



Report of Investigation

Reference Material 8544

NBS19 Limestone

(Carbon and Oxygen Isotopes in Carbonate)

This Reference Material (RM) defines the Vienna Pee Dee Belemnite (VPDB) scale for isotope-number ratios of carbon (C). It also defines the VPDB scale for isotope-number ratios of oxygen (O) in carbonates. The equivalent name for this RM, as used by the International Atomic Energy Agency (IAEA) and the U.S. Geological Survey (USGS), is NBS19 and is listed in column 1 of Table 1. This material was also formerly called TS Limestone. A unit of RM 8544 consists of one bottle containing approximately 0.4 g of carbonate.

Table 1. Reference Values for the Relative C and O Isotope-number Ratios

Name	$10^3 \delta^{13}\text{C}_{\text{VPDB}}^{(a)}$	$10^3 \delta^{18}\text{O}_{\text{VPDB}}^{(a)}$	$10^3 \delta^{18}\text{O}_{\text{VSMOW}}^{(b)}$
NBS19	+1.95 exact	-2.2 exact	+28.65

^(a) The $\delta^{13}\text{C}_{\text{VPDB}}$ and $\delta^{18}\text{O}_{\text{VPDB}}$ values are exact values that form the basis for the VPDB scales for C and O and were set at an international consultants' meeting at the IAEA in 1984 [1].

^(b) This value is calculated from data in [2] using the relationship between VPDB and VSMOW on page 36 in [3].

Reference Difference in Isotope-Number Ratio Values: The differences in measured isotope-number ratios of stable carbon isotopes [$N(^{13}\text{C})/N(^{12}\text{C})$] are reported as $\delta^{13}\text{C}$ values, where:

$$\delta^{13}\text{C} = ([N_{\text{sample}}(^{13}\text{C})/N_{\text{sample}}(^{12}\text{C})] - [N_{\text{VPDB}}(^{13}\text{C})/N_{\text{VPDB}}(^{12}\text{C})]) / [N_{\text{VPDB}}(^{13}\text{C})/N_{\text{VPDB}}(^{12}\text{C})]$$

VPDB refers to the Vienna PDB scale, which is determined by assigning a $\delta^{13}\text{C}$ value of +1.95 ‰ to this RM [1,4].

The differences in measured isotope-number ratios of stable oxygen isotopes [$N(^{18}\text{O})/N(^{16}\text{O})$] in carbonates are reported as:

$$\delta^{18}\text{O}_{\text{VPDB}} \text{ values, where } \delta^{18}\text{O} = ([N_{\text{sample}}(^{18}\text{O})/N_{\text{sample}}(^{16}\text{O})] - [N_{\text{VPDB}}(^{18}\text{O})/N_{\text{VPDB}}(^{16}\text{O})]) / [N_{\text{VPDB}}(^{18}\text{O})/N_{\text{VPDB}}(^{16}\text{O})].$$

VPDB refers to the Vienna PDB scale, which is determined by assigning a $\delta^{18}\text{O}$ value of -2.2 ‰ to this RM [1,4].

Expiration of Value Assignment: **RM 8544** is valid, within the measurement uncertainty specified, until **31 December 2020**, provided the RM is handled and stored in accordance with instructions given in this Report of Investigation (see "Instructions for Handling, Storage, and Use"). The reference values are nullified if the RM is damaged, contaminated, or otherwise modified.

Maintenance of RM Certification: 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) will facilitate notification.

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

Support aspects involved in the issuance of this RM were coordinated through the NIST Measurement Services Division.

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INSTRUCTIONS FOR HANDLING, STORAGE, AND USE

Distribution: The distribution of RM 8544 (NBS19) is limited to one unit per three-year period of time.

Storage and Stability: RM 8544 is stable at normal room temperatures. To minimize the potential for oxygen isotope exchange between carbonate and atmospheric water, this RM can be stored in a desiccator.

REFERENCES

- [1] Hut, G.; *Consultants' Group Meeting on Stable Isotope Reference Samples for Geochemical and Hydrological Investigations* (September 1985); IAEA, Vienna, Austria, pp. 16-18 (1987).
- [2] Verkouteren, R.M.; Klinedinst, D.B.; *Value Assignment and Uncertainty Estimation of Selected Light Stable Isotope Reference Materials: RMs 8543-8545, RMs 8562-8564, and RM 8566*, NIST Special Publication pp. 260-149; U.S. Government Printing Office: Washington, DC (2004); available at <http://www.nist.gov/srm/publications.cfm>.
- [3] Coplen, T.B.; Hopple, J.A.; Böhlke, J.K.; Peiser, H.S.; Rieder, S.E.; Krouse, H.R.; Rosman, K.J.R.; Ding, T.; Vocke, Jr., R.D.; Révész, K.M.; Lamberty, A.; Taylor, P.; De Bièvre, P.; *Compilation of Minimum and Maximum Isotope Ratios of Selected Elements in Naturally Occurring Terrestrial Materials and Reagents*; U.S. Geological Survey Water-Resources Investigations Report 01-4222, p. 98 (2001).
- [4] Coplen, T.B.; *Normalization of Oxygen and Hydrogen Isotope Data*; Chem. Geol. Vol. 72, pp. 293–297 (1988).

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