

ASPHALTIC (BITUMINOUS) BRECCIAS WITH CARBOLITE (CARBON ALLOTROPE) AND BALLEEN STRUCTURES IN SILICA AS INDICATIVE OF THERMAL SHOCK: MORE EVIDENCE OF A HOLOCENE METEORITE IMPACT EVENT IN THE CZECH REPUBLIC. M. Molnár¹, P. Švanda², L. Beneš³, K. Ventura⁴, K. Ernstson⁵. ¹Resselovo nám. 76, Chrudim 537 01, Czech Republic; molnar@ego93.com, ^{2,3,4}University of Pardubice, Czech Republic; Pavel.Svanda@upce.cz Ludvik.Benes@upce.cz Karel.Ventura@upce.cz, ⁵Faculty of Philosophy I, University of Würzburg, D-97074 Würzburg, Germany (kernstson@ernstson.de).

Introduction: At the last year's LPSC a paper was presented [1] that reported on a proposed Holocene meteorite impact strewn field in the Czech Republic documented by widespread finds of black, green and white glasses, iron silicide particles, glass-like carbon, pumice-like carbon matter and various forms of glassy scoria. Meteorite impact was substantiated by typical shock metamorphism. Remarkably no associated clear impact craters could be established. Here we report on the resumption of the field work revealing a new type of spotty deposits of a so far completely unknown asphaltitic (bituminous; in the following: asphaltic only) breccia obviously adding to the earlier investigated impact evidence.

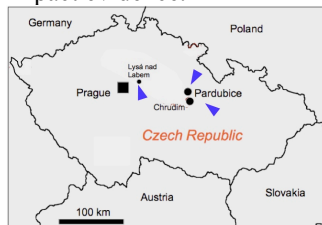


Fig. 1. Location map for the studied asphaltic breccia deposits.

Geologic setting: In the agricultural landscape of the Elbe valley in the surroundings of Mochov and Přerov nad Labem near Lysá nad Labem (Fig. 1) the commonly light-colored Upper Cretaceous sandy marls and clays locally alternate with superficially very dark to black places which must not be confused with coal marls exposed further away in the south. The peculiar matter forming the uppermost cover and only sometimes penetrating to somewhat greater depth is mostly carbonaceous pointing to some kind of pyrolysis of organic matter. Typical constituents are asphaltic boulders frequently forming real polymictic breccias with sedimentary and crystalline fragments (Fig. 2). Various strange mixtures of organic and inorganic matter add to a real "zoo" of peculiar samples (Fig. 3). This asphaltic mass has apparently been frequently confused with anthropogenic asphalt ignoring the very details of facies and texture. Meanwhile similar occurrences have been reported from the whole territory of Bohemia and Moravia.

Methods: The bituminous boulders were examined by thin-section polarizing microscopy of the breccia components and by XRD (D8 ADVANCE, Bruker AXS) and SEM (TESCAN VEGA 3 EasyProbe with

EDX analyser) of the bituminous mass especially focussing on a conspicuous type of tiny fibres. Diffractograms were compared with a database of standards, PDF-4 + database (CITACE).

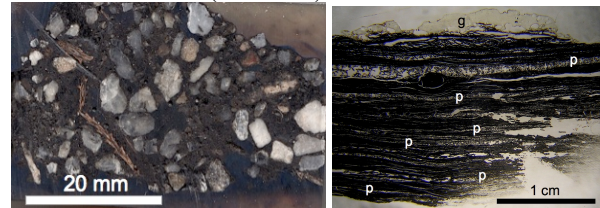


Fig. 2. Cut face of a polymictic breccia with dominantly quartzite components in asphaltic matrix. **Fig. 3.** From the asphaltic breccia: p = glassy pumice-like lamination within carbonaceous organic matter, g = vesicular glass with mineral fragments. Photomicrograph, plane light.

Results: *Thin sections of polymictic breccias - ballen silica.* From the many studied thin sections we mention the observation of typical but not in all cases diagnostic shock effects in breccia clasts like multiple sets of PDF in feldspar, diaplectic feldspar, extreme fracturing of quartz grains, multiple sets PF in quartz, kink bands in mica and ballen structures in silica. We will only address the latter here, because an observation in the asphaltic breccia (Fig. 2) remarkably corresponds to results of the XRD and SEM-EDX ensuing analyses.

Ballen structures in silica form a characteristic texture in quartz that in general is considered a result from various stages of phase transformation and recrystallization of amorphous silica like e.g., diaplectic glass and hence are regarded as shock indicator (e.g., [2]). A different model has recently been suggested [3] that proposes a formation of ballen in quartz in an extreme thermal shock event. We support this hypothesis: In Fig. 4 A a quartz particle has completely been transferred to diaplectic glass that has in part acquired a ballen texture with slightly polygonal shape of individual ballen. In a second grain (Fig. 4 B) the diaplectic glass has got a brick wall texture only faintly reminding of the commonly observed roundish ballen pattern. Finally in Fig. 4 C the diaplectic glass casing the brick wall ballen has degenerated into "ballen" lamellae. A fracture-mechanical process of ballen formation is fur-

ther supported by Fig. 5. In a third grain of diaplectic glass the ballen network appears to trace a planar fracture (PF) pattern in the former quartz grain similar to the brick wall pattern in Fig. 4, and the passage of the ballen texture into sets of quartz PDF also underlines the validity of the new hypothesis dispensing with multiple phase changes. The postulated [3] strong thermal shock from cold to hot and to cold again matches well the observation in the asphaltic breccia where the diaplectic, ballen-bearing silica grains are regularly found in contact with melt glass (Fig. 5 C).

