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INTERN RAPPORT.

DATO: 4-5-1981	RAPPORT NR: 1146	KARTBLAD No 32-4 Mandal	Antall sider —«— bilag

SAKSBEARBEIDER Geologist Øyvind Gvein

RAPPORT VEDRØRENDE: THE KNABEN AREA. REPORT FROM THE FIELD SEASON 1980 AND A COMPILATION OF RESULTS FROM ELKEM'S AND N.G.U.'S EXPLORATION WORK IN THE REGION.

RESYMÉ: Geological mapping in the Knaben - Kvina Mine area has outlined the regional trend of the rocks. Structures controlling the ore deposits are however not detected.

Drilling of one deep hole in the southern sectors of the Knaben II-deposit was abandoned because of repeated falling downs. A new attempt is proposed for 1981.

Reconnaissance mapping in anomalous stream-sediment-aries (sampled 1979) north and south of Knaben does not reveal any new deposits.

Mag. measurements demonstrate that the ore-bearing rock in the Knaben II-quarry produce a negative anomaly of some 400 γ . A series of profiles are measured in the area Knaben-Kvina Mine, but the mag. curves are almost flat.

FORDELING

OSLO:

- [ ] HK
- [ ] Arkiv

KIRKENES:

ANDRE:

- [ ] Union Minerals (2 eks)
- [x] U.S.B.
- [ ] Vestlandske Bergmeste

KOMMENTAR:

THE KNABEN PROJECT 1980.

REPORT NO. 1146.

CONTENTS.

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THE KNABEN PROJECT 1980.

1. INTRODUCTION.

Sydvaranger's geologists Gvein and Rui together with 4 students have been in the Knaben field this summer. Rui and the students ended their work about 1st of August. Geophysicist Logn has visited the field for a week. He has measured the magnetical variations in the field and introduced mag. equipment to the one studentteam. Olmore has visited the field during some days at the end of June.

The drilling should have started about 1st of July, but the contractor had a rigcollapse and did not commence before 25th of August. The scheduled long hole in the Knaben II-deposit was suspended because of repeated falling downs and waterloss in the hole.

At the end of August we received a report from the company Elkem-Spigerverket concerning their molybdenumexploration in the region during the years 1965 and 1966. The company have concentrated their work west of the main molybdenum zone in Knaben, and investigated some areas by blast-samples in profiles. Further they have studied a lot of deposits in the region. Some maps and conclusive remarks are given in this report.

The proposes for the field season were :

- Structural mapping in the Knaben II-Kvina Mine area.
- Reconnaissance mapping in anomaleous streamsediment-areas. Map the Flottorpzone - SE of the Knaben field.
- Evaluate mag. measurements as an explorationmethode in the area.
- Streamsedimentsampling in areas SE and W of the Knaben field.
- Drilling of one 600 m hole in the southern sectors of the Knaben II-orebody and some short holes in the Bragold field 1 km SW of the Knaben II-mine.

Concerning the Flottorpfield, the farmers in the neighbourhood have claimed around the ancient workings. According to an agreement between the farmers and a private investigator this rights are leased out for an unspecified period. No mapping is therefore carried out in the Flottorpfield this year by us.

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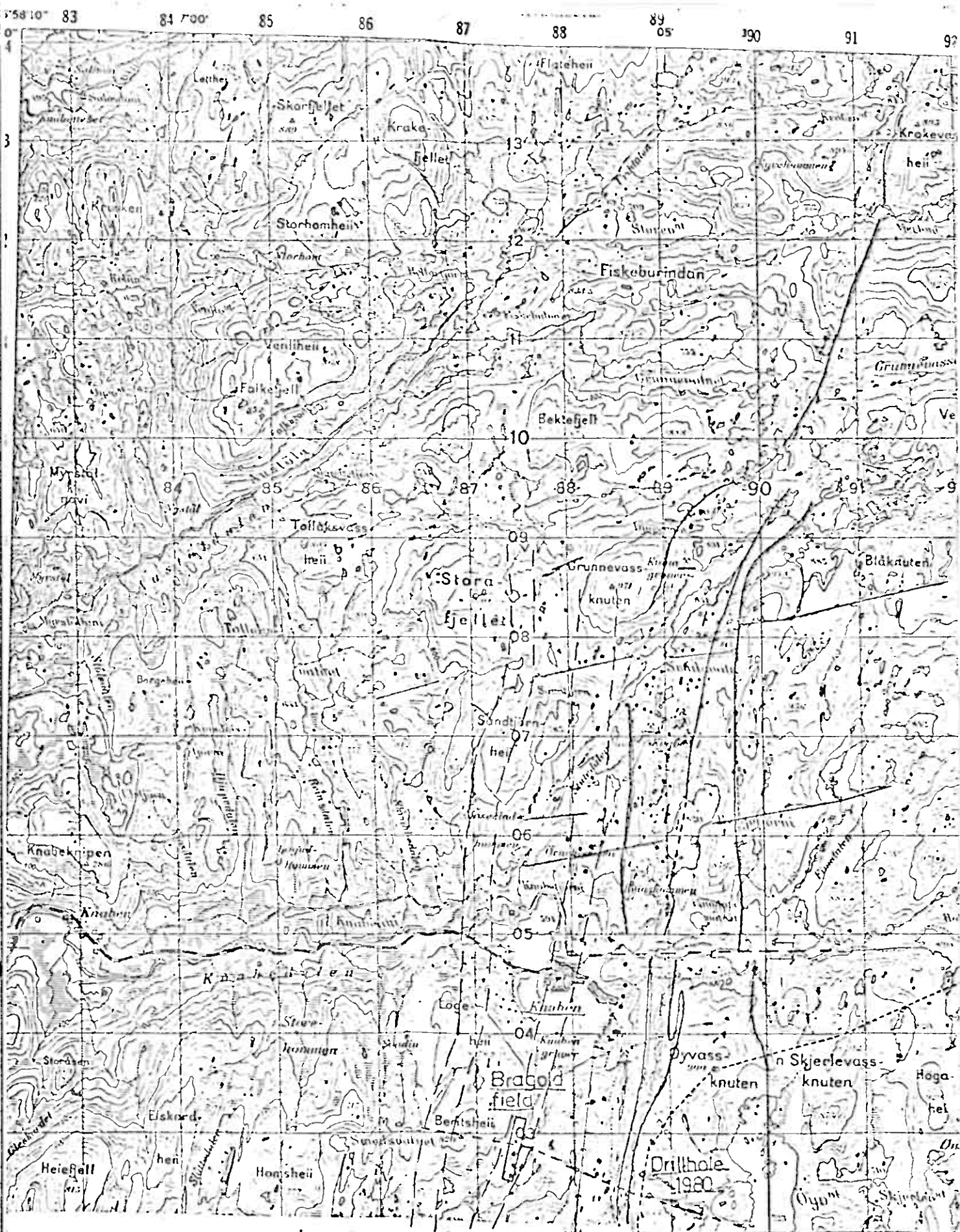


FIG.

- Pink granitic gneiss.
- Rusty gneisses with remnants of meta supracrustal rocks.
- Finegrained gneiss. Markerhorizon.
- Metadiabase.
- ---- Fault.
- • Prosp. pits and small mines.

Scale 1 : 50000

2. GEOLOGY.

Rui and Gvein have been searching for structural elements in the Knaben field, but apart from planar structures, without success.

A regional extention of the gneisses is, however, outlined by some finegrained gneiss-horizons as markerhorizons. Such a marker-horizon is chosen as the western border for the zone including the Knaben I - Kvina Mine area. This zone is characterized by rusty (iron sulphide bearing) gneisses and remnants of amfibolite and finegrained gray gneisses. The ordinary pink gneiss-granite is alternating with the other rocks in the zone. West of this zone there are still some rusty gneiss-zones in pink gneiss-granite, but the markerhorizon is chosen as a border to make the relation between the Knaben I - Kvina area and the Knaben II-area clear.

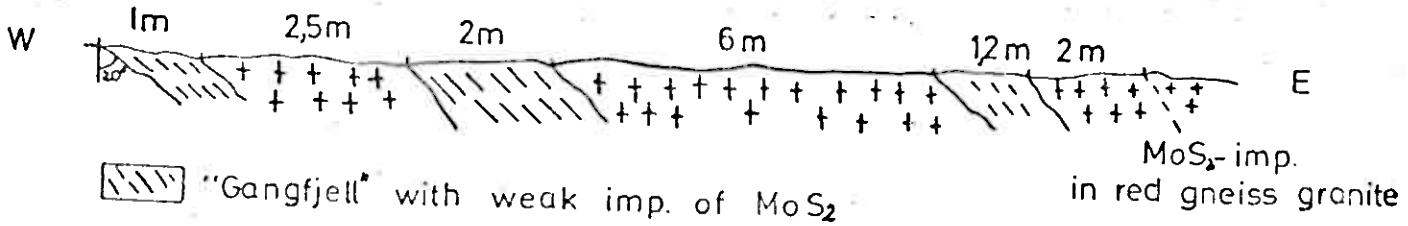
The main strike of the gneisses is confirmed by a 10 m thick fine-grained gneiss longer east (see map facing page).

A displacement along the Knabeåni fault is shown to be 150-200 m.

2.1 Reconnaissance mapping in anomalous streamsedimentareas.

The conclusions after the mapping in the anomaleous areas are given in p. 4. In the northern area - B - minor amounts of MoS_2/quartzveins corresponding to the anomaleous values, are found in connection with the gneiss-zone striking across the Knaben I - Kvina areas.

In area A west of the Kvina Mine a lot of small occurences of MoS_2 are known. Map p. 5 shows the anomal Mo figures in relation to the mineralization. The mineralization is connected to two eastern zones corresponding to the Bragold zone (our one drillingtarget in 1980), and a western zone. Sparing mineralization on quartzveins in 1-3 m strands of gangfjell occur. (See fig.).



"Gangfjell" with weak imp. of MoS_2

Red gneiss granite.

Strands of gangfjell in red gneissgranite.

Nr. 5.5000. 5-74.

In the eastern zone Elkem has analysed samples from blast-hole profiles and demonstrated contents of 0,01 - 0,05 %.

In area D there are a lot of widespread anomaleous values. MoS_2 is not found in outcrops apart from a few small prospecting pits. The overburden in the area is however icetransported from north and this could-at least-be a part of the explanation for the anomaleous values.

In the area adjacent to the river Kvina small amounts of MoS_2 in pegmatites is shown in ancient prospecting pits.

2.2 Chemical data for the rocks in the mine-area.

12 rock chips of gneissgranite, gangfjell and aplite from The Knaben II-mine and The Bragold area are analysed at Skyline Labs, Colorado, for the main elements, Rb and Th and the Emission spec. package of 31 trace-elements.

