

GENERATIVE PROJECT

Exploration Potential for Gold and (Cu,Zn) Massive
Sulfide Deposits within the Caledonian Volcanic
Complexes of Western Norway

FOLLDAL VERK A/S - AMOCO NORWAY OIL COMPANY

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1 Regional Geology Map of the Hardangerfjord Area

Summary and Conclusions

This report gives a review of known gold- and massive sulfide mineralizations in two volcanic areas in Western Norway. On the basis of these informations some suggestions for exploration in these terrains are given.

In the Hardangerfjord area massive sulfide mineralizations occur within a Caledonian volcanic sequence. On the island of Karmøy massive sulfides occur as ore horizons within greenstones that belong to an ophiolite sequence. On Bømlo quartz-gold mineralizations occur within gabbros that belong to the Lykling ophiolite. On the islands of Stord, Tysnesøy, Varaldsøy, and the peninsula of Ölve massive sulfides occur generally in association with felsic volcanics and volcanoclastics. Two small gold mineralizations are known, too. Another gold occurrence is situated within granitic gneisses of the Precambrian basement. At the massive sulfide occurrences of the Hardangerfjord area sampling and assaying for gold is proposed.

In the Sunnfjord area three (Cu,Zn) massive sulfide mineralizations are known that occur within Caledonian pillow lavas. On the basis of already existing geophysical results drilling is proposed on two of the occurrences as well as follow-up work on a stream sediment survey.

1. Introduction

This report gives a review of known gold- and massive sulfide occurrences within two volcanic areas of Western Norway: the Hardangerfjord- and the Sunnfjord area. The source of information is based on reports from the archives of the NGU and published literature. Suggestions are given for possible exploration targets.

2. Location and Access

Two different areas are mentioned in this report:

The Hardangerfjord area is centered at 60° lat. and 5°30' long. It is located at the western coast of Norway between the cities of Bergen and Stavanger. The area is sheared by numerous smaller and

larger fjords that are all navigable. A large part of the outcrop area is located on islands. All harbours are ice free due to the moderate climate that is caused by the Gulf Stream. Field work would be even possible during the very late fall and very early spring. The area is crossed by numerous paved main- and secondary roads. The access to all the areas of interest would be possible by car. The ferry system connecting the different islands is well developed. The main service supply centers are Bergen, Haugesund, and Stavanger. The cities of Bergen and Stavanger are serviced daily by jet flights from Oslo.

The Sunnfjord area is located about 180 km north of the Hardangerfjord area on the Norwegian west coast. The volcanics are mainly exposed on the southern shore of the Stavfjord. The access is possible by car on several secondary roads. Supply centers are Førde and Florø. The main service supply centers are the cities of Aalesund that is located about 120 km northeast of the area, and Bergen 120 km to the south. The city of Aalesund is serviced daily by jet flights from Oslo.

3. Regional Geology

The volcanic complexes in Western Norway represent eugeosynclinal volcanics belonging to the Caledonian geosyncline that extends throughout the whole length of Norway.

In Western Norway the Caledonian volcanics can be found in two different geographical areas (Fig. 1): In the Hardangerfjord area including the islands of Stord, Bømlo, and Karmøy as well as a part of the rocks of the Bergen Arc system and in the Sunnfjord area.

3.1 Hardangerfjord Area

To the northeast the Caledonian volcanics in the Hardangerfjord area are bordered by the Bergsdalen nappe that is older in age (1275 m.y.) and is similar to the rocks of the Telemark suite. This nappe consists mainly of meta-rhyolites, quartzites, amphibolites, and granites. These rocks will not be discussed in this report. In the southwest and south the volcanics are bordered by the Precambrian basement

