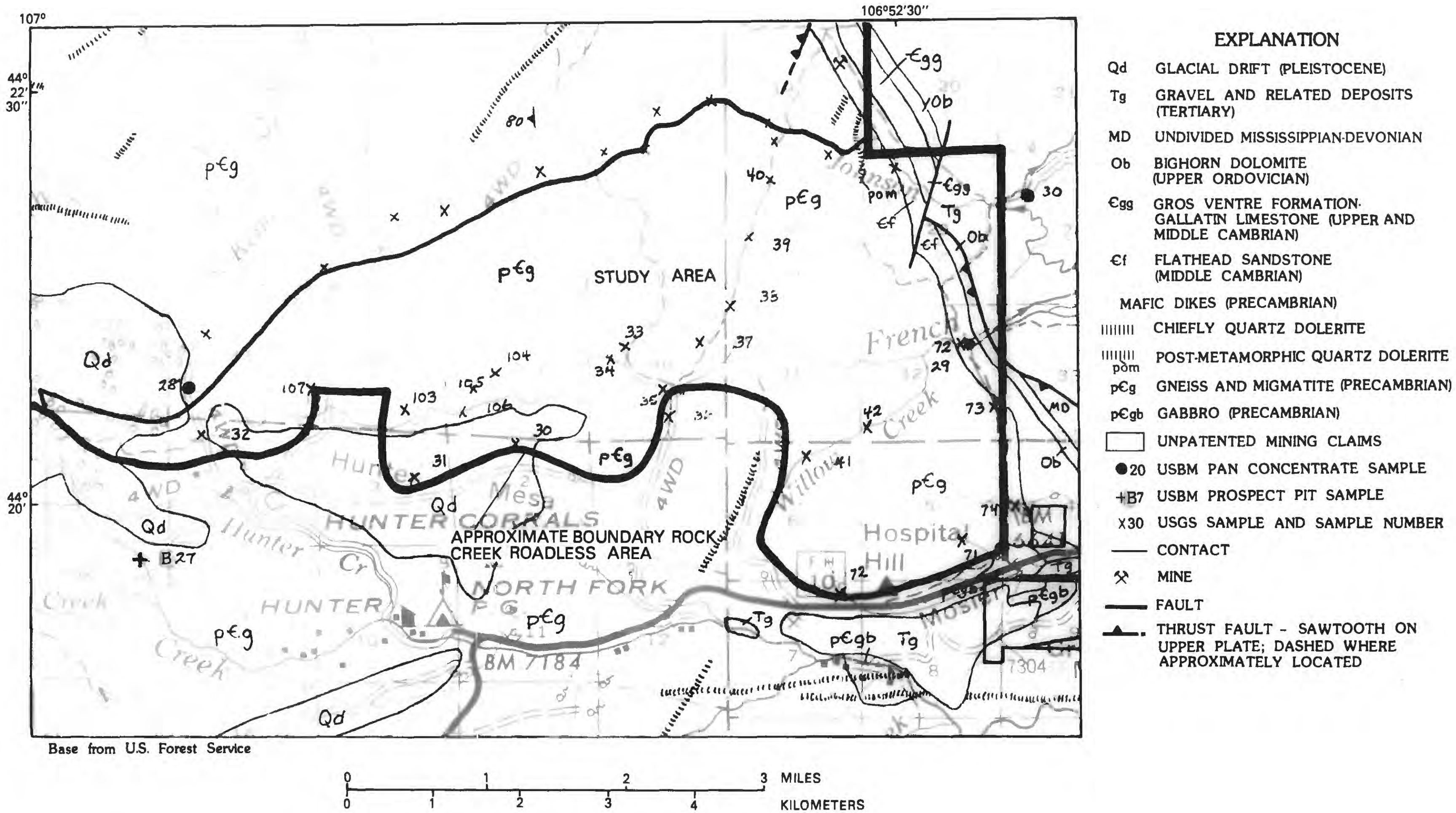


Figure 2.--Geology, sample localities, and prospects in the Rock Creek Roadless Area.

