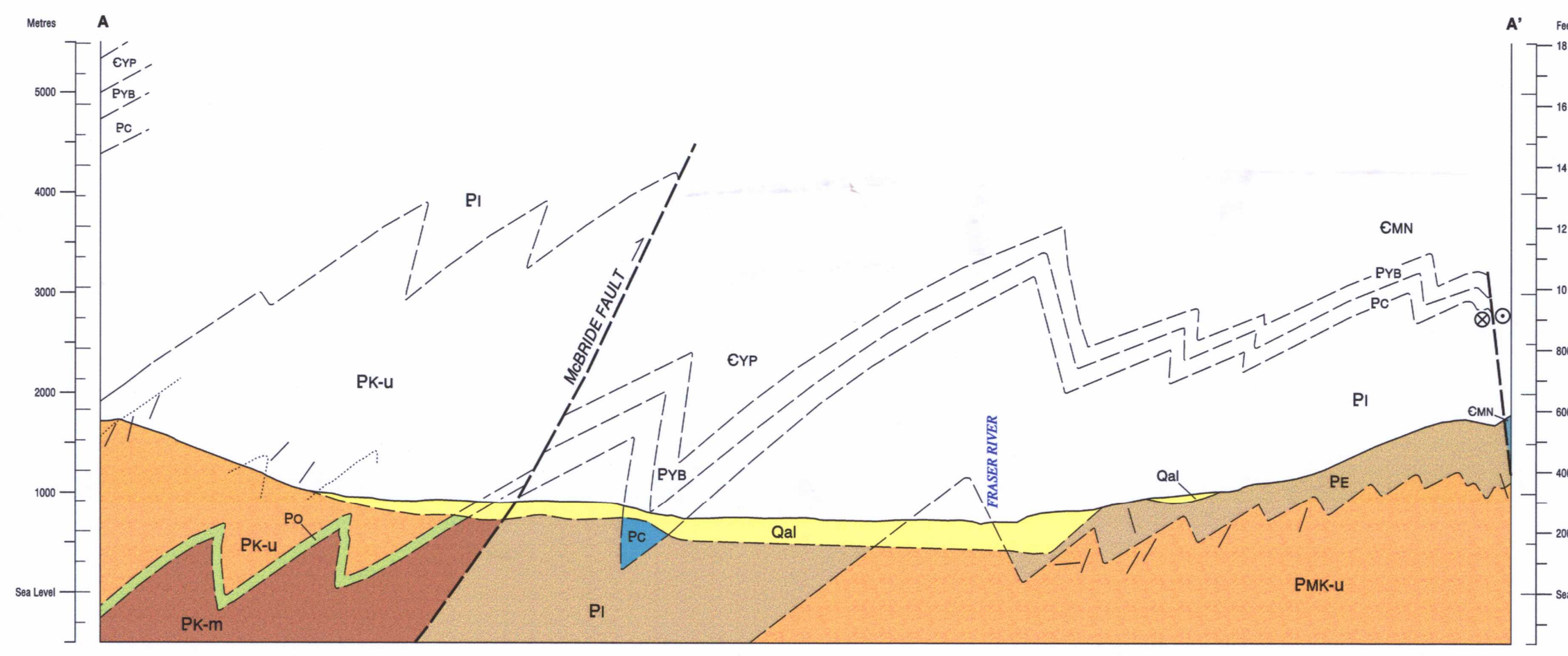
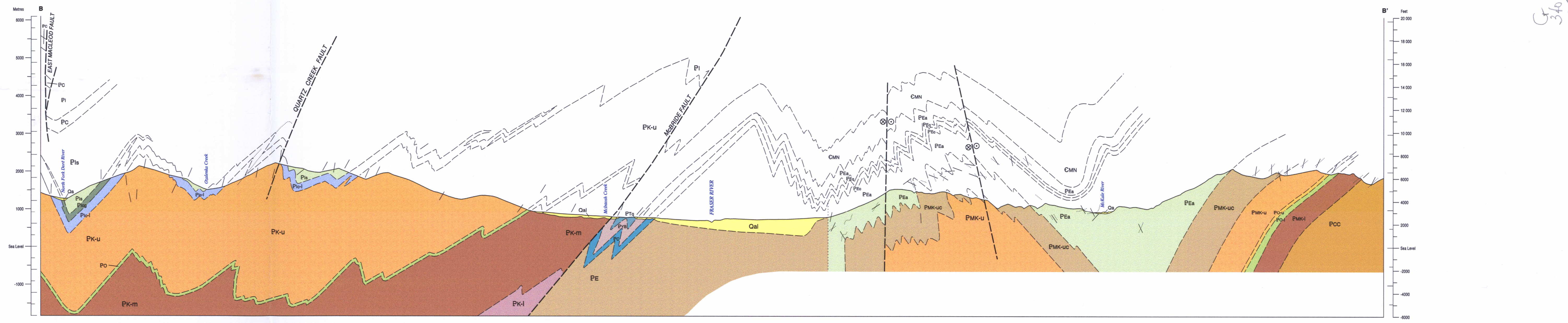
Natural Resources Canada / Ressources naturelles Canada

