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The Mofjell Project:
Summary and conclusions

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REPORT

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Title:
The Mofjell Project: Summary and conclusions

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Summary:
The Mofjell project commenced in 2008 as a cooperation between GEXCO Norge AS, the county administration of Nordland and NGU. As GEXCO faced financial difficulties the external funding ended in 2009. The project area included Mofjellet and the eastern part of Plurdalen, an area with a large potential for economic sulfide deposits with Zn, Cu, Pb, Ag and Au.
NGU has focused the studies on establishing the geological setting of the Mofjell Group and its relation to ore formation. Another very important goal has been to assess the potential for economic ore deposits in the area, including enrichment of precious metals.
On the basis of lithological observations and geochemistry, the Mofjell Group consists of a largely bimodal volcanic-sedimentary assemblage formed in an island-arc to back-arc setting. The data also show that the proportion of felsic volcanic rocks is much higher than previously described. A bimodal volcanic suite mixed with sediments is a geological environment which is regarded as favorable for both rich and large massive sulfide deposits.
Nine main ore zones at different structural levels are identified in the Mofjell Group. Because of extensive post-mineralization deformation it is very difficult to decide if some of these ore zones originally were connected. During the field work nearly all the sulfide deposits were visited, sampled and investigated in some detail. In correspondence with bedrock mapping, these studies have shown that the deposits are volcanogenic massive sulfide (VMS) deposits genetically associated with felsic and mafic volcanic rocks formed in an oceanic island arc environment. The geochemistry and mapping of the ore zones and the sulfide deposits have shown that there are clear differences between a number of them regarding metal content and size.
The economically most interesting ore zones and deposits, which are strongly recommended for more investigations are the Hellerfjellet deposit in the Stangfjell-Hellerfjell zone, the Hesjelia zone, Heramb and Bertelberget in the Raudvatn zone, the Småvatnan zone, the Sølvberget deposit in the Sølvberg zone and the Mofjellet deposit in the Mofjell zone.

Keywords: Gold	Silver	Sulfide
Ore deposit	Base metals	Structure
Scientific report	Mofjell	Caledonides

CONTENT

1. INTRODUCTION

The Mofjell project commenced in 2008 as a cooperation between GEXCO Norge AS, the county administration of Nordland and NGU. However, the company GEXCO faced financial difficulties and the cooperation project was therefore ended in April 2009. Some limited field-work was carried out in 2009 with financial support from the county and NGU. GEXCO was sold to the Finnish company Sotkamo Silver OY in 2010, a daughter company of Sotkamo Silver AB in Sweden, which focused on project in Finland, and showed very little enthusiasm regarding the Mofjell areas. No fieldwork was therefore carried out in 2010, and the project is now ending. The company still has claims in the area (Figure 1).

The project area originally included the areas of Mofjellet, Plurdalen, Grønfjelldalen, and areas to the north of Umbukta and south of Sauvatnet (see Figure 1). This is an area with a large potential for economic sulfide deposits with Zn, Cu, Pb, Ag and Au.

The prospecting campaign run by GEXCO had a focus on finding deposits which could be an addition to the ore which is remaining in the Mofjellet mine, and which could be a basis for new mining activity in the region. The work used new air-borne, high-resolution geophysics (TEM, magnetometry) as a basis for follow-up work on anomalies, including sampling and diamond drilling.

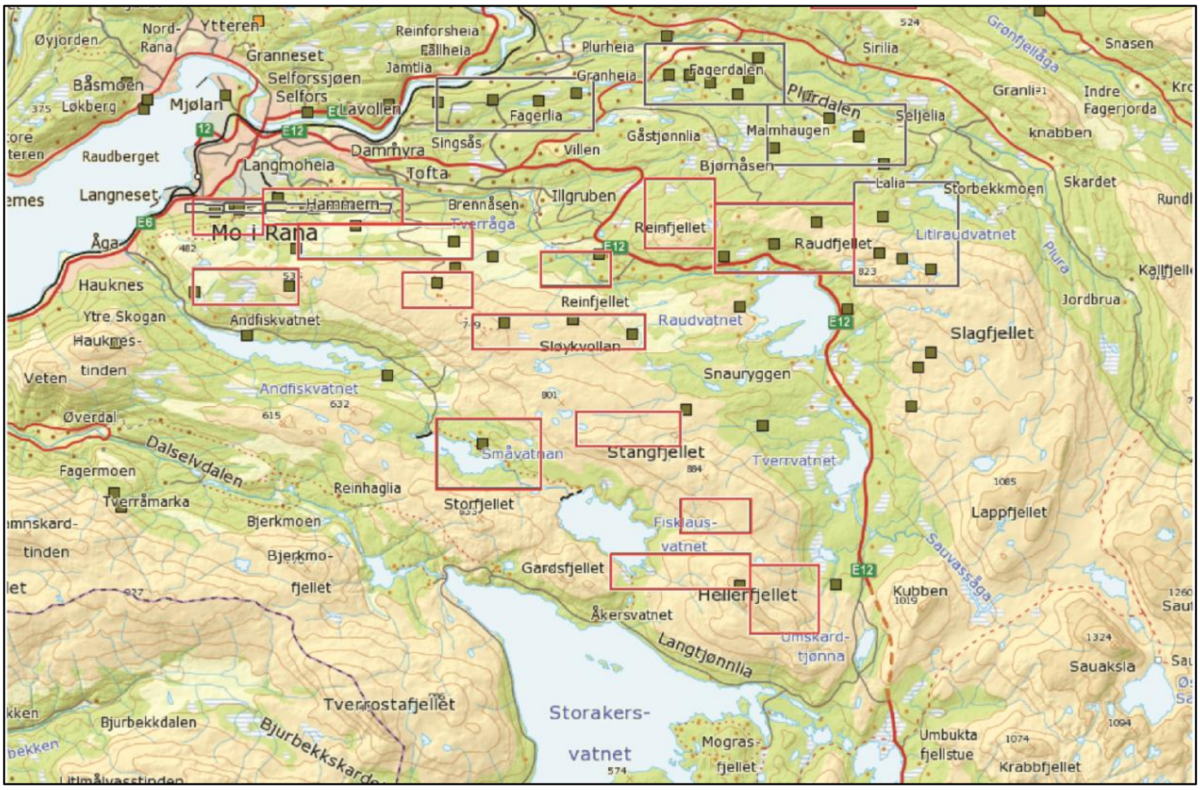


Figure 1: Map showing the project area. The brown points are sulfide deposits registered in the ore database of NGU. Claims held by Sotkamo Silver AB are shown by red squares, while grey squares mark claims held by Geopartner AB (source: prospecting.no, sept. 2013).

One of the main tasks for NGU has been to establish the geological setting for the lithologies in the Mofjell Group and their relations to ore formation. Another very important task has been to assess the potential for economic ore deposits in the area, including enrichment of precious metals. This work has been carried out together with GEXCO, and includes studies of the various lithologies and known and partially worked sulfide deposits, as well as other interesting mineralizations in the area.

This report is a review of the work which was carried out during the project and also includes recommendations for further work in the area. We also would like to refer to the NGU reports 2008.088 (Bjerkgård et al., 2008) and 2009.038 (Bjerkgård et al., 2009) for additional detailed information.

Regarding geochemical analyses, whole-rock lithogeochemistry was carried out by XRF at NGU. Geochemical analyses on metals in the project were carried out by ALS Chemex in Vancouver, Canada. Gold was analyzed by atomic absorption and Fire-Assay, while the other elements were analyzed by ICP-MS on melt-tablets with Li-tetraborate. Some mineralogical analyses were done on SEM (at NGU), both semi-quantitative and quantitative analyses (the latter focusing on sphalerite and barium-bearing phases).

2. RESULTS BEDROCK GEOLOGY

2.1 Overview of the geology in the Rana region

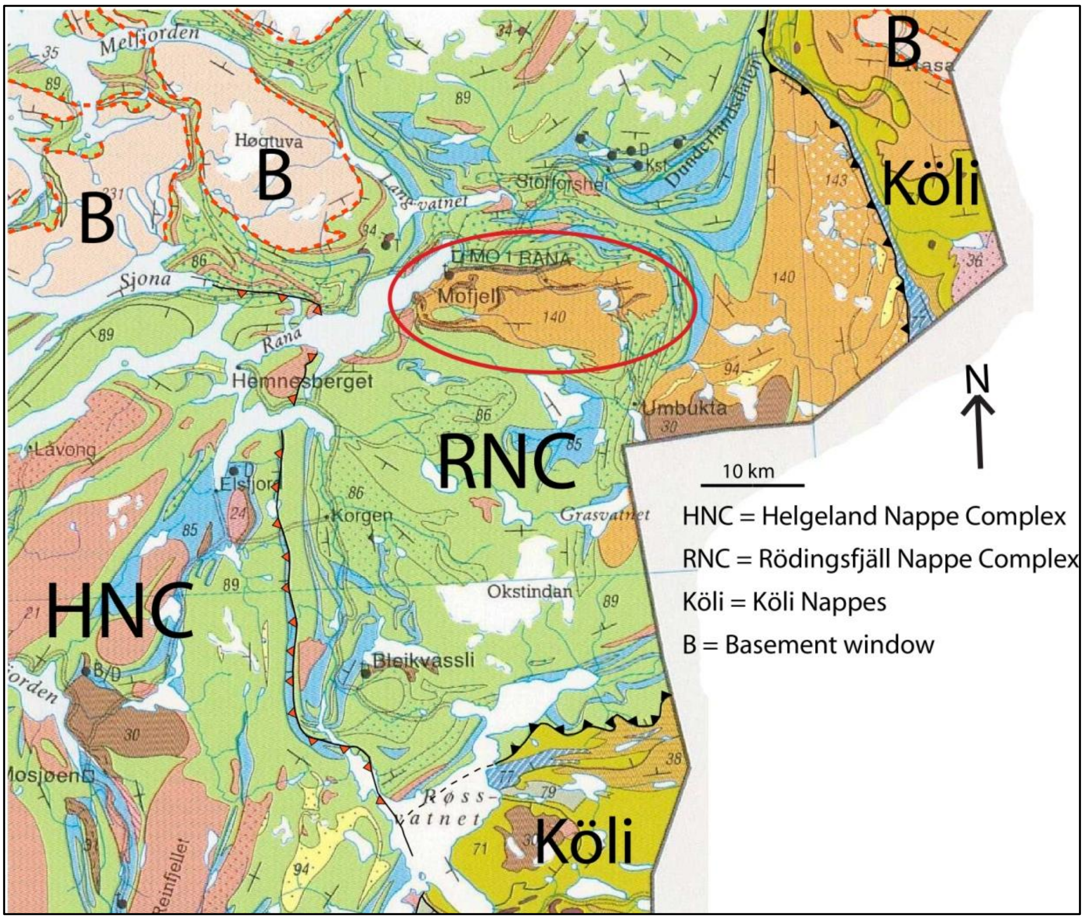


Figure 2: Overview of the tectonostratigraphy in the Rana region (modified from Sigmond et al., 1984). The investigated area, The Mofjell Group, is situated in the Rödingsfjäll Nappe Complex (RNC), and is marked by the red ellipse.

The Mofjell Group is part of the Rana–Hemnes Zn-Pb-Cu metallogenic area, which covers a large area around the Okstindan mountains in Nordland (Figure 2, Bjerkgård & Hallberg, 2012). In the area, there are two major sulfide deposits: Bleikvassli and Mofjell, as well as numerous smaller deposits, especially in the Mofjell district (op.cit.). The deposits are situated in the Rödingsfjäll Nappe Complex in the Uppermost Allochthon of the Scandinavian Caledonides (Bjerkgård et al. 1997, Sandstad et al., 2012). According to Grenne et al. (1999), most of the sequences in the Rana-Hemnes area were probably deposited on the margin of the Laurentian plate during rifting of Rodinia and development of an Atlantic-type or passive margin.

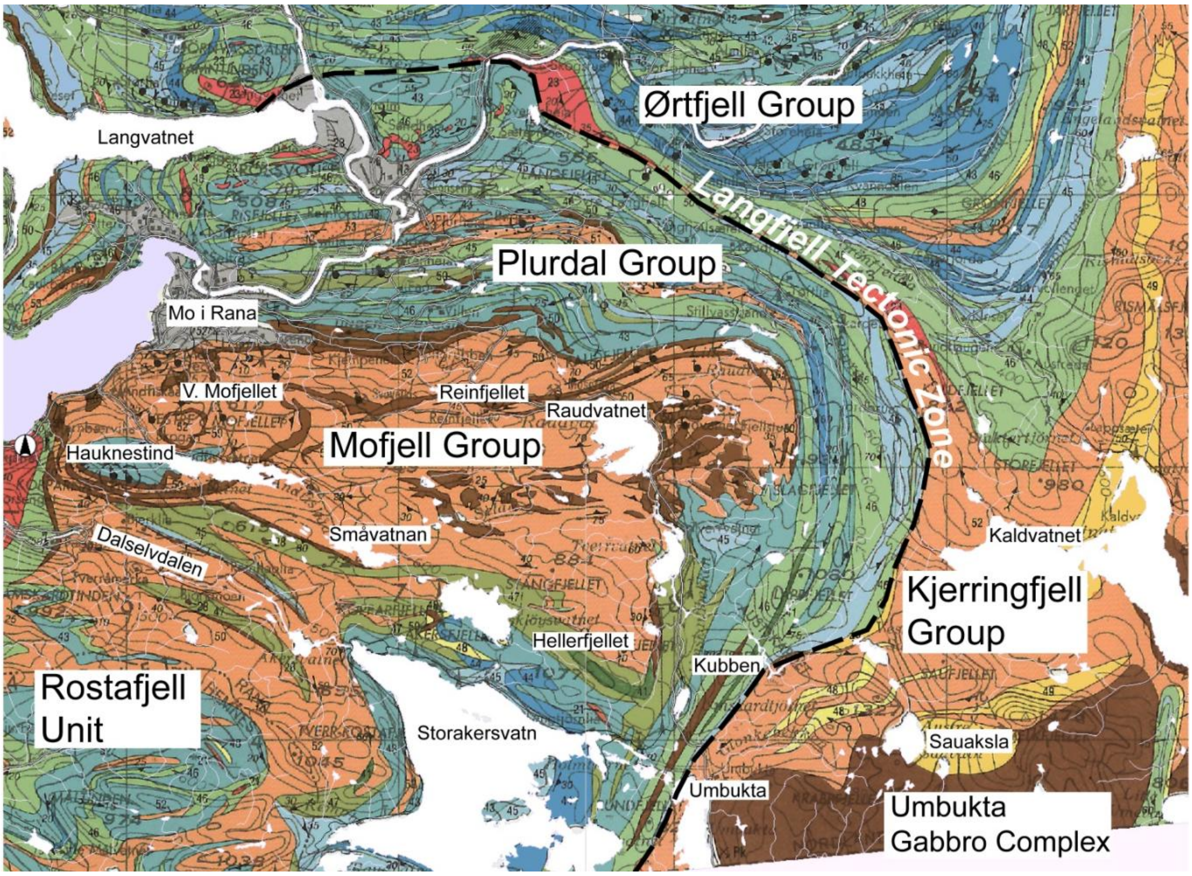


Figure 3: Map showing the geology east and south of Mo i Rana with the main tectonic and geological units. Orange colors are mainly quartz-feldspar gneisses in the Mofjell and Kjerringfjell groups, blue colors are calcite and dolomite marbles in the Plurdal, Ørtfjell Groups, blue-green colors are calcareous schists in the Plurdal, Ørtfjell and and Rostafjell units, green colors are various mica schists (partly kyanite, graphite or/and garnet-bearing), brown colors are amphibolite and gabbro, while red colors are granitic rocks. The thick stippled line marks the Langfjell Tectonic Zone. (Modified from the 1:250 000 bedrock map Mo i Rana, Gustavson & Gjelle, 1991).

The Mofjell Group (Søvegjarto et al., 1988) is separated from the Plurdal and Rostafjell Unit by a major unconformity, which is probably also a tectonic boundary (Figure 3). The group in general, is dominated by quite massive grey gneisses with persistent layers of amphibolite and aluminous biotite and muscovite gneisses (Figure 6). The group was mapped in great detail in 1:5000 and 1:10000 scales by M. Marker in 1974-1981 and 1999. For detailed descriptions of the lithologies refer to Marker (1983).

During this project the eastern and southern part of the Mofjell Group, and adjoining units were mapped, which also resulted in finalizing the 1:50000 map sheet Storakersvatnet (Marker et al., 2012). The mapping showed that the Mofjell Group has tectonic boundaries to the Rostafjell unit as well as to the Plurdal Group in the south.

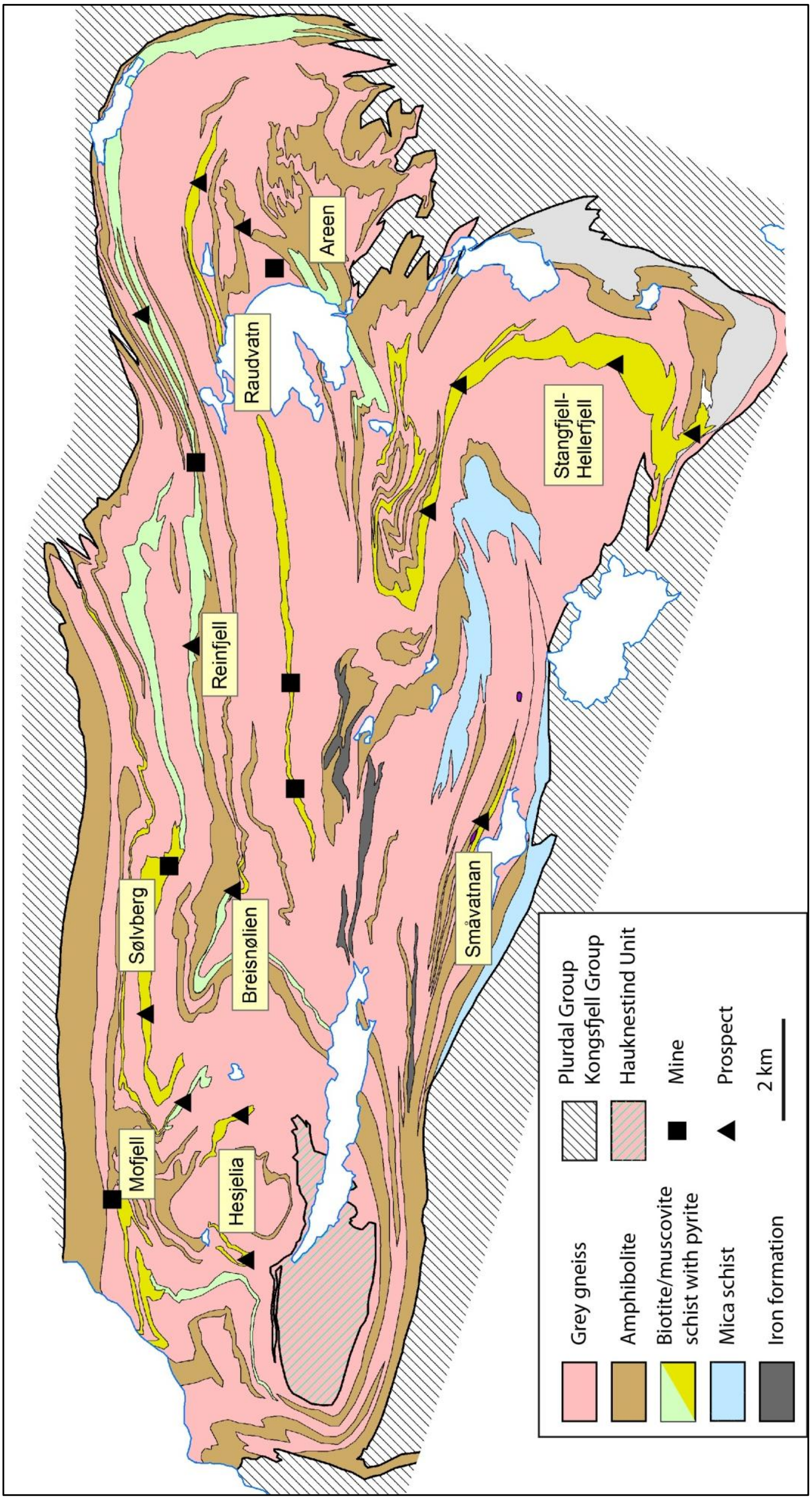


Figure 4: Simplified geology of the Mofjell Group, including the most important ore deposits and ore horizons (which are named). The map is based on Marker, 1983 and Marker et al., 2012.

2.2 Rock descriptions

The grey gneiss consists of quartz and plagioclase with varying proportions of subordinate biotite and muscovite. The more schistose and micaceous type of gneiss most likely represent greywacke type metasediments. The massive units probably are of igneous origin (Figure 5), and this seems to be confirmed by lithogeochemistry (see section 2.3).

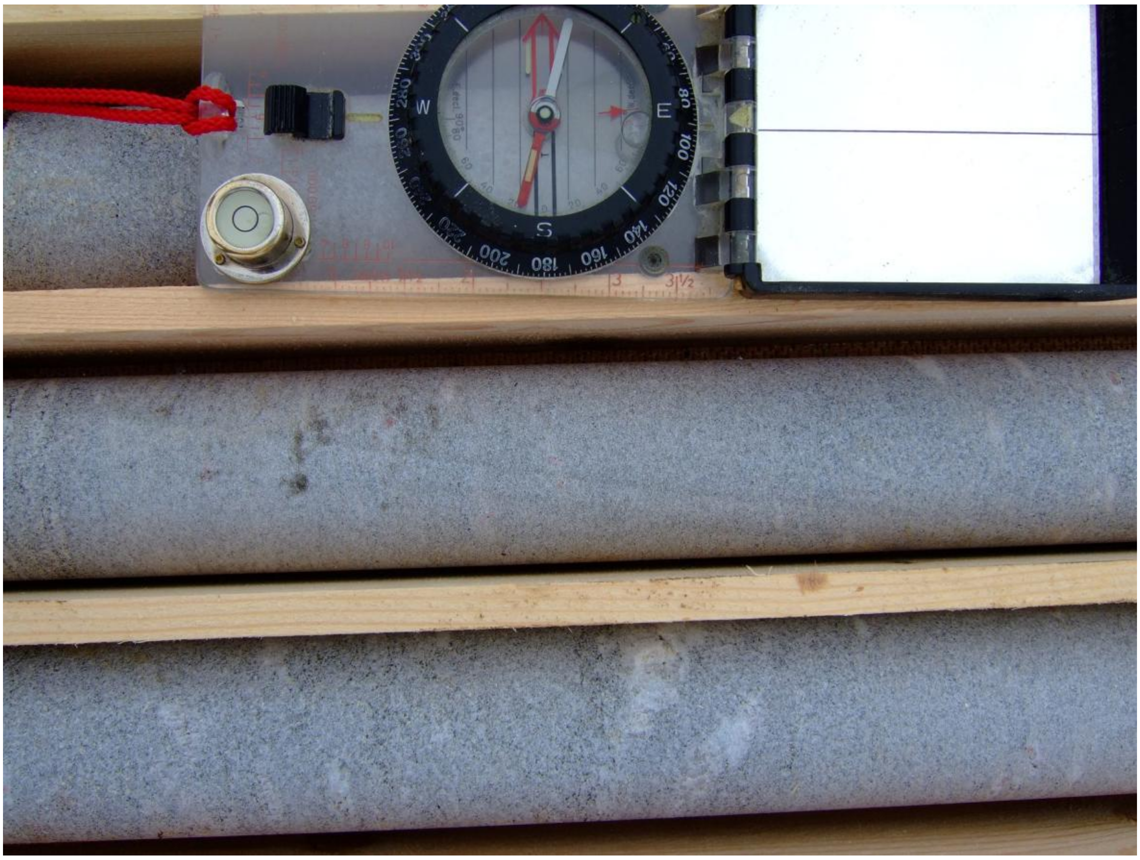


Figure 5: Typical massive grey gneiss. Drillhole 4608 at Heramb, depth c. 170 m.

Parts of the commonly garnet-bearing amphibolites contain pods and stripes of calc-silicate rock (interpreted to represent pillow lavas originally). In attenuated parts in fold limbs they contain significant amount of biotite replacing hornblende.

The biotite and muscovite gneisses or schists are generally rich in quartz and aluminosilicates in addition to mica. They may form separate, generally persistent layers, but grade into each other with changing proportions of biotite and muscovite. Biotite-dominated types may also contain amphibole and grade into hornblende-biotite gneisses. The biotite gneisses contain excessive kyanite in addition to garnet and staurolite, while the muscovite gneisses are mostly poor in these minerals.

The biotite (+/-hornblende) and muscovite gneisses invariably contain disseminated pyrite (Figure 7), as well as quartz-rich exhalites. The zones can be traced for several kilometers along strike and are important by hosting all the stratabound Zn-Pb-Cu sulfide mineralizations recorded in the Mofjell Group, including the Mofjellet deposit.

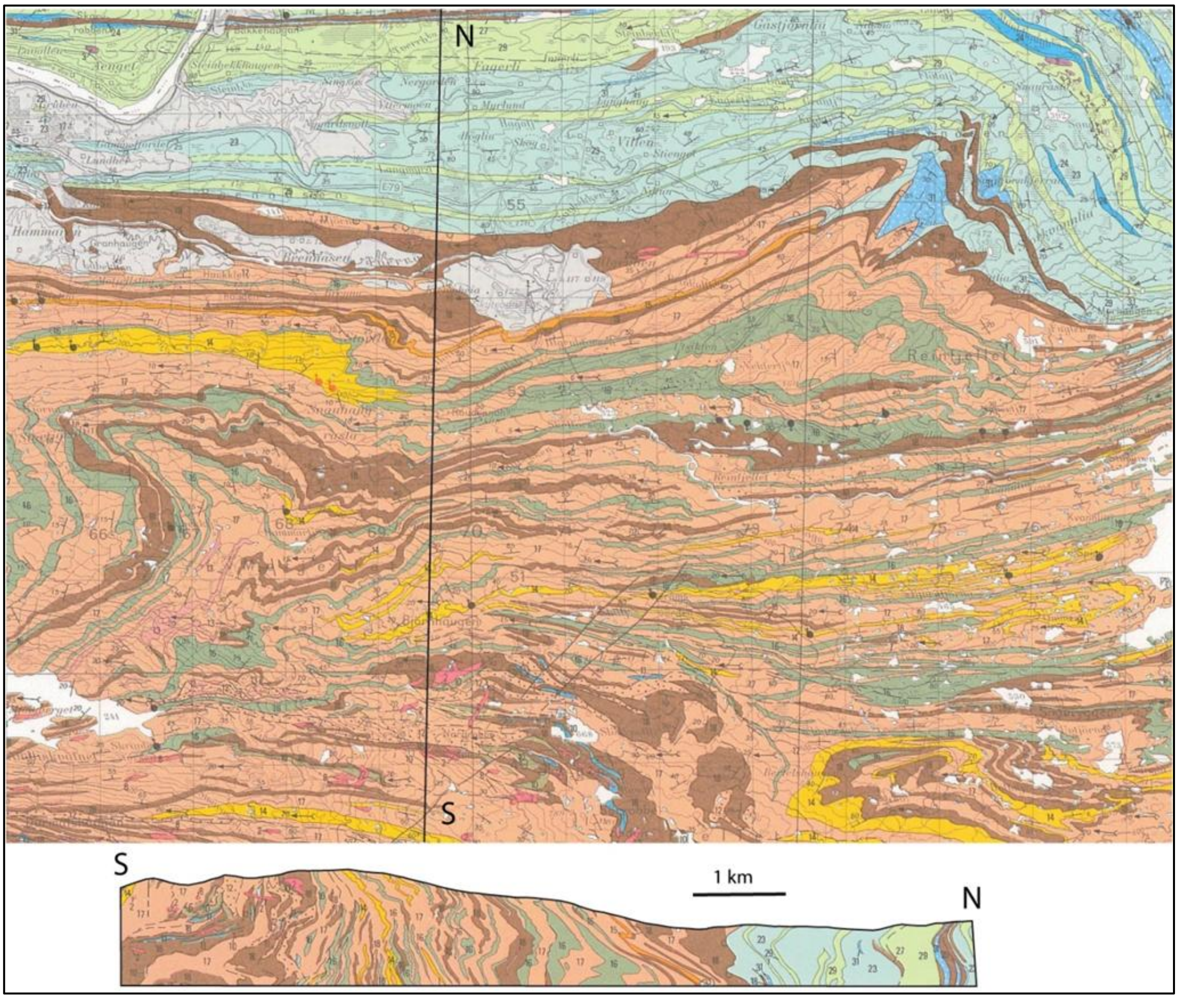


Figure 6: Part of the 1:50000 geological map Storforshei (Søvegjarto et al., 1989), showing the lithologies of the Mofjell Group. Legend: brown – amphibolite, green – biotite schist, yellow – muscovite schist, red-orange – grey gneiss, light red – felsic volcanic/keratophyre, red – tonalitic intrusions, blue – marble, greenish-blue – calcareous schists.

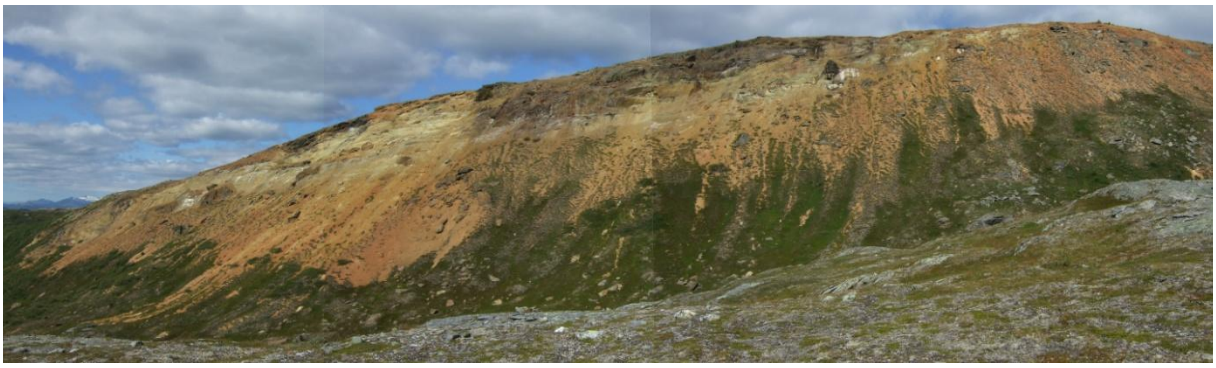


Figure 7: Pyritiferous biotite gneiss at Raudsandhaugen. Photo towards the north.

2.3 Lithogeochemistry

During the project a number of bedrock samples were collected systematically from most of the main units in the Mofjell Group for whole-rock geochemistry, geochronology and petrography. The main purposes of the work were to determine the age, origin and setting of the Mofjell Group, and thus to contribute to the understanding of the formation and origin of the sulfide deposits. In addition to the data collected during this project, also a number analytical data from previous work (mainly from the former NGU Bleikvassli project) have been included (e.g. Bjerkgård et al., 1995).

2.3.1 Geochemistry of amphibolites

Extensive units of amphibolite occur throughout the Mofjell Group (Figure 6), and are therefore well suited for analyses of geological and tectonic variations in the unit.

The data from the Mofjell Group amphibolites are plotted in various discriminant diagrams in Figure 8 and Figure 9. The data are consistent, and show that the amphibolites have tholeiitic compositions with a strong island-arc affinity.

Only three samples have been collected from the Plurdal Group, due to low degree of outcrop, but also because the unit has not been prioritized in this project. There are thus too few data to characterize the unit (see Bjerkgård et al., 2009). However, there are indications that they have a different origin than the Mofjell amphibolites, e.g. a lack of negative Nb anomaly.

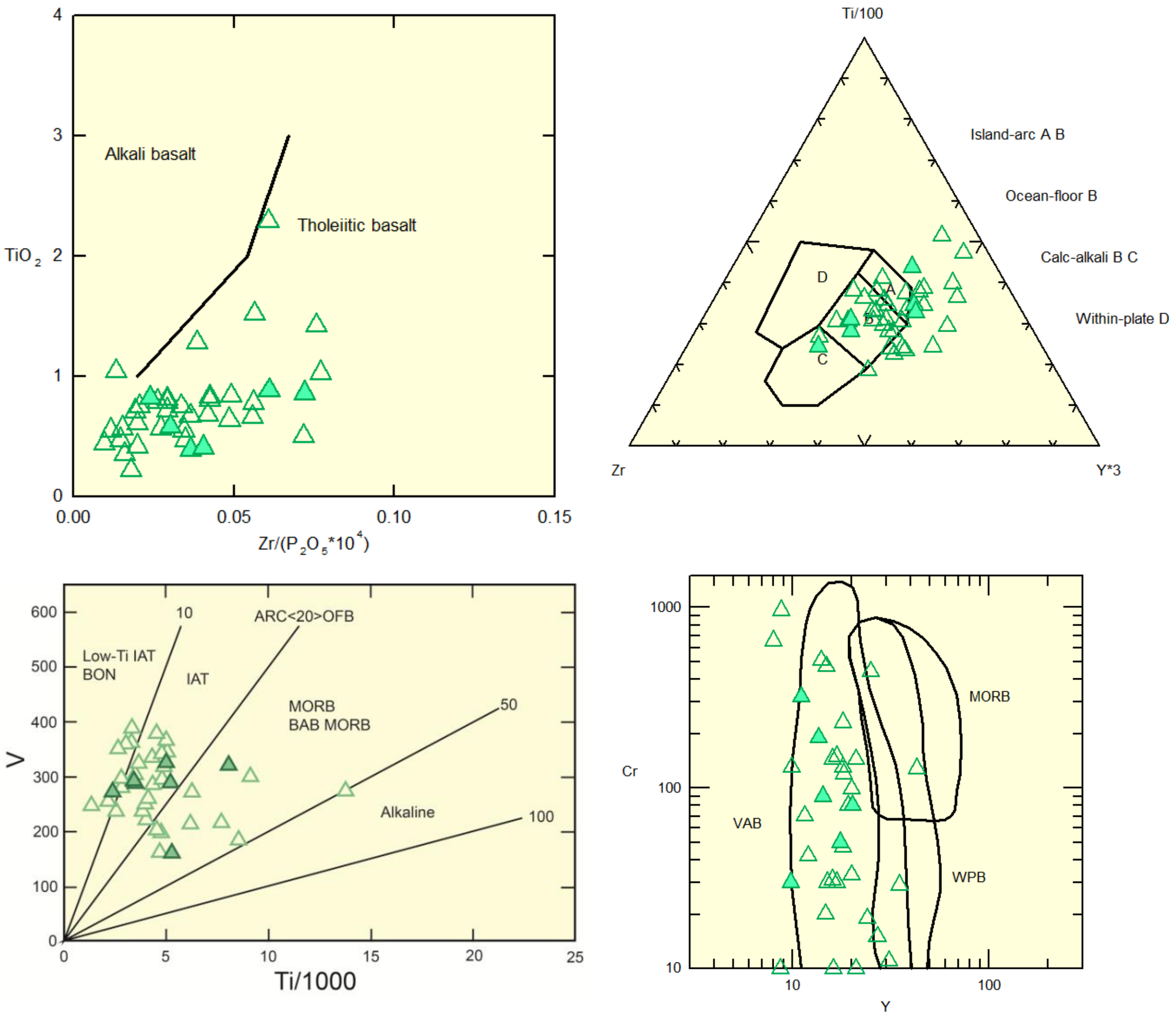


Figure 8: Discriminant diagrams for amphibolites in the Mofjell Group. Open triangles are massive amphibolites, while the filled triangles are banded and schistose, probably tuffitic in origin. Diagrams from Winchester & Floyd (1977), Pearce & Cann (1973), Shervais (1982), Pearce (1982)

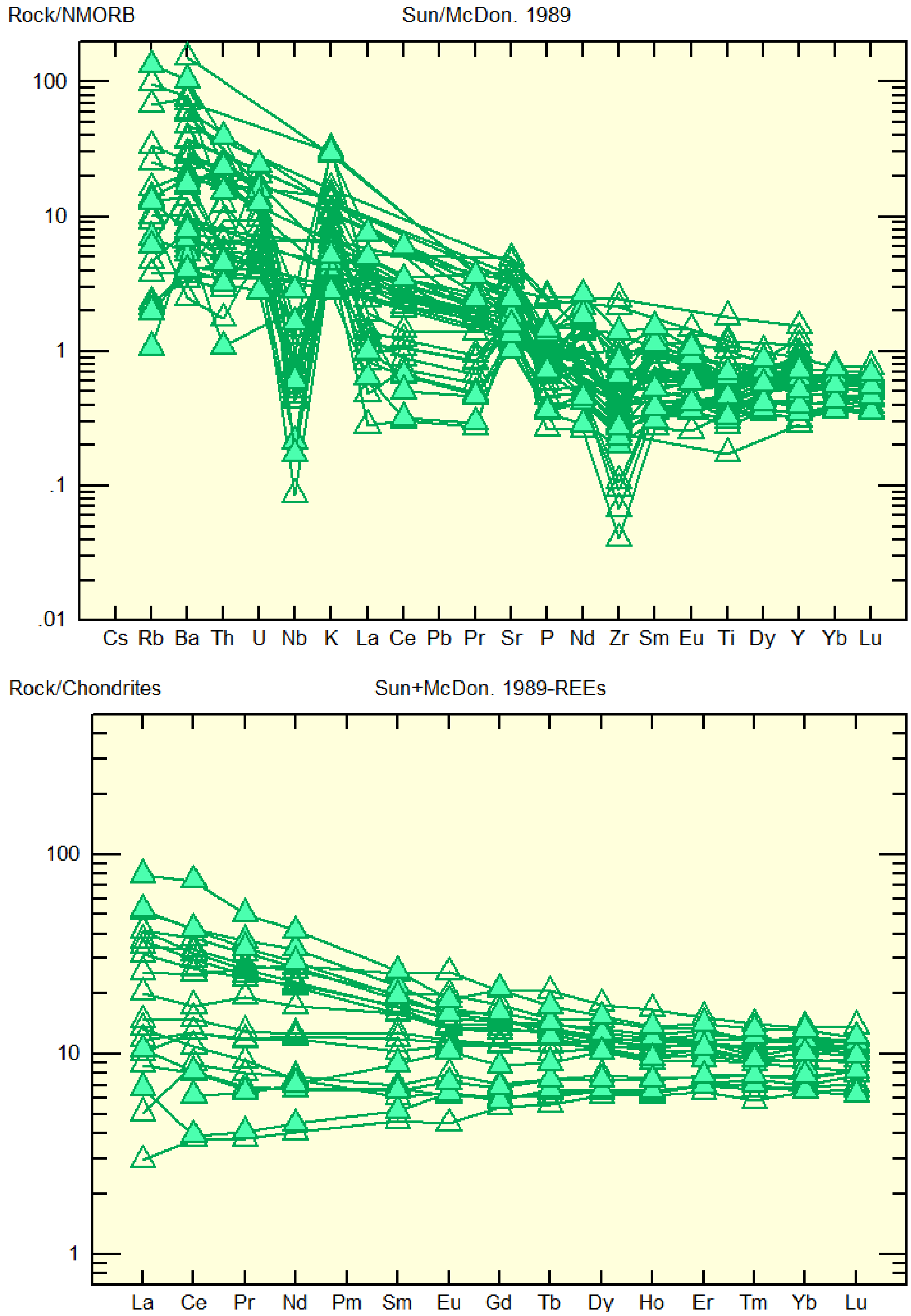


Figure 9: Spider diagrams for amphibolites in the Mofjell Group (upper diagram normalized to NMORB, lower diagram to chondrite, both normalizing data from Sun & McDonough, 1989). Open triangles are massive amphibolites, while the filled triangles are banded and schistose, probably tuffitic in origin.

2.3.2 Geochemistry of grey gneiss and felsic metavolcanics

The grey gneiss is very interesting and important, since it dominates the Mofjell Group. The origin of these rocks have so far been rather obscure.

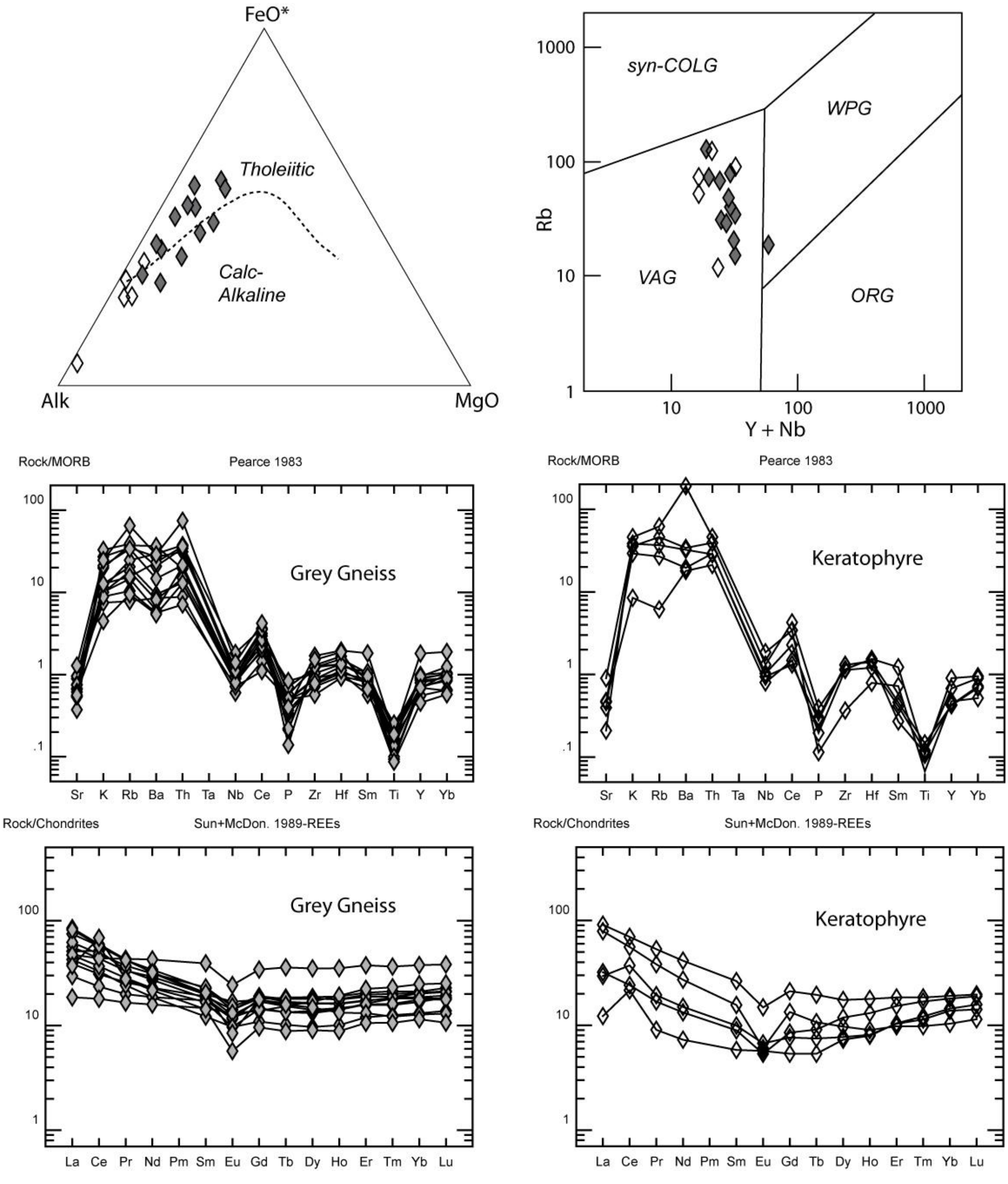


Figure 10: The composition of grey gneisses (filled symbols) and felsic metavolcanics/keratophyre (open symbols) displayed in discriminant diagrams and spider diagrams (grey gneiss to the left and keratophyre to the right). Diagrams from Irvine & Baragar (1971) and Pearce et al. (1984), normalizing data from Pearce (1983) and Sun & McDonough (1989).

In the Mofjell group are also rocks which are interpreted to be felsic metavolcanics on the basis of being homogeneous and having feldspar or/and quartz fenocrysts. These are generally spilitized, i.e. so-called keratophyres.

In Figure 10 samples of grey gneiss and keratophyre are plotted in various discriminant diagrams. In the AFM diagram (Irvine & Baragar, 1971) both rock types straddle the boundary between calc-alkaline and tholeiitic composition, while in the Rb vs. Y+Nb diagram (Pearce, 1984) the two types overlap and plot in the VAG (volcanic-arc granite) field. The similarity between the grey gneiss and keratophyre is further underlined in the spider diagrams in Figure 10. In the MORB normalized spider diagrams (Pearce, 1983), both rock types show a pronounced enrichment in K, Rb, Ba and Th and depletion in Nb, Ti, P, which is a typical pattern for volcanic-arc tectonic setting. The chondrite normalized patterns show slight enrichment of LREE and a negative Eu anomaly for both rock types, which is typical for low-Al felsic rocks formed during partial melting of greenstones/metabasalts (Drummond & Defant, 1990).

In conclusion, the samples of grey gneiss have very similar composition and are quite similar to the felsic magmatic/volcanic rocks of the Mofjell Group. The geochemical data indicate that the rocks, including large parts of the grey gneiss are of a magmatic character, and originated in a volcanic-arc setting.

2.3.3 The Kjerringfjell Group

The Mofjell and Plurdal Group are separated from the Kjerringfjell Group by the Langfjell Tectonic Zone (see Figure 3). This structure is a shear zone of presumably early Caledonian age. In the zone are granitic and pegmatitic rocks, which partly are deformed by, and partly crosscut, the structures and the rocks (Figure 11). The intrusive rocks are thus syntectonic and may be used to yield an age of the structure.

