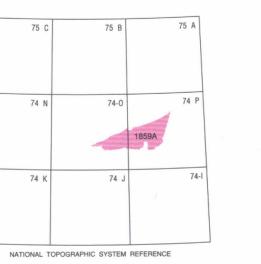
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105°00' 1962, 1963, 1964), Gilboy (1980), and Slimmon and Macdonald (1987). Bedrock exposure is generally good, except LEGEND Black Lake garnet-sillimanite-cordierite metapelite e-chlorite-actinolite greenschist mylonite ultramylonite (Afm). On the east side of the mylonite triangle, the wall rocks are garnet-sillimanite-cordierite schists (Abp), with incipient development of partial melt and concordant leucogranite sheets. Amphibolite and biotite amphibolite Rohica mafic garnet-clinopyroxene-orthopyroxene-hornblende mylonite Robillard coarse granitoid orthogneiss Faraud paragneiss-leucogranite banded mylonite Bohica mafic hornblende-garnet porphyroclastic mylonite pillard rhythmically layered garnet-sillimanite metapelite Faraud migmatitic sillimanite-garnet-andalusite paragneiss with linopyroxene meta-anorthosite (Abam: mylonite) illivrav biotite-hornblende granite coarse leucogranite Local occurrences Figure 2. Principal structural and kinematic elements of the East Athabasca mylonite triangle Aca Chipman amphibolite Ag leucogranite (Agm: mylonite) ohica mafic / Hawkes leucogranite mylonite Ap pyroxenite, peridotite, anthophyllite rock Chipman garnet granite, locally nonmylonitic hornblende-biotite granite (proto)mylonite Aan anorthosite Fault zone..... Magmatic zone.....mz Chipman hornblende-garnet-clinopyroxene metadykes (>60% vol.) Furnbull hornblende-biotite granite, locally nonmylonitic Map unit designations in parentheses refer to subsidiary lithologies within the principal map unit Chipman hornblende-clinopyroxene tonalite with igneous texture Figure 1. Location of the East Athabasca mylonite triangle within the western Canadian Shield (after Hoffman, 1988) Acm Chipman hornblende ± clinopyroxene ± garnet tonalite mylonite Fault, sinistral strike-slip, approximate. . Fault, normal dip-slip, approximate. . Fault, undifferentiated, approximate. . Chipman hornblende metatonalite (transitional fabric) hr hornblende-biotite ± garnet granite (Afgm: mylonite) Chipman dyke, undifferentiated. . Fehr dyke, undifferentiated. . Chipman hornblende metatonalite (undifferentiated) Turcotte biotite-garnet-hornblende granite, locally nonmylonitic Magmatic foliation: oblique. . Foliation: oblique, vertical. . . Chipman hornblende ± garnet annealed tonalite mylonite Extension lineation, fold axis. . Bradley garnet-clinopyroxene granite mylonite Foliation with strike-slip shear-sense: dextral, sinistral. . . Vertical foliation with strike-slip shear-sense: dextral, sinistral. . Ard Reeve garnet-sillimanite ± orthopyroxene diatexite (Ardm: mylonite) Abkg Brykea garnet-clinopyroxene granite mylonite Foliation with dip-slip shear-sense: extensional, thrust. . . Agg Godfrey garnet-hornblende ± clinopyroxene granite mylonite, locally nonmylonitic hornblende-garnet cumulate metagabbro U-Pb isotopic age determination in millions of years, zircon (z); monazite (m) (R.R. Parrish, geochronologist). . Hawkes leucogranite / Bohica mafic mylonite Amg Mary garnet-hornblende-two pyroxene granite mylonite (Ampg: porphyroclastic) shape fabrics (Acgn). Relict isoclinal folds and feldspar porphyroclasts indicate that the straight gneiss is an annealed Mary garnet-hornblende granitic ribbon gneiss and protomylonite with panels and rafts of poorly foliated Bohica complex (Ab). Aam Axis two pyroxene ± garnet granulite mafic mylonite Hawkes garnet-hornblende-two pyroxene leucogranite Pine Channel garnet-sillimanite-orthopyroxene diatexite Hawkes garnet-hornblende-two pyroxene leucogranite mylonite, locally nonmylonitic Apdm Pine Channel garnet-sillimanite-orthopyroxene diatexite mylonite Using a variety of structural criteria (Hanmer and Passchier, 1991), the East Athabasca mylonite triangle is divided Arm Reeve diatexite - Mary granite mylonite into four kinematic sectors. All shear criteria in the upper deck, as well as the Godfrey (Agg) and Clut (Acgm) granites mylonites are significantly older than the Late Archean ribbon fabrics of the East Athabasca mylonite triangle. A single MAP 1859A

