Morphology of hibonite-bearing inclusions separated from the Murchison meteorite

L. Kööp[1,2,4], A. M. Davis[1,2,3,4], and P. R. Heck[2,4],

[1]Department of the Geophysical Sciences, [2]Chicago Center for Cosmochemistry, [3]Enrico Fermi Institute, The University of Chicago, Chicago, IL, [4]Robert A. Pritzker Center for Meteoritics and Polar Studies, Field Museum of Natural History, Chicago, IL

Introduction

Hibonite ($CaAl_{12}O_{19}$) is among the first phases predicted to condense from a cooling gas of solar composition and hibonite-rich inclusions preserve the **largest isotope anomalies** of all materials that formed in the solar system [1, 2]. But due to their small size, isotopic studies have been limited to only a few elements (O, Ti, Ca, Zr, Al-Mg, Ca-K, Be-B).

We have recovered **281 inclusions** for isotope analysis. Here, we present their morphology.

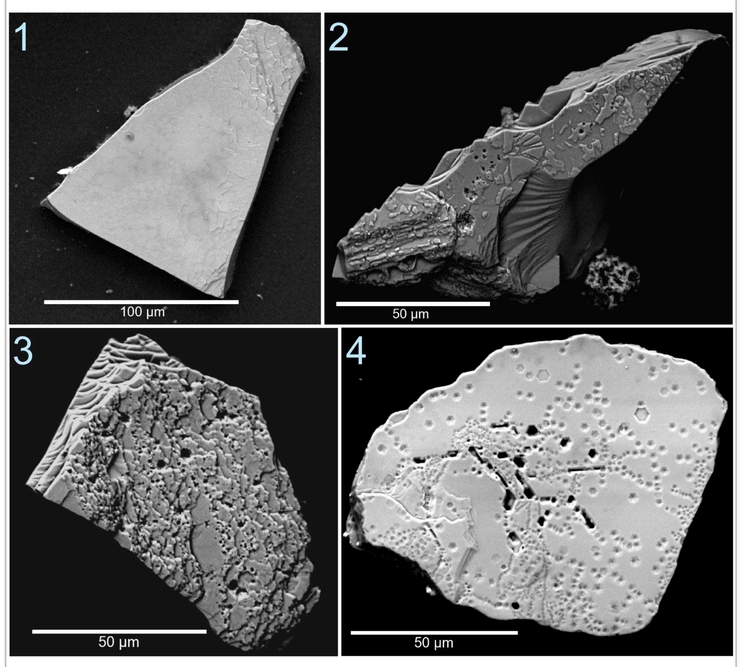
Methods

A ~92 g piece of Murchison from the Field Museum collection was disaggregated in 40-70 freeze-thaw cycles. Hibonite-bearing grains were picked from the heavy fraction (>3.31 g cm^{-3}) and characterized by scanning electron microscopy. Additional hibonite grains were picked from a Murchison HF acid residue prepared by [3]. All images were collected using back-scattered electrons.

Results

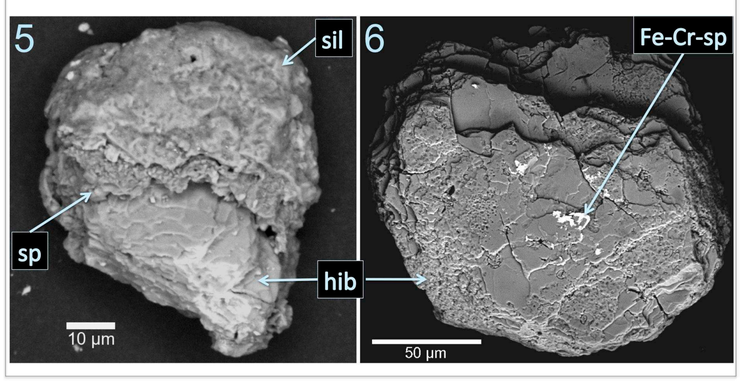
Typical features of PLAty hibonite Crystals (PLACs):

- Most PLACs occur as angular crystal fragments (Figs. 1, 2, 3).
- The surfaces of PLACs were found to be smooth, decorated or dominated by layering (Figs.1, 2 and 3, respectively).
- Many PLACs have hexagonal pits (Fig 4).



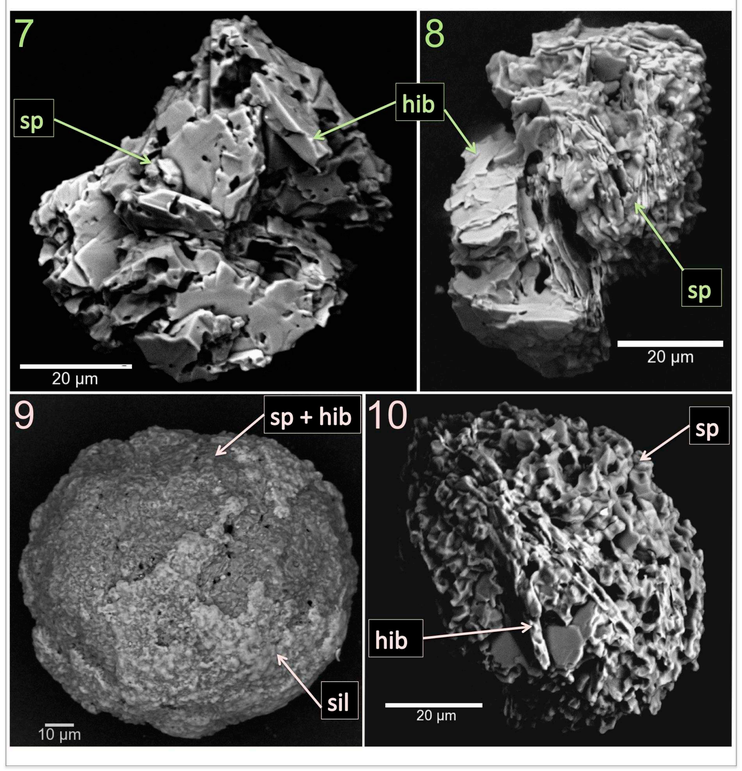
PLACs – rare features:

