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FULL LENGTH ARTICLE

Chemistry of the Egyptian Mediterranean coastal waters

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KEYWORDS

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Abstract Investigation on the major ions of seawater; Na^+, K^+, Ca^{++}, Mg^{++}, SO_4^- and Br^- is based on more than 660 samples collected at 21 sections distributed along the Egyptian Mediterranean coast starting from Salloum to Arish during summer (2008), in addition to some samples taken at certain sections during spring (2008) and the winters of 2008, 2009 and 2010.

In respect of the analysed major ions, the total average content (mg/l) and their corresponding chlorinity ratios are as follows: Na^+; 12,337, 0.586, K^+; 381.2, 0.0180, Ca^{++}; 403, 0.0183, Mg^{++}; 1506.6, 0.0709, SO_4^-; 3068, 0.139 and Br^-; 64.9, 0.00296. The ion content and their chlorinity ratios indicate interesting temporal and spatial fluctuations. The Mg/Ca ratio average fluctuated between 3.1 and 4.6.

With respect to the total average of ion/chlorinity ratios, Na and Mg showed almost positive declinations above the normal oceanic ratios. K, Ca and Br/chlorinity ratios, on the other hand, deviated strongly below normal while SO_4/Cl ratio mean is closely nearer to normal. Strong anomalies of chlorinity ratios could be detected at several locations that coincided with high dilution and drop of salinity affected with land based effluents; e.g. in front of Mex, Krir and Sahl El-Tina areas.

Introduction

The Egyptian Mediterranean coast lies at the South East sector of the Levantine sub-basin, from longitudes 25°30′ E to 34° E and extends northwards to latitude 33° N. The salinity of the Mediterranean Sea is uniformly high throughout the basin, surface water averages about 38‰ except the extreme western parts, and the salinity can approach 40‰ in the Eastern Mediterranean during the summer. The salinity of seawater is made up of all the dissolved salts. Six major ions make up >99% of the total dissolved salts in seawater. They are Na^+, Cl^-, SO_4^{-2}, Mg^{+2}, Ca^{+2} and K^+. These major ions are conservative; they have constant ratios, to one another, and to salinity in almost all ocean waters. They almost always consist of 55% Na^+, 31% Cl^-, 8% SO_4^{-2}, 4% Mg^{+2}, 1% for each of Ca^{+2} and K^+. Variations in salinity depend almost entirely on; balance between evaporation and precipitation, extent of mixing surface and deeper water, anthropogenic modification and diluted level of seawater in front of hot spots, outfall and local climatic changes. Such pollution in the Egyptian eastern coast had a detrimental effect on its flora

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and fauna as well as the different recreational activities. Fahmay (2001) showed that the hydrochemical characteristics of the southern Mediterranean off shore waters in front of Egypt have been affected by the oceanic biomass cycle.

Concerning the investigation of the major ions in the Egyptian Mediterranean coastal water, two previous researches were done. The first work was restricted in a study of Ca, Mg and SO_4^{-2} in addition to S‰ and alkalinity in the coastal water between Agami and Rashid areas during April 1999 (Nessim et al., 2005). The second work revealed a monitoring survey of S‰, TDS, Ca^{+2}, Mg^{+2}, SO_4^{-2} and Br^- in coastal water at 8 sections extending between Sahl El-Tina and Barani during the year 2000–2001 (Nessim et al., 2010). The present study concerned a great monitoring programme to investigate the major cations Na^+, K^+, Ca^{+2} and Mg^{+2} and anions SO_4^{-2} and Br^- in addition to S‰ in the whole coastal water through 21 sections representing the Egyptian Mediterranean coast between Salloum and Arish, Fig. 1. The study was based on a high number of water samples (>660) collected seasonally during the period (winter 2008–winter 2010).

Material and methods

The coastal Egyptian Mediterranean seawater starting from Arish (East) to Salloum (West) was subjected to a great oceanographical monitor (winter 2008–winter 2010). Five cruises were done during winter, spring and summer 2008, winter 2009 and winter 2010 on board NIOF, El-Yarmouk Research vessel. The studied area comprised 21 longitudinal sections (Fig. 1), 10 sections to the east (Eastern Harbour-Arish) and 11 to the west (Mex–Salloum). Two to five vertical stations were collected perpendicularly at each section at standard depths (0–200 m depth) using Niskin bottles (Fig. 2).

Salinity was determined by measuring the electrical conductivity of samples, chlorinity was calculated according to the known formula:

$$S‰ = 1.80655\ Cl‰$$

The alkali metal ions Na^+ and K^+ were measured directly by using a Flame Photometer Model PFP7 with a limit detection of <0.2 ppm for both elements. The alkaline earth's metals Ca^{+2} and Mg^{+2} were analysed titrimetrically against EDTA solution using Eriochrome black-T as indicator. Ca was analysed by titration against the same standard solution (EDTA) using another indicator (Murexide). Magnesium content was computed as a difference between total hardness and calcium contents. Sulphate was precipitated as barium sulphate and measured turbidimetrically (Bather and Riley, 1954). Bromide was analysed according to the method of Morris and Riley (1966) and subsequently revised by Grasshoff (1976).

Results and discussion

Seasonal and sectional averages of the studied major ions and their corresponding chlorinity ratios are tabulated in Tables 1–3 and illustrated in Figs. 3–8.

Sodium

The earth's crust contains 2.6% sodium by weight making it the sixth most abundant element on earth. The total average of Na-content for the total number of samples is 12.337 g/l. The western part samples had an average above this mean, being 12.413 g/l while the eastern one is little lower (12.267 g/l). Spring and summer (2008) samples showed the

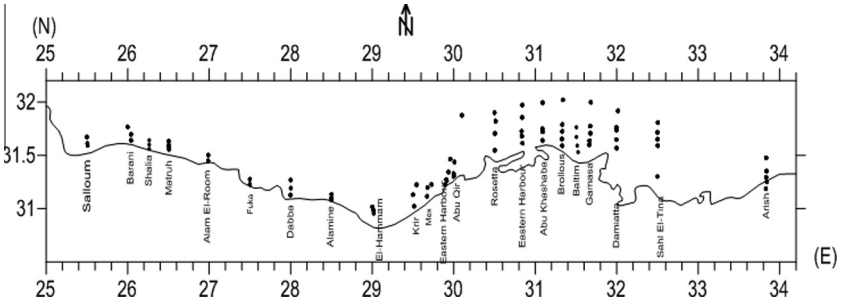

Figure 1 Sampling stations along the Mediterranean Egyptian coast during 2008–2010.

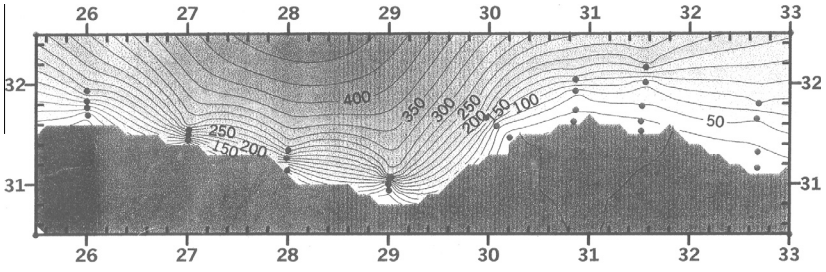

Figure 2 Tentative Bathymetry in metres of the Survey Area.