ANOTHER WEIRD ROCK FROM SPACE: A UNIQUE ENSTATITE ACHONDRITE FROM THE SAHARAN DESERT. A. Patzer, D. H. Hill and W. V. Boynton, Lunar and Planetary Institute, University of Arizona, Tucson AZ 85721(apatzer@lpl.arizona.edu).

Introduction: Two stones of 4.72 kg claimed to be falls in 1990 were recovered from Occidental Sahara recently. Both rocks turned out to be intact and completely covered with fusion crust. In accord with the find/fall location they were unofficially named "Itqiy" by the present owner.

Macroscopically, the meteorite predominantly consists of subhedral, equigranular silicate grains 0.5 to 4 mm in diameter and is relatively metal rich (~23 vol%). The metal phase mainly forms grains of about 0.2 to 2 mm, but also passes through the rock as a network of veins. No other phases are apparent in hand specimen.

Microscopically, the silicates show optical characteristics of pyroxene. Numerous triple junctions between grains are indicative of extensive recrystallization. Several grains exhibit severe mosaicism and therefore indicate a high degree of shock, to which the meteorite has been exposed. Within the silicate grains we found abundant metal globules (on average 20 μm across), which are often arranged along planes, as well as fine metal veins cutting through the pyroxene crystals without specific orientation (fig. 1). Furthermore, a few intergrowths of different sulfides and metal as well as tiny occurrences of sulfides within some metal grains have been detected. The intergrowths appear as intergranular areas with about 0.2 to 1 mm in diameter (fig. 2). Most probably due to prior sawing with water, many metal veins are at least partly oxidized and turned into "limonitic" mineral assemblages.

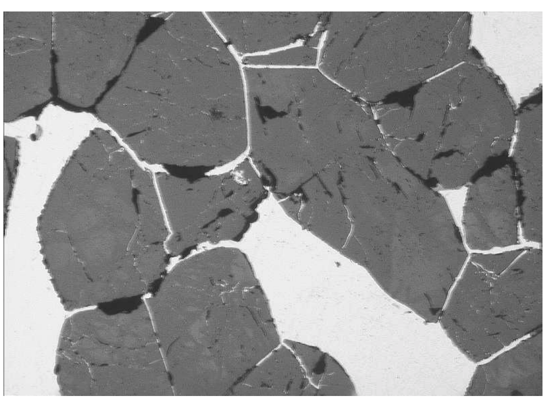

Fig. 1: Enstatite and metal as main constituents of unusual achondrite "Itqiy" (selected area = 2 mm).

Results and discussion: Analyses of the mineralogical and chemical composition of a polished slab and a thin section of "Itqiy" have been performed with a Cameca SX-50 electron microprobe using the procedures of [1]. Additionally, we examined several bulk samples via INAA [2], which is still in progress.

A modal analysis of the sample slab could distinguish three main phases and quantified them as 77.6 % silicate, 14.3 % metal, and 8.4 % "rust".

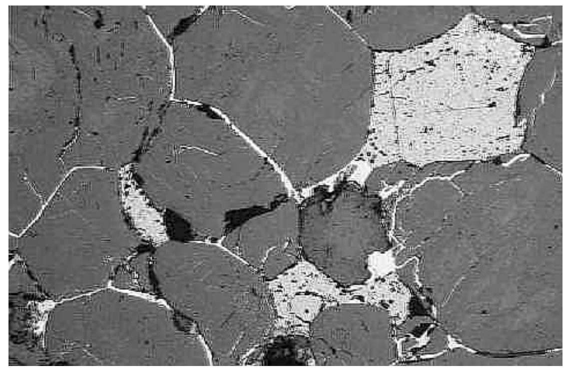

Fig. 2: Intergranular sulfide regions in "Itqiy" (selected area = 2 mm).

The silicate phase of the meteorite has been identified to be almost exclusively enstatite ($En_{96.8}Fs_{0.2}Wo_{3.0}$). The chemical composition of the pyroxene is very homogeneous throughout the examined regions. It essentially resembles the composition of EL chondritic enstatite [3], but the CaO content is higher (1.67 wt% compared to 0.1 to 0.8 wt% in ELs).

The metal phase of "Itqiy" is kamacite (90.4 wt% Fe, 5.77 wt% Ni, 3.13 wt% Si, and 0.33 wt% Co on average). Its relatively high amount of Si as well as inclusions of metal in enstatite imply highly reducing conditions at the time of its formation. Such conditions of low oxygen fugacity are in fact ascribed to the accretion area of enstatite chondrites [4]. Interestingly, the metal phase of "Itqiy" generally yields EH (and not EL) chondritic elemental abundances [5,6] (fig. 3).

Aside from their silicate and metal compositions, EHs and ELs can be distinguished in terms of their bulk Mg/Si and Fe/Si ratios [5]. Our samples show an Mg/Si ratio (0.82) in the lower range of EL chondrites but a Fe/Si ratio (1.13) that plots considerably higher than any EL chondritic composition and even significantly higher than those observed for EH chondrites.

Examination of the volumetrically small intergranular sulfide regions and the tiny intrametal sulfides led to the identification of Mg-Mn-Fe sulfides that vary considerably in composition (fig. 4). In enstatite chondrites, the same type of sulfides either forms niningerite or alabandite, with niningerite being diagnostic of EH chondrites [e.g. 7,8] and alabandite representing a characteristic Mn-rich sulfide of EL chondrites.

