

Isotopic anomalies and presolar grains: Probes of nebular processes

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The solar system formed by gravitational collapse of a molecular cloud core composed of gas and dust. Some of the dust survived solar system formation to be incorporated into meteorites. Known types of presolar dust include diamond, SiC, graphite, Al₂O₃, SiN, hibonite, spinel, organic compounds, and silicates¹. The chemical properties and thermal resistance of these materials cover a large range. Thus, different degrees or styles of chemical and thermal processing in the solar nebula should produce different fractionations among the presolar materials.

Compositional classes of chondrites originated through processing in the solar nebula. Volatility-based and metal-silicate fractionations are the best-known signatures of this processing. The assemblage of presolar grains in a chondrite class correlates with the degree of volatility-controlled fractionation reflected in its bulk composition^{2,3}. For example, CI chondrites and CM2 matrices have bulk compositions most like the solar photosphere⁴. They also have the highest abundances of thermally labile but chemically resistant presolar graphite and the P-3 noble-gas component in diamonds, they have the highest SiC abundances and among the highest diamond abundances, and they have D-rich organics and presolar oxides. Thus, they contain the widest variety of presolar materials and the highest abundances of labile components in meteorites^{2,3}. In contrast, CV3 and CO3 chondrites show some of the largest refractory lithophile element enrichments⁴. These meteorites have no detectable presolar graphite, very low P3 contents in diamonds, little D-rich organics and SiC, but among the highest matrix-normalized diamond abundances. Thus, CV3s and CO3s contain among the most fractionated assemblages of presolar materials in chondrites^{2,3}. Other meteorites show similar correlations.

These correlations have important implications. First, presolar grains experienced the same processes that produced the volatility-controlled chemical fractionations among chondrite classes. Second, most of the material that makes up chondrites did not evaporate and recondense in the solar system. Instead, chondrites formed primarily from thermally processed presolar dust, only some of which remains recognizable. Third, assumed relationships among chondrite classes should be re-evaluated.

References

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The influence of heterotrophic bacteria and fungi on K-feldspar dissolution

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We studied the influence of heterotrophic microorganisms on the dissolution of a silicate mineral (K-feldspar) under a variety of growth conditions that reflect the range of conditions that might occur in nature. As a preliminary phase we screened a number of newly isolated bacterial strains and 5 strains of fungi (from the University of Westminster collection) for their ability to release Al and Si, as a measure of dissolution from feldspar. Forty strains of heterotrophic bacteria were isolated from garden soils. Aerobic liquid and solid media (C/N sufficient, K limited, Fe limited, glucose only and soil extract) at 26°C were used for isolation. Isolates were grown in aerobic batch cultures of each medium (above), buffered at pH7, containing 1% mineral powder (w/v), at 26°C rotating at 100rpm. Mineral dissolution was followed for 48h by monitoring release of Al and Si from the mineral by ICP-AES. The isolate (identified by 16S rRNA sequencing as *Bacillus megaterium*) that during the screening experiments showed the highest enhancing effect on feldspar dissolution was selected for more detailed study in order to establish the pattern of bacterially induced solute release from the mineral structure. Similar studies were carried out with one fungal strain (*Fusarium oxysporum*). The dissolution of the feldspar in the presence of *B. megaterium* and *F. oxysporum* was monitored every 4, 8, 10, 17, 20, 24, 28, 32, 36, 40, 48, 72 and 96h of incubation in C/N sufficient, K limited, N limited and Fe limited media. Samples for chemical analyses were taken after feldspar was allowed to settle; 50ml solution were removed from each flask and centrifuged at 10,000rpm for 10 min in order to remove cells from suspension. Five ml of the supernatant were acidified and analysed for Al and Si. The cells were re-suspended in phosphate buffer and centrifuged twice in order to remove all Al and Si loosely associated with the cells, but not permanently bound to the cell surface or taken-up internally. Five millilitres of the pooled supernatants were acidified and used for analysis. The cells were dried, digested with concentrated nitric acid at 100°C for 1h and also analysed for their Al and Si content. Additionally, the bacterial and fungal cells involved in feldspar dissolution experiments were studied by X-Ray Microanalysis TEM. Our results show that bacterial and fungal cells appear to play an important role in the dissolution of K-feldspar partly through acting as sink for Al and Si released from the mineral thus driving further dissolution.