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

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ABSTRACT

The Snowbird Tectonic Zone (STZ) is one of the most profound geophysical anomalies of the Canadian Shield (traceable from Hudson Bay to the Cordilleran Foothills), yet its age and tectonic significance remain controversial. At the crux of this controversy is the apparent paradox provided by Archean ages of deformation within STZ mylonites from the exposed Canadian Shield that contrast with evidence for significant Paleoproterozoic tectonic activity along the subsurface extension of the STZ in Alberta. In 1992, LITHOPROBE collected more than 500 km of crustal-scale seismic reflection data along a transect in central Alberta, extending from the Archean Hearne Craton into Proterozoic crust west of the Rae Province. The Hearne segment of the transect is essentially within the western hinterland to the Trans-Hudson Orogen and, like the exposed correlatives of northern Saskatchewan (Cree Lake and Mudjatik domains), is composed of Archean crust with evidence for a strong tectonic and thermal overprint in the Paleoproterozoic (ca. 1.8 Ga). The transect also crosses the Thorsby Low, a major aeromagnetic low that corresponds with the subsurface trace of the STZ. To the immediate southeast of the Thorsby Low are a belt of biotite leucogranites (Rimbey granites) that crystallized at 1.78 to 1.85 Ga and are interpreted as magmatic rocks in the hanging wall (Hearne Province) of a southeast-dipping subduction zone. In this scenario, the STZ (Thorsby Low) is a suture zone that formed during the closure of a marginal basin that separated the Hearne Province from Proterozoic crust of northern Alberta.

The seismic transect reveals prominent dipping reflections throughout the entire thickness of the crust (35 to 45 km) that appear to sole into a reflective lower crust, the base of which is interpreted to be reflection Moho. The reflection geometry within the crust is suggestive of compressional deformation, and delineates two regions of crustal-scale thrust imbrication with opposing dip of reflection fabrics. The eastern region is within the Hearne Province and shows evidence for a west-northwest verging thrust belt. Geochronology of basement rocks sampled in exploratory petroleum wells indicates that the crust in this region is largely Archean in age but records a strong overprint of Paleoproterozoic age (1.78 to 1.81 Ga), similar to the Hearne in the exposed Shield to the northeast. The western region of the seismic transect is characterized by northwest-dipping reflection fabrics; the dip reversal occurs beneath ca. 1.78 to 1.85 Ga granitic rocks of the Rimbey belt, although the relative age of the reflection fabrics is unresolved at present. The STZ is delineated by a steep northwest-dipping, crust-penetrating shear zone that offsets the Moho and truncates dipping basement reflection fabrics of inferred Paleoproterozoic age. The STZ is thus interpreted to have accommodated shortening during late stages of Rae-Hearne collision, coeval with convergence between the Superior and Rae provinces during 1.75 to 1.85 Ga.

In the subsurface, the Paleoproterozoic age of the STZ is inferred on the basis of: truncation of ca. 1.94 fabrics of the Taltson Magmatic Zone along the trace of the STZ, the Paleoproterozoic age of compressional fabrics in the crust and their truncation against the trace of the STZ, and the Paleoproterozoic age of the Rimbey granites. The inferred age of the STZ in the subsurface is at odds with data that suggest an exclusively Archean age for this structure in the exposed Shield. This apparent contradiction can be resolved if: 1) the Thorsby marginal basin was generated during counterclockwise rotation of the Hearne during easterly-dipping subduction in the Trans-Hudson (ca. 1.96 to 1.86 Ga) and then 2) the Paleoproterozoic convergence is partitioned between oblique-slip faults in the Taltson Magmatic Zone and thrust imbrication observed in the Hearne Province. This would effectively allow the exposed STZ to remain quiescent during Paleoproterozoic assembly of the Shield. However, as the age (1.75 to 1.85 Ga) and regional extent of reactivation of the exposed western Hearne Province becomes recognized, it becomes difficult to avoid including the western STZ in the Paleoproterozoic tectonic evolution of the Shield.