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Level of some major constituents of the Egyptian Mediterranean Coastal waters

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Abstract

Investigation of the chemical composition of the Egyptian Mediterranean coastal water at the end of 20th and the beginning of the 21st century was carried out. The study of some major constituents is based on a large number of samples taken through four cruises (August 2000 and March 2001) along 8 sections lie perpendicular to the coast starting from Sahl El-Tina in the east in Barani to the west. The water column till 200 m depth at (3-4) locations along each section was subjected to determination of salinity, total dissolved salts, calcium, magnesium, sulphate and bromide contents. The ionic relationships and salinity levels were discussed. With respect to the total average concentration of the analyzed samples, the respective studied variables levels were as follows: 38.22‰, 39.55 g/l, 403.4 mg/l, 1585.8 mg/l, 63.6 mg/l and 2.75 g/l for salinity, TSD, Ca^{2+}, Mg^{2+}, Br^{-} and SO_4^{2-} respectively. Most of these ions /chlorinity ratios and their averages reflect variety of deviations from the corresponding normal oceanic levels. Only few data give chlorinity ratios nearly similar to those of ocean. Most of Ca^{2+}, Br^{-} and SO_4^{2-}/chlorinity ratios reveal negative declinations below the oceanic ones while Mg^{2+}/Cl^{-} ratios of most data display positive declination above normal which indicate a relative excess of Mg^{2+} ions along the coast. The Mg/Ca ratio average computed for all samples (3.9) is higher than normal (3.0) and realize this phenomenon. The intrusion of relative low saline water from Atlantic Ocean, the land based effluents at different hot spots areas, the high rate of evaporation in addition to many physical, chemical and biological processes affect the salinity and consequently the major ions levels and their chlorinity ratios either spatially or temporary to a certain extent. Insignificant correlation coefficients between Ca and other studied variables content were found for winter data. The near shore results of summer cruises display good correlations between Ca^{2+} and each of Mg^{2+} and salinity being, r = 0.415 and 0.768, $p<0.02$, respectively. Direct significant correlations were also computed between Mg^{2+} and each of Br^{-} and salinity in the winter surface samples, being 0.483 & 0.448 respectively ($p<0.01$).

Keywords: Mediterranean Coast, Major constituents, Chlorinity ratio, Total dissolved salts, Egypt .

1. Introduction

One of the most important marine environmental conditions is the noticeable fluctuation in the hydrography of the south eastern Mediterranean Sea since the construction of Aswan High Dam in 1966. Investigation of the oceanographyical structure of Egyptian Mediterranean water is obviously important in favor of its natural resources either biological or non biological origin, recreational and other economical marine purposes and to reveal the effect of coastal pollution. The last previous research was restricted to the region between Agami and Rashid during April 1999 (Nessim *et al*., 2005). The present work deals with the monitoring survey of the level of some major constituents during the year 2000-2001 in the water column till 200 m depth along Egyptian Mediterranean Coast between Sahl El-Tina to the east and Barani to the west. These major constituents are calcium, magnesium, bromide and sulphate in addition to total dissolved salts (TDS) and salinity measurements. Calcium is an alkali earth metal and one of the major constituents in seawater comprising 1.2 % by weight of the TDS with a concentration range (400-450 ppm). In the open ocean variation in Ca concentration is rarely happened, in general, and most often tide with salinity fluctuations. Chlorinity ratio of the major element, on the other hand, remains nearly constant despite changes of salinity. At certain restricted and semi enclosed areas under local conditions, calcium can be partially reduced where dilution by rivers and land based input, precipitation of $CaCO_3$ happened or concentrated with evaporation at surface water or regeneration in the deep water due to high hydrostatic pressure, decreasing pH and cooling condition (Masoud *et al*., 2006).

Magnesium is the third most abundant major ion in seawater after sodium and chloride. Its ion is essential to the basic nucleic of chlorophyll in the primary producers. The relative concentration of Mg in

organisms is approximately the same as in seawater.

Bromides in typical seawater of salinity 35% is of concentration 65 mg/l representing 0.2 % of TDS. Its ions are needed by eosinophils which use it to generate antiphrastic brominating compounds by the action of eosinophils peroxidase.

The chief commercial resource of brome is the ocean water from which the element is extracted by means of chemical replacement (oxidation) by chlorine.

Sulphate is the major anion in marine water. It forms ionic interactions with most positively charged species. In fact, more than one half of it is in the form of an ion pair with $NaSO_4$ and $MgSO_4$ dominating. SO_4^{2-} can serve as an electron acceptor (oxygen source) or microorganism degrading organic material in water if the dissolved oxygen is depleted, that process leads to formation of the toxic gas (H_2S).

