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Note:

Effects of the December 1991–May 1992 floods on the Dead Sea vertical structure

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INTRODUCTION

During the winter of 1991/92, the Dead Sea level rose by about 2 m (Table 1). This was due to an extremely rainy winter with 150–200% of the average annual precipitation (e.g., 1247 mm in Jerusalem vs. average of 590 mm and 1389 mm in the Galilee vs. annual average of 900 mm; The Meteorological Service). The calculated addition of runoff water to the Dead Sea during this winter, assuming a surface area of 750 km^2 and a sea-level rise of 2 m, amounted to about 1.5×10^9 m^3. Most of the runoff water entered the Dead Sea through the Jordan River. The measured volume of runoff water of the Jordan River at Naharayim between October 1991 and April 1992 was 621×10^6, of which the Yarmouk runoff is estimated to be about half (Hydrological Service). Estimations for the sources of the remaining volume are: Shomeron, 150×10^6 m^3; Gilad, 250×10^6 m^3; Moab, 450×10^6 m^3; Judean Mountains, 50×10^6 m^3. (A. Ben-Zvi, Hydrological Service, pers. comm.). The winter of 1979/80 witnessed a similar amount of inflowing water and sea-level increase (Anati et al., 1987). However, due to more intense mixing the epilimnion that developed was more saline and consequently less stable than that developed during winter 1991/92.

Table 1. Dead Sea water levels

Date	Sea level (m)
16. IX. 91	–408.14
10. X. 91	–408.37
19. XI. 91	–408.37
12. XII. 91	–408.31
22. I. 92	–407.99
24. II. 92	–407.10
29. III. 92	–406.37
4. V. 92	–406.37

Source: Hydrological Service.

This note documents the changes that took place in the Dead Sea between December 1991 and May 1992 (Beyth et al., 1992). Reference is made to water profiles sampled in August, 1991 (Beyth et al., 1991) at site En-Gedi-320.

Dead Sea water profiles were taken on 18.III.92 at site En-Gedi-320 east of En-Gedi and on 4.V.92 at site Masada-100, east of Masada. Water samples were collected with Nansen bottles at En-Gedi-320 at depth intervals of 10–50 m down to 310 m, and at Masada-100 pumped through a hose at depths down to 80 m. Chemical analyses were made by the Dead Sea Works Ltd. Brine densities were measured on the same water samples and are presented after correction to 25 °C. Detailed temperature profiles were obtained with a thermistor which was lowered down to 130 m at En-Gedi-320 and to 77 m at Masada-100. A few samples were collected on the abovementioned dates and on 1.III.92 from the surface water of the lake at the southern part, close to the P-8 pumping station.

RESULTS AND DISCUSSION

Figure 1 presents the dilution profiles of the upper 30 m as sampled on the above dates, as well as the dilution factor of the sample collected from the Dead Sea surface on 1.III.92. The dilution was calculated with reference to the magnesium concentrations normalized to the average magnesium concentration of the deep brine

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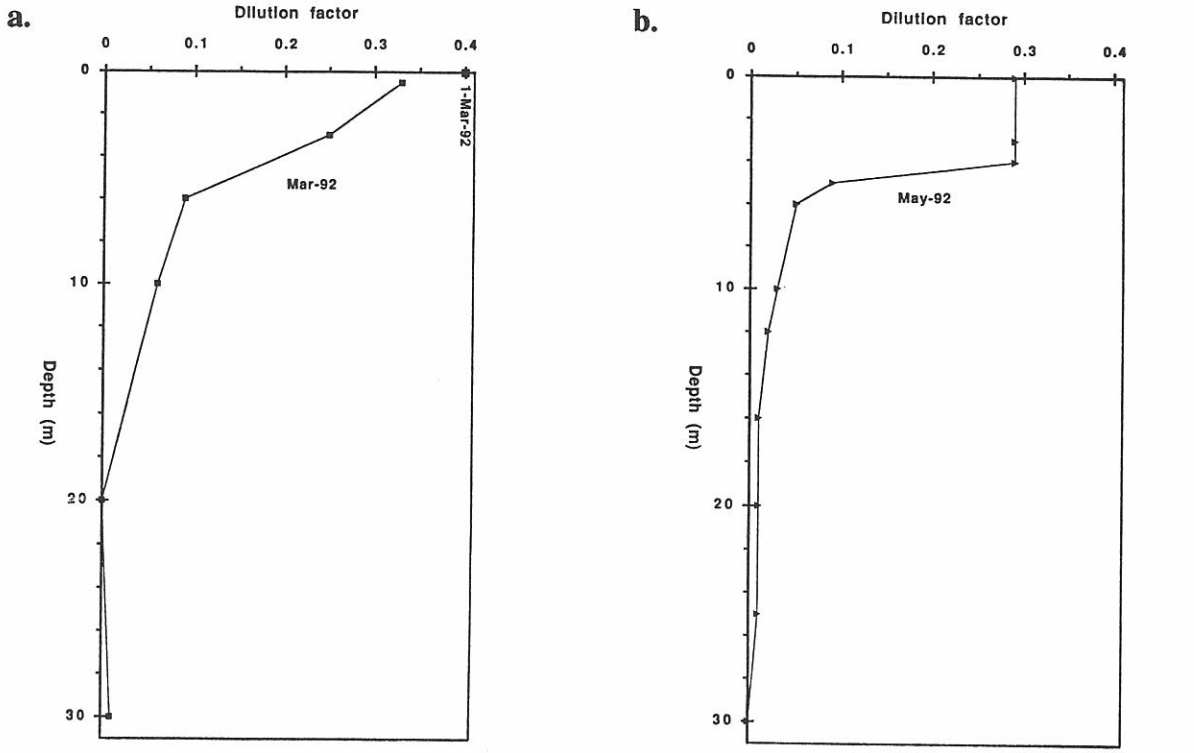

