THE POSSIBLY SMALLEST COMPLEX IMPACT CRATER ON EARTH? T. M. Walesiak, 65/4, Skarbka z Gor Street, Warsaw, 03-287, Poland (tomasz.walesiak@wp.pl).

Introduction: It is considered that on Earth transition from simple to complex impact craters happens at a minimum diameter of about 2 km [1]. Observations of Lunar, Martian and impact structures on other planets suggest that the threshhold depends on various factors like gravity, velocity and density of the impactor, and on target conditions. Recent field work in Poland has shown that a newly discovered possible small meteorite crater reveals a distinct excentrical inner elevation.

Observations: The crater (Fig. 1) is located in northeast Poland in a target of Quaternary. The rim-to-rim diameter is roughly 150 m, and a NW - SE topographic profile is shown in Fig. 2. From this figure it becomes evident that in the northern part a rim wall is not well developed.

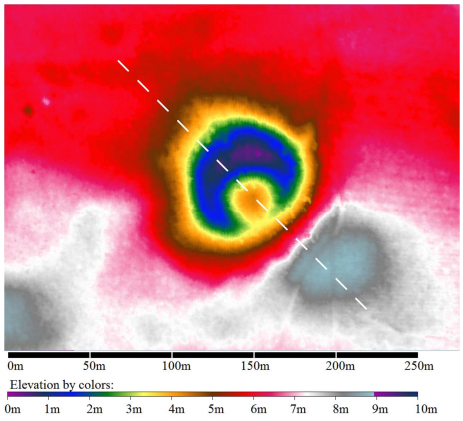

Fig. 1. Crater hypsometric map (from Laser air scanning; Centr. Resort Geod. Cart. Doc.).

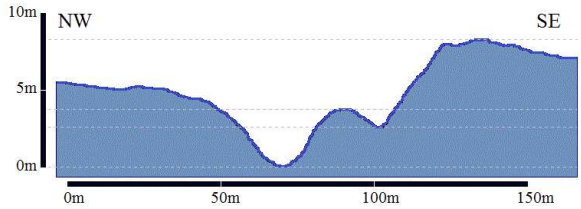

Fig. 2. Crater profile along the line in Fig. 1.

Preliminary sampling on the crater floor and in the surroundings revealed a host of vesicular melt rocks completely strange to the regional geology (Fig. 3A), and angular and subrounded cobbles and boulders of polymictic breccias (Fig. 3B, 3C, 4) suggested to have originated from deformed moraine material (till). Typical is the shrapnel character of many rocks (Fig. 5) sampled on the floor, as well as outside the crater assumed to be ejected material. Metal detector and magnet probing of the soil revealed material that could in part be meteoritic and is now under closer inspection.

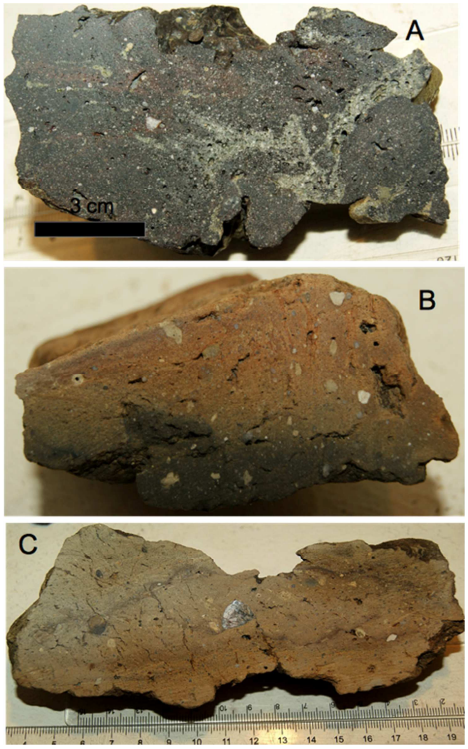

Fig. 3. Melt rock (A) and polymictic breccias (B, C) from the nearest crater area suggested to have originated from impacted moraine (till) material.

