BITYITE $2M_1$ FROM ERÄJÄRVI COMPARED WITH RELATED Li—Be BRITTLE MICAS

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Bityite was encountered in thee lithium pegmatite dykes in the Eräjärvi area in Orivesi, southern Finland. The mineral is closely associated with beryl occurring in pseudomorphs after it or in cavities with bertrandite, fluorite and fluorapatite as a fine-scaled white or yellowish mass with a pearly lustre. This is the first description of the mineral from Finland.

A bityite sample found in a small abandoned feldspar quarry called Maantienvarsi was studied in detail. Wet chemical analysis shows (wt %): SiO_2 33.35, Al_2O_3 34.61, Fe_2O_3 tot. 1.37, MgO 1.84, CaO 14.07, BeO 7.21, Na_2O 0.10, K_2O 0.16, Li_2O 2.32, H_2O+ 5.33 and F 0.39. The formula computed on the basis of 24 anions is as follows ($Z=2$):

$Ca_{1.93}K_{0.03}Na_{0.02}(Li_{1.19}Al_{3.68}Mg_{0.35}Fe_{0.13})(Al_{1.53}Be_{2.21}Si_{4.26})O_{19.30}(OH)_{4.54}F_{0.16}$. The mica is monoclinic and the space group is C2/c or Cc with $a=4.99$ Å, $b=8.68$ Å, $c=19.04$ Å and $\beta=95.17°$. The refractive indices are $\alpha=1.650$, $\beta=1.658$, $\gamma=1.660$ and $-2V\text{calc.}=52.9°$. The specific gravity is near 3.05 and the density is 3.12 g/cm^3. The following infrared absorbtion bands were recorded for the mineral (cm^{-1}): 3620, 3451, 1634, 1400, 949, 707, 537 and 431. The lack of absorbtion near 800 cm^{-1} caused by Al—O—Al stretching vibrations indicates ordering of tetrahedral Si and Al + Be.

The analytical data collected from the literature show a series between trioctahedral bityite $Ca_2(Li_2Al_4)(Al_2Be_2Si_4)O_{20}(OH)_4$ and octahedral mica margarite $Ca_2Al_4(Si_4Al_4)O_{20}(OH)_4$. Natural Li—Be brittle micas are always deficient in Li, and there seems to be a miscibility gap between the end members. In contrast to the ideal formula, at most 1—1.2 of the two possible Li atom sites are filled. The valency balance is achieved by substituting Al^{3+} for $Li^{1+} + Be^{2+}$ and O^{2-} for $(OH+F)^{1-}$. The replacement of cations may be more complex.

The Maantienvarsi Li—Be mica is typical bityite with the high content of Li and Be and its properties agree well with those of similar micas. The sum of octahedral cations, 5.35, is the highest known of the Li-Be micas reported in the literature.

Key words: bityite, brittle micas, physical properties, chemical composition, unit cell, infrared spectroscopy, Eräjärvi, Finland.

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Introduction

White Li- and Be-rich brittle mica replacing beryl was detected in the granitic pegmatite »Maantienvarsi» dyke during pegmatite studies carried out by one of the authors (SIL) in the Eräjärvi pegmatite area (Lahti 1981, 1983). Mineralogical studies confirmed that its chemical composition and physical properties are comparable to those given by Strunz (1956) for bityite. The mineral is relatively common in pseudomorphs after beryl or in cavities in the Maantienvarsi dyke. Bityite was later also encountered in two nearby dykes, »Suonlaita» and »Keskimetsä»; their mineralogy has been described earlier by Lahti (1981). Each of the dykes is zoned and exhibits large sugar albite or cleavelandite replacement bodies and fracture fillings containing beryl, columbite—tantalite, Li phosphates and silicates.

The mineral is not easy to recognize and may be confused with other micas. About three kilometres north of the Maantienvarsi pegmatite there is the well-known Viitaniemi pegmatite (Volborth 1954, Lahti 1981), in which fine-grained greenish yellow muscovite (gilbertite) with beryllium phosphates (väyrynenite and hydroxyl herderite) in pseudomorphs after beryl is a common mineral. Spectrographic determination of one muscovite sample indicates 570 ppm beryllium. In the Leikattu pegmatite, in the western part of the area, the pseudomorphs are filled with montmorillonite and bertrandite, whereas in the Juurakko dyke black or silky light green chlorite occurs with beryl and bertrandite. The beryllium content of the Juurakko black, iron-rich chlorite is as high as 1100 ppm (emission spectrography).