2. Material and Methods

Four cruises were carried out during the period from August 2000 and March 2001 to investigate the Oceanography of Egyptian coastal Mediterranean water on board the NIOF, R/V El-Yarmouk Research vessel. The studied area comprises eight longitudinal sections almost run perpendicular to the coast and lie between lat. 26° and lat. 33° E. These sections are namely; Sahl El- Tina, Manzalah, Burullus Abu-Qir, Alamin, Ras-El-Hekma, Matrouh and Barani. These profiles are extended from East to West and cover 50-70 km off the shoreline (Figure 1). Three to four vertical stations were sampled along each section.

Water samples were collected at each station and at standard depths (till 200 m depth) using Niskin bottles. Cruises of March 2001 represent late winter while those of August- September 2000 reveal summer one. Salinity was determined by measuring the electrical conductivity of water samples, chlorinity was calculated according to the known formula:

$$S‰ = 1.80655\ Cl‰$$

TDS (mg/l) was directly measured by the same conductivity apparatus for the water column at only 14 stations along four sections of the western part during summer cruises.

Calcium and magnesium were analyzed titrimetrically according to the method of Heron and Mackerth (1960) using Eriochrome black-T as indicator. Calcium was determined by titration against EDTA using another indicator (Murexide). Bromide was analyzed according to the method of Morris and Riley (1966) and subsequently revised by Grasshoff (1976). Sulphate was precipitated as barium sulphate and measured gravimetrically (Bather and Riley, 1954).

3. Results and Discussion

3.1. Total dissolved salts (TDS)

TDS consist of inorganic salts and dissolved materials either natural or anthropogenic. The salts are chemical compounds comprised anions such as CO_3^{2-}, Cl^-, SO_4^{2-}, Br^- and NO_3^- and cations such as Mg^{2+}, Ca^{2+},K^+,and Na^+. TDS data gave a slight regional varation; Matrouh area, subjected to a considerable recreational activities, exhibits its water the highest TDS average (39.71 ppt) while Barani,near the Egyptian-Lybian border, gave its water the lowest one (39.46 ppt), Ras El-Hekma and Alamin sections occupy their waters an intermediate averages (around 39.5 ppt). TDS, in general, showed a considerable variation ranging between 38 ppt in bottom water (150m depth) at the offshore st. 4 of Alamin area and 39.9 ppt detected at many locations (eg. the upper 50 m water layer at sts. 1&2, Matrouh).

3.2. Salinity

It is defined as the total amount of solid materials in grams dissolved in one kilogram of seawater when all the carbonate has been converted to oxides, the bromine and iodine are replaced by chlorine and all organic matter completely oxidized. The investigated salinity ranges between 36.51‰ (st.3, 75m depth) at Dameitta section during summer and 39.11‰ in the bttom water of st. 1 (Barani, Winter). During winter, the salinity averages for the different sections at the eastern part are nearly identical (around 38.3‰), the western sections gave slight lower averages (approx. 38.15‰). Evaporation is especially higher in its eastern part causing water level to decrease and salinity to increase eastwards. Summer samples, on the other hand, reveal a reversible trend where the salinity average of western part is relatively higher than that of eastern one, being 38.70 and 38.00‰, respectively. The vertical distribution of salinity at the offshore locations displays a certain homogeneity most of the water column during winter .The water column near Burullus is nearly homogeneous and may be one of formation zones of intermediate waters (Abdel Moati and Said, 1987). The mixing layer became more shallow during summer A slight increase in salinity downwards could be noticed at certain near shore locations such as Ras El-Hekma and Matrouh (Winter).

3.3. Major cations

3.3.1. Calcium (Ca)

Noticeable temporal and special variations in Ca content as well as its chlorinity ratio of Egyptian Mediterranean Coastal water could be detected through these cruises (Tables 1a, 1b, 2a and 2b, Figures 2&3).

