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Element screening of drill cores from mine tailings with Laser-Induced Breakdown Spectroscopy and Energy Dispersive X-ray Fluorescence: a case study at the former Pb-Zn mine Maubacher Bleiberg, Germany

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Recovery of metals from mine waste gets more and more important. The lower energy consumption compared to primary mining and the additional usage of residues like quartz could make a recovery profitable. Furthermore, from an ecological point of view, mine waste remediation costs could be minimized.

Tailings are residues from ore processing, including size reduction and mineral separation by flotation. They are characterized by a strong heterogeneity due to separation processes during deposition, due to different rock sources during ore processing, periodically moving spigot points, as well as alteration processes after deposition.

Fast element screening of drill cores can be used to locate zones of element enrichment and depletion (e.g. base metals). A detailed sampling of these zones for further analysis is then possible. This can save time and money by reducing the number of samples compared to a statistical sampling.

In this study, drill cores from a 50 years old Pb-Zn-tailing deposit (Maubacher Bleiberg, near Aachen, Germany) have been investigated. Relative elemental compositions of sediment cores were determined by X-ray fluorescence (XRF) using an Itrax^{TM} core scanner (from COX, operated at Geopolar, University of Bremen) as well as by Laser-Induced Breakdown Spectroscopy (LIBS) using a LIBS core scanner (from LTB, operated in our working group). Beside lead and zinc, also the major elements of the silicate and oxide phases are investigated.

The application of these techniques as core scanner only provides semi-quantitative results. Apart from element concentrations, signal intensities are also influenced by the characteristics of the sediment matrix, such as particle size, water content, mineralogy, density, and sample surface. However, zones of element enrichment or depletion can be well recognized and no further sample preparation other than a flat sample surface is needed.

The ITRAX^{TM} core scanner is a flat beam X-ray scanner using an intense non-destructive micro X-ray beam for scanning sediment core surfaces and generating element profiles with a maximum resolution of 100 μm. At each measurement point, a dispersive energy spectrum is generated and peak area integrals are calculated for each element reflecting their relative concentration in the sediment. Generally, the ITRAX^{TM} core scanner delivers a 1-D element line scan (z $\geq$ Mg) of the core.

In contrast, the LIBS core scanner is able to produce a 2-D element mapping, making it suitable not only for laminated, but also for inhomogeneous cores. The LIBS technique uses an intense focused laser pulse ablating a small amount of the sample and generating a vaporizing and exiting plasma. The obtained atomic and ionic emission spectrum is characteristic for the elemental composition of the sample. For element mapping, peak integrals from optical spectra are calculated and transformed into grey value pictures. In unconsolidated sand, the method may reach its limits, due to strong matrix effects and the size of the craters.

The results of the two scanning methods are compared and validated with respect to bulk quantitative chemical analysis results gained by X-ray fluorescence. The advantages and disadvantages of the applied methods will be discussed.