geoconvention
Virtual Event
September 21-23
2020
CSPG · CSEG · CWLS · GAC · MAC · IAH

Deciphering the timescales and mode of Archean orogenesis in the Pikwitonei Granulite Domain using multi-mineral petrochronology

Besim Dragovic
University of South Carolina

Victor E. Guevara
Amherst College

Mark J. Caddick
Virginia Tech

Chris G. Couëslan
Manitoba Geological Survey

Summary

Many of Earth's Archean cratons record a phase of high- to ultra-high temperature (HT/UHT) metamorphism, which may ultimately be required to produce the dense, strong, relatively anhydrous rocks that comprise much of Earth's stable cratonic crust. HT/UHT metamorphic rocks can record the dynamic processes that drive the necessary crustal heat fluxes and resultant departures from normal crustal geothermal gradients that lead to significant degrees of melt generation and craton stabilization. Understanding the pressure-temperature-time (P-T-t) evolution of Archean HT/UHT metamorphism is critical to deciphering styles of Archean tectonism. However, the timescales over which HT/UHT conditions persisted in the Archean have been challenging to quantify, due the antiquity of such rocks and the extreme thermal conditions of HT/UHT metamorphism.

We present the results of U-Pb zircon and monazite, Sm-Nd and Lu-Hf garnet geochronology, and geospeedometry, coupled with an estimated P-T evolution, to elucidate the rates and conditions of HT/UHT metamorphism in the Archean Pikwitonei Granulite Domain (PGD), a large (> 15,000 km^2) granulite-facies metamorphic terrane situated along the northwestern margin of the Superior Province.

The PGD forms part of the Hudson Bay Terrane, which is thought to have collided with the North Caribou Terrane (to its south) at ~2720 Ma via subduction-accretion-style processes. Peak temperatures in the region range from ~750ºC in the southernmost part of the PGD, to ~1000˚C in the central/western PGD (~40-60 km apart). Previous studies have suggested that HT conditions were maintained for over 100 Ma in the region, from ~2.71-2.60 Ga. In the west-central PGD, in-situ monazite and zircon dating (using laser ablation split stream inductively coupled mass spectrometry (LASS), high precision ID-TIMS analyses on microsampled fragments, coupled with mineral trace element chemistries, show UHT peak metamorphic conditions occurring after ~2673 Ma, followed by near-solidus residence and zircon growth for

at least ~24 Ma. In samples from the southern part of the PGD, HT metamorphic conditions persisted to ~2600 Ma, revealed by combined zoned Lu-Hf and Sm-Nd garnet geochronology of a ~7 cm garnet. Finally, major element zonation is preserved in many garnets throughout these localities, implying that heating to UHT conditions may represent short-lived thermal excursions superimposed on ambient HT conditions.

By integrating these petrochronological techniques to decipher *P-T* conditions and timescales, on samples from across the PGD, we seek to provide insight into the possible drivers for HT/UHT metamorphism, partial melting, and stabilization of cratons in the Archean.