

Petroleum hydrocarbon concentration in sediments along northern west coast of India

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Gas chromatography revealed that nonpolar material extracted from surface sediments collected along the northern west coast of India was originated from petroleum hydrocarbon residue. Petroleum hydrocarbon levels as determined by fluorescence spectroscopy were in the range $0.04\text{--}0.3\ \mu\text{g.g}^{-1}$ (wet wt, chrysene equivalents). The values indicate that the coastline is not polluted by petroleum hydrocarbons.

Contamination of nearshore environment along northern west coast of India by petroleum hydrocarbons is caused by oil tanker traffic, harbour operations, effluent discharges from petroleum processing industries, river runoff and sewage. The sediment serves as a long term sink to these inputs¹. Therefore contamination in sediment may be an indicator of petroleum hydrocarbon pollution of the ecosystem². This study has been undertaken to monitor pollution by petroleum hydrocarbons along the northern west coast of India.

Three locations at 5, 10 and 15 km distance from the shore at several transects (24 stations) were sampled during March-April 1988 using van Veen grab along the northern west coast of India (Fig.1) and were deep frozen until analysis.

Wet sediment ($\sim 100\text{ g}$) was digested³ with KOH (3 g) and methanol (100 ml) for 90 min. The cool methanol solution was extracted with hexane. The organic layer was dried over anhydrous sodium sulphate and concentrated to a minimum volume. It was then column chromatographed using alumina (grade I, 1.15 g) filled in pasteur pipette and solvent systems in the following order; hexane (4 ml), hexane: dichloromethane (7:3, 4 ml) and dischloromethane (4 ml). The latter two eluates were combined, evaporated to dryness at low pressure. Gas chromatographic analyses³ of first and third- fourth fractions were performed (Perkin-Elmer, sigma 2000) using a glass FSOT column (length 40 m, internal diam 0.25 mm) with methyl silicon liquid phase (Perkin-Elmer, Part No.0092348) and a flame ionisation detector (FID). Nitrogen (ratio 1:70; 1 ml.min⁻¹) was used as the carrier gas. Column temperature was programmed ($100^{\circ}\text{--}300^{\circ}\text{C}$) at the heating rate of $10^{\circ}\text{C.min}^{-1}$. The detector and the

injector temperatures were maintained at 350°C . The fluorescence of hexane solutions (10 ml) of third and fourth combined fraction were measured at 360 nm on fluorescence spectrophotometer (Perkin-Elmer, LS 3B) and petroleum hydrocarbon concentrations (PHC) were expressed as chrysene equivalent units³. Saudi Arabian Mix crude residue (bp $< 100^{\circ}\text{C}$, SAM) as a standard was also studied by calibrating total aromatic fraction obtained in the alumina column chromatography. Total organic carbon (TOC) was determined by dichromate method using ferroin as an indicator⁴.

The chromatograms obtained in gas liquid chromatography (GLC) were composed of an

