A new carbonaceous chondrite from the Es Smara region, Western Sahara: compositional and textural data.

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Introduction

A single piece of about 155 grams (Figure 1) and several small fragments, totally weighing 805 grams, were found on 15 March 2021 by Mouloud Bachikh and a group of friends during a meteorite search in the El-Aasli area near Jabal Kaur Al-Bared, west of Es Smara, Morocco (GPS coordinates 26°40.35' N, 11°46.16' W). The meteorite is partially covered with fresh fusion crust. A cut surface reveals large chondrules and large Calcium Aluminum Inclusions (CAIs) set in a dark, fine grained matrix (about 75 vol.%). The type specimens, weighing 22 g, and one thin section are on deposit at the Museo di Storia Naturale-Sistema Museale di Ateneo of the University of Firenze, Italy (Inv. # I-3710). One polished thin section is on deposit at University Museum of Meteorites (UMM), Agadir, Morocco. Bachikh Mouloud holds the main mass. The meteorite has been submitted for approval to the Nomenclature Committee of the Meteoritical Society with the name Smara 002.

Figure 1:image of one of a fragment of the meteorite Smara 002 on the site of recovery.

Instruments and methods

Optical microscopy was performed at the laboratories of the Dipartimento di Scienze della Terra, Università di Firenze, Italy, using an Axioplan-2 polarizing optical microscope equipped with Axiocam-HR camera. SEM-BSE images have been obtained both at the Scientific Research center of the Ibn Zohr University, Agadir, with a Jeol-JSM IT100 SEM and at the Centro di Servizi di Microscopia Elettronica e Microanalisi (MEMA) of the University of Firenze with a Zeiss EVO-40. Electron microprobe analyzer–wavelength dispersive spectrometry (EMPA-WDS) analyses have been performed at the Firenze laboratories of the IGG – CNR (National Council of Research) with a JEOL-JXA 8230 microprobe.

Experimental results

The SEM-BSE image of polished section of the meteorite shows a chondritic texture with relatively large, well-formed porphyritic olivine-pyroxene (POP) and porphyritic olivine (PO) chondrules, ranging in size from 400 to 1500 µm and set in a fine grained, dominant (75 vol.%) silicate matrix (Figure 2). Large CAIs ranging in size from 400 to 800 µm and consisting of melilite and spinel are present (Figure 3).

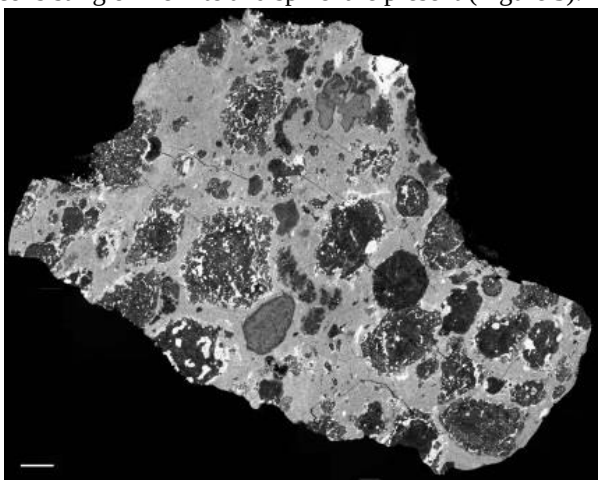

Figure 2: SEM-BSE photomosaic image of the meteorite displaying the general texture; scale bar is 500 µm.

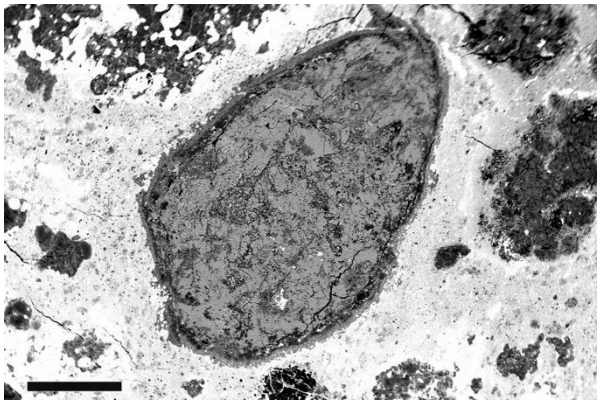

Figure 3: SEM-BSE image of a CAI surrounded by matrix; medium grey is melilite, dark grey is spinel; surrounding pale grey is fayalitic olivine; scale bar is 300 µm:

PO and POP chondrules consist mainly of compositionally homogeneous Fo-rich olivine and Fs-rich orthopyroxene, while the matrix is mostly consisting of Fa-rich olivine with scattered iron oxides. Opaque phases are mainly composed of framboidal magnetite inside chondrules and iron oxides as weathering products around chondrules (Figure 4). Pentlandite is present as small blebs inside chondrules. Fe,Ni alloys are absent except for very rare awaruite grains and an undetermined intermetallic phase, consisting of Pt, Fe and Ni (Figure 5). The meteorite displays a moderate weathering and a low shock stage.

