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## THE OCCURRENCE OF TUFFACEOUS HORIZONS IN THE TERTIARY OF THE POLISH LOWLAND AND THE CARPATHIAN FOREDEEP

by

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The well-surveyed Tertiary deposits of autochthonous character are distributed over two distinct areas in Poland (Fig. 1): one exceeding 150 000 km<sup>2</sup> in the Polish Lowland (central and northern part of the country); the other, considerably smaller, is situated in the south—in the Carpathian foredeep (NEY et al., 1974). The two sedimentary basins are separated by denudation zone connected with the metacarpathian ridge in places up to several dozen kilometres wide, that zone is almost completely devoid of Tertiary deposits. The two separate basins differed distinctly in tectonic regime, rate of basement subsidence, type of deposits, thickness of profile and stratigraphic range.

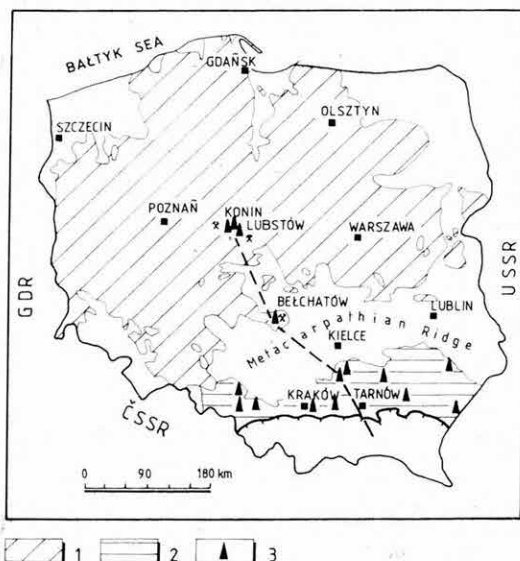


Fig. 1. Some important localities of tuffaceous horizons in Poland

1 Boundary of the Polish Lowland Miocene, 2 boundary of the Carpathian fore-deep Miocene,  
3 exposures of the tuffaceous horizons

The differences are substantial; in consequence, up to the present the correlation of the profiles of the two basins has remained unsolved.

The Carpathian foredeep deposits the main part of which has been assigned to the Middle Miocene (Upper Karpatian, Badenian, Lower Sarmatian), consist of marine sediments with rich micro- and macrofauna of biostratigraphic importance.

On the other hand, the Miocene of the Polish Lowland consists of deposits of limnic type with abundantly coal-bearing swampy sediments of practical importance. Its stratigraphy was based on differentiated spore—pollen assemblages with an auxiliary utilization of lithological characteristics (CIUK, 1980).

In recent years the search for correlative horizons led to the identification of pyroclastic rocks in the Lowland Miocene, in the Bełchatów and Konin areas (Fig. 1—3); these rocks can be connected with the extensive, effusive Carpathian volcanism of the Badenian—Sarmatian ages (MAHEL, 1983).

The discovery of pyroclastics in a few localities of the Polish Lowland region permits to attempt the correlation—on a general scale—of some basic links of the Polish Lowland Miocene with stratigraphically the well-documented Badenian and Sarmatian deposits of the Carpathian foredeep. This is possible on the assumption that the a common source of volcanogenic material was situated south of both those zones, i.e. in the Carpathian Mountains. It might have been a relatively common late-geosynclinal rhyolite—andesite neovolcanism of Badenian—Sarmatian age, from the region of Slovakia and northern Hungary (MAHEL, 1983). The tuffaceous intercalations of the Carpathian foredeep are of the same age and petrogenetic type. They have outcrops (Fig. 1) at many localities in the whole foredeep region. The majority of them are connected with the Skawina and Chodenice Beds (Lower and Middle Badenian). According to ALEXANDROWICZ and PAWLIKOWSKI (1980), tuffaceous intercalations in the Chodenice Beds, which are also found far beyond Poland, have the farthest distribution and the greatest accumulation of volcanogenic material.

