UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Preliminary geologic map of the Abercrombie Mountain area, Pend Oreille County, Washington

By

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This map is preliminary and has not been reviewed for conformity with U. S. Geological Survey editorial standards and stratigraphic nomenclature

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INTRODUCTION

This map is part of a 1:48,000 scale preliminary geologic map series covering the Sandpoint 2° quadrangle. The series is a by-product of the Sandpoint 2° project, conducted under the auspices of the Regional Framework Studies Program and the Branch of Western Regional Geology. All the maps are 15' blocks photographically mosaiced from published 7.5' topographic quadangles. The preliminary geologic map series is designed to fill out areas within the Sandpoint 2° quadrangle not covered by geologic mapping at a scale of 1:62,500 or larger. Maps of this series make geologic information available as the project progresses so that interested parties do not have to wait until completion of the entire 2° sheet. In addition, a greater amount of information can be presented on the more detailed base of the preliminary maps than will appear on the final 2° compilation.

The preliminary maps are more detailed and accurate than reconnaissance maps, but because they are the outgrowth of 2° scale mapping and limited by the haste necessary to cover so large an area in a reasonable length of time, they are not the quality of U.S. Geological Survey maps released in more formal publication series. The coverage is relatively detailed in some areas but almost reconnaissance in others. The maps should therefore be considered preliminary and subject to refinement.

The central part of the geologic map was compiled directly from the map of Dings and Whitebread (1965) with only minor modifications and almost no field checking (see index of geologic mapping on map sheet). The few modifications resulted from re-mapping or re-interpretation of peripheral areas, but most were only simplifications necessitated by the reduction of map scale from 1:24,000 to 1:48,000.

DESCRIPTION OF MAP UNITS

Qag GLACIAL AND ALLUVIAL MATERIAL (Quaternary)--Includes drift from both alpine and continental glaciations, talus, and all alluvial material in modern drainages. In Pend Oreille River valley and some tributaries, also includes generally horizontal beds of tan-weathering slightly indurated sand, silt and clay deposited in glacial lakes.

Tb OLIVINE TRACHYBASALT OF DINGS AND WHITEBREAD (1965) (Tertiary)--Flows of olivine trachybasalt; found only at Basalt Hill 7 km north of Metaline Falls. Maximum thickness about 60 m. Contains microphenocrysts of clinopyroxene, olivine, and sodic plagioclase in matrix of glass, palagonite, and orthoclase. Trace amounts of magnetite or ilmenite, apatite, biotite, and limonite. Aphanitic to fine grained. Dark greenish gray to black; weathers brown. Locally vesicular. Not examined by authors; above description condensed from Dings and Whitebread (1965). Could be older or younger than Tiger Formation.

Tt TIGER FORMATION (Tertiary)--Includes conglomerate, fanglomerate, and minor sandy or arkosic beds. Locally well bedded, but commonly massive indistinct bedding. Nearly monolithologic at most places. Dominant clast type generally that of nearest bedrock formation, reflecting local provenance. Northwest of Box Canyon dominent clast is Ledbetter Slate, south of Cement Mountain is dolomite of Metaline Limestone, and between, is a mixture of slate and porphyritic biotite monzogranite. Clast size ranges from less than 1 cm to about 3 m; well rounded to barely rounded. Thickness variable in map area; thickest section reported by Park and Cannon (1941) is about 300 m, 10 km south of Cement Mountain. Gager (1982) interprets Tiger Formation as sedimentary accumulation in interplate basin(s) formed during listric normal faulting associated with emplacement of metamorphic core complex.

Ksc MONZOGRANITE OF SAND CREEK (Cretaceous)--Porphyritic biotite monzogranite. Characterized by abundant pink microperthitic orthoclase phenocrysts to 5 cm long (average, 3 cm). Most groundmass potassium feldspar is orthoclase also, but some is microcline. Average plagioclase composition an_{30}. Smoky gray anhedral quartz crystals average just under 1 cm across; slightly more abundant than in most granitic rocks of region. Biotite is only mafic mineral other than opaque minerals; most is slightly chloritized even in rocks that appear unaltered. Color index averages 8. Accessory minerals include abundant allanite and magnetite, and minor zircon and apatite. No muscovite, sphene, or hornblende seen. Texture is porphyritic, with medium-to-coarse-grained hypidiomorphic granular groundmass. Slightly seriate and finer grained near borders, may be chilled margins. Biotite from sample collected in southwest corner sec. 10, T. 38 N., R. 43 E., yields a potassium argon age of 98.7 $\pm$ 3.0 m.y. (Miller and Engels, 1975; recalculated using current IUGS approved constants (Steiger and Jager, 1977)).

