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Phytomining of valuable metals from waste incineration residues using hyperaccumulator plants

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Worldwide the availability of primary sources of certain economically important metals is decreasing, resulting in high supply risks and increasing prices for this materials. Therefore, an alternative way of retrieving these high valuable technical metals is the recycling and use of anthropogenic secondary sources, such as waste incineration residues. Phytomining offers an environmentally sound and cheap technology to recover such metals from secondary sources. Thus, the aim of our research work is to investigate the potential of phytomining from waste incineration slags by growing metal hyperaccumulating plants on this substrates and use the metal enriched biomass as a bio-ore.

As a first stage, material from Vienna's waste incineration plants was sampled and analyzed. Residues from municipal wastes as well as residues from hazardous waste incineration and sewage sludge incineration were analyzed. In general, the slags can be characterized by a very high pH, high salinity and high heavy metal concentrations. Our work is targeting the so-called critical raw materials defined by the European Commission in 2014. Thus, the target metal species in our project are amongst others cobalt, chromium, antimony, tungsten, gallium, nickel and selected rare earth elements. This elements are present in the slags at moderate to low concentrations.

In order to optimize the substrate for plant growth the high pH and salt content as well as the low nitrogen content in the slags need to be controlled. Thus, different combinations of amendments, mainly from the waste industry, as well as different acidifying agents were tested for conditioning the substrate. Washing the slags with diluted nitric acid turned out to be effective for lowering the pH. The acid treated substrate in combination with material from mechanical biological waste treatment and biochar, is currently under investigation in a greenhouse pot experiment.

The experimental setup consists of a full factorial design involving six plant species and an unplanted control as well as two different substrates. Fast growing species (Brassica napus, B. juncea, Nicotiana tabacum) will be harvested after two months, whereas slowly growing hyperaccumulators (Sedum plumbizincicola, Alyssum pintodasilvae) will be harvested after four months of growth. The plant tissue will be analyzed for the accumulation of the target metals. Moreover, the influence of plants on the substrate and solubility of certain metals is going to be evaluated.