Thermochemical coupling in deep mantle plumes: A case study of Turkana, N. Kenya

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Subducted oceanic crust forms the likely source for a dense and more fertile layer at the core-mantle boundary. Numerical modeling predicts that entrainment of this dense material by an upwelling thermal plume will result in episodic volcanism occurring at episodic intervals on time scales of several to hundreds of millions of years (Lin & van Keken 2005).

Our study of 40 my of mafic eruptive activity in Turkana, Kenya reveals volcanological and geochemical features that are fully compatible with the numerical models, suggesting that magmatism in this part of the East African Rift System reflects deep entrainment of recycled oceanic crust by a thermally-driven plume. Volcanism at Turkana occurred in three distinct pulses separated by several million years each. No flood basalt province typical of strictly thermal plume head volcanism is associated with any of the pulses. The most voluminous pulse (26-16 Ma) led to rift propagation to both north and south, with fault growth and new rift basin development. Episodic volcanism is also reported from Samburu, Kenya, 200 km to the south (Tatsumi & Kimura 1991) and 100 km to the north in Ethiopia (George *et al.* 1998) in each case subsequent to peak Turkana episodes. These features contrast with observations in Afar, where plume head volcanism occurred 30 Ma and modern basalts are erupted along extensional features in the rift axis.

Mafic lavas from the major episode in Turkana – including abundant picrites – are geochemically distinctive. They have Sr-Nd-Pb-He isotopic signatures characteristic of high-μ ocean island basalts, and olivine Ca, Ni contents indicative of a pyroxenitic source (Sobolev *et al.* 2005, Herzberg 2006). We postulate that entrained fertile pyroxenite has been a source of mafic volcanism at Turkana.

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Impact-generated ultrafine particles of olivine and serpentine suggesting a source of aerogels in the air of the early Earth

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Intense impacts of meteorites on to early oceans have been suggested in the period of Late Heavy Bombardment [1, 2]. The mechanism of oceanic impact is different from that of subaerial impact. The oceanic impacts generate Ultrafine Particles (UPs) [3] and have possibility to generate a large amount of UPs of serpentine. However, few experimental investigations of impact-serpentinization exist. The UPs formation following impact explosion might influence the environment of the early Earth.

We performed shock-recovery experiments using a single-stage propellant gun to simulate simple ocean impact events of meteorites. The samples are powder of olivine with and without water in steel sample container. The products were analyzed with XRD, SEM and TEM.

SEM observation shows the formations of UPs of metal oxides. In addition, TEM observation shows the formation of UPs of olivine with different compositions from the starting one, serpentine and brucite. The grains of such UPs were some hundreds of nanometres in size.

Formation of UPs was unexpected from our impact experiments because the experimental conditions were far below the theoretical vaporization and/or melting conditions of starting materials. Here we propose that the presence of water significantly promoted the conversion of samples into UPs. The UPs formation by oceanic impacts may influence the change of Earth's environment such as generating aerosol and shielding sunlight.

References

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