ABSTRACT

Acid mine drainage (AMD) is one of the major environmental problems faced by coal mines throughout the world. This work addresses the geochemical characterization of AMD, control of mineralogy of coal and mine overburden on its generation, consequent metal enrichment and mobility in water soil, and sediments in and around the Makum coalfields of Assam, India. Mine discharges produced by oxidation of sulphide minerals vary widely in pH and metal concentrations contaminating surrounding water. Various oxy-hydroxides (goethite and ferrihydrite) and hydroxysulphates (schwertmannite and jarosite) of Fe precipitate from the AMD and scavenge metals. Mineralogy of these secondary precipitates is primarily controlled by pH. There is a general agreement between the observed mineralogy and that predicted by hydrogeochemical modeling. The overburden can be broadly categorized into two on the basis of acid generating potential. The pyrite bearing laminated carbonaceous shale is acid generating, whereas non-laminated carbonaceous shale, sandstone, carbonate-bearing siltstone with or without pyrite generates alkaline discharge because of their high neutralization potential owing to high dolomite content. Coal seams are highly acid generating due to presence of pyrite of different textural types. Acid base accounting corroborates the observed chemical characteristics of the AMD. Surface features of pyrite observed under FESEM and the presence of intermediate products confirm pyrite oxidation as the dominant mechanism of AMD generation. Concentrations of Cd, Cr, Cu, Mn, Ni, Pb and Zn in overburden are above their respective crustal abundance. Leaching study indicates that pyrite-rich overburden releases very high concentration of metals in comparison to their pyrite-poor counterparts. Makum coal has higher concentrations of Cd, Cu, Ni and lower concentrations of Cr, Mn, Pb and Zn as compared to their world average values. Sequential extraction of overburden indicates that, other than Mn, Zn and Pb, metals are mostly bound to residual fraction and not bioavailable. However, all metals are easily bioavailable from coal. Metals are highly enriched in soil and sediments and their bioavailability is primarily controlled by pH. The order of bioavailability in soil and sediment is Cd > Mn ≥ Pb > Ni ≥ Zn > Cu > Cr.

Keyword: Acid Mine Drainage; Hydrogeochemistry; Mineralogy; Acid Base Accounting; Makum Coalfield; Metal Mobility