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Chemical Characterization and Source Identification of Beached Oil from Two Areas Along the North-Western Coast of Qatar

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Over the years there have been several reports of oil spills affecting particularly the northern coast of Qatar. In most cases, the source of oil spills is not identified. The spilled oils are very resistant to degradation and can affect the coastal ecosystem over many years. Even today, after 24 years, some of the oil that was spilled during the 1991 Gulf War can be found in sand, close to the Al Zubahra UNESCO site.

The Maersk Oil Research and Technology Center in Doha (MO-RTC) has established the Oil Fingerprint project in collaboration with the University of Qatar and the University of Copenhagen. One of the objectives of the collaboration is to identify the potential source and origin of oil spills based on their chemical composition.

A total of 38 samples were collected. During the sampling campaign it was discovered that the coast was contaminated with highly weathered oil that could originate from the Gulf War era but also with more fresh oil that most likely originates from recent oil spills in the Arabian Gulf. We therefore collected polluted soil samples and contaminated sediments from two main areas along the beach in North-western Qatar. The samples were analysed using gas chromatography – mass spectrometry in selected ion monitoring mode (GC-MS/SIM) and the oil composition was characterized. The likely source of the beached oil was identified by a comparison of diagnostic source ratios by comparing petroleum hydrocarbon fingerprints of steranes and hopanes of the spills against an oil database. The initial chemical fingerprinting based on selected ion chromatograms (SICs) of steranes (m/z 217) and hopanes (m/z 191), were remarkable similar as were the C29-/C30-Hopane ratios between sampling sites. However, a more detailed pixel-based analysis showed significant differences between samples.

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The process also included an assessment of the physical and biological weathering effects on the oil spills. Petroleum biomarker patterns (steranes and hopanes) are identical for all 14 samples included in this pilot study. The only differences observed were in the relative concentration of LMW and HMW steranes. This could be due to real source oil differences, however, the general weathering patterns indicate that these differences are more likely due to extensive weathering of especially two samples (9–02, 3–02) but also 8–01 and 10–01 shows severe weathering effects. Analysis of alkyl-PAHs provided an overall evaporative weathering degree for the samples. Distinct differences in the isomer patterns were observed for 3- to 4-ring alkyl-PAHs and this cannot be immediately explained as biodegradation. The largest fraction of the samples seems to originate from the same source but other sources are clearly present. A more detailed analysis with normalization to Euclidean norms within six selected SICs revealed more source specific information. In conclusion, the results indicate at least 2–3 different sources on the basis of differences in PAH isomer patterns. This was confirmed by visual inspection of SICs of C1–C3 alkyl-substituted phenanthrene, dibenzothophene, chrysene and pyrene isomers. Apart from the finding that the spills originate from several sources, the evaporation profiles indicated that not all of the spills are crude oils but that some are also heavy fuels. This suggests ongoing bunker flush off the coast of Qatar.

These findings are of importance in further bioremediation processes in which, different approaches should be investigated to achieve high efficiency strategies if removal of oil pollutants from AlZubaraa area.