# ASPHALTIC (BITUMINOUS) BRECCIAS WITH CARBOLITE (CARBON ALLOTROPE) AND BALLEN STRUCTURES IN SILICA AS INDICATIVE OF THERMAL SHOCK: MORE EVIDENCE OF A HOLOCENE METEORITE IMPACT EVENT IN THE CZECH REPUBLIC

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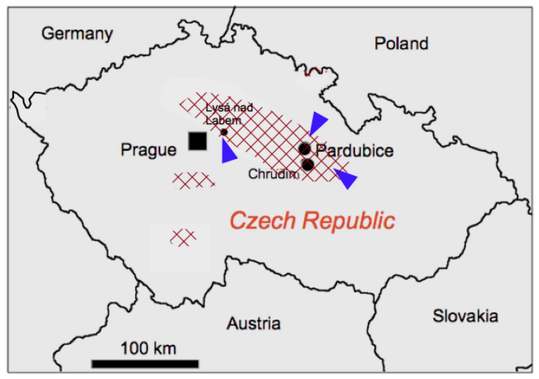
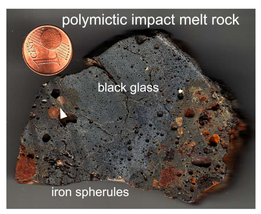


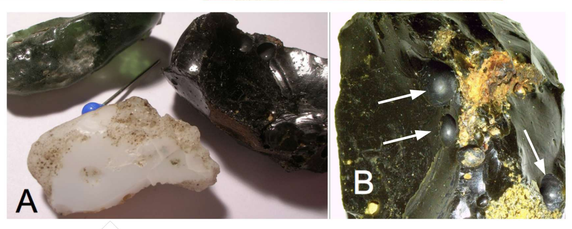

Location map for the investigated impact areas (hatched) and the studied asphaltic breccia deposits (▲).

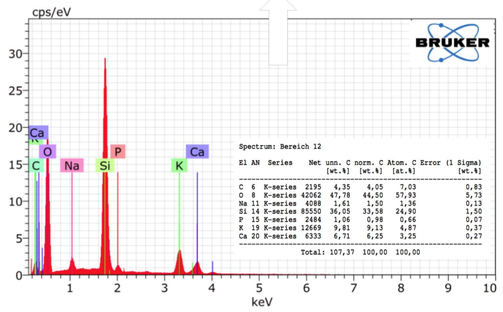
## Previous investigations [1] - impactites, glasses and shock metamorphism from the Czech impact strewn field





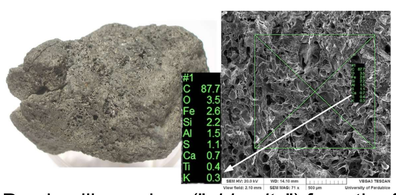
A: Green, black and white glass. Black glass in B with iron spherules (arrows).



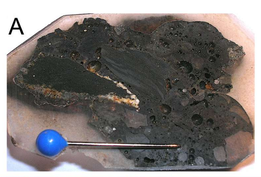




EDS: white glass. Green and black glass have similiar composition, which closely resembles glass from melting local Cretaceous marls (at 1,300 °C).

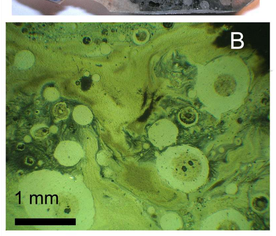
Glass-like carbon



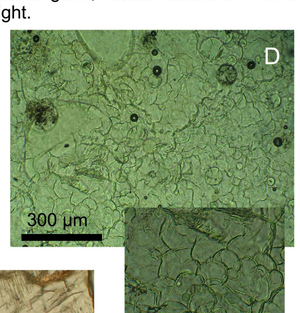

Pumice-like carbon ("*chiemite*") from the field and under the SEM.

