BERGVESENET
MED BERGMESTEREN FOR SVALBARD
Postboks 3021, N-7441 Trondheim

Rapportarkivet 2001

Bergvesenet rapport nr	Intern Journal nr	Gammelt internt rapp. nr.	Rapport lokalisering	Gradering
BV 5627				
Kommer fra ..arkiv Elkem Skorovas AS	Ekstern rapport nr P4 - 20	Oversendt fra Skorovatn Gruber	Fortrolig pga	Fortrolig fra dato:

Tittel

GRONG FELT PROJECT - SMÅVATN - SØNDRE MØKKELVIK AREA
A Prelimerary Report covering fieldwork Summer 1973

Forfatter	Dato År	Bedrift
Reinsbakken, Arne	1973	Elkem Skorovas AS

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Namskogan Røyrvik	Nord-Trondelag		18242	Grong

Fagområde	Dokument type	Forekomster
Geologi		Grongfeltet

Råstoffgruppe	Råstofftype
Malm/metall	Cu, Zn

Sammendrag / innholdsfortegnelse

Rapporten bygger på feltarbeider utført sommeren 1973 med detaljert geologisk kartlegging i området Småvatn - Søndre Møkkelvikfjell. Den inneholder en generell geologisk beskrivelse av området med spesiell vekt på mineraliserte soner i forskjellige bergarter.

Rapporten inneholder også en kort beskrivelse av metamorfe bergarter og strukturgeologi med foldemønstre.

Rapporten mangler kart og øvrige vedlegg.

GRONG-FELT PROJECT

Småvatn - Söndre Mökkelvikfjell Area

A Preliminary Report covering fieldwork Summer 1973

by Arne Reinsbakken

Dec. 1973

Contents:

INDEX

Småvatn - Søndre Møkkelvikfjell Area

Introduction:

The object for the field work of Summer 1973 was to carry out a more detailed mapping program over the Småvatn - Søndre Møkkelvikfjell area. Particular attention was given to the mineralized zones, their differences, similarities and relationship to various rock units. Along with trying to distinguish a stratigraphic sequence, the various structures were mapped in detail for structural analysis, to hopefully distinguish the overall regional structural pattern and to help indicate any relationship of mineralization concentrations to a preferred stratigraphic horizon or structural plane and direction.

In conjunction with this detailed geological mapping, a Turam electromagnetic survey was carried out over the same area by a crew from NGU. Their grid system was transferred onto the geological map to help coordinate the geophysical and geological interpretations.

The field season was started July 1st. by investigating various Helicopter electromagnetic anomaliesthroughout the area, using mini-gun electromagnetic equipment. The various anomalous areas checked were plotted onto air photo overlays and a small report was written with results and possible reasons.

Because of the extremely bad weather this summer, some of the area in Søndre Møkkelvikfjell area has not been covered in detail and the mapping at Lille Tromselv was not done at all. Three days in September were spent in the Blåhammern - Havdalsvatn area with Chris Halls looking at the geology mapped by the English students and collecting samples from some of the typical vasskis mineralized zones.

General Geology:

Much of the central part of the area is underlain by a fragmental volcanic sequence composed mostly of layered intermediate tuffs and minor acid tuffs (Keratophyres) and an agglomeratic sequence that thickens to the North East - Søndre Møkkelvikfjell area. This agglomerate horizon contains mostly intermediate (andesite), moderate green, elongate fragments set in a fine-grained tuffaceous matrix of similar composition. Minor lighter coloured felsic to acid fragments are found in some horizons. Much of the tuffs occur as irregular discontinuous bands of gritty f.g. volcanic material. Most of this pyroclastic horizon is extremely schistose and the larger fragments are notably flattened and elongated within this schistosity plane.

A rusty pyrite and pyrrhotite mineralized zone occurs as a stratigraphically controlled band within this pyroclastic sequence and appears related to a thin keratophyric rich banded horizon in connection with the coarser grained agglomerate horizon.

Minor en echelon elongate fragments of schistose gabbro and light coloured aplitic and felsic dykes are found throughout the sequence and probably represent the lightly folded and elongated pieces of originally cross cutting gabbroic and felsic dykes and sills.

In the Voldtjernbekken area and to the southwest, the f.g. pyroclastic sequence is found interfingering with massive flows ranging from light green coloured, massive, fine to medium grained crystalline and amygdaloidal flows, med.-grained h.blende bearing gabbroidal andesite, and calcite amygdular andesites, to extremely fine grained varieties carrying zones rich in epidote knots. A very fine-grained lighter coloured felsic-rich sequence also occurs North east from Voldtjernklumpen and is overlain by a darker green, very fine-grained, massive, almost flinty horizon that could also represent a flow sequence. Much of the flow units are more massive with slight traces of a primary schistosity, and their contacts are relatively sharp.

