Survival and growth in an ultrabasic environment: How do they do it?

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In this report, we discuss the microbiology of a site that presents a combination of metabolic and physiological challenges that are so great that life as we know it should not be possible. Anything growing here will present a conundrum with regard to the growth of any microbial life with which we are familiar. The site, called the Cedars, (north of San Francisco, CA), consists of a number of springs that emerge from the subsurface after flowing through ultramafic rocks. The emerging water is highly alkaline (pH ~ 12), extremely low Eh (~ - 650 mV), contains very low levels of monovalent cations, and has low levels of DIC. In addition, while there is abundant energy in the form of hydrogen, (and some methane), there are no electron acceptors present. Despite the fact that no organisms we know of should be able to grow here, the emerging waters contain viable (10^2 to 10^3 cells ml^{-1}) bacteria. 16S rDNA gene sequences of bacteria collected on filters or harvested from mineral surface "enrichments" showed only a few dominant species. Single cell genomic analysis via MDA (multiple displacement amplification) was used to confirm the identities of the major species and to begin looking at the gene content of these microbes. Whole genome sequencing via MDA approaches is now underway in the hopes that the gene content of these microbes will yield insights into the mystery of how they make a living in this otherwise very inhospitable, seemingly 'impossible' place.

Lu-Hf isotope inheritance from subducting detrital zircons during crustal formation

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Detrital zircons are the dominant carrier of Hf in subducting sediment and hence are important for the Hf elemental and isotope budget and associated Lu/Hf in newly formed island arc rocks. We analysed a series of 21 island arc rocks (<55 wt. SiO_2) from the Banda Arc for their Lu-Hf isotope systematics, a subduction regime characterised by sediment subduction. Samples collected along arc from North to South-East show decreasing $^{176}Hf/^{177}Hf$, ranging from mantle like-values to more crustal signatures (ε_{Hf} 13.0 to -3.4). The range in Hf isotopes is consistent with previous investigation of O-Nd-Sr-Pb-He isotopes [1,2] and reflects source mixing between the mantle wedge and evolved subducting crustal material (SCM). Ratios of $(La/Yb)_N$ vs. Hf isotopes exhibit two variable trends that distinguish between crustal assimilation during magma ascent and SCM source mixing in the mantle wedge. A Hf-O isotope two-component mixing model indicates incorporation of 1-10 % SCM. Decreasing Hf isotopes that are indicative of increasing amounts of SCM in the source of the arc rocks show a negative correlation with Hf abundances. Because Hf is considered to be fluid-immobile, this trend points to partial SCM melting with zircon (partially) entering the melt phase. Partial dissolution of SCM detrital zircons is supported by increasing Zr concentrations in the arc rocks (normalized to MgO contents to minimize differentiation effects) coupled with decreasing Lu/Hf. Hence, the Lu-Hf isotope budget of the Banda rocks records that subduction of reworked crust results in the partial Hf isotope inheritance of the subduction component coupled with low Lu/Hf in new, mafic crust. Projecting this mechanism to the Hadean eon, rapid crustal recycling in subduction zones can effectively create a low Lu/Hf reservoir with low Hf isotopes in predominantly mafic crust. Such a crust may have acted as the host reservoir for Hadean zircons with low Hf isotope ratios [e.g., 3]. This is an effective alternative mechanism to explain the Hadean Hf isotope zircon record without the need of extensive formation of continental crust, or long enduring formation of melts from a TTG source [4].

[1] Vroon *et al*. *GCA*, 1995 [2] Vroon *et al*., *JGR*. 1996 [3] Harrison *et al*. *EPSL* 2008, [4] Blichert-Toft & Albarède, *EPSL*, 2008