Aquifer Systems in Southern Ontario: Hydrogeological Considerations for Well Drilling and Plugging

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Abstract

Three groundwater regimes have been identified in the Paleozoic bedrock terrain of southern Ontario based on geological and geochemical criteria: a shallow fresh water regime, an intermediate depth brackish sulphur water (dissolved H_2S) regime and a deep brine regime. The shallow fresh water regime is an active, topography-driven flow system. Fresh water is encountered in petroleum and water wells up to 250 metres below the surface. Fresh water occurs in unconsolidated glacial and post-glacial sediments overlying Paleozoic bedrock, as a regional contact aquifer at the interface between the sediments and the bedrock, and in karstic Paleozoic limestones and dolostones in areas of thin drift. Individual aquifers in glacial drift are generally unconfined to partly confined, forming complex, local systems with limited lateral extent. The contact aquifer extends beneath most of southern Ontario and is the source of potable water for a large proportion of domestic water wells in southern Ontario. It has only recently been possible to map the geographic extent of the karst aquifer system and detailed studies have yet to be initiated.

Aquifers in the intermediate to deep regimes are contained in several discrete regional paleokarst horizons developed in limestones and dolostones at regional unconformities. Aquifers are generally thin, and are confined between thick aquitards of shale, evaporites and non-karstic limestone and dolostone. All of these confined aquifers display downdip geochemical zonation from fresh water at the subcrop edge to brines in the deep subsurface, separated by an intermediate zone of brackish sulphur water. Buoyancy effects related to the presence of deep subsurface brines probably prevent deep penetration of fresh water. At least one active flow system has been documented in the sulphur water system, confirmed by meteoric water signatures in oxygen and hydrogen isotopic compositions.

Unique isotopic signatures have been identified for the deep brines in each confined aquifer, indicating very long residence times and no active flow in the deep brine regime.

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