GOSPODARKA SUROWCAMI MINERALNYMI

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Initial evaluation of the basalt from Kłopotno deposit as a raw material for multipurpose application

Key words

Basalt, raw mineral, utilization

Abstract

The results of the researches showed that the basalt from the Kłopotno deposit can be apply to the production of the rock wool (the low value of the acidic module, small amount of the phenocrysts <10%, viscosity).

The values of the parameters which qualify the ability crystallization melt indicate that this basalt is not a praper material for the production of the rock casting.

The basalt for the Kłopotno deposit can be utilized as the the raw material for production of the crushed stone aggregate for highway engineering and railway engineering, concrete aggregate, aggregate for rock dust and filling material (very high compression strenght, very good frost resistance and very small absorbability).

Introduction

There is not output in the Kłopotno deposit. This deposit belongs to the Tertiary Volcanic Formation of the Lower Silesia. It is situated inside of the basaltic massive of area of Rębiszów — Izera Mountains (fig. 1). Actually the results of the mineralogical and chemical investigations of the basalts are known (Adamczyk, Derewecki 2004 — in the press). The

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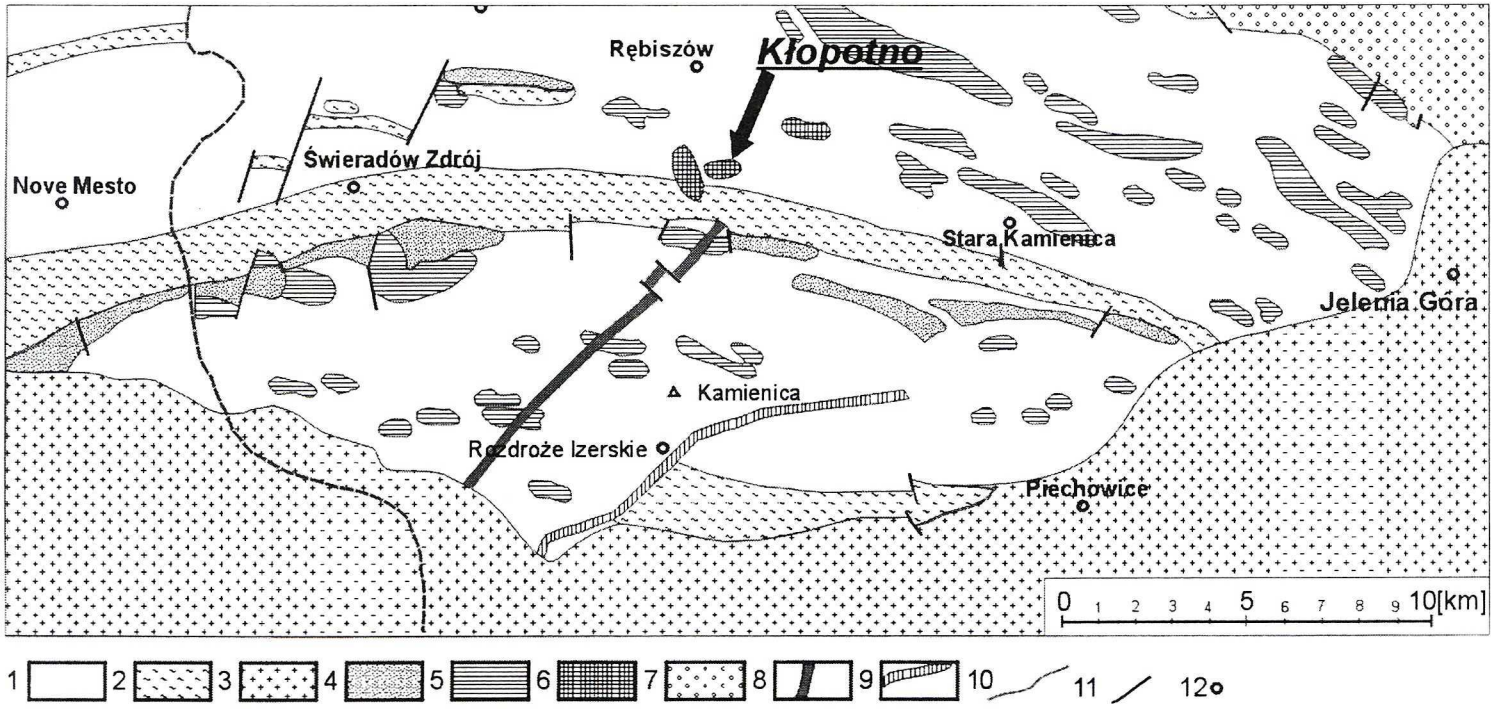