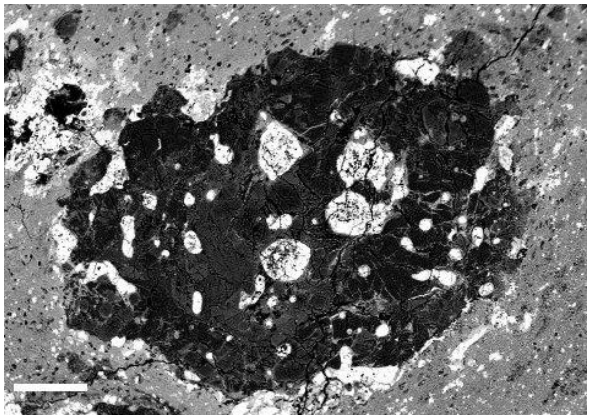

Figure 4: SEM-BSE image of a POP chondrule displaying euhedral olivine amd orthopyroxene crystals (dark grey) and rounded framboidal magnetite (white); pale grey is fayalitic matrix; scale bar is 100 µm.

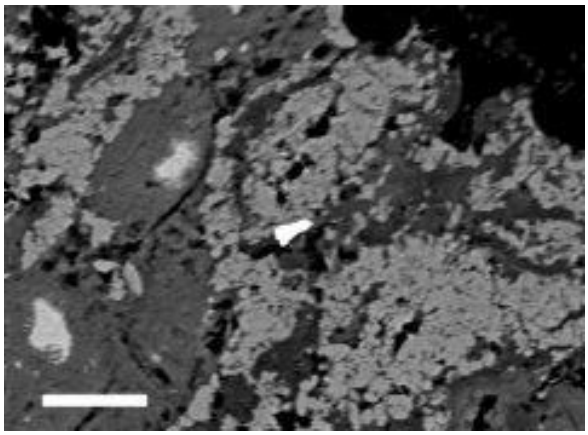

Figure 5: SEM-BSE image of a grain of an undetermined intermetallic compound rich in Pt,Fe,Ni; scale bar is 10 µm.

For classification purposes, the general minerochemical features of the matrix and of selected phases were analyzed by EMPA on both individual olivine and orthopyroxene grains inside PO and POP chondrules, as well as on olivine in the matrix. The olivine in the matrix is fayalitic ($Fa_{28.9\pm2.5}Fo_{71.1\pm2.3}$, N=10), whereas in chondrules is markedly forsteritic ($Fa_{4.7\pm3.9}Fo_{95.3\pm3.5}$, N=45, Fe/Mn = 58.9; Cr_2O_3=0.2, CaO= 0.3, all in Wt.%); orthopyroxene in chondrules is enstatitic ($Fs_{1.9\pm0.6}En_{96.2\pm0.6}Wo_{1.9\pm0.8}$, N = 25, Fe/Mn = 18.3; Al_2O_3 = 1.2, Cr_2O_3 = 0.5, all in Wt.%).

Moreover, a mesostasis with albitic composition is apparent ($An_{77.1}Or_{0.4}$). A very small BO chondrule shows olivine with a marked fayalitic composition ($Fa_{25.1\pm0.6}Fo_{74.9\pm0.5}$, N=6). CAIs consist of melilite with variable composition and almost pure spinel (Al_2O_3 = 68.9, MgO = 28.2, in Wt.%).

Opaque phases are mostly represented by framboidal magnetite with Cr_2O_3 = 1.5 and Al_2O_3 = 0.6 (all in wt%) and pentlandite (Fe = 43.3, Ni = 20.3, S = 35.0, all in Wt.%). Tiny small grains of awaruite (Ni = 71.1, Fe = 28.9, in Wt.%) are occasionally found. A small grain of a Pt-dominant intermetallic compound (Fe = 33.9, Ni = 20.3, Pt = 45.8, in Wt.%) was also detected (Figure 5).

Discussion and conclusions

According to textural and compositional data, as well as to the measured magnetic susceptibility the meteorite can be classified as an unequilibrated, Carbonaceous chondrite belonging to the CV group. The marked compositional inhomogeneity and the well formed chondrules suggest a petrologic type 3. The presence of pentlandite and magnetite suggests that the meteorite belongs to the oxidized-Bali (ox-B) subgroup [1,2,3,4,5,6,7,8].

References:

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