After a careful search for altered beryl crystals, small amounts of bityite were encountered in one pegmatite dyke in the Kitee—Tohmajärvi area, eastern Finland (see Kallio and Alviola 1975) and in the Kaatiala dyke, western Finland (see Haapala 1966). The mineral may also occur elsewhere in beryl-bearing dykes where hydrothermal solutions caused alteration at the end of the crystallization of the dyke.

Bityite has been reported as a rare mineral from only a few pegmatite deposits. Its properties and occurrence are not fully known. The type bityite was described by Lacroix (1908) from Mt Bity, Madagascar. The mineral bowleyite described by Rowledge and Hayton (1947) from Londonderry, western Australia, is also bityite (Strunz 1956). Bityite or intermediate micas between bityite and margarite have later been reported from several localities in Africa (Gallagher and Hawkes 1966), from the USSR (Beus 1956, Kutukova 1959), from Germany (Tennyson 1960) and from Italy (Lin and Guggenheim 1983).

A great variety of names have been given for Li-Be micas in the literature. To avoid confusion in definitions, the present authors use the following classification (see Figure 3 showing the atomic composition of the micas in Li *vs.* Be diagram):

- bityite contains both Li and Be > 1 atom/formula
- beryllium margarite contains Be > 1 atom/formula and Li < 1 atom/formula
- lithian and/or beryllian margarite contains both Li and Be < 1 atom/formula.

For this study bityite was separated from a pseudomorph after beryl of the Maantienvarsi pegmatite dyke (abandoned feldspar quarry). One of the authors (SIL) is responsible for the mineralogical studies and the other (RS) for the chemical analysis.

Occurrence

Bityite always occurs in close association with beryl, replacing it either in pseudomorphs after beryl (Fig. 1) or in cavities associated with altered beryl crystals in a dyke in the middle of the Maantienvarsi pegmatite. The 2—4-m-wide dyke occurs in an almost E—W direction in the contact between a Svecokarelian late orogenic

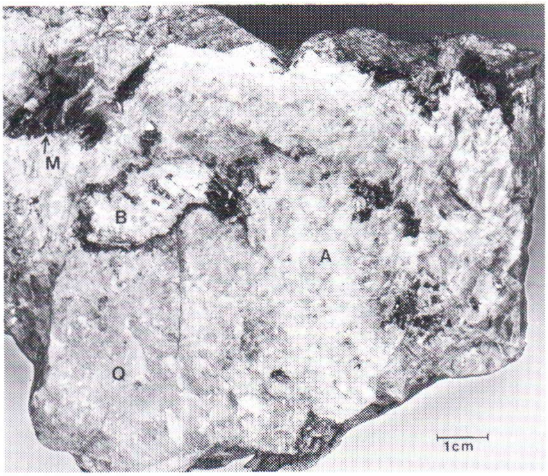

Fig. 1. Bityite-bearing pseudomorph (B) after beryl in a pegmatite sample from the Maantienvarsi feldspar quarry. Associated minerals: A = albite, Q = quartz and M = muscovite.

microcline granite stock and surrounding mica schist. The main minerals are perthitic microcline, quartz, albitic plagioclase, muscovite and black tourmaline. There is a small abandoned feldspar quarry at the dyke.

The dyke is zoned. The border zone is composed of fine-grained oligoclase pegmatite of increasing grain size so much so that the intermediate zone contains microcline crystals one metre long. The rare minerals, including beryl, bityite, spodumene, cassiterite, Fe-tantalite, lepidolite, zircon, lithiophilite and its alteration products, are concentrated in albite-rich pegmatite parts between the big microcline crystals or in small sugar albite or cleavelandite veins crosscutting them.

