Submicron-Scale Search for Carbonate in Primitive Extraterrestrial Materials

G. J. FLYNN[1], L. P. KELLER[2], S. WIRICK[3] AND C. JACOBSEN[3]

[1]SUNY, Plattsburgh NY USA george.flynn@plattsburgh.edu

[2]NASA Johnson Space Center, Houston TX USA

[3]SUNY, Stony Brook NY USA

Carbonates occur frequently in the hydrous meteorites and the hydrous interplanetary dust particles (IDPs). These carbonates are presumed to have formed by aqueous processing on the parent bodies of those meteorites and IDPs. However, recent astronomical evidence suggests carbonates might be formed by condensation as well. Kemper et al. [1] reported detection of Ca-carbonate in dust ejecta from NGC 6302, a planetary nebula so hot that its emission peaks in the ultraviolet. More recently, Lisse et al. [2] reported detection of carbonate in dust released from comet Temple-1 as a result of the Deep Impact excavation. Both results were unexpected, because carbonate is generally believed to be formed by aqueous processing. Its presence in NGC 6302 would suggest formation as a condensate while its presence in Temple-1 is consistent with either direct condensation or the possibility that regions of Temple-1 were warm enough at some time to allow liquid water. Neither identification of carbonate is unambiguous, however, since each group detected a broad absorption feature that was "best fit" by the sum of several mineral absorption features including carbonate.

Scanning Transmission X-ray Microscopes (STXMs) employ a focused x-ray beam to image an ultra-thin sample using monochromatic x-rays. STXMs are usually employed to study organic compounds. However, STXMs can also locate and identify certain minerals that have strong, narrow absorption features, which occur as a result of transitions induced from the electron core to higher electron energy levels. Carbonates have a strong absorption, resulting from the C-O bond, near 290 eV, allowing the efficient location of carbonates down to ~200 nm in size by comparing maps of the sample at the energy of the carbonate-specific absorption and just off that energy. Positive identification requires the acquisition of a full X-ray Absorption Near-Edge Structure (XANES) spectrum or TEM characterization of the spot. We have begun a search for carbonate in sections, ~100 nm thick, of primitive anhydrous IDPs and, eventually, samples of Wild-2 returned by NASA's Stardust spacecraft. We found carbonate in one anhydrous IDP [3], suggesting carbonate may occur as a nebula condensate in our Solar System.

References: [1] Kemper, F. et al. (2002) *Astronomy & Astrophysics*, 394, 679-690. [2] Lisse, C. et al. (2005) *Dust in Planetary Systems*, LPI, Abs.#4105. [3] Flynn, G. J. et al. (2005) *Dust in Planetary Systems*, LPI, Abs.#4011, 2005