Geologic Map of the Coeur d'Alene 30 X 60 Minute Quadrangle, Idaho

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INTRODUCTION

This compilation of the geology of the 1:100,000-scale Coeur d'Alene 30' x 60' quadrangle relied extensively on previous mapping. The principal sources were the seven unpublished 1:62,500-scale field maps used to prepare the 1:250,000-scale map of Griggs (1973). We supplemented Griggs' data with extensive field work in 1999, primarily in the northeast corner of the quadrangle. Basalt stratigraphy is based on the regional framework developed by Wright and others (1973) and Swanson and others (1979a, 1979b). Quaternary mapping in the Rathdrum Prairie area is based on our past unpublished and new work. The areal extent of the sources are shown on Figures 1 and 2. The geology of the Coeur d'Alene 1:100,000 quadrangle will also be published as a digital version in the Digital Data Series (see the Idaho Geological Survey's Web site: www.idahogeology.org).

The oldest and most abundant rocks in the Coeur d'Alene quadrangle are Precambrian (Figures 3 and 4). These include low-grade metasedimentary rocks of the Belt Supergroup and high-grade (amphibolite facies) metamorphic rocks whose protolith is either the Belt Supergroup or the basement rocks that predate the Belt metasedimentary rocks. The high-grade rocks are exposed in a metamorphic core complex in the western part of the map area (Priest River complex in Figure 4). Previously unmapped, deformed granitic rock (orthogneiss) of probable Cretaceous age is included in the core complex. Plutonic rocks of Cretaceous age are also present as intrusions within the low-grade Belt Supergroup. Relatively undeformed Eocene igneous rocks are exposed as plutons in the northwestern part of the map area and as a few rhyolite and dacite dikes in the central part. Flows of Miocene Columbia River basalt cover much of the western part of the quadrangle, although in places these flows are covered with Miocene sediments. Abundant Quaternary gravels in and near the Rathdrum Prairie were deposited by catastrophic floods derived from Glacial Lake Missoula.

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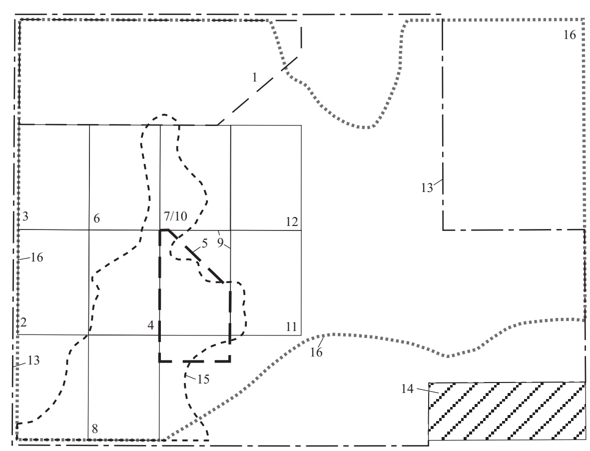

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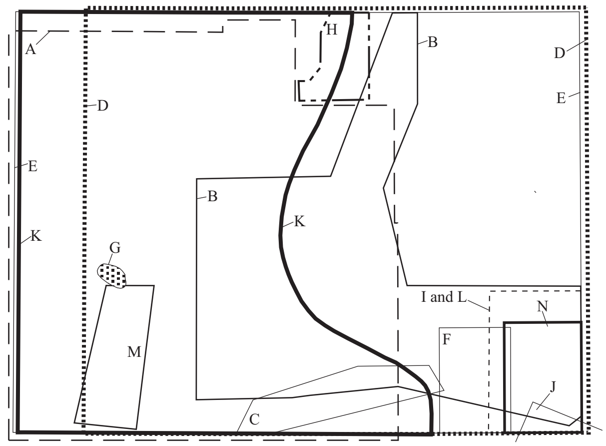
Figure 1. *Previous mapping used as primary sources of data.*



A. Anderson, 1940
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D. Griggs, 1968
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I. Ransome and Calkins, 1908
J. Shenon and McConnel, 1939
K. Swanson and others, 1979a
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N. Willoughby, 1986

Figure 2. *Previous mapping used as secondary sources of data.*

DESCRIPTION OF ROCK 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.

HOLOCENE DEPOSITS

Qal—Alluvial deposits (Holocene)—Stream deposits in modern drainages. Most deposits are composed of stratified, poorly sorted, and laterally discontinuous beds of sandy gravel with sand and silt lenses. Thickness of 3 m or less.

Qla—Lacustrine sediments and alluvium (Holocene)—Moderately to well-sorted, silt and sand deposits in bays of Coeur d'Alene Lake and Hayden Lake. The deposits are mainly located within the lakes' high-water zones and are interbedded with and grade upstream into alluvium of tributary streams. Soils are deep and poorly drained and include muck of the Pywell series and silt loam of the Cald, Cougar Bay, Pywell, and Ramsdell series (Weisel, 1981). Thickness as much as 5 m.

Qls—Landslide deposits (Holocene)—Nonsorted and poorly sorted, stratified angular basalt clasts mixed with silt and clay. Mass-movement slope deposits are mainly associated with steep basalt rimrock and the interbedded fine-grained sediments and weathering surfaces. Locally may include columns of basalt carried either by mass movement processes or by Glacial Lake Missoula floods. Gradations from talus to smaller landslide deposits are present and difficult to distinguish. Thickness as much as 12 m.

Qfg—Fluvial gravel (Pleistocene and Holocene)—Moderately to poorly sorted sandy gravel and sandy silt in abandoned drainageways of the latest Glacial Lake Missoula floods. The Coeur d'Alene and Hayden Lake basins were inundated by the largest releases from Glacial Lake Missoula. Unit is mostly reworked Miocene sediment and colluvium that were previously carried and deposited by lower energy Missoula floods in slack-water areas. Includes various thicknesses of Holocene alluvium and wetland bog deposits. Thickness as much as 3 m.

Qp—Palouse Formation (Pleistocene and Holocene)—Loess composed of massive silt and clayey silt of the Palouse hills in the eastern Columbia Plateau. Consists of many layers that represent periods of rapid loess deposition followed by long surface exposure and soil development. Depositional and soil units within the Palouse Formation form complex surface and subsurface patterns that are discontinuous and difficult to map. Thick, welded, clayey B horizons of paleosols are locally exposed through erosion, especially on steep amphitheater-shaped slopes with northerly aspects, and form low knobs below the high ridge crests of the Palouse hills. Where the loess is thin, it is mostly composed of late Pleistocene and Holocene deposits. The Palouse Formation has previously been restricted to only Pleistocene loess deposits, but some workers have included Holocene loess in it. The Palouse Formation overlies a Miocene-Pliocene surface primarily developed on the basalt of the Priest Rapids Member (Wanapum Basalt) and Tertiary alluvial deposits. Soils include the Santa and the Taney series (Weisel, 1981). Shown only by an overlay pattern without well-defined boundaries. Thickness less than 3 m. Thin to absent on surfaces scoured by Glacial Lake Missoula floods.

DEPOSITS OF GLACIAL ORIGIN

Qghcy—Gravel of Hoodoo channel, younger (late Pleistocene)—Poorly sorted, coarse boulder outwash gravel that forms the lowest terrace of Hoodoo channel and records the meltwater flow through Granite Lake to the Pend Oreille

River. Graded to the outlet of Pend Oreille Lake at Bayview at an elevation of 670 m (2,200 feet). Contains kettles from melted blocks of ice. Probably records overflow of the lake during the last phase of alpine glaciation in the region. Moraines of alpine valley glaciers in the Selkirk and Cabinet Mountains are still intact and postdate the retreat of Cordilleran ice from the southern end of the Purcell Trench. Postdates the last Cordilleran ice dam at Clark Fork about 12,000 years ago. Thickness as much as 18 m.

Qghcm—Gravel of Hoodoo channel, middle (late Pleistocene)—Poorly sorted very coarse boulder gravel with a granule and sand matrix; the gravel forms the middle terrace of Hoodoo channel and records the lowest elevation of flow through the Spirit Lake part of the Hoodoo channel. Graded to an elevation of 700 m (2,300 feet). Probably resulted from overflow of the Pend Oreille Lake basin during Cordilleran deglaciation of the Purcell Trench, or from a late ice-marginal and noncatastrophic drainage of Glacial Lake Missoula. Thickness as much as 30 m.

Qghco—Gravel of Hoodoo channel, older (late Pleistocene)—Poorly sorted, very coarse boulder gravel that forms the highest terrace of Hoodoo channel; graded to approximately 730 m (2,400 feet). Probably represents the last emptying cycle of a much diminished and shallow Glacial Lake Missoula. Thickness as much as 30 m.

Qgtow—Bouldery till and outwash deposits (late Pleistocene)—Nonsorted, bouldery clay till and boulder outwash deposits that form a modified end moraine at the south end of Lake Pend Oreille. Clay till recorded in well logs and exposed by excavations in Farragut State Park. Probably equivalent in age to the gravel of Farragut State Park and the distal facies of the oldest gravel of Hoodoo channel (*Qghco*). Thickness as much as 25 m.

CATASTROPHIC FLOOD DEPOSITS AND REWORKED OUTWASH

Qgu—Gravel, undivided (Pleistocene)—Shown only in cross section. Bouldery flood gravels of Rathdrum Prairie undivided for the purpose of the cross section. Fills a deep paleovalley between Round Mountain and Twin Lakes (Adema, 1999). Thickness as much as 180 m.

Qgf—Gravel of Farragut State Park (Pleistocene)—Poorly sorted, sandy boulder gravel at the Glacial Lake Missoula flood breakout from the south end of Lake Pend Oreille. Probably represents the last drainage from Glacial Lake Missoula and outwash from late Wisconsin glacial retreat. Includes reworked outwash facies from the bouldery till moraine (*Qgtow*) at the southern end of Lake Pend Oreille. Thickness from 10 to 30 m.

Qgc—Channel gravel, undivided (Pleistocene)—Latest Wisconsin catastrophic flood and outwash gravel and sand deposited in channelways cut into high energy fans and bars of Glacial Lake Missoula flood origin. Deposited during declining stages of last catastrophic flood event. The last overland flood event was post-“S” ash (13,000 years ago) and pre-Glacier Peak ash (11,200 years ago), perhaps 12,800 years ago (Stradling and Kiver, 1986). Moderately sorted and stratified in the lower flow regimes. The channels are commonly developed at the margin of the Rathdrum Prairie because the larger boulders armor the center of the flood path. Locally includes angular basalt columns derived from the basalt rimrock. Soil is gravelly loam of the Kootenai series (Weisel, 1981). Thickness from 3 to 12 m.

Qdg—Distal gravel deposits (Pleistocene)—Moderately sorted, sandy flood gravels. These deposits form eddy bars at the mouths of the tributary valleys to the Rathdrum Prairie. Lower energy eddy flows deposit finer facies behind the main bar form. May be mantled by post-Glacial Lake Missoula flood lacustrine silt and alluvial deposits. Thickness as much as 60 m.

Qds—Distal sand and silt deposits (Pleistocene)—Moderately sorted sand and silt with some gravel deposited in a lower energy, Glacial Lake Missoula flood regime; represents slack-water sediments in waning floodwaters or finer facies of pendant bar deposits. Includes planar medium-bedded sand of low flow regime. Overlain by postflood lacustrine silt and peat deposits in local basins. Thickness from 3 to 10 m.

Qgb—Gravel of Beck Road (Pleistocene)—Poorly sorted flood gravel graded to the lowest valley-filling episode of flooding continuous with the Spokane Valley, about 640 m (2,100 feet) at the Idaho-Washington state line. The gravel is associated with the most developed incision representing a large abandoned river channel meandering westward into Washington (Gerstel and Palmer, 1994). Two separate sets of thick-bedded foresets are exposed in deep gravel pits. Soil is very stony and includes the gravelly silt loam of the Garrison series (Weisel, 1981). Thickness in excess of 25 m.

Qgcd—Gravel of Coeur d’Alene (Pleistocene)—Mixed deposits of poorly to moderately sorted, stratified cobbly sand and sandy gravel carried by outburst floods and currents of reverse outflow from inundation of the Coeur d’Alene basin. Composes the deposits damming Coeur d’Alene Lake and forming giant current ripples on the lake bottom shown in seismic profiles (Breckenridge and Othberg, 1999a). Soil is gravelly silt loam of the McGuire series (Weisel, 1981). Thickness from 6 to 25 m.

Qgdg—Gravel of Dalton Gardens fan (Pleistocene)—Poorly sorted sandy gravel deposited in a large fan formed downstream from Hayden Lake outlet. Lobate in form at the downstream margin. Soil is fine gravelly silt loam of the Avonville series (Weisel, 1981). Thickness from 3 to 15 m.

Qgga—Gravel of Garwood (Pleistocene)—Poorly to moderately sorted sandy gravel deposited in a large fan formed downstream from the flood outlet of Lake Pend Oreille. Probably represents waning stages of the last recognizable flood event or a very small late flood. Includes local fans composed of gravel contributed from side drainages and rimrock basalt. Soils are gravelly silt loam of the Kootenai series and silt loam of the Bonner series (Weisel, 1981). Thickness from 3 to 15 m.

Qgm—Gravel of McGuire (Pleistocene)—Poorly sorted sandy flood gravel graded to an intermediate level of 650 m (2,140 feet) near Post Falls. Though extensive, the gravel unit appears to be characterized by incision and scour unconformities of a waning flood; the surface is marked by channel erosion and lag deposits. Soil is gravelly silt loam of the Garrison series (Weisel, 1981). Thickness from 20 to 30 m.

Qgmb—Gravel of McGuire, bar facies (Pleistocene)—Coarse, poorly sorted, imbricate flood gravel with parallel bedding. Forms a large longitudinal bar extending several miles west to the Idaho-Washington state line. Graded to the gravel of McGuire. Soil is very stony silt loam of the Garrison series. Thickness from 6 to 12 m.

Qgg—Gravel of Green Ferry (Pleistocene)—Coarse flood gravel. Consists of an extensive sheet of flood deposits in the quadrangle. Has poor sorting and variation in bedding; graded to about 670 m (2,200 feet) at Post Falls. Probably represents the last episode of major flood events about 12,800 years ago. Soil is gravelly silt loam of the McGuire-Marble association (Weisel, 1981). Thickness in excess of 30 m.

Qggf—Gravel of Green Ferry, fan facies (Pleistocene)—Poorly sorted, sandy flood gravel with channel cut and fill structures. The deposits form a large coalescing fan complex characterized by scour and fill features and concentrations of lag boulders, dissected by waning phases of flooding and smaller, later flood events. The depositional morphology of the fan tends to form lobes. Soils are fine gravelly silt loam of the Avonville series and gravelly silt loam of the Garrison series (Weisel, 1981). Thickness from 3 to 25 m.

Qggb—Gravel of Green Ferry, bar facies (Pleistocene)—Bouldery flood gravel. Coarse, poorly sorted imbricate flood gravel with large-scale foreset bedding. Forms a large channel bar with well-developed current ripples at the surface. Soil is gravelly silt loam of the Avonville series (Weisel, 1981). Thickness as much as 12 m.

Qgs—Gravel of Scarcello Road (Pleistocene)—Mixed deposits of poorly to moderately sorted, stratified cobbly sand and sandy gravel carried by outburst floods. Forms a well-developed terrace at about 720 m (2,360 feet) in elevation. Soil is gravelly silt loam of the Kootenai series (Weisel, 1981). Thickness from 6 to 25 m.

