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The Enigmatic Luzice (Czech Republic) Megablock and Melt Rock Megabreccia: Evidence of a Meteorite Impact Origin

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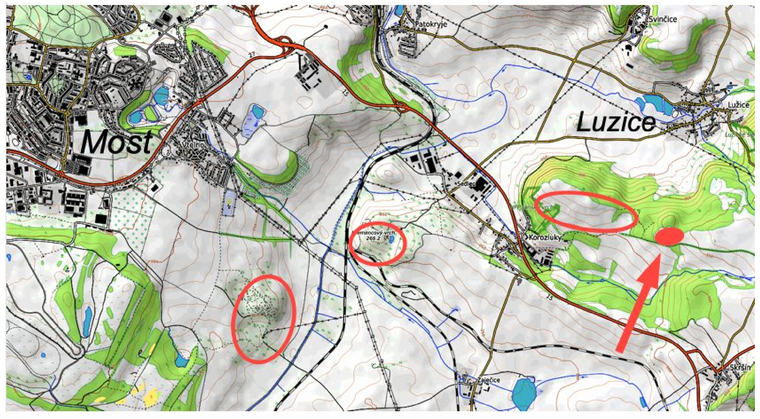
Abstract: We report an unusual polymict melt rock megabreccia in the form of an allochthonous non-volcanic megablock within the Tertiary volcanic province of the Bohemian Massif. It is considered a relict of a suspected low-altitude airburst impact.

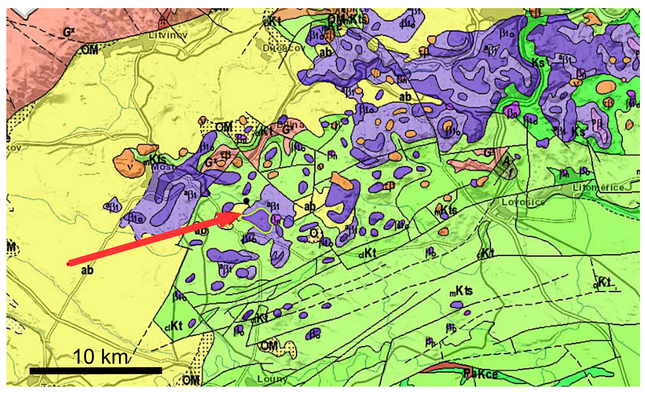
Introduction: About 70 km northwest of Prague, mining in an abandoned quarry has exposed a quarry face whose rocks and material composition are a mystery to geologists. It is a block about 100-200 m in size, located on the margin of the Tertiary Paleogene-Neogene volcanic province of the Bohemian Massif within the extensive Upper Cretaceous deposits. The block represents a megabreccia, and its variegated components include minor layered complexes, polymict breccia bodies, and intercalated slag-like melt rocks.The excavated material for road construction was called porcelanite; however, a discussed volcanism was excluded by geologists. Here we report petrographic investigations and present a new model for the origin and formation of this block.

Location map for the proposed impact under discussion.



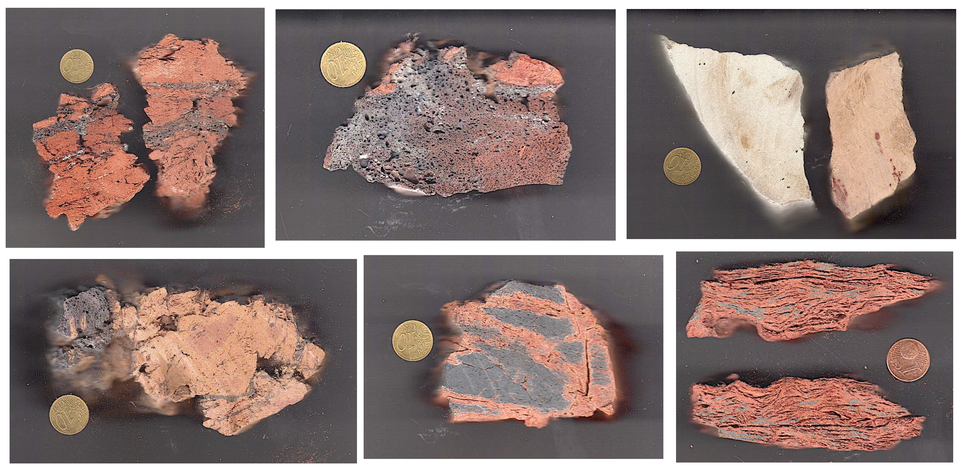
The location for the megablock under discussion (arrow). Red ellipses encircle facially similar deposits, which have not been investigated so far.

