MINERAL RESOURCE POTENTIAL OF THE GALLATIN DIVIDE ROADLESS AREA, GALLATIN AND PARK COUNTIES, MONTANA

By

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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 provides 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. The Gallatin Divide (G1548) and Hyalite (H1548) Roadless Areas in the Gallatin National Forest, Gallatin and Park Counties, Mont., were designated wilderness study areas in 1977 by the Montana Wilderness Study Act (Public Law 95-150). These areas were classified as further planning areas during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, January 1979. This report discusses the results of a mineral survey of these areas, which are combined and referred to here as the Gallatin Divide Roadless Area (01548).

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The Gallatin Divide Roadless Area is underlain mainly by volcanic rocks of Tertiary age, which overlie Paleozoic and Mesozoic sedimentary rocks and Precambrian metamorphic rocks. No prospecting for mineral deposits is known to have been done in the area, and no mineral production has been reported.

The Shedhorn Sandstone of Permian age underlies several square miles in the southern part of the area and contains a small resource of phosphate-bearing rock. The phosphatic beds are thin, low grade, discontinuous, and, for the most part, deeply buried. Petrified wood is abundant in the southern part of the area but is widely scattered and of poor quality. A slight potential exists for oil and gas, but possibly productive structures are small and deeply eroded. No significant geochemical anomalies were found for any element, and the potential for geothermal energy is low. Building stone, limestone, and deposits of sand and gravel occur in the roadless area, but all are available and more accessible outside of and near it. No placer deposits containing significant amounts of minerals of economic interest were disclosed by pan sampling.

INTRODUCTION

The Gallatin Divide Roadless Area is in southwestern Montana, just north of the northwest corner of Yellowstone National Park (fig. 1). It extends from the park boundary north-northeast along the crest of the Gallatin Range for about 35 mi (56 km) and covers an area of approximately 236 mi^2 (611 km^2) or 151,000 acres (61,100 hectares). Most of the area is in Gallatin County, but parts along the east side are in Park County. The entire area is within the Gallatin National Forest.

General access to the roadless area is provided by U.S. Highway 191 along the Gallatin River and U.S. Highway 89 along the Yellowstone River. Unimproved roads extend into all the main canyons, some as far as the boundary of the roadless area, but further access is restricted to stock and foot trails.

The entire roadless area, except for the lowermost parts of Fridley and Big Creek drainages, is above 6,000 ft (1,830 m); Mt. Bole and Mt. Chisholm, in the northern part of the area, are the highest points, 10,333 ft (3,150 m). Both flanks of the range are incised by deep, steep-walled canyons, many of which head in small glacial cirques. Evidence of glaciation—cirques, rock-basin lakes, U-shaped valleys, glacial deposits, and other features—is found throughout the roadless area.

