DIFFERENCES IN THE ELEMENTAL ABUNDANCE OF CI CHONDRITES AND THE PHOTOSPHERE

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Introduction: : Except for fragile (Li) and highly volatile elements (H, He, C, N O, etc.), the composition of CI chondrites appears to mirror Photospheric data (Fig. 1). Thus, CI abundances are often used as a baseline for solar composition. But CI chondrites are rocks and, thus, must have been subject to some processing of their components both during and after accretion. Processing requires chemical change and (at least) minor fractionation of elements.

Have we overestimated the precision with which CI abundances represent solar values? In 2021, *[1]* presented a plot of log (Photospheric-CI) abundances where errors were <~30%. That plot (their Fig. 6) strongly suggested a fractionation trend of fewer refractories and enrichment of moderately volatile elements in CI vs. the Sun. However, the large error bars on the plot meant that multiple lines could be drawn through the data. What [1] needed was independent verification of that trend. That verification came from abundances derived from the Genesis Solar Wind (SW) Sample Return Mission (Fig. 2).

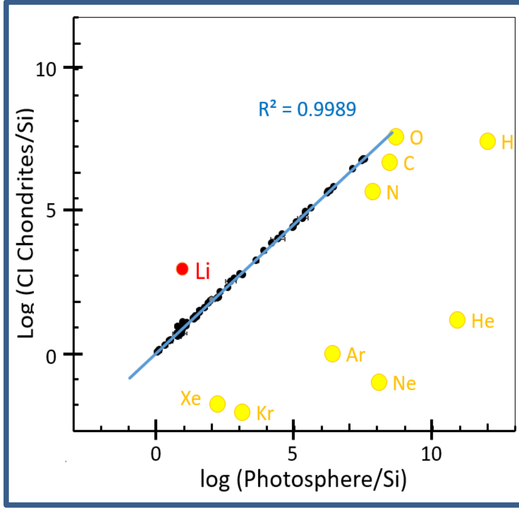
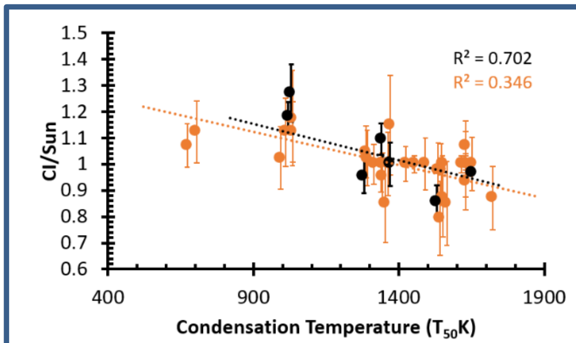


Fig. 1: Log (CI) vs. Log (Photospheric) abundances (Si normalized). Yellow markers are highly volatile elements; Red marker is Li, subjected to early nuclear burning; black markers show linear trend with a correlation coefficient ~1. Because of the outstanding correlation, it has been assumed that CI = solar abundance. But on this "10x10" Log scale, a 30% error looks negligible.

Results/Discussion: In Fig. 2 all data are Mg normalized. LHS: linear change of CI/solar ratio. Orange is Photospheric, black is Genesis, trendlines (with R^2) indicate reasonableness of overlapping trends.RHS: fractional differences between CI and Photosphere. Solar are Photosphere and Genesis (circles, squares) respectively. Moderately volatile elements (blue) and refractories (brown) have averages given by the arrows. The 0.16 diffence between arrows in Fig. 2 is outside 1σ of the individual averages. A similar trend was predicted by Desch et al. [2], whose 1D model of the protoplanetary disc included aerodynamic forces on CAI/AOA particles with time, controlled in part by the formation of Jupiter. Refractories tended to settle into the Sun or, later, in the pressure field around Jupiter, but there was still mixing throughout the disc. [2] concludes that CI abundance represents the outer protoplanetary disc, and predicts a CI chondrite to solar fractionation of ~12% between moderately volatile and refractory elements.

Conclusion: Although the Fig. 1 shows that there is a good correlation between CI and Photospheric composition, the errors in individual elemental abundances may be too large for the purpose of some models. In addition, knowing the reason for these variations in elemental abundances may tell us about the history of the protoplanetary disc.



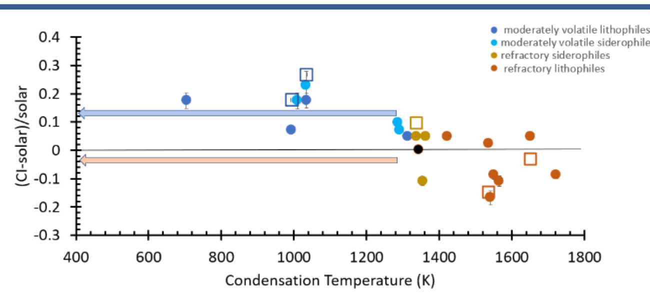


Fig. 2. Linear plots showing the differences of CI and solar vs. Condensation Temperature. 1σ<13%.

References: [1] Asplund et al. (2021) Astron & Astroph **653** 141A doi: 10.1051/0004-6361/202140445. [2] Desch et al. (2018) Astrophys. Jour. Supl. Series, **238**:11 (DOI: 10.3847/1538-4365/aad95f).