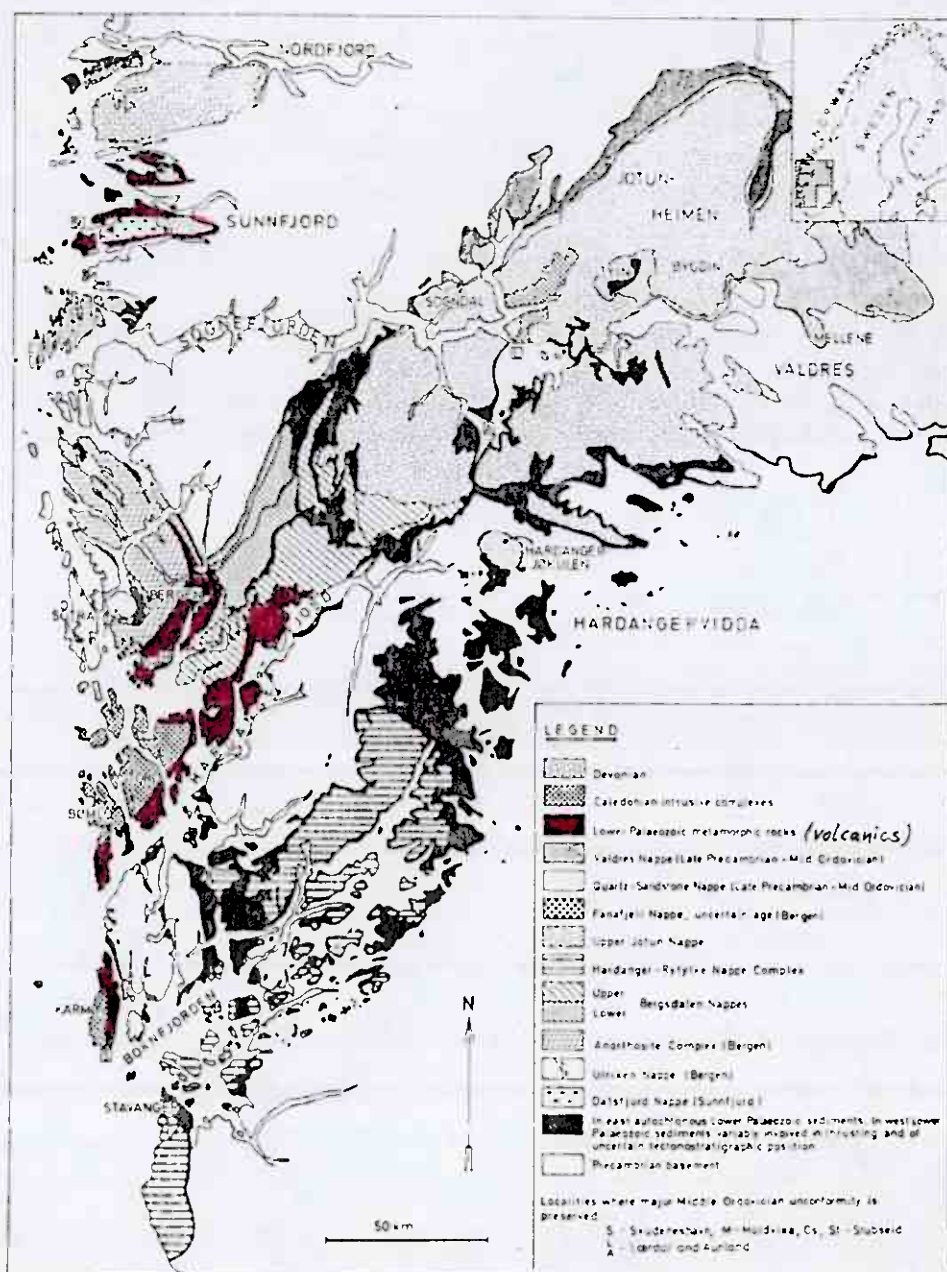


Fig. 1: Regional Geology Map of Western Norway
after Sturt (1978)

and in the northwest by the Bergen Arc System that consists of several different nappes, partial Precambrian and partial Caledonian in age. The larger Bergen Arc consists in parts of mafic volcanics that are supposed to be Caledonian in age.

The rocks in the Hardangerfjord area are very similar to those of the Trondheim area and have been correlated with them. Table 1 shows a correlation of the different geological units of the Hardangerfjord area with those of the Trondheim area:

Formations in the Hardangerfjord area	Trondheim area	
Limesandstone/phyllites, acid and mafic volcanics, black schists, quartzite	Horg-Group	
Lime and calcareous phyllite, sandstone and schist, conglomerate, polymict green conglomerate	Upper Hovin-Group	
Greenschists with keratophyres etc., black schists, phyllite, marble	Upper Greenstone, Jonsvann-Formation	allochthonous
	Lower Hovin-Group	
quartzkeratophyre, phyllite, greenschists with polymict conglomerate, phyllite and greywake, greenschists with polymict conglomerate, quartzschists with congl., greenschists with greywake congl. etc.	Stören-Group	
Thrust		
Micaschist, cambro-ordovician gneiss and granite, precambrian		autochthonous

Tab. 1: Correlation of geological units of the Hardangerfjord- and the Trondheim area

A typical succession of the rocks in the Hardangerfjord area can be found on the island of Varaldsøy. Here one can find typical greenstones with pillow lavas and thin layers of quartzkeratophyres, sulfides etc. similar to the lower greenstones in the Trondheim area. The greenstones extend further to the southwest to the islands of Tysnesøy, Stord, and Bømlo. On these one can find a large part of plutonic rocks as granites and gabbros, the so called Sunnhordaland eruptive complex. These rocks were first thought to be of Caledonian age, too, but an age determination showed that they are somewhat older (664 m.y.). Greenstones can be found further to the south on the island of Karmøy which is a part of an ophiolite complex. This is contrasting to the other rocks in the Hardangerfjord area that were probably deposited in an island arc environment. Ultramafics, gabbros, sheeted dykes, greenstones and deep sea sediments form the ophiolite sequence. Furthermore, mafic volcanics can be found on the islands of Finnøy and Rennesøy, further to the southeast. These rocks are supposed to belong to the Hardanger-Ryfylke nappe complex.

