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THE DIDEROT METEORITE: THE SECOND CHASSIGNITE. P. Beck[1], J-A. Barrat[2], Ph. Gillet[1], I.A. Franchi[3], R.C. Greenwood[3], B. Van de Moortele[1], B. Reynard[1], M. Bohn[4] and J. Cotten[2]. [1]Laboratoire des Sciences de la Terre, CNRS UMR 5570, Ecole Normale Supérieure de Lyon, 46 allée d'Italie, 69364 Lyon Cedex 7, France. E-Mail : pbeck@ens-lyon.fr, [2]U.B.O.-I.U.E.M., place Nicolas Copernic, F-29280 Plouzané Cedex, France. E-Mail : barrat@univ-brest.fr, [3]Open University, Planetary & Space Science Research Institute Walton Hall, Milton Keynes MK7 6AA, United Kingdom, E-Mail: i.a.franchi@open.ac.uk, [4]Ifremer-Centre de Brest, (CNRS-UMR 6538), BP70, 29280 Plouzané Cedex, France. E-Mail : Marcel.Bohn@ifremer.fr.

Introduction: Whilst the number of identified martian meteorite has increased greatly in the last decade (with more than 30 members recognized at the time of the writing), the Chassigny meteorite, which was seen to fall in 1815, remained unique within the martian meteorite group. In August 2000, a 611 g meteorite was discovered in the Moroccan Sahara by meteorite hunters. Mineralogy, major and trace element chemistry as well as oxygen isotopes revealed an unambiguous Martian origin and strong affinities with Chassigny. Since the stone hasn't receive an official name yet, the working name Diderot was given, after the French encyclopaedist born in the city of Langres, a few kilometers distant from the Chassigny village.

Diderot is a dunite: olivine 89.6 % (in volume), augite 3.1 %, chromite 4.6 %, sanidine 1.6 %, orthopyroxene-pigeonite 1.0 %, and phosphate 0.2 %. The sole noticeable deviation from Chassigny mode is the total absence of plagioclase in Diderot [1]. The texture of the meteorite is that of a cumulate, dominated by millimetric anhedral to subhedral olivine crystals, sometimes poikilitically enclosed in augite. Based on textural observations, the following crystallization sequence can be inferred: chromite, chromite+olivine, chromite+ intercumulus phases (K-feldspar, pyroxene, apatite). The two cumulate phases, olivine and chromite, display melt inclusions that contain pyroxenes, olivine, (Si, Al, K, Na)-rich glass, apatite and kaersutite.

Diderot membership to the Martian meteorite group was primary suggested from petrographical similarities with Chassigny. The Mn/Fe ratios in olivine (~0.018) and pyroxenes (~0.030), that is diagnostic of planetary assemblages [2] distinguished a Martian origin, later confirmed by oxygen isotopes measurements. Bulk rock analysis yield $\Delta^{17}O = +0.305$ symbol pour mil in agreement with other martian meteorites.

Olivine crystals in Diderot show a narrow range of chemical composition, testifying of a high degree of post-magmatic re-equilibration. They have a mean forsterite content of 78.7 +- 0.5 significantly higher than olivines from Chassigny (Mg # = 69). Three pyroxenes are present: augite, pigeonite and orthopyroxene. High-Ca pyroxene can poikilitically enclose pyroxene while low-Ca pyroxenes are only encountered as interstitial post-cumulus phases, sometimes having exsolved augite lamellae (1 μm). Poikilitic low-Ca pyroxene was not observed in the 1 cm^2 section studied but we note they are less abundant than high-Ca pyroxene. The chemical composition of pyroxenes shows a broad variation, and they display a vertical trend in the qualidrateral representation of figure 1, as was previously observed for Chassigny.

