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Nickel and manganese transfer from soil to plant in lateritic mining soils from New Caledonia

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New Caledonian ferritic soils (more than 50 % of iron) are naturally rich in metals (chromium, nickel, cobalt, and manganese), deficient in major nutrients (nitrogen, phosphorous, and potassium), and unbalanced for the calcium/magnesium ratio. Under these particular ecological conditions, New Caledonia, recognized as a hot-spot of biodiversity, is a natural laboratory to study and understand the adaptation strategies of plants to metalliferous soils, and particularly the tolerance and (hyper)accumulation of metals by plants. Moreover, understanding such mechanisms is essential to develop rehabilitation or phytoremediation techniques for polluted soils, as well as phytomining techniques.

Thus, in order to understand the soil – plant relationship and metal mobility along a toposequence in a future nickel mining massif, field experiments were conducted in an isolated ultramafic massif of New Caledonia. Several plant species of two endemic and frequent plant genera were chosen: Tristaniopsis guillainii and T. calobuxus (Myrtaceae), and Phyllanthus serpentinus and P. favieri (Euphorbiaceae), because of their nickel and/or manganese accumulating or hyperaccumulating nature. Leaves, twigs, and roots of all plants were collected along the soil sequence and their associated rhizospheric and bulk soils were sampled. Next, a series of characterization techniques were adapted and then coupled to cryogenics. The combined use of those multiple techniques (cryo-microtomy, cryo-SEM, μXRF, cryo-XAS, and soil characterization) allowed to study co-location and speciation of nickel and manganese in the different plant organs and soils (rhizospheric and bulk).

Bioaccumulated nickel and manganese had different distribution patterns. In leaves, Ni accumulated in non photosynthetic tissues (e.g. epidermis) whereas Mn preferentially accumulated in mesophyll whatever the plant species. Nevertheless, in spite of a different speciation in soils, nickel and manganese were both found as similar divalent organometallic complexes in the different plant parts.