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Heavy-metal contamination of rivers by mining gallery waters during the flood in 2002 in Saxony/Germany and low-cost rapid analysis of contaminated river sediments by XRF

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The Ore Mountains between Bohemia and Saxony are effected by age-long mining for silver mining and winning of other ores. A lot of galleries were driven to keep water away from the mines. Today they still drain off water into the rivers which are used as receiving streams.

Sulphide- and sulpharsenide-minerals are unstable. The decomposition of these minerals is caused by the influence of oxygenated drainage water. As a result of this process free cations of iron, copper, lead, zinc, cadmium and residuals of acid (sulphuric acid, acid sulphur, arsenous acid).

Already during the transport in the gallery water transformations and precipitations proceed: iron precipitates as sol of iron-(III)-hydroxide-flocks and carries manganese and arsenic, as well as a part of zinc and copper along, on the other hand a bigger part of cadmium keeps in dissolution.

From 1844 until 1877 in the silver mining area of Freiberg/Brand-Erbisdorf/Halsbrücke the gallery “Rothschönberger Stolln” was driven with a length of 50 km. In 1995/1996 we determined during four measuring cycles the loads of selected contaminants of five different measuring points in a gallery segment, which takes 29 km.

As the annual input into the stream system Triebisch/Elbe with the mudflat of the North Sea as receiving stream we determined:

• 19.000 t solid matter (hereof 10.400 t gypsum)
• 820 kg cadmium
• 420 kg arsenic
• 1450 kg lead
• 1140 kg copper
• 111 t zinc

During the flood in August 2002 occurred:

• a total sinking of the Münzbach
• a partial sinking of the Freiberger Mulde

into the Rothschönberger Stolln. Thereby its flow increased from 600 l/sec in average to 10 m^3/sec.

Over three days during the flood in 2002 water samples were taken and analysed and the discharge was detected. So it was possible to calculate the loads.

There wasn′t a dilution of the loads, in fact the contents and loads increased:

mean value daily value increase factor
1995/1996 14.08.2002
mg/l mg/l n-fold
content: 0,067 1,340 20
lead 5,080 7,590 1,5
zinc 0,038 0,068 1,8
cadmium 0,019 0,230 12
arsenic

load: kg/d kg/d n-fold
lead 4,0 626 167
zinc 303,3 3548 12
cadmium 2,3 318 14
arsenic 1,1 108 9,5

Parts of these contaminants don′t arrive the ocean, but deposit on the continuing flow path of the rivers. The maintenance of the water bodies and during construction works stream sediments need to be removed and depolluted. With the X-ray fluorescence spectrometry (XRF) a very low-cost and - with a measurement period of 30 seconds - a very quick method for the rough calculation of contaminant loads is available. The results of investigations of the sediments of the Freiberger Mulde and the Triebisch in 2011/2012 are presented. High contents of arsenic, cadmium, thallium and lead are identified as waste, which needs to be controlled.