Constraints on the formation mechanism of early Solar System organic matter in primitive IDPs

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Chondritic, porous interplanetary dust particles (CP IDPs) are the most primitive samples of extraterrestrial material available for laboratory analysis [1]. The individual grains in these CP IDPs are coated by layers of carbonaceous material [2], typically ~100 nm thick, which holds the grains together. We analyzed these grain coatings by X-ray Absorption Near-Edge Structure (XANES) spectroscopy [3]. The grain coatings in CP IDPs are organic and appear to have formed prior to the aggregation of the most primitive dust particles available for laboratory analysis, making the grain coatings the oldest surviving samples of the pre-biotic organic matter in our Solar System. The thickness and C-XANES spectrum for the coatings on all grains in an individual CP IDP are very similar, independent of the mineralogy of the underlying grain. This indicates that mineral specific catalysis (e.g. the Fischer-Tropsch process), one widely accepted model for organic formation in the early Solar System, was not the production mechanism for the primitive organic matter coating the grains in CP IDPs. Our observations are consistent with the alternative model, that primitive organic matter was produced by irradiation of carbon-bearing ices that condensed on the grain surfaces.

[1] Ishii *et al*. (2008) *Science* **319**, 447–450. [2] Thomas *et al*. (1996) in *Physics, Chemistry & Dynamics of Interplanetary Dust*, ASP Conf. Series **104**, 283–286. [3] Flynn *et al*. (2003) *Geochim. Cosmochim. Acta* **67**, 4791–4806.

Groundwater chemistry and the active bacterial community in a pristine confined aquifer

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Iron-reducing and sulfate-reducing bacteria are widespread throughout anoxic aquifers, but the interplay of their activity with the chemistry of groundwater is poorly defined. We quantify how the distribution of active bacterial populations varies with the chemical composition of groundwater in the Mahomet aquifer of east-central Illinois. To sample actively growing microbes, we deployed *in situ* sediment traps in 19 wells across the aquifer. We then profiled the bacterial community using terminal restriction fragment length polymorphism (T-RFLP) and 16S rRNA gene libraries. Groundwater at each well had a concentration ratio of ferrous iron to sulfide of at least 10, indicating iron reduction should be the predominant bacterial process throughout the Mahomet. The molecular analyses revealed significant populations of sulfate-reducing bacteria growing alongside iron reducers, indicating sulfate reducers are not excluded by active iron reduction. We employed multivariate statistics to compare the structure of bacterial communities across the aquifer, then analyzed these results for correlations to concentrations in groundwater of ferrous iron, sulfide and sulfate. Ferrous iron and sulfide are commonly used as indicators of the nature of microbial activity in aquifers, but we observed no statistically significant relationship between bacterial community structure and the concentration of either ion. Communities in areas of high sulfate groundwater are more similar to each other than those from areas with low sulfate concentrations. Populations of the iron reducers *Geobacter*, *Geothrix*, and *Desulfuromonas* comprise 32-34% of the bacterial community in low sulfate areas, but only 18% in high sulfate areas. Areas with a greater abundance of iron reducers also have the highest measured sulfide concentrations, indicating sulfate reducers are most active there. These results argue the relationship between iron reducers and sulfate reducers may be not only competitive, but mutualistic.