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Geological and geophysical investigations in the Holum mine Area

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ORKLA INDUSTRIER A/S

MINING SECTION
EXPLORATION

GULF ORKLA
LØKKEN VENTURE

Report no: L.V.17 Date: January 31st 1983

Title: Geological and geophysical investigations in the Holum mine area.

ORKLA INDUSTRIER A.S.

MINING SECTION, EXPLORATION

Report no: LV (Løkken Venture) 17	Date: January 31, 1983
Title: Geological and geophysical investigations in the Holum mine area	
Prepared by: Tor Grenne	Areas name:
Map no., name: 1521 III Løkken	Coordinates (UTM): NQ 290-325, 900-913
Field work period(s): July-august 1982	Pages: 7 Map enclosures: 6

Summary (purpose, execution, results):

The Holum mine is a vasskis-like pyrite-pyrrhotite layer of 0.2 - 1 m thickness, traceable for 350 metres along strike. It occurs in the stratigraphic lower part of the inverted volcanic sequence. There are no indications of the presence of proximal, metal-bearing massive sulphides at this stratigraphic level in the Holum mine area. Sulphide disseminations are found within the greenstone SE of Holum mine. This can possibly represent a feeder zone to a deeply buried sulphide orebody at a higher stratigraphic level.

VLF anomalies are mostly caused by dark slates, but a parallel VLF and magnetic anomaly N-NW of Holum mine is not explained by the present investigation and should receive some more attention.

Key words: Vasskis, lava types, cherty sediments, sulphide disseminations, VLF, magnetometer measurements

Project initiated (date): July 1982	Report finished (date): January 21, 198

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INTRODUCTION

The old prospect "Holum mine" is known to contain trace amounts of chalcopyrite in a "vasskis"-like sulphide deposit. The objective of the present investigation was to get a better understanding of the nature of this deposit and its geological environment. In particular, the possibility that a larger and richer deposit could be spatially related to the prospect was considered, and zones of alteraion and sulphide mineralization in the greenstones were looked for as possible feeder zones to more proximal massive sulphides. VLF measurements were carried out in the same area during July 1982, and anomalies from this investigation were also followed up by some geological mapping.

Ca. 2 sq. km NE of the valley Kloppdalen and SW of lake Lomtjønna is mapped in the scale 1:5000 on map sheet Kustoin CE 118-5-3. (Encl. 3). The area west of here is highly covered with large marshes and detailed mapping is impossible. A few exposures are, however, marked on the 1:20.000 map (Encl. 2).

GEOLOGY

Metagabbro

Relatively homogeneous, coarse to medium grained ophitic leucogabbro occur as a 200 m thick, SW-NE-striking body within greenstones in the northwestern part of the mapped area. The NW boundary is not exposed, but in SE one can see clear intrusive relationships to the greenstones, with several irregular gabbro veins into the latter. Similar metagabbro is seen also on exposures in the east-southeastern part of the mapped area (Encl. 3).

Mafic dykes

Mafic dykes are found in the lower part of the lava pile, and also cutting the gabbro. Their thickness range from 20 cm to more than one metre. General strike is N-S, with an easterly dip of between 30° and 55°. Dykes in the central part of the area are oriented more SSW-NNE with a more gentle dip of 26-28°. The attitude of the dykes is thus broadly perpendicular to the layering in this area.

Lavas

Lava types vary from massive to pillowed and subordinate pillow breccias. Original pillow shape is well preserved due to very little deformation, and consistently show way up to SE. Dip of layering is mostly between 50° and 60° to northwest in the NW part of the area, 30-40° in the SE, and the sequence is clearly inverted.

The lower portion of the lava pile, in NW, is generally non-vesicular and consists of pillow lavas alternating with apparently thick units of massive greenstones. Some of the massive flows and also some pillow lavas are plagioclase phyric, with phenocrysts of the size 1-5 mm.

Up-sequence, towards the central part of the area, pillow lavas are dominant, and differ from those lower down in being generally lighter and fairly vesicular. At two localities apparantly primary pillow elongation shows a northwesterly plunge of 30^{o} - 50^{o}. Stratigraphically above these pillowed flows, in the SE corner of the mapped area, there is a sequence of apparantly thick massive flows. In many outcrops they show a gabbro-like appearance, with a medium grained ophitix texture sometimes with abundant plagioclase phenocrysts. However, gradations towards finer grained, often highly vesicular flow-tops and alternation with subordinate pillow lavas reveal their extrusive nature.

