Comparative characteristics of the petrographic composition and quality of coal series С_1^2 and С_1^3 of the Prydniporovia Block

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Abstract. Taking into consideration the whole history of geological development of the Western Donbas, data on composition and grade of С_1^2 series coal involved information about the geotectonic development of the Basin. To satisfy the objectives, a system of research methods, covering petrographic, computational, statistical, chronological, comparative and other methods, has been applied. In the process of identification of the petrographic composition and grade of series С_1^2 coal on the territory of the Prydniprovia Block, and determination of lateral regularities of their change as well as change in stratigraphic section of the Lower Carboniferous, data of petrographic as well as chemical and technological indices of the coal seam c_1 were generalized along with data of all seams of С_1^3 series. The activities helped define genetic features of series С_1^2 coal as well as stratigraphic and lateral regularities of changes in the coal composition. The differences in the petrographic composition as well as in the chemical and technological characteristics of series С_1^2 and С_1^3 are indicative of dissimilar conditions of formation of their peat depositions. It has been determined that compared with С_1^3 series coal, the coal of С_1^2 series contains more humidity and fewer mineral impurities. It is characterized by higher values of sulfur content, volatile-matter content, and combustion heat. The ultimate composition of coal seams of С_1^2 series is characterized by smaller values of carbon and oxygen contents as well as greater hydrogen content. The conclusions on common features and differences in the petrographic composition as well as chemical and technological features of coal seams of С_1^2 and С_1^3 series, and regularities of their changes over the area of the seam occurrence was assessed.

Keywords: coal seam, vitrinite, liptinite, inertinite, petrographic composition
Introduction.

Expansion of coal seams over the whole multi-kilometer mass of the field, starting from the top of the Visean layers up to the Upper Carboniferous, is the feature of coal formation of the Donets Basin (Radziwill, 2012). Coal of C1,2–C1,7 series of the Middle Carboniferous has been studied in the most thorough manner. In terms of the Lower Carboniferous, the basic commercial seams are observed in C1,3 series. Due to their poor carbon bearing degree, the “subcoal” series of the Visean age (C1,2) belong to the least understood Donbas series. Petrographic as well as chemical and technological characteristics of coal seams of the Mezhova series were studied according to the certain wells while researching the basic carbon Samara series (C1,1). The lithological and facial characteristics of C1,2 series have been analyzed more thoroughly. It has been proved (Radziwill, 2012) that it is an independent rock complex differing greatly from carbon rocks of the underlying series (C1,3), and from the overlying carbon mass (C1,4). Further, three smaller subformations have been separated within the Low Carboniferous formation. The subformations are characterized by structural features as well as sediment and pett accumulation. Poorly carbonized bottom swampy-marine transgressive subformation underlies the carbon formation (Radziwill, 2012).

Early information concerning petrology and coal grade of C1,2 series was obtained for single wells in Pavlohrad District. During detailed exploration in the late 1950s within Kosminni and Mezhivski sites, b6 and b7 coal seams were prospected and analyzed. During the following years, geological prospecting activities helped to identify seams of C1,2 series in Petrykivka District, and Novomoskovsk District as well as in the territory of the Southern Donbas.

In large, the exploration degree of the petrographic composition and coal grade of C1,2 series may be evaluated according to the generalized scientific sources (Ivanova, 2018, 2018a, 2014; Savchuk, 2006, 2013, 2014a, b, 2017; Shulha, 2010). Specifically, The Atlas of the Lower Carboniferous of the Donets Basin contains no information concerning the problem. In more detail, the chemical and technological as well as petrographic characteristics of the series coal were considered by S.V. Savchuk, who published his paper in 1963 under the supervision of O.Z. Shyrokov. Coal seams of C1,2 series were characterized only for the Pavlohrad-Petrozavodka coal area. Information concerning composition of series C1,2 coal seams and their grade, obtained in the process of geological prospecting activities in Novomoskovsk District, Petrykivka District, and the territory of the Southern Donbas, was generalized together with series C1,3 seams (Ivanova, 2018, 2014; Shulha, 2010). Therefore, it turned out that comparison of features of petrographic and technological characteristics of series C1,2 coal seams and coal seams of C1,3 series is not sufficient. Up to now, information on the petrographic as well as chemical and technological characteristics of series C1,2 coal seams, obtained within the considerable area from Petrykivka deposit in the west to the Southern Donbas in the east has been covered by a negligible quantity of papers (Radziwill, 2012; Savchuk, 2017). At the same time, the first coal seams, formed at the very beginning of the pulsing development of the Donets Depression and which originated the initial commercial coal reserves in Ukraine, are associated with the C1,2 series. That is why the information is of practical and theoretical value.

