DO WE ALREADY HAVE SAMPLES OF CERES? H CHONDRITE HALITES AND THE CERES-HEBE LINK.

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Summary: We investigate the hypothesis that halite grains in the brecciated H chondrites Zag and Monahans originate from Ceres. Evidence includes mineralogy of the halites consistent with formation on a large, carbonaceous, aqeuosly active body close to the H chondrite parent body >4 Ga ago. Evidence also includes orbital similarities between 1 Ceres and the purported H chondrite parent body (HPB) 6 Hebe, possibly facilitating a gentle transfer between the bodies.

Discussion: Halite grains in the Monahans and Zag H-chondrites are exogenous to the H chondrite parent body and were transported to the HPB >4 Ga ago. Examination of minerals and carbonaceous materials entrained within the halites shows that the halite parent body (HaPB) is consistent with a carbonaceous body [1]. It is probably a large body due to the variety of entrained carbonaceous materials which probably accreted from multiple sources. The halite grains contain intact, HaPB-origin, ancient fluid inclusions indicating that transfer between the HaPB and the HPB was a gentle process resulting in a ΔT of <25 °C. Ejection from the HaPB may have been via cryovolcanic processes similar to those on modern-day Enceladus, which have been interpreted to include halite from spectroscopic observations. The ΔTmax to preserve the brine-bearing halite restricts the impact velocity to the HPB at less than 7350-700 m/s, depending upon the fraction of kinetic energy used heat the sample. [2-6]. Therefore the HaPB and HPB must have shared nearby orbits at the time of the HaPB-HPB transfer.

Evidence presented elsewhere indicates asteroid 6 Hebe is a favored candidate for the HPB based on reflectance spectrum similarity with H chondrites and dynamical arguments [7,8]. The modern orbits of Ceres and Hebe are reasonably similar, with aphelion/perihelion of Ceres and Hebe of 2.99/2.55 and 2.91/1.94 AU, respectively. Initial calculations indicate an approximate mean infall velocity of 1.20 to 1.38 km/s. While higher than 350-700 m/s, the orbits may have been more favorable >4 Ga ago. Additional dynamical factors need to be investigated.

A combination of factors suggests Ceres as the HaPB. It is a carbonaceous body with suggestions of past aqueous activity [9], which is consistent with the mineral species found in H chondrite halites. Ceres is also a large body capable of accreting the range of carbonaceous materials noted [5]. It is relatively near to purported HPB Hebe, which is required to preserve halite fluid inclusions. The above evidence defines a hypothesized scenario featuring ejection of halite grains from Ceres onto Hebe. Halite was then entrained in H-chondrite near-surface breccias and ejected from Hebe for transport to Earth.