CI Chondrites are Depleted in Refractory Elements.

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Introduction A major justification for adopting CI abundances as solar is the agreement with spectroscopic photospheric abundances [1] (here AAG21), but given uncertainties, differences as large as ≈ 30% are possible.

Results The AAG21 abundances have significantly smaller errors than in earlier compilations. **Figure 1** shows that Mg-normalized photospheric abundances show a 1 sigma depletion in CI abundances for elements with condensation temperatures [2] greater than ≈ 1200K. Only AAG21 data for elements with errors < 20% (1 sigma) are plotted. Only one of the nine elements with Tc < 1200K has a Photosphere/CI ratio lower than 1.13 (below the red dashed line), while only four of the 31 elements with Tc > 1200K have a higher ratio. (The absolute placement of the reference line is arbirtrary; placing the CI abundances onto the Photospheric scale shifts all data uniformly.) No horizontal line can be drawn such that it fits all data within quoted errors. Using the six AAG21 elements with errors <10% (S, Na, Si, Mg, Ca, Al), the refractory elements are depleted by 14 ± 6%. **Figure 2** shows that the AAG21 fractionations are confirmed when Genesis bulk solar wind (SW) abundances are used as solar. At 2 sigma, the SW data show no first ionization potential (FIP) fractionations. K and Na fluences are based on diamond-like-C SW collectors [3]; other elements are from Si collectors [4]. A significantly higher Na fluence from Si collectors [4] can be explained by radiation damaged redistribution of surface contamination Na [5].

Discussion The fractionations from **Figs 1 and 2** could be due to enrichments of volatile elements in CIs; however, a CI refractory element depletion due to CAI loss is more plausible, and such a depletion (12%) is predicted by the nebular evolution models of [6]; the missing CAIs were accreted to the Sun. Thus, two independent observations and one theoretical study conclude that CIs are depleted in refractory elements by 10-20%. *Solar Rare Earth Elements (REE):* The nominal errors in AAG21 are 12-14%, but the precision among the REE is smaller. This justifies, for the first time, calculation of a solar REE pattern. The REE show a significant range in volatility producing a range of observed fractionations among CAIs, but the AAG21/CI pattern is flat, suggesting that the lost CAIs from CIs had a flat REE pattern. Although less certain, intermediate volatility elements (e.g. Si, Mg, Fe Cr) appear to be depleted in CIs relative to AAG21, suggesting a relatively low fractionation temperature with some ameboid olivine aggregates (AOA) lost with the CAIs. *Solar Twins:* The Galaxy is full of stars of close to solar mass, age, and composition. Relative abundances between these stars and the Sun are precise (few %). Relative to the average of 79 solar twins, the Sun is depleted in refractory elements by roughly 10% [6]. This might indicate that the CAIs lost from CIs were ejected from the solar system. There is considerable scatter among refractory elements, thus a better comparison is the Sun relative to individual stars of the same age; this is in progress.

References: [1] (Asplund M. et al. (2021) *Astronomy & Astrophysics* 653 A141-A171. [2] Wood B.E. et al. (2019) *American Minerologist* 104 844-856. [3] Rieck K. et al.(2023) *Rapid Commun Mass Spectometry rom.*doi.org/10.1002/rcm.9454 [4] Heber V. et al. (2021) *Astrophysical J* 907 15-31. [5] Rieck K. et al. (2021) 52nd LPSC abs.#2638. [6] Desch S. et al. (2018) Astrophysical J. Supplment Series, 238:11-41. [6] Bedell M. et al. (2018) *Astrophysical J.* 865 68-81. [7] Lodders K. (2021) *Space Sciences Reviews.* 217 44-77.

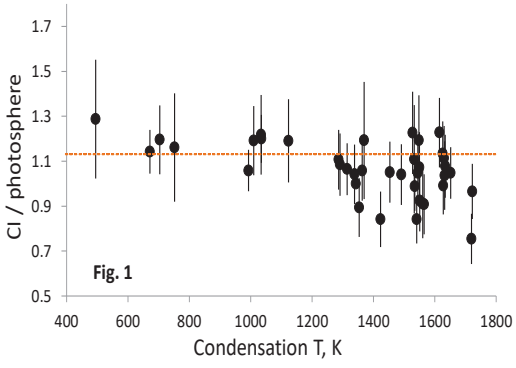

Fig. 1 Mg normalized abundances [1]; CI [7]

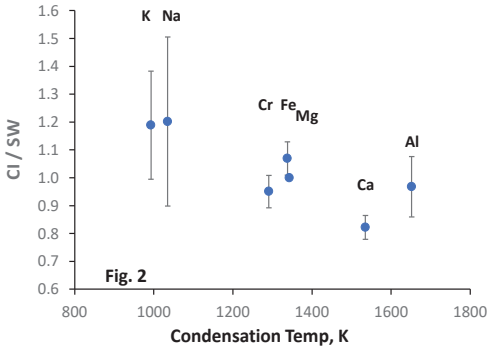

Fig 2 Genesis SW Mg normalized (text); CI