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The importance of tonstein from the Coal Seam 610 as the correlation horizon in the southwestern part of the Upper Silesian Coal Basin

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Based on the similarity of discussed rocks from the "1-Maja" Mine and "Moszczenica" Mine and their stratigraphic position an assumption can be made that they belong to the same horizon. Accordingly, the upper section of the Poręba Beds in the region of the "Moszczenica" Mine should be verified for the purpose of correlation. Simultaneously, results of the author's study and those of the Czech author's seem to indicate that transport of pyroclastic material to the peat swamp of the Coal Seam 610 could take place from the W–E or the WSW–ENE directions.

INTRODUCTION

Tuffaceous measures in the Marginal Beds have been found in the northeastern part of the Upper Silesian Coal Basin and the region of Ostrava and Karvina in the Czech Republic. Based on the tuffaceous horizons and tonsteins, repeated attempts were made to correlate profiles of the Marginal Beds in Poland with those in the Czech side of the Upper Silesian Coal Basin (J. Kralik, 1964; M. Dopita, J. Kralik, 1977; J. Ryszka, W. Gabzdyl, 1986; I. Lipiarski, 1994; M. Dopita, P. Martinec, 1994). It has been noted that these measures are of limited occurrence in the southwestern part of the Upper Silesian Coal Basin. Till present, two tonstein horizons in the Poręba Beds (Namurian A) have been discerned in the Polish part of the basin. The first horizon is connected with the widespread Coal Seam 610 (W. Gabzdyl, 1990; W. Łapot, 1992): the second one — connected with the Coal Seam 626 in the northern part of the basin is of local importance only (W. Łapot, 1993). In the course of mining work in the region of Moszczenica it was noticed that tonstein band was missing in the Coal Seam 610; however, it was present in the Coal Seam 609 which occurred below a marine horizon Id. Tonstein from this seam is the focus of this paper; tonstein from the Coal Seam 610 in the "1-Maja" Mine was also studied for the purpose of comparison.

SAMPLING AND METHOD OF STUDY

For laboratory study, two tonstein samples were collected from the Coal Seam 609 in the eastern and westerns sectors of a mining area of the "Moszczenica" Mine; other sample was collected from the Coal Seam 610 in the "1-Maja" Mine (Fig. 1). All of the samples were collected at a section about 6 km long.

Microscopic examination and X-ray, thermal, and chemical analysis were employed to analyse tonstein samples. Trace elements such as Ag, Cd, Co, Cr, Cu, Ni, Pb, and Zn were determined using the Atomic Absorption Spectrometry method while the Atomic Emission Spectrometry was applied to determine Ga, V, and Zr. In addition, grain-size analyses of rocks under this study were made; required disintegration of sampled rocks was achieved by repeated freezing.

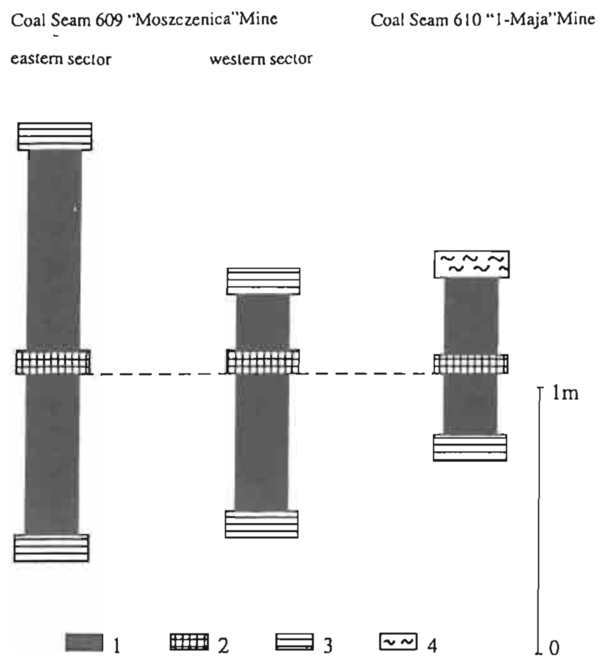

Fig. 1. Lithological profiles of sampled coal seams
1 — hard coal, 2 — tonstein, 3 — claystone, 4 — mudstone

Profile litologiczne opróbowanych pokładów węgla
1 — węgiel, 2 — tonstein, 3 — iłowiec, 4 — mułowiec

RESULTS OF LABORATORY STUDY

Rocks under this study are grey; they are of aleuritic-psammitic texture and compact structure, and of layered character due to the presence of coal laminae both in top and bottom. Strongly battered coal laminae are also present; it was also noticed that the sample from the eastern sector of the "Moszczenica" Mine contains nodules up to 20 mm in size, composed mainly of clay minerals and secondary — of pyrite. Nodules are of pelitic texture and have a thin coal envelope.

