Environmental Mineralogy Study of Arsenic in Biological Passive Treatment System

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The geochemistry of arsenic in anaerobic sediments and groundwater environments is strongly influenced by groups of microorganisms. Sulphate reducing bacteria, iron reducing/oxidizing bacteria and arsenic metabolizing bacteria can exert profound effects on both precipitation and dissolution reactions of arsenic minerals; Here we study an anaerobic biochemical reactor, which was built to reduce/ remove metals (as, Zn, Cd) from landfill leachate. Mineralogical analysis has been applied to search for predominant minerals and evidence of arsenic mineralization such as arsenic sulfides (orpiment, arsenical pyrite) and ferric oxyhydroxides with adsorbed arsenate. with this perspective, physiochemical data (meta-data) were generated by chemical analysis of recovered core samples and pore water samples from the site. The organic matter availability in the bioreactor solids was determined using a pyrolysis technique. Geochemical modeling of water chemistry data in the bioreactor was performed to give insights into the chemical reactions potentially controlling the concentration of arsenic. For solid phase analyses, the samples were treated by low-temperature ashing to remove organics and minerals were analyzed qualitatively by X-ray diffraction method. The analysis indicated minerals such as sphalerite (ZnS), tennantite (Cu, Fe) as_4 S_{13}, pyrite arsenian $Fe(S,as)_2$. QEMSCAN, Quantitative Evaluation of Minerals by Scanning Electron Microscopy, was also applied to identify trace arsenic bearing minerals. A genomics study of the bioreactor revealed the presence of arsenic resistant microbes such as *Sedimentibacter* (*Family XI Incertae Sedis*), *Simplicispira* (*Comamonadaceae*) and genera related to *Peptococcaceae*, as well as arsenic detoxifying genes such as *ars*C (arsenate reductase genes), *aox*R (arsenite oxidation genes), *arr*B (arsenate respiratory reductase). Mineralogy of samples was correlated with presence of these microbes identified from the core samples by using principal component analysis. Identifying the predominant minerals and their correlation with microbial composition could reveal arsenic removal mechanisms by bacteria in this system and arsenic contaminated sites.

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