The petrographic type (Table 1) of all the pyroclastic rocks in the foredeep is similar, indicating relationship with the rhyolite-andesite volcanism. The rocks are tuffites or, exceptionally, tuffs and, sporadically, also bentonites.

The tuffaceous intercalations  $T_1$ — $T_3$  in the Polish Lowland Miocene deposits—from the “Konin” brown coal mine and the Bełchatów tectonic trough, to have analogous genetic characteristics. They represent a rhyolitic and rhyolitic—dacitic volcanism. The composition of the pyroclastic material is very similar but its percentage is considerably smaller, especially at Konin, due to a greater distance from the source of eruption. The grain size of the pyroclastics is finer; due to this suffered—to a greater extent—degradation and secondary transformation. The secondary clay components are of a different nature a fact connected with conditions of the sedimentation in a low-pH peat-bog basin. In the Konin area the basin was characterized by poor subsoil drainage, which resulted in the development of metabentonites and wetzsteins. At Bełchatów it had intensive drainage which, in turn, contributed to the formation of tonsteins (paratonsteins). Aluminosilicate decomposition proceeded towards illitization and kaolinization.

From the petrographic point of view the tuffogenic  $T_1$ — $T_3$  (Tab. 1) markers are tonsteins (paratonsteins), meta-bentonites and honestones (wetzschiefers). The  $T_1$  layer is a paratonstein in the Bełchatów mine but in the Konin one it changes into a meta-bentonite grading locally into a honestone. In paratonstein the pyrogenic components are represented by pyrogenic quartz, feldspars (sanidine), partly apatite and volcanic glass. Aluminosilicates (biotite, feldspars) and volcanic glass were partly altered into kaolinite in the peat-bog environment of fairly high drainage. In meta-bentonite autigenic illite is very common whereas the pyroclastic components are similar to those identified in paratonsteins. Illite was formed by degradation of kaolinite.

Fine-grained volcanic glass forms the matrix of the rock. Its chemical composition could not be determined in details because of the basic troubles met in separation of sufficient amounts for analysis. However, high content of pyrogenic quartz



(5–9%) and domination of K-feldspars over plagioclases point to acidic, presumably rhyolitic or rhyo-dacitic type of volcanic dust.

Volcanogenic layers occurring in the Carpathian foredeep are tuffites, bentonites and, rarely, lithoclastic tuffs. Apart from volcanic glass they contain pyrogenic quartz, biotite, femic minerals (amphibolites and pyroxenes) and feldspars. Types of feldspars and the chemistry of volcanic glass point to acidic, rhyolitic, rhyo-dacitic and/or andesitic volcanism.

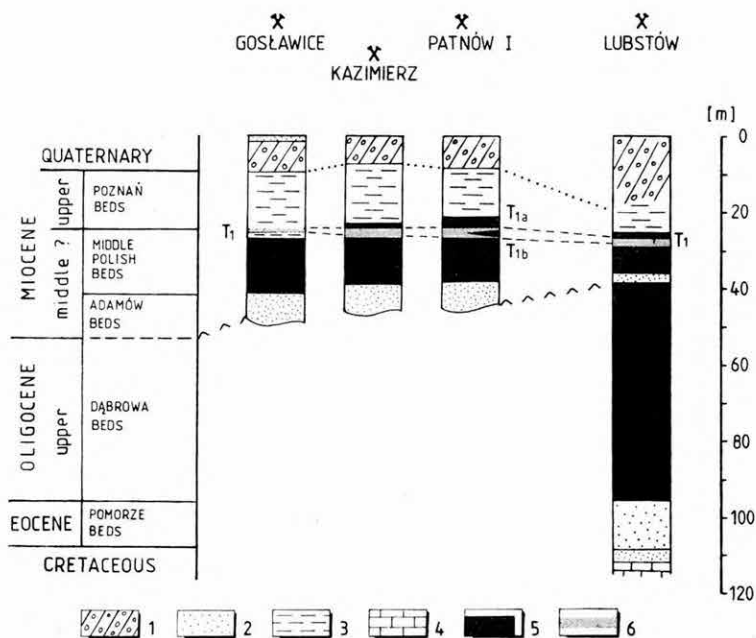


Fig. 2. Tuffaceous horizon  $T_1$  in the Miocene profile of the Konin area brown coal mines

