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NEW DATA ON THE BOCHNIA TUFF FROM CHODENICE, FORECARPATHIANS, POLAND

Chodenice, once a village situated about 4 km to the west from the centre of Bochnia and later incorporated into the town, is the type locality for the Chodenice Beds (Niedźwiedzki 1883, *fide* Alexandrowicz 1961). This series, up to 350 metres in thickness, mostly consists of dark-grey or brownish, marly clays intercalated by fine-grained sandstones and sands and few pyroclastic levels at the top. In the general stratigraphic column of the Carpathian Foredeep the Chodenice Beds directly overlie the Badenian Evaporites, well known from e.g. salt mines in Wieliczka and Bochnia, both these units belonging to the so-called folded Miocene (Fig. 1).

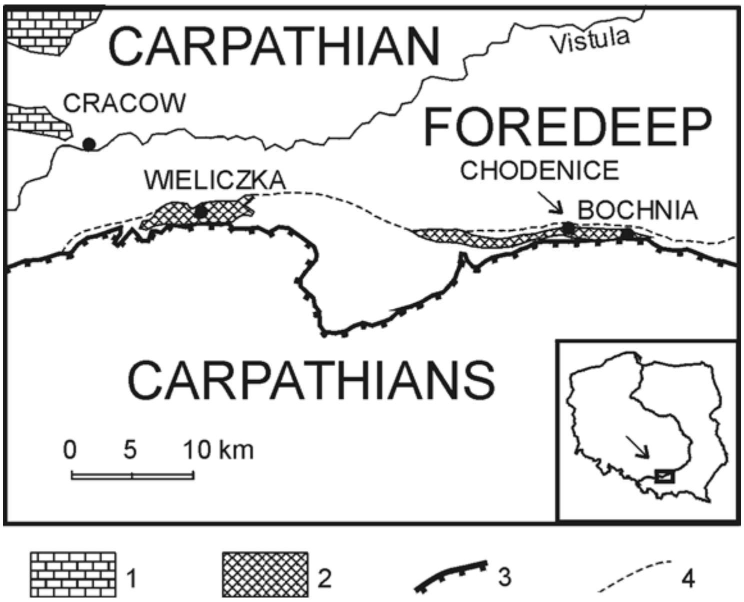

Fig. 1. Geological sketch of the Wieliczka-Bochnia area. 1 - platform Mesozoic sediments; 2 - Miocene salt deposits; 3 - Flysch Carpathians border; 4 - extent of folded Miocene sediments.

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The whole Miocene sequence of the Carpathian Foredeep contains at least ten pyroclastic levels. Well-preserved and bentonized tuffs or bentonites were reported from the vicinities of Bochnia and Wieliczka, the area of the Upper Silesia, southern margin of the Holy Cross Mountains and from drillings in the eastern part of the Carpathian Foredeep (Parachoniak 1954, 1962; Alexandrowicz, Pawlikowski 1980; Alexandrowicz 1997). Three of these pyroclastic levels, labelled WT-1, WT-3, and TB, were recognized to be significant for regional correlations. The levels WT-1 (Wiewiórka 1979) and WT-3, appearing below and within the evaporite series, respectively, were used as correlation layers for salt-bearing deposits from Wieliczka and Bochnia (Bukowski 1999). The level TB (Bochnia Tuff), occurring at the top of the Chodenice Beds, is considered as the most broadly developed pyroclastic level in the whole Carpathian Foredeep. In the area between Wieliczka and Bochnia it was encountered in several natural outcrops (Chodenice, Chełm n/Raba, Moszczenica, Sułków), in the Bochnia salt mine as well as in numerous drillholes. In other parts of the Carpathian Foredeep this level was reported from Upper Silesia (Alexandrowicz, Pawlikowski 1980) and from drillholes near Mielec and Przemyśl (Parachoniak 1962).

A natural outcrop of the Bochnia Tuff in Chodenice is situated on the high, right (eastern) bank of the Grabowiec creek, its detailed sketches were presented by Parachoniak (1954). Actually this outcrop is significantly smaller, not more than one metre in height and around 2.5 metres in length. The layers dip to the south at steep angles of around 60°; most of them represent hell-grey or even whitish, medium- and fine-grained tuffs, only at the southern edge of the outcrop the tuffs contact with brown, marly clays. Tuffs occur in multiple layers, several centimetres in thickness, the layers of more coarse-grained materials are generally thicker, less distinct, and easily weathering into loose debris and grains. The fine-grained varieties are thinner, harder, and more distinctly laminated. The observed gradual successions from medium- to fine- and very fine-grained varieties enables to distinguish three cycles of pyroclastic sedimentation. However, based on older data from no longer existing outcrops at Chodenice and Chełm n/Raba, Wieser et al. (2000) reported seven such cycles.

Microscope analysis revealed that medium-grained varieties are composed of crystaloclasts, glass shards and sparse rock fragments disseminated in clay matrix. Well-preserved vitroclasts and crystaloclasts (mostly quartz, K-feldspars, plagioclases, and scarce flakes of muscovite and weathered biotite) are of dimensions of tiny ashes and volcanic dusts, usually below 0.1 mm. Fine-grained varieties display distinct lamination on microscopic scale, they are richer in clay matrix, whereas crystaloclasts of quartz and feldspars are less frequent and smaller.

The clay fraction (below 2 μm), separated by sedimentation of dispersed samples in distilled water, accounted for 10-12 wt. % of the fine-grained tuff samples, but only for 2-3 wt. % of the medium-grained ones. On the other hand, two medium-grained samples yielded over 50 wt. % of sandy grains (> 0.0625 mm), whereas two fine-grained ones only around 30 wt. % and 10 wt. % of such a material. The X-ray diffraction patterns of the distinguished clay fractions demonstrated that a mixed-layered smectite, with the main peak at 15.6 Å, is the predominant component of all the analysed samples.

Heavy minerals were separated in tetrabromoethane ($C_2H_2Br_4$, d=2.97 g·cm^{-3}) from the earlier distinguished coarser grains (> 0.0625 mm) of disintegrated samples, after removal of clay particles. Microscope investigations of grain mounts enabled to recognize rutile, zircon, apatite, garnet, staurolite, biotite, and opaque crystals, presumably ilmenite.

One sample of biotite separated from the Bochnia Tuff from Chodenice was dated with the Ar/Ar method to 12.2 ± 0.4 Ma (Wieser et al. 2000). The observed succession of strata reflects, however, at least three subsequent volcanic events. Further studies are aimed at distinguishing of minerals for dating purposes from all three documented eruption cycles. Direct contact of the medium-grained tuff with overlying marly clays suggests that the whole sequence observed in the discussed outcrop at Chodenice is reversed.

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