The samples are listed in table 1, the results in table 2, the C.I.P.W.- norm in table 3, and the E. spec. analyses in table 4.

Table 1.

Analyses-rock chip samples from Knaben.

Sample No.	Locality
2	Gangfjell 0,2 m from the footwall in Knaben II-quarry.
3	Pink gneissgranite 0,3 m from the border " " "
4	" " 2 m " " " " " " "
6	Grey aplite from the Knaben II-quarry.
12	Gangfjell 4-5 m from the footwall in " " "
13	" 7-8 m " " " " " " " "
14	" 10-12m " " " " " " " "
15	Red aplite, block in the Knaben II-quarry.
16	Pink gneissgranite, Dh. Bragold 20,3 m
17	Aplitic phase, " " 23,5 m
18	Gangfjell, " " 29,1 m
19	Grey aplite, " " 29,7

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TABLE NO. 2

Sample no.		2	3	4	6	12	13	14	15	16	17	18	19
Type		G.fj.	Gr.	Gr.	Apl.	G.fj.	G.fj.	G.fj.	Apl.	Gr.	Apl.	G.fj.	Apl.
SiO_2	%	74,3	69,0	68,7	77,6	77,1	76,1	73,8	72,9	69,9	76,8	74,9	75,6
Al_2O_3	%	11,7	14,8	15,3	11,8	11,2	12,3	12,8	12,9	14,9	12,2	13,1	13,0
Fe_2O_3	%	0,91	1,10	1,30	0,13	0,73	0,56	0,47	0,99	1,40	0,20	0,49	0,36
FeO	%	0,73	1,40	1,60	0,42	0,89	1,00	0,99	0,78	1,40	0,33	0,85	0,45
MgO	%	0,22	0,57	0,68	0,06	0,27	0,28	0,25	0,21	0,56	0,06	0,27	0,08
MnO	%	0,01	0,03	0,03	0,01	0,02	0,02	0,02	0,03	0,03	0,01	0,02	0,01
CaO	%	0,74	1,80	1,90	0,73	0,90	0,91	0,96	0,93	1,70	0,85	1,20	0,86
Na_2O	%	2,6	3,8	4,0	2,6	2,7	2,9	3,0	2,6	4,0	3,0	3,4	3,2
K_2O	%	5,6	5,1	5,1	5,9	4,8	5,5	5,8	6,8	5,0	5,3	5,2	6,2
P_2O_5	%	0,04	0,04	0,06	< 0,02	0,02	0,02	0,02	0,02	0,05	< 0,02	0,02	< 0,02
F	%	0,05	0,11	0,14	0,04	0,06	0,06	0,06	0,05	0,10	0,02	0,05	0,03
L.O.I.	%	0,7	0,3	0,2	0,3	0,3	0,4	0,5	0,6	0,2	0,1	0,3	0,2
Rb	p.p.m.	335	345	350	320	345	405	385	390	320	275	275	300
Th	"	< 50	< 50	< 50	< 50	85	< 50	< 50	< 50	85	< 50	75	80
Mo	"	2000	30	20	300	1500	3000	200	20	10	20	70	50
Cu	"	700	15	20	150	200	500	500	15	20	500	300	100

TABLE NO. 5

W - norm.

Sample no.	2	3	4	6	12	13	1	1		17	8	10
Q	34,9	21,3	19,3	36,2	38,8	33,4	29,	28,	21,4	35,2	30,1	29,5
c	0,3	0,2	0,3		0,2	0,1	0,1		0,2	0,4		
or	34,8	30,9	30,6	35,7	29,3	33,1	35,5	41,5	29,9	32,1	31,2	37,1
ab	24,5	35,0	36,4	23,9	25,1	26,5	27,8	24,1	36,4	27,6	30,1	29,1
an	3,2	8,1	8,2		4,0	4,0	4,3	3,6	7,5	4,1	5,2	2,8
di								0,3			0,1	0,3
hd				0,1				0,3			0,2	0,6
en	0,6	1,6	1,9	0,2	0,8	0,8	0,7	0,5	1,6	0,2	0,7	0,1
fs	0,5	1,5	1,6	0,6	0,9	1,2	1,3	0,5	1,3	0,4	0,9	0,7
mt	1,0	1,2	1,4	0,1	0,8	0,6	0,5	1,1	1,5	0,2	0,5	0,4
ap	0,1	0,1	0,1									
fr	0,1	0,2	0,2	0,1	0,1	0,1	0,1	0,1	0,2		0,1	
Sum femic	2,1	5,5	6,6	1,0	2,3	2,7	2,8	2,4	5,4	0,8	2,6	1,2
Sum salic	97,9	04,5	93,4	99,0	97,7	97,3	97,2	97,6	94,6	99,2	97,5	98,8

JOB NO. NJQ 004
PAGE 1

ITEM NO. SAMPLE NO.
1 = 02 GANGFJELL
2 = 03 GNEISSGRANITE
3 = 04 " "
4 = 06 APLITE
5 = 12 GANGFJELL
6 = 13 "
7 = 14 "
8 = 15 APLITE

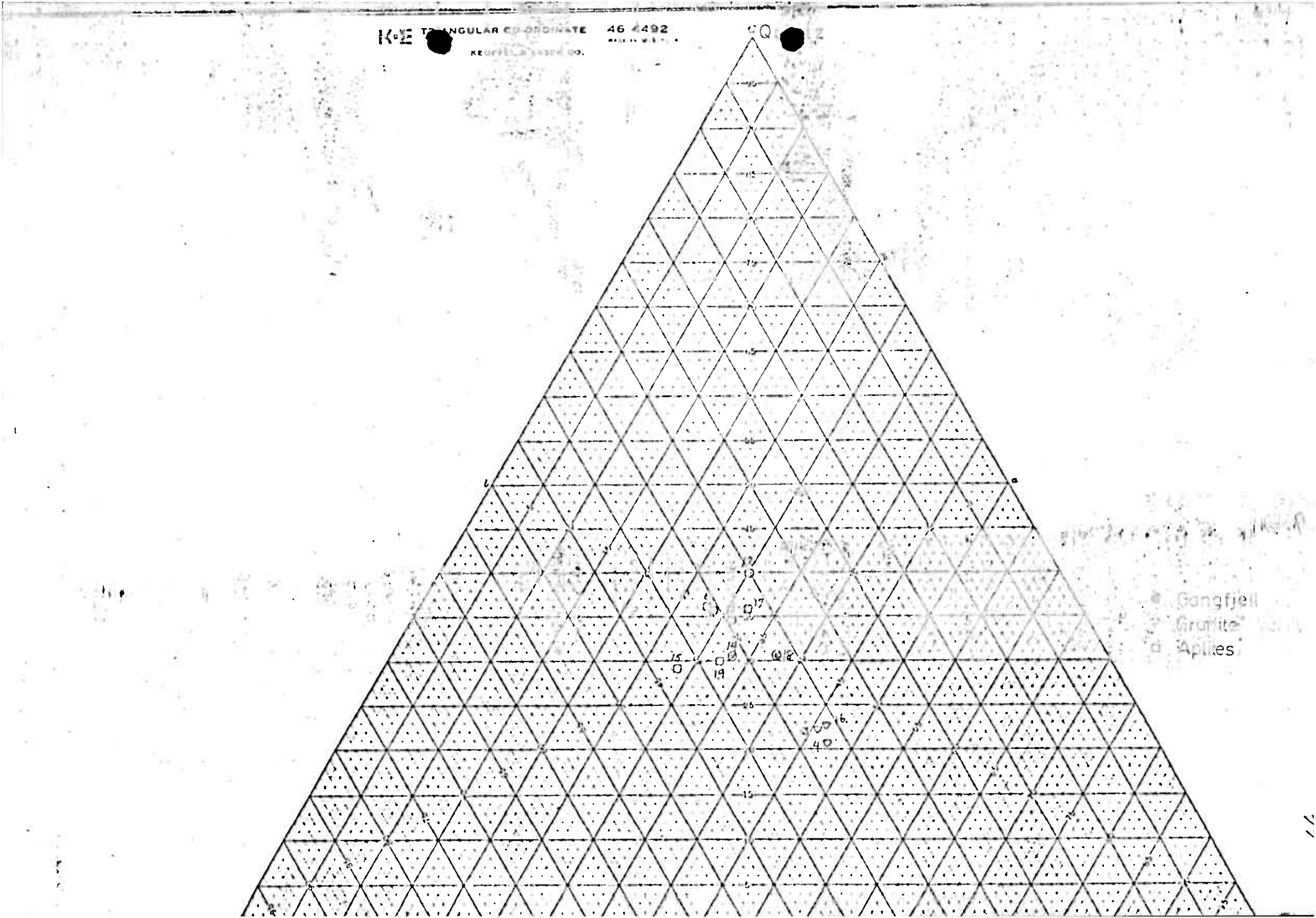
ITEM	1	2	3	4	5	6	7	8
ELEMENT								
Fe	1.5%	2%	3%	0.5%	0.7%	1.5%	1%	1.5%
Ca	0.2%	1%	1%	0.2%	0.3%	0.3%	0.3%	0.5%
Mg	0.2%	0.3%	0.7%	0.03%	0.15%	0.2%	0.2%	0.15%
Ag	<1	<1	<1	<1	<1	<1	<1	<1
As	<500	<500	<500	<500	<500	<500	<500	<500
B	<10	<10	<10	<10	<10	<10	<10	<10
Ba	700	1000	1000	200	300	300	500	1000
Be	<2	2	2	<2	2	<2	<2	<2
Bi	<10	<10	<10	<10	<10	<10	<10	<10
Cd	<50	<50	<50	<50	<50	<50	<50	<50
Co	<5	<5	<5	<5	<5	<5	<5	<5
Cr	<10	<10	<10	<10	<10	<10	10	<10
Cu	700	15	20	150	200	500	500	15
Ga	20	20	30	20	20	20	50	20
Ge	<20	<20	<20	<20	<20	<20	<20	<20
La	100	100	100	20	20	70	70	100
Mn	100	300	300	50	150	200	150	300
Mo	2000	30	20	300	1500	3000	200	20
Nb	20	20	20	<20	<20	20	20	20
Ni	5	5	5	5	5	5	5	5
Pb	70	50	50	50	50	50	70	70
Sb	<100	<100	<100	<100	<100	<100	<100	<100
Sc	<10	<10	<10	<10	<10	<10	<10	<10
Sn	<10	<10	<10	<10	<10	<10	<10	<10
Sr	200	200	200	100	100	100	100	200
Ti	1000	3000	3000	500	1000	1500	1000	1500
V	10	20	30	<10	15	20	10	10
W	<50	<50	<50	<50	<50	<50	<50	<50
Y	<10	<10	10	<10	<10	10	<10	70
Zn	<200	<200	<200	<200	<200	<200	<200	<200
Zr	70	200	200	30	70	50	100	150