More basic volcanics in the area are represented by more dark green chlorite rich massive basaltic to basaltic-andesite flows. To the North, these are found as medium-grained crystalline flows, and to the south of the NE / SW - trending pyroclastic belt, as massive to thinbanded tuffs?

Several minor massive acid volcanics occur within the area and are present as very elongate, thin lensoid shaped bodies stretched out within the schistosity plane of the enclosing pyroclastic metavolcanics. A thin, very highly fractured, glassy, bluish-green coloured, massive rhyolitic body outcrops in the Voldtjernbekken area. A more continuous, massive, dense, greyish coloured dacitic-("Quartzitic andesite") occurs to the west and appears to be the continuation of this acid volcanic horizon.

To the west occurs a large area underlain by very schistose, light coloured, well-banded quartz sericite schist representing a thick quartz-keratophyre unit that shows sharp contacts with the enclosing intermediate tuffs, with slight thin interlayering gradation immediately at the contacts. Several varieties of this quartz keratophyre can be distinguished with the typical "Quartz eye porphyry" forming the most dominant and characteristic variety. This phase contains characteristic large elongate bluish-tinted quartz grains set in a strongly schistose sericitic to feldspathic matrix. Elongate chloritized h.blend porphyry remnants form a minor variety in the Finhustjern Area. Minor zones of rusty, disseminated pyrite are also present. Towards the NW., in the Fisktjern area, the keratophyre occurs more thin banded and layered in nature.

Several anomalous volcanic varieties are found within the area mapped. Immediately north-east from Voldtjernklumpen, within the dark green massive basic volcanics, occurs an isolated band(?) of stilpnomelane or biotite (?) bearing basic lavas. To the North of Søndre Møkkelvikfjell directly east from the large, North-South trending Trondheimite, occurs a N-S trending horizon of lighter green coloured amphibolte needles as (tremolite? Actinolite?)-bearing, massive flows.

Several intrusive phases have been recognized within the Smivatn - Søndre Møkkelvikfjell area and much of the area south and north of this NE-SW trending volcanic belt is underlain by these intrusives.

Trondheimite as coarse grained, light coloured, quartz, plagioclase and minor chlorite bearing, forms north-south trending bodies within the massive and banded greenstones north of Søndre Møkkelvikfjell.

The eastern contacts with the greenstones, are sharp and appear concordant. The western contacts, however, are very difuse, containing numerous, thin, irregular, aplitic (fine grained Trondheimite equivalents) dykes cutting through the massive banded greenstones. Similar, more isolated irregular aplitic and felsic dykes are found within the tuffaceous, sedimentary-volcanics to the south.

The most prominant single unit within the map area is the coarse to medium-grained quartz bearing diorite - granite? that caps Voldtjernklumpen and forms a sheet-like body dipping gently to moderately southover to the Tunnsjøflyene area. This intrusive forms a continuous sheet that stretches from Voldtjernklumpen southwestward to the Smivatn Gård and the Tunnsjøflyene area to the south.

Characteristic of this coarse-grained diorite? is the sheet-like form giving it a concordant or sill like appearance. Also the diorite, coarse-grained and dark to moderately grey in colour, has a strongly foliated nature with the large, blue-tinted quartz grains, so typical of this unit, occuring as elongated, flattened sheets. Another distinctive character of this "Quartz diorite" is the extreme light coloured, almost complete alteration of the feldspar ground mass, much of which may be a deuteric effect.

although some zones of strongly hydrothermal vein type alteration has been noted. The prominant bluish tinted quartz grains found within the coarse-grained diorite is also typical of the Quartz keratophyre to the northwest and may suggest a genetic relationship between the two.

The northern, footwall contact of this quartz diorite appears very sharp at the Voldtjernklumpen area and the southern hanging wall contact in the Tunnsjøflyene area and Småvatn Gård south area, is extremely irregular and marked by numerous dykes and sills intruding the highly altered, partly digested greenstones. Numerous large irregular to small, somewhat rounded and partly digested, xenolithic blocks of greenstones are found here within the quartz diorite.

This contact area is also characterized by numerous intrusive dyke phases that cross cut each other. The coarse-grained quartz diorite phase appears earliest, cut by a porphyritic hornblende diorite or diabase dyke phase that occurs sporadically and has an intimate association to this contact zone.

These two earlier dyke phases are cut by a later, light coloured, fine grained aplite or micro-Trondheimite dyke phase.

The northerly or footwall contact of this quartz-diorite at Voldtjernklumpen is also characterized by the occurrence of coarse-grained strongly foliated to massive hornblende gabbro within the masses but can occur as large sheeted bodies similar to the quartz-diorite intrusive, i.e. gabbro sheet-like body on south slope of Søndre Møkkelvikfjell (Refer to schematic cross - section I). Similar gabbroic bodies occur along this contact from Voldtjernklumpen to Småvatn Gård south area and there appears to be an intimate association in time and space between these two intrusive phases.

