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Migration behavior of uranium from groundwater to the surface environment in uranium mine sites

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The mill tailings pond at the Ningyo-toge Environmental Engineering Center, JAEA in Okayama Prefecture, Japan, is a reservoir that collects groundwater containing U and other heavy metal elements leached from uranium ore tailings buried underground, but these elements have not migrated to the surrounding environment and function as a natural migration control system. Understanding these migration dominating phenomena is important for assessing exposure near the surface environment in the safety assessment of radioactive waste disposal systems.

This study aims to investigate the migration behavior of U in the mill tailings pond and former open pit mine site where groundwater flows from the upwelling to surface environment and to understand the geochemical processes of migration dominating phenomena of radionuclides in the surface environment. Samples were collected from groundwater at the former open pit mine site from bore holes and surface water at mill tailings pond. The concentration of U and Fe, and other trace elements in water and solid samples were determined by ICP-MS/MS. The chemical states of U and Fe were determined by XAFS analysis.

The groundwater had a high concentration of divalent iron and a low redox potential, but a high concentration of dissolved uranium, which is thought to have leached from the tailings as uranyl ions. Groundwater migrated to the surface, where it was oxidized by contact with the atmosphere to form ferrihydrite precipitates, resulting in lower dissolved iron concentrations. Uranium concentrations were low in the surface water after ferrihydrite precipitation and high in the precipitation. Uranium in the precipitate was hexavalent, suggesting that it was transferred to the precipitate by adsorption and /or coprecipitation reactions between uranyl ions and the precipitate.

It is suggested that the distribution behavior of uranium and ferrihydrite based on the migration behavior of uranium obtained in this study can explain the migration dominating phenomena of uranium and heavy metal elements by groundwater oxidation.

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