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MISCELLANEOUS FIELD STUDIES
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MINERAL RESOURCE POTENTIAL OF THE BRIDGER WILDERNESS AND THE GREEN-SWEETWATER ROADLESS AREA, SUBLETTE AND FREMONT COUNTIES, WYOMING

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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 the Bridger Wilderness and the Green-Sweetwater Roadless Area in the Bridger-Teton National Forest, Sublette and Fremont Counties, Wyo. The Bridger Wilderness was established by Public Law 88-577, September 3, 1964. The Green-Sweetwater Roadless Area (04901) was divided into nonwilderness (108,092 acres) and wilderness (79,742 acres) during the Second Roadless Area Review and Evaluation (RARE II) by the U.S. Forest Service, April 1979.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The U.S. Geological Survey and the U.S. Bureau of Mines made a mineral and geological survey of the Bridger Wilderness and the contiguous Green-Sweetwater Roadless Area in 1980-82. The study area comprises about 580,000 acres of the Bridger-Teton National Forest, along the high and rugged west slope of the Wind River Range, Sublette and Fremont Counties, Wyo.

The Wind River Range has a core of Precambrian rocks with a major fault along the southwest flank of the range. The fault trace is presently covered by Tertiary and Quaternary deposits. Most of the study area is underlain by a Precambrian complex of high-grade metamorphic and felsic igneous rocks. Paleozoic and Mesozoic sedimentary rocks are exposed in the northwestern part, and Quaternary glacial deposits are common throughout the area.

Moderate potential for oil and gas at depth is assigned to the western approximately one-third of the study area. This classification is based upon geologic and geophysical evidence that suggests the Wind River fault has trapped oil- and gas-bearing sedimentary rocks below a wedge of Precambrian crystalline rocks along the southwestern flank of the range. The Wind River fault is interpreted to dip about 30° northeast under the range. Confirmation of this geologic structure would require deep seismic profiles across the central and northern parts of the study area.

The only mining within the study area was for an insignificant amount of coal from the Frontier Formation. The mineral resource potential for coal is considered low due to the thinness and limited extent of the coal-bearing beds in the study area.

Except for minor prospecting, exploration activity within the study area has been confined to the Schiestler Peak molybdenum prospect in the southern part of the study area. This prospect, covering about 2 mi^2, has been thoroughly investigated by diamond drilling, extensive sampling, and tunneling by the claim owners and lease holders. Geochemical, geologic, and petrographic studies made for this survey indicate that the mineralized rock at Schiestler Peak is low grade and confined to small pods. There is no evidence of a potential for molybdenum resources in this area.

Although mining activity and exploration in the study area have been minor, for geologic reasons potential for resources of several other commodities, in addition to coal and molybdenum, were investigated. Gold, base metals, radioactive elements, banded iron-formation, and phosphate rock were given special attention in favorable areas; however, this survey did not indicate a potential for mineral resources in the study area. The areas of mineral occurrences are small, widely dispersed, of low metal content, and in a geologic environment not conducive to formation of mineral deposits.

INTRODUCTION

The Bridger Wilderness and the contiguous Green-Sweetwater Roadless Area (04901) comprise about 580,000 acres along the crest and west flank of the Wind River Range, Wyo. (fig. 1). The terrain consists of a rugged, high alpine backbone with glacial cirques along the crest and old, deeply incised peneplains along the western edge. Elevations range from 7,290 ft near Boulder Lake to 13,804 ft on Gannett Peak, the highest point in Wyoming. The Green River, which heads in the northern end of the range, and its many tributaries drain most of the region; the Sweetwater River drains the southern part. Pinedale, Wyo., on U.S. Route 191, is the nearest town and is just west of the central part of the range.

The Bridger Wilderness and the Green-Sweetwater Roadless Area, hereafter called the "study area," is a heavily used recreational area. Access is from numerous trailheads along the west boundary. Well-maintained horse and walking trails reach about half of the study area. One can travel by foot only, with great difficulty, into the more remote and rugged parts of the study area. The major access points are Green River Lakes, New Fork Lakes, Willow Creek Guard Station, Elkhart Park, Boulder Lake, Scab Creek, and Big Sandy Opening. The road to Elkhart Park is paved, but those to the other access points are secondary gravel roads passable with passenger cars. The Fitzpatrick Wilderness, Wind River Indian Reservation, and Popo Agie Primitive Area bound the study area on the east.

Previous geologic investigations within the study area have been few and scattered. The Paleozoic and Mesozoic sedimentary rocks in the northern part of the study area were mapped in detail (Richmond, 1945), and some of the glacial deposits were studied (Richmond, 1973). The Precambrian rocks were largely unknown except in a few places (see, for example, Worl, 1968, 1972). Mineral resource studies in contiguous areas concern the Fitzpatrick Wilderness, formerly known as the Glacier Primitive Area (Granger and others, 1971); the Popo Agie Primitive Area, east of and adjacent to the study area (Pearson and others, 1971); and the Scab Creek Instant Study Area, a small U.S. Bureau of Land Management area along the west border of the present study area (Worl and others, 1980).

GEOLOGY

The Wind River Range is a northwest-trending massif of Precambrian basement rocks exposed in an area 125 mi long and 35 mi wide (fig. 2). East of the study area, the basement terrane is overlain by less resistant Paleozoic and Mesozoic sedimentary rocks that dip gently east beneath the Wind River Basin. The same strata are exposed near the northwestern boundary of the study area in fault and depositional contact with the Precambrian rocks (Richmond, 1945). Several small outliers of Paleozoic rocks just east of the town of Boulder are surrounded by Tertiary sedimentary rocks (Love, 1950). The Wind River fault, a major fault along the west flank of the range, dips eastward under the range and places Precambrian crystalline rocks over upturned and folded Paleozoic and Mesozoic sedimentary rocks of the Green River Basin. The west flank of the range and the trace of the thrust fault are covered by Tertiary gravels and Pleistocene glacial deposits.

