Deuterium Content of the U. S. National Bureau of Standards Isotope Reference Samples

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(Received October 30, 1959)

Recently, there are many reports on the mass spectrometric determination of

natural abundance of deuterium in fresh and marine water. The authors have also measured deuterium content of marine water in the West Pacific and in the Antarctic and of spring water samples in Japan, using the Tokyo tap water collected on May 17, 1957 as the working standard. For the comparison of the authors' results with others, it was necessary to determine the absolute deuterium content of their working standard precisely.

Five standard water samples of known deuterium content were prepared by diluting heavy water sample with the Tokyo tap distilled water and protium oxide, and their deuterium content is shown in the second column of Table I. This method is similar to that described by Kirshenbaum[1]. A sample of water (about 20 mg.) was converted into hydrogen gas by means of modified zinc method[2]. A deuterium mass spectrometer of 60° sector type was used, and $(HD)/(H_2)$ ratio was determined by plotting the ratio of $M/e=3$ to $M/e=2$ against H_2 ion current, and extrapolating to zero H_2 ion current (zero pressure). The order of analyses on the mass spectrometer was standard water, working standard, working standard, and the same standard water. The results are summarized in Table I.

TABLE I. DEUTERIUM CONTENT OF THE STANDARD TOKYO TAP WATER (WORKING STANDARD)

Standard		Standard Tokyo tap water D atom %
Sample No.	Deuterium content	
5	0.0149	$0.0148_7+0.00006$*
9	0.0139	$0.0149_0\pm0.00008$
14	0.0169	$0.0149_5\pm0.00008$
15	0.0153	$0.0149_2\pm0.00003$
16	0.0109	$0.0148_2\pm0.00008$
	Mean	$0.0148_9\pm0.00005$**

* Average deviation.
** Probable error.

TABLE II. DEUTERIUM CONTENT OF THE U. S. NATIONAL BUREAU OF STANDARDS REFERENCE SAMPLES

Sample*	Deviation from the standard Tokyo tap water, %	SMOW-scale	D atom %
No. 1 (NBS-1)	$+0.21\pm0.16$	-4.76	$0.0149_3\pm0.0001$
No. 1A (NBS-1A)	-13.95 ± 0.12	-18.22	$0.0128_3\pm0.0001$
Difference	14.16	13.46	

* Sample No. 1: steam condensate from the Potomac River water. No. 1A: snow water from Yollowstone.

The deuterium content of the reference samples of isotopic abundance supplied by the U. S. National Bureau of Standards was measured, using the same Tokyo tap water as the working standard. The results are shown in Table II, together with the value expressed in SMOW-scale suggested by Craig[3]. Difference of the deuterium content between two reference samples is 14.16%, which is 13.46 in SMOW-scale. Craig also pointed out that the relative enrichments of NBS-1A to NBS-1 $[(R_{1A}-R_1)/R_1\times100]$ measured by him and by the authors are as follows:

The authors	Craig
-14.13 ± 0.23	-14.25 ± 0.25

The numbers agree perfectly within the uncertainties indicated above[3].

The value given by Friedman in Mohler's list[4] is -15.33, which is a little larger than the authors', but the reason for the discrepancy is not clear.

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1) I. Kirshenbaum, "Physical Properties and Analysis of Heavy Water", McGraw-Hill Book Co., Inc., New York (1951), p. 382.
2) T. Titani, Y. Horibe and M. Kobayakawa, *Mass Spectroscopy (Shitsuryo Bunseki)*, **6**, 27 (1956).
3) H. Craig, private communication.
4) F. L. Mohler, "Reference Samples of Isotopic Abundance. Revised List", U. S. National Bureau of Standards, Washington (1957).