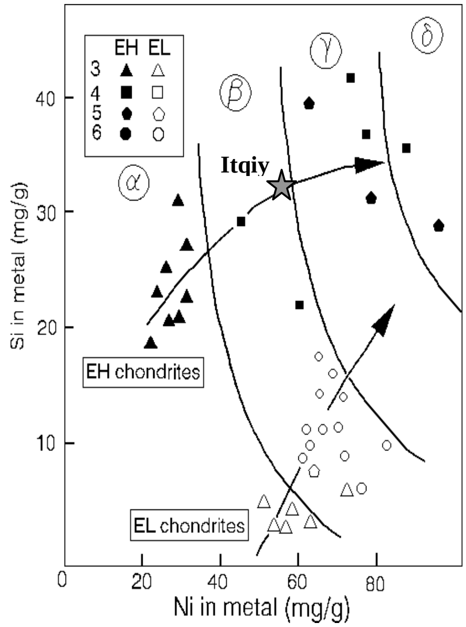

Fig. 3: Average composition of kamacite of "Itqiy" (diagram after [5]).

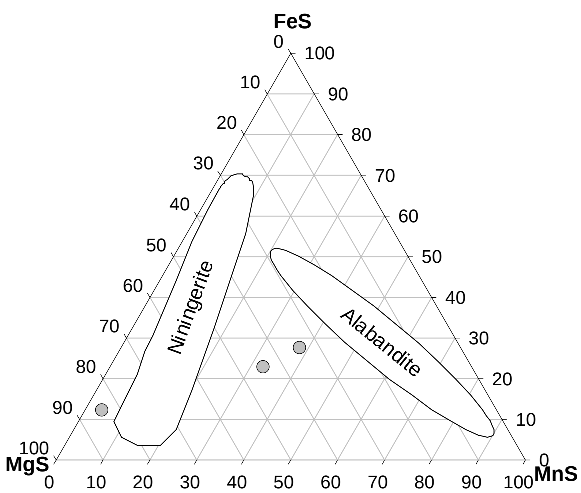

Fig. 4: Compositions of Mg-Mn-Fe sulfides of "Itqiy".

The intergranular sulfide regions in "Itqiy" also contain kamacite, oldhamite, and a Fe-Cr sulfide (fig. 5). Both oldhamite and kamacite appear as globules. Some kamacite drops are surrounded by oldhamite. The Fe-Cr sulfide (S:Fe:Cr = about 5:3:1) is often present as exsolution lamellae, similar to those formed by troilite in enstatite chondrites [9]. As described in [8], there exists an invariant reaction of troilite (FeS) to daubreelite ($FeCr_2S_4$) in EH3 chondrites. Possibly, the Fe-Cr sulfide in "Itqiy" represents an incomplete stage of this reaction.

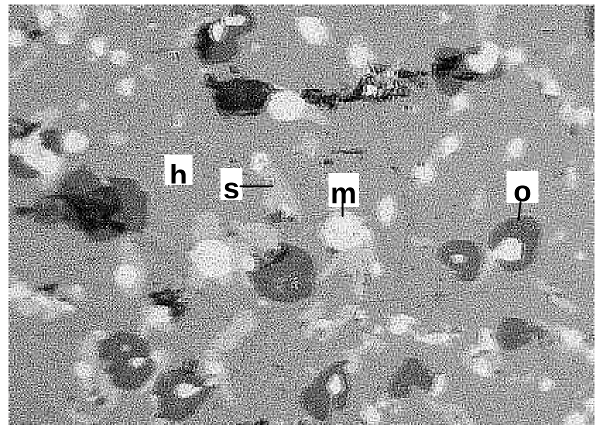

Fig. 5: Sulfide region of "Itqiy". Four different phases can be distinguished (h = Mn-Mg-sulfide as host phase, o = oldhamite, s = Fe-Cr-sulfide, m = metal; selected area = 0.1 mm).

In brief, several classifying parameters of "Itqiy" are ambiguous when compared to the composition of enstatite chondrites. Its metal phase obviously seems to reflect an EH chondritic parentage, while the silicate fraction of this meteorite shows a genetic affinity to EL chondrites. The sulfides though exhibit unusual chemical compositions, i.e. elemental concentrations that match neither those of niningerite nor alabandite and are not observed in enstatite chondrites so far.

Conclusions: "Itqiy" shows an overall homogeneous, coarse-grained, achondritic texture. No relic chondrules are present. With respect to its mineralogy the meteorite exhibits a bimodal composition: Its quantitatively dominating pyroxene fraction resembles EL chondritic enstatite whereas the metal phase reveals compositional characteristics of EH chondritic kamacite. Sulfide phases of "Itqiy" could be identified as oldhamite, which is a common Ca-sulfide of enstatite chondrites, as well as a Fe-Cr sulfide that shows Cr concentrations in between those of troilite and daubreelite, both being sulfides also observed in enstatite chondrites. Additionally, we found an unusual Mg-Mn-Fe sulfide with highly variable compositions.

References: [1] Kring D. A. et al. (1996) *JGR, 101,* 29353. [2] Hill D. H. et al. (1991) *Nature, 352,* 614. [3] Sears D. W. et al. (1982) *GCA, 46,* 597. [4] Larimer J. W. and Bartholomay M. (1979) *GCA, 43,* 1455. [5] Zhang Y. et al. (1995) *JGR, 100,* 9417. [6] Kong P. et al. (1997) *GCA, 61,* 4895. [7] Brearley A. J. and Jones R. H. (1998) in: *Planetary Materials* (ed. J. J. Papike), *Rev. Min., 36,* MSA, 3-262. [8] El Goresy et al. (1988) *Proc. NIPR Symp. Ant. Met., 1,* 65. [9] Ramdohr P. (1973) *The Opaque Minerals in Stony Meteorites.* [10] Goodrich C. A. and Delaney J. S. (2000) *GCA, 64,* 149.