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Major Role of Iron and Manganese Reducing Bacteria in the Dissolution , Redistribution and Availability of Trace Metals Associated to Oxy -hydroxides in Soils (e.g. Ferralsols)

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Fe and Mn oxides are present in different types of soils and in particular in Ferrasols where they are very often time rich in metals like Ni, Co, Cr , Al. In New-Caledonia an higher mobility and availability of trace elements where observed in colluvio-alluvial and plain Ferralsols ,mainly after rainy events . In such soils the trace metals are associated to Mn and Fe oxides . It appears that reduction processes may be involved to increase the metal mobility to water and the availability to plants. . . . Depending on water and organic matter contents , bacterial activities may control redox conditions and direct or indirect oxide weathering and dissolution of major and trace elements. Studies have been done to determine this possible involvement.

After Chemical , physico-chemical and mineralogical analysis of soils originating from Ouenarou , New Caledonia , experiments have been performed to determine the possible role of Mn and Fe –reducing bacteria on weathering of oxy-hydroxides and on behaviour and fate of metals in relation with organic matter biodegradation .

Soils have been incubated in different conditions (aeration , nature and content of organic matter, inhibitors of bacterial activity) in experimental devices . Analysis have been done on the gaseous , liquid and solid phases to measure microbial activity , organic matter biodegradation and minealization , mineral element dissolution , transformation and weathering of the solid phases .

Results show , in anaerobic conditions , the major role of bacterial activities on soil

organic matter biodegradation and the correlation with dissolution of ferric and manganese oxides by bacterial reduction processes . Such weathering is at the origin of the release of cobalt ,nickel , and chromium . The development of aero-anaerobic bacteria and anaerobic bacteria able to reduce iron and to dissolve ferric oxides was observed. Weathering of oxides was also well determined by analysis of the solid phase by different mineralogical and chemical methods . But it is of major interest to underline an evolution of the distribution of metals in the different geochemical compartments and a metal transfer from the less available phase (well cristallized ferric oxides)to the more available (water soluble, exchangeable) and more « reactive « compartments such as poorly –crystallized Fe –oxides .

Experiments with pure strains of bacteria isolated from soils and with synthetic goethite substituted or not in metals (Al, Co, Cr , Ni) allow to observe the release of metals by bacterial reduction of goethite , the impact of substituted metals on kinetic of dissolution (either congruent or inhibited depending on the metal present in the goethite) and the importance of contact or proximity between bacteria and minerals .

So the coupling of biodegradation of soil organic matter with the activity of iron and manganese reducing bacteria play a major role in the behaviour and availability of trace elements in soils having trace metals associated with or substituted in iron and manganese oxides and oxy-hydroxides .Such processes appear strongly involved in the increase of the availability and transfer of metals to soil solution and plants .The knowledge of different parameters are in progress but improvements are needed on the nature , dynamic and activity of bacterial communities