The geological setting: According to the geological survey map 1 : 500,000 (below), the outcrop is located in a smaller area of Miocene terrestrial gravels and clays overlying the Upper Cretaceous, partially bounded by volcanic rocks. These are generally widespread assemblages of partially weathered basaltic rocks, unspecified melilitic olivine-bearing rocks, and subvolcanic breccias. Other adjacent complexes consist of basaltic volcaniclastics (predominantly redeposited autoclastics, and some epiclastics and pyroclastics from earlier effusions in the Central Bohemian Mountains). Not further specified occurrences of porcelanites are mentioned. The Upper Cretaceous rocks are described as calcareous claystones and marls.

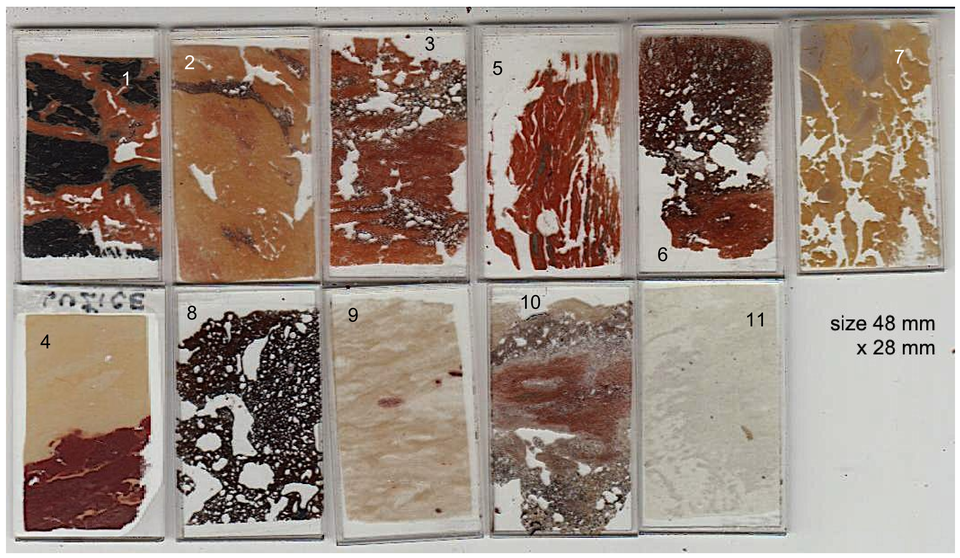


Section of the geological general map 1 : 500,000 of the Czech Republic. Arrow: the megabreccia near Luzice. Purple and light purple: volcanic rocks. Green: Cretaceous. Yellow: Cenozoic/Neogene Reddish: crystalline basement, Arrow: Megablock.

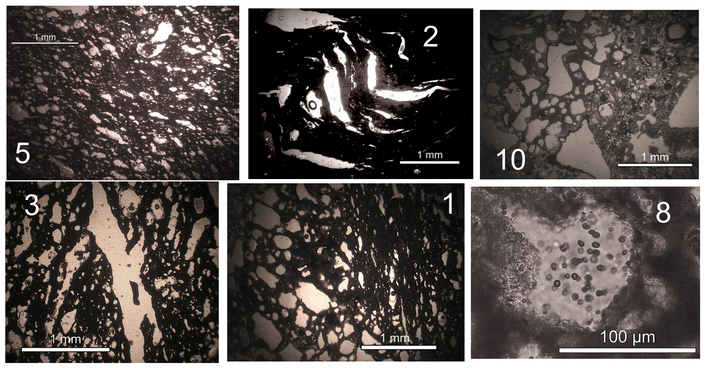
The abandoned quarry exposing the megabreccia.



Selection of polymictic breccia cuts.

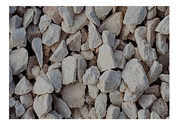


Selection of scanned thin sections.