The Kjerringfjell Group comprises the major Umbukta Gabbro Complex and a number of mafic dikes crosscutting the schists in the group. The geochemical data of the mafic rocks are presented in Figure 12. The data show that the dikes have the same composition as the gabbro complex, with both being tholeiitic and with a trace element chemistry in accordance with a continental rift environment (e.g. note the weak positive Nb anomaly, compared to the strong negative anomaly in the Mofjell Group amphibolites (Figure 9)).

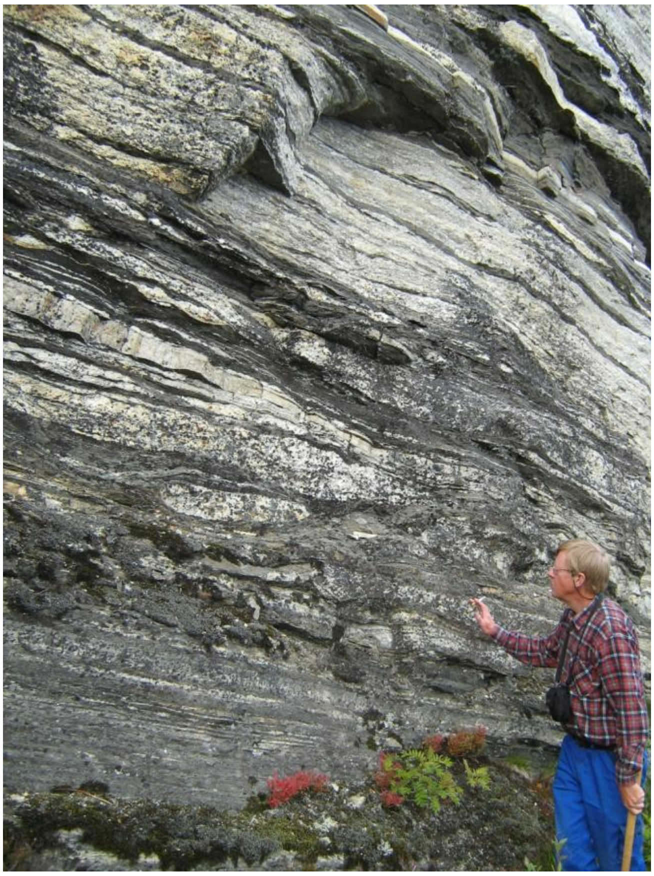


Figure 11: Deformed granitic pegmatite (light color) in schist in the Langfjell Tectonic Zone.

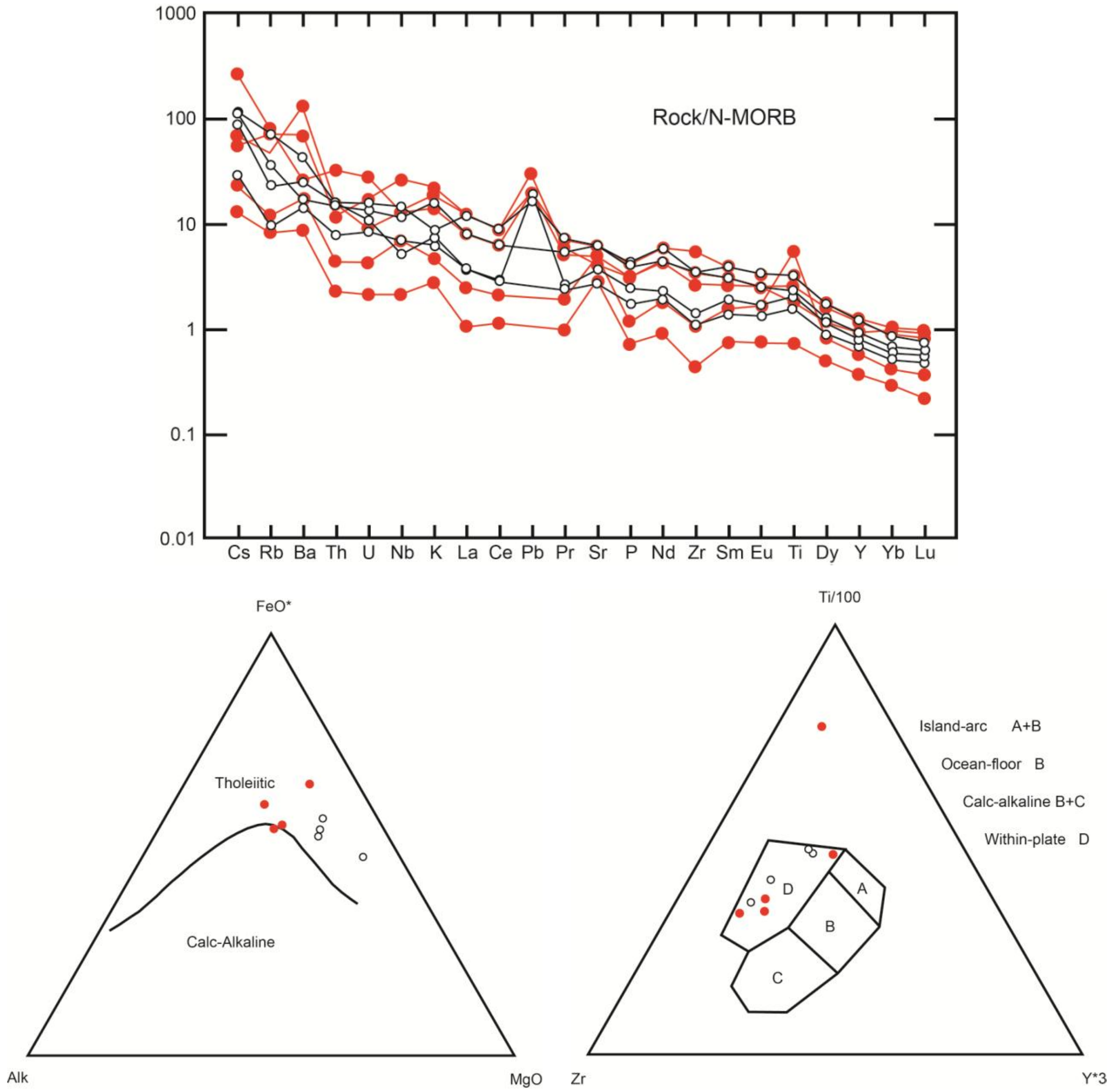


Figure 12: Amphibolites in the Kjerringfjell Group (black, open circles) and the Umbukta gabbro (red, filled circles). Diagrams from Irvine & Baragar (1971) and Pearce & Cann (1973), normalizing data from Sun & McDonough (1989).

2.3.4 <u>Summary and conclusions on lithogeochemistry</u>

Both lithological observations and lithogeochemistry show that the Mofjell Group consists of a largely bimodal volcanic-sedimentary assemblage. The data also show that the proportion of felsic volcanic rocks is much higher than previously described.

The lithogeochemistry of the felsic and mafic rocks in the Mofjell Group are consistent, and show that the unit originated in an island arc setting.

Looking on the more regional picture, earlier work (e.g. Bjerkgård et al., 1997) strongly indicate that the part of the Rödingsfjäll Nappe Complex constituting the Kongsfjell Group to the south of Mofjellet between Røssvatnet and Mo i Rana (Figure 2), was formed in an extensional back-arc regime (based on lithological assemblages, lithogeochemistry). Thus both the Mofjell and Kongsfjell Group were formed in an arc setting, but if they were part of the same marginal regime, is difficult to say without geochronological constraints. A possible paleotectonic model for this part of the Rödingsfjäll Nappes Complex is shown in Figure 13.

Lithogeochemistry data on correlatives of the Plurdal Group in the Bleikvassli/Røssvatn area, indicate that this unit could be part of the back-arc regime (e.g. Bjerkgård et al., 1995, 1997).

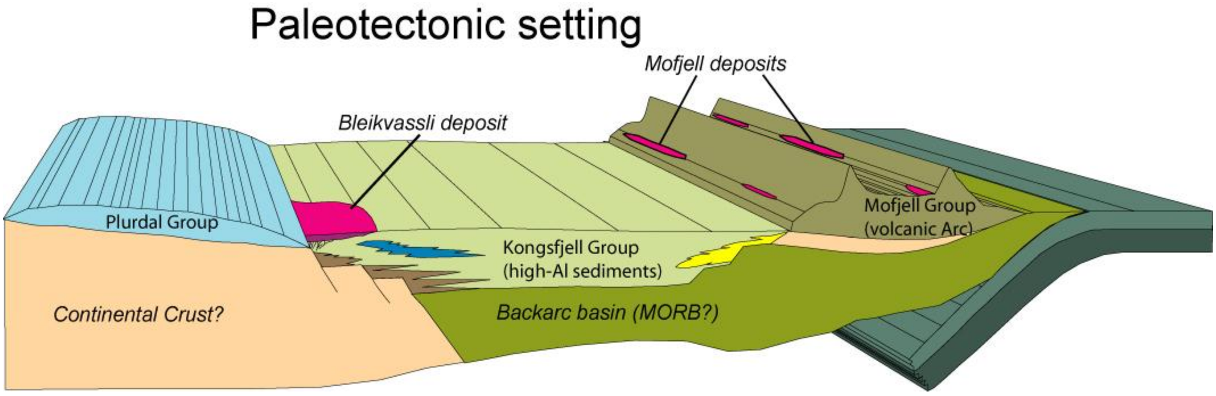


Figure 13: Paleotectonic model for the southern part of the Rödingsfjäll Nappe Complex, between Røssvatnet and Rana.

The differences in lithochemistry between the Mofjell Group and Kjerringfjell Group, indicate that they were formed in two different tectonic environments and came in contact with each other at a later stage, perhaps in connection with thrusting along the Langfjell Tectonic Zone. If so, this zone is a very important Caledonian structure, in relation to the development of the whole Rödingsfjäll Nappe Complex.

3. RESULTS ORE GEOLOGY

During the field seasons in 2008 and 2009, most of the known mineralizations in the Mofjell Group were inspected, sampled and mapped in some detail. The data sets have been analyzed, compared and integrated with data from the NGU national ore database, as well as prospecting campaigns carried out by the company Bergverksselskapet Nord-Norge (BNN).

Previous detailed bedrock mapping in the Mofjell area by Marker (1981) provides a basis for grouping of the deposits into different structural levels in the Mofjell Group. Eleven main levels of sulfide mineralizations in the area are defined (Figure 14, Figure 15).

The sulfide deposits are in most cases related to extensive zones of iron sulfides (mainly pyrite) hosted by quartz-muscovite and biotite schists. The pyrite locally occurs in massive layers, which have been mined, as the Mos, Areens, Reinfjellet and Avensjøen deposits. The largest of these, the Mos mine, produced c. 52 000 t of pyrite in the period 1911-1920 from a total resource of c. 120 000 t. Contents of Cu and Zn were on average 0.5 and 1 %, respectively. The other pyrite mines produced less than 300 t in total.

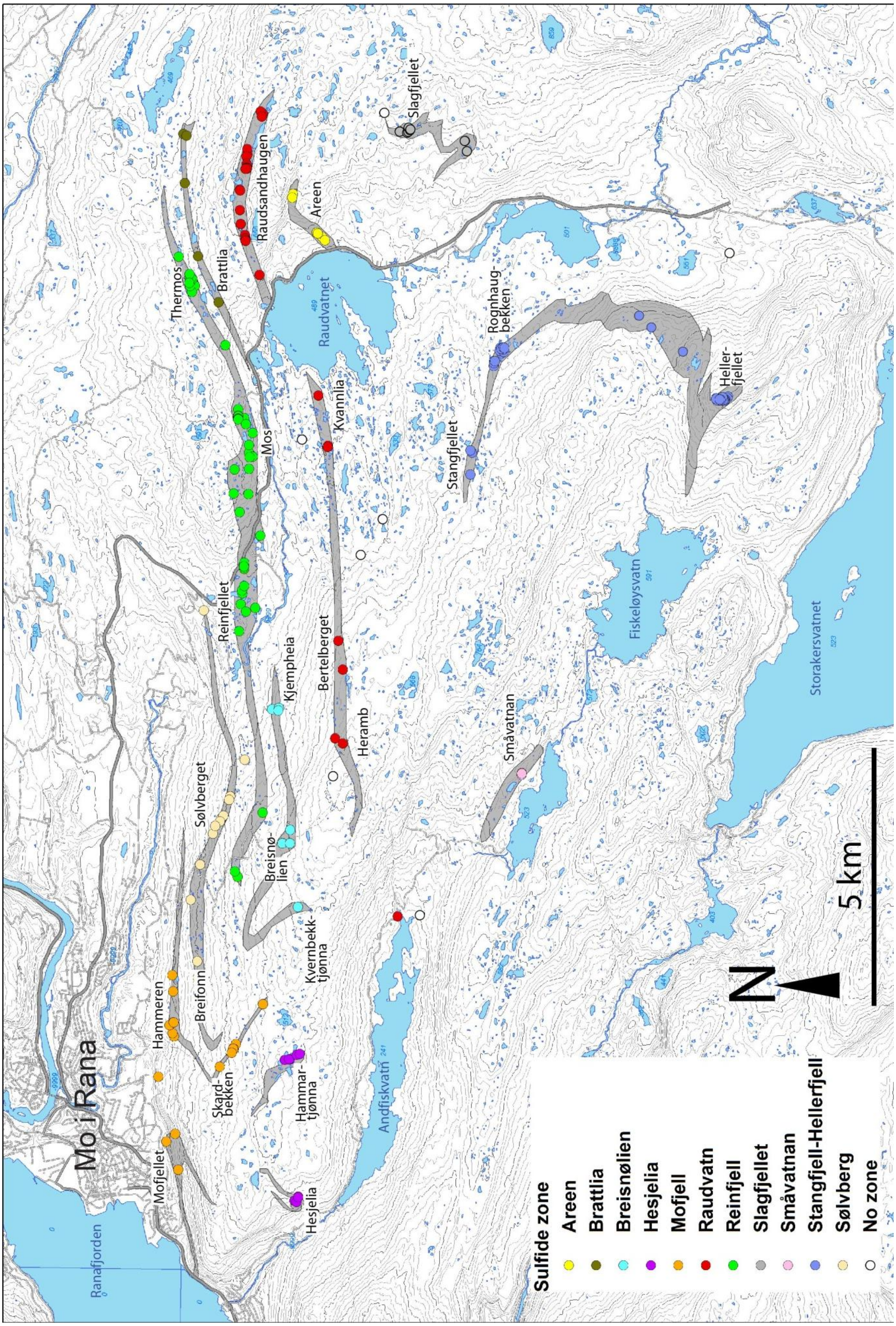


Figure 14: Overview of the mineralized zones in the Mofjell district. The most important deposits in the different zones are named.

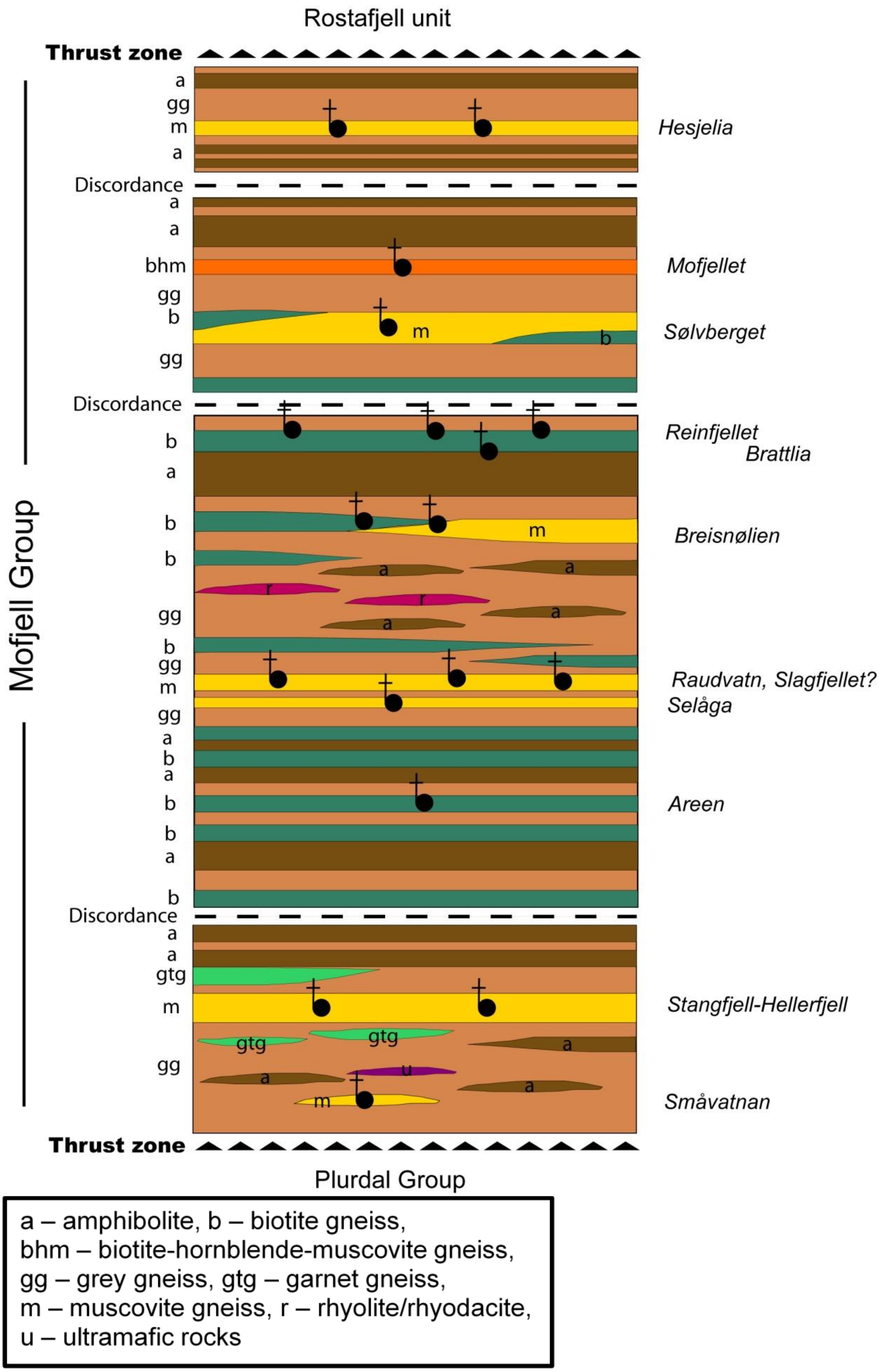


Figure 15: Schematic tectonostratigraphy of the Mofjell Group, displaying the setting of the most important sulfide zones.

3.1 Descriptions of the ore zones

In this section characteristic features of the mineralized zones are described, including structural setting, host rocks, ore grades, mineralogy, etc. The zones are described sequentially from the top to the bottom according to their structural position in the Mofjell Group, as shown in Figure 15.

3.1.1 <u>The Hesjelia zone</u>

The Hesjelia zone is situated above a probable discordance on the top of Mofjellet. In this area two mineralizations are outcropping in a major fold closure of a recumbent fold structure oriented east-west. The structure has its closure to the south and has a length of c. 2.9 km. The mineralizations are associated with a tightly folded unit of muscovite gneiss (Figure 16).

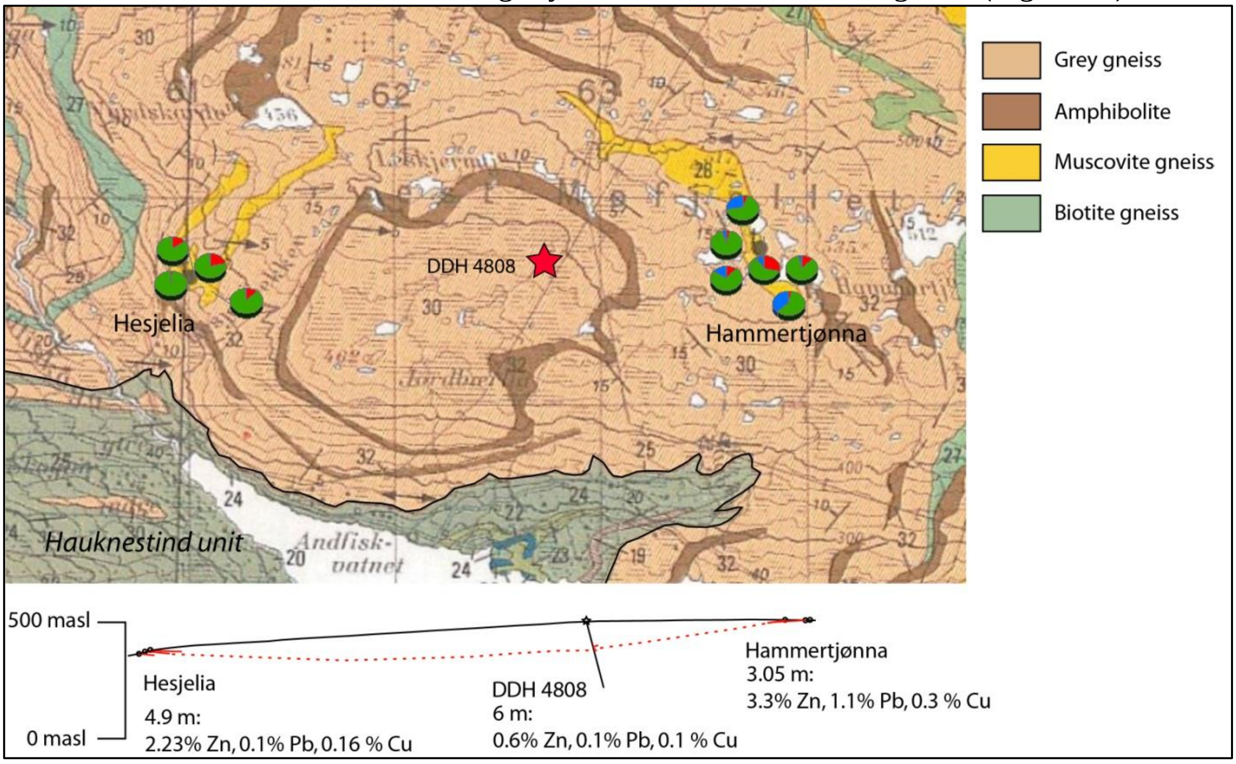


Figure 16: Section of the 1:50000 bedrock map Mo i Rana (Søvegjarto et al., 1988), showing the Hesjelia-Hammertjønna zone. The position of DDH 4808 is also shown. The pie diagrams show the proportions of Cu (red), Zn (green) and Pb (blue) in the prospects. The yellow color on the background map marks the muscovite gneiss zone which is associated with the deposits. The cross section below the map shows the connection between the two deposits as indicated by DDH 4808. Background squares on the map are 1x1 km

The outcrop of the mineralization at Hesjelia in the west has a length of about 130 m distributed on 5 prospects. The mapping during this project and data from old drillholes show that the mineralization consists of several lenses and stripes of semimassive to massive sulfide mineralization in muscovite schist. From reports of the drilling in 1959 it is up to 4.9 m thick with 2.23 % Zn, and 0.16 % Cu. An average yields 2.9-3.4 % Zn and 0.2-0.25 Cu % at an average thickness of 2.95 m (Bjerkgård et al., 2009). Mapping by portable XRF showed the presence of a halo of barium and zinc above the mineralized zone.

The mineralization at Hammertjønna is outcropping discontinuously over a length of nearly 350 m in five small showings. Drillholes from the 1980s yielded intersections of 0.6 to 3.85 m averaging 1.4 % Zn, 0.4 % Pb, 0.2 % Cu, 7 g /t Ag, with the best intersection having 3.05 m with 3.3 % Zn, 1.1 % Pb, 0.3 % Cu and 9 g /t Ag. Portable XRF identified a halo of barium (0.1-0.3 % Ba) up to 0.5 m in the main mineralized zone.

Geophysical data (TEM) indicated a connection between the mineralizations at Hammertjønna and Hesjelia and drillhole 4808 in 2008 strengthened this assumption (Figure 16). At about 110 m depth a weak mineralization was intersected in the hole assaying 0.14 % Cu, 0.09 % Pb, 0.60 % Zn and 3 g/t Ag over 6 m interval. Anomalous barium-values (up to 0.3 %) were found beneath the richest mineralization in the hole.

Main sulfides in both Hesjelia and Hammertjønna are pyrrhotite or/and pyrite and sphalerite, while chalcopyrite is subordinate to accessory and galena is accessory mineral (Table 1). The content of galena is generally slightly higher in the Hammertjønna deposits.

Among trace minerals are silver-bearing phases, mainly freibergite, most common, but also some bismuth telluride are found. These phases are generally present as inclusions in galena. In one of the sections from Hesjelia one grain of a palladium-antimony mineral was found with a formula close to $Pd_{12}Sb_{13}$, a mineral which could be sudburyite ((Pd,Ni)Sb), but in that case without the nickel.

Table 1: Mineralogy in the different prospects of the Hesjelia ore zone.

		Sulfides and oxides				
Sample	**Deposit**	**Main**	**Subordinate**	**Accessory**	**Trace**	**Gangue**
HAM-01	Hammertjønna	py	po,cpy	sl,gl	ss	qz, mus, bi, ep, plag, hy
Hammertj-01	Hammertjønna	py, sl		cpy, gl		qz, mus, hy, plag
HAM-02	Hammertjønna s.2	po,sl	cpy	gl,mb		qz, ky, bi, hy
HAM-04	Hammertjønna s.4	po,sl	gl	py,cpy	fa,te	qz, ky, bi, plag, hy
HES-01	Hesjelia s.2 (3)	po	py	sl,cpy	gl,fa,te	qz, mus, kfs, plag, hy
HES-02	Hesjelia s.1 (2)	po,sl	py,cpy		gl,mb	qz, amph, fsp, hy, ba
HES-04	Hesjelia (1)	py,po,sl,cpy		gl,mt	mb	fsp, qz, ep, amph, chl, bi, hy, ba
HES-01-09	Hesjelia	sl, po	py	cpy, gl		qz, hy, bi, ap
HES-02-09	Hesjelia s.4	py	sl	cpy, chc	cov	qz, mus, hy, plag

py-pyrite, po-pyrrhotite, cpy-chalcopyrite, sl-sphalerite, gl-galena, mb-molybdenite, ss-sulphosalt, mt-magnetite, te-telluride, fa-fahlore, cov-covellite, chc-chalcocite, qz-quartz, mus-muscovite, bi-biotite, ep-epidote, plag-plagioclase, hy-hyalophane, ky-kyanite, kfs-K-feldspar, amph-amphibole, ba-barite, ap-apatite, chl-chlorite, fsp-feldspar

As mentioned above, the mineralizations in the Hesjelia zone are characterized by high barium content, mainly present in hyalophane with 21-28% celsian component (analyses by SEM). In addition some barite was found in the Hesjelia showings, and barium-bearing mica with 2.5-5.5 wt. % Ba is present in both Hesjelia and Hammertjønna (see section 3.3.4 for mineral data).

The main gangue minerals in the Hesjelia zone are quartz, muscovite, biotite, plagioclase and hyalophane. Kyanite is quite common in the Hammertjønna deposits, while clinoamphibole (probably hornblende) is present in the Hesjelia deposits.

3.1.2 The Mofjell zone

The Mofjell zone is situated structurally below the Hesjelia zone and is the northernmost of the sulfide zones. It is mineralized over a strike length of 8 km from the Ranafjord to 4-500 m.a.s.l. in the slopes of W Mofjellet (Figure 17).

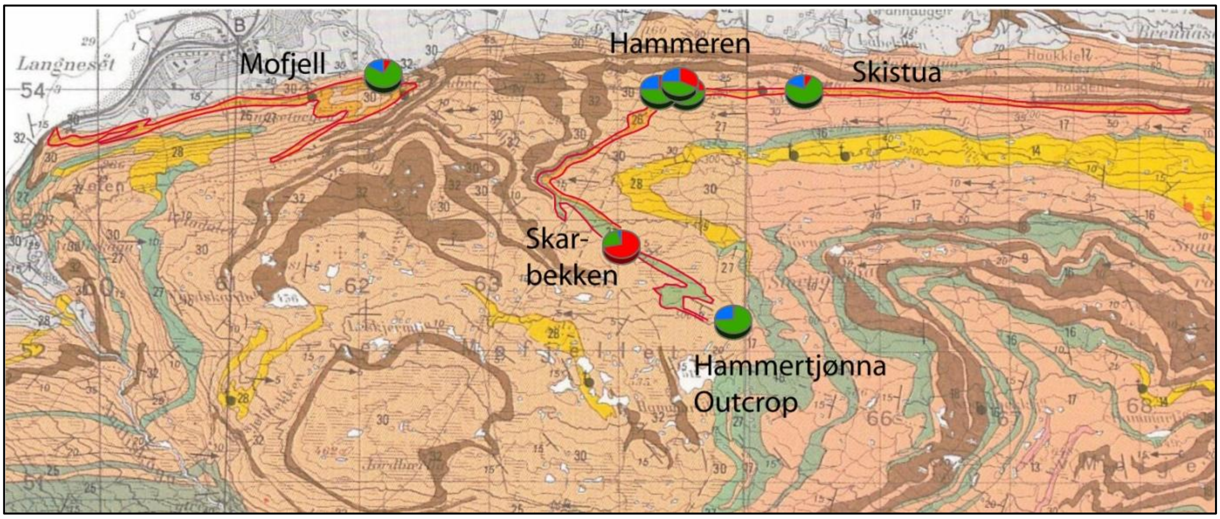


Figure 17: Section of the 1:50000 bedrock map Mo i Rana (Søvegjarto et al., 1988), showing the Mofjell sulfide zone (outlined in red). The orange color is pyritiferous light amphibole-bearing biotite-muscovite gneiss and green color is biotite gneiss. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in the Mofjellet mine and prospects. Otherwise see legend in Figure 16.

The Mofjellet deposit produced 4.35 Mt of ore with average grades of 3.61 % Zn, 0.71 % Pb and 0.31 % Cu in the period 1928-1987. The average silver and gold contents in the mainly semi-massive ore were around 10 and 0.3 ppm, respectively (Bjerkgård & Hallberg, 2012). Outcrops of the deposit are located at several places in the steep north-facing slopes of Mofjellet, as well as further east at Skistua and Hammeren (Figure 17). A possible resource of at least 1 mill. t. ore is still left in the mine.

The Skarbekken occurrence is found in the southern continuation of the Mofjell zone, about 1 km from the Mofjellet mine (Figure 17). It consists of several small prospects over a strike length of c. 200 m. In the main prospect is a 1.5 m thick zone with several layers and lenses of semi-massive pyrite-pyrrhotite mineralization with lesser chalcopyrite and minor sphalerite (Figure 18).

Figure 18: The main Skarbekken prospect, with sulfide-veined mineralization below pyrite-impregnated mica schist.

It is a possibility that Skarbekken may represent a more proximal part of the Mofjellet deposit, taking into account the higher copper content and the lens-like sulfide occurrences.

The main Mofjellet ore deposit consists of alternating semi-massive ore layers, layers of sulfide disseminations and layers of wall rock at a meter-scale or less (Figure 19). The ore layers rarely contain as much as 50 % sulfides. The most important ore minerals are pyrite and sphalerite, while galena, chalcopyrite and pyrrhotite occur in subordinate amounts. Various sulphosalts, arsenopyrite, native antimony and gold-silver alloys are found in variable, but generally accessory amounts (see Bjerkgård et al., 2001, Cook, 2001). Important gangue minerals include quartz, biotite, muscovite, barite, calc-silicates (epidote, amphibole, diopside, garnet), calcite, plagioclase, and magnetite.

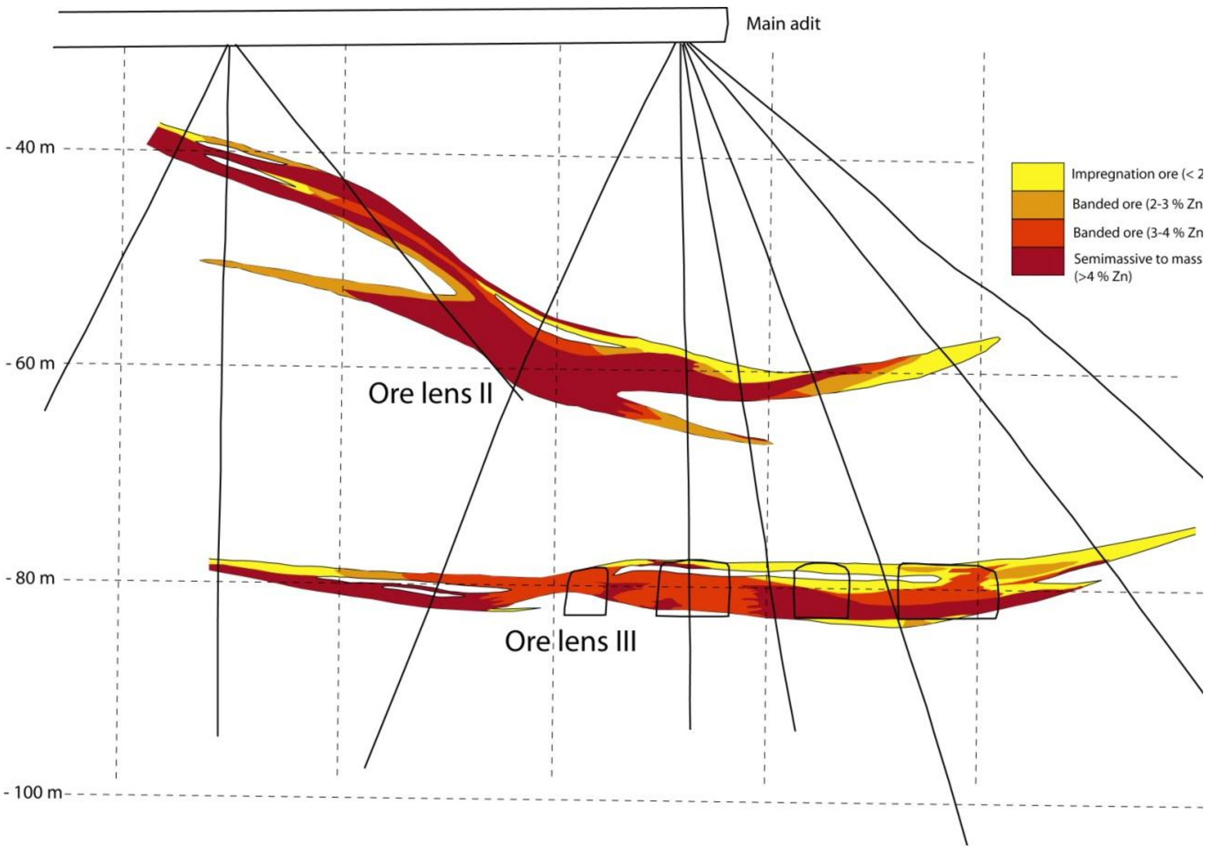


Figure 19: Typical cross section of the eastern part of the Mofjellet deposit, showing strongly folded sulphide ore (Profile 43600 Y).

Commonly, coarse sulfides form disseminations and semi-massive veins, overprinting the more fine-grained sulfide layers or injected into layers of wall rock. These coarse sulfides have much higher contents of galena, chalcopyrite and sulphosalts, and commonly lower contents of sphalerite and pyrite, than the major ore layers and were apparently formed by remobilization of sulfides from the original layers.

High gold grades have been found in the disseminated parts of the ore body (up to 5-10 ppm) (Bjerkgård et al., 2001, Cook, 2001), but the investigations so far have not been able to delineate any gold-rich zones.

The outcrop of the Mofjellet deposit at Skistua is very similar to the mined ore, consisting of rich pyrite-sphalerite impregnations with subordinate galena and accessory chalcopyrite in a matrix of quartz, epidote, clinoamphibole and barite with minor muscovite, biotite and plagioclase. Similar mineralization is known from the Hammeren prospects further west.

The Skarbekken mineralization on the other hand, consists of semimassive pyrite-pyrrhotite-chalcopyrite ore with accessory sphalerite and galena. Late magnetite replaces pyrrhotite. Bi- and Ag-tellurides and sulphosalts are associated with galena. The gangue minerals are quartz, staurolite, biotite, muscovite and epidote/clinozoisite.

3.1.3 The Sølvberget zone

The Sølvberget sulfide zone is situated structurally some 500 m below the Mofjell zone and can be followed for more than 4 km along strike (Figure 20).

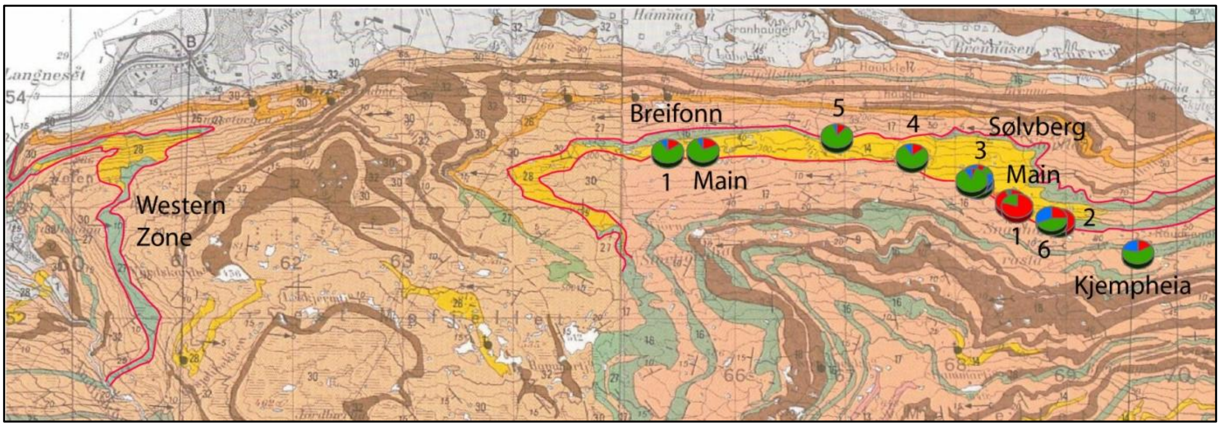


Figure 20: Section of the 1:50000 bedrock map Mo i Rana (Søvegjarto et al., 1988), showing the Sølvberget sulfide zone (outlined in red). The yellow color is pyritiferous muscovite gneiss and green color is biotite gneiss, see also legend in Figure 16. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in the prospects.

Sulfide mineralizations are associated with light rusty muscovite gneisses, containing small amounts of iron sulfides (mainly pyrite, Figure 21). A number of prospects mark the outcropping upper flank of a north-closing major recumbent fold structure, with a gentle dipping fold axis to the west. This structure may have concentrated the sulfide mineralization, and is recommended as a target for further exploration. The fold structure is outcropping again in the western part of Mofjellet (Western Zone in Figure 20), but no prospects or richer mineralizations are known from this part of the structure.

During the 1980s, geophysics and a number of drill holes documented that the Sølvberget zone has the potential of being a quite large, but probably not very rich, sulfide deposit.

Figure 22 shows the extent of the Sølvberget zone, including the drillholes and TURAM geophysics from the 1980s. Figure 23 and Figure 24 show vertical profiles with the results from the drilling. The seven westernmost drillholes (Figure 22) did not intersect any sulfide mineralization, which seems to indicate that the deposit is delimited in that direction. This is also indicated by the geophysics (Figure 22). In the east, the ore zone ends because it is exposed and eroded. This is because the ore zone as shown on the profiles, plunges westwards with an angle of 5-10 degrees.

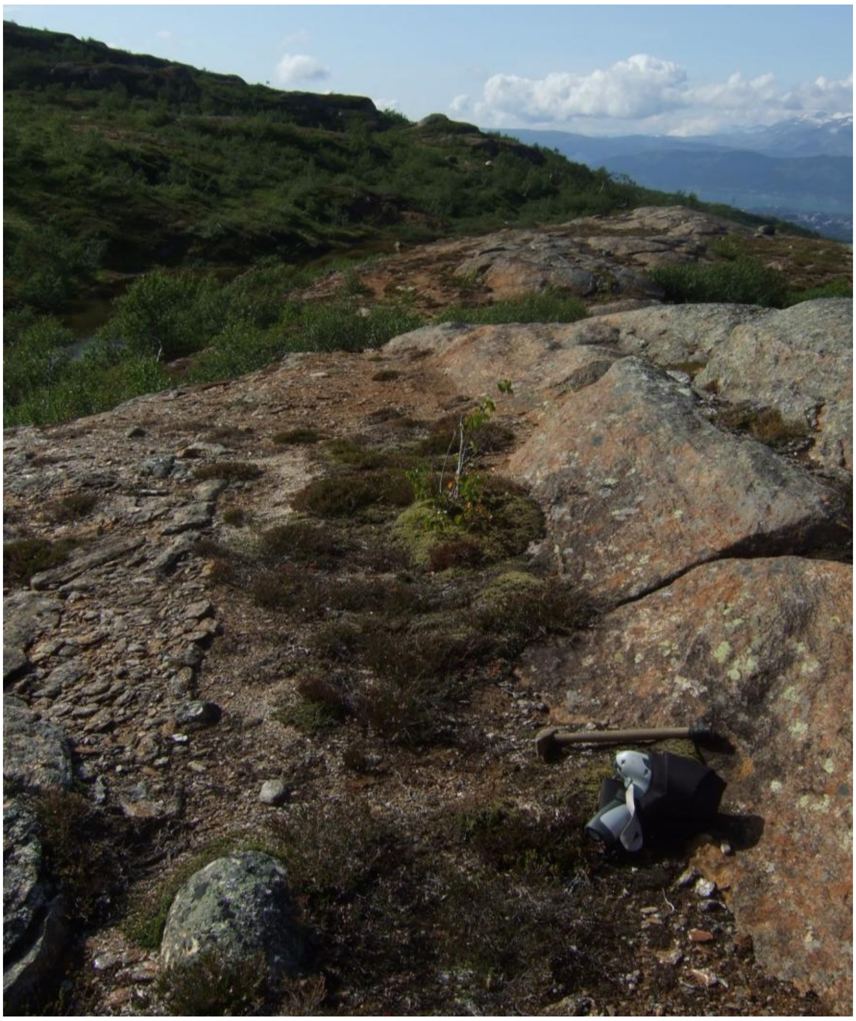


Figure 21: Typical rusty, pyrite-bearing muscovite gneiss in the easternmost outcrops of the Sølvberget zone (looking westwards).

The ore in the drillholes contains generally 0.2-0.3 % Cu, < 0.1 % Pb and 1.2-2.5 % Zn over intervals 0.5 to 5 m. Contents of Ag are generally less than 5 g/t and Au less than 0.1 g/t. There are, however, Pb-rich veins and zones associated with the main ore in some of the hole, which generally are strongly enriched in Ag (100-300 g/) and also show some enrichment of Au (up to 1.7 g/t).

On the basis of the drillhole data, a very crude resource estimate of 4-6 mill. t. with 0.4 % Cu, <0.1 % Pb and 1.6 % Zn is calculated. This is based on a plate of ore with length 3600 m, a width of 160 m and a thickness of 2-3 m (sp.wt 3.5 g/cm^3). The low grades and restricted thickness of the ore zone revealed so far, is probably not economic. However, the recumbent folding in the area makes it possible that additional resources are found in fold hinges and at depth, especially in the south.

The drill holes have not been investigated during this project, but the various prospects have been mapped and sampled and analyzed partly by portable XRF (see Figure 20 and Figure 22 for location).

