DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine their mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the West (W 4613) and East (E 4613) Palisades Roadless Areas, Targhee and Bridger National Forests, Teton and Bonneville Counties, Idaho, and Teton and Lincoln Counties, Wyoming. The West and East Palisades Roadless 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.

SUMMARY

The West and East Palisades Roadless Areas lie within the Idaho-Wyoming thrust belt that contains hydrocarbon source beds, reservoir formations, fluid seals, structures, and hydrocarbon thermal maturities comparable to those in producing oil and gas fields farther south in the belt. Therefore, the areas have high potential for oil and gas resources; all parts of the study area are under lease application for oil and gas. High-grade phosphate beds within the study area contain 98 million tons of inferred phosphate-rock resources, but they are in thinner and less accessible beds than those being mined from structurally higher thrust sheets to the southwest. Coal seams in the northern part of the area are too thin, sparsely distributed, and lenticular to constitute a resource. Moderately pure limestone is present, but it is available from other sources closer to markets. Abundant sand and gravel deposits lie along the boundaries and just outside of the roadless areas, but sand and gravel are also available from sources closer to markets. Silver, copper, molybdenum, and lead geochemical anomalies for stream-sediment and rock samples offer little promise for the occurrence of metallic mineral resources, except for those metals that may augment the value of phosphate in the Phosphoria Formation. The potential for geothermal resources is untested by drilling but regarded as low.

GEOGRAPHIC SETTING

The Palisades study area encompasses 247,090 acres, or about 386 sq mi, of the Snake River Range along the Idaho-Wyoming border. The area extends from the Snake River at Alpine, Wyoming northward to the Teton Basin near Victor, Idaho. Jackson, Wyoming, lies 7 mi east of the northern part of the area. Altitudes range from 10,025 ft at Mount Baird and above 9,500 ft at numerous other peaks to about 5,600 ft in Swan Valley.

Only pack trails traverse the rugged and relatively inaccessible roadless areas. Helicopters were used for field work, begun by the Bureau of Mines during the summer of 1979, and by the U.S. Geological Survey in the summer of 1980, and completed in 1982.

GEOLOGY, GEOPHYSICS, AND GEOCHEMISTRY

The West and East Palisades Roadless Areas lie within the northern part of the arcuate Idaho-Wyoming-Utah salient of the Cordilleran foreland thrust belt. The salient, here designated the Idaho-Wyoming thrust belt, extends southward from the Snake River Plain and then southwestward toward the western end of the Uinta Mountains in north-central Utah.

The area, like other parts of the thrust belt, is underlain mainly by westward-thickening Paleozoic and Mesozoic resistant limestone, quartzite, and dolomite, and weaker mudstone, claystone, and sandstone. The rock units are summarized in figure 3 and in the description of map units.

Regional compression moved the strata tens of miles eastward and northeastward during Cretaceous and early Tertiary time, forming large thrust sheets that are folded and also cut by imbricate thrust slices (Oriel and Moore, 1985). Principal thrust sheets are, from west to east (and from uppermost to lowest, and generally from oldest to youngest), the St. John, the Absaroka, the Darby, and the Jackson (or Prospect Mountain; fig. 4). Igneous rocks, now exposed in several small bodies at Indian Peak, intruded thrust strata, probably in mid-Eocene time.

The Palisades region was deformed most recently by extensional stresses, which formed the Snake River Plain volcanic rift and Basin and Range Provinces, whose eastern boundaries overlap (are overprinted on) the thrust belt. The Snake River Range has been rising since Miocene time, while the bounding Swan Valley asymmetrical graben has been sinking, and both have been tilted and rotated down to the northeast. The Teton Range block, which adjoins the Palisades area on the north, has also been rising and rotating (down to the west) since Miocene time (Oriel and Moore, 1985); these movements tilted and deformed adjoining older thrust sheets, overturning folds within them (Dimitre Dunn, 1983). Very coarse to fine detritus was shed, during Miocene and Pliocene time, by the rising mountain blocks into adjoining grabens and basins (Swan Valley, Jackson Hole, and Teton Basin), which were also invaded by volcanic flows and volcaniclastics.

