**TOF-SIMS ANALYSIS OF PREBIOTIC ORGANICS IN METEORITES: GAINING INSIGHT INTO FORMATION MECHANISMS.** D. N. Simkus[1], C. D. K. Herd[1], Y. S. Goreva[2], and T. J. McCoy[2]. [1]Dept. of Earth & Atmospheric Sciences, University of Alberta, Edmonton, Canada (simkus@ualberta.ca) [2]Dept. of Mineral Sciences, NMNH, Smithsonian Institution, Washington, D.C.

**Introduction:** The organic precursors to life, including the chemical building blocks of protein, lipids and DNA, are known to be produced by abiotic chemical reactions in the presolar nebula and on asteroids in the early solar system. Understanding the conditions and reactions involved in the synthesis of these compounds is key to understanding the potential for life to exist beyond Earth.

The geochemistry of carbonaceous chondrite meteorites provides a window into the chemical processes that took place in the presolar nebula and on parent body asteroids in the early solar system. A wide range prebiotic organic compounds have been identified in these meteorites using bulk solvent extractions and GC-MS, GC-IRMS, and HPLC techniques [1-5]. These methods provide a wealth of information about the types and concentrations of prebiotic compounds produced in space, as well as potential synthesis reactions; however, a key question that remains is whether these compounds vary spatially across a meteorite section.

Identifying associations between prebiotic organic compounds and specific minerals or textures in a meteorite promises to provide information about the chemical reactions (e.g. Strecker amino acid synthesis) involved in their formation, the role of mineral surfaces as potential catalysts for prebiotic synthesis reactions, the timing of synthesis, the mobility of the compounds, and the role of water in the formation and preservation of these molecules. Some organics have been previously observed in association with matrix clays and serpentines in chondrule accretion rims using an $OsO_4$ vapor method [6]; however, their molecular identities could not be determined using this technique.

**ToF-SIMS:** Time-of-flight secondary ion mass spectrometry (ToF-SIMS) offers a unique opportunity to examine the spatial distribution of specific organic compounds across a meteorite sample and observe potential compound-mineral associations (Figure 1). The method exhibits high spatial resolution, and the ability to detect a very large range of elemental and molecular species, inorganic and organic, up to masses > 1000 amu.

There have been very few ToF-SIMS investigations of organic compounds in meteoritic materials so far [7-11]. A range of polycylic aromatic hydrocarbons (PAHs) [7, 10], and amino acids and carboxylic acids [10] have been identified within the Murchison meteorite using ToF-SIMS. Some spatial variations have also been observed for fragments of organic compounds in the Murchison meteorite using this technique [10], although the molecular sources of these fragments still remain to be determined. Identification of the prebiotic organic compounds exhibiting spatial variations in the Murchison meteorite will certainly provide insight into formation mechanisms. The Tagish Lake carbonaceous chondrite is also a key next target for ToF-SIMS analysis, due to its high sample heterogeneity as a result of varying degrees of parent body aqueous alteration, in combination with its unique pristine nature.

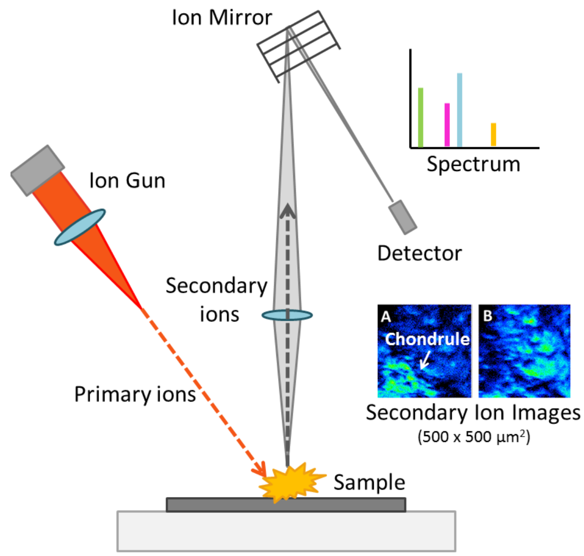


**Figure 1.** Illustration of the ToF-SIMS technique, adapted from [11]. A primary ion beam is focused towards a small target on a meteorite sample. The emitted secondary ions are separated and detected based on their time-of-flight (determined by their mass-to-charge ratio). Secondary ion images, produced by rastering the primary ion beam over the set surface area, reveal spatial variations in organics (e.g. ions that (A) correlate and (B) anticorrelate with the presence of a chondrule [10]).

**References:** [1] Botta, O. and Bada, J. L. (2002) *Surv Geophys*, *23*, 411-467. [2] Jungclaus, G. A. et al. (1976) *Meteoritics*, *11(3)*, 231-237. [3] Martins, Z. et al. (2008) *Earth Planet Sci*, *270*, 130-136. [4] Pizzarello, S. and Shock, E. (2010) *Cold Spring Harb Perspect Biol*, 1-19. [5] Elsila, J. E. et al. (2012) *Meteor Planet Sci*, 1517-1536. [6] Pearson, V. K. et al. (2002) *Meteor Planet Sci*, 1829-1833. [7] Stephan, T. et al. (1999) *LPSC 30*, #1569. [8] Steele et al. (2013) *LPSC 44*, *#2854*. [9] Rost et al., (2010) *LPSC 41*, *#1973*. [10] Simkus et al. (2015) *LPSC 46*, #2513. [11] Stephan, T. (2001) *Planet Space Sci*, *49*, 859-906.