

The List of Additional Comments on the 26th Technical Committee Meeting on JAEA's URL Projects

Stefan Mayer (IAEA)	
1	The intrinsic interest and merit of Horonobe RD&D to support the national DGR (Deep Geological Repository) programme could be slightly reformulated; especially, as already commented, it may be premature to assert a relative similarity between Horonobe site properties and the geological formations that will eventually be studied for the ongoing site selection. Rather, lessons learnt in site characterization approaches, as well as in the methods of inferring a representative site descriptive model from site characterization at Horonobe, will be very useful to guide the approach during site selection. If the future site is sedimentary, then similarities can also be useful for the earlier site viability assessments.
2	ON the relative merits of studying the upper, more highly fractured and heterogeneous domain, as well as the lower domain with apparently more homogeneous, diffusion dominated or controlled transport properties: Obtaining site data and developing corresponding models for both provides a range of hypothetical site properties; if both are used to conduct generic assessments, it can provide understanding for a range of isolation and containment - it is assumed better isolation and containment in the lower layers, albeit with more challenging mechanical properties for operations.
3	ON the "variability of sedimentary rock properties": all properties (mechanical, chemical, transport relevant) indeed depend significantly on the sediment composition; however, the generic studies tend to focus on the relative merits of diffusion dominated transport in argillaceous rocks, and look at the formation to ensure relatively homogeneous properties are present over a scale relevant to the overall disposal layout, without being perturbed by significant features - it would then be useful if Horonobe URL could provide generic information relative to those points, and provide the implementer (NUMO) with future expertise on how to effectively characterize a site during early screening; the generic studies tend to also focus on the mechanical properties of the sedimentary rock, and while it is unlikely that the same elasto-plastic behaviour would be observed at Horonobe and at the future site, an important expertise to develop is the method for setting up long term experiments to establish rock mechanical behaviour, which can then be used for the design of ground support (100 years + stability needed!). Observations in other URF(Underground Research Facility)s in sedimentary rock have so far shown that sedimentary rock response after a few decades is difficult to predict.
4	The opportunity to have a URF accessible as a center of training appears as very interesting.
5	I am not sure why there is a focus on coastal areas; the greater relevance seems to be the capacity to conduct generic studies in sedimentary formations, in a more complex setting (upper domain, fractures, features) and an apparently more homogeneous setting (lower domain).
6	The label of "optimized disposal concepts" had been discussed during the meeting. Although it is explained in the slide, it carries the tendency to be misunderstood. It would be helpful to replace the label with the actual scope - I had understood "technological developments to improve EBS (Engineering Barrier System) construction efficiencies", or something like that.
7	On the further experimental plans, I had understood that these would be driven by two national considerations: build upon already gained understanding to address open questions - so a continuity of prior RD&D plan; take on board specifications of needs from NUMO consistent with the next stages of the national DGR programmes site selection needs, as well as relevance to the NUMO generic safety case that was developed over the past years. They could also be driven, or rather complemented, by the interest in involving international partners: for this a good awareness of comparable RD&D efforts in other URFs is useful, to insert any specific experiment in the suite of experiments conducted in other URFs. Coordinated R&D performed in Europe over the past decade may provide a good illustration: several URFs and their national DGR programmes have discussed the most significant needs to progress the technological basis, and have designed a suite of experiments (for example on seal emplacement). This might enhance the relevance and interest for cooperation with international partners.
Johan Andersson (SKB, Sweden)	
1	Possibly, the most important contributions of the Honorobe URL, is the capacity and competence attained for carrying out full scale EBS tests of different repository concepts, both with regards to installation/handling and to assess the evolution of the EBS after installation. This capability will be even more important when the NUMO programme advances and the current repository concepts need to be developed into practical designs.
2	ON the antother importance of the lower domain: excavating the lower domain will also provide essential experience in underground construction at great depths in Japan.
3	ON the variability of the sedimentary rocks: for example, the formation of an EDZ would be very dependent on the geological setting, but i) it would be of interest to assess if current handling of EDZ is too conservative at least for the Honorobe type rock and ii) the testing procedure could later be used when NUMO eventually will carry out similar tests during the DI (Detailed Investigation) stage.
4	The capability at Honorobe to carry out full scale test of EBS concepts would be anyway very valuable, when NUMO now needs to further develop and optimize repository concepts even if LS (Literature Suvey) sites would not fully match the site properties at Honorobe.
Stratis Vomvoris (Nagra, Switzerland)	
1	ON the further consideration for the next step, it is recognized that although excavation of a new level (150 to 250 meters deeper) would be beneficial the final decision needs to consider all relevant aspects, including time and costs required in the context of the overall programme for the next 9 years.

