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The Great Debate: Natural versus Anthropogenic Chloride – with Application to Upstream Oil & Gas Facilities

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Upstream oil and gas facilities in Alberta and across the western Canadian prairies are located in natural environments ranging from open grasslands to boreal forest and mountainous alpine terrains. The environment is dominated by climate and landscape, which is reflected in the composition of soils and groundwater. Chloride accumulates through both natural and anthropogenic processes in soils and groundwater across the region, which can be a complicating factor in environmental assessment, permitting, monitoring, remediation, reclamation and ultimately closure.

Natural chloride exists in a variety of primary sources, and its release through processes such as soil development, groundwater flow, and evapotranspiration can locally produce elevated baseline chloride concentrations. Chloride may originate as saline water deposited in ancient seas and released through deep flow of formation waters towards discharge points, diffusion out of uplifted marine shale, and potentially by tracer concentration in unsaturated soils. Methods have been developed to distinguish source(s) of chloride in groundwater and soil using concentrations of various constituents in the environmental medium, such as the ratios of dissolved constituents, stable isotope ratios, and the abundance of radiogenic isotopes.

In locations where elevated chloride concentrations occur in the environment, it is important for environmental assessment and monitoring programs to determine whether the source of chloride is natural or has originated from anthropogenic impacts. Typically, several potential sources of chloride are present at facilities; produced water from leaking pipelines or storage ponds and pits, accidental releases, de-icing agents, and dust suppressants can all affect chloride concentrations in soil and groundwater. These sources have characteristic compositions that can be differentiated from one another; however, natural sources may not be obvious and can be difficult to distinguish from anthropogenic sources of chloride.

Matrix will present information on common sources of chloride at upstream oil and gas facilities, demonstrating the impact each source has on groundwater and soil composition. The presentation will include practical tools to distinguish chloride sources when elevated concentrations are found in groundwater or soils. For example, produced water spilled at a SAGD facility in northeastern Alberta would likely lead to shallow groundwater with elevated concentrations of not just chloride, but also silica, lithium and boron derived from the steaming of Mannville Group sediments.

Hugh Abercrombie

Dr. Hugh Abercrombie has over 25 years of experience in technical, resource, environmental and business development with hands-on expertise in low temperature water-rock-organic interactions in thermal recovery, geochemistry of process-affected and contaminated waters, shallow groundwaters and sedimentary basin waters and gases. He has contributed more than 100 scientific and technical publications in areas ranging from sampling and analysis of process-affected waters in the oil sands mining and in situ thermal recovery, CO2 evolution in sedimentary basins, coal bed methane and shale gas, as well as theoretical and laboratory analysis of rocks and minerals, including clay minerals. His technical expertise is complemented by practical experience in applying risk management to planning, forecasting and financial analysis of natural resource and environmental projects in the mining and energy sectors.