Qghl—Gravel of Hayden Lake (Pleistocene)—Coarse, poorly sorted gravel forms a terrace at about 700 m (2,300 feet) along the eastern margin of Rathdrum Prairie. Characteristically contains columns of basalt eroded from the nearby rimrock and large rip-up clasts of clay from the Latah Formation. Soils are fine gravelly silt loam of the Avonville series and gravelly silty loam of the Kootenai series (Weisel, 1981). Thickness from 12 to 15 m.

Qgtl—Gravel of Twin Lake (Pleistocene)—Poorly sorted, bouldery flood gravel deposited as a major pendant bar in the lee of Round Mountain, a scoured bedrock knob. Soils are gravelly silt loam of the Kootenai series and the Kootenai-Rathdrum association (Weisel, 1981). Thickness as much as 25 m.

Qgsly—Gravel of Spirit Lake, younger (Pleistocene)—Poorly sorted, bouldery flood gravel deposited as a large fan directly from the earlier and larger flood breakouts from Lake Pend Oreille. Forms the second (youngest and lower) of two high fan surfaces isolated by later flood erosion. Soil is cobbly silt loam of the Kootenai series (Weisel, 1981). Thickness as much as 30 m.

Qgslo—Gravel of Spirit Lake, older (Pleistocene)—Poorly sorted, bouldery flood gravel deposited as a large fan directly from the earlier and larger flood breakouts from Lake Pend Oreille. Forms the first (oldest and highest) of two high fan surfaces isolated by later flood erosion. Locally contains some very large boulders greater than 5 m that were probably carried in icebergs. Surface marked by giant current ripples up to 150 m (500 feet) between crests and 12 m (40 feet) in height. Pattern of current ripples shows divergent flow directions both north toward the Pend Oreille River drainage and south down Rathdrum Prairie as the floodwaters were deflected by the Mount Spokane uplands. Soils are gravelly silt loam and silt loam of the Kootenai-Rathdrum association mantled by loess and Mazama volcanic ash (Weisel, 1981). Thickness in excess of 30 m.

Qgrp—Gravel of Ross Point (Pleistocene)—Poorly to moderately sorted, coarse, stratified sandy gravel forms the highest preserved remnant flood terrace south of Spirit Lake at about 713 m (2,340 feet) in elevation. Represents the earliest of the flood deposits recognized in the area; may be equivalent to the gravel of Spirit Lake. Has the most soil development of all the Rathdrum Prairie gravel units: the gravelly and sandy silt loam of the Avonville series and the McGuire-Marble association (Weisel, 1981). Thickness in excess of 50 m.

OLDER SEDIMENTS

Ts—Sediment (Miocene)—Mostly deeply weathered yellow to orange silt and clay, but also quartzite pebbles and cobbles, and sand. Clasts derived primarily from the Belt Supergroup. Typical thickness is 5-15 m. Cobble and pebble gravels consist of mature, rounded quartzite and other rock types derived from the Precambrian Belt Supergroup and the Mesozoic-Tertiary intrusions. In the western part of the area, the unit forms a flat to gently sloping upland surface 730-790 m (2,400-2,600 feet) in elevation that is underlain by basalt of the Priest Rapids Member (Wanapum Basalt). The unit grades laterally into thick colluvium or residuum of pre-Tertiary rocks. These deposits are probably graded to high base levels formed when the Miocene plateau basalt flows blocked and diverted stream drainages (McDaniel and others, 1998). These basalt-related sediments are considered part of the Latah Formation. The age of the deposits in the eastern part of the area is unknown, and these deposits are not included in the Latah Formation. Unit includes clay-rich interbeds of sediment between flows of Columbia River Basalt Group exposed 2 km west of Coeur d'Alene. Most interbeds are too poorly exposed or too thin to show at map scale, so they are included in the basalt map units.

COLUMBIA RIVER BASALT GROUP

Saddle Mountains Formation(?)

Tmfb—Basalt of Mica Flats (Miocene)—Medium gray to dark gray, fine-grained basalt. Microphyric with abundant plagioclase laths and needles, typically < 1 mm in length; a few scattered plagioclase phenocrysts as laths as much as 4 mm in length, or as clear to waxy clots and clusters as much as 4 mm across. Diktytaxitic cavities common but irregularly distributed. Freshly broken surfaces commonly have a rough, irregular texture. Known only from outcrops along U.S. Highway 95 and in a small rock quarry west of the highway, just south of Mica, and in the Idaho Highway Department's quarry east of Mica. Stratigraphically above Priest Rapids Member (Rosalia chemical type) where exposed along the highway. Probably underlain there by an interbed containing quartzite pebbles and cobbles. Unit consists of one known flow having reverse magnetic polarity. The mean paleomagnetic direction for the basalt of Mica Flats is distinct from the mean direction for Priest Rapids' Rosalia flows from nearby locations. Chemically the unit is also distinct from Priest Rapids, as well as from other known Wanapum and Saddle Mountains Basalt chemical types. Because of its position above Priest Rapids (Rosalia chemical type), it is tentatively correlated with Saddle Mountains Basalt. Additionally, it does not appear to be time-correlative with younger Priest Rapids (Lolo chemical type), the uppermost Wanapum unit found farther to the south, because the paleomagnetic direction differs significantly from that of the Lolo unit. At least 12 m is exposed in the quarry east of Mica, although the base of the unit has not been uncovered.

Wanapum Formation

Tpr—Priest Rapids Member (Miocene)—Medium gray to dark gray basalt. Typically has a grainy, felty texture caused by abundant small plagioclase and olivine phenocrysts and by microvesicles and diktytaxitic cavities. The denser parts of the flows are dark gray to black and fine grained; they lack the grainy texture, although small plagioclase phenocrysts are apparent. Outcrops weather gray-brown to reddish brown. In thick flows, large, poorly defined basal columnar zones 3-6 m thick change upward to slabby, platy zones that are typically medium bluish gray on fresh surfaces. Above the platy zones, flows commonly have a thick blocky to hackly entablature, 15 m or more thick, and in places well-developed thin, vertical to radiating columns. The top of the entablature grades upward into an increasingly vesicular, rubbly in places, flow top. Thin flows are more vesicular throughout and generally have only weakly developed basal columns and a vesicular flow top. Pillow-palagonite complexes are locally common at the base of flows or flow units (series of chemically similar thin flows that grade laterally into a single flow). The Priest Rapids Member consists of one or more flows of Rosalia chemical type and has reverse magnetic polarity. Thicknesses of individual flow units range from 8 to 25 m for thin units and as much as 180 m for thick units.

Grande Ronde Formation

Tgn$_2$—Grande Ronde N$_2$ magnetostratigraphic unit

(Miocene)—Dark gray to black, fine-grained aphyric to very sparsely plagioclase-phyric basalt. Locally, at least one flow near the top of this unit has a Priest Rapids-like grainy, felty texture. Large columns of the basal colonnade are generally visible only in quarry cuts. Natural exposures are typically of the thick entablature, consisting of either thin, well-developed and commonly radiating columns, or poorly developed columns with a blocky, hackly character. These entablature exposures are commonly cliff-forming masses that can be traced laterally for several miles. Individual flows are generally over 30 m thick and may be more than 60 m thick. Locally, hyaloclastic material is associated with the top of individual flows, especially near contacts with basement rocks.

Grande Ronde N_2 has normal magnetic polarity and is the lowermost basalt unit exposed on most of the Coeur d'Alene quadrangle; generally, its base either is not exposed or lies directly on prebasalt basement rocks. However, on the east side of Coeur d'Alene Lake near the south edge of the Coeur d'Alene quadrangle, the top of a Tgr_2 flow is exposed along the shoreline beneath the base of Tgn_2; this Tgr_2 flow is also present beneath the Tgn_2 along the west shoreline of the lake at University Point and Black Rock, but is too thin to show at map scale. Tgn_2 is overlain by either *Ted* or *Tpr* flows.

Tgr_2—Grande Ronde R_2 magnetostratigraphic unit (Miocene)—Dark gray to black, fine-grained aphyric to very sparsely plagioclase-phyric basalt similar to Tgn_2. One flow, with reverse magnetic polarity, is the lowermost basalt unit exposed along the Coeur d'Alene Lake shoreline. Only the vesicular top and upper part of the blocky entablature of this flow are exposed.

INTRUSIVE ROCKS

Tr—Rhyolite dikes (Eocene)—Light gray rhyolite dikes, most or all of which are porphyritic. Phenocrysts are quartz, andesine, and biotite. Present only in the area southeast of Beauty Bay, where Anderson (1940) mapped these dikes as rhyolite porphyry.

Td—Dacite dikes (Eocene)—Gray, porphyritic dacite dikes. Phenocrysts of plagioclase, biotite, quartz, and hornblende are set in a fine-grained groundmass. Present only at the mouth of Wolf Lodge Creek.

Tbgf—Fine-grained biotite granite (Eocene)—Gray, fine-grained, biotite granite. Locally forms lit-par-lit injection into *YXgn*. Potassium feldspar is interstitial. Termed the Rathdrum Mountain Granite by Rhodes and Hyndman (1984). Unpublished U-Pb zircon data of M.E. Bickford indicate an approximate 52 Ma age for this rock (Rhodes and others, 1989).

TKdd—Diabase and diorite dikes (Tertiary or Cretaceous)—Fine- to medium-grained, pyroxene-bearing mafic dikes mapped by Hobbs and others (1965) in and near the Coeur d'Alene mining district. Most are probably quartz diorite or diorite in the IUGS classification scheme (Streckeisen, 1976).

TKla—Lamprophyre dikes (Tertiary or Cretaceous)—Lamprophyre dikes with biotite or hornblende phenocrysts or microphenocrysts in a fine-grained groundmass. These dikes were mapped in and near the Coeur d'Alene mining district by Hobbs and others (1965).

TKg—Granitic rocks, undivided (Tertiary or Cretaceous)—Predominantly medium-grained granite and granodiorite, but may include diorite. Largest intrusion is the Beauty Creek stock, a porphyritic biotite granite described by Anderson (1940) as porphyritic quartz monzonite. Composed of 25 percent quartz, 30 percent zoned andesine, 30 percent orthoclase, 15 percent biotite, and trace amounts of zircon, apatite, and magnetite (Anderson, 1940).

TYqd—Quartz diorite dikes and sills (Tertiary, Cretaceous, or Proterozoic)—Dark green, fine-grained, hornblende quartz diorite. Previously considered Precambrian in age (Griggs, 1973), but many dikes cross-cut stratigraphy and are thus unlike the Precambrian sills in the Prichard Formation north and east of the map area. All or part of unit may be Cretaceous or Eocene in age.

Kphgd—Porphyritic hornblende-biotite granodiorite (Cretaceous)—Light gray, limonite-stained, highly porphyritic, hornblende-biotite granodiorite. Matrix is fine grained. Average composition is 30 percent quartz, 30 percent plagioclase, 20 percent orthoclase, 8 percent biotite, 7 percent hornblende, and 5 percent calcite, epidote, zoisite, apatite, and zircon (Kun, 1970). Plagioclase has prominent zoning and is typically altered. Unit continues to the north along east side of Pend Oreille Lake where a sample of presumably similar rock yielded a K-Ar date (biotite) of 87.7 Ma (recalculated from Miller and Engels, 1975).

Kbgd—Biotite granodiorite (Cretaceous)—Light gray, medium-grained, equigranular, biotite granodiorite of the Hayden Lake stock. Readily weathers to grus. Composed of 25 percent quartz, 40 percent zoned andesine, 15 percent interstitial microcline, 15 percent biotite, and extraordinarily large amounts of epidote in addition to chlorite, sphene, zircon, allanite, zoisite, sericite, and apatite (Anderson, 1940). K-Ar date on biotite is 83.8 Ma (recalculated from Miller and Engels, 1975).

Khgd—Hornblende-biotite granodiorite (Cretaceous)—Gray, medium-grained, hornblende-biotite granodiorite. Mafic mineral content varies, and unit probably is composed of multiple plutons or plutonic phases. Three typical samples contain 22-23 percent quartz, 41-43 percent plagioclase, 10-19 percent microcline, 11-13 percent biotite, and 6-15 percent hornblende (Gillson, 1927). A mafic marginal phase at Cape Horn east of Bayview contains 25 percent biotite and 5 percent hornblende (Gillson, 1927). Biotite is typically in thick euhedral books. Mafic phase mapped to the north as granodiorite of Salee Creek (Miller and others, 1999). Includes hornblende-bearing phases of the Kelso Lake pluton. Termed the Bayview batholith by Gillson, (1927) and Anderson (1940). A K-Ar date on biotite of 74.6 Ma (recalculated from Miller and Engels, 1975) is from the less mafic central part of the exposed pluton or plutons.

Kqd—Biotite-hornblende quartz diorite (Cretaceous)—Dark gray, equigranular, medium-grained quartz diorite. Rock contains about 13 percent quartz, 55 percent plagioclase, 15 percent biotite, 30 percent altered hornblende, and no potassium feldspar. Trace amounts of sphene, apatite, magnetite, and zircon; trace pyroxene in cores of hornblende. Appears to be a marginal phase to the *Khgd* unit. Extent is uncertain.

Kog—Orthogneiss (Cretaceous)—Gray, moderately to strongly foliated, moderately lineated biotite- and hornblende-biotite tonalite, granodiorite, granite, and quartz diorite. Muscovite bearing at the eastern edge of Round Mountain and magnetite-rich phase in roadcuts along U.S. Highway 95 near the mouth of Cougar Creek. Rocks mapped as *Kog* are heterogeneous and range in composition from granite to quartz diorite. Contains amphibolite bodies up to 100 m wide with contacts approximately parallel to foliation. Foliation is overprinted locally by s-c fabric (see Simpson and Schmid, 1983) with top-to-the-east sense of shear. Radiometric dates do not exist, but orthogneiss is considered to be Cretaceous based on similarities with deformed, approximately 94-Ma phases of the Cretaceous Idaho batholith near Lowell (Toth and Stacey, 1992) and to the Cretaceous Newman Lake orthogneiss exposed immediately west of the map area (Armstrong and others, 1987).

KYam—Amphibolite (Cretaceous or Proterozoic)—Black to dark gray, fine- to medium-grained, foliated to lineated hornblende-plagioclase meta-igneous rock. Present in schist considered by some workers as metamorphosed Prichard Formation (Griggs, 1973) and thus may be metamorphosed Proterozoic basaltic sills. However, those associated with *Kog* unit and those with relict pyroxene are probably Cretaceous.

PALEOZOIC ROCKS

Ꞓl—Lakeview Limestone (Cambrian)—Light to dark gray, thin- to thick-bedded, blocky limestone (Griggs, 1973). Includes blocky gray dolomite unit in upper part; contains some silty to sandy intervals and is metamorphosed to marble or hornfels adjacent to granitic intrusive rocks. Unit was mined for lime at Bayview (Savage, 1969). Thickness at least 2,000 feet (610 m), with the top eroded (Griggs, 1973).

Ꞓrg—Rennie Shale and Gold Creek Quartzite (Cambrian)—Rennie Shale is a fissile olive-colored fossiliferous shale, about 30 m (100 feet) thick, that is poorly exposed (Griggs, 1973). Underlying the shale is white to pale pink, vitreous coarse-grained quartzite. Contains some pebble conglomerate at its base. Thickness according to Griggs (1973) is about 500 feet (152 m).

