Helvite group minerals from syenite pegmatites in the Oslo Region, Norway. Contribution to the mineralogy of Norway, No. 68

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Most helvite group minerals from the syenite pegmatites in the Oslo Region are manganese rich with helvite mol% ranging from 65% to 98.5%. From the present investigation on sixteen helvite group minerals, only two fall in the genthelvite field of the helvite–danalite–genthelvite triangular composition diagram. Yellow helvite (98–98.5 mol% helvite) from the Saga I quarry at Mørje, Porsgrunn and a very pale green genthelvite (98 mol% genthelvite) from Bratthagen in Lågendalen are among the purest helvite group end members hitherto reported. The Saga and Sandøy helvites are the first examples of fluorescence among the manganese rich helvites.

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Helvite minerals, $R_4Be_3(SiO_4)_3S$ (R = Mn, Fe, Zn), have been known from the syenite pegmatites in the Langesundsfjord area in the southern part of the Oslo Region since the middle of the nineteenth century. Brøgger (1890) described the morphology of helvite from a few localities in the Langesundsfjord area. Oftedal & Sæbø (1963) published semiquantitative chemical analyses, X-ray crystallography and optical data on helvite group minerals from several localities in Norway, among them four samples from the syenite pegmatites in the Langesundsfjord area. Two samples from this area were also analysed by Dunn (1976).

Since the paper by Oftedal & Sæbø (1963), several new localities of helvite group minerals have been found in the syenite pegmatites in the Oslo Region. Analyses of helvites from the new localities together with re-analysed old samples presented here give a more detailed knowledge of the compositional variation found in the helvite group minerals in this type of occurrence.

Localities

Helvite group minerals have been found in syenite pegmatites at nearly thirty localities in the southern part of the Oslo Region. Material from sixteen localities has been available for the present investigation. The localities are marked in Fig. 1 with numbers referring to the following brief description of the localities, the helvite group minerals and the coexisting minerals.

1. A roadcut near the old route of motorway E–18 at Kokkersvold, Langangen, Porsgrunn. The helvite occurs as lemon yellow tetrahedra up to 3 mm across in intergrown aggregates coexisting with fluorite, biotite, magnetite, pyrochlore and microcline.

2. A roadcut at motorway E–18 at Blåfjell, Langangen, Porsgrunn. The locality was described by Raade et al. (1983). The samples investigated show pale brown helvite crystals as mm-size tetrahedra in natrolite together with analcime, eudidymite, chiavennite and acmite.

3. A mineral-rich pegmatite near the southern hilltop on Stokkøy in the Langesundsfjord. Helvite in tetrahedral crystals up to several cm has been described by Brøgger (1890). The analysed helvite has a canary yellow colour and occurs together with nepheline (partly altered to natrolite), microcline, magnetite, acmite, biotite, zircon, melanite, titanite, pyrochlore, apatite, albite, analcime, fluorite, meliphanite and sulphides.

