

MINERALOGY AND CHEMISTRY OF LARGE CHONDRULES FORMED <0.8 MILLION YEARS AFTER CAIS

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Introduction: Since decades detailed Al-Mg-studies on the age of chondrules in chondrites lead to the assumption that chondrules formed at least 1-2 My after Ca,Al-rich inclusions (CAIs). Recently, we have investigated several macro chondrules [1] from five ordinary chondrites (NWA 5072, NWA 4572, Sahara 97210, Ilafegh 013, Adrar 003) and one unique chondrite (HaH 180) in order to see, if these have similar ages to the “normal-sized” chondrules. Here, we will present details on the mineralogy and composition of these macro chondrules.

Results: Ion probe Mg/Al-isotope analyses of Chaussidon and Bischoff [2] revealed that three macro chondrules formed within the first 0.3 (± 0.3) million years and two others are slightly younger $\sim (0.8 \pm 0.3)$ million years). These authors also found that the old chondrules consist of ¹⁶O-poor silicates [2].

All studied macro chondrules (>3 mm) can be characterized by having barred or radial textures (e.g., barred olivine (BO), radial olivine-pyroxene (ROP), barred olivine-pyroxene (BOP)), which leads to the assumption that chondrules with these textures were once completely molten. It has been shown that the distributions of different chondrule types are drastically different between macro chondrules and “normal-sized” chondrules [1]. The porphyritic types clearly dominate among the normal-sized chondrules.

The old chondrules analyzed in this study have abundant rapidly-crystallized, zoned grains of olivine and pyroxenes embedded in a fine-grained groundmass, which consists in three cases of an intergrowth of An-rich plagioclase ($\sim \text{An}_{75-90}$) and Ca-bearing pyroxene. In the two other cases Si,Al-rich glasses having SiO₂-concentrations of up to 90 wt% were found intergrown with Ca-rich pyroxene. In all cases the chondrule-dominating phases olivine and pyroxenes contain considerable concentrations of FeO (Fa₇₋₄₁ and Fs₅₋₄₂, respectively).

The major element bulk compositions of the old chondrules were obtained by defocussed beam electron microprobe analyses. The determined bulk composition of the macro chondrules revealed that all are FeO rich (12-20 wt%) similar to the compositions of normal-sized type II chondrules (e.g., [3]).

Conclusions: With some exceptions macro chondrules appear to be systematically older than normal-sized chondrules. We suggest that their formation started contemporaneous with Ca,Al-rich inclusions and covered a large time range, in which also the cluster chondrites formed [4]. The accretion of the final parent body, however, occurred late, after formation of normal-sized chondrules and at a time most ²⁶Al had decayed.

References: [1] Weyrauch M. and Bischoff A. 2012. *Meteoritics & Planetary Science* 47:2237-2250. [2] Chaussidon M. and Bischoff A. 2014. *Meteoritics & Planetary Science* 49: this issue. [3] Kita N.T. et al. 2010. *Geochim. Cosmochim. Acta* 74:6610-6635. [4] Metzler K. and Chaussidon M. 2014. *Meteoritics & Planetary Science* 49: this issue.