Tabell 4 p. 2

JOB NO. NJQ 004
PAGE 2

ITEM NO. SAMPLE NO.
9 = 16 GNEISSGRANITE
10 = 17 APLITE
11 = 18 GRANITOLL
12 = 19 APLITE
13 = 20 } Monzonite
14 = 21 }

ITEM	9	10	11	12	13	14
ELEMENT						
Fe	2%	0.5%	1.5%	0.3%	5%	3%
Ca	0.7%	0.3%	0.5%	0.3%	3%	2%
Mg	0.7%	0.07%	0.2%	0.05%	1.5%	1%
Ag	<1	<1	<1	<1	<1	<1
As	<500	<500	<500	<500	<500	<500
B	<10	<10	<10	<10	<10	<10
Ba	700	500	700	700	2000	2000
Be	<2	<2	<2	<2	2	<2
Bi	<10	<10	<10	<10	<10	<10
Cd	<50	<50	<50	<50	<50	<50
Co	<5	<5	<5	<5	<5	<5
Cr	<10	<10	<10	<10	<10	<10
Cu	20	500	300	100	3	5
Ga	30	20	20	15	30	30
Ge	<20	<20	<20	<20	<20	<20
La	70	<20	<20	<20	70	50
Mn	300	50	200	70	700	500
Mo	10	20	70	50	2	2
Nb	20	<20	<20	<20	20	20
Ni	5	5	5	5	5	5
Pb	50	30	30	50	20	30
Sb	<100	<100	<100	<100	<100	<100
Sc	<10	<10	<10	<10	15	10
Sn	<10	<10	<10	<10	<10	<10
Sr	300	200	300	200	1000	1000
Ti	2000	500	1500	300	7000	5000
V	30	10	10	<10	30	20
W	<50	<50	<50	<50	<50	<50
Y	<10	<10	<10	<10	50	50
Zn	<200	<200	<200	<200	<200	<200
Zr	100	20	100	20	300	200


K&E TRIANGULAR CO-ORDINATE 46 4492
KEUFFEL & ESSER CO.
Q
Sangfjell
Granite
Aplites

In the triangular diagram page 11 the normative amounts of quartz, K-feldspar and plagioclase are plotted. The diagram demonstrates that the gneissgranite-composition is well defined (few samples !) The gangfjell - or the orebearing rock - by fieldevidence shown to represent a bleached modification of the surrounding gneiss-granite (page 14) is enriched in quartz and depleted in plagioclas compared to the gneissgranite. The amount of femic minerals in the gneissgranite are also essential higher than in the gangfjell. The gangfjell is weakly enriched in K while Rb is nearly constant through the series. F is higher in the gneissgranite which is a surprising fact.

The emission spec. analyses are shown in table 4 p. 9-10. From this table it is obvious that the only guide-element for Mo apart from Mo itself is Cu.

Microscopic studies of the analyzed rocks show similar minerals; quartz, microcline and plagioclase (An_{10-20}). (Table 5).

TABLE 5.

Mineralcontent thin sections.

	Gneissgranite in % (estimated)	Gangfjell in % (estimated)	Aplite in % (estimated)
Quartz	20-30	30-40 (partly secondary)	30
K-feldspar	30-40	40-50	40
Plagioclase (An_{10-20})	20-30	10	25
Biotite	5-10	5-10	3
Muskovite		x	
Chlorite	x	x	x
Calsite		x	
Apatite	x	x	
Magnetite	2- 3	x	2
Pyrite	x	2	x
Phyrotite		x	x
Chalcopyrite		x	(x) in some samples
Molybdenite		x	(x) "

A part of the quartz-content in the gangfjell is however secondary. The sulphides is - in space - close connected to the quartz-veinlets Calcite very often occurs in small amounts together with the sulphides. Sericittization of plagioclases is common in all three rocktypes, but most outstanding in the gangfjell. Another important difference is that the gangfjell is enlowered in magnetite compared to gneissgranite. Mag. measurements across the quarry of Knaben II confirm this in a weak negative anomaly. The magnetite in the gneissgranite is concluded to be the Fe-source for the ironsulphides.

The aplites are not discussed so far. In the triangular diagram they show similarities to the gangfjell, but remembering the secondary veinlets in the gangfjell, the aplites are in origin richer in quartz.

The aplites together with pegmatites are the younger rocks in the field. Regarded as a late stage magmatic rock this enrichment in SiO_2 is correct.

Aplites occur usually in narrow zones, quantitatively limited. A faint impregnation of molybdenite and other sulphides may occur. The role of the rock in the oregneiss, if any, is not understood so far.

2.3 Drilling.

Two targets were on the drillprogram for 1980.

1. Onelong hole in the southern sectors of the Knaben II deposit.

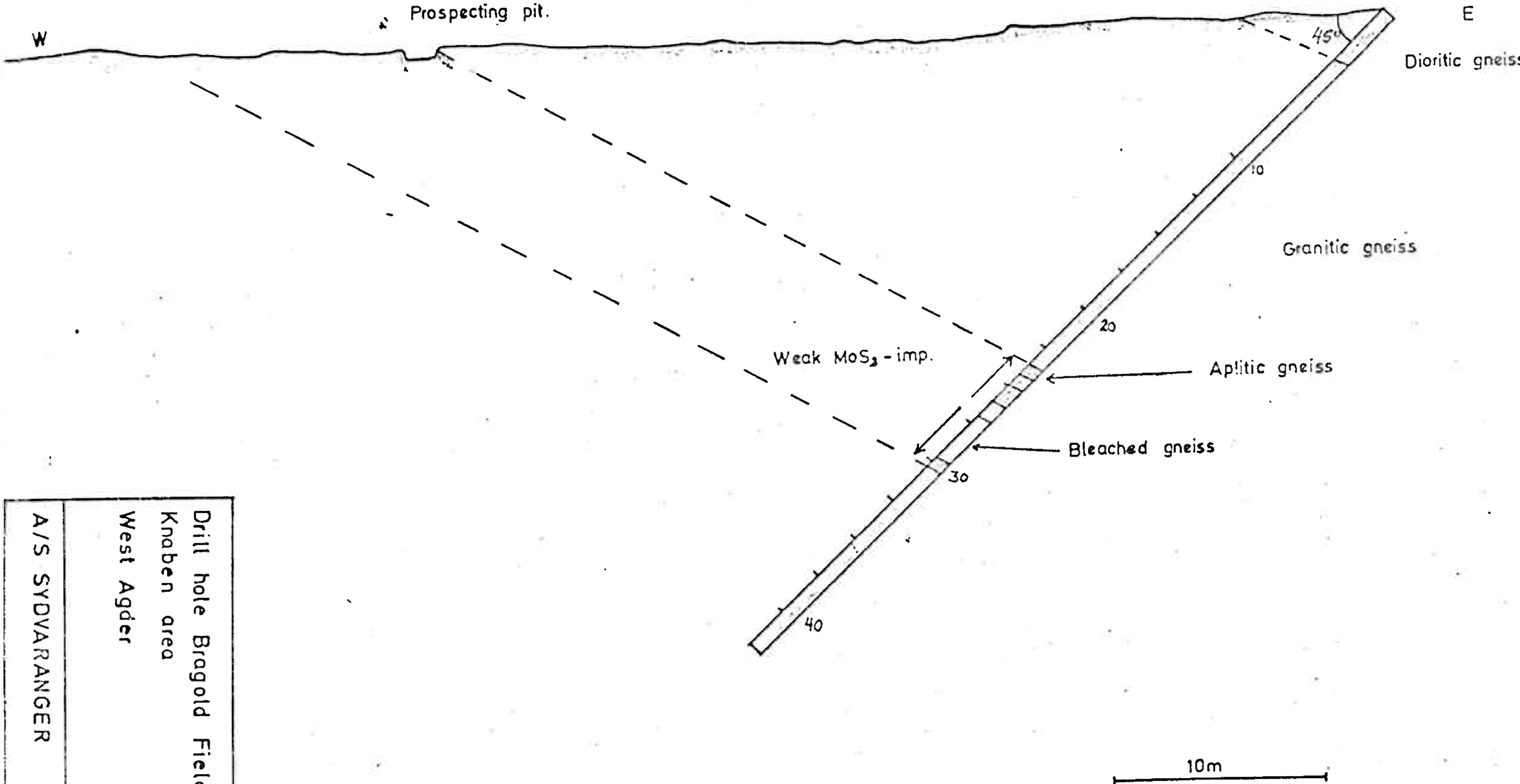
2. One or two short holes in the Bragold zone 1,5 km SW of the Knaben II-quarry.

As earlier mentioned the drilling did not commence before 25th of August - at the long-hole-site. Near the depth of 100 m there was a couple of falling downs and waterloss. After one week of cementing without success, the rig was moved to another site for a new attempt We dissucceded again and the long hole drilling in 1980 was suspended.

Drill-hole 7/5 (from the long hole site).

The drill-site is shown in map fig. 1 . Corelog is enclosed (App.1).

The core of 108 m length enters pink granitic augengneiss and



Drill hole Bragold Field Knaben area West Agder	M 1:10
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continues in "rusty gneiss with remnant of supracrustal rocks". (Map p. 2). Granitic augengneiss dominates this zone, altering with amfibolites and zones of finegrained quartzrich gneiss. Nine shorter gneissintervals (0,2-1 m) are bleached, and when bleaching occur the rock is sulphidebearing. Pyrite and phyrotite is the common sulphides, rarely molybdenite and chalcopyrite. Four of these zones are bordering amfibolite, two pegmatite and three are inside the gneiss.

Two pegmatite dikes are parallell to the foliation in the hanging-wall and cutting the footwall.

The occurence of bleached gneiss - gangfjell - in this core, undoubtedly altered red gneiss by means of sulphides, is evidence for a metasomatic origin of the gangfjell and the ore.

Drillhole Bragold.

The Bragold field is situated SW of Knaben, map. p. 2. Knaben Mine Company has previous worked 4 prospecting trenches and 3 adits across a 10 m thick mineralized zone. The mineralization is connected to quartz veins, but molybdenite may occur in patches impregnated in the rock. The rock constitutes of ordinary pink augengneiss, occasionally bleached, and some 0.2-1 m thick zones of aplite. Foliation 20°-30°, dipping east.

In 1966 Elkem sampled the Bragold area in 7 blastholeprofiles. The result from their work is presented in fig. 2.

Our drillhole in Bragold is sited where the mineralization seem to be most obvious (fig. 2). Drillsection is shown at facing page, description of the core in the enclosure.

The core shows weak (0,01 %) moly-dessemination for 6 m. The ore zone consists of aplitic rocks and bleached gneiss. Veinlets of smoky quartz are characteristic.