Fig. 1. Geologic sketch of the Izera Block

1 — bright gneiss, 2 — mica-chloritoid schists, 3 — Karkonosze granite, 4 — leucogranite, 5 — granite, 6 — basalt, 7 — Kaczawa metamorphic series, 8 — microgranite vein, 9 — izera quartz, 10 — fault, 11 — border, 12 — place

Rys. 1. Szkic geologiczny fragmentu bloku izerskiego

1— gnejsy jasne, 2 —łupki łyszczykowe i chlorytowe, 3 — granit Karkonoszy, 4 — leukogranity, 5 — granity, 6 — bazalty, 7 — seria metamorficzna gór Kaczawskich, 8 — skała żyłowa — mikrogranit, 9 — kwarc izerski, 10 — uskoki, 11 — Granica Państwa, 12 — miejscowości

detailed technological researches have not been done yet. The results of these researches would give the possibility to precise the utilization of the basalt.

The aim of this work is indicating the possibilities of the utilization of the basalt from the Kłopotno deposit. For realizing the aim was necessary to do analyses which were usually done for the rock materials (compression strenght, absorbability, frost resistance) and some petrurgic properties (acidic module, crystallize ability, viscosity).

1. Experiment, method

Nine different basalt samples were taken from the Kłopotno deposit (fig. 2). The detailed mineralogical and petrographic characteristic was presented in the other work (Adamczyk, Derewecki 2004 — in the press). In this work the systematic position of the basalt was presented. The systematic position of the basalt was established on the base of the classification of the volcanic rocks which were done using the chemical composition (TAS). In this work the results of the researches of the mineralogical and chemical composition were applied for describing the possibilities of utilization of the basalt for the rock metallurgy (the production of the rock wool and basaltic rock casting). Becomes of it was necessary to establish the normative composition of the investigating samples, acidic module, viscosity. It was done on the base of the chemical composition.

Moreover some technological properties were fixed for the samples: compression strenght in air-dry condition, frost resistance, absorbability. The properties were fixed according to the standards (PN-84/B-04110, PN-85/B-04101, PN-85/B-04102).