The pseudomorphs filled with bityite are always small, 0.5—3.0 cm in diameter, and also contain varying amounts of small, purple fluorite crystals and occasionally thin transparent bertrandite crystal plates, light green fluorapatite, quartz and corroded remnants of beryl. The cavities rich in bityite are also small and contain the same minerals, but the crystals of fluorite, fluorapatite and bertrandite are often euhedral. Bityite has crystallized as an alteration product of beryl from fluorine-rich, probably acid hydrothermal solutions or fluids, although Černý (1968) has suggested that alumoberyllosilicates of alkalies and alkali earths are indicative of alkaline parent solutions.

Physical properties

Bityite occurs as a fine-scaled ($\varnothing < 0.3$ mm) white or yellowish mass. The strong pearly lustre of the mineral is one of its characteristic properties. The indices of refraction measured by the immersion method are as follows: $\alpha = 1.650 \pm 0.001$, $\beta = 1.658 \pm 0.001$, $\gamma = 1.660 \pm 0.001$, $\gamma - \alpha = 0.010$ and $-2V\text{calc.} = 52.9°$. The determinations were carried out in Na light. The index of the refraction of the liquids was tested on an Abbe refractometer. The optic axial angle could not be measured in a universal stage because the mica flakes are so thin.

The refractive indices of the Maantienvarsi bityite are very close to those reported for the Madagascar bityite ($\alpha = 1.651$, $\beta = 1.659$ and $\gamma = 1.661$; Strunz 1959) and Londonderry bityite ($\alpha = 1.650$, and $\gamma = 1.661$; Rowledge and Hayton 1947). Substitution of Al by Li + Be causes an increase in the refractive indices, and the corresponding values of the Be—Li margarites intermediate in composition are generally much lower.

The specific gravity of the Maantienvarsi bityite, almost 3.05, was measured with heavy liquids. The density of the liquids was tested with a Westphal balance. Exact determination failed owing to the fine particle size of the mineral, but the value obtained is close to the calculated density 3.12 g/cm^3 and the specific gravity of other bityites described in the literature.

X-ray studies

The mineral was studied with a precession camera. O-, 1- and 2-level, a- and b-axis photographs were taken using Zr-filtered Mo radiation. The precession photographs show monoclinic symmetry for the mineral with systematic absences of $h+k \neq 2n$ for general reflections and $1 \neq 2n$ for h01 reflections, indicating possible space groups of C2/c or Cc. On the basis of three mica flakes studied the mineral is a two layer-type modification (polytype $2M_1$). The unit cell dimensions measured from the films are as follows: $a = 4.99$ Å, $b = 8.68$ Å, $c = 19.04$ Å, $\beta = 95.17°$ and $V = 821.33$ Å^3. The shrinkage of the films was corrected using silicon reflections exposed to the films.

The unit cell data on the Maantienvarsi bityite and the type bityite from Mt Bity Madagascar, are almost identical. Professor Th. G. Sahama kindly donated a small sheet of the type bityite (from Madagascar) for our studies. He had got the mica sample from Professor Hugo Strunz, who used the same material in his studies in 1956. The precession camera studies show that the symmetry, unit cell dimensions ($a = 5.02$ Å, $b = 8.69$ Å, $c = 19.07$ Å, $\beta = 95.08°$ and $V = 828.64$ Å^3) and intensities of the reflections of both bityites are nearly identical. X-ray powder diffraction studies on the same material with a Debye-Scherrer camera (114.6 mm in diameter) confirmed the results and both of the x-ray powder diffraction film data are comparable to those given for bityite in JCPDS-card 11—400.

The unit cell of the Li- and Be-rich brittle mica of intermediate composition from the Mops pegmatite (the chemical composition given in Table 1, analysis no. 10) and studied in detail by Lin and Guggenheim (1983) is slightly greater. Their results are, however, consistent with our determinations, because the substitution of Al by Li + Be reduces the lateral dimensions of both octahedral and tetrahedral sheets in particular.

Chemical analysis

For the chemical analysis bityite was separated with heavy liquids (dijodmethan) and a Franz isomagnetic separator. The density fraction 3.05—3.15 was accepted for study. The chemical composition of bityite was first analysed semiquantitively with an electron microprobe and optical emission spectrograph and then with wet chemical methods.

