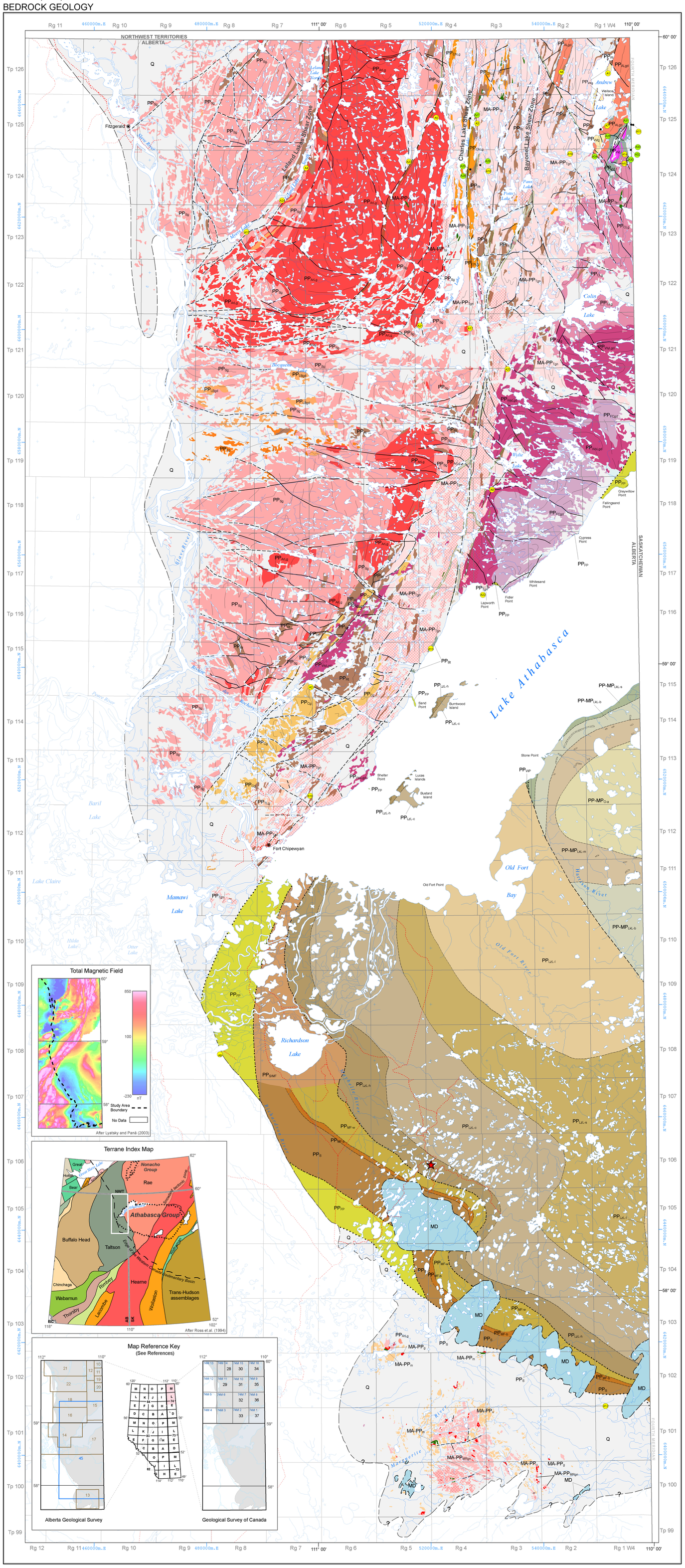
NTS 74M, 74L, PART OF 74E
BEDROCK GEOLOGY



AGE — UNIT NAME AND DESCRIPTION

PHANEROZOIC

QUATERNARY

Q — Glaciolacustrine, glaciofluvial, till, eolian and organic deposits; subordinate alluvium, colluvium; areas beyond the Canadian Shield are blanketed by Quaternary deposits, which are not represented on the map.

DEVONIAN

MD — Middle Devonian outliers intersected by drillholes consist of calcareous and muddy sandstone to mudstone, calcareous mudstone and carbonaceous shale (partly sandy), locally basal breccia of basement fragments and reworked Athabasca Group; disseminated pyrite and bitumen impregnation are common.

Phanerozoic strata undifferentiated; mostly blanketed by Quaternary deposits.

LATE PALEOPROTEROZOIC TO EARLY MESOPROTEROZOIC

ATHABASCA GROUP (ca. 1.76 – 1.50 Ga)

OTHERSIDE FORMATION

$PP\text{-}MP_{O\text{-}a}$ — **Archibald Member**: pebbly quartz arenite; maximum transported grain size up to 8 mm; crossbedding and ripple crossbedding.

LOCKER LAKE FORMATION

$PP\text{-}MP_{LkL\text{-}m}$ — **Marsin Member**: pebbly, fining-upward quartz arenite; maximum transported grain size between 8 and 16 mm; crossbedding and horizontal lamination.

