Where life meets rocks: Understanding P cycling during the early phases of soil formation

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Deglaciated forefields are natural environmental laboratories where the interactions betweeen life and the inorganic realm can be investigated. The forefield of the Damma glacier, located in the Swiss Alps, has been extensively studied in the framework of a multidisciplinary project (BigLink) aiming at a better understanding of the initial phases of soil formation and development. A key aspect is to determine how nutrient availability changes along the chronosequence and which are the processes driving these changes. While the influence of soil development on the distribution of phosphorus (P) forms in soil is known, still little information is available on the rates and relative importance of the processes driving these changes. Here, we present data on the stable isotopic signature of oxygen bound to P in phosphate (δ^{18}O-P) extracted from soils (between 12 and 300 years old) and plants sampled along the chronosequence.

We performed a sequential extraction of P from soils of different age including a resin extraction (plant available P), an hexanol extraction (microbial P) and an HCl extraction (as a proxy for mineral P). We also extracted P from monocotylendon grasses. All P pools were then analyzed for their δ^{18}O-P. We also measured δ^{18}O in water from soils and plants, and soil phosphatase. The mineral pool bears the signature of igneous material and shows no significant change along the sequence. The isotopic signatures of the plant available and microbial P pools are more variable and already at the very first site, they show a significant deviation from the parent material, being close to temperature-dependent equilibrium with water. Phosphorus extracted from grasses shows even heavier values and reflect equilibration with leaf water.

Phosphate from plant residue and, to a lesser extent, organic matter mineralization contribute to the plant available P pool. But overall, our data suggest P is rapidly cycled in the soil by the microbial community, starting very early in the soil development.

Sources and cycling of nitrogen in the Gulf of Trieste (N. Adriatic Sea)

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The sources of nitrate were determined using the stable isotope approach in the Slovenian part of the Gulf of Trieste and its main river tributaries Rižana and Dragonja. The sampling was performed in May, August and November 2010. At both river mouths impacts on the nitrogen cycle from municipal sewage or agriculture were observed through elevated nitrate concentrations and $\delta^{15}N_{NO3}$ values. This was most probably due to leaching of organic fertilizers from agricultural land and was more pronounced in August in Rižana and in November in Dragonja. Mixing along the salinity gradient was the main control on the spatial variations in isotopic composition of nitrate in the investigated part of the Gulf of Trieste. The relation between the isotopic composition of nitrate and its concentration showed that nitrate at most marine sampling locations was the result of mixing between its marine and terrestrial origins. In May, a strong terrestrial influence of river Rižana was observed at locations 'K 0 m' and 'ERI2 0.3 m' (Bay of Koper) with more negative $\delta^{13}C_{POC}$ values. The impact of nitrification was observed in November at all sampling locations at depths from 10 – 20 m. The correlations between $\delta^{15}N_{PN}$ and NO_3^- concentration indicated that NO_3^- assimilation was a major source of N in particulate organic matter (POM) in all sampling months. The low values of fractionation factors ε (0.4‰, 1.1‰ and 1.4‰), compared to other studies, were probably the consequence of different phytoplankton species and different growth conditions. The carbon isotopic mass balance calculation of POM revealed high contributions of allochthonous OM from freshwater inflows in May. The proportion of allochthonous vs. autochthonous OM decreased with depth. On the other hand the POM in August and November was mainly of autochthonous origin. In November a higher contribution of allochthonous OM was observed only at the surface.