DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-1589-A

Base from U.S. Geological Survey, 1:24,000
Eureka North, Fontine, Ksanka Peak, Mount Marston, and Stahl Peak, 1963

SCALE 1:48 000

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 KILOMETERS

CONTOUR INTERVAL 20 AND 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology by J. W. Whipple, 1981-1982; assisted by J. C. Sample, 1981, and L. A. Lefkowitz, 1982

HIGH POTENTIAL FOR COPPER AND SILVER RESOURCES IN VEINS AND LOW POTENTIAL FOR BARITE RESOURCES IN VEINS

MODERATE TO HIGH POTENTIAL FOR COPPER, SILVER, LEAD, AND ZINC IN VEINS

LOW POTENTIAL FOR COPPER RESOURCES IN STRATA-BOUND DEPOSITS

LOW POTENTIAL FOR ZINC RESOURCES IN VEINS ASSOCIATED WITH METADIORITE SILLS

× PROSPECT OR MINE--Numbered prospects or mines are discussed in text or table 1

CORRELATION OF MAP UNITS

Qa	Holocene	QUATERNARY
Qg	Pleistocene	QUATERNARY
Unconformity		
Zd		LATE PROTEROZOIC (?)
Ym	Missoula Group	MIDDLE PROTEROZOIC
Ybs	Missoula Group	MIDDLE PROTEROZOIC
Ypl	Middle Belt carbonate	MIDDLE PROTEROZOIC
Ymb	Middle Belt carbonate	MIDDLE PROTEROZOIC
Yr	Ravalli Group	MIDDLE PROTEROZOIC

Belt Supergroup

EXPLANATION OF MAP UNITS

Qa ALLUVIUM (QUATERNARY)

Qg GLACIAL DEPOSITS (QUATERNARY)

Zd METADIORITE SILL (LATE PROTEROZOIC(?))

BELT SUPERGROUP (MIDDLE PROTEROZOIC)

MISSOULA GROUP

Ym McNamara Formation--Grayish-green siltite, argillite, and minor arenite

Ybs Bonner Quartzite, Mount Shields, Shepard, and Snowslip Formations--Argillite, siltite, limestone, arenite, and conglomerate

Ypl Purcell Lava--Basalt flows

Ymb MIDDLE BELT CARBONATE--Dolomite, limestone, argillite, siltite, and arenite of the Helena Formation and middle part of the Wallace Formation

Yr RAVALLI GROUP, UNDIVIDED--Argillite, siltite, and minor arenite of the Empire and upper part of the Grinnell Formations

——— CONTACT

—|— NORMAL FAULT--Bar and ball on downthrown side

THRUST FAULT--Sawteeth on upper plate

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 resource potential. 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 resource potential survey of the Ten Lakes Wilderness Study Area in the Kootenai National Forest, Lincoln County, Mont. The Ten Lakes Wilderness Study Area was established as a congressionally designated study area by Public Law 95-150, in 1978, and later as a further planning area during the Second Roadless Area Review and Evaluation (RARE II, No. 1-683) by the U.S. Forest Service, January 1979.

MINERAL RESOURCE POTENTIAL
SUMMARY STATEMENT

Geological, geochemical, and geophysical investigations and a survey of mines and prospects were conducted in the Ten Lakes Wilderness Study Area in order to evaluate the mineral resource potential. Four types of mineral occurrences of probable value were identified in the area: (1) copper-silver-barite-bearing veins in basaltic lava, (2) zinc-bearing veins associated with metadiorite sills, (3) copper-silver-lead-zinc-bearing veins in calcareous metasedimentary rocks, and (4) stratabound copper. Mineral exploration and mining occurred at seven properties in the study area and at two properties adjacent to the area. On the basis of available surface geologic data and reasonable extrapolations of the subsurface geologic framework from these data, there seems little likelihood for occurrence of oil and gas resources in the study area.

If the source of metals in some of the vein systems is shallowly buried plutons, additional mineral deposits may be present at depth. Areas of copper-silver-bearing veins in basalt, which were the focus of past-mining activity, are assigned a high resource potential. Another area has a moderate to high potential for metals in the copper-silver-lead-zinc-bearing veins. Areas of zinc-bearing veins, stratabound copper occurrences, and barite veins are assigned low resource potential.