2.4 Conclusion drilling.

The management committee-meeting autumn 1980 concluded that the long hole should be drilled in 1981. A new attempt from a site near the 1980-site will probably fail again, and it is therefore

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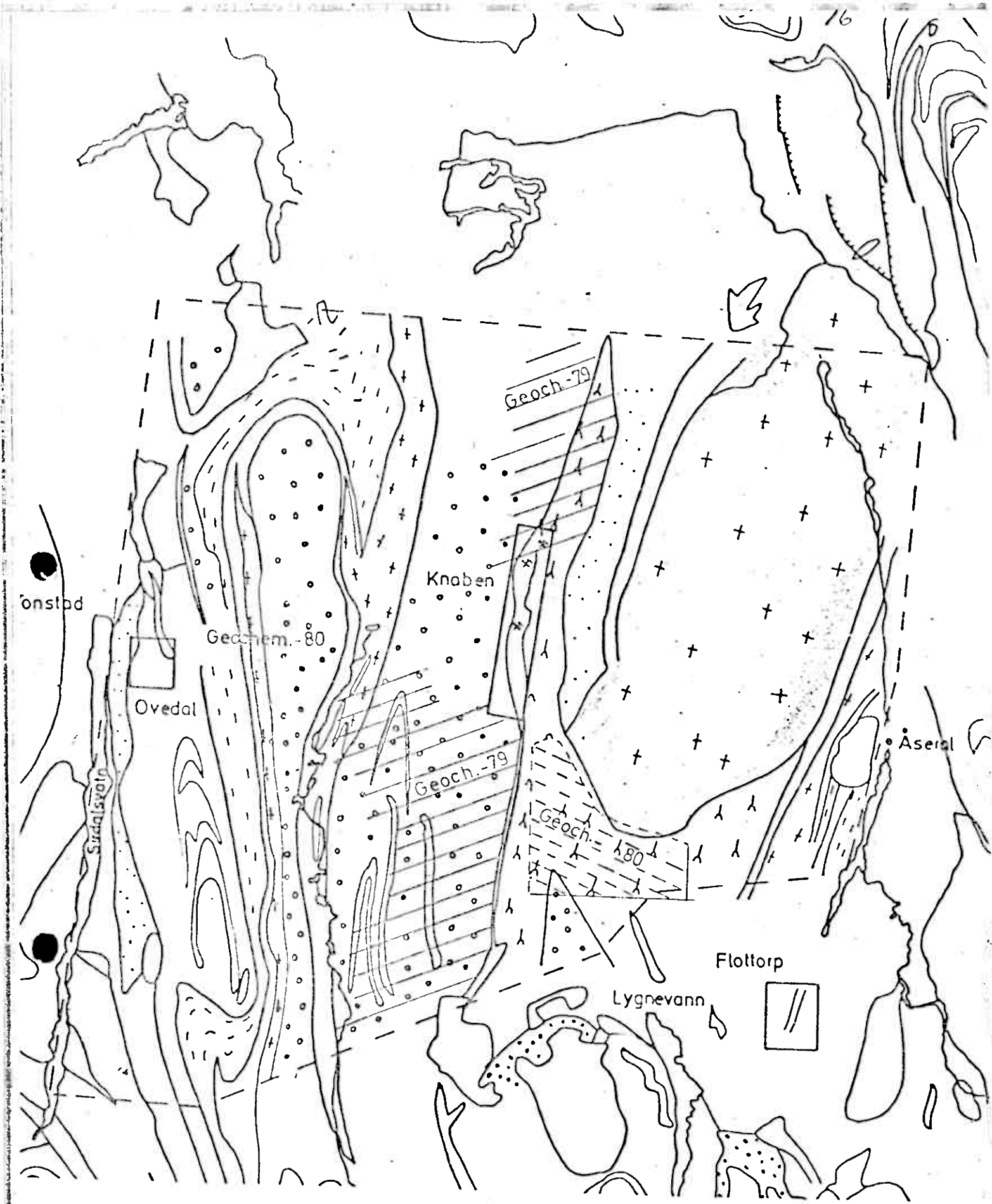
Geoch.-79
Knaben
Geochem.-80
Ovedal
Sudalsvatn
Geoch.-79
Geoch.-80
Åseral
Flotlorp
Lygnevann
STREAMSEDIMENT-SAMPLED AREAS
1979
1980
Monzonite

proposed to move - southwards (Map. fig. 1). The Bragold mineralization is concluded to be uneconomic.

3. GEOCHEMISTRY.

3.1 Introduction.

Some 250 streamsedimentsamples are collected SE and W of the Knaben area (map facing page). In the eastern area the samples are collected 500 m apart, in the western area mostly where roads cross streams.

In the autumn 1980 15 samples were sent to Skyline Labs. and analysed by Emission spec. on a package of 31 trace-elements. The content was shown to be below the detection limit for most of the elements. After discussion with, and recommandation from Union-geologist S. Olmore, Oxalic Acid Leachates of the same 15 samples were analysed. By this methode only chemical compounds deposited on the mineral-grains are extracted, i.e. the method is thought to illuminate the chemical dispertion.

Technique.

Five grains of sieved streamsediments or soil are boiled in 1,5 N. oxalic acid for five minutes. The resultant oxalic solution is filtered and evaporated to dryness, and heated to 450°C to convert oxalate to oxides.

In our samples the Oxalic Leachate residue amounts 0,5 % - 3 % of the sample weight.

Oxalic Leachate analyses of these 15 samples showed enlarged values for most of the elements. Especially a trend to increasing Sn-figures against the monzonite batholite east of Knaben, resulted in analysing of some 190 additional samples. In addition to 160 samples from the 1980-collection, 30 samples from the area north of Knaben representing both the anomaleous and background-content in the 1979 samples were analysed. An accident at Skyline Labs., however, ruined about 40 of the 190 samples in "overboiling" in the process of obtaining the oxalic leach residue.

3.2 Results.

Table 6 (next page) demonstrates the results from analysing the same samples treated in different manner. 27 samples collected west

Table 6.

Samples from the 1979 season.

Number 1979	Treated in nitric acid p.p.m. of total Mo	Cu	Oxalic acid leachate p.p.m. of the leachate Mo	Cu	Sn	Pb	Mn
12	3	10	20	50	50	150	700
13	2	10	70	150	70	300	700
14	12	10	70	50	70	150 +	500
15	8	10	50	50	30	150	700
16	8	10	30	30	70	100	500
17	14	10	50	30	50	200	700
18	6	10	100	70	100	200	1000
19	5	5	20	15	20	100	500
20	7	5	500	150	150	500	700
21	15	15	300	70	50	200	700
22	17	5	150	50	50	150	500
23	14	10	500	200	150	700	1000
25	5	10	150	150	100	300	1000
27	4	5	300	150	100	500	1000
29	11	10	300	100	70	500	1000
189	1	10	30	200	100	1000	1000
190	1	5	20	70	70	150	500
191	1	5	30	150	100	1000	1000
192	2	10	30	150	150	1000	1000
193	2	5	100	200	150	1000	700
194	2	10	20	50	50	500	500
195	2	5	50	150	150	500	1000
201	4	10	70	150	100	1000	1000
202	3	160	10	100	50	2000	700
203	3	5	< 2	30	30	300	300
204	4	10	< 2	20	20	100	200
205	2	5	< 2	30	50	200	300

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of Kvina Mine in 1979, treated ordinarily in nitric acid, are compared to the oxalic acid leachate.

A few things can be stated :

a) Streamsediments treated with nitric acid pick up mineralization (at least in areas contaminated by mans work). (See map p. 5).

b) Some of the high Mo-values from nitric treatment are also high the oxalic leachate - if the Mn-content in the leachate is high

c) In the leachate high Mo is followed by high Cu, high Pb (not shown in the table) and often high Sn.

The 15 samples from 1980 first analysed (dissolved in nitric acid) are marked on map . fig. 3 and fig. 4. All these samples show Mo-values below the detection limit of 2 p.p.m. Mo, and Cu in the intervall 2-5 p.p.m.

The Mo, Sn, Cu and Pb -figures for the oxalic residue are likewise plotted in the mentioned maps.

In the maps the highest Mo and Sn-values are coloured. Compared to the Mo-values in the mineralized area west of Kvina Mine - up to 500 p.p.m. - the areas in fig. 3 and fig. 4 are very low. Sn looks a little better, especially in the eastern area (fig. 4), but there is no real anomal areas.

3.3 Conclusion.

Streamsediments prepared in the usual manner by nitric acid is very low in the trace-elements, often below the detection limit. Oxalic acid leachates either give distinct anomalies,but single high values are more typical adjacent to the monzonite border SE of Knaben. It is therefore proposed to carry out some reconnaissance geological mapping and solid rock geochemistry in the area adjacent to the monzonite border.

4. GEOPHYSICS.

In 1979 suceptibility measurements were carried out on samples from Knaben. The results showed that the gangfjell is lower in suceptibility than the bordering gneissgranite. Studies of thin sections likewise demonstrate the low magnetite-content in the gangfjell.

Sydvaranger's geophysicist Dr. Logn has in 1980 tested the variations in magnetism in some profiles in the Knaben area. Two instruments were used, namely a Proton magnetometer for measuring the total intensity and the N.G.U.-model, a small and stabel instrument for vertical intensity. The results from the instrument were nearly identical.

Dr. Logn started the work in the Knaben II-quarry and continued south of the quarry and in the Bragold field. One of the students continued later on in the Knaben I - Kvina area. The localities for the measured profiles are shown in facing map.

The profile through the quarry is shown on page 21. A lot of iron scrap mask the result in shorter intervals, but apart from that it is demonstrated that the orebearing rock is a some 400 gamma lower than the bordering rock.

In the Bragold field there is also a variation in magnetite intensity, but no correspondence to the mineralized sone.

South of the quarry and in the area Knaben I - Kvina Mine the magnetic variation-curves are weakly undulating, with some peaks where amfibolite-zones are crossed.