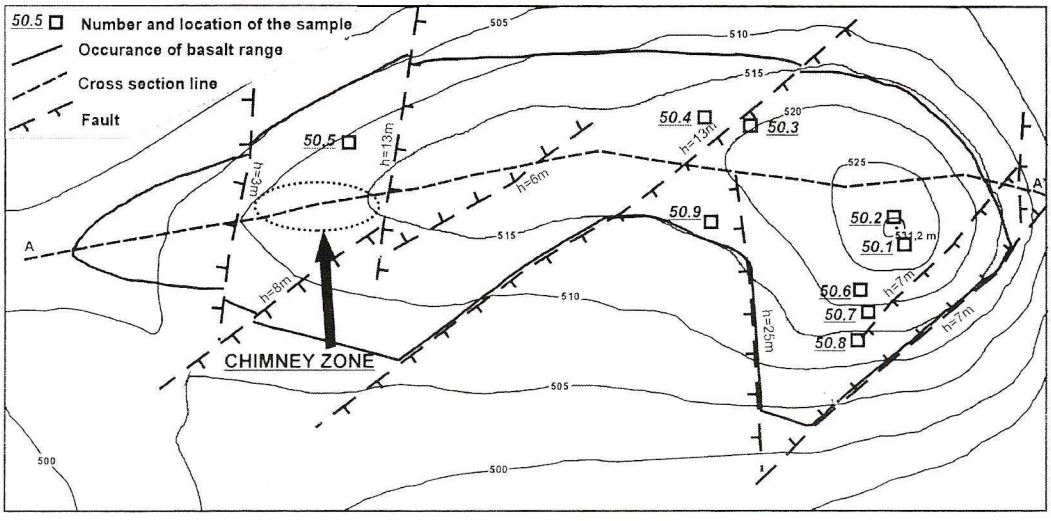

Fig. 2. Sketch of the Kłopotno deposit with samples location

Rys. 2. Szkic złoża Kłopotno z lokalizacją pobranych próbek

2. Results

The investigating basalt is grey and dark grey in color. It presented porfiritic or aphanitic texture. The rock is consolidated and disordered, sometimes tubercular texture. Two types of the basalt were distinguished: A type — unchanged basalt and B type — changed basalt (often presents tubercular structure). The olivine and augite are phenocrysts. Their size is smaller than 2 mm, moreover there are xenolites in the basalt. They are gneiss xenolites of the rock which are placed in the neighbourholed.

The content of the phenocrysts, established using planimetric analysis, oscillates 3.4 to 8.3%, but the olivine dominates. The content of the groundmass is always above 90% (tab. 1). The small content of the phenocrysts is advantageous for the utilization of the basalt in the rock metallurgy (Kapuściński, Pozzi 1984; Pozzi 1984). It is not much phenocrysts which guarantee narrow interval of the soften melting in the manufacturing process (Kapuściński et. all. 1980).

Moreover the presence of nepheline influence the reducing of the flux melt temperature of the basalt.

Acidic module was counted on the base of the chemical composition of the basalt. Acidic module is the relation of the acidic oxides to the alkaline oxides (tab. 2).

$$M_k = \frac{SiO_2 + Al_2O_3}{CaO + MgO + Na_2O + K_2O + FeO + Fe_2O_3 + MnO}$$

The values of this module range from 1.24 to 1.54 and are inside the section M_k = = 1.20—2.30. It the basalt presents the values of M_k typical for this section is possible to utilize this type of basalt for the production of the rock wool. The values of the basalt from Kłopotno deposit are similar to values of the basalt from Rębiszów (Łysa Góra). Moreover the presence of the nepheline will influence the reducing of the flux temperature of the basalt.

TABLE 1

Participation of the phenocrysts and groundmass of the Klopotno basalt deposit [% vol.]

TABELA 1

Udział prakryształów i ciasta skalnego w bazalcie ze złoża Kłopotno [% obj.]

Component	Number of sample									Average		
	50.4	50.5	50.6	50.7	50.8	50.9	50.1	50.2	50.3	A type	B type	whole rock
Phenocrysts	7.0	3.4	8.2	6.8	5.5	5.4	4.7	4.9	6.6	6.1	5.4	5.8
Groundmass	93.0	96.6	91.8	93.2	94.5	94.6	95.3	95.1	93.4	94.0	94.6	94.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0			
Type of basalt	A	A	A	A	A	A	B	B	B			

TABLE 2

Normative composition (% wt.) and acidic module value (M_k) of the Klopotno basalt deposit

TABELA 2

Skład normatywny oraz wartości modułu kwasowośc (M_k) bazaltu ze złoża Kłopotno [% wag.]

Normative mineral	Number of sample								
	50.4	50.5	50.6	50.7	50.8	50.9	50.1	50.2	50.3
Quartz			1.2						
Anorthite	31.1	30.2	31.4	30.0	34.8	46.9	30.5	34.1	34.9
Diopside	24.5	22.3	16.8	22.3	18.4	9.5	21.4	14.1	16.5
Hipersthene	3.1	8.4	15.7	5.7		12.4		11.6	
Albite	12.4	10.2	12.8	13.3	9.4	6.2	12.9	15.3	14.3
Ortoklase	0.9	1.9	1.5	1.1	1.5	0.8	1.1	1.2	1.2
Olivine	7.3	7.5	0.0	6.8	13.0	4.5	11.6	2.4	13.1
Nepheline							1.2		0.1
Apatite	1.1	2.1	4.0	2.9	2.2	1.9	2.9	4.4	3.9
Piryt		0.3	0.2		0.3	0.3			
Ilmenite	5.7	5.0	4.8	4.3	5.9	5.6	4.4	5.2	4.1
Magnetite	13.5	4.3	11.6	13.7	1.1	2.5	13.9	11.5	12.0
Hematite	0.2	7.8			13.4	9.4		0.1	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
M_k	1.33	1.35	1.48	1.32	1.24	1.54	1.29	1.52	1.37

