Merging Geochemical and Metagenomic Data to Predict C and N-fixation Pathways in Hydrothermal Microbial Communities

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Comparisons among isotopic data from multiple hot spring microbial communities (biofilms) indicate that geochemically similar hot springs can host functionally distinct biofilms, as in the case of Octopus Spring and 'Bison Pool' (BP) in Yellowstone National Park. Isotopic variations coupled with metagenomic (MG) data allow prediction of predominant C-fixation pathways in biofilms. Comparison of measured biofilm fractionation with that found in literature predict the reductive tricarboxylic acid cycle and the 3-hydroxyproprionate pathway (TCA and 3HP) to dominate at the high temps. MG data reveal that biofilms found at high temps can perform TCA and the acetyl-coenzyme A pathway (ACP), but not 3HP. Combining these results, we predict biofilms above ~80°C in BP predominately utilize TCA for fixing carbon. Using this methodology, we also predict C-fixation dominance to shift to ACP at ~80°C, and to the pentose phosphate cycle at ~66°C. BP biofilm N isotopic data reveal a shift from N-limitation at high temps to N-fixation at lower temps, born out in MG data. Sharp changes in isotopic signatures over short thermal gradients hint at shifts in limiting factors driving biofilm complexity.

The generation, evolution and preservation of the continental crust

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The geology of the continental crust is marked by peaks in the crystallization ages of zircon, and the ages of rocks that represent new continental crust. There is increasing evidence that these may reflect the different preservation potential of rocks generated in different tectonic settings, rather than major changes in the rates at which new crust is generated. The development of dry granulite facies rocks appears to facilitate the stabilization of continental crust, and granulite facies conditions are associated with the generation of new crust behind retreating plate margins. For example, much of the crust of eastern Australia was stabilized in accretionary orogens with dominant granite-turbidite basins from ~520-220 Ma, and the proportion of new crust can be estimated from Hf isotope variations in magmatic zircons.

Mafic and granitic rocks have different Lu/Hf ratios, and combined Hf-O isotope data in Archaean zircons indicate that much of the initial crust generated was mafic in composition. The proportions of felsic and mafic crust may therefore have been similar to that predicted by heat production considerations. A number of studies have highlighted that zircons remain poor windows into the upper mantle. We review the constraints of a recent analysis of the evolution of depleted upper mantle from Hf isotopes in near concordant zircons and from Nd isotopes in titanites.

Reconciling the sedimentary and igneous records of the evolution of the crust requires better constraints on the erosion factor 'K', which relates the model age of the bulk sediments to the average model age of the crustal sources from which they derived. We indicate how this may be evaluated from studies of Hf and Nd isotopes in recent river systems. Present models of crustal evolution are based on records from "stable" areas and they may therefore be biased by the formation of stable supercontinents. One issue is how such records compare with those from settings with poor preservation potential.