

## Distribution of phosphate in sediments of Gulf of Kutch

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### Abstract

Total phosphate in the sediments ranges from 0.15 to 0.29% in the bulk samples and from 0.09 to 0.23% in the acid soluble fractions of the samples. There was no appreciable variation in the phosphate within the Gulf and no significant relation was observed between phosphate content and texture of the sediments. Invariably higher concentrations of phosphate were associated with the acid soluble fractions as compared to the acid insoluble fractions. The contributions made by the acid insoluble fractions to the phosphate concentration in the bulk samples was probably through the detrital minerals with which it might be associated, while the contributions made by the acid soluble fraction was probably in the form of adsorbed phosphate than in association with the carbonate phase.

### Introduction

Productivity in a marine or estuarine environment depends to a certain degree on the nutrient content of the waters such as phosphates, silicates and nitrates. Under favourable conditions, the bottom sediments act as reservoir for the nutrients in overlying waters especially phosphates, and also provide suitable sites for the formation of deposits rich in phosphate. The surficial sediments from the Gulf of Kutch region have been under intensive study at NIO for their chemistry with a view to understanding the bulk distribution of the various chemical elements, their partition among different components of the sediments and the processes of their incorporation into the sediments. Information pertaining to elements such as Al, Ti, Fe, Mn, Ni, Co, Cu, Zn and calcium carbonate has been published by Murty *et al.* (1978) and Paropkari *et al.* (In Press) and the present paper deals with the distribution of phosphate in the Gulf sediments.

### Methods

Figure 1 gives the location of the stations from where the surficial sediment samples were collected during the 2nd Cruise of *RV Gaveshani* in February-March, 1976 using a La Fond-Dietz snapper. Dissolved oxygen and water column phosphate analyses were performed aboard the ship. Primary productivity measurements were carried out by Radhakrishna *et al.* (1978).

A suitable aliquot of the representative sample obtained from the collection made at each station was digested with hydrofluoric and perchloric acids following the method of Chester and Hughes (1968) for the determination of phosphorus in bulk samples. To understand the extent to which the phosphate is associated with the acid soluble fractions of the sediments, they were leached with 3 N HCl and the phosphate concentrations in the bulk samples and acid soluble leaches were determined colorimetrically following the method of Riley (1958). The data obtained are presented in Table I along with depth of sampling and texture of sediments and the concentrations of phosphate in various fractions.

The data enables the following observations to be made in regard to the distribution pattern :

(1) Phosphate content ranges from 0.15 to 0.29% in the bulk samples and from 0.09 to 0.23% in the acid soluble leaches.

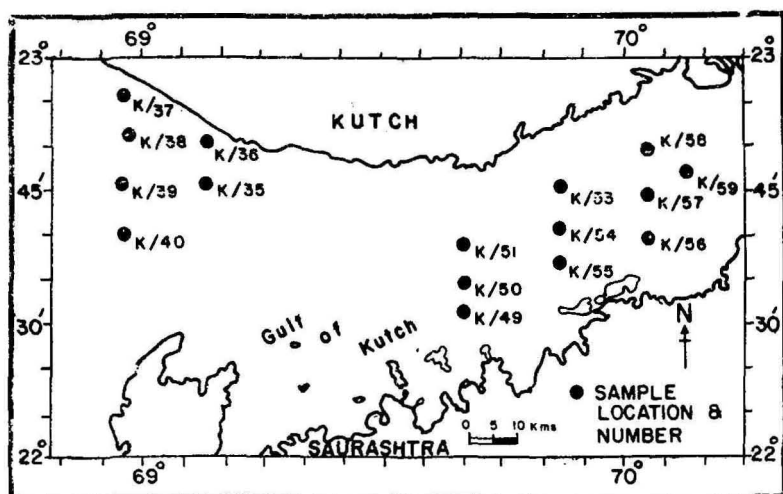


Figure 1.