Aeromagnetic and reconnaissance gravimetric surveys were conducted in the Palisades area. Most anomalies on the residual aeromagnetic map of the region (U.S. Geological Survey, 1981) can be explained by volcanic, Archean, and intrusive units mapped on the surface. A broad, elliptical anomaly at the bend of the Snake River near Astoria Hot Springs cannot be related to exposed rocks.

Major negative gravity anomalies in the valleys suggest about 5,000 ft of fill in Swan Valley, perhaps more in Teton Basin, and about 10,000 ft in Jackson Hole. Gravity data are insufficient within the Snake River Range to define such local features as the intrusives at Indian Peak, or sites of major thrust sheets.

Samples of 603 rocks, stream sediments, panned concentrates, and waters were analyzed (Antweiler and others, 1984; Hopkins and others, 1984). Geochemical anomalies for several metals are evident for three different geologic settings: stratabound silver and copper in the mid-Mesozoic Nugget Sandstone; base metals and molybdenum associated with Tertiary intrusive igneous rocks; and silver, chromium, lead, vanadium and zinc in the Permian Phosphoria Formation.

EXPLORATION AND MINING ACTIVITIES

All of the Palisades area is under lease application for oil and gas. Several helicopter-supported, seismic-reflection surveys in and near the study area were underway during the summers of 1979 through 1983. More than a half-dozen proprietary reflection lines cross the area.

Although parts of the federally withdrawn phosphate-bearing lands of Idaho and Wyoming lie within the Snake River Range, no leases or lease applications for phosphate have been issued in the Palisades area.

The vaguely defined Pine Creek coal mining district is the only one within the study area (Benham, 1983), but very little coal has been mined.

"Limerock" placer-claims were staked in Mike Harris and Pole Canyons from 1922 to 1928. Limestone, quarried on a small scale from Pole Canyon, was used for rip-rap.

The mining claims located within the study area include 13 lode, 19 coal, 35 limestone, and 4 placer. There are no active or patented claims.

Southwestern parts of the Palisades area have been classified by the U.S. Geological Survey as potentially valuable for geothermal steam and associated geothermal resources, but no applications for geothermal leases have been submitted.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Oil and Gas

The highest resource potential for the Palisades area is for the occurrence of oil and gas. The area lies in the northern part of the Idaho-Wyoming thrust belt, in which many large and prolific oil and gas fields have been found (Petroleum Information, 1981; Ver Ploeg and De Bruin, 1982; Lamerson, 1982; Powers, 1983). The same rock formations are present throughout the belt, including the same hydrocarbon source beds, the same potential reservoir rocks, and the same impermeable seals. Comparable structures, including anticlines that may entrap oil and gas both above and below thrust faults, are also present, as is comparable thermal maturity of source rocks. Moreover, eastward thinning and facies changes of most Paleozoic and Mesozoic units, which are inclined predominantly to the west, are favorable for the presence of numerous stratigraphic, as well as structural, traps.

Hydrocarbon source-beds within the thrust belt (see fig. 3) include organic-rich shales in all Cretaceous units above the Gannett Group and in the Phosphoria Formation; the total organic carbon content of these rocks is one weight percent or more (Warner, 1982). Significant source beds are also present in Mississippian strata (Sando and others, 1981, p. 1442) and probably in most other Paleozoic and lower Mesozoic units, which have been studied insufficiently but contain locally abundant organic debris. Thermal maturation and peak generation of hydrocarbons from Paleozoic sources probably preceded thrusting; the assumption that these hydrocarbons migrated out of the region before the development of favorable structural traps (Warner, 1982), overlooks the probable role of stratigraphic traps in retaining some hydrocarbons.

Reservoir beds in the thrust belt are present in, and produce from, almost all stratigraphic units from the Ordovician Bighorn Dolomite to Cretaceous sandstones. The Nugget Sandstone has the greatest production, but Mississippian limestones and Pennsylvanian sandstones are also productive. Intergranular porosity in sandstones and clastic limestones, and intercrystalline porosity in coarser dolomites are augmented by fracture porosity produced during compressive deformation. Sufficient shales are present throughout the sequence to provide required seals.

Intrusives within the Snake River Range and evidence of elevated geothermal gradients north and west of the range prompted sampling for thermal data at 34 sites. Conodont color alteration indices (CAI) for all samples range from 1.0 to 2.0 (B. R. Wardlaw written commun., Nov. 11, 1983), well within the range (oil-generation "window") of optimum thermal maturity for oil.