Kt TWO-MICA GRANITIC ROCKS UNDIVIDED (Cretaceous)--Mixed muscovite-biotite granitic rocks ranging in composition from monzogranite to granodiorite. Most common type is medium-to-coarse-grained equigranular to sparsely porphyritic granodiorite. In Little Muddy Creek area, rock is identical to Phillips Lake Granodiorite of Miller and Clark (1975). Medium-to-fine-grained two-mica dikes, and alaskite, pegmatite, and aplite dikes similar to those in Phillips Lake mass are present in map area also. Rocks near margin of body appear slightly more mafic. Subtle to well-developed foliation developed in most of body. Cretaceous age based on discordent potassium-argon apparent ages for co-existing muscovite (88.1 $\pm$ 2.6 m.y.) and biotite (80.5 $\pm$ 2.4 m.y.) (Miller and Engels, 1975; recalculated using current IUGS approved constants). Emplacement age considered to be about 100 m.y. based on amount of discordance between mica apparent ages and on similarities to nearby two-mica rocks yielding concordant 100 m.y. ages.

Ks GRANITIC ROCKS OF THE SPIRIT PLUTON (Cretaceous)--Chiefly hornblende-biotite granodiorite and tonalite. Two, and possibly three, of Yates (1964) sub-units of Spirit pluton recognized, although not shown separately on map. Dominant rock type is medium-grained hornblende-biotite tonalite (Ks_2 of Yates, 1964). Distinguished by subhedral to euhedral plagioclase, small quartz crystals, contorted biotite, seriate texture, and association with abundant tabular inclusions and schlieren of metamorphic rock. Second most abundant rock is sphene-bearing biotite granodiorite (Ks_3 of Yates, 1964). Distinguished by thick books of biotite up to 5 mm across, and by elongate fractured quartz grains. Varient of this rock containing potassium feldspar phenocrysts may be Ks_4 of Yates (1964). Biotite from southwest part of pluton, west of map area yielded 102 $\pm$ 3.0 m.y. (recalculated using current IUGS approved constants) potassium-argon age.

Kgu GRANITIC ROCKS UNDIVIDED (Cretaceous(?))--Occurs as two small stocks and one dike-form body in Hooknose Ridge area. Western body is medium-to fine-grained hornblende-biotite granodiorite and coarse grained poikilitic hornblende gabbro. Both have relatively low color index for this type of rock. Fine-grained dikes associated with granodiorite. Eastern stock is more mafic. Medium-to fine-grained hornblende-biotite granodiorite most common rock type, but also minor fine-grained porphyritic hornblende tonalite. Former distinguished by blocky 5 mm long potassium feldspar crystals in equigranular groundmass of light and dark minerals.

DS SILURIAN AND DEVONIAN ROCKS UNDIVIDED (Silurian and Devonian)--Unit not mapped or examined by authors; following description condensed from Dings and Whitebread (1965). Black slate and argillite; contains beds of limestone, conglomerate, sandstone, and quartzite. About 95 percent of unit is black carbonaceous slate and argillite almost identical to most of Ordovician Ledbetter Slate. Even though appearance of the two units is the same, slates of Silurian-Devonian unit contain no disseminated carbonate minerals, but parts of Ledbetter Slate do. Carbonate in Silurian-Devonian unit restricted to discreet limestone beds, commonly medium to dark gray, which occur as isolated lenses less than 0.6 m thick. Some conglomerate contains only carbonate clasts, but most is mixture of phyllite, chert, quartzite, and vein quartz. Maximum thickness estimated to be about 610 m. Silurian graptolites identified in slate from Horsefly Hill (sec. 28, T.40 N., R. 43 E.), and Devonian corals, bryozoans, and brachiopods identified in limestone from Limestone Hill (sec. 16, T. 40 N., R. 43 E).