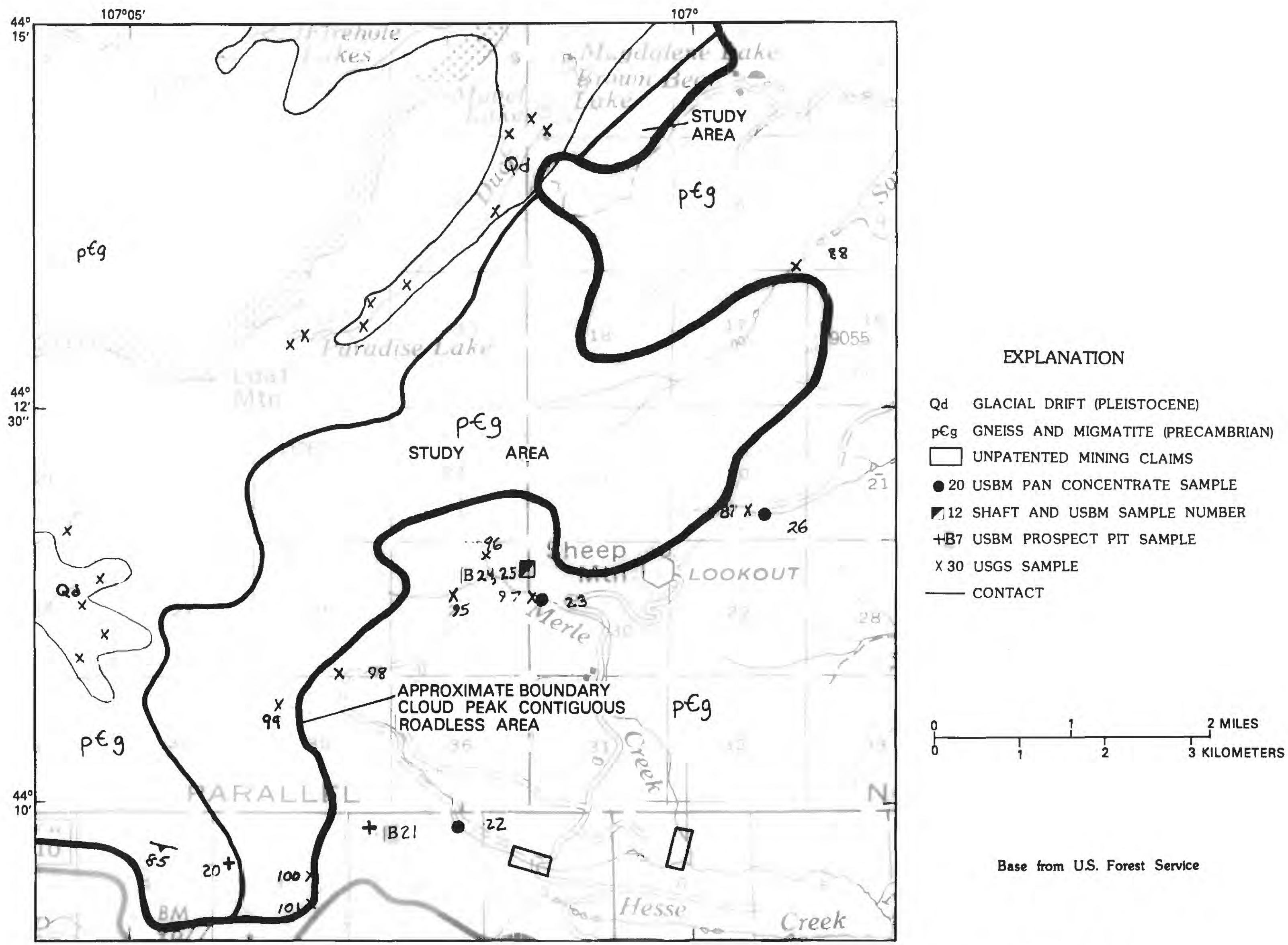


Figure 3.--Geology, sample localities, and prospects in the southeast portion of Cloud Peak Contiguous Roadless Area.

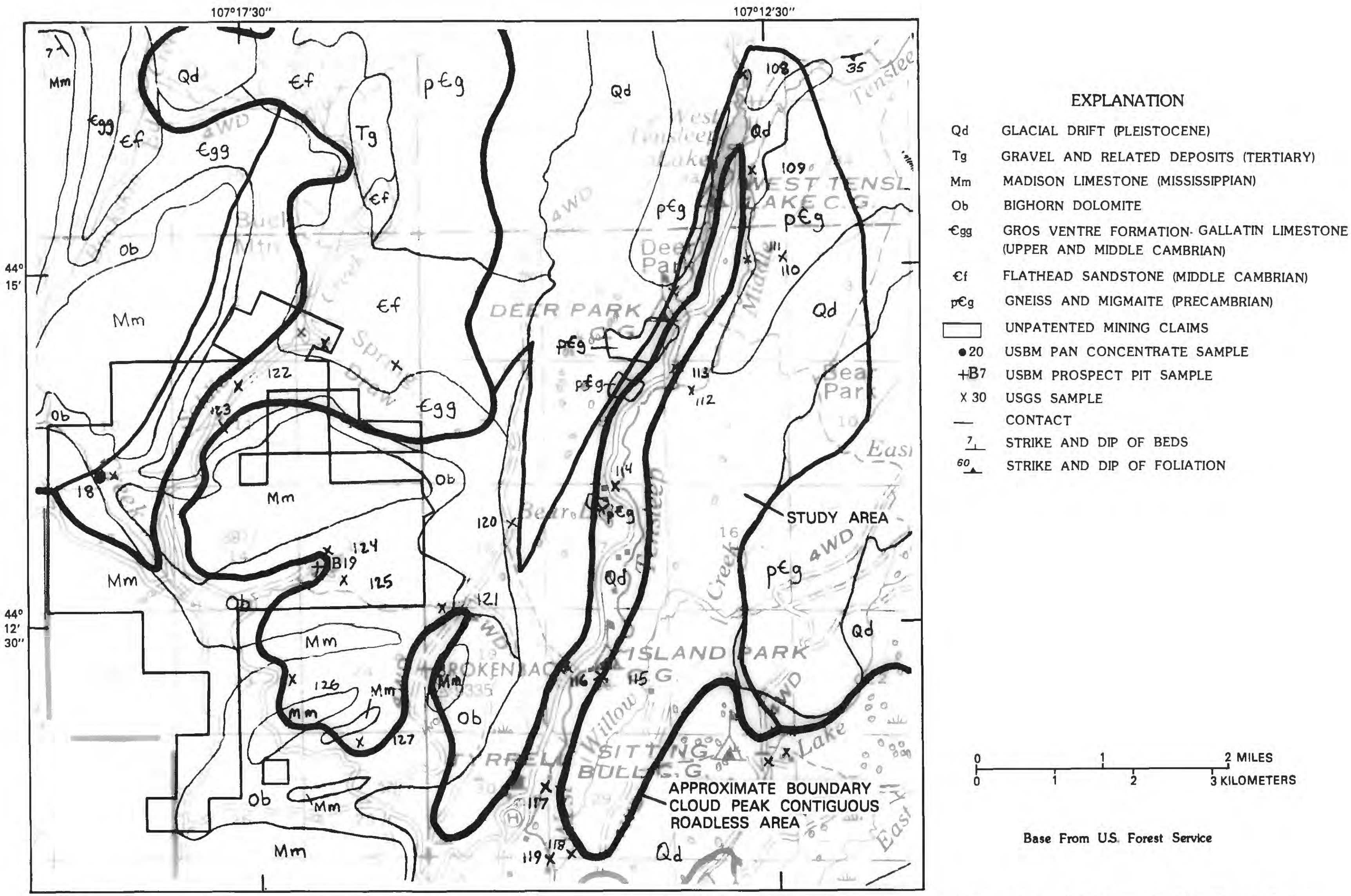


Figure 4.--Geology, sample localities, and prospects in the southern portion of the Cloud Peak Contiguous Roadless Area.

