

United States Geological Survey

Reston Stable Isotope Laboratory

Report of Stable Isotopic Composition

Reference Materials USGS51 and USGS52 (Nitrogen and Oxygen Isotopes in Nitrous Oxide, N₂O)

These reference materials (RMs) are intended for normalizing stable nitrogen ($\delta^{15}\text{N}$) and oxygen ($\delta^{18}\text{O}$) relative isotope-ratio measurements of unknown nitrous oxide (N₂O) samples [1,2]. A unit of USGS51 and USGS52 consists of approximately 200 μmol N₂O sealed in a 6-mm borosilicate tube. These RMs were prepared by the Reston Stable Isotope Laboratory (RSIL) of the U.S. Geological Survey using the same high vacuum line used to prepare NBS 16 and NBS 17 carbon dioxide [3]. Previously, USGS51 and USGS52 were known as N-51 and R-6, respectively.

Recommended values: Stable nitrogen isotopic compositions are expressed herein as delta values [4] relative to atmospheric nitrogen, which is isotopically homogenous [5]. On this scale, the $\delta^{15}\text{N}_{\text{AIR}}$ value of USGS32 KNO₃ has a consensus value of +180 ‰ exactly, and that of IAEA-NO-3 is +4.7 ‰ [6,7]. Stable oxygen isotopic compositions are expressed herein as delta values relative to VSMOW (Vienna Standard Mean Ocean Water) on a $\delta^{18}\text{O}$ scale normalized such that the $\delta^{18}\text{O}$ value of SLAP (Standard Light Antarctic Precipitation) is -55.5 ‰ [8]. In Ostrom and others [1,2], only the Tokyo Institute of Technology (Laboratory 1 in Table 2) calibrated USGS51 and USGS52 through decomposition of ammonium nitrate. Therefore, Ostrom and others [1] indicate that the complete the complete set of values reported by Laboratory 1, presented below, can be used provisionally for normalizing N₂O isotopic measurements to improve interlaboratory consistency.

Preliminary isotopic compositions of USGS51 and USGS52 nitrous oxide reference materials
[The superscripts α and β refer to the central and outer N atom in N₂O respectively. Site preference (S_p) is the difference between $\delta^{15}\text{N}^\alpha$ and $\delta^{15}\text{N}^\beta$ [9].]

Name	$\delta^{15}\text{N}_{\text{AIR}}$	$\delta^{15}\text{N}^\alpha_{\text{AIR}}$	$\delta^{15}\text{N}^\beta_{\text{AIR}}$	$\delta^{18}\text{O}_{\text{VSMOW-SLAP}}$	S_p	Data source
USGS51	+1.32 ± 0.04 ‰	+0.48 ± 0.09 ‰	+2.15 ± 0.12 ‰	+41.23 ± 0.04 ‰	-1.67 ‰	[1,2]
USGS52	+0.44 ± 0.02 ‰	+13.52 ± 0.04 ‰	-12.64 ± 0.05 ‰	+40.64 ± 0.03 ‰	+26.15 ‰	[1,2]

Expiration of Reference Value: The reference values for the isotopic compositions of USGS51 and USGS52 are valid until December 31, 2029 or until they are re-evaluated, provided these RMs are 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 RM is damaged, contaminated, or otherwise modified.

Maintenance of RM certification: The Reston Stable Isotope Laboratory (RSIL) will monitor these RMs. The RSIL will notify the purchaser if substantive technical changes are observed that affect the stable nitrogen or oxygen isotopic compositions over time.

Distribution and Stability: Units of USGS51 and USGS52 are supplied in 6-mm borosilicate glass tubes. Once opened, the contents should be used for stable isotope normalization

Instructions for Use: These RMs can be opened with a glass-tube breaker [10–13].

Reporting of stable-isotope-delta values: The following recommendations are provided for reporting stable oxygen and nitrogen isotope-delta values:

- The $\delta^{18}\text{O}$ values of all oxygen-bearing substances should be expressed relative to VSMOW-SLAP on a scale where $\delta^{18}\text{O}_{\text{SLAP}} = -55.5 \text{ ‰}$ exactly [8,14].
- The $\delta^{15}\text{N}$ values of all nitrogen-bearing substances should be expressed relative to atmospheric nitrogen gas (N_2) [5].
- Authors should report δ values of internationally distributed (secondary) isotopic reference materials that were assumed for normalization of data for samples of similar chemical composition, 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. Thus, for reporting isotope-delta values of nitrous oxide samples, the USGS51 and USGS52 values used or assumed for normalization should be included in publications. In this manner, readers can re-normalize measurement results to current values of USGS51 and USGS51 as they are improved with new techniques. Improved values are posted on the Web site of the RSIL (<http://isotopes.usgs.gov/lab/referencematerials.html>).
- Reporting of $\delta^{18}\text{O}$ values relative to SMOW should be discontinued [15].

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