National Institute of Standards & Technology

Report of Investigation

Reference Material 8546

NBS28

(Silicon and Oxygen Isotopes in Silica Sand)

This Reference Material (RM) defines the NBS28 scale for isotope-number ratios of silicon (Si). It is also used in developing and validating methods for measuring relative differences in isotope-number ratios of oxygen (O) in silicates. The equivalent name for this RM used by the International Atomic Energy Agency (IAEA) and the U.S. Geological Survey (USGS) is NBS28. A unit of RM 8546 consists of one bottle containing approximately 0.4 g of silica sand (optical).

Reference Values: While the values for this RM (see Table 1) are either defined or reference values, its widespread use permits comparability of data from different laboratories. A reference value is a non-certified value that is the best estimate of the true value; however, the value may reflect only the measurement precision and may not include all sources of uncertainty [1].

Table 1. Reference Values for the Relative Si and O Isotope-Number Ratios of RM 8546

IAEA Name	$10^3\ \delta^{29}Si_{NBS28}$[(a)]	$10^3\ \delta^{30}Si_{NBS28}$[(a)]	$10^3\ \delta^{18}O_{VSMOW}$[(b)]	*Standard Deviation* $10^3\ \delta^{18}O_{VSMOW}$[(b)]
NBS28	0 exact	0 exact	+ 9.58	± 0.09

[(a)] The $\delta^{29}Si_{NBS28}$ and $\delta^{30}Si_{NBS28}$value are exact values that define the zero of the NBS28 scale for Si isotopes [2].

[(b)] The $\delta^{18}O_{VSMOW}$ value is value is expressed as a consensus mean and a standard deviation (n = 8) [3]. (Vienna Standard Mean Ocean Water: VSMOW)

Expiration of Value Assignment: RM 8546 is valid indefinitely, within the measurement uncertainty specified, provided the RM is handled and stored in accordance with instructions given in this Report of Investigation (see "Instructions for Handling, Storage, and Use"). Periodic validation of this RM is not required. The reference values are nullified if the RM is damaged, contaminated, or otherwise modified.

Maintenance of RM: NIST will monitor this RM over the period of its validity. If substantive technical changes occur that affect the value assignment before the expiration of this report, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

The technical aspects involved in the issuance of this RM were coordinated through the NIST Chemical Sciences Division by R.D. Vocke, Jr.

Support aspects involved in the issuance of this RM were coordinated through the NIST Office of Reference Materials.

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Robert L. Watters, Jr., Director
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Reference Values for the Relative Difference in Isotope-Number Ratios: The differences in measured isotope-number ratios of stable silicon isotopes [$N(^{29}Si)/N(^{28}Si)$], [$N(^{30}Si)/N(^{28}Si)$] and stable oxygen isotopes [$N(^{18}O)/N(^{16}O)$] are reported as $\delta^{29}Si$, $\delta^{30}Si$, and $\delta^{18}O$ values, respectively. The relative difference in isotope-number ratios for silicon and oxygen are defined as:

$$\delta^{29}Si = ([N(^{29}Si)_{sample}/N(^{28}Si)_{sample}] - [N(^{29}Si)_{NBS28} / N(^{28}Si)_{NBS28}]) / [N(^{29}Si)_{NBS28} / N(^{28}Si)_{NBS28}]$$

$$\delta^{30}Si = ([N(^{30}Si)_{sample}/N(^{28}Si)_{sample}] - [N(^{30}Si)_{NBS28} / N(^{28}Si)_{NBS28}]) / [N(^{30}Si)_{NBS28} / N(^{28}Si)_{NBS28}]$$

$$\delta^{18}O = ([N(^{18}O)_{sample}/N(^{16}O)_{sample}] - [N(^{18}O)_{VSMOW} / N(^{16}O)_{VSMOW}]) / [N(^{18}O)_{VSMOW} / N(^{16}O)_{VSMOW}]$$

NBS28 refers to the silicon δ scale, which is defined by assigning $\delta^{29}Si$ and $\delta^{30}Si$ values of 0 (exact) to NBS28 Silica Sand (RM 8546).

VSMOW refers to the Vienna SMOW oxygen δ scale, which is defined by assigning a $\delta^{18}O$ value of 0 to VSMOW2 (RM 8535a).

INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

Distribution: The distribution of RM 8546 (NBS28) is limited to one unit per customer per three-year period of time.

Storage and Stability: RM 8546 is stable at normal room temperatures. To minimize the potential for contamination, it is recommended that this RM be stored in the container in which it is supplied.

SOURCE, PREPARATION, AND ANALYSIS[(1)]

Sample Preparation: RM 8546 (NBS28) was obtained by I. Friedman (USGS) from the Corning Glass Company. The material was washed with acid to remove impurities and the fraction between 100 μm and 177 μm was separated and packaged.

Analytical Methods: The reference value for the $\delta^{18}O$ of RM 8546 (NBS28) is a consensus mean involving eight independent measurements as reported at the 1993 IAEA Consultants' Group Meeting on Stable Isotope Reference Samples [3].

The relative difference in isotope-number ratios for Si and O reported in Table 1 are the values accepted by the Commission on Isotopic Abundances and Atomic Weights of the International Union of Pure and Applied Chemistry (http://ciaaw.org/silicon.htm (accessed Mar 2015) and http://ciaaw.org/oxygen.htm (accessed March 2015), respectively) for this RM as of the date of this Report.

Reporting of Stable Isotope δ Values: Authors should state the $\delta^{30}Si$ and $\delta^{18}O$ values of other internationally distributed isotopic reference materials similar to RM 8546 (NBS28) which have been interspersed among their unknowns.

[(1)] Certain commercial equipment, instrumentation, or materials are identified in this report to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the NIST, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

REFERENCES

[1] May, W.E.; Parris, R.M.; Beck II, C.M.; Fassett, J.D.; Greenberg, R.R.; Guenther, F.R.; Kramer, G.W.; Wise, S.A.; Gills, T.E.; Colbert, J.C.; Gettings, R.J.; MacDonald, B.S.; *Definitions of Terms and Modes Used at NIST for Value-Assignment of Reference Materials for Chemical Measurements*; NIST Spec. Pub. 260-136, U.S. Government Printing Office: Washington, DC, (2000); available at http://www.nist.gov/srm/upload/SP260-136.PDF (accessed Mar 2015).

[2] Coplen, T.B.; Böhlke, J.K.; De Bièvre, P.; Ding, T.; Holden, N.E.; Hopple, J.A.; Krouse, H.R.; Lamberty, A.; Peiser, H.S.; Revesz, K.; Rieder, S.E.; Rosman, K.J.R.; Roth, E.; Taylor, P.D.P.; Vocke, Jr., R.D.; Xiao, Y.K.; *Isotope-Abundance variations of Selected Elements*; Pure Appl. Chem., Vol. 74, pp. 1987-2002 (2002); available at http://ciaaw.org/pubs/SNIF.pdf (accessed Mar 2015).

[3] Gonfiantini, R.; Stichler, W.; Rozanski, K.; *Standards and Intercomparison Materials Distributed by the International Atomic Energy Agency for Stable Isotope Measurements*, in reference and intercomparison materials for stable isotopes of light elements, Vienna, Austria, International Atomic Energy Agency, IAEA-TECDOC-825, p. 13-29 (1995).

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