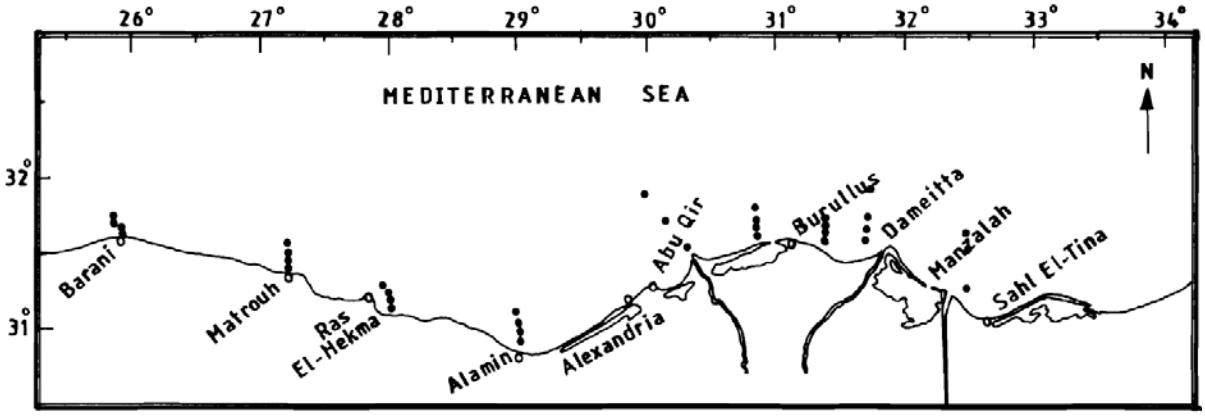

Figure 1: Egyptian Mediterranean Coast and sampling locations.

The summer samples gave relative higher content average than that of spring one, being 413, 394 mg/l, respectively. According to the total average of calcium content of each section, maximal levels (448 mg/l) were computed for Barani and Dameitta region while, minimal ones (374 mg/l) was for Alamin and Burullus during summer cruises. For spring samples, Sahl El-Tina, Matrouh and Ras El-Hekma sections gave the highest averages (405-415 mg/l) while the rest sections showed relative low averages (≤390 mg/l). The total average of all samples of 403.5 mg/l is lower than the finding of Nessim *et al*. (2005) in Alexandria coastal water. The low Ca content in spring coastal samples is found in a good agreement with those reported by Mahmoud (1998) in Alexandria coastal water and could be attributed to its relative high consumption by organisms during this period.

Table (1-a): Averages of S‰ & major ions content in seawater along Egyptian Mediterranean Coast during summer 2000.

parameter	St. No	Barani	Matrouh	Ras El-Hekma	Alamin	West average	Abu-Qir	Burullus	Dameitta	Sahl El Tina	East Average	Total Average
S‰	1	38.92	38.86	38.72	38.78	38.82	38.03	37.00	38.35	37.32	37.93	38.38
	2	38.65			38.60	38.63	37.84	37.68	38.79	37.78	38.02	38.33
	3	38.71	38.74	38.76	38.48	38.67		37.81	38.56	37.68	38.02	38.35
	4	38.61	38.74	38.79	38.64	38.70						
	Average	38.69	38.77	38.76	38.59	38.70	37.94	37.61	38.77	37.64	38.00	38.35
Ca^{2+} (mg/l)	1	491.0	432.0	438.6	444	451.4	415.2	363	460.8	378.2	404.3	427.9
	2	462.8			418.3	440.6	434.7	350.8	445.5	355.2	396.6	418.6
	3	439	410.3	449.8	364.6	415.9		393.2	444.9	381.5	385.5	400.7
	4	426.7	455.1	419.1	348.7	412.4						
	Average	447.9	432.6	435.3	374.2	422.5	425	374.3	447.7	372.7	404	413.3
Mg^{2+} (mg/l)	1	1585	1630.6	1650.8	1512	1594.6	1879.3	1531	1814	1506	1682.6	1638.6
	2	1607			1602	1604.5	1920	1480.4	1696.3	1389.4	1668.6	1636.6
	3	1661.4	1660	1677	1653.4	1663		1666.3	1808.8	1487.8	1592.2	1627.6
	4	1639.4	1550	1664.3	1628.7	1620.6						
	Average	1630.7	1610.6	1666.3	1623.8	1632.9	1899.7	1582.8	1772.2	1460.4	1678.8	1655.8
Br^{-} (mg/l)	1	66.6	64.9	69.2	57.1	64.5	31.1	58.1	46.4	48.5	46	55.3
	2	66.6			59.2	62.9	34.8	54.9	41.8	54.9	46.6	54.8
	3	67.2	67.0	67.8	59.4	65.2		50.6	41.2	55.6	49.7	57.5
	4	66.9	66.7	68.1	58.9	65.2						
	Average	66.9	66.4	68.2	59	65.1	33	53.4	42.3	54.1	45.7	55.4
SO_4^{2-} (mg/l)	1						2650.7	2583.3	2695.7	2615.3	2636.3	
	2						2717	2512.4	2249.3	2517.8	2499.1	
	3							2538.3	2709.2	2636.1	2627.9	
	4											
	Average						2683.8	2538.6	2553.7	2595.3	2592.9	