Results of grain-size analyses (Tab. 1) indicate that tonstein from the "1-Maja" Mine is coarser — since a fraction over 0.50 mm makes as much as about 73% of total sample grains; slightly finer are tonstein samples from the "Moszczenica" Mine (where the fraction greater than 0.50 mm constitutes about 60% in the western sector and 51% in the eastern sector).

In microscopic examination tonsteins reveal the presence of granular components such as quartz, biotite, accessory minerals, devitrified volcanic glass, fragments of volcanic rocks, as well as a matrix composed mainly of microcrystalline kaolinite, and infrequent siderite.

Quartz occurs in the form of grains of pyrogenic and terrygene origin; veinlets of autogenous quartz are also present. As to pyrogenic quartz, it is visibly elongated and its elongation factor reaches 6.0 (which is the case of the "1-Maja" Mine); sometimes pits are visible that are characteristic for magmatic corrosion. Terrygene quartz is predominantly sharp-edged and its size is less than 0.16 mm. Frequent veinlets of autogenous quartz were noted in the samples collected from the "1-Maja" Mine and the western sector of the "Moszczenica" Mine; they are arranged parallel to coal laminae.

Biotite occurs in the form of foil up to 0.22 mm thick. Fresh biotite foils were found in tonstein from the "1-Maja" Mine; in the remaining samples biotite is subject to kaolinization of different intensity. Biotite from the western sector of the "Moszczenica" Mine is subject to slightly weaker kaolinization in comparison with tonstein from the eastern sector — where is advanced to such a degree that only infrequent aggregates contain relics of biotite. Visual examination of sample from the eastern sector of the "Moszczenica" Mine reveals that there are pyritic inclusions in biotite, that concentrate along faces of cleavage. Similar situation, though occasional only, deals with the sample from the "1-Maja" Mine. It seems likely that iron released in the course of kaolinization concentrates in the form of pyrite; as to sulphur, it is being delivered from outside.

Feldspars represented by potash feldspars and occasionally plagioclases form grains reaching 0.22 mm in size. Potash feldspars are broken, sometimes their shape is dagger-like (as in the case of samples from the "1-Maja" Mine and the

Table 1

Grain-size analysis of tonstein (% by weight)

Grain size [mm]	Coal Seam 609 "Moszczenica" Mine		Coal Seam 610 "1-Maja" Mine
	eastern sector	western sector	
>2	15.0	12.0	9.3
2–1	11.2	19.3	22.2
1–0.50	25.3	29.4	41.9
0.50–0.25	25.2	21.8	17.3
0.25–0.125	12.0	7.1	5.0
0.125–0.063	6.0	6.0	2.4
<0.063	5.3	4.4	1.9
Total	100.0	100.0	100.0

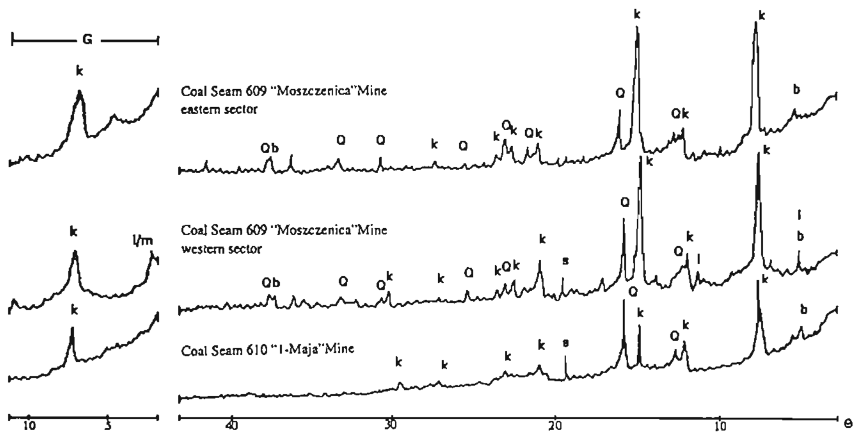

Fig. 2. Diffractograms of tonstein from Coal Seams: 609 ("Moszczenica" Mine) and 610 ("1-Maja" Mine)
k — kaolinite, Q — quartz, b — biotite, i — illite, i/m — mineral of mixed-package texture of illite/montmorillonite type, s — siderite, G — glycol-treated sample