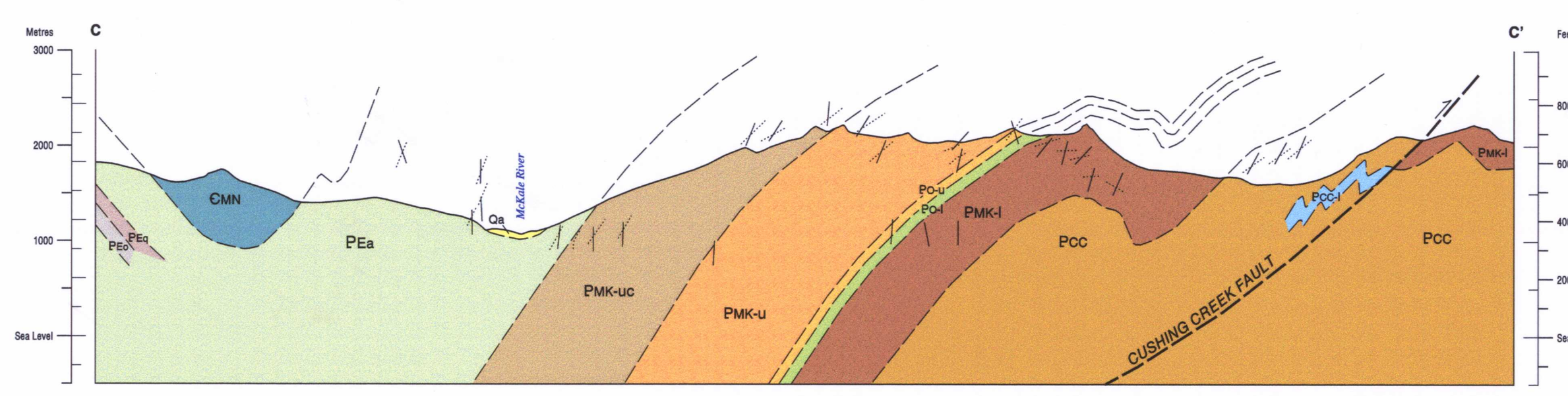
GEOLOGICAL SURVEY OF CANADA / COMMISSION GÉOLOGIQUE DU CANADA



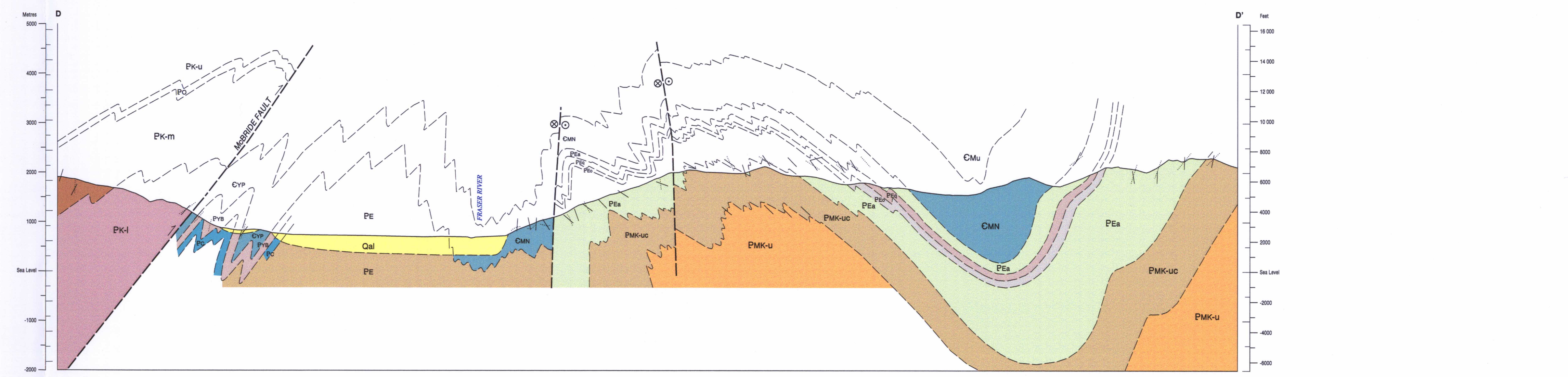
Structure cross-section along A - A'



Structure cross-section along B - B'



Structure cross-section along C - C'



Structure cross-section along D - D'

DESCRIPTIVE NOTES

The McBride map area comprises part of the larger, McBride 1:250,000-scale map area, which was studied originally by Campbell et al. (1973) and has seen only local attention subsequently (Carey and Simony, 1985). The central feature of this map area is the Southern Rocky Mountain Trench (SRMT), a dramatic flat-floored valley filled with Quaternary drift, which separates the Park Ranges of the western Rocky Mountain Fold-and-Thrust Belt to the east from the Cariboo Mountains of the Omineca Belt to the west. Rocks in the Rocky Mountains are characterized by fold-and-thrust style structural geometries, whereas the rocks of the Cariboo Mountains are part of an extensive foldbelt of the metamorphic internides of the Canadian Cordillera, characterized by higher metamorphic grade and different structural style. In general the McBride map area is underlain almost exclusively by structurally folded, low-grade, metasedimentary strata of the Neoproterozoic Windermere Supergroup and the Neoproterozoic–Cambrian Cariboo and Gog groups. This map was produced using the results of foot traverses that carefully defined and traced out distinct stratigraphic units and structural geometries.

STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS

The stratigraphic nomenclature differs between the Park Ranges and the Cariboo Mountains. However, as a result of new field observations made during preparation of this map, the stratigraphy of the Rocky Mountains can be correlated with improved precision to those units in the Cariboo Mountains. We have tried to rectify some of the potential confusion by colour-coding the correlative units on the map and showing suggested correlatives in the legend.

Strata of two groups that can be correlated across the SRMT are present in the McBride map area. Strata of the Kaza Group and lower Cariboo Group, both of Neoproterozoic age, dominate the western half of the map area. Strata of the Miette Group and Gog Group, of Neoproterozoic to Lower Cambrian age, occur east of the SRMT in the Park Ranges. Collectively the Neoproterozoic units represent sedimentation on a continental margin that shoaled from basin floor setting (Kaza Group and Cushing Creek/McKale formations of the Miette Group) up through slope setting (Isaac Formation of the Cariboo Group and upper McKale/East Twin formations of the Miette Group). In the Park Ranges, shallow-water strata of the Gog Group overlie deep-water sedimentary rocks of the Miette Group.

The Miette Group comprises a sequence of feldspathic coarse pebbly to granular sandstone ("grit") and interbedded metamorphosed mudrock (pelite). Sedimentary structures are typical of those formed in turbidite settings and include massive sandstone and sediment gravity flows as well as classic Bouma sequences. Based on the relative proportions of pelite to grit, the composition of the grit deposits, and their position relative to a very well-defined stratigraphic marker, the Miette Group is subdivided into three informal formations (Cushing Creek, McKale, and East Twin formations; Hein and McMechan, 1994).

The Cushing Creek Formation (unit PCC) is composed predominantly of dark grey to black pyritic slate with 1–3 cm thick sandstone beds and local thin-bedded limestone (unit PCC-l). There is an upward increase in the presence of granule sandstone with calcareous cement as this unit grades into the overlying McKale Formation. The Cushing Creek Formation is tightly folded and bound along its base by a thrust fault, but is estimated to be a minimum of 380 m thick (Carey and Simony, 1985). The equivalent stratigraphy in the Cariboo Mountains is the lower Kaza Group (unit PK-l) which is characterized by interbedded pelite and grit, the grit comprising a subordinate component of the unit. The pelite is characteristically dark grey and the grit and sandstone commonly contain a calcareous cement. This unit is present only in the bush-covered western wall of the SRMT, but occurs extensively in the adjacent Eddy and Lanezi map areas.

The McKale Formation (unit PMK) (>3000 m) is subdivided into three units that include two lower units (unit PMK-l and unit PMK-u) that are dominated by grit, and an upper unit (unit PMK-uc) that is relatively mud-rich but contains local limestone pebble conglomerate and grit bands. Units PMK-l and PMK-u are composed of thick successions (up to 180 m) of coarse pebble to granule conglomerate separated by 10–40 m thick intervals of thin-bedded green to rusty pelite. The grit is composed of stacked, metre-scale graded beds with little intervening pelite. Pelite deposits between major grit units are classic Bouma turbidite beds composed of ripple- and parallel-laminated sandstone and silty mudstone. The correlative stratigraphic units in the Cariboo Mountains include the middle Kaza Group (unit PK-m; equivalent to the lowermost McKale Formation, unit PMK-l) and the upper Kaza Group (unit PK-u; equivalent to the upper McKale Formation unit PMK-u). The middle Kaza Group is composed predominantly of interbedded, green-weathering, coarse sandy to granular feldspathic grit and thin interbeds of banded greenish pelite. In contrast to the equivalent lower McKale Formation, the middle Kaza Group grit units are not organized into discrete sheets but form amalgamated sand-rich successions with discontinuous interbedded pelite. The upper Kaza Group (unit PK-u) is similar to the middle Kaza Group and consists of stacked sheets of feldspathic grit interbedded with green to dark grey pelite. The grit tends to be grey to brown, in part reflecting the presence of calcareous cement. Both the grit and pelite of the upper Kaza Group contain pyrite and thus the unit weathers to a streaked rusty appearance.

