KHENEG LJOUÂD (MOROCCO): THE UNIQUE LL5/6 METEORITE FALL.

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Introduction: In addition to the large number of meteorite finds from Morocco, several falls have been recovered over the last fifteen years. Since the fall of Benguerir on November 2004, all falls were described, classified and submitted from our research group from the Hassan II University of Casablanca [1]. Great efforts are employed to document these falls by conducting field missions to the fall sites where the local eyewitnesses are interviewed. These eyewitness testimonials provide the basic information on the fall including time, direction, colors, sonic booms, strewnfield, etc.. Field missions and interviews are fundamental to building a consistent fall story and subsequent meteorite recovery. Eyewitness testimonies are reported in a document specifically designed for this goal [2].

Kheneg Ljouâd fireball: On Wednesday, 12th July 2017, around 23:13 Summer Moroccan time (GMT+1) a bright fireball was widely seen throughout southern Morocco [3], traveling from the NE to the SW, with termination of the fireball southwest of Tata close to the village of Igdi in the Guelmime-Es Smara province. The fireball lasted for several seconds and was followed by a series of sonic booms heard throughout southern Morocco. This event was subsequently reported on the national TV news station (Al Oula) The authorities of the area including soldiers reported the fireball.

Field mission: A field mission was organized by H. Chennaoui Aoudjehane, M. Aoudjehane, A. Bouferra and H. El Harbi on the 15th July to record the fall information and acquire samples for classification and submission of the data to the NomCom. The fall site is in a militarized area within Morocco, close to the border with Algeria. The team were granted authorization to enter the area, and on 16th July traveled to the fall site. Military and nomads where the first to arrive at the site and the first piece was found within 12 hours of the fireball. Despite the remoteness of the area, and high summer temperatures of 53°C, there were around a hundred people searching for the meteorite.

The team collected pieces of the meteorite on the ground and meet several hunters with fresh, black, fusion-crusted stones. The largest complete piece seen was about 850 g. Coordinates for three smaller stones are a complete 15 g stone (28°59'03.3"N, 8°24'38.7"W) and two pieces totalling 22 g (28°57'28.3"N, 8°25'39.6"W), and a stone of ~1 g (28°59'55.1"N, 8°24'25.5"W). Total mass collected to date is near 10 kg. The area has the name of Kheneg Ljouâd.

Meteorite description: Fusion crusted stones ranging from <1 g to 1.2 kg are reported. Stones are quite rounded with shallow regmaglypts. The fusion crust is matte black. The interior of the stones is dominantly whitish gray, with a few thin shock veins traversing the broken and cut sections. Troilite is common and occurs as pods to 1 cm and veinlets.

Optical and SEM imaging of a polished mount shows a range of chondrule types, though largely recrystallized and integrated with the matrix. The chondrules still recognizable include a large BO (to 5 mm), PO and, PP. Feldspar shows a range of sizes, some grains to 200 μm, though the majority <50 μm. Metal and troilite is heterogeneously distributed across the mount, with the largest grains to 100 μm. Metal dominated by tetrataenite, with only two small (20 μm) grains of kamacite found. Metallic Cu is rare, and occurs as grains (~5 μm) at tetrataenite/troilite boundaries. Metal+troilite occupies <2 vol% of the section. Troilite is dominantly single crystal, though rare grains show twin lamellae. Pentlandite, <20 μm, is rare occurring as subhedral grains within troilite. Chromite is common as large, to 200 μm, anhedral grains and small, <5 μm, subhedral and euhedral grains in feldspar. A few small melt pockets observed in the mount are consistent with shock stage S3 .

Microprobe analysis provide the following data: Olivine $Fa_{31.0\pm0.2}$, FeO/MnO=61.0±3.4, n=15; low Ca pyroxene $Fs_{25.0\pm0.4}Wo_{2.1\pm0.2}$, FeO/MnO=37.0±1.7, n=7; high Ca pyroxene $Fs_{10.7}Wo_{43.1}$ and $Fs_{11.0}Wo_{43.0}$; Feldspar $Ab_{84.4\pm2.2}An_{10.6\pm0.3}Or_{5.0\pm2.3}$, n=4; tetrataenite (at%) $Fe_{42.9\pm0.2}Co_{2.1\pm0.1}Ni_{54.9\pm0.2}$, n=4; pentlandite $Fe_{38.6\pm1.0}Ni_{13.8\pm1.0}Co_{0.6\pm0.6}S_{46.9\pm0.3}$, n=5. Magnetic susceptibility (P. Rochete, CEREGE) log χ (× 10^{-9} m^3/kg) = 3.70.

Classification: Chondrules largely integrated with the matrix are consistent with high petrologic type; the predominance of feldspars <50 μm across is consistent with type 5/6. Silicate mineral and metal chemistry are consistent with LL, W0, S3. Kheneg Ljouâd is the only recorded LL5/6 fall out of a total of 59 with such a classification.

References: [1] Chennaoui Aoudjehane H. 2016. Meteoritics & Planetary Science 51, S1 Abstract #6119 [2] Larouci N. et al, 2014, Bulletin de l'institut Scientifique Section Sciences de la Terre, n° 36, 69–83. [3] www.lpi.usra.edu/meteor/metbull.php?code=66103

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