Environmental geochemistry in relation to agriculture and human health in Hainan Island, China

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As the biggest island in tropical China, Hainan Island possesses advantageous hydrothermal conditions, high biodiversity and soil diversity.

The environmental geochemistry of this area is determined mainly by the special geological background and pedo-geochemical processes, which are characterized by the diversified lithology and tropical soil formation processes.

One major problem is the high Al toxicity of soils of the island. Total and exchangeable aluminum of soils in different weathering stages are high as compared to that of parent materials. About a half of the studied soils contain exchangeable aluminum higher than the threshold value of causing hazard to plant. Soils developed from basalt in the north part of the Island have the highest aluminum content while that from marine deposit lowest.

Agricultural production, including tropical cash crop cultivation, is affected soil acidity and acidification. Rubber cultivation has an accelerated acidification. Rice and upland crops also changed the acidity of soils of the Island.

Calcium is severely deficient in soils, surface water and plant. One nutritional problem is the intake of Ca of local people from their daily diet is much lower than that of nation-average as well as that of subtropical region.

It is suggested that based on the understanding of the environmental geochemistry problems, we are able to adjust agricultural structure in the way of interfering the cycling of some important plant nutrients for improving agricultural production and human health in this tropical Island.

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Dynamic reactivity of metals in soils – Relevance to uptake by plants

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To predict the availability of metals to biota, it is necessary to understand both solution and solid phase supply processes in the environment. The kinetics of metal release from particles and complexes can limit the rate of uptake of metals. Complex dissociation rates in solution can be measured by several approaches. The rate of release of metal ions from particles in soils and sediments has been difficult to assess directly. The technique of DGT (diffusive gradients in thin-films) had been used to measure dissociation kinetics in solution and release from solid phase in soils. DGT perturbs the equilibrium system by lowering the local concentration of metals and measuring their supply. By modelling the dynamics of the DGT-soil system, kinetic information, such as the rate constant of supply from the solid phase and the labile pool size of metals, can be obtained.

Measurements have been performed in several metal soil systems. The results show that the rates of Zn and Cd supply are generally faster than those of Ni for the same soil. Relative slow rates of supply for Ni are consistent with general understanding of its kinetics of release from complexes. In clay soils the rate of release of Zn and Cd are generally too fast to measure, but measurable rates can be observed in some sandy soils. The rate of supply of Zn in freshly spiked soils is higher than in historically contaminated soils, indicating that the aging effect relates to the kinetics of resupply and cannot be solely attributed to a fraction of Zn being rendered unavailable. The rate of As release from solid phase to solution in the rhizosphere was much slower than that in the bulk soil. These kinetic findings are relevant to the uptake of metals by plants because DGT emulates the prime effect of the plant on soil, namely removal of metals.

To assess the metal dynamics in soils in relation to uptake by plants, we have used the measured Michaelis-Menten parameters of plants to predict the fluxes of metal that they remove from a given soil. The fluxes were comparable to the fluxes measured by DGT, showing that plants and DGT perturb the metal chemistry of the soil to similar extents. The soil kinetic parameters measured by DGT which influence the metal uptake by the device, will therefore also exert a control on the metal uptake by plants.

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