Novel stable isotopes as tracers of Archaean plate tectonics

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Constraining the onset of convergent plate tectonics (subduction) is one of the most fundamental debates about the Earth's history. Plate tectonics is the major mechanism controlling the interface between the modern Earth's surface and interior and has moderated the compositional evolution and rate of formation of the continental crust.

The majority of Archaean continental crust is comprised of tonalite-trondhjemite-granodiorite (TTG) suite rocks, which were derived from partial melting of hydrous garnet- and amphibole-bearing metabasaltic crust. However, whether this occurs in subduction zones [1] or overthickened eclogitic crust [2] is unknown.

One of the key arguments for the existence of Archaean subduction is provided by the similarity in "arc" signature (i.e. decoupling of large-ion lithophile elements and high-field strength elements) between modern subduction-related rocks and ancient TTG series [3]. In particular the "high-pressure TTG" group [4, 5] requires melting of hydrous mafic rocks that were buried into the mantle to depths >50 km, which is compellingly similar to subduction [3].

Common geochemical proxies such as trace elements and long-lived isotope systems provide important, but often ambigious tracers of mantle-crust interaction. More recently, non-traditional stable isotopes have increasingly been exploited for their potential to fingerprint geological processes. For example, the thallium and molybdenum stable isotope systems have been successfully employed to identify distinct components in subduction zone settings [6, 7]. Here we will present the application of novel stable isotope systems to various Archaean TTG rock suits in order to evaluate if their isotopic signature is consistent with subduction models or rather indicates different modes of geodynamics operating on the early Earth.

[1] Foley *et al*. (2002) *Nature* **417**, 637-640. [2] Rapp *et al*. (2003) *Nature* **425**, 605-609. [3] Moyen & Martin (2012) *Lithos* **148**, 312-336. [4] Halla *et al*. (2009) *Precamb Res* **174**, 155-162. [5] Moyen (2011) *Lithos* **123**, 21-36. [6] Nielsen *et al*. (2017) *Rev Mineral Geochem* **82**, 759-798. [7] Freymuth *et al*. (2016) *Geology* **44**, 987-990.