CONTRIBUTIONS TO THE MINERALOGY OF NORWAY

No. 18. Classification of some Norwegian Members of the Helvine Group

By

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Abstract. Helvines associated with contact aureoles of the Oslo Region are rich in Mn, moderately rich in Fe, and rather poor in Zn; mean for 5 localities: 60% Mn-helvine, 30% Fe-helvine, 10% Zn-helvine. Those from nepheline syenitic pegmatite are essentially Zn-helvines. Helvine from a granite pegmatite in Northern Norway is a nearly pure Mn-helvine. Some of the results are discussed.

Helvine is now known to occur at the following Norwegian localities, all but one in the Oslo Region.

Contact-skarn deposits: Hørtekollen, Glomsrudkollen, Kjenner Bi-mine, Rien in Sande, Isi in Bærum (vein). These have been described by V. M. GOLDSCHMIDT (1911). Later discovered: Nyseter (Grua).

Cavities in nordmarkite: Flaen near Grorud (H. NEUMANN, 1950).

Nepheline syenitic pegmatite in the Langesundsfjord area: Arøy skerries, Upper Arøy, Sigtesøy, Stokøy. These have been described by W. C. BRØGGER (1890). Later discovered: Låven (H. NEUMANN). Lågen valley north of Larvik (P. CHR. SÆBØ. Preliminary description below).

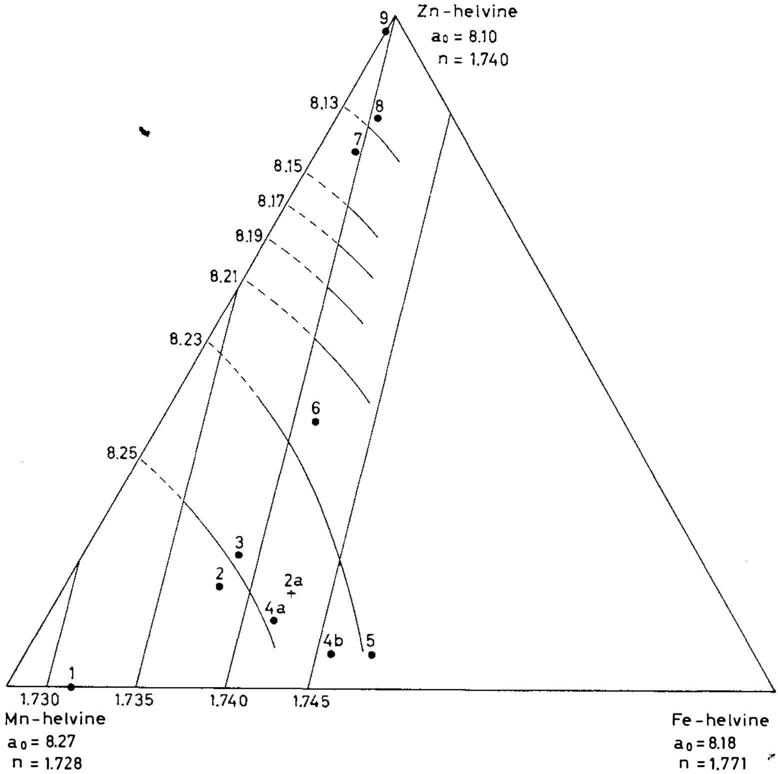
Granite pegmatite: Ågskaret in the Holand fjord, Northern Norway. (I. OFTEDAL, 1950).

Material from a number of these localities was available for the present investigation, most of it kindly supplied by Dr. H. Neumann, Director of the Mineralogisk-Geologisk Museum in Oslo. The chemical compositions of the various specimens were determined approximately by spectrochemical methods. In addition unit cell dimensions and refractive indices were measured. A few remarks on the spectrochemical work may be expedient. Standard mixtures were prepared from pure albite with known percentages of MnO, Fe_2O_3 and ZnO added; these percentages were chosen so as to give convenient intensities for the lines Mn 3224, Fe 3100, Zn 3345. Also the helvine samples were diluted with albite, in the ratios 1:10 and 1:50, to reduce the intensities of the pertinent lines. Al and Be lines were utilized as internal standards. Fairly reliable working curves were obtained, but the results can not be claimed to be very accurate. The Zn determinations appear to be quite good, while the determinations of Mn and Fe are more uncertain. The resulting percentages of Mn, Fe, Zn have been recalculated to percentages of the "molecules" Mn-helvine ("Helvine"), Fe-helvine (Danalite) and Zn-helvine (Genthelvine). These must add up to approximately 100% in each case, and this condition is tolerably well fulfilled in most cases. In doubtful cases a further check is afforded by the trends of the unit cell dimensions and refractive indices, which are approximately known from earlier work (see below) and also from the most reliable of the present data. In all cases the resulting percentages of the 3 helvine components were adjusted so as to add up to 100%, and they are doubtless sufficiently accurate for a general classification of the specimens. The results of the various determinations are recorded in the table. — Some comments. 1, *Ågskaret:* Yellow transparent tetrahedra up to 1 mm in size. 2, *Hørtekollen:* Yellowish brown to dark brown tetrahedra up to 5 mm in size. 3, *Flaen:* Perfect tetrahedra more than 10 mm in size, brown, transparent, in cavities and fissures in the nordmarkite with many other minerals: quartz, orthoclase, albite, sphene, allanite, hornblende, biotite, chlorite, fluorite, magnetite, pyrite, and more rarely galena, milarite, bastnäsite, wulfenite, bertrandite (very rare). Helvine, milarite, bertrandite are among the very latest products. 4, *Glomsrudkollen:* Yellow tetrahedra up to 1 mm in size with abundant black sphalerite. The central parts of the tetrahedra are brown — sample 4b; sample 4a is yellow material from outer zones. 5, *Grua:* Reddish brown crystals in a matrix of