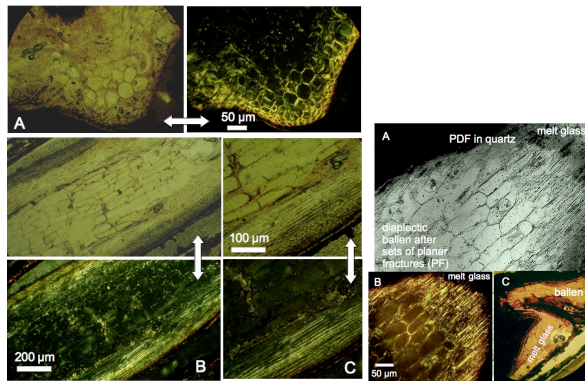


Fig. 4. Diaplectic glass from shocked quartz in the asphaltic breccia. Photomicrographs of ballen structures, plane light and crossed polarizers (see text).

Fig. 5. Ballen and planar features (PF and PDF), plane light (A, C) and crossed polarizers (see text).

Carbolite. Relatively abundant orange transparent fibres in the asphaltic boulders attracted particular attention (Fig. 6 A) and were found on both the boulder weathered surface and on fracture surfaces. SEM-EDX analysis show pure carbon and oxygen (Fig. 6 B), the latter possibly a contaminant from the air. XRD executed on the fibres after dissolution of the asphalt revealed a small amount of crystalline quartz (JCPDS No. 00-046-1045) and wider hexagonal carbon lines (JCPDS No. 00-050-0926) with lattice parameters $a = 11,928 \text{ \AA}$ and $c = 10,620 \text{ \AA}$ (CITACE) [xy] and an average crystallite size of 92 \AA (Fig. 7). Two weak diffraction lines did not match any standard.

With respect to the identified grid parameters, we identified the fibres as carbolite. The synthesis and characterization of this carbon allotrope was first described in 1995 [4, 5]. The synthesis was conducted at high rates of carbon vapour cooling. Carbolite synthesis by hydrometallurgical processes at high temperatures and pressures was introduced much later [6]. In the above-stated publications, the prepared carbon quasi-1D is characterized as an orange semi-transparent material. This is in good accordance with our observations. BSE featured additional information about the surface texture of the fibres. We observed carbolite

fibres consisting of helically twisted strips with a considerably larger width compared with their thickness (Fig. 6 C).

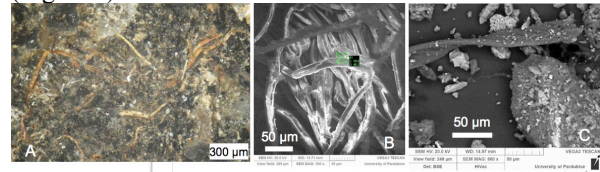


Fig. 6. Carbolite from the studied area. A: photomicrograph. B: SEM-EDX. C: BSE.

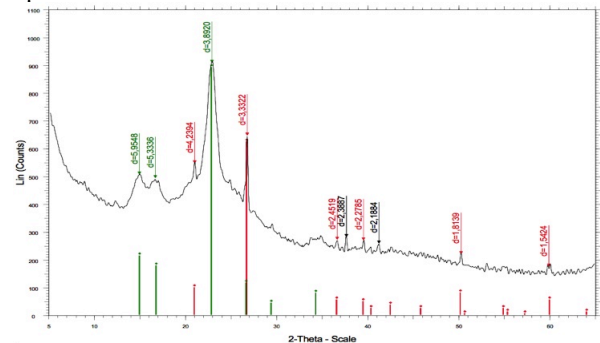


Fig. 7. XRD spectrum for the carbolite fibres.

Conclusions: The synthesis of two completely differing approaches to peculiar observations features a model of an extreme thermal shock signature in an asphaltic breccia that explains both the formation of the carbon allotrope carbolite, hitherto unknown from a natural environment, and the formation of silica diaplectic glass with ballen structures from an impact shock event. The observations add to earlier field and lab work [1] and strengthen the hypothesis of a young meteorite impact event that has affected larger parts of the Czech Republic. Details of this event remain rather enigmatic which concerns both the lack of a definite impact location with a formation of e.g., a crater structure, and the formation of the here discussed peculiar asphaltic breccia. Natural asphalt or bitumen deposits to have possibly supplied the breccia matrix are unknown in the regions under discussion. A meteoritic near-surface strong air burst event may vaguely be considered that caused brecciation, shock metamorphism and formation of melt rocks and glasses [1] in the surficial geologic strata. Such an air burst could possibly have produced the asphaltic matter by a kind of pyrolysis of the target vegetation.

References: [1] Molnár, M. et al. (2017) *LPSC XLVIII*, Abstract #1920. [2] Ferrière L. et al. (2009) *Eur. J. Min.*, 21, 203-217. [3] Chanou, A. et al. (2015). Bridging the Gap III, Abstract 1112. [4] Tanuma, S. and Palnichenko, A. (1995) *J. Mater. Res.* 10(5), 1120-1125. [5] Tanuma, S. et al. (1995) *Synthetic Metals*, 71, 1841-844. [6] Kozhvakhteev, E. M. (2013) *Russ. J. Inorg. Chem.*, 58(12), 1542-1546.