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A STUDY OF PHYSICO – CHEMICAL PROPERTIES OF THE NEPHELINE BASANITE FROM DEPOSIT HUSINÁ

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ABSTRACT: *The submitted article deals with experimental study of chemical and physico-chemical properties of the nepheline basanite from deposit Husina. The aim of presented work was to study his chemical and mineral composition and melting temperature. The melting temperature measuring was realized using Marsh furnace and high-temperature microscope. On the base of these basanite properties is possible to appreciate his further industrial utilization.*
KEYWORDS: *nepheline basanite, chemical and mineral composition, melting temperature, thermal analyses*

INTRODUCTION

As approximately 250 stone quarries (in mining, occasionally mining, as a abandoned) mostly based on andesites (presenting the most often exploited rock) are located in Slovakia, vulcanic rock represent one of the most important raw materials needed to produce various forms of the building stone. Andesites and basalt rocks are centrobaric raw materials used for manufacturing of offhand worked stonecutter's products and hammer-milled gravel aggregate.

To its resistance of constant load, resistance of salts and chemical defreezing resources, it is used for roads, paths, squares and other vulnerable places [5]. Basalts in Slovakia have been also mined for petrurgic purposes (fusing basalt). Other opportunities of basalts industrial utilization mostly depend on the knowledge of chemical and physico – chemical properties.

PETROGRAPHIC CHARACTERISTIC AND UTILIZATION OF NEPHELINE BASANITE FROM DEPOSIT HUSINÁ

Basalts in Slovakia exist in neogene vulcanites mostly in south Slovakia in the surrounding of the Fiľakovo and the Cerová vrchovina Mts. (Figure 1). Deposit Husiná is situated in cadastral territory of village Husiná (region Rimavská Sobota) and Nové Hopny (region Lučenec) (Figure 2). Stone quarry belongs to the deposits of the Pliocene – Pleistocene basalt formation, situated in the Cerová vrchovina Mts., which form the thick flows of olivine basalts either or nepheline basanites with mean thickness of 20 m. This deposit (together with deposit Bulhary and Konrádovce) has been registered as Slovak republic deposit of fusing basalt since 1998 [1]. Basalt in surface quarry Husiná is used in building industry as a building stone (Figure 3). Nowadays, a production of basalt in deposit Husiná is 100 000 ton per year and still growing therefore the increase of mining up to 450 000 – 500 000 ton per year is expected.

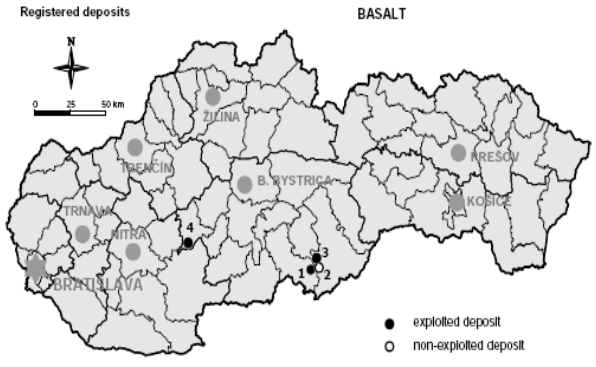


Figure 1. Registered deposit of basalts in Slovakia (Source of data: according to reference [1])

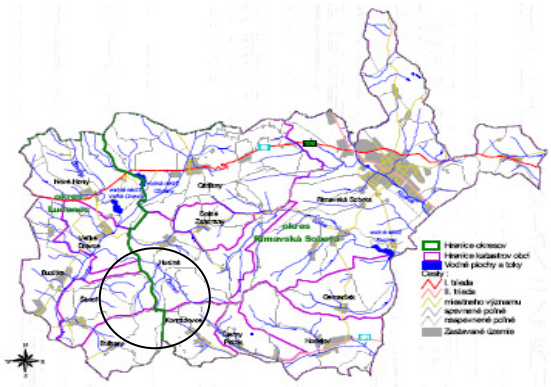


Figure 2. Location of deposit Husiná (Source of data: according to reference [4])

Products of mining raw material are utilized as a crushed stone in concreting plant, asphalt mixing plant, for highway and engineering structure, but also as an aggregate for track lodge and

regulation of water course. Moreover, some of them are also used to manufacturing of set and curb. Using cast stocks of fusing basalt, manufacture tubes, elbows, channels, floor tiles, fittings, special cast stocks characterized by high resistance to abrasion, abrasion and action of the acids are produced [3].