Ol
Olq
Old

LEDBETTER SLATE (Ordovician)--Fissile carbonaceous black slate. Lesser amounts of blocky fracturing black argillite and siltite, finally laminated argillite and fine-grained quartzite, and minor limy argillite and limestone. Some slate contains carbonate bearing zones; much of slate contains pyrite. Bedding ranges from well-defined and laminated to extensive slate masses in which recognizable bedding never existed or has been destroyed by cleavage. Lenses and thin beds of fine-grained black quartzite (Olq) most abundant in middle 300 m of formation. Dolomite (Old) uncommon, probably restricted to 30-45 m thick lenses in upper 150 m of formation. Contact with overlying Silurian-Devonian unit poorly defined; "placed at base of lowermost dark gray to black crystalline and fossiliferous limestone or associated quartzite of Silurian or Devonian age" (Dings and Whitebread, 1965). Apparent thickness estimated by Dings and Whitebread (1965), 670 to 760 m.

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METALINE LIMESTONE (Cambrian)--Subdivided into three lithologic units by Dings and Whitebread (1965), who emphasize the units are not formational members. Described here from youngest to oldest. Cmg, gray massive limestone. Medium gray, irregularly mottled, fine-grained, massively bedded limestone; sparse medium gray chert through most of unit. Contains several dolomite zones of irregular thickness. At least 540 m thick in Lead King Hills. bedded dolomite. White to light gray fine-to medium-grained dolomite. Some beds of black to dark gray dolomite with streaks and spots of white dolomite; black shale interbeds near base. Most medium-to thick-bedded, but no bedding recognizable over large areas. Contains 1 m- to 3 m-thick beds of intraformational breccia with matrix of black dolomicrite in middle part of unit. Other beds in this part of unit have en echelon veinlets of white crystalline dolomite called zebra banding by Dings and Whitebread (1965). Unit appears to be at least 1160 m thick (Dings and Whitebread, 1965). Ꞓmb, bedded limestone. Dark gray to black thin bedded phyllitic limestone and limy phyllite in lower 115 m. Grades upward into blue-gray limestone and impure shaly limestone with irregular wavy bedding. Contains oolitic and algal-bearing zones. Upper 120 m are dark gray to black thinly interbedded limestone, shale, and limy shale; bed thickness ranges from 0.5 to 15 cm. Weathers gray and brown. Contains Middle Cambrian trilolites about 180 m above base (Dings and Whitebread, 1965). Section on hill southeast of Metaline Falls at least 290 m thick. Ꞓma, silicified and dolomitized Metaline Limestone; includes parts of all three lithologic units making up formation. Rock commonly medium to dark gray, irregularly brecciated. Consists of variable amounts of crystalline dolomite, coarse calcite, some limestone, sparse jasperoid, and locally sulfide minerals. Sedimentary structures almost everywhere destroyed. Many small bodies not shown on map (Dings and Whitebread, 1965). Includes Josephine Breccia of Mills (1977), the main ore-bearing rock in the zinc-lead mines of the Metaline area.

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MAITLEN PHYLLITE (Cambrian)--Formation consists of interbedded phyllite, quartzite, phyllitic carbonate rocks, and carbonate rocks. Lower half made up of phyllite beds from a few centimeters to several tens of meters thick and beds of quartzite from a few centimeters to about one meter thick; Upper half of formation grades from almost pure phyllite to phyllitic limestone. Most of lower part is pale gray-green phyllite with 1 to 10 cm interbeds of tan or gray argillaceous quartzite. Internal deformation, chiefly small-scale folding, cleavage, and slip cleavage common in this part of section. Much of layering in unit probably transposed bedding, sedimentary structures only locally preserved. Limy upper part of formation consists of thin layers (beds?) of dark gray impure limestone and dolomitic limestone with phyllitic partings. Much of rock, even where mostly limestone looks like phyllite. Appears to grade upward into Metaline Limestone. Grades downward into Gypsy Quartzite. A zone of archaeocyathid-bearing limestone (€mr), the Reeves Limestone Member of Yates (1964), found at base of formation some places. Reeves varies from 0 to 200 m in thickness; probably tectonically thinned and thickened. Some carbonate-bearing phyllite above Reeves Limestone Member locally. Thickness of Maitlen, as calculated from outcrop width, about 2650 m. This figure is approximation, at best, due to pervasive internal deformation present throughout formation. Archaeocyathids near base of formation are late Early Cambrian age (Little, 1960).

