STEIN

MAGASIN FOR POPULÆRGEOLOGI

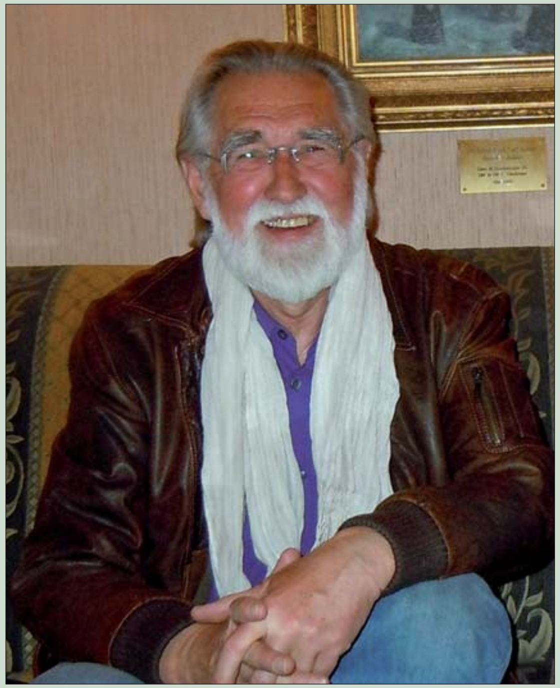
SÆRHEFTE 1 ROY KRISTIANSEN 70ÅR

Innholdsfortegnelse

Bazzitt, Heftetjern, Tørdal, Telemark. Krystallen måler 30 x 12 mm. Foto: Frode Andersen. Samling: Norsk Bergverksmuseum.

Forsidebilde: Kristiansenitt fra Heftetjern, bildebredde 2,5 mm.
Samling/Foto: Joy Desor, Bad Homburg, Tyskland.

Til Roys 70 års dag!



Det er med stolthet og glede redaksjonen i STEIN kan presentere dette "festskriftet" som utgis i forbindelse med at en av våre trofaste skribenter, Roy Kristiansen (f. 1943), fyller 70 år 6. oktober 2013.

Her følger vi en tradisjon med røtter tilbake til 1600-tallets Tyskland. En måte å hedre en som gjennom et langt liv har bidratt til vitenskapen var å utgi et såkalt festskrift. Artiklene i dette heftet er skrevet for å hedre en som på en usedvanlig måte, siden 1970-tallet, har gitt viktige bidrag til mineralogien og som har satt norske mineraler på verdenskartet.

Roy er en enestående, entusiastisk, dedikert amatørmineralog (og mykolog) full av kunnskap og smittende engasjement for å se det store i det små. Med undring som drivkraft har han utviklet en usedvanlig god teft og ikke minst tålmodighet for å finne nye mineraler. Han har bidratt til at 7 nye mineraler (hele 5 for Norge) er blitt beskrevet og karakterisert. Listen over artikler der han alene eller sammen med andre deler av sin nyervervede kunnskap om sine funn er lang.

Mange har først møtt Roy gjennom artiklene i STEIN. Jeg møtte han første gang på slutten av 1980-tallet i en skuff på Musée National de la Geologie i hovedstaden på Madagaskar. Her lå en prøve som Roy hadde sendt museet i forbindelse med et bytte. Prøver fra Roy finnes i museer og samlinger verden over. Hans nettverk av kontakter er imponerende. Alt dette vitner om det som er særlig karakteristisk for Roy, nemlig hans raushet. Han deler villig både prøver, kunnskap og informasjon fra hans rikholdige litteratursamling til mineraloger, profesjonelle og amatører, over hele verden. Flere kan fortelle at det var Roys oppmuntring og entusiasme som fikk dem til å undersøke mineralprøven som til slutt viste seg å gi ny innsikt og kunnskap.

Det var noe av dette som gjorde at han i 2009 ble den første nordmann og europeer som ble tildelt Pinch-medaljen.

Norsk mineralogi hadde vært mye fattigere uten Roy. Derfor vil vi også hedre han med dette heftet.

For redaksjonen,
Knut Edvard

Evolution of the Minerals of Beryllium

Edward S. GREW and Robert M. HAZEN

Introduction

The elements beryllium and scandium are Roy Kristiansen's favorites and he has devoted much of his mineralogical activities to study of minerals containing Be or Sc as essential constituents. Roy has contributed to the discovery of several new Be and Sc minerals and of new localities for existing minerals. To celebrate Roy's 70^{th} birthday, we have written this overview of the 111 species containing essential beryllium from the perspective of mineral evolution, an extension of material presented earlier (Grew and Hazen 2009, 2010).

This perspective is relatively new to mineralogical science – it envisages the critical role played by time (Zhabin 1979; Hazen et al 2008), that is, "mineral evolution frames mineralogy in a historical context" (Hazen and Ferry 2010). Mineral evolution addresses questions such as: Were the minerals we find today present on the early Earth, over 3400 million years ago? Are some minerals that formed on early Earth no longer present? And What do changes in Earth's near-surface mineralogy through 4.5 billion years of history reveal about our planet's evolving geosphere and biosphere?

Beryllium minerals are relative late comers on Earth – the oldest reported occurrence in the geologic record is 3000 million years for beryl and emerald (Figs. 1, 2), over 1500 million years after formation of Earth, a marked contrast with several minerals of scandium: thortveitite $(Sc_2Si_2O_7)$, davisite $(CaScAlSiO_6)$ and eringaite $(Ca_3Sc_2Si_3O_{12})$, which formed in the solar system before Earth (Ma et al 2011; Ma 2012).

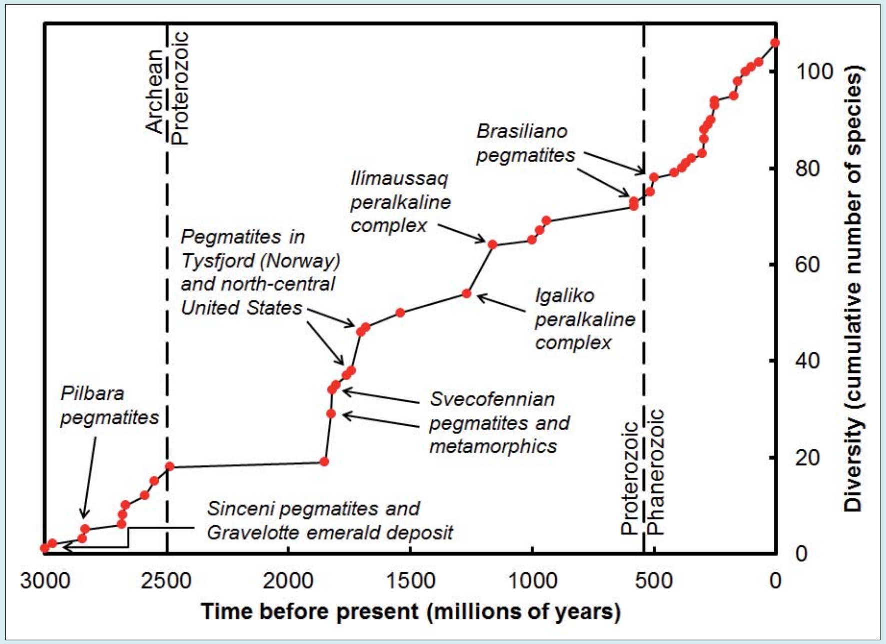


Figure 1. Plot of 106 Be minerals for which geo-chronological data are available (Grew and Hazen, unpublished data).

The minerals of beryllium

Table 1 lists in alphabetical order the 112 minerals containing essential Be that are considered valid by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (CNMNC IMA), together with their formulae, which are largely taken from the 2012 CNMNC IMA list (the list can be downloaded from the CNMNC IMA website or the RRUFF website). We question the validity of two of the approved species, and thus we have not included them in our count. Bohseite may not be distinct from bavenite given the results reported by Lussier and Hawthorne (2011). Krivovichev et al. (2004) found that clinobarylite could be considered the 1*O*-polytype of $BaBe_2Si_2O_7$, for which barylite is the 2*O*-polytype, in which case these minerals are not distinct species, but polytypes of a single species. Vinogradovite is also listed by the CNMNC IMA as a valid mineral containing essential Be, $(Na,Ca,K)_5(Ti,Nb)_4(Si_6BeAl)O_{26}\cdot 3H_2O$. However, we do not consider Be an essential constituent of vinogradovite, because there is no evidence for significant Be in the type material (Semenov et al. 1956). Significant Be substitutes for Si and Al at the Si(2) site in several samples of vinogradovite from the Ilímaussaq complex (Greenland), but it is not dominant at this site, i.e., Si ≈ 6, Al ≈ 1.2, and Be ≈ 0.8 out of 8 atoms total at the Si(2) site (Kalsbeek & Rønsbo 1992), and thus the Ilímaussaq vinogradovite would not qualify as a mineral species distinct from type vinogradovite.

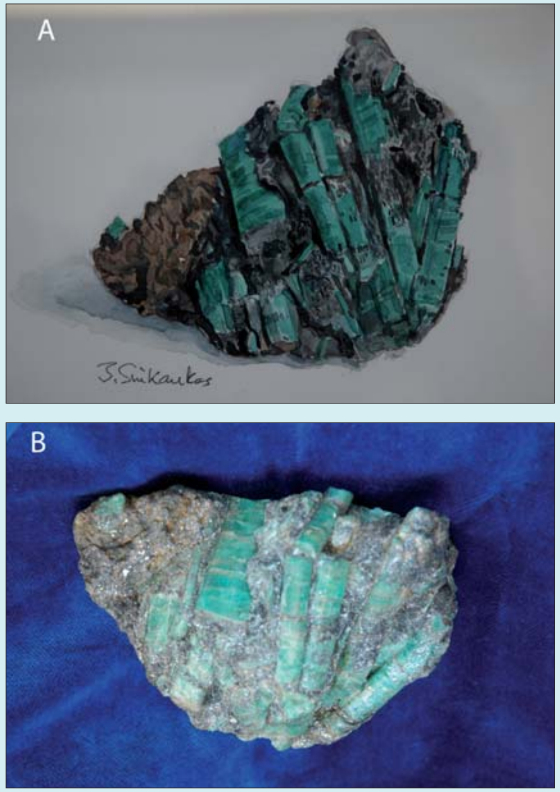


Figure 2. Emerald in mica schist matrix from Murchison greenstone belt, South Africa; 90 x 75 mm. A. Photograph of the painting by John Sinkankas, which was also published as Figure 5 of the colored section in Sinkankas (1981). B. Photograph of the specimen itself in nearly the same orientation. Both photographs are © Peter Lyckberg, and are being published with permission courtesy of Peter Lyckberg. The painting and specimen are in the collection of Peter Lyckberg.

None of the valid unnamed minerals (Smith & Nickel 2007) in the list updated in 2011, which is also available at the CNMNC IMA website, appears to be distinct from an approved mineral. However, there are three additional minerals included in Table 1, bringing the total to 111 valid Be minerals in our view, including IMA 2012-039 (Grice et al. 2013). Pršek et al. (2010) reported a hingganite in which Nd is dominant among the rare earth elements + yttrium, which is potentially a new species, hingganite-(Nd). Hawthorne (2002) suggested that yttrian milarite approaching the end-member $K(CaY)Be_3Si_{12}O_{30}$ in composition could be a distinct mineral. Group assignment is

Figure 3. Bertrandite, $Be_4Si_2O_7(OH)_2$, in pseudo-hexagonal prisms from the Golconda mine, Governador Valadares, Minas Gerais, Brazil. Photograph of sample R060800 reproduced with permission from the RRUFF Project (Downs 2006).

based largely on Back and Mandarino (2008) and Mills et al. (2009).

Beryllium minerals include 66 silicates (e.g., Figs. 3-4), 27 phosphates (e.g., Figs. 5-6), 2 arsenates, 11 oxides and hydroxides (e.g., Fig. 7), 1 carbonate (Fig. 8) and 4 borates (e.g., Fig. 9).

Some basics of mineral evolution

Zhabin (1979) was among the first to raise the possibility of mineral evolution, suggesting some parallels with biological evolution. He gave three stages of mineral formation: (1) meteoritic, (2) basaltic and (3) crustal, and noted that the succession of minerals in a given deposit repeated the succession overall on the planet. Zhabin (1979) introduced the concepts of "panchronous" minerals, which have been forming from the earliest era until the present time, "monochronous" minerals, which formed only once in the history of the Earth, and "polychronous" minerals, which formed more than once.

Hazen and his colleagues (e.g., Hazen et al 2008, 2009, 2011, 2012; Hazen and Ferry 2010) have taken the conceptualization of mineral evolution much further, emphasizing the co-evolution of minerals and life forms and the relationship between increasing mineral diversity and the "Great Oxidation Event" and growth of supercontinents from tectonic plate movements. The mineral kingdom can be considered as an example of a nonliving system that becomes increasingly diverse with the passage of time due to three mechanisms: (1) progressive separation and concentration of elements by physicochemical processes; (2) an increase in the range of intensive variables, such as pressure, temperature, and the activities (effective concentrations) of H_2O, CO_2 and O_2; and (3) biological activity (Hazen and Eldredge 2010). There are three eras that followed the formation of prenebular "ur-minerals" over 4600 million years ago: (1) Planetary Accretion, which extended up to 4550 million years, (2) Crust and Mantle Reworking from 4550 to 2500 million years

Figure 4. Chiavennite, $CaMn^{2+}(BeOH)_2Si_5O_{13}\cdot 2H_2O$, in aggregate of pale yellow to orange spearhead-shaped blades associated with orthoclase and analcime from Tvedalen, Larvik, Vestfold, Norway. Photograph of sample R070349 reproduced with permission from the RRUFF Project (Downs 2006).

Figure 5. Beryllonite, $NaBe(PO_4)$, in columnar aggregate from Kunar Province, Afghanistan and in glassy fragments from the type locality of Stoneham, Maine, U.S.A. Coin diameter is ~1 cm. E.S. Grew samples and photo.

and (3) Biologically Mediated Mineralogy, from 2500 million years to the present. The eras are further divided into 10, partially overlapping stages, for example, two stages of meteorite formation at the dawn of Earth's history 4500-4560 million years before present, whereas other stages, such as granite and pegmatite formation and plate tectonics, began on the Early Earth, most likely after 4000 million years ago and continue to the present day.