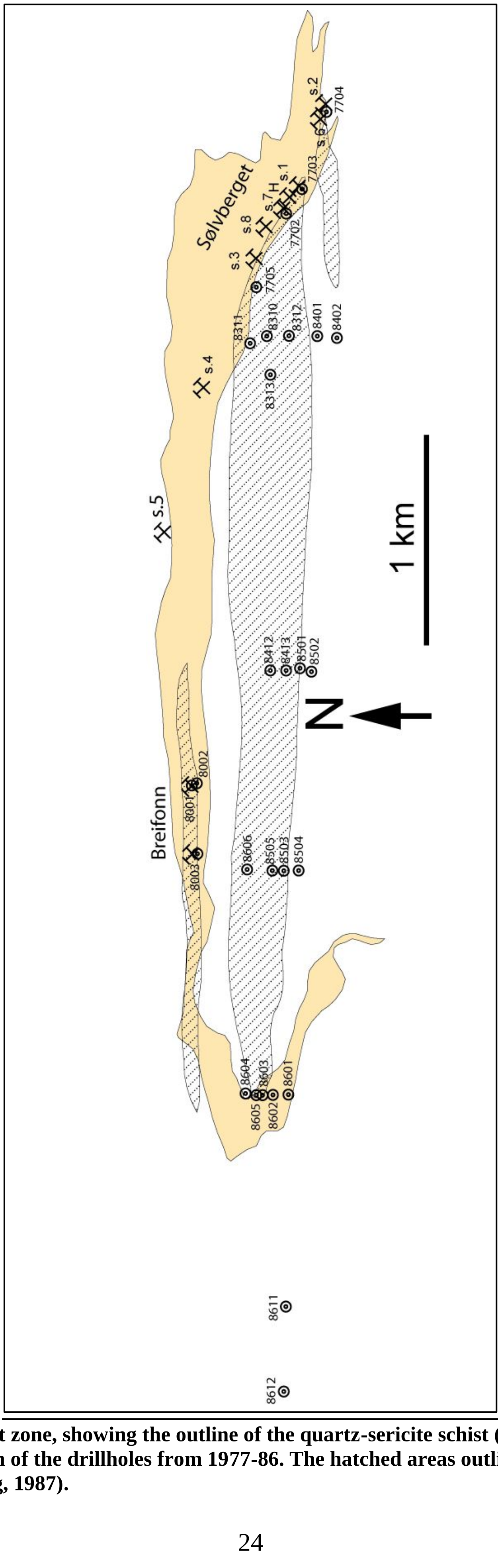
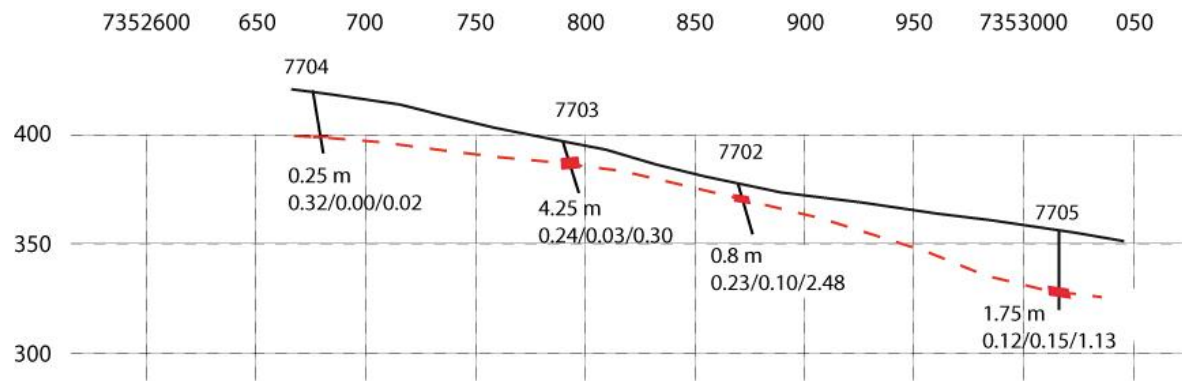


Figure 22: The Sølvberget zone, showing the outline of the quartz-sericite schist (in yellow), the various prospects and the location of the drillholes from 1977-86. The hatched areas outline TURAM anomalies over the deposit (Rønning, 1987).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7702
7705
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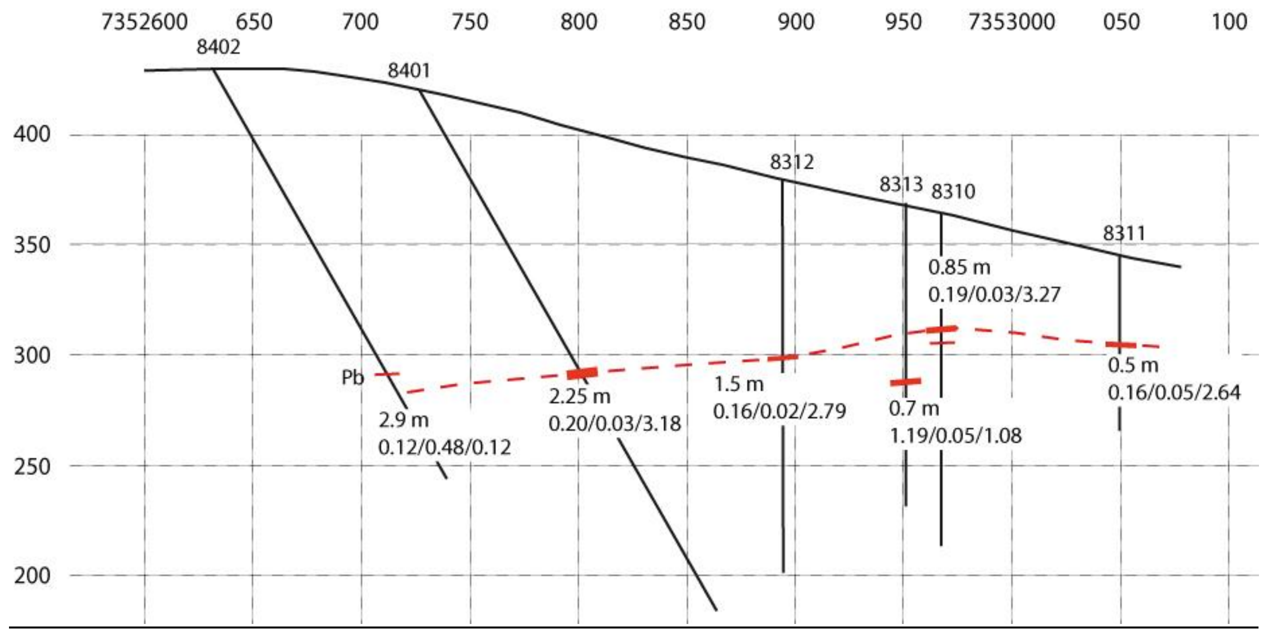
300
0.25 m
0.32/0.00/0.02
4.25 m
0.24/0.03/0.30
0.8 m
0.23/0.10/2.48
1.75 m
0.12/0.15/1.13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8310
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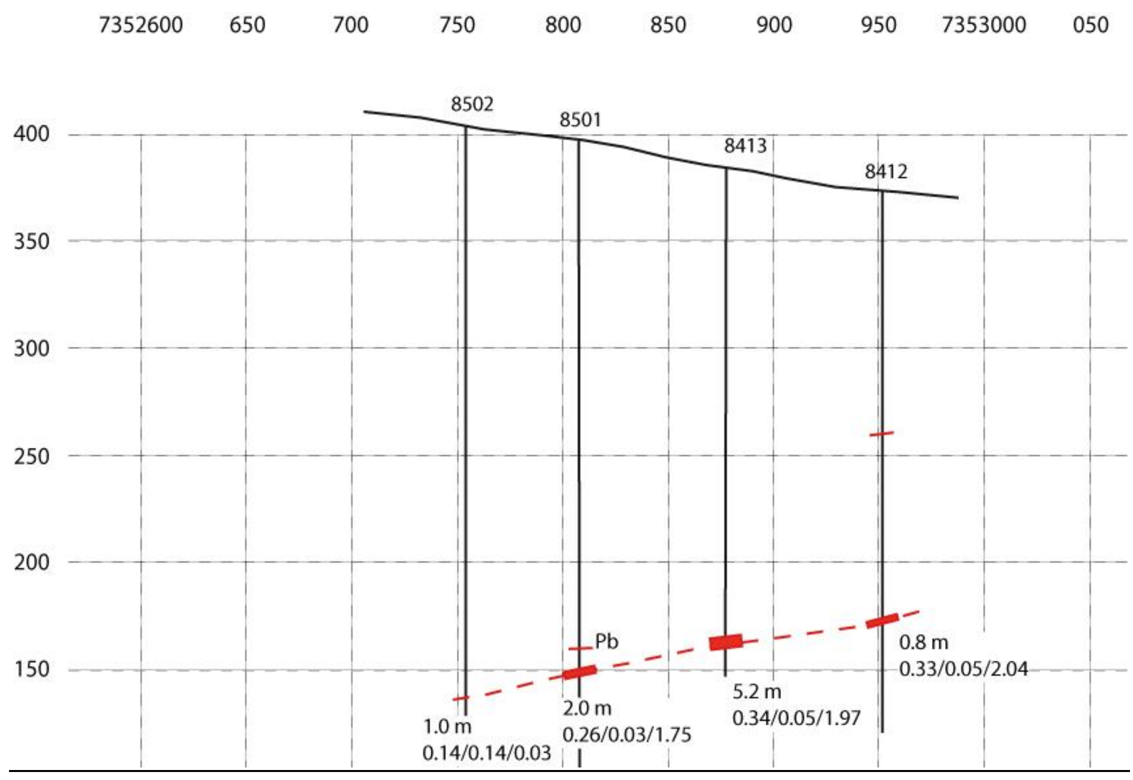
400
350
300
250
200
0.85 m
0.19/0.03/3.27
Pb
2.25 m
0.20/0.03/3.18
1.5 m
0.16/0.02/2.79
0.7 m
1.19/0.05/1.08
0.5 m
0.16/0.05/2.64
2.9 m
0.12/0.48/0.12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7353000
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8413
8412
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250
200
150
Pb
0.8 m
0.33/0.05/2.04
5.2 m
0.34/0.05/1.97
2.0 m
0.26/0.03/1.75
1.0 m
0.14/0.14/0.03

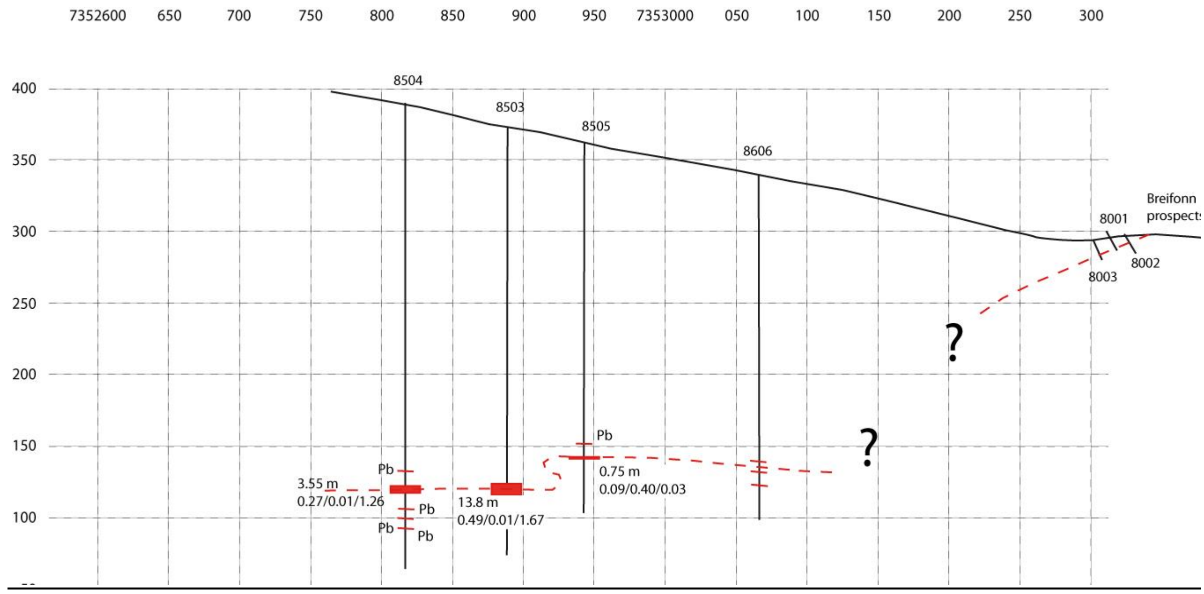


Figure 23: Four S-N oriented vertical profiles (three on previous page) through the Sølvberget deposit showing the ore intersections in the drillholes (see Figure 22 for location of the profiles). The data shown are thickness in meters and contents of Cu/Pb/Zn, respectively. Pb means lead-rich veins and zones. The grid is UTM north (X) and depth (Y – m.a.s.l.), respectively.

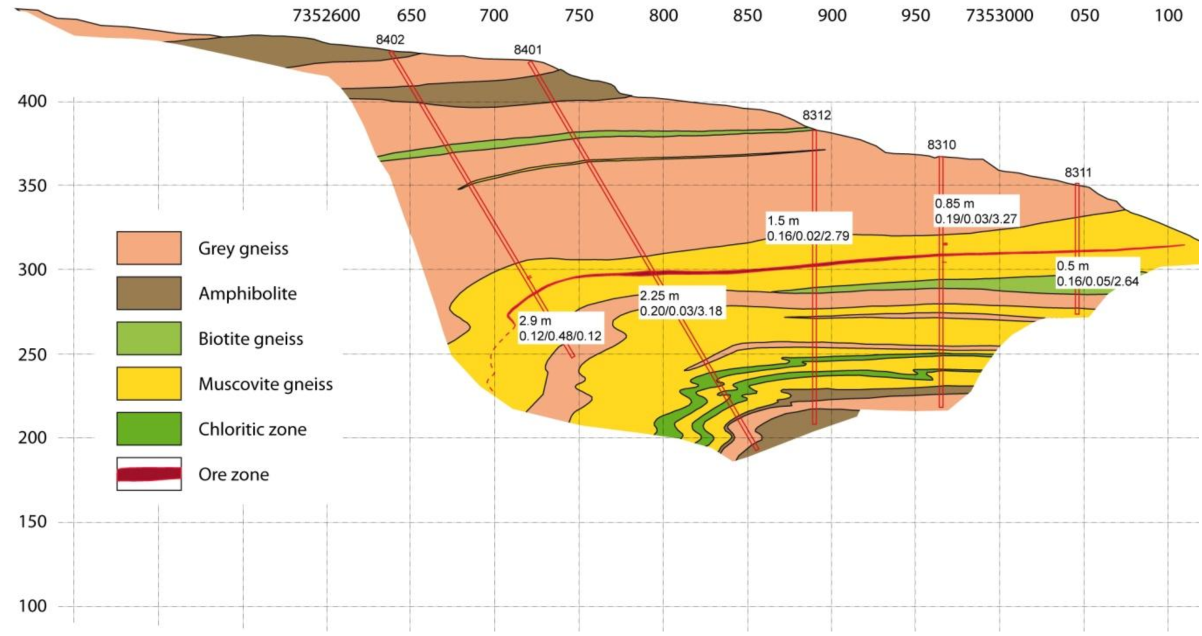


Figure 24: Detailed S-N oriented profile showing geology and ore intersections in the drillholes. (see Figure 22 for location of the profiles, compare with Figure 23). The data shown are thickness in meters and contents of Cu/Pb/Zn, respectively. The grid is UTM north (X) and depth (Y), respectively.

The easternmost prospect (no.2), is a small pit about 230 m to the east of the main prospect, comprising weak pyrite impregnation in quartz-sericite and quartz-amphibole-biotite schist. Measurements with handheld XRF showed only up to 0.23 % Zn and 0.11 % Cu. The zone is exposed further east for another 100 m as rusty mica schist/gneiss (Figure 21).

Prospect no. 6 is a small pit 70 m to the west from no.2, and comprises both semi-massive thin (up to 10 cm) pyrite-rich veins and impregnated biotite-amphibole-chlorite schist. Handheld XRF shows values between 0.01-3.4 % Zn, <0.01-0.47 % Cu and up to 0.06 % Pb. The zone is about 3 m thick and is overlain by quartz-sericite schist with weak pyrite impregnation.

At prospect no.1, which is c. 60 m to the east of the main prospect, the mineralized zone has been worked in two small adits, where two semi-massive 1- 1.5 m thick pyrite-pyrrhotite layers occur separated by a 4 m thick layer of weakly impregnated quartz-sericite schist. In addition to iron sulfides, the mineralization contains subordinate magnetite and accessory chalcopyrite. Matrix consists of amphibole, quartz, staurolite and biotite with accessory garnet. Handheld XRF shows values of <0.01-0.29 % Zn, 0.03-0.74 % Cu and up to 0.11 % Pb.

The Sølvberg main prospect/mine (aka Bertelberget) is quite low in base metals, and contains veins and lenses of mainly pyrrhotite and pyrite with accessory chalcopyrite and sphalerite. The veins often contain more copper than zinc. Average of 6 samples from the richest parts in two of the central prospects yielded 0.6 % Cu, 1.0 % Zn, 0.1 % Pb, 9 g/t Ag and 0.1 g/t Au. In contrast to the Hesjelia and Mofjell zones, the content of barium is low (< 0.1 %).

Prospect 7 is above the main zone and consists of pyrite and pyrrhotite in quartz-sericite schist. XRF analyses shows less than 0.1 % Cu+Pb+Zn.

Prospect 3 shows 75 cm semi-massive/massive pyrrhotite-pyrite-sphalerite mineralization, surrounded by quartz-sericite schist. An average of 4 samples analyzed yielded 1.45 % Zn, 0.70 % Cu, 0.14 % Pb.

Prospect 4 is situated below the main zone and consists of partly rich pyrite impregnation in quartz-sericite schist. According to handheld XRF analyses the contents of base metals are not above background.

The two Breifonn prospects are situated 300 m apart, c.3 km to the west from the Sølvberg main prospect (Figure 22). The mineralization in these prospects consists of lenses of massive pyrrhotite-sphalerite with lesser chalcopyrite and galena and of veins with chalcopyrite-pyrrhotite with some sphalerite and galena, hosted in quartz-sericite (Figure 25). Analyzed samples from the prospects show that they have relatively high contents of base metals and silver (2.1 % Cu, 7.8 % Zn, 0.8 % Pb, 19 g/t Ag and 1.6 % Cu, 7.3 % Zn, 1.0 % Pb, 16 g/t Ag for the eastern and western prospect, respectively), but nearby drilling seem to indicate a restricted size of this type of mineralization. It is likely that this is a remobilization, perhaps due to the nearby fold structure.

The connection between the Breifonn prospects and the main zone is uncertain, as shown in Figure 23. There are Pb-rich zones in the drillholes, and the content of Cu is also rather high in some sections, which could fit with the findings in the prospects. As shown in Figure 23, the Breifonn prospects seem to be on a higher structural level than the Sølvberg zone as intersected in the drillholes. Furthermore, the geophysical data (TURAM) shows Breifonn to be a conductor separated from the main Sølvberg zone (Figure 22).

Figure 25: Veins of mainly massive chalcopyrite-pyrrhotite in quartz-sericite schist.

3.1.4 The Reinfjell zone and Brattlia zone

The Reinfjell zone is structurally situated c. 600 m below the Sølvberget zone and extends from Storbekktjønna at Raudfjellet in the east to Tverråga in the west, a length of c. 8 km (Figure 26). There are also some small prospects further west at the same level (Anleggs-hammeren).

The Brattlia zone is c. 300 m to the south of the Reinfjell zone. It is a thin but extensive zone with some minor pyrite mineralizations (Figure 26).

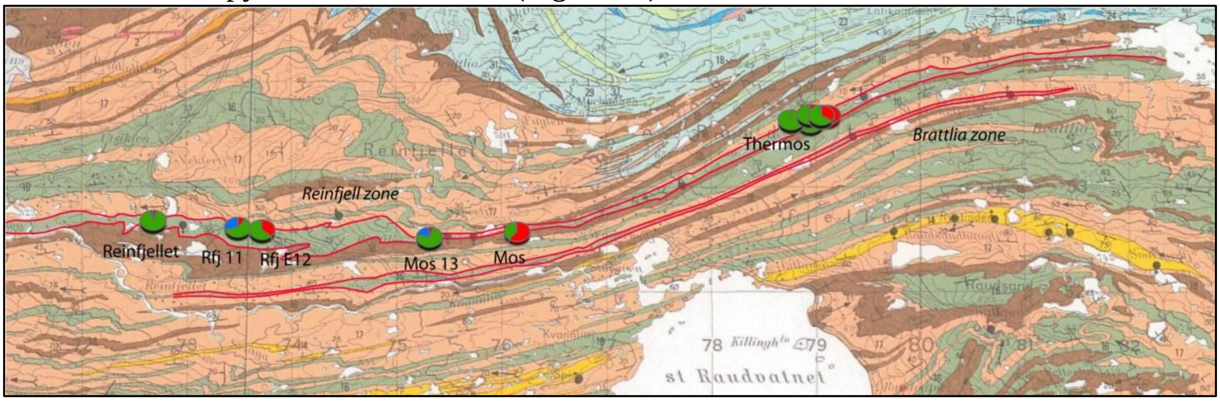


Figure 26: Section of the 1:50000 bedrock map Storforshei (Søvegjarto et al., 1989), showing the Reinfjell and Brattlia sulfide zone (outlined in red). The green color is biotite gneiss, generally pyritiferous. See also legend in Figure 16. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in prospects and mines with more than 0.5 % Cu+Zn+Pb.

In both the Reinfjell and Brattlia zones the mineralizations are associated with thin, extensive horizons of biotite gneiss. The biotite gneiss is generally variably impregnated with pyrite, which have been subject to mining where the pyrite occurs in massive layers. The largest of the workings was Mos mine, as mentioned in the introduction. The biotite gneiss is usually associated with extensive horizons of amphibolite, indicating that the gneiss represents altered amphibolite (discussed further below, see chapter 3.4).

The most important deposits in these zones are Thermos, Mos Mine and Reinfjellet, which all are found in the Reinfjellet zone. All the Brattlia deposits are very low in base metals (0.03-0.26 % Cu+Zn+Pb).

The mineralizations at ***Thermos*** are dominated by pyrite, while sphalerite is the most common accessory found interstitially between the pyrite grains. The most massive sulfide zones are generally less than 0.5 m thick, and are generally surrounded by rich impregnation to semi-massive pyrite zones up to 3 m thick, occurring in mainly chlorite-sericite to sericite-dominated schist, grading into biotite schist.

There are at least 12 showings at Thermos, which partly seems to occur in two parallel zones (Figure 27), but this is probably due to a rather open fold structure with a gently west-dipping fold axis. The contents of base metals in the Thermos mineralizations are rather modest, with the highest values found in the main prospect (marked H in Figure 27): 1.43 % Cu+Zn+Pb and 5 g/t Ag and in prospect no. 9: 1.61 % Cu+Zn+Pb and 10 g/t Ag.

The main sulfide is pyrite, with subordinate chalcopyrite and sphalerite, while galena occurs in accessory amounts in one of the examined samples, often with inclusions of fahlore or/and Bi and Ag tellurides (Table 2). Late magnetite occurs in subordinate to accessory amounts, containing inclusions of the sulfides. Quartz, plagioclase and amphibole are main gangue minerals, while garnet, biotite and spinel are subordinate. The zinc-bearing spinel is light greenish blue and is commonly associated with the sulfides.

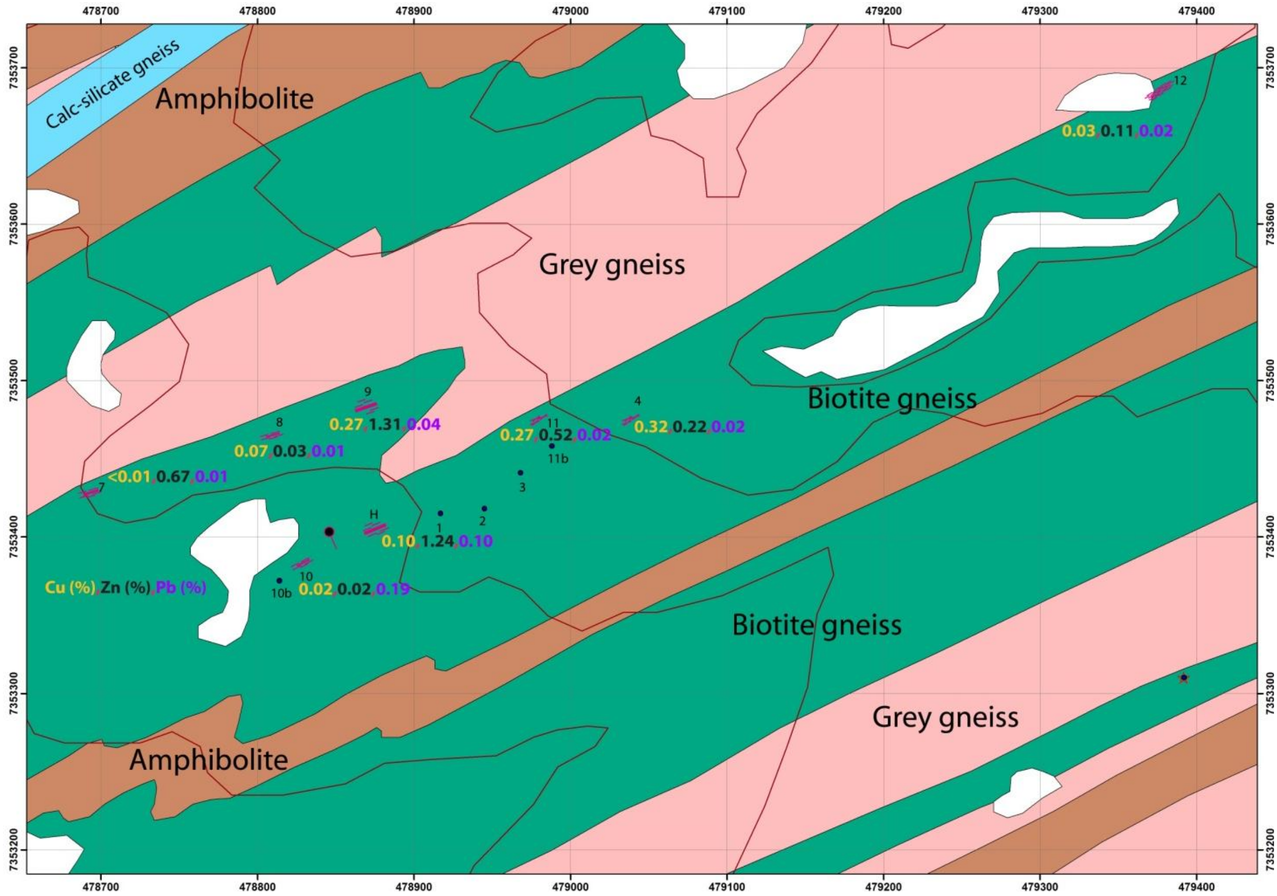


Figure 27: The main showings (numbered) at Thermos with average contents of Cu, Zn and Pb. The red streaks symbolize the mineralizations which can be seen in some of the diggings.

Table 2: Mineralogy in some of the prospects belonging to the Reinfjell zone.

			Sulfides and oxides				
Sample	Deposit	S basemet.	Main	Subordinate	Accessory	Trace	Gangue
AnlV-01	Anleggshammeren V	0.15	py		po,cpy	gl,ilm,hem	qz, gt, amph, bi, st
AnlV-02	Anleggshammeren V (bekk)	0.15	py		cpy	po,ilm,hem	qz, bi, ky, st, gt
AV-01	Avensjøen	0.03	py,po		cpy	feoh	bi, plag, qz, mus
Mos-01	Mos gruve	3.46	cpy,sl	po,py	gl	te,mt	plag, amph, bi, sp, clz, qz
Mos-02	Mos gruve	1.15	py	cpy,sl,mt	po		qz, amph, ep, plag
Rfj-03	Reinfjellet	4.76	py,sl	cpy,mt	gl	po,mb	qz, ep, amph, bi
Rfj13-01	Reinfjellet s.13	0.24	py	cpy,mt	sl	po	qz, mus, bi, ep, plag
RFJ14-01	Reinfjellet s.14	0.27	py		sl,cpy	gl,po	qz,chl,amph,sp,mus
Rfj-07	Reinfjellet s.11	1.42	py		cpy,mt,gl		qz, plag, st, bi, chl, amph, gt,sp
Th-04	Thermos	1.87	py	po,sl	cpy,mt		qz, amph, sp
Th-06	Thermos s.11	0.81	cpy	feoh	sl,mt		plag, qz, chl, sp, gt, amph, bi
Th-07	Thermos s.4	0.56	py,po	cpy	sl	mt	qz, plag, amph, sp, bi, chl, gt
Th-08	Thermos s.9	2.38	py,sl,mt		cpy,po,gl	te,ss	amph, plag, qz, gt, sp, cpx, ep

For mineral abbreviations see Table 1.

Mos mine was worked on a very massive pyrite mineralization and c. 52 000 t pyrite was mined between 1911 and 1920. Contents of base metals were very low (drillhole data yielded an average of 1.13 % Zn, 0.5 % Cu, 0.012 % Pb), while contents of Ag is 2-4 ppm and Au < 0.1 ppm in average of dump samples. In the contact zone to the massive pyrite occurs chlorite-rich schist with lenses enriched in chalcopyrite (one sample yielded 2.9 % Cu, 0.4 %

Zn, 0.2 % Pb and 54 g/t Ag), which grades into pyrite-bearing quartz-sericite-biotite gneiss with lesser chalcopyrite and sphalerite.

Along strike are a number of small showings and prospects, but most of these have only weak impregnation of iron sulfides. The only exception is prospect no. 13 situated c. 850 m to the east of Mos mine (Figure 26). It consists of a small adit with an inclined shaft. A 0.4-0.75 m thick massive pyrite layer is present in the mine opening. Three analysis yielded 0.02-0.12 % Cu, 0.36-1.08 % Zn, 0.07-0.45 % Pb, 6-50 g/t Ag, < 0.1 g/t Au.

The Reinfjellet area consists of more than 15 showings and prospects over a strike length of more than 1.5 km (Figure 26). Most of these are similar to Mos and Thermos, being rather low in base metals and rich in lenses and thin layers of pyrite in quartz-sericite and sericite-biotite schist. Only three of the prospects have contents of base metals > 0.5 %, but only the main prospect show elevated values (0.24 % Cu, 4.06 % Zn, 0.21 % Pb, 23 g/t Ag and 0.34 g/t Au). It is outcropping as a 0.75 m thick layer of massive sulfides in a small stream (Figure 28). It is associated with quartz-sericite and chlorite-bearing schists.

Figure 28: Massive pyrite layer outcrop in a small stream in the main Reinfjellet prospect. In the hangingwall (above the chisel) are quartz-sericite and chlorite schists.

This massive zone can be followed eastwards, outcropping in several showings almost to the main road (e.g. about 800 m). The other showings are much lower in base metals, typically less than 0.5 %. A content of 1.2 g/t of Au in prospect no. 11 is notable, even though the content of base metals is only 0.7 %.

Pyrite is the major sulfide mineral, while sphalerite and chalcopyrite occur mainly in subordinate to accessory amounts in the samples studied, and galena is mainly found in trace amounts (Table 2). As in the other deposits in the Reinfjellet zone, magnetite is a late phase replacing the sulfide minerals (Figure 29). Quartz and amphibole are the main gangue phases, while biotite, chlorite, epidote and muscovite are subordinate. Bluish-green zinc spinel is occasionally associated with the sulfides.

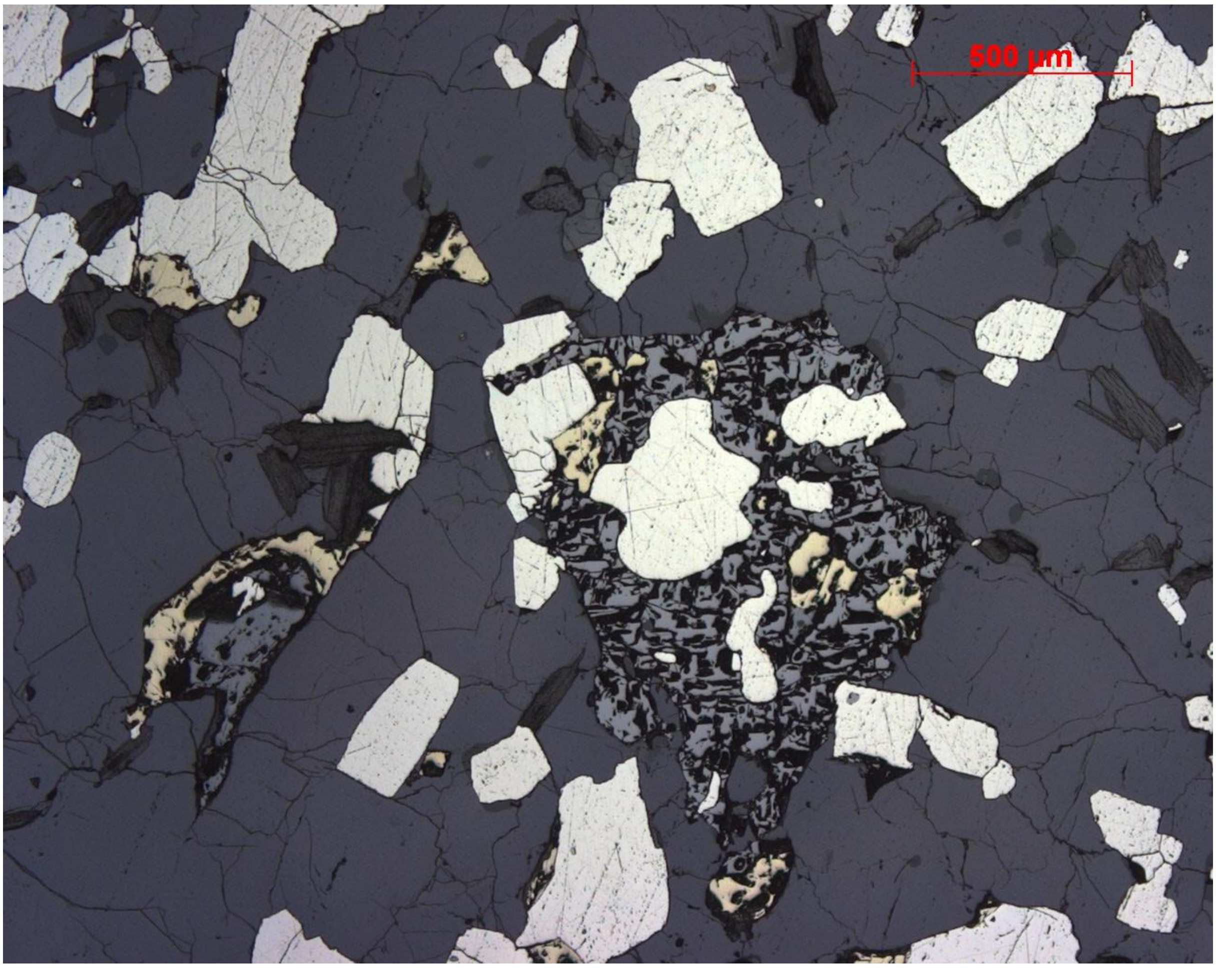


Figure 29: Photomicrograph showing magnetite (grey) replacing pyrite (white) and chalcopyrite (yellow). (from Reinfjellet prospect no. 13).

3.1.5 The Breisnølien zone

The Breisnølien zone is situated at the north slope of Mofjellet, structurally about 1000 m beneath the Sølvberg zone (Figure 30). It extends for 6 km from Kjempheia to Kvernbekktjern and further towards Andfiskvatn in the south.

The mineralizations at *Breisnølien* are associated with a thin horizon of muscovite gneiss, which east and westwards grades into biotite-bearing gneiss. An amphibolite layer is associated with the biotite gneiss (Figure 30).

There are three small prospects/showings at Breisnølien, all associated with the muscovite gneiss. In the main prospect the mineralization consists of a rich impregnation of pyrite (quite coarse-grained) and very minor sphalerite in quartz-sericite gneiss. The zone is c. 2 m thick with variable amounts of sulfide. Average values from dump samples show 0.15 % Cu, 1.54 % Zn, 0.03 % Pb, 6 g/t Ag and 0.21 g/t Au. A small showing 250 m to the east (s.2 in Figure 30) displays a vein network of mainly sphalerite with minor pyrrhotite, galena and chalcopyrite in the muscovite gneiss. Average of analyzed dump samples show 0.14 % Cu, 3.97 % Zn, 0.04 % Pb, 7 g/t Ag and 0.16 g/t Au.

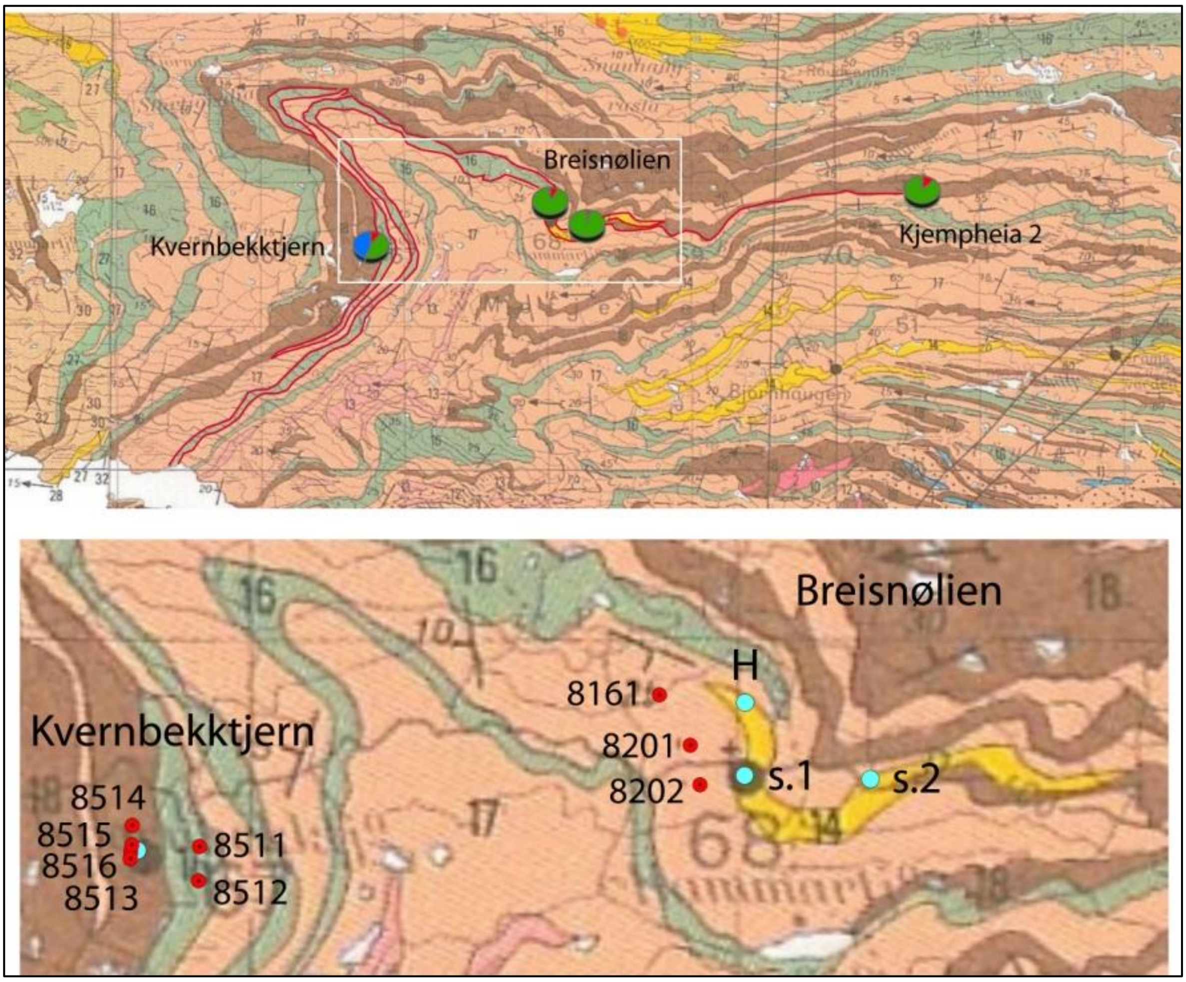


Figure 30: Section of the 1:50000 bedrock map Mo i Rana (Søvegjarto et al., 1988), showing the Breisnølien sulfide zone (outlined in red). The green color is biotite gneiss, generally pyritiferous, while brown is amhibolite (see alos legend in Figure 16). The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in prospects and mines with more than 0.5 % Cu+Zn+Pb. The lower map show the location of drillholes at Breisnølien and Kvernbekktjern.

Data from three holes to the west of the mineralization (Figure 30) intersected impregnation with quite low base metal values in several zones (best section was 2.7 m with 2.21 % Cu+Pb+Zn and 15 g/t Ag in hole 8202, see Table 3)

Table 3: Analyzed sections in drillholes at the Breisnølien mineralization (see Figure 30 for location). Pb, Cu, Zn % and Ag g/t.

Hole_ID	From	To	Pb	Cu	Zn	Ag
bh8202	22.3	22.8	0.12	0.15	1.2	16.5
bh8202	66.1	68.8	0.11	0.43	1.67	15.22
bh8201	19.9	20.35	0.03	0.06	0.48	5.2
bh8161	14.4	17.1	0.03	0.20	0.48	5.80
bh8161	31.4	32.2	0.13	0.08	1.4	9.3

The Kvernbekktjønna prospect contains 2-5 cm stripes of sphalerite, galena and pyrrhotite in chlorite-bearing quartz-sericite gneiss. Above is a zone of weak pyrite impregnation in chlorite-sericite schist. The total thickness of mineralization accessible in the prospect is only 0.5 m. Average of two samples yielded 0.35 % Cu, 1.50 % Zn, 1.44 % Pb, 18 g/t Ag and 0.3 g/t Au.

Six drillholes from 1985 around the prospect (see Figure 30) did not intersect any interesting mineralization (the best interval was 0.95 m with 0.07 % Cu, 0.15 % Zn, and 0.12 % Pb).

There are some small showings in the eastern part of the zone, named Kjempeheia s.1 and 2. The mineralizations consist of mainly disseminated pyrrhotite in quartz-rich amphibole-mica schist/gneiss. One analysis yielded 0.10 % Cu, 0.63 % Zn, < 0.01 % Pb.

3.1.6 The Raudvatn zone

The Raudvatn zone stretches from the area north of Raudsandhaugen in the east to Heramb in the west, a distance of nearly 13 km (Figure 31). A small prospect by the Andfiskvatnet lake another 3.5 km to the SW may be part of the same zone. The most interesting deposits along this zone are Heramb, Bertelberget, Kvannlia, Raudsandhaugtjern and Raudsandhaugen.

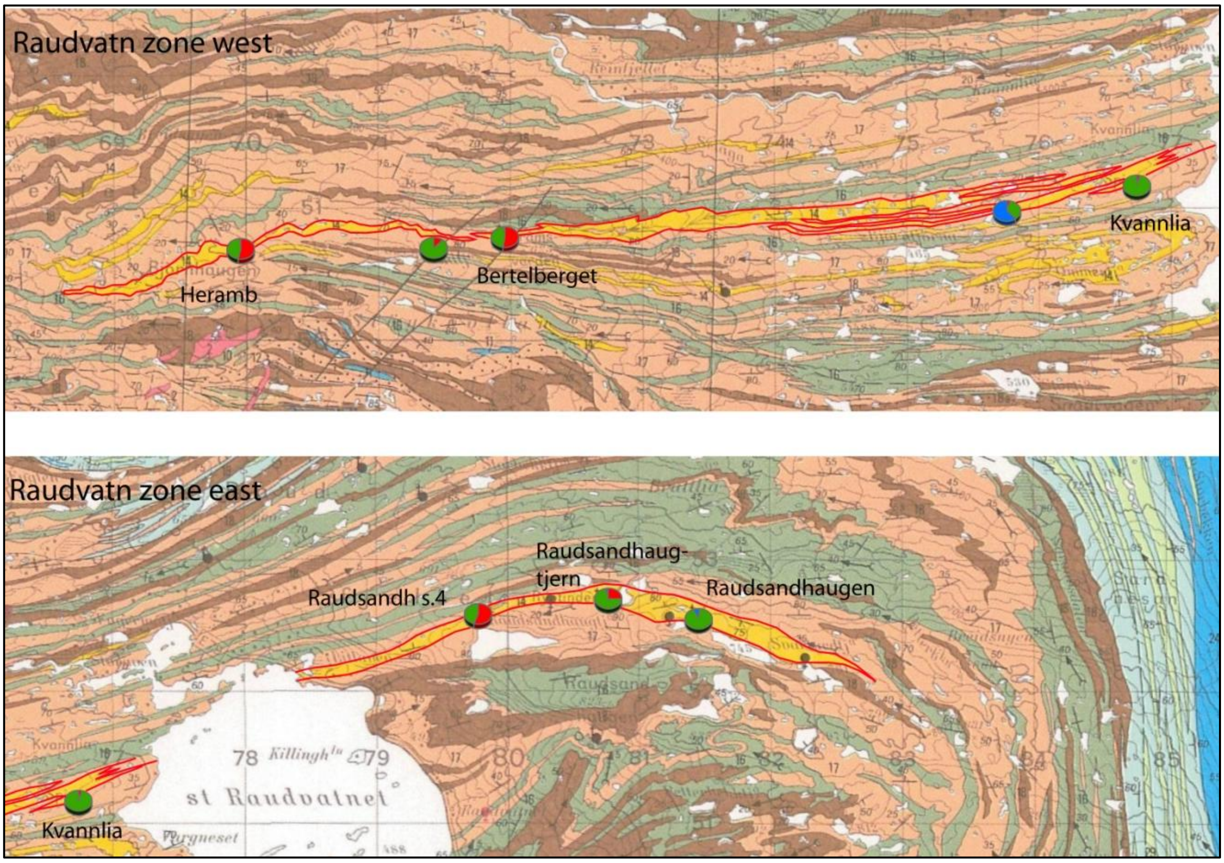


Figure 31: Section of the 1:50000 bedrock map Storforshei (Søvegjarto et al., 1989), showing the Raudvatn sulfide zone (outlined in red). The yellow color is pyritiferous muscovite gneiss. See also legend in Figure 16. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in prospects and mines with more than 0.5 % Cu+Zn+Pb.

All the deposits are associated with horizons of generally pyritiferous muscovite gneiss, quite similar to the Reinfjell zone (described in section 3.1.4). These zones are strongly folded, especially in the Kvannlia area, just east of Raudvatnet (Figure 31).

The *Heramb and Bertelberget deposits* are the easternmost in the Raudvatnet zone. They are c. 2 km apart, but may somehow be connected according to the regional geophysical data, including TURAM (Dalsegg, 84, Figure 32) and the 2007 TEM data by GEXCO.

