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## Short Communication

# Distribution of Aliphatic Hydrocarbon in Coastal Surface Sediments from the Red Sea of Yemen

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**ABSTRACT**

During the field work the author has collected samples, but the identification of oil and oil by–products accomplished at the lab. .The concentration of Aliphatic from 22.8 $\mu gg^{-1}$ at Al-Salif Station to 21.72 $\mu gg^{-1}$ At Ghurirah station. The unresolved complex mixture (UCM) represents components resistant to weathering and bacterial breakdown. This pollution is a consequence of localized oil operation and/or heavy ship traffic. However, some aliphatic hydrocarbons were sourced by natural biogenic processes by marine algae and phytoplankton.
***Keywords:*** Aliphatic Hydrocarbon, Red Sea and Sediments.

## INTRODUCTION

Republic of Yemen is one of the seven countries, which have shoreline on the Red Sea; the shoreline of Yemen is an extension of the Red Sea shoreline located in the southeast section of the Red Sea. It extends from Midi in the north to Dhubab near Bab-El-mandab. The season of the monsoon winds drive the upwelling and, in turn, cause a seasonal periodicity throughout the food web. However, there are different types of impacts on the coastal and marine environment of Yemen. These impacts are mainly caused by human and developmental activities, which introduce pollutants to the marine environment and cause the detraction of some special habitats. The most widely recognized issue is that of oil-related pollution, where considerable attention has been focused. However, other areas of concern include the impact of growing industrial and domestic effluents, unplanned coastal development as well as various miscellaneous anthropogenic activities such as fishing, hunting and tourism.

No major spills have yet occurred in Yemen water. However, the potential threat remains strong, either from shipping accidents or through problems at oil transfer points along the coast (EPC, 1996).

Offshore hydrocarbon exploration; As yet offshore production of gas or oil has started. However, plans have been proposed, giving rise to the risk of possible oil spills, discharges of oil-based mud and contaminated water.

The seawater is already polluted by oil and this pollution has, also, affected the beaches in many countries all over the world.

Oil pollution has bad effects on plants; it may interfere with light penetration and photosynthesis. The oil film has also an effect on gas exchange across the water surface.

**Description of the Study Area**

The Red Sea bibliographic information was extensively cited in Edwards & Head (1987); Morcos & Varley (1990), and Sheppard *et al.* (1992). Moreover, most of the recent information on the Yemen Red Sea coastal environment, flora and fauna was detailed or quoted in IUCN (1987), Rushdi *et al.* (1991), and Dekker & Capelle (1994). The Red Sea is a long narrow basin separating Africa from Asia, and extending from NNW to SSE between latitudes of 30 $^{o}$N to 12$^{o}$ 30'N almost in a straight line. Its total length is 1932 km and average breadth is 280 km. The maximum breadth is only 306 km in the southern sector near Massawa. It attains its minimum breadth of 26 km at the southern end in the Straits of Bab El-mandab. The area of the Red Sea is 4.6 x $10^5$ $km^2$ and mean depth is about 500 m. The maximum recorded depth is 3039 m in the axial trough at 19$^{o}$ 35' N, 38 $^{o}$ 40' E. The real separation of the Red Sea from the Gulf of Aden lies to the north of Bab el Mandab near the Great Hanish Island. The bottom relief of the Red Sea can be divided into the following regions; the coral reef zone, coastal shelves, the main trough, the axial trough, the hot brines region of the Red Sea and the Straits of Bab el Mandab.

Mangroves are salt-tolerant trees usually found in association with mudflats. Globally, mangrove ecosystems contain more than 60 species of trees and provide living space for more than 2000 species of fish, invertebrates and epiphytic plants (Clough, 1993).There are two types of mangroves in Yemen (*Avicennia marina* and *Rhizophora macronata*)

Yemen's mangrove communities include faunal assemblages of fish, crab, shrimp shells, clams, birds, and green turtles and it is important to productive organic carbon

