Northwest Africa 10769: an ungrouped chondrite related to the "supra-TFL" chondrites. V.Moggi Cecchi[1], G.Pratesi[2], C.Maccelli[2], M.Zoppi[2], S.Caporali[3], I.A.Franchi[4], R.C.Greenwood[4], [1]Museo di Storia Naturale, 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]Dipartimento di Chimica, Università degli Studi di Firenze, Via della Lastruccia 3, 50019, Sesto Fiorentino (FI), Italy; [4]Planetary and Space Sciences Research Institute, Open University, Walton Hall, Milton Keynes, GB-MK7 6AA United Kingdom;

Introduction

A new meteorite, weighing 149 g, was purchased in 2015 by Nicola Castellano at the Torino Mineral Show (field label C139). The outer surface of the main mass displays a partial black fusion crust. The cut surface reveals a chondritic texture, with opaque phases and chondrules set in a silicate matrix. The meteorite has been submoitted for classification and officially approved by the Nomenclature Committee of the Meteoritical Society under the name NWA 10769. Although preliminary data suggested a classification as R chondrite, further analyses and oxygen isotope data indicated that NWA 10769 is an Ungrouped Chondrite. The type specimen, weighing 20,6 g is on deposit at the Museo di Storia Naturale dell'Università di Firenze, while the main massis held by owners.

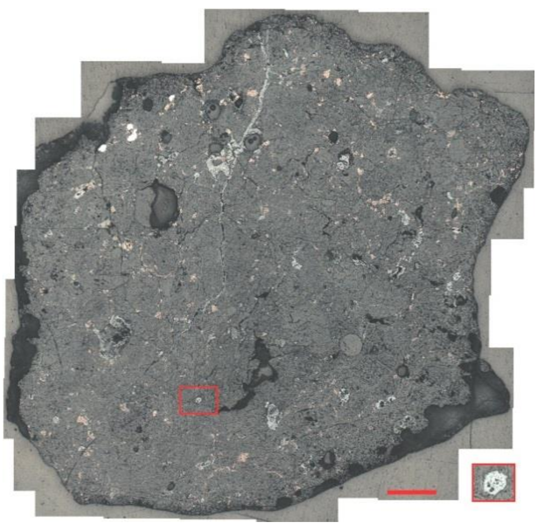

Figure 1: Polarizing optical microscope photomosaic of a thin section of NWA 10769; grey areas are silicates; light grey is trevorite and iron oxides; creamy-yellow areas are sulphides; reflected light, crossed polars; sc.bar 1 mm

Instruments and methods

SEM analyses have been performed at the Dipartimento di Chimica of the University of Florence using a Hitachi SEM, while EMPA-WDS analyses at the Firenze IGG – CNR laboratories was undertaken with a Jeol microprobe. Micro-RAMAN analyses have been performed at the Museo di Storia Naturale, Università degli Studi di Firenze laboratories with a Horiba/Jobin-Yvon equipped with a 1800 g/mm single holographic grating. The spectrograph was coupled to a He-Ne laser source emitting at 632.8 nm (red-light region) and a laser spot of about 3 mm^2. 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 shows a marked chondritic texture consisting of well-defined, large (up to 1.5 mm) chondrules, as well as chondrule and mineral fragments set in a slightly recrystallized matrix of silicates and sulphides (Figure 2). Chondrules account for about 60 % of the section by area and are of various textural types, the most common being PO, RP, C and poikilitic pyroxene. Opaque phases, mainly pentlandite, form globular aggregates about 240 µm in size or continuous rims made of tiny grains around chondrules. Metal alloys are extremely rare (Figure 2). Silicate phases, both in the matrix and among fragments, are mainly represented by olivine, orthopyroxene and diopside (Figure 3). The thin section displays a moderate weathering and a low shock stage.

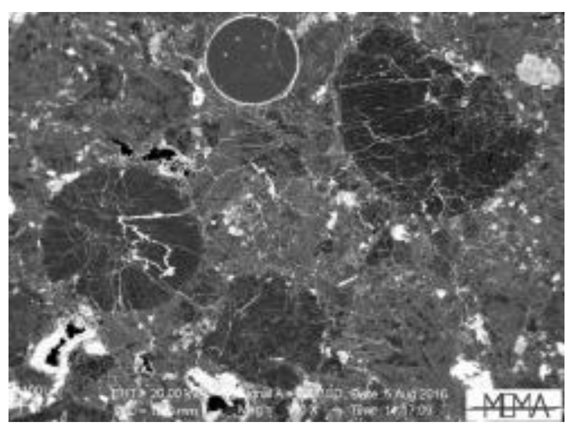

Figure 2: SEM-BSE image of an area of NWA 10769 displaying a sulphide-rimmed C, an enstatite rich and two PO chondrules; white spots are sulphides;

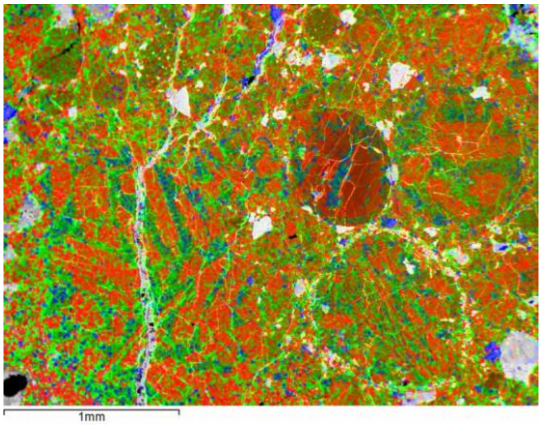

Figure 3: X-ray compositional map of an area of NWA 10769; an Mg-rich porphyritic pyroxene and two porphiritic olivine-pyroxene chondrules are visible; blue spots are clinopyroxene or apatite; Red = Mg; Green = Si; Blue = Ca.