A distinctive unit, the Old Fort Point Formation (unit PO), forms the break between the two grit-rich intervals of the McKale Formation. The Old Fort Point Formation, which was first recognized in the Jasper area (83D/9; Charlesworth et al., 1967), can be correlated regionally throughout the southern Canadian Cordillera (Ross and Murphy, 1988; Ross et al., 1995). It consists of three informal members that record deposition during a major cycle of sea level change that included transgressive, highstand, and falling sea levels. The lower member of the Old Fort Point Formation (unit PO-l) is composed of green, laminated, calcareous siltstone and sandy limestone. The middle member (unit PO-m) is absent in the eastern McBride map area as a result of erosion beneath the upper member but consists of dark pyritic slate and local dark grey limestone beds. The upper member (unit PO-u) is composed of interbedded, quartzose, grey limestone turbidites, grey to tan limestone clast breccia, and local conglomerate. In the western part of the McBride map area, outcrops of the Old Fort Point Formation were mapped at three localities north of Doré River, but the rest of the map pattern in the Cariboos is inferred from local structural patterns and where known exposures of the formation outcrop in the southerly adjacent Eddy map sheet.

The uppermost unit of the McKale Formation (unit PMK-uc) is composed predominantly of thin-bedded grey to black slate with 2–5 cm thick ripple- and parallel-laminated calcareous sandstone interbeds. The contact with the underlying upper McKale Formation (unit PMK-u) is relatively sharp over an interval of about 50 m, and is recognized by the appearance of distinctive blue-grey pelite and calcareous sandstone and the occurrence of intervals up to 100 m thick of quartz pebble conglomerate associated with thin- to medium-bedded, sandy, grey limestone turbidites (shown in an unlabelled pink band north of McKale River). Also present, although less common than lower McKale Formation units, is quartz feldspar pebble-granule conglomerate. This interval of the McKale Formation correlates with the lower Isaac Formation (unit PI-l) of the Cariboo Group. The blue to grey pelite that characterizes the Isaac Formation is directly comparable to the pelitic facies in unit PMK-uc. Although four informal members of the Isaac Formation have been recognized in the adjacent Eddy, Lanezi, and Goat River map areas only the lower Isaac Formation (unit PI-l) with local conglomerate units (unit PIcg), and the lower Isaac Formation carbonate member (unit PIc-l) occur in the McBride map area. The lower Isaac Formation carbonate member (unit PIc-l) can vary from 0–150 m thick. It is very diverse lithologically and contains varying proportions of thin-bedded, black, limestone-pelite turbidite, massive grey calcarenite to mud-rich boulder conglomerate, calcareous pebbly grit, and very clean, coarse-grained quartz arenite. It is directly comparable to the carbonate interval in the upper McKale Formation. Collectively the Isaac Formation and upper McKale Formation are interpreted as recording progradation of slope facies sediments, including resedimented deep-water carbonate, over the basin floor sand-rich turbidite facies of the Kaza Group and lower McKale Formation.

The McKale Formation is overlain by the slate-rich East Twin Formation (unit PE). Lithologically the slate of the East Twin Formation is similar to the uppermost McKale Formation slate (unit PMK-uc) but what distinguishes the two units is the presence of conglomerate and grit in the latter. Sand-poor East Twin Formation (unit PEa) includes two distinctive units, an orange-weathering, thin-bedded limestone unit (unit PEo) and a unit of varicoloured green and purple slate with interbeds of crossbedded quartz sandstone (unit PEq). These units are tentatively correlated with the Cunningham and Yankee Belle formations west of the SRMT. The East Twin Formation is overlain by the Gog Group, which is composed of shallow-water quartz sandstone of the McNaughton Formation (unit ЄMN; Young, 1979) and limestone of the Mural Formation (unit ЄMu). The contact between the East Twin Formation and the McNaughton Formation appears conformable at a local scale, but variation in the thickness between the base of the McNaughton and the top of unit PEq is suggestive of an erosional break.

STRUCTURE

The McBride map area is characterized by two different structural regimes separated by the SRMT. In the Rocky Mountains, the strata are disposed in a fold pair (Cushing Creek Anticline and Mount Rider Syncline) that developed in response to deformation above a footwall ramp in the Cushing Creek Fault (Carey and Simony, 1985). The latter is an east-vergent thrust fault a small portion of which is present in the northeast corner of the McBride map area. Both folds are associated with parasitic minor folds. The Cushing Creek Anticline is a low-amplitude fold that is cored by tightly folded Cushing Creek Formation. The Mount Rider Syncline continues along strike to the northwest and southeast where it becomes part of the Mount Robson Synclinorium (Mountjoy, 1980). The syncline is cored by the Lower Cambrian Gog Group and is asymmetrical with a gently southwest-dipping eastern limb and a steeply northeast-dipping western limb with tight, minor folds that cascade to the floor of the SRMT.

The major fold structure in both the Cariboos and Park Ranges is associated with a prominent axial planar cleavage shown on the map as S2. In the Cariboos and southwestern Park Ranges the S2 foliation is a sub-mm scale crenulation cleavage that often appears as a simple slaty cleavage in arenaceous units and in strongly sheared fold limbs. In pelitic rocks, and especially in relatively broad fold hinge areas, the S2 cleavage can usually be seen to crenulate an older phyllosilicate alignment (S1) that appears roughly parallel to bedding but, in the rare instances where it can be measured, consistently dips slightly steeper to the southwest relative to upright bedding. S1 is interpreted to be axial planar to rare, northeast-verging mesoscopic D1 folds in the Cariboos (Ferguson, 1994, p. 184), but in the Park Ranges, the effect of D1 is inferred only because the foliation axial planar to megascopic fold structures (S2) forms a weak crenulation where it intersects bedding. In the northeast corner of the map area the cleavage shown as axial planar to the megascopic fold structure does not produce a crenulation [Carey and Simony (1985) mapped it as S1] and is shown on our map as S2 merely to associate it with the similarly oriented S2 fabric in the rest of the map area. The absence of an older, approximately bed-parallel cleavage in the vicinity of the Cushing Creek thrust implies that this region represents the northeastern limit of D1 deformation in this area.

The intersection of S2 and bedding in the Cariboos and the Park Ranges produces a gently plunging crenulation lineation (L2). Throughout most of the map area L2 plunges gently to the northwest in agreement with the regional plunge of the Omineca Belt, but in the vicinity of Mt. Rider Syncline L2 plunges gently to the southeast reflecting the periclinal nature of this gently southeast- plunging structure.

The S2 foliation is crenulated by two younger fabrics: a locally developed, generally weak, mm- to cm-scale crenulation roughly coaxial to S2, and a cm-scale upright, kink crenulation cleavage oriented at high angles to regional strike that typically produces a steeply plunging crenulation lineation where it interacts with S2. The weak coaxial crenulation is interpreted as a second crenulation of the S2 cleavage in oversteepened fold limbs of the megascopic fold structure, and is considered to be the result of progressive D2 deformation. This late- stage D2 fabric is relatively common in the Cariboos, where it is shown as S3, but is quite rare in the Park Ranges, and is not shown on this map although Carey and Simony (1985) note the presence of this fabric (their S2) just to the north of the map area, and Ferguson (1994) shows a single measurement of it (his S3) near the mouth of East Twin Creek. The upright kink crenulation cleavage is the youngest fabric in both ranges, and is denoted as S4 in the Cariboos, and S3 in the Park Ranges. In the Park Ranges this fabric (S3) is well developed just to the west of Mt. Rider Syncline where it appears to be associated with a pair of high-angle dextral strike-slip faults that may merge to the northwest with the Late Cretaceous Walker Creek dextral fault system (McMechan, 2000). The S4 fabric in the northern Cariboos is ubiquitous and probably reflects more regional distribution of dextral strike-slip deformation west of the SRMT.