The objective of the article was to identify the features of the petrographic composition and quality of coal seams of series C1,2 and to establish rules of their change in the area of distribution of coal seams. Taking into consideration the whole history of geological development of the Western Donbas, data on composition and grade of C1,2 series coal involved information about the geotectonic development of the Basin. The territory can be considered as a system of large tectonic blocks, among which the Samara Block, occupying a central share of the Western Donbas, is their biggest part. The Kalmius Block is east of the Samara Block; the Prydniprovia Block is west of it (Radziwill, 2012).

Materials and methods of investigation.

To satisfy the objectives, a system of research methods, covering petrographic, computational, statistical, chronological, comparative and other methods, has been applied. In the process of identification of the petrographic composition and grade of series C1,2 coal in the territory of the Prydniprovia Block, and determination of lateral regularities of their change as well as change in the stratigraphic section of the Lower Carboniferous, data on petrographic as well as chemical and technological indices of a coal seam c1 were generalized along with data of all seams of C1,3 series. The activities helped define genetic features of series C1,2 coal as well as stratigraphic and lateral regularities of changes in the coal composition.

Results.

The Prydniprovia Block is a site of the southern boundary of the Dnieper-Donets Depression. It has been proved that Precambrian rocks of the Prydniprovia Block rise slightly over the Samara Block. The
Vorskla fault borders the Block northwestwards; the Mykhailivka fault and Karabyrivka fault border it to the north east. In the context of the Prydniprovia Block, measures of C\textsubscript{1}\textsuperscript{2} series occur within the area of the Petrykivka deposit and Novomoskovsk deposit. They occur transgressively right on the rocks of crystalline basement. Average thickness of the series is minor being 127 m and 167 m respectively. In terms of the whole 2.3-4.3 m thickness of the coal seams and layers, the total carbonous coefficient is 1.9-2.5.

The series deposits are represented by limestones alternating with argillites, aleurites, sandstones, and coal. Marine deposits are the characteristic feature of facial composition of the series.

Generally, seams of the series are characterized by a noncommercial thickness being 0.05 to 0.50 m. Within the bottom share of the series (B\textsubscript{1}-B\textsubscript{3}) the number of coal layers is 11. They are not common within the area characterized by the unstable thickness not exceeding 0.45 m. For the most part, the top share of the series (B\textsubscript{4}-C\textsubscript{1}) is represented by aleurites. Such seams as b\textsubscript{3}, b\textsubscript{4}, b\textsubscript{5}, b\textsubscript{6}, and b\textsubscript{7} are characterized by a noncommercial thickness exclusive of b\textsubscript{1} and b\textsubscript{2} seams.

Within the Petrykivka deposit, b\textsubscript{7} seam with more than 0.45 m thickness prevails southwest of sites №1-2 and №3-4.

Exteriorly, coal of b\textsubscript{7} seam is greyish-black with a brownish shade in places; it is of mean density being sometimes viscous. Its jointing is either tabular or thinly laminated; fracture is uneven angular one.

Mineral impurities are in the form of fine grains as well as in the form of individual inclusions. They are represented by pyrite, calcite, and kaolinite. Pyrite is the commonest, being available in the form of concretions, layers, and small inclusions. Calcite is presented in the form of gouges in endogenic fractures. Kaolinite, filling usually vitrite fractures, occurs relatively often.

