Mineralogical effects on microbial diversity and accumulation in subsurface communities

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The rocks and minerals that comprise the subsurface lithology; each have properties that will potentially benefit specific microbial communities, especially those uniquely adapted to take advantage of these surfaces. We present experimental evidence that microorganisms colonize rock surfaces according to the rock's chemistry and the organism's metabolic requirements and tolerances. We investigated this phenomenon using laboratory reactors, which allowed microbial colonization of assorted surfaces by both a pure culture of the sulfur-oxidizing bacteria (SOB) *Thiothrix unzii* and a diverse mixed environmental sulfur-metabolizing microbial inoculant collected from Lower Kane Cave, WY, USA. Variations in microbial community structure on each surface were characterized and quantified by SEM, total biomass accumulation measurements, and high-throughput 16S rRNA sequencing.

We found that the combination of mineral properties such as buffering-capacity, nutrient content and aluminum content; as well as cell wall electronegativity, and competitive exclusion control biomass density and diversity of microbial communities attached to rock and mineral surfaces. Diversity analysis reveals that nearly identical communities, primarily composed of neutrophilic SOB, colonize a variety of carbonate surfaces. This resulted in aggressive dissolution of the carbonate minerals, producing a characteristic weathered surface texture. In contrast, a variety of silicate surfaces accumulate highly dissimilar communities with abundant acidophilic microorganisms colonizing only non-buffering quartz. Nutrient rich minerals consistently accumulated substantial biofilms. Nutrient poor and potentially toxic aluminosilicates accumulated very sparse, but highly diverse biofilms composed of a relatively large relative abundance of microorganisms that have been shown to have the ability to neutralize toxic aluminum. Also, Gram-positive bacteria are almost completely excluded from colonization of carbonate surfaces, but are abundant on all of the silicates.

Additionally, members of the genus *Thiothrix* (often found in mid-ocean ridge environments) show an affinity for basalt in both pure and mixed cultures, where it competitively excludes other SOB. These results suggest that adaptations to specific rocks are retained despite displacement of the organism in time and space from an ancestral rock habitat.

Is Diamond a repository of mantle helium and noble gases ?

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The high $^{3}He/^{4}He$ ratios observed in some oceanic island basalts has been explained by the presence of a primordial undegassed reservoir, a model now often considered untenable. Other geodynamic models have been suggested but need further testing [1]. Considering the very high $^{3}He/^{4}He$ in diamonds from pipes, and a range spanning six orders of magnitude varying with location, age and history, we propose that diamonds can be an important repository of helium and other noble gases in Earth's mantle. Residence times of billions of years are implied from preserved internal zonation. This work has evolved from combining our review of noble gas data for natural diamonds [2], with recent data and perspectives for Earth's deep carbon through time [3]. The mantle, at depths > 150 km along continental and oceanic geothermal gradients is in the diamond stability field [4]. Considering the low solubility of C and incompatibility of noble gases in mantle silicates and oxides, diamonds trapping large amounts of noble gases can crystallize within a large volume of Earth's mantle in the presence of carbonate or methane. The true amount of diamond crystallizing will be much larger than that actually erupted [5]. The noble gases can be released when diamonds graphitize or oxidize, and the mobility of a variety of small degree melts may be the rate-limiting step. It will be important to investigate the solubility of noble gases in diamond forming melt at mantle conditions.

[1] Class C and Goldstein SL (2005). *Nature* ***436***, 1107. [2] Basu S, *et al*. submitted Earth Sci Reviews 2013. [3] Hazen RM, Jones AP, Baross J (eds) *Carbon in Earth* RIMG 75, 2013. [4] Stachel T, Brey GP and Harris JW (2005) Elements 1, 73. [5] Shirey *et al*.., (2013) *Rev. Mineral. & Geochem*. ***75***, 355.

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