Dyfraktogramy tonsteinów z pokładów: 609 (KWK „Moszczenica") i 610 (KWK „1-Maja")
k — kaolinit, Q — kwarc, b — biotyt, i — illit, i/m — minerały o strukturze mieszanopakietowej typu illit/montmorillonit, s — syderyt, G — próbka glikolowana

western sector of the "Moszczenica" Mine). Elongated grains (as in the samples from eastern sector of the "Moszczenica" Mine) or grains affected by magmatic corrosion are scarce. Feldspars are strongly affected by kaolinization.

Accessory minerals include zircon and infrequent apatite and garnet. Predominantly they are noted in the samples from the "1-Maja" Mine and the western sector of the "Moszczenica" Mine. Size of zircon is between 0.04 (in the eastern sector of the "Moszczenica" Mine) and 0.14 mm (in the "1 Maja" Mine). Most frequently, it displays characteristic pleochroic fields. Apatite grains are not greater than 0.08 mm; they are effectively crushed and surrounded (as in the samples from the "1-Maja" Mine and the western sector of the "Moszczenica" Mine). Garnets are extremely scarce and are noted only in the sample from the "1 Maja" Mine.

Abundant crumbs of devitrified volcanic glass and other volcanic rocks occur in tonstein from the Coal Seam 609 in the "Moszczenica" Mine (in both sectors). Some difficulties can be met in their identification as in the microscopic image differences become obliterated between devitrifying crumbs

Table 2

Chemical analyses of tonstein (% by weight)

Component	Coal Seam 609 "Moszczenica" Mine		Coal Seam 610 "1-Maja" Mine	Coal Seam 479 (Czech, M.Dopita *et al.*,1977)
	eastern sector	western sector		
SiO_2	40.04	41.04	48.75	45.65–49.53
TiO_2	0.45	0.41	0.59	0.29–0.45
Al_2O_3	36.70	28.97	28.86	29.62–30.97
Fe_2O_3	1.79	1.84	1.75	0.43–0.57
FeO	2.43	8.44	1.53	0.45–2.00
MnO	0.02	0.19	0.06	0.00–0.03
CaO	3.07	2.70	0.41	0.27–1.20
MgO	1.58	2.34	1.23	1.52–3.29
Na_2O	0.19	0.77	0.70	0.58–0.75
K_2O	0.20	0.60	2.66	1.94–4.02
H_2O^-	0.58	0.46	0.22	–
C^-	0.05	0.52	0.18	–
Ing. loss	12.93	12.65	12.96	11.43–14.32
Total	100.03	100.93	99.90	–
SiO_2/Al_2O_3	1.86	2.40	2.87	2.52–2.84
K_2O/Al_2O_3	0.006	0.022	0.100	0.070–0.146

