Sulfate Adsorption and Desorption Properties of Alberta Soils and Their Relevance to Transport Properties and Leaching /Redistribution Rates

Tony Knafla
GL 09-9155-50

The energy sector is a source of potentially deleterious sulfate impacts in surface soils. Various practices in the up-stream oil and gas industry can result in subsoil sulfate salts being brought to the surface where increased salinity can cause impairment of vegetative growth. Sulfate redistribution occurs after site remediation activities such as excavation of produced-water impacted soil followed by soil replacement, when excavation depths or the quality of backfill are inadequate. Commonly, calcium sulfate is used as an amendment to soil to reduce high sodium levels at produced water releases, or as part of the oilsands consolidated tailings process, increasing sulfate concentrations. Drilling muds can contain high levels of soluble sulfate salts and historical applications of large quantities at drill sumps have

resulted in many sites experiencing deteriorated soil quality and reductions in vegetation growth. Another example is the blocks of elemental sulfur from processing natural gas, crude oil, or bitumen. These sulphur blocks are typically stored outdoors where they are exposed to rainfall and erosion from wind.

Relocated sulphates may subsequently leach out of the root-zone though the rate may be influenced by sorption/desorption properties and may be slower than the predominantly non-sorptive chloride ion. In some cases, sulphate may also migrate upwards due to groundwater discharge or redistribute upwards into clean backfill following excavation of chloride impacts in soil with elevated background sulphate. In all cases, an understanding of sulphate sorption/desorption soils would be useful for transport modeling and leaching. There are numerous literature references to sulphate adsorption and desorption, though data is limited for Alberta clayey soils and the relatively high sulphate concentrations often found therein. This project proposes to perform sulphate adsorption / desorption experiments on a range of Alberta soils to estimate effective distribution coefficients as an aid to transport modeling. Equilibrium has a large library of soil cores collected from across the province which may be used for the sorption/desorption experiments. This project builds on previous sulphate research performed by Equilibrium with various sulphate risk assessments for the oil and gas industry. In-kind support from

Exova via preferred analytical rates is also available.

Industry would benefit from this project in terms of improved ability to estimate the current and future risks from sulphates in or near the root-zone. This could lead to improved sulphate management practices and be an important step toward sulphate guidelines for root-zone soils. It would also help estimate the potential effectiveness of sulphate-based (eg, gypsum) remediation techniques for SAR which rely on the solubilisation of and transport of sulphate through soil. This could ultimately reduce both investigation and remediation costs and improve environmental performance.

Policy Issue

Additional Science for the Refinement of Regulatory Guidelines/Directives/Policies/Criteria. Natural versus anthropogenic Impacts

Knowledge Gap

Development of sulphate soil quality and remediation guidelines – evaluation of natural salt distribution, fate and transport after redistribution, sulphate, transport modeling

2012 EQM_Sulfate Report