The geology in the area is characterized by several alternating thin layers of amphibolite, biotite gneiss and muscovite gneiss, separated by thicker units of grey gneiss (Figure 32). The

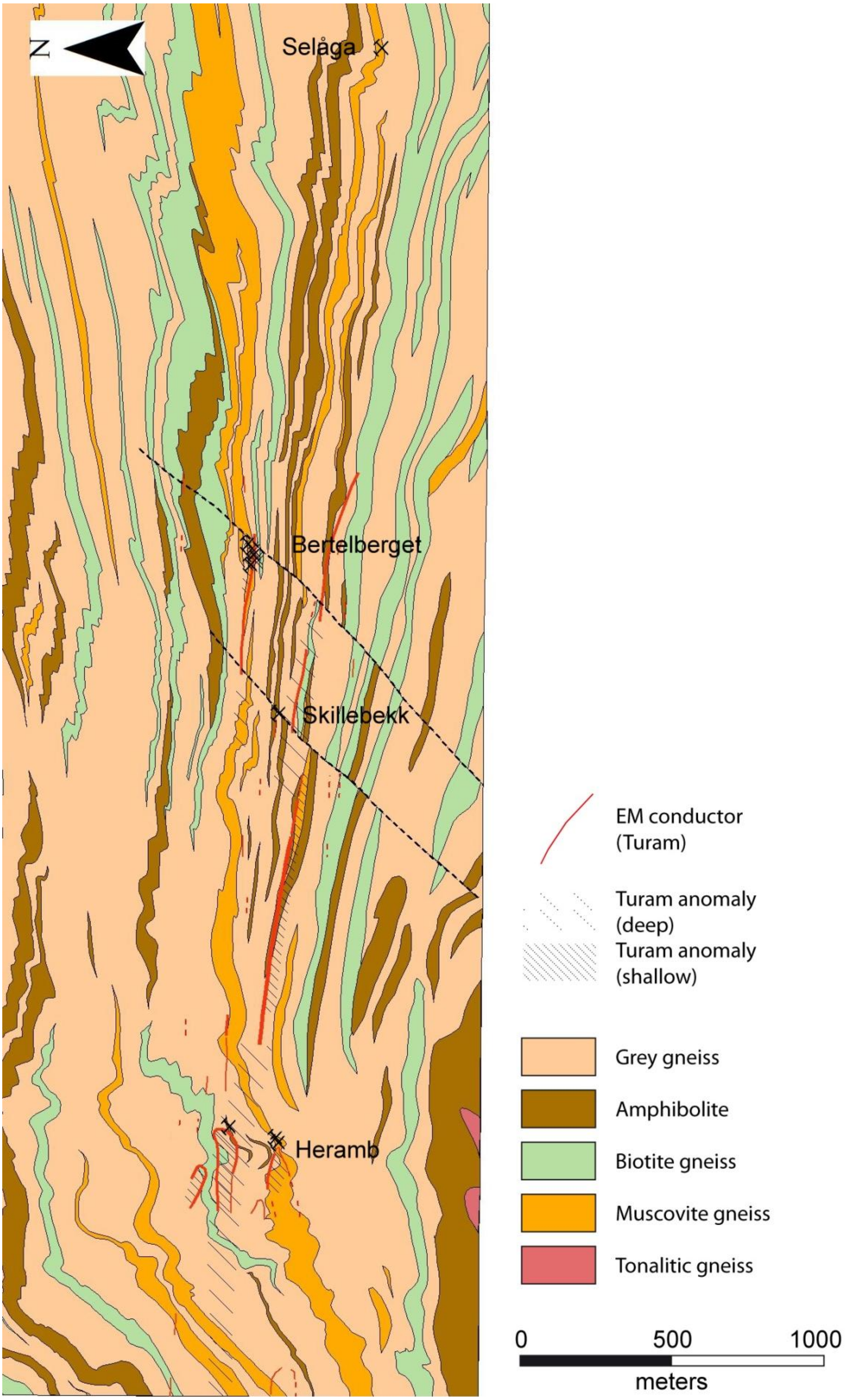


Figure 32: Geology in the Heramb-Bertelberget area of the Raudvatn ore zone. Superimposed are ground geophysical data (TURAM, Dalsegg, 1984).

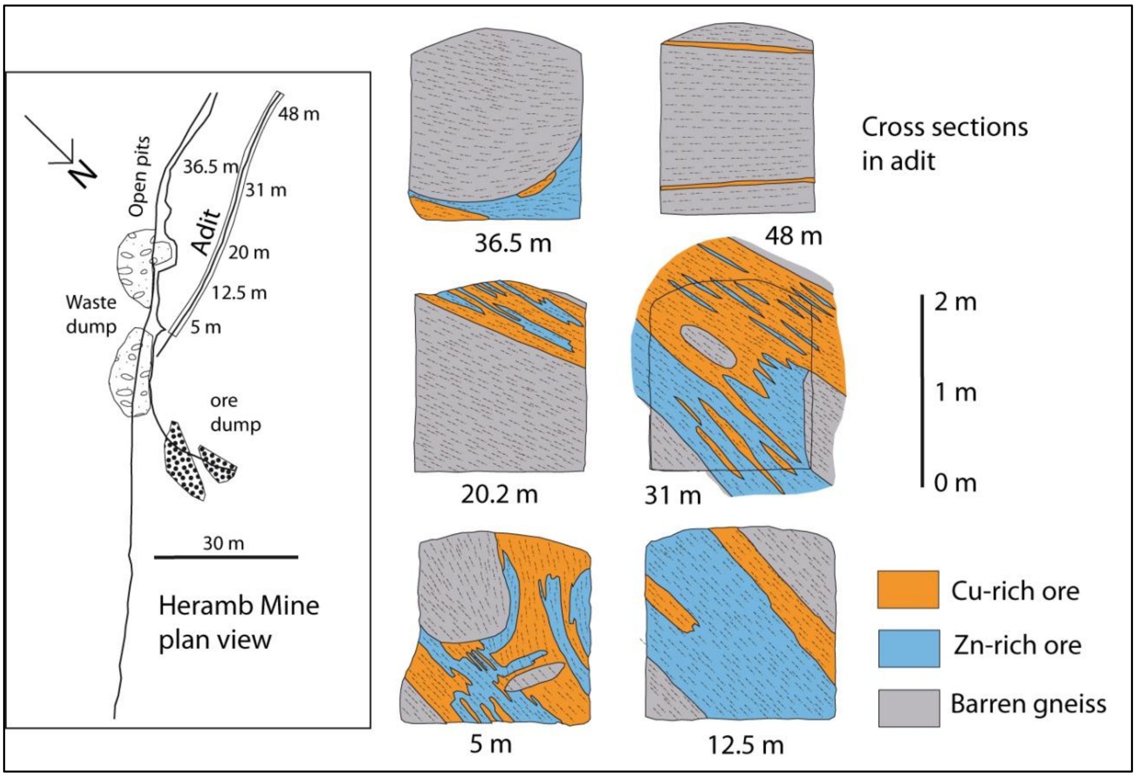


Figure 33: Plan view of the Heramb Mine, with detailed cross sections from the now inaccessible adit (modified from Krefting, 1911).

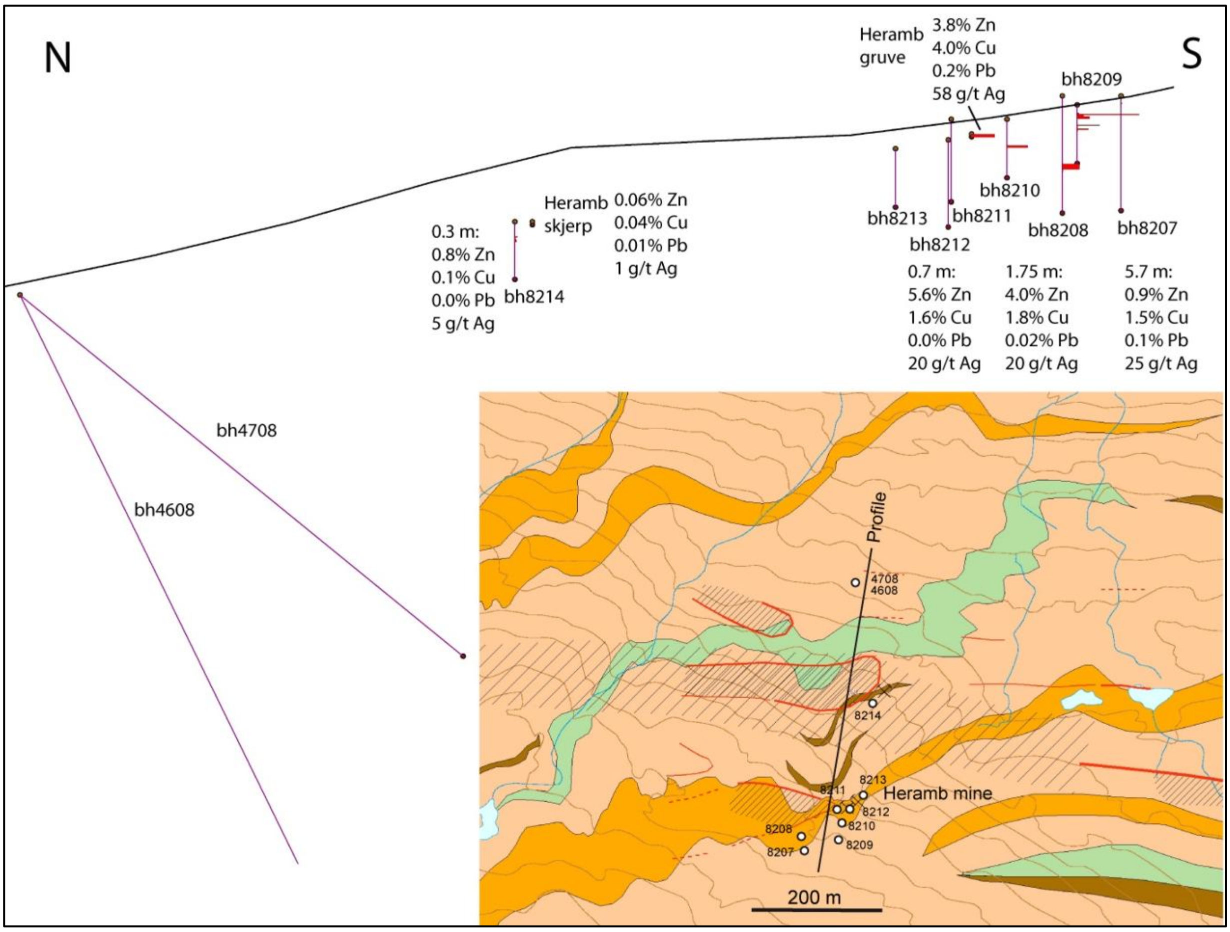


Figure 34: Part of the map in Figure 32 and a vertical profile through the Heramb mineralization, showing projected drillholes with metal values. The superimposed hatched areas and red lines mark distinct geophysical conductors (TURAM, Dalsegg, 1984).

latter is often quite homogeneous and massive (e.g. close to and to the west of Heramb, Figure 5), and is probably mainly of volcanic/intrusive origin (rhyolite/rhyodacite).

The *Heramb* mineralization is characterized by massive sulfide veins carrying pyrrhotite and variable amounts of pyrite, chalcopyrite and sphalerite (Table 4). There are also some veins strongly enriched in coarse-grained galena. An average of 14 samples from the dump yielded 3.7 % Cu, 3.1 % Zn, 0.2 % Pb, 45 g/t Ag and 0.45 g/t Au.

Test mining was carried out at Heramb in 1910 and 1911, and an adit c. 50 m long was mined (Figure 33). This resulted in production of 193 tons with 2.87 % Cu, 4.80 % Zn. The ore zone in the adit had a thickness of 1-2 m over the first 36 m and varied from being very copper-rich to zinc-rich (Figure 33). In the last 14 meters of the adit only thin veins of mineralization were encountered. According to Krefting (1911) the average of the ore over a length of 36 m was 1.2 m with 1.9 % Cu and 3.4 % Zn.

In 1982 eight holes were drilled around the Heramb deposit to investigate the continuation of the sulfide-rich veins towards depth. Only three of the holes intersected partly rich sulfide veins (Figure 34), and restricted partly the extent of the mineralization to the north and south. The best intersections were 1.75 m at 1.8 % Cu, 4 % Zn, 20 g/t Ag (bh8208) and 5.7 m at 1.5 % Cu, 0.9 % Zn, 25 g/t Ag (including 1.2 m at 4.8 % Cu, 0.9 % Zn, 73 g/t Ag¸ bh8209).

A very strong geophysical anomaly (TEM and TURAM, see Figure 34) c. 200 m to the north of the deposit was the target for drilling in 2008 (bh4608, bh4708), but no mineralization was found. The reason for this anomaly remains unknown.

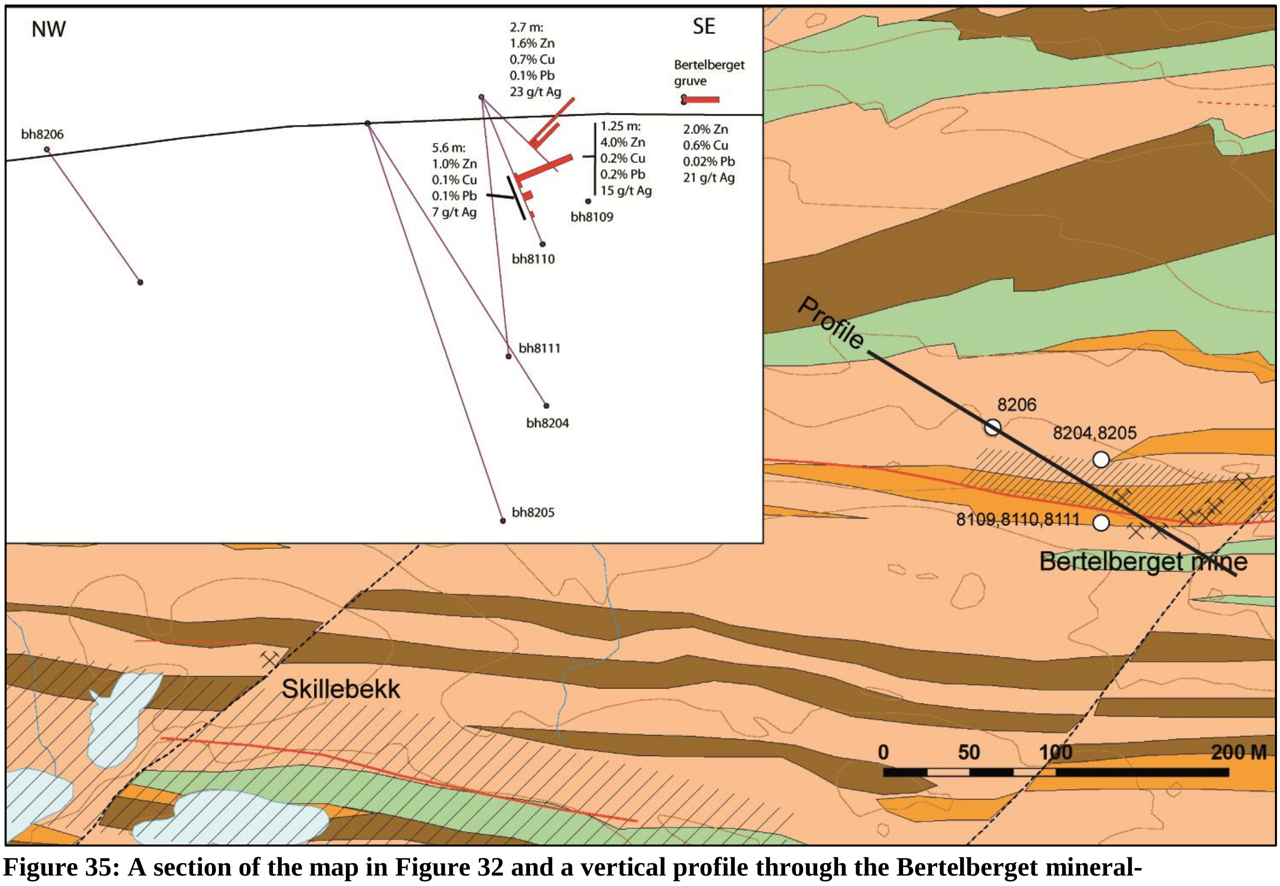


Figure 35: A section of the map in Figure 32 and a vertical profile through the Bertelberget mineralization, showing projected drillholes with metal values. The superimposed hatched areas and red lines mark distinct geophysical conductors (TURAM, Dalsegg, 1984).

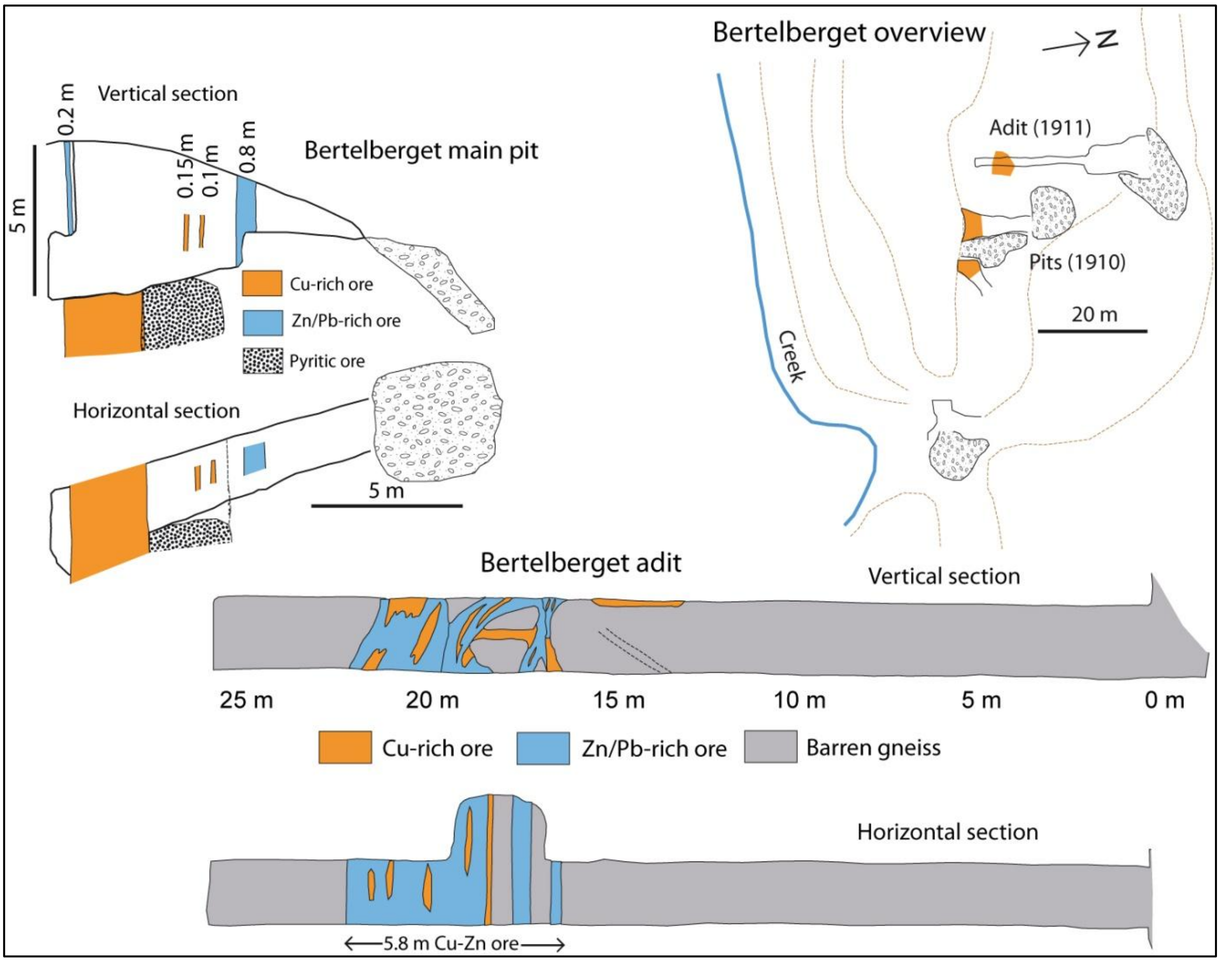


Figure 36: Plan view and detailed cross sections of main workings of the Bertelberget mine, showing the distribution of the different ore types (modified from Krefting, 1911).

Table 4: Mineralogy in the Heramb and Bertelberget prospects.

			Sulfides and oxides				
Sample	Deposit	S basemet.	Main	Subordinate	Accessory	Trace	Gangue
Heramb-01	Heramb gruve	23.89	cpy,po,sl			gl,cub	bi, qz, plag, cc, clz
HE-02	Heramb gruve	13.26	po,sl,cpy		gl	te,fa,cub	qz, mus, amph, chl, bi
Ski-01	Skillebekk	2.60	po,sl	cpy	apy		qz, cc, clz
BB-02	Bertelberget s.2	1.96	py,po	cpy	sl		qz, mus, bi, chl, plag
BB-03	Bertelberget s.3	13.67	cpy,po,sl		gl	py,te,mb,cub	bi, mus, qz, clz
BB-04	Bertelberget s.3	3.31	py,sl,po	cpy,mt	apy		amph, ep, chl, qz?

The *Bertelberget* mineralization is different from Heramb, by having lenses and layers of coarse massive pyrite with pyrrhotite and lesser sphalerite and chalcopyrite (Table 4). Average of 7 dump samples yielded 2.0 % Cu, 1.7 % Zn, 0.1 % Pb, 21 g/t Ag, 0.37 g/t Au.

Test mining was carried out at Bertelberget in 1910 and 1911, at the same time as at Heramb. The workings included a 25 m long adit and some smaller pits (Figure 36). Both the adit and the main pit intersected quite rich copper and zinc ore over a thickness of 5-6 meters. Analyses from the adit carried out in 1952 and referred to by Kleinevoss (1967) yielded 0.7-1.17 % Cu, 2.82-3.81 % Zn and 46.4-47.6 % S.

Six holes were drilled in 1982 and two intersected mineralization of 2.7-5.6 m thickness with 1.0-1.6 % Zn, 0.1-0.7 % Cu, 0.1 % Pb and 7-23 g/t Ag (Figure 35). In the deepest intersection was an interval of 1.25 m with 4.0 % Zn, 0.2 % Cu, 0.2 % Pb and 15 g/t Ag. The rather restricted drilling has not delimited the ore zone, which may extend more to the south than the depth of the deepest holes. However, the ore zone may be rather limited in length (2-300 m) according to the geophysical data (Figure 32, Figure 35).

About 400 m to the west, and possibly at a lower structural level than the Bertelberget and Heramb mineralizations, is the Skillebekk prospect (Figure 35). The prospect is a 12 m long and up to 2.4 m deep trench oriented N-S (across strike). It revealed a 2.7 m wide zone of pyrrhotite-pyrite mineralization with some scattered aggregates of chalcopyrite and sphalerite (Figure 37). Two samples from the prospect yielded 0.2-0.4 % Cu, 1.8-2.2 % Zn, < 0.01 % Pb and 1-57 g/t Ag.

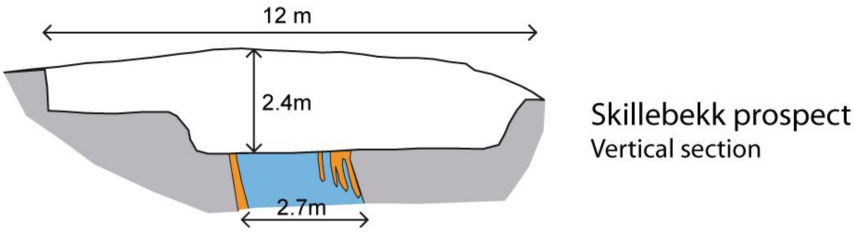


Figure 37: Vertical section (N-S) of the Skillebekk prospect mineralization. Same legend as in Figure 36.

The Skillebekk prospect is probably at the same structural level as the *Selåga* prospect; about 2 km to the east (see Figure 32). The main working at Selåga is a c. 10 m long and 3-5 m deep trench, running southwards (Figure 38). The mineralization consists of a network of semi-massive to massive pyrite layers/veins hosted by quartz-sericite schist. The veins range in thickness from < 1 to > 20 cm. In addition to pyrite occur small amounts of pyrrhotite and sphalerite, and occasionally also chalcopyrite (Table 4). An average of 8 samples from the dump yielded 0.48 % Zn, 0.09 % Cu, 0.01 % Pb and 2 g/t Ag.

Figure 38: The Selåga prospect, photo taken westwards. Pyrite-bearing quartz-sericite schist is seen in the trench/adit opening.

According to TURAM measurements in 1979 (Singsaas, 1980) the mineralization at *Kvannlia* has an extent of 1600 m along strike from the main prospect and eastwards to showing no.1 (Figure 30, Figure 31),. Two drill holes close to the main prospect to a depth of 200 m only intersected weak impregnations of iron sulfides.

The mineralization in the main prospect is c. 3 m thick and consists of bands and lenses of pyrite enrichments in quartz-sericite schist. The most massive lenses are 5-10 cm thick and contain lesser amounts of sphalerite. Some veins and lenses of pyrite with very minor sphalerite, chalcopyrite and galena are present in a c. 30 cm thick quartz rich layer in the footwall of the mineralization. An average of five dump samples yielded 2.0 % Zn, 0.1 % Cu, <0.1 % Pb and 5 g/t Ag.

Showing no. 1 consists of thin bands and lenses of sulfides associated with quartz segregations in sericite schist. The sulfides include pyrite, sphalerite, galena and arsenopyrite and the whole zone is 20-40 cm thick. This showing shows very high gold contents (up to 27 g/t and an average of 7 samples is 7 g/t) and also silver (up to 283 g/t and average 89 g/t), which correlate well with enrichments of arsenic (up to 0.3 %). The nature of the mineralization shows that this is a secondary enrichment, probably due to the strong deformation and intense folding in the area.

The *Raudsandhaugtjern*, *Raudsandhaugen and Raudfjell East* mineralizations to the east of Raudvatnet consist of more than 20 small prospects and showings over a strike length of more than 3 km, all situated in the same muscovite gneiss layer (Figure 39). Pyrite is the dominant sulfide, occurring in rich impregnations to thin semi-massive stripes in quartz-sericite schist (Figure 40). Locally the mineralizations reach thicknesses of 3-4 m, but approx. 1 m is more common. Generally the contents of base metals are very low, with Cu+Zn+Pb contents of 0.05-2.2 %. In the main prospects the content of zinc is 1-2 %, and is found as sphalerite, as zinc spinel (gahnite) in 1.2 mm bluish-green crystals and as zinc staurolite in up to cm-sized orange prismatic crystals. In showing no.4 are also found rich impregnation of pyrrhotite and chalcopyrite in quartz-rich matrix.

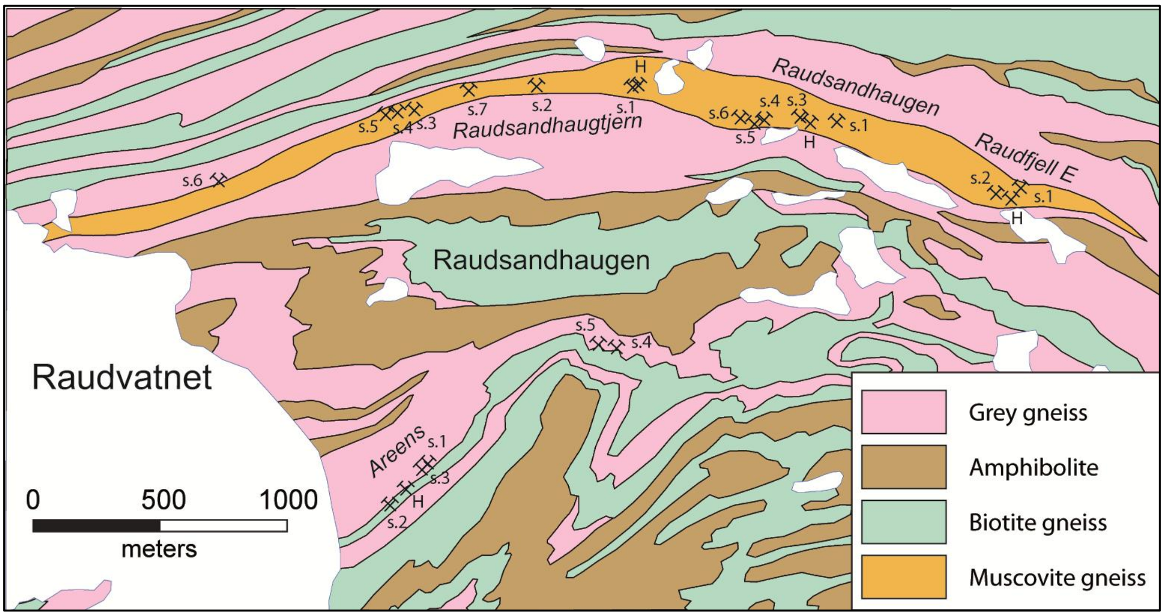


Figure 39: Geological map of the eastern part of the Raudvatn zone and the Areens zone, showing the various prospects. The letter H marks the main prospects.

Figure 40: The mineralized zone in the Raudsandhaugtjern main prospect. A 20 cm massive pyrite layer is present to the right of the hammerhead, while the rest of the outcrop comprises semimassive pyrite in quartz-dominated matrix.

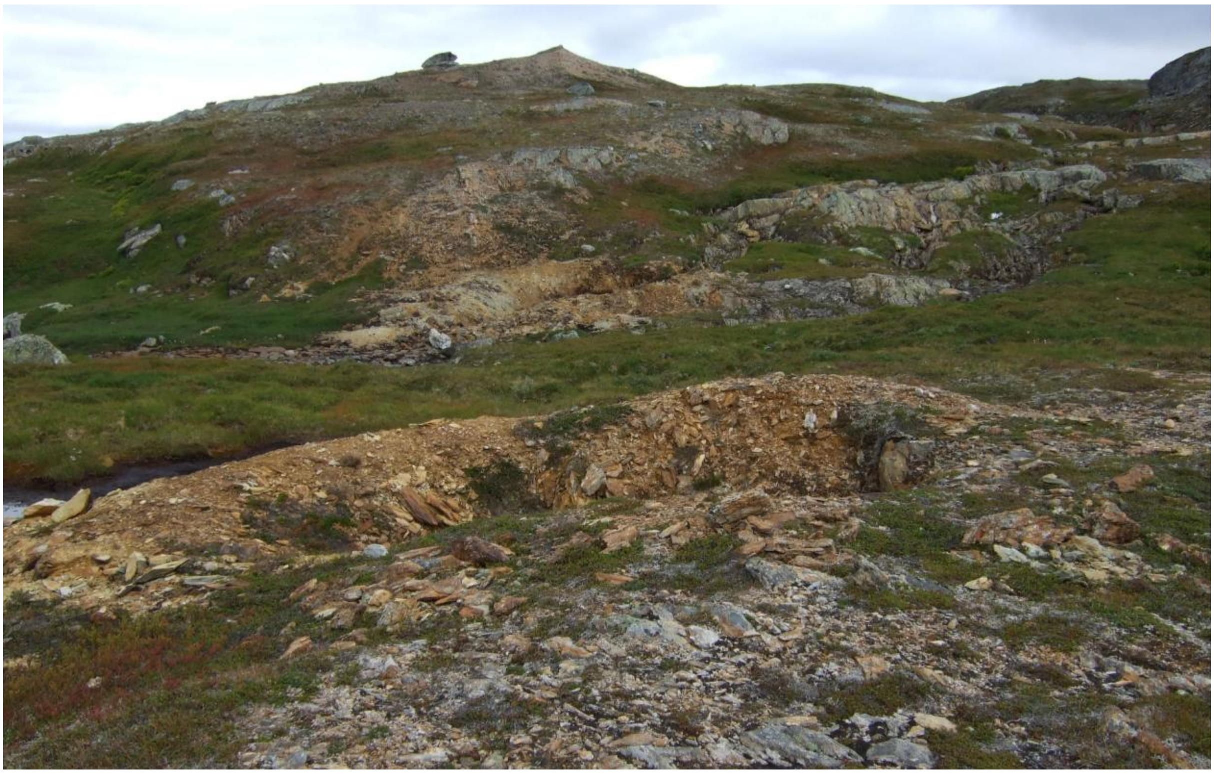


Figure 41: Photo towards the east showing prospect no. 3 (foreground) and the main prospect of the Raudsandhaugen mineralization.

Figure 42: Photo towards the west showing thin bands of pyrite impregnation in quartz-sericite schist (to the right of hammer) close to prospect no. 5 of the Raudsandhaugen mineralization.

Table 5: Mineralogy in some of the Raudsandhaug prospects.

			Sulfides and oxides				
Sample	Deposit	S basemet.	Main	Subordinate	Accessory	Trace	Gangue
RaH-02	Raudsandhaugen	4.35	py,sl		cpy,gl	po,te, mb	plag, qz, ep, amph, gt, ser, bi
RaH-06	Raudsandhaugen s.6a	0.31	py		sl	cpy	qz, mus, plag, st, bi
Ratj-02	Raudsandhaugtjern no.6	0.30	py		sl	cpy,po	qz, plag, st, bi, gt, mus
Ratj-04	Raudsandhaugtjern s.4	1.52	po,cpy	sl	py	gl,te,fa	qz, bi, plag, st, sp, chl, mus
Ratj-05	Raudsandhaugtjern s.2	0.51	py			po,sl,cpy	qz, bi, st, plag, gt, mus
Ratj-06	Raudsandhaugtjern	0.96	py	sl,cpy	gl	ss	qz, st, bi, mus

The mineralogy observed in thin sections confirms that the mineralizations are dominated by pyrite, while sphalerite and locally chalcopyrite and/or galena occur in accessory amounts (Table 5). Quartz, muscovite, biotite and plagioclase are the main gangue minerals.

3.1.7 The Areen zone

The Areen zone extends eastward for c. 1.2 km from the eastern shore of Raudvatnet (Figure 39). The mineralizations are associated with a folded layer of muscovite-biotite gneiss, which is generally rusty due to disseminated iron sulfides. There are five prospects/showings and a small mine in the zone distributed on two restricted areas c. 1000 m apart. The western, lower area is the area of the main mineralization, where a small pyrite mine was in operation for a few years from 1910 (c. 200 t produced). The mine is now filled with the waste rock, but material from the tailings and the other small showings, show that the mineralization consists of pyrite in rich impregnation to massive bands with very little base metals (0.17 % Cu+Zn+Pb), but it is, quite rich in gold (up to 0.98 g/t). The massive sulfide bands were up to 0.5 m thick.

The mineralization is totally dominated by pyrite, the grains of which have small inclusions of chalcopyrite, pyrrhotite, sphalerite and rare galena and molybdenite. Associated with galena are occasionally tiny grains of sulphosalts. The matrix is dominated by quartz, biotite, muscovite and late chlorite, while large porhyroblasts of staurolite and kyanite (party replaced by muscovite) are subordinate.

The eastern prospects s.4 and s.5, which are 70 m apart, some 1000 m NE of the mine described above (Figure 39), contain a different type of mineralization than the main part of the zone. In these prospects are bands of semi-massive to massive pyrite with quite high amounts of sphalerite and some chalcopyrite (The averages are 0.05 % Cu, 3.49 % Zn, 0.03 % Pb and 1.00 % Cu, 4.61 % Zn, 0.02 % Pb in no. 4 and 5 respectively).

The degree of outcrop is very limited in this area, meaning that the extent of this mineralization is not known. Geophysics (TEM) show only a very weak anomaly in the area, which could indicate that the mineralization is quite small.

3.1.8 The Slagfjell zone

The Slagfjell zone is situated c. 3 km to the east of Raudvatnet (Figure 43) and consists of 6 small prospects/showings over a strike length of c. 300 m. The mineralizations are associated with muscovite and biotite gneiss, which also extends some 5-700 m eastwards. It is possible that this zone is a continuation of the Raudvatn zone, but the complex fold structures in this part of the Mofjell Group make this difficult to determine.

The mineralization in the prospects consists of thin stripes and impregnations of mainly pyrite in graphite-bearing muscovite gneiss. The thickness of the mineralized zone is up to 3-4 m. A drillhole intersected 3.75 m with 0.9 % Zn, 0.06 % Cu and 0.08 % Pb. The seven richest dump samples yielded 0.3-0.4 % Cu+Pb+Zn (mainly Zn) and 2-8 g/t Ag.

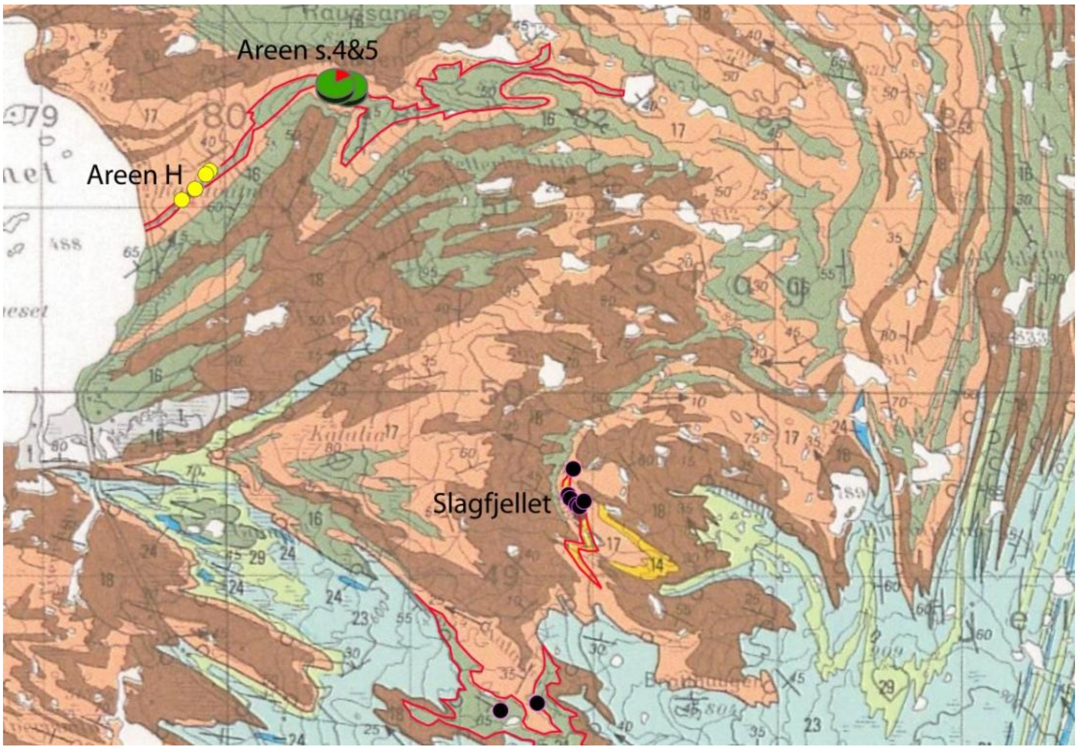


Figure 43: Section of the 1:50000 bedrock map Storforshei (Søvegjarto et al., 1989), showing the Areen and Slagfjellet sulfide zones (outlined in red). The yellow and green colors are pyritiferous muscovite gneiss and biotite gneiss, respectively (see also Figure 16). The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in prospects and mines with more than 0.5 % Cu+Zn+Pb. The yellow (Areen) and black (Slagfjellet) dots are deposits with less than 0.5 % Cu+Zn+Pb.

3.1.9 The Stangfjell-Hellerfjell zone

The Stangfjell-Hellerfjell zone is defined by a strongly deformed, folded layer of mainly rusty muscovite gneiss, which stretches from Stangfjellet in the north to Hellerfjellet in the south, a length of more than 20 km along strike (Figure 44).

There have been some exploration at three different places along the zone, namely at Stangfjellet, Rognhaugbekken and Hellerfjellet. Exploration work during this project has resulted in discovery of three additional mineralizations in the zone, called Avanbekken, the Barium deposit and Hellerfjelltjønna (Figure 44).

Mineralizations at ***Stangfjellet*** occur at several levels, of which only two have base metal values above 1 %. The north-easternmost is a c. 1 m thick pyrite impregnated zone of which 10 cm is rich in sphalerite and galena together with pyrite (two analyses show 1.14-1.16 % Zn, 0.06-0.12 % Cu, 0.16-0.33 % Pb and 2-3 g/t Ag). The main pit to the west consists of a c. 1 m thick zone of rich pyrrhotite impregnation with subordinate pyrite and accessory chalcopyrite and sphalerite. The zone is folded with an axis gently dipping westwards. An average of three analysis yielded 0.72 % Zn, 0.42 % Cu, 0.07 % Pb and 6 g/t Ag.

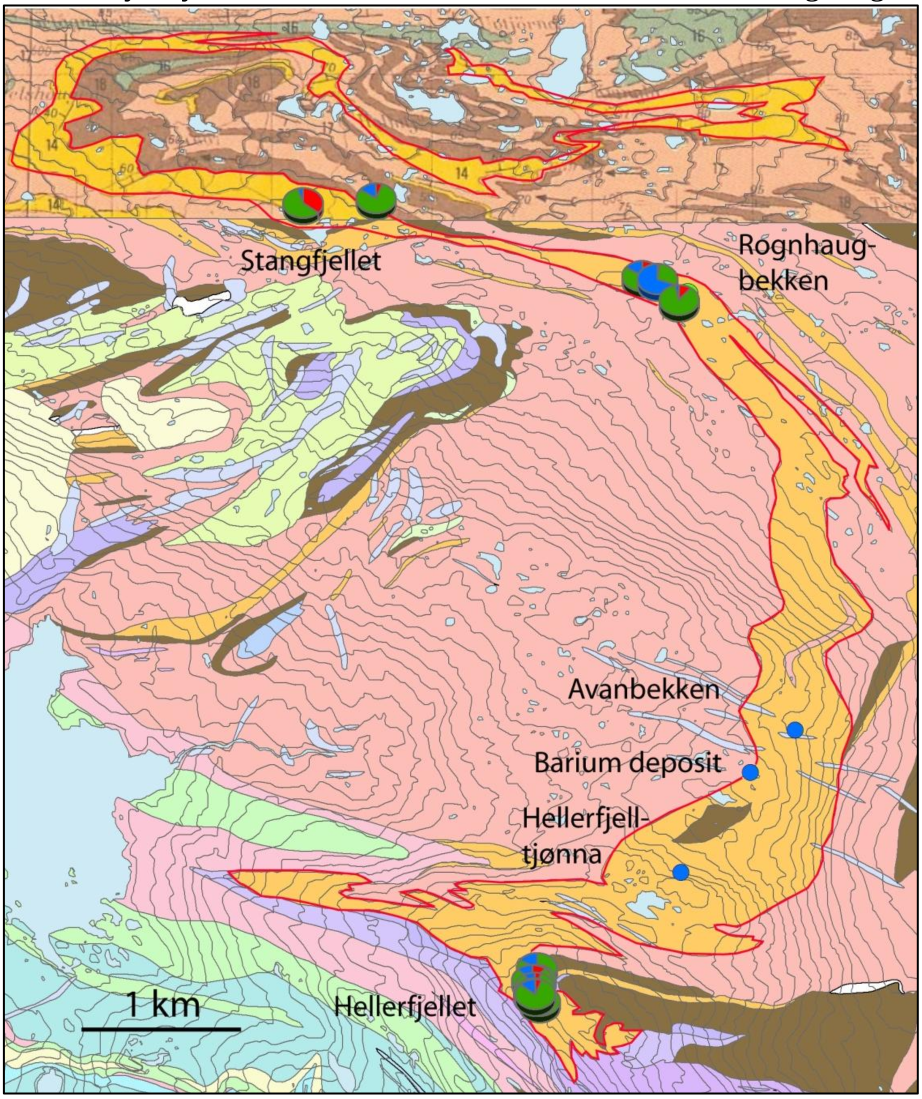


Figure 44: Bedrock map showing the Stangfjell-Hellerfjell sulfide zones (outlined in red). The yellow color is pyritiferous muscovite gneiss. See also legend in Figure 16. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in prospects and mines with more than 1 % Cu+Zn+Pb. The blue dots show other mineralizations described in the text.

At *Rognhaugbekken* is an area of c 500 x 120 m, covered by 16 small pits, and which have been explored by ground geophysics and 14 drillholes with a total length of 745 m (Figure 45).

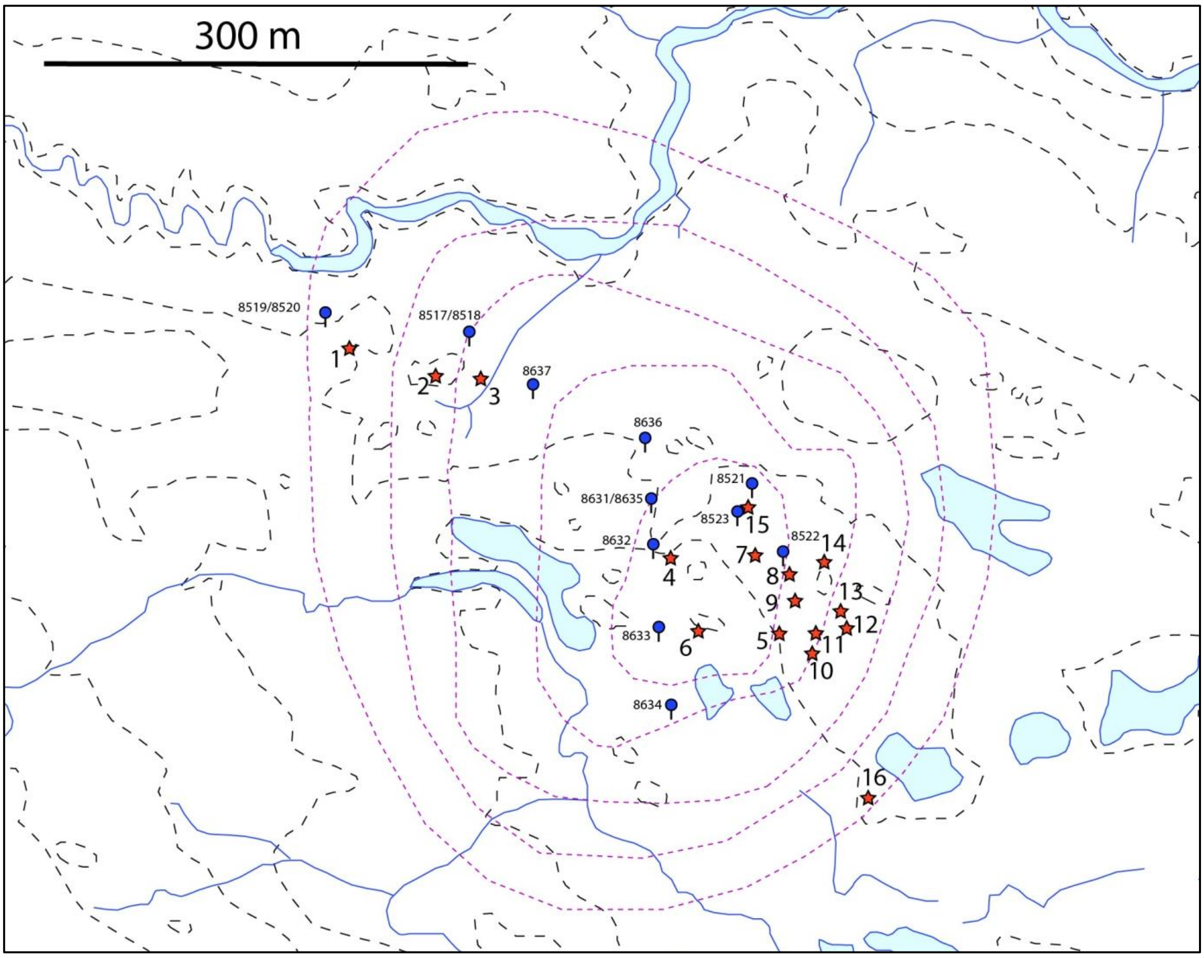


Figure 45: The Rognhaugbekken area. Pits are shown with red stars (numbered 1-16) and drillholes as blue thumbnails. Stippled purple lines show the geophysical anomaly over the deposit (aerial TEM, 2007).

