GEOME 2
Manuscript received: March 10, 1997
Accepted: May 14, 1997

Geologica Macedonica, Vol. **11**, pp. 45–49 (1997)
ISSN 0352 – 1206
UDC: 548/549 : 553.44 (497.17)

Original scientific paper

MINERALOGICAL CHARACTERISTICS OF JOHANNSENITE IN THE SASA ORE FIELD

Tena Šijakova-Ivanova and Blažo Boev

Faculty of Mining and Geology, Štip, Republic of Macedonia

The paper presents the mineralogical, crystallographic and crystallochemical characteristics of johannsenite in the Sasa ore field. Investigations were conducted at the Faculty of Mining and Geology, Štip, and at the Institute for Crystallography and Petrography in Zürich, Switzerland.

Key words: johannsenite; Sasa; crystallographic characteristics; crystallochemical characteristics

INTRODUCTION

Mount Osogovo is situated east of Skopje close to the Macedonian – Bulgarian border. Several lead-zinc occurrences are associated with the intrusions of granodiorite-quartz-dioritic magma. This magma caused contact-metasomatic changes in the surrounding marbles and cipolines. The process resulted in the development of a series of contact-metasomatic, non-metallic rare minerals.

Although the names of these minerals were reported as early as 1961 by Barić, pertinent data about their determination can not be found, neither in published or in reference literature. The only paper in which few data can be found is that of Barić (1961).

Very little is know about the mineralogical properties of johannsenite. However, it has been known that it is an end member of the diopside group. This made possible the formation of a successive order of minerals between hedenbergite – johannsenite in which Fe^{2+} is diadochially replaced by Mn^{2+}.

Ferrojohannsenite was named by Hutton (1956). He suggested ferrojohannsenites to be called pyroxenites as its composition consists predominantly of $MnSiO_3$. He also suggested to dismember johannsenite and hedenbergite of the basis of the order of end member predominance (supposing that magnesium in the end members is evenly distributed). According to this assumption, minerals that have similar composition to that of johannsenite, are called ferrojohannsenite, whereas minerals with composition similar to the composition of hedenbergite are called manganese hedenbergite.

MINERALOGICAL CHARACTERISTICS

Microscopic characteristics

Johannsenite occurs as large crystals that are elongated towards the axis "*c*" but flat towards the axis "*b*". Columnar and ring radial aggregates up to 20 cm in length are very common. The elongated prismatic crystals are intergrown in plane (100) in common aggregate (Fig. 1).

It is olive green to greenish observed as one crystal under a microscope. Its colour changes along the "*c*" crystallographic axis from light green into dark green. This points to change in the chemical composition in the environment during crystallization. This also results in moderate changes in the chemical composition of the mineral. Its hardness amounts to 6, and specific weight to 3.5. It has glass-like luster (Fig. 2).

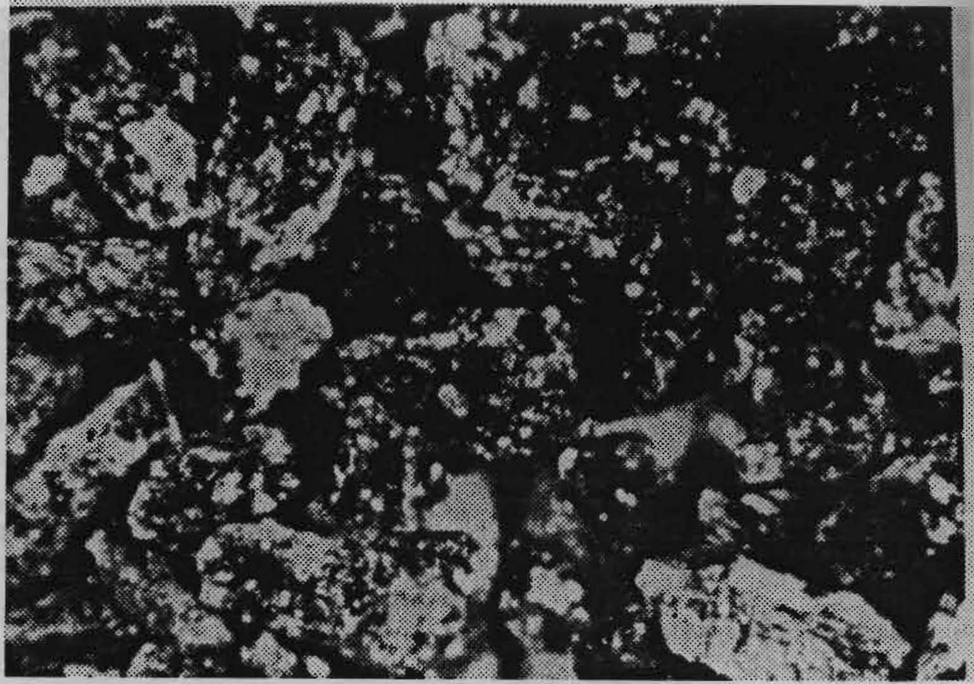


Fig. 1. Johannsenite-ferrojohannsenite grains (×15)

Fig. 2. Johannsenite grains (× 60)

Microscopic properties

Johannsenite has first order interferential colours. Pleochroism is from light green-yellow to light yellow. Perfect cleavage along (110), and imperfect cleavage along (001) can also be noticed. The angle of cleavage directions is 87°. The angle of tarnish is around 44.5°. Twin couples along (100) as well as polysynthetic twins can be found (Fig. 3).