The Precambrian core of the range is an igneous and high-grade metamorphic basement complex that is strongly jointed and locally highly sheared. A belt of low- to medium-grade metamorphic rocks forms the southeastern tip of the range and is entirely outside the study area. The rocks within the study area are typical of high-grade regional metamorphic terranes in that they are a mixture of felsic gneisses and felsic igneous rocks. Contacts are gradational, and there is evidence for injection, metasomatic alteration, partial melting, and more than one period of penetrative deformation—in many places within a small area. The metamorphic rocks are foliated and generally layered. Boudins, schlieren, ghost structures, highly attenuated layering, and appressed and rootless fold hinges are common features (Worl, 1972). These rocks formed in a zone of deep burial and anatexis and probably represent the high-temperature boundary between metamorphic rocks and igneous rocks.

Metamorphic rocks in the basement complex are migmatite and felsic gneiss with some zones of pyroxene gneiss. The metamorphic rocks have not been dated, but something of their relative ages is known in that they are intruded by granodiorite, granite, and porphyritic granite. Even the gneisses are migmatitic in the sense that there are generally two fractions in the rock: an igneous-appearing (or geochemically mobile) felsic part and a metamorphic-appearing (or geochemically immobile) mafic part. The distinction in the field between migmatite and gneiss was made on the basis of the amount of mafic material present. Distinction between gneisses was made partly on the type of mafic material and partly on the mineralogy of the felsic portion.

The felsic portion of the migmatite and gneisses is massive and even-grained and ranges from hornblende tonalite to granite. Complexly intermixed with the light-colored felsic part is a dark, mafic part in bands, pods, and boudins. The mafic part is mainly amphibolite, biotite schist, and hornblende-biotite gneiss, but locally includes banded iron-formation (taconite), metagabbro, mafic gneiss, ultramafic rock, ferruginous-garnet gneiss, sillimanite gneiss, and diopside-hornblende gneiss. The migmatite and gneiss complex contains dikelike bodies of amphibolite and hornblende-biotite gneiss that may represent metamorphosed and partially assimilated mafic dikes.

Igneous rocks of the basement complex range from diorite to granite and are present as plutons, pods, dikes, and irregular bodies. Three general units of genetically related types were delineated from field mapping: granodiorite, granite, and porphyritic granite. The granodiorite and granite have been dated as 2,642±9 Ma old (Stuckless and Van Trump, 1983) and the porphyritic granite as 2,575±50 Ma old (J. S. Stuckless, written commun., 1983) by the U-Pb zircon method. Diabasic dikes are the youngest igneous rocks in the study area and are not metamorphosed.

Paleozoic and Mesozoic sedimentary rocks exposed in the northwestern part of the Wind River Range represent a complete section from Cambrian through Cretaceous. The formations have a total thickness of about 7,700 ft in the study area (Richmond, 1945). The basal formation, the Flathead Quartzite, is in depositional contact with the crystalline rocks and in places is flat lying. However,

