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Gas potential of the coal rock massif of the South Western part Donets coal basin, Ukraine

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ABSTRACT: Distribution of natural gases within theSouth Western part Donets basin is very irregular that stipulated by the depth variation to the methane zone and degassing level of the coal measure.The coal rock massif of the South Western part Donets coal basin is represented by Mississippian and Pennsylvanian strata of Carboniferous period. It has been made a comparison of the coal rock massifs gas content for different local structures.The issues of miner's safety and environmental protection motivate local experts to research these coals as potential gas plays. Are presented the results of gas content evaluation in commercially-produced coal seams.Commercial coal reserves of the Donets basin are confined to the C_2^7-C_2^5 suites of Middle Carboniferous age and to single coal seams of operating thickness of the C_3^1 suite in the Upper Carboniferous. Gas accumulations attributed to separated structures can be determined as gas collectors in the coal-mine workings.

KEYWORDS: Donetsk basin, tectonic structures, methane, coal deposits, coal bed methane.

I INTRODUCTION

The Donets basin is one the most explored geological regions in Ukraine and its main as coal-producing basin. Commercial coal reserves of the Donets basin are confined to the C_2^7-C_2^5 suites of Middle Carboniferous age and to single coal seams of operating thickness of the C_3^1 suite in the Upper Carboniferous. The Carboniferous sedimentary sequence is represented by alternation of sandstones, siltstones and shales of variable thickness and rather thin beds of limestones, coal and coal shales (fig. 2). Recently a lot of attention is paid to study and solve the issue of integrated development of coal and coalbed methane fields in the Donbas.

Gas content of coal seams in different coal-bearing suites differs. Many factors stipulate gas occurrence in the coal-bearing formations, namely the type of geological structure in the first instance, the rock type of coal seams overburden, presence of brittle and plicate deformations, coal composition and its thermal maturity, hydrogeological and hydrogeochemical conditions.

During the decades a considerable input into the knowledge of geological, tectonic-magmatic, litho-facies, coal gas content and its spatial distribution, and coal petrographic characteristics of the region was made by M.L. Levenshtein, A.Ya. Radzivill, V.F. Shulga, I.O. Maydanovich,V.V. Lukinov, L.I. Pimonenko, V.F. Baranov, V.F.Prykhodchenko, Ch. Dzamalova, K.I. Bagrintseva, A.M. Bryzhanyov, V.Yu. Zabigaylo, Yu.M. Nagorny, S.Yu. Prykhodchenko, M.V. Zhykalyak and many others.

This study is aimed to analyze of gas content of geological local structures and gas content of coal seams and host rocks of the Donetsk-Makiivka, Central and Krasnoarmiysk coalmine districts surrounding the Kalmius-Torets depression.

II METHODOLOGY

During 2010-2020 it was analyzed the azimuth and dip angle of the coal seams and host rocks as well as gas their gas-bearingness (residual gas content) sampled from the working faces in the mines of the Central, Krasnoarmiysk and Donetsk-Makiivka coalmine districts. The coal rock massif of the South Western part Donets coal basinis represented by Mississippian and Pennsylvanian (Bashkirian and Moscovian stage) strata of Carboniferous period (fig. 2). On the basis of industrial reports on detail exploration and our thematic researches it has been made a comparison of the coal rock massifs gas content for different local structures. That analysis was supplemented by study of gas composition in different geo-structural settings. First of all this study is designed to meet challenge of coal production safety (so-called emergency category of coal mines) depending on the gas content in working rock massif because of

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continuous increasing of mining depth year by year.

III RESULTS AND DISCUSSIONS

The coal-bearing strata in the Donetsk-Makiivka, Krasnoarmiysk and Central coalmine districts occurring on flanks of the Kalmius-Torets depression (Fig. 1) dipping towards its centroclinal part and stipulating high gas content of a coal rock massif. Spatial gas development are very irregular in the coal-bearing massifs of the southwestern part of the Donbas and different for anticlinal and synclinal structures that proved by different depth to the methane zone (100 – 300 m for anticlines and 350 – 600 m for synclines, sometimes it can go deeper to 800 – 900 m) that is testified by gas regime in the coal mines.

