VOLATILE TRACE-ELEMENT ABUNDANCES IN PRIMITIVE METEORITES: APPLICATIONS TO ANALYSIS OF COMETARY PARTICLES. D. S. Lauretta and J. Goreva, University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ 85721, USA (lauretta@lpl.arizona.edu, jgoreva@lpl.arizona.edu).

Introduction: We are developing new techniques for the analysis of volatile trace elements in very small samples using inductively coupled plasma mass spectrometry (ICP-MS) in preparation for samples returned by the Stardust mission. The instruments that will serve as the bases of our experiments are the ELEMENT2 high-resolution ICP-MS and the Isoprobe multi-collector ICP-MS. The Isoprobe MC-ICP-MS is already installed and available for use. We are in the process of expanding this facility to add the ELEMENT2, making it the ideal place to perform both trace-element and isotopic analyses nearly simultaneously. We are developing techniques for introducing samples to the plasma. We are working on three areas of sample introduction: 1) Thermal heating of small particles under controlled atmospheres; 2) Laser ablation of small particles embedded in aerogel and other matrices; and 3) Direct injection of small particles into the plasma. In addition, we plan to investigate direct analysis of aerogel material with the goal of determining concentrations of volatile elements that may have recondensed on this material after sample collection.

Trace-element Analysis: We are interested in the abundances of volatile elements in Stardust grains and along particle tracks in the aerogel used to collect these grains. The primary goals of this research are (1) to constrain the initial abundances of volatile elements in Stardust grains and use this information to interpret their origin and thermal history and (2) to determine the amount of heating experienced by Stardust grains during collection. The abundances and isotopic compositions of such elements in Stardust grains may reflect low-temperature gas-solid interactions in the outer, early solar system.

The suite of elements of interest includes: Au, As, Ag, Ga, Sb, Ge, Sn, Pb, Bi, Tl, Hg, Zn, Se, Te, In, and Cd. This set of elements includes the most volatile, non-ice-forming elements. All of these trace elements are either chalcophile or siderophile under the conditions expected in the solar nebula. Thus, they were likely incorporated into solid material through gas-solid reactions with metal or sulfide grains. A subset of the volatile trace elements of interest (Au, As, Ag, Ga, Sb, Ge, and Sn) are predicted to condense in the solar nebula by dissolving into the bulk metal phase prior to sulfide formation [1,2]. Another subset are predicted to condense either into the metal (Pb, Bi, Tl, and Hg) or into the sulfide (Zn, Se, Te, In, and Cd) during metal sulfurization in the early solar system [1,3,4]. Elements that previously condensed in the metal may be transferred to the growing sulfide layer. Because of their high volatility and their mobility in aqueous systems, these elements may be excellent indicators of both thermal and hydrological processes experienced by primitive chondritic meteorites and cometary particles.

Results: A thermal analysis (TA-) ICP-MS technique has been applied it to the study of volatile trace-element abundances in primitive meteorites [5,6]. To date meteorites from the CI, CM, CV, CO, LL, L, and H chondrite groups have been analyzed. Of all these meteorites, the CI chondrites are probably the most similar to cometary material [7]. This study has produced some intriguing results. Of the entire suite of elements analyzed, S, As, Se, Sb, Te, Cd, and Hg are released at detectable levels when the meteorites are heated to relatively low temperatures (< 400 ^{o}C). There is a correlation between release of As, Se, Sb, and Te and low-temperature S release from a wide variety of primitive meteorites. The relative abundances of As, Se, Sb, and Te in this low-temperature phase is highly variable. There is a strong correlation between As and Se low-temperature release in Vigarano, Kainsaz, Chainpur, and Parnallee. However, in some meteorites (Grosnaja, Murchison, Orgueil) only Se is released and in others (Ornans and Supuhee), only As is released. These results are intriguing because they clearly do not reflect a simple volatility trend. Some other process is controlling the abundances of these elements in low-temperature phases in carbonaceous and ordinary chondrites. We will continue to develop these techniques using CI and CM chondrites as analogs for cometary particles.

References: [1] Wai and Wasson 1977 *Earth and Planetary Science Letters* **36**, 1-13. [2] Wai and Wasson 1979 *Nature* **282**, 790-793. [3] Larimer 1973 *Geochimica et Cosmochimica Acta* **37**, 1603-1623. [4] Lauretta et al. 1999 *Earth and Planetary Science Letters* **171**, 35-47. [5] Lauretta et al. 2001 *Geochimica et Cosmochimica Acta* **65**, 2807-2818. [6] Lauretta et al. 2002 *Lunar and Planetary Science* **XXXIII**, #1602. [7] Campins and Swindle 1998 *Meteoritics & Planetary Science* **33**, 1201-1211.