THERMAL MATURITY OF ORGANIC MATTER WITHIN CARBONIFEROUS CLASTIC ROCKS IN THE DROGOMYŚL IG-1 DRILL HOLE (THE UPPER SILESIAN COAL BASIN, POLAND)

DOSAŽENÍ STABILITY TERMICKÉ PŘEMĚNY ORGANICKÉ HMOTY KARBONSKÝCH HORNIN VE VRTU DROGOMYŚL IG-1 (HORNOSLEZSKÁ UHELNÁ PÁNEV)

Zdzisław ADAMCZYK[1] , *Ewa KRZESZOWSKA*[2] , *Andrzej PORSZKE*[3]

[1] *Ph.D.Silesian University of Technology, Institute for Applied Geology, Gliwice, Poland, e-mail: zdzislaw.adamczyk@polsl.pl*

[2] *Ph.D.Silesian University of Technology, Institute for Applied Geology, Gliwice, Poland, e-mail: ewa.krzeszowska@polsl.pl*

[3] *Ing., Ph.D. Laboratorium Inżynierii Lądowej „Labotest" Sp. z o.o. Katowice, Poland aporszke@labotest.pl*

Abstract

The aim of the study was to determine the thermal maturity level of organic matter on the basis of reflectance measurements performed on vitrinite from Carboniferous sandstones, mudstones and claystones in the Drogomyśl IG-1 drill hole in the Upper Silesian Coal Basin, Poland.

Random reflectance R_r of vitrinite in the sandstones varies between 0.72% and 1.28%, while in the fine-grained rocks between 0.77 and 1.31%, which corresponds to paleotemperature of 110 to 180^{o}C. Calculated geothermic paleogradients varies between 60^{o}C/km and 63^{o}C/km which leads to the conclusion that minimum thickness of the sedimentary overburden eroded from the surface of Carboniferous beds was from 4800 to 5000m. However, taking into consideration only geothermic paleogradients (70^o - 100^{o}C/km), calculated for the layers occurring below the depth of 1500m, the thickness of the eroded overburden should be from 5600 to 8000m.

Abstrakt

V článku jsou publikovány výsledky výzkumu úrovně termických přeměn organické hmoty v karbonských horninách z vrtu Drogomyśl IG-1 v polské části hornoslezské uhelné pánve. Výzkum vycházel ze studia odraznosti vitrinitu v pískovcích, prachovcích, jílovitých prachovcích a jílovcích. Odraznost náhodná R_f vitrinitu, vyseparovaného z horninové matrix, dosahuje v pískovcích hodnot od 0,72 do 1,28%, v horninách jemnozrnných 0,77 do 1,31%, což odpovídá paleoteplotám v rozmezí od 110 do 180^{o}C. Vypočtené průměrné geotermické paleogradienty dosahuji hodnot 60 – 63^{o}C/km. Tyto hodnoty ukazují na to, že minimální mocnost zerodovaného pokryvu z aktuálního povrchu karbonu mohla dosahovat cca 4800 – 5000 m. Vezmeme-li v úvahu pouze vypočtené geotermické paleogradienty pro hloubky vyšší než 1500 m (dosahováno je zde hodnot 70 – l00^{o}C/km) musela by minimální mocnost zerodovaného pokryvu činit cca 5600 až 8000 m.

Key words: thermal maturity, diagenetic processes, paleotemperature, reflectance of vitrinite, Carboniferous strata

1 INTRODUCTION

Diagenetic processes, which took place in geological history of the Carboniferous strata in the Upper Silesian Coal Basin (USCB), significantly influenced petrographical properties of rocks, including organic matter. It is known that the higher the diagenesis level, the more intensive the anisotropy effect visible in organic matter in reflected light. The reflectance of organic matter plays an important role in the determination of thermal maturity level, as well as in the reconstruction of thermal history of formation of geological series. It is a very sensitive parameter of diagenetic alteration. Vitrinite reflectance measurements allow to determine changes in the thermal maturity level of organic matter, according to the depth of subsidence. It is hence possible to evaluate the maximum paleotemperature affecting the sediment during diagenesis.

The aim of the study was to determine the thermal maturity level of organic matter on the basis of reflectance measurements performed on vitrinite from Carboniferous sandstones, mudstones and claystones in the Drogomyśl IG-1 drill hole in the Upper Silesian Coal Basin.

2 AREA DESCRIPTIONS, METHODS AND MATERIAL STUDIED

The Drogomyśl IG-1 drill hole, made in 1978, was located in the disjunctive tectonics zone of the USCB, on the southern wing of main syncline, ca 4 km north from the Carpathian overthrust (Fig. 1).

For investigation 16 samples of sandstones (Fig. 2) and 17 samples of fine-grained stones (11 samples of mudstones, 5 samples of claystones and 1 sample of clayey siderite) were collected. Then the organic matter occurring in laminas was mechanically separated in quantities enabling microscopic examination. Observations were performed for both the incident and the reflected light rays through the use of an AXIOSKOP microscope made by Zeiss. The reflectance measurements were carried out on vitrinite grains according to the ICCP recommendation and Polish Standard PN-92/G-04524 (equivalent to ISO 7404/5-1984).

