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MINERAL RESOURCE POTENTIAL OF THE CENTENNIAL MOUNTAINS WILDERNESS STUDY AREA AND CONTIGUOUS AREAS, IDAHO AND MONTANA

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Mineral Surveys Related to Wilderness Study Areas

In accordance with the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts applicable to certain National Forest lands and with the Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) dealing with certain areas which formally had been identified by the Bureau of Land Management as "natural" and "primitive" areas prior to November 1, 1975, the U.S. Geological Survey and the U.S. Bureau of Mines have conducted surveys to determine the mineral-resource potential of such areas. Results must 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 the Centennial Mountains Wilderness Study Area, including the Centennial Mountains Instant Study Area (BLM) and the Mt. Jefferson and Mt. Jefferson West Further Planning areas in the Targhee and Beaverhead National Forests, Idaho and Montana. The Mt. Jefferson and Mt. Jefferson West areas were classified as Further Planning during the Second Roadless Area Review and Evaluation (RARE II) by the National Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL
SUMMARY STATEMENT

Geologic, geochemical, and geophysical investigations and a survey of the mines and prospects have been conducted to determine the mineral-resource potential of the Centennial Mountains Wilderness Study Area, including the Centennial Mountains Instant Study Area (BLM) and the Mt. Jefferson and Mt. Jefferson West Further Planning areas, Idaho and Montana. The area studied encompasses approximately 150 mi^2 (390 km^2) of terrane underlain by rocks ranging in age from the Precambrian through the Cenozoic. Phosphate is present in large amounts within the study area. A low to moderate potential exists for the discovery of oil and gas. The potential for geothermal energy and coal is low. The potential for economic deposits of precious and base metals is considered to be low. Nonmetallic deposits are present in the area. Building stone is not considered of economic value due to its occurrence in areas of difficult access and the presence of similar deposits in nearby areas that are much more easily accessible. Pumiceous ash has low potential because of low quality.

Phosphate is the major commodity of economic interest, and very large amounts of it are in the study area. Resources are estimated to be 395,012,000 tons (358,349,000 t) of acid-grade (>31 percent P_2O_5) rock, 635,595,000 tons (576,600,000 t) of furnace-grade[1] (>24 percent P_2O_5) rock, and 828,543,000 tons (751,642,000 t) of beneficiation-grade (>18 percent P_2O_5) rock.[1] Probable byproducts derived from processing the phosphate include vanadium, chromium, uranium, silver, fluorine, and the rare earths, lanthanum and yttrium.

The potential for oil and gas is low to moderate. Two structures are of interest: the Peet Creek anticline, a structure buried beneath an overthrust(?) at the west end of the Western Centennials, and the Odell Creek anticline at the west end of the Eastern Centennials.

A geochemical survey did not detect any evidence of precious metals or anomalous concentrations of base metals.

A thin bed of coal is in the Western Centennials. Its grade, lenticularity, difficulty of access, and distance from railheads suggest that it cannot be mined economically.

Sources of building stone are in the study area, but localities are difficult to reach and are far from railheads.

A pumiceous ash bed is near the west end of the Western Centennials, but here, too, access is difficult and railheads are distant.

Geothermal springs are not known in the area although a few are along the north side of Centennial Valley some 5 mi (8 km) north of the study area.

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[1]A cumulative method has been used in the determination of furnace-grade and beneficiation-grade resources. Resources of furnace-grade rock include acid-grade rock amounts; resources of beneficiation-grade rock include both acid-grade and furnace-grade rock amounts.

INTRODUCTION

The Centennial Mountains include parts of Beaverhead County, Montana, and Clark and Fremont Counties, Idaho; the mountains trend east, and the Continental Divide follows their crest (fig. 1). They form a massive, almost impassable barrier between Centennial Valley on the north and the broad expanse of the Snake River Plain on the south. The proposed Wilderness Study Area encompasses the central more rugged part of the mountains and includes parts of both the Targhee and Beaverhead National Forests. Four contiguous parcels of land, totaling about 96,176 acres (38,922 hectares), make up the Wilderness Study Area (fig. 2). The first of these, encompassing about 46,126 acres (18,667 ha), is wholly in Montana (north of the Continental Divide) and consists of the U.S. Bureau of Land Management's Centennial Mountains Instant Study Area.[2] The second area, known as Management Unit 1 of the Centennial Planning Unit of the Targhee National Forest, consists of some 38,750 acres (15,682 ha) within Idaho (south of the Continental Divide). The third and fourth parcels include about 11,300 acres (4,573 ha) of National Forest land which cover the Mt. Jefferson and Sawtell Peak areas in the eastern part of the Centennial Mountains. Both are Forest Service Further Planning roadless areas (Unit 1-962 of the Beaverhead National Forest in Montana—the Mt. Jefferson area, and Unit 4-962 of the Targhee National Forest in Idaho—the Mt. Jefferson West area).

Details of the geography and geology of the area are incorporated in a separate map prepared as an integral part of the mineral resource evaluation (Witkind, 1981). Only the more salient details of the geology described in that report are repeated here.