Table (1-b): Averages of S‰ & major ions content in seawater along Egyptian Mediterranean Coast during winter 2001

parameter	St. No	Barani	Matrouh	Ras El-Hekma	Alamin	West Average	Abu-Qir	Burullus	Manzalah	Sahl El- Tina	East Average	Total Average
S‰	1	38.02	38.13	38.05	38.08	38.07	37.85	38.20	38.25	38.30	38.15	38.11
	2	38.04	38.17	38.11	38.09	38.10	38.32	38.34	38.32	38.23	38.30	38.20
	3	38.12	38.19	38.24	38.21	38.19	38.36	38.30	38.34	38.28	38.32	38.26
	4				38.24			38.36	38.26	38.34	38.32	38.28
	Average	38.08	38.17	38.15	38.18	38.15	38.28	38.32	38.29	38.30	38.30	38.23
Ca^{2+}(mg/l)	1	406.3	369.2	466.8	418.5	415.2	384	394	389.5	432.5	400	407.6
	2	402	438.9	408.1	391.3	410.1	369.2	380.8	390.3	419.7	390	400.1
	3	377	402.3	362.4	374	378.9	350.6	387.2	390	384.6	378.1	378.5
	4				397.6			391.5	395.7	421	402.7	
	Average	390.4	409.4	404.8	390	395.4	360.6	388.4	392.4	411.4	390.6	396
Mg^{2+}(mg/l)	1	1459	1273.2	1374.8	1263	1342.5	1677.5	1573.5	15775	1589.5	1604.5	1473.5
	2	1472.8	1264.9	1306.1	1317.3	1340.3	1649.8	1606	1600.7	1607.3	1616	1478.2
	3	1465.7	1541.8	1299.1	1358.4	1416.3	1690.4	1638.4	1776.8	1632.2	1684.4	1550.4
	4				1315.9			1710	1708	1609	1675.7	
	Average	1466.2	1375	1319.2	1326.7	1371.8	1676.1	1654.9	1693.9	1613.2	1659.5	1515.7
Br^{-}(mg/l)	1	71.5	67.7	74	68.3	67.6	74	71.9	81.7	76.1	75.9	71.8
	2	72.2	67.3	75.4	66	68.5	74.7	72.6	80.3	73.8	75.4	72
	3	71.7	69.2	70.4	67.6	67.7	77.2	71.1	79.2	73.6	75.3	71.5
	4				66.9			72.9	76.9	74.5	74.8	
	Average	71.8	68.2	73.1	67.2	68	76	72.3	78.8	74.3	75.4	717
SO_4^{2-}(mg/l)	1	2464.3	2627.4	2722.8	2808.5	2655.8	2219	2938.5	2826.5	2875.5	2714.9	2685.4
	2	2557.8	2905.3	2949.5	2604.3	2754.2	2442.8	2721.3	2256	2832.3	2563.1	2658.7
	3	2688.7	2823.2	2797.1	2756	2766.3	2639.7	2714.6	2812.6	2853.4	2755	2760.7
	4				2632.2			2892.6	2710.4	3181.6	2928	
	Average	2658	2812.8	2835.6	2689.5	2748	2525.6	2819.7	2673.9	2987.4	27517	2750

Table (2-a): Chlorinity ratio averages of some major ions along Egyptian Mediterranean Coast during summer 2000.