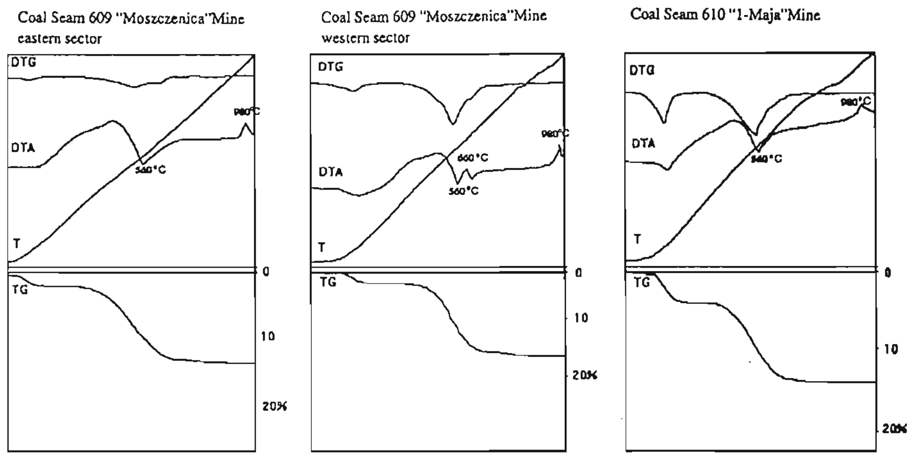

Fig. 3. Differential thermal analysis curves of tonsteins from Coal Seams: 609 ("Moszczenica" Mine) and 610 ("1-Maja" Mine)

Krzywe termiczne analizy różnicowej tonsteinów z pokładów: 609 (KWK „Moszczenica") i 610 (KWK „1-Maja")

of volcanic glass or rocks being subject to kaolinization — and microcrystalline matrix.

Kaolinite being a predominant matrix of tonstein is mainly microcrystalline. Platy and vermicular kaolinite occurs in the Coal Seam 609 in the "Moszczenica" Mine and is dominant in its eastern sector. Nodular concentrations are filled with kaolinite in the form of gel which displays a very weak optical anisotropy (which is the case of the sample from the eastern sector of the "Moszczenica" Mine).

As to siderite — it occurs mainly as the filling of exfoliating biotite foils (the samples from the "1-Maja" Mine and the western sector of the "Moszczenica" Mine).

Microscopic observation is the basis for conclusion that according to W. Łapot (1992), tonstein from the Coal Seams 610 (in the "1-Maja" Mine) and 609 (in the western sector of the "Moszczenica" Mine) should be considered as granular-complex-multiple or according to A. Schüller and K. Höehne's classification — as granular, pseudomorphous. As to tonstein from the Coal Seam 609 (in the eastern sector of the "Moszczenica" Mine) it is, according to the authors cited, granular and lumpy.

The X-ray analysis (Fig. 2) confirmed the presence of main minerals such as kaolinite, quartz, and biotite on all diffractograms; the presence of siderite was also detected in the samples from the "1-Maja" Mine and the western sector of the "Moszczenica" Mine. No reflections characteristic for feldspars were noted — and this fact provide an evidence of well advanced kaolinization.

Differential thermal analysis curves (Fig. 3) clearly show characteristic effects connected with coal burning (the exothermic effect in the range of 200–450°C), the presence of kaolinization (the endothermic effect at 560°C while the exothermic one at 980°C); also, the effect characteristic for siderite can be seen at the temperature of about 660°C on the differential thermal analyses (DTA) curve for the sample from the western sector of the "Moszczenica" Mine.

SiO_2 and Al_2O_3 (Tab. 2) are the main chemical components of tonstein; both are rather distinctly differentiated in the examined samples. This differentiation is illustrated pretty well by nodular relations SiO_2/Al_2O_3 and K_2O/Al_2O_3; the same relations are also used to define a degree of kaolinization of tuffaceous material. The lowest values of these relations deal with the samples from the eastern sector of the "Moszczenica" Mine (1.86 and 0.006, respectively), and the highest — from the "1-Maja" Mine (2.87 and 0.100, respectively); accordingly, the band from the Coal Seam 609 in the eastern sector of the "Moszczenica" Mine represents tonstein of more advanced kaolinization. The content of the remaining components are close to each other except for FeO which reaches 8.44% in the sample from the western sector of the "Moszczenica" Mine. Such a situation is connected with the presence of siderite; on the other hand the elevated FeO content in the sample from the eastern sector of the "Moszczenica" Mine (2.43%) as compared with that of the "1-Maja" Mine (1.53%) is connected with the presence of pyrite. In addition, the increased content of MnO (0.19%) in tonstein

Table 3

Content of trace elements in tonstein (ppm)

Trace element	Coal Seam 609 "Moszczenica" Mine		Coal Seam 610 "1-Maja" Mine
	eastern sector	western sector	
Ag	29	16	12
Cd	10	8	31
Co	74	57	61
Cr	406	276	351
Cu	172	169	120
Ga	23	80	96
Ni	151	195	126
Pb	885	170	506
V	73	45	35
Zn	955	738	923
Zr	131	38	189

from the western sector of the "Moszczenica" Mine is due to the substitution of this element in siderite.