The sample was dried at 105°C. One portion (0.1 g) was fused with sodium carbonate. Silica was determined gravimetrically by dehydration with hydrochloric acid and the residual silica retained in the filtrate was determined colorimetrically. Aluminium, magnesium and calcium in the filtrate of silica were analysed by atomic absorption spectrophotometry.

One portion (0.1 g) was decomposed by treatment with hydrofluoric-sulphuric acid, and aliquots were taken to measure manganese and total iron colorimetrically, and sodium, potassium, beryllium and lithium by atomic absorption spectrophotometry. H_2O+ was determined gravimetrically using the Penfield method. Fluorine was analysed with an ion-selective electrode.

Table 1 shows the chemical analysis (no. 12) of the mineral compared with eleven Li—Be brittle mica analysis taken from the literature. Computed on the basis of 24 (O, OH, F) the formula of the mineral may be written as follows ($Z = 2$):

$$Ca_{1.19}K_{0.03}Na_{0.02}(Li_{1.19}Al_{3.68}Mg_{0.35}Fe_{0.13})_{5.35}$$
$$(Al_{1.53}Be_{2.21}Si_{4.26})_8O_{19.30}(OH)_{4.54}F_{0.16}.$$

Infrared spectrum

The infrared spectrum of the Maantienvarsi bityite is compared in Figure 2 with the spectrum of Li and Be poor margarite (Li < 500 ppm and Be < 50 ppm, spectrographic determinations) from Enontekiö, northern Finland. The spectra were recorded at the Technical Research Centre of Finland with a Perkin-Elmer 983 spectrophotometer fitted with a Data Station 3600 computer. The conventional pressed disc-

Table 1. The chemical composition of Maantienvarsi bityite (no. 12) compared with the composition of the related Li—Be brittle micas reported in the literature.

	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	32	29.84	30.16	30.88	31.95	30.44	33.1	36.1	33	31.26	33.37	33.35
TiO_2	0.1	—	0.00	—	—	—	0.0	0.2	0.0	—	0.00	0.00
Al_2O_3	42	47.35	45.59	46.22	41.75	45.56	37.0	40.8	37	44.37	36.24	34.61
Fe_2O_3	0.0	0.81	0.13	0.37	—	0.38	0.02	0.02	0.02	0.17	0.19	1.37
MnO	—	—	—	—	—	—	—	—	—	—	0.00	0.00
MgO	—	1.22	1.06	0.87	0.13	0.67	0.1	0.1	0.1	—	0.04	1.84
CaO	14	11.70	13.18	13.90	14.30	13.48	14.5	12.7	14.6	13.64	14.42	14.07
BeO	2.5	1.18	1.88	2.67	2.27	3.26	7.2	3.8	7.2	4.1	7.30	7.21
BaO	—	—	0.00	—	—	0.04	—	—	—	—	—	—
Na_2O	0.8	1.93	1.08	0.70	0.40	0.57	0.1	0.4	0.1	0.19	0.29	0.10
K_2O	0.5	0.55	0.52	0.21	0.16	0.25	0.03	0.1	0.03	0.01	0.04	0.16
Li_2O	0.05	0.47	0.72	0.38	2.73	0.78	1.8	1.9	2.0	2.1	2.39	2.32
H_2O+	6	4.48	3.80	3.40	6.50	3.98	6.1	4.7	6.0	5.1	5.72	5.33
F	—	0.70	1.64	1.35	—	0.82	—	—	—	—	0.00	0.39
	97.95	100.23	99.76	100.95	100.19	100.23	99.95	100.82	100.05	100.94	100.00	100.75
—O=F	—	0.29	0.69	0.57	—	0.35	—	—	—	—	—	0.16
	97.95	99.94	99.07	100.38[1]	100.19	99.88[2]	99.95	100.82	100.05	100.94	100.00[3]	100.59[4]
Atoms based on 24 (O, OH, F)												
Si	4.25	3.96	4.04	4.08	4.12	4.01	4.21	4.62	4.20	4.01	4.26	4.26
Al	2.95	3.66	3.36	3.07	3.18	2.96	1.59	2.21	1.60	2.73	1.50	1.53
Be	0.80	0.38	0.60	0.85	0.70	1.03	2.20	1.17	2.20	1.26	2.24	2.21
ΣZ	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Al	3.63	3.75	3.83	4.13	3.16	4.12	3.96	3.95	3.95	3.98	3.94	3.68
Ti	0.01	—	—	—	—	—	0.00	0.02	0.00	—	0.00	0.00
Fe^{3+}	0.00	0.08	0.01	0.04	—	0.04	0.00	0.00	0.00	0.02	0.02	0.13
Mn	—	—	—	—	—	—	—	—	—	—	—	0.00
Mg	—	0.24	0.21	0.17	0.03	0.13	0.02	0.02	0.02	—	0.01	0.35
Ba	—	—	—	—	—	0.00	—	—	—	—	—	0.00
Li	0.03	0.25	0.39	0.20	1.41	0.41	0.92	0.98	1.02	1.08	1.23	1.19
ΣY	3.67	4.32	4.44	4.54	4.60	4.70	4.90	4.97	4.99	5.08	5.20	5.35
Ca	1.99	1.66	1.89	1.97	1.97	1.90	1.98	1.74	1.99	1.88	1.97	1.93
Na	0.21	0.50	0.28	0.18	0.10	0.15	0.02	0.10	0.02	0.05	0.07	0.02
K	0.08	0.09	0.09	0.04	0.03	0.04	0.00	0.02	0.00	0.00	0.01	0.03
ΣX	2.28	2.25	2.26	2.19	2.10	2.09	2.00	1.86	2.01	1.93	2.05	1.98
OH	5.32	3.97	3.39	3.00	5.59	3.50	5.18	4.01	5.09	4.37	4.87	4.54
F	—	0.29	0.69	0.56	—	0.34	—	—	—	—	—	0.16
(OH + F)	5.32	4.26	4.08	3.56	5.59	3.84	5.18	4.01	5.09	4.37	4.87	4.70
O	18.68	19.74	19.91	20.44	18.41	20.16	18.82	19.99	18.91	19.63	19.13	19.30