Structures (antiforms and fault-truncated wedges) favorable for the entrapment of oil, besides those now exposed to erosion, must also be present at depth, as indicated by folds that plunge beneath thrust sheets.

Therefore, the high potential we and others (Powers, 1978, 1983; Spencer, 1983) assign to the Palisades area for oil and gas, is based on favorable source beds, potential reservoirs and seals, structural and stratigraphic traps, and a favorable thermal regime, comparable to those in the already proven, highly productive southern part of the Idaho-Wyoming thrust belt.

Phosphate Rock

Phosphate rock is present within the extensively but discontinuously exposed and faulted Permian Phosphoria Formation in the Palisades area. Moderately rich phosphorite beds (containing as much as 36 percent P_2O_5 in one seam), are present at four stratigraphic levels within the Phosphoria Formation, but only those within the basal Meade Peak Phosphatic Shale Member are sufficiently thick to be of commercial interest.

Twenty-three stratigraphic sections of the member have been sampled for analyses along a total strike length of 74 mi and each of the sections was examined for phosphate rock zones containing at least 14 percent P_2O_5. Using a dip mining distance of 250 ft to calculate resource tonnage, the Palisades area contains 98 million tons of inferred phosphate-rock resources (Benham, 1983). These strata also contain an average of 2.39 percent fluorine that could be recovered as a byproduct, and lesser amounts of vanadium and uranium (Sheldon, 1963; Gere and others, 1966).

Units of phosphate rock that contain 24 or more percent of P_2O_5 are thinner and less accessible in the Palisades area than those 20 to more than 30 ft thick now being mined in the structurally higher Meade thrust sheet in the Soda Springs and Pocatello areas to the southwest (U.S. Geological Survey, 1977, v. 1, p. 48).

Coal

The Cretaceous Frontier and Bear River Formations contain coal seams and beds that trend northwest along the northeastern part of the Snake River Range. The seams are thin, steeply dipping, and discontinuous. Two areas have been mined for small amounts of coal, the Shu-Fly No. 2 Claim containing volatile C bituminous and an unnamed prospect containing lignite (Benham, 1983).

Limestone

The Mississippian Mission Canyon Limestone, exposed in the Jackson, Absaroka, and St. John thrust sheets, contains relatively pure limestone. Exposures of the formation in the Jackson sheet trend northwesterly along ridges from south of Teton Pass to Pole Canyon, a distance of 12 mi, and are as much as 1/2 mi wide; beds dip 10° to 65° SW.

Two groups of claims were located along these limestone exposures: the Silver King Nos. 1-10 claims, and the Trail Creek Nos. 1-8 with their associated Birch Limerock Placers Nos. 1-8 claims. Only one property, the Silver King, has produced, supplying rip-rap for local use.

The limestone is of good quality, averaging 95.7 and 93.8 percent $CaCO_3$, respectively, and is suitable as flux for smelters and for use in glass making, sugar-beet refining, and paper making, as well as for rip-rap. However, other limestone sources are closer to markets, and deposits in the Palisades area are useful only for local needs (Benham, 1983). Crushed and broken limestone is readily available in large volumes from the rock avalanche deposit along Blowout Canyon.

Sand and Gravel

Sand and gravel deposits are abundant along most margins of, and just outside of, the Palisades area, especially on alluvial terraces along the Snake River. The sand and gravel supplies far exceed projected local needs, so that deposits along the major roads outside the Palisades area are more than adequate.

Base and Other Metals

Despite the significant geochemical anomalies, described above and by Antweiler (1984), our data are inadequate to ascertain with assurance the resource potential for metals detected; the potential is probably low. Stratabound metal deposits in the Nugget Sandstone are low-grade, small, and discontinuous. Although the intrusives at and near Indian Peak, together with the associated mineralization, may possibly represent the top of a porphyry system, the low conodont color alteration indices for nearby strata and the absence of significant gravity or magnetic anomalies imply that no large intrusive mass is present at moderately shallow depths. Vanadium and associated metals in the Phosphoria Formation could probably be extracted profitably only if recovered as by-products of phosphate mining.

