JOURNAL OF ENGINEERING annals OF FACULTY OF ENGINEERING HUNEDOARA

USEFULNESS OF MINERAL RAW MATERIALS WITH SPATHIC SUBSTANCE CONTENT IN INDUSTRY

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ABSTRACT:
Mineral raw materials are a part of the natural resources and represent the foundation of metallurgic, electrotechnical, energy, chemical, building, and glass, ceramic and other industries. Submitted article deals with properties of feldspathic raw material specialized on their prospective utilization in metallurgy.
KEYWORDS:
feldspathic raw materials, granites, tufaceous rocks, melting temperature, utilization of feldspar stocks

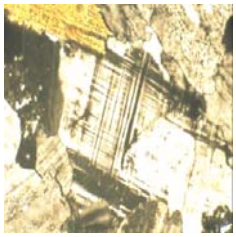
1. INTRODUCTION

Mineral raw materials are a part of the natural resources. They are non renewable and exhaustible sources, which are possible to utilize financially considering their qualities and amounts in various fields of industry [10].

Mineral raw materials are rocks or other combination of minerals and based on their formation we divide rocks to magmatic (erupted) – solidified from melted rocks (magma), sedimental (sedimented) – settled from solutions and free elements, metamorphic (transformed) – rocks changed by heat and pressure, residual (remains) – hardened non transferred effloresced rocks [3]. Feldspar stocks are rocks, the most significant and characteristic element of which are minerals from the group of feldspars or their mixture.

1.1. Characteristic of mineral raw materials with spathic substance content

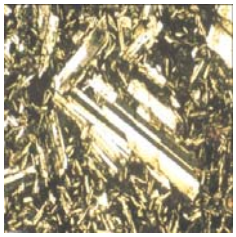
Feldspars are group of monoclinic (orthoclase minerals, sanidine minerals) and triclinic (microcline and plagioclase minerals) potassium and sodium selenite aluminosilicates and next to quartz are most widespread rock-forming minerals, which represent 60% of the Earth's crust. Potassium feldspars (orthoclase, microcline) and acid member of plagioclastic line (albite, oligoclase, andesine) have industrial meaning.



a, K-feldspar (microcline) in granite 50x

b, K-feldspar (perthitictic) in granite 25x

c, Na-Ca feldspar in andesite 50x



d, Na-Ca feldspar in basalt 25x

Figure 1. Minerals of magmatic rocks **a,** K-felspar, **b**, (perthitictic) K-feldspar, **c,** Na-Ca feldspar in andesite, **d,** Na-Ca feldspar in basalt (Source of data: according to reference [13])

As a feldspar stocks prove competent venous rocks (pegmatite, aplite), eruptive rocks (granites) and deposits (feldspathic sands and gravel sands) [8]. Feldspar has a high content of alkali. These warmed on high temperature (1400°C) melt quartz and kaoline [3]. Feldspars are an individual group of tectosilicates, which have a crucial importance from the viewpoint of the composition of rocks of the Earth crust.

The standard characteristics of feldspars are the tabular crystals, see (010), limited pinacoids, or prismates. The arrangement of feldspars is tabular with a notable cleavage. Their color is usually light. The shine of feldspars is glassy, hardness is 6, density varies based on their composition from 2,6 do 2,9 g/cm^3. All feldspars have a perfect fissility based on (001) and a very good one based on (010) [6,8,9].

Based on the norm STN 72 1370 [10] feldspars are characterized based on:

- mineralogical and chemical composition, which are expressed by a classifying sign,
- granularity.

Based on the amounts of oxides and their ratio it is possible to divide feldspars to groups mentioned on table 1.

