Bergvesenet

Postboks 3021, N-7441 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
5362				

Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:
Falconbridge				

Tittel

Evje-Iveland prosjektet. Diverse rapporter fra 1968-1970.

Forfatter	Dato År	Bedrift (oppdragsgiver og/eller oppdragstaker)
		Falconbridge Nikkelverk AS

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Iveland	Aust-Agder	Østlandske	15123	Mandal

Fagområde	Dokument type	Forekomster (forekomst, gruvefelt, undersøkelsesfelt)
Geologi Kjemiske analyser		Birkeland

Råstoffgruppe	Råstofftype
Malm/metall	

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

AGDER
EVJE-IVELAND.

Vertikalmappe nr. 1026
For A 4

554.02.15. GEOLOGI BIRKELAND.

554.02.15. GEOLOGI - BIRKELAND
EVJE-IVELAND.

LOCATION

Name, Bekken Prospect Pit. Map unit F9. Air photograph I 61 64-2629. The prospect pit lies on the south side of the Birkeland stream about 200 m ENE of Aukland Farm (Refer EM map Birkeland - Aukland).

STATUS

A government holding now leased for five years on a first option basis to A/S Sulfidmalm.

HISTORY

It is known to have been worked in 1897 (see "Beretning om Evje Nikkelverk 1872 - 1897"). The first owners were A/S Evje Nikkelverk, subsequently taken over by A/S Raffineringsverket in 1925. Now belongs to the state. Regional mapping in a scale of 1:15'000 was carried out by V.H. Wiik in 1967. Geophysical work in the form of an electromagnetic survey was carried out by a Sulfidmalm crew in August 1967. This present investigation was carried out in the summer of 1968.

GEOLOGICAL SETTING

A small water filled prospect pit 2 m x 3 m that regionally speaking lies on the border zones of the main basic complex of the Evje-Iveland area. The rocks outcropping in the immediate vicinity of the pit are mostly amphibolites these becoming more gneissic and migmatitic as one moves north and east.

The prospect is partly located on a shear that strikes parallel to the stream. On a regional scale the stream itself seems to follow a strong tectonic feature and it is rather surprising to find amphibolites striking across this stream. These amphibolites are well foliated, medium grained and contain in part disseminated pyrite.

STRUCTURES

Shearing parallel to the stream (E-W) is very dominant and in the amphibolites in the vicinity of the prospect pit three well defined shears occur, 94/24S, 90/28S and 92/38S. These shears are in part occupied by quarts veins.

The amphibolites in the stream strike obliquely to these shears i.e. 165/20W and 170/24W.

A lineation in the amphibolite plunged 85° towards 262.

CHARACTERISTICS OF ORE

Mineralization was seen in situ at one place only - in connection with meta ultrabasics in a shear zone. The entire shear zone was highly weathered, the ultrabasic material was entirely hornblenditic, but so much altered and sheared that it was impossible to decide whether the rock was intrusive or merely a shear product of the amphibolite. The mineralization in the shear zone consisted of fairly massive pyrrhotite and minor pyrite.

The dumps were examined and yielded some massive sulphides, a lot of which were in vein form. Minor disseminations of pyrite were found in amphibolite.

- cont'd -

From the scanty evidence presented here and from a working knowledge of the area in general it is suggested that the mineralization is structurally controlled and is epigenetic.

ANALYSES

Specimen No.	Ni	Co	Cu	Fe	S	Ca	Mg	
VHW 2b	0.35	0.04	0.26	26.1	12.6	1.8	7.5	X1
VHW 2	1.3	0.11	0.12	53.5	40.0			X2

X1 impregnated ultrabasic from dumps

X2 massive pyrrhotite from dumps.

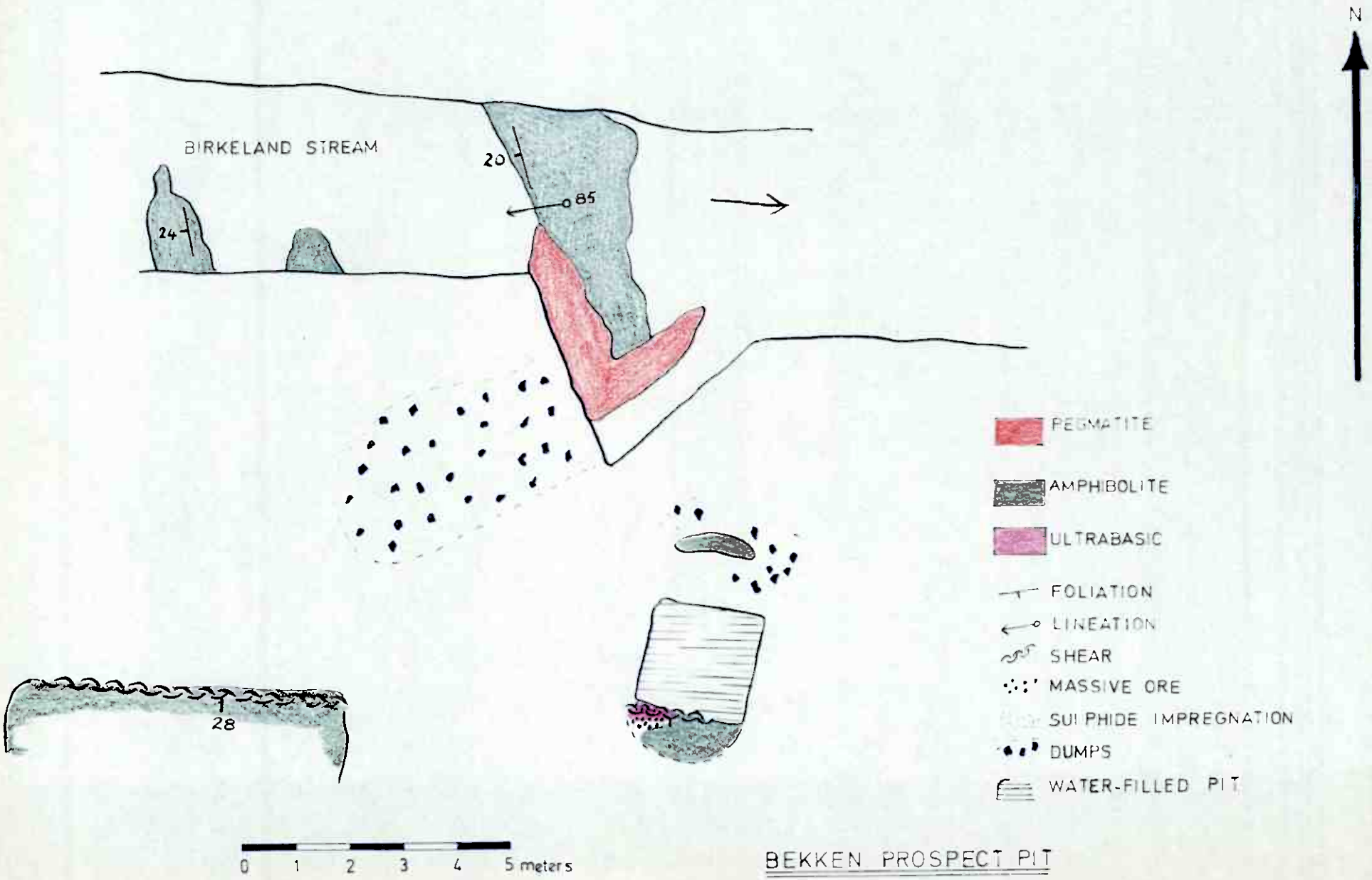
Analyses carried out at F.N., Kristiansand, February 1968.
As can be seen from the results the Ni/S ratio for the samples is poor and is fairly consistent with the average Ni/S ratio for the Birkeland area.

