The minerals of the Jahren pegmatite, one of the major pegmatites in the Larvik Plutonic Complex

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Introduction

The Jahren pegmatite has been a well-known mineral locality for a long time, mostly for the small feldspar quarry which was operated for a short time around 1920 (Andersen 1924) (Fig. 1), but also from finds during road constructions of RV 301 between Stavern and Helgeroa.

In spring 2017 Jahren fetched interest again when works on a large area just north of the old quarry, building cottages in the so called «Jahrehagen», was started. This affected the Jahren pegmatite locality. First, by the construction of a road north of the quarry. This cut the northernmost part of the pegmatite. Second, by digging a cable trench through a large part of the dumps from the quarry. And last, by blasting in the pegmatite to prepare the ground for two of the cottages (Fig. 2). All these actions led to both interesting and good mineral finds both for the mineralogical interested collectors.

Fig. 1. *Jahren feldspar quarry around 1920 (Andersen 1924). NGU photo archive ref. NGU005245.*

The construction work at Jahrehagen has been a boost to the knowledge and interest for the Jahren pegmatite, but unfortunately it will eventually put an end to the accessibility to the most interesting parts. Some are already inaccessible, like the cottage grounds and the quarry dumps, which have been covered and reclaimed. The quarry itself will be in someone's cottage garden, and only the parts close to the road and south-east of the road will be accessible.

Fig. 2. *The old Jahren feldspar quarry behind the pine trees and the prepared cottage ground in front. Note the pegmatite outcrop to the left. Photo taken by P. Andresen in March 2018.*

Geology of the pegmatite

The Jahren pegmatite is situated approximately 2 km SW of Stavern, and is cut by the road RV 301 (Helgeroaveien), within Larvik municipality, Vestfold. (Fig. 3) This is in the semi-circular intrusion number 4, within the Larvik Plutonic Complex (LPC). The pegmatite is close to the border of intrusion number 6, but also intrusion 5, which is mapped to pinch out close to Stavern. These intrusions were formed within the early Permian Oslo rift (Oftedahl & Petersen 1978; Dahlgren 2010).

The pegmatite is one of the largest known pegmatites in the LPC, with the visible part stretching between 120-150 meter, and with a variable thickness of up to 6-8 meter (Fig. 4). The dike is dipping towards NW and strikes NE-SW. Numerous apophyses are branching out from the main pegmatite.

Fig. 3. *Aerial view of the Jahren pegmatite area. Photo taken on 13 September 2014. Courtesy of Blom Norway AS.*

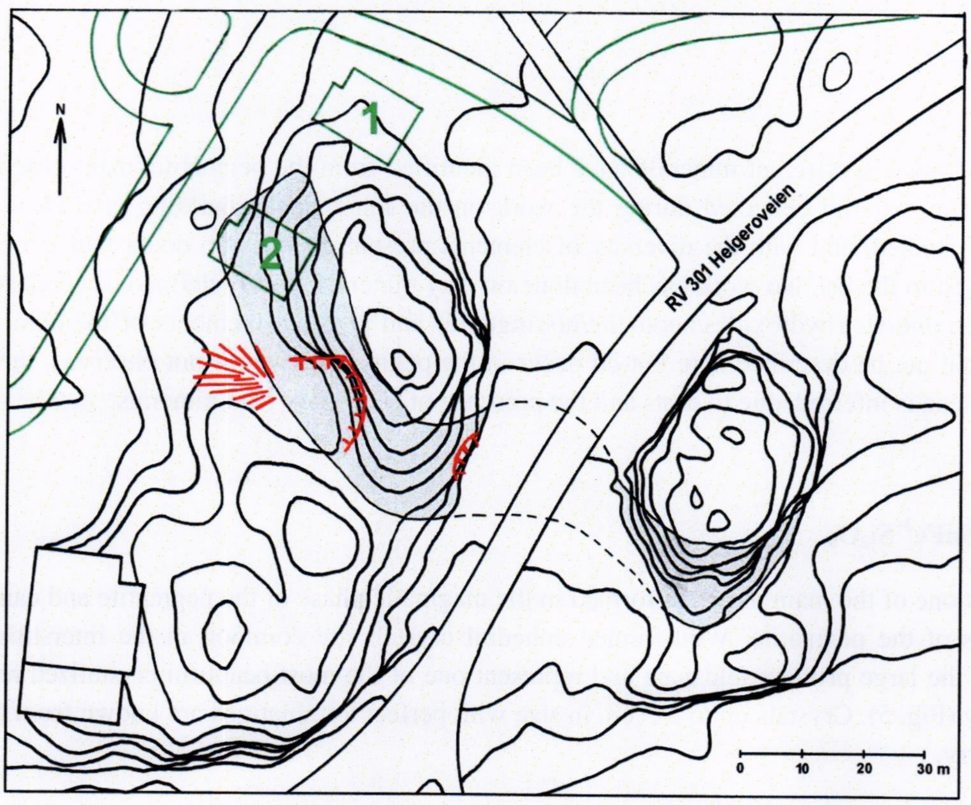

Fig. 4. *Sketch map of the Jahren pegmatite (in grey) and the old feldspar quarry and dump (in red). Recently constructed roads and cottages (No. 1 and 2) shown in green.*

The pegmatite belongs to the Stavern type of pegmatites (Dahlgren 2010); Fredriksvärn type of Brögger (1890). The mineral distribution in the pegmatite is variable, and it is difficult to interpret a defined zonation throughout the dike. The section exposed SE of the RV 301 road appear finer grained than the section NW of the road. There the pegmatite is dominated by microcline, albite, amphiboles, aegirine and mica. Quartz occurs, but less common than in NW section. The numbers of intersticial cavities are lower than in the NW section, and not of the same size as in the part where the quarry is situated. In the section where the pegmatite was quarried for feldspar, the grain size and size of intersticial cavities are considerable larger than in other exposed parts. Single feldspar individuals reach up to 1 m and euhedral quartz crystals up to 10 cm have been found on the dumps. This part is also considerable richer in minerals with Li, Be, Ti, Zr, Nb, Th and REE, compared to the SE section of the pegmatite. The two newly exposed areas are both in this northern part and named "Jahrehagen roadcut" and "Jahrehagen cottage ground". Both appear to be even more enriched in the elements Li, Be, Ti, Zr, Nb, Th and REE, than the core in the quarry, but with smaller grain size and cavity size, more like the parts in SE, except the frequency of cavities are much larger.

