THE STRUCTURE AND COMPOSITION OF LARGE METAL NODULE FROM THE GHUBARA L5 CHONDRITE. C. A. Lorenz[1], S. N. Teplyakova[1], A. V. Korochantsev[1], N. N. Kononkova[1], I. A. Roshina[1], D. A. Sadilenko[1] [1]Vernadsky Institute of geochemistry and analytical chemistry, 119991, Kosygin St. 19, Moscow, Russia, c-lorenz@yandex.ru.

Introduction: The metal nodule of 5.8 g weight was found among the fragments of Ghubara L5 chondrite. Here we report the preliminary results of microscopic, EMP and XRF studies of nodule. The nodule is composed of FeNi grains and troilite blebs. The metal demonstrates widmannstätten texture that is unique in chondritic metal and indicate relatively slow cooling.

We propose that nodule could be formed by the partial or complete impact melting of chondrite precursor. The metal nodule was ejected out of parent body and reaccreted. Then, metal was deeply buried, reheated up to ~900°C during the thermal metamorphism of L-chondrite parent body and cooled slowly enough for growth of the fine octahedrite pattern.

Results: The 5.8 g metal nodule is 4x2.5x0.7 cm in size and has compressed elliptical shape. It has smooth surface with no evidences of intergrowth with surrounding chondrite host. The nodule is composed by 400-1400 μm polygonal grains of taenite composition and do not consist of silicate inclusions. The grain boundaries have nucleated 20-60 μm wide rims of kamacite and minor taenite-kamacite intergrowth, those form continuous network through the nodule. The grains compose of plessite fields, subdivided by kamacite lamellae of 20-60 μm wide (7.34 wt% Ni; Ni/Co=8.5) and minor zonal taenite (14.4-19.1 wt% Ni, Ni/Co=23-25), those follow the widmannstätten directions. Several largest grains demonstrate well formed fine widmannstätten texture (Fig. 1). The metal grains have different orientation of kamacite lamellae and represent individual crystals. The taenite areas, growing close to the grain boundaries, have higher Ni/Co ratio (36-40) in comparison to that of taenite from central parts of FeNi grains. The troilite (15 vol.%) forms rounded, smoothed polygonal and worm-like grains up to 2 mm in size, distributed among the metal grains. The small (30 μm) round troilite inclusions were found in the FeNi metal. Troilite locally consists of fine inclusions of pentlandite (16.6 wt.% Ni). The accessory 10 μm grains of chromite occur in the troilite and on the troilite-metal margins. The products of terrestrial weathering (rust) are patchy localized on the nodule surface. The bulk composition of nodule determined by XRF is (wt.%) Fe 80.1; Ni 11.7; Co 0.59; S 5.09; P 0.2; total 98.0; bulk Ni/Co=20.

Discussion: The Ghubara nodule is unique due its large size in contrast to metal nodules from the other chondrites [1]. The nodule has elliptic shape, smooth surface and do not consist of silicate inclusions. All these features are not common for chondritic metal nodules [1, 2]. The average Ni content of nodule metal (13.7 wt.%) is higher than that of metal nodules and big metal masses from H-chondrites [1-3], but lower than that of L-chondrite metal [4]. The bulk Ni/Co ratio of nodule metal (20) is chondritic. The troilite content of Ghubara nodule is close to that of metal-troilite inclusions in shocked chondrites [3, 5]. We suggest that most probably, the nodule metal has chondritic origin.

The shape of nodule suggests that nodule was formed from the melted metal in the open space or by liquation in the melt. The metal-troilite melt could be segregated from chondrite material by impact melting, how it was noted for shocked chondrites, and could be ejected out of parent body without mixing with chondritic silicates. The other possibility is that nodule could be formed in the large pool of impact melt by liquation of immiscible metal-sulfide and silicate liquids and join of metal and sulfide globules into large nodules. However, the nodule is not associated with complementary silicate melt and probably was separated from it before its incorporation into chondritic body. This could be possible if the following impact splattered the hot liquated melt from the pool. In this case the metal nodule could segregate from the ejected portion of liquated melt due centrifugal force. Another way is impact disruption of solidified pool and mechanical segregation of metal nodule from surrounded silicate melt.

