Metakomatiites, Dynamical Modeling and the Late Veneer

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During core formation, silicate mantles are stripped of their highly siderophile elements (HSEs) due to strong partitioning behavior into metal. However, the HSEs are present in mantle-derived rocks at concentrations orders of magnitude higher than expected. Analysis of komatiites shows that there is a time-dependent HSE depletion trend in late Archean and early Proterozoic samples [1]. We present data for older (>3.75 Ga) ultramafic schists to (i) show that they are metamorphosed komatiites; (ii) extend the HSE depletion trend into the Eoarchean; and (iii) evaluate models to explain this trend. One hypothesis attributes HSE enhancement to an extraterrestiral source, a late accretion event dubbed the "Late Veneer" (LV) [2]. Assuming a chondritic composition, ~1% of Earth's current mass is required to cause the observed signal. The HSEs are in chondritic relative proportions despite their dissimilar metal-silicate partition coefficients. An LV may not be exclusive to Earth: there is evidence in martian meteorites and lunar samples that these bodies may have experienced their own LVs [3,4], lending credence to an extraterrestrial explanation. Dynamical simulations have shown the presence of planetesimals at the time of the LV to be a plausible reservoir for an LV [5]. To test this possibility, simulations [cf. 6] used four different impact velocities (1.1, 1.2, 1.3, and 1.4 times Earth's v_e), three impact angles (30°, 45° and 60°), and two different impactor masses (1% and 0.1% $M_{\oplus}$). The 1% mass assumption represents a single LV impactor, while 0.1% Earth mass impactors correlate to one of ten impactors with an equivalent total mass. The results have defined the parameter space that would have allowed large impactors to cause the HSE enhancement observed in the mantle.

[1] Maier *et al* (2009) *Nature* **460**, 620-623. [2] Chou (1978) *Proc. Lunar Planet. Sci. Conf.* IX, 219–230. [3] Day *et al* (2010) *Earth Plan. Sci. Lett.* **289**, 595–605. [4] Brandon, A.D. *et al* (2012) *Geochim. Cosmochim. Acta* **76**, 206–23. [5] Bottke *et al* (2010) *Science* **330**, 1527-1530. [6] Canup, R. (2008) *Icarus* **196**, 518–538.

Metamorphic-hydrothermal transition in the alteration of pillow and dike basalts from the Rodriguez Triple Junction

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Alteration processes caused by interactions between seawater and basalt are one of the main effects which modify the geochemical and mineralogical composition of the oceanic crust, alter the mineral assemblages to upper greenschist facies and may form seafloor massive sulfides at mid-ocean ridges.

A series of INDEX cruises explore the intermediate to slow spreading southern Central Indian Ridge. This area is characterized by complex structured rift valleys and isolated active volcanic edifices in the central graben. Active hydrothermal activity is associated with a small satellite volcanic ridge at the eastern rift valley wall (Kairei). Dredges and TV-grabs were used to recover fresh and altered basalt samples in the vicinity of the vent field. This study presents the effects of variable alteration processes, related to (i) high-temperature near-neutral pH seawater and isochemical metamorphic overprinting, and (ii) seawater-derived acidic hydrothermal alteration.

The tholeiitic basalts are represented by sheet flows and pillow basalts with dispersed vesicles up to cm sizes. They can be distinguished into two groups: 1) basalts with an aphyric to porphyritic texture with variable phenocrysts and 2) holocrystalline basalt sample. Both fresh basalt types display a mineral composition of major plagioclase, minor olivine, clinopyroxene, and Cr-spinel. The mineral composition of altered rock samples indicate a range from low temperature basalt seawater alteration up to upper greenschist facies-like temperatures including albite, chlorite, actinolite, epidote(?), sphene while the plagioclase is almost pristine. The seawater altered rocks contain saponite, celadonite, and palagonite within the vitrious groundmass.

Basalts at mid-ocean ridges display a variety of alteration processes which contribute to sustained element fluxes. The Rodriguez triple junction with a variety of rift-related processes is a key region to study the diverse influence of fluid flow along mid-ocean ridges.

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