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PROGRESS REPORT

ON

GEOLOGIC INVESTIGATIONS IN THE KOOTENAI-FLATHEAD AREA, NORTHWEST MONTANA

3. NORTHERN LINCOLN COUNTY

By

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N O R T H W E S T   M O N T A N A

3. NORTHERN LINCOLN COUNTY

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A B S T R A C T

This third progress report covers work completed in the Ural and north half of the Yaak River quadrangles of Lincoln County, northwest Montana during the 1960 field season. (See fig. 1.) The map area embraces 1,220 square miles amounting to nearly 34 townships in the northwest corner of the State.

The Kootenai River divides the Ural quadrangle and is an arbitrary boundary between the Purcell Range west of the river and the Selish Range east of the river. This report also covers a very small corner of the Whitefish Mountains located east of the Tobacco River Valley. A large part of the Ural and all the north Yaak River quadrangle lies within the Purcell Range.

The area mapped, similar in lithology and structure to other quadrangles in Lincoln County, is underlain by Precambrian Belt rocks subdivided into four major conformable groups. From oldest to youngest, they are Prichard Argillite of the Pre-Ravalli Group, Ravalli Group, Piegan Group, and the Missoula Group.

Precambrian rocks were folded during the Laramide orogeny into broad and moderate north and northwest-trending anticlines and synclines to be subsequently faulted by north to northwest-striking faults, northeast faults, and east-striking faults. The older north to northwest-striking fault structures parallel and often follow fold axes.

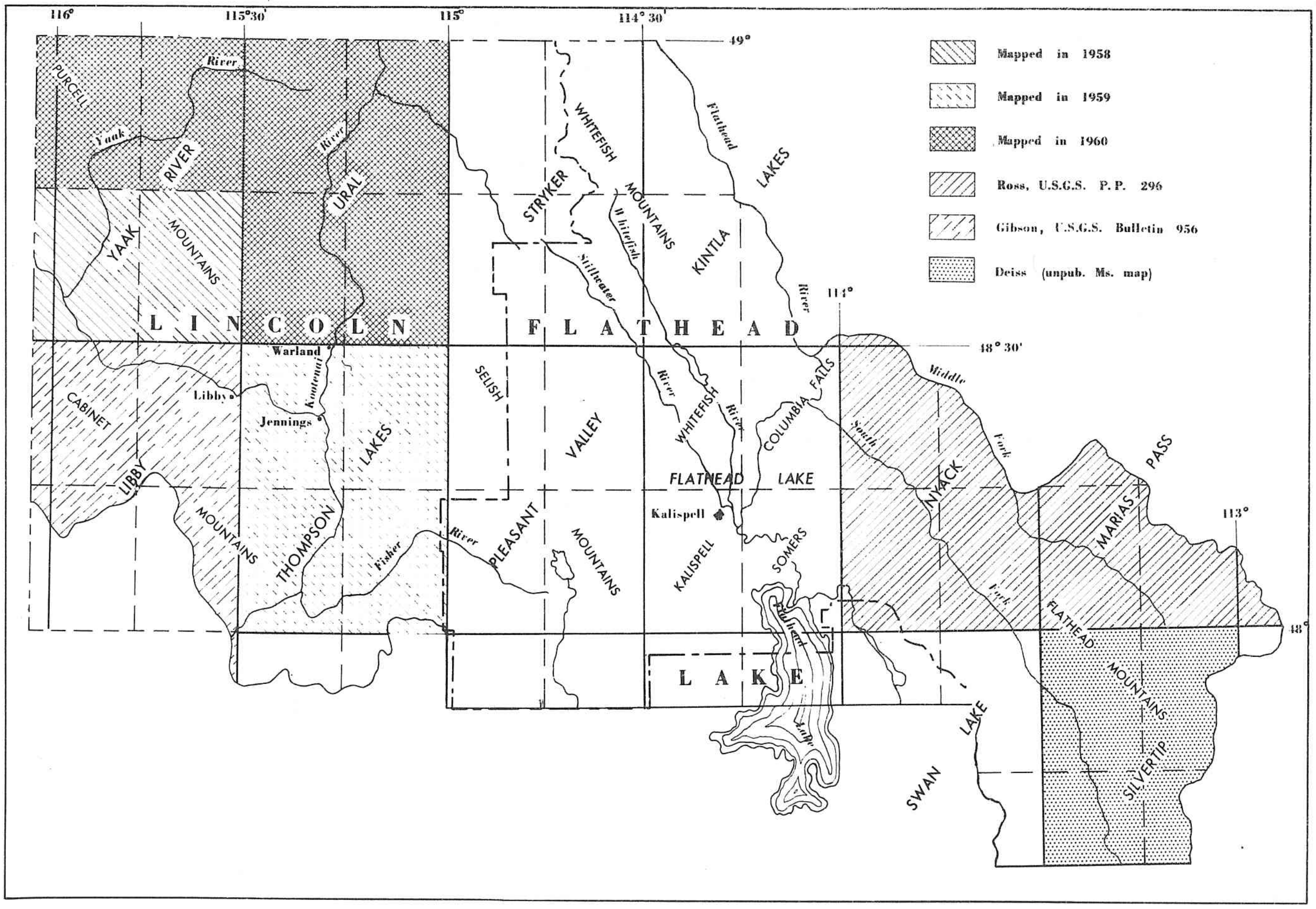

Figure 1.--Index map of northwest Montana showing location of quadrangles being mapped.

Igneous rocks within the area include Precambrian metadiorite sills intrusive into Prichard, Ravalli, and uppermost Piegan strata, the Purcell Basalt which is composed of at least two flow units which were extruded into shallow water, and late Mesozoic or early Cenozoic metadiorite and syenite as a dike and stock intrusive into Prichard sediments.

The lowest strata of the Prichard Argillite mapped in the quadrangles were observed on an anticline west of Yaak River. Ravalli and Piegan Groups thin to the north, whereas the Ravalli Quartzite becomes more blue-toned and argillaceous in the eastern part of the Ural quadrangle. The basal Missoula unit, mapped in the Thompson Lakes and south Yaak River quadrangles as the Striped Peak Formation, was not recognized in the Ural and north Yaak River quadrangles.

Gold-quartz, lead-silver, copper, and barite veins occur within the quadrangles as lode deposits. At one mine, the Independence property in the Whitefish Range, a copper vein is associated with the Purcell Basalt. Two placers on the Kootenai River south of Rexford, Montana, were active during the summer of 1960.

I N T R O D U C T I O N

This bulletin is the third annual report covering mapping progress of the Kootenai-Flathead mineral survey. The other two progress reports (1. Western Lincoln County, Montana Bur. Mines & Geol. Bull. 12, and 2. Southeastern Lincoln County, Montana Bur. Mines & Geol. Bull. 17) cover work completed in 1958 and 1959. This report is on the progress of the survey of 1960. (See fig. 1.)

The mineral survey, initiated in 1958 under the direction of the Montana Bureau of Mines and Geology, is sponsored by the Pacific Power & Light Company and the Great Northern Railway Company.

The purpose of the five-year program is to ascertain the potential mineral resources of part of northwest Montana through a reconnaissance geologic mapping project in Lincoln, Flathead, and Lake Counties and to stimulate prospecting activity through a field office at Kalispell. The eventual aim of the program is to contribute to new economic development.

Upon completion of the project a final report will be issued summarizing the results of all field work.

SCOPE OF REPORT

Mapping progress during the 1960 field season amounted to six 15-minute quadrangles (plates 1 to 6, in pocket), including four in the Ural and two in the Yaak River quadrangle (north half). The data was gathered by a party of 5 during a 5-month period.

The map area (see fig. 1) comprises about 1,220 square miles or 34 townships. Additional data on mines and prospects in the Stryker and Pleasant Valley quadrangles adjacent to the map area were obtained on short reconnaissance trips. In the south Yaak River quadrangle additional mapping and some revision was also initiated during the 1960 field season and will be incorporated in a future bulletin.

Surface geology was plotted on U. S. Forest Service planimetric maps in conjunction with Forest Service aerial photographs.

ACKNOWLEDGMENTS

The program is carried on under the supervision of Mr. W. S. March, Jr., Associate Director, and Mr. U. M. Sahinen, Chief Geologist, Montana Bureau of Mines and Geology, and who have also critically read the manuscript. Mr. R. A. Watson, Geologist, Mineral Research and Development Department, Great Northern Railway Company and Mr. G. A. Duell, Staff Geologist, Pacific Power & Light Company participated in the planning phases of the project.

D. A. Sommers and A. W. Shelden, graduate students from the University of Rochester and Montana State College respectively, mapped the northeast and northwest 15-minute Ural quadrangles and provided economic data on properties in their respective map areas. Drs. G. E. McGill and W. J. McMannis, field advisors for Mr. Sommers and Mr. Shelden, field checked the geology of these quadrangles. The lithology and structure of the sedimentary rocks of the northeast and northwest Ural quadrangles were obtained for this report from progress reports written by Sommers and Shelden.

Through the 1960 field season K. T. Bondurant, Assistant Geologist, contributed substantially to mapping progress in the south Ural and north Yaak River quadrangles. A. W. Shelden assisted during a 3-week period in completion of mapping of the north Yaak River area.

Since Bureau assay facilities were not available during the last half of 1960, rock analyses were made by the Willis H. Ott Metallurgical Laboratory at Seattle. The cost of analysis was jointly shared by Great Northern Railway Company and the Pacific Power & Light Company. Ore analyses were kindly provided by the Anaconda Company assay laboratory in Butte at a nominal cost. R. B. Holmes drafted all maps.

The writer is indebted to many individuals who provided information and services concerning various properties throughout the quadrangles. These include W. L. Fewkes of Rexford, B. Hansen of Eureka, J. D. Daniels of Valcour, G. Kenelty and C. Tallmadge of Libby, and M. Fishel, F. A. Stahl, and Harold and Carl Luke of Kalispell, Montana. Mr. E. J. Strasburger of Butte, Montana, provided maps and unpublished reports on the Independence mine.

PREVIOUS WORK

Previous work in the Ural and north Yaak River quadrangles consists of reports by Calkins and MacDonald (1909) on a brief geologic reconnaissance in the north Yaak River area and Daly (1912) who mapped a strip along the International Boundary between the 116° meridian and the west flank of the Whitefish Range. Schofield (1914, 1915) and Leech (1958, 1960) mapped the Cranbrook-Fernie area in southern British Columbia. Billingsley (1916, unpublished private report) mapped parts of both the Ural and Yaak River quadrangles. Reconnaissance mapping by Lambert was used for compilation of the State Geologic Map of Montana published in 1955. Alden (1953) describes glacial deposits near Eureka, and Flint (1924), Shepard (1922, 1926), and Leech (1959) investigated the structure of the Rocky Mountain Trench. The earliest investigation was made by Gibbs (1873) who described the physical geography of the northwestern boundary of the United States in 1857-1860.

G E O G R A P H Y

LOCATION AND ACCESSIBILITY

The Ural and Yaak River quadrangles occupy the northwest corner of Montana joining the International Boundary on their north border (see fig. 1). The Yaak River quadrangle abuts the Idaho-Montana line near its western boundary, whereas the east boundary of the Ural quadrangle extends to the west flank of the Whitefish Range and crosses the Rocky Mountain Trench to the south. The map area (plates 1 to 6, in pocket) lies between longitudes 115° to 116° 2' West. The north Yaak River section occupies that area between latitudes 48° 45' to 49° North. The Ural quadrangle lies between latitudes 48° 30' to 49° North.

The Ural quadrangle is accessible by State Highway 37 and the Great Northern Railway main line that follow the Kootenai River to Rexford. Between Rexford and Eureka, the highway and railroad parallel the Tobacco River. U. S. Highway 93 follows the Stillwater River north from Kalispell through Olney, Fortine, and Eureka to Roosville at the International Boundary, and thence to Cranbrook, British Columbia, and other Canadian towns. The port of entry at Roosville is operated by U. S. and Canadian customs officials throughout the year.

County Road 92 traverses the area from Rexford west to Yaak, and then follows the Yaak River to join U. S. Highway 2 west of Troy near the Montana-Idaho line.

A Forest Service road from Warland follows the east side of the Kootenai River to and up Fivemile Creek via Lake and Fortine Creeks to Trego. Another Forest Service road traverses the area (southwest Ural quadrangle) via the South Fork of Big Creek to Pipe Creek in the south Yaak River quadrangle. The map areasare reasonably accessible by other Forest Service and logging roads that follow tributaries of the Kootenai and Yaak Rivers.

Upon completion of the proposed Libby Dam the Great Northern Railway tracks will be relocated possibly up Fisher River and Wolf Creek to the Flathead Valley. Rexford and other adjacent points, which will be within the reservoir area, may be inundated by as much as 40 feet of water.

TOPOGRAPHY AND DRAINAGE

Daly (1912, p. 26) described the remarkably long and straight topographic depression which he named the Rocky Mountain Trench occupying the Kootenay Valley in British Columbia. It extends southeasterly along the Tobacco River and Stillwater Valleys to split into two segments near the head of Flathead Lake. The west segment continuing past Flathead Lake, dies out in the vicinity of St. Ignatius. The east segment follows the Swan River and Clearwater

River Valleys to where it terminates near the Blackfoot River. Leech (1959, p. 324) believes the topographic form of the Rocky Mountain Trench south of 49° 30' is the result of block faulting.

A second topographic feature described by Daly (1912, p. 26) and named the Purcell Trench, extends north from Bonners Ferry through Kootenay Lake in British Columbia to merge with the Rocky Mountain Trench about 200 miles north of the International Boundary. Calkins (1909, p. 11) was of the opinion the Purcell Trench extended south to the vicinity of Coeur d'Alene Lake since a definite and persistent zone of depression occurs between Bonners Ferry and this point.

These trenches and other topographic features form boundaries for mountain ranges in northwestern Montana, Idaho, and British Columbia. In this report the Purcell Range, extending southeast from British Columbia beyond the International Boundary into northwest Montana, is bounded at its southern extremity by the loop of the Kootenai River. The Selish Mountains is that range extending south from the Tobacco River and bounded by the Rocky Mountain Trench to the east and the Kootenai River to the west. This range terminates southwest of Flathead Lake. These and other adjacent ranges lies in the central part of the physiographic province called the Northern Rocky Mountains; however, the Rocky Mountains in British Columbia are restricted to the ranges east of the Rocky Mountain Trench.

The terrain is mountainous and heavily forested with the more dense timber growth on north slopes. Where sedimentary beds are near horizontal, rugged, precipitous cliffs result. Peaks rise from altitudes of 5,500 feet to as much as 7,700 feet. Northwest Peak and Mt. Robinson are at elevations of 7,700 feet and 7,518 feet respectively, and are situated in the north part of the map area. The lowest elevation is at Warland which is approximately 2,180 feet above sea level.

The Kootenai River and its tributaries, including the Yaak, Fisher, and Tobacco Rivers, drain the area throughout Lincoln County. The Kootenai River heads in British Columbia and enters the United States at Gateway in the Tobacco River Valley. The river makes a semi-circular loop into northwest Montana and northern Idaho, returning to British Columbia north of Bonners Ferry, Idaho.

The gradient of the Kootenai River between Gateway and Warland is estimated to be 4 feet per mile. The Tobacco River, between its headwaters and junction with the Kootenai, may be as great as 34 feet per mile. The Yaak River, which heads in British Columbia and flows through the western part of the map area, has an estimated gradient of about 12 feet per mile between the north and south boundaries of the map area.

CLIMATE AND VEGETATION

Temperature and precipitation records for Flathead Valley were obtained from the U. S. Weather Bureau at the Kalispell County Airport.

Temperature and precipitation in the Eureka area is similar to that at Kalispell, although precipitation in the mountains would be greater than in the Flathead Valley.

The mean annual precipitation in the Kalispell area for the period between 1921 to 1950 is 16.38 inches. The mean annual temperature for a 30-year period is 43.2°F. The highest temperature recorded in the last 40 years is 104°F. in 1960, and the lowest is -38°F. in 1950. Seasonal snowfall averaged 68.3 inches during an 11-year period.

Mountain slopes throughout the quadrangles are forested with secondary growth fir, pine, spruce, and larch. Some virgin cedar is confined to the smaller difficultly accessible tributaries. On rocky ridges and slopes the country is more open. In burned or cutover areas brush and grass provide browse and grazing for game animals.

GLACIATION

Glacial drift composed of coarse till is a conspicuous feature south of the International Boundary in the Ural and Yaak River quadrangles. About one-third of the northern area of the northeast Ural quadrangle is covered by interbedded glacial silts, clays, and gravels. Till-covered slopes and ridges obscure outcrops so that in some northern areas the determination of lithology and bedding becomes a problem.

From the appearance of sorted and unsorted sand and gravel deposits underlying lacustrine silts situated several miles north and northwest of Eureka, it seems probable there was some delta-type deposition near the center of the Tobacco Valley. Drumlin-like hills, some of which are believed to be rock-cored, are located east and north of Eureka. These drumlin-like features trend about S. 30° E. and indicate direction of movement of the ice mass down the valley.

Along the Kootenai River near Rexford, dissected gravel banks can be traced along a probable ancient outwash terrace of the last glacial episode.

