

Wiesław HEFLIK *, Anna KRZYCZKOWSKA *

PALYGORSKITE OF ALWERNIA—REGULICE

UKD 549.623.3Palygorskit:552.323.5(438.312 Alwernia—Regulice)

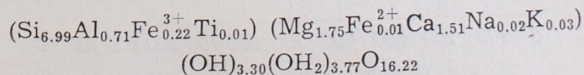
Abstract. Palygorskite from the melaphyre quarry at Alwernia—Regulice near Cracow has been analysed microscopically, chemically as well as by DTA, X-ray and IR methods. Genetically, the palygorskite from Alwernia—Regulice is closely associated with the paragenesis of heulandite, saponite and others. It originated as a result of overlapping of hydrothermal and supergene processes.

In the melaphyre quarry at Alwernia—Regulice near Cracow, the authors have found concentration of palygorskite (Phot. 1) that fills the rock fissures. It is accompanied by idiomorphic quartz (Phot. 2) and, subordinatedly, by calcite, siderite and iron hydroxides. Moreover, ferrous-magnesium chlorites and minerals from the montmorillonite group (saponite) have been noted.

Palygorskite from Alwernia—Regulice is pink-rusty-yellow in colour. It forms elongated fibres whose concentrations resemble thin crumpled chamois-leather. The area of each fragment of this "leather" varies from 100 to 300 cm².

When viewed under the microscope (Phot. 3) at one nicol, the palygorskite shows rusty-brown tinge and weak pleochroism in the range of rusty-brown colour. It has a slightly positive relief. As appears from conoscopic observations, it is biaxial ($2V$ about 25°) $n_\gamma = 1.558$, $n_\gamma - n_\alpha = 0.019$.

Upon separation from quartz and other impurities, the palygorskite from Alwernia—Regulice was subjected to chemical analysis (Table 1), which served as a basis for calculating its structural formula:



* Academy of Mining and Metallurgy, Institute of Geology and Mineral Deposits, Cracow (Kraków), al. Mickiewicza 30.

Table 1

Chemical analysis of palygorskite from Alwernia—Regulice near Kraków

Component	Content weight %	Element	Atomic ratio on the basis of 20 O
SiO ₂	52.91	Si	6.988
TiO ₂	0.09	Ti	0.003
Fe ₂ O ₃	4.37	Fe ³⁺	0.217
FeO	0.04	Fe ²⁺	0.004
Al ₂ O ₃	9.17	Al ³⁺	0.713
Na ₂ O	0.11	Na	0.014
K ₂ O	0.40	K	0.033
H ₂ O ⁺	7.50	OH	3.304
H ₂ O ⁻	8.57		
CaO	8.32	Ca	1.513
MgO	8.92	Mg	1.755
Total	100.40		

Compared with palygorskite occurring in other place in the world (Dric, Aleksandrowa 1966), that from Alwernia—Regulice has a relatively high content of CaO and —H₂O and lower content of Al₂O₃.

Figure 1 presents the DTA curve of the investigated mineral and those of palygorskites taken from the literature (Ivanova 1961, Stoch 1974). On the curves in question the following peaks are visible: endothermic at 110—180°, 280—300°, 500°, 660°, 720—850° and exothermic at 340°, 780—880°. Palygorskite contains a substantial amount of water, which is differently bound and removed at different temperatures. It is successively: zeolitic, crystallization and constitution (OH groups) water. The presence

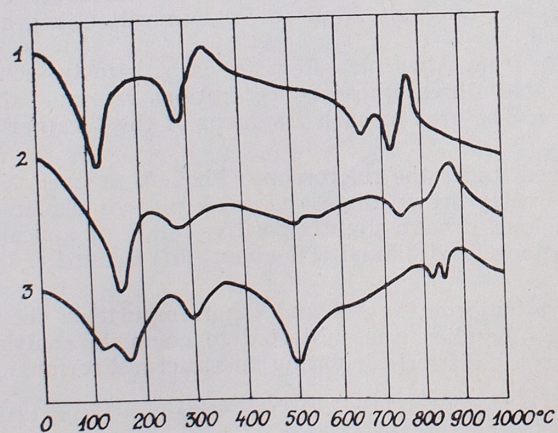


Fig. 1. DTA curves of palygorskites
1 — from Alwernia—Regulice, 2 — from USSR (Ivanova 1961, heating rate 80°/min), 3 — from Czerkasy, USSR (after Stoch 1974)

of exothermic peaks is presumably due to the crystallization of clinoenstatite.

