



# Bergvesenet

Postboks 3021, N-7441 Trondheim

# Rapportarkivet

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Tittel

Rapporter fra gruvefeltet Sjangeli

Forfatter

Petersson, Walfr., Spargo, Edm., Lund-bohm, Hj.,

Dato    År

Bedrift (oppdragsgiver og/eller oppdragstaker)

Kommune

Narvik

Fylke

Nordland

Bergdistrikt

1: 50 000 kartblad

14312

1: 250 000 kartblad

Narvik

Fagområde

Geologi

Dokument type

Forekomster (forekomst, gruvefelt, undersøkelsesfelt)

Sjangeli

Råstofgruppe

Malm/metall

Råstofftype

Cu

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

Rapporten består av tilsammen 8 rapporter av forskjellige forfattere. Rapportene er trolig kopier fra NGU's Bergarkiv. På den ene av rapportene er BA-nr. ikke lesbart. Rapportene er fra tiden 1891 - 1902

Rapportene beskriver kobberforekomsten ved Sjangeli. den ligger i Skjomen området på Riksgrensen mellom Norge og Sverige. Forekomsten ligger både på norsk og svenk side av grensen. Rapportene inneholder både geologiske beskrivelser og beskrivelser over historikk. Det er ikke vedlagt kart

3914J

Report

on

Sjangeli mininefield

by

P. Holmsen.

## Report on Sjangeli Miningfield.

Far away in Norrland in upper Torned lappaläster quite near the Norwegian frontier, there is a most interesting miningfield called Sjangeli or Johangeli, which, on the request of Mr. Alvin Jacobi, civil engineer of Stockholm, I closely examined during a several day's sojourn there last August.

### History.

Even Sjangeli has its history, which is however partly shrouded in the veil of tradition. The field is said to have been discovered by a lepp and that already more than 100 years ago some experimental work were established. Sure it is, that the pretended first experimental work has left imperishable proofs engraved in the rock, namely in different places marks of the heavy crossmouthed chisel or borer. As this mineborer went out of use in the beginning of the present century, when the pickinborer or jumper got in use was introduced, some attempt at working the field may be likely have taken place about a hundred years ago.

The first authentic and detailed description of Sjangeli mining ground / as far as can be ascertained / was made by Mr. Ahnsten, a mineurveyor, who in 1844 was engaged in taking measurements there. Ahnsten has written a detailed description of several of the then existing exploitations and the metallic veins found in or near them.

Ahnsten's work is one of the intrinsic merit and have been a great help in the investigations that have been undertaken during the present summer, though these have been extended over a large area, so since 1844 many veins have been discovered which have some of them been exploited. About 20 years ago some Frenchmen commenced experimental operations on Sjangeli miningfield, but they can scarcely have been very extensive or of long duration.

Supplement to the History of the Field.

From what has just been stated it will be seen that Sjangell richfield has only been worked by fits and starts and not thoroughly exploited.

This circumstance is fully explained by the situation of the richfield and the therefrom arising hopeless state of the transport of the ore exploited. The ore has always been conveyed eastwards to the Swedish ironworks / I do not now include the experimental workings of the Frenchman / being transported by reindeers during the winter a distance of 10 Swedish miles <sup>10</sup>/<sub>10</sub>, and a very slight calculation will prove that the expenses of this kind of transport more than swallowed up the value of the ore, which fact rendered the entire Sjangell exploitation a perfectly hopeless undertaking.

Mr. Jacobi has therefore come to the conclusion that of the exploitation of Sjangell is to be made lucrative, it is a condition sine qua non that the ore passes to the Norwegian coast. Mr. Jacobi was himself with us while I was prospecting this field, the result of which will be described below, and I feel sure that Mr. Jacobi's plan concerning the ore being conveyed to the Norwegian coast can be realised and that a suitable means of communication / road or railway / could be built which according to circumstances comparative ease.

Situation.

So that the situation of the field may be fully understood, I will briefly describe the latter part of our journey to Sjangell. After passing Bøtt, the large Vestfjord of Isfoten is reached, where the wellknown winterfishing goes on. To the upper or north end of the fjord the mighty Ofotefjord intersects it in an easterly direction and, towards the interior part divides into seven fjordarms.

\* / One Swedish mile = 6 to 7 English miles.

One of these is in Norwegian maps named Skjomenfjord and runs south or rather in a southeasterly direction. As is a well-known fact these fjords are free from ice all the year round. On coming to the interior of Sjomenfjord we found what appeared to be an excellent harbour and a pretty populous village Elvegaard, at the mouth of the river Elvegaard. From the village a tolerably good road led up to the valley for about a Norwegian mile / 11 kilometer / to the farm Bogholmen. The ground along the river may be described as a plain on the whole, with a slight rise towards Bogholmen. From this farm the real ascent to Sjängeli began. Immediately above Bogholmen the river divides into two branches one going southeast and the other northeast. We followed the course of the latter during the greater part of our journey and found the ascent continuous but on the whole not very steep although high and craggy mountains dominated both sides at some distance from the road. At the top of the plain I have just described, which spread by degrees and to a certain degree even had the appearance of a mountain table-land, we passed a pretty large lake, "Langevandet", which may be considered as the real source of the Elvegaard=river.

From Langevandet the road still continues to rise, the frontier and the watershed is now passed, as here are the sources of the waters that disembose in "Torneå träsk". At a distance of about 2 and 3 kilometer from Sjängeli a mount in-torrent, with a good fall, plenty of water and rapid current was passed, that might be of great technical importance, should exploitations begin on a large scale.

From Bogholmen to Sjängeli took us 10 hours, without counting our halts, and the way back took us a somewhat shorter time. It is a slow journey with a packhorse, but a good pedestrian walks from Sjängeli to Bogholmen in 6 hours, when stoppages are not included.

In the rugged ground of the fell, where several icy-cold streams have to be passed, it can scarcely be

expected that even a good pedestrian accomplishes more than 5 km. an hour, which could bring the distance between Sjangeli and Bogholmen to about 30 km. and from the coast / Elvegaarden / to Sjangeli to about 40 or 41 km. thereof.

Elvegarde to Bogholmen about 11 km.

Bogholmen to Langevand " 22 "

Langevand to Sjangeli " 8 "

It must be remembered that on the whole road down to Bogholmen there are no acclivities / with the single exception of one just at the miningfield and this might easily be omitted / but the road continues in a constant descent towards the valley.

The position of the field has been stated as 2,500 feet above the level of the sea, but an aneroidal barometer we had with us showed a still greater height, so that Sjangeli may be considered as close upon 3,000 feet above t.s.

#### The geological conditions.

Ancient granite predominates from Elvegaarden, via Bogholmen up to Langevand, forming high and sometimes very wild crags, while from Langevand or from leaving the frontier argillites prevail more especially argillous quartz which runs from N. to S. often makes an abrupt descent towards the west.

The road at about 4 to 5 kilometer from the miningfield lay almost parallel with a broad belt of almost snow-white rock, which chiefly consisted of white quartz with a blend of carbonates of lime. Farther on when passing the rapid mountain torrent previously mentioned, and when 2 or 3 km. from the miningfield a broad lode of greenstone or diorite was observed, running as it appeared from northeast to southwest.

At last the field was reached and our attention was at once attracted to the dark, almost jetblack hue of the mineral, which makes Sjangeli field stand out distinctly from the light argillous quartz surrounding it, and look like an island in the ocean.

I took profiles and found that Sjangelifield was not of any great extent, as to the south, west and north it does not spread far beyond the 16 allotments /"utmål"/, which in 1889 were duly recognised as belonging to Mr Jacobi by the government mining surveyor.

Only towards the east did the field seem to extend any distance beyond the boundaries of the allotments, but I had no reason to carefully measure that part of Sjangelifield. The field chiefly consists of a compact, black very ferruginous hornblend mass, which is hard, responding to blows, brittle and intersected with very fine cracks and fissures. 1)

As a rule the mineral is stratified, even if to no considerable degree, and has about the same stratification and slope as the surrounding gneisses i.e. the course is N. to S. with a steep dip towards the west.

In outward appearance there is a little difference visible between the field and the surrounding fell. Right through the field from N. to S. runs a mountain ridge, two or three hundred feet in height the many tops of which often consist of a crystalline granular compact composite of black hornblende or aegirite and grayish-white feldspath, so a kind of sabbro.

The mountain ridge is broken in two places by broad elens running E. to W. one broader, where what remains of the buildings belonging to the fields are to be found and a narrower but far steeper elen sloping to the east and traversed by Sjangeli stream, which has its basin in the Sjangeli trask /lake/ situated at the west boundary of the field. This mountain ridge contains the more important ores, while the field not unfrequently shows more or less broad or narrower lodes of epidote, the course and slope of which generally runs parallel with the mineral 2). Although epidote appears abundant side by side with the veins of ore it seems to have nothing to do with the formation of the mineral lodes, since the epidote streaks occur constantly in the Sjangeli fell

1) Mr. Schumacher speaks of Sjangelifield as a consisting of micaceous iron ore.  
2) The same was observed in the other mineral concentrations.

without a trace of ore. Some slith quartz seams also occurs in the field, but do not seem to have anything to do with the appearance of the ore, since no ore has been found in the quartz seams of the field with the exception of faint traces of copperpyrite just where the quartz seams run side by side with mineral lodes. Solitary narrow or illious veins consisting of foliaceous mica and chlorite schist also traverse the field following the ore lodes and frequently combined with some ore themselves.

Later on I will return to these, as a rule, dead veins, when the conditions of the ore and the exploitations will be more fully described.

I must now mention in a cursory way the mineral productions that occur and which make Sjangelifield of interest and value both from an economic and metallurgic point of view.

The ores occur in streaks of differing breadth which Mr. Ekenstam called strikes and which may be explained as narrow ore lodes without one large extension in the field and as yet unknown extension in depth.

The strikes, that have hitherto been observed, stretch and dip in the same direction as the surrounding rocks but are of very differing length and breadth. The thickness or breadth can vary from a few inches to one or two feet or perhaps more, while the extension in the open - as far as can be observed - may be apparently only a few meters, while at other places the solitary strikes may be followed for a distance of thirty to forty metres and even farther.

The most abundant copperore is the variegated copperore / indio-copper / then copper-lance, copperpyrites and here and there but not very often sulphurpyrites and finally the constantly recurring magnetite, which is formed almost everywhere in the different strikes.

In the east on/ day, the above named copperores, in consequence of the effects of the atmosphere have become malachite and copperlazar, which product of decomposition

will be of little practical importance, since the appearance

as thin layers in the open, or in plains and crevices of but slight depths, they have however been of no slight use in discovering the many strikes as the green & blue "coppering" shows from afar where the ores are to be found.

The copperores mentioned may appear in a pure state but are more generally found in close connection with ironores.

When for instance variegated copperore, which is the form it generally takes, becomes mixed to a certain degree with the black ironore, the latter becomes lighter in colour and of a brighter lustre<sup>1)</sup>. This connection is the most common in the Sjängelifield and is generally very rich in copper. This lighter coloured ore very often runs to one apparently pure ironore, where the admixture of copperore cannot be discovered by the eye, but where chemical analysis proves the presence of copper to the degree of 6% Cu and even more. Just as the copperstrike may run into ironore, so the latter may in its turn go over to black lithis mica /lepidolite/ often with any decided limits or course. This circumstances makes it a risky business to pursue the veins in the depth. As a general I found that when the exploitations existing in the field reach any important depth the strike that lay in open day had been lost as the slide either partly or entirely casts up, while the workings were almost vertical and the metallic lodes, as previously mentioned, make a decided even perceptible dip to the west. At the time of my sojourn at Sjängelifield all the excavations or workings were free from water, ice or gravel and the ground was cleared so that they were fully accessible for my investigations, but in one of these experimental workings can it be said that the mineral lodes were exhausted on the depths, even though they might show themselves otherwise than in the open viz. sometimes broader sometimes narrower. Even when they were apparently lost, - where one had worked ones self away from the strike - this might easily be recovered by setting a few shots in the hanging side of the respective workings.

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<sup>1)</sup> This is lithis ore, which is often livercoloured, which Mr Jkenstam denominated "copperliver" i.e. livercoloured copper.

Besides the numerous streaks, that have occasioned more or less prospecting, there are many others, which are as yet not brought to day or examined, for when examining the workings as yet exploited, more or less important streaks were found by chance on the superficial surface of the rock.

Judging from the abundance and number of the copper lodes, that are in the open, it is to be supposed that many more strike are hidden in the mountain which either appear on the surface as an insignificant fissure or else never appear at all. So that to arrive at a solution of this very important question for an eventual exploitation of the mines, it would be of no little interest if an experimental shaft or stull were run north across the general direction taken by the mineral veins.

Farther on it will touch on the advisability such a measure. Let me now proceed to a more special description of the workings and hitherto unworked streaks and I must then attention to the accompanying map of Mr Jacobis sixteen allotments.

Beginning at the north with:

a/ Henrikes allotment, I must previously remark, that the ore lodes are always to be considered as observed at the bottom of the respective workings.

1/ Works a / vide the map / is 1.5 meters N-S and 3.6 m. E-W being 1.8 m. in depth and showing only sign of ore.

2/ Workings No 1 is 6 m. in length N-S and 2 m. in breadth E-W being 4 to 5 m. deep. The workings is perpendicular so that the ore lode / the usual admixture of variegated copper and iron ore / casts up and is 6 inches in width.

A sample taken hence has been analysed by Dr. Tamm of Stockholm / on Sept. 12:th 1891 / and found to contain 8.18 per cent of Cu. No 1 and a / seem to be of the same vein.

Let me here remark that the sample cited in my text are all analysed by the same Dr. Tamm and the analysis are dated Sept. 12:th 1891.

b/ Tornbergs allotment.

1/ Working No 2 is but an insignificant one. The streaks of ore were 4 inches wide.

2/ Works No 3 were 4 1-5 3 m. E-W and of a depth of 3 m. At the bottom of the works the ore was 12" /inches/ in width, but at the toping 9" to 10"

Sample No 3 was taken here analysed in Stockholm by Dr. Lamm and proved of 13.26 per cent Cu.

c/ Burmans allotment.

1/ The working b/ is beneath a steep rock and several narrow crevices were observable here.

2/ Works No 4 / Ekenstams "Carl" ) are about 13 m. N-S 4.3 m E-W and about 11 or 12 m. in depth. The exploitation here seems to have been pretty considerable and was probably carried on by the Frenchmen after Ekenstams time. At the bottom of the works there is now but a very slight trace of ore and it is not what may be called a real vein, but there is a 3-6" broad coat of epidote, which may be followed by an excavation.

On the rock itself there was plenty of partly good ore / variegated copper and usual liver coloured ore / which shows that there is a vast amount of ore broken, and certainly the working of this mine should be again undertaken as good results would assuredly accrue. A sample from this working analysed in Stockholm by Dr. Lamm showed 9.10 per cent Cu. and one taken from the outer rock 10.92 per cent Cu.

3/ Some five or six metres farther north there were again open workings on the same lode as "Carls" and lying on the edge of the river or torrent. One very nearly remained unobserved, since it was hidden by a snowdrift, it was however duly dug out and about examined. It is 8 to 9 m. long N-S 2 m. in breadth and about 3 m. deep. In this working there were only very unimportant traces of ore.

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1) Mr. Ekenstam says concerning "Carl" this working lies close to the minestream. Its depth is 17 ft. 9 inches and length 30 ft. in an almost rectangular form. In the open the streak was about 2" broad after being dug out or just the same width as it had appeared at the east side of the working. At a depth of 8 ft. the vein was 9" broad. At the depths of 11 ft. the vein casts, when an important increase occurs in the breadth of the streak so that at a depth of 15 ft. it was 35" in breadth. It may be said that this streak consists of 3/4 copper ore and 1/4 of dead mineral. The ore was mostly fine liver coloured

It is probable that "Carl's" streak continues on the other side of the river and it is possibly the same that was worked at b.

7 or 8 m. From "Carl's" streak towards the west there was an unexploited ore lode, which showed very fine variegated copper ore.

d/ In the allotment Carl quite close to the mine "Carl" there were several pretty powerful lodes 3 to 4" in breadth which are however, yet unexploited.

e/ Allotment Berzelius.

1/ Working N:o 5 / vide map/ is 5 m. in length 2 in breadth and 3 in depth and only very faint streaks are found here.

2/ Working N:o 6 is 3 m. in length, 2 in breadth and about 3 in depth. Several streaks were visible here, the broadest being about 4 or 5 inches.

3/ Working N:o 7 is 4 m. in length, 2 in breadth and 1.5 in depth and shows only faint streaks.

4/ Working N:o 8 " ) is 6 m. in length, 3 in breadth and 3 in depth with only faint streaks in the open, mostly consisting of iron ore.

5/ Working N:o 9 looks more lucrative being 7 m. in length, 4 broad and about 6 m. in depth.

In the open not much ore was to be seen but some epidote while at the bottom two streaks were seen the one at the southern slope being about 6" in width and showing variegated copper ore and copper pyrites. Farther to the north a somewhat narrower streak is to be seen and from this a sample N:o 9 was taken, which on being analysed in Stockholm by Dr. Tamm was found to contain 17.47 per cent Cu.

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copper, in which there were spots of serpentine /epidote/.

) Ekenstams says of the "Baramstaregrufvan" / the surveyors mine / - my Nos 8, 9 and 10 that there are two workings, the one lying east being 8 ft. in depth. On continuing the blasting only two narrow streaks were found. At the upper edge of the working the metallic east does not seem to have been more than 2 or 3" broad consisting chiefly of talc slate, quartz and some lead ore, but at a depth of 8 ft. the larger streaks are 25" broad, of which 14 to 16" is cohering metal and the rest dead rock / gneiss and micaceous slate /. The copper ore itself had an uncommon appearance and was found in small knots / glands / consisting of bright yellow copper pyrites of

/ some iron glance was also found therein/.

6/ Working N:o 10 is 4 m. west of N:o 9 being 8 m. in length, 3 m. in width and 3 in depth and at the bottom has several streaks 3 to 4" broad and containing copper- and iron-ore.

7/ Working N:o 11 is 4 m. in length, 2 in breadth and 4 in depth.

At the bottom there was a 12" lode of copper- and sulphurpyrite. Samples of this and adjacent ceste contained 14.98 per cent Cu.

N.B. Eastward of N:o 11 lay a 6 to 8" streak in open day consisting of copper- and sulphurpyrite.

Near the limits of Berzelius and John there were workings /a/ of a 8 to 9 inches quartz slide with faint traces of copperpyrites.

f/ Alletment Fredrika.

1/ Working N:o 12 is 6 m. in length, 3 in breadth and 4 in depth. The ore streak is about 12" broad and consists of copper- and ironore. Samples analysed in Stockholm by Dr. Tamm gave 17.58 per cent Cu.

2/ Working N:o 13 is a continuation of N:o 12 being 10 m. S. of it, 6 m. in length and 3 in breadth and 3 deep. The metallic vein is 8 to 12" in width and continues still farther south.

This lode seems very promising.

3/ Working N:o 14 is 5 m. in length, 2 in breadth and 2 in depth; the streaks only 2".

4/ Working N:o 15 is 6 m. in length, 2 in breadth and 3 in depth. The lode in the very middle of the bottom thereof is a few inches in width, and consists of epidote and small knots of coner glance.

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unusual metallic lustre and livercoloured copperore. The samples were found to contain in N:o 1. 82 per cent Cu and 0.0576 pr. cent A.G. with traces of gold; N:o 2 had 21.14 per cent Cu. "As for Skonstam".

4/ Working N:o 16 is 4 m. in length, 2 in breadth and 2 in depth, the lode being only between 2 and 3 inches.

5/ Working N:o 17 is 3 m. in length, 2 in breadth and 3 in depth, and has 2 veins, the broader of which is from 12 to 16" with epidote impregnated with copper.

6/ Working N:o 18 has only faint suggestions of copper.

7/ Working N:o 19 / - new level / lies high upon the mountain is 4 m. in length, 4 in breadth but is not driven to any depth. Copper impregnation is found over the whole extent of the working but no lode. Samples analysed by Dr. Tamm show but 2.05 per cent Cu.

8/ Workings were seen in the immediate vicinity but little exploited with a 4" streak.

9/ Allotment Isaac / Isak/.

Working N:o 20 is 7 m. in length, 2 in breadth, 1 decm. The lode is simply 1" in breadth, containing iron and a little copper.

10/ Working N:o 21 is 8 m. in length, 3 in breadth and 2 in depth. The streak but 3 to 4 inches with ferruginous copper.

11/ Working N:o 22<sup>1)</sup> is 21 m. in length, 8 in breadth and 3 to 4 in depth. The streak or streaks several inches broad go in into the hanging wall.

12/ Working N:o 23 is 9 m. in length, 3 in breadth and 3 in depth. We here find a live foliated slate of hornblende, glimmer and probably chlorite which is 24 inches wide and impregnated with ore, the upcast also contains an ore lode 4 to 5" broad of excellent quality. Herefrom the sample N:o 23, which analysed in Stockholm by Dr. Tamm showed 28.26 per cent Cu.

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<sup>1)</sup> Ekenstam says: Allotment Zacharias contains 2 mines, of which the large mine / my workings N:o 22 / is one. The vein is pretty rich being 7 to 8 inches wide. The length of the level is 60 ft., while the breadth varies as seen by the map. My N:o 23 is apparently Ekenstams "large level in Lars-works". He remarks concerning this level: "It is driven to a depth of 26 feet and the bottom the streak was 16" broad but, run into dead casts. At a depth of 18 feet the lode is said to have been still broader /30"/. In this mine the lode has been most constant etc.etc. The rock is much split.

5/ Working N:o 24 - 6 m. in length, 4 m. in breadth and of a depth of from 4 to 5 m. is high the slope. In the southern stop there is a fine streak, which goes in into the hanging 8 to 10" wide <sup>1)</sup>. Hence sample N:o 24 was taken, which when analysed in Stockholm proved to be of 3.67 per cent Cu.

6/ Working N:o 25 is 5 to 6 m. in length, 3 in breadth and 11 in depth situate on the north side of the steep slope and has probably been exploited after Ekenstams time. The level is driven away from the lodes, which stand in into the hanging side. From the streak now visible / 6 to 7" in width/ samples N:o 25 was analysed in Stockholm by Dr. Tamm and found to contain 24.64 per cent Cu.

7/ Level working N:o 26 is of no importance; the streak is 2".

8/ Level working N:o 27 is unimportant the streak in S. slope 2".

9/ Working N:o 28 was called Isaks / Isaacs / mine <sup>2)</sup> and is said to be of the very oldest of the field. It is about 31 m. in length, about 3 m. across and of different depths, the deepest being about 10 m. In the southern end a streak is plainly visible of about 6 to 7 inches in width and many narrower but inconsiderable ones. Towards the north the ores becomes impure, largely ferruginous and containing little copper.

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<sup>1)</sup> Ekenstam says of this: N:o 24 the middle level is 14 to 16 ft. in depth and the rock is discriminated by iron glimmer. The streak 8 to 10" of entirely pure ore after the streak had almost disappeared on the half of the depth.

<sup>2)</sup> Ekenstam writes concerning Isaks mine:

"This mine is only an average 18 ft. in depth / the other dimensions may be seen from the map / and is opened on a lode that seems in the open to have been 3 or 6" in breadth but at the depth of 10 ft. was 10" and continued of same width at 14 ft. At the southern stoping the ore was pretty pure but at the northern largely mixed with dead casts. The streak appeared at the bottom still 10 to 11" in breadth and pretty pure. The fall of the cast was about 30 degrees out of the vertical. In the north part of the mine the ore made a cast to the east, but appeared to join with the main lode lower down. In some places at the bottom the streak was mixed with talc slate. At both extremities the ore lode is visible, but near the bottom at the north end it was only 3" in width, at the south end however broader. At both spots it appeared likely to be broader lower down, as in Johns mine it was observed that when the streak gives over, the west one becomes purer and richer in ore. At a distance of 4 ft." etc.

When exploiting Issacs mine in days to come a shaft should be sunk at the southern end to a depth of 11 to 16 m. and thence a level driven in a northerly direction so as to undermine the above mentioned open working.

Here should be erected and thus prevent the exploitation from being hindered by snow or ice during the winter months.

h/ Allotment John.

1/ N:o 29 a streak in the precipitous mountain 2 to 3 inches in width and not worked.

2/ N:o 30 a faint streak, never worked.

3/ N:o 31 only faint streak not worked.

4/ N.N. A few metres eastwards a streak 4" in width shown in Ekenstams map.

5/ Working N:o 32 is 3 m. in length, 3 in breadth and 3 in depth, the streak but 1 to 2".

6/ Working N:o 32 /a/ N.E. of 32 is apparently Ekenstams "East mine" and is 5 m. in length, 3 in breadth and 3 or 4 m. in depth. The streak is 4 to 5 inches wide. Ekenstam reckons the East mine as belonging to the allotment Zacharias.

1/ The allotment Adoll.

1/ Working N:o 33 is 8 m. in length, 2 in width and 2 in depth, having 7 streaks each 2 to 4" and containing iron ore and malachite.

2/ Working N:o 34 is 2.5 m. in length, 2 across and 3 m. deep, the streak being 2 to 3 inches in width and consisting of malachite. This lies near "ojanseli träsk" /lake/.

3/ Working N:o 35 is 8 m. farther south on the same lode being 1.5 m. in length / N. to S. / 2.5 m. in width and 0.5 in depth, the streak but 2".

4/ Working N:o 26 is 5 m. in length, 3 across and 4 m. deep. The streaks being 3 to 6 inches in width containing good ore. Sample N:c 36 taken hence and analysed in Stockholm by Dr. Tamm showed 19.51 per cent Cu.

5/ Working N:o 37 is 3 m. in length, 2 in breadth and 1 in depth, the streak being here but 2 to 3 inches broad.

6/ Working N:o 38 is 3 m. in length, 2 in breadth and

2 deep; the rock being foliaceous slate with indistinct streaks of ironore.

8/ Working N:o 40 is 4 m. in length, 4 in breadth and 1 meter in depth. In the hanging wall there is a vein of quartz 2" in width but no ore.

9/ Working N:o 41<sup>1)</sup> is 4 m. in length, 3 in breadth and 3 in depth; the streak being 3 to 4" in width and containing very fair ore.

N.B. N:is 38, 40 and 41 are evidently on the same lode.

10/ Working N:o 42<sup>2)</sup> is 3 m. in length, 2.5 in breadth and 2 deep and contains an about 20" slate slide with impregnated ore free from iron. A sample taken, N:o 42, hence and analysed in Stockholm proved of 15.78 per cent Cu.

11/ N:o 43 is due east of N:o 42 is unexploited east some few inches in width.

k/ The allotment Helena.