The different prospects were mapped and measured by portable XRF in 2009 (Table 6), and samples were taken where possible. The analytical results from the samples (Table 7) show that the mineralization is not very rich in base metals, which is in accordance with the drill hole results and the field data from the portable XRF.

Drillhole 8520 from the western part of the mineralization intersected 0.95 meter (33.00-33.95 m) with 0.22 % Cu, 0.70 % Zn, 0.19 % Pb and 10.3 g/t Ag, while drillhole 8523 close to pit no. 15 intersected 4.95 m with 0.78 % Zn, 0.14 % Cu, 0.23 % Pb in two zones of 1.7 m with 2.39 % Zn, 0.33 % Cu, 1.06 % Pb and 1.35 m with 1.44 % Zn, 0.36 % Cu, 0.02 % Pb.

According to Kruse (1987) the mineralizations are concentrated in ruler or rod-like structures controlled by folding about a fold axis dipping gently westwards (plunge/dip = $277^{o}/16^{o}$). This could explain the circular geophysical anomaly over the deposit (Figure 45).

Table 6: Analytical data obtained by portable XRF for some of the Rognhaugbekken prospects (base metals in %, Ag, Mo, As, Se in g/t).

	Zn	Cu	Pb	
Rognhaugbekken s.3	0.03-2.48	0.01-0.05	0.05-7.33	Ag: <20-140
Rognhaugbekken s.2	0.64-0.83	0.04-0.07	0.13-0.19	Mo: <10-140
Rognhaugbekken s.1	0.10-5.03	0.04-0.05	0.03-0.87	As: <100-1040
Rognhaugbekken s.15	0.04-4.13	0.05-0.10	0.01-0.08	Se: <20-130
Rognhaugbekken s.4	0.15-1.86	0.02-0.11	0.05-0.40	
Rognhaugbekken s.10	0.06-1.19	0.03-0.40	<0.01-5.06	
Rognhaugbekken s.11	1.5	<0.01	0.05	
Rognhaugbekken s.13	0.01-0.02	<0.01	<0.01-0.11	
Rognhaugbekken s.9	0.03	0.30	1.16	
Rognhaugbekken s.16	0.07	0.01	0.05	

Table 7: Average geochemistry data (samples) for some of the Rognhaugbekken prospects (base metals in % and Ag and Au in g/t).

	totbas	Ag	Au	Cu	Zn	Pb
Rognhaugbekken-s.1	1.033	10.0	0.09	0.1165	0.7440	0.1725
Rognhaugbekken-s.10	0.378	1.0	0.04	0.2090	0.1055	0.0632
Rognhaugbekken-s.11	0.967	1.0	0.03	0.0015	0.9110	0.0540
Rognhaugbekken-s.15	0.568	1.0	0.01	0.2240	0.3380	0.0060
Rognhaugbekken-s.3	2.218	18.0	0.24	0.0552	0.6130	1.5500
Rognhaugbekken-s.4	1.115	2.0	0.01	0.1285	0.9440	0.0429

The *Avanbekken* mineralization (Figure 44) was found during mapping in 2009. It is a 20 m wide zone (7-8 m true thickness) with weak impregnations of pyrite, sphalerite and galena in quartz-sericite schist (Figure 46, Figure 47). To the south the mineralization is crosscut by a trondhjemitic dyke and disappears under soil cover, while to the north it can be followed for c. 200 m before wedging out. Two samples analyzed yielded base metal values of 0.17-0.28 % Zn, 0.01-0.02 % Cu, 0.23-0.27 % Pb, while portable XRF showed <0.01-0.72 % Zn, <0.01-0.06 % Cu, <0.01-1.88 % Pb (34 measurements).

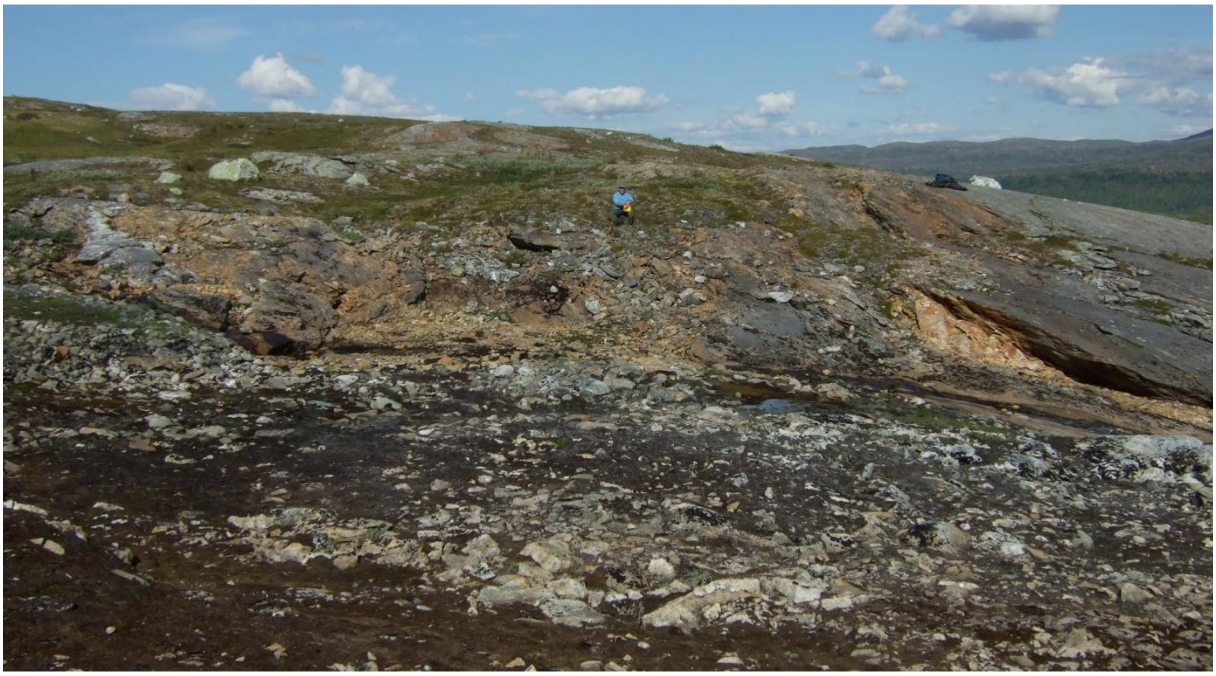
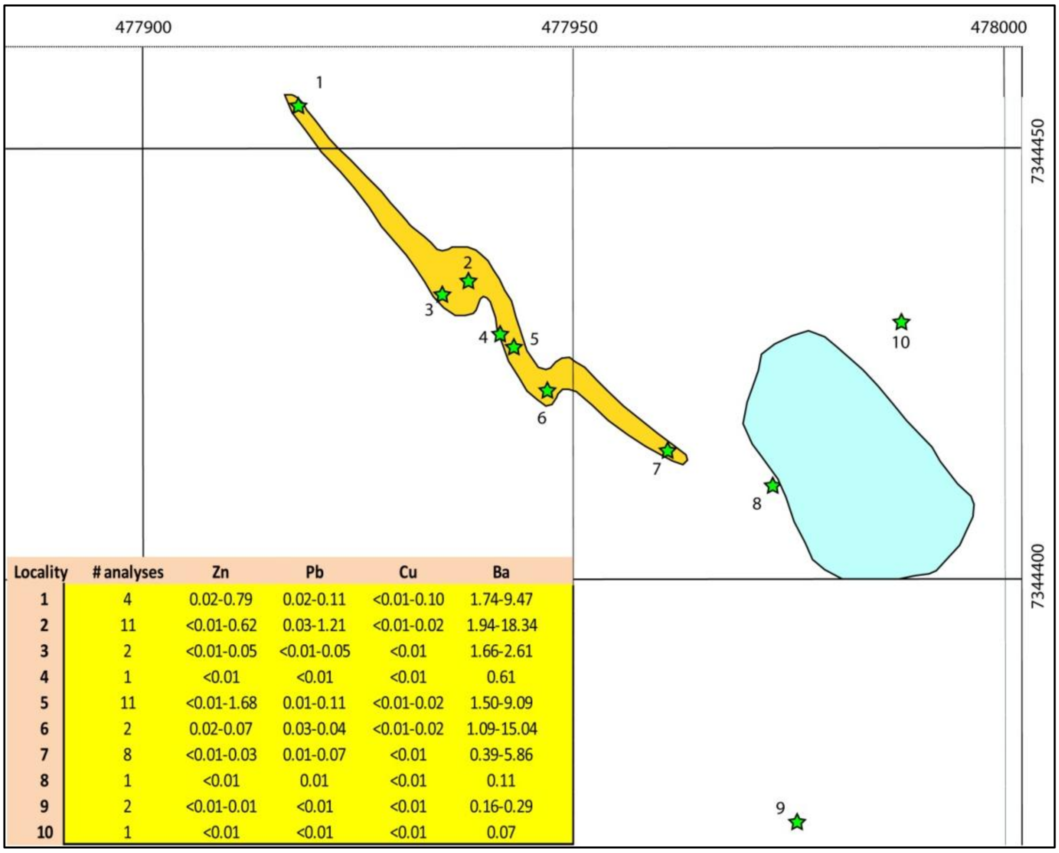


Figure 46: The Avanbekken mineralization consisting of weakly mineralized quartz-muscovite schist. (Photo looking northwards).

Figure 47: Detail of the strongly fissile quartz-muscovite schist at Avanbekken.

The ***Barium deposit*** is situated on the easternmost part of Stangfjellet and is a lens of barium-rich mineralization, c. 65-70 m long and up to 3 m thick in the central parts (Figure 48).



Locality	# analyses	Zn	Pb	Cu	Ba
1	4	0.02-0.79	0.02-0.11	<0.01-0.10	1.74-9.47
2	11	<0.01-0.62	0.03-1.21	<0.01-0.02	1.94-18.34
3	2	<0.01-0.05	<0.01-0.05	<0.01	1.66-2.61
4	1	<0.01	<0.01	<0.01	0.61
5	11	<0.01-1.68	0.01-0.11	<0.01-0.02	1.50-9.09
6	2	0.02-0.07	0.03-0.04	<0.01-0.02	1.09-15.04
7	8	<0.01-0.03	0.01-0.07	<0.01	0.39-5.86
8	1	<0.01	0.01	<0.01	0.11
9	2	<0.01-0.01	<0.01	<0.01	0.16-0.29
10	1	<0.01	<0.01	<0.01	0.07

Figure 48: The Barium deposit at eastern Stangfjellet. The table shows analyses (in %) by portable XRF at the numbered localities on the map.

The mineralization is banded on cm- to dm scale with alternating quartz-rich and barium-rich bands (Figure 49). There are also lenses and schlieren enriched in graphite, especially in the eastern part of the deposit.

Figure 49: Banded barium mineralization at eastern Stangfjellet. The lighter bands are enriched in mainly Ba-feldspar.

Associated with the most barium-rich bands are mm-sized grains of sphalerite and galena, especially in the western half of the deposit. Analyses with portable XRF show values up to 1.68 % Zn, 1.21 % Pb, 0.10 % Cu and 18.3 % Ba (Table in Figure 48). The barium content is generally higher than 1.5 % and the average of 34 analyses is 4.5 % Ba. The average of total base metals is below 0.5 % in the best part of the deposit (localities 1-5 in Figure 48). Three samples analyzed by the NGU laboratory (Table 8) confirm the analytical data from the field, and show in addition some enrichment of Ag and Mo.

Table 8: Metal contents of three samples from the Barium deposit (Cu, Zn, Pb and Ba in %, Ag, Au and Mo in ppm).

Locality/Sample	Cu	Zn	Pb	Ba	Ag	Au	Mo
2/Stfj-04	0.005	0.21	0.32	7.56	40	0.04	301
2/Stfj-05	0.007	0.30	0.25	17.55	31	0.04	78
6/Stfj-06	0.010	0.06	0.01	7.43	4	-0.01	45

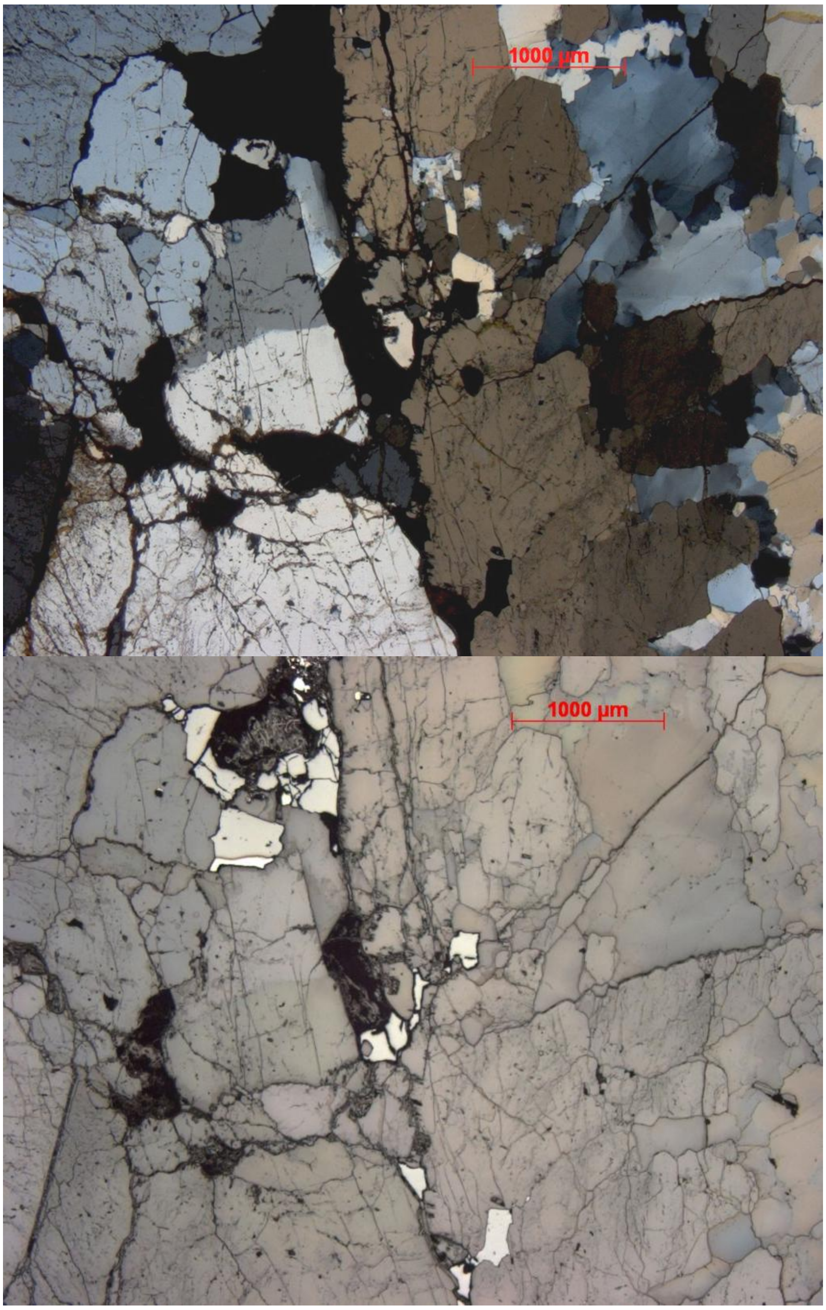


Figure 50: Photomicrographs of a sample (Stfj-05) from the barium deposit.
The upper photo shows the matrix, which consists of celsian (cloudy large grains) and quartz.
The lower photo shows the same section in reflected light with disseminated small grains of sphalerite and galena.

The barium-bearing mineral in the deposit is celsian ($BaAl_2Si_2O_8$), generally with less than 10 % of albite or/and orthoclase component (see also section 3.3.4). Except for celsian, quartz is the only other important silicate in the matrix (Figure 50). Sulfides, mainly sphalerite and galena, occur in scattered small grains.

The *Hellerfjellet* mineralization is situated in the southernmost part of the Stangfjell-Hellerfjell zone, and consists of 21 small workings over a length of more than 200 m (Figure 51). In outcrop the mineralization consists of several massive sulfide lenses, up to 1.5 m thick but only a few meters long, surrounded by weaker impregnations in muscovite gneiss. The massive lenses appear to be located at different levels within the muscovite gneiss. The whole mineralized zone appears to be between 1.5 and more than 3 m thick. The muscovite gneiss is characterized by thin lenses enriched in graphite, also close to the richer zones of mineralization.

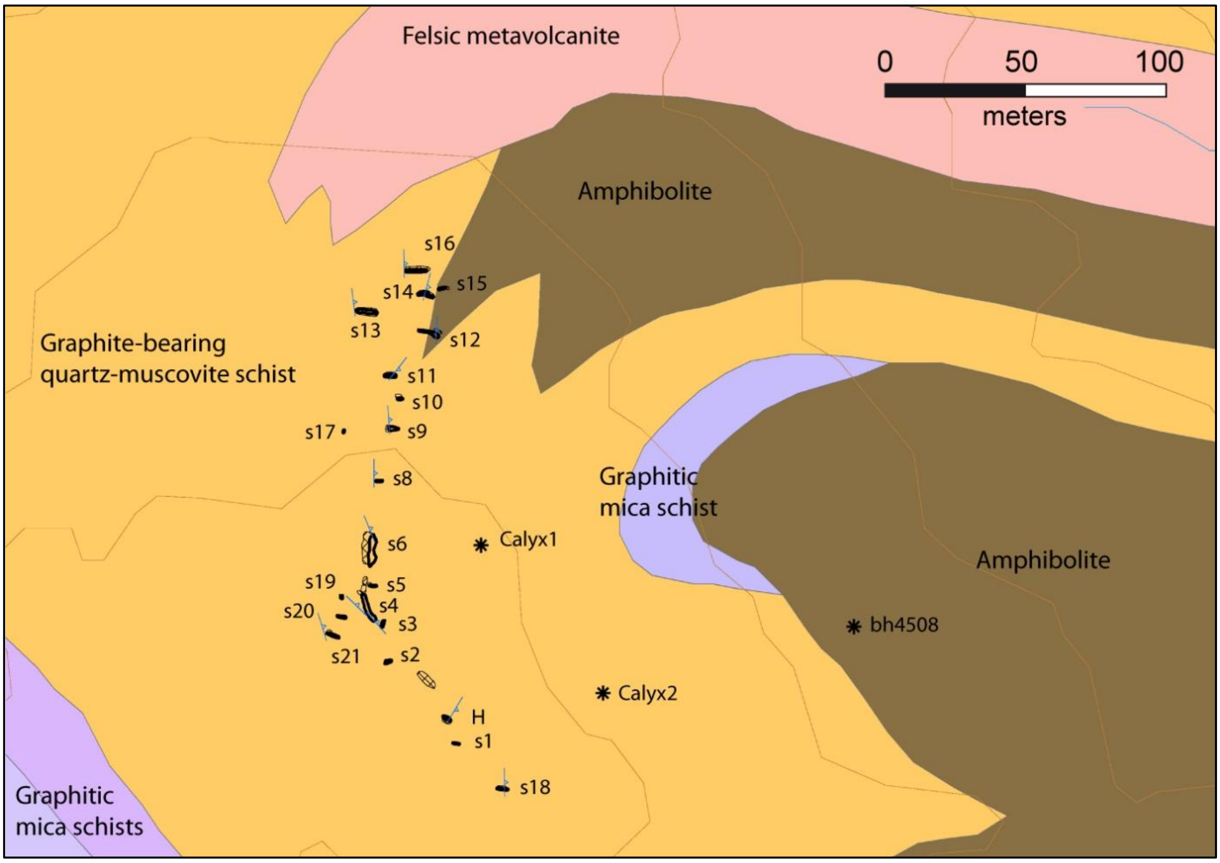


Figure 51: Geological map of the Hellerfjell area, showing the various prospects and drill holes (marked with stars). North is up.

Table 9: List of the Hellerfjellet prospects, some with metal contents (Cu, Zn, Pb in %, Ag, Au and Ba in ppm).

Deposit	Σ Basemetaller	Ag	Au	Cu	Zn	Pb	Ba
Hellerfjellet W	0,03	0	0,00	0,01	0,02	0,00	437
Hellerfjellet s.18							
Hellerfjellet s.1							
Hellerfjellet	16,81	124	0,04	0,32	14,95	1,54	3873
Hellerfjellet s.2							
Hellerfjellet s.21	0,08	1	0,01	0,00	0,04	0,04	17914
Hellerfjellet s.3	3,99	25	0,01	0,26	3,13	0,59	12271
Hellerfjellet s.20	1,16	10	0,00	0,13	0,87	0,16	250
Hellerfjellet s.4	42,22	195	0,03	1,71	36,53	3,98	15227
Hellerfjellet s.19							
Hellerfjellet s.5							
Hellerfjellet s.7							
Hellerfjellet s.6	18,21	95	0,05	1,23	15,10	1,88	7286
Hellerfjellet s.8							
Hellerfjellet s.17	2,20	16	0,01	0,29	1,58	0,33	8151
Hellerfjellet s.9	6,11	25	0,01	0,02	3,58	2,51	15048
Hellerfjellet s.10							
Hellerfjellet s.11	0,11	3	0,01	0,04	0,06	0,01	165
Hellerfjellet s.12							
Hellerfjellet s.13	0,03	1	0,01	0,00	0,01	0,01	552
Hellerfjellet s.14							
Hellerfjellet s.15							
Hellerfjellet s.16	2,48	2	0,01	0,02	2,02	0,44	1725

The mineralization at Hellerfjellet is generally very rich in base metals and silver, and several of the massive lenses contain more than 10 % Cu+Pb+Zn and > 100 g/t Ag (see Table 9). The mineralization is also enriched in barium (0.4-1.8 % Ba in the massive lenses).

GEXCO drilled one hole in 2008, which showed that the mineralization continues at least 250 m along dip from the outcrops (Figure 52). The best intersections were 5 m with 1.23 % Zn, 0.35 % Cu, 0.35 % Pb, 27 g/t Ag and 1 m with 1.82 % Zn, 0.16 % Cu, 0.59 % Pb and 24 g/t Ag. The geophysical data (TEM) indicates that the zone has an extent of at least 1.5 km along strike.

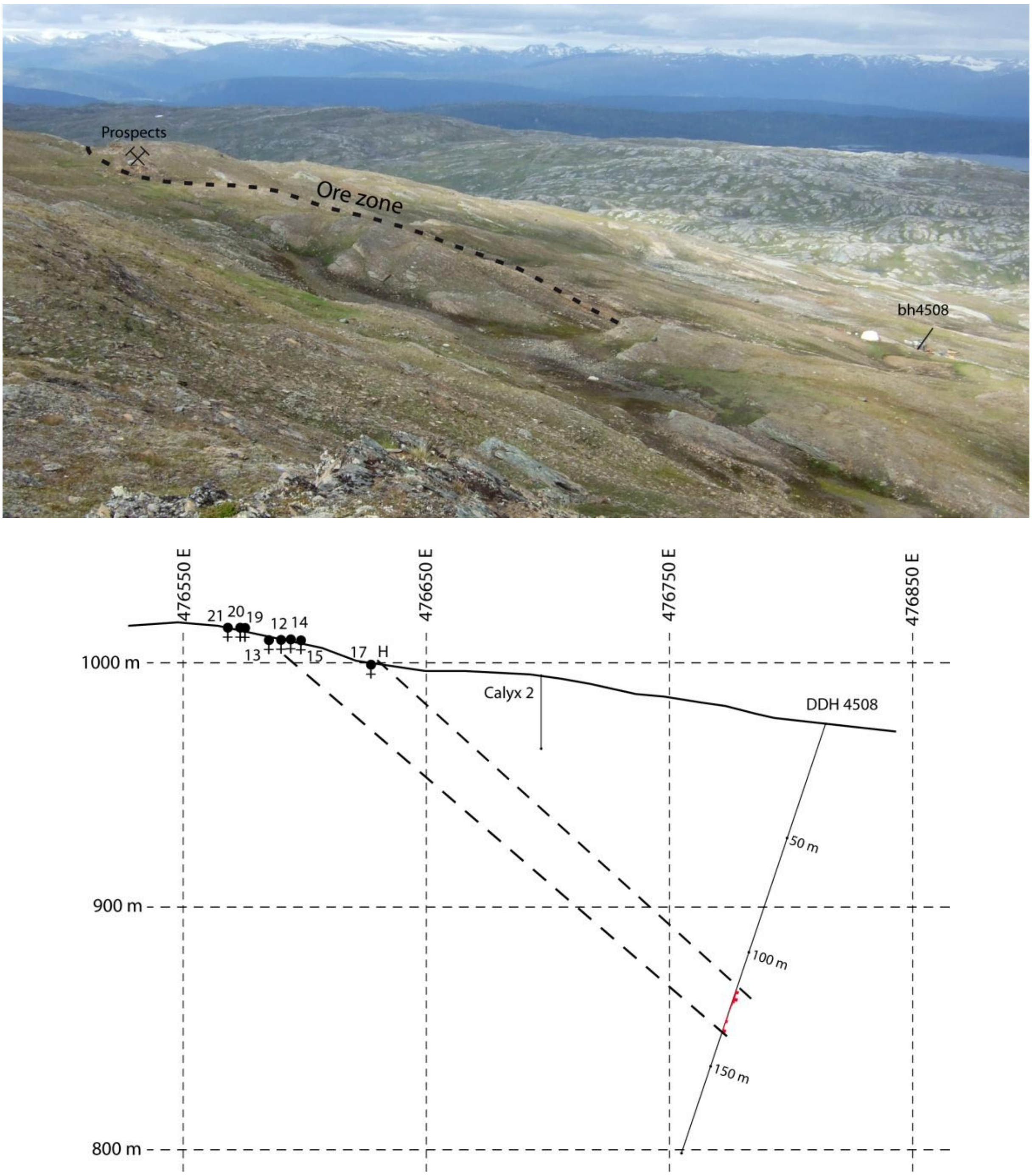


Figure 52: Overview photo showing the outcrop of the ore zone and the drill hole site (bh4508), and W-E profile through the Hellerfjellet mineralization. Because of the projection, the drillhole and the mineralized zone have a steeper inclination on the figure than in reality.

The massive lenses are dominated by sphalerite and pyrrhotite, while galena and chalcopyrite are present in subordinate amounts. Pyrite and/or pyrrhotite dominate in impregnated schists. Sulphosalts, including freibergite and Fe+Ni rich varieties occur in accessory amounts, generally as small inclusions in galena. Quartz, clinoamphibole and celsian are the most common silicates, while biotite, muscovite, staurolite and plagioclase are less common.

3.1.10 The Småvatnan zone

The Småvatnan zone has been placed at the lowermost level in the Mofjell Group, but its position, structurally and stratigraphically, is uncertain, mainly because of a number of unconformities in the area. The zone has a total length of c. 2 km, but is crosscut by later granitic intrusions (Figure 53).

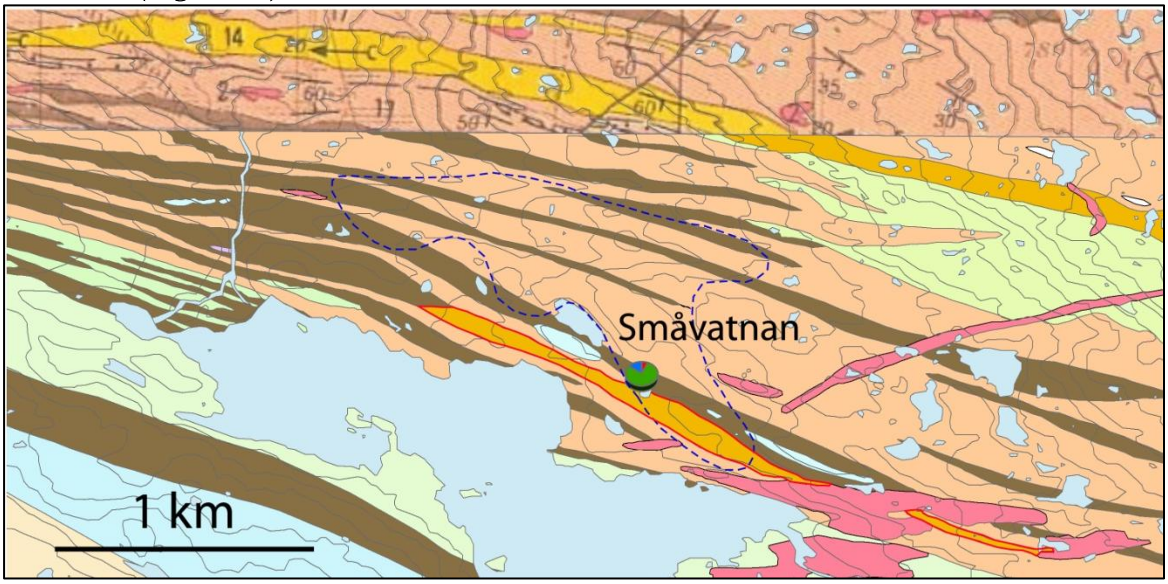


Figure 53: Bedrock map showing the Småvatnan sulfide zones (outlined in red). The yellow color is biotite-muscovite gneiss, brown is amphibolite and red is granitic intrusions. The pie diagrams show the proportions of Cu (red), Zn (green) og Pb (blue) in the Småvatnan prospect. The stippled blue curve shows the extent of the TEM anomaly associated with the deposit.

Only one deposit is known in this zone – Småvatnan. This mineralization has been followed along strike for only 30 m. It is associated with a zone of biotite-muscovite gneiss, which is locally hornblende-bearing. The lithologies in the area are strongly deformed and folded, which also affects the mineralization, making it ruler-shaped. It probably plunges c. 25 degrees to the west-northwest.

A lot of cover with swampy terrain makes it impossible to follow the mineralization westwards, but a weak TEM anomaly in its presumed continuation could be due to sulfides (Figure 53).

The Småvatnan mineralization consists of lenses and veins of partly semi-massive sphalerite-galena ore, which is up to 1 m thick, and surrounded by impregnations, mainly pyrite-bearing. The mineralized zone has an overall thickness of 3-4 m. Average metal contents based on 13 dump samples is 0.6 % Cu, 10.0 % Zn, 1.9 % Pb, 141 g/t Ag and 0.3 g/t Au. 19 analyses by portable XRF on 6 samples yield an average of 1.6 % Cu, 6.8 % Zn, 1.6 % Pb and 5.8 % Ba.

The matrix to the sulfides comprises mainly quartz, calcite and barite in a sugary texture, while the wallrock constitutes quartz-biotite-muscovite schist.

3.1.11 Iron formations

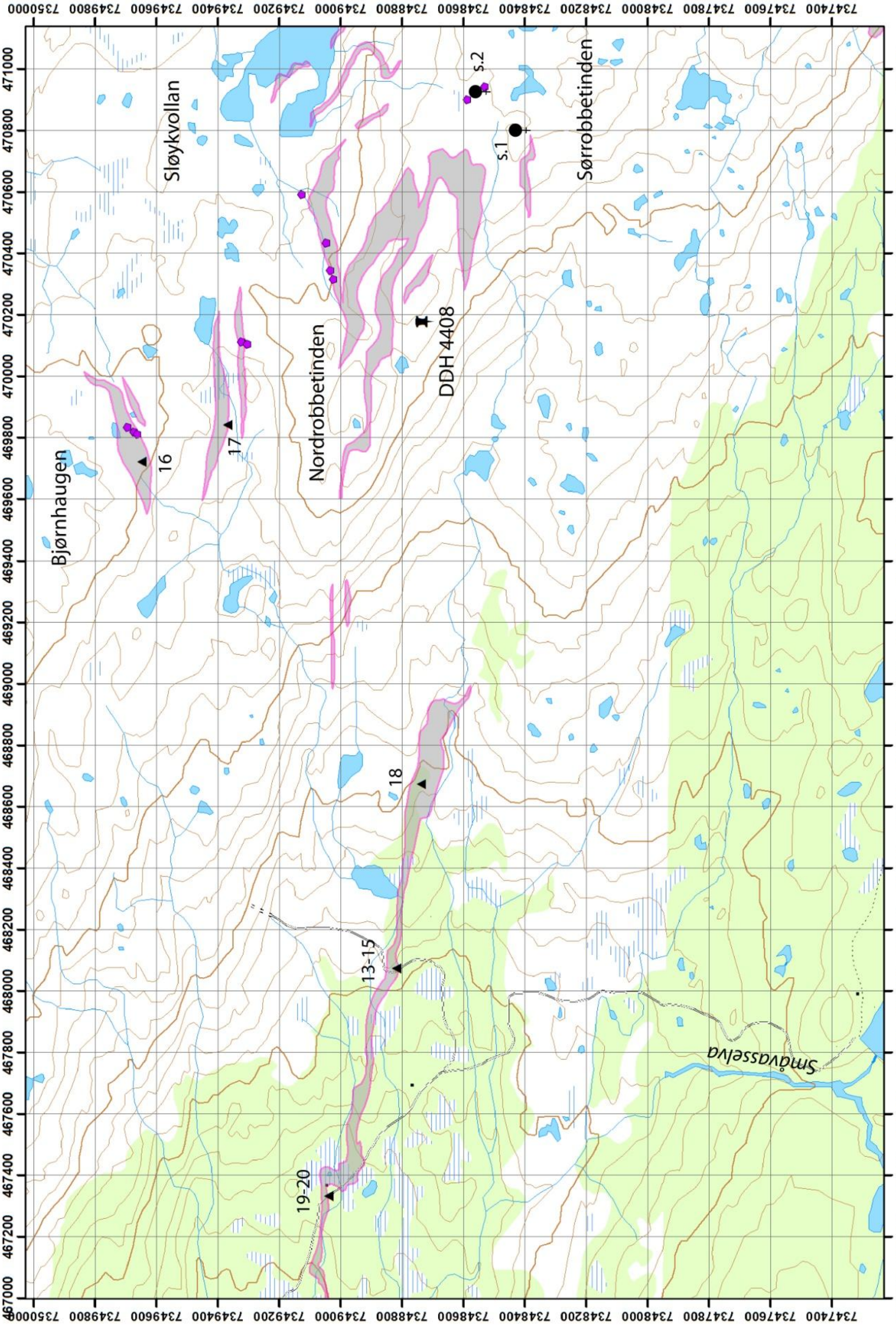


Figure 54: Overview of the most important iron formations at Southern Mofjell (grey color). Numbers refer to bedrock samples from 1999, analyzed by ICP-MS. Red dots mark observations and measurements with portable XRF from 2009. Black pin marks the drillhole 4408 by GEXCO.

Iron formations are present at the southern part of Mofjellet, between Andfiskvatnet and Sløykvollen (Figure 54). These iron-rich rocks form extensive, partly folded lenses. Most of the lenses consist of varying proportions of biotite, iron-rich garnet (almandine) and iron-rich amphibole (partly grunerite). Analyses by portable XRF on the lenses between Bjørnhaugen and Nordrobbetinden yielded 0.02-0.04 % Zn, <0.01-0.9 % Cu, <0.01-0.02 % Pb, 7-17 % Fe, up to 0.28 % Mn and up to 0.29 % P.

During the fieldwork in 2009, two small prospects, not previously described, were found close to Sørrobbetinden (Figure 54). The largest, called *Sørrobbetinden 1* contains two thin zones of pyrrhotite mineralizations with lesser pyrite, separated by a quartz-rich rock (Figure 55). A number of XRF analyses in the field showed 10-31 % Fe, but very low contents of base metals. The field data were confirmed by one laboratory analysis which gave 0.02 % Cu, <0.01 % Zn, 0.01 % Pb, 34 % Fe and 0.01 % Ba. The other prospect, *Sørrobbetinden 2*, is at approximately the same level as no. 1, but contains only a few grains of iron sulfides in a quartz rock. Associated with this mineralization is an at least 3 m wide horizon of very fine-grained quartz-magnetite rock with bands of magnetite up to 3 cm thick. There are also thin zones enriched in mm-sized magnetite crystals.

Figure 55: Sørrobbetinden prospect no.1. The hammerhead is standing on the lower contact of the upper pyrrhotite zone and the quartz rock.

Further down the slopes towards Småvasselva and Andfiskvatnet, is a 2 km long horizon of iron formation (Figure 54), which is dominated by biotite, garnet and grunerite. Locally it contains quite a lot of quartz and also scattered pyrrhotite. This horizon was investigated and sampled at three localities in 1999. Analyses were carried out by ICP-MS after acid digestion (not suitable for elements like Fe, Cr, Ti, Ba, P which occur in some acid resistant minerals). The results obtained (Table 10) show very low contents of both base metals and precious metals. However, a value of 0.38 % Ba (sample TB99.019) is notable, especially if Ba is present in barite, which is only partially dissolvable by this analytical method.

Table 10: ICP-MS analyses of samples from 1999 (see Figure 54 for location).

Sample	East	North	Rock description	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	Au	V	Ba	Ti	S
TB99.013	468074	7348818	garnet-biotite schist	0.006	0.025	0.030	1.53	36.8	13.7	431	7.03	2.6	83	892	0.357	0.02
TB99.014	468074	7348818	quartz-garnet-grunerite w/pyrrhotite	0.024	0.015	0.008	1.04	35.8	11.8	603	5.68	2.9	40	122	0.048	1.85
TB99.015	468074	7348818	quartz-garnet-grunerite w/pyrrhotite	0.016	0.011	0.009	1.21	27.6	10.5	840	3.68	4.7	26	34	0.032	0.72
TB99.016	469724	7349648	garnet-amphibole-quartz rock	0.029	0.005	0.003	0.62	23.2	8.8	215	5.47	2.3	37	343	0.113	0.66
TB99.017	469844	7349368	garnet-quartz-amphibole rock	0.013	0.003	0.006	0.37	12.6	4.8	419	3.38	1.2	51	374	0.073	0.05
TB99.018	468674	7348738	garnet-amphibole rock	0.002	0.002	0.004	0.16	12.2	4.1	292	3.44	< 0.2	50	543	0.096	< 0.01
TB99.019	467334	7349038	garnet-bearing amphibolite?	0.001	0.001	0.008	0.08	37.8	21.4	375	5.07	< 0.2	92	3849	0.332	< 0.01
TB99.020	467334	7349038	sulfide-bearing garnet-amphibole rock with quartz lenses	0.033	0.001	0.002	0.84	44.0	24.2	487	6.44	3.3	28	79	0.039	2.94

Cu, Zn, Pb, Fe, Ti, S in %, Ag, Ni, Co, Mn, V and Ba in ppm and Au in ppb.

3.2 Metal characteristics and classification of the Mofjell deposits

Plot of the metal content of the main sulfide occurrences in the different ore zones in the Mofjellet area in the Cu-Zn-Pb diagram (Figure 56), shows that, with few exceptions, most of the occurrences either plot in the Zn-Pb-Cu or in the Cu-Zn field. The most important occurrences which fall into the Cu-Zn field are the ones in the Raudvatn, Reinfjell and Breisnølien ore zones. Deposits of the Mofjell, Sølvberg, Småvatnan and Hellerfjell zones plot mainly in the Zn-Pb-Cu field. In the Hesjelia ore zone, all the Hesjelia prospects plot in the Cu-Zn field, while the ones at Hammertjønna are more Pb-rich and partly plot in the Zn-Pb-Cu field. The different metal proportions may indicate a lateral zonation, and similar zonations are also observed in the Mofjell and Raudvatn zones.

A lithotectonic classification system, defined by Franklin et al. (2005), is based on the principal volcanic and sedimentary lithological units that formed concurrently with the deposits in a certain district. The volcanic rocks may be dominated by felsic or mafic compositions, and the sediments may be immature to mature, pelitic, argillitic, sandstone or wackes, all according to the tectonic setting. There are five classes defined in the system:

Bimodal mafic: Incipient-rifted bimodal arcs above intra-oceanic subduction zone – basalt dominated, but up to 25 % felsic volcanic strata, minor terrigeneous sediments.
Mafic or back-arc mafic: Mature intra-oceanic back-arc, dominated by basaltic flows, very minor felsic flows or domes and minor sediments (argillitic).
Pelitic-mafic: Mature basalt-pelitic back-arc successions, with equal proportions of sediments and basalt, or sediment-dominated (e.g. Besshi), felsic components are rare.
Bimodal-felsic: Continental-margin arcs and related back-arcs. Felsic volcanic rocks constitute 35-70 %, basalt 20-50 %, terrigeneous sediments up to 10 %.
Siliciclastic-felsic: Mature epicontinental back-arcs – siliciclastic rocks are dominant (up to 75-80 %), while felsic volcaniclastic and volcanic rocks constitute most of the remainder (mafic rocks up to 10 %).

As discussed in chapter 2, The Mofjellet Group comprise large units of grey gneiss, (which to a large extent represent felsic metavolcanic rocks), amphibolite (mafic metavolcanic rocks/metabasalt), and minor metasediments as mica schist and quartz-feldspar gneiss. The geochemical signature shows that the rocks were formed in an arc to back-arc setting, likely close to a continental margin, on the basis of the large amounts of sediments to the south of Rana (see section 2.3.4 and Figure 13). Thus, the deposits in the Mofjellet area fall into the bimodal-mafic or bimodal-felsic class, as defined above.

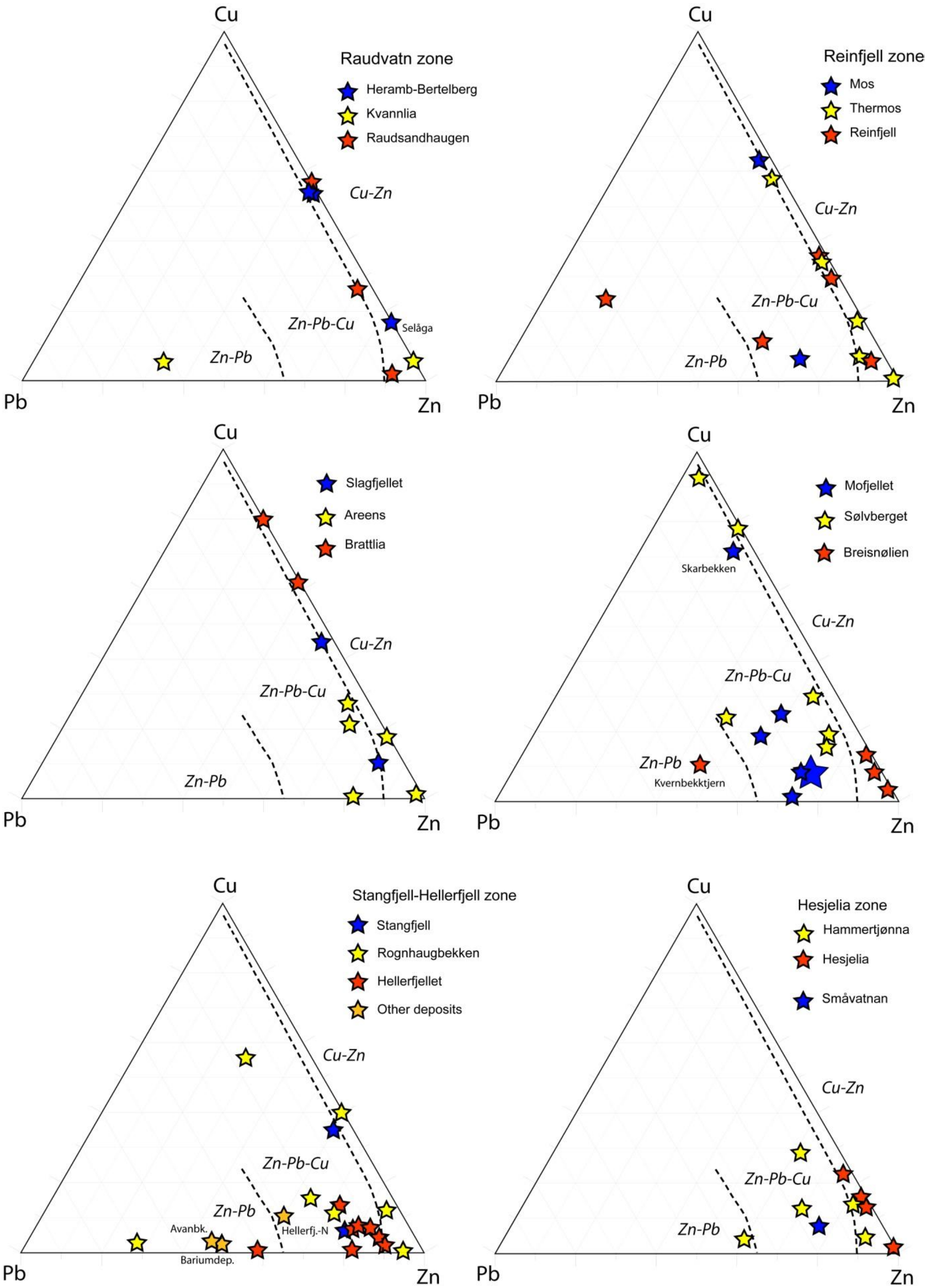


Figure 56: Triangular plots showing the proportion of base metals in the main sulfide occurrences in each ore zone. The dashed lines distinguish between Cu-Zn, Zn-Pb-Cu and Zn-Pb type of massive sulfide deposits (divisions by Franklin (1993)). The large star marks the major Mofjellet deposit.

