توزيع المركبات الحلقية الهيدروكربونية في الرسوبيات السطحية لسواحل مدينة عدن - اليمن

نبيل عبده احمد الشوافي

الخلاصة

تم إنجاز هذا العمل الميداني التعرف على التلوث النفطي مشتقاته النفطية لسواحل مدينة عدن وكان تراكيز المركبات الحلقية الهيدروكربونية في الرسوبيات السطحية من $0.14ngg^{-1}$ وزن جاف في المحطة(9) منطقة الساحل الذهبي إلى $17.1ngg^{-1}$وزن جاف في المحطة (3) منطقة ساحل أبين 2 .ينتج هذا التلوث عن عمليات نفطية محلية وكذلك عن حركة ومرور ألبوا خر.

الكلمات الافتتاحية: جاز كروماتوجرافي ، الهيدروكربونات الحلقية، ساحل عدن، رسوبيات بحرية.

Title: Distribution of Polycyclic Aromatic Hydrocarbons (PAH) in Surface Sediments from Aden Coast - Yemen

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ABSTRACT

Field work has been carried out to identify the occurrence of oil and oil by- product pollution along Aden coast .The concentration of Polycyclic Aromatic Hydrocarbons (PAH) in sediment samples ranged from $0.14ngg^{-1}$ at Gold Moor to $17.1ngg^{-1}$dry wt. at station Abyan coast 2. The concentration of PAH in the sediments is unrelated to grain size
This pollution is a consequence of localized oil operation and/or heavy ship traffic.

Key words: Gas chromatography (G.C.); polycyclic aromatic hydrocarbons (PAH); Aden coast; marine sediments

Introduction

The Red Sea and Gulf of Aden are among the busiest tanker routes in the world. Most of the oil produced in the region is also exported via sea and pipeline, while refinery industry is located in the coastal areas. The widespread oil pollution in the Red Sea and Gulf of Aden is therefore not surprising (Wennink & Nelson- Smith, 1979; Dicks, 1987; DouAbul & Heba, 1995; DouAbul& Al-Shwafi, 1997), and a chronic input of hydrocarbons into the sediments is to be expected.

Whereas oil pollution of the coastal zone seems to be widespread, contamination of sea water by domestic and industrial waste water is limited to urban areas (Al-Shwafi, *et al.,* 2005).

Discharge of wastewater containing heavy metals or other toxic pollutants may locally deteriorate seawater quality along the coastal (Grimalt *et al*, 1985).

The Red Sea is a too long narrow basin which receives dispersed pollutants, although high temperature (>25 ^{0}C) and salinities (Up to 37%) favorable for oil degradation (Grimalt, *et al*., 1985).

Marine pollution of the Gulf of Aden had recently drawn the attention of national and international agencies as well as public awareness of the enormous increment of pollutants particularly oil and trace metals (Hassan *et al* .,2003).

Material and Methods

Nine samples of surficial (20 cm depth) sediments were collected on 16-21 April from 9 stations (1Al- Omal Island, 2 Abyan Coast (1), 3 Abyan Coast (2), 4 Syra'a, 5 Free Area, 6 Algader Area, 7 Infront of Refinery, 8 Steam Station and 9 Gold Moor) ('Fig.1), by means of Smith- Maclntyre

grab samplers. As soon as the samples had been acquired, they were placed in glass containers and kept frozen at- $10C^0$ until