1/ Working N:o 44 is 8 m. in length, 2 in breadth and 1 m. in depth. Along the whole length of it there is a 2 to 4" broad streak of extremely fair ore, which when sample N:o 44 was analysed in Stockholm by Dr. Tamm proved to be 16.20 per cent Cu.

L/ The allotment Gustaf /Dustavus/.

1/ Working N:o 45 is 8 m. in length, 2 in breadth and 4 in depth.

These are crevices and spots throughout the entire working that are / dis/ coloured a rusty brown by disintegrated sulphur and copperites, so a kind of impregnation of the above named ores. There is besides a streak of 8 to 10" width containing copper and ironore.

2/ Working N:o 46<sup>3)</sup> is 4 m. in length, 2 in width and

<sup>1)</sup> Ekenstam remarks concerning "Årnbergs mine" /my N:o 41 /: The ore showed itself but faintly at the bottom, was rich and seems to have formed a bunch for there was no real lode observable. At the bottom of the working was 2 to 3" streak apparent".

<sup>2)</sup> Ekenstams words are: "In this allotment /N:o 18 Adolf / a streak occurs that has been exploited long ago. Climmer slate is seen here discriminated with copperore". My N:o 42.

<sup>3)</sup> Ekenstam observes: "In that allotment N:o 13 "Bo gsmine" /my N:o 46 in Gustafs utmärl/ when working horizontally in the field, the rock has been blasted to the extent of 145 Sktt. The lode was 7 ft. in width at one place where the blasting had gone to a depth of 18 ft. The live part of the lode

in depth showing the same disintegration as in N:o 45. In the hanging wall of the lode there is a 4" broad quartz vein. At the bottom of the working there is a lode containing copperpyrites, which is 20 to 24" in width and beside the copperpyrites a 4 inches streak of the common Sjangeli ore.

A sample N:o 46 from this working was analysed in Stockholm by Dr. Tamm and showed 5.63 per cent Cu.

3/ Working N:o 47 is 5 m. in length, 3 in breadth and 4 deep.

The whole bottom of the working was indiscriminated with copperpyrites.

A sample of this N:o 47 on being analysed in Stockholm by Dr. Tamm was found to contain 4.87 per cent Cu.

m/ The allotment Gabriel.

1/ Working N:o 48 is 10 m. in length, 3 in breadth and 4 deep. Right across the working there is 7 to 8" east of pure variegated copperore, while 4 m. farther south, running parallel to the above mentioned east there is one 4" in width consisting of variegated copperore and moreover 4 m. farther north another parallel east 4 to 5" wide also of variegated copper.

The sample taken hence when analysed in Stockholm by Dr. Tamm contained 42.82 per cent Cu.

2/ Working N:o 49 is 4 m. in length, 1.5 in breadth and 1 m. in depth having a 8 to 9" streak of common Sjangeli ore. Sample ore N:o 49 taken here contained 12.67 per cent Cu.

3/ Working N:o 50 is 5 m. in length, 3 in breadth and 4 deep, the streak being about 2 to 3" inches wide and is probably the same as is worked N:o 49.

n/ The allotment Thilda.')

1/ Working n:o 51 is 5 m. in length, 3 in breadth and 4 m. in depth.

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varied greatly. The greater part of it consisted of a kind similar to the finely granulated ironore, but in it there were also copperpyrites, livercoloured copperore, magnetic pyrite and sulphurpyrites all more or less indiscriminated. Samples being sent to the laboratory in Helsingfors they were found to contain 6.5 per cent refining copper, 0.0624 per cent silver and unmistakable traces of gold.')

\*) Ekenstam observes concerning this allotment n/: Two streaks appear here which are not convergent in the open. Near the

The lode is from 4 to 8 inches wide, higher up in the rock 8 to 11 inches, wide consisting of malachite, copper-pyrites and ironore, while to the east there is a streak of copper and sulphur-pyrites.

The lode seems to divide and be of great length proceeding on to the allotment Gabriel.

o/ The allotment Bernades.

Working N:o 52<sup>1)</sup> is 3 metres in length, 2.5 in breadth and 2 deep.

This workings contains a quartz vein 6 inches in width and beside it a narrower ore streak about 4 to 5 wide. The course and downcast of the quartz slide is the same as the Sjängeli fell or mountain; while immediately north of the working there are three ore streaks, exploitation having been undertaken of the one.

Sample N:o 52 was taken about 10 m. north of the working and when analysed in Stockholm by Dr. Tamm proved 4.19 per cent Cu.

p/ The allotment Haparanda.

1/ Working N:o 53 is 3 m. in length, 1.5 in breadth and 1 m. in depth.; The streak is 3 to 4" in width in the underlaying wall, apparently, a continuation of N:o 52.

q/ In the allotment Erik there was only an open working 5 m. in length and 5 m. in breadth, containing narrow streak of ore.

highest top of the mountain a fine lode appeared, that certainly has an admixture of rock with the ore, but the latter was rich, the lode 8 to 12" wide and stretched to a distance of 30 to 40 yards.

\*) Skanstam places 4 lodes here, one 15" in width with 4" pure livercoloured copper and proposes that blasting on a to not great extent, judging from what I saw, unless it is N:o 52 which seems to be the case since Skanstam's 15" lode consisted of a 4" wide prestreak a 3" wide quartz-vein and the other 6" of talc-fo sile and greenstone.

H.B. The fourth streak mentioned by Skanstam could not be discovered.

It will be noticed that in the above description of the ore finds in Sjangeli mining field, side by side with my own, I cite Mr. Ekenstams observations. It can scarcely be expected that mine should agree in every respect with his, since my observations embrace many more workings and finds ore than Ekenstams, as since 1844 many lodes have been discovered, which have been partially worked, by more or less important mining-operations.

Ekenstam often notes shreater width than I, when speaking of a lode, since he includes all those minerals that seem to belong to the same lode even if they are dead as quartz, serpentine / epidote / diorite, slimmer, chlorite etc.etc. whereas I only notice the real metallic lodes. It must also be remebered that many workings look very different now from what they did in Ekenstams day, as a good deal of mining has been undertaken, but as it appears without sufficient technical supervision or guidance for as has been already said the headings have been sunk plumb, while the lodes, as far as can be ascertained, all have a down-cast to the west. The consequence of this has been that they have worked away from the lode observed by Ekenstam, which runs into the hanging ~~xxix~~ of the working and could therefore scarcely be observed by me.

Taking all in all the chief results of the prospecting of indications and finds of ore at Sjangeli mining field briefly described above, is that a firm conviction is felt that there is a large supply of rich copper ores at Sjangeli. This conclusion is arrived at even when examining those workings, works and lodes that have already been laid bare and it may be concluded with tolerable certainty that a great number of ore finds, and those probably rich, are as yet not discovered, though in all probability they would be found and exploited if real mining operation were commenced.

But notwithstanding these facts Sjangeli field presents peculiar or rather local difficulties in the way of lucrative mining operations.

First of all the situation is anything but favourable, far away in the north, 3000 ft. above the sea and on a very exposed mountain, which fact will cause many climatic difficulties for an eventual mining undertaking. It may be affirmed

however that Sjangeli is scarcely in a more exposed position than many other ore-fields e.g. the more important of those belonging to R3ros copper mines, which also lie 3000 feet above the sea and fully as far if not farther inland than Sjangeli, and yet these works have given the chief contingent of an important and lucrative mining industry for nearly 300 years. The chief reason why a continuous working of Sjangeli field has as yet not taken place as I believe because attempts have always been made to transport the ore eastwards, probably because the field happens to be on Swedish soil.

These impractical attempts at transport have utterly crushed the possibility of exploiting Sjangeli miningfield.

The carriage or transport must be to the Norwegian coast and must be made as easy and cheap as possible; this is a "sine qua non".

Secondly it will be noticed that the hard, brittle and fissile nature of Sjangeli fell has awakened great misgiving in Mr. Ekenstams mind, for time after time he harks back to this subject, and judging from the figures cited by him, the break of ore in 1844 must have been frightfully expensive, which fact was probably owing both to the organisation of work / since it seems that all work was paid for by the day and not by contract / and to the then imperfect tools and explosives. But since 1844 such vast progress has been made in the technics of breaking grounds that with machine drills, dynamite and steel borers no experienced miner / "mining man" / would dread attacking Sjangeli field.

Thirdly the finds of ore lie spread about all over the field so that eventual mining operations cannot be confined to some few spots.

This circumstances is of certain importance, since the lodes are so narrow, generally but a few inches in width and,

-40-

as far as can be ascertained, of no great extension in field.

It would certainly be very desirable if all the ore at Sjançeli had been concentrated at one or two places; but one must now take the locality as it is.

If however the lodes are narrow and of but slight extent the richness of the ores fully compensates for these facts. From 18 of what seemed to me the most promising casts I took samples during my stay at Sjançeli, which were in September last analysed by Dr. Tamm of Stockholm.

These samples, as seen by the above description as to where they were taken, being chosen by me with due discernment as representing the average quality of the respective streaks, prove an average of 15.11 per cent Cu. Such richer streaks are well worth exploiting, even if they be narrow.

Besides it must be noted, that the real copper streaks, more especially those that occur in the central part of the field, are plentifully accompanied by large quantities of apparently pure iron ore, where the copper ore is otherwise not to be perceived.

At different places I took samples of this iron ore, two of which were analysed in Stockholm last August by Victor Gröndal and contrary to all expectations they were found to contain more than 6 per cent / on an average 6.51 per cent / Cu.

If a glance be cast on the map it will be seen that many of the workings are concentrated in the Isaac and Adolf allotments, and this spot I call the central part of the field. Through this the heart of the mining field a stoll should be driven, the best direction being from the east where the ridge is precipitous.

Mr Ekenstam himself advised this step, the advantages being obvious.

In the first place it would be a very proper experimental exploitation as it would go right across all the leads of the lodes and would serve greatly to concentrate the mining operations by building dressineworks in the open, simply

the necessary supervision and finally for some years to come render the exploitation of this part of the field independent alike of mining-machinery and the hard weather of the Sjangeli fell.

Similar stull work of varying length will probably be called for in the field, but to lay down any special rules concerning how to break ground in the most advantageous way when working the lodes, would carry me too far, and must be left to the engineers that from time to time may be intrusted with the direction of the mining-operations.

One very important fact is that just as there are certain difficulties in the way of mining operations, which have already been enumerated, there are also special advantages.

Among these I include what is certainly of the utmost importance that the dressing of the ores, which at many mines is unavoidable, expensive and wastes a good deal of the ore /I mean the mechanical concentration of the ore/ can be dispensed with for the ores of this miningfield. Every mechanical preparation has hitherto been based on the difference existing between the specific weight of the ores and the kind of rock attending them. The rocks of Sjangeli field are of great specific weight in consequence of containing iron, so that an ordinary mechanical preparation would not be very effective and would moreover entail great loss of ore.

In my opinion this process may be easily dispensed with, as the stuff, as taken directly from the workings, only by dressing by hands, may easily be concentrated to 8 or 10 per cent Cu., which is probably sufficient for the further working of the orestuff so as to obtain the metals contained therein.

My idea has been that, when cheap and easy communication is opened to the Norwegian coast, the further ore-dressing should be accomplished on the fell, by the ore of 8 to 10 per cent, that had been handsorted, being smelted down

/perhaps with some admixture of sulphurpyrites / and concentrated to some 30 per cent and while liquid immediately be subjected to a Bessemerprocess, the Bessemer-copper then being submitted to electrolyte treatment, by which means even the silver and possibly gold in the ores would be won. The mechanical power so necessary for every department of mining can be obtained from the Sjangeli river, that flows righth through the mining field.

The supply of water does not seem to be very considerable more particularly in wintertime; but it must be observed that "Sjangeli tråsk" /lake/ whence the stream emanates, might easily be dammed up some 2 or 3 m. and thus form a considerable reservoir. Moreover a good fall is easily obtainable, so as to increase the mechanical power.

Should the power at command really prove insufficient for that machinery by aid of which the ores are to be refined to pure metals, the necessary waterpower may easily be obtained in the immediate neighbourhood as above stated.

It is my firm conviction that important and lucrative mining operations can be carried on here with a management that be technical, rational and economical, and I warmly recommend the Sjangeli orefield.

Trondhjea den 5 oktober 1891.

P. Holmsen

Bergmestere i det Trondhjemske bergdistrikt.

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DESCRIPTION OF

Some of the most important Oredeposits in Sjangeli and Unna  
Alakats in "Jukkasjärvi socken" of "Norrbottens län".

by

Walfred Petersson.

1895.

SJANGELI OREFIELD, known since the end of the 16:th century and having been exploited at different times with interruptions of longer or shorter duration, is located about 4 Kilometer East of the Swedish Norwegian frontier at 68° 12' northern Latitude by 0° 10' East from Stockholm within "Jukkesjärvi socken" of "Norrbottens län".

The rock within the territory consists of Hornslate with narrow layers of an often dolomitic Limestone and larger or smaller lens-shaped bodies of massy Gabbro. The Hornslate is to the East bordered by a gray slaty Gneis and to the west by a deep Dolomitic Limestone, which itself to the west is bordered by slates of different kinds. To the North is the orebearing territory bounded by Arguillite, Quartzite and Gneis. To the South forms Umas Alekats Orefield (which will be described below) a continuation of the same.

In the above mentioned Hornslate which dip more or less steeply toward Northwest occurs, within a territory of about 3 Kilometers in length and 0.5 Kilometers in width, a large number of copperore-lodes, of which a hundred at least have been examined or exploited to a larger or smaller extent.

A detailed examination of all in 1894 discovered lodes was, during the summer 1894, made by the Stategeologist Mr. H. J. Lundbohm and myself, over which examination Mr. Lundbohm submitted a report.

This examination proved that copperores occur partly as very numerous stratified bodies consisting of Bornite, copperglance and Magnetite, or zones rich in Bornite and Copperglance within the Hornslate and partly as veins and fissureveins. The orebreaks are generally narrow, but contain often ore of very high copperpercentage. The extension in the open is also generally not very large, and within the same vein varies the copperpercentage very materially both in the extension in the field and on the depth.

Work formerly carried on here at Sjangeki seems mostly to have been aimed at getting rich ore. On this account older cuts and mines have the shape of more or less deep narrow hollows, which have been abandoned as soon as the ore has shown tendencies to grow leaner, without any attempts to ascertain whether these have been transitory or not.

For the same reason have a number lately discovered rich oreveins, which in the open only have shown a insignificant width, not been examined and before 1894 has no thorough examination of the field been undertaken.

During one investigations 1894, when a map over the whole field was drafted, and all then known lodes were examined and described, was also cut a large number of trenches, so as to strip the different orestrées and ascertain their length, width and quality.

But an account of the large number of orelokes which then had to be examined it was not possible to more thoroughly examined any one or through a more extensive mining find out its nature. I was therefor commissioned to, with the assistance of Mr. K: Huldt, Mining Engineer and super numerary officer in "Kongl. Kommers Kolleg.", during the summer 1895, examine a part of the most important orefinds in Sjangeli, and also investigate the surrounding country with view of finding new oredeposits or other minerals which may be of value. To carry out this we arrived at Sjangeli the 10:th of July this year. August 23:4 I left the orefield while Mr. Huldt remained until Sept. 9:th to superintend the finishing of a part of the commenced investigative works.

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The Sjangeli deposits and the already known lodes at Unns Ala-  
vants were stripped of the soil and trenches were cut which step for  
step were followed to ascertain the conditions of the lodes regarding  
their quality and extension both in the field and depth. Numerous  
specimens of the ore were also collected by Mr. Huldt and their rich-  
ness in copper was imidiately determined approximately by the calori-  
metric metod. The ore, received during working the most important  
cuts and mines, was dressed under the supervision of Mr. Huldt, and  
were estimated to their quantity. General specimens were also collected  
from the same and have laterbeen analysed at the Mining department  
of "KemiskTekniska Byrån Stockholm.

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GABRIELS BORNITZKÄRPNING.

The most important find of pure Bornite as fissure veins is the one which made 1891 within the measure Gabriel.

This lode, which in the open only was very small, has by continued work and examination shown itself to be a network of fissures and veins with mostly pure Bornite and also a mixture of Bornite, Copperpyrites and pieces of the surrounding mineral. With regard to these dimensions the oreveins are very various. They widen suddenly from a couple of millimeters in thickness to as much as 3 decimeters and decrease even as abruptly from a considerable width to about nothing. The mineral between the larger fissures is more or less closely intersected by cracks, partly empty and partly filled with Bornite. The orebearing ores are easily distinguished from the others by their surfaces being aerated giving them a drusy appearance. Within the deposit in question are the Borniteveins known for about a length of 30 meters, a width of 8 meters and a depth, from the surface of the rock, of 5 meters. Within these boundaries has a particularly rich vein of Bornite been examined. It continues with few interruptions from the open to a depth of about 4 meters, where it is replaced by a Permatitic mineral. From this mainfissure extend numerous crossfissures, and the orebearing zone is here over 1 meter in width, but with very various percentage of Bornite, as is shown by fig. 2 (a-b) Sheet 3. Before any blasting had been commenced here only a very small lens of Bornite was visible. After taking away the rock for a thickness of about a couple of decimeters, which rock itself contained a considerable quantity pure Bornite, the wall had the appearance shown by Fig. 2 -a. By further blasting to a thickness of 2 decimeters the appearance was as shown by Fig. 2 - b. By continuation of the work a narrow fissure was found, which after a depth of 2 decimeters was widening inward, and was found with entirely pure Bornite having a width of 15 centimeters. It seemed to be still widening. The mainvein on the contrary was narrowing quickly inward, but seemed to continue with the same width obliquely forward toward the steep wall. The Bornite-lenses shown on Fig. 2 highest up to the right are connected with the large vein through a partly empty

partly Bornite-filled fissure. After blasting here was also found much Bornite. Through an other crack these lenses are also connected with a Bornitevein, or rather a network of partly Bornite-filled cracks, a few meters to the Southwest, which oredeposit is shown by Fig. 2-c. Also toward Northwest have been noticed several streaks of Bornite, but they have not been examined on account of lack of time. Besides these fissureveins of Bornite have also shirty deposits of Bornitebearing Ironore been noticed.

On the basis of these examinations the above mentioned territory may be considered as rich in fissures filled with copperore. A quantity of ore obtained from blastings was roughly dressed giving partly 1:st ore with a copperpercentage of 55.05 % partly 2:d ore, consisting of a mixture of Copperpyrites and Bornite, with 27.46 % copper and at last a 3:d ore having copper to 6.10 % but which ore easily may be concentrated to a higher percentage. A considerable quantity of washstuff was also obtained showing copper to 17.56 %.

The extension of this Bornitebearing closure can not yet be determined with any certainty. In the open end also from examinations made it has been found that the Borniteveins are bounded by a not very shirty variety of Hornslate, forming an about 10 meters wide layer of thinly foliated slate, stretching NE to SW and dipping about 60° NW. In the direction of the strike has been found several smaller Bornite-lenses, which seems to indicate that the new found deposit not is separate. Deeper down has the orevein - as mentioned - been replaced by a permatitic mineral sometimes containing Bornite. The new westerly vein has shown itself to be Bornite - bearing all the way as far as it has been investigated.

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The Bornite occurs besides as fissure fillings also as small lenses or vein in certain zones, which follow the planes of stratification of the Hornslate. It is often mixed with Ironore and is also at certain places aptly or entirely substituted by this ore.

As typical for this kind of ore may be mentioned the deposits in "Snögrufvan" and a cut within the measure "Berzelius" (# 35).

SNÖGRUFVAN.

The ore in "Snögrufvan" forms as a body a large lens having its extension lengthways parallel with the strike of the surrounding Hornslöte. In the open at the South end of the mine is no ore visible but immediately below the surface appears a Bornite-bearing Ironore with a width of a few centimeters. This is widening downward, but is at the same time lowered in grade by Hornslöte, and gradually passing into ore consisting of a grayish black fine slate mixed with quartz, Epidote and Ironore. In this mixture appear streaks of pure Bornite, which, not having any large extension, appear very frequently, sometimes having a length of several decimeters and here and there forming lenses 5 to 10 centimeters in width. The slate show also impregnations of Bornite. This ore had in the old cut a length of 11 meters and a maximum width of 1.19 meters, with an average width of about 55 centimeters. A quantity of ore broken loose 1894 gave after coarse dressing 1:st ore with 18.80 % and 2:d ore with 53.69 % copper.

By going down on the South part of this vein it was found to be rich in Bornite, as streaks lenses and as impregnations for a width of 0.9 to 1.2 meters. Of this width is 0.5 to 0.3 meters very rich on pure lenses of Bornite down to about 1.8 meters below the bottom of the old pit. Here the Bornite percentage decreases very suddenly and Epidote and Ironore become predominating making the copper percentage at a depth of 2 meters very low. By continuing the sinking the mineral was found to grow richer in copper at a depth of 3 meters but here the further continuation of the work was prevented by snowfalls and it could not be determined with certainty if a new lens commenced here or not. By a trial boring, in a direction of 55° downward to the NW from a depth of 1.85 meters, was found a new ore. but neither its extension nor its quality could be determined.

In the direction of the strike have several small parties of ore-bearing mineral been found of the same kind as in "Snögrufvan", but not of so large extension or so rich as these. They are however important because they show that the ore in "Snögrufvan" is not an

isolated deposit, but is a part of an of several larger or smaller lenses consisting orebreak.

By working this mine during the summer 1895 was mined about 10 cub. meters or about 32 Tons of ore. This gave by dressing about 1.9 Tons 1:st ore with a copperpercentage of 14.40 % 5.1 Tons 2:d with 5.48 % and 3.2 Tons 3:d ore with 2531 % copper. Besides these was obtained 6.5 Tons washstuff with 3.95 % copper.

Fig. 3 Sheet 3 gives a view of the two ends in the pit, which was sunk during the summer to a depth of about 2 meters below the bottom of the old pit.

### BERZELIUS 35.

The above mentioned trench within the measure Berzelius consists of Hornslate crossed by small lenses of Bornite and narrow streaks of the same mineral, sometimes having a width of up to 9 centimeters. Here, as in the "Snöskärpningen", is no ore visible in the open South from the trench, except a narrow streak of Ironore, which however lower down passes into pure Bornite. Fig. 4-6 is intended to show the occurrence, at the bottom of the cut, of a very rich body of ore. The above mentioned narrow streak of Ironore can be followed for at least 10 meters southwards, and is partly in the ~~surface~~ surface of the rock very rich in Bornite. For a length of 1 meter is entirely pure Bornite having a width of 1.5 centimeters. The orebearing zone is in the trench about 1.2 meters wide for a length of 3 meters and showed no tendency to diminish by going down 1 meter farther. North from the trench in the direction from the strike is the mineral strip for a length of 19 meters and contains, according to Hult, for the whole length impregnated Bornite and Copperpyrites, although not very plenty. About 50 meters farther in the same direction is a small cut in an ore resembling this, which seems to indicate that here is an orebreak of considerable length, in which the ore however, as in "Snögrufvan", is collected in lenses divided by slate with only little copper. The ore taken from this trench during 1894 was roughly dressed and showed by analyses 16.59 % copper. A specimen taken last summer from the whole quantity of ore obtained here, without it being dressed or shorted at all, gave by analyses

4.93 % copper. A sample from the whole bottom, after finishing the work, gave 6 % and a sample from the ore shown at Fig.4 -b gave 14.3 % copper.

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Besides these two now mentioned orebodies are here in Sjangeli found others of the same kind, of which particularly may be mentioned the one examined in trench # 33 within the measure Berzelius. The orebearing zone is here stript for a length of 7-8 meters with a width varying between 12 and 60 centimeters. A sample of coarsely dressed ore mined 1894 showed 5.53 % copper. This ore may easily be concentrated.

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In this connection may also be described the ore which is found in

FONDSHÄRPNINGEN.

This oredeposit, which was discovered 1893 and consists of almost pure finely grained Bornite, has by investigations during 1894 and 1895 been found to be a collection of narrower or wider streaks of Bornite sparsedly mixed with finely grained Ironore and sometimes widening to 6 to 9 centimeters. It is enclosed in a slate impregnated with Bornite and forms a bed streaking in direction of the strike of enclosing minerals with a width of sometimes 44 cm. and is stript for a length of about 50 meters. Through investigations of last year it has been found that the ore extends in the field to a depth of 1-2 meters even where no ore was to be seen in the open.

The lode is valuable on account of its high percentage of copper. A typical specimen gave 44.37 % and after coarsely dressing loose rock broken during the examination was obtained 1:st ore with 30.74 % and 2:d ore, principally consisting of orebearing slate, with 2.43 % copper.

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An oredeposit with the same character as "Fondskärpningen" was discovered last summer 27 meters North from the South head of Snögrufvan. By blasting here on a 2 centimeters wide streak of Bornite appeared an 8 cm. wide ore of the same look as the one in "Fondskärpningen". It was followed for a length of 2 meters, but time allowed not a closer examination.

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To a certain degree resembling above described oredeposits is the orevein in Skiffergrufvan.

#### SKIFFERGRUFVAN.

This orevein, which follows the strike and dip of the surrounding Hornslate  $\frac{NE - SW}{65^\circ W}$ , consists of partly a narrow streak of sometimes pure Bornite, sometimes Ironore, sometimes of both together in varying proportions, partly of a thinly foliated Hornslate containing Bornite in layers or as smaller grains and narrow lines. The ore has the shape of an elongated lens with a total depth of at one place 1.50 meter. It has been struck for a length of 20 meters, but is probably extended a few meters farther to the North. In the level going through "Grufberget" has the same vein been found on a depth of about 10 meters below the surface of the rock. As before has been mentioned consists the lode of several layers, of different quality. Nearest the hanging wall is a layer of Bornite-Ironore 1 to 3 cm. in thickness, generally rich in Bornite with as high as 24.57 % copper, but also of a leaner kind, with only 2.0 % copper. This Bornite Ironore rests on an about 40 cm. thick layer of thinly foliated Hornslate, of which a large sample by analysis gave 2.48 % copper. This Hornslate is itself resting on a slate of the same kind, but denser, less thinly foliated, and with impregnated grains of Bornite. It is of about the same thickness but showed only 0.5 % copper. Below this is in the North head of the mine a slate 10 cm. in thickness somewhat richer in Bornite and below this again a 14 cm. thick slate pretty richly impregnated with grains and narrow shists of Bornite (a sample of this showed 3.76 % copper). A general specimen taken

9 meters South of the North head of the old pit, from the whole width of the layer ca. 6.2 % copper, while the different layers varied in richness between 0.8 and 27. %. By the investigation of last summer it has been proved that the copper content in this deposit is varying very suddenly both in the extension in the field as well as on the depth, and the ore obtained from here is likely to be of very various quality. But as the vein is generally wide and because the surrounding copperbearing minerals seem easy to concentrate, the deposit may deserve attention particularly as there are reasons to suppose that new lenses of the same kind and nature may be found in the same strike, and the mining of this ore could be done in connection with the exploitation of others in Grufberget occurring deposits.