The volcanics of the Hardangerfjord area host several sulfide and gold occurrences that will be discussed later in detail.

3.2 Sunnfjord Area

The volcanics of the Sunnfjord area are exposed about 150 km north of these of the Hardangerfjord area and can be found on the geological map Måløy (1:250000). Especially about the Stavfjord- and Solund areas that are situated within this district good geological information is available (NGU No. 302). The rocks from both areas can be correlated with those of the Trondheim area. They consist of pillow lavas, massive greenstones, greenschists (tuffs), quartzkeratophyres, and sediments. The geological succession reflects a typical eugeo-synclinal environment. The occurrence of limestone layers indicates a relatively shallow water environment. In the Stavfjord area the occurrence of a large amount of subvolcanic gabbro bodies indicates that the area must have been situated close to the eruptive center. It is suggested that the volcanics were deposited in an island arc environment. The rock were subjected to regional metamorphism that never exceeds the greenschist facies and were folded during the Caledonian orogenesis. Several sulfide occurrences are known within the district.

4. Known Ore Occurences

Numerous massive sulfide occurences and a few gold mineralizations can be found within the Caledonian volcanic complexes of Western Norway. The different areas will be discussed according to their geographical position from the south to the north.

4.1 Hardangerfjord Area

4.11 Karmøy

Numerous sulfide occurences can be found on the island of Karmøy on different ore horizons. On this island all the rock units that can be found in a typical ophiolite sequence are present: serpentized peridotites, gabbros, sheeted dykes, greenstones (pillow lava), volcanoclastics, cherts, and phyllites. The largest known massive sulfide occurences are the old Vignes- and Rödklev mines that are located within the mafic volcanic sequence. So these occurences are undoubtedly Cyprus-type deposits.

The Vignes ore zone:

Around 1870-80 the Vignes mine was the largest one in Norway. The ore was mined between 1866 and 1894. Altogether, 1.3 mm tons of ore were produced with an average of 1.66 % Cu. According to old reports the ore was bound to a zone of chlorite schists, probably tuffs, that were intercalated with "quartz rich schists" which might have been keratophyres. This rock type seemed to have been quite common within the old mines. Altogether, six different ore bodies were mined down to a depth of 732 m. After the Vignes mine had been closed, the production was started at the Rödklev mine in 1904. This deposit is located on the same geological horizon as the Vignes mine. The Rödklev mine, however, never reached this importance. In parts the ore was banded with sphalerite. At the two mines the structural geology is very complicated characterized by complex folding and faulting.

On the same horizon of the Vignes- and Rödklev mine trenching and other investigations were conducted over a striking length of 4.5 km in 23 different places. It is possible to follow the chlorite schists over this whole length. Mostly the mineralizations are impregnations of pyrite with little chalcopyrite. At two places i.e. at Avløpsholmen and the Jordan mine most of the investigations were

performed. At Avlöpsbolmen, a small island close to the Vignes harbour, a narrow impregnation zone was found within black schists, containing 1 % Cu. At the Jordan mine a little orebody was found containing 3.7 % Cu. Other investigations on the ore horizon were carried out at Kolstö and Fiskaa where the ore was said to be very rich in Cu.

The striking continuation of the Vignes ore zone extends to the island of Feöy where another sulfide occurrence can be found. The ore, however, is described to be located within a gabbro. The ore contained mostly pyrrhotite, chalcopyrite, and magnetite averaging in 2.5 % Cu and 2 % Ni. The ore was mined until 1924. The total production was 37000 tons.

The Linderat-Hopkins-Huelva II-Muttergrube-Kolstö-ore horizon:

This ore horizon is stratigraphically positioned 300 to 400 m higher than the Vignes ore zone but isn't as important. The horizon is a little bit folded and in many parts can only be recognized by the rusty weathering and the enrichment with some pyrite grains in the rocks. The ore horizon is apparently also located within chlorite schists. Some investigations have been carried out at the above mentioned mineralizations. Mostly the ore can be found in very narrow zones, containing pyrite, pyrrhotite with little chalcopyrite. Some trenches were made including some test shafts, but none of the occurrences was subject to economic exploitation.

