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JARANDOLITE $\text{Ca}[\text{B}_3\text{O}_4(\text{OH})_3]$, CALCIUM BORATE FROM SERBIA: NEW NAME AND NEW DATA¹

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The new data are given on calcium borate jarandolite from Jarandol basin (Serbia) which short description has been published earlier (Stojanović' 1992, Stojanović' *et al.* 1993) under the tentative name «srbianite». Jarandolite forms columnar aggregates of flattened individuals up to 1.5 cm in length and associates with colemanite, howlite, ulexite, veatchite, studenitsite, pentahydroborite, and montmorillonite. The mineral is colourless, semi-transparent. The lustre is vitreous, cleavage is highly perfect on (001). Micro-indentation hardness is $H_{\text{average}} = 645 \text{ kg/mm}^2$ (approximately 5 on Mohs' scale). Density (exp): $2.49 (2) \text{ g/cm}^3$, density (calc) = 2.57 g/cm^3 (from empirical formula); 2.57 g/cm^3 (from structural data). The mineral is optically biaxial, positive. $2V = 60(2)^\circ$, $n_p = 1.573(2)$, $n_m = 1.586(2)$, $n_g = 1.626(2)$. Dispersion of optical axes is medium, $r > v$. Elongation is positive. Orientation is following: $Np = c$, $Nm = b$, $aNg = +8^\circ$. Pleochroism is absent. The simple forms {001}, {011}, and {11} are observed. Micro-twinning is on (001). IR-spectrum and thermogram are given. Chemical composition (wet analysis, wt %) is: $\text{Na}_2\text{O} 0.05$, $\text{K}_2\text{O} 0.07$, $\text{CaO} 30.56$, $\text{MgO} 0.02$, $\text{MnO} 0.01$, $\text{Fe}_2\text{O}_3 0.20$, $\text{Al}_2\text{O}_3 0.03$, $\text{SiO}_2 0.20$, $\text{B}_2\text{O}_3 55.44$, $\text{Cl} 0.21$, $\text{H}_2\text{O} 13.36$, $-\text{O} = \text{Cl}_2 -0.05$, total 100.10. The empirical formula of jarandolite is: $\text{Ca}_{1.02}(\text{B}_{2.99}\text{Si}_{0.01})\text{O}_{4.125}(\text{OH})_{2.70}\text{Cl}_{0.01}$. The spiral-screwed chains of colemanite type underlie in the base of crystal structure of jarandolite, which has been studied on monocrystal ($R = 0.035$). The mineral is monoclinic, the space group $P2_1/a$, $a = 8.386(3)$, $b = 8.142(4)$, $c = 7.249(3) \text{ \AA}$, $\beta = 98.33(3)^\circ$, $V = 489.7 \text{ \AA}^3$. The strongest lines of X-ray powder diagram are following $[d, \text{ \AA} (I, \%) (hkl)]$: $4.32 (57) (111)$, $3.39 (100) (201)$, $3.13 (50) (211)$, $2.93 (23) (-202)$, $2.606 (25) (221)$, $1.849 (25) (-421, 420)$. 1 table, 5 figures, and 8 references.

New hydrous calcium borate, jarandolite, with chemical composition $2\text{CaO} \cdot 3\text{B}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$ was found by geologist of geofactory «Non-metals», Belgrade, Stoyan Anić'ić' in volcano-sedimentary boron deposits Pobrđjski Potok and Piskanja approximately 280 km southward from Belgrade (Fig. 1), nearby small mountainous town Balevats on the shore of Jbar River. The mineral study, which results are given in this article, was made in All-Russian Scientific-Research Institute of Mineral Resources (VIMS), Moscow; Lomonosov Moscow State University, and Central Scientific-Research Institute of Geology of Non-Metallic Raw Materials (TsNIIGeolnerud), Kazan. Borate is named jarandolite after occur-

rence of its segregations in volcano-sedimentary rock mass of Jarandol basin of Miocene age in Serbia.