The contents of determined trace elements are variable (Tab. 3) which is reflected by the mineral composition of discussed rocks. The elevated contents of Cd, Co, Cr, Pb, and Zn in the samples from the "1-Maja" Mine and the eastern sector of the "Moszczenica" Mine should be attributed to greater participation of pyrite, and Zr — of zircon.

RECAPITULATION

Development of tonstein occurring in the Coal Seams 610 and 609 in the Jastrzębie region in respect of its texture, grain-size distribution, mineral and chemical composition, as well as its stratigraphic position indicate that in reality the two make only one (and the same) coal seam. Tonstein is also known in the Coal Seam 479 (according to Czech lithostratigraphic pattern) within the Czech part of the Upper Silesian Coal Basin, and is also wide-spread over there. The Czech tonstein seems to be coarser than that in Polish part of the basin and is similar to the Biotite Sandstone (M. Dopita, J. Kralik, 1977; J. Horak, V. Spachman, 1989). Mineral composition is very close, and worthy of noting is the size of granular components that are considerably greater than tonstein grains in the region of Jastrzębie. In the Czech side of the basin it is frequently dolimitized (J. Horak, L. Sykora, 1993) which makes it similar to tonstein in the Coal Seam 610 described in the Jejkowice Trough (Z. Adamczyk, 1993); on the other hand, in the area of the "Moszczenica" Mine it is subject to sideritization. Remarkable is the differentiation of chemical composition of tonstein between both sides of the Polish–Czech border. It should be noted that this differentiation follows the strike of beds; this particularly deals with the main components SiO_2 and Al_2O_3 (Tab. 2). Molecular relations between SiO_2/Al_2O_3 and also K_2O/Al_2O_3, making possible to classify kaolinized tuffaceous inserts (W. Łapot, 1992) suggest that stronger kaolinization of tonstein was taking place in the region of Moszczenica while the poorer — in the region of the "1-Maja" Mine and on the Czech side of the Upper Silesian Coal Basin.

Considering observations of the size of mineral components as well as grain-size distribution an assumption can be made that transport of pyroclastic material to a peat swamp could take place from the W–E and from the WSW–ENE directions.

It seems likely that based on described examination — tonstein from the Coal Seam 610 in the region of the "1 Maja" and Coal Seam 609 "Moszczenica" Mines might be applied to correlation purposes. Thus, the correlation of the upper section of the Poręba Beds in this region should be subject to verification.

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ZNACZENIE TONSTEINU Z POKŁADU 610 W POŁUDNIOWO-ZACHODNIEJ CZĘŚCI GZW JAKO HORYZONTU KORELACYJNEGO

Streszczenie

Warstwy brzeżne (górna część) występujące w polskiej części Górnośląskiego Zagłębia Węglowego (GZW) były wielokrotnie korelowane, na podstawie poziomów tufogenicznych, z warstwami ostrawskimi — ich odpowiednikiem stratygraficznym po czeskiej stronie zagłębia. Zauważono ograniczone występowanie tych utworów w rejonie południowo-zachodnim GZW. W pokładzie 610 warstw porębskich (namur A) występuje przerost tonsteinu, który spełnia rolę reperu petrograficznego w GZW. Jego znaczenie dla celów korelacyjnych dostrzeżono również w czeskiej części zagłębia. Jednakże w rejonie Jastrzębia tonstein występuje w pokładzie 609 na obszarze kopalni „Moszczenica", zaś w kopalni „1-Maja" w pokładzie 610. Jego pozycja stratygraficzna i wykształcenie (struktura, tekstura, skład ziarnowy), skład mineralny i chemiczny są bardzo podobne. Wydaje się, że tonstein z pokładu 609 w kopalni „Moszczenica" i tonstein z pokładu 610 w kopalni „1-Maja" jest tym samym poziomem. Korelacja górnego odcinka warstw porębskich w tym rejonie powinna zatem ulec weryfikacji.

Uwzględniając spostrzeżenia, a także biorąc pod uwagę wyniki badań tonsteinu występującego po czeskiej stronie zagłębia, należy przypuszczać, że transport materiału piroklastycznego mógł przebiegać z W na E lub WSW na ENE.