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GYPSY QUARTZITE (Cambrian)--Formation is predominantly medium- to fine-grained quartzite, with lesser amounts of conglomeratic quartzite and phyllitic argillite. About 280 m of massively bedded white vitreous quartzite makes up basal part of Gypsy. Overlain by about 75 m of interbedded brown and green argillite and argillaceous quartzite. Argillitic rocks rest beneath about 170 m of crossbedded purple, white, and black striped quartzite which is overlain by about 450 m of pink, white, and tan quartzite in which a few striped beds occur. About 440 m of interbedded quartzite and argillite form top of formation. Phyllitic argillite beds progressively more abundant up section in upper 440 m of formation. Some quartzite and argillite are carbonate-bearing in uppermost 200 m. Section basically same on both sides of Flume Creek fault, except thickness of all subunits is less on west side by about 30 percent. Also, interval with pink and purple quartzites found on east side, is white with abundant disseminated magnetite on west side. About 75 km to southwest, Early Cambrian trilobites and gastropods found in uppermost carbonate-bearing part of correlative Addy Quartzite (Miller and Clark, 1975). Gypsy Quartzite rests unconformably on Proterozoic Z Three Sisters Formation of Walker (1934).

WINDERMERE GROUP (Proterozoic Z)

Zt THREE SISTERS FORMATION OF WALKER (1934)--Quartzite, conglomeratic quartzite (grit), conglomerate, phyllitic quartzite, and phyllite. West of Flume Creek fault, base is 5 m-thick fractured white fine-grained vitreous quartzite. Overlain by about 2 m of dolomite. Quartzite, phyllitic quartzite, and phyllite make up lower 300 m of formation above dolomite. Grit found locally near middle of formation. Conglomerate with argillaceous matrix occurs about 100 m from top; upper 100 m is interbedded conglomerate, phyllitic quartzite, and phyllite. Total thickness of section west of Flume Creek fault about 600 to 1200 m. East of Flume Creek fault, section is thicker and less deformed. Small area of Three Sisters Formation 2 km east of Sullivan Lake is southwest end of northeast striking belt of well exposed Three Sisters Formation extending into British Columbia. In this belt, contact between Three Sisters and underlying Monk Formation appears to be gradational; base of Three Sisters placed at base of lowest occuring quartzite or grit bed. Lower 700 m of formation consists of 80 or 90 percent gray to brownish-gray phyllitic argillite interlayered with beds of quartzite and grit up to 5 m thick. About 1100 m of white, tan, green and pink grit, quartzite, and conglomerate overlie the argillitic rocks. Next 200 m consists of green conglomerate that contains a 1 m-thick lava flow (greenstone) and about 35 m of probable volcaniclastic rocks above and below flow. Grit and quartzite similar to that in 1100 m-thick center part of formation make up upper 100 m of formation. Total thickness of Three Sisters east of Flume Creek fault appears to be about 2100 m, more than double average thickness of formation on west side of fault.

Zm MONK FORMATION--Only partial section exposed on either side of Flume Creek fault. On west side of fault upper 240 m of formation, as calculated from outcrop width, made up of white to cream-colored coarse-grained dolomite. Massively bedded, but locally faint laminae on weathered surfaces. Top 5 m are thin bedded white siliceous dolomite. May be some argillite in unexposed parts of section. East of fault, lower part of formation made up of diamictite, phyllite, quartzite, and thinly interlayered phyllite, quartzite, and dolomite; phyllonitic near Harvey fault. About 20 km northeast of Harvey Creek, on strike, a complete, relatively well-exposed section of Monk Formation consists of following: Chiefly argillite, but contains substantial amounts of dolomite, conglomerate, and quartzite. Lower 150 m of unit is a green-matrix conglomerate, which contains a high proportion of volcanic material probably derived from underlying Leola Volcanics. Conglomerate grades upward into 150 m of dark-gray fissile indistinctly bedded carbonaceous argillite, the predominant rock type of Monk formation. Argillite highly cleaved, forms poor outcrops. Argillite overlain by about 50 m of tan-weathering diamictite. More dark-gray argillite overlies diamictite and grades upward into well-bedded gray-green argillite about 50 to 100 m thick. Gray-green argillite lies immediately below about 20 m of thin-bedded limestone, lower 2 m of which is intraformational edgewise limestone conglomerate. Upper 500 m made up of dark-gray argillite and tan thick- to massively-bedded carbonate rocks. Beds of carbonate rocks occur at random intervals in argillite but become increasingly abundant and quartzitic upward in unit. Rests with apparent unconformity on Leola Volcanics and appears to grade upward conformably into Three Sisters Formation. Calculated thickness from outcrop width is about 1150 m. Southeast of Helmer Creek fault only miner diamictite; dominant lithology is carbonaceous argillite containing unsupported quartz grains. Numerous impure carbonate beds in this area.

