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PRELIMINARY DATA ON BABINGTONITE FROM MICHAŁOWICE  
(KARKONOSZE MASSIF, POLAND)

**Abstract:** Babingtonite was found in the miarolitic pegmatite in the Michałowice granite quarry near Szklarska Poręba (Karkonosze massif, Poland). The crystal chemical formula of babingtonite is  $\text{Ca}_{1.96-2.01}\text{Na}_{0.00-0.03}(\text{Fe}^{2+}_{0.49-0.69}\text{Mn}_{0.13-0.32}\text{Mg}_{0.11-0.32})\text{Fe}^{3+}_{1.03-1.12}\text{Al}_{0.00-0.02}[\text{Si}_{4.94-4.98}\text{O}_{14}(\text{OH})]$ . The unit cell dimensions are:  $a=6.779(1) \text{ \AA}$ ,  $b=7.553(2) \text{ \AA}$ ,  $c=11.744(2) \text{ \AA}$ ,  $\alpha=104.3$ ,  $\beta=91.8$ ,  $\gamma=93.6$ , volume  $580.8(2) \text{ \AA}^3$ , calculated density  $3.278 \text{ g/cm}^3$ . Babingtonite formed in low-temperature hydrothermal conditions. On the basis of paragenetic association was established, that temperature of crystallization is about  $100^\circ\text{C}$  and pressure about 0.5 kbar.

**Keywords:** babingtonite, pegmatite, granite, Michałowice, Karkonosze massif, Poland

INTRODUCTION

Babingtonite  $\text{Ca}_2\text{Fe}^{2+}\text{Fe}^{3+}[\text{Si}_5\text{O}_{14}(\text{OH})]$  is a rare inosilicate mineral (space group  $P \bar{1}$ ). The structure of babingtonite contains chains of  $\text{SiO}_4$  tetrahedra parallel to Y axis. The  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  atoms take two different crystallographic sites, designated Fe1 and Fe2, respectively (Amthauer 1980, Czank 1981, Burns, Dyar 1991). Fe1 octahedra are occupied by other divalent atoms (Mn, Mg). Fe2 octahedra are occupied by other trivalent atoms, mainly Al. Calcium atoms are bonded to the seven O atoms to form 7-coordinated polyhedron. Babingtonite was described in Poland only in pegmatites from the Paszowice in Strzegom-Sobótka massif (Janeczek, Sachanbiński 1992).

SAMPLE DESCRIPTIONS

Babingtonite was found in the miarolitic pegmatite in the Michałowice granite quarry near Szklarska Poręba (Karkonosze massif, Poland), associated with microcline, quartz, albite (Fig. 1), epidote, calcite, chlorite and hematite in succession of crystallization. Tabular and prismatic crystals of babingtonite (Fig. 2) are translucent, with vitreous luster and dark greenish black colour. Range up to 5 mm long, 3 mm wide and 1 mm thick. The babingtonite shows brown-pinkie and emerald-green pleochroic colours. Many crystals of babingtonite contain small inclusions of chlorite (brunsvigite?) (Fig. 3). Babingtonite had been identified as undetermined pyroxene on the basis of morphological data (Karwowski et al. 1983).

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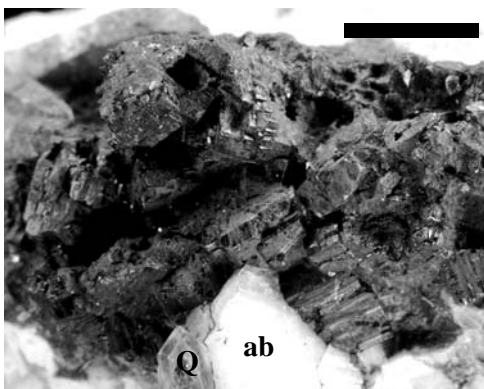


Fig. 1. Babingtonite in pegmatite with albite (ab) and quartz (Q). Scale bar is 5 mm.

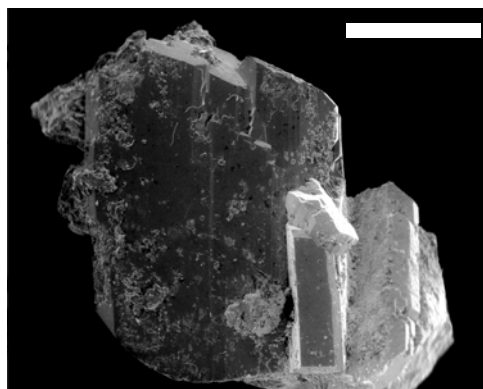


Fig. 2. The morphology of babingtonite crystals (SE). Scale bar is 2.5 mm.

#### ANALYTICAL METHODS

The images of babingtonite morphology by secondary electrons (SE) were carried out using ESEM – XL 30 TMP (Philips/FEI) scanning electron microscope. Electron-probe microanalyses in the wavelength-dispersive scans (WDS) mode and BSE images were performed using a Cameca SX 100 in the Inter-Institutional Laboratory of Microanalysis of Minerals and Synthetic Substances at Faculty of Geology, Warsaw University.

The unit cell dimensions were determined by single crystal method (KM-4 diffractometer, SHELX-97 package program) in Institute of Chemistry and Environmental Protection, Jan Długosz Academy, Częstochowa.

#### RESULTS

The chemical compositions of babingtonite are given in Table 1. In the structure of babingtonite from Michałowice Na substitutes Ca, whereas Mn and Mg replace  $Fe^{2+}$ . Aluminum substitutes  $Fe^{3+}$ . The babingtonite can contain hydroxyl groups, which might explain low total in all micro-chemical analyses.