Figure 3. Deposit of nepheline basanite in Husiná locality (Source of data: according to reference [4])

MACROSCOPIC CHARACTERISTIC AND MICROANALYSIS OF NEPHELINE BASANITE FROM DEPOSIT HUSINÁ

Basanite, an igneous rock, is compact, fine grained, but not quite equally grainy. The colour is alternately stone and charcoal grey. Fracture plains of rock are generally equal and have ragged surface and the segmentation of surface area is small. The shape of the fragments bested in basanites is platy or irregular and the edges are sharp. The mechanical solidness is one of the important physico-chemical properties and is in remembered rock high. From mineralogical point of view majority elements of nepheline basanite are pyroxene (diopside augite), plagioclases, andesine – labradorite. Minority group of minerals create olivin, magnetite and nepheline. In a few isolated cases come through of this rock also other minerals, e.g. iddingsite, calcite and xenolith of silica. Sequantitative occurrence of minerals in nepheline basanite samples from deposit Husina is illustrated in the Table 1.

Table 1. Percentage of minerals in nepheline basanite samples from deposit Husiná

Mineral name	Sequantitative occurrence of minerals [%]
Pyroxene (augitdiopside-augit	37
Plagioclase (labradorite)	35
Nepheline	6
Olivine + iddingsin	6
Magnetite	6
Others minerals	10

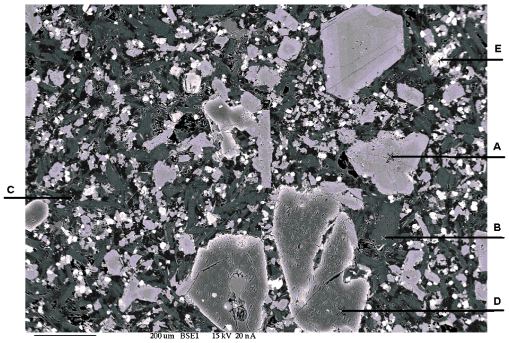


Figure 4. Presence of minerals in the sample of nepheline basanite from deposit Husiná

The nepheline basanite samples from deposit Husiná were submitted to WDS and EDS analyses. Wave analysis of variance was done with CAMECA SX 100 equipment. An quantitative data evaluation of chemical composition of individual points was confirmed with installed software. In A – point pyroxene presence, in B – point presence of plagioclase, in C – point nepheline presence, in D – point presence of olivine and in E – point presence of magnetite (Figure 4). EDS analyze was done with high – resolution scanning electron microscope JEOL JSM-7000F with auto – emission jet and micro-analytical element INCA Energy 250 Microanalysis System (EDS) and HKL Chanel 5 (EBSD) Oxford Instruments company. The results of EDS analyze are displayed in Figures 5 and 6.