X-ray examinations were carried out on the DRON-1 diffractometer, using Ni-filtered CuK_α radiation and powder preparations. The resultant data are presented in Table 2.

Table 2

Interplanar spacings of palygorskites

Palygorskite from Alwernia—Regulice		Palygorskite from Glasgow (USA) (Christ <i>vide</i> Stoch 1974)		Palygorskite (Dric, Aleksandrowa 1966)		Attapulgitite from USA (Christ 1969, <i>vide</i> Stoch 1974)	
<i>d</i> (Å)	<i>I</i>	<i>d</i> (Å)	<i>I</i>	<i>d</i> (Å)	<i>I</i>	<i>d</i> (Å)	<i>I</i>
11.24	4	10.35	100	10.33		10.54	100
7.02	0,5						
6.47	2	6.33	19	6.34		6.42	10
6.017	1						
5.372	1	5.382	13	5.39		5.418	7
5.252	1						
5.155	2						
4.960	1						
4.452	5	4.462	29	4.461		4.479	23
4.250*	9	4.258	11	4.110		4.258	15
3.986	2	3.988	4	3.649		4.137	10
3.791	2						
3.692	4	3.648	3	3.649		3.681	7
		3.436	2	3.435			
3.328*	10	3.351	7			3.444	5
3.278	6						
3.234	5	3.223	16			3.246	20
3.200	5					3.205	18
3.153	4	3.170	23	3.167			
3.017	3	3.088	11				
				2.985			
2.854	1	2.885	3	2.975			
2.645	3	2.673	6			2.698	4
		2.605	10			2.601	10
2.557	4	2.585	15	2.583		2.548	13
2.542	4	2.536	17				
		2.507	12				
2.427	2			2.499			
2.271	1			2.231			
2.050	1			2.055			
2.023	1						
1.800	2			1.801			
1.670	2			1.616			
				1.492			

* Admixture of quartz.

Infrared absorption analysis was performed with the UR-10 (Zeiss) spectrophotometer using KBr disks technique. The spectrum was recorded in the range of 400—1800 and 3000—3800 cm^{-1} .

It is evident from the spectrum (Fig. 2) that investigated sample contains, besides palygorskite, a small admixture of quartz whose bands coincide in some spectral regions with the absorption bands of palygorskite. The most characteristic for quartz are absorption maxima 780 and 800 cm^{-1} . The other absorption bands are associated with palygorskite,

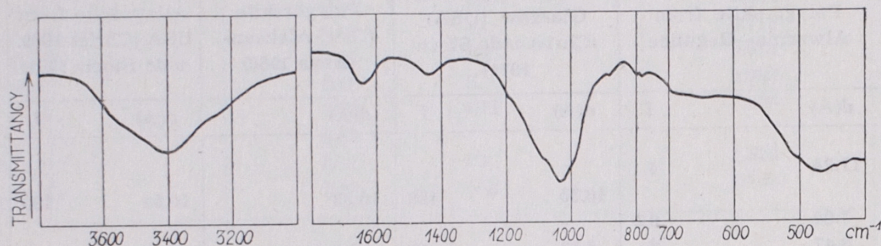


Fig. 2. Infrared absorption spectrum of palygorskite from Alwernia—Regulice

which shows an intensive band produced by Si-O vibrations of the ν_3 type in the range of 900—1200 cm^{-1} with the maxima 990, 1030, 1080 and 1190 cm^{-1} . Vibrations of the ν_4 type appear as intensive bands in the range of 400—550 cm^{-1} . Since the mineral under study contains zeolitic and crystallization water in its crystal lattice, absorption bands produced by valence (3400, 3560 cm^{-1}) and deformation (1640 cm^{-1}) vibrations in the H_2O molecules may be observed. The absorption bands due to stretching vibrations of OH groups (3612 cm^{-1}) coincide with the broad band of H_2O molecules.

Palygorskite is a mineral of sedimentary or hydrothermal origin (Stoch 1974). It occurs in lacustrine and marine, particularly lagoonal and near-shore, deposits, where it forms by crystallization or due to the action of Mg-rich hydrothermal solutions on the terrigenous clay sediments (Caillère, Rouaix 1958, Ratiejev 1963). It is usually accompanied by montmorillonite.