Haugesundsynken-Patmos-Klevensynk-ore horizon:

Stratigraphically, this ore horizon is located about 100 m higher than the one described above. The mineralizations are very small with either very low or without copper content. Only at the Patmos mine very little mining was conducted between 1914 and 1916. The mineralizations on this ore horizon consist mainly of massive pyrite, pyrrhotite, and very little chalcopyrite.

Landanes-Skeisvoll-Vaage-Sörvelde-Gloppe-Bukhöy-ore horizon:

This ore horizon is located within greenschists and starts at Bukvika within a quartzschist (probably keratophyre). A lot of trenching has been done at this horizon. In a shaft at Skeisvoll sulfides with a thickness of 1.5 m are exposed at a depth of 15-20 m. At Vaage the sulfides consist mostly of pyrite and pyrrhotite. At Sörvelde

some trenches can be found. Analyses of samples from the dumps showed 0.03 % Cu. The other mineralizations on this horizon are small with very low copper contents.

Vikingstad-Hauge-ore horizon: (iron formation)

This horizon lies 1.5 km higher in the stratigraphical succession than the Vignes ore zone. It is characterized by its high content of magnetite. The horizon starts on the small island of Mosfeltholmen where almost massive magnetite can be found with a thickness up to 2 m interlayered with pyrite. In the striking continuation other occurrences as at Vikingstad and Haugavaagen can be found with varying pyrite contents. Often a banding with jasper can be observed. Copper is reported to be absent in these mineralizations.

Dale- ore horizon:

On this short horizon a 15 m deep shaft was sunk at Dale, north of Torvestadt. A 1 m thick ore horizon is exposed that contains mostly pyrrhotite.

Other occurrences on Karmøy:

At the eastern coast an occurrence called Ryggje is located in a lower stratigraphical position than the Vignes ore horizon. Within a chlorite schist magnetite and pyrite crystals as well as schlieren of chalcopyrite can be observed. 1 km NW of Kopervik a deep shaft was sunk, called Klondyke. This work was done as a result of investigations by dowzers, but no ore has ever been found there. 1 km south of Kopervik the Kloststein mine is located. Between 1919 and 1921 about 140 tons of ore were produced containing 5.30 % Cu, 42.5 % S, 37.4 % Fe, and 0.02 % As! Here a shaft was sunk into an about 1 m thick impregnation zone. At Sørstokke the mine was run in 1890, 1895/97, and 1911/14. 7300 tons of ore were produced. The average content was about 0.5 % Cu.

A lot of work was conducted on the massive sulfide mineralizations on Karmøy by trenching, tunneling etc. Most of the work was concentrated at the old Vignes mines, and conducted by A/S Vignes Kobberverk and other companies during the end of the 1960ies by geophysical investigations and diamond drilling. CP and IP investigations were conducted at the Vignes mine in 1972/73 by A/S Sydvaranger. Since that

time apparently no exploration work was done. Lesser work was done at all the other, smaller mineralizations. One thing that is totally missing are assays on the gold content of the ore, although some of the mineralizations seem to be arsenopyrite bearing as for example the Kloststein mine.

4.1.2 Bömlo

On the island of Bömlo one can distinguish two different types of ore occurrences:

- vein type gold-quartz mineralizations with native gold, pyrite, pyrrhotite, chalcopyrite, and galena
- massive sulfide occurrences with low copper contents bound on ore horizons within greenschists

mainly the gold occurrences had been subject for mining during the end of the last century between 1883 and 1900 by the British Oscar Gold Mining Company and the Norwegian companies Dalsverket and Badlyverket. The mining activities, however, were not very successful and the mineralizations were found to be too small.

Gold occurrences:

Lykling Area: (Uren, Flatanes, Carl Olsen, Gopleskog, Risvik, Storhaugen, Haugesundsgangen, Bukskinnskloven, Bømmerlöen)

Most of the investigations for gold have been conducted in this area. Numerous old trenches and mines can be found. The area was investigated in detail by Amalixsen. The results, including a map with the occurrences, can be found in NGU report no. 1750/35A. Also several other older NGU reports give descriptions of the mineralizations and previous mining activities.

In this area the Lykling ophiolite is exposed, consisting of serpentinites, gabbros, greenstones (pillow lava and volcanoclastics), quartzkeratophyre, plagiogranite, and sediments. The sequence is similar to the Karmøy ophiolite. North of this sequence the rocks of the so called Sunnhordaland plutonic complex (or -batholite) are exposed. The gold occurrences can be found within the gabbros of the ophiolite sequence.

