Formation of the IIE non magmatic iron meteorites

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The well preserved ~450 kg fragment of the IIE non-magmatic iron (NMI) Mont Dieu II (MDII) meteorite [1] has been investigated to understand the formation of IIE NMI meteorites that are not directly related to core formation [2]. The present study focuses on the abundant large silicate inclusions of MDII, studied under SEM/EDX, and for which major and trace elements were measured by ICP-OES & ICP-MS. Oxygen isotopes were measured by laser-fluorination.

The silicate inclusions are characterized by coarse-grained granular texture, crossed by metal veins. Round structures (~ 1 mm) composed of ferromagnesian minerals are present, interpreted as relict chondrules. Three well-preserved barred olivine chondrules, a feature so far only described for Netschaëvo NMI IIE [3], and glass have been observed. Low Ca-Px, Ol and albitic Pl are the major mineral phases. FeO-rich glass (interpreted as relict from the impacted body), Chr, Tro, Schr, (chlor)Ap and Fe-Ni metal are found as minor phases. The $\Delta^{17}O$ of MDII is 0.714±0.024 ‰. The Fa and Fs molar contents of the relict chondrules are similar to those observed in H-type OC. The IIE NMI seem also related to OC based on their oxygen isotopic compositions [4], as the $\Delta^{17}O$ of MDII falls within the range defined for H 3-6 OC [4; 5].

Based on these results, an impact formation model is proposed, where a Fe-Ni impactor collided with an H-chondrite parent body. A position near the edge of the asteroid and at a shallow depth of the magma pool is favored for MDII, because fast cooling is necessary to preserve the chondrules and glass. After this first stage of fast cooling, a second phase involving slower cooling is needed to permit the development of the Windmanstätten pattern.

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The composition of the lower crust of the Oman Ophiolite

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Fundamental questions remain as to where, how, and to what extent chemical fractionation occurs in the oceanic lower crust and upper mantle, prior to eruption of MORB. There is no continuous drill core through oceanic crust *in situ*. Thus, to address these questions, we turn to the Oman ophiolite, where there is a continuous section from residual mantle peridotite to submarine lavas formed at an oceanic spreading ridge.

We present a detailed, stratigraphically-constrained, bulk composition for the lower crust of the Wadi Khafifah section of the Oman ophiolite. Together with sheeted dikes and lavas having trace element contents similar to MORB, the bulk crustal composition meets two fundamental criteria for a mantle-derived melt: (1) It has Mg# in equilibrium with Fo90 mantle olivine; (2) it is multiply saturated in ol+aug+opx±plag/sp at shallow mantle pressures. In addition, clinopyroxene crystallizes early, eliminating the so-called 'pyroxene paradox'. The parent magma – with major element composition indistinguishable from primitive MORB – represents an aggregate produced by polybaric decompression melting of depleted MORB mantle (DMM), which has crystallized approximately 5% olivine – probably by reactive fractionation (Collier & Kelemen, J Petrol 2010) in the crust-mantle transition zone – prior to emplacement within the crust. An additional 40-60% fractional crystallization (ol+aug+ plag) in the lower crust is required to produce the observed sheeted dike and lava compositions. Where data are available for comparison, gabbro compositions reported here are similar to analysed samples from modern fast-spreading mid-ocean ridges. Thus, our results are relevant for understanding modern fast-spreading oceanic crust.

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