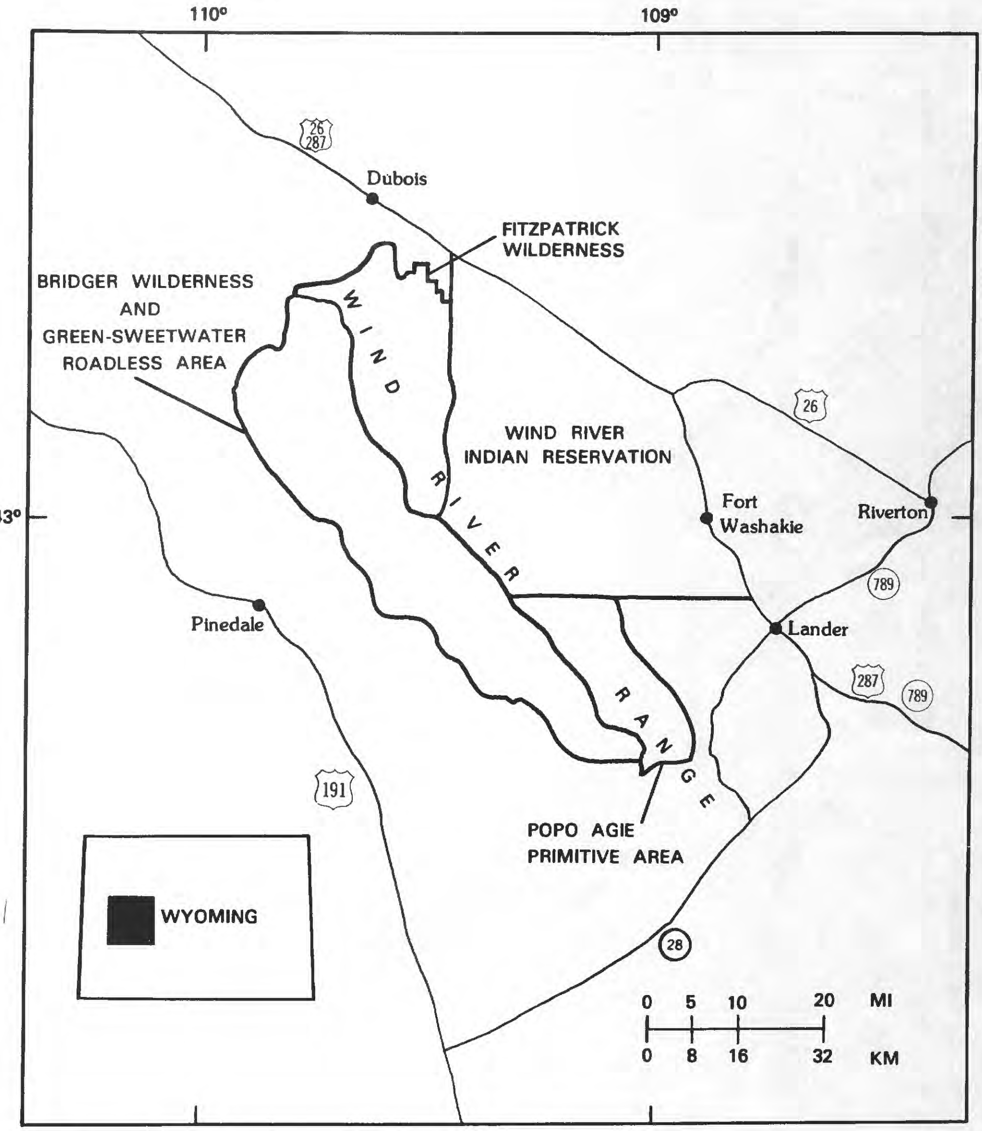

Figure 1.—Map showing location of the Bridger Wilderness and Green-Sweetwater Roadless Area(04901), Sublette and Fremont Counties, Wyo.

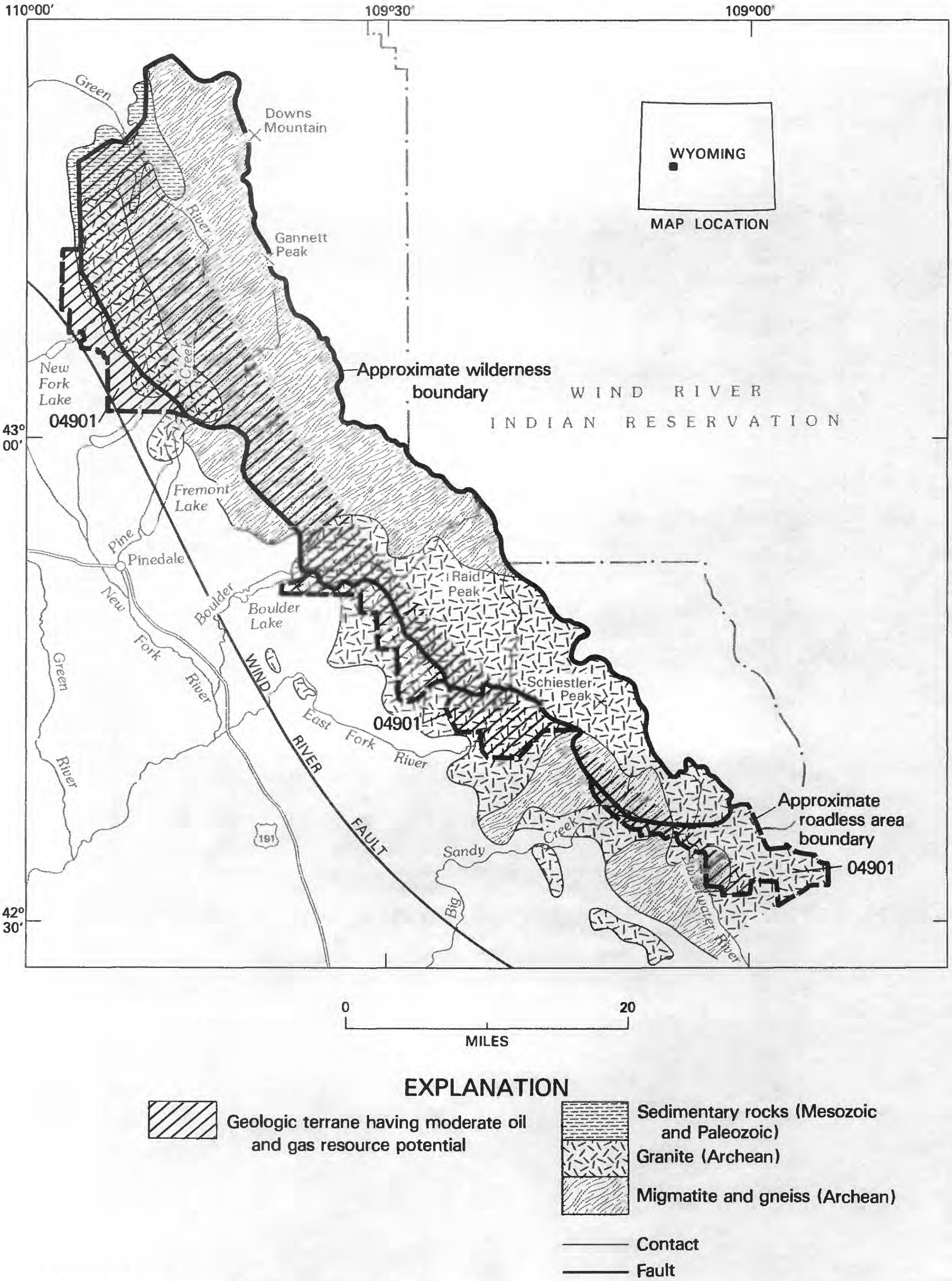

Figure 2.--Map showing simplified geology and mineral resource potential in the Bridger Wilderness and Green-Sweetwater Roadless Area, Wyo.

most of the strata are folded and highly faulted. Several large folds parallel the trend of the range, and major faults with the same trend place crystalline rocks against the sedimentary rocks.

Precambrian rocks in the core of the Wind River Range are highly fractured and sheared along major zones that generally trend parallel to the length of the range and dip steeply east. The centers of the major shear zones are easily eroded masses of rock flour and clay. The extensive shearing and fracturing is related to movement during the Laramide orogeny.

