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Rare Earth Element pollution originating from electronic waste: Leaching and mobility in porous media

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Rare earth elements (REEs) are used in a growing number of technological applications and products. Consequently, elevated release to the environment of these contaminants of emerging concern and potential risk of environmental contamination is also increasing. Electronic waste (E-waste) could be a key source of REE pollution, as E-waste typically contains REE and is often handled in unsafe and environmentally hazardous ways. In this study, a set of leaching tests was run with various solutions relevant to environmental conditions showing that less than 1% of REEs available in the E-waste partitioned to solution except at acidic conditions (pH 2). When REEs do leach from E-waste, the extent of their mobility in porous media was found to be very limited except at acidic conditions (pH 2). Measurements of REE transport through saturated sand in natural soil demonstrated that the REE mobility was extremely low with complete REE retention in the soil even after the passage of up to 215 pore volumes of a 500 ppb REE solution. Aqueous REEs are therefore not expected to be highly mobile in the environment. The presence of natural or anthropogenic nanoparticles may affect REE behavior during leaching and/or transport. Measurements indicated that silica nanoparticles can increase the concentration of fluid-mobile REEs during E-waste leaching, but both plastic and silica nanoparticles have a negligible effect on REE transport. Ultimately, the experiments and analysis presented here suggest that the threat of REE pollution from E-waste is minimal except at specific sites with unusual environmental conditions.