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Cr-54 anomalies and accretion ages of meteorite parent bodies

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A positive correlation between 54Cr excesses and accretion ages is observed among meteorites including iron meteorites, pallasites, mesosiderites, aubrites, HED meteorites, angrites, ureilites, acapulcoites and chondrites (including E, O, R, CK, CO, CV, CH-CB, CR, CM and CI) [1]. This suggests that 54Cr carriers were injected into the forming solar nebula. We could constrain the solar system evolution based on this observation. However, there are still many unsettled issues concerning the 54Cr anomalies, the accretion ages and the interpretation of the correlation. Here, we examine some of the most important issues.

26Al Heterogeneity: Homogeneous distribution of 26Al is assumed for calculating accretion ages of chondrites parent bodies. It is also assumed for estimating accretion ages of differentiated meteorite parent bodies. But, at present heterogeneous distribution of 26Al [2] cannot be ruled out. Comparison of precisely determined Al-Mg ages and other ages is needed to solve this problem.

Exceptions: The NWA011 grouplet (basaltic achondrites) and Tafassasset (primitive achondrite) do not fit the correlation. They both have high 54Cr excesses [3,4] similar to that of CR chondrites and yet apparently formed early when there was enough 26Al. A possible explanation may be that early-formed planetesimals in the terrestrial-planet formation region were gravitationally scattered into the far end of the asteroidal belt, capturing CR-like materials. This is an ad hoc explanation but is shown to be possible by numerical simulations [5].

CAIs: CAIs have 54Cr, 50Ti and 48Ca isotope anomalies which are larger than those found in bulk meteorites. 54Cr and 50Ti anomalies in CAIs and bulk meteorites appear to be well correlated with each other [6] but 48Ca anomalies are not so well correlated with them [7]. Since CAIs formed early, they do not fit the trend formed by various meteorites on the 54Cr vs. accretion age diagram. If we consider that the isotope anomalies of neutron-rich isotopes in CAIs and bulk meteorites originated from a similar source, then, a kind of chemical fractionation that enriched carriers of the neutron-rich isotopes must have operated during CAI formation. Otherwise, the anomalies in CAIs may have originated from a totally different source.

Other issues such as the way to estimate accretion ages of differentiated meteorite parent bodies will also be discussed at the meeting.

References

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