Speleothem evidence for coupling between Iberian peninsula hydrology and North Atlantic oceanic and atmospheric modes

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Stable isotopic and trace element compositions of speleothems have emerged as essential proxies of aridity/humidity changes in the terrestrial realm, especially for high frequency changes. We present a suite of speleothem records from three time frames from the Northwest Iberian Peninsula spanning orbital phases of the last 120 ky to climate changes of the past millenium.

Calibration of dripwater trace element chemistry in particular caves has revealed the most robust trace metal suites for hydrological reconstruction; these vary from cave to cave depending on bedrock geology and significance of marine aerosols to Mg budgets. Monitoring of rainwater oxygen isotopic chemistry has revealed significant synoptic controls and correlations with NAO state.

Over the long term record covering 120-60 ka, hydrological balance is strongly modulated by obliquity in this location, probably due to influence of latitudinal temperature gradients on storm tracks.

During the last deglaciation, trace elements indicate pronounced aridity during millennial scale cold events H2 and the Mystery Inverval, periods of reduced Atlantic Meridional Overturning Circulation (MOC).

In the last thousand years, our stalagmite record suggests drier conditions during the Medieval Warm Period and an extended wet period including the Little Ice Age. This contrasts with the inferred humidity changes in a Scottish speleothem [1], a spatial pattern consistent with centennial shifts in North Atlantic Oscillation.

[1] Proctor *et al*. (2000) *Clim. Dyn*. **16**, 815-820.

Partial melting of heterogeneous sources: Implications for the petrogenesis of alkaline magmas

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Alkaline rocks (nephelinites and basanites through to alkali olivine basalts and transitional basalts) are significant rock types in oceanic and continental intraplate igneous provinces. Although near-solidus melts of fertile mantle peridotite can be nepheline normative, major- and trace-element and isotopic compositions of alkaline lavas suggest a more complex petrogenesis involving melting of sources containing both peridotite and "enriched" lithologies (e.g., recycled oceanic crust, sediment, or metasomatic veins.)

We have explored the hypothesis that the sources of these alkaline magmas are lithospheric and that the enriched components are dominantly metasomatic veins formed during passage through the lithosphere of low-degree melts of asthenospheric garnet peridotite. Samples of such veins are known in the geological record and thus this hypothesis can be tested quantitatively via melting experiments and geochemical models based on them.

Experiments on amphibole-rich vein compositions (and their dehydrated equivalents) at 1.5 and 2.5 GPa yield melts with major- and trace-element compositions similar to observed nephelinites and basanites. The continuum from nephelinites and basanites to less alkaline basalts (e.g., alkali olivine basalts) can also be reproduced experimentally by interaction between veins and peridotite during partial melting (see Pilet *et al*., this volume).

The best matches to observed nephelinite and basanite compositions require high degrees of melting of the metasomatic veins, consistent with the expected enhanced melting of low-solidus heterogeneities during adiabatic ascent of multi-lithologic assemblages that are in thermal equilibrium (note that while melting of the veins is enhanced, melting of the surrounding peridotite is suppressed).

Quantitative modeling of alkaline magma petrogenesis based on this hypothesis involves several adjustable parameters (e.g., compositions and relative amounts of the veins and peridotite; the time interval between formation of the veins and their subsequent melting.) For reasonable values of these parameters, the hypothesis that the enriched components in the sources of alkaline magmas are metasomatic veins can account for much of the substantial variability (i.e., isotope, trace and major elements composition) observed for such magmas.