4. The same locality as no. 3. The coexisting minerals are the same. The colour of the helvite is apple green.

5. Saga I larvikite quarry at Mørje, Porsgrunn.

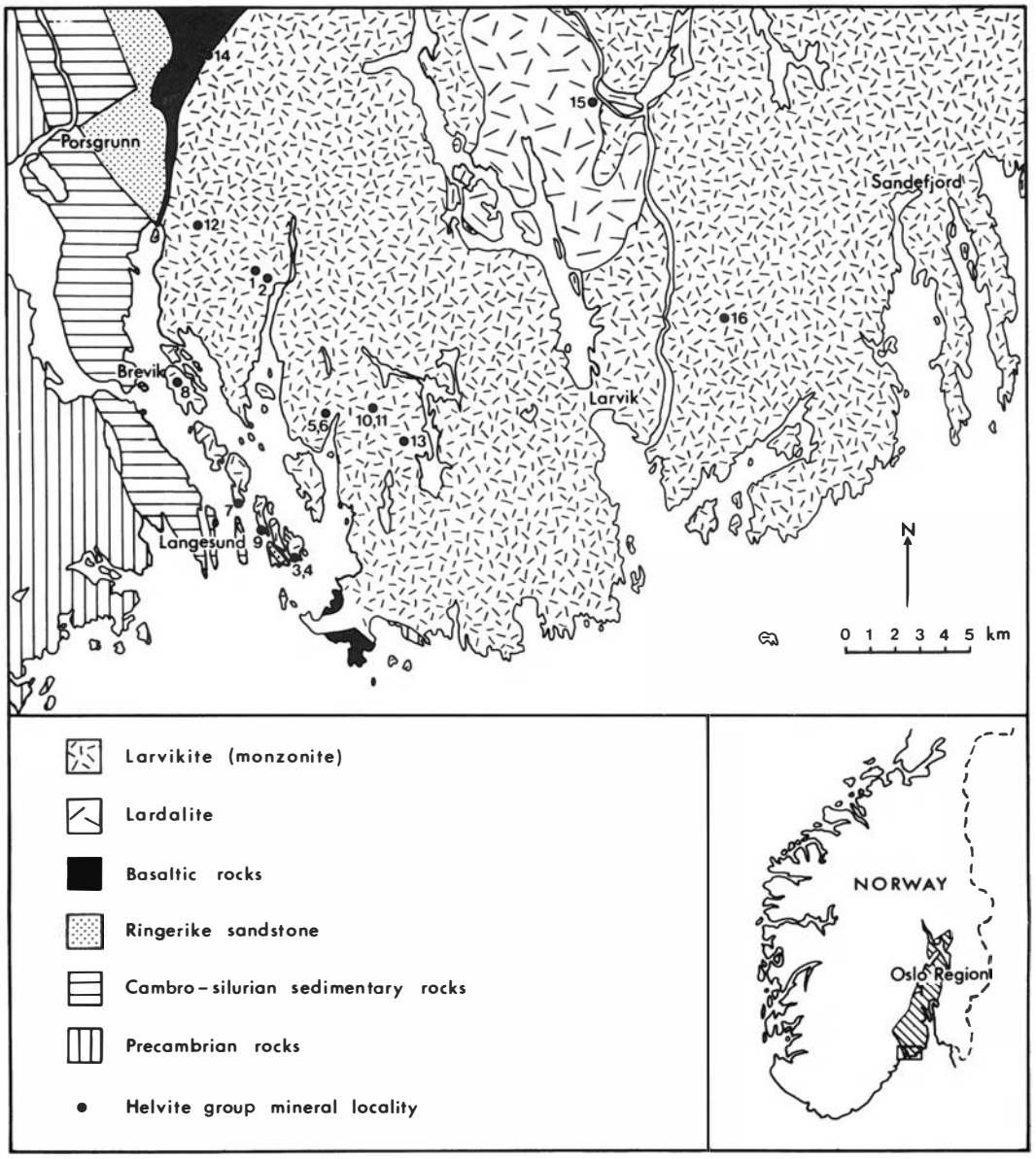

Fig. 1. Simplified geological map of the southern part of the Oslo Region, with the helvite group mineral localities marked.

The helvite occurs as yellow tetrahedra up to 1 mm in druses in analcime with natrolite, acmite and calcite. Nearly seventy mineral species have been found in this pegmatite, among them twelve Be minerals. The helvite fluoresces deep red in long- and shortwave UV-light.

6. The same locality as no. 5. The helvite occurs as yellow tetrahedra <0.2 mm lining small fissures in leucophanite. This helvite fluoresces deep red in long- and shortwave UV-light.

7. The southern part of Siktesøy in the Langesundsfjord. The helvite occurs as yellow brown tetrahedra up to 1 mm in small druses in albite and analcime with natrolite, acmite, magnetite, pyrophanite, zircon and chlorite.

8. A stone quarry on Sandøy in the Lange-

sundsfjord. The helvite occurs as yellow tetrahedra up to 1 mm in analcime together with acmite between larger microcline crystal individuals. The helvite fluoresces deep red in long- and shortwave UV-light.

9. The southern part of Lille Arøy. This helvite was described by Brøgger (1890: 174). The helvite occurs as medium brown helvite crystals up to 1 mm in natrolite.

10. Vevja larvikite quarry in Tvedalen, Brunlanes. The helvite occurs as a brown tetrahedra 8 mm across in a vug lined with analcime in microcline.

11. The same locality as no. 10, but from a different pegmatite dyke. The helvite occurs as pale brown tetrahedral crystals up to 2 mm with a thin outer zone of yellow brown colour. The helvite occurs in vugs in analcime with natrolite, acmite, chiavennite and eudidymite.

12. A roadcut at motorway E–18 at Skredderrønningen in Eidanger, Porsgrunn. The helvite occurs as medium brown tetrahedra up to 5 mm across in druses lined with analcime, coexisting with chiavennite, epididymite, bertrandite, natrolite, gonnardite, chlorite, acmite, hematite, fluorite and calcite.

13. Treschow larvikite quarry in Tvedalen, Brunlanes. The helvite occurs as tetrahedral crystals up to 3 mm across, typically zoned (phantom) with an inner crystal of brown colour (13a) and an outer zone of pale yellowish brown colour (13b). The helvite occurs in druses with albite in analcime.

14. A syenite pegmatite dike in basalt in a water tunnel at Buer in Bjørkedalen, Skien. The locality was described by Segalstad & Larsen (1978). The helvite occurs as greenish yellow tetrahedra up to 2 mm across with calcite, albite, microcline, acmite, pyrophanite, zircon and gadolinite-(Ce).