INTRODUCTION

The Ten Lakes Wilderness Study Area contains 34,000 acres or 53 mi² in Lincoln County, Mont., in the Kootenai National Forest. The study area spans the southern end of the Galton Range, and its northern limit coincides with the boundary between the United States and Canada. In the north part of the study area, about 6,500 acres or 10.1 mi² are presently designated the Ten Lakes Scenic Area.

Geological, geochemical, and geophysical studies were conducted by the U.S. Geological Survey during the 1981 and 1982 field seasons. The U.S. Bureau of Mines conducted a study of all mines, prospects, and mining claims in and adjacent to the study area in 1980. Results of these investigations are published as part of a map series on the Ten Lakes Wilderness Study Area and are as follows: (1) geologic map (Whipple, 1984), (2) geochemical map (Leinz and Whipple, in press), (3) geophysical map (Bankey and others, in press), and (4) mines and prospects maps (Hamilton and Avery, 1983, fig. 1). Summations of these publications are included in the enclosed pamphlet.

GEOLOGY

Slightly metamorphosed Proterozoic sedimentary and igneous rocks of the Belt Supergroup underlie all the Ten Lakes study area and consist of varicolored argillite, siltite, arenite, limestone, dolomite, basalt, and diorite. The oldest exposed rocks are assigned to the upper part of the Grinnell Formation which is overlain successively by the Empire, Helena (map unit includes middle Wallace Formation), Snowslip, Shepard, and Mount Shields Formations, the Bonner Quartzite, and the McNamara Formation. Approximately 9,800 ft of stratigraphic section is represented. Just northeast and outside the study area boundary, the Libby Formation overlies the McNamara and is in turn unconformably overlain by Middle Cambrian rocks. For the most part, Belt strata were deposited in shallow, nearshore marine environments and conjugate fluvial environments.

Igneous rocks of the study area include the Purcell Lava, which is predominantly basalt and intertongues with the Snowslip Formation or, in some places, separates the Snowslip and Shepard Formations. The Purcell consists of several thin (less than / ft thick) flows, most of which were extruded in a subaerial environment. A Precambrian(?) metadiorite sill has intruded the Empire Formation and, in places, separates the Empire Formation from the Helena Formation.

All rocks in the study area rest on two thrust plates. The Ten Lakes thrust fault is the major structural element that separates the plates. The lower or easternmost thrust plate is characterized by numerous asymmetric folds with steep west-dipping axial planes that indicate original thrust transport to the east. This plate is bounded on the northeast by a major down-to-the-west normal fault, which probably flattens with depth, and on which both the lower and upper thrust plates of the Ten Lakes fault have slid back to the west. The original direction of movement of the upper thrust plate, with respect to the lower plate, was also from west to east; the amount of eastward movement is unknown. A large normal fault borders the study area on the west and forms the eastern edge of the Rocky Mountain trench. This frontal fault is downfaulted to the west and separates the Tobacco Plains from the Galton Range; it is estimated to have 9,000-9,800 ft of vertical displacement.

MINES, PROSPECTS, AND MINERALIZED AREAS

Prospecting, claim staking, and mining began in the 1890's when miners developed base- and precious-metal veins. County mining records indicate that 117 claims were located within or adjacent to the study area from the 1890's to 1981. Many of the claims were relocations; six were patented, but there are no records of past mineral production nor is there any indication of current mineral production from the study area. Only desultory mining activity, consisting primarily of prospecting and minor claim staking, is presently pursued.

Four types of mineral occurrences have been identified in the study area: (1) Copper and silver minerals, locally associated with barite, occur in well-developed vein systems and shear zones in the Purcell Lava; this is the most extensive and most explored of the types of mineral occurrences. (2) Veins that contain copper, lead, zinc, and silver minerals are present near the south end of the study area on the nose of Gibralter Ridge, and are in the Helena Formation; some of these veins were prospected as recently as 1982. (3) Small isolated occurrences of zinc minerals in veins associated with a thin metadiorite sill also have been prospected. (4) Stratabound copper minerals occur in some calcareous arenite beds in the McNamara Formation and in talus derived from the Grinnell and Shepard Formations.