Macerals of the vitrinite group are widespread in the petrographic composition of b\textsubscript{7} seam. In the context of certain wells, their share varies from 49.0 to 75.0% being 65.1% on average. Macerals of liptinite follow them in abundance (Table 1). Compared with the liptinite group, macerals of inertinite group occur to a lesser degree, being 16.5% on the average. It should be noted that in terms of certain layer intersections, the composition of all the maceral groups varies over a wide and approximately equal value range being 26, 20, and 22% respectively. In some wells, layers of sapropelic-humus coal, represented mainly by boghead-cannel, occur in addition to humus coal.

Coal of the layer intersections belongs to the two petrographic types – durain-clarain and clarain-durain. In terms of typical petrographic composition, coal of the seam belongs usually to a spore durain-clarain subtype (Table 1).

Petrographic composition of b\textsubscript{7} and b\textsubscript{8} coal seams within Petrykivka deposit is almost identical to the composition of b\textsubscript{6} seam (Table 1). An almost similar amount of vitrinite, liptinite, and inertinite is indicated. In terms of certain layer intersections, changes in the content of the vitrinite maceral group take place within the same b\textsubscript{6} seam intervals. Petrographic subtype of such coal seams as b\textsubscript{7} and b\textsubscript{8} is a durain-clarain spore one.

In total, coal of C\textsubscript{1}\textsuperscript{2} seam of Petrykivka deposit belongs to a durain-clarain type. Spore coal subtype is the most widespread one (Table 1). Nonavailability of the seams consisting of durain coal type should be noted.

Macerals of the vitrinite group are the commonest ones within the organic group of c\textsubscript{1} seam coal (C\textsubscript{1}\textsuperscript{2} series). In the context of certain layer intersections, their number varies from 43.0 to 71.0%. On average, it is 60.0% in terms of the seam being less compared with C\textsubscript{1}\textsuperscript{2} series seams (Table 1).

Macerals of the liptinite group follow them; their mean is 22.0%. Compared with the liptinite group, the number of inertinite group macerals is lower, being 18.0% on the average. In comparison with C\textsubscript{1}\textsuperscript{2} series seams, petrographic composition of c\textsubscript{1} seam is more variable being characterized by the lower amount of the vitrinite group, and larger amount of macerals of inertinite and liptinite groups (Table 1).

As for the layer intersections, coal of c\textsubscript{1} seam belongs predominantly to the clarain-durain group (81.7%). Occurrence of the layer intersections, the coal of which belongs to a durain type (12.2%), should be mentioned. Durain-clarain varieties are 6.1% only (Table 1).

As for the spread area of c\textsubscript{1} seam, clarain-durain with 65-50% vitrinite content prevails. Mixed clarain-durain types occur along the southern extension of the sites; spore types are present along the northern one. Clarain-durain with 50% down to 40% of vitrinite content, and durain-clarain with 80% down to 65% of vitrinite content forms small areas. On the whole, coal of c\textsubscript{1} seam of Petrykivka deposit belongs to a clarain-durain spore type.

Table 1 demonstrates the typical petrographic composition of each commercial seam of C\textsubscript{1}\textsuperscript{2} series within the Petrykivka deposit (exclusive of c\textsubscript{1} seam).

In the context of certain seams, content of macerals of the vitrinite group varies from 49 to 65%; its average value is 54.2%. Inertinite content is 19 to 26%; and liptinite is 16 to 26%. In terms of the average seam values, the quantity of maceral groups varies within the fewer ranges (Table 1).
From the viewpoint of its material composition, the Lower Carboniferous coal of \( C_1^2 \) series of the Petrykivka deposit belongs to a claraín-durain type. Sometimes, it belongs to a durain or to a durain-claraín type.