In the western areas (Encl. 2) there also occur highly vesicular greenstones as massive flows closely associated with sediments above and below. Due to lack of exposure, the stratigraphic relationship between those and the lavas in the better investigated section further west is unclear.

Vasskis at Holum mine

This vasskis horizon can be traced for about 350 metres along strike in the valley of the river Mosbrunnskjerva. In the southwest it occurs as a 0,5-1 m thick massive and compact normal vasskis with essentially very fine grained pyrite. Chalcopyrite is not seen here. Towards NE pyrrhotite becomes dominant, with subordinate pyrite and traces of chalcopyrite. Here the unit is not more than 20-30 cm thick and exhibit a vague banding in addition to the normal massive appearance.

Banded cherty sediments

Units of this type are found in the upper portion of the examined part of the lava pile. The first one appear at the boundery between the light, vesicular pillow lavas and the overlying coarse, ophitic massive flows. Others occur higher up, separating simular, thick massive lavas. The banded units may have a thickness up to 3-4 metres, with individual brownish-red cherty layers between 0.5 and 5 cm alternating with somewhat thicker tuffaceous layers. Dark cherty bands may contain minor amounts of pyrite, and in the NE where this type is the dominant, one can also see thin (less than 5 mm) almost pure pyrite layers. Soft-sediment folding structures in the lowest banded cherty unit may indicate a southwesterly component of movement.

Coarse to finer grained clastic sediments

In the best investigated part of the area (Encl. 3) clastic non-volcanogenic sediments make their first appearance in the upper part of the stratigraphy, overlying the lowest banded cherty unit between the vesicular pillow lavas and the higher thick massive flows. Here it takes the form of a relatively local breccia with angular to sub-rounded greenstone clasts up to 10 cm across loosely packed in a limestone or finegrained green matrix.

Green gritty or sandy sediments and darker slates, often with some pyrite dissemination are frequently found further west, where they appear to be intercalated with commonly highly vesicular metabasaltic lavas. The stratigraphic relationship between these lavas and sediments, and the volcanic sequence to the east is however unclear due to lack of exposures.

Alteration and sulphide dissemination zones

Pyrrhotite and subordinate pyrite disseminations occur mainly in the lower part of the lava pile (Encl. 3), forming a ca. 200 m wide zone that strikes approximately SW-NE. Alternatively, it is possible that this mineralization is separated into two or more zones of a more SSW-NNW orientation. The sulphides mostly occur as fine to medium grained disseminations, locally relatively rich and occasionally with trace amounts of chalcopyrite. The highest concentrations of sulphides were seen in the extreme northeast and southwestern parts of the zone, in the latter area sulphides may also form thin (of the size 1-2 mm) irregular veins or pyrrhotite enrichment between individual pillows in pillow lavas. This is also the only place in the area of sulphide mineralization where significant alteration in the form of bluish-green partly quartz-rich greenstones, can be seen.

Another type of alteration, however, is found to the SE in the mapped area (Encl. 3) where pillow lavas are strongly oxidized and stained bluish to purple by very fine grained disseminations of hematite. The greenstones here frequently exhibit a fragmental breccia-like appearance, where the "matrix" is usually the most hematite-rich part. It appears from the map that this alteration rock type may not be relatable to any stratigraphic unit, but rather seems to be confined to a SSW-NNE-trending fracture/fault zone. The orientation of this zone coincides well with the strike of mafic dykes in the area. Thus it seems possible that the zone represents an early, syn-volcanic, tensional fracture and normal fault, along which oxidizing sea-water could easily have percolated and altered the fractured and brecciated wall rocks. That this may be an early fault-zone is also indicated by the areal distribution of the coarse, obviously short-transported, partly calcite-cemented greenstone breccias (see Encl. 3), which occur adjacent to the fault and dissappear northeastwords along strike.