Table 1. Classification of feldspars based on the amounts of oxides and their ratio (Source of data: according to reference [10])

Feldspar	Marking	K_2O: (K_2O+Na_2O)	CaO: (Cao+Na_2O-K_2O)
potassium	K	above 0,75 till 1,00	–––––––––
potassic-sodium	KNa	above 0,60 till 0,75	
sodium-potassium	NaK	above 0,40 till 0,60	
sodium	Na	above 0,00 till 0,40	
Sodium-calcium	NaCa	–––––––	above 0,16 till 0,63
calcific-sodium	CaNa		above 0,63 till 1,00

1.2. Mineral resources of feldspars in Slovak republic area

One of the most important raw material sources of feldspars in Slovakia is the stocks around Rudník Mountains, north east from the village of Rudnik on the edge of the body of Poproč granites. It is a plane of intensely albitized granites with mineral composition: flint, albit, potassium and muscovite. The average amount of feldspars is 42%.

The next deposit Brehov is west from the village and is made of hydro thermally modified ryodacite tufa in the upper part of the Ryodacite body. By the process of adularisation of the main body the potassium feldspars accumulated – Adulares. The mineral composition of the raw material stock: flint, potassium, illite and kaolinite. The feldspars substance contents is from 44,4 to 76,7 % [13].

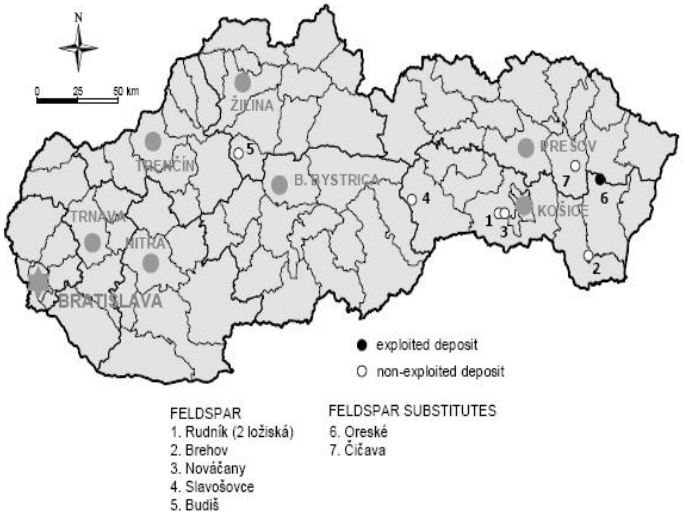


Figure 2. Registered deposits of feldspars and substitutes in SR (Source of data: according to reference [13])

At the present the mined deposit of the added ceramic raw stock (feldspar substitute) is the Oreske deposit. The deposit of ryolite tufite Oreské is situated in Košice region and is placed about 1,5 km southeasterly from village Oreské. It is situated at the foot of a mountain morphologically expressive mountain system of Vihorlat Mountains [9]. Oreske deposit is situated in group of strata neogen deposits, which are included in baden era [12]. The deposit consist of 30 m thick position of fine grained ryolite pumice tufas and tufytes of the baden era with 3-4 % of crystal clasts contents (plagioclas, flint, titanium magnetite and biotite).

Other stock of feldspar raw materials is the Cicava deposit that represents a unique raw material that does not belong to tufas and is marked as a transformed ryodacit. This deposit consists of a dike of ryodacites. Considering the small amounts they have a non balanced supply. In the perm veporica there is a well known deposit of Slavosovce created from adularized metaarcoses. The minerals composition is: albite, illite, local kaolinite. The total amount of feldspars substances is about 7 % (Na, K). As seen on the Picture number 3, there are feldspars deposits as well as of their substitutes that are registered in Slovakia [13].

1.3. Utilization of feldspar stocks

Usefulness of feldspathic rocks is governed by predominant kind of feldspathic minerals, chemism, degree of decomposition, feldspathic ratio in the rock and by others factors.

Feldspars play an important role as fluxing agents in ceramics and glass applications, and also are used as functional fillers in the paint, plastic, rubber and adhesive industries. Their utilization introduces 90 % from total quantity. In remembered manufacturing industries are used as a aluminium source by glass-making, as a addition in ceramic mixtures, glazes and enamels [13,2].