1 Gravels, 2 sands, 3 clays, 4 cretaceous limestones, 5 soft brown coal, 6 tuffaceous intercalations

The uppermost tuffaceous horizon  $T_1/T_{1a}+T_{1b}$  has the widest extent in the Polish Lowland. It is found in all brown coal exposures of the Konin area (Kazimierz, Pałnów, Lubstów outcrops) and at Bełchatów mine (Fig. 2, 3). Horizon  $T_1$  is relatively thick (up to 40 cm), has partly a two-layered structure, and is characterized by graded bedding. Its distribution over a relatively large area and the stability of structure predispose it to a role of an important marker horizon. It played that role in the correlation of Miocene profiles of Konin and Bełchatów. It seems that horizon  $T_1$  can be simultaneously correlated with an extensive tuffite horizon of the Chodenice Beds (the Bochnia Tuffite, according to ALEXANDROWICZ and PAWLIKOWSKI, 1980) in the Carpathian foredeep (Fig. 4). The latter authors (1980) ascribe to it a role of a marker horizon of lithostratigraphic importance in the Paratethys region. Evidence from the Polish Lowland indicates that it can also be identified beyond the Carpathian region. Accordingly, it has a considerably increased extent and is important as a common marker horizon for Miocene profiles in separate basins: one in the Carpathian foredeep, the other in the epivariscan platform area of Central Poland. The latter finding

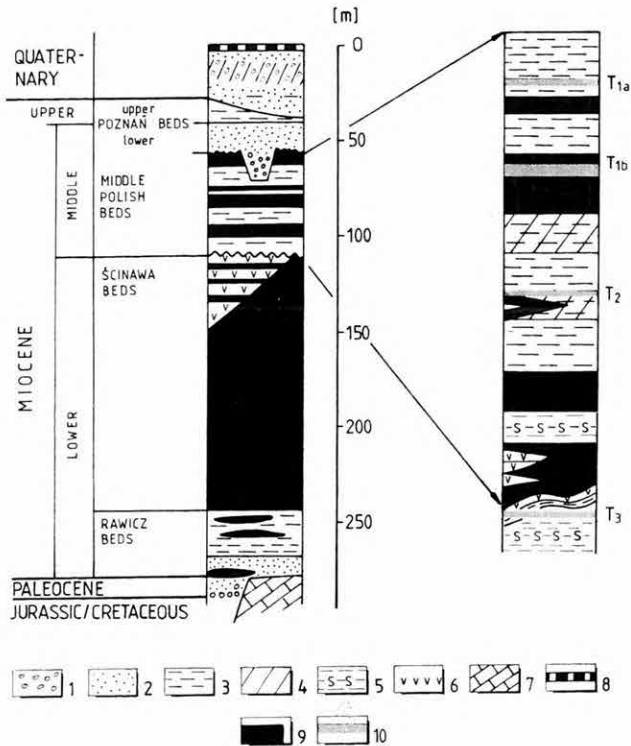


Fig. 3. Tuffaceous horizons in the Miocene profile of the "Bełchatów" brown coal outcrop

1 Gravels, 2 sands, 3 clays, 4 coal clays, 5 sapropelites, 6 lacustrine limestones, 7 limestones, 8 peat, 9 brown coal, 10 tuffaceous intercalations

is important, especially for the Miocene of the Polish Lowland where there are no biostratigraphic horizons which might facilitate a direct correlation with the marine Miocene of the Carpathian foredeep.

