

Czesław AUGUST¹

POST-MAGMATIC CLAY MINERALS AND ZEOLITES IN ALKALI BASALTS FROM LOWER SILESIA, SW POLAND

INTRODUCTION

Alkali basalts and related rocks in Lower Silesia (SW Poland) represent the eastern part of the Central European Cainozoic Volcanic Province. These rocks occur as lava flows, more rarely as veins and volcanic necks. Nephelinites, basanites, tephrites and olivine basalts are most widespread. Post-magmatic, hydrothermal clay, zeolite and carbonate mineralisation is common and not preferably related to any of these petrographic types. The hydrothermal mineral associations crystallised in miaroles and other irregular cavities. Though generally no regular pattern of spatial distribution of the mineralised zones is found, a higher concentration of miaroles near the top of brecciated lava flows is observed (August, Awdankiewicz 1993). Clay and zeolite mineralisation is rare in the necks where the miaroles are mainly filled with calcite, aragonite and dolomite.

METHODS

Samples were collected in almost all quarries (c. 35) of the Cainozoic volcanic rocks in Lower Silesia. Representative samples were studied using the optical microscope, scanning electron microscope (Tesla BS-300), X-ray diffraction (SIEMENS 5005), thermal analysis (Derivatograph 1500Q) and electron microprobe (Cambridge Microscan 9, WDS method).

CLAY MINERALS AND ZEOLITES

Clay minerals are represented only by smectites which occur in two generations in the miaroles: 1) trioctahedral saponite found on the surface of the miaroles and forming the base for zeolites, and 2) dioctahedral Mg,Fe-montmorillonite (Tab. 1) formed after the zeolites. The third smectite generation is a light beige to pink mineral, filling cavities and fissures in volcanic breccias. According to Japa et al. (1986), it is a poorly crystalline dioctahedral Fe-smectite. Kościówko et al. (1986) described only two (the first and the third) of these clay mineral generations.

Two zeolites, natrolite and phillipsite, are most common in the miaroles. They occur in parageneses with scolecite, thomsonite, chabasite, offretite, and anal-

¹ Institute of Geological Sciences, Wrocław University, ul. Cybulskiego 30, 50-205 Wrocław, Poland, e-mail: august@ing.uni.wroc.pl

cime; the number of mineral species inside one miarole is limited to 2-3 (August, Przylibski 1994). Analcime is also found in basalts and breccias as a rock-forming mineral (August, Kierakowicz 1995).

Tab.1. Chemical composition of hydrothermal smectites in basaltoids from Lower Silesia.

Component	Trioctahedral smectite				Diocetahedral smectite			
SiO ₂	44,41	56,89	50,34	47,62	51,34	50,97	47,84	45,39
Al ₂ O ₃	19,41	18,02	8,53	6,43	28,84	19,40	24,76	23,50
Fe tot.	2,17	3,42	5,58	6,34	2,18	5,84	9,53	10,35
MgO	21,43	10,90	22,10	21,78	3,78	5,78	6,27	5,23
CaO	1,48	1,76	1,84	1,99	1,69	2,55	2,22	2,34
K ₂ O	0,07	0,66	0,15	0,23	0,43	0,65	0,69	0,48
Na ₂ O	0,03	0,01	0,12	0,12	0,49	0,59	0,93	0,99
TiO ₂	-	-	0,09	0,02	0,02	0,02	0,13	0,20
MnO	0,22	0,02	0,06	0,02	0,02	0,05	0,17	0,14
Total (without H ₂ O & OH)	89,22	91,68	89,61	84,55	88,79	85,85	92,54	88,62

Tab.2. Chemical composition of zeolites in alkali basalts from Lower Silesia.

Zeolite	Chemical formula	Localities
natrolite	Na _{15,7} K _{0,01} (Al _{15,9} Si _{24,03} O ₈₀)nH ₂ O (sample from Gracze)	Ligota Tuł., Gracze, Kowalskie, Targowica, Wilcza G., Żółkiewka, Jałowic, Księginki, Rębiszów
phillipsite	K _{1,9} Ca _{2,4} (Al _{3,93} Si _{10,3} O ₃₂)nH ₂ O (from Księginki quarry)	Gracze, Targowica, Kowalskie, Wilcza Góra, Lubień, Łysanka, Winna G., Bukowa G., Zaręba, Sulików, Jałowic, Rębiszów
chabasite	Ca _{1,46} Na _{0,08} K _{0,5} (Al _{3,8} Si _{8,2} O ₂₄)nH ₂ O (from Żółkiewka quarry)	Kowalskie, Targowica, Żółkiewka, Wilcza Góra, Księginki, Zaręba, Sulików, Leśna, Uniegoszcz
offretite	K _{0,8} Ca _{1,0} Mg _{1,0} (Al _{5,1} Si _{12,9} O ₃₆)nH ₂ O	Sulików
thomsonite	Na _{10,8} Ca _{3,42} (Al _{17,2} Si _{22,2} O ₈₀)nH ₂ O	Gracze
analcime	Na _{15,9} (Al _{15,9} Si ₃₂ O ₉₆)nH ₂ O	Sulików
scolecite	no chemical data	Rębiszów

Parageneses dominated by natrolite occur mainly in nephelinites whereas those with phillipsite are characteristic of basanites and basalts. The zeolites mentioned represent various structural groups, but their chemical varieties are limited to Ca-K-Na and, occasionally, Mg-Ca-K members of the zeolite group (Tab. 2).

CONCLUSIONS

The distribution and structures of the post-magmatic mineral associations in the miaroles indicate that these minerals formed due to various hydrothermal processes. Saponite, Mg,Fe-montmorillonite and zeolites crystallised from aqueous solutions enriched in Mg, Fe, Ca, Na, and K originated from magma degas-

sing during the final stage of lava cooling. The smectite found in volcanic breccias formed in a different process, probably linked with the decomposition of sideromelane by low-temperature hydrothermal solutions rich in Si, Fe and Al, with minor Ca and K, partly of meteoric origin, penetrating the breccias.

The identified zeolites represent various structural types which indicate various thermal conditions of crystallisation. However, they display rather uniform chemical compositions – most of them belong to the Ca-K-Na, low-silica varieties, with rare Mg-members of the zeolite group.

The observed crystallization sequence of the smectites and various zeolite species reflects changing temperature and composition of hydrothermal fluids in the miaroles. The smectites and zeolites stability diagrams (e.g. Kawano, Tomita 1997) show that Mg,Ca members of the mineral association crystallise at relatively high pH, high Si/Al and Na/K ratios, and high temperatures whereas at lower values of these parameters (but still relatively high Na/K ratio), crystallisation of thomsonite and natrolite is stimulated in hydrothermal solutions.

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