Most of the exploration and development activity at the mines and prospects in the study area has been on copper-bearing, quartz-barite-siderite veins in the Purcell Lava. The veins occur in shear or breccia zones that trend west-northwest and range in thickness from 6 in. to 12 ft. In addition, the copper mineral chalcopyrite commonly occurs as vesicle fillings in the lava near mineralized shear zones. Although copper is the principal metal in the veins, silver, gold, cobalt, and lead occur in sparse amounts.

Barite is an important gangue mineral in most of the copper-bearing veins in the Purcell Lava. The amount of barite varies, but has been reported to be as much as 60.6 percent BaO (Johns, 1970, p. 152) in a vein exposed just off the Burma road and northwest of the study area. Many of the veins exposed in prospects on Green Mountain (nos. 2, 3 on map) also contain large amounts of barite, but were developed only for copper.

Veins hosted by dolomite beds in the lower part of the Helena Formation have been explored at several prospects on Gibralter Ridge near the south end of the study area. The quartz-calcite veins contain lead, zinc, silver, and copper minerals, and range in thickness from 0.4 to 16 in. In addition to well-defined veins at the prospects, small veinlets and fracture fillings were observed at several outcrops, and samples from them contained as much as 1,000 ppm lead, 1,900 ppm zinc, 700 ppm copper, and 1.5 ppm silver.

Metal-bearing veins associated with metadiorite sills are common in rocks of the Belt Super-group in the Whitefish Range and elsewhere in Montana; however, only small isolated veins are in metadiorite in the Ten Lakes study area. A vein associated with metadiorite is exposed at one prospect on the south end of Gibralter Ridge; a sample from the vein contained 400 ppm zinc. Samples of other veins in metadiorite typically contain 150-200 ppm zinc.

Stratabound copper minerals are disseminated in some calcareous arenite beds of the lower McNamara Formation and in blocks of siltite in talus from the Shepard and Grinnell Formations. Mineralized strata in the McNamara are less than 4 in. thick and contain about 2,000 ppm copper and 0.5-3 ppm silver. Samples of malachite-stained talus from the Shepard and Grinnell Formations contain 1,000 ppm copper.

A seismic survey was not a part of the investigations of the Ten Lakes study area, but at least two commercial seismic reflection crews were active in 1982 along Grave Creek on the southern margin of the area. The recognition of stratiform seismic reflections at depth, obtained by Vibroseis surveys in northwestern Montana, west of Glacier National Park, and rumors of hydrocarbon seepages in this region have led to numerous applications for oil and gas leases in the region.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

The determination of the mineral resource potential of the Ten Lakes Wilderness Study Area is based largely on geological, geochemical, geophysical, and mine and prospect data that were gathered during 1980-82.

The Ten Lakes area has a high resource potential for copper and silver in veins in the Purcell Lava. Aeromagnetic anomalies in the vicinity of Independence Peak suggest small shallowly buried granitic intrusions (Bankey and others, in press), which could have been the source of the ore-forming fluids that formed the metalliferous veins. Stream-sediment samples from most of the streams that drain the Independence Peak area have anomalously high copper contents (Leinz and Whipple, in press). A smaller area south of Independence Peak and east of Sinclair Creek has a similar geological, geochemical, and geophysical setting and also is considered to have a high resource potential for copper.

Although most of the copper- and silver-bearing veins in the Purcell Lava also contain barite, the resource potential of the study area for barite is low. If any of the copper- and silver-bearing veins were to be mined, barite possibly could be recovered as a byproduct.

An area in the vicinity of Gibralter Ridge near the southern boundary of the Ten Lakes study area has a moderate to high resource potential for copper, silver, lead, and zinc in veins, mainly in the Helena Formation. The dolomite host rocks in the Helena Formation and in calcareous siltite of the Empire Formation are locally silicified and pyritic, suggesting some hydrothermal alteration. No geophysical anomalies are centered over Gibralter Ridge, but small aeromagnetic highs on the east and west sides of the ridge are interpreted to be small buried plutons (Bankey and others, in press).

A low resource potential is assigned to the Ten Lakes area for zinc-bearing veins associated with metadiorite sills. The sills in the area are relatively thin, laterally discontinuous, and relatively devoid of metal-bearing veins.

