EVIDENCE FOR A HOLOCENE IMPACT EVENT IN THE PARDUBICE - KUNĚTICKÁ REGION (CZECH REPUBLIC) STRENGTHENED. M. Molnár1, P. Švanda2, P. Janíček3, K. Ventura4, K. Ernstson5. 
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Introduction: Two contributions were presented at the past LPSCs [1, 2], that reported on a Holocene meteorite impact strewn field in the Czech Republic, first proposed by geologist Z. Štaffen. 

Resumption of field work and extensive mineralogical-petrographical analyses revealed widespread occurrences of black, green and white glasses, iron silicide particles, glass-like carbon, pumice-like carbon matter (chimie, [3]), various forms of glassy scoria and polymictic asphaltic (bituminous) breccias [2]. Meteorite impact was substantiated by abundant and typical shock metamorphism (Fig. 3). Remarkably, no associated clear impact craters could be established, what is resumed in this paper as an important observation. Here we report on new field work and analyses, which shed more light on the unusual impact event in the Czech Republic.

The new exposures - geologic setting: The new exposures are located in the immediate vicinity of Kunětická hora, one of the most prominent magmatic bodies of the Bohemian Massif (Fig. 1), according to recent investigations a phonolite. Geologically noteworthy are contact metamorphic formations of porcelainite and spotted spilosite, the formation of which is generally attributed to lava flows in contact with Cretaceous marl limestones and clay slates. Dense black obsidian-like glasses found at the Kunětická hora occur together with finds of polymictic melt rock scoria and polymictic asphaltic breccias and chimie. The new outcrop was exposed by a sinkhole from which up to 15 cm large porcelainite glass cobbles together with a 20 cm thick layer of melt rock scoria were recovered.

Results: A polymictic breccias (Fig. 3A), the polymictic melt rock scoria (Fig. 3B) and the procelainite glasses (Fig. 3C) were examined by thin-section polarizing microscopy and by XRD (D8 ADVANCE, Bruker AXS) and SEM (TESCAN VEGA 3 EasyProbe with EDX analyser).

The polymictic breccia: Characteristic photomicrographs of the polymictic breccia in Fig. 4 show an enormous fragmentation of the quartz grains and calcites. All the quartzes, without contact to each other, are finely shattered throughout, without losing coherence. The calcite has been completely transformed into a "pulp" of mosaicism and relics of micro-twins. Most spectacular are abundant quartzes with a hardly, if at all, known fracture texture (Fig. 5). An almost pulverized outer fracture zone more or less sharply encloses a more spared core area. Fig. 6 shows that these are not singular cases. Two features should also be emphasized: typical spallation fractures at the surface of the marginal fracture zones and partial transitions into sets of planar fractures (PFs, cleavage in quartz) (Fig.6).

Fig. 1. Location map. 
Fig. 2. Shock effects from the Czech impact event, photomicrographs [2]. A, B: scoria melt rock, ballen structures and PDF in quartz. C-F: asphalitic breccia: PDF in feldspar, multiple sets of PF in quartz, PDF and kinkbands in quartz, silica diaplectic glass and ballen structures, plane light and xx polarizers.

Fig. 3. Investigated samples: Cut faces of a polymictic breccia with partially bituminous matrix, a melt rock scoria and a black glass from the sinkhole outcrop.

Fig. 4: Polymictic brecca (Fig. 3A), photomicrograph of extremely shattered but coherent quartz grains "swimming" in a fine-grained matrix (left). Calcite, completely crushed to mosaicism and relics of micro-twins (right).
Fig. 5. Quartz grain fracturing in the polymictic breccia (Fig. 3A) - fracture-mechanically a mineralogical phenomenon.

Fig. 6. More concentrically fractured quartz grains. Their size is of the order of the grains in Fig. 4. Right: Quartz grains with sets of strictly planar (PFs) and sub-planar fractures.

The melt rock scoria: The glass matrix in Fig. 7 contains polymictic components, including breccias-in-breccias typical for impact. Quartz grains are rare, but they also show the unusual fracture texture known from Fig. 5, 6, and PFs as a shock effect.

Fig. 7. Melt rock scoria: thin section, transmitted light. Breccia-witin-breccia texture in glass matrix, c = carbonaceous, g = glass particles. mm-scale. Concentrically fractured quartz grain and sets of PFs in quartz.

The porcelanite glass: The black porcelanite glass could be confused with obsidian and because of the vicinity to the Kunětická hora phonolite may be associated with it. A remarkable difference is the much higher Mohs hardness of 7 of the glass compared to a hardness of 5-6 for obsidian. Equally remarkable is an equal hardness of 7 for the black impact glass Ighizite from the Zhamanshin impact structure in Kazakhstan. The chemistry of the glass is also roughly the same as that of porcelanite (Fig. 8), with the very low Na and K contents standing out against a phonolite. A further impact indication is possibly provided by the table in Fig. 8. While the glass shows a depletion for Si and Ca as well as an enrichment for Fe in comparison with the porcelanite, the glass experimentally produced from porcelanite has similar values to the natural porcelanite rock. A different magnetic behavior - diamagnetic/paramagnetic - of the elements could have influenced the formation of the glass under the effect of an extreme impact magnetic field (pinch effect, EMP).

Fig. 8. SEM-EDX data for Kunětická hora porcelanite, the porcelanite glass and an experimentally produced glass from the porcelanite. Also see text.

Discussion: Apart from the descriptions here with the great similarities to the impactites described earlier ([1,2]) with different melt rock and breccia formations and strong shock effects, there is an apparently new, as yet undescribed form of impact shock effects in quartz with an enormous, more or less concentric fringe-like fragmentation with a largely intact core (Figs. 5, 6). The only reasonable explanation for this is an extremely short-term deformation in the form of an extreme external thermal shock at a high confining pressure, which has maintained the coherence of the grains. Other individual shock effects are the multiple edge spallation fractures and the multiple sets of cleavage in quartz (planar fractures, PFs). The chemical SEM-EDX analyses go in the same direction that the porcelanite glass cannot be attributed to an endogenous magmatic process (obsidian), but became an impact glass and occurs together with other impactites. The proximity to Kunětická hora, which may irritate geologists, is therefore purely coincidental, especially since comparable impact phenomena are widespread and occur at great distances.

Conclusions: The new findings on an impact event in the Czech Republic presented here strongly support the hypothesis, expressed earlier, that a widespread near-ground impact airburst [4] happened, which had enormous shock effects on the ground among which extreme thermal shock is especially significant. In view of the absence of impact craters, the Czech event may be seen in relation to airburst impacts like that which formed the Libyan Desert Glass, despite the recently expressed doubts about its airburst origin [5].