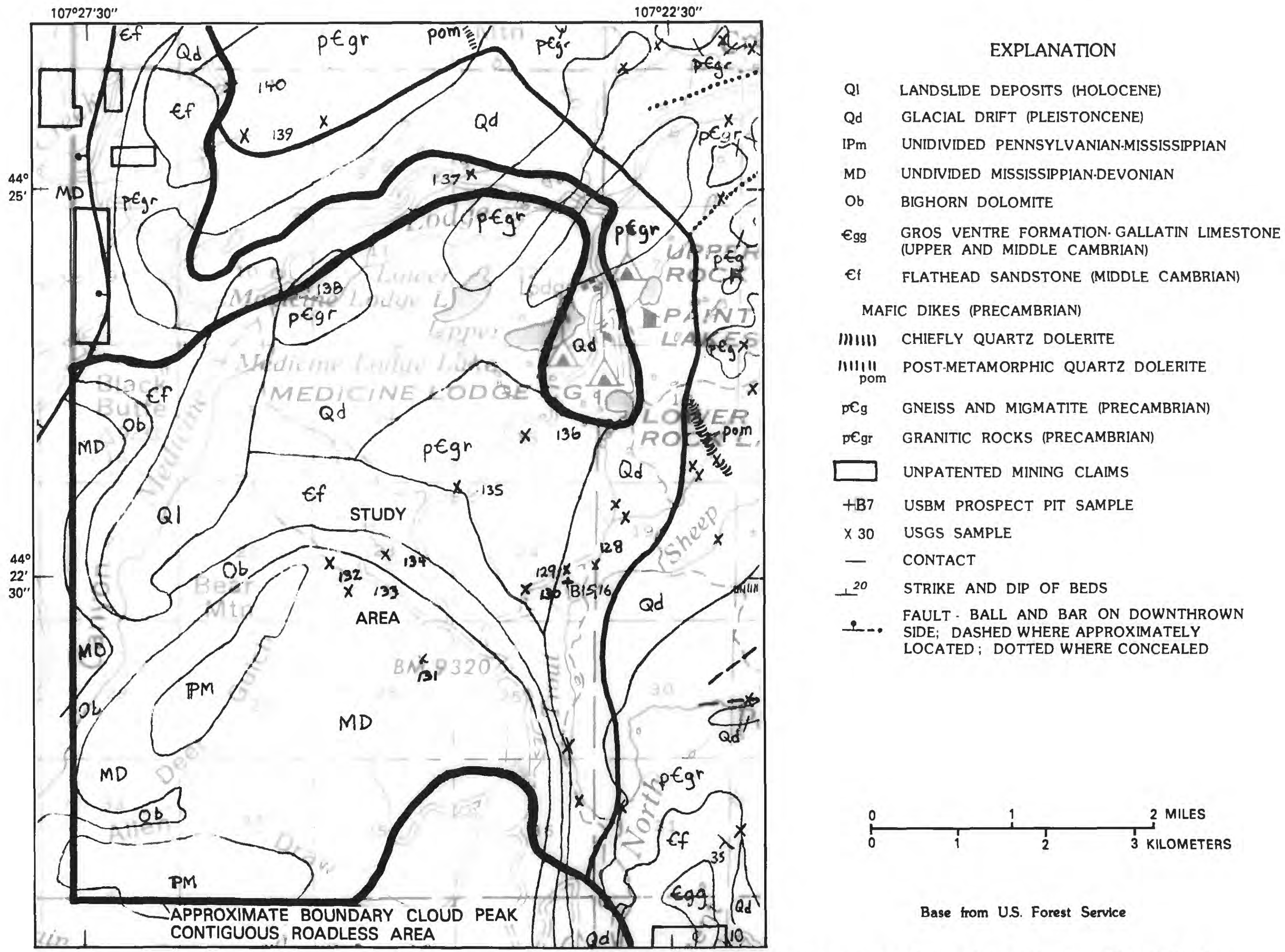


Figure 5 .--Geology, sample localities, and prospects in the west-central portion of the Cloud Peak Contiguous Roadless Area.