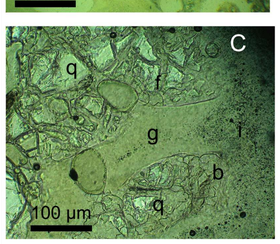


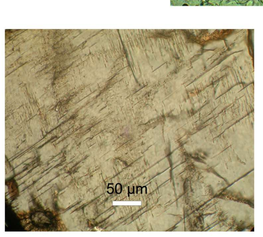

Typical scoria from the strewn field; A: cut surface of a black vesicular glass with tiny rock fragments. B: Melt glass with vesicles, schlieren and mineral fragments; C: q - quartz grain with open, glass-filled fissures (f), g - glass, b - ballen structures, i - tiny gas or fluid inclusions in glass,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




Shock metamorphism in impactites from the Czech impact strewn field



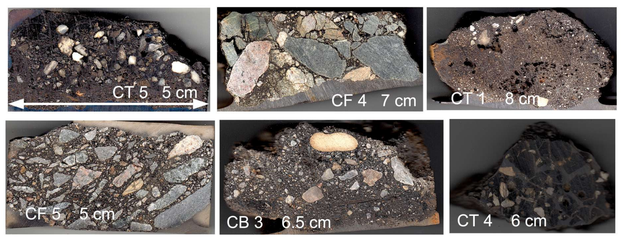




Planar deformation features (PDF) in feldspar. Photomicrograph, plane light.

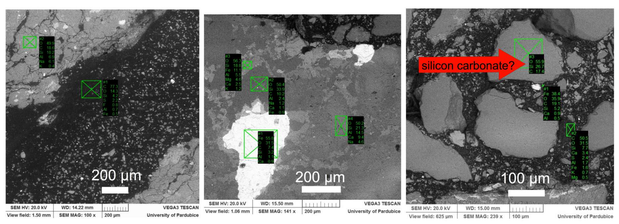
## The asphaltic (bituminous) polymictic breccia


From the air ....

.... in the field.

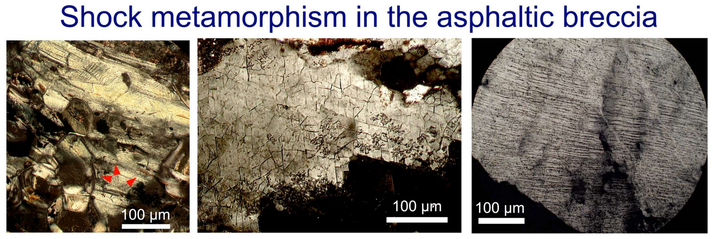



Rock and glass fragments in asphalt/glass breccia matrix.



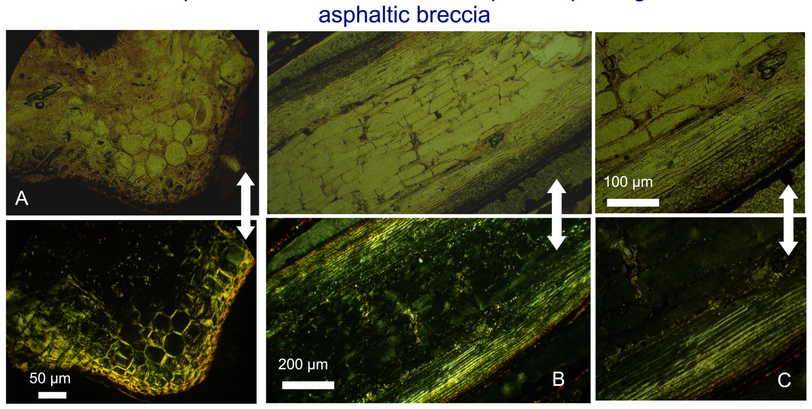

Asphaltic polymictic breccia under SEM - EDS. Fragment of silicon carbonate?

## Shock metamorphism in the asphaltic breccia




Multiple sets of planar deformation features (PDF) in feldspar. - Multiple sets of planar fractures (PF) in quartz. - Decorated planar deformation features (PDF) and kink bands in quartz. Photomicrographs, crossed polarizers.

## Shock metamorphic BALLEN structures in diaplectic quartz grains from the asphaltic breccia

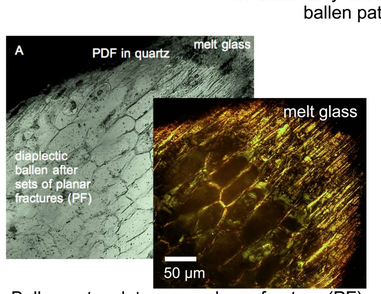



Diaplectic glass from shocked quartz in the asphaltic breccia. Photomicrographs of ballen structures, plane light and crossed polarizers.