BELT SUPERGROUP

Yl—Libby Formation (Middle Proterozoic)—Dark gray argillite and light gray to green siltite, green and red siltite, pink, fine-grained quartzite, and minor chert. Nonresistant and poorly exposed. Lower part is predominantly dark gray argillite and lighter-colored siltite. Coarsens upward into siltite and quartzite that contain dark green chert as thin beds and rounded clasts. Upper part eroded, but at least 200 m remain.

Ysp—Striped Peak Formation, undivided (Middle Proterozoic)—Quartzite and interbedded siltite and argillite. Probably consists largely (or entirely?) of Ysp_1. Shown only where lack of mapping prevented subdivision.

Ysp_4—Striped Peak Formation, member four (Middle Proterozoic)—Light gray to red, fine- to medium-grained arkosic quartzite and interbedded siltite and argillite. Characterized by 30- to 40-cm-thick tabular beds of flat-laminated, pink quartzite with red argillite caps and wavy laminated green siltite-green argillite in zones 10-30 cm thick. Less common are centimeter-scale-thick “apple green” argillite-siltite beds, and 1- to 2-m-thick beds of pink quartzite that locally contain large-scale, tangential cross-stratification. Thickest quartzite beds and quartzite with medium-grained sand lag deposits are present low in the unit. Mudchips are common throughout, as are conspicuous detrital muscovite flakes. Quartzite contains less potassium feldspar and more plagioclase (as much as 20 percent) than is present to the south (Lewis and others, 2000) and southeast (Lewis, 1998).

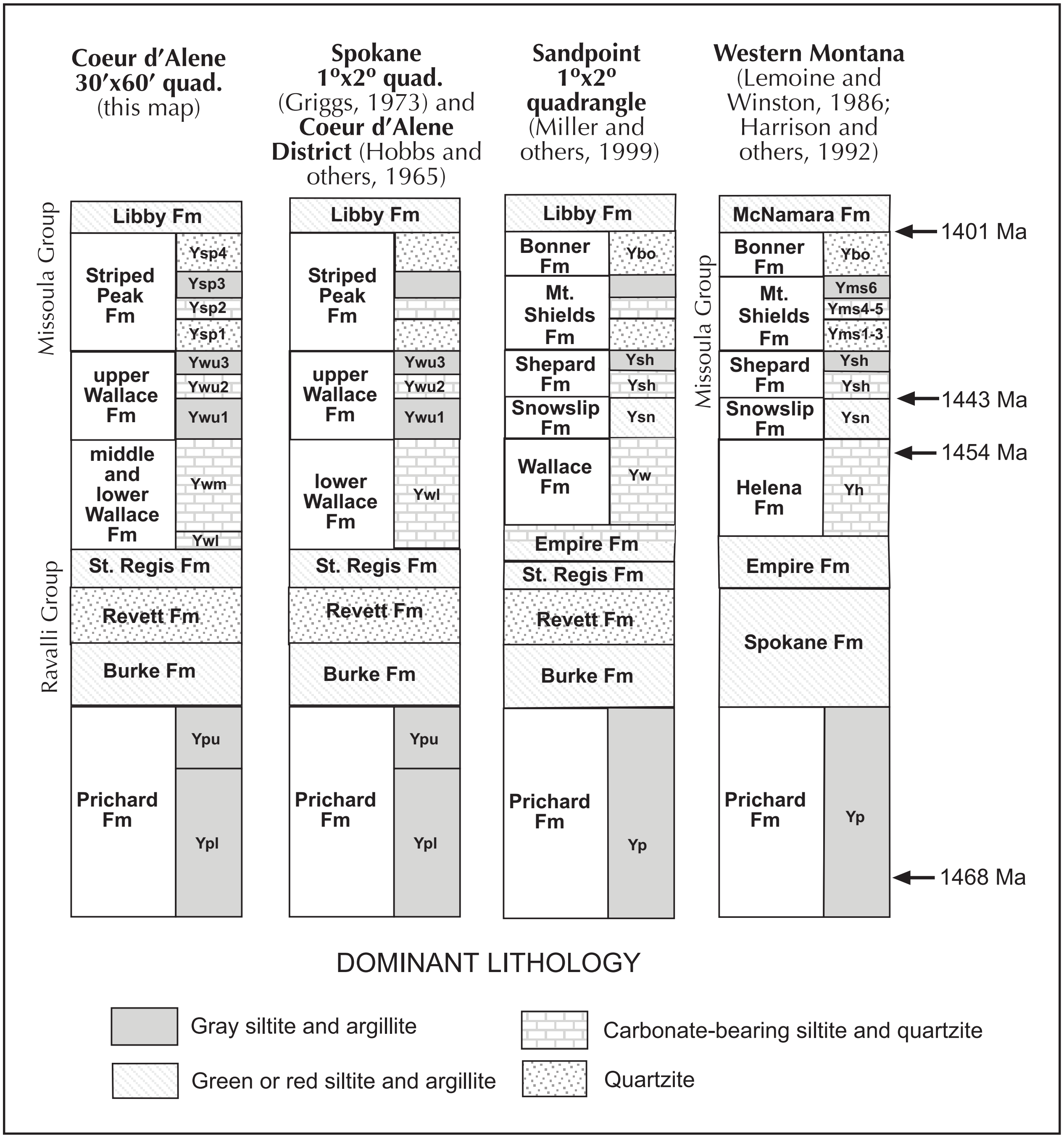

Figure 3. *Summary of Belt Supergroup nomenclature in the Coeur d'Alene quadrangle and surrounding area. Ages are U-Pb zircon dates of sills (Prichard Formation; Evans and others 2000) and volcanic rocks (Helena and younger formations; Anderson and Davis 1995).*

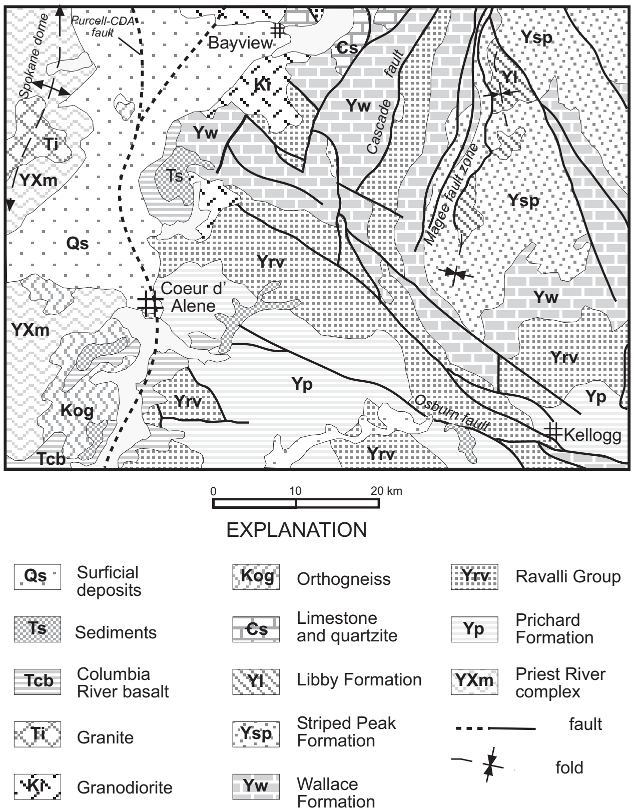

Figure 4. *Simplified geologic map of the Coeur d'Alene 30′x 60′ quadrangle.*

Red chert clasts were noted at one quartzite locality on the ridge east of Calamity Creek in the northeast corner of the map area. Below this quartzite at this locality is a 20-cm-thick ash(?) bed with no internal structure and a conchoidal fracture pattern. Base of *Ysp*$_4$ is drawn at the lowest appearance of 20- to 30-cm-thick tabular light green quartzite. Upper contact is the lowest appearance of dark gray argillite and gray siltite of *Yl*. Equivalent to uppermost Striped Peak Formation (quartzite member of Harrison and Jobin, 1963) near Clark Fork and to the Bonner Quartzite (Nelson and Dobell, 1961) present in the Missoula area (Figure 3). Thickness approximately 280 m in the northeastern part of the area.

Ysp$_3$—Striped Peak Formation, member three (Middle Proterozoic)—Rusty weathering, wavy laminated, dark gray siltite and dark gray to black argillite, and lesser amounts of gray to greenish gray quartzite in thin beds as much as 10-cm thick. Totally black argillite is rare. Thin, dark gray argillite chips occur sparsely within some 10-cm-thick, dark gray argillite layers. Unit is equivalent to member six of the Mount Shields Formation (Figure 3) described to the northeast in the Kalispell quadrangle (Harrison and others, 1992) and to the laminated argillite and siltite member of the Striped Peak Formation in the Clark Fork area (Harrison and Jobin, 1963). Thickness approximately 120 m in the northeastern part of the area.

Ysp$_2$—Striped Peak Formation, member two (Middle Proterozoic)—Tan-weathering, white stromatolitic dolomite and tan-weathering, green dolomitic siltite. The dolomitic siltite is low in the unit and grades upward from carbonate-free siltite and argillite of *Ysp*$_1$. Unit weathers recessively, forming benches. Distinctive "boxwork" weathering pattern formed by resistant, millimeter-scale-thick vertical and horizontal siliceous stringers. Algal mats typically flat, rarely as scattered, low algal domes. Rare 5- to 10-cm-thick layers of ooids. This carbonate interval is mapped as the dolomite member of the Striped Peak Formation to the north near Clark Fork (Harrison and Jobin, 1963) and as members four (green dolomitic siltite) and five (boxwork dolomite) of the Mount Shields Formation (Figure 3) to the northeast in the Kalispell quadrangle (Harrison and others, 1992). Thickness approximately 100 m in the northeastern part of the area.

Ysp$_1$—Striped Peak Formation, member one (Middle Proterozoic)—Pale purplish red, fine-grained, flat-laminated quartzite and green and red argillite and siltite. Equivalent to the argillite, siltite, and quartzite member of the Striped Peak Formation near Clark Fork (Harrison and Jobin, 1963) and to the lower three members of the Mount Shields Formation to the northeast (Harrison and others, 1992). Lowest part (Mt. Shields member 1 equivalent; Figure 3) is characterized by fine- to very fine-grained, pink, flat-laminated quartzite in beds 20-30 cm thick, capped by red argillite layers as much as 3 cm thick. Mudcracks, mudchips, and ripple marks common. Uncommon 20-cm-thick beds of pale green quartzite are present near the base.

Middle part (Mt. Shields member 2 equivalent) is characterized by flat-laminated 0.5- to 1.0-m-thick beds of fine- to medium-grained quartzite that form 15- to 30-m-thick cliffs with blocky talus. Diffuse brown wisps of carbonate in the quartzite average a few centimeters in thickness and 10-15 cm in length. Uppermost part of this quartzite is medium grained and distinctly coarser than all other quartzite in the area except the thin sand lags in the *Ysp*$_4$ unit. Thin red argillite drapes at the tops of the quartzite beds are commonly rippled. Mudcracks and mudchips are less common than in the underlying interval. Flat-laminated to low domal stromatolites occur both near the base and at the top of this quartzite interval. The stromatolites are interbedded with centimeter-scale-thick calcitic white quartzite and locally with layers as much as 20 cm thick of cross-stratified ooids. Salt casts increase in abundance upward in this subunit.

Upper part of unit (Mt. Shields member 3 equivalent) is characterized by thin quartzite beds, green and red siltite and argillite, and abundant salt casts. The quartzite is most abundant in the lower part of this subunit. The upper part of the subunit contains distinctive dark green siltite beds. Quartzite in Ysp_1 contains more potassium feldspar (12-25 percent) and less plagioclase (1-15 percent) than is present to the south (Lewis and others, 2000) and southeast (Lewis, 1998). Overall thickness of Ysp_1 uncertain but about 350 m in the northeastern part of the area.

Ywu—Wallace Formation, upper member, undivided (Middle Proterozoic)—Predominantly green and dark gray siltite and argillite, but locally contains unmapped carbonate intervals equivalent to upper member two. Shown where lack of mapping or poor exposure prevents subdivision.

Ywu_3—Wallace Formation, upper member three (Middle Proterozoic)—Rusty weathering, dark gray, laminated and thinly laminated siltite and argillite. Lower part is unevenly laminated light green to white siltite with thin gray to black argillite caps. Rare, very fine-grained white quartzite containing scattered black mudchips is also present in beds as much as 20 cm thick. Above this are 5- to 10-cm-thick beds of slightly dolomitic, dark green siltite interstratified with uneven laminations and thin (< 3 cm thick) graded beds (couplets) of dark green siltite and pale green argillite identical to rock types in Ywu_2. The uppermost part of the unit is unevenly laminated dark green siltite and pale green argillite similar to lower rock types but lacking any trace of carbonate. Includes rare 10-m-thick beds of light green quartzite and green decimeter-scale-thick siltite beds. Contact with the overlying Mt. Shields Formation (Ysp_1) is the lowest occurrence of centimeter-scale-thick, very fine-grained pink quartzite with red argillite caps. Lower contact is very gradational and best placed above the highest dolomitic siltite of Ywu_2. Equivalent to the nondolomitic upper part of the Shepard Formation (Figure 3) in western Montana (Lemoine and Winston, 1986). Relationship to Clark Fork section (Harrison and Jobin, 1963) uncertain, as are the relationships of other Wallace units to the Clark Fork section. Thickness about 80 m in the northeastern part of the area.

Ywu_2—Wallace Formation, upper member two (Middle Proterozoic)—Tan- and brown-weathering, dolomitic green siltite and argillite with minor interstratified, 10- to 20-cm-thick beds of dolomitic, very fine-grained quartzite. Argillite and siltite are thinly laminated, microlaminated, and in couplets. Lower contact placed at the lowest appearance of carbonate. Uneven laminations of dark green siltite and pale green argillite at the base of unit pass upward into intervals of thicker uneven couplets of dark green siltite and pale green argillite. Weathered outcrops are distinctive brown (siltite) and tan (argillite) as dolomite content increases up section. Scattered dolomitic quartzite layers as much as 20 cm thick also are present. Bedding locally discontinuous in middle and upper parts, with thin gray limestone pods and silty and sandy ripple trains within the thicker argillites. Centimeter-wide straight cracks that penetrate bedding to 10-cm depths are associated with layers of flat rip-up pebble conglomerates as much as 5 cm thick near the middle. Upper part is uneven siltite-argillite couples (graded beds over 3 cm thick) and uneven laminations of slightly dolomitic siltite and argillite. Upper contact problematic but placed at the highest, thick dolomitic laminated unit. Equivalent to the middle and lower parts of the Shepard Formation (Figure 3) in western Montana (Lemoine and Winston, 1986). Thickness about 300 m in the northeastern part of the area.

Ywu_1—Wallace Formation, upper member one (Middle Proterozoic)—Rusty weathering green siltite and dark green and gray argillite, and subordinate pale green fine-grained quartzite. Quartzite beds as much as 5 cm thick are locally common, although not abundant. Couplets of planar-laminated dark gray argillite and green siltite are near the base of the unit. At stratigraphically higher levels, decimeter-scale-thick green siltite beds are more common. Large, straight-sided cracks, visible on bedding-plane surfaces, commonly disrupt laminations to a depth of several centimeters. These are rarely associated with mudchips and are interpreted as water-escape structures; only near the upper contact are true desiccation cracks and mudchips common. Unit is at the stratigraphic level of the Snowslip Formation (Figure 3) mapped to the northeast in Montana (Harrison and others, 1992), but the lack of red zones and the paucity of mudcracks distinguish it from the Snowslip. Thickness about 300 m in the northeastern part of the area.