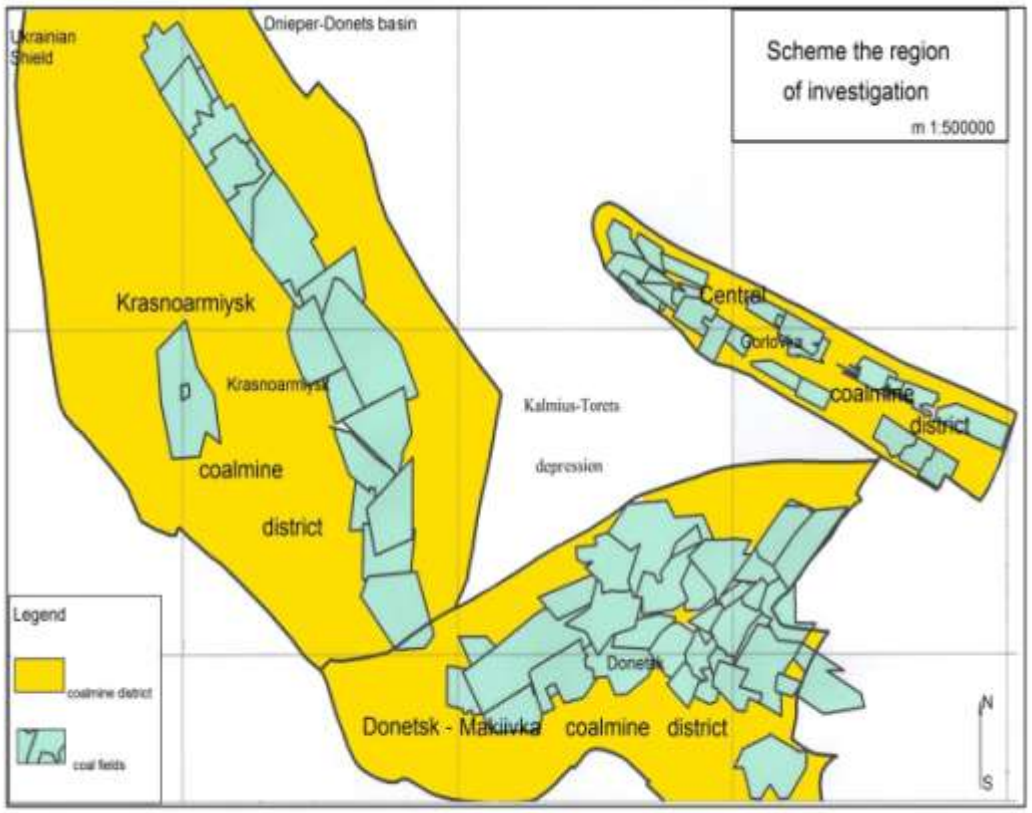

Figure 1. Outline the region of investigation

Possibilities to reveal dependence of gas content of coal seams of coal-bearing massifs on deep structures in the Karsnoarmiysk, Central and Donets-Makiivka coalmine districts become available due to shift of the mining towards tectonically complicated marginal parts of coal fields and increasing of depth of mine headings.

Rock occurrence is complicated by faults like thrusts, normal and reverse faults. While mining of the coal seems it is found that faults can ramify on branches and have a stepwise structure in the mimes producing coal from the Kamenska, (k), Almazna(l) and Gorlivka (m) suites, but their impact onto bulk fracturing and gas content is different. Gas distribution in coal rock massif both in coals and host rocks are tightly linked to the structural fractures of coal fields and tectonic structures of higher rank. The strata of anticline folds as well as zones of some faults (Main Anticline, Central, Italian, French thrusts, and Glybokoyarsky, Fedorivsky and other normal faults) are gas-bearing [5, 6].

