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Mantle sources and melting processes beneath São Miguel, Azores: origin of a unique geochemical signature inferred from Sr-Nd-Pb-Hf isotope systematics

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The submarine Azores plateau straddles the Mid-Atlantic Ridge (MAR) between 37.5˚N and 40.5˚N. The mantle melting beneath the Azores plateau is related to a geophysical anomaly in the Earth's upper mantle and is influenced by the hyper-slow spreading (3 mm/yr full spreading rate) Terceira axis, which runs along the Azores platform in a NW-SE direction. The about 60 km long island of São Miguel is located at the eastern edge of the platform and consists of four large volcanic centres. The eastern volcanoes (*Agua de Pau*, *Furnas* and *Nordeste*) are aligned in an E-W striking structure, whereas the westernmost volcano (*Sete Cidades*) is directly situated on the NW-SE trending Terceira axis.

The extreme variation of Sr, Nd, and Pb isotope compositions of the São Miguel lavas is long known and has been suggested to be due to either recycled sediments or metasomatized subcontinental lithosphere. Here, we compare the compositions of the endmembers of the lavas in order to determine the nature of the sources and the melting processes beneath the island of São Miguel. The lavas from the easternmost volcano *Nordeste* have unusually radiogenic Sr and Pb isotope values ($^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$ up to 0.706 and 20.1 and low Nd and Hf isotope ratios), indicating a source evolution with high time-integrated Rb/Sr and U/Pb ratios. Gradients with decreasing Sr, Nd, and Pb isotope ratios occur along the volcanoes further to the west with the *Sete Cidades* volcano representing the source with the lowest Sr and Pb isotope ratios. Linear trends between all isotope ratios indicate mixing between two dif-

ferent mantle sources. The major and trace element data indicate small, but significant differences in both, degree and depth of partial melting between the eastern and western volcanoes. Lower CaO, Al_2O_3, and Na_2O, but higher FeO^T concentrations probably indicate deeper melting and higher melting degrees beneath the eastern volcanoes than underneath the western part of the island. Large variations in incompatible element ratios also show considerable heterogeneity among the different volcanoes. The lavas from the westernmost *Sete Cidades* volcano have the highest Ce/Yb and Nb/Zr either reflecting a smaller melting degree or a more enriched source beneath the western volcanoes. The low FeO^T and high Al_2O_3 and CaO in the *Sete Cidades* lavas correspond to higher Ba/Th, Ba/Rb and Sm/Yb ratios than in the samples from the eastern volcanoes. Sr and Pb isotope ratios correlate negatively with the incompatible element ratios Nb/La, Nb/Zr and Ba/La.

The observed correlations between isotope ratios and major and trace element ratios suggest that tapping of the sources with the highest Sr and Pb isotope ratios occurs preferentially at the highest pressures combined with higher melting degrees. It also shows a correlation between geochemical composition and local tectonics where the *Sete Cidades* volcano is connected to the ultraslow spreading axis in contrast to the E-W trend of the eastern volcanoes. This shows that melting conditions are not only related to local tectonics, but that sampling of heterogeneous source components is also dependent on the melting conditions.