



What the Shale? Impacts on Shallow Soil and Groundwater Quality from near Surface Marine Shale Bedrock in Alberta

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Almost all the bedrock exposed at surface and beneath the glacial drift Alberta is sedimentary in origin. Of the total area of the province, nearly 50% of this bedrock comprises fine grained siltstone, mudstone (or shale) deposited in what was originally a marine environment. Marine shales are deposited in deep water in generally anoxic conditions, predominantly by suspension settling, and are texturally immature meaning that the particles they are made up from do not experience a significant amount of weathering and erosion prior to deposition. Because of this, they contain a variety of unstable minerals and compounds preserved in their rock matrix. Some of these immature components include clay minerals, metal oxides and sulfides, and organic matter. Because they are very low permeability in-situ, they can also preserve pore water (connate water) at the time of deposition, which in the case of marine shales would comprise residual seawater, that can persist over long periods of geological time.

Of the marine shales occurring as the uppermost bedrock unit in Alberta, nearly a third are exposed at surface or beneath relatively shallow drift deposits (<15 m). There are four broad geographic areas where this occurs that include: 1) the Rocky Mountain Foothills and 2) the Sullivan Lake Plain area in Southern Alberta and 3) the Clear Hills Uplands and 4) Caribou Mountain Uplands and surrounding lowlands in Northern Alberta. As several of these areas are locations of active oil and gas development, the occurrence of shallow marine shale can pose challenges for remediation and reclamation of facilities as the nature of this bedrock material results in exceedances of multiple parameters defined in the Alberta Tier 1 soil and groundwater remediation guidelines including salts, metals and petroleum hydrocarbons under natural, pre-development conditions.

The presentation will describe example scenarios where multiple parameters were attributable to the marine shale bedrock, and the techniques that were used to connect the geological material as a source of those parameters. Some examples from the Clear Hills Uplands will include natural petroleum hydrocarbons related to an immature oil kerogen and oxidation of natural pyrite that has generated significant concentrations of sulphate in soil and groundwater. Examples from the Alberta Foothills will include a mature oil kerogen and elevated salinity that could be attributable to connate water.

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Alex Haluszka is a principal hydrogeologist in Montrose Environmental Solutions Canada Inc.'s western hydrogeology team with over 15 years of applied experience in water supply and disposal hydrogeology, regional mapping and hydrodynamics of the Western Canada Sedimentary Basin (WCSB), project management, and groundwater numerical modelling. Alex has a significant background in sedimentary depositional systems, naturally fractured rocks, and how geology relates to hydrostratigraphy and groundwater flow. He has applied these skills to evaluate and optimize water supply and disposal strategies, evaluate contaminant fate and transport, and assess groundwater/surface water interactions. One of his current focus areas is providing technical oversight and direction on site assessment and risk management activities on a large portfolio of upstream oil and gas contaminated sites in Alberta for Montrose.

Phil Richards is a chartered senior forensic chemist with over 20 years of experience as a professional chemist. He is qualified as an expert as an analytical chemist at the Court of the Kings Bench in Alberta. He specialises in chemical data interpretation, in particular source characterisation and the fate and transport of organic contaminants.