GEOLOGY EAST ATHABASCA MYLONITE TRIANGLE SASKATCHEWAN

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The East Athabasca mylonite triangle, northern Saskatchewan, forms a segment of the Snowbird tectonic zone, a high amplitude linear anomaly in the horizontal gravity gradient map of the Canadian Shield which extends from the Canadian Rocky Mountains to the coast of Hudson Bay, separating the Rae and Hearne structural provinces (Fig. Goodacre et al., 1987; Hoffman, 1988). Low amplitude anastomosing linear elements in the magnetic field occur alon the trend of the gravity anomaly and define an elliptical area, or crustal-scale "lozenge", 300 by 100 km, south of Lake Athabasca (Geological Survey of Canada, 1987). In the Stony Rapids area, the Snowbird tectonic zone is geologically manifested as the Late Archean East Athabasca mylonite triangle (ca. 2.6 Ga; R. Parrish, unpub. data, U-Pb in zircon), a 75 by 80 by 125 km wedge-shaped zone of high grade mylonites (Fig. 2) located at the northeastern end of the "lozenge" structure (Fig. 2 inset). The area was mapped by the Geological Survey of Canada during the summers of 1990 and 1991 (Hanmer et al., 1991, 1992; see also Hanmer, 1987). Previous mapping of parts of the area was completed by Alcock (1936), Colborne (1960, 1961, 1962), Colborne and Rosenberger (1963), Johnston (1960, 1961,

DESCRIPTIVE NOTES

in the extreme northern, southeastern, and southwestern corners of the area. Float plane service is available from WALL ROCKS On the west side of the East Athabasca mylonite triangle, the immediately adjacent wall rocks are predominantly amphibolite or extensively biotitized amphibolite (Aa), and sillimanite-garnet-andalusite metapelitic migmatite with abundant, crosscutting, coarse leucogranite (Faraud gneiss Afp). They are intercalated with the rocks of the East Athabasca mylonite triangle and, in the case of the Faraud gneiss, are transformed into spectacular banded ribbon

EAST ATHABASCA MYLONITE TRIANGLE East Athabasca mylonite triangle is structurally divided into an upper and a lower deck, both of which are extensively and penetratively mylonitized. Layering and foliations in the lower deck are steeply dipping with moderately southwest-plunging extension lineations. The lower deck comprises three kinematic sectors: a central septum which has experienced progressive pure shear and relatively low finite strain, flanked by sinistral and dextra shear zones to the east and west, respectively. The upper deck is entirely composed of a shallowly southwest-dippin top-side-down shear zone in the east, which progressively becomes a steeply dipping, dextral shear zone in the west Layering and foliations are parallel to the shear zone boundaries. Extension lineations plunge down-dip in the eas and porpoise moderately about the strike direction in the west. The upper deck can either be described as an extensional shear zone with a lateral ramp, or a dextral shear zone with a "releasing" bend.

The upper deck is composed of garnet-sillimanite-orthopyroxene Pine Channel diatexite (Apd, Apdm), injected by 1-10 m thick orthopyroxene ± garnet granite sheets (ca. 2.6 Ga). Discrete, kilometre-scale sheets of orthopyroxene-plagioclase ± garnet, two pyroxene-plagioclase ± garnet Axis mafic granulite (Aam, ca 2.6 Ga) predominate in the higher structural levels of the upper deck. Coarse gabbroic to microgabbroic textures are locally preserved, indicative of a plutonic origin. The Axis mafic granulite, itself cut by Rea pyroxene metagranite (Argm, ca 2.6 Ga), is intercalated with the diatexite, but the origin of the intercalation remains uncertain.

