On the bulk mineralogical composition of carbonaceous chondrites in high-Mg/Si planetary systems.

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The study of the chemical composition of chondritic meteorites provides important informations to constrain chemical evolution of our planetary system. The bulk elemental composition of CI-type carbonaceous (c-) chondrites is the most consistent with the Solar elemental composition.

Observations of FGK stars in the Solar neighbourhood show that more than half of them have Mg/Si ratios between 1 and 2 (Delgado Mena et al. 2010). The Mg/Si is the most important elemental ratio, which determines the silicate mineralogy of terrestrial planets. The Earth-like Mg-silicate composition can be moderately common for rocky planets in the Milky Way Galaxy. The majority of FGK stars with Mg/Si ranging from 1 to 2 are moderately rich in Mg having higher Mg/Si than solar ratio. A small fraction of these stars may host rocky planets, which have a greatly different mineral composition compared to the terrestrial mantle. It has been assumed that a given group of chondritic materials in the Mg-enhanced planetary systems are most representative of the chemical composition of the host star, similarly to the CI-chondrites in the Solar System.

In the planetary systems with higher Mg/Si ratio than Solar (Mg/Si=1.05) (Asplund et al. 2005), the mineral composition or given mineral species of the chondrite components are richer in Mg than that of chondrites in the Solar System.

Chondrules are thought to be composed of Mg-rich olivine in most chondrites. Pyroxenes can also be found in chondrules and they are consist primarily of low-Ca pyroxenes containing enstatite ($Mg_2S_2O_6$), bronzite and hypersthene $(Mg,Fe)SiO_3$. The aluminium-rich chondrules contain plagioclase (mostly labradorite, bytownite and anorthite) and spinel ($MgAl_2O_4$).

CAIs (calcium-aluminium-rich inclusions) can be richer in forsterite, spinel, anorthite than chondrites in Solar-system.

The AOAs (amoeboid olivine aggregates), having comparable sizes to CAIs in the same meteorites, are composed mostly of forsterite. AOAs in Mg-rich chondritic materials can contain higher amounts of anorthite and spinel.

In the Mg-rich c-chondrites, the mixture of matrix minerals is olivine-rich, while it also contain pyroxenes, oxides, carbonates, metal, sulfides and phyllosilicates. The matrix is richer in volatile elements compared to the other components of chondrites.

A very small fraction of stars are thought to harbor rocky planets with high bulk Mg/Si ratio (Mg/Si > 1.5). The two most abundant mineral groups in meteorites are olivines ($(Mg,Fe)_2SiO_4$) and pyroxenes ($(Mg,Fe,Ca)SiO_3$). In chondritic materials of the most high Mg/Si systems ($1 < Mg/Si < 2$), the ratio of the species of these groups may generally be similar to the meteorites of the Solar System.

References

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