As previously mentioned, these intrusive bodies now occur as flat sheets and appear concordant or sill-like within the enclosing greenstone units. However, the intrusive units do have a slight crosscutting nature and appear to have been flatted parallel to the primary schistocity by an early intense isoclinal folding deformation phase. This is best demonstrated by the small discontinuous, en echelon pattern of gabbro lenses found within the pyroclastic sequence in the Voldtjernbekken - søndre Møkkelvikfjell area.

These gabbroic lenses, now strongly schistose parallel to the primary schistocity in the enclosing tuffs, probably represent isoclinally folded and transposed remnants of originally cross-cutting gabbroic dykes.

If this is the case, then these dioritic, Trondheimitic and gabbroic intrusives must have been emplaced very early in the deformational history of the area and probably are pre F_1 or penecontemporaneous with the major deformation.

The gabbro problem:

Several varieties of gabbroic intrusives are found within the area. The most common variety is the strongly schistose and foliated coarse grained variety mentioned in conjuction with the quartz-diorite footwall contact. A second, more isolated variety found within the Småvatn Gård south area occurs as massive bodies, generally more dark coloured and very massive in nature. The grain size is also generally finer and these gabbroic units appear very similar to some fine grained micro-gabbros intruding the greenstones of the south eastern slopes of Skorovas-Klumpen.

A bit more problematic is the occurrence of a mottled, massive greenstone at the intrusive contact zone against the coarse grained quartz-diorite in the Tunnsjøfjyene area. These h.blende-porphyroblastic massive metavolcanics with their light coloured feldspathic matrix and large h.blende crystals could be mistaken, at first glance, with some of the metagabbros in the area.

Metamorphism:

As noted by previous workers in the area, the regional metamorphic grade lies within the greenschist facies, with characteristic minerals including chlorite, sericite, albite, calcite and minor amphibole (actinolite?) and stilpnomelane. Stilpnomelane, according to H.G.F. Winkler (1967), is restricted to the lowest temperature subfacies in the Barrovian facies series.

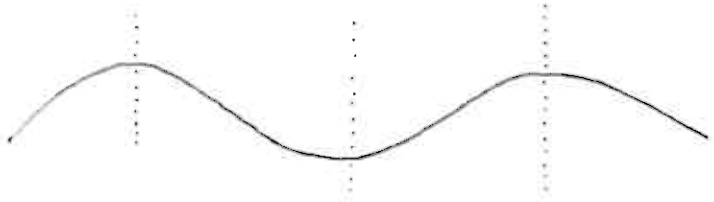
Contact metamorphism associated with the gabbroic and Trondheimitic intrusives appear to be negligible in most places throughout the map area. However, as previously mentioned, there is considerable digestion and assimilation of the massive greenstones and tuffs found in contact with the lowerpart of the southward dipping "quartz-dioritic"sheet in the Tunnsjøfjyene area. The large xenolithic blocks within the quartz-diorite also show this assimilated nature.

Structure:

Only a very brief account will be given here; a detailed structural analysis is in progress and will be completed while at N.T.H., spring 1974. An accompanying sketch sheet shows the various structural styles found in the Småvatn - Søndre Møkkelvikfjell area and the accompanying description should be self explanatory. Axial directions are also shown to help orientations on the geological map.

A structural map and overlay sheet also accompanies this report, however, some changes and additions are anticipated following the completion of the structural analyses.

In addition to the four fold styles shown on the accompanying sheet, a later, roughly north-south trending, open warping style fold:



is found warping the main schistocity surface. These are especially prominant in the greenstones east and south-east of Voldtjernklumpen. These folds are characterized by long wave lengths, low amplitudes and near vertical axial planes, and their axial directions plunge southward, gently down the dip of the main schistocity in this area.

Fold styles identical to these found in the Småvatn - Søndre Møkkelvikfjell area have been noted inside the Skorovas mine and their relationships will be discussed in more detail in conjunction with the structural analyses report that is to follow this.

An interesting observation in connection with the fold phases of the map area is the parallelism of the flat, near E-W-trending, "so called" F_1 style folds

Shown in cross-section

to the electromagnetic anomalies obtained by NGU summer '73 covering the same Småvatn - Søndre Møkkelvikfjell area. Another interesting observation is the thickening or lensing of the massive pyrrhotite and pyrite mineralized horizon in conjunction with an F_3 style fold crosscutting the stratigraphically controlled, rusty sulfidemineralized horizon.

