Gas potential of the Krasnoarmiysk coalmine district coal rock massif versus its tectonic faulting, Donbass, Ukraine

Газов потенциал и тектонски нарушения във въгленосния масив на Красноармейския въгледобивен район, Донбас, Украйна

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Абстракт. Разгледана е връзката между газовия потенциал и тектонски нарушените зони във въгленосния масив, разработван от въгледобивната компания „Краснолиманская“. Направено е сравнение за влиянието на тектонските нарушения във въглищните пластове от свитите Алмазна и Горловска (Среден Карбон). Установено е изменение на газоносността в зависимост от отдалечеността от разлома.

Key words: coal seam, Krasnoarmiysky coalmine district, tectonic impact, coal gas.

The possibilities to reveal a dependence of the coal rock massifs gas potential on deep-seated structures in the Krasnoarmiysk coalmine district are steadily increasing due to the move of coal mine working faces towards tectonically complicated peripheral parts of mine fields coupled with increasing depth of the mining as well. This study is based on analysis of the coals and host rocks sampled in the mines of SE Krasnolimanska Coal Co. during 2007–2013.

The coal rock massif of the Krasnoarmiysk coalmine district is represented by Mississippian and Pennsylvanian strata of Carboniferous period. At the Krasnoarmiysk coalmine district there are three coal-bearing suites under production as follows: Kamenska ($\mathbf{C_2}^5$, coal seam ***k***), Almazna ($\mathbf{C_2}^6$, coal seam ***l***), and Gorlivska ($\mathbf{C_2}^7$, coal seam ***m***); while at SE Krasnolimanska Coal Co. the Almazna and Kamenska suites are under production. The coal seams m_4^2 and l_3 have as similar as different features that can be referred to the accumulation time (sedimentation) and overprinting (post-sedimentary) processes (Vergelska, Pravotorova, 2008; Vergelska, 2010; Vergelska et al., 2011).

The studied area is located within the hanging wall of the major Central thrust in the Krasnoarmiysk coalmine district. The Carboniferous rocks form a monocline dipping to the east and northeast at angle 3–14°. At the central part of the area studied it is observed a gentle dipping flexure with elevated northwest flank. The host rocks strikes northwest on the flanks and proximal to meridional one within the fold closure. Vertical height of the flexural bend is about 100 m. The stratal inclination at the flanks and the closure is practically unchanged. The occurrence of rocks is complicated by disjunctive faults (fourteennormal ones and seven upthrusts). During coal extraction it had been documented that these faults split into subordinate branches or have staircase array in $\boldsymbol{l_3}$ and $\boldsymbol{m_4^2}$ coal seams governing poulation density of fractures and gas content of those seams.

The tectonic faulting of the coal rock massif within the North-Rodinska-2 license area of the SE Krasnolimanska Coal Co. is different for coal seams $\boldsymbol{m_4^2}$ and $\boldsymbol{l_3}$. The zones of rock damage and fracturing are built by the post-formation tectonic processes in the coal seam $\boldsymbol{l_3}$ while such disturbances are minor or decay in the $\boldsymbol{m_4^2}$ coal seam.

The coal seams of that area are characterized as low gas-bearing ones up to 16.3 m^3/t of gas content (Kravtsov, 1979). Coal samples selected for the analysis of the residual gas component (Vergelska, Pravotorova, 2008; Vergelska, 2010; Vergelska et al., 2011) testifies that their component composition changes depending on the distance from fault plane. Methane is characteristic constituent for all of residual gas samples varying from 22.22 to 77.4 vol.%. Hydrogene is also typical for all coal samples (the highest concentration is about 3.97×10^{-2} vol.%, the lowest is 1.21×10^{-3} vol.%). The unsaturated hydrocarbons are represented by ethylene (the highest is about 0.845×10^{-3} vol.%, and the lowest one is 2.7×10^{-6} vol.%) and propylene (traces). Their concentrations increase while approaching the fault plane.

The gas content of the sandstones (host rock) at favorable conditions range from 0.01 to 0.27 m^3/t

and closely related to the presence of dissolved gas in formation waters. The sandstones have different permeability (Kravtsov, 1979; Tirkel et al., 2008). Higher permeability of sandstones is caused by weak metamorphism of the rock massif and stipulates active degassing of coal seams and even accumulation of gas in them at favorable conditions (Kravtsov, 1979; Vergelska et al., 2011). It is identified helium in those samples besides of methane homologues helium. This may point out at present-day gas inflow from deeper sources viathe damage zones to the coal rock massif.

The gas potential of the Almazna and Gorlivska coal-bearing suites is different. The highest gas content is characteristic of Almazna formation (C_2^6), which is confirmed by previous, exploration studies, observations at the mine and gas saturation of the collected samples (Vergelska, Pravotorova, 2008; Vergelska, 2010; Vergelska et al., 2011).

Conclusions

The dynamics of the tectonic-sedimentaryl regime of the coal rock massif within the license area mine of SE Krasnolimanska Coal Co. emphasizes recurrent splitting of the coal seams and changing of their thickness (towards the Central thrust) as well as abundant erosion gaps and pinch-outs.

Considerable fracturing of the coal rock mass testifies to reorganization of the coal seam ***l*** rock massif followed by considerably quiet tectonic regime. Inherited faults typical for the Almazna and Gorlivka suites, for example Glubokoyarsky or Fedorivsky normal ones have different influence on dislocation of the coal seams and formation of fractures. The Glubokoyarsky fault is inherited from older tectonic disturbance and distinctly traced in the seams $\boldsymbol{l_3}$ and $\boldsymbol{m_4^2}$. At the same time the amplitude of the Fedorivsky fault (25 m) taken upon seam $\boldsymbol{l_3}$ almost completely attenuates in $\boldsymbol{m_4^2}$ seam.

Due to re-structuring of the existed coal rock massif the hydrocarbon content and zonation is also changed.

While studying residual gas content in the coal seams it was found that the volume and variety of gases is increased toward the fault planes.

The gas content of the coal seams in the area studied is correlated with depth: the deeper their occurrence the higher is their gas content (Kravtsov, 1979; Radzivill, 2001; Tirkel et al., 2008; Vergelska et al., 2011).

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