Direct Analysis of Early Solar System Aqueous Fluids

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We lack fundamental information on early solar system aqueous fluids [1]. Fluid inclusions are present in carbonates, sulfides and halides in astromaterials, whose characterization is finally becoming feasible. The ordinary chondrite regolith breccias Monahans 1998 (H5) and Zag (H3-6) contain fluid inclusion-bearing halite (NaCl) crystals dated at ~4.5 billion years old [2,3]. Freezing studies to measure the eutectic temperature demonstrated that the brines likely contain divalent cations (Ca, Mg, Fe) [1]. Halite is effective at preservation (at least 250 MY) of organic phases and structures [4]. Thus, compositional data on fluid inclusions in halite will reveal unique information on the origin and activity of aqueous fluids in the early solar system, and interactions with organics.

To measure fluid compositions from individual fluid inclusions we performed TOF-SIMS depth profiling at ultra-high vacuum at ~110 K using a 30 kV Bi^+ analysis ion beam and a 1 kV O_2^+ sputtering ion beam.

Halite fluid inclusion FI1 contains H_2O, K, Na, Cl and $NaCl•2H_2O$. FI2 contains H_2O, K, Na, Cl, Al, Fe, Ca, $NaCl•2H_2O$ and C-N-O-H species originating from organic molecules. Mass overlap with NaOH species prevented definitive identification of Ca in FI1.

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