parameter	St. No	Barani	Matrouh	Ras El-Hekma	Alamin	West Average	Abu-Qir	Burullus	Damitta	Sahl El Tina	East Average	Total Average
Ca^{2+}/Cl	1	0.0228	0.0201	0.0205	0.0207	0.02103	0.0197	0.0177	0.0220	0.0183	0.0194	0.020218
	2	0.0216			0.0196	0.0206	0.0207	0.0168	0.0213	0.0170	0.0190	0.01980
	3	0.0205	0.0191	0.0210	0.0170	0.01943		0.0188	0.0214	0.0183	0.0195	0.01946
	4	0.0200	0.0212	0.0195	0.0163	0.01995						0.01925
	Average	0.0209	0.0202	0.0203	0.0175	0.01973	0.0202	0.0180	0.0214	0.0179	0.0194	0.0196
Mg^{2+}/Cl	1	0.0736	0.0758	0.0770	0.0704	0.0742	0.0893	0.0747	0.0850	0.0729	0.0805	0.07735
	2	0.0751			0.0749	0.0750	0.0917	0.0710	0.0811	0.0664	0.0776	0.07630
	3	0.0775	0.0774	0.0782	0.0776	0.07768		0.0796	0.0870	0.0713	0.0793	0.07849
	4	0.0767	0.0723	0.0775	0.0761	0.0757						
	Average	0.0761	0.0751	0.0777	0.0760	0.0762	0.0905	0.0760	0.0848	0.0701	0.0804	0.0783
Br^{-}/Cl	1	0.00309	0.00302	0.00323	0.00266	0.00300	0.00148	0.0284	0.00219	0.00235	0.00222	0.002610
	2	0.00311			0.00277	0.00294	0.00166	0.00263	0.00200	0.00263	0.00223	0.002585
	3	0.00314	0.00312	0.00316	0.00279	0.003053		0.00242	0.00198	0.00267	0.00236	0.002706
	4	0.00313	0.00311	0.00317	0.00275	0.00304						
	Average	0.00312	0.00310	0.00318	0.00276	0.00304	0.00157	0.00256	0.00206	0.00259	0.00220	0.00262
SO_4^{2-}/Cl	1						0.126	0.126	0.127	0.127	0.1265	
	2						0.130	0.120	0.108	0.128	0.1195	
	3							0.121	0.130	0.126	0.1257	
	4											
	Average						0.128	0.122	0.122	0.127	0.1243	

Table 2-b: Chlorinity ratio averages of some major ions along Egyptian Mediterranean Coast during winter 2001.

parameter	St. No	Barani	Matrouh	Ras El-Hekma	Alamin	West Average	Abu-Qir	Burullus	Manzalah	Sahl El- Tina	East Average	Total Average
	1	0.0193	0.0175	0.0229	0.0199	0.0199	0.0183	0.0186	0.0184	0.0204	0.0189	
	2	0.0191	0.0208	0.0298	0.0129	0.0207	0.0174	0.0179	0.0184	0.0198	0.0184	
	3	0.0179	0.019	0.0168	0.0177	0.0179	0.0165	0.0183	0.0184	0.0182	0.0178	
	4				0.0195			0.0184	0.0187	0.0198	0.019	
Ca^{++}/Cl	Average	0.0185	0.0194	0.0237	0.0177	0.0198	0.017	0.0183	0.0185	0.0194	0.0185	0.01915
	1	0.0693	0.0603	0.064	0.0599	0.0634	0.0801	0.0744	0.0745	0.075	0.076	
	2	0.0699	0.0599	0.0621	0.0614	0.0633	0.0778	0.0757	0.0755	0.076	0.0763	
	3	0.0695	0.0729	0.0616	0.0658	0.0675	0.0796	0.0773	0.0837	0.077	0.0794	
	4				0.0609			0.0805	0.0807	0.0758	0.079	
Mg^{++}/Cl	Average	0.0696	0.0651	0.0623	0.062	0.0648	0.0791	0.078	0.0799	0.0761	0.0783	0.0716
	1	0.0034	0.00321	0.00345	0.00324	0.00335	0.00353	0.0034	0.00386	0.00359	0.0036	
	2	0.00343	0.00319	0.00356	0.00308	0.00332	0.00352	0.00342	0.00379	0.00349	0.00356	
	3	0.0034	0.00328	0.00339	0.00321	0.00332	0.00364	0.00335	0.00373	0.00347	0.00355	
	4				0.00325			0.00343	0.00363	0.00351	0.00352	
Br^{-}/Cl	Average	0.00341	0.00323	0.00347	0.00321	0.00333	0.00359	0.00341	0.00372	0.0035	0.00356	0.00344.5
	1	0.117	0.124	0.129	0.133	0.126	0.106	0.139	0.133	0.136	0.129	
	2	0.131	0.138	0.14	0.08	0.122	0.115	0.128	0.106	0.134	0.121	
	3	0.127	0.134	0.132	0.128	0.13	0.124	0.128	0.133	0.135	0.13	
	4				0.123			0.136	0.128	0.15	0.138	
SO_4^{-}/Cl	Average	0.126	0.133	0.134	0.118	0.128	0.119	0.133	0.126	0.139	0.129	0.129

