



## **Sorption and biodegradation of petroleum hydrocarbons in (semi)-arid coastal soil environments as a function of salinity and temperature**

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A common source of contamination of soil and groundwater in (semi)-arid coastal regions are accidental spills of petroleum products, such as crude oil, gasoline, and diesel fuel. In subsurface environments contaminated by petroleum products, the geochemical conditions near the water table, in particular, the oxygen availability, moisture content, salinity, pH, nutrient concentrations and temperature are important determinants of biogeochemical processes. In order to quantify the sorption and biodegradation rates of petroleum hydrocarbons in (semi)-arid coastal soil environments, we conducted a series of controlled-laboratory batch experiments under variable salinity, temperature and water chemistry conditions. The soil samples were collected from the eastern coast of Qatar which is close to the two largest off-shore oil and natural gas fields of the country (North Gas and Al-Shaheen Oil Fields), and volatile benzene and naphthalene were used as petroleum hydrocarbons. The initial physical characterization of soil samples showed sand classification with the texture class of locally-called sabkhas soils. The results of solid-phase chemical characterization suggested that the dominant minerals of the soil were calcite, dolomite and gypsum and the concentrations of chloride and sodium were found to be high ( $> 400$  mg/L) with a chloride-to-sodium ratio of  $\sim 1.6$ . The results of sorption experiments showed that the rates of naphthalene adsorption was more than benzene where the initial aqueous concentrations of benzene and naphthalene were reduced at equilibrium due to sorption by approximately 10% and 75%, respectively. This difference was attributed to the organic carbon-water partitioning coefficient which is higher for naphthalene. A comparison of the results from the sorption rate experiments at early and late sampling times showed that sorption was stronger for benzene under higher salinity condition. Naphthalene, on the other hand, showed a sorption behavior which seemed to be influenced by the temperature as its sorption decreased by 18% from 5°C to 35°C. We also developed a sorption kinetics model to define the sorption behavior of benzene and naphthalene hydrocarbons for the specific coastal soil collected from the Qatar site. The model assumes two sorption sites on the soil, one site in local equilibrium and the other site undergoing first-order kinetic sorption, and the best fits were achieved with the Langmuir sorption isotherm. In this presentation, we present the results of sorption and biodegradation batch experiments as well as the design of a unique flow-through and dynamic soil column experiments to understand the dynamic responses of the fate, transport and degradation of hydrocarbons and the soil biogeochemical processes to the relatively abrupt changes in hydrogeochemical and climatic conditions.