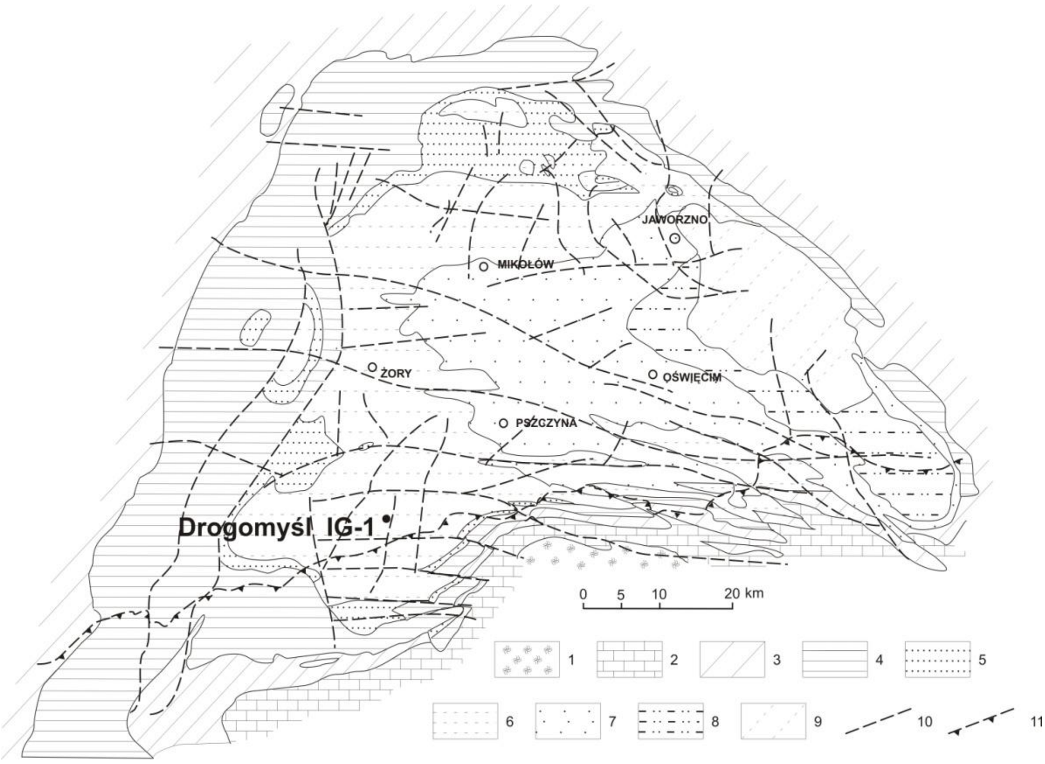

Fig. 1 Geological solid map of the Upper Silesian Coal Basin.
1 – metamorphic rocks. DEVONIAN: 2 – carbonate and clastic marine sediments. CARBONIFEROUS: Namurian A – Upper Visean: 3 – diastrophic marine sediments. Namurian A: 4 – Paralic Series. Namurian B+C: 5 – Upper Silesian Sandstone Series. Westphalian A + B: 6 – Siltstone Series. Westphalian C + D: Cracow Sandstone Series: 7 – Łaziska Beds, 8 – Libiąż Beds. Stephanian: 9 – Kwaczała Arkose. 10 – main faults, 11 – Carpathian overthrust