The most significant structure in the area is the Wind River fault along the west flank of the range (fig. 2). This is a major structure that places the Precambrian rocks of the Wind River Range over Paleozoic and Mesozoic sedimentary rocks along the northeastern margin of the Green River Basin. The trace of the fault is covered everywhere by late Tertiary coarse clastic sedimentary rocks and Pleistocene glacial debris.

The approximate trace of the Wind River fault was determined from oil well information and from gravity and seismic data (see, for example, Gries, 1981). The dip of this fault, however, has long been in question and is of paramount interest because the sedimentary rocks that underlie the fault and Precambrian rocks are potentially oil and gas bearing. Several structural models that have been proposed are illustrated in figure 3. The four models shown are a low-angle thrust (A), a low-angle thrust that steepens with depth (B), a high-angle reverse fault (C), and a high-angle fault that flattens with depth (D). Berg (1962) suggested that the Wind River Range formed as a giant fold-thrust, the main fault of which dips at a low angle under the range. A deep seismic-reflection profile across the southernmost end of the range was recently completed by COCORP (Consortium for Continental Reflection Profiling). Results suggest a major low-angle thrust that dips eastward beneath the range and extends for a considerable distance into the crust (Smithson and others, 1979; Hurich and Smithson, 1982), similar to model A (fig. 3).

On the basis of a computer-generated down-plunge projection of structures at the northeastern end of the range, Mitra and Frost (1981) suggested that the Wind River fault has an average dip of 40° E.

Although low-angle thrust faulting seems to be well documented in the southern part of the range by the COCORP line, data are not available to adequately define the nature of the fault along the rest of the range. Other models, such as those illustrated (fig. 3), also have credence and must be considered. The steeper the angle of the Wind River fault, the shorter the distance the wedge of sedimentary rocks would extend eastward under the study area. Only model A (fig. 3) of those illustrated would place sedimentary rocks at exploitable depths beneath the area.

GEOCHEMISTRY

An extensive geochemical survey of the study area was conducted in conjunction with the geologic mapping and resource appraisal (Lee and Antweiler, in press). About 4,000 samples (1,134 stream-sediment, 587 panned-concentrate, 259 soil, and 2,029 rock samples) were collected. An additional 550 samples (110 stream-sediment, 90 panned-concentrate, and 350 rock samples) were collected during detailed studies of the Schiestler Peak molybdenum prospect and vicinity (Benedict, 1982; Lee and others, 1982). Six-step, semiquantitative emission-spectrographic analyses for 31 elements were made of all samples, and atomic-absorption determinations for antimony, bismuth, cadmium, lead, and zinc were made on selected rock samples. Atomic-absorption analysis for gold was made on all panned-concentrate samples (Lee and Antweiler, in press).

About 94 rock samples were collected from prospect pits and altered and mineralized zones and were analyzed by the U.S. Bureau of Mines (Ryan, 1982). All were analyzed by semiquantitative spectrographic methods, and those from areas of placer claims were analyzed by fire-assay methods for gold and silver.

Stream-sediment samples were collected from most active first-order streams in the study area as well as from all second-order and larger streams. At each sample site, a composite of fine material was taken from several localities within the stream. Panned heavy-mineral concentrates were collected from streams that are large enough to deposit gravel-size and coarser sediment. These samples were generally taken in the proximity of the stream-sediment sample localities.

Rock and soil samples were collected with two objectives in mind: (1) to identify and evaluate zones of mineralized and altered rock, and (2) to provide an even geographical distribution of representative rock samples throughout the study area for the determination of background abundances of elements. Some mineralized float samples were taken if the parent outcrop was inaccessible or unknown. Soil samples were collected at some of the rock sample localities to provide well-mixed composites of the outcrops and, in other cases, were taken where no outcrop was available.

The results of the geochemical survey do not indicate any major zones of metal anomalies. However, many samples did contain one or more metals in slightly anomalous concentrations. Table 1 is a summary of anomalous values for each sample type. Thresholds defining anomalous values of an element for a sample type were determined from statistical parameters (see Lee and Antweiler, in press). In many cases the anomalous values were ranked into ranges of values.

Some stream-sediment samples contained silver, copper, molybdenum, lead, tin, and zinc, and panned concentrates contained anomalous amounts of gold, silver, cobalt, molybdenum, and tin (table 1). The anomalous concentrations are lithologically controlled. Stream-sediment and panned-concentrate samples having anomalous concentrations of molybdenum and tin were from areas of felsic plutonic rocks, and such samples having anomalous concentrations of silver, cobalt, copper, lead, and zinc were from areas of mafic igneous and mafic metamorphic pods in gneiss and migmatite. Panned concentrate having anomalous concentrations of gold were from the drainage basins of the Sweetwater, Little Sandy, and Big Sandy Rivers in the southern part of the study area and from the Roaring Fork drainage basin in the northernmost part. Except for zinc in Pine Creek and gold in Roaring Fork, no more than one stream-sediment or panned-concentrate sample from a single drainage