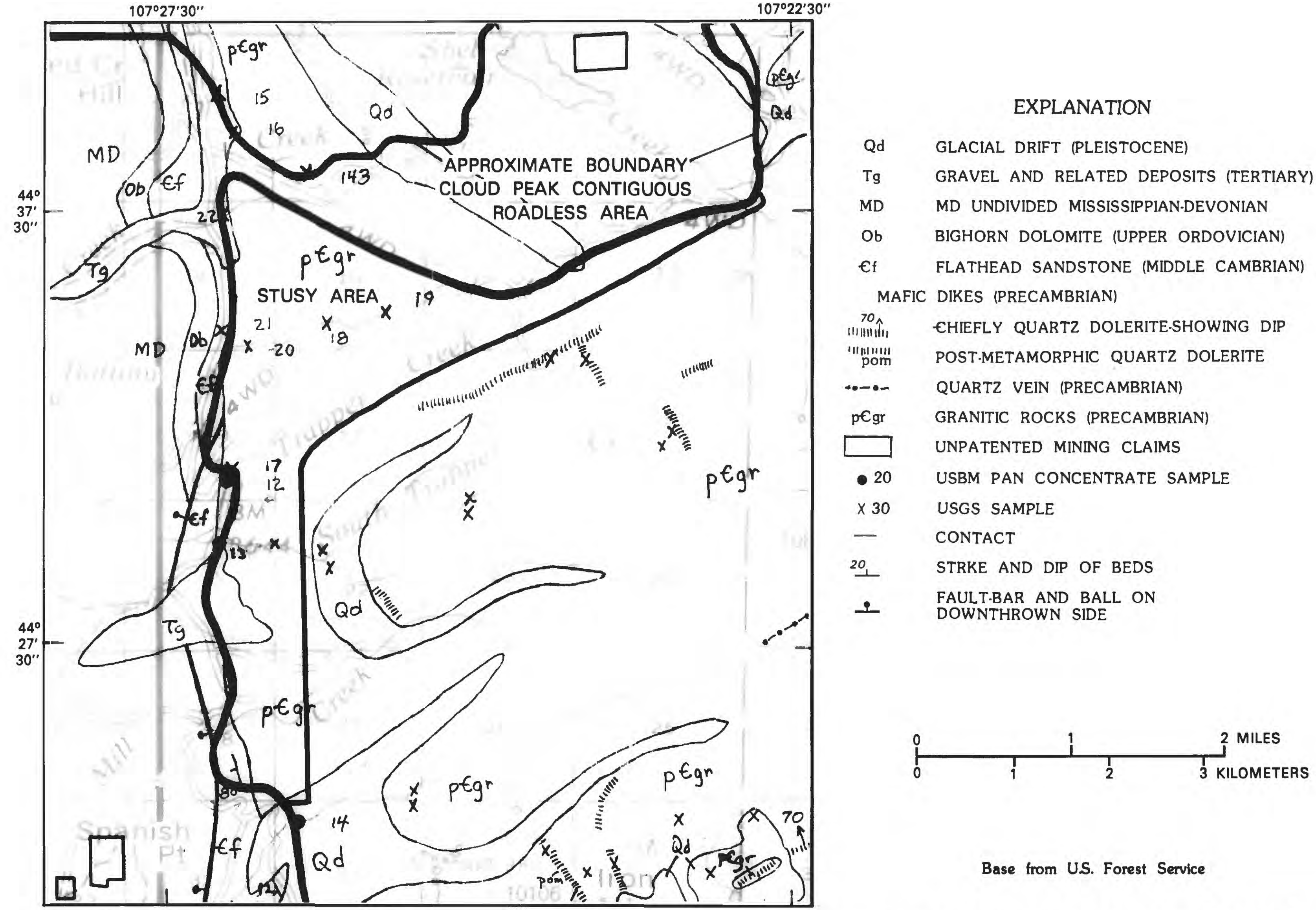


Figure 6.--Geology, sample localities, and prospects in the upper part of the west-central portion of the Cloud Peak Contiguous Roadless Area.

