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In-situ mineralogical-geochemical analysis of salt, sedimentary and crystalline rocks using a portable X-ray fluorescence analyzer

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In the site selection procedure for a repository for heat generating radioactive waste in Germany, rock salt, claystones and crystalline rocks are considered as potential host rocks. The knowledge about the geochemical and mineralogical composition of rocks is essential for their characterization and for evaluation of suitability of a future repository for nuclear waste. This study describes a method, which allows a rapid determination of the relevant major, minor and trace element content of salt, sedimentary and crystalline rocks in the field by using a portable energy dispersive X-ray fluorescence analyzer (mXRF).
For the determination and calibration of the main, minor and trace element content different samples were tested by using a Niton XL3t mXRF from ThermoFisherScientific. The mXRF is equipped with a 50 kV Ag anode and allows the analysis of up to 30 elements from Mg to U. The detection limit depends on the element of interest and varies between 1 ppm and 1 wt.-% (manufacturer information).
In a first step the calibration for rock salt samples was performed. Powder samples, originating from the Gorleben salt dome (Staßfurt z2 Hauptsalz, Upper Permian), which were previously analyzed by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), provided as reference samples for the calibration of bromide. By comparing the evaluated data, the mXRF was calibrated for bromide concentrations between 50 and 3000 ppm, which covers a wide range of common bromide content in salt rocks. Additional measurements with the mXRF were carried out on rock salt samples and drilling cores from different sites of Northern Germany. The mXRF delivers, with the special calibration to bromide, excellent correlating values compared to measurements performed by ICP-OES.
Further investigations regarding the application of the method on different rock types (claystones and crystalline rocks) were started. For each rock type the calibration has to be carried out separately due to rock type dependent matrix effects. Rock samples, previously analyzed by wavelength dispersive X-ray fluorescence (WDX) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS), will provide as reference materials.
mXRF is a simple and fast method to analyze on site and to preselect points of interest for sampling and further investigations, but it does not replace a professionally equipped chemical laboratory.