The megascopic D2 fold structure in the Cariboo Mountains portion of the McBride map area is dominated by upright to northeast-vergent, close to tight folds that lie on the northeast flank of the Ozalenka fan (Ferguson and Simony, 1991), a major cleavage fan that is part of a nearly continuous fold belt that extends from the SRMT (McBride Fault) for more than 60 km to the southwest largely as southwest-vergent open to close folds. Differences in structural style (folding vs. faulting) between the Cariboos and the Park Ranges are largely the result of stratigraphically controlled multilayer characteristics, principally a dramatic westward thickening of the Windermere Supergroup across the SRMT.

The apparent gradational easterly transition from a continuous northeast-vergent fold belt to a northeast-vergent fold-thrust belt across the SRMT as depicted on our cross-sections, and the apparent correlation of structural fabrics between the Cariboos and Park Ranges, should not be considered as evidence of time-equivalence of structures across the SRMT. Northeast-verging folds in the Rocky Mountains adjacent to the SRMT southeast of McBride map area are constrained as Cretaceous in age (100–135 Ma; McDonough and Murphy, 1994). In contrast, megascopic, southwest-vergent folds in the southwestern Cariboos, which have been traced and correlated to D2 folds just to the west of McBride map area, are cut by and are clearly at least as old as the Jurassic (165 Ma) Hobson Lake pluton (Reid et al., 2001). In between these areas, upright megascopic folds in the southeastern Cariboos have been dated at between 154 and 125 Ma (Currie, 1988). Northeastward development of the megascopic fold structure across the Cariboo Mountains into the fold-thrust belt of the western Rockies therefore seems to have been a slow progressive event, and the absolute age of structures across the SRMT may differ by millions if not tens of millions of years, particularly when the significance of a younger post-metamorphic thrust fault, and strike-slip faulting in and adjacent to the SRMT are considered.

SOUTHERN ROCKY MOUNTAIN TRENCH

The Southern Rocky Mountain Trench is a notable northwest–southeast-trending physiographic feature that bisects the McBride map area and hosts the northward-flowing Fraser River. It is a flat-floored feature that is filled mostly with glaciolacustrine clays (unit Qal) from a post-glacial (<8000 years BP) lake. Gilbert-style pebbly delta fans with foresets up to 15 m thick are well exposed along the west wall of the SRMT at the mouth of Clyde Creek and beach ridges formed from talus of the local bedrock are prominent locally just east of McBride townsite and extend up to 300 m above the valley floor, attesting to the former presence of a lake of considerable depth. The overall relief of the SRMT is impressive, with distances from floor to peak of more than 1400 m. The origin of the SRMT is uncertain but it does not appear to host a major strike-slip fault, as is the case of the Northern Rocky Mountain Trench (Leech, 1966). The extensive glacial cover means that outcrop is limited in the valley floor, which is largely used for agricultural purposes. However both the east and west walls of the SRMT have reasonable exposure that affords some insight into the structure on either side of the Trench.

On the western side of the SRMT sporadic outcrops of the "Trench assemblage" (unit PT) comprise tightly folded and possibly transposed (?) pelitic schist (unit PTs), quartzite (unit PTq), and marble (unit PTm). The stratigraphic affinity of these rocks is uncertain but the occurrences of thick quartzite invite correlation with the McNaughton or Yanks Peak formations. Other possible correlations are indicated on the map legend. The Trench assemblage along the west side of the SRMT is separated from structurally higher and significantly older rocks of the Kaza Group by the southwest-dipping McBride Fault. Even though there is no obvious offset of metamorphic isograds across the fault, the McBride Fault is likely a post-metamorphic fault because it maintains a similar relationship (higher grade, stratigraphically older Kaza in the hanging wall and lower grade, stratigraphically younger Trench assemblage in the footwall) as far south as the Valemount area, about 70 km to the southeast.

Outcrops of tightly folded micaceous quartzite occur along the eastern wall of the Trench and these are correlated with the quartzite of the McNaughton Formation. The contact with easterly adjacent slate and phyllite of the East Twin Formation is concealed but is steep and likely a fault contact. Importantly, the thin pelite interbeds within the quartzite outcrops contain metamorphic biotite, which is not present in the McNaughton Formation occurring upslope in the Park Range. Thus the McNaughton Formation in the Trench floor cannot be a down-dropped block from higher elevation, and therefore a normal fault is not considered tenable. We suggest a strike-slip fault, of uncertain magnitude but likely moderate (about 20 km?; see McMechan, 2000), as a possible interpretation. This may represent a southerly component of the Late Cretaceous, right-lateral, Walker Creek fault system recognized to the north (McMechan, 2000). The anticline just east of the SRMT is locally breached by an unnamed fault with minor displacement. The fault surface is well-exposed and contains fibres and slickenlines indicative of the progression from dip-slip, to oblique dip-slip to pure dextral strike-slip motion, lending support to the idea of strike-slip deformation along the eastern wall of the SRMT.

METAMORPHISM

Rocks in the McBride map area lie entirely within the greenschist metamorphic facies. Pelitic rocks in the Park Ranges are dominated by chlorite and muscovite with local occurrences of chloritoid (Carey and Simony 1985). Chlorite porphyroblasts typically less than 0.5 mm are ubiquitous in pelitic rocks of the Cariboo Mountains, but rare to absent in the Park Ranges. The chlorite porphyroblasts are consistently oriented parallel to S1 cleavage and as such are typically highly deformed by the S2 crenulation cleavage. In many areas chlorite porphyroblasts serve as the only evidence of the S1 fabric. Biotite occurs sporadically at low elevations in the Cariboos, in Mt. Rider Syncline of the Park Ranges, and in "Trench Assemblage" rocks of the SRMT. The first appearance of the biotite isograd is strongly dependent on bulk composition. Sequestering of Fe in early diagenetic minerals (pyrite and ankerite) in the pelitic rocks that dominate the area has effectively pushed the silicate bulk composition towards Mg-rich values, delaying the first appearance of biotite. Thin section analysis shows that metamorphic biotite in the Cariboo Mountains and in Mt. Rider Syncline is randomly oriented relative to the main S2 fabric, suggesting post-D2 metamorphism. Thus metamorphic biotite in McBride map area might be partly the same age as, or even younger than, the regional Cretaceous metamorphism recognized in the central and southern Cariboo Mountains (100–135 Ma; McDonough and Murphy, 1994). This may explain why there is an apparent lack of offset of the first appearance of the biotite isograd across McBride Fault.

ECONOMIC GEOLOGY

No major mineral occurrences were discovered during mapping. The banks of alpine streams draining the sulfide-rich Cushing Creek Formation are associated with gossanous breccias composed of clasts of black slate in a rusty resistant carbonate matrix. Although these have been staked in the past they are considered the products of recent weathering and cementation of talus during weathering of pyrite in bedrock slate.

REFERENCES

Campbell, R.B., Mountjoy, E.W., and Young, F.G.
1973: Geology of the McBride map-area, British Columbia; Geological Survey of Canada, Paper 72-35, 105 p.

