MAP GQ-375

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GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGIC MAP OF THE PACKSADDLE MTN. QUADRANGLE IDAHO

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QUADRANGLE LOCATION

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By J. E. Harrison

INTRODUCTION

The Packsaddle Mountain quadrangle is part of the U. S. Geological Survey's program of regional investigations. An area in northern Idaho and western Montana was selected in 1957 as containing scientific data bearing on the complex geologic history of the Belt basin as well as the poorly understood process of trace metal movement during metamorphism. Modern detailed geologic maps are essential to study of these problems, and this quadrangle is the second one to be published in the series planned for the area.

Previous geologic work has been confined to reconnaissance mapping by Calkins (1909), by Campbell and others (1915) along the route of the Northern Pacific Railway, by Sampson (1928) in the southern part of the quadrangle, and by Anderson (1930) in the northeastern part. The quadrangle is joined on the east by the Clark Fork quadrangle, mapped by Harrison and Jobin (1963).

Fieldwork was done in part concurrently with work in the Clark Fork quadrangle (Harrison and Jobin, 1963). This report emphasizes the rocks and structures not previously described in the report on the Clark Fork quadrangle. Geologic mapping in the eastern half of the quadrangle was done in part by my associate D. A. Jobin. John P. McArdle, District Ranger, U. S. Forest Service, gave generous cooperation and logistic aid.

GEOLOGIC SETTING

Precambrian and Cambrian sedimentary rocks exposed in the quadrangle are shattered by faults, intruded by sills, dikes, and small plutons, and covered in low areas by glacial debris. The huge natural lake fills an ancient fault-controlled valley that is probably a southern extension of the fault-controlled Purcell trench which can be traced northward from Bottle Bay into Canada. The bottom of the lake is at 1,100 feet altitude, the lowest topographic point within a 100-mile radius. Although the lake is dammed by Pleistocene deposits at its southern end (Alden, 1953, pl. 2), it seems reasonable to believe that these deposits have raised the lake level only a few hundred feet (Alden, 1953, p. 144) and that the deeper parts of the present lake formed a pre-Pleistocene lake.

The geologic record begins with deposition of more than 30,000 feet of fine-grained sand, silt, clay, and carbonate sediments in a Precambrian geosyncline. In the late Precambrian these strata were intruded in their lower part by quartz diorite sills and then gently folded. Some faulting and metamorphism probably accompanied these early tectonic movements. During latest Precambrian and Early Cambrian time, the area was uplifted and then leveled by erosion.

An encroaching Middle Cambrian sea deposited conglomeratic sandstone, then shale, and then limestone over the tilted and beveled Precambrian rocks. There is no stratigraphic record between Cambrian and Pleistocene time. Later intrusions tentatively called Cretaceous(?) in age are dated on the basis of the generally accepted Cretaceous age of batholithic intrusion in the northern Rocky Mountains. A radiometric age-dating study of these rocks is being undertaken.

Granodiorite plutons and sheets were intruded, probably in Late Cretaceous time, accompanied by block faulting and contact metamorphism. Faulting continued after the granodiorite was intruded; early fractures were filled by diabase or diorite, and later fractures by granodiorite porphyry. A few early fractures were filled by quartz and sulfide minerals. Right lateral movement on one major transcurrent structure—the Hope fault—accompanied intrusion of the dikes.

During the Pleistocene a continental ice sheet advanced across the area, one lobe moving eastward up the Clark Fork valley and another moving southward across the Pend Oreille Lake basin. The ice overrode Gold and Grouse Mountains, dammed the Clark Fork to form Glacial Lake Missoula, and dammed the tributaries of all the streams in the area emptying into Pend Oreille Lake basin. Since retreat of the ice the streams have been cutting down through the Pleistocene deposits; a large mass-wasting deposit due to weathering of highly jointed granodiorite is still forming on Packsaddle Mountain.