$PP\text{-}MP_{LkL\text{-}b}$ — **Brudell Member**: pebbly quartz arenite and thin conglomerate; maximum transported grain size greater than 16 mm; gradational base and top.

$PP\text{-}MP_{LkL\text{-}s}$ — **Snare Member**: pebbly, irregularly coarsening-upward quartz arenite; maximum transported grain size from 2 to 16 mm; crossbedding and horizontal lamination; sparse mudstone interbeds are generally less than 50 cm thick.

WOLVERINE POINT FORMATION

PP_{WP} — Recessive thick beds (commonly >50 cm) of pale red and green mudstone; subordinate thin interbeds of friable, clay-rich, medium- to fine-grained quartz arenite and siltstone with irregular red and green mottling in patches 5–15 cm in diameter on a white to pale yellow background; pale pink streaks in the quartz arenite are hematite stain on siderite and/or pyrite cement; thin interbeds of very hard, rounded, green and red intraclasts are diagnostic and the most common site of pervasive apatite cement that in places preserves volcanic glass shards as pseudomorphs; the pseudomorphed vitric tuff beds are up to 3 cm thick and contain rare pumice fragments up to 2 cm in diameter, feldspar grains; fresh rounded K-feldspar and minor plagioclase sand grains; siliciclastic pebbles are absent; includes 1644 ±13 Ma zircon grains (Reference 44).

LAZENBY LAKE FORMATION

$PP_{LzL\text{-}l}$ — **Larter Member**: sparsely pebbled quartz arenite with maximum transported grain size <8 mm, fining upward and to the northeast; finer grained parts contain <1% clay intraclasts, but lack mudstone interbeds; <1% clay matrix.

$PP_{LzL\text{-}s}$ — **Shiels Member**: quartz-pebbly quartz arenite with maximum transported grain size >8 mm (locally >32 mm), much greater than the underlying Clampitt and overlying Larter members; fines upward and toward the northeast; mudstone and clay intraclasts are rare.

$PP_{LzL\text{-}c}$ — **Clampitt Member**: recessive pebbly coarse-grained quartz arenite and medium- to coarse-grained quartz arenite with maximum transported grain size <8 mm between the coarser pebbly and conglomeratic Hodge and Shiels members; finer grained portions include muscovite flakes; interbeds up to 20 cm thick of indurated massive-bedded and flat-laminated red hematitic mudstone to very fine grained quartz arenite; mudstone intraclasts generally 5–10 mm across (rarely up to 10 cm), and indurated by hematite and quartz; interstitial clay varies from 2% to 60%.

$PP_{LzL\text{-}h}$ — **Hodge Member**: quartz-pebbly quartz arenite; a 5–30 cm thick basal conglomerate (maximum transported grain size >8 mm) grades upward to quartz arenite with horizontal lamination and low-angle, overturned and minor trough crossbeds.

MANITOU FALLS FORMATION

$PP_{MF\text{-}w}$ — **Warnes Member**: consists of medium-grained quartz arenite with northerly paleocurrent directions and four discrete intraclast-rich and pebbly subunits (lithofacies), which in descending order are: upper quartz-pebbly to granule-rich (maximum transported grain size >2 mm) quartz arenite with <2% quartz pebble to granule conglomerate, and sparse, horizontally laminated, fine to very fine grained quartz arenite and mudstone interbeds <10 cm thick; middle quartz arenite with >1% clay intraclasts and no pebbles; lower quartz arenite with <1% intraclasts and sparse, small quartz pebbles to granules; basal quartz-pebbly quartz arenite with minor quartz-granule conglomerate.

$PP_{MF\text{-}b}$ — **Bird Member**: consists of a lower and an upper conglomeratic quartz arenite; the lower arenite unit includes at least 2% conglomerate, defined as beds thicker than 2 cm with at least 30% clasts, and maximum transported grain size >2 mm; clasts are 99% quartz; blue quartz is noticeably more common along the south-central and southwestern margin of the basin, as it is in the subjacent basement of those areas; clay matrix is minor, commonly 1%–3%; clay intraclasts are sporadic in quartz arenite and conglomerate beds; the conglomeratic beds are horizontally bedded, with minor pebble imbrication, and intercalated with dominantly trough- and planar-crossbedded quartz arenite (outlined in places by heavy-mineral laminae), as well as lesser ripple crosslamination; very fine quartz arenite and siltstone interbeds 1–3 cm thick are horizontally to ripple crosslaminated and pale grey, and have no desiccation cracks.

PP_{SMF} — Smart and Manitou Falls formations undifferentiated.

SMART FORMATION

PP_{S} — Remarkably uniform, fine to coarse quartz arenite with common low-angle crossbeds, horizontal bedding, ripple crosslaminae, and sparse isolated pebbles increasing in abundance downward; trough-crossbedding dominates toward the base; a discontinuous basal, pebbly, mudstone-rich subunit may locally host oncoids; complete sections typically contain two slightly different, fining-upward quartz arenite subunits; the lower strata contain more trough-crossbeds and have been informally referred to as the Shea Creek beds, whereas the upper strata are characterized by horizontally laminated and low-angle crossbedding.

