NWA 6685: A NEW LODRANITE FROM NORTHWEST AFRICA

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Introduction: NWA 6685 is a new meteorite bought in 2010 at Erfoud market by an Italian meteorites dealer [1].

The meteorite consists in a single stone weighing 524 g with fusion crust. A cut surface on one side reveals an achondritic texture. The type specimen (23.4 g), and a polished thin section are on deposit at the *Museo di Scienze Planetarie della Provincia di Prato*, Italy (inv. N° 5151). An anonymous collector holds the main mass.

Instruments and methods

Optical microscopy and imaging have been performed at the laboratories of the Museo di Scienze Planetarie di Prato by means of a Axioplan-2 polarizing optical microscope equipped with Axiocam-HR camera and Axiovision 4.1 software. SEM-EDX X-ray maps have been perfomed at the Dipartimento di Chimica of the Università degli Studi di Firenze by means of a Hitachi S-2300 SEM equipped with EDX analyzer and a Noran System Six software. 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 isotopes ratio were determined at the PSSRI laboratory at Open University (UK) [2].

Petrographyc description: The analyzed thin section displays a prevailing coarse grained texture, with a small fine grained portion. The coarse grained area is dominated by large olivine phenocrysts (up to 8 mm) and subordinate orthopyroxene and Ca-pyroxene crystals, partially embedded in an interstitial fine-grained matrix constituted by the same mineral phases (see figure 1). Most commonly the olivine crystals are surrounded by pyroxenes but the reverse condition has been observed as well. Both the matrix and the fine grained portion are consisting of the same minerals, in grains ranging from 0.01 to 0.1 mm. In the studied thin section plagioclase was not detected. Opaques consist of kamacite and troilite plagues, frequently altered to iron oxides, witnessing a medium-high weathering degree. Small chromite grains (up to 200 µm) are also present (see figure 5).

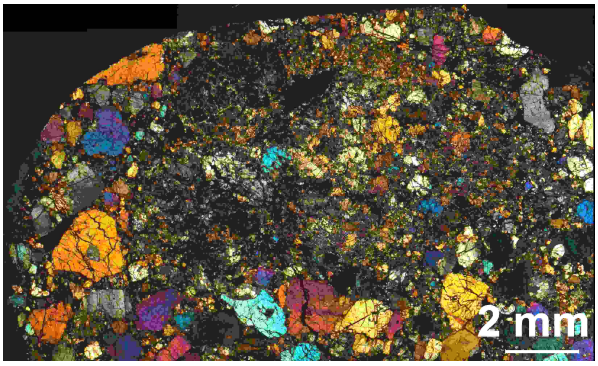

Fig 1. Photomosaic of polarizing optical microscope images of a thin section of NWA 6685; transmitted light, crossed polar.

A modal analysis perfomed by means of elemental mapping image analysis on three different areas of the samples returned the results in Table 1.

	Zone 1	Zone 2	Zone 3	Average
Kamacite	0,3	0,2	0,0	0,2
Troilite	2,6	1,4	2,1	2,0
$Oxides_{(weathering)}$	1,1	4,3	3,7	3,0
Olivine	51,4	68,5	42,8	54,2
Orthopyroxene	38,5	18,6	41,7	33,0
Ca-pyroxene	4,3	4,9	8,0	5,7
Plagioclase (Al)	0,0	0,0	0,0	0,0
Chromite	0,1	1,8	1,6	1,2
Troilite/Silicates ratio	0,0267	0,0141	0,0232	0,0212

Table 1. Modal analysis performed on three different zones of NWA 6685.

The troilite/silicates ratio for this meteorite plots in the region typical of Lodranites [3] (see figure 2). Slightly undulose extinction of olivine and pyroxene crystal allows to assign a moderate shock.

Minerochemical description: EMPA analyses evidenced relatively low amounts of iron in olivine ($Fa_{10.8}$) and in orthopyroxene ($Fs_{10.7}Wo_{1.9}$). Diopsidic Ca-pyroxene ($Fs_{3.4}Wo_{44.6}$) was also detected. No compositional zoning was evidenced by SEM-EDX investigations on olivine (figure 3) and orthopyroxene (figure 4)

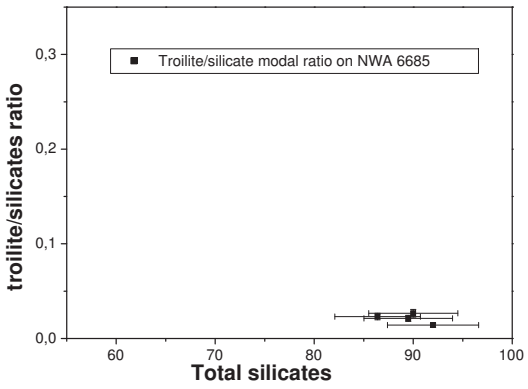

Figure 2: Plot of troilite/silicates ratio vs. the total amount of silicates displayed in table 1.