These parts of the pegmatite have undergone a hydrothermal stage, with alteration of several primary minerals like aenigmatite, possibly britholite-(Ce), pyrochlore group minerals and others, mobilizing Ti, Ce, Nb, Be and other elements, and forming several minerals in a secondary growth, both in the cavities and in casts after primary minerals. Areas of the cottage ground pegmatite have a mineralogy that can be compared to the Virikkollen pegmatite (Larsen & Kolitsch 2012). Although the Virikkollen is more diverse in respect to Be-minerals the two pegmatites share many features including being rich in Be, mainly eudidymite and epididymite, rich in zektzerite, and with the presence of the same or a similar mineral as UK-17 (aspedamite-like mineral).

Minerals

So far more than 30 different minerals have been identified from the pegmatite, many discovered the last year. The material collected during the work on the Jahrenhagen building grounds is far from completely studied, and with the diversity of elements present, there is no doubt that more minerals will be added to the list. No work has been done on clay minerals, poorly defined, secondary iron and manganese minerals (hydroxides/neotocite/hissingerite) and possible members of the chlorite group, and they will not be described here but do occur in the pegmatite. Even if not observed, the presence of early galena is inferred, due to casts and the presence of secondary lead minerals.

Aegirine $NaFe^{3+}Si_2O_6$

Aegirine is one of the main minerals formed in the magmatic phase of the pegmatite and can be found in all parts of the pegmatite. Well-formed euhedral crystals are common in the interstitial cavities created by the large primary feldspars and represent one of the most beautiful crystalized minerals of the locality (Fig. 5). Crystals up to 2-3 cm in size with perfect terminations are known from the dumps of the quarry.

Fig. 5. Aegirine crystal, 2,8 cm wide and 2,6 cm high, from the dumps of the feldspar quarry, collected by Øivind Thoresen in June 2017. Photo: Ø. Thoresen.

Aenigmatite $Na_2Fe^{2+}{}_5TiSi_6O_{20}$

Aenigmatite is a frequent accessory mineral within the primary magmatic phase of the NW part of the pegmatite. Usually as grains ranging from 1 to 3 cm. Aenigmatite is often altered. Casts of what is believed to have been aenigmatite have been found, mostly filled with a greenish clay-like mass, but sometimes also with secondary formed Ti-minerals. As a great rarity aenigmatite crystals occur in cavities in the cottage ground. Aenigmatite and amphiboles can be difficult to distinguish. The aenigmatite differ from amphibole with less distinct cleavage, brown to reddish brown streak and colour on tiny fragments.

Albite $NaAlSi_3O_8$

The mineral occurs in intersticial cavities, often as epitaxial growth on microcline crystals, but also colourless to white crystals.

Amphibole group

Amphiboles are the most common mafic minerals in the pegmatite. Samples of amphiboles from the quarry have been analysed and determined to be **ferro-edenite** (Larsen 1998) and **ferro-richterite** (Piilonen *et al.* 2013). There is a possibility to find other amphibole species, considering the variation in chemistry and alteration of the various parts of the pegmatite. Epitaxial overgrowth of a new generation of amphibole on primary amphibole in cavities is common in the new roadcut. An amphibole with bluish, asbestos-like termination has been found in the cottage ground material. This mineral could be **riebeckite**.

Arsenopyrite FeAsS

Crystals of arsenopyrite were found as a primary mineral in the cottage ground area. Most of the crystals were partially altered on the surface, replaced by a bluish green secondary mineral (scorodite?) and a brown secondary mineral (yukonite/arseniosiderite?). Initial SEM-EDS analyses did not confirm which secondary As-minerals are present, only that there are several.

Astrophyllite $K_2NaFe^{2+}{}_7Ti_2Si_8O_{28}(OH)_4F$

Astrophyllite is found as plates, rarely larger than 2 cm, as a primary magmatic mineral on the dumps of the quarry and in the northern areas. It is often found together with aenigmatite, where it shows alteration around the edges. Tiny crystals of astrophyllite have been found in cavities in material exposed after work on the cottage ground.

Bastnäsite-(Ce) $(Ce,La)(CO_3)F$

Bastnäsite-(Ce) is the most common Ce-bearing mineral in the pegmatite and always as a secondary formation. It occurs as pseudomorphs after what probably has been britholite-(Ce) or fluorapatite, judging from the hexagonal outlines. These masses are usually cream to brick red in colour and devoid of visible crystals. A late stage secondary form of bastnäsite-(Ce) occurs in cavities as thin hexagonal, sub-millimetre plates, usually in clusters.

Britholite-(Ce) $(Ce,Ca)_5(SiO_4)_3OH$

A long-prismatic, metamict mineral in poorly developed crystals found as a primary, magmatic mineral on the quarry dump is probably britholite-(Ce).