FAIR POINT FORMATION

PP_{FP} — Overall fining-upward sequence of coarse quartz arenite to granulestone with disseminated polymict pebbles to cobbles; minor interbeds of conglomerate and mudstone; basal coarsening-upward portion is locally preserved; pebbles are rounded, subspherical quartzite with lesser amounts of oblate, well-indurated, fine quartz arenite and mudstone, partially weathered, pink, angular to subrounded granitoid gneiss (more common upward) and sparse dark brown, fine-grained, commonly angular and bladed pebbles decreasing in abundance upward (indurated hematitic quartz arenite, rhyolitic shards and possible regolith); 2%–5% interstitial clay, mainly kaolinite.

MESOARCHEAN TO PALEOPROTEROZOIC

TALTSON MAGMATIC ZONE

PALEOPROTEROZOIC

TALTSON PLUTONIC ROCKS

PP_{Cg} — **Chipewyan Granite**: massive to weakly, locally foliated, medium- to coarse-grained pink to red granite; includes rafts and xenoliths of basement gneisses and high-grade mylonites; emplacement age is 1925 +5/-3 Ma (Table 1).

PP_{Wlg} — **Wallace Island Granite**: sub-kilometre-scale bodies of weakly to nonfoliated, white to light grey, muscovite granite, biotite granite, leucogranite; coarse grained to pegmatitic; inferred emplacement age is 1923–1921 Ma (Table 1); equivalent to "Colin Lake White Granite" of McDonough et al. (2000c).

PP_{ChLg} — **Charles Lake Granitoid**: typically massive to foliated megacrystic granite with 15%–30% K-feldspar megacrysts in a medium-grained, biotite-rich matrix; megacrysts (3–10 cm long) have distinctive biotite inclusions; locally fine-grained porphyry with 5–12 mm long feldspar phenocrysts, 2%–3% disseminated, fine-grained pyrite and local specks of hornblende; local leucocratic granite with 3% mafic minerals, equigranular, medium to coarse grained; local minor pegmatite masses; deformed into amphibolite to greenschist facies protomylonite to mylonite; inferred emplacement age is >1933 Ma. (Table 1).

PP_{Sg} — **Slave Granitoid**: typically whitish grey granite to monzogranite with feldspar megacrysts (1–5 cm long) and abundant knots (up to 5 mm across) of garnet, cordierite and hercynite in biotite envelope, within a medium-grained, massive to weakly foliated matrix; minor inclusions, patches and lenses of metasedimentary rock, pegmatite dikes and quartz veins; to the east, xenoliths of paragneiss, banded basement gneiss and high-grade mylonite; mylonitic near Leland Lakes and Charles Lake shear zones, with mottled appearance and abundant white to pink to red rounded to subrounded feldspar augen (2–6 mm long) in a sheared, foliated matrix of lenticular quartz, feldspar, chloritized biotite, sericite and minor epidote; inferred emplacement age of a Slave granite dike is 1934 ±2 Ma (Table 1); $\varepsilon Nd_{(1.93\ Ga)}$ values range from -3.8 to -8.9 and T_{DM} from 2.6 to 3.5 Ga (Reference 9).

PP_{LBgd} — **La Butte Granodiorite**: typically medium-grained granodiorite but ranging to fine and coarse grained with up to 5% feldspar phenocrysts (8–20 mm long) in a medium-grained matrix; generally medium-grey, locally brownish grey to mauve; age unknown; intimately associated with Slave granitoid; includes xenoliths of Arch Lake and Francis granitoids; intrudes Francis granite.

PP_{ArLg} — **Arch Lake Granitoid**: massive to well-foliated mylonitic granite to syenogranitic gneiss with 30%–50% tabular K-feldspar megacrysts (1 x 3 cm) in a fine- to medium-grained matrix of biotite, quartz, feldspar and magnetite; locally gradational to Slave granitoid; locally forms L-S tectonite with rods of blue quartz in association with high-grade mylonite in the Charles Lake and Leland Lakes shear zones; emplacement age is 1938 ±3 Ma (Table 1); $\varepsilon Nd_{(1.93\ Ga)}$ values range from -5.2 to -9.8 and T_{DM} from 2.6 to 3.0 Ga (Reference 9).

PP_{Fg} — **Francis Granite**: commonly medium-grained granite with 5%–15% pink to reddish pink tabular feldspar megacrysts (25–35 mm long) in a medium-grained, typically massive matrix; typically medium-grey with pink spots; age unknown, possibly a phase of Arch Lake granitoid.

PP_{ALgd} — **Andrew Lake Granodiorite**: massive to well-foliated biotite-hornblende granodiorite to diorite gneiss with 30%–40% equant, K-feldspar phenocrysts (5–15 mm) in a medium- to coarse-grained matrix of biotite, hornblende, quartz and feldspar; locally cut by pink granite dikes; emplacement ages obtained from two plutons are 1959 ±3 Ma and 1962 +16/-10 Ma; $^{207}Pb/^{206}Pb$ titanite ages ranging from 1860 to 1863 Ma may represent cooling ages (Table 1).

