

The ungrouped chondrites have attracted a lot of attention recently. This group includes highly reduced chondrites such as Acfer 370 [1] and even more reduced ungrouped chondrite El Medano 301 (EM 301) [2]. Acfer 370, an ungrouped chondrite of petrologic type 3 [1] and NWA 7135, an ungrouped chondrite of petrologic type 3/4 [3], that show affinities with dark chondritic clasts in the Cumberland Falls aubrite (CFC) [4]. Other chondrites, defined as low-FeO ordinary chondrites, have OC whole-rock chemical composition but olivine and pyroxene richer in Mg than OCs [5]. It was suggested that these clasts are the fragments of an otherwise unsampled “F chondrite” (F for “Forsterite”) parent body which upon a collision with the aubrite parent body led to the formation of Cumberland Falls polymict breccia [5]. Chondritic clasts inside IIE iron meteorites (also reduced), defined as HH chondrites, with reduced olivine and pyroxene compositions and higher concentration of siderophile elements than OCs, are thought to be fragments of a different parent body than H chondrites [6-8].

Here we report results on investigation of a new ungrouped chondrite from Chile, Chug-Chug 086 (CC 086), and discuss its affinities with other reduced ungrouped chondrites.

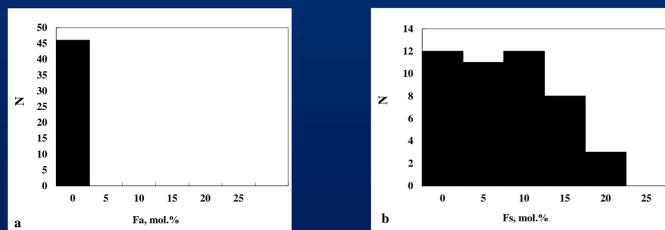


Fig. 4. Fa of olivine (a) and Fs of low-Ca pyroxene (b) of CC 086.

Average olivine composition of CC 086 is Fa  $2.13 \pm 0.08$ , (Fig. 4a) and average orthopyroxene composition is Fs  $12.3 \pm 5.0$  (Fig. 4b), Wo  $1.21 \pm 1.20$ , Fe/Mn =  $21.2 \pm 8.7$ , clinopyroxene is represented by pigeonite (Fs 10.5-27.5, Wo 6.6-14.8), augite (Fs 2.6-22.4, Wo 30.3-43.7) and diopside (Fs 1.0-9.2, Wo 46.0-49.6). Glass of plagioclase composition is: Ab 9.7-83.4, Or 0.13-17.4. Fe,Ni-metal contains 6.37 wt% of Ni, 0.46 wt% of Co, sulfide is represented by troilite.

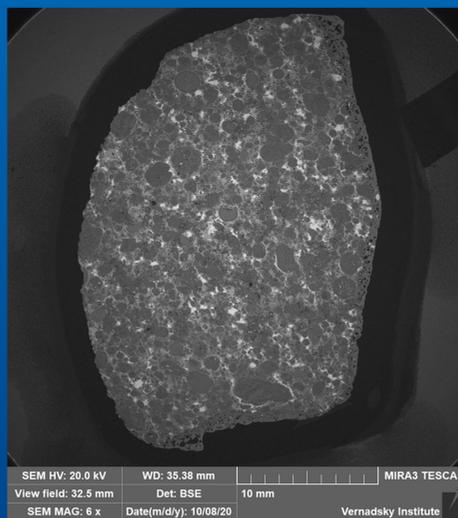


Fig. 1. BSE image of CC 086.

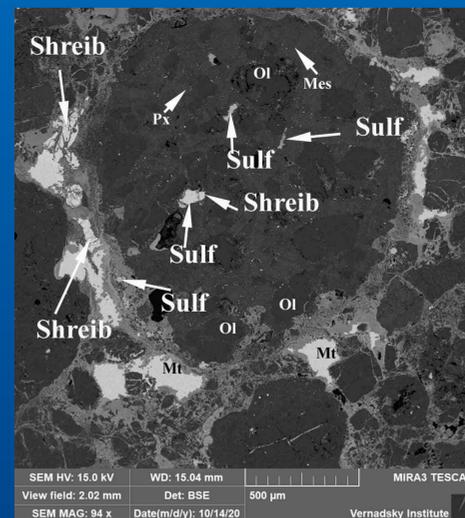


Fig. 2. POP chondrule of CC 086.

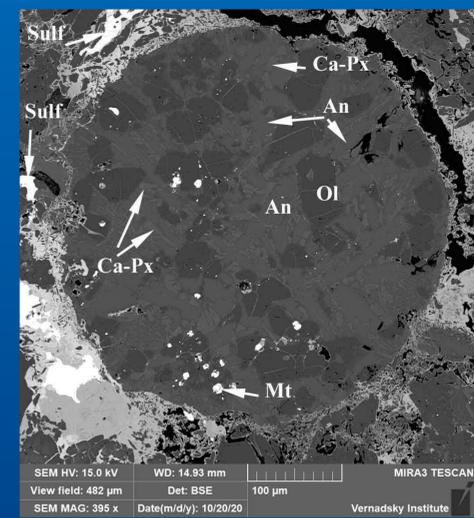


Fig. 3. Al-rich chondrule of CC 086.

