Archaea and Bacteria in an arsenic-rich shallow-sea hydrothermal system, Papua New Guinea

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The shallow-sea hydrothermal vents off Ambitle Island (Papua New Guinea) discharge hot (98 ºC), slightly acidic (pH 6), As^{III}-rich (~1,000 µg/L), chemically reduced fluids. Near the vent orifices, rocks and sediment are coated with As^{V}-rich (up to 7 wt. %) hydrous ferric oxides and green and orange biofilms. Shallow porewater chemistry changes rapidly with increasing lateral distance from the vents, approaching ambient seawater values within a few meters. Interestingly, porewater arsenic concentrations remain elevated even at 300 m lateral distance, predominantly as the oxidized As^{V} form (Price, R.E. *et al*., 2007. *Appl. Geochem.*, in press).

Bulk genomic DNA was extracted from the biofilms and from near-surface sediment samples, amplified using standard bacterial and archaeal 16S ribosomal RNA primers, and sequenced. The archaeal communities in the orange and green biofilms consist entirely of uncultured, deeply-branching Crenarchaeota. The corresponding bacterial libraries were surprisingly sparse in thermophilic phyla (e.g., Thermus, Thermotogales, Aquificales), and dominated by several typically aquatic and sedimentary taxa. As an example, Bacteria in the green biofilm were nearly half alpha-Proteobacteria; strict phototrophs were not identified.

The archaeal librairies from sediment samples along a transect were also dominated by uncultured Crenarchaeota, but a few Euryarchaeota and Korarchaeota sequences were identified. Interestingly, a number of clones were >97% similar to *Nitrosopumilus maritimus*, the first chemolithoautotrophic nitrifying archaeon and the first mesophilic Crenarchaeote in pure culture (Könneke, M. *et al*., 2005. *Nature* **437**, 543-546). Actinobacteria and gamma- and delta-Proteobacteria were ubiquitous along this same transect, and green sulfur and green non-sulfur Bacteria were found at 7.5 m and at 90 m from the vent, respectively.

In addition to gene surveys, several thermophiles were cultured from this site. Here, we report on a novel Bacterium isolated from the green biofilm on an anoxic, chemolithoautotrophic medium amended with 4,000 µg/L As^{III}. The strain, PNG2, grows optimally at ~50 ºC, but not above 60 ºC. Based on the 16S gene sequence, PNG2 is an alpha-Proteobacterium, but with very low similarity (~90%) to any sequenced environmental clones or cultured strains.

Biogeochemistry of the Salton Sea, California

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The Salton Sea is a saline, closed basin lake 70 meters below sea level in the southern desert of California. It is the largest lake in California with a surface area of 945 km^2 and an annual inflow of 1,600 million m^3. The Sea is hypereutrophic due to nutrient inputs from farm runoff, and the elevated sulfate concentration results in high rates of hydrogen sulfide production. The salinity of the Sea is 47 g/L and rising, with an annual salt load of 4 million metric tons. Construction of a salt repository is being considered to control the rising salinity, improve water quality, and maintain the Sea as a refuge for migratory birds. We estimate 700,000 metric tons of calcite are precipitating in the Sea each year, along with 7,000 tons of iron sulfide minerals. Hydrogen sulfide production rates, reoxidation rates in the water column, and atmospheric releases of H_2S have been measured. In addition, we have measured dimethylsulfide concentrations >6 uM in the surface water, which are the highest ever reported. Hydrodynamic modelling of the proposed modified Sea indicates that persistent stratification could occur, with the potential for episodic releases of hydrogen sulfide during fall mixing.