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Continental Emergence as a Driver of Cratonization

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Archean cratons, large blocks of >2.5 billion-year-old crust underlain by thick lithosphere, are some of the most stable and enduring parts of the continental crust. Indeed, many have remained un-modified since the Neoarchean time period, 2.8-2.5 Ga. The last crustal tectonothermal event to occur on most cratons is represented by widespread intrusion of a suite of granitoid rocks, including peraluminous and metaluminous suites. In many locations, these Late Archean granitoids intruded coeval with high-temperature metamorphism. The Late Archean granites represent a distinctly different rock type than had been produced in such regions prior to the Neoarchean. Granitoid rocks that pre-date NeoArchean granites are often sodic tonalite-trodhjemite-granidiorite suite rocks that were formed by partial melting of basaltic compositions. Thus, the rise of Neoarchean granites have been used to argue for a tectonic transition in Earth's geodynamic operation around this time. Other models for the formation of cratonic blocks include lateral collision of pre-existing continental nuclei, underthrusting of oceanic lithosphere, and the impingement of mantle plumes. One important aspect of continental stabilization is the distribution of heat producing elements (U, Th, K) within a given crustal column, which thus far has been evaluated only with modern crustal compositions projected back in time.

In this presentation we aggregate geologic data from several well-studied cratons, including the measured HPE concentrations from rock types common to Archean cratons. We use these observations to set up geologically accurate thermal models for the evolution of Neo-Mesoarchean crustal blocks. Our results show that Archean sediments are a key factor in the stabilization of ancient crustal blocks, as the Archean TTG suite of rocks have relatively low HPE concentrations. Thus, the emergence of continental crust above sea level, and the corresponding production of sediments, created an intense thermal engine that was capable of significantly differentiating the crustal column – a column that would have been more difficult to differentiate on a planet without sedimentary rocks present. The emergence of continents may have been an instrumental ingredient to the process by which the continental crust achieved final differentiation and stabilization.