EXTRA REMARKS

The electromagnetic results give some anomalous showings these, however, are difficult to interpret because of A. large amount of wire lying around. B. steeply undulating topography. C. the profiles are probably run obliquely to any mineralized zones.

Name of examiner Frank Larson .....

March 12, 1970
FN/hm



BEKKEN PROSPECT PIT

EVJE-IVELAND PROJECT

CATALOGUE No. .....

LOCATION

Name, Paascheskjerp south. Map unit F9. Air photograph I-61 64-2629. Lies about 20 m east of Bekken prospect pit on the northern side of Birkeland stream and about 200 m ENE of Aukland farm. (Ref. Birkeland E.M. map).

STATUS

Unknown.

HISTORY

Very little known, mentioned in a few early reports on the area. Regional mapping in scale 1:15'000 was carried out here in 1967 by Wiik, an electromagnetic survey was run in the same year by a A/S Sulfidmalm team. The present study was undertaken in the summer of 1968.

GEOLOGICAL SETTING

Two small prospect pits that are filled with water outcrops being very limited. The main rock type is an amphibolite which is medium grained and at times has a meta gabbroic appearance. In places the amphibolites are well sheared, rust but no sulphides is associated with these shears. Ultrabasic rocks were noted as A. thin bands parallel to the foliation. B. black sheared bands. Type A. are green hornblenditic/meta pyroxenitic rocks and of an intrusive origin. Type B. are considered to be shear products, they consist of a lustrous black hornblende orientated parallel to the plane of shearing.

STRUCTURES

The foliation in the rocks around the prospect is 125/50 SW, two dominant shears also trend in more or less the same direction being measured at 120/28 SW and 125/48 SW.

CHARACTERISTICS OF ORE

As no mineralization can be seen in present day outcrops it is perhaps useful to quote Bjørlykke's diary for 140. He hade presumably more opportunity to observe actual mineralization than we have today.

"At the prospect one can see "dykes" of pyrrhotite with big pyrite crystals, these dykes are about 5 cm thick. The smaller veins are richer in copper and pyrite. There are inclusions in the pyrrhotite of bullet shaped lumps of gabbro which are impregnated with pyrrhotite and chalcopyrite. The gabbro in the area of the pits has in places a weak dissemination.

ANALYSES

Specimen No.	Ni	Co	Cu	Fe	S	
0/BIRK 7	0.6	0.06	0.11	39.9	19.0	x1
0/BIRK 6	0.1	0.01	0.06	20.6	2.7	x2

x1 massive pyrrhotite in meta pyroxenite

x2 pyrrhotite in meta pyroxenite.

Analyses carried out at F.N., Kristiansand, February 1968.

Name of examiner Bruhlicka

March 12, 1970
FN/hm

LOCATION

Name: ORREKNAPPEN MINE. Map unit F9. Air photograph No. 1-61 64-2629. Access is by road. The mine lies about 30 m to the west of the road to Aukland farm, approx. half way between the farm and where the road joins the main Frikstad-Vatne road.

STATUS

A government holding.

HISTORY

Mutet 22.6.1916. Trial exploration was carried out from 1869-72 when a $1\frac{1}{2}$ m deep pit was sunk. In 1907 the mine was pumped empty of water and sampling was carried out. In 1917 trial work was carried out by Evje Nikkelverk A/S. The shaft was sunk to a depth of 15 m and a cross-cut 80 m long was driven in the direction of the ores foliation. Two diamond drill holes proved to be barren. 285 t of ore with a Ni content of 2% were produced. Work was continued until 1918 but then abandoned.

Published records

Barth, T.F.W. The Nickeliferous Evje-Iveland Amphibolite and its relation. N.G.U. No. 168a. 1947.

Bjørlykke, H. Flåt Nickel Mine. N.G.U. No. 168b. 1947.

Vogt, J. Om nikkel, navnlig om muligheten at gjenoptage den norske bergverksdrift paa nikkel. Tekn. Ugeblad 1901 og 1902 pp 1-38. Et tiårstilleg i T.U. 1911.

Unpublished records

Bjørlykke, H. Dagbok for arbeide for A/S Raffineringsverket, Evje sommeren 1940, p. 7. Sulfidmalm files Evje-Iveland file 1.

Bjørlykke & Carstens. Rapport over geologiske undersøkelser ved Flåt grube 1940. Sulfidmalm files. Evje-Iveland file 1.

Poulsen, A.O. Nikkelmalmfeltet i Iveland. N.G.U. Bergarkiv rapport nr. 2608. Copy in Sulfidmalm files.

GEOLOGICAL SETTING

The orreknappen mine lies within, but near the eastern margin of the more massive, basic rocks of the Iveland-Evje complex. The rocks that outcrop in the immediate vicinity of the mine are amphibolites and coarse hb. diorite. The amphibolites are mostly med./fine grained. Pegmatites are fairly abundant in the area. The mine lies 400 m south of a strong east-west structural feature and 250 m north west of a strong NE/SW structural feature.

