NWA 6687: A NEW LUNAR METEORITE FROM NORTHWEST AFRICA. V. Moggi-Cecchi[1], S. Caporali[1,2], G. Pratesi[3], I.A. Franchi[4], R.C. Greenwood[4], [1]Museo di Scienze Planetarie, Via Galcianese 20/h, I-59100 Prato, Italy, e-mail v.moggi@pratoricerche.it, [2]Dipartimento di Chimica, Via della Lastruccia 3, 50019, Sesto Fiorentino, [3]Dipartimento di Scienze della Terra, Via G. La Pira 4, I-50123, Firenze, [2,3]Università degli Studi di Firenze, Italy, [4]Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA United Kingdom

Introduction:

A single black stone, weighing 42,4 g and lacking fusion crust was found in Morocco in 2010 and purchased from the anonymous finder by G.Tomelleri. A cut surface on the type specimen reveals a dark grey interior which displays several small white clasts [1]. A total of 9.5 g of sample, one polished thin section and one block are on deposit at the *Museo di Scienze Planetarie della Provincia di Prato*, Italy (inventory number MSP 5153). The main mass is held by an anonymous collector.

Instruments and methods

Optical microscopy and imaging have been been performed at the laboratories of the Museo di Scienze Planetarie of Prato by means of a Axioplan-2 polarizing optical microscope equipped with Axiocam-HR camera. EMPA-WDS analyses have been performed at the Padova laboratories of the IGG – CNR (National Council of Research) with a Cameca Camebax Microbeam microprobe. Oxygen isotope measurements were undertaken at the Open University by laser-assisted fluorination [2].

Experimental results

The thin section of the meteorite displays a brecciated texture, consisting of medium-grained intersertal basaltic inclusions set in a fine grained matrix (Figure 1). The matrix contains isolated mineral clasts, mainly consisting of augite, plagioclase and olivine, and a fine-grained mineral debris enclosed within a dark, partly glassy and vesicular matrix (Figure 2). The large medium-grained inclusions consist of elongated plagioclase and clinopyroxene crystals set in a glassy matrix. Three main inclusions, all displaying the same textural features, have been observed in the thin section analyzed: two of them display a rounded shape, with a diameter ranging from 1 to 1.5 mm (Figures 3 and 4). The third one has a subellictical shape, with a major axis up to 8 mm in length (Fig. 5). Opaque phases are represented by ilmenite, ulvospinel and chromite. EMPA analyses of NWA 6687 revealed that olivine has a markedly variable composition ($Fa_{33.7\text{-}49.2}$; mean FeO/MnO = 108; Cr = 1500 ppm, Mn = 3100 ppm); pyroxene is variable and displays augitic composition ($Fs_{23.8\text{-}31.2}En_{24.9\text{-}30.0}Wo_{27.3\text{-}30.0}$Al-$px_{13.9\text{-}19.5}$; FeO/MnO mean = 65.6; V = 400 ppm; Ca = 0.61 afu); plagioclase is anorthitic and much more homogeneous ($An_{83.4}Or_{0.8}$; K = 0.008 afu).

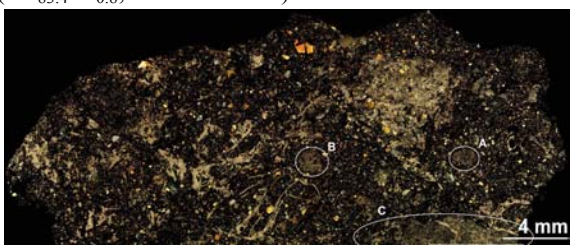

Figure 1: photomosaic of polarizing optical microscopes images of a thin section of NWA 6687. Yellow to blue crystals are olivine; black areas is matrix; A, B and C are medium-grained basaltic inclusions; transmitted light, crossed polars.

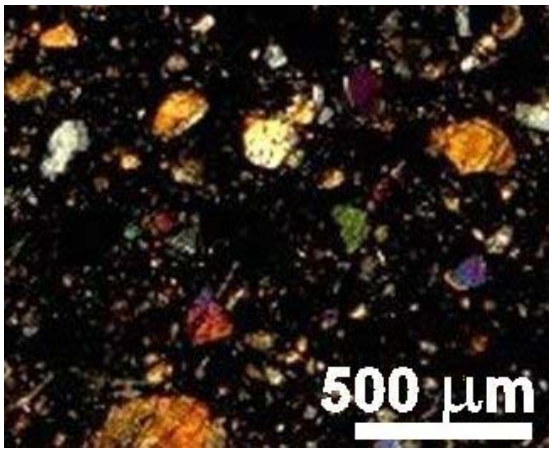

Figure 2: polarizing optical microscopes image of a thin section of NWA 6687. Yellow to blue crystals are olivine; white crystals are plagioclase; black areas are glass; transmitted light, crossed polars.