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The supposition that other oredeposits of the same character may be found in connection with those in "Skifferskärpningen" is based on the conditions found during stripping the rock of earth, which has been performed North from Pit No 52 in measure Adolf to ascertain whether these, with each other similar, ores in Skifferskärpningen and Adolfskärpningen belong to the same layer. It was found that in the same direction of the strike of the mineral in Adolfskärpningen appeared a long row of small lenses of the same kind as the larger ones in question. They occur thus: That when the ore streak is followed toward the strike to the South, the next lens is found toward the west. None of all these small lenses is of any practical value with regard to their size or quality, but their presence is of importance because it is characteristic for the occurrence of certain Sjangeli-ores.

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The ore most common in Sjangeli orefields is Bornite, sometimes with sometimes without a lower percentage of copper glance, in close mixture with Ironore. Oredeposits of this kind are generally sharply defined, mostly through a fissure by the enclosing Hornslate, and form more or less narrow stratified streaks which not always follow the strike and dip of the surrounding slate.

typical for this kind of ores is the one found in

"LANGGRUFVAN".

Fig. 1 Sheet 3 shows a crosssection of the South head of the old cut in Långgrufvan from which clearly is seen that the ore is not forming a regular layer, but has very irregular boundaries against the enclosing rock and does not follow the planes of stratification of this. From the plan of the bottom in the new trench Fig. 1-b North from the old cut is also evident that even in its horizontal extension has the ore not the character of a layer. This ore followed however, as most of the same kind do, the planes of stratification in the Hornslate.

Långgrufvan has in former time been a pretty extensively worked and according to older reports much ore has been mined here. In the pits of the old mine resp. 3 and 9 meters in depth was 1894 found only Ironore in the bottom. North from the mine was found by uncovering the rock an Ironore rich in Bornite having a length of 7 meters and 11-20 cm. in width. During 1895 this stripping was continued Northward as far as possible and a copper-ore was followed for nearly 30 meters from the old mine, having a depth of from 3 to 25 cm. and holding between 0 and 50 % copper. Richer and leaner parts of this vein are alternating. As is shown by Fig. 1-b is there for a length of 5 meters Bornite-Ironore of a depth between 7.5 and 20 centimeters and 10 to 20 % copper or an average depth of 15.3 centimeters and a meanrichness in copper of 16.5 %. A one meter long Ironore without Bornite is then followed by ore rich in copper: 5 - 12 centimeters wide with copper between 12.5 and 20 %, (Single pieces showed 30 % copper) or averaging 10 centimeters in width and 15.9 % copper. Within a distance of one meter from this commences a rich copperore 2 meters in length and 9 - 13 centimeters deep. This is gradually dwindling away, but is followed by a rich Bornite-Ironore which reaches to the North and of the old pits and probably has been crossing over these in the open.

South from the old mine has the vein been followed for 23 m. The vein consists here of Ironore, generally lean in copper or without copper, occasionally rich in Bornite and copperglance.

In the direction of the strike has also been noticed a streak of Ironore, which probably is a continuation of the vein in Långgrufvan. The vein has been followed continually for all length of 80 meters and with a few interruptions for at least 100 meters. The quality of the ore is within wide limits very various both in the field and depth. Through examinations has been found that Iron and copperore appear substituting each other in the same vein in direction of the strike, and old pits show the same conditions on the depth. It is likely that an eventual mining here will give alternating lean and very rich copperores, and that the Ironore in the bottom of the old pits will be followed by copperores deeper down.

Ore mined during 1893 was roughly dressed and gave 1:st ore with 16.75 %  $\text{Fe}$  2:d ore with 7.46 % and 3:d ore with 3.01 % copper.

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Except Långgrufvan has amongst veins of this kind,

"ANNA KAJSA SKÄRPNINGEN"

been particularly examined through trenches and pits during 1895.

This one which consists of Ironore with Bornite and copperglance is now uncovered for a length of 42 meters, of which 20 meters is very rich in copper. Farthest to the North is Ironore on which a pit has been sunk to a depth of 3 meters. In the bottom of this has been bored a 2 meters deep hole from which the borings showed no copper. Even the south end of the vein consists of Ironore without copper, but which much quartz. Within the copperbearing part of the vein is the richness in copper varying between 7.5 and 26.5 % with a width of the ore from 10 to 28 centimeters. Small parts of almost pure Ironore together with very rich copperore appear here and there, partly in the hanging wall of the last, or partly entirely substituting the same.

An estimate gave an average width of 16 cm. for a length of about 20 meters and about 14 % copper.

The vein continues in both ends of the trench as an Iron-ore with no copper. On account of the thick earth covering the vein has not been bored to its full length and it can not be determined whether it again will appear as copperbearing or not. It was found during the work that the vein, which on the surface showed no copper, after a few blasts became rich in Bornite and that the copperpercentage was varying both in the strike and by the depth, and that this deposit thus conforms to all parts with the ore in Långgrufvan.

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Analogous with the Bornite-Ironores are the larger or smaller lenses, very rich in copper, which in larger numbers are found in Sjangeli Orefield and of which following have been more closely examined.

Pit within the measure Berzelius (34).

On a small but very fine and rich ore lens was sunk a smaller pit. The ore formed a 0.65 meter long and at the widest 35 cm. wide lens, which at a depth of 2.5 meters entirely disappeared. The ore obtained from this pit amounted, after dressing, to 0.4 Tons with 22.18 % of copper and a smaller quantity washstuff.

Pit within measure Isak (39).

This vein was discovered in the last part of 1894 and consists of Ironore with very much copperglance. During the examinations 1895 it was found to have the shape of a very abruptly tapering lens, with alternating shists of very rich ore (sometimes 20 cm. thick and 15 - 30 % copper) with others of a mineral more or less impregnated with copperglance or Bornite having a length of somewhat over 5 meters and a width varying between 1 and 73 cm. A specimen taken across the strike at a place where the ore was 73 cm. wide, gave 8 % copper.

At the North ends of these lens has been noticed an other one of copper-glance-bearing Ironore with a length of a couple of meters, but with very low percentage of copper.

Here appears an Ironore rich in Bornite and copperglance of which a sample taken 1894 gave 19.43 % copper. This Ironore is surrounded by a Bornite-bearing slate of which a small specimen gave 6.95 % copper. From investigations during 1895 it was found that the ore forms a very elongated lens 16 m. in length and with a maximum width of 15 centimeters. The most copper is concentrated within a length of 8 meters and the average width can be estimated to 10 cm. The copperpercentage was in four samples varying between 5.5 and 23 %.

Orclodes of this kind, which singly are too small to be worked advantageously, as they likely have no large extension in depth, appear very frequently in Sjangeli Orefields. At an eventual exploitation of the field such small lenses are likely to be found here and there and may then be utilized in connection with other works.

Of special interest is

TORNEBERGSKÄRPIINGEN.

which also was closely examined during last summer. The ore in this pit consists of narrower and wider streaks of Bornite and Copperglance in a mixture of Magnetite, Hornblende a.s.o. The ore streak is stript for 30 meters in length and is more or less rich in copper for 22 meters. The width has in the open been varying between 3 and 20 cm. and has increased somewhat by the depth. Toward the North passes the copperbearing ore into pure Ironore, sharply defined against the surrounding Hornslate. Toward the South it changes into Bornitebearing Ironore which latter passes into Hornslate. Within the same vein is thus appearing Ironore, Bornite-Ironore and slate impregnated with Bornite, which later changes to ordinary Hornslate. The copperpercentage has within the copperbearing part been varying between 5 and 15.5 % by a width of 11.5 to 30 cm.

An approximate estimate gave an average width of 15 cm. a length of at least 10 meters and copper to about 10%. As before has been mentioned is copperbearing Ironore stript for 12 meters farther in this vein, having a width varying between 13 and 30 centimeters and a little lower copperpercentage. From notes regarding this lode is found that, while the width of the whole vein is in the open varying between 3 and 9 centimeters for a length of 8 meters North of the old pit, it is at a very low depth widening to 11-9 centimeters. Immediately South of the old pit, where no ore was visible in the surface, was at a depth of 0.3 found an ore 0.3 meters wide and with about 9% copper. North of the copperbearing part of the lode was sunk a pit to a depth of about 2 meters, without any change in quality of the Ironore could be noticed. Deep soil-covering prevented the farther following of the vein and it can not at present be determined how far the vein goes, or if it farther North again will become copperbearing.

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To the Bornite-Ironores belongs the ore, which, formerly to known, now has been examined during last summer within measure BURMAN (19).

The ore consists here of thin shists and more or less dense impregnations of Bornite in a mineral rich in magnetite, which also itself is impregnated with Bornite for sometimes 0.5 meters in width. The richest ore appears as several long tail laying shists or veins varying between 3.5 and 17 cm. in width and containing about 2 - 15% copper (at an average about 10 cm. in width and 6.6% copper for a length of about 45 meters). The copperpercentage is varying, not only in the strike but also by the depth, so that when at the surface was found an orebearing mineral with about 1.6% copper was a couple of decimeters farther down an ore with 7% copper. At an other place, where a 13 cm. wide ore at the surface showed 5.5% was 3 decimeters farther down the width 9 to 10 cm. with 12% copper.

By working this mine will probably be obtained ore in pieces with 10 to 15 % copper and also a large quantity of Hornslate with impregnations of Bornite having 1 to 2 % copper, which last ore easily may be concentrated.

... is also found ... according to Mr. Huldé these

HERMAN (89-90).

Copperpyrites appears very sparse in Sjangeli and according to what at present is known appears this mineral in any larger quality only in measure Herman, where during 1895 a large stock was discovered by Mr. Huldé.

The copperpyrites is here found in a light coloured quartz mineral as a stratum 0.9 meters in thickness and partly as single impregnations

or partly in smaller lumps, 2-4 centimeters in width. A small specimen from across the strike showed about 6 % copper. An other large

sample from near the East end of the orestreak and collected across the vein, which here is 76 cm. wide, gave 3.5 % copper. Two other samples from an other part, and collected across the 1 meter wide vein gave resp: 6 and 6.5 % copper. A sample from a 20 cm thick layer in the foot wall of the same vein gave 16 %.

A specimen taken from all the loose ore received during the work gave without any dressing whatever 9.29 % copper.

In the hanging wall of this and divided from the same by a thin layer of slate, a few decimeters in thickness, is an other vein of copperpyrites of the same width and length.

East of this deposit of copperpyrites is a partly drusy (sometimes Bornitebearing) Ironore, occasionally in form of round balls enclosed in the slate, which balls are very rich in copper. (One gave by analysis 28 % copper). A few meters to the South of this copperpyrites is an other similar orestreak striking in the same direction and of about the same thickness, which has been followed for a length of about 30 meters.

In the neighbourhood of this deposit have several fine ore lodes been found during last summer. About 9 meters from the old trench (89) was found a stratum of slate rich in Bornite and copper glance, striking in direction NE and having a width of 0.5-1 meter.

The slate is here for a width of 18-20 cm. richly impregnated with the mineral. (A sample gave 10 %, but after a little blasting became the ore very much richer). About 40 meters NE from here in the direction of the strike was noticed a similar layer of slate although leaner and having a width of 1 meter. 18 meters Sw is also found slate impregnated with Bornite. According to Mr. Huldé belong these three finds to the same layer, which then should have an extension of at least 60 meters.

About 10 meters from the old pit has been found slate ~~bornite~~ with both impregnations and 2.5 cm. wide stripes of Bornite. It is 10 cm. in width, but was widening deeper down to 20 cm. and could be followed for 2.5 meters toward the west. A sample showed 8 % copper.

In the old cut (89) is a lens of fine Bornite in Magnetite - bearing slate impregnated with Bornite and Copperpyrites. A specimen of ore from this cut gave 25.93 % copper.

From what is said above may be concluded that important ore-streaks are to be found within measure Herman. Their extension is however very little known as they were found at the end of August and immediately occurred snowfalls prevented their farther examination.

These discoveries of new Orelodes seem to indicate that, although Sjangeli has been known for a long time and although active investigations of the field have been going on, especially during last years, still new and important oredeposits may be found here. In this connection I will refer to two discoveries made at Grufberget during the last day of our stay in Sjangeli. In the steep wall, which to the Southwest forms the boundaries of Grufberget, have long ago been noticed single spots and impregnations of Malachite. By a closer examination were several shists of a slate richly impregnated with copperglance found, having a width of about 0.5 meters. (A sample showed by analysis 7 % copper). An other ore of the same kind was found outside of the old drift, since a large snowheap which probably had been lying there for many years had melted away. A sample of this ore gave 6 % copper. Time allowed not a closer examination of any these new discoveries, sometimes with a perfectly new appearance. These greenstone

UNNA ALAKATS.

A territory, about 3.5 Kilometers South West from Grafberget in Sjangeli and 1 - 2 Kilometers East North East from Stonemark # 263 has during our investigations this year been found to be particularly interesting both from a scientific and a practical point of view, because a comparatively large number of oredeposits occurring here are of a very different nature from those in Sjangeli. Only one lode of any importance was known here before, within the measure Karl. By Claims Folke, Gustaf, Oscar and Pelle had been secured a territory in which a few insignificant copper impregnations had been noticed. During our investigations this summer where - as before has been mentioned - several new lodes discovered, both within and outside the old measures. Most of these seem to be very promising both on account of the richness of the ore and on account of their extension. These new deposits have all been secured by Mr. Jacobi through the measure Elias, Edward, Josef, Victor, Erik, Paulus, Marcellus and Julianus.

A geological map was drafted last summer over the whole territory between the high ridge Ruopsokpakte (Rosoka) and Unna Alakats, containing an area of about 5 1/3 square kilometers running (2.85 Km. ENW - WSW by 1.96 Km NNW - SSE), East from the frontier to Ruopsokjokk. All outlines of lakes, rivers and measures and all other points on this map were measured by Mr. Huld by the aid of a distance-tube.

In the valley between Ruopsokpakte (Rosoka) and Unna Alakats appear a large number of small hills separated from each other by narrower or wider earthcovered belts. Here passes Abiskoelfven, which at its upper course is called "Kmajokk", to Torne Trask in many windings and turns. At the west side of the map in the watershed between the Atlantic and the Baltic Sea. The origin of Kamajokk is one, just outside the lower corner of the map from Stuur Alakats abruptly falling small rivulet, which divides into two branches of which one runs into Tjonojärvi and from there through "Nordelfven" to "Ofotenfjærd", while the other is Kamajokk.

Within this territory occur Hornslate and Greenstones of very various look, sometimes with an evident shisty structure, sometimes with an perfectly massy Dolomitic appearance. These Greenstones

and Hornslate from a stratum about 1 Kilometer in width, which toward North East connects with the Hornslate in Sjangeli Orefield. In the slate which particularly in the westerly part are richer in narrower or wider layers of Limestone, appear lensformed bodies of entirely massy Dacnite.

The strike of the minerals within the territory is NE - SW. The dip is toward the West. The above mentioned Hornslate minerals are covered by a pretty thick layer of Limestone, which again is covered by a Kurite resembling mineral belonging to the slates. This mineral is toward the East only a few meters in width, but widens toward the west to a couple of Kilometers at the same time it shows a recurvation of the stratum. The strike is in the westerly part toward NNW. North East of this slate is a very large layer of Limestone, which also is very curved and to the west is bordered by Granite and Gneisy minerals. The orebearing Hornslate rests on pretty finely grained Gneis, which itself is resting on a bed of the ordinary Hornslate occurring in the Scandinavian mountains.

The creveins within this territory are - as can be seen on the map Sheet 2. - found principally at the foot of Unna Alakts Souteast from Kamajokk. The ore consists here of copperglance and Bornite more or less richly impregnated in a thinly foliated sometimes Chloritic Hornslate, which often appears at the confines of the, in the ordinary Hornslate frequently appearing massy Greenstones, but also has been noticed as regular layers in the same. The bounds between the massy Greenstone and the Hornslate are often very difficult to distinguish and the former are only marked on the map when they distinctly through their structure or mineral composition differ from the same. The Greenstones have often an appearance which coincides with the shisty structure of some of the Hornslate. Those occurring in the very orebearing territory are either partly or entirely of quite different look from the ordinary generally Diorit-resembling Greenstone, as they are lean in dark minerals, is finely grained, and contain Magnetite and Bornite as Impregnations. They sometimes change into ordinary Greenstone, but have also been noticed as regular vein in the same. The ore seems to appear in close connection with this variety of lighth coloured Greenstones and on several occasions it has been

the presence of this which has led to a closer investigation with positive results.

In the following is given a description of all orebodies, which until the end of 1895 have been discovered at Unna Alakats, arranged according to the Claims within which they occur.

#### PELLE and JULIANUS.

Within the first mentioned measure is a very old pit (1) in a slaty mineral  $\frac{N 40^{\circ} E}{NW}$ . Only a small lens of Bornite has been found here. At the point Pell is a slaty mineral with single stripes of quartz and spots of Malachite. It is very little striated.

A few meters outside the measure Pelle was found slate with plenty lines of quartz and Bornite (2). The mineral which is striking  $N 60^{\circ} E$  is uncovered to a width of 2 meters. The total extension lengthways is not known. This lode is covered by measure Julianus.

#### MARCELLUS.

Here appears several new deposits of which none has been examined. Near the foot wall of the Limestone is a slaty body with spots of Malachite (3) in a Diorite-resembling Greenstone. West of this has for a length of about 25 meters been noticed a mineral which contains numerous grains of Bornite (4). Farther to the west near the border of the measure is a layer of slate striking  $N - S$  and dipping steeply toward West. This slate is rich in Bornite and Copperglance (5). Somewhat North of this has been seen an orebearing slate, not marked on the map. At the western edge of the measure is a quartz-resembling layer, with some Bornite and Malachite on fissure surfaces (6), in the immediate neighbourhood of the foot wall of the Limestone.

#### OSKAR.

Within these measure has no ore been found.

#### GUSTAF.

In the east part of this measure is a Bornite bearing slate (7) striking  $N 5^{\circ} E$  and steeply inclined toward the West. Immediately south from here is an old pit (8) in Hornslate, which contains

Bornite in narrow stripes and also a across running fissure filled with quartzite and Bornite.

At the north shore of the little lake, which almost entirely lays within the measure, is an old pit in the steep slope, but without ore. Above this pit was during the work this summer found a slate (9) rich in Bornite, partly as impregnations, partly as sometimes several cm. wide, shists. Analysis of a sample gave 44 % copper. The depth of the orebearing slate was here 1.4 cm. and it could be followed for a length of 10 meters (Somewhat East from here has also been seen an orebearing slate of unknown extension and richness). A specimen collected across the strike gave about 2.5 % copper. Through dressing, this ore could be brought to a higher percentage of copper and besides there will be obtained a certain quantity of ore suitable for concentration.

Near the westerly part of the measure is seen a Bornite bearing slate below a mountain wall (10), which not is known to its extension or richness.

Immediately North of the measure has orebearing slate been noticed (11) at both edges of the earthcovered low ground between two hills. Whether the whole distance is orebearing (in which case it should be 23 meters wide) or not could not be determined.

and partly in a ... direction (12), but these finds have not yet been examined.

KARL.

The middle and the South part of this measure consists of a partly perfectly massy partly dioritic mineral forming a small hill with generally steep sides. Around this hill passes a thinly foliated mineral rich in Bornite and copperglance having various depth and often disappearing under the hill. This slate is not rich enough to be of any value. The orebearing of slate (12) a few meters NorthWest from the hill is rich and has been worked. At the beginning of 1895 was the vein stript for a length of 10 meters with an average width of about 1.20 meters. The ore from last year was roughly dressed and gave 1:st ore with 5.37 % - 2:d ore with 3.24 % copper.

As it was considered important to find out the condition of one deposit here in Unna Alakats, both regarding its extension in field and depth, thus enabling one to form this judge other

similar here occurring lodes, several trenches were dug and blastings both in the surface of the rock and toward the depth, were performed here. Through this work it was established that the ore vein consists of alternating parties richer or leaner in Bornite, of which the former generally are found in the middle of the vein (XXXX or more often appear in the foot than in the hanging wall) having a width of 1-4 cm. Four specimens from different places across the strike of the vein, 1.1 - 1.7 meters in width showed resp: 11.0 - 9.3 - 7.5 and 7.5 % copper, while the copperpercentage in three samples from from the foot, amounted to resp: 3.8 - 2.0 and 2.5 % and from the hanging resp. 3.3 3.1 and 1.8 %.

The vein has been uncovered for a length of 22 meters and to a depth of 5-6 meters under the surface, without showing any remarkable changes regarding either width or copperpercentage.

In the western part of the measure at the edge of above mentioned hill is a thinly foliated slate rich in Chlorite and with impregnations of ~~Sphaxx~~ Bornite.

The same material is also occurring at the North shore of the lake with FOLKE. None of these finds have been examined.

Within this measure has Bornite bearing slate been noticed, partly in direction of the strike of above mentioned slate (14) and partly in a Northerly direction (15), but these finds have not yet been examined.

In the northern part of the measure occurs a chlorite bearing slate with small pieces of quartz. (16) Like what is found

All below cited oredeposits have been discovered during the summer 1895 while surveying for the drafting of the map Sheet 2.

All contains a variety of partly secondary distributed minerals. PAULUS.

For the examination of a before noticed thinly foliated slate (16) the rock was stripped of the soil at the edge of a small Hill. A fine ore was found here, which may be of importance at an eventual exploitation of Unna Alakats. The orebearing slate strikes N-S and dips about 70° west. It can be followed for a length of about 60 m. and is in the pit about 2 cm. wide. The ore consists of copperglance with secondary Bornite and Magnetite partly as small impregnations in the slate, partly in the form of round flattened or beanshaped

aggregates of these minerals, which aggregates easily can be distinguished from the surrounding soft slate. By analysis such a bean was found to hold 43 % copper. For finding out the quality of the ore in the direction of the strike was about 20 meters south of the first cut sunk an other pit. Before the blasting was in the surface of the rock noticed slate that was more than 1.20 meters wide and contained a 9 centimeters wide layer of copperglance of the same kind as in the above mentioned small lenses.

This deposit seems to be very valuable as the orebearing slate has larger extension in the field and also is of considerable depth, at the same time it contains very rich ore. Further examinations are however necessary to determine whether the slate to its whole extension is copperbearing to the same degree as here or not.

#### ERIK.

North of the Pointis found slate with Bornite and Copperglance (17). The same mineral is also occurring at the North shore of the small lake within the measure. None of these finds have been examined. The quartz appearing within this claim and at "Josef" contains sometimes Copperpyrites and Sulphurpyrites in small quantities.

#### JOSEF.

In the southwesterly part of the measure occurs a Bornite bearing slate with small lenses of quartz. (18) like what is found in the large pit within measure Karl.

In the northwesterly part of the measure is a small steep hill consisting of partly a massy partly a slaty dioritic mineral. Round this hill runs a thinly foliated rock (19) consisting of quartz, Chlorite, a.s.o. with grains of sulphurpyrites and Bornite and a couple of streaks of Ironore lean in Copper.

This orebearing streak can be followed over 100 meters in length and connects probably with the fine ore in measure Edward described below. The depth is various and amounts sometimes to 3 to 4 meters. This vein has not been examined within territory Josef.

Through the middle of this territory runs, in an East to Westerly direction, a vein (20) 0.7 to 0.1 meters in width and consisting principally of copperbearing Ironore. It is not entirely uncovered and has not been closely examined.

In the East part of the measure is a somewhat Bornitebearing slate (21).

At the mouth of the small river Kamajokk were found two large loose stones with very fine Bornite and copperglance. This seems to indicate that such ore is to be found in the neighbourhood. The soil is here very deep and rendered examinations difficult, but in an about 0.5 meters deep trench was found a slate rich in Bornite (22) striking N 25° E and dipping 60° NW which seems to indicate that here is a deposit of ore. The quality and size of the same can only be determined through more extensive work.

EDVARD.

Farthest North toward the NV border of the measure has been noticed Bornitebearing slate (23).

At the south edge is the continuation (24) of the orebearing slate coming from and passing around the small hill in measure Josef.

On a very insignificant streak, just North of the above cited, was the 10:th of August through a small blast uncovered a vein of almost pure copperglance 7 centimeters in width. By farther blasting it was found to be a following dimensions and quality:

- 6 cm pure Copperglance (with 38-52 % Copper)
- 9 " slate richly impregnated with Copper.
- 10 " " sparsely " " "
- 75 " Hornslate
- 9 " Slate richly impregnated with Copperglance.
- 16 " Hornslate
- 35 " Slate richly impregnated with Copper

about 160 cm. glance and containing 2 - 3 centimeters wide stripes of almost pure copperglance.

A specimen from across the whole 1.6 centimeters wide vein gave by analysis 6.2 % Copper.

Toward the South the vein is stript for 6 meters then again covered by earth. Between 9 and 20 meters in the direction of the strike is an ore uncovered of the same look as the above, with Copperglance richly impregnated in the slate for 0.8 meters the sparse impregnations of the same mineral for 1 meter. From 20 to 27 meters is covered by earth. At 36 meters appears again slate with impregnated copperglance to a depth of about 2 meters.

This lode seems to have large extension in the field, particularly as it probably connects with the above described orestreak in measure Josef.

#### VIKTOR.

In the southwesterly part of the measure is the Hornslate crossed by a quartz lead (25) 2 - 4 centimeters wide and with lumps of Bornite.

In the westerly part is a slate comparatively richly impregnated with copperglance (26) but the extension of the same has not been determined.

On the shore of the lake, extending within the northern limit of the measure, was noticed a large stoneblock with a particularly fine streak of Bornite and Copperglance in a mineral impregnated with finely grained Copperglance.

This block originates very likely from the nearest surrounding.

East from here at the waters edge is a fine copperore (28) much resembling the above. The ore was found to be slate impregnated with Bornite having a depth of 20 - 45 centimeters and one ore two 3 - 7 centimeters, sometimes 20 centimeters, wide shists of principally Bornites holding 28 % copper. The richest slate varies in width between 5 and 20 centimeters, and a sample gave 10 % copper. The leaner slate showed somewhat over 2 % copper. The vein is at present stript for a length of a about 2 meters from the shore, but is probably farther extended.

East of this lode occurs, in slaty parties (29) of the light-coloured surrounding mineral, Bornite as grains and small lenses.

North from here at the North shore of the lake is a 0.3 meters wide party with impregnated Bornite and a Bornitebearing quartzlead.

" RUOPSOKJARVI.

Near the South shore of a forementioned lake, located about 3 kilometers west from Sjangeli, are strong compassindications of magnetic Ironore. The ore reaches up to the surface of the rock. This territory which is secured by measures Stina and Greta was surveyed by Mr. Huldé and a magnetic map was drafted during August 1895. From this is seen that there are two different ore-streaks of which ~~the~~ <sup>the</sup> westerly one has a length of 100 meters. The magnetic map shows also that here is not a collected body of ore, but a system of scattered lenses or glands. Both the ore and the enclosing rock contain frequent impregnations of copperpyrites and Magnetic pyrites. Fine pure Bornite was also found last summer at two places within the measure.

