AQUEOUS ALTERATION IN TWO CM CARBONACEOUS CHONDRITES FROM THE GROVE MOUNTAINS, ANTARCTICA

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Introduction: Chondrules and CAIs in CM chondrites are small - typically <0.5 mm in diameter - and have a narrow size-range. The modal abundance of matrix and chondrule in CMs are 70 and 20 vol%, respectively [1], and the bulk of CMs is composed of extremely fine-grained hydrous matrix. Despite their nearly solar chemical composition (highly volatile elements excluded), the CM group is mainly composed of phyllosilicates, attesting to early secondary processing of their parent asteroids [2,3]. The bulk of the minerals hydration probably occurred in these meteorites parent bodies after ice that accreted with rocky materials have melted. Indeed, there is a wealth of petrologic evidence in CM chondrite showing that primary components have been transformed by in situ water - rock interactions and demonstrating the alteration of primary anhydrous minerals and their replacement by phyllosilicate-rich assemblages [4,5].

Samples and Experiments: Two CM samples (GRV 020025 and 050179) were were collected from Grove Mountains, Antarctica. They were embedded in epoxy, and then cut into ~1 mm thin slices. Polished thin sections were prepared from the both slices without water. Both of the surface areas are 1.2 cm^2 and 1.31 cm^2, respectively. Textural observations of phyllosilicates was used the back-scattered electron (BSE) image mode of the electron probe microprobe analyzer (EPMA) JXA-8230 in College of Earth Sciences, Guilin University of Technology. Quantitative analyses of individual minerals were carried out using the same EPMA. Natural and synthetic minerals were used as standards. The operating conditions were 15 keV accelerating voltage and 20 nA beam current. The analyses were corrected using the conventional ZAF program.

Results and discussion: GRV 020025 and 050179 were classified as CM chondrite[5-7]. Phyllosilicates are common in CAIs, chondrules and matrix of the both chondrites. Quantitative analyses show low totals (79-85 wt%), suggestive of presence of OH and/or H_2O. Besides SiO_2 (14.5-28.3 wt%), MgO (8.26-20.9 wt%), Al_2O_3(4.05-15.8 wt%), phyllosilicates are highly FeO-rich (23.6-40.5 wt%). Most CAIs, chondrules and matrix in GRV 020025 and 050179 contain fine-grained and needle-shaped phyllosilicates, which are typical aqueous alteration products and are common in CM carbonaceous chondrites. In CAIs from GRV 020025 and 050179, the presence of phyllosilicates and absence of melilite (one of the most common primary phases of CAIs) indicate that these CAIs have been nearly completely been altered. Assuming the precursor of the phyllosilicates is melilite in CAIs. Where and when the alteration took place is a controversial issue. Very low abundances or absence of extinct radionuclides (*e.g.* ^{26}Al) in the alteration products of CAIs suggests that the secondary processes took place > 5 Ma after the earliest CAI formation [8]. Such a long interval points to an asteroidal origin of the alteration, because it is too long for residence in the solar nebula. The discovery of significant ^{36}Cl (half life of 0.3 Ma) in sodalite in alteration assemblages of a Ningqiang CAI [9] suggests that CAI alteration could have took place as early as ~2 Ma, hence probably in the nebula. Another evidence for a nebular origin of the alteration is very high heterogeneity of CAI alteration in some carbonaceous chondrites. However, phyllosilicates are commonly found in the alteration assemblages of CAIs, chondrules and matrix in the GRV 020025 and 050179 CM chondrites, suggesting aqueous reactions probably occurred in the parent body. Elmaleh et al. think that alteration resulted in Fe import and Ca export by the fluid phase and in massive Fe-rich phyllosilicates formation. Aqueous Fe^{2+} was transported to the initially Fe-depleted CAI, where local changes in PH conditions, and possibly mineral catalysis by spinel promoted the partial oxidation of Fe^{2+} into Fe^{3+} by water and the formation of Fe-rich phyllosilicates close to the cronstedtite endmember. Such mechanisms produce H_2, which opens interesting perspectives as hydrogen may have reacted with carbon species, or escaped and yield increasingly oxidizing conditions in the parent asteroid[3]. As discussed above, phyllosilicates are common in CAIs, chondrules and matrix in GRV 020025 and 050179, the progress of aqueous alteration took a long time and a large scope in their meteorites parent body.

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