Downstream of spring emergence, because the solubility of ironIII(hydr)oxides is practically nil, and because dissolved Fe^{2+} extremely inhibits calcium-carbonate precipitation, removal of ferrous iron by precipitation of Fe^{3+} compounds is prerequisite to enable calcium-carbonate deposition farther downstream.

Cool springs precipitating aragonite and magnesian calcite, Eastern Alps: significance of Mg/Ca ratio

Sanders, D.[1], Wertl, W.[1] & Rott, E.[2]

[1] Faculty of Geo- and Atmospheric Sciences, University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria;
[2] Faculty of Biology, University of Innsbruck, Sternwartestraße 15, 6020 Innsbruck, Austria

On the Silvretta metamorphic basement near the city of Landeck (Eastern Alps), aragonite and magnesian calcite precipitate from ‘cool’ or ‘ambient’ (non-thermal, <20 °C) limestone-depositing springs. The Silvretta basement is part of the Austroalpine structural unit of the Eastern Alps; in the considered area, the basement consists of a monotonous series of quartz phyllite overthrust by more variegated series composed mainly of schists with albite blasts, garnet mica schist, gneiss, and amphibolite. In the recharge area of the springs, the basement hosts copper-iron sulphide deposits with Mg-Ca-Fe carbonates as gangue minerals. Limestone deposit A is situated between 800 to 910 m a.s.l. and consists of, both, fossil spring limestones and actively-forming limestones; present mean annual temperature (MAT) at site is about 8 °C. Spring-limestone deposit B extends from 1680 m to 1800 m a.s.l., and is entirely fossil; $^{234}U/^{230}Th$ dating of a sample of aragonitic cementstone yielded an age of 8.9±0.3 ka. At deposit B, present MAT is below zero °C. The fossil spring limestones at both locations, and the actively-forming limestones at location A, are dominated by aragonite and magnesian calcite. Fossil spring-associated limestones are represented by phytoclastic tufas, intraclastic tufas, moss tufas, and slope breccias. Wood fragments, grass shoots, and moss tufts are locally permineralized by calcium carbonate; in addition, calcified pellets are common. At location A, precipitation of aragonite and magnesian calcite takes place in three moss-tufa deposystems. The springs shed an uncommon type of Mg-(Ca)-HCO_3^- waters with Mg/Ca ratios between about 2.6 to 5. We suspect that these spring waters were produced by oxidation of metal-sulphide mineralizations and associated dissolution of Mg-Ca-Fe carbonate gangue minerals. Precipitation of aragonite and magnesian calcite from these cool springs results mainly from elevated Mg/Ca ratio. Comparison of our data with carbonate precipitation in diverse other depositional environments underscores that carbonate mineralogy and polymorphy are primarily steered by Mg/Ca ratio.

Geochemical fingerprinting of Coltan ores by machine learning on uneven datasets

Savu-Krohn, C.[1], Rantitsch, G.[1], Auer, P.[2], Melcher, F.[3] & Graupner, T.[3]

[1] Department of Applied Geosciences and Geophysics, University of Leoben, Peter-Tunner-Str. 5, 8700 Leoben, Austria; christian.savu-krohn@unileoben.ac.at; gerd.rantitsch@unileoben.ac.at;
[2] Chair for Information Technology, University of Leoben, Austria; auer@unileoben.ac.at;
[3] Federal Institute for Geosciences and Natural Resources, Stilleweg 2, 30655 Hannover, Germany; frank.melcher@bgr.de; torsten.graupner@bgr.de

Columbite (niobium rich)-tantalite (tantalum-rich) ore concentrates (Coltan) have been identified as one of several raw materials that were used to finance the civil wars in Central Africa. The term „Blood Coltan“ was coined in the Congolese civil war as the sale of such minerals powered the fighting, especially in the eastern provinces of the Democratic Republic of the Congo (DRC). The United Nations took the initiative and an expert group proposed that measures should be taken to certify tantalum-bearing mineral products along their trade chain (United Nations Security Council 2006). Therefore, Coltan ores were obtained from the Ta-Nb-Sn provinces in Africa (DRC, Rwanda, Burundi, Uganda, Mozambique, Ethiopia, Ghana, Nigeria and Namibia) and analyzed geochemically (Melcher et al. 2008, 2009, this volume). Preliminary results demonstrate that the major and trace element concentration patterns, mineral assemblages in the ore concentrates, and zoning characteristics in the different pegmatite provinces from Africa distinctly differ from each other (Melcher et al. 2008, 2009, this volume), thus geochemical fingerprinting may be applied to distinguish mineral matter produced within regions affected by the civil war from other sources.

Two modern machine learning techniques, Boosting and Support Vector Machines are introduced and applied to a data set, describing the geochemical composition of Coltan ores from the NE margin of the Congo Craton and the adjacent Kibaran Belt in Central Africa. Soft margin Linear Programming Boosting and soft margin Support Vector Machines respect the nonparametric properties of geochemical data. To respect the presence of uneven datasets, a parameterized performance measure λ together with common methods for its optimization is considered. Optimization of the classification function threshold improves the performance as class importance is shifted towards one of those classes. The optimization of their learning parameters results in an accuracy of up to c. 90 %, if spot measurements are assessed to estimate the provenance of ore samples originating from two mining districts. The average performance of the Support Vector Machines is significantly better or at least equal compared to that of Linear Programming Boosting.

The study demonstrates that methods from machine learning can be applied successfully to estimate the provenance of Coltan ores with unknown origin. As an important implication, the classifier can be adapted on the