Southwest from here was found a layer rich in Bornite, having a depth of 1.19 meters and striking N 30° E, laying in dense Horn-slate. 50 meters from here toward South West in the direction of the strike is a layer rich in Magnetite, Copperpyrites and Sulphur-pyrites probably connected with aforesaid layer.

These deposits have not been examined but seem, on account of occurrence of Bornite, to deserve a closer examination.

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Report no. 3916

The purpose of the survey was to determine the extent of the ore deposits in the area of Sjängeli. The first plate of the map was made in 1895 and the second in 1896. The purpose of the survey was to determine the extent of the ore deposits in the area of Sjängeli.

ORE DEPOSITS OF SJANGELI.

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Valfr. Petersson.

1896

The purpose of the survey was to determine the extent of the ore deposits in the area of Sjängeli. The first plate of the map was made in 1895 and the second in 1896. The purpose of the survey was to determine the extent of the ore deposits in the area of Sjängeli.

The object of the survey which I and Mr. G. Thorell have made this summer, on the request of Mr. Alwin Jacobi, has been in the first place to examine more closely the copperore deposits, found in 1895 at Unna Allakats, and to continue the geological investigation of the region around Sjangeli, for ascertaining whether new orebodies, analogical with the already known, were to be found or not. Besides this, a more thorough work has been carried on on a couple of typical deposits within the Sjangeli field, for better finding out the nature of the Sjangeli ores than earlier more superficial work has enabled one to do, and finally for continuing as far as time allowed, a topographical and geological detailed map, commenced by Mr. Lundbohm in 1894 at Sjangeli and by myself in 1895 at Unna Allakats over the orebearing territory.

In accordance with this plan for the summer we worked principally with the ore of Unna Allakats, in Snögrufvan and in Anna Kajsa grufvan at Sjangeli, at the same time as a smaller work was carried on at Ruopsuokjaure and at the orefield at Valfojokk, discovered in the summer. The work was followed step by step by both of us, and in the first place we drafted detailed maps, showing the principal oredeposits and also a larger topographical, geological map in the scale 1:4000, embracing all oredeposits belonging to Mr. Jacobi, which are situated in these regions. Within the limits of this map we find all before mentioned maps of Sjangeli / by Lundbohm in 1894 /, Unna Allakats / by myself in 1895 / and Ruopsuoks measures / by Auldt in 1895 /. During this time I made longer or shorter geological excursions, while Mr. Thorell made numerous determinations of copper in the colorimetric way, serving to lead the work. He also had charge of the dressing and cleansing, of the taking of general samples and the weighing of some profiles s.s.o. The following is a report of the results of these investigations, and following maps are appended, made by us during the summer:

Sheet 1. Sketch of a geological map over the region of the ore-field of Sjangeli; scale 1 : 50 000.

Sheet 2. Geological map over the orefields of Valfojokk, Sjangeli, Unna Allakats, Ruopsuokjaure and Ruopsuok; scale 1 : 4000.

Sheet 3. Map over Valfojokk and the N.W.E. part of Sjangeli. With lengthprofile; scale 1 : 4000.

Sheet 4. Detailed maps over oredeposits at Unna Allakats.

1 / Rostgrufvan and others; with levelled curves / equidistance of 2 m. /; scale 1 : 800.

2 / Böngrufvan; scale 1 : 60.

3 / Epsilongrufvan, scale 1 : 4.

Sheet 5. Detailed maps over oredeposits at Sjangeli and Valfojokk;

1/ The measure of Mathis in the orefield of Valfojokk; scale 1 : 800.

2/ Långgrufvan, South pit; scale 1 : 32.

3/ Anna Kajsackärpningen; scale 1 : 80.

4/ Snögrufvan; 1 : 80.

Time has not allowed a complete geological investigation, but sufficient material has been gathered for drafting a geological map over the Sjangeli and its neighbourhood, enabling me to append a sketch / Sheet 1. /. This may be sufficiently detailed and sufficient for practical purposes, regarding the Swedish part of the field. On the Norwegian side, on the contrary, observations cannot be marked on the map with any degree of correctness because of the lack of available cartographical material.

This report is not the right place for a detailed description of this map, and I therefore confine myself to giving an account of the most important results of the geological investigation, taken from a purely practical view.

The copperores within the territory in question are always bound to a black greenish, fine-grained, sometimes thinly foliated hornslate, differing in this respect from other within the field appearing hornslates, called "Sjangelislite". In this Sjangelislite, striking N.W.E.-S.S.W with more or less steep dip

toward N.W. There appear partly narrow layers of Limestone and partly massy Gabbro as in the direction of the strike elongated lenses. The copperores are always found in the very Sjangelislite and not in the Limestone or Gabbro.

The Sjangelislite appears in several separate parallel layers, of which the principal is "Sjangelistrecket", which runs from the N.W. foot of the ridge of Unne Allakat over the orefield of Sjangeli, on the South slope of the Sjangelitjåkko and further is seen in the valley of Valfojokk N.E.E. of Sjangeli, being thus known on a length of about 7500 meters and a width of about 600 meters. In this streak there appear numerous and partly considerable oreveins within the orefields of Unna Allakats, Sjangeli and Valfojokk.

An other layer of Sjangelislite, goes over the southern part of Ruopsuokjaure / = Kosokajärvis / and probably stretches toward N.N.E. over the Sjangelitjåkko to the S.E. slope of Jerbele and has thus a length of more than 6000 meters and a width of about 250 m. Its extension westward is not known. On this stratum the orefield of Ruopsuokjaure is located. There have also been made small founds of bornite on the N.E. slope of the Sjangelitjåkko; they seem to be valueless, but are important, because they show that the Sjangelislite is orebearing, even in places where no larger oreveins have hitherto been found.

It is not unlikely that a third stratum of Sjangelislite is located further northwards, as a Sjangelislitelike mineral with single grains of bornite has been noticed at the East foot of the Jerbele, but if so or not, could not be determined during this summer.

The above mentioned "Sjangelistrecket" is resting on gneis and Euritikal and amphibolic slate. It is covered with Limestone and a lightcoloured hornslate, partly containing lenses and lumps of olivinstone and magnetite, but free from copperminerals. "Ruopsuokjaurestrecket" rests on above mentioned olivinstonebearing Hornslate. It is overlaid by an other kind of Hornslate and by rusty and Euritikal slates.

Both towards N.E., E. and S.E. as W. / in Norway / these minerals are covered by an other series of minerals of entirely different kind and partly different appearance. While the former are entirely crystalline with upright shists, the latter consists of argillite sometimes gneissoid, apparently clastic minerals, argillite, and sparagmite and conglomerate, all with sometimes horizontal or slightly inclined shistsq having in the main a North-Easterly dip. This series of minerals always rests on a conglomerate of quartz or a black sparagmite, which lies as a roof over and abruptly cuts the lower vertical shists of Sjangeli=slate and analogical minerals, showing an apparent discordance.

These nearly horizontally lying minerals which form the tops of the peaks around Sjangeli, are as far is known at present without copperminerals. This is an important circumstance to know at further search for oredeposits within these regions.

By a detailed study of the relations of these minerals to the rock on which they are resting and also of their general strike and dip; it has been possible to determine the boundaries within which ores of the Sjangelitype may be successfully found, and a new orefield / that of the Valfojokk / has also been found and its connections with the Sjangeli field established.

In order to show by examples the value of the geological investigation in general and particularly the found discordance from purely practical point of view we give here a detailed account of the discovery of the orefield of Valfojokk.

On the 4:th of August this year, about 3 km. N.N.E. from the orefield of Sjangeli, in the valley of Valfojokk, during a geological excursion, there were found the same minerals as those which are copperbearing at Sjangeli and Unna Allskats. By a closer investigation of the surrounding within which these minerals occurred there was found a number of copperorelodes of the same kind as those which before are known as orebearing from the two above mentioned orefields. Here as well as there the ore principally consists of Bornite, often with more or less copper=glance, partly on a close mixture with ironore as borniteironore, partly as more or less well defined oreveins in the Hornslate.

Besides this an ironore, rich in sulphur and copperpyrite, occurs in numerous smaller veins. Also bornite in smaller, single lenses or as middlemass in a peculiar breccie, and at least also together with copperpyrites in quartz. Thus almost all the different kinds of ores, which are found in the before known orefields, reoccurred here. These new veins, occurring in Sjangelislate, lie straight in the direction of the strike of the Sjangeliores. The analogy with Sjangeli is also seen from the appearance in the slate of narrow alyers of limestone and small lenses of Gabbro in the Sjangelislate, which also is covered by the same lighth coloured Hornslate as in the northern part of Sjangeli. In the south part of the field there also appears the same coarse ocellated granite as on the south east of Sjangeli. - In the meantime there is no connection in the open between the Sjangelislates of Valfojokk and of Sjangeli. The ridge between the two orefields consists of argillite and gneissoid, nearly horizontally lying minerals. Continued Geological investigations however showed that these were resting discordant on the orebearing slates, belonging to a considerably younger formation, and evidently stretching below the former, connecting the orebearing slates of Valfojokk and of Sjangeli to one continuous layer, covered by younger minerals, belonging to quite another series.

The valley of Valfojokk is bounded from the north to the south by very steep, almost perpendicular, rocky walls. Both the north and the south wall consists of almost horizontal shists of argillite or gneissoid minerals, resting on a black or darkgray sparagmite, sometimes changing into a coarse conglomerate of quartz. This rests discordant on the towards N.W. more or less steeply inclined, Hornslates, which in several places are continuing with unaltered strike and dip below the horizontal layers, north towards S.S.W. and N.N.E. It is therefor likely that the orebearing slate runs farther towards N.N.E., but how far and to what degree this may be the case can not be determined by the means at our disposal at a geological investigation. At an excursion towards the north to the valley of Håikamajokk, running parallelly with that of Valfojokk, there were only found younger

The breaks in the open between the orefields of Valfojokk and of Sjangeli being caused by a discordance and the probability of the minerals enclosing the copperores forming a continuous layer between these orefields, leads naturally to the supposition that the part of the stratum which is covered by younger minerals also is orebearing like those parts which have been open to examination. The circumstance that the Sjangelislite almost everywhere, where it is found, is more or less copper-orebearing seems to justify such a supposition; but if the ore is to be found in such quantities as to pay an eventual search for it, that is impossible to say.

S J A N O E L I .

Two deposits in this have only been subjected to investigation, viz. Anna Kajsagrufvan and Snögrufvan, besides which smaller works to some degree have been done in Långgrufvan and some other places. The object of this work has been to find out how the more known typical deposits appear deeper down and in their extension in the field, and thus by mining and dressing ore on an larger scale to determine the available quantity of ore at an eventual exploitation.

ANNA KAJSAGRUFVAN.

On this deposit there has been sunk a pit, 3.5 m. deep, 4 m. to the South of the south end of the most bornitebearing vein. The pit was extended sideways to a depth of 3 m. in both end of the veins. It went on in copperfree ironore, 3.5 m. of depth, where bornite ironore was found, which however not was examined. At the mining the ore proved to be much richer in the north than in the south part of the cut, and the obtained quantities were dressed separately. During the three weeks the mining was carried on there was loosened in the north part 11.5 cbm. solid rock, of which 2.0 cbm. was gauge. 9.5 cbm. was ore, giving 1.20 tons 1:st ore with 23 % copper, 0.42 tons 2:nd with 5.75 % copper, 2.53 tons 3:d ore and 1.85 tons washstuff. From the south mining, which partly was driven in copperfree ironore there was obtained 26 cbm. solid rock, giving 17.18 cbm. gauge, 8.82 cbm. orebearing rock, which gave by dressing 1.14 tons 1:st ore with 11.74 % copper, 1.80 tons 2:nd with 5.41 % copper, 2.11 tons 3:d and about 4.62 tons washstuff. The 3:d ore holds about 1.7 % copper, in conformity with the analysis of a sample from the whole mine. A general sample from the whole mine of the washstuff showed 1.67 % copper. Both these are suitable for concentration.

The ore has the same length deeper down as in the open, that is 20 m., but shows a very apparent inclination in the field of 51° of the strike towards S.W. / See the lengthprofiles on the detailed map sheet 5 /. In the direction of the strike towards

S.W. there was found a new bornite ironore, 3.5 m. deep below the surface.

Concerning the quality of the ore the following is to be added in the copperbearing part of the vein there can be distinguished several parallel zones, in the middle a copperrich ironore with 10-12 and up to 30 % copper. On one or both sides Hornslate, more or less rich in grains of bornite with 5-6 and down to 1.5 % copper; sometimes there appear two narrow shits of ore, rich in copper, separated by ironore or bornitebearing slate. The north part of the ore is much richer than the south one. The richest copperore swells out to 24 cm. in width, while it generally is 4-5 to 10-11 cm. wide. The detailed map on sheet 3 gives a view of the variations of the orevein in width and copperpercentage.

#### LANGGRUFVAN.

Having stated in my report of 1895 that although the bottom of Långgrufvan only contained ironore, the copperore may be found deeper down, I had the south pit sunk deeper this summer. The ore was first tapering out, and 1.8 m. below the old bottom it was only 2 cm. wide. Here the ironore began immediately to widen and grew bornitebearing. 2.5 m. down / or 12 meters below the mark on the east edge of the pit / the bottom was as shown by fig. 2, sheet 5. In the N.E. head there is a very rich bornite ironore, 13 cm. wide, surrounded by a 3 cm. wide shist of ironore, less rich in bornite, but richer in epidote. The bottom consists of bornite ironore, varying between 27 and 16.5 cm. in width, richest in the N.E. and pretty lean in the S.W. The S.W. head consists of ironore with a small quantity of copperore nearest the bottom. The orebearing party thus seems to be dipping towards S.W., which is analogical with the conditions of other deposits such as Anna Kajsagrufvan / see foregoing page /, Skifferskärpingen a.s.o. At a depth of 1 m. there was obtained a smaller throw / see fig. /.

When it thus had been found that the copperore continued below the bottom, the work was discontinued.

SHÜGRUEVAN.

In this mine, where last year the work was carried on on a large scale, it has this year consisted in sinking the pit and driving a level. During the first part of the summer the old pit was sunk 3.05 m. in hornslate with little or no ore. A small lense in the hanging wall, already noticed last year by trial drilling, was found, but proved to be of no importance. By going down to 3.65 m. there was found in the north wall a very rich copperore of the same kind as the one in the open. The sinking having been continued 6 m., or, to a depth below the mark of 11.4 m., a level was commenced driving N.E., on this vein, and it was driven about 8 m. during the summer on a vein of varying depth and copperpercentage, as shown by fig. 4, sheet 5.

The ore has generally been very rich, consisting either of richly impregnated grains of bornite in hornslate with epidote or narrow or wider streaks of bornite, 2-3 or 6-10 m/m wide, alternating with lean or bornitefree slate. Besides is the hornslate in the hang of the vein finely impregnated with bornite to a width of 10-20 cm. When the ore first was found in the north wall it was about 10 cm. wide, with very frequently appearing 1-2 cm. wide stripes of bornite. A typical piece of this ore gave by analysis 14.5 % copper. By going down 1.5 m. farther, the ore had widened to 40 cm., of which 20 cm. rich and 20 cm. lean nearest the foot wall.

Besides this ore there was found a lense of copperpyrites, more or less finely impregnated in the hornslate, which here was containing pretty much quartz and epidote. It was lying on a depth of 9 m. in the S.W. part of the pit. A typical piece gave by analysis 3.5 % copper. The orebearing body had a length of 1.1 m. and a width of 0.3-0.4 m., and is still left in the bottom and the walls of the pit. Possibly there is a connection between this vein and an orelense of copperpyrite and bornite in the west wall of the level, 4.5 cm. wide, but with unknown length.

The ore taken from the first 4.3 m. of the level gave by cleansing:

0.194	tons	1:st ore	with	20.30 %	copper
1.10	"	2:nd "	"	9.27 %	"
2.62	"	3:d "	"	1.23 %	"
21.61	"	washstuff	"	0.60 %	"

The 3:d ore was formed by larger pieces and could not with available appliances be cleansed very carefully. After further crushing and dressing half the metallic percentage could be obtained in an ore with 5 % copper. The washstuff may also easily be concentrated.

As a comparison to these results may be remembered that Lundbohm in 1894 from 128 kg. ore obtained:

42 %	/	53.8 kg.	/	1:st ore	with	18.80 %	copper
58 %	/	64.2 kg.	/	2:nd "	"	5.69 %	"

and that the ore taken up in 1895 gave

1.80	tons	1:st ore	with	14.40 %	copper
5.1	"	2:nd "	"	5.48 %	"
2.2	"	3:d "	"	2.31 %	"
6.5	"	washstuff	"	3.95 %	"

Besides above great works on a larger scale following smaller works have been carried out during 1896 within one ore-field of Sjangeli.

#### SNÖGRUFVAN.

This mine has formerly been worked. It is located within Burman on the south shore of Sjangelijokk and is marked on Lundbohms map with N:o 20. It was emptied on the later part of the summer. The bottom and the walls are almost without copperore, but old heaps of refuse showed that here was a deposit of the same kind as that of Snögrufvan. As the examinations of Snögrufvan have shown that several crelenses were located close to each other, we decided to investigate, whether the same conditions should exist here too, and from the bottom of the mine there were therefor drilled several holes in different directions.

The borings were collected for every 0.3 m. of the depth of the hole and were tested for copper. At one of these holes driven in the plane of strike and dip of the hornstone  $N 52^{\circ} E$  and with an inclination of  $87^{\circ} NW$  copper was found already at 0.3 m., which lasted to a depth of about 2.4 m. At 3.5 m. there was again found copper which lasted to the bottom / 4 m. / . On account of these experiences the bottom of Karlsgrufvan was sunk deeper, and after 0.25 m. there was found a fine ore of the same kind as that of Snögrufvan. After another sinking of 0.45 m. there was ore all over the whole new bottom to a width of 0.3 m. and containing 2-3 cm. wide lenses of pure bornite.

Further investigations regarding the new ore could not be made for want of time. Above description proves however that this mine / in older reports considered to be one of the best in Sjangeli / still contains ore, and this is not exhausted, as has been supposed in later times. That the ore has been of good quality and of considerable quantity appears from the reports given by Busch in 1842 and by Ekenstam in 1845. Ekenstam found this deposit so promising that he recommended the work to be carried on with as many men as comfortably might be used to work on the place.

On the 27:th of August to the south of Karlsgrufvan there was found a fine vein of bornite ironore most rich in copperglance, of the same kind as in Anna Kajsgrufvan. A small cut was made on the vein, stripping the ore for a length of 32 m. and a width, sometimes amounting to 20 cm. The copper-percentage is partly very high.

The deposit of copperpyrite found last year in Herman has been stript this year 4 m<sup>8</sup> further towards the south having the same width, but higher copperpercentage than before, 2 m. to the East from this vein there was found in the later part of the fall a vein, rich in copperglance and bornite, having a width of 0.25 m. and with unknown length.

Within Ellen, Jacob, Anna, Alma and Maximus there have this year been found new deposits mor or less rich in hornite, but which have not yet been subjected to any closer examination.

As the numerous lately discovered more promising deposits made in 1895 on the south side of Kamajokk on the northwest-slope of the ridge of Allakats had not been subjected to an investigation, this summer's work was concentrated here, and a great part of those that were found last year, with some new ones, were examined by blasting and digging of trenches. It was considered better concentrating the work on a few typical deposits than making superficial investigations in numerous places. This is the cause why many of the in reports of last year mentioned veins have not been examined this year.

The greatest part of the work at Unna Allakats has been done in the measures Edward, Josef, Victor and Paulus. In the summer there was made a minesurveyor-map with levelled curves / equidistance of 2 m. / over those places, which is appended on sheet -4.

A here and there copperbearing stratum of chlorite-hornblende runs in a curved line from the S.E. part of the measure of Edward through the North part of the measure of Josef to the south part of the measure of Victor. This stratum / N:o 19 on the map over Unna Allakats of 1895 / has during these two years been stripped on a length of 160 m.

In the measure of Edward near the South shore of Kamajokk there was toward the end of the work of 1895 found a rich vein of ore, consisting of copperglance. / See my report of 1895 /. In the direction of strike towards the south there was at that time made a blast, which proved that the orebearing mineral reached farther toward S.E., at the west foot of the rocky hill. The work was continued this year around the south side of this hill, to the measure of Victor and by those investigations following facts have been known.

In the measure of Edward the work of last year / N:o 24 on the map of 1895 / has been continued by blasting. It then was found that the orebearing parties mentioned in that report consist of larger or smaller lenses in a lean slate, which again

forms irregular bodies in a not orebearing hornslate. In the south part of the cut called Sjögrufvan there appears an analogical body of orebearing slate, 0.25-0.6 m. wide, stript for a length of 9 m., and by a not orebearing party separated from the slate in which the ore lenses of last year were found.

In the cut marked on the minesurveyor-map just on the South of Sjögrufvan there have been found several parties of copperglance and bornitebearing slate: in the north end two, separated by slate, 5 m. wide, leanly copperglancebearing bodies of unknown extension, and in the south part, partly a larger vein, varying in width between 0.25 and 1 m. of unknown extension, and small copperpercentage, partly a thinly foliated lean copperpyritebearing body, and finally farthest towards east a copperglance- and magnetitebearing mineral which possibly may belong to the vein which has been stript in the S.W. part of "Rostgrufvan". In the long cut, following the south foot of the hill, there are stript several smaller and larger orelands and ore lenses. In the west part of the ore consists of chloritic, partly quartz hornslate, containing copperglance and bornite as small usually lenseshaped aggregates of 1-2 cm. in width. This slate is sometimes orebearing for a width of 6-5 m., but only in small lenses the richness in copper is greater than 2%. A large typical piece of this ore gave by analysis 1.25% copper. In a few places there occur however comparatively pure copperglance, but it seems to be in no such quantity as to raise the copperpercentage of the ore at large.

Farthest toward the west in "Rostgrufvan" there is stript a stratum of slate for a length of 3 m. and a width of 1 m. It runs N.W.-S.E. and contains richly impregnated copperglance. The copperpercentage amounts probably to 1-2%.

3 m. on the south of here, there is a body of slate with richly impregnated copperglance, 2 m. wide, but with insignificant length, and also two small lenses of richly impregnated ore, one 0.5 m. in diameter and the other 0.1-0.2 m. all in copperfree or very lean chloriteslate.

A few meters on the East of these there is the west point of a continuous cretreak, about 15 m. in length, consisting of quartz chloriteslate with impregnate copperpyrite and bornite. In one place it has a width of 2 m., but is mostly only 0.35 m. wide. A typical piece of this ore vein gave by analysis 1.25 % copper. The eastern part of this crevein is about 40 cm. wide and bears richly impregnated copperglance and bornite for a width of 15 cm.

In the east part of "Rostgrufvan" there appears ore different from the one described above. About 10 m. on the east of the east end of last described crevein there are three parallel layers of orebearing mineral. The uppermost of these layers consists of 0.3 m. wide hornslate with copperpyrite and bornite / small copperpercentage / and can not be defined to its length being too little stript. The middle one is separated from the uppermost by a 0.8 m. wide slate and consists of richly magnetitebearing hornslate with impregnated copperglance and bornite in aggregates of 5 m/m. It is stript for a length of 1.25 m. and is 0.5 m. wide. A typical piece gave by analysis 2.6 % copper. The undermost of these layers consists of a 0.25 m. wide fine grained bornitebearing mineral of the same appearance as the below described ore of Ormgrufvan. The bornite is partly very finely impregnated, partly as 2-3 m/m aggregates. A typical piece gave by analysis 1.6 % copper.

2.5 m. on the east of the former, there is a copperbearing mineral and 4 m. farther a complex of ore lenses, of which the uppermost, which is stript for a length of 6 m. and is 0.5 m. wide, at the middle consists of hornslate with bornite and copperglancebearing ironore, giving by analysis of a small piece 0.8 % copper. Parallel with this, there is a 2 m. long vein, 0.25 m. wide, of copperpyrite and sulphurpyrite impregnated in slate, and near this layer there is a 4 m. long, 0.1-0.3 m. wide ore of the same kind as that of "Ormgrufvan" and with very small copperpercentage.

The ore mined here was cleansed and gave 1.2 tons 1:st ore with 2.92 % copper and 2.8 tons 2:d ore with small copperpercentage.

... on the former there begins a new ore-  
se, stript to a length of 6.5 m. and having a width of 0.20-0.25 m.  
It consists of a quartziferous mineral with finely impregnated  
bornite and copperpyrite as 2-6 m/m aggregates. A typical piece  
gave by analysis 4 % copper.

This oredeposit has not been followed farther. In the  
direction of its strike eastward the hornslate is pyritebearing,  
sometimes rich in scales of malachite on the dissolved surface,  
indicating the presence of several copperbearing minerals. In the  
cut on the east of "Rostarufvan", marked on the mine-surveyor-  
map / Sh. 4. / there is a hornslate, equally impregnated with  
sulphur and copperpyrite in secondary quantity. The analysis  
of a large block gave 0.87 % copper.

On the east from here there is a quartz layer, sharply  
bent in its west part of varying depth, sometimes amounting to  
two meters. It contains larger or smaller lumps of copperpyrite  
and bornite and scales of native copper. These minerals are very  
evenly distributed.

Smaller and larger bodies of this quartz frequently  
appear on the east and the S:E. of "Rostarufvan", generally  
containing small lumps of copperore. In the part marked on the  
mine-surveyor-map / Sheet 4 / farthest toward the east there is a  
fine ore lense of nearly pure bornite, and 100 m. on the east  
from here was by blasting in a similar quartzvein been found copper  
in considerable quantity. Here there was made a trench 2.5 m.  
long, 0.75-0.65 m. wide and 1 m. deep. The dressed ore gave 0.5 tons  
1:st ore, containing 13.41 % copper and about 0.4 tons 2:d ore,  
which by more carefull cleansing without difficulty might have  
been brought to the same copperpercentage as 1:st ore. The ore in  
this cut, which is called "Kisarufvan", consists of copper pyrite  
with some bornite as lumps, 1 dm. or more in diameter, embedded  
in the quartz, generally elongated parallelly with the enclosing  
mineral. In the hornslate, surrounding the quartz, there appear  
also impregnated copper-and sulphurpyrites, but without practical  
value.

At the east end of the above mentioned "Rostarufvekullen"  
there has been found partly copperpyritebearing hornslate, as a

streak, running N.N.E.-S.S.W. and partly immediately N.E. from here ironore with richly impregnated copperpyrite and bornite, having a length of 8.2 m. and a depth of 12-43 cm. In the south part of this vein the ore is lean in copper /analyses of stuffs from different parts have shown 1.75 %-0.5% and obly "traces" of copper /. In the south part however there was found a party very rich n bornite, having a length of 2 m. and a depth of 0.2 m. 3 m. on the east from here the chloratic hornslate is richly impregnated with sulphur and copperpyrite and some bornite for a width of 0.8 m.

