Microbial Fe(III)-reduction in highly calcareous agricultural soils

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Although iron is the fourth most abundant element in the Earth's crust, plants may develop iron deficiency symptoms (iron chlorosis) due to low iron bioavailability. Iron chlorosis symptoms include insufficient leave chlorophyll content, poor growth and low crop yield. In particular, plants grown on calcareous soils of arid and semi-arid regions are prone to iron chlorosis because calcium carbonate buffers pH at high pH values where iron solubility is low and soil acidification strategies of diverse plant families – which would otherwise increase iron solubility and hence availability – are compromised. Agronomic practices to alleviate iron chlorosis include the application of inorganic iron fertilizers or synthetic iron chelators. Occasionally, temporary flooding of soils was shown to increase iron phytoavailability; it was speculated that microbial iron reducing activities mobilized iron during such flooding events. However, information on microorganisms with Fe(III)-reducing capabilities inhabiting calcareous soils is scant. To study flooding effects in relation to microbial activity in greater detail, we incubated soil slurries prepared from twenty-four different calcareous soils from southern Spain in the laboratory and monitored changes in iron mineralogy. The concentration of ferrous iron remained constant in control experiments with sterilized soils. In contrast, native soils produced significant amounts of ferrous iron from soil ferric minerals and the extent of ferrous iron production correlated well with native contents of dissolved organic carbon. The addition of organic acids that are typically found in root exudates further increased the production of ferrous iron. Comparative examination of soil samples suggests significant microbial mobilization of both poorly crystalline and crystalline soil iron oxides. Threshold values required for adequate iron nutrition of tolerant plants were reached in 18 slurries of native soils and 22 of the native soils that had been amended with organic acids. Microbial mechanisms that probably contributed to the mobilization of iron include respiration, fermentation and sulfur-cycle mediated reduction of soil iron minerals.

Distribution of branched tetraether lipids in a Black Sea sediment core: Insights into continental temperature evolution in Central Europe over the past 40000 years

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The MBT/CBT proxy based on the relative distribution of branched tetraether membrane lipids found in peat bogs, soils and ancient sediments is a promising tool for past annual air temperature and soil pH estimations. The first studies support its application in marine sediments (e.g. [1, 2]). Nevertheless the uncertainties on the source of the biomarkers (producing organisms and/or possible aquatic production) and the need of new calibration datasets clearly speak for more studies.

We present the first paleo-record of branched tetraether lipids in Central Europe from a sediment core retrieved in the Black Sea, over the past 40000 yrs BP. As the Black Sea encountered a transition from a lacustrine to a marine stage at the beginning of the Holocene period, we could explore the MBT/CBT proxy in the two realms. During the marine stage and especially during the reconnection of the Black Sea to the Mediterranean Sea, MBT/CBT-derived temperature profile seems to be biased possibly due to the major reorganization in the water column and/or the salinity shifts. However, using the MBT/CBT global lake calibration [3], the core-top yields reconstructed temperatures similar to the instrumental spring temperature in the Black Sea basin and to the present mean annual atmosphere temperature registered above the core.

Whatever calibration datasets, the Holocene/LGM reconstructed temperature drop is consistent with existing paleo datasets from the area. Furthermore, the temperature profile of the last glacial period shows synchronous variations with major climatic events recorded elsewhere in the Northern Hemisphere.

[1] Weijers *et al*. (2007) *Science* **315**, 1701–1704. [2] Rueda *et al*. (2009) *Org. Geochem.* **40**, 287–291. [3] Sun *et al*. (2011) *J Geophy Res-Biogeo* **116.**