Minerochemical and textural features of three new carbonaceous chondrites: Dar al Gani 1068 and Northwest Africa 11706 and 11707. V.Moggi Cecchi[1], G.Pratesi[2], I.A.Franchi[3], R.C.Greenwood[3], [1]Museo di Storia Naturale-SMA, Università degli Studi di Firenze, Via G. La Pira 4, I-50121, Firenze, Italy, e-mail: vanni.moggicecchi@unifi.it; [2]Dipartimento di Scienze della Terra, Università degli Studi di Firenze, Via G. La Pira 4, I-50121, Firenze, Italy; [3]Planetary and Space Sciences, Open University, Walton Hall, Milton Keynes, MK7 6AA United Kingdom;

Introduction

Three new carbonaceous chondrites from Sahara have been classified in 2018 at the Museo di Storia Naturale-SMA dell'Università di Firenze, Italy. The first one, weighing 15 g, was found in November 1999 by Romano Serra of the Museo del Cielo e della Terra of San Giovanni in Persiceto (Bologna, Italy), during an expedition to search for meteorites in the Dar al Gani desert of Libya. It appears as a small stone partially covered by fusion crust. The meteorite has been submitted for classification and officially approved by the Nomenclature Committee of the Meteoritical Society under the name DaG 1068 [1]. The type specimen, weighing 3.5 g is on deposit at the Museo di Storia Naturale-SMA dell'Università di Firenze (RI3346), while the main mass is on deposit at the Museo del Cielo e della Terra.

Two other new CC, weighing 116 and 470, respectively, were purchased in 2016 by Hichame Mimaghador at the Erfoud market in Morocco. Both are single stones completely covered by a black fusion crust, which displays several cracks. The meteorites have been submitted for classification and officially approved by the Nomenclature Committee of the Meteoritical Society under the names NWA 11706, and 11707. The type specimens, weighing 19.4 and 20.7, respectively, are on deposit at the Museo di Storia Naturale-SMA dell'Università di Firenze (RI 3347 and RI3348), while the main masses are with the owner.

Instruments and methods

BSE images and EMPA-WDS analyses were undertaken at the Firenze IGG – CNR laboratories with a Jeol microprobe. Oxygen isotope measurements were undertaken by laser-assisted fluorination at the Open University (Richard Greenwood and Ian Franchi).

Experimental results

Textural features

The thin section of DaG 1068 shows a marked chondritic texture consisting of separated, well-formed chondrules (ranging in diameter from 500 to 2000 µm) of different kinds, often surrounded by metal, in a fine-grained matrix (Figure 1). The most abundant types are PO, with minor POP, BO and RP types. Main minerals are olivine, orthopyroxene, Ca-rich plagioclase and a fassaitic clinopyroxene. Opaques mainly consist of troilite and altered kamacite.

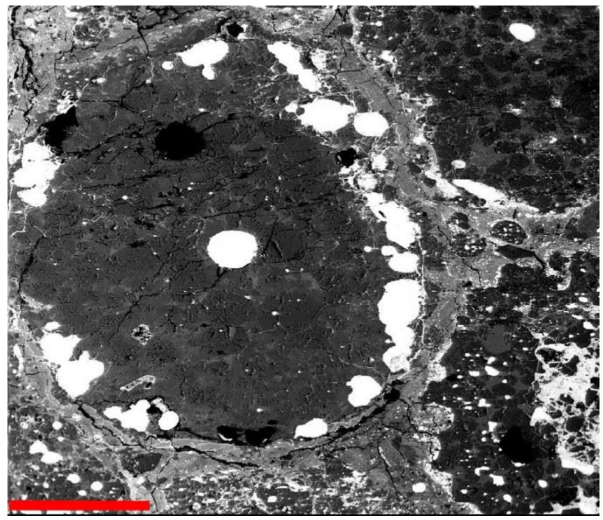

Figure 1: SEM-BSE image of an area of Dag 1068 displaying a metal-rimmed POP chondrule; pale grey is high-Ca pyroxene, dark grey is Fe-poor olivine; white spots are sulphides; sc.bar is 500 microns;

The thin section of NWA 11706 displays a texture consisting of millimeter-sized granular olivine-rich chondrules containing magnetite blebs well integrated in a medium grained olivine-rich matrix. A fine grained olivine-augite-plagioclase aggregate 500x250 µm wide is visible (Figure 2).

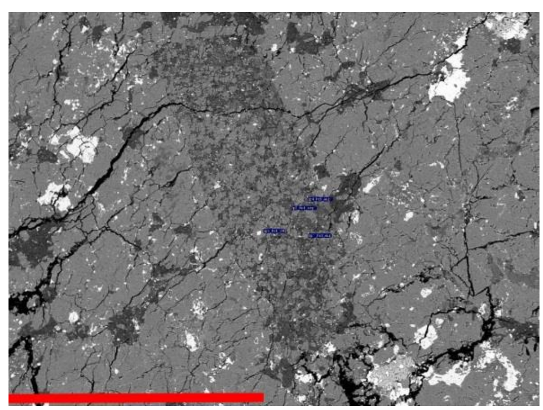

Figure 2: SEM-BSE image of a clast of NWA 11706; medium grey is high-Ca pyroxene, dark grey is plagioclase; pale grey is Fe-rich olivine; white spots are sulphides; sc. bar is 500 microns

Main minerals are Fe-rich olivine, augite, intermediate plagioclase. Opaques are mainly pentlandite and Cr-rich magnetite, with minor altered kamacite.

The thin section of NWA 11707 shows a texture consisting of well-formed, millimeter-sized granular chondrules containing magnetite blebs (Figure 3). Chondrules are surrounded by a medium grained, recrystallized matrix with disseminated opaque phases. Main minerals are olivine, orthopyroxene, augite, albitic plagioclase. Opaque phases are mainly represented by troilite and Cr-rich magnetite, with minor kamacite.

