United States Geological Survey

Reston Stable Isotope Laboratory

Report of Stable Isotopic Composition

Reference Material NBS 1a

(Hydrogen and Oxygen Isotopes in Water)

This reference material (RM) is intended for daily normalization of stable hydrogen-isotope (δ^2H) and oxygen-isotope (δ^{18}O) measurements of unknown waters with an isotope-ratio mass spectrometer or a laser absorption spectrometer. A unit of this RM consists of one 50-mL glass ampule of snow meltwater from Yellowstone, Wyoming [1,2]. It was identified as NBS 1A by Gonfiantini [3] and Coplen and others [4].

Recommended Values: Stable hydrogen and oxygen isotopic compositions are expressed herein as delta values [5] relative to VSMOW (Vienna Standard Mean Ocean Water) on scales normalized such that the δ^2H and δ^{18}O values of SLAP (Standard Light Antarctic Precipitation) are –428 ‰ and –55.5 ‰, respectively [3,6]. Each stable isotopic composition is given as a reference isotope-delta value with its standard deviation.

Stable hydrogen isotopic composition:	$\delta^2H_{VSMOW\text{-}SLAP} = -183.2 \pm 0.7$ ‰ (n = 24)	[3]
Stable oxygen isotopic composition:	$\delta^{18}O_{VSMOW\text{-}SLAP} = -24.36 \pm 0.03$ ‰ (n = 4)	[4]

Technical coordination for this RM was provided by Haiping Qi of the Reston Stable Isotope Laboratory (RSIL).

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Expiration of Reference Value: The reference values for the isotopic composition of NBS 1a are valid until December 31, 2049, provided the RM is handled in accordance with the instructions given in this Report of Stable Isotopic Composition (see "Instructions for Use"). A reference value is nullified if the glass ampule containing the RM is inadvertently broken.

Source of the RM: NBS 1a snow meltwater from Yellowstone, Wyoming was sealed in 50-mL ampules by the National Bureau of Standards (now National Institute of Standards and Technology, NIST) [1,2].

Stability: NBS 1a is stable at normal room temperatures. The reference values in this Report of Investigation apply only to freshly opened ampoules.

Instructions for Use: This RM is intended for calibration of instrumentation and for calibrating unknown waters by interspersing aliquots of the RM among water sample unknowns. The unused fraction of this RM should be stored carefully in a glass vial having a conical insert cap to minimize evaporation and resulting isotopic fractionation.

Reporting of Stable-isotope-delta Values: The following recommendations are provided for reporting stable hydrogen and oxygen isotope-delta values [6]. It is recommended that:

- The δ^2H values of all hydrogen-bearing substances be expressed relative to VSMOW-SLAP on a scale where the δ^2H of SLAP = –428 ‰ exactly.
- The δ^{18}O values of all oxygen-bearing substances be expressed relative to VSMOW-SLAP or relative to Vienna Peedee belemnite (VPDB; for carbonates) on a scale such that the δ^{18}O of SLAP = –55.5 ‰ relative to VSMOW, and for carbonates, such that δ^{18}O of NBS 19 calcium carbonate = –2.2 ‰.
- Authors report delta values of international distributed (secondary) isotopic reference materials as though they had been interspersed among and used for normalization of unknowns, as appropriate, for the measurement method. In this manner, measurement results can be adjusted in the future as analytical methods improve and consensus values of internationally distributed isotopic reference materials change.
- Reporting of delta values relative to SMOW and PDB (Peedee belemnite) be discontinued [7].

REFERENCES

[1] Mohler, F. L., 1955, Reference Samples of Isotopic Abundance: Science, v. 122(3164), p. 334–335. https://doi.org/10.1126/science.122.3164.334

[2] Mohler, F. L. 1960, Isotopic Abundance Ratios Reported for Reference Samples Stocked by the National Bureau of Standards. National Bureau of Standards (USA), Technical Note No. 51, 8 p. https://www.govinfo.gov/app/details/GOVPUB-C13-ca35d631c91738e9d9d24459191efcc2

[3] Gonfiantini, R., 1978, Standards for stable isotope measurements in natural compounds: Nature, v. 271, p. 534–536. https://doi.org/10.1038/271534a0

[4] Coplen, T. B., Kendall, C., and Hopple, J., 1983, Comparison of stable isotope reference samples: Nature, v. 302, p. 236–238. https://doi.org/10.1038/302236a0
[5] Coplen, T. B., 2011, Guidelines and recommended terms for expression of stable-isotope-ratio and gas-ratio measurement results: Rapid Communications in Mass Spectrometry, v. 25(17), p. 2538–2560. https://doi.org/10.1002/rcm.5129
[6] Coplen, T. B., 1994, Reporting of stable hydrogen, carbon, and oxygen isotopic abundances: Pure and Applied Chemistry, v. 66(2), p. 273–276. https://publications.iupac.org/pac/pdf/1994/pdf/6602x0273.pdf
[7] Coplen, T. B., 1995, Discontinuance of SMOW and PDB: Nature, v. 375, p. 285. https://doi.org/10.1038/375285a0