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TOTAL MERCURY DISTRIBUTION IN SURFACE SEDIMENTS FROM THE ARABIAN GULF

By

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دراسة توزيع عنصر الزئبق في الرسوبيات السطحية لقاع الخليج العربي

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توضح هذه الدراسة مدى تأثير التلوث النفطي الذي تعرض له الخليج العربي أثناء حرب الخليج على البيئة البحرية وذلك من خلال تحليل عدد ٥١ عينة رسوبية من سطح قاع الخليج العربي تم جمعها في فبراير عام ١٩٩٢م أثناء رحلة سفينة البحوث الأمريكية «ماونت ميتشيل» . وقد تم التحليل لمعرفة تركيز عنصر الزئبق في الرسوبيات وكذلك التحليل الحجمي للحبيبات . ووجد أن قيم التركيزات لعنصر الزئبق أقل من المتوقع حيث أنها تتراوح ما بين ٠٣٢ر - ٠٢٧ر - ميكرو جرام / جرام ، مما يفسر أنه ليس هناك أي تلوث بالزئبق في رسوبيات قاع الخليج العربي .

Key Words: Mercury, Arabian Gulf, Sediments, Distribution

ABSTRACT

Surface sediment samples collected during the first leg of Mt. Mitchell cruise and covering the entire Gulf, were analysed for their total Hg content. The total Hg concentrations ranged from 0.032 to 0.27 µg/g dry wt. The values obtained were compared to ROPME data generated earlier. Though differences in areas of sampling and methodologies exist, the values obtained in the present study are lower than ROPME values, contrary to expectations. This may be due to the fact that the samples were collected primarily from open sea areas rather than coastal areas, therefore, measurements of Hg made close to shore may reveal higher levels. Although no definite trend is observed in the spatial distribution of Hg, an effort was made to correlate the concentrations of Hg and mean grain size (Mz) of the sediments. Possible explanations for observed distribution are discussed. It is concluded that there is no apparent Hg contamination observed in the surface sediments of the Arabian Gulf, either from local industrial sources or as a direct result of the extensive Gulf war oil spill.

INTRODUCTION

The Arabian Gulf is a shallow basin lying on the continental shelf sloping into deeper waters through the strait of Hormuz into the Gulf of Oman. It is rarely deeper than 100 meters with an average depth of between 31 to 37 meters. Asymmetrical in profile, it has a gentle slope from the western to eastern side. While the eastern coastline is marked by mountains and cliffs, the western shores are mostly sandy, [1]. Several unique features of high salinities and temperatures alongwith strong winds (Shamal) during summer determines much of the current patterns in the Gulf. The discharges into the Gulf are primarily domestic and industrial in nature with discharges from oil exploration and exploitation amounting to the majority of contamination problems. While a few studies have been conducted along the Kuwaiti, Saudi Arabian and Bahraini coasts concerning Hg levels in coastal sediments and selected marine organisms, [2&3], to the best our knowledge no published information is available

on Hg levels in sediments from the open waters of the Gulf. This assumes greater importance in light of the increasing industrial and marine activities along the Gulf coastlines. Thus, this study may serve as a baseline observation of the Hg distribution in marine sediments throughout the Gulf.

MATERIAL AND METHODS

In February 1992 the US NOAA ship Mt. Mitchell undertook several cruises in the Gulf to study the impacts of the Gulf war oil spill. Leg 1 of this venture, undertaken in association with the Regional Organization for the Protection of the Marine Environment (ROPME), was planned so as to sample several stations along 16 cross-shore transects. We utilised this opportunity to collect more than 50 sediment samples covering nearly all geographical locations in the Gulf for the purpose of establishing a baseline of Hg levels in sediments (Fig.1).