PP_{WyLgd} — **Wylie Lake Granodiorite**: moderately to well-foliated, biotite-rich granite to granodiorite gneiss; typically coarse-grained, equigranular, locally abundant lenticular K-feldspar megacrysts (5–10 mm long) in a medium- to coarse-grained matrix of biotite, chlorite, quartz, feldspar and minor hornblende; schlieren of biotite concentrations or metasedimentary rocks are present locally; emplacement age for the pluton exposed north of Lake Athabasca is 1963 +6/-4 Ma and a core sample south of Lake Athabasca yielded an emplacement age of 1974 ±5 Ma (Table 1); $\varepsilon Nd_{(1.96\ Ga)}$ values range from -3.4 to -6.0 and T_{DM} from 2.6 to 2.8 Ga (Reference 9).

PP_{FCgd} — **Fishing Creek Granodiorite**: coarse-grained, massive to weakly foliated, quartz-rich granodiorite with 20%–30% plagioclase, 10%–20% euhedral K-feldspar with biotite inclusions and 5%–10% biotite as small pods enclosing minor garnet; emplacement age of 1968 ±5 Ma was obtained from a core sample south of Lake Athabasca (Table 1).

PP_{CLg} — **Colin Lake Granitoid**: moderately to well-foliated, lineated, mylonitic, biotite-granite to quartz-diorite gneiss with 30%–50% lenticular K-feldspar megacrysts (3 x 8 cm) in a medium- to coarse-grained matrix of biotite, quartz, feldspar and minor hornblende; minor pegmatite masses; emplacement age is 1971 ±4 Ma (Table 1); $\varepsilon Nd_{(1.97\ Ga)}$ values range from -3.9 to -6.0 and T_{DM} from 2.6 to 2.8 Ga (Reference 9).

PP_{TLg} — **Thesis Lake Granite**: typically dark coloured with up to 10% red to pink microcline augen (6–13 mm long) in a medium-grained matrix that includes blue-grey quartz and hypersthene; subordinate pegmatitic pods, patches and dikes; age unknown.

BURNTWOOD COMPLEX*

PP_{Bt} — **Low-Grade Metamorphic Tectonite**: sericite and/or cholorite schist interlayered with fragmental rocks containing pebble-sized clasts; locally banded or 'curly' sericite/chlorite mylonitic schist; zircon grains from a hematite-cemented fragmental rock yielded ages (2.5; 2.3-2.1; 1.94; 1.93 Ga) in the range of the Taltson basement complex and late Taltson plutons (Table 1).

WAUGH LAKE COMPLEX*

PP_{WLi} — **Igneous Rocks**: mostly mafic igneous rocks (gabbro, basalt and possibly tuff), variably sheared under low to very low grade metamorphic conditions; include Martyn Lake monzonite plug with an emplacement age of 1973 ±3 Ma (Table 1).

PP_{WLt} — **Low-Grade Metamorphic Tectonite**: variably chloritized biotite schist, chlorite-sericite-quartz schist, quartz-sericite schist, quartzite (locally ferruginous, garnetiferous, graphitic); quartzofeldspathics muscovitic fragmental rocks with grain and fragment size in the range of greywacke and conglomerate; medium- to coarse-grained, sericitic and/or chloritic, sheared granite and retrogressed granite gneiss; locally abundant quartz and quartz-tourmaline veins; minor pegmatite; zircon grains from a foliated, weakly brecciated, muscovitic quartzofeldspathic rock yielded ages (2.7 Ga; 2.3-2.0 Ga) in the range of the Taltson granitoid gneiss (Table 1); late low-grade shearing between ca. 1839 and 1820 Ma (Table 2).

RUTLEDGE RIVER COMPLEX*

PP_{Rt} — **High-Grade Metamorphic Tectonite**: large inliers of impure quartzite, biotite+garnet+sillimanite+cordierite gneiss in the Leland Lakes area, and biotite+garnet+sillimanite gneiss common in areas to the east; locally pervasive metamorphic pegmatite layers and veins; equivalent to "Rutledge River Group" of McDonough et al. (2000g); $\varepsilon Nd_{(1.97\ Ga)}$ values range from -5.1 to -5.5 and T_{DM} from 2.8 to 2.9 Ga (Reference 9).

MESOARCHEAN TO PALEOPROTEROZOIC

TALTSON BASEMENT COMPLEX

$MA\text{-}PP_{Ta}$ — **Amphibolite**: well-foliated, gneissic or layered amphibolite; typically medium-grained; biotite and minor pyrite are common; composition ranges from hornblendite to feldspathic-biotite amphibolite; local mafic granulite and gabbro; $\varepsilon Nd_{(2.2\ Ga)}$ values range from -4.3 to +3.9 and T_{DM} from 2.59 to 2.78 Ga (Reference 39).

