Origin of Si and O isotope heterogeneities in igneous zircon

DUSTIN TRAIL[1,2], PATRICK BOEHNKE[3], MING-CHANG LIU[2], PAUL SAVAGE[4], MARTHA MILLER[1], ILYA BINDEMAN[5]

[1]Dept. of Earth and Environ. Sciences, University of Rochester
[2]Dept. of Earth, Planetary and Space Sciences, University of California, Los Angeles
[3]Dept. of the Geophysical Sciences, The University of Chicago
[4]School of Earth and Environ. Sciences, University of St. Andrews, UK.
[5]Dept. of Earth Sciences, University of Oregen

Weathered silicate material yields Si and O isotope fractionations away from mantle values. Like O isotopes, Si isotope heterogeneities are also present in granitoid rocks reflecting the original source rock [e.g., 1-2]. Si isotope variations are magnified with the degree of weathering exposure to more negative δ^{30}Si values [3]. This gives Si isotopes the added advantage over O isotope investigations alone as they also have the potential to be a definitive proxy for identifying the presence of pelitic sediment in a melt source.

To extend the terrestrial Si isotope record to the mineral scale, we take the approach that δ^{30}Si values should not be considered as an isolated system, but rather should be considered with δ^{18}O. We developed an ion microprobe analytical protocol for zircon to conduct simultaneous measurements of both isotope systems. This method was used to investigate coupled Si and O isotope compositions of igneous zircon from 9 different Phanerozoic granitoids classified as (S)edimentary, (I)gneous, and (A)norogenic.

Phanerozoic zircon from (S)edimentary-type rocks contain heterogenous δ^{18}O and δ^{30}Si values consistent with the assimilation of metapelitic material into the source melts, distinct from the isotopic character that defines (I)gneous- and (A)norogenic-type zircons. In most cases, the Si and O isotopic compositions of detrital Archean zircons reflect compositions of mantle-derived zircon. Coupled δ^{18}O and δ^{30}Si measurements of Hadean zircon restrict the characteristics of Hadean material altered in low temperature environments. Our preferred model is that some source melts involved fractional addition of chemical sediments and metabasalts.

[1] Savage et al. (2012) GCA 92: 184-202. [2] O'Neil, J.R., Chappell, B.W., (1977) *J. geol. Soc. Lond.*, 33 559-57. [3] Opfergelt, S., Delmelle, P. (2012). *Comptes Rendus Geoscience*, 344(11): 723-738.