

Composition and zoning of fassaite in type B2 refractory inclusions

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Type B (pyroxene-rich) refractory inclusions are a major type of Ca-, Al-rich inclusion found in meteorites. Most of what we know about them comes from studies of Type B1s, which have melilite-rich mantles. Little detailed data exist for B2s (no mantles). Differences between B1s and B2s can help us understand the formation of both types. In [1], we focused on melilite, and here we focus on fassaite (Ti-, Al-rich pyroxene). Normative An/Ge is lower in Type B1 inclusions than in B2s. As An/Ge increases, melilite incoming temperature decreases, affecting the composition of fassaite. We conducted electron probe traverses across fassaite grains in three B2s whose normative An/Ge (0.45–0.87) span the range observed for typical B2 inclusions [1]. Maximum $\text{TiO}_2^{\text{tot}}$ ($\text{Ti}_2\text{O}_3 + \text{TiO}_2$) are lower than in B1s and with increasing An/Ge, decrease from 9.9 to 7.4 wt %, consistent with decreasing amounts of prior crystallization of melilite. Contents of V_2O_3 (≤ 0.6) and Sc_2O_3 (≤ 0.2) are strongly correlated with $\text{TiO}_2^{\text{tot}}$ and are also lower than in B1s. Better-formed, subhedral to euhedral grains are more common in B2s than in B1s. Some are unzoned, have patchy zoning of Ti, or crystallographically controlled sector zoning of Mg and Al (Di and CaTs components, resp.). Sector zoning also affects $\text{TiO}_2^{\text{tot}}$ but not $\text{Ti}^{3+}/\text{Ti}^{\text{tot}}$. As expected for fractional crystallization, many grains are concentrically zoned from Ti-rich cores (typically 8–9 wt % $\text{TiO}_2^{\text{tot}}$) to Ti-poor rims (< 4 wt %), as in B1s. We observed three features of B2 fassaite that contrast with B1s. 1) Sector zoning is much more common in Type B2 inclusions than in B1s. 2) We found no sharp Ti-V enrichments (“spikes”) like those in B1 fassaite [2] that appear to record a change in redox conditions late in the crystallization history. 3) $\text{Ti}^{3+}/\text{Ti}^{\text{tot}}$ does not decrease from core to rim in zoned crystals. Such decreases are seen in some B1 fassaite due to depletion of the liquid in $\text{Ti}^{3+}/\text{Ti}^{4+}$ by fractional crystallization, as $D^{\text{fassaite/L}}$ for $\text{Ti}^{3+} > D^{\text{Ti}^{4+}}$ [3]. These imply that B1 liquids did not readjust their $\text{Ti}^{3+}/\text{Ti}^{4+}$ ratios, maybe because they were isolated from the reducing nebular gas by their surrounding melilite mantles. Late-forming cracks may have allowed reequilibration of residual liquid with the vapor, increasing the proportion of Ti^{3+} and yielding Ti^{3+} -rich spikes in late fassaite. With relatively little early melilite to create mantles, perhaps B2 liquids maintained equilibrium with the gas during fassaite growth, allowing readjustment of their $\text{Ti}^{3+}/\text{Ti}^{4+}$, and maintaining uniform ratios and preventing spikes in the crystals.

References

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Saccharides, lipids and oxidation products in Asian dust and marine aerosols of the East Asia/Pacific region

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One aspect of the Asian/Pacific Regional Aerosol Characterization Experiment (ACE-Asia) was to determine the organic compounds and their sources in the aerosol particles. During the ACE-Asia campaign in 2001 spring to autumn, atmospheric particles were collected on quartz filters using high-vol. air samplers at the two island sites. Marine aerosol samples were also collected over the western North Pacific, the East China Sea and the Sea of Japan. Aliquots of filters were extracted with a methylene chloride/methanol mixture (2:1), concentrated and then silylated with BSTFA at 80°C for 60 min. This procedure derivatizes COOH and OH groups to the corresponding trimethylsilyl (TMS) esters and ethers, respectively. The reaction products were analyzed by GC-MS.

More than 100 compounds were identified in the aerosol samples. They are categorized into different classes in terms of functional groups and sources. First, sugars were detected, including levoglucosan, galactosan and mannosan which are tracers for biomass burning, as well as saccharides. Second, homologous fatty acids (C_{12} - C_{30}) having strong even/odd carbon number predominances and a maximum at C_{16} (palmitic acid) were present, suggesting a contribution from terrestrial higher plants and marine biota, as well as cooking. A trace of dehydroabietic acid (derived from conifer burning) was also found. The third group includes dicarboxylic acids ($> \text{C}_3$) and other polar oxidation products (e.g., glyceric, maleic). The fourth group includes *n*-alkanes (C_{18} - C_{35}) with a strong odd/even predominance, suggesting an important contribution from higher plant waxes. Emissions from vehicle traffic (urban) were assessed from the non-wax alkanes and UCM with hopane biomarkers. The fifth includes PAH ranging from phenanthrene to coronene, all combustion products of coal and petroleum.

In addition to secondary photochemical oxidation products in the atmosphere, we identified major external sources including (1) the plant wax composition which fits with an origin from the deserts of northwestern China; (2) high levels of tracers from biomass burning smoke and from agricultural soil resuspension; and (3) high levels of PAH mainly from coal combustion.