In parts, where the rocks have been tectonized a number of hydrothermal quartz veins and -schlieren can be observed that are mostly cm-thick but can come up to a thickness of 0.5 m. In these places, where quartz veins are abundant, most of the old mines and trenches are located. A few data about assays are available from old reports:

Risvik: 30.6 ppm Au, 9.0 ppm Au, 30-200 ppm Au

Bukskinnskloven: 11.8 ppm Au, 7.45 % Cu

Haugesundgangen: 66.8 ppm Au, 20 tons ore contained 15 ppm Au, 0.18 % Cu

Gopleskog: 20.5 ppm Au

These analyses were made of rocks containing hydrothermal quartz. According to old reports the country rocks should even have contained higher concentrations of gold, too. More recent analyses by NGU show that the gold contents in the country rocks are low. In the ore the gold occurs as native gold or is often present in higher amounts within pyrite, chalcopyrite, and galena.

Nordnes:

About 50 m southeast of the road between Nordnes and Selvaag a small water-filled shaft can be found. It was sunk into a 1 m thick quartz vein. The country rocks are dark, massive amphibolitic rocks containing a fine grained, quartz-feldspar rock type. On a dump some grains of chalcopyrite can be observed within the rocks. According to old reports the mineralization should be gold bearing but no analyses are reported.

Hille (Vipemyr):

Several small mines and trenches are located 50-100 m from the beach at the Bjørnøysund. The mineralizations can be found within massive greenstones and are very small with low copper contents. No Au analyses are reported.

Other gold mineralizations about which almost no information was available are:

- Stensvaag: sulfides within a quartz vein, located at the southgoing fjord south of the Kulleseid channel
- Mynteklubben
- Meland: located at the farm Meland, south of Bremnes church
- Hisken: gold bearing quartz veins over the whole Store Hisken, southern part of Bremnesøy

Other ore occurrences (sulfides):

Vaage:

Disseminated and massive pyrite can be found within some trenches at Vaage, 70-80 m northeast of the road Vaage-Nordnes. The mineralization occurs probably a horizon within greenschists. Only traces of copper are present. No Au analyses are available.

Espevaer:

The occurrences are located on the southern end of the island. They consist of pyrite and magnetite bound to a horizon within greenschists. The mineralizations are very small. No analytical results are available.

Other occurrences about which very little information was available:

- Kulleseid: pyrite mineralization in a schist at the Kulleseid channel
- Lakseid: pyrite/pyrrhotite mineralization northeast of the
Lakseid gaard
- Lindøy: pyrite mineralization within greenschists at the northend
of Lindøy, north of Kullerøy
- Tresvik: pyrite mineralization within greenschists
- Fylkesnes: chalcopryrite and pyrrhotite within schists southeast of
Alfsvaag mine
- Alfsvaag: 4 trenches, chalcopryrite within greenschists, mined 1882-
85 by Vignes Kobberverk, production: 813 tons, average
content: 3.2 % Cu, NGU conducted CP and VLF investigations
in 1980
- Halderaker: pyrite, pyrrhotite, and chalcopryrite in schistose parts
in a gabbro, at Strömfjord northeast of the Halderaker
farm
- Langøy: pyrite and chalcopryrite mineralizations at Alfsvaag, west
of Fylkesnesgaardene
- Risdal: very small pyrite mineralization

There is no evidence about exploration work on Bömlo at present or during the last years.

4.1.3 Stord

On the island of Stord all the ore occurrences can be found in the

southern part of the island where the Caledonian volcanics are exposed. The most important occurrences are Nysaether mine, Rostnes, Høgaasen, and Guldberg, all massive sulfide occurrences. The only mine that produced copper was apparently Guldberg, where the content averaged at 3 % Cu and 40 % S. The ore is located within dark schists. Mining was carried out with interruptions between 1866 and 1909. The ore occurrence Hysingstad can be found close to Guldberg within the same geological environment. All the other occurrences on Stord have apparently only been mined for their content of sulfur. No Cu analyses are reported.

At the Høgaasen mine with its occurrences Gadalen, Björnevad, Isdals-
easen, and Traeshaugen, mining was started in 1874 and finished in 1900. The production started again in 1911, and between 1912 and 1937 3 mm tons of massive sulfide ore containing about 23 % S were produced.

Other mines that had been in production during the end of the last century were Nysaether and Rostnes. Other ore occurrences on Stord are Harlinddalen (sulfides with little galena), Klokkenhullet (sulfides within mica schists), and the sulfide occurrences Knoroy, Lattenes, and Skobrekke.

At present no exploration activities are known from Stord.

