Journal of Geology, Geography and Geoecology

Journal home page: geology-dnu-dp.ua

ISSN 2617-2909 (print)
ISSN 2617-2119 (online)

Journ.Geol.Geograph. Geology, 30(1), 145–152.
doi: 10.15421/112113

Comparative characteristics of the petrographic composition and quality of coal series C_1^2 and C_1^3 of the Prydniporovia Block

Vyacheslav S. Savchuk, Vasyl F. Prykhodchenko, Dmytro V. Prykhodchenko, Valeriia V. Tykhonenko

Dnipro University of Technology, Dnipro, Ukraine, nmugeology@gmail.com

Received: 30.06.2020
Received in revised form: 24.07.2020
Accepted: 16.12.2020

Abstract. Taking into consideration the whole history of geological development of the Western Donbas, data on composition and grade of C_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 C_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 C_1^3 series. The activities helped define genetic features of series C_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 C_1^2 and C_1^3 are indicative of dissimilar conditions of formation of their peat depositions. 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. The 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. The conclusions on common features and differences in the petrographic composition as well as chemical and technological features of coal seams of C_1^2 and C_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

Порівняльна характеристика речовинно-петрографічного складу і якості вугілля світ C_1^2 та C_1^3 Придніпровської брили

Савчук В.С., Приходченко В.Ф., Приходченко Д.В., Тихоненко В.В.

Національний технічний університет «Дніпровська політехніка», м. Дніпро, Україна, nmugeology@gmail.com

Анотація. Враховуючи історію геологічного розвитку Західного Донбасу у цілому, узагальнення матеріалів зі складу та якості вугілля світи C_1^2 виконано з урахуванням геотектонічного розвитку басейну. Для виконання поставлених задач використано комплекс методів досліджень, що включає петрографічний, розрахунковий, статистичний, хронологічний, порівняльний, тощо. При визначенні типового петрографічного складу та якості вугілля світи C_1^2 на площі Придніпровської брили і встановленні латеральних закономірностей їх зміни, та зміни у стратиграфічному розрізі нижнього карбону були додатково узагальнені дані петрографічних та хіміко-технологічних показників вугільного пласта c_1, та узагальнені данні для усіх пластів світи C_1^3. Це дозволило визначити генетичні особливості вугілля світи C_1^2 та встановити стратиграфічні і латеральні закономірності зміни складу вугілля. Виявлена різниця, як у петрографічному складі, так у хіміко-технологічних показниках вугільних пластів світ C_1^2 и C_1^3 вказує на різні умови формування їх торфовищ. Встановлено, що вугілля світи C_1^2 у порівняні з вугіллям світи C_1^3 вміщує більше вологи та менше мінеральних домішок. Для них характерні більш високі значення сірчистості, виходу летких, теплоти згоряння. Елементний склад вугільних пластів світи C_1^2 характеризується меншими значеннями вмісту вуглецю та кисню та більшою кількістю вмісту водню. Оцінено спільність та відмінність у петрографічному складі та хіміко-технологічних властивостях вугільних пластів світ C_1^2 та C_1^3 і закономірностях їх зміни по площі поширення пластів та у стратиграфічному розрізі.

Ключові слова: вугільний пласт, вітриніт, ліптиніт, інертиніт, петрографічний склад

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 Donetsk Basin (Radziwill, 2012). Coal of C_2^3-C_2^7 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 C_1^3 series. Due to their poor carbon bearing degree, the "subcoal" series of the Visean age (C_1^2) 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 (C_1^3). The lithological and facial characteristics of C_1^2 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 (C_1^1), and from the overlying carbon mass (C_1^3). Further, three smaller subformations have been separated within the Low Carboniferous formation. The subformations are characterized by structural features as well as sediment and peat accumulation. Poorly carbonized bottom swampy-marine transgressive subformation underlies the carbon formation (Radziwill, 2012).