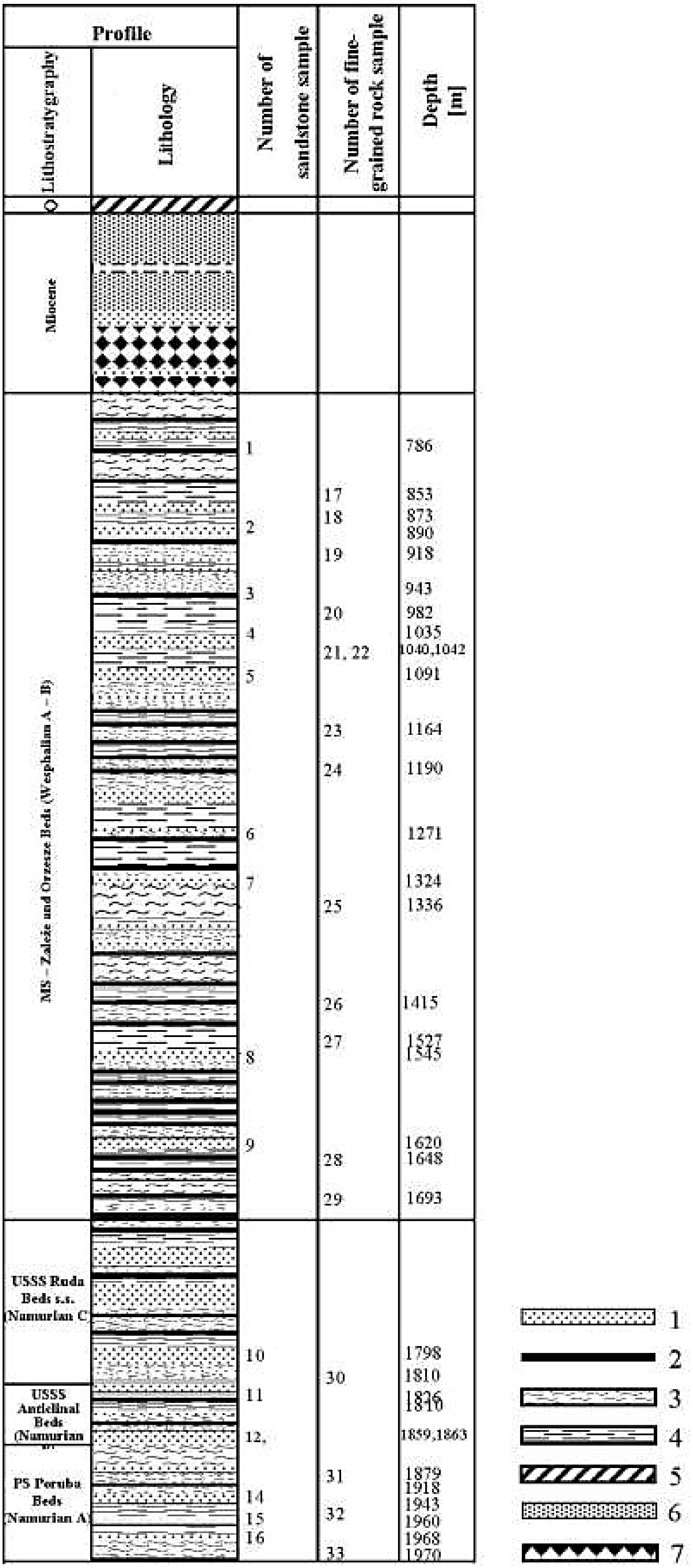

Fig. 2 Simplified lithostratigraphic profile of the Drogomyśl IG-1 drill hole.

Explanations: 1-sampled sandstone layers, 2-more important coal seams, 3-mudstones, 4-claystones, 5-gravels, loams and sands, 6-calcalerous and sandy clays, 7-conglomerates, Q-Quaternary, MS-Mudstone Series, USSS-Upper Silesian Sandstone Series, PA-Paralic Series.

3 RESULTS

3.1 Lithostratigraphy

In the Drogomyśl IG-1 drill hole down to the depth of 1982m, the Carboniferous, Tertiary and Quaternary strata were found [10]. Carboniferous is represented by the Paralic Series, Upper Silesian Sandstone Series and Mudstone Series. The thickness of these strata is 1219.8m. The Paralic Series is built up mainly from the interdigitating sandstone and mudstone complexes. The Upper Silesian Sandstone Series contains mainly thick sandstone layers, while the Mudstone Series is characterized by the occurrence of predominantly mudstone and claystone layers. Coal seams occur in each of the series and they represent 7.80 % of the total thickness of the Carboniferous strata.

Tertiary deposits occur to the depth of 762.2m and they are 754.2m thick. They are represented by Miocene, incompetent clays, calcareous clays, sandy clays and – in the bottom part – sandstones and conglomerates. Quaternary sediments, thickness of which is 8m, are Pleistocene gravels and Holocene loams and sands.

3.2 Petrography

The Carboniferous sandstones are light grey to dark grey, sometimes with a brown tint. They are predominantly well-sorted and their degree of roundness is low or medium. The structure of the sandstones under research is mostly dense, in some cases slightly porous. Some of the sandstones are characterized by an oriented structure, which is caused by the occurrence of thin coal laminas, diagonal bedding of the cross type or by changing coloration of sandstone layers. A few sandstones, especially those situated more deeply in the profile of the Carboniferous rocks, are distinguished by the occurrence of coal laminas, in which cleavage can be observed. The sandstones are composed of quartz, feldspars (orthoclase, plagioclase, and sporadically microcline and sanidine), micas (muscovite, biotite), heavy minerals (zircon, rutile, apatite, titanite, garnets), rock debris (of metamorphic rocks – quartzites, gneisses, magmatic rocks – granites and sedimentary rocks – argillaceous and silicic rocks), organic matter in the form of coal laminas, strongly elongated lens, small particles and dispersed pigment. The mineral composition of the cement is mostly mixed: siliceously-calcareously-clayey, however each of these components can be predominant (Table 1) [11].

