

## Geological effects of the comet fall on the territory of Central Europe at the end of Miocene\*

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It is well known that the Bohemian and Moravian moldavites are presumed to have formed in connection with the fall of a cometary core in Bavaria and with the origin of the Ries and Steinheim meteorite craters. In 1967 the distinguished Czech selenologist Mr. Josef Sadil pointed to the possibility of finding analogous craters in Bohemia and Moravia. In the following year I set to work on his repeated suggestion. After plotting the Setinheim and the Ries craters on the map, as well as the moldavites localities of the strewn field in southern Bohemia and some finds in south-western Moravia, I inferred the further course of the line connecting these points. The extended line runs through north-eastern Moravia, near the towns of Hranice and Valašské Meziříčí. In this area there are some localities whose rather enigmatic origin has long attracted the attention of geologists. Already in 1952 Dr. F. Chmelík informed me about peculiar sediments in a sandpit on the left roadside between Ústí near Hranice and Horní Těšice. Like some of his colleagues he regarded them as glacial sediments. On detailed inspection of the sandpit I did not find the least traces of Nordic rocks, which otherwise are common in the glaciogene and glaciofluvial deposits in the neighbouring western, north-western and northern areas. My conclusions on the pre-Quaternary age of the sediments considered were also confirmed by later studies of J. Tyráček. It was only in connection with the newly arisen problem that I returned to this locality and discussed it with Dr. Z. Roth, the editor of the respective map sheet. I called his attention again to the extraordinary material, i. e. to the angular blocks embedded in small well-worn quartz gravel. The other phenomena of interest observed by my colleagues or by myself are the amphitheatre of Jasenice near Valašské Meziříčí, the Poruba tectonic window, the amphitheatre on the central summit of Mt. Radhošť and the Magura octahedrite. Thus, following the tentative line starting at the Steinheim crater in Bavaria I got as far as north-western Slovakia. I am well aware that in doing so I move on a very thin ice and that my ideas will undoubtedly provoke criticism and polemics. Nevertheless, I pluck up courage and stimulation from a 15-year struggle for the recognition of my discovery of stone industries in Bohemia, 250,000 up to 500,000 years old.

In the present lecture I would like to mention several finds and localities that could be connected with the fall of the cometary core (see K. Žebera 1969), and consequently of the fall of moldavites in Bohemia and Moravia. It depends on further investigations whether my observations and considerations will be

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definitely confirmed or disproved. Undoubtedly, it will not be easy and it will take some time before the problem can be resolved; it suffices only to realize for how many decades the genesis of the Ries crater has already been disputed.

(1) Following the line from east westwards, the first is the locality, where the large Magura octahedrite, i. e. iron-nickel meteorite, was discovered on Mt. Magura east of Námestovo in Slovakia.

(2) Semicircular Radhošť amphitheatre on the south-eastern side of the central summit of Mt. Radhošť. Originally I myself thought this amphitheatre to be a head scar of an immense rockslide, although its location seemed to me very strange already at my first visit in 1952 (K. Žebera 1958, p. 32). The occurrence of a rock-slide would be reasonable in a mountain col or in a depression between two summits, but the Radhošť amphitheatre is right on the top. It developed in subhorizontal sandstone beds cut across by its edge, which is quite unusual for the rockfalls or rock slides. In my opinion, this topographical form may be an explosion crater, of which only the north-western part has been preserved, being strongly remodelled by weathering processes during the Pliocene and Quaternary. It would be necessary to look for vitrified sandstones in the valley of the river Bečva and for shatter cones and coesite in the amphitheatre itself (R. Rost 1961).

(3) The circular Jasenice amphitheatre near Valašské Meziříčí. It was deepened in the Těšín Shale at a diameter of about 2 km. The conspicuous elevation in its centre is made up of enormous blocks of Jurassic limestone and recalls the central cones of lunar craters. The amphitheatre is drained south-westwards by a narrow canyon-like valley into the river Bečva, where it would also be expedient to search for the shatter cones.

(4) At a small distance to the west is the Poruba tectonic window, the origin of which may have been facilitated by extraterrestrial forces. The existence of an explosion crater can again be postulated.

(5) Farther to the west there is the Těšice locality of small-grained quartz gravel and sand with blocks of angular rocks. The large angular blocks and occasional chaotic bedding of the deposit led to the opinion that these sediments are of glacial (morainic) origin. The absence of Nordic rocks that are characteristic of the glacial sediments of the Moravian-Gate area was decisive for dating them as pre-Quaternary. Z. Roth (1926, p. 136—137) placed these chaotically bedded sediments preliminarily in the Pliocene.

