MECHANISM OF FORMATION OF THE FINE-GRAINED METAL IN IIE IRONS AND POSSIBLE METEORITE ANALOGS.

S. N. Teplyakova[1], C. A. Lorenz[1]. [1]Vernadsky Institute, Kosygin St. 19, Moscow 119991, Russia. *E-mail: elga.meteorite@gmail.com.

Introduction: The IIE irons belong to a non-magmatic group of iron meteorites because magmatic Ga-Ni, Ir-Ni trends are poorly defined [1]. It was proposed that IIE metal formed in a pool of impact-generated melt on the chondritic parent body [1]. Our data of siderophile elements distribution in 5 IIE irons indicate that the IIE irons are the products of fractional crystallization of Fe,Ni metal in the core of H chondritic asteroid [2]. Meanwhile, cm-sized parent crystals of taenite (γ-Fe) of some structurally anomalous IIE with silicate inclusions are much smaller in comparison with those of magmatic iron meteorites (up to 2 m-sized in IIIAB [3]). Fine-grained polygonal texture and abundance of silicate inclusions of IIE should indicate remelting of the indigenous metal and mixing with silicate regolith due to some impact events. Here we reconstruct in details a crystallization history of structurally anomalous IIE irons with the silicate inclusions based on the modal mineral compositions and mineral chemistry and compare the IIEs texture with that of large metal nodule with silicate inclusions from the Budulan mesosiderite which is similar to the IIE irons by formation mechanism.

Results and Discussion: Metal of 5 IIE irons - Watson 001, Tobychan, Elga, Verkhne Dnieprovsk, Miles consists of polygonal cm-size grains (1-6 cm). Fine widmannstätten texture is observed in each grain. The metal grains have different orientation of kamacite-taenite lamellae and represent individual crystals. On the grain boundaries the rounded and ameba-shape silicate inclusions (SIs), troilite (Tr) nodules and large xenomorphic segregations of schreibersite have nucleated. Some of SIs have prolonged apophyses propagating along the taenite grain boundaries. Schreibersite also forms intermittent rims on the SIs and Tr nodules. Swathing kamacite always rims the xenomorphic schreibersite. Xenomorphic schreibersite has a low Ni content (Ni – 16.7 at. %) compare to schreibersite lamellae (Ni - 27.6 at.%) formed during subsolidus reactions. Small size of the γ-Fe parent grain is a result of rapid cooling of melt. During the quick crystallization of the melt containing immiscible phosphide, sulphide and metal liquids, the growing crystals of γ-Fe squeeze immiscible liquids between their grains. Based on bulk composition of metal of the IIE Elga iron and phase diagrams [4, 5] we recognize that γ-Fe starts to crystallize from ~1511°C and contains ~0.2 мас. % P. Crystallization of the melt was completed at ~1060-1100°C [5] to produce polygonal shape grains of taenite and xenomorphic schreibersite aggregates, delineating taenite. Schreibersite has a similar composition on the rims of the non-metallic inclusion and between taenite grains that means its simultaneously formation. So low-Ni xenomorphic schreibersite differ from schreibersite forming during subsolidus reactions and we propose that xenomorphic segregations of schreibersite were crystallized directly from the metallic melt as mentioned before [6, 7] and here.

A 6 cm-sized metal nodule of the Budulan mesosiderite comprises 1-5 mm polygonal Fe,Ni crystals with embedded SIs that have apophyses propagating along the metal crystals. In contrast to IIEs, the nodule contains mostly crystalline pyroxene-feldspar fragments with only minor glass [8]. The mesosiderites are generally believed to be the impact breccias of HED-like silicates and IIIAB metal [9]. The texture of Budulan nodule obviously formed by near-surface mixture of molten metal and silicate fragments, similar to that of the IIEs supporting the proposed near-surface IIE formation history. Prevalent crystalline texture of the SIs in the Budulan nodule could be easily explained by initial solid state of the silicates before the mixing with the molten nodule metal.

Thus, proposed mechanism of genesis of IIE with the SIs by surface mixing of endogenous metal and silicate fragments, confirmed by observations of the same impact metal-silicate texture of breccia in a different type of meteorites – in mesosiderites.

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