GEOLOGIC MAP OF THE ELMIRA QUADRANGLE, BONNER COUNTY, IDAHO

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2007

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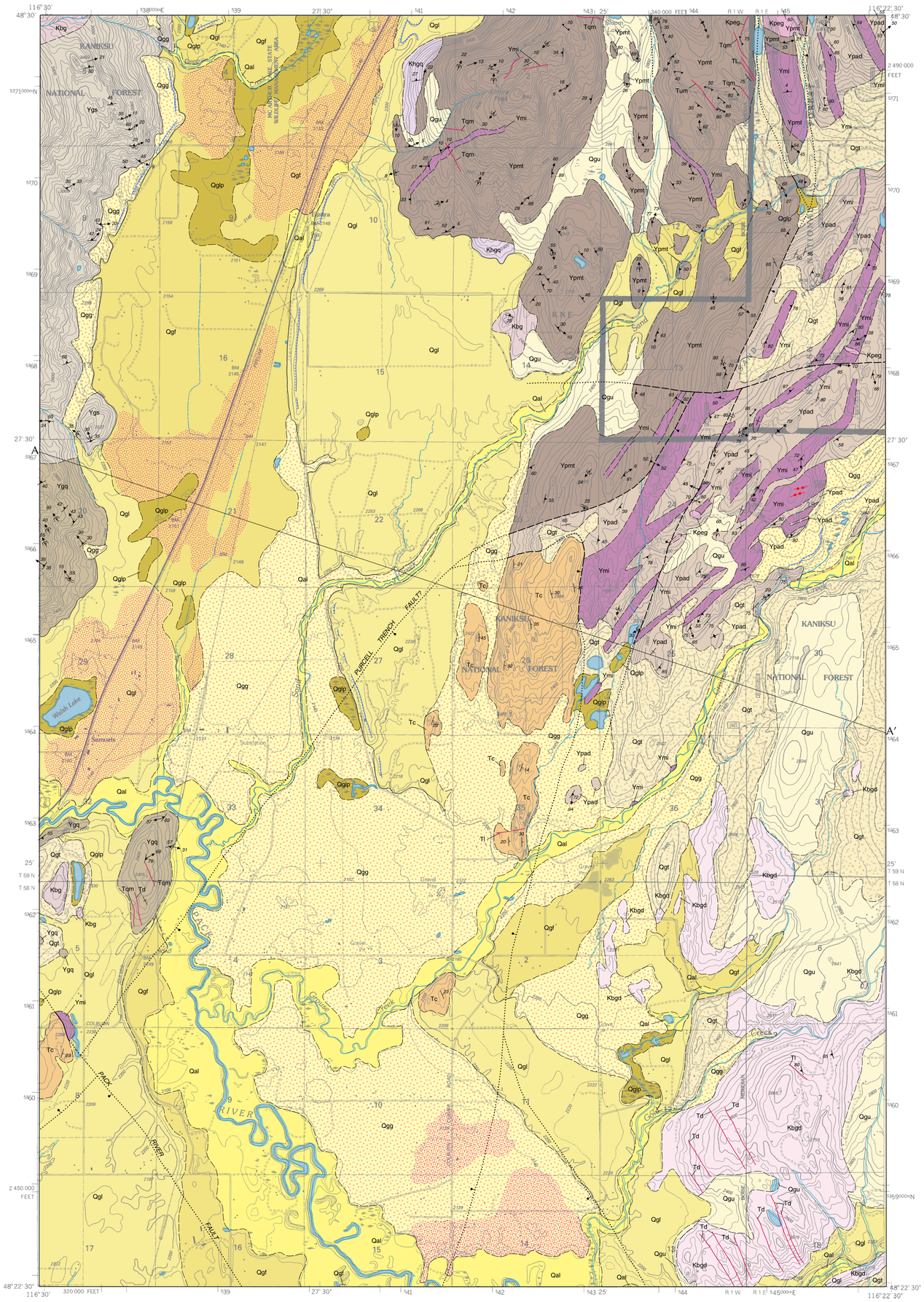

Base map scanned from USGS film-positive base, 1996.
Revision by USDA Forest Service 1996.
Topography comiled 1986. Planimetry derived from imagery taken 1992.
Public Land Survey System and survey control current as of 1996.
Transverse Mercator. 1927 North American Datum.
10,000-foot grid ticks based on Idaho coordinate system, west zone.
1000-meter Universal Transverse Mercator grid ticks, zone 11.
National geodetic vertical datum of 1929.

