Polish Geological Institute Special Papers, 7 (2002): 143–148
Proceedings of the IV European Coal Conference

THE INFLUENCE OF TECTONIC FACTOR ON METHANE BEARING CAPACITY IN CHOSEN AREAS OF THE UPPER SILESIAN COAL BASIN

Sławomir KĘDZIOR[1]

A b s t r a c t . The paper presents general information on variability of coalbed methane bearing capacity in tectonic zones, faults, rock fissures etc. Methane occurrences were compared in two tectonic zones of the Upper Silesian Coal Basin — the zone of fault-block tectonics and the folded one. The influence of big size faults (i.e. Bzie–Czechowice fault) and neighbouring fissures on methane bearing capacity is strongly marked in the zone of fault-block tectonics. The most important tectonic factors influencing the methane occurrence in the folded zone are Chwałowice and Jejkowice depressions and also Orlová and Michalkovice overthrusts. The methane bearing zones are parallel to Chwałowice and Jejkowice depressions bottom axis. Presence of Carpathian nappes intensifies rock fissuring process, which could involve the methane migration and cause degasification of coal seams lying under these nappes.

K e y w o r d s : coalbed methane, methane bearing capacity, tectonics, Upper Silesian Coal Basin, Poland.

INTRODUCTION

Methane bearing capacity is measured by methane content (volume) in mass unit (Mg) of dry ash free (daf) coal [m^3 CH_4/Mg daf]. It is very important parameter for estimating methane resources in coal series and for describing the occurrence of coalbed methane in rock mass.

The Upper Silesian Coal Basin (USCB) is located in southern Poland and in the region of Ostrava–Karviná in Czech Republic. It is the largest coal basin in Poland and also one of the largest in Europe. It covers the area of about 7,400 km^2 (Jureczka, Kotas, 1995). The USCB area is divided into two tectonic zones: the fault-block tectonic zone covers northern, central, and southern parts of the basin, and the folding zone covers western and south-western parts. There are many big-size regional faults in the fault-block tectonics zone: Kłodnica fault, Książęcy fault, Bełk fault, Jawiszowice fault, and Bzie–Czechowice fault. These faults are located within main syncline and they are probably connected with Variscan tectonic epoch; they were restored in the Alpine orogeny (Herbich, 1981). Main elements of the folding zone are Orlová and Michalkovice overthrusts and also Jejkowice and Chwałowice depressions. They are connected with the lateral tectonic pressure acting from the western direction (Kotas, 1985).

The aim of this paper is the comparison of tectonic factors influencing the methane occurrence in the USCB fault-block zone and in the folding one. Apart from this, the influence of Carpathian nappes on methane bearing capacity of coal beds was described.

EXPERIMENTAL

Tectonic influence on methane content was analysed in three representative areas:

— the area of middle part of Bzie–Czechowice fault in the south of the USCB (fault-block tectonics),

— the area of Chwałowice depression in the south-western part of the USCB (folding zone),

— the area covered by Carpathian nappes.

Methane bearing capacity survey was made in the boreholes drilled in the area of Silesia, in 1 Maja and Morcinek Coal

[1] University of Silesia, Department of Applied Geology, 41-200 Sosnowiec, Będzińska 60, Poland