Towards the north the rock is richly covered with earth, which has prevented further examinations in that direction.

25 m. on the north from this vein the slate is cut through by a small quartzlead with plenty of bornite, which also appears as irregular lenses in the enclosing hornslate. This vein, which on the map of 1895 is marked as N:o 25, has been examined this year, and is called "Kvartssångsgrufvan". By this examination it was found that the vein is bornitebearing for a length of 18 m., of which 11 m. are very rich in bornite. It strikes N.N.W.-S.S.E. and has almost vertical dip and a width varying from 5-0 cm. and an average width of 2.4 cm. The enclosing hornslate contains on both sides 2-3 cm. wide and 10-30 cm. long lumps of bornite ironore of varying copperpercentage / different analyses have given 2.0, 2.5, and 9.3 % copper /. The ore from a cat. 11 m. long and 0.2 - 0.6 m. deep below the surface of the rock gave by dressing 0.2 tons 1:st ore, consisting of bornite from the quartz-lead and bornite ironore from the hornslate, holding 21.8 % copper and about 4 tons 2:d ore, consisting of large pieces of hornslate with small lenses of bornite ironore with probably 1 % copper.

5 m. N.E. from the above lense there was found on the 26 of July a small lense of bornite at the edge of a rock covered with earth. By removing the earth and blasting, it proved to contain a particularly fine carperore, 8 m. long and 0.25-1.8 m. wide. It got the name of "Victorgrufvan", and the ore consists of bornite / with copperpyrite in secondary quantity/, partly

impregnated in a close gray-green, drusy mineral, partly as fissureveins and druses in the surrounding gabbrolite rock. On a surface of about 12 m. this is closely cut by 3-4 cm. wide fissures, filled with bornite. A large typical piece gave by analysis 16.16 % copper, which may be a pretty true estimate of the copperpercentage of the whole deposit.

The deposit, which in 1895 was discovered on the south shore of the Kamajokk, 50 m. on the north of the measure of Victor and marked on the map as N:o 28 with the name of "Epsilongrufvan", has this year been further examined by blasting for a length of 7 m. It thus was found that the vein strikes N-60°-W. and has a steep dip S.W., a width of 18-70 cm. and very irregular shape as is shown by fig. 3 sheet 4. As has been mentioned in the report of 1895 the vein consists partly of bodies with about 28 % copper, partly of slate, impregnated with bornite with 2-10 % copper. The ore consists of bornite without ironore, partly as small elongated lenses, 1 cm. long and 2-3 m/m wide, partly as larger, elongated bodies, 60 cm long and 10-15 cm. wide, surrounded by slate with more or less richly impregnated bornite. By dressing the mined rock there was obtained 0.5 tons 1:st ore with 14.28 % copper and 1.2 tons 2:d ore, principally consisting of hornslate with impregnated bornite and 1 ton 3:d ore, that is hornslate with single grains of bornite. By more careful dressing which could not be made on this occasion, the 1:st ore may obtain greater copperpercentage and the 2:d ore, which now seems to hold only 1-2 % copper, may give the same 1:st ore.

The cut, 70 m. on the west of the measure of Victor / N:o 26 on the map of 1895 /, called "Antonsgrufvan", and which has a 0.5 wide vein of chloritic hornslate with impregnated bornite and copperglance of unknown length has not been examined this year.

In the measure of Elias there was found last summer partly copperglance and bornitebearing slate in the neighbourhood of the Kamajokk, partly a couple of irregular deposits of an other kind on the west and the south of the measure. Those towards the south have been examined this year by removing the earth and by blasting.

Chloritic hornslate, rich in quartz, of the same kind as that of "Snögrufvan", with copperglance and bornite as aggregates 2-3 cm. large, pretty evenly impregnated, occur a.a. about 45 m. on the S.W. of the point as two separated, 1 m. deep, layers, striking N.E.-S.W. and dipping towards N.W., of which both have low copperpercentage. Also 40 m. on the east of the measure there has been found the same orebearing slate, but here with richly impregnated coppermineral, of which the copperpercentage in some bodies amounts to 6%. In the place, where the blasting was done and which is called "Ormgrufvan", there also appears a variety of ore, consisting of a fine-grained, light, somewhat magnetite-bearing mineral, with very finely impregnated bornite, sometimes not discernible with the naked eye. This variety of ore which by analysis of different stuffs has proved holding about 2-3.75% copper, appears in an irregular running vein, as 0.1-0.3 m. wide stripes. It has been stripped for a length of 20 m. and in the west part of "Ormgrufvan" it changes into above mentioned copperbearing chloriteslate. - Besides these different kinds of ore there also occurs a layer of ironore, 0.3 m. deep with malachite on surfaces of cracks, but otherwise no visible coppermineral. By removing of the earth, it is stripped for a length of 13 m., but may be still longer. Although it has not any considerably great copperpercentage, it is remarkable on account of its resemblance to the usual Sjangeli ironores, which in many places, both in the field and on the depth, changes into ironore, of which amongst others "Långgrufvan" gives us an instance.

In the measure "Matteus" / in my report of 1895 called "Erik" / there was blasted a small stripe of bornite, discovered this year, striking N.E.-S.W. and dipping 55° N.W. Deeper down this stripe widened and was in one place 3 cm. wide, but then tapered out deeper down and was replaced by several smaller borniteveins, 1-6 cm. wide, and irregular lumps of bornite, grown into the enclosing hornslate. The ore from this mine, called "Matteusgrufvan", gave by cleansing 0.2 tons 1:st ore with 23.17% copper and 0.83 gram silver, per 100 kg. ore, and 1.2 tons 2:d ore and 2.47 tons 3:d ore, from which by further dressing there

may be obtained ore with very great copperpercentage.

About 5 m. on the west of the former the hornslate contains, for a width of 1.5 m. small bornitelenses, sometimes 5-6 cm. long and 2-3 cm. wide with copperpyrite and sulphurpyrite.

### BÖNGRUFVAN.

This name has been given to the ore deposit, in the measure of Paulus, which on the map of 1895 is marked as H:o 16, as there here appears a type of ore, which has large extension within Unna Allakats, and as the location is very favorable, there was here commenced a large work with the object of getting guidance for judging other similar ore deposits.

As has been mentioned in my report of 1895 the ore consists of chloritic hornslate of the same kind as that of Sjögrufvan, containing copperglance and bornite, partly impregnated or as small lenses, often having the size of beans, partly as more or less continuous, narrow or wider sheets. This slate is nearest the open most dissolved, making the aggregates of copperminerals lying loose, surrounded by crusts of malachite, quite loose so as to be picked up by the fingers. In the non dissolved rock on the contrary they are quite grown in.

The richest orebodies, which hold about 50 % copper, consists of small lumps, 5-6 m/m in diameter or of small sheets, lying more or less close in a slate with impregnated copperglance. They have the shape of lenses, 6 m. long and 0.5-1 m. wide, and are enclosed in slate with sparsely appearing, impregnated copperglance, which slate again is surrounded by an other copperfree slate.

Last summer there was made here a 36 m. long cut on the vein found last year, and at a distance of resp. 18 and 32 m. from there in the direction of the strike S.W. the earth was removed and a few blasts were put in the rock. In right angles to the stripe the earth has been removed, partly S.E. from the south end of the large cut, partly N.W. from its north part. At last there has been driven a level, first in the direction of the strike, then towards the south across the ore. found there by

the removing of the earth.

By those works following observations have been made regarding the quality and extension of the ore of "Bönggrufvan".

In the large cut there is stript a slate, 22 m. long and 3 m. wide. In this slate there appear large lenses of richer ore, resp. 5, 6 and 7 m. long and 1 m. maximum width. Here there also occur occasional small glands and shists of very rich copperglance in the leanly impregnated slate. There are rarely to be found any distinct limits between the rich and lean or dead slate but they change more or less rapidly into each other. A guidance for judging the copperpercentage of the different ores is given by following analyses from different parts of the large pit:

	<u>copperpercentage</u>
1. To the naked eye pure, close copperglance -----	50.0 %
2. Slate with richly impregnated grains and stripes of copperglance -----	15.0 %
3. Slate with 0.5 m/m wide stripes of copperglance	12.0 %
4. D:o with closely impregnated grains of copperglance generally less than 5 m/m large -----	3.0 %
5. D:o with pretty closely impregnated grains of copperglance, 4-5 m/m large -----	2.25 %
6. D:o with sparsely impregnated grains of copper= glance. -----	1.0 %
7. D:o with an occasional 10 M/m large lense -----	0.75 %
8. D:o with very sparse grains of copperglance 5 m/m in diameter -----	0.4 %
9. D:o with pretty closely impregnated grains of copperglance, 1-2 m/m in size -----	0.4 %
10. D:o with sparsely impregnated grains of copper= glance, 1-2 m/m in size -----	0.15 %
11. D:o without any to the naked eye discernible coppermineral -----	0.20 %
12. D:o     D:o     D:o     D:o	Traces.

The ore marked as lean on the detailed map of Böngrufvan Sheet 4. has the same appearance as the above stuffs N:o 6-10, while the one marked as the richer consists of a mixture of N:o 1-5.

At the work of this summer a particular weight was laid on finding out the extension of the ore-bearing rock, and very little work was done on the very veins. The mineral ores was coarsely dressed and gave:

0.21 tons 1:st ore with	12.57 %	copper *)
2.65 " 2:d " "	3.00 %	"
12.75 " 3:d " "	1.00 %	"

A great part of the mined rock consisted of large blocks weighing 0.1-0.2 tons. The breaking and dressing of these rocks would have required more work and time than I had at my disposal, and it is on this account that the quantity of dressing ore is smaller than what in other conditions might have been the case. Besides above described, large lenses of ore several others have been noticed in the direction of the strike, of which one, 5 m. wide and of unknown length, has been stript 2 m. S.W. from the large one, and an other, 2 m. wide ore, 9 m. N.W. of this. The first of these has proved to be lean in copper and of the same appearance and copper percentage as the above mentioned 3:d ore but with small lenses of rich ore. The other not stript to any great extent in a deep trench, gave by analysis of a general sample, taken across the whole width, 2.75 % copper.

JACOBIGRUFVAN.

This cut, located within the measure of Karl and on the map of 1895 marked as N:o 12, has this year been subjected to work only so far that a 6 m. long pit has been made in the open and in the direction of the strike of the vein towards N.E. the width of the ore varies between 0.94 and 1.41 m. and the quality was the same as stated in the report of last year.

\*) 0.9 gram silver per 100 kg. ore.

By cleansing the ore, mined last year, there was obtained:

5.1	ton	1:st	ore	with	4.73 %	copper
14.2	"	2:d	"	"	3.72 %	"
11.5	"	3:d	"	"	1.00 %	"
5.0	"	washstuff	"		probably very high copperpercentage	
and 7.5	"	gouge.				

As a comparison may be mentioned that the cleansing of ore made 1894 by Lundbohm gave:

25 %	1:st	ore	with	-----	5.37 %	copper
and 75 %	2:d	"	"	-----	3.24 %	"

Besides above mentioned work there have been done a few smaller blastings in copperlance- and bornite-bearing slate of the same kind as that of "Sjögrufvan" and "Bönggrufvan". Amongst other places about 130 m. on the north of the measure point of Folke / new deposit / and within the measure Folke / N:o 14 on the map of 1895 /. This work has further shown that the orebearing mineral has large extension within the orefield of Unna Allakats and that its quality chiefly coincides with the facts resulting from the works of a large scale.

#### VALFOJOKK.

The oreloides within Valfojokk are mostly found in the centre of the hornslate, but smaller loches are also found scattered around in other parts of the slate. Partilularly numerous are the loches within the measure of "Mattie", over which there was made a map in the scale 1:800 / Sheet 5/.

The ore usually occurs as long stratified formations, in which there are found more or less distinct lenses of different mineralogical composition and copperpercentage. The strike is generally N.E.-S.W., and they have a slope dip towards N.W. The ore consists partly of a bornitebearing ironore of the same kind as the ore at Anna Kajsa grufvan in Sjangoli, partly of a close mixture of Hornslate, feldspar, magnetite and bornite

/ nearest conforming with the ore of Tornberskärpningen in Sjangeli / partly also of ironore, rich in copper- and sulphurpyrites, and at last too of bornäzelenses together with quartz and epidote.

### THE OREFIELD OF MATTIE.

Farthest toward S:E. there are a couple of small streaks, 0.1 m. deep. of hornslate with bornite and magnetite / N:o 56, 2, 3, /, but which have not been investigated with regard to their extension and quality. About 30 m. farther S.W. in the direction of the strike of above layers there has in several places been noticed malachite on the surfaces of the hornslate / N:o 4, 5, 6, 7 and farther towards S.W., about 15 m. from Valfojokk, there is a vein of ironore, rich in bornite, / 9 /, stript for a length of about 3 m., but not closely examined. 10 m. west from here there are two lodes of bornitebearing slate, not examined / N:o 10, 11 /.

In the direction of the strike of these lodes, 35 m. N.E. from the Valfojokk, there are several oreveins, of which two have been examined during the summer. The most easterly of these / N:o 29, 30 / consists of a  $40^{\circ}$  toward N.W. dipping layer of very fine-grained, nearly close ironore, very richly impregnated with large and smaller grains of copperpyrites and some bornite. The depth of the vein is 25 cm., and it was stript for a length of 10 m.

Two smaller lodes / 31, 32, /, lying immediately west from here, consists of hornslate with scales of Malachite, but are not examined. Farthest toward N.E., there is an other orevein / N:o 1 /, which has been followed for a length of about 30 m. but which <sup>has</sup> likely much larger extension. It dips like the above mentioned  $40^{\circ}$  towards N.W. The ore, which is 48-5- cm. wide, consists of fine-grained slate, rich in magnetite and containing bornite / and some copperglance / in varying proportions. The copperpercentage seems to be highest in the middle of the vein, but varies very materially in the direction of the course, being sometimes nearly pure bornite / as at N:o 1. /, sometimes slate without any bornite / as at N:1 a / an analysis of two typical

pieces from those lodes gave resp. 11.98 and 8.20 % copper.  
This vein should be further examined.

A couple of meters on the west of the S.W. point of  
the last vein, there is found ironore with impregnations of sul-  
phurpyrites. / N:o 29 a /.

A few meters N.W. from here there is a vein of hornslate,  
rich in quartz / N:o 27 b, 27, 26, / with bornite and some copper-  
glance, partly very rich in copper, having a depth of 15 cm.,  
and a known length of about 40 m. It is likely that the vein  
continues towards Valfojokk, where orebearing slate has been  
noticed in a couple of places / N:o 13, 14. /.

About 10 m. N.W. from the last there is a new vein  
/ N:o 25-28 /, known for a length of 15 m. It consists of horn-  
slate, rich in magnetite and with more or less bornite. Whether  
the orebearing slate, noticed 15 m. nearer Valfojokk / N:o 15 /,  
belongs to the same vein, should not be determined.

N.W. from here, on a width of about 30 m. there are sever-  
al collections of orebearing slate, of which none seems to be of  
any practical value.

At a distance of 30 m. N.W. from the last mentioned  
orelode / N:o 25-28. / there is a vein of bornitebearing slate,  
rich in magnetite / N:o 22 /, but it has not yet been examined.

10 m. on the north from here there is a 0.5 m. deep  
orevein / N:o 20 / dipping 30° towards W. as the same kind as the  
one described above with the name of n:o 1. In the stript part of  
the vein, the copperpercentage does not seem to be very high.  
This is probably the same vein which 40 m. farther towards N.E.  
has been stript for a length of 3 m. /N:o 24/ and having a depth  
of 0.4 meters, being pretty rich in bornite. It seems to conti-  
nue northwards to N:o 49, where hornslate with lenses of bornite  
have been found.

Immediately on the west of this vein there have been  
found several scattered lodes, of which the one, marked with N:o  
23, consists of 3 cm. wide elongated lenses of a close copper-  
bearing ironore, lying in a bornitebearing hornslate, rich in  
epidote, with a width of 0.3 m.. This deposit possibly belongs  
to the same vein as that which is seen 20 m. farther towards S.W..

at N:o 48, consisting of a close ironore without any microscopically visible bornite, but rich in malachite on the surfaces of the slate, having a depth of 0.1 m. To the same lode belongs probably also the same lode which 10 m. farther to the S.W. / at 21 / has been stript, and consists of hornslate with epidote and bornitebearing ironore, of the same kind as above mentioned. This vein has here a width of 1 m. and dips 40° N.W.

A few meters farther towards N.W. there are found several other oredeposits. Of these N:o 53 consists of bornite with quartz and epidote, not examined and probably valueless. N:o 47 also seems to be of no importance. N:o 54, on the contrary, is a 0.1 m. deep vein of hornslate with 1 cm. wide shists of ironore, rich in bornite, flatly dipping towards N.W. The vein is only visible for a length of 2 m. and has not been examined, but seems to be worth of a closer examination.

About 20 m. S.W. from here there has been working on a deposit of bornite /N:o 46 /, in the shape of larger or smaller lenses, often 30 x 10 cm. in size, and fissureveins in hornslate, resembling the ore of Snögrufvan at Sjangeli. An analysis of a typical stuff from this deposit gave 12.97° copper. The ore seems to dip pretty slowly towards N.W., is 1.25 m. deep and is seen in the open for a length of 7 m. The lode seems to be promising and worth of continued working.

All other in the N.W. part of this measure found oredeposits consist partly of copperpyritebearing hornslate / N:o 55 / partly of layers of ironore with sulphurpyrites / N:o 44, 45, 42, 60 / and have no veins.

Beyond the measure of Mattie there are only found a few oredeposits on the north side of Valfojokk.

Within the measure of Janne there has been noticed a smaller deposit of bornite in mixture with magnetite, as a 16 cm. long and 2.6 cm. wide lense, lying in a quartzvein / not closely examined / and a few smaller deposits of somewhat orebearing slate, but which, as far as known at present, are without any practical value.

Within the measure of Olof in the N.W. corner of the

field, there occurs bornite in several places, partly together with quartz in small, drusy lense, partly as lumps, as big as walnuts, in a , partly as small impregnations in a 0.1 m. deep layer of talkslate, and at last also near the N.E. border of the measure together with limespar and some copperpyrite as middlemass in a peculiar breccia, of which the broken pieces consists of hornslate. In none of those places the bornite seems to occur in such quantities as to be worth mining.

On the south side of valfojokk there are also found a great many copperoredeposits, of which most are lying in the direction of the strike of the oreveins, within the measure of Mattie, that is, within the boundaries of Marta, Gustaf, and Arvid. A separate vein of smaller deposits also runs trough the S.E. part of the measure of Johanna. While the ore on the north side of the river principally occurs as borniteore more subordinately on the south of the river.

Within the measure of Marta bornite has been noticed only as a small lense together with quartz and epidote. Besides this, copperpyrites occur in large quantities, partly as sparse impregnations in hornslate of a depth from 0.3-0.5 up to 2 m. partly as impregnations in ironore. Finally there occurs ironore without any microscopically visible copperminerals, but with malachite as scales on the planes of the slate, giving indications of copper. Scales of malachite are also noticed in several places on the walls of the rock, which also indicates the presence of copperminerals, though the way of their occurring has not yet been examined.

In the west part of the measure of Gustaf there is a deposit of pure bornite with copperpyrites, quartz and magnetite, in large lumps which, having been trenched, seemed to be very fine. The surrounding mineral is copperpyritebearing hornslate. If the lode is of such importance that any larger quantity of ore may be obtained, cannot be determined without further work.- Besides above mentioned deposits there have within this measure been noticed two smaller lodes of ironore with sulphur- and copperpyrite in small quantities, and two smaller veins of hornslate with impregnated sulphur- and copperpyrite, but as far as known

at present, without practical value. No work has been done on those deposits. In the measure of Arvid there appear plenty of copperpyritebearing streaks of slate, partly having a width of 1 m. and more, of which several seem to be worth a closer examination, which time did not allow this summer. Such is particularly the case with one streak, 13 m. west from the measure. This one consists of a 1 m. wide layer of slate, richly impregnated with copperpyrites, and 7 m. farther towards N.E. the copperpyrite occurs, mixed with bornite.- About 45 m. N.N.E. from the measure there are also several similar parties of slate, but they have not been examined.

In the S.E. part of the measure of Johanna bornite occurs in several places, partly impregnated in hornslate rich in epidote, partly in granés of quartz. Two veins of copperbearing ironore have also been found. They have not however been examined by removing of the earth or blacting.

The measures of Davida, Ake, Ville and Pelle have been secured principally for debarring strange claimants from the orefield, and the rock is in those measures mostly covered by loose earth.

#### RUOPSUOKJAURE.

This orefield is located about 7 km. west from Sjangeli, on the south shore of Ruopsuokjaure, near the frontier of Norway, 1.75 km. south from the stonemark N:o 264. Before 1895 there had here only been found ironore of insignificant depth, often with impregnated copperpyrite and magnetitepyrite. In the report of 1894, dated April 1895, the state-geologisk Mr. Lundbohm says a.o.t. regarding these oredeposits: "From what is known at present this ironore must be considered as valueless, and only under the conditions that it changes into copperore, it deserves to be considered. Any particular indications that such should be the case do not however exist."

During the summer of 1895 bornite was found in small quantities in two places, but then there were made no closer in-

vestigations regarding these deposits. Only this year removing of the earth and blasting have been carried on, and a map has been made of the orefield, by which following facts have resulted. The number below refer to the large map in scale 1 : 4000 /sheet2/. Farthest westward near a large snowcrowned hill there was in two places found sulphur- and copperpyrites, impregnated in olivinstonebearing hornslate, but both of them seem, although having a depth of 1-1.5 meters, to be entirely valueless.

1. Immediately west of the most westerly measurepoint, marked on the map, a smaller blasting was carried on on a layer of slate with impregnated bornite, and copperpyrites, having a depth of about 1 m. and being similar to the ore of Snögrufvan in Sjangeli. The vein runs N.-S. and steeply dips towards W. Towards the south its continuation is covered by and it seems to stretch towards the north for a length of about 15 m. and a width of 1 m.

2. A 1.7 - 2 m. wide layer of hornslate with bornite, partly finely impregnated, partly as small almondshaped lenses and copperpyrites in small quantity. In the middle of the layer there occurs pretty richly impregnated bornite to a width of 0.3 m. The strike is N. 40° E., and the dip steep toward N.W. The extension of the field as to the length is not known, as it is covered with earth. The richest ore is estimated to hold 6-7 % copper, and the lenses not fully 1 %.

3. Near to the direction of the course of the former there is a very little uncovered crevice of the same kind as this. It has a depth of about 0.5 m. and sometimes contains up to 5-8 cm. long and 4-5 cm. wide lenses of bornite.

4. Hornslate with flows of malachite, lying in the direction of the strike of the former; not examined by trenching.

5. Hornslate with scales of malachite; not examined.

6. Trench in hornslate with fine-grained, sparsely impregnated copperpyrite. The depth exceeds 3 m. At present without value.

7. Hornslate with scales of malachite; not examined.

8. 1.5-2m. deep magnetite with impregnated sulphurpyrite and scales of malachite.

- 9. Hornslate with impregnated sulphurpyrite; not examined.
- 10. Hornslate with flows of malachite; not examined.
- 11. " " " " " " " "
- 12. Trench in ironore with impregnated sulphurphyrite and malachiteflows for a width of 1 r.
- 13. Trench on a deposit of mixed copper- and sulphyrite, magnetite hornslate and some bornite. Also a rich amount of malachite and lapis lazuli.

Of all these veins and to judge from all hitherto made investigations, there are only N:o 1, 2, 3, and possibly N:o 13 which seem to contain copper in such quantity as to be worth of any considering. In what degree they may be worth of exploitation, is impossible to determine without further investigative work.

Stockholm 1 November 1896

(sign.) Valfr. Petersson.

3917

Report

on the survey of Sjangeli mines, made in  
1897.

by

Walfr. Petersson.

Since the surveys which I made during the two last years at and in the vicinity of the Sjangeli copper deposits gave a very favorable result both from a practical and a scientific standpoint, I was requested by Engineer Alwin Jacobi to continue these surveys during the past summer, in order to obtain as complete a report as possible as to the nature and extent of the ore deposits discovered here during the last few years, and also in order to find new oriferous districts in the Sjangeli vicinity.

In these surveys, I have been assisted by the mining engineer at the Isberg, Nordmarken and Finmossen Mines in Vermland, Mr. E. A. Dahlgren, besides which a student at the Stockholm School of Mines, Mr. E. A. Jonsson, made the numerous chemical analyses which were requested during the course of the investigations, and assisted in the geological surveys in the district north of Sjangeli.

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In compliance with our orders, extensive excavations and blastings were made under the direct supervision of engineer Dahlgren, principally in the Valfojokk Ore Field, which was discovered last year, and in the oriferous sections of Mount Ruopsuok, besides which the Herzen Concession in the Sjangeli Ore Fields was surveyed more thoroughly. Where it was considered suitable, ore-picking trials were made on the masses of ore obtained in the trial mining-work.

Simultaneously, I made geological surveys, partly on Mount Ruopsuok and in the district west and south of this mountain, in a region extending from Mount Matjolak along the river Jordelven to the river Stenelven, and furthermore in the high mountain district on both sides of the Swedish-Norwegian frontier between the river Kalixelven in the west, Abisko-jokk in the south, Selmajokka and Zartivvae in the north-east, and Allakats and Sjangeli in the north, partly in the district between the Swedish-Norwegian frontier in the north-east, Abisko-jokk in the south-east, and Sjangeli in the south.

In these surveys, engineer Dahlgren assisted by making detail maps in the districts where it was considered necessary, among which we may specially mention Mount Ruopsuok, where the geological conditions are quite complicated, but where, owing to these detail surveys, a hitherto unknown oriferous district was discovered and measured, besides which several new ore-finds were made. Even in Sjangelitjåkko copper ore was discovered in several places, and finally, at the close of the summer, we discovered quite an extensive district in which zinc and lead ore as well as copper ore occurred, about 20 km. north-west of Valfojokk, on the low mountain Kuokula.

In the surveyed districts there also occurred rocks in which there is no prospect of finding copper ore of the Sjangelitype.