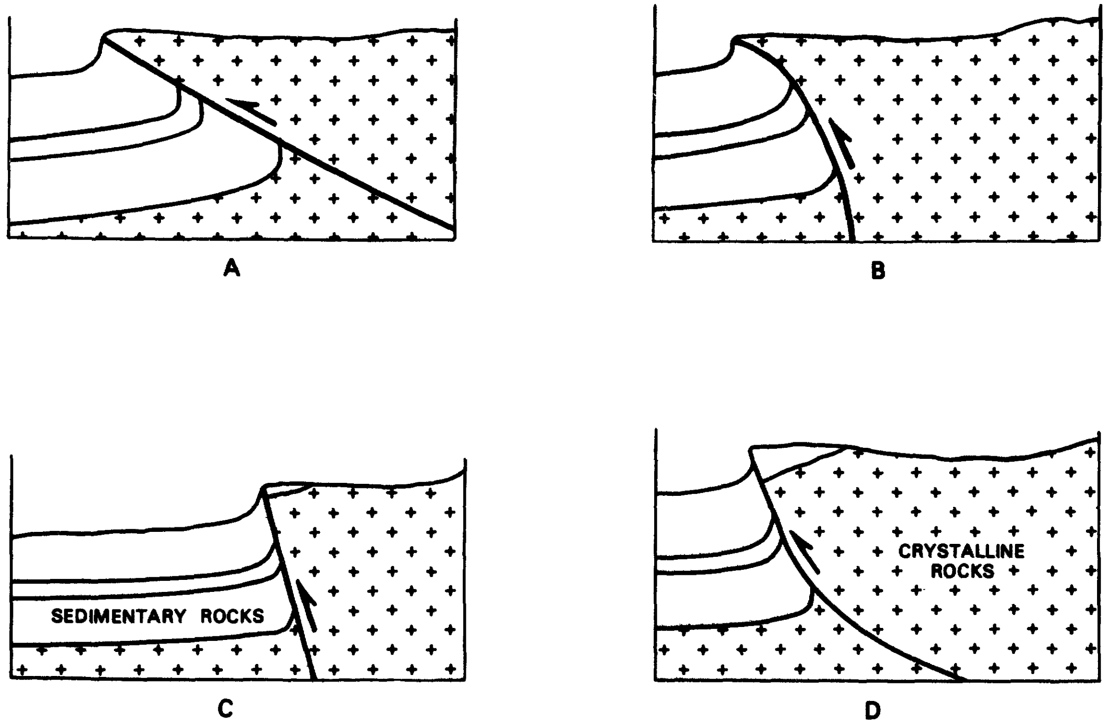

Figure 3.—Diagrams illustrating models of uplift of the Wind River Range, Wyo.: A, low-angle thrust; B, low-angle thrust that steepens with depth; C, high-angle reverse fault; and D, high-angle fault that flattens with depth.

basin showed anomalous concentrations of any element. The only anomalous concentration not adequately explained by the present geologic knowledge of the study area is one tin concentration greater than 20 ppm in a stream-sediment sample. This anomaly is worthy of further investigation.

Table 1.--Summary of chemically anomalous samples, exclusive of the Schiestler Peak molybdenum prospect

Element	Number of samples	Range of values (ppm)
Stream-sediment samples		
Ag---	4	0.5-1.0
Ag---	1	1.1-3.0
Ag---	1	3.1-7.0
Cu---	8	100-150
Cu---	1	151-200
Mo---	7	7-10
Mo---	1	11-20
Pb---	16	151-200
Sn---	1	21-50
Zn---	12	200
Panned-concentrate samples		
Au---	4	0.05-0.10
Au---	8	0.11-1.0
Au---	1	10.0-50.0
Ag---	1	1.0-2.0
Ag---	2	2.1-5.0
Ag---	2	5.1-10.0
Co---	6	101-150
Mo---	2	11-20
Mo---	1	201-700
Sn---	11	21-30
Sn---	2	31-70
Soil samples		
Ag---	3	0.5-1.0
Ag---	1	1.1-2.0
Co---	1	70-150
Cu---	8	100-200
Cu---	1	500-1,000
Mo---	8	5-15
Mo---	1	16-20
Pb---	2	100-150
Sn---	2	10-15
Zn---	11	200-300
Zn---	1	300-700
Rock samples		
Ag---	11	1.0-1.5
Ag---	10	1.6-3.0
Ag---	3	3.1-7.0
Co---	9	100-150
Co---	8	151-300
Co---	4	301-700
Co---	3	1,501-3,000
Cu---	66	150-300
Cu---	15	301-1,000

Table 1.--Summary of chemically anomalous samples, exclusive of the Schiestler Peak molybdenum prospect--Continued

Element	Number of samples	Range of values (ppm)
Rock samples--continued		
Cu---	3	1,001-3,000
Cu---	4	3,001-7,000
Mo---	20	11-20
Mo---	8	21-70
Mo---	1	71-200
Mo---	1	701-1,500
Pb---	11	101-150
Pb---	8	151-300
Pb---	3	301-500
Pb---	1	501-1,500
Sn---	5	21-30
Zn---	8	201-300
Zn---	9	301-700
Zn---	2	701-1,500
Zn---	1	3,001-5,000

Some rock and soil samples contained anomalous concentrations of silver, cobalt, copper, molybdenum, lead, tin, and zinc (table 1). In the area between Gannett Peak and Downs Mountain (fig. 2), numerous rock samples yielded anomalous concentrations of more than one of these metals. This is a zone characterized by a variety of ultramafic, mafic, and metasedimentary pods in migmatite. Many of the pods bear sulfides, and a few contain lenses of nearly massive sulfide minerals. Iron staining is common, even on pods that do not contain visible sulfides. Silver, cobalt, copper, lead, and, in a few places, tin and zinc are present in anomalous concentrations in some samples from these pods. Felsic dikes cutting the sulfide-bearing pods contain in many places disseminated sulfides and in a few places are slightly enriched in the same elements, as well as in molybdenum. Two small prospect pits in the Pine Creek drainage basin are along mafic pods that have lenses of massive sulfide minerals. Cobalt was present in highly anomalous concentrations in the sulfide-rich samples from these pods (Ryan, 1982; Lee and Antweiler, in press). Neither pod is more than a few feet long.

The Schiestler Peak molybdenum prospect (fig. 2) was extensively sampled (Lee and others, 1982; Ryan, 1982; Benedict and Worl, in press). Results indicate that mineralization was very localized and insignificant. A few samples from the surrounding area contained anomalous concentrations of molybdenum.