Glacial striations and fluting occur on some of the ridges and sides of valleys. Glacial erratics are commonly found on ridges throughout the map area. Erratics up to 2 feet in diameter were noted resting on bedrock surfaces. In the NW Ural quadrangle glacial striae striking southwesterly were observed by Arthur Shelden at an elevation of 6,000 feet on Mt. Webb.

Glacial striae, plucking, and beveling of outcrop edges and fluting accompanied by polishing were noted in gentle-dipping Ravalli Quartzite along the divide between Bristow Creek and the East Branch of Big Creek in secs. 28, 29, and 30, T. 33 N., R. 29 W. The south-trending striae were observed for a distance of 2½ miles along U. S. Forest Service Trail 70. Contours from the Forest Service map indicate the ridge elevation is between 5,400 feet to 5,600 feet.

Bearings of striations and the orientation of the drumlin-like hills indicate that the ice movement down Tobacco Valley was about S. 30° E. to about the location of Black Butte, where it partially split. One mass of ice headed down the Kootenai River while the other portion proceeded along the Tobacco River Valley approximately parallel to U. S. Highway 93. The ice may have been relatively mobile since in some places it moved along small valleys nearly perpendicular to the direction of flow of the main mass of ice. Small cirques on north slopes of the higher ridges indicate alpine glaciers moved only short distances at the extreme heads of tributaries. The general direction of ice movement throughout the central and west part of the map area was south to southwesterly. (See fig. 2.)

At the head of Lake Creek at an elevation between 4,000 to 4,100 feet, sorted and unsorted material composed of sand and gravel are overlain by buff-colored clay and silt. The material is similar to stratified drift and unsorted gravel in outwash deposits. The material may be reworked glacial drift dropped by the glacier at this point with subsequent ponding and deposition of silts and clays.

Glacial erratics, boulders and cobbles of limestone and quartzite believed to be of Paleozoic age, occur on Precambrian Ravalli bedrock near the head of Lake Creek on a north-south ridge in sec. 4, T. 32 N., R. 27 W. Glacial striae strike S. 30° W. in this area.

Glacial striae and constructional feature trends indicate the well-established drainages occupying the Kootenai, Tobacco, Yaak, and Moyie valleys were largely responsible for direction of movement of the Cordilleran ice sheet in north and central Lincoln County. The direction of movement of the ice mass in the vicinity of the Kootenai River was south or slightly west of south. In the Yaak River drainage, the ice moved south to slightly southeast. On the west slope of the ridge separating the Yaak and Moyie Rivers at "The Scout" mountain, striae trend S. 45° W. To the south along Buckhorn Mountain ridge in sec. 29, T. 36 N., R. 34 W., hummocky topography consisting of unsorted gravels is believed to be glacial till. The gravel is between elevations of 5,600 to 5,800 feet. Striations were recorded at an elevation of approximately 6,000 feet on "The Scout" mountain. Locally, such as at Huckleberry Mountain, the ice appeared to split and pass around the peak as indicated by west-bearing striations.

In the Tobacco River Valley the general direction of ice movement was about S. 30° E. to Black Butte where the ice sheet split into two segments. One continues up Tobacco Valley, and the other segment down the Kootenai River Valley.

ROCK TYPES

Thick assemblages of Precambrian Belt argillites, quartzites (with intermediate gradations between these compositions), and carbonate rocks deposited in shallow seas as conformable sediments

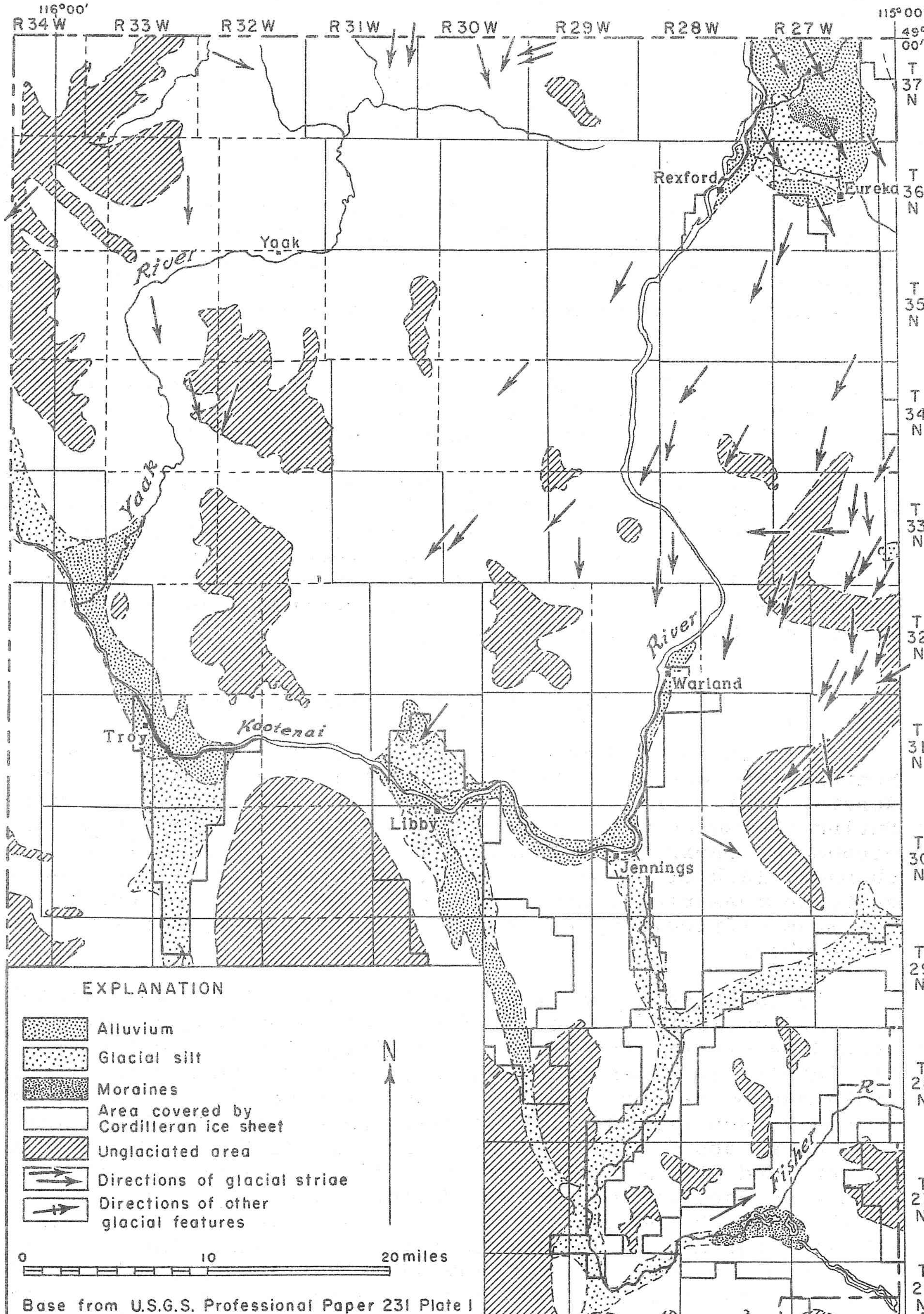

Figure 2.--Map showing direction of movement of Cordilleran ice sheet, Lincoln County.

outcrop throughout the Ural and Yaak River quadrangles. They are the basal or Pre-Ravalli Group (Prichard Formation), Ravalli Group, Piegan Group, and the Missoula Group including the Purcell Basalt and undifferentiated basal Missoula strata.

Very limited outcrops of Paleozoic limestone and quartzite believed to be of Devonian-Mississippian age are exposed on the east flank of the Tobacco River Valley (plate 1). Daly (1912) mapped the limestones as Devonian rocks, and Leech (1960) believes they are upper Devonian and Mississippian strata.

Cenozoic sediments mapped as unconsolidated glacial till and drift, and lacustrine sand, silt, and clay are present locally on the lower ridges and throughout the valleys and small tributaries. Recent alluvium borders the major streams and rivers.

Igneous rocks are present in both the Ural and north Yaak River quadrangles. Metadiorite sills are the most numerous in the north Yaak River area. One metadiorite dike was mapped near the mouth Hellroaring Creek. A syenite stock outcrops a short distance east of Warland. The Purcell Basalt extends to the east from the 115° 30' meridan to the Whitefish Mountains, Glacier National Park, and the Flathead region.

THE BELT SERIES (PRECAMBRIAN)

Belt series sediments were recognized at Three Forks, Montana, and described by A. C. Peale in 1893 as Precambrian strata. This series was tentatively assigned to the Algonkian. During the succeeding years Belt rocks presented a mapping problem because of their great areal extent, rapid horizontal facies changes, lack of fossil evidence, poor marker horizons, and difficulty in measuring descriptive sections. In some areas mapping was made difficult by a terrain covered by glacial drift, soil, and timber.

To facilitate regional correlation Mr. C. P. Ross (1959, p.6) proposed dividing the series into four major groups which are in ascending order: Pre-Ravalli, Ravalli, Piegan, and Missoula. The Pre-Ravalli is broadly equivalent to the Prichard Formation and rocks mapped as the Fort Steele and Aldridge Formations in British Columbia (see fig. 3). The Ravalli Group includes the Altyn, Appekunny, and Grinnell of Glacier National Park and the Burke, Revett, and St. Regis of the Coeur d'Alene district. The Piegan is a term used to include the Wallace, Newland, Siyeh, and Kitchner-Siyeh and others, although the lower and upper boundaries of these formations are not precisely the same. The Missoula Group includes the Striped Peak and Libby Formations believed equivalent to the green-colored argillaceous and arenaceous strata and intercalated limestone of Glacier National Park and the Flathead region, and the sediments mapped as Shepard and Kintla A in Glacier National Park by Willis, The Fentons, and others, and the Gateway,

	Libby quadrangle Gibson	South Yaak River quadrangle Johns	Thompson Lakes quadrangle Johns	Ural and North Yaak River quadrangles (this report)	British Columbia Schofield	British Columbia Leech
Missoula Group	Top eroded Libby 6,000+	Top eroded Libby 9,000*	Top eroded Libby 7,600	Top eroded Gateway mapped above Purcell lava west of Kootenai River & Shepard and Kintla east of Kootenai River above lava 1,700	Gateway 2,000	Roosville 1,740 Phillips 400
	Striped Peak 2,000+	Striped Peak 2,000	Striped Peak 3,500	Purcell Basalt 550**	Purcell "Lava" 300	Gateway 2,000(?)
Piegan Group	Wallace 12,000	Wallace 14,500	Piegan Group (Wallace) 13,000	Piegan Group 8,000+	Siyeh and Kitchner 8,500	Purcell andesitic lava mapped at top of Siyeh Siyeh and Kitchner 4,700 to 7,000
Ravalli Group	Ravalli Group 10,000	Ravalli Group 12,000	Ravalli Group 11,000	Ravalli Group 7,000	Creston 5,000	Creston 6,000
Pre-Ravalli Group	Prichard 9,700+	Prichard 9,000	Prichard 6,000	Prichard 12,000+	Aldridge 8,000	Aldridge 8,000+ Fort Steel 6,000

* This figure to be revised.
**The basalt is believed to be 700 feet thick in the NE Ural quadrangle, and Sediments between the two flows in the NW Ural quadrangle mapped as Piegan Strata.

Figure 3.—Correlation of Belt Series in Ural and north Yaak River quadrangles with formation in nearby areas.

Phillips, and Roosville units mapped east and west of the Kootenai River in southern British Columbia. (See fig. 3.)

Pre-Ravalli Rocks

Prichard Formation.--The Prichard Formation of the Pre-Ravalli Group is the basal unit of the Belt series. It includes the Fort Steele and Aldridge Formations mapped by Schofield, Leech, and others in British Columbia. The base of the Prichard is not exposed in Lincoln County or nearby areas; however, there is a possibility that a contact exists between Pre-Belt gneisses and schists and metamorphosed Belt rocks on Beaver Creek in southern Ravalli County where Crowley (1960, p. 19) observed that rocks believed to be Pre-Belt differed in mineralogy and metamorphism from those assigned to the Belt series. Features believed to be distorted ripple marks were observed in Belt quartz-muscovite schist which is thought to be basal Prichard (?).

The Prichard Formation is homogeneous and consists of argillite and quartzite with a texture both fine grained and compact. Prichard beds can be recognized without difficulty in northern Idaho and northwest Montana. The formation outcrops extensively in the west part of the north Yaak River quadrangle and to a lesser extent along the Kootenai River and near the center of the SE and SW Ural 15-minute quadrangles.

In Lincoln County, the lowest strata in the Pre-Ravalli section observed to date occur on an anticline in the western part of the north Yaak River quadrangle. At this location medium- and thick-bedded white and grey sericitic quartzite is interbedded with rusty-weathering greyish-brown quartzite, dark- and light-grey argillite and schistose rocks containing sericite, biotite, and quartz. Beds, which in part may be their equivalent, were mapped by Leech (1960) as the Fort Steele Formation in the west half of the Fernie area of British Columbia. They are described as white siliceous quartzite, grey argillaceous quartzite, and dark-grey argillite, with some dolomitic and calcareous argillite. Leech places the contact with the overlying Aldridge Formation where the beds commence to weather a rust color.

Leech assigns a thickness of 6,000 feet for the Fort Steele Formation based on observations by Rice (1937) in the Cranbrook area.

Somewhat higher in the section at American Creek in the northwest corner of the State, grey-brown rocks with schistose partings and grey quartzites overlie medium- and coarse-grained grey-brown sandstone. The sandstone beds lense out to the southeast. Limited occurrences of coarse sandstone have been reported by others north of the Boundary, and Schofield describes a conglomerate containing pebbles of grey quartzite, black slate, and an igneous rock of volcanic origin probably related to andesite. The occurrence of the conglomerate and evidence of contemporaneous erosion led Schofield (1915, p. 38) to believe that the broad basin receiving sediments was relatively shallow and that subsidence and deposition took place at about the same rate.

In the Ural and north Yaak River quadrangles upper Prichard beds, believed to be approximately equivalent to the Aldridge Formation, include thin- to thick-bedded dark-, medium-, and light-grey and blue-grey argillites. The rocks contain abundant biotite and some pyrrhotite and pyrite. They are commonly banded or laminated. A rusty-brown weathering on the surface and along joint planes results from oxidation of the iron minerals and biotite. Very sparse ripple marks and mud cracks occur throughout the formation.

In lower Prichard horizons, northwest of Sylvanite, peculiar-looking concretions occur along bedding planes in the argillites. The concretions, irregular-shaped and up to a foot in width, are biotite and sericite rich. The material appears to be abstracted from the surrounding sediments. A white halo deficient in biotite and sericite surrounds them. Other minerals noted within the concretions were feldspar, quartz, hornblende, and garnet. Garnets were also found parallel to bedding planes in banded quartzitic argillite or disseminated throughout the quartzitic argillite as small crystals. The largest garnets, up to a quarter of an inch in diameter, are in bands parallel to bedding.

It is believed that at least 12,000 feet of Prichard strata are exposed in the anticline west of the Yaak River; however, only several thousand feet are exposed throughout other sections of the map area. The contact with overlying Ravalli strata is gradational over several hundred feet and was placed where dark- to light-grey and blue-grey banded and laminated argillites are conformably overlain by grey-weathering grey or white-colored quartzites and argillaceous quartzites.

Leech describes the Aldridge in the Purcell and Rocky Mountains of British Columbia as rusty-weathering grey argillaceous quartzite, quartzite, and siltstone and laminated platy dark-grey to black argillites and siltstone. He believes the thickness is less than 10,000 feet and may be around 8,000 feet.

Ravalli Group

Throughout the map area the Ravalli is a homogeneous mappable unit that is essentially a magnetite-bearing fine-grained light-colored quartzite, argillaceous quartzite, and argillite which becomes more purple and green-toned and argillaceous in the north and eastern part of the Ural quadrangle. No attempt was made to subdivide the unit.

The Ravalli outcrops extensively in the center of the Ural quadrangle (plates 3 and 4) where bedding is relatively flat. Where beds are near horizontal, massive blocky cliffs are formed.

The unit occurs on limbs of anticlines and synclines in the north Yaak River quadrangle. The group is resistant to erosion and forms prominent talus slopes. Ripple marks, mud cracks, and cross bedding are present, and in some areas, these features are many. Individual beds range from 1 to 3 feet thick and are as much as 6 to 8 feet thick. The quartzite beds commonly form persistent dip slopes. Magnetite, occurring as small octahedral crystals disseminated throughout the rock, is a common feature. On rare occasions larger octahedral magnetite crystals occur on shear or join planes. Magnetite, on oxidation, fills voids with bright-orange iron oxides.

The greater part of the group is a medium- to light-grey, green-grey, and white quartzite and argillite with intermediate gradations between the two compositions. Green and grey-green quartzite and argillaceous quartzite with pale-green surface weathering is exposed at the base of the section. Magnetite-bearing light-grey quartzite is present. Locally, sparse to moderate amounts of biotite occur in this basal unit. Toward the center the beds become lighter colored and argillaceous. The dominant lithology in this part of the section is a medium- to light-grey argillite, argillaceous quartzite, and quartzite containing mud cracks, some biotite, and weathering green grey. Dark-grey and green-grey argillites are also present. Upper Ravalli beds consist of thick-bedded massive medium- to white-colored and purple-toned quartzite exhibiting well-developed cross bedding. The contact between the Ravalli Group and the overlying Piegan is quite sharp and was placed where green and grey-green argillites and slightly calcareous argillites overlie white-colored and cross-bedded quartzites of the Ravalli Group. The Ravalli Group ranges in thickness from about 7,000 feet in the southern part of the Ural quadrangle to between 4,500 and 5,000 feet thick in the north Ural and north Yaak River quadrangles.