Background on beryllium

Beryllium is a quintessential crustal element: it is highly enriched in the upper continental crust compared to other reservoirs, i.e., 2.1 parts per million vs. 1.4 parts per million in the lower crust and 70 parts per billion in primitive mantle (Rudnick and Gao 2005; Palme and O'Neill 2004). However, less than 10 parts per million are rarely sufficient to stabilize a mineral of which Be is an essential constituent (e.g., Grew 2002). Normally further enrichment by at least an order of magnitude is necessary for the more common Be minerals, notably beryl, to appear, for example, 70 parts per million in granitic pegmatites (Evensen and London 2002; London and Evensen 2002). Consequently, important factors in the formation of Be minerals and the analysis of their occurrence in geologic time are:

1) With very rare exception Be in crustal material must be concentrated by processes such as fractionation and hydrothermal activity in order for Be minerals to form.
2) Formation of diverse suites of new Be minerals has been realized by processes such hydrothermal reworking and metamorphism of preexisting Be minerals, in some cases after a substantial time interval.
3) Analysis of the occurrence of Be minerals in geologic time must take into account issues of preservation, biases in sampling, and the fact that Be minerals may be forming in certain environments today that cannot be currently observed.

Some caveats in interpreting the geologic record

In reporting the first occurrences of Be minerals in the geologic record, we are dealing with sample bias problems similar to those faced by paleontologists. Most importantly, the geologic record is incomplete. As pointed out by Barton & Young (2002), deposits of Be minerals formed on or near the Earth's surface would be lost to erosion, i.e., beryllium minerals could have formed in these environments in the Proterozoic or earlier, but did not survive.

Figure 6. Väyrynenite, $BeMn^{2+}PO_4(OH)$, forming pink mass with defined cleavage planes from the Viitaniemi pegmatite, Eräjärvi, Orivesi, Finland. Photograph of sample R050243 reproduced with permission from the RRUFF Project (Downs 2006).

Figure 7. Magnesiotaaffeite-6N'3S, $BeMg_2Al_6O_{12}$, as a greyish purple flattened tabular hexagonal crystal from Ratnapura District, Sri Lanka. Photograph of sample R090019 reproduced with permission from the RRUFF Project (Downs 2006).

Geological and mineralogical investigations are not evenly spread over the globe, and this also is a source of potential bias into the reported distributions. For example, the presence of numerous centers of mineralogical research and mining activity in Scandinavia undoubtedly played a role in stimulating the many discoveries of Be minerals in the Svecofennian province, Oslo igneous province, and Neoproterozoic pegmatites in Norway.

Beryllium minerals in the Archean eon (4000 to 2500 million years)

Pegmatites are the primary sources of Be minerals found in Archean rocks. The two oldest reported Be minerals are beryl and phenakite from southern Africa. Beryl is reported in pegmatites coeval with the Sinceni pluton, Swaziland, and thus dated at 3000 ± 100 Ma using Rb-Sr isotopes (Trumbull 1993); an older age for the Sinceni Pluton suggested by a 3074 ± 4 Ma $^{207}Pb/^{206}Pb$ zircon evaporation age (Maphalala & Kröner 1993) needs confirmation (Trumbull 1993). Emerald and phenakite occur in biotite schist associated with "albitite pegmatoid" and phenakite in the pegmatoid in the Gravelotte emerald deposit (Figs. 1; 2), Murchison greenstone belt, South Africa (Robb & Robb 1986; Grundmann & Morteani 1989) for which the zircon age of 2969 ± 17 Ma on the Discovery Granite (Poujol 2001) probably best dates crystallization of this "pegmatoid." Granitic pegmatites ranging in age from 2850 to 2550 million years associated with greenstone belts in the Pilbara (Fig. 1) and Yilgarn Cratons, Western Australia (e.g., Sweetapple & Collins 2002; Jacobson et al. 2007) and the Superior Province, Ontario and Manitoba, Canada (e.g., Breaks et al. 2005; Černý 2005) contain 7 silicate and 3 phosphate Be minerals, evidence that the differentiation of granitic melts was more than sufficient to enrich resulting pegmatites to give a diversity of Be minerals in Archean orogenic belts.

Peralkaline rocks are very rare in Archean complexes, and there are only two reports of Be minerals in peralkaline rocks of that era – meliphanite and behoite as metasomatic minerals associated with nepheline syenite of the Sakharjok complex, Keivy Alkaline Field, Kola Peninsula, Russia (Bel'kov & Denisov 1968; Batiyeva & Bel'kov 1984; Lyalina et al. 2009), which was dated at 2682 ± 10 Ma (Zozulya et al. 2005).

Metamorphic Be minerals are also reported from just one locality in strictly Archean rocks: chrysoberyl in a granulite-facies plagioclase-biotite-quartz gneiss 2640 2649 million years in age, Yilgarn craton, Australia (Downes & Bevan 2002). However, two Be silicates and one Be oxide are found in granulite-facies anatectic

Figure 8. Niveolanite, $NaBeCO_3(OH)\cdot 2H_2O$, as a fibrous aggregate 1.5 cm across, part of type specimen, from Mont Saint-Hilaire, Rouville, Montérégie, Québec, Canada. Horváth Collection HC11128. Photo © László Horváth. Reproduced with permission courtesy of László Horváth.

Figure 9. Rhodizite, $KBe_4Al_4(B_{11}Be)O_{28}$, pale yellow crystal with pink tourmaline (rubellite) from Manjaka, Sahatany Pegmatite Field, Antananarivo Province, Madagascar. Coin diameter is ~1 cm. E.S. Grew sample (gift of François Fontan) and photo.

veins of earliest Paleoproterozoic age (2485 million years) in the Archean Napier complex: khmaralite (and beryllian sapphirine, Fig. 10), surinamite (Fig. 11) and magnesiotaaffeite-6*N*'3*S* (Grew et al. 2000, 2006).

Based on reported occurrences, by the earliest Paleoproterozoic, there were 18 Be minerals (Fig. 1), 16% of the total known. Fifteen of these minerals have been reported in rocks as young as 0.15-33 million years, largely in the Alpine-Himalayan belt, and could be forming today (see below).

Beryllium minerals in the Proterozoic eon (2500 to 542 million years)

Reported first occurrences in the geologic record of Be minerals suggest four periods of marked increases in species diversity generally separated by more extended periods of modest increases (Fig. 1):

1. Metamorphic and metasomatic rocks and granite pegmatites both between ~ 1800 and ~1850 million years in age in the Svecofennian province of Sweden and Finland (e.g., Holtstam and Langhof 1999; Jonsson 2004; Holtstam and Andersson 2007; Nysten and Gustafsson 1993; Lahti 1989; Lindroos et al. 1996).
2. Pegmatites associated with the Tysfjord granite, 1742 Ma, Nordland, Norway (Husdal 2008, 2011) and Harney granite, Black Hills, South Dakota, USA, 1700 Ma (e.g., Campbell and Roberts 1986; Norton and Redden 1990; Dahl and Foland 2008), plus the Animilie Red Ace pegmatite, Penokean Orogen, Wisconsin, USA, 1760 Ma (e.g., Falster et al. 2001; Sirbescu et al. 2008).
3. Ilímaussaq and Igaliko peralkaline complexes, Gardar Province, southwest Greenland, 1160 Ma and 1273 Ma, respectively (e.g., Petersen and Secher 1993; Krumrei et al. 2006; McCreath et al. 2012)
4. Pegmatites associated with the late Neoproterozoic-Cambrian Brasiliano orogeny, Minas Gerais, Brazil, 585-500 Ma (e.g., Atencio 2000; Morteani et al 2000; Pedrosa-Soares et al. 2011).

The Svecofennian province is unrivaled in its diversity of reported Be minerals: 17 are first reported in the geological record from this province and a total of 30 species are reported in all (e.g., väyrynenite, Fig. 6). A major contributor to this diversity is Långban and similar deposits in the Bergslagen ore region of central Sweden. Their history began with submarine volcanic-hydrothermal

Figure 10. Beryllian sapphirine (dark blue, Spr) separated from quartz (gray, Qtz) by selvages of sillimanite (white) and garnet (pink, Grt). With increasing Be content, beryllian sapphirine acquires the superstructure characteristic of khmaralite, $Mg_4(Mg_3Al_9)O_4[Si_5Be_2Al_5O_{36}]$. From pegmatite in Casey Bay, Enderby Land, Antarctica. Coin diameter is ~1 cm. E.S. Grew sample and photo.

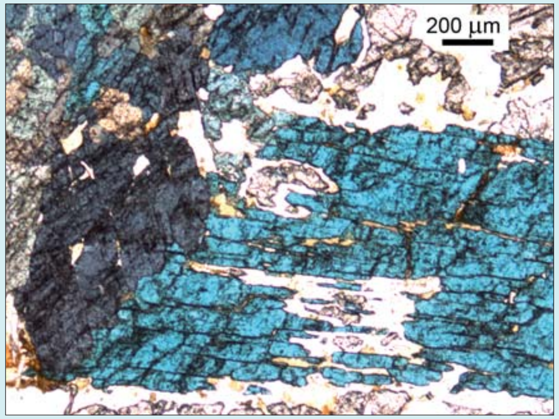


Figure 11. Surimanite, $Mg_3Al_3O(Si_3BeAlO_{15})$, showing purple, blue and greenish pleochroism in plane-polarized light under the microscope. Surinamite formed from breakdown of beryllian sapphirine and khmaralite during high-grade metamorphism of pegmatite. From Casey Bay, Enderby Land, Antarctica. E.S. Grew sample and photomicrograph.

exhalation and precipitation in a back-arc setting at 1890 Ma followed first by regional amphibolite-facies metamorphism and vein formation through remobilization at about 1850-1800 Ma (Svecofennian event) and then by brittle deformation possibly at about 1000 Ma. Multiple reworking of an unusual mix of constituents in an oxidizing environment where the chalcophile elements Pb, Sb, As and Sn combined with Be in oxides and silicates resulted in several minerals that are "endemic" ("monochronous" of Zhabin 1979) – not reported elsewhere (e.g., welshite, Fig. 12).

Pegmatites in Nordland, South Dakota and Wisconsin are combined in this analysis because of their unusual Be minerals and their age of 1700-1760 million years. Many of the new minerals are secondary, derived from the alteration of primary Be minerals, in most cases, beryl.

Pegmatites associated with the Late Proterozoic-Cambrian Brasiliano orogeny also carry a diverse Be mineral assemblage, e.g., moraesite (Fig. 13), in part due to an addition of 7 reported new minerals, 4 of which are secondary phosphates of the roscherite group.

The Ilímaussaq and Igaliko peralkalic intrusions constitute another premier locality for Be minerals, both in new minerals introduced and in overall diversity. However, in contrast to Långban, few of the minerals are "monochronous" (Zhabin 1979) such as sørensenite (Fig. 14). Instead, many of the most unusual minerals (e.g., tugtupite, Fig. 15) have been reported in younger peralkaline complexes, notably Khibiny and Lovozero on the Kola Peninsula (362-370 Ma) and Mont Saint-Hilaire, Quebec (124 Ma) – examples of "polychronous" minerals (Zhabin 1979).

Beryllium minerals in the Phanerozoic eon (542 million years to the present)

The reported number of Be minerals increases steadily and relatively steeply in the Phanerozoic (Fig. 1). Granitic pegmatites, metasomatic deposits and peralkaline intrusions all contributed to the steady increase. However, the proportion of new minerals relative to the total number of Be minerals reported is significantly lower at localities rich in Be minerals, e.g., Mont Saint-Hilaire (2 new, e.g., niveolanite, Fig. 8, 19 total) vs. Ilímaussaq and Igaliko peralkaline intrusions (14 new, 19 total). Adding to the increase are (1) reworking of older Be deposits – høgtuvaite formed by Caledonian metamorphism (414 Ma) of a Be-rich precursor of Proterozoic age (1800 Ma, Grauch et al. 1994; Skår 2002) and (2) a geologic environment not reported previously, volcanic rocks in the Eifel district, Germany (e.g., Schminke 2007, Lengauer et al. 2009) and the Roman volcanic province (e.g., Della Ventura et al. 1992).

Bearsite, glucine and jeffreyite are the only Be minerals of the 112 in the 2012 CNMNC IMA list for which a date could not be assigned, even approximately. The first two are supergene minerals. Bearsite formed in the zone of

Figure 12. Welshite, $Ca_4[Mg_9(Sb^{5+})_3]O_4[Si_6Be_3Al(Fe^{3+})_2O_{36}]$, crystal 3.5x2 mm, from Långban, Sweden. Photograph by Erik Jonsson. Reproduced with permission courtesy of the Swedish Museum of Natural History.

Figure 13. Moraesite, $Be_2(PO_4)(OH)\cdot 4H_2O$, needles, from Itinga, Minas Gerais, Brazil. Photograph of sample R070480 reproduced with permission from the RRUFF Project (Downs 2006).

oxidation of the Bota-Burum uranium deposit (Kazakhstan) hosted by Devonian volcanic rocks (Kopchenko and Sidorenko 1962; Pekov 1998), but it is unlikely the supergene minerals in this deposit are Devonian. Glucine formed where weathering had penetrated a highly fractured and brecciated beryl-fluorite deposit in the Boevskoye ore field, central Urals, Russia (Ginzberg et al. 1966, Pekov 1998), and like bearsite, would be much younger than the Paleozoic rocks hosting it. As regards jeffreyite, did it form in a rodingitized granite dike cutting an Ordovician ophiolite (Wares and Martin 1980), a unique occurrence for a Be mineral, as Grice and Robinson (1984) reported? Or could introduction of Be into the rodingitized granite be related to later alkaline intrusives (R. F. Martin, personal communication 2009)?

Could any beryllium minerals be forming now?

Beryllium minerals formed by geologic processes that are in progress at the present time are probably forming now, for example, in continental collision zones and volcanic provinces associated with cooling plutons and magma chambers. This includes most if not all of the 20 Be minerals reported in granitic pegmatites in the Alpine and Himalayan orogenic belts (e.g., beryllonite, Fig. 5), some of which formed as recently as 7 Ma (Pakistan Himalaya, Laurs et al. 1998). Collision is ongoing in the Himalayan belt, so that pegmatites with Be minerals could be forming at depth. Although quiescent today, the Roman volcanic province was active up until 40 000 years ago (e.g., Della Ventura et al. 1992), so the 5 minerals from this province could also be considered as candidates for minerals that could be forming now.

Among the less obvious candidates is surinamite (Fig. 11), a metamorphic mineral restricted to relatively deep-seated rocks (> 8 kbar, e.g., Grew 2002). It is reported in rocks no younger than 1050 Ma (Chimwala, Chipata district, Zambia, de Roever and Vrána 1985; Johnson et al. 2006). If surinamite were forming today, it is unlikely it would be exposed any time soon.