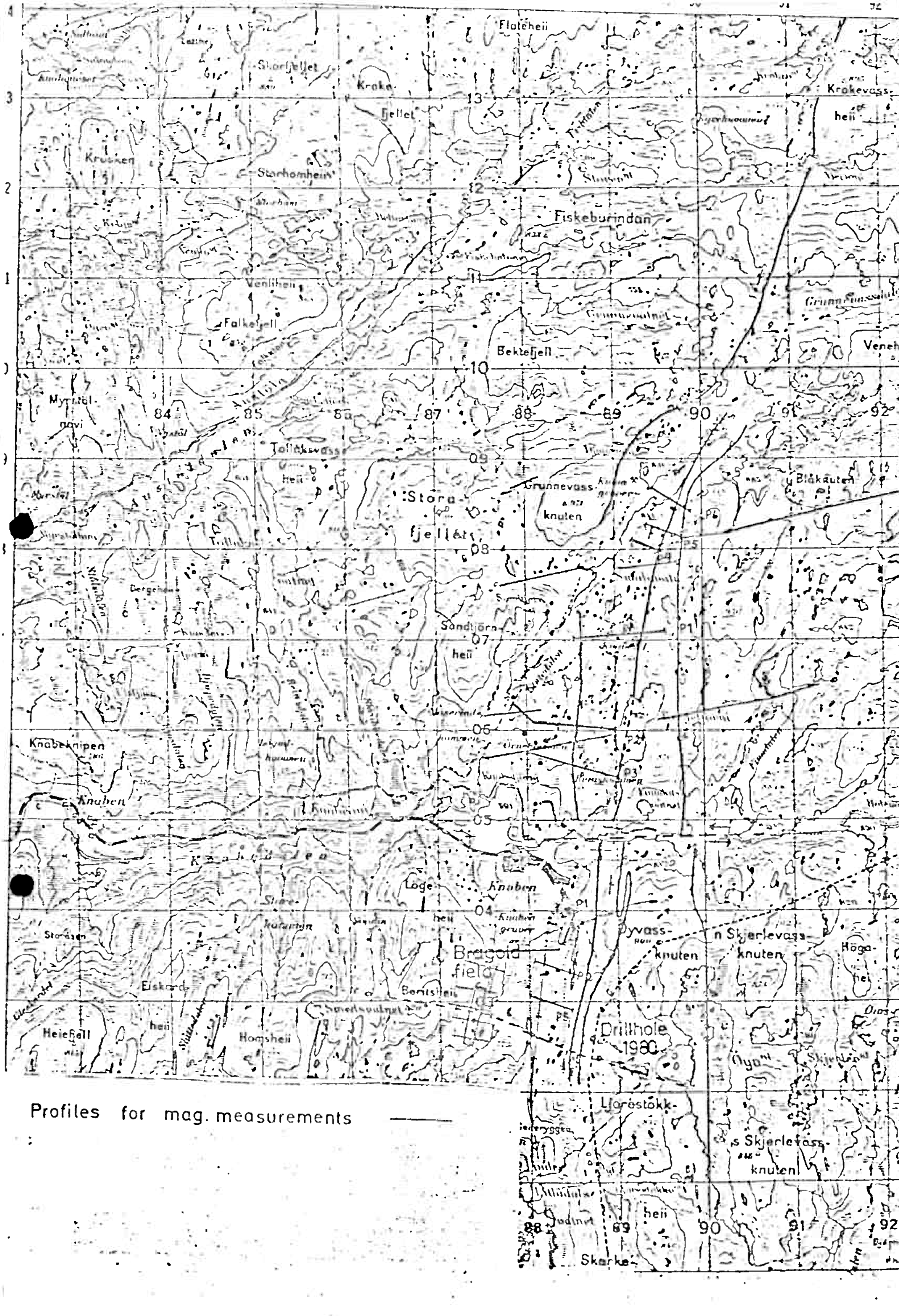
4.1 Conclusion.

It is demonstrated that the gangfjell in the Knaben-quarry can be recognized by a weak negative anomaly. South of the Knaben II-quarry and in the Knaben I - Kvina area, gangfjell is suggested not to be outcropping. The method is positive, the geology negative .

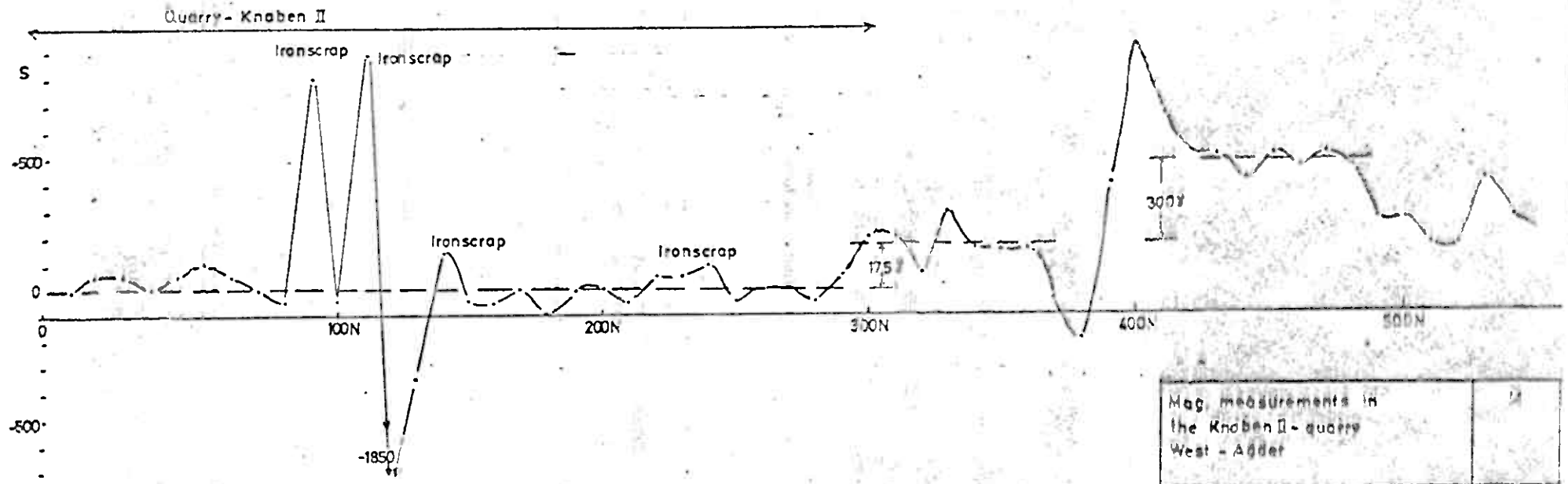
5. N.G.U. AND ELKEM'S INVESTIGATIONS IN THE REGION.

5.1 Introduction.

According to an agreement between Elkem and Sydvaranger a change of reports occured in 1980. Elkem's report concerning their work in the region was made available to us in August.



Profiles for mag. measurements ———



Mag. measurements in the Knaben II - quarry West - Agder	M
A/S SYDVARANGER	M18

The map fig. 5 shows the areas where Elkem has worked. The area south of Knaben where N.G.U. has run a geochemical investigation is also showed at the map. The black spots in fig. 5 are prospecting pits described in a report (Holmsen, 1961) concerning molybdenite occurrences in the county. Often only the locality is mentioned.

5.2 Geochemistry and prospecting pits in the Omland area.

In area 1, key map. fig. 5, N.G.U. collected streamsediment - and soil samples 1979. No report exist, but maps have been made available to us. Geologically the area is situated in the continuation of the Knaben area. A. Bugge (1963) mentions that Mo-mineralization occurs sparingly; connected to quartz veins and sticks in a "fahlband"-zone. The typical bleached "gangfjell" is seldom. According to Bugge the area is sampled very carefully, and so are the railway tunnel crossing in E-W direction (see map.fig.6). The best section in the tunnel asseyed 0,02-0,03 % MoS_2; as a rare exeption 0,10 %.

Map. fig. 6 demonstrates the Mo-content in streamsediments in the area. A few high values occur scattered, but only one of these - in the southern part - can be explained by nearby mineralizations. On basis of the known mineralizations and contaminations from the prospecting pits in the area, this negative result is surprising.

Inside a small area with a series of prospecting pits, N.G.U. has run a soilsedimentprogram as a study of the method. (Fig. 7, key map. fig. 6). The map demonstrates that the soilsediments are well contaminated in heavy metals around one of the mining areas, probably the greatest. Apart from that the anomalies are weak. It is interesting to recognize that Pb could be a better "joining-element" to molybdenum than cupper, but the amount of data is too small to confirm that.

Elkem has described the Mo-mineralization in the area as connected to small lenses of grey gneisses (gangfjell) in augengneiss. Analyses from sampling in blastholeprofiles in the Omland area (partly inside the soilsampled area) show values up to 0,09 % MoS_2. The mineralization is thought to be uneconomic.

5.3 Geochemistry and prospecting pits west of Lake Sirdalsvann.

During the summer 1965 Elkem collected some 1600 stream sediment-samples in an area west of Lake Sirdalsvann (Area 2 and 3, fig. 5). The samples were reanalyzed by N.G.U. in 1978 for the elements Mo, Cu and Zn, (Olerud, 1980). Maps fig. 8 and fig. 9 demonstrate the Mo-values. Map. fig. 8, covering the northern area, shows very low Mo-content and no anomalies.

The southern area, fig. 9, is anomale in the area around the old prospecting pits. The magnitude of the Mo-values is similar to the results from the 1979-investigation near Knaben, where known mineralization was detected by streamsediments.

The old prospecting pits and small mines west of the southern sector of Lake Sirdalsvann were studied by Elkem geologists in 1965-66. The localities Bringedalsfeltet, Gjuptjerni, Konnstali and Indre Sandsmark (fig. 9) are described as weakly mineralized deposits without economic interest. The mineralization is connected to a series of small lenses or zones of metasediments in a homogenous pink augengneiss. Molybdenite occur along the plane of foliation or together with quartzveins.

The Rannestad field, the southernmost in the field, was in 1965 sampled in 5 blasthole-profiles across 2 parallel metasedimentzones of some 15 m thickness.

Aritmetic average of 24 assays from 148 blastholes are 0,027 % MoS_2. The Rannestad field is declared uneconomic.

5.4 Other fields located in the key map. fig. 5.

Area 4, The Gursli field.

This area is explored by both Elkem and Folldal and is described in the report from Sydvaranger in 1979.

There are a lot of small mines in the area from the period 1915-1919. A total of some 38000 t of crude ore with an average of 0,17 % was mined.

The area is concluded to be of no economic interest.

Area 5, The Lake Stolsvann.

This is an old prospecting pit in a quartz vein with traces of molybdenite.

Area 6, The Ovedalarea.

Small occurences where molybdenite is connected to quartz veins. In Ovedal a couple of adits were worked in 1918 and some 50 tons of ore were excavated. Small, but occationally very rich pockets of molybdenite.
Elkem gives no recommendation for further work.

Area 7 and 8, Josdal and Guddal.

Traces of molybdenite in pegmatite-veins.

Area 9, Kvina River.

SW of the Knaben Mine on both sides of the river Kvina there is a lot of prospecting pits where molybdenite is not at all reported or connected to pegmatite veins. The area is not interesting.

Area 10, Motland.

A zone of inhomogenous gneisses are said to be impregnated in the surroundings of pegmatites. In 1965 Elkem recommends blasthole-sampling, but that has not taken place.
It is proposed to look at this locality in 1981.

Area 11, Hestad Mines.