The complex texture of the nodule metal reflects several stages of cooling. The coarse-grained texture of nodule indicates relatively slow cooling, that however, was not enough to crystallization of whole nodule as single crystal. Such a cooling can not be realized in the open space and probably occurred in the layer of debris after the re-accretion of ejecta onto the parent body. The internal textures of metal grains are corresponding to finger plessite and fine octahedrite [6]. These textures were formed during the slow cooling of metal below 900°C, which did not affected on the initial polycrystalline texture of primary taenite [6]. The slow cooling of metal below 900°C could take place after the thermal metamorphism of L-chondrite parent body. The metamorphic grade 5 of the host chondrite, corresponding to heating up to 950°C, is in agreement with this proposition. The widmannstätten texture is quite rare for chondrite metal and was only found in Portales Valley chondrite [7]. The width of kamacite lamellae in Ghubara nodule is less than that of Portales Valley metal, indicating the higher cooling rates of Ghubara nodule.

Formation of the large volume of metal from chondritic source must be accompanied by simultaneous formation of metal-troilite-free silicate melt. In our previous investigations of Ghubara chondrite we found an achondritic inclusion, which is similar by composition to L-chondrite, but free of metal and troilite, and similarly to Ghubara metal nodule, has elliptical-like shape, smooth surface and sharp contact with chondrite host [8]. This inclusion was interpreted as a portion of impact melt, ejected out of parent body, and could be a silicate complement to the nodule metal.

Conclusions: We propose the chondrite source of Ghubara metal-troilite nodule. Probably, the metal-troilite melt was segregated from chondrite by impact melting, but the scale of this melting is a questionable. Further investigation of microelement composition of nodule will allow us to draw its history in more details. The unique complex texture of the metal grains within the nodule reflects multistage cooling history of this object and will provide us information about cooling rates and burial conditions on the Ghubara parent body.

References: [1] Kong P. et al. (1998), MAPS 33, 993-998. [2] Ikeda Y. et al. (1997) AMR 10, 335-353. [3] Rubin A. (1995) Meteoritics 30, 412-417. [7] Widom E. et al. (1986) *GCA 50*, 1989-1995. [4] Wilkening L. (1978) Meteoritics 13, 1-9. [5] Buchwald V. (1975) Handbook of iron meteorites. Univ. Calif. Press, 97-99. [6] Ruzicka A. et al. (1999) *LPSC XXX*, 1616.pdf. [8] Korochantseva E. et al. (2007) *MAPS 42*, 113-130.

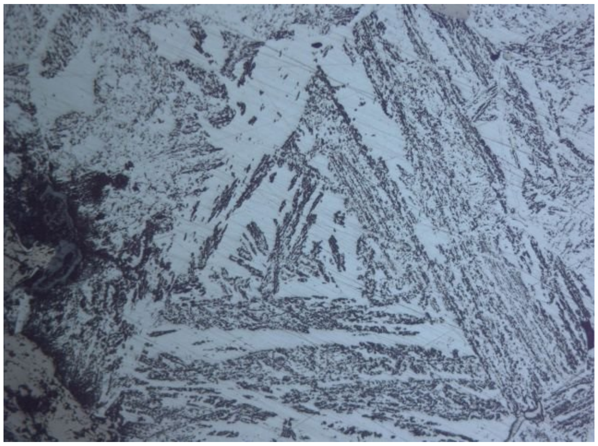

Fig. 1. The fine octahedrite texture of the large metal grain within the metal nodule of Ghubara L5 chondrite (etched polished surface, reflected light, the width of picture is 0.5 mm).