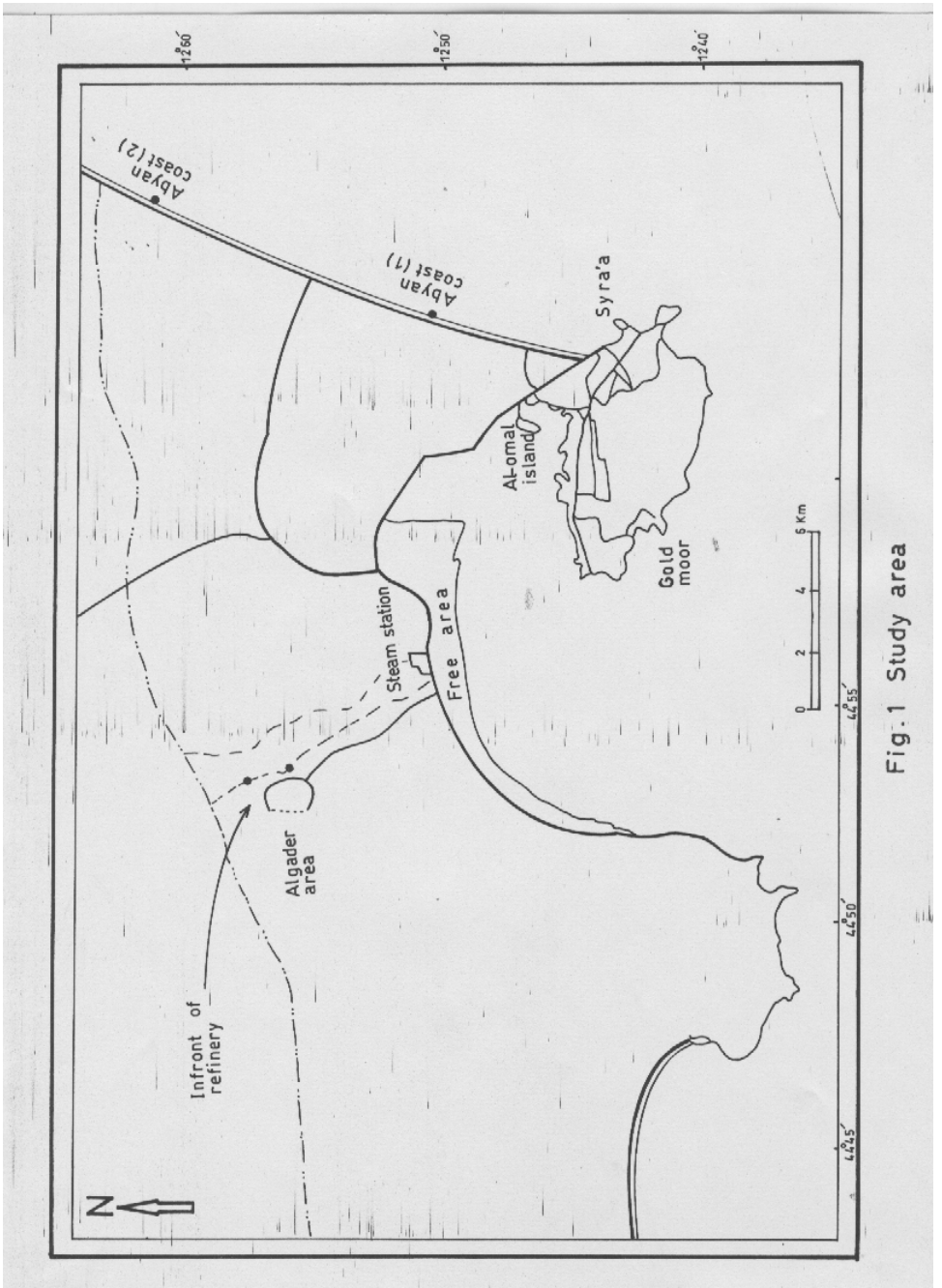


Fig. 1 Study area

analysis. The procedure used for extraction and analysis of PAH in the sediment samples was performed according to conventional procedures (Farrington, *et al*., 1977). A total of 10 g of dried sediment was subjected to soxhlet method for methylene chloride and concentrated in Kudma-Danish tube. The extracts were fractionated by alumina:Silica gel (80-100 mesh) chromatography. The extracts were sequentially aluted from the column with 50 ml of n- hexane using a calibration with Marib light crude. Blank determinations were carried out by repeating the procedure with pre- extracted samples. The samples were dried at 40 C^{0} over night and analysed by gas chromatography (HP-5890-GC and HP- 5970-MSD Hewitt-Packard). Grain size analysis of the sediment was carried out using the combined dry sieve and pipette method according to Folk, (1974). Percentage Total Organic Carbon (%TOC) was determined following the procedure of El-Wakeel and Riley (1957).

