Petrological and geochemical evidence for within-plate tectonic origin of some igneous rocks from the Lower Benue rift

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Methods and Results

The igneous rocks in the Lower Benue rift (otherwise, Lower Benue Trough) had been shown to have predominantly alkaline character and formed in an extensional, within-plate setting using mainly petrographic and major-element oxide data [1, 2, 3]. In this study, petrographic and geochemical (major, trace and REE) studies reveal that some volcanic and subvolcanic rocks within the original widths of the rift belong to alkali basalt series, with generally high fractionation indices $[(La / Yb)_N]$; 7.06 to 17.65 for basaltic, and 23.59 to 135. 35 for trachytic rocks, as well as strong enrichments in the incompatible elements. The basic sills generally show evidence of alteration reflected in depletions in the more mobile LILE (Rb, K, Ba and Sr) and high Th/Ta ratios.

Discussion of Results

This study corroborates the predominantly alkaline character of igneous rocks in the region [1, 2, 3] and suggests derivation from alkali olivine-basalt magma, generated through low degrees of partial melting of an enriched lithospheric mantle due to an asthenospheric uplift with HIMU signatures, in a within-plate continental rift setting. Coulon *et. al.* [4] obtained similar mantle sources, as well as an N-MORB source for rocks from other parts of the rift. The alteration in the rocks is likely an effect of interaction with an aqueous fluid phase and crustal contamination; interaction of the igneous rocks in the rift with an aqueous fluid phase had been suggested [2, 5, 6].

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2D, 3D, and *in situ* STXM in geomicrobiology

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Species-Sensitive Mapping using STXM

Biogeochemical processes such as metal binding and mobilization, (bio-)mineral precipitation and dissolution are often microbially mediated and controlled by chemical micro- or nano-environments with strong geochemical gradients. A fundamental understanding of the underlying mechanisms requires quantitative mapping of relevant organic and inorganic species such as bio-macromolecules, metals and minerals at spatially relevant scales. Scanning transmission X-ray microscopy (STXM) combines the speciation-sensitivity of near edge X-ray absorption fine structure spectroscopy with ~30 nm spatial resolution [1].

$CaCO_3$ biomineral nucleation on the surface of planktonic cyanobacteria was investigated in 2D STXM experiments. Therefore, the biochemical composition of potential nucleation sites and the mineralogical composition of the precipitates were mapped [2] both dry and *in-situ*. A model of the nucleation mechanism was developed, which involves the fast and reversible adsorption of Ca^{2+} to the extracellular polymers, the precipitation of an intermediate, aragonite-like phase, and eventually the precipitation of calcite. This model was verified in an element-specific 3D STXM angle-scan tomography study [3].

Several other biogeochemical applications of soft X-ray spectromicroscopic species-mapping will be illustrated such as microbial anaerobic Fe-oxidation [4], metal adsorption, and biomineralization within natural river biofilms [5].

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