4.1.4 Tysnesøy

On the island of Tysnesøy only a few ore occurrences are known. They are located within the Caledonian volcanic/sedimentary sequence.

No information is available of the sulfide occurrence Skjellevik. The occurrence Høglærøy is located on a island in the south of Tysnesøy within marbles. Here copper- and lead sulfides can be found. On the small island of Lyngøy a sulfide occurrence is reported.

On the small island of Vernøy an impregnated zone with arsenopyrite and galena is described. The content of arsenopyrite is about 15 %. The mineralization is described in connection with a serpentinite and quartz veining. An analysis showed 4 ppm Au. The occurrence, however, is located on a very narrow peninsula.

4.1.5 Varaldsøy - Ölve District:

On the island of Varaldsøy and the peninsula of Ölve numerous (copper) massive sulfide and one gold occurrence can be found. A description of the geology of the area that includes a map with all the locations of the old mines is given by Foslie (NGU no. 147).

The gold occurrence is called Ölve Gullverk and is located at Slagget on the peninsula of Ölve. Foslie reports that native gold was found within a chlorite schist that is located within keratophyres. In older reports the rock type is described as a dark green schist containing talc and quartz- and carbonate veins. Test mining had been carried out between 1887 and 1888, contemporaneous with the gold mining activities on Bömlo. 800 tons of ore were taken out with an Au content of 1.25 ppm. Two analyses of the gold bearing schists are reported: one with 275 ppm Au and one with 26 ppm Au.

Ten old copper-pyrite mines can be found on the peninsula of Ölve: Gravdal mine, Femsteinvik mine, Hytteheiane trenches, Fossaaskar mine, Flatafjell mine, Sundfjordskar mine, Dyraasen mine, Lökke mine, Roaldstveit mine, Atramadal mines, and several smaller occurrences. On the island of Varaldsøy 10 old mines are located, too: Svinlands mine, Sandvikfjell trench, Hisdalen mine, Nygruben mine, Valaheien mine, Storhidler mine, Seltevikfjell mine, Kvitsand mine, Haukanes mine, and Graaskolt mine. Very little was produced during the first mining periods 1642-73 and 1759-73. At the Valaheia mine, one of the larger occurrences, 162000 tons of pyrite ore were produced between 1867 and 1888. The ore contained 40-41 % S and 0.4 % Cu. At the Valaheia- and Nygruben mine 412000 tons of ore are reported to be probably left, possibly larger quantities. All other occurrences are reported to be quite small.

A/S Sulfidmalm and Elkem Spigerverket apparently did some work on the Atramadal mines during the 1970ies.

4.1.6 The Bergen Arc Area

Within the Caledonian volcanic sequence of the Bergen Arc System only one massive sulfide occurrence is known. The old Sejersberget/Lungegaard mine is located within the town of Bergen close to the Lungegaards hospital. Copper bearing pyrite was mined here between 1791 and 1845. No further information was available about this occurrence.

4.1.7 Gold mineralization located within the Precambrian Basement

Nils Berg gold mine:

In Sveio kommune, on the southern side of the Hardangerfjord, several small gold mines are located at Hovdaneset in Norheim. The Nils Berg mine, the largest one, is located within a quartz vein (0.5-1.0 m thick) within a granitic gneiss. The average content is reported to be 11-12 ppm Au. Of 50 tons of quartz 382.2 g Au were produced (=7.65 ppm). Other present ore minerals are pyrite, pyrrhotite, and chalcopyrite.

Halsnøy:

On the island of Halsnøy a gold finding within a quartz vein is reported. The content was 0.6 ppm Au and 1 ppm Ag. No further information is available.

4.2 Sunnfjord Area

The three major massive sulfide occurrences within the Sunnfjord area are located at the Stavfjord (Grimeli and Vaagedalen) and on the island of Svanøy. They are all located within a Caledonian greenstone complex.

Grimeli:

At this massive sulfide occurrence mining was carried out in 1759-82, 1851-1906, and 1914-19. A few thousand tons of ore were taken out with an average content of 3-4 % Cu. Mining was carried out at three different places: Vestre-, Nedre-, and Øvre Gruve.

The mineralizations are predominantly located within massive greenstones (pillow lavas) with transitions to metagabbros. The ore can be found in different horizons that vary in thickness between a few cm up to several meters. The length is about up to 2 km. The ore is often folded. Occuring ore minerals are chalcopyrite, sphalerite, pyrite, and pyrrhotite.

