Northwest Africa 12727, 13596 and 13597: three new unequilibrated ordinary chondrites from Sahara.
V.Moggi Cecchi[1], G.Pratesi[2], S.Caporali[3,4], I.A.Franchi[5], R.C.Greenwood[5], [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]Consiglio Nazionale delle Ricerche, Istituto dei Sistemi Complessi, Via Madonna del Piano 10, 50019 Sesto Fiorentino (FI), Italy, [4]Dipartimento Ingegneria Industriale, Università degli Studi di Firenze, Via S. Marta 3, 50139 Firenze, Italy; [5]Planetary and Space Sciences, Open University, Walton Hall, Milton Keynes, MK7 6AA United Kingdom;

Introduction

We present the minerochemical and textural features of three new unequilibrated ordinary chondrites from Sahara classified in 22020 at the Museo di Storia Naturale-SMA dell'Università di Firenze, Italy. All the specimens were collected by nomads in Western Sahara. The first one (NWA 12727), weighing 4560 g, was purchased in March 2018 by Giorgio Tomelleri at Erfoud, Morocco. It is a single piece with a black fusion crust. A cut surface reveals weakly weathered and displays scattered white inclusions. A big, 1 cm wide white spot is visible on one side of the external surface. A total of 21.7 g specimen and a thin section is on deposit at the Museo di Storia Naturale dell'Università di Firenze-SMA (Inv.N° 3456-I). Tomelleri holds the main mass. The other two, named NWA 13596 and NWA 13597 and weighing 90 and 411 g, respectively, were both purchased in October 2018 by Mario Di Martino at the Turin Mineral Show, Italy. Both meteorites are partially covered by a brown, stained fusion crust. The type specimens, weighing 18.1 g and 20.8, respectively, and one thin section per meteorite are on deposit at MSN-Fi (Inv.#s I-3569 and I-3570).

The three meteorites have been submitted for classification and officially approved by the Nomenclature Committee of the Meteoritical Society under the names Northwest Africa 12727, 13597 and 13598, respectively [1].

Instruments and methods

BSE images and EMPA-WDS analyses were undertaken at the Firenze IGG – CNR laboratories with a Jeol microprobe.

Experimental results

Textural features

In the thin section of NWA 12727 a chondritic texture can be observed, with PO, POP, BO and RP chondrules (ranging in size from 800 to 1600 µm) and chondrule fragments set in a fine grained matrix (figure 1). Large olivine crystals in PO chondrules are zoned from core to rim. Olivine is markedly inhomogeneous and Mg-rich in chondrules, while Fe-rich in the matrix. Orthopyroxene in chondrules is inhomogeneous, too, with a core-rim variability. Opaque phases are represented by iron oxides, Fe-Ni alloys and troilite rimming chondrules or present as individual grains scattered in the matrix. The weathering grade is moderate (W2) while the shock stage is rather low (S2).

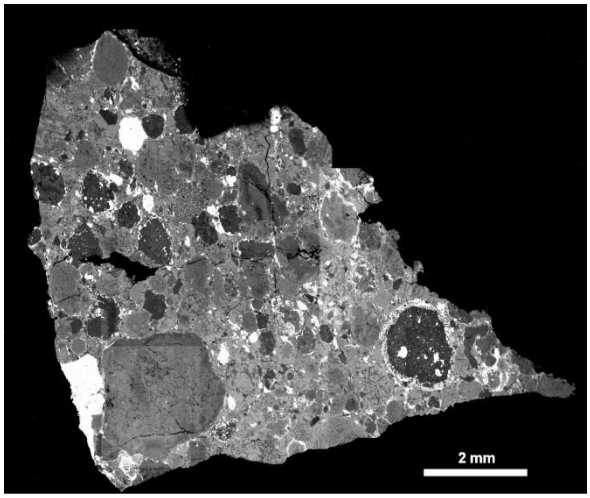

Figure 1: SEM-BSE photomosaic of NWA 12727 displaying a typical unequilibrated chondritic texture; white areas are opaque phases; light to dark grey are silicates;

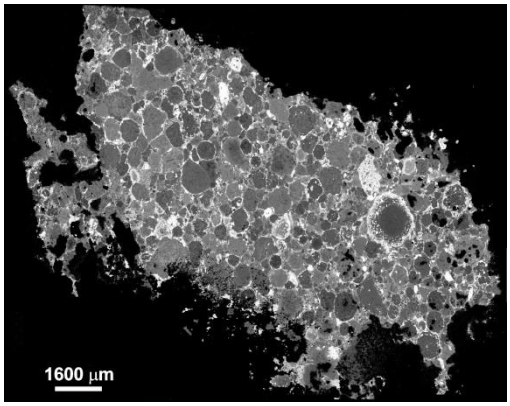

Figure 2: SEM-BSE photomosaic of NWA 13596 displaying a displaying a typical unequilibrated chondritic texture, with sever al armoured chondrules; white areas are opaque phases; light to dark grey are silicates;