The least obvious candidates for potential new discoveries would be a subset of the 37 Be minerals that have been reported from only one locality, for example, the Långban deposit. Although similar deposits with minerals of Be, Sb, As, Pb are known elsewhere, e.g., Franklin and Sterling, New Jersey; Kombat Mine, Namibia; and Starlera, Val Ferrera, Switzerland (Brugger and Gieré 1999), none have produced the diversity in Be minerals for which Långban is famous. The Tip Top mine in the Black Hills, South Dakota, is another such locality. Well-studied granitic pegmatites with secondary Be minerals are too numerous to enumerate, but there are five Be minerals at the Tip Top mine that have not been reported from any of them. In summary there are Be minerals for which the chances are relatively low that they are forming now, even at depth.

Figure 14. Sørensenite, $Na_4Be_2Sn(Si_3O_9)_2\cdot 2H_2O$, pink, columnar masses from Kvanefjeld, Ilímaussaq complex, West Greenland. Coin diameter is ~1 cm. E.S. Grew sample (gift of Ted Johnson) and photo.

Figure 15. Tugtupite, $Na_4BeAlSi_4O_{12}Cl$, from Kvanefjeld, Ilimaussaq, Greenland. Photograph of sample R050562 reproduced with permission from the RRUFF Project (Downs 2006).

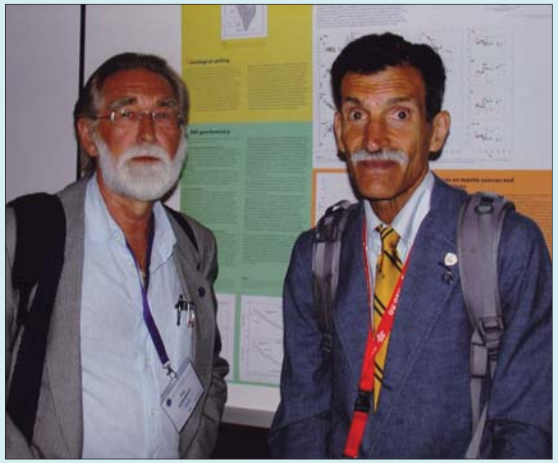
Conclusion

Beryllium minerals result from a variety of processes that concentrate Be and combine it with other constituents under favorable conditions. Diversity in Be mineral assemblages appears to require special circumstances. For example, diversity in granitic pegmatites depends not only on degree of fractionation, but also on alteration and reworking of pre-existing Be minerals, commonly beryl, to create a host of secondary minerals. Diversity in deposits such as Långban depends not only on combining elements such as Be with Sn, As, Sb and Pb, but also on a relatively oxidizing environment in which the latter four form oxides and silicates instead of sulfides and sulfosalts. Currie et al. (1986) suggested that the diversity of rare minerals in the Mont Saint-Hilaire intrusive might be due to the interaction of magma with Cl brines, i.e., again an appeal to special circumstances to explain mineralogical diversity.

The reported first occurrences of Be minerals in the geologic record show an episodic distribution. This feature is particularly marked in the Proterozoic, with spikes at 1800-1850 Ma, 1715-1760 Ma, 1160 Ma and 560 Ma, but the stepwise aspect of the cumulative curve is also evident in the Phanerozoic and Archean (Fig. 1). Many of the spikes are due to Be minerals found in association with orogenic events, notably Svecofennian, Penokean, Brasiliano, and Appalachian, whereas others are associated with major peralkaline intrusions, most notably the Ilímaussaq. However, it must be emphasized that there is considerable diversity in Be minerals in younger orogenic belts (Alpine-Himalayan – mostly Cenozoic) and peralkaline complexes (Khibiny and Lovozero in the Devonian; Chilwa and Mont Saint-Hilaire in the Cretaceous), although relatively few new minerals have been reported from the younger occurrences. This might be taken to mean that the possibilities for forming new Be compounds in geologic systems were pretty much exhausted by the end of the Cretaceous, and the increase in recent time is simply due to the addition of Pleistocene volcanic occurrences to the rock record that is available for sampling. But taking the longer view, the Cenozoic may simply have been too short a time period for the rare combination of special circumstances that would be needed to produce another Långban, Ilímaussaq or Tip Top Mine: a time interval of 65.5 Ma for the Cenozoic vs. nearly 2000 Ma for the Proterozoic.

Acknowledgments

We thank Roy Kristiansen for his continuing interest in our study of Be mineral evolution and for providing reference on these minerals, as well as keeping us up to date on the latest information. ESG thanks François Fontan and Ted Johnson for specimens of rhodizite and sørensenite, respectively. Robert Downs, Ulf Hålenius, László Horváth and Peter Lyckberg are thanked for permission to reproduce photographs of beryllium minerals from the RRUFF project, Swedish Museum of Natural History and personal collections respectively. ESG was supported by U.S. National Science Foundation grant EAR 0837980 to the University of Maine. RMH thanks the NASA Astrobiology Institute, the Deep Carbon Observatory, and the Carnegie Institution of Washington for support of mineral evolution research.



Roy Kristiansen og Edward S. Grew.

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Table 1. List of beryllium minerals

Number	Mineral name	Formula	Supergroup or Group
Be1	Alflarsenite	$\mathrm{NaCa_2Be_3Si_4O_{13}(OH)\cdot 2H_2O}$	
Be2	Almarudite	$\mathrm{K(\square,Na)_2(Mn,Fe,Mg)_2[(Be,Al)_3Si_{12}]O_{30}}$	Milarite
Be3	Aminoffite	$\mathrm{Ca_3(BeOH)_2Si_3O_{10}}$	
Be4	Asbecasite	$\mathrm{Ca_3TiAs_6Be_2Si_2O_{20}}$	
Be5	Atencioite	$\mathrm{Ca_2(Fe^{2+})_3Mg_2Be_4(PO_4)_6(OH)_4\cdot 6H_2O}$	Roscherite
Be6	Babefphite	$\mathrm{BaBePO_4F}$	
Be7	Barylite	$\mathrm{BaBe_2Si_2O_7}$	
Be8	Bavenite	$\mathrm{Ca_4Be_2Al_2Si_9O_{26}(OH)_2}$	
Be9	Bazzite	$\mathrm{Be_3(Sc,Fe^{3+},Mg)_2Si_6O_{18}\cdot Na_x\cdot}n\mathrm{H_2O}$	Beryl
Be10	Bearsite	$\mathrm{Be_2(AsO_4)(OH)\cdot 4H_2O}$	
Be11	Behoite	$\mathrm{Be(OH)_2}$	
Be12	Berborite	$\mathrm{Be_2(BO_3)(OH)\cdot H_2O}$	
Be13	Bergslagite	$\mathrm{CaBeAsO_4(OH)}$	Herderite
Be14	Bertrandite	$\mathrm{Be_4Si_2O_7(OH)_2}$	
Be15	Beryl	$\mathrm{Be_3Al_2Si_6O_{18}}$	Beryl
Be16	Beryllite	$\mathrm{Be_3(SiO_4)(OH)_2\cdot H_2O}$	
Be17	Beryllonite	$\mathrm{NaBe(PO_4)}$	
Be18	Bityite	$\mathrm{CaLiAl_2(Si_2BeAl)O_{10}(OH)_2}$	Mica
	Bohseite	$\mathrm{Ca_4Be_3AlSi_9O_{25}(OH)_3}$	Cf. bavenite
Be19	Bromellite	BeO	
Be20	Bussyite-(Ce)	$\mathrm{(Ce,}\mathit{REE}\mathrm{)_3(Na,H_2O)_6MnSi_9Be_5(O,OH)_{30}F_4}$	
Be21	Chiavennite	$\mathrm{CaMn^{2+}(BeOH)_2Si_5O_{13}\cdot 2H_2O}$	Zeolite
Be22	Chkalovite	$\mathrm{Na_2BeSi_2O_6}$	
Be23	Chrysoberyl	$\mathrm{BeAl_2O_4}$	
	Clinobarylite	$\mathrm{BaBe_2Si_2O_7}$	Cf. barylite
Be24	Clinobehoite	$\mathrm{Be(OH)_2}$	
Be25	Danalite	$\mathrm{Be_3(Fe^{2+})_4(SiO_4)_3S}$	Cancrinite-Sodalite
Be26	Ehrleite	$\mathrm{Ca_2ZnBe(PO_4)_2(PO_3OH)\cdot 4H_2O}$	
Be27	Eirikite	$\mathrm{Kna_6Be_2(Si_{15}Al_3)O_{39}F_2}$	Leifite
Be28	Epididymite	$\mathrm{Na_2Be_3Si_6O_{15}\cdot H_2O}$	
Be29	Euclase	$\mathrm{BeAlSiO_4(OH)}$	
Be30	Eudidymite	$\mathrm{Na_2Be_3Si_6O_{15}\cdot H_2O}$	
Be31	Faheyite	$\mathrm{Be_2Mn^{2+}(Fe^{3+})_2(PO_4)_4\cdot 6H_2O}$	
Be32	Ferrotaaffeite-2*N*'2*S*	$\mathrm{Be(Fe^{2+},Mg,Zn)_3Al_8O_{16}}$	Högbomite
Be33	Ferrotaaffeite-6*N*'3*S*	$\mathrm{Be(Fe^{2+})_2Al_6O_{12}}$	Högbomite
Be34	Footemineite	$\mathrm{Ca_2(Mn^{2+})_5Be_4(PO_4)_6(OH)_4\cdot 6H_2O}$	Roscherite

Be35	Fransoletite	$Ca_3Be_2(PO_4)_2(PO_3OH)_2\cdot 4H_2O$	
Be36	Friedrichbeckeite	$K(\square Na)Mg_2(Be_2Al)Si_{12}O_{30}$	Milarite
Be37	Gadolinite-(Ce)	$Ce_2Fe^{2+}Be_2O_2(SiO_4)_2$	Gadolinite-Datolite
Be38	Gadolinite-(Y)	$Y_2Fe^{2+}Be_2O_2(SiO_4)_2$	Gadolinite-Datolite
Be39	Gainesite	$Na_2(Be,Li)(Zr,Zn)_2(PO_4)_4\cdot 1.5H_2O$	Gainesite
Be40	Genthelvite	$Be_3Zn_4(SiO_4)_3S$	Cancrinite-Sodalite
Be41	Glucine	$CaBe_4(PO_4)_2(OH)_4\cdot 0.5H_2O$	
Be42	Greifensteinite	$Ca_2(Fe^{2+})_5Be_4(PO_4)_6(OH)_4\cdot 6H_2O$	Roscherite
Be43	Gugiaite	$Ca_2BeSi_2O_7$	Melilite
Be44	Guimarãesite	$Ca_2Zn_5Be_4(PO_4)_6(OH)_4\cdot 6H_2O$	Roscherite
Be45	Hambergite	$Be_2BO_3(OH)$	
Be46	Harstigite	$Ca_6Be_4Mn^{2+}(SiO_4)_2(Si_2O_7)_2(OH)_2$	
Be47	Helvite	$Be_3(Mn^{2+})_4(SiO_4)_3S$	Cancrinite-Sodalite
Be48	Herderite	$CaBePO_4(F,OH)$	Herderite
Be49	Hingganite-(Ce)	$BeCe(SiO_4)OH$	Gadolinite-Datolite
Be50	"Hingganite-(Nd)"	$BeNd(SiO_4)OH$	Gadolinite-Datolite
Be51	Hingganite-(Y)	$BeY(SiO_4)OH$	Gadolinite-Datolite
Be52	Hingganite-(Yb)	$BeYb(SiO_4)OH$	Gadolinite-Datolite
Be53	Høgtuvaite	$Ca_4[(Fe^{2+})_6(Fe^{3+})_6]O_4[Si_8Be_2Al_2O_{36}]$	Sapphirine
Be54	Hsianghualite	$Li_2Ca_3Be_3(SiO_4)_3F_2$	Zeolite
Be55	Hurlbutite	$CaBe_2(PO_4)_2$	
Be56	Hyalotekite	$(Pb,Ba,K)_4(Ca,Y)_2(B,Be)_2(Si,B)_2Si_8O_{28}F$	
Be57	Hydroxylherderite	$CaBePO_4(OH)$	Herderite
Be58	Jeffreyite	$(Ca,Na)_2(Be,Al)Si_2(O,OH)_7$	
Be59	Joesmithite	$Pb^{2+}Ca_2(Mg_3Fe^{3+}{}_2)(Si_6Be_2)O_{22}(OH)_2$	Amphibole
Be60	Khmaralite	$Mg_4(Mg_3Al_9)O_4[Si_5Be_2Al_5O_{36}]$	Sapphirine
Be61	Kyzylkumite	$Be(V^{3+})_2TiO_6$	
Be62	Leifite	$Na_7Be_2(Si_{15}Al_3)O_{39}(F,OH)_2$	Leifite
Be63	Leucophanite	$NaCaBeSi_2O_6F$	
Be64	Liberite	Li_2BeSiO_4	
Be65	Londonite	$CsBe_4Al_4(B_{11}Be)O_{28}$	
Be66	Lovdarite	$K_2Na_6Be_4Si_{14}O_{36}\cdot 9H_2O$	
Be67	Magnesiotaaffeite-2*N*′2*S*	$BeMg_3Al_8O_{16}$	Högbomite
Be68	Magnesiotaaffeite-6*N*′3*S*	$BeMg_2Al_6O_{12}$	Högbomite
Be69	Makarochkinite	$Ca_4[(Fe^{2+})_8(Fe^{3+})_2Ti_2]O_4[Si_8Be_2Al_2O_{36}]$	Sapphirine
Be70	Mariinskite	$BeCr_2O_4$	
Be71	Mccrillisite	$NaCs(Be,Li)Zr_2(PO_4)_4\cdot 1\text{-}2H_2O$	Gainesite
Be72	Meliphanite	$Ca_4(Na,Ca)_4Be_4AlSi_7O_{24}(F,O)_4$	
Be73	Milarite	$Kca_2(Be_2AlSi_{12})O_{30}\cdot H_2O$	Milarite
Be74	Minasgeraisite-(Y)	$CaBe_2Y_2Si_2O_{10}$	Gadolinite-datolite

