Building Eoarchean crust: the arc tholeiite – TTG connection

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A pertinent issue in Archean research is the genetic relation between the TTG suite and the associated mafic supercrustals. Here we present a coherent model for the geodynamic evolution of the oldest (3.65 to 3.85 Ga) continental crust in southern West Greenland. Within the Isua Supracrustals, tholeiitic and boninite-like metabasalts dominate the sequence, both displaying trace element patterns consistent with a subduction-related origin. This is well demonstrated by correlated trace element variations in Nb/Th, La/Yb, Gd/Yb, Zr/Nb in Isua tholeiites [1]. Boninite-like rocks in Isua are derived from ultradepleted sources with εHf(3720) of up to ca. +12.9 [2], providing for the first time Hf-isotope evidence from the mafic rock record for the preservation of depleted Hadean mantle domains.

Petrological phase equilibria and trace element modeling suggest a close relationship between Isua arc tholeiites and the TTGs [3,4]. Notably, Hf-Nd isotope signatures between the two lithologies overlap in both showing the characteristic decoupling of initial Hf-Nd isotope compositions. Systematically elevated ^{142}Nd anomalies of tholeiites and TTGs [5] are also in agreement with a related origin. The decoupled Hf-Nd signature is likely an inherited feature from melting of the tholeiites. This is also underlined by new Hf and O in zircon data from Eoarchean TTGs [6] that indicate melting of a thickened mafic crust to form the TTGs. We therefore propose an arc-arc collisional setting, where the TTGs formed by polybaric melting of arc tholeiites at 10-20% of partial melting.

The cause for the decoupling of the Hf and Nd isotope systems is most likely a subduction-related mantle source overprint. Cumulate segregation processes in an early magma ocean or an early metamorphic overprint during intrusion of the TTGs might be alternative scenarios, but they cannot account for all trace element characteristics found in mafic rocks from the Isua region [1].

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Holocene intermediate water circulation at the Carolina Slope from sedimentary ^{231}Pa/^{230}Th

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Meridional overturning circulation (MOC) may play a crucial role in global climate change both at Milankovich and abrupt timescales, making it an important target for paleoceanographic study. Measured ratios of ^{231}Pa/^{230}Th in sediment cores are sensitive to deep and intermediate water residence times, and may provide a dynamical tracer of past MOC strength in the waters overlying core sites. We will present a new ^{231}Pa/^{230}Th record from core KN140-2-51GGC on the Carolina continental slope at 1790 m. This core has an expanded Holocene section [1], allowing for detailed examination of circulation during the 8.2 ka event, resumption of Labrador Sea Water Production, mid-Holocene climate optimum, and cooler late Holocene.

Previous records of Holocene ^{231}Pa/^{230}Th at intermediate depths show no net ^{231}Pa transport [2] (sedimentary ratios at the seawater production ratio of 0.093) or a transition from low ratios in the erly Holocene to production-ratio levels in the mid-to-late Holocene [3]. Sedimentary ratios similar to the production ratio may suggest sluggish MOC in intermediate water in the eastern and central Atlantic. Our results indicate that sedimentary ratios at the Carolina slope remained below the ^{231}Pa/^{230}Th production ratio in seawater throughout the Holocene. These ratios, falling between 0.08 and 0.07 in the earliest Holocene and between 0.07 and 0.06 through the remainder of the Holocene, indicate export of ^{231}Pa, possibly through vigorous ventilation at intermediate depths. This discrepancy between our record and published sites may point to influence of Labrador Sea Water, or the influence of the deep western boundary current along the North American continental slope, at our site. Sediment composition analyses, particularly biogenic opal content, will allow for better constraints on the influence of particle type on ^{231}Pa scavenging at this site. ^{231}Pa/^{230}Th results will be compared to predictions from advection/scavenging models to assess the role of MOC vs. water column ingrowth/scavenging in determining sedimentary ratios. This new record will enable improved comparison between intermediate and deep sites, enhanced understanding of existing water mass boundary records through the addition of a dynamical tracer of ventilation strength, and cross-basinal comparison of ventilation at intermediate depths.

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