The Influence of Microorganisms on Subsurface, Salt-Based Nuclear Waste Repositories

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Subterranean salt formations have been considered by some countries, and are in use by others, for the permanent disposal of nuclear waste. Because the biogeochemistry of other deep geologic settings (e.g., granite, clay) differs significantly from subterranean salt, it is not possible to extrapolate microbial activity from one site type to the other. However, because of a lack of sufficient data, this is precisely what has been done in most safety case scenarios in salt. Thus, performance models assume the worst-case scenarios: 1) that the organisms present in rock salt will thrive on the organics present in the radioactive waste, leading to the generation of complexing agents that enhance radionuclide solubility, 2) that they will take up significant amounts of radionuclides and transport them away from the repository, and 3) that they may interact adversely with barrier components, thereby compromising their integrity.

Current research being conducted by Los Alamos National Laboratory for the Waste Isolation Pilot Plant (WIPP) and by the Helmholtz-Zentrum Dresden-Rossendorf for the German concept is providing a more realistic view of the potential effects of all microorganisms, both indigenous and introduced, on salt-based nuclear waste repositories. Results suggest: 1) that the activity of repository-indigenous and introduced organisms will be constrained by the projected conditions (some combination of low water activity, high chaotropicity, anoxic atmosphere) and also by a lack of suitable organic substrates in the near-field but that organisms located in the far-field will not be as constrained; 2) that some organisms may alter brine composition in ways that may affect radionuclide solubility; 3) that the radionuclides present in some waste drums are inhibitory, but not completely lethal, at their soluble concentrations in repository brine; 4) that bioassociation of radionuclides appears to differ with oxidation state, organism, and brine composition; and 5) that microbially-induced radionuclide transformation via redox reactions may be limited to the far-field.