UTM Grid and 1996 Magnetic North Declination at Center of Map

SCALE 1:24,000

1 0.5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER

Contour interval 40 feet.
Supplemental contour interval 20 feet.

IDAHO
QUADRANGLE LOCATION

Field work conducted 2006.

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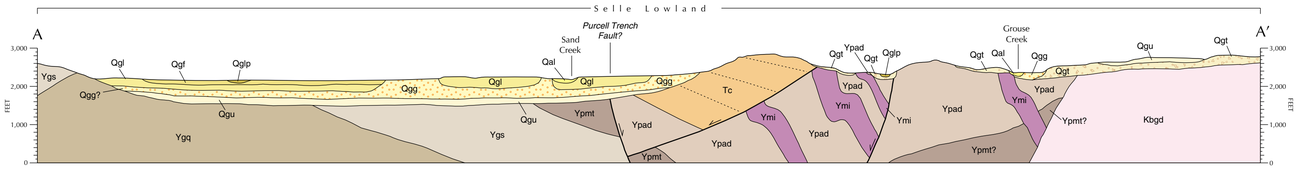
Digital cartography by Jesse S. Bird and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

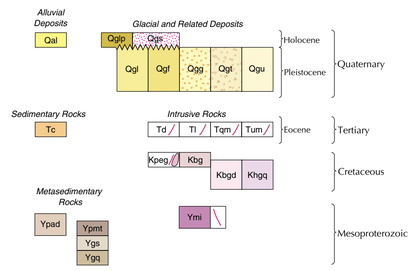
Note on printing: The map is reproduced at a high resolution of 600 dots per inch. The inks are resistant to run and fading but will deteriorate with long-term exposure to light.

PDF map (Acrobat Reader) may be viewed at www.idahogeology.org.

Map version 10-9-2007.



CORRELATION OF MAP UNITS



INTRODUCTION

Quaternary deposits on this 1:24,000-scale Elmira quadrangle were mapped in 1988-1989 and 2004-2006 by R.M. Breckenridge. Surficial mapping of part of the quadrangle by A.F. Harvey III (1984b) aided our compilation. Bedrock mapping was conducted in 2006 by R.S. Lewis and R.F. Burmester, and augmented mapping by Harrison and Schmidt (1971) and Doughty (1995).

Low metamorphic grade metasedimentary rocks of the Belt-Purcell Supergroup, Precambrian in age, occupy the northeastern part of the Elmira quadrangle and Cretaceous granodiorite the southeastern part. Amphibolite facies metasedimentary rocks are present to the west. A central zone of intermediate-grade metasedimentary rocks is exposed north of the Pack River fault and again east of Elmira. Eastward tilted Eocene conglomerate is exposed in the central and southwestern parts of the map.

The geomorphic subsection of the quadrangle is the Selle Lowland (Savage, 1967). During the Pleistocene glaciations a lobe of the Cordilleran Ice repeatedly advanced southward from Canada along the Purcell Trench. Tributary valley glaciers from the Selkirk Range on the west side of the trench and the Cabinet Range on the east side contributed to the main ice stream. The Pack River drainage was the source of a major tributary valley glacier in the Selkirk Range. South of this quadrangle the ice blocked the Clark Fork valley, formed Glacial Lake Missoula, and deeply scoured the Pend Oreille Lake basin. After retreat of the continental ice, alpine glaciers persisted until nearly 10,000 years ago in the higher cirques of the Selkirk Range. Glacial deposits fill the depression of the Purcell Trench and form the Selle Lowland. Holocene alluvium, colluvium, sand deposits, and lacustrine sediments are reworked glacial deposits.

DESCRIPTION OF MAP UNITS

Intrusive rocks are classified according to IUGS nomenclature using normalized values of modal quartz (Q), alkali feldspar (A) and plagioclase (P) on a ternary diagram (Streckeisen, 1976). Mineral modifiers are listed in order of increasing abundance for both igneous and metamorphic rocks. Grain size classification of unconsolidated and consolidated sediment is based on the Wentworth scale (Lane, 1947). Bedding thicknesses and lamination type are after McKee and Weir (1963), and Winston (1986). Thicknesses and distances are given in abbreviation of metric units (e.g., dm=decimeter). Multiple lithologies within a rock unit description are listed in order of decreasing abundance. Soil series are from Weisel and others (1982). Unified Soil Classifications of the surficial units are from Harvey (1984a).

