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Geological disposal of toxic waste: optimisation for practicality and operational safety

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Assuring safety of geological disposal for extremely long periods of time – thousands or hundreds of thousands of years – is seen to be a major challenge in the process of gaining acceptance for the siting of repositories for radioactive or other toxic waste. While such post-closure safety cases certainly influence technical stakeholders, it is common that greatest concerns for the general public involve much shorter time periods. Indeed, such concerns usually focus mainly on the period when the repository is operational and, maybe, a few decades – at the most centuries - thereafter. The long-term emphasis may be, to some extent, counter-productive, as exotic analyses are proposed to solve rather unlikely problem scenarios. Discussion of exotic future perturbations can cause confusion and may actually increase levels of public consternation.

Long-term safety cannot be discounted, but should be seen in the context of the decreasing hazard of the waste due to decay and slow dispersion processes. Selection of a suitable stable site and tailoring the design of engineered barriers to ensure that safety is provided by well-defined processes (e.g. low solubility of key species, releases limited by aqueous phase diffusion) can provide very high levels of environmental protection. Traditional over-conservatism of performance assessment, over-emphasis of unrealistic "what if?" scenarios and exaggeration of the significance of system uncertainties, however, often leads to drastic over-design of the engineered barriers. This is not only costly, but also gives practical problems and operational safety concerns when attempts are made to realise these designs under the tight constraints set by working underground.

There can be many advantages of simplified designs which place particular emphasis on operational practicality and a safety case focused on the periods of greatest public concern. Even if not strictly necessary from a technical viewpoint, special considerations of monitoring (or even inspectability) of emplaced waste can be included in the designs from an early stage. A by-product of such an approach is that the public can be directly involved in discussions of design requirements, which inevitably increases their understanding of key issues and, hopefully, foster acceptance. The paper will discuss approaches which can be used to optimise particular designs for intermediate and deep geological disposal concepts while still ensuring that sufficient long-term performance is assured.