Structural Styles:

Småvatn - Søndre Møkkelvikfjell Area AR

F_1

280 - 300°

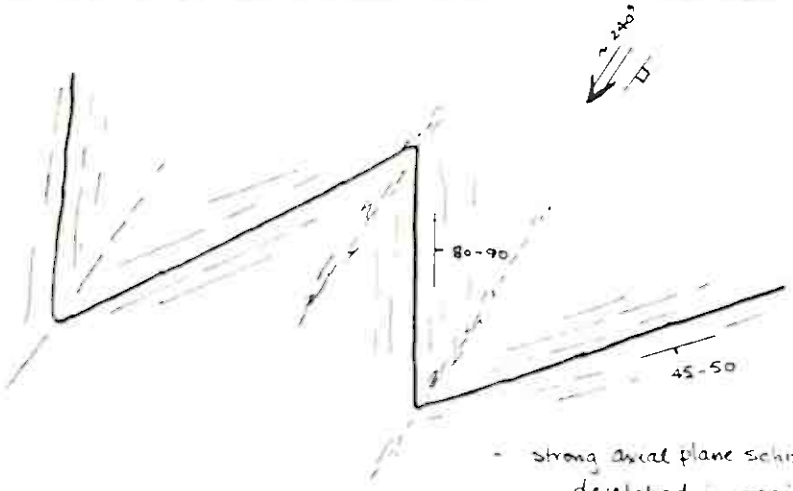
- best visible in keratophyritic units north of Småvatn wård area
- tight isoclinal to more open
- axial planes parallel main schistocity
- gouge and lineations on quartz rocks and mineral lineations parallel this trend

Re F.

- find hints of a very tight isoclinal minor folding preserved in Iron formation and quartzites

---

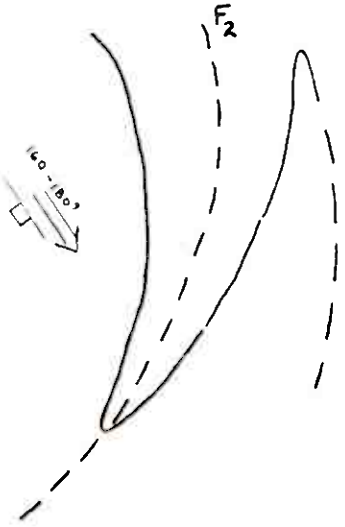
F_2



- strong axial plane schistocity and cleavage developed in major hinge zones.
- marked crenulation of main schistocity surface developed along limbs

---

F_3



- more open warp and drag fold style

and in minor folds

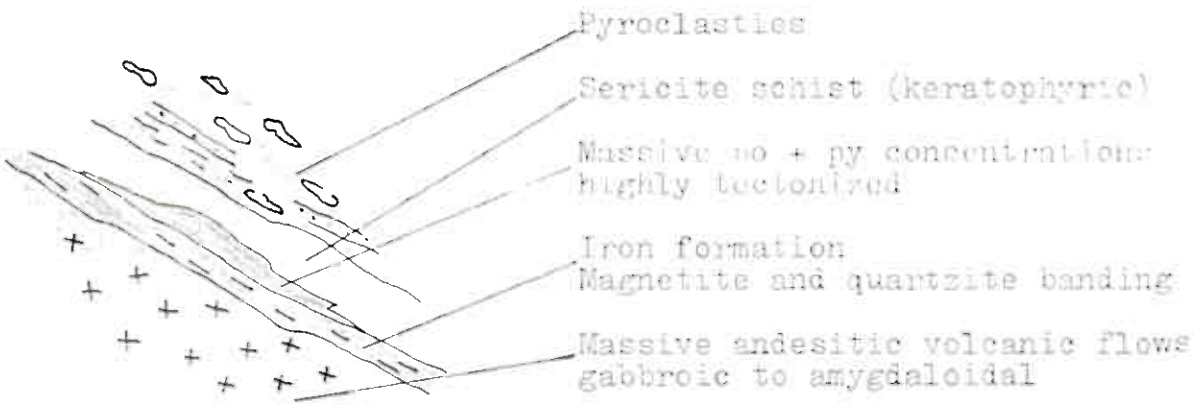
- very inconsistant and irregular fold styles and trends

- controlled by orientation of previous dominant folds and folding surfaces

Mineralization:

A much more detailed description of the various mineralized showings throughout the area, with their characteristic similarities etc., will follow this report in conjunction with thin section and polished section studies to be carried out at N.T.H. in the new year (1974).

However, some generalized observations and conclusions can be drawn here. The rusty po and py mineralized zones and bands of the Voldtjern-bekken and Søndre Møkkelvikfjell areas appear to be stratigraphically controlled and closely associated to a thin sericite schist band and a thin banded magnetite and quartzite horizon. This relationship appears to be duplicated from the Hausvik area down to Småvatn and even the Grøndalsfossen skjerps. An idealized section might appear as follows:



Very similar relationships have been seen in the vasskismineralized horizons from the Blåhammern - Havdalsvatn area as mapped by the English students. Thin vasskis mineralizing bands are found sandwiched between keratophyres on one side and jaspis (massive, thick) on the other.