Chromite is found as euhedral crystals sometimes enclosed in olivine. The grains are widely zoned, with a typical increase in Fe and Ti from core to rim. The range of chemical composition of chromites in Diderot is much greater than in Chassigny. The temperature inferred from chromite/olivine equilibration is 1030 °C [3, 4], significantly lower than the expected crystallization temperature of both phases in mafic systems (~1300 °C), suggestive of post-magmatic diffusive re-equilibration.

Contrary to Chassigny, plagioclase is totally absent in Diderot. The only feldspar observed is sanidine, which composition is more restricted than Chassigny alkalic feldspar. This observation indicates that the silicate liquid interstitially crystallizing between cumulative phases was rich in alkali elements. Additional evidence for the involvement of an alkali-rich liquid in Diderot petrogenesis occurs within melt inclusions. Melt inclusions contains euhedral to subhedral crystals of olivine, low-Ca and High-Ca pyroxene, phosphate, kaersutitic amphibole and a significant amount of silicate glass. This glass was analyzed by electron microprobe and found to be rich in Al, K and Na. Olivines are black though rich in Mg ($Fo_{78.5}$). Black forsteristic olivine exists on Earth, and is supposed to be produced by high-temperature oxidation. None of the associated products (magnetite and hyperstene) was though noticed in the present study of the meteorite. High-resolution transmission electron microscope (TEM) images of a black olivine from Diderot revealed Moiré fringes, testifying of a partial distortion of the crystal probably produced during the shock event suffered by the meteorite. In some area, Raman spectra of black olivine have a broad band close to 750 cm^{-1}, in addition to the diagnostic olivine peaks. This observation is consistent with building of Si-O-Si bridges, which consequences crystal lattice modification and change of Fe valency. This change in Fe valency may be responsible for the color of olivine. Such a deformation of olivine was never described in a natural olivine and manifests an unusually strong shock metamorphism.

There is no clear evidence in the trace element composition of Diderot for terrestrial contamination. For instance, the concentrations in Ba and Sr, which are highly sensitive to hot-desert alteration are not anomalous. The CI normalized REE pattern of Diderot is LREE enriched, like the Chassigny one (Fig. 2).

Since Diderot and Chassigny share strong chemical and petrographic similarities, they can have crystallized from similar melts. The lack of plagioclase is the main particularity of Diderot with regard to Chassigny.

References: [1] Floran *et al.*, 1978. *GCA* **42**, 1213-1229. [2] Papike *et al.*, 2003. *Am. Min.* **88**, 469-472. [3] Sack and Ghiorso, 1991. *Cont. Min. Pet.* **106**, 474-505. [4] Sack and Ghiorso, 1991. *Am. Min.* **76**, 827-847. [5] Jochum et al., *Meteoritics & Planet. Sci.* **36**, A90.

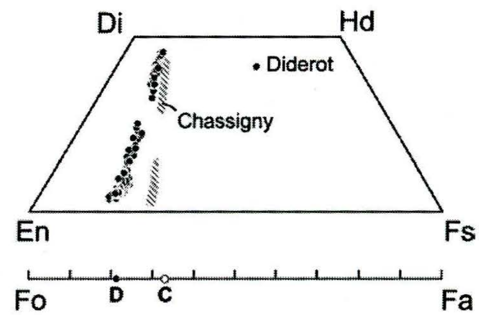

Figure 1 : Olivine and pyroxene compositions in Diderot and Chassigny ([1]).

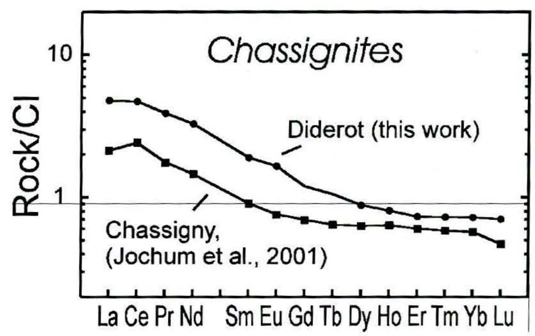

Figure 2: CI normalized REE abundances in Diderot and Chassigny ([5]).