The area was investigated by Follidal Verk A/S by geological mapping (Skjerlie). Later NGU conducted quite detailed studies, mainly by geophysics. This included a CP and VLF survey. Some good conductors were detected. At Nedre grube a conductor with a length of 450 m

and 600 m depth was detected, at Övre gruve one with 380 m length and 600 m depth. A few short holes were drilled but no economic mineralization was found. NGU estimated the reserves at 1.5 mm tons with 2-4 % Cu+Zn.

Vaagedalen:

About 7 km east of the Grimeli mine the Vaagedalen mine can be found within the same greenstone series.

Mining was carried out between 1914 and 1919. The occurring rock types are pillow lavas and some layers of calcareous greenschists (tuffs). The ore is similar to that at Grimeli but it is richer in Zn and carbonate.

Also here geophysical investigations were conducted by NGU. A CP survey showed that a conductor at the known mineralization had a depth of about 500 m and a length of 900 m. A 13.5 m! deep hole was drilled but no economic mineralization was found. The ore reserves were calculated at 0.7 mm tons with 2-4 % Cu+Zn.

A stream sediment survey was conducted in 1970 by NGU for Follidal Verk in the area from the Vaagedalen mine towards the east and the south. Very good anomalies for Cu, Zn, Pb, and Ni were detected in the northern part of the area that never were followed up.

Svanöy:

The sulfide mineralizations on the island of Svanöy consist of two occurrences that lie close to each other. Mining was carried out in the 1860ies and 1880ies, and 1905-07, and 1911-1920. About 36000 tons of ore were produced averaging 43 % S and 1.75 % Cu. The mineralizations occur within greenstones, tuffaceous chlorite schists, and gabbros. Occurring ore minerals are chalcopyrite, sphalerite, pyrite, and pyrrhotite. In 1965 EM- and magnetic surveys were conducted by NGU. The surveys resulted in indicating some good anomalies. No follow-up work was done at the Svanöy occurrences.

apart from the three ore occurrences described above several other small mineralizations can be found especially around the old mines.

Here it should be mentioned that in none of the reports or none of the geological maps graphite schists were reported.

5. Land Status and Competitor Activity

All information about staked claims is based on the list of 1982. A new claim list will come out in June 1983.

At present no claims are held on the old massive sulfide mines on Karmøy.

On Bømlo two claims are held by a private person on the Lykling Au-showings. These claims were applied in 1975 and might have gone out now. One claim is held by a private person on the Mynteklubben gold showing. Orkla Industrier A/S holds 15 claims on the Risvik Au mineralizations. The Norwegian State holds 10 claims on the Alsvaag sulfide occurrence.

At present no claims are held on the island of Stord.

One claim is held by A/S Sulfidmalm on the Au/As/Pb occurrence on Vernøy.

A/S Sulfidmalm holds 15 claims on sulfide occurrences and on the gold occurrence on the peninsula of Olve and three claims on sulfide occurrences on the island Varaldsøy. A/S Sydvaranger holds four claims on sulfide occurrences on Varaldsøy.

Four claims are held by A/S Sulfidmalm on the small gold mines (Nils Berg) in Sveio kommune.