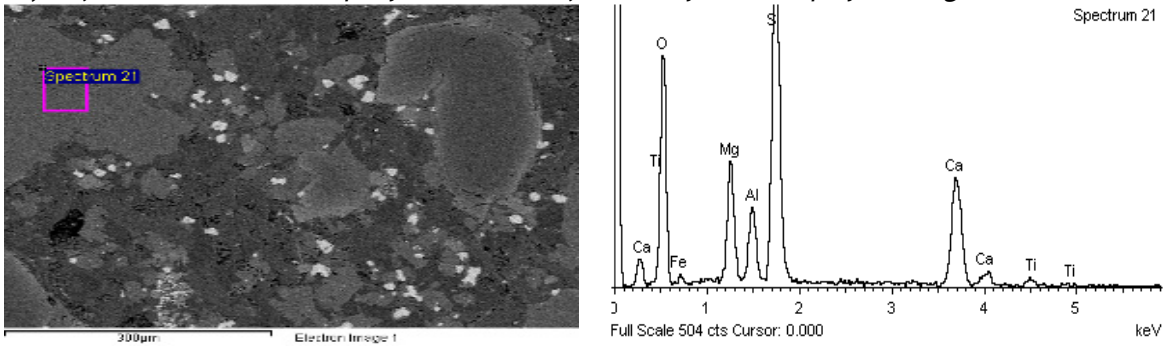


Figure 5. EDS analyze of element spectrum in marked point

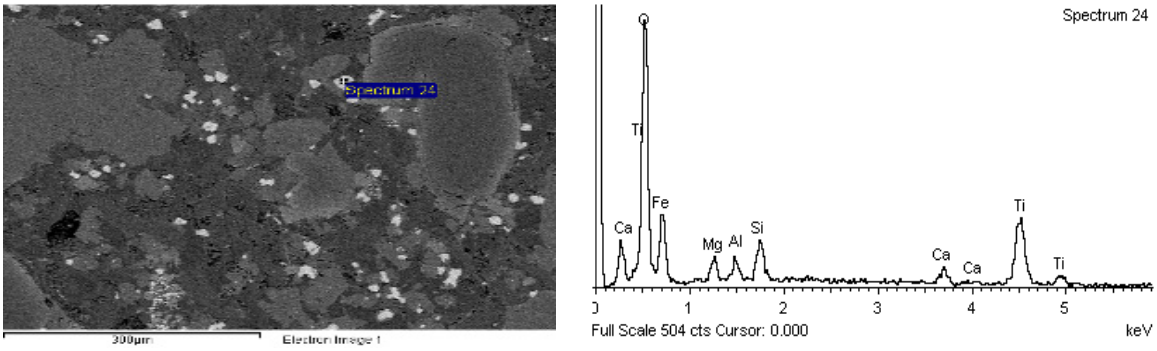


Figure 6. EDS analyze of element spectrum in other marked point

The results of EDS analysis confirmed presence of elements and in that way correctness of assigned minerals on the base of WDS analyze. From microscope point of view it confirmed, that is concerned fine grained rock, unevenly granulated, which has holocrystalline till hemicrystalline porphyric structure. In rock was observed nodulation of olivine with maximum size 1,6 mm, which predominated over nodulation of pyroxene (they were choppy with maximum size 0,8 mm). Few glass was occurred in the basic substance. The size of magnetic crystals was 0,006 – 0,021 mm. Nepheline pokilities had size 0,6 mm and others minerals of substance ground were in size 0,1 – 0,09 mm.

METODOLOGY & RESULTS - CHEMICAL COMPOSITION & MELTING TEMPERATURE OF NEPHELINE BASANITE FROM HUSINÁ

On the base of chemical composition analysis we can observe, that majority components of nepheline basanite from deposit Husiná are SiO_2, Al_2O_3, MgO a CaO. Chemical composition is illustrated in percentage by weight in Table 2.

From analysis results, that this rock is silicate compound with basicity 0,31, it is an acid material.

Table 2. Chemical composition of nepheline basanite from deposit Husiná

Title of locality	Chemical composition in percentage by weight [%]					
Husiná	SiO_2	Al_2O_3	CaO	MgO	Fe_2O_3	FeO
	45,36	16,09	9,84	9,37	3,41	5,32
	MnO	TiO_2	K_2O	Na_2O	P_2O_5	S
	0,16	2,10	2,05	3,68	0,43	0,11

Knowledge of physico – chemical properties of molten polycomponent oxidic systems is very important for their following utilization [2, 6]. The melting temperature is important physical parameter characteristic of the vulcanic rocks. By the experimental measuring it is necessary complex observation of sample conduct. Melting temperature has to be equal to temperature, when the sample is totally melting [6]. Basalt sample melting and melting temperature measuring was realized using March furnace. Sample was placed into ceramic sample boat on the base of Al_2O_3. Melting process of sample is visible on the cross-section, in one-centimeter intervals from left to right. Temperature gradient is graphic illustrated in Figure 7.

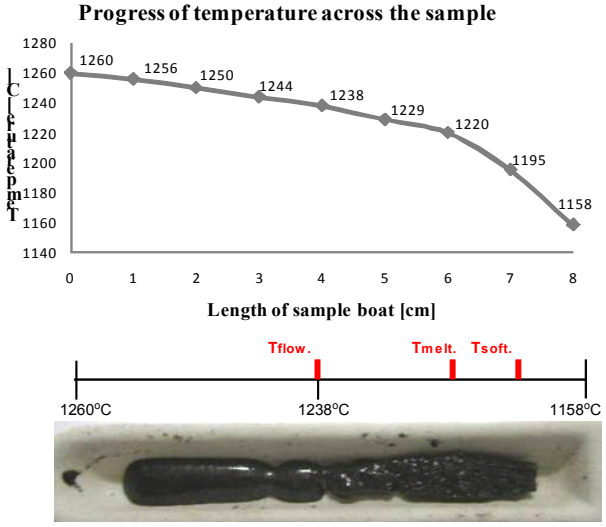
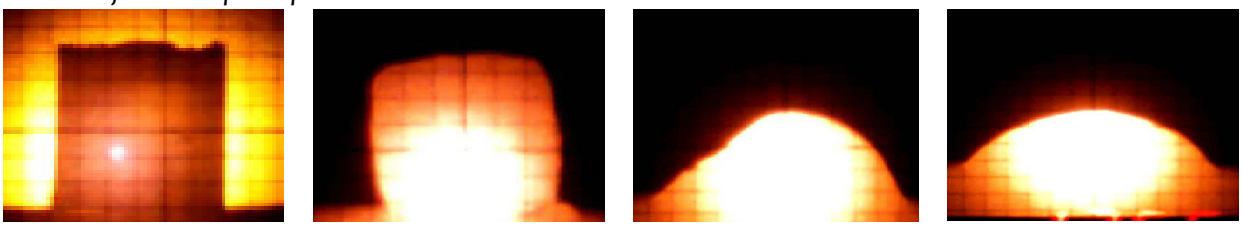