Ywml—Wallace Formation, middle and lower members, undivided (Middle Proterozoic)—Calcareous and noncalcareous, very fine-grained quartzite or siltite, black argillite, and green dolomitic siltite and argillite. Shown where the lack of mapping or poor exposure prevents subdivision. Equivalent to the lower Wallace unit of Griggs (1973) and Hobbs and others (1965) as shown in Figure 3. Relationship to Clark Fork section (Harrison and Jobin, 1963) uncertain, as are relationships of other Wallace units to the Clark Fork section. Thickness highly uncertain but about 1,200 m.

Ywm—Wallace Formation, middle member (Middle Proterozoic)—Gray, calcareous, very fine-grained quartzite or siltite and black argillite and lesser amounts of noncalcareous white quartzite. A green dolomitic siltite and argillite interval may also be present, but it was only observed east of the map area. Alternatively, the green interval might represent the upper part of the lower member. Vertical calcite ribbons, horizontal pods, and molar tooth structures are common in some siltites over 20 cm thick. White quartzite also occurs as hummocky cross-stratified planar beds 15-30 cm thick. Quartzite contains 5-13 percent potassium feldspar and approximately 15-20 percent plagioclase. Characterized by graded beds (couplets and couples) that have the pinch and swell sediment type of Winston (1986) in which scours and loads of quartzite cut or deform the tops of subjacent black argillite. Argillite caps commonly contain ptygmatically folded siltite- or quartzite-filled cracks that taper downward. On bedding plane surfaces, the cracks are generally discontinuous and sinuous, occurring as isolated "birdsfoot" cracks, short parallel cracks, or radial cracks around loads. Relatively thin interval of green, dolomitic siltite and argillite that closely resembles the lower member may be present in the lower third of the unit. Equivalent to the middle member of Wallace as mapped by Harrison and others (1986). Mapped as part of the lower Wallace by Griggs (1973). Thickness highly uncertain but about 1,000 m.

Ywl—Wallace Formation, lower member (Middle Proterozoic)—Massive green siltite and thinly laminated green siltite-argillite couplets with varied amounts of carbonate (dolomite) and recessive-weathering calcite pods. Subdivided only in a few localities. Best exposed east of the area at the mouth of Shoshone Creek, where an orange-weathering dolomitic siltite appears to be at the top of the unit. Equivalent to the lower member of Wallace as mapped by Harrison and others (1986). Thickness highly uncertain but about 200 m.

Ysr—St. Regis Formation (Middle Proterozoic)—Pale purple to gray siltite, argillite, and quartzite. Also, light green siltite and darker green argillite or dark green siltite and light green argillite couplets. Typically mudcracked, 1-cm-thick siltite-argillite couplets but with thin (2-5 cm) and rarer thick (10-20 cm), tabular, fine-grained quartzite beds with green argillite caps similar to those of the Revett Formation. Abundant mudchips. Thickness about 250 m.

Yr—Revett Formation (Middle Proterozoic)—Quartzite with siltite and argillite. Characteristically 20-cm- to rare 1-m-thick beds of fine-grained to rare medium-grained quartzite. Some vitreous; most feldspathic with orange-brown spots. Feldspar is mostly potassium feldspar in the central and eastern part of the area (12-20 percent; 3 percent plagioclase), but two samples from the southwestern part contain subequal amounts of plagioclase and potassium feldspar. Rippled tops and ripple cross lamination more common than trough cross lamination; much is flat laminated. Thickness about 600 m.

Yb—Burke Formation (Middle Proterozoic)—Siltite and quartzite. Pale green siltite in 10- to 20-cm-thick beds, typically with macroscopic magnetite octahedra and darker green argillite partings. Includes some flat-laminated, fine-grained, gray to white quartzite in scattered beds and zones. Includes hornfelsed siltite and quartzite in the South Chilco Mountain area south of Lake Pend Oreille (Griggs, 1973) that may alternatively be a downdropped block of the Striped Peak Formation. Thickness uncertain but about 1,000 m.

Yp—Prichard Formation, undivided (Middle Proterozoic)—Gray, rusty-weathering siltite and minor quartzite. Minor discontinuous carbonate layers. Rare mudcracks. Shown where the lack of mapping or poor exposure prevents subdivision. See Hobbs and others (1965), Griggs (1973), or Cressman (1989) for more detail.

Ypu—Prichard Formation, upper part (Middle Proterozoic)—Map unit of Griggs (1973) described as dark to medium gray, very thinly bedded argillite commonly interlaminated with light gray siltite and also containing some thicker siltite beds. Grades upward into an interbedded and interzoned argillite, siltite, and quartzite sequence. Upper contact placed at highest dark gray argillite by Browne (2000a), similar to mapping by Griggs (1973), but ASARCO geologists placed contact lower than these two workers (at first light-colored quartzitic interval; Larry Appelgate, written commun., 1998). Total thickness is 2,500-3,500 feet (760-1070 m) according to Griggs (1973).

Ypl—Prichard Formation, lower part (Middle Proterozoic)—Map unit of Griggs (1973) described as predominantly medium to light gray, thin- and evenly bedded siltite, and laminated in part; some argillite laminae and beds. Some beds or zones of gray to white quartzite have been subdivided locally (*Yqp* unit). Thickness according to Griggs (1973) 7,500+ feet (2,290+ m); base not exposed.

Yqp—Quartzite of the Prichard Formation (Middle Proterozoic)—Nearly white to light gray impure to pure quartzite mapped by Hobbs and others (1965) in the southeast part of the area. Individual quartzite zones probably as much as 50 m thick are discontinuous laterally.

BELT SUPERGROUP OR PRE-BELT METAMORPHIC ROCKS

High-grade (amphibolite facies) metasedimentary rocks in the western part of the area are part of the Priest River metamorphic complex. Meta-igneous rocks to the north and northwest within this complex have U-Pb ages that range from 1,576 to 2,651 Ma, indicating a pre-Belt age (Clark, 1973; Evans and Fischer, 1986; Armstrong and others, 1987; Doughty and others, 1998). However, some may be basement upon which the sedimentary rocks were deposited rather than intrusive into the sedimentary package (Doughty and others, 1998). Thus, all or part of the complex may be younger than the intrusions and correlate with the lower part of the Belt Supergroup.

YXs—Schist of the Priest River metamorphic complex (Proterozoic)—Fine-grained garnetiferous muscovite schist. Mapped as Prichard Formation by Griggs (1973).

YXq—Quartzite of the Priest River metamorphic complex (Proterozoic)—Strongly lineated and foliated light gray to white quartzite. Contains 5 percent or less muscovite and 15 percent feldspar. Coarsely recrystallized, and resembles vein quartz. Areas of *YXq* within *Kog* are either remnants of unmelted country rock or extremely large quartz veins.

YXgn—Gneiss of the Priest River metamorphic complex (Proterozoic)—Purplish brown sillimanite-biotite gneiss. Locally schistose and includes minor amounts of quartzite and amphibolite. Layering probably inherited from sedimentary protolith. Predominant mineral assemblage is quartz, plagioclase, potassium feldspar, biotite, and sillimanite. Includes rocks mapped as the Hauser Lake gneiss of Weisenborn and Weis (1976), gneiss of Cable Peak (Weis, 1968) and metamorphic rocks, undivided (Weis, 1968). See Rhodes (1986) and Doughty and others (1998) for a more detailed description of the Hauser Lake gneiss.

BELT SUPERGROUP NOMENCLATURE

Nomenclature for Belt Supergroup units is complicated by the many formation names in northern Idaho that differ from those developed in western Montana (Figure 3). We have adopted "Idaho terminology" similar to that of Hobbs and others (1965) and Griggs (1973), with the exception of that for the lower Wallace Formation. Here, we follow the usage of Harrison and others (1986) and subdivide the lower Wallace of Hobbs and others (1965) and Griggs (1973) into informal middle and lower members. A regional stratigraphic nomenclature is currently being pursued by Don Winston and the authors. A likely outcome involves assigning formation rank to the present members of the upper Wallace Formation and carrying the easily recognized Shepard Formation west into Idaho.

GEOLOGIC HISTORY

Most of the Coeur d'Alene quadrangle is underlain by a thick sequence of fine-grained siliciclastic and carbonate-bearing clastic rocks of the Belt Supergroup (Figures 3 and 4). These rocks were deposited between about 1,470 and 1,400 Ma during the Middle Proterozoic (Anderson and Davis, 1995; Evans and others, 2000). Continental reconstructions suggest that the Belt basin was intracratonic (e.g., Moores, 1991; Dalziel, 1991; Doughty and others, 1998; Burrett and Berry, 2000); a rifting event may have triggered initial subsidence. The lower part of the Belt (Prichard Formation) was deposited in relatively deep water under anoxic conditions. Intrusion of tholeiitic magmas formed extensive sills north and east of the area (Bishop, 1973). Units above the Prichard were deposited in relatively shallow water (near or above wave base) and under more oxidizing conditions. Algal mats and sedimentary structures such as mudcracks and salt casts are well preserved in the younger Belt rocks (Winston, 1986). Protoliths for high-grade (amphibolite facies) metasedimentary rocks in the western part of the quadrangle (units *YXgn*, *YXq*, and *YXs*) may have been deposited at the same time as the Belt Supergroup. Alternatively, some or all of these units may be the basement of the Belt (see discussions by Armstrong and others, 1987; Doughty and others, 1998; and Rhodes and Hyndman, 1988).

Deformation and magmatism during the East Kootenai orogeny at about 1,300-1,350 Ma affected rocks to the north in Canada (McMechan and Price, 1982) and may have affected rocks in the study area as well. Rifting of the former continent in the Late Proterozoic led to the accumulation of sedimentary and volcanic rocks of the Windermere Group in northeastern Washington (Miller, 1994). Rocks of this age are not found in the Coeur d'Alene quadrangle, although they may have once existed. Later rifting that formed the continental margin to the west lead to the deposition of Cambrian sedimentary rocks on a regional angular unconformity (Campbell, 1959), indicating that the Belt rocks were folded or faulted during one or both of the events above. No record exists of additional sedimentation or deformation in the Paleozoic or early Mesozoic.

The region was subjected to compressional deformation during the Cretaceous Sevier Orogeny, when the Belt Supergroup was strongly folded and faulted (Fillipone and Yin, 1994; Rhodes and Hyndman, 1988). Contractional faults and a strong cleavage formed in the southeastern part of the area (Clark, 1970). At the present level of exposure, all of these faults are relatively steep (reverse). We believe these structures are related to regional thrusting in the

Cretaceous and refer to them as thrust faults regardless of present dip. An example is the Alhambra fault south of Kellogg. During this time, rocks in the western part of the area were deformed at deeper levels and acquired a foliation (S_2 of Rehrig and others, 1987) as well as a lineation defined by sillimanite.

Magmatism in the Cretaceous affected the western half of the quadrangle (Figure 4). The Hayden Lake stock and similar rocks to the north were intruded into the Belt Supergroup. These plutonic rocks lack significant fabric and presumably were emplaced at relatively shallow crustal levels or after much of the deformation in the area. Biotite K-Ar dates of 75 Ma and 83 Ma provide minimum emplacement ages. Even less certain are the ages of some of the other intrusive rock units (*TKdd*, *TKla*, *TKg*, *TYqd*). The greatest uncertainty is for quartz diorite dikes (*TYqd*) that were previously assigned to the Proterozoic and thought to represent sills in the Prichard Formation (Griggs, 1973). Some may indeed be Proterozoic, but because many tend to be discordant to bedding and are concentrated in areas of faulting, a Cretaceous or Eocene age seems more likely.

Orthogneiss southwest of Coeur d'Alene (*Kog*) formed from plutons that resided at deeper crustal levels than the Hayden Lake stock and related rocks. The Cretaceous age is suggested because chemically and mineralogically the orthogneiss more closely resembles the Na- and Ca-rich Idaho batholith than the K-rich Proterozoic orthogneiss in the region. Widespread K-Ar cooling ages of 46-52 Ma (Miller and Engels, 1975; Harms and Price, 1992; Doughty and Price, 1999) indicate that this orthogneiss and the surrounding amphibolite facies metasedimentary rocks of the Priest River metamorphic complex were brought to near-surface levels during the Eocene. The timing details and the role that the Purcell-Coeur d'Alene detachment fault played in this unroofing event are still being debated.

Most of the mylonites in the footwall of the Purcell-Coeur d'Alene fault may have formed during late Cretaceous compressional strain before the intrusion of the fine-grained biotite granite of Rathdrum Mountain (*Tbgf*) at about 52 Ma (Rhodes and Hyndman, 1984, 1988; Rhodes and others, 1989; Doughty and Price, 1999). Of the three foliations in the area, only the latest may have formed or been superimposed upon earlier fabrics during down-to-the-east faulting along the Purcell-Coeur d'Alene fault in the Eocene (Rehrig and others, 1987). The mylonitic fabric in the footwall of the fault has kinematic indicators that show top-to-the-east motion. This mylonitic fabric was later folded into the Spokane dome (Rhodes and Hyndman, 1984) contemporaneously with uplift.

Doughty and Price (1999) have suggested that there is a relatively steep normal fault within the Purcell Trench to the north that cuts the Spokane dome mylonite zone. One is likely to be present in the Coeur d'Alene area as well. We speculate that a relatively steep normal fault extends from north of Athol south through Coeur d'Alene Lake. It appears to intersect (and cut) the Purcell-Coeur d'Alene fault southeast of Round Mountain but is entirely covered by surficial deposits. Alternatively, the Purcell-Coeur d'Alene fault may extend the entire length of the map area and not be offset by a younger fault. The trace of the northern extension of the Purcell-Coeur d'Alene fault from Athol north to Sandpoint is uncertain, partly because of cover by glacial deposits and partly because the exposed bedrock is largely granitic rocks that have little or no fabric. We show the Purcell-Coeur d'Alene fault (mylonite zone) continuing due north from Round Mountain more or less where McCarthy and others (1993) suggested it might be located. Alternatively, it may continue as a steeper structure north of Athol.

Extension in the central and eastern part of the quadrangle was probably localized along north-northeast-striking faults such as the Cascade fault. Both the steep bedding and some faults in the Magee fault zone probably originated during contractional deformation, but the present configuration appears strongly dependent on down-to-the-west normal faulting. West-northwest faults such as the Osburn fault are thought to have had right-lateral strike-slip motion at this time and served to transfer the extension from the area of the Priest River metamorphic complex eastward into Montana (Sheriff and others, 1984; Rehrig and others, 1987). Movement on the Purcell-Coeur d'Alene fault had ended by Miocene time (about 16 Ma) when drainages in the area were invaded by Columbia River basalt. No offset of basalt is apparent across the fault. The Columbia River basalt disrupted drainages in the area and established a new base level. Drainage systems that previously had transported sediment out of the area now deposited their sediment at the margins of the basalt flows, or upstream from them. These sediments (*Ts*) are widespread in the region south of the map area.