The data helps conclude that according to its petrographic composition, \( C_1^2 \) series coal of the Petrykivka deposit differs from \( C_1^3 \) series coal. In their total petrographic composition, they contain more macerals of the vitrinite group, and fewer macerals of the inertinite and liptinite groups. On the whole, \( C_1^2 \) series coal belongs to a spore durain-claraín type and \( C_1^3 \) series coal belongs to a spore claraín-durain type. Stratigraphic section from bottom seams to the top ones explains that typical petrographic composition has a tendency to decreased vitrinite quantity. In turn, the maceral content of the inertinite and liptinite groups increases. As for the petrographic composition, seam \( c_7 \) coal is found in between \( C_1^2 \) series seams and other seams of \( C_1^3 \) series (Table 1).

Among the coal seams of \( C_1^2 \) series, \( b_7 \) seam is the most widespread, occurring mainly in the field of Novomoskovska #4 mine within the area of Novomoskovsk deposit. The seam is of variable thickness (0.1 m to 1.40 m). 0.75-0.90 m thickness prevails; its mean thickness is 0.73 m. The central share of the site demonstrates more than 0.8 m thickness of the seam. It is represented by small separated areas within the remaining territory.

Hence, according to the mining conditions, reserves of \( b_7 \) seam have been referred to the noncommercial ones.

The seam is of complex structure. Layers of carbonic argillites are 0.05-0.20 m, and 0.30-0.40 m more rarely. Argillite occurs within the seam roof; aleurite occurs less frequently. Its depth varies from 250 to 750 m being 415 m on average.

Predominantly, the coal is of a humic type. Sometimes, sapropelic-humic layers occur. Microscopically, the coal is semi-dull and semi-lustrous striated densely with rare vitrain bands.

The coal is a complex mixture of vitratin-inertinite-liptinite maceral groups.

The vitrain group is the basis of the petrographic composition. The amount of the mineral varies from 46.0% up to 81.0%, being 68.0% on average. The liptinite group, the mean of which is 17.0%, follows vitrain in maceral content within the total organic coal mass. In terms of the certain wells, its amount varies from 5.0 to 26.0%. The inertinite group is the least occurred one. Its average content is 15.0 %, somewhat less than the liptinite group content (Table 1). In terms of the certain wells, its amount varies from 9.0% to 36.0%.

From the viewpoint of its material composition, the coal belongs to the durain-claraín (60%) and claraín-durain (40%) types. Nonavailability of a durain coal type should be mentioned. The spore coal subgroup is the most widespread among the petrographic subtypes (Table 1). As for the area, spore durain-claraín type is the typical petrographic composition.

In the context of the petrographic composition of \( c_7 \) seam, occurring within the area of the mine Novomoskovska #4, the average amount of the maceral vitrinite group is 63.0% (55-74%). The quantity of macerals of inertinite and liptinite groups is almost identical, being 18.0% and 19.0% respectively (Table 1).

In terms of the typical material composition of \( c_7 \) seam, durain-claraín type prevails (76%). The number of durain-claraín type samples is 22%. The number of layer intersections consisting of a durain coal type is low, being 2% on average (Table 1). The shares of the spore coal subtypes and the mixed one are represented almost identically. In the context of the deposit, the petrographic subtype of the coal seam is of claraín-durain spore type.

In terms of petrographic composition of \( C_1^3 \) series (\( c_7-c_8 \)), the other coal seams of the mine Novomoskovska #4 also differ from petrographic composition of \( b_7 \) seam (\( C_1^2 \) series)

Hence, stratigraphic section of the Novomoskovsk deposit shows that a gradual decrease in the vitrain maceral group takes place from the \( b_7 \) seam to \( c_7 \) seam as well as the increase in inertinite and liptinite macerals (Table 1). Coal of \( C_1^2 \) series belongs to a durain-claraín type and coal of \( C_1^3 \) series belongs to a claraín-durain type.

The data concerning the difference in petrographic compositions of seams of \( C_1^2 \) and \( C_1^3 \) series are indicative of dissimilar conditions of the formation of peat depositions. The information is also supported by the data on the composition and grade of the series coal.