LOWER DECK The lower deck is principally composed of garnet-sillimanite ± orthopyroxene Reeve diatexite (Ard, Ardm). In the east, the diatexite is intercalated with the hornblende-plagioclase ± clinopyroxene ± garnet metatonalitic Chipman batholith (Ac, Act, Acm, Acgn (ca. 3.4 Ga), Acu). Abundant, scattered decimetre- to kilometre-scale inclusions of anorthosite (Aan), layered amphibolite (Aca), pyroxenite, anthophyllite rock, and peridotite (Ap) appear to represent fragments of a dismembered layered mafic complex, dispersed within the Chipman batholith. In the west, the diatexite metadiorite, and meta-anorthosite of the Bohica mafic complex (Ab (ca. 2.62 Ga), Abm, Abh, Aba, Abam). The Chipman batholith (Ac) is intruded by a swarm of generally thin (<1 m), but locally mappable, discontinuous, concordant granite veins (Acg, ca. 3.13 Ga) and a swarm of subconcordant, 1-100 m thick hornblende-plagioclas hornblende-garnet- plagioclase, and clinopyroxene-garnet mafic metadykes . The mafic dykes may occupy 60-100% of the outcrop and constitute a mappable unit, though they decrease in abundance toward the west. Other mafic map units are garnet-clinopyroxene-plagioclase granulite (Amp) and a hornblende-plagioclase-garnet mafic gneiss derived from a cumulate pluton (Ahm), both of uncertain affiliation.

A number of granitic intrusions were emplaced into the lower deck. In the west, the Reeve diatexite and Bohica complex are intruded by hornblende-garnet, two pyroxene-bearing Mary metagranite (Amg, Ampg, Amr, ca. 2.6 Ga) and Hawkes metaleucogranite (Ahl (2.6 - ca. 2.61 Ga), Ahg). These, plus four other distinctive granitic map units, the garnet-clinopyroxene Bradley (Abdg) and Brykea (Abkg, 2.62 Ga) metagranites, the garnet-hornblende clinopyroxene Godfrey metagranite (Agg) and the biotite-garnet-hornblende Turcotte (Atg) metagranite, are possible components of a single batholith. An apparently linked network of hornblende-biotite granites (Acgm, Amtg) cuts the aforementioned granites. The Clut granite (Acgm, 2.615 Ga) forms a shallowly south- and west-dipping sheet under the Godfrey metagranite (Agg, 2.6 Ga), beneath the eastern part of the upper deck. It appears to extend into the western part of the lower deck as the anastomosing array of Melby-Turnbull granite sheets (Amtg, 2.61 Ga). The hornblende-biotite ± garnet Fehr granite (Afg, 2.6 Ga, Afgm) cuts the Chipman batholith and its associated mafi dykes, but is itself cut by a later set of subconcordant hornblende-plagioclase-garnet mafic metadykes. The coarse biotite-hornblende Beed granite (Abeg) cuts the mafic mylonites of the Bohica complex. The biotite-hornblende megacrystic McGillivray granite (Am, 2.62 Ga) cuts the Clut granite and the Mary batholith. The Stevenson biotite leucogranite (Asg; perhaps part of the eastern wall rock), the Felsic Lake biotite leucogranite (Aflg), and leucogranite (Ag), often strongly mylonitized (Agm), occurs throughout much of the dextral shear zone, north of the