In my report of the surveys made in 1896, I gave an account of the principal features of the Sjangeli districts geology which were most important from a practical standpoint, and how the knowledge thereof obtained through the geological surveys led to the discovery of two so important ore-fields as Unna Allakås and Valfojokk, and it is therefore not necessary to give a new description thereof in this report. During the past summer I have principally made a detailed survey of the districts in Norway where smaller copper ore deposits had already been discovered, and have made the annexed geological chart of it / pl. L:1/. From this chart it will be seen that the geological conditions here are more complicated than in the so-called Sjangeli range, in that anthophyllitic schist, serpentine and rusty schist of different kinds / partly hornblende schist and partly micascist / alternate with dolomite and Sjangeli schistaceous rocks, while in the south-west gneiss-ose rocks and gabbro occur. It is a deplorable fact, however, that in many places the earth-covering and great snow and ice fields prevent the determination of the limits of the different kinds of rock. Surveys, however, proved that copper ore of the Sjangeli type / i.e. bornite and copper glance / occurs in a certain stratum which, with the strike / NNE-SSW/ and the dip / quite steep towards WNW / which is usual in

this district, extends from the northwest end of Ruopsuok-  
jaure across Ruopsuok, on whose southern slope it is seen  
the wedge out. To a great extent this stratum is hidden by  
masses of loose rocks or by snowfields, and is, only at  
"Brorsgrufvan", visible for a continuous distance of about  
300 m. in length. With regard to the nature and extent of the  
ore-deposit discovered here during the summer, I would refer  
to the report on this years explorations given below.

On the floor of this stratum an isolated deposit,  
of bornite and copperglance in hornblendeschist has been  
discovered / Bachkegrufvan / and since last year these minerals  
are also known in the Ruopsuok; the ore-field still farther  
on the floor. After a continued survey of the district around  
the latter ore-field, it has been found that the Sjängeli  
schistose rock occurring here is on the southwest bounded by  
anthophyllitic scist, but on the northeast extends further  
along the northwestern slope of Sjängelitjåkko and into Valfo-  
jokk, and even there smaller copper-ore deposits are found  
which have not, however, been more closely examined.

On the floor of the Brorsgrufvan stratum, on the  
highest summit of Ruopsuol, there is iron-ore, with some  
copperpyrites of varying thickness and partly irregular form,  
in a folded hornblende-schist, which contain numerous strata  
of very impure dolomite.

Smaller Iron-ore deposits also occur in several  
other places in this schist, which extends with unaltered  
character across the entire Ruopsuok summit. Partly on account  
of snow and partly on account of a covering of loose rocks  
and gravel, both on the northwest and the southwest, the con-  
dition of this kind of rock in the direction of the strike  
cannot be given. The ore-deposits here discovered are covered  
by the concessions Louis, Wilhelm and Alwin.

In the western part of the district which the map  
covers, there occurs a kind of rock similar to the latter,  
which also contains narrow lime-layers and smaller deposits  
of iron-ore bearing copperpyrites, which has been covered

quite a Sjangeli-schistose appearance, which contains iron-ore bearing copperpyrites, which has been covered by the concessions Nils and Erik. Even the relation of this kind of rock to the surrounding rock has been impossible define.

The other kinds of rock indicated on the map do not contain oredeposits. There are exceptions to this rule, but they are practically without importance. Thus there has been found in the anthophyllitic schist in the south part of Ruop= suok a littel deposit of magnetic pyrites / concession Karl /, and in the gneissose rock on the northwest shore of Tjuono= jaure, a vein of zinkblende / concession Lundquistarufvan /, besides which some copper pyrites with magnetic pyrites has been found in the rusty schist in the concession Julius.

In the rest of the district referred to on page 2. south of Allakats and Sjangeli, the fundamental rock consists to a predominating degree, of granit eand gneis rocks, in which there are no prospects of finding ores, and of a lamellar schist / phyllite and mica-schists etc. /, in which it would also be useless to look for Sjangeli ores.

As I stated in my report for 1896, my previous investigations and surveys have proved that in the Sjangeli district there are two series of rock distinctly differing from each other in their natural stratification, and age. While the one series; the older one, contain Sjangeli schist, which, wherever it occurs has been found to bear copper ore in smaller or larger quantities, no ore has been found in the other, or younger series. By following the boundary-lines of these two series of rock by step, I have now throughtout the entire northwestern half of the topografical map of Sjangeli determined their extent, and in so doing I have found that the younger rock-series forms a covering over the older one, extending from an irregular line ~~having~~ running from north to south about 1 km. east of the Swedish-Norwegian boundry towards the east and north over the entire district north and west of Sjangeli and Allakats. Only the Valfojokk river valley and the deep, broad valley between Tornetrask and Rombaksfjorden

have cut down through this covering, which is in places nearly 1000 m. thick, and in these valleys one can see that the rock-species of the older rock-series continue under the younger covering with unaltered character. This fact was proved in the Valfojokk Valley during the summer of 1896, and was the initial step to the discovery of the Valfojokk ore-field; this year the same observation was made 20 km. further towards the north in the aforesaid broad valley, west of the Torneträsk, and prompted me to make the detailed surveys which resulted in the discovery of still another new ore-field / Kuokula ore-field / with ores of the same kind and the same manner of occurrence as at Sjangeli. The great importance of this fact from a practical point of view was held forth by me in my report for 1896. The discovery of the Kuokula ore-field implies that the so-called Sjangeli stratum has an essentially greater longitudinal extent than we had hitherto dared supposed, namely, about 40 km.

West and south of Sjangeli, the younger rock-series has been observed, although to a smaller extent, namely, Matjalak and in a few places in the Nordelv Valley, and in Gardetjåkko, Snarpapakte, Tjålmetjåkko, and other high mountains north of Allasjåkk. The older series consists here, as also northwest of Sjangelitjåkko, of mica-schists and granitic rocks.

After this short resumé of the purely practical results of the summer's geological surveys, I now proceed to give a report of the explorations which were made during the summer.

Before I begin this part of my report, however, I wish to call attention to one or two matters which must be taken into consideration in estimating the results of the work done.

The trial work done during the year has principally consisted in blastings along certain cut-cropping ore-veins. In this work stress has been laid upon obtaining as complete information as possible in regard to the nature of the occurrence of the ore, and not upon getting a large quantity of ore, and therefore the most work has frequently been done in the dead, surrounding rock leaving the ore which in the future when

regular mining has been begun, can be utilized to far greater advantage. The trial pickings, which were made here and there, were accomplished by means of very primitive utensils, and the picked coarse ore has generally been about the size of a man's head, and seldom under the size of a fist. The results of the picking consequently appear by far less favorable than will be the case when regular mining has been begun, but I have considered these trials to be valuable, as they show the result can be obtained with different kinds of ore by panning under the most unfavorable conditions.

### Valfojokk.

By the surveys made last year, it was proved that on both banks of the stream Valfojokk numerous ore-deposits occur in Sjangeli schist, with a strike NNE-SSW and with 50 to 70 degrees dip to WNW. As we did not then have time to make more exhaustive surveys we had to be satisfied with proving the existence of a great number of such deposits, and leave the detail surveys in regard to the extent and nature of the ore till a coming year.

When it came to making such surveys last summer by removing the earth-covering and blasting, it was considered best to examine first one or two promising deposits, from which it would be possible afterwards to make conclusions in regard to others which were analogous with these, and afterwards to examine other deposits without such exhaustive work.

Therefore we devoted our first attention to the concession MATHIE. The position of the different mine openings will be seen on the accompanying chart / Pl. 1:2 /.

### MATHIE.

#### No 1.

The deposit of bornite in the form of lenses and crevice-fillings in Sjangeli schist which was mentioned in the report for 1896 under number 46, was explored this year by

blasting out an opening 6 m. long and 3 m. deep. The ore consisted of / 1 / a breccia, consisting of fragments of Sjängeli schist cemented together with bornite, and an inferior quantity of copperpyrites; thickness, 0.2 - 0.3 m.; / 2 / a chloritic hornblende schist with numerous lenses of copperpyrites and sulphur pyrites; thickness, 0.6 - 0.7 m.; / 3 / of a Sjängeli schist rich druses of bornite and copperpyrites, and hornblende schist with fine, sprinkled grains of copperglance. In the north eastern portion of the opening there occurs an iron ore, partly rich in bornite, in two strata 5 cm. thick.

In our trial work, we obtained, after coarse picking, 3 tons of bornite ore and 2 tons of pyrite ore.

The bornite ore consisted of:

17 %	first-class coarse ore, containing	16.20 %	copper
17 %	second-class coarse ore, containing	7.14 %	"
49 %	third-class coarse ore, containing	2.43 %	"
17 %	ore for washing, containing	3.94 %	"

The pyrite ore consisted of:

25 %	first-class coarse ore, with 2.77 % copper
57 %	second-class and third-class coarse ore, with 1.40 % Cu.

An analysis of a typical, rich pyrite ore, gave 8% Cu.

At the southern end of the opening, there is a deposit of pyrite-ore 0.9 m. thick; in the north wall there is an iron-ore deposit 5 cm. thick.

No 2.

This deposit of bornite-bearing ironore, which was discovered in 1896, and was then exposed to a length of 3 m. and a thickness of 0.4., has not been explored this year.

No 3.

In blasting to a depth of 0.5 m. on this deposit of iron-ore with copper-pyrites and some bornite, the visible ore-lense was blasted away.

No 4.

A stratum of close ironore, discovered here during the summer, with large and small lenses of copper-glance, sometimes containing all the way to 25.5 % copper, was explored by blasting an opening 16.5 m. long and in places up to 2 m. deep. The iron-ore, whose thickness varies between 0.2 and 0.6 m.,

does not contain bornite or copper glance finely sprinkled in it, as is the case in the so-called bornite iron-ore in Sjangeli and other ore-fields, but only in nodules from the size of a walnut to the size of a fist, which occurred too sparingly, however, to make it worth while to mine this deposit for copper-ore.

N:o 5.

A schist-deposit bearing malachite, which was observed here during the summer, was explored by means of blasting thus exposing a stripe, 3-4 cm. thick, of chlorite-schist very rich in bornite and copperglance infusions, surrounded by chlorite-bearing Sjangelischist with small quartz-lenses and narrow stripes of quartz, and numerous narrow cross-oreveices filled with lime-spar. 0.6 m. in the roof of the said rich orevein, the Sjangelischist is, to a thickness of 0.2 m., quite rich in copperglance, partly infused, and partly as filling in narrow oreveices. The aforesaid rich orevein gradually merges into normal Sjangeli-schist with copper-glance infusions. At the bottom of the opening, which is 8 m. long and in places 1. m. deep, the width of the ore is 0.3 - 1.0 m.

As a result of coarse picking of the blasted rock, 2.2 tons of ore was obtained, consisting of:

23 %	1:st class coarse ore, containing	3.63 %	copper
23 %	2:d " " " "	2.34 %	"
32 %	3:d " " " "	0.29 %	"
22 %	ore for washing	1.40 %	"

N:o 6.

In the immediate vicinity of the aforesaid deposit, we discovered last year a malachite-bearing schist. In the course of the explorations made this year, it was found that the schist to a length of 6 m. and a width of 2 m. was infused with lenses and grains of copperglance and bornite, and with these minerals in numerous cleavages. The analysis of a typical sample of schist containing oregrains only visible with great difficulty with the naked eye, showed the presence of 2.5 % copper, and the analysis of a sample of schist rich in grains of ore 1 m/m. in diameter, showed 4 % copper.

By continuing blasting, we found that the deposit constituted a lense, which at a depth of 2.5 m. nearly ran out. There are many reasons for supposing, however, that there are here a long series of lenses of oriferous schist, separated from one another by dead rock. It is probable that the adjacent deposit N:o 5 also belongs to this series.

The ore procured from this ore-lense, four tons, was coursepicked and gave:

25 %	1:st class coarse ore, containing	3.37 %	copper.
25 %	2:d " " " "	1.85 %	"
50 %	3:d " " " "	0.70 %	"

In this quantity of ore, we have not counted the ore for washing obtained during the enriching process, whose quantity and percentage of copper can be estimated as equal to second-class coarse ore.

N:o 7.

In order to find out the cause of the very rusty appearance of the surface of the rock, a little opening was done here, which showed that the hornblende schist was partly very rich in copper-pyrite infusions.

N:o 9.

A deposit of schist bearing bornite and copper glance discovered last year was explored this summer by means of a little blasting work. The deposit proved to consist of small pockets containing partly fine-grained iron-ore bearing copper glance / in some places 17.6 % copper /, partly hornblende schist with ore-infusions. One of these pockets was 3 m. long, another 1 m. long and 0.15 m. broad.

N:o 10.

A bornite-bearing schist deposit, known since last year, was now carefully explored, and proved to consist partly of copper glance, very finely infused in a bluish iron-ore slightly differing from the surrounding schist, with a thickness varying from 5 to 15 cm.; partly of copper glance and hornite-bearing schist all the way up to a width of 0.4 m., sometimes with stripes of pure bornite 1-1.5 cm. wide.

The ore, which is exposed to a length of 17.5 m., varies greatly both in thickness and copper percentage. To the

The ore-bearing copper-yrates partly intimately infused, partly in narrow stripes and laminae, has in several typical samples been found to contain 3 - 4 % of copper. All transitions from richer to poorer and to copper-free iron-ore and schist occur.

The ore varies, not only in the direction of the strike, but also towards the depth, both in thickness and copperpercentage.

N:o 14.

A hornblende-schist, bearing malachite, which was discovered in 1896, was explored to a depth of one meter, and the deposit proved to be bornite-iron-ore stripes, 1.6-3 cm. wide, in Sjangeli-schist and at a distance of 0.3 m. therefrom, in the hanging wall, a thin schist, 16 cm. thick with narrow strata and small infusions of copperglance, and here and there nodules, 2-3 m/m in diameter, of the latter mineral. We followed the schist for a length of 8 m.

N:o 15.

6 m. SE from the most southwestern end of the Mathiegruften, we found, during the summer's work, a bornite-iron-ore vein 1-3 cm. wide, containing from 26 to 32 % copper. With certain interruptions, this ore-vein was followed for a distance of 20m. At a depth of 0.25 m. in the floor of this vein, we found, where this ore ran out to a point, to the SW, a new vein, 3-4 cm. thick, but not quite so rich as the latter.

When this vein, at a distance of 2,4 m., ran out to a point, we found in the direction of the strike of the first vein, a third vein consisting of entirely pure bornite, 1-1.5 cm. wide, and with a hornite-schist 2-3 cm. thick in the hanging wall.

N:o 16.

While blasting in the bornite-deposit discovered here last year, we found a vein 3.6 - 4 cm. wide consisting of nearly pure bornite, 0.5 m. long and running out to a point at a depth of 0.75 m. below the surface. By continued blasting towards the NW. we discovered, 0.8 m. under the surface of the rock, 3.5 m. from the aforesaid orevein, a very rich vein of

bornite, 3-3.5 cm. wide, with schist bearing copper-glance, 0.2 m. thick, in the hanging wall.

No 17.

A find entirely new for this summer, in the immediate vicinity of the Valfojokk find, was explored by means of a opening 2 m. long, and was found to consist of a vein, 10 cm. thick, of almost entirely pure bornite, and a hornblende-schist rich in epidote, and 0.3 m. thick, with small pockets of bornite and copper-glance / an analysis of typical samples of this ore gave 3.5 % of copper /.

Besides the aforesaid deposits, situated within the Mathei concession, we have explored the following deposits discovered north of the Valfojokk.

J A N N E.

A new find of entirely pure bornite, together with quartz and epidote, 41 km. SW of the point of concession, proved to have a length of 1.5 m. and a maximal width of 0.2 m. It ran out to a point at a depth of 0.5 m.

P E L L E .

The bornite-pocket discovered last year was found, by blasting, to be very insignificant and without practical importance.

O L O F.

Just north of the point of concession, we discovered this year an ore-deposit consisting of small bornitelenses, in some cases 2-3 cm. wide, and isolated lumps up to 20 cm. thick. The explorations hitherto made are not sufficient for us to form any definite opinion of this deposit.

The breccia mentioned in my report of 1896 with a cement of bornite, copper-pyrite and calc-spar, has been proved, during the exploring-work which we did this past summer, to be of no practical importance.

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South of Valfojokk the following deposits has been explored during the summer:

### G U S T A F:

A deposit of bornite in quartz together with copper-pyrites and magnetite, discovered last year, was this summer explored to a length of 4 m. and in places 2 m. deep, and it has thus been found to be a regular vein with a strike E-W, and with a steep northern dip. The ore consists partly of copper pyrites and rich bornite deposits in stripes and pockets in quartz, partly of almost entirely pure bornite and copper-pyrites, sometimes all the way up to 15 cm. broad. The thickness of the ore varies, for a length of 3.5 m. between 0.15 and 0.7 m.

### M A R T H A.

A pocket of copper-pyrites in a magnetite-bearing hornblende-schist, found in 1896, was explored by means of an opening 13.5 m. long. The deposit proved to consist of a hornblende-schist more or less richly infused with bornite and copper-pyrites, with a thickness varying between 0.20 and 1.10 m. / the average thickness is about 0.65 m. /, and with varying percentage of copper. A couple of typical samples of coarse ore were found, on analysis, to contain respectively 4.62 and 6.38 % copper.

Even in two other places in this district smaller blastings have been made on small bornite and copper-pyrite deposits, which, however do not appear to be of any considerable extent.

### J O H A N N A.

A deposit of copper-pyrites discovered last year has this year been explored by a blasting 12 m. long. In the northeastern part of this blasting bornite occurs partly as crevasse-filling, partly infused in small quantities in hornblende-schist for a length of 5 m.; in its southwestern part there occurs, to a length of 5-6 m., copper-pyrites partly richly and partly more sparingly infused in the hornblende-schist, with a width varying between 0.29 and 0.54 m. and running out to a point to the southwest. The richer ore, a typical, coarse sample of which was found, on analysis, to contain 9.43 %, has a thickness of 0.09 - 0.20., and is generally surrounded on both

sides by the poorer ore.

In the most eastern part of the concession, we made, towards the close of the summer, a discovery of copper-glance in the form of infusions in hornblendeschist, with a width of 0.10-0.15 m. and as yet unknown length.

A coarse sample of this ore was analysed and found to contain 27.56 % copper.

In the south part of the concession, on the border of the Åke concession, the ore-deposit discovered last year was found to consist of a hornblendeschist rich in copper-pyrites, 0.1 m. thick.

The malachite-bearing schist in the western part of the concession which was discovered last year, was found, when blastings were made this summer, to contain bornite and copper-glance in slight quantities.

#### A K E.

8m. west of the point of concession, we found, during blastings made this summer, bornite, sparingly infused in the hornblendeschist.

#### D A V I D A.

Northwest of the centre of the concession, two new oredeposits have been discovered this year.

One of these, situated about 10 m. from the centre of the concession, bears bornite and copper-glance iron-ore of the same kind as in Mathiegrufvan. In the ore-vein, which is exposed to a length of 12 m., the copper is concentrated within a stretch of 2-3 m. where the thickness varies between 0.31 and 0.5 m. On analysing two typical coarse samples of this ore, we found they contained 3.96 and 6.90 % copper respectively.

The other deposit, situated 16 km. further to the northwest, consist of a bornite and copper-pyrite ore of poor quality, exposed for a length of 3 m.

#### A R V I D.

1. The deposit of copper-pyrites discovered last year, situated NW. of the centre of the concession, was explored this year by blasting in it for a distance of 7 m., and the deposit

was found to consist of an iron-ore vein 0.10-0.65 m. thick, with copper-pyrites in extremely varying quantities, partly finely infused, and partly in stripes 2-3 cm. wide.

2. East of the centre of the concession, copper-pyrites occur in quite rich quantities, partly infused in the hornblende-schist, partly in a quartz-vein 0.15 m. wide, and partly as crevasse-filling
3. SE of the latter there occurs a schist-deposit 4 m. long and 0.20-0.60 m. thick, with bornite and copper-pyrites sparingly infused.
4. SSW from this deposit, and in the direction of its strike, a new deposit was discovered this year, consisting of bornite-bearing iron-ore. By blasting this was exposed to a length of 22 m. and was found to be very rich in bornite throughout 16 m. of its length. As in all ores of this kind, the copper-percentage changes abruptly, and so does the thickness; the latter varies between 0.14 and 0.83 m. the richest ore is sometimes 0.22-0.25 m. thick. The deposit, with respect to size and value, seems to be comparable with Mathiegrafvan.
5. In the southern part of the concession, we discovered this year still another deposit of the aforesaid description, which we exposed for a length of 19 m., and proved to be perfectly analogous to the preceding deposit.
6. In the eastern part of the concession, a schist rich in magnetite and bearing copper-bornite and copper-pyrite has been found, this year, with a thickness varying between 0.15 and 0.95 m. /average thickness 0.42 m. / and of unknown length /. it has been exposed for a length of 7 m., but extends further in both directions /. Analyses of typical samples of coarse ore from this deposit have contained respectively 3.57 and 4.49 % copper.
7. In still another place in this concession a schist bearing bornite and copper-pyrites has been discovered this year, with a thickness of more than 1 m. We have unfortunately not had time to explore this deposit.

## KUOPSUK.

In this extensive mountain, mostly situated on Norwegian territory, a few smaller ore-deposits have been known for several years / within the concession Jils, Erik and Karl /, which have not, however, been closely explored. One of the chief objects of the summer's work was to explore these deposits thoroughly and, by means of a careful geological survey, to try to find new ore-deposits in this vicinity. As we have already said, we also found several ore-deposits which were hitherto unknown, and we at once explored them by means of excavations and blasting-work, to the extent that already on August 3 concession was granted on all known deposits within the Norwegian part of Kuopsuk.

Respecting the situation of the different deposits, see Pl. 1:1. Detail-chart of some of the separate deposits on this same plate are also given.

## J I L S.

The ore consists of fine-grained magnetic ore, which contains copper-pyrites in varying quantities, and on the floor is surrounded by a 3 cm. thick deposit of hornblende-schist rich in copper-pyrites. The copperpercentage of the ores varies between "traces" and 1.7 % and somewhat more.

The ore is exposed for a length of 25 m., and in some places it is 1.8 m. thick. 15 m. to the SW on the direction of the strike, there is a similar ore exposed to a length of 10.5, with a thickness varying between 0.15 and 1.0. This ore does not contain any copper visible to the naked eye, and an analysis of coarse samples thereof only showed traces of copper. Another typical coarse sample from this concession from the more northern ore, was found on analysis to contain 0.05 % of copper, 36.54 % iron-ore and 0.233 % phosphorus.

## E R I K.

The ore consists of fine-grained, sometimes almost compact magnetic iron-ore quite rich in quartz, with slightly bluish tinge, and frequently containing fine-grained copper-pyrites. Nearest the floor there is a deposit of irregular

shape, with copper-pyrites in crevice-fillings and pockets, and also finely infused, besides which there occurs here a thin mineral formation very rich in copper-pyrites.

The copper-percentage of the ore varies, according to several analyses, from "traces" to 2.5 % and somewhat more.

The deposit is exposed to a length of 73.5 m., but is probably still longer. The thickness varies between 1.6, 1.0 and somewhat less.

#### O T T O.

The ore deposit consist of a cupropyriferous magnetic iron-ore of the same kind as that in the concession Nils and Erik, but only 0.05 - 0.60 m. thick. The vein is exposed to a length of 80 m.

#### J U L I U S.

The ore in this concession consists of a somewhat cupropyriferous iron-ore, and partly of a mixture of copper pyrites and magnetic-pyrites, in small quantities in hornblende-schist or in quartz. The deposit is about 50 m. long.

#### B R O R.

This deposit, which was discovered in the beginning of July, consists, in contrast to the above described Kuopsuok-deposits, of bornite, and, in lesser quantities, copper-glance, very finely infused in a striped hornblende-schist.

The ore forms partly a continuous vein 25 m. long and 0.10-0.63 m. thick / average thickness 0.33 m. / and partly several larger or smaller lenses, which together form an oredeposit which, by the exploring done this summer, has been exposed to a length of 100 m.

The copper-percentage in this ore varies between 1.25 to 5 % in the poorer ore and 7.5 to 9 % in the richer ore.

#### W I L H E L M.

This concession, which is situated on the highest summit of Kuopsuokq contains an ore-deposit, discovered during the summer, which in some places is very thick.

The ore consists of fine-grained magnetic iron-ore which sometimes contains infusions of copper-pyrites. The

deposit has a very irregular form, which at least partial depends upon the rock being so extremely folded in this place. The thickness varies between a few centimeters in the northeastern part of the concession up to 10 m. With larger or smaller interruptions, the deposit has been exposed to a length of about 300 m. in this concession. In the direction of its strike to the NE, ore of the same kind has been discovered in several different places in the concessions Louse and Alwin.

Single coarse sample of the cupre-pyritiferous ore have, on analysis, been found to contain 0.9 - 3.75 % copper. The pure iron-ore, without any copper visible to the naked eye, was found, on analysing a typical coarse sample, to contain 0.15 % copper, 60.89 % iron, and 0.217 % phosphorus.

LOUISE and ALWIN.

In these concessions, there occur, as we have already said, only smaller deposits of iron-ore poor in copper, belonging to the same vein as the ore in the Wilhelm concession and therefore no special exploring has been done in them.

EACHKE.

This deposit, situated near the Swedish-Norwegian frontier, consists of bornite and copper-glance, in the form of small infusions and pockets in hornblende-schist. Since it was not discovered until the blasting-work in this vicinity had been finished, it has not been explored to any noteworthy degree, with respect to its extent and exact nature. A typical coarse sample from this deposit was found, on analysis, to contain 2.30 % copper.

KARL.

The ore in this concession consists of magnetic pyrites with copperpyrites in small quantities. As the magnetic-pyrites do not contain any nickel, and the copperpyrites occur in very small quantities, the deposits seems to lack practical significance.

LUNDQVISTGRUFVAN.

This deposit, which was discovered this year in

of the Ruopsuok Mountain, near the disembogement of the Tjuonojokk River into the Tjuonojaure Lake. The ore consists of zincblende in a vein, at the most 6 cm. thick in the gneissose rock occurring here. The zincblende is dark brown and free from admixtures of leadglance.

#### S J A N G E L I.

After the concession-survey had been made at Ruopsuok, the exploring-work was left off there and the force of workmen was removed to Siangeli. Here the work was concentrated on the concessions Herman and Ellen where, firstly, a regular opening in the day was begun in the deposit of copper-pyrites mixed with bornite discovered two years ago, and, secondly, exploitations were made in new finds of a variety of ore consisting of copperglance and bornite, very intimately mixed with almost compact, poor iron-ore of an appearance quite different from that of the usual, so-called bornite iron-ore. Finally a few small explorations were made in the concessions John and Isak.

#### The H E R M A N day-opening.

The opening N:o 19, Bl. 2:1. See also Pl. 2:2  
In my report for year 1895, the following was said in regard to this deposit, viz:

"Copper-pyrites occur in a stratified deposit with an average thickness of 0.9 m., with a NNE - SSW strike and WWW steep dip, partly as infusions, and partly in nodules 2-4 cm. in diameter. A small general sample thereof, taken straight across the strike, of the 0.76 m. wide ore near the east end of the exposed ore, showed 3.5 % copper, and two others taken straight across the strike of the 1m. wide ore in another part of the deposit showed respectively 6 and 6.5 % copper, while a sample of a 0.2 m. thick deposit near the floor of the same vein showed 16 %, and a general sample of all the unpicked ore obtained during this exploration showed 9.89 % copper. At the bottom of the copper-pyrites there occurs a partly drusy, occasionally borniteferous iron-ore."