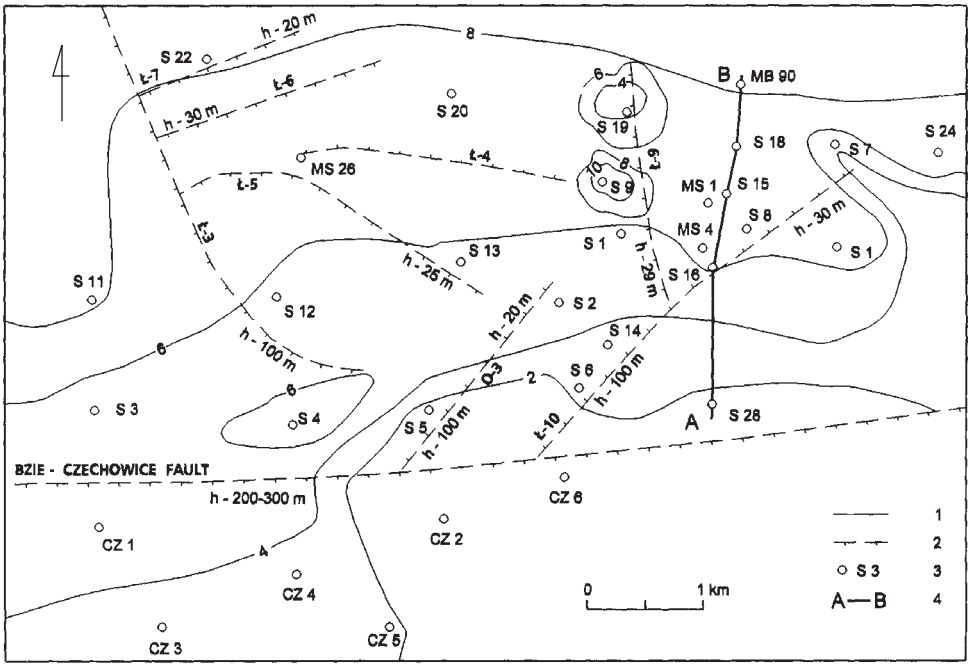

Fig. 1. Changeability of methane bearing capacity in area of Bzie–Czechowice fault (level –800 m over sea level) (after Kędzior, 2000)

1 — methane bearing capacity isolines, *2* — faults, *3* — surface boreholes, 4 — line of cross-section A–B

Mines. The coal samples were degassed under very low pressure (7–10 mm Hg) in a stationary gas laboratory. Methane bearing capacity measurements were made in compliance with the instructions given by Borowski (1975) and Niemczyk, Daniel (1986).

In spite of methane bearing survey made in coal samples from the surface boreholes, some parts of survey were made in the underground mine boreholes, in 1 Maja Coal Mine. The results of methane bearing capacity survey were marked on maps. Next, the methane bearing isolines were drafted in accordance with interpolation rules (Figs. 1 and 3). Apart from this, the cross-section through Silesia coal deposit was drawn (Fig. 2). On the basis of maps and cross-section, the influence of tectonics (faults and troughts) on methane occurrence were described.

The results of methane survey shown on maps can be more or less disturbed by the mine exploitation made in the southern area of Chwałowice depression and in the middle part of Bzie–Czechowice fault. The influence of coal exploitation on degassing the rock mass reaches about 60–100 m in each direction (Grzybek, 2000).

THE RESULTS OF WORK AND DISCUSSION

The area of middle part of Bzie–Czechowice fault (fault-block tectonics)

Methane content decreases towards Bzie–Czechowice fault direction (from 8 m^3/Mg daf, to 1–2 m^3/Mg daf close to the fault) in this area (Fig. 1). On the southern side of the dislocation (downthrow), the amount of methane is lower than on the northern one (upthrow) (to 4 m^3/Mg daf). There are various methane fields on the both sides of Bzie–Czechowice dislocation. Methane bearing field is interrupted by the fault, which divided the coal series into blocs with different gas-logged levels: the higher gas-logged level on the northern side, and the lower one on the southern.

The dislocation mentioned above supposes to be a kind of a pathway for the gas. It caused degasification of a big part of coal deposit near itself. Methane amount increases with the depth in the northern part of the area. The Miocene clay cover thickness is about 200 m and it increases towards Bzie–Czechowice fault direction, to 400–500 m in the downthrown block. The impermeable Miocene cover caused detention of methane migrating through the rock fissures. Finally, secondary gas accumulation under the cover rock came into being — the upper (secondary) methane maximum interval. The both factors (tectonics and impermeable cover) can be reasons of presence of the methane tectonic traps (i.e. area of Silesia Mine) (Fig. 2).

