

The East Athabasca Mylonite Zone: An Archean Segment of the Snowbird Tectonic Zone in Northern Saskatchewan¹

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The East Athabasca Mylonite Zone is a triangular segment of the Snowbird tectonic zone, characterized by a complex flow pattern. Polyphase deformation occurred under transitional to granulite facies conditions at ca. 3.2 and ca. 2.6 Ga.

The Snowbird tectonic zone, clearly delimited as a pronounced linear anomaly in the horizontal gravity gradient map of the Canadian Shield, is well exposed as a triangle of high grade mylonitic rocks (125 by 80 by 75 km) in the Stony Rapids area, northern Saskatchewan (Figure 1). The triangular structure (Tantato Domain of Gilbois, 1980; Slimmon, 1989) lies at the northeast end of the largest (300 by 100 km) of a chain

of magnetically defined elliptical domains which may represent relatively stiff, crustal-scale 'boudins' (see Hanmer *et al.*, 1991 for references).

Tantato Domain is divided into two structural decks (Figure 2; Hanmer *et al.*, 1991). The fan-shaped lower deck is characterized by upright foliations and shallowly to moderately southwest plunging extension lineations. The upper deck is arcuate. Foliations parallel to the northwest-southeast-trending margin dip shallowly to the southwest and truncate the upright foliations of the lower deck, whereas those parallel to the northeast-southwest trending margin are upright. All extension lineations in the upper deck plunge shallowly, toward

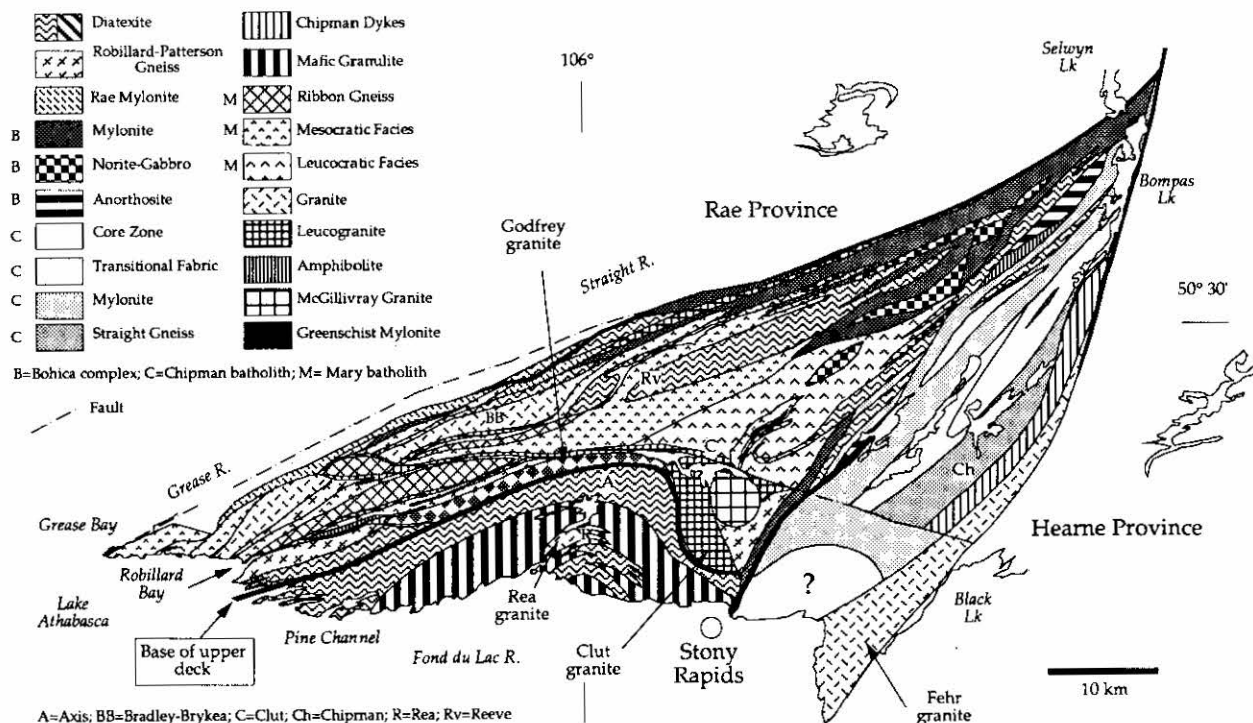


Figure 1 - Geology of East Athabasca Mylonite Zone.

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either the southwest or the northeast. Preliminary geochronological data (unpublished; U-Pb in zircon) have been obtained by R. Parrish (Geochronology Laboratory, Geological Survey of Canada). In order to more clearly convey the structural nature of the Snowbird tectonic zone in the map area, we suggest that the name East Athabasca Mylonite Zone (referred to as the Mylonite Zone for brevity) should replace the non-genetic term 'Tantato Domain'.