Brookite TiO_2

Jahren is the second known brookite locality in the LPC. It occurs in casts probably after aenigmatite and as a secondary phase in cavities. So far it has only identified in the northern part at the Jahrehagen roadcut and the cottage ground, where it is rather common. The brookite is identified by EDS and based on crystal morphology. It contains significant amounts of Nb and Fe, which indicate that mobilizing of these two elements have been simultaneous from altering of aenigmatite, astrophyllite and primary pyrochlore group minerals. The crystal morphology of brookite shows great variation from short- to long-prismatic crystals. The latter being the most dominating. Crystals often show irregular/skeletal growth, indicating rapid crystallisation. Metallic grey to black is most common, but also translucent brown crystals occur. As rutile has also been identified it is possible that some of the crystals may be other TiO_2 polymorphs.

Calcite $CaCO_3$

The mineral has only been found as late stage fracture-fillings in an amphibole rich part of the pegmatite exposed at the cottage ground. Quartz epimorphs after a carbonate is present in cavities too.

Chevkinite-(Ce) $(Ce,La,Ca,Th)_4(Fe^{2+},Mg)(Fe^{2+},Ti,Fe^{3+})_2(Ti,Fe^{3+})_2(Si_2O_7)_2O_8$

Well-formed crystals to 4 cm are described from the roadcut of RV 301 (Larsen 2010). Crystals and fragments of crystals could be found on the quarry dumps as well. Crystals are long prismatic, black, with brown streak colour (fig. 6). The mineral is always metamict. After the blasting of the cottage ground, a zone rich in amphibole was exposed in which a large number of chevkinite-(Ce) samples were found, mostly massive but also in good crystals up to 7-8 mm in size.

Fig. 6. *Chevkinite-(Ce) crystal (5 mm) in feldspar. Collection and photo: T. Kjærnet.*

Elpidite $Na_2ZrSi_6O_{15}·3H_2O$

Elpidite crystals have been known from the quarry dumps for a long time, but often altered and not in particular good quality. With the discovery of the Jahrehagen roadcut in the spring of 2017, elpidite was one of the minerals that caught the interest of collectors. Cavities in this part of the pegmatite were often rich in freestanding fresh straw-yellow elpidite crystals (Fig. 7). Rich samples of elpidite crystals were found in the cable trench in the old dump. In the cottage ground elpidite was occurring quite abundantly, but mostly altered. However, elpidite also occur as crystals on cavities in this part. The crystals are usually small, only 1-2 mm, but sometimes with well-developed terminations (Fig. 8). A few samples with double-terminated crystals have been found. Elpidite has often been found fully to partly embedded into quartz crystals associated with epididymite.

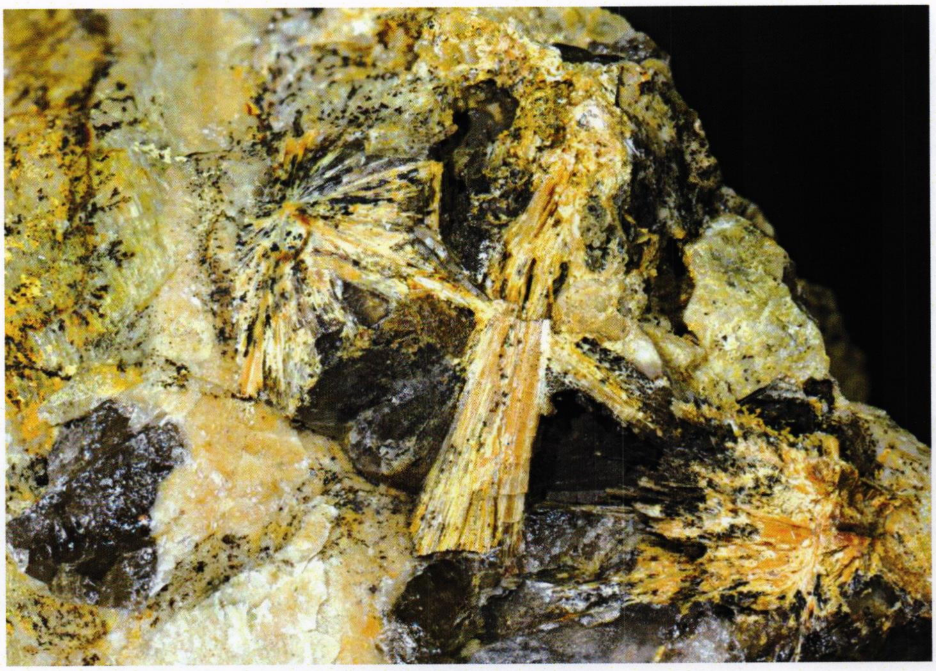

Fig. 7. Straw yellow elpidite aggregates. Field of view 22 mm. Collection and photo: T. Kjærnet.

Fig. 8. Well terminated elpidite crystals from the Jahrenhagen roadcut. SEM photo: A.O. Larsen.

Epididymite $Na_2Be_2Si_6O_{15}\cdot H_2O$

The feldspar quarry was known for epididymite crystals up to 2 cm before 2017. The new roadcut at Jahrehagen was rich in microcrystals of epididymite, sometimes difficult to distinguish from thin elpidite crystals, but with different crystal habitus (Fig. 10). However, in the trench dug through the quarry dump a fragment of a crystal measuring about 7 x 4 x 2 cm was discovered (Fig. 9). This lead to extensive search of the dumps by several collectors and resulted in more extraordinary finds. The best sample was a single euhedral crystal about 3.5 cm in height (frontispiece of this publication). More large fragments were found, and it is possible there have been a large cavity with a crystal reaching perhaps 10 cm or more, but this is speculations only.