All iron assumed ferric — not determined [3] ignition loss as H_2O+ [2] omitted wt% S 0.11, Cl 0.20 [1] omitted wt% Cr_2O_3 0.40, Cl 0.13 [4] omitted (ppm) B 1500, Ga 160, Cu 14, Sn 88, Cr<20, Ti<200, emission spectrographic determinations.

The locations of the samples and references:

1. Namhere Mine, Ankola, Uganda (Gallagher and Hawkes 1966).
2. USSR (Beus 1956).
3. Urals, USSR (Kutukova 1959).
4. Urals, USSR (Kutukova 1959).
5. Maharitra, Madagaskar (Strunz 1956).
6. Urals, USSR (Kutukova 1959).
7. No Beer pegmatite, Bikita district, Zimbabwe (Gallagher and Hawkes 1966).
8. Mops pegmatite, Salisbury district, Zimbabwe (Gallagher and Hawkes 1966).
9. Benson 4 pegmatite, Mtoko District, Zimbabwe (Gallagher and Hawkes 1966).
10. Mops pegmatite, Zimbabwe (Lin and Guggenheim 1983, microprobe analysis of the sample no. 8 in this table).
11. Londonderry feldspar quarry, western Australia (Rowledge and Hayton 1947).
12. Maantienvarsi, Finland (This study).

technique, in which 1 mg of the powdered sample was ground with 300 mg KBr, was used.

The following absorption bands were recorded for Maantienvarsi bityite (cm^{-1}): 3620, 3451, 1634, 1400, 949, 707, 537 and 431. The spectrum is near to that given by Farmer and Velde (1973) for two »beryllium margarite» samples from Zimbabwe. They studied the material of Gallagher and Hawkes (1966), whose analyses are referred to in Table 1 (nos. 8, 10 and 9) in this study. In fact, the composition of the sample richest in Be (7.2 wt %) and Li (2.0 wt %) is near the composition of the Maantienvarsi Li- and Be-rich mica called bityite by the present authors.

Farmer and Velde (1973) have discussed the infrared spectrum of Li- and Be-bearing margarites and related micas in detail. The sharp absorption bands that characterize the spectrum of both the bityite and the margarite studied by the present authors distinguish them from those reported by Farmer and Velde (1973). In their interpretation, the diffuse absorptions of the micas are due to the random substitution of tetrahedral Al by Be compensated by additional Li in octahedral layers.