Deformation

As mentioned above, the stratigraphy is clarly inverted in the investigated area. Igneous and sedimentary layering is SW-NE with a NW-dip of between 30 and 70° in the eastern part, whereas to the west layering bends into a generally E-W strike direction with a northerly dip of about 45°. In general the greenstones are virtually undeformed, while a weak schistosity may often be seen in the less competent sedimentary rocks. Minor tight folds probably related to this schistosity are found only locally.

The area is cut by several fracture zones, and at least some of them are obviously faults. The most conspicuous one is trending ESE-WNW in the southern part of the mapped area (Encl. 2). The extension towards WNW is unclear, but it seems likely that this fault is responsible for the difficulties in linking the geology of the western area to the well mapped section further east (see Encl. 1). The character of the two SW-NE-trending fractures just SE of river Mosbrunnskjerva is however more unclear; anyhow, taking the rock types on both sides into account, large scale faulting is not likely to have occured here.

GEOPHYSICAL INVESTIGATIONS

Profile direction: SW-NE, 60^g
Profile interval : 100 metres
Measurement interval: 25 metres
VLF station: NAA
Measured area: 1,54 sq.km

The area has been covered by both VLF and magnetometer measurements. In the western part of the area several VLF anomalies (Encl. 4 and 5) appear to be related to the clastic sedimentary rocks which may include dark bituminous slates. These anomalies coincide with the strike of the sediments, and stop abruptly at the ESE-WNW trending fault. Magnetic anomalies are not found here (Encl. 6). East and northeast of the fault there is one marked anomaly ca. 200 metres NNW of Holum mine. There are no exposures here, but gabbro can be seen both NW and SE of the anomaly. A minor positive magnetic anomaly is trending parallel, but displaced 50-100 metres NW of the VLF anomaly. Due to the overburden both these anomalies can not be explained at present.

Within the greenstones souheast of the river Mosbrunnskjerva the magnetic pattern is more variable, but no marked anomalous zones can be seen. VLF data show a minor anomaly ca. 450 m SSE of Holum mine, in the area of sulphide disseminations and partly veining within the greenstones.

DISCUSSION AND CONCLUSIONS

Mapping in the Holum mine area has shown an inverted lava sequence composed of generally non-vesicular pillow lavas in the middle, and thick, massive ophitic, partly highly vesicular flows in the upper portion of the pile. The lower lavas are intruded by mafic dykes and a leucogabbro. Within the upper lavas thin sedimentary units of cherty and tuffaceous material occur, together with local coarse greenstone breccias. The breccias may be derived from syn-volcanic fault scarps; such primary faults are possibly represented in the area by zones of brecciated and highly oxidized greenstones. Grey-green clastic sediments and dark slates are intercalated with highly vesicular lavas in the area west of Holum mine, these may relate to the uppermost parts of the volcanic stratigraphy. Holum mine, a vasskis-type pyrite-pyrrhotite sulphide layer with traces of chalcopyrite, of 0.2-1 m thickness, is situated in the lower portion of the examined lava sequence, close to the intrusive gabbro contact. The sulphide horizon dips to the NW, underneath the gabbro body. Sulphide dissemination and partly thin veining is found in greenstones SE of the vasskis. Unless the southeastern area was considerably down-faulted relative to the Holum mine rocks (which appears not to be the case), the mineralized greenstones occupy a somewhat higher stratigraphic position than the vasskis, and there appears to be no genetic relationship between the disseminations and the sulphide layer. Thus there can not be found any field indication of more proximal massive sulphides adjacent to the vasskis in this area.