Fig. 9. *Fragment of a large epididymite crystal, 7 cm wide and 4 cm high, collected from the dump of the feldspar quarry in June 2017 by Peter Andresen. Photo: Ø. Thoresen.*

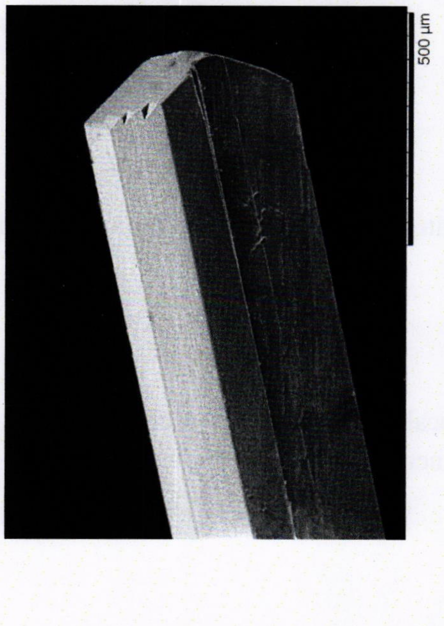

Fig. 10. *Epididymite crystal from the Jahrenhagen roadcut. SEM photo: A.O. Larsen.*

Eudidymite $Na_2Be_2Si_6O_{15}\cdot H_2O$

A sample of eudidymite was found when searching in the cable-trench. Its identification is not confirmed, but the mineral has the characteristic terminations of eudidymite. Another find of eudidymite was made in the cottage ground where the mineral occurs as masses of crystals and single crystals in cavities. Swallowtail-twins are common. A few samples of epitaxial growth of eudidymite on epididymite have been found in this material.

Fig. 11. *Aggregates of eudidymite crystals. Field of view appr. 15 mm. Collected at the quarry dump by A. Mikalsen. Photo: E. Hollund.*

Fluorapatite $Ca_5(PO_4)_3F$

White to colourless, hexagonal crystals of fluorapatite occurs in cavities in the Jahrehagen roadcut.

Fluorite CaF_2

Fluorite is not a common mineral in the Jahren locality. The mineral occurs as small, pale violet to colourless masses. It was found as an accessory mineral with amphibole in a chevkinite-(Ce) rich part of the pegmatite.

Gypsum $CaSO_4$

Gypsum has been found as fracture fillings in chevkinite-(Ce) samples where it occurs as colourless plates up to 2 mm in size and as smaller individual platy crystals. This is the third find of gypsum within the LPC.

Hambergite $Be_2(BO_3)(OH)$

Åsheim (1994) described hambergite as colourless translucent and striated crystals from the locality.

Ilmenite $Fe^{2+}TiO_3$

Ilmenite is mentioned in Larsen (2010), but without any description. Grey metallic thin plate-shaped crystals of a mineral that might well be ilmenite, have been found in the cottage ground. The crystals are formed in the primary magmatic event and occur in microcline feldspar.

Magnetite $Fe^{2+}Fe^{3+}{}_2O_4$

Magnetite is a common accessory mineral in most of the primary pegmatite. It usually forms irregular masses, but octahedral crystals have been found.

Mica group

Dark mica, probably annite, is a common accessory mineral in the primary pegmatite. Polylithionite is mentioned from the quarry by Larsen (2010). White secondary mica, probably muscovite, is common in both the roadcut and in the cottage ground.

Microcline $KAlSi_3O_8$

Microcline is the major mineral in the pegmatite. It is usually pale brick-red, but larger individuals are greyish. The largest individuals of microcline are found in the quarry and may reach nearly 1 m (Andersen 1924). Crystals of microcline is common in intersticial cavities from a few millimetres to partial crystal with faces exceeding 10 centimetres.

Molybdenite MoS_2

Irregular plates of molybdenite occur in the magmatic phase of the pegmatite. The mineral is rare in the Jahren pegmatite compared to pegmatites of the Tvedalen type.

Opal-AN $SiO_2 \cdot nH_2O$

Thin crusts of hyaline opal are not uncommon on fractures in the Jahrehagen roadcut and the cottage ground. The mineral shows green fluorescence in shortwave ultraviolet light.

Pyrochlore group

Pyrochlore is a common accessory mineral in the northern parts of the pegmatite. The primary pyrochlore is always metamict, but show a great variety in alteration, from fresh dark brown glassy crystals to dull yellowish-white. The primary pyrochlore is probably a calciopyroclore, altering to keno- or hydropyrochlores (Piilonen 2012). In the Jahrehagen roadcut and the cottage ground a secondary phase of pyrochlore is common on cavities and in altered masses of elpidite and zektzerite (Fig. 12). These pyrochlores are well formed translucent, octahedra ranging from pale yellow to brown in colour.