The mineralized horizon appears quite discontinuous throughout the map area and in many places none to very little sulfide mineralization is found associated with the well banded magnetite and quartzite horizons. An interesting question arises as to how much of this discontinuity in mineralization along this horizon is due to primary distribution, (i.e. a sedimentary gradation from sulfide to oxide deposition) - and how much is due to a secondary remobilization accompanying deformation? It appears that any great thickness of massive ore in the mineralized horizon is definitely tectonically controlled.

Correlation to outside areas:

Rough similarities can be drawn to the geology at the Skorovas - Tunnsjø areas. These shall be given in point form:

1. Pyroclastics and tuffaceous, intermediate volcanics occupies most of the Småvatn - Søndre Møkkelvikfjell area with some intercalated massive flows to the south. In the Tunnsjø area however, much of the volcanic sequence consist of closepacked pillow lavas and dense massive flows with only small zones of pyroclastic and tuffaceous equivalents. Much similarities can be seen in the massive volcanic units from both areas, such as the "epidot knot" horizons, the felsic and acid massive horizons, the "stilpnomelane"-bearing massive volcanic flows, the lighter greencoloured actinolite-bearing massive volcanics and the darker green, extremely fine grained, almost flinty, massive units also noted by the English students.

   The pyroclastic sequence of the Småvatn - Søndre Møkkelvik-fjell area and the close-packed pillow lava section from the Blåhammern - Havdalsvatn area are both quite calc.rich - with calc.filled amygdales and cavities, and could be the same horizon, only reflecting the primary differences in the distance from the original source area; i.e. - pillows forming close to the source vent and pyroclastics and tuffs at a greater distance off into the basin.

2. The "quartz porphyry" keratophyric units are similar in both areas.

3. The mineralization, vasskis etc. as previously mentioned appear stratigraphically controlled in both areas.

4. The massive, glassy, highly fractured rhyolitic volcanic unit found in the Voldtjern-bekken area appears identical to a rhyolitic unit found inside the Skorovas mine associated with a Cu rich ore band.

* * *

List of studies in progress and to be carried out while at N.T.H. starting 15. Jan. 1974:

1. Detailed structural analysis and interpretation of data from the Småvatn - Søndre Møkkelvikfjell area.

2. Mineralogical description of various rock units and a petrological and chemical analyses of the sulfide mineralizations and their enclosing rocks using thin sections, polished sections and some micronprobe studies. This is to be done in conjunction with samples collected from the Skorovas mine area.

3. Photographic examples of various rock units and minor fold styles from summer 1973.

4. Compilation map (geological and structural) over the Nordli area from Reinsbakken '72 and Reymer 72 - 73 data.

x x x

Further Investigation - Suggestion:

1. A diamond drilling program investigating the connection between the electromagnetic anomaly (EGU summer 1973) running between geophysical profiles 7400 x in the 1200 - 1400 y areas, and the southward projection of the elongate acid volcanic unit found in the Voldtjern-bekken area.

- - - - - - - -

LEGEND: Småvatn – Søndre Møkkelvikfjell Area
Summer 73

Volcanics

- dark green chloritic rich basic - andesitic greenstones

M - massive flows, visible grain size (+ + +)

E - dark green schistose greenstones with epidotic eyes and knots

S - dark chloritic - stilpnomelane? rich greenstones

F - dark green extremely fine grained, dense to almost flinty greenstones

A - massive andesitic greenstone with epidote - actinolite, pale and intermediate green colour

- moderate green, epidote, chlorite and minor carbonate rich greenstones of intermediate (andesitic) composition generally pyroclastic nature, schistose

- tuffaceous banding, layering

- gritty tuffs

- agglomerates

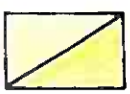
- massive crystalline andesitic flows

- amygdaloidal, usually carbonate filled

- massive crystalline gabbroic andesite

- more acid to felsic composition, very light coloured, banded or thin layered nature

- massive, moderate-light grey coloured dacitic flows (called "quartzite andesite" in previous reports)



- acid volcanic unit (Rhyolitic - dacitic composition), pale bluish grey colour, massive, glassy, highly fractured nature

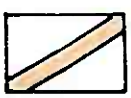
- light grey-white to greenish coloured, schistose, quartz keratophyre

- strongly banded and schistose nature

- "Quartz porphyry" large elongate pale bluish tinted quartz grains

Hb Hb - dark green elongate hornblend remnants, chloritized

- rusty zones with disseminated pyrite

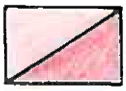


- rusty bands, massive po and py bearing

- Iron Formation, thin massive magnetite banding, generally associated with quartzite banding

