CHRUDIM - PARDUBICE: EVIDENCE FOR A YOUNG METEORITE IMPACT STREWN FIELD IN THE CZECH REPUBLIC. M. Molnár[1], K.Ventura[2], P. Švanda[3], Z. Štaffen[4], M.A. Rappenglück[5] K. Ernstson[6], [1]Resselovo nám. 76, Chrudim 537 01, Czech Republic; molnar@ego93.com. [2,3]University of Pardubice, Czech Republic; Karel.Ventura@upce.cz, Pavel.Svanda@upce.cz. [4]Vraclav 8, 565 42 Vraclav, Czech Republic; Zdenek.staffen@centrum.cz. [5]Institute for Interdisciplinary Studies, Gilching, Germany; mr@infis.org [6]Faculty of Philosophy 1, University of Würzburg, Germany; kernstson@ernstson.de

Introduction: Roughly ten years ago during geologic field work in the region between Vraclav and Vysoké Mýto one of the authors (Z.Š.) was surprised at a peculiar land surface where, moreover, he discovered large amounts of black glass and scoria. He excluded an anthropogenic origin and suggested a kind of high-temperature meteorite impact event. His colleagues from Czech geology were not convinced, and the discovery fell into oblivion for some time. Meanwhile, due to increased interest in Holocene impacts (e.g., [1-5]) the Czech occurrence (Fig. 1) aroused again attention, and here we report on preliminary results of new field campaigns and first material analyses.

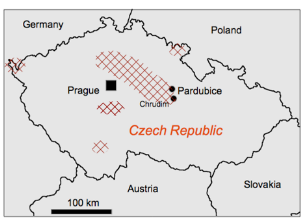

Fig. 1. Location map for the field evidence of the postulated impact event (hatched areas).

Fig. 2. Geologic field work in the Chrudim postulated impact area.

Geology: The region around Pardubice and Chrudim (Fig. 1) where most of the field work has so far been done is occupied by Pleistocene loam and gravel over Cretaceous marls.

Methods: Field studies have included mapping of the intriguing matter and collecting samples, and performing coring and trenching (Fig. 2). Rock and glass samples were subjected to thin-section examination and SEM-EDX analyses. Radiocarbon age dating and preliminary experiments on glass formation of local rock material add to the investigations.

Material: The finds of the intriguing matter are mosty confined to roughly circular sites with diameters between 10 and 200 m which are frequently grouped close together and sometimes show flat depressions. The matter can be allocated to glass pieces (Fig. 3 A, B), to dense, hard glassy carbon matter (Fig. 3 C), to scoria (Fig. 5), to metallic particles (Fig. 3 D) and to pumice-like carbon matter (Fig. 6). Compounds (e.g., scoria and glass [Fig. 5 A, B], glass and metallic matter [Fig. 4]) and intermixed tiny rock fragments can be observed. Drill cores show breccia-style glass and rock fragments in a loamy matrix (Fig. 3 E). Black, up to 5 cm sized glass fragments are abundant besides white and drop-shaped green glass with varying hue (Fig. 3 A). The chemical composition closely resembles that of glass that has experimentally been produced (at 1,300 °C) from local marly bedrock.

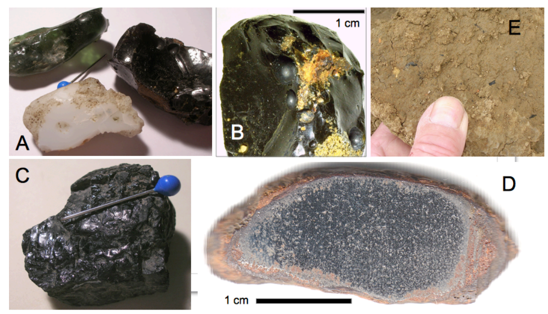

Fig. 3. A: Green, black and white glass from the proposed impact strewn field. B: Black glass with embedded metallic spherules. C: Dense, glassy carbon matter. D: Metallic particle, cut and polished surface E: Splinters of black glass and rock fragments in a drill core from the strewn field.

The pumice-like strongly vesicular matter (Fig. 6) has a glassy to metallic luster on freshly crushed surfaces. It consists of nearly 90 % carbon and, subordinately, of a few other elements (Fig. 6). A radiocarbon age dating revealed no statistically significant 14C corresponding to a numerical age of > 48,000 years.

Shock metamorphism: In thin section only few mineral grains, mostly quartz, contribute to the glass and scoria matter. Frequently, quartz grains are heavily fractured with irregular widely open, glass-filled fissures, but the grains have remained coherent (Fig. 5 C). Fracture-mechanically speaking, the open, obviously tensile fractures have resulted from a dynamic spallation process which may point to shock deformation [6]. This is substantiated by clear shock metamorphism observed in the scoria piece in Fig. 5. In its edge area the strongly fractured quartz grain in Fig. 5 C shows so-called ballen silica (b), an imbricate arrangement of either α-quartz or α-cristobalite structure, which is more expressively shown in Fig. 5 D.
Ballen silica is considered as in proof of shock metamorphism and, hence, of meteorite impact [7].