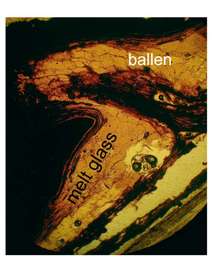
Common shape: roundish to slightly polygonal ballen in diaplectic silica glass.

The diaplectic glass has got a brick wall texture only faintly reminding of the commonly observed roundish ballen pattern.

The diaplectic glass casing the brick wall ballen has degenerated into "ballen" lamellae.




Ballen network traces a planar fracture (PF) pattern in the former quartz grain similar to the brick wall pattern and shows a passage into sets of quartz PDF.




The diaplectic, ballen-bearing silica grains are regularly found in contact with melt glass

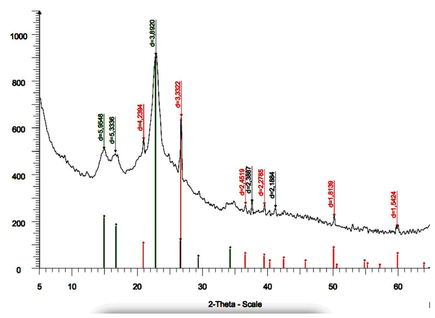
## Carbon allotrope: carbolite

-- The synthesis and characterization of this carbon 1D allotrope was first described in 1995 [4, 5]. The synthesis followed high rates of carbon vapor cooling.

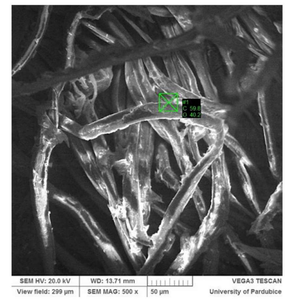
-- 2013: Carbolite synthesis by hydrometallurgical processes at high temperatures and pressures [6].

-- Obviously carbolite has hitherto been unknown from a natural environment.


Carbolite filaments in asphaltic breccia, photooptical

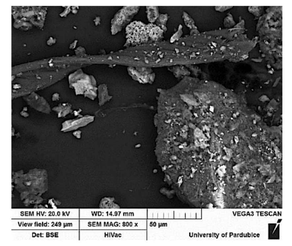



XRD spectrum for the carbolite filaments




SEM-EDS Pure carbon and oxygen the latter possibly a contaminant.

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 Å and c = 10,620 Å (CITACE) [xy] and an average crystallite size of 92 Å. Two weak diffraction lines do not match any standard.




BSE Helically twisted strip of a carbolite filament.

## The meteorite impact event in the Czech Republic - discussion and conclusions

-- In addition to strong evidence from earlier studies new field and lab investigations strengthen the reality of a young meteorite impact event in the Czech Republic.

-- The new results focus on the discovery of the widespread occurrence of an asphaltic (bituminous) polymictic breccia.

-- The asphaltic breccias should have formed in the impact event because of abundant and in apart strong shock metamorphism.

-- Strong shock metamorphism is indicated by the frequently observed ballen structures in silica that have obviously formed from diaplectic quartz.

-- In addition to common ballen shape (roundish to polygonal) the here described ballen may also degenerate into a brick wall and lamellar texture corresponding with a planar fracture (PF) pattern of shocked quartz and closely related to quartz planar deformation features (PDF).

-- The abnormal ballen texture in the asphaltic polymictic breccia supports a new hypothesis on ballen formation purely mechanically by an extreme thermal shock from cold to hot and to cold again [3] thus dispensing with the commonly favored model of phase transformations and recrystallization of amorphous silica like e.g., diaplectic glass.

-- A strong thermal shock executed with the formation of the asphaltic breccia would amazingly be compatible with the formation of the carbolite allotrope if the extreme impact PT conditions with carbon vaporization, which were needed e.g. for the lab synthesis [4-6], are considered.

-- The possible verification of silicon carbonate in the asphaltic breccia, so far unknown from a natural occurrence, would also fit into this scenario with regard to the high PT lab synthesis from silica and carbon dioxide [7].

-- Details of the young meteorite impact event that has affected larger parts of the Czech Republic remain enigmatic which concerns both the lack of a definite impact location with the 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*, 1841-1844. [6] Kozhbakhteev, E. M. (2013) *Russ. J. Inorg. Chem., 58(12)*, 1542-1546. [7] Santoro et al.(2011) PNAS, 108 (19), 7689-7692.