All samples were collected using a McIntyre"s Grab taking utmost care to avoid any contamination of the sediments . Samples were deep frozen in plastic bags immediately after collection. Upon reaching the shore laboratory, the samples were thawed, dried at 50°C and each individual sample was treated separately for grain size analysis using standard sieve and pipette techniques. Sediment weights in each whole ϕ size class were computed and subsequently used as variables. Following the grain size analysis, mean grain size was calculated using the graphical method, [4&5] and a computer programme [6]. The samples were then ground to a fine powder, and 1-2 grams of the powder were digested in sulphuric and nitric acids (Aristar Ultrapure-Merck) at 100°C using a modified method described in MOOPAM, [7].

The digests were then analysed in a BACHARAC Model 50B mercury analyser system using the cold vapour technique after reduction with acidified SnCl2. A minimum detection limit of 2-5 ng was obtained using this method. This method was further checked by analysing marine sediment reference material BCSS-1 from NRC, Canada and excellent recoveries of up to 97% were obtained by adjusting the sample size. Replicate analysis of the reference material and a few sediment samples gave a coefficient of variation of not more than 6% for total Hg.

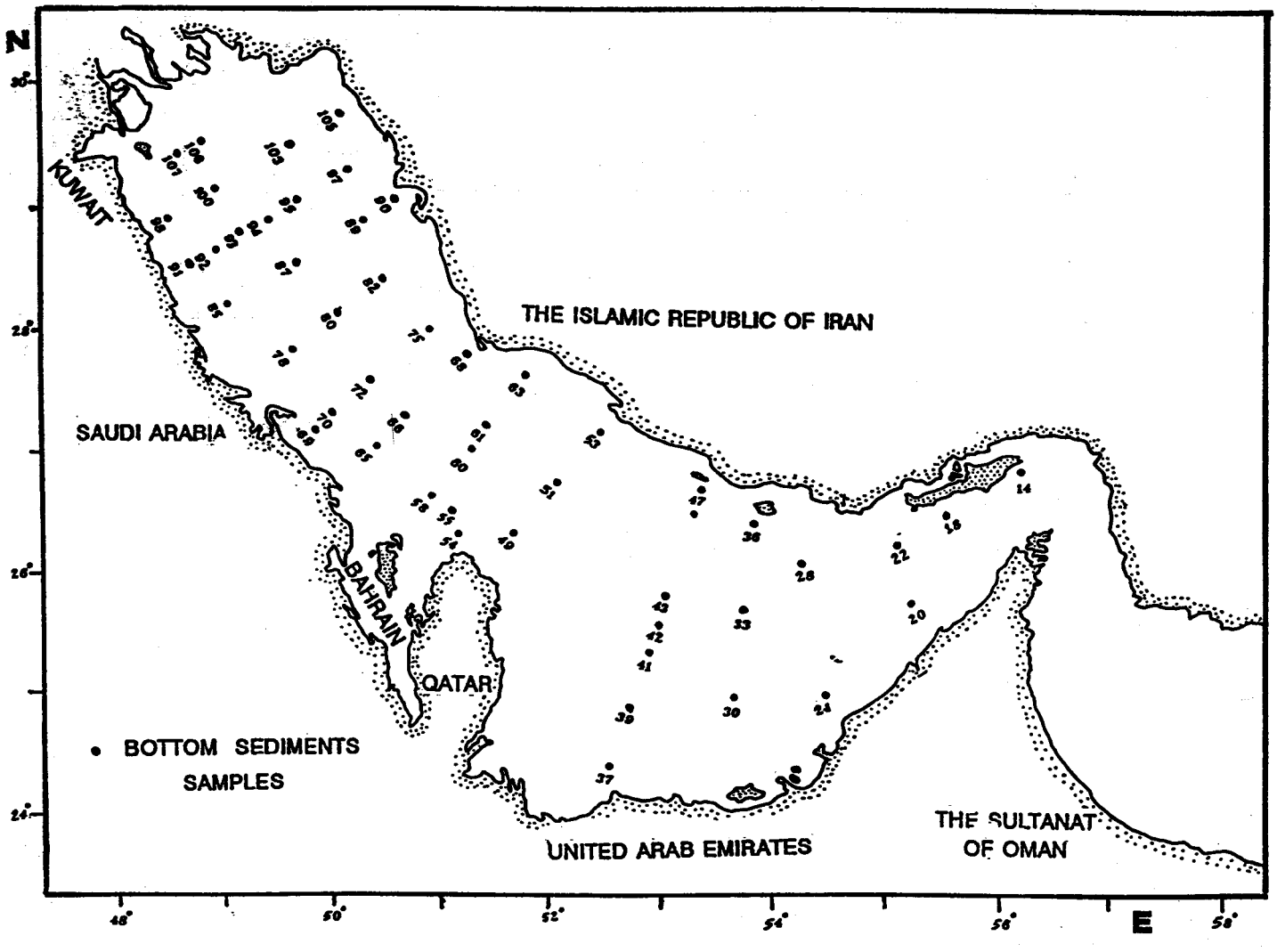

Fig. 1: Map of the Arabian Gulf showing the sample locations.

RESULTS AND DISCUSSION

As mentioned earlier, it is clear from Figure 1 that nearly all areas of the Gulf were covered by the grid of over 50 samples. The concentrations observed are given in Table 1. The results indicate relatively low levels of total Hg in Gulf sediments.

Table 1.
Mercury concentrations in µg/g dry Wt. in Bottom Sediments from the Arabian Gulf.

Station No.	Mercury Conc. µg/g	Station No.	Mercury Conc. µg/g
14	0.052	65	0.032
18	0.085	66	0.085
20	0.035	68	0.06
22	0.124	69	0.06
24	0.052	70	0.072
28	0.058	72	0.06
30	0.27	75	0.065
33	0.056	78	0.032
36	0.105	80	0.08
37	0.064	82	0.08
39	0.05	85	0.054
41	0.034	87	0.062
42	0.06	89	0.048
43	0.063	90	0.05
46	0.074	91	0.092
47	0.07	92	0.082
49	0.05	93	0.058
51	0.25	94	0.048
53	0.07	95	0.068
54	0.042	97	0.065
55	0.06	98	0.07
58	0.09	100	0.058
60	0.07	103	0.06
61	0.078	105	0.065
63	0.072	107	0.13
		108	0.05

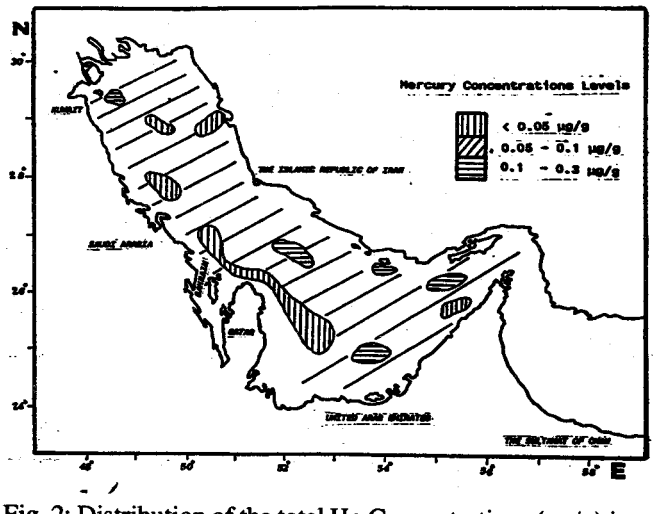

Fig. 2: Distribution of the total Hg Concentrations (µg/g) in surface sediments from ROPME Sea Area.