For the establishing the utilization of the basalt for the petrurgy is necessary to fix the crystallization ability of the melt (Stoch, Wyszomirski 1976). On the base of the chemical composition there parameters are counted: A (elements which crystalize very easily — magnetite, ulvospinel, olivine, diopside), B (elements which crystalized with difficulty — anorthite) and C (element which crystalized with very difficulty — albite, nepheline).

On the base of the results of the chemical analysis the normative composition of the basalt was counted (tab. 2). The parameters describing the ability of the basalt for crystallization were counted using the results of the normative composition (tab. 3). The results were presented in the figure 3. On the base of the ability for the crystallization it can be said that the basalt from the Kłopotno deposit can be used for petrurgy only in the limited scale because the projection points of the investigated sample are situated in the area for the bests raw materials. The similar position presents the basalt from Rębiszów (Łysa Góra).

TABLE 3

Crystallize ability parameters of the basalt samples from Kłopotno deposit

TABELA 3

Parametry zdolności krystalizacyjnych badanych próbek

Number of sample	Parameter [% wt.]		
	A	B	C
50.4	53	34	13
50.5	55	33	11
50.6	50	36	14
50.7	53	33	14
50.8	51	39	10
50.9	42	51	7
50.1	51	33	15
50.2	45	38	17
50.3	46	38	16

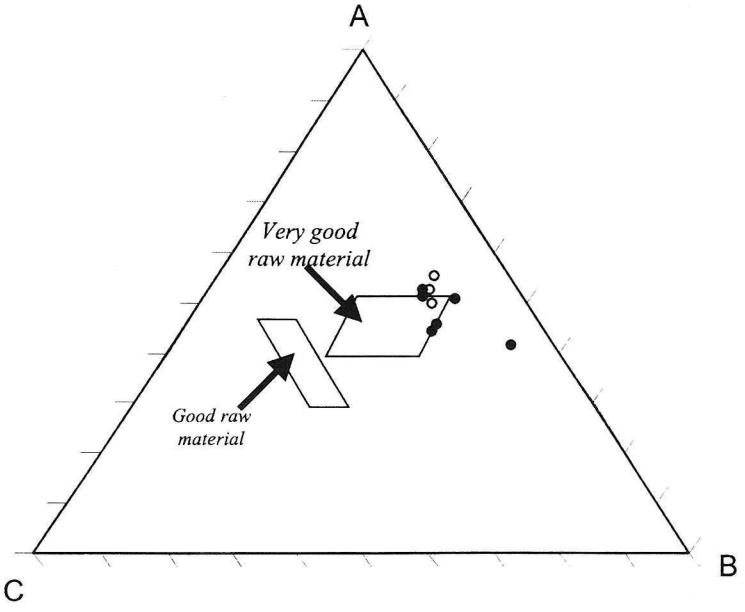

Fig. 3. Diagram indicating crystallize ability of the basalt samples (parameters A, B and C)
● — fresh basalt (A type), o — alteration basalt (B type)

Rys. 3. Diagram składników A, B i C wskazujących na zdolności krystalizacyjne badanych próbek bazaltów
● — bazalt świeży (typ A), o — bazalt przeobrażony (typ B)

Viscosity is also very important parameter. It indicate the possibility of the utilization of the basalt for the production of the rock wool. The viscosity was counted (tab. 4) on the base of average chemical analysis (average of the 9 samples, Adamczyk, Derewecki 2004 — in the press) which was done by Bottinga-Weill method (Bottinga, Weill 1972). The optimum defibering which goes during the production of the rock wool is observed when the viscosity of the melt in the temperature 1250°C has the value to 10 Pa·s (Żołnierczyk 1981). The viscosity of the basalt from the Kłopotno deposit present the value 2.15 Pa·s. It is connected with the relation of the oxides: SiO_2, Al_2O_3, MgO and CaO. It indicate the possibility of the utilization of the basalt from the Kłopotno deposit for the production of the rock wool and defibering can go in the temperature even below 1200°C.

