SEARCH FOR SUGARS AND RELATED COMPOUNDS IN RESIDUES PRODUCED FROM THE UV IRRADIATION OF ASTROPHYSICAL ICE ANALOGS. M. Nuevo[1,2,*], S. A. Sandford[1], C. K. Materese[1,3], and G. W. Cooper[1]. [1]NASA Ames Research Center, Moffett Field, CA, USA; [2]BAER Institute, Petaluma, CA, USA; [3]ORAU, Oak Ridge, TN, USA. *E-mail: michel.nuevo-1@nasa.gov.

Introduction: A large variety and number of organic compounds of biological and prebiotic interests have been detected in meteorites, including a sugar and related compounds such as sugar acids and sugar alcohols [1]. The presence of these compounds in meteorites, along with amino acids, amphiphiles, and nucleobases [2–6], indicates that molecules essential to life can be formed abiotically under astrophysical conditions.

This hypothesis is supported by extensive laboratory studies involving the formation of complex organic molecules from the ultraviolet (UV) irradiation of astrophysical ice analogs (H_2O, CO, CO_2, CH_3OH, CH_4, NH_3, etc.). In particular, these studies show that the organic residues recovered at room temperature after the UV irradiation of such ice mixtures contain amino acids [7–9], amphiphiles [4], nucleobases [10–13], as well as other complex organic compounds [14,15].

However, to the best of our knowledge, no systematic search for the presence of sugars, sugar acids, and sugar alcohols in laboratory residues have been reported to date, despite the fact that those compounds are involved in a large number of biological processes. Only a limited number of small (fewer than 4 carbon atoms) sugar-related compounds such as glycerol and glyceric acid [14], and more recently 2–4-carbon aldehydes [16] have been detected in residues.

Experiments: CH_3OH vapor and H_2O+CH_3OH vapor mixtures in proportions 5:1, 2:1, and 1:1 were prepared and deposited onto a cold substrate (<20 K) inside a high-vacuum chamber (~10^{-8} torr). While being individually deposited, the ice layers were simultaneously irradiated with an H_2-discharge UV lamp that emits mainly Lyman-α photons and photons with energies in the H_2 transition line range. After irradiation, samples were warmed under vacuum to allow for the original volatiles to sublime away. The remaining refractory materials (the “residues”) were extracted from the sample chamber and analyzed with gas chromatography coupled with mass spectrometry (GC-MS). Identifications of compounds in these residues was performed by matching both the retention times and mass spectra of individual peaks with known standards, and with the NIST database of mass spectra whenever commercial standards were not available.

Results: In this work, we show preliminary results obtained from the systematic search for sugars and sugar-related compounds (mostly sugar acids and sugar alcohols) in organic residues produced from the UV irradiation of pure CH_3OH ices and H_2O+CH_3OH ice mixtures in different proportions, and compare our experimental data with measurements of these compounds in primitive meteorites. The first results confirm the presence of small (2–4 carbon atoms) sugar acids and sugar alcohols. Our method is currently being improved to detect larger (5- and 6-carbon atoms) compounds in the residues.

References: [1] Cooper G. W. et al. (2001) *Nature*, *414*, 879. [2] Kvenvolden K. et al. (1970) *Nature*, *228*, 923. [3] Cronin J. R. and Pizzarello S. (1997) *Science*, *275*, 951. [4] Dworkin J. P. et al. (2001) *PNAS*, *98*, 815. [5] Folsome C. E. et al. (1971) *Nature*, *232*, 108. [6] Stoks P. G. and Schwartz A. W. (1979) *Nature*, *282*, 709. [7] Bernstein M. P. et al. (2002) *Nature*, *416*, 401. [8] Muñoz Caro G. M. et al. (2002) *Nature*, *416*, 403. [9] Nuevo M. et al. (2008) *OLEB*, *38*, 37. [10] Nuevo M. et al. (2009) *Astrobiology*, *9*, 683. [11] Nuevo M. et al. (2012) *Astrobiology*, *12*, 295. [12] Materese C. K. et al. (2013) *Astrobiology*, *13*, 948. [13] Nuevo M. et al. (2014) *ApJ*, 793, 125. [14] Nuevo M. et al. (2010) *Astrobiology*, *10*, 245. [15] de Marcellus P. et al. (2011) *Astrobiology*, *11*, 847. [16] de Marcellus P. et al. (2015) *PNAS*, *112*, 965.