SEDIMENTARY AND METASEDIMENTARY ROCKS

The formations of the Belt Series exposed in the Packsaddle Mountain quadrangle are the same ones visible in the Clark Fork quadrangle except that the Libby Formation is missing (see Harrison and Jobin (1963), and Harrison and Campbell (1963), for description). Three formations of Cambrian age crop out in the southern part of the Packsaddle Mountain quadrangle, whereas no Cambrian rocks occur in the Clark Fork quadrangle, and these rocks are described here more fully than are the Belt rocks.

Terms used in describing layered rocks are those suggested by McKee and Weir (1953).

Belt Series

Formations of the Belt Series exposed in the quadrangle are, from oldest to youngest, Prichard, Burke, Revett, St. Regis, Wallace, and Striped Peak. The Belt Series rocks are metamorphosed to the greenschist facies by both regional and contact metamorphism. Rocks above the middle of the Wallace Formation have chlorite-sericite-zone mineralogy, whereas lower rocks have biotite-zone mineralogy. Contact metamorphism, also of the biotite zone, is shown by the formation of hornfels or gneissoid rocks within a few feet of sills or dikes, or within a few hundred feet of stocks, and was studied in detail by Gillson (1929).

The Belt rocks were fine-grained thin-bedded or thinly crossbedded sediments whose coarsest detrital grain size was fine sand. The most common rock types now, in order of decreasing abundance, are siltite (metamorphosed siltstone), argillite (metamorphosed claystone or silty claystone), quartzite (metamorphosed sandstone), and impure limestone or dolomite. Graded bedding is abundant in all the clastic rock types; mud cracks and ripple marks are common, though generally more abundant in the upper part of the section. Fossil algae occur in the Prichard, Wallace, and Striped Peak Formations.

Contacts between formations and members are gradational by interbedding. The interbedded zones commonly are several tens of feet thick, but between some units are a few hundred feet thick. The apparent range in thickness of some members is probably due more to inability to choose exactly the same contact than to any real differences in thickness.

Prichard Formation.—About 13,000 feet of Prichard Formation is exposed; the base is hidden. The formation has been divided into three members. The lower member, more than 10,000 feet thick, consists of interlayered beds of greenish-gray, micaceous, slightly argillitic quartzite. The middle member, about 2,000 feet thick, is laminated black and white or pale green argillite. The upper member 600 to 1,000 feet thick, consists of alternating layers each a few feet thick, of laminated argillite like that of the middle member and of siltite like that of the overlying Burke Formation.

Pyrrhotite is common in small crystals scattered through the argillite and siltite layers. Its weathering gives Prichard outcrops a characteristic rusty stain. Iron sulfide in the form of pyrrhotite is concentrated in films and thin lenses along bedding planes in layers of laminated black argillite and green siltite. The original sulfide mineral probably was pyrite that was disseminated more abundantly in the black shale layers than in other rock types, and was redistributed by metamorphism. A number of prospect adits have been driven along these layers.

Burke Formation.—The Burke Formation, about 3,200 feet thick, is principally dark-gray siltite and gray-green silty argillite, in alternating layers that average about 10 feet thick. The siltite characteristically has a light-gray-weathering rind. The upper part contains 1- to 4-foot beds of white or light-gray even-bedded or thinly cross-laminated quartzite. Siltite of the Burke is highly feldspathic, commonly containing as much as 30 percent feldspar, mostly plagioclase. Purple streaking, either parallel to bedding or in concentric rings across it, is common particularly in the middle of the formation.

Revett Formation.—The Revett Formation, about 2,000 feet thick, is distinguished by its many beds of blocky white to gray or buff, crossbedded, nearly pure quartzite. Most of these beds are about 20 feet thick, but a few are as thick as 200 feet. Quartzite forms perhaps a third of the formation; the remainder is mostly laminated green siltite and subordinate green argillite. Sparse carbonate minerals occur, principally in the siltite.

St. Regis Formation.—The St. Regis Formation is about 1,100 feet thick and consists predominantly of laminated purple and green argillite and siltite that is locally dolomitic. Siltite is more abundant near the base, and argillite is more abundant near the top. Near the base is a little fine-grained quartzite; a few thin beds of waxy green argillite are scattered through the upper half of the formation, as are scattered crystals of dolomite and siderite. Most of the formation has a distinctive purple color, particularly in the argillitic layers, but rocks in outcrops west of Packsaddle Mountain are mostly green.