Erik Webb (Sandia National Laboratory, USA)	
1	The research conducted at the upper levels of the Horonobe research stations appear to be very well managed and to have collected exactly the right information and demonstrated important practical and geological research topics.
2	The research on emplacement seems innovative and the research on retrieval is unique and should continue.
3	Investigating both the upper and lower zones of the Wakkanai Formation is important. If Japan is fortunate, you will find rock-water-stress conditions for a future repository that are like the Lower Wakkanai. However, until a site is found, you should also investigate less favorable conditions like the upper zone.
4	There are several new technologies being developed and tested as part of research programs on oil and gas extraction, CO2 sequestration, and basic geoscience. These new techniques could add great value and help the Horonobe URL and JAEA remain at the cutting edge. I would recommend investigating: <ul style="list-style-type: none"> a. Wireless sensors that can be emplaced and receive both power and send data remotely. b. Non-reactive tracers based on metal-tuned ligands c. Deep characterization of sealing materials and mathematical descriptions based on "Persistent Homology" d. Sensing while drilling to understand rock stress characteristics ahead of the drill bit (before being disturbed) e. Distributed Acoustic Sensing (DAS) for seismic data collection as a replacement for classical seismometers
5	A critical data type for any argillite rock is 'creep'. The ability of these type of rocks to fill voids during and after closure are important to the safety case.
6	International partnerships remain very important in the global nuclear waste management community. JAEA can be a global leader by helping to educate emerging countries who are beginning new nuclear waste disposal programs and countries like the US who are training a new generation.
7	One method used in the US to build understanding, good will and recruit future scientists are experimental competitions. Several university professors and their student teams are provided partial information on an experiment and they use that information to predict the results. Then it would be judged which group developed the best prediction and provide them with a small award.
Ian McKinley (McKinley Consulting, Switzerland)	
1	The geological profile at the Horonobe URL looks very relevant for studies to support a deep geological repository. For such a site, the lower domain would be the obvious focus for waste disposal, with upper formations representing overburden to be tunneled through and the GBI (Gosphere Biosphere Interface).
2	At the -350m level, relevant work could involve technology development that is not directly linked to the host formation (e.g. robotics and tele-operated equipment development and testing). It could also be useful to test models of coastal site evolution (especially resulting from sealevel change), as there is no other sedimentary URL in such a setting.
3	Technology for site characterisation from the surface can be tested at the Horonobe URL, which allows confirmation of interpretations by underground / <i>in-situ</i> studies. This is very valuable for organisations planning first site studies - e.g. NUMO.
4	It is strongly recommended that work is included at deeper levels (at least -500m, even deeper would be better), as this would allow technology required for deep construction to be developed / tested and characterisation of ambient conditions (THMC(B): Thermo-Hydro-Mechanical-Chemical(-Biological) interactions) together with the impacts of a repository on such conditions.
5	The Horonobe URL is a valuable resource for training - which is critically important in both Japan and other countries in the region. Opportunities for mentoring / knowledge transfer could be even wider, especially for national programmes with potential coastal sites that do not have access to URLs (e.g. UK).
6	<i>In-situ</i> studies could support other high priority R&D topics in advanced programmes (e.g. developing and testing of "next generation" mass transport models).
7	Current financial restrictions could be eased by co-funded projects - which may be conveniently organised via bilateral or multinational agreements, as in European URLs.
Katsumi Kamemura (Fukada Geological Institute, Japan)	
1	It is highly recommended to carry out similar experiments in the deeper part (ex. 500m in depth) as those in the current depth (i.e. 350m in depth). It will provide not only a better understanding of the variability of geological environment characteristics in the site but also practical confidence in case of deep excavation in terms of safety.