The most favorable conditions for gas accumulation and preservation are related to anticline folds and cupolas where coal seams are characterized by increased methane content. For synclinal forms a detectable gas appearance is become apparent from the depth about 700 m.

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3.1 Central coalmine district

Dependence of coal seams gas content on tectonic deformations is well traced in the Central coalmine district (fig. 1) of the Donbas within the Gorlivka anticline. The mines located on the north flank of the Gorlivska anticline are characterized by steep dip of bedding planes of 40–60°, sometimes up to 69 – 82° and rather deep degree of degassing of coal seams, however, the concentration of methane is drastically increasing while intersection of fault zones by working faces. For the coal mines located on the southern flank of Gorlovka anticline it is typical angle dips of 38-50° (rarely up to 76°), mostly to the south, south west or south east, and methane concentrations in coal production vary from 4.9 до 100 m^3/t/day with average values of 20.0 to 54.0 m ^{3}/t/day depending on depth of mining and distance from tectonic faults [1].

Inasmuch as practically all mines of the district are located on the flanks of the Main (Gorlivka) Anticline so its faults govern the gas content, concentration and activity while secondary faults have usually only post-diagenetic impact on coal rock massif.

3.2 Donetsk-Makiivka coalmine district

The coal formation strikes near east-west in the Donetsk-Makiivka coalmine district (fig. 1), but near the Vetkivska flexure the strike direction is sharply changed to northeastern one. General gently dip of coal formation (angle dips of 8-25°) is complicated by plicate deformations and faults in the southern part of it in particular. Bedding planes dip angles within the flexures and outcrops reach 30-40° and gradually decrease to 5-10°while plunging towards north and east[1].

Mostofsamplesforcomponentcompositiono fresidualgascontentthat werecollectedinthecoalseamsm_3, $l_1$and$l_4$of the Zasyadko mineare significantly difference. Thechemicalanalysisrevealsgascompositionasfollo wing: methane, nitrogen, carbondioxide, ethane, butane, propane, pentane, and heavierandunsaturatedhydrocarbons aswell [1, 3, 7]. Sampledcoals aredifferentupon their gas content duetovariousdepthsanddegreefracturingthatcharacte risticofanindividualcoalseamoccurrenceand the coal formation as a whole. Coal samples from the area of the Vetkivska flexure are significantly enriched with gas.

Most of faults in the Donetsk-Makiivka coal district are sealed that prevents outgassing of the coal rock massif.

3.3 Krasnoarmiysk coalmine district

Zones of active fracturing of 30 m width are followed by the faults of the Krasnoarmiysk coalmine district (fig. 1). Here one can see discordant beds without and offset and ones with amplitude 1.0-15.0 m, sometime more.In general, the coal seams are characterized as middle- to low gas-bearing ones till the depth of 600 – 800 m. Upon exploration data the values of methane production can reach 16.3 $м^3$/t/dayvarying a bit in separate zones of a coal seam [1, 7].

Residualgascontentofsampledcoalshassho wnthattheircomponentcompositionchanges depending on the distance from the fault zone. Methane is characteristic of all samples with concentrations varying from 22.26 to 77.4 vol.%. Hydrogenistypicalforallcoalsamples (max concentration at $3.97x10^{-2}$vol.%, and min $1,21x10^{-3}$vol.%). Unsaturated hydrocarbons are represented by the gases as following: ethylene (max $0.845x10^{-3}$vol.%, min $2.7x10^{-6}$vol.%) andpropylene (traces). Their concentration is increasing towards the fault planes [5].

Gas saturation of the sandstones (host rocks) under favorable conditions changes from 0.01 до 027 $м^3$/tand closely related to presence of dissolved gas in the formation water. The sandstones have different gas permeability [2, 4, 7]. Higher permeability is stipulatedbyweakermetamorphismoftheformationan dfavorstoactivedegassingofthecoalseamsandaccum ulationofgaswheretheporosityishigher[1].