Geothermal Resource

Heat-flow data are not available for the Palisades area but thermal phenomena are known from nearby localities. Although a geothermal resource is unproved in the Palisades area, such a resource is possible but the potential is low.

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Map symbol (Fig. 4)	Geologic age		Formation or group	Oil or gas	Thickness (feet)
Qu	QUATERNARY		undifferentiated		
Tvc	TERTIARY	Late	volcaniclastic rocks and conglomerate		0-5000′
Ti	TERTIARY	EOCENE(?)	intrusive rocks		
Ku	CRETACEOUS	Late	Frontier Formation	RS ●	2000′+
	CRETACEOUS	Late	Aspen Shale	RS ●	2000′
	CRETACEOUS	Early	Bear River Formation	RS ✸	1000′
	CRETACEOUS	Early	Gannett Group		550′-750′
Ju	JURASSIC		Stump Formation	R ●	
	JURASSIC		Preuss Sandstone/salt	R ✸	300′
	JURASSIC		Twin Creek Limestone	RS ✸	760-1,100′
JTrn	JURASSIC(?) and TRIASSIC(?)		Nugget Sandstone	R ✸	400′
uPz	TRIASSIC		Ankareh Formation	R ✸	500′-550′
	EARLY TRIASSIC		Thaynes Formation	RS ☼	400′-900′
	EARLY TRIASSIC		Woodside Formation		400′-800′
	EARLY TRIASSIC		Dinwoody Formation	R ☼	440′-600′
	PERMIAN		Phosphoria Formation[1]	RS ☼	200′-220′
	PENNSYLVANIAN		Wells Formation	R ☼	1000′
	MISSISSIPPIAN		Amsden Formation	R ☼	400′-700′
	MISSISSIPPIAN	Madison GROUP	Mission Canyon Ls.[2]	R ☼	700′-1000′
	MISSISSIPPIAN	Madison GROUP	Lodgepole Limestone	RS ☼	400′-800′
lPz	DEVONIAN	Darby Fm.	Three Forks Fm. / Jefferson Fm.	RS ☼	400′-600′
	ORDOVICIAN		Bighorn Dolomite	RS ☼	400′-500′
	CAMBRIAN		Gallatin Formation		200′
	CAMBRIAN		Gros Ventre Formation		650′-900′
	CAMBRIAN		Flathead Sandstone		200′-250′
pE	PRECAMBRIAN		Archean gneisses, intrusive rocks		

● Oil productive
✸ Oil and gas productive
☼ Gas productive
[1] And equivalent strata
☼ Gas with condensate productive
R Known or potential reservoir rock
S Known or potential source rock
[2] Brazer limestone of some authors

Figure 3.--GENERALIZED STRATIGRAPHIC CHART FOR THE NORTHEASTERN PART OF THE IDAHO-WYOMING THRUST BELT. Shows formations identified as hydrocarbon source beds and productive reservoirs farther south in the belt. (Modified from Hayes, 1976, p. 80, and Powers, 1983, p. N6)

TABLE 1.--CLAIMS AND PROSPECTS IN THE PALISADES AREA
[from Benham, 1983]