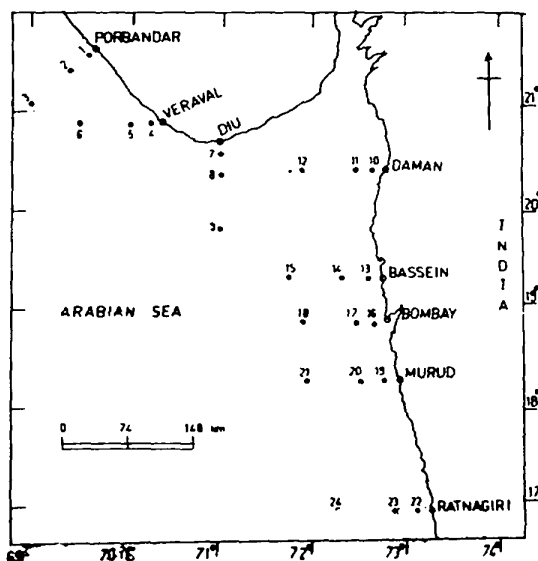


Fig. 1—Sampling locations

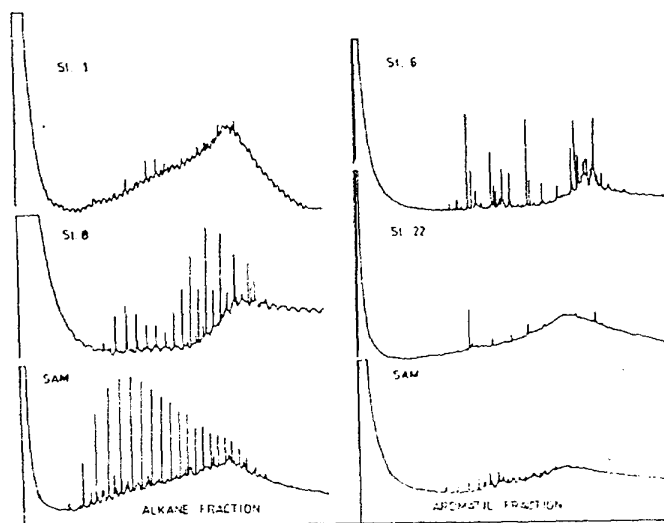


Fig. 2—Gas chromatograms of alkane fractions corresponding to sts 1, 8 and Saudi Arabian Mix crude residue (SAM) and gas chromatograms of aromatic fractions corresponding to sts 6, 22 and SAM crude residue

envelope of unresolved complex mixture (UCM) along the baseline (Fig.2). In addition to UCM, alkane fractions corresponding to sts 5, 6, 8, 9, 11-14 and 16 afforded a paraffinic profile while aromatic fractions corresponding to sts 1-3, 8-13, 16-21, 23 and 24 showed presence of sharp peaks at intermittent positions in the chromatograms. Comparison of the chromatograms in IOC-UNESCO Manual³ and chromatograms obtained from alkane and aromatic fractions of SAM (Fig.2) clearly indicated that the residues have been originated from crude oil or its fraction^{5,6}.

The buildup of organics along the northern west coast of India is quite evident from the values of TOC (Table 1) which range from 0.8 to 3.4%. Lowest average value of 0.9% was observed at Diu (sts. 8, 9) while highest average TOC of 2.8% was observed at Ratnagiri (sts 22-24). PHC range expressed as chrysene equivalent units was 0.04-0.30 $\mu\text{g.g}^{-1}$ wet wt (Table 1). Comparison of TOC and PHC values indicated that buildup in surface sediments from other sources may be predominant. PHC values obtained using SAM as the standard ranged in 0.52-3.68 $\mu\text{g.g}^{-1}$ wet wt (Table 1). These values were higher than PHC values obtained using chrysene as the standard. It has been reported^{7,8} that PHC values obtained using crude as a standard generally did not match with the values obtained using chrysene as the standard. Generally high values of the concentrations are obtained using crude oil residue as the standard because weight to fluorescence ratio of crude oil is higher than that of chrysene. Bombay coast is highly vulnerable location due to heavy

Table 1—Details of sediment analyses at the locations

St. no.	Sediment type*	Moisture contents (%)	Total organic carbon (%)	Petroleum hydrocarbon concentration ($\mu\text{g.g}^{-1}$)	
				Chrysene eq. units	SAM eq. units
1	C-S	56	1.43	0.21	2.67
2	S	49	1.39	0.19	2.45
3	S	49	1.47	0.13	1.65
4	—	—	—	—	—
5	S	44	1.50	0.10	1.26
6	C, S-S	52	1.16	0.06	0.77
7	—	—	—	—	—
8	C-S	59	0.80	0.06	0.77
9	S	29	0.90	0.05	0.64
10	S	45	1.01	0.07	0.89
11	S	48	1.10	0.12	1.53
12	S	49	1.00	0.10	1.26
13	C-S	46	1.36	0.15	1.90
14	C-S	43	1.36	0.06	0.77
15	S	44	1.41	0.09	1.13
16	C-S	47	1.63	0.30	3.68
17	C-S	45	1.56	0.10	1.26
18	C-S	48	1.58	0.10	1.26
19	Sd	59	0.82	0.14	1.78
20	S	44	1.90	0.18	2.30
21	S	40	1.92	0.18	2.30
22	S	41	2.48	0.08	1.01
23	S	43	2.50	0.07	0.89
24	S	37	3.40	0.04	0.52

* C = Clay, S = Silt, C-S = Clay and Silt, S-S = Sand-silt, Sd = sand

tanker traffic, offshore production activities, domestic wastewater and industrial effluent input. But the petroleum hydrocarbon levels observed in the sediments off Bombay (sts. 16-18) were low.

NAS⁹ concluded that a range of PHC in sediments in polluted coastal regions is 100-12000 $\mu\text{g.g}^{-1}$ while in unpolluted coastal basins it is around 70 $\mu\text{g.g}^{-1}$. The contaminations observed in the present area were much less than the values of other areas^{8,10-13} indicating that the area under investigations is not polluted by petroleum hydrocarbons.

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