The Robillard gneiss outcrops to the southeast of Clut Lakes and north of Sucker Bay. It comprises a white, very coarse granitoid orthogneiss (Arg, ca. 1.9 Ga) with xenoliths, rafts, and mappable panels of garnet-sillimanite metapelite (Arp) which locally preserves a rhythmic compositional layering, presumably of primary origin, west of Robillard Bay. The Robillard gneiss contains no evidence that it ever experienced granulite facies metamorphism, or developed a high grade mylonitic fabric. Some mylonite map units are undifferentiated composites of two map units: Ahb, Hawkes leucogranite (Ahl) with mafic rocks of the Bohica complex (Ab); Abg, mafic rocks of the Bohica complex (Ab) with Hawkes leucogranite (Ahl); Arm, Reeve diatexite (Ardm) with Mary granite (Amg); Abc, mafic rocks of the Bohica complex (Ab) with tonalite of the

The distribution pattern of the tectonic fabrics in the East Athabasca mylonite triangle is complex. The upper deck is penetratively ultramylonitized, except for the lenses of diatexite (Apd) near Sucker Bay. Very few feldspar porphyroclasts are preserved in the mylonites, and very few minor structures are present, despite the abundance of rigid garnet porphyroblasts and garnet-rich layers, indicating that tectonic flow was remarkably homogeneous at a scales. The base of the upper deck is marked by the present lower limit of this exceptionally homogeneous flow. places it coincides with the base of the Pine Channel diatexite (Apdm). However, along the lateral ramp, south of Wiley and Melby lakes, it lies within diatexite, the lower part of which has been assigned to the lower deck (Ardr Accordingly, the boundary between the lower and upper decks can be considered as a fabric transition. Along the trailing edge, south of Clut Lakes, the fabric transition has transgressed into the Godfrey granite (Agg) beneath the diatexite (Apdm), but its lower limit is masked by the younger Clut granite (Acgm). There is no indication that the boundary between the lower and upper decks is anywhere a discrete fault or localized shear zone. Within the lower deck, ribbon fabrics with few feldspar porphyroclasts are extensively developed throughout except for parts of the Chipman batholith and the central septum, as well as the Beed granite (Abeg), McGillivray granite (Am), parts of the Turcotte granite (Atg), and the Robillard gneiss (Arg). Chipman tonalite (Ac), with coarse igneous textures and a nebulous banding of dispersed amphibolite and clinopyroxenite inclusions, passes progressively westward, via a transitional well foliated metatonalite (Act), into tonalitic ribbon mylonite (Acm) However, to the east, the tonalite is transformed into an annealed, medium- to fine-grained straight gneiss, devoid of

Between the central septum and the upper deck, the Clut granite (Acgm) is protomylonitic to mylonitic. Its shallowly dipping foliation is concordant with that in the upper deck and discordant to that of the central septum. Elsewhere in the lower deck, between Reeve Lake and Lake Athabasca, the generally homogeneous development of mylonitic fabrics is replaced by a heterogeneous pattern that reflects partitioning of flow at all scales. Large lenses of coarse ribbon gneiss, with lenticular polycrystalline feldspar stripes, 5 by 200 mm, (Amr), derived by the deformation of ver coarse Mary granite, are enclosed by kilometre-scale belts of fine grained, granoblastic, particularly porphyroclast mylonite (Amp) derived from the same protolith. Other lenses composed of coarse isotropic diatexite (Ard), or Bradley and Brykea granite mylonite (Abdg, Abkg), are also flanked by the porphyroclastic mylonite. This anastomosing geometry is also reflected in the orientations of mylonitic foliation along the shore of Lake Athabasca, west of Robillard Bay. Furthermore, the anastomosing strands of hornblende-biotite Melby-Turnbull granite (Amtg) are intruded along the porphyroclastic mylonite belts.

