Tectonic History of the Southwestern Margin of the Rae Province in Northwestern Saskatchewan

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Summary
The southwestern Rae margin in northwestern Saskatchewan includes 3.01-2.94 Ga and 2.62-2.58 Ga granitoids typical of the Rae Province. The Arrowsmith Orogen produced 2.37 Ga metamorphism and 2.33-2.30 Ga post-collisional granitoid rocks. Initial deposition of the Murmac Bay group at about 2.33 Ga was derived from an unknown Paleo- to Mesoarchean source; higher stratigraphic levels record diverse locally exposed rocks and a 2.2-2.0 Ga suite possibly exposed to the west. Multiple terrane accretions during the Taltson Orogen produced a 1.94-1.92 Ga southeast-striking regional foliation, which was overprinted by a 1.91-1.90 Ga northeast-striking fabric associated with tectonism along the Snowbird Tectonic Zone. Circa 1.84-1.83 Ga terrane accretion farther west and terminal collision in the Trans-Hudson Orogen resulted in widespread faulting, deposition of the Martin Group, and the historic Beaverlodge uranium and gold deposits.

Abstract
Integration of data from the southwestern margin of the Rae Province in Saskatchewan and the Taltson Magmatic Zone to the west is shedding more light on the region's tectonic history. The oldest rocks include 3.01-2.94 Ga granitoids (Hartlaub et al., 2004; Ashton et al., 2009) south of Uranium City and 3.2-3.1 Ga granitoid gneisses in the basement complex to the Taltson Magmatic Suite (McNicoll et al., 2000), which may link under the Athabasca Basin (Fig. 1). Much of the remaining area in northwestern Saskatchewan is underlain by 2.62-2.58 Ga and rare 2.71 Ga granitoid basement, which may not be represented in the Taltson Magmatic Zone but is characteristic of the Rae Province elsewhere (e.g. LeCheminant and Roddick, 1991).

In the northern Rae Province, ca. 2.50-2.46 Ga granitoid rocks emplaced the Queen Maud Block were attributed to rifting by Schultz et al. (2007). Based on subsequent widespread 2.39-2.34 Ga metamorphism (Fig.1; Berman et al., 2005; Schultz et al., 2007), the granitoids were alternatively interpreted as a continental arc by Berman et al. (2007) and the metamorphism attributed to the Arrowsmith Orogen involving terrane accretion on the western flank of the Rae Province (Berman et al., 2005). Early 2.5-2.4 Ga granitoids have not been recognized in northwestern Saskatchewan, but 2.45-2.38 Ga felsic to intermediate plutonic rocks are exposed in the eastern Taltson Magmatic Zone (van Breemen et al., 1987; Bostock and Loveridge, 1988; McNicoll et al., 2000). Late 2.33-2.29 Ga post-collisional granites are emplaced in the Archean granitoids at Uranium City (Hartlaub et al., 2007), and occur as a component of strongly magnetic felsic to intermediate orthogneiss west of Uranium City (Ashton et al., 2007a) and along strike in the easternmost Taltson Magmatic Zone (Bostock et al., 1991; van Breemen and Bostock, 1994; McNicoll et al., 2000). In Saskatchewan, Arrowsmith metamorphism is recorded

Figure 1

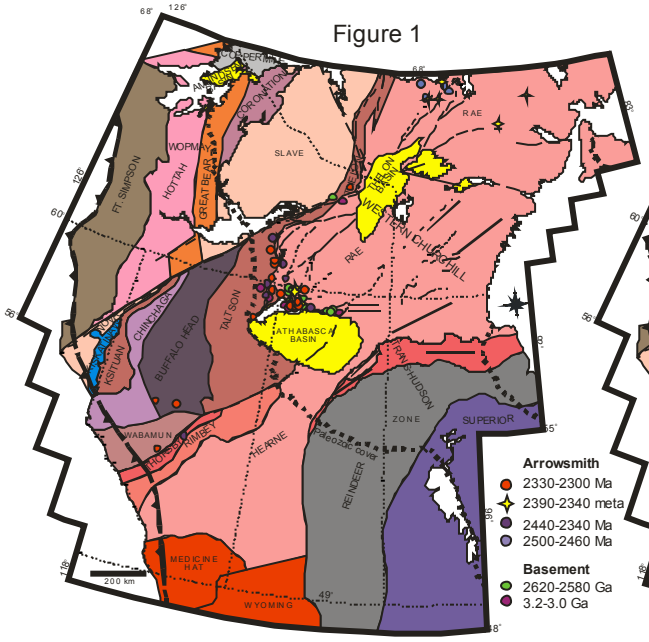
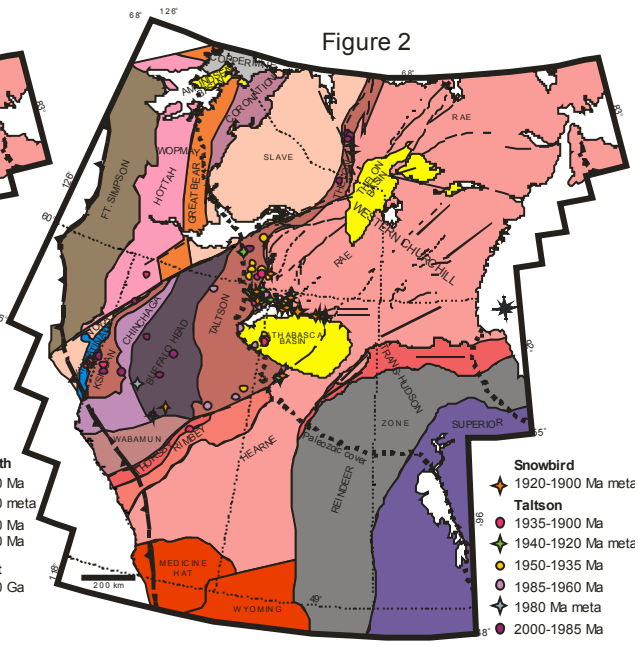


Figure 2



by 2.37 Ga zircon overgrowths (Ashton et al., 2009) and by hornblende and biotite K/Ar ages (Koster and Baadsgaard, 1970) from west of Uranium City, suggesting that the terrane accreted to the western Rae margin in the north may well extend southwards.