Table 2 explains chemical and technological characteristics of the coal seams of \( C_1^2 \) and \( C_1^3 \) series. \( C_1^2 \) series coal is characterized by high humidity. In the context of the Prydniprovia Block, it is 9.9 % on average. Predominantly, the coal is of mid-ash type (Table 2). On the territory of the Prydniprovia Block, ash content of coal patches of \( C_1^2 \) series varies from 7.0 to 21.0%. It is 12.8% for the Petrykivka deposit and 11.8% for the Novomoskovsk deposit. Its high content has been identified within the areas of seam thinning. In terms of ash, concentratability is medium and heavy. The ash is of a ferrous type. It has high content of \( \text{Fe}_2\text{O}_3 \) (24.4-29.9 %) and \( \text{CaO} \) (8.3 – 8.7 %), and low content of \( \text{SiO}_2 \) and \( \text{Al}_2\text{O}_3 \). High content of Na and K oxides (8.5-10.3%) as well as Mg (3.0-
Table 1 - Petrographic composition, types, and subtypes of coal seams of \( C_1^2 \) and \( C_1^3 \) series of Prydniprovia Block in the Western Donbas

| Deposit, district, site | Series | Seam | Petrographic composition, % | Petrographic type of coal, % | Petrographic subtype of coal, % | Petrographic subtype of seams |
|-------------------------|--------|------|----------------------------|-----------------------------|-------------------------------|-------------------------------|
|                         |        |      | Vt | I     | L     | durain-clarain | clarain - durain | durain | mixed | spore one |
| Petrykivka deposit      | \( C_1^2 \) | \( b_6 \) | 49.0-75.0 | 65.1 | 9.0-29.0 | 16.5 | 13.0-35.0 | 18.4 | 55.0 | 45.0 | 0 | 24.0 | 76.0 | durain-clarain spore |
|                         | \( C_1^2 \) | \( b_7 \) | 49.0-75.0 | 65.2 | 14.0-23.0 | 17.0 | 7.0-25.0 | 17.8 | 75.0 | 25.0 | 0 | 40.0 | 60.0 | durain - clarain spore |
|                         | \( C_1^2 \) | \( b_8 \) | 49.0-75.0 | 65.1 | 9.0-29.0 | 16.8 | 7.0-35.0 | 18.1 | 65.0 | 35.0 | 0 | 31.3 | 68.7 | durain - clarain spore |
|                         | \( C_1^3 \) | \( c_1 \) | 43.0-71.0 | 60.0 | 5.0-34.0 | 18.0 | 13.0-32.0 | 22.0 | 6.1 | 81.7 | 12.2 | 52.5 | 47.0 | clarain - durain spore |
|                         | \( C_1^3 \) | \( c_2 \) | 49.0-65.0 | 54.2 | 19.0-26.0 | 22.0 | 16.0-26.0 | 23.8 |                   |     |     |     |                   |     |
| Novomoskovsk deposit, Field of mine #4 | \( C_1^2 \) | \( b_7 \) | 46.0-81.0 | 68.0 | 9.0-36.0 | 15.0 | 5.0-26.0 | 17.0 | 60.0 | 40.0 | 0 | 38.0 | 62.0 | durain - clarain spore |
|                         | \( C_1^3 \) | \( c_1 \) | 55.0-74.0 | 63.0 | 11.0-27.0 | 18.0 | 12.0-25.0 | 19.0 | 22.0 | 76.0 | 2.0 | 47.0 | 53.0 | clarain - durain spore |
|                         | \( C_1^3 \) | \( c_9 \) | 56.0-71.0 | 58.6 | 11.0-27.0 | 19.5 | 16.0-24.0 | 21.9 |                   |     |     |     |                   |     |
| Prydniprovia Block      | \( C_1^2 \) | \( b_7+b_8 \) | 46.0-81.0 | 66.5 | 9.0-36.0 | 15.9 | 5.0-35.0 | 17.6 | 58.0 | 42.0 | 0 | 37.0 | 63.0 | durain - clarain spore |
|                         | \( C_1^3 \) | \( c_1 \) | 46.0-81.0 | 61.5 | 9.0-29.0 | 18.0 | 7.0-35.0 | 20.5 | 14.0 | 79.0 | 7.0 | 47.0 | 53.0 | clarain - durain spore |
|                         | \( C_1^3 \) | \( c_1 \) | 46.0-81.0 | 58.1 | 9.0-29.0 | 20.0 | 7.0-35.0 | 21.9 |                   |     |     |     |                   |     |