$MA\text{-}PP_{Tgn}$ — **Granitoid Gneiss**: typically pink to reddish, fine- to medium-grained, equigranular gneiss with variable proportions of feldspar, quartz, biotite and hornblende; includes well-foliated to mylonitic or banded varieties of a) biotite- and K-feldspar-rich syenogranite gneiss (protolith emplacement ages of 2330 ±3 Ma) with concordant U-Pb zircon age of 2138 ±2 Ma; b) white-weathering hornblende granite gneiss with U-Pb zircon age of 2380 ±10 Ma; c) biotite-hornblende granite to granodiorite or hornblende diorite layered gneiss (protolith emplacement ages of 2382 ±5 Ma, 2393 +12/-8 Ma and 3186 +17/-13 Ma); locally dismembered and ptygmatically folded and locally highly sheared gneiss; and d) biotite-rich tonalite gneiss (protolith emplacement ages of 2562 ±6 Ma and 3076 +15/-5 Ma); also includes interlayered amphibolite gneiss, minor amphibolite and gabbro pods; pervasively intruded by medium-grained pink granite dikes coplanar to fabric; locally intruded by migmatite veins and/or pegmatite (emplacement age of such a pegmatite granite is 2335 ±2 Ma); $\varepsilon Nd_{(2.2\ Ga)}$ values range from -17.9 to -3.1 and T_{DM} from 2.5 to 3.6 Ga (Reference 9); $\varepsilon Nd_{(2.2\ Ga)}$ values range from -19.3 to -1.6 and T_{DM} from 2.59 to 3.37 Ga (Reference 39).

MARGUERITE RIVER COMPLEX*

$MA\text{-}PP_{g}$ — **Granite**: white to pink leucogranite and biotite granite; brick red where hematized; typically massive, locally foliated to mylonitic with mortar texture; commonly with minor garnet or garnet-chlorite±biotite clots up to 7 mm; medium- to coarse-grained with feldspar phenocrysts up to 1 cm; includes pegmatitic leucogranite.

$MA\text{-}PP_{ArLg}$ — **Arch Lake-Type Granitoid**: pink to red granite to granodiorite; consists of white to red feldspar, quartz and minor biotite; tabular feldspar phenocrysts from 6 to 15 mm length, typically aligned subparallel; coarse grained; massive to weakly foliated.

$MA\text{-}PP_{m}$ — **Hornblende Quartz Monzonite**: dark to medium greenish grey colour, commonly mottled pink and white or with dark streaks; consists of white, green, pink or red feldspar, hornblende, minor biotite, quartz and locally garnet; medium to coarse grained; massive to foliated.

$MA\text{-}PP_{MRgn}$ — **Granitoid Gneiss**: dark- to light-coloured biotite granodiorite, quartz monzonite and granite commonly foliated to mylonitic with mortar texture; rarely massive; consists of variable proportions of white feldspar, quartz, biotite and hornblende, with clots of garnet-biotite±chlorite (up to 13 mm); fine to coarse grained with up to 2 cm feldspar phenocrysts that are locally tabular; locally pegmatitic; includes rare minor lenses of fine- to medium-grained, massive to slightly banded amphibolite.

$MA\text{-}PP_{u}$ — **Undifferentiated Bedrock**

* Burntwood, Waugh Lake and Rutledge River complexes correspond to lithological assemblages previously assigned the rank of Group; existing data are insufficient to satisfy IUGS-required criteria for formal stratigraphic classification.

** Map units of the Marguerite River Complex are not arranged chronologically, as no isotope ages exist; based on its lithology and on the closest isotope age (A12), the Marguerite River Complex appears to be part of the Taltson magmatic zone.

Symbol Legend

- Mylonitization under high- to medium-grade metamorphic conditions: well-banded quartzofeldspathic mylonite, protomylonite and ultramylonite with sparsely preserved, subhorizontally stretched quartz lineations, amphibolite pull-aparts and ductile feldspars indicative of upper amphibolite to granulite facies during shearing; variable greenschist- and subgreenschist-grade overprint.
- Mylonitization under low-grade metamorphic conditions: well-foliated, light-coloured mylonite to proto-mylonite with abundant sigma-type porphyroclasts.
- Erosional edge of Phanerozoic strata
- Erosional edge of Athabasca Group
- Unconformity within Athabasca Group
- Formation and member boundary
- Fault: known, inferred
- Structural trend
- Athabasca Group outcrop (Wilson, 1985)
- U-Pb age sample (see Table 1)
- $^{40}Ar/^{39}Ar$ age sample (see Table 2)
- Dragon Lake Athabasca uncomformity-type uranium prospect
- Town/hamlet
- Paved road
- Unpaved/winter road

