Mineral chemistry of pyrochlore in residually inherited Fe-P-Nb-laterite ore bodies at Sokli carbonatite complex

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The Sokli carbonatite complex in Northern Finland has undergone extensive laterization and a vertical profile through the sequence varies from 0 to 70 metres. It contains a partially weathered saprock, saprolite, laterite covered by glacial deposits. The laterite is strongly enriched in phosphate, niobium and tantalum.

Locally the weathering profile is covered by a black Fe-P-Nb-REE enriched bed, 5 – 30 mm thick, which is situated directly beneath the glacial deposits and is interpreted to be residually inherited.

The residual bed contains pyrochlore which deviates texturally and chemically from the pyrochlores in main laterite and in fresh rock by being smaller (20µm) in diameter and by their euhedral crystal habit. These grains typically contain high density of fluid inclusions. SEM-EDS and microprobe study indicate that A-site occupancy is dominated Ca and Na of the pyrochlore structure while, along with the weathering, those two ions are detected to become partially replaced by K, Sr, Ba in laterite profile. Contradictory to the pyrochlores in fresh carbonatite-phoscorite and in laterite profile, the pyrochlore in residual bed lack uranium and has extremely low contents of thorium.

The role of Iron redox cycling for the natural acidification of ground water

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In wide areas of Western Australia (WA) springs are occuring that release acidic ground water ($pH<3$) into gypsum-rich playas. The origin of the acidity is related to the oxidation of Fe(II) and the subsequent precipitation of ferric (hydr)oxides (McArthur *et al*, 1991). The similarity of these systems to acidic mining lakes (AML) is striking. AML are forming upon oxidation of Fe(II) and sulfate-rich ground water, the pH typically ranges between 2.7 and 3.3 and is buffered by the solubility of schwertmannite (Regenspurg *et al*., 2004). Acidic conditions in AML are stabilized by an acidity-driven iron cycle at the sediment-water interface, where oxidation and reduction of Fe balance each other with respect to the alkalinity budget (Peine *et al*, 2000).

We therefore determined Fe(III) reduction rates, Fe(III) mineralogy and the Fe(III) reducing microbial community at three sites from iron-oxide rich (up to 7 % dithionite extractable Fe) soil material fully saturated with acidic ground water. The maximum Fe(III) reduction rate was 4.8 nmol g^{-1} h^{-1}, a value similar to AML. Jarosite was the onliest Fe(III) XRD detectable mineral, schwertmannite appeared to be missing. The occurrence of *Acidophilium cryptum*, an acidophilic Fe(III)-reducing bacteria could be proved. These observations suggest that also in the acidic ground waters an acidity driven iron cycle exists. They further imply the question how such a low pH can develop in a system that, contrary to AML, is not affected by pyrite oxidation.

Significant acidification from Fe(II) oxidation occurs only, if the corresponding anion originates from a strong acid, such as sulfate. Fe(II) in the ground waters from WA are regarded to be generated during weathering of Fe(II) bearing minerals and/or reductive dissolution of Fe(III) minerals. Both processes, however, generate HCO_3^- as the corresponding anion. We therefore postulate that HCO_3^- has been replaced by sulfate through the dissolution of gypsum and deposition of $CaCO_3$ as so-called calcretes:

$$Fe(HCO_3)_2 + CaSO_4 \rightarrow CaCO_3 + FeSO_4 + 2\,H^+$$

References

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