Earliest Archean magmatic events: Insights from detrital zircon studies

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Detrital zircons offer the only direct method for studying the Earliest Archean (Hadean) Eon. The largest number of Early Archean detrital zircons has been found in the Yilgarn Craton in Western Australia, where a nearly continuous $^{207}Pb/^{206}Pb$ age spectrum from 4400 to 3800 Ma has been reported (Peck et al., 2001 and references within; Mojzsis et al., 2001; Nelson, 2001; Nelson et al., 2000; Amelin, 1998). Questions remain (Parrish and Noble, 2003; Nelson, 2002) as to what geologic significance should be placed on ages from 4400-3800 Ma grains in light of finding variable ages within single crystals. We have pooled previously published analyses with our data set to evaluate discrete events. If the oldest concordant spot is interpreted as the age for each zircon, then ~100 grains (>3.8 Ga, > 80 % concordant) show distinct $^{207}Pb/^{206}Pb$ age 'peaks' over five intervals: 4325-4275 (n=5), 4200-4175 (n=8), 4125-4100 (n=12), 4025-4000 (n=12), and 3925-3900 (n=5) Ma. Conspicuous 'gaps' occur from 4275-4200 (n=1) and 3900-3800 (n=2) Ma. Within our collection, only grains older than 4300 Ma exhibit unusual intra-grain age variability. No consistent correlation is observed between oldest age and lowest U concentration, as would be predicted by the excess ^{231}Pa hypothesis of Parrish and Noble (2003). Most of our younger 4300-3800 Ma grains are largely homogeneous in age within CL domains. Middle Archean (3700-3300 Ma) overgrowths were observed on 4324, 4323, 4167, 4103 Ma grains, indicating their involvement in younger events. Nearly all of our >3800 Ma zircons exhibit clear zoning in CL (oscillatory and/or sector), and aside from age appear to be largely unremarkable igneous zircons. We thus interpret the age 'peaks' as distinct igneous events that resulted in new zircon crystallization, and in some cases disturbed older zircons resulting in ancient Pb-loss within those grains. These events were likely the result of intense meteorite bombardment, and/or proto-tectonics on the nascent Earth.

Suppression of Radium uptake in barite crystals by introduction of competing ions (e.g. Sr)

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Barite is one of the most common industrial scale-forming minerals owing to its low solubility (pK_{sp}=9,96 at 20ºC, (Blount, 1977)) in aqueous media. Significant levels of radioactivity have been reported owing to incorporation of isotopes from the ^{226}Ra and ^{228}Ra (e.g. Wilson and Scott, 1992). A static double diffusion system allowing slow crystallisation from aqueous solutions in a porous medium (Putnis et al., 1995) has been used to prepare radioactive barite crystals. These have been characterised by WAXS-XRD, SEM-EDX, AFM and gamma spectroscopy. The effect of competing ions (Sr^{2+}) in inhibiting radium uptake during barite scale formation is currently being explored.

Two reservoirs A and B connected to the porous medium (a porous silica hydrogel column) contain, respectively, $BaCl_2$ spiked with a ^{226}Ra solution and Na_2SO_4 (column 7). In the columns 3, 4 and 6 $SrCl_2$ in different concentrations has been add (0.5M, 0.3M and 0.05M respectively) to the reservoir A. The activity profile of the columns with respect to their length is presented below.

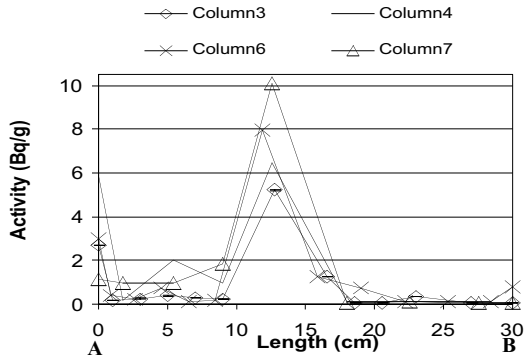

Figure 1. Total activity profile of the columns 3-4-6-7.

Where the activity of ^{226}Ra is less (and Sr concentration is greatest), the reservoir of $BaCl_2$ contains higher concentrations of ^{226}Ra. The introduction of a competing ion (Sr^{2+}) appears to have an effect on the activity of ^{226}Ra taken up by the barite crystals. Further testing is required over a wider range of concentration of the competing ion with respect to barium in order to understand mechanisms and kinetics of scale formation.

Blount, C. W. (1977). Am. Min. 62. 942-957. Putnis, A., et al. (1995). Geol. Mag. 132. 1-13. Wilson, A. J. and Scott, L.M. (1992). Health Phys. 63(6). 681-685.