The distribution of coral reefs along both sides of the Red Sea coast shows north-south variations in both coral diversity and community structure. In the southern Red Sea, the steady increase in muddy substrate and mangroves causes significant reef development to be pushed out further from shore. Four factors are thought to be important in limiting coral development in Yemen: 1) the rarity of hard substrates suitable for coral settlement, because of the great depth of alluvial sediments on Tihama and shallow coastal shelf, 2) the shallow bathymetry of the region combined with strong seasonal south-south-westerly winds leads to rough weather that lead to destabilization of soft substrates, high turbidity and sediment stress, 3) there may be localized salinity and sediment stresses resulting from flash floods (IUCN 1987), and 4) the relatively high nutrient levels which promote algal competition (Sheppard et al. 1992). Of these, the first is considered to be the most significant limiting factor (IUCN 1987). Three types of coral formation along the coastline were found during the IUCN survey (1987): fringing reefs, patch reefs and bottom reefs. Reefs north of Al Hodiedah differ in their structure from those to the south. In general, reefs in the north of Al Hudaydah were dominated by massive and encrusting types of corals combined with some forest and foliose forms, except in few locations where soft corals were dominant. South of Al Hodiedah, forest and foliose species become more dominant. Percentage of coral cover ranges from less than 10% north of Hodiedah to over

50% in the southernmost reefs near Al Mukha. Coral diversity is higher in the southern region (more than 25 species) than in the northern part (about 10 species) of the Yemeni Red Sea coast. A section of 100% cover of Galaxea spp, 200 m wide extending for several kilometers were identified in the region between Al Mukha and Dhubab. Further, the shallow reef rock substrate north of Al Hodeidah is dominated by the brown algae *Sargassum* spp. and red calcareous algae, while *Sargassum* were rare or absent further south.

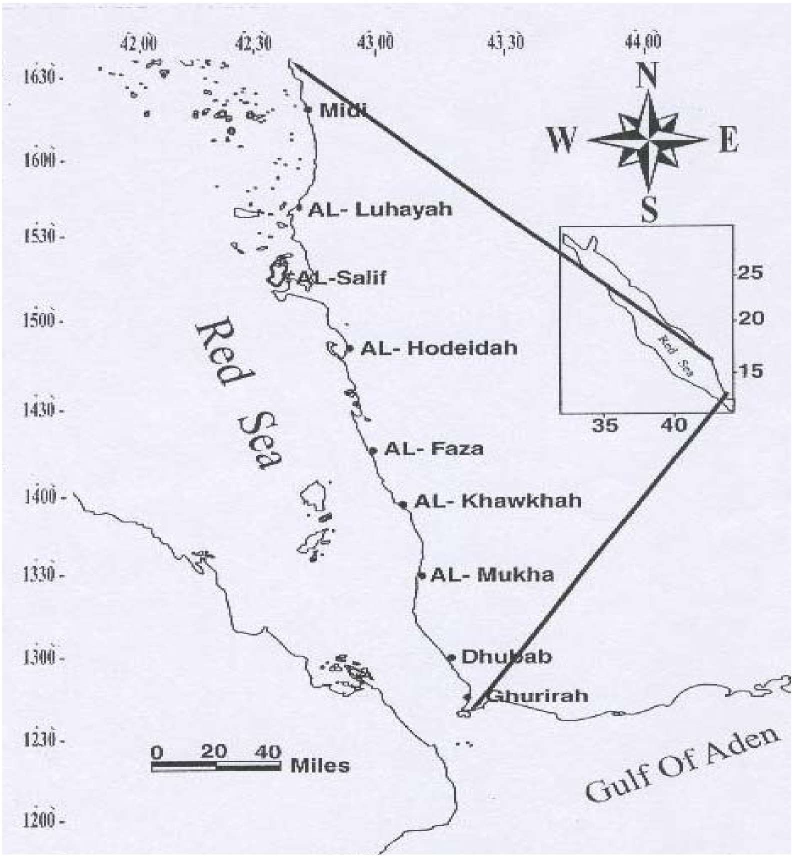


**Figure (1):** Location of selected sampling sites.

## MATERIAL AND METHODS

Samples of surface sediment were collected between February 1999 and January 2000 from Nine stations by Van Van grab samples (Fig, 1). As soon as the samples are acquired, they were placed in glass jars and kept frozen until the time of analysis. A reference station (RF) was selected at Al-Fazaa, being far from oil contamination. The procedure used for extraction and analysis of aliphatic hydrocarbon in the surficial sediment samples were based upon that of IOC (total organic carbon) (1976,1982). For the present work a Perkin-Elmer Spectroflourometer was used. Blank determinations were carried out by repeating the procedure with pre-extracted samples. Lotus 1-2-3- we used to subtract the blank spectra from the spectra of the samples. Using a calibration with Kuwait export blend crude oil and the detector suspense was 45.8 mV at 360nm emission wavelength.