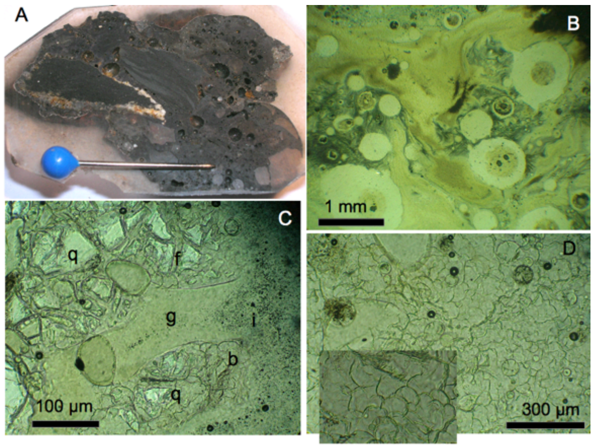

Fig. 5 A-D. Typical scoria from the strewn field; A: cut surface of a black vesicular glass with tiny rock fragments. B: Melt glass with vesicles, schlieren and mineral fragments; C: q - quartz grain with open, glass-filled fissures (f), g - glass, b - ballen structures, i - tiny gas or fluid inclusions in glass, D: ballen silica in the adjacent quartz grain, detail inserted. B-D photomicrographs, plane light.

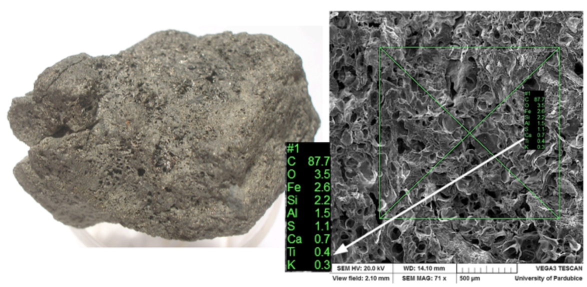

Fig. 6. Pumice-like carbon matter from the strewn field, size: 3.5 cm, and SEM image with EDX analysis.

Discussion: With regard to the shock metamorphism in scoria and glass from the large strewn field of very peculiar finds with some focus on the Pardubice/Chrudim region, the about ten years old original idea of a cosmic event in the Czech Republic has manifested. Extensive field work and beginning lab analyses including SEM-EDX and polarizing microscopy leave no doubt that according to established impact criteria [e.g., 8] a meteorite impact has happened. Many major features of this impact process are only vaguely evident and still open to further more detailed investigations. The question of existing true impact craters has to be answered, and the analysis of suspected meteoritic matter among the metallic samples is still at the beginning in particular focusing on possible industrial sources. The importance of the discovery reaches beyond a local interest, when the remarkable correspondence of the Czech finds to finds at two other young meteorite impact sites in Germany, the Chiemgau impact strewn field [3, 9-10] and the Nalbach (Saarland) impact [2, 11-12] is visualized. Surprisingly, most finds in the Czech, Bavarian and Saarland impact areas have identical counterparts in each other site and may easily be confused. Besides the shock metamorphism also established in the Chiemgau and Nalbach fields, this concerns in particular the black glasses, the scoria, the metallic matter, dense glassy carbon pieces and the pumice-like carbon matter. The latter, that after its type locality in the Bavarian Chiemgau has been named *chiemite*, has the same texture, the same physical properties (e.g., high electrical conductivity) and nearly identical chemical composition at all three sites. For its formation extreme pressures and extreme temperatures (4-6 GPa, 2,500-4,000 K) must have existed [9, 10], and for its origin a shock coalification of target organic matter (wood, peat) has been suggested [10]. Likewise surprising, radiocarbon dating of both the Czech and the Bavarian matter has revealed a numerical age of $>$ 48,000 years that has to be made consistent with an obvious Holocene impact event. Correspondingly, only the Chiemgau impact could reasonably well be dated to the Bronze Age/Celtic era by archeological artifacts intermixed in catastrophic impact layers [13]. The Nalbach impact is also considered a very young, Holocene event, in particular due to an archeological excavation of mortal remains together with chiemite, various glasses, scoria and brecciated rock from deep beneath the foundation of a Romanesque church (W. Müller, pers. comm.). A Holocene age also for the Czech impact is concluded from the concentration of the peculiar finds in the upper soil layers and the very fresh status of the impact glasses. Hence, it could be important to consider a possible coincidence of a triple impact event that affected a distance of at least 650 km in Central Europe.

Acknowledgements: We thank Dr. Ivo Světlík for the radiocarbon age dating.

References: [1] Losiak, A. (2016) *Meteoritics & Planet. Sci*., 51, 681-695 [2] Berger, N. et al. (2015) *LPI XXXXVI*, Abstract #1256 [3] Ernstson, K. et al. (2010) *J. Siber. Fed. Univ. Engin. & Techn.*, 72-103. [4] Folco, L. et al. (2011) *Geology*, 39, 179-182. [5] Tancredi, G. et al (2008*) LPI XXXIX*, Abstract #1216. [6] Ernstson, K. (2014) *http://www.impact-structures.com/impact-educational/meteorite-impact-spallation-from-mega-to-micro-scale,* accessed 1/2/17 [7] Ferrière, L. et al. (2008) *Eur. J. Mineral*., 21, 203–217 [8] French, B.M. and Koeberl, C. (2010) *Earth-Sci. Rev.,* 98, 123-170 [9] Shumilova, T.G. (2012) *LPI XXXXIII*, Abstract #1430. [10] Ernstson, K. et al. (2013) in: Proc. Yushkin Memorial, Syktyvkar, Russia, IG Komi SC UB RAS, 2013. 546 p. [11] Ernstson, K. et al. (2013) *Meteoritics & Planet. Sci*., 48, s1, Abstract #5058. [12] Berger, N. (2014) Diploma thesis, University of Trier, 103 p. [13] Ernstson, K. et al. (2012) *Medit.Archaeology Archaeometry*, 12, 249-259.