Adits and prospecting trences are worked in this area. Elkem's conclusive remarks are small occurences connected to pegmatites. No economic interest.

Area 12, The Flottorp Area.

This area is mapped by Folldal, but the report has not been accessible to us.

In 1941-42 it was drilled some 1600 m concluding that the ore is irregulary and the quantities small. Sydvaranger proposed to carry out some geological mapping in this area in 1980, but according to an agreement between the claimholders and a private investigator the rights are leased out for an unspecified period.

Area 13, The Knaben Area.

The map facing page shows Elkem's exploration areas in the Knaben vincinity in 1965/66. They concentrated on the mineralized zone west of Kvina - Knaben I - Knaben II, the Bragoldzone. (Indicated map p. 2).

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The most interesting fields were mapped in scale 1:1000 and a lot of blasthole-profiles were analysed in this comprehensive exploration. (The results from the Bragold field, map. fig. 2, give an example on the work).
The conclusion is negative.

Conclusion.

The regional work, carried out in areas of previous workings, has not exposed Mo-mineralization of economic interest or areas for increasing or even continuing exploration. There are, however, some localities (black spots on map. fig. 5) that have to be surveyed, but old workings, known but unknown, do not create optimism.

6. SUMMARY - AND PROPOSALS FOR FURTHER WORK.

6.1 Summary.

This report are dealing with the results from the field season 1979 and data from Elkem's and N.G.U.'s exploration in the region.

Geology.

The area Knaben II - Knaben I - Kvina Mine is mapped and the regional trend of the rocks is shown by some thin markerhorizons. Reconnaisance mapping in the anomalous streamsediment-areas (from 1979) has not led to new deposits, only weak Mo-mineralization.

Drilling of the long hole in the southern sectors of the Knaben II-deposit was abandoned after some 100 m, because of repeated falling downs and waterloss in the hole.

Thin zones of bleached sulphidebearing gneiss occur in the core, proving that the origin of the gangfjell is metasomatic.

A short hole in the Bragold-zone SW of Knaben shows that this zone is uneconomic.

Geochemistry.

250 streamsedimentsamples are collected SE and W of Knaben. The content of trace-elements in a selection of samples is by Emission Spec. shown - mostly - to be below the detection limits.

The Oxalic-acid leachates of the samples, meant to throw light upon the chemical dispersion in streamsediments, is analysed. No anomalies have come up, but a small content of Sn seem to reach the highest values against the monzonite batholite SE of Knaben.

APPENDIX I CORELOGS.

CORE DESCRIPTION

Dh Bragold 1980.
Coordinates, map 1:5000 Knaben Bl. 2 : y = 387 465, x = 650 2930.
Plunge : 50^{g} in 320^{g} N direction.
Depth : 44,2 m.

Depth	Rock
0	
3,2	"Dioritic" gneiss with feldsparaugen. Small amounts po and py, traces of moly. Foliation 21°.
23,35	Pink gneissgranite with elongated feldsparaugen. Biotite common. Pegmatitebands at 8.6 and 8.7, 9.9, 10.10 and 11.0, 2-5 cm. 23.30 2 cm vein of smoky quartz, but no mineralization.
24,1	Aplite, pink. Some mm-thick veinlets of smoky quartz. Traces of cpy and moly. Foliation 25°. (E.spec. sample 23,5 m 20 p.p.m. Mo).
25,05	Pink gneissgranite with a few quartz veins (smoky quartz).
26,1	Aplitic granite. Disseminated moly, trace cpy. Well foliated.
27,0	Ordinary augengneiss pink. Some veinlets of smoky quartz, traces moly and cpy.
28,3	Pink and bleached augengneiss. Veins of smoky quartz. Traces moly and cpy.
29,6	Finegrained bleached gneiss, biotitebearing. Traces moly and cpy. E.spec. sample 29.1 - 70 p.p.m. Mo.
30,3	Aplite and bleached grey gneiss. Traces moly, cpy. Foliation 20°. E.spec. sample 29.7 - 50 p.p.m. Mo.
33,3	Pink augengneiss, barren.
34,0	Biotiterich gneiss with feldsparaugen.
35,5	Pink augengneiss.
43,0	Biotite (and hbl) rich gneiss with feldsparaugen. 4 aplitezones 10-25 cm. Pink. At 40.7 cpy, po and 2 grains of moly.
43,4	Bleached gneiss, traces smoky.
44,2	Biotiterich gneiss with pink augen.

CORE - DESCRIPTION.

Dh 7/5 (Profile 7, Dh-5 in the previous system) KNABEN.
Coordinates, map 1:5000 Knaben Bl. 2 : y = 388647, x = 6502580.
Plunge : Vertical.
Depth : 108 m.

Depth	Rock	Joints
0		
30.3	Pink homogenous augengneiss, biotitebearing. The augens about 1 cm, some elongated. Very weak foliation. Sample at 2 m.	5.5 two joints, rusty and weathered. 8.7 and 9.2 small joints as (1). 16.5 and 16.9 joints (45°). 18.0 as (1), 23.5 as (1), 27.7 as (2) weathered.
34.5	Amfibolite banded by cm thick finegrained quartz/feldsparbands. The foliation at the hanging border is 54° (0° is horizontal) and some folded. (After 1 m 36° which is about the main dip). Sample from the border 30.2-30.4.	33.5 joint as (1).
35.1	Amfibolite banded by cm-thick pink K-feldsparbands. Sample 34.4 m.	
36.1	Pink augengneiss, weakly foliated. Resembling the top of the hole, but less dark minerals. Sample 35.6 m.	
37.3	Amfibolite (Bi/Hbl), banded by 1-5 cm bands of pink augengneiss.	
37	Red augengneiss, weak foliation.	
38.2	Amfibolite with tiny bands og augengneiss.	
38.4	Red augengneiss.	
40.8	Amfibolite with bands of red augengneiss, until 10 cm thick. 39.65-39.80 sample.	
55.1	Pink augengneiss as at the top of the hole. Elongated K-feldsparaugen, Bi-bearing (and Hbl!) More coarsegrained red feldspar (pegmatitic) 10 cm from the footwall. At 52.9 5 cm of pegmatite. 46.6 sample. Hang-area footwall parallell 30°.	42.5, 42.7, 44.2 joints 45°. 45.7 as (2). 48.3, 48.5 (45°). 49.9 (1). Some waterloss around 45 m.

	Rock	Joints
57.4	Amfibolite/biotitegneiss banded by 1-10 cm feldsparbands. Foliation 30°. 55.5 m sample.	56.7 as (1).
58.05	Pink/red augengneiss.	
58.8	Amfibolite with two 2 cm bands of red augengneiss.	
59.7	Red/pink augengneiss with Bi/Hbl. The last 5 cm bleached, small amounts of po. in the bordering zone to the depth.	
60.0	Amfibolite. Small amounts of po.	
61.1	Pink augengneiss with augens until 2 cm. Bi/Hbl. The last 15 cm bleached.	
63.9	Amfibolite with white bands of feldspar and quartz. Finegrained po. and py. in small amounts. 63.6 sample.	
64.5	Bleached augengneiss with Bi and smoky quartz ("Gangfjell"). Small amounts of po., py. Traces of MoS_2. 64.1 sample.	
65.0	Red augengneiss.	
66.45	Bleached augengneiss (with milky quartz). Small amounts of po. and py. Traces of MoS_2. 65.3 sample.	
69.7	Red augengneiss, Bi/Hbl. 4 bands of amfibolite - until 15 cm thick.	
69.95	The interval begins with a biotite rich zone 5 cm thick and continous with bleached iron sulphide bearing gneiss. Not MoS_2.	
75.1	Pink augengneiss with Bi/Hbl. 70.7-70.9 bleached with small amounts of po./py.	74.2-75.3 two parallell vertical joints, weakly rusty.
77.0	Pink augengneiss, more quartz than usual - less dark minerals. Weak foliation. 76.5 and 76.7 to bands of aplite 5-10 cm thick. 35°. 75.7 m sample.	

Depth	Rock	Joints
78.0	Pink augengneiss, biotitebearing. Weakly zoned. In the middle some bleached, py.	
78.9	As above, pegmatitic 78.15-78.30.	
81.85	Quartz/feldspar pegmatite. Hanging border near parallell to foliation, footwall is irregular (cutting).	80.5 two parallell joints. 81.3 type (1) and (2). Falling downs possible.
82.1	Bleached gneiss with po. and py. Traces cpy and MoS_2.	
83.35	Pegmatite cutting at footwall.	82.5 joint type (1) crossing 45° joint. Rusty. Falling downs and water-loss. Not succeded to sement.
83.95	Bleached gneiss with small amounts of po. and py.	
84.8	Pegmatite cutting at footwall. 84.1-84.2 aplite.	
85.9	Pink augengneiss.	85.9 as (1).
86.4	Pegmatite near parallell to foliation.	
88.5	Pink gneiss grading into bleached gneiss with some sulfides.	87.9-88.0 double-joint. Falling downs possible.
90.5	Pink gneiss with narrow Bi-schist-zones. 88.7-88.75 Bi-schist attend to soft clay-like mass.	88.9-89.3 and 89.6-90.5 double joints dangerous.
91.7	Pink and green augengneiss. The first 5 cm altered Caolinisized.	
95.0	Pink augengneiss with Bi/Hbl.	
101.3	Pink augengneiss (partly with feldspar). Some small intervalls bleached and sulfidebearing.	
103.5	Banded rock Bi-bands and finegrained quartz/feldspar bands. Foliation 30°. 101.5 sample.	
104.2	Pink augengneiss with two Bi-rich bands. Folded downwards.	

Depth	Rock	Joints
104.45	Banded rock as 103.5 m.	
105.0	Amfibolite. Sample 105.0 m.	
106.5	Alternating amfibolite and pink gneiss with thin bands of dark minerals.	106.5-107.2 vertical joint waterloss and falling downs.
108.0	Gneiss some brecciated. Breccia-coloured K-feldspar. At 108.0 m the hole was abandoned.	

Geophysics.

Mag. measurements are carried out in the Knaben II-quarry and in some profiles northwards against Kvina. The quarry demonstrates that the gangfjell gives a negative anomaly of some 400 γ compared to the bordering gneiss. In the other profiles the curves are weakly undulating, i.e. no cutcropping gangfjell.

Exploration by N.G.U. and Elkem.

Areas of known Mo-mineralization in the region are explored by geochemical means, geological mapping and blasthcleprofiles with following assaying. A lot of occurences are studied, especially The Bragoldzone and its continuation against north. The investigations conclude that no economic Mo-mineralization is detected. Some localities in an official report concerning Mo-occurences are still not surveyed.

6.2 Proposals for further investigation.

Drilling.