Significant lithologic changes were reported by Shelden in NW Ural and by Sommers in NE Ural and SE Ural. In the NW Ural the basal quartzite changes to a light-grey quartzite and argillaceous quartzite. The middle unit thickens and is a massive medium-grey argillite with magnetite and discontinuous red and green streaks of argillite. The upper quartzite thins northward. The upper unit along Dodge Creek road is partially a dusky and pale-green quartzite some argillaceous with thin stringers of coarse-grained silicified sandstones. In the NE Ural the upper quartzites become more argillaceous and purple colored. This change is northerly from the southern part of the quadrangle to Rexford. In SE Ural north of Davis Mountain the upper beds change to a more medium-grey and grey-purple and green color. They are also more argillaceous.

The Ravalli Group is equivalent to the Creston Formation in southern British Columbia which Leech (1958, p. 7) describes as a grey and green argillite and argillaceous quartzite, and a grey, white and purple quartzite weathering grey and green, and in places to purplish tints and brown shades. The formation is 6,000 feet thick in the Canadian Purcells.

Piegan Group

The Piegan Group was mapped in the northeast and northwest parts of the Ural quadrangle, and in the trough and core of a syncline and anticline repsectively, in the north Yaak River quadrangle. A part of the basal Piegan Member was mapped in the SW corner of the Ural 30-minute quadrangle. The formation becomes less heterogeneous as mapping proceeds in a northerly direction. Pyrite cubes and limonite psuedomorphs occur most abundantly in the calcareous horizons of the group. Mud cracks and ripple marks are well developed in the argillaceous members. Molar-tooth structure is present on weathered surfaces of calcium or magnesian-bearing carbonate rocks. It is poorly developed in calcareous argillites. A distinctive weathering, common only to some strata in the Piegan Group, consists of orange-brown weathering which penetrates from $\frac{1}{4}$ to 1 inch into outcrops. This type of weathering is believed most common toward the middle of the group and is associated with the calcareous argillites.

In southern Lincoln County the Piegan was mapped as the Wallace Formation where it is the most heterogeneous of the Belt groups. The dominant lithology of the group there is a sandy or calcareous argillite with subordinate calcareous or dolomitic limestone. Further north in the Ural quadrangle the group is composed of three recognizable map units which, in ascending order, are argillite, limestone and dolomite, and quartzitic argillite. The basal argillite grades into a quartzitic argillite whereas the upper quartzitic argillite is, in places throughout the Ural quadrangle, gradational to a banded argillite.

A part of the basal portion of the Piegan has been mapped in the extreme SW corner of the Ural quadrangle where it is a thin- or medium-bedded banded and laminated grey-green and medium-grey argillite and quartzitic argillite. In this area about a half of the specimens tested were slightly calcareous and some horizons contain small to large cubes of pyrite or limonite psuedomorphs. Near the base of the group interbedded medium grey-green quartzite and grey-purple argillite occur.

In the SE Ural quadrangle east of Pinkham Creek, the lowest beds mapped were grey-green and grey-brown banded argillites, calcareous argillites, with subordinate amounts of interbedded grey-yellow weathering limestone. Some argillite contained nodules filled with calcite; in some instances the calcite has been removed leaving a void. In the NE Ural quadrangle interbedded grey purple-toned noncalcareous argillites and quartzitic argillites and green-grey argillites occur on either side of Pinkham Creek. These beds are believed to represent the lower member of the Piegan Group in this area and are similar to grey-green quartzite and grey-purple argillite occurring as the base of the Piegan described in the previous paragraph.

Only the lower part of the middle limestone-dolomite unit is present in the SE Ural quadrangle. Beds in this part of the section are dark- and medium-grey molar-tooth limestone with interbedded light-grey calcareous and siliceous argillite. A middle Piegan horizon containing suspicious looking fossil (?) remains was observed south of Bear Lake in the NE$\frac{1}{4}$ sec. 26, T. 34 N., R. 27 W. The objects in this limestone bed are about the size and shape of walnuts with radial plate-like partitions similar to septa in corals.

In the NE Ural quadrangle Sommers reports the middle Piegan consists of approximately 4,000 feet of interbedded light-grey to medium dark greenish-grey medium-bedded limestones and medium dark bluish-grey dolomites with some greenish-grey argillites. Molar-tooth weathering is prominent in this middle unit. Small anhedral blebs of pyrite are common and evidently produce the orange-brown weathered surface color of some Piegan horizons.

In this area upper Piegan consists almost wholly of 2,000 to 3,000 feet of light- to medium dark greenish-grey thin-bedded non-calcareous argillites, with an absence of molar-tooth structure. Some beds, approximately 2 feet thick, vaguely resemble algal structures. The extreme upper beds near the Purcell contact are prominantly finely-banded dark green-grey argillite with alternating dark bands. Curious "flow structures", possibly channels, were noted about 500 feet below the Purcell Basalt in upper Piegan green-grey argillites.

Shelden reports the Piegan Group in the NW Ural quadrangle as consisting of three distinct mappable units. The lower unit, which is about 2,000 feet thick, is a homogeneous thin-bedded irregularly-banded dark grey-green and grey-green argillite that locally is slightly calcareous, occasionally exhibits elliptical tube-like holes aligned parallel to bedding, and rarely exhibits what is described as "poorly developed" molar-tooth structure. The tube structures on weathered surfaces are the result of the differential weathering of calcite segregations (?) in argillite. The darker bands in the argillite are distinctly coarser grained and may be partly composed of detrital biotite.

The middle unit consists of approximately 4,000 feet of thin- to thick-bedded molar-tooth blue-grey limestone and dolomitic limestone that weathers to a distinct pale yellowish-orange or buff-colored surface. Numerous oolitic limestone lenses were noted in an impure limestone at the top of this unit.

The upper unit consists of a homogeneous sequence of thin- to medium-bedded greenish-grey to light-grey siliceous argillites, argillaceous quartzites, and fine-grained quartzites. Weathered surfaces are characteristically greenish grey in color and in most outcrops weather to $\frac{1}{4}$- to 3-inch beds. Although exposures are not continuous, Shelden observed only one calcareous horizon approximately 6 feet thick near the top of this unit.

In the north half of the Yaak River quadrangle the Piegan units include a lower member consisting of grey-green argillites and slightly calcareous quartzitic argillites. Continuing up section the middle member is a medium- and dark-grey limestone with molar-tooth structure. The upper unit consists of interbedded and banded olive-green and pale-green quartzites and argillites. In this area a large part of the Piegan section, especially south of the International Boundary, is covered with glacial till so that a complete descriptive section is not possible to obtain.

The thickness of the Piegan Group in the Ural and Yaak River quadrangles is believed to be about 8,000 feet. The top of the Piegan was placed at the base of the upper Purcell Basalt flow. Sediments between flows in the NW Ural and NE Yaak River quadrangles were lithologically very similar to underlying Piegan strata and were placed in this latter group.

Leech (1958, p. 8) described the Kitchner-Siyeh, which is the Piegan equivalent, as grey-green argillite and dolomitic argillite. The lower part, mapped as the Kitchner, is a grey and green argillite and dolomitic argillite weathering grey to brown, and a grey dolomite and sandy dolomite weathering a buff to red brown. Some grey quartzite is also present. The upper or Siyeh part of the formation is dominantly a laminated green and grey argillite with local purple facies and is overlain by the Purcell andesitic lava. Leech reports the thickness of the Kitchner-Siyeh to be about 7,000 feet near Bull River. Bull River joins the Kootenai River in British Columbia about 18 miles north of Roosville. In subsequent work in the Purcell Range near the 49th parallel, Leech (1960, Map 11) limited the use of the term Siyeh to the Canadian Rocky Mountains east of the Kootenai River. The equivalent of the base of the Siyeh in the Canadian Rocky Mountains (mountain ranges east of the Kootenai River in British Columbia) was not recognized in the Purcell Mountains. The Kitchner is described as grey and green argillites, dolomitic argillite, and grey dolomite. Two upper divisions above the Kitchner include a lower noncalcareous green and less commonly purple quartzite and an upper one of green and purple quartzite and dolomitic argillites and quartzites.

Missoula Group

The Missoula Group in southern Lincoln County includes the Striped Peak Formation, quartzite and argillite, and the Libby Argillite described in Montana Bureau of Mines and Geology Bulletin 17. The top of the Libby Formation is an erosional surface.

Striped Peak beds cannot be recognized in the Purcell and Selish Ranges in northern Lincoln County. Rocks believed to be the equivalents of lower Missoula strata (Striped Peak) were mapped in the Ural and north Yaak River quadrangles above the Purcell Basalt, as the Gateway Formation west of the Kootenai River, and as the Shepard and Kintla A east of the Kootenai River. On the geologic map they appear as undifferentiated Missoula strata.

In the NW Ural quadrangle an undetermined thickness of sediments occurring above the upper Purcell Basalt flow was mapped by Schofield as the Gateway Formation. In the NE Ural quadrangle the 600 to 700 feet of sediments above the Purcell flow were reported by Somers to be characteristically identical to the stratigraphic sequence mapped as the Shepard Formation in the Whitefish Range. The overlying 1,000 feet of sediments, which Sommers believes is equivalent to the basal Kintla (Kintla A) conformably overlie the Shepard Formation. Sediments in the NW Ural quadrangle, believed to be the Shepard and Kintla A equivalents, occur above the Purcell Basalt and were mapped as the Gateway Formation appearing in the geologic map (plate 2) as undifferentiated basal Missoula Group strata.

Purcell Basalt.--The Purcell Formation has been recognized as a marker horizon extending from the 115° 30' meridian east to Glacier National Park by Daly, Willis, and others as early as the beginning of the Century. In British Columbia its value as a marker bed is questionable* since several or more flows occur above this basalt.

In northern Ural quadrangle the Purcell Basalt includes two flows separated by as much as 150 feet of grey and green siliceous argillite. The total thickness of the two flows may be as great as 700 feet. In the Purcell Range north of latitude 49° Leech (1960, Map 11) describes lavas through a greater stratigraphic range; the highest flows are separated from the lower flows by considerable thicknesses of sedimentary beds. The lower, main lavas described by Leech are mapped as the Purcell Basalt in this report.

In the NE Ural quadrangle a sharp contact separates the finely-banded green argillites of the upper Piegan unit from the grey-green and bluish-green Purcell lava. A baked zone, about 1-foot thick, occurs below the lava and chunks of baked argillite are found in the lava as high as 20 feet above the contact. Minor amounts of pyrite, chalcopyrite, and malachite are present in these baked inclusions in minor quantities.

A description of the occurrence of the Purcell Basalt in the NE and NW Ural quadrangles is included in the section on igneous rocks.

Undifferentiated basal Missoula strata.--Sediments mapped as basal Missoula beds overlying the Purcell Basalt mapped east and west of the Kootenai River in the Ural quadrangle are not similar to Striped Peak rocks near Libby. The Phillips Formation of southern British Columbia is similar in composition, texture, and color to the Striped Peak; however, the Phillips is believed to occur too high in the Missoula section to be correlated with basal Missoula beds.

Striped Peak sedimentation is believed to represent a change in depositional conditions between Piegan and Missoula time.

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*Personal communication, Mr. G. B. Leech.

Differences in color, texture, and rock composition in the Libby area occur between the two groups. Basic igneous rocks including metadiorite and hornblende gabbro sills commonly intrusive into pre-Missoula sediments are not found in the Missoula Group indicating a possible culmination of igneous activity at the close of Piegan time. For this report the contact between the Piegan and Missoula Groups was placed at the base of the top flow of the composite Purcell Basalt.

Strata overlying the Purcell Basalt in the NE Ural quadrangle include about 1,600 to 1,700 feet of grey and green argillites, sandstones and quartzites, some dolomite, and purple-grey argillites and argillaceous sandstone. The basal part of the Missoula unit (Shepard Formation) consists of about 700 feet of interbedded argillites, sandstones, and dolomites. The lowest beds are green-grey and light-grey thin-bedded argillites grading into green-grey sandstones which display graded and cross bedding. Some quartzites are present. Higher in the section dark- to light-grey dolomites with prominent algal zones grade into fissile green-grey argillite. Overlying beds (Kintla A) include 1,000 feet of conformable interbedded purplish-grey argillites and argillaceous sandstone. At the base of this unit some finely-banded and laminated green-grey silty argillite interbedded with purple argillites occur. Mud cracks, ripple marks, and salt crystal casts are present throughout this interval.

In the NW Ural quadrangle beds (Gateway Formation) overlying the Purcell Basalt do not conform to those described to the east. The lowest strata include 150 feet of light-grey sandstone and siltstone or shale which is locally conglomeratic. Above these strata beds of an unknown thickness include thin-bedded silty limestone and dolomite weathering to a buff color. Some grey-green banded argillites are also present.

PALEOZOIC ROCKS

Devonian Strata

Cliff-forming limestone of the Paliser Formation and an underlying quartzite member outcrop on the east side of the Rocky Mountain Trench within a short distance east of Roosville. At the lowest elevation of this sequence a tan to light-red calcareous quartzite is overlain by the cliff-forming massive, mottled and nodular dark-grey Paliser Limestone which weathers light grey. The fossiliferous limestone contains brachiopods and crinoid fragments. Sommers is of the opinion that if the quartzite can be identified as Mississippian Quartzite of the Rocky Mountain Formation, then, there is evidence for overturning within the fault block. A covered fault separates Paleozoic sediments from basal Missoula strata to the east. About 1,850 feet of limestone and quartzite are exposed in this sequence; the lower 300 feet consisting of quartzite. These Paleozoic sediments have been identified by Leech (1960) as Devonian and Mississippian strata.

QUATERNARY SEDIMENTS

Glacial Deposits

Unconsolidated glacial deposits attributed to the Cordilleran ice sheet of late Pleistocene time are present in the map area. They include heterogeneous till and drift and lacustrine stratified silts and clays. Dissected bench or terrace-like gravels border the Kootenai River and occur as remnants of larger deposits which were subsequently removed by the Kootenai River.

Buff-colored clays and silts are horizontal and overlie gravel and sand deposits throughout the Tobacco and Yaak River Valleys. The gravels and sands are both sorted and unsorted.

At the William Fewkes property in Rexford, a water well was drilled in gravels to a depth of 59 feet.* At the Ranger Station at Eureka and at Lloyd's Cafe north of Eureka, water wells were drilled to depths of 206 feet. The drillers encountered 100 feet of gravels, 100 feet of blue clay, and bottomed in gravels. At both the Evergreen Cafe and a nearby ranch (about a half a mile southeast of Eureka), water wells were drilled to approximately 340 feet before intercepting bedrock. The bedrock was described as a shale, and was probably an argillite. In the well at the Cafe, a 2-foot log was encountered at a depth of between 180 to 200 feet. The log was said to resemble a larch, and upon exposure to air, fragments completely disintegrated within a short time. The well drilled at the Evergreen Cafe intercepted silt, clay, and gravel. The final 10 feet of the hole was in bedrock.

Recent Alluvium

Recent alluvium borders the Kootenai, Yaak, and Tobacco Rivers in the quadrangles. Gold-bearing sand and gravel, containing very fine gold, occurring at and slightly above river elevation, has been productive from bars along the Kootenai River.

IGNEOUS ROCKS

Syenite Stock

A syenite stock, the dimensions of which are about 2,100 feet by 3,700 feet, outcrops in secs. 25, 26, T. 32 N., R. 29 W. The stock my be fault-controlled as an east-trending structure was mapped extending from Barron to Warland Creeks. The trace of the fault is covered and its exact position is not known.

In hand specimens, the rock is a white-colored medium-grained and moderately altered phaneritic type composed largely of feldspar with small amounts of biotite, muscovite, and very small amounts of

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*Personal communication, W. L. Fewkes.

quartz. Weak kaolinitic alteration of near-surface specimens is attributed to surface weathering. Some surface specimens are stained with iron oxides, probably from accessory pyrite.

The feldspars are believed to be dominantly orthoclase. A few feldspar grains exhibited albite twinning; however, weak surface alteration generally obliterated twinning observable with a hand lens.

The stock is probably correlative with other syenite, pyroxenite, and quartz monzonite stocks intrusive during late Mesozoic or early Cenozoic time during the Laramide orogeny.

Dikes

Aplite.--A leucocratic dike rock was observed in a short inclined shaft on the Hoyt property in the Warland Creek syenite stock. From field examination the dike rock is fine grained and composed of feldspar and quartz with some euhedral biotite and small crystals of hornblende. Some accessory pyrite may be present. The rock was field identified as an aplite, and the attitude of the dike was believed to be vertical.

Relationships between the aplite and syenite in the Warland stock are not conclusive since the aplite occurrence is limited to one exposure in the short inclined shaft; however, it is believed intrusive into the syenite and genetically related to the stock.