During the Pleistocene, a lobe of the Cordilleran ice sheet moved south down the Purcell Trench from Canada into northern Idaho. Glacial Lake Missoula was formed when this lobe blocked the Clark Fork drainage near its mouth into Lake Pend Oreille. At its maximum, the lake was over 610 m (2,000 feet) deep against the ice dam. Repeated failures and re-formations of the Clark Fork ice dams resulted in catastrophic outbursts of as much as 2,000 cubic km (500 cubic miles) of water flowing across northern Idaho and into the Channeled Scabland of Washington (Waitt, 1985). The main path of the floods was from the southern end of Lake Pend Oreille across Rathdrum Prairie and through the Spokane Valley. The enormous energy of the flood water transported coarse boulder gravel downstream. This gravel forms the Rathdrum-Spokane aquifer, which is the sole source of ground water for the area's urban and rural population. The largest of the floods would have removed evidence of earlier flood events, so only the physical record for the late Wisconsin floods and ice advances remains. Similar floods, however, likely recurred in earlier Pleistocene glaciations. Remnants of the oldest recognized gravel form high expansion flood bars at Spirit Lake (*Qgslo*, *Qgsly*) and at Ross Point (*Qgrp*). Pendant bars formed behind bedrock obstructions at Round Mountain (*Qgtl*), and eddy bars dammed the side valleys (*Qdg*). Lakes bordering the Purcell Trench (Spirit, Twin, Hayden, Coeur d'Alene, Fernan, Hauser, and Newman) formed behind bars of flood gravel deposited at the mouths of valleys (Breckenridge, 1989). Younger gravel units mapped in the Rathdrum Prairie formed gravel sheets and fans and resulted from younger and smaller floods after the late Wisconsin maximum, about 18,000 years ago. The Mount St. Helens set S tephra of approximately 13,000 years ago is associated with late flood deposits, and the last flood is immediately postdated by the Glacier Peak ashes B and G (about 11,200 years ago; Kiver and others, 1991). Small alpine glaciers postdate the Cordilleran ice retreat in the high elevations of the Selkirk and Cabinet Mountains north of the map area. Eolian deposits of silt, the loess of the Palouse Formation (*Qp*), accumulated on the Columbia Plateau throughout the Quaternary to the present and were mainly a result of ice age erosion and winds (Busacca, 1991).

GEOCHEMISTRY

Over ninety samples from the Coeur d'Alene quadrangle were analyzed by X-ray fluorescence (XRF) methods for major and trace element concentrations at Washington State University as part of this study and other related STATEMAP projects. Results for igneous intrusive rocks are presented in Table 1; those for metasedimentary rocks are in Table 2, and those for basalts are in Table 3. Sample locations are shown on the map, and their latitude and longitude are listed in the tables. Also reported here are two samples outside the map area: one, a garnet-muscovite schist from an exposure just south of the quadrangle along the west side of Coeur d'Alene Lake (99RL244); and the other, an augen gneiss of Laclede (99RL262), a Proterozoic igneous rock within the Priest River complex, but from north of the area.

The two analyzed samples from the fine-grained biotite granite unit (*Tbgf*) have significantly different chemical compositions (Table 1). Sample 99RL202 from a pluton on the northwest side of Spirit Lake has a lower SiO_2 content (68 versus 74 percent) and a lower K_2O content (3.7 versus 5.2 percent) than sample 99RL256 collected from a larger pluton extending west from Rathdrum Mountain. The pluton at Rathdrum Mountain has K_2O well in excess of Na_2O and Rb in excess of Sr, characteristics common to epizonal Eocene granite plutons in central Idaho (Lewis and Kiilsgaard, 1991). Although the pluton at Rathdrum Mountain lacks miarolitic cavities that characterize the epizonal granite, it may be similar in age and origin but was emplaced at deeper levels than those in central Idaho. A sample collected from the Beauty Creek stock (unit *TKg*, sample 99RL281) is similar in composition to the pluton of *Tbgf* on the northwest side of Spirit Lake. Both have K_2O/Na_2O ratios of 1.1 to 1.3, and SiO_2 contents in the 68-69 percent range.

Samples of biotite granodiorite from the Hayden Lake stock and the hornblende-biotite granodiorite north of Hayden Lake (units *Kbgd* and *Khgd*) have similar major element concentrations (compare 99RL208, 99RL257, and 99RL258). Most trace element concentrations are also similar. However, the sample from the Hayden Lake stock contains considerably more Sr than samples from the hornblende-bearing unit (708 ppm versus 297 and 348 ppm). Biotite K-Ar ages on the two rock units of 83.8 and 74.6 Ma (recalculated from Miller and Engels, 1975) suggest two episodes of magmatism. All three samples have K_2O in excess of Na_2O. In this regard, they are unlike the bulk of the Idaho batholith, which is relatively sodic. The higher K_2O contents and the presence of euhedral biotite books are similar to some of the satellite plutons southeast of the southern lobe of the Idaho batholith (Lewis and others, 1987; Lewis, 1989, 1990) as well as the potassic series of the Boulder batholith of Montana (Tilling, 1973).

Craig Wavra and Rolland Reid analyzed thirteen samples of "deep igneous rocks" (our orthogneiss unit, *Kog*) from southwest of Coeur d'Alene that they described as granite gneiss, granodiorite gneiss, and tonalite gneiss (Rolland Reid, written commun., 1998). These rocks have a moderate SiO_2 range from 69 to 76 percent and a wider K_2O range from 2.8 to 5.9 percent. One anomalous analysis with 83 percent SiO_2 and only 1.2 percent K_2O we attribute to contamination by quartzite. Two samples of diorite gneiss from the same area have SiO_2 contents of 55-57 percent. K_2O exceeds Na_2O in ten of the samples, and Rb exceeds Sr in three samples. The four orthogneiss samples we analyzed (Table 1) have compositions that are within the range found by Wavra and Reid.

Chemical compositions of argillite-siltite from different formations of the Belt Supergroup (Table 2) largely overlap, a result consistent with those of previous workers (e.g., Harrison and Grimes, 1970; Harrison and Hamilton, 1971). Concentrations of Sr are higher in the siltite-argillite and siltite samples of the Prichard Formation (111 and 76 ppm) relative to other noncarbonate-bearing siltite or argillite samples in the Belt (58 ppm or less). This distinction was originally noted by Jack Harrison (written commun., 1991). Copper concentrations are 44 ppm or less in all samples, with the exception of 99RL251, an argillite-siltite from the lower part of the Libby Formation that contains 148 ppm Cu. Zinc concentrations exceed 100 ppm in only two samples (99RL279 and 98RL052), both from the Prichard Formation. Concentrations of K_2O are highest (greater than 4 percent) in the argillite-siltite samples from the Prichard, St. Regis, lower Wallace, and Striped Peak Formations. K_2O content of siltite-argillite in the middle and upper members of the Wallace and in the Libby Formation ranges more widely (2.6 to 5.4 percent K_2O). Carbonate-bearing samples have low total oxides because CO_2 was not analyzed. These carbonate-bearing rocks also have low K_2O concentrations (0.8-3.8 percent) relative to the noncarbonate rocks and, as expected, high CaO concentrations. Quartzite samples have lower K_2O concentrations (1.4 to 3.8 percent) as a result of the high quartz sand content in these rocks. Sample 98RL176 is from the "lower green marker" in the Sunshine Mine and has an unusually high silica content (80.35%).

Seven samples of metasedimentary gneiss and schist from the Priest River metamorphic complex (units *YXgn* and *YXs*) have an expected moderate range in chemical composition. The most schistose sample (99RL244) also has the lowest SiO_2 content (62 percent) and the highest Al_2O_3 content (23 percent). This sample is from just south of the map area. Metasedimentary rocks from the Priest River metamorphic complex are compositionally similar in many respects to the Belt Supergroup. However, they typically have higher Sr concentrations (all but one sample exceed 143 ppm). This may be a metamorphic effect, as Sr is known to increase with increasing metamorphic grade in this region (Harrison and Hamilton, 1971). Alternatively, all or some of the metasedimentary rocks of the Priest River complex may predate the Belt Supergroup, as discussed in the previous section. All of the analyses of Columbia River basalt (Table 3) match well with previously published results (Griggs, 1978; Swanson and others, 1979b; Wright and others, 1973, 1979, 1980). Significant differences exist in both major and trace element contents of the different units, but variations within the units are small. One important result was from an analysis of samples collected on Mica Flat southwest of Coeur d'Alene. These samples are from a previously unknown flow with a chemical composition unlike that of the underlying Priest Rapids member.

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Table 1. XRF analyses of intrusive rocks from the Coeur d'Alene 30' x 60' quadrangle. Sample without map number is from northwest of the area near Priest River.

Map no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Sample no.	99RL202	99RL256	99RL281	99RL208	99RL257	99RL258	99RL207	99RL246
Mineralogy	biotite	biotite	biotite	biotite	hornblende-biotite	hornblende-biotite	hornblende-biotite	
Lithology	**granite**	**granite**	**granite**	**granodiorite**	**granodiorite**	**granodiorite**	**quartz diorite**	**orthogneiss**
Form	pluton	pluton	stock	stock	pluton	pluton	pluton	pluton
Unit	Tbgf	Tbgf	TKg	Kbgd	Khgd	Khgd	Kqd	Kog
30' x 60' quad.	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene
7.5' quad.	Spirit Lake W.	Rathdrum	Mt. Coeur d'Alene	Hayden Lake	Athol	Bayview	Spades Mtn.	Mica Bay
Lat.	47.943521	47.840934	47.601721	47.757873	47.920039	47.918792	47.870128	47.555151
Long.	-116.922807	-116.964141	-116.660813	-116.679304	-116.698476	-116.621699	-116.573267	-116.816263
				Unnormalized results (weight %)				
SiO_2	68.07	74.36	69.56	65.40	66.85	64.66	55.39	65.12
Al_2O_3	15.74	14.07	15.25	16.17	15.16	15.62	16.97	17.24
TiO_2	0.621	0.126	0.467	0.664	0.529	0.673	1.363	0.456
FeO*	3.57	1.27	2.67	4.50	3.85	4.87	8.79	3.67
MnO	0.050	0.039	0.054	0.095	0.079	0.095	0.143	0.099
CaO	2.75	1.07	2.31	4.46	3.90	4.36	8.00	3.86
MgO	1.07	0.29	1.17	1.67	1.54	2.03	4.77	0.94
K_2O	3.68	5.17	4.45	3.68	3.93	3.83	1.77	4.21
Na_2O	3.40	3.10	3.47	2.46	2.72	2.57	1.44	3.42
P_2O_5	0.200	0.049	0.165	0.256	0.159	0.192	0.335	0.189
Total	99.15	99.54	99.57	99.35	98.72	98.90	98.97	99.20
LOI	--	--	--	--	--	--	--	--
				Normalized results (weight %)				
SiO_2	68.66	74.70	69.86	65.83	67.72	65.38	55.97	65.64
Al_2O_3	15.88	14.13	15.32	16.28	15.36	15.79	17.15	17.38
TiO_2	0.626	0.127	0.469	0.668	0.536	0.681	1.377	0.460
FeO*	3.60	1.28	2.68	4.53	3.90	4.92	8.88	3.70
MnO	0.050	0.039	0.054	0.096	0.080	0.096	0.144	0.100
CaO	2.77	1.07	2.32	4.49	3.95	4.41	8.08	3.89
MgO	1.08	0.29	1.18	1.68	1.56	2.05	4.82	0.95
K_2O	3.71	5.19	4.47	3.70	3.98	3.87	1.79	4.24
Na_2O	3.43	3.11	3.49	2.48	2.76	2.60	1.46	3.45
P_2O_5	0.202	0.049	0.166	0.258	0.161	0.194	0.339	0.191
				Trace elements (ppm)				
Ni	4	4	10	4	1	4	6	6
Cr	6	0	23	3	16	27	113	11
Sc	14	12	9	21	18	18	39	15
V	45	9	39	102	69	92	217	83
Ba	2054	773	904	882	634	845	629	1059
Rb	88	167	180	132	174	178	70	98
Sr	605	140	472	708	297	348	369	1280
Zr	261	113	218	210	147	169	164	206
Y	19	24	23	33	21	27	33	28
Nb	12.1	14.6	17.6	18.4	12.6	14.4	16.6	14.1
Ga	18	17	17	21	16	19	22	21
Cu	3	2	2	5	7	8	12	12
Zn	56	29	43	54	51	60	84	131
Pb	14	30	28	15	33	28	9	27
La	79	38	35	51	8	33	28	40
Ce	103	74	89	79	28	56	55	85
Th	12	16	18	12	7	10	5	13

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO; LOI is loss on ignition.
"†" denotes values > 120% of highest standard in lab.

Table 1. XRF analyses of intrusive rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

	9	**10**	**11**	**12**	
Sample no.	99RL299	98TF807	98TF806B	98TF806A	99RL262
Mineralogy		biotite	hornblende-plagioclase		biotite
Lithology	orthogneiss	orthogneiss	orthogneiss	amphibolite	augen gneiss
Form	pluton	pluton	sill	sill	pluton
Unit	Kog	Kog	Kog	KYam	Yag
30' x 60' quad.	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Sandpoint
7.5' quad.	Rockford Bay	Rockford Bay	Rockford Bay	Rockford Bay	Laclede
Lat.	47.579986	47.58002	47.60413	47.60413	48.156111
Long.	-116.897718	-116.89739	-116.88085	-116.88085	-116.795833
			Unnormalized results (weight %)		
SiO_2	71.06	69.81	61.91	51.28	71.85
Al_2O_3	15.65	15.97	19.05	13.61	14.10
TiO_2	0.215	0.292	0.366	1.597	0.373
FeO*	2.11	2.57	5.00	14.18	2.26
MnO	0.036	0.042	0.083	0.251	0.046
CaO	2.68	2.82	5.45	8.57	1.52
MgO	0.71	0.84	1.69	4.79	0.60
K_2O	2.59	2.70	1.19	0.97	5.21
Na_2O	4.52	4.53	4.66	2.17	3.24
P_2O_5	0.061	0.086	0.160	0.140	0.139
Total	99.63	99.66	99.56	97.56	99.34
LOI	--	0.35	1.86	1.69	--
			Normalized results (weight %)		
SiO_2	71.32	70.05	62.18	52.56	72.33
Al_2O_3	15.71	16.02	19.13	13.95	14.19
TiO_2	0.216	0.293	0.368	1.637	0.375
FeO*	2.12	2.58	5.03	14.53	2.27
MnO	0.036	0.042	0.083	†0.26	0.046
CaO	2.69	2.83	5.47	8.78	1.53
MgO	0.71	0.84	1.70	4.91	0.60
K_2O	2.60	2.71	1.20	0.99	5.24
Na_2O	4.54	4.55	4.68	2.22	3.26
P_2O_5	0.061	0.086	0.161	0.144	0.140
			Trace elements (ppm)		
Ni	6	1	5	13	5
Cr	2	5	9	34	0
Sc	10	7	17	†53	6
V	24	28	46	367	27
Ba	962	782	675	192	1334
Rb	56	65	25	9	145
Sr	411	385	693	126	382
Zr	134	126	132	85	234
Y	6	6	14	32	17
Nb	9.3	7.3	6.1	8.1	20.1
Ga	17	18	20	19	16
Cu	6	1	14	13	6
Zn	27	30	54	141	36
Pb	11	9	10	4	28
La	35	21	20	8	94
Ce	39	41	43	0	149
Th	4	2	20	13	27

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO; LOI is loss on ignition.
"†" denotes values > 120% of highest standard in lab.

Table 2. XRF analyses of metasedimentary rocks from the Coeur d'Alene 30' x 60' quadrangle. Sample without map number (99RL244) is from just south of the area along the west shore of Coeur d'Alene Lake.

