FORMATION OF THE MONT DIEU IIE NON MAGMATIC IRON METEORITE, AND ORIGIN OF ITS SILICATE INCLUSIONS. N. Van Roosbroek[1, 2], S. Goderis[2], V. Debaille[3], J. W. Valley[4], and Ph. Claeys[2]. [1]Geo-Institute, Katholieke Universiteit Leuven, B-3001 Leuven, Belgium (nadia.vanroosbroek@student.kuleuven.be), [2]Earth System Sciences, Vrije Universiteit Brussel, B-1050 Brussels, Belgium, [3]Dept. des Sciences de la Terre et de l'Environnement, Université Libre de Bruxelles, B-1050 Brussels, Belgium, [4]Dept. of Geoscience, Univ. of Wisconsin-Madison, Madison, WI, 53706, USA

Introduction: Recently, the Mont Dieu meteorite was confirmed as a fine octahedrite IIE iron meteorite [1-3]. The original fragments in the collection of the *Musée National d'Histoire Naturelle* in Paris show rust damage. The much better preserved ~450 kg fragment of the non-magmatic iron (NMI) Mont Dieu II meteorite preserved at the *Royal Belgian Institute of Natural Sciences* in Brussels was studied, with special emphasis on the silicate inclusions. The good state of preservation of this large fragment provides a unique way to study the Mont Dieu meteorites. The metal phase shows a clear widmanstätten texture, composed essentially of kamacite, with fine lines of Ni-rich taenite, and locally troilite associated with schreibersite. The study focuses on the abundant large, rounded, brownish silicate inclusions present in Mont Dieu (Fig. 1). These were studied under SEM/EDX, major and trace elements were determined by ICP-OES & ICP-MS, and oxygen isotopes were measured.

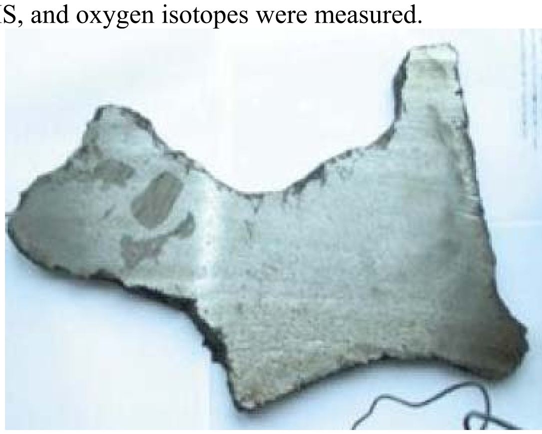

Fig. 1 Fragment of the Mont Dieu II showing distribution of silicate inclusions (field of view, 20 cm).

Silicate inclusions: The silicate inclusions are characterized by coarse-grained granular texture, crossed by metal veins ranging from 250 μm to fine veinlets. Round structures (~ 1 mm in diameter) composed of ferromagnesian mineral are present mainly and interpreted as relict chondrules. The majority ressembles chondrules identified in chondrites, others display a recrystallized structure. Three are barred olivine chondrules (Fig. 2), a feature that to our knowledge has so far not been described in other non-magmatic iron meteorites, except for Netschaëvo IIE NMI [4].

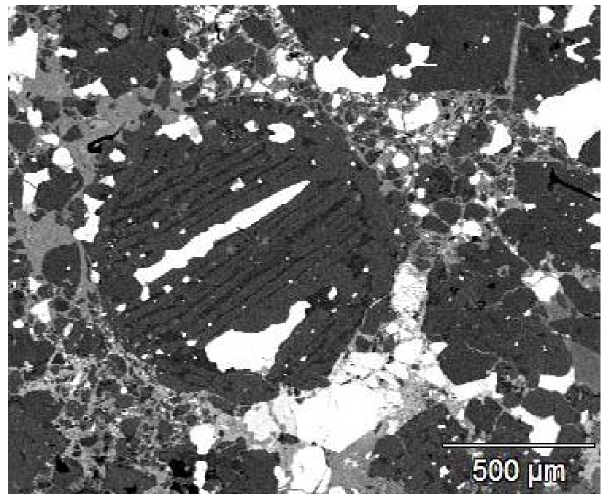

Fig. 2 SEM-BSE image of barred olivine chondrule (nr. 9), plagioclase, altered troilite and rare pyroxene and glass occur between the laths of olivine.

Low Ca-pyroxene is the most common mineral in the silicate inclusions, it occurs in the matrix and in the chondrules. In the matrix, its composition is homogeneous with a mean ferrosilite (Fs) content of 12.9±0.6 mol %. In the well-preserved chondrules Fs reaches 14.9±6.3 mol %, while this is 15.0±2.5 mol % in the recrystallized chondrules. Olivine is the second most abundant mineral, and is particularly present in the chondrules. The mean fayalite (Fa) value for the matrix is 14.9±1.5 mol % and up to 17.4±5.3 mol % in the well-preserved chondrules. In the recrystallized chondrules the mean Fa value is 16.4±2.7 mol %. Albitic plagioclase occurs between the olivine and pyroxene crystals, together with FeO-rich glass, which is only found within the chondrules. The glass appears well-preserved and contains up to 4.7 wt% FeO, confirming its glassy nature. Chromite, troilite, schreibersite, (chlor)apatite and Fe-Ni metal are found as minor mineral phases often surrounding the chondrules.