The general pattern of total Hg distribution in sediments representing larger parts of the Gulf depicts ranges between 0.05 to 0.10 µg/g of total Hg with lower values (<0.05) also observed largely on the western side as shown in Figure 2. The total Hg levels for the entire Gulf ranged from 0.032 to 0.27 µg/g; however, the majority of the concentrations ranged between 0.05 to 0.08 µg/g. The mean value obtained for all samples was 0.065 µg/g. As is evident, these values are quite low and do not suggest any contamination. A few comparatively higher values of 0.25 and 0.27µg/g were also randomly observed and do not show any regular trend.

The mean grain size (Mz) distribution of the bottom sediments of the Arabian Gulf ranges from 0.47 to 6.74 ϕ (1.39 to 0.0094 mm). As shown in figure 3, a general coarsening trend is observed southward covering most of the shallow areas (20-40m) of the Arabian shallow shelf or homocline. The fine grained materials 3 to 7 ϕ of very fine sand and silt cover most of the deep water zone of the northern floor facing the Iranian side due to terrigenous supply from the local rivers, [8].

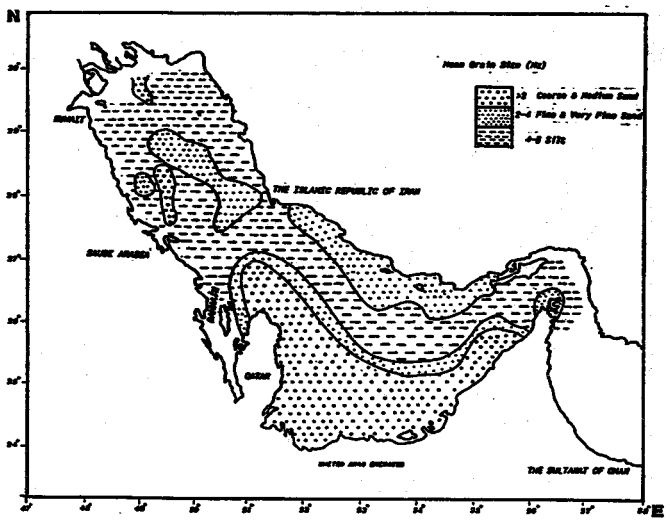

Fig. 3: Spatial distribution of mean grain size (Mz) across the bottom of the Arabian Gulf (Mahmoud, 1993).

A negative correlation was observed between the mean grain size and Hg concentrations in the bottom sediments (Fig. 4). The relationship between Hg levels in sediments and grain size showed that higher levels were recorded in the finer sediments. On the other hand, Figure 5 depicts the relationship between the Mz of bottom sediments and Hg Concentrations in the northern and southern Arabian Gulf. While a weak correlation is seen in the northern Gulf, a relatively strong correlation is found in the southern Gulf. This may be due to different sources of mercury input in these two regions.

As mentioned above, only limited data are available on total Hg levels in Gulf sediments and those data are largely confined to intertidal or nearshore sediments [2&3]. No comparable data are apparently available for the open Gulf areas. Examining the nearshore sediment data for Hg, it is clear that total Hg levels

are generally low in the Gulf region ranging from 0.099 to 0.7 µg/g in over 80 samples. The ROPME reports did, however, show 3-4 µg/g in a coastal core sample taken near the outfall of a shut-down chlor-alkali plant in Kuwait.

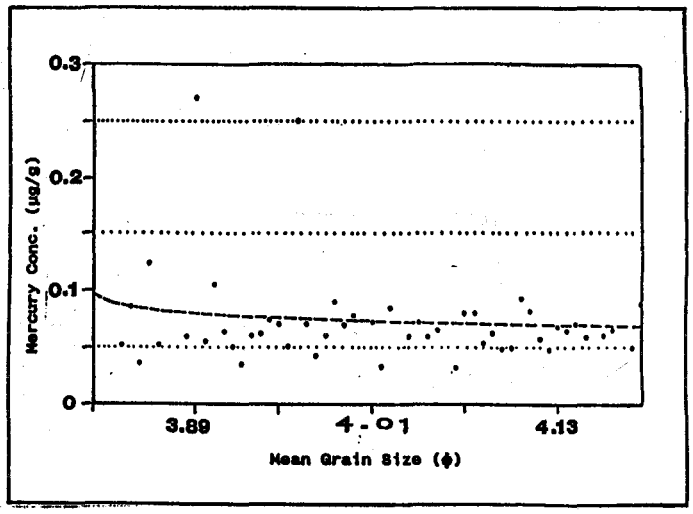

Fig. 4: Correlation analysis between mean grain size (Mz) and Hg concentrations of bottom sediments samples.