Descriptive Notes

Taltson Magmatic Zone

Northeastern Alberta is underlain by the Taltson magmatic zone, the southern segment of the approximately 3000 km long, north-trending, Early Proterozoic (2.0–1.9 Ga) Thelon-Taltson orogenic belt. The exposed segment of the Taltson magmatic zone forms a 300 km by 100 km belt extending from the Great Slave Lake shear zone in the Northwest Territories to Lake Athabasca in northeastern Alberta (see index map). Based on its aeromagnetic signature and drillhole data, the Taltson magmatic zone has been traced another 300 km south, beneath the Paleoproterozoic Athabasca Group and the Phanerozoic strata of the Western Canada Sedimentary Basin, where it appears to be truncated by the Snowbird tectonic zone (e.g., Hoffman, 1988; Ross et al., 1994). Small outliers of the Taltson magmatic zone exist south of the Athabasca Group in the Marguerite River watershed. The Taltson magmatic zone has been interpreted as a subduction and collision Himalayan-type orogen (e.g., Ross et al., 1994; McDonough et al., 2000g); as a Tian Shan–type orogen developed in a plate-interior setting, in response to distant plate boundary compression (Chacko et al., 2000; De et al., 2000); and as an intracontinental orogen triggered by mantle downwelling and Rayleigh-Taylor–type flow-induced stress at the base of a crust weakened by anomalously high radioactive-heat production (Pană et al., 2007).

In Alberta, the main area of the exposed Taltson magmatic zone consists of ca. 1.97–1.93 Ga granitoid rocks that intruded and reworked Archean to Paleoproterozoic Rae crust at the northwestern margin of the Churchill Province (e.g., Chacko et al., 2000; McDonough et al., 2000g; McNicoll et al., 2000). The westernmost relic of the Rae crust is the Taltson basement complex, represented by a curving, generally northerly trending linear body of high- to medium-grade metamorphic tectonite. It consists of a composite succession of Archean (3.2 Ga, 3.1 Ga, 2.6 Ga) and Early Proterozoic (2.4–2.1 Ga) metaplutonic gneiss units with subordinate supracrustal gneiss and minor amphibolite (e.g., Godfrey, 1986; McNicoll et al., 2000). The supracrustal gneiss has been inferred to be derived from ca. 2.13–2.09 Ga clastic sedimentary rocks of the Rutledge River Basin and the amphibolite from metamorphosed ophiolite remnants (Bostock and van Breemen, 1994; McDonough et al., 2000g; McNicoll et al., 2000). Low-grade metamorphic sequences are assigned to the Waugh Lake complex southeast of Andrew Lake and to the Burntwood complex on the north shore of Lake Athabasca. The Waugh Lake complex consists of variably sheared igneous rocks and sheared and layered rocks of uncertain origin. McDonough and McNicoll (1997) interpreted the Waugh Lake complex as a volcano-sedimentary sequence deposited between 2.02 and 1.97 Ga in an intra-arc basin. The Burntwood complex consists of phyllonite and hematite/limonite-cemented quartzofeldspathic rocks of uncertain origin interpreted either as correlative to the Waugh Lake complex (Godfrey, 1986) or as a lower stratigraphic unit of the Athabasca Group (McDonough and McNicoll, 1997).

The Taltson basement complex is flanked by moderately to strongly foliated granitoid plutons with minor Taltson basement complex roof pendants. Plutons on the east side consist of weakly peraluminous to metaluminous I-type granitoid rocks: 1) the ca. 1971 Ma Colin Lake granodiorite to quartz diorite; 2) the ca. 1974–1963 Ma Wylie Lake–Fishing Creek suite of granodiorite, quartz diorite and quartz monzonite; and 3) the ca. 1962–1959 Ma Andrew Lake suite of granodiorite to diorite. Plutons on the west side of the Taltson basement complex have peraluminous S-type granitoid compositions, are characterized by abundant mafic clots of biotite, garnet, andalusite, hercynite and cordierite, and include 1) the ca. 1960–1934 Ma, polyphase Slave granite to monzogranite; and 2) the ca. 1938 Ma Arch Lake quartz monzogranite to syenogranite. Several smaller, variously foliated plutons of uncertain geochemical affiliation are enclosed in the Taltson basement complex: 1) the Charles Lake granite suite with monazite metamorphic ages of ca. 1933–1919 Ma; and 2) the ca. 1925 Ma Chipewyan and Thesis syenogranite to quartz monzonite suite (Chacko et al., 2000; De et al., 2000; McDonough et al., 2000g). Peak metamorphic conditions of 6–7 kbar and temperatures as high as 1045°C were reached during the emplacement of the late plutons (Langenberg and Nielsen, 1982; Chacko and Creaser, 1995; Berman and Bostock, 1997).