TABLE 1.  $P_2O_5$  content in the sediments along with texture of sediments and water depth

Sl. No.	Water depth in meters	Texture of the sediments	$P_2O_5$		
			A	B	C
K 35	20	—	0.29	0.23	0.06
K 36	15	Silty clay	0.18	0.13	0.05
K 37	14	Silty clay	0.19	0.13	0.06
K 38	15	Clayey silt	0.21	0.12	0.09
K 39	26	Silty clay	0.19	0.11	0.08
K 40	42	Sand-silt-clay	0.16	0.11	0.05
K 49	36	Sand-silt-clay	0.22	0.15	0.07
K 50	38	Silty clay	0.19	0.12	0.07
K 51	41	Sand-silt-clay	0.15	0.09	0.06
K 53	30	Silty sand	0.17	0.13	0.04
K 54	39	Sandy clay	0.17	0.11	0.06
K 55	32	Clayey silt	0.19	0.13	0.06
K 56	22	Sand-silt-clay	0.18	0.11	0.07
K 57	21	Sand-silt-clay	0.20	0.12	0.08
K 58	21	Sand-silt-clay	0.18	0.12	0.06
K 59	14	Clayey silt	0.23	0.12	0.11

A=In bulk samples;  
 B=Acid soluble leaches;  
 C=Acid insolubles.

(2) Contributions made by the acid soluble leaches constitute significant portion of the phosphate concentrations associated with the bulk samples.

(3) Phosphate content in the sediments does not show any appreciable variation and is not related to the texture of the sediments in any significant measure.

In the bottom sediments, phosphorus is considered to be present as: (i) interstitial phosphate, (ii) adsorbed phosphate and (iii) phosphate bound in some insoluble inorganic or organic compounds. In the last category is included the phosphate represented by discrete detrital phosphate minerals like apatite, monazite, xenotime, etc. and other detrital minerals like feldspars, pyroxenes, amphiboles, micas and clay minerals in which phosphate is held in crystal lattices. The phosphate content in the bulk samples includes all these forms while that in the acid soluble leaches represents that which is associated with the carbonate phase and in the adsorbed state. Coarse fraction studies have not revealed the presence of any discrete minerals of phosphate in these sediments. The only terrigenous minerals reported from these sediments are quartz, feldspars, mica and ferromagnesian minerals (Hashimi *et al.*, 1978). This being the case, the contribution made by the detrital minerals appears to be through the phosphate held in the crystal lattices of the non-phosphate minerals including clays only. This perhaps accounts for the very low values of phosphate associated with the acid insoluble fractions.

Phosphate associated with the acid soluble fraction of the sediments, i.e., in association with the carbonate phase and/or in adsorbed state can occur in at least two kinds of associations: (i) in areas of high organic productivity associated with reducing conditions during their formation and (ii) in areas which do not have a high organic productivity and associated with oxidising conditions in the environment. Environmentally, the Gulf is characterised by the presence of strong tidal currents. The dissolved oxygen measurements in the bottom waters reveal them to be highly oxygenated with their oxygen content varying from 4 to 5 ml/litre. The waters are very turbid and the euphotic zone is only about 1.5 m. Phosphate concentrations are high throughout the water column but the production is low: 66.05  $\text{mgC m}^{-3}$  near the surface, 40.62 at 1.5 m and 80  $\text{mgC m}^{-2}$  integrated for the euphotic zone. Obviously light is a limiting factor because of high turbidity. Low production in the overlying waters and the presence of oxygenated waters at the bottom coupled with strong tidal currents are reflected in the low organic content (0.16 to 0.52%) of the bottom sediments throughout the Gulf region (Setty and Ambre, 1977).

Chemical precipitation of phosphate minerals from the water column is precluded for obvious reasons. Presence of highly oxygenated waters at the bottom and the organic poor substrate do not favour the formation of an interstitial environment rich in phosphate which can facilitate the phosphatisation of the pre-existing carbonate materials such as shells of foraminifera, and molluscs which are uniformly low (16-20%) in these sediments (Hashimi *et al.*, 1978). In view of this it is quite likely that major portion of the phosphate associated with the acid soluble fraction is tied up with the sediments in the adsorbed state. The fact that (i) the waters are characterised by high concentrations of phosphate, (ii) large quantities of finer materials are kept in suspension as evidenced by the turbidity of the waters and (iii) silts are capable of adsorbing large quantities of phosphate and that in the natural state they seldom approach saturation with phosphate (Jitts, 1959) support this view. The possibility of organic matter providing a masking effect and preventing the silt particles from adsorbing phosphorus is ruled out in view of its low content in these sediments. The presence of phosphate in ferri-phosphate form is

also ruled out in the absence of any significant correlation between phosphate and iron in the acid soluble fractions.

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