- A few PLACs exhibit rims of spinel (sp) and/or silicates (sil; Fig. 5).
- Others have minor overgrowths of spinel or other phases (Fig. 6).
- For a few PLACs, 120° angles between margins are observable (Fig. 6).



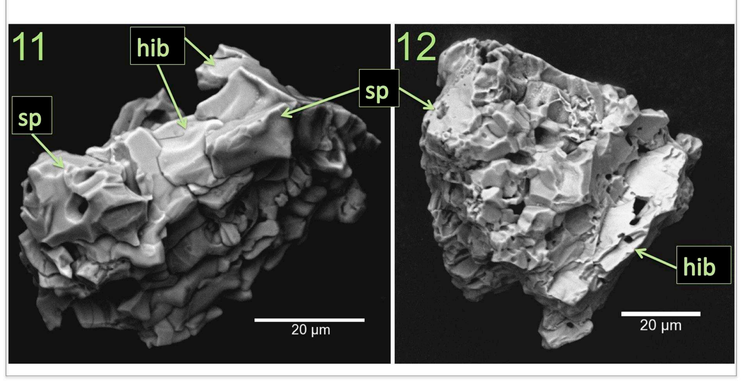
Typical features of Spinel-HIBonite inclusions (SHIBs):

- SHIBs are either angular (Figs. 7 & 8) or almost spherical (Figs. 9 & 10).
- Most SHIBs contain fine-grained (<5 µm) anhedral spinel and thick (several microns, Figs. 7 & 10) or thin hibonite (hib) plates (Fig. 8).
- Non-acid-treated SHIBs are often partially surrounded by silicates (Fig. 9).



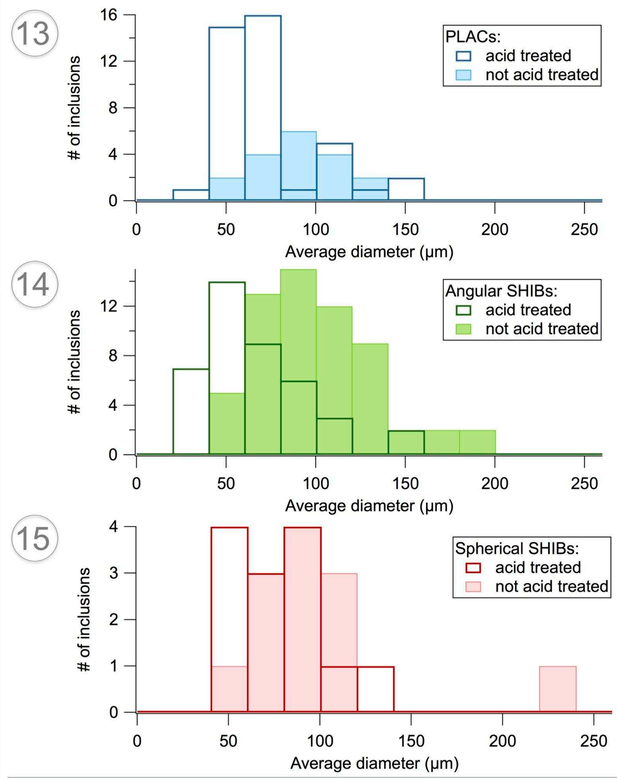
SHIBs – rare features:

- In some SHIBs, hibonite grains are amoeboid and non-platy (Fig. 11).
- Others consist of only one hibonite plate and a spinel aggregate (Fig. 12).



Sizes and abundances:

- 88 PLACs, 163 SHIBs and 30 unclassified grains were found.
- Average sizes range from 30 µm to 233 µm (Figs. 13–15).
- Acid-treated grains are smaller on average than non-acid-treated grains (Figs. 13–15).



Summary & outlook

- A large set of hibonite-bearing inclusions was recovered.
- The inclusions display considerable textural diversity.
- The difference in abundances and sizes of acid-treated and untreated SHIBs indicates that partial dissolution may have furthered their disaggregation.
- The large number and sizes of the recovered inclusions provide ideal conditions for a comprehensive isotopic study of these fascinating objects.

References: [1] Yoneda S. & Grossman L. (1995) GCA, 59, 3414-3444. [2] Ireland T. (1990) GCA, 54, 3219-3237. [3] Amari S. et al. (1994) GCA, 58, 459-470.

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