From west to east, the following major, northerly trending, high- to low-grade shear zones cross the Alberta–Northwest Territories border: the Leland Lakes, Charles Lake and Bayonet Lake shear zones. The crosscutting relationships between shear zones and granitoid bodies are very complex, indicating concurrent deformation and granitoid intrusion during the ca. 2.0–1.9 Ga Taltson tectonothermal event (e.g., McDonough et al., 2000g). Shear zone deformation between ca. 1.95 Ga and 1.93 Ga was initiated at pressures of approximately 5–7 kbar and temperatures of 800°–850°C (Grover et al., 1997), partly contemporaneous with the 'late' granitoid pulses. Strain was heterogeneously partitioned in zones of high non-coaxial deformation within the Taltson basement complex and the adjacent plutons. The 1.93–1.91 Ga monazite ages and the 1.92–1.85 Ga titanite ages, estimated on variably foliated granitoid rocks (McNicoll et al., 2000), likely record syntectonic uplift above the 700° and 600°C isotherms, respectively, during the passage from granulite- to amphibolite-facies metamorphic conditions. $^{40}Ar/^{39}Ar$ hornblende data from both sheared and massive diorite plutons indicate cooling above the 525°C isotherm at ca. 1.90–1.85 Ga. $^{40}Ar/^{39}Ar$ dates on muscovite, from mylonitic micaceous gneisses and from Charles Lake granitoid, record slow cooling through 350°–325°C between ca. 1.86 and 1.80 Ga, and probably mark the cessation of deformation under low-grade metamorphic conditions (Plint and McDonough, 1995; Pană, 2010).

The scant isotopic evidence of fault-zone–related tectonism between 1.80 and 1.70 Ga suggests that the deposition of the Athabasca Group occurred on a tectonically quiescent, partly peneplaned Taltson magmatic zone.

Athabasca Group

The late Paleoproterozoic to early Mesoproterozoic Athabasca Group straddles the Alberta-Saskatchewan border, with approximately 10% of its area in Alberta, and lies on Archean to Early Proterozoic igneous and metamorphic rocks of the Churchill Province, in Alberta, the basement of the Athabasca Group consists of the Taltson magmatic zone and possibly its Rae infrastructure at the western margin of the Churchill Province. The Athabasca Group comprises four unconformity-bounded quartzose fluvial sequences, which show distinct sub-basin architecture, grain-size distribution, and paleocurrent directions (Collier, 2007; Kupsch, 2007; Post and Ramaekers et al., 2007). Discontinuities in paleocurrent-direction patterns and maximum-grain-size distribution separated by unconformities show that Athabasca Group sediments were deposited as four distinct sequences in three distinct, stacked sub-basins. Sequence 1 is of nearby derivation and is confined to the Jackfish sub-basin in the western part of the Athabasca Basin. Sequence 2 is confined to the Cree sub-basin, which reaches its greatest depth in the eastern part of the Athabasca Basin. In Alberta, it consists of distal, relatively fine-grained and thin units derived predominantly from the east. Sequence 2 overlies sequence 1 completely, except for a narrow belt along the western Athabasca Basin margin. Sequences 3 and 4 are found in the Mirror sub-basin, overlying the Cree sub-basin in the central area of the Athabasca Basin, and their sediments are derived largely from the south, especially the coarser units. A prominent unconformity, suggesting a considerable hiatus, separates sequences 1 and 2. Abrupt paleocurrent-direction discontinuities indicate a major basin reorganization between sequence 2 and the overlying sequences 3 and 4. The latter two have similar paleocurrent patterns, suggesting a lesser degree of discontinuity between them.

Sequence 1 consists of the Fair Point Formation, confined to the Jackfish sub-basin in the western part of the Athabasca Basin. The Fair Point Formation is about 380 m thick and includes the lower Lobstick and the upper Beartooth members. Sequence 1 underwent considerable compaction under inferred greater stratigraphic thickness before being extensively eroded. Sequence 2 begins with the well-sorted, sandy Smart Formation in the west and Read Formation in the east, which are overlain by the Manitou Falls Formation that spans the entire Athabasca Basin. The Manitou Falls Formation consists of three members: conglomeratic Bird Member, sandy Collins Member and clay-intraclast–rich Dunlop Member. The Warnes Member along the southern margin and Raibl Member along the northern margin of the Athabasca Basin are finer grained tongues above and below the Bird Member, respectively. These strata record interfingering alluvial megafans. The upper part was probably eroded and the preserved aggregate thickness is up to 1100 m. Sequence 3 includes the Lazenby Lake and Wolverine Point formations, widespread in the central and western parts of the Athabasca Basin. These strata, with an aggregate maximum-preserved thickness of about 600 m, record a third mega-alluvial fan west of the Snowbird tectonic zone. Euhedral zircon grains in tuffaceous intraclasts of the Wolverine Point Formation are dated by the U-Pb method at 1644 ±13 Ma (Rainbird et al., 2007). Sequence 4 comprises the Locker Lake and Otherside formations, which are limited to the central portion of the Athabasca Basin, and the Douglas and Carswell formations, which are restricted to the Carswell meteorite structure surrounding Cluff Lake, Saskatchewan. The Locker Lake Formation includes the pebbly Snare Member, conglomeratic Brudell Member and pebbly Marsin Member. The Otherside Formation consists of the pebbly Archibald and sandy Birkbeck members. The preserved aggregate thickness is estimated at 1150 m. Although erosion in different places at different times and lateral thickness variation of individual lithostratigraphic units prevent direct estimates of the entire thickness of the Athabasca Group, it is inferred that the aggregate thickness of stratotypes amounts to 3800 m (Ramaekers et al., 2007). The timing of Athabasca Group deposition is poorly constrained by the cessation of the tectonothermal evolution of the basement at ca. 1800 Ma and by ca. 1300 Ma crosscutting mafic dikes (Annesley et al., 2005). Additional time constraints are provided by the U-Pb zircon age of 1644 ±13 Ma, from tuffaceous intraclasts of the Wolverine Point Formation (Rainbird et al., 2007), and the Re-Os isochron age of 1541 ±13 Ma, yielded by organic matter from black mudstone of the Douglas Formation (Creaser and Stasiuk, 2007). Based on these data and stratigraphic relationships, the Athabasca Group is inferred to have been deposited between about 1760 Ma and 1500 Ma (Ramaekers et al., 2007).