Carey, J.A., and Simony, P.S.
1985: Stratigraphy, sedimentology, and structure of Late Proterozoic Miette Group, Cushing Creek area, British Columbia; Bulletin of Canadian Petroleum Geology, v. 33, p. 184–203.

Charlesworth, H.A.K., Weiner, J.L., Akehurst, A.J., Bielenstein, H.U., Evans, C.R., Griffiths, R.E., Remington, D.B., Stauffer, M.R., and Steiner, J.
1967: Precambrian geology of the Jasper region; Alberta Research Council Bulletin 23, 74 p.

Currie, L.D.
1988: Geology of the Allan Creek area, British Columbia; M.Sc. thesis, University of Calgary, Alberta, 152 p.

Ferguson, C.A.
1994: Structural geology and stratigraphy of the northern Cariboo Mountains between Isaac Lake and Fraser River, British Columbia; Ph.D. thesis, University of Calgary, Alberta, 331 p.

Ferguson, C.A. and Simony, P.S.
1991: Preliminary report on structural evolution and stratigraphic correlations, northern Cariboo Mountains, British Columbia; in Current Research, Part A; Geological Survey of Canada, Paper 91-A, p. 103–110.

Hein, F.J. and McMechan, M.E.
1994: Proterozoic and Lower Cambrian strata of the Western Canada Sedimentary Basin. in Geological Atlas of the Western Canada Sedimentary Basin, (comp.) G.D. Mossop and I. Shetsen; Alberta Research Council and Canadian Society of Petroleum Geologists, Calgary, p. 57–67.

Leech, B.G.
1966: The Rocky Mountain Trench; in The World Rift System, (ed.) T.N. Irvine; Geological Survey of Canada, Paper 66-14.

McDonough, M.R. and Murphy, D.C.
1994: Geology and structure sections, Valemount , British Columbia; Geological Survey of Canada, Map 1843A, scale 1:50,000.

McMechan, M.E.
2000: Walker Creek fault zone, central Rocky Mountains, British Columbia - southern continuation of the Northern Rocky Mountain Trench fault zone; Canadian Journal of Earth Sciences, v. 37, p. 1259–1273.

Mountjoy, E.W.
1980: Mount Robson map-area, Alberta and British Columbia; Geological Survey of Canada, Map 1499A, scale 1:250,000.

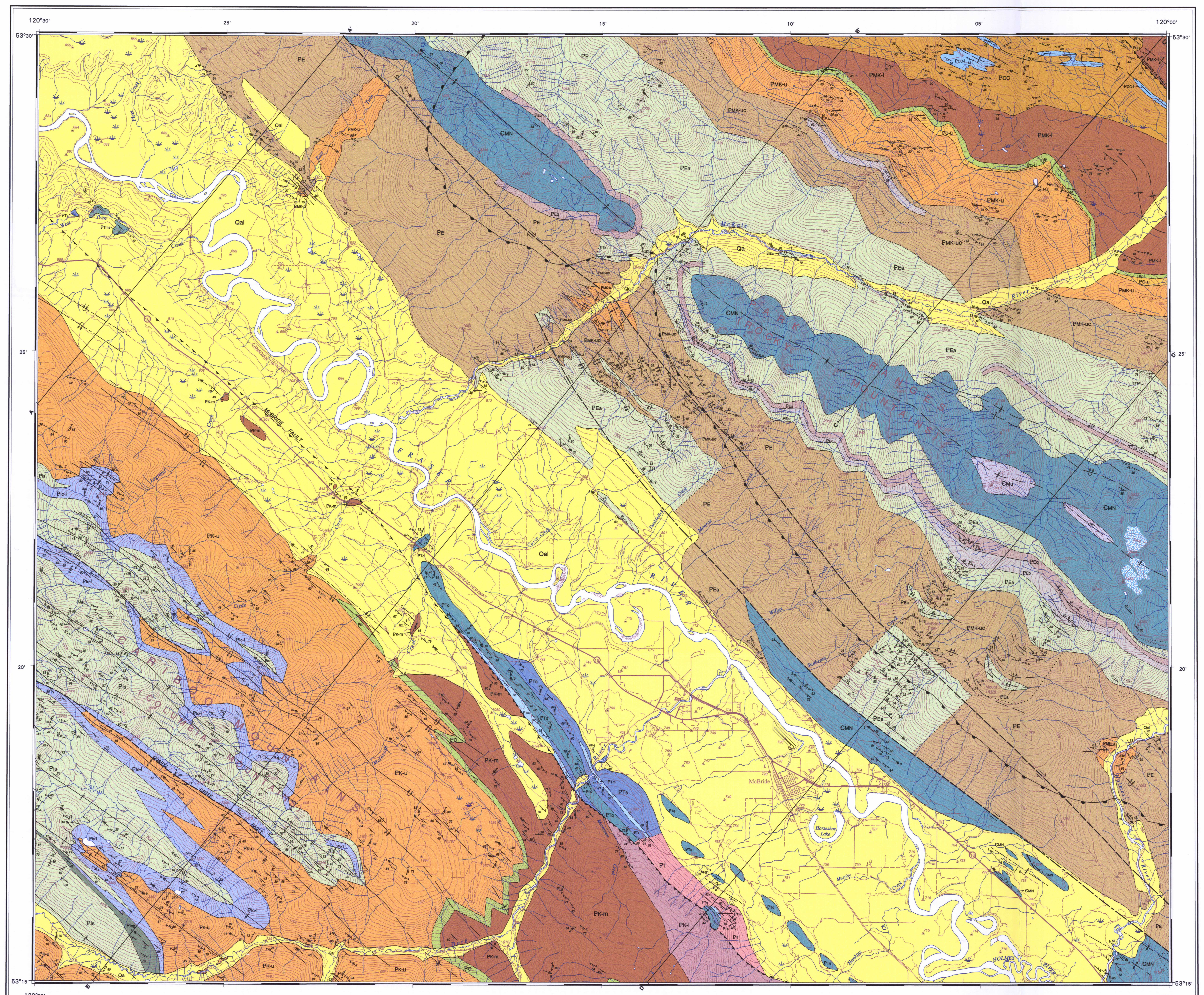
Murphy, D.C.
1987: Suprastructure/infrastructure transition, east-central Cariboo Mountains, British Columbia: geometry, kinematics and tectonic implications; Journal of Structural Geology, v. 9, p. 13–29.

Reid, L.F., Heaman, L.M., Simony, P.S., Pattison, D.R.M., and Ross, G.M.
2001: Multiple Mesozoic metamorphic and deformational events in the Cariboo Mountains, central British Columbia; Geological Association of Canada, Abstracts with Program, v. 26, p. 125.

Ross, G.M. and Murphy, D.C.
1988: Transgressive stratigraphy, anoxia, and regional correlations within the Late Precambrian Windermere grit of the southern Canadian Cordillera; Geology, v.16, p. 139–143.

Ross, G.M., Bloch, J.D., and Krouse, H.R.
1995: Neoproterozoic strata of the southern Canadian Cordillera and the evolution of seawater sulfate; Precambrian Research, v. 73, p. 71–99.

Young, F.G.
1979: The lowermost Paleozoic McNaughton Formation and equivalent Cariboo Group of eastern British Columbia, piedmont and tidal complex; Geological Survey of Canada, Bulletin 288, 60 p.



