Introduction of the “KiNa” international project of natural analogue studies of the long-term stability of bentonite

*Satoru Suzuki[1], Tsutomu Sato[2], Tsubasa Otake[2], Kikuchi Ryosuke[2], Fujimura Tatsuya[2], Takahiro Goto[1], Yusuke Ogawa[1], Patrik Sellin[3], Daniel Svensson[3], Albert H. Gilg[4], Ulf B. Andersson[5], Elizaveta Klein[6], Olivier X. Leupin[6], Simon Norris[9], Russell W. Alexander[10], Mehran Behazin[7], Nicolas Michau[8]

1. Nuclear Waste Management Organization of Japan , 2. Hokkaido University, 3. SKB, 4. TU Munich, 5. Luossavaara-Kiirunavaara AB, 6. Nagra, 7. NWMO, 8. ANDRA, 9. RWM, 10. Bedrock Geosciences

Disposal of high level radioactive waste is based on multi-barrier systems, where the barriers are supposed to retain their properties for hundreds of thousands of years. To demonstrate long term stability, experimental results can be complemented with the studies of natural systems (Natural Analogues). Bentonite is a common barrier material in many repository concepts and the aim of this natural analogue project is to assess the long-term behaviour of bentonite and its interaction with iron-minerals at the repository-like conditions.
Significant clay alteration zones have been encountered in the Kiruna (Lapland, Sweden) magnetite(-hematite)-apatite deposits, which are hosted in weakly to strongly metamorphosed intermediate to acid volcanic and subvolcanic rocks. These up to 50 m thick soft clay alteration zones occur within ores and within the country rocks along the ore contact of the southern parts of the Kiirunavaara ore body. They are found at various levels to depths of at least 1200 m below the surface, in zones further into the hanging wall and footwall lithologies of the deposit. The predominant clay mineral in the alteration zones of all deposits is a dioctahedral Fe-poor montmorillonite (Rieger 2017). K-Ar data of various Na-exchanged size fractions from two clay-altered gneiss samples from the nearby Johannes ore body, Malmberget, which are dominated by R3-ordered illite-smectite, yield age values ranging from 837 ±14 Ma to 941 ±15 Ma (Gilg et al. 2017, Rieger 2017).
In many respects, the clay layers in the Kiruna deposits resembles a bentonite barrier in a repository: the clay layers are in the meter scale, the surrounding is fractured rock under the water table and the magnetite could serve as an analogue for an iron corrosion product. A project has been initiated to further study the Kiruna clay with focus on:
geological site description and genesis of smectite-dating, mineralogical and chemical investigation understanding the very long-term behavior of bentonite under conditions of direct relevance to deep geological disposal; examination of long-term iron oxide minerals - bentonite interaction; the potential erosion properties of bentonite; and Microbiological investigation.
NUMO-Hokkaido University Joint Team is now responsible for mineralogical and geochemical investigations of iron oxide-bentonite interactions. So far, preliminary investigations have confirmed a high degree of montmorillonite, a substantial swelling pressure at high dry density, a low hydraulic conductivity and somewhat surprisingly low interaction with the magnetite.

References

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Keywords: Benotnite, Iron ore, Natural Analogue