GEOLOGIC SETTING

The Centennial Mountains trend east in a region dominated by north- and northwest-trending mountain ranges. Their steep, straight north flank is probably the result of recurrent movement along the east-trending Centennial fault zone, one of the major active fault zones of southwestern Montana. Movement along the fault zone is normal; the Centennial Valley, situated north of the mountains, is downthrown relative to the mountains (Witkind, 1981). Faulting has persisted from Miocene(?) time to the present; sporadic earthquakes still shake the area.

The mountains are divided into two almost equal parts by northeast-flowing Odell Creek, which follows the Odell Creek fault. The mountains east of the creek are known as the Eastern Centennial Mountains, those west of the creek as the Western Centennial Mountains. The Odell Creek fault is normal; the Western Centennial Mountains are downthrown. The fault appears to end northeastward against the Centennial fault.

Eastern Centennial Mountains

The Eastern Centennial Mountains consist of a core of Precambrian crystalline rocks overlain by well-indurated Paleozoic and Mesozoic rocks. The Phanerozoic rocks range in age from Middle Cambrian to Early Cretaceous, and consist of an irregular sequence of sandstones, shales, limestones, and dolomites. In all, they total about 5,500 ft (1,670 m) in thickness.

The Phosphoria Formation of Permian age, because of its contained phosphate deposits, is economically significant. Of the many units that make up the Phosphoria in this area, only the Meade Peak and the Retort Shale Members contain phosphate, and of these only the Meade Peak contains large amounts of phosphate. Locally the Meade Peak, some 14 ft (4 m) thick, is formed wholly of phosphate rock, but commonly it appears as upper and lower phosphate beds, each about 3 ft (1 m) thick, separated by a bed of silty dolomite or calcareous siltstone about 8 ft (2.5 m) thick. Additional details about the Phosphoria Formation are given in Witkind (1981).

The Eastern Centennials are further divided, again in two almost equal parts, by the Willow Creek fault, which, like the Odell Creek fault, trends northeast, is normal with the west block downthrown, and appears to end northeastward against the Centennial fault.

The crustal block east of the Willow Creek fault has been uplifted and tilted southward; its east end is concealed beneath a volcanic pile of Eocene(?) rocks that underlie Sawtell Peak. These volcanic rocks are dark-gray to black pyroxene trachyte porphyries. West of the Willow Creek fault the Phanerozoic sedimentary strata have been deformed into a southeast-plunging anticline. The north limb and part of the core of the anticline have been eroded leaving only the south limb, which, from a distance, resembles a southward-tilted fault block. The anticline, like the fault block east of the fault, has been uplifted and tilted southward.

A small volcanic pipe, possibly a diatreme, intrudes the sedimentary rocks that form the south limb of the anticline. The diatreme(?), near the crest of the Eastern Centennials has been described by Witkind (1974, 1980). It is near the top of coincident large aeromagnetic and gravity dome-like anomalies (R. A. Martin, written commun., 1981). No hint of the geophysical highs is reflected by the surface rocks.

The sedimentary sequence along the south flank of the Eastern Centennials is overlain by the Eocene(?) pyroxene trachyte flows which in turn are mantled by rhyolitic ash-flow tuffs. Remnants of these volcanic rocks along the crest imply that at one time the entire range was covered by these rocks.

Western Centennial Mountains

The Western Centennial Mountains are composed of upper Mesozoic and lower Tertiary strata that differ considerably in age and lithology from those exposed in the Eastern Centennials. These rocks, essentially sandstones and siltstones, appear to be part of a thrust plate that may have been shoved northeastward into its present position (Witkind, 1977, 1981).

These rocks apparently have undergone at least two episodes of folding. During the first episode they were deformed into a series of northwest-trending folds, some of which are marked by southwest-dipping axial planes. Possibly these folds formed when the stratigraphic sequence was thrust northeastward. A

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[2] A U.S. Sheep Experiment Station within this B.L.M Instant Study Area covers about 16,650 acres (6,738 ha).

second episode of folding occurred after the volcanic rocks were emplaced. The entire Western Centennial Mountains block was folded to form an elongate eastward-trending dome. The north flank of this dome has been eroded, exposing the underlying sedimentary rocks. Only near the west end of the range is the domal aspect preserved in the folded volcanic rocks.

The south flank and the crest of the Western Centennials are covered by Pliocene(?) volcanic rocks. Andesitic and basaltic lava flows, separated into two sequences by volcaniclastic rocks, overlie the upper Mesozoic-lower Tertiary sedimentary rocks. These lava flows, in turn, are overlapped by rhyolitic ash-flow tuffs.

MINING ACTIVITY

No formally organized mining districts are in the study area; however, the central part is commonly referred to as the "Centennial Mountains district," an area of known phosphate resources and recorded past production. No mines were open during the summer of 1979. In the past, the only mining was concentrated in the phosphate deposits at the west end of the Eastern Centennial Mountains, chiefly near the crest and along the south flanks of Sheep and Taylor Mountains. Leases on these phosphate deposits were obtained by J. R. Simplot Company in 1953, 1954, and 1955; exploration began in 1954. Between 1956 and 1958, 296,000 tons (268,500 metric tons) of phosphate were mined from open pit mines on the leased properties. The ore was trucked some 35 mi (56 km) via Odell Creek to a railhead at Monida, Montana. All access roads to the mines from the north have been washed out for decades. The amount of material surface-mined represents a small percentage of both identified and undiscovered phosphate resources within the study area that would have to be recovered mainly by underground mining methods.