Along the road in the SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 15, T. 35 N., R. 33 W., acid igneous float, possibly from a covered dike or stock, is abundantly scattered over the surface. Megascopically the rock contains white feldspar phenocrysts up to 2 cm. long in a medium-grained groundmass of red and white-colored feldspars, muscovite, quartz, and biotite (listed in decreasing abundance). The feldspars and biotite are fresh; a few small feldspars with albite twinning were observed. The rock was megascopically identified as a porphyritic granite.

Metadiorite.--One north-trending, vertical metadiorite dike, intrusive into Prichard beds striking N. 30° E., 15° SE., was mapped in Hellroaring Creek in sec. 25, T. 35 N., R. 33 W. Other dikes in the north Yaak area were reported by Daly (1912, p. 208) just north of the International Boundary and a short distance west of the 115° 30' meridian. Daly believed these dikes near the Boundary represented vents for the Purcell lava.

The dike mapped in Hellroaring Creek is a dark-colored and medium-grained rock which has only been slightly altered. Specimens observed megascopically were composed of grey feldspar and somewhat finer-grained ferromagnesian minerals. The feldspar is believed to be plagioclase and the dominant ferromagnesian mineral is hornblende. Sericite, biotite, and magnetite were identified, and the accessory mineral pyrrhotite is present as small scattered grains. The dike rock is similar in appearance and composition to metadiorite sills described below with the exception that the rock is finer grained, feldspar content exceeds the ferromagnesian minerals, and the rock shows less alteration.

Gibson mapped similar metadiorite dikes in the Libby quadrangle which he assigned to the late Mesozoic era. The age of the Hellroaring dike cannot be established from available evidence. The question of whether the dikes intruded the Belt section during middle Belt time to become vents in some places for the Purcell Basalt or whether the dikes were intrusive during Late Cretaceous or early Tertiary time will have to be solved by age dating specimens in question. In accordance with Gibson's observations and other evidence observed in the south Yaak River quadrangle, the age of the metadiorite dike was tentatively assigned to late Mesozoic or early Cenozoic time.

Sills

Metadiorite.--Many metadiorite sills were mapped in the Yaak section (plate 6) intrusive into Prichard sediments, and to a minor extent, the strata of the Piegan Group. Some sills northwest and west of Yaak, Montana, occur as erosional remnants capping ridges and peaks. Two small metadiorite sills outcrop in the NW Ural quadrangle, in Young Creek and in a cirque at the head of Caribou Creek respectively, in upper Ravalli and Piegan strata. Some metadiorite was observed on a talus slope near Big Creek; the source of this float was not located. Specimens collected from the talus were similar to those from the Young Creek sill. No metadiorite was mapped in the NE, SE, or SW Ural quadrangles of the map area.

The sills in the Yaak quadrangle range in thickness from 5 feet to 1,400 feet with strike lengths to several miles. The majority of sills were observed in the Prichard Formation and none were mapped in strata of the Missoula Group. The sills, variable in texture and composition, contain fine- to coarse-grained ferromagnesian minerals and fine- to medium-grained feldspars. Some border zones of the sills are biotite-rich. Megascopically, the sill rock is a blackish-green and dark-green color in which feldspars are dominantly grey and less commonly white. The average mineral composition metadiorite sill would include hornblende, plagioclase, biotite, quartz, and sericite. Hornblende content ranges from 60 percent to 80 percent whereas the plagioclase content may increase from 15 percent to as much as 40 percent in different specimens. Chalcopyrite as small scattered grains was noted in a few specimens.

In a sill in the SE$\frac{1}{4}$ sec. 16, T. 36 N., R. 33 W., dark-brown hornblende crystals attain lengths up to 6 cm. long. In another sill in the SW$\frac{1}{4}$ sec. 15, T. 35 N., R. 33 W., hornblende grains range from $\frac{1}{2}$ cm. to 1 cm. long.

The Young Creek intrusive, Shelden reports, is about 100 feet thick and consists of an aphanatic dark green-grey rock with no macroscopically identifiable minerals. In thin section the rock was composed of highly altered plagioclase microliths in a matrix of chlorite and small amounts of secondary quartz and ilmenite. The ferromagnesian minerals altering to chlorite and ilmenite, the depth of baking at the contact of the sill and sediments amounts to several feet.

The Caribou Creek sill is about 300 feet below the Purcell Basalt. It is a green-grey rock with sporadic phenocrysts of plagioclase and is similar in appearance to the Purcell lava. It is conceivable that the magma may have reached the surface through a local fissure as a lava flow.

Flows

By Arthur W. Shelden

Purcell Basalt.--Daly (1912) encountered basic extrusive rocks interbedded with Belt sediments in the Purcell Range while mapping the geology along the 49th parallel and subsequently called them the "Purcell Lavas." The Purcell Basalt (Wilmarth, 1938, p. 1746) is well exposed in the walls of amphitheater-like glacial cirques on either side of the main north-trending ridge in the northwestern corner of the map area where they occur in the trough of a northward-plunging syncline. These limited outcrops in the Purcell Range of Montana represent the southern-most boundary of the widespread Purcell lavas in the Purcell Range of southeastern British Columbia. The lava-capped subsidiary ridges and Mt. Robinson owe their height and ruggedness to the resistant nature of the volcanic rocks. The Purcell lavas, which are interbedded with the upper-most strata of the Piegan Group and are overlain by basal Missoula strata, consist of a lower basic flow and an upper acidic flow separated by approximately 75 feet of thin-bedded greenish-grey argillites and quartzites.

The lower flow is an estimated 450 feet thick and can be subdivided into three zones: a lower lava breccia zone, i.e., a lava containing angular fragments of sediments; a middle highly porphyritic, non-amygdaloidal lava zone; and an upper aphanitic amygdaloidal lava zone. The lava breccia zone ranges from 5 to 40 feet in thickness and is the result of lava having flowed on soft, unconsolidated sediment, with subsequent incorporation of the sediment into the lavas. Locally, blocks of consolidated, ripple-marked sediment, whose dimensions range up to several feet, have been included in the lava. The lava itself is a slightly amygdaloidal aphanitic pale greenish-colored rock containing lath-like dark greenish-black blebs, which in thin section proved to be a mixture of chlorite and secondary quartz pseudomorphs after plagioclase (?) surrounded by a matrix of fine-grained chlorite and sericite. The amygdules consist of quartz rimmed with chlorite. Generally, the contact between the lava and underlying sediments is conformable and the sediments are rarely baked to a depth greater than 6 inches.

The middle zone averages 200 feet in thickness and consists of a massive, dark greyish-green porphyritic basalt containing lath-like plagioclase phenocrysts up to 4 cm. long and 0.5 cm. wide. The only other macroscopically identifiable mineral is small octahedra of magnetite. Localized alternating bands of non-porphyritic and porphyritic lava suggest that the zone consists of several flow units. In thin section the basalt is found to be profoundly altered to a fine-grained matrix of chlorite, cryptocrystalline quartz, and ilmenite surrounding the plagioclase phenocrysts, and the plagioclase itself is highly seriticized. Relict structures of amphibole and pyroxene in the form of needles of secondary ilmenite arranged parallel to cleavage planes in a matrix of chlorite are common. Blebs of penninite and green chlorite intergrowths are also most likely the alteration products of ferromagnesian minerals.

The upper zone of the lower flow includes numerous flow units ranging from 6 inches to several feet in thickness. The rock-type is a non-porphyritic, highly amygdaloidal dark greenish-black basalt containing sporadic plagioclase phenocrysts up to 0.5 cm. long and sparse octahedra of magnetite. The entire sequence is approximately 200 feet thick. The lava adjacent to the contact of each succeeding flow unit is a dusky-yellow color which grades into the characteristic greenish-black color of the basalt. The pronounced contrast in color may be due to rapid chilling of the lava at its upper and lower surfaces. Locally, the flow units are separated by thin beds of light-grey magnetite-bearing argillite. Many flow units are characterized by vertical pipe amygdules near the base that blend into round amygdules which in turn grade into a zone of horizontal, elongated amygdules arranged in a parallel manner suggesting flowage near the surface of the flow. A few ropy surfaces on flow units were noted. The amydules consist of quartz with minor amounts of specular hematite, chlorite, and calcite. Study of thin sections under a petrographic microscope reveals that the lava is intensely altered to a mass of pale-green secondary chlorite, cryptocrystalline quartz, altered microliths of plagioclase and abundant needles of secondary ilmenite. In some flow units the plagioclase microliths are somewhat coarser and exhibit a trachytic texture in thin section.

The paucity of outcrops prohibited a complete examination of the upper lava flow, and its total thickness is unknown, although it most likely does not exceed 100 feet. The lower 20 feet consists of a rhyolite or quartz latite flow and is unique in that it has no known counterpart in the Purcell Basalt of other areas. The rock is a greyish-green porphyritic lava with phenocrysts of quartz up to 1 cm. in diameter and plagioclase up to 4 cm. in length. The plagioclase phenocrysts in hand specimens have a pronounced greenish tinge and examination of thin sections reveals their rather complete alteration to sericite and cryptocrystalline quartz. Both the plagioclase and quartz are substantially embayed suggesting that they were somewhat out of equilibrium with the liquid lava. Orthoclase is present, but in subordinate amounts to plagioclase. The groundmass was probably once a glass, but is now completely devitrified to a mass of secondary chlorite, sericite and quartz with leucoxene, apatite, and zircon as accessory minerals. The overlying rock is a greyish-green slightly vesicular basalt similar in appearance to the non-porphyritic basalt in the middle zone of the lower flow. The vesicles are often filled with quartz and brownish-colored calcite. The upper surface of the flow has been eroded to an unknown depth.

Comparison of the following chemical analyses indicates the high degree of alteration of the Purcell Basalt. Column 1 is the chemical composition of a specimen of Purcell Basalt (porphyritic basalt in middle zone of lower flow) collected just north of Mt. Robinson by Daly (1912, p. 210). Column 2 is the average composition of a normal tholeiitic basalt, and column 3 is the average composition of a normal alkali basalt (Nockolds, 1954, p. 1021).

	1	2	3
SiO_2	41.50	50.83	45.78
TiO_2	3.33	2.03	2.63
Al_2O_3	17.09	14.07	14.64
Fe_2O_3	3.31	2.88	3.16
FeO	10.08	9.06	8.73
MnO	trace	0.18	0.20
MgO	12.74	6.34	9.39
CaO	0.97	10.42	10.74
Na_2O	2.84	2.23	2.63
K_2O	0.22	0.82	0.95
H_2O at 110° C.	0.21)	0.91	0.76
H_2O above 110° C.	6.99)		
CO_2	none		
P_2O_5	1.08	0.23	0.39
	100.36	100.00	100.00

It is readily apparent that the Purcell lava is abnormally low in silica and particularly calcium oxide, and high in alumina and magnesium oxide. The latter is a reflection of the abundant secondary chlorite and sericite in the lavas, and the low calcium content probably reflects the rather complete alteration of the calic plagioclase to clay minerals. The analysis of the Purcell Basalt does not lend itself to calculation of its normative mineralogy because of the intense alteration.

Textural relationships of opaque minerals can be used to interpret their petrogenesis and the alteration history of the lavas. Microscopic examination of thin sections cut normal to the contact between two successive flow units in the upper lava zone of the lower flow suggests that deuteric alteration is responsible for the high degree of alteration in the lavas. The abundant feather-like needles of ilmenite, which are clearly alteration products, are sharply truncated by the succeeding lava flow, i.e., the alteration of ferromagnesian minerals to ilmenite, etc., was essentially complete before the next flow occurred. The hardened skin-like surface of a cooling lava flow conceivably could confine escaping gases and residual solutions, thus enhancing deuteric alteration in the slowly cooling interior portions of the flow. Also, the sediments stratigraphically above and below the Purcell lavas are relatively unaltered, suggesting that the intense alteration was limited to the lavas during their cooling period rather than pronounced post-lava alteration. This does not deny the fact that the lavas again underwent slight alteration during the regional metamorphism of the Belt sediments.

In contrast to the ilmenite, the magnetite octahedra are much younger in age and their crystallization is not genetically related to the cooling of the lava flows. In view of the fact that the magnetite is also found in the argillite between flow units, it cannot be regarded as a primary constituent of the lava or even a secondary constituent resulting from the deuteric alteration of the lavas. It is more likely that the octahedra of magnetite in the lavas are genetically related to the magnetite described in the Ravalli Quartzite and are post-Purcell hydrothermal deposits. Indeed, magnetite octahedra were also observed in argillites of the overlying Missoula Group.

The Purcell Basalt is considered to be genetically related to the Purcell sills because of (1) the similarity in composition and (2) the absence of related intrusive rock overlying the lavas. Biotite samples from Purcell sills in southeastern British Columbia give aragon^{40}/potassium^{40} ages of 558 to 835 million years with the latter figure being assumed to indicate time of intrusion (Hunt, 1960). Pillow structures are common in the lavas in adjacent areas and the presence of thin beds of argillite between flow units strongly suggest that some, if not all, of the lava was extruded into the shallow waters of the Beltian seas as several individual flows with sufficient time for cooling between flows.

The Purcell Basalt is about 700 feet thick in the NE Ural quadrangle where its composite thickness is believed to be made up of at least two flows. A 1-foot zone of argillite separates the 2 flows at outcrops a short distance west of Eureka, Montana. Large feldspar laths and phenocrysts are common in the middle zone of the lava. The upper zone of the basalt is fine grained and contains many amygdaloidal cavities that are filled with calcite and quartz. The upper part of the flow contains no feldspar phenocrysts.

Dark green-grey to light-grey thin-bedded argillites of the basal Missoula Group mapped as the Shepard conformably overlie the basalt. On the Burma Road in the NE corner of the map area (plate 1) an agglomerate of Purcell pebbles immediately overlies the basalt flow.

S T R U C T U R A L   G E O L O G Y

SEDIMENTARY ROCK STRUCTURE

Folds in the sedimentary Belt strata are moderate to broad symmetrical and assymetrical structures striking north or slightly west of north. An anticlinorium and synclinorium, with small superimposed folds on the larger structure, occur in the SW and SE Ural quadrangles in Prichard and Ravalli sediments. Broader folding appears to take place in the two basal Belt groups, whereas moderate folds are present in the Piegan Group of the map area.

Fold axes are displaced by longitudinal and transverse faulting. Longitudinal faults often closely follow fold axes of structures which are believed to be in zones of weakness more susceptible to fracturing than the fold flanks.

The longest fold and the one covering the greatest area is the Sylvanite anticline extending from the southwest corner of the Yaak River map area to the Idaho line. A syncline east of the 115° 30' meridian has the Purcell Basalt and basal Missoula sediments outcropping on the flanks and in the trough of the structure respectively.

Sylvanite Anticline

The Sylvanite anticline continues from southern Yaak River quadrangle into the map area through Ts. 35 and 36 N., Rs. 33 and 34 W., to pass into Boundary County, Idaho, west of Rock Candy Mountain. The gentle plunging fold is an assymetrical one whose axial trace trends between N. 35° to 40° W. The fold plunges about 50° southeast, and in the southern half of the Yaak River quadrangle the structure is more symmetrical with smaller superimposed folds on its flanks and crest. The fold is in Prichard sediments which are intruded by numerous metadiorite sills and one dike. The Sylvanite mines, now consolidated as the New Morning properties (Johns, 1959, p. 32), are located near the crest of this structure.

Other Folds

A symmetrical and faulted south-plunging syncline and north-plunging anticline traverse the Yaak quadrangle map area in a northerly direction east of the Sylvanite anticline.

The syncline follows the South Fork of the Yaak River, crosses about 1½ miles east of Yaak, Montana, and continues on a bearing of N. 5° to 20° W. into British Columbia. At a point about 7 miles north of the International Boundary the fold closes so that the

Ravalli-Piegan contact wraps around the nose of the syncline. In the map area the trough is composed of Piegan beds and the Ravalli Quartzite occurs on the flanks.

The north-plunging anticline follows the North Fork of the Big Creek and Windy Creek in a northerly direction and crosses the International Boundary into British Columbia near the 115° 35' meridian. The core of the fold, in Prichard Argillite, dies out by plunging a short distance north of the Boundary. Prichard beds disappear beneath the Ravalli Group.

In the NW Ural quadrangle the structure consists of a broad moderate plunging syncline trending about N. 20° W. and plunging about 15°. A north-plunging anticline faulted along its east limb, crosses Dodge Creek in the northeast corner of the map area. The plunge of the fold ranges from 5° to 15°. The fold is essentially in Ravalli Quartzite and Argillite.

A broad northwest-plunging anticlinal structure whose axial trace trends about N. 30° W., and commences northeast of Pinkham Creek in the SE Ural quadrangle, traverses the NE Ural quadrangle, and becomes truncated just east of Rexford. On the east flank of this structure northeast of Rexford, the Purcell Basalt strikes N. 70° W., 38° NE. The northwest extension of the basalt disappears and does not outcrop again in the NE Ural quadrangle.

FAULTS

Description of Faults

Faults in the Ural and Yaak River quadrangle map areas fall into three groups based upon general trends. The older more persistent faults are northwest-striking structures trending between north and N. 30° W. The second group includes the northeast faults trending between N. 35°-70° E. The third group strikes within about 10° of east-west. Faulting post-dates folding.