Be75	Moraesite	$Be_2(PO_4)(OH)\cdot 4H_2O$	
Be76	Mottanaite-(Ce)	$Ca_4(CeCa)AlBe_2(Si_4B_4O_{22})O_2$	Hellandite
Be77	Nabesite	$Na_2BeSi_4O_{10}\cdot 4H_2O$	Zeolite
Be78	Niveolanite	$NaBeCO_3(OH)\cdot 2H_2O$	
Be79	Odintsovite	$K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$	
Be80	Oftedalite	$KSc_2(Be,Al)_3Si_{12}O_{30}$	Milarite
Be81	Pahasapaite	$Li_8(Ca,Li,K)_{10}Be_{24}(PO_4)_{24}\cdot 38H_2O$	Zeolite
Be82	Parafransoletite	$Ca_3Be_2(PO_4)_2(PO_3OH)_2\cdot 4H_2O$	
Be83	Pezzottaite	$CsLiBe_2Al_2Si_6O_{18}$	Beryl
Be84	Phenakite	Be_2SiO_4	Willemite
Be85	Rhodizite	$Kbe_4Al_4(B_{11}Be)O_{28}$	
Be86	Roggianite	$Ca_2BeAl_2Si_4O_{13}(OH)_2\cdot nH_2O$ $(n < 2.5)$	Zeolite
Be87	Roscherite	$Ca_2(Mn^{2+})_5Be_4(PO_4)_6(OH)_4\cdot 6H_2O$	Roscherite
Be88	Ruifrancoite	$Ca_2\ (\square,Mn^{2+})_2(Fe^{3+},Mn^{2+},Mg)_4$- $Be_4(PO_4)_6(OH)_4\cdot 6H_2O$	Roscherite
Be89	Samfowlerite	$Ca_{14}(Mn^{3+})_3Zn_2Be_2Be_6Si_{14}O_{52}(OH)_6$	
Be90	Selwynite	$NaKBeZr_2(PO_4)_4\cdot 2H_2O$	Gainesite
Be91	Semenovite-(Ce)	$(Na,Ca)_9Fe^{2+}Ce_2(Si,Be)_{20}(O,OH,F)_{48}$	
Be92	Sørensenite	$Na_4Be_2Sn(Si_3O_9)_2\cdot 2H_2O$	
Be93	Sphaerobertrandite	$Be_3SiO_4(OH)_2$	
Be94	Stoppaniite	$(Fe^{2+})_2Be_3Al_2Si_6O_{18}$	Beryl
Be95	Strontiohurlbutite	$SrBe_2(PO_4)_2$	
Be96	Surinamite	$Mg_3Al_3O(Si_3BeAlO_{15})$	Sapphirine
Be97	Sverigeite	$NaBe_2(Mn^{2+})_2SnSi_3O_{12}(OH)$	
Be98	Swedenborgite	$NaBe_4Sb^{5+}O_7$	
Be99	Telyushenkoite	$CsNa_6Be_2(Si_{15}Al_3)O_{39}F_2$	Leifite
Be100	Tiptopite	$K_2(Li,Na,Ca)_6(Be_6P_6)O_{24}(OH)_2\cdot 1.3H_2O$	Cancrinite-Sodalite
Be101	Trimerite	$CaBe_3(Mn^{2+})_2(SiO_4)_3$	
Be102	Tugtupite	$Na_4BeAlSi_4O_{12}Cl$	Cancrinite-Sodalite
Be103	Tvedalite	$Ca_4Be_3Si_6O_{17}(OH)_4\cdot 3H_2O$	
Be104	Uralolite	$Ca_2Be_4(PO_4)_3(OH)_3\cdot 5H_2O$	
Be105	Väyrynenite	$BeMn^{2+}PO_4(OH)$	
	Vinogradovite	Not a Be mineral – see text	
Be106	Wawayandaite	$Ca_6Be_9(Mn^{2+})_2Bsi_6O_{23}(OH,Cl)_{15}$	
Be107	Weinebeneite	$CaBe_3(PO_4)_2(OH)_2\cdot 4H_2O$	Zeolite
Be108	Welshite	$Ca_4[Mg_9(Sb^{5+})_3]O_4[Si_6Be_3Al(Fe^{3+})_2O_{36}]$	Sapphirine
Be109	Zanazziite	$Ca_2Mg_5Be_4(PO_4)_6(OH)_4\cdot 6H_2O$	Roscherite
Be110	Ferrochiavennite	$Ca_{1-2}Fe[(Si,Al,Be)_5Be_2O_{13}(OH)_2]\cdot 2H_2O$	Zeolite
Be111	Unnamed	$K(CaY)Be_3Si_{12}O_{30}$	Milarite

Nye IMA-godkjente mineraler fra Norge 1982–2012

Av Gunnar Raade

Denne artikkelen om nye norske mineraler er først og fremst skrevet for å tydeliggjøre hvilken betydning Roy Kristiansen har hatt i norsk mineralogi når det gjelder å finne (ofte ørsmå) nye mineraler og sørge for å få dem undersøkt og beskrevet av fagekspertisen. Når jeg har valgt tidsrommet 1982 til 2012, så er årsaken ganske enkelt den at det er i den perioden jeg har vært medlem av IMA-kommisjonen for nye mineraler.

Nye mineraler skal godkjennes av en kommisjon under *International Mineralogical Association* (IMA). Kommisjonen som steller med dette ble opprettet i 1959 og het opprinnelig *Commission on New Minerals and Mineral Names* (CNMMN). Den skiftet navn til *Commission on New Minerals, Nomenclature and Classification* (CNMNC) i juli 2006. Kommisjonen har hatt følgende formenn (Chairmen):

Michael Fleischer 1959-1974
Akira Kato 1975-1982
Joseph A. Mandarino 1983-1994
Joel D. Grice 1995-2002
Ernst A.J. Burke 2003-2008
Peter A. Williams 2008-

Selv kom jeg med i kommisjonen som norsk representant etter Professor Henrich Neumann i 1982, nærmere bestemt fra og med IMA-mineral 82-65. I alle disse årene til og med 2012 har jeg behandlet 2.014 forslag til nye mineraler. Og jeg har faktisk ikke forsømt en eneste avstemning. Jeg har tjenestegjort under fem forskjellige formenn. Som en kuriositet kan jeg nevne at Akira Kato og jeg hvert eneste år siden 1982 har utvekslet julekort. Jeg var forøvrig til stede ved et kommisjonsmøte i Regensburg i 1974 mens Mike Fleischer var formann.

Figuren viser utviklingen i antall mineraler per år behandlet av kommisjonen. I 1982 var det totalt 109 forslag til nye mineraler, deretter sank antallet og lå i mange år på 40 til 70. I de fire siste årene har aktiviteten økt betydelig, og i 2011 endte vi på 115 nye mineralforslag. Sammendragene som representantene skal gjennomgå har økt betraktelig i omfang, fra én side til ofte ti-femten sider for hvert mineral. Avstemningen foregår hver eneste måned året rundt.

Oversikten nedenfor viser 29 nye norske mineraler fra 1982 til 2012, med IMA-nummer, mineralnavn, kjemisk formel, forfattere og lokalitetsangivelse. Dataene er tatt fra de sammenfatningene som er sendt ut til kommisjonsmedlemmene. Det kan derfor forekomme at formler eller rekkefølgen av forfattere avviker noe fra det som er publisert i tidsskriftartikkelen om mineralet.

Roy har bidratt med fem nye norske mineraler, først og fremst det som er oppkalt etter ham, kristiansenitt. Jeg er glad for at jeg fikk anledning til å være med på å beskrive dette nye mineralet. Dernest noterer vi oss oftedalitt, heftetjernitt, aspedamitt og ferrochiavennitt. Det er Heftetjern-pegmatitten i Tørdal som har vært Roys spesialområde. Det er verdt å merke seg at Roy også har vært involvert i beskrivelsen av to ikke-norske mineraler:

82-21 **Kaatialaitt** $Fe(H_2AsO_4)_3 \cdot 5H_2O$ (Raade, Mladeck, KRISTIANSEN, Din) Kaatiala, Finland

84-34 **Zimbabweitt** $(Na,K)_2PbAs_4(Ta,Nb,Ti)_4O_{18}$ (Foord, Taggart, Gaines, KRISTIANSEN) Karoi district, Zimbabwe

Det har i de seneste årene vært et markant oppsving i norsk mineralogi når det gjelder nye mineraler. I hvert av årene 2003, 2006, 2011 og 2012 hadde vi fire nye mineraler fra Norge i kommisjonen. Tomas Husdal har vært den største bidragsyteren med i alt åtte mineraler, seks av dem fra Stetind-pegmatitten i Tysfjord. Både Roy og Tomas kommer sikkert til å bidra med flere nye mineraler i årene som kommer.

Oversikt over nye norske mineraler 1982-2012

1983-57 **Heneuitt** $CaMg_5(CO_3)(PO_4)_3(OH)$ (Raade, Mladeck, Din) Tingelstadtjern, Modum.

1987-043 **Kamphaugitt-(Y)** $Ca_2Y_2(CO_3)_4(OH)_2 \cdot 3H_2O$ (Raade, Brastad) Hørtekollen, Lier.

1990-027 **Tvedalitt** $(Ca,Mn)_4Be_3Si_6O_{17}(OH)_4 \cdot 3H_2O$ (Larsen, Åsheim, Raade, Taftø) Tvedalen, Larvik.

1990-051 **Høgtuvaitt** $(Ca,Na)_2(Fe^{2+},Fe^{3+},Ti)_6(Si,Be,Al)_6O_{20}$ (Grauch, Lindahl, Fitzpatric, Foord, Graff, Hysingjord, Evans, Burt) Høgtuva, Rana.

1996-034 **Raadeitt** $Mg_7(PO_4)_2(OH)_8$ (Chopin, Brunet, Ferraris, Prencipe, Medenbach) Tingelstadtjern, Modum.

2000-051 **KRISTIANSENITT** $Ca_2ScSn(Si_2O_7)(Si_2O_6OH)$ (Raade, Ferraris, Gula, Ivaldi, Bernhard) Heftetjern, Tørdal.

2001-009 **Gjerdingenitt-Fe** $K_2(H_2O)_2(Fe,Mn)[(Nb,Ti)_4(Si_4O_{12})_2(O,OH)_4] \cdot 4H_2O$ (Raade, Ferraris, Gula, Ivaldi) Gjerdingselva, Lunner.

2003-001 **Heulanditt-Ba** $(Ba,Ca,K,Na,Sr)_5Al_9Si_{27}O_{72} \cdot 22H_2O$ (Larsen, Nordrum, Doebelin, Armbruster, Petersen, Erambert) Vinoren, Kongsberg.

2003-015 **Gjerdingenitt-Mn** $(K,Na)_2(Mn,Fe)(Nb,Ti)_4(Si_4O_{12})_2(O,OH)_4 \cdot 6H_2O$ (Raade, Chukanov, Kolitsch, Möckel, Zadov, Pekov) Gjerdingselva, Lunner.

2003-024 **Grenmaritt** $(Zr,Mn)_2(Zr,Ti)(Mn,Na)(Na,Ca)_4(Si_2O_7)_2(O,F)_4$ (Bellezza, Franzini, Merlino, Perchiazzi, Larsen) Vesle Arøya, Langesundsfjord.

2003-045 **Oftedalitt** $(Sc,Ca)_2KBe_3Si_{12}O_{30}$ (Cooper, Hawthorne, Černý, Ball, KRISTIANSEN, Bernhard) Heftetjern, Tørdal.

2006-005 **Hundholmenitt-(Y)** $(Y,REE,Ca,Na)_{15}(Al,Fe^{3+})Ca_xAs^{3+}{}_{1-x}(Si,As^{5+})Si_6B_3(O,F)_{48}$ x = 0,78 (Raade, Johnsen) Hundholmen, Tysfjord.

2006-023 **Aluminotaramitt** $Na(CaNa)_{\Sigma 2}(Mg_3Al_2)_{\Sigma 5}(Si_6Al_2)_{\Sigma 8}O_{22}(OH)_2$ (Oberti, Boiocchi, Smith, Medenbach) Liset, Selje, Møre og Romsdal.

2006-024 **Alumino-magnesiotaramitt** $Na(CaNa)_{\Sigma 2}(Fe^{2+}{}_3Al_2)_{\Sigma 5}(Si_6Al_2)_{\Sigma 8}O_{22}(OH)_2$ (Oberti, Boiocchi, Smith, Medenbach) Liset, Selje, Møre og Romsdal.

2006-056 **Heftetjernitt** $ScTaO_4$ (Kolitsch, Raade, KRISTIANSEN) Heftetjern, Tørdal.

2007-017 **Eirikitt** $KNa_6Be_2(Si_{15}Al_3)_{\Sigma 18}O_{39}F_2$ (Larsen, Kolitsch, Gault) Vesle Arøy, Langesundsfjorden.

2008-023 **Alflarsenitt** $NaCa_2Be_3Si_4O_{13}(OH) \cdot 2H_2O$ (Raade, Grice, Cooper) Tvedalen, Larvik.

2008-035 **Stetinditt** $CeSiO_4$ (Schlüter, Malcherek, Husdal) Stetind, Tysfjord.

2009-005 **Fluorbritholitt-(Y)** $(Y,Ca,\mathit{Ln})_5[(Si,P)O_4]_3F$ (Pekov, Zubkova, Chukanov, Husdal, Zadov, Pushcharovsky) Lagmannsvik, Hamarøy.

2010-027 **Sveinbergeitt** $Ca(Fe^{2+}{}_6Fe^{3+})Ti_2(Si_4O_{12})_2O_2(OH)_5(H_2O)_4$ (Khomyakov, Cámara, Sokolova, Hawthorne) Buer, Vesterøy, Sandefjord.

2010-065 **Atelisitt-(Y)** $Y_4Si_3O_8(OH)_8$ (Malcherek, Mihailova, Schlüter, Husdal) Stetind, Tysfjord.

2011-055 **Perbøeitt-(Ce)** $(CaCe_3)(Al_3Fe^{2+})(Si_2O_7)(SiO_4)_3O(OH)_2$ (Bonazzi, Bindi, Chopin, Husdal, Lepore) Hundholmen, Tysfjord.

2011-056 **Aspedamitt** $\square_{12}(Fe^{3+}{}_2Fe^{2+})Nb_4(ThNb_9Fe^{3+}{}_2Ti^{4+}O_{42})(H_2O)_9(OH)_3$ (Cooper, Ball, Abdu, Hawthorne, Černý, Kristiansen) Herrebøkasa, Aspedammen, Østfold.

2011-062 **Bastnäsitt-(Nd)** $NdCO_3F$ (Miyawaki, Yokoyama, Husdal) Stetind, Tysfjord.

