Boron Isotope Systematics In South Italy Volcanoes

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In an attempt to better understand the distinct role played by slab-derived fluids and continental material in arc-magma production, this latter either as a mantle component or as a crustal/lithosphere contaminant, boron concentrations and isotopic compositions were determined in representative lavas from South Italy where subduction and extensional tectonics are tightly linked.

$\delta^{11}B$ and $^{87}Sr/^{86}Sr$ have been determined in representative lavas from Aeolian Volcanic Arc, Phlegrean Volcanic District and Mt. Etna. In Aeolian lavas $\delta^{11}B$ shows significant cross-arc variations (-5.9 to +2.3‰), and it is positively correlated with mobile/immobile element ratios. Progressively lower $\delta^{11}B$ and $^{87}Sr/^{86}Sr$ are indicative of decreasing subduction contributions toward the backarc region. $\delta^{11}B$ measured on Phlegrean Volcanic District products varies between –3.0 and –10.6 ‰ and is not correlated with B content or with B/immobile incompatible element ratios. A good negative correlation is observed between $\delta^{11}B$ and $^{87}Sr/^{86}Sr$. The $\delta^{11}B$ measured in selected samples of Mt Etna ranges between -6 and -3.5‰. and displays good positive correlation with $^{87}Sr/^{86}Sr$. $\delta^{11}B$ observed in South Italy lavas is consistent with the addition of slab-derived fluids to the mantle sources for calc-alkaline lavas of the Aeolian arc (as in western Pacific arcs) and an additional component characterized by low B/immobile element ratios and low $\delta^{11}B$ in the Phlegrean Volcanic District. The small increase of $\delta^{11}B$ in the Mt. Etna lavas reveals the presence of subduction-like fluids in their genesis. Overall B and Sr isotopic systematics suggest that addition of even small amounts of slab-derived fluids to the mantle dramatically influences $\delta^{11}B$ systematics without having significant effects on $^{87}Sr/^{86}Sr$. On the other hand, addition of crustal material or a lithospheric mantle component can dramatically change $^{87}Sr/^{86}Sr$ while leaving $\delta^{11}B$ (and B/Nb) little modified.

Seismic Anisotropy and Heterogeneity Beneath the MELT Region

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We use teleseismic P and S delay times and shear wave splitting observations to constrain isotropic and anisotropic heterogeneity in the mantle beneath the southern East Pacific Rise (SEPR). The data comprise 462 P and S delay times and 18 shear wave splitting observations recorded during the Mantle ELectromagnetic and Tomography (MELT) experiment. We estimate the melt content and temperature variations beneath the SEPR from the magnitude of isotropic velocity variation. Our results indicate that the variation in melt content beneath our array is at most approximately 1.2%, and maximum variation in temperature is approximately 100 K. We approximate the seismic velocity anisotropy of the upper mantle with an hexagonally symmetric tensor. This assumption and the assumption of two-dimensionality of mantle flow beneath the ridge imply that for P waves and for S waves polarized in the slow direction (i.e., parallel to the rise axis) the seismic velocity anisotropy is approximated by a $\cos(2\Theta)$ dependence, where Θ is the angle between the hexagonal symmetry axis (i.e., the mean orientation of the crystallographic a-axis of olivine) and the direction of wave propagation. Using this description of seismic velocity anisotropy, we have developed a tomographic technique that employs a non-linear inversion of P and slow S polarization delay times to image simultaneously V_P and V_S structures. We solve for isotropic heterogeneity throughout the model and for the magnitude of anisotropy within a few discrete domains. We couple V_P and V_S using three different forms of constraint, 1) V_P/V_S variations smooth, 2) V_P/V_S fixed, and 3) $\partial \ln V_S = \partial \ln V_P = 2.2$. We couple the P and S anisotropy through the hexagonal tensor. Within the anisotropic domains the dip of the hexagonal symmetry axis Θ is fixed for each inversion. A set of inversions are performed using various starting models with Θ between 0° and 180° and for various domain dimensions. From each tomographic model we predict the split times of vertically propagating S waves via the Christoffel equation. The misfit of the models to P and S data, and the resulting isotropic heterogeneity, are sensitive to both variation in Θ and the dimensions of the anisotropic domains. In the vicinity of the rise the average dip of the hexagonal symmetry axis best fitting the data is near horizontal or dipping shallowly (< 30°) to the west. Given the resolution of our data, a sub-axial region characterized by a vertically aligned symmetry axis may exist, but is limited to be less than 80 km deep. Geodynamic modeling further indicates that passive flow driven by asymmetric plate motion alone is not a sufficient explanation of the anomalies. Asthenospheric flow from hotspots in the Pacific superswell region back to the migrating ridge axis in conjunction with the asymmetric plate motion can create many of the observed anomalies.