SHEAR SENSE

in the lower deck between Heppner and Rosinski lakes, indicate a top-side to the southwest displacement. Elsewhere within the lower deck, the sinistral and dextral shear zones are separated by the central septum, within which anastomosing shear zones are developed, and both sinistral and dextral shear criteria are present. There is often a relationship between the orientation of the shear plane, as manifested by the mylonitic foliation, and shear sense. Fabrics trending about 020° show sinistral shear, fabrics trending about 060° show dextral shear, and those dipping

gently to the south and west show a top-side-down displacement, reflecting the boundary conditions of the east and west sides of the lower deck and the eastern part of the upper deck, respectively. SYNTECTONIC MAGMATISM In the lower deck, several ca. 2.62-2.60 Ga igneous intrusions were demonstrably emplaced during mylonitization Within the Mary granite (Amg), extensively mylonitized older phases are locally cut by less deformed, mylonitic phases. South of East Hawkes Lake, Hawkes leucogranite (Ahl) contains an already mylonitized panel of diatexite (Ardm). Strands of Melby-Turnbull granite (Amtg), although emplaced into thoroughly mylonitic dextral shear zones are themselves heterogeneously mylonitized, and coarse granitic textures are extensively preserved. The Clut granite (Acgm), which truncates mylonitic fabrics in the lower deck, was emplaced beneath the garnet-hornblende clinopyroxene Godfrey granite mylonite (Agg) and subsequently mylonitized at lower grade (hornblende-biotite) Apparently, the Melby-Turnbull and Clut granites (Amtg, Acgm) were emplaced syntectonically during coeval shearing in the lower deck and displacement of the upper deck. Furthermore, the McGillivray granite (Am) cuts the mylonitic Clut granite (Acgm), but is itself deformed by a 50-100 m thick, west-dipping, extensional, biotite-hornblende myloniti shear zone (Taylor Bay fault) along its western contact. Apparently both the Clut and McGillivray granites (Acgm, Am were emplaced into a dilational region adjacent to the trailing edge of the actively moving upper deck. The Fehr granite (Afg) cuts Chipman batholith mylonite (Acm), but is itself thoroughly mylonitized in its northeastern part (Afgm). The ca. 3.13 Ga Chipman dykes are syntectonic with respect to the Chipman batholith straight gneiss (Acgn) because they preserve all the deformation states from isoclinally folded, transposed, and dismembered to crosscutting, with joint-controlled contacts and apophyses, even within a single outcrop. Accordingly, the annealed

low-angle crosscutting vein of mafic granulite (Aam) southeast of Axis Lake suggests that the gabbroic-noritic magma of the upper deck may have been intruded into already mylonitic diatexite (Apdm) prior to being mylonitized itself, however, this relationship remains equivocal. Greenschist facies biotite-chlorite-actinolite mylonites (Ags) and discrete brittle faults occur along the eastern as well as in its interior (Platt Creek-Kaskawan Lake; Clut Lakes). The discontinuous occurrence of the mylonites may indicate that they were partially cut out by later brittle faulting. The brittle faults show little evidence of quartz veining the high grade mylonites. Black-Bompas and Platt-Kaskawan faults are sinistral. Straight-Grease fault is dextral. Clut fault is a dip-slip fault of uncertain shear-sense, but its geometry and location suggest that it is a south-side-down

normal fault. The sudden increase in the density of Chipman dykes south of Steinhauer Lake is suggestive of an extension of the Clut fault, but no direct evidence has been found. Granulite facies mineral assemblages are developed throughout the upper and lower decks of the East Athabasca mylonite triangle. The mylonite fabrics of the upper deck were exclusively developed in anhydrous assemblages; amphibole and biotite form postkinematic pseudomorphs after orthopyroxene and garnet. In the lower decl

synkinematic hornblende is common, even in granulite facies tectonites, particularly in the Chipman batholith (Ac ubkg, Abdg, Atg). Along the northwest margin of the lower deck, the Bohica complex and Felsic Lake granit mylonites (Abh, Aflg) and the mylonitized Faraud gneiss (Afp) constitute a 2 km wide amphibolite facies mylonite belt derived by the further shearing of the granulite facies mylonites to the southeast during cooling and which was also the site of minor reworking during the interval ca. 2.18-1.8 Ga. The Clut (Acgm), Melby-Turnbull (Amtg), Fehr (Afg), Beed (Abeg) and McGillivray (Am) granites were emplaced and deformed at amphibolite facies.

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