First information on borate with close chemical composition, which was determined by data of microprobe analyses, but without data on crystal structure and with some inexact optical constants, was published earlier in the theses of reports of conference of Serbian Crystallographic Association (Stojanović', 1992; Djurić' *et al.*, 1993) and Yugoslavian Mineralogical Association (Stojanović' *et al.*, 1993). The authors give the name srbianite to studied borate, after the find place in Serbia. Already after publication of data on new borate the applica-

¹ Is approved by Commission on New Minerals and Mineral Names of International Mineralogical Association on September 2, 2003

tion (registration № MMA 95–020, see Can. Mineral., 1996) was handed in Commission on New Minerals and Mineral Names IMA (IMA CNMMN). However, approved new mineral, Commission did not affirm suggested name, and longstanding (up to 2003 year) debates on this question have not brought to its positive solution.

At the same period (1992–1994 years) parallel to work of D. Stojanovic' with colleagues we also studied early-unknown borates from volcano-sedimentary boron deposits Pobrđjski Potok and Piskanja. Firstly the new sodium-calcium borate, studenitsite $\text{NaCa}_2[\text{B}_9\text{O}_{14}(\text{OH})_4]\cdot 2\text{H}_2\text{O}$, was studied and described (Yamnova *et al.*, 1993; Malinko *et al.*, 1995), this mineral was approved by the IMA CNMMN in 1994 year. At the same time, in 1995 year, S.V. Malinko with co-authors gave the application on new mineral, jarandolite, in the IMA CNMMN, however, this application was received by Commission later than analogous application from Serbian authors. Because of that, admitted the priority of D. Stojanovic' with co-authors, the authors of present article have postponed publication of their researches, waiting for the solution of the IMA CNMMN on application 95–020.

The Chairman of the IMA CNMMN E.A.J. Burke gave the detailed information about consideration of application 95–020 on new borate and permitted to use the text of his com-

ments in this publication.

Comment of the Chairman of the IMA CNMMN

The history of proposal 95–020 is a long, sad, and unique one in the history of the CNMMN! The initial data for this mineral were mailed by Dobrica R. Stojanovic' to Joe Mandarino, Chairman of the CNMMN, on 25 November 1992, but this letter never arrived in Toronto. A new letter was mailed on 16 June 1993, it was received on 27 July 1993, and answered on 28 July 1993: more information was needed on some data. Stojanovic' replied to this letter, without the data, on 28 December 1994, but the letter was forwarded to Joel Grice who had meanwhile taken over as CNMMN chairman. Joel Grice asked for the same additional info as Joe Mandarino in a letter of 23 March 1995, and got these data in April 1995. The proposal for the new mineral with the name srbianite (95–020) was mailed to the CNMMN members on 31 May 1995. From this proposal it was evident that the name srbianite had already been published, *without CNMMN approval*, in Serbian journals in 1992 and 1993.

The voting results of proposal 95–020 were published in CNMMN Memorandum Vol. 21 No. 8 of 30 August 1995: the mineral was approved, but the name 'srbianite' was suspended because of a lack of the requested majority of 'yes' votes. Joel Grice suggested to choose a more specific name for a second voting, but Stojanovic' requested that the name 'srbianite' would be submitted again. This was sent to CNMMN on 31 January, and the results appeared in Memorandum Vol. 22 No. 4 of 30 April 1996. The name was suspended for the second time, and Joel