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Journ. Geol. Geograph. Geoecology, 30(1), 145–152.
Table 2 - Characteristics of the chemical composition and grade of coal seams of $C_1^2$ and $C_1^3$ series (Prydniprovia block of the Western Donbas)

| Deposit, district | Series | Seam     | Technical analysis, from-to/average | Ultimate composition, % |
|-------------------|--------|----------|-------------------------------------|-------------------------|
|                   |        |          | $W_b$, % | $A_d$, % | $S_b$, % | $V_{daf}$, % | $Q_{daf}$ MJ/kg | $C_{daf}$ | $H_{daf}$ |
| Prydniprovia block | $C_1^2$ | $b_6$ | 3.7-12.4 | 8.0-20.0 | 1.98-8.28 | 42.0-48.0 | 27.5-28.9 | 68.0-74.0 | 5.4-5.8 |
|                   |        | $b_7+b_8$ | 8.7 | 14.8 | 4.0 | 45.1 | 28.1 | 70.3 | 5.56 |
|                   |        | $b_7$ | 4.1-13.6 | 7.0-21.0 | 1.99-7.24 | 41.0-45.0 | 28.9-29.7 | 71.0-72.0 | 4.8-5.4 |
|                   |        | $b_7+b_8$ | 9.1 | 11.0 | 2.96 | 44.9 | 29.3 | 71.5 | 5.20 |
|                   | $C_1^3$ | $c_1$ | 3.7-12.4 | 7.0-21.0 | 1.98-8.28 | 41.0-48.0 | 27.5-29.7 | 68.0-74.0 | 4.8-5.8 |
|                   |        | $b_7$ | 8.9 | 12.8 | 3.49 | 45.0 | 28.7 | 70.9 | 5.46 |
|                   |        | $c_1$ | 1.5-18.7 | 4.0-32.0 | 0.41-7.52 | 39.0-49.0 | 27.6-30.0 | 72.0-74.0 | 4.7-6.0 |
|                   | $C_1^3$ | $c_1$ | 8.8 | 13.9 | 1.87 | 44.6 | 28.3 | 72.6 | 5.37 |
|                   |        | $c_1$ | 9.8 | 14.3 | 1.56 | 44.7 | 29.8 | 73.6 | 5.19 |
| Novomoskovsk      | $C_1^2$ | $b_6$ | 9.0-13.0 | 7.0-19.0 | 1.48-10.74 | 44.0-49.0 | 27.6-30.5 | 70.0-74.0 | 4.7-5.8 |
|                   |        | $b_7$ | 11.0 | 11.8 | 4.97 | 47.0 | 29.4 | 72.4 | 5.44 |
|                   | $C_1^3$ | $c_1$ | 6.6-17.0 | 7.0-24.0 | 0.52-14.07 | 43.0-48.0 | 28.8-30.3 | 71.0-75.0 | 4.5-5.68 |
|                   |        | $c_1$ | 9.9 | 12.7 | 3.47 | 46.0 | 29.5 | 72.8 | 5.16 |
| Prydniprovia block | $C_1^2$ | $b_6+b_7$ | 3.7-13.0 | 7.0-21.0 | 1.48-10.74 | 41.0-49.0 | 27.5-30.5 | 68.0-74.0 | 4.7-5.8 |
|                   |        | $b_6+b_7+b_8$ | 9.9 | 12.3 | 4.23 | 45.9 | 29.1 | 71.6 | 5.45 |
|                   | $C_1^3$ | $c_1$ | 1.5-18.7 | 4.0-32.0 | 0.40-14.07 | 39.0-48.0 | 27.6-30.5 | 71.0-75.0 | 4.5-6.0 |
|                   |        | $c_1$ | 9.4 | 13.7 | 2.67 | 43.4 | 28.7 | 72.7 | 5.27 |
3.44%) is a specific feature of chemical ash composition of the area. The coal is of sulfide and multisulfide type. Sulfur amount of certain samples varies broadly from 1.99 to 10.77%; 3.49% is its average value for the Petrykivka deposit, and 4.97% for the Novomoskovsk deposit. Average sulfur content in the coal of C_1^2 series of the Prydniprovia Block is 4.23% (Table 2). Phosphorus amount in the coal is increased. Within the area of Petrykivka District, volatile-matter content (V_{daf}, %) varies from 41.0% to 48%, being 45.0% on average. As for the area of Novomoskovsk District, its values are greater, being 44.0% to 49.0% (47.0% on the average). In terms of C_1^2 series on the territory of the Prydniprovia Block, average value of the index is 45.9% (Table 2). Combustion heat per the fuel mass is almost 28.7 MJ/kg for Petrykivka deposit coal, and 29.4 MJ/kg for the coal of the Novomoskovsk deposit. High coal humidity decreases combustion heat in terms of a dry ashless fuel (O_i^r). Its values are 20.3-20.5 MJ/kg only, which is typical for lignite. Carbon content (C_{daf}, %) is from 68.0% to 74.0% (70.9% on the average) for Petrykivka District, and 72.4% for Novomoskovsk District. Hydrogen amount is almost similar (5.46% and 5.44% respectively). C_1^2 series coal does not experience coking. Only for certain samples from Novomoskovsk deposit, does plastic layer thickness achieve 5 mm. Plastometric shrinkage varies from 32 up to 55 mm, being 45 mm on the average. Semicoke output per dry mass varies from 62.3% up to 80.1% if ash content is up to 17%. Output of semicoking resin is high, being 9.6% up to 21.9% (13.9% on the average). The resin contains numerous paraffins and phenols, which may be used for distillation. The coal is black characterized by a uniform grade composition; it belongs to D grade.

