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The history of one compound megachondrule

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We studied a megachondrule from an unclassified meteorite from the Sahara Desert, acquired in 2010. The meteorite, measures ca. 4×5 cm, exhibits a glossy brown desert varnish, and is cut by numerous fractures. Petrological, mineralogical, and chemical analyses (SEM-EDS), have led to the preliminary classification of the meteorite as an unequilibrated ordinary chondrite (L3, S3, W2/W3). Quantitative phase abundances indicate the following composition (in wt%): olivine (54), pyroxene (33), feldspar (5), goethite (3), and iron sulfides (5). In addition chromite, ilmenite and Fe-Ni phases are present.

Examination of a thin section reveals ca. 400 well-defined, closely packed chondrules, predominantly ellipsoidal or spherical, with diameters 0.62 - 0.85 mm. Moreover the meteorite contains megachondrules (or their fragments), compound chondrules, and clasts. Seven megachondrules of different types, with size > 2.5 mm were identified.

The investigated compound megachondrule measures 2.8×3.2 mm. It comprises a primary ellipsoidal megachondrule (2.1×2.8 mm) and a secondary megachondrule of variable thickness (0.3–0.5 mm) of enveloping type, both classified as porphyritic olivine (PO). Their similar chemical and mineralogical compositions suggest they are “siblings”. We found olivines (Fa7 -35), low-Ca orthopyroxenes, high-Ca clinopyroxenes (pigeonite and augite) and high-Ca plagioclase (bytownite) mesostais.

Additionally, three secondary porphyritic pyroxene-olivine (PPO) adhering type chondrules, (0.3 to 0.4 mm in diameter) are attached to the enveloping chondrule. They can be determined as “independent” in comparison to megachondrules (PO), due to its mesostasis enriched in Na and higher proportion of pyroxenes relative to olivines.

The presence of compound chondrules suggests dynamic conditions within the early solar nebula, where chondrule formation likely occurred through a multi-stage process. Proposed sequence of these cosmic events is presented in the study.

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