Time and temperature dependency of carbon dioxide triggered metal(loid) mobilization

JUDITH MEHLHORN[1]* AND BRITTA PLANER-FRIEDRICH[1]

[1]University of Bayreuth, Environmental Geochemistry Group, Universitätsstrasse 30, 95440 Bayreuth, Germany (*correspondence: judith.mehlhorn@uni-bayreuth.de, b.planer-friedrich@uni-bayreuth.de)

Carbon capture and geologic storage is a frequently discussed option to reduce atmospheric CO_2 concentrations with the risk of leakage from storage sites to overlying aquifers and soils. The long-term effects of CO_2 on a soil can be investigated at natural analogues, e.g. cold volcanic CO_2 exhalations, so-called mofettes. We could show from natural samples of mofettes in a wetland area in Czech Republic that, compared to CO_2-unaffected references, a strong mobilization of metal(loid)s (e.g. As, Pb) occurred due to soil acidification and decreased iron (hydr)oxide content (by 85 % to 1.2 ± 0.4 g kg^{-1}), the main sorbent in CO_2-unaffected soils. However, some metals (e.g. Ni, Cu) seemed to profit from organic matter accumulation in mofettes by resorption and showed a net-immobilization.

Studying natural mofette sites can reveal long-term effects of CO_2 on a soil, but the processes and dynamics that occur immediately after mofette formation (or CO_2 leakage from storage sites) remain unknown. We started a long-term laboratory batch experiment, in which we simulate the early state of a mofette by exposing hitherto CO_2-unaffected soil and water from the Czech wetland site to gaseous CO_2 at 15, 22, and 35 °C with continuous monitoring of redox potential, pH, and aqueous concentration of As, Cu, Fe, Mn, and S.

Initial results, after only 14 days of CO_2 exposure, show a decrease in redox potential and pH towards suboxic conditions. The aqueous concentration of all considered elements increased, but with interesting differences: while Mn already reached a constant level after 3 days (increase to 199 % of initial concentration), S, As, Cu, and especially Fe are continuously mobilized from the solid phase (so far to 149 %, 143 %, 172 %, and 183 %, respectively). For these 4 elements, mobilization increased with temperature, indicating a microbial influence on the mobilization processes.

The experiment will be continued until a constant concentration level of all elements in the aqueous phase is reached. Further analysis, especially of the solid phase at the end of the experiment, will reveal details on mobilization processes and rates and increase our understanding of CO_2-induced changes in soils.