The main exploitation of feldspars in ceramic industry is in the course of stoneware production (5 till 20 % feldspar in mass) and at more quantity in the course of solid porcelain (around 25 % in mass), utility ceramics, sanitary ceramics (20 till 40 % feldspar in mass) [7].

2. METHODOLOGY AND RESULTS

In experimental part the mineral raw materials with spathic substance content were used. There were samples of granites from locality Rudník and ryolite tufites from locality Oreské. In tables no. 2 and 3 is mentioned the chemical composition of examined feldspar stocks.

Table 2. Chemical composition of granite from locality Rudník (in mass %)

Al_2O_3	Fe_2O_3	TiO_2	SiO_2	CaO	MgO	Na_2O	K_2O
12,65	1,21	0,39	76,41	0,21	0,24	3,21	4,74

Table 3. Chemical composition of ryolite tufites from locality Oreské (in mass %)

SiO_2	CaO	MgO	Al_2O_3	Fe_2O_3	Na_2O	K_2O	TiO_2	MnO
70,32	1,67	0,21	15,30	1,48	1,82	3,31	0,19	0,1

Based on the chemical composition the melting temperature was measured. Melting temperature is important parameter in metallurgical processes. It represents changing of metal and alloys or any kind of substances from solid form to fluid state.

Melting process was monitored on three samples of granites (fig. 3 – 5) in thermal interval 900 °C till 1350 °C. Melting-down of samples was realized in Marsh furnace.

Figure 3. Sample melted at 900°C

Figure 4. Sample melted at 1200°C

Figure 5. Sample melted at 1350°C

Temperature course of spot samples is visible in one centimeter interval along cross-section from left to right. Melting-down of samples is more markedly under authority of higher temperatures in 2nd and 3rd sample.

Melting process on five samples of ryolite tufites (fig. 6 - 10) was monitored in thermal interval 800°C až 1230°C.

Figure 6. Sample melted at 800°C

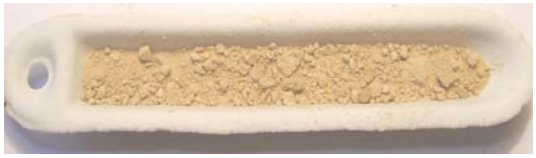


Figure 7. Sample melted at 900°C

Figure 8. Sample melted at 1000°C

Figure 9. Sample melted at 1100°C

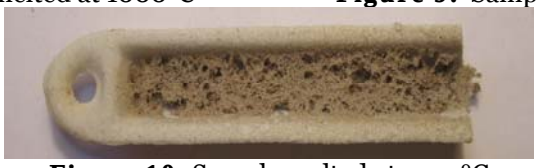


Figure 10. Sample melted at 1230°C

In this case melting process is most evident by last the fifth sample at temperature 1230 °C. At this temperature the sample was porously molten.

3. THE CONCLUSIONS

Feldspars represent raw material resources play. In glass and ceramic their utilization introduces 90 % from total quantity. Comparing temperatures of granites and ryolite tufites was determined, that granites with given chemical composition melt during higher temperatures. Measured temperatures were achieved by reason of higher content of Al_2O_3, SiO_2 and alkali (Na_2O a K_2O). Both samples melted above 1100 °C, when that ceramic mass bakes above 1100 °C in ceramic industry. Based on the results both samples contributed for bigger compactness and bulk density of flinders. Based on the chemical composition and attained melting temperatures it is possible to suppose, that examined feldspars stocks are suitable for prospective utilization in metallurgy. In thermal interval 900 °C till 1300 °C there is a change of e.g. melting-down and melting of cover powders in continuous casting process.

Acknowledgements
This work was financially supported by Scientific Grant Agency of the Ministry of Education of Slovak republic (the grant VEGA No. 1/0764/08) and Slovak Academy of Sciences.

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