Copper-mineralized rocks in the McNamara Formation occur over a seemingly widespread area, but the Ten Lakes study area has a low resource potential for stratabound copper. The thin interval of mineralized strata and relatively low copper content preclude any higher classification. The isolated occurrences of stratabound copper minerals observed in talus from the Shepard and Grinnell Formations are not considered significant.

Little is known about the oil and gas resource potential of the Ten Lakes Wilderness Study Area. No hydrocarbon seepages have been located in or near the Ten Lakes area. Reports of oil-saturated limestone along Trail Creek and Thoma Creek east of the Ten Lakes area were examined and sampled; however, no samples contained significant hydrocarbons, no hydrocarbon seepages were observed, and the rock in question contained no visible porosity.

Neither the rocks in the Belt Supergroup nor the inferred underlying crystalline rocks would have oil or gas unless these rocks rest in fault contact above hydrocarbon source beds and the hydrocarbons would be trapped by structural closures in the subsurface. This may be the circumstance farther east, near the western margin of Glacier National Park, but this structural configuration is considered to be highly unlikely beneath the Ten Lakes study area. Narrow belts of Phanerozoic sedimentary rocks that could be source beds of hydrocarbons were examined both east and west of the study area, but they do not extend into the area and are erosional remnants on the downthrown sides of large normal faults. Therefore, these rocks cannot be projected to extend beneath the Ten Lakes area, and there is little likelihood of the presence of oil and gas in the study area.

REFERENCES

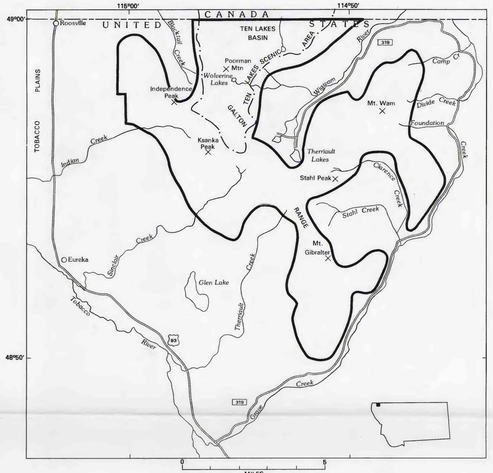
Bankey, Vicky, Hoover, D. B., and Kleinkopf, M. D., in press, Geophysical map of the Ten Lakes Wilderness Study Area, Lincoln County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1589-D, scale 1:48,000.

Hamilton, M. M., and Avery, D. W., 1983, Mineral investigation of the Ten Lakes RARE II Area, Lincoln County, Montana: U.S. Bureau of Mines Open-File Report MLA 48-83, 17 p.

Johns, W. M., 1970, Geology and mineral deposits of Lincoln and Flathead Counties, Montana: Montana Bureau of Mines and Geology Bulletin 79, 182 p.

Leinz, R. W., and Whipple, J. W., in press, Geochemical map of the Ten Lakes Wilderness Study Area, Lincoln County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1589-C, scale 1:48,000.

Whipple, J. W., 1984, Geologic map of the Ten Lakes Wilderness Study Area, Lincoln County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1589-B, scale 1:48,000.



INDEX MAP SHOWING LOCATION OF THE TEN LAKES WILDERNESS STUDY AREA, LINCOLN COUNTY, MONTANA

Table 1.--Identified mineral resources, Ten Lakes Wilderness Study Area

[Pct, percent]

Map No.	Property	Type	Tonnage[1]	Products	Grade[1]
1	Twin Peaks mine--Red Bird/ Midnight, and Copper Kettle/ patented claims) and Eureka.				
	Northwest part of vein---	--do--	150,000	Copper----	0.36 pct
				Silver----	.42 oz/ton
	Southeast part of vein---	--do--	290,000	Copper----	.91 pct
				Silver----	.23 oz/ton
4	Independence (patented claim).				
	High grade part of vein---	--do--	18,000	--do------	2.9 pct
	Low grade part of vein---	--do--	1,300,000	--do------	.5 pct

[1]Metric conversion: tons x 0.9072 = tonnes; ounces (troy) per ton x 34.285 = grams per tonne.

MINERAL RESOURCE POTENTIAL MAP OF THE TEN LAKES WILDERNESS STUDY AREA, LINCOLN COUNTY, MONTANA

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