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Geochemical consequences of thermomechanical plumes in subduction zones. Implications for crustal making processes

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Geochemical consequences of composite plumes formed in subduction zones have been studied using a thermomechanical numerical model of an oceanic-continental subduction zone. This model includes dehydration of subducted crust, aqueous fluid transport, partial melting and melt emplacement. Subduction of crustal material to sublithospheric depth results in the formation of tectonic rock melanges composed of basalts and sediments that evolve to partially molten plumes which rise through the mantle prior to emplacement. We have investigated the composition and the geochemical evolution of liquids derived from composite plumes by analyzing the differing proportions of the endmembers in the source, i.e. basalts and sediments. Our results show that the proportions of the components are limited to short range variations over an interval of Xb(basalt/(basalt+sediment)) $= 0.4 - 0.8$, which allows for granodioritic melt production[1]. We have further calculated Sr and Nd isotopic initial ratios of the melange at any time during the simulations, based on the fraction of the components in the melange. Liquids derived from composite plumes inherit the geochemical characteristics of the parental magma and show distinct temporal variations of radiogenic isotopes. The decoupling between radiogenic isotopes and major elements is an interesting result, and may explain short range variations observed in some batholiths along the Cordillera. Batholiths formed along active continental margins display homogeneous major element composition but substanstial variation in radiogenic isotopic compositions, suggesting widely varying proportions of mantle and crustal components in their source that may be explained by melts derived from composite plumes.

References

[1] Castro A., Gerya, T., García-Casco, A., Fernández, C., Díaz Alvarado, J., Moreno-Ventas, I., Löw, I. (2010). Melting relations of MORB-sediment mélanges in underplated mantle wedge plumes. Implications for the origin of cordilleran-type batholiths. Journal of Petrology, 51, 1267-1295.