The only current mining activity is from a group of nine claims near Reas Peak which annually produces from 50 to 100 tons (45 to 91 t) of decorative building stone.

GEOCHEMICAL SURVEY

As no known base or precious metal deposits occur in the area, it was decided that the most feasible way to assess the mineral potential of the mountains was to conduct a geochemical survey by sampling stream sediments. It is this detailed geochemical survey of sediments collected from active streams that forms the basis of the U.S. Geological Survey's mineral resource appraisal. A bulk sample of silt was collected from a stream embankment at every sample locality. A comparable sample was collected from sand and gravel bars along the stream floor at selected localities; these samples were panned to concentrate the heavy minerals. The silt samples presumably reflect the suspension load carried by the stream; the panned concentrates reflect the saltation and traction loads. In addition to these samples, soil samples were collected from several other localities where geologic relations suggested that some mineralization may have occurred. In all, 581 samples were collected; of these, 311 are silt samples, 227 are panned concentrates, and 43 are soil samples. All samples were analyzed for 30 elements by the 6-step DC-arc semiquantitative emission-spectrographic method. Data derived from these semiquantitative spectrographic analyses are stored on magnetic tape, and are available from the National Technical Information Service (NTIS) (McDanal and others, 1980).

The results of the sampling suggest that no significant mineralized deposits are at or near the surface within the Centennial Mountains Wilderness Study Area. The semiquantitative spectrographic analyses did not detect any gold or silver, and although chromium, copper, lead, molybdenum, nickel, tin, vanadium, and zinc were detected, the amounts were not anomalous.

PHOSPHATE RESOURCES OF THE BUREAU OF LAND MANAGEMENT'S CENTENNIAL MOUNTAINS INSTANT STUDY AREA, BEAVERHEAD COUNTY, MONTANA

Within the Bureau of Land Management's Centennial Mountains Instant Study Area, only phosphate in the Phosphoria Formation has significant mineral resource potential.[3] Identified resources of phosphate within the Meade Peak Member include 41,931,000 tons (38,039,000 metric tons) of acid-grade (>31 percent P_2O_5) rock, 77,624,000 tons (70,419,000 t) of furnace-grade (>24 percent P_2O_5) rock and 92,894,000 tons (84,272,000 t) of beneficiation-grade (>18 percent P_2O_5) rock. Hypothetical resources are estimated at 133,947,000 tons (121,515,000 t) of acid-grade rock, 247,968,000 tons (224,952,000 t) of furnace-grade rock, and 296,744,000 tons (269,202,000 t) of beneficiation-grade rock. Identified resources of the Retort Shale Member include 23,961,000 tons (21,737,000 t) of acid-grade rock, 33,268,000 tons (30,180,000 t) of furnace-grade rock, and 41,285,000 tons (37,453,000 t) of beneficiation-grade rock. Hypothetical resources are estimated to be 76,541,000 tons (69,437,000 t) of acid-grade rock, 106,272,000 tons (96,408,000 t) of furnace-grade rock, and 131,886,000 tons (119,645,000 t) of beneficiation-grade rock. In addition to the phosphate, vanadium, chromium, uranium, silver, and fluorine are probable byproducts.

Resource estimate

The potential for phosphate development is high. Identified resources are: 65,892,000 tons (59,776,000 t) of acid-grade rock, 110,892,000 tons (100,599,000 t) of furnace-grade rock, and 134,179,000 tons (121,725,000 t) of beneficiation-grade rock in the Meade Peak and Retort Shale Members. Hypothetical resources are 210,488,000 tons (190,952,000 t) of acid-grade rock, 354,240,000 tons (321,360,000 t) of furnace-grade rock, and 428,630,000 tons (388,847,000 t) of beneficiation-grade rock in the two members.

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[3] A cumulative method has been used in the determination of furnace-grade and beneficiation-grade resources. Resources of furnace-grade rock include acid-grade rock amounts; resources of beneficiation-grade rock include both acid-grade and furnace-grade rock amounts.

MINERALIZED AREAS AND PROSPECTS OF MANAGEMENT UNIT 1, CENTENNIAL PLANNING UNIT, TARGHEE NATIONAL FOREST, CLARK AND FREMONT COUNTIES, IDAHO

A mineral resource survey indicates that Management Unit 1, Centennial Planning Unit, Targhee National Forest, Clark and Fremont Counties, Idaho, has high potential for the production of phosphate rock that includes fluorine, uranium, vanadium, and rare earths. There is also a potential for coal and oil production. Except for an intermittent building stone operation, there are no producing mines within the study area.

The phosphate is in gently dipping marine strata of the Permian Phosphoria Formation. Deposits in the study area are terminated on the north by the steep scarp created by the Centennial fault. The south side of the mountains is the 10° to 20° dip-slope of the sedimentary beds; consequently, phosphate-bearing rock crops out southward over a distance of about 2 mi (3.2 km), from altitudes near 9,600 ft (2,926 m) on Taylor Mountain, down to about 7,200 ft (2,195 m) along Taylor Creek.