As a result of the above accepted correlation, the "Middle Polish" brown coal seam, as well as the Middle Polish Beds and Adamów Beds, assigned up to now to the Upper Miocene (Fig. 2, 3) according to CIUK (1980), should be shifted to the Middle Miocene. This would make them correspond to the Chodenice Beds (Upper Badenian) in the Miocene profile of the Carpathian foredeep. Similarly, it is postulated that the age of the clay-coal complex at Bełchatów should be lowered (Fig. 4).

Tuffaceous intercalations T<sub>2</sub> and T<sub>3</sub> from the Bełchatów mine (Fig. 3) presumably correspond to tuffite horizons of the Lower Badenian Skawina Beds in the Carpathian foredeep; according to ALEXANDROWICZ and PAWLIKOWSKI (1980) these horizons are also distributed over a very large area. They were reported from numerous localities on the southern side of the Holy Cross Mts. It is likely that the fall of pyroclastic material extended farther northward, beyond the zone of the Carpathian foredeep.

On the basis of the occurrence of tuffaceous horizons it can be assumed that the Badenian and Lower Sarmatian (Middle Miocene, acc. to RÖGL and STEININGER, 1983) deposits of the Carpathian foredeep have their equivalent in the Bełchatów

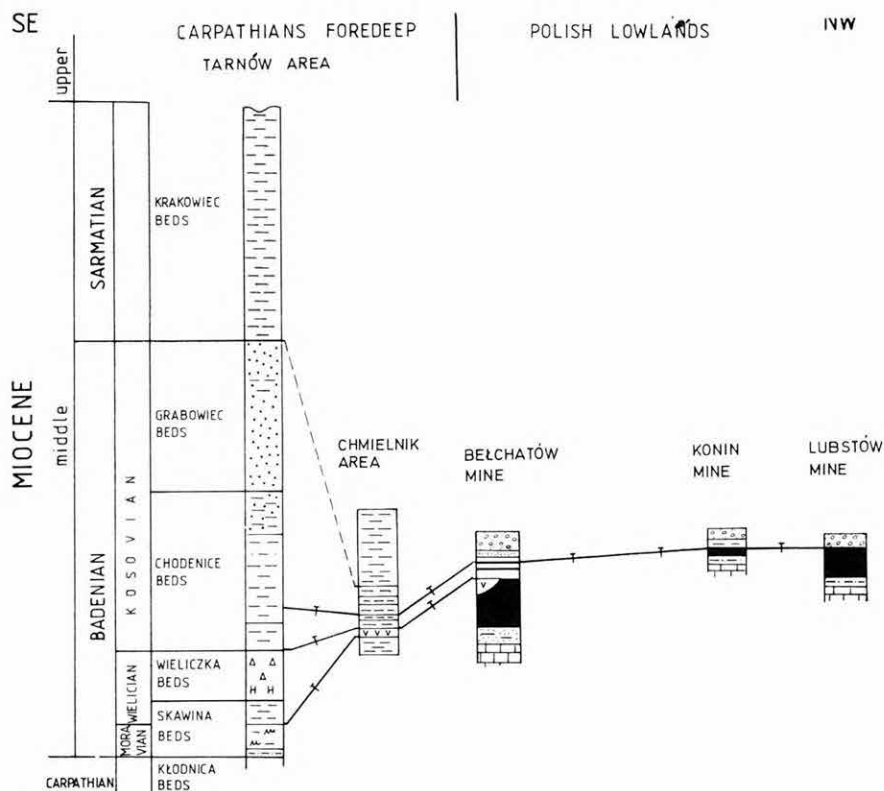


Fig. 4. Correlation of tuffaceous horizons of the Miocene of the Carpathian foredeep and the Polish Lowland

clay—coal sequence and corresponding to the Middle Polish Beds and Adamów Beds. On the other hand, the main seam of the Bełchatów area is an equivalent of the Karpatian coal-bearing deposits, and thus belongs already to the Lower Miocene. This finding may have further implications if it is accepted that the main Bełchatów deposit is an equivalent of the brown coal seam of group II (Ścinawa coal seam) in the profile of the Tertiary Lowland.

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