Tab. 1 Results of planimetric analysis of the studied sandstones from the Drogomyśl IG-1 drill hole (% vol.)[11]

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Quartz	46.4	29.5	23.0	20.0	17.0	20.9	18.2	13.8	20.7	21.2	21.6	30.2	20.7	24.8	17.3	31.0
Feldspars	3.3	3.0	9.1	3.7	6.3	1.4	3.0	1.8	2.4	1.4	1.6	0.0	0.2	6.0	6.6	1.8
Micas	1.7	2.6	0.6	0.3	2.7	0.4	1.5	1.5	1.4	3.0	3.4	4.8	0.6	4.9	0.8	4.3
Zircon	0.6	0.4			0.8	0.3	1.0	0.2	0.5	0.3		1.5	0.2			
Rutile					0.2				0.2			1.3		0.1		
Coal	2.1	2.6	1.0	0.5	0.8	0.3	0.4	3.0	1.0	1.2	2.0	0.2	1.1	2.1	1.3	6.2
Chlorite, Glauconite		0.5							0.2	0.3	0.4	0.8	0.4	0.6	0.2	1.3
Rock debris	9.1	7.8	46.5	42.0	46.2	23.2	39.2	23.4	43.0	49.4	42.0	17.8	48.0	27.1	46.8	15.5
Cement	36.8	53.6	19.8	33.5	26.0	53.5	36.7	56.3	30.6	23.2	29.0	43.4	28.8	34.4	26.2	39.0
Volcanic glass															0.8	0.9
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

In fine-grained rocks collected for examination the following lithological types were ascertained: mudstones, clayey mudstones, claystones and – in one case – clayey siderite. They are from light grey to dark grey, sometimes with a brown tint.

The mudstones under research show a disoriented or locally oriented structure. They are composed of quartz, muscovite and biotite, and – in smaller quantities – orthoclase, plagioclases or, sporadically, such accessory minerals as zircon and rutile. The organic matter is present in the form of laminas, which are often folded, or fine-dispersed pigment. In fissures of the coal laminas calcareous minerals were observed. The cement in the mudstones is most often clayey-siliceously-calcareous, clayey-calcareous or sideritically-clayey.

Clayey mudstones are characterized by oriented structure, caused by the occurrence of coal laminas, parallel orientation of mica flakes or disoriented with local orientation due to the presence of coal laminas. Main mineral components are quartz and clay minerals, represented by kaolinite and illite. Furthermore micas (biotite and, in small quantities muscovite) can be found. The organic matter is present in the form of laminas, particles or lenses.

Claystones tend to show a disoriented or locally oriented structure. They are kaolinitic-illitic or kaolonitic-illitic-sideritic claystones. They contain individual quartz grains (up to the 0,01mm in diameter) microoolithic siderite and dolomite crystals. The oganic matter occurs in the form of laminas or lenses.

Clayey siderite is characterized by a disoriented or locally oriented structure. Beside siderite and clay minerals (mostly kaolinite) it contains calcite and dolomite, and sporadically individual grains of muscovite, quartz and coal.

3.3 Reflectance measurements

For each of the sample measurements of the random reflectance R_r of vitrinitic organic matter contained in the examined samples were carried out. Then the reflectance anisotropy was determined as a difference between the maximum R_{max} and minimum R_{min} reflectance values.

The random reflectance R_r of organic matter in sandstones varies between 0.72% and 1.28% (Table 2). The R_r value increases with the depth, which is typical for this parameter in coal basins in the world, Poland among others [12]. However, local deviations from this rule were noticed (Fig. 3). The random reflectance R_r of organic matter in samples located deepest (samples 7 and 16) is characterized by substantially lower values in comparison to the samples from higher parts of the profile. The difference of R_r values in the case of sandstone samples 15 and 16 is as much as 0.24%.

Tab. 2 Results of random (R_r), maximum (R_{max}) and minimum (R_{min}) reflectance measurements (S_r S_{max}, S_{min} - standard deviation), performed for the organic matter separated from the samples of Carboniferous sandstones (Drogomyśl IG-1 drill hole) [11]

Sample number	Depth [m]	R_r [%]	S_r [%]	R_{min} [%]	S_{min} [%]	R_{max} [%]	S_{max} [%]	ΔR [%]
1	786	0.72	0.07	0.67	0.07	0.77	0.07	0.10
2	890	0.76	0.05	0.71	0.09	0.80	0.04	0.09
3	943	0.84	0.05	0.78	0.05	0.88	0.04	0.10
4	1035	0.82	0.05	0.77	0.04	0.86	0.04	0.09
5	1091	0.81	0.08	0.71	0.09	0.86	0.06	0.15
6	1271	0.91	0.04	0.87	0.03	0.95	0.03	0.08
7	1324	0.77	0.06	0.72	0.06	0.80	0.05	0.08
8	1545	0.83	0.05	0.77	0.06	0.88	0.04	0.11
9	1620	0.97	0.09	0.92	0.09	1.03	0.08	0.11
10	1798	1.08	0.06	0.99	0.09	1.13	0.05	0.14
11	1826	1.08	0.08	0.99	0.09	1.13	0.06	0.14
12	1859	1.14	0.06	1.06	0.07	1.21	0.04	0.15
13	1863	1.12	0.09	1.05	0.09	1.17	0.10	0.12
14	1918	1.17	0.06	1.11	0.05	1.22	0.03	0.11
15	1960	1.28	0.07	1.22	0.08	1.34	0.06	0.12
16	1968	1.04	0.09	0.96	0.09	1.10	0.09	0.14