Table 1. U-Pb Geochronological Data

Site	Sample Identifier	Easting	Northing	Crystallization Age (Zrn)	Metamorphic/ Cooling Age	Rock Type	Reference
Taltson plutonic rocks							
A1	MRB-TAN-61	551559	6645400	1923 ±2 Ma	1921–1913 Ma (Mnz)	Wallace Island (Colin Lake muscovite) granite	38
A2	MSB-94-55	498660	6536334	1925 +5/-3 Ma		Chipewyan granite	38
A3	MRB-VCH-28	527014	6637373	>1933 Ma	1933–1919 Ma (Mnz)	Charles Lake granite	38
A4	MRB-MLL-15	497832	6628503	1934 ±2 Ma		Western Slave granite dike	38
A5	MSB-94-31	529970	6637529	1938 ±3 Ma	1938–1931 Ma (Mnz)	Arch Lake syenogranite	38
A6	MRB-TAN-70	543260	6645642	1959 ±3 Ma	1932–1925 Ma (Mnz)	Andrew Lake granodiorite	38
A7	MRB-MAN-27	550266	6635412	1962 +16/-10 Ma	1860–1853 (Ttn)	Andrew Lake granodiorite	27, 38
A8	MSB-93-107	530609	6571395	1963 +6/-4 Ma		Wylie Lake granodiorite	38
A9	Z-7478	482480	6470899	1968 ±5 Ma*		Fishing Creek-type quartz diorite (drillhole FC-75)	47
A10	MSB-93-148	554459	6629377	1971 ±4 Ma		Colin Lake quartz diorite	27
A11	DP5-55	556037	6635040	1973 ±3 Ma		Martyn Lake monzonite	41
A12	Z-7477	551099	6408416	1974 ±5 Ma*		Wylie Lake-type granodiorite (drillhole FC-095)	47
Metamorphic tectonite							
A13	MSB-95-45	520002	6543208	2.5; 2.3–2.1; 1.94–1.92 Ga		"quartz pebble sandstone," Burntwood Complex	27
A14	MRB-MAN-14	554502	6631004	2.7; 2.3–2.0 Ga		"Mu-feldspathic wacke," Waugh Lake Complex	27
A15	MSB-93-15	487201	6617210		1926–1923 Ma (Mnz)	"pelitic gneiss," Rutledge Lake Complex	38
A16	MSB-MCH-41	528854	6629079		1925–1919 Ma (Mnz)	"pelitic gneiss," Rutledge Lake Complex	38
Taltson orthogneiss							
A17	MSB93-101	526984	6600093	2138 ±2 Ma	1917 ±6 Ma (Ttn)	syenogranite gneiss	39
A18	MSB94-95	498521	6517017	2330 ±3 Ma		syenogranite gneiss	39
A19	MSB93-MC10	544786	6631073	2335 ±2 Ma		pegmatitic granite	39
A20	MSB93-116	516121	6629719	2382 ±5 Ma	1917–1913 Ma (Zrn)	granodiorite gneiss	39
A21	MSB94-33	518052	6600565	2393 +12/-8 Ma	1936–1925 Ma (Mnz)	granite gneiss	39
A22	MSB94-47	529280	6552731	2562 ±6 Ma		tonalite gneiss	39
A23	MSB93-139	533671	6592823	3076 +15/-5 Ma	1930–1917 Ma (Mnz)	tonalite gneiss	39
A24	MSB93-2	493524	6622818	3186 +17/-13 Ma	1930–1917 Ma (Mnz)	granite gneiss	39

All ages reported here have been determined by thermal ionization mass spectrometry (TIMS), except for those marked (*), which have been determined by sensitive high-resolution ion microprobe (SHRIMP). Mineral abbreviations: Mnz, monazite; Ttn, titanite; Zrn, zircon. Co-ordinates are in UTM zone 12 projection, NAD83 datum.

Table 2. $^{40}Ar/^{39}Ar$ Geochronological Data

Site	Sample Identifier	Easting	Northing	Plateau Age	Mean K-Ar Age/ Nr. of Analyses	Mineral/ Closure T	Rock Type	Reference
Taltson plutonic rocks								
A26	MCH-38	527033	6628335	1681 ±11 Ma#		Kfs/170°C	Charles Lake granite	42
A26	MCH-38	527033	6628335	1799 ±11 Ma	1772 ±40 Ma/88	Bt/300°±25°C	Charles Lake granite	42
A27	VCH-28	527014	6637373