NWA 1052 and NWA 1054: two new primitive achondrites from North West Africa.
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Introduction

NWA 1052 and NWA 1054 are two meteorites bought in 2001 at the Bologna Mineral Fair from a Moroccan dealer by Matteo Chinellato. The main masses weigh 22 and 86 g, respectively, and are both slightly weathered. One of them (NWA 1052) presents a small portion of fusion crust. The cut surfaces of both hand samples show a texture similar to that of an equilibrated chondrite, with small metal grains set in a dark brown matrix but without visible chondrules. The Museum of Planetary Sciences of Prato (MSP) owns both the type specimens (MSP2365 and 2366) and the corresponding thin sections [1].

Instruments and methods

SEM images and EDS analyses have been performed at the MEMA center of the Earth Sciences Department of the University of Florence by means of a Philips 515 SEM. EMPA-WDS analyses have been performed at the laboratories of the IGG – CNR (National Council of Research) with a Jeol JXA 8600 microprobe.

Experimental results

From a petrographic point of view either the thin sections and the hand specimens look to be composed by a fine grained aggregate. Both the thin sections display a granular texture with grains mainly represented by olivine, pyroxene, Fe-Ni alloy and troilite whose sizes range from 200 to 700 µm. Olivine and low-Ca pyroxene are the main silicate phases (Figure 1) although high Ca-pyroxene and plagioclase are also common; apart from silicates, major phases are metal and troilite. Accessory phases include chlorapatite and a Mg-rich chromite. Terrestrial weathering products, like those presented in Figure 2, are fairly uncommon. An approximate mineral mode gave for both sections the following results (in vol %): low-Ca pyroxene = 35, olivine = 25, plagioclase = 15, augite = 5, opaques = 15, terrestrial weathering products = 5. Both sections show a marked recrystallization texture with abundant 120° triple junctions and many interstices filled with metal. Terrestrial weathering grade is rather low (W1) for both specimens and optical features (sharp extinction of olivine) indicate that both the specimens are very weakly or not shocked (S1).

SEM and EMPA analyses revealed that olivine is homogeneous and has a typical forsteritic composition, (Fa = 5.95 mol %); low-Ca pyroxene is homogeneous, too, with a bronzitic composition (Fs = 7.60, Wo = 1.44 mol %). High Ca-pyroxene is rather markedly augitic (Fs = 4.88, En = 39.06, Wo = 56.06 mol %) and plagioclase has an anorthitic composition (An = 24.02, Ab = 62.49, Or = 13.49 mol %). Chlorapatite grains can be also seen, mostly in association with Fe,Ni alloy and/or troilite (Figure 3 and 5). Grains of a phase containing chromium have been detected by means of x-ray maps and therefore analyzed (Figure 4 and 5). Their composition is intermediate between magnesiochromite $MgCr_2O_4$ and chromite $Fe^{(++)}Cr_2O_4$; furthermore they present a marked Al-Cr substitution (Al_2O_3 = 5.50 wt. %). A more detailed study is now in progress to define their mineral chemistry.

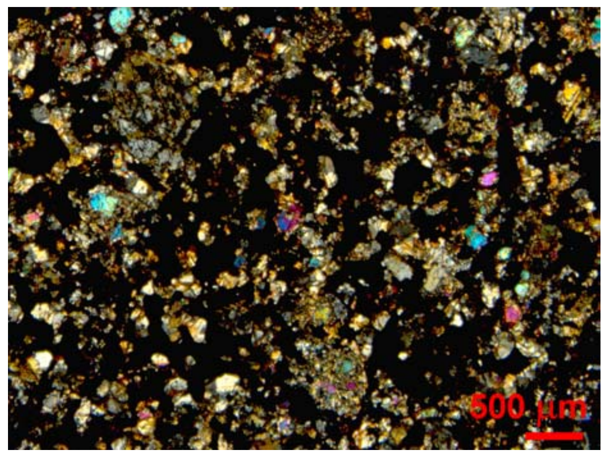

Figure 1: polarizing optical microscope image of a thin section of sample NWA 1052 (MSP2365). Blue, green and pink grains are olivine, black areas are metal and troilite; transmitted light, crossed polars.

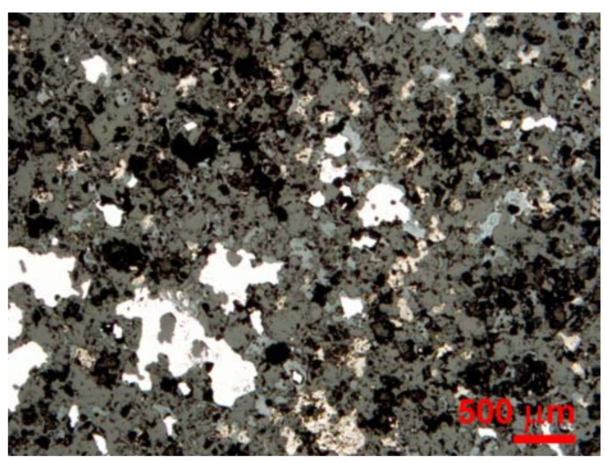

Figure 2: polarizing optical microscope image of a thin section of sample NWA 1054 (MSP2366). Fe,Ni alloy (white) and troilite (pink-brown) are sometimes surrounded by thin rims of alteration products (light gray); reflected light, plane polars.

