Sulfate reduction associated with petroleum contamination in the Umm Er Radhuma aquifer

SERGUEY ARKADAKSKIY[1*], ALI SHAMRANI[1], ORFAN SHOUAKAR-STASH[2]

[1]Environmental Protection Department, Saudi Aramco, Dhahran 31311, Saudi Arabia (*correspondence: serguey.arkadakskiy@aramco.com)

[2]Isotope Tracer Technologies Inc. 695 Rupert St. Waterloo, ON, Canada, (orfan@it2isotopes.com)

The Umm Er Radhuma (UER) aquifer is an important member of the Upper Mega Aquifer (UMA) system of the Arabian Peninsula. The UMA aquifers are hosted in Lower Cretaceous to Neogene lithologies and are an essential, yet non-renewable groundwater resource for most of Saudi Arabia, Bahrain, and the UAE [1]. The UER aquifer consists of Paleogene karstic limestone with excellent hydraulic properties and it is heavily utilized as an agricultural, domestic and municipal groundwater source throughout the Eastern Saudi Arabia. Isolated sections of the aquifer contain naturally occurring H_2S associated with the microbial reduction of sulfate leached from the anhydrite layers of the overlying Rus aquitard. Elevated H_2S concentrations have also been found in areas of the aquifer impacted by hydrocarbon contamination. The high H_2S toxicity and the proximity of those areas to sensitive receptors necessitated that a geochemical study be conducted to determine the origin and/or timing of the H_2S formation.

This presentation will focus on the preliminary results from the analyses of UER groundwater samples collected at two contaminated sites – site A impacted with light crude oil and site B impacted with diesel and gasoline. The samples were collected from monitoring wells inside and outside of the hydrocarbon plumes. Parameters such as ORP, pH and T were determined in the field, while dissolved major and trace contents, $\delta^{18}O$ and $\delta^{2}H$ of $H^{2}O$, $\delta^{13}C_{DIC,}$ and the $\delta^{34}S$ of dissolved SO_4 and sulfide were determined in commercial labs in Saudi Arabia and Canada. Results demonstrate that samples proximal to and from within the hydrocarbon plumes have redox parameters, terminal electron acceptor contents and ratios, and $\varepsilon^{34}S_{sulphate\text{-}sulphide}$ consistent with ongoing bacteriogenic sulfate reduction (BSR) associated with hydrocarbon oxidation. Future work will focus on the microbiological populations at the contaminated sites so that an optimal groundwater remediation strategy can be designed.

[1] Schultz (2017) Dissertation, Darmstadt Tech. Uni. pp.105