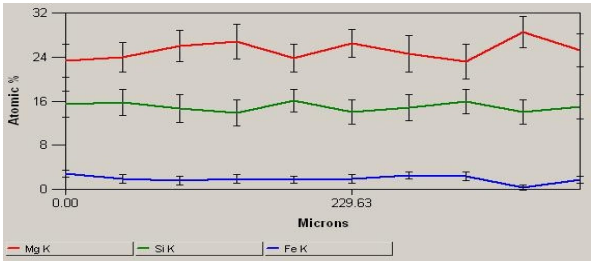

Figure 3: Compositional line profile (edge to edge) of an olivine crystal of NWA 6685 meteorite.

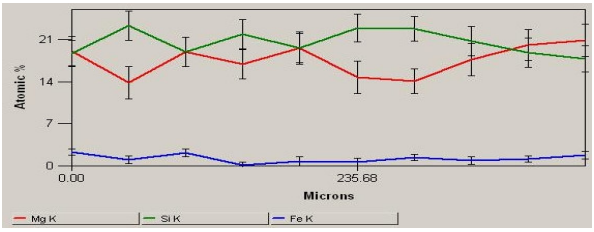

Figure 4: Compositional line profile (edge to edge) of an orthopyroxene crystal of NWA 6685 meteorite.

The iron/manganese (FeO/MnO) ratio in olivine and orthopyroxene is 23 and 14, respectively, whereas appreciable amounts of chromium (ranging from 0.40 to 0.80 wt.%) were detected in the troilite grains.

Oxygen isotopic analyses performed on unweathered bulk sample gave the following results: $\delta^{17}O$ = 0.10; $\delta^{18}O$ = 2.50; $\Delta^{17}O$ = -1.2 (all ‰).

Conclusions: The absence of chondrules as well as the coarse grained texture and the presence of olivine crystals rimmed by graphite suggest for this meteorite a classification as lodranite [4,5]. Minerochemical data such as the Fa content of olivine and the Fs content of orthopyroxene, their Fe/Mn ratios and oxygen isotope data confirm this hypothesis [6,7].

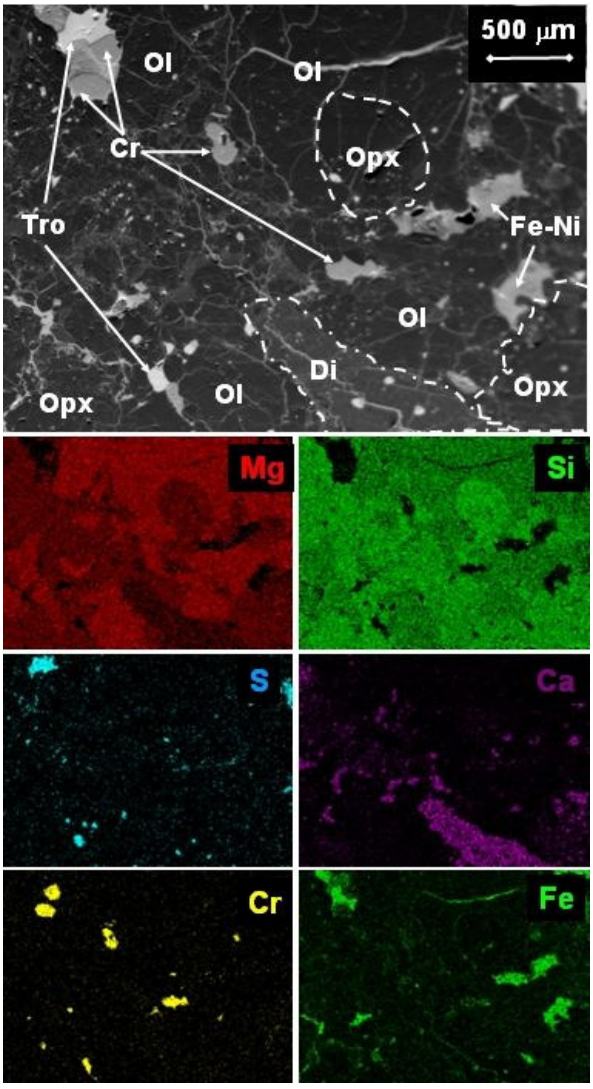

Figure 5: SEM image (above) and the relative EDX elemental maps (below) of a portion of NWA 6685. The mineral phases are indicated as follow: Olivine (Ol), Orthopyroxene (Opx), Troilite (Tro), Diopside (Di) and Taenite-Kamacite (Fe-Ni). Marker = 500 µm.

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References: [1] Moggi-Cecchi V., et al. (2012) *MAPS,* **47** (in press); [2] Miller M.F. et al. (2000) *Rapid* Commun. Mass Spectrom. **13**, 1211; [3] Moggi-Cecchi V., et al. (2011) LPSC **XXXXII**, #1398; [4] McCoy T.J., et al. (1997) Geochim. Cosmochim. Acta **61**, 623-637; [5] McCoy T.J., et al. LPSC **XXIV** #945; [6] Zipfel J., Palme H., LPSC **XXIV** #1579, [7] Patzer A., et al. (2004) MAPS, **39**, 61-85.