Most of the exposed rock around the shaft is fine- to medium-grained amphibolite in part containing a little biotite and a little quartz. Ore minerals were found associated with these amphibolites, mostly as small grains in aggregates of felspar and quartz grains.

Most of the visible ore at the mine is connected with shears. On one rock face a distinct shear 120/27 cuts the rocks, which are for the most part amphibolites although modifications occur. In the actual main shear zone the rock is a strongly schistose, lustry black hornblendite. Massive ore occurs below this shear zone both as veins and massive clumps. There are also sulphides developed along joint surfaces and as veins parallel to the shear.

Ultrabasic rocks (meta. pyroxenites) also occur as a thin coating (10 cm) on a plane 125/69 which is possibly a shear.

STRUCTURES

The foliation in the Orreknappen area varies but the main trend is roughly NW/SE falling towards the west. In the actual mine area the foliation proved difficult to measure because of the rather massive nature of the rocks. The three measurements made were 293/90, 198/85 NW, and 225/90. Lineations were recorded in two places, both reflecting the linear arrangement of mineral grains (hornblende and biotite). The lineations recorded were 230/30 SW, and 240/32 SW.

As stated above some of the ore seems to be connected to a rather flat flying shear striking 120/27 SW. A dominant shear (joint) on 125/69 SW was noted and on this face were veins of chalcopyrite striking 137/90.

From the old records it seems that the mine has been worked to a vertical depth of 70 m probably following a vertical or near vertical orebody. It could be possible that the mineralization is controlled by the intersection of two different structures and in this respect it is interesting to note that the intersections of the joint 125/69 with the foliation 198/85 gives a linear structure trending 225 and 70.

CHARACTERISTICS OF ORE

The massive ore consists mainly of pyrrhotite with minor pyrite and chalcopyrite. The main mineralizations visible were -

a) connected with shears
b) as veins
c) as concentrations along joint surfaces
d) as disseminations

The smaller veins are rich in pyrite and chalcopyrite whereas larger veins are rich in pyrrhotite - usually having more chalcopyrite towards the border. In places the massive ore has inclusions of amphibolite which is slightly sheared and contains disseminated ore minerals. A polished section of a sample of massive pyrrhotite gave the following minerals:

	Est. % by Vol.
Pyrrhotite	74
Marcasite	7
Chalcopyrite	1
Pentlandite + Violarite	2
Goethite	4
Gangue silicates	12

In hand specimen the sample shows coarse parting planes of pyrrhotite over 3 cms in diameter. In polished section, the pyrrhotite shows development of marcasite blades along these parting planes. Exsolution blebs of pentlandite, now altered to violarite, are difficult to distinguish from the marcasite, since they follow along the same crystallographic directions. Chalcopyrite is a minor constituent, occurring as blebs and streaks in the pyrrhotite and adjacent to patches of gangue.

Veinlets of secondary goethite transact the section and often rim the subhedral grains of silicate inclusions.

FALCONBRIDGE NIKKELVERK, AKTIESELSKAP

ANALYSES

Specimen No.	Ni	Co	Cu	Fe	S
O/Birk 1	0.6	0.04	0.4	31.8	17

Analysis carried out at FN K'sand, February 1968.

Specimen No.	Ni	Co	Cu	Fe	S	
2 68 E9a	1.43	0.066	0.07	51.5	36	massive ore
3 68 E9	0.86	0.053	1.38	44.2	22	ultrabasic + po & cp.
4 68 E9	1.45	0.05	0.06	53.0	37	massive ore

Analyses carried out at FN K'sand, September 1968.

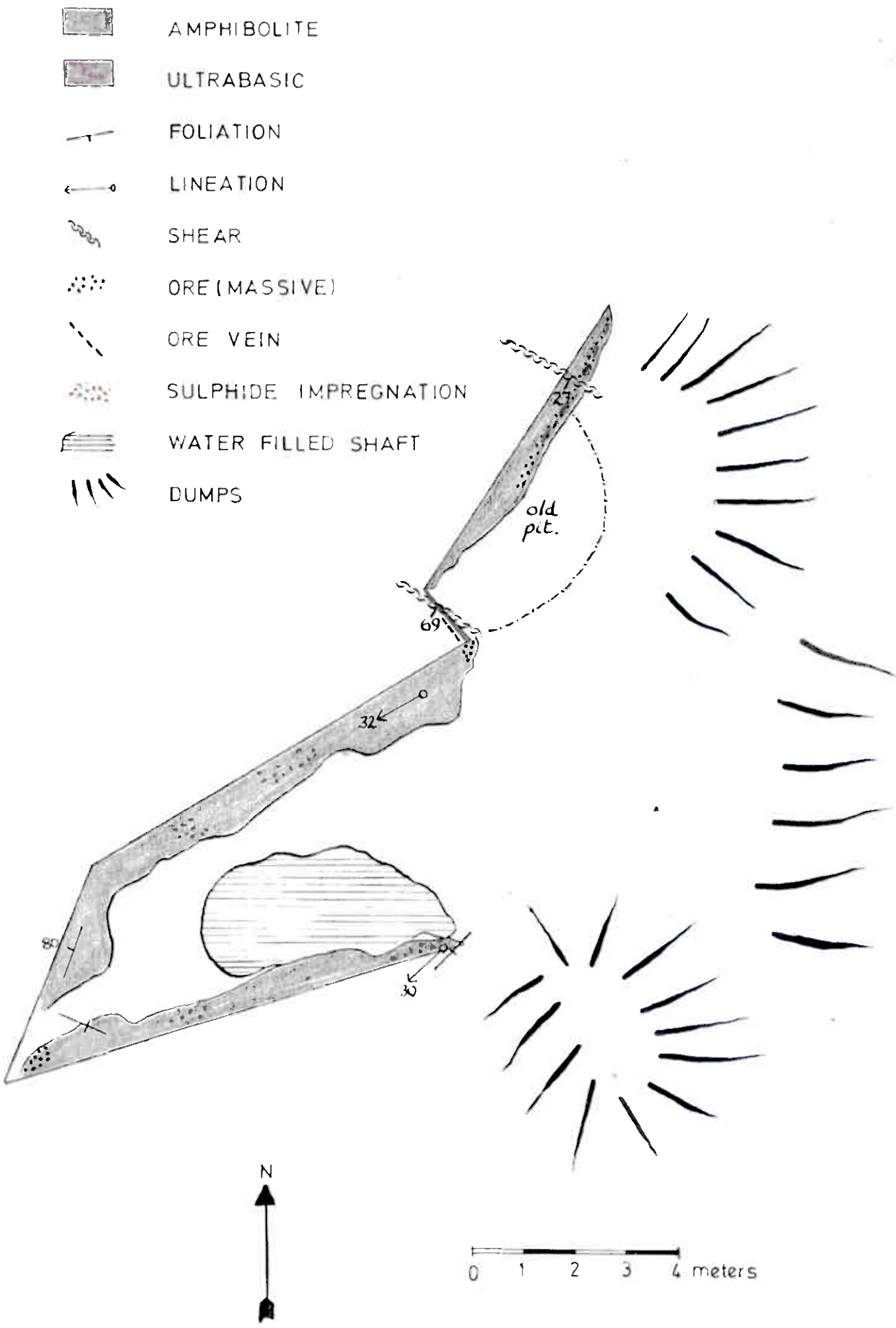
Specimen No.	Ni	Co	Cu	Fe	S
2 68 F9a	1.43	0.066	0.07	51.5	36.0[1]
3 68 F9	0.86	0.053	1.38	44.2	22.0[2]
4 68 F9	1.45	0.05	0.06	53.0	37.0[3]