1. Upper Deck

a) Pine Channel Diatexite

The Pine Channel diatexite, 4 km thick, is white to tan and comprises a banded, leucocratic, quartzofeldspathic matrix with an highly variable content of lilac to delicate pink garnets, orthopyroxene, graphite and sillimanite. Mylonitic to ultramylonitic ribbon fabrics are penetratively developed throughout the Pine Channel diatexite, except near Pine Channel. There, kilometric lenses of often highly irregular, folded migmatite with cross-cutting garnet-orthopyroxene granitoid sheets form a stack of steeply southeast-dipping 'horses', bounded above and below by their highly attenuated ultramylonitized equivalents.

b) Fond du Lac Mafic Granulites

The Fond du Lac mafic granulites are a 5 km thick stack of sheets (< 2 km thick), essentially orthopyroxene-plagioclase-magnetite $\pm$ garnet in composition, separated from one another by thin, but often mappable, horizons of diatexite ribbon mylonite. South and

east of Axis Lake, the mafic granulites preserve isotropic coarse ophitic gabbroic/noritic igneous textures over a thickness of more than a kilometre, which grade into annealed mylonites.

2. Lower Deck

a) Bohica Complex

Very coarse, primary ophitic textures to strongly flattened, flaser fabrics are locally preserved in norite, gabbro and diorite, especially in the central part of the Mylonite Zone. The coarse igneous textures can be followed progressively into garnet-two pyroxene to garnet-hornblende ($\pm$ pyroxene) mylonites. Two large bodies of anorthosite and gabbroic anorthosite ultramylonite, locally with splendid ribbon fabrics, locally strongly annealed, outcrop on the southeast side of the complex.

b) Chipman Batholith

In the tonalitic Chipman batholith (pre-ca. 3.2 Ga), Hammer *et al.* (1991) identified a coarse-grained, low strain central core, flanked to the southeast by strongly annealed tonalitic straight gneisses (mylonites), and to the northwest by clinopyroxene-bearing tonalite ribbon mylonites and ultramylonites. Widespread xenoliths and rafts represent the remains of a dismembered layered mafic-anorthositic-ultramafic complex. An important swarm of garnet-hornblende and garnet-clinopyroxene Chipman dykes was emplaced throughout the batholith. However, east of a line through Chipman Lake, and spatially coincident with the strongly annealed tonalitic straight gneisses, the dykes are locally so common that