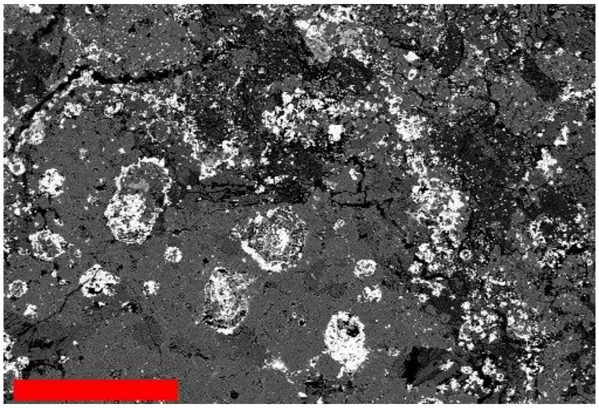

Figure 3: SEM-BSE image of a PO chondrule of NWA 11707; pale grey is Fe-rich olivine, dark grey is plagioclase; white blebs are magnetite; scale bar is 300 microns;

Minerochemical features

As concerns DaG 1068, SEM and EMPA analyses show that olivine is markedly inhomogeneous and ranges from $Fa_{2.5}$ mol. % (Fe/Mn = 8.6±1.1, N = 15) in PO and POP chondrules to $Fa_{33.9}$ mol. % (Fe/Mn = 46.5±1.1, N = 7) in BO chondrules, while low-Ca pyroxene displays a wide compositional variation, ranging from $Fs_{2.1}Wo_{0.9}$ mol. % in orthopyroxene to $Fs_{9.5}En_{62.6}Wo_{27.9}$ mol. % in fassaite (Al_2O_3 = 15.4 Wt.%, N = 5). Felspar is anorthitic ($An_{95.5}Or_{4.4}$).

As concerns NWA 11706 and 11707, SEM and EMPA analyses show that olivine is Fe-rich and homogeneous for both meteorites and ranges from $Fa_{34.7}$ mol. % (Fe/Mn = 142.0±8.1, N = 7) for NWA 11706 (PO chondrules) to $Fa_{28.0}$ mol. % (Fe/Mn = 93.6±10.1, N = 8) for NWA 11707; low-Ca pyroxene is Fe-rich and homogeneous, too ($Fs_{23.6}Wo_{1.7}$ mol. % for NWA 11707). Plagioclasic glass is variable ($An_{55.0}Or_{1.1}$ for NWA 11706 and $An_{17.2}Or_{5.3}$ for NWA 11707). Magnetite is Cr-rich for both meteorites (Cr_2O_3 = 1.7-2.7 wt. %). Oxygen isotope measurements provided the following results: $\delta^{17}O$ = -0.84 ‰, $\delta^{18}O$ = 2.28 ‰, $\Delta^{17}O$ = -2.03 ‰ (DaG 1068); $\delta^{17}O$ = -5.76 ‰, $\delta^{18}O$ = -1.91 ‰, $\Delta^{17}O$ = -4.76 ‰ (NWA 11706); $\delta^{17}O$ = -3.58 ‰, $\delta^{18}O$ = -1.93 ‰, $\Delta^{17}O$ = -4.06 ‰ (NWA 11707);

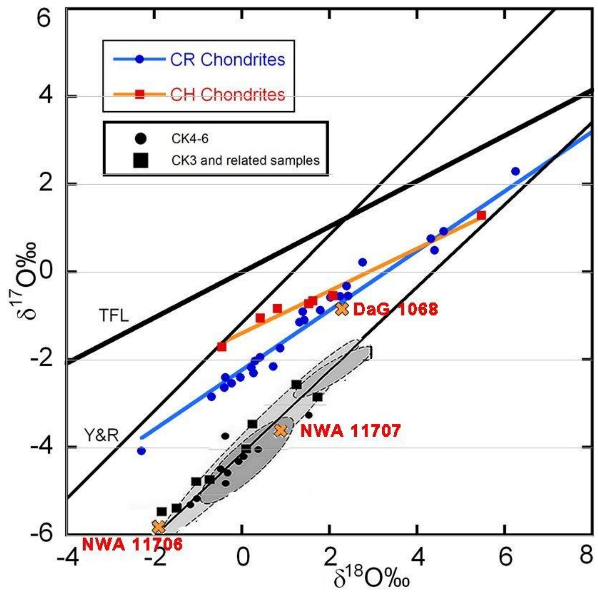

Figure 4: Oxygen isotope diagram displaying isotopic data for DaG 1068, NWA 11706 and 11707; literature data from Clayton and Mayeda (1999), Young and Russel (1998) and Schrader et al (2011);

Discussion and conclusions:

Textural and compositional data suggest a classification of DaG 1068 as CR3 chondrite, while data for NWA 11706 and 11707 suggest a classification as CK5 and CK4, respectively.

Oxygen isotope data appear to confirm this hypothesis (Figure 4) [1;2;3;4;5;6]

References: [1] Gattacceca J., et al. (2019) Meteorit. Planet. Sci. 54 in press. [2] Greenwood R.C., et al. (2000), Geochimica et Cosmochimica Acta, 64, 3897-3911; [3] Clayton R. N. and Mayeda T. K. (1999), Geochim. Cosmochim. Acta 63, 2089-2017; [4] Schrader D.L. et al. (2011). Geochim. Cosmochim. Acta 75, 308-325; [5] Young E. D. and Russell S. S. (1998) Science 282, 452-455; [6] Greenwood R.C. et al. (2010). Geochim. Cosmochim. Acta 74, 1684-1705;