1) massive pyrrhotite.
2) meta ultrabasic-rich in pyrrhotite and chalcopyrite.
3) massive pyrrhotite.

Analyses carried out at FN K'sand 28.9.1968.

NAME of examiner: Frank Dixon

FN/hm February 15, 1969.



ORREKNAPPEN MINE

Location	1 km. E. of Birkeland shafts	Lab. No.	6766
Sample Description	No. 23-F9 (V.H.W.)	PTS No.	1243

MINERALS	Est. % by Vol.	Grain Size (m.m.) Max.	Avg.
Feldspar $\pm$ An_{47}	44	1.50	0.40
Orthopyroxene	3	0.75	0.15
Clinopyroxene	10	0.85	0.20
Quartz	6	0.50	0.15
Amphibole	26	1.25	0.30
Biotite	6	0.50	0.15
Apatite	1	0.15	0.08
Pyrrhotite & Pyrite	Tr	0.10	0.05
Magnetite	2	0.40	0.10
Hematite	Tr	0.10	0.05
Ilmenite	2	0.35	0.10

DESCRIPTION

Pol-thin examination confirms the hand sample characteristics of this rock as medium grained, equigranular and of igneous origin. Clear granular plagioclase of andesine composition is interspersed with green poikiloblastic amphibole which has obviously been derived from pyroxene. Relicts of clino- and to a lesser extent orthopyroxene are usually enclosed in blocky grains of amphibole. Other patches of amphibole are poikiloblastic, containing numerous small inclusions of (usually) quartz. Biotite occurs in ragged laths, usually associated with amphibole.

The opaque assemblage consists of scattered grains of magnetite and ilmenite with rare specks of pyrrhotite, pyrite and hematite (after magnetite).

CLASSIFICATION

Metagabbro.

THE BIRKELAND AREA (F.N.)

The Birkeland area lies near the eastern margin of the more massive basic rocks of the Iveland-Evje complex. The Orreknappen Nickel Mine and the Bekken and Paasche prospect pits are located in this area. Detailed descriptions of these can be found in the Catalogue of Prospect Descriptions (compare also EM map Birkeland-Aukland, scale 1:1'000).

The main rock type at Orreknappen is a medium-grained amphibolite which gradually changes in a northerly direction into hornblende and dioritic gneiss; rocks north of the Birkeland stream being mainly gneissic.

The amphibolites are fine- and medium-grained and are essentially plagioclase-hornblende rocks. They may be either foliated or more massive. The gneisses are generally well foliated and hornblende rich, however, a slight banding with more dioritic layers alternating with hornblenditic layers is quite common. Both migmatitic and agmatitic structures were noted. Of more limited occurrence are examples of banding with alternations between a relatively light dioritic gneiss, a darker dioritic hornblende gneiss, and a massive, in part structureless amphibolite. In the field one gets the impression that this amphibolite represents an intrusive phase.

In thin section, the rock texture of this amphibolite is granoblastic with some reaction textures. Sub-euhedral, fresh amphibole grains occur in a mass of strongly sericitized or sanssuritized plagioclase. In some parts of the T.S. the plagioclase is relatively fresh (An 30-35). Apapite is abundant as euhedral, evenly distributed grains.

A thin section was also taken of an adjoining dioritic layer. All the minerals in this rock were quite fresh and the rock is a stable regional-metamorphic gneiss. Considering the paragenesis and An content (An 27) of this rock, the amphibolite might well be intrusive rather than of the same nature as this gneiss. The relatively large amount of apatite could also indicate an intrusive character.

About 500 m east of the Bekken prospects and surrounded by gneisses are outcrops of a meta-gabbroic rock. The same rock type also occurs to the north of Bekken. This rock is medium grained and equigranular, relicts of clino- and to a lesser extent orthopyroxene are usually enclosed in blocky grains of amphibole. Some of the amphibole has gone over to biotite.

Pegmatites are abundant and quite large, some being over 100 m in length.

An interesting rock type is the so-called coarse hornblende diorite which in the Birkeland area is confined to the vicinity of the Orreknappen Mine. The rock is essentially a dioritic rock with hornblende aggregates (sometimes up to 10 cms in length) in a feldspar groundmass. Wiik regards this rock as being akin to the Flåt ore diorite whereas Barth (1947) calls it a hb. gabbro and gives it the special name Evjeite. The rock has a clear metamorphic paragenesis and at times looks like a product of migmatization.

In many places it is seen to be intimately associated with a fine/medium grained amphibolite and the two are almost certainly related. The field relations between the two rock types are complicated to say the least; at times the contact between them is sharp, at others there is a wavy contact and in some cases there is a gradual transition from one rock type into the other.

At one locality about 60 m to the east of Orreknappen Mine all these three contact phenomena are seen in the same outcrop, plug fragments of hb. diorite isolated in the amphibolite.

As to the problem of its origin, if as Wiik suggests, it is intrusive, then it seems that it must have received its present character not through regional metamorphism but as a result of autometamorphic processes in the course of its intrusion, plus perhaps also some effects of regional metamorphism. In fact, thin section examination shows that it has undergone considerable metamorphism. Certain of the contact relationships and the fact that one can find fragments of coarse hb. diorite in the amphibolite seem to disprove the theory that it is intrusive.