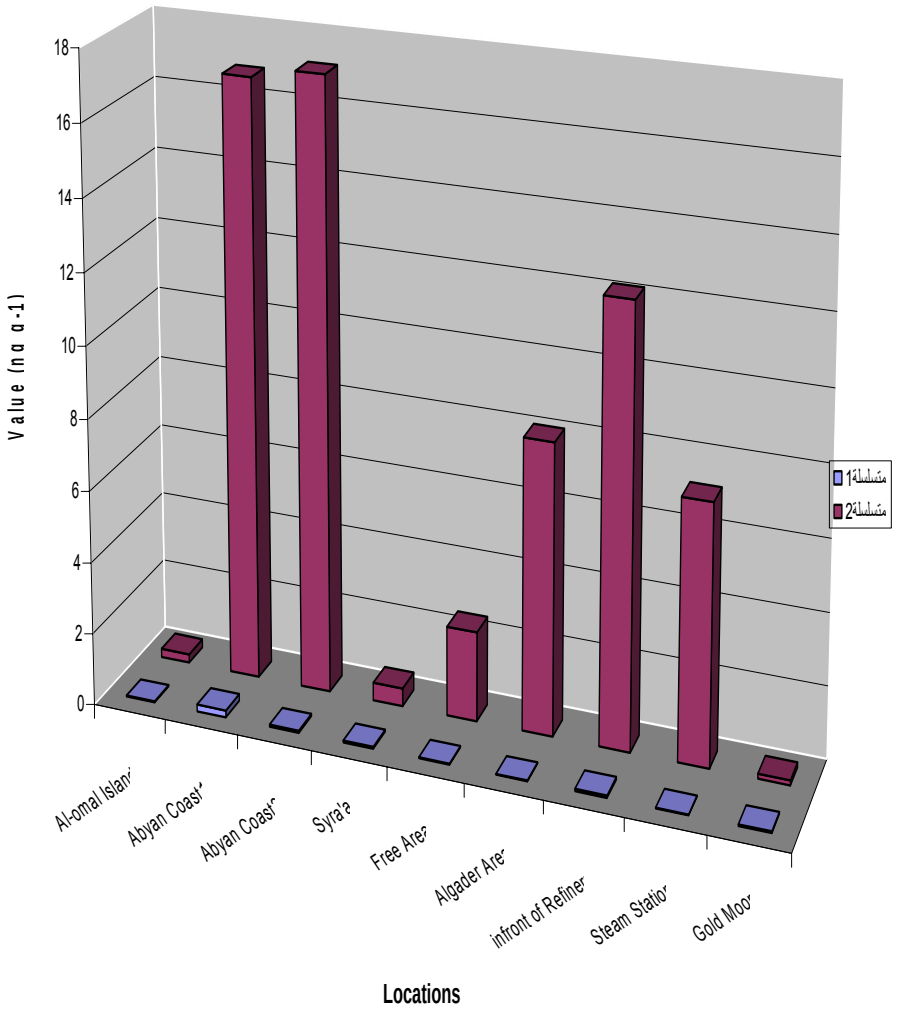
Result and Discussion

The distribution of PAH in sediment samples from Aden coast are summarized in Tables 1 and 2. The latter gives sediment types based on grain size Fig.2 gives total PAH. The PAH appears divisible into two groups: (1) low molecular weight PAH incorporating naphthalene, biphenyl, and phenanthrene and anthracene, and (2) large molecular weight homologues (fluoranthene, pyrene, chrysene, benzopyrenr and perylene). The concentration of PAH in sediment samples ranged from 0.14 ng g^{-1} dry wt at station 9 (Gold Moor) to 17.1 ng g^{-1} dry wt at station 3 (Abyan coast 2). It is apparently evident that all of these sites are contaminated to some extent with PAH.

The highest concentrations were found in station 7 (front of Refinery) and in stations 2 and 3 (Abyan coast1 and Abyan coast 2) on open sea

water . This suggests that PAH has originated from at least two different sources; first, from refineries and port areas and second, probably from natural seep due to tank-shipping operations. Similar

Fig.2 Total PAH concentration and % TOC



conclusions were reached by DouAbul, *et al.*, (1984), Grimalt, *et al.*, (1985) and DouAbul and Al-Shiwafi (1998). The concentration of PAH in surficial sediments of Aden coast do not relate to grain size or %TOC (Table 2).

***Conclusion*:**

The pattern of the distribution of PAH in Aden coastal sediments appears to be governed mainly by its proximity to potential oil pollution sources (oil refinery and heavy ship traffic).

Recommendation:

- These data are the first of their kind for this area and should furnish valuable information for future studies, both that they provide as the background values

  in the event of a major oil pollution incident.
- Since oil is the major source of pollution to the Red Sea and Gulf of Aden, measure should be taken by EPC to enforce the enacting Law No. (16) of 2004 regarding the protection of marine environment from pollution, in particular Article (12). Yemeni Government is kindly requested to implement

  International Convention (MARPOL) concerning the protection of the marine environment from pollution in general an oil pollution in particular.

