

# United States Geological Survey

## Reston Stable Isotope Laboratory

# Report of Stable Isotopic Composition

## Reference Material USGS24

### (Carbon Isotopes in Graphite)

This reference material (RM) is intended for calibration of stable carbon ( $\delta^{13}\text{C}$ ) measurements of carbon-bearing substances with an elemental analyzer (EA) and an isotope-ratio mass spectrometer or laser absorption spectrometer. This RM consists of 0.8 g of USGS24 graphite. There is no limit on distribution. USGS24 was prepared by the Reston Stable Isotope Laboratory (RSIL) of the U.S. Geological Survey, Reston, Virginia [1]. This RM may also be available from the U.S. National Institute of Standards and Technology (NIST) [2] as RM 8541 or from the International Atomic Energy Agency (IAEA) [3].

**Recommended Values:** Stable carbon isotopic compositions are expressed herein as delta values [4] relative to VPDB (Vienna Peedee belemnite) on a scale normalized such that the  $\delta^{13}\text{C}$  values of NBS 19 calcium carbonate and LSVEC lithium carbonate are +1.95 ‰ and -46.6 ‰, respectively [5]. The  $\delta^{13}\text{C}$  value of USGS24 with expanded uncertainty is [5]:

$$\text{Reference value: } \delta^{13}\text{C}_{\text{VPDB-LSVEC}} = -16.05 \pm 0.07 \text{ ‰}$$

The uncertainty is an estimated expanded uncertainty ( $U = 2u_c$ ) about the reference value that provides an interval that has about a 95-percent probability of encompassing the true value [6]. The value of the consensus mean and the associated combined standard uncertainty were calculated using a multivariate Bayesian approach [5].

**Expiration of Reference Value:** The reference value for the isotopic composition of USGS24 is valid until December 31, 2029, provided the RM is handled in accordance with the instructions given in this Report of Stable Isotopic Composition (see “Instructions for Use”). The reference value is nullified if the RM is damaged, contaminated, or otherwise modified.

Technical coordination for this RM was provided by Haiping Qi of the RSIL.

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**Maintenance of RM Certification:** The Reston Stable Isotope Laboratory (RSIL) will monitor this RM over the period of its certification. The RSIL will notify the purchaser if substantive technical changes occur that affect the certification before the expiration of this report.

**Distribution and Stability:** USGS24 is stable at normal room temperatures. The RSIL has monitored this RM for a period of twenty years, and no change in isotopic composition has been observed. To minimize the potential for contamination, it is recommended that this RM be stored in the container in which it is supplied.

**Instructions for Use:** USGS24 can be interspersed among every 10–15 samples. Ideally, users also may choose to use USGS40 L-glutamic acid, along with USGS41 L-glutamic acid, which is enriched in  $^{13}\text{C}$  and  $^{15}\text{N}$ , to make isotope-ratio-scale adjustments. A pair of USGS40 and USGS41 RMs can be used at the beginning, the middle, and the end of the analysis sequence to enable satisfactory scale correction and correction of drift with time.

**Reporting of Stable-isotope-delta Values:** The following recommendations are provided for reporting stable carbon isotope-delta values. It is recommended that:

- The  $\delta^{13}\text{C}$  values of all carbon-bearing substances be expressed relative to VPDB-LSVEC on a scale such that the  $\delta^{13}\text{C}$  values of NBS 19 calcium carbonate and LSVEC lithium carbonate are +1.95 ‰ and –46.6 ‰, respectively [5,7].
- 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. Improved, recommended values of USGS24 are posted on the Web site of the Commission on Isotopic Abundances and Atomic Weights of the International Union of Pure and Applied Chemistry [8].
- Reporting of  $\delta^{13}\text{C}$  values relative to PDB (Peedee belemnite) be discontinued [9].

## REFERENCES

- [1] Stichler, W., 1995, Interlaboratory comparison of new materials for carbon and oxygen isotope ratio measurements, in Reference and intercomparison Materials for stable isotopes of light elements: Vienna, International Atomic Energy Agency, TECDOC-825, p. 67–74.
- [2] National Institute of Standards and Technology (NIST), <http://ts.nist.gov/measurementservices/referencematerials/index.cfm>
- [3] International Atomic Energy Agency (IAEA), <http://www.iaea.org/programmes/aqcs/>

- [4] 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, 2538–2560.
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- [6] ISO/IEC Guide 98-3:2008, Uncertainty of Measurement, Part 3: Guide to the expression of uncertainty in measurement (GUM: 1995).
- [7] Coplen, T. B., 1994, Reporting of stable hydrogen, carbon, and oxygen isotopic abundances: *Pure and Applied Chemistry*, v. 66, p. 273–276.
- [8] Commission on Isotopic Abundances and Atomic Weights of the International Union of Pure and Applied Chemistry, <http://www.ciaaw.org/>
- [9] Coplen, T. B., 1995, Discontinuance of SMOW and PDB: *Nature*, v. 375, 285.