Salinity and Major Ions in Lake Manzalah, Egypt

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The northern delta lakes in Egypt receive various types of water ranging from Nile fresh water (salinity < 1‰) to coastal Mediterranean sea water (salinity > 39‰). Mixing inside the lake systems leads to the appearance of various in-lake environments. Variations in salinity and subsequent variations in the major ions have been evaluated.

Lake Manzalah is the largest (900 km2) and most productive Nile delta lake, boardered by the Mediterranean Sea to the north, the Suez Canal (east) and the Nile branch (west). The average depth is 1 m. About 6,600 million m3 of fresh and brackish water reaches the lake annually.

During 1982/83, 50 stations were sampled monthly. Salinity was measured using inductive salinometer; chloride argentometrically ; calcium, magnesium, sodium and potassium by an ICP spectrometer; sulphate by turbidimetry; bicarbonate and carbonate by titration.

The lake is divided into 2 regions, the N.W. region (average salinity 41.9 + 9‰) and the main lake region (average salinity 2.49 + 1.1‰). Since 1933 (average lake salinity 24‰), the progressive increase in drainage water reaching the lake and the Nile flood cessation since 1965 as well as the restriction of marine water flowing through the lake-sea connection during late 1960's (average salinity 9‰) are the main reasons for salinity declination in the lake. In 1982, the amount of water discharging into the lake was 7.7 times the lake water volume. Salinities at the lake-sea connection reached 19.9‰ during summer. The mixing of fresh and sea water appears at the coastal Mediterranean waters opposite to the lake-sea connection and the resulting brackish water enters the lake as a side way current.

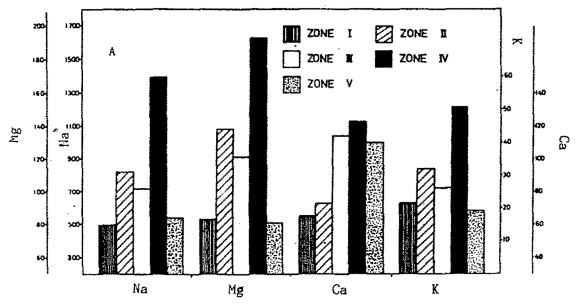

Figure 1. Zonal averages (mg/l) of major ions in lake Manzalah.

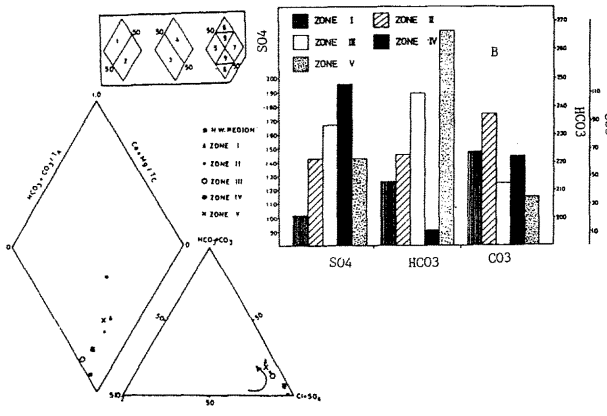

Figure 2. Multivariate graph for major ions in lake Manzalah.

According to salinity, stations were grouped into 4 water types:Type A (0-5‰), Type B (5-20‰), Type C (20-40‰) and Type D (>40‰) with the following salinity/chlorinity relations S‰=1.888 Cl‰+ 0.126; S‰=1.794 Cl‰+ 0.121; S‰=1.783 Cl‰+1.349 and S‰=1.754 Cl‰+ 2.042; indicating deviations in the relative proportions than those of oceanic waters.

The average concentrations of different cations and anions are represented in Figure 1. Zonal fluctuations are related to the quality of water reaching each zone. The relative abundance for cations was Na > Mg > Ca > K while for anions was Cl > HCO3 + CO3 > SO4. Anoxic conditions prevailing in certain lake areas lead to reduction in sulphate concentrations.

Table 1. Ion/Chlorinity ratios for lake Manzalah water.

Water type ION	A S‰(0-5‰)	B S‰(5-20‰)	C S‰(20-40‰)	D S‰(>40‰)
Na	0.5594	0.5518	0.5477	0.5353
Mg	0.0684	0.0665	0.0630	0.0628
Ca	0.0223	0.0206	0.0188	0.0185
K	0.0277	0.0208	0.0202	0.0196
SO4	0.1433	0.0994	0.0988	0.0843
HCO3	0.1963	0.0553	0.0100	0.0050

Table 1 shows the different ion/chloride ratios for different water types. The chlorinity ratios for all ions showed a progressive decrease by increasing salinity, despite the progressive increase in the mean ion concentration with increasing salinity.

Relations among cations and anions (Figure 2) classified the lake water as soft in relation to its content of dissolved salts. The N.W. region and areas affected by sea water invasion represent a halite dominated system while others are shifted towards carbonate enriched systems.