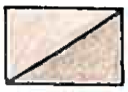
LEGEND (cont)

Intrusives



- light coloured, fine to medium grained [illegible] [illegible]
  light coloured, fine grained, felsite and aplite dyke equivalents

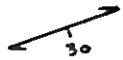
- coarse grained, strongly foliated, quartz bearing diorite [illegible]
  generally with slightly to completely altered feldspars
  + + + large, pale bluish tinted, elongate quartz grains



- Hornblende gabbro, generally schistose, but some darker more massive varieties noted
  med to coarse grain size

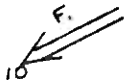
SYMBOLS: Småvatn - Søndre Møkkelvikfjell Area Summer 73

- Schistocity $S_1 = S_0$



- foliation in intrusive rocks

- penetrative cleavage

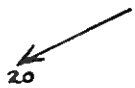


- Fold Axis - direction and amount of plunge and fold phase indication

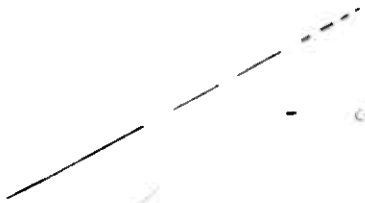
- Axial Planar surface with strike and dip

- Lineations with direction and amount of plunge

Hb - Hornblend mineral lineations
B - boudins
Q - quartz rods
A - amygdales
Cr - Crenular lineations



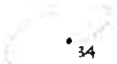
- fragment elongation in agglomerates



- Geological Contacts — observed - - assumed

- minor lineation features — — fracture system

- Major Airphoto linear features — — jointing system and faults?



- Outcrop patterns with location numbers

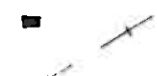
♀ - Sulphide mineral showing (Py. Po and minor cpy)

♂ - Iron Formation banded magnetite and quartzite

- NGU (Summer 73) Geophysical grid system pegs

- Swamp covered area

- major road



- building house, cabin, etc.