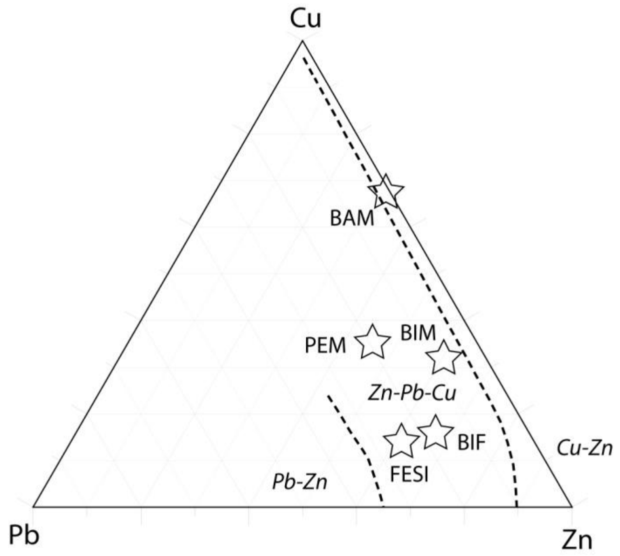


Figure 57: Triangular diagram for classification of VMS deposits based on ratios of Cu, Zn and Pb (from Franklin 1993). The stars show the average ratios of deposits worldwide grouped according to host-rock lithologies (data basis from Franklin et al., 2005).

BAM – Back-Arc Mafic
PEM – Pelitic Mafic
BIM – Bimodal Mafic
BIF – Bimodal Felsic
FESI – Felsic Siliclastic

In the triangular base metal diagram in Figure 57 the average compositions of VMS deposits worldwide of the five lithotectonic classes are plotted in the diagram, showing that they have different ratios of Cu, Zn and Pb. Tectonic settings with larger proportion of mafic rocks have higher Cu vs. Zn and Pb ratios, than the felsic-rich. Furthermore, the proportion of Pb increases in accordance with higher contents of sedimentary rocks.

Comparing Figure 56 and Figure 57, show that the larger deposits in Mofjellet, including Mofjell, Sølvberg, Småvatnan and Hellerfjell, all plot in the Zn-Pb-Cu field, and mainly close to the average ratio of bimodal felsic (BIF) deposits. The only important exceptions are the Heramb and Bertelberg deposits of the Raudvatn zone, which both plot close to the back-arc mafic composition (BAM). The other deposits close to this composition (BAM), are small prospects.

In Figure 58 to Figure 71 the average contents of the metallic elements are displayed for the main deposits in each of the ore zones. The data are presented in a table in the appendix.

Figure 58 show that most of the sulfide zones have deposits with more than 2 % Cu+Zn+Pb, the exceptions are the Brattlia and Slagfjellet zones. Other zones which are relatively low in base metals are the Breisnølien and Reinfjell zones, as well as the eastern part of the Raudvatn zone. These zones, and especially the very long Reinfjell zone, as well as the eastern Raudvatn, are characterized by being the zones with the highest proportions of pyrite. The richer deposits are Hellerfjellet, Småvatnan and Breifonn with more than 10 %, but also Hesjelia and Heramb contain more than 5 % Cu+Zn+Pb.

Since *zinc* is the dominating metal in most of the Mofjell deposits, it has nearly the same distribution as the base metals (Figure 59), while *lead* is low in the Raudvatn zone (Figure 60). Compared to zinc and lead, *copper* is particularly enriched in the Heramb, Bertelberg and Sølvberget deposits (Figure 61), but depleted in the zinc and lead rich Hellerfjellet and Hesjelia deposits.

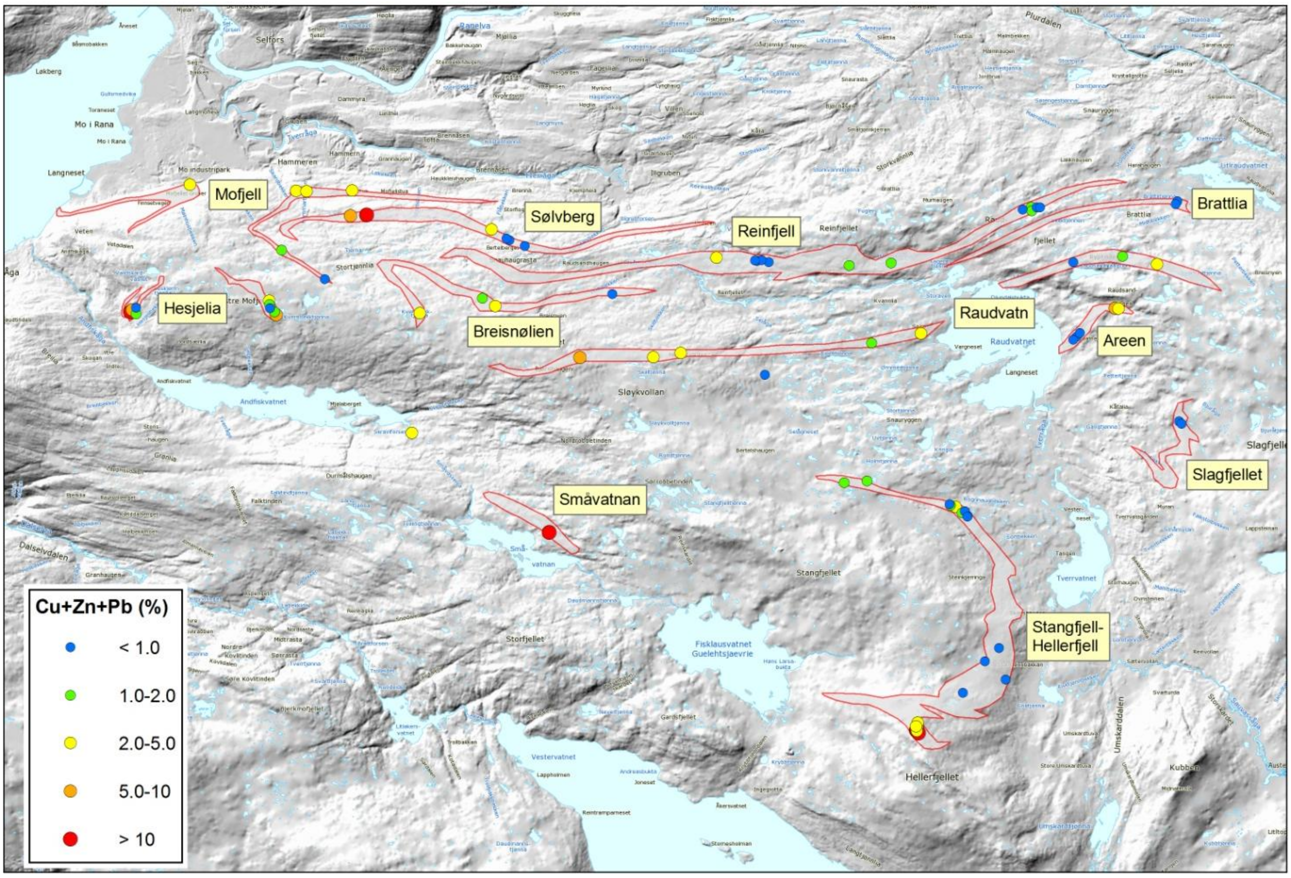


Figure 58: The zones of sulfide mineralization showing the average content of Cu+Zn+Pb in the main deposits.

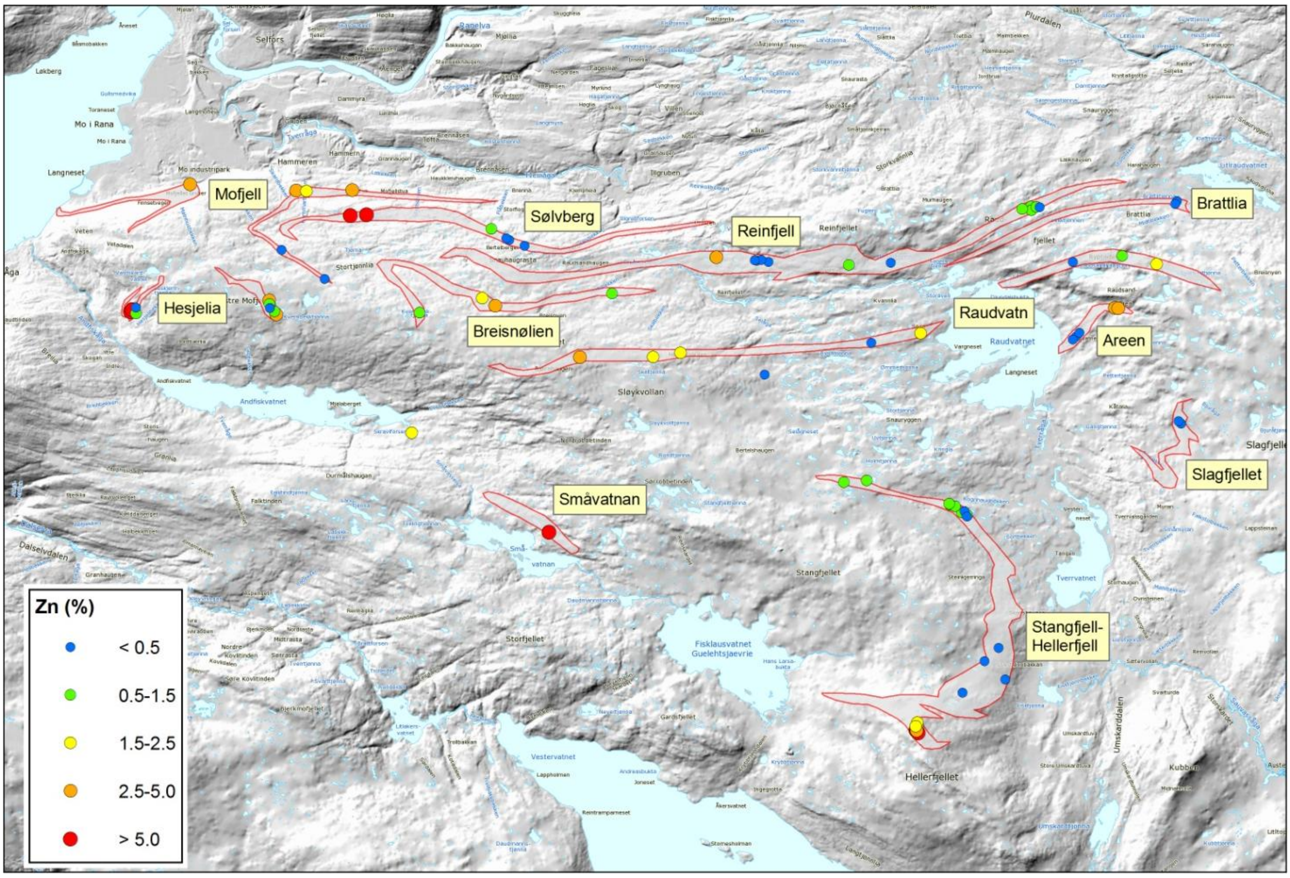


Figure 59: The zones of sulfide mineralization showing the average content of zinc in the main deposits.

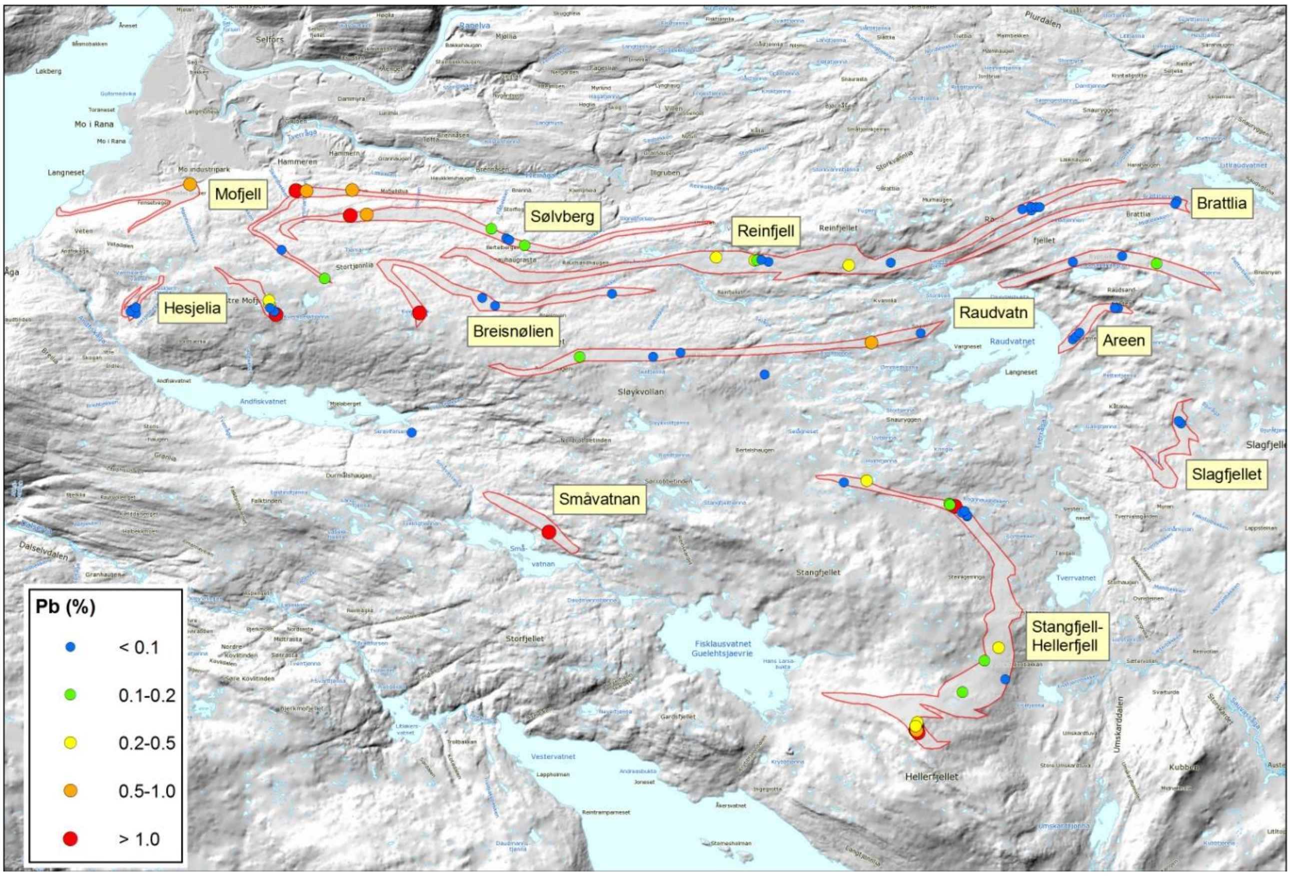


Figure 60: The zones of sulfide mineralization showing the average content of lead in the main deposits.

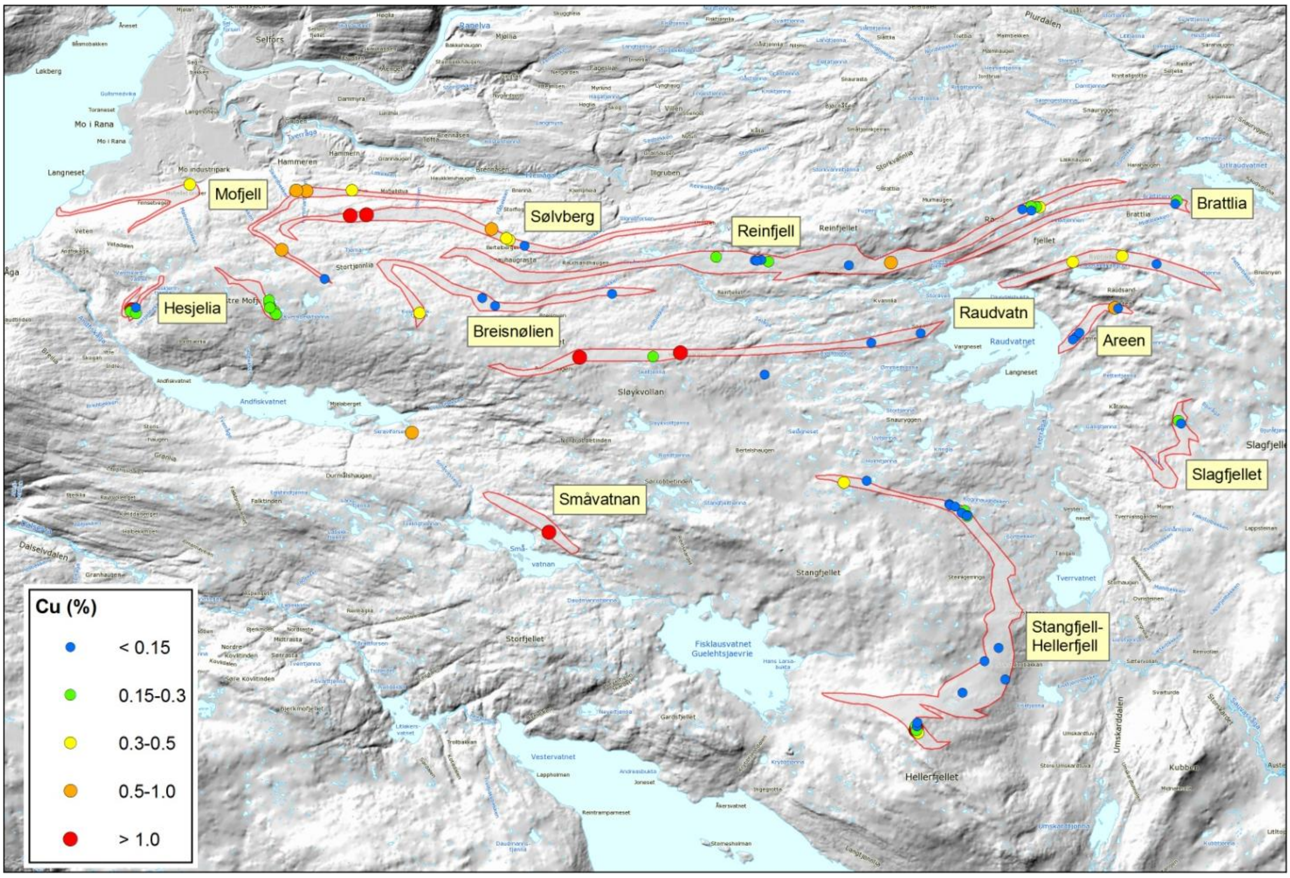


Figure 61: The zones of sulfide mineralization showing the average content of copper in the main deposits.

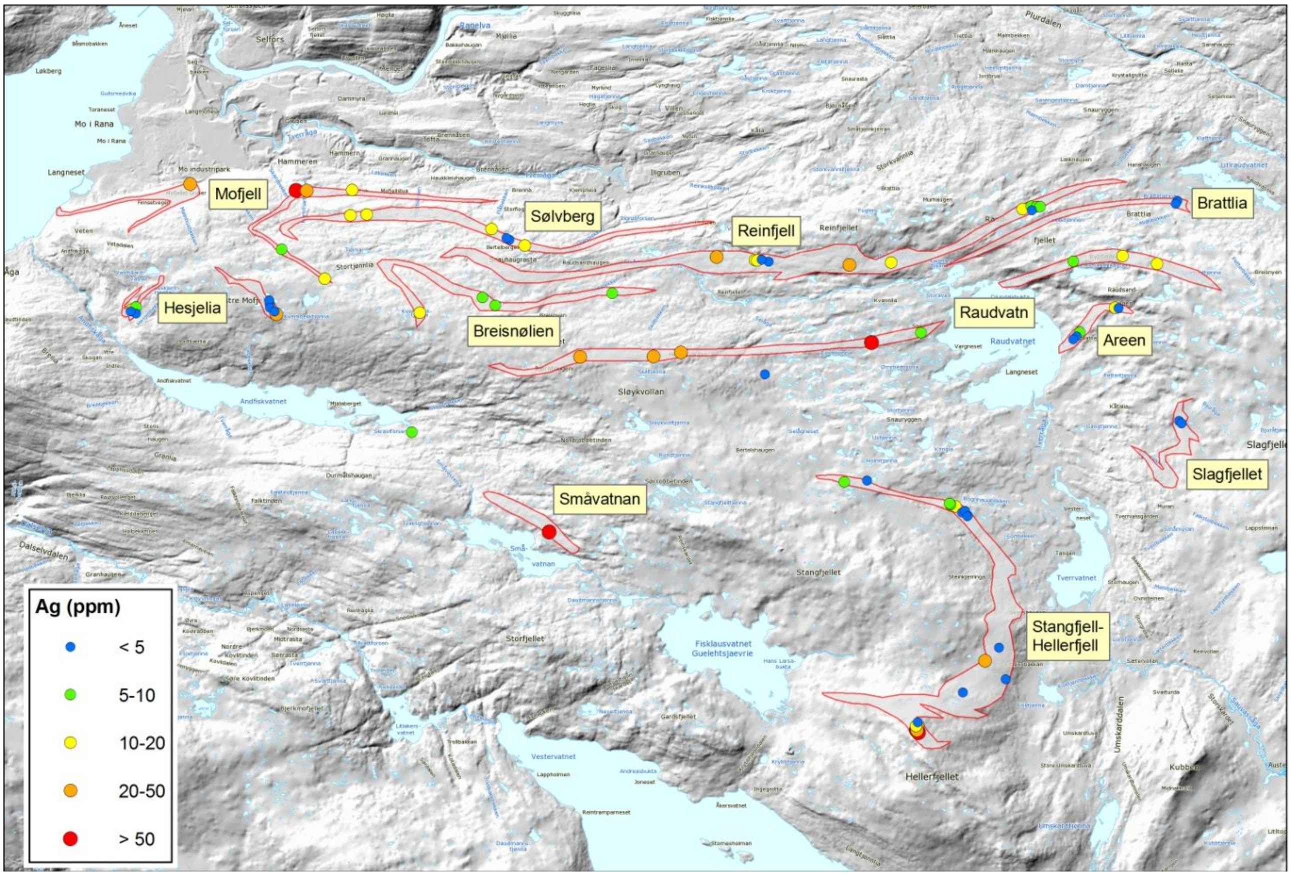


Figure 62: The zones of sulfide mineralization showing the average content of silver in the main deposits.

S*ilver* (Figure 62) tends to follow the same pattern as zinc or lead, and is particularly enriched in the Småvatnan and Hellerfjellet deposits, but also in Heramb and the Hammeren prospect in the Mofjell zone, which both are more copper-rich. The higher *gold* values are found in the base metal poor Areens and Reinfjell deposits, in Mofjellet, Bertelberg-Heramb and one of the Kvannlia prospects (Figure 63). Note that the base metal-rich Småvatnan, Hellerfjellet and Hesjelia deposits are very poor in gold.

The Mofjell, Hesjelia, Småvatnan and Stangfjell-Hellerfjell zones are characterized by high *barium* contents (Figure 64). None of the other zones show any barium enrichment. Data for the main Mofjellet deposit is taken from a report by Kruse (1973), who reported an average of 3.31 % barite, corresponding to 1.95 % Ba, based on 21 drillhole samples. In comparison samples from the Skistua prospect (data in this project) contain c.10 % Ba. Furthermore, massive lenses and veins of barite have been observed in drill cores from the Mofjellet deposit. In the Hellerfjell and Hesjelia deposits barium is mainly present in feldspar minerals (celsian and hyalophane), while barite is the main Ba-phase in the Mofjellet and Småvatnan deposits (see also section 3.3.4).

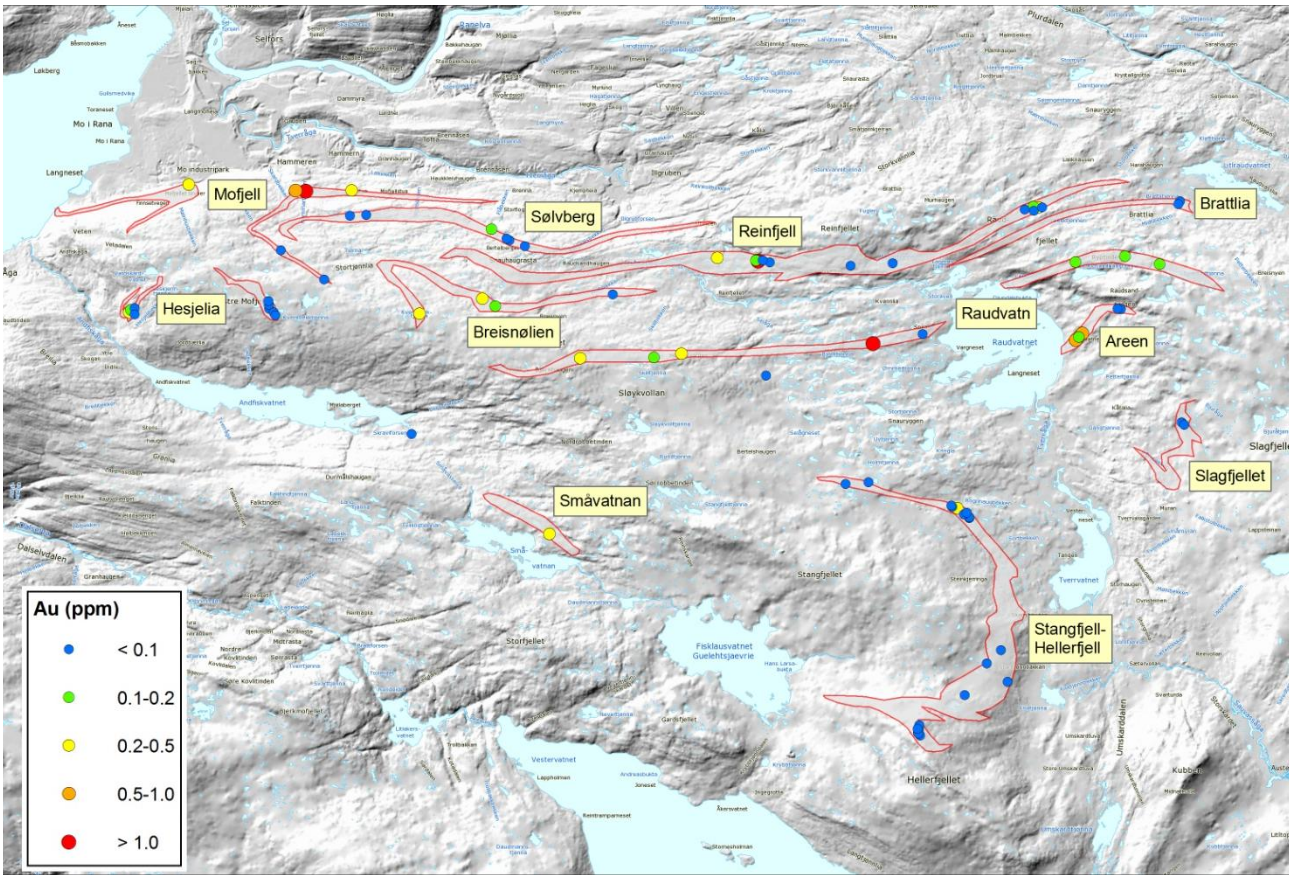


Figure 63: The zones of sulfide mineralization showing the average content of gold in the main deposits.

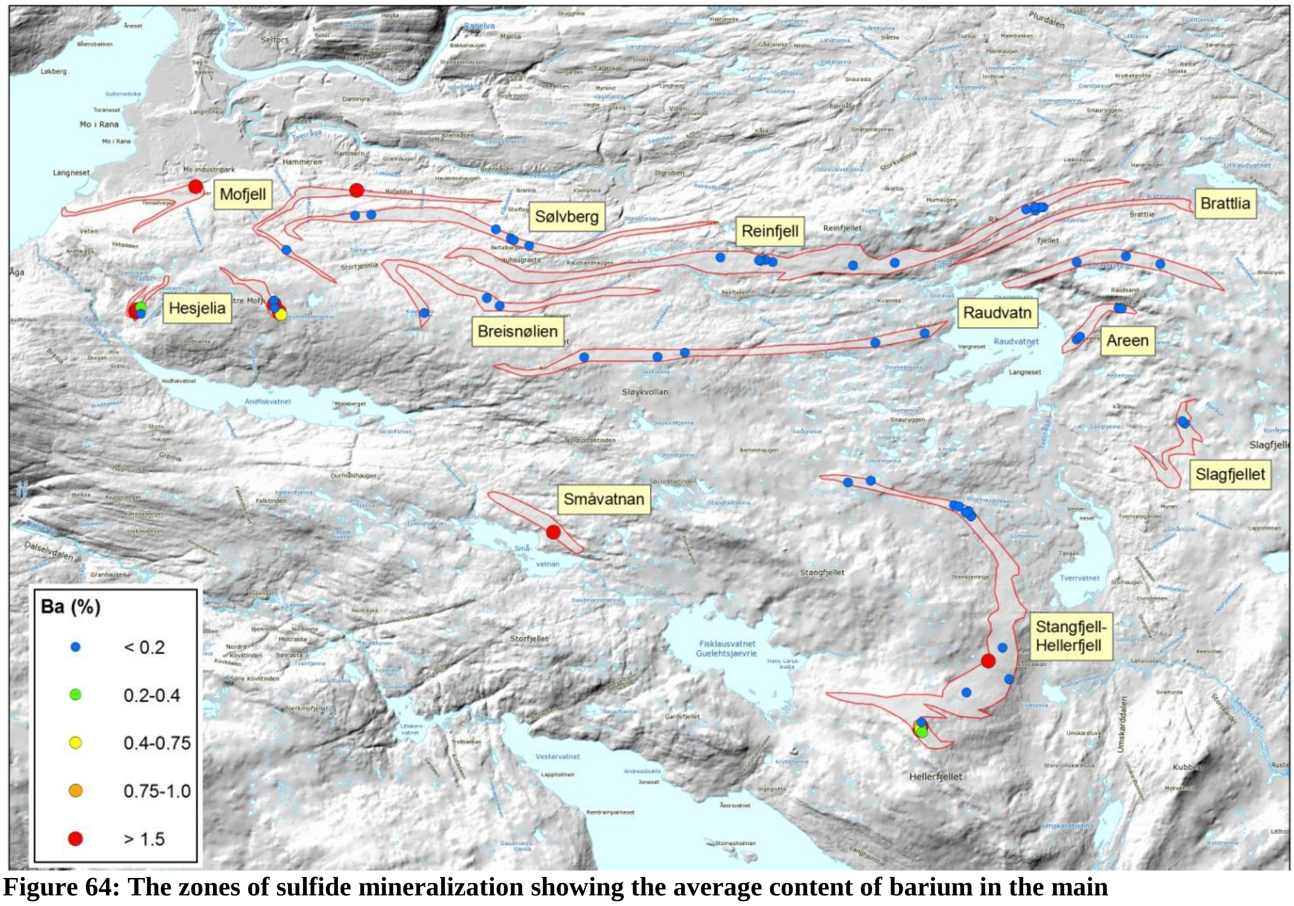


Figure 64: The zones of sulfide mineralization showing the average content of barium in the main deposits.

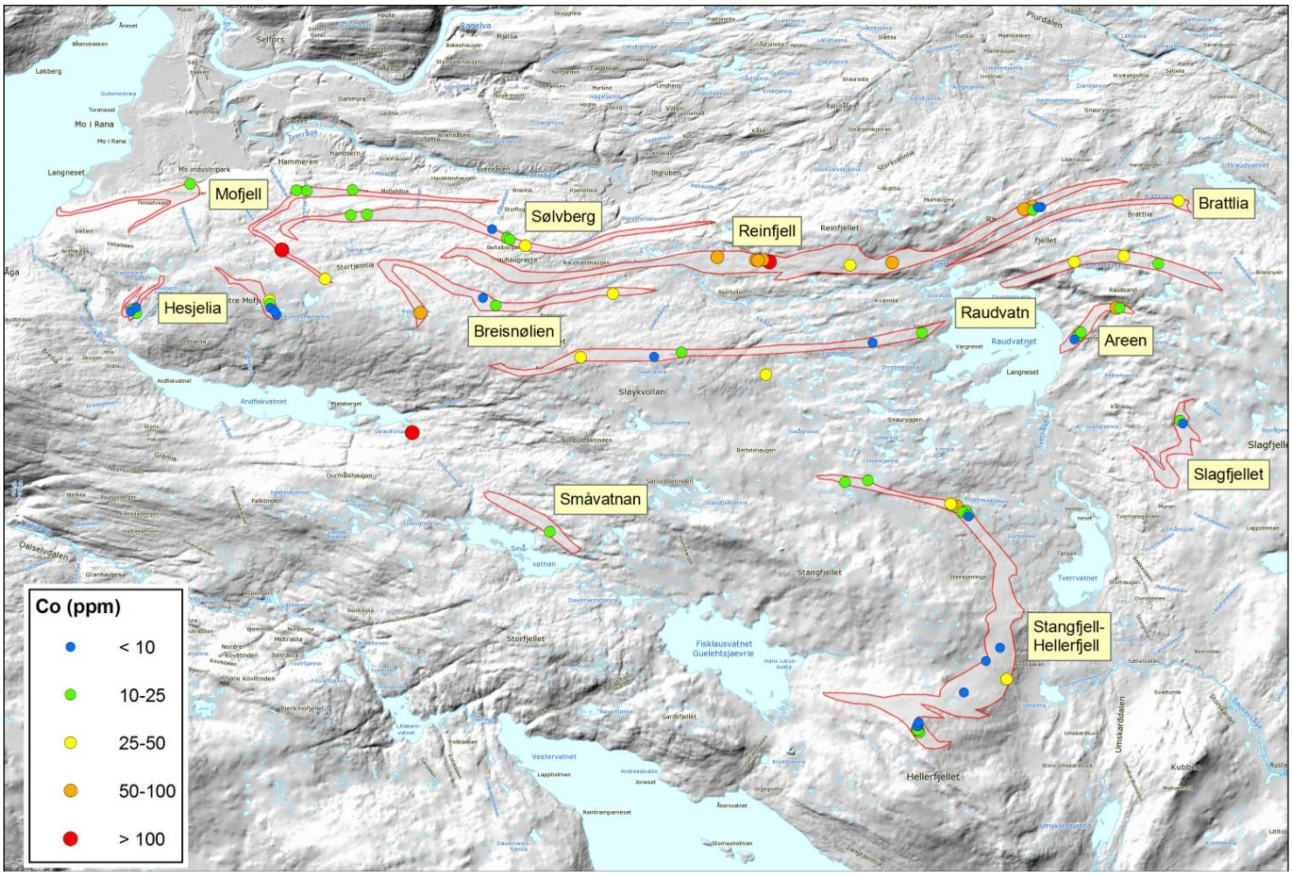


Figure 65: The zones of sulfide mineralization showing the average content of cobalt in the main deposits.

Cobalt (Figure 65) is particularly enriched in the Reinfjell zone, in some of the minor prospects in the eastern part of the Raudfjellet zone, and in the Breisnølien zone. These zones are also the most pyrite-rich, indicating that cobalt perhaps is present in the pyrite lattice. The highest values however, are found in the Skarbekken deposit in the Mofjellet zone (average 146 ppm).

Nickel (Figure 66) is enriched in the Stangfjell-Hellerfjell zone and the Breisnølien zone, as well as the Småvatnan, Breifonn and Avensjøen deposits. The values are particularly low in the Raudvatn, the Areens and most of the Reinfjell zone, except Avensjøen. It should be noted that high values are also found outside the main zones, associated with rusty, partly graphite-bearing schists.

Bismuth (Figure 67) shows to some extent a similar pattern as lead, being enriched in the Breifonn deposits in the Sølvberg zone, Småvatnan and Hellerfjell. But in contrast to lead, bismuth is also high in some of the Reinfjell and one of the eastern Raudvatn deposits.

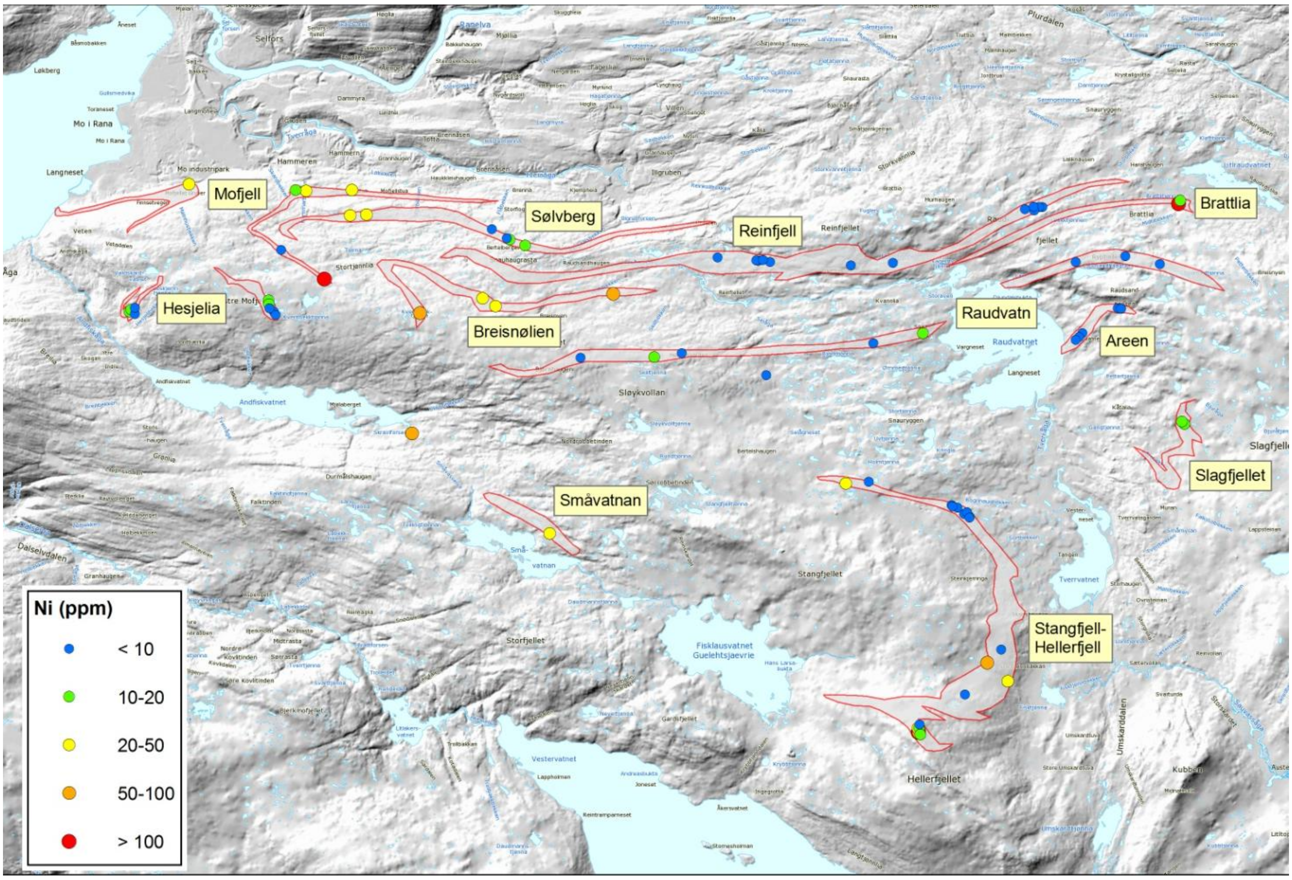


Figure 66: The zones of sulfide mineralization showing the average content of nickel in the main deposits.

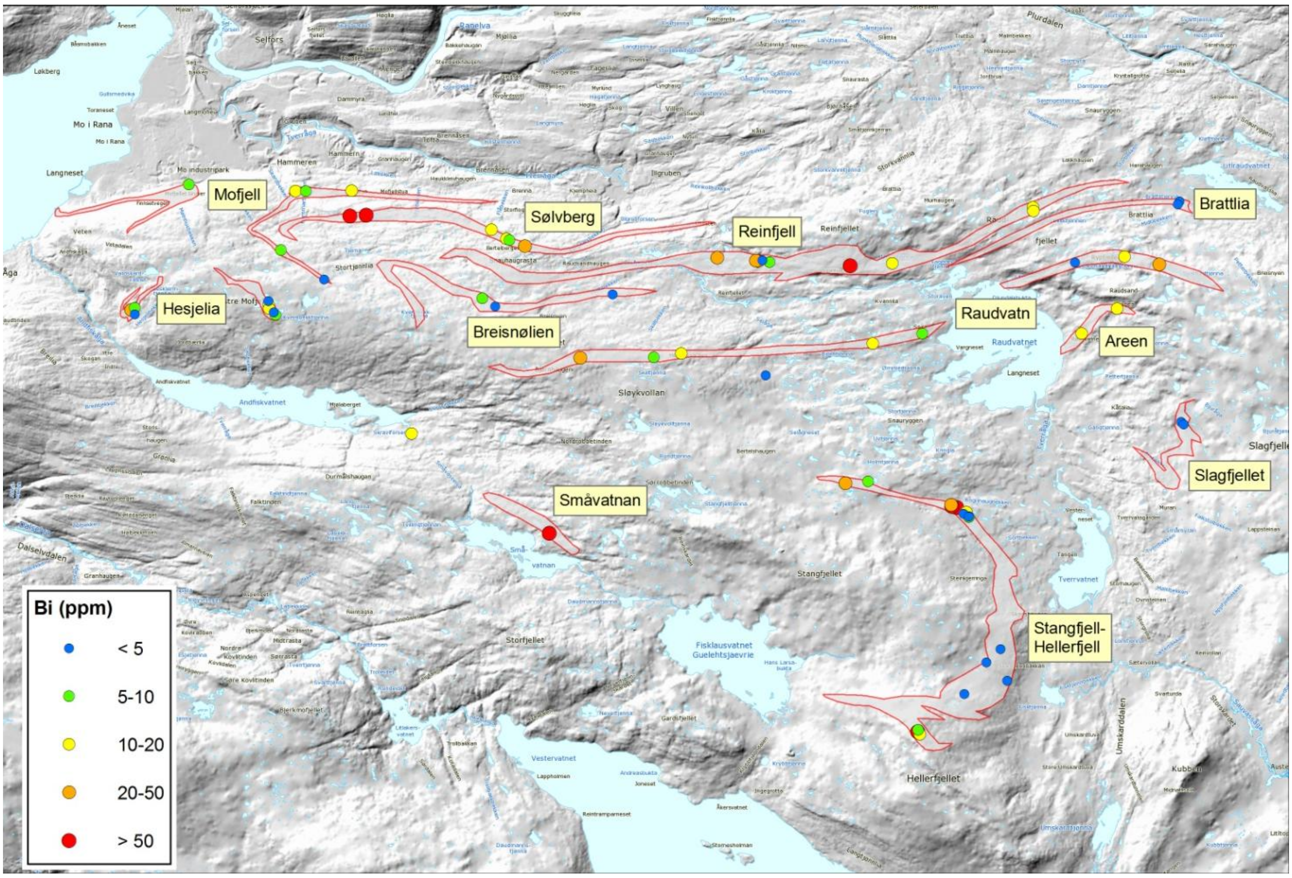


Figure 67: The zones of sulfide mineralization showing the average content of bismuth in the main deposits.

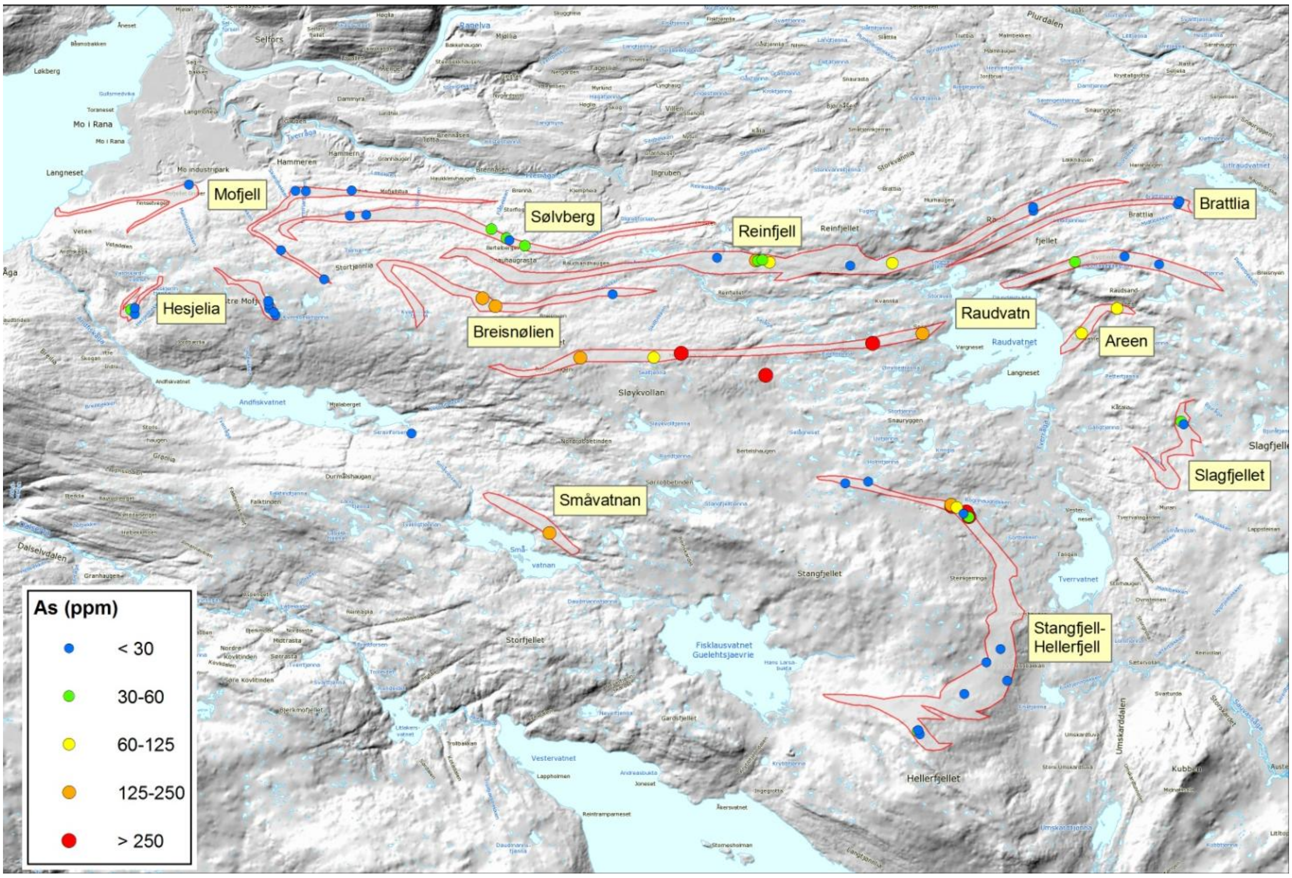


Figure 68: The zones of sulfide mineralization showing the average content of arsenic in the main deposits.