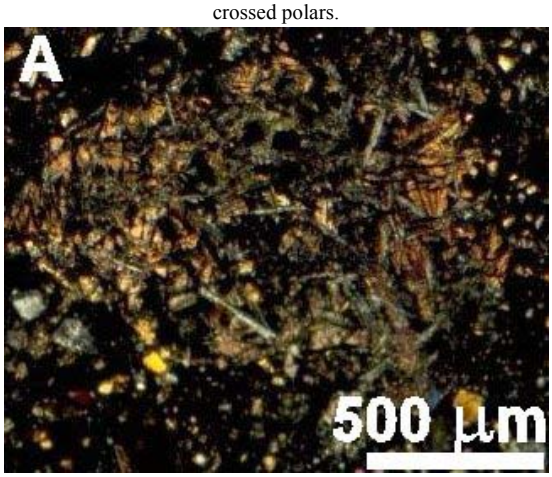

Figure 3: blow-up image of the inclusion A in Figure 1; elongated grey crystals are plagioclase, cream yellow crystals are pyroxene, black areas are glass; transmitted light, crossed polars.

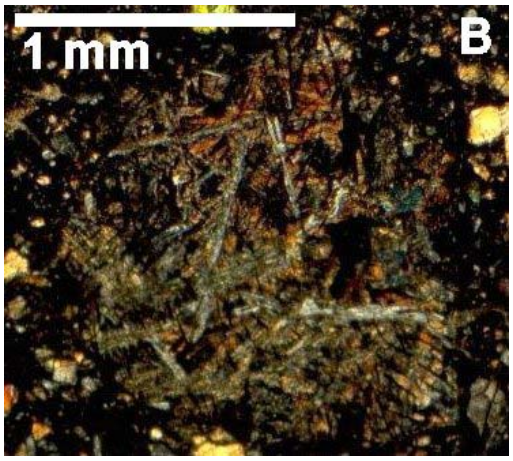

Figure 4: blow-up image of the inclusion B in Figure 1; elongated grey crystals are plagioclase, cream yellow crystals are pyroxene, black areas are glass; transmitted light, crossed polars.

Replicate analyses performed on both matrix and medium-grained inclusions revealed no significative compositional variations among plagioclase crystals belonging to inclusions A and B, while those belonging to the matrix display a slightly different composition (inclusion A = $An_{82,9}Ab_{16,4}Or_{0,70}$; inclusion B = $An_{85,7}Ab_{13,7}Or_{0,6}$; matrix = $An_{79,8}Ab_{18,6}Or_{1,6}$). A greater variability was revealed by pyroxenes, especially for what concerns the matrix (inclusion A = $Fs_{26,2}En_{30,0}Wo_{27,3}$Al-$px_{16,5}$; inclusion B = $Fs_{31,2}En_{24,9}Wo_{30,0}$Al-$px_{13,9}$; matrix = $Fs_{23,8}En_{27,7}Wo_{29,0}$Al-$px_{19,5}$). Ilmenite has a remarkably high content of chromium (Cr_2O_3 mean = 0.24 wt%), while chromite contains vanadium (V_2O_5 mean = 0.24 wt. %). The oxygen isotope composition of NWA 6687: $\delta^{17}O$ = 3.58 ‰, $\delta^{18}O$ = 6.84 ‰, $\Delta^{17}O$ = 0.02 ‰, plots near the TFL [3].

Figure 5: blow-up image of the inclusion C in Figure 1; elongated grey crystals are plagioclase, cream yellow crystals are pyroxene, black areas are glass; transmitted light, crossed polars.

Discussion and conclusions

The set of data collected on this achondrite point to its classification as a lunar feldspathic breccia. The oxygen isotope data are consistent with this classification. The medium-grained intersertal texture of the inclusions as well as other textural features are characteristic of lunar breccias. Other minerochemical features such as the mean FeO/MnO ratios of both olivine and pyroxene, Cr and Mn contents of olivine, V and Ca amounts of augite and the K content of plagioclase, previously indicated as distinctive for lunar meteorites [4,5,6,7], support this hypothesis.

References: [1] Moggi-Cecchi V., Caporali S. and Pratesi G. (2012) *MAPS,* **47** (in press); [2] Miller M.F. et al. (2000) *Rapid* Commun. Mass Spectrom. **13**, 1211-1217; [3] Newton J. et al. (2000) *MAPS,* **35**, 689-698. [4] Papike J.J. et al. (2005) *AM*, **90**, 277-290; [5] Karner J.M. et al. (2003) *AM***, 88**, 806-816; [6] Papike J.J. et al. (2003) *AM***, 88**, 469-472; [7] Karner J.M. et al. (2004) *AM***, 89**, 1101-1109 ;