From 1953 to 1955, the Bannack Chemical Company, a subsidiary of J. R. Simplot Company, acquired leases on the Centennial Mountains phosphate deposits, 226.02 acres (91.47 ha) of which were in sec. 11, T. 14 N., R. 40 E., Idaho (Service, 1966, p. 182). The company began mining the Centennial Mountains deposits in 1956, and within two years shipped a total of 296,000 tons (268,500 t) of acid-grade ore (J. R. Simplot Company, oral commun., 1979), 89,600 tons (81,300 t) of which were from the study area (Popoff and Service, 1965, p. 123). Sunray DX Oil Company obtained a 20-yr lease on 845.70 acres (342.24 ha) in the Taylor Creek drainage that was eventually transferred to Mr. Leonard Garrand, who still holds the lease (Leonard Garrand, oral commun., March 1980). Other leases within the area, currently held by Bannack Chemical Company, total 847.67 acres (343.04 ha).

Current leases and applications for leases for oil and gas are in a 2-mi (3.2-km)-wide strip along the southern edge of the study area.

About 12 mining claims or claim groups have been located within the study area since 1896, mainly from 1950 to 1974. Most were lode claims, presumably for gold. Workings consist only of a few prospect pits.

One claim, filed in 1912, was located for coal. The prospect included a 110-ft (33.5-m) adit and produced a few tons of coal for use by the school at Kilgore, Idaho (Kirkham, 1927, p. 41). The 3-ft (0.9-m)-thick seam of coal crops out for about 0.25 mi (0.4 km) (Mansfield, 1920, p. 148-149).

The only currently active mining claims in the study area are a group of nine claims (Tincup 1-9) for decorative building stone located along the Continental Divide, about 1 mi (1.6 km) northwest of Reas Peak. Eight of the claims are in Management Unit 1, and one is in the Mt. Jefferson Further Planning area in Montana. Since 1968, an estimated 50 to 100 tons (45 to 91 t) of ornamental building stone has been produced annually (Lyle Thompson, oral commun., May 1980).

Resource estimate

Identified resources in the study area are estimated at 27,208,000 tons (24,683,000 t) of acid-grade rock, 39,095,000 tons (35,466,000 t) of furnace- grade rock, and 60,945,000 tons (55,288,000 t) of beneficiation-grade rock (furnace grade includes acid grade and beneficiation grade includes both). Hypothetical resources are estimated at 91,424,000 tons (82,938,000 t) of acid-grade rock, 131,368,000 tons (119,175,000 t) of furnace-grade rock and 204,789,000 tons (185,782,000 t) of beneficiation-grade rock. The identified resources are confined to the Meade Peak Member; the phosphorite beds in the Retort Member pinch out easterly and are not sufficiently defined to allow resource estimates. In addition, uranium, vanadium, and fluorine are probable byproducts. Other possible byproducts include rare earths (Altschuler and others, 1967, p. 125).

Relatively mild topography, gently dipping strata, and sparse timber in the areas containing phosphate are favorable to development of the resources. However, the winter snow cover is usually deep, and the U.S. Weather Bureau has recorded this range as having the longest winters in the United States (Visher, 1946).

In the Centennial Mountains study area, 35 samples of phosphorite with 18 percent and greater P_2O_5, contained an average 3.76 percent fluorine. Fluorine is included in the mineral structure of the fluorapatite, a major mineral constituent of phosphorite.

Uranium has been found to average 0.004 percent in the Meade Peak Member of the Phosphoria (Gulbrandsen, 1960). Forty samples from the study area, containing at least 13 percent P_2O_5, averaged 0.0118 percent U_3O_8.

Rare earths are trace constituents of marine apatite; their output would probably result as a byproduct of phosphate production in the study area. The rare earths (lanthanum and yttrium) generally make up from 0.01 to 0.1 percent by weight of marine apatite (Altschuler and others, 1967, p. 125).

In 1918, petroliferous phosphatic shale was found in the Centennials in sec. 16, T. 14 N., R. 42 E. The bed is 4 ft (1.2 m) thick and reportedly contains 6 gallons of oil per ton (25 l/t) (Condit, 1919, p. 24); however, data for resource calculations are unavailable.

U.S. Bureau of Mines coal samples were taken from near-surface exposures. Analyses shows the coal to rank as subbituminous A; however, sufficient data are not available for resource calculations.

MINERALIZED AREAS AND PROSPECTS OF THE MT. JEFFERSON FURTHER PLANNING AREA (AREA 1-962), BEAVERHEAD COUNTY, MONTANA

A mineral resource survey indicates that the Mt. Jefferson Further Planning area has low potential for the discovery of phosphates and their included byproducts.

Within the study area, the Phosphoria Formation is exposed for about 0.75 mi (1.2 km) northeastward from Reas Peak along the Continental Divide. It becomes thin and sandy, and the potential for resources is thought to be low. No leases or claims are on outcrops of the Phosphoria Formation; analytical data are unavailable.