The sharp infrared spectrum of the Maantienvarsi bityite indicates the well-ordered structure of the mineral. Evidence also exists for the absence of absorbtion near 800 cm^{-1}, which

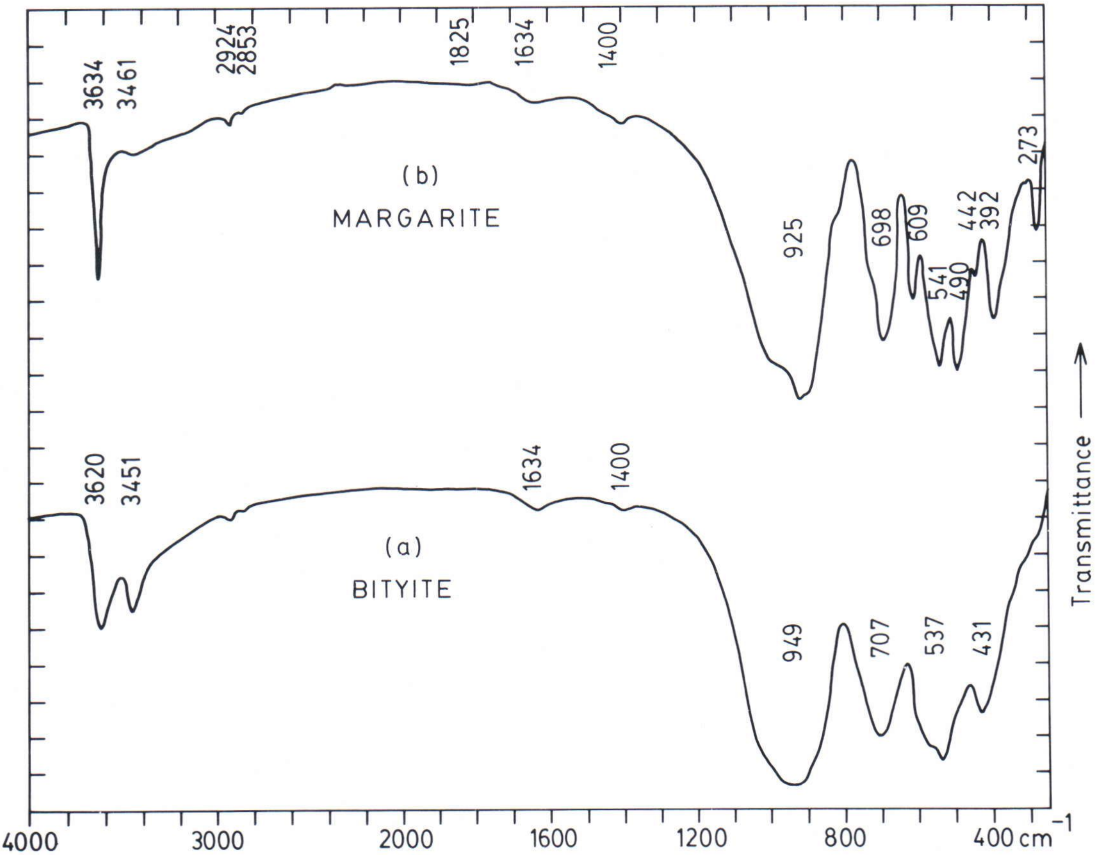

Fig. 2. The infrared spectrum of (a) bityite from the Maantienvarsi pegmatite compared with that of (b) margarite from Enontekiö, northern Finland.

should indicate Al—O—Al bonds in the structure (Farmer and Velde 1973). Silicon and aluminium + beryllium do not occupy alternate sites in the tetrahedral layers and thus the Al—O—Al stretching vibrations typical of disordered micas are prevented.

The infrared spectrum or margarite and bityite shows many common absorbtions. The most prominent differences are below 700 cm^{-1}, but the absorption bands between 3460 and 3650 cm^{-1} caused by OH groups are also different. As shown by Farmer and Velde (1973) and confirmed by the present authors, bityite has two strong OH absorptions near 3620 and 3450 cm^{-1} in contrast to the one strong and one to two weak absorptions in the spectrum of margarite.

