Geophysical Research Abstracts
Vol. 19, EGU2017-1590-1, 2017
EGU General Assembly 2017

Prolonged episodic Paleoproterozoic metamorphism in the Thelon Tectonic Zone, Canada: an in-situ SHRIMP/EPMA monazite geochronology study

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The Thelon Tectonic zone (TTZ), Nunavut, Canada, is a >500km long geophysically, lithologically and structurally distinct N-NNE striking Paleoproterozoic boundary zone between the Slave and Rae Archean provinces. The TTZ has been interpreted as a ca. 2.0 Ga continental arc on the western edge of the Rae craton, that was deformed during collision with the Slave craton ca. 1.97 Ga. Alternatively, the Slave-Rae collision is interpreted as occurring during the 2.35 Ga Arrowsmith orogeny while the ∼1.9-2.0 Ga TTZ represents an intra-continental orogenic belt formed in previously thinned continental crust, postdating the Slave-Rae collision.

The central part of the TTZ comprises three >100 km long, ∼10-20 km wide belts of ca. 2.0 Ga, mainly charnockitic plutonic rocks, and a ca. 1910 Ma garnet-leucogranite belt. Metamorphism throughout these domains is upper-amphibolite to granulite-facies, with metasedimentary rocks occurring as volumetrically minor enclaves and strands of migmatites. The Ellice River domain occurs between the western and central plutonic belts. It contains ca. 1950 Ma ultramafic to dacitic volcanic rocks and foliated Paleoproterozoic psammitic metasedimentary rocks at relatively lower grade with lower to middle amphibolite-facies metamorphic assemblages.

In-situ U-Pb analyses of monazite using a combination of Sensitive High-Resolution Ion Microprobe (SHRIMP) and Electron Probe Microanalyzer (EPMA) were carried out on high-grade metasedimentary rocks from seventeen samples representing the eastern margin of the Slave Province and all major lithological domains of the TTZ. 207Pb/206Pb monazite ages from SHRIMP analysis form the foundation of this dataset, while EPMA ages are supplementary. The smaller <6μm spot size of EPMA allowed for further constraint on ages of micro-scale intra-crystalline domains in some samples.

Monazite ages define four distinct Paleoproterozoic metamorphic events and one Archean metamorphic event at ca. 2580 Ma. The latter is recorded exclusively along the eastern margin of the Slave Province. Metamorphism ca. 1996 Ma, recorded in one high-grade gneiss from the central plutonic belt appears to reflect a regional contact metamorphism associated with intrusion of 2000 Ma plutons. Throughout the TTZ, a selection of monazite grains included in garnet porphyroblasts define a metamorphic event ca. 1962 Ma. One sample from the eastern margin of the Slave Province similarly records metamorphism at 1961 Ma in monazite grains in the matrix. This sample interestingly does not record the ca. 2580 Ma metamorphism typical of the Slave Province. The longest lived and most wide spread metamorphic event in the TTZ occurred ca. 1922 to 1883 Ma. This event is interpreted as the main compressional/collisional and anatectic event, with partial melting forming the extensive ca. 1910 Ma garnet-leucogranite belts. Three samples, located in the eastern margin of the Slave province, the Ellice River domain and the eastern plutonic belt, record younger metamorphism at ca. 1814 Ma. These events may represent post-collisional transpression coeval with movement along nearby regional-scale faults.