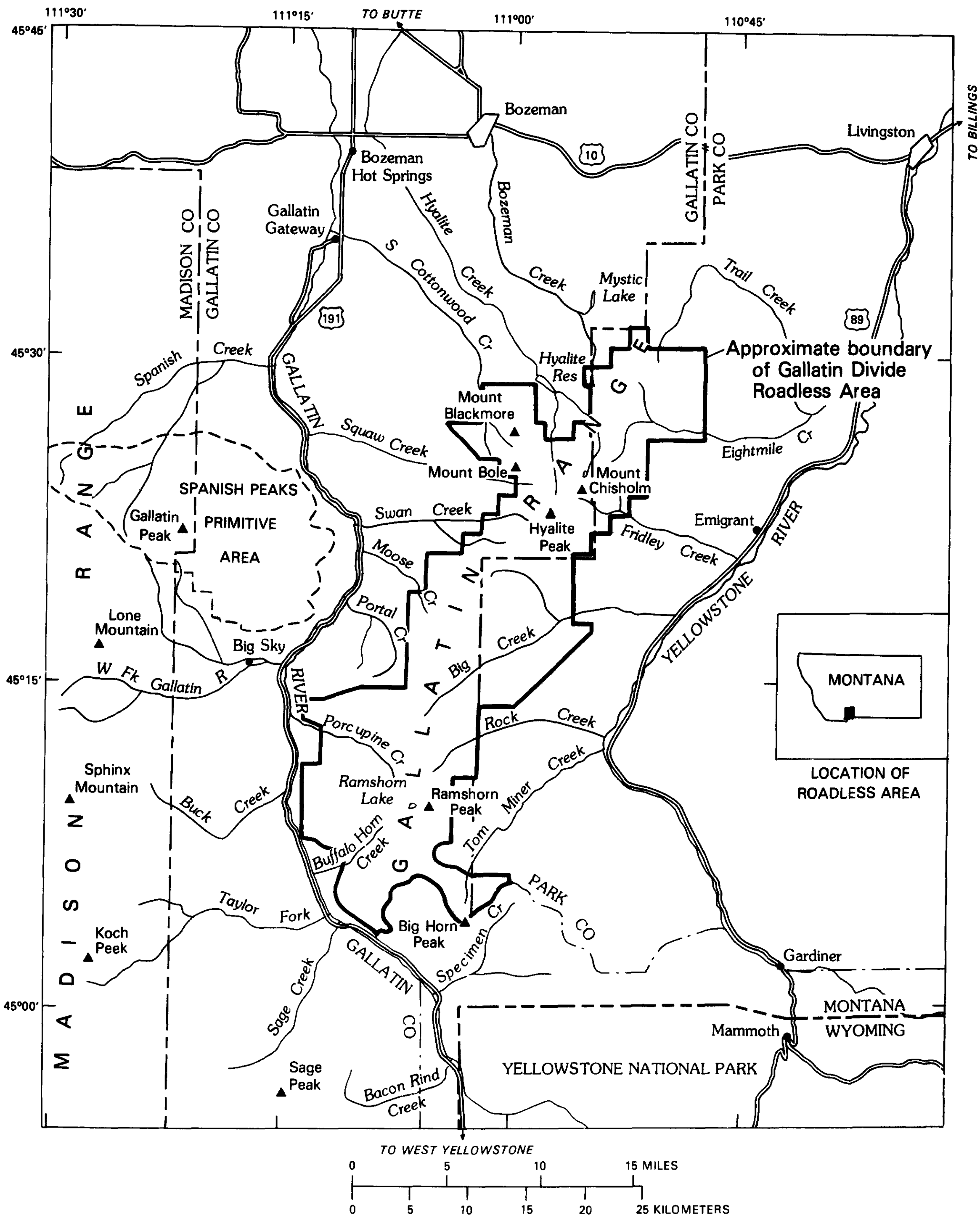

Figure 1.--Index map of the Gallatin Divide Roadless Area (01548) and vicinity, showing principal drainages, other topographic features, and main access roads. Heavy solid line is approximate boundary of roadless area; dashed line is boundary of previously studied Spanish Peaks Primitive Area (Becraft and others, 1966).

Fieldwork in the roadless area was carried out by the U.S. Geological Survey during 2 months in 1979 and 1 month in 1980, and a total of about 90 man-days was spent in the field by the U.S. Bureau of Mines in 1978 and 1979. The U.S. Bureau of Mines contribution to this report was summarized from a more detailed unpublished file report available for inspection at the Bureau of Mines, Western Field Operations Center, Spokane, Wash.

GEOLOGY

The Gallatin Range of southwestern Montana and northwestern Wyoming extends about 60 mi (96 km) northwest from the vicinity of Mt. Holmes in northwestern Yellowstone National Park to Bozeman Pass between Bozeman and Livingston, Mont. The west flank of the range is drained by the Gallatin River and the east flank by the Yellowstone River, both tributaries of the Missouri River.

The Gallatin Range is geologically part of a Tertiary structural block that also includes the Madison Range to the west. The two ranges are separated geographically, but not geologically, by the Gallatin River. The Gallatin-Madison block consists of a basement of metamorphic rocks of Precambrian W (Late Archean) age, 2,500-3,000 m.y. old (James and Hedge, 1980, p. 13), overlain by a sequence of dominantly carbonate Paleozoic sedimentary rocks 3,000-4,000 ft (915-1,220 m) thick and a sequence of dominantly clastic Mesozoic sedimentary rocks, mainly Cretaceous, perhaps 10,000 ft (3,050 m) or more thick. Volcanic rocks of Eocene and younger age are widespread in the Gallatin Range and underlie nearly 75 percent of the roadless area.

Prevolcanic rocks of the Gallatin-Madison block were folded and faulted along northerly and northwesterly trends during Laramide deformation (Hall, 1961, p. 184-185). The uplifted rocks were then eroded and in Eocene time were buried by volcanic rocks—lava flows and volcaniclastic rocks—of the Absaroka volcanic field. The Gallatin-Madison block subsequently was tilted gently southeastward during late Cenozoic uplift of the block along a range-front fault that defines the west side of the Madison Range.