Map no.	Name	Location	Workings	Sample data
1	Unnamed coal prospect	NE1/4NW1/4 sec. 30, T. 3 N., R. 45 E., Idaho. In Wood Canyon; Lower Cretaceous Bear River Formation	Five-inch coal seam in caved adit	One sample analyzed as lignite A coal
2	Shu-Fly No. 2 coal	SW1/4SW1/4 sec. 5, T. 2 N., R. 45 E., Idaho. Along North Fork Rainey Creek; Upper Cretaceous Frontier Formation	Two-foot coal bed with calcite stringers in caved adit	Two samples analyzed as high volatile C bituminous coal
3	Silver King Nos. 1-10	NW1/4NW1/4 sec. 26, T. 2 N., R. 45 E., Idaho. In Pole Canyon; Mississippian Mission Canyon Limestone	Two limestone quarries	CaO in eight samples ranged from 51.2 to 56.1 percent
4	Trail Creek Nos. 1-10 Birch Placers (lime rock) Nos. 1-8	NE1/4NE1/4 sec. 36, T. 2 N., R. 45 E., Idaho. Along Mike Harris Creek; Mississippian Mission Canyon Limestone	Two small pits and dozer scrape	CaO in five samples ranged from 44.9 to 56.1 percent
5	Arts Happy Day Nos. 1, 2, 3 Lodes	Sec. 19 and 20, T. 1 N., R. 45 E., Idaho. On and near Palisades Creek; St. John thrust fault, with altered zones, crosses the claim; country rock is limestone	None	Three samples; no significant assays
6	Bluebird Lodge	SW1/4SW1/4 sec. 32. T. 1 N. R. 45 E., Idaho. In Sheep Creek Canyon; Quartzite and quartzite conglomerate. No economic minerals	One pit-8 ft by 4 ft, 1 ft deep	One sample; no significant assays
7	Townview 20 acre placer (South of Study area boundary)	NW1/4NW1/4 sec. 8, T. 1 S., R. 45 E., Idaho. 1/4 mi east of Palisades; Talus consisting of unconsolidated andesite cobbles, silt, and clay	None	Two pan samples; one contained three very small particles of gold
8	Tripoli No. 1 160 acre (65 ha) placer	W1/2W1/2 sec. 27, T. 2 S., R. 46 E., Idaho. Unconsolidated sand and gravel	None	Two pan samples; no gold detected
9	Virginia Gold No. 14 160 acre (65 ha) placer	NE1/4 sec. 24, T. 39 N., R. 117 W., Wyo. 1/2 mi west of mouth of Coburn Creek; unconsolidated sand and gravel	None	Five pan samples; no gold detected

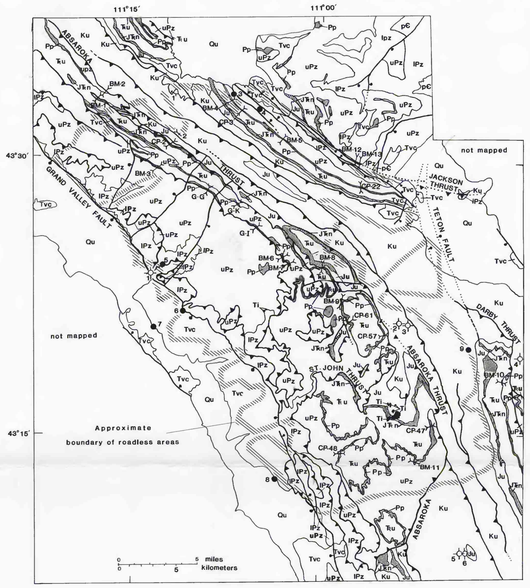

FIGURE 4.--MAP SHOWING SIMPLIFIED GEOLOGY AND MINERAL RESOURCE POTENTIAL IN THE PALISADES ROADLESS AREAS, IDAHO AND WYOMING.

TABLE 2.--DRY HOLES DRILLED FOR PETROLEUM NEAR PALISADES STUDY AREA

Map no.	Operator	Borehole	Location	Completion date	Total depth (feet)
1	Edwin Allday	43-24 Federal	NE1/4SE1/4 sec. 24, T. 1 N., R. 44 E., Ida.	Unknown	5,760
2	Shell Oil	23-8 Teton Federal	NE1/4SW1/4 sec. 8, T. 39 N., R. 117 W., Wyo.	11-23-81	10,299
3	Getty Oil	1-Teton	NE1/4SE1/4 sec. 8, T. 39 N. R. 117 W., Wyo.	4-25-79	9,300
4	Chevron USA	1-21 Astoria Unit-Federal	SE1/4SE1/4 sec. 21, T. 39 N., R. 116 W., Wyo.	10-11-82	16,350
5	Delhi Oil Corp.	1-A Unit	SE1/4SW1/4 SE1/4 sec 25., T. 37 N., R. 117 W., Wyo.	12-22-50	4,699
6	True Oil	44-25 Greys River	SE1/4SE1/4 sec. 25, T. 37 N., R. 117 W., Wyo.	1-17-72	14,861
(South of map)	Sunmark Exploration	1 Praeter Mountain --Federal	SE1/4SE1/4 sec. 15, T. 35 N., R. 118 W., Wyo.	10-30-81	14,284

MINERAL RESOURCE POTENTIAL MAP OF THE WEST AND EAST PALISADES ROADLESS AREAS, IDAHO AND WYOMING

By
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