Reflected light optical observations together with micro-RAMAN analyses on NWA 10769 confirmed the presence of trevorite (Figure 4) and suggested similarities in the paragenesis of this meteorite with a set of ungrouped chondrites from the desert (NWA 960, HaH 180, NWA 2336, NWA 4486, NWA 4294, NWA 2041 [1,2]). The meteorite appears unbrecciated in the thin section studied, and the poor matrix-chondrule integration suggests a petrologic type 3. Shock and weathering features are not marked, pointing to a shock stage of S1 and a weathering grade of W2.

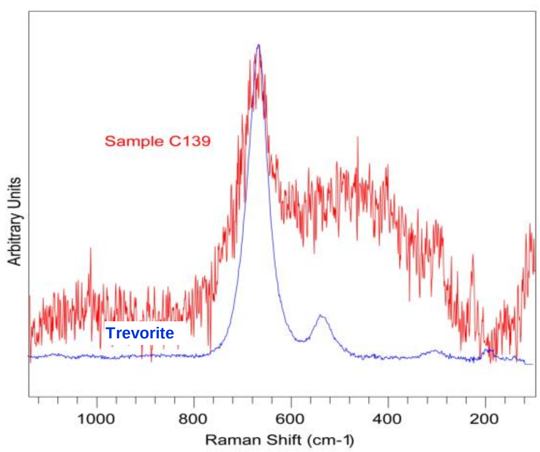

Figure 4: Micro-RAMAN spectrum of a trevorite grain represented in the blow-up of Figure 1;

Minerochemical features

SEM and EMPA analyses show that olivine is slightly inhomogeneous and ranges from $Fa_{19.1}$ mol. % to $Fa_{26.1}$ mol. % (mean $Fa_{24.7}$), while low-Ca pyroxene displays a wide compositional variation, ranging from Fs_{11} mol. % to $Fs_{21.2}$ mol. % (mean $Fs_{14.4}$). SEM analyses performed on the opaque phases confirmed the presence of pentlandite, Ni-rich pyrrhotite, kamacite, taenite and tetrataenite. Oxygen isotope measurements provided the following results: $\delta^{17}O$ = 3.65 ‰, $\delta^{18}O$ = 5.95 ‰, $\Delta^{17}O$ = 0.56 ‰. O-isotope data confirm a possible relationship with the the so-called "supra TFL" chondrites [1,2] suggested by the paragenesis (figure 5).

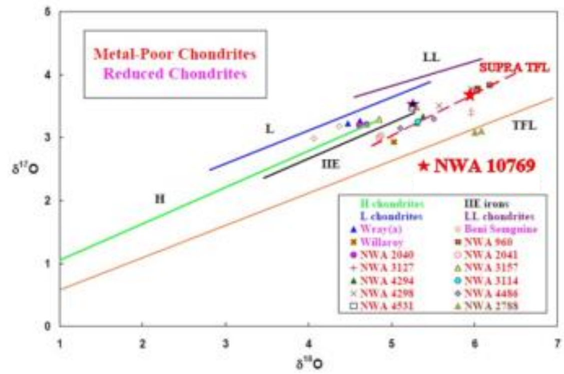

Figure 5: Oxygen isotope diagram displaying isotopic data for H, L and LL ordinary chondrites; data for NWA 10769 plot exactly among those of the supposed "supra TFL" group (modified from [1];

Discussion and conclusions:

Although some textural and compositional data and the similarities with other R chondrites [3,4,5,6] suggested a classification of both meteorites as R chondrite, further analyses and new textural and minerochemical data showed similarities with other unequilibrated chondrites (NWA 960, HaH 180 etc. [1,2]) and therefore pointing to a classification as ungrouped chondrite. Oxygen isotope data appear to confirm this hypothesis [7].

References: [1] Rumble D. et al. (2007), Lunar Planet. Sci. XXXVIII, Abstract #2230; [2] Bunch T. et al. (2010), Lunar Planet. Sci. XLI, Abstract #1280; [3] Bouvier, A. et al. (2016) MAPS, in press; [4] Grady M. et al. (2014), Atlas of Meteorites, 1st ed., CUP, Cambridge, pp.350; [5] Schulze H. et al. (1994); Meteoritics and Planetary Science, 29, 275-286; [6] Weisberg M.K. et al. (1991), Geochimica et Cosmochimica Acta, 55, 2657–2669; [7] Greenwood R.C., et al. (2000), Geochimica et Cosmochimica Acta, 64, 3897-3911;