The unit cell dimensions are:  $a=6.779(1) \text{ \AA}$ ,  $b=7.553(2) \text{ \AA}$ ,  $c=11.744(2) \text{ \AA}$ ,  $\alpha=104.3$ ,  $\beta=91.8$ ,  $\gamma=93.6$ , volume  $580.8(2) \text{ \AA}^3$ , calculated density  $3.278 \text{ g/cm}^3$ .

The crystals of babingtonite show zoning underlined by packing of chlorite inclusions (Fig. 3), caused variability Mn and Mg substitutions in structure (Tab. 1).

On the basis of macro- and microscopic observations of pegmatite association position of babingtonite in mineral succession was determined. The babingtonite forms inclusions within last generation of colourless quartz. Intergrowths of babingtonite, calcite, chlorite and hematite were observed.

Because of fluid inclusions within investigated babingtonites were not founded till now, on the basis of paragenetic association was established, that temperature of crystallization was about  $100^{\circ}\text{C}$  and pressure about 0.5 kbar.

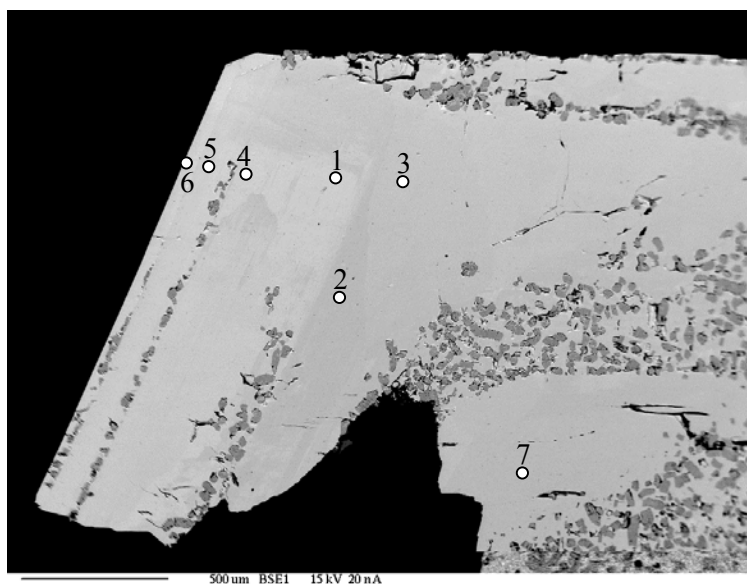


Fig. 3. BSE image of babingtonite with chlorite inclusions (1 - 7 – analytical points).

Table 1. Chemical compositions of babingtonite from Michałowice (wt %).

	1	2	3	4	5	6	7	8	9
SiO <sub>2</sub>	52.28	52.89	52.48	52.44	52.28	52.33	52.71	53.78	52.41
TiO <sub>2</sub>	0.04	0.03	n.d.	n.d.	0.01	0.02	0.02	0.01	-
Al <sub>2</sub> O <sub>3</sub>	0.05	0.17	0.14	0.09	n.d.	0.14	0.10	0.20	-
Fe <sub>2</sub> O <sub>3</sub> *	14.40	14.53	15.66	15.86	15.57	15.18	14.97	12.59	13.93
FeO*	8.68	6.47	6.23	7.64	6.56	6.46	6.73	8.85	12.52
Cr <sub>2</sub> O <sub>3</sub>	n.d.	0.01	n.d.	0.04	n.d.	n.d.	0.04	-	-
MnO	1.91	1.68	1.94	2.13	3.53	4.03	1.67	1.99	-
MgO	0.93	2.27	1.99	1.07	1.01	0.77	2.08	1.50	-
CaO	19.55	19.89	19.83	19.81	19.31	19.54	19.75	19.70	19.57
Na <sub>2</sub> O	0.01	0.02	0.04	0.04	0.14	0.09	0.04	0.01	-
H <sub>2</sub> O	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	1.57
total	97.85	97.97	98.29	99.12	98.41	98.56	98.11	97.37	100.00
Number of cations on the basis of 9 cations									
Si	4.98	4.98	4.94	4.94	4.96	4.96	4.97		
Al	0.01	0.02	0.02	0.01	-	0.02	0.01		
Fe <sup>3+</sup>	1.03	1.03	1.11	1.12	1.11	1.08	1.06		
Fe <sup>2+</sup>	0.69	0.51	0.49	0.60	0.52	0.51	0.53		
Mn	0.15	0.13	0.15	0.17	0.28	0.32	0.13		
Mg	0.13	0.32	0.28	0.15	0.14	0.11	0.29		
Ca	2.00	2.01	2.00	2.00	1.96	1.98	1.99		
Na	0.00	0.00	0.01	0.01	0.03	0.02	0.01		

\* Calculated on charge balance, n.d. – not determined, 1-7 – babingtonite from Michałowice, 8 – babingtonite from Paszowice (Janeczek and Sachanbiński, 1992), 9 – theoretical composition for Ca<sub>2</sub>Fe<sup>2+</sup>Fe<sup>3+</sup>[Si<sub>5</sub>O<sub>14</sub>(OH)].

### CONCLUSIONS

In the structure of babingtonite from Michałowice isomorphic substitutions of Mn, Mg, Na and Al were determined. Babingtonite formed in low-temperature hydrothermal conditions, and it was the last among minerals of the pegmatites to crystallize.

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