The value of compression strenght in the condition of the air-dry R_c are different and range from 285 to 378 MPa (tab. 5). These values indicate the very large compression strenght of the investigate basalt (PN-84/B-01080-above 200 MPa).

The R_c values of the basalt from Kłopotno deposit show that it is a proper material for the production of the the crushed stone aggregate for highway engineering and railway engineering, concrete aggregate, aggregate for rock dust and filling material (PN-84/B-01080).

TABLE 4

Average chemical composition of the Kłopotno basalt deposit (% wt.) and viscosity counted Bettinga-Weill (1972) method

TABELA 4

Średni skład chemiczny bazaltu ze złoża Kłopotno (% wag.) oraz lepkość obliczona metodą Bettinga-Weilla (1972)

Chemical component	Bazalt from Kłopotno deposit	Viscosity	
		temp. [°C]	[Pa·s]
SiO_2	39.69	1 000	3.40
TiO_2	2.57	1 050	3.15
Al_2O_3	14.59	1 100	2.90
Fe_2O_3	9.64	1 150	2.65
FeO	5.95	1 200	2.40
MnO	—	1 250	2.15
MgO	9.38	1 300	1.90
CaO	12.82	1 350	1.65
Na_2O	1.40	1 400	1.40
K_2O	0.21	1 450	1.16
P_2O_5	1.19	1 500	0.91
S	0.36		
H_2O^-	0.06		
LOI	1.96		

TABLE 5

Compression strenght values R_c [MPa] and absorbability [%] of the Kłopotno basalt deposit

TABELA 5

Wartości wytrzymałości na ściskanie R_c [MPa] i nasiąkliwości [%] próbek bazaltu ze złoża Kłopotno

	Number of sample									Average		
	50.4	50.5	50.6	50.7	50.8	50.9	50.1	50.2	50.3	A type	B type	whole rock
R_c	289	378	365	310	285	322	284	296	328	325	303	317
Absorbability	0.30	0.30	0.10	0.50	0.45	0.55	0.20	0.10	0.25	0.37	0.18	0.31

TABLE 6

Average values of the compression strenght values (R_c) and absorbability of the basalt from Kłopotno and Rębiszów (Łysa Góra) deposits

TABELA 6

Średnie wartości wytrzymałości na ściskanie R_c i nasiakliwości bazaltu ze złóż Kłopotno i Rębiszów

	Kłopotno deposit	Rębiszów deposit
R_c [MPa]	317	290
Absorbability [%]	0.31	0.13

The investigated basalt is material of the I class (the value of R_c is not smaller than 160 MPa). It can be used for the production of broken aggregate used as powder to build and keep up track structure (PN-B-11114).

The basalt from Kłopotno deposit is also a proper material for the production of concrete aggregate (PN-84/B-04101). The values of the compression strenght in the air-dry state confirm this theory. The typical value for the magmatic rocks is 150 MPa for the aggregate of the type 50. All investigated samples are the material of this type.

The absorbability of the basalt from the Kłopotno deposit shows (tab. 5) that it is the rock very small absorbance.

The results of the observations of the rocks during 25 cycles of the refrigeration indicated the lack of the changes in the color of the rocks and cracks and damages in the rocks. According to the fact it can be said that the investigated basalt characterized a very good frost-resistance.

The technological parameters of the basalt from the Kłopotno deposit are almost the same (tab. 6) as the parameters of the basalt from Rębiszów (Łysa Góra).

Conclusion

The low value of the acidic module, small amount of the phenocrysts (below 10%) and fine grain groundmass show that the basalt from Kłopotno deposit is a proper material for the production of the rock wool.

The parameters which describe the ability of the melt for crystallization indicate that the investigated basalt can be a proper material for the petrurgy but in the limited range (production of the basaltic rock casting).

The value of viscosity 2.15 Pa·s which was counted for the temperature 1250°C show that the basalt from Kłopotno deposit can be used for the production of the rock wool.

The basalt from the Kłopotno deposit can also be used for the production of the the crushed stone aggregate for highway engineering and railway engineering, concrete aggregate, aggregate for rock dust and filling material because of the very high compression strenght, very good frost-resistance and very small absorbance.