Fig. 4. Detail of the polymictic breccia in Fig. 3C exhibiting breccia-within-breccia and flow texture. Field width 2 cm.

Fig. 5. Schrapnel-like shape of many fractured rocks points to exceptional deformation processes.

Discussion: According to current impact research (e.g. [1, 2]) a meteorite impact crater is considered as having been approved if:
-- the impact is directly witnessed by men,
-- the crater is related with meteorites as relics of the impactor, or
-- minerals and rocks give evidence of shock metamorphism.

For the time being the crater under discussion lacks any of these prerequisites because rock analyses especially for shock effects are due to start now. On the other hand, the abundant melt rocks and polymictic breccias with flow textures and breccia generation as shown in Fig. 3 and Fig. 4 have the typical appearance of impactites, and their occurence obviously linked to the crater and related debris masses makes the formation in a meteorite impact event very probable, in particular since alternative explications can hardly if at all possible account for the observations. This concerns a man-made (e.g., military, reservoir) origin or geogenic formation (e.g., volcanism, tectonics, big landslides, dead-ice depression). We are aware however of the fact that the textures of impact breccias and till deposits may have much in common, and in the present case shock deformation, impact excavation and ejection could well have affected a till diamictite as a parent rock for the formation of a similar impactite breccia.

A peculiar morphological signature is the excentrical elevation inside the depression that on the whole shows a distinct asymmetry (Figs. 1, 2). In general, small meteorite craters are bowl-shaped, and complex structures with a central uplift are formed only for increased diameters due to collapse and elastic rebound of the transient crater (e.g., [3]). A central uplift in a meteorite crater with a diameter of less than 200 m is so far unknown, and that is why we prefer to speak of an inner elevation or inner peak avoiding the "uplift" term as long as its true nature is not settled. For example, the elevation as the result of ring wall material slumping back into the excavation cavity at the end of the crater development must be taken into consideration, although the dinstinct circular form does not really speak in favor of this possibility. Hence, a very unusal rebound mechanism possibly related to a swampy underground at the time of impact, and a strongly oblique impact trajectory leading to the observed distinct asymmetry may be considered. Whether or not we are dealing with a complex crater in the common sense, this question is subordinate here.

When did the proposed impact event happen? From the fresh appearance of the rocks and crater morphology a post-glacial, Holocene age is anyway indicated. Moreover, an event even in historical times cannot be excluded with regard to local old traditions. January 9/10, 1871: A fireball was observed followed by a loud explosion heard up to distances of about 150 km. It may be speculated on a connection with the 3D/Biela comet fragmentation. April 4, 1661: A very loud explosion over distances of about 100 km was reported, and a luminous phenomenon comparable to three suns was observed. July 20, 1704: A fireball in the direction of the crater but at a 400 km distance was observed followed by a light/fire column for the next two hours. For the same year a large fire close to the crater location was reported. In any case, none of these reports (e.g., [4]) from the 17th to the 19th century shows compelling evidence of a relation to the proposed impact, and a future radiocarbon dating of the formation of the crater or a dating by archeological findings may possibly become more enlightening. Estimated ages of trees and records in old maps prove an existence of the crater since more than 100 years.

Conclusions: A circular rimmed depression exhibiting rocks typical of meteorite impact strongly speaks in favor of a cosmic origin, all the more another formation (man-made, geogenic) fails to explain the intriguing observations. Since diagnostic shock effects have not been studied so far, the crater must be considered a probable meteorite crater for now. The observed distinct asymmetry of the crater featuring an excentrical, however clearly circular elevation requires further considerations with regard to the possibility whether very small craters may also show a complex structuring otherwise subject to larger craters only.

References: [1] French, B. M. (1998) Traces of Catastrophe, LPI contribution No. 954, Houston. [2] French, B. & Koeberl, C. (2010) *Earth Sci. Rev.*, 98, 123-170. [3] Melosh, H.J. (1989) Impact Cratering. A geologic process. Oxford Univ. Press. Oxford. [4] Old polish newspapers e.g. “Merkuryusz Polski Ordynaryjny”, “Gazeta Polska” etc.