Most northwest faults are vertical to high-angle persistent structures with large displacements and are responsible in part for important physiographic features in the area. Both high-angle thrusts and normal faults are included in this group. The high-angle thrust fault following Pinkham and Gut Creeks (plates 1 and 4) to the Kootenai River has a displacement in excess of 7,000 feet as it cuts out the Ravalli Group.

The greater number of northeast-striking faults were mapped in the NE Ural quadrangle where these fractures displaced the Purcell Basalt. Sommers is of the opinion that these faults are a series of reverse and normal faults with a very high-angle of dip. He states there is probably little or no strike-slip movement for this group.

The third east-west-striking group is represented by four faults in the map area with this trend. Northeast and east-west structures displace northwest faulting. The relationship between the northeast and east-striking structures was not possible to determine from available field evidence. In the Thompson Lakes quadrangle south of the map area, northeast faults are believed to displace east-striking structures. However, this relationship is not conclusive and the two fault groups may be contemporaneous.

The three largest northwest faults in the map area include the Gut Creek-Pinkham Creek fault, the Windy Creek fault, and the northwest extension of the Pipe Creek fault that follows the South Fork of the Yaak River to continue up the West Fork of the Yaak to the International Boundary. At the Boundary Daly mapped the fault as an east-dipping normal fault. Other moderately persistent structures were mapped in the South Fork of Big Creek and near the head of Young and Dodge Creeks in the NW Ural quadrangle (see plate 2). One north-striking bedding fault was mapped at the Prichard-Ravalli contact about a half a mile east of Fish Lakes in sec. 13, T. 36 N., R. 31 W.

Persistent northeast faulting was mapped (plate 6) near Clark Mountain in the south-central part of the quadrangle. A metadiorite sill is faulted at this locality.

In Barron Creek (plate 3) an east-striking fault was traced for a strike length exceeding 16 miles. This fault plane is vertical or near vertical and may have exerted some structural control on the emplacement of the syenite stock east of Warland. The north block moved down relative to the south block.

Age of Faults and Folds

The writer (1960, p. 14) mapped folded and faulted Cambrian rocks in Swamp Creek in the Thompson Lakes quadrangle. In the NE Ural quadrangle (plate 1) Sommers mapped a faulted block of Devonian limestone and Mississippian (?) quartzite east of Roosville. Since folding precedes faulting, field evidence indicates folding and faulting is post-Devonian; folding and igneous activity in northwest Montana is believed related to the Laramide orogeny occurring during Late Cretaceous to early Tertiary time.

Summary of Faulting

Three fault trends in the map area include northwest, northeast, and east-west structures. One north-striking bedding fault was mapped a half a mile east of Fish Lakes.

Three major persistent faults in the quadrangles are north to northwest faults paralleling Pinkham and Windy Creeks and the South Fork of the Yaak River. The Pinkham Creek fault is a high-angle reverse fault with displacement exceeding 7,000 feet. The

Windy Creek fault is also a high-angle reverse structure following an anticlinal axis. The South Yaak River is normal fault and parallels a synclinal axis. The west side of the structure is dropped relative to the east.

The fault trace of the Barron Creek structure extends in an easterly direction for more than 16 miles. The fault is believed to be vertical, the north block dropping relative to the south block. The fault displaces sedimentary contacts, fold axes, and a north-striking fault.

O R E   D E P O S I T S

Ore deposits in the Ural, Yaak River, Pleasant Valley, and Stryker quadrangles include placer deposits and four types of lode deposits classified according to mineral content.

The lodes are widely scattered, whereas the placers are confined to the Kootenai and Yaak River alluvium or the slightly elevated bench sands and gravels bordering the rivers. Production from all placers within the map area has been small.

Lode deposits are classified as copper veins, lead-silver veins, barite veins, and gold-quartz veins. Lead and silver occur as argentiferous galena, copper as chalcopyrite, and gold as the native element.

LODES

Copper Veins

Copper veins, for the most part, are in the Star Meadows area of the NE Pleasant Valley quadrangle and east of Eureka in the Ksanka-Poorman Mountain section of the Stryker quadrangle. Only a limited reconnaissance of these areas was undertaken during the 1960 field season; therefore, the list of properties visited is by no means complete.

Copper veins are from a few feet to as much as 17½ feet wide. The largest vein mapped, at the Independence mine northeast of Eureka, is 17½ feet wide with poorly-defined vein walls. The average vein width at other properties is about 3 feet. Chalcopyrite is the principal vein mineral in a calcite, quartz, or calcite-siderite gangue. Barite and pyrite are also present. Tenorite, malachite, and chrysocolla and native copper were noted in some veins.

Silver-Lead Veins

Argentiferous galena in a 3½-foot ore zone and a 2½-foot vein occurs at the Second Chance and Jager properties respectively, in the Ural and Stryker quadrangles. The principal gangue mineral is quartz associated with minor amounts of chalcopyrite and pyrite.

Barite Veins

Barite veins occur in or adjacent to the Purcell Basalt at the Bonnett-Hoerner prospect, and sparse to moderate amounts of barite occur with other copper minerals at the Green Mountain and Peterson properties in the NW Stryker quadrangle. These latter occurrences of barite are also associated with the Purcell lava. Barite veins at the Bonnett-Hoerner prospect are up to 16 inches wide.

Gold-Quartz Veins

Only one occurrence of gold-quartz veins is so far known within the area. These veins are at the Hoyt property a short distance east of Warland. At this locality gold-bearing quartz fissure veins have intruded a syenite stock. The veins are up to 16 inches wide and contain small amounts of malachite. Sparse amounts of manganese in iron oxide-bearing quartz veins occur in upper tributaries of Gold Creek in secs. 2 and 3, T. 37 N., R. 30 W. The veins are up to 1 foot wide and contain sparse amounts of galena and very sparse chalcopyrite.

DESCRIPTION OF MINING PROPERTIES--URAL QUADRANGLE

Second Chance

The Second Chance prospect (recently renamed the McGuire property) is located about 1 mile up McGuire Creek on the north slope of the drainage in the NW$\frac{1}{4}$ sec. 24, T. 34 N., R. 29 W. The property was originally located in the early 1900's by a prospector named McGuire. One claim was relocated by Marion Fischel of Kalispell in 1958.

The property is in the upper Prichard Formation adjacent to the contact between the Pre-Ravalli and Ravalli Groups. A sheared zone up to 8 feet wide includes several veins from 1 to about 3$\frac{1}{2}$ feet wide. The smaller veins occur adjacent to the footwall of the larger vein, and the mineralized zone strikes N. 30° W. and dips 70° E. (See fig. 4.) A grey calcareous argillite occurs west of the sheared zone, whereas a dark- to medium-grey argillite occurs on the east side of the sheared zone. In this area the sediments strike N. 35° W. and dip 70° E. Mineralization in the 3- to 8-foot sheared zone includes milky quartz, argentiferous galena, chalcopyrite, pyrite, and iron oxides.

The property has been developed by a pit 18 x 15 x 3 feet and two accessible adits which are 600 and 40 feet in length respectively. The lower adit follows a quartz stringer for a short distance. The remaining length of the adit is west of the sheared zone and continues in country rock for a distance of 570 feet. The center 40-foot adit intercepts a quartz vein at the portal and continues on a 4-inch quartz stringer in the hanging wall for a distance of 15 feet. Additional development work at the cut indicates a 2-foot fault* occurring in the footwall and paralleling the mineral zone. The fault appears to strike northwest and contains both gouge and brecciated rock fragments.

Fig. 4

Mr. Fischel reports that grab and selected samples assayed 15 percent lead and 42 percent lead respectively with 7 ounces silver per ton. A channel sample across a $3\frac{1}{2}$-foot vein in the pit assayed 9.6 percent lead, 0.12 percent copper, and 3 ounces silver. The latter sample was taken by the writer in 1958.

Bonnett-Hoerner

The Bonnett-Hoerner barite property is five miles southeast of Eureka, Montana, in sec. 6, T. 35 N., R. 26 W. One claim was located by Messrs. Bonnett and Hoerner in 1958.

Barite veins of 16-, 12-, and 5-inch thicknesses are exposed in a bulldozer cut in Purcell Basalt. The larger of the three veins outcrops for a distance of about 50 feet at the base of the cut. The veins strike N. 65° E. and dip 30° SE. adjacent to a fault zone striking N. 40° E.

Development work includes an 80 x 20-foot bulldozer cut and an inaccessible adit a short distance north of the property. The adit dump rock is composed of calcite-siderite gangue and Purcell Basalt.

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*Personal Communication, Mr. Marion Fischel.

A representative sample from the three veins assayed 90 percent $BaSO_4$ (barium sulfate). A sample of the 16-inch vein assayed* 86 percent $BaSO_4$.

As the property is still in the development stage no accurate estimate of ore reserves is possible.

Hoyt (North Star Group)

The Hoyt property consists of seven claims and a fraction located on the Warland syenite stock and a 120-acre patented timber claim in secs. 25 and 26, T. 32 N., R. 29 W. The property is owned by Mrs. Carol Tallmadge of Libby, Montana.

Development work includes a 170-foot inaccessible inclined shaft, a pit 5 x 15 x 10 feet, and two bulldozer cuts near the ridge top at the southeast end of the stock, and a 180-foot caved adit and 20-foot accessible inclined shaft located on the northwest side of the stock. A few other workings which were not visited are reported to occur at the north end of the stock.

A 14- to 16-inch malachite-stained quartz vein in the short inclined shaft strikes north and dips about 34° E. The 180-foot caved adit was driven in an easterly direction at a point about 50 feet below the incline. A sample at the collar of the shaft across a 14-inch vein assayed 0.10 ounce gold and 0.10 ounce silver. About 6 inches of gouge on the footwall of the structure assayed a trace of gold and silver. Mrs. Tallmadge reports the quartz vein in the 170-foot shaft assayed from $30.00 to $35.00 per ton in gold. Other veins were reported to assay $8.00 to $10.00 of gold a ton.

The veins at the southeast end of the syenite stock strike about N. 10° W. and dip 30° E. The bulldozer cuts are on a 10-inch vein striking N. 20° W. and dipping 67° SW. Some equipment, including an old compressor, was observed at the 170-foot shaft, and two cabins, a collapsed compressor house, and an ore bin were noted at the 20-foot inclined shaft. Production from the property has been small, perhaps only amounting to a few hundred tons. The owners were reported to have constructed a mill at one time.

Kenelty

Mr. Gerald Kenelty of Libby recently found small stringers of quartz and iron oxides that outcrop in the NW¼ sec. 25, T. 33 N., R. 29 W. The mineralization is exposed on a newly constructed logging road near the head of Ural Creek and can be traced for a distance of 25 to 30 feet.

The Copper King claims were staked by Gerald and Garth Kenelty in August 1960. Two claims were located during this period.

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*Personal communication, Mr. James P. Murphy.

The veins, from $\frac{1}{4}$ to 6 inches wide, occur in a sheared zone containing specular hematite, quartz, and other iron oxides. The sheared zone trends N. 45° E. in the Ravalli Quartzite. Ravalli bedding in the area trends north-south and dips from 10° to 28° E.

A representative sample from the veins assayed a trace of gold and copper and 0.10 ounce silver a ton.

Big Creek

The Big Creek property consists of a 300-foot accessible adit driven on a small quartz vein in the Prichard Formation. The portal of the adit is about 150 feet above the North Fork of Big Creek about 100 yards west of the Forest Service guard station in the SE$\frac{1}{4}$ sec. 28, T. 35 N., R. 30 W.

The vein, occupying a small fault just west of the major shear zone of the high-angle reverse fault, pinches and swells in width from less than 1 inch to a maximum of 18 inches. For the greater part of its length the quartz vein is barren. The vein pinches out entirely near the face of the adit. Minerals observed in the narrow portions of the vein were appreciable amounts of galena, marcasite, and minor amounts of sphalerite, pyrrhotite, and native silver.

A sample taken for 25 feet along a 3-inch portion of the vein assayed 7.3 percent lead, 1.7 percent zinc, 0.1 percent copper, and 5.1 ounces silver.

There was no production from the property and its present status is unknown. Small amounts of galena, pyrite, and siderite were noted in a prospect pit excavated on the surface exposure of the quartz vein.

Big Creek Extension

Two short adits have been driven on a barren quartz vein located high on the ridge just north of the Big Creek property in the NW$\frac{1}{4}$ sec. 27, T. 35 N., R. 30 W.

The vein is in the strong shear zone of the north-trending fault and is in itself strongly sheared by post-vein movement along the fault. Specimens of quartz found at an ancient cabin a short distance from the vein contained a trace of gold, silver, and lead.

Other Prospects

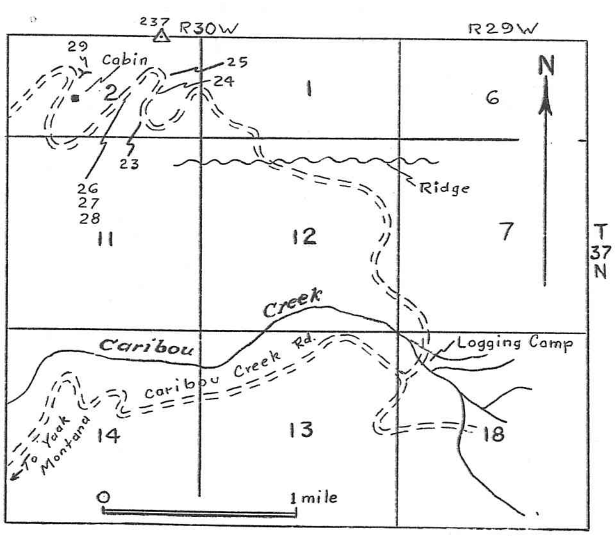
A short adit in the Purcell Basalt was mapped in the SE$\frac{1}{4}$ sec. 11, T. 36 N., R. 28 W. Small amounts of barite and calcite are associated with the basalt flow at this locality, and small masses of barite and calcite occur near the portal of the adit. No veins or mineralized zones were observed in the workings.

Undeveloped Surface Veins and Miscellaneous Ore Deposits

Chalcopyrite, malachite, and tenorite disseminated throughout coarse-grained sandstone interbedded with argillite in the upper horizons of the Ravalli Group were observed in a road cut on the South Fork of Young Creek road in the NW$\frac{1}{4}$ sec. 20, T. 37 N., R. 28 W. A grab sample ran 0.5 percent copper, 0.6 ounce silver a ton, and a trace of gold. The mineralization has been developed by a small surface pit.

Vein quartz containing traces of galena, chalcopyrite, pyrite, and native silver was noted on a skid trail on the south side of Young Creek in the SE$\frac{1}{4}$ sec. 14, T. 37 N., R. 29 W. The quartz is from 2 inches to 4 inches thick and appears to be coming from a shear zone exposed in the road cut, although the vein itself was not observed. A selected sample of quartz contained 0.1 percent copper, 0.8 percent lead, 0.5 ounce a ton in silver, and 0.005 ounce a ton in gold.

Several small north-trending quartz veins averaging less than 12 inches wide are noted in the Gateway Formation. These veins are exposed in road cuts on the north side of the east-trending ridge north of Caribou Creek in the S$\frac{1}{2}$ sec. 2, T. 37 N., R. 30 W. Mineralization is limited to traces of galena, chalcopyrite, and pyrolusite. No veins that were sampled contained more than 1 percent manganese and the average being somewhat less. The pyrolusite is associated with iron oxides. Two vein trends were observed; the most common is north to N. 15° E. Another set of veins trend N. 65°-85° W. The veins are either vertical or dip at high angles to the southwest. The only development work noted in the area was a 10-foot adit on 2 closely-spaced parallel north-trending 6- to 8-inch pyrolusite and iron oxide-bearing quartz veins. The work was reported to have been done by Jim Hubbard around the early 1900's. A sketch of the area is shown in fig. 5.



Sample No.	Width	Au	Ag	Cu	Pb	Mn
23	--	None	None	0.04	0.36	0.34
24	--	None	0.05	--	--	0.38
25	0.5'	None	0.10	--	1.00	0.24
26	0.4'	None	None	0.04	0.36	0.34
27	0.5'	None	None	--	--	0.62
28	1.0'	None	0.05	--	--	0.90
29	0.5'	None	None	--	--	0.27

Figure 5.--Sketch of Caribou-Gold Creek area in sec. 2, T. 37 N., R. 30 W., Lincoln County, Montana.

Exposed at the top of the lower Purcell lava in the glacial cirque wall just west of Geneva Lake is a 6- to 18-inch horizon of lava and quartzitic argillite containing magnetite octahedra in such abundance that it would make low-grade iron ore. A grab sample of the ore ran 14.2 percent FeO, 41.5 percent Fe_2O_3, and 0.26 percent TiO_2. The magnetite occurs in what may be the oxidized top of the lava flow. The limited extent of this horizon is such that it probably does not warrant exploitation.

East of the J. D. Daniel ranch in the SE$\frac{1}{4}$ sec. 7, T. 32 N., R. 28 W., and about 50 feet east of the Valcour road a vein up to several feet wide outcrops in Prichard Argillite. The vertical fissure vein strikes about N. 50°-60° E. and contains considerable chlorite and iron oxides in quartz.