ALLUVIAL DEPOSITS

Qal **Alluvium (Holocene)**—Varied silt, sand, and gravel deposits in modern stream drainages. Coarser in the Selkirk and Cabinet Range source areas and finer in the Selle Lowland. Moderately sorted to well sorted silt, sand and pebble and cobble gravels with scattered boulders. Mostly reworked glacial outwash and lacustrine deposits in the lowlands and reworked till and colluvium in the mountains. Typical soils are silt loam to sandy- and gravelly loam. Unified Classification is GP-GM and SP-SM Soil series of Hoodoo and Wrencoe. Thickness is thin to several meters.

GLACIAL AND RELATED DEPOSITS

Qglp **Peat deposits (Pleistocene to Holocene)**—Organic muck, mud and peat bogs in poorly drained paleoglacial outwash channels and kettles of the Selle Lowland. Interbedded with thin layers of fine sand, silt and clay. Soils of the Pywell series and Pt in the Unified Soil Classification. Thickness varies from 1-5 m.

Qgs **Sand deposits (Pleistocene to Holocene)—**pattern only. Sand deposits mostly from reworked glaciofluvial (*Qgf*) and glaciolacustrine (*Qgl*) units. Forms eolian dunes near Elmira. May also include large current ripples (*f*) from glacial outbursts from the Kootenai River ice dam near Bonners Ferry. The soil type is Selle-Elmira. Thickness varies from 2-6 m. SP-SM of the Unified Soil Classification.

Qgu **Glacial deposits, undivided (Pleistocene)**—Mostly loose cobbly silty sand with a silty fine sand matrix; pebble-to boulder-sized gravel. Includes deposits of till and associated proglacial outwash and glacial sediments. Occasional large boulders on bedrock and in till. Unstratified to poorly bedded, unsorted to moderately sorted. In tributary drainages and on slopes, composed of discontinuous remnants of till and kame terraces; on steeper unstable slopes may take the form of mass movements. May include some interbedded lake sediments. Soils mainly silt loam of the Pend Oreille series. Thickness varies from several to tens of meters.

Qgt **Till deposits (Pleistocene)**—Dense silt pebble and cobble till with local boulders deposited by the Purcell Trench Lobe of the Cordilleran Ice sheet. Poorly stratified compact basal till includes ground moraine and some interbedded. proglacial deposits. Extensive deposit occupies the Grouse and Sand creek drainages. Includes some kame terraces along valley margins. Soils include silt loams and gravelly silt loams of the Pend Oreille and Vay-Ardtoo series. Thickness varies; may exceed 50 m (160 feet).

Qgl **Glaciolacustrine deposits (Pleistocene to Holocene)**—Massive to finely laminated clay, silt, and sand deposited in ice marginal and post glacial lakes (*f*) occupying the Purcell Trench. Exhibits well developed rhythmites and beds of sand and silt. This unit includes deposits in the Selle Lowlands and discontinuous terraces in tributary valleys at about 732 m (2400 feet) and as high as 792 m (2600 feet). Mostly well sorted and finely laminated. Contorted bedding and loading structures are common. Overlain by glaciofluvial outwash deposits on terraces and in tributary valleys. Soils are silt loam and silty sandy loams of the Mission-Cabinet-Odenson series. CL to ML and SM classes in the Unified Soil Classification. Thickness tens of meters to over hundreds of meters in drill holes of the Selle Lowland.

Qgf **Glaciofluvial deposits (Pleistocene)**—Coarse silt, sand, and gravel deposits derived from glacial outwash. Mostly stratified sands and rounded gravels. Commonly occurs in channels within and interbedded with *Qgl*. Soils are gravelly silt loam to gravelly sand loam of Bonner-Kootenai series. Unified Soil Classification GM, GP, and SM. Thickness a meter to over tens of meters.

Qgg **Deposits of glacial outwash gravels (Pleistocene)**— Sandy cobble boulder gravel mostly preserved as terrace deposits from alpine valley glaciers in the Pack River valley probably underlies *Qgl* in the Selle Lowland; includes kame terraces of the Purcell Trench Lobe along the east slopes of the Selkirk Mountains. Soils of the Bonner-Kootenai series. SP-SM and ML classes in the Unified Soil Classification. Thickness varies; may exceed 50 m (160 feet).

SEDIMENTARY ROCKS

Tc **Sandpoint conglomerate (Eocene)**—Moderately to poorly sorted conglomerate containing clasts of Mesoproterozoic mafic sills (Ymi) and siltite and quartzite of the Prichard Formation. Eocene dike clasts are reported by Doughty and Price (2000) but we did not see examples during our investigation. Most clasts 2-20 cm across; some Ymi clasts to 10 m, quartzite clasts to 1 m. Abundant chlorite and epidote in matrix.

