DAR AL GANI 872: YET ANOTHER EUCRITE, YET ANOTHER LESSON TO LEARN? A. Patzer[1], D. H. Hill[1], W. V. Boynton[1], P. P. Sipiera[2], and G. A. Jerman[3]. [1] Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721(apatzer@lpl.arizona.edu), [2] Schmitt Meteorite Research Group, Harper College, Palatine, IL 60067, [3] NASA Marshall Space Flight Center, Huntsville, AL35812.

Introduction: DaG872 is a new meteorite from Libya that we classified by means of optical microscopy and an electron microprobe. A comprehensive INAA study of this sample is in progress.

Preliminary data on DaG872 connect it to the eucrite clan. Eucrites are basaltic meteorites that are mainly composed of pigeonite and plagioclase and presumably originate from the surface of the asteroid 4Vesta [1,2,3]. Most eucrites are brecciated and relatively little shocked. DaG872 shares the former feature, however, it exhibits shock phenomena of considerable degree.

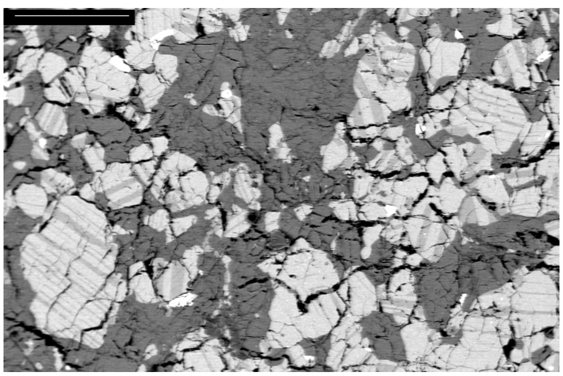

Fig. 1: BSE micrograph of the coarse-grained lithology(dark gray Ca-rich plagioclase and light gray exsolved pigeonite) in DaG872 (scale bar = 200 μm).

Results and discussion: Examination of the mineralogical and chemical composition of a thin section of DaG872 has been performed with a petrographic microscope and a Cameca SX-50 electron microprobe using the procedures of [4]. The INAA is based on parameters as given by [5].

In transmitted light, pyroxene and plagioclase can be easily recognized. The sample appears fresh and lacks limonitic staining (owing to the virtual absence of metal) but shows numerous small calcite veins as well as one major fracture filled with calcite cutting deep into the sample. In addition, the meteorite was substantially shocked leading to the manifestation of heavily fractured silicates, kinked lamellae, and strong mosaicism as well as possibly maskelynitization of plagioclase and incipient formation of "mixed melts". These phenomena are attributable to stage 2b of shock metamorphosed basaltic achondrites [6]. Highly shocked eucrites are rare due to their original geological setting as non-porous surface rocks of an asteroid.

In reflected light, DaG872 displays three opaque phases: ilmenite, chromite, and troilite. In addition, two tiny blebs of Fe,Ni-metal were observed.

A modal analysis of DaG872 could distinguish eight phases and quantified them as 42.7 vol% pyroxene, 41.2 % plagioclase, 4.0 % calcite veins, 3.3 % ilmenite, 2.9 % Mg rich silica, 2.5 % silica, 1.8 % chromite, and 1.6 % troilite.

The majority of our thin section (UA1902) consists of relatively coarse-grained pyroxene and plagioclase (crystal sizes from about 0.1 to 1mm) with a relict igneous, subophitic texture (fig. 1). We also observed a few small, finer-grained zones of granulitic texture (fig. 2). No clear boundaries exist between both lithologies. About ¼ of UA1902 is composed of a thoroughly shock-veined area that appears dark gray in contrast to the light gray colored main rock. A closer investigation of this area is underway.

The pyroxene turned out to be homogeneous ferroan pigeonite (En_{36-37} $Wo_{1.6-3.0}$ Fs_{60-63}), which we assume has been at least partly inverted to orthopyroxene [see e.g. 7] (this question will be specifically addressed in the course of the ongoing study). It is penetrated by variably distributed, wide, and oriented augite exsolution lamellae (En_{30-31} Wo_{42-44} Fs_{25-28}) sometimes showing a herringbone texture (twinning). The heterogeneous exsolution of the pigeonite host suggests non-synchronous formation of augite lamellae [8]. Some discrete augite crystals could also be identified. The pigeonite present in the granulitic clasts reveals no exsolution. According to the classification scheme describing the degree of equilibration of eucritic pyroxenes by [9], we tentatively call DaG872 a type 6 eucrite. The thorough homogenization of the pigeonite host was probably caused by post-shock thermal annealing induced by a cover of impact melt and hot impact breccias [9, 10]. This interpretation is consistent with the exsolution texture of pigeonite implying slow annealing at subsolidus temperatures [8].

Unlike the pigeonite, plagioclase of DaG872 proved to have a heterogeneous, bytownitic to anorthitic composition with An contents spanning a range of 79-99 (average value is 87.5 ± 2.4; fig. 3). In addition, many plagioclase grains contain clouds and chains of pyroxene inclusions [11]. They are mostly in the form of tiny rounded blebs, though sometimes they appear as μm-sized crystals that tend to be more Ca rich than the main pigeonite. In two cases we detected almost pure orthoclase (Or_{99} $Ab_{0.4\text{-}0.5}$). Neither the plagioclase nor the pyroxenes revealed clear zoning, however, we occasionally found slightly Mg-enriched pigeonite cores reflecting the original zoning trend.