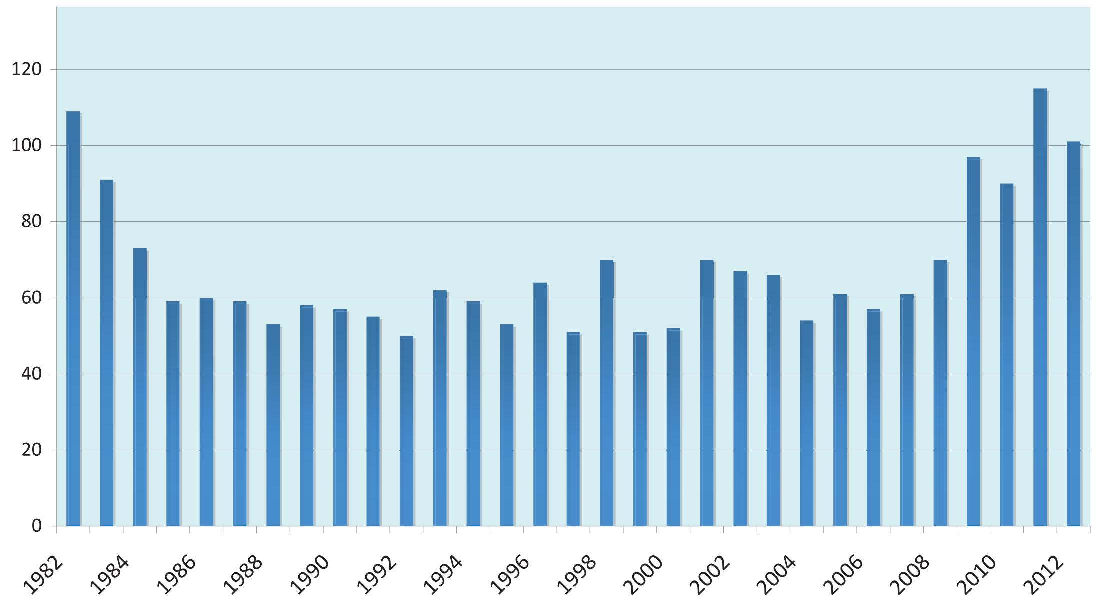
2011-094/095 **Cayalsitt-(Y)** $CaY_6Al_2Si_4O_{18}F_6$ (Malcherek, Schlüter, Husdal) Stetind, Tysfjord.

2012-015 **Schlüteritt-(Y)** $(Y,REE)_2AlSi_2O_7(OH)_2F$ (Cooper, Husdal, Ball, Hawthorne, Abdu) Stetind, Tysfjord.

2012-039 **Ferrochiavennitt**. $Ca_{1-2}Fe[(Si,Al,Be)_5Be_2O_{13}(OH)_2]\cdot 2H_2O$ (Grice, Kristiansen, Friis, Rowe, Selbekk, Cooper, Larsen, Poirier) Langangen og Tvedalen.

2012-054 Navnet er ikke frigitt. $(CaCe_{2.5}Na_{0.5})(Al_4)(Si_2O_7)(SiO_4)_3O(OH)_2$ (Bonazzi, Bindi, Chopin, Husdal, Lepore) Stetind, Tysfjord.

2012-084 Navnet er ikke frigitt. $Mn_4Nb_6O_{19}\cdot 14H_2O$ (Friis, Larsen, Kampf, Evans, Selbekk, Kihle) Tvedalen, Larvik.



Antall forslag til nye mineraler behandlet av CNMMN/CNMNC 1982-2012.

Hingganite-(Y) from a syenite pegmatite at Virikkollen, Sandefjord, Vestfold, Norway

Alf Olav Larsen, Radek Škoda, Knut Edvard Larsen

Introduction

Gadolinite group minerals have the general formula $A_2X_xZ_2T_2O_8[O_{2-x}(OH)_{2-2x}]$ where $0 \leq x \geq 1$, and A = Y, REE, Ca; X = Fe^{2+} or vacancy; Z = Be, B; and T = Si. Several gadolinite group minerals have been found in the Larvik Plutonic Complex: gadolinite-(Ce), gadolinite-(Y), hingganite-(Ce), hingganite-(Y), homilite, and datolite (Larsen 2010). Investigation of pegmatite material collected at the locality Virikkollen near Sandefjord, recently described by Larsen & Kolitsch (2012), revealed a mineral that occurs as pale beige spherulites. Preliminary analyses showed this mineral to be Ca-rich hingganite-(Y), ideally $Y_2\square Be_2Si_2O_8(OH)_2$ or $YBeSiO_4(OH)$, which can be expressed as the Fe-free analogue of gadolinite-(Y). The new find initiated a study of this rare mineral.

The occurrence

In April 2010, one of the authors (KEL) observed that expansion of the root system of a small rowan tree combined with repeated frost cracking had exposed a cavity about half a metre across in a pegmatite dike in a road cut of Haneholmveien (Haneholm road) on the eastern side of a small hill called Virikkollen, located 1 km SW of the centre of Sandefjord town. The pegmatite dike appears to have a sheet-like shape and is situated about 4-5 m above the street level. Thorough investigation on the locality showed that the primary pegmatite minerals include microcline, black amphiboles, aegirine, magnetite and minor amounts of fluorapatite, zircon, pyrochlore, biotite and albite. The cavity was lined by large aegirine and microcline crystals and hosted a unique assemblage of late stage, hydrothermal minerals (Larsen & Kolitsch 2012), among them zektzerite and an aspedamite-like mineral (UK-17). Other hydrothermal minerals included second generation aegirine, bastnäsite-(Ce), bertrandite, chalcedony, epididymite, ilmenite, pale mica, milarite, monazite-(Ce), hingganite-(Y), opal, second generation of pyrochlore, quartz, second generation of zircon, plus black manganese oxide crusts and unspecified clay material.

The mineral description

Hingganite-(Y) from the Virikkollen locality occurs as pale beige, radiating spherulites up to 1 mm across, often as intergrown aggregates. The spherulites are abundantly dispersed in the grundmass, mainly quartz and aegirine. The streak is white. No fluorescence is observed under short- and long-wavelength UV light. A back-scatter image of a split and polished spherulite (Fig. 1) show that the composition is rather complex with intergrown silicates, and probably a fine alteration along the hingganite needles. In addition, the spherulite is rimmed by a late-stage hingganite with slightly different chemical composition.

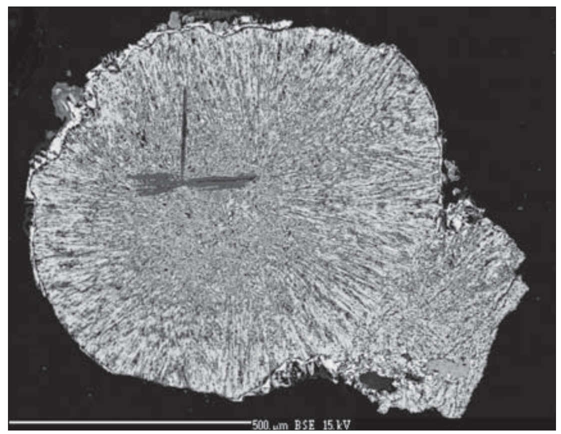


Fig. 1. Cross section of a spherulite of hingganite-(Y) from Virikkollen, Sandefjord. SEM micrograph (BSE mode), R. Škoda.

The chemical composition

Quantitative analyses were carried out using an electron microprobe. The average of 9 spot analyses on the main part of the mineral is shown in Table 1. Ba, Sr, P, Sc, K, Mg, Na and Al were sought, but not detected. The quadrant diagram of the main species in the gadolinite group (Fig. 2) shows the distribution of the *apfu* of (Fe+Mn) *vs.* (Y+REE), clearly indicating that the Virikkollen mineral as a hingganite, and

Table 1. Chemical composition determined by LA-ICP-MS and EMP (average of 9 analyses), and number of atoms calculated on the basis of Si = 2.

	LA-ICP-MS (wt.%)	EMP (*n*=9) (wt.%)	No. of atoms
SiO_2		27.13 (26.81-27.29)	2.000
ThO_2		0.13 (0.09-0.14)	0.002
UO_2		0.02 (0.00-0.06)	0.000
Y_2O_3	31.22	30.60 (29.33-31.58)	1.200
La_2O_3	0.13	0.14 (0.09-0.24)	0.004
Ce_2O_3	1.27	1.37 (1.24-1.51)	0.037
Pr_2O_3	0.29	0.40 (0.33-0.45)	0.011
Nd_2O_3	2.33	2.60 (1.91-2.83)	0.068
Sm_2O_3	1.90	1.40 (1.15-1.67)	0.036
Eu_2O_3	0.24	0.19 (0.15-0.24)	0.005
Gd_2O_3	3.70	3.49 (3.30-3.67)	0.085
Tb_2O_3	0.71	0.65 (0.58-0.76)	0.016
Dy_2O_3	4.55	4.07 (3.80-4.31)	0.097
Ho_2O_3	0.94	0.85 (0.83-0.96)	0.020
Er_2O_3	2.40	2.13 (2.03-2.27)	0.049
Tm_2O_3	0.25	0.21 (0.16-0.26)	0.005
Yb_2O_3	1.27	0.82 (0.70-0.95)	0.019
Lu_2O_3	0.10	0.06 (0.03-0.08)	0.001
CaO		4.27 (3.77-4.69)	0.338
MnO		0.10 (0.04-0.14)	0.006
FeO		2.60 (2.46-2.82)	0.161
BeO	8.79	9.33 (9.12-9.51)*	1.652*
B_2O_3	3.78	2.65 (2.34-2.91)*	0.338*
H_2O		3.47 (2.94-3.75)**	1.706**
Total		98.69	

* Be and B were calculated on the basis of gadolinite-hingganite and datolite end member composition, respectively.

** OH was calculated to keep the formula electro-neutral.

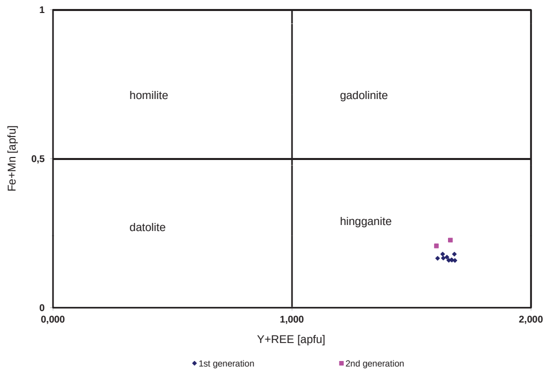


Fig. 2. Quadrant diagram on the apfu of (Fe+Mn) vs. (Y+REE) of the main species in the gadolinite group showing the position of the spot EMP analyses, all within the hingganite region.

with Y as the dominating rare earth element the mineral is hingganite-(Y). The empirical formula for hingganite-(Y) from Virikkollen on the basis of Si = 2 is

$(Y_{1.20}Ca_{0.34}Dy_{0.10}Gd_{0.09}Nd_{0.07}Er_{0.05}Sm_{0.04}Ce_{0.04}Ho_{0.02}Yb_{0.02}Tb_{0.02}Pr_{0.01})_{\Sigma 1.99}(\square_{0.84}Fe_{0.16})_{\Sigma 2.00}(Be_{1.65}B_{0.34})_{\Sigma 1.99}Si_{2.00}O_{10.00}(OH)_{1.68}$.

Two spot analyses on the outer zone of late stage hingganite-(Y) show that this phase is slightly enriched in Fe (average 0.22 *apfu*) (Fig 2).

The contents of Be and B were calculated on the basis of gadolinite-hingganite and datolite end member composition, respectively. In addition, REE, Be and B were determined using a laser ablation inductively coupled plasma mass spectrometry instrument (LA-ICP-MS). The results are shown in Table 1. Most of the analytical results for the REE by this technique are within the variations of the EMP analyses. Interestingly, the calculated Be and B contents differ only slightly from that measured by LA-ICP-MS.

X-ray crystallography

X-ray powder diffraction data on the hingganite-(Y) were obtained using a Panalytical X'pert Pro diffractometer equipped with automatic divergence slits (Cu$K\alpha_1$ radiation, λ = 1.54056 Å). Finely ground mineral was dispersed on a zero-background silicon plate. Data were collected from 5º to 70º 2θ. Lanthanum hexaboride (LaB_6, NIST SRM 660a) was used as internal standard. The X-ray powder diffraction pattern was indexed using the monoclinic space group $P2_1/a$, and least-squares refinement was done by the program CELREF (Laugier & Bochu 1999). The unit-cell dimensions found are a = 9.8654(17), b = 7.6033(12), c = 4.7561(7) Å, β = 90.11(3)º, V = 356.75(10) Å^3.

Conclusion

The diversity of minerals in the pegmatites in the Larvik Plutonic Complex (LPC) became famous through the monograph by Brøgger (1890). Among all the alkaline complexes worldwide, the pegmatites of the LPC show the largest diversity in beryllium minerals with 26 species, among them 11 type species (Raade 2008; Larsen 2010). Hingganite-(Y) has previously been identified from the LPC: as tiny, beige crystals in the Tuften quarry, Tvedalen, and as groups of radiating, pale rose coloured crystals at Bratthagen, Lågendalen. The present paper is yet another description of the rare beryllium mineral hingganite-(Y) from the LPC.

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Detail of the Virikkollen sample showing white spherulites of hingganite-(Y) associated with quartz, aegirine and Fe-hydroxides. Field of view 20 mm. Photo by A. O. Larsen.

Roy Kristiansens mineralogiske bidrag - En bibliografi

Sammenstilt av Knut Edvard Larsen

Bidrag i bøker og tidsskrifter

1971

Kristiansen, R. & Raade, G.: Surface alteration products of løllingite. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, s. 36. [Første funn av skorodítt i Norge, fra Jennyhaugen, Drag; Foreløpig beskrivelse av sekundært produkt på löllingitt fra Kaatiala, Finland]

1972

“Contributions to the mineralogy of the Li-pegmatite at Ågskardet”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 38-39

Kristiansen, R. & Raade, G.: Kainosite from Grytting, Gjerstad. Pharmacosiderite from Jennyhaugen, Drag i Tysfjord. Bismutite from Ågskardet, Holandsfjord. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, s. 40.

“Still more on barylite”. *Mineralogical Record* **3**, 230.

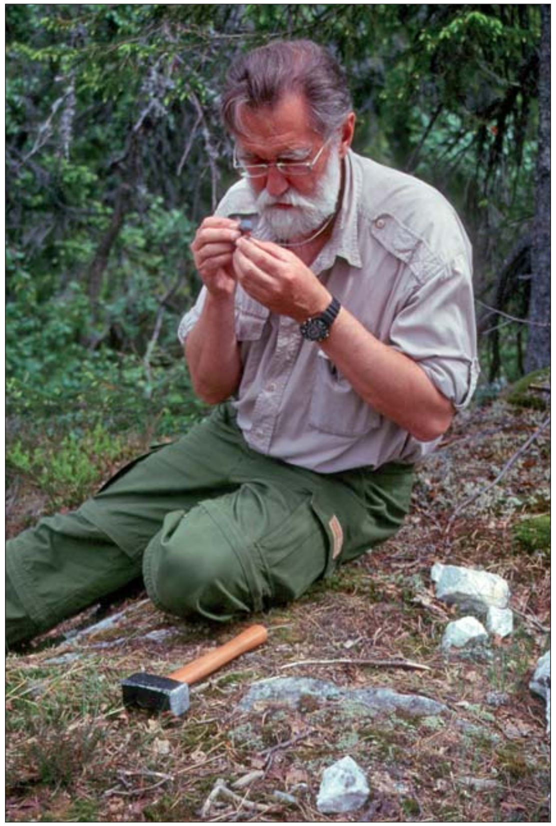
1974

“Rhabdophane, synchysite, parisite, bavenite”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 51-52. [Beskrivelser av rhabdofan fra Herrebøkasa; synchysitt fra Grytting, Gjerstad; parisitt fra Tangen, Kragerø; oppsummering av funn av bavenitt i Norge (9 lokaliteter)]

1975

“Lokkaite, a mineral new to Norway”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 55-56. [Om funn av lokkaitt-(Y) fra Tangen, Kragerø]

”On thortveitite”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 57-58. [En oppsummering av hittil kjente funn av thorveititt i verden]



Roy Kristiansen mai 2001, at Heftetjern.
Foto: Knut Edvard Larsen.