GEOCHEMISTRY

Geochemical evaluation of the Gallatin Divide Roadless Area is based on 484 stream-sediment samples, 227 rock samples, and 31 panned concentrates of stream sediments collected by the U.S. Geological Survey, and 76 stream-sediment samples collected by Los Alamos Scientific Laboratory (Bolivar, 1978, 1980). Analytical data and six geochemical anomaly maps are presented by Simons and others (in press).

Anomalous concentrations of 20 elements were detected, but many of these elements (beryllium, bismuth, gold, molybdenum, silver, thorium, tin, and tungsten) were found in very small amounts and in only a few samples, and the others (boron, chromium, cobalt, copper, lanthanum, lead, nickel, niobium, uranium, vanadium, yttrium, and zinc) were found mostly in low concentrations and in samples widely scattered over the roadless area. No significant geochemical anomaly was defined for any element.

GEOPHYSICS

Geophysical investigations of the Gallatin Divide Roadless Area comprised aeromagnetic and gravity surveys and were made to obtain information on subsurface lithology and structure that would assist in the evaluation of mineral resources. The geologic features referred to below are shown by Simons and others (in press).

The most significant subsurface features inferred from the combined geophysical data are (1) the broad extent of Precambrian metamorphic rocks, veneered by Tertiary volcanic rocks, on the northeast side of the Spanish Peaks fault, marked by a high-amplitude positive gravity anomaly and low-amplitude positive magnetic anomalies; (2) the transection of the metamorphic rock terrane by a thick or deeply rooted, northeast-trending belt of Tertiary volcanic rocks, inferred from the occurrence of a major negative gravity anomaly and a sequence of positive magnetic anomalies corrected for mountainous terrain effects; and (3) the intersection of this thick volcanic-rock belt with an east-trending thick volcanic-rock deposit of unknown extent, the latter also marked by a negative gravity anomaly and positive magnetic anomalies.

MINING DISTRICTS AND MINERALIZATION

Mining activity

No prospects or mining claims were found during this study, and no minerals are known to have been produced from the Gallatin Divide Roadless Area. The nearest mineral deposits are the Thumper Lode mica mine on a north tributary of Squaw Creek, about 3.5 mi (5.6 km) west of the roadless area (McMannis and Chadwick, 1964, p. 37-38); the Karst asbestos mine west of the Gallatin River, about opposite the mouth of Moose Creek, 4 mi (6.4 km) west of the roadless area (McMannis and Chadwick, 1964, p. 38-42); a copper prospect near the head of Levinski Creek, just north of the roadless area boundary; and the Walton calcite prospect near Almart, 0.5 mi (0.8 km) west of the roadless area. A few small showings of chalcopyrite and copper oxide minerals have been reported along the Spanish Peaks fault on both sides of the Gallatin River (McMannis and Chadwick, 1964, p. 43).

Placer gold deposits discovered along the Gallatin River near Big Sky and Almart in the 1860's were mined sporadically until the 1940's. Small and low grade, they yielded only a few hundred ounces of gold. The roadless area has no known placer occurrences.

Coal deposits of the Livingston field, 6 mi (10 km) northeast of the roadless area, were discovered in the 1870's. Although production of coal and coke peaked in 1910, it continued intermittently until 1943. Small amounts of low-grade coal are reported to have been mined on Taylor Fork and West Fork Gallatin River, several miles west of the area (Hall, 1961, p. 173-174).

In the 1880's, prospecting for silver-, lead-, and zinc-bearing veins on lower Hyalite Creek and for mica- and asbestos-bearing lenses near Karst was begun. Both areas are well outside the roadless area, and only a few tons of ore were mined. In the 1890's, prospecting for copper was done near the head of Levinski Creek and for calcite near Almart, west of the roadless area boundary; lode claims were located and a mill was built near Almart but no production was recorded. In the 1920's prospecting for phosphate rock was begun in the Gallatin Valley. Phosphate rock within the roadless area was investigated by the U.S. Geological Survey in 1928 and again in 1947-48 (Condit and others, 1928, p. 147-191; Swanson and others, 1953, p. 12-13). The Gallatin and Yellowstone Valleys were prospected for oil and gas in the 1920's, but no exploratory drilling for oil or gas has been done in the roadless area, and the nearest test hole is in Carrot Basin, about 9.5 mi (15 km) southwest of the roadless area (Tutten, 1960). This hole started in the Morrison Formation (Jurassic) and bottomed in the upper part of the Madison Limestone (Mississippian) at a depth of 2,140 ft (653 m). Minor oil stains were noted in the Morrison and in the Dinwoody Formation (Triassic), but no commercial oil or gas was found. Oil and gas lease applications for parts of the roadless area and vicinity were filed in the 1960's and 1970's, but none have been granted due to provisions of the Montana Wilderness Study Act. Petrified wood has been collected from deposits in the area, but little, if any, has been produced commercially.