The new site for the drillhole in the southern sector of the Knaben II-deposit is shown in the map fig. 1, and in section 9 in the blockdiagram. Drill hole 9/3 did strike only weak mineralization and this can be due to siting too far west. The interpretation of the upper limit of the orebody show that it is possible. There is also a fault between section 7 and -9 where the southern block seems to be thrown weakly east.

The upper limit of the orebody can also mean that the structure controlling the ore is converging. At all events the hole should cut good mineralization to justify more drilling in the deposit.

Geology/geochemistry.

The border-zone adjacent to the monzonite-batholite is proposed for reconnaissance mapping and - solid rock geochemistry.

Surveying - Mo-mineralization.

One of the localities mentioned by Elkem, Motland, and a few other localities where molybdenite is reported, will be surveyed.

May 5th, 1981.

Gyvind Gvein

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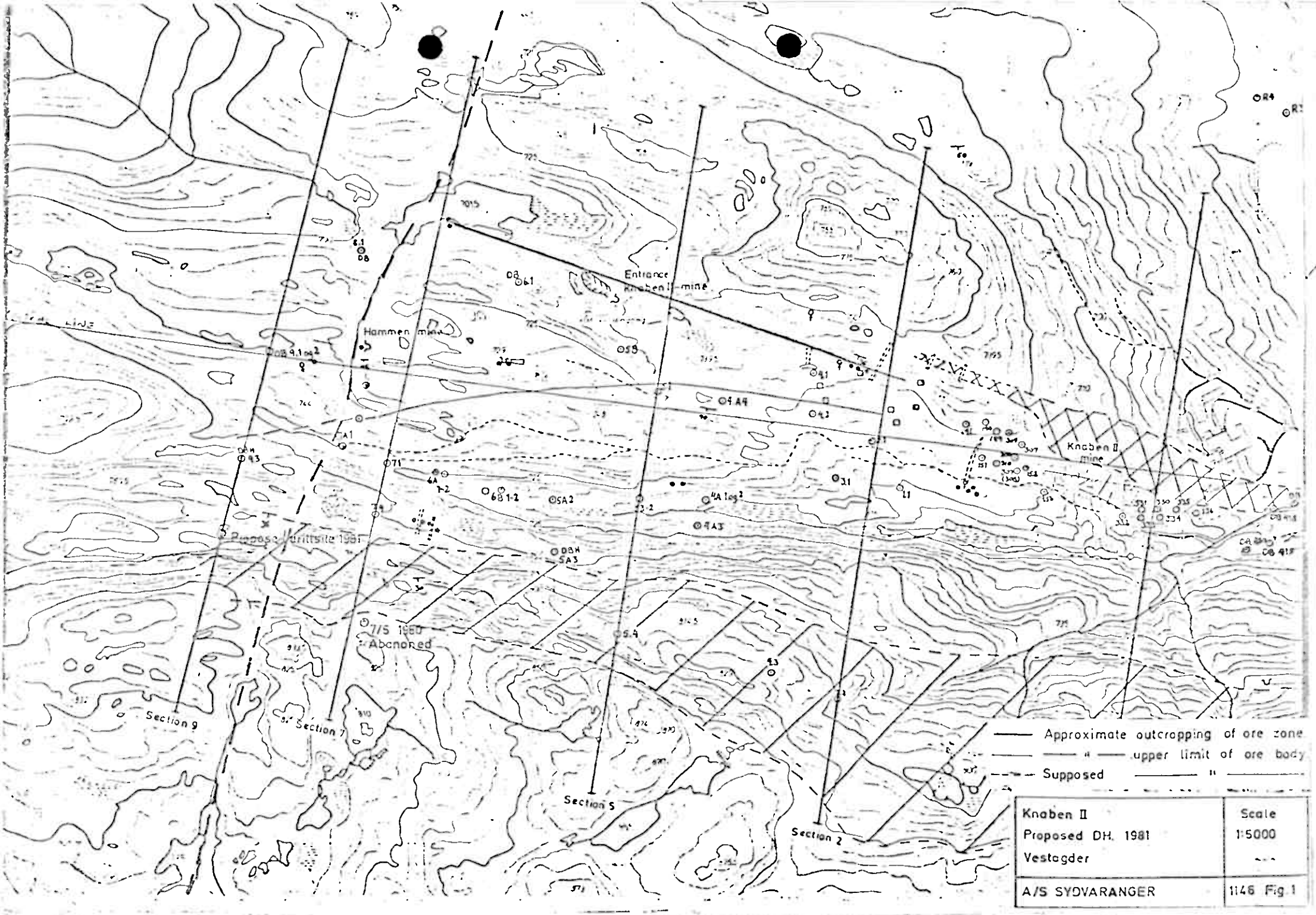
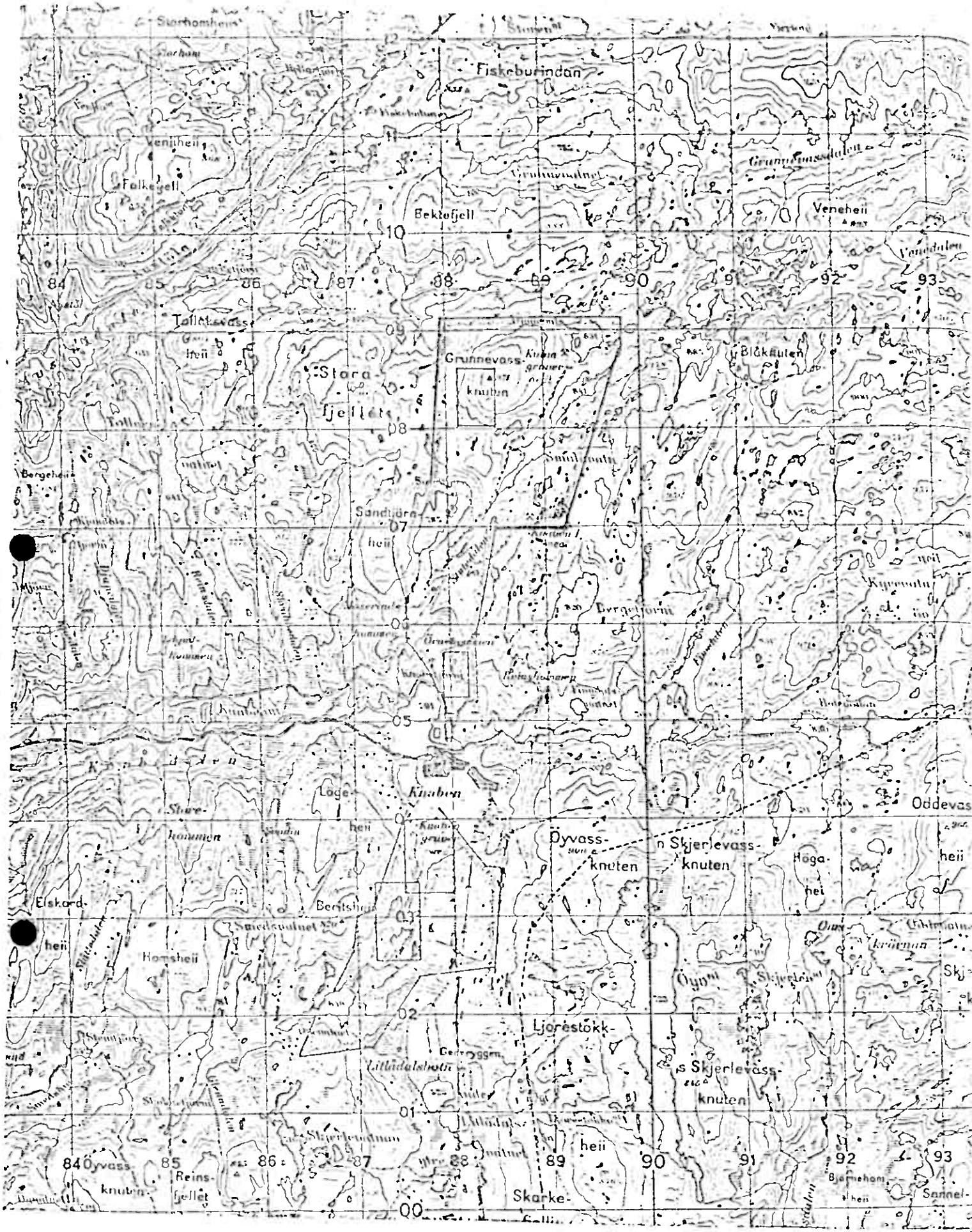

Entrance Knaben II-mine
Hammen mine
Knaben II mine
Proposed drillsite 1981
7/5 1980 Abanoned
Section 9
Section 7
Section 5
Section 2
Approximate outcropping of ore zone
" " upper limit of ore body
Supposed " "
Knaben II
Proposed DH. 1981
Vestagder
Scale
1:5000
A/S SYDVARANGER
1146 Fig. 1