Many rock samples from the study area showed slightly anomalous concentrations for only one metal, copper or zinc most commonly. Most of these samples were from mafic pods in the metamorphic rocks. Silver and lead anomalies are widely scattered within the metamorphic rocks, and molybdenum is widely scattered in felsic dike rocks. Phosphoria Formation samples from scattered localities in the northern part of the study area contained anomalous amounts of molybdenum, lead, or zinc.

Twelve metamorphic rock samples and 34 granite samples were collected from within the Bridger Wilderness and the contiguous Green-Sweetwater Roadless Area to evaluate radioelement favorability within the crystalline rocks. An additional 44 granite samples were collected from areas adjacent to the study area (Stuckless and Van Trump, 1983). The average uranium, radium-equivalent uranium, and thorium contents are given in table 2. These average values given for the granite samples are not markedly different from those reported for average granite.

GEOPHYSICS

Aeromagnetic, gravity, and electromagnetic surveys were made for this study (Long, in press). An aeromagnetic survey for part of the study area was flown in 1969 by the U.S. Geological Survey (unpub. data) at a barometric elevation of 13,500 ft, along east-west flight lines spaced about 1 mi apart. The magnetic data were compiled relative to an arbitrary datum at a contour interval of 20 gammas. The primary aeromagnetic data used were two lower level surveys conducted by the U.S. Department of Energy and flown with a 400-ft terrain clearance at a flight-line spacing of about 3 mi (Geodata International, Inc., 1979). The data were compiled to produce a residual-intensity magnetic-contour map, having a contour interval of 20 gammas, that would help to identify any large, near-surface magnetic deposits. Some of the magnetic anomalies revealed by the high- and low-level surveys are associated with topography, but many anomalies are consistent with the magnetic properties of the rocks exposed at or near the surface. The following discussion pertains primarily to the low-level survey.

Magnetically, the study area is characterized by a large, northwest-trending magnetic high, which covers the northern and central parts of the Wind River Range. This magnetic high is terminated at its southern end by a large, broad magnetic low, which separates the high from the large magnetic anomaly associated with the known iron-ore deposit farther south, at Iron Mountain. The northern magnetic high shows magnetic variability that could be the result of susceptibility contrasts in the Precambrian rocks or the result of a deeper seated body of different lithology. A northeast lobe of the major magnetic-high area is separated by a magnetic-low area. It is suggestive of a broad shear zone, or may be only a topographic effect of a steep-walled, narrow canyon of the upper Green River.

A broad magnetic-low anomaly at the southern end of the range may be indicative of the more felsic granitic rocks reflecting a lower magnetic susceptibility than do the surrounding metamorphic rocks.

The diabase dikes and the ultramafic bodies show little magnetic expression, although most have moderate to high magnetic susceptibilities. They are probably too small in proportion to their distance below the aircraft to have any magnetic expression in the data. One exception is an east-west magnetic trend that is coincidental with a narrow, east-west line of exposed Precambrian dikelike amphibolite bodies (Worl and others, in press). The coincidence of the magnetic trend and the dikelike amphibolite bodies suggests a major lithologic change across this area of the map.

Gravity data gathered for the study area indicate that a positive Bouguer anomaly parallels the structural trend of the entire Wind River uplift, which agrees with the analysis of Hurich and Smithson (1982). The additional gravity data collected for this study help to verify their suggestion that the axis of the gravity field is northeast of the axis of the entire uplift. Steepening of the magnetic contours along the southwestern edge of the Wind River Range is partially coincident with steepening of the gravity contours, which suggests a relationship to the trace of the Precambrian rocks along the Wind River fault.

Due to the density contrast between the sedimentary rocks and the overthrust Precambrian rocks, it is possible to infer the strike of the fault from the trend of the gravity contours. Therefore, it can be inferred that the northwest-trending fault is continuous from one shown by Hurich and Smithson (1982) northward to an area near New Fork Lakes. At this point, part of the contours bend slightly westward. The remaining contours bend north and show a gradient change that may imply a structural difference between this trend and the trend of the fault.

A ridge in the gravity contours separating two deeper parts of the Green River Basin, near Pinedale, indicates a deep-seated structural ridge or a lithologic change. This feature is complemented by an aeromagnetic low that extends eastward.

An AMT (audio-magnetotelluric) survey was made in the area of the Schiestler Peak molybdenum prospect. For a discussion of the method as applied to mineral exploration, see Strangway and others (1973). The AMT data show high resistivities, rather than the usual low resistivities associated with mineral deposits.

A ground magnetic survey was conducted in the area of the body of banded iron-formation (taconite) near Downs Mountain (Worl, 1968). Six profiles were completed across the deposit. Indications are that the taconite, having a very high susceptibility compared to the surrounding area, does not extend beyond the outcrop. By analysis of the profiles, it is inferred from the very short wave lengths that the sources of the anomalies are at or near the surface.

Table 2.—Uranium and thorium contents of granite and metamorphic rock samples from the Bridger Wilderness and vicinity (Stuckless and Van Trump, 1983)

Rock type	Number of samples	Uranium (ppm) Average	Uranium (ppm) Range	Radium-equivalent uranium (ppm) Average	Radium-equivalent uranium (ppm) Range	Thorium (ppm) Average	Thorium (ppm) Range
Granite---------	78	2.28	0.4-12.7	1.87	0.4-8.3	22.8	2.1-98.2
Metamorphic-----	12	1.79	0.3- 7.4	1.83	0.4-8.6	22.4	6.6-77.4

MINING ACTIVITY

There has been practically no mining activity within the Bridger Wilderness and the contiguous Green-Sweetwater Roadless Area, and there is little physical evidence of mineral exploration. The only known mineral production from within the boundaries of the study area was a small tonnage of coal from the center of sec. 20, T. 36 N., R. 109 W. (Ryan, 1982).