Percentage organic carbon (%TOC) was determined by the procedure proposed by El-Wakeel and Riley (1957).

## RESULT AND DISCUSSION

The distribution of aliphatic hydrocarbons in the sediment samples from the Red Sea coast of Yemen are summarized in table 1. The range of carbon chain length of n-alkanes for the sediment samples are C10 –C31. The bimodal distribution with two maxima around C17 and C27 suggest two different sources of hydrocarbons both biogentic and anthropogenic (Fig. 2). Biogenic sources for hydrocarbons are indicated by the dominate of the odd carbon n-alkanes (C15, C17, C25 and C29) which are synthesized by marine algae (Blumer, et al., 1971; Hwang, et al, 2002), and higher plants (Matsumoto and Hanya, 1981; Lowe, et al, 2006). The presence of pristance and phytane in significant concentrations supports the biogenic origin of hydrocarbon in these samples; it has been reported to be synthesized by both zooplankton and fish (Burns,et al., 1982).

On the other hand, the anthropogainic contribution of hydrocarbons is evident from the presence of the unresolved complex mixture (UCM) in all of the samples analysed. The UCM represent components resistant to weathering and bacterial breakdown and its presence in chromatograms has frequently been taken as an evidence of petroleum contamination (Farrington, et al., 1977).

This study also shows the presence of even- carbon numbered n-alkanes, which may be related to a contribution from artificial sources (Matsumoto and Hanya, 1981). The carbon preference index (CPI), which is an important parameter in relation to hydrocarbon sources (Mazurek and Simoneit, 1984) has a ratio close to unity and is assigned to a polluted environment. CPI for the sediment samples ranged from ND in Al-Fazaa to 2.0 in Al-Salif, which may indicate biogenic in these sediment samples.

The presence of squalane, a major organic constituent in polluted water, was intimately correlated with anthropogenic sources of hydrocarbons (Matsumoto and Hanya, 1981).This compound was encountered in all sediment samples of the Red Sea coast of Yemen. (Table 2) and may serve to indicate the polluted nature of the region. Burns et al., (1982) reported elevated values of squlane in some sediment samples, which are constantly subjected to oil pollution.

The sources of these hydrocarbons include disposal of automobile and industrial lubricants, spillage from oil- storage facilities and leakage from motor vehicles (Al-Shwafi, 2000; Hamid, 1990).

From (Table 2), the % TOC ranges from 0.03 at Ghurirah station to 0.07 at Al-Hodiedah station The concentration of Aliphatic hydrocarbon in surficial sediment of the Red Sea coast of Yemen do not relate to % TOC.

## CONCLUSION

In conclusion, the distribution of n-alkane (Aliphatic hydrocarbon) in surficial sediments sample from the Red Sea Coast of Yemen were found to contain measurable amounts of hydrocarbons. The components seem to be derived from both biogenic as well as anthropogenic source, The concentration of Aliphatic hydrocarbon in surficial sediment of the Red Sea coast of Yemen do not relate to % TOC (Table 2).

A major fraction of petroleum consists of aliphatic hydrocarbons which may be used to detect its presence in the environment. The local marine environment of Yemen is exposed to a relatively high chronic input of petroleum hydrocarbons from industrial effluent, sewage and oil spills.