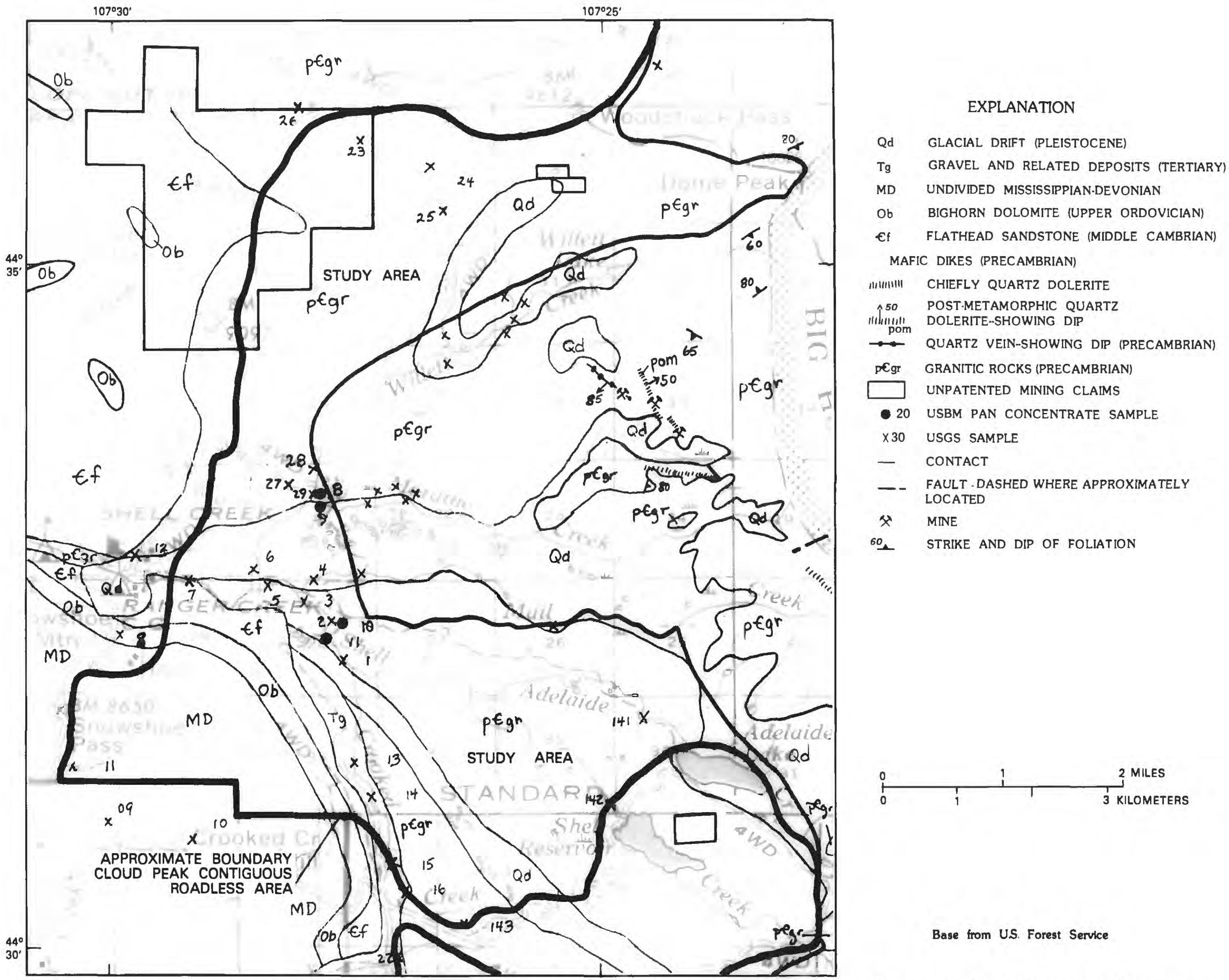
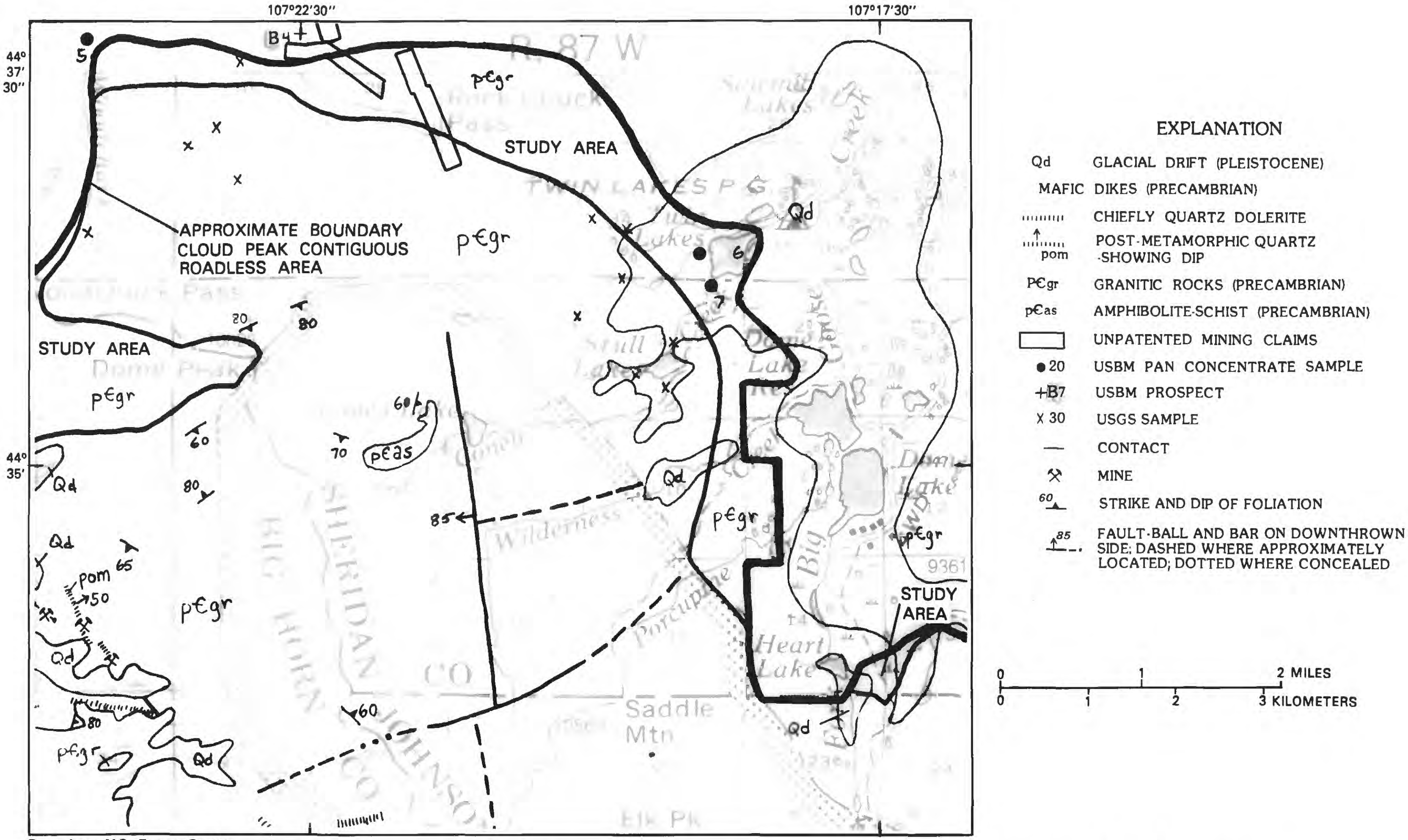
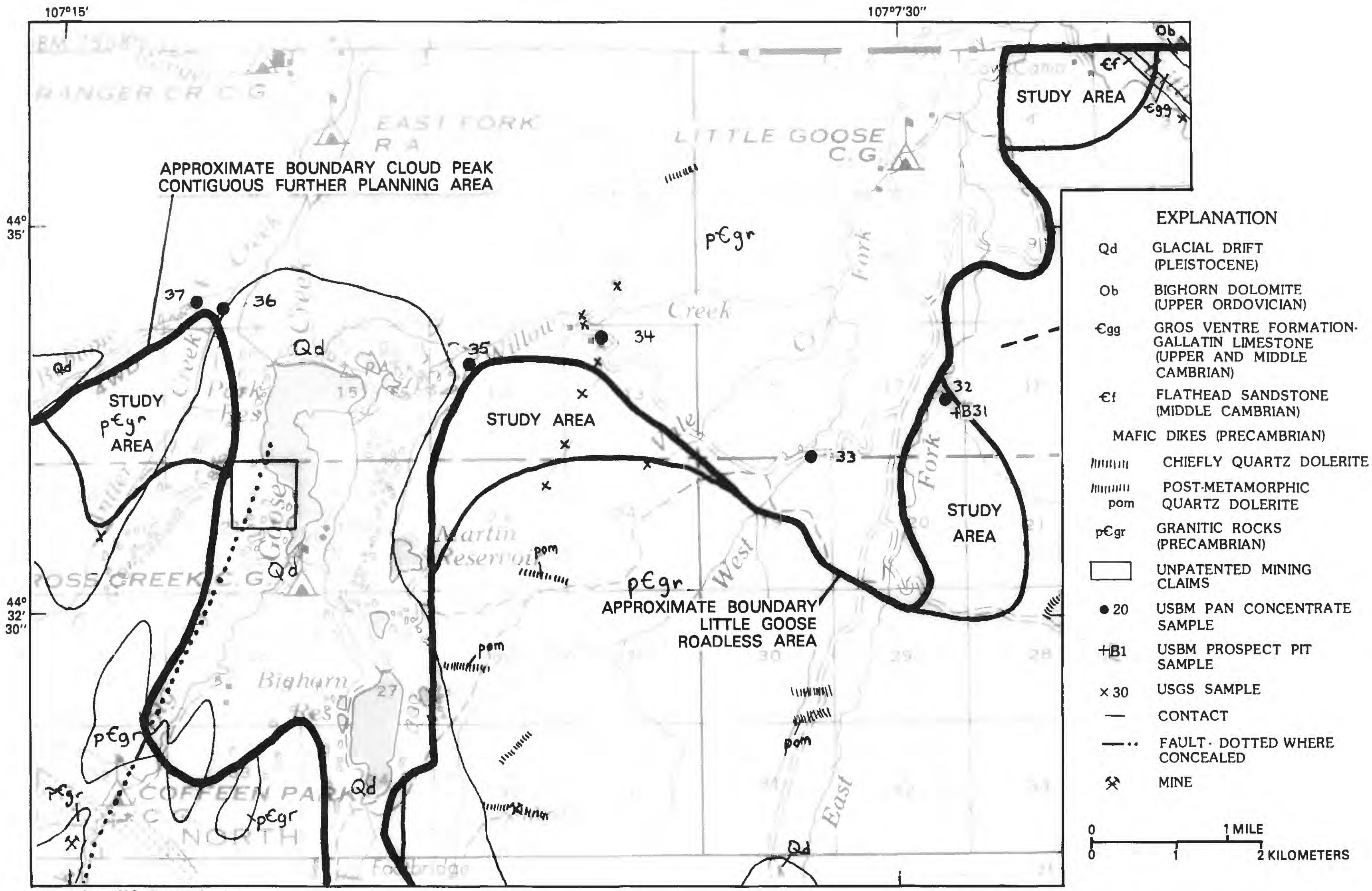