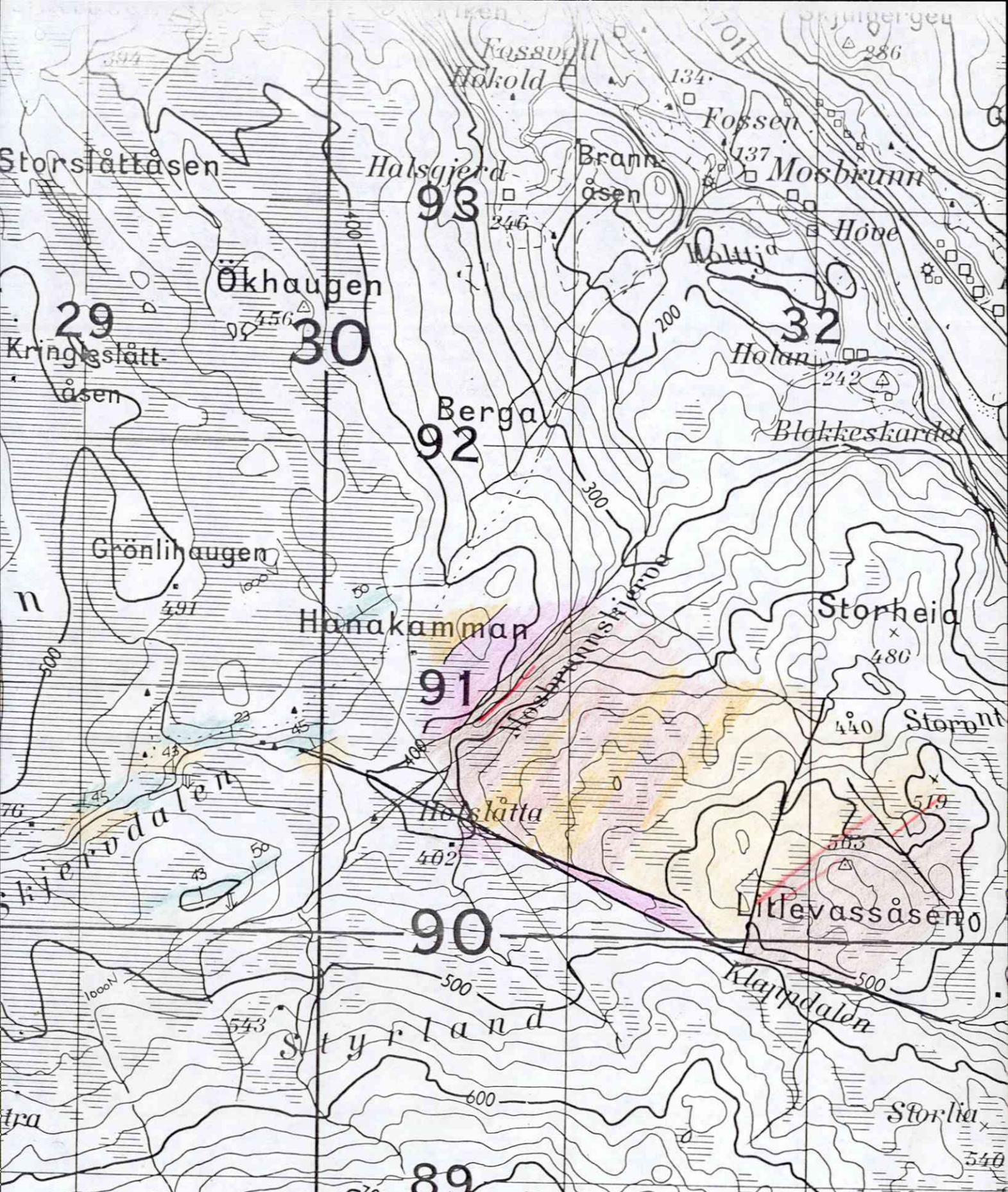
If the disseminations represent a sulphide feeder zone, a possible related orebody must have been located higher up in the volcanic sequence. The only possible exhalites that may reflect such sea-floor hydrothermal activity in the area are the banded cherty sediments in the SE. A proximal sulphide orebody at this stratigraphic level, related to the dissemination zones in NW, would however (if it existed) probably be found at a depth of more than 500-600 metres, and would thus be of very little interest from an economic viewpoint.

VLF anomalies in the area seem to be caused by dark slates in the sediments and by the sulphide disseminations/veining in the greenstones. However, the parallel VLF and magnetic anomalies N-NW of Holum mine is not explained by the present investigation, as it occurs in an area largely covered by marsh and moraine, with gabbro exposed on both sides.

RECOMMENDATIONS

The VLF and magnetic anomalies NW of Holum mine should be further investigated by GENIE or other geophysical methods. Other investigations in the Holum mine area are not recommended.

