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Oxygen isotope heterogeneity in partially metamictic zircons

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Mineral separates of two granitoid samples belonging to the late orogenic granitoids from the Wilson Terrane, northern Victoria Land, Antarctica, were investigated for their $^{18}O/^{16}O$ ratios. Quartz, K-feldspar, and biotite were separated from metaluminous Kfs-magacrysts-bearing granite and from peraluminous (Ms+Grt+Crd-bearing) granite, respectively. Aliquots of these minerals were measured by conventional laser fluorination. Zircon crystals from the same samples were separated and investigated by Cathodo Luminescence (CL), laser microprobe-ICP-MS (LAM-ICP-MS), and Raman analyses. The same zircons were then ion-probed for oxygen isotope composition (SIMS). Distinct structural domains were identified on the basis of CL and back scattered electron microscope images. Distinct (U/Pb) radiometric ages were also measured among different zircon crystals, but no systematic bearing on U/Pb ages were identified for the different structural sites. Trace elements investigations of the zircons from the two granitoids revealed large intra-mineral variations in LREE contents, and significant inter-mineral differences, whereas HREE elements concentrations were consistent among the two samples.

Large inter-crystalline O-isotope variations were also observed, but only U-rich samples yielded significantly $\delta^{18}O$ zoning at the crystal scale. Few zircon crystals showed $\delta^{18}O$ values in equilibrium with the paragenetic minerals (10.2-10.9 ‰), and crystal with $\delta^{18}O$ values as low as 1.3 ‰ were also measured. Most of the zircons showed intermediate $\delta^{18}O$ values, in the range of 4.5-6.5 ‰. The $\delta^{18}O$ values of the paragenetic minerals are in the range of the values expected for the rocks having been cooled undisturbed, and the inter-mineral oxygen isotope fractionations are consistent with those of similar granitoids from the same area.

The zircons showed distinct degrees of metamictization, likely resulting from variable chemical compositions and distinct amounts of radiation flux. Raman measurements revealed that crystal domains with low δ^{18}O values were characterized by low degrees of crystallinity and/or amorphous structures. These features were interpreted in terms of zircons crystals having experienced differential radiation damage. The oxygen isotope data were used to in order to constrain the thermal regime experienced by their granite host rock after emplacement.