A thin section taken across the contact between the coarse hornblende diorite and medium-grained amphibolite showed that the composition and mineral character of the two rock types is essentially the same, the only difference being the difference in grain size.

In the writers opinion, the rock has been formed by a local metamorphic-metasomatic process and is not related to the Flåt "Ore Diorite".

Ultrabasic rocks were found in situ at only three localities - the three nickel localities. All the rocks are meta-pyroxenitic/hornblenditic and occur in connection with tectonic features, either occupying shear zones or as layers or bands along fracture planes. Most of the ultrabasics are slightly mineralized.

The foliation in the area varies but the main trend here is roughly NE/SW with dips towards the west. All the linear structures in the area plunge towards the south-west. The Birkeland area falls into the regional fracture pattern; dominant regional fractures run E/S, NW/SE and NE/SW.

12th March, 1969
FN/hm

THE ELSHAUGEN AREA (F.N.)

The Elshaugen area is situated on the eastern flank of the Iveland-Evje area, Elshaugen farm lying roughly 5.5 km due south-east of Kjettevann.

Geologically speaking the area consists essentially of a north-west/south-east trending belt of massive basic rocks which are sandwiched between more acidic and gneissic rocks (see Geol. Map Elshaugen, scale 1:5'000). The rocks to the north-east of the basic belt are essentially granitic in nature, those to the south being more dioritic and hornblende-dioritic. Pegmatites are abundant and they are for the most part elongated parallel to the zone of basic rocks.

The most dominant rock type in the basic belt is a medium to coarse grained amphibolite which to the naked eye consists solely of dark green-black hornblende and plagioclase, and has a high colour index. To the north-west of the basic belt another type of massive amphibolite/ meta-gabbro is found; it is medium grained and has a lower colour index than the previously mentioned one. Under the microscope it is seen to contain 50% plagioclase - An_{44}, 40% hornblende, 2 - 3% biotite and chlorite, augite, apatite and magnetite as accessories. This rock is termed a meta-gabbro and is regarded as being essentially different in mode of origin from the first mentioned massive amphibolite.

Amphibolite can also be found as a medium grained foliated rock, both in the basic body and within the basic gneisses.

Towards the south-east end of the basic body are outcrops of a noritic rock which contains 52% orthopyroxene, 20% clinopyroxene, 15% plagioclase (andesine/labradorite) and biotite, opaques and zircon as minor constituents. Apart from this noritic rock, small bodies of ultrabasic rocks are found in the general area. They have a sheared, altered appearance and contain macroscopically visible phlogopite and fibrous actinolite.

The surrounding gneisses display typical gneissic structures. In some localities good examples of migmatitic structures can be seen.

The dominant foliation strike in the zone is to north and north-west and this is also a dominant shear direction.

An old prospect pit is situated near Elshaugen Farm and a detailed description of this is given in the catalogue of prospect descriptions.

12th March, 1969
FN/hm

FALCONBRIDGE NIKKELVERK, AKTIESELSKAP

LOCATION

Name: ORREKNAPPEN MINE. Map unit F9. Air photograph No. 1-61 64-2629. Access is by road. The mine lies about 30 m to the west of the road to Aukland farm, approx. half way between the farm and where the road joins the main Frikstad-Vatne road.

STATUS

A government holding.

HISTORY

Mutet 22.6.1916. Trial exploration was carried out from 1869-72 when a 1½ m deep pit was sunk. In 1907 the mine was pumped empty of water and sampling was carried out. In 1917 trial work was carried out by Evje Nikkelverk A/S. The shaft was sunk to a depth of 15 m and a cross-cut 80 m long was driven in the direction of the ores foliation. Two diamond drill holes proved to be barren. 285 t of ore with a Ni content of 2% were produced. Work was continued until 1918 but then abandoned.

Published records

Barth, T.F.W. The Nickeliferous Evje-Iveland Amphibolite and its relation. N.G.U. No. 168a. 1947.

Bjørlykke, H. Flåt Nickel Mine. N.G.U. No. 168b. 1947.

Vogt, J. Om nikkel, navnlig om muligheten at gjenoptage den norske bergverksdrift paa nikkel. Tekn. Ugeblad 1901 og 1902 pp 1-38. Et tiårstilleg i T.U. 1911.

Unpublished records

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Bjørlykke & Carstens. Rapport over geologiske undersøkelser ved Flåt grube 1940. Sulfidmalm files. Evje-Iveland file 1.

Poulsen, A.O. Nikkelmalmfeltet i Iveland. N.G.U. Bergarkiv rapport nr. 2608. Copy in Sulfidmalm files.

GEOLOGICAL SETTING

The orreknappen mine lies within, but near the eastern margin of the more massive, basic rocks of the Iveland-Evje complex. The rocks that outcrop in the immediate vicinity of the mine are amphibolites and coarse hb. diorite. The amphibolites are mostly med./fine grained. Pegmatites are fairly abundant in the area. The mine lies 400 m south of a strong east-west structural feature and 250 m north west of a strong NE/SW structural feature.

Most of the exposed rock around the shaft is fine- to medium-grained amphibolite in part containing a little biotite and a little quartz. Ore minerals were found associated with these amphibolites, mostly as small grains in aggregates of felspar and quartz grains.

Most of the visible ore at the mine is connected with shears. On one rock face a distinct shear 120/27 cuts the rocks, which are for the most part amphibolites although modifications occur. In the actual main shear zone the rock is a strongly schistose, lustry black hornblendite. Massive ore occurs below this shear zone both as veins and massive clumps. There are also sulphides developed along joint surfaces and as veins parallel to the shear.

Ultrabasic rocks (meta. pyroxenites) also occur as a thin coating (10 cm) on a plane 125/69 which is possibly a shear.

STRUCTURES

The foliation in the Orreknappen area varies but the main trend is roughly NW/SE falling towards the west. In the actual mine area the foliation proved difficult to measure because of the rather massive nature of the rocks. The three measurements made were 293/90, 198/85 NW, and 225/90. Lineations were recorded in two places, both reflecting the linear arrangement of mineral grains (hornblende and biotite). The lineations recorded were 230/30 SW, and 240/32 SW.

As stated above some of the ore seems to be connected to a rather flat flying shear striking 120/27 SW. A dominant shear (joint) on 125/69 SW was noted and on this face were veins of chalcopyrite striking 137/90.

