Paleoproterozoic Evolution of the Snowbird Tectonic Zone - Fact or Fiction? - Another Perspective

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ABSTRACT

Ross et al. have synthesized several large and significant geophysical and petrological data sets, combining them with seismic reflection profiles (LITHOPROBE), to present an elegant geological model of the Paleoproterozoic structure of the buried Precambrian basement in Alberta. However, they propose tectonic boundary conditions to account for the geological model which are not supported by current knowledge. The proposed boundary conditions are required to permit southeast directed subduction at the leading edge of a Hearne continent along the covered southwest segment of the Snowbird Tectonic Zone (STZ), without involving its exposed Archean segment to the northeast. They are predicated on: 1) interpretation of potential field patterns in terms of an apparent truncation of the ca. 2.0 to 1.9 Ga Taltson magmatic zone by the STZ, despite the absence of an equivalent signature on the other side of the 'fault'; 2) a ca. 1.85 to 1.78 Ma magmatic belt, interpreted as a continental magmatic arc on the basis of its potential field signature (Rimbey High), despite geochemical evidence to the contrary; and 3) southeastward dips of fundamental structures, despite the well-established relationship between dip-slip displacement vectors in oblique collisional settings.

In order to generate the Rimbey 'arc' above a southeast-dipping subduction zone during closure of a basin floored by thin continental to oceanic crust and suturing along the STZ, Ross et al. propose two possible scenarios. In the first, the opening of the basin is related to strike-slip displacements along north-south oriented strike-slip faults within the Taltson magmatic zone, analogous to recent basins related to major Himalayan faults, such as the South China Sea (Red River Fault) and the Andaman Sea (Sagaing Transform). However, this model requires the existence of a north-south-trending, crustal-scale, dextral fault, of appropriate age (pre-1.85 Ga). The basin must be large enough to sustain southeastward subduction and generation of the Rimbey magmas for a period of at least ca. 70 Ma (1.85 to 1.78 Ga). Accordingly, the fault displacements must be correspondingly important. To close the basin, similar magnitude sinistral displacements are required, perhaps along the same fault, during the period 1.85 to 1.78 Ga. However, 1) the faults within the Taltson magmatic zone form an anastomosing system of discontinuous segments, with both dextral and sinistral elements, for which no through-going master fault is known; 2) dextral shearing post-dates sinistral shearing, the converse of the Ross et al. model; and 3) the shear zones are contemporaneous with plutonism (ca. 2.0 to 1.90 Ga) and too old to have accommodated closure of the proposed basin. Although younger greenschist facies shear zones are known, they too show either dextral or sinistral displacements, and the largest of them clearly curves toward the STZ trend at the latitude of Lake Athabasca, well to the north of the STZ. In the second model, Rae and Hearne crusts separate and converge by a swiveling motion about a hinge point. However, during basin opening, the 'scissors' action of opening southwest of the hinge would be balanced by convergence and compression to the northeast. Even assuming that such a mechanism were capable of producing a basin of the size predicted by the Ross et al. model, the action should result in a pre-1.85 Ga northeast-trending fold belt (no decoupling), or thrust belt (decoupling) northeast of the hinge point. Conversely, basin closure by the same mechanism should result in a 1.85 to 1.78 Ga rift (no decoupling), or major detachment fault (decoupling). Until such major convergent and divergent structures are demonstrated, there is a more appealing explanation for the Ross et al. data.

The geometry of the Archean/Paleoproterozoic boundary in the western Canadian Shield represents a jagged continental margin, composed of a pair of re-entrants defined by rifted and transform segments, inherited from Paleoproterozoic break-up and controlled by the Archean structure of the interior of the western Churchill continent. The southwest segment of the STZ is one of the transform segments. The geometry of this jagged margin strongly influenced Paleoproterozoic tectonics and magmatism during eastward subduction at the edge of the western Canadian Shield and its accreted Proterozoic terranes.