1977

Nefedov, E.I., Griffin, W.l. & Kristiansen, R.: Minerals of the schoenfliesite-wickmanite series from Pitkäranta, Karelia, USSR. *Canadian Mineralogist* **15**, 437-445.

1978

”Mineralnotater. Lokkaitt, $(Y,Ca)_2(CO_3)_3 \cdot 2H_2O$, et nytt mineral for Norge. Tveititt fra USA”. *NAGS-nytt* **5** (4), 26-27.

1979

Dunn, P. J., Gaines, R.V. & Kristiansen, R.: Mossite discredited. *Mineralogical Magazine*. **43**, 553-554

1980

Raade, G., Haug, J., Kristiansen, R. & Larsen, O.: Langesundsfjord. *Lapis* **5**, 22-28.

1982

Povarennykh, A.S., Keller, P. & Kristiansen, R.: Infrared absorption spectra of swedenborgite and queitite. *Canadian Mineralogist* **20**, 601-603.

1983

Raade, G. & Kristiansen, R.: Inneslutninger av wodginite i kassiteritt fra Høydalen, Tørdal. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 119-121.

1984

Raade, G., Mladeck, M.H., Kristiansen, R. & Din, V. K. : Kaatialaite, a new ferric arsenate mineral from Finland. *American Mineralogist*. **69**, 383-387

Gaines, R.V, Foord, E.E. & Taggert jr., J.E. & Kristiansen, R.: A new alkali-lead-arsenate-tantalate from St.Anna-mine, Karoi district, Zimbabwe. Résumé des Communications et Posters présentés…..[full tittel mangler], 9.-11.May, 1984, s.62

1986

Foord, E.E.; Taggert jr., J.E.; Gaines, R.V.; Grubb, P. L.C & Kristiansen, R. (1986): Zimbabweite, a new alkali-lead-arsenic tantalate from St. Anns mine, Karoi District, Zimbabwe. *Bulletin de Minéralologie*, **109**, 331-336.

1989

”Tre nye urankarbonater for Norge”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 141-143. [om funn av kamotoitt-(Y), urancalcaritt og joliotitt fra Bjertnes, Krødsherad]

1990

”Nye sekundære uranmineraler fra Bjertnes, Krødsherad”. *STEIN* 17 (1), 25-28

Zimbabweitt, holotype, TL, 1.5 x 1 cm,
fra St. Ann’s Mine, Karoi District, Zimbabwe.
Foto og samling: Roy Kristiansen.

“Thalenitt fra Hundholmen, Tysfjord”. *Interne notater 1961-1990*. Mineralogisk-Geologisk Museum, UiO, Oslo 1991, ss. 155-157

1992

”Dårlig mineralkultur”. *STEIN* **19** (2), 91-97 [Debattinnlegg omkring ikke godkjent navnvgivning av nytt Cu-Te mineral fra Gråurdfjell, Oppdal 1990]

”Apropos teineitt fra Oppdal”. *STEIN* **19** (2), 98.

1993

”Bogga 80 år”. *STEIN* **20** (1), 5-7 [Portrett av Borghild Nilssen med liste over hennes vitenskapelige arbeider.]

”Thalenitt-liknende mineraler fra Åskagen, Sverige”. *STEIN* **20** (1), 7-8, 58-60.

”Debatt”. *STEIN* **20** (1), 26 + 28. [Svar til Peter Chr. Sandviks innlegg i STEIN 19 (3), s. 155, med tittelen ”Dårlig mineralkultur eller entusiasme”. Sandviks innlegg er et svar på Kristiansens første innlegg i STEIN 19 (2).]

”Litt om mineralfunn på Hvaler”. Øyene/ Hjembygda Hvaler. Lokalhistorisk tidsskrift **15**, 42-49

”Nye analyser av norske mikrolitter”. *Interne notater 1990-1993*. Mineralogisk-Geologisk Museum, UiO, Oslo 1993, ss. 207-211 [analyser av mikrolitter fra Solås, Høydalen og Ågskardet]

"Thalenitt fra Hundholmen". *STEIN* **20** (2), 121-123

"Caysichitt-(Y) og chernovitt-(Y) fra Lindvikskollen, Kragerø; to nye mineraler for Norge". *STEIN* **20** (2), 125-128

Raade, G., Sæbø, P. C., Austrheim, H. & Kristiansen, R.: Kuliokite-(Y) and its alteration products kainosite-(Y) and kamphaugite-(Y) from granite pegmatite in Tørdal, Norway, *European Journal of Mineralogy.* **5**, 691-698.

1994

"To nye mineraler for Norge - manganokolumbitt og hingganitt-(Yb)". *STEIN* **21** (2), 88-93

"En mineralhistorisk godbit". *STEIN* **21,** 129-131. [Om et brev skrevet av W.C. Brögger til den franske mineralogen A. Lacroix datert 24.4.1922]

"En oppfordring". *STEIN* **21** (2), 132. [En oppfordring til leserne av STEIN til å skrive artikler om de første pionerene i norsk mineralogi]

1997

Raade, G. & Kristiansen, R.: (Nb,Fe)-substituted anatase from Herrebøkasa, Østfold, Norway. *Norsk Bergverksmuseum Skrifter* **12**, 14-15. [Også publisert i *STEIN* 24 (3), 122-123]

"Thortveititt $Sc_2Si_2O_7$ - et historisk tilbakeblikk og dagens status". *Norsk Bergverksmuseum Skrifter* **12**, 22-25.

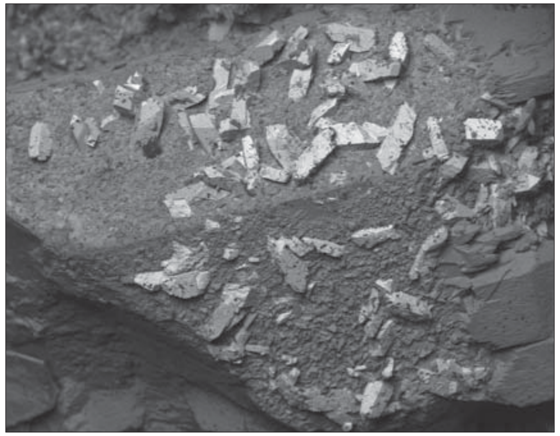
"Thortveititt $Sc_2Si_2O_7$ - et historisk tilbakeblikk og dagens status". *STEIN* 2**4** (3), 111-115.

1998

"Høydalen Li-pegmatitt, Tørdal, Telemark". *Norsk Bergverksmuseum Skrifter* **14**, 17-28

"Apropos kontakt med stein i Zimbabwe. *STEIN* **25** (1), 20-21 [om oppdagelsen av zimbaweitt]

"Til minne". *STEIN* **25** (4), 4-5. [Minnord, Jan Haug (1934-1998)]



Kristiansenitt-krystaller, Heftetjern, Tørdal, Telemark. SEM-foto: Harald Folvik, NHM, Oslo.

"Høydalen Litium-pegmatitt- Tørdal i Telemark". *STEIN* **25** (4), 21-30.

1999

"Beryllium-mineraler i Norge". *Norsk Bergverksmuseum Skrifter* **15**, 34-46

"Beryllium-mineraler i Norge". *STEIN* **26** (2), 8-23

"Steinprat med Arne Næss på Tvergastein". *STEIN* **26** (3), 6-9

2000

"Om oppdagelse og oppdagerglede". *STEIN* **27** (1), 3

"Mer om Rynersonitt". *STEIN* **27** (1), 12-13

"Boralsilitt - $Al_{16}B_6Si_2O_{37}$ - et nytt mineral fra Antarktis og Norge!" *STEIN* **27** (1), 33

Raade, G. og Kristiansen, R.: Mineralogy and geochemistry of the Heftetjern granite pegmatite, Tørdal: a progress report. *Norsk Bergverksmuseum Skrifter* **17,** 19-25.

"Eksotiske mineral-lokaliteter (Exotic mineral-locations)". *STEIN 27* (2), 20-24. [Om typelokalitetene Rockall, Nord Atlanteren (Bazirittt) og Khmara Bay, Antarktis (Khamaralitt)]

Raade, G. & Kristiansen, R.: Scandium enrichment in the Heftetjern granite pegmatite, Telemark, Norway. 4th International Mineralogy in Museums Conference, Melbourne, Australia, s. 83.

"Kopparbergmessa 17. - 18. juni 2000". *STEIN* **27** (3), 24-26 [Reportasje fra]

"Personalia. Hans Vidar Ellingsen 70 år". *STEIN* **27** (3), 34-35.

"Ny leder for NAGS: Knut Edvard Larsen. En samtale med Roy Kristiansen. *STEIN* **27** (4), 32-34".

2001

"Sjeldne tantalniobater fra Sentral-Afrika. Eksotiske mineralokaliteter II. Exotic mineral-locations II". *STEIN* **28** (2), 21-28 [om thoreaulitt, foorditt, plumbomikrolitt, rankamaitt og cesplumtantitt fra Kongo demokratiske republikk (Zaire)]

Larsen, A. O., Kristiansen, R. og Nordrum, F. S.: Mineralogia Norvegica 1983-2001. *Norsk Bergverksmuseum Skrifter* **18***,* 53-69

"Nye species for vitenskapen". *STEIN* **28** (4), 37. [Lederartikkel]

"Raadeitt – enda et nytt magnesiumfosfat fra Modum". *STEIN* **28** (4), 6-7

"Tantal-holdige mineraler i Iveland og Evje". *STEIN* **28** (4), 27 [Kommentar til Olav Revheims artikkel i STEIN 28 (3), 28-31 om tantalmineraler i Iveland/Evje]

2002

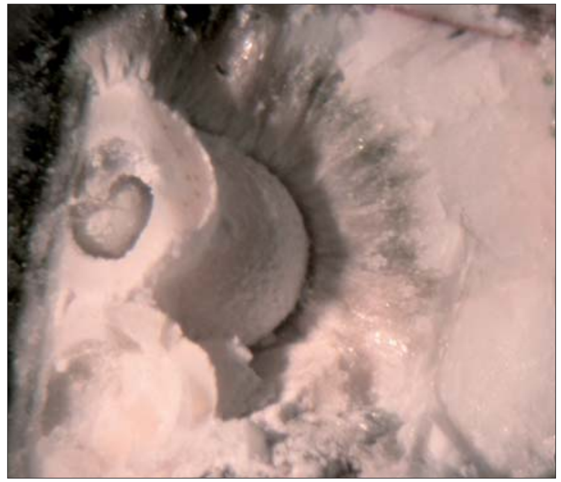
"Alf Olav Larsen 50 år". *STEIN* **29** (1), 3-4

Kristiansen, R., Nordrum, F. S og Larsen, A. O.: Mineralogia Norvegica 2001-2002. *Norsk Bergverksmuseum Skrifter* **20***,* 83-85

2003

Kristiansen, R., Nordrum, F. S og Larsen, A.O.: Mineralogia Norvegica 2002-2003. *Norsk Bergverksmuseum Skrifter* **25***,* 90-92

"Scandium-mineraler i Norge". *STEIN* **30** (2), 14 - 23.



Fargeløse, parallelt orienterte bladformede krystaller av alflarsenitt rundt en sfære av kalsitt i massiv kalsitt, holotype, Tuften, Tvedalen. Bildebredde 5mm. Foto: Roy Kristiansen.

Raade, G. & Kristiansen, R.: "Scandium as a trace element in the Heftetjern pegmatite mineral". *In* Raade, G. & Segalstad. T. V. (red): SCANDIUM 2003. An international symposium on the mineralogy and geochemistry of scandium. *NGF, Abstracts & Proceedings of the Geological Society of Norway* **2**, 36-37

"Mineralspalta. Bavenitt på Scandium-symposiet". *STEIN* **30** (4), 24. [om funn av bavenitt i Li-bruddet, Iveland]

2004

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Pezzotta F., Guastoni A., Forner H., Demartin F., Kristiansen R.: Exceptional chiavennite associated with pezzottaite from the Sakavalana Pegmatite, Ambatovita, Madagascar. PIG-article. 9s. [Publisert on-line på hjemmesiden til The Pegmatite Interest Group, Mineralogical Society of America] http://www.minsocam.org/MSA/Special/Pig/PIG_articles/Pezzotta_Chiavennite.pdf

2005

Pezzotta, F., Guastoni, A., Forner, H., Demartin, F., Kristiansen, R.: Découverte exceptionnelle de chiavennite associée à pezzottaite dans la pegmatite de Sakavalana, Mandrosonoro, Madagascar. *Le Règne Minéral* **62**, 25-28

”Milaritt-gruppens mineraler i Norge”. *Norsk Bergverksmuseum Skrifter* **30**, 21-29.

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2004-2005. *Norsk Bergverksmuseum Skrifter* **30**, 113-116.

”Italia - en spennede og mangfoldig mineralnasjon”. *STEIN* **32** (4), 18-21.

2006

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2005-2006. *Norsk Bergverksmuseum Skrifter* **33**, 63-64.

”Klassiske pegmatittforekomster i Hvaler og Kråkerøy, Østfold”. *Norsk Bergverksmuseum Skrifter* **33**, 65-74.

”Liandratitt, $U^{6+}(Nb,Ta)_2O_6$, fra Herrebøkasa, Østfold”. *STEIN* **33** (2), 28

”Turmaliner. En liten orientering”. *STEIN* **33** (2), 34.

Cooper, M.A., Hawthorne, F.C., Ball, N.A., Černý, P., Kristiansen, R.: Oftedalite, (ScCa) $KBe_3Si_{12}O_{30}$, a new mineral species of the milarite group from the Heftetjern pegmatite, Tørdal, Norway: description and crystal structure. *Canadian Mineralogist* **44**, 943-949.

”Fleire inntrykk fra Kopparberg Mineralmessen”. *STEIN* **33** (3), 18-19.

2007

”Originalbeskrevne mineraler fra Norge inn i et nytt årtusen”. *STEIN* **34** (1), 30-34.