Discussion

Bityite was described as a new mineral by Lacroix (1908) and the unit cell data for the mineral were given by Strunz (1956). Lin and Guggenheim (1983) carried out a detailed crystal structure analysis of a related Li- and Be-bearing mica, and later Guggenheim (1984) examined closely the structure of the Li-Be and other brittle micas. The structural determination by Lin and Guggenheim (1983) was preceded by a study by Farmer and Velde (1973), who used infrared spectroscopy to investigate the ordering of tetrahedral cations of brittle micas. The data available on the chemistry and properties of bityite and related micas are, however, limited.

Strunz (1956) generalized the formula of bityite as $Ca_2(Li_2Al_4)(Al_2Be_2Si_4)O_{20}(OH)_4$. Most of the Li- and Be-bearing micas described in the literature are intermediate in composition between trioctahedral bityite and dioctahedral margarite $Ca_2Al_4(Al_4Si_4)O_{20}(OH)_4$. Table 1 lists the chemical analyses and atomic composition of bityite and related micas given in the literature. Beryllium occurs in the tetrahedral coordination replacing aluminium and silica. Lithium and aluminium occupy octahedral cation sites with minor magnesium and iron.

The valency balance between octahedral and tetrahedral layers is achieved by substituting Al^{3+} for $Li^{1+} + Be^{2+}$. Replacement of O^{2-} by $(OH+F)^{1-}$ also seems probable, because nearly all the micas analysed show excess (OH + F). The fluorine concentration is not very high, although the mineral often occurs with fluorite or other fluorine-rich minerals. The substitutions of various elements in the Li-Be brittle micas have been examined in many papers (see *e.g.* Strunz (1956), Ginsburg (1957), Schaller *et al.* (1967) and Guggenheim (1984)).

Calcium is the main interlayer cation, but potassium and especially sodium can replace it in small amounts. The miscibility gap towards ephesite $Na_2(Li_2Al_4)(Al_4Si_4)O_{20}(OH)_4$ is very large, as shown by Schaller *et al.* (1967). Beus (1956), however, gives an analysis (see Table 1, no. 2 in the present study) of a lithian beryllian margarite, where 22 % of the interlayer cations are occupied by sodium. However, no beryllium-bearing ephesites are known.

Only limited data are available on the trace element composition of brittle micas. In general trace elements seem to show marked variation between samples.

If we follow the formula proposed for the mineral by Strunz (1956), no ideal bityite is known. Figure 4 shows that the content of Li in micas, and similarly also the sum of octahedral cations, which is generally between 4.3 and 5.4, increases concomitantly with the increasing content of Be. Three bityite analyses given in Table 1 (no. 10 from Zimbabwe, no. 11 from Londonderry and no. 12 from Finland) contain more than five cations in the octahedral sites, when six are available.

The ratio of Si/Al + Be in tetrahedral sites in the Li- and Be-bearing brittle micas is near 1 : 1, and the cations show the ordered structure indicated by the infrared studies by Farmer and Velde (1973) and the present authors, and

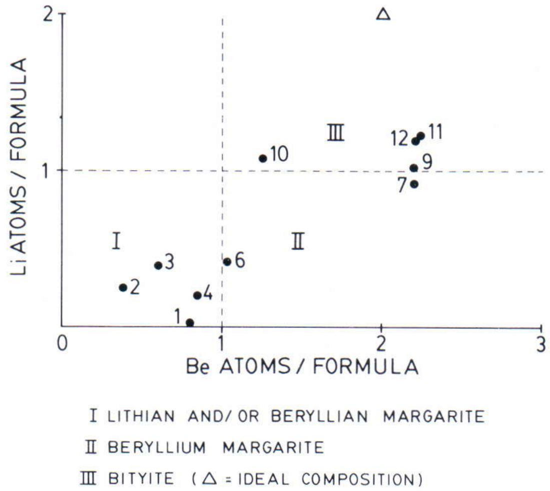

Fig. 3. The Li *versus* Be diagram of the Li—Be brittle micas given in Table 1. The figure shows the classification of micas used in this study.

confirming the crystal structure determination by Lin and Guggenheim (1984). The aluminium content fluctuates, but decreases generally with increasing Li + Be substitution. The Be/Li ratio varies between 1.0 and 2.4, being generally more than unity.