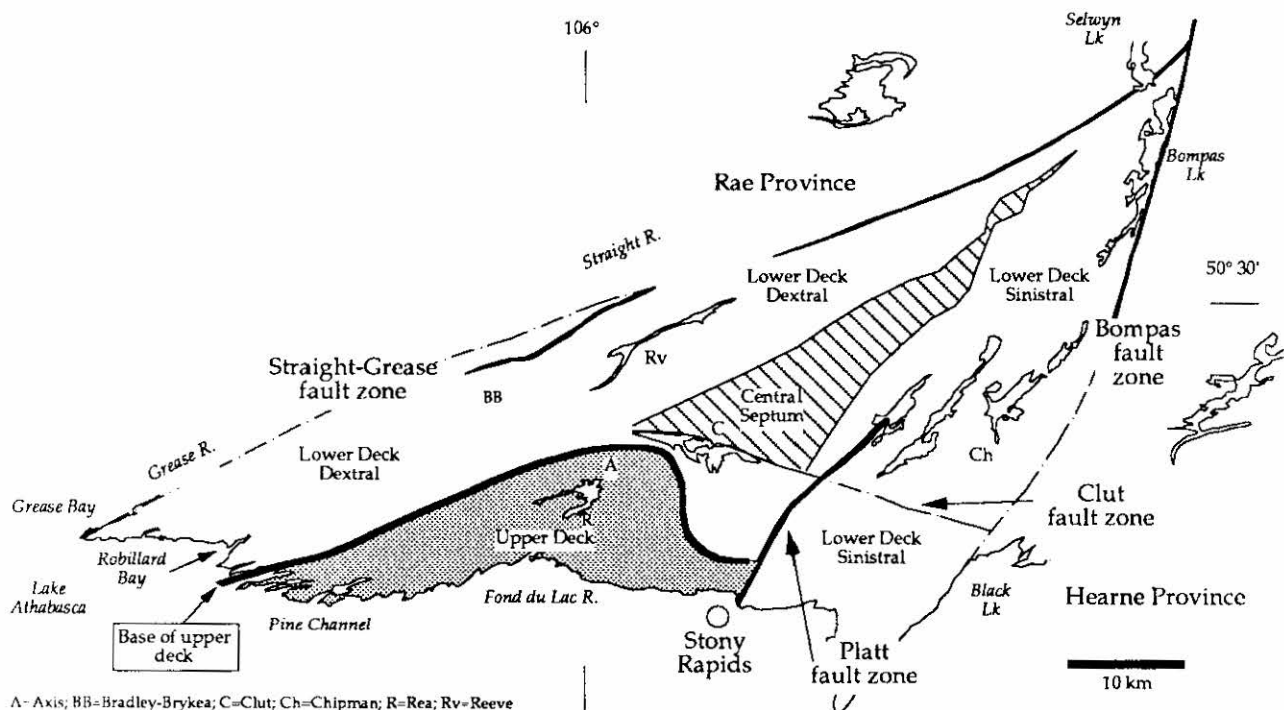


Figure 2 - Structural framework of East Athabasca Mylonite Zone.

they may form 70 (or more) percent of the map unit in belts up to 1.5 km thick. The dykes show a complete range of deformation, from early transposed components of the tonalite gneissosity, to later cross-cutting, isotropic dykes with pristine igneous contacts. The earlier, strongly foliated dykes and the tonalitic straight gneisses are crosscut by an array of 1 to 10 m thick leucogranite veins (Hanmer *et al.* 1991; ca. 3.2 Ga.).

c) Mary Batholith

Hanmer *et al.* (1991) first distinguished the Mary batholith as a compositionally monotonous, strongly garnetiferous meta-granite to meta-granodiorite. The garnets occur in two distinctive microstructural settings: as 2 to 5 mm single grains rimmed by hornblende, apparently after pyroxene (core-type), and as small (<1 mm) grains arranged in rims, one grain thick, mantling aggregates of hornblende after clinopyroxene (rim-type). The abundance of mafic minerals lends a mesocratic aspect to the Mary granitoids west of Mary, hence the term western mesocratic facies (ca. 2.6 Ga.).

By contrast, granitoid rocks in the eastern part of the Mary batholith are distinctly leucocratic (eastern leucocratic facies; ca. 2.6 Ga.), yet contain the same mineral assemblages and garnet microstructures just described. Locally, there are map-scale panels of the mesocratic Mary material within the leucocratic granitoids. Elsewhere, the garnet-hornblende-clinopyroxene content of the leucocratic granitoid is highly variable, both between and within individual outcrops. In the latter case the transitions are always gradational. This strong mineralogical variation is an hallmark of the Mary batholith. The presence of a map-scale raft of garnet-pyroxene layered metagabbro with well preserved cumulate layering, plus abundant evidence of the mechanical disaggregation of fist to football sized garnet-pyroxene aggregates within the host granitoid, suggest to us that part of the mineralogical heterogeneity in the Mary batholith may reflect variation in the xenocryst population at all scales.

d) Other Granites

Discrete, map-scale plutons and sheets of generally leucocratic granite occur throughout the lower deck of the Mylonite Zone. They probably do not represent a related suite of granites and are only grouped here for clarity of presentation.

The Godfrey granite was described by Hanmer *et al.* (1991) as a coarse-grained, garnet-pyroxene metagranite, lining the base of the upper deck in the Clut Lakes area. It may closely resemble the meso- to leucocratic facies of the Mary batholith. We cannot exclude the possibility that this granite is related to the Mary batholith. The Brykea granite is a strikingly salmon pink granite ultramylonite with abundant, 1 mm cherry red garnets set in a fine-grained, sugary annealed matrix with variable proportions of small feldspar porphyroclasts. The Bradley granite is a splendid ribbon ultramylonite derived at the expense of a very coarse grained protolith. The Fehr granite (ca. 2.6 Ga.) outcrops along the eastern margin of the Mylonite Zone.

To the southwest, it is generally isotropic and extremely coarse grained, with the exception of a few, local, discrete shear zones with upright fabrics, trending sub-parallel to the regional strike. To the southeast, the granite is charged with abundant amoeboid clots of coarse, polycrystalline hornblende $\pm$ orthopyroxene, visibly derived by the disaggregation of larger, metre-size xenoliths, reminiscent of the xenocrystic mafic phases of the Mary batholith.

The granite is cut by a swarm of strike-parallel mafic dykes, one to tens of metres wide, which may locally account for 20 percent of the Fehr granite. Some of the dykes carry abundant 2 to 4 mm garnets, commonly replaced by plagioclase. Although its contact with the Chipman batholith is abrupt, veins of Fehr granite cut across both the batholith structure and the Chipman dykes. Accordingly, there are at least two dyke swarms in the eastern part of the Mylonite Zone.