As it results from the determined anisotropy value $\Delta R = R_{max} - R_{min}$ (Table 2) the sandstones from the deeper layers are distinguished by a higher degree of diagenesis. The highest degree of diagenesis has been recorded for the sample located deepest in the profile, which is however characterized by a lowered (in comparison to the general tendency) random reflectance value that is R_r=1.04% (standard deviation S_r=0.09).

The random reflectance R_r of organic matter in fine-grained rocks varies between 0.77% and 1.31% (Table 3). It shows higher values than the organic matter contained in the sandstones. In the upper part of the Carboniferous beds, to the depth of ca 1200m, the difference is 0.02% on average, but from the depth of ca 1300m it increases to 0.10% on average and up to 0.30% in the extreme cases, as it is at the depths of about 1500m and 1970m.

Similarly to the sandstones also fine-grained rocks from the lower part of the profile contain organic matter characterized by a high ΔR value. It suggests substantially a higher degree of diagenesis of these rocks in comparison to the rocks coming from the upper part of the studied profile.

Tab. 3 Results of random (R_r), maximum (R_{max}) and minimum (R_{min}) reflectance measurements (S_r $S_{max,}$ S_{min} - standard deviation), performed for the organic matter separated from the samples of Carboniferous fine-grained stones (Drogomyśl IG-1 drill hole) [11]

Sample number	Depth [m]	R_r [%]	S_r [%]	R_{min} [%]	S_{min} [%]	R_{max} [%]	S_{max} [%]	ΔR [%]
17	853	0.82	0.05	0.78	0.04	0.87	0.04	0.09
18	873	0.77	0.04	0.74	0.04	0.80	0.04	0.06
19	918	0.83	0.06	0.77	0.04	0.86	0.05	0.09
20	982	0.80	0.06	0.79	0.05	0.88	0.04	0.09
21	1040	0.85	0.04	0.81	0.04	0.89	0.04	0.08
22	1042	0.89	0.08	0.84	0.09	0.95	0.08	0.11
23	1164	0.87	0.05	0.83	0.05	0.92	0.04	0.09
24	1190	0.87	0.04	0.82	0.06	0.92	0.04	0.10
25	1336	1.02	0.05	0.97	0.05	1.07	0.04	0.10
26	1415	0.98	0.08	0.91	0.07	1.03	0.08	0.14
27	1527	1.13	0.09	1.04	0.11	1.26	0.09	0.22
28	1648	1.12	0.06	1.01	0.15	1.21	0.11	0.20
29	1693	1.02	0.10	0.87	0.15	1.07	0.09	0.20
30	1810	1.18	0.07	1.11	0.07	1.23	0.06	0.22
31	1879	1.31	0.05	1.17	0.23	1.36	0.04	0.19
32	1943	1.31	0.09	1.04	0.12	1.39	0.06	0.35
33	1970	1.25	0.06	1.16	0.10	1.31	0.05	0.15

4 DISCUSSION

The increase in vitrinite reflectance with depth, both for the sandstones and fine-grained rocks is in conformity with the general rule observed in the USCB [12]. However, for the depth of 1500 m two populations of results were obtained (Fig. 3). Below this depth a distinct change in the reflectance gradient from 0.35%/km to 0.74%/km was also found.

Using algorithms by: Barker (1983) [13] and Barker and Pawlewicz (1986) [14], and taking into consideration the random reflectance R_r values of organic matter contained in the examined rocks, the paleotemperature of the Carboniferous strata in the study was determined. For the sandstones it varies from ca 110^{o}C at the roof of the Carboniferous layers to ca 180^{o}C at the depth of 1970 m (Table 4).

The paleotemperature values, estimated for the sandstones, are very similar to the results obtained from the examination of smectite content in minerals characterized by a mixed-leyer structure of illite/smectite type, which are constituents of cement in the Carboniferous sandstones (Table 5). The paleotemperature value evaluated on that basis varies from 120^{o}C to 160^{o}C [11].

The random reflectance R_r values for the organic matter in fine-grained rocks show, that the peleotemperature determined through the use of the Barker-Pawlewicz's algorithm (1986) varies from 120^{o}C to almost 190^{o}C (Table 6).

Comparing these results it can be observed that the paleotemperatures calculated for fine-grained rocks are on average 10^{o}C higher than the paleotemperatures determined for the sandstones from the similar depth.