The character of Bzie–Czechowice fault could have change since the gas found pathway to hermetic trap screen, after filling the fault fissure by Miocene clays. Bzie–Czechowice fault influence on methane content is similar to the influence of the

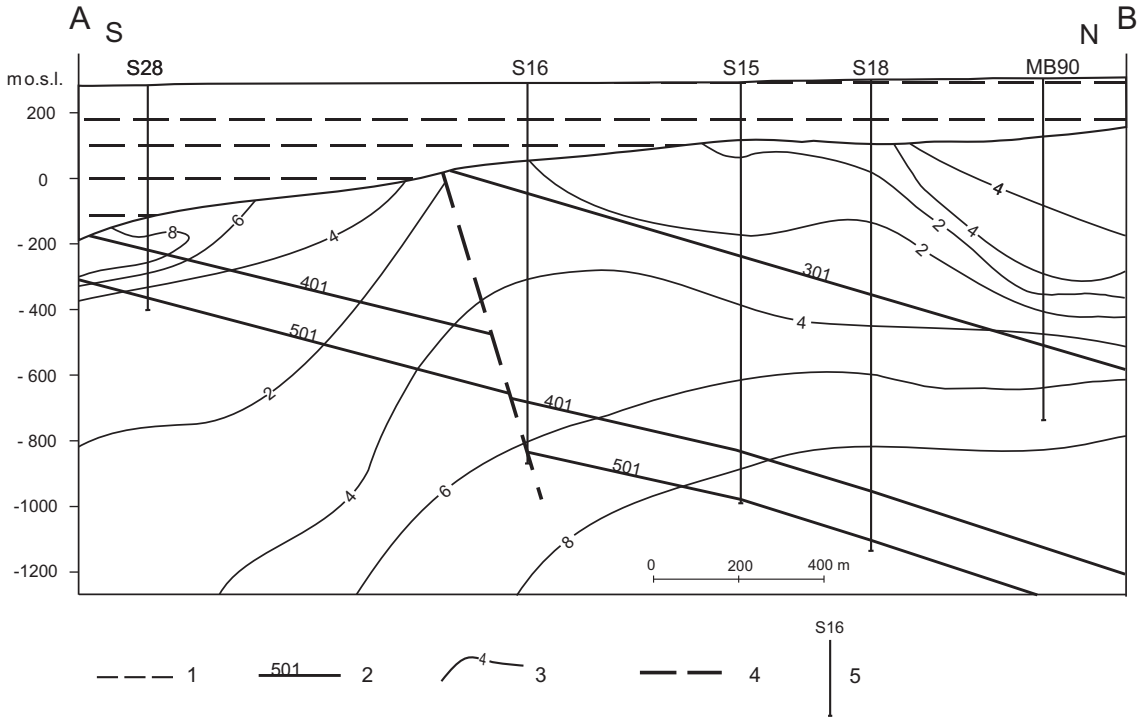

Fig. 2. Cross-section A–B through Silesia coal deposit

1 — Miocene clays and claystones, *2* — coal seams, *3* — methane bearing capacity isolines, *4* — fault, *5* — surface boreholes

