Geophysical Research Abstracts
Vol. 16, EGU2014-4010-1, 2014
EGU General Assembly 2014

Isotopic compositions of volcanic arc rocks in the Southern Volcanic Zone (33°-43°S), Chile: along- and across-arc variations

Guillaume Jacques (1), Kaj Hoernle (1), Jim Gill (2), and Heidi Wehrmann (1)

(1) GEOMAR Helmholtz Centre for Ocean Research Kiel, 24148 Kiel, Germany, (2) University of California, Santa Cruz CA 95064, USA

We investigate young, olivine-bearing volcanic arc (VA) rocks from the Southern Volcanic Zone (33-43°S; SVZ) in Chile, and from the backarc (BA) in Argentina for their major and trace element, and Sr-Nd-Hf-Pb-O isotope geochemistry. The compositional data are processed to identify the source components contributing to the arc magmas and to estimate their proportions, with the aim to better understand the effects of the large-scale along-arc tectonic variations onto melt generation and erupted compositions. The Transitional (T) SVZ (34.5-38°S; Jacques et al., 2013) samples overlap the BA samples in Sr and Nd isotopes, whereas the Central (C) SVZ (38-43°S; Jacques et al., submitted, Chemical Geology) samples are shifted to slightly higher Sr and/or Nd isotope ratios. All samples form a tight correlation on the Pb isotope diagrams. The VA samples plot at the radiogenic end of the positive BA array and overlap trench sediment, indicating mixing between a South Atlantic MORB-type source and a slab component derived from subducted trench sediments and altered oceanic crust. On the Nd versus Hf isotope diagram, the VA and BA form two sub parallel linear trends, neither pointing to subducting sediment. The VA may display an asthenospheric mantle array, whereas enriched Proterozoic lithospheric mantle may be involved in the BA. The CSVZ samples have higher fluid-mobile to fluid-immobile element ratios and lower more- to less-incompatible fluid-immobile element ratios than the TSVZ samples, consistent with higher hydrous melt flux and higher degrees of melting resulting in higher magma production and eruption rates in the CSVZ. Low δ^{18}O(melt) of CSVZ lavas suggests that the source of the enhanced water flux is likely to be hydrated lower crust and serpentinized upper mantle of the incoming plate, resulting from the multiple large fracture zones in this part of the SVZ. The δ^{18}O(melt) values of the NSVZ, TSVZ and BA, on the other hand, largely overlap the MORB mantle range and extend slightly above it. We propose a quantitative mixing model between a mixed-source (slab-derived melt and a heterogeneous mantle wedge beneath the volcanic arc) using Arc Basalts Simulator 3. Our models predict partial slab melting (including sediments and oceanic crust) in both TSVZ and CSVZ. The ratio of sediment to altered oceanic crust differs significantly between the TSVZ (60:30) and the CSVZ (30:70), and the amount of slab-derived hydrous melt added to the mantle wedge is higher in the CSVZ than in the TSVZ. Finally, the NSVZ samples are shifted to higher Sr isotope ratios and Δ8/4, lower ^{206}Pb/^{204}Pb, Nd and Hf isotope ratios, but have similar Δ7/4 as the other VA samples. This is inconsistent with the pre-existing models of crustal assimilation or subduction erosion of the Paleozoic upper crust. Assimilation or subduction erosion of lower crust similar in composition to that beneath Arizona, and thought to be present its conjugate pair in the Chilenia Terrane beneath the volcanoes, could explain the NSVZ geochemical variations.