Zl LEOLA VOLCANICS--Unit is made up almost entirely of greenstone derived from basalt flows and tuffaceous and volcaniclastic rocks. Most rocks phyllitic, highly sheared, and with few exceptions, no primary features are preserved. Most greenstone recrystallized and contains small porphyroblasts of blue-green hornblende. Formation appears to grade downward into Shedroof Conglomerate. No unconformity apparent between the two formations. Contact is placed at base of lowest group of massive flows in lower part of Leola. Thickness calculated from outcrop ranges from 160 to 1030 m in quadrangle; large range partly due to structural reasons, but most variation probably primary. In a more complete and less metamorphosed section 10 km to the northeast, thickness calculated from width of outcrop ranges from about 1530 to 1850 m. There, flows up to 25 m thick are massive and show little primary or secondary internal features except for well developed pillows in lower few hundred meters of formation. None of greenstone in quadrangle suitable for isotopic dating, but K-Ar whole rock dates on basalt flows from similar greenstone of correltative Huckleberry Formation 70 km southwest of area suggests the basalt was extruded between 837 and 928 m.y. ago (Miller, McKee, and Yates, 1973; recalculated using current IUGS approved constants).

Zs SHEDROOF CONGLOMERATE--Boulder and pebble conglomerate. Tan to rusty brown in lower part with abundant carbonate minerals in groundmass. Upper part characteristically gray-green with abundant chlorite and (or) epidote in groundmass and less carbonate minerals than in lower part. Clasts make up more than 50 percent of rock in most of tan lower part, but less than 25 percent in gray-green upper part. Clast size ranges from about 50 cm to less than 1 cm; most groundmass material is sand size. Quartzite, tan dolomite, and argillite most abundant clast types, minor granitic clasts present. Sorting poor, and degree of roundness fair to good. Most clasts flattened and elongated, and show preferred orientation parallel to slip cleavage developed in most of unit. All rock relatively well recrystallized even where sedimentary structures are preserved. Thickness ranges from 0 to 200 m in quadrangle. Appears to pinch out to southwest, but occurs again as thick as 460 m 65 km to southwest near Chewelah, Washington (Campbell and Loofbourow, 1962). Only 10 km northeast of Harvey Creek, the formation appears to be up to 3250 m thick.

BELT SUPERGROUP (Proterozoic Y)

Ywa_2 WALLACE FORMATION, UPPER ARGILLITE--Black to gray, phyllitic to schistose argillite. Most rock is highly phyllitic. One or more well developed slip cleavage(s) most places. Pencil slate common where two intersecting cleavages developed. Where not destroyed, bedding ranges from thinly laminated light and dark gray layers to silty argillite that shows no bedding features. Cross lamination, channel-and-fill and graded beds present in laminated part of section. Tan to gray dolomite and limy dolomite beds to 2 m thick sparsely scattered through section; normally separated by more than 50 m of carbonate-free argillite. Thickness of unit preserved in quadrangle is about 450 m as calculated from outcrop width; figure is estimate only, owing to probable unmapped folds, small faults and effect of slip cleavage. Unit is unconformably overlain by Shedroof Conglomerate.

Ywc WALLACE FORMATION, CARBONATE--Gray and tan dolomite and limy dolomite, argillite and siltite; minor limestone. Thin to thick bedded, platy to blocky weathering. Locally weathers into 3 to 10 m slabs that show fine internal layering. Algal structures present but not abundant. About 1/3 of unit is interlayered argillite and siltite. Much of carbonate rock is argillaceous and (or) arenaceous. Carbonate rock forms conspicuous rusty red soil. Poorly exposed most places, but locally well exposed. Apparent thickness calculated from outcrop width is about 300 m, but may be thinned or thickened structurally; thickness ranges from 330 m to 490 m in map area to east. Base of unit is base of lowest thick carbonate bed. May be equivalent to Sheppard Formation east of Purcell Trench (see sketch map).