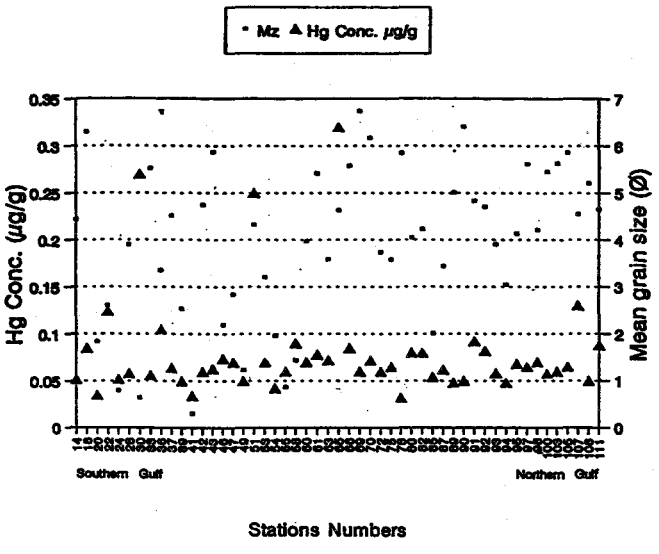

Fig. 5: Relationship between Hg concentrations µg/g and Mean grain size (Mz) of bottom sediments in the Northern and Southern Arabian Gulf

In a related study of coastal sediments carried out during March 1992 on board Mt. Mitchell, areas heavily affected by the Gulf war oil spill were examined. e.g. Abu Ali, Tanagib and their inner bays. The levels observed in this study were also very low (range 0.03 to 0.08 µg/g, Kureishy, unpublished data). Even the core samples from this area showed uniform concentrations of Hg throughout the sediment column, although oil penetration to a depth ranging from 5-10 cms was clearly observed.

Comparing our values with the reported Hg levels in sediments from other marine areas, it becomes evident that unless the samples were collected from known polluted areas, the range of Hg concentrations is between 0.005 and 1.0 µg/g dry wt. A limited comparison is given in Table 2:

Table 2
Comparison of Hg levels in sediments from different coastal areas.

Area	Mercury (µg/g)	Reference
Izmir bay in Turkey	0.06 - 0.55	Balci and Turkoglu, 1993
Italian coast sediments	0.04 - 2.03 (av. 0.23)	Giordano et al, 1992
Cardiff Bay, U.K	0.005 - <0.5	Hitchcock and Thomas 1992
SE coast of India	0.073 - 0.169 (av. 0.122)	Subramaniam and Mohanchandran (1990)
Arabian Gulf	0.032 - 0.27	This Study

Values from the Gulf are not unlike those reported elsewhere, hence we concluded that there is no apparent Hg contamination observed in the surface sediments of the Gulf, either from industrial/ land-based sources or as a direct result of the large Gulf war oil spill. Our samples, collected from comparatively open areas in the Gulf, contained relatively low Hg concentrations. However, samples taken closer to the shore and near centers of industrial activity probably contain higher concentrations, as has been shown in sediment data from Kuwaiti, Bahraini and Saudi Arabian coastal waters [2&3]. In fact, sediments from the Qatari coastal zone and within the EEZ of Qatar also display relatively higher values than those reported for open Gulf waters (Kureishy, unpublished data).

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