





### **Faculty, Energy and Environment**

# Origin of TPHs and PAHs in the marine sediment nearby oil and gas extraction sites on the west coast of Qatar

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#### **Abstract**

Total Petroleum Hydrocarbons (TPHs) and Polycyclic Aromatic Hydrocarbons (PAHs) are priority pollutants which are known to be associated with petroleum products. They are released into the marine environment via accidental spillage, exploration and transportation. Sixty-six surface sediment samples were collected along the western coastal area. The concentration of organic hydrocarbons (TPHs and PAHs) were determined using GC-FID and GC-MS, respectively. Sediment characteristics including pH, temperature, TOC and particle size were also measured. The results indicated low concentrations of TPH (<0.001-0.246 µg/g dry weight sediment) and PAHs (<0.001-0.044 µg/g dry weight sediment). The concentrations for both organic pollutants were lower compared to the previous studies done within Qatar and in the Arabian Gulf and also indicated below the available permissible limit set by the Ministry of Municipality and Environment of Qatar and other Sediment Quality Guidelines (SQGs) used worldwide (NOAA). Pollution concentration profile is site specific where concentrations are high within the proximity of the source and derived from both direct inputs of petrogenic and pyrogenic contribution.

**Keywords:** Total Petroleum Hydrocarbons (TPHs), Polycyclic Aromatic Hydrocarbons (PAHs), Marine sediment, Oil and gas extraction, Qatar.

## Aims and Objectives

- To assess the impact of petroleum and gas extraction activities on the pollution of coastal marine sediment of the western coastline of Qatar.
- Concentrations of the organic hydrocarbons in the marine sediment were determined.
- Sediment samples data obtained were compared to the available permissible limit set by the Ministry of Municipality and Environment of Qatar and other Sediment Quality Guidelines (SQGs) used v
- Certain indicators were used to investigate the type and origin of petroleum (Rostami et al., 2019).

# Study Area and Sampling

Multiple surface coastal marine sediment samples (5 – 10 cm) were collected and homogenised into one sample from 20 sampling stations at Dukhan area (about 10 km length along the coastline) where several petroleum extraction stations occur (Figure 1). A flow diagram summarizing the sampling procedure is shown below in (Figure 2).

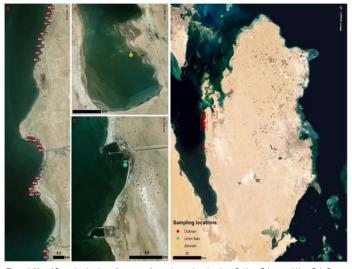


Figure 1. Map of Qatar showing the sediment sampling stations at three locations: Dukhan, Zekreet and Umm Bab. Base map: WorldView-2 satellite data acquired in November 2011 by DigitalGlobe, Inc (Esri).

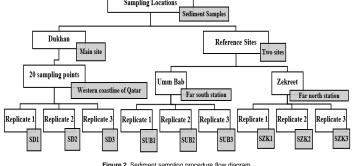
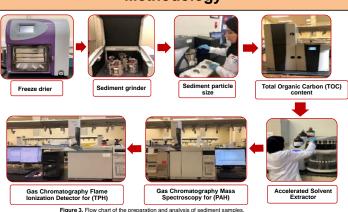


Figure 2. Sediment sampling procedure flow diagram

## Methodology



#### Results and Discussion

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Figure 4. Mean total petroleum hydrocarbon concentrations in sediment samples of Qatar western coastline compared with local guidelines.

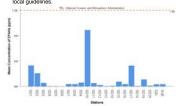


Figure 5. Mean total polycyclic aromatic hydrocarbons concentrations in sediment samples of Qatar western coastline compared with international guidelines.

#### Concentration of sediment TPH and PAH

- Many factors might contribute to the decrease of hydrocarbons concentrations such as the enforcement of regulations and the use of advanced technology that is more environmentally friendly during different phases of oil and gas extraction and production (Lang et al., 2007).
- Low concentrations of hydrocarbons observed in the present study is likely related to an increase in sediments temperature.
- This mainly contributes to volatilization, degradation and solubility of low molecular weight PAHs such as acenaphthylenes and naphthalenes by disturbing the partitioning of the PAHs between organic and aquatic phases (Cui et al., 2016).

#### Origin of petroleum hydrocarbon

- In the presence of fresh crude oil, the ratio of the concentration of total n-alkanes of LMW (C10 -C18) to the concentration of n-alkanes of HMW (C20 - C32) are used as indicator (Gearing et al., 1976; Rostami et al., 2019).
- Based on the results, low TPH concentrations (<LOD, refer to Figure 4) were obtained in almost all the sites studied that calculating for LMW/HMW TPH ratio is not feasible. The low levels could be attributed to the weathering of the aliphatic (n-alkanes) components of the petroleum crude oil.
- Pyrogenic processes e.g., combustion of oil, coal, and wood, pyrolysis or natural fires, and industrial combustion activities, produce mainly high molecular weight (HMW) PAHs and nonalkylated PAHs (Law et al., 1994, Baumard et al., 1998). Therefore, the ratio between the LMW compounds (2-3 rings) and HMW compounds (4-6 rings) can be used also as an indicator to differentiate petrogenic from pyrogenic PAHs
- The ratio of LMW/HMW PAHs<1 indicates sediment pollution is by pyrolytic inputs while LMW/HMW PAHs>1 represents petrogenic source of pollution.
- Sites (SD3-SD9) that are directly close to the oil and gas refinery have LMW/HMW ratios ranging from 1.38 to 28.5 (> 1) which is expected to be contributed from petrogenic source. Sites that are farthest have PAH source that are derived from both direct inputs of petroleum and combustion sources.
- Variations could come from the fact that there is a refinery located in the area where there is a direct source of oil and gas (i.e., unburned) products via leakage and wastewater effluents and combustion of these products during refining processes (i.e., flare stack).
- Predominance of these HMW PAH may be related to the deposition, slow degradation and persistence of these compounds in marine sediments (Oros and Ross, 2004; Readman et

#### Conclusion

- According to the results obtained from the present study, it can be concluded that oil and gas extraction activities along the western coastline of Qatar did not have a direct impact on the marine sediments to the extent that environmental quality standards are exceeded.
- Further studies would be beneficial to investigate the atmospheric deposition of these petroleum hydrocarbon contaminants and their levels in the marine waters especially in this part of the country to compare and evaluate their contributory levels to environmental pollution

# References

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