Formation mechanism and elemental migration of redox front around the fracture in crystalline rock

Fuminori Akagawa[1], Koshi Yamamoto[2], Hidekazu Yoshida[3]

[1] Earth and Planetary Sci., Nagoya Univ., [2] Earth and Planetary Sci., Nagoya Univ, [3] NUM

Redox fronts are created at the boundary between two rock/groundwater systems with different oxidation environments. The development of redox fronts in the geological environments, e.g. in the near-field and far-fields, of high level radioactive waste repositories of all designs is usually unavoidable. The normal condition of rocks and groundwaters at depth is reducing and, as a consequence, the introduction of air and oxidising waters into a repository during its excavation and construction will cause oxidation of the exposed rock surfaces, and a redox front will be established. In the case that the excavated repository is left open for any length of time during the operation, the continuous supply of oxidants will cause the redox front to migrate from the excavation walls into the host rock. This might occur if a repository is left open for an extended period of time for monitoring and retrievability considerations, before a decision is made to close and seal the facility.

Redox fronts, and elemental accumulations at them, occur naturally in rock formations where ever a groundwater passes from reducing to oxidising conditions, or vice versa. Some economic ore deposits and uneconomic major or trace element accumulations form in these situations when mineral-rich fluids precipitate dissolved species on encountering a change in the physico-chemical environment, i.e. at a geochemical discontinuity where either temperature, pressure, ph or Eh changes significantly. As some of these phenomena are formed at redox fronts they may, at first sight, be considered analogue at redox fronts in the host rock of the repository.

As an analogue of near-field redox front created in the crystalline rock has been traced and some significant features related elemental accumulation and migration due to the Fe and Mn oxidation have been revealed by the recent study. As a preliminary report, the major chemical process of redox front and elemental migration in the crystalline rocks has been discussed.