Tailings pond mixed species biofilm gives metal precipitates

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Background

Our group has been interested in metal ion resistance and tolerance of bacteria growing as a biofilm compared to that of their free-swimming planktonic state [1]. As expected overall bacteria growing as a biofilm are more tolerant to metals. Recently we have moved from single model species to environmental community isolates. This study utilized the Calgary biofilm device (CBD) as a microscale reactor to cultivate mixed species biofilms directly from Alberta oil sands tailings pond sediments, under a variety of different culture conditions [2]. This approach revealed that the organisms within the biofilms strongly represented the indigenous population in the tailings used as the inoculum and contained over 10 different genera per biofilm including organisms belonging to *Pseudomonas, Thauera, Hydrogenophaga, Rhodoferax* and *Acidovorax* [2].

New results

Subsequently we have been challenging these organisms to salts of metals known to be present in the tailings ponds and at other mining sites including Cu, Pb, Cr, V, Ni, Zn, and Sr as well as Ag, due to its strong microbial biocidal activity. We observed that the mixed species biofilms showed higher tolearance to metal ion stress than a monospeci biofilms isolated from the community. The highest tolerance was to Pb and Sr. The metals Cu, Ag, Pb and Sr were found in deposits on, and within, the biofilms suggesting that the organisms in the biofilm community were seeding the crystal formation not seen in monospecie biofilms (example see Figure 1).

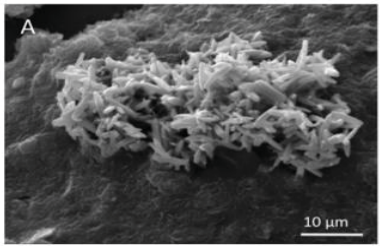

Figure 1: Scanning electron microcrosopy image of biofilm exposed to 1000 mg/L $CuSO_4$. Crystals shown to be Copper by energy dispersive spectrometry.

Summary

A process of growing mixed species biofilms directly from environmental samples has been established. This growth method demonstrated biogeochemical transformation of several metal ions to preciptiates on and within the biofilm.

[1] Harrison *et al.* (2007) *Nature Rev. Microbiology*. **5**, 928-938.
[2] Golby *et al.* (2012) *FEMS Micro. Ecol.* **79**, 240-250.

Mantle flow, slab-surface temperatures and melting dynamics in the north Tonga arc – Lau Basin

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The Fonualei Spreading Centre is a nascent series of en échelon ridges that extend north from near Fonualei volcano, on the Tonga arc front, to the Mangatolu Triple Junction in the northeastern Lau Basin. Fresh basaltic glasses dredged from these ridges afford an excellent opportunity to evaluate geochemical changes with increasing depth to the slab. Here we augment previously published major and trace element data with new Sr, Nd, Pb, Hf and U-Th-Ra isotope data for selected Fonualei Spreading Centre samples as well as present new Hf isotope data from boninites and seamounts to the north of Tonga. The Pb and Hf isotope data are used to appraise interpretations of the extent and distribution of Samoan plume mantle beneath the Lau Basin based on He and Pb isotope data. If elevated ^{208}Pb and lowered Hf isotope ratios in lavas from Niuafo'ou Island and the Mangatolu Triple Junction reflect a Samoan plume influence this is not visible in He isotopes. The boninite and seamount data indicate that the tear in the northern end of the slab may not extend east as far as the boninite locality. Mantle flow is inferred to be oriented to the southwest. In the Fonualei Spreading Centre lavas, Ce/Pb, $^{87}Sr/^{86}Sr$ and $^{208}Pb/^{204}Pb$ increase, whereas U/Th, Th/Nb and $^{143}Nd/^{144}Nd$ decrease, with increasing distance from the arc front. These changes are accompanied by increasing slab surface temperatures (725-940 ºC) as inferred from decreasing H_2O/Ce ratios. Consistent with experimental data, the geochemical trends are interpreted to reflect changes in the amount and composition of wet pelite melts and aqueous fluids derived from the slab under appropriate conditions. With one exception, all of the lavas preserve both ^{238}U excesses and ^{226}Ra excesses. Ba-Yb, Na_8-Fe_8 and U-series isotope systematics suggest that lavas from the Fonualei Spreading Centre and Valu Fa Ridge reflect fluid-fluxed melting. However, there is a change to decompression melting in lavas from the East and Central Lau Spreading Centres where slab surface temperatures reach ~ 900-1000ºC. A similar observation is found for the Manus and East Scotia back-arc basins and may reflect the absence of lawsonite in the subducted basaltic crust.