Two active claim groups are known within or adjoining the boundary of the study area. One extends into Management Unit 1 and is discussed in the summary report for that area. The other group (Tincup numbers 10-15), is located for gold, about 0.75 mi (1.2 km) northwest of the Mt. Jefferson summit and has no record of production. The claims were filed after fieldwork was completed for this study. No other resources are known to occur in the study area.

Two inactive lode claims, the High Hope and the Round Pine Hellroaring, were sampled. No ore minerals were noted in the workings; assay results showed no anomalous metallic values. Other claims in the study area were recorded during the period 1955 to 1957, but could not be identified in the field. All are inactive lode claims, located presumably for gold or uranium. There are no placer claims, no patented claims, and no mineral leases in the study area.

Resource estimate

The mineral potential of the area is low. No claims or leases have ever been located on the phosphate occurrences. Building stone at the south boundary of the study area has been claimed and worked on a small scale since 1968, with an annual production estimated at 50 to 100 tons (45 to 91 t).

MINERALIZED AREAS AND PROSPECTS OF THE MT. JEFFERSON WEST RARE II STUDY AREA (AREA 4-962), FREMONT COUNTY, IDAHO

A mineral resource survey indicates that the Mt. Jefferson West Further Planning area has low potential for the discovery of economic metallic and nonmetallic minerals.

The only claims in the study area are two inactive lode claim groups located July 4, 1955, and September 20, 1970. There are no placer claims, no patented claims, and no leases in the study area; workings consist only of a few prospect pits.

The Phosphoria Formation does not occur within the Mt. Jefferson West study area.

Resource estimate

Potential for the discovery of economic minerals in the Mt. Jefferson West Further Planning area is believed to be low based on the general geology of the area and the paucity of claims located there.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL OF THE CENTENNIAL MOUNTAINS WILDERNESS STUDY AREA

The mineral resource potential of the proposed Wilderness Area was evaluated by teams of geologists, geochemists, and geophysicists from the U.S. Geological Survey and the U.S. Bureau of Mines. The Geological Survey team's appraisal is based on geological, geochemical, and geophysical surveys of the area. The U.S. Bureau of Mines' economic appraisal is based on an examination of all mines, prospects, and quarries in the area, sampling of the various units within the Phosphoria Formation noted for their contained phosphate, and estimates of tonnages and grades of the contained phosphate.

Phosphate

Phosphate is the major commodity of economic value in the proposed Wilderness Area, and significant amounts are contained within the Meade Peak and Retort Shale Members of the Phosphoria Formation. The Phosphoria Formation crops out near the crest of the Eastern Centennials, but is deeply buried beneath the Western Centennials. Although phosphate rock was mined in the past by open pit techniques, the remaining deposits would have to be mined by underground methods.

It is estimated that the Meade Peak Member of the Phosphoria Formation contains about 69,139,000 tons (62,722,000 t) of acid-grade (>31 percent P_2O_5) rock, about 116,719,000 tons (105,885,000 t) of furnace-grade (>24 percent P_2O_5) rock, and 153,839,000 tons (139,560,000 t) of beneficiation-grade (>18 percent P_2O_5) rock.[4] Hypothetical resources are estimated at 225,371,000 tons (204,453,000 t) of acid-grade rock, 379,336,000 tons (344,127,000 t) of furnace-grade rock, and 501,533,000 tons (454,984,000 t) of beneficiation-grade rock.

The Retort Shale Member is estimated to contain about 23,961,000 tons (21,737,000 t) of acid-grade rock, 33,268,000 tons (30,180,000 t) of furnace-grade rock, and 41,285,000 tons (37,453,000 t) of beneficiation-grade rock. Hypothetical resources are estimated at about 76,541,000 tons (69,437,000 t) of acid-grade rock, 106,272,000 tons (96,408,000 t) of furnace-grade rock, and 131,886,000 tons (119,645,000 t) of beneficiation-grade rock.

Total phosphate resources (including hypothetical resource data) are estimated to be 395,012,000 tons (358,349,000 t) of acid-grade rock, 635,595,000 tons (576,600,000 t) of furnace-grade rock, and 828,543,000 tons (751,642,000 t) of beneficiation-grade rock.

Probable byproducts derived from processing the phosphate include vanadium, chromium, uranium, silver, fluorine, and the rare earths, lanthanum and yttrium.

Most of the phosphate is within those south-dipping Phosphoria beds that crop out in the west end of the Eastern Centennial Mountains; farther east correlative beds contain minor amounts of phosphate or are essentially barren (fig. 3).

Oil shale

Petroliferous black shales in the Retort Shale Member of the Phosphoria Formation contain small amounts of kerogens. Condit (1919) sampled a black shale on Reas Peak (sec. 16, T. 14 N., R. 42 E.) which yielded about 6 gallons of oil/ton (25 l/t).

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[4]A cumulative method has been used in the determination of furnace-grade and beneficiation-grade resources. Resources of furnace-grade rock include acid-grade rock amounts; resources of beneficiation-grade rock include both acid-grade and furnace-grade rock amounts.

Oil and gas

The potential for oil and gas is low to moderate; that sector possibly underlain by structures suitable for the accumulation of oil and gas is shown in figure 3. It is unlikely that such structures underlie the bulk of the Eastern Centennials, chiefly because most have been removed by erosion. By contrast, in the Western Centennials one or more likely targets are concealed beneath a blanket of folded lower Tertiary-Upper Cretaceous sedimentary rocks that may have been thrust northeastward into its present position.