Map no.	**13**	**14**	**15**	**16**	**17**	**18**		**19**
Sample no.	99RL201	99RL252	99RL274	99RL275	99RL278	99RL301	99RL244	99RL279
Color								gray
Mineralogy	sillimanite-biotite	sillimanite-biotite	sillimanite-biotite	sillimanite-biotite	sillimanite-biotite	sillimanite-biotite	garnet-muscovite	sulfide-rich
Lithology	schist	gneiss	gneiss	gneiss	gneiss	gneiss	schist	siltite-argillite
Form	layer	layer	layer	layer	layer	layer	layer	bed
Formation								Prichard
Member								lower
Unit	YXgn	YXgn	YXgn	YXgn	YXgn	YXgn	YXs	Ypl
7.5' quad.	Spirit Lake E.	Rockford Bay	Rockford Bay	Post Falls	Coeur d'Alene	Post Falls	Harrison	Mt. Coeur d'Alene
Lat.	47.957538	47.5197	47.622179	47.656482	47.68791	47.693625	47.4375	47.606983
Long.	-116.873545	-116.977488	-116.987625	-116.967448	-116.865475	-116.990134	-116.797777	-116.686793
				Unnormalized results (weight %)				
SiO_2	69.14	71.56	75.60	67.78	71.73	72.09	61.70	61.06
Al_2O_3	19.07	15.09	14.28	17.94	14.30	14.07	22.82	20.26
TiO_2	0.981	0.676	0.683	0.918	0.675	0.566	1.097	0.796
FeO*	4.62	3.72	2.78	5.36	5.18	3.45	4.96	6.52
MnO	0.046	0.033	0.025	0.039	0.029	0.042	0.075	0.085
CaO	0.19	1.04	0.42	0.38	0.75	0.87	0.12	0.70
MgO	1.09	1.38	1.11	1.39	1.01	1.14	0.79	1.98
K_2O	2.54	3.34	3.57	4.27	3.26	4.71	5.61	5.06
Na_2O	0.45	1.93	1.10	0.85	2.03	2.08	0.62	1.73
P_2O_5	0.025	0.052	0.037	0.043	0.053	0.054	0.046	0.078
Total	98.15	98.83	99.60	98.97	99.02	99.08	97.84	98.27
				Normalized results (weight %)				
SiO_2	70.44	72.41	75.90	68.49	72.44	72.76	63.06	62.14
Al_2O_3	19.43	15.27	14.34	18.13	14.44	14.20	23.32	20.62
TiO_2	0.999	0.684	0.686	0.928	0.682	0.571	1.121	0.810
FeO*	4.71	3.77	2.79	5.41	5.23	3.49	5.07	6.63
MnO	0.047	0.033	0.025	0.039	0.029	0.042	0.077	0.086
CaO	0.19	1.05	0.42	0.38	0.76	0.88	0.12	0.71
MgO	1.11	1.40	1.11	1.40	1.02	1.15	0.81	2.01
K_2O	2.59	3.38	3.58	4.31	3.29	4.75	5.73	5.15
Na_2O	0.46	1.95	1.10	0.86	2.05	2.10	0.63	1.76
P_2O_5	0.025	0.053	0.037	0.043	0.054	0.055	0.047	0.079
				Trace elements (ppm)				
Ni	9	5	7	4	10	13	30	29
Cr	71	42	39	60	37	32	108	68
Sc	24	13	16	18	13	14	28	25
V	107	70	61	111	67	59	108	98
Ba	482	902	1198	1409	572	1103	824	895
Rb	127	146	140	164	175	196	180	254
Sr	59	150	203	223	143	182	79	111
Zr	307	265	306	307	298	268	269	225
Y	44	41	36	40	35	31	144	50
Nb	33.0	14.9	16.4	17.8	15.5	16.7	22.1	17.5
Ga	27	20	19	22	19	16	26	24
Cu	5	15	5	29	18	11	1	31
Zn	75	67	62	71	91	80	89	117
Pb	4	19	10	6	13	36	34	30
La	27	47	58	62	58	38	151	68
Ce	75	96	113	130	104	88	118	111
Th	13	15	15	24	17	10	23	19

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 2. XRF analyses of metasedimentary rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Sample no.	98RL052	99RL250	99RL290	99RL218	99RL280	99RL217	99RL289	98RL176
Color			light gray	light gray	light gray	purple	purple	green
Mineralogy								
Lithology	siltite	siltite	quartzite	quartzite	quartzite	siltite-argillite	siltite-argillite	argillite
Form	bed	bed	bed	bed	bed	bed	bed	bed
Formation	Prichard	Burke	Burke	Revett	Revett	St. Regis	St. Regis	St. Regis
Member	lower							(lower marker)
Unit	Ypl	Yb	Yb	Yr	Yr	Ysr	Ysr	Ysr
7.5' quad.	Lane	Carlin Bay	Cataldo	Lamb Peak	Mt. Coeur d'Alene	Lamb Peak	Kellogg West	Kellogg East
Lat.	47.520017	47.538143	47.576756	47.812433	47.576593	47.810453	47.618272	47.50139
Long.	-116.51493	-116.78136	-116.252755	-116.372503	-116.730963	-116.368252	-116.209661	-116.07000
				Unnormalized results (weight %)				
SiO_2	66.22	76.08	90.78	92.91	82.04	65.79	66.93	80.35
Al_2O_3	17.18	13.66	4.95	4.36	10.37	17.65	16.09	12.46
TiO_2	0.744	0.530	0.115	0.167	0.319	0.554	0.590	0.214
FeO*	4.29	2.35	0.70	0.20	1.49	5.25	4.70	1.36
MnO	0.130	0.002	0.003	0.000	0.006	0.017	0.014	0.001
CaO	0.41	0.05	0.06	0.01	0.17	0.14	0.33	0.09
MgO	2.20	0.60	0.19	0.03	0.38	1.67	2.67	0.32
K_2O	4.46	3.83	1.35	1.71	2.67	6.31	5.37	4.08
Na_2O	1.83	2.14	1.60	0.11	2.41	1.11	1.27	0.10
P_2O_5	0.106	0.020	0.026	0.014	0.051	0.088	0.155	0.044
Total	97.57	99.27	99.77	99.52	99.90	98.58	98.12	99.02
				Normalized results (weight %)				
SiO_2	67.87	76.64	90.99	93.36	82.12	66.74	68.22	81.15
Al_2O_3	17.61	13.76	4.96	4.38	10.38	17.90	16.40	12.58
TiO_2	0.763	0.534	0.115	0.168	0.319	0.562	0.601	0.216
FeO*	4.40	2.37	0.70	0.20	1.49	5.32	4.79	1.37
MnO	0.133	0.002	0.003	0.000	0.006	0.017	0.014	0.001
CaO	0.42	0.05	0.06	0.01	0.17	0.14	0.34	0.09
MgO	2.25	0.60	0.19	0.03	0.38	1.69	2.72	0.32
K_2O	4.57	3.86	1.35	1.72	2.67	6.40	5.47	4.12
Na_2O	1.88	2.16	1.60	0.11	2.41	1.13	1.29	0.10
P_2O_5	0.109	0.020	0.026	0.014	0.051	0.089	0.158	0.044
				Trace elements (ppm)				
Ni	25	13	6	6	6	24	24	8
Cr	56	31	4	7	25	43	36	6
Sc	20	10	2	11	13	19	14	5
V	88	44	9	9	21	84	58	16
Ba	829	768	216	198	495	854	1064	289
Rb	184	176	41	55	103	285	239	179
Sr	76	57	21	7	86	25	33	4
Zr	251	223	154	422	189	195	228	145
Y	45	38	20	17	28	43	43	25
Nb	17.7	15.3	4.8	6.3	9.2	15.7	13.9	12.9
Ga	22	16	5	5	9	24	22	12
Cu	27	13	2	9	1	2	1	1
Zn	137	55	2	0	17	89	72	6
Pb	15	9	3	3	6	2	3	0
La	53	39	19	23	7	51	44	28
Ce	94	82	49	68	59	102	101	69
Th	15	11	5	7	10	15	13	10

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 2. XRF analyses of metasedimentary rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Sample no.	99RL216	99RL215	99RL285	99RL288	99RL220	99RL223	99RL287	99RL226
Color	green	light gray	gray	gray	gray	gray	green	green
Mineralogy		calcareous	carbonate-bearing	carbonate-bearing				dolomitic
Lithology	siltite-argillite	quartzite	quartzite	siltite	siltite-argillite	argillite-siltite	siltite-argillite	siltite-argillite
Form	bed	bed	bed	bed	bed	bed	bed	bed
Formation	Wallace	Wallace	Wallace	Wallace	Wallace	Wallace	Wallace	Wallace
Member	lower	middle	middle/lower	middle/lower	upper	upper one	upper one	upper two
Unit	Ywl	Ywm	Ywml	Ywml	Ywu	Ywu_1	Ywu_1	Ywu_2
7.5' quad.	Lamb Peak	Lamb Peak	Grizzly Mtn.	Kellogg West	Cataract Peak	Pond Peak	Pond Peak	Pond Peak
Lat.	47.80839	47.808874	47.73797	47.622968	47.847385	47.7627	47.780657	47.792518
Long.	-116.359267	-116.356737	-116.003272	-116.195062	-116.499577	-116.058304	-116.001308	-116.00243
				Unnormalized results (weight %)				
SiO_2	67.07	80.66	67.20	35.76	76.52	73.70	66.21	59.07
Al_2O_3	17.23	6.85	6.78	8.49	11.94	13.48	17.43	12.88
TiO_2	0.587	0.248	0.282	0.348	0.523	0.624	0.764	0.540
FeO*	3.41	0.30	1.08	5.02	3.47	3.21	4.95	3.97
MnO	0.003	0.019	0.032	0.215	0.009	0.018	0.029	0.114
CaO	0.13	5.53	13.48	19.61	0.14	0.13	0.30	6.21
MgO	3.55	0.11	1.50	13.10	1.78	1.92	1.95	6.71
K_2O	4.21	0.93	1.86	2.51	2.93	3.73	4.45	3.78
Na_2O	1.93	2.81	1.80	0.88	1.63	1.67	1.66	0.84
P_2O_5	0.086	0.040	0.048	0.077	0.085	0.089	0.129	0.097
Total	98.20	97.50	94.06	86.01	99.02	98.58	97.87	94.21
				Normalized results (weight %)				
SiO_2	68.30	82.73	71.45	41.58	77.27	74.77	67.65	62.70
Al_2O_3	17.55	7.03	7.21	9.87	12.06	13.67	17.81	13.67
TiO_2	0.598	0.254	0.300	0.405	0.528	0.633	0.781	0.573
FeO*	3.47	0.31	1.14	5.84	3.50	3.26	5.06	4.21
MnO	0.003	0.019	0.034	0.250	0.009	0.018	0.030	0.121
CaO	0.13	5.67	14.33	†22.80	0.14	0.13	0.31	6.59
MgO	3.61	0.11	1.59	15.23	1.80	1.95	1.99	7.12
K_2O	4.29	0.95	1.98	2.92	2.96	3.78	4.55	4.01
Na_2O	1.97	2.88	1.91	1.02	1.65	1.69	1.70	0.89
P_2O_5	0.088	0.041	0.051	0.090	0.086	0.090	0.132	0.103
				Trace elements (ppm)				
Ni	22	5	1	7	20	17	19	22
Cr	51	13	12	22	35	46	57	48
Sc	18	12	5	0	13	16	25	19
V	71	19	19	51	52	59	101	82
Ba	932	216	362	969	437	668	910	871
Rb	190	33	62	136	114	147	195	153
Sr	20	94	133	187	34	37	53	76
Zr	189	159	306	125	318	384	285	167
Y	46	22	23	47	39	36	47	34
Nb	16.4	8.0	9.8	12.0	13.4	14.9	19.4	12.5
Ga	22	7	8	16	13	17	23	15
Cu	2	44	2	0	38	13	6	15
Zn	51	15	15	48	37	70	66	42
Pb	0	9	20	5	8	12	5	15
La	44	12	10	48	46	41	52	39
Ce	89	55	62	55	99	76	72	58
Th	15	5	9	11	12	15	15	13

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 2. XRF analyses of metasedimentary rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**
Sample no.	99RL283	99RL224	99MDM048	99MDM031	99RL228	99RL229	99RL282	99RL221
Color	gray-green	dark gray	green	purple	pink	light gray		dark gray
Mineralogy	dolomitic							
Lithology	siltite-argillite	argillite-siltite	siltite	quartzite	quartzite	dolomite	dolomite	siltite-argillite
Form	bed	bed	bed	bed	bed	bed	bed	bed
Formation	Wallace	Wallace	Striped Peak	Striped Peak	Striped Peak	Striped Peak	Striped Peak	Striped Peak
Member	upper two	upper three	one	one	one	two	two	three
Unit	Ywu_2	Ywu_3	Ysp_1	Ysp_1	Ysp_1	Ysp_2	Ysp_2	Ysp_3
7.5' quad.	Jordan Creek	Pond Peak	Cathedral Peak	Pond Peak	Cathedral Peak	Jordan Creek	Pond Peak	Spyglass Peak
Lat.	47.878251	47.759684	47.958224	47.850574	47.99894	47.947386	47.809899	47.798196
Long.	-116.121964	-116.104522	-116.144345	-116.113326	-116.193074	-116.121284	-116.122981	-116.203191
	Unnormalized results (weight %)							
SiO_2	66.20	66.69	72.11	78.48	90.90	24.89	19.07	68.51
Al_2O_3	14.53	17.09	11.51	6.74	5.06	3.38	3.41	16.72
TiO_2	0.602	0.794	1.044	0.179	0.128	0.255	0.194	0.746
FeO*	4.05	4.87	3.56	1.98	0.62	1.68	1.64	3.35
MnO	0.037	0.009	0.014	0.051	0.001	0.153	0.209	0.005
CaO	1.76	0.13	0.54	2.80	0.01	29.55	32.57	0.04
MgO	4.22	2.10	3.93	3.30	0.26	19.15	20.13	2.45
K_2O	4.25	5.35	4.34	3.28	2.74	1.24	0.83	4.65
Na_2O	1.32	0.67	0.91	0.36	0.06	0.20	0.56	1.32
P_2O_5	0.121	0.124	0.335	0.055	0.018	0.081	0.078	0.075
Total	97.09	97.83	98.29	97.22	99.79	80.58	78.69	97.86
	Normalized results (weight %)							
SiO_2	68.18	68.17	73.36	80.72	91.09	30.89	24.23	70.01
Al_2O_3	14.97	17.47	11.71	6.93	5.07	4.19	4.33	17.08
TiO_2	0.620	0.812	1.062	0.184	0.128	0.316	0.247	0.762
FeO*	4.17	4.98	3.62	2.03	0.62	2.09	2.09	3.42
MnO	0.038	0.009	0.014	0.052	0.001	0.190	†0.27	0.005
CaO	1.81	0.13	0.55	2.88	0.01	†36.67	†41.39	0.04
MgO	4.35	2.15	4.00	3.39	0.26	23.76	25.58	2.50
K_2O	4.38	5.47	4.42	3.37	2.75	1.54	1.05	4.75
Na_2O	1.36	0.68	0.93	0.37	0.06	0.25	0.71	1.35
P_2O_5	0.125	0.127	0.341	0.057	0.018	0.101	0.099	0.077
	Trace elements (ppm)							
Ni	27	21	38	14	9	0	0	15
Cr	55	76	80	14	7	14	14	62
Sc	16	27	12	10	0	0	0	18
V	80	98	56	26	12	34	21	88
Ba	991	979	456	795	267	101	176	469
Rb	170	202	107	81	62	46	40	205
Sr	46	31	36	64	12	59	76	40
Zr	198	317	919	213	145	266	191	315
Y	30	38	66	22	13	19	25	35
Nb	15.8	18.5	22.5	6.4	5.0	6.9	4.7	17.9
Ga	18	21	13	10	4	7	5	23
Cu	4	31	9	1	3	4	2	14
Zn	41	38	80	22	4	18	14	20
Pb	6	12	7	3	0	8	2	33
La	39	22	72	21	0	22	17	62
Ce	73	34	156	40	17	56	59	121
Th	15	18	26	3	5	11	6	14

