How reliable are the U-Pb ages measured on inherited zircon?

I.S. WILLIAMS

Research School of Earth Sciences, The Australian National University, Canberra, ACT, Australia (ian.williams@anu.edu.au)

U-Pb ages measured *in situ* on inherited zircon cores by both ion microprobe and laser ICP-MS are adding a valuable new dimension to studies of magma genesis. A question remains however: how are inherited zircon and its U-Pb isotopic systems affected by magmatic processes? Finding an answer by direct comparison of zircon in igneous rocks and their source rocks is difficult because rarely are both exposed, but some areas of regional metamorphism are exceptions.

At Cooma, SE Australia, a sequence is exposed where Ordovician turbidite was subject to progressive early Silurian low-pressure greenschist to granulite facies regional metamorphism that at peak produced a small granodiorite pluton. Detrital zircon in the low grade turbidite ranges in shape from euhedral to anhedral, and in age from early Paleozoic to Archean, with distinctive composite mid and late Proterozoic age groups. Detrital monazite is strongly rounded and mostly late Proterozoic. With increasing grade monazite first dissolved, almost disappearing by upper-amphibolite facies, then regrew. Monazite in the migmatite and granodiorite preserves no inheritance. In contrast, zircon appears unaffected by metamorphism until the inception of partial melting at upper-amphibolite facies, when platelets of new zircon precipitated in preferred orientations on the surfaces of the detrital grains. In the migmatite and granodiorite these platelets have amalgamated to wholly enclose the grains in new growth characterised by {211} crystal faces and low Th/U. Even in the granodiorite, the zircon cores appear to preserve the original range of detrital zircon morphologies and U-Pb isotopic compositions unmodified.

Adjacent to the Cooma Complex there are large, batholithic, cordierite-bearing, peraluminous granodiorite plutons with chemical and isotopic compositions consistent with derivation from sedimentary source rocks. In the more mafic of these, virtually every zircon contains an inherited core. A case study of one inheritance-rich granodiorite has found that, as in the various rocks of the Cooma Complex, these cores have a range of ages and morphologies, with the more euhedral cores being on average the youngest. Further, the inherited cores have the same mix of ages in the same relative proportions as the nearby low grade Ordovician turbidite. This, and the presence of some inherited zircon cores of early Ordovician age, points to the source of the granodiorite being deep-seated Ordovician sediment, not an underlying Proterozoic basement as some have postulated.

Smectite incubation of organic molecules under seafloor hydrothermal conditions

L. B. WILLIAMS[1], B. CANFIELD[2], J.R. HOLLOWAY[3], AND P. WILLIAMS[4]

[1] Center for Solid State Science, Arizona State University Tempe, AZ 85287 USA (Lynda.Williams@asu.edu)

[2,3,4] Dept. of Chemistry & Biochemistry, Arizona State University, Tempe AZ 85287 USA (MrDNA@asu.edu, john.holloway@asu.edu, pw@asu.edu)

Smectite clay minerals may be important phases for organic synthesis reactions in seafloor hydrothermal systems. As smectite reacts with hydrothermal fluids to more stable minerals (illite or chlorite), the structural changes may provide mechanisms for organic polymerization. Smectite interlayers may behave as “nano-incubators” that protect and stabilize bio-oligomers that would otherwise degrade under hydrothermal conditions.

Experiments were performed to monitor progressive steps in the catalytic process while simulating seafloor volcanic T, P conditions. Experiments used sealed Au capsules at 300˚C, 1kbar. K-saturated smectite (SWy-1) was reacted in a 1:1 ratio with alcohols (methanol/ethanol) over a period of one month. Reaction progress was monitored weekly.

Smectite reacted to R0 ordered I/S with 27% illite after one week, 37% illite after 2 weeks, and R1 ordered I/S with 51% illite after 4 weeks. Coincident with the mineralogical reaction was a significant change in the organic products (Table 1). In the absence of smectite, alcohols breakdown to CH_4, CO_2, CO and H_2.

Table 1. Classes of reaction products observed

RXN Period	n-alkanes	alkyl-benzenes	bicyclic aromatics	n-methyl esters
Week 1	yes	yes	no	no
Week 2	trace	yes	no	trace
Week 3	trace	yes	yes	yes
Week 4	no	yes	yes	yes

These results show that organic complexity increases as a function of mineralogical reaction, and suggest that the presence of smectite protects the organic compounds from breakdown. Future experiments will control fO_2 and pH, and will use dilute aqueous reactants to better simulate hydrothermal vent fluids.