INTRUSIVE ROCKS

Tl **Lamprophyre dikes (Eocene)**—Biotite lamprophyre dikes with 1-2 mm biotite phenocrysts in a fine-grained groundmass. High magnetite content (magnetic susceptibility about 15 x 10^{-3} SI units). One dike that cuts the Sandpoint conglomerate northwest of the mouth of Jones Creek in the central part of the map yielded a 47.15 ± 0.24 Ma $^{40}Ar/^{39}Ar$ date on biotite (Doughty and Price, 2000).

Td **Dacite dikes (Eocene)**—Dacite dikes, generally porphyritic, with phenocrysts of potassium feldspar, plagioclase, hornblende, and biotite. Commonly light gray, resistant, and form cliffs and talus slopes.

Tqm **Quartz monzonite dikes (Eocene)**—Fine-grained biotite-hornblende quartz monzonite grading to monzonite. Acicular hornblende. One dike at the northern map boundary contains abundant subangular to rounded clasts of quartzite and granitic rocks where it crosses the ridge west of Bloom Lake.

Tum **Ultramafic dike (Eocene)**—Altered massive ultramafic dike exposed near the northern map boundary. Contains olivine, actinolite, and chlorite. Moderate magnetite content (magnetic susceptibility about 5 x 10^{-3} SI units).

Kpeg **Pegmatite (Cretaceous)**—Small masses of pegmatite intrusive into metasedimentary rock in the northeastern part of the map.

Khgq **Hornblende-biotite granodiorite and quartz diorite (Cretaceous?)**—Massive to foliated hornblende-biotite granodiorite and quartz diorite. Typically fine grained. Includes rocks mapped as "mixed granitic and metamorphic rocks of Deep Creek" (Miller and others, 1999). Harrison and others (1972) obtained a 58.1 Ma biotite K-Ar age (recalculated with new decay constants) on the southern mass, which they describe as fine-grained granodiorite. We interpret this as a cooling age, not a crystallization age.

Kbg **Biotite granodiorite and granite (Cretaceous)—**Massive to foliated biotite granodiorite and granite. Body in north-central part of map is equigranular medium-grained biotite granodiorite with about 7 percent biotite and a low magnetite content (magnetic susceptibility about 0.01 x 10^{-3} SI units).

Kbgd **Biotite granodiorite (Cretaceous)**—Massive to weakly foliated, medium- to coarse-grained biotite granodiorite exposed in southeast part of map. Typically porphyritic, with 1-3 cm potassium feldspar phenocrysts. Contains conspicuous books of biotite. Moderate magnetite content (magnetic susceptibility about 2 x 10^{-3} SI units). Includes rocks mapped as "granodiorite of Rapid Lightning Creek" (Miller and others, 1999). Biotite gives K-Ar ages of 75, 78, 92, and 98 Ma (Harrison and others, 1972; Miller and Engels, 1975; recalculated using new decay constants) indicating differential uplift or multiple plutons.

Ymi **Mafic intrusive rocks, undivided (Mesoproterozoic)**—Medium-grained hornblende gabbro, biotite quartz diorite, biotite-hornblende quartz diorite and fine-grained diorite. Low magnetite content (magnetic susceptibility 0.2-0.6 x 10^{-3} SI units). Occur as sills in the Prichard Formation. Thinner bodies on Elmira Peak are amphibolite. Probably all are Moyie Sills similar to the sills described by Bishop (1976), Höy (1989), Anderson and Goodfellow (2000), and Gorton and others (2000). Most are tholeiites or differentiates from tholeiitic magma and they intruded into middle and lower parts of the Prichard Formation. Intrusion of many sills was at shallow levels closely following sedimentation (Cressman, 1989; Sears and others, 1998).

BELT-PURCELL SUPERGROUP

Ypad **Prichard Formation, members a, b, c and d (Mesoproterozoic)**—Rusty weathering, dark gray siltite and argillite couplets, siltite, and rare lighter quartzite. Low magnetite content (magnetic susceptibility 0.04-0.2 x 10^{-3} SI units). All members a through d to the southeast in the Trout Peak quadrangle (Lewis and others, 2006) contain mafic sills, as do the rocks assigned to this unit in the Elmira quadrangle. Stratigraphic nomenclature from Cressman (1985). Units a-d mapped together because quality of exposures or fault blocks precluded subdivision. Ypad in the Elmira quadrangle is thick and may extend down-section farther than Prichard units to the southeast in the Trout Peak quadrangle where stratigraphy is better constrained by confidence in recognition of Prichard unit C above Ypab (Lewis and others, 2006). May also extend lower than Plains, Montana section described by Cressman (1985).

