Transformation of jarosite containing various oxyanions to goethite

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Jarosite [$KFe_3(SO_4)_2(OH)_6$] is one of the important Fe minerals commonly found in acid mine drainage. It precipitates in waters with high concentration of SO_4 and at pH < 3. Many different oxyanions can coprecipitates with jarosite, and therefore, this mineral can play an important role in attenuating toxic oxyanions such as AsO_4, SeO_4, and CrO_4. However, with increasing pH, jarosite transforms to goethite, and during this process coprecipiated oxyanions can be released to water or readsorbed on the goethite surface. Although the transformation of jarosite containing toxic oxyanions is very important to understand the behavior of those oxyanions in acid mine drainage, no systematic studies have been performed.

Jarosite containing 10 anion mole% [oxyanion/(oxyanion + sulfate)] were precipitated at room temperature. AsO_4, CrO_4, SeO_3, SeO_4, and MoO_4 were coprecipitated with jaoriste. Additionally pure jarosite was also precipitated to compare the transformation of jarosite. Those samples were aged in water adjusted to pH 4 and 8 for 1, 3, 15, 45, 90, and 180 days. The mineralogical changes and solution compositions were investigated using XRD and ICP-AES. The quantitative analysis of mineral compositions were obtained by Siroquant computer program.

For all jarosite samples, with increasing pH and aging time, more jarosite was transformed to goethite. However, at pH 4 the changes were much smaller than those at pH 8. Different anions played different roles in the transformation of jarosite. The transformation rates of jarosite containing SeO_4 and CrO_4 were relatively high and similar to pure jarosite while those with MoO_4, SeO_3, AsO_4 were lower, indicating that those three oxyanions decrease the transformation rate of jarosite. Those results are probably related to the previously reported precipitation rate of jarosite with oxyanions, in which the precipitation rates of jarosite with SeO_4 and CrO_4 were highest and those with other oxyanions were low. Generally, with the increase of goethite, the concentrations of sulfate also increases. The concentrations of Se and Cr were also higher in solution after the aging experiment, indicating that jarosite with different oxyanions can affect the behaviors of those anions in acid mine drainage.