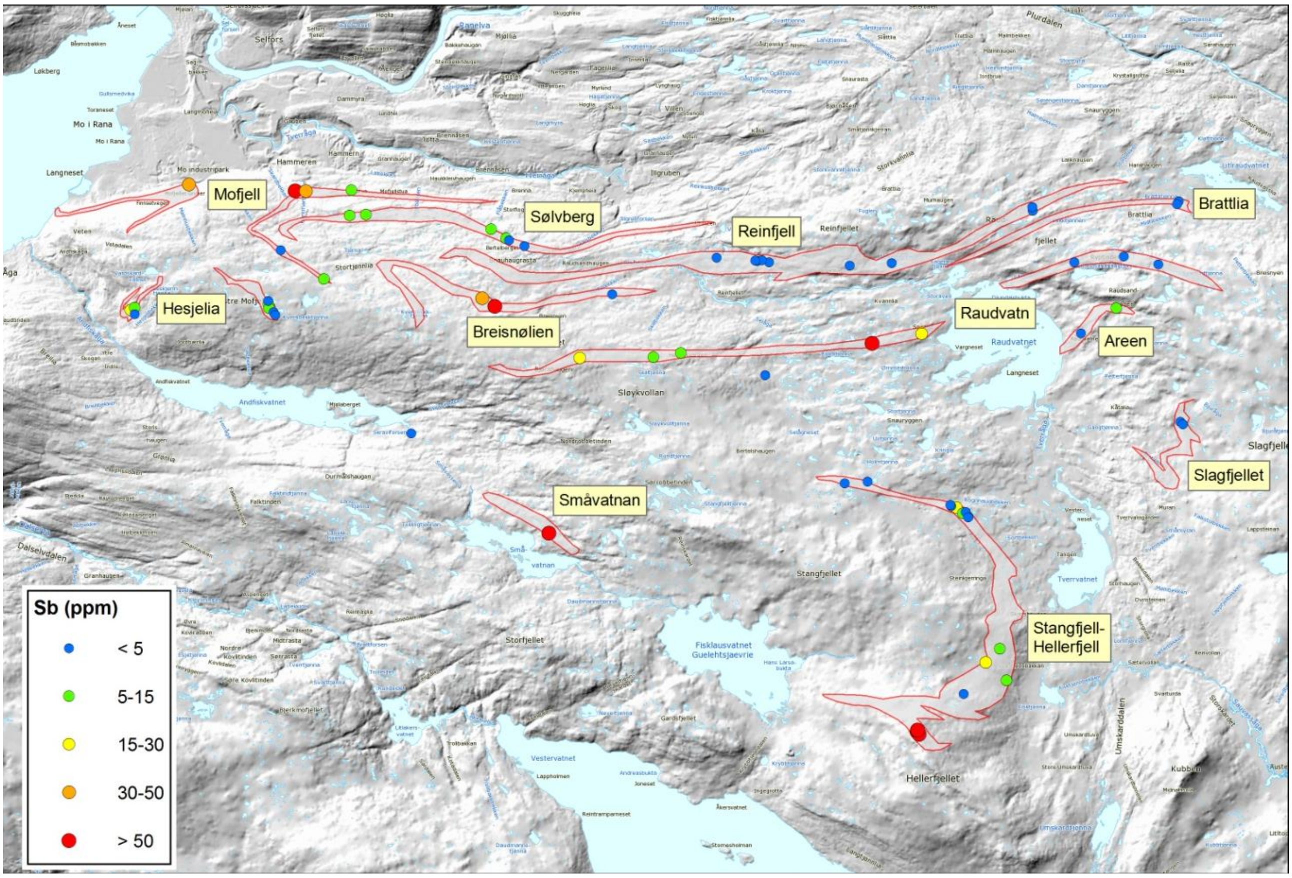


Figure 69: The zones of sulfide mineralization showing the average content of antimony in the main deposits.

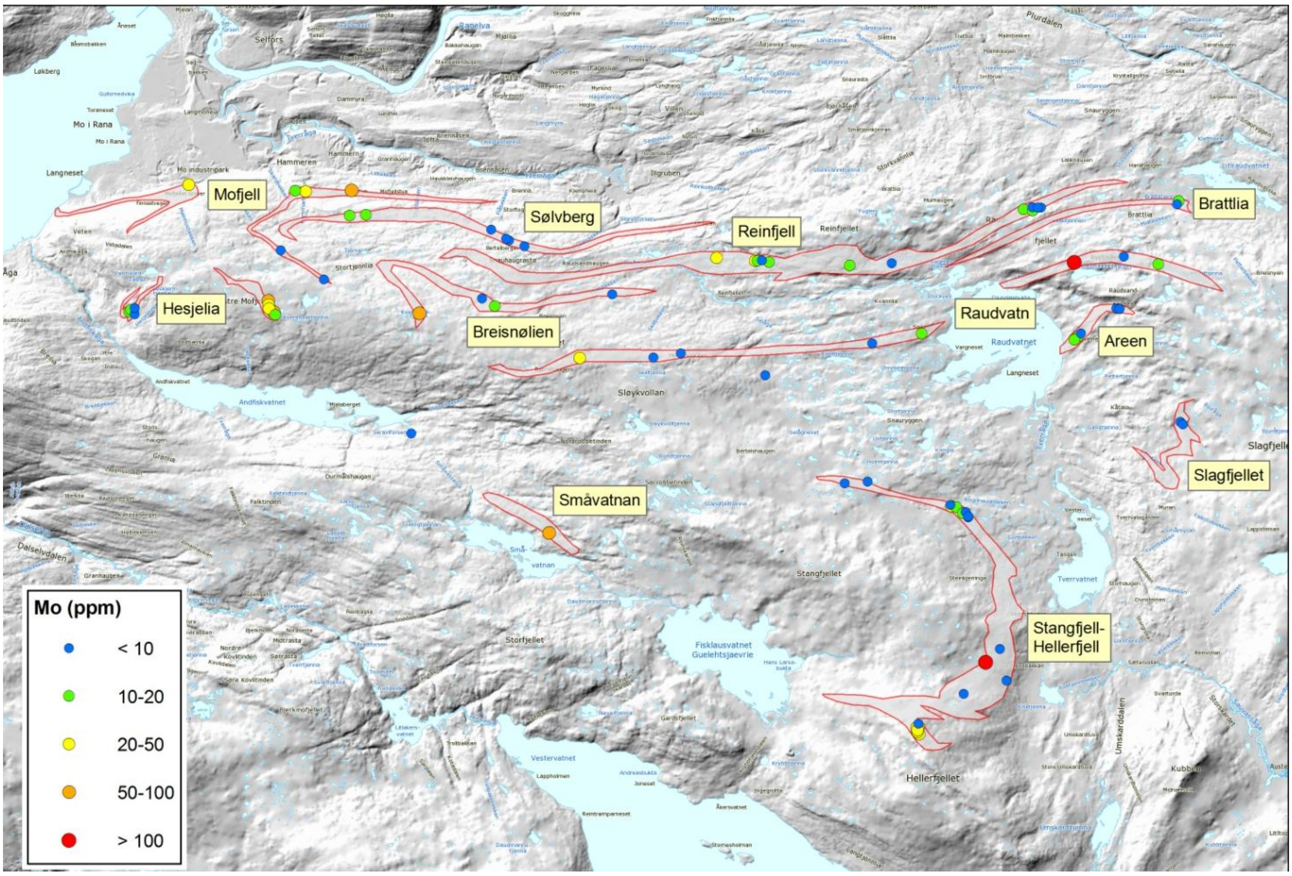


Figure 70: The zones of sulfide mineralization showing the average content of molybdenum in the main deposits.

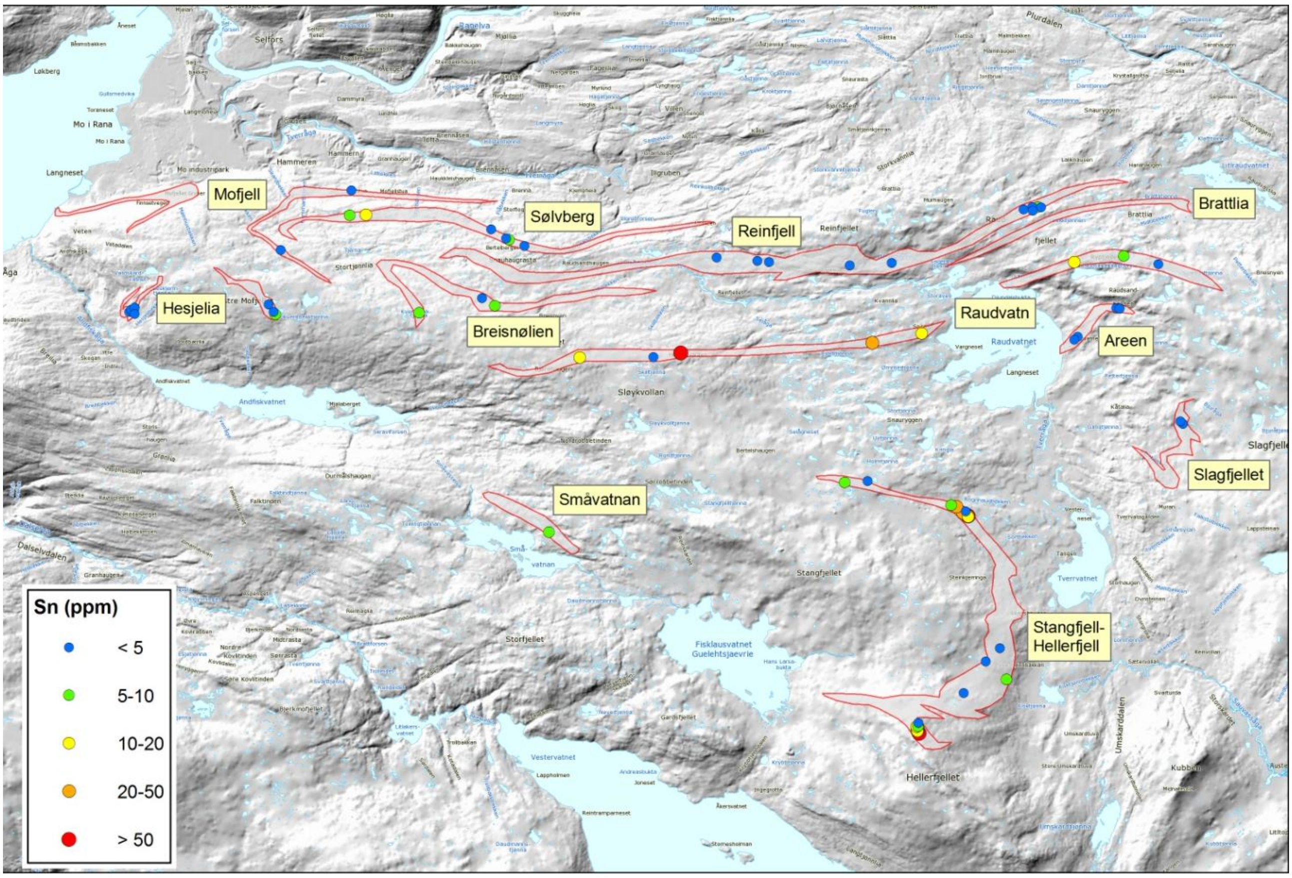


Figure 71: The zones of sulfide mineralization showing the average content of tin in the main deposits.

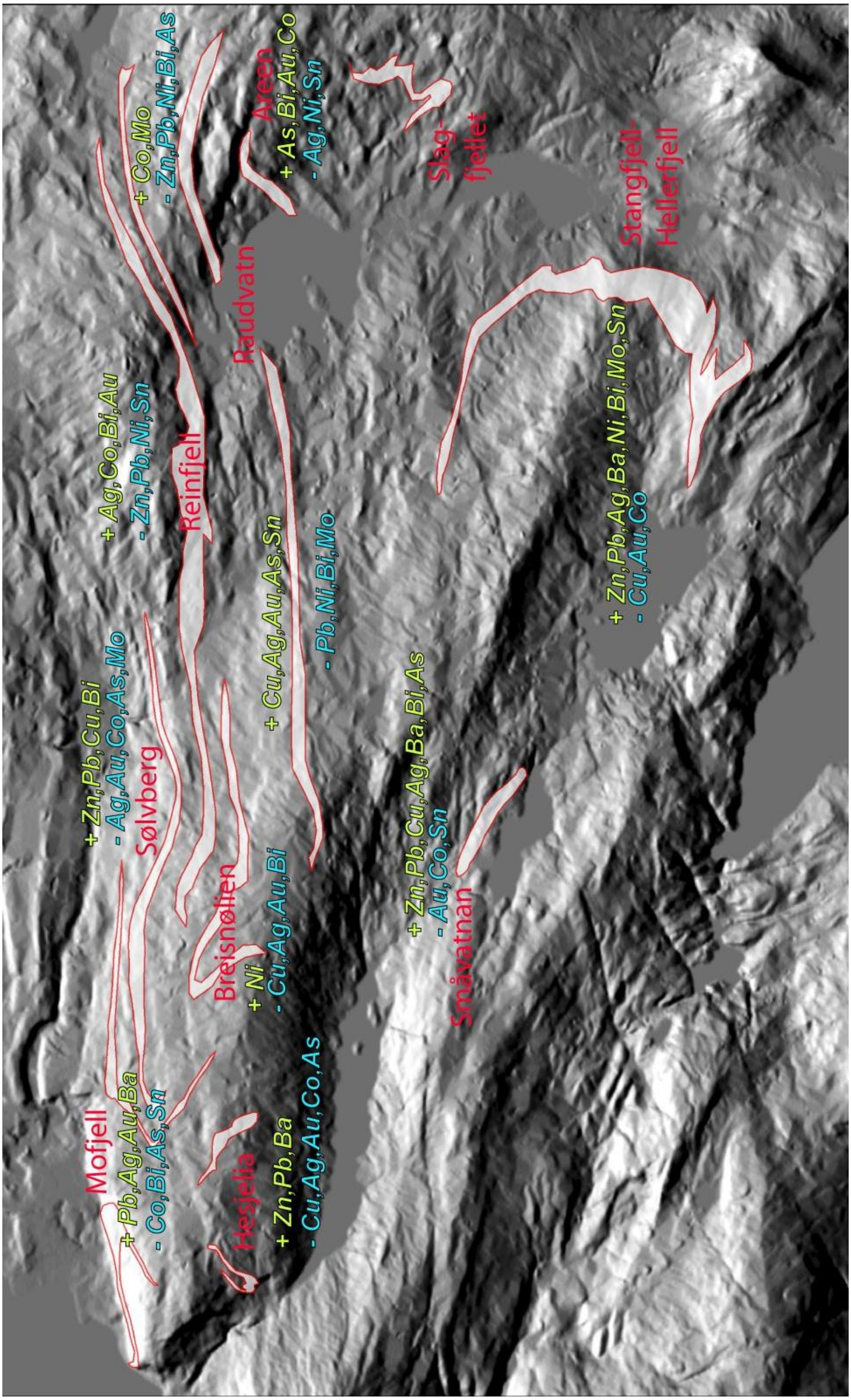


Figure 72: Overview of the Mofjellet ore zones showing the general enrichment and depletion of the different metals in relation to an average Mofjell district deposit.

Arsenic (Figure 68) is characteristic for the western part of the Raudvatnet zone (i.e. Heramb-Bertelberget, Kvannlia), and the Breisnølien, Småvatnan and Rognhaugbekken deposits. Some enrichment is also found in the major Areens and Mos deposits. All other zones and deposits are relatively poor in arsenic.

Antimony (Figure 69) is generally low except for some enrichment in the Hellerfjell, Breisnølien, Mofjellet and Småvatnan deposits. Especially high values have been found in the Småvatnan deposit (up to 780 ppm).

Molybdenum (Figure 70) shows some enrichment in the Hellerfjell zone (up 300 ppm), Småvatnan, Hammertjønna, Kvernbekktjern og Reinfjellet. One of the smaller Raudvatn prospects has the highest value of 940 ppm.

Tin (Figure 71) shows some enrichment in the western part of Raudvatn zone (especially Bertelberget deposit – 206 ppm) and the Rognhaugbekken (102 ppm) and Hellerfjell (154 ppm) deposits in the Hellerfjell zone.

Figure 72 gives an overview of the general patterns of metal distribution in the Mofjell ore zones and shows similarities between some of the deposits and ore zones. The most striking is the barium-rich deposits, which are found in the western and southern part of the Mofjellet area (Mofjellet, Hesjelia, Småvatnan and Hellerfjellet). These deposits are generally rich in lead, zinc, silver and molybdenum but low in elements like cobalt, arsenic (except Småvatnan) and tin (except Hellerfjellet). These similarities could point to some common sources of metals or similar physicochemical conditions during formation. It is also a possibility that these deposits originally were part of the same stratigraphic sequences, disrupted during the extensive deformation (folding, faulting, thrusting), especially since these deposits are separated by unconformities (see Figure 15).

The north and eastern part of the Mofjellet area, including the Reinfjell zone, the eastern part of Raudvatn zone and Areen zone are enriched in cobalt, and partly also rich in gold and bismuth. As mentioned above, these zones are generally characterized by having pyrite-rich, low base metal deposits. These mineralizations are most likely representing sulfides deposited distally from any vent systems.

3.3 Mineralogical descriptions and mineral chemistry

Some of the samples from the Mofjell deposits have been analyzed by SEM, in order to identify certain minerals and to investigate their chemistry. The analyses also provide information about which minerals host certain elements, about metamorphic reactions and conditions, and is also economically important (e.g. which minerals host the silver and gold).

3.3.1 Staurolite

Zincian staurolite has been known for a long time from some of the Mofjellet deposits, as well as from the Bleikvassli deposit in the southern part of the Rödingsfjäll Nappe Complex (Spry & Scott, 1986, Cook, 1993). In the Mofjellet area the mineral is common in the pyritiferous deposits of the Reinfjell and Raudvatn ore zones together with the zinc-spinel gahnite. The staurolite crystals have a deep orange color, and are locally found in up to a few cm long crystals.

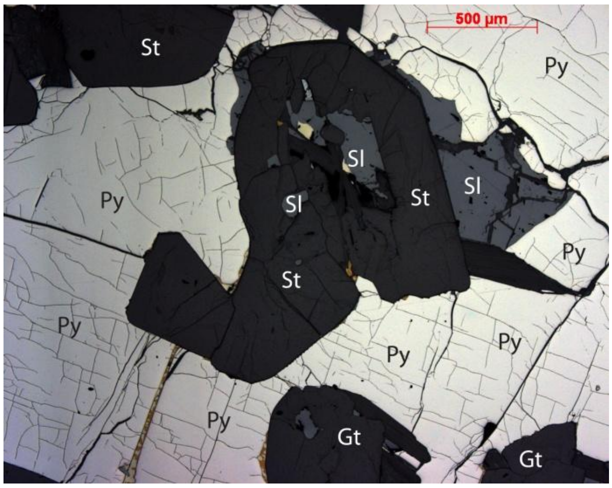
Seven grains of staurolite in the Raudsandhaugtjern deposit were analyzed by SEM and the data are displayed in Table 11.

Table 11: Mineralogical analyses of staurolite from the Raudsandhaugtjern deposit.

Sample	Ratj-06	Ratj-06	Ratj-06	Ratj-06	Ratj-06	Ratj-06	Ratj-06
analysis no.	1-1	1-2	1-7	2-4	2-5	3-1	3-2
si	27.93	26.36	27.23	26.60	28.23	26.16	26.58
ti						0.28	0.57
al	49.77	50.54	50.89	50.28	51.16	48.11	48.47
fe	4.91	5.5	5.77	5.98	5.59	4.94	5.41
mn		0.75	0.69	0.55	0.77	0.70	0.22
mg	2.46	2.49	2.25	2.17	2.23	2.25	2.36
ca							
na	1.31	1.05	1.12	1.34	1.40	0.81	1.01
k							0.15
cr				0.21			
ba							
zn	8.43	8.78	9.2	8.63	9.05	8.12	8.17
sum	94.81	95.47	97.15	95.76	98.43	91.37	92.94
tot.O	2.648	2.638	2.681	2.641	2.723	2.541	2.580
factor	8.685	8.718	8.580	8.707	8.447	9.053	8.913
si	4.04	3.83	3.89	3.86	3.97	3.94	3.94
ti	0.00	0.00	0.00	0.00	0.00	0.03	0.06
al	8.48	8.64	8.56	8.59	8.48	8.54	8.47
fe	0.59	0.67	0.69	0.72	0.66	0.62	0.67
mn	0.00	0.09	0.08	0.07	0.09	0.09	0.03
mg	0.53	0.54	0.48	0.47	0.47	0.51	0.52
ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00
na	0.37	0.30	0.31	0.38	0.38	0.24	0.29
k	0.00	0.00	0.00	0.00	0.00	0.00	0.03
ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
zn	0.90	0.94	0.97	0.92	0.94	0.90	0.89
cr				0.02			
sum cations	14.907	15.001	14.984	15.003	14.983	14.873	14.915

The table shows that staurolite contains between 8.1 and 9.1 wt. % ZnO, corresponding to nearly one cation of Zn per formula unit. The mineral also contains significant amounts of sodium, i.e. 0.2-0.4 cations per formula unit. On the basis of the data, a general formula can be written as
$(Ti_{0\text{-}0.1}Mn_{0\text{-}0.1}Na_{0.2\text{-}0.4}Fe_{0.1\text{-}0.2}Mg_{0.5}Zn_{0.9\text{-}1.0})(Al_{8.4\text{-}8.5}Fe_{0.5\text{-}0.6})(Si_{3.8\text{-}4.0}Al_{0\text{-}0.2})O_{20}(O, OH)_4$

The zincian staurolite has a tendency to occur close to, or have inclusions of sphalerite (Figure 73). The staurolite is thus a later phase, formed at the expense of sphalerite during the regional metamorphism. Zinc and partly iron in the staurolite may come from sphalerite, while magnesium, alumina and silica may come from phyllosilicates (biotite, sericite, clay minerals). The excess sulfur from the reaction may combine with iron and form pyrrhotite and/or pyrite.



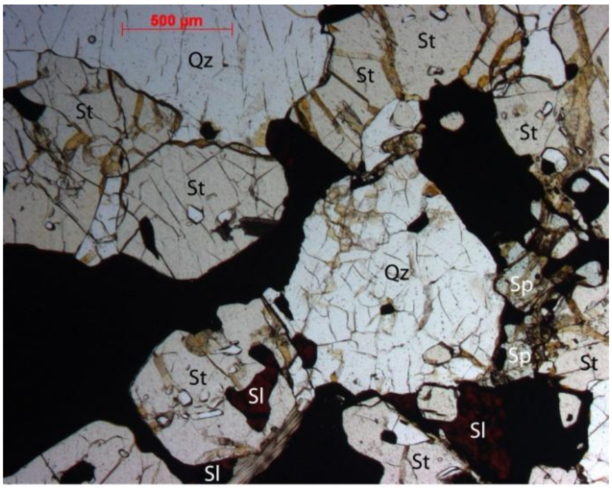


Figure 73: Photomicrographs from the Raudsandhaugtjern deposit, showing the relationships between staurolite and sphalerite. Sl-sphalerite, St-staurolite, Sp-spinel, Gt-garnet, Qz-quartz, Py-pyrite

3.3.2 Zinc-bearing spinel - gahnite

In the Raudvatn and Reinfjell zones of pyritiferous mica schist, zinc spinel is quite common as up to 1-2 mm sized bluish-green pyramidal crystals. Especially in the Thermos deposit, gahnite is quite common in samples on the dumps. In addition to several of the deposits in the Raudvatn and Reinfjell zones, gahnite has also been found in the Stangfjellet deposit, and is also reported from the Mofjellet deposit (Kruse, 1979).

Analytical data by Spry & Scott (1986) from the Thermos deposit show that the gahnite is close to end member composition, i.e. $(Zn_{0.8}Fe_{0.1}Mg_{0.1})Al_2O_4$. Similar compositions have been documented from the Bleikvassli deposit (Vokes, 1962, Spry & Scott, 1986), while gahnite from the Ripudden and Gräskevardo deposits across the Swedish border contain less magnesium (Sundblad, 1982).

Gahnite may form as a result of reaction between sphalerite and aluminous minerals (e.g. mica or clay minerals, Spry & Scott, 1986), but in the deposits of Mofjellet area it appears that gahnite is formed from the breakdown of zinc-bearing staurolite, since remnants of staurolite are found in the core of some gahnite grains (Figure 74). Gahnite also formed at the expense of chlorite, where chlorite has replaced staurolite (Figure 75). In other cases gahnite is found to overgrow clinoamphibole (Figure 76).

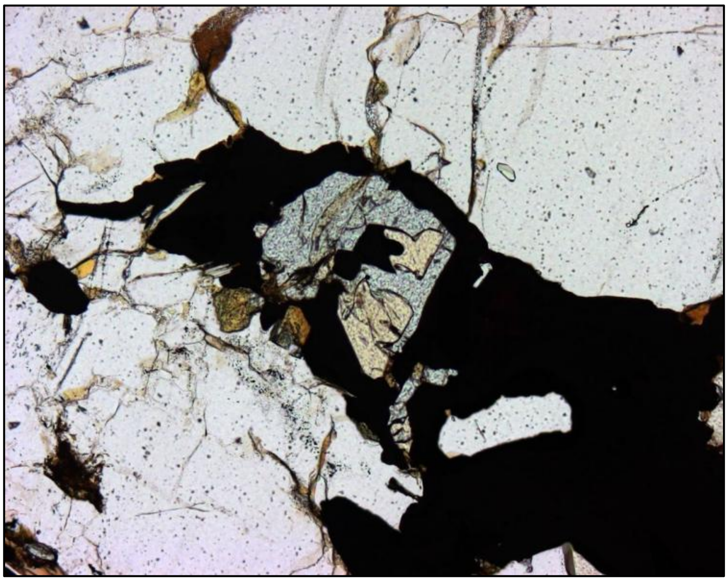


Figure 74: Grain of gahnite (bluish) with inclusions of partially resorbed staurolite (light brown). Sample from the Raudsandhaugtjern prospect no.4. The gahnite grain is about 300 microns across.

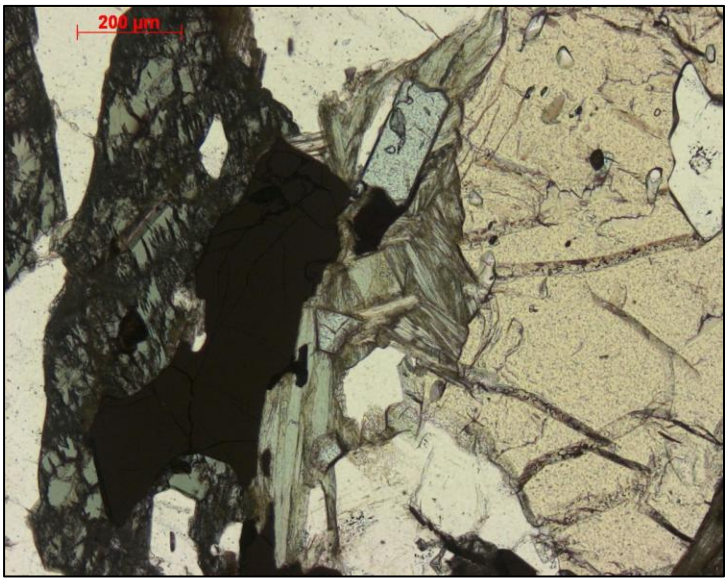


Figure 75: Grains of gahnite (bluish) overgrowing chlorite, the latter which is replacing staurolite. Sample from the Raudsandhaugtjern main prospect.

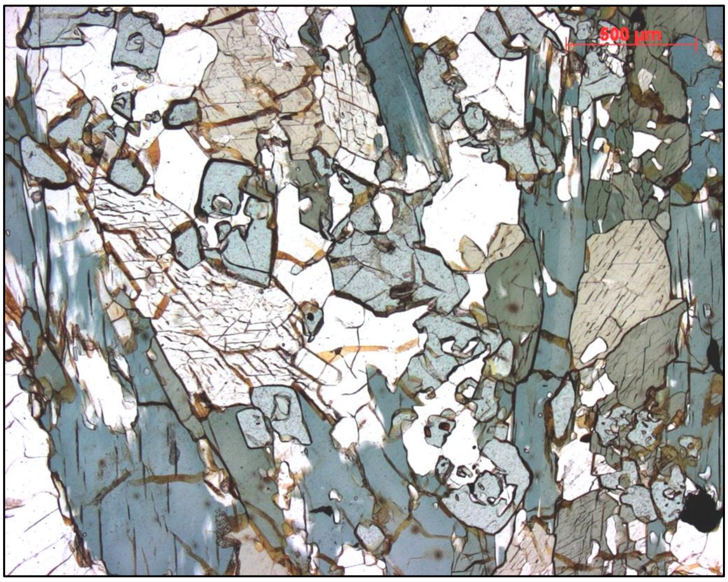
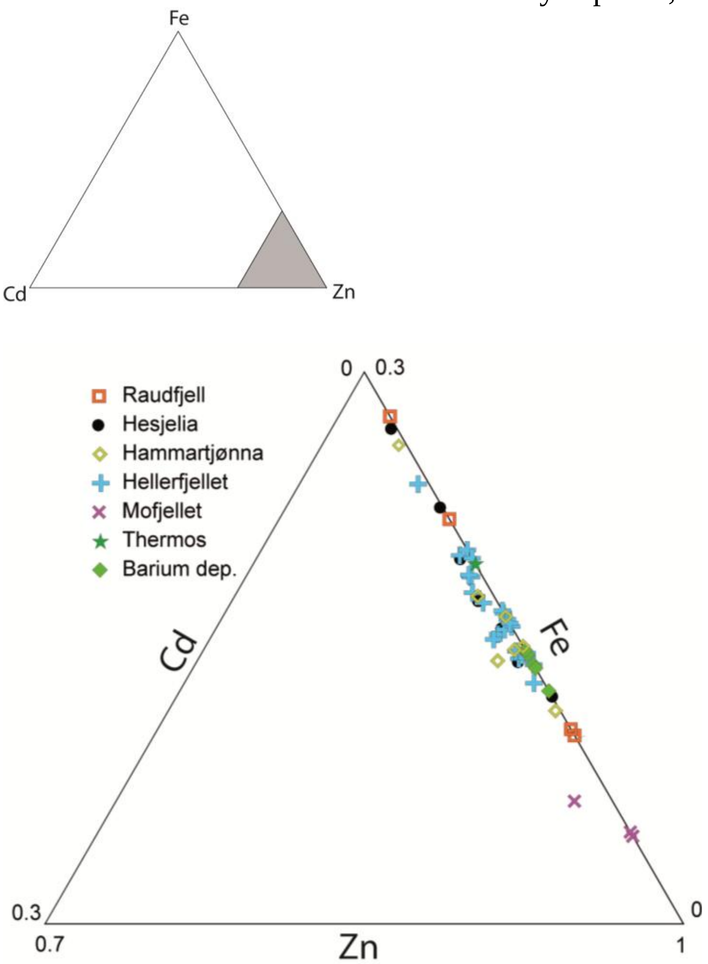


Figure 76: Grains of gahnite (light bluish prisms) overgrowing clinoamphibole (light to dark green). Sample from the Thermos main prospect.

3.3.3 Sphalerite

Sphalerite is the most important sulfide in the Mofjell deposits, and SEM analyses of the mineral have been carried out for some key deposits, and the data are displayed in Figure 77.



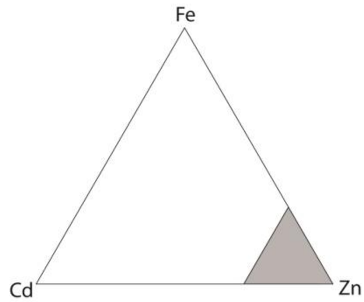


Figure 77: Composition of sphalerite in some of the Mofjell deposits displayed in a ternary Zn-Fe-Cd diagram.

The data show that the sphalerite grains contain between 5 and 28 % Fe and 0 and 2 % Cd per formula unit (e.g. $(Cd_{0.00}Fe_{0.05}Zn_{0.95})S$, $(Cd_{0.02}Fe_{0.07}Zn_{0.91})S$ and $(Cd_{0.00}Fe_{0.28}Zn_{0.82})S$). Sphalerite analyzed from the Skistua deposit, which is part of the main Mofjellet deposit, have low iron content (5-7 %) compared to the other deposits, which ranges from 10 to 25 % Fe per formula unit.

3.3.4 Barium-bearing minerals

The Mofjell, Hesjelia and Stangfjell-Hellerfjell zones, as well as the Småvatnan deposit, are characterized by high barium contents (see section 3.2 and Figure 64). Barium is mainly present in feldspar minerals (celsian and hyalophane, Figure 78), but also in barite, especially in the Mofjellet and Småvatnan deposit.

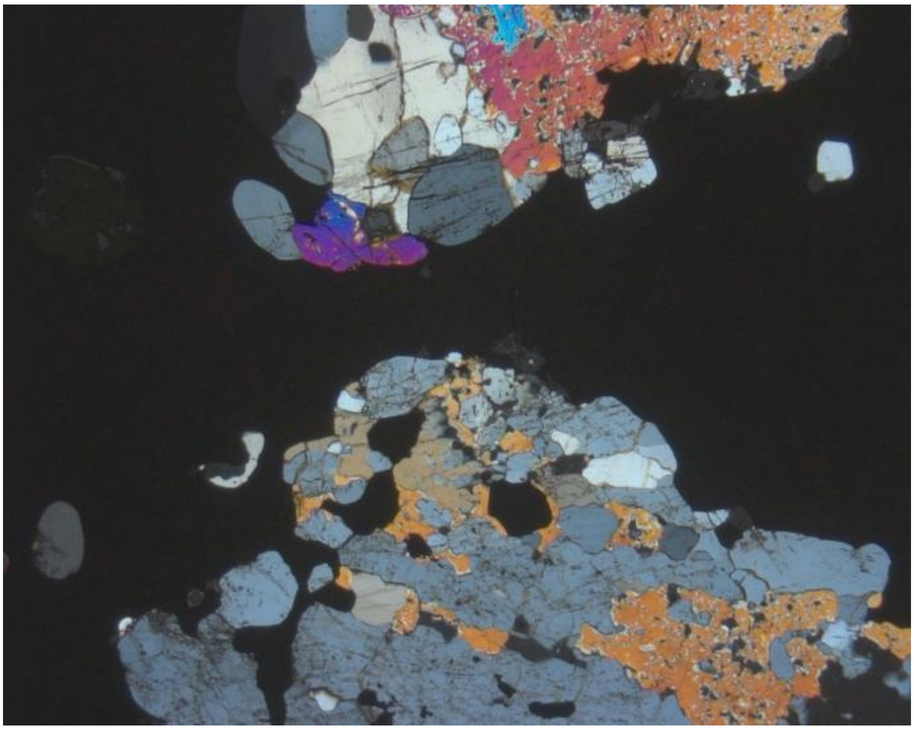


Figure 78: Photomicrograph from the Hellerfjellet deposit showing celsian (dark grey), quartz (light grey) and staurolite (colored) as matrix phases between sulfides (black).

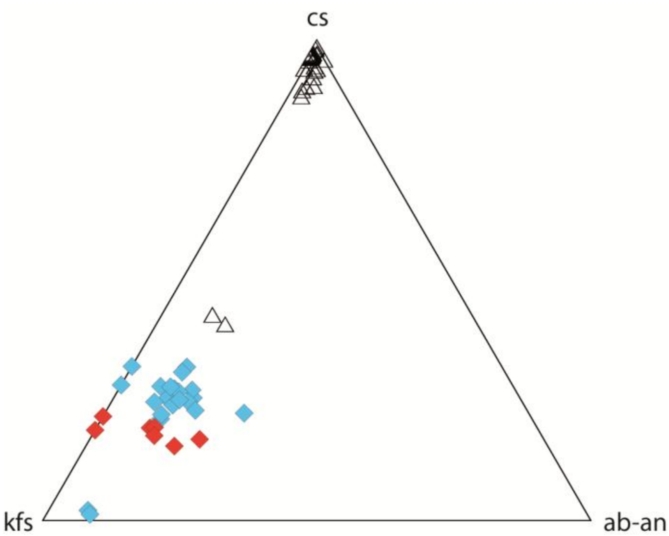


Figure 79: Composition of barium-bearing feldspars in some of the Mofjell deposits displayed in a ternary K-feldspar (kfs) – Celsian (cs) – Plagioclase (ab-an) diagram. Open triangles: Hellerfjellet and the Barium deposit, blue diamonds: Hesjelia deposit, red diamonds: Hammartjønna deposit.

The composition of the barium feldspars has been analyzed by SEM. The data show that the feldspars are either nearly close to the celsian end member, or hyalophane with mainly 15-30 % of the celsian component (Figure 79). Celsian is only found in the Stangfjell-Hellerfjell zone, while hyalophane is almost exclusively found in the Hesjelia zone. In the latter zone, the hyalophane in the Hesjelia deposit seems to be slightly richer in barium than the Hammer-tjønna deposit (Figure 79).

3.3.5 Silver-bearing minerals

Silver is a valuable minor component in a number of the Mofjell deposits (see section 3.2). The element follows more or less the same distribution as lead (and zinc), and is particularly high in the Småvatnan, Hellerfjellet and Heramb deposits (see Figure 62).

Silver is commonly lattice-bound in the main sulfides, especially in galena, but also pyrite, pyrrhotite, chalcopyrite and sphalerite may contain silver. SEM analyses on the main sulfides in the Mofjell deposits show a very low content of Ag, usually below detection limit, also in galena.

Minerals of the tetrahedrite-tennantite-freibergite family (i.e. $(Ag,Cu,Fe, Zn)_{12}(Sb,As)_4S_{13}$) are some of the main silver carriers in the Mofjell deposits. Freibergite has been found in a number of the deposits, including Hesjelia, Hammertjønna, Heramb, Bertelberget, Sølvberget and Mofjellet (for the latter deposit, see Cook, 2001). The mineral is generally found in close association with galena (Figure 80).

33 grains of freibergite (from Hellerfjellet, except for one grain from Hammertjønna) have been analyzed by SEM. The grain from Hammertjønna contains 10.2 % Ag (1.6 Ag per formula unit - pfu), while the Hellerfjellet grains contains 11.5-28.4 % Ag (1.8-5.2 Ag pfu). A collective formula for the freibergite samples analyzed may be written as $Cu_{4.7\text{-}8.3}Ag_{1.6\text{-}5.2}Fe_{1.6\text{-}4.1}Zn_{0.0\text{-}2.6}Sb_{2.9\text{-}4.9}S_{12.1\text{-}14.5}$. The compositions are different from what was obtained by Cook (2001) from the Mofjellet deposit, in which the freibergite varied from being antimony-rich (tetrahedrite) to arsenic-rich (tennantite).

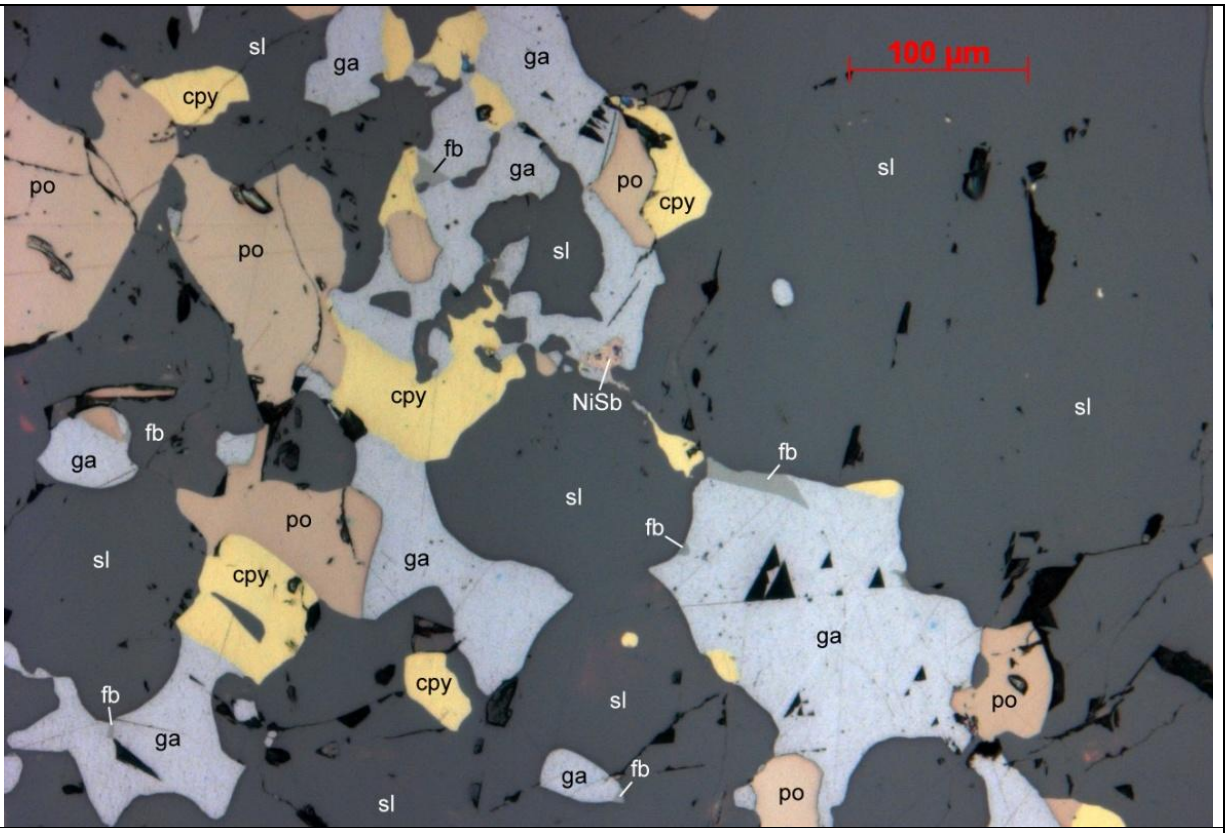


Figure 80: Photomicrograph from the Hellerfjellet deposit (prospect no. 6), showing typical sulfide textures, and including some minor phases. sl – sphalerite, po – pyrrhotite, cpy – chalcopyrite, ga – galena, fb – freibergite, NiSb – iron-nickel-antimony-sulfide.

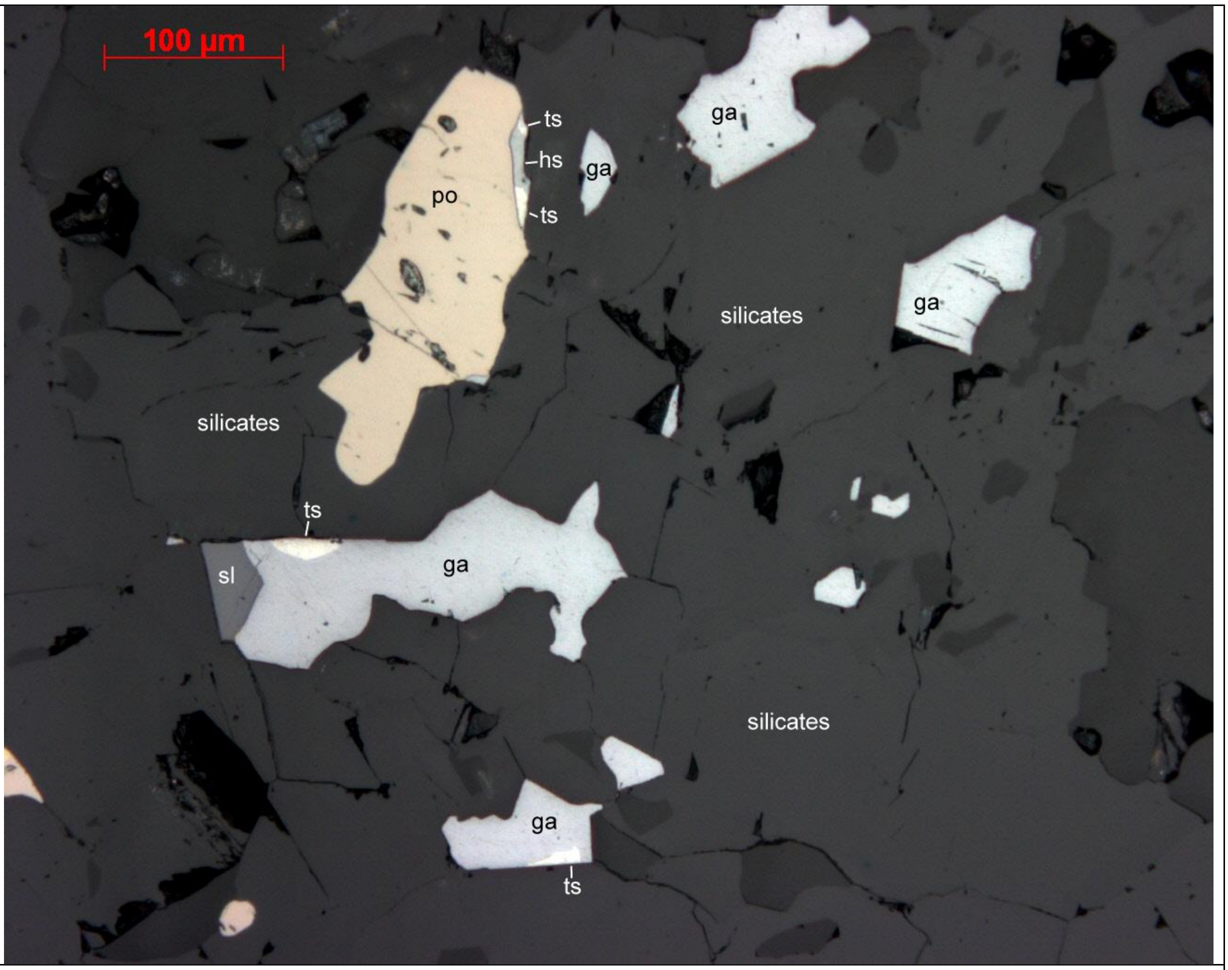


Figure 81: Photomicrograph from the Thermos deposit (prospect no. 9), showing disseminated sulfides (pyrrhotite – po, sphalerite – sl and galena – ga) with associated bismuth telluride (tsumoite – ts) and silver telluride (hessite – hs).

