Fe and Pb isotopic signatures of the processing of REE-bearing heavy minerals in a contaminated stream near Ipoh city, Malaysia

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The processing of igneous-type rare earth element (REE) deposits may generate radioactive wastes as well as acid drainage due to their high content of radioactive elements (e.g. Th, U) and the use of acids to decompose REE minerals. To establish appropriate indicators and assess the environmental impacts of REE extraction, we have investigated geochemical and isotopic signatures of contamination from heavy mineral processing in Kinta River and two of its tributaries near Ipoh city, Malaysia as a case study. Our preliminary investigation showed that water from a tributary near an ilmenite processing plant was anthropogenically influenced, as indicated by low pH and high Fe and Cl concentrations, while water qualities of others were mainly controlled by the underlying lithology.

The REE patterns and Pb isotope ratios of the water and sediment samples from the tributary resemble those of leaked water from the tailings pond of the ilmenite processing plant. These data suggest that contamination of REEs, U, and Th in the tributary is due to heavy mineral processing. Therefore, they may be used as indicators of environmental impacts. In this tributary, the Fe isotope ratios decrease downstream with decreasing Fe concentrations, which may be due to isotope fractionation during oxidative precipitation of Fe-hydroxides. However, the fraction of remaining Fe in the downstream seems to be overestimated due to the effect of colloidal Fe. The concentrations of REEs, U and Th decrease downstream with different removal efficiencies (Th>U>REEs). The results of geochemical modeling suggest that Th may be removed by precipitation with increasing pH while U may be taken up and transported by Fe-hydroxides precipitated from the stream water. Therefore, Fe isotope signatures and geochemical modeling may be useful to understand chemical processes occurring in a contaminated river.