TABLE 1
Distribution of polocyclic aromatic hydrocarbons (ng g^{-1}) in sediments from Aden coast, 16-21 April 2006. ND= non detection

	STATION								
Compounds	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Naphthalene	**0.03**	**1.5**	**1.0**	**0.01**	**0.3**	**0.06**	**0.9**	**0.4**	**ND**
Biphenyl	**ND**	**1.3**	**1.3**	**0.02**	**0.2**	**0.04**	**0.7**	**0.3**	**0.01**
Phenanthrene	**0.02**	**1.0**	**1.2**	**0.03**	**0.3**	**0.9**	**0.9**	**0.5**	**0.02**
Anthracene	**0.01**	**2.0**	**3.0**	**0.02**	**0.2**	**0.8**	**1.4**	**0.9**	**0.01**
Fluoranthene	**0.01**	**3.0**	**1.5**	**0.01**	**0.3**	**0.09**	**2.3**	**1.1**	**0.02**
Pyrene	**0.02**	**1.5**	**1.9**	**0.02**	**0.3**	**1.3**	**1.1**	**0.8**	**0.01**
Chrysen	**0.1**	**2.7**	**2.8**	**0.05**	**0.2**	**2.1**	**2.1**	**1.3**	**0.03**
Benzopyrene	**0.05**	**2.3**	**2.5**	**0.04**	**0.3**	**1.6**	**1.5**	**0.8**	**0.02**
Perylene	**ND**	**1.5**	**1.9**	**0.3**	**0.4**	**1.2**	**1.3**	**1.1**	**0.02**

TABLE 2
Total PAH concentrations in samples of surface sediment from Aden coast in relation to their sedimentological parameters. 16-21 April, 20006

Station	Total PAH Concentration ng g^{-1} dry wt	Sediment type	%TOC
1	**0.24**	**Medium Sand**	**0.03**
2	**16.80**	**Very Fine Sand**	**0.05**
3	**17.10**	**Coarse Sand**	**0.06**
4	**0.50**	**Medium Sand**	**0.05**
5	**2.50**	**Very Fine Sand**	**0.03**
6	**8.09**	**Fine Sand To Medium**	**0.02**
7	**12.20**	**Medium Sand**	**0.07**
8	**7.20**	**Fine Sand**	**0.02**
9	**0.14**	**Fine Sand**	**0.04**

References

Al-Shiwafi,N.,A.I.Rushdi and A.Ba-Issa. (2005) Trace metals in surface seawater and sediments from various habitats of the Red Sea coast of Yemen .*environ Geol*.**48**: 590-598.

Dicks, B. 1987. Pollution. In: *Red Sea (Key Environments)*. Edited by Edwards. A.J. and S.M. Head. Pergamon Press, Oxford, 44 pp.

DouAbul, A.A.Z., Al-Saad, H.T. & Darmoian, S. A. 1984. Distribution of petroleum residues in surfisial sediments from Shatt Al-Arab river and the north-west region of the Arabian Gulf.*Mar. Pollut. Bull.***15:** 198-200.

Dou Abul, A A.Z. And Heba, H.M.A. 1995. Investigations following a fish kill in Bab el- Mandeb, Red Sea during November 1994. Report submitted to Environmental Protection Council (EPC) (Dutch Support Project to Technical Secretariat EPC, Yemen) 105pp.

DouAbul, A A.Z.& Al-Shwafi, N. A. 1997. Petroleum hydrocarbons in the Red Sea coast of Yemen. Paper accepted in the International Conference on the Biology of Coastal Environment (ICBCE 97) Bahrain, 4-7 April 1997.

DouAbul, A.A-Z and Al-Shiwafi HA (1998) Dissolved/dispersed hydrocarbons in Arabian region. *Mar Poll Bull* **36:** 844-850.

El-Wakeel, S. K. and Riley, J. P. 1957. The determination of organic carbon in marine mud. *J. du conseil Int. pour l'explor. De la Mer* **12**: 180-183.

Farrington, J.W, Frew, N. M., Gachwend,P. M. & Tripp, B.W. 1977. Hydrocarbons in cores of north-western Atlantic Coastal and continental margin sediments Estuarine, *Coastal and Shelf Science.* Coast. Sci.**1**: 71-79.

Folk, R. l. 1974. *Petrology of sedimentary rocks*: Hemphill Publishing Co. Austin, Texas.

Grimalt,J, Albaiges,J, Al-Saad, H.T and DouAbul, A.A.Z. (1985) N-alkane distributions in surface sediments from the Arabian Gulf. Naturwissenschaften 72, S-35

Hassan,M.A.Heba,Mahyoub,A.Seed,Nabil,A.Al-shwafi and Hamid,T.Al-Saad. (2003) Petroleum Hydrocarbons and Trace Metals on Mollusca (*Tivela Ponderosa*) from the Gulf of Aden . *J.KAU: Mar. Sci.,* **14**: 77-86.

Wenink, C. R. and Nelson-Smith, A. 1979. *Coastal oil pollution study for the Gulf of Suez and Red Sea coast of the Republic of Egypt*. IMCO, London. Oxford , UK.