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 2. XRF analyses of metasedimentary rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**44**	**45**	**46**	**47**	**48**
Sample no.	99RL227	99RL238	99RL230	99RL233	99RL251
Color	red	green	green	greenish gray	black
Mineralogy					
Lithology	quartzite	siltite	siltite	siltite-argilliite	argillite-siltite
Form	bed	bed	bed	bed	bed
Formation	Striped Peak	Striped Peak	Libby	Libby	Libby
Member	four	four			
Unit	Ysp_4	Ysp_4	Yl	Yl	Yl
7.5' quad.	Cathedral Peak	Jordan Creek	Cathedral Peak	Cathedral Peak	Bumblebee Mtn.
Lat.	47.985867	47.898057	47.926448	47.932536	47.748803
Long.	-116.172226	-116.03437	-116.190461	-116.18903	-116.274757
			Unnormalized results (weight %)		
SiO_2	85.04	66.76	71.05	72.26	67.08
Al_2O_3	8.60	18.34	14.39	12.03	19.22
TiO_2	0.253	0.704	0.533	0.410	0.690
FeO*	1.44	3.24	3.63	3.03	3.86
MnO	0.003	0.015	0.020	0.076	0.017
CaO	0.08	0.15	0.29	3.00	0.09
MgO	0.41	2.32	2.78	1.92	0.84
K_2O	1.68	5.05	3.10	2.63	5.15
Na_2O	1.72	1.49	2.31	1.67	1.25
P_2O_5	0.048	0.068	0.082	0.077	0.075
Total	99.27	98.13	98.18	97.10	98.27
			Normalized results (weight %)		
SiO_2	85.66	68.03	72.37	74.42	68.26
Al_2O_3	8.66	18.69	14.66	12.39	19.56
TiO_2	0.255	0.717	0.543	0.422	0.702
FeO*	1.45	3.30	3.69	3.12	3.92
MnO	0.003	0.015	0.020	0.078	0.017
CaO	0.08	0.15	0.30	3.09	0.09
MgO	0.41	2.36	2.83	1.98	0.85
K_2O	1.69	5.15	3.16	2.71	5.24
Na_2O	1.73	1.52	2.35	1.72	1.27
P_2O_5	0.048	0.069	0.084	0.079	0.076
			Trace elements (ppm)		
Ni	13	29	18	17	25
Cr	12	65	32	28	54
Sc	11	19	13	14	21
V	30	98	63	43	79
Ba	86	827	795	1148	546
Rb	67	225	140	126	202
Sr	20	35	58	57	28
Zr	266	217	199	178	246
Y	17	24	31	46	56
Nb	7.4	16.4	13.6	11.9	17.0
Ga	8	22	19	16	21
Cu	3	0	4	3	148
Zn	10	35	61	32	25
Pb	0	0	1	6	6
La	25	39	27	41	71
Ce	41	61	59	86	125
Th	7	13	14	12	17

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO

"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle.

Map no.	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**
Sample no.	97FC	97SM	98ALC	98M	98MP	97CH	00RL401	00RL402
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	dike	dike	flow	flow	flow	flow	flow	flow
Formation			Saddle Mtns	Saddle Mtns	Saddle Mtns	Wanapum	Wanapum	Wanapum
Member			Mica Flats	Mica Flats	Mica Flats	Priest Rapids	Priest Rapids	Priest Rapids
Unit	TKdd	TKdd	Tmfb	Tmfb	Tmfb	Tpr	Tpr	Tpr
7.5' quad.	Fernan Lake	Fernan Lake	Mica Bay	Mica Bay	Mica Bay	Athol	Coeur d'Alene	Coeur d'Alene
Lat.	47.698151	47.715555	47.617075	47.616917	47.622542	47.876111	47.749016	47.749372
Long.	-116.6864	-116.6685	-116.8747	-116.8742	-116.8605	-116.7236	-116.7726	-116.7586
				Unnormalized results (weight %)				
SiO_2	49.92	53.98	50.87	52.98	50.93	49.37	49.61	49.19
Al_2O_3	14.35	15.18	12.94	13.35	12.96	12.59	12.71	12.57
TiO_2	1.363	1.076	2.954	3.016	2.938	3.677	3.600	3.640
FeO*	7.70	7.23	14.15	12.24	14.20	14.90	14.57	15.11
MnO	0.130	0.107	0.204	0.188	0.192	0.234	0.238	0.245
CaO	7.33	6.71	8.06	8.29	8.03	8.18	8.44	8.44
MgO	6.27	8.30	3.90	3.56	3.99	4.40	4.30	4.39
K_2O	4.28	1.75	1.76	1.70	1.68	1.25	1.43	1.44
Na_2O	2.54	2.54	2.64	2.71	2.74	2.85	2.72	2.65
P_2O_5	0.831	0.284	0.282	0.297	0.297	0.782	0.785	0.796
Total	94.71	97.16	97.76	98.33	97.96	98.23	98.40	98.47
				Normalized results (weight %)				
SiO_2	52.71	55.56	52.03	53.88	51.99	50.26	50.42	49.95
Al_2O_3	15.15	15.62	13.24	13.58	13.23	12.82	12.92	12.76
TiO_2	1.439	1.107	†3.02	†3.07	†3.00	†3.74	†3.66	†3.70
FeO*	8.13	7.44	14.48	12.45	14.50	†15.17	†14.81	†15.35
MnO	0.137	0.110	0.209	0.191	0.196	0.238	0.242	0.249
CaO	7.74	6.91	8.24	8.43	8.20	8.33	8.58	8.57
MgO	6.62	8.54	3.99	3.62	4.07	4.48	4.37	4.46
K_2O	4.52	1.80	1.80	1.73	1.72	1.27	1.45	1.46
Na_2O	2.68	2.61	2.70	2.76	2.80	2.90	2.76	2.69
P_2O_5	†0.88	0.292	0.288	0.302	0.303	†0.80	†0.80	†0.81
				Trace elements (ppm)				
Ni	85	164	9	15	6	0	16	17
Cr	131	368	46	38	40	33	31	31
Sc	22	18	34	29	32	35	41	45
V	168	166	†530	†534	†512	450	433	439
Ba	†2820	627	497	628	441	659	577	554
Rb	125	45	49	51	47	30	35	33
Sr	†1103	585	257	269	255	275	287	284
Zr	366	164	182	187	183	209	217	217
Y	32	20	37	39	38	49	52	51
Nb	16.8	9.9	22.3	21.3	22.9	18.7	20.1	17.7
Ga	19	22	27	22	25	24	21	23
Cu	29	23	14	18	15	14	24	23
Zn	105	77	134	139	132	153	155	154
Pb	31	11	8	10	12	9	1	6
La	58	49	36	40	29	12	32	24
Ce	97	53	53	68	80	54	59	66
Th	10	3	9	8	8	8	5	5

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**
Sample no.	98K031603	98BH	98MR	98K031901	97BR	97RB	98K031605	98K031810
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum
Member	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids
Unit	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr
7.5' quad.	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Fernan Lake	Fernan Lake	Hayden	Mica Bay	Mica Bay
Lat.	47.627096	47.678495	47.668137	47.655826	47.637526	47.786772	47.547454	47.523943
Long.	-116.8271	-116.8144	-116.8493	-116.7275	-116.6789	-116.7747	-116.8446	-116.7672
				Unnormalized results (weight %)				
SiO_2	49.81	49.54	48.62	50.00	49.57	48.99	49.29	49.84
Al_2O_3	12.84	12.68	12.28	12.95	12.62	12.61	12.53	12.56
TiO_2	3.676	3.635	3.561	3.701	3.601	3.506	3.604	3.616
FeO*	14.67	14.22	14.74	13.44	14.67	14.63	14.22	14.77
MnO	0.243	0.240	0.243	0.242	0.238	0.245	0.243	0.236
CaO	8.62	8.54	8.35	9.20	8.48	8.37	8.47	8.47
MgO	4.33	4.35	4.41	3.78	4.49	4.42	4.34	4.26
K_2O	1.20	1.41	1.31	1.28	1.35	1.25	1.34	1.15
Na_2O	2.67	2.58	2.52	2.70	2.55	2.77	2.66	2.57
P_2O_5	0.781	0.793	0.741	0.795	0.760	0.764	0.754	0.761
Total	98.84	97.99	96.78	98.09	98.33	97.55	97.45	98.23
				Normalized results (weight %)				
SiO_2	50.39	50.56	50.24	50.97	50.41	50.22	50.58	50.74
Al_2O_3	12.99	12.94	12.69	13.20	12.83	12.93	12.86	12.79
TiO_2	†3.72	†3.71	†3.68	†3.77	†3.66	†3.59	†3.70	†3.68
FeO*	†14.84	14.51	†15.23	13.70	†14.92	†14.99	14.59	†15.04
MnO	0.246	0.245	0.251	0.247	0.242	0.251	0.249	0.240
CaO	8.72	8.72	8.63	9.38	8.62	8.58	8.69	8.62
MgO	4.38	4.44	4.56	3.85	4.57	4.53	4.45	4.34
K_2O	1.21	1.44	1.35	1.30	1.37	1.28	1.38	1.17
Na_2O	2.70	2.63	2.60	2.75	2.59	2.84	2.73	2.62
P_2O_5	†0.79	†0.81	†0.77	†0.81	†0.77	†0.78	†0.77	†0.77
				Trace elements (ppm)				
Ni	3	1	2	4	3	1	4	3
Cr	31	32	30	29	29	27	29	30
Sc	34	40	35	37	33	34	29	37
V	†456	†456	431	†457	439	420	445	446
Ba	539	552	533	525	578	619	522	496
Rb	28	31	32	29	31	28	27	26
Sr	292	287	281	299	286	286	284	286
Zr	210	210	207	210	209	203	204	207
Y	50	51	49	49	49	49	49	47
Nb	18.4	19.0	18.2	19.2	18.7	17.5	17.9	18.6
Ga	23	23	23	24	26	26	24	22
Cu	15	10	13	16	13	10	16	15
Zn	154	154	147	153	152	152	148	153
Pb	7	4	7	6	2	6	7	7
La	21	26	42	15	36	31	20	25
Ce	50	63	67	86	87	51	72	75
Th	4	8	6	5	7	5	4	6

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**
Sample no.	98K031811	97MH	98GR	98GRTOP	98ML	98K031704	98K031803	98K031804
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum	Wanapum
Member	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids	Priest Rapids
Unit	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr	Tpr
7.5' quad.	Mica Bay	Mica Bay	Mica Bay	Mica Bay	Mica Bay	Mount Coeur d'Alene	Mount Coeur d'Alene	Mount Coeur d'Alene
Lat.	47.512173	47.609437	47.616412	47.599277	47.607866	47.54392	47.620682	47.622282
Long.	-116.7925	-116.8707	-116.7627	-116.7516	-116.8724	-116.7369	-116.7255	-116.7312
				Unnormalized results (weight %)				
SiO_2	49.74	49.04	49.88	49.49	49.61	50.05	49.84	49.75
Al_2O_3	12.61	12.79	12.82	12.77	12.90	12.48	12.70	12.51
TiO_2	3.611	3.729	3.666	3.626	3.708	3.640	3.650	3.585
FeO*	14.52	14.74	13.61	14.17	13.83	14.17	14.37	14.77
MnO	0.244	0.249	0.233	0.245	0.236	0.236	0.237	0.248
CaO	8.50	8.61	8.62	8.61	8.66	8.50	8.61	8.51
MgO	4.43	4.47	4.32	4.29	4.18	4.27	4.20	3.68
K_2O	1.22	1.30	1.30	1.31	1.28	1.33	1.29	1.20
Na_2O	2.68	2.65	2.55	2.47	2.72	2.68	2.57	2.69
P_2O_5	0.761	0.787	0.778	0.759	0.786	0.772	0.782	0.762
Total	98.32	98.36	97.78	97.74	97.91	98.13	98.25	97.71
				Normalized results (weight %)				
SiO_2	50.59	49.86	51.01	50.63	50.67	51.00	50.73	50.92
Al_2O_3	12.83	13.00	13.11	13.07	13.17	12.72	12.93	12.80
TiO_2	†3.67	†3.79	†3.75	†3.71	†3.79	†3.71	†3.72	†3.67
FeO*	†14.77	†14.98	13.92	14.50	14.13	14.44	14.63	†15.12
MnO	0.248	0.253	0.238	0.251	0.241	0.241	0.241	0.254
CaO	8.65	8.75	8.82	8.81	8.84	8.66	8.76	8.71
MgO	4.51	4.54	4.42	4.39	4.27	4.35	4.27	3.77
K_2O	1.24	1.32	1.33	1.34	1.31	1.36	1.31	1.23
Na_2O	2.73	2.69	2.61	2.53	2.78	2.73	2.62	2.75
P_2O_5	†0.77	†0.80	†0.80	†0.78	†0.80	†0.79	†0.80	†0.78
				Trace elements (ppm)				
Ni	2	4	3	1	6	5	2	1
Cr	29	29	30	36	32	32	32	31
Sc	30	32	34	32	33	39	31	29
V	†455	452	†471	†463	442	451	448	436
Ba	517	616	548	541	488	554	555	518
Rb	29	29	29	25	28	31	29	26
Sr	286	285	288	291	291	287	293	283
Zr	204	211	210	208	208	208	209	207
Y	48	50	50	50	50	50	50	49
Nb	18.3	18.5	18.4	18.0	19.6	18.7	18.2	17.2
Ga	21	24	23	21	23	22	23	25
Cu	12	14	15	14	14	16	17	15
Zn	150	158	155	154	160	158	151	156
Pb	8	6	6	3	6	5	7	5
La	19	38	24	30	21	7	12	30
Ce	52	59	53	68	70	91	73	67
Th	6	6	7	5	7	7	7	7