From the old records it seems that the mine has been worked to a vertical depth of 70 m probably following a vertical or near vertical orebody. It could be possible that the mineralization is controlled by the intersection of two different structures and in this respect it is interesting to note that the intersections of the joint 125/69 with the foliation 198/85 gives a linear structure trending 225 and 70.

CHARACTERISTICS OF ORE

The massive ore consists mainly of pyrrhotite with minor pyrite and chalcopyrite. The main mineralizations visible were -

a) connected with shears
b) as veins
c) as concentrations along joint surfaces
d) as disseminations

The smaller veins are rich in pyrite and chalcopyrite whereas larger veins are rich in pyrrhotite - usually having more chalcopyrite towards the border. In places the massive ore has inclusions of amphibolite which is slightly sheared and contains disseminated ore minerals. A polished section of a sample of massive pyrrhotite gave the following minerals:

	Est. % by Vol.
Pyrrhotite	74
Marcasite	7
Chalcopyrite	1
Pentlandite + Violarite	2
Goethite	4
Gangue silicates	12

In hand specimen the sample shows coarse parting planes of pyrrhotite over 3 cms in diameter. In polished section, the pyrrhotite shows development of marcasite blades along these parting planes. Exsolution blebs of pentlandite, now altered to violarite, are difficult to distinguish from the marcasite, since they follow along the same crystallographic directions. Chalcopyrite is a minor constituent, occurring as blebs and streaks in the pyrrhotite and adjacent to patches of gangue.

Veinlets of secondary goethite transact the section and often rim the subhedral grains of silicate inclusions.

FALCONBRIDGE NIKKELVERK, AKTIESELSKAP

ANALYSES

Specimen No.	Ni	Co	Cu	Fe	S
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Analysis carried out at FN K'sand, February 1968.

Specimen No.	Ni	Co	Cu	Fe	S	
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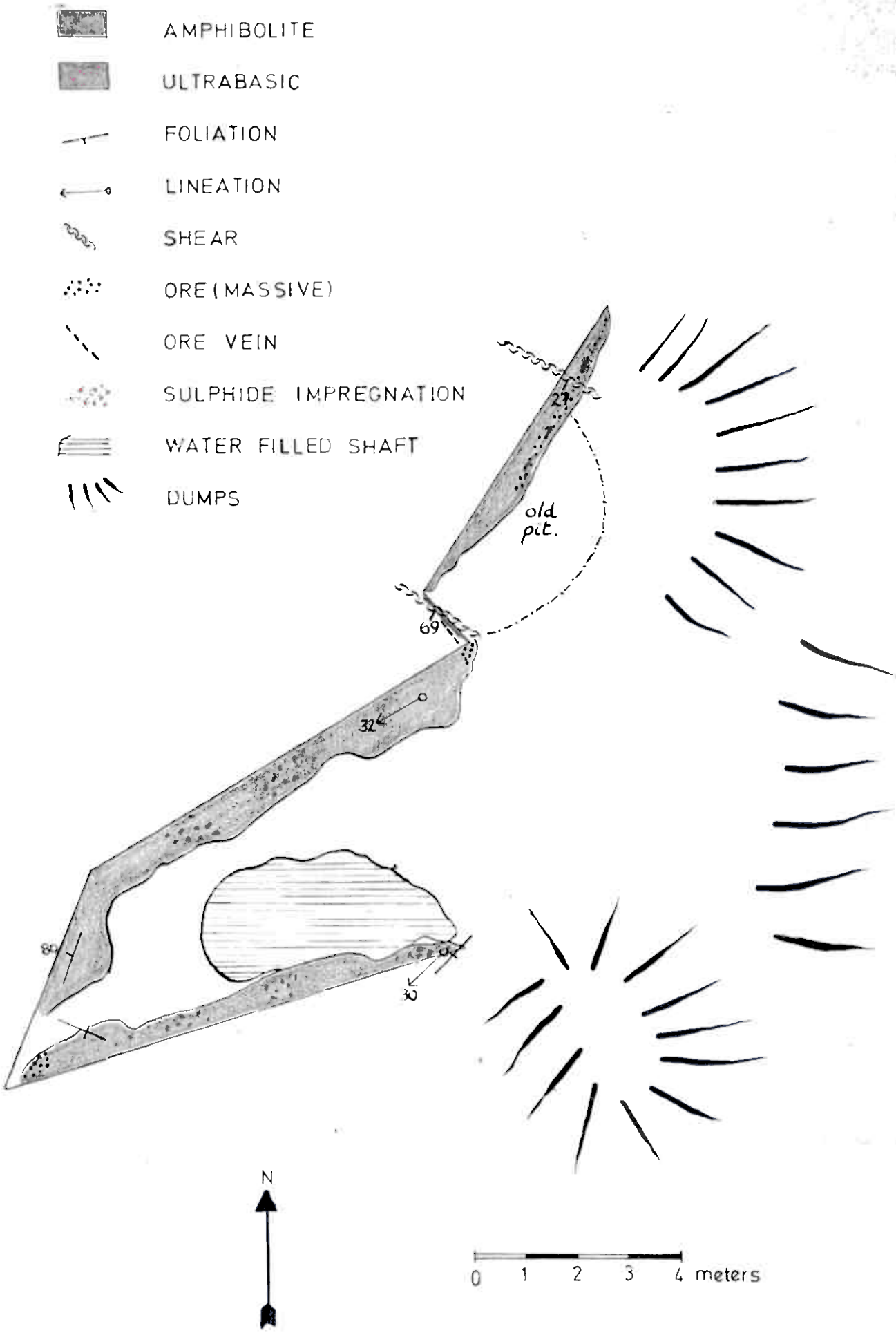
1) massive pyrrhotite.
2) meta ultrabasic-rich in pyrrhotite and chalcopyrite.
3) massive pyrrhotite.

Analyses carried out at FN K'sand 28.9.1968.

NAME of examiner: Frank Krexon

FN/hm February 15, 1969.



ORREKNAPPEN MINE

LOCATION

Name, Bekken Prospect Pit. Map unit F9. Air photograph I 61 64-2629. The prospect pit lies on the south side of Birkeland stream about 200 m ENE of Aukland farm. (Refer EM map Birkeland - Aukland.)

STATUS

A government holding.

