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Raman spectroscopy-based screening of zircon for reliable water content and oxygen isotope measurements

Chuan-Mao Yang[1,2,3,†], Yi-Gang Xu[1,2,4,*], Xiao-Ping Xia[1,*,‡], Yu-Ya Gao[5,6], Wan-Feng Zhang[1,2], Ya-Nan Yang[1,2], Qing Yang[1,2], and Le Zhang[1,2,§]

[1]State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China
[2]CAS Center for Excellence in Deep Earth Science, Guangzhou 510640, China
[3]College of Earth and Planetary Sciences, University of the Chinese Academy of Sciences, Beijing 100049, China
[4]Southern Marine Science and Engineering Guangdong Laboratory, Guangzhou 511458, China
[5]Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China
[6]National Institute of Metrology, Beijing 102200, China

Abstract

Water content and oxygen isotopes in zircon provide crucial constraints on magma source and process, yet they can be significantly modified by zircon metamictization, which causes secondary water absorption into the zircon crystal and the concomitant oxygen isotope changes. Therefore, it is imperative to develop a screening scheme to select the least-metamict zircons for the analyses. We propose a screening scheme based on our study on the Suzhou A-type granite (South China) through integrating Raman spectroscopy, water and trace element measurements, and oxygen isotope analysis. The results show that the primary water content is retained in zircon when the full-width at half maximum (FWHM) is <8 cm^{-1} or the Raman shift is >1007 cm^{-1} of $\nu_3(SiO_4)$ vibration band, while the primary $\delta^{18}O$ is preserved at <10 cm^{-1} FWHM or >1005.5 cm^{-1} Raman shift. Changes in trace element concentrations in Suzhou zircons are different from previous observations in metamict zircons but most likely related to magma evolution, which implies that trace elements are insensitive to metamictization. Primary $\delta^{18}O$ in Suzhou zircons (4.5–6.0‰) fall into the mantle range, indicating a dominant mantle contribution to Suzhou granites. Primary water content was estimated at ca. 650–1400 ppm, significantly higher than those of typical I-type granite (400–736 ppm) and upper mantle-derived zircons (81–177 ppm). The high primary zircon water content was not controlled by the sub-solidus process, temperature, pressure, and cation charge balance but considered to reflect the high-water content in melts. This suggests a hydrous origin for the Suzhou A-type granite, which challenges the conventional view of anhydrous petrogenesis for A-type granites.

Keyword: Zircon water content, A-type granite, Raman spectroscopy, full-width at half maximum (FWHM), Raman shift, SIMS, trace element