PROJECT SONATA 14_Anna Potysz

Factors affecting stability of slags: single-phase and multi-phase experimental approach

General project overview

Research problem.

Metals are routinely used as essential components for a broad array of consumer and industrial electric goods, indispensable for the functioning of modern societies. Pyrometallurgy is an industrial sector responsible for a considerable percentage of the worldwide metal supply. However, apart from advantageous metal production, pyrometallurgical processing integrally entails generation of large volumes of wastes. Metallurgical slags are heterogenic solid wastes; slags are composed of various phases (synthetic equivalents of minerals) and they are characterized by relatively high content of toxic elements (e.g. Pb, Cd and As) unrecovered during pyrometallurgical processing.

Formerly, industry disposed of the slags at poorly protected dumping sites without any environmental monitoring from the moment of disposal onward. This resulted in development of vegetation cover (involving soil and plants) and subsequent long-term slag exposure to a variety of chemical (the presence of inorganic and organic acids) and biological factors (microbial activity) collectively termed "Biogeochemical Weathering". Only recently, it has been discovered that biogeochemical weathering may cause the release of metals from slags into the local environment. Due to a lack of environmental awareness and appropriate oversight, the presence of excessive metal concentrations is a shared characteristic of numerous dumping sites across Europe (including Poland), and the world at large.

An important factor determining metal migration from slag to the environment is susceptibility of phase components to (bio)weathering. It is important to note that most of carried by far studies have focused on (bio)weathering of whole slag ***(multi-phase experimental approach)***, whereas comparison of (bio)weathering of individual phases separately ***(single-phase experimental approach)*** has rarely been undertaken. Furthermore, the fate of metals (released from slags) in the environment depends on occurrence of immobilizing mechanisms (e.g. precipitation of secondary phases entrapping metals). Thus, potential counterbalance between (bio)weathering factors and factors preventing metals migration should both be known. Complete understanding of slag (bio)weathering is crucial for preventing the dispersal of metal contaminations in the environment.

Research hypothesis: *(Bio)weathering of toxic element-rich and toxic element-free slag phases may proceed at different rates and it may in turns affect strength and activity of weathering factor.*

Research objectives and experimental works

The research subject undertaken in the frame of this project is interdisciplinary; it stays at the frontiers of mineralogy, microbiology and plant sciences. An integrated experimental approaches will be carried out to investigate interactions ongoing at slag/vegetation cover interface at dumping sites. The study aims: i) to unravel which phase is the most susceptible to dissolution and which one is the most stable under specific environmental conditions, ii) to investigate impact of slags on activity of weathering factor (e.g. bacterial activity), iii) to elucidate how slags behave under various redox conditions (oxygen-rich atmosphere and oxygen-depleted environment), iv) to decipher plants behavior in the presence of slags (seeds germination and metal uptake by the plants) and v) to explore whether metals released from slags can be precipitated (secondary phases formation). All laboratory simulations will investigate weathering process in a single-phase system (at which only one phase component is present) and in multi-phase system (including heterogenic slag composed of various phases).

Contribution to Earth and Environmental Sciences.

(Bio)weathering addressed in the frame of this project will contribute to full understanding of (bio)weathering processes ongoing at dumping sites. In addition, it has implications for understanding corresponding processes ongoing at surfaces of minerals (natural equivalents of slag synthetic phases) and rocks.