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The effect of secondary phyllosilicates on Ni and Cr trapping in serpentine soil developed under temperate climate of SW Poland

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Ultramafic rocks such as peridotites and/or serpentinites occur sparsely on the Earth's surface. However, because of unusual geochemical properties (elevated Ni and Cr content) of the parent material, soils developed in ultramafic areas are of high interest. With the exception of shallow young and very old pedons, soils derived from both peridotite and serpentinite are commonly called serpentine soils. In Poland, ultrabasic rocks are known only from the large geological unit called the Fore Sudetic Block (SW Poland). Associated serpentine soils have principally developed from serpentinites and/or partially serpentinized peridotites. Traces of non-ultramafic material of glacial origin were also evidenced within most of the investigated serpentine soils (Weber 1981, Kierczak *et al.* 2007).

It is well admitted that two types of pedons can result from weathering of ultrabasic rocks under temperate climate: (i) well drained and shallow with weakly developed C horizon and (ii) poorly drained with well developed saprolite (Berre *et al.*, 1974). In terms of clay mineralogy, vermiculite is stable phase in well drained soils, whereas smectites and/or mixed layer chlorite-vermiculite occur within poorly drained pedons (Bonifacio *et al.*, 1997), serpentine and chlorite being present along the profile.

The studied soil profile, derived from partially serpentinized peridotite, is located on the top of the hill in the vicinity of the village Szklary (SW Poland). The pedon is well drained, shallow ($<$40 cm) with two distinguished horizons (A and A/C). The cation exchange capacity is highly saturated and varies from 22.5 to 18.5 upwards the profile. Ca/Mg ratio is always <1 and their pH (H_2O) is neutral and do not vary significantly (7.2 – 7.4). Thus, the soil was classified as Hypereutric Magnesic Siltic Cambisol (WRBSR-FAO classification). The parent rock contains serpentine and forsterite as main minerals, amphiboles and chlorite often associated with spinel or forming single crystals are also present as minor phases. Furthermore, electron microprobe study evidenced that serpentine and forsterite are Ni-rich whereas chlorite and spinel are Cr-bearing phases. Primary minerals, except of spinel, are generally susceptible to weathering in soil conditions and may release part of Ni and Cr. Therefore, identification of the clayous weathering products provides information about the secondary trapping of Ni and Cr and thus relative immobilization of these metals in soil.

Ni bearing serpentines are always evidenced by X-ray diffraction in soil clay fraction (<2 μm), but their relative amount decreases in the finest clay fraction (<0.2 μm). Furthermore, proportions of smectites, which are the main Ni bearing secondary phyllosilicates, increase in the fine clay fraction (<1 μm) of investigated soil. In Szklary, smectites, probably nontronite (Fe-rich smectite), which is a usual weathering product of serpentine, occur in the well drained uphill location, whereas Bonifacio *et al.* (1997) show the accumulation of smectites in lower landscape positions. Petrographic observations of soil thin sections evidenced that chlorite associated with spinel do not display any weathering effects in the investigated soil from Szklary. However, chlorite is always present in the soil clay fractions. No vermiculite has been found in the soil clay fractions but presence of interstratified chlorite/vermiculite suggests weathering of chlorite.

In Szklary, smectite is the most important secondary Ni-bearing phyllosilicate and also the major constituent of the finest (<0.2 μm) soil clay fraction. It plays a key role in the secondary trapping of the Ni mobilized during the early weathering of primary Ni bearing silicates such as forsterite and serpentine. The weathering of chlorite in the early stage is evidenced, but more experiments are needed to understand if the alteration of chlorite would favour the Ni and Cr mobility, or on the contrary improve the metal immobilisation in smectites.

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