Initial deposition of the Murmac Bay group may have overlapped emplacement of the 2.33-2.29 Ga post-collisional granitic suite. Rare basal conglomerate is dominated by 2.33 Ga quartz-feldspar porphyry clasts, consistent with erosion of a proximal felsic volcanic centre. A sample of the far more extensive basal quartzite, however, yielded only 3.95-3.41 Ga detrital zircon, whereas a stratigraphically overlying psammitic gneiss contained zircon in the 3.80-2.33 Ga range. Although the source of the pre-3.2 Ga detritus is unknown, ancient crust is known from the western margin of the Rae Province (e.g. Thériault, 1992; McNicoll et al., 2000) making it the most likely candidate. If the 3.01-2.94 Ga basement granites to the Murmac Bay group at Uranium City represent an extension of this Paleo- to Mesoarchean crust, the detrital zircon record preserved within the quartzite and psammitic gneiss could represent its gradual erosion and exhumation. The absence of 2.5-2.38 Ga detritus in these lower stratigraphic units suggests that initial deposition of the Murmac Bay group did not result from erosion of the Arrowsmith Orogen, but rather was more likely a result of rifting. A pelitic rock inferred to represent the highest stratigraphic level analyzed from the Murmac Bay Group yielded detrital zircon ages reflecting the exposed basement rocks at 3.0, 2.7, 2.6, and 2.32 Ga, although 2.5-2.4 Ga detritus also indicates an input from the early Arrowsmith rocks. The largest and youngest mode, however, is at 2.17 Ga, which is within a 2.2-2.0 Ga range of detritus that is also represented in psammopelitic gneiss 65 km east of Uranium City (Ashton et al., 2007b), metapsammite from 225 km further northeast at Snowbird Lake (Martel et al., 2008), and paragneiss of the Rutledge River Basin, the latter of which also underwent high-grade metamorphism at 2.09-2.04 Ga (Bostock and van Breemen, 1994). Potential sources for this detritus include 2.14 Ga granitic rocks in the eastern Taltson Magmatic Zone (McNicoll et al., 2000) and 2.19-2.16 and 2.09-2.01 Ga granitoids in the southwestern Buffalo Head, Chinchaga, and Ksituan domains (Villeneuve et al., 1993). It is unclear whether this 2.2-2.0 Ga event represents terrane accretion or episodic rifting of the southwestern Rae margin.

The exposed Taltson Magmatic Zone (Fig. 2) can be divided into four zones from west to east that are characterized by distinct rock suites: 1) 2.01-1.98 Ga granitic to granodioritic rocks possibly representing an early continental arc, 2) 1.95-1.92 Ga mainly S-type granites, 3) a basement complex including 3.2-3.1, 2.56, and 2.44-2.27 Ga components, and 4) 1.98-1.96 Ga quartz dioritic to granitic rocks (e.g. Bostock et al., 1987; Villeneuve et al., 1993; McDonough et al., 2000; McNicholl et al., 2000) possibly representing a younger arc built on Rae crust. Circa 1.94-1.92 Ga metamorphism in the Taltson Magmatic Zone (McDonough et al., 2000) can be traced eastward into the Rae Province at least as far as the Black Bay Fault, beyond which it is overprinted by a younger metamorphic event. The Thluicho Lake group, a greenschist-facies conglomerate-arkose-argillite succession deposited in an intermontane basin (Hunter, 2007) between 1.92 and 1.82 Ga (Ashton et al., 2009), is probably correlative with the Nonacho group (van Breemen and Aspler, 1994). The earliest regional fabric affecting rocks as young as the Thluicho Lake group in northwestern Saskatchewan strikes southeastward. It is thought to be synchronous with the 1.94-1.92 Ga metamorphic culmination associated with Taltson orogenesis, suggesting that terrane accretion was from the southwest. Westward warping of this fabric into the present north-northeastward trend generally associated with the Taltson Magmatic Zone is attributed to subsequent terrane accretion to the west (e.g. Slave, Hottah).

Farther east in the southern Rae Province, a variably overprinting northeast-striking regional fabric is most intense in the vicinity of major structural discontinuities including the Black Bay Fault, Grease River Shear Zone, and Snowbird Tectonic Zone (Fig. 2). This fabric is attributed to deformation associated with 1.91-1.90 Ga high-T, high-P metamorphism that affects rocks in the hanging wall of the northwest-dipping Snowbird Tectonic Zone (e.g. Baldwin et al., 2003). Debate continues as to whether the Saskatchewan segment of this discontinuity represents a suture (e.g. Walcott and Boyd, 1971; Hoffman, 1988) stitching the Rae and Hearne provinces or an intra-cratonic fault (e.g. Hanmer et al., 1995; Mahan and Williams, 2005).

Younger open north-trending folds and brittle-ductile to brittle faulting is jointly attributed to post-1.84 Ga accretion of the Fort Simpson-Nahanni Terrane to the west and ca. 1.83 Ga terminal collision in the Trans-Hudson Orogen to the east (Fig. 2; Ashton et al., 2009). The Beaverlodge vein-type uranium deposits, lode gold deposits of the Uranium City area, and Cu-Ag-Pb occurrences spatially associated with the Thluicho Lake group were likely formed at about this time.

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