Melt rock facies in thin section

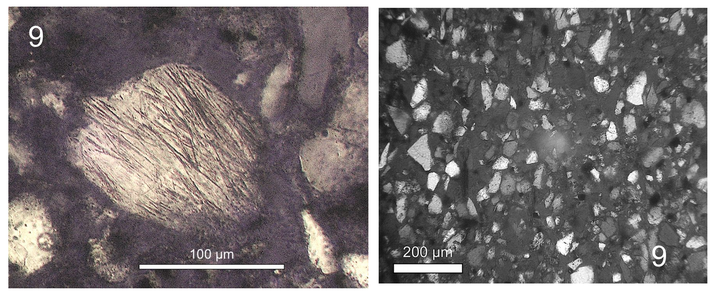
Photomicrographs; PPL, representative also for slides 4, 6, 7. 10, 11 - except for 9 (see below). Complete extinction for crossed polarizers (no photo). We see sharply fractured hollow spaces, which in most part are strongly aligned in flow texture and completely penetrate a melt glass matrix. Mineral grains of any kind are absent. In the cavity 8 (and in others) numerous mostly hollow spherules of unidentified nature, about 5 µm in size, have accumulated (presumably during preparation from the matrix). The reason for the more or less opaque matrix of the melt glass also in PPL is unknown for the time being.



Industrial pebble quicklime.

The nature of the sharply fractured cavities could be explained by Cretaceous limestone fragments that became quicklime in the highly heated matrix and later dissolved out. How the process took place remains mysterious for the time being.

Shock metamorphism - shock fracturing



Left: Multiple sets (five at least) of planar deformation features (PDF) in quartz grain prove shock deformation and shock pressure > ≈ 8-10 GPa. - **To the right:** Slide 9 (here at slightly rotated XX) is the only exception among all samples analyzed so far. The microstructure consists practically solely of an extremely dense packing of continuously sharp-edged broken quartz grains, from which the grain with the PDF also originates. Since a sedimentary texture can be excluded, an extreme crushing under high confining pressure, e.g. of a quartz sandstone, must have occurred. If we assume an impact, then in a first phase at relatively low pressures of few GPa, quartz grains could have experienced multiple sets of planar fractures (PF) or dense networks of irregular fractures known e.g. from impact heavy thermal shock. In a second phase of continuous penetrating deformation and compression the original sandstone attained the texture seen in slide 9.,

Discussion: The continuous transformation of the most diverse breccia samples into practically pure glass without any mineral grains, suggests that the rock was more or less homogeneously heated to temperatures above 1,720 °C (melting temperature of quartz) or more, and a relationship to volcanism can be excluded. We therefore formulate our model for the formation of the Luzice mega-melt breccia as follows:

#There has been an impact in the region as the heat source, according to presumed Cretaceous components in the megabreccia in the Upper Cretaceous or younger. The megabreccia belongs in some way to the excavation and ejection of the cratering.

Our extensive scanning of high-resolution digital terrain models does not detect a crater.

Hence, subsequent volcanism and densely scattered extrusions may have completely destroyed an existing impact structure. Impact rarefaction and transtension tensile features may have initiated and facilitated volcanism.

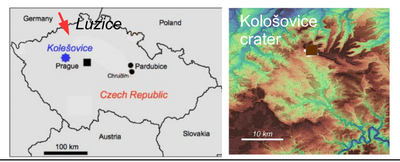
A low-altitude airburst impact and very shallow impact features would only allow a relatively short survival due to dense volcanic overprinting.

The widespread occurrences of the redeposited auto-, epi- and pyroclastics and (subvolcanic) breccias, as well as the porcelanites and melilitic rocks, could also be seen in connection with an impact event,

Conclusions: The melt glass megabreccia excludes volcanism and stands for an impact event in the region. The geological circumstances speak for a low-altitude airburst, without a more exact sequence of events being recognizable so far, which new geologic mapping would have to reveal.

A simultaneous impact with the 20 km-diameter Kološovice crater, which has only recently been discovered and described about 60 km south of Luzice, may be discussed. A Cretaceous or post-Cretaceous age for both is assumed, and a low-altitude airburst impact is suggested for Kološovice, too (see Reference).

Kološovice - Luzice: Czech twin impacts?



Reference:

M. Molnár, K. Ventura, J. Poßekel K. Ernstson.

THE KOLEŠOVICE 20 KM-DIAMETER STRUCTURE (CZECH REPUBLIC): EVIDENCE OF AN AIRBURST IMPACT CRATER

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