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Chemical weathering controls on the accumulation of Nickel in rice (*Oryza sativa* L.) cultivated in basalt-derived paddy fields

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Chemical weathering intensity controls the accumulation of Nickel in rice (*Oryza sativa* L.) cultivated in basalt-derived paddy fields

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Globally, a high concentration of nickel (Ni) in agricultural soil is closely related to basalt weathering. Rice grains readily accumulate Ni, however, the evolution of Ni distribution and mobilization in paddy fields with basalt weathering remain unclear.

This study investigated the distribution, geochemical fraction, and mobilization of Ni in basalt bedrock-paddy soil-rice plant continuums under the contrasting climates in China. Results show that Ni was more inclined to remain in the soil during basalt weathering in tropical rather than temperate climates. The concentration of Ni in rice grains from the studied temperate regions was higher than that in the tropical regions. The concentration of Ni bound to Fe (hydro)oxides in paddy soil from temperate regions was five times higher than that in tropical regions. In contrast, the concentration of Ni found in phyllosilicate clays in paddy soils (smectite/illite) from the temperate regions was only ~1/4 of that in the tropical paddy soils (kaolinite), and the ratio of Ni concentration in phyllosilicate clays to highly reactive Fe (hydro)oxides in paddy topsoil in temperate regions was one order of magnitude less than that in tropical regions, which contributes to the low bioavailability of Ni in tropical paddy soils. Furthermore, the accumulation of Ni in rice grains was insensitive to soil pH in tropical regions, but showed significant negative correlations with the degree of chemical weathering in temperate and tropical regions.

These observations support the hypothesis that chemical weathering and the dissolution-recrystallization of Fe (hydro)oxides induced by frequent redox fluctuations in paddy soils cause Ni repartition between Fe (hydro)oxides and phyllosilicate minerals, which influence Ni geochemical cycling and bioavailability, and fundamentally regulate Ni accumulation in rice.