**Table (1): n-Alkane concentrations in surface sediments (μg/g$^{-1}$dry weight).**

| **Location** | **$C_{10}$** | **$C_{11}$** | **$C_{12}$** | **$C_{13}$** | **$C_{14}$** | **$C_{15}$** | **$C_{16}$** | **$C_{17}$** | **$C_{18}$** | **$C_{19}$** | **$C_{20}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Midi | 0.07 | 0.04 | 0.06 | 0.06 | 0.05 | 0.09 | 0.08 | 0.05 | 0.06 | 0.07 | 0.05 |
| Al-Luhayah | 0.06 | 0.04 | 0.05 | 0.4 | 0.04 | 0.08 | 0.06 | 0.04 | 0.06 | 0.06 | 0.05 |
| Al-Salif | 0.09 | 0.08 | 0.8 | 0.7 | 0.9 | 1.00 | 1.1 | 1.02 | 1.3 | 1.6 | 1.07 |
| Al-Hodiedah | 0.08 | 0.09 | 0.07 | 0.6 | 0.7 | 1.00 | 1.00 | 1.02 | 1.2 | 1.3 | 1.05 |
| Al-Fazaa | 0.02 | 0.01 | 0.01 | 0.03 | 0.01 | 0.04 | 0.01 | 0.02 | 0.03 | 0.05 | 0.04 |
| Al-Khawkhah | 0.03 | 0.07 | 0.07 | 0.09 | 0.4 | 0.3 | 0.09 | 0.3 | 0.07 | 0.1 | 0.8 |
| Al-mukha | 0.07 | 0.08 | 0.08 | 0.5 | 0.8 | 0.9 | 1.0 | 1.01 | 1.1 | 1.01 | 1.1 |
| Dhubab | 0.09 | 0.08 | 0.09 | 0.7 | 1.0 | 0.9 | 1.1 | 1.09 | 1.07 | 1.1 | 1.2 |
| Ghurirah | 1.0 | 0.9 | 0.09 | 0.8 | 1.1 | 1.0 | 1.2 | 1.1 | 1.1 | 1.2 | 1.3 |
| **Location** | **$C_{21}$** | **$C_{22}$** | **$C_{23}$** | **$C_{24}$** | **$C_{25}$** | **$C_{26}$** | **$C_{27}$** | **$C_{28}$** | **$C_{29}$** | **$C_{30}$** | **$C_{31}$** |
| Midi | 0.06 | 0.09 | 0.04 | 0.02 | 0.08 | 0.09 | 1.1 | 0.9 | 0.07 | 0.8 | 0.4 |
| Al-Luhayah | 0.04 | 0.08 | 0.04 | 0.03 | 0.05 | 0.08 | 0.09 | 0.07 | 0.04 | 0.7 | 0.3 |
| Al-Salif | 1.05 | 1.3 | 1.8 | 1.7 | 1.3 | 0.9 | 0.7 | 1.4 | 0.6 | 1.3 | 1.09 |
| Al-Hodiedah | 1.03 | 1.2 | 1.6 | 1.2 | 0.6 | 0.4 | 0.6 | 1.2 | 0.5 | 1.2 | 0.8 |
| Al-Fazaa | ND | 0.01 | 0.01 | ND | 0.03 | 0.01 | 0.01 | ND | 0.01 | ND | ND |
| Al-Khawkhah | 0.09 | 0.08 | 0.4 | 0.1 | 0.09 | 0.7 | 0.04 | 0.1 | 0.6 | 0.07 | 0.5 |
| Al-Mukha | 1.02 | 1.1 | 1.3 | 1.2 | 0.9 | 0.7 | 0.3 | 1.1 | 0.2 | 1.0 | 0.09 |
| Dhubab | 1.03 | 1.09 | 1.3 | 1.07 | 1.02 | 0.9 | 0.7 | 1.2 | 0.4 | 1.3 | 1.1 |
| Ghurirah | 1.0 | 1.1 | 1.4 | 1.04 | 1.0 | 1.0 | 0.9 | 1.3 | 0.5 | 1.3 | 1.2 |

**Table (2): Pristane, Phytane, Squalane and Total n-Alkanes (μg/g-1dry weight) in Sediments,CPI, UCM values and % TOC**

| Location | Pristane | Phytane | Squalane | Total n-Alkanes | CPI | UCM | % TOC |
|---|---|---|---|---|---|---|---|
| Midi | 0.02 | 0.06 | 0.04 | 4.72 | 1.1 | 0.8 | 0.05 |
| Al-Luhayah | 0.02 | 0.01 | 0.03 | 2.46 | 0.9 | 0.5 | 0.04 |
| Al-Salif | 1.01 | 0.9 | 1.2 | 22.8 | 2.0 | 2.1 | 0.05 |
| Al-Hodiedah | 0.5 | 0.4 | 0.6 | 18.44 | 1.3 | 1.6 | 0.07 |
| Al-Fazaa | ND | ND | ND | 0.35 | ND | 0.4 | 0.05 |
| Al-Khawkhah | 0.03 | 0.01 | 0.09 | 4.91 | 0.5 | 0.5 | 0.04 |
| Al-Mukha | 0.5 | 0.3 | 0.4 | 16.56 | 1.2 | 0.9 | 0.06 |
| Dhubab | 0.09 | 0.6 | 1.02 | 19.53 | 1.5 | 1.6 | 0.04 |
| Ghurirah | 1.0 | 0.9 | 1.1 | 21.72 | 1.8 | 1.9 | 0.03 |

