

Aqueous alteration of primary rock on the CM parent body

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Introduction: Most brecciated CM chondrites contain clasts of a specific, well-characterized rock type termed "primary accretionary rock" by [1]. This rock represents densely packed agglomerations of chondrules, refractory inclusions and fragments most of which are mantled by fine-grained dust layers. In our interpretation these dust mantles have formed in the solar nebula and the primary accretionary rock represents the first rock generation of the CM parent body prior to parent body alteration processes.

SEM investigations of a large thin section (Fig.1) from the brecciated CM chondrite Nogoya revealed that it consists of a variety of lithic fragments most of which show the typical accretionary texture as described above. Nevertheless, many of these fragments (Fig.1; Nog-1 to Nog-5) appear distinctly different on BSE images due to variations in their mineralogical composition and the alteration state of chondrules, refractory inclusions, and other coarse-grained components. Obviously, these fragments were aqueously altered to varying degrees on the parent body, but, nevertheless, were able to preserve their original accretionary fabric in form of pseudomorphic "ghost structures". Similar primary fragments can also be found in Cold Bokkeveld and ALH83100. In the following, four fragments of primary rock from Nogoya are described, three of which show secondary induced ghost structures.

Nog-1 (Fig. 2) is the least altered fragment of primary rock consisting of apparently unaltered Fe-rich (lower right) and Mg-rich chondrules (upper left) and mineral fragments most of which exhibit accretionary dust mantles. The Fe-rich units between the larger chondrules are mainly PCP-rich objects [1] composed of tochalite, serpentines and minor amounts of calcite and pentlandite.

Nog-2 (Fig. 3) consists of extensively to totally altered chondrules with dust mantles. Chondrule olivine (oliv.) is dominantly replaced by serpentine (serp.). The material between chondrules is dominated by fine-grained intergrowth of cronstedtite and Fe-poor serpentine, frequently in pseudomorphic replacement of PCP-rich objects. Accessories are pyrrhotite, pentlandite, and minor amounts of magnetite.

Nog-3: (Fig.4) is another extensively altered fragment with ghost structure that was exposed to somewhat different alteration conditions than Nog-2. It is almost free of pyrrhotite, contains very little pentlandite and is interspersed with clusters of secondary magnetites (magn.). Dust mantle structures are well-preserved.

Nog-5: (Fig.5): is similar to Nog-3 and consists of extensively altered chondrules with dust mantles. It contains large amounts of magnetite clusters and is cross-cut by Ca-sulfate veins. This fragment was apparently altered to a somewhat higher degree than Nog-3.

Additionally, Nogoya contains several fine-grained breccia clasts (Nog-A to Nog-D) that lack chondrule relicts, consisting mainly of Mg-rich serpentines with minor amounts of magnetite, pyrrhotite, pentlandite, and occasionally Ca-sulfate veins. They may represent extremely altered CM or admixed CI material.

Conclusions: Variations in the mineralogical composition of altered primary rock fragments indicate that a single starting material (primary accretionary rock) was affected under different alteration conditions on the CM parent body. Fragments of different alteration state are good candidates to study this variety of alteration conditions, since each fragment provides unique information on the specific alteration conditions in its source region, i.e. temperature, pressure, fluid composition, and alteration duration. The presence of these secondary alterations does not affect the controversy on the existence of preaccretionary aqueous alteration features in certain primary rock fragments from CM chondrites [1, 2].

References: [1] Metzler et al. (1992), *GCA* **56**, 2873-2897, [2] Kerridge et al. (1994), *Meteoritics* **29**, 481

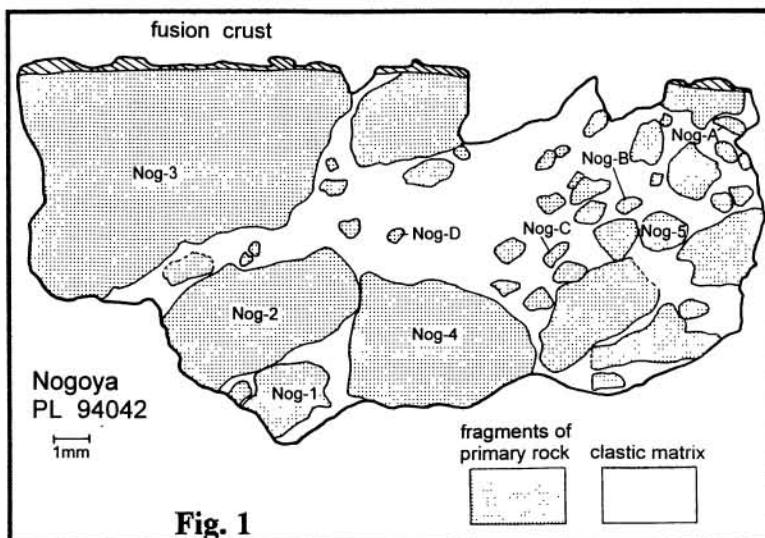


Fig. 1

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