HISTORY

It is known to have been worked in 1897 (see Beretning om Evje Nikkelverk 1872 - 1897). The first owners were A/S Evje Nikkelverk, the prospect was taken over by A/S Raffineringsverket in 1925. Now belongs to the State. Men with best first hand knowledge are Albert Frikstad and Orest Landsverk.

Unpublished records.

Bjørlykke H. Dagbok for arbeide for A/S Raffineringsverket, Evje, sommeren 1940. Sulfidmalm files.

GEOLOGICAL SETTING

A small water filled prospect 2 m x 3 m that regionally speaking lies on the border zones of the main basic complex of the Evje-Iveland area. The rocks outcropping in the immediate vicinity of the pit are mostly amphibolites these becoming more gneissic as one moves north and east.

The prospect lies immediately north of a shear that strikes parallel to the stream. The stream itself seems to follow a strong tectonic feature and it was rather a surprise to find amphibolites striking across this stream. These amphibolites are well foliated, medium grained and contained in part disseminated pyrite.

STRUCTURES

Shearing parallel to the stream is very dominant and in the amphibolite behind the prospect three shears occur, 94/24 S, 90/28 S, and 92/38 S. Amphibolites strike obliquely in this amphibolite being 165/20 W and 170/24 W, a lineation in the amphibolite plunged 85° towards 262.

CHARACTERISTICS OF ORE

Massive ore was seen in situ at one place only - in connection with meta ultrabasics in a shear zone. The ore consisted of irregular clumps of pyrrhotite with minor pyrite. From the ore on the dumps a lot of the mineralization seemed to be in the form of veins. Minor disseminations of pyrrhotite and pyrite occur in the amphibolites.

FALCONBRIDGE NIKKELVERK, AKTIESELSKAP

ANALYSES

An analysis carried out by A. Merry Jnr. in 1897 gave 1.41% Ni and 0.38% Cu.

Specimen No.	Ni	Co	Cu	Fe	S	Ca	Mg
VHW 2b	0.35	0.04	0.26	26.1	12.6	1.8	7.5[x1]
VHW 2	1.3	0.11	0.12	53.5	40.0[x2]		

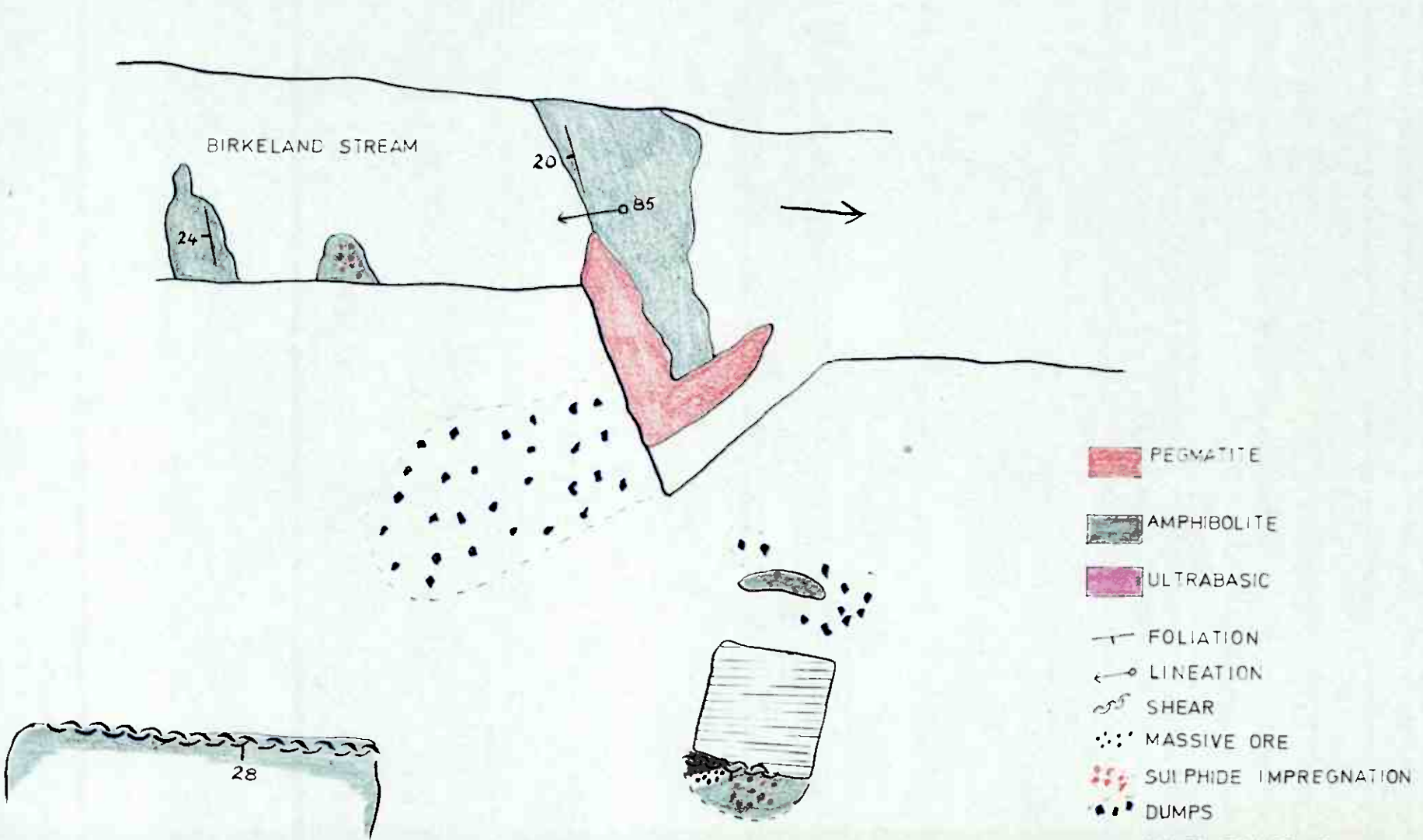
x1: impregnated ultrabasic

x2: ore: - massive pyrrhotite.

Analyses carried out at FN K'sand, February 1968.

NAME of examiner: Frank Hixon

FN/hm Feb. 15, 1969



BEKKEN PROSPECT PIT

THE BIRKELAND AREA (F.N.)

The Birkeland area lies near the eastern margin of the more massive basic rocks of the Iveland-Evje complex. The Orreknappen Nickel Mine and the Bekken and Paasche prospect pits are located in this area. Detailed descriptions of these can be found in the Catalogue of Prospect Descriptions (compare also EM map Birkeland-Aukland, scale 1:1'000).

