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Methylmercury production and release in Fe-rich mineral and organic soils from Iceland

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Soils in subarctic regions accumulate anthropogenic mercury (Hg) emitted in temperate and tropical regions and transported over long distances in the atmosphere. Anoxic conditions in these soils can lead to microbial formation of methylmercury (MeHg), a potent neurotoxin, which can bioaccumulate along the food chain. The methylation of Hg in Icelandic soils, which are commonly high in Fe and organic matter contents, has not been studied to date. Yet, these soils are particularly relevant to evaluate the role of Fe and C in Hg methylation. During water-saturated periods, which may intensify with increasing impacts of climate change (e.g., floodings, permafrost thaw), Hg methylation may be related to microbial iron and/or sulfate reduction.

This study aimed to quantify MeHg production in Icelandic soils and evaluate the role of soil depth, Fe speciation and organic C content in MeHg production. The soil selection included 6 topsoils (0-25 cm) and 3 subsoils (70-130 cm) with varying C content (4-25 wt. %), Fe content (4-11 wt. %) and C:Fe molar ratio (2-31). The soils were incubated at a solid to liquid ratio of 1:10 during 4 months in an anoxic atmosphere. During the incubation, we followed in parallel: (i) MeHg production and release in the aqueous phase with MeHg concentrations measured by GC-ICP-MS, (ii) Fe reduction and solid-phase speciation change by X-ray absorption spectroscopy, and (iii) microbial community dynamics by 16S rRNA gene amplicon sequencing.

The MeHg production was higher in the topsoils compared with subsoils, although the C content was similar. Among the topsoils, the highest Hg methylation potential (10%) and release to the aqueous phase (8% of produced MeHg) was observed in a soil with a low C content (6%). The MeHg production trend correlated in particular with the relative abundance of *Geobacter*, suggesting a key role of these Fe reducers in Hg methylation. The gradient of MeHg production over these 9 contrasting soils from Iceland shows that a combination of Fe and C biogeochemical cycles shapes Hg methylation in Fe-rich subarctic soils.