

NITROGEN ISOTOPE COMPOSITION OF AMINO ACIDS IN BENNU SAMPLES.

OPHELIE MCINTOSH¹, ALLISON A BACZYNSKI¹, MILA
MATNEY¹, HANNAH L. MCLAIN², KENDRA
FARNSWORTH³, JASON P. DWORKIN⁴, DANIEL P.
GLAVIN⁴, JAMIE E. ELSILA⁴, CHRISTOPHER H. HOUSE⁵,
KATHERINE H. FREEMAN⁶, HAROLD C. CONNOLLY JR.⁷
AND DANTE S. LAURETTA⁸

¹Penn State

²Catholic University of America

³University of Maryland

⁴NASA Goddard Space Flight Center

⁵NfOLD Laboratory for Agnostic Biosignatures, Georgetown
University

⁶The Pennsylvania State University

⁷American Museum of Natural History

⁸University of Arizona

Samples collected from the carbonaceous B-type asteroid Bennu and delivered to Earth by the OSIRIS-REx mission provide a pristine record of the chemical processes that occurred in the early solar system [1]. Analysis of Bennu samples identified 33 amino acids with a combined abundance of ~70 nmol/g [2]. Additionally, ammonia, a potential precursor for the synthesis of amino acids and other soluble organic molecules, was detected in high abundance (~13.6 $\mu\text{mol/g}$) and enriched in ^{15}N ($+180 \pm 47\%$) [2]. The latter suggests that ammonia and possibly other nitrogen-containing soluble molecules formed in a cold molecular cloud or the outer regions of the protoplanetary disk. To determine whether amino acids from Bennu have an interstellar provenance, we measured their ^{15}N isotope values.

Sample OREX-800107-183 (0.2697 g) was homogenized into a powder following an established protocol [3]. The amino acid enantiomers were derivatized [after 4], producing N,O-bis(trifluoroacetyl) methyl esters. Commercial standards of amino acid enantiomers were used as a reference for the isotopic measurements.

Full separation of the derivatized amino acid enantiomers allowed peak trapping [after 5] and measurement of the nitrogen isotopic composition. Gas chromatography–electron impact ionization Orbitrap mass spectrometry [6] resulted in $\delta^{15}\text{N}$ values for glycine ($+185 \pm 10\%$) and b-alanine ($+170 \pm 4\%$).

The enriched ^{15}N values confirm the extraterrestrial provenance and suggest formation from the ^{15}N -enriched ammonia ($+180 \pm 47\%$) [2]. Likely formation pathways are Strecker synthesis for glycine and Michael addition for b-alanine. These ^{15}N -rich values point to a low-temperature origin permitting stable ammonia ice. Thus, Bennu's parent body, or components thereof, likely formed beyond Jupiter's orbit.

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References: [1] Lauretta D.S. & Connolly H.C. Jr. et al.

(2024) *MAPS*, 59, 2453–2486. [2] Glavin D.P. & Dworkin J.P. et al. (2025) *Nat. Astron.*, 9, 199–210. [3] Elsila J. E. et al. (2012) *MAPS*, 47(9), 1517–1536. [4] Zeichner S. et al. (2022) Goldschmidt2022, doi: 10.46427/gold2022.12538. [5] Eiler J. M. et al. (2017) *Int. J. Mass Spectrom.*, 422, 126–142. [6] McIntosh O. et al. (2025) LPSC, 1123.