

NOTES AND COMMENT

REDEFINITION OF SALINITY¹

Two definitions of salinity have been in use since the early part of this century (Knudsen 1901; Forch, Knudsen and Sørensen 1902). The procedural definition is that salinity is the amount (in grams) of dissolved solid material in a kilogram of seawater after all the bromine has been replaced by an equivalent quantity of chlorine, all the carbonate converted to oxide, and all of the organic matter destroyed. In practice, this procedure is difficult to carry out with high precision, and an empirical relation between salinity and chlorinity has been used as a working definition:

$$S‰ = 0.030 + 1.8050 Cl‰. \quad (1)$$

This relation is useful because of the relative constancy of proportions of the major constituents of seawater, and because of the availability of a precise chemical method for determining chlorinity. However, it is based on only nine salinity determinations; the constant 0.030 results from the use of water from the Baltic Sea for the low concentrations. Carritt and Carpenter (1959) have estimated that the uncertainty of a computed value of salinity from a measured value of chlorinity using this relation can be as much as 0.04‰, owing to variations in the composition of seawater.

With the development of precise methods for measuring the electrical conductivity of seawater to a precision of 1 in 10^5 , it became possible to consider a new definition of salinity based on conductivity. Accordingly, Roland Cox undertook an extensive investigation of the conductivity/chlorinity relationship, using a large number of seawater samples from all parts of the world ocean; the results of this research are described by Cox, Culkin, and Riley (1967). To supervise the preparation of oceanographic tables based on these investigations, an international Joint Panel

on Oceanographic Tables and Standards was established by UNESCO, the International Council for the Exploration of the Sea (ICES), the Scientific Committee on Oceanic Research (SCOR), and the International Association for the Physical Sciences of the Ocean (IAPSO).

In October 1966, *International Oceanographic Tables* were published jointly by UNESCO and the National Institute of Oceanography of Great Britain (Joint Panel on Oceanographic Tables and Standards 1966). These tables contain a new definition of salinity, as discussed below. At the same time, ICES urged all oceanographers to use only these tables in the future for computing salinity of seawater from conductivity. In October 1967, IAPSO endorsed the *Tables* and the definition of salinity and the relation between salinity and chlorinity contained therein, recommended their use by oceanographers, and recommended that all oceanographic data reports henceforth should include an explicit statement of the particular tables used to establish the values of salinity reported. In the same month, the salinity definition was endorsed by the Executive Committee of SCOR.

In preparing the *Tables*, the following arbitrary relation between salinity and chlorinity was used:

$$S‰ = 1.80655 Cl‰. \quad (2)$$

This relation is compatible with expression (1) with respect to older data of lower precision, such as those resulting from chlorinity titrations, giving identical results at salinity 35‰ and differing by only 0.026‰ at salinities 32 and 38‰.

The relation between salinity and conductivity ratio² was based on precise deter-

¹ This notice will be published in a number of journals, to give wide distribution to the new definition.—EDITOR.

² Conductivity ratio, R_t , is the ratio of the conductivity of a water sample to that of water having a salinity of exactly 35‰, both samples being at the same temperature (15C for R_{15}) and under a pressure of one standard atmosphere.

minations of chlorinity and R_{15} on 135 natural seawater samples, all collected within 100 m of the surface, and including samples from all oceans and the Baltic, Black, Mediterranean, and Red Seas. After chlorinity was converted to salinity, using expression (2), the following polynomial was computed by least squares:

$$S\text{‰} = -0.08996 + 28.29720 R_{15} \\ + 12.80832 R_{15}^2 - 10.67869 R_{15}^3 \\ + 5.98624 R_{15}^4 - 1.32311 R_{15}^5. \quad (3)$$

The root mean square deviation between a single point and the line was 0.002‰ in chlorinity for samples having chlorinity above 15‰ and 0.005‰ for lower concentrations. Because of the variable composition of the diluting river water, the estimation of salinity is less precise in regions such as estuaries and the surface layers of the Baltic Sea. There is also evidence that for deep oceanic waters (below 2,000 m), the mean salinity from chlorinity is about 0.003‰ lower than that from conductivity (Cox et al. 1967).

Expression (3) constitutes the recommended definition of salinity. The *International Oceanographic Tables* include a tabulation of this expression for conductivity ratios R_{15} from 0.85000 to 1.17999 (at intervals of 0.00001) and salinities from 29.196 to 42.168‰, along with correction tables for measurements at other temperatures. Recently, new tables connecting refractive index anomaly with salinity have been added (from the measurements of Rusby 1967).

The conductivity method is now in widespread general use for the estimation of salinity, and the redefinition of salinity is

required for its use. On behalf of the international organizations that have endorsed the new salinity definition and the associated tables, we would like to encourage their use by all oceanographers.

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ON THE MICROSCOPIC DETERMINATION OF THE VOLUME SIZE DISTRIBUTION OF FINE-GRAINED SUSPENDED PARTICLES¹

Samples of fine-grained suspended solids from natural waters are frequently collected on cellulose membrane filters for the

determination of the particle size distribution by microscopy and of the concentration of the suspended solids by weighing.

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