Within the subophitic framework of pyroxene and feldspar crystals, patches of silica melt have been found. They often occur as amalgamation of amorphous or cryptocrystalline SiO_2 and a phase that shows a pigeonitic composition. In some cases they resemble melt pockets or form veins. More often, however, they are closely associated with feldspar-pyroxene intergrowths, which appear to be locally molten.

Opaque minerals have been observed in only minor abundances. Two of these phases, ilmenite and chromite, are ubiquitous, the former one showing a homogeneous composition whereas the latter includes Ti rich and Ti poor varieties. The grain size of the ilmenite crystals typically ranges between 20-50 µm but can reach up to 150 µm. The chromites are generally smaller and exhibit 10-30 µm sizes. Ilmenite as well as occasionally chromite can also be found as tiny elongated inclusions within augite lamellae (clouding: [11]). The coexistence of low- and high-Ca pyroxenes and ilmenite-chromite assemblages are generally interpreted as recrystallization products [e.g. 9] indicating metamorphic alteration of the rock. The clouding of plagioclase and augite supports this observation and, in analogue to the homogenization and exsolution of pyroxene, most likely resulted from post-shock heating [11].

Troilite was observed as another minor component. The sulfide tends to occur in loosely arranged clusters of µm-sized droplets and crystals, often associated with the melt pockets. Within the granulitic zones, troilite seems to be more homogeneously distributed (fig. 2). Finally, we identified several zircons of 10-20 µm.

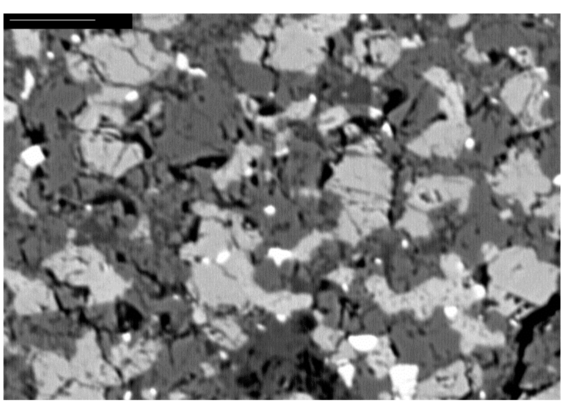

Fig. 2: BSE micrograph of the fine-grained, granulitic lithology (dark gray plagioclase, light gray pigeonite, and white troilite) in DaG872 (scale bar = 20 µm).

Conclusions: Overall, we group DaG872 with the monomict non-cumulate (basaltic) eucrites displaying a predominant coarser-grained, relict subophitic and a fine-grained, granulitic lithology. Both lithologies have been altered by metamorphism, which took place after the brecciation event [see also 12]. According to preliminary petrographic criteria as well as compositional and exsolution characteristics of its pyroxenes, the sample represents a metamorphic type 6 eucrite. Assuming the metamorphic type to be a function of burial depth on the parent body [10] and taking into account the relatively high shock stage, the excavation of DaG872 required a major impact event on its parent body.

References: [1] Duke M. B. and Silver L. T. (1967) *GCA* **31**, 1637. [2] Consolmagno G. J. and Drake M. J. (1977) *GCA* **41**, 1271. [3] Drake M. J. (2001) *MAPS* **36**, 501. [4] Kring D. A. et al. (1996) *JGR,* **101**, 29353. [5] Hill D. H. et al. (1991) *Nature,* **352**, 614. [6] Stöffler D. et al. (1988) *Meteorites and the Early Solar System* (ed. J. F. Kerridge), Univ. Arizona Press, 165. [7] Takeda H. et al. (1997) *AMR* **10**, 401. [8] Boctor N. Z. et al. (1994) *Meteoritics* **29**, 445. [9] Takeda H. and Graham A. L. (1991) *Meteoritics* **26**, 129. [10] Yamaguchi A., Taylor G. J. and Keil K. (1996) *Icarus* **124**, 97. [11] Harlow G. E. and Klimentidis R. (1980) *Proc. LPSC* **11**, 1131. [12] Yamaguchi A. et al. (2001) *GCA* **65**, 3577.

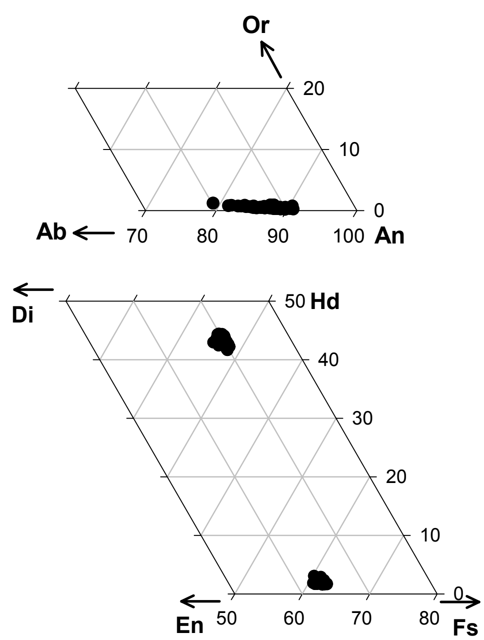

Fig. 3: Chemical composition of pigeonite, augite, and plagioclase in DaG872.