Meteorite consists of well-defined chondrules (~90%) and matrix (~10%) (Figs. 1,2), average size of chondrules is  $283 \pm 270$   $\mu\text{m}$ , however, several chondrules, up to 4 mm, also occur. POP (Fig. 2), OP and PP chondrules are abundant, BO and PR chondrules are rare. One Al-rich chondrule occurs in the section (Fig. 3). CAIs are absent. Main minerals in the meteorite are olivine, pyroxene, Fe,Ni-metal, troilite, glass and products of terrestrial weathering. Silica, schreibersite, and chromite are secondary minerals. Modal abundance of weathering products, Fe,Ni-metal and troilite – 19 vol.%. Glass of plagioclase composition occurs in chondrules.

Shock features are minimal and correspond to stage S1, weathering grade is W3.

Olivine and pyroxene in CC 086 are very reduced than those in OCs. Olivine is homogeneous and orthopyroxene has variable composition like those in very reduced ungrouped meteorite, EM 301, with average olivine and low-Ca pyroxene of Fa  $3.9 \pm 0.3$  and Fs  $12.8 \pm 4.9$ , respectively. These values are far lower than the values for OCs and even for chondrites designed as “reduced” chondrites (Fig. 6). Olivine and low-Ca pyroxene are the dominant mineral phases, and low-Ca pyroxene shows zoning with higher MgO contents along the crystal rims (reverse zoning). Unlike NWA 7135 and the CFC, it does not contain highly reduced mineral phases like dauberelite.

The Co content of kamacite is in the range of that observed in H-chondrites (0.46 wt%).

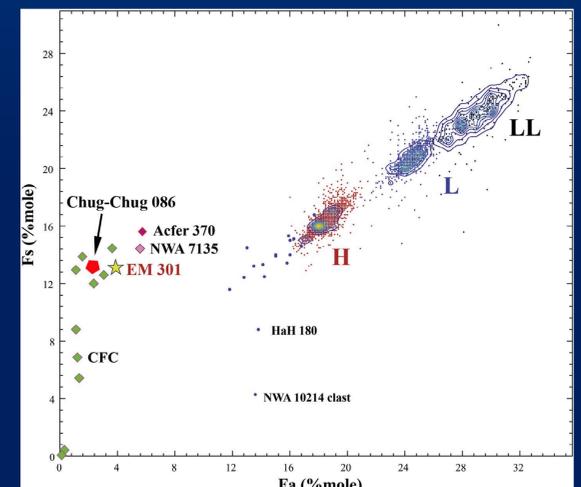


Fig. 6. Fa vs. Fs in the reduced chondrites compare to ordinary chondrites.

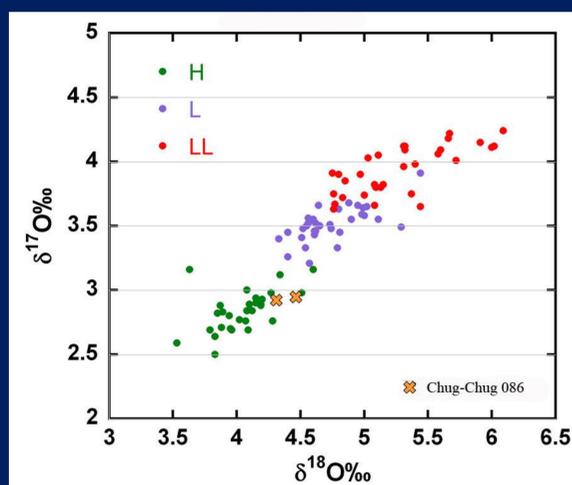


Fig. 5. Oxygen isotopic compositions of CC 086 compare to ordinary chondrites.

Oxygen isotopic compositions of CC 086 are:  $\delta^{17}\text{O}$  2.923, 2.949;  $\delta^{18}\text{O}$  4.312, 4.464;  $\Delta^{17}\text{O}$  0.715, 0.628 (‰) (Fig. 5).

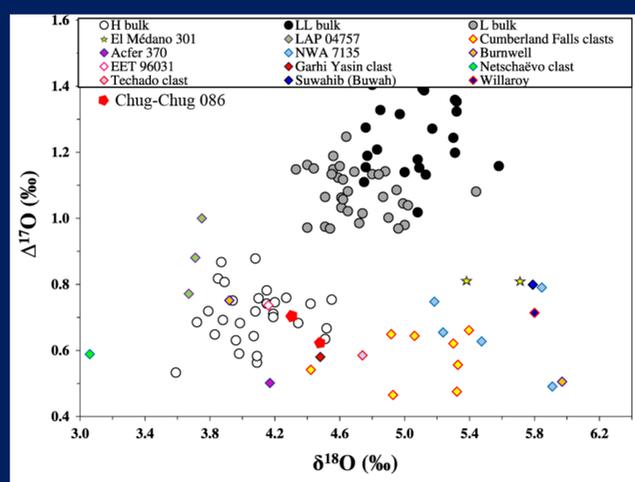


Fig. 7. Oxygen isotopic composition of all reduced chondrites and clasts compare to ordinary chondrites [2].

Oxygen isotopic compositions are  $\Delta^{17}\text{O} = +0.72, +0.63$ ‰, are similar to those of H-chondrites, and closed to those of the CFC, EET 96031 and the Garhi Yasin clast (Fig. 7).

### Summary.

Thus, this meteorite is an ungrouped forsterite-rich chondrite although its oxygen isotopic composition, average chondrule size and Co content in kamacite are in the range of H chondrite. The CC 086 olivine composition probably does not correspond to the Prior's law – the more abundant metal, the less reduced olivine and low-Ca pyroxene in chondrites – like for all ordinary chondrites. Modal abundance of weathering products, Fe,Ni-metal and sulfide in CC 086 is much lower than that of EM 301 (31 vol.%), but it is difficult to value a precise content of the Fe,Ni-metal in CC 086.