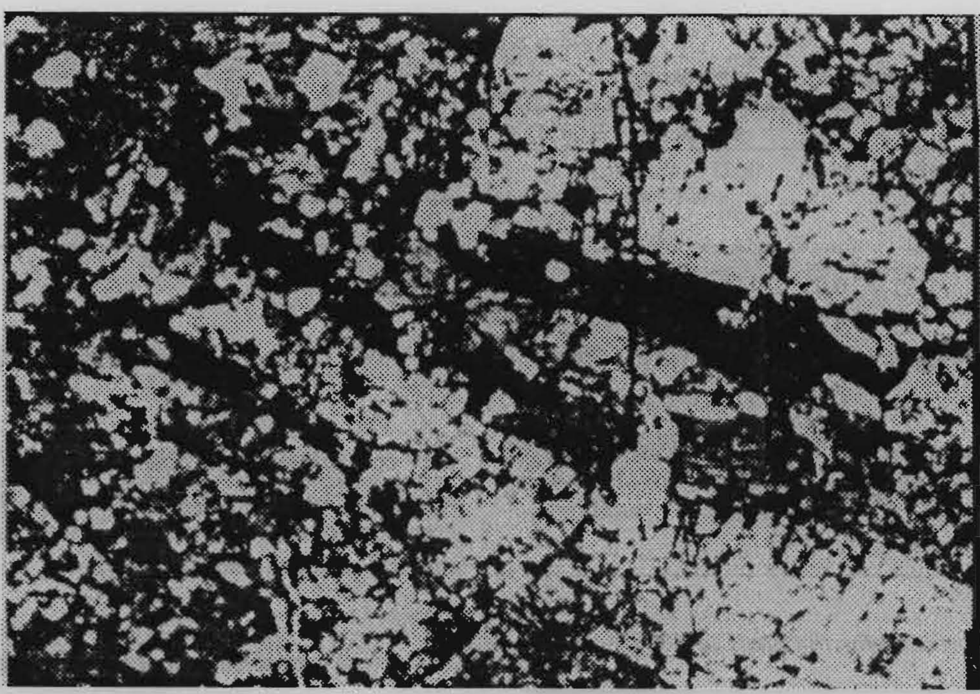
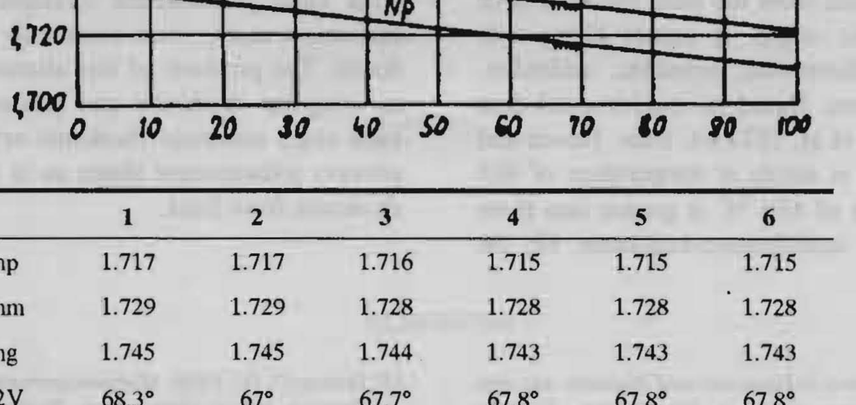


Fig. 3. Microscopic photograph of johannsenite (ferrojohannsenite) with clear twins (× 50 N+)

Crystals are commonly fresh sometimes, but crystals decomposing to bustamite, rhodonite and an isotropic mineral similar to kaolin (most probably xonothlite $Ca_5Si_5H_2O$ can also be found.

Dependence between optical characteristics and the chemical composition is given in Diag. 1.



