OXYGEN ISOTOPE RATIOS ARE PRESERVED IN WATER-POOR JACK HILLS ZIRCONS

E. D. Cameron1, J. W. Valley1, D. Ortiz-Cordero1, K. Kitajima1, and A. J. Cavosie2 1WiscSIMS, Dept. Geoscience, Univ. Wisconsin, Madison, Wisconsin 53706, USA (ecameron4@wisc.edu), 2Dept. Applied Geology, Curtin Univ., Perth, W. Australia

Figure A

The Jack Hills detrital zircons are notable for being the only "plentiful" source of >4.0 Ga terrestrial material. Such zircons provide the only geochemical information about the Hadean Earth. Values of δ18O in >4.0 Ga detrital zircons that are slightly elevated above mantle values suggest: that the parent rock of the zircons interacted at low temperature with liquid water before subsequent burial and melting; that Earth cooled quickly after core and Moon formation; and that habitable conditions for life existed 800 Ma before the oldest known microfossils [1].

Interest in the ties between the Jack Hills zircons and the origin of life has increased following the report of two ~4-μm graphite inclusions with δ13C = −24 ± 5‰ in a 4.1 Ga detrital Jack Hills (JH) zircon that is interpreted to be igneous and unaltered [2]. However, high δ18O values for some JH zircons are reported to correlate with high OH/O ratios, suggesting cryptic alteration and general unreliability of the high δ18O JH zircons [3]. OH correlates with radiation damage that is known to open fast pathways for exchange in zircon, which could allow alteration of zircons. Alternatively, some studies have been vigilant to avoid analysis of damaged domains in zircon. We have reanalyzed δ18O by SIMS in Jack Hills zircons first reported by [1] to be unaltered based on U-Pb concordance, magnetism and CL imaging. Our new data include measurement of 16OH to monitor "water" as a further precaution against radiation damage. When compared against an anhydrous standard, background corrected OH/O is a useful tool for evaluating the fidelity of a single SIMS domain in zircon [4].

Here we present new analyses of 154 detrital Jack Hills zircons of >3.8 Ga age for δ18O and OH/O (fig. A). Each zircon was analyzed by SIMS with 2 to 3 ~10-μm spots on an IMS 1280 at UW-Madison. These spots were placed close to domains previously recorded as ~90% concordant in U-Pb ages, and correlated with CL imaging [1]. OH/O ratios were background corrected by comparing against the KIM-5 bracketing zircon standard. Additionally, using measured [U], [Th] and U-Pb age of the zircons, we calculated the maximum alpha-decay dose each grain could have accumulated, assuming no annealing after regional metamorphism at 2.6 Ga.

Results show that most zircons of [1] have OH/O ratios that are not distinguishable from background. There is no correlation of OH/O to δ18O in our data. This is notably different from "group 4" zircons from [3] that are dark in CL, apparently altered, and display a correlation between high δ18O and OH/O (triangles in fig. A). This confirms that mildly elevated δ18O in zircons that pass the tests of alteration applied by [1,5] are not altered, radiation damaged, or hydrous. There appears to be only a slight correlation between high max. alpha-decay dose and high OH/O ratios for our zircons (fig. B). 14% of the grains analyzed for combined OH/O and δ18O plot above the first percolation point, suggesting that some annealing could have occurred after 2.6 Ga as proposed by [3]. The lack of correlation between OH/O and δ18O strengthens the conclusions of [1,5] that δ18O is preserved in carefully selected zircons providing evidence for Hadean oceans and a Cool Early Earth before 4.3 Ga.