15. A roadcut at mainroad RV–8 at Bratthagen in Lågendalen. The locality and the genthelvite were described by Oftedal & Sæbø (1963). The genthelvite occurs as very pale green masses and crystals together with catapleiite, analcime, microcline and pyrochlore. The genthelvite fluoresces bright green in long- and shortwave UV-light and shows a faint green phosphorescence after being UV-irradiated. Oftedal & Sæbø (1963) described the fluorescence as yellow.

16. Håkestad larvikite quarry in Tjølling. The helvite occurs as yellow tetrahedra up to 5 mm across in analcime with microcline, biotite, nepheline, magnetite, ferroan hornblende, melilphanite, titanite, polymignite, britholite, pyrochlore, zircon, natrolite, gonnardite, wulfenite and bertrandite.

In addition to the occurrences already mentioned, helvite group minerals have been found in syenite pegmatites at Arøyskjærene and at other localities both at Siktesøy and Lille Arøy in the Langesundsfjord (Brøgger 1890), Låven in the Langesundsfjord (Oftedal & Sæbø 1963), Klåstad larvikite quarry in Tjølling (Raade et al. 1980), Åros and Heia in Tvedalen, Kariåsen, Husebyåsen and Fokserød near Sandefjord and Stålaker in Tjølling (S. Berge, pers. comm.), Slevolden in Eidanger (I. Burvald, pers. comm.).

Density and optical properties

The density of the helvite group minerals was determined at 22°C by the sink/float method using methylene iodide diluted with acetone for minerals with $D < 3.32$ g/cm^3 and Clerici's solution diluted with water for minerals with $D > 3.32$. The results are shown in Table 1.

The colours of the helvite group minerals are stated in the previous chapter. The refractive indices were measured by the immersion method using sodium light. The results are shown in Table 1.

The refractive indices for the end member helvite group minerals correspond excellently with the theoretical values given by Dunn (1976), while the density for the same minerals is slightly lower than the theoretical values (genthelvite $D = 3.66$ g/cm^3, helvite $D = 3.20$ g/cm^3).

Chemical composition

The helvite minerals were analysed using a JEOL 840A scanning electron microscope equipped with a Tracor energy dispersive XRF detector. The net intensities were corrected for atomic number effect, absorption and fluorescence. A helvite from Hørtekollen, Sylling, Buskerud county (Goldschmidt 1911) was used as a calibration standard. The helvite standard material was chosen from a single, brown, transparent crystal 20 mm across which was analysed for the main elements (except S, which is taken from Goldschmidt (1911)) and minor elements by atomic absorption spectrometry after decom-

Table 1. Composition, measured and calculated unit cell dimensions, refractive indices and density for the investigated helvite group minerals.

Locality	Helvite mol%	Danalite mol%	Genthelvite mol%	*a*(Å) meas.	*a*(Å) calc.	n_D	D(g/cm³)	
1	80.7	10.7	8.6	8.277	8.266	1.740	3.24	
2	91.4	6.2	2.4	8.262	8.280	1.735	3.23	
3	69.4	8.3	22.3	8.243	8.243	1.741	3.29	
4	40.3	6.2	53.5	8.192	8.188	1.742	3.39	
5	98.0	1.0	1.0	8.293	8.288	1.728	3.17	0.1% CaO, 0.2% Al_2O_3
6	98.5	1.0	0.5		8.289			0.2% CaO, 0.1% Al_2O_3
7	76.6	11.7	11.7	8.263	8.259	1.740	3.25	
8	93.7	2.4	3.9	8.283	8.282	1.738	3.20	
9	80.7	13.9	5.4	8.261	8.269	1.731	3.24	
10	65.5	30.4	4.1	8.259	8.256	1.746	3.30	
11	73.6	20.8	5.6	8.265	8.262	1.742	3.25	
12	75.1	21.1	3.8	8.267	8.265	1.739	3.27	
13a	68.7	26.5	4.8	8.257	8.258	1.746	3.30	
13b	85.9	12.8	1.3	8.269	8.277	1.740		
14	67.9	15.2	16.9	8.252	8.246	1.742		
15	1.9	0.1	98.0	8.120	8.113	1.740	3.65	<0.1% CaO, <0.1% Al_2O_3
16	79.6	9.2	11.2	8.265	8.262	1.740	3.28	
				±0.001		±0.001	±0.01	