The presence of angular blocks, up to 75 cm across, may tentatively be interpreted as blocks fallen into small-grained quartz gravel at the explosion of an immense meteorite or of a cometary core in the near vicinity. Sediments of similar character have also been found north of this locality, at Lučice near Běloutín (I. Čícha — J. Paulík 1962, p. 137), and are likewise presumable at other places of the Kelč Upland (Z. Roth 1962, p. 136—137).

The Těšice quartz gravels are strikingly similar to the Slavětice moldavite-bearing gravels, ESE of Třebíč in south-western Moravia. However, we did not succeed in finding any moldavites during our short inspection.

(6) The moldavite localities close to Třebíč in south-western Moravia, lying right in the strewn field or in its immediate vicinity, are of special importance for our conclusions. The moldavite gravels to the east of Třebíč (e. g. Slavětice moldavite-bearing gravel and sand) date most probably

from the time of moldavites fall but they underwent a long transport (re-deposited moldavites). Moldavites from the localities between Znojmo and Moravský Krumlov were presumably transported to a still greater distance. They are most probably deposited in the redeposited gravels of Pliocene age.

(7) The moldavite localities of the strewn field in southern Bohemia, which provide a reliable support to our considerations, are numerous: Lipnice, Borovany and Ledenice in the Třeboň Basin; Bukovec, Kamenný Újezd, Krásejovka, Vrábče—Nová Hospoda, Slávče, Habří, Kvítkovce and Dolní Chrášťany in the České Budějovice Basin; the Besednice locality outside these basins. Most of the moldavite localities, however, yield moldavites that were more or less transported soon after their fall or redeposited in the Pliocene and Quaternary (K. Žebera 1967, 1969).

(8) It cannot be excluded that in the trend of the theoretic line of meteorite flight or, we can say, in a strongly elongated ellipse of scatter, there is another explosion crater between Netolice and Podeřístě. A striking depression is there filled with chaotically deposited sediments of very unusual character for the South-Bohemian basins. The investigation of these phenomena is extremely difficult and time-demanding, as 14—15 million years have elapsed since their origin.

(9) and (10). The ellipse of scatter also covers the finding places of the Bohumilice and Výškovice octahedrites. They were discovered above the contour-line of 500 m a. s. l., as were the moldavites of the strewn field in the Třeboň and the České Budějovice Basins. The topographical location and mineralogy of these octahedrites are analogous to those of the Magura octahedrite.

(11) In Bavaria the Ries crater falls in the ellipse of scatter, which is terminated by the

(12) Steinheim crater.

In my opinion, the fall of the iron-nickel meteorites and of moldavites as well as the origin of explosion craters were connected with the fall of a cometary core on the Earth's surface, as I already suggested in my lecture of 1967 (K. Žebera 1969). The comet flew from east westwards and encountered the Earth's atmosphere between 49° and 50° north lat. under a small departure to the south. Its flight is thus presumed over the High Tatra Mts., southern Moravia, southern Bohemia to Bavaria.

The encounter of the comet with the Earth was accompanied by several explosions. The first occurred on the impact of the cometary core upon the atmosphere, the others on the fall of parts of the core upon the Earth's surface (Radhošť, Jasenice, Netolice, Ries, Steinheim). The melting of meteoric glass set in probably at the explosion in the atmosphere. I do not exclude, however, that some parts of the cometary core could have obtained their vitreous character in the interplanetary space.

The other phenomena accompanying the fall of the comet on the Earth have already been mentioned briefly in my paper of 1969 (pressure wave, fires, cloud-bursts).

In conclusion I would like to note that the report on the find of a moldavite in the High Tatra Mts., which was circulated two years ago, is not quite illogical on the hypothesis developed in this paper.

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### Geologické účinky dopadu kométy do strednej Európy koncom miocénu

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Koncom miocénu preletela nad Vysokými Tatrami, južnou Moravou, južnými Čechami kométa, ktorá skončila svoju púť v Bavorsku. Pohybovala sa medzi 49° a 50° severnej šírky s malou odchýlkou na juh. Keď sa kométa dostala do atmosféry Zeme a keď sa stretla so Zemou, nastalo niekoľko explózií, ktoré boli sprevádzané pádom magurského oktaedritu, vyrazením amfiteátra na Radhoští a na území dnešnej Jasenice pri Valašskom Meziříčí, pádom vicenického oktaedritu, pádom vltavínov v oblasti Třebíče na juhozápadnej Morave a v južných Čechách. Ďalej bol vyrazený lievik v brízosti Netolic, potom nastal pád oktaedritu u Bohumilic a Výškoviec v južných Čechách a ďalej došlo k vyrazení lievika Rieského a Šteinheimského v Bavorsku. Pád kométy sprevádzala tlaková vlna, požiare a veľké lajaky.

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