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Biogeochemical gradients and microbial communities in Winogradsky columns established with polluted wetland sediments

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Abstract:

A Winogradsky column is a miniature ecosystem established with enriched sediments that can be used to study the relationship between biogeochemical gradients, microbial diversity and pollutant transformation. Biogeochemical processes and microbial communities changed with time and depth in Winogradsky columns incubated with heavy-metal-polluted wetland sediments for 520 days. 16S rRNA surveys were completed by geochemical analyses, including heavy metal proportioning, to evaluate gradients in the mostly anoxic columns. Oxygen was depleted below the water-sediment interface (WSI), while NH_4^+, Fe_2^+, S_2^- and acetate increased by one order of magnitude at the bottom. Microbial niche differentiation occurred mainly by depth and from the light-exposed surface to the interior of the columns. Chemical gradients resulting from nutrient uptake by algae and from iron and sulphate reduction mainly drove diversification. Heavy metal proportioning did not significantly influence microbial diversity as Cu and Zn were immobilised at all depths. Proteobacteria were abundant in the top water and the WSI layers, whereas Firmicutes and Bacteroida dominated down-core. Together with low diversity and richness of communities at the WSI and column bottom, changes in the bacterial community coincided with algal-derived carbon sources and cellulose fermentation, respectively. We expect this study to be the starting point for the use of Winogradsky columns to study microbial and geochemical dynamics in polluted sediments.

Keywords: heavy metal pollution, microbial indicators, biogeochemical cycles, wetland, Winogradsky columns, water-sediment interface