Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.9965

Phosphorous as a Cosmothermometer in Primitive Interplanetary Dust Particles

GEORGE J FLYNN[1], PAUL NORTHRUP[2] AND SUSAN WIRICK[3]

[1]SUNY-Plattsburgh
[2]Stony Brook University
[3]Focused Beam Enterprises

Presenting Author: george.flynnb@plattsburgh.edu

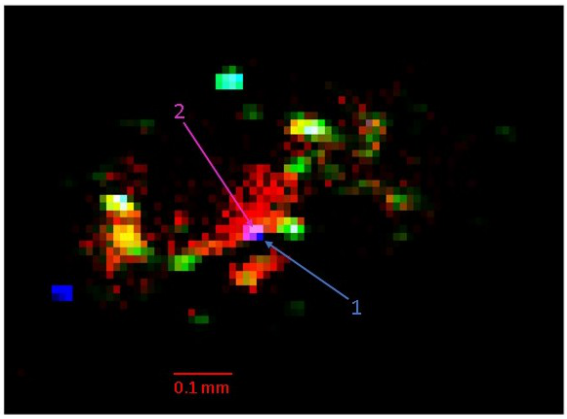

Figure 1: Three color map showing Cl (red), S (green), and P (blue) in the L2036 AL14 cluster IDP. (An 0.1 mm scale bar is shown in red)

Modeling by Fegley and Schaefer [1] indicates that P condenses from a cooling gas of Solar composition at 1285K as a phosphide, schreibersite, which reacts with the gas at lower temperatures forming phosphates, fluorapatite at 712K and whitlockite at 680K. The whitlockite then reacts with gaseous HCl to form chlorapatite at 470K. So P is a particularly useful cosmothermometer, with the mineralogy of the P-bearing grains in primitive material indicating the temperature range when these grains were isolated from further interaction with Nebular gas. The anhydrous, chondritic porous interplanetary dust particles (CP IDPs) collected by NASA from the stratosphere after gentle deceleration in the upper atmosphere, never experienced significant aqueous or thermal processing making them the best preserved samples of the original condensates from the Solar Nebula currently available for laboratory study [2]. We mapped the Cl, S, and P by x-ray fluorescence and performed Cl-, S-, and P-XANES (x-ray absorption near edge structure) spectroscopy in six anhydrous cluster IDPs using the Tender Energy Spectrometer endstation on Beamline 8BM at the National Synchrotron Light Source II (Brookhaven National Laboratory). All of the P hot-spots had P-XANES spectra demonstrating they were phosphates not phosphides, indicating the grains interacted with Nebula gas at least down to ~700 K. However the majority of these phosphates had P-XANES spectra inconsistent with either fluorapatite or chlorapatite. A majority of these phosphates, e.g. Spot 1, contained no detectable Cl, indicating that most phosphate grains in primitive IDPs did not interact with HCl gas, suggesting they were isolated from the Solar Nebular gas before it cooled below ~420K. A few phosphates, e.g. Spot 2, had much higher Cl spatially associated with the P, with a background corrected Cl:P count rate ratio of 37:40. However the P-, and Cl-XANES spectra were inconsistent with chlorapatite. Examination of these spots at higher resolution or extraction of the grains is required to determine if the cluster IDPs contain any Cl-bearing phosphates.

References: [1] Fegley and Schaefer (2010) Cosmochemistry, in Principles and Perspectives in Cosmochemistry, Springer-Verlag, 347-377. [2] Ishii et al. (2008) Science, 319, 447-450.