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Isotopes in the outer solar system as tracers of volatile origin and evolution

KATHLEEN MANDT[1], JACOB LUSTIG-YAEGER[2], DENNIS BODEWITS[3], STEPHEN FUSELIER[4], ADRIENN LUSPAY-KUTI[2], OLIVIER MOUSIS[5], KARLHEINZ TRATTNER[6] AND PETER WURZ[7]

[1]NASA Goddard Space Flight Center
[2]Johns Hopkins Applied Physics Laboratory
[3]Auburn University
[4]Southwest Research Institute
[5]Origins Institut, LAM, Aix Marseille University
[6]LASP, CU
[7]University of Bern

Presenting Author: kathleen.mandt@nasa.gov

Comparative planetology using isotope geochemistry has played a critical role in understanding processes at work in and of the history of outer Solar System bodies [see 1, and references therein]. The $^{12}C/^{13}C$ measured in methane on Titan has enabled us to determine the maximum length of time that methane has been present in the atmosphere [2,3], showing that methane has not been present in Titan's atmosphere throughout the history of the solar system and is limited to no more than 1 billion years (Gyr) [3]. Observations of $^{14}N/^{15}N$ in HCN and N_2 in the atmosphere of Titan provides direct evidence of how photochemistry influences stable isotopes [5,6] and helped us to determine that Titan's nitrogen originated as NH_3 in the protosolar nebula [7]. The lower limit observed for $^{14}N/^{15}N$ in HCN in Pluto's atmosphere [8] provides a valuable tool for determining the origin of nitrogen for Pluto [9] for which work is ongoing. Finally, D/H in solar system atmospheres and icy remnants of planet formation provides a powerful tool for mapping solar system ice composition and atmosphere evolution. We have conducted a thorough re-analysis of D/H and oxygen isotope measurements made by Rosetta at comet 67P/Churyumov-Gerasimenko evaluating fractionation processes on the surface and in the coma of comets that have implications for interpreting cometary D/H measurements.

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