Wallace Formation.—The Wallace Formation is about 10,200 feet thick and is the most heterogeneous unit in the quadrangle. Five members have been mapped. The lower calcareous member is about 2,500 feet thick. Its lower half is carbonatic green argillite and siltite interlayered with sparse white dolomitic quartzite and, near the base, waxy green argillite; its upper half is mostly green silty limestone and blue-gray dolomitic limestone. The argillite member is about 2,800 feet thick and consists of black or dark-gray argillite interbedded with laminated black and green argillite or silty argillite. Carbonate minerals are sparse in this member. The argillite, siltite, and limestone member is about 3,500 feet thick and consists of interlayers about 20 feet thick of all the rock types of the Wallace. The upper calcareous member is about 1,000 feet thick and consists principally of blue-gray dolomitic limestone, greenish-gray thin-bedded carbonatic siltite, and green calcareous argillite. This member is similar to the upper part of the lower calcareous member and is indistinguishable from it in a small exposure. The laminated argillite and siltite member is about 400 feet thick and consists principally of papery black argillite thinly interlaminated with green siltite or white calcareous siltite. The upper part of this member contains lenses and pods of green argillitic siltite and thin beds of blue-gray dolomitic limestone. Siderite is common in slightly carbonatic argillites and siltites. Molar-tooth structures (Harrison and Jobin, 1963, p. K-14) are common in dolomitic limestone of the first, third, and fourth members. Stromatolites (fossil algae) are common in these same members and are also present in the upper member.

Striped Peak Formation.—The Striped Peak Formation, which crops out only in a fault block in the southeastern part of the quadrangle, is about 2,000 feet thick. Green micaceous quartzite characteristic of the top of this formation in the Clark Fork quadrangle (Harrison and Jobin, 1963, p. K-19) is exposed near the fault that cuts out rocks stratigraphically above the Striped Peak, which suggests that virtually the full thickness of the Striped Peak is exposed in this quadrangle.

Four members of this formation have been mapped. The argillite, siltite, and quartzite member is about 600 feet thick. It consists principally of red and green siltite and quartzite in its lower part, of red feldspathic quartzite and red shaly argillite in its middle part, and of red and green argillite and siltite in its upper part. The dolomite member is about 400 feet thick and consists of blue-gray to tan dolomite, dolomitic limestone, silty dolomite, and green dolomitic siltstone. The laminated argillite and siltite member is about 300 feet thick and consists of thinly interlaminated black argillite and olive to white siltite that is locally calcareous. The quartzite member is about 700 feet thick and consists of red feldspathic quartzite containing partings and interbeds of red argillite; a few feet of green micaceous quartzite is characteristic of the top and bottom of this member.

Cambrian rocks

Three Cambrian formations crop out in the southern part of the quadrangle. These were originally named by Sampson (1928) and are the Gold Creek Quartzite of Middle(?) Cambrian age, overlain by the Rennie Shale and Lakeview Limestone of Middle Cambrian age. The type locality of the Rennie Shale is in a small south-trending valley at the south-central edge of the quadrangle along the east side of sec. 30, T. 54 N., R. 1 E.

Gold Creek Quartzite.—The Gold Creek Quartzite is exposed along the ridge west of Packsaddle Mountain, where it unconformably overlies the lower part of the middle member of the Wallace Formation. At a few places the surface of unconformity can be seen, and measurements of dip in the rocks above and below differ by an average of about 7°; differences in strike were not detected.

The quartzite is about 400 feet thick. It has a basal conglomerate a few feet thick, above which is thin-bedded and thinly crossbedded, blocky to massive, slightly feldspathic, pink to buff or white fine- to coarse-grained quartzite containing scattered pebbles and pebble beds. The basal conglomerate contains a few cobbles of Belt rocks but consists principally of quartz pebbles in a matrix of poorly sorted sand. Hematite colors some layers pink. Scattered through the rock are pebbles of jasper which have no known local source. Voids in the rock are apparently due to weathering out of carbonatic rock grains or carbonate cement.

