OXYGEN ISOTOPIC COMPOSITION OF CLUSTER CHONDRITE CLASTS AND THEIR COMPONENTS IN ORDINARY CHONDRITES. K. Metzler[1] and A. Pack[2], [1]Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Strasse 10, 48149 Münster, Germany. E-mail: knut.metzler@uni-muenster.de. [2]Georg-August-Universität Göttingen, Geowissenschaftliches Zentrum, Goldschmidtstrasse 1, 37073 Göttingen, Germany. E-mail: andreas.pack@geo.uni-goettingen.de.

Introduction: Cluster chondrites (clch´s) are a specific type of chondritic rock, which occurs as lithic clasts in unequilibrated ordinary chondrites (UOC`s). They are interpreted as fragments of chondritic lithologies of unknown original dimensions [1]. The largest clast found so far has a diameter of 10 cm. Cluster chondrites are characterized by high chondrule concentrations, low amounts of interchondrule matrix, and close-fit textures of interlocked deformed and undeformed chondrules (Fig. 1). These rocks seemingly formed by the accretion of freshly formed hot and viscously deformable chondrules within hours to a few days after chondrule forming events. They seem to represent primary accretionary rocks with mechanically unaltered internal textures [1]. This distinguishes them from other UOC´s, most of which seem to have been mechanically reworked after accretion down to the mm scale [e.g. 2, 3].

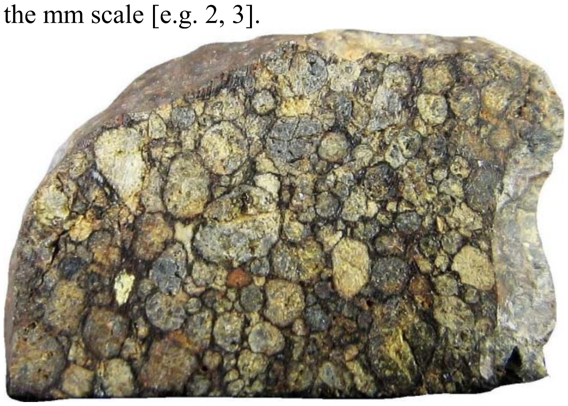

***Fig. 1**. Deformed and interlocked chondrules in a clch clast from NWA 3119 (sawn surface; width of field is 1.4 cm)*

Samples and analytical methods: In order to further characterize cluster chondrites and their components we measured the bulk oxygen isotopic composition of 7 cluster chondrite clasts from 6 different meteorites (Krymka, NWA 869, NWA 3119, NWA 4522, NWA 5205, NWA 5421) by IR laser fluorination. First results were published in [4]. Furthermore, 104 chondrules were measured *in-situ* by 193 nm UV laser fluorination. The errors (1σ SD) are 0.25 ‰ ($\delta^{18}O$) and 0.04 ‰ ($\Delta^{17}O$) for both methods. For all chondrules the textural and chemical types were determined. The investigated chondrules include all major chondrule textural types, i.e. porphyric olivine pyroxene (POP), porphyric olivine (PO), porphyric pyroxene (PP), granular olivine pyroxene (GOP), radial pyroxene (RP), barred olivine (BO), and cryptocrystalline (C) chondrules. In order to distinguish between chondrules of chemical types I (Fo, Fa ≤ 10 mol%) and II (Fo, Fa ≥ 20 mol%), respectively, the core compositions of the most Mg-rich olivine and pyroxene grains have been measured by SEM-EDX. Chondrules with Fo/Fa values between 10 and 20 mol% were left "undefined" in order to avoid misidentification due to a possible increase of Fo/Fa values caused by mild thermal metamorphism.

Results: Bulk cluster chondrite clasts plot on the trend defined by H, H/L, L, and LL chondrites of petrologic type 3 (Fig. 2). The L cluster chondrite clast (petrologic type 4) falls in the field of L chondrites and the LL cluster chondrite clasts (petrologic types < 3.5 to 3.7) plot at the upper end of the LL chondrite field.

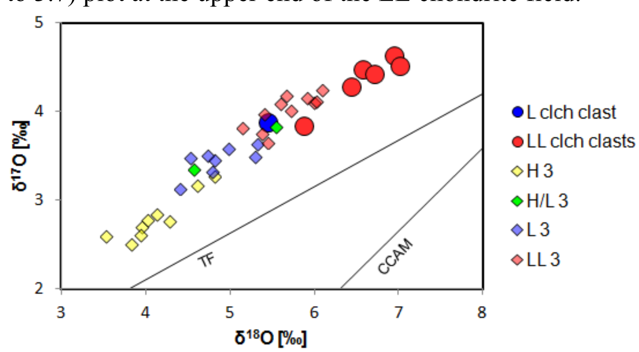

***Fig. 2.** Bulk oxygen isotope data for 6 clch clasts of petrologic type 3 from LL chondrites (red circles) and 1 clch clast of petrologic type 4 from an L chondrite (NWA 869; blue circle). The values for bulk H, H/L, L, and LL chondrite falls are shown for comparison [6]. TF: Terrestrial fractionation line; CCAM: Carbonaceous chondrite anhydrous mineral line.*

The in-situ chondrule data in all cluster chondrite clasts scatter over the entire range of chondrules from H to LL chondrites (Fig. 3), a fact also known from other UOC´s [e.g. 5]. The range of literature data for UOC chondrules is shown in Fig. 4. The chondrules fall on a trend or mixing line with slope 0.63 that is similar to the slope of 0.69 observed by [5] for chondrules from other UOC´s. In Fig. 3 the data are shown for various chondrule textural types. No correlation between oxygen isotopic compositions and textural types is observed. In Fig. 4 the same data set is shown where data points are marked according to their chemical types. As in case of texture, no correlation between chondrule types and oxygen isotopic composition is observed. Four areas of interchondrule matrix were measured *in-situ* in cluster chondrite clasts. The oxygen isotopic data are also shown in Fig. 4 (green symbols). Matrix falls on a parallel trend of the OCs and OC chondrules; possibly with a slight (~0.5 ‰) enrichment in ^{16}O.