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Sample no.	00GJT	98K031912	97HI	97RD	98CB	98RR	00WLQ	98K031908
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Wanapum	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde
Member	Priest Rapids							
Unit	Tpr	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2
7.5' quad.	Mount Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Coeur d'Alene	Fernan Lake	Fernan Lake
Lat.	47.598429	47.681389	47.693498	47.676619	47.668859	47.626358	47.638798	47.632357
Long.	-116.7432	-116.8065	-116.8706	-116.8106	-116.8294	-116.7683	-116.6263	-116.6987
				Unnormalized results (weight %)				
SiO_2	50.28	55.18	53.69	53.86	53.92	52.78	53.58	53.82
Al_2O_3	13.51	14.73	13.95	13.97	14.08	13.53	13.90	14.20
TiO_2	3.816	1.985	1.880	1.894	1.922	1.872	1.888	1.945
FeO*	13.62	9.04	11.05	10.91	9.95	11.00	11.86	9.55
MnO	0.217	0.177	0.214	0.202	0.235	0.209	0.210	0.205
CaO	9.05	8.54	8.48	8.49	8.66	8.38	8.46	8.77
MgO	3.18	3.70	4.62	4.47	4.11	4.55	4.52	4.43
K_2O	1.13	1.44	1.39	1.45	1.40	1.31	1.31	1.24
Na_2O	2.73	2.93	2.92	2.92	2.86	2.85	2.91	2.75
P_2O_5	0.823	0.387	0.375	0.389	0.429	0.372	0.394	0.392
Total	98.36	98.11	98.57	98.56	97.57	96.85	99.03	97.30
				Normalized results (weight %)				
SiO_2	51.12	56.24	54.47	54.65	55.27	54.49	54.11	55.31
Al_2O_3	13.74	15.01	14.15	14.17	14.43	13.97	14.04	14.59
TiO_2	†3.88	2.023	1.907	1.922	1.970	1.933	1.907	1.999
FeO*	13.85	9.21	11.21	11.07	10.20	11.36	11.97	9.81
MnO	0.221	0.180	0.217	0.205	0.241	0.216	0.212	0.211
CaO	9.20	8.70	8.60	8.61	8.88	8.65	8.54	9.01
MgO	3.23	3.77	4.69	4.54	4.21	4.70	4.56	4.55
K_2O	1.15	1.47	1.41	1.47	1.43	1.35	1.32	1.27
Na_2O	2.78	2.99	2.96	2.96	2.93	2.94	2.94	2.83
P_2O_5	†0.84	0.394	0.380	0.395	0.440	0.384	0.398	0.403
				Trace elements (ppm)				
Ni	13	4	1	5	7	4	9	8
Cr	34	46	46	51	41	48	44	48
Sc	48	31	32	30	33	37	33	36
V	447	289	291	284	289	291	280	301
Ba	1411	731	554	562	808	497	511	518
Rb	26	32	30	31	31	31	33	26
Sr	317	335	306	309	328	306	306	327
Zr	226	167	159	161	165	159	164	164
Y	58	38	35	35	36	36	37	38
Nb	20.4	12.1	11.2	12.2	12.6	11.8	12.0	12.4
Ga	23	22	22	20	24	25	22	21
Cu	26	25	19	20	22	20	31	21
Zn	168	125	114	112	118	118	119	128
Pb	3	5	5	6	6	5	5	7
La	20	30	18	34	24	32	31	18
Ce	53	38	48	35	40	31	40	35
Th	2	5	5	6	5	6	3	4

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**
Sample no.	97HA	97YT	97OM	98K031602	98K031604	98K031703	98K031708	98K031709
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde
Member								
Unit	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2
7.5' quad.	Fernan Lake	Fernan Lake	Hayden	Mica Bay	Mica Bay	Mica Bay	Mica Bay	Mica Bay
Lat.	47.687241	47.63275	47.845833	47.610067	47.56322	47.537472	47.588946	47.599593
Long.	-116.7373	-116.7029	-116.7864	-116.8101	-116.8244	-116.7511	-116.7932	-116.7768
				Unnormalized results (weight %)				
SiO_2	53.63	53.97	53.42	53.97	54.33	54.81	53.93	54.23
Al_2O_3	13.82	14.04	13.71	14.13	13.94	14.21	13.80	14.09
TiO_2	1.876	1.865	1.878	1.927	1.901	1.936	1.876	1.931
FeO*	11.22	11.44	11.72	10.20	10.59	9.89	10.95	10.24
MnO	0.207	0.203	0.203	0.201	0.206	0.197	0.206	0.196
CaO	8.49	8.48	8.44	8.63	8.51	8.70	8.52	8.67
MgO	4.73	4.63	4.69	4.03	4.47	4.19	4.41	4.10
K_2O	1.32	1.42	1.33	1.33	1.46	1.37	1.30	1.32
Na_2O	3.01	2.81	2.69	2.98	2.81	3.00	2.89	2.90
P_2O_5	0.374	0.380	0.386	0.387	0.376	0.389	0.369	0.396
Total	98.68	99.24	98.47	97.79	98.59	98.69	98.25	98.07
				Normalized results (weight %)				
SiO_2	54.35	54.38	54.25	55.19	55.11	55.54	54.89	55.30
Al_2O_3	14.01	14.15	13.92	14.45	14.14	14.40	14.05	14.37
TiO_2	1.901	1.879	1.907	1.971	1.928	1.962	1.909	1.969
FeO*	11.37	11.53	11.90	10.43	10.74	10.02	11.14	10.44
MnO	0.210	0.205	0.206	0.206	0.209	0.200	0.210	0.200
CaO	8.60	8.55	8.57	8.83	8.63	8.82	8.67	8.84
MgO	4.79	4.67	4.76	4.12	4.53	4.25	4.49	4.18
K_2O	1.34	1.43	1.35	1.36	1.48	1.39	1.32	1.35
Na_2O	3.05	2.83	2.73	3.05	2.85	3.04	2.94	2.96
P_2O_5	0.379	0.383	0.392	0.396	0.381	0.394	0.376	0.404
				Trace elements (ppm)				
Ni	3	4	6	7	1	3	4	4
Cr	45	45	46	44	44	45	44	51
Sc	33	31	30	34	36	32	33	34
V	295	286	295	304	299	303	302	281
Ba	542	523	603	531	478	545	495	565
Rb	30	28	28	30	29	30	31	30
Sr	301	307	312	319	308	325	310	321
Zr	156	162	163	163	158	164	159	165
Y	35	35	36	37	34	40	35	37
Nb	11.9	11.7	11.5	13.4	13.2	12.6	11.6	13.0
Ga	21	22	23	23	23	22	22	24
Cu	20	23	29	23	25	22	23	21
Zn	117	117	119	180	116	126	118	118
Pb	0	8	5	9	4	4	3	5
La	16	27	50	29	9	18	15	2
Ce	36	19	50	53	37	55	69	45
Th	6	5	5	6	1	6	6	6

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**
Sample no.	98K031808	97MB	97MC	98UP	98VP	98K031801	98K031805	98K031806
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde
Member								
Unit	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2	Tgn_2
7.5' quad.	Mica Bay	Mica Bay	Mica Bay	Mica Bay	Mica Bay	Mount Coeur d'Alene	Mount Coeur d'Alene	Mount Coeur d'Alene
Lat.	47.60696	47.600067	47.604243	47.50596	47.60811	47.615104	47.623695	47.621353
Long.	-116.7655	-116.8602	-116.8712	-116.8741	-116.81	-116.6944	-116.7375	-116.7382
				Unnormalized results (weight %)				
SiO_2	54.37	54.35	53.67	53.63	53.48	53.88	54.25	54.58
Al_2O_3	14.27	14.39	14.38	13.97	13.87	13.90	14.16	14.06
TiO_2	1.894	1.918	1.954	1.905	1.875	1.901	1.924	1.889
FeO*	10.27	10.79	10.49	11.04	11.27	10.86	10.51	11.00
MnO	0.200	0.201	0.200	0.204	0.206	0.210	0.206	0.200
CaO	8.67	8.71	8.74	8.47	8.46	8.57	8.59	8.50
MgO	4.45	4.60	4.48	4.35	4.57	4.44	4.22	4.04
K_2O	1.26	1.21	1.20	1.30	1.26	1.35	1.37	1.38
Na_2O	2.90	3.03	3.01	2.91	3.01	2.85	2.92	2.90
P_2O_5	0.369	0.394	0.398	0.396	0.378	0.405	0.384	0.381
Total	98.65	99.59	98.52	98.18	98.38	98.37	98.53	98.93
				Normalized results (weight %)				
SiO_2	55.11	54.57	54.48	54.63	54.36	54.78	55.06	55.17
Al_2O_3	14.46	14.45	14.60	14.23	14.10	14.13	14.37	14.21
TiO_2	1.920	1.926	1.983	1.940	1.906	1.933	1.953	1.909
FeO*	10.41	10.83	10.65	11.25	11.46	11.04	10.67	11.12
MnO	0.203	0.202	0.203	0.208	0.209	0.213	0.209	0.202
CaO	8.79	8.75	8.87	8.63	8.60	8.71	8.72	8.59
MgO	4.51	4.62	4.55	4.43	4.65	4.51	4.28	4.08
K_2O	1.28	1.21	1.22	1.32	1.28	1.37	1.39	1.39
Na_2O	2.94	3.04	3.06	2.96	3.06	2.90	2.96	2.93
P_2O_5	0.374	0.396	0.404	0.403	0.384	0.412	0.390	0.385
				Trace elements (ppm)				
Ni	4	7	8	3	5	2	4	3
Cr	44	45	48	51	49	45	49	44
Sc	31	33	33	36	30	31	29	33
V	302	292	295	282	292	280	283	297
Ba	513	569	607	565	491	523	527	594
Rb	26	25	26	28	30	28	29	31
Sr	317	320	324	310	307	313	318	323
Zr	157	168	165	160	159	160	162	162
Y	36	39	40	36	36	34	41	35
Nb	11.4	13.1	12.7	12.2	14.2	12.0	11.1	13.3
Ga	22	22	19	22	21	25	24	21
Cu	22	18	19	21	27	28	27	23
Zn	119	119	123	120	121	118	121	120
Pb	6	7	1	8	3	6	6	5
La	19	19	10	24	26	2	12	13
Ce	52	46	53	31	41	50	49	52
Th	3	6	7	6	2	4	4	4

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**
Sample no.	98AP	98K031905	98K031909	97SB	98K031702	98K031706	98K031813	98BR
Lithology	basalt	basalt	basalt	basalt	basalt	basalt	basalt	basalt
Form	flow	flow	flow	flow	flow	flow	flow	flow
Formation	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde	Grande Ronde
Member								
Unit	Tgr_2	Tgr_2	Tgr_2	Tgr_2	Tgr_2	Tgr_2	Tgr_2	Tgr_2
7.5' quad.	Coeur d'Alene	Fernan Lake	Fernan Lake	Fernan Lake	Mica Bay	Mica Bay	Mica Bay	Mica Bay
Lat.	47.629588	47.631761	47.637079	47.646247	47.540829	47.574464	47.512593	47.518721
Long.	-116.7684	-116.7092	-116.6723	-116.7305	-116.7684	-116.771	-116.8117	-116.8473
				Unnormalized results (weight %)				
SiO_2	53.46	54.06	53.55	53.95	53.80	53.96	54.24	53.36
Al_2O_3	13.27	13.58	13.51	13.52	13.56	13.50	13.86	13.57
TiO_2	2.138	2.173	2.165	2.122	2.181	2.175	2.208	2.173
FeO*	11.72	11.69	12.40	12.38	11.89	12.26	11.09	12.06
MnO	0.199	0.193	0.199	0.198	0.194	0.200	0.201	0.182
CaO	7.54	7.75	7.65	7.58	7.67	7.63	7.70	7.53
MgO	3.77	3.55	3.78	3.82	3.71	3.74	3.47	3.22
K_2O	1.68	1.61	1.64	1.62	1.56	1.64	1.88	1.27
Na_2O	2.89	3.06	2.94	2.97	3.12	2.95	2.91	2.85
P_2O_5	0.372	0.416	0.381	0.383	0.376	0.375	0.381	0.380
Total	97.04	98.08	98.22	98.54	98.06	98.43	97.94	96.59
				Normalized results (weight %)				
SiO_2	55.09	55.12	54.52	54.75	54.86	54.82	55.38	55.24
Al_2O_3	13.67	13.85	13.76	13.72	13.83	13.72	14.15	14.05
TiO_2	2.203	2.215	2.204	2.153	2.224	2.210	2.254	2.250
FeO*	12.08	11.92	12.63	12.56	12.13	12.46	11.32	12.48
MnO	0.205	0.197	0.203	0.201	0.198	0.203	0.205	0.188
CaO	7.77	7.90	7.79	7.69	7.82	7.75	7.86	7.80
MgO	3.89	3.62	3.85	3.88	3.78	3.80	3.54	3.33
K_2O	1.73	1.64	1.67	1.64	1.59	1.67	1.92	1.31
Na_2O	2.98	3.12	2.99	3.01	3.18	3.00	2.97	2.95
P_2O_5	0.383	0.424	0.388	0.389	0.383	0.381	0.389	0.393
				Trace elements (ppm)				
Ni	10	11	9	10	12	12	14	7
Cr	29	29	26	26	31	33	33	37
Sc	34	28	27	28	27	33	32	33
V	412	416	423	402	426	416	411	408
Ba	627	632	624	651	628	631	659	615
Rb	39	41	39	41	36	39	40	30
Sr	320	331	324	327	327	326	331	341
Zr	165	167	167	169	168	167	169	171
Y	35	34	34	35	35	35	35	36
Nb	12.5	12.3	12.7	12.3	12.8	12.5	12.2	13.7
Ga	21	22	20	24	24	23	21	24
Cu	31	33	29	34	31	39	32	34
Zn	129	122	120	120	125	125	122	144
Pb	6	9	7	6	8	8	5	10
La	40	28	22	60	0	7	10	39
Ce	29	63	48	47	54	40	45	59
Th	6	6	4	4	4	5	5	7

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.

Table 3. XRF analyses of basaltic rocks from the Coeur d'Alene 30' x 60' quadrangle (continued).

Map no.	**105**	**106**	**107**
Sample no.	98DP	98PR	98K031802
Lithology	basalt	basalt	basalt
Form	flow	flow	flow
Formation	Grande Ronde	Grande Ronde	Grande Ronde
Member			
Unit	Tgr_2	Tgr_2	Tgr_2
7.5' quad.	Mica Bay	Mica Bay	Mount Coeur d'Alene
Lat.	47.591642	47.541306	47.623808
Long.	-116.7994	-116.8232	-116.7403
Unnormalized results (weight %)			
SiO_2	53.43	53.29	54.35
Al_2O_3	13.58	13.39	13.73
TiO_2	2.158	2.123	2.206
FeO*	12.36	12.98	11.12
MnO	0.197	0.195	0.181
CaO	7.57	7.59	7.73
MgO	3.57	3.64	3.35
K_2O	1.74	1.55	1.62
Na_2O	2.78	2.99	3.05
P_2O_5	0.369	0.379	0.380
Total	97.75	98.13	97.72
Normalized results (weight %)			
SiO_2	54.66	54.31	55.62
Al_2O_3	13.89	13.65	14.05
TiO_2	2.208	2.163	2.258
FeO*	12.64	13.23	11.38
MnO	0.202	0.199	0.185
CaO	7.74	7.73	7.91
MgO	3.65	3.71	3.43
K_2O	1.78	1.58	1.66
Na_2O	2.84	3.05	3.12
P_2O_5	0.377	0.386	0.389
Trace elements (ppm)			
Ni	8	8	9
Cr	39	37	28
Sc	33	36	29
V	408	406	414
Ba	591	657	716
Rb	35	39	37
Sr	326	333	340
Zr	168	170	172
Y	37	36	38
Nb	13.4	14.2	12.8
Ga	21	23	21
Cu	28	27	34
Zn	141	125	130
Pb	9	7	5
La	27	23	19
Ce	31	47	54
Th	6	3	7

Major elements normalized on a volatile-free basis; FeO is total Fe expressed as FeO
"†" denotes values > 120% of highest standard in lab.