Fig. 1. Calculated dilution profile of the upper water body of the Dead Sea at (a) En-Gedi-320 on 18.III.92 and surface brine at P-8 pumping station on 1.III.92. (b) Masada-100 on 4.V.92. See text for dilution calculation.

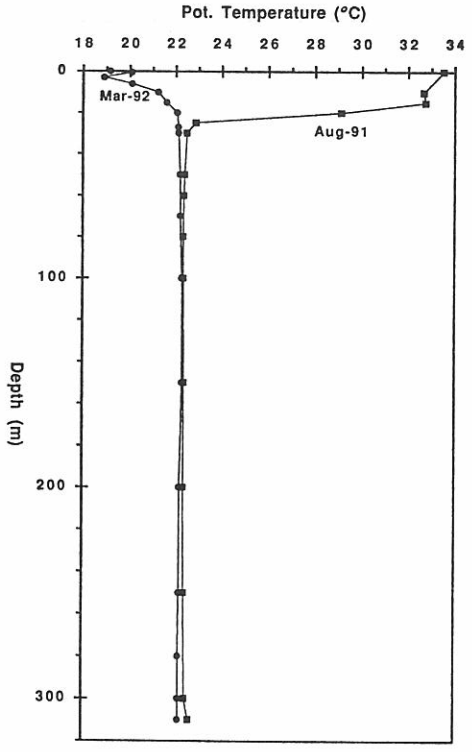

Fig. 2. Potential temperature profiles (measured by reversing thermometers) of the Dead Sea at station En-Gedi-320 measured on 5.VIII.91 (squares) and 18.III.92 (circles).

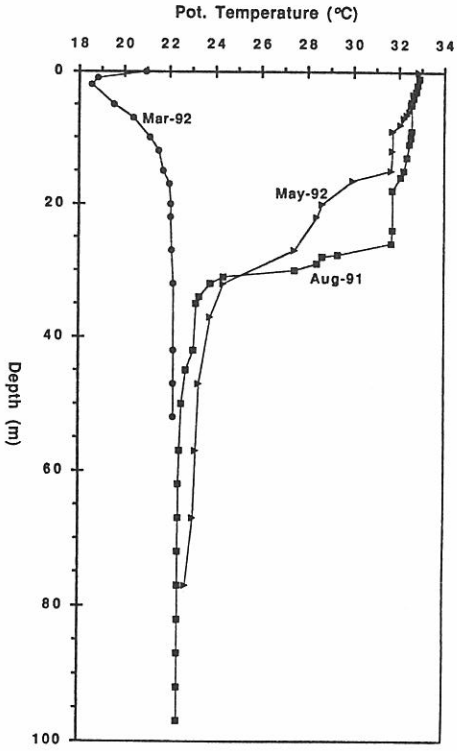

Fig. 3. Temperature profiles (measured by thermistor) of the Dead Sea at station En-Gedi-320 measured on 5.VIII.91 (squares) and 18.III.92 (circles) and at station Masada-100 measured on 4.V.92 (triangles).

