Arsenopyrite weathering in tungsten mine tailings: A TEM analysis

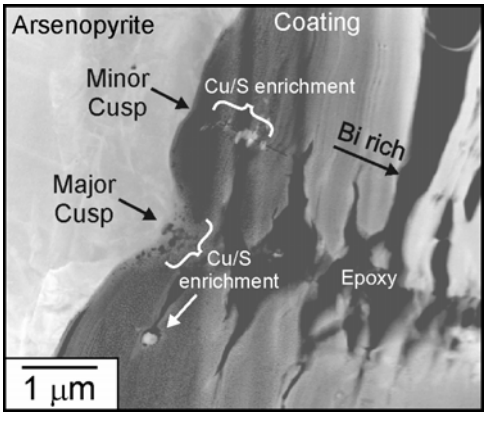
B.M. PETRUNIC AND T.A. AL

Department of Geology, University of New Brunswick, PO Box 4400, Fredericton, NB, E3B 5A3, Canada (o0bsn@unb.ca)

The Mount Pleasant tungsten mine is located approximately 60 km south of Fredericton, NB, Canada. The tailings that resulted from a two-year mining operation have been exposed to oxidizing conditions since 1997. Consistent with the oxidation of sulfide-bearing minerals, the pore water in the oxidation zone is characterized by a relatively low pH and elevated SO_4, As and metal concentrations compared to the pore water at depth. Of particular environmental concern are the elevated As concentrations, which reach a maximum of 7.1 mg/L in the oxidation zone.

Samples from two oxidized arsenopyrite (FeAsS) grains were obtained for Transmission Electron Microscopy (TEM) analysis. Energy dispersive X-ray spectroscopy analyses collected in scanning TEM mode suggest that the bulk secondary mineral is similar in composition to scorodite ($FeAsO_4 \cdot 2H_2O$), a common arsenopyrite oxidation product (Fig. 1). Variable amounts of Ca, Si and Bi occur throughout the coating. Several distinct secondary-mineral inclusions, including wulfenite and copper sulfides, are found embedded within the bulk secondary coating. A Cu- and S-rich layer occurs along the perimeter of the arsenopyrite and ranges in thickness from approximately 50 nm to 500 nm. The Cu sulfide coating is thickest where the perimeter of the arsenopyrite grain forms discrete cusps. It is probable that aqueous Cu interacts with S from arsenopyrite leading to the precipitation of Cu sulfide at the interface. Variability in the rate of Cu sulfide accumulation at the interface may cause spatial variations in the diffusion rates for O_2, S, Fe and As during weathering. This variability could result in non-uniform oxidation of arsenopyrite and the consequent formation of the prominent cusp features.

Figure 1: A dark-field STEM image of an oxidized arsenopyrite grain.



Anthropogenic heavy metal discrimination in stream sediments around an abandoned zinc smelter by using isotope tracers

YANG YUANGEN, LIU CONGQIANG, BI XIANGYANG AND SUN LI

Institute of Geochemistry, CAS, Guiyang City, Guizhou Province, 550002, China (yangyuangen@hotmail.com)

This study focused a small catchment close to a previous-abandoned zinc smelter. Water and sediments were sampled at the main watercourse of a stream and two tributaries. Water pH value, DO, EC were immediately measured in the field. Filtered water was used to analyze metal concentrations. Sediments were determined both metal concentration and their chemical forms, and lead and sulphur isotope compositions. Air-dried sediment particulates were fixed, imaged and analyzed on SEM-EDX.

Stream water pH values were usually higher than 7, and increased downstream. DO and EC fluctuated greatly with a decreasing tendency downstream. Pb, Zn and Cd concentrations in stream water usually fell downstream, highest metal concentrations were observed in the intersection sample. Similar fluctuation of heavy metal concentrations in stream sediments was discovered, highest metal concentrations were found in the most upstream sample, the Pb, Zn and Cd concentrations were as high as 21850, 28175 and 82 mg/kg, respectively. Pb and Zn were mainly bound to iron and manganese oxides in stream sediments; both correlation analysis and SEM-EDX observation testified the retain of Pb and Zn on iron hydroxides. Higher bioavailability of Cd than Pb and Zn was found.

In stream sediments, $^{206}Pb/^{204}Pb$ ratios varied from 18.491 to 18.748, $^{207}Pb/^{204}Pb$ ratios from 15.631 to 15.835, $^{208}Pb/^{204}Pb$ ratios from 38.929 to 39.461. As shown in $^{208}Pb/^{206}Pb$ x $^{206}Pb/^{207}Pb$ diagram, sediment samples plotted in a good agreement with mine ore samples, this indicated heavy metals in stream sediments were originated from mine ores. Considering the existence of ancient zinc smelters, it is reasonable to judge that anthropogenic activities brought great heavy metal accumulations in the small catchment. Sulphur isotope compositions further confirmed this relation.

Acknowledgements

This study was jointly funded by the Knowledge-renovation Program of CAS (KZCX2-105) and the 'Western Light' of CAS.