Figure 7.--Geology, sample localities, and prospects in the northwest portion of the Cloud Peak Contiguous Roadless Area.



Base from U.S. Forest Service

Figure 8.--Geology, sample localities, and prospects in the northern portion of the Cloud Peak Contiguous Roadless Area.



Base from U.S. Forest Service

Figure 9.--Geology, sample localities, and prospects in the northern portion of the Cloud Peak Contiguous and Little Goose Roadless Areas.

quartz and Precambrian gneiss. In a few places the mostly friable sandstone has been metamorphosed to quartzite. The Flathead Sandstone on the west side of the range is described as about 250 ft of coarse-grained, gray quartz sandstone that weathers red brown (Kiilsgaard and others, 1972, p. 18). Highly ferruginous lenses in the lower part of the formation represent places where precipitation from ground-water solutions was especially favored (Segerstrom, Weisner, and Jackson, 1976).

The Gros Ventre Formation (Єgg) of Middle and Late Cambrian age conformably overlies the Flathead Sandstone and is conformably overlain by the Gallatin Limestone (Єgg) of Late Cambrian age. These formations consist of grayish-green glauconitic shale and sandstone, and gray limestone, and have a combined thickness of about 780 ft on the east side of the Bighorn Mountains and about 580 ft on the west side. They are poorly exposed and generally form gentle grass-covered slopes.

The Bighorn Dolomite (Ob) of Late Ordovician age consists mostly of dolomite but contains some interbeds of sandstone and limestone. It conformably overlies the Gallatin Limestone and has a thickness of about 405 ft (Segerstrom, Weisner, and Jackson, 1976).

The Madison Limestone (Mm) of Mississippian age unconformably overlies the Bighorn Dolomite and is itself dolomitic limestone. Minor ferruginous and glauconitic lenses occur in the lower part of the formation. On the west flank of the Bighorn Mountains, a basal conglomeratic sandstone about 2 ft thick is overlain by about 3 ft of sandy dolomite which in turn is overlain by about 600 ft of limestone and interbedded dolomite (Segerstrom, Weisner, and Jackson, 1976). The basal unit is considered here to be undivided Mississippian and Devonian rock (MD).

Several post-Madison formations of Paleozoic age are present along the west-central flank of the Bighorn Mountains and are designated as undivided Pennsylvanian-Mississippian (PM) in figure 5. These rocks include the Amsden Formation (Pennsylvanian), consisting of thin-bedded, red dolomite, limestone, sandstone, and shale about 240 ft thick, and the Tensleep Sandstone (Late Pennsylvanian and Early Permian) consisting of about 260 ft of well-bedded and crossbedded, white to reddish-brown sandstone.

Scattered Tertiary deposits (Tg) consist of pebble gravel, sand, silt, and volcanic ash.

Quaternary deposits of glacial drift and colluvium (Qd) are lumped together as a single unit and can be found throughout the study areas. Glacial moraines fan out in all directions from the central highland of the Bighorn Mountains. Narrow valleys and steep stream gradients have prevented the accumulation of alluvium.

A Holocene landslide deposit (Ql) is present in the west-central part of the Cloud Peak Contiguous Roadless Area (fig. 5).

GEOCHEMISTRY

Evaluation of mineral resource potential is based mainly on the sampling of stream sediments and rock outcrops. None of the samples contained minerals or elements in sufficient concentrations to indicate mineral resource potential. Indeed, the Bighorn Mountains are singularly lacking in evidence of mineral occurrences, such as extensive areas of altered rock that characterize mineralized areas elsewhere in the Rocky Mountains.

The abundances of 14 elements in 80 rock samples from the Rock Creek and Piney Creek Roadless Areas are compared with crustal abundances of these elements in similar rocks (table 1). Similar results were obtained on samples from the Cloud Peak Contiguous and Little Goose Roadless Areas. In all, partial results from analyses of 440 U.S. Geological Survey samples and 113 U.S. Bureau of Mines samples from the three study areas have been gathered (Segerstrom, Weisner, and Jackson, 1976).