In thin section many quartz gains show overgrowths in which the original grain is outlined by a thin zone of hematitic dust. Many large quartz grains show strain patterns unknown in the local Belt rocks. The white to buff quartzite consists of well rounded but poorly sorted grains of quartz, a little plagioclase and potassium feldspar, and traces of magnetite, hematite, sphene, and muscovite.

Rennie Shale.—The Rennie Shale is a highly fossiliferous, olive, papery fissile shale about 100 feet thick. It is so soft and easily eroded that outcrops are rare, but its presence is commonly indicated by abundant tiny chips of shale in float. A. R. Palmer (written communication, 1961) examined two collections of trilobites and brachipods, one from near the base and one from the upper part, and reported that both collections correspond with the Albertella zone in the lower part of the Middle Cambrian, which is also present in the Gordon Shale in western Montana.

Lakeview Limestone.—Stratigraphic and structural controls on the Lakeview Limestone are poor. Not only is the Lakeview poorly exposed, but also, except for one small area, continuous exposure of the unit is interrupted by faults or intrusive rocks. It is at least 2,000 feet thick; the top is not exposed.

The lower part of the formation is light- to dark-gray or black, thin-bedded, blocky to massive limestone that is locally fossiliferous and oölitic. Seven analysed1/ samples contained between 80 and 98 percent total carbonate minerals, of which only a few percent is dolomite. A few hundred feet of the highest exposed beds is light-gray to tan thin-bedded blocky dolomite that locally is sandy or silty; three samples contain between 79 and 98 percent total carbonate minerals, of which only a little is calcite. Most of the rock is marbleized in white patches and irregular streaks, or in irregular zones of large glistening crystals; near intrusive bodies the limestone is completely marbleized and is white. Much of the rock is fractured and contains calcite veinlets along the fractures.

One collection of fossils from a black silty limestone near the base of the unit was reported by A. R. Palmer (written communication, 1961) to include several genera of trilobites and brachiopods, the most significant of which is a probable new genus of the brachiopod Pegmatretid family, known previously only in the Albertella zone of the lower Middle Cambrian in eastern Nevada.

1/ Samples analysed for calcium and magnesium by J. A. Thomas, U. S. Geological Survey, by methods accurate to within ± 3 percent.

Surficial deposits

Four types of surficial deposits are mapped: glacial deposits of Pleistocene age, and mass-wasting, talus, and alluvial deposits of Recent age. Alluvial deposits include deltaic deposits of the Clark Fork, beach deposits, and recent stream deposits. An interesting feature of the mass-wasting deposits, which consist principally of angular to rounded boulders and cobbles, is the abundance of ice-cold year-round springs issuing from beneath them. One of these is within 500 feet of the top of Packsaddle Mountain, which suggests that permanent ice exists within the mass-wasting deposit.

Igneous rocks

Igneous rocks in the quadrangle include quartz diorite sills of probable Precambrian age, and diabasic to granodioritic sills, dikes, and plutons of probable Cretaceous age. In composition and superficial appearance some of the sills believed to be Precambrian ("Purcell" sills) are remarkably similar to diabase-diorite rocks thought to be Cretaceous. Their structural relations, however, are consistently different. The Precambrian(?) intrusive rocks form sills, whereas the Cretaceous(?) mafic intrusive rocks are in small plutons or in dikes that fill joints or faults which at many places cut or offset the Precambrian(?) sills.

Detailed descriptions have been given by Anderson (1930), who described all the varieties seen in the quadrangle but called the diabase-diorite sequence lamprophyres, and by Harrison and Jobin (1963). Only brief descriptions will be given here.

The Precambrian(?) quartz diorite is a greenish-black to mottled white and greenish-black, medium- to coarse-grained rock. It has generally been changed considerably since intrusion, and what apparently was largely a quartz-hornblende-pyroxene rock is now a hornblende-biotite-quartz-feldspar-calcite-epidote rock. The multiple exposures in the northwestern part of the map can be reconstructed into two pre-faulting "Purcell" sills.

