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Are CI Chondrites Cometary Samples? A Search for Olivine and Use as a Discrimination Index.

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CI chondrites are among the most unusual type of carbonaceous chondrites. There are only five CI1 meteorite falls. They are heavily altered (BULLOCK et al., 2005), yet show a similar bulk composition to the solar photosphere (ANDERS and GREVESSE, 1989; LODDERS, 2003). There still remains uncertainties about the origin and formation of the parent bodies for such meteorites. One theory is that CI chondrites derive from cometary nuclei, based on evidence from textural and mineralogical arguments (CAMPINS and SWINDLE, 1998) and orbital parameters (GOUNELLE et al., 2006).

We now have known cometary material to compare to CI chondrites. The NASA sample return mission Stardust returned to Earth on January 2006. This mission collected cometary dust particles by flying through the coma of comet 81P/Wild 2. The Preliminary Examination (Science, 314, 2006) and subsequent studies (MaPS, 43, 2008), showed that expected hydrated minerals seem to be absent. This may in part be because finer-grained hydrated minerals are less likely to survive the collection process (ISHII et al., 2008) although experimental studies (BURCHELL et al., 2006; NOGUCHI et al., 2007) have shown that coarser ($>$ μm) phyllosilicates can survive capture under conditions analogous to the Stardust encounter.

To determine the relationship between CIs and returned cometary material, we may therefore have to focus on the distinctive composition of anhydrous minerals, which are rare in CI meteorites. Olivine is a common mineral in the solar system, and has been reported in diverse compositions within Stardust samples, especially with distinctive levels of Fe, Cr and Mn. In cold cometary bodies it is unlikely that the chemical composition of olivine will have been affected by parent body processing, so olivines are likely to be unaltered and could provide evidence for any primary genetic link between CIs and cometary material.

In this study we present an optimised analytical technique to detect micrometer-sized olivine grains in large area searches of the matrix of CI chondrites, locating the sparse grains, which can then be characterised by microanalysis (Electron Microprobe, TEM, TOF-SIMS). We then compare CI olivine compositions with Stardust ones, in order to distinguish any genetic link.

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