”Sekundære uranmineraler i Norge”. *Norsk Bergverksmuseum Skrifter* **35**, 49-59

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2006-2007. *Norsk Bergverksmuseum Skrifter* **35**, 67-68.

”Mineraler i gamle kvarts og feltspatbrudd i Hvaler og Kråkerøy”. *Natur i Østfold* **26** (1-2), 58-68.

2008

”Nye mineralfunn i Norge” *STEIN* **35** (1), 16-21. [Beskrivelse av triplitt og rynersonitt fra Herrebøkasa; bazzitt fra Høydalen, bismoclitt fra Heftetjern og pumpellyitt -(Al) fra Nordre Boksjø]

Bernhard, F., Hauzenberger, C., Walter, F. & Kristiansen, R.: Pseudosinhalite, magnesiotaaffeite-6*N*3*S* and magnesiotaaffeite-2*N*2*S* as replacement products of spinel in dolomite marble from Strubenberg, Styria, Austria. *Canadian Mineralogist*, **46**, 1195-1205.

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2007-2008. *Norsk Bergverksmuseum Skrifter* **38**, 84-86.

”33. IGC. Den 33. internasjonale geologiske kongressen i Oslo (Lillestrøm) 2008”. *STEIN* **35** (4), 18-21.

”Fascinerende…. spennende og uventete nye mineraler, - eller bare kuriositeter?” *STEIN* **35** (4), 22-25.

2009

Lussier, A.J., Cooper, M.A., Hawthorne, F.C., & Kristiansen, R.: Triclinic titanite from the Heftetjern granitic pegmatite, Tørdal, southern Norway. *Mineralogical Magazine* **73**, 709-722.

Raade, G. & Kristiansen, R. : Fluorthalénitt-(Y) from Hundholmen, Tysfjord, north Norway. *Norsk Bergverksmuseum Skrifter*, **41,** 21-30.

“A unique assemblage of Scandium-bearing minerals from the Heftetjern-pegmatite, Tørdal, south Norway”. *Norsk Bergverksmuseum Skrifter*, **41**, 75-104.

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2008-2009. *Norsk Bergverksmuseum Skrifter* **41**, 105-107.

”Pinch-medaljen 2009”. *STEIN* **36,** 20-21.

2010

Kolitsch, U., Kristiansen, R., Raade, G. & Tillmanns, E. : Heftetjernite, a new scandium mineral from the Heftetjern pegmatite, Tørdal, Norway. *European Journal of Mineralogy*. **22**, 309-316.

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2009-2010. *Norsk Bergverksmuseum Skrifter* **43**, 111-113.

”Caysichitt-(Y) og chernovitt-(Y) fra Lindvikskollen - igjen!” *STEIN*, **37** (3), 14-15.

Heftetjernitt. Del av holotypen, fra Heftetjern, Tørdal, Telemark. Høyde på bilde: ca 1mm. Foto: Roy Kristiansen.

”München-messa 2009”. *STEIN*, **37** (3), 26-28. [Reportasje fra]

”Bokanmeldelse. The Langesundsfjord”. *STEIN*, **37** (3), 32-35.

”Heftetjernitt og triklin titanitt fra Heftetjern i Tørdal”. *STEIN* **37** (4), 20-22.

2011

”Alf Olav Larsen får Pinch-medaljen for 2011”. *STEIN* **38** (1), 28-29.

”IMA-kongress i Budapest 2010”. *STEIN* **38** (1), 28-29. [Reportasje fra]

”An interview with Frank C. Hawthorne”. *Norsk Bergverksmuseum Skrifter* **46,** 101-104. (også publisert på: http://www.mindat.org/article.php/1203/Roy+Kristiansen%3A+An+Interview+with+Frank+C. Hawthorne]

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2010-2011. *Norsk Bergverksmuseum Skrifter* **46**, 105-113.

Miyawaki, R., Momma, K, Yokoyama, K., Shigeoka, M, Matsubara, S., Ito, M., Nakai, I, & Kristiansen, R.: Mn-bearing hellandite-(Y) from Telemark, Norway. Abstracts for Annual Meeting of Japanese Association of Mineralogical Sciences 2011, R1-P20, 1 s.

”Turmalinnomenklatur 2011”. *STEIN* **38** (4), 36.

2012

”Almgjotheii-en sjelden borosilikatpegmatitt i Rogaland. *Norsk Bergverksmuseum Skrifter* **49**, 81-92. [med appendix: ”Intervju med Edward S.Grew”]

Larsen, A.O., Nordrum, F. S. og Kristiansen, R.: Mineralogia Norvegica 2011-2012. *Norsk Bergverksmuseum Skrifter* **49**, 140-141.

”Aspedamitt-et thorium-heteropolyniobat fra Herrebøkasa ved Aspedammen”. *STEIN* **39** (3), 10-11.

Cooper, M.A., Abdu, Y.A., Ball, N.A., Černý, P., Hawthorne, F. and Kristiansen, R. (2012): Aspedamite, Ideally $\square_{12}(Fe^{3+}, Fe^{2+})_3Nb_4[Th(Nb,Fe^{3+})_{12}O_{42}]\{(H_2O),(OH)\}_{12}$, a New Heteropolyniobate Mineral Species from the Herrebøkasa Quarry, Aspedammen, Østfold, Southern Norway: Description and Crystal Structure. *Canadian Mineralogist* **50**, 793-894

2013

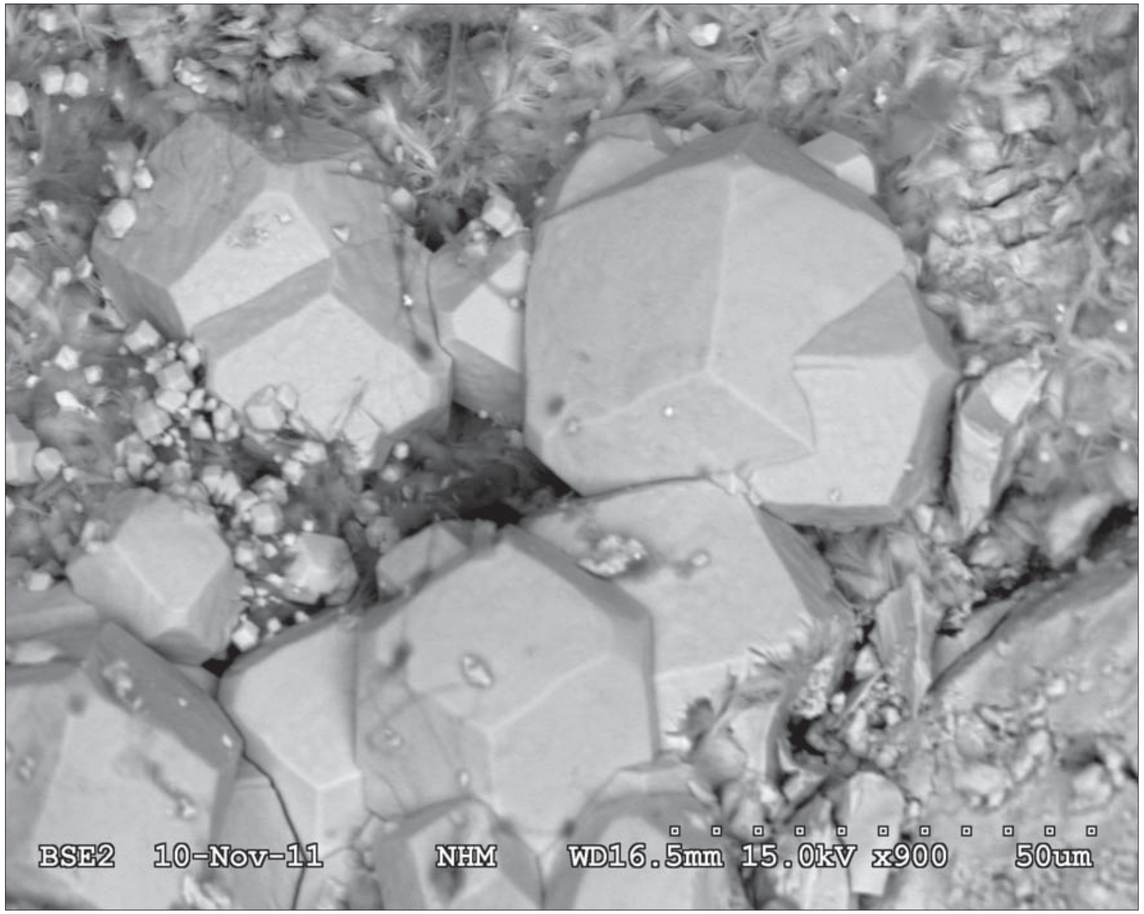
Grice, J.D. & Kristiansen, R.: Hydrogen in the gugiaite structure. GAC-MAC Annual Meeting 2013, Winnipeg,Canada. Technical Program, Abstract. http://gac.esd.mun.ca/gac_2013/search_abs/sub_program.asp?sess=98&form=10&abs_no=12

“Norsk Geosofisk Sælskab”. *STEIN* **40** (1), 34-35.

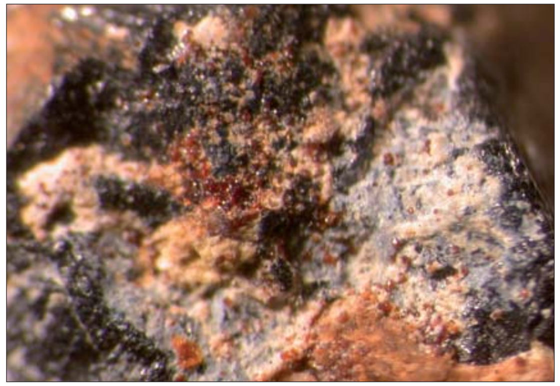
“Surkhobitt fra Bratthagen i Lågendalen”. *Norsk Bergverksmuseum Skrifter* **50**, 89-92.

Larsen, A.O., Larsen, K.E. og Kristiansen, R.: Mineralogia Norvegica 2012-2013. *Norsk Bergverksmuseum Skrifter* **50**, 118-120.

”Sveinung Bergstøl in memoriam (1929-2013)”. *STEIN* **40** (2), 36.



Aspedamitt, holotypen, fra Herrebøkasa, Halden, Østfold.
SEM-foto av Harald Folvik, NHM, Oslo.



Små røde granatliknende krystaller av aspedamitt, holotypen, fra Herrebøkasa, Halden, Østfold. Bildebredde: 2 mm. Foto: Roy Kristiansen.

Melkehvite og fargeløse irregulære krystalline aggregater av liberitt og bromellitt i flogopitt-matriks. 7 x 6 cm. Samling og foto: Roy Kristiansen.

Krystall av kristiansenitt, Heftetjern, Tørdal. Samling og foto: Roy Kristiansen.

Kristiansenitt-krystall i hulrom, Heftetjern, Tørdal. Samling og foto: Roy Kristiansen.

Heftetjern forekomsten, Tørdal, Telemark. Sept. 2005. Foto: Knut Edvard Larsen.

Grice, J.D., Kristiansen, R., Friis, H., Rowe, R., Poirier, G.G., Selbekk, R.S., Cooper, M.A., & Larsen, A.O.: Ferrochiavennite, a new beryllium silicate zeolite from syenite pegmatites in the Larvik plutonic complex, Oslo region, southern Norway. *Canadian Mineralogist* **51**, 285-296.

Beige til blekgule sfære-liknende aggregater av ferrochiavennitt, Blåfjell, Langangen. Holotype. Innsamlet i 1976. Bildebredde: 2mm. Foto: Roy Kristiansen.

Om Roy

Ellingsen, H.V. & Haugen, A. (2002): Kristiansenitt – et nytt mineral fra Tørdal. STEIN, 29 (1), 32-34.

Wiik, G. H. (2003): Portrettet. Roy Kristiansen-en mann med sans for det store eller i det små, eller var det omvendt. *STEIN* **30** (3), 16-19

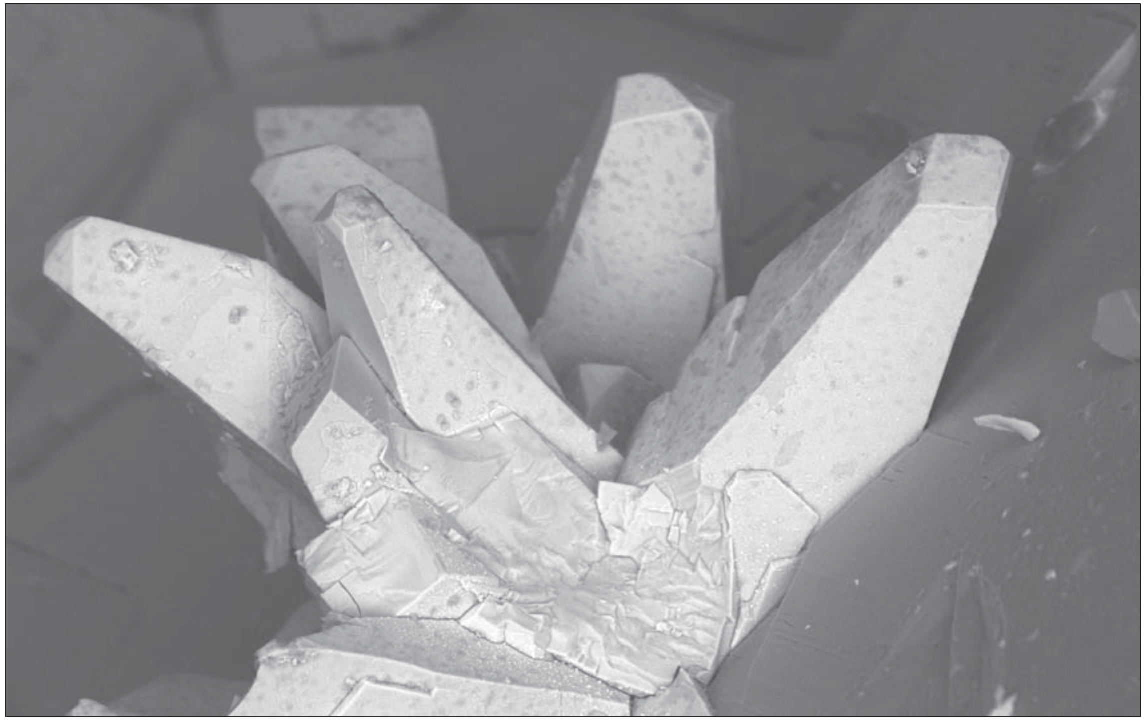
Grew, E.S. (2009): The Pinch medal for 2009 to Roy Kristiansen. *Canadian Mineralogist* **47**, 481-482.

Grew, E.S. (2009): The Pinch medal for 2009 to Roy Kristiansen. *Elements* **5**(1), 55.