Two anticlinal structures are of interest. The first is the Peet Creek anticline, a Jurassic(?) structure concealed beneath a thrust plate(?) of upper Mesozoic and lower Tertiary rocks in the Western Centennials (fig. 3, no. 6). The other is the Odell Creek anticline near the west end of the Eastern Centennials (fig. 3, no. 5). Details about both structures are given in Witkind (1980).

The Odell Creek anticline has never been tested, but the Peet Creek anticline was tested by American Quasar Petroleum Company in 1978. The test was unsuccessful—only one small oil show and several gas shows were detected—and this failure, coupled with several other unsuccessful tests of nearby structures, has dampened the interest of many petroleum geologists in this area.

Coal

Only a thin bed of coal (ranked as subbituminous A) is exposed near the abandoned Scott and Bucy mine in the Western Centennials (fig. 3, no. 8); its thinness (2.5 to 6 ft, (0.8 to 1.8 m)), lenticularity, and distance from a railhead suggest that at present it cannot be mined economically.

Mineral deposits

Gold.—The potential for precious metal deposits at or near the surface appears to be low. Although placer gold was reported from the Lakeview area (fig. 3, no. 9), recent sampling has failed to detect more than minute traces of gold in the alluvial deposits near there.

Base metals.—The potential for base metal deposits at or near the surface also appears to be low. Base metal deposits are not known in the mountains, and the geochemical stream sampling program failed to detect any anomalous concentrations of these metals. Elsewhere in North America massive sulfide deposits have been found in Precambrian crystalline rocks, and the possibility that comparable deposits may be in the Centennial Mountains cannot be discounted. Samples of rock from the diatreme(?) (fig. 3, no. 13) show concentrations of lead somewhat higher (50 ppm) than that contained in other samples (10 ppm) collected near the diatreme(?).

Building stone

Some rocks (quartzite and dolomite) suitable for building stone crop out in the area, but these localities are difficult of access and long truck haulages are required to get them to market. Annual production of 50 to 100 tons (45 to 90 t) comes from one set of nine claims near Reas Peak (fig. 3, no. 11).

Pumice

The potential for pumice is low. A bed of pumiceous volcanic ash is exposed along the dip slope of the Western Centennials near the south edge of the proposed Wilderness Study Area (fig. 3, no. 14). The ash bed crops out near Rock Spring and extends eastward through the east half of sec. 17, T. 14 N., R. 38 E., Clark County, Idaho, into secs. 16 and 21 of the same township and range. The deposit is accessible only over unimproved roads, and is distant from the nearest railhead at Spencer, Idaho.

Geothermal

No known geothermal resources are in the study area. Of the several clusters of warm springs known in the region, the nearest to the proposed wilderness study area is Elk Springs in the S 1/2, sec. 31, T. 13 S., R. 1 W., along the north side of Centennial Valley (fig. 3, no. 12). These springs, about 5 mi (8 km) north of the proposed wilderness study area, have temperatures of about 58°F (24°C). Other warm springs along the north side of Centennial Valley have temperatures that are about 84°F (29°C) (J. L. Sonderegger, Montana Bureau of Mines and Geology, oral commun. 1980). Temperatures of springs along the north face of the Centennial Mountains range from 41° to 42°F (5° to 5 1/2°C).

