

MINERALOGICAL RECORD OF ALTERATION BY HEAVY ICES IN A COMETARY CLAST IN A PRIMITIVE METEORITE.

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Introduction: Probable and definitively cometary material available for study on Earth includes chondritic-porous interplanetary dust particles (CP-IDPs), ultra-carbonaceous Antarctic micrometeorites (UCAMMs), and samples of 81P/Wild 2 returned by the Stardust mission. Additionally, a hypothesized cometary micro-xenolith was recently identified in the Renazzo-like (CR) carbonaceous chondrite LaPaz Icefield (LAP) 02342 [1]. The carbon-rich clast is enriched in Na compared to the surrounding matrix and contains ¹⁶O-poor Na-sulfates in regions that appear to have experienced minor aqueous alteration of some silicates. Such ¹⁶O-poor material is rare in the sample record and has been observed previously in the matrix of ungrouped carbonaceous chondrite meteorite Acfer 094 [2,3] and in IDPs [4], albeit with different mineralogy. UCAMMs rich in Na (compared to chondritic values) have been reported [5], although a similar sulfate phase has not been identified. A possible overabundance of Na in comet 67P compared to chondritic was initially proposed to be a consequence of preferential depletion of this moderately volatile element in the inner disk, with transfer into the region of condensation of cometary materials [6]. If such scenario is correct, perhaps primordial cometesimals were created in a ¹⁶O-poor environment. Further study of this clast can help us understand the extent and effects of alteration and potential source of ¹⁶O-poor ices.

Methods: FIB samples were prepared with an FEI Helios G3 equipped at the Naval Research Laboratory (NRL). No e-beam imaging was done of the sample during thinning in order to avoid changing the functional group chemistry of the organic matter prior to STEM measurements. STEM analyses were performed with the Nion UltraSTEM 200-X at NRL. The microscope is equipped with a Gatan Enfium ER spectrometer for EELS and a windowless, 0.7 sr Bruker SDD-EDS detector. Data were collected at 60 kV and 200 kV operating voltages.

Results and Discussion: The sodium-sulfate phase noted in previous work on this clast [1] is part of a complex assemblage that includes two different carbonates and a hydrated clay or carbonate, as well as organic matter with variable functional group chemistry and other altered Fe-bearing silicates with Fe-sulfides (Fig. 1).

Further analysis and understanding of the phases present in the Na-rich region of the hypothesized cometary xenolith will provide a better understanding of the reactions that have taken place in this grain and the nature of the ¹⁶O-poor phase(s). The possible reactions of refractory cometary dust with isotopically heavy water and possibly H₂S derived from cometary ices to form the assemblage seen here can help constrain the degree of the alteration, conditions during alteration, and the fluid chemistry required. Additional study of the “pristine” and altered GEMS in the clast will allow comparison with GEMS from IDPs [7], UCAMMs [8], and GEMS-like material identified in Paris meteorite matrix [9].

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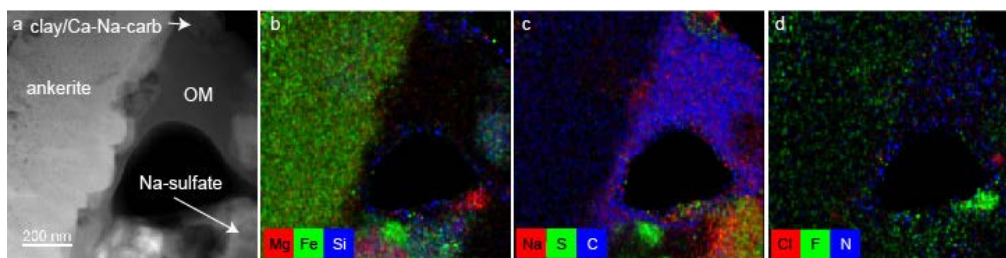


Figure 1. HAADF image and EDS maps showing complex assemblage of phases near Na-rich organic matter and Na-sulfate.