Caught in the act! Unravelling crustal contamination

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Quantifying the effects and mechanisms of crustal assimilation by mantle derived magmas is key to our understanding of mantle geochemistry. Aiming to unravel these processes, we have studied a suite of lava-hosted amphibolite-granulite facies xenoliths from monogenetic volcanic centres around Quillacas (QL) and Pampas Aullagas (PA) on the Bolivian Altiplano[1]. The xenoliths are in various states of reaction, providing a direct insight into how ascending magmas assimilate crust: contamination has been "caught in the act". Host lavas are porphyritic, with plagioclase-hornblende dominated assemblages. Entrained xenoliths are holo- to hypocrystalline and typically gneissose with abundant quartz, fibrolitic sillimanite, garnet and plagioclase. The lava-xenolith interface is commonly defined by intergranular mafic and/or felsic glass (quenched melt).

Host lavas are shoshonitic and enriched in incompatible trace elements (e.g. LILE) probably as a result of crustal contamination. PA lavas display a higher degree of enrichment which is reflected by higher $^{87}Sr/^{86}Sr$ ratios from 0.7163 to 0.7167. QL lavas exhibit significantly lower $^{87}Sr/^{86}Sr$ ratios, between 0.7027 and 0.7102. Xenoliths from PA exhibit extreme SiO_2 (up to 90 wt %) compared to QL xenoliths (70 wt %) and display relative depletion in incompatible trace elements. This is likely to reflect higher degrees of melt loss. Despite their more refractory nature the PA xenoliths generally display *higher* $^{87}Sr/^{86}Sr$ (up to 0.7329) in comparison to QL xenoliths (0.7120).

The incompatible trace element signatures and Sr isotopic ratios are decoupled and thus reflect the complex, multistage processes involved during crustal assimilation. Clearly, further assimilation of such material would not lead to the coupled trace element vs. isotopic trends typically expected for crustal contamination. In order to unravel the mechanisms of contamination, we aim to carry out *in situ* analyses on intergranular glass and individual minerals to constrain elemental and isotopic gradients and budgets.

[1] Davidson, J.P., de Silva, S.L., 1995. Late Cenozoic magmatism of the Bolivian Altiplano. *Contrib Mineral Petrol* **119**: 387-408.

Geochemical evidence for the climatic impact of ocean circulation

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A number of numerical and conceptual models invoke a role for the ocean's large-scale circulation in past and potential future climate changes. Yet depite a wealth of circumstantial evidence for such a link, the complex interactions and general covariation of a variety of climate influences make it difficult to isolate the particular connection between climate and ocean circulation. Here we focus on an interval and a location for which most climate influences were of opposing sign to previously inferred changes in circulation. We discuss new and exisiting geochemical evidence for changes in the Atlantic's meridional overturning circulation (MOC) and the climate of the North Atlantic region during the last deglaciation.

Following the last glacial maximum, the global and regional climate influences of summer insolation, atmospheric grenhouse gas concentrations, retreating ice sheets and declining albedo all combined for a tendency for warming in the northern hemisphere. At the time of the deglacial iceberg discharge Heinrich event, H1, previous evidence indicated a weakening in the MOC and a cooling in at least some sites in the North Atlantic. A particularly strong line of evidence came from sedimentary $^{231}Pa/^{230}Th$ from the Bermuda Rise, and alkenone Uk37' sea-surface temperature estimates from the Iberian Margin, individual records from distant locations with potential competing influences on the respective geochemical signals.

Our new results include additional $^{231}Pa/^{230}Th$ measurements from the deep western boundary of the Atlantic, and a high-resolution TEX86 sea-surface temperature measured on the same core previously studied on the Bermuda Rise. These will be discussed in the context of other sedimentological, faunal, isotopic and elemental data indicating that despite the multiple warming influences, when the MOC weakened, the North Atlantic region cooled beyond even the conditions of the last glacial maximum.