RELATIONSHIP OF DAUBRÉELITE WITH TROILITE: A STUDY OF TROILITES OF ENSTATITE CHONDRITES AT THE NANOSCALE

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Introduction: Enstatite chondrites (E) belong among the most reduced materials in our Solar system. They are divided according to their bulk iron content into EL (low iron) and EH (high iron) groups [1, and references therein]. Petrologic types from 3 to 6 are met in both groups. Some anomalous enstatite chondrites are also reported. The reducing conditions of their origin are reflected in their mineralogy. Enstatite chondrites consist of nearly end-member enstatite, Si-bearing Fe-Ni metal, Cr-Ti-bearing troilite (FeS), and other sulfides of normally lithophile elements such Mg, Ca, and Mn. The presence of either alabandite (MnS) or niningerite (MgS) is one of the mineralogical features to distinguish EL from EH chondrites. Due to impact melting followed by fast cooling, (Mg,Mn) monosulfide is replaced with keilite $(Fe_{>0.5},Mg_{<0.5})S$ [2]. A new classification scheme has been proposed based on sulfide and metal chemical variation [1]. Among others, the presence of daubréelite ($FeCr_2S_4$), either as grains or lamellas in troilite, combined with Cr content in troilite has been established to define subgroups of EL and EH chondrites. This study aims to investigate daubréelite lamellas in troilite at the nanoscale.

Samples and methods: Four enstatite chondrites were selected for the study. The selection has been made based on findings published in previous studies [3, 4, 5, 6, 7] as well as microprobe measurements carried out during the current study. For purposes of studying the relationship between troilite and daubréelite at the nanoscale, two enstatite chondrites containing daubréelite were selected: Asuka 881314 (A-881314) and Yamato 691(Y-691). For comparison, two enstatite chondrites without known daubréelite presence and additionally containing keilite instead of alabandite or ninigerite were selected: Yamato 791790 (Y-791790) and Yamato 86004 (Y-86004). All samples have been loaned from the National Institute for Polar Research (NIPR) collections. Lamellas from selected troilite grains were extracted using FIB attached to the Zeiss Auriga Compact SEM. A nanoscale study was conducted using JEOL 2200FS TEM.

Preliminary results and discussion: All selected enstatite chondrites were an object of numerous studies in the past [3, 4, 5, 6, 7]. However, their minerals have not been studied at the nanoscale so far. Asuka 881314 is classified as EL3, Y-691 as EH3, and Y-791790 as EH3, although it shows some anomalies. Yamato 86004 is classified as EH-imp melt. As stated above, no daubréelite has been reported in Y-791790 and Y-86004 in previous studies, and it has not been discovered during the current study on a microscopic scale either. During our TEM studies, lamellas of daubréelite tens of nanometers wide were discovered in troilite grains from A-881314 and Y-691. No daubréelite lamellas at the nanoscale were discovered in troilite in Y-791790 and Y-86004. The SAED patterns of troilite indicate either complex twinning or other FeS polytype than that observed for troilite found commonly in most of the other meteorites. Further investigation will be required to resolve (1) whether the FeS polytype occurring in studied samples indeed represent troilite; (2) if Cr and Ti are incorporated directly into the crystal structure of FeS minerals; and (3) the potential mutual crystallographic relationship with hosted daubréelite (if present).

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References: [1] Weyrauch M. et al. (2018) *Meteoritics & Planetary Science* 53:394–415. [2] Keil K. (2007) *Chemie der Erde* 67: 37–54. [3] Lin Y. and Kimura M. (1998) *Meteoritics & Planetary Science* 33:501–511. [4] Kimura M. and Lin Y. (1999) *Antarctic Meteorite Research* 12:1–18. [5] van Niekerk D. and Keil K. (2011) *Meteoritics & Planetary Science* 46: 1484–1497. [6] Weisberg M. K. and Kimura M. (2012) *Chemie der Erde* 72: 101–115. [7] Kimura M. (1988) *Antarctic Meteorite Research* 1:51–64.