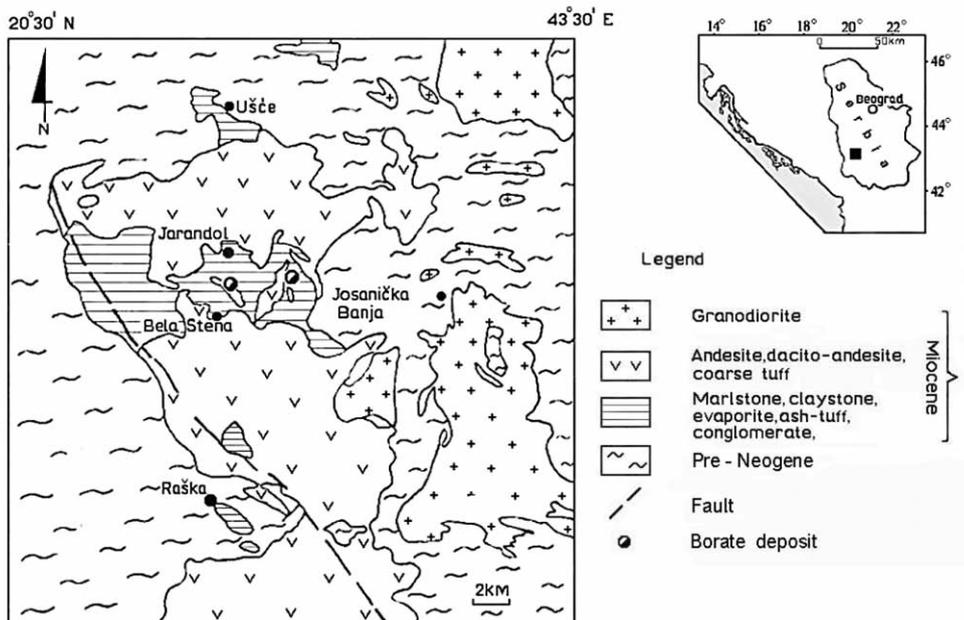


FIG. 1. The location of boron deposits in Jarandol volcano-sedimentary basin (Obradovic' J. *et al.*, 1992)



FIG. 2. The fragment of jarandolite crystals intergrowth from the core of borehole

suggested again a more site-specific name. In spite of this, Stojanovic' asked for a third vote, but now on the name 'serbianite'. This name was submitted to CNMMN on 29 August 1997, and the result of the voting appeared in Memorandum Vol. 23 No. 11 of 26 November 1997: the name was rejected with an overwhelming majority. Joel Grice was then very lenient in proposing Stojanovic' to choose a different name for a fourth voting.

Stojanovic' did not reply to this offer from Joel Grice until June 2002, asking indeed for a fourth vote, but again on the names 'srbianite' or 'serbianite'. Joel Grice consulted his fellow CNMMN officers and the new Chairman-elect, but did not reply to this letter. Next step: Stojanovic' sent a copy of his June 2002 letter to Ernst Burke (3rd CNMMN chairman involved) in February 2003. He made it clear in his answer (12 February 2003) to Stojanovic' that his wish was impossible: we had three CNMMN votings on these names, and all three were negative. Allowing a fourth vote on these names would be against all rules, and accepting one of these names would be a very significant, but inadmissible precedent for all authors wishing to circumvent CNMMN procedures.

In order to save the results of this new (and unique) borate mineral, Ernst Burke offered two alternatives to Stojanovic': 1) propose a new name, like Joel Grice had already suggested three times; this could have been done easily, because the Serbian literature with the name 'srbianite' was apparently so obscure that it was never mentioned in GeoRef or Web of Science; 2) cooperate with a Russian team that had proposed the same mineral (from the same locality as 95–020) in March 1995, just after Joel Grice received the borate dossier from Joe Mandarino. In view of the previous gap of almost 5 years, Ernst Burke demanded from Stojanovic' that he would answer him before 11 April 2003; if he did not receive the reply by that date he would lift the priority for the mineral.

In the first week of April 2003 Ernst Burke received an answer from Stojanovic' on his proposals. The latter repeated his wish of June 2002 / February 2003 to have a fourth vote on the names 'srbianite' or 'serbianite'. Ernst Burke consulted two members of

the IMA Council (the past-president and the secretary), who backed his intention to stick by the CNMMN rules after having been lenient towards Stojanovic' twice (allowing a third voting on 'serbianite', and proposing a fourth vote on another name). Ernst Burke decided then to give the Russian team the opportunity to name the mineral, as Stojanovic' obviously refuses to follow the CNMMN voting results.

The present publication is the result of this long procedure to give a name for this borate mineral. Because the type locality is the same as in the original proposal 95–020, there is no problem there. Only the holotype material will of course be different. The decision to approve the mineral was already published (without the name, as usual) in the yearly list of new minerals, e. g., in *Canadian Mineralogist*, 34 (1996), 687. The outcome of the CNMMN vote on jarandolite was published in Memorandum Vol. 29, Nr. 9; votes for the mineral: 25 yes, 1 no, 0 abstain; votes for the name: 24 yes, 2 no, 0 abstain.

The authors of the jarandolite proposal have communicated to the CNMMN chairman that their main goal is to publish an extended set of data on this mineral under an approved name. In their paper they will mention the previous work of the team of Stojanovic', and corresponding references will also be given. This has to be considered as a very honourable attitude from the Russian team.

