Are there interrelations between iron oxide surface area and the trace metal content?

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We measured trace metal concentrations of, e.g., uranium and vanadium in secondarily formed iron oxide encrustations on oxidatively weathered black shales by using electron microprobe and laser ablation ICPMS. The results obtained with a spatial resolution at the micro-scale were complemented with nano- to micro-scale measurements of surface topography. Vertical scanning interferometry and confocal laser scanning microscopy were the tools of choice for the study of surface topography due to their nanometer-scale height resolution and an almost millimeter-size field of view. This combination of methods was used to avoid surface measurement artefacts caused by, e.g., steeply dipping surface component flanks.

The direct measurements were then used to calculate surface roughness parameters, i.e., the peak-valley height, *Rt*, ten point surface height, *Rz*, and the root mean square roughness, *Rq*, as well as the surface area ratio, *F*, that quantifies the *total* surface area. We introduce the application of new convergence graphs calculated for each roughness parameter, respectively. For this purpose roughness parameters were calculated for sample sections of decreasing size.

Convergence plateaus result for *Rz* and *Rt* and indicate that at least two size groups of surface components exist of the iron oxides, i.e, ferrihydrate, goethite, and hematite. Small-scaled components have typically a vertical and lateral extension range of several hundred nanometers while large-scaled components are in the micron range. Different values of the surface roughness parameter *Rq* indicate different vertical ranges of height deviations. Thus, we can distinguish between uniformly and variably sized components forming the iron oxide surfaces. Variability in *F* is in the range of an order of magnitude and demonstrates the impact of the surface component on the fluid-rock interface size.

Convergence graphs of roughness parameters suggest a possible interrelation between the trace metal concentration of iron oxide encrustations and their surface architecture. Higher encrustation/substratum trace metal concentration ratios were found for those encrustations characterized by the small-scaled surface components mentioned above.

These data that characterize the types and dimensions of surface morphology components of different iron oxide minerals may provide important constraints for an interaction between rock surfaces and colloidal trace metal transport and capturing in the presence of newly-formed iron oxides during weathering.