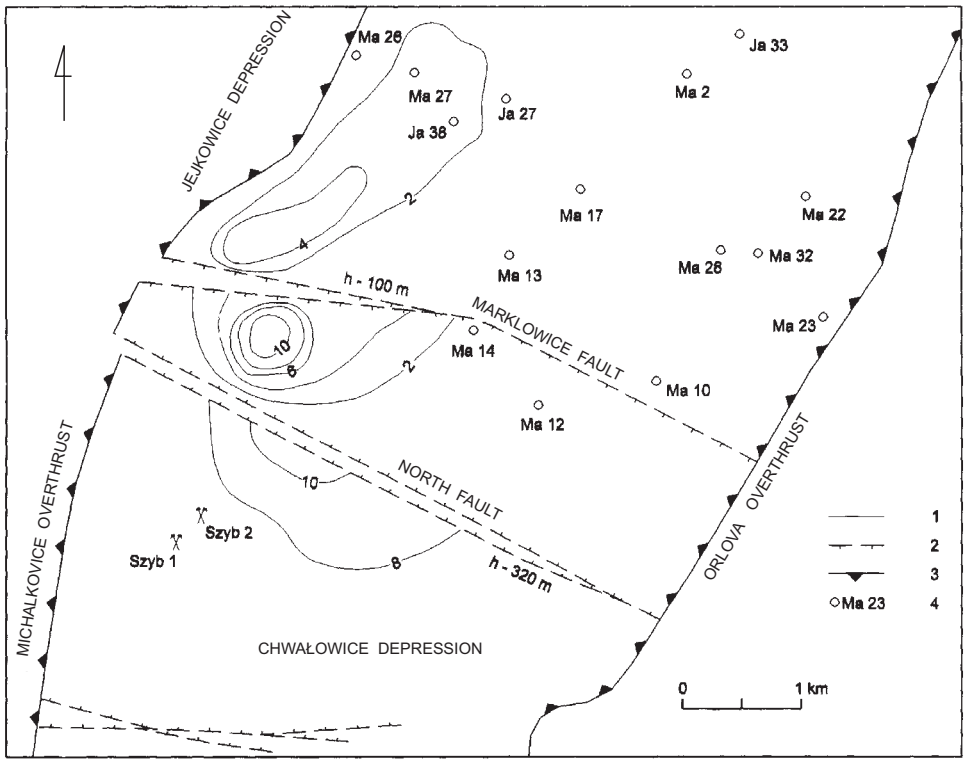

Fig. 3. Changeability of methane bearing capacity in the area of Chwałowice depression (level –580 m over sea level)

1 — methane bearing capacity isolines, *2* — faults, *3* — overthrusts, *4* — surface boreholes

other big-size dislocations in the USCB. This problem was first described by Tarnowski (Jawiszowice and Bełk faults) (1973, 1989). Apart from this, a large degassed area in the downthrow of Kłodnica fault was noticed (Kędzior, 1998).

The area of Chwałowice depression (the zone of fold tectonics)

A big part of Chwałowice depression contains small amount of methane. Methane bearing capacity is below 1 m^3/Mg daf. Geological survey made during the coal exploitation proved the presence of rock fissures in the areas situated near Michalkovice and Orlová overthrusts. They could make a degasification of coal beds in the mentioned areas.

There are single, isolated methane bearing zones, where the methane content is higher in relation to the neighbouring areas (about 7–10 m^3/Mg daf) (Fig. 3). Radzivill (1999) described a lateral, isolated gas bearing structures in the Donbas Coal Basin, which were made under strong tectonic compression. The isolated high methane zones in Chwałowice depression can be of the same origin like those in Donbas. The tectonic structures in the folding zone of the USCB were made in consequence of lateral tectonic pressure acting from the western side. Methane bearing field in this area can be a result of such tectonic conditions. The shape of some methane zones is parallel to Chwałowice depression bottom axis (Fig. 3).

The area covered by Carpathian nappes

Methane survey in the zone of Carpathia

n nappes were made in boreholes drilled over these nappes and Carboniferous coal beds (Kaczyce and Cieszyn areas). There is no increased methane content in coalbeds under thrusted from the south Carpathian nappes. Methane bearing capacity does not exceed 5 m^3/Mg daf. Presence of these nappes intensifies rock-fissuring process, which could involve the methane migration. The areas of high methane content are concentrated in some distance off the zone of Carpathian thrust (i.e. in Silesia and Kaczyce Coal Mine areas).

CONCLUSIONS

There are many aspects of the influence of tectonics on methane content in coal beds of the Upper Silesian Coal Basin (USCB). Some tectonic aspects have an effect on methane bearing capacity of coal in the USCB zone of fault-block tectonics, and the others in the folding zone.