Ypmt **Metamorphosed Prichard Formation (Mesoproterozoic)**—Quartz-biotite-muscovite schist grading to gneiss, and feldspathic muscovite-biotite quartzite. Typically contains 5 -10 mm long lenses of muscovite. Probably equivalent to *Ypad* described above, but metamorphic grade is higher and rock is more coarsely recrystallized.

METASEDIMENTARY ROCKS OF THE PRIEST RIVER COMPLEX

Ygs **Gneiss and schist (Mesoproterozoic)**—Muscovite-biotite-plagioclase-quartz gneiss, biotite-muscovite schist, and muscovite-biotite schist. Includes unmapped amphibolite and granitic sills. Pegmatite bodies tens of meters across form cliffs and large talus blocks. In addition to micas, schist contains quartz and plagioclase. Unit is considered to be equivalent to the Hauser Lake gneiss (Weis, 1968; Weisenborn and Weis, 1976) and is probably metamorphosed Prichard Formation. Included in "mixed granitic and metamorphic rocks of Soldier Creek" by Miller and others (1999).

Ygq **Granofels and quartzite (Mesoproterozoic)**—Biotite-muscovite-quartz-feldspar granofels, feldspathic biotite quartzite, and muscovite-biotite-feldspar-quartz gneiss. Similar to gneiss and schist unit (*Ygs*) but more quartz-rich. Includes unmapped amphibolite and granitic sills. Probably metamorphosed Prichard Formation.

STRUCTURE

PURCELL TRENCH FAULT

Unlike to the north and south, where a sharp metamorphic change (amphibolite facies on the west and greenschist-facies on the east; Miller and others, 1999) is agreed on, placement of the Purcell Trench fault in the Elmira quadrangle is not straightforward. We place it east of where it was mapped by Miller and others (1999) and continue it farther north than Doughty and Price (1999, 2000). The metamorphosed Prichard formation (*Ypmt*) in the central part of the map is interpreted to be in the footwall of the fault, with the Sandpoint conglomerate and relatively unmetamorphosed Prichard Formation (*Ypad*) in the hanging wall. *Ypmt* is characterized by coarse lenses of muscovite and on Elmira Peak it contains garnet. Garnet barometry from there indicates pressures of about 6 kb (Doughty and Price, 2000). Potassium argon and argon-argon ages show no sharp break across the quadrangle. Biotite from a biotite-muscovite granite dike immediately west of the quadrangle was dated at 53 Ma (Fillipone, 1993). Metasedimentary rocks from the *Ypm* and *Ygq* units have yielded 63 and 59 Ma $^{40}Ar/^{39}Ar$ ages on biotite (Doughty and Price, 2000). Granodiorite in the eastern part of the quadrangle and east of the map has yielded biotite K-Ar ages of 98, 78, 75 Ma (Harrison and others, 1972; Miller and Engels, 1975; recalculated with new decay constants). These dates suggest a multi-stage uplift history along this portion of the Purcell trench.

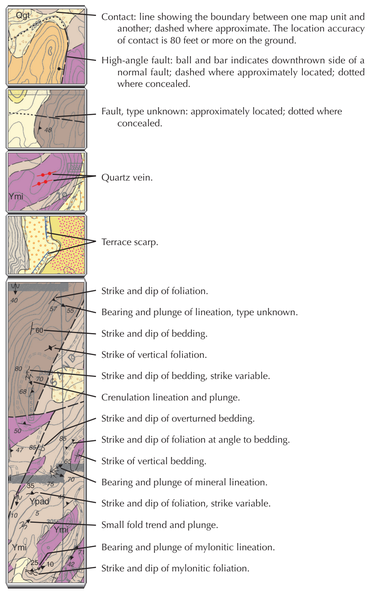
PACK RIVER FAULT

The herein named Pack River fault is a northwest-striking structure in the southwestern part of the Elmira quadrangle. Eocene Sandpoint Conglomerate (*Tc*) is down faulted on the southwest side of this structure.

ACKNOWLEDGMENTS

Mark McFaddan assisted with a traverse in the southeast part of the quadrangle and reviewed the map. Ted Doughty provided copies of his maps as well as insights on the complex structural history of the region.

SYMBOLS



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