A molybdenum prospect on Schiestler Peak (fig. 2), in unsurveyed T. 32 N., R. 104 W. of the Temple Peak 7.5-minute quadrangle, has been explored intermittently since claims were first filed in 1940. A total of 61 claims in the Schiestler Peak area were recorded as of May 1983. In the 1960's, the claim owner shipped for testing large samples taken from two areas on the west side of the peak. Two short diamond-drill holes in one of the areas date from this time. In 1979 and 1980, a lease holder drove an adit below one of the mineralized outcrops in an attempt to intercept the mineralized zone.

A few small prospect pits are within the boundaries of the study area, mostly in gneissic rocks in the northern part. All are shallow (3-ft maximum depth), and some consist only of a small blast hole in or along a pegmatite or quartz vein.

Only 15 claims or groups of claims fall within the boundaries of the study area. These are mainly lode claims in the Schiestler Peak molybdenum prospect area and placer claims in the Sweetwater and Big Sandy drainage basins (Ryan, 1982). One group of 36 claims is 0.25 mi outside the boundary, 5 mi west of Schiestler Peak, near the Big Sandy opening. Many uranium claims were located just west of the southern part of the study area.

Oil and gas leases cover the basin along the west margin of the study area. Many of these leases extend into the study area; the eastern borders of the leases are shown in figure 2. Several wells have been drilled close to the study area boundary, eight within 1 mi of it. Oil and gas shows in these wells have been recorded, but there has been no production, and the wells are now capped.

MINERALIZED AREAS

Mineralized rock is rare in the Bridger Wilderness and the contiguous Green-Sweetwater Roadless Area. The Precambrian granitic complex that makes up the core of the Wind River Range is not of a type that contains abundant metal deposits. The area lacks the Tertiary volcanic and intrusive rocks that are progenitors of mineralization elsewhere in the region. Mineralized rock that is present consists of minor, scattered occurrences of base-metal sulfides, small pods of molybdenite-bearing rock in one area, scattered small pegmatites, and a small body of banded iron-formation (taconite).

The base-metal sulfides, mainly pyrite, with minor chalcopyrite and sphalerite, are found in three types of occurrences: disseminations along and in sheared rock, pods and disseminations in mafic to ultramafic boudins in migmatite and gneiss, and disseminations along felsic dikes where the dikes cut mafic bodies. These occurrences of sulfides are most common in the northern half of the study area, within the gneisses and migmatites. The metals are endogenetic, and the meager amount of associated altered rock is related to shearing or supergene processes.

Molybdenite is a common trace mineral occurring as large flakes and coarse-grained crystals in pegmatites and pegmatitic granite, and as small, well-formed flakes or rosettes in aplite. Most of the occurrences are within porphyritic granite in the Schiestler Peak area (Benedict, 1982). At the Schiestler Peak prospect, mineralized rock forms two small pods. In the eastern, uppermost pod, large grains and rosettes of molybdenite are scattered through a small aplite body that is subhorizontal and parallel to the foliation of the enclosing porphyritic granite. An adit 250 ft long and 60 ft below this zone did not cut mineralized rock, and there is unmineralized rock 30 ft above the zone. This pod is exposed close to the top of the south ridge of Schiestler Peak, on its vertical east face, and also on a bench on the west slope. Areal extent of the pod is about 200 ft east-west and 300 ft north-south.

The western, lower pod of mineralized rock at Schiestler Peak is near the margin of a porphyritic granite in a zone of alternating bands of porphyritic and equigranular granite and iron-stained aplite sheet dikes. This pod is less mineralized and not as large as the eastern and upper pod. Molybdenite here is mainly present as large grains in a medium-grained, equigranular granite.

Pyrite and chalcopyrite also occur locally at Schiestler Peak. They are found with the molybdenite grains and as separate clusters of small euhedral to subhedral crystals; pyrite is found as thin veinlets along fractures. Altered rock is limited in extent, consisting of an area of bleaching and silicification about 4 in. in diameter around molybdenite grains.

Small pegmatite dikes, less than 3 ft in width, occur mainly in the gneisses and migmatites. All outcrops of pegmatites seen in the field are simple pegmatites that are generally unzoned and composed of quartz, feldspar, and mica. Magnetite is locally abundant, and single small beryl crystals were noted at two localities. Extensive complex pegmatites that exist 5 mi south of the study area (Bayley and others, 1973) have been explored for gemstones, columbite-tantalite, and beryl.

Banded iron-formation (taconite) occurs as discrete bodies in migmatite and migmatitic gneiss in the northern part of the study area. The largest occurrence is discontinuous, lenticular lenses of taconite in gneiss, with taconite making up 50 percent of the exposures in an area 3,600 ft long and 2,500 ft wide (Worl, 1968). The resistant, dark-green to dark-brown taconite stands in dark contrast to the surrounding light- to medium-gray gneiss and migmatite. The iron content of 30 hand specimens ranged from 11 to 36 percent and averaged 25 percent. The Atlantic City iron mine of the U.S. Steel Corporation, where taconite is mined as iron ore, is about 6 mi east of the southern tip of the study area.

The Permian Phosphoria Formation contains beds of a marine phosphorite that in parts of the Western United States are a major source of phosphate for fertilizer. The Phosphoria Formation is about 260 ft thick in the Green River Lakes area (fig. 1). Phosphate rock contains abundant fluorine and potentially recoverable amounts of vanadium, uranium, and rare earths. Trenching and sampling in the Gypsum Creek area by the U.S. Geological Survey in

1950 (Swanson and others, 1951) indicated that no beds contained more than 12.7 percent P_2O_5.