- Electricity power lines telephone lines

- Electromagnetic anomalies taken from NGU Reports in Hausvik Sysrapp

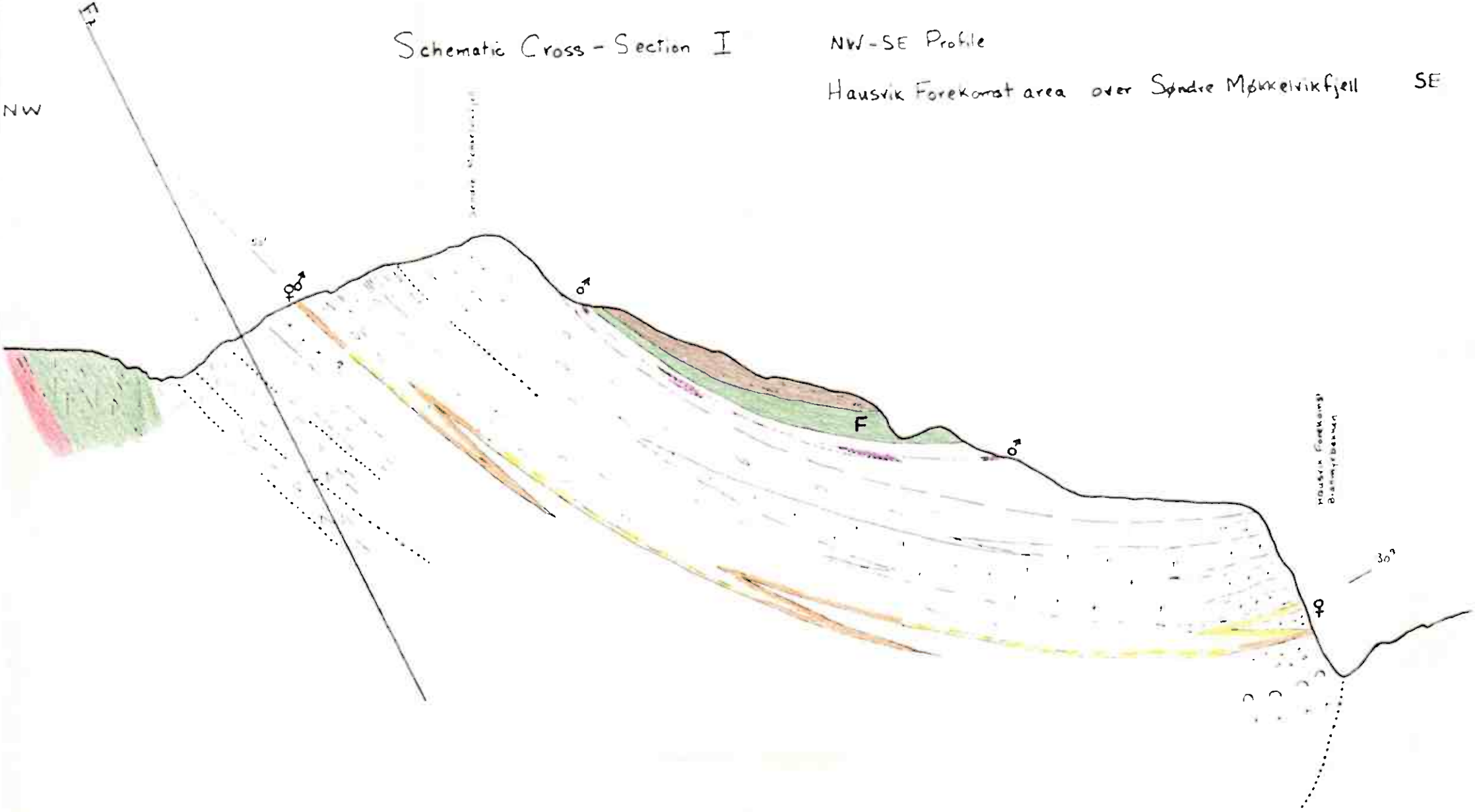
Schematic Cross-Section I

NW-SE Profile

Hausvik Forekomst area over Søndre Mykkelvikfjell

NW

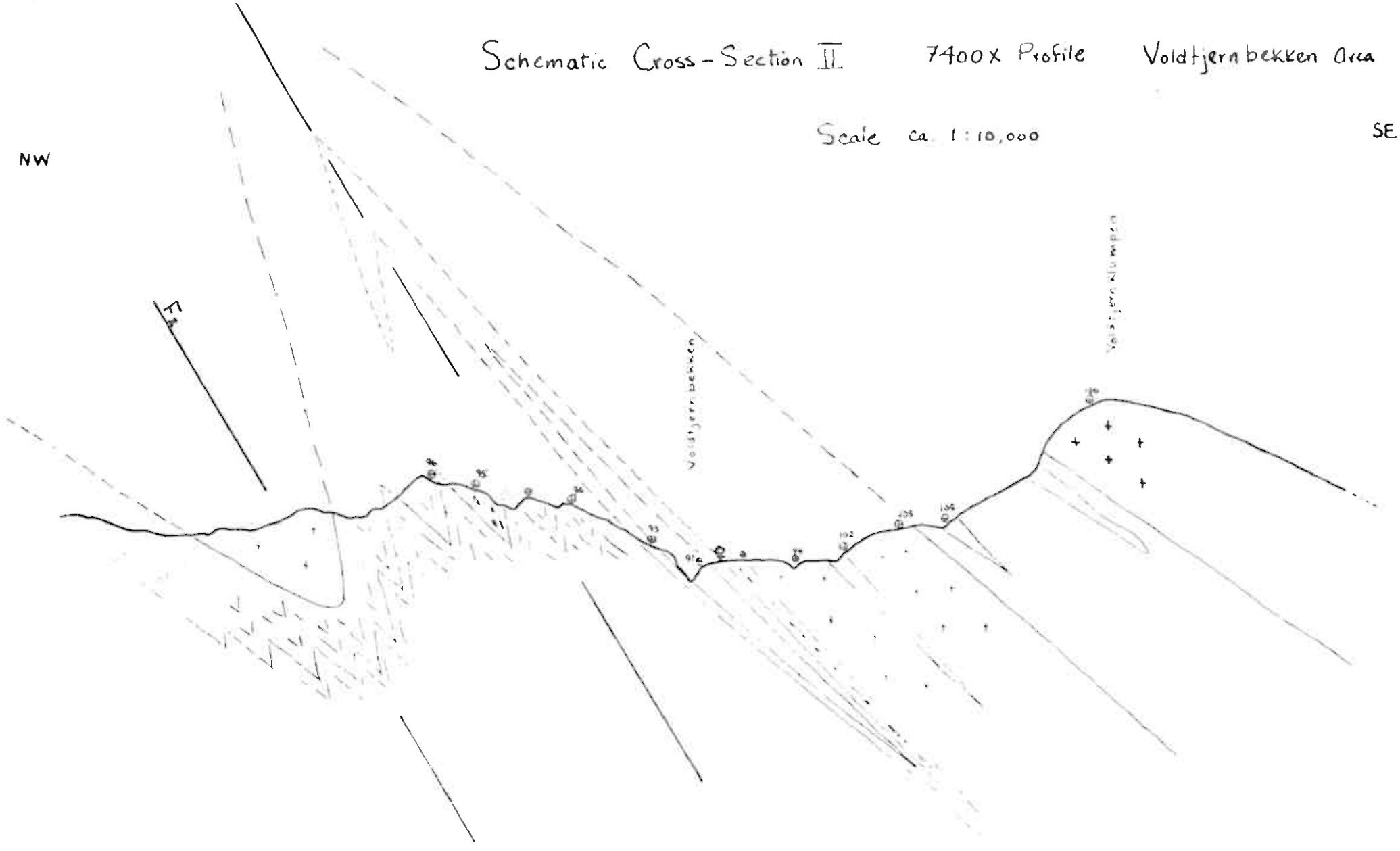