On the basis of some previous works [2], [4], [15] a diagram was constructed (Fig. 4), which takes into account the results of calculations performed according to the Barker-Pawlewicz's algorithm [14].

The research work, which was carried out, proves that the paleotemperature values for the Carboniferous strata, calculated on the basis of the random reflectance R_r, compared with the results of the other authors, are equivocal. Similar values of temperatures estimated for smectite illitization and paleotemperatures, calculated by the Barker-Pawlewicz's algorithm, show that for the purposes of the organic matter maturity evaluation the Barker-Pawlewicz's algorithm is more reliable and useful.

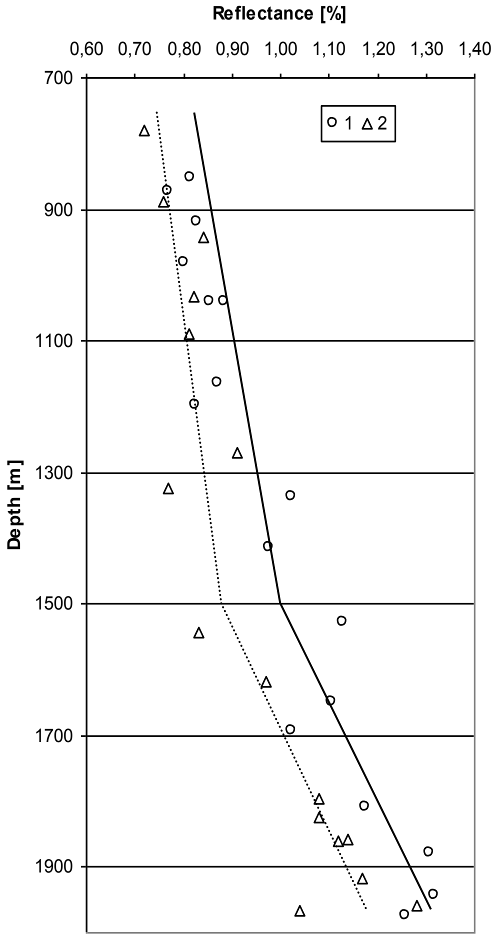

Fig. 3 Relationship between R_r and depth.
Explonations: 1-fine-grained rocks, 2- sandstones.

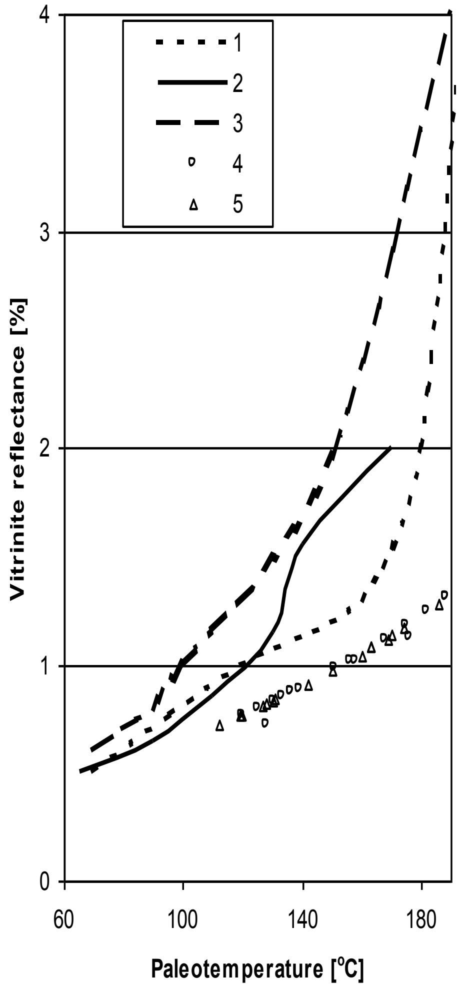

Fig. 4 Paleotemperature variability in relation to vitrinite reflectance.
Explanation: 1-according to Batten and Gaupp [15] ,
2 – according to Bostick [2], 3 – according to Arredondo et al. [4], 4 – fine-grained rocks,
5 – sandstones. Paleotemperatures for clastic rocks (4, 5) calculated through the use of Barker-Pawlewicz`s algorithm [14]

Tab. 4 Paleotemperature values calculated according to the Barker's [13] and Barker-Pawlewicz's [14] algorithms for the samples of Carboniferous sandstones (Drogomyśl IG-1 drill hole).

