

2.1.P17

Characterisation of sediments – Bulk analysis compared to image analysis combined with EDAX

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Sorption processes in aquifers are among the parameters controlling the transport and concentration of organic contaminants in the ground water. In aquifers characterised by low organic carbon content (OC < 0.1 wt%) the minerals with high specific surface area and reactivity contribute to the sorption process. Thus, this has to be taken into account in ground water modelling. But how do we determine the amount of minerals that can contribute to a sorption process?

Results and Discussion

In the present study we compare the combination of Image Analysis (IA) of micrographs and EDAX (IA-EDAX) with bulk analysis. For this purpose we have selected three different sandy, low OC aquifers previously described [1].

Using X-ray diffraction, wet chemical analysis, and EDAX we have identified groups of minerals as well as their fraction by volume. Next we have used IA to calculate the fraction of the different minerals on surface area basis.

The results (Table 1) demonstrate that the amount of volumetrically determined quartz is more than twice the quartz content determined from IA-EDAX. This means that although the quartz content is high by volume, the quartz grains themselves have low surface area resulting in a low surface fraction available for sorption. By contrast the amount of chemically determined total Fe-oxides are two orders of magnitude lower than Fe-oxides determined from IA-EDAX. Thus, even a low FeO content causes a very high surface area fraction available for sorption. This high surface fraction is most likely caused by the high surface area of FeO, and by surface coating of other grains.

In conclusion, IA-EDAX provides information on the available mineralogical surface area where sorption processes actually can take place. IA-EDAX is a relatively time consuming method, but this kind of information is not derived from chemical bulk analysis methods.

Table 1. IA-EDAX compared to bulk analysis of the three Danish aquifers: Drensted, Vejen and Vestskov.

MINERAL	DRENGSTED		VEJEN		VESTSKOVEN	
	IA-EDAX	Bulk	IA-EDAX	Bulk	IA-EDAX	Bulk
QUARTZ, %	40	85	25	90	15	80
Fe-OXIDE, %	35	0.3	40	0.25	70	0.3

References

- [1] Madsen L., Lindhardt B., Rosenberg P., Clausen L., and Fabricius I. (2000) *J. Environ. Qual.* **29**, 1488-1500.

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Cr(VI) reduction by green rust

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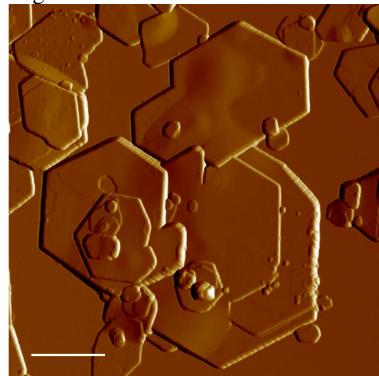
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Cr(VI) is a known carcinogenic contaminant sometimes leaked from industry or leached from fly ash to soil and groundwater. It is soluble and toxic in low concentrations. Cr(III) is considered nontoxic, even in relatively high concentrations and is an important trace metal in mammalian metabolism. Therefore, groundwater remediation and waste water treatment seeks to reduce Cr(VI) to Cr(III). Green rust, a layered, mixed-valent iron hydroxide, is known to reduce Cr(VI) to Cr(III) quickly and effectively. In order to optimise the potential of green rust as a remediation agent, understanding about the reaction is necessary.

In this study, a sulphate green rust was reacted with chromate. Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM) and Scanning TEM (STEM) were used to characterize the composition, structure and morphology of the intermediate and end products. Upon reaction with Cr(VI), Cr(III)-substituted ferrihydrite is produced. When left in solution, the ferrihydrite dissolves and reprecipitates as Cr(III)-substituted goethite.

Goethite has low solubility and the incorporation of Cr(III) into the mineral structure decreases solubility even more. We consider goethite a very effective sink for trivalent chromium. The observed reactions likely take place in natural environments, at the redox boundary in aquifers where green rust is stable, but also in permeable reactive barriers (PRB) that use metallic iron. When considering effective alternatives for remediation of redox active contaminants, green rust in suspension might be one of the answers.



AFM deflection image of green rust single crystals. The scale bar is 500 nm.