STRUCTURE

The Pend Oreille River valley is a structural and topographic low. Paleozoic rocks in the valley have been downdropped along the Flume Creek fault on the west and the Slate Creek fault on the east. Within the valley, the Paleozoic rocks between these two bounding faults define a broad antiformal structure, upon which several minor folds are superimposed (Dings and Whitebread, 1965). The folds are chaotically broken by numerous high angle normal and second-order reverse faults. Both the major bounding faults and the smaller normal and reverse faults within the valley indicate an extensional tectonic regime. Large folds, in part overturned, flank the valley on either side and indicate a major period of compressional tectonics. The following discussion attempts to group related structures and suggest how these groups are interrelated.

The Flume Creek Fault appears to be the youngest fault in the map area, and cuts Cretaceous and possibly Tertiary granitic rocks a few km south of the map area. Its southernmost exposure, south of the map area, is on the projected traces of both the Newport fault to the south and the Jump Off Joe fault to the southwest; the projected juncture of the three faults is concealed beneath an extensive area of glacial-alluvial material. The Flume Creek fault trace is nowhere exposed in the Abercrombie Mountain map area, but three diamond drill holes about 2 km northwest of Metaline Falls penetrate the fault and indicate a dip ranging from 40 to 85 degrees east (Wimmler and Cole, 1949). The fault juxtaposes strata as young as Ordovician against the Proterozoic Z Monk Formation. Dings and Whitebread (1965) suggest the fault has a minimum of 3.7 km of throw based on stratigraphic separation.

We suggest, however, that the displacement is more on the order of 15 km, based on offset of major fold axes within terranes of similar structrual style. Specifically, the partially preserved anticline centering near the mouth of Lunch Creek on the west side of the Flume Creek fault appears to be the offset equivalent of the large anticline west of Sullivan Lake. Furthermore, regional geologic relations well south of the map area, extrapolated northward to the Flume Creek fault in the Melatine area, suggest that the movement was not simple normal slip, but that the western block was pushed from beneath the eastern block. The action of the lower (western) block moving from beneath the upper (eastern) block is interpreted as having created the extensional regime that produced the structures exposed in the Pend Oreille valley. This interpretation appears to be consistent with a comprehensive regional tectonic model proposed by R. A. Price (1982).

Even though most of the high angle normal and reverse faults in the Pend Oreille River valley are suggestive of an extensional regime, it cannot be demonstrated directly that the high angle faults and the Flume Creek fault are the same age. The higher degree and semi ductile style of deformation in the western block suggest that these rocks were once in a higher pressure-temperature environment than those immediately east of the Flume Creek fault. In addition the composition and texture of the monzogranite of Sand Creek suggests it may be the differentiated high level part of the Spirit pluton, the main body of which lies west of the map area.

The Slate Creek fault may be the same age as, and developed as a result of movement along, the Flume Creek fault, but the Harvey and probably the Russian Creek faults are older. The Harvey fault clearly pre-dates a Cretaceous granodiorite pluton east of the map area. In the Russian Creek area, however, relations are poorly exposed and it is not entirely certain that the Russian Creek fault is cut by the Cretaceous (?) rocks in that area or if the fault passes around the north end and cuts the stock. If the latter is the case, and the two faults are contemporaneous, then the mass they bound represents a wedge-shaped block that has been thrust from beneath the younger Paleozoic rocks in the Pend Oreille valley.

The Harvey fault appears to be a younger over older reverse or thrust fault of large displacement. Analogous to the Flume Creek fault, the rocks east of the Harvey fault may have under thrust the hanging wall rather than a more conventional overthurst relationship. Movement on this fault, however, clearly pre-dates that on the Flume Creek fault, and probably is contemporaneous with development of the large, in part overturned, folds on both sides of the Pend Oreille valley.

The faults around, and north of, Sullivan Lake and those in the Lunch Creek area are probably roughly contemporaneous with the Harvey fault, and represent adjustments in the cores of the tight folds in those areas.

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