Bentonite analogues for geological disposal of radioactive waste – current status and future outlook

Heini M. Reijonen[1*] & W. Russell Alexander[2]

[1]Saanio & Riekkola Oy, Laulukuja 4, 00420 Helsinki Finland (heini.reijonen@sroy.fi)

[2]Bedrock Geosciences, Veltheimerstrasse 18, 5105 Auenstein, Switzerland

Numerous studies on bentonites, focussing on bentonite interaction with other components of the engineered barrier system (EBS) and a range of host rock environments, are present in the literature. In this article (Reijonen & Alexander, 2015), recent bentonite NA studies were briefly reviewed and gaps in the current literature identified. The aim was to:

1) suggest where relevant new information could be obtained by data mining published bentonite NA studies with a new focus of current safety case requirements

2) collect relevant information by revisiting known bentonite analogue sites and conducting investigations with more appropriate (and up-to-date) analytical techniques

3) identify novel study sites where, for example, bentonite longevity in very dilute to highly saline groundwater conditions can be studied (cf. Reijonen & Marcos, 2015).

It must be noted that the use of NAs in safety case development is likely to be site and repository design-specific in nature and thus emphasis is placed on the appropriate use of relevant NA data on bentonite longevity (see also discussion in Alexander et al., 2014; 2015; Reijonen et al., 2015).

This brief overview of several recent NA studies has shown that, although most processes relevant to the long-term behaviour of EBS bentonite under repository conditions could be addressed by NA studies, few have been done to an appropriate level. Either the boundary conditions have not been fully defined or the environments studied were not as relevant as hoped or the studies simply were not focussed enough on supplying data for the safety case (i.e. bottom-up vs. top-down studies; cf. Alexander et al. 2014). This is reflected in the strength of the qualitative discussion and strong process understanding regarding engineered clay barriers and their longevity in general but, on the other hand, in the lack of usable quantitative data.

Nevertheless, it is clear from Reijonen & Alexander (2015) that many NAs of relevance do exist and much information of use in the safety case, both quantitative and qualitative, could be provided. These data could be produced by a mixture of means, including:

- obtaining relevant information by data mining published NA studies with a new focus of current safety case requirements (cf. McKinley & Alexander, 2007; Alexander et al., 2007)

- obtaining relevant information by revisiting known bentonite analogue sites and conducting investigations with more appropriate analytical techniques (cf. Milodowski et al., 2015)
- identifying novel study sites where, for example, long-term stability of bentonite in very low salinity groundwaters can be studied (cf. Reijonen & Marcos, 2015)

References

Alexander, W.R., McKinley, I.G. & MacKenzie, I.G. (2007). Development of an optimised natural analogue programme to support the Japanese HLW/TRU disposal programme (Part 1), MCM-TR-07-01, MCM, Baden-Dättwil, Switzerland.

Alexander, W.R., McKinley, I.G. & Kawamura, H. (2014). The process of defining an optimal natural analogue programme to support national disposal programmes. Proc. NEA-GRS Workshop on natural analogues for Safety Cases of repositories in rock salt. 4 – 6 September, 2012, Braunschweig, Germany. Radioactive Waste Management NEA/RWM/R(2013) pp 29-43, NEA/OECD, Paris, France.

Alexander, W.R., Reijonen, H.M. & McKinley, I.G. (2015). Natural analogues: studies of geological processes relevant to radioactive waste disposal in deep geological repositories. Swiss Journal of Geosciences, 108, 75-100.

McKinley, I.G. & Alexander, W.R. (2007). Development of an optimised natural analogue programme to support the Japanese HLW/TRU disposal programme (Part 2), MCM-TR-07-02, MCM, Baden-Dättwil, Switzerland.

Milodowski, A.E., Norris, S. & Alexander, W.R. (2015). Minimal alteration of montmorillonite following long-term reaction in natural alkali solutions: implications for geological disposal of radioactive waste. Appl. Geochem. (*submitted*).

Reijonen, H.M. & Alexander, W.R. (2015). Bentonite analogue research related to geological disposal of radioactive waste – current status and future outlook. Swiss Journal of Geosciences, 108, 101-110.

Reijonen, H.M. & Marcos, N. (2015). Bentonite erosion: true or false? NAWG 14 Workshop, *extended abstract*, GTK, Espoo, Finland.

Reijonen, H.M., Alexander, W.R., Marcos, N. & Lehtinen, A. (2015). Complementary considerations in Posiva's safety case - support from natural analogues and natural systems. Swiss Journal of Geosciences Special Issue, 108.