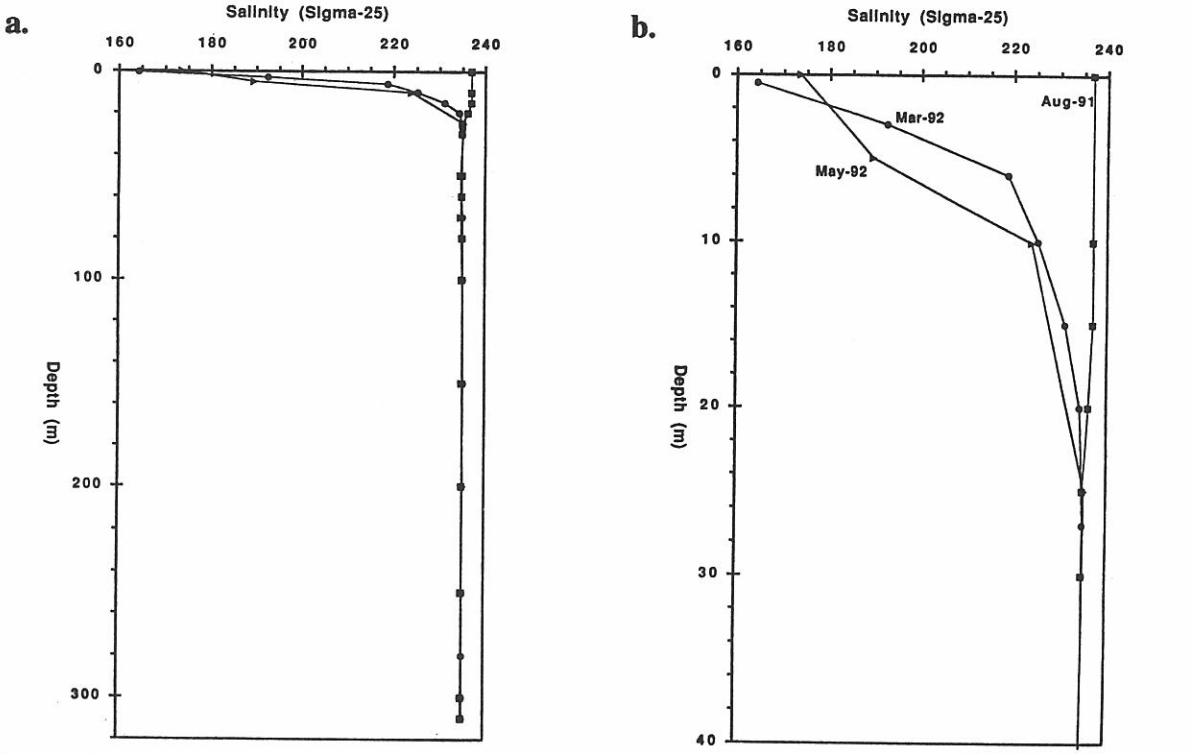

Fig. 4. Salinity profiles (Sigma-25) of the Dead Sea measured at station En-Gedi-320 measured on 5.VIII.91 (squares) and 18.III.92 (circles) and at station Masada-100 measured on 4.V.92 (triangles). (a) Full profile. (b) Detailed profile of the top 40 m, crossing the thermocline.

(100–310 m) at En-Gedi-320 on 5.VIII.91, which was 45.87 g/l. The profiles indicate that a layer of diluted Dead Sea water formed over the main water body during the winter of 1991/92. No evidence for the dilution of the entire brine body was detected. The dilution profiles show the diluted layer to be about 20 m deep. The dilution factor decreases with depth, with a dilution factor of about 0.3 (30% dilution) at the surface to 0.02–0.05 (2–5%) at a depth of 10 m. A decrease in the dilution factor of the surface water (0–0.5 m) between 1.III.92 and 4.V.92 is evident: from 0.4 on 1.III.92 to 0.32 on 18.III.92 to 0.29 on 4.V.92. The slightly higher Na/Cl ratio (0.26–0.27 vs. 0.25) of the uppermost water mass at the southern sites (Masada-100 and around P-8) suggests some halite dissolution.

Figures 2–4 exhibit the temperature and salinity profiles taken on 18.III.92 and 4.V.92 along with the 5.VIII.91 reference profiles. The temperature profiles show a pronounced heating of the diluted upper water layer between March and May 1992: from a cold layer on 18.III.92 of 22 m with temperature increasing with depth from <20 °C at the surface to >22 °C at 20 m, to a warm upper layer on 4.V.92, with temperature decreasing from >32 °C at the surface to about 23 °C at 47 m (Fig. 3). A slight temperature decrease (<1 °C) is observed between August 1991 and March 1992 (Figs. 2 and 3).

The upper layer is expected to deepen only slightly in the coming months. However, its high dilution factor is expected to prevent overturning of the whole water column for at least 2–3 years.

ACKNOWLEDGMENT

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