Besideshomologuesofhydrocarbongasesitisdetected tracesofheliuminthesamplestakenfromcoalseamsan dhostrocks.

Thismaypointoutontoactivegasregimeinthefractured zonesofacoalrockmassifofpresent-dayinfluxofgasintoit.

Dependenceofthedepthtomethanezoneand degreeofcoalformationdegassingongroundwatercirc ulationratesiswellobservedinwestofKrasnoarmiyskc oalminedistrict: underincreased water content the mine is characterized by decreased gas content and the boundary of methane zone is plunging till the depth of 300 – 500 м.ForthesouthwesternpartoftheDonetsbasinthepoten tiallygas-bearingstructuresarebothanticlinesandsynclines (ongreaterdepth) andsometypesoftectonicdisturbances.

An elevation of the methane zone reacted to anticline uplift is one of the features speaking in favor of increased gas saturation of a coal rock massif. At the depth of 500 – 700 m the coal seams are gas-containing in synclines as well. Tectonic

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faults redistribute gaseous hydrocarbons in spite of the structural form of a coal rock massif.

Thus, the faults and fracture density have a significant impact of gas potential of a coal rock massif as whole and coal seams in particular. Depending of the sealing properties the faults can prevent or favor degassing of a coal rock formation. Overburden rocks of coal seams usually seal free, absorbed and adsorbed gases confined in a rock coal.

Gas content of the coal seams in the Kamyanska, Almazna and Gorlivka suites are different. Thehighestgascontentischaracteristicoftheal maznas uite (C_2^6) thatprovedbyexplorationmapping, subsurface observations and analysis of gas samples, see Fig. 2.

IV CONCLUSIONS

Gas concentration and component composition of coal seams in disturbed and undisturbed massifs differ. Concentration of hydrogen, helium and heavier hydrocarbons is significantly increases in a disturbed massif.Presenceofhydrogenandheliuminrelativelyun disturbedmassifsmaybeexplainedbyupwardmigratio nofgasesupdip the beds of coal. Drastic decrease of the gas concentration in the thinnest part of a coal seams can be interpreted as the result of additional compaction of a coal matter comparing to its average density. Heavy disturbance of acoal rockmassifdrastically change its gas regime regardless of tectonic type of the structure. Most of faults favor degassing of the coal formation, however, while crossing different structural forms these ones can produce traps for gas accumulation in some places along the strike.

