30

Resolving Complex Hydrogeological Settings Using an Integrated Geochemical Approach

Jon Fennell and Ian Grant, Integrated Sustainability Consultants Ltd.
Michael Brewster, Devon Canada

Safe and responsible development of Alberta's oil sands deposits is the goal of the energy industry and the provincial government. This includes the management of wastes streams generated during the extraction process. The common practice for liquid waste management is injection into subsurface formations suitable to accept such wastes. In certain formations, challenges have arisen due to cumulative pressure build-up from nearby projects using the same injection interval (e.g., basal McMurray Formation in the Winefred Lake area). This challenge has prompted the need to identify alternative formations to facilitate continued and sustainable liquid waste disposal operations.

To address this challenge, Devon Canada initiated an investigation to identify a new disposal formation. Elevated pore water salinity in the shallower Grand Rapids Formation presented an opportunity; however the source of salinity was unclear. Recent investigations into elevated salinity in the Mannville Group formations have revealed the potential for connectivity between deeper Devonian formations and shallower intervals (Cowie 2012). The upward movement of highly saline pore water has been identified as a possible mechanism, following the dissolution of soluble salts in the middle Devonian, collapse of the overlying strata, and creation of pathways for fluid movement.

Results of Devon's investigation revealed the presence of something quite different - a complex hydrogeological setting influencing local groundwater flow conditions in the Grand Rapids Formation, with lower salinity pore waters (e.g., 5000 mg/L TDS) juxtaposed to highly saline intervals (up to 30,000+ mg/L TDS). Controls on flow patterns, exerted by topographic features and buried channels were suspected based on geological evidence and groundwater modeling results. Selected trace elements and isotopes in water sampled from the Grand Rapids and adjacent formations confirmed hydrochemical separation between the intervals and the presence of a localized hydrodynamic trap. This trap is the manifestation of upland recharge areas to the south and incised bedrock channels beneath in the study area. This combination of physical factors has thus created favorable conditions in the Grand Rapids Formation for the safe disposal of liquid waste streams (i.e., hydrodynamic containment).

This presentation will outline the unique geochemical conditions identified in the study area, and underscore the importance of employing an integrated approach to resolving complex hydrogeological systems.

Jon Fennell, M.Sc., Ph.D., P.Geol.

Dr. Fennell is Vice President of Geosciences and Water Security, and Principal Hydrogeologist at Integrated Sustainability Consultants Ltd. (a water, waste and energy management firm based in Calgary). He has over 28 years consulting experience in the natural resource sector, the majority of which is directly related to water management in the conventional and unconventional oil and gas sector. Jon received his B.Sc. degree in Geology from the University of Saskatchewan in 1985, M.Sc. in Hydrogeology from the University of Calgary in 1994, and Ph.D. in Geochemistry from the University of Calgary in 2008. His areas of specialization include physical and chemical hydrogeology, groundwater-surface water interactions, environmental forensics, water supply, waste disposal, risk assessment and risk mitigation. Jon's skills also extend to assessing the effects of climate variability, climate change, and land use on basin hydrology, as well as developing effective management strategies to ensure water security and basin sustainability.