USGS41 is discontinued. It is replaced by USGS41a [1] (https://www.usgs.gov/media/files/rsil-report-stable-isotopic-composition-reference-material-usgs41a), which has a higher chemical purity than USGS41.

United States Geological Survey

Reston Stable Isotope Laboratory

Report of Stable Isotopic Composition

Reference Material USGS41

(Carbon and Nitrogen Isotopes in L-glutamic Acid)

This reference material (RM) is intended for calibration of stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) measurements of unknown carbon- and nitrogen-bearing substances with an elemental analyzer (EA) and an isotope-ratio mass spectrometer by quantifying drift with time and quantifying isotope-ratio-scale contraction when used with USGS41 L-glutamic acid enriched in ^{13}C and ^{15}N [2]. This RM consists of 2 g of USGS41 L-glutamic acid [2]. There is no limit on distribution. USGS41 was prepared by the Reston Stable Isotope Laboratory (RSIL) of the U.S. Geological Survey, Reston, Virginia [2]. Technical coordination for this RM was provided by Haiping Qi of the RSIL.

Recommended Values: Stable carbon isotopic compositions are expressed herein as delta values [3] relative to VPDB (Vienna Peedee belemnite) on a scale normalized such that the $\delta^{13}C$ values of NBS 19 calcium carbonate and L-SVEC lithium carbonate are +1.95 ‰ and –46.6 ‰, respectively [4]. Stable nitrogen isotopic compositions are expressed relative to atmospheric nitrogen, which is isotopically homogenous [5]. Stable carbon isotopic [4] and nitrogen isotopic [2] compositions with combined uncertainties [2] of USGS41 are:

Stable carbon isotopic composition :	$\delta^{13}C_{VPDB\text{-}LSVEC} = +37.63 \pm 0.05$ ‰
Stable nitrogen isotopic composition:	$\delta^{15}N_{AIR} = +47.57 \pm 0.11$ ‰

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

Reston, Virginia 20192
September 11, 2026

Tyler B. Coplen, Director
Reston Stable Isotope Laboratory

Expiration of Reference Value: The reference value for the isotopic composition of USGS41 is valid until December 31, 2034, 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.

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: USGS41 is stable at normal room temperatures. The RSIL has monitored this RM for a period of eight 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: Ideally, users may choose to use USGS40, along with USGS41 L-glutamic acid, which is enriched in ^{13}C and ^{15}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. These RMs should be interspersed among every 10–15 unknowns. Over several years, measurements on USGS41 by the RSIL and other laboratories have shown that the mass fractions of carbon and nitrogen of USGS41 consistently are higher than those of USGS40. There is about 2.8 % excess carbon and 2.5 % excess nitrogen in USGS41 as compared to USGS40. The higher mass fraction of carbon and nitrogen in USGS41 was likely caused by the heating process during preparation of USGS41. The estimated mass fractions of carbon and nitrogen of USGS41 are 41.9 % and 9.76 %, respectively. Thus, USGS41 should not be used to quantify the mass fractions of carbon and nitrogen of unknowns; rather, USGS40 should be used for this purpose.

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

- The $\delta^{13}C$ values of all carbon-bearing substances be expressed relative to VPDB-LSVEC on a scale such that the $\delta^{13}C$ values of NBS 19 calcium carbonate and LSVEC lithium carbonate are +1.95 ‰ and –46.6 ‰, respectively [4], even though LSVEC is no longer recommended as a RM for $\delta^{13}C$ measurement [6].
- The $\delta^{15}N$ values of all nitrogen-bearing substances be expressed relative to atmospheric nitrogen [5].
- 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] Qi, H., Coplen, T. B., Mroczkowski, S. J., Brand, W. A., Brandes, L., Geilmann, H., and Schimmelmann A., 2016, A new organic reference material, L-glutamic acid, USGS41a for $\boldsymbol{\delta}^{13}C$ and $\boldsymbol{\delta}^{15}N$ measurements − a replacement for USGS41: Rapid Communications in Mass Spectrometry, v. 30(7), p. 859–866. https://doi.org/10.1002/rcm.7510

[2] Qi, H., Coplen, T. B., Geilmann, H., Brand, W. A., and Böhlke, J. K., 2003, Two new organic reference materials for $\delta^{13}C$ and $\delta^{15}N$ measurements and a new value for the $\delta^{13}C$ of NBS 22 oil: Rapid Communications in Mass Spectrometry, v. 17(22), p. 2483–2487. https://doi.org/10.1002/rcm.1219

[3] 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

[4] Coplen, T. B., Brand, W. A., Gehre, M., Gröning, M., Meijer, H. A. J., Toman, B., and Verkouteren, R. M., 2006, New guidelines for $\delta^{13}C$ measurements: Analytical Chemistry, v. 78(7), p. 2439–2441. https://doi.org/10.1021/ac052027c

[5] Mariotti, A., 1983, Atmospheric nitrogen is a reliable standard for natural ^{15}N abundance measurements: Nature, v. 303, p. 685–687. https://doi.org/10.1038/303685a0

[6] Assonov, S., 2018, Summary and recommendations from the International Atomic Energy Agency Technical Meeting on the development of stable isotope reference products (21-25 November 2016): Rapid Communication in Mass Spectrometry, v. 32(10), p. 827−830. https://doi.org/10.1002/rcm.8102

[7] Coplen, T. B., 1995, Discontinuance of SMOW and PDB: Nature, v. 375, p. 285. https://doi.org/10.1038/375285a0

.