



ESRF

	Experiment title: The path of sulfur from war debris into urban soils	Experiment number: EC-620
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Shifts: 15	Local contact(s): Marine Cotte, Barbara Fayard	<i>Received at ESRF:</i>
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Report:

The project aims at evaluating the sulfur pool and sulfur release from war debris within urban soils. This is a contemporary and exigent issue as it has a major impact on urban water quality. In large cities like Hamburg or Berlin, the sulfate content within near-surface groundwater aquifers is continuously rising since 30 years and has already reached the fourfold of the federal limits for drinking water in some areas. This cannot be explained by known sulfur sources as acid rain or traffic impact and is understood to originate in the lixiviation of war debris within these urban soils. Therefore, the dominating sulfur release processes, the kinetics and transport mechanisms are analyzed. In addition, sample preparation and data analysis methods shall be optimized.

During the allocated beamtime, elemental maps and sulfur XANES spectra of several thin sections of embedded soil material could be analyzed. Undisturbed soil core specimen were taken at a debris loaded site of the inner city of Berlin. This soil profile consists of 6 horizons of partly very different origin and composition, but for all of them, the majority of the parent material is of anthropogenic origin: war debris. Samples of the second and third horizon (counted from top to bottom) could be investigated. Characteristic areas, comprising different debris compounds with clearly visible and accessible interface between war debris and soil, were chosen with a VLM. Thereof, elemental maps of the fundamental soil elements Si, Al, Na, P and S were taken. To quickly identify the most interesting areas, S maps were taken at different incident energies, below and above the sulfate peak energy (2474eV and 2500eV, respectively), yielding a "sulfide-map" and a "total-sulfur-map". Within

these areas, spectra at representative spots and linescans across debris-soil-interfaces were taken. These spectra show very heterogeneous sulfur speciation and clear modification and change-overs at the interfaces, as exemplary displayed in figure 1. Besides, these measurements allow for further conclusions about sample (soil as well as debris) composition. Thus, for instance, P is always colocalized with S, whereas Na and Al are colocalized with S and Si.

However, as a start, the preparation method was investigated. Therefore, sulfur standards and elementary debris ingredients were embedded in the sulfur free resin and also cut into thin sections. The sulfur XANES spectra of those samples did not show any intrinsic differences in sulfur speciation and were identical to those of pure standards. This leads to the conclusion that the preparation method does not induce changes in sample composition or sulfur speciation and is therefore very well suited for future measurements.

Additionally, first images and spectra of soil colloids obtained from percolation water could be taken and analyzed. Soil solution was sealed between two silicon-nitride

windows and then studied in the same way as the above described thin sections. The investigated colloids are rich in sulfur and heterogeneous in sulfur speciation. Particularly, change-overs can be observed at the interfaces.

As it is assumed that the colloidal fraction of the soil solution is a major pathway, in terms of a carrier, of the sulfur compounds from the war debris to the groundwater, their sulfur load shall be further studied in the future. Sampling will cover seasonal as well as local differences and distinct parameters will be simulated in laboratory experiments. In addition, the hitherto not studied horizons of the above described soil profile shall complement the dataset and analysis with respect to soil forming and sulfur lixiviation.

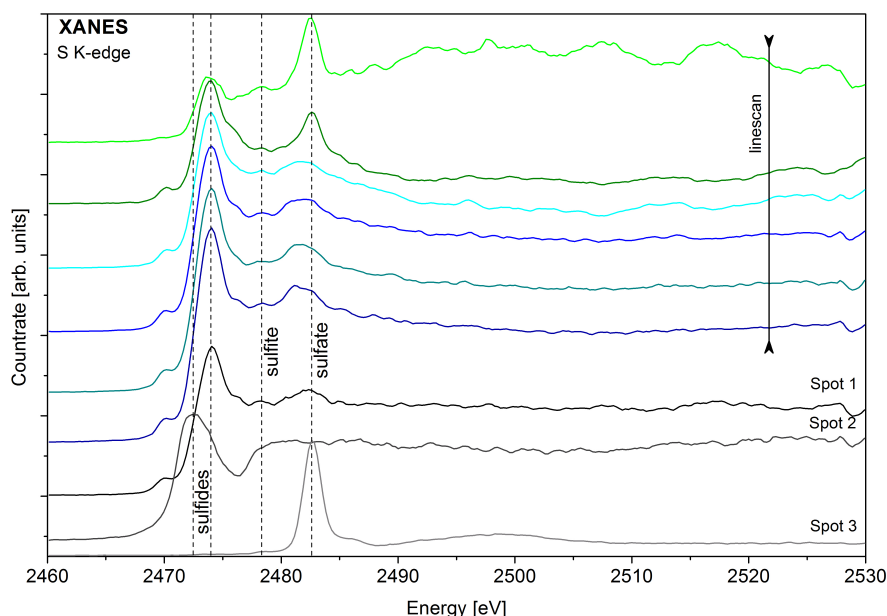
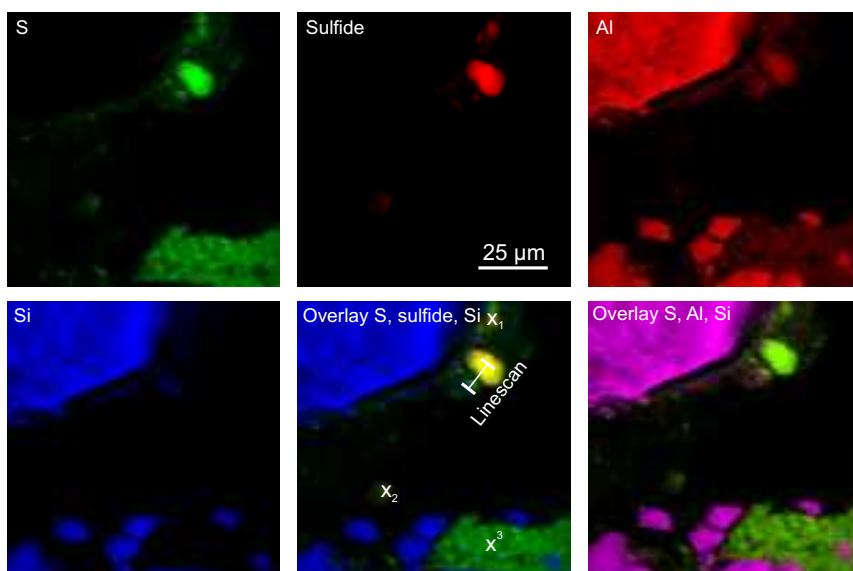


Figure 1: elemental maps and sulfur XANES spectra of debris particles and soil material within a thin section
Linescan: top to bottom - outer area to particle center