E.A.J. Burke, chairman of the IMA CNMMN

Occurrence

Deposits, in which ores the new calcium borate was determined, are located in Sought-West Serbia and confined to the chain of continental sedimentary basins, situated along Balkan Peninsula at the East of Mediterranean Sea region, which was formed as a result of intensive Oligocene-Pliocene tectonogenesis. One of them is Jarandol Miocene lacustrine basin with area up to 200 km², in which borate deposits was found. Magnesite deposits, containing borate layers and coal intercalations, alternating with analcime-enriched tufogenic rocks, clays, and marls, compose this sedimentary basin. Subsequent Oligocene-Pliocene volcanism and tectonic activity have formed here the lacustrine facies of Neogene volcano-sedimentary formations with thickness 850–1500 m. As a result of extremely diverse conditions of sedimentation in Jarandol basin the volcano-sedimentary series, consisting of argillaceous rocks, which contain different amounts of tufogenic and carbonaceous sediments, coaly, magnesite, and borate lens, was formed (Obradovic' *et al.*, 1992).

Borate deposits mainly occur in tufogenic and argillaceous rocks at different depth from day surface and have thickness from 1 to 12 m

(average is 4 m). Main boron minerals in them are colemanite, howlite, ulexite, and veatchite. In earlier studied by us new borate from these ores, studenitsite $\text{NaCa}_2[\text{B}_9\text{O}_{14}(\text{OH})_4]\cdot 2\text{H}_2\text{O}$, the veinlets of pentahydroborite are determined firstly for this deposit. In single cases in volcano-sedimentary rocks of Jarandol basin there were the finds of searlesite and lüneburgite, filling the cracks in magnesite deposits. The distribution of montmorillonite in assemblage with borates is typical.

Morphology and physical properties.

The studied samples of new borate from 1.5×3.0 to 2.0×3.5 cm in size, which was collected from the core of hole at the depth nearly 100 m from day surface, are presented by the fragments of aggregate of jarandolite crystals, intergrowing along elongation, with tabular habit (Fig. 2). The size of separate individuals varies within the limits from first millimeters to 1.5 cm in length at the thickness from a fraction of millimeter to 1–2 mm. The mineral is colourless, semitransparent in mass and transparent in small fragments. The colour in powder is white. In some samples there are the smectite segregations, which tincture the neighboring jarandolite crystals in light brown colour. The lustre is vitreous, cleavage is highly perfect on (001). The micro-indentation of the mineral was measured by E.G. Ryabova on apparatus PMT–3, calibrated on rock salt at load 50 g, exposition 15 sec.; average value is calculated by five imprints: $H_{\text{average}} = 645 \text{ kg/mm}^2$ ($H_0 = 6.0$); $H_{\text{min}} = 616 \text{ kg/mm}^2$ ($H_0 = 6.0$); $H_{\text{max}} = 669 \text{ kg/mm}^2$ ($H_0 = 6.1$). The imprint is correct; the mineral is brittle. The density, measured with hydrostatic weighing, is $2.49(2) \text{ g/cm}^3$. The density, calculated from empirical formula, is 2.57 g/cm^3 . The mineral does not interact with water, slowly dissolves in diluted HCl and H_2SO_4 . In cathode and ultraviolet rays the min-

eral does not luminesce.

The mineral is optically biaxial, positive. $2V_{\text{exp}} = 60(2)^\circ$; $2V_{\text{calc}} = 59^\circ 23'$. Refractive indexes measured by immersion method in white light are: $n_p = 1.573(2)$, $n_m = 1.586(2)$, $n_g = 1.626(2)$. Dispersion of optical axes is medium, $r > v$. Elongation is positive. Orientation is following: $Np = c$, $Nm = b$, $aNg = +8^\circ$. Pleochroism is absent.

The seven samples of crystal fragments with traces of faces were measured on two-circle reflected goniometer GD–1. On the six crystals there are only two simple forms: pinacoid {001} and orthorhombic prism {110}. On the seventh crystal the traces of two faces of orthorhombic prism {11} are noted. The quality of faces is bad, all signals of goniometer was fixed only by reflections (from here there is a precision of measuring $\sim 1^\circ$). The surface of all faces is imperfect: the pinacoid is slightly curved; on the prism faces there are the traces of dissolution. For goniometric measuring the crystals are regulated by faces of zone [100]. The transition to standard mineralogical setting ($c_{001} = 8.33^\circ$) was made with Wulff net. The theoretical values of spherical faces coordinates was calculated by values of unit cell parameters of the mineral: for {110} $-\varphi_{\text{exp.}} -10^\circ$, $\varphi_{\text{calc.}} = 9.31^\circ$, $\rho_{\text{exp.}} -43^\circ$, $\rho_{\text{calc.}} = 42.08^\circ$, for {-111} $\varphi_{\text{exp.}} \sim -34^\circ$, $\varphi_{\text{calc.}} = -33.21^\circ$, $\rho_{\text{exp.}} -47^\circ$, $s_{\text{calc.}} = 46.67^\circ$. The crystal appearance is tabular (elongation along [100], flattening on [001]). The habit is pinacoid-orthorhombic (Fig. 3).