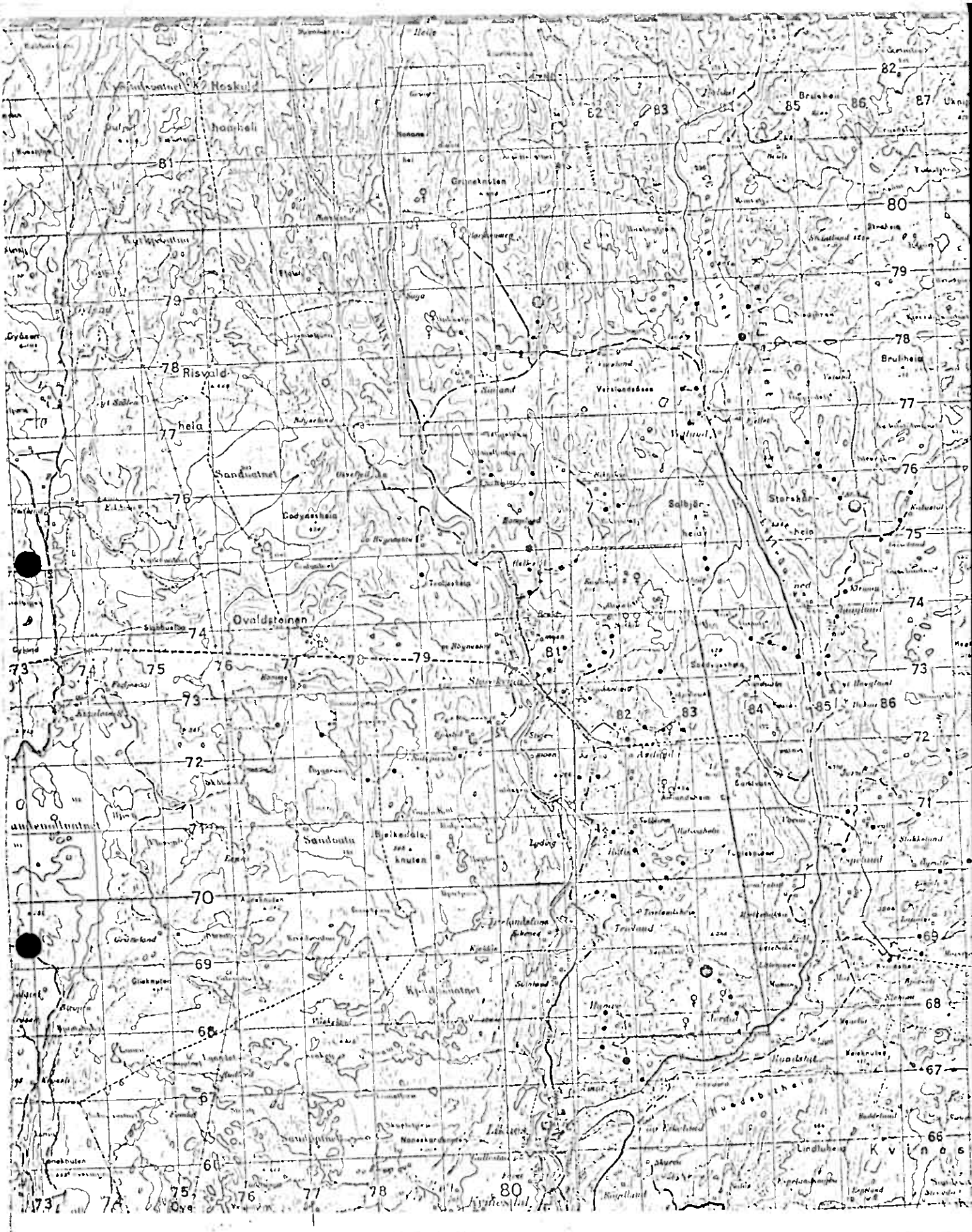


AREAS IN KNABEN EXPLORED BY ELKEM 1965/66.

M 1:4500

M 1:1000

Fig 5



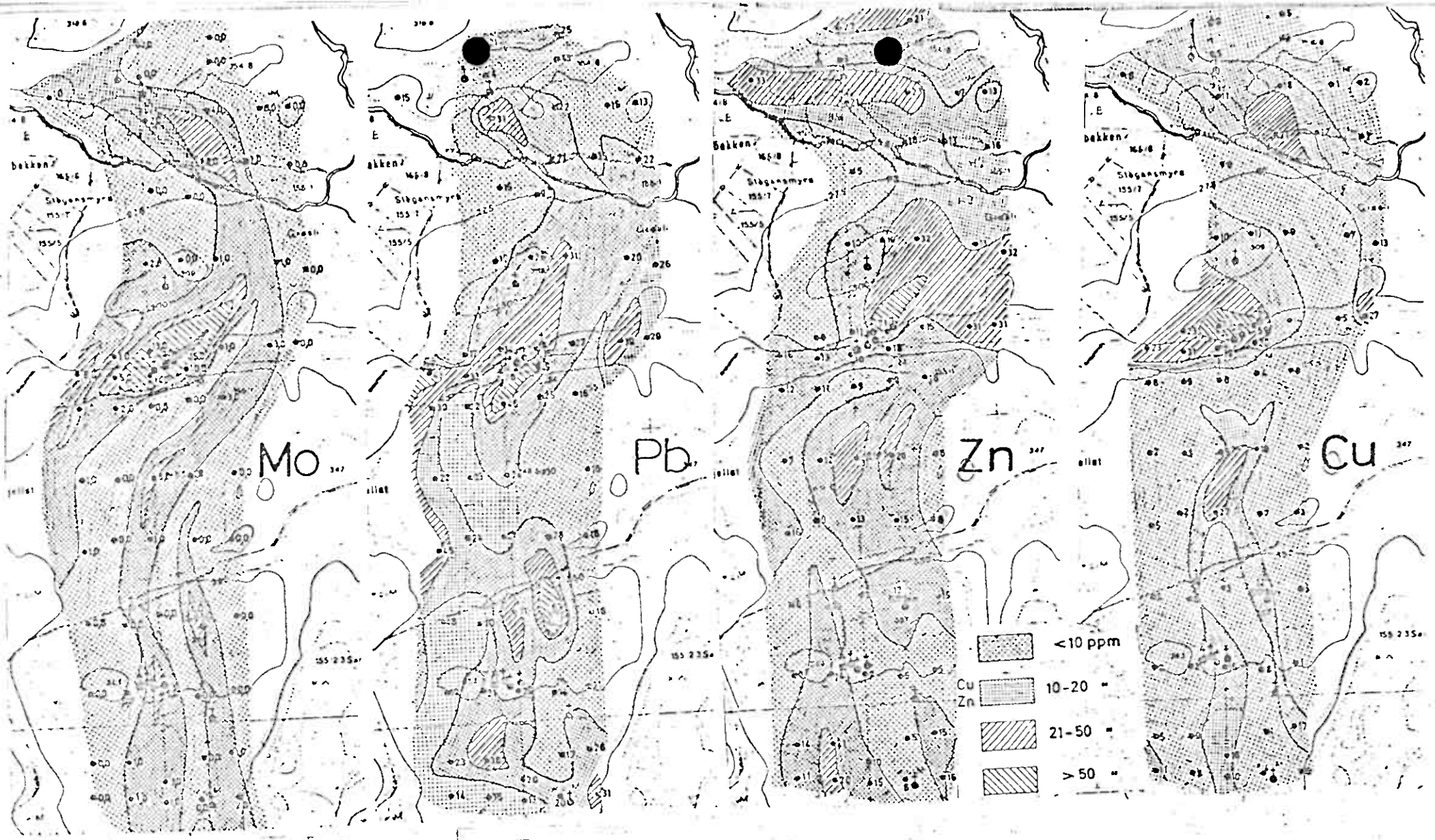
- < 4ppm
- 4-7ppm
- 8-10ppm
- >10ppm

Mo-explored areas. Elkem 1965/66

Soilsampled area

Prospecting pit (small mine) Mo

Mo in streamsediments Åmlandshei, Kvinesdal Vestagder (U.S.B) 1979	M 1:50 000
A/S SYDVARANGER	1146. Fig 6



Mo

<1,0 ppm

1,0 - 4,9 "

5,0 - 9,9 "

10,0 - 15,0 "

>15,0 "

Pb

<20 ppm

20 - 30 "

31 - 40 "

41 - 60 "

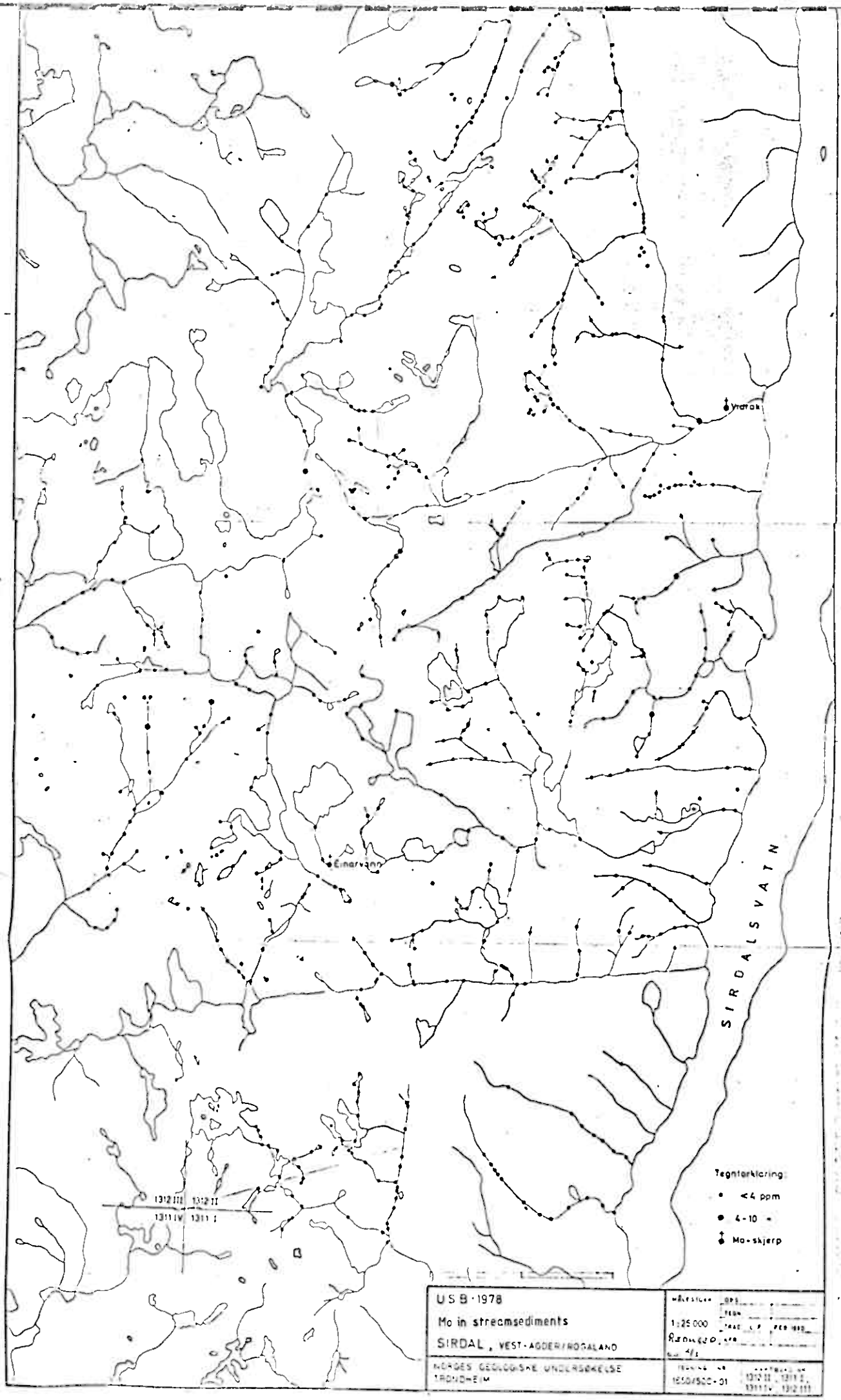
>60 "

Prospecting pit

Sampling points.

Key map. See fig.

Soil geochemistry Omlandsheii, Telemark Vest Agder After U.S.B. 1979	M 1:5000
A/S SYDVARANGER	1146. Fig. 7


Ytterak
Einarvann
SIRDALSVATN
1312 III
1312 II
1311 IV
1311 I
Tegnforklaring:
< 4 ppm
4 - 10 "
Mo-skjerp
USB · 1978
Mo in streamsediments
SIRDAL, VEST-AGDER/ROGALAND
NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM
1:25 000
1650/500-01