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The role of crustal melting in the formation of rhyolites: Constraints from SIMS oxygen isotope data (Chon Aike Province, Patagonia, Argentina)

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Abstract

We report on the oxygen isotope composition of Jurassic rhyolites from a silicic large igneous province, the Chon Aike Province (Patagonia, Argentina). Quartz is shown to have refractory behavior with respect to diffusional oxygen isotope exchange, making it a robust tracer of magmatic processes. Detailed secondary ion mass spectroscopy (SIMS) transects across 24 quartz crystals reveal homogeneous, but elevated, oxygen isotope values (10.9–12.5‰). None of the analyzed grains display distinct discontinuities in ^{18}O values. Late hydrothermal exchange is limited to a few tens of micrometers next to cracks, some grain boundaries, and inclusions. No correlation with igneous zoning as revealed by cathodoluminescence (CL) was found. Finally, quartz crystals display little to no inter-grain variability at a sample or outcrop scale. Zircons (7.5–10.1‰), in contrast, display significant inter-crystalline oxygen isotopic heterogeneity (>2.0‰) at a sample scale, but core-rim analyses reveal no systematic variations. This is interpreted to confirm the antecrystic nature of zircons, while quartz crystals mostly are phenocrysts. The studied quartz and zircon provide, hence, complementary information on the evolution of the magmatic system of the Chon Aike Province. Zircon likely captures information about the deeper source region, in contrast to quartz that will record the last stages of the magmatic system and thus might provide important information on the buildup and duration of magma chamber processes in the upper crust. The data illustrate that quartz—in the absence of recrystallization—can retain its magmatic signature and is thus a useful tracer of pre-eruptive magmatic processes. The high $\delta^{18}O$ values of both zircon and quartz require a significant (>50%) crustal—most likely sedimentary—contribution in the melt formation process, either via assimilation or anatexis. This conclusion yields new constraints on petrological models for the Chon Aike Province.

Keywords: Oxygen isotopes, SIMS, rhyolites, crustal melting, quartz, zircon