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Heavy-metal contamination of soils in Saxony/Germany by foundry fumes and low-cost rapid analysis of contaminated soils by XRF

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For hundreds of years in the Ore Mountains between Bohemia and Saxony silver and other ores are produced and smelted. Sulphide- and sulpharsenide-ores needed to be roasted first. In doing so the sulphide sulphur was oxidised under formation of sulphur dioxide SO_2 and arsenide conversed into elemental arsenic and arsenide trioxide $As2O_3$ respectively.

Also the metals lead, cadmium and zinc are components of hut smokes, in the field of nickel foundries also nickel.

The contents of soils basically reflect the geogenic conditions, which are caused by decomposition- and relocation-effects of the mineralisations, in the area of foundries also with influences by with the hut smokes anthropogenic mobilised elements.
The Saxonian Agency for Environment and Geology drafted in 1992 a Soil Investigation Program with the aim of investigation of the contamination of Saxonian soils with arsenic and toxic heavy metals. In order of this Agency GEOMONTAN investigated 1164 measuring points in the grid 4 * 4 km.soil profiles and extracted soil samples for analysis. In the result of the laboratory examinations the Agency edited the “Soil atlas of the Free State of Saxony”. 27 elements, pH and PAK are shown in detailed maps and allow in whole Saxony the first assessment of the contamination of soils with arsenic and toxic heavy metals.
Each of the investigated soil profiles represent an area of 16 km^2. Already by the different use of the districts (agricultural, industrial, urban) restricts representative values.
GEOMONTAN in the meantime used at the exploration of a copper deposit in Brandenburg/Germany with approx. 50,000 single tests at drill cores a very fast low-cost method: the X Ray fluorescence spectrometry (XRF) with a handheld instrument. Approx. 40 elements hereby are determined in a focussed X-ray spot of 3 mm of diameters. The device can be put directly on a section of the soil or measure loose substrata in a PVC bag through or in a cuvette. The measurement time is 30 seconds. In connection with the input of information, the relocating and the sample preparation 20 measurings can be carried out per hour. This leads at personnel expenditures of € 50/hour at a price of € 2.50/analysis of simultaneous 40 components. At requirement the transfer of the files from the instrument in Excel tables still would rise expenses.
XRF is a fast low-cost method for the first assessment of the contamination of soils and the delimitation of areas of different contaminations. When exact laboratory analyses are still requested, the interesting areas from which bulk samples have to be taken for the laboratory examinations, with XRF can be fixed.
The contamination with arsenic and toxic heavy metals is only subordinated by modern flue gas treatment in metallurgical plants and renunciation of thermal methods with hut smoke today. The whereabouts of arsenic and lead in the soil shows, though, that the soil has protected the groundwater against the contamination.
GEOMONTAN has examined the Saxonian areas with radioactive fallout of the Chernobyl accident in the order of the BGR Hannover 1993. In the results of the analysis by BGR Cs-134 was already disintegrated and Cs-137 only 13 cm deep in the uppermost soil layers infiltrated during the 8 years after the accident. This means that soil protects groundwater against contaminations out of the air too.

In the last years some German federal state governments decided the end of mine water winning for the public water supply and deregulated the water protection zones. The water supply was converted in water of water supply dams. The hazard of contamination of this open reservoirs by accidents or terrorism is increasing. Underground water bodies in karst caves and old mines without toxic mineralizations would be a good reserve in cases of contaminations of open drinking water reservoirs, but they must be protected as drinking water resources.