Palygorskite with clinoptilolite has been found in the deep-water deposits of the Atlantic Ocean. It arose there presumably from montmorillonite as a result of the activity of Mg-rich hydrothermal solutions (Bonatti, Joensun 1968). The well known Attapulgis and Mormoiron deposits formed as lacustrine sediments. Palygorskite clays appear on a large scale in the bentonites near Cherkess in the Ukraine. They owe their to the transformation of montmorillonite in a closed sea basin (Kukovski, Ostrovska 1961). Palygorskite encountered in igneous rocks, i.e. in the Volhynia basalts (Shashkina 1958), is, as a rule, of hydrothermal origin.

Genetically, the palygorskite from Alwernia—Regulice is closely associated with the mineral paragenesis of heulandite, sepiolite, saponite and of other minerals from Rudno near Krzeszowice that are embedded in melaphyre rocks, comagmatic with the melaphyres from Alwernia—Regulice (Piekarska, Gaweł 1954, Żabiński 1960). The minerals in question usually occur in vacuoles produced by gas bubbles escaping from magma. They arose as a result of successive hydrothermal and supergene processes.

According to Piekarska and Gaweł (1954), the first stage of mineralization of the vacuoles is represented by one millimeter thick silica layers coating their walls, which are often green from delessite or, less frequently, red from iron oxides. Red heulandite crystals appear on those layers. The successive stage of mineralization of the Cracow igneous rocks involved the rise of calcite in the form of fairly large crystals. In most cases they are dissolved as a result of the subsequent activity of silicic solutions, constituting relict forms in agates. In the process of silica deposition at that stage of mineralization, precipitation of delessite, which gives green colour to agate and jasper, takes place. According to Piekarska and Gaweł (1954), ptilolite (syn. of palygorskite) precipitates almost simultaneously. Delessite and ptilolite may also be deposited in fissures and interstices not filled with silica. The final stage of silica precipitation involves the formation of amethyst, accompanied by insignificant amounts of goethite.

REFERENCES

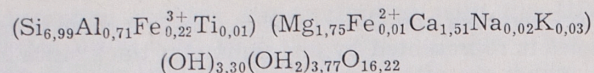
- BONATTI E., JOENSUN O., 1968: Palygorskite from Atlantic deep sea sediments. *Amer. Miner.* 53, 975.
- CAILLÈRE S., ROUAIX S., 1958: Sur la présence de palygorskite dans la région de Taguenout-Haguret (A.O.F.). *C.R. Acad. Sci. Paris* 246, 1442.
- [DRIC V. A., ALEKSANDROVA V. A.] ДРИЦ В. А., АЛЕКСАНДРОВА В. А., 1966: К вопросу о кристаллохимической природе палыгорскитов. *Зап. Всес. Минер. Общ.*
- [IVANOVA V. I.] ИВАНОВА В. И., 1961: Термограммы минералов. *Зап. Всес. Минер. Общ.* 40, 1.
- [KUKOVSKI E. G., OSTROVSKA A. V.] КУКОВСКИ Е. Г., ОСТРОВСКА А. В., 1961: Первое в СССР месторождение палыгорскитовых глин. *Зап. Всес. Минер. Общ.* 90, 598.
- PIEKARSKA E., GAWEŁ A., 1954: Heulandyt z Rudna koło Krzeszowic. *Rocz. Pol. Tow. Geol.* 22, 353.
- [RATIEJEV M. A.] РАТЕЕВ М. А., 1963: Минералогия и генезис палыгорскитов и сепиолитов в морских отложениях карбона Русской Платформы. *Литология и Полезные Ископаемые.*
- [SHASHKINA V. P.] ШАШКИНА В. П., 1958: О палыгорските из базальтов Волыни. *Минерал. Сборник* 12.
- STOCH L., 1974: *Minerały ilaste*. Wyd. Geol. Warszawa.
- ŻABIŃSKI W., 1960: Z badań krzemianowo-magnezowych produktów przeobrażenia melafirów krakowskich. *Spraw. z Pos. Kom. Nauk. PAN, Oddz. w Krakowie.*

