Chemical evolution of olivine-hosted melt inclusions in MORB

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We have now determined experimentally mineral-melt partition coefficients (Ds) for 20 trace elements along the solidus of fertile and depleted lherzolites in the pressure range 3.0 to 1.5 GPa. These data allow us to model accurately the evolution of melts and solid residues during decompression melting beneath mid-ocean ridges. With increasing pressure cpx-melt Ds decrease by a factor 5-8 for HFSE and REE, and ~2 for Sr, but increase for Na and Li. This leads to several characteristic features of melt and residue evolution.

First, most MORB glasses have compositions that match ≤15% batch melts generated at depths just above the spinel-garnet transition. The constant fractionation of Zr from Hf for cpx-melt under *all* conditions ($D_{Zr}/D_{Hf} = 0.52\pm0.03$) and the near-chondritic Zr/Hf in MORB places tight constraints on the melt fraction. The high apparent depth of extraction reflects the fact that the majority of the incompatible trace elements in aggregated polybaric melts are supplied at the base of the melting region, where Ds are lowest and the source most fertile.

Second, HFSE and REE variations in olivine-hosted melt inclusions are consistent with them being low-degree melts of lherzolite, progressively depleted by fractional melting with a small threshold porosity. In many respects the melt-inclusion trends complement those seen in residual cpx from abyssal peridotites. The tendency for cpx-melt Ds to increase with decreasing pressure ensures that the source is very effectively stripped of trace elements at depth, especially Zr. Depleted melts from the upper reaches of the melting region will carry marked HFSE depletions (e.g. low Zr/Sm). Significant prior melting in the garnet field cannot generate sufficiently Zr-depleted residues to explain these features.

Finally, incompatible element trends displayed by melt inclusions resemble those expected for the trapped residual porosity in upwelling peridotite. We suggest that melt inclusions form through the peritectic production of olivine during melting in the spinel lherzolite field, which traps interstitial melt. Olivine compositions are subsequently modified by Fe-Mg diffusion in the magma chamber, while HFSE and REE trapped in inclusions are not. This is directly analogous to residual cpx in which the major elements (e.g. Ca) are profoundly modified from their near-solidus values, while the trace elements appear to have survived intact. The fact that olivine is a reactant, rather than product, of the garnet lherzolite melting reaction may explain why few melt inclusions have unequivocal garnet signatures. This method of inclusion formation obviates the problem of keeping disparate, and often highly depleted, melts isolated prior to entrapment.

Contribution of biogeochemistry to the reconstruction of Hominid paleobiology

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Geochemistry of fossil bones have started as early as geochemistry itself, but contributions to hominid paleobiology have really started to be significant since about 20 years. Two conditions have to be fulfilled before geochemical analyses of fossil bones can be interpreted as palaeobiological proxies. The first one is to have a reasonable level of knowledge about the relationships between environmental parameters, such as diet, drinking water, geological background, and the measured geochemical signal. This is achieved through laboratory experiments and measurements on monitored individuals of different species. The second condition is to be able to eliminate potential contaminants enclosed in the fossil bone matrix and to purify a fraction that belongs to the fossil and preserved a biogenic signal, or at least to be able to identify specimens which geochemical signals have been significantly altered by diagenesis. The worst scenario would be to interpret diagenetically altered geochemical signals as reflecting palaeobiological parameters. Since fossil hominid material is scarce, it is necessary to first test the feasability of the planned geochemical analyses on animal bones.

The most spectacular contributions of biogeochemistry to the reconstruction of hominid palaeobiology have used stable isotopes of light elements, especially C and N, as markers of palaeodiets. Carbon isotopic ratios are especially powerful in savanna contexts, where C_4-grasses and C_3-trees, and their respective consumers, are readily identifiable. Since some mammal herbivores have a diet specialized on one or the other kind of plants, it is possible to use their remnants to test for possible diagenetic alteration in the studied site. For specimens older than a few thousand years, only tooth enamel is stable enough to provide reliable isotopic results. This approach has shown that different species of South African Hominids were incorporating food items from savanna ecosystems in their diet, 3 to 1.8 millions years ago. Much younger Neandertals from France and Belgium, 120,000 to 35,000 years old, were shown to have been highly carnivores and eating the flesh of large ungulates from open environments, using collagen C and N isotopic compositions. Attempts have been made to also use trace elements, such as strontium and barium, as palaeodietary markers. However, the behaviour of these elements in modern food web is not perfectly known, and many problems remain with diagenetical alteration for this approach to be determinant in hominid palaeobiology.