The simple twins are observed in polished sections. The measured value of orientation of normal to plane of composition face, $DN_g \sim 83^\circ$, corresponds well to theoretical angle $81.67^\circ = 90^\circ (cN_g) - 8.33^\circ (c_{001})$ for penetration twin on (001).

In IR-spectrum of jarandolite the wave numbers for maximums of absorption bands (Fig. 4) are following (cm^{-1} ; s — strong band, w — weak band, sh — shoulder): 3550 s, 3115, 2980, 1447, 1402 s, 1369, 1300 s, 1226, 1135 sh,

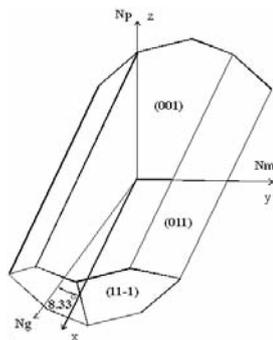


FIG. 3. The appearance of jarandolite crystal

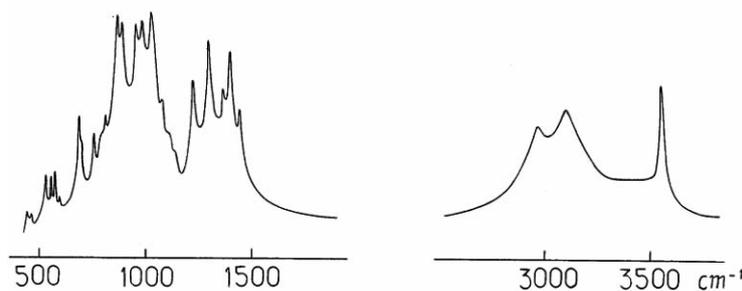


FIG. 4. IR-spectrum of jarandolite

Table 1. Data of calculation of X-ray powder diagram of jarandolite (Co radiation, DRON UM-1)

| $I_{\text{obsr}} \%$ | $d_{\text{obsr}} \text{ \AA}$ | $d_{\text{caler}} \text{ \AA}$ | hkl |
|----------------------|-------------------------------|--------------------------------|-----------|
| 2 | 4.77 | 4.76 | -111 |
| 57 | 4.32 | 4.31 | 111 |
| 5 | 4.16 | 4.15 | 200 |
| 5 | 4.08 | 4.07 | 020 |
| 4 | 3.54 | 3.54 | 021 |
| 5 | 3.48 | 3.47 | -211 |
| 100 | 3.39 | 3.385 | 201 |
| 13 | 3.18 | 3.18 | 121 |
| 50 | 3.13 | 3.13 | 211 |
| 23 | 2.93 | 2.93 | -202 |
| 8 | 2.795 | 2.793 | 221 |
| 5 | 2.758 | 2.758 | -212 |
| 14 | 2.690 | 2.691 | 022 |
| 25 | 2.606 | 2.603 | 221 |
| 17 | 2.360 | 2.358 | 311 |
| 19 | 2.287 | 2.288 | 320 |
| 6 | 2.212 | 2.215 | -203 |
| 12 | 2.155 | 2.153 | 222 |
| 10 | 2.115 | 2.117 | 231 |
| 11 | 2.074 | 2.074 | -401, 400 |
| 12 | 2.061 | 2.062 | -123, 023 |
| 3 | 2.033 | 2.035 | 040 |
| 3 | 2.009 | 2.010 | -411, 410 |
| 4 | 1.975 | 1.977 | 140 |
| 7 | 1.951 | 1.953 | 203 |
| 5 | 1.944 | 1.945 | 123 |
| 11 | 1.921 | 1.920 | -402 |
| 3 | 1.867 | 1.869 | -412, 411 |
| 25 | 1.849 | 1.848 | -421, 420 |
| 1 | 1.826 | 1.827 | 240 |
| 1 | 1.782 | 1.782 | -332 |
| 7 | 1.756 | 1.757 | -142 |
| 4 | 1.736 | 1.737 | -422, 421 |
| 5 | 1.693 | 1.693 | -403, 402 |
| 5 | 1.658 | 1.658 | -413 |
| 5 | 1.627 | 1.626 | 510 |
| 2 | 1.323 | 1.323 | 601 |
| | | 1.322 | -161 |
| 2 | 1.309 | 1.309 | 620 |