Another important silver-bearing mineral is hessite (Ag_2Te), which has been found in two of the Areens prospects, the Skarbekken prospect in the Mofjell zone, Kvernbekktjern in the Breisnølien zone, Heramb, two of the Raudsandhaugtjern prospects, Hellerfjellet and Thermos (Figure 81). Hessite is commonly associated and intergrown with other tellurides, and often bismuth-tellurides like tsumoite (BiTe) (Figure 81) or even native bismuth (Figure 82). The tellurides and bismuth are with few exceptions either associated with grains of galena or sphalerite.

There are also more complex silver tellurides found in the Hellerfjellet deposit, including possibly tellurium-bearing canfieldite (Ag_8SnS_6) and pirquitasite (Ag_2ZnSnS_4). Other silver-bearing phases found in Hellerfjellet are pyrargyrite ($Ag_3(Sb,As)S_3$) and argentite (Ag_2S).

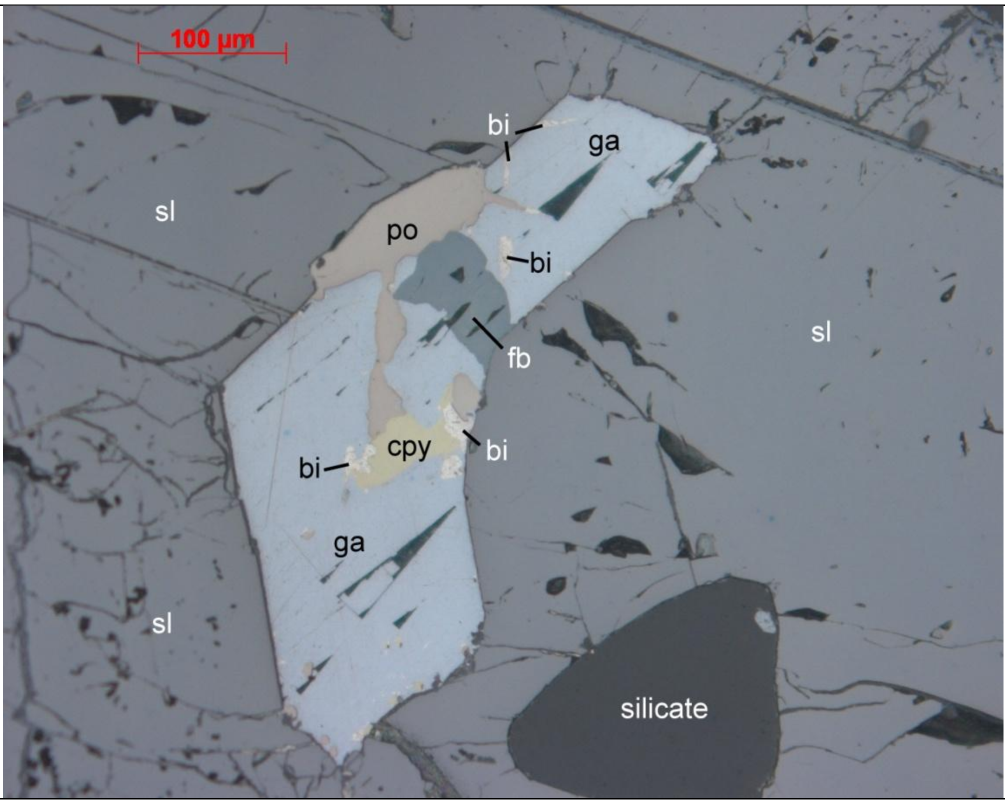


Figure 82: Photomicrograph from the Skarbekken prospect, showing a grain of galena (ga) in sphalerite (sl), intergrown with pyrrhotite (po) and chalcopyrite (cpy) and with inclusions of freibergite (fb) and native bismuth (bi).

3.3.6 Other mineralogical observations

Molybdenite has been found as thin laths, often associated with and included in sphalerite, in a number of the deposits.

Kesterite – $Cu_2(Fe,Zn)SnS_4$ – was identified by SEM in the Hellerfjellet deposit. The mineral is commonly found together with freibergite as inclusions in galena, but has not been found to be associated with the tellurides mentioned above.

Breithauptite – NiSb – was also identified by SEM in Hellerfjellet, found as tiny inclusions in galena (Figure 80).

Another complex *Fe-Ni-Zn-Ag-Sb sulfide* was also found as tiny inclusions in galena in Hellerfjellet. This could be a very fine intergrowth of iron-rich tucekite – $(Fe,Ni)_9Sb_2S_8$ – with an Ag-bearing phase.

In one of the Hesjelia samples a tiny grain (6-7 µm) of palladium-antimonide ($Pd_{12}Sb_{13}$, could also be sudburyite - PdSb) was found in a complex intergrowth of sphalerite, chalcopyrite, pyrrhotite and galena.

3.4 The nature and origin of the sulfide-bearing mica schists

The major sulfide deposits are almost exclusively related to extensive zones of iron sulfides (mainly pyrite) hosted by quartz-muscovite and biotite gneisses/schists (Figure 14 and Figure 15). At some places the pyrite was mined, e.g. the Mos mine (see section 3.1.4).

The close association between the extensive zones of pyritiferous mica schists and the sulfide deposits, clearly points to a common origin. One possibility is that the schists represent distal depositions of sulfides from the hydrothermal vents at the seafloor, so-called plume fall-outs or/and resedimented erosion products. Another possibility is that the schists are parts of the alteration zones beneath and surrounding the main centers of hydrothermal activity.

Locally these zones contain enrichments of gold, e.g. the Areens, Reinsfjell and Mofjellet zones, which could be economically important.

Some investigations have been carried out on the mica schists, including geochemistry, to try to understand their nature and origin. This is important also with respect to finding new base metal deposits and to assess the economic potential in the known deposits.

The elements Al, Ti and Zr are generally regarded as some of the most immobile during hydrothermal alteration and metamorphic overprint. They can therefore give some clues to which lithologies the deposits and zones are related to. REE data may also hint to the origin of the rocks, but also give some clues to processes responsible for the alteration.

Figure 83 show ternary Al-Ti-Zr and REE spider diagrams for the most extensive, pyritiferous mica schist zones (Raudvatn East, Reinfjell). In addition the Thermos mineralization is included, representing the eastern part of the extensive Reinfjell zone. In the diagrams the average values for the main lithologies (amphibolite and grey gneiss) are shown for comparison.

The schist samples are generally distributed between the average compositions of amphibolite and grey gneiss in the ternary diagrams (Figure 83). Even though the samples show a large range, there is a tendency for the biotite-quartz schist samples to group around the amphibolite average, while the quartz-muscovite schist samples plot closer to the grey gneiss average, but with an extension toward the amphibolite. This is an indication that the biotite schists are mainly derived from the amphibolite, while the muscovite-rich schists seem to have more of a mixed or different origin. The range in the muscovite schist data could perhaps also reflect variations in the composition of the original rock.

In the REE spider diagrams, the quartz-muscovite generally are depleted in the LREE (La-Sm) and relatively enriched in HREE (Dy-Lu) compared to LREE and show a negative Eu anomaly (Figure 83). The biotite-quartz schists and a few muscovite schist samples do not show this pattern.

The depletion in total REEs and relative depletion in LREE compared to HREE for especially the Raudvatn zone and the Thermos deposit with respect to REE patterns can be explained by the influence of seawater. Seawater is characterized by a positive La anomaly, a negative Ce anomaly and a weak LREE depletion compared to HREE (Figure 84). These trends and especially a high La/Ce ratio are evident in the data from the Reinfjell zone. The seawater influence may be due to mixing in sulfides deposited at the seafloor, at some distance from the vent sites, e.g. plume fall-outs.

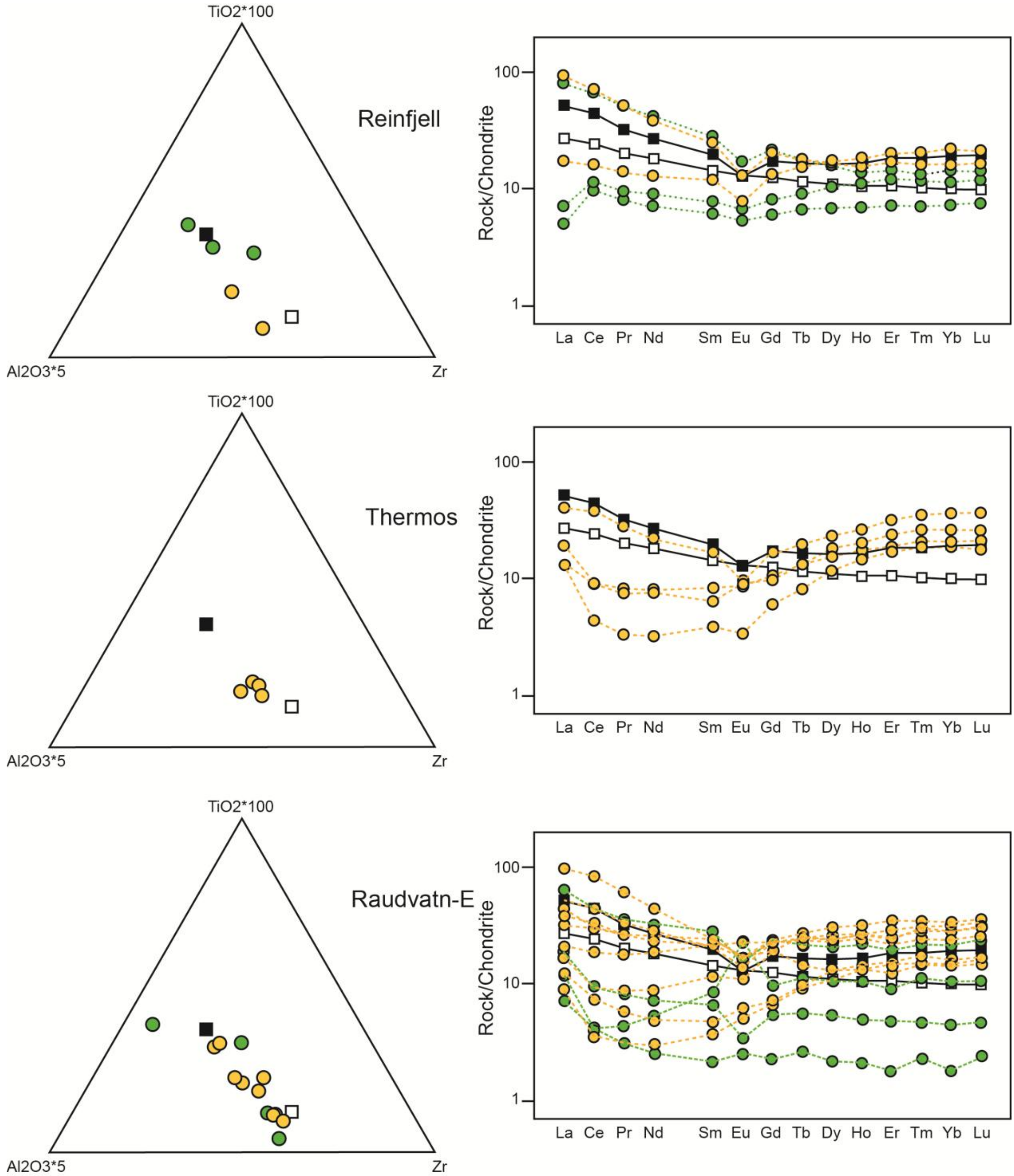


Figure 83: Ternary diagrams of Al, Ti and Zr, and REE spider diagrams from the most extensive pyritiferous mica zones (Raudvatn, Reinfjell, including Thermos), compared to the average of amphibolite and grey gneiss. Green circles are biotite-quartz schist, yellow circles are quartz-muscovite schist, filled square is average amphibolite and open square is average grey gneiss.

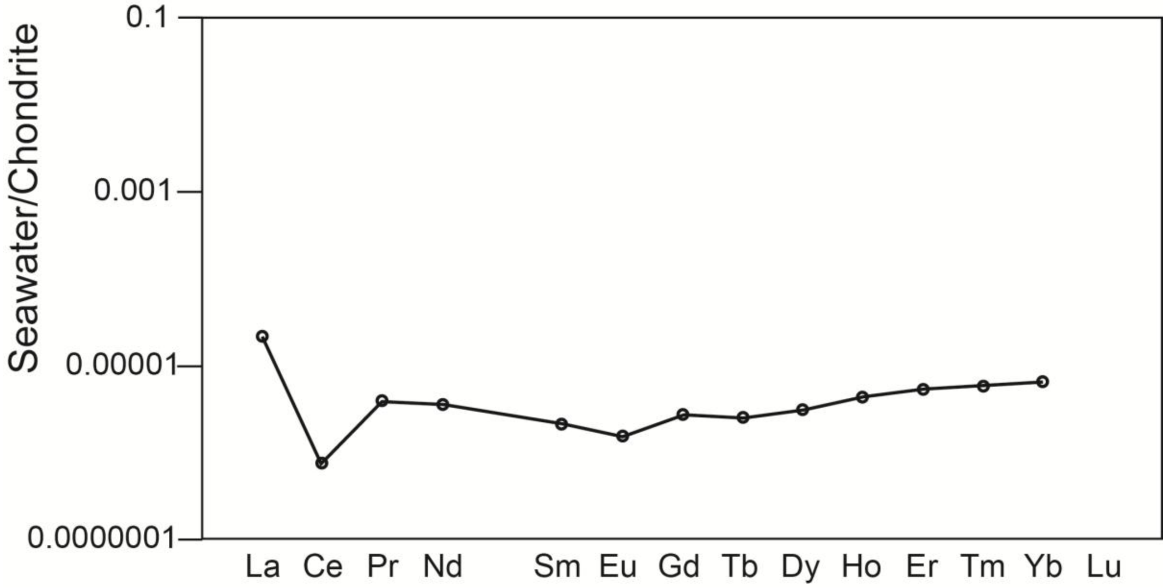


Figure 84: Example of typical chondrite-normalized pattern for seawater REE data (data from Pacific Ocean by Bau et al., 1996).

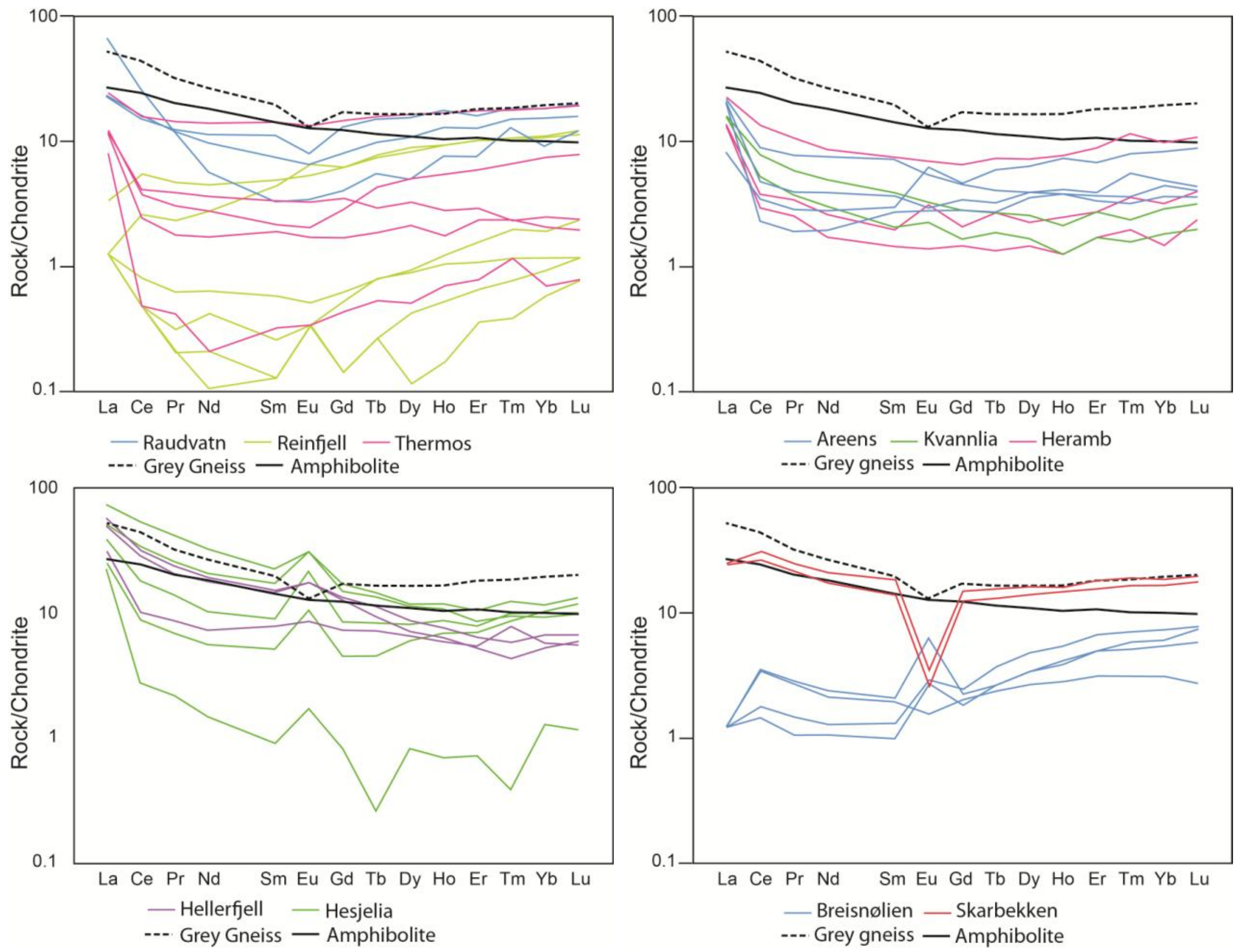


Figure 85: REE spider diagrams of ore samples from different ore deposits. All samples have contents of Fe_2O_3 > 20 %. Average grey gneiss and amphibolite are shown as references.

Figure 85 displays REE data for sulfide-rich samples (lower limit is Fe_2O_3 = 20 %) from several ore deposits representing different ore zones. The Reinfjell and Thermos sulfides of the Reinfjell zone are generally strongly depleted in REE, especially in LREE, which again could be explained by a large influx of seawater in the hydrothermal precipitates. Similar, but less pronounced patterns are displayed by the Areens, Raudvatn E, as well as the Heramb and Kvannlia deposits (the latter representing Raudvatn W). The Hellerfjellet and Hesjelia (both Hammartjønna and Hesjelia occurrences) deposits, show higher LREE/HREE ratios and pronounced positive Eu anomalies. The Breisnølien deposit show positive Eu and Ce anomalies. These patterns are typical of hydrothermal reduced fluids (e.g. see Spry et al. 2000) and thus these sulfides were probably deposited directly at the seafloor with less seawater mixing. The Skarbekken occurrence, which is part of the Mofjellet deposit, show a very different REE pattern than the other deposits, having a flat pattern with a pronounced negative Eu anomaly. It is also less depleted in total REE than the other deposits. The deposit is quite rich in magnetite, which is a late phase overgrowing the sulfides (see section 3.1.2). The pattern may therefore be explained by entrainment of a late oxidizing fluid phase, e.g. a magmatic source.

3.5 Summary, discussions and conclusions regarding ore geology

During the field periods in 2008 and 2009 nearly all the sulfide deposits (a total of 219 mines, prospects and showings) in the Mofjell Group were visited, of which most have been sampled (150 localities) and investigated in some detail.

In conjunction with bedrock mapping, these studies have shown that the deposits are of a volcanogenic massive sulfide (VMS) origin, genetically associated with felsic and mafic volcanic rocks formed in an oceanic island arc environment (see also section 2.3.4). This is an environment which elsewhere has been found to be favorable for rich, but generally not very large sulfide deposits (i.e. an average of 3.4 Mt for 291 deposits in this setting worldwide, Franklin et al., 2005). However, a few gigantic deposits in this setting are also known, including the 150 Mt Kidd Creek and the 200 Mt Horne deposit, as well as several deposits in the Urals in Russia with + 100 Mt of ore (Franklin et al., 2005).

As much as nine major ore zones at different structural levels are identified in the Mofjell Group (Figure 14, Figure 15). Some of these zones, like the Raudvatn, Reinfjell and Stangfjell-Hellerfjell zones are quite extensive, with lengths along strike of 8-20 km.

Due to extensive deformation, including several phases of folding and formation of discordances probably formed by internal thrusting, it is very difficult to determine if some of these zones were once connected. However, the lithologies and geochemical data for some of the zones are quite similar, which could indicate correlations or at least similar sources for metals or similar conditions during formation. The most evident is the barium- and metal-rich Mofjellet, Hesjelia, Småvatnan and Hellerfjellet deposits and related zones in the western and southern Mofjellet area (Figure 14). It is a possibility that these deposits originally were part of the same lithologic sequences, disrupted during the extensive Caledonian deformation. This seems to be supported by the thick units of amphibolites, which are found close to all of these deposits (Figure 4).

The pyritiferous deposits belonging to the Reinfjell, eastern Raudvatn and Areens zones probably all formed in a similar way. On the basis of lithogeochemical patterns and mineralogy, most deposits in these zones are probably distal sulfide accumulations, formed at the seafloor away from the vent sites.

The geochemistry and mapping of the ore zones and the sulfide deposits have shown that there are clear differences between a number of them regarding metal content and size. The economically most interesting ore zones and deposits are the Hellerfjellet deposit in the Stangfjell-Hellerfjell zone, The Småvatnan zone, The Hesjelia zone, Heramb and Bertelberget in the Raudvatn zone, the Sølvberget deposit in the Sølvberg zone and the Mofjellet deposit in the Mofjell zone.

4. RECOMMENDATIONS FOR FURTHER WORK

4.1 Lithogeochemistry

155 samples of different rocks have been subject to whole rock analysis (excluding ore samples), of which around 120 samples also have been analyzed for REE. A number of the samples are from altered lithologies, and only around 80 samples are from supposed un-altered rock. The latter samples have mainly been taken from easy accessible localities (i.e. close to roads).

With this background, it is recommended to collect a number of additional samples from more remote parts of the area of the main units of grey gneiss and amphibolite. In this way it may be possible to correlate some of the units to help unravel the lithostratigraphy in the area.

4.2 Follow-up work on the different ore zones

4.2.1 The Hesjelia zone

The Hesjelia zone represents a recumbent fold structure, closing to the south and with a total length of c. 2.9 km from the Hesjelia to the Hammertjønna deposits (Figure 16). Geophysical data indicate a connection between the mineralizations at Hammertjønna and Hesjelia and one drillhole in 2008 strengthened this assumption. At c. 110 m depth a weak mineralization was intersected in the hole assaying 0.14 % Cu, 0.09 % Pb, 0.60 % Zn and 3 g/t Ag over 6 m interval. Furthermore, both the Hesjelia and Hammertjønna mineralizations are characterized by being barium-rich, as is the mineralization in the drillhole from 2008.

The thickness of the ore zones in the deposits are rather restricted, (c. 3 m), and the mineralizations are not very rich (c. 3 % Zn, 0.2-0.3 % Cu, 0.5-1 % Pb, < 10 g/t Ag). However, the length of the ore zone (almost 3 km) and the presence of fold structures, mean that this zone have a potential for hosting an economic ore body.

4.2.2 The Mofjellet zone

Interpretations and calculations from old data and additional diamond drilling in 2006-2007 led to a resource estimation of c. 0.76 Mt of ore with c.4.2 % base metals. Later work and drilling refined the resource estimate to a measured resource of 0.3 Mt zinc-rich ore, as well as 0.4 Mt of indicated ore and 2.85 Mt of inferred ore in the Mofjell deposit according to http://www.silver.fi/tiedostot/reports/Financial%20Reports/Gexco_AB_SotkamoSilver_5562241892_Prospekt.pdf

In addition to the base metals, the deposit contains 10-20 g/t Ag and locally high gold grades.

On this basis the Mofjell deposit deserves more work in order to secure larger identified resources and to define the gold distribution.

4.2.3 The Sølvberget zone

The Sølvberget zone has a length of more than 4 km (Figure 20). A number of prospects mark the outcropping upper flank of a north-closing major recumbent fold structure, a structure which may also control the sulfide zone, and is recommended as a target for further exploration. The fold structure is outcropping again in the western part of Mofjellet, but no prospects or richer mineralizations are known from this part of the structure.

During the 1980s, geophysics and a number of drill holes documented that the Sølvberget zone have the potential of being a quite large (>> 1 mill. t), but probably not very rich sulfide deposit (c. 2-2.5 % Cu+Zn+Pb).

The two Breifonn prospects are very rich in base metals (1-2 % Cu, 7-8 % Zn, 0.8-1 % Pb, 16-19 g/t Ag). This mineralization seems to be on a higher structural level than the Sølvberg main zone. as shown by the old drillholes (Figure 23). Furthermore, the geophysics (TURAM) indicates that Breifonn represents a conductor separated from the main Sølvberg zone (Figure 17).

More drilling is recommended in the Sølvberget zone, especially at the fold hinges, to restrict the mineralization and to find out if the structures have led to the formation of thicker ore layers. More work is also recommended at Breifonn to determine the nature and extent of this rich mineralization.

4.2.4 The Reinfjell zone

The Reinfjell zone is characterized by a number of small pyrite-rich deposits with low contents of base metals. The mineralizations are associated with thin, extensive horizons of biotite gneiss, which have been subject to mining where the pyrite occurs in massive layers (e.g. Mos mine).

The only deposit in the zone which is rich in base metals is the main Reinfjellet prospect, with a calculated average of 0.24 % Cu, 4.06 % Zn, 0.21 % Pb, 23 g/t Ag and 0.34 g/t Au. It is outcropping as a 0.75 m massive thick layer in a small stream (Figure 28). This massive zone can be followed eastwards for almost 800 m in a number of showings. The other showings however, are much lower in base metals, typically less than 0.5 %. Locally gold grades above 1 ppm have been found.

Because of the generally low contents of base metals, this zone has low potential for economic mineralization. More work here should not be given high priority.

4.2.5 The Breisnølien zone

The Breisnølien zone is quite long, extending for 6 km on the north to north-west slope of Mofjellet. The mineralization is associated with a thin horizon of muscovite gneiss, which grades into biotite-bearing gneisses.

On the basis of drilling in the 1980's and sampling and mapping during this project, the mineralization has been found to be rather low in base metals and of limited thickness and extent. More work on this zone is not recommended.

4.2.6 The Raudvatn zone

Only the western part of the Raudvatn zone seems to have any mineralization potential, i.e. the Heramb-Bertelberget area (Figure 31). The eastern part, to the east of Raudvatnet, comprises pyrite-rich, base metal poor, small showings.

Both the Heramb and Bertelberget deposits are open at depth and may also somehow be connected, according to geophysical data (Figure 32). A very strong geophysical anomaly (TEM and TURAM) c. 200 m to the north of the Heramb deposit was the target for drilling in 2008, but no mineralization was found. The reason for this anomaly remains unknown. More work is recommended in the area determine if the deposits are connected, and to constrain the extent of the mineralization.

4.2.7 The Areen zone

The Areen zone extends eastward for c. 1.2 km from the eastern shore of Raudvatnet and the mineralization is associated with a folded layer of muscovite-biotite gneiss (Figure 39). The main deposit was mined for pyrite (c. 200 t produced), and the mineralization has very low base metal grades (0.17 % Cu+Zn+Pb), but is quite rich in gold (up to 0.98 g/t).

However, two prospects that are located 1000 m to the NE of the mine, consist of bands of semi-massive to massive pyrite with quite high amounts of sphalerite and some chalcopyrite (The averages in the two prospects are 0.05 % Cu, 3.49 % Zn, 0.03 % Pb and 1.00 % Cu, 4.61 % Zn, 0.02 % Pb). The degree of outcrop is very limited in this area, meaning that the extent of the mineralization is not known. The TEM geophysics shows only a very weak anomaly in the area, which could indicate that the mineralization is limited in extent.

4.2.8 The Småvatnan zone

Only one deposit is known in the Småvatnan zone consisting of a mineralized zone with an overall thickness of 3-4 m. Average metal contents based on 13 dump samples is 0.6 % Cu, 10.0 % Zn, 1.9 % Pb, 141 g/t Ag and 0.3 g/t Au. 19 analyses by portable XRF on 6 samples yield an average of 1.6 % Cu, 6.8 % Zn, 1.6 % Pb and 5.8 % Ba. This mineralization has been followed along strike for only 30 m. It is associated with a zone of biotite-muscovite gneiss, which is locally hornblende-bearing. The lithologies in the area are extensively deformed and folded, which also affects the mineralization, making it ruler shaped.

A lot of cover with swampy terrain makes it impossible to follow the mineralization westwards, but a weak TEM anomaly in its presumed continuation could be due to sulfides (Figure 53).

The high contents of base metals and silver make this deposit an interesting target. It is recommended to be investigated by drilling to find out whether the geophysical anomaly associated with the deposit is caused by sulfides.

4.2.9 The Stangfjell-Hellerfjell zone

The outcrops of the *Hellerfjellet* deposit consist of a number of small, very rich sulfide lenses (> 10 % Cu+Zn+Pb, > 100 g/t Ag) surrounded by weak sulfide disseminations (see section 3.1.9). The only drillhole by GEXCO intersected 5 m with c. 2 % base metals and 27 g/t Ag 250 m downdip from the outcrops. TEM data indicates that the mineralization may extend for at least 1.5 km along strike, showing that this is a very interesting target, deserving further work, including more diamond drilling to delineate the mineralization.

The *Barium mineralization* in the same ore zone, 2-3 km to the north of Hellerfjellet, is interesting because of the high Ba content. The enrichment of barium compared to other elements, probably means that it is a distal deposition of minerals. It is a possibility that the mineralization somehow is connected to Hellerfjellet, which also is quite rich in barium, or that it is connected to an unknown mineralization.

The *Avanbekken* mineralization consists of a 7-8 m thick quartz-sericite schist with pyrite-sphalerite-galena dissemination. It extends 200 m to the north, while the southern extension is not known. The few analysis of the mineralization show low base metal content, but more work is recommended to assess the mineralization potential (e.g. ground geophysics – IP?).

Rognhaugbekken appears to be a ruler-shaped deposit, a shape attained due to extensive deformation. The deposit has been subject to quite detailed investigations, and according to the existing data, is not rich in base metals. Even though richer mineralization at depth is not ruled out, this deposit should not be prioritized.

4.2.10 Other zones

The less extensive Brattli and Slagfjellet zones have no interesting mineralizations and the geochemical data are also disappointing. No more work is therefore recommended in these zones.

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Table A1: Average content of metals in the main Mofjell deposits (continued on next page)

Deposit	Ore zone	east	north	totbas	Ag	Au	Cu	Zn	Pb	Ni	V	Fe%	Mn	Co	S%	As	Sb	Bi	Cd	Mo	Ba	Sn
Areens grube s.5	Areen	480534	7351472	5.624	10.2	0.02	1.00	4.61	0.02	10	26	23.93	454	52	23.29	62	11	15	118	7	48	2.0
Areens grube s.4	Areen	480604	7351457	3.578	0.8	0.08	0.05	3.49	0.03	5	25		1007	22						7	44	1.5
Areens grube	Areen	479772	7350897	0.305	2.0	0.16	0.06	0.22	0.02	3	198		2169	21						16	103	4.0
Areens grube s.2	Areen	479702	7350837	0.142	2.0	0.98	0.00	0.12	0.02	3	61		232	9						14	125	2.0
Areens grube s.3	Areen	479832	7350977	0.049	6.0	0.89	0.01	0.03	0.00	10	21	20.04	287	12	22.34	91	2	15	0	9		
Brattlia s.1	Brattlia	481772	7353597	0.259	0.7	0.01	0.21	0.05	0.00	20	26	19.82	522	45	13.00	5	2	4	4	11		
Brattlia s.2	Brattlia	481742	7353537	0.114	0.4	0.00	0.07	0.04	0.00	106	46	18.88	432	166	12.59	12	2	2	0	5		
Breisnølien s.2	Breisnølien	468204	7351511	4.152	6.5	0.16	0.14	3.97	0.04	37	92	3.85	499	11	2.86	150	60	4	35	18	1095	6.0
Kvernbekktjern	Breisnølien	466703	7351365	3.294	18.0	0.32	0.35	1.50	1.44	57	113		929	51						55	151	9.0
Breisnølien	Breisnølien	467948	7351668	1.718	5.8	0.21	0.15	1.54	0.03	35	47	16.20	338	8	15.41	167	35	7	56	9	886	2.5
Kjempeheia s.2	Breisnølien	470532	7351747	0.743	6.1	0.02	0.10	0.63	0.01	82	56	8.42	201	50	6.13	2	2	4	44	5		
Hesjelia s.1	Hesjelia	460952	7351393	10.879	2.0	0.23	0.17	10.70	0.01	14	15		697	4						14	44248	3.0
Hesjelia hovedskjerp	Hesjelia	460980	7351432	8.420	17.7	0.14	1.32	7.00	0.10	12	9	24.92	717	21	29.96	59	27	22	395	13	35623	2.0
Hammertjønna s.4	Hesjelia	463844	7351334	5.776	47.6	0.01	0.22	3.48	2.08	4	8	15.14	215	3	4.29	3	3	6	115	19	7455	6.0
Hammertjønna s.1	Hesjelia	463704	7351617	4.476	3.3	0.01	0.20	4.03	0.25	13		4.83	564	31	4.56	3	3	3	138	72	460	
Hammertjønna	Hesjelia	463718	7351541	1.947	4.3	0.07	0.24	1.36	0.34	11	7	9.22	373	16	10.46	10	9	12	48	36	20765	3.0
Hammertjønna s.3	Hesjelia	463812	7351393	1.730	2.8	0.05	0.24	1.43	0.07	5	45	5.20	218	2	3.18	3	5	4	47	78	15401	2.0
Hesjelia s.2	Hesjelia	461059	7351355	1.290	4.7	0.02	0.16	1.11	0.02	8	8	21.90	398	17	23.19	18	2	3	89	10	133	0.5
Hammertjønna-p	Hesjelia	463726	7351469	0.547	2.9	0.09	0.16	0.34	0.05	5		7.61	407	7	8.10	21	6	11	13	34	50	
Hesjelia s.4	Hesjelia	461054	7351480	0.531	9.0	0.07	0.12	0.40	0.01	3	3	3.45		1		7	15	6		2	3470	2.0
Hammeren s.1	Mofjell	464242	7353807	4.906	56.1	1.00	0.94	2.74	1.22	18	40	5.94	373	14	7.69	26	51	16	147	17		
Skistua	Mofjell	465357	7353810	4.346	11.0	0.44	0.39	3.08	0.88	21	116	6.87		22		3	14	15		88	99700	1.0
Mofjellet	Mofjell	462130	7353930	4.322	20.6	0.41	0.38	3.18	0.76	22			520	14		27	37	7		24	19500	
Hammeren	Mofjell	464452	7353797	3.817	44.3	1.09	0.97	2.21	0.64	22	33	9.25	327	19	10.08	21	34	10	111	24		
Skarbekken	Mofjell	463955	7352622	1.174	9.8	0.10	0.85	0.27	0.06	2	6	25.63	872	146	18.50	4	2	7	18	3	406	1.0
Hammertjørna pp	Mofjell	464812	7352047	0.685	10.8	0.03	0.01	0.50	0.17	171	23	2.90	136	44	1.61	7	12	2	19	3		
Heramb gruve	Rauvatn	469892	7350487	6.959	45.3	0.45	3.73	3.07	0.16	7	20	15.69	616	29	13.19	136	21	24	76	23	175	13.3
Bertelberget	Rauvatn	471892	7350577	3.708	21.5	0.37	1.95	1.69	0.06	5	14	23.45	405	12	15.89	332	6	12	41	4	94	107.8
Skillebekk	Rauvatn	471353	7350494	2.299	29.3	0.18	0.29	2.01	0.00	14	6	42.83	889	6	32.96	75	8	6	74	5	3	4.0
Raudsandhaugen	Rauvatn	481371	7352346	2.194	15.6	0.12	0.03	1.99	0.17	4	17	17.12	379	21	34.51	12	4	37	79	11	19	1.0
Kvannlia	Rauvatn	476676	7350967	2.092	5.2	0.07	0.11	1.97	0.02	15	22	19.48	307	19	17.34	165	18	8	135	12	559	17.5
Raudsandhaugtjern	Rauvatn	480688	7352498	1.566	16.5	0.14	0.40	1.10	0.06	7	12	17.44	313	41	27.36	22	3	16	67	5	306	9.0
Kvannlia s.1	Rauvatn	475692	7350775	1.035	78.8	6.08	0.05	0.34	0.65	5	11	5.07	92	7	5.40	895	156	13	25	4	521	25.0
Raudsandhaugtjern s.4	Rauvatn	479703	7352381	0.872	5.4	0.14	0.49	0.38	0.00	6	23	19.74	644	42	35.13	47	2	2	1	475	103	11.0
Selåga	Rauvatn	473567	7350141	0.577	2.1	0.05	0.09	0.48	0.01	4	2	22.64	228	47	32.34	312	2	2	18	5		

Deposit	Ore zone	east	north	totbas	Ag	Au	Cu	Zn	Pb	Ni	V	Fe%	Mn	Co	S%	As	Sb	Bi	Cd	Mo	Ba	Sn
Reinfjellet	Reinfjell	472606	7352476	4.506	23.2	0.34	0.24	4.06	0.21	8	10	27.20	301	61	32.46	26	5	21	143	37	2	1.0
Thermos s.9	Reinfjell	478870	7353483	1.613	9.5	0.17	0.27	1.31	0.04	3	7	28.05	441	53	17.90	15	4	11	29	4	10	3.0
Thermos	Reinfjell	478875	7353405	1.429	4.8	0.09	0.10	1.24	0.10	3	21	17.97	362	15	32.24	20	5	10	79	11	54	1.8
Mos gruve	Reinfjell	476077	7352368	1.100	12.9	0.08	0.69	0.37	0.04	5	34	20.00	186	55	40.53	61	2	14	8	4	14	1.8
Mos gruve s.13	Reinfjell	475242	7352317	1.078	27.4	0.04	0.06	0.78	0.23	3	2	24.56	168	41	45.86	17	3	66	19	10	19	0.5
Thermos s.11	Reinfjell	478979	7353475	0.812	9.0	0.26	0.27	0.52	0.02	3	10		3873	1						2	38	6.0
Reinfjellet s.11	Reinfjell	473414	7352412	0.687	17.9	1.17	0.07	0.41	0.20	3	17	15.34	463	57	9.98	48	3	36	1	18	83	1.5
Thermos s.7	Reinfjell	478692	7353430	0.684	15.0	0.04	0.00	0.67	0.01	-5	16		232	50						17	15	2.0
Thermos s.4	Reinfjell	479038	7353475	0.562	6.0	0.06	0.32	0.22	0.02	6	24		852	10						5	70	3.0
E12 v/Reinfjellet	Reinfjell	473644	7352387	0.503	1.7	0.05	0.18	0.31	0.01	2	17	14.11	597	107	6.20	63	3	6	1	12	115	0.5
E12 v/Reinfjellet I3	Reinfjell	473502	7352429	0.424	1.3	0.05	0.12	0.29	0.01	1	14	13.03	549	75	9.89	46	3	2	19	10	110	
Reinfjellet s.10	Reinfjell	473370	7352419	0.405	18.9	0.15	0.09	0.06	0.25	3	5	25.30	229	92	10.00	129	3	26	2	39	50	
Slagfjellet s.3	Slagfjellet	481810	7349215	0.449	5.0	0.07	0.20	0.23	0.01	12	22	9.51	289	15	8.31	37	2	4	3	10	153	2.0
Slagfjellet	Slagfjellet	481859	7349169	0.407	2.7	0.01	0.04	0.34	0.02	19	21	4.50	434	7	4.46	27	2	2	14	5	178	3.0
Småvatnan	Småvatnan	469279	7347003	11.389	96.7	0.43	1.13	11.32	2.31	45	35	7.87	1016	15	4.64	177	448	56	606	57	57569	5.2
Skravlefossen	Småvatnan	466542	7348987	2.545	6.2	0.01	0.66	1.87	0.02	75	9	33.00	545	116	30.67	28	2	12	81	1		
Breifonn hovedskjerp	Sølvberg	465646	7353323	10.720	18.9	0.03	2.09	7.80	0.83	33	21	33.26	1593	12	30.50	17	10	68	665	15	401	11.8
Breifonn s.1	Sølvberg	465328	7353312	9.891	15.5	0.01	1.57	7.32	1.00	50	24	30.93	1420	13	28.37	3	7	50	418	20	284	7.5
Sølvberget s.3	Sølvberg	468130	7353033	2.294	11.6	0.17	0.70	1.45	0.14	7	5	15.86	176	2	7.55	49	6	13	42	10	451	2.0
Sølvberg s.1	Sølvberg	468482	7352818	0.627	3.0	0.08	0.49	0.13	0.01	14	10	21.80		11		8	3	10		6	409	10.0
Sølvberg s.6	Sølvberg	468792	7352704	0.451	14.0	0.04	0.11	0.20	0.14	14	3	16.70		29		59	5	32		1	117	5.0
Sølvberg hovedgruve	Sølvberg	468427	7352858	0.433	3.0	0.08	0.40	0.02	0.01	3	20	39.00		21		32	12	11		4	1455	2.0
Hellerfjellet s.4	Stangfjellet	476585	7343055	48.188	219.8	0.03	1.91	41.74	4.54	115	12	19.02	1198	61	18.36	35	131	65	2444	40	17840	38.0
Hellerfjellet s.6	Stangfjellet	476590	7343090	18.205	94.8	0.05	1.23	15.10	1.88	86	158	14.42	878	38	12.19	10	64	10	893	28	7286	40.0
Hellerfjellet	Stangfjellet	476623	7343006	16.809	123.9	0.04	0.32	14.95	1.54	14	17	5.72	461	11	7.47	12	97	15	784	41	3873	154.0
Hellerfjellet s.9	Stangfjellet	476598	7343140	6.114	25.0	0.01	0.02	3.58	2.51	17	167		775	5						80	15048	10.0
Hellerfjellet s.3	Stangfjellet	476594	7343047	3.986	25.0	0.01	0.26	3.13	0.59	81	174		1007	11						39	12271	18.0
Hellerfjellet s.16	Stangfjellet	476605	7343213	2.477	2.0	0.01	0.02	2.02	0.44	8	22		155	3						6	1725	2.0
Rognhaugbekken-s.3	Stangfjellet	477358	7347518	2.218	18.0	0.24	0.06	0.61	1.55	3	34	27.90		62		86	21	101		20	24	31.0
Hellerfjellet s.9b	Stangfjellet	476576	7343138	2.196	16.0	0.01	0.29	1.58	0.33	23	72		1626	5						28	8151	11.0
Stangfjellet-s.2	Stangfjellet	475600	7348023	1.488	2.3	0.02	0.09	1.15	0.25	10	52	4.38	370	22	2.60	11	3	9	19	6	1515	0.5
Stangfjellet-h	Stangfjellet	475144	7347993	1.204	5.7	0.02	0.42	0.72	0.07	42	13	16.92	246	22	10.64	2	2	25	56	5	327	8.0
Rognhaugbekken-s.4	Stangfjellet	477493	7347387	1.115	2.0	0.01	0.13	0.94	0.04	3	82	23.70		12		19	8	5		18	16	32.0
Rognhaugbekken-s.1	Stangfjellet	477262	7347538	1.033	10.0	0.09	0.12	0.74	0.17	3	72	25.10		35		589	3	57		47	70	8.0
Rognhaugbekken-s.11	Stangfjellet	477598	7347333	0.967	1.0	0.03	0.00	0.91	0.05	10	83	9.65		12		353	3	1		6	351	102.0
Rognhbk(=3)	Stangfjellet	477246	7347561	0.931	8.7	0.04	0.14	0.60	0.19	10	14	21.45	842	28	14.82	146	2	30	23	4		
Rognhaugbekken-s.15	Stangfjellet	477549	7347425	0.568	1.0	0.01	0.22	0.34	0.01	3	3	48.80		21		265	3	14		7	17	2.0
Avanbekken	Stangfjellet	478221	7344699	0.488	1.0	0.01	0.01	0.22	0.25	3	9	2.02		2		13	6	1		2	453	2.5
Hellerfjelltjønn-N	Stangfjellet	477508	7343809	0.472	1.0	0.02	0.05	0.28	0.14	3	3	1.75		1		3	3	1		3	616	1.0
Barytt-Stangfjellet	Stangfjellet	477942	7344435	0.392	25.0	0.03	0.01	0.19	0.19	56	275	3.17		8		6	27	1		141	108467	0.7
Rognhaugbekken-s.10	Stangfjellet	477596	7347319	0.378	1.0	0.04	0.21	0.11	0.06	3	3	35.80		6		50	3	10		10	86	15.0
Starrtjønnbakkan	Stangfjellet	478354	7344071	0.229	2.0	0.02	0.02	0.18	0.03	33	303	6.72		28		3	10	4		1	567	9.0

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