NATURAL ANALOGUE
Working Group

Natural analogues of cement: safety assessment implications of the unique systems in Jordan

W.R.Alexander[1], G.Kamei[2] & A.E.Milodowski[3]

1. Bedrock Geosciences, Auenstein, Switzerland, 2. JAEA, Tokai, Japan, 3. BGS, Keyworth, UK,

In many repository designs, cement-based materials are expected to dominate, ensuring long-term maintenance of hyperalkaline conditions which are predicted to suppress the solubility of key radionuclides in the waste and enhance their sorption on the cement. Models of cement evolution predict that leaching of the cementitious material in the repository by groundwater will produce an initial stage of hyperalkaline (pH~13.5) leachates, dominated by alkali hydroxides, followed by a longer period of portlandite and CSH buffered (pH~12.5) leachates. It has also been predicted that, as the hyperalkaline porewater leaches out of the near-field, significant interaction with the repository host rock (and, where applicable, bentonite buffer and backfill) may occur. This could possibly lead to deterioration of those features for which the host rock formation and bentonite were originally chosen. Here, the safety assessment implications of the novel data from Phase IV of the Jordan Natural Analogue Study, which looked into interaction of cementitious hyperalkaline leachates on repository host rocks and clays, are presented. Several sites across Jordan have been studied, but the focus here will be on two particularly contrasting sites:

- *Maqarin* in northern Jordan – this represents repository host rocks with advective groundwater systems. Hydrogeological, hydrochemical and structural data collected on the fractured rock at the site will be used to assess the likely implications of hyperalkaine leachate interaction on the long-term flow conditions in similar repository host rocks (e.g. granites, fractured sediments)
- *Khushaym Matruk* in south-central Jordan – this represents repository host rocks with diffusive groundwater systems. Here, hyperalkaline leachates are diffusing through an impermeable, clay-rich sediment, so providing information on the likely controls on leachate interaction in tight repository host rocks (eg claystones)

In addition, data are provided on the nature of the secondary phases produced following interaction of the leachates with clays present at the sites. These include mixed-layer illite/smectites and so are particularly good analogues of reaction of cement leachates on the bentonite buffer which is an integral part of the EBS in some L/ILW repository designs. This work will be contrasted with that presented by Alexander et al and Fujii et al (both this session) which are focussed on bentonite reaction in leachates from low alkali cements. These cements are under consideration for use in repositories where bentonite and concrete will be placed together as they produce lower pH leachates (pH 10 to 11) which are believed to be less aggressive to bentonite.