	1	2	3	4	5	6
np	1.717	1.717	1.716	1.715	1.715	1.715
nm	1.729	1.729	1.728	1.728	1.728	1.728
ng	1.745	1.745	1.744	1.743	1.743	1.743
2V	68.3°	67°	67.7°	67.8°	67.8°	67.8°
ng-np	0.028					

Diag. 1. Dependence between optical properties and the chemical composition in minerals of the hedenbergite-johannsenite series (Troger 1958)

Table 1

Chemical composition of johannsenite

	1	2	3	4	5	6
SiO_2	48.48	48.93	48.84	48.53	48.92	49.83
TiO_2	0.34	–	–	0.04	–	–
Al_2O_3	–	–	–	–	–	–
Fe_2O_3	0.27	0.91	0.05	1.70	2.33	1.50
FeO	9.27	9.27	9.27	9.27	9.27	9.27
MnO	19.01	18.66	18.84	17.40	16.81	16.69
MgO	0.25	0.21	0.49	0.48	0.49	0.40
CaO	22.83	22.43	22.63	22.66	22.32	22.12
K_2O	–	–	–	–	–	–
Na_2O	–	–	–	–	–	–
H_2O	–	–	–	–	–	–

Total of ions for the basis of 6(O)

Si	1.99	2.00	2.00	1.99	2.00	2.03
Al	–	–	–	–	–	–
Al	–	–	–	–	–	–
Ti	0.01	–	–	0.001	–	–
Fe_3	0.01	0.03	0.001	0.04	0.07	0.4
Fe_2	0.32	0.32	0.32	0.32	0.32	0.32
Mn	0.66	0.65	0.65	0.60	0.58	0.57
Mg	0.02	0.01	0.03	0.03	0.093	0.02
Na	–	–	–	–	–	–
Ca	1.00	0.98	0.99	0.99	0.98	0.96
K	–	–	–	–	–	–

mol.proc	1	2	3	4	5	6
$FeSiO_3$	16.00	16.33	16.08	16.49	16.75	17.11
$MnSiO_3$	33.00	33.16	32.66	30.93	30.37	30.48
$MgSiO_3$	1.00	0.51	1.51	1.55	1.57	1.07
$CaSiO_3$	50.00	50.00	49.75	51.03	51.31	51.34

Crystallochemical properties

The crystallochemical formulas indicate that they coincide with the formula of the ideal johannsenites. If we hold on Hutton's rule, since the most common component in $MnSiO_3$ we can classify this mineral as ferrojohannsenite (Table 1).

X-ray difractometer examinations

X-ray diffraction were made by Philips difractometer. Cu-anticathode with Ni-filter was used at conditions of 40 kV and 20 A. The following values – *d* and intensitites *I* were obtained.

Sasa johannsenite 3.02 (10), 2.55(8), 2.60 (5)

Johannsenite Broken Hill-Hutton (1956) 3.008 (10), 2.544 (8), 2.593 (5).

Results obtained are in good agreement with the data presented in the work of C. Osborne Hutton (1956) and with the values presented in Deer, Howie and Zussman (1982) and JCPDS cards.

CONCLUSIONS

The johannsenite from the Sasa ore field is of contact metasomatic origin. It occurs along with ilvaite, rhodonite, bustamite, actinolite, andradite, grossular and epidote. Based on experimental data obtained by Bowen et al. 1933 cit. Deer, Howie and Zussman (1982) it is stable at temperature of 965 °C. At temperature of 830 °C it grades into three clinic polymorphic modification-bustamite. On the other hand johannsenite oxidizes, hydrotizes and carbonizes easily, most commonly grading into rhodonite. The products of this alteration can be found as irregular rhodonite and johannsenite parts. In such cases columnar rhodonite crystals retain their primary johannsenite shape as is the case with the rhodonite from Sasa.

REFERENCES

[1] Barić Lj., 1961: *Ferro-Johannsenit und Bustamit aus dem Blej-Zink vorkommen Sasa in Mazedonien*. Fortsehr Miner. **39**, 137–139.

[2] Deer W. A., Howie R. A. and Zussman J., 1982: *An Introduction to the Roeks Forming Minerals*.

[3] Hutton C. O., 1956: *Manganopyrosmalite, bustamite and ferroan johannsenite from Broken Hill*, New South Wales, Australia, Am, Mineral, 41–58.

[4] Troger W. E., 1958: *Optische Bestimmung der gestteinsbilden den Minerale*.

Резиме

МИНЕРАЛОШКИ КАРАКТЕРИСТИКИ НА ЈОХАНСЕНИТОТ ВО РУДНОТО ПОЛЕ САСА

Тена Шијакова-Иванова и Блажо Боев

Рударско-геолошки факултет, Штип, Република Македонија

Клучни зборови: јохансенит; Саса; кристалографски каракетристики; кристалохемиски карактеристики

Во трудот се прикажани минералошките, кристалографските и кристалохемиските карактеристики на јохансенитот од рудното поле Саса. Испитувањата се вршени на Рударско-геолошкиот факултет во Штип и во Институтот за кристалографија и петрографија во Цирих, Швајцарија.