Early information concerning petrology and coal grade of C_1^2 series was obtained for single wells in Pavlohrad District. During detailed exploration in the late 1950s within *Kosminni* and *Mezhivski* sites, b_6 and b_8 coal seams were prospected and analyzed. During the following years, geological prospecting activities helped to identify seams of C_1^2 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 C_1^2 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 C_1^2 series were characterized only for the Pavlohrad-Petropavlivka coal area. Information concerning composition of series C_1^2 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 C_1^3 seams (Ivanova, 2018, 2014; Shulha, 2010). Therefore, it turned out that comparison of features of petrographic and technological characteristics of series C_1^2 coal seams and coal seams of C_1^3 series is not sufficient. Up to now, information on the petrographic as well as chemical and technological characteristics of series C_1^2 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 C_1^2 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 C_1^2 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 C_1^2 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 hugest 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 C_1^2 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 of petrographic as well as chemical and technological indices of a coal seam c_1 were generalized along with data of all seams of C_1^3 series. The activities helped define genetic features of series C_1^2 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 Karabynivka fault border it to the north east. In the context of the Prydniprovia Block, measures of C_1^2 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_4-B_9) 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_9-C_1) is represented by aleurites. Such seams as b_3^3, b_4, b_5, b_7, b_8, and b_9 are characterized by a noncommercial thickness exclusive of b_6 and b_7 seams.

Within the Petrykivka deposit, b_6 seam with more than 0.45 m thickness prevails southwest of sites №1-2 and №3-4.

Exteriorly, coal of b_6 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 $в_6$ 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 $в_7$ and $в_8$ coal seams within Petrykivka deposit is almost identical to the composition of b_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_6 seam intervals. Petrographic subtype of such coal seams as b_7 and b_8 is a durain-clarain spore one.

In total, coal of C_1^2 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_1 seam coal (C_1^3 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_1^2 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_1^2 series seams, petrographic composition of c_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_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_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_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_1^3 series within the Petrykivka deposit (exclusive of c_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_1^3 series of the Petrykivka deposit belongs to a clarain-durain type. Sometimes, it belongs to a durain or to a durain-clarain 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-clarain type and C_1^3 series coal belongs to a spore clarain-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_1 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, $в_7$ 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 $в_7$ 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 0.30-040 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 vitrain-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-clarain (60%) and clarain - 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-clarain type is the typical petrographic composition.

In the context of the petrographic composition of c_1 seam, occurring within the area of the mine *Novomoskovska #4*, the average amount of the maceral vitrain 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_1 seam, durain-clarain type prevails (76%). The number of durain-clarain 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 clarain-durain spore type.

In terms of petrographic composition of C_1^3 series (c_o-c_6), 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 b_7 seam to c_6 seam as well as the increase in inertinite and liptinite macerals (Table 1). Coal of C_1^2 series belongs to a durain-clarain type and coal of C_1^3 series belongs to a clarain-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, concentratibility is medium and heavy. The ash is of a ferrous type. It has high content of Fe_2O_3 (24.4-29.9 %) and CaO (8.3 – 8.7 %), and low content of SiO_2 and Al_2O_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
		b_7+b_8	49.0-76.0 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
		$b_6+b_7+b_8$	49.0-76.0 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	$c_2^1-c_{10}$	49.0-65.0 54.2	19.0-26.0 22.0	16.0-26.0 23.8						clarain - durain spore
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_0-c_6	56.0-71.0 58.6	11.0-22.0 19.5	16.0-24.0 21.9						clarain - durain spore
Prydniprovia Block	C_1^2	$b_6+b_7+b_8$	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-c_{17}	46.0-81.0 58.1	9.0-29.0 20.0	7.0-35.0 21.9						clarain - durain spore

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^a, %	A^d, %	S_t^d, %	V^{daf}, %	Q_s^{daf} MJ/кг	C^{daf}	H^{daf}
Petrykivka	C_1^2	b_6	3.7-12.4 8.7	8.0-20.0 14.8	1.98-8.28 4.02	42.0-48.0 45.1	27.5-28.9 28.1	68.0-74.0 70.3	5.4-5.8 5.56
		$b_7+ b_8$	4.1-13.6 9.1	7.0-21.0 11.0	1.99-7.24 2.96	41.0-45.0 44.9	28.9-29.7 29.3	71.0-72.0 71.5	4.8-5.4 5.20
		$b_6+ b_7+ b_8$	3.7-12.4 8.9	7.0-21.0 12.8	1.98-8.28 3.49	41.0-48.0 45.0	27.5- 29.7 28.7	68.0-74.0 70.9	4.8-5.8 5.46
	C_1^3	c_1	1.5-18.7 8.8	4.0-32.0 13.9	0.41-7.52 1.87	39.0-49.0 44.6	27.6-30.0 28.3	72.0-74.0 72.6	4.7-6.0 5.37
	C_1^3	c_1-c_{10}	9.8	14.3	1.56	44.7	29.8	73.6	5.19
Novomoskovsk	C_1^2	b_7	9.0-13.0 11.0	7.0-19.0 11.8	1.48-10.74 4.97	44.0-49.0 47.0	27.6 - 30.5 29.4	70.0-74.0 72.4	4.7-5.8 5.44
	C_1^3	c_1	6.6-17.0 9.9	7.0-24.0 12.7	0.52-14.07 3.47	43.0-48.0 46.0	28.8 - 30.3 29.5	71.0-75.0 72.8	4.5-5.68 5.16
Prydniprovia block	C_1^2	$b_6+ b_7+ b_8$	3.7-13.0 9.9	7.0-21.0 12.3	1.48-10.74 4.23	41.0-49.0 45.9	27.5 - 30.5 29.1	68.0-74.0 71.6	4.7-5.8 5.45
	C_1^3	c_1	1.5-18.7 9.4	4.0-32.0 13.7	0.40-14.07 2.67	39.0-48.0 43.4	27.6 - 30.5 28.7	71.0-75.0 72.7	4.5-6.0 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). Phosphorous 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, the 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 features of coal seams of C_1^2 and C_1^3 series, 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-westerly 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.