This summer we have stoped down this deposit to a

depth of 5 m. and to a length of 6 m., and have laid the same open along the strike to the SW 30 m. further.

The richest ore consists of copper-pyrites and some bornite in a grey-green hornblendeschist, and occurs as a narrow vein, seldom 0.2 m. thick, at the bottom of a hornblendeschist 0.25-0.8 m. thick, which contains stratum-like stripes and small aggregates of copper-pyrites and a few scattered grains of bornite. In the roof thereof, however, the Sjangeli-schist is sparingly infused with copper-pyrites to a width 0.1-2.1 m. after which ordinary Sjangeli-schist continues. At the bottom of the copper-pyrite ore, the schist contains also scattered infusions of copper-pyrites and magnetite, and irregular, large and small nodules of brownish iron-ore, which in the eastern-most part of the opening forms continuous stratum-like, but irregular veins. Here and there large nodules of pure bornite occur, both in the rich copper-ore and at its bottom. Their occurrence contributes in a considerable degree to the increase of the copperpercentage of the deposit.

The cupre-pyritiferous Sjangeli-schist has been followed up by blasting 17 m. further to the southwest, and in the direction of its strike rich quantities of copper-pyrites have been observed in several places all the way into the steep mountain-wall, and thus this ore-vein has been followed for a length of about 40 m. Towards the northeast its continuation is obscured by gravel and blocks of rock, which could not be removed. The average thickness of the vein can be estimated at about 1 m.

In its hanging wall two parallel veins of schist containing sparingly infused pyrites have been exposed by removing the earth, but they have not been explored.

The ore obtained by this exploration was subjected to coarse picking, which left 36 tons of ore, classified as follows:

11 %	1:st class ore	with	9.52 %	copper
28 %	2:d " "	"	3.25 %	"
56 %	3:d " "	"	1.20 %	"
5 %	ore for washing	"	6.71 %	"

On account of unfavorable circumstances, the picking could not, however be done as thoroughly as desirable. By means of a more careful picking, the copper-percentage both in 1:st class and 2:d-class ore would be increased in an essential degree, and from the 3:d-class ore a considerable quantity of second-class ore could be obtained. In the picking now done, the ore was seldom broken to finer pieces than one cubic-decimeter.

HERMAN - ELLEN.

/ See chart, Pl. 2:1 /

75 m. SW of the abovedescribed Herman Day-opening, we observed in several places in the rock infusions partly of copper-pyrites and partly of copper-glance and bornite. In order to find out in what degree this district is ore-bearing we did quite thorough blasting-work here to a slight depth but over a large area. Thus we first removed the earth and blasted to a length of 33 m. at right angles to the direction of the strike. This showed what the Sjangeli-schist contains copper-ore in quite rich quantities, partly in small pockets and nodules, and partly finely infused in the schist. The ore does not, however, occur en masse, but is distributed in a number of large or small pockets in two zones, resp. 11 and 6.2 m. wide, separated by a deposit of normal Sjangeli-schist 3.5 m. thick, without ore. In these oriferous zones, the schist is somewhat different from the usual Sjangelischist, being lighter in colour, more compact, richer in felspar, and sometimes containing porphyric hornblende-crystals. The more easterly and thicker of the aforesaid oriferous zones contains partly several small deposits bearing copper-pyrites in slight quantities, partly three separate deposits which bear bornite in more (less or) rich quantities;

Thus, for instance, in the eastern end of the opening, there is a vein of schist quite rich in bornite, 0.35 m. wide and 7 m. west thereof, there is a schist-layer 2 m. thick, which contains 4 separate bornite-bearing veins with a width varying between 0.12 and 0.25 m. We did not have time to determine the length of this oriferous zone.

In the western zone, there is an almost compact, poor iron-ore, with finely infused copper-glance and bornite, and a brownish schist, rich in magnetite, also very finely infused with copper-glance and bornite. In this zone, which is 6.2 m. thick, 6 such oreveins has been observed. Their thickness, which is varying, sometimes reaches 0.8 m. In the direction of the strike to the northeast, such ore-veins have been observed with a length of 30 m. and have been explored by openings, N:o 11 and 12. In the first-mentioned of these, a quantity of ore has been blasted out, which, after picking, produced:

4 tons	1:st class	Coarse ore,	with	5.85 %	copper;
2.5 "	2:d	" " " "	" "	2.58 %	" "

Even the little quantity of the ore obtained during the exploration-work in the western ore-zone in opening N:o 14, was subjected to test-picking, and produced 1.8 tons of ore as follows:

17 %	1:st class	coarse ore	with	6.16 %	copper
28 %	2:d	" " " "	" "	2.31 %	" "
55 %	3:d	" " " "	" "	1.57 %	" "

Even further to the north the same kind of ore has been found and been explored by openings N:o 8, 7, 6 and 4. The first of these openings exposed a lenticular deposit, quite poor in copper, 7.5 m. long and 0.6 m. thick at the most. In the direction of its strike, but separated therefrom by non-oriferous schist, is the ore-lense, 8 m. long and in some places 2 m. thick, in which opening N:o 7 was made. In this lense, the copperpercentage varies abruptly and within wide limits. In order to get some idea as to the kind of ore to be obtained here, a small quantity of ore was blasted out, and subjected to test-picking, which left 9 tons of metallic ore as follows:

11 %	1:st class coarse ore	with	4.97 %	copper
33 %	2:d " " " "		2.72 %	"
56 %	3:d " " " "		1.75 %	"

Opening N:o 4 has in ist western part the same kind of ore as the preceding, 0.6 m. thick in the northern and 0.2 m. in the southern part.

Of the other openings shown on Pl. 2:1 only N:o 3 deserves to be mentioned. This contains a vein of schist, 0.2 m. wide, quite rich in bornite pockets and grains of copper-pyrites. At a distance of 2.5 m. from here, in the hanging wall, there is a depth of schist 0.12 m. thick, with copper-glance finely infused, and bornite-pockets 2-3 m/m. wide and up to 0.1 m. long. The length of the strike is not yet known.

#### J O H N.

By blasting in the northwestern corner of this concession, near the engineer's house, we found a vein of pure bornite, 5 cm. wide, which, however, ceased a meter or two distant. Immediately east thereof, we found a schist bearing copper-glance and bornite, which with one or two small interruptions, was followed up to a length of 10 m. The average width is 0.24, of which 0.10 consists of very rich ore.

#### I S A K.

About 15 m. northwest from the preceding concession, we did some blasting, on a small ore-pocket which we had already observed. Here we found a partly very rich ore-vein with ores of several different types / among others, also of the same kind as in Herman - Ellen /. The average thickness is 0.36 m. / varying between 0.09 and 0.063 m. / and the vein has a length of more than 12 m. / its continuation towards the NNE is obscured by a covering of gravel /.

Besides the exploring-work, an account of which has just been given, the mine-opening work required by law has also been done in the orefields of Ojängeli, Valfojokk, Unna Allakats and Ruopsuokjåure. The new information obtained in regard to these orefields and the ores occurring in them,

has in every case corroborated the results of the exploring-work of former years, which has been accounted for in the reports of preceding years.

### S U M M A R Y.

The results of the exploring-work done during the summer are short, the following:

By means of the geological survey, the extent of the oriferous rocks of the Sjangeli district has been accurately determined. In connection therewith, several new ore-deposits have been discovered outside of the hitherto known ore-fields, namely on Mount Kuopsuok in Norway, and at Sjangelitjåkko and Kuokule, Sweden.

Earth has been removed and blastings have been made principally in Valfojokk and Kuopsuok ore-fields and in the concession Herman on Sjangeli.

In the Valfojokk ore-field, more extensive work has been done, principally on the concession Mathie, where, during last year the largest number of ore-deposits were discovered, besides which numerous small blastings were made in the other concessions. This exploring-work has proved that bornite, copper-glance and copper-pyrites occur in varying quantities, mixed with magnetite, or with hornblende, chlorite etc., in different ways, over the whole ore-field, especially in a wide zone, which extends in a NNE direction through the concession Arvid, Märts and Mathie. In this zone ore-deposits occur in very great quantities, and during the course of the exploringwork, new finds were made almost daily. The ores generally show the same properties as the Sjangeli and Unna Allakats ores, well known since the explorations made during the preceding years. They generally constitute more or less elongated, narrow lenses, quite sharply defined from the surrounding Sjangeli-schist or stratum-like deposits of comparatively great longitudinal extent, / the orevein of the Mathiegrufvan, for instance, is over 66 m. long / in which the copper-percentage abruptly changes within wide limits. The thickness of the oredeposits varies greatly. While the thickness of the richest

ores is very slight, down to one or two cm., in the poorer ores it reaches one meter or more. A thickness of 0.26-0.50 m. is very usual in ores of average copper-percentage. As to copper-percentage there are ore in the field with the most varying percentages. The occurring in small stripes frequently contains 27-38 % copper. In the thicker and more important deposits, typical coarse ore-samples have been found to contain 12-5 % copper, and less. Finally there also quite ores which, after coarse-picking, produce ore containing 3.4-3.6 % copper, and all degrees of transition to non-cupriferous iron-ore and schist. Generally copper-pyrites occur in large quantities in the Valfojokk than in the Sjangeli and Unna Allakats orefields.

Explorations on Ruopsuok have proved that bornite and copper-glance only occur here in two different places, namely on the concessions Bashke and Bror. While the former deposits is not yet carefully explored, the latter has been found to contain a large supply of copper-ore, with about 6-8 % copper. Including small interruptions, this deposit has a length of 100 m. and the average thickness is about 0.33 m. The other deposits on Ruopsuok contain principally iron-ore, and only in an inferior degree copper-pyrites.

By means of blastings on the concessions Herman and Ellen, in the Sjangeli district, much new ore has been discovered, since the copper-pyrites in the Herman-dayopening have been found to have a much greater longitudinal extent than has hitherto been known, and several new deposits of bornite-bearing ore have been exposed.

Even the blastings on the concessions John and Isak have exposed new ores, and they show, furthermore, that even in the Sjangeli-district, which has been so carefully explored, both long ago and recently, there are quite a number of deposits which have not yet been discovered.

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The results of the explorations of the summer, which have essentially increased our knowledge of the ore resources of the Sjangeli district, especially as regards the Valfojokk and Ruopsuok orefields, have not given me cause in any respect to alter my opinion of them, which I have expressed in my preceding reports.

Stockholm, in November 1897.

Walfr. Petersson.

DESCRIPTION

over

SJANGELI COPPEROREFIELD

and

OTHER ADJOINING MINERAL LODES.

By

HJ. LUNDBOHM

Upon the application by Mr. Jacobi in Stockholm June 1894 to the chief for Sveriges Geologiske Undersökning that I may be commissioned to make a survey and examination of Sjangeli Copperorefield in Norrbottens Län, and since the accordance with instructions for said institution the application herefor went to the chief of Kungliga Civildepartementet received I the order to, at the expense of Mr. Jacobi, carry out said work. On this account I went in the middle of Juli 1894 to Sjangeli in company with the manager of the Miningdepartement of Kemiskt Tekniska Byrån in Stockholm Dr. Fil. Valfrid Petersson who had agreed to assist me.

Between us the work was thus divided that Mr. Petersson first made about 90 preliminary quantitative analyses of minerals which were supposed to be more or less copperbearing. Then he made a magnetic map over a part of the field as well as a Mark-scheidermap over some of the most important Claims and within them located orelokes, and at last were collected the 40 specimens which are mentioned in the following description or report.

During the time this was done by Mr. Petersson I drafted a geological map of the whole field and surveyed certain parts of the same; examined all lodes and measured the most important in detail. I examined also some in the neighbourhood of Sjangeli. At Unna Allokats And Ruopsakakte in Norway located trenches and pits, and directed the preliminary work which during the summer was carried out, under the immediate superintendence of the foreman E. C. Lundquist, by 3 Swedish miners and 5-6 Norwegian workmen.

The maps drafted by us and appended to this description are:

General Geological Map over Sjangeli Orefield.

Scale 1 : 4000

Geological Map over Sjangeli Orefield in two sheets.

Scale 1 : 6000

Detailed map over some of the more important trenches and pits.

Markscheidermap over Sjangeli Mine in four sheets.

Sjangeli orefield which is supposed to have been known since 1696 and which on several occasions has been exploited to a greater or smaller extent, partly to find out the productiveness of the oredeposits and partly for producing ore, has before been described in following with one exception unprinted work.

Geschworne J.A. Busch' berättelse till Jukkasjärvi Koppareruf-Bolaget den 28 Sept. 1842 / appended is a smaller Map in Scale 1:1000.

Annotationer öfver Sjangeli Kopparmalmsfält inom öfver Torneå. Lanmark / with references to the map / scale 1:1600/drafted.

by the autor in the summer 1844 by G. Ekenstam March 1845. Underdänig berättelse om undersökning af Malmfyndigheter inom Cellivare och Jukkasjärvi socknar af Norrbottens län. Om Sjangeli by O. Gumbelius. Printed in Sveriges Geol. Undersök. Ser. G. N:o 23, 1887. Page 82.

Rapport om Sjangeli Ertsfält af P. Holmsen, bergmästar i det Trondhjemske Bergdistrikt, Okt. 1891.

Report on the Sjangeli Miningfield in Sweden by Charles Roberts September 1893.

In the first three of these is found closer information upon the history of the orefield, which also, on the basis of previous reports, is most fully treated by Gumbelius.

Ekenstams description of the orefield is very complete and contains many valuable informations both regarding the extension of the oreveins as well as the composition of the ores and the cost of mining.

In Holmsens report the trenches are described more briefly, but it gives latter analyses and a number of other informations of value.

Roberts report is only a very short review based on impressions which the author got during a visit at the place.

In the following description I shall quote from above mentioned Reports such statement which I think in any way may contribute to forming an opinion about the value of the orefield.

## The location Surroundings and Climate of Sjangeli.

Sjangeli is a ridge of mountains located at 68°12' North by 0°-10' East from Stockholm not fully 10 km. East of the Swedish-Norwegian frontier, between the stonemarks # 263 and 264 about 30 km. SW from Torneträsk and 47 Km. from the innermost point of that part of Ofoten bay which is called Sjomenbay. South from the mountains is a clearly defined valley continuing all the way to Torneträsk and at the bottom runs the river which in the beginning of its passage is called Kamajokk and further on Abiskojokk. West from the frontier the water finds its way to the Sea in a likewise generally well defined Glen through Nordelfven and lower down Sjomenelfven which both form several large rapids and Waterfalls. On the south side of this Glen is found the path which leads from the coast to Sjangeli. On the north side is proposed to build the railroad which should connect the mines with the harbour in Sjomen. The road from the coast is for a littel more than 7 English miles fairly good. It is then very rough during the ascent, till the planes are reached, when it again is easy to travel with the exeption of crossing a few smaller rivulets and streams.

In Abiskoelfvens valley seems to grow a thick and coarse birchwood, but the boundaries of this are only a few km. SE from Sjangeli and in the valley south from the Mountain and for several miles to the west is only found occasional trees and shrubberies. Sjangeli mountains is perfectly devoid of trees. During our stay at the place our fuel was taken from the birchwood, and the slopes of the mountains were robbed off all the scanty growing juniperushushes we could find. But in spite of this absence of all vegetation the country is of great beauty and grandeur. The valley in which Kamajokk river finds its way between small lakes is large and wide. Above are even and wide highlands on which rest gigantic, sometimes softly rounded sometimes wild and rocky mountainridges; with peaks reaching above the snowregion or covered with glittering newfallen snow. All this seen in a lighth only found in mountain-regions gives to the country a beauty which cruses one to forget the

difficulties and inconveniences otherwise connected with the life in a place like this.

The climatic conditions in Sjangeli are naturally very unfavourable but ought not to be of any essential impediment to a regular exploitation of the mines.

#### The Geological Conditions of Sjangeli and Surroundings.

At the bottom of the valley east of Sjangeli appears a gray strongly compressed Gneis which seems to contain layers of Quartzite and therefore probably not belongs to the igneous Rock. On this Gneis rests as is shown on the general Map sheet I, the Orebearing rock, more or less steeply inclined to the SW and, consisting of a dark, green, dense Hornslate, which contains smaller stratas of an often dolomitic Limestone, and larger or smaller lensshaped bodies of strongly transformed Gabbro. This Hornslate is to the west bounded by an about 150 meters wide steeply to the SW inclined stratum of sometimes grey sometimes white dolomitic Limestone which seems to have an wedgeshaped stretching to the North, but to the SW goes very far and a couple Kilometers from Sjangeli is of a considerable depth. Nearest from the West from this Limestone stratum has on several places been found a hard brown or grey slate comparatively rich in Quartz West from this begins more or less transformed Hornslate.

Between Sjangeli and in direction WSW on the other side of the Norwegian frontier, in Ruopsakpakte located trenches, is such slate most common, often containing Gneis and generally coarser and not of an other appearance than the Hornslate found within the orefield. In some places are however found varieties looking like the last. Larger and smaller probably lensshaped parts of massy Greenstones appear frequently and here is also as in Sjangeli found smaller stratas of Limestone.

Within a smaller Territory on both sides of the frontier occurs a strongly transformed dark green and / on surface dissolved by the air / rustcoloured Blivinstone.

Immediately to the North from the Orefield seems the Ore-carrying Zone of Hornclate in Argillite with streaks of blue-grey quartzite. These series of minerals are in the mountain-chains located N and NNE covered by a coarsegrained grey mostly strongly compressed and transformed Granit, which also farther to the East is found under the Argillite and quartzite and probably, as far as at present can be judged, seems to be of a latter period than these.

It was not possible to determine the geological age of the minerals during our stay at Sjangeli. F. Svenonius has however on his geological General Map over Norbottens län placed them in the Micaseries and Phyliteseries, which both are considered to be laying over the Hyaliteseries and therefor should be of the Silurian age.

Printed 1892 in the Report over Apatite Investigations in Norbotten.

### SJANGELI OREFIELD.

The territory within which the ore at present is found and which is known as Sjangeli Orefield is a little more than one half kilometer in width and has a length of about 3 kilometer, running in the direction NNE - SSW and forms a smaller independent mountain ridge on the large Mountain called Sjangeli. On the NW side this Ridge is bordered by a not very deep Glen, and to the North by a small Marsh called Sjangeli Träsk, with an area of about 0,16 Square-kilometer and supplied with water through several small rivulets running down from the Mountains in the West. 1st outlet is to the East side through the Brook marked on the Map. This brook falls on a distance of 400 meters about 38 meters, passes then over a terraced shaped plateau and runs at last through a steep slope to the bottom of the valley forming several small waterfalls.

The southeast side of the Mountain is generally very steep, and at several places, as for instance the claims Anna, Fredrik, Theodor, and so others, it raises almost perpendicular. The bottom of the valley East of the field is probably located about 300 meter below the highest point. All lodes in the Northern part of the field are since 1889 covered by 16 on the Map marked Claims and the owner of these has through Titles - the name of which are marked on the Map - got full possession of all known ore lodes Southwest and East of the

regular claims or allotments. The minerals within the field are, as before has been mentioned, Hornstone and Gabbro and smaller shreds of Limestone. The Hornblende is of various appearance but generally dark green of very fine structure or very dense. Under the microscope it is found by Mr. Petersson to contain mostly blue Amphibol but also Felspar in very small grains often with specks of Sositenedes and sometimes Titanite, Turmaline and other minerals. Occasionally Quartz occurs in larger or smaller lensshaped bodies in the late and usually appresses with sharp lines of demarcation is generally massy, middlecoarse to finely grained, on the borders occasionally slaty. It consists generally of more or less strongly transformed Plagioclas and probably new Amphibol, together with Titanomagnetite, Pynite and Biotite, the last two more scarce. Some of the Gabbro-lumps in the northern part of the field are of a slaty appearance with very little felspar, but with plenty Porphyric Chrystals of Amphibol, or aggregates of such. Epidote is very common as filling fissures both in the slate and gabbro. Both minerals show, with the exception of a different grain, a surprising similarity under the Microscope.

As the number of specimens examined, there will be over 100, of which about 100 have been examined.

THE OREDEPOSITS.

The copperbearing minerals found in Sjangeli are copperglance Bornite and in smaller quantities copperpyrites. Also Malachite but only significant as a guide for mining the ore, and very seldom native copper. The first two appear almost always together exceptionally alone, but mostly in combination with Magnetite.

Both regarding the mineralogical composition and productivity, the Sjangeli Ores show greater variations. But it is hardly possible to refer the different varieties to any certain distinctly different types, because they are through a great many transitory forms closely connected to one another. Notwithstanding this, and with regard to their occurrence, following different kinds may be distinguished.

1. Magnetite with Bornite and copperglance in very varying quantities.
2. Magnetite with copperpyrites both in tabular beds and in

veins.

3. Bornite and copperglance / without Ironore / laying  
as shists or lensshaped bodies in Hornslate.

4. Bornite and Copperglance / with very little Magnetite /  
as fissureveins cutting the texture of the Hornslate.

Those belonging to classes 1, 2 and 3 are either laying  
in conformity with the planes of stretification of the Rock, which  
are inclined  $55^{\circ}$  -  $70^{\circ}$  to WNW. from the horizon, or they cut the  
same at a very oblique angle. The thickness of the veins or ore-  
carrying Zones varies between a few centimeters and 1 to 1,5 meter.  
About the extention of the same is very little known, but when some  
only have a length of a few meters others have been followed for  
at least 800 meters.

It is very remarkable and interesting, both from a purely  
practical and also from a scientific point of view, that as far as  
is known at present the ore only is found together with Hornslate,  
and with few exeptions never in the massy Gabbro.

The number of places where ore is found is very large and  
if all, even the smaller without practical value, are taken into  
account there will be over 130, of which about 100 have been examined.  
Most of these are located within the above mentioned 16 Claims and  
particulary in Isak, Adolf and John, or the territory called Gruf-  
berget of which there is a Markscheidermap in Scale 1 : 800.

The ores of the Sjängeli Field are as seen from what has  
said above, with regard to their mineral and chemical combination  
very different from other copperores found in Sweden. These cir-  
cumstances as well as the Geological occurence and in connection,  
with this the interesting and important question how the ores have  
originated, shall need a further treatment than what may be proper  
in this Report which only purposes to show the purely practical  
results of the examinations.

Analyses made at different times and given in the following  
description and tables pages 61-67, show a very various richness  
of ore from the same veins and trenches, which also seems to need  
an explanation.

As previously has been remarked and as again will be shown

in the description of the different oreveins, these are of a very varicus nature, so that in the same vein may at one place be found a very rich copperore and in an other only a few meters distant a very lean kind, or Ironore with a low percentage of copper. The distrubition of the copperminerals is also very irregular. The richest ore is sometimes found in the centre of the vein, sometimes in the hanging wall, or at the foot wall. An ordinary sample of one piece gives therefor generally a wrong idea of the quality of the ore.

The collection of specimens, representing the true composition of the different qualities of ore which can be mined, is connected with great difficulties, as only small quantities are obtainable in the narrow pits. But to make every sample as nearly as possible represent the whole obtainable quantity of ore which could be meined at an eventual exploitation, great care was exercised by us. Nearly all samples were taken from new blasts, the dressing was done under the immediate supervision of mr. Petersson and the ore, as it came up, was only riden of such gauge which could easily be taken away.

By crushing and dividing special care was taken to insure against faukts arrising from different grade og hardness a.s.o. The copper-percentages are generally lower in these samples than those given by Holmsen, Roberts and Ekenstam / Table Pages 61-63/.

By a practical working of the mine it nught to be possible to more carefully dress the ore; thus raising the metallic percentage and it should also be rememered that a great many of Sjangelis ores are very suitable for concentration.

In accordance with the instructions I received from mr. Jacobi ops should be made over the whole field and all lodes examined.

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As basis for the drawing of maps was used the Claims or allotments. The placing on the map of the trenches was done partly by the use of distance-tube and partly by coordinates measured from the stonemarks in the corners of the Claims. Lodes and points to the SW from the Claims were measured from a new baseline. /A - B on the general map /. The measuring on the east slope of the mountain - The Claims Maximus to Snorre - was an account of the rough ground very difficult and some of these points may not be correct.

To facilitate this all trenches had been emptied of water and cleaned and in order to not have to do this slow and expensive work over at another time the following contains an extensive description of all excavations whether they contain ore of value or not.

Statements in older reports giving the width of the crevins are often very disagreeing, probably on account of the difficulty in defining the ore limits. To prevent mistakes as much as possible in this respect, numerous samples were taken of such minerals in the hanging wall and at the foot of the veins which could be suspected to contain copper, and on these were immediately made quantitative calorimetric determinations of copper by Mr. Petersson. The width of the crevins as given in the following report are therefore in most cases probably correct.

#### CLAIM HENRIKA.

In this claim is only one trench of any importance namely:

1. Henrikaskärpningen. This is about 3.5 meters in length and 3 meters in depth. The rock is normal Sjangeli slate which however nearest to the ore seems to contain a greater quantity small lustrous particles of Ironore than usual. Otherwise occur spots of numerous fissures and cracks filled with Epidote.

The ore is finely grained of a blue colour and consists of Magnetite with Borite and Copperglance, partly finely impregnated, partly collected in small irregular bodies and mostly appearing in the middle of the vein, which is of a leaner character at the sides.

As is seen on the map / Sheet IV Fig. I., the vein forms a shist, in the open hardly more than 1.5 c.m., but at the bottom overaging 12 c.m. in width, which is parallel with the texture of the rock and slopes 54°W. About the strike of the ore is nothing known with certainty because the soil has prevented the following at the vein for any greater length. Lohmsen thinks it probable that a smaller trench with signs of ore located 60 meters to the north belongs to the same vein. To the south in the course of the vein are some insignificant orestreaks on the east side of the Gabbro gland in claim Tornberg, and it may

ne possible that these are connected with the ore in Henrika T  
trenches. The specific gravity of the slate is about 3.12 and  
of the ore, in average from 10 weighings 4.1. The copper=  
percentage in one sample taken from pieces broken loose from  
the orestreak, and which at the crushing weighed 120 Kgr.  
amounted to 4.16 %, the silver quantity to 1.20 gram per 100 Kgr.  
ore, a sample taken by Holmsen gave 8.18 % copper and one piece  
brought by Roberts 6.76 % copper.

Ekenstam states that in the trench in claim Johannes  
which probably is the one in the question, is the ore vein in  
the depth of 7 or 8 feet 10 to 11 inches wide and at the depth  
of 13 feet 8.5 inches, but he has probably not measured only the  
pure one. In two by Ekenstam made proofs was the copper resp.  
15.62 and 9.6 % and silver in the first "3 Lod pr. Center" of  
metallic copper or 0.093 % equal to 9.30 gram pr. ton.