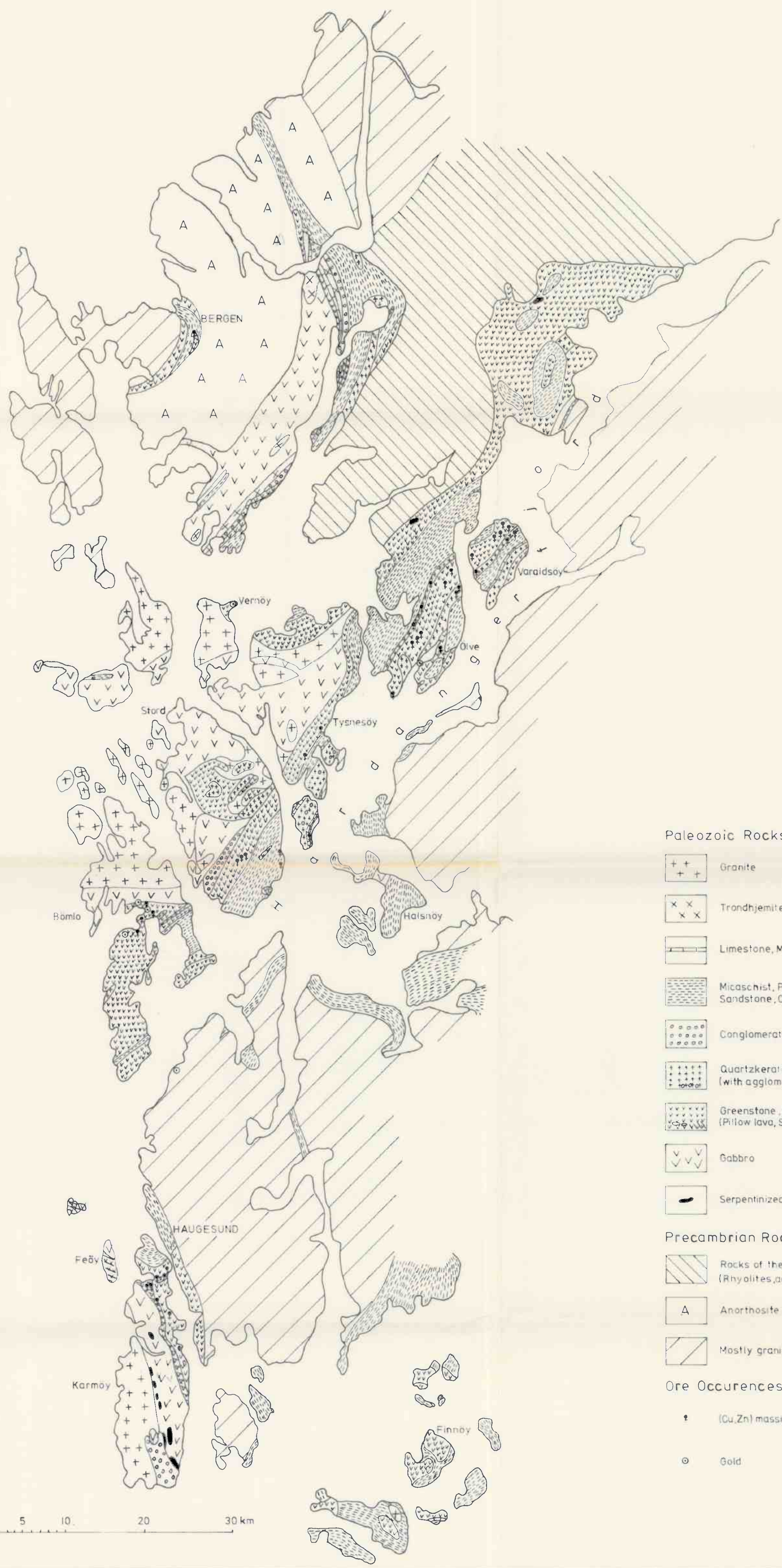
The Norwegian State holds 8 claims on the old Grimeli mine in Sunnfjord.

At present no competitor activity is known in the areas of interest.

6. Suggestions for Exploration

A few gold occurrences are known within the Hardangerfjord area. Analyses about the Au contents of the known massive sulfide occurrences are not available. Therefore it would be interesting to visit all the old mines and prospects to take ore samples and assay these for Au. Successful exploration for massive sulfide deposits is uncertain in this area, as the known occurrences are in general small in tonnage and low in Cu and Zn.

Composite to that the massive sulfide occurrences in Sunnfjord, Grimeli and Vaagedalen seem to be very interesting. NGU found very good conductors around the old mines. Mineralization was indicated to a depth of 500 m at both occurrences. Only very short holes were drilled (maximum 14 m) on these anomalies. NGU calculated the ore reserves on the basis of the geophysical CP survey and these short drill holes. As these calculations seem to be worthless and good geophysical anomalies were found and the ore grades are reasonable it is proposed to drill a hole at both the Grimeli and Vaagedalen occurrences. For this claims have to be lent by the state at the Grimeli occurrence. Before drilling a CEM shoot back survey should be conducted over this area. In addition to that it would be interesting to conduct follow-up work on the stream sediment survey that was done by NGU for Folldal Verk in 1970.



FOLLDAL VERK A/S - AMOCO NORWAY J.V.

PROJECT

REGIONAL GEOLOGY MAP OF THE
HARDANGERFJORD AREA

after: Foslie, Sturt, Thon, Furnes, Færseth, Solli, Dons, Holtedal

Date: 4/83 Scale: 1: 325 000

Paleozoic Rocks

- ++ Granite
- xx Trondhemite
- Limestone, Marble
- ▨ Micashist, Phyllite, Sandstone, Chert
- Conglomerate
- ++++ Quartzkeratophyre, Rhyolite (with agglomerate)
- vvvv Greenstone, Greenschist, Basalt (Pillow lava, Sheeted dykes)
- vv Gabbro
- Serpentinized peridotite

Precambrian Rocks

- ▨ Rocks of the Bergsdalen Nappe (Rhyolites, amphibolites, quartzites, granites)
- A Anorthosite Complex
- ▨ Mostly granitic gneisses

Ore Occurrences

- (Cu,Zn) massive sulfides
- Gold

0 5 10 20 30 km

