Placing the risk of thermal mobilization into perspective

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Introduction

The oil sands deposits of northern Alberta are significant in size and volume. Of the 170 billion barrels of currently recoverable oil, more than 95% is too deeply buried to economically recover it via surface mining techniques. As such, the industry has responded with in situ technologies such as SAGD (steam assisted gravity drainage) and CSS (cyclic steam stimulation) - both employing the injection of high temperature steam into the target formations via steel wells. In the late 1990s it was discovered that heat from these production casings was being transferred to shallow aquifers and raising local groundwater temperatures to comparatively high values (greater than 40°C). Investigations at two separate projects confirmed the presence of anomalous groundwater quality conditions downgradient of operating production pads (i.e., elevated arsenic concentrations).

Theory and/or Method

Natural sediments contain a number of inorganic and organic constituents with the ability to become mobilized in response to elevated groundwater temperatures. Constituents identified thus far include various metals, metalloids, and soluble organic compounds. Increased microbial activity has also been identified, leading to the suspicion that mobilization reactions are being facilitated more easily than anticipated. Although the risk of thermal mobilization is real, it does not apply equally to all oil sands areas, as a number of constraining factors exists: i) constituents must be present in the host sediments; ii) they must be able to be mobilized, which will be influenced by how they are associated with the host sediments (i.e., on a mineral surface or part of the mineral lattice); iii) geochemical conditions must be suitable for mobilization to occur and be sustained (e.g., changes to pH and oxidation-reduction potentials); and, iv) the system must lack attenuating mechanisms that will retard or sequester mobilized constituents. From a source-pathway-receptor standpoint, the associated risks posed by thermal mobilization will not be the same for every site, and will be highly dependent on: i) the presence of suitable source materials; ii) the presence of an open and active pathway for constituent movement (e.g., extensive aquifer with active groundwater flow); and iii) the occurrence of a sensitive receptor that may be affected if attenuating processes are not successful.

Conclusions

The discovery of thermal mobilization of constituents near existing thermal in situ operations has prompted the government of Alberta to reassess how groundwater in non-saline aquifers will be monitored and managed going forward. Considering that a “concern” with thermal mobilization at a given project or site does not automatically equate to an “issue”, a logical approach to assessing the risk is needed to put thermal mobilization into perspective. This presentation will explore some of the extenuating circumstances surrounding this phenomenon, and help place into context the mounting environmental challenge for Albertans.