Compared with C_1^3 series, coal of C_1^2 series differs in greater average values of humidity, sulfur content, volatile-matter content, combustion heat, and a smaller number of mineral impurities. The coal differs in its ultimate composition as well. It is characterized by high hydrogen content and smaller values of carbon content (Table 2).

The data have helped draw conclusions on common features and differences in the petrographic composition as well as chemical and technological characteristics of series C_1^2 and C_1^3, and regularities of their changes over the area of the seam occurrence and relying upon stratigraphic section.

Conclusions.

According to their petrographic composition, coal seams of C_1^2 series belong to the spore durain-clarain type:

1. It has been identified that in terms of the total petrographic composition, C_1^2 series coal differs from C_1^3 series coal. Lower series coal is characterized by a greater content of vitrain group and smaller amount of the inertinite and liptinite groups.

2. A similar pattern has been identified for the changes in the petrographic composition of series C_1^2 and C_1^3 occurrence. The amount of the vitrain maceral group increases in north-westerly direction, in a south-eastwardly direction; in turn, the amount of inertinite and liptinite maceral groups decreases.

3. It has been determined that compared with C_1^3 series coal, the coal of C_1^2 series contains more humidity and fewer mineral impurities. It is characterized by higher values of sulfur content, volatile-matter content, and combustion heat. Ultimate composition of coal seams of C_1^2 series is characterized by smaller values of carbon and oxygen contents as well as greater hydrogen content.

4. A similar pattern has been identified for the changes in the chemical and technological characteristics of series C_1^2 and C_1^3 occurrence. Increase in combustion heat and in carbon content as well as decrease in the amount of mineral impurities take place in a north-westernly and south-easterly direction.

The differences in the petrographic composition as well as in the chemical and technological characteristics of series C_1^2 and C_1^3 are indicative of dissimilar conditions of formation of their peat depositions. In the future, it is required to perform certain activities aimed at the determination of features of maceral composition of coal seams of C_1^2 series, analysis of their petrographic structure, and consideration of the formation conditions of their peat depositions.

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