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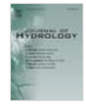

Groundwater mixing dynamics at a Canadian Shield mine

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Abstract

Temporal and spatial variations in geochemistry and isotopes in mine inflows at the Con Mine, Yellowknife, are studied to access the impact of underground openings on deep groundwater flow in the Canadian Shield. Periodic sampling of inflow at 20 sites from 700 to 1615 m depth showed that salinities range from 1.4 to 290 g/l, with tritium detected at all depths. Three mixing end-members are identified: (1) Ca(Na)–Cl Shield brine; (2) glacial meltwater recharged at the margin of the retreating Laurentide ice sheet at ~10 ka; and (3) modern meteoric water. Mixing fractions, calculated for inflows on five mine levels, illustrate the infiltration of modern water along specific fault planes. Tritium data for the modern component are corrected for mixing with brine and glacial waters and interpreted with an exponential-piston flow model. Results indicate that the mean transit time from surface to 1300 m depth is about 23 years in the early period after drift construction in 1979, but decreases to about 17 years in the past decade. The persistence of glacial meltwater in the subsurface to the present time, and the rapid circulation of modern meteoric water since the start of mining activities underline the importance of gradient, in addition to permeability, as a control on deep groundwater flow in the Canadian Shield.

Keywords

Groundwater; Canadian Shield; Mixing; Environmental isotopes; Geochemistry; Brine; Tritium; Con Mine; Radioactive waste

Figures and tables from this article:

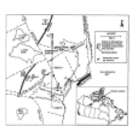

Fig. 1. Map of the southern area of the Con Mine showing mineralized shear zones, faults, and surface water bodies in the area sample. The drift sections represent the north–south limits between regular sampling locations at each level, and illustrate the westerly offset of drifts with increasing depth.

Figure options