Copies of this map may be obtained from the Geological Survey of Canada:
601 Booth Street, Ottawa, Ontario K1A 0E8
3303-33rd Street, N.W., Calgary, Alberta T2L 2A7
101-605 Robson Street, Vancouver, B.C. V6B 5J3

Published 2003

LEGEND

This legend is common to maps 1967A, 2001A, 2003A, and 2004A.
Not all map symbols shown in the legend necessarily appear on this map.

CENOZOIC

QUATERNARY

- **Qa,Qal** — Qa: predominantly alluvial deposits along the bottoms of montane valleys; in many areas gradational with debris cones and major talus slopes along steep mountainsides. Qal: combined alluvial and lacustrine deposits within Rocky Mountain Trench. Alluvium consists mostly of Holocene sandy deposits along floodplain of Fraser River. Lacustrine deposits consist of unconsolidated clay-rich sediments along high-standing terraces above Fraser River. These are capped locally by cobbly sand, Gilbert-type delta foreset deposits. The clay-rich sediments typically are thin-bedded clay and silty sand with locally abundant dropstones
- **Qf** — Emergent portion of fan deltas along east shore of Isaac Lake

CARIBOO MOUNTAINS

PALEOZOIC (NEOPROTEROZOIC?)

NEOPROTEROZOIC? - CAMBRIAN
NEOPROTEROZOIC? - LOWER CAMBRIAN
CARIBOO GROUP (PI - ЄDC)

- **ЄDC** — DOME CREEK FORMATION: dark-coloured argillite and siltstone
- **ЄMu** — MURAL FORMATION: archeocyathid-bearing limestone consisting of two massive, thick-bedded units with an intervening medium-bedded, mudstone-rich interval
- **ЄMI** — MIDAS FORMATION: monotonous mudstone and silty mudstone with less than 25% medium-to thin-bedded, typically bioturbated, quartzose sandstone
- **ЄYP** — YANKS PEAK FORMATION: dominated by medium- and, rarely, thick-bedded, trough and wedge planar-cross-stratified quartz arenite and rare quartz-pebble conglomerate, alternating with mudstone-rich sequences similar to those that make up the Midas Formation. Bioturbation generally is restricted to the mudstone-rich units and is found only in the upper two thirds of the unit

NEOPROTEROZOIC

UPPER PROTEROZOIC (NEOPROTEROZOIC)

YANKEE BELLE FORMATION (PYBz - PYBb)

- **PYBb** — Betty Wendle Member: a distinctive, tripartite unit with a sharp lower contact. The basal division consists of fining-upward, medium- to thin-bedded, carbonate-clast conglomerate interbedded with alternating green and purple silty argillite. The basal division grades upward into monotonous green argillite with rare, thin-bedded, fine-grained sandstone (carbonate noteably absent). The middle green argillite, which constitutes the thickest division of the member, is overlain by a thin and discontinuous stromatolitic boundstone interval interbedded with green argillite
- **PYBa** — Amos Bowman Member: a mixed, cyclic unit of medium- to thin-bedded, low-angle, undulose cross-stratified carbonate and quartzose sandstone within a background of green-coloured silty argillite, upward increase in proportion of limestone; sharp contact with Betty Wendle Member
- **PYBz** — Zig Zag Member: medium- to thick-bedded, trough and wedge-planar, cross-stratified quartz arenite and rare, feldspathic, quartz-pebble conglomerate. Unit is found at the base of the Yankee Belle Formation only in the northeastern Cariboo Mountains
- **PYB** — YANKEE BELLE FORMATION, undivided

CUNNINGHAM FORMATION (PC-l - PC-u)

- **PC-u** — Upper Cunningham (informal): medium-bedded packstone-wackstone, intraclastic conglomerate, and shale arranged in shoaling-upward cycles
- **PC-m** — Middle Cunningham (informal): interbedded, crossbedded packstone-grainstone, siliciclastic shale and quartz sandstone; local stromatolitic dolomite; similar to Yankee Belle Formation. Absent west of Betty Wendle Fault
- **PC-l** — Lower Cunningham (informal): composed of thin-bedded, current-laminated limestone, massive wackstone-packstone and thin shale interbeds. Becomes more thickly bedded upsection
- **PC** — CUNNINGHAM FORMATION, undivided: limestone and dolostone unit consisting of planar and wedge-planar, cross-stratified, ooid-pisoid grainstone and wackestone

ISAAC FORMATION (PI-l - PIs)

- **PIs** — Upper Isaac (informal): thin-bedded, blue-grey, pyritic slate/mudstone; thin beds and laminae of fine-grained, calcareous sandstone to siltstone; local intraformational slumped intervals and orange weathering limestone beds; granule sandstone and conglomerate beds are conspicuously absent
- **PIb / PIc-m** — Middle carbonate member: variable proportions of thin-bedded, brown to black, sandy limestone turbidite; limestone conglomerate; massive to graded sheets of calcarenite (ooid-pisoid-intraclast packstone and wackestone); and massive, muddy conglomerate/slumps with interbeds of black to blue, silty slate/mudstone and quartz sandstone; locally with sheets of very clean quartz arenite that also forms matrix to conglomerate units. PIb: black shale; very fissile, thinly laminated, organic-rich
- **PIc-l** — Lower carbonate member: variable proportions of thin-bedded, brown to black, sandy limestone turbidite, limestone conglomerate; massive to graded sheets of calcarenite (ooid-pisoid-intraclast packstone to wackestone); and massive, muddy conglomerate/slumps with interbeds of black to blue, silty slate/mudstone and quartz sandstone
- **PIcg / PI-l** — Lower Isaac (informal): shale/slate, blue to black; thin interbeds of calcareous sandstone and prominent, interbedded medium- or thick-bedded sandstone to granule sandstone. The sandstones form laterally discontinuous sheets up to 100 m thick, are arkosic and locally conglomeratic (unit PIcg, where mappable)
- **PI** — ISAAC FORMATION, undivided: slate and silty argillite, dominantly dark-coloured, distinctly blue to black or grey; thin beds of calcareous sandstone; local occurrences of granule sandstone sheets, carbonate-clast conglomerate and olistostrome; large pyrite crystals are common, and zones of slump-folded mudstone and intraclastic conglomerate are also present; thin sandstone beds typically are massive or normal-graded with ripple-crosslaminated to parallel-laminated tops

KAZA GROUP (PK-l - PK-u)

- **PK-u** — Upper Kaza (informal): medium- to thick-bedded granule sandstone, feldspathic, light brown to tan; interbeds of green to dark grey pelite

OLD FORT POINT FORMATION (PO-l - PO-u)

- **PO-u** — Upper member: medium- to thick-bedded, coarse grained, quartzose sandstone and quartz pebble conglomerate, commonly with pebble- to cobble-sized carbonate clasts and a brown, calcareous cement. Sharply overlies the middle or lower member with local erosional relief
- **PO-m** — Middle member: banded black and grey sulphidic (pyrite) pelite; locally with thin-bedded, black, crystalline, silty limestone and calcareous, brown sandstone
- **PO-l** — Lower member: rhythmically thin-bedded, chloritic siltstone to sandy limestone and green pelite, generally arranged in a thinning-upward sequence that grades into the middle member
- **PO** — OLD FORT POINT FORMATION, undivided
- **PK-m** — Middle Kaza (informal): medium- to thick-bedded feldspathic granule sandstone (grits) to sandstone; interbeds of green to dark grey pelite; grits are noteably green to greenish grey and pyritic, particularly the interval underlying the Old Fort Point Formation
- **PK-l** — Lower Kaza (informal): thin- to medium-bedded feldspathic granule sandstone and sandstone; interbeds of dark-coloured pelite; pelite intervals are generally thicker than those within the upper and middle Kaza Group; sandstone is commonly calcareous with metaconcretions

SOUTHERN ROCKY MOUNTAIN TRENCH

PALEOZOIC (NEOPROTEROZOIC?)