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
T_{max} [ºC]	112	119	131	128	127	142	120	130	150	163	163	170	169	174	186	160

Tab. 5 Results of X-ray analysis for the fine fraction below 2 μm obtained for the Carboniferous sandstones (Drogomyśl IG-1 drill hole)

Sample number/Depth [m]	Θ_n – angle theta – normal sample	Θ_g – angle theta – glicol sample	%Smectite
no /1395	4.57	4.12	21
no /1723	4.75	4.59	10
no /1751	4.86	4.59	11
10/1798	5.02	4.47	12
11/1826	4.96	4.59	10
no /1843	4.94	4.55	11
12/1859	4.85	4.59	10
no /1889	4.89	4.71	<9
14/1918	4.92	4.76	<9
15/1960	4.96	4.76	<9
16/1968	4.86	4.82	<9

Tab. 6 Paleotemperature values calculated according to the Barker's [13] and Barker-Pawlewicz's [14] algorithms for the samples of Carboniferous fine-grained rocks (Drogomyśl IG-1 drill hole)

Sample number	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
T_{max} [ºC]	128	120	130	125	133	139	136	136	158	151	176	168	156	175	188	188	182

Making assumption that the values of geothermic paleogradients range from 30 to 50^{o}C/km, which is typical for sedimentary basins, a minimum thickness of sedimentary overburden can be evaluated. It is from ca 2400 to 4000m which was eroded from the Carboniferous surface [16]. For the examined rocks the average geothermic paleogradients are: 60^{o}C/km for the sandstones and 63^{o}C/km for the fine-grained rocks. It though can be deducted that the minimum thickness of the eroded sedimentary overburden is 4800 to 500m. Taking into consideration the change in trend of the reflectance value below the depth of 1500m, a conclusion should be drawn that the geothermic paleogradient value for the described Carboniferous strata, occurring deeper is considerably higher (ca 100^{o}C/km for the sandstones and 70^{o}C/km for the fine-grained rocks). Therefore, to achieve the same level of thermal maturity, the thickness of the eroded overburden should be from 5600 to 8000m. Probably, an additional factor, which would enable reaching the observed level of thermal maturity was a source of heat, coming from inside the Earth.

5 CONCLUSIONS

The organic matter in the sandstones and fine-grained rocks (mudstones, clayey mudstones and claystones) under research occurs in the form of coal laminas, elongated lens or dispersed pigment. The random reflectance R_r of vitrinite separated from these rocks is variable and ranges between:

- 0.72 and 1.28% in the sandstones, while the reflectance anisotropy ΔR = 0.08 – 0.15%,
- 0.77 and 1.31% in fine-grained rocks, while the reflectance anisotropy ΔR = 0.06 – 0.35%.

The curve shape of relationship between R_r and depth shows a distinct change as from the depth of ca 1500m.

The R_r values suggest that the paleotemperatures in the Carboniferous strata were in the range from 110 to 180°C, however in the fine-grained rocks they were about 10°C lower.

Comparing the values of paleotemperatures obtained from calculations and based on the smectite content in minerals characterized by mixed-layer structures of illite/smectite type to the data published in scientific papers, it was ascertained that it is the Barker-Pawlewicz's algorithm, which is most useful for the purposes of the organic matter maturity evaluation in the Upper Silesian Coal Basin.

The calculated geothermic paleogradients varies between 60°C/km and 63°C/km which leads to the conclusion that the minimum thickness of the sedimentary overburden eroded from the surface of Carboniferous beds is from 4800 to 5000m. However, taking into consideration only the layers occurring below the depth of 1500m, where the change in trend of the reflectance value was found, the calculated geothermic paleogradients range between 70°C/km and 100°C/km. This suggests that the thickness of the eroded overburden should be from 5600 to 8000m.

REFERENCES

[1] BOSTICK N.H.*Time as a factor in thermal metamorphism of phytoclast (coal particles)*. C. R. 7. Congr. Internat. Strat. Geol. Carbonifere, Krefeld, 1971, 2, 1973, pp.183-193.

[2] BOSTICK N.H. *Microscopic measurements of the level of catagenesis of solid organic matter in sedimentary rocks to aid exploration for petroleum and to determine former burial temperatures.* Society of Economic Paleontologists and Mineralogists, Special Publication 26, 1979, pp.17-43.

[3] BOSTICK N.H., CASHMAN S.M., MCCULLOH T.H., WADDELL C.T. *Gradients of vitrinite reflectance and present temperature in the Los Angeles an Ventura Basins*, California. In: Oltz, D.F. (Ed.): Low Temperature Metamorphism of Kerogen and Clay Minerals, Pacific Section SEPM Special Symposium 1979, pp.65-96.

[4] ARREDONDO C., LOPATIN N. V., BOSTICK N. H., — *Summary of paleotemperature studies in works of Soviet scientists. International Document. International Committee for Coal Petrology. Urbana*, 1979

[5] STACH E., MACKOWSY M. TH., TEICHMÜLLER M., TAYLOR G.H., CHANDRA D., TEICHMÜLLER R. *Stach's Textbook of Coal Petrology*. Berlin, Stuttgart, Gebrüder Borntraeger, 1982

[6] SWADOWSKA E., SIKORSKA M. *Historia pogrzebania skał kambru na podstawie refleksyjności macerałów witrynitopodobnych w polskiej części platformy wschodnioeuropejskiej*. Przegląd Geologiczny, 1998, pp.699—706.

