

REDOX investigations around a drift in the Tono Uranium Mine, Japan

K. HAMA¹ AND A.B. MACKENZIE²

¹ Horonobe Underground Research Center, Japan Nuclear Cycle Development Institute, Japan
(hama@tono.jnc.go.jp)

² Scottish Universities Research Reactor Center, Scotland
(A.MacKenzie@surre.gla.ac.uk)

Introduction

Redox fronts are important geochemical boundaries which need to be considered in any safety assessment for a future deep repository for radioactive waste. During construction and operation of an underground facility, air will be introduced into the geological formation and an oxidised zone will be generated around the facility which will potentially have a strong influence on the mobility of redox sensitive elements. Therefore, there is requirement to develop appropriate methodology for characterisation of such oxidised zone.

Methods

The Japan Nuclear Cycle Development Institute (JNC) has been carrying out geoscientific studies to develop methodologies that may be used in the characterization and safety assessment of a future repository site that has yet to be chosen. The study programme includes geochemical investigations at Tono Uranium Mine, which is entirely a research facility located in the Tono area of central Honshu island. Shafts and drifts have been excavated in Neogene sedimentary rocks which contain the uranium deposit. For the redox study, a cored borehole was drilled from a drift wall. Core samples were treated under anaerobic conditions to avoid additional oxidation. Activities of uranium-series nuclides (²³⁸U, ²³⁴U, ²³⁰Th, ²²⁶Ra, ²¹⁰Pb) and thorium-series nuclides (²³²Th, ²²⁸Th) were determined. Ratios of Fe(II)/Fe(III) and aerobic/anaerobic bacteria were also measured.

Results

Sixteen samples were obtained at depths of up to 1.77 m from the drift wall. The Fe²⁺/Fe³⁺ ratio increased markedly between 40 and 50 cm from the drift wall, with a corresponding decrease in the number of aerobic bacteria over this distance. Conversely, the number of anaerobic bacteria increased from 40-60 cm. The results provide evidence of an Fe²⁺/Fe³⁺ redox front between 40 and 50 cm. There is also evidence for oxidation of U⁴⁺ throughout the core. However, decreased uranium contents were observed at less than 70 cm. Most activity ratios of ²³⁴U/²³⁸U and ²³⁰Th/²³⁸U activity ratios suggested that this section of rock had experienced recent, rapid removal of uranium. On the other hand, the results are consistent with recent deposition at 70 cm from drift wall. Deposition of uranium at 70 cm, on the reduced side of the front, could be interpreted as indicating that there is also a U⁴⁺/UO₂²⁺ redox front close to the Fe²⁺/Fe³⁺ redox front.

Leaching process of rhyolite through acid alteration in the active magmatic-hydrothermal system of Satsuma-iwojima volcano, Japan

S. HAMASAKI¹ AND H. SHINOHARA²

¹ AIST Geological survey of Japan, Higashi 1-1-1 central 7, Tsukuba, Ibaraki, Japan (hamasaki-st@aist.go.jp)

² AIST Geological survey of Japan, Higashi 1-1-1 central 7, Tsukuba, Ibaraki, Japan (shinohara-h@aist.go.jp)

Iwodake, a summit cone of Satsuma-iwojima, is highly altered by volcanic vapor and acid hydrothermal solutions. Series of volcanic rock samples with various degree of the acid alteration were collected to investigate change of rock chemical composition during the leaching process of chemical elements. The samples range from unaltered rhyolite of SiO₂ = 71-72 wt % to highly leached rocks of 99 wt % SiO₂. All the rock-forming elements, except Si and several trace elements, decrease their contents with advance of the acid leaching. However, the decreasing patterns differ from each other and can be characterized and grouped by each element.

The Al₂O₃ and Fe₂O₃ components decrease constantly with increasing SiO₂ content. The MgO and MnO contents show rapid depletion patterns, indicating that both are mobile. The CaO is leached more rapidly than Na₂O, and K₂O content does not decrease until about 90 % SiO₂, which indicate that K is less mobile than other alkali elements such as Ca and Na. P₂O₅ decreases slowly, and the TiO₂ content remains constant.

The Sr, V and Ga decrease constantly as leaching. The Rb, Y, Th and Cs don't decrease until increasing silica content of about 95 wt %, Zr, Nb and Hf don't decrease until 98 wt % SiO₂, and they decrease rapidly after that. Ba and Ta remain constant during the leaching similarly as TiO₂. These indicate that although some LIL elements have leached and some are immobile, most of HFS elements appear to be immobile.

The light REEs such as La-Sm series decrease gradually with increasing SiO₂ content as leaching. Eu has leached constantly. The other hand, heavy REEs such as Gd-Lu series remain almost constant until increasing silica content reaches to 95 wt %, and decrease rapidly after that. The chondrite-normalized REE patterns of the altered samples show almost equal depletion without conspicuous fractionation, except Eu, with increasing intensity of silicification. The large negative anomaly and constant decreasing of Eu is likely caused by the leaching of Eu-rich plagioclase.