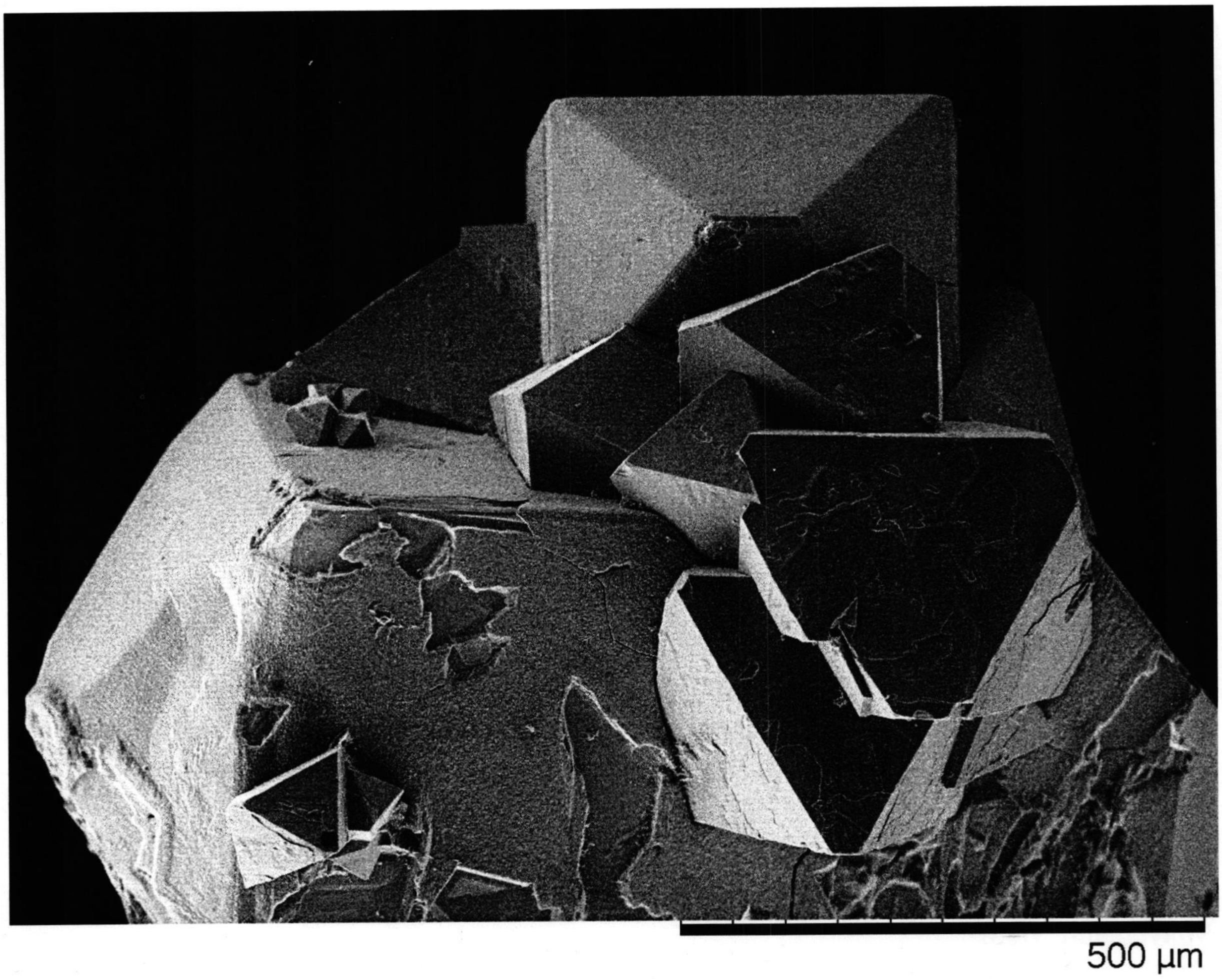

Fig. 12. *Octahedral crystals of a pyrochlore group mineral growing on a tetragonal zircon crystal. From the Jahrenhagen roadcut. SEM photo: A.O. Larsen.*

Pyrite FeS_2

Heavily altered pyrite occurs both primary in pegmatite and secondary on cavities.

Quartz SiO_2

Crystals of smoky quartz was the main reason for collectors to visit the locality for many years, and the locality was known to already be depleted after numerous visits. Nice crystals have been found, *e.g.* as pictured by Larsen *et al.* (2010, p. 196) showing a 10 cm tall, well-developed crystal. Good crystals were found in the Jahrehagen roadcut, where small zones in the samples were of the amethyst variety. Quartz gives valuable information about the crystallization of the pegmatite; it is the last mineral to crystalize in the magmatic event, containing inclusion of euhedral zircon, microcline, elpidite, epididymite, a.o. Quartz crystals inside a larger mass of smoky quartz indicate additional pulses of magmatic silica being added to the pegmatite. Then, at least, two hydrothermal events have occurred; first giving an epitaxial overgrowth on some crystals, then an event with very small crystals, filling fractures and coating other minerals in the intersticial cavities.