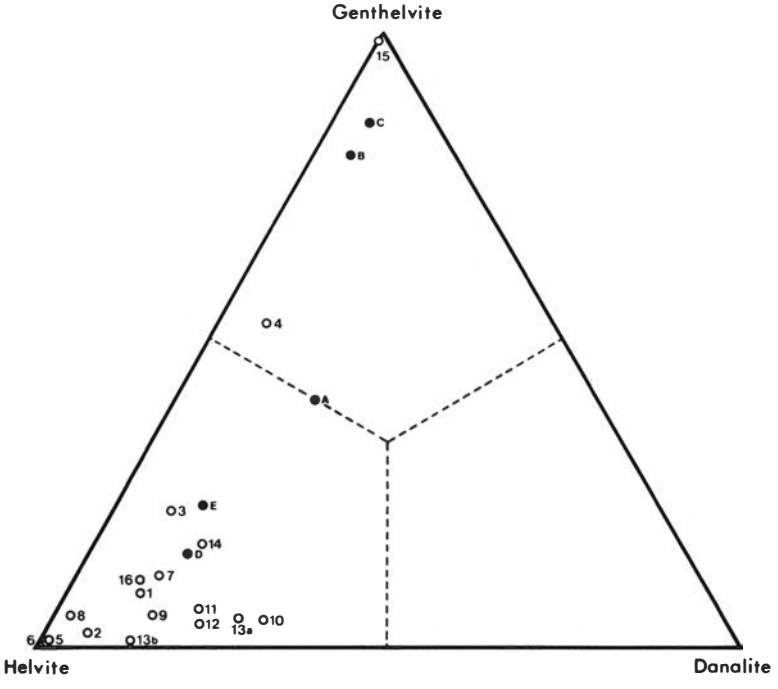

Fig. 2. Helvite–danalite–genthelvite triangular composition diagram with the respective field borders marked and the analysed helvite minerals plotted. Open circles are analyses from this investigation, while filled circles are analyses from the literature: A, B, C from Oftedal & Sæbø (1963) and D, E from Dunn (1976).

position using a mixture of HCl and HF in a closed system. The following results were found (in weight percent): SiO_2 32.08, Al_2O_3 0.23, MnO 27.02, FeO 16.14, ZnO 7.40, CaO 0.15, MgO 0.26, BeO 13.26, S 5.86, total 102.40, less O =S 2.92, total 99.48. The results are very close to those found by Goldschmidt (1911) and Dunn (1976) (sample no. 70). Minor elements in the helvite group end member samples (nos. 5, 6 and 15) were analysed using a Leitz scanning electron microscope equipped with a Microspec wavelength dispersive XRF detector and the Hørtekollen helvite as calibration standard. The content of Mn, Fe and Zn were recalculated to a total of 100% of the respective mol% of helvite, danalite and genthelvite assuming stoichiometry in the formula $(Mn,Fe,Zn)_4Be_3(SiO_4)_3S$. The results are shown in Table 1 and plotted in a helvite–danalite–genthelvite triangular composition diagram together with other helvite mineral analyses from the Langesundsfjord area (Fig. 2). Most helvite group minerals in the Langesundsfjord are true helvites. Only four samples fall into the genthelvite region in Fig. 2. No danalites are found. As shown in Table 1, the Bratthagen genthelvite and the Saga helvites are very pure end members in the helvite group.

X-ray crystallography

The helvite minerals were run in a Philips APD 1700 diffractometer with a scan speed of 0.01° $2\Theta s^{-1}$ using $CuK\alpha_1$ radiation ($\lambda = 1.54051$Å) and graphite monochromator. Si (NBS 640A) was used as internal standard. The unit cell dimensions were determined by least squares refinement using Philips APD 1700 software program CRYSTALLOGRAPHY/REFINE. The calculated unit cell dimensions were found using measured values for helvite ($a = 8.291$Å) and genthelvite ($a = 8.109$Å) from Hassan & Grundy (1985) and theoretical value for pure danalite ($a = 8.20$Å) from Deer et al. (1963), assuming linearity between the unit cell dimension and chemical composition. The results are shown in Table 1. Relative deviation between measured and calculated a is better than 0.25% in all samples.

The unit cell dimensions found for the end member helvite minerals are very close to those found by Dunn (1976) on helvite from East Moulton Mine, Montana, USA (PDF 29–217) and genthelvite from De-Mix quarry, Mt. St. Hilaire, Quebec, Canada (PDF 29–224) with $a = 8.2937$Å and $a = 8.1206$Å, respectively.

Conclusion

Most helvite group minerals from the syenite pegmatites in the Oslo Region are manganese rich with helvite mol% ranging from 65% to nearly 100%. This is not in accordance with what was found by Oftedal & Sæbø (1963) who analysed four samples from the syenite pegmatites, three of which were dominantly zinc rich helvites, and concluded that helvite group minerals from the syenite pegmatites in the Oslo Region tend to be genthelvites. This erroneous assumption has been repeated by Neumann (1985: 238) in his review on Norwegian minerals.

Both the Bratthagen genthelvite and the Saga helvite are among the purest end members in the helvite group hitherto reported.

The Saga and Sandøy helvites are the first examples of fluorescence among the manganese rich helvites. Greenish fluorescence of genthelvite is previously known (Oftedal & Sæbø 1963; Dunn 1976).

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