Huizing, M.E. (2009): 2009 Pinch medal presented: Roy Kristiansen. *Rocks & Minerals* **84**, 199

Takk

til Roy som gav verdifulle opplysninger til denne artikkelen uten at han var klar over det.



Gruppe med krystaller av Kristiansenitt, Heftetjern, Tørdal, Telemark. SEM-bilde av Harald Folvik, NHM, Oslo.

Vennen Roy

Av Thor Sørlie

Roy har et stort hjerte og er en raus person. Ingen jeg kjenner har et så stort kontaktnett som Roy. Roy kjenner alle og alle kjenner Roy. Ingen «amatør» jeg vet om har oppnådd det faglige nivå som Roy innehar, det ligger virkelig høyt!

Min personlige vei til Roys vennskap var litt spesiell. Jeg hadde jo hørt fra steinsamlere i Fredrikstad «at det bodde en samler på Kråkerøy, som var noe helt utenom det vanlige og hadde hele sin samling i en skoeske»; i tillegg var han så uoppnåelig og i sin egen sfære, at man omtrent måtte ha audiens.

Jeg visste jo at en av hans lidenskaper falt sammen med ett av mine store interessefelt; berylliumholdige mineraler. Vårt første lille «hei» skjedde på Kongsbergsymposiet i 1997 og så var det i gang.

Hvorfor akkurat jeg skriver disse innledende ordene, har en enkel forklaring; det var jeg som var så heldig å få ta med Roy på hans aller første tur til forekomsten på Heftetjern i 1998 da han fant Kristiansenitten!

En fantastisk tur som for Roy ble et magisk øyeblikk, og etter det har jo Heftetjern og Roy vært uatskillelige.

Takk for hyggelig og givende vennskap så langt, og lykke til med fremtiden, Roy!

Mvh Thor

I tilfeldig rekkefølge ønsker noen av Roys venner å hilse han på 70 år-dagen (se neste side).

Roy Kristiansen ved Heftetjern-pegmatitten. Mai 2005. Foto: Knut Edvard Larsen.

We are sorry we can't be with you on your special day, but we will think of you and remember the lovely dinner you cooked for us and our happy times together in Norway!

Congratulations on your birthday!

Priscilla Grew

Priscilla and I wish you a most happy birthday! We hope that you'll enjoy good health, success in your mushroom and mineral studies and happy times in the coming years. May there be more new fungi and mineral species in your future!

Ed Grew

De de beste ønsker for 70 årsdag, med takk for mange flotte turer, spesielt til Heftetjern, kunnskapsformidling, inspirerende samtaler innen mange områder. Som vi håper fortsetter i årene som kommer.

Astrid Haugen og Hans Vidar Ellingsen

For your 70th Birthday we wish you all the best. The best of health and the discovery of many more new species of minerals and fungi in the future.

László & Elsa Horváth

Gratulerer med dagen, Roy!

Du har alltid vært en viktig inspirasjonskilde for meg, både gjennom lange telefonsamtaler og prøver av sjeldne mineraler, men aller viktigst: artiklene dine.

Følelsen fra da jeg leste om "Thalenitt fra Hundholmen" (Stein nr. 2, 1993) sitter ennå i!

Tomas Husdal

Congratulations on your 70th birthday. You have greatly enhanced the research of myself and my colleagues in the past, and we look forward to you doing so for many years to come.

Frank Hawthorne

Thank you for your collaboration & best wishes on your 70th birthday!

Reminder: Septuagenarians are advised to remain in a seated upright position when venturing out on their sykkel.

Mark Cooper

Legenden i norsk amatørgeologi rundar år. Nesten utruleg at ein mann som vart omtalt med age blant dei lærde da eg sjølv var ein famlande nybyrjar berre er 70 år !

Eit imponerande livsverk i forskning og oppdagingar ligg bak Deg.

Eg ynskjer Deg mange nye, gode år, Roy !

Torgeir T. Garmo

Dear Roy, keep up your enthusiasm for both minerals, mushrooms and good food! It keeps away old age!

Uwe Kolitsch

I am glad to send you my warmest anniversary greetings. You are among the most serious mineral collectors, whose contribution to mineralogy can scarcely be overestimated. It is a pleasure to communicate with you.

I wish you to preserve your enthusiasm and the joy of life for a long time.

Nikita Chukanov

Gratulerer med dagen Roy!

Takk for din innsats og dine bidrag innen norsk mineralogi.

Naturhistorisk museum har stor glede av at du bruker våre laboratorier, og at du deler din kunnskap med oss.

Rune Selbekk

Kjære Roy, gratulerer med 70-årsdagen.

Vi har hatt kontakt og kjent hverandre i flere ti-år. Men det tok vel nesten femten år før vi traff hverandre første gang. Din første hilsen var: Jasså – er det sånn du ser ut – og det var det vel den gang i alle fall.

Jeg har satt stor pris på vår vennskap, dine brev og telefonsamtaler med mineralogiske oppdateringer, filosofiske refleksjoner og tullprat. Felles forankring i kjemien, berylliummineralene og REE-mineralene. Det synes jeg vi skal holde fast ved.

Arne Åsheim

Ciao, Roy. I enjoy addressing to you my heart-felt congratulations for reaching the significant threshold of seventy, through a life of minerals, fungi, stamps and so many friends successfully collecting.

Ad maiora !

Roberto Allori

I am delighted to have the opportunity to congratulate my friend Roy, the epitome of the term "a gentleman and a scholar", on his 70th birthday. May we continue to share tiny pieces of incredible rarities for years to come.

Mark Feinglos

My sincere congratulations on your 70th anniversary! Please accept my best wishes of strong health, well-being and success in all your projects and plans! I deeply hope you will continue to gladden all of us with new mineralogical finds and scientific discoveries and our friendship and cooperation will remain with us for many years to come! I am proud to be a friend of such a great and versatile person like you!

Anatoly Kasatkin

Jeg ønsker deg lykke til med dagen, 70 år er ingen hindring for noe som helst! Jeg ser frem til å fortsette våre sammenkomster på museet, med trivelige og lærerike diskusjoner ved SEM/EDS'n!!!!

Harald Folvik

I first met Roy when he won the Pinch Award and I was impressed what a fine gentleman of the old school he was.

His knowledge of rare species was extensive and since that meeting we have become good friends with him visiting my home for a week, as well as my collections of rare mineral species. I look forward to many more visits from him as I always learn a lot from those visits.

William W. Pinch

I had the pleasure to meet Roy 8 years ago, at the Munich show, we share the same passion for pegmatite and alkaline rock rarities, in special for Be-minerals; during the years our friendship has tightened and I am anxious to appoint my first trip to Norway to visit him and see his outstanding collection;

Happy birthday my friend

Luiz Menezes

Du er som et leksikon. Kunnskapen du har om mineralogi er utrolig. Ønsker

man å lære om mineraler og naturen generelt, er du den rette personen å være på tur med. Nysgjerrig, reflektert, engasjert, produktiv og generøs er noen ord som jeg synes beskriver deg. Gratulerer med dagen og fremtiden.

Atle Michalsen

Du har siden 1970-tallet vært en viktig pådriver for mineralogien i Norge, og med alle dine kontakter og bekjentskaper i inn- og utland har dette resultert i utallige spennende funn og vitenskapelige artikler. Jeg er svært fornøyd med at du i det siste også har økt fokus på mineralene i LPC-området.

Svein Arne Berge

Gratulerer med 70-årsdagen.

Du er en kløpper til å finne nye og sjeldne mineraler.

Norsk mineralogi trenger sånne som deg. Håper du vil fortsette arbeidet ditt med mineraler i mange år framover og ikke la sopp og andre uhumskheter stjele oppmerksomheten din.

Lars Kvamsdal

Congratulations, Roy, on your 70th birthday ! I hope your retirement years will be happy and productive and that perhaps a few more fungi may bear your name. I also hope that you can complete your mineral "want list". God bless you.

Bill Lechner

Gratulerer med 70-årsdagen. Ditt vennskap har vært oss en berikelse. Det kan ikke sies mer presist.

Alf Olav og Sissel Larsen

Mine hjerteligste gratulasjoner med de 70 år!

Du er en stor fargeklatt i mineralmiljøet og en inspirator både sosialt og faglig. Det er alltid en fornøyelse å prate med deg, enten det er på telefon eller på forskjellige møteplasser.

Fred Steinar Nordrum

Gratulerer så mye med 70-årsjubileet Roy! Vi har flere sammenfallende interesser; mineraler fra granitt- og syenittpegmatitter, Heftetjern-pegmatitten, larvikittområdets mineraler mm. Roy har alltid vært svært kunnskapsrik, god til å dele kunnskap og svært inspirerende å kjenne!

Frode Andersen

Congratulation with your jubilee and continuous mineral enthusiasm. As a museum curator I knew your name from our inventory books well before we met and became friends. You still the source for exotic minerals for museums. It is a double pleasure to be your friend.

Dmitriy Belakovskiy

Disse sender også sine hilsener

Trond Lindseth, Igor Pekov,
Hans Jørgen Berg, Henrik Friis,
Jörgen Langhof.

STEIN utgis av Norske Amatørgeologers Sammenslutning (NAGS), en paraply-organisasjon for 29 geologiforeninger over hele landet og som er åpen for alle som er interessert i stein og geologi. Se www.nags.net/stein for nærmere opplysninger.

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Redaksjon:
Ansv. redaktør: Thor Sørlie, Iddeveien 50, 1769 Halden
Tlf: 90 66 49 92, redaktor@nags.no
Layout-ansvarlig: Trond Lindseth, Rypsveien 2, 3370 Vikersund
Tlf: 99 28 98 28, layout@nags.no
Økonomi- og abonnentansvarlig: Knut Edvard Larsen, Geminiveien 13, 3213 Sandefjord
Tlf: 96 22 76 34, abonnement@nags.no

Skribenter i dette nummer:

Edward S. Grew, School of Earth and Climate Sciences, University of Maine, Orono, ME 04469, USA, esgrew@maine.edu

Robert M. Hazen, Geophysical Laboratory, Carnegie Institution of Washington, Washington DC, 20015, USA, rhazen@ciw.edu

Gunnar Raade, førstekonservator emeritus, Østbyfaret 6 D, NO-0687 Oslo, Norway, gunn-ra@online.no

Alf Olav Larsen, Bamseveien 5, N-3960 Stathelle, Norway. alf.olav.larsen@online.no

Radek Škoda, Laboratory of Electron Microscopy and Microanalysis, Institute of Geological Sciences Faculty of Science, Masaryk University, Kotlářská 2, CZ-611 37 Brno, Czech Republic. rskoda@sci.muni.cz

Knut Edvard Larsen, Geminiveien 13, N-3200 Sandefjord, Norway, knut.edvard.larsen@online.no

Thor Sørlie, Iddeveien 50, N-1769 Halden, Norway, kts@halden.net

STEIN gis ut fire ganger i året.
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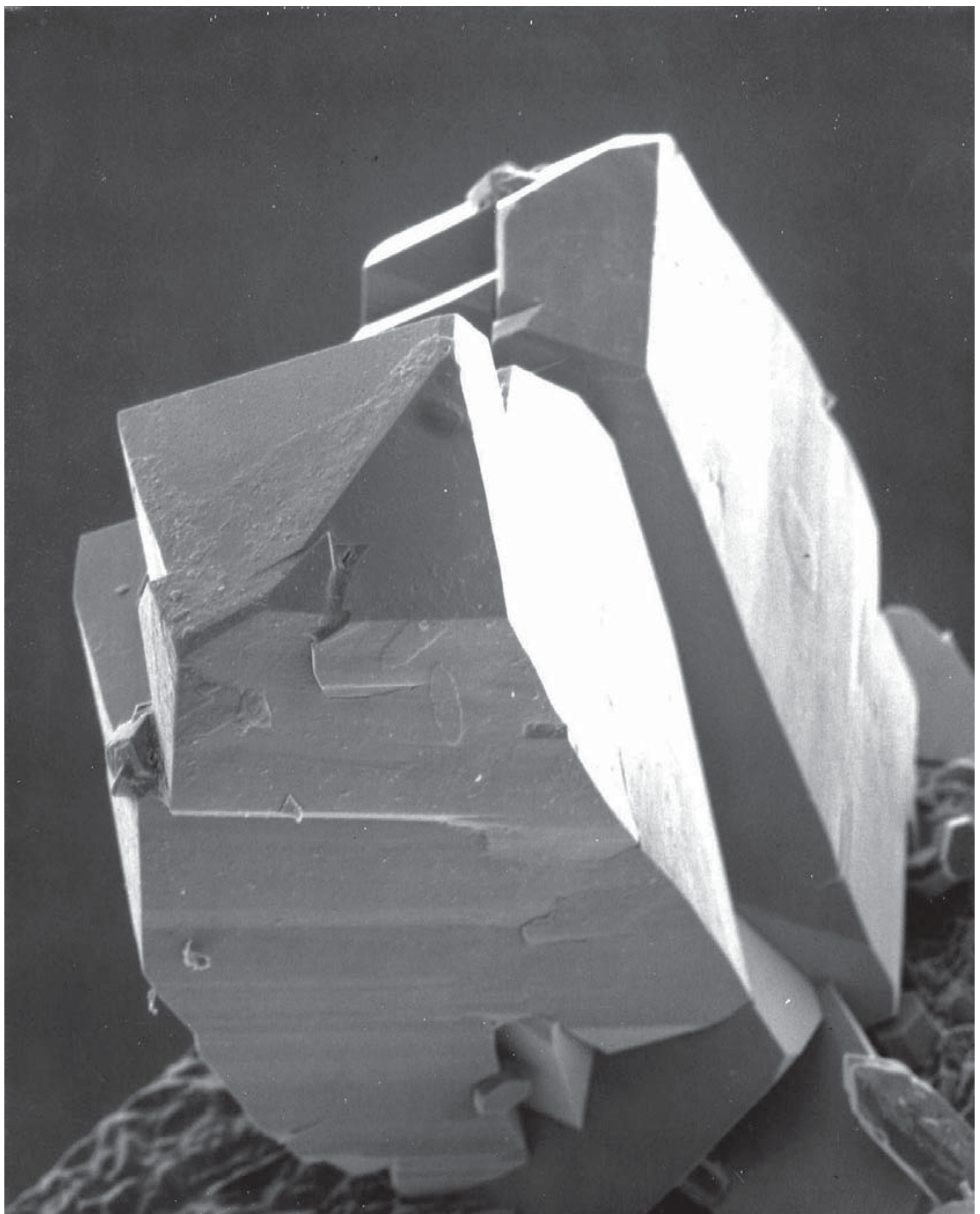

Krystaller av kristiansenitt. SEM-foto av Alf Olav Larsen.