Both the thin sections of NWA 13597 and NWA display a chondritic texture, with PO, POP and RP chondrules ranging in dimensions from 400 to 1200 µm (NWA 13596) and from 350 to 1250 µm (NWA

13597) set in a fine grained matrix (figure 2). PO chondrules display zoned olivine crystals (figure 3) while olivine grains and elongated pyroxene grains can be observed in POP chondrules. For both meteorites olivine is markedly inhomogenesous and Mg-rich in chondrules, while Fe-rich in the matrix. Orthopyroxene in chondrules is inhomogeneous, too, with a core-rim variability. In NWA 13596 plagioclase is Na and K-rich. An elongated 40x10 µm SiO_2 crystal has been detected inside a chondrule of NWA 13597. Opaque phases are consisting in both cases of iron oxides, Fe-Ni alloys and troilite as individual grains scattared in the matrix or rimming chondrules. For NWA 13597 the weathering grade is rather high (W3), as well as the shock stage (S1). A lower oxidation and shock have been observed forn NWA 13598 (W2, S2).

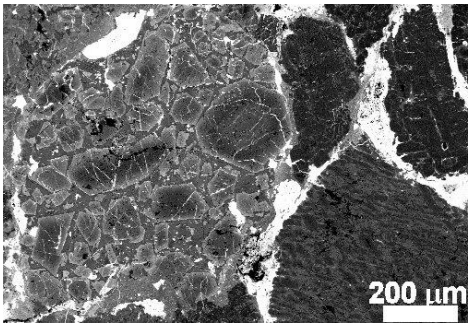

Figure 3: SEM-BSE image of an area of NWA 13597 displaying a PO and a PP chondrule; zoned olivine crystals with a marked core-to-rim Fe content variability are visible; pale grey is glass, dark grey is Fe-poor olivine (right) and low-Ca orthopyroxene; white areas

Minerochemical features

As concerns NWA 12727, SEM and EMPA analyses show that olivine is slightly inhomogeneous and ranges from $Fa_{14.5\pm9.5}$ mol. % (Fe/Mn = 63.0, N = 33) in PO and POP chondrules to $Fa_{34.3\pm1.4}$ mol. % (Fe/Mn = 62.9, N = 10) in BO chondrules, while low-Ca pyroxene ranges from $Fs_{11.1\pm7.0}Wo_{0.7\pm0.1}$ mol. % (Fe/Mn = 25.2, N = 15) in orthopyroxene of PP chondrules to $Fs_{25.4\pm1.5}Wo_{0.7\pm0.1}$ mol. % (Fe/Mn = 34.3, N = 6) in matrix. Feldspar is albitic ($An_{40.1}Or_{46.7}$). Oxygen isotope measurements provided the following results: $\delta^{17}O$ = 3.99 ‰, $\delta^{18}O$ = 5.79 ‰, $\Delta^{17}O$ = 0.973 ‰.

As concerns NWA 13596 and 13597, SEM and EMPA analyses show that olivine is slightly inhomogeneous for both meteorites and ranges, for NWA 13596, from $Fa_{9.6}$ mol. % to $Fa_{25.4}$ mol. % (Fe/Mn = 45.6±28.4, N = XX) for both chondrules and matrix and, for NWA 13597, from $Fa_{10.9}$ mol. % to $Fa_{23.7}$ mol. % (Fe/Mn = 43.9±30.2, N = 107) for both chondrules and matrix; low-Ca pyroxene is slightly inhomogenesous for both meteorites ($Fs_{12.0\pm5.5}Wo_{0.9\pm0.4}$; N = 65; Fe/Mn = 17.5±11.3 for NWA 13596; $Fs_{12.1\pm5.2}Wo_{0.7\pm5.2}$ mol. % for NWA 13597).

Discussion and conclusions:

Textural and compositional data suggest a classification as LL3.3 for NWA 12727. Oxygen isotope data appear to confirm this hypothesis (Figure 4).

As concerns NWA 13596 and NWA 13597 a classification as H3 has been proposed for both meteorites, with an estimated subtype of 3.5 and 3.7, respectively, based on the mean deviation of olivine Fa content [1;2;3;4;5;6].

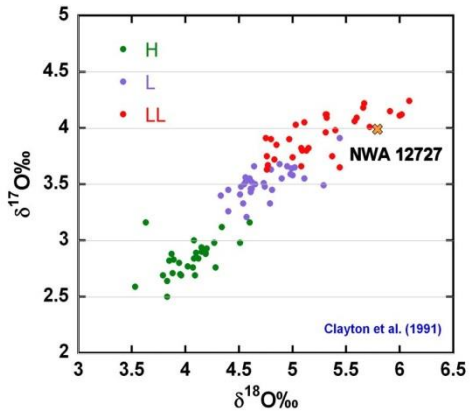

Figure 4: Oxygen isotope diagram displaying isotopic data for NWA 12727;

References: [1] Gattacceca J., et al. (2021) Meteorit. Planet. Sci. 55 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;