Multi-factorial analysis of surface interactions in single species environmental bacteria and model surfaces

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Environmental bacterial populations consist of diverse communities with differences in cell surface physiology and surface chemistry. Subsurface environments are made up of a heterogeneous mineralogy which also has a range of surface chemistries. Biofilm formation and structure in environmental bacteria was examined in relation to the surface chemistry of both the micro-organisms and the substrata. A set of bacteria isolated from subsurface environments were used, some Gram positive and some Gram negative. The attachment and proliferation into biofilms of these strains was tested on 3 surfaces with different surface chemistries polystyrene (hydrophobic), Tissue culture treated polystyrene (less hydrophobic, negatively charged), and Quartz (hydrophilic, negatively charged).

The surface chemistry of bacterial isolates was shown to be either hydrophobic or hydrophilic but this appeared to have no predictable influence on cell attachment and biofilm proliferation. A multi-factorial cell attachment experiment showed that attachment of bacterial cells to surfaces is highly variable and dependent on a combination of factors. The extent of attached growth differs by organism and substratum, but planktonic growth does not. The hydrophobic model surface (polystyrene) is related to greater attached growth while only two strains of organism show substantial attached growth on the hydrophilic, negatively charged mineral surface of quartz *Pseudomonas putida* Pse1 and *Sphingomonas xenophaga* strain Sph2.

These studies show that general characterisation of cell and substratum properties (i.e. hydrophobicity) do not strongly distinguish between the tendency for attachment and proliferation of growth or otherwise. Furthermore, genetically similar strains exhibit very different and unpredictable attachment profiles.

Comparison of the biogeochemical influences of angiosperm-only, gymnosperm-only, and mixed forest trees on Critical Zone processes

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Forests play a vital role in regulating many processes occurring in the Critical Zone, including weathering, element uptake, complexation, transport, and sequestration. A greater understanding of the impact of two broad groups of trees, the angiosperms and the gymnosperms, on critical zone processes is needed. Potential differences between the tree types with regard to mycorrhizal fungal associations, leaf chemistry, litter seasonality, rooting architecture and organic exudates may affect these processes. Our previous study of well-separated angiosperms and gymnosperms indicates these trees may have different interactions with some elements (e.g. Ca, Mg, Fe, K). Here, we examine an expanded element suite and use soil profiles beneath single tree types to assess the impact of a mixed forest on Critical Zone geochemistry.

Field sites A and B are in the western Cascade Mountains of Washington State, USA. Each has shallow soils underlain by granodiorite parent material. Site A contains angiosperms (*Alnus rubra* and *Acer macrophyllum*) on one half of the study transect, and gymnosperms (*Pseudotsuga menziesii* and *Thuja plicata*) on the other half. Site B is a more complex grove: the center of the 21m study transect is composed of conifers only, while each end of the transect contains both conifers and maple, but in different proportions at each end.

Plotting soil chemical data as mass change versus depth allows comparison of geochemical profiles between sampling sites. We use the site A angiosperm and gymnosperm element profiles as endmembers when interpreting the profiles of mixed vegetation at site B. For most of the element profiles examined (Al, Na, Ca, P, Fe, Mg, Mn, Ni, Co, and Pb), the coniferous middle section of site B resembles the gymnosperm profile from site A. The profiles of the two end sections appear to be intermediate between the angiosperm and gymnosperm endmembers with regard to extent of element depletion or accumulation with depth. Other elements (K, Zn, Mo) have more complicated profiles. These data indicate that at field scales, the full biogechemical impact of a mixed forest on soil geochemical profiles may potentially be interpreted as a mixing model of the net influences of endmember tree types.