STRENGTHENING THE HYDROGEOLOGIC CONTRIBUTION TO SAFETY OF A NUCLEAR WASTE REPOSITORY BY SITING BELOW A MAJOR RECHARGE AREA FOR GROUNDWATER

Clifford I. Voss - U.S. Geological Survey

A nuclear waste repository located below a regional groundwater recharge area may provide significant hydrogeologic safety advantages in Sweden, adding to the safety provided by the engineered barrier system. This concept of multiple-barrier waste isolation has been an essential element of the repository system to be implemented in Sweden. At a recharge-area repository location, should the unlikely event of engineered barrier failure occur, escaping radionuclides would follow extremely long and deep subsurface paths, allowing most radionuclides to decay to harmless levels before reaching the surface. In contrast, a nuclear waste repository located within a groundwater discharge area has very short paths, possibly allowing escaping radionuclides to reach the surface in a short time. Because most coastal areas of Sweden are within or near the primary discharge areas for regional ground-water flow, a coastal repository may provide a lower margin of the hydrogeologic safety component in the multiple-barrier system than a repository located below a major inland recharge area. The international principle of containment system 'optimization' might then lead to selection of an inland recharge-area site, if one could be identified, and if this is a socially- and economically-feasible option.

There are two major difficulties in reliably locating major groundwater recharge areas in Sweden. First, high-density brines exist at depth in the bedrock, and the groundwater flow field is driven in a complex manner by both topographic relief and by variable-density forces in the fluid. Second, because of the extreme heterogeneity of the fractured bedrock, the internal hydrogeologic structure and bedrock properties will remain unknown at required spatial scales making it impossible to ascertain the subsurface flow pattern. Despite these difficulties, groundwater recharge-area sites with long flow paths may be revealed through the prospective use of variable-density ground-water flow simulation to evaluate the possible range of flow patterns in the bedrock. A simulation is required for each potential bedrock description that can be envisaged. Then, the most advantageous sites are those that remain major recharge areas in all simulations, irrespective of the modeled bedrock description.