ND- Non Detection

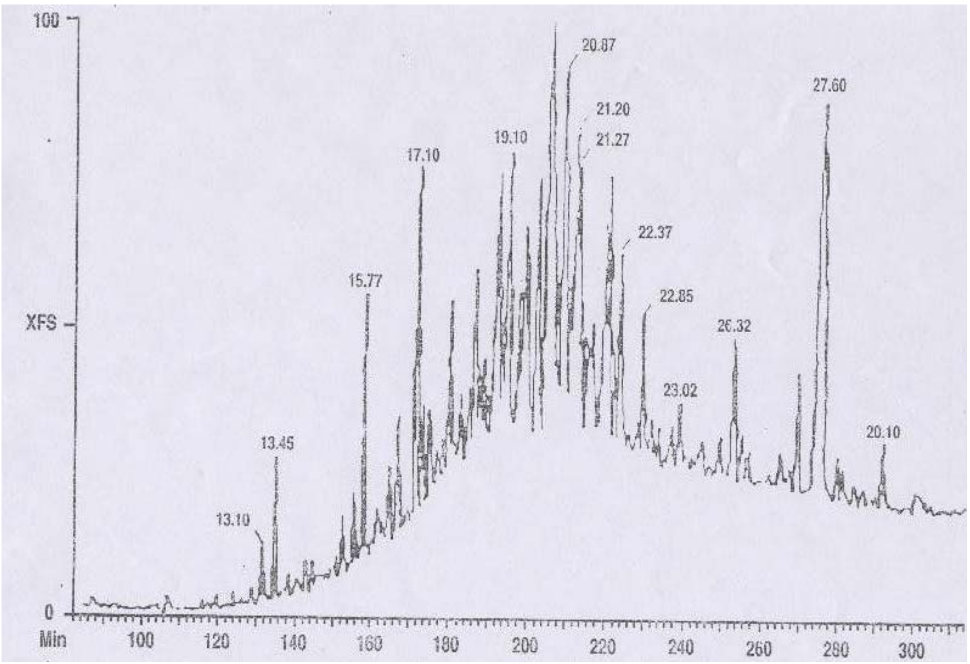


**Figure (2): Chromatograms of aliphatic hydrocarbon in Red Sea sediment cost of Yemen.**

## RECOMMENDATIONS

It is recommended that a continuous monitoring program for the Red Sea coast of Yemen should be formulated and conducted to ensure that the concentrations of Aliphatic hydrocarbons remain within the baseline levels established during the present survey

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# توزيع المركبات الهيدروكربونية الأليفاتية
# في رسوبيات الساحل اليمني على البحر الأحمر

نبيل عبده احمد الشوافي

قسم علوم الأرض والبيئة –كلية العلوم-جامعة صنعاء

**ملخص**

أنجز هذا العمل لغرض التعرف على بقايا التراكيز النفطية الألفاتية المتواجدة على الساحل اليمني للبحر الأحمر وكانت هذه التراكيز من 22.8 ميكروجرام في محطة الصليف إلى 21.72 ميكروجرام في محطة الغردقة وأظهر التحليل بان الخليط المعقد غير المنحل بواسطة التعرية والبكتيريا يعود إلى إن هذا المتبقي من النفط مصدره غير طبيعي وهو العمليات النفطية المحلية وكذلك من مرور السفن والبواخر، أما وجود بعض المركبات الأليفاتية فان مصدرها طبيعي من الطحالب والكائنات النباتية الخضراء الموجودة في عمود مياه البحر.

المصطلحات الرئيسة: الهيدروكربونات الأليفاتية ، البحر الأحمر ، الرسوبيات .