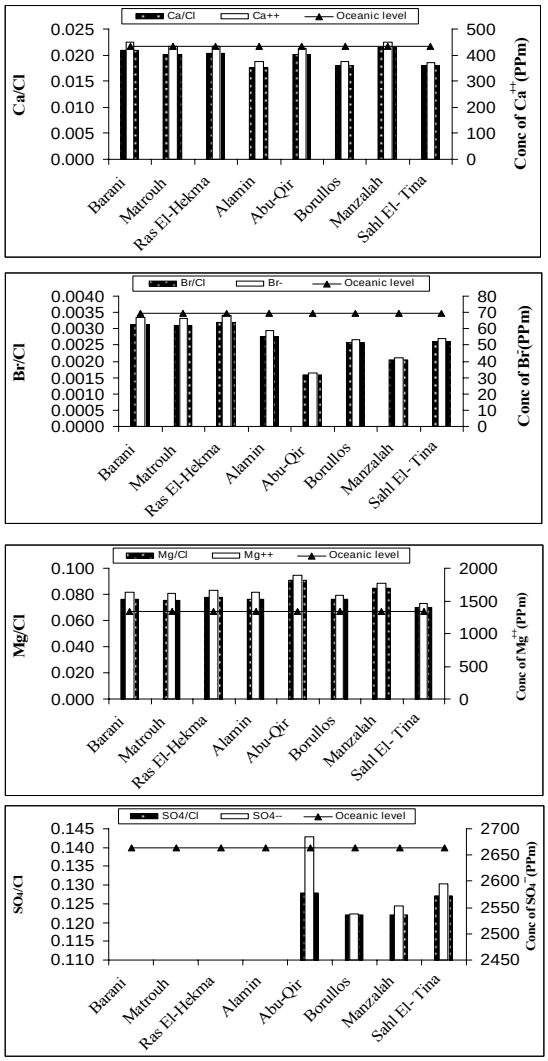

Figure 2: averages of major constituents content and their chlorinity ratios along Egyptian Coast during August 2000.

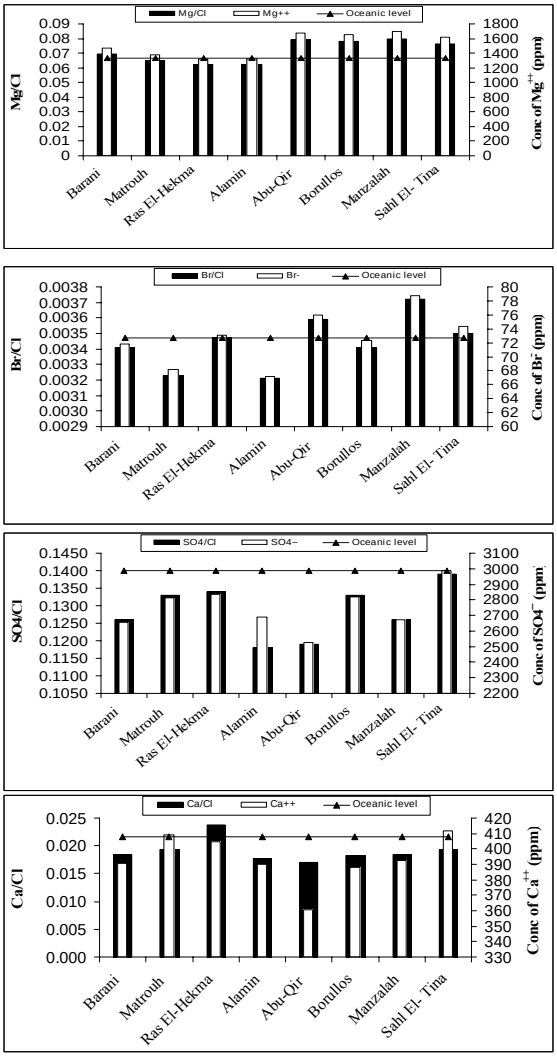

Figure 3: averages of major constituents content and their chlorinity ratios along Egyptian Coast during March 2001.

Laterally, most of Ca values tend to decrease seawards; the near shore and shallow stations exhibited more calcium content than those of offshore, being nearly 28 mg/l as Ca-gradient, on average.

A remarkable eastwards increase in Ca- sectional average during winter could be computed at the Eastern part starting from the lowest average of 361 mg/l at Abu-Qir to 411 mg/l at Sahl El-Tina (Table 1b). For summer samples, the near shore stations at the western part gave its water an Eastwards increase in Ca-average starting from Matrouh to El-Alamin (Table 1a). The offshore stations, on the other hand, reflect a reversible trend along this part.