Figure 7. Temperature course of basalt sample using March furnace

From experimental results (Figure 7) was possible to visual identify the softening temperature, the melting temperature and the flowing temperature. An interval of softening was defined from 1195°C to 1220°C, whereby softening temperature is 1195°C. Melting temperature was determined on 1220°C and the interval of melting is estimated from 1220°C to 1238°C. Flowing temperature was considered on 1238°C and over this temperature sample was fluent. To verify the progress of temperature, the sample melting was carried out using high-temperature LEITZ Wetzlar microscopy. The results of basanite sample melting measurement are shown in Figure 8.

Obtained results show, that softening of the sample begins at temperature 1160°C (solidus temperature). Solidus temperature presents beginning of sample melting interval. Normative DIN 5173 the melting interval finishes by achievement of hemispherical shape of prior cube, in our case at

temperature 1220°C (liquidus temperature). Over this temperature the sample begins flow. Melting interval of our sample represents 60 °C.



1100 1160 1213 1220

Figure 8. Basanite sample melting course on the high-temperature microscope

The comparison of results achieved from both methods (Marsh furnace and high-temperature microscopy) for samples of nepheline basanite from deposit Husiná showed that temperature range given from microscope is higher about 35°C, whereas temperature range given from Marsh furnace was determined visually, however, it belongs to range achieved from microscopy observation.

DIFFERENTIAL THERMIC ANALYSIS OF NEPHELINE BASANITE FROM LOCALITY HUSINÁ

From melting point of view is very important to know conduct of natural material throughout his heating. In the Figure 8 is displayed derivatogram analyzing of natural material. Obtained results confirm, that in sample of nepheline basanite wasn`t beheld exothermic and endothermic thermal effect.

Table 2. Results of TG analyze from weighting (mg) sample from locality Husiná

Weight of shot before analyze [mg]	*32,10 mg*
General weighted decrease [mg]	*0,16 mg*
General weighted decrease [%]	*0,5 %*

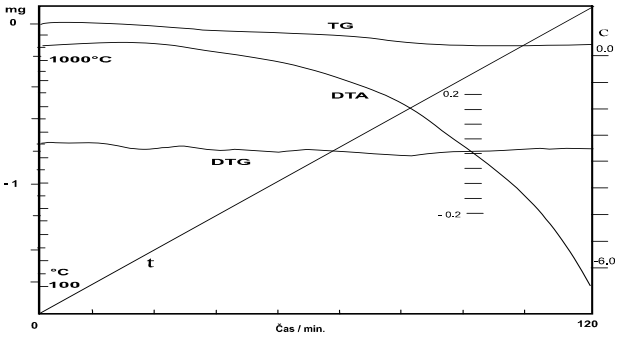


Figure 8. Derivatogram of nepheline basanite from locality Husiná

From interpretation of TG curved line results, that weight-shortage begins at 420 °C and finishes at 790°C. The annealing loss of nepheline basanite from locality Husiná was 0,5 percentage by weight (Table 2). From analysis results, that given sample doesn't contain crystalline water that could disrupt the process of melting.

CONCLUSIONS

The utilization degree of raw materials in various industrial regions mainly depends on knowledge of their properties. A nepheline basanite from locality Husiná has been predominantly used in the building industry as a building stone, nowadays. Natural thermal processes, which are connected with his natural formation, predestinate him also another industrial utilization. The results from chemical and physico-chemical analysis of basanite's properties show that this material is suitable for processing the melting's. The key melting parameter – melting temperature was verified using two different experimental ways and was established on 1220°C. Finally, it is possible to conclude that nepheline basanite from deposit Husiná has so unique properties suitable in fields as petrurgy, metallurgy, but mainly nanomaterials technology.

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