The values of chromium, copper, nickel, strontium, and vanadium are consistently higher in samples of mafic-dike samples than in samples of granite, gneiss, and stream sediments; for example, the mafic rocks contain about 130 ppm copper (arithmetic mean), as compared with less than 5 ppm (arithmetic mean) in gneiss and granite.

Among other elements, lanthanum and lead are consistently higher in the samples of granite, gneiss, and stream sediments than in samples of mafic dikes. Concentrations of zirconium as great as 1,000 ppm are common in stream-sediment samples, whereas those in samples of granite and gneiss samples do not exceed 500 ppm, and in samples of mafic dikes do not exceed 200 ppm.

In summary, the values of chromium, copper, lead, strontium, and vanadium are normal for the types of rock they represent. The values of lanthanum and zirconium in some stream-sediment samples in the study area approximate concentrations found in regular stream sediments.

Gold and silver were found at or near the lower limit of detection (0.05 ppm for Au, and 0.5 ppm for Ag) in a few stream-sediment samples. Platinum and palladium were detected in three samples of mafic rock that were selected for special analysis because of the relatively high chromium and nickel content in the samples. The values of both platinum and palladium ranged from 7 to 15 ppb (parts per billion), which is close to background for the type of rock sampled.

MINING DISTRICTS AND MINERALIZED AREAS

Mining activity in the study areas has been minimal and consists of small prospects; there are no mining districts. The study areas have no record of mineral production. At the time of the field investigation, evidence of current small-scale mining activity or prospecting near the study areas was found at two localities in the Cloud Peak Contiguous Roadless Area: B19 in the southern part (fig. 4) and north of B4 in the northern part (fig. 8).

Of the 37 samples taken by the U.S. Bureau of Mines during this investigation, only five had copper values of significance (table 2). Southeast of the Cloud Peak Contiguous Roadless Area on the north side of Merle Creek (fig. 3), a trench and a small, inaccessible shaft exposed a zone of copper minerals in Precambrian gneiss (samples B24, B25; table 2). No other prospects or mineral exposures that would indicate that this copper mineralization extends into the study area were seen.

A small deposit of bentonite (sample B19, fig. 4) is present near the southwest boundary of the Cloud Peak Contiguous Roadless Area. In 1980, the clay was being extracted by hand methods from an adit about 15 ft long. This deposit pinches out about 200 ft inside the study area; the part being mined is about 400 ft outside the approximate boundary of the study area.

Table 1.--Comparison of abundance of 14 elements in rocks of the Rock Creek and Piney Creek Roadless Areas to rocks of the earth's crust

Element	Forty mafic dikes (mean)	Crustal abundance[1]	Forty granitic and gneissic rocks (mean)	Crustal abundance[2]
		(Percent)		
Fe----	16	8.56	2.9	2.7
Mg----	7.3	4.5	1.0	.56
Ca----	9.0	6.72	1.9	1.58
Ti----	.75	.90	.28	.23
		(Parts per million)		
Mn----	1,700	2,000	290	600
Ba----	190	300	740	830
Co----	71	45	7.7	5
Cr----	670	200	12	25
Cu----	130	100	4.7	20
Ni----	260	160	13	8
Pb----	2.6	8	14	20
Sr----	130	440	480	300
V-----	330	200	60	40
Zr----	88	100	160	200

[1]Data for basalts (Vinogradov, 1962).

[2]Data for felsic granites and granodiorites (Vinogradov, 1962).

A small prospect pit in the west-central portion of the Cloud Peak Contiguous Roadless Area (samples B15, B16, fig. 5) shows localized copper minerals. This pit, in Precambrian granite, exposes a quartz vein containing a little chalcopyrite and malachite (samples B15, B16, table 2). Surface overburden prevented tracing of the vein. No mineralized rock was recognized elsewhere in this vicinity.

Several prospect pits and a trench lie 1-1.5 mi north of the Cloud Peak Contiguous Roadless Area (north of sample B4, fig. 8). Altered granite and granite containing disseminated pyrite are exposed in some of the pits. The trench exposes a zone of altered rock, between the contact of a mafic dike and granite, that contains copper (sample B2, table 1). The full extent of this

Table 2.--Sample and assay data for U.S. Bureau of Mines samples containing more than 0.10 percent copper

Sample			Assay data	Remarks
Number	Type	Width or type	of copper (percent)	
B-2	Chip-------	7 ft--------	0.17	Trench 200 ft long, 20 ft deep; sample taken across alteration zone along contact of mafic dike and granite; quartz, secondary clay, iron oxide, and hematite present.
B-15	Specimen---	------------	.90	Prospect pit 12 ft diameter, 6 ft deep; quartz vein several feet wide in granite; consists of iron- and malachite-stained quartz containing chalcopyrite.
B-16	Grab-------	3-ft grid---	.14	Same prospect as sample 15; sample is of granite and quartz.
B-24	Specimen---	------------	.69	Dump of a small, caved shaft and adjacent trench; country rock granite gneiss; mafic and pegmatitic rock also present; most rock on dump iron stained, some malachite stained.
B-25	Grab-------	5-ft grid----	.21	Do.

small occurrence of copper is not exposed on the surface because of the overburden, but no evidence exists that the mineralized area extends into the adjacent Cloud Peak Contiguous Roadless Area.

The Bighorn Mountains are flanked on either side by major oil- and gas-producing areas, the Powder River Basin to the east and the Bighorn Basin to the west. Land leased for oil and gas is shown in figure 10. No oil or gas has been produced, however, from within the Bighorn Mountains in the region of the Cloud Peak Primitive Area. The closest oil and gas field to the east lies 12 mi distant from the Rock Creek Roadless Area; however, a few dry holes have been drilled in search of oil and gas within 4 mi of the Rock Creek Roadless Area (Wayne Southerland, Geologist, Bureau of Land Management District Office, Buffalo, Wyo., oral commun., 1981; Mapel, 1959, p. 134). The closest oil and gas field to the west is about 16 mi west of the Cloud Peak Contiguous Roadless Area, although a deposit of heavy oil in the Tensleep Sandstone is only 5 mi to the west (Richard Schuman, Bronco Oil Co., oral commun., 1981).