Wiesław HEFLIK, Anna KRZYCZKOWSKA

ПАЛЫГОРСКИТ З АЛВЕРНИ—РЕГУЛИЦ

Streszczenie

W pracy przedstawiono charakterystykę mineralogiczną palygorskиту pochodzącego z kamieniołomu melafiru w Alwerni—Regulicach koło Krakowa. Mineral ten poddano obserwacji mikroskopowej, analizie chemicznej, termicznej analizie różnicowej, badaniom rentgenowskim oraz spektroskopowym w podczerwieni. Na podstawie analizy chemicznej wyliczono wzór strukturalny minerału:



Pałygoraskit z Alwerni—Regulic jest genetycznie ściśle związany z paragenetą heulandytu, sepiolitu, saponitu i in. Powstał on w wyniku nakładania się procesów hydrotermalnych i hipergenicznych w obrębie melafirów Alwerni—Regulic.

OBJASNIENIA FIGUR

Fig. 1. Krzywe DTA pałygoraskitów
1 — z Alwerni—Regulic, 2 — z ZSRR (Iwanowa 1961, prędkość ogrzewania pieca 80°/min),
3 — z Czerkasów, Ukraina (Stoch 1974)

Fig. 2. Widmo absorpcyjne w podczerwieni pałygoraskitu z Alwerni—Regulic

OBJASNIENIA FOTOGRAFII

Fot. 1. Skupienia pałygoraskitu z Alwerni—Regulic, wygląd makroskopowy. Zm. × 2

Fot. 2. Współwystępujący z pałygoraskitem (P) z Alwerni—Regulic idiomorficzny kwarc (Q). Nikole X, pow. × 20

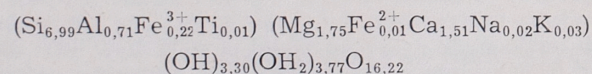
Fot. 3. Mikroskopowy obraz pałygoraskitu z Alwerni—Regulic. Jeden nikol, pow. × 20

Веслав ХЕФЛИК, Анна КШИЧКОВСКА

ПАЛЫГОРСКИТ ИЗ КАРЬЕРА АЛВЕРНЯ—РЕГУЛИЦЕ

Резюме

В работе дана минералогическая характеристика паłyгорскита из мелафирового карьера Алверня—Регулице вблизи Кракова. Минерал исследовался микроскопически и с помощью химического, дифференциального термического, рентгеновского и ИК-спектрального методов. По данным химического анализа была вычислена структурная формула этого минерала:



Паłyгорскит в данном местонахождении находится в близкой парагенетической связи с гейландитом, сепиолитом, сапонитом и другими минералами. Он образовался в итоге наложения гидротермальных и гипергенных процессов в мелафирах района Алверня—Регулице.

ОБЪЯСНЕНИЯ К ФИГУРАМ

Фиг. 1. График ДТА паłyгорскитов

1 — образец из карьера Алверня—Регулице, 2 — образец из СССР (Иванова 1961, скорость нагрева печи 80°/мин), 3 — образец из Черкасс, УССР (Сток 1974)

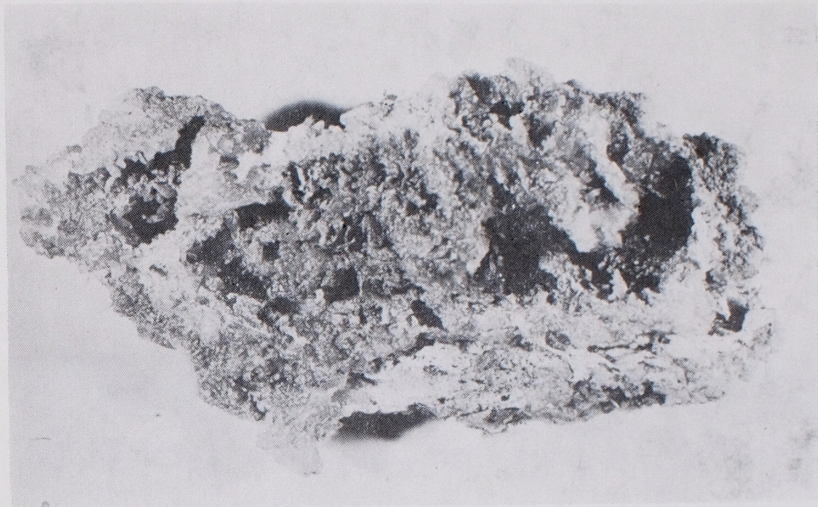
Фиг. 2. ИК-спектр поглощения паłyгорскита из карьера Алверня—Регулице