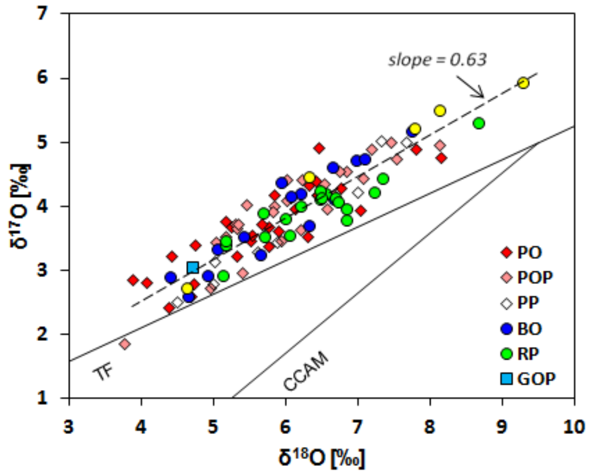

Fig. 3. *Oxygen isotope data for chondrules of various textural types from clch clasts. Dashed line: Mixing line, best fit*

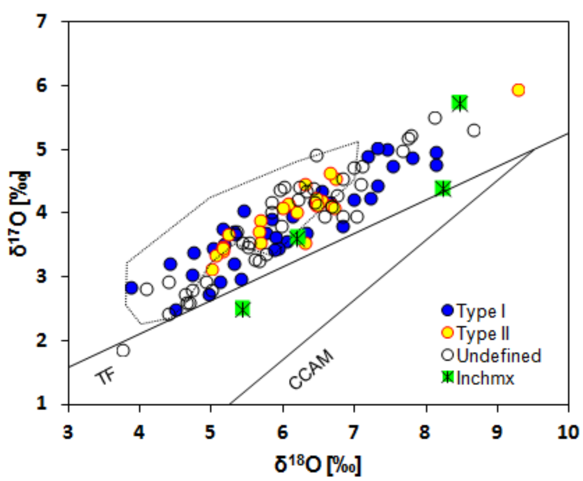

Fig. 4. *Oxygen isotope data for chondrules from clch clasts, marked according to their chemical types (I, II, “undefined”; see text). Inchmx: interchondrule matrix areas in clch clasts. Framed field: Main field of literature data for UOC (H, L, LL) chondrules [6,7,8]*

The *mean* isotope compositions of the different textural and chemical chondrule populations from the studied L and LL cluster chondrite clasts are very similar (Fig. 5) with the exception of the C type chondrules which have higher $\delta^{18}O$ values. The C type chondrule population, however, was heterogenous and small compared to other textural types and more data are necessary to substantiate the observation.

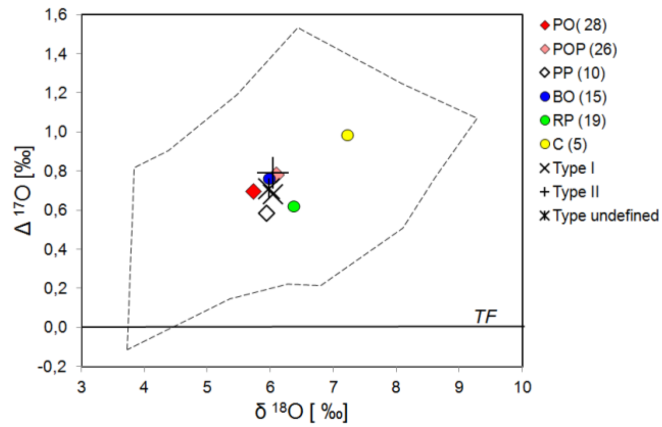

Fig. 5. *Mean oxygen isotope values for chondrules of various types from clch clasts. Chondrules of all types, except for C type chondrules, are nearly identical within analytical errors (Number of chondrules in parenthesis) Framed field: Variation of individual chondrule data.*

Conclusions: The absence of a relation between chemical and textural chondrule types and oxygen isotopes suggests that the variations seen may have been established during chondrule melting. This observation distinguishes the cluster chondrite (and likely all OC chondrules) from chondrules in carbonaceous chondrites that show distinct relations between isotopy and type [e.g. 9]. During chondrule melting, interaction with the surrounding gas could be responsible for the observed trend, as concluded by others [e.g. 5]. Bulk clasts of cluster chondrites and their chondrules have oxygen isotopic compositions similar to that of other UOC´s. This suggests that cluster chondrites formed from the same material as other UOCs, but preserved an earlier state of chondrite accretion (accretion of hot and viscous chondrules).

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