THE AGOUDAL (HIGH ATLAS MOUNTAINS, MOROCCO) SHATTERED LIMESTONE: PETROGRAPHICAL AND GEOCHEMICAL STUDIES AND ADDITIONAL EVIDENCE OF IMPACT.

H. El Kerni[1,2], H. Chennaoui Aoudjehane[1], T. Marjanac[2]. [1]Hassan II University Casablanca, Faculty of Sciences Ain Chock, GAIA Laboratory, BP 5366 Maarif 20000 Casablanca, Morocco. Email: houdaelkerni@gmail.com, [2]University of Zagreb, Faculty of Sciences, Horvatovac 102a, 10000 Zagreb, Croatia.

Agoudal is the first and the only confirmed impact structure in Morocco so far, by the existence of well-preserved outcrops of shatter cones in a Jurassic marly limestone formations [1]. Its size and its age are still debated [1, 2, 3], although estimates based on the denudation rate of the High Atlas Mountains and distribution of shatter cones has led to constrain the minimum size between 1 and 3 km and a minimum age of 1 My [1], which is quite older than the Agoudal meteorite [4]. Additionally, to the Agoudal shatter cones, another macroscopical structural feature related to the impact was observed in the field: vertical to overturned strata trending N150-N160 that are not related to the High Atlas tectonics [1].

In order to prospect possible microscopic impact features in Agoudal target rocks and to study the Agoudal shattered limestone, we conducted petrographic observations and geochemical analyses. Samples of shatter cones and breccia were collected in the Agoudal impact site during a field mission, then thin sections were prepared and studied under the optical microscope (plane polarized light, PPL).

Petrography: The shattered limestone consists of fine-grained carbonates (micrite) that represent about 85% of the thin sections, cemented by calcite, with a relatively low but somewhat variable amount of quartz grains: 5 to 8 quartz grains were detected in one thin section with a size of 20-100 μm with no traces of microscopical mineral deformation such as PDFs. Some potassic phyllosilicates (montmorillonite, illite), and accessory iron-oxides were observed. The thin sections of Agoudal breccia show poorly sorted and rarely subrounded fragments with clastic matrix (as determined by optical microscopy) containing lithic and mineral clasts that locally carry very thin calcitic veins. The finest-grained material appears, optically, as a mixture of phyllosilicate alteration and felsic mineral particles. These gray-brownish colored, very fine-grained, matrix bearing vein samples comprises very angular clasts of lithic fragments (1 mm to 1 cm in size). No evidence of possible melt components has been detected in this breccia. No breccia in breccia neither meteorite in breccia were observed.

Geochemistry: XRD analyses were conducted to compare the Agoudal shattered limestone to a fragment of a non-shattered limestone included in a sample of breccia, collected from the impact site. The Results reveal the existence of a new high temperature mineral phase magnesiowüstite [(Mg, Fe) O]in the shattered limestone. This mineral is not common in terrestrial sediments; it is formed almost exclusively by high-temperature metamorphism of dolomites and magnesian limestones [5]. It was suggested that the only plausible mechanism of its formation is by fractionation processes related to vaporization and/ or condensation of ejecta during a major impact event [6] (ex. Cretaceous/Tertiary boundary [5]).

Additional analysis such as calcimetry, were performed on the Agoudal shattered limestone and breccia. In one hand, it has provided indication of the total carbonate content of 85% in the Agoudal limestone and of 83% in the Agoudal breccia, and in the other hand, it was compared to the content of calcite in Steinheim shattered limestone which is of 75%. Further comparison with other shattered limestones from other impact craters would give an idea about the amount of calcite that should be contained in a limestone material to form shatter cones, and if this amount plays a role in their formation

References: [1] Chennaoui Aoudjehane H. et al. 2016. *Meteoritics & Planetary Science* (*in press*). [2] Lorenz et al. 2015. *Meteoritics & Planetary Science 50*, Nr 1, 112–134. [3] Rochette P. et al 2014. *Meteoritics & Planetary Science 49* # 5211. [4] Hutzler A. et al. 2015. Ph. D thesis. Aix Marseille University-France, 198pp. [5] Kyte F.T and Bohor B. F. 1995. *Geochim Cosmochim Acta 59*:4967-4974. [6] Deer W. A. et al. 1992. *2nd edition Longman*. pp. 696.