UPPER PROTEROZOIC (NEOPROTEROZOIC)

- **PTs** — Dark-coloured phyllite, probably equivalent to Isaac, middle Cunningham, or Midas formations
- **PTms** — Cream-coloured, banded marble, and green silty argillite with fine-grained quartzite, probably equivalent to Yankee Belle or Cunningham formations
- **PTm** — Cream-coloured, banded marble, probably equivalent to Cunningham, Yankee Belle, or Mural formations
- **PTq** — Quartzite and quartz pebble conglomerate, locally feldspathic. Probably equivalent to Yanks Peak Formation or Zig Zag Member of the Yankee Belle Formation
- **PT** — TRENCH ASSEMBLAGE, undivided: highly sheared sedimentary units in the footwall of the McBride Fault. Compositional layering typically consists of transposed bedding. Probable stratigraphic equivalent of subdivisions, in Cariboo Mountains nomenclature, listed with descriptions and shown schematically on structural cross-sections

ROCKY MOUNTAINS

Stratigraphic equivalent, in Cariboo Mountains nomenclature, shown in bold type

PALEOZOIC (NEOPROTEROZOIC?)

NEOPROTEROZOIC? - CAMBRIAN
NEOPROTEROZOIC? - LOWER CAMBRIAN

- **ЄMa** — MAHTO FORMATION: quartzite (quartz sandstone) shale, phyllite, sandy dolostone (structure section only)
- **ЄMu** — MURAL FORMATION: archeocyathid-bearing limestone consisting of two massive, thick-bedded units with an intervening medium-bedded, mudstone-rich interval
- **ЄMN** — McNAUGHTON FORMATION, **YANKS PEAK FORMATION:** medium- to, rarely, thick-bedded trough and wedge-planar cross-stratified quartz arenite and rare, quartz pebble conglomerate, alternating with thinner, mudstone-rich intervals

NEOPROTEROZOIC

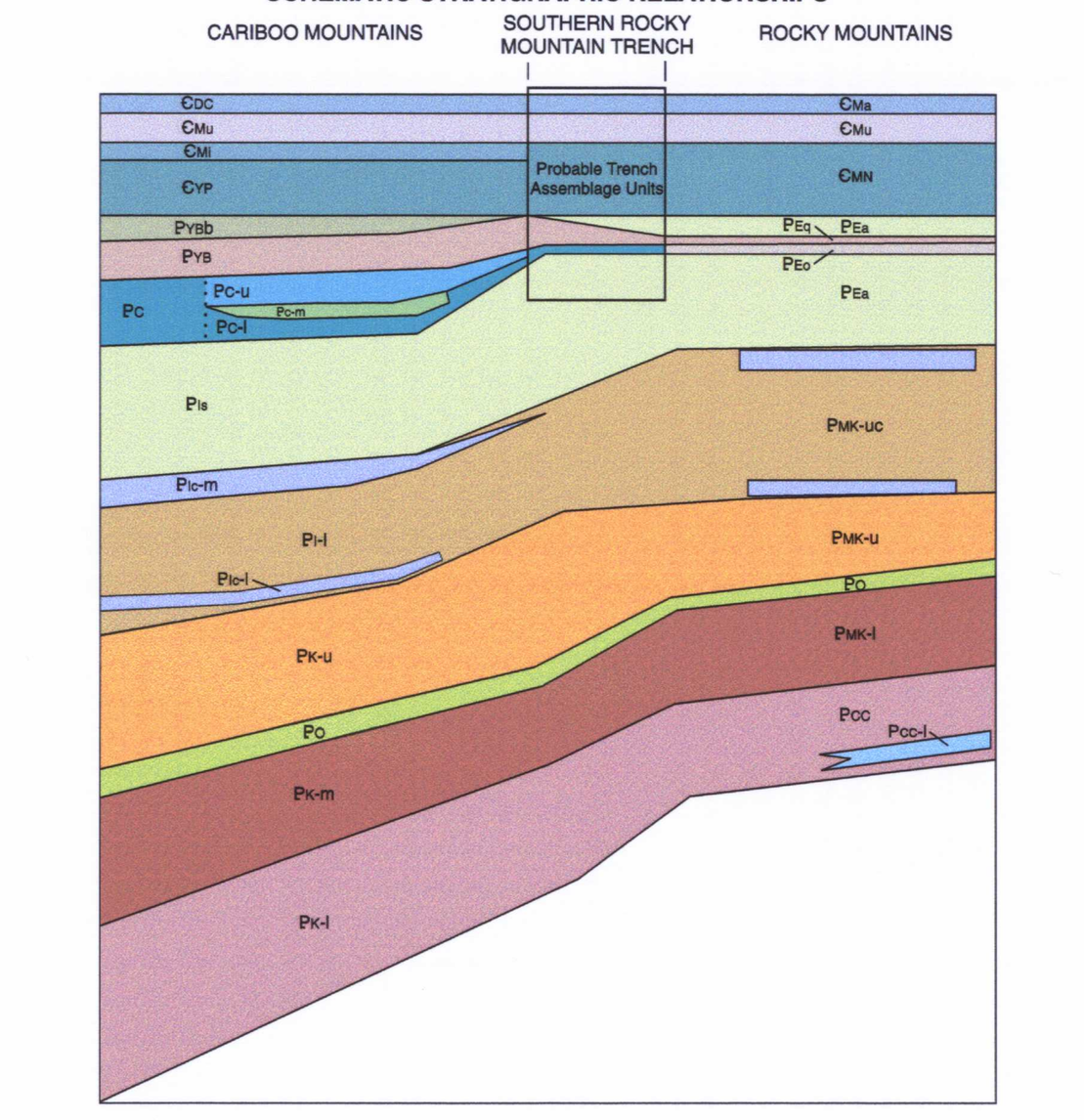
UPPER PROTEROZOIC (NEOPROTEROZOIC)
EAST TWIN FORMATION (PEa - PEq)

- **PEq** — **YANKEE BELLE FORMATION:** green argillite-quartzite unit, thin- to medium-bedded, fine-grained, low-angle, cross-stratified quartzite with green argillite interbeds
- **PEo** — **YANKEE BELLE and/or CUNNINGHAM formations:** orange limestone unit, thin-bedded, orange weathering, grey, crystalline limestone with argillite partings
- **PEa** — EAST TWIN FORMATION; **Upper Isaac:** dominantly argillite characterized by very low percentage of sandstone interbeds (<<5%)
- **PE** — EAST TWIN FORMATION; **ISAAC FORMATION**, undivided: dominantly dark-coloured slate and silty argillite with local concentrations of sandstone or carbonate-clast conglomerate and olistostrome
- **PMK-uc** — McKALE FORMATION (upper calcareous); **Lower Isaac:** argillite characterized by relatively high percentage (5-25%) of calcareous, feldspathic or quartzose grit beds and carbonate clast conglomerate
- **PMK-u** — McKALE FORMATION (upper); **Upper Kaza:** medium- to thick-bedded, feldspathic grit, pebbly sandstone and sandstone with interbeds of green to dark grey-coloured pelite. Grits are notably light brown to tan in colour and commonly calcareous