Locality	Mn-helv.	Fe-helv.	Zn-helv.	n(Na)	a_0, Å
1. Ågskaret	92	8	∠ 1	1.732	8.265
2. Hørtekollen	65	20	15	1.737	8.245
3. Flaen, Grorud	60	20	20	1.740	8.25
4a. Glomsrudkollen........	60	30	10	1.741	8.245
4b. —»—	55	40	5	1.746	
5. Grua	50	45	5	1.747	8.229
6. Stokøy	40	20	40	1.742	8.225
7. Låven	15	5	80	1.739	8.137
8. «Brevik«	10	5	85	1.742	
9. Lågendalen	2	∠ 1	98	1.738	8·116
Limits of error............				±0.005	±0.005

pyroxene, magnetite, calcite with small quantities of fluorite and molybdenite. 8, *"Brevik"*: An old specimen consisting mainly of analcime was found to carry yellow helvine tetrahedra up to 2 mm in size. Other minerals are zircon, bastnäsite (weibyeite), natrolite, mica, pyrophanite and eudidymite(?). Probably the specimen comes from the eudidymite locality in Greater Arøy. 9, *Lågendalen:* A newly discovered occurrence of nepheline syenitic pegmatite which will be described in more detail later. The locality is a large road cut about 7 km north of the Bommestad Bridge near Larvik. Irregular pegmatitic dikes up to 40 cm wide occur in a light foliated foyaite. They are very similar to the pegmatites in the Langesundsfjord. The helvine is colourless to light greenish and the crystals are mainly tetrahedra up to 10 mm in size. They are sometimes intergrown with nearly colourless sphalerite. As is seen from the table the helvine represents the practically pure Zn end member (genthelvine). There are also small quantities of galena. The helvine is associated with large quantities of analcime and albite. Aegirine is common and occurs in bent and fractured crystals. Other minerals which occur fairly abundantly are catapleite, astrophyllite, pyrophanite, monacite, fluorite, muscovite. In cavities barylite has been found, and also crystals of ramsayite. The helvine, as well as the sphalerite, shows a strong yellow fluorescence in ultraviolet light, probably the first example of this phenomenon in helvine.

The examined helvines have been plotted on a triangular diagram (see figure) like the one used by GLASS, JAHNS and STEVENS (1944).



The numbers correspond with the table. 2a (+) represents the analysis of helvine from Hørtekollen by V. M. Goldschmidt (l.c.).

Also the unit cell dimensions (a_0) of the end members and the general distribution of the refractive indices(n) have been taken from their paper. Comparison with the above table shows that the chemical compositions generally agree well with the refractive indices as required by the diagram. In one or two cases the refractive indices have actually been used to adjust somewhat doubtful Mn/Fe ratios.

It is seen that helvines from contact skarn and related deposits are Mn-Fe-helvines with minor Zn contents, all fairly close to the mean composition: 60 Mn-helvine + 30 Fe-helvine + 10 Zn-helvine. Those from nepheline syenitic pegmatite tend to be essentially Zn-helvines. The Stokøy helvine occupies an intermediate position. The helvine from granite pegmatite is a nearly pure Mn-helvine.

It is well known that Zn is in general far more abundant in contact skarn deposits of the Oslo Region than in the nepheline syenitic pegmatites. Both Grua and Glomsrudkollen are noted for considerable sphalerite deposits, while only minute quantities of sphalerite are known from the Langesundsfjord pegmatites. Both in Glomsrudkollen and in Lågendalen helvine is found in actual contact with sphalerite, but the Zn-contents of the helvines differ enormously. It appears that the diadochy of Zn, Mn, Fe in helvine must depend largely on the physical conditions of formation, probably essentially on the temperature. This can hardly be discussed in detail at present, since both contact aureoles and nepheline syenitic pegmatites are apparently high temperature deposits. It seems natural to suppose that the latter represent the lower temperatures of the two. The equilibrium helvine-sphalerite may probably be used as a temperature indicator if the system can be studied more closely.

The curved lines in the diagram indicate approximately the dependence of the unit cell edge length on composition. Considering Mn-Zn helvines only, it is seen that this dependence is not at all linear. The unit cell of Mn-helvine is only weakly influenced by Zn-helvine substitutions up to about 50%. But between 60% and 80% substitution the cell size decreases very rapidly, and between 80% and 100% Zn-helvine again more slowly. The reason for this may probably be sought in the rather different chemical characters (bonding properties) of Mn and Zn. The properties of Mn may predominate until a considerable percentage of it has been replaced by Zn, and *vice versa.*

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