The chemical character of the basalt and some technological properties show that the basalt from the Kłopotno deposit is similar to the basalt from Rębiszów (Łysa Góra).

REFERENCES

Adamczyk Z., 1998 — Wstępna ocena przydatności bazaltu z Rębiszowa jako surowca do wielokierunkowego użytkowania. Gosp. Sur. Mineral., Wyd. IGSMiE PAN Kraków, s. 177—184.

Adamczyk Z., 2003 — Zeolites in Tertiary basaltoids from Rębiszów (Lower Silesia, SW Poland). Arch. Min. t. LIV , 23—32.

Adamczyk Z. 2004 — Charakterystyka petrograficzna trzeciorzędowego bazaltu ze złoża Kłopotno (Dolny Śląsk). Górnictwo Odkrywkowe, in press.

Bottinga Y., Weill D.F., 1972 — The wiscosity of magnetoc silicate lignids a model for calculation. Am. J. Sci 272, p.438—475.

Dokumentacja geologiczna złoża bazaltu „Kłopotno" w kategorii C1 z określeniem jakości kopaliny w kategorii B. Przedsiębiorstwo Geologiczne we Wrocławiu. Wrocław XII 1974.

Dokumentacja geologiczna złoża bazaltu „Kłopotno" w kategorii C1. Dodatek nr 1. Wrocław, II 2000.

Kapuściński T., Pozzi M., 1980 — Wpływ budowy petrograficznej bazaltów na ich własności technologiczne w procesie włókien mineralnych. Szkło i Ceramika, s.76—79.

Kapuściński T., Pozzi M., 1984 — Dobór surowców mineralnych i odpadowych do produkcji wełny mineralnej. Mater.Budowl. nr 9, s. 18—20.

Kapuściński T., Pozzi M., 1985 — Utilization of Silesia basalts and waste metallurgical slaga for mineral wool production. Gospodarka Surowcami Mineralnymi, t. I, z. 3—4, s. 466—485.

Żołnierczyk W., 1981 — Analiza przydatności skał bazaltowych do produkcji wełny mineralnej. Materiały Budowlane. Biuletyn Informacyjny o Budownictwie, cz.A, nr 7—8, s. 6—9.

PN-84/B-01080. Kamień dla budownictwa i drogownictwa. Podział i zastosowanie wg własności fizyczno-mechanicznych.

PN-84/B-04110. Materiały kamienne. Oznaczanie wytrzymałości na ściskanie.

PN-85/B-04101. Materiały kamienne. Oznaczanie nasiąkliwości wodą.

PN-85/B-04102. Materiały kamienne. Oznaczanie mrozoodporności metodą bezpośrednią.

PN-86/B-06712. Kruszywa mineralne do betonu.

PN-B-11114. Kruszywa mineralne. Kruszywa łamane do nawierzchni kolejowych.

ZDZISŁAW ADAMCZYK, MARCIN DEREWECKI

WSTĘPNA OCENA PRZYDATNOŚCI BAZALTU ZE ZŁOŻA KŁOPOTNO JAKO SUROWCA DO WIELOKIERUNKOWEGO UŻYTKOWANIA

Słowa kluczowe

Bazalt, surowiec mineralny, użytkowanie

Streszczenie

Na podstawie przeprowadzonych badań stwierdzono przydatność bazaltu ze złoża Kłopotno do produkcji wełny mineralnej (niska wartość modułu kwasowości, niewielka zawartość prakryształów — do 10% obj., drobnokrystaliczne ciasto skalne, lepkość).

Obliczone wartości parametrów określających zdolność krystalizacyjną stopu wskazują, że bazalt ten nie stanowi dobrego surowca do produkcji leizny skalnej.

Bazalt ze złoża Kłopotno można zastosować jako surowiec do produkcji elementów drogowych i kolejowych, kruszyw kolejowych i drogowych, kruszyw do betonów oraz mączek i wypełniaczy, z uwagi na bardzo wysoką wytrzymałość na ściskanie, bardzo dobrą odporność na zamrażanie i bardzo małą nasiąkliwość.