Terrace gravels and talus along the Gallatin River have been utilized extensively for road building, and welded tuff has been quarried on a small scale from beds on the ridge between Porcupine Creek and Gallatin River (Hall, 1961, p. 173-175); none of the localities is within the roadless area.

Mineral commodities

Mineral commodities in the roadless area are phosphate rock and petrified wood. Some construction materials—sand and gravel, limestone, and building stone—occur in the area, but the deposits are small or inaccessible, and the materials are more readily available nearby and outside of the area. Pan sampling in all the principal drainages disclosed no placer deposits of economic interest. No oil or gas, coal, geothermal energy sources, or other mineral deposits are known to exist in the area, and the likelihood is slight that any are present in significant amounts.

Locations of deposits of phosphate rock and petrified wood, and of areas under lease or lease application for oil and gas, are shown in figure 2.

Phosphate rock

Shedhorn Sandstone of Permian age, containing a little phosphate rock, occurs over several square miles in the southwestern part of the roadless area and underlies a much larger area in the subsurface. Swanson's (1970) study of phosphate resources of southwestern Montana included sampling in lower Porcupine Creek in the roadless area and at two other places outside of but near the roadless area, one near the mouth of West Fork Gallatin River and the other just north of the mouth of Taylor Fork. At the Porcupine Creek locality, the section sampled was 8 ft (2.4 m) thick and contained 1 ft (0.3 m) of phosphate rock analyzing 23 percent P_2O_5; the rest of the section had 8 percent or less P_2O_5. The section sampled on West Fork Gallatin River was 18 ft (5.5 m) thick and contained about 3 ft (0.9 m) of phosphate rock averaging 15 percent P_2O_5; the rest of the section averaged about 3 percent P_2O_5. The Taylor Fork section contained 2.5 ft (0.8 m) of phosphate rock averaging 19 percent P_2O_5. Swanson states (1970, p. 736-737), "The phosphate rock is less than 3 ft thick near the Gardiner fault [Spanish Peaks fault of this report] in the north [Porcupine Creek and West Fork Gallatin River localities]***and presumably also in most of the area east of the Gallatin River and Sage Creek. Thus none of that rock is considered to be minable."

A sample of a bed of phosphate rock 0.7 ft (0.2 m) thick, from the north side of Elkhorn Creek, contained 18.6 P_2O_5 (Condit and others, 1928, pl. 2).

For the present study, phosphate rock was sampled at four localities by the U.S. Bureau of Mines. A 64-foot-thick (20 m) exposure of phosphate-bearing rock between Buffalo Horn and Tepee Creeks averages 4.1 percent P_2O_5, and a 14-foot-thick (4 m) part of the exposure contains 13.1 percent P_2O_5. The other three sampled exposures assay less than 2 percent P_2O_5. No metallic commodities were detected in the phosphate samples.

Data at hand suggest that phosphate-bearing rock in the roadless area is thin, discontinuous, and low grade and that most of it is deeply buried. Better quality phosphate rock is readily available elsewhere. If, in the future, these sources are depleted, or if local markets develop, then deposits in the area could have mineral resource potential.

Petrified wood

About 15 mi^2 (39 km^2) of the Gallatin Petrified Forest is in the southern part of the roadless area. Petrified wood occurs in Eocene volcanic rocks and is contained in at least 15 beds. One bed mapped by Ritland (1968) contains petrified tree stumps that average 2 ft (0.6 m) in diameter and in height; the trees are an average distance of 32 ft (10 m) apart. An acre (0.4 hectare) of the bed is calculated to contain about 50 trees, which have a total volume of about 300 ft^3 (8 m^3) and a total weight of about 50,000 lb (23,000 kg) of petrified wood. However, to recover 1 lb (0.45 kg) of wood, 850,000 lb (386,000 kg) of rock would have to be mined.

Samples of the best quality of petrified wood available were collected by the U.S. Bureau of Mines and were cut and polished to determine whether an attractive product could be made. The wood was found to be fractured, leached, and discolored, and no slabs larger than 3 in. (8 cm) across could be cut.