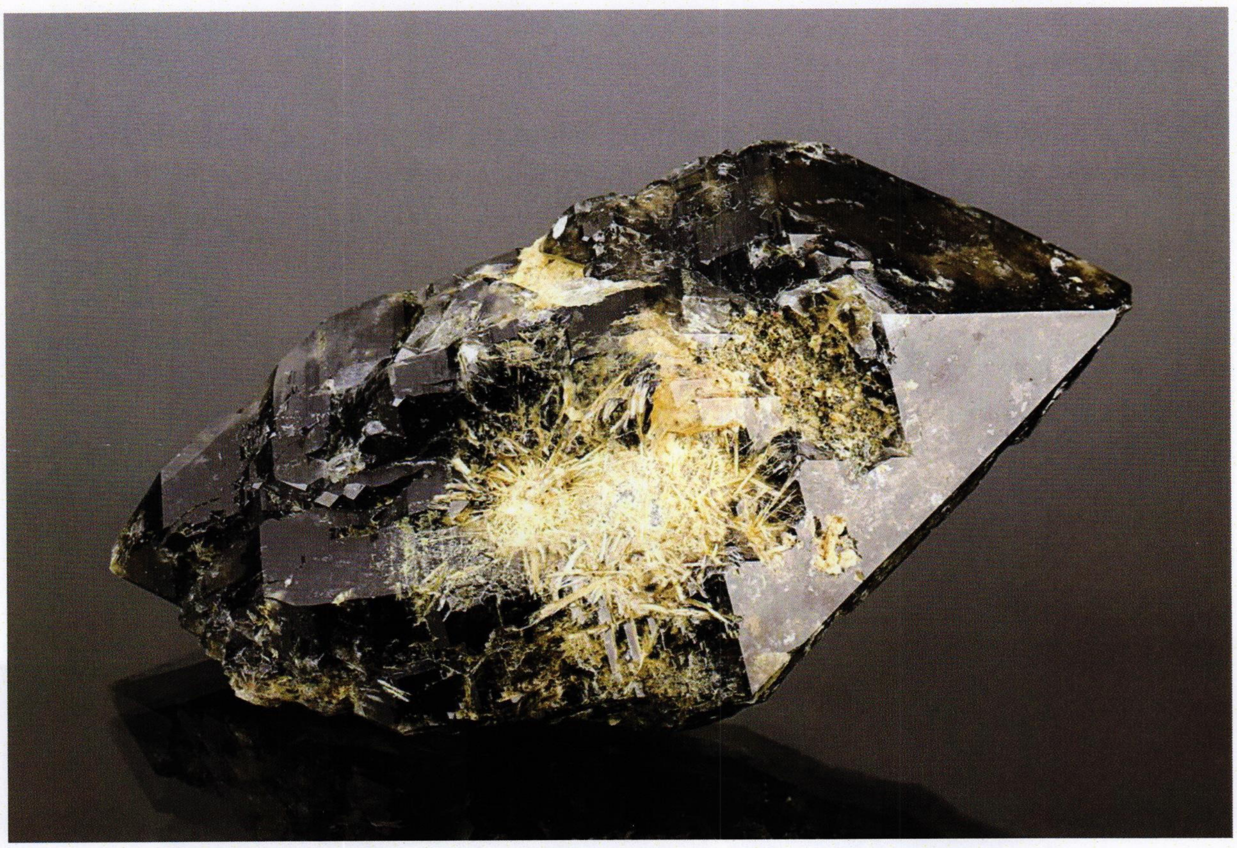

Fig. 13. *Smoky quartz crystal (7.5 cm wide and 4 cm high) intergrown with yellow elpidite crystals. Collected by Bjørn Kåre Stensvold in May 2017 at the Jahrenhagen roadcut. Photo: Ø. Thoresen.*

Rhabdophane Group

Piilonen *et al.* (2013) mentioned finding a member of the rhabdophane group in material from the quarry dump.

Rutile TiO_2

Occurs usually as tiny (< 1 mm) crystals lining casts after what might have ben aenigmatite. It is most common as pale brown needle like crystals, and only in the Jahrehagen roadcut, except one sample with more platy crystals found on the cottage ground. Those were grey metallic and can be easily confused with brookite.

Sphalerite ZnS

Massive nodules of dark brown sphalerite up to 1 cm in size occur sparsely in the pegmatite and belong to the magmatic phase.

Thorite $ThSiO_4$

Thorite was first found on the dumps as prismatic brown crystals up to 2 cm in size inside a large amphibole aggregate (Fig. 14). Investigations with scintillometer have shown areas in the pegmatite with increased radiation level, which represent enrichment of thorite in these areas. One such area where was found in the NW area of the Jahren locality.

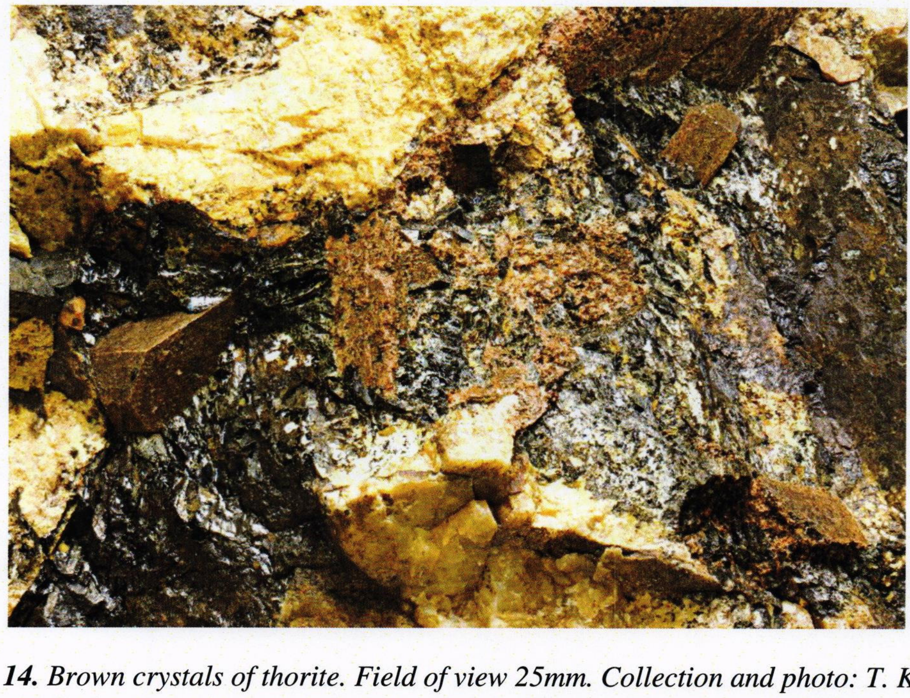

Fig. 14. *Brown crystals of thorite. Field of view 25mm. Collection and photo: T. Kjærnet.*

Titanite $CaTiSiO_5$

Titanite is found as a rare accessory mineral, formed in the magmatic phase, as brown crystalline masses and crystals.

Wulfenite $PbMoO_4$

Pale yellow, stubby to long-prismatic crystals of wulfenite have been found in samples on the cottage ground. One in a cast after galena, the second together with eudidymite in a cavity, partially covered with late formed tiny quartz crystals.

