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Perspective

Concentration and mobility of lithogenic trace metals in soils: significance of anthropogenic lateral redistributions

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1. Introduction

One of the main current concerns regarding soil quality is the presence of trace metals that constitutes a risk of toxicity for plants and animals [1, 5, 7, 11]. Trace metals in soils can have either a lithogenic origin when they inherit from the lithosphere or an anthropogenic origin when they result from man's activities (mining, metallurgy of non-ferrous metals, combustion of fossil energy sources, solid waste or sewage sludge) [5]. Recent studies showed that concentration of lithogenic trace metals in soils could not be explained without taking man's activities into account.

2. Redistribution of lithogenic trace metals in cultivated lands

Concentration of lithogenic trace metals in soils is usually explained by the weathering of primary minerals that are inherited from the bedrock. Weathering leads to accumulation or impoverishment of mineral phases with their consequences on trace metal concentration in saprolite and soil [2, 5]. Lateral redistribution of soil materials along slopes by erosion is also a major process explaining trace metal concentration in soils in cultivated lands [9]. Detailed spatial analysis of Cr concentration in soils developed in weathered metamorphic rocks showed that it varied according to material redistribution due to the effect of tillage: homogenisation of Cr concentration in the topsoil and accumulation of Cr-rich materials in areas located above former edges because of tillage erosion [10]. Thus, in cultivated lands, presence of lithogenic trace metals in soils results from both vertical (rock weathering and pedogenesis) and lateral (tillage homogenisation and erosion) redistribution processes.

3. Consequences for mobility of anthropogenic trace elements in soils

Mobility of trace metals in soils depends on the chemical and physical properties of the soil and especially on their speciation [5, 7, 11]. Because of lateral redistribution processes, soil materials can be moved downslope and exposed to new conditions leading an increase in the mobility of trace metals [3, 11]. Quantin et al. [8] showed that under reducing conditions similar to those existing in waterlogged soils, chemical and bacterial processes can reduce Mn oxide and release Co and Ni that were located within the Mn-oxide lattice with an increase in their bioavailability as a consequence. The possible toxicity of Cr in waterlogged soils was also shown by Cooper [4] because of the presence of Cr(VI), which is soluble and toxic. A seasonal release of trace metals was recorded in wetlands by Olivie-Lauquet et al. [6]. Their results showed that redox processes in the presence of organic ligands cause the transfer of trace metals from the solid phase to the soil solution.

4. Conclusion

These new results show clearly that in cultivated lands and in land that have been cultivated for years in the past, the concentration of lithogenic trace metals in soils cannot be only explained by natural processes. They are affected by redistribution processes along hillslopes that are related to agricultural usage of soils. As a consequence, soil materials can be moved

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towards areas where the mobility and toxicity of trace metals are much greater. Thus, a trace metal can be endogenous, but with a concentration and mobility strongly man-affected. Finally, such results point out the necessity to study soil distribution as a result of both pedogenesis and modifications by man, and to analyse the consequences of soil material redistribution on metal trace mobility.

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