A study initiated by the U.S. Department of Energy (1979, p. 17) concluded that "the Wind River Range could contain a major uranium district." This conclusion was based upon the assumption that the lithologies in the Wind River Range were similar to a uranium occurrence 75 mi to the northeast at the Copper Mountain prospect. Radioactive granite is present at Fremont Butte (secs. 17 and 21, T. 32 N., R. 107 W., outside the study area), where it occurs as fine- to medium-grained equigranular dikes and pods. Samples of this granite showed relatively low uranium content (Love, 1954). Numerous uranium claims have been located south and west of the study area, but no significant amount of uranium has been discovered.

The Atlantic City-South Pass gold districts are 5-7 mi southeast of the southern tip of the study area. Gold occurs in quartz veins in graphitic schist and metadiorite and locally in graywacke. Some gold was recovered from placer operations downstream from the vein systems. Mineralization along the quartz veins was mostly lean, but there are local rich ore shoots (Bayley and others, 1973). Chalcopyrite accompanied the gold in a few later veins. Most mining was prior to 1875. There have been several attempts to resume operations of existing mines, including a recent surge of activity (1981), but there have been no recent major operations. There are a few minor workings just south of the southeastern tip of the study area (Ryan, 1982) and a couple of placer claims within the study area. The study area itself is essentially devoid of quartz veins and of the rock types that host gold-bearing quartz veins in the mining districts.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The Wind River Range was probably thoroughly prospected for base and precious metals around the turn of the century. More recent prospecting has been for placer gold, molybdenite, and for whatever caught the eye of the prospector, namely base-metal sulfides, pegmatite minerals, and sheared and altered rock. The only recent physical exploration has been at the Schiestler Peak molybdenite prospect, the site of the only registered lode claims within the study area. A few placer claims in the Sweetwater and Big Sandy drainage basins extend into the study area. During this study, several commodities were considered as potential targets because of exploration activity, presence of mineralized rock, geologic similarities to deposits elsewhere in the region, nearby mining and exploration activities, and geologic models that predict oil and gas at depth.

A moderate potential for oil and gas at depth is assigned to the western approximately one-third of the study area (fig. 2). The geological, geophysical, and geochemical surveys conducted for this evaluation do not indicate a potential for any other commodity.

Oil and gas

The Paleozoic and Mesozoic sedimentary rocks of the Green River Basin are known to be oil and gas bearing. There are no producing wells in the immediate vicinity, but shows from several wells have been reported, some of which are next to the northwestern boundary of the study area. Exposures of Paleozoic and Mesozoic rocks in the study area are limited, and the oil and gas potential of the areas of these exposures is low.

Potential oil- and gas-bearing reservoirs may exist at depth beneath the study area in sedimentary rocks that may underlie the Wind River fault and the wedge of Precambrian rocks that was thrust over them. The dip of the fault is an important consideration in determining the oil and gas potential of the study area. The steeper the angle of the Wind River fault, the shorter would be the distance that the wedge of sedimentary rocks would extend eastward under the study area.

Because the dip of the fault is not exactly known along much of the range, the potential for oil and gas at depth is difficult to judge. The area shown (fig. 2) as having moderate oil and gas potential is approximately that covered by oil and gas leases (Ryan, 1982), but the area having potential may be larger or smaller. Assignment of moderate potential to this area is based upon the assumption that the Wind River fault dips at a shallow angle to the east and that oil- and gas-bearing units underlie the fault.

Molybdenum

Molybdenum is present at the Schiestler Peak prospect; several rock samples from scattered localities in the range contained more than 10 ppm molybdenum. Extensive sampling (Benedict, 1982; Lee and others, 1982; Ryan, 1982) indicated that the molybdenite in the Schiestler Peak area is restricted to two small pods, each about 200 by 300 ft; no resources were identified.

Gold

Trace amounts of gold were found in panned concentrates of heavy minerals from a few streams, mainly in the southern part of the study area. The major gold mining districts of Atlantic City and South Pass are a few miles southeast of the southern tip of the study area, where gold occurs in extensive quartz veins in low-metamorphic-grade schists. Such veins and country rocks are lacking in the study area.

Base metals

Sulfide minerals in shear zones, mafic pods, and felsic dikes are sparse and generally disseminated. Samples from the shear zones containing pyrite did not contain anomalous quantities of metals, but those from the small sulfide-bearing pods and crosscutting felsic dikes contained copper, lead, zinc, cobalt, silver, and molybdenum, in slightly anomalous amounts. All these occurrences are in small, discontinuous, and widely scattered mafic pods.

Radioactive elements

Although a study by the U.S. Department of Energy (1979, p. 17) suggests that a major uranium district might be developed in the Wind River Range, no geologic, geochemical, or geophysical evidence for the occurrence of uranium or thorium deposits was found during this investigation. The granites of the

Wind River Range are not those conducive to granitic-type deposits (Stuckless and Van Trump, 1983).

Banded iron-formation

Banded iron-formation (taconite) intimately mixed with granite gneiss crops out in an area of about 2 mi^2 in the northern part of the study area. About half of the outcrop is taconite in pods and lenses 2-30 ft wide and 5-250 ft long. The iron content of each taconite lens is highly variable. The iron content of 30 samples ranged from 11 to 36 percent and averaged 25 percent. A magnetic survey by Long (in press) suggests that the banded iron-formation is in a relatively thin sheet at the surface.

Phosphate

The Paleozoic Phosphoria Formation, exposed in the northern part of the study area, contains beds of marine phosphorite, and elsewhere in the region it is a major source of phosphate for fertilizer. Trace to anomalous amounts of molybdenum were detected in samples from the Phosphoria Formation. The beds in the study area are thin and do not contain more than 12.7 percent P_2O_5 (Swanson and others, 1951). The other elements present in phosphorite are extracted only as a byproduct of phosphate mining.

Coal

A little coal was mined from a small area just inside the study area. This is the only exposure of the coal-bearing Frontier Formation within the study area. The coal seams seen in nearby oil wells are thin.

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