The petrology of extrasolar chondrites

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The cosmochemical principle that the bulk composition of chondritic meteorites is similar to the spectrally-derived composition of the sun is extended to other stars. Extrasolar chondritic mineralogy is first derived via simple four-component CMAS normative calculations for 476 stellar chemical compositions from a variety of sources.

The most common exochondritic mineral assemblage in the CMAS system is the solar one: anorthite (an) - fosterite (fo) - enstatite (en) – diopside (di). It is closely followed by an-fo-en-cordierite (cd). Other assemblages combine for less than 10% of stellar compositions, and include such assemblages as: An-en-di-quartz (qz), an-en-qz-cd, an-fo-cd-spinel (sp), and fo-sp-various silica-poor Ca/Mg phases.

Equilibrium condensation calculations for major elements show that stars with higher C/O or Si/O ratios than solar can have insufficient H_2O in the nebular gas to oxidize Mg, Si, Al, Ca during silicate condensation. Reduction of the nebular gas via silicate condensation leads to lower condensation temperatures for silicates, sulfide, silicide and nitride condensates, and CO breakdown into graphite and/or methane. Below 800K, this last reaction destabilizes the reduced condensates.

The percentage of stars with non-solar condensation sequences in a given survey ranges from fewer than 5% to more than 70%, depending on the study. Studies of stars from different research groups often lie in different mineralogical fields, and are not always within error of each other.

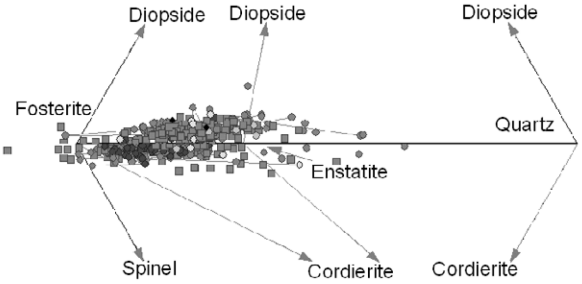

Figure 1: Equal-O projection of stellar compositions from anorthite into (truncated) fosterite-quartz-diopside and fosterite-quartz-spinel ternary diagrams. Circles: stars with planets; squares: stars without planets. Grayscaled by study.

Anoxia in coastal permeable sediments induces the release of Dissolved Organic Matter (DOM)

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Highest DOM concentrations are typically found in coastal waters where waves and currents circulate this DOM at various rates through the upper layers of sandy permeable sediments. To determine the effect of this flushing process on DOM, we injected ^{13}C-labeled DOM originating from an algal culture (*Rhodomonas lens*) in laboratory columns filled with sand from St Georges Island, FL.

Three fluid front velocities were chosen: 0.2, 0.9 and 2.2 cm h^{-1}. The DOM release largely exceeded the input of DOM, although the ^{13}C-labeled DOM was degraded to DI^{13}C through respiration. Results showed that the DOM injected to the columns triggered a release of DOM from the sand, and that the release rates increased with decreasing flow velocities. This suggests that the DOM release at low flushing rates is caused by the development of anoxic conditions produced by the degradation of ^{13}C-labeled DOM and reduced oxygen supply. To verify this hypothesis, we artificially caused oxic-anoxic oscillations in laboratory sand columns fed with algal DOM. The results showed that the DOM was consumed in oxic conditions and released in anoxic conditions. Changes in the DOM composition were monitored by ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS), and the results indicated that a large fraction of compounds from algal DOM were removed while new ones were released. The released DOM therefore originated from a different pool of organic matter originally present in the sediment.

We conclude that in coastal sands, redox oscillations in the upper sediment layer caused by changes in flushing rate and associated DOM and oxygen supply leads to cycles of DOM sorption and desorption, with DOM loading of the sand during periods of high sediment flushing and enhanced DOM release during calm conditions.