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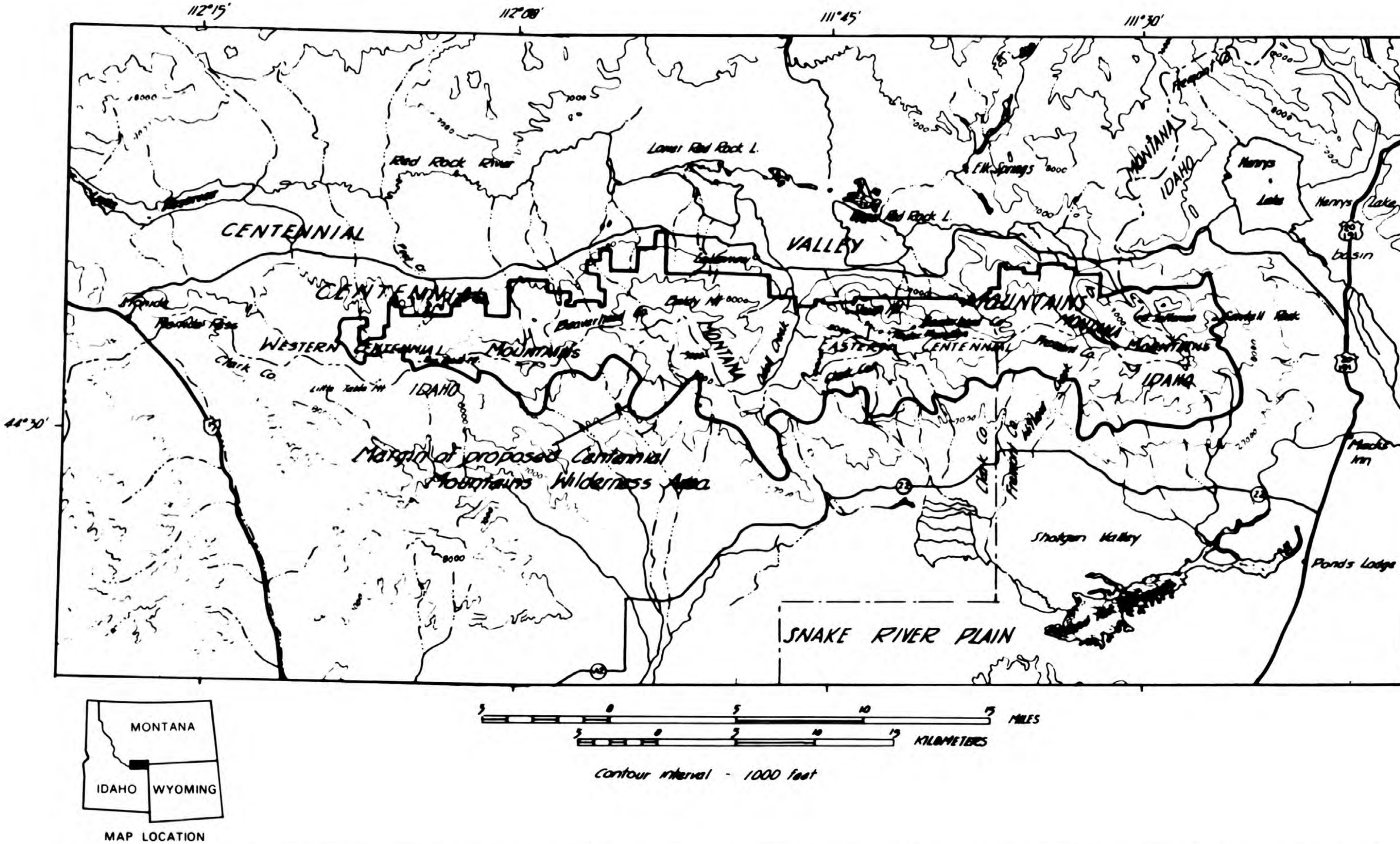

Figure 1.--Index map showing location and relation of major topographic features of the Centennial Mountains Wilderness Study Area