OLD FORT POINT FORMATION (PO-l - PO-u)

- **PO-u** — Upper member: medium- to thick-bedded, coarse-grained quartzose sandstone and quartz pebble conglomerate commonly with pebble to cobble-sized carbonate clasts. Locally with interbedded, grey, sandy limestone. Sharply overlies the middle or lower member with local erosional relief
- **PO-m** — Middle member: dark grey to black, sulphidic (pyrite) mudstone or phyllite, locally with thin-bedded, black crystalline limestone
- **PO-l** — Lower member: rhythmically interbedded thin beds of chloritic, calcareous siltstone to sandy limestone and green pelite, generally arranged in a fining- and thinning-upward sequence that grades up into the middle member
- **PO** — OLD FORT POINT FORMATION, undivided
- **PMK-l** — McKALE FORMATION (lower); **middle Kaza:** medium- to thick-bedded, brown weathering, feldspathic grit, pebbly sandstone and sandstone with interbeds of green to dark grey pelite
- **PCC-l / PCC** — CUSHING CREEK FORMATION; **lower Kaza:** dark-coloured, sulphidic argillite and silty argillite with thin- to medium-bedded, black, crystalline limestone. Dark grey feldspathic sandstone is <10%. PCC-l: limestone-rich intervals of CUSHING CREEK FORMATION; **lower Kaza**

SCHEMATIC STRATIGRAPHIC RELATIONSHIPS



- Geological boundary (defined, approximate, assumed)
- Geological boundary (assumed projection under cover of younger deposits)
- Indication of bedding
- Bedding, tops known (inclined, vertical, overturned)
- Bedding, tops unknown (inclined, vertical)
- Bedding, approximate (outcrop not visited)
- Bedding and cleavage (S2) that are parallel
- Foliation (Sp) primary cleavage, recognized along Lanezi Lake
- First foliation (S1) slaty cleavage (inclined, vertical)
- Second foliation (S2) <mm-scale crenulation or slaty cleavage (inclined, vertical)
- Third foliation (S3) cm-scale crenulation cleavage (inclined, vertical)
- Fourth foliation (S4) cm-scale crenulation cleavage (inclined, vertical)
- Prominent cleavage, approximate (outcrop not visited)
- Shear fabric surfaces, Isaac Lake fault zone
- Second generation shear fabric surfaces, Isaac Lake fault zone
- First lineation intersection (L1) SpxS1, recognized along Lanezi Lake
- First lineation intersection (L1) S0xS1
- Second lineation intersection (L2) S0xS2, S1xS2 crenulations, mullions, F2 fold axes
- Third lineation intersection (L3) S0xS3, S1xS3 crenulations
- Slickenline lineation on faults or sheared surfaces
- Fault (solid circle indicates downthrown side; defined, approximate, assumed)
- Fault (dip of surface, trend and plunge of slickenlines shown if known; defined, approximate, assumed)
- Reverse fault (with R in hanging wall; defined, approximate, assumed)
- Strike-slip fault (oblique slip if with reverse or normal symbols; defined, approximate, assumed)
- Strike-slip fault (sense unknown; defined, approximate, assumed)
- Fault (assumed projection under cover of younger deposits)
- Thrust fault (teeth indicate upthrust side; defined, approximate, assumed)
- Thrust fault (teeth indicate upthrust side; assumed projection under cover of younger deposits)
- Anticline (upright, overturned, defined, approximate)
- Syncline (upright, overturned, defined, approximate)
- Tight anticline-syncline pair (southwest-vergent, northeast-vergent)
- Trace of axial plane, younger folds (approximate)
- Anticline, syncline (assumed projection under cover of younger deposits)
- Diabase dyke (defined, approximate)
- Intrusive carbonate dyke (defined, approximate)
- Metamorphic isograds (teeth on high-grade side, garnet, based on first appearance)
- Metamorphic isograds (teeth on high-grade side, biotite megascopic, based on first appearance)
- Metamorphic isograds (teeth on high-grade side, biotite microscopic, based on first appearance)
- Measured stratigraphic section (RAR: measured by G.M. Ross; RAR-CAF: measured by C.A. Ferguson)
- Line of structure section
- Change in mapping precision; stratigraphic subdivisions are amalgamated at dotted line
- Orientations of S2 cleavage (structure sections only)
- Strike-slip motion toward reader (structure sections only)
- Strike-slip motion away from reader (structure sections only)

Geology by C.A. Ferguson and G.M. Ross based on ground observation by C.A. Ferguson and G.M. Ross, 1987 - 1995; northeastern region modified from Carey (1984).

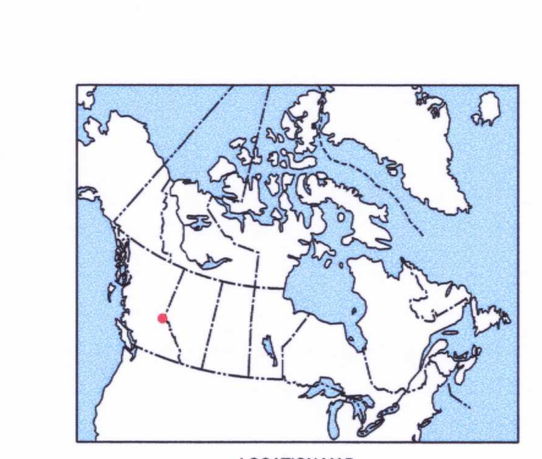
Digital cartography by P.R.J. Wozniak, Geological Survey of Canada (Calgary)

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Digital base map from data compiled by Geomatics Canada, modified by the Geological Survey of Canada

Mean magnetic declination 2003, 20°18' E, decreasing 11.8' annually

Elevations in metres above mean sea level



LOCATION MAP

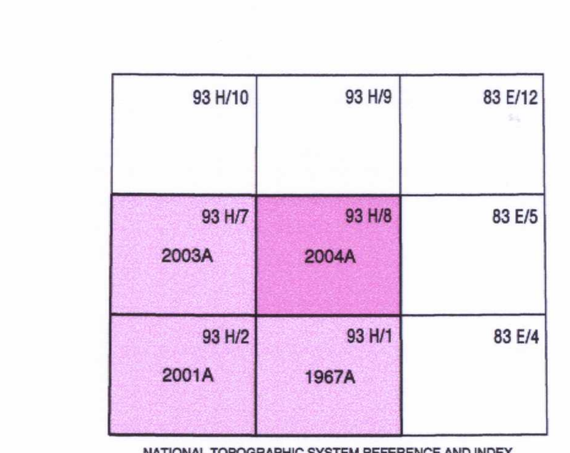
MAP 2004A
GEOLOGY AND STRUCTURE CROSS-SECTIONS
MCBRIDE
BRITISH COLUMBIA

Scale 1:50 000/Échelle 1/50 000

kilometres 1 0 1 2 3 4 kilomètres

Universal Transverse Mercator Projection
North American Datum 1983

Projection transverse universelle de Mercator
Système de référence géodésique nord-américain, 1983



NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

Recommended citation:
Ferguson, C.A. and Ross, G.M.
2003: Geology and structure cross-sections, McBride, British Columbia; Geological Survey of Canada, Map 2004A, scale 1:50 000.