The Li *vs.* Be plot (Figure 3) shows that, compared with the ideal formula of bityite, the Li content is never ideal: at most 1—1.2 of two possible atom sites are filled. From a detailed crystal structure analysis, Lin and Guggenheim (1983) have concluded that the octahedral M(1) site in the structure of the Li—Be brittle mica from the Mops pegmatite, Zimbabwe (see Table 1, analysis no. 10) contains 0.55 Li and 0.45 vacancy, whereas the other octahedral sites M(2) and M(3) are fully occupied by Al. Lithium for vacancy substitution in the octahedral sheets is possibly a common feature of all the Li- and Be-bearing margarites and bityites and may explain the intermediate structure of the micas.

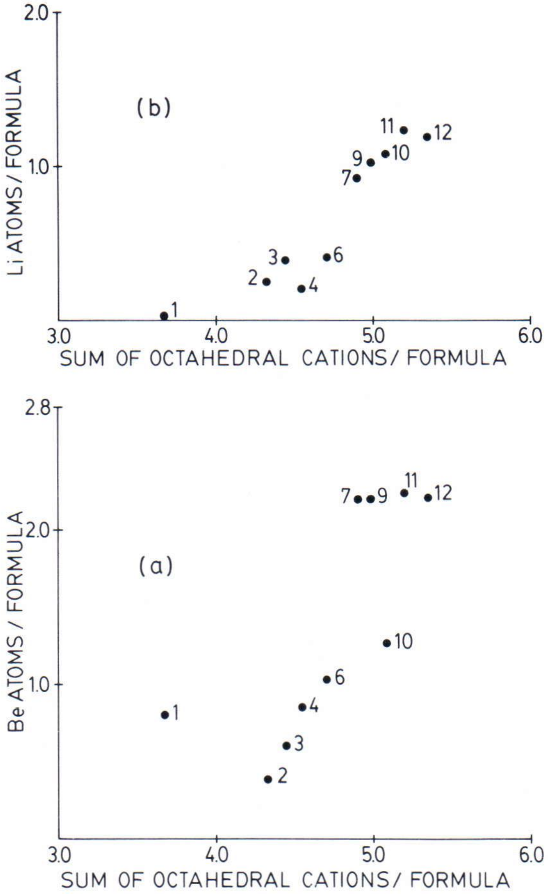

Fig. 4. a) The Be *versus* octahedral cation sum diagram, b) the Li *versus* octahedral cation sum diagram. The figures were compiled from the chemical analyses given in Table 1.

Two separate groups — bityites and Li- and Be-bearing margarites — can be distinguished in the figures for the Li *vs.* Be (Figure 3), Li *vs.* octahedral cation sum (Figure 4b) and Be *vs.* octahedral cation sum (Figure 4a). This indicates a miscibility gap between the end members. According to the classification, only four samples (nos. 9—12) plot in the bityite field and two in the beryllium margarite field (nos. 6 and 7) being, however, very near the border lines; the others are lithian and/or beryllian margarites. Analysis no. 10 is a microprobe analysis of sample no. 8, but includes Li and Be from the wet chemical data. Lin and Guggenheim (1983) have suggested that the difference in the silica content of the mica may be due to quartz contamination. The type bityite from Madagascar (no. 5) can be plotted in the lithium margarite field, but it has been omitted because the old analysis of the mineral is erroneous (Fleischer 1950) and contains excessively low concentrations of beryllium.

The mica sample studied from the Maantienvarsi pegmatite, Finland, is typical bityite in composition and closely resembles bityite (bowleyite) from Londonderry with a nearly similar content of Li and Be. The physical properties also agree well with those reported for similar micas. The mineral is rich in silica and poor in aluminium, having the lowest Al/Si ratio 1.22 of all the micas given in Table 1. The contents of magnesium and iron in the mineral are considerable compared with those in other Li- and Be-bearing micas. The sum of the octahedral cations, 5.35, is the highest known in bityites.

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