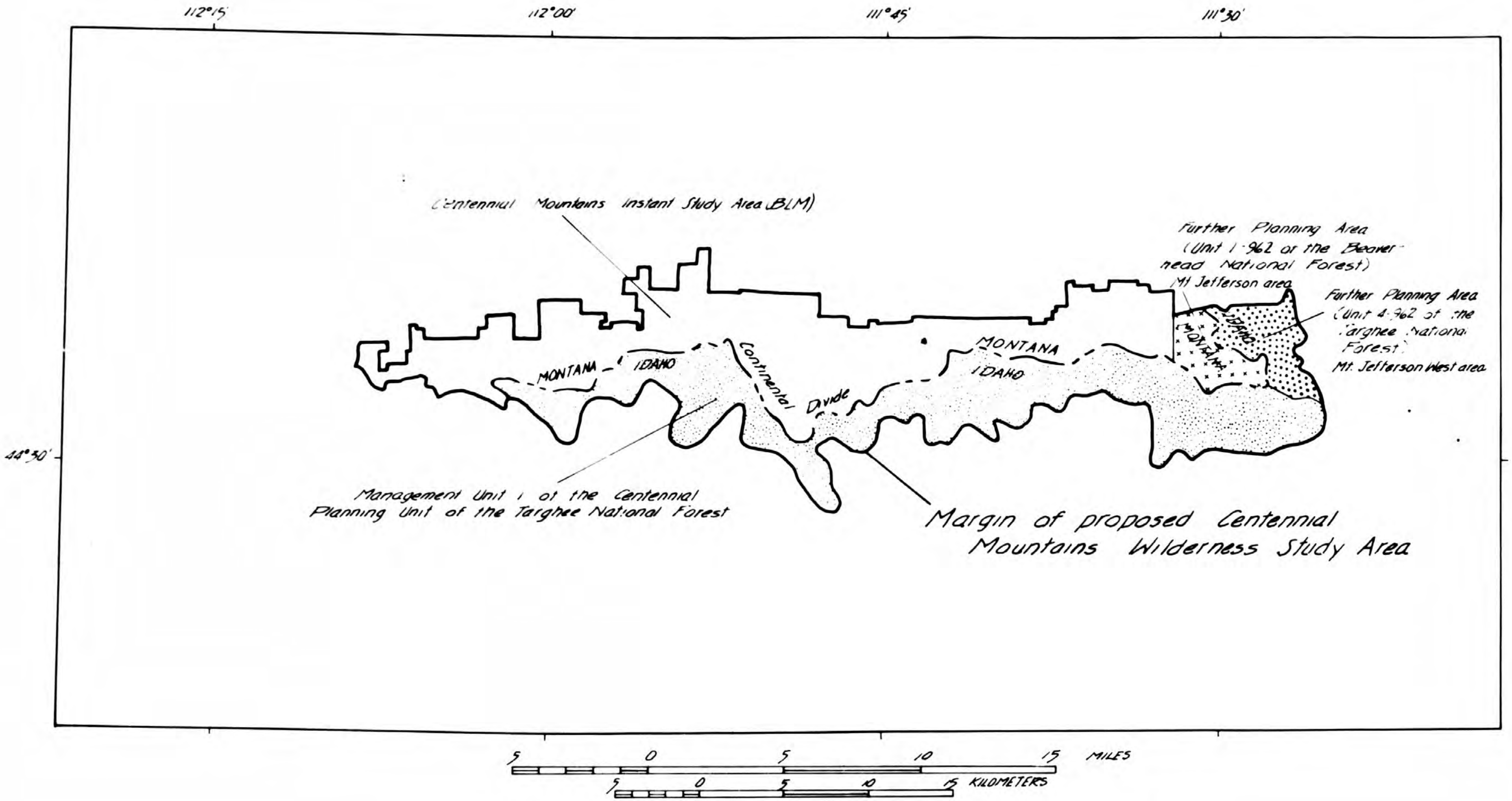

Figure 2.--Map showing four contiguous areas of the Centennial Mountains

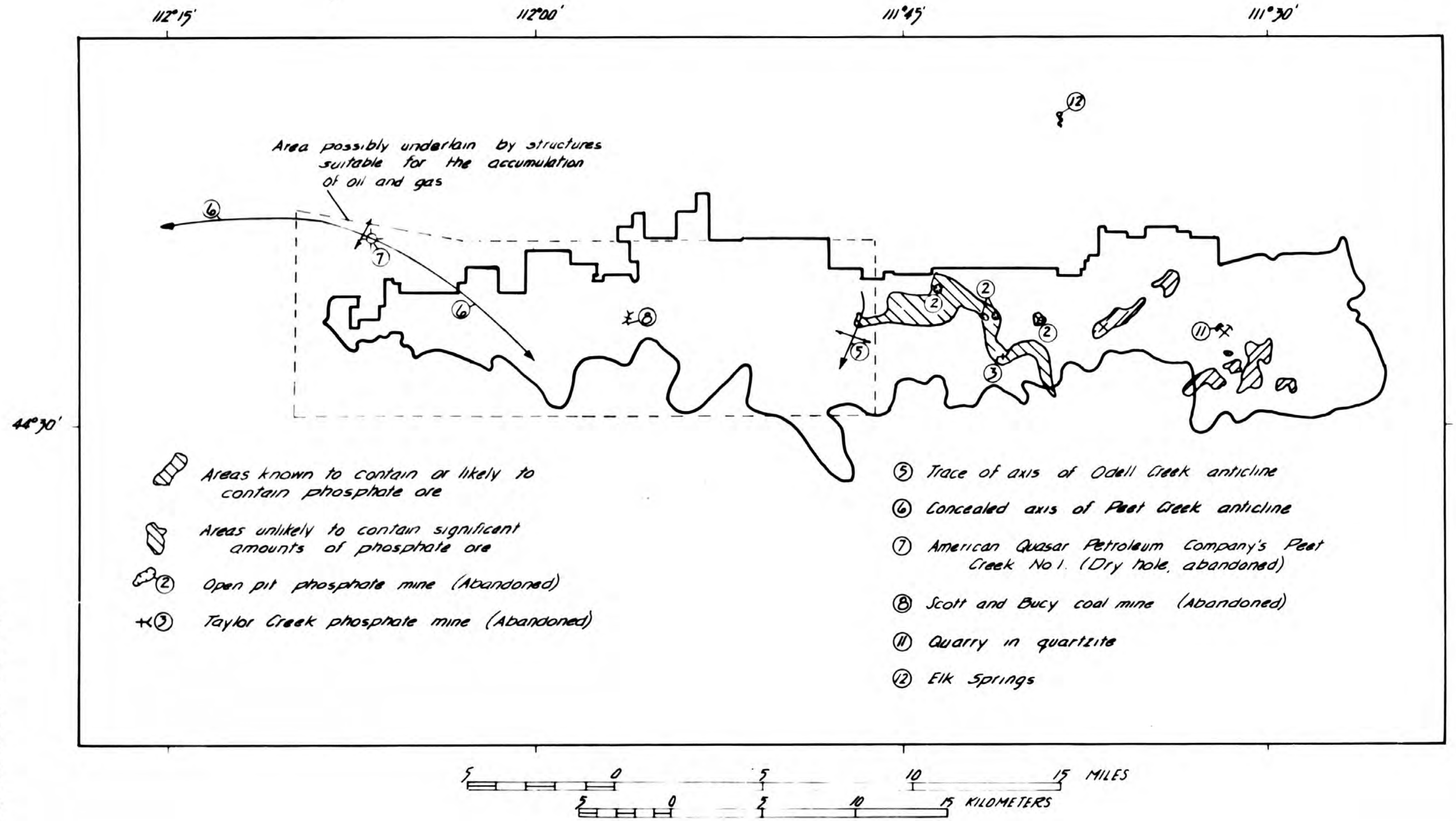

Figure 3.--Map showing areas of mineral-resource potential of the Centennial Mountains Wilderness Study Area

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