Several quartz veins containing chlorite and sericite outcrop on the ridge southwest of Lost Soul Mountain in the SE$\frac{1}{4}$ sec. 35, T. 33 N., R. 30 W. These veins are from 1 to 6 inches wide and strike N. 70° W.

Some galena was reported to have been recently found on the Jim Meeker ranch 2 miles northeast of Rexford in sec. 11, T. 36 N., R. 28 W. The discovery was made while digging a well. Mr. Meeker has the mineral rights to the property.

Stonehill Placer

This placer is situated a half a mile south of Stonehill, a Great Northern Railway siding, on a gravel bench above the Kootenai River. The placer is east of the river in sec. 2, T. 34 N., R. 29 W., and at a slightly higher elevation (10 to 12 feet) than the river.

The property was operated for a two-week period during the early 1930's. It was reported that about $80.00 in fine gold was recovered at this time. The fine gold occurs about 2 feet from the surface in fine to coarse sandstone and gravel. The property is located on private ground.

Development or sluicing was confined to an area of 40 x 90 feet. Mr. Frank Logsdon of Rexford was reported to have worked the property at one time. Remnants of old sluicing equipment and iron pipe remain at the placer site. A string of colors can be recovered from each pan of material.

Sutton Creek Placer

The Sutton Placer is located at the mouth of Sutton Creek in sec. 36, T. 35 N., R. 29 W. Mr. Marion Fischel of Kalispell is presently operating the property. The operators have designed a washing plant to recover the fine gold and have recovered considerable amounts with the new equipment. Mr. Fischel reports a gold-sand concentrate assays about 41.5 ounces of gold to the ton.

DESCRIPTION OF MINING PROPERTIES--NORTH YAAK RIVER QUADRANGLE

Esther May

The Esther May asbestos property was staked by Romeo and Virginia Garrison in 1946. The property comprises two claims. The country rock is Piegan Argillite that, in the vicinity of the mine, has been hydrothermally altered, and silica introduced. A churn drilling program is reported to have intercepted amphibole asbestos in a number of holes.

The property is described in more detail in the Montana Bureau of Mines and Geology Bulletin 12, "Geologic Investigations in the Kootenai-Flathead Area, Northwest Montana."

Canuck Copper

The Canuck Copper claim was staked by Robert Sands, W. E. Fields, Diane and Claude Burrus, and L. M. and F. Piatt in July 1960. The prospect is near the center of sec. 23, T. 37 N., R. 34 W., on American Creek, adjacent to a logging access road into American Creek.

A 6- to 8-inch vertical quartz vein containing chalcopyrite, galena, pyrite, and pyrrhotite strikes east-west and occurs in a metadiorite sill (?). The igneous body is covered except for a small exposure adjacent to the vein. The exact relationship of igneous rocks with sediments is unknown. Prichard sediments in the area strike north and dip 36° E.

A sampled width of 6 inches assayed 0.20 percent copper, 0.73 percent lead, 0.015 ounce gold, and 0.20 ounce silver to the ton.

Phillips

The Phillips prospect is in the NW$\frac{1}{4}$ sec. 25, T. 37 N., R. 31 W. at the foot of a small falls on the East Fork of the Yaak River. Mr. Elmer G. Phillips owns the mineral rights to this quarter section.

Development consists of a small caved pit on the vein on the north side of the river. The pit is excavated for a distance of about 8 feet into the hillside. Quartz float is scattered about the sides and base of the pit. The vein is about 18 inches wide and strikes N. 20° W. and dips 58° NE. It contains quartz, pyrite, malachite, and a trace of iron oxides. The vein is believed to occupy a fault zone. A northwest fault crosses the Yaak River at the prospect. The fault creates a falls on the East Fork of the Yaak River with the west side dropped about 30 feet.

A sampled width of 1$\frac{1}{2}$ feet assayed 0.02 ounce gold and 0.20 ounce silver per ton.

Hoerner

This property was staked by Vincent Hoerner of Columbia Falls in sec. 3, T. 35 N., R. 33 W. The prospect is on the west side of Spread Creek. One claim was located at this locality.

A vertical quartz vein from 8 to 28 inches thick strikes east-west. The vein is adjacent to a metadiorite sill. The vein occurs in Prichard Argillite striking N. 5° W. and dipping 16° E. The vein assayed a trace of gold, silver, and copper.

Larue-Cripe

A narrow tremolite-asbestos vein in the NW$\frac{1}{4}$ sec. 25 and NE$\frac{1}{4}$ sec. 26, T. 35 N., R. 32 W. strikes N. 70° E. and dips 55° NW. The vein is developed by 2 small surface pits. The vein, ranging in thickness from 3 to 6 inches, is in ripple-marked and mud-cracked Piegan Argillite.

Undeveloped Surface Veins

A small caved pit with slickensided quartz on the dump was noted on a divide southeast of the Buckhorn mine of eastern Boundary County, Idaho. The small excavation was in the SW$\frac{1}{4}$ sec. 20, T. 36 N., R. 34 W. The pit may have been excavated in an attempt to find the southeast surface extension of the Buckhorn vein. Mr. D. F. MacDonald reported in U. S. G. S. Bulletin 384 that the Buckhorn mine produced some "good looking" ore containing both gold and galena.

Traces of metallics were observed in float found in upper Hudson Creek in the NE$\frac{1}{4}$ sec. 18, T. 36 N., R. 30 W. A grab sample of material assayed 0.05 ounce silver, 0.03 percent copper, 0.18 percent lead, and 1.96 percent ferric iron oxide.

In the NW$\frac{1}{4}$ sec. 16, T. 35 N., R. 34 W. a $2\frac{1}{2}$- to 4-foot quartz vein, with small amounts of chalcopyrite, malachite, azurite, tenorite, tourmaline, and epidote, is developed by a 25-foot adit. The vein is in a metadiorite sill. A selected sample from the vein assayed 0.02 ounce gold, 0.50 ounce silver, and 0.95 percent copper to the ton.

Other white barren iron-stained quartz veins with sparse malachite, iron oxides, chlorite, tourmaline, epidote, and ankerite range from several inches wide to 4 feet wide. These veins were mapped in sec. 32, T. 36 N., R. 33 W., sec. 32, T. 36 N., R. 34 W., NE$\frac{1}{4}$ sec. 24, T. 37 N., R. 33 W., secs. 25, 34, and the NE$\frac{1}{4}$ sec. 5, T. 35 N., R. 34 W., and in sec. 22, T. 32 N., R. 35 W.

The 14-inch quartz vein in the SE$\frac{1}{4}$ sec. 34, T. 35 N., R. 34 W. assayed 0.05 ounce silver and 0.16 percent copper. The 28-inch vein in the SW$\frac{1}{4}$ sec. 25, T. 35 N., R. 34 W. assayed 0.035 ounce gold and 0.70 ounce silver per ton.

Solo Joe

The Solo Joe placer is on the East Fork of the Yaak River in sec. 28, T. 37 N., R. 30 W., on a slightly elevated bench bordering the river. Tailings cover approximately a half an acre. The original locator was Solo Joe Perriault, a prospector and homesteader in the Yaak area, who did the original development in the early 1900's. A Captain Mappot worked the placer from about 1938 to 1940. Production from the property has been small.

Copeland

The Copeland placer and prospect are in the NE corner of the SE Yaak River quadrangle about $1\frac{1}{2}$ miles west of the mouth of Copeland Creek in the SW$\frac{1}{4}$ sec. 5, T. 34 N., R. 30 W.

The placer is in Recent creek gravels; a few colors were panned from surface gravels and sands bordering the stream. A collapsed cabin, an old flume about 75 feet long, and a water wheel remain at the placer site. Production from the property was not determined; however, it appears to be very small.

The adit is about 200 to 250 feet north of the placer on the north slope of Copeland Creek. A narrow trail ascends a prominent talus slope to the caved tunnel. The country rock is Prichard Argillite which strikes N. 15° W. and dips 50° SW. Vertical joints striking N. 70° W. are prominent above the adit on the hillside.

The adit dump is covered with an igneous-looking rock containing very sparse amounts of chalcopyrite and calcite. The dump rock consists of large sericitized feldspar phenocrysts in a biotite-chlorite matrix. It seems probable that a dike or small stock is cut by the tunnel a short distance from the portal. The size of the dump indicates the tunnel is probably about 40 to 60 feet long.

Some placering was supposed to have taken place on the Yaak River near the mouth of Meadow Creek. The report was not verified.

DESCRIPTION OF MINING PROPERTIES--STRYKER QUADRANGLE

Independence

This copper property is on the north slope of Indian Creek in the Whitefish Mountains of the Stryker quadrangle in secs. 22, 23, 26, 27, T. 37 N., R. 26 W. (See fig. 6.) The Independence mine is reached by a $3\frac{1}{2}$-mile trail from the mouth of Indian Creek. The property is owned by Mr. E. J. Strasburger of Butte, Montana. The claims were located by Edward Boyle of Eureka in 1892.

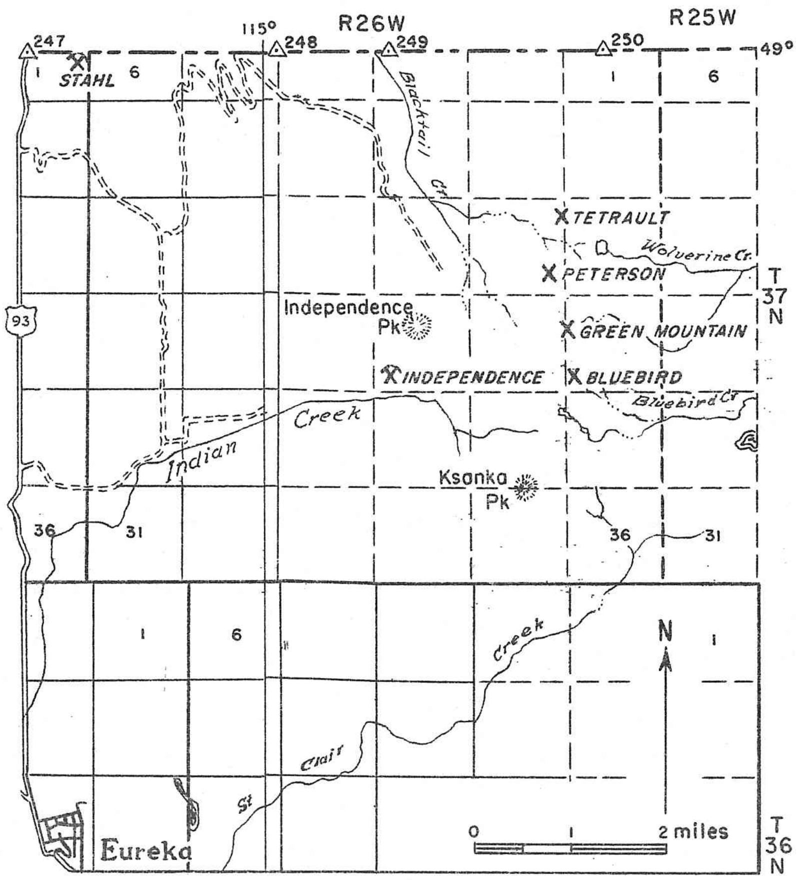


Figure 6.--Map showing location of properties in Whitefish Range, Stryker quadrangle.

The property includes the Independence patented claim (Survey No. 4421) and five other unpatented claims including the Dickey Lode, Safety Lode, Pearl, Liberty, and National Lode claims. The Little Willie Lode described in the old reports is now the Pearl Lode.

The group is developed by several pits and trenches and four adits of which the accessible lower adit (No. 3) is 1,145 feet long; two other inaccessible adits (Nos. 1 and 2) are respectively 370 and 326 feet in length. (See fig. 7.) A 50-foot accessible adit is located on the Liberty claim. Two other inaccessible adits and three shallow pits are observed on Liberty ground.

Calcite-chalcopyrite vein material was intercepted in the upper (No. 1) and middle (No. 2) adits on the Independence claim. In the lower adit a $17\frac{1}{2}$-foot vein containing chalcopyrite and with poorly defined walls strikes N. 35° W. and dips near vertical. (See fig. 8.) The vein also contains calcite, pyrite, and iron oxides. The mineralization occurs in the Precambrian Purcell Basalt that is a marker between the Piegan and Missoula Groups. Upper Piegan