Compared to other IIE meteorites, SiO_2, FeO, MgO, and Al_2O_3 concentrations in Mont Dieu II are closer to those measured in the silicate inclusions of Netschaëvo [4]. However, the latter shows higher Ni and Rare Earth Elements (REE) concentrations than that measured in Mont Dieu. Mont Dieu has a relatively flat REE pattern with a slight enrichment in HREE, resulting in a $(La/Yb)_N$ ratio of 0.6. Overall, glass phases preserved in other IIE's such as Weekeroo Station, Kodaikanal, Elga, or Colomera, have higher SiO_2 and K_2O and lower concentrations in other oxides.

The oxygen isotope analyses carried out on Mont Dieu yield a mean $\Delta^{17}O$ of 0.714±0.024 ‰.

The fayalite and ferrosilite molar contents of the seven recrystallized chondrules are similar to those observed in H-type ordinary chondrites that have been linked to IIE NMI based on their oxygen isotopic compositions [5]. In terms of its oxygen signature, Mont Dieu II falls within the range defined for H 3-6 chondrites [5,6] (Fig. 3).

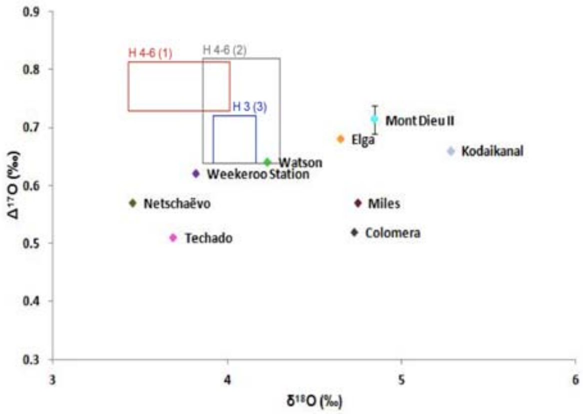

Fig. 3 Diagram of the oxygen isotopic composition of Mont Dieu II (in blue) versus other IIE's containing silicate inclusions (data from litterature: (1):[6]; (2):[7]; (3):[8]).

Interpretation: The mineralogy, major element composition of Mont Dieu II silicate inclusions and its oxygen isotopic values shows similarities with ordinary chondrites, more specifically the H-chondrites. However, it appears more reduced than the H-chondrites, and its REE pattern is closer to that of enstatite chondrites. Despite these differences, it seems likely that Mont Dieu II originated as an H-chondrite.

Within the IIE's NMI Mont Dieu II ressembles Netschaëvo based on several arguments : i) angular shape of inclusion, ii) relict chondrules in the silicate inclusions and a mineralogy dominated by pyroxene, iii) silicate inclusion are more reduced than H- chondrites, iv) the abundance of Fe-Ni and troilite. Mont Dieu can be considered as part of the Netschaëvo subgroup. The preservation of glass and its oxygen isotopic composition indicate a more primitive nature for Mont Dieu and would perhaps place it in a new group between the Netschaëvo group and H chondrites.

Based on these characteristics, the Mont Dieu II fragment promises to provide more insight in the further understanding of the IIE NMI formation process. At this point, the following model is proposed to account for the formation of the Mont Dieu II meteorites. An H-chondrite parent body was impacted by an Fe-Ni impactor that created a magma pool on the parent body. The material of the impactor is mixed with the silicate material when sinking towards the bottom of the magma pool. A certain amount of the impactor sinks to the magma pool. The upper part of the magma pool consists of a silicate-metal mixing region. In this environment, Mont Dieu II was formed. A position near the edge and at a shallow depth of the magma pool is favored for Mont Dieu II, because fast cooling is necessary to preserve the chondrules and glass. No strong evidence for shock was observed in the silicate phase, meaning that Mont Dieu II did not form at the surface of the parent body. This scenario should be strengthened or adapted with quantitative analyses in future investigations.

References:

[1] Grossman, J. N. 1997 *Meteorit. Planet. Sci.* Supp. 31: A159-166. [2] Desrousseaux, A. et al. 1996 *Meteorit. Planet. Sci.* 31: A36. [3] Van den Borre, N. et al. 2007 *Meteorit. Planet. Sci.* 42: A5234. [4] Olsen, E. and Jarosewich, E. 1971 *Science* 174: 583-585. [5] Clayton, R. N. and Mayeda, T. K. 1996 *Geochim. Cosmochim. Acta* 60: 1999-2017. [6] Folco, L. et al. 2004 *Geochim. Cosmochim. Acta* 68: 2379-2397. [7] Clayton, R. N. et al. 1991 *Geochim. Cosmochim. Acta* 55: 2317-2337. [8] Franchi, I. A. 2008 *Rev. Min. Geochem.* 68: 345-397.