The conclusions on the influence of tectonic factor on methane content in fault-block tectonics are as follows:

— division of Carboniferous series into blocs with different gas-logged levels; it relates to the large, regional faults like Kłodnica fault, Książęcy fault, Bzie–Czechowice fault and others;

— formation of the natural migration pathways for gas (methane); gas (methane) saturation of the upthrows and escape from the downthrows — this feature characterizes the majority of the faults occurred in the fault and block zone, especially the ones related to brittle tectonic regime;

— acting as a trap of gas screens after filling the fault fissure by clay substance — characterized by faults of smaller size, especially related to liable tectonic regime. There is a possibility of changing in time from the degassed type of faults into the gas accumulated ones (trap) (i.e. Bzie–Czechowice fault), or changeability of the both features within one fault.

The fold zone of the USCB has the other tectonic aspects, which have an influence on coalbed methane occurrence. The most important are:

— rock fissuring in the overthrust zones are conductive to coal degasification,

— lateral order of gas bearing zones is fallen in line with Jejkowice and Chwałowice depressions bottom-axis,

— geodynamic pressure acting from the western side caused detention of methane in isolated structures.

Carpathian nappes thrusted from the south intensified rock fissures. It probably caused gas migration from the coal seams lying under nappes to the neighbouring areas.

REFERENCES

BOROWSKI J., 1975 — Badanie gazonośności pokładów węglowych z zastosowaniem nowych metod. Komunikat GIG nr 645. Katowice.

GRZYBEK I., 2000 — Problemy geometryzacji pola metanonośności i szacowania zasobów metanu wynikające z eksploatacyjnego odgazowania pokładów węgla. Mat. VII Sem. nt. Metodyka rozpoznawania i dokumentacji złóż kopalin oraz geologicznej obsługi wierceń: 211–219. Wrocław.

HERBICH E., 1981 — Analiza tektoniczna sieci uskokowej Górnośląskiego Zagłębia Węglowego. *Rocz. Pol. Tow. Geol*. **51**, 3–4: 383–434.

JURECZKA J., KOTAS A., 1995 — Coal deposits — Upper Silesian Coal Basin. In: The Carboniferous system in Poland (A. Zdanowski, H. Żakowa Eds.). *Pr. Państw. Inst. Geol*. **148**: 164–173.

KĘDZIOR S., 1998 — Ukształtowanie stropu strefy wysokometanowej w rejonie zachodniej części uskoku kłodnickiego oraz uskoków Wojciecha i środkowego (obszary górnicze KWK Wujek i KWK Staszic) — GZW. Mat. XXI Symp. Geologia formacji węglonośnych Polski: 23–26. AGH, Państw. Inst. Geol., Pol. Tow. Geol. Kraków.

KĘDZIOR S., 2000 — Modele metanonośności złoża węgla kamiennego Silesia. *Zesz. Nauk. PŚl. Górn*. **246**: 213–221.

KOTAS A., 1985 — Uwagi o ewolucji strukturalnej Górnośląskiego Zagłębia Węglowego. Mat. konf.: 17–46. UŚl., Pol. Tow. Geol., Państw. Inst. Geol. Sosnowiec.

NIEMCZYK B., DANIEL J., 1986 — Możliwości rozpoznania gazonośności złóż węgla GZW w świetle dotychczasowych badań w otworach wiertniczych oraz rozwój potrzeb i badań w tej dziedzinie. *Zesz. Nauk. PŚl., Górn*. **149**: 157–163.

RADZIVILL A., 1999 — Tectono-physical criteria of formation of gas-bearing structures in Donbas and other coal basins. [Eng. Sum.]. Mat. XXII Symp. Geologia formacji węglonośnych Polski: 107–108. AGH, Państw. Inst. Geol., Pol. Tow. Geol. Kraków.

TARNOWSKI J., 1973 — Występowanie metanu w południowo-wschodniej części Górnośląskiej Niecki Węglowej. *Prz. Górn*. **10**: 380–388.

TARNOWSKI J., 1989 — Geologiczne warunki występowania metanu w Górnośląskiej Niecce Węglowej. *Zesz. Nauk. PŚl*. **924** *Górn*. 166: 126 p.