Oil and gas

A number of areas within or near the roadless area are under oil and gas lease application (fig. 2). The geology of these areas is shown by Simons and others (in press).

Within the roadless area, possible oil- or gas-bearing structures are concealed over about 73 percent of the area by Tertiary volcanic rocks, and the possible existence of such structures cannot be determined on the basis of surface geologic studies. Another 8 percent of the area is underlain by Precambrian metamorphic rocks, in which oil-gas prospects are nil. Within areas underlain by Paleozoic and Mesozoic sedimentary rocks, folds are small and deeply eroded;

the Buck Creek anticline, most of which is outside the roadless area, is eroded down to the Three Forks Formation (Devonian), and the Grouse Mountain anticline is eroded down to Madison Limestone (Mississippian). Other folds are too small to be significant.

The southern half of the Gallatin Divide Roadless Area is part of the upper Gallatin Valley area of Cannon (1971, p. 563-565, table 4) who concluded that the valley area has little potential for oil and gas because it is too small and too deeply eroded. On the basis of information provided by surface geology, the oil and gas potential of the roadless area appears to be low.

Construction materials

Many of the major drainages of the roadless area, particularly Hyalite, Cottonwood, Squaw, Swan, Porcupine, Buffalo Horn, and Tepee Creeks, have small deposits of sand and gravel. However, access to all these deposits, except those of Hyalite, Porcupine, and Tepee Creeks, is difficult, and extensive and more accessible deposits of suitable material are available along the Gallatin River and indeed have been exploited in the past.

Some welded tuff near the mouth of Porcupine Creek has been quarried for building stone (Hall, 1961, p. 175), and the welded tuff around the head of Elkhorn Creek might also be suitable but is rather inaccessible.

Limestone is abundant in the southwestern part of the roadless area, in Moose and Swan Creeks, and between Cottonwood and Hyalite Creeks, but it is equally abundant and much more accessible in places outside of and adjoining the roadless area.

Coal

No coal was seen in the area, but some may occur in the poorly exposed Cretaceous strata in Porcupine, Tepee, and upper Buffalo Horn Creeks. The little coal that has been produced near the roadless area came from thin beds in Upper Cretaceous rocks (Hall, 1961, p. 173-174). It is unlikely that coal beds of sufficient thickness and quality to be minable are present in the roadless area.

Geothermal energy resources

No hot springs were seen in the area, and the nearest hot spring is Bozeman Hot Springs, about 7 mi (11 km) west of Bozeman and 15 mi (23 km) northwest of the roadless area; this spring is reported by Waring (1965, p. 32) to have a temperature of 137°F (58°C) and a flow of 250 gal/min. The area around Bozeman Hot Springs is considered by Sammel (1979, p. 112-113) to be favorable for the discovery and development of local sources of low-temperature geothermal water. A warm spring issuing from the Spanish Peaks fault near the mouth of Levinski Creek, on the east side of the Gallatin River (fig. 2), has been developed as a private recreation facility. No volcanic or intrusive rocks younger than Pliocene(?) occur in the roadless area. The Eocene volcanic rocks that make up so much of the roadless area would be excellent reservoirs for geothermal fluids, but the lack of heat sources indicates that the potential for geothermal energy in the area is low.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The Gallatin Divide Roadless Area has low potential for mineral and energy resources. The principal mineral commodities of the roadless area are phosphate rock and petrified wood. Deposits of phosphate rock are thin, discontinuous, and low grade, and most are deeply buried. Petrified wood is abundant but is widely scattered and of poor quality. Large deposits of alluvium exist along some drainages, but no placer deposits of economic interest were disclosed by pan sampling. The area has a slight potential for oil and gas, but possibly productive structures are small and deeply eroded. No significant geochemical anomalies were found for any element. No mine workings or mining claims were found. No geothermal energy resources are known. Building stone, limestone, and deposits of sand and gravel occur in the roadless area but are more readily obtained from deposits outside it.

