Microbial metal interactions – Thinking beyond the surface

LESLEY A. WARREN[1]*, KELSEY L.I. NORLUND[1] AND ADAM P. HITCHCOCK[2]

[1]School of Geography and Earth Sciences, McMaster University (*correspondence: warrenl@mcmaster.ca)
[2]Department of Chemistry, McMaster University

Our work combining field and laboratory integrated microbial geochemical investigation with high-resolution techniques enabling characterization and visualization at the bacterium scale (STXM), have indicated a repeated motif of socially organized microbial cooperation, 'pod' formation, that is directly linked to geochemical processes. Results will be presented from an integrated experimental approach including geochemical experimentation, scanning transmission X-ray microscopy (STXM), fluorescent *in situ* hybridization (FISH) [1], ecology and molecular genetics for our recent discovery of an environmental sulphur redox cycling consortium involving two common mine bacteria: *Acidithiobacillus ferroxidans* and *Acidiphilium sp*. The two bacterial strains are specifically spatially segregated within a macrostructure of extracellular polymeric substance (EPS), enabling coupled sulphur oxidation and reduction reactions confirmed by STXM results. Pod formation by type culture strains was induced and linked to ecological conditions and involves quorum sensing. The proposed sulphur geochemistry associated with this bacterial consortium produces 40-90% less acid than expected based on abiotic AMD models, with implications for both AMD mitigation and AMD carbon flux modeling. These results highlight how microbes cooperatively orchestrate their geochemical environment, underscoring the need to consider community activity in constraining their geochemical impacts.

[1] Norlund, Southam, Tyliszcczak, Hu, Karunakaran, Obst, Hitchcock & Warren (2009) *Environmental Science & Technology* **43**, 8781–8786.

Galapagos Islands – Tracing a volcanic groundwater system using noble gases

R.B. WARRIER[1]*, M.C. CASTRO[1], C.M. HALL[1] AND N. D'OZOUVILLE[2]

[1]Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan, USA (*correspondence: warrierr@umich.edu) (mccastro@umich.edu, cmhall@umich.edu)
[2]Galapagos Islands Integrated Water Studies (GIIWS) (pajarobrujo@gmail.com)

Noble gases dissolved in groundwater have been commonly used as conservative tracers to study sedimentary systems. Temperatures derived from dissolved noble gases in water have also been regarded as a potentially robust indicator of past climate. However, few studies have demonstrated the applicability of noble gases in identifying recharge sources and flow paths in volcanic systems. Our study attempts to characterize the hydrogeology of the volcanic islands of San Cristobal and Santa Cruz in the Galapagos archipelago. Of particular relevance is the identification of recharge areas and timing of recharge using the atmospheric component of noble gases.

Water samples were collected from springs and groundwater for both islands as well as one lake in San Cristobal and analyzed for He, Ne, Ar, Kr, and Xe concentrations and isotopic ratios. For some samples, concentrations of noble gases indicate that equilibration with air saturated water (ASW) occurred within expected temperature and altitude range values. Specifically, altitudes between 250 and 730m and temperatures of 19 and 28°C are found for San Cristobal while altitudes between 160 and 870m and temperatures between 16 and 27.5°C are found for Santa Cruz, suggesting that these are the altitude and temperature range value at which recharge occurs. For other samples, recharge altitudes derived from measured noble gas concentrations are unexpected and extend above the peaks of these islands. Similarly, noble gas temperatures (NGTs) calculated for these samples using assumed recharge altitudes do not compare with expected temperatures in these islands. While some samples indicate high altitude and low equilibration temperatures, other samples indicate high altitude and high equilibration temperatures.

Our preliminary results might suggest that re-equilibration of rain water with soil air, as in sedimentary systems, may be lacking here probably due to rapid water infiltration through fractures. Loss of noble gases by outgassing due to bacterial action might also be a factor.