The Tensleep Sandstone and the Madison Limestone have been investigated for oil and gas in the study areas because these formations have yielded oil and gas in the Bighorn and Powder River Basins. No oil and gas has been discovered yet within the study areas, and it is unlikely that any will be discovered in the future because of the limited extent of the Tensleep and Madison Formations within the study areas and the lack of seismic evidence indicating suitable entrapment structures.

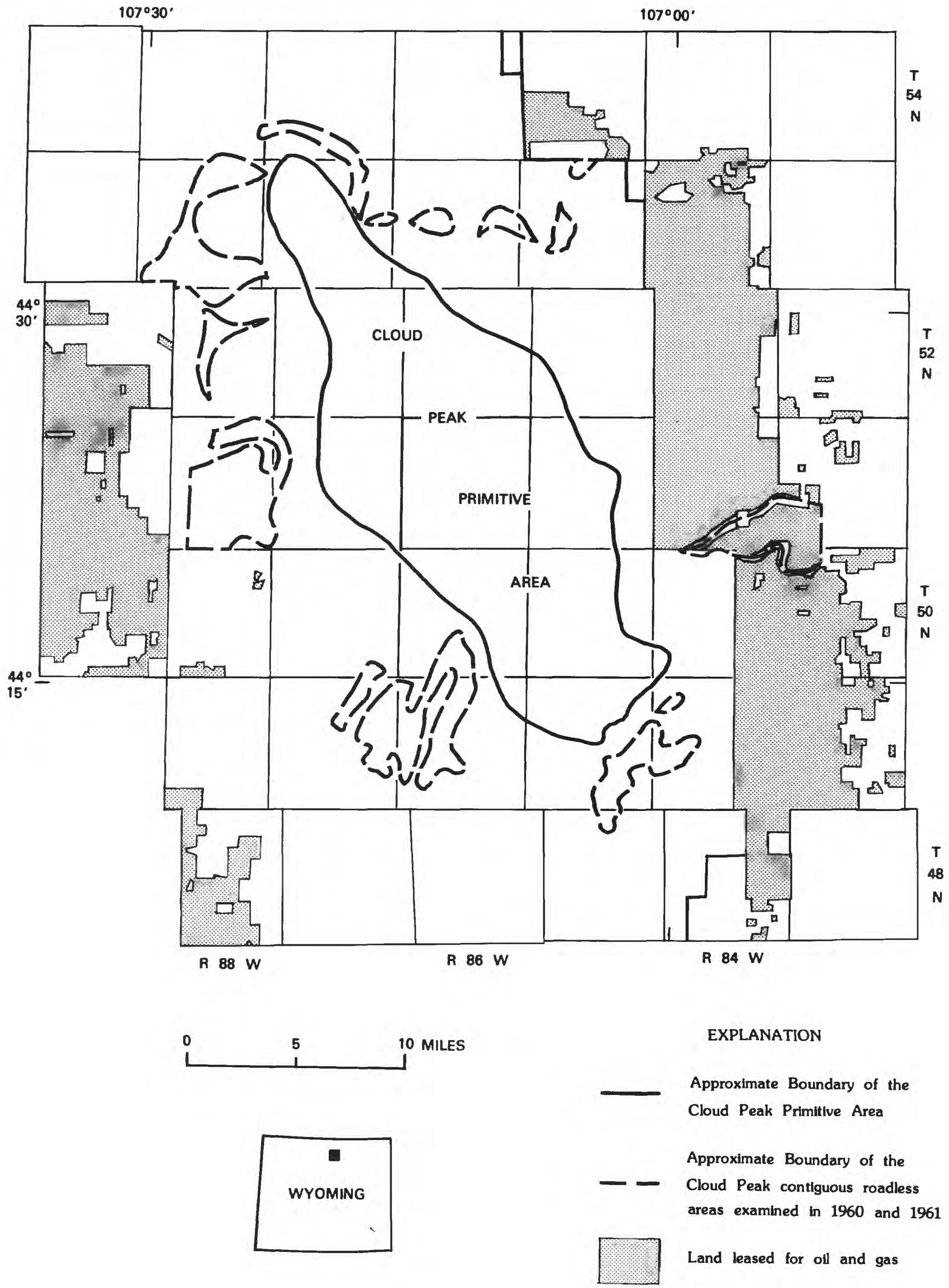


Figure 10--Map showing oil and gas leases for the Cloud Peak Primitive Area and contiguous roadless areas.

Coal fields are present both east and west of the areas studied, but coal-bearing formations are not known in the study area, and no coal leases existed in 1981.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Parts of the Cloud Peak Contiguous, Little Goose, and Rock Creek Roadless Areas, in the Bighorn Mountains of Wyoming, were studied for mineral resource potential. The Bighorns lack extensive areas of altered rock which characterize mineral occurrences elsewhere in the Rocky Mountains. The areas studied have no history of metal production. Copper mineralization is present to the northwest of the study areas but has yielded no production. Ferruginous beds in the Flathead Sandstone and the Madison Limestone are much too thin (about 3 ft) and widely separated, and their grade (20 percent iron or less) is too low for them to be considered as a potential source for iron ore. Glauconitic beds occur in the Gros Ventre Formation and Madison Limestone, but they cannot be considered as a source of phosphate minerals. A small deposit of bentonite clay has been mined adjacent to the study areas. Nonmetallic commodities such as feldspar, limestone, building stone, clay, sand, and gravel are available in large quantities in more accessible areas nearby. The geologic setting negates the possibility of extensive deposits of organic fuels. In conclusion, the results of investigations by both the U.S. Geological Survey and the U.S. Bureau of Mines indicate that the study areas have low potential for resources of metals, oil, gas, or coal; nonmetallic commodities are more easily accessible elsewhere.

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