References

Ivanova, A.V., 2018. Genesis and evolution of salty Ukrainian coal and problems of its mining. Synopsis of a thesis for the degree of Doctor of Geology: specialism area 04.00.16 “Geology of solid fossil fuels” 31p.

Ivanova A.V., Zaitseva L.B., Spirina O.I., 2018a. Geotectonic regime of formation of the coal-bearing deposits in the Western Donets Basin (Ukraine). Geological Journal №1. P.66-79. https://doi.org/10.30836/igs.1025-6814.2018.1.126569

Ivanova, A.V., Zaitseva, L.B., 2014. Rol heodynamiky v torfonakopychennia ta formuvanni rechovynno-petrohrafichnoho skladu vuhillia Zakhidnoho Donbasu [Role of geodymanic in the process of peat accumulation and formation of mineral and petrographic composition of the Western Donbas coal}. Tektonika i stratyhrafia 41, 40-48 (In Ukrainian).

Radziwill, A. Ya., Shulha, V.F., Ivanova, A.V., 2012. Etapy utvorennia vuhletsevykh formatsii v heolohichnykh strukturakh Ukrainy [Formation stages of carbon formations within geological structures of Ukraine]. Kyiv, LAT&K. (In Russian)

Savchuk, V.S., Prykhodchenko V.F., Prykhodchenko D.V., Tolubets D.V., 2017. Osoblyvosti skladu vuhilnykh plastiv svity C_1^4 Donetskoho baseinu [Features of composition of coal seams of C_1^4 series of Donetsk basin]. Visn. Dnipropetr. Univ. Ser. Geol. Geogr. 25(1), 63-71 (in Russian)

Savchuk, V., Prykhodchenko, V., Buzylo, V., Prykhodchenko, D., & Tykhonenko, V. 2013. Complex Use of Coal of Northern Part of Donbass. Mining of Mineral Deposits, 112-119. https://doi.org/10.1201/b16354-34

Savchuk, V.S., Prykhodchenko V.F., Prykhodchenko D.V., 2014a. Perspektivy ispolzovaniya kamennykh uglei severnykh okrain Donbassa [Possibilities of using black coal of the northern margins of the Donbas] Ugol Ukrainy 12, 47–54 (In Russian).

Savchuk, V., Prykhodchenko, V., Prykhodchenko, D. & Tykhonenko, V. 2014b. Petrographic Characteristic of Middle Carboniferous Coal of Bashkirian Formation in Lozovskoi Coal Area of Western Donbas. Progressive Technologies of Coal, Coalbed Methane, and Ores Mining, 417-421. https://doi.org/10.1201/b17547-71

Savchuk V.S., 2006. Nyzhnokarbonove vuhillia Ukrainy: sklad, yakist ta osnovni naprmy yoho ratsionalnoho vykorystannia.[Lower Carbonaceous coal of Ukraine: composition, quality and main directions of its rational use] Synopsis of a thesis for the degree of Doctor of Geology: specialism area 04.00.16 “Geology of solid fossil fuels” 36p. (in Russian).

Shulha, V.F., Ivanova, A.V., Zaitseva, L.B., Pankova, M.H., 2010. Klimaticheskaya zonalnost i petrograficheskii sostav rannekarbonovykh uglei VEP [Climatic zonality and petrographic composition of the early Carboniferous period of EEP]. “Geologicheski zhurnal”, 1, 58-65 (In Russian).