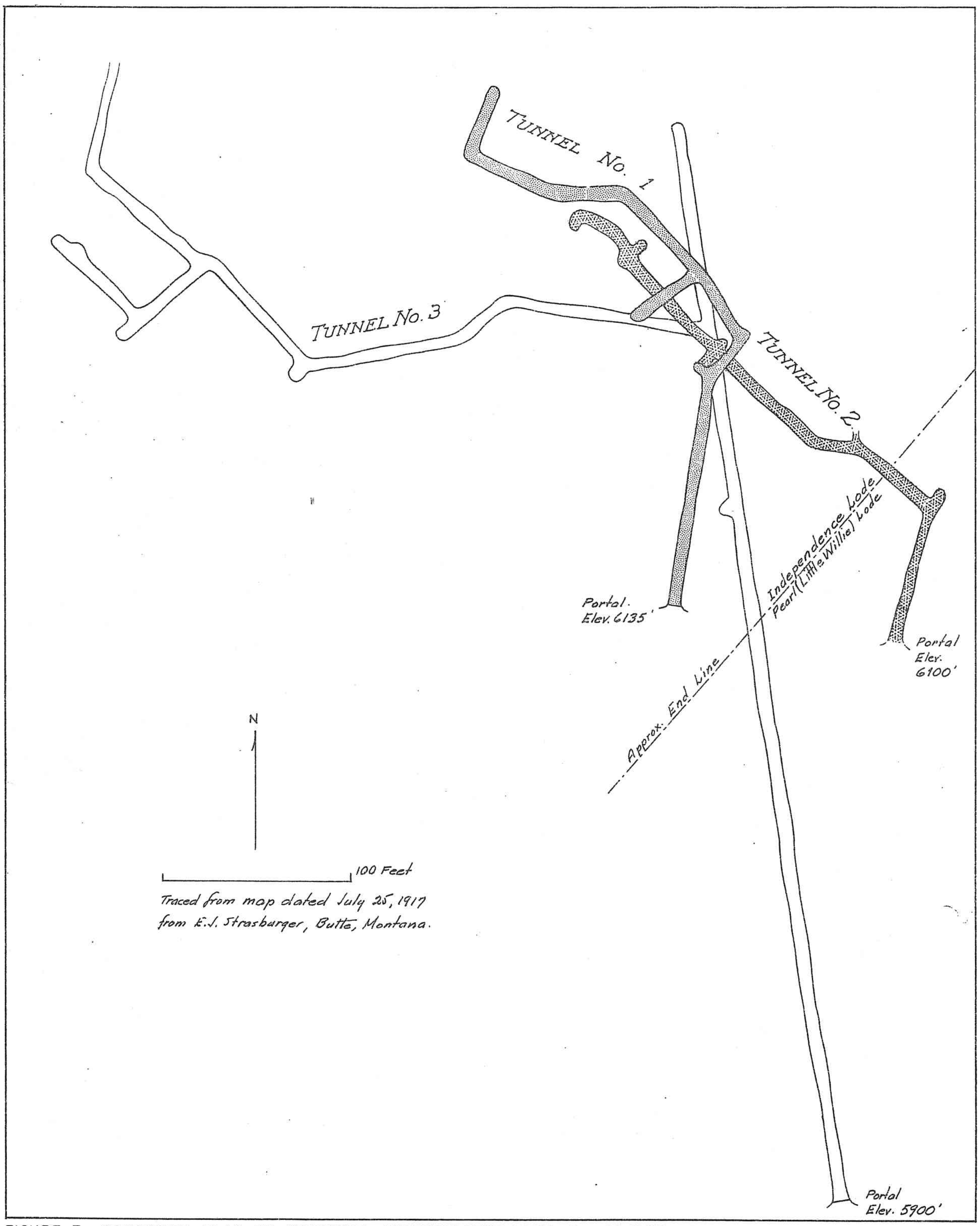


FIGURE 7--COMPOSITE PLAN OF WORKINGS, INDEPENDENCE MINE, Sec. 22, T. 37 N., R. 26 W., LINCOLN COUNTY, MONTANA

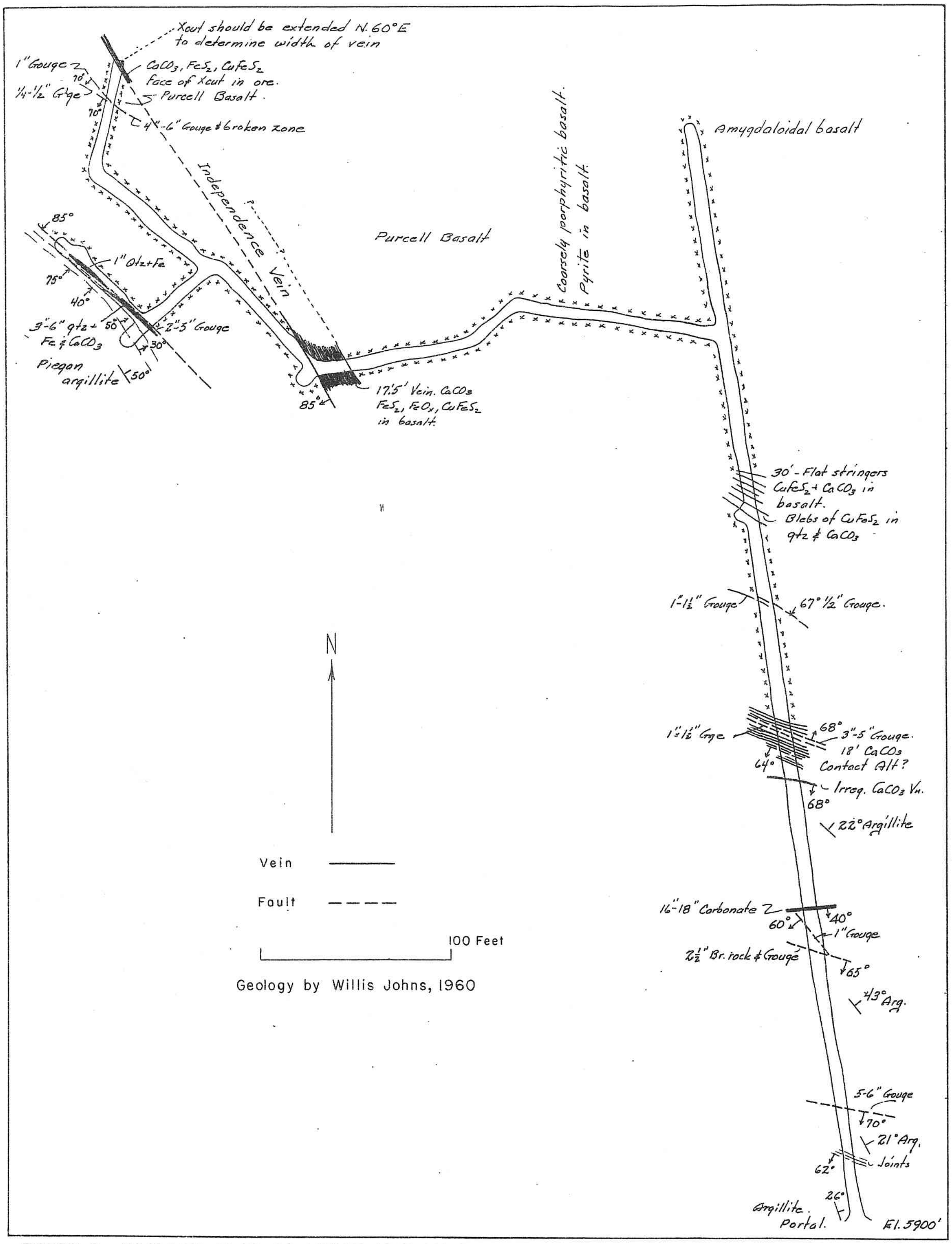


FIGURE 8--GEOLOGIC PLAN OF LOWER ADIT, NO. 3, INDEPENDENCE MINE, LINCOLN COUNTY, MONTANA

sediments (Siyeh) are mud-cracked medium-grey and banded grey-green slightly calcareous and noncalcareous argillites and quartzites striking N. 49° W. and dipping 9°-43° NE.

The 50-foot adit on the Liberty claim crosscuts a 6-inch vein at the portal of the tunnel. The vein strikes N. 50° W. and dips 65° E.; and it carries quartz and sparse amounts of malachite and pyrite. The adit crosscuts a second 2-foot quartz vein at a point 30 feet from the portal. This vein strikes N. 35° E. and dips 76° SE. A selected dump sample from the adit assayed 3.77 percent copper and 0.60 ounce silver a ton.

The basalt flow is overlain by about 50 feet of banded grey-green sandy argillite followed by about 150 feet of grey, grey-green, and red-purple coarse-grained sandstones and quartzites intermixed with argillite. Above this are red-purple crossbedded, coarse-grained sandstones, quartzites and argillites. The sediments above the flow are believed to represent the Shepard and lower Kintla units of the Missoula Group.

Vein material at the Independence mine is estimated to contain between 3 to 3½ percent copper. Some selected specimens of ore have assayed as high as 32 percent copper; however, these high-grade samples are rare.

There has been no production from the property to the writer's knowledge. Ore reserves would be difficult to determine without additional development work. A selected sample from a 5-ton dump at the portal of No. 1 adit on the Independence claim assayed 9.80 percent copper, 0.005 ounce gold, and 0.70 ounce silver a ton.

Bluebird

This prospect is at the head of Bluebird Basin in the Whitefish Mountains of the Stryker quadrangle near the section line between secs. 23 and 24, T. 37 N., R. 26 W. The prospect is developed by a 25 x 4 x 4½-foot discovery pit. No history is available concerning this deposit; however, it is believed the work was done shortly before 1900.

A 4-foot massive white quartz vein containing chalcopyrite, sparse chalcocite, and pyrite strikes N. 20°-30° W. and dips 85° NE. The vein occurs in the Purcell Basalt which, in this locality, strikes about N. 10° W. and dips 20° SW. A barren quartz vein below the base of the flow in the Piegan Argillite is located at a point 125 feet to the northeast. A covered fault striking about N. 40° W. between the veins truncates the volcanics. The northeast fault block moved about 150 feet northwest relative to the southwest block so that the lower section of the flow is in fault contact with grey-green thin-bedded argillite of the Piegan Group.

Selected specimens from the Bluebird prospect assayed 2.36 percent copper, 0.002 ounce gold, and 0.20 ounce silver a ton.

Two other vertical quartz veins striking N. 25° W. were observed in the Purcell volcanics a quarter of a mile to the south. A mile or more to the south, moderate amounts of barite float were observed on the east side of the divide.

Green Mountain

The Green Mountain prospect is in the Whitefish Mountains in a saddle southeast of Green Mountain, in the NW$\frac{1}{4}$ sec. 24, T. 37 N., R. 26 W. The vein occurs at the top of the Purcell Basalt and is readily visible from U. S. Forest Service Trail No. 88 located about a quarter of a mile to the east.

A 3- to 4-foot quartz vein follows the upper contact of the flow and sediments for about 100 feet. Vein material includes barite, chalcopyrite, sparse tenorite, malachite, and pyrite in a quartz gangue. Brecciated volcanics have been invaded by quartz, barite, and copper and iron sulfides. The Purcell Basalt in this area strikes about N. 10° W. and dips 20° SW.

Development work at the property amounts to several shallow pits. In a park below the upper workings, a collapsed cabin and a caved adit (?) were observed.

Grab samples of barite-bearing vein material assayed 1.05 percent and 1.74 percent copper and 0.10 ounce and 0.40 ounce silver a ton.

Peterson

The Peterson property (Twin Peaks Mining Company) consists of lower, middle and upper adits near the head of Blacktail Creek in the SW$\frac{1}{4}$ sec. 14, T. 37 N., R. 26 W. The property is in the Whitefish Mountains of the Stryker quadrangle. The prospect was located around 1900 by Gus Peterson who staked 5 claims on copper showings in the Purcell Basalt outcropping extensively on the west flank of a north-trending divide between Ksanka and Poorman Mountains. At the base of a 30-foot shaft, Mr. Peterson encountered a 4-foot copper vein. In 1929 Howard and Herbert Poston of Kalispell formed the Twin Peaks Mining Company to develop the property. A 220-foot upper adit was driven to intercept the vein near the base of the shaft. The vein assayed 2 percent copper, 3 ounces silver, and a trace of gold a ton. At the time of the visit, this shaft and adit were caved. In 1940 Messrs. Hugh, Ross, and Warren Kirkpatrick of Kalispell did additional development work at the property.

At the time of examination the upper and lower adits were caved, and the middle adit was believed too dangerous to enter; consequently, no underground observations were made at the property. All information was obtained from observing dump material and estimating adit lengths.

Dump rock from the short upper adit contains sparse disseminated chalcopyrite and malachite associated with quartz veinlets in Purcell Basalt country rock. The center tunnel, which is believed to be about 300 to 400 feet long, has a 25-foot vertical shaft at the portal. The adit is in

Purcell volcanics, and the dump rock is entirely flow material with sparse chalcopyrite in quartz associated with barite and calcite. The lower tunnel is estimated to be about 300 feet long. The dump rock contains sparse chalcopyrite, malachite, hematite, barite, and calcite as disseminations and veinlets in Purcell country rock. Two pits and a 15-foot tunnel were noted in this vicinity.

Selected specimens from the upper adit assayed 0.20 ounce silver and 2.53 percent copper a ton. Selected specimens of ore-bearing dump rock assayed 2.67 percent copper and 0.05 ounce silver a ton. There has been no production from this property which has evidently been idle for 15 or 20 years.

Tetrault

The Tetrault property is reported to be in sec. 14, T. 37 N., R. 26 W. on the west slope of Poorman Mountain at the base of a steep cliff in Purcell Basalt. Mr. U. L. Poston of Kalispell reports that a 2-foot vein of good grade massive chalcopyrite is exposed at the portal of the adit. The vein is not intercepted in the adit which was extended for a distance of 25 feet into the cliff. The prospect is difficult to reach and was not visited during the reconnaissance trip into the Whitefish Range.

Jager

The F. W. Jager prospect is in sec. 15, T. 35 N., R. 25 W. in the Stryker quadrangle of the Whitefish Range. The prospect is on the north side of Deep Creek approximately 300 feet from the Deep Creek road. The property is being developed by Mr. Fritz W. Jager of Fortine, Montana.

Six unpatented claims were located by Mr. Jager in 1929 on a northeast-striking 30-inch silver-bearing galena vein. Mr. Jager reports the outcrop assays 20 ounces in silver and 55 percent lead per ton. The vein at the base of a discovery shaft adjacent to the sampled surface outcrop assays 37 percent lead and 13 ounces silver to the ton.

The prospect is developed by a 5 x 8 x 6-foot discovery pit, a 70-foot adit intersecting the argentiferous galena vein at shallow depth, and a 476-foot lower adit being driven to intercept the vein at tunnel elevation. This lower adit was mapped during a short visit to the property.

In the lower adit at a distance of 87 feet from the portal, a 4-foot calcite-siderite-quartz vein strikes N. 70° W. and dips 80° SW. Some iron oxides and small amounts of pyrolusite are associated with the vein material. Parallel-trending faults with 2 to 3 inches of gouge and breccia occur on the hanging wall and footwall sides of the vein. The remaining 389 feet of adit is in barren siliceous and/or slightly calcareous argillite of the Piegan (?) Group. Several small northwest-striking bedding faults were mapped. (See fig. 9.)

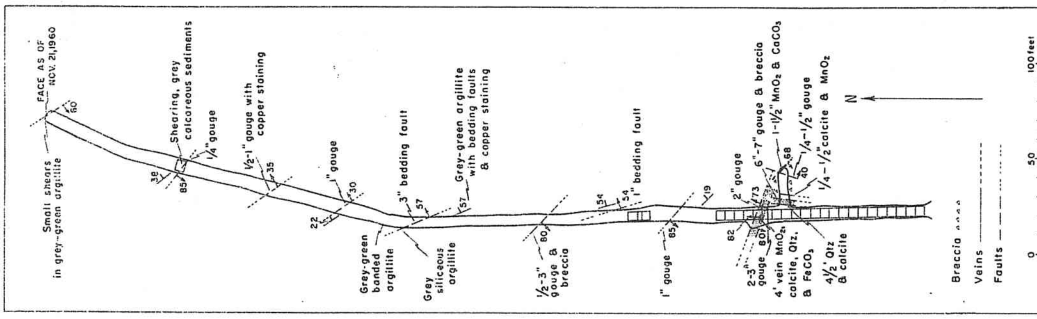


Figure 9.--Geologic plan of lower adit, Jager prospect, Stryker quadrangle, Lincoln County.

The prospect is in grey and grey-green banded siliceous and slightly calcareous argillites. Bedding strikes N. 30°-40° W. and dips 19°-38° NE.

A 4-foot channel sample across the calcite-siderite-quartz vein assayed 0.69 percent manganese. The analyst reported no gold or silver.

Other Properties

A prospect developed by 2 pits is located about a quarter of a mile below the Peterson prospect in Blacktail Creek. Some barren quartz occurs in the Purcell Basalt at this locality. Other quartz veins are observed in Blacktail Creek approximately a half a mile below the Peterson property.

A 2-foot quartz-barite vein was mapped on the northeast slope of Green Mountain above U. S. Forest Service Trail 88 in the SE$\frac{1}{4}$ sec. 13, T. 37 N., R. 26 W.

DESCRIPTION OF MINING PROPERTIES--PLEASANT VALLEY QUADRANGLE

Foolsburg

This property, owned by Bill and Jess Stubbs of Kalispell, consists of 1 patented claim on the east side of Griffin Creek in the SE$\frac{1}{4}$ sec. 19, T. 30 N., R. 24 W. The claim is about 22 airline miles northwest of Kalispell in the Pleasant Valley quadrangle. The property was initially developed around 1920 by the Stubb Bros., Blanche Lewis, and Nick Searles. The Foolsburg claim was patented in 1955.

Development consists of a 240-foot lower adit and a 300-foot upper adit; both adits are on the vein. An estimated difference in elevation is about 60 feet. The adits are on a fissure-filled chalcopyrite-bearing quartz vein which ranges from 16 to 54 inches.

The principal vein mineral is chalcopyrite, although tenorite, azurite, and malachite occur with a quartz, siderite, and calcite gangue. An ore shoot, ranging in width from 16 to 30+ inches, is estimated to be about 125 to 140 feet long. The vein strikes N. 85° W. and dips 80° SW. The property is in green and grey-green banded argillite of the Piegan Group which strikes N. 85° W. and dips 15° SW.

At a distance of about 190 feet from the portal, a vertical fault zone from 2 to 6 inches wide strikes N. 55° E. This fault displaces the vein and another fault striking N. 70° W. and dipping 56° SW. The latter fault gouge is from 1 to 1½ inches wide, contains brecciated fragments, and its relationship to the vein is not clear. The drift follows the northeast-striking fault in a southwest direction for 60 feet. The displaced segment of the vein was not found. Vein bending adjacent to the fault indicates the displaced vein segment probably moved northeast; the drift should have followed the fault in a northeast direction to intercept the ore shoot.

The lower tunnel intercepts the vein near creek elevation and follows it in a N. 80° W. direction. The structure varies from 16 inches to 4 feet in width. Only sparse amounts of chalcopyrite are noted in the quartz-siderite gangue. The lower adit should be advanced an additional 50 to 75 feet since the orebody may have a westerly rake.

A 38-inch chip sample across the vein in the upper adit assayed 4.87 percent copper, 0.80 ounce silver, and 0.05 ounce gold a ton. A grab sample from the lower adit dump assayed 2.98 percent copper, 0.60 ounce silver, and 0.15 ounce gold per ton.

West Virginia

This property was reported to have been found by John Sullivan and Bill Doyle prior to 1900 with mine development financed by Charles Conrad of Kalispell. An ore shoot 37 x 4 x 20 feet was found at shallow depth in the shaft; the hand-sorted high-grade ore was packed out on horses. The high-grade was supposed to have assayed 1.0 ounce gold, 50 percent copper, and about 200 ounces silver to the ton. This information was supplied by Art Stahl of Cranbrook, British Columbia, who prospected in the area about 1905. The mine is in the NE¼ sec. 19, T. 30 N., R. 24 W., on the east side of Griffin Creek. The mine is believed to be on U. S. Forest Service ground; however, it is very close to the boundary between private and National Forest land. Harold Luke believes the property is presently open for location.

Development consists of an inaccessible 30-foot shaft along which the vein has been stoped, and a 60-foot adit crosscut to the vein. An additional 150 to 160 feet of drifting along a small fault to the displaced vein segment was reported to have been done by Mr. Sucetti during the 1920's.

The vein at the collar of the shaft is stoped. The structure is believed to be from 20 to 24 inches wide and vertical and strikes N. 65° E. and dips 75° SE. Vein minerals identified in samples from a small stockpile were chalcopyrite, azurite, and a few flecks of bornite in a hematite-stained siderite-quartz gangue. Considerable bright-red pulverent hematite is associated with the ore minerals. An adit crosscut intercepts the vein at the base of the shaft. At this location a flat fault striking N. 35° E. and dipping 5° NW. shifts the vein about 150 feet southwest. The fault selvage is from 1/4 to 3/8 inch wide, and movement of the flat-lying upper plate was northeast relative to the lower plate. The adit continuation along the normal fault to the faulted vein segment was accessible but dangerous.

The ore shoot was localized above the flat fault and bornite was reported to have been the essential copper mineral mined. The only copper mineral noted in possible commercial quantities in samples from a small stockpile was chalcopyrite. According to Art Stahl, production amounted to one carload (about 60 tons) of ore.

Humdinger

The Humdinger unpatented claim, located in 1934 between Logan and Johnson Creeks in the NW¼ sec. 26, T. 31 N., R. 24 W. by Fred, Leroy, Ernie, and Harold Luke, is reached by a short access road from the Talley Lake-Logan Creek-Star Meadow road. The property, in the Pleasant Valley quadrangle, is about 25 airline miles northwest of Kalispell. The property is in grey-green banded argillite of the Piegan Group. There has been no production from the prospect.