The Clut granite (ca. 2.62 Ga.) is a voluminous biotite-hornblende leucogranitic protomylonite which occupies the Clut Lakes area and bounds the internally unfoliated, late-syntectonic megacrystic hornblende-biotite McGillivray granite (Hanmer *et al.*, 1991; ca. 2.62 Ga.) on its western and northern sides. Note that the McGillivray granite intruded the already deformed Clut granite (Hanmer *et al.*, 1991).

Along strike to the west and south of the Clut Lakes granite is a suite of structurally controlled biotite-hornblende leucogranite sheets, each one up to several hundreds of metres thick, or more. They lie preferentially within the belts of porphyroclastic mylonite which enclose the map-scale lozenges of ribbon gneiss and Reeve diatexite. We refer to them as the Melby-Turnbull granites. Although the isotropic to poorly foliated parts of the granite sheets have abrupt intrusive contacts and contain misoriented xenoliths of the adjacent porphyroclastic mylonites, they are themselves locally to extensively mylonitised. We suggest that they were emplaced during the waning stages of mylonitisation.

e) Robillard-Patterson Gneiss

Two map-scale slices of a white granitoid gneiss, with included rafts of rhythmically layered garnet-sillimanite meta-(psammo)pelite, occur within the lower deck, east of Robillard Bay and west of Patterson Creek. The granitoid component, is well banded, coarsely rodded and irregularly folded. At the grain-scale, the rock is coarsely recrystallised and generally lacks a shape fabric. Pegmatite veins in a variety of strain states are common and may crosscut both banding and folding in the gneiss. In the eastern part of the Patterson Creek slice, the irregular, intimate mixture of granitic and metasedimentary components is distinctly migmatitic; in the western part, the very coarse-grained granitoid intrudes and includes a large mass of isotropic gabbro. We suggest that the fabrics in the Robillard-Patterson gneiss may be older than the deformation and metamorphism of the adjacent Mylonite Zone rocks.

3. Structure and Metamorphism

Foliations within the fan-shaped lower deck (Figure 2) are generally steeply dipping and concordant with the Mylonite Zone boundaries, except in the southwest, along the shore of Lake Athabasca. Here, the foliation is commonly very shallow dipping and highly variable in orientation. Nonetheless, extension lineations tend to plunge moderately to shallowly southwestward, irrespective of foliation attitude.

The distribution, development and preservation of high strain fabrics in the lower deck are complex. The principal low strain zone is the Central Septum (Figure 2) of heterogeneously deformed Bohica complex mafic rocks and leucocratic Mary batholith granites which extends northeast from the Clut Lakes. It is flanked on either side by extremely attenuated Reeve diatexite, Chipman batholith and Bohica complex granulite facies ribbon mylonites.

Outside of the relatively low strain zones, the rocks of the lower deck are highly attenuated mylonites or straight gneisses, with the exception of the Robillard-Paterson gneiss. To the northwest of the Central Septum, garnet-hornblende-pyroxene ($\pm$ sillimanite) ribbon mylonites are developed from Reeve diatexite, Bohica complex and Mary batholith lithologies. Within 2 km of the northwest margin of the Mylonite Zone, mylonites are so fine grained that the ribbon structure is difficult to discern in the field. Biotite-chlorite-bearing greenschist mylonites derived from metapelitic and leucogranite sheets form a 100 m wide belt at the northwest edge of the Mylonite Zone. To the southeast of the Central Septum, garnet-two pyroxene ribbon mylonites are developed from Reeve diatexite, anorthosite and mafic rocks of the Bohica complex and from the Chipman batholith. A narrow belt, less than a kilometre thick, of garnet-hornblende ribbon mylonites is developed along the eastern margin of the Mylonite Zone in rocks of the Chipman batholith and the northern part of the Fehr granite. These pass eastward into a very narrow zone, about 100 m thick, of biotite-chlorite mylonites derived

from metapelitic rocks and the western margin of the Bompas granite.

Within the upper deck, the strike of the foliation in the penetratively developed orthopyroxene-plagioclase, garnet-orthopyroxene and sillimanite-orthopyroxene ribbon mylonites is concordant with respect to the deck margin, whereas the extension lineation is everywhere oriented northwest-southeast. Although the base of the lower deck coincides with a lithological boundary in the east, in the west it lies within the Pine Channel diatexite (Figure 3). The boundary is everywhere the convex limit of penetrative, completely transposed ribbon mylonites. Within the adjacent lower deck, the Pine Channel diatexite is a ribbon mylonite with abundant cross-cutting and open to tight folded granite veins. At the boundary of the upper deck, the granite sheets are totally transposed and the ribbon fabric becomes even more extremely attenuated.

4. Acknowledgments

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5. References

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