The Cretaceous(?) granodiorite is a gray to mottled black and white, fine- to course-grained rock consisting principally of quartz, microcline, andesine, hornblende, and biotite. Internal structure in this rock is moderately well developed and can commonly be seen in alinement of tabular feldspar crystals or, in finer-grained rocks, in alinement of biotite crystals. Intrusion of this rock is believed in part responsible for the peculiar fracture pattern of the area (Harrison, Jobin, and King, 1961).

The diabase-diorite is a greenish-black to gray, fine- to medium-grained rock that in some dikes is slightly porphyritic. Most rocks are highly altered (deuteric?). A few of these dikes cut the granodiorite in the bold exposure of granodiorite along Pend Oreille Lake. Some of the dikes between Garfield Bay and Green Bay have irregular inclusions of granodiorite in them.

The youngest intrusive rock in the quadrangle is mottled black, white, and gray granodiorite porphyry that has a granophyric groundmass. Phenocrysts in this rock are principally orthoclase, plagioclase, hornblende, and biotite. Dikes commonly show a faint parallel alinement of phenocrysts and have a thin chill margin.

STRUCTURAL GEOLOGY

A complex shattered-glass pattern of fault traces in the quadrangle is the result of adjustments in a wedge of rock caught between the major northwest-trending Hope Fault on the north, the west-trending Osborn fault system that is about 40 miles to the south, and the north-trending Purcell Trench fault system, which is represented by faults in the northwestern part of the quadrangle. The first movement on some of the faults probably accompanied gentle folding and tilting of the Belt rocks before the Cambrian quartzite was deposited. A pre-Middle Cambrian throw of several thousand feet is required on the fault southeast of Packsaddle Mountain to explain the lack of Cambrian rocks in the fault block exposing the Striped Peak. Later, block faulting accompanied intrusion of the Cretaceous granodiorite (Harrison, Jobin, and King, 1961), and post-intrusion faulting in the area is well established (Sampson, 1928; Anderson, 1930). Renewed movement on older faults appears to be common.

Most of the faults are steep to vertical, and the lack of apparent offset shown at many fault intersections is in part a function of poor exposures and in part a function of dip slip movement on nearly vertical fractures. A few low-angle thrust faults of small throw were seen in the overturned beds near the head of West Johnson Creek. These thrust faults are too small and too discontinuously exposed to map. One major thrust is interpreted as bringing St. Regis over Prichard west of Barton Hump. Although it is tempting to interpret more of the poorly exposed faults as thrusts, their straightness across several thousand feet of topographic relief seems to preclude such an interpretation.

Drag folds and cleavage border most faults in zones a few tens to a few hundreds of feet wide. In intensely deformed areas, such as that east of Garfield Bay, cleavage is developed to the point where bedding is locally obliterated.

A general regional dip to the east results from the position of the quadrangle on the west side of a large syncline, probably of Precambrian age, whose axis is at the eastern edge of the Clark Fork quadrangle (Harrison and Jobin, 1963). Small folds west of Garfield Bay disrupt this regional pattern, but these wrinkles are probably related to drag along the major faults of the Purcell Trench system and not to the older fold system to which the major syncline belongs.

ECONOMIC GEOLOGY

Veins of base- and precious-metal sulfides have been mined in the quadrangle. The Lakeview Limestone makes good agricultural lime and Portland cement and has been quarried for these purposes near the south end of Lake Pend Oreille where it is most easily accessible.

Veins and mines in the quadrangle have been described by Sampson (1928). By far the most important mine in the area is the Talache, which was developed via a 3,500-foot crosscut from the mill at Talache west to the main vein. None of the mines was operating during the time of the writer's fieldwork, and only a few were accessible in part. The veins shown on the geologic map consist principally of vein quartz and pyrite, with sparse galena, pyrite, chalcopyrite, and sphalerite. Sampson reports that the high-grade ores were valued chiefly for their silver, which is contained in tetrahedrite, polybasite, and proustite.

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