Development consists of 2 pits exposing 2 close-spaced veins and a caved 100-foot adit crosscut intersecting the veins at a shallow depth. The development was essentially accomplished during the mid-thirties. Adit dump rock contains sparse chalcopyrite and tenorite in a brecciated quartz-siderite-talc gangue. Some native copper was found by the Lukes in one of the pits on the outcrop. The 2 close-spaced pits are approximately 40 to 50 feet in elevation above the portal of the adit and expose veins trending east-west and N. 75° E. The vein in the upper pit (No. 1) strikes easterly and dips 65° N. The quartz-siderite-calcite vein is 14 inches wide and contains considerable iron oxides. Pit No. 2, a 40-inch vein, strikes N. 75° E. and dips 55° N. and contains tenorite, malachite, and sparse native copper in a quartz-siderite-calcite gangue. Considerable amounts of a white and red-toned heavy nonmetallic mineral, probably barite with some celestite (?), occurs in the vein.

Yukon

This property was located by Fred and Ernie Luke in 1929 in the SW¼ sec. 1, T. 30 N., R. 25 W. in the Pleasant Valley quadrangle. The unpatented claim is 1 mile west of Star Meadow and an eighth of a mile north of the Star Meadow road. Development includes a 257-foot adit crosscut to the vein approximately 70 feet of drifting on the vein, a 10 x 12 x 8-foot pit on the outcrop, and a 20-foot shaft a short distance east of the above mentioned pit. In recent years Harold, Leroy, and Karl Luke have done a small smount of underground development on the property.

At the portal of the adit a 12- to 16-inch vein striking easterly contains chalcopyrite, chrysocolla, and tenorite in a quartz-siderite matrix. Some small kaolinized Piegan Argillite horses of sedimentary rock are noted within the structure. Chalcopyrite, tenorite, malachite, and chrysocolla are found on the dump.

A 30- to 42-inch quartz siderite vein intersected by the adit contains sparse amounts of chalcopyrite, tenorite, chrysocolla, manganese dendrites, and iron oxides. The vertical vein strikes east-west. The vein outcrop in the pit is from 14 to 22 inches wide. Sparse to moderate amounts of chalcopyrite and tenorite are found in quartz-siderite gangue. About 50 feet east of the pit a 20-foot inaccessible shaft was sunk on the easterly extension of the vein. The vertical vein in the shaft also strikes east-west, is 14 to 18 inches wide, and is reported to widen at depth.

The property is in grey-green banded Piegan sediments which strike N. 10° W. and dip 12° SW. The dense country rock contains considerable manganese oxide staining.

Some ore from the Yukon (about 15 to 20 tons) was included in a 100-ton shipment from the Foolsburg mine in the late thirties. The ore is reported to have averaged $27.00 a ton in copper. A sample of adit dump material assayed 3.37 percent copper, 0.15 ounce silver, and 0.002 ounce gold to the ton.

Crosley-Sucetti

These two prospects are in sec. 1, T. 30 N., R. 25 W. on a small drainage between Swanson and Swaney in the Star Meadows district of the Pleasant Valley quadrangle. Mr. Crosley of Star Meadow did the initial work in the area prior to 1910. Mr. Sucetti did additional prospecting and development in the early 1920's. Development work consists of a short discovery adit near the center of sec. 1 on a 4- to 6-inch quartz-siderite vein and a 30-foot adit on the 12- to 16-inch specular hematite-bearing quartz-siderite vein. The specular hematite vein strikes N. 85° W. and dips 75° S. It contains some chlorite. The properties are in Piegan and Ravalli (?) Groups of the Precambrian Belt series. They have been inactive for many years.

Stahl

Mr. Art Stahl reports that in 1904 he located and did some development work on a property about a quarter of a mile north of the West Virginia mine on the east side of Griffin Creek. The workings were not found during this visit, but from the description given, they should be on private ground near the section line between secs. 18 and 19, T. 30 N., R. 24 W.

A 6-inch to 3-foot mineralized zone was developed by a 60-foot adit. A few small stringers from 2 to 3 inches wide were reported to have assayed high in copper and silver.

Harvey-Nickolas

Al Harvey and Bob Nickolas of Kalispell have recently staked ground in the vicinity of Johnson Peak. They are reported to be several miles northwest of the Humdinger prospect and north of the Yukon property in T. 31 N., R. 24 W. Mr. Harvey states a sample from a 30-inch vein assayed 14.9 percent copper, 0.20 percent lead, 1 ounce silver, and a trace of gold to the ton.

Figure 10, which is a plan map of the Star Meadow district area, shows the locations of the above described properties.

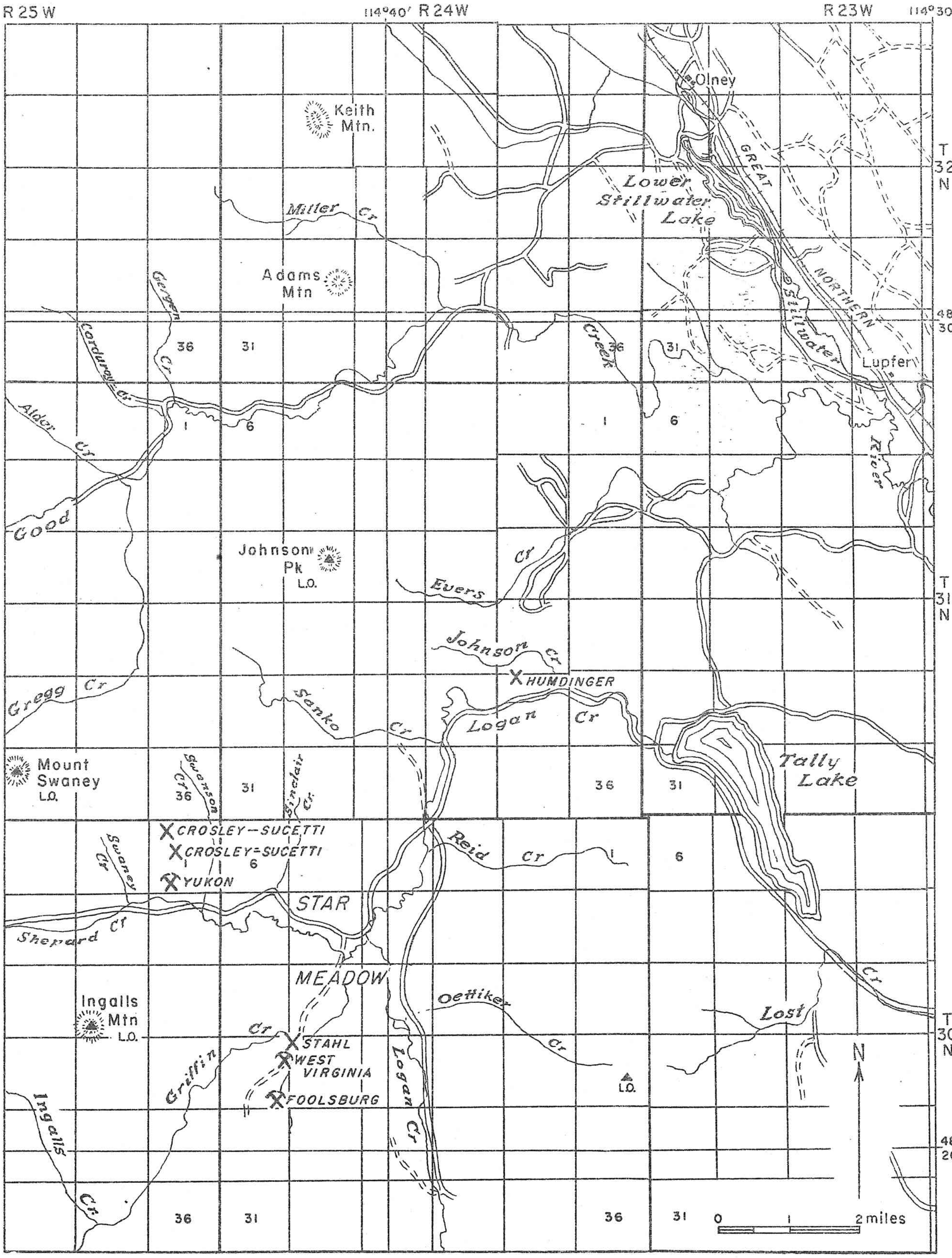


Figure 10.--Map showing locations of properties in Star Meadows district, Selish Range, Pleasant Valley quadrangle, Flathead County, Montana.

NONMETALLIC DEPOSITS

Clay

Glacial lacustrine clays and silty clays overlie interbedded sands and gravels in the Tobacco and Yaak River Valleys and extend for short distances up the tributaries of these rivers. The silica content of these clays ranges from 57.8 percent to 77.1 percent, and the alumina oxide content ranges from 8.4 percent to 17.8 percent. The clays contained small amounts of iron and magnesium oxides and moderate amounts of calcium oxides. The analyses of seven representative clay samples are listed in the Appendix of this report.

Limestone

A faulted block of Devonian limestone immediately east of Roosville at the International Border was sampled for calcium, magnesium, alumina, and ferric iron oxide. Other representative samples of impure Precambrian Belt limestones within the Piegan Group were collected within the Ural quadrangle.

A 300-foot chip sample* of Devonian limestone above the abandoned kiln at Roosville contained 98.6 percent calcium carbonate, 0.76 percent magnesia, 0.05 percent alumina, and 0.15 percent ferric iron. Another 200-foot chip sample below the kiln contained 97.4 percent calcium carbonate, 1.48 percent magnesia, 0.53 percent alumina, and 0.15 percent ferric iron. The limestone kiln was operated by Mr. Art Stahl in 1905. Bulk lime was shipped to Kalispell, Libby, and Great Falls. The property operated for a period of 2 years. During this time about 165 tons of lime were produced and sold for $10.00 a ton. During the operation 2 men produced 6 tons of bulk lime a day.

Representative samples of Belt limestones ranged from 35.2 percent to 54.9 percent silica, 7.6 percent to 13.5 percent alumina, 8.8 percent to 22.5 percent calcium oxide, and 2.0 percent to 6.9 percent magnesia. The samples contained small amounts of iron oxides.

Quartzite

Some light-grey to white-colored beds of fine-grained quartzite in the upper Ravalli Group contain as high as 82 percent silica and 3.7 percent combined iron oxides. The silica content, however, is not considered high enough to be of commercial grade.

C O N C L U S I O N S

The map area includes the Ural and north Yaak River quadrangles comprising an area of 1,200 square miles in the Selish and Purcell

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*Analyzed by the Willis H. Ott Laboratory for Great Northern Railway Company.

Ranges of northwest Montana. It is underlain by the Precambrian Belt series which has been subdivided into four major groups which are in ascending order Pre-Ravalli, Ravalli, Piegan and Missoula Groups. The Pre-Ravalli (undivided Prichard Formation) is composed of basal interbedded white sericitic quartzite, grey-brown quartzite, and light-grey argillites and schistose rocks containing sericite, biotite, and quartz. The greatest exposed thickness of Pre-Ravalli rocks amounting to more than 12,000 feet occurs on an anticline in the western part of the north Yaak River quadrangle. Upper Pre-Ravalli beds are more widely exposed throughout the quadrangle and amount to several thousand feet of rusty weathering banded and laminated dark- to light-grey and blue-grey biotite-bearing argillites.

The greater part of the Ravalli Group is a medium- and light-grey, green-grey, and white quartzite and argillite which is magnetite-bearing and tends to form cliffs and dip slopes. The thickness of the unit varies from 4,500 feet to 7,000 feet; it thins in the northern part of the map area.

The Piegan is composed of three units. The lower unit is a slightly calcareous or noncalcareous argillite, and the argillite is very commonly a banded grey to grey-green color. The middle unit consists of dark- or light-grey or blue-grey molar-tooth limestone interbedded with some green-grey argillites. Pyrite cubes in the unit are common. The upper unit includes green-grey and grey siliceous argillites, argillites, and quartzites with only minor amounts of limestone and dolomite present. The thickness of the Piegan Group is about 8,000 feet.

The greyish-red and grey quartzites of the Striped Peak Formation of the basal Missoula Group were not recognized within the map area. The base of the upper flow of the Purcell Basalt in the NW Ural quadrangle or the base of the composite flow in the NE Ural quadrangle was taken as the contact between the Piegan and Missoula Groups. Sediments of the Missoula Group are essentially sandstones and quartzites with some dolomite and purple-grey argillites and argillaceous sandstone and grey and green argillites. Ripple marks and salt crystal casts are present in this sequence. The Missoula unit is believed to be about 1,700 to 1,800 feet thick. A faulted block of Devonian limestone and Mississippian (?) Quartzite outcrops east of Roosville on the International Border.

Glacial deposits attributed to the Cordilleran ice sheet during the late Pleistocene epoch include till and drift, lacustrine stratified silts and clays, and terrace-like gravels bordering the Kootenai River. Glacial striations were noted to elevations of 6,000 feet.

Igneous Precambrian metadiorite sills are most numerous in the Prichard Argillite. The Purcell Basalt is a lava extending easterly from the 115° 30' meridian to the eastern border of the map area. A syenite stock intrusive into Prichard sediments during late Mesozoic or early Cenozoic time outcrops east of Warland.

Folds in the sedimentary Belt section are both moderate to broad structures with north or northwest trends. North to northwest faults are displaced by northeast and east-west faults. The large and persistent northwest faults parallel or closely follow fold axes of both anticlines and synclines.

Ore deposits include lodes and placers. Productions from placers has been very small, and only sparse to moderate amounts of copper, lead, and silver are present in widely scattered deposits throughout the reconnaissance area. The nonmetallic mineral barite is present in both the Ural and Stryker quadrangles.

SUGGESTIONS FOR PROSPECTING

Base-metal deposits in the quadrangles are associated with Precambrian metadiorite sills and the Purcell Basalt, and a later Tertiary acid igneous intrusive. Faults were observed to provide structural control for some of the ore deposits throughout the map area.

In the northwest sector of the Whitefish Mountains of the Stryker quadrangle mineralization is largely confined to the Purcell Basalt. It is essentially limited to sparse or moderate amounts of chalcopyrite associated with barite and calcite. From limited observations, prospecting activity should prove more successful if it is confined to the volcanic flow exposed on the east and west sides of the north-trending divide extending from south of Ksanka Peak beyond Poorman Mountain to the north.

Traces of base-metal mineralization in float and mantle rock were observed in upper Hudson Creek north of Mount Henry in the Yaak River quadrangle. This occurrence may be worthy of further investigation.

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APPENDIX.--Analyses of clays, limestones, and quartzites in Lincoln County, Montana.

Sample No.	Location	CaO %	MgO %	CO_2 %	Al_2O_3 %	FeO %	Fe_2O_3 %	SiO_2 %
1.	Glacial clay and silt, SW¼ sec. 11, T. 36 N., R. 28 W.	11.80	4.42	9.83	9.60	----	2.84	57.80
2.	Glacial clay, underlying peat bed, SW¼ sec. 22, T. 36 N., R. 26 W.	4.44	2.25	3.12	17.80	1.80	2.02	61.30
3.	Glacial clay, SW¼ sec. 22, T. 36 N., R. 26 W.	5.73	2.34	----	17.30	1.90	2.12	62.80
4.	Clay, SW¼ sec. 1, T. 36 N., R. 28 W.	15.60	5.15	----	14.90	----	4.78	42.20
5.	Clay, grab sample, S½ sec. 18, T. 37 N., R. 28 W.	4.39	1.60	5.48	8.36	1.55	1.12	77.10
6.	Clay, S½ sec. 18, T. 37 N., R. 28 W.	3.24	1.67	5.04	10.30	0.60	2.29	76.80
7.	Clay, grab sample, S½ sec. 18, T. 37 N., R. 28 W.	7.21	2.33	5.15	12.20	----	3.63	67.40
8.	Quartzite, Ravalli Group, NW¼ sec. 36, T. 35 N., R. 28 W.	1.11	1.03	----	15.10	1.91	1.89	75.20
9.	Quartzite, grab sample, SW¼ sec. 35, T. 36 N., R. 29 W.	----	----	----	----	1.57	1.13	82.20
10.	Limestone, Paleozoic, Rt. 93, 49 Parallel, T. 37 N., R. 27 W.	14.30	5.95	30.30	1.28	0.38	1.90	45.40
11.	Limestone, Wallace Formation, Orthor Lake, NW¼ sec. 28, T. 36 N., R. 27 W.	20.60	2.02	14.70	7.66	1.06	1.55	47.10
12.	Limestone, Piegan Group, SW¼ sec. 10, T. 37 N., R. 29 W.	22.50	6.96	23.80	8.80	0.39	2.27	35.20
13.	Dolomite, Piegan Group, SE¼ sec. 14, T. 37 N., R. 29 W.	8.86	5.94	13.00	13.50	1.04	2.35	54.90
*14.	Limestone, Paleozoic, 300', sec. 1, T. 37 N., R. 27 W.	55.25	0.76	----	0.05	0.15	----	----
**15.	Limestone, Paleozoic, 200', sec. 1, T. 37 N., R. 27 W.	54.57	1.48	----	0.53	0.15	----	----

*Above kiln; **Below kiln. Samples 14 and 15 from Great Northern Railway Company.