Factors controlling the release of species from some South African fly ashes to the environment

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Fly ashes from South Africa coal-fired stations are mostly alkaline and when in contact with water release some major and minor species into solution. However, there is a need to assess the leaching of these species to fully understand the effect of ash disposal on the environment. The up-flow percolation (column) and dissolution kinetics tests were employed on two South African fly ashes to evaluate how species are mobilized from the fly ashes. The results of the leaching tests showed that the initial leachates from the fly ashes contain high concentrations of species such as Ca, Mg, Na, K, SO₄, Sr, Ba, which decreased as the leaching continued until steady states were achieved. PHREEQC predicted several mineral phases that could control the concentrations of some species in the leachates. Ca and SO₄ were controlled by portlandite, anhydrite and gypsum; Barite and celestite were predicted as the mineral phases controlling Ba and Sr; Mg was controlled by sepiolite. No mineral phases were predicted to be controlling Na and K. Comparison of the concentrations of each of the species in the fly ashes before and after the leaching showed that some species were significantly released while the release of some species was low. The study shows that several factors including secondary mineral formation could influence the release of species from fly ash to the environment.

Solid-state speciation of As and Sb associated with mine waste and downstream sediment at the Giant Mine, Yellowknife, Canada

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Prior to mining at Giant, arsenic (As) and antimony (Sb) were associated with arsenopyrite, stibnite, and Sb-bearing sulfosalts in the gold ore. Roasting of the ore, and subsequent deposition of mine waste in the environment, has resulted in the association of As and Sb with many mineralogical phases, and the presence of multiple oxidation states. Arsenic and Sb are largely associated with maghemite, a mineral phase resulting from the breakdown of arsenopyrite and pyrite in the roaster, and later deposited in sediment. Maghemite was identified by petrography and synchrotron-based µXRD (x-ray diffraction). Synchrotron-based microXANES (X-rav Absorption Near Edge Spectroscopy) was used to determine oxidation states of As and Sb. As(V), As(III), Sb(V), and Sb(III) are associated with maghemite in the roaster products and sediment. However, the ratio of oxide bound Sb(III/V) and As(III/V) varies, most notably in the sediment where it shows a marked increase with depth, in response to changes in redox conditions. The oxidation state of Sb in the deepest zone (-30cm) is reduced further to Sb(III) bonded to sulfur suggesting a destabilization of Sb bound to maghemite and a reprecipitation or sorption of Sb with secondary sulfides (visible in thin section). Arsenic and Sb are also present in particles that include metals associated with the sulfide and sulfosalt fraction of the Giant ore (Cu, Zn, Ga, Pb). At the sediment-water interface (SWI) these particles also host As(V), As(III), Sb(V), and Sb(III) oxidation states. However, in deeper sediment the As is more reduced in these particles. As(III) bonded to sulfur is present at 22 cm below the SWI, and As(I-) 30 cm below the SWI. In general, the oxidation states of As and Sb in sediment show more reduction with depth. However, at 30cm below the SWI, under reducing conditions, the Sb(V) oxidation state persists. These results highlight distinct differences in the behaviour of Sb and As as well as the need to understand both the source inputs of the metalloids and the post-depositional geochemical conditions.