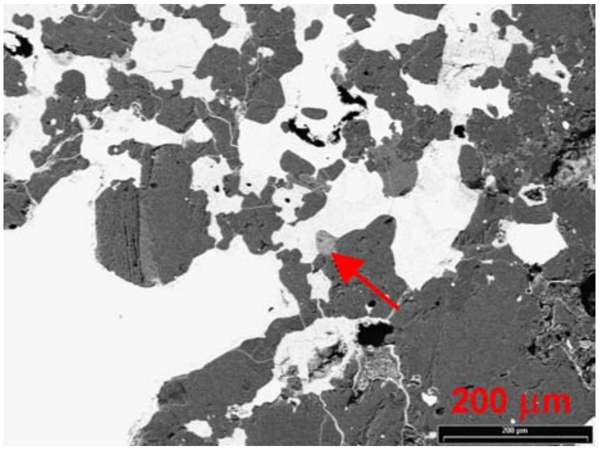

Figure 3: SEM-BSE images of a chlorapatite grain (red arrow) in sample NWA 1052

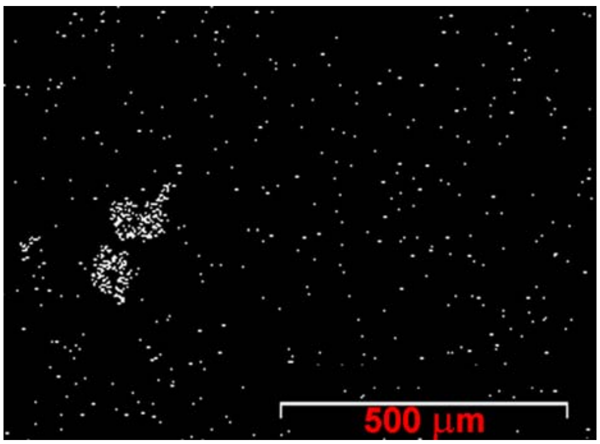

Figure 4: X-ray map of Cr distribution in sample NWA 1052.

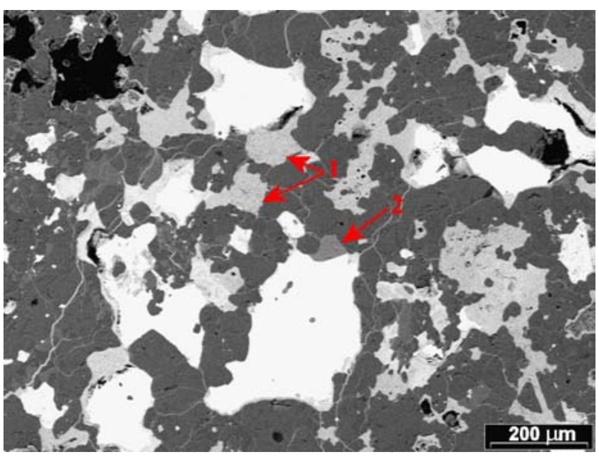

Figure 5: SEM-BSE image of chromite (1) and chlorapatite (2) grains in sample NWA 1052.

Discussion and conclusions

Recent studies have suggested that acapulcoites and lodranites are the products of complex partial melting and melt migration processes on a common parent body [2–4]. They have been interpreted as the result of ultrametamorphism of previously chondritic parent bodies. Acapulcoites are considered highly metamorphosed chondritic materials, whose Fe,Ni-FeS system (but probably not the silicate system) suffered melting [2,3]. Higher temperatures, including partial melting of the silicate system, have been hypothesized for lodranites [2,4]. The classification of acapulcoites and lodranites is largely based on petrographic criteria [3,4]. However, this clan is heterogeneous in textures, mineral compositions, O-isotopic and bulk lithophile, siderophile and chalcophile element compositions.

The studied meteorites strongly resemble highly equilibrated chondrites, especially due to the presence of few remnant chondrules, but the marked recrystallizzation texture suggest a classification as primitive achondrites. This hypothesis has been confirmed by EMPA data on olivine and low-Ca pyroxene, which display low Fe contents and a homogeneous compositions. Due to the presence of a fine grained granular texture, the belonging to the lodranite group can be excluded, while the Cr_2O_3 contents of high-Ca pyroxenes, (1.56 - 1.85 wt. %), are, according to [5], in good agreement with those displayed by acapulcoite meteorites, since winonaites exhibit much lower contents (around 0.2 wt. %).

References: [1] Pratesi G. and Moggi Cecchi V. (2005) *MAPS,* **40**, in press; [2] Mittlefehldt D. W. et al. (1996) *GCA,* **60***,* 867–882. [3] McCoy T. J. et al. (1996) *GCA,* **60***,* 2681–2708. [4] McCoy T. J. et al. (1997) *GCA,* **61***,* 623–637. [5] Kimura M. et al. (1992) *Proc. Nipr Symp. Ant. Meteorites*, **5**, 165-190