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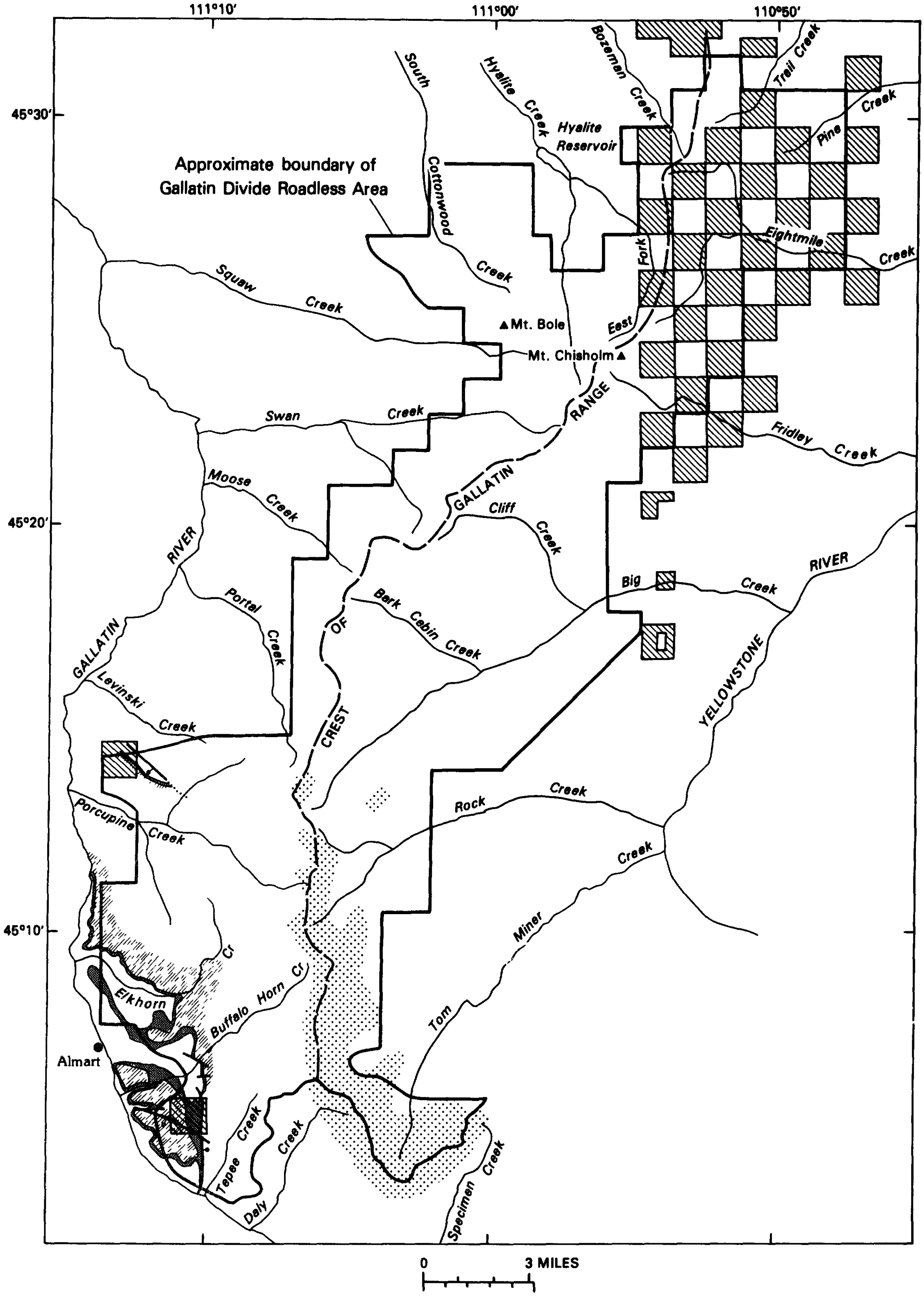

Figure 2.--Map of Gallatin Divide Roadless Area, showing outcrop and inferred subsurface Permian Shedhorn Sandstone in the southwestern part of the roadless area (after Hall, 1961, pl. 2); approximate location of the Gallatin Petrified Forest; and tracts in the roadless area or within 1 mi (1.6 km) of it that are leased for oil and gas exploration or for which applications for lease have been made, as of 1980.

EXPLANATION

OUTCROP OF SHEDHORN SANDSTONE

SUBSURFACE EXTENT OF SHEDHORN SANDSTONE--To estimated depth of 1,000 ft (300 m)

CONTACT

FAULT--Dotted where concealed; bar and ball on downthrown side

LEASED LAND--Tracts in the roadless area or within 1 mi (1.6 km) of it that are leased for oil and gas exploration or for which applications for lease have been made, as of 1980

GALLATIN PETRIFIED FOREST--Approximate location

Figure 2.--Continued

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