Xenotime-(Y) YPO_4

Pinkish brown, small, tabular crystals of xenotime-(Y) occur together with zircon crystals and elpidite in the same material as the aspedamite-like mineral (UK-17b). This is the third locality for this mineral in LPC, and the richest find so far.

Zektzerite $LiNaZrSi_6O_{15}$

Zektzerite was first noticed in June 2017 when two blocky crystals of zektzerite, totally measuring 3x2x1 cm, were observed on an epididymite sample. When the dumps were investigated at night using shortwave ultraviolet light, it revealed that zektzerite occurred abundantly in the Jahren locality (Kjærnet 2018). The mineral occurs mostly as masses in intersticial cavities in the pegmatite, but sometimes as crystals up to 1 cm. The mineral can easily be mistaken for quartz, which it resembles, being colourless and translucent. The zektzerite masses may reach up to 5-6 centimetres, but are usually smaller. Small crystals are present in cavities at both the Jahrehagen roadcut and the cottage ground.

Zircon $ZrSiO_4$

Zircon is a rather common accessory mineral in the pegmatite and well-developed crystals are frequently found. Most zircon is formed early in the magmatic phase and the mineral often shows zonations. A radiating halo round some zircons indicates elevated actinide content. The surface of primary zircon at the cottage ground often has a crackled outer zone, sometimes with a partial overgrowth of pyrochlore. In the Jahrehagen roadcut and the cottage ground zircon was formed during a later stage as well. This zircon occurs as long-prismatic, yellow to brown crystals or as tetragonal bipyramids without prism faces. These crystals are very small (< 1 mm) and almost colourless to very pale yellow translucent.

UK-17b, aspedamite-like mineral

This is a mineral structurally similar to aspedamite and menezesite, and to the still not fully described heteropolyniobate called UK-17 from Virikkollen (Larsen & Kolitsch 2012). It is found in a small area in the cottage ground associated with elpidite, zektzerite, eudidymite, pyrochlore group minerals, and zircon. Like the Virikkollen mineral it occurs as orange-brown to red dodecahedral crystals, usually < 0.1 mm. It is one of the latest formed minerals and occurs on the last generation of microcrystalline quartz and a platy silicate likely to be in the chlorite group. Sometimes it grows in fractures in the rock. Preliminary SEM-EDS studies reveal that it is chemically close to UK-17 mineral from Virikkollen. In addition to dominant Nb and O, the mineral has a significant content of W, Mn, Fe and Th. It appears to contain more Mn than Fe, suggesting a chemical difference to UK-17 and aspedamite. The unit cell of UK-17b is a = 12.9980(2) Å, which is very similar although slightly larger than that of UK-17 where a = 12.962(1) Å (Larsen & Kolitsch 2012). Both UK-17 and UK-17b have larger unit cells than that of aspedamite from Herrebøkasa (a = 12.9078(6) Å), but smaller than that of menezesite (a = 13.017(1) Å) (Atencio *et al.* 2008; Cooper *et al.* 2012).