[7] TAYLOR G.H., TEICHMÜLLER M., DAVIS A., DIESSEL C.F.K., LITTKE R., ROBERT P. *Organic petrology*. Gebrüder Borntraeger. Berlin, Stuttgart, 1998

[8] ADAMCZYK Z., KOMOREK J. *Reflectance of vitrinite from barren rock inserts of coal seams of the Upper Marginal Beds in the Jejkowice Trough (USCB).* Zeszyty Naukowe Politechniki Śląskiej z. 241, 1999, pp. 21-35.

[9] KARWASIECKA M. *Wyniki badań dojrzałości termicznej materii organicznej w GZW*. W: Plewa S., red. „Rozpoznanie pola cieplnego Ziemi w obszarze GZW dla potrzeb górnictwa i ciepłownictwa". Studia Rozprawy Monografie 90 Instytut Gospodarki Surowcami Mineralnymi i Energi PAN, Kraków, 2001 pp. 85-102.

[10] BUŁA Z. *Dokumentacja geologiczno-wynikowa otworu wiertniczego Drogomyśl IG-1*. Archiwum OG PIG Sosnowiec, 1980

[11] ADAMCZYK Z., PORSZKE A. *The role of diagenetic varibility of carboniferous from the Drogomyśl IG-1 bore-hole in evaluation of its gas-bearing potential. Mineral Resources Management 18*, 2002, pp. 67-82.

[12] GABZDYL W. *Geologia złóż węgla*. Złoża świata. Warszawa PAE. 1994

[13] BARKER C.E. *Influence of time on metamorphism of sedimentary organic matter in selected geothermal systems, western North America*. Geology No. 11, 1983, pp.384-388.

[14] BARKER C.E., PAWLEWICZ H.J. *The correlation of vitrinite reflectance with maximum temperature in humic organic matter*. In: Buntebarth, G, Stegena L. (Ed.): Paleogeothermics, Lecture Notes in Earth Science, 5, Springer, Berlin, 1986, pp.79-93.

[15] BATTEN D.J., GAUPP R. *Maturation of petroleum organic matter in Cretaceous strata of the Northern Calcareous Alps. Neues Jahrbuch für Geologie und Paläontologie Mh. 3, 1985*, pp. 157-175.

[16] KOTAS A. *Coal deposits and coal resources*. Prace Państwowego Instytutu Geologicznego 142, 1994

[17] KOTAS A., ADAMCZYK Z. *Analiza porównawcza wyników badań refleksyjności witrynitu substancji organicznej z otworu wiertniczego Drogomyśl IG-1 w GZW.* Recenzowane Materiały Konferencyjne XXVII Sympozjum naukowego nt. Geologia Formacji Węglonośnych Polski, Kraków 2004, pp. 63-70.

RESUME

V článku jsou publikovány výsledky výzkumu úrovně termických změn organické hmoty v karbonských horninách, které byly zjištěny ve vrtu Drogomyśl IG-1. Vrt je situován v jižním křídle hlavní dílčí brachystruktury v polské části hornoslezské uhelné pánve. Touto částí pánve probíhá i významná tektonická zóna.

Cílem studie bylo stanovit stupeň termických změn organické hmoty v důsledku paleoteploty a paleotlaku v původní mocnosti karbonských sedimentů. Výzkum vycházel ze studia odraznosti vitrinitu v organické složce, obsažené v karbonských pískovcích, prachovcích, jílovitých prachovcích a jílovcích.

Náhodná odraznost Rf vitrinitu, vyseparovaného z horninové matrix z vrtu Drogomyśl IG-1, dosahuje v pískovcích hodnot od 0,72 do 1,28%, v horninách jemnozrnných 0,77 do 1,31%. To odpovídá paleoteplotám v rozmezí od 1100 do 1800C. Vypočtené průměrné geotermické paleogradienty dosahuji hodnot 60 – 630C/km. Tyto hodnoty ukazují na to, že minimální mocnost zerodovaného pokryvu z aktuálního povrchu karbonu mohla dosahovat cca 4800 – 5000 m. Vezmeme-li v úvahu pouze vypočtené geotermické paleogradienty pro hloubky větší než 1500 m (je zde dosahováno hodnot 700 – l000C/km) musela by minimální mocnost zerodovaného pokryvu činit cca 5600 až 8000 m.

Porovnáním vypočtených hodnot paleotemperatur s hodnotami získanými dříve na základě výzkumu změn komplexu illit-smektitových minerálů je zjištění, že nejvhodnější pro stanovení paleotemperatur karbonských hornin v případě hornoslezské uhelné pánve je použití algoritmu metody Barker-Pawlewicz (Barker a Pawlewicz, 1986).

Analyzujíc geotermální paleogradienty v komplexech svrchnokarbonských hornin je možno konstatovat, že hlavním faktorem vedoucím k tepelné vyzrálosti organické hmoty byl zdroj tepla z hlubin Země.