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Reheating and magma mixing recorded by zircon and quartz from high-silica rhyolite in the Coqen region, southern Tibet

Shao-Rong Chen[1], Qing Wang[1,*], Di-Cheng Zhu[1], Roberto F. Weinberg[2], Liang-Liang Zhang[1], and Zhi-Dan Zhao[1]

[1]State Key Laboratory of Geological Processes and Mineral Resources, and School of Earth Science and Resources, China University of Geosciences, Beijing 100083, China

[2]School of Earth, Atmosphere and Environment, Monash University, Melbourne, Victoria 3800, Australia

Abstract

Understanding the formation of high-silica rhyolites (HSRs, SiO_2 > 75 wt%) is critical to revealing the evolution of felsic magma systems and magma chamber processes. This paper addresses HSR petrogenesis by investigating an integrated data set of whole-rock geochemistry, geochronology, and mineral composition of the ~74 Ma Nuocang HSR (SiO_2 = 74.5–79.3 wt%) from the Coqen region in southern Tibet. Cathodoluminescence (CL) images show that zircons from the Nuocang HSRs can be divided into two textural types: (1) those with dark-CL cores displaying resorption features and overgrown by light-CL rims, and (2) those comprising a single light-CL zone, without dark-CL cores. In situ single-spot data and scanning images demonstrate that these two types of zircon have similar U-Pb ages (~74 Ma) and Hf isotopic compositions [$\varepsilon_{Hf}(t)$ = –9.09 to –5.39], indicating they were generated by the same magmatic system. However, they have different abundances of trace elements and trace element ratios. The dark-CL cores are likely crystallized from a highly evolved magma as indicated by their higher U, Th, Hf, Y, and heavy rare earth elements concentrations, lower Sm/Yb ratio, and more negative Eu anomalies. In contrast, the uniformly light-CL zircons and the light-CL rims are likely crystallized from less evolved and hotter magma, as indicated by their lower U-Th-REE abundances and higher Ti-in-zircon temperatures. This is consistent with the Ti-in-quartz geothermometer in quartz phenocrysts that reveals that the light-CL zones are hotter than dark-CL cores. We propose that the composition and temperature differences between cores and rims of zircons and quartz record a recharge and reheating event during the formation of the Nuocang HSRs. This implies that HSR is a result of mixing between a hotter, less evolved silicic magma and a cooler, highly evolved, and crystal-rich mush. This study shows that zircon and quartz with distinct internal textures can be combined to disentangle the multi-stage evolution of magma reservoirs, providing critical insights into the origin of HSRs.

Keywords: High-silica rhyolites, zircon trace elements, Ti-in-quartz geothermometer, magmatic process, Lhasa Terrane