MULTIPLE IMPACT DEFORMATION OF THE PUŁTUSK H-CHONDRITE.

A. Krzesińska[1]. [1]Institute of Geological Sciences Polish Academy of Sciences INGPAN, Podwale 75, Wrocław, PL-50449, Poland. E-mail: agatakrz@twarda.pan.pl

Introduction: The Pułtusk meteorite is an H4-5 chondritic breccia. In spite of its moderate shock index – S3 [1], it registers complicated impact history. Based on HR-XCT and microscopic observation, as well as EMPA analyses of metallic veins, igneous-textured enclaves [*sensu* 2], impact melt clasts and darkened, cataclastic zones, at least three impact events may be identified.

Synaccretional impact I_1: Large, metallic veins are composed of ameboid, connected in 3D kamacite grains. Veins are depleted in troilite (2.9 vol%), and poikilitically enclose silicate clasts. Chondritic rock around the veins is rich (2.5 vol%) in large (up to 800 µm) merrillite and plagioclase (150 µm) crystals. Such mineralogy and texture suggest that Fe,Ni-metal was unmixed from impact melt and incorporated into the partly equilibrated chondritic rock. When metal cooled slowly, phosphorous reacted with the silicates and formed merrillite. Postimpact increase in temperature explains coarse grained textures of igneous enclaves – products of fractionation and crystallization of silicate melt. Veins, phosphates and enclaves testify for synaccretional impact into parent body . Probably, I_1 is the same event as impact (~4.5 Ga) identified in Kernouvé [3], and Portales Valley [4].

Postimpact fluid activity: Two chemical types of apatite occur in Pułtusk: **(1)** small, equilibrated chlorapatite grains in the host rock (5.1 ± 0.8 wt% of Cl) and **(2)** Cl- and F- apatite with strong negative correlation of Cl and F (1.5 – 6.5 wt% of Cl and 0 – 3.3 wt% of F), overgrown with the large, postimpact I_1 merrillite grains. The two types suggest two episodes of fluidisation [5]. At the second one, after I_1 event, fluid fractionation occurred.

3.7 Ga impact I_2: Impact melt rock is minor part of the Pułtusk. It cooled with rate of ~15 ºC/s – was quenched near the surface of the parent body. As the gas retention age of clasts is ~3.7 Ga [6] - similar to other H-chondrite impact melt breccias [e.g. 7, 8], I suggest that they were formed in large impact event I_2,which had place not so far from I_1 crater. Clasts were thrown from I_2 crater and incorporated into the post-I_1 rocks.

Oblique collision I_3: The most prominent in Pułtusk are cataclastic zones with pseudotachylytes and microfaults [9] cutting all the products of former impacts. As Pułtusk is weakly shocked (S3), observed high strain-rate shear deformation is related to oblique collision [9, 10, 11]. More evidence for shear-dominated impact comes from Pułtusk magnetic fabric [12]. In cataclastic zones of Pułtusk, CM2.6 xenoliths occur. They are hydrated and weakly shocked, like other CM xenoliths in H chondrites [13] but ductily sheared along with the host. They might have been incorporated during I_3, oblique collision of H and CM-like bodies.

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