The water column at most studied areas shows its calcium content as well as its chlorinity ratio irregular vertical variations. At certain nearshore stations of some sections e.g Dameitta and Ras El-Hekma (summer) and Barani (winter), the values tend to increase down wards, a reversible trend was detected at stations 1 and 2 (Abu - Qir) during winter where the values decreased downwards. The intrusion of relative low saline subsurface Atlantic water into the Mediterranean Sea to compensate for the negative water balance in addition to vertical convection or stagnation is responsible for many variations. The high variety of Ca- content and its chlorinity ratio might be contributed to its involvement with the biosphere and with carbonate system in the waters. A great part of the water column tends sometime to be homogeneous in Ca- content e.g station 3 (Matrouh) and station 2 (Barani) during summer and station 4 at Sahl El-Tina during late winter.

With respect to the Ca/Cl oceanic ratio (0.0216) reported by Culkin and Cox (1966) most of computed data(>85%), show negative deviations while minor portion 11 % was found above normal and only 4 % were nearly identical.

According to statistical treatment, no correlations between Ca and other studied variables contents for winter data were found. The summer results, on the other hand, reflect good correlations between Ca and each of Mg and salinity, being r = 0.415 and 0.768 respectively, (p = 0.02).

3.3.2. Magnesium (Mg)

Magnesium concentration in Egyptian Mediterranean coastal water fluctuated between 1175 mg/l at Matrouh surface water (winter) and 1982 mg/l at Dameitta (bottom water, summer) with an average of 1585 mg/l, extremities values <1000 or >2000 mg/l were rarely happen.

The computed Mg/Ca ratio, in general, is higher than that for normal oceanic water (up to 3.9, on average) (Figures 2&3). The eastern samples showed relative higher Mg/Ca ratio (≥4) if compared with those of the western part (≤4).

With respect to the total average value of each section computed for winter data (Table 1b), the eastern waters were characterized with high Mg-content (a round 1660 mg/l), the western water, on the other hand, exhibited lower Mg content (around 1372 mg/l). This increment did not exceed 25 mg/l for seawater. For summer samples (Table 1a), Sahl El-Tina represents the lowest average while Abu- Qir gave the highest, being 1460 and 1900 mg/l, on average, narrow relative range in magnesium content averages in the western water was computed (1610-1666 mg/l). Summer samples contain more amounts of Mg than winter ones, being 1656 and 1516 mg/l, respectively. According to the total average of Mg content for each station, a pronounced seawards increase particularly at the eastern part during winter cruises and at the western part during summer (Tables 1a & 1b).

Despite the irregular vertical variations of mg-content as in Ca- content, a pronounced down wards increase in the values could be observed at certain sites; (e.g Sahl El-Tina (st. 2), El Manzalah (sts. 1 & 2), Burullus (st. 1) and Barani (st. 1) during winter and at Dameitta (st. 1) and Abu-Qir (st. 2) during summer. The deep or bottom waters of most locations exhibited relative higher amount of Mg than that at surface ones. The Mg-chlorinity ratio of most samples showed positive declination above normal oceanic ratio (0.0669) of Culkin and Cox (1966) while a small portion of samples was found at level below this ratio. All winter samples in the eastern part showed their water noticeable positive declination while most of the Cl-ratios of the western samples gave negative ones (Table 2b) . The down wards increase in chlorinity ratio at some locations followed the corresponding magnesium contents.

Magnesium is directly correlated via Br and salinity in the surface winter samples, being r = 0.483 and 0.448 respectively, p<0.02.Reversible correlations between Mg and Br were computed for the near shore and offshore summer data, being r = –0.442 and –0.401, respectively, p <0.02.

3.4. Major anions

3.4.1. Bromide (Br)

Relative wide fluctuations either spatially (laterally and vertically) or temporary in bromide concentrations and its chlorinity ratios were reported during the two seasons. Contrary to the two studied cations Ca and Mg, winter samples exhibited higher levels in Br contents as well as their chlorinity ratios than those of summer samples particularly at the eastern part being 75.4 and 45.7 mg/l, on average, respectively. Abu-Qir water, subjected to a certain dilution through land-based sources, reflect a marked drop in its bromide content and its chlorinity ratio reaching its minimal levels, 33 mg/l, 0.00157 respectively during summer (Tables 1a & 1b). Such dilution effect was not observed during winter where the average of Br concentration raised to be more than double (76 mg/l).

This area, gave its water a gradual seawards increase in Br content and chlorinity ratio during the two seasons. Sahl El-Tina samples showed the same trend; seawards increase during summer. A reversible condition i.e regional average tends to decrease seawards at Burullus and Dameitta sections (summer) and at Manzalah (winter). Similar to Ca and Mg conditions, Br content and its chlorinity ratio showed irregular vertical variations at most locations. Significant correlations between Br and sainity data of the near shore, off shore and surface water (summer) were computed, being r = 0.408, 0.416 and0.753 respectively, $p<0.02$.

