Comparison of Archean tectonic modes through petrochronology

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High-temperature (HT) to ultra-high-temperature (UHT) metamorphic rocks can record the dynamic processes that drive crustal heat fluxes and result in a departure from normal crustal geothermal gradients. In the Archean, HT processes led to particularly significant melt generation and cratonic stabilization. Understanding the pressure-temperature (*P-T*) evolution of Archean HT metamorphism, and in particular its durations and rate, is thus important: indeed, it may reflect our clearest window into possible styles of Archean tectonism. Here, we describe and compare results of U-Pb, Sm-Nd and diffusion-based chronology techniques, coupled with estimated metamorphic *P-T* evolution of two Neoarchean terranes in order to begin to characterize the diversity of tectonic style at a crucial period of Earth history.

The Beartooth Mountains (BM) expose Archean rocks of the Wyoming Craton that are dominated by an ~2.8 Ga calc-alkaline granitoid batholith that contains widespread, up to km-scale metasedimentary roof pendants, studied here. In contrast, the Pikwitonei Granulite Domain (PGD) consists of >15,000 km^2 of high-grade metamorphic rocks situated in the NW Superior Province. Both terrains are interpreted as reflecting cratonic margins undergoing metamorphism and magmatism at approximately the same time (~2.7 Ga). *P-T* paths from each domain appear to record clockwise evolution, reaching temperatures of ~800 and 950 °C, respectively, at ~5–8 kbar. However, metamorphic timescales from the BM are brief (< 2 Myrs within 50 °C of peak temperature), while substantial evidence suggests maintainance of HT conditions in the PGD for up to 100 Myrs. Evidence for UHT metamorphism in the PGD is numerous and suggests that these conditions were repeatedly attained for substantially briefer periods and over far shorter lengthscales than the overall regional-scale HT evolution.

Through interpretation of the depths, temperatures, and most importantly, timescales inferred from this study, we examine the possible drivers for HT/UHT metamorphism, partial melting, and stabilization of cratons in the Archean.