Lithospheric control of plume impact: Evidence from dyke geochemistry

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Dyke swarms in continental flood basalt (CFB) provinces carry more information about the magmatic systems than coeval lavas since they often are less differentiated and less prone to removal by erosion. Moreover, dykes directly record the site of magma emplacement whereas eruptive vents for CFB lavas are rarely known and can be distant from the sampling site. Here we report on ~250 samples from the Early Cretaceous Henties Bay Outjo dyke swarm (HOD) in NW Namibia, which is the best exposed major dyke swarm associated with South Atlantic rifting and breakup. The goals of this research are to assess the geochemical variability of dyke magmas, to determine the composition of the mantle source and physical conditions of melting, and to understand the influence of the continental crust and lithosphere on magma composition, ascent and emplacement. And finally, we are interested in the time-space variation of these parameters.

Chemical and isotopic compositions distinguish three end-member magma groups in the HOD. In order of decreasing abundance these are: (a) crustally-contaminated tholeiites, with “spiky” trace element patterns and enriched isotope ratios ($^{87}Sr/^{86}Sr_i$ = 0.710-0.712, εNd_i = -2 to -7) very similar to the main series of Etendeka flood basalts, (b) MORB-like tholeiites with relative flat trace element patterns and depleted isotope ratios ($^{87}Sr/^{86}Sr_i$ = 0.704-0.705, εNd_i = +2 to +6), and (c) alkaline, trace element enriched basalts ($^{87}Sr/^{86}Sr_i$ = 0.7055-0.7059, εNd_i = 0 to -2). In general, dykes in the southern part of the HOD (lat. 20-23º) are more diverse and more primitive. Neither picritic nor alkaline dykes have been so far observed to the North (lat. 17-20º). Interestingly, the most primitive dykes (MgO > 6 wt.%), with the highest magmatic temperatures (1350°C) and the greatest apparent depth of melting (highest Zr/Y and Dy/Yb ratios) occur in the southern area although the proposed plume impact is farther north (Walvis Ridge). The dyke diversity may be controlled more by crustal permeability than differences in magma source.

Biogeochemical Mechanisms Underlying the Manganese Dependence of Litter Decomposition

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Climate change is predicted to impact the organic and inorganic composition of foliar litter, and global warming may increase soil microbial and enzymatic activity, with uncertain consequences for litter decomposition rates and pathways in soils. Recent work has identified the bioavailability of key resources (e.g, assimilable C or inorganic nutrients) as the main control of litter decomposition rates. A particularly strong correlation was established between manganese (Mn) content in needle litter and litter decomposition rates across a variety of boreal forest ecosystems, suggesting that Mn is an essential component of the decomposition pathway. There is good reason to assume that this is due to the critical role of Mn(III)-ligand complexes acting as potent oxidizers in the enzymatic breakdown of lignin. Here we related changes in Mn form and distribution to lignin transformation over the course of a 7-year litter decomposition experiment in an old growth forest ecosystem. Soft-ionization mass spectrometry, FTIR and X-ray absorption spectroscopy analyses of fresh needles, litter at different decomposition stages, and mineral soil show that the formation of oxidative Mn species is well correlated with lignin decomposition. Spatially-resolved synchrotron-FTIR and X-ray microprobe imaging revealed that microorganisms colonizing individual needles redistribute and transform reduced Mn(II) present in the vascular system of fresh needles into oxidative Mn(II/III) forms at the sites of lignin decomposition. These mechanistic insights suggest that Mn bioavailability and form are important parameters for improved model predictions of litter decomposition rates in forest soils. The response of ecosystem Mn fluxes to rising temperatures and CO_2 concentrations and, specifically, its implications for litter decomposition rates will be discussed.

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