3.4.2. Sulphate (SO_4)

A wide fluctuation in sulphate content at the studied sites vertically or regionally as well as seasonally could be noticed. Contrary to Ca and Mg but similar to Br variation, the summer average of sulphate content is lower than that of winter one. Regionally, the average values of the eastern and western parts are nearly identical during winter (around 2750 mg/l), in this period, the near shore water (st. 1) and to a less extent the offshore water (sts. 2&3) showed a gradual increase in SO_4^{2-} content average eastwards along the western part. The offshore water at st. 2 of the eastern part reflects the same trend. Vertically, the SO_4^{2-} content average at nearshore waters tend to increase downwards at the two parts (eastern and western) affected with land based effluents. The partially consumption of the ions by the upper surface organisms and its regeneration near the bottom explain such vertical variation (Nessim, 1988).

With respect to the normal SO_4^{2-}/Cl^- ratio in oceans of (0.140) reported by Morris and Riley (1966), most of samples (> 80 %) were found below it.

At Sahl El-Tina section, the chlorinity ratio of the water column at st. 4 gave a strong positive declination reaching its maximum average (0.150) corresponding to sulphate content average of 3.182 g/l during winter. The total average ratio for this section (Table 1b) represents the highest sectional average (0.139) which is closely nearer the normal oceanic ratio.

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مستويات بعض العناصر الأساسية لمياه البحر المتوسط أمام الساحل المصرى

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يختص البحث بالتركيب الكيميائى للمياه المصرية الساحلية للبحر المتوسط و تأتى أهمية هذه الدراسة بأنها تسجل الخصائص الكيميائية فى نهاية القرن العشرين و بداية القرن الحادي والعشرين و هى ضرورية لكل الانشطة الساحلية. و تعتمد الدراسة على عدد كبير من العينات المائية و التى تم جمعها خلال أربعة رحلات بحرية بمركب الأبحاث الخاصة بالمعهد (اليرموك), رحلتان منها فى صيف 2000 و إثنان آخران فى شتاء 2001 و تم تقسيم الشاطىء المصرى الى 8 قطاعات عمودية على خط الشاطىء ما بين سهل الطينة شرقا و برانى غربا ويحوى كل قطاع على 3 أو 4 محطات تغطى حوالى 50-70 كم من الشاطىء و تم جمع عينات المياه من عمود الماء و حتى عمق 200 م على الأعماق القياسية المعروفة.

تم دراسة التغيرات فى الملوحة و الأملاح الذائبة الكلية و كذلك تراكيز الأيونات : الكالسيوم و المغنسيوم و البروميدات و الكبريتات و النسب الكلورونية لها و مقارنتها بالنسب المحيطية القياسية.و قد أعطت المتغيرات المتوسطات التالية: الملوحة 38,22 جزء فى الالف , الأملاح الكلية الذائبة 39,55 جم/ لتر-الكا لسيوم 403,4 مجم/لتر, المغنسيوم 1585,8 مجم/لتر, البروميدات 63,3 مجم /لتر و الكبريتات 2,75 جم/لتر.

و قد لوحظ أن معظم النسب الكلورينية تعكس متوسطاتها اختلافات متفاوتة عن النسب المحيطية الثابتة أما النسب الكلورينية التى تتطابق أو تقترب من النسب المحيطية فهى قليلة. و قد أعطى الكالسيوم و البروميدات و الكبريتات نسبا كلورينية فى معظم الأحيان أقل من النسب المحيطية المقابلة و بدرجات متفاوتة بينما يعطى المغنسيوم نسبا كلورينية أعلى من النسب المحيطية فى معظم العينات مما يدل على وجود هذا العنصر بوفرة فى المياه المصرية.

و تبلغ نسبة تركيز المغنسيوم : الكالسيوم حوالى 3,9 أعلى من النسبة المعروفة فى المحيطات (3) مما يؤكد هذه الظاهرة.

و يؤدى دخول ميا ه المحيط الأطلنطي الأقل فى الملوحة الى البحر المتوسط عن طريق مضيق جبل طارق كذلك نتيجة للصب المستمر للمصارف فى مياه البحر بالإضافة الى عمليات البخر المستمر الى تغير تراكيز الأملاح الذائبة و بالتالى النسب الكلورينية لها اذا ما قورنت بالتركيب الكيميائى شبه الثابت لميا ه المحيطات.