ОБЪЯСНЕНИЯ К ФОТОСНИМКАМ

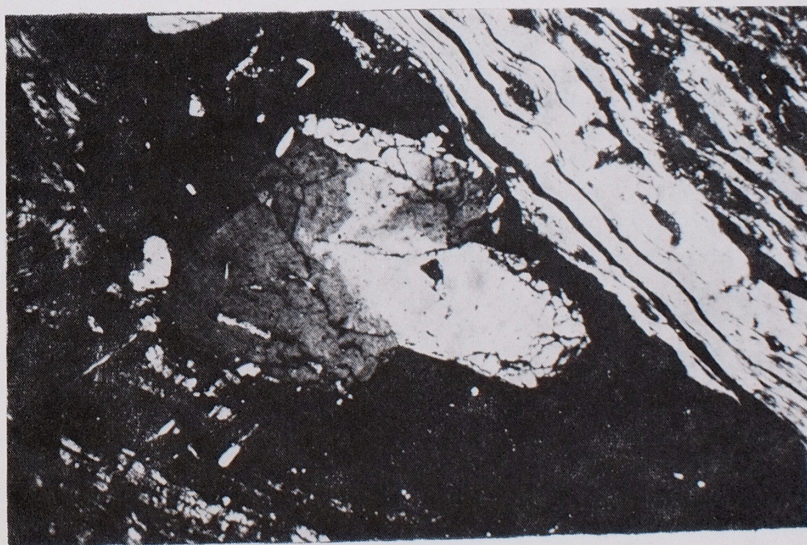
Фото 1. Скопления паłyгорскита в карьере Алверня—Регулице, макроскопический вид. Уменьш. × 2

Фото 2. Идиоморфный кварц (Q), сопровождающий паłyгорскит (P) в карьере Алверня—Регулице. Николи X, увел. × 20

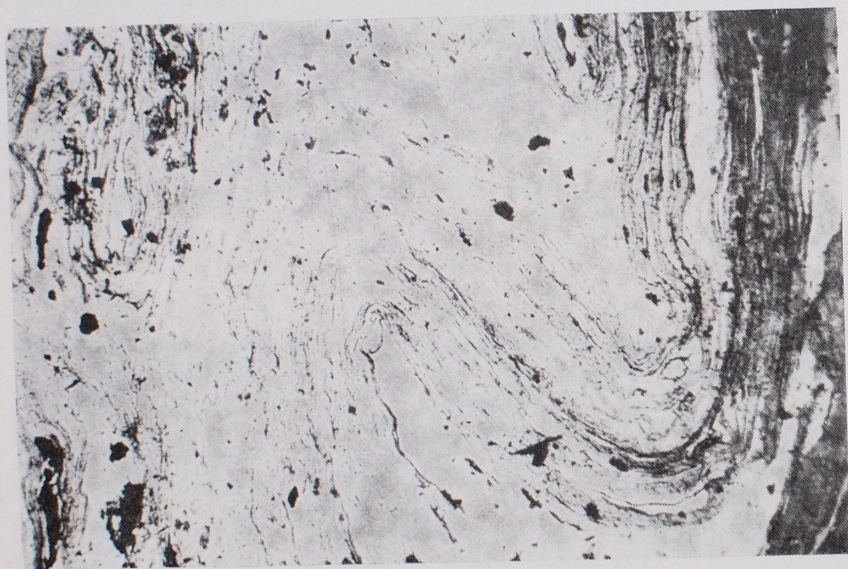
Фото 3. Микроскопический вид паłyгорскита из карьера Алверня—Регулице. 1 николь, увел. × 20



Phot. 1. Aggregates of palygorskite from Alwernia—Regulice. Scale 1:2



Phot. 2. Idiomorphic quartz (Q) co-occurring with palygorskite (P) from Alwernia—Regulice. Crossed nicols, magn. $\times 20$



Phot. 3. Microphotograph of palygorskite from Alwernia—Regulice. One nicol, magn.
× 20