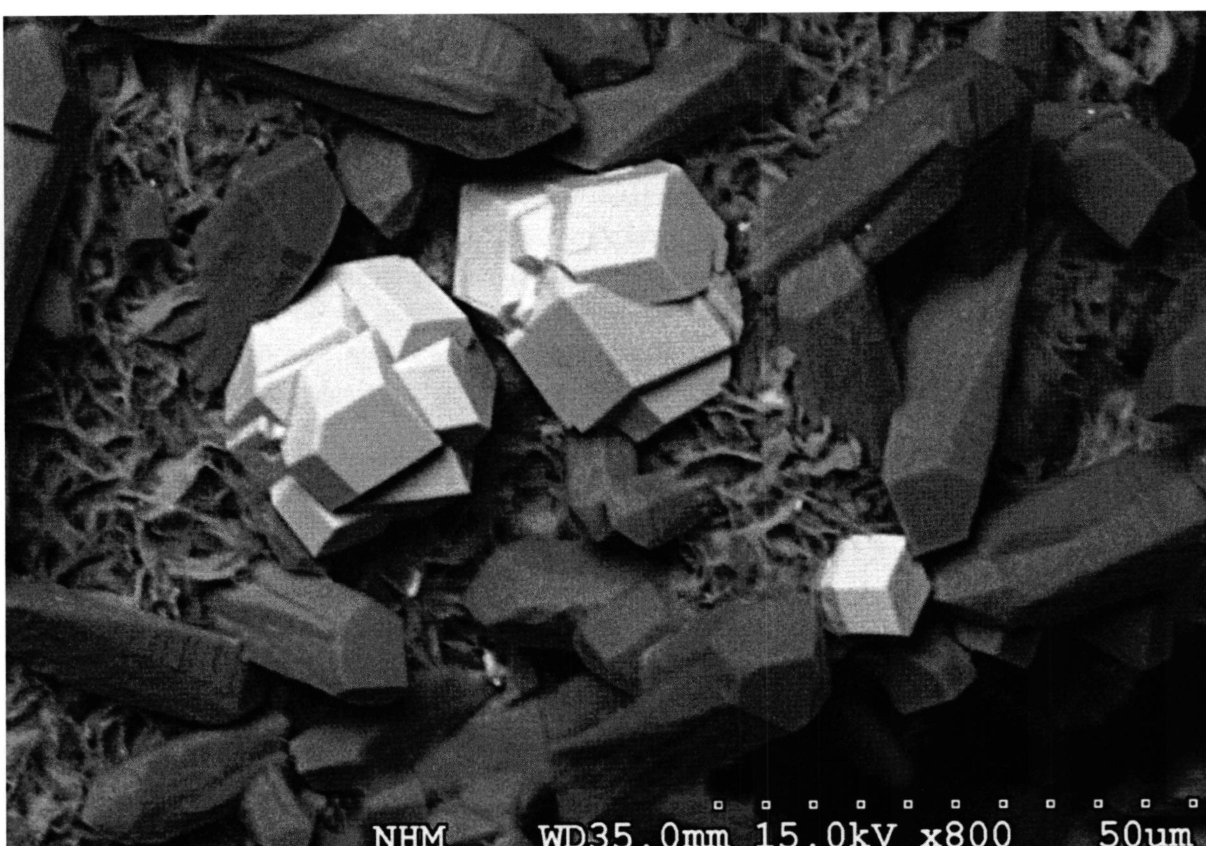

Fig. 15. *Dodecahedral crystals of aspedamite-like mineral (UK-17b), growing on a mica like mineral together with last generation of quartz crystals. From the cottage grounds. SEM photo: H. Friis.*

Table 1. *Analysed minerals.*

Mineral	Analytic method	Reference
Arsenopyrite	SEM-EDS	HF
Astrophyllite	SEM-EDS	TH
Bastnäsite-(Ce)	PXRD & SEM-EDS	TK, HF & AOL
Brookite	SEM-EDS	AOL
Elpidite	PXRD	TK
Epididymite	PXRD	TK & HF
Rutile	PXRD & SEM-EDS	HF & AOL
Gypsum	SEM-EDS	HF
Thorite	PXRD & SEM-EDS	TK & AOL
Wulfenite	SXRD	HF
Zektzerite	PXRD & SEM-EDS	TK & AOL
UK-17b	SXRD & SEM-EDS	HF
Xenotime-(Y)	SXRD & SEM-EDS	HF

Analytic work not referred to in the descriptions (AOL = Alf Olav Larsen, HF = Henrik Friis, TH = Tomas Husdal and TK = Torfinn Kjærnet).

Conclusion

The similarity in mineralogy between the Jahren and Virikkollen pegmatites is interesting as they are both situated in intrusion 4 in close proximity to the border of intrusion 5 for Virikkollen and intrusion 6 for Jahren. Generally, the pegmatites of this intrusion have not received as much attention as pegmatites in other intrusion segments as they have been considered to be relatively devoid of rare minerals. However, this is clearly not the case and perhaps intrusion segment 4 will yield more interesting minerals in the future.

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References

Andersen, O. (1924): Statsgeologenes årsberetninger for 1923. Undersøkelser av feltspatforekomster i Fredriksverns omegn. *Norges Geologiske Undersøkelse* **122**, 18-23.

Åsheim, A. (1994): Hamberg(itt). Stein **21 (2)**, 117-119.

Atencio, D., Coutinho, J.M.V., Doriguetto, A.C., Mascarenhas, Y.P., Ellena, J. & Ferrari, V.C. (2008): Menezesite, the first natural heteropolyniobate, from Cajati, São Paulo, Brazil: description and crystal structure. *American Mineralogist* **93**, 81-87.

Brögger, W.C. (1890): Die Mineralien der Syenitpegmatitgänge der südnorwegischen Augit- und Nephelinsyenite. *Zeitschrift für Kristallographie* **16,** 1-235 + 1-663.

Cooper, M.A., Abdu, Y.A., Ball, N.A., Černý, P., Hawthorne, F.C. & Kristiansen, R. (2012): Aspedamite, ideally $\square_{12}(Fe^{3+},Fe^{2+})_3(Nb_4[Th(Nb,Fe^{3+})_{12}O_{42}]\{(H_2O),(OH)\}_{12}$, a new heteropolyniobate mineral species from the Herrebøkasa quarry, Aspedammen, Østfold, Southern Norway: Description and crystal structure. *The Canadian Mineralogist* **50**, 793-804.

Dahlgren, S. (2010): The Larvik Plutonic Complex. The larvikite and nepheline syenite plutons and their pegmatites. *In* Larsen, A.O. (ed.) (2010): *The Langesundsfjord. History, Geology, Pegmatites, Minerals.* Bode Verlag Gmbh, Salzhemmendorf, Germany, pp 26-37.

Kjærnet, T. (2018): Zektzeritt - mer utbredt i Larvik plutonkomplekset enn man skulle tro? *Norsk Mineralsymposium 2018*, 23-28

Larsen, A.O. (1998): Revisjon av nomenklatur for de sorte amfibolene fra Oslofeltets syenittpegmatitter. *Norsk Bergverksmuseum Skrift* **14**, 9.

Larsen, A.O. (ed.) (2010): *The Langesundsfjord. History, Geology, Pegmatites, Minerals.* Bode Verlag Gmbh, Salzhemmendorf, Germany. 239 pp.

Larsen, K.E. & Kolitsch, U. (2012): An unique mineral suite in a syenite pegmatite at Virikkollen, Sandefjord, Larvik Plutonic Complex, Norway. *Norsk Bergverksmuseum Skrift* **49**, 35-44.

Oftedahl, C. & Petersen, J.S. (1978): Southern part of the Oslo Rift. *Norges Geologiske Undersøkelse Skrifter* **337**, 163-182.

Piilonen, P.C., Poirier, G., Rowe, R. & Larsen, A.O. (2012): Pyrochlore supergroup minerals from the alkaline pegmatites in the Larvik Plutonic Complex, southern Norway. *Norsk Bergverksmuseum Skrift* **50**, 63-81.

Piilonen, P.C., McDonald, A.M., Poirier, G., Rowe, R. & Larsen, A.O. (2013): Mafic minerals of the alkaline pegmatites in the Larvik plutonic complex, Oslo rift, southern Norway. *The Canadian Mineralogist* **51**, 735-770.