Location map Holum mine area	Scale: 1:50.000	Draw: TG Date: jan. 83
Orkla Industrier A.s 7332 LØKKEN VERK Gulf - Orkla Venture	No: Enclosure no: 1 Report no: 17	



Geological map of the Holum mine area
Legend : see end. no: 3

Scale: 1:20.000

Draw	TG
Trac	AM
Date:	feb 83

No:

Enclosure no 2

Report no 17

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Gulf - Orkla Venture

LEGEND

- Hematite-rich, partly brecciated greenstones
- Coarse-grained (gabbroic) massive greenstone/porphyritic
- Grey-green grit, sandstone and dark slate, locally pyrite-bearing (undifferentiated)
- Greenstone breccia
- Banded cherty sediments
- Mainly pillow lava, generally vesicular/pillow breccia
- Mainly pillow lava, generally non-vesicular/porphyritic/pillow breccia
- 'Vasskis'
- Mainly massive greenstone/porphyritic
- Gabbro
- Lithological boundaries/inferred
- Fractures, faults
- Strike and dip of layering, with way-
- Plunge of primary pillow elongation
- Strike and dip of schistosity
- Strike and dip of mafic dykes
- Sulphide disseminations
- Prospect

Geological map of the Holum mine area, eastern part

Scale: 1:5.000

Draw: TG
Trac: AM
Date: feb.8

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Gulf - Orkla Venture

No: GL 34
Enclosure no: 3
Report no: 17

Scale

600N 700N 800N 900N 1000N 1100N 1200N 1300N 1400N 1500N

10 0 -10 -20

2600 V
2500 V
2400 V
2300 V
2200 V
2100 V
2000 V
1900 V
1800 V
1700 V
1600 V
1500 V
1400 V
1300 V
1200 V
1100 V
1000 V
900 V
800 V
700 V
600 V
500 V
400 V

V
NAA
N
mN

HOLUM

Dip angle

Scale: 1:5000

Draw	LAH.FIE
Trac	AM

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Gulf - orkla Venture

No: GfI M3

Encl. no 4

Report no 17

Date: sept 82

600N 700N 800N 900N 1000N 1100N 1200N 1300N 1400N 1500N

2600 V
2500 V
2400 V
2300 V
2200 V
2100 V
2000 V
1900 V
1800 V
1700 V
1600 V
1500 V
1400 V
1300 V
1200 V
1100 V
1000 V
900 V
800 V
700 V
600 V
500 V
400 V

V
NNA
N
SmN

HOLUM
VLF-anomali map
Frazer curves

Scale: 1:5000
Draw: AM
Trac: AM

Orkla Industrier A.S
7332 LØKKEN VERK
Gulf - Orkla Venture

No: Gf I M6
Encl. no5
Report no17
Date: sept. 82

600N 700N 800N 900N 1000N 1100N 1200N 1300N 1400N 1500N

50.800 / 50.600 — 2600 V
800 / 400 / 50.600 — 2500 V
400 / 800 / 50.600 — 2400 V
800 / 400 / 50.600 — 2300 V
400 / 800 / 50.600 — 2200 V
800 / 400 / 50.600 — 2100 V
400 / 800 / 50.600 — 2000 V
800 / 400 / 50.600 — 1900 V
400 / 800 / 50.600 — 1800 V
800 / 400 / 50.600 — 1700 V
400 / 800 / 50.600 — 1600 V
800 / 400 / 50.600 — 1500 V
400 / 800 / 50.600 — 1400 V
800 / 400 / 50.600 — 1300 V
400 / 800 / 50.600 — 1200 V
800 / 400 / 50.600 — 1100 V
400 / 800 / 50.600 — 1000 V
800 / 400 / 50.600 — 900 V
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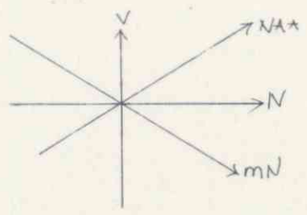
400 / 800 / 50.600 — 400 V
400



HOLUM Total magnetic field map	Scale: 1:5000	Draw Trac	AM AM
Orkla Industrier A.s 7332 LØKKEN VERK Gulf - Orkla Venture	No: GfI M8 Encl. no 6 Report no 17 Date: sept 82		