300 m.y. of komatiite evolution in the Barberton Greenstone Belt

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Ultramafic magmas erupted through the 300 m.y. history of the Barberton greenstone belt in South Africa, the type locality of komatiite. Despite 30 years of investigation, there are very few complete geochemical analyses of these rocks. We analyzed major and trace elements of samples from four stratigraphic formations that span the complete history of the belt. The oldest well preserved komatiites are in 3.5 Ga Komati Fm. Most of these have sub-chondritic Al/Ti and depleted HREE; they are thought to have formed during deep (>300km) partial melting in a hot mantle plume. Less abundant are komatiites with chondritic Al/Ti and undepleted HREE, which formed during shallower melting. Most komatiites in the Komati Formation are non-vesicular and show no evidence of having erupted as hydrous lavas, but some uncommon examples, which contain large amygdales and are coarse-grained, may have contained some water. 3.48 Ga Hooggenoeg Fm komatiites have chondritic Al/Ti and undepleted HREE. 3.3 Ga Weltevreden komatiites have slightly super-chondritic Al/Ti and positively sloping REE profiles, characteristics consistent with shallower melting of a source that either was enriched in garnet or had previously undergone extensive partial melting. Some Weltevreden komatiites contain olivine with the composition Fo96. The liquid composition inferred using this composition and whole-rock compositions contains 33% MgO. If anhydrous this magma erupted at about 1660° C making it the hottest magma on earth. Two types of komatiites occur in the 3.3 Ga Mendon Fm. The first has Al/Ti and HREE similar to most komatiites from the Komati Formation; the second has very high Al/Ti which may indicate a garnet enriched source.

The diversity of komatiite compositions implies that there were major variations in the temperature and perhaps composition of the source and the melting mechanism through the 300 m.y. history of the Barberton belt.

Measurement of ^{232}Th, ^{230}Th and ^{231}Pa in modern and fossil deep-sea corals

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Deep-sea corals are abundant in the ocean and their aragonite skeletons have the potential to form dateable, high-resolution records of past ocean processes. In this study we make precise analyses of U, Th and Pa isotopes in the skeletons of both modern and fossil deep-sea corals using multiple-ion-counting ICP-MS. Neither Th nor Pa are expected to reside in the crystal lattice of aragonite, nevertheless the concentrations in cleaned modern corals are measurable, with typical values of ^{232}Th 100-2000pg/g, ^{230}Th 40-100 fg/g and ^{231}Pa 1-3 fg/g. Cleaning experiments on fossil deep-sea corals show that ^{232}Th contamination from ferromanganese crusts can be reduced to the levels seen in modern corals. Such incorporation of Th and Pa at formation is potentially problematic for accurate dating, but coupling U-Th and U-Pa analyses offers the potential to improve the chronology, and to reconstruct the initial ^{231}Pa/^{230}Th ratio.

We analyzed four species of modern deep-sea corals (*D. dianthus, F. alabastrum, C. ambrosia, and L. pertusa*) in a global distribution including samples from the North Atlantic, Southern Ocean and Pacific. ^{232}Th/^{230}Th ratios ranged from 210 in the central Pacific where detrital inputs (and hence ^{232}Th inputs) are expected to be low and up to 36,000 in samples from the detrital-rich continental shelf in the Atlantic. In the west Atlantic basin comparison of typical seawater ^{231}Pa/^{230}Th ratios to our seven-point modern-coral depth transect shows that the corals have a ratio that is approximately 40 times lower than seawater. This result is consistent with the observation that falling marine particles (with the marked exception of opal) scavenge Th more efficiently than Pa. The fractionation caused by this difference in scavenging is recorded in marine sediments, and has been used as a proxy for ocean circulation and productivity. Yet sediment composition generally varies through time, complicating the interpretation of the signal. Deep-sea corals may form a new, high-resolution, pure carbonate archive of marine ^{231}Pa/^{230}Th ratios in the past.