The main rock type at Orreknappen is a medium-grained amphibolite which gradually changes in a northerly direction into hornblende and dioritic gneiss; rocks north of the Birkeland stream being mainly gneissic.

The amphibolites are fine- and medium-grained and are essentially plagioclase-hornblende rocks. They may be either foliated or more massive. The gneisses are generally well foliated and hornblende rich, however, a slight banding with more dioritic layers alternating with hornblenditic layers is quite common. Both migmatitic and agmatitic structures were noted. Of more limited occurrence are examples of banding with alternations between a relatively light dioritic gneiss, a darker dioritic hornblende gneiss, and a massive, in part structureless amphibolite. In the field one gets the impression that this amphibolite represents an intrusive phase.

In thin section, the rock texture of this amphibolite is granoblastic with some reaction textures. Sub-euhedral, fresh amphibole grains occur in a mass of strongly sericitized or sanssuritized plagioclase. In some parts of the T.S. the plagioclase is relatively fresh (An 30-35). Apapite is abundant as euhedral, evenly distributed grains.

A thin section was also taken of an adjoining dioritic layer. All the minerals in this rock were quite fresh and the rock is a stable regional-metamorphic gneiss. Considering the paragenesis and An content (An 27) of this rock, the amphibolite might well be intrusive rather than of the same nature as this gneiss. The relatively large amount of apatite could also indicate an intrusive character.

About 500 m east of the Bekken prospects and surrounded by gneisses are outcrops of a meta-gabbroic rock. The same rock type also occurs to the north of Bekken. This rock is medium grained and equigranular, relicts of clino- and to a lesser extent orthopyroxene are usually enclosed in blocky grains of amphibole. Some of the amphibole has gone over to biotite.

Pegmatites are abundant and quite large, some being over 100 m in length.

An interesting rock type is the so-called coarse hornblende diorite which in the Birkeland area is confined to the vicinity of the Orreknappen Mine. The rock is essentially a dioritic rock with hornblende aggregates (sometimes up to 10 cms in length) in a feldspar groundmass. Wiik regards this rock as being akin to the Flåt ore diorite whereas Barth (1947) calls it a hb. gabbro and gives it the special name Evjeite. The rock has a clear metamorphic paragenesis and at times looks like a product of migmatization.

In many places it is seen to be intimately associated with a fine/medium grained amphibolite and the two are almost certainly related. The field relations between the two rock types are complicated to say the least; at times the contact between them is sharp, at others there is a wavy contact and in some cases there is a gradual transition from one rock type into the other.

At one locality about 60 m to the east of Orreknappen Mine all these three contact phenomena are seen in the same outcrop, plug fragments of hb. diorite isolated in the amphibolite.

As to the problem of its origin, if as Wiik suggests, it is intrusive, then it seems that it must have received its present character not through regional metamorphism but as a result of autometamorphic processes in the course of its intrusion, plus perhaps also some effects of regional metamorphism. In fact, thin section examination shows that it has undergone considerable metamorphism. Certain of the contact relationships and the fact that one can find fragments of coarse hb. diorite in the amphibolite seem to disprove the theory that it is intrusive.

A thin section taken across the contact between the coarse hornblende diorite and medium-grained amphibolite showed that the composition and mineral character of the two rock types is essentially the same, the only difference being the difference in grain size.

In the writers opinion, the rock has been formed by a local metamorphic-metasomatic process and is not related to the Fiåt "Ore Diorite".

Ultrabasic rocks were found in situ at only three localities - the three nickel localities. All the rocks are meta-pyroxenitic/hornblenditic and occur in connection with tectonic features, either occupying shear zones or as layers or bands along fracture planes. Most of the ultrabasics are slightly mineralized.

The foliation in the area varies but the main trend here is roughly NE/SW with dips towards the west. All the linear structures in the area plunge towards the south-west. The Birkeland area falls into the regional fracture pattern; dominant regional fractures run E/S, NW/SE and NE/SW.

12th March, 1969
FM/hm

EVJE-IVELAND PROJECT

CATALOGUE No. .....

LOCATION

Name, Paascheskjerp south. Map unit F9. Air photograph I-61 64-2629. Lies about 20 m east of Bekken prospect pit on the northern side of Birkeland stream and about 200 m ENE of Aukland farm. (Ref. Birkeland E.M. map).

STATUS

Unknown.

HISTORY

Very little known, mentioned in a few early reports on the area. Regional mapping in scale 1:15'000 was carried out here in 1967 by Wiik, an electromagnetic survey was run in the same year by a A/S Sulfidmalm team. The present study was undertaken in the summer of 1968.

GEOLOGICAL SETTING

Two small prospect pits that are filled with water outcrops being very limited. The main rock type is an amphibolite which is medium grained and at times has a meta gabbroic appearance. In places the amphibolites are well sheared, rust but no sulphides is associated with these shears. Ultrabasic rocks were noted as A. thin bands parallel to the foliation. B. black sheared bands. Type A. are green hornblenditic/meta pyroxenitic rocks and of an intrusive origin. Type B. are considered to be shear products, they consist of a lustrous black hornblende orientated parallel to the plane of shearing.

STRUCTURES

The foliation in the rocks around the prospect is 125/50 SW, two dominant shears also trend in more or less the same direction being measured at 120/28 SW and 125/48 SW.

CHARACTERISTICS OF ORE

As no mineralization can be seen in present day outcrops it is perhaps useful to quote Bjørlykke's diary for 140. He hade presumably more opportunity to observe actual mineralization than we have today.

"At the prospect one can see "dykes" of pyrrhotite with big pyrite crystals, these dykes are about 5 cm thick. The smaller veins are richer in copper and pyrite. There are inclusions in the pyrrhotite of bullet shaped lumps of gabbro which are impregnated with pyrrhotite and chalcopyrite. The gabbro in the area of the pits has in places a weak dissemination.

ANALYSES

Specimen No.	Ni	Co	Cu	Fe	S	
0/BIRK 7	0.6	0.06	0.11	39.9	19.0	x1
0/BIRK 6	0.1	0.01	0.06	20.6	2.7	x2

x1 massive pyrrhotite in meta pyroxenite

x2 pyrrhotite in meta pyroxenite.

Analyses carried out at F.N., Kristiansand, February 1968.

Name of examiner .....

March 12, 1970
FN/hm