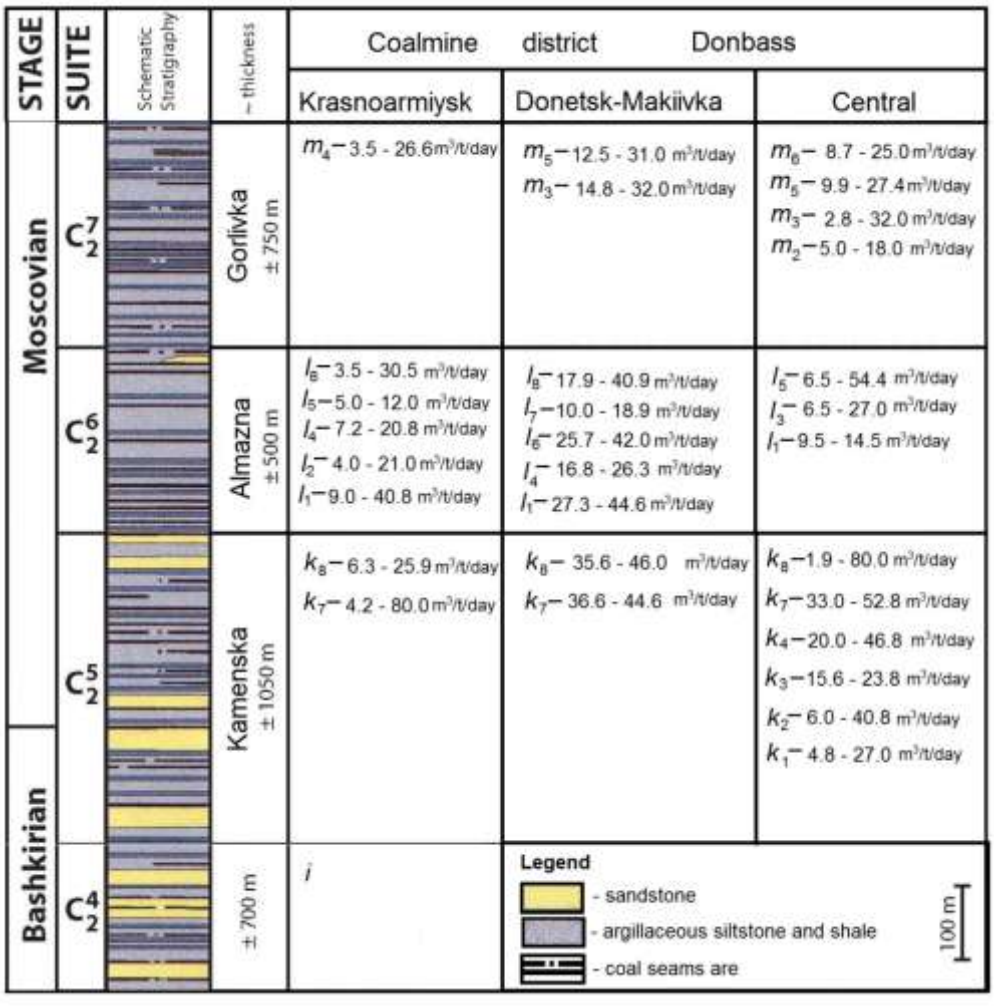

Figure 2. Gas contentof coal seams (Pennsylvanian) of the SW Donets coal basin

Coal seams have increased gas saturation in the vicinity of oblique faults as well and typical for tectonic fault zones. Gas accumulations attributed to separated structures can be determined as gas pools drained by coalmine workings. It is established particular relationships between the coal seams faults and their absorbed gas content.

REFERENCES

[1]. Gas-bearingness of USSR coal basins and fields Ed.-in chief A.I. Kravtsov. – Moscow, Nedra Press, 1979. – vol. 1: Coal basins and fields of the European part of USSR. 628 p.

[2]. RadzivillA.Ya.(2001).On the issue of methane concentration changes with depth in the coal formation of the Folded Donbas" Inst. Fundamental Res. Treatises. Kiev: Znannya Publ. P. 105-110.

[3]. RadzivillA.Ya.,Ivanova A.V., Zaytseva L.B.(2007). Geology of CBM basins (provinces) in Ukraine.Kiev. LOGOS Publ. 179 p.

[4]. Tirkel M.G., Antsiferov V.A., Glukhov A.A.(2008). Research on gas-bearing potential of the coal formation. Donetsk: VEBER Publ. 208 p.

[5]. Vegrelska N.V., Pravotorova O.V.(2008). Peculiarities of geological structure of some coal seams the Krasnoarmiysk coalmine district: Krasnolimanskacoal mine case study. Tectonics and Stratigraphy. Is. 36. P. 85-91.

[6]. Vergelska N. V., PravotorovaO. V., NazarovaI. O.(2011). On peculiarities of coal gas content in the tectonic active zone: Case study for North-Rodinska-2 SE Krasnolimanska Coal Co. Lease.UkrNDMI NAS Ukarine Treatises, Donetsk, Is. 9 (2). P. 440–450.

[7]. VergelskaN. V. (2014). Geological prerequisitestoe valuategas-bearingness of the Krasnoarmiys kcoalmine district, Donbass.Tectonics and Stratigraphy. Is. 41. P. 41–46.

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