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FORMATION OF JADEITE FROM PLAGIOCLASE: CONSTRAINTS ON THE P-T-t CONDITIONS OF SHOCKED METEORITES

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Introduction: It is well known that sodic plagioclase decomposes into jadeite and silica phase (coesite or stishovite) at high pressures. However in shocked meteorites, only jadeite has been found without silica phase even in the grain having a chemical composition of plagioclase. We have conducted in situ X-ray diffraction experiments on this decomposition reaction using Kawai-type high-pressure apparatus and synchrotron radiation, and found differences in nucleation kinetics between jadeite and silica phase. P-T-t conditions for the presence of jadeite and no silica phase have been constrained based on the experimental kinetic data.

Results and Discussion: The starting material is natural albite ($Ab_{98.0}An_{0.4}Or_{1.6}$). Fully amorphization was not observed during compressions up to 27 GPa at room temperature, but occurred by heating at high pressures. The amorphization pressure decreases with increasing temperature. For example, we have observed that albite becomes amorphous at 23 GPa and 1173 K. This amorphization pressure is much lower than those reported in previous shock experiments and DAC studies at room T.

Crystallization kinetics of high-pressure assemblages from amorphous albite was examined by time-resolved X-ray diffraction measurements every 10 s using energy dispersive method. We observed that jadeite first appears from amorphous albite and nucleation of stishovite is significantly delayed. Pressure and temperature dependences on the crystallization rate of jadeite and stishovite were determined to estimate P-T-t kinetic boundaries among amorphous albite, jadeite (no stishovite), and jadeite + stishovite.

Extrapolations of kinetic data obtained to the time scale of 1 s indicate that only jadeite is present between 1473–1973 K at around 20 GPa. Stishovite also appears at higher T, and both jadeite and stishovite are not formed at lower T. In the time scale of 10 s, these kinetic boundaries shift to lower T by 200–400 K. Thus, the presence of jadeite without silica phase found in shocked meteorites can be explained due to the difference in crystallization kinetics from amorphous albite. This can be an important constraint on the P-T-t conditions of shock events.

Reaction microstructures of recovered samples were observed by SEM, which were compared to those of shocked meteorites. Preliminary results suggest that the grain size of reaction products in shocked meteorites is much smaller than that in the experiments probably due to differences in P-T-t conditions.

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AlO(OH) IS A MAJOR CONSTITUENT OF THE CAI "BLUE MOON" FROM THE RENAZZO (CV3) CHONDRITE

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Water- and (OH)-bearing phases in Ca-Al-rich inclusions (CAIs) are known from CM chondrites [e.g., 1] as well as from micrometeorites and IDPs [e.g., 2–6]. They are widely believed to be parent body alteration products of former non-hydrous phases and comprise typically Fe, Mg phyllosilicates, which take the place of, e.g., diopside, that commonly covers spinel + melilite + perovskite intergrowths [7]. Here we report on the first occurrence of AlO(OH) as a major constituent in a CAI.

Blue Moon is a large (~3 mm), bright blue colored CAI from a Renazzo sample of the NHM in Vienna. It has an irregular, elongated shape and consists of complex intergrowths of refractory minerals of varying grain sizes, forming two distinct lithologies, which differ in texture and mineral abundances. The principal units appear to be AlO(OH) (up to ~100 µm) enveloped by hibonite laths (up to ~50 µm long) embedded in spinel, which form an amoeboid, fluffy network that is incompletely rimmed by gehlenite and embedded in anorthite (±gehlenite ± spinel ± diopside ± forsterite). Wollastonite, nepheline, and calcite are rare interstitial phases.

AlO(OH) commonly encloses small elongated, rounded perovskites. AlO(OH) is optically isotropic and Raman-amorphous [8] and fairly pure with (EMP analysis) 85 wt% Al_2O_3 and low Na_2O (~0.1), SiO_2 (~0.5), CaO (~0.5), and TiO_2 (~0.1 wt%) contents. Hibonite contains some TiO_2 (1–4 wt%); spinel, diopside, and forsterite are very poor in FeO (0.1, 0.1, and 0.4 wt%, respectively) and anorthite is free of Na. Refractory trace element (RTE) contents (as determined by SIMS) are ~200–350 × CI in perovskite, 3–20 × CI in all other phases, except AlO(OH) and calcite (~1–2 × CI). Ubiquitous are negative abundance anomalies of Yb, Eu, and Ce in most phases, except AlO(OH), and calcite, which have only an Yb deficiency. AlO(OH) contains excess ^{26}Mg with an initial $^{26}Al/^{27}Al$ of $(5.24 \pm 0.14) \times 10^{-5}$.

Because AlO(OH) cannot be a primary phase condensed from solar nebula gas it had to have a precursor that was Al-rich and RTE-poor, perhaps AlN, or Al_4C_3, or ? Such a phase, however, will need a gas that was more reducing than the solar nebula [e.g., 9]. The abundant negative abundance anomalies of Yb and Eu point into the same direction. However, the small but also common Ce(-) anomaly (not present in perovskite!) demonstrates the highly refractory nature of the assembly for condensation conditions close to those predicted for the solar nebula [9].

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