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# The effects of experimentally induced zircon annealing on melt inclusion-zircon geochemistry: A case study of Archean zircon from the Barberton Complex

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Crystalline melt inclusions (MIs) in Archean zircons can potentially constrain the evolution of magmatic processes. However, to obtain a homogeneous glassy MI representative of the parent melt, devitrified MIs must be heated above the liquidus. Although, it is well known that radiation damaged domains in zircon undergo temperature-time dependent annealing, the effects of annealing on zircon stable isotope and trace element compositions (for comparison to MIs) has received less attention. In this study, we heated multiple aliquots of low-magnetism zircons with relatively low levels of radiation damage ($D_{eff}$<$9.6 \times 10^{14}$ α-events/mg) from a 3.304 Ga tonalite gneiss xenolith from the Barberton greenstone belt (sample B87-18NM0; Kamo and Davis, 1994) in an internally-heated pressure vessel at 0.4GPa and 1000–1200°C. Zircons were imaged by SEM (CL, BSE) to determine the zoning patterns around the MIs. The radiation damage preserved in the heated and unheated zircons was determined by measuring broadening of the $\nu_3(SiO_4)$ Raman stretching band of zircon (FWHM). Oxygen isotope ratios ($\delta^{18}O$), OH/O ratios, and trace and rare earth element (TREE) concentrations were measured in the zircons and MIs using SIMS. The FWHM and Raman shift of the zircon $\nu_3(SiO_4)$ band show a systematic increase of zircon crystallinity with increasing experimental temperature. Despite increasing crystallinity, the $\nu_3(SiO_4)$ FWHM is not correlated with $\delta^{18}O$(Zrn) values in the heated or unheated zircons, suggesting that $\delta^{18}O$ was unchanged by laboratory heating in these low initial radiation damage zircons. FWHM and OH/O are positively correlated in both heated and unheated zircons. The unheated zircons have the largest FWHM and OH/O (uncalibrated $OH/O_{MAX}=3.5\times10^{-4}$) demonstrating that $H_2O$ was lost during experimental heating due to the progressive annealing of radiation-damaged domains in the zircons. Zircon TREE concentrations and FWHM values are not correlated in analyzed domains in both the heated and unheated zircons. Our results demonstrate that pre-experimental zircon TREE concentrations and $\delta^{18}O$(Zrn) remain intact during laboratory heating, while secondary $H_2O$ hosted in radiation damaged domains is partially lost. Thus, zircon with low pre-experimental radiation damage are well preserved and this enhances the preservation potential of MIs hosted in Archean zircon.

[1] Kamo & Davis (1994), *Tectonics* 13(1), 167-192.