SE



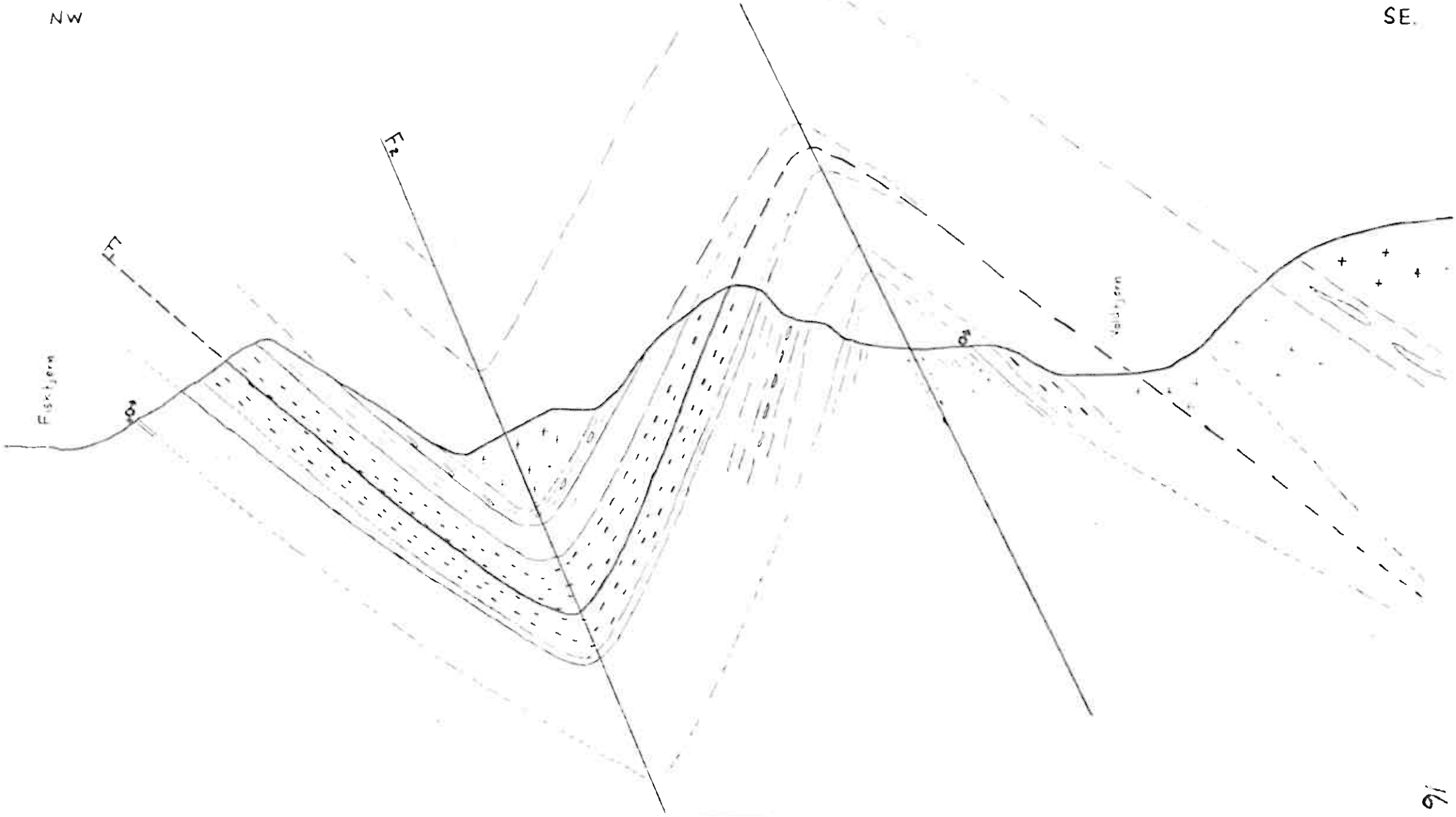
Schematic Cross-Section II 7400x Profile Voldtjernbekken Area

Scale ca. 1:10,000

NW SE



Schematic Cross Section III NW-SE Profile
ca. Voldtjern - Fiskjern



Schematic Cross – Section IV NW – SE Profile across Småratn S and Ø Skjerp areas.

NW. SE.