Meteorites as Building Blocks of Terrestrial Planets

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Meteorites and planets are made of the same material, the extremely well mixed interstellar medium (ISM): (1) Most elements have the same isotopic compositions in planets and meteorites (except for very volatile elements). This is not the result of widespread gas phase equilibration at the beginning of the solar system: Physically separable s-process components of Os [1] and Zr [2] in chondritic meteorites indicate that complete vaporization did not occur in the source region of primitive meteorites, instead the ISM must have been extremely well mixed. If s-process components were delivered with observed presolar SiC-grains [1, 2], all solar system materials, including the Earth, must contain the same amount of SiC. (2) Meteorites, the Earth and Mars have received the same fractions of short lived radioactive nuclides: $^{182}W/^{184}W$ ratios in various solar system samples, including the Earth [3], indicate that ^{182}Hf (9 my) was uniformly distributed in the inner solar system. The $^{26}Mg/^{24}Mg$ ratios of Earth and Mars are indistinguishable from chondrites, lower than in early formed Al-enriched material and higher than in Al-depleted meteorites [4]. Injection of ^{26}Al must have led to very uniform distribution throughout the inner solar system.

Compositional uniformity of the ISM is supported by the similarity in heavy element abundances between Sun and CI-chondrites. Deviations from CI-patterns are the result of processes in the early solar nebula and leads to five basic components: (a) *refractory component* (Ca, Al, Sc, REE, etc.) (b) Early formed *forsterite* (bulk Mg/Si-ratio). (c) Variable amounts of *FeNi-metal-alloys* (Fe-content).(d) *Moderately volatile elements* (Mn, Na, Zn, S, etc.) and (e) *Highly volatile elements* (rare gases, N etc.). Gas solid reactions produced various degrees of oxidation and affected the oxygen isotopic composition.

The Earth is composed of the same components with strong affinities to type 3 carbonaceous chondrites, which thus resemble the major nebular fractionations in the inner solar system [5]. Major differences are: Volatile depletion in the Earth is stronger than in C3 chondrites and the Earth has a higher Fe/Mg ratio than chondrites. The latter can be achieved by later, collisonal erosion [6].

References:

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