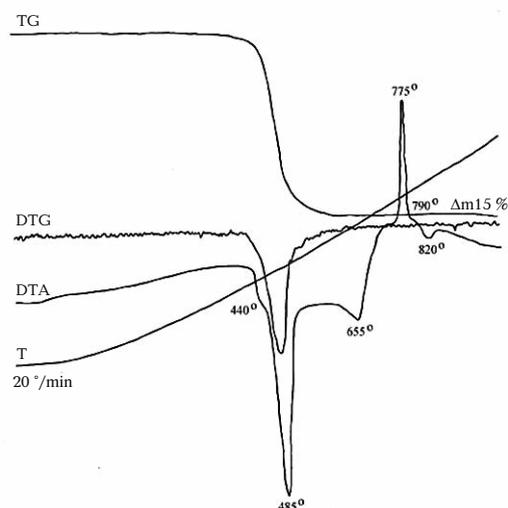


FIG. 5. Derivatogram of jarandolite. Thermoanalyzer «Thermoflex», preparation mass is 30 mg, $T_{\text{max}} \sim 1000^\circ\text{C}$

1110 sh, 1075, 1026 s, 983 s, 953 s, 889 s, 867 s, 810, 795 sh, 756, 695 sh, 687, 597 w, 577, 560, 533, 444 w, 419 w. Two groups of bands in the ranges $850 - 1050 \text{ cm}^{-1}$ (most intensive) and $1220 - 1450 \text{ cm}^{-1}$ (less intensive) correspond to stretching vibrations with participation of the bonds $^{\text{IV}}\text{B}-\text{O}$ (in tetrahedrons $\text{BO}_2(\text{OH})_2$ and $\text{BO}_3(\text{OH})$) and $^{\text{III}}\text{B}-\text{O}$ (in triangles BO_3) respectively. The bands at 2980 and 3115 cm^{-1} are caused by $\text{O}-\text{H}$ -valent oscillations of two OH -groups, forming very strong hydrogen bonds. The narrow band at 3550 cm^{-1} corresponds to almost free (non forming hydrogen bonds) OH -group. It is obvious that only the latter OH -group can replace Cl without significant energy expenses, which would be necessary for break of hydrogen bonds. The absence of bands in the range $1500 - 1700 \text{ cm}^{-1}$ is evident of the absence of molecules H_2O in crystal structure of jarandolite.

On thermogram of jarandolite (thermal analysis was made by R.N. Yudin, the rate of heating is $20^\circ/\text{min}$ (Fig. 5), three endothermic effects are distinctly displayed; the first effect is connected to double peak with two non-equivalent maximums: less significant at 440°C and more strong at 485°C ; this reaction is accompanied by conformed minimum on DTG curve, and also large ledge on thermogravimetric curve, which fixes approximately 15% loss of mass. The second endothermic peak is the less pronounced endothermic reaction, characterized by flattened peak with maximum at 655°C on DTA curve; it is not accompanied by the loss of mass. The third endothermic effect has the maximum at 820°C . Apparently, the first, most strongly pronounced endothermic reaction is connected to dehydroxylation. The total loss of mass during thermal analysis (approximately 15%) is completely concern to this endothermic reaction and close to content of H_2O in the mineral, which was determined by chemical analysis (13.36%). The endothermic reaction, characterized by flattened peak with maximum at 655°C , apparently, is caused by some crystal structural changes of the mineral, whereas the endothermic peak at 820°C fixes its melting. In addition to endothermic reactions, on thermogram of jarandolite the exothermic reaction with maximum at 775°C is strongly pronounced, evidently, it is connected to so-called borate regrouping, i. e. reconstruction of crystal structure, which is peculiar to most of hydrous borates under increased temperatures.

Chemical composition

Chemical composition of jarandolite was

studied by method of wet chemistry (analyst S.P. Purusova) from the sample, which was preventively studied by physical, optical, and X-ray methods. The contents of main components are following (wt %): Na_2O 0.05, K_2O 0.07, CaO 30.56, MgO 0.02, MnO 0.01, Fe_2O_3 0.20, Al_2O_3 0.03, SiO_2 0.20, B_2O_3 55.44, Cl 0.21, H_2O 13.36, $-\text{O}=\text{Cl}_2$ -0.05 , total 100.10. The empirical formula of jarandolite, calculated on 3 atoms (B + Si) is $\text{Ca}_{1.02}(\text{B}_{2.99}\text{Si}_{0.01})\text{O}_{4.125}(\text{OH})_{2.79}\text{Cl}_{0.01}$ (taking in account only components with content >0.005 atoms per formula unit). The ideal formula is $\text{Ca}(\text{B}_3\text{O}_4)(\text{OH})_3$. The compatibility by Gladstone-Dale criterion is good: $1 - (\text{K}_p/\text{K}_c) = -0.003$ («Superior») for D_{calc} ; $1 - (\text{K}_p/\text{K}_c) = -0.037$ («Excellent») for D_{exp} .

X-ray and structural studies

X-ray and structural studies of jarandolite was made by N.A. Yamnova, Yu.K. Egorov-Tismenko, and D.Yu. Pushcharovskii (1994). For X-ray structural analysis the monocrystal with line sizes $0.450 \times 0.300 \times 0.250$ mm was selected. The parameters and symmetry of monoclinic (Laue class $2/m$) unit cell of jarandolite are following: $a = 8.386(3)$, $b = 8.142(4)$, $c = 7.249(3)$ Å, $\beta = 98.33(3)^\circ$, $V = 489.7$ Å³, these values have been determined by Laue swing method and refined by automatic diffractometer P Syntex ($\text{MoK}\alpha$ radiation, flat graphite monochromator). Space group is $P2_1/a$. The X-ray powder diagram (Tabl. 3) is good indexed with the obtained unit cell parameters.

Crystal structure of this mineral was solved by direct method with the program MULTAN up to R-factor 0.035 and entirely is considered in the article (Yamnova *et al.*, 1994). The formula of jarandolite $\text{Ca}[\text{B}_3\text{O}_4(\text{OH})_3]$ ($Z = 4$, X-ray density 2.54 g/cm^3) corresponds to this structure.

The parallel (001) goffered layers-walls of centrosymmetric pairs of Ca-polyhedra, united on mutual O-vertexes, compose the base of crystal structure of jarandolite. The walls are interlaid by boron-oxygen bands of colemanite type $[\text{B}_3\text{O}_4(\text{OH})_3]$, which are elongated along b axis of unit cell and formed by tetrahedra of two types, $\text{BO}_2(\text{OH})_2$ and $\text{BO}_3(\text{OH})$, and triangle BO_3 groups. However, in contrast to colemanite, in crystal structure of jarandolite the rings are as if curled around spiral axis 2_1 . The structure of cationic constructions is also different: in colemanite the bands of centrosymmetric pairs of eight-vertex Ca-polyhedra are endless along the a axis of unit cell whereas in jarandolite these bands are united in the layer-walls. As

it is above-mentioned, two out of three hydroxyl groups form strong hydrogen bonds.

Jarandolite is structurally and chemically close to colemanite $\text{Ca}[\text{B}_3\text{O}_4(\text{OH})_3] \cdot \text{H}_2\text{O}$ ($P2_1/a$, $a = 8.743$, $b = 11.264$, $c = 6.102$ Å, $\beta = 110.115^\circ$, $Z = 4$), which is distinguished from jarandolite by optical constants ($n_p = 1.586$, $n_m = 1.592$, $n_g = 1.614$, $2V = 125^\circ$), optical sign, density ($D = 2.54 \text{ g/cm}^3$), and other characteristics.

The standard sample of jarandolite is deposited in Fersman Mineralogical Museum RAS, Moscow (registration № 1538/1).

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The leading role in the study of new borate played an outstanding specialist in mineralogy of boron deposits S.V. Malinko (1927–2002), and we devote the conclusion of this work to her memory.

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