#### CLAIM TORNBORG.

2. Trench on the east slope of a Mountain consisting, partly  
of slaty, porphyritic Gabbro and partly Hornslate in thin shists  
which slope 70° W. The ore veins seems principally to consist of  
Ironore with Malachite on fissure surfaces and is nowhere wider  
than 7 c.m. but often only 2 to 4 c.m. It was examined on a  
length of 8 meter, but was very likely a greater extention.  
The direction of the vein goes towards Henrika-skärpningen.
3. Trench close above No 2 in slaty porphyritic Gabbro  
which contains thinly foliated nonporphyritical shists. In one  
of these shists, 5 to 10 c.m. wide carrying Epidote and Magnetite,  
is a little impregnated Bornite, otherwise no Copperore.
4. Tornbergs-skärpningen. The only trench within the claim which can  
be considered to be of any value is about 4 meters in length and  
3 meters in depth. The ore vein consists of narrower or wider  
streaks of Bornite and Copperegalnse, laying in  
Magnetite and Hornblende a.s.o. and varies in width between 10  
and 20 c.m. The whole coppercarrying Zone is however larger.  
For instance in the width of the ore on a length of 8 meters  
between 3 and 9 c.m. The rock is here rich on Iron on a width  
of about 4 meters and contains a couple of narrow seams con-

rich ore 13 Kgr. and lean ore 8 Kgr. The first carried 9.49% copper, the last 5.99%. Native copper were found in very small quantities.

Holmsen states about this trench that the vein was 12 inches in width at the bottom, and 9 to 10 inches at the ends, and that a proof showed 13.26 % copper and 0.006 % silver.

Roberts brought pieces which gave 17.99 % copper.

#### CLAIM FREDRIKA.

5.

Trench in slaty porphyritic Babbro. In one small crack filled chiefly with Epidote were found grains of Bornite. Otherways no more.

6.

A not worked but partly uncovered orevein not very wide but rich in sedimentary Malachite. Ought to be further examined.

7.

Anna Kajsa Skärpningsen, is probably the most important within the claim. It contains two smaller trenches, the north cut nearly 6 meters and the south 3 meters in length, and located on a vein which both regarding the quality of the ore and the width is of a very various nature.

The ore is finely grained to dense and consists of Magnetite, Bornite and Copperglance, mostly as a homogenous mixture but also in separate aggregates or small streaks. The pure ore seems to be surrounded by an apparently leaner kind, and the vein is probably very varying regarding the quality of the ore.

11.

Fig. 2 Sheet IV. shows the dimensions of the orevein in the south cut. The width of pure ore varies between 10 and 17 c.m. and will probably average 10 c.m. On certain places the width of the vein is 40 c.m. and at an average 23 c.m. Only very small specimens could be obtained but these showed: from the North Trench 15.48 % and from the South, where the ore was dressed and sorted, rich ore in lumps and streaks 11.32 % and lean ore with impregnated Bornite 3.04 % copper.

In the northern part of the trench the orevein is tapering off, but will probably not disappear although this could not be definitely ascertained on account of the soil covering the rock. To the south the ore can be followed to the foot of the Mountain and is known of a length of altogether 42 meters.

South of the trenches where the width sometimes is 20 to 25 m.c. shows, in the open mostly Ironore.

Holmsen states that in the northern cut has the ore a width of 12 inches and contains 17.58 % copper and in the south about 8 to 12 inches. He adds that this vein looks to be very promising. Of two samples taken by Roberts one shows 13.57 % and another 1.70 % copper.

8. A small trench in Hornslate dipping 53° W. In the south end contains this slate numerous small layers of Ironore about 2 to 4 c.m. in width and one stratum slate 1 to 5 c.m. thick with plenty sedimentary Malachite. This could only be followed for a few meters distance, but probably belongs the Malachite the carrying slate which is found about 8 meters North of the cut to the same vein. Several veins are found in the neighborhood. In Roberts specimen of the slate contains 4.20 % copper.

9. In the direction of the course of the vein about 30 meters south of trench 8 is a stratum thin slate 30 to 40 c.m. wide, which contains many layers, very rich in Malachite and which was used for 3 meters, but apparently is of much greater extension.

10. The rock is an a width of a few decimeters more or less impregnated with Bornite, particularly in a layer several centimeters wide, which can be followed for 4 or 5 meters up the slope of the Mountain.

11. Trench in Hornslate with 60° inclination westward. It shows a 7 c.m. thick vein of Ironore impregnated with Bornite. A sample by Holmsen shows 2.05 % copper.

12. Very small cut in coppercarrying Hornslate with an about 2 c.m. wide shist looking like Ironore with copper. Stript on a length of 0.5 meters.

13. Very small trench in Rock showing a very small percentage of copper.

14. Trench in dense Hornblende. No collected ore found, only Epidote layer specked with Ironglence and some Bornite.

Between 13 and 14 is a smaller cut at both ends of which is a 5 to 8 c.m. wide reddish Ironore. No copper found.

About 10 meters SE from 13 is found small lumps of Iron-

and Copperore.

15. At both ends of the 3 meters long trench appears a 7 to 8 c.m. wide streak of lean Ironore and Bornite or Copperglance.

16. In a small trench on the slope of a Mountain are two copperbearing shists on a distance of 70 c.m. from each other. The westerly one / Slate impregnated with Magnetate and copper mineral / is stript on a length of 4 meters and seems to be generally very lean. The easterly is about 50 c.m. wide and is rich on Epidote but carries very little copper.

17. On the steeps of the Mountain is a vein of white quartz, with some hydrated oxide of Iron and Hornblende a.s.o. 40 c.m. wide which undoubtedly is a continuation of the vein seen on the North shore of Sjangelibäcken within the Claim Isak, and thus is known on a length of about 70 meters. Analyses of a large sample taken in the neighborhood of the number showed Gold at the rate of 0.16 grain pr. 100 kgr. Rock.

CLAIM BURMAN.

18. Small trench with unimportant orestreaks.

19. A not exploited crevein running in the open for a length of 25 meters, and probably connected with a somewhat more to the North located lode, in which case the vein is at least 36 meters long. The further extention to the South is not known on account of it not being stript of the soil.

The vein is in the open not more than 20 c.m. wide, sometimes narrower. After blasting it was found at one place to be of a dense stratified mineral rich in Iron with a width of 13 cm. and containing a considerable amount of Bornite partly distributed in thin shists, partly finely impregnated. A typical sample showed 11.82 % copper.

West of the crevein and nearly parallel to it runs another quartzlead.

20. Burmans Trenches are two pits filled with water and ice, having a length of 20 to 30 meters, 4 meters wide and accor-

ding to statement 11 to 12 meters deep. When Holmsen visited Sjangeli these pits were emptied and he says regarding the quality of the ore: On the bottom remains very little ore, not collected in any definite vein or streaks. But there is a 5 to 6 inches wide lead of Epidote which can be followed to the open. On the old heaps of refuse found much ~~partly~~ good ore which shows that a considerable quantity of ore has been mined here and he thinks that if work is again commenced new fine ore will be found. A sample from the pit taken by him shows 9.78 % copper and another from loose pieces laying around 10.42 % .

Ekenstam states regarding this trench, that it was 20 feet long 7 feet wide and 17 3/4 deep. That the ore vein in the open had been two inches wide, on the depth of 8 feet 9 inches and that it at a depth of 11 feet increased considerably, reaching a width at 15 feet of 35 inches. The vein consisted of 3/4 copper ore and 1/4 gangue. The ore is mostly livercoloured with spots of Serpentine. Two samples showed resp: 29.68 % and 29.60 % copper. He also advises that the work here be continued with so many men as conveniently can be placed at the pit. During the year 1844 had only by searching for ore, been obtained 7 to 8 tons ore from this cut.

Hornblende with Epidote, Ironore and Bornite in irregular lenses  
Both these Samples carry 0.006 % silver.

CLAIM CARL.

21. A 2 to 3 c.m. wide vein of Bornite and particularly fine sometimes pure copperglance which abruptly cuts the planes of stratification of the enclosing rock. By blasting could the length of the vein be determined to more than 3 or 4 meters. A sample of pure copperglance showed by analysis 71.59 % copper. In the neighborhood is an unimportant streak of Ironore in small lenses.
22. Trench of probably Quarry in Hornblende, without ore.
23. Small insignificant streak of copperore.

24. Trench with no ore.
25. A long not worked streak, in the open showing Ironore. In the direction of the course of the same are several streaks of Ironore with Malachite.

CLAIM BERZELIUS.

26. At the south end of the trench are two resp: 40 and 50 c.m. wide leads of Rock rich in Epidote with Bornite. All that has been mined during the last two years contains very little ore.
27. In a small trench occurs pure Bornite with crystals of Magnetite, forming a 2 c.m. wide lens or possibly a small vein.
28. Small trench in magnetic Ironore which at the widest part is 14 c.m., but sometimes only 3 or 4 c.m. wide. Has been followed for a length of 4 or 5 meters. A small streak of Malachite is all what is visible of copperore.
- One meter to the east of this is a smaller cut with very little ore.
29. Trench in stratified Hornblende dipping 70°W and containing a streak of Ironore hardly over 2 c.m. wide.
30. A trench about 4 meters long and 4 meters deep with an over-streak at the bottom and South end, varying between 18 and 40 c.m. in width. The ore consisting according to Mr. Petersson of Epidote with impregnated Sulphur-pyrites, Bornite and Copper-pyrites. North of the trench the vein can be followed for a length of at least 22 meter, but it is of no considerable depth or width East of, and near, the crest-streak is a narrow quartz-lead. A sample of the ore / 24 Kgr. / coarsely dressed in sizes of a fist showed only, 1.77 % copper. The dressing could have been done more carefully but in such case the quantity of ore would have been smaller.
- A sample brought by Roberts showed 1.89 % copper.
32. Trench about 5.5 meters in length and 4.55 meters in depth. At the South end and the West side remains according to Dr. Petersson an over-streak about 7 c.m. wide which can be followed to the North end and has a width at the bottom of about 5 to 6 cm. It consists mostly of copper-pyrites. A small sample gave

0.99 % copper.

Sample taken by Holmsen from this trench showed 14.98 %<sup>1)</sup> and one by Roberts consisting of two pieces / one copper-pyrites with Bornite and the other gauge with some Malachite / 10.38 % copper.

Ekenstam speaks of two trenches in Claim Bergmästaregrufvan of which the East probably is the one described above as No 32.

Of two orebodies is one said to have a width of only 2 to 3 inches in the open, and to consist of slaty Talk, Quartz and some Graphite. The other should at a depth of 8 feet have been 25 inches wide of which 16 to 16 inches Ore, the rest Gauge. At the bottom should the rock have been impregnated with streaks of copperore. Of two specimens one showed 52 % copper 0.0516 % silver and evident signs of gold, the other 21.14 % copper.

33. In this shallow trench appears a peculiar ore, much resembling the one found at Unna Alakats, and consisting of dark Hornblende with Bornite and possibly also Copperglance, partly in streaks 5 to 10 u.m. wide and partly in lenses from a few millimeters to several centimeters extension and sometimes appearing very frequently. The orebearing zone, which seems not to be very distinctly defined from the enclosing homogenous Rock, is in the open at both ends of the cut quite narrow, but has at the bottom following dimensions:

	0.5 meters from the North End 35 c.m. wide								
2.0	"	"	"	"	"	"	12	"	"
2.5	"	"	"	"	"	"	52	"	"
3.0	"	"	"	"	"	"	16	"	"
4.3	"	"	"	"	"	"	80	"	"
5.0	"	"	"	"	"	"	82	"	"
6.0	"	"	"	"	"	"	25	"	"
7.0	"	"	"	"	"	"	25	"	"

To get an idea of the extension in the field and the depth of the vein much blasting is necessary. A sample, coarsely dressed, showed 5.53 % copper. The ore seems to be very suitable for concentration.

<sup>1)</sup> One specimen by Holmsen probably from this cut showed 0.005 % silver.

cutting the stratas of the Rock.

35. At the south end of the trench is no visible copperore, but there are two veins of Ironore which generally follow the planes of stratification of the surrounding rock, having a slope of 72 °W. Sometimes they cut the same.

The rock in bottom of the trench, for a length of about 3 meters and 1.5 meters width shows all over impregnated Bornite, and the same minerals forms a number irregular veins. The two largest of these runs together and at the junction the width is about 7 c.m. Otherwise it varies between 3 and 0.5 c.m. or less. Some of the veins follow the plains of stratification others cut the same for instance one part of the largest vein with a slight inclination. It contains lumps of Epidote. In the foot wall is also bornite but the hanging wall is on the contrary lean. The width of the Bornite carrying zone is at least 1.5 meter. It is impossible without extensive exploitation to determine the extension in the field of the ore. To form an opinion of the quality of the now known ores a specimen was taken from a blast showing 16.59 % copper. Dressing this for higher percentage of copper would not pay on account of the way Bornite occurs in the rock, but the ore ought to be very suitable for concentration.

Sample by Roberts showed 13.43 % copper.

36. Small not stript crestreak on the border between Berzeliya and Carl.

Claims Isak, Adolf and John.

Within these claims are a great number of small copperore-lodes. Most of them are so insignificant that it would not pay to work them, but here are also located some of the most important deposits in the field and particularly those which formerly have been exploited. During the last years has also extensive work been done here. To show the results of this and to facilitate the examination of the most important oreveins regarding their extension in the field and dip it has been necessary to make a map and profiles or sections of the more important parts of the Claims in the Markscheiderscale.

This was done by Mr. Petersson and in doing it not only were all the trenches measured and marked on the map, but also as far as possible all smaller crevices, so as to ascertain whether they are isolated or belonging to any definite crevices of larger extension. All these small veins will be described. The numbers here refer as before to the Geological map scale 1:1600.

37. ISAK. The Hornslate contains here a layer about 160 c.m. thick of a foliated mineral resembling Flint with less Hornblende than the other. In this are four 2 to 7 c.m. thick shists which carry Bornite partly in small lenses and partly as a fine intermixture. The Bornite quantity seems to be very varying also in the direction of the course, and the lode is of particular interest principally because it gives a good opportunity to study the way the mineral occurs. In the neighbourhood is a out in Hornslate with Epidote without ore.
38. ISAK. Old almost overgrown trench in Hornslate with an 8 c.m. wide lens of Ironore and in the North end a narrow streak of a flinty mineral with large not very frequent grain of Bornite. This vein resembles the above described as 37 and is located in the direction of the course of this.
39. ISAK. Crestreak 8 to 21 c.m. wide consisting of Magnetite much Bornite and Copperglance, the last probably predominating. Stript on a length of 5.5 meters and gradually disappearing or at least tapering towards both ends. In the East end the ore seems to consist of mainly Magnetite. A sample of dressed copperore showed 17.56 % copper. The streak was discovered by Mr. Petersson one of the last days of his stay at Sjangeli and has not been closely examined.
40. ADOLF. Small streaks of partly copperbearing Ironore. The slate dips 62° W.
41. ISAK. In the ends of the small trench is no other visible ore except a few small streaks of Ironore and in the bottom are only irregular probably disappearing copperbearing stripes.
42. ADOLF. In the neighbourhood of the small limestone layer is a regular slate dotted with Bornite which however seems to be of

no large extension lengthways.

43. ISAK STALLGRUFVAN, located on the North slope of the Mountain, is somewhat over 8 meters deep and connects through an about 11 meters long Drift with the West end of the Level which runs out of the East ~~and~~ side at the foot of the Mountain. On the bottom of the shaft appears a streak of ore shown on the map / Fig 4 Sheet IV /. It consists of Bornite and Copperglance the last predominating, forming irregular shists of lenses with a width from a few millimeters to one decimeters and surrounded by Hornslate richly impregnated with above mentioned minerals. The width of the richest ore, which however not is perfectly pure, varies between 2 and 23 c.m. to which should be added more or less rich surrounding minerals, giving the whole ore strike a width of about 40 c.m. Samples from blasts divide by dressing in: rich ore with continuous shists of copper mineral and lean ore with only small glands and grains as a reticulated mass showed the first 12.50 % the last 5.97 % of copper.

The above described crevein is known only on a length of 2.7 meters. At the north end it disappears very suddenly probably to reappear again, which however not could be ascertained on account of the narrow space in the shaft. At the south end it seems to disappear in the neighbourhood of a Dleft sloping about NE and crossing the drift. It is possible that here is a heave. By blasting in the direction of the course of the vein small streaks of Ironore were found which may be a continuation of the vein and in such case it is likely that the orezone described as Stollen g belongs to the same strike. This may also be the case with the ore in the deep trench N:o 44.

Holmsen gives the width of the ore in this shaft to 6 or 7 inches and a sample taken by him showed 24.64 % copper.

About Stallgrufvan Ekenstam / who call Lars Storgufvan / says that the crevein was on a depth of 26 feet 16 inches wide. At 18 feet it seemed to have been 30 inches in width and at certain places, according to statements by workingmen, even 37 inches, of which only 3 or 4 inches gauge. At the North and South end the width is said to be diminishing to 2 or 3 inches. Ekenstam says further that the ore in this mine has shown the

pure ore. During exploitations year 1844 was mined over 12 tons of ore. Two samples from this Lars Mellangruffvan /N:n 49°/ showed resp: 29.03 % and 12.4 % copper.

44. ISAK. Trench 6.25 meters deep about in the direction of the strike South from Stollgruffvan. The Hornslate slopes 62°W. In the bottom is a 90 c.m. long and 50 c.m. wide lens of pure copperbearing Ironore which to the North side abruptly tapers to nothing, but continues in the southeend, here the ore is not coherent however, but appears in narrower or wider small shists within a 7 to 40 c.m wide zone, which to judge by sedimentary Malachiteseems to continue to the open, probably obliquely cutting the planes in the Rock. It is possible that this belongs to the same vein as in Stoll-gruffvan and it is ~~it~~ likely to be Holmsens N:o 24 from which samples taken by him gave 5.67 % copper.

45. ADOLF: In the direction of the course 18 meters South of N:o 44 is a shallow trench in the North part of which are found flames of Iron-ore 80 c.m. wide, but of no length to speak of. In the South part is a narrow stripe of Iron-ore, at the extension of which occurs one 2 cm wide and also several narrower small steaks of pure ore, rich in copper, which however not could be followed for more than 1 meter in length.

46-47. ISAK LANGGRUFFVAN or as it also is called Isaksgruffvan has been explated to a length of about 32 meters partly to a very small depth under the surface and partly in two through a band divided shafts, of which the south is about 9 meters and the North somewhat over 3 meters in depth. The width of the mine is about 3 meters and it has a steep slope to the West although less than the ore vein, which in the open is found near the foot - and at the bottom near the hanging wall. The quality of the ore and its occurrence deserves for different reasons a closer description.

In the North end wall near the open is the vein 11 cm. wide and consists of a remarkably fine Iron-Ore rich in Bornite, which having a width of not less than 11. cm. but sometimes amounting to 15 or 20 cm continues for a length

of 7 meters or to the North end of the North shaft. Here is a trow of 60 cm. and with an inclination of about 20° NE placing the vein at the end of the shaft near the East wall and at the bottom near the West wall of the Mine. The ore has also changed its nature being at the bottom Ironore with very little copper. / Fig.5. Sheet IV/. The same is found in the deeper South shaft where the width of the ore varies between 2 and 16 cm. and on a length of 3.20 meters, as an average from 11 measurements was 8.5 cm. in width. In the South end is the vein high up only 2 cm. wide, nearer the bottom 15 cm. Here is also found a small narrow cretreak parallel with the first.

About 18 meters South from the North end of the Långgrufvan is a small trench on a vein which in the hanging wall consists of fine ore rich on Bornite and in the foot of lean Iron-ore. In the direction of the strike, 17 meters more to the South has been observed a reddish brown Iron-ore 4 to 5 cm wide and 4 meters farther to the South at N:o 47 is found streaks 1 to 2 cm. wide of the same ore. These three last strikes belong /according to mr. Petersson who has examined these as well as Långgrufvan/ to the same vein which has been exploited there, making the known length about 80 m.

Långgrufvans ore lode is very interesting because it shows how various the Sjangeli ore are both in the course and at different depths. In the most Northern part of the vein on a length of 7 meters is the known ore a close mixture of Bornite and Magnetite and partly on the borders of the ore zones of minerals with less copper. A sample from this part of the vein showing 13.49 % copper. In a sample from the North shaft was none and in one from the South only traces of copper. In the trench 18 meters South of the Mine is - as previously has been mentioned - rich fine ore. Of two pieces taken from Långgrufvan by Roberts one showed only traces, the other 10.27 % copper.

Ekenstam says about this mine : " It is located on a vein, which in the open seems to have been 5 to 6 inches. At a depth of 6 feet the vein was 10 inches, at 14 feet still 10 inches, and in the South and fairly pure but in the North somewhat mixed with gauge. The ore was also in the middle of the Mine 10 to 11 inches wide and fairly pure. At an other place where the vein spreads to 16 inches the ore is less rich.

The vein could be noticed in both walls, but was near the bottom

in the North end only 3 inches wide. Here were also two veins. In the South end the vein was 7 inches wide but at both places it seemed to be wider deeper down. During 1841 was mined 7 tons of ore and it is said to be of the same quality as in Claim Lars, of which at another place in the report is stated that samples showed resp: 29.03% and 12.4 % copper."

From the description by Ekenstam, and from the circumstance that mining operations not have been going on to any greater extent in any of the trenches, is clearly shown the various nature of the ore both regarding the extension in the field and dip/. in this as well as in the other creveins. As no records have been kept of the ore taken from the mine during the exploitations it is not possible to form a true estimate of the value of the lode.

ISAK SKIFFERSKÄRPNINGEN located on the very Mountain close to Stollgrufvan is 6.5 meters long 2.3 meters wide and about 1.5 meters deep. The nature of the lode is shown through following profile or section which was measured in the North wall.

- The planes of stratification slope 63° W.
- a. Middlecoarse Hornslate.
  - b. Hornslate 5 cm. deep with one or more stripes of brown Iron-ore, probably without copper.
  - c. Hornslate 2 cm. Thinly foliated bearing Malachite.
  - d. A 1 to 3 cm. wide shist of partly very pure Bornite, partly Magnetite. A sample / 12 Kgr. / gave by analysis 2.01 % copper. The same shist can be followed in the bottom of the trench where it is richer in Bornite, and varying in width sometimes amounting to 4 cm. It is also found in the South end. A number of pieces from the bottom / 6 Kgr. / showed 24,57 % copper.
  - e. Hornslate 42 cm. in depth, thinly foliated with dots of Bornite and Malachite. A large sample / 117 Kgr. / gave 2.48 % copper, traces of Gold and 0.005 % silver, analogous to 50 gram pr. ton ore.
  - f. Hornslate 48 cm. Comparatively solid, more thickly foliated and

dotted scarce with grains of Bornite. Analysis showed only 0.5 % copper.

g. Hornslate 10 cm. deep in thinner shists with numerous small quartzlenses and a little more Hornite than in f.

h. Hornslate 14 cm., thinly foliated in two or more hardly one cm. wide and not continuous shists with much Bornite. A sample / 66 Kgr. / gave 3.76 % copper.

At the South end which was very difficult to examine was only observed the upper streak of Bornite and a copperbearing layer of slate about 60 cm.

In this trench located hardly 5 meters North of the above described, is found the same layers as in that and of about the same thickness. Otherwise nothing has been determined with certainty regarding the extension in the field of this stratum. To the North not very far away is evidently found an extension of Långgrufans orestreak, but it cannot be considered as a continuation of the one in question on account of the different nature of the ores and also on account of topographical conditions.

ADOLF This trench is located 36 meters South of 48 about in the direction of the course. It is 4.5 meters deep at the hanging wall and in the bottom is some fine ore / as shown below / which in the South end can be followed for a distance upwards. It is leaner in the North end and seems gradually to disappear. The enclosing rock carries somewhat copper. The planes of stratification dipping  $61^{\circ}$  W. are plainly cut by the ore at an angle of  $70^{\circ}$ . At the South edge of this trench is a thinly foliated layer 20 cm. in thickness, which on a width of 10 cm. is of green colour from Malachite and which also has a 2 cm. wide streak of Bornite.

A sample by Holmsen from this excavation showed 19.51 % copper.

ADOLF. In the bottom of this trench located a little more westward is an ore vein 12 cm. wide, rich in copper, but not of any considerable length.

If the lode at N:o 50 belongs to the same streak as 48 the extension of this should be known on 50 meter.

At N:o 52 about in the direction of the course and 75 meters South from 50 appears again thinly foliated copperbearing Hornslate.

As is shown by section of the level / Fig. 8 Sheet IV / is here found orebearing layers which undoubtedly form a continuation of 48. The vertical distance between the known lodges is about 12 meters.

Holmsens 23 is probably the same as my 48. From the hanging wall has he taken a sample which showed 28.25 % copper.

Sample by Roberts - 1 piece Bornite and two pieces slaty mineral with plenty Malachite - showed 13.05 % copper.

ADOLF. Trench having in the bottom and the South and a 3 to 4 cm. wide shist rich in Bornite surrounded by slate with plenty sedimentary Malachite. In the North end is no ore.

Sample by Holmsen / N:o 42 / showed 15.78 %, by C. Roberts 12.91 % copper.

ADOLF. Narrow streaks of ore rich in Bornite.

" Slate with sedimentary Malachite observed in three different places. 55.

ADOLF. A trench more than 3 meter deep, in the bottom and South end of which an ore streak can be followed, rich in Magnetite, Bornite and copperglance. The whole streak is hardly over 9 cm. and the richest ore only about 2 cm. Near the open is no visible ore, which seems to indicate that it occurs in lenses.

JOHN. A 1.5 to 2 meter deep cut in which at the bottom and the South end the rock here and there is richly impregnated with Bornite and copperglance on a width of not more than 15 cm. At the South end is also a comparatively pure Iron-ore 15 to 21 cm. wide.

JOHN. Fine Iron-ore with Bornite 7 to 8 cm. wide visible on a length of 30 cm. The North end covered and it seems to disappear upward and to the south.

ADOLF. In the foot wall of this about 2 meters deep trench is a 3 to 5g or at most 10 cm. wide streak of Iron-ore with copper. Possibly is this connected with a streak of very fine 10 to 16 cm. wide Magnetite, Bornite and a considerable quantity copperglance located a few meters North East from this trench.

9. ISAK. The trench is located high up on the steep of the Mountain and has been worked in the open to a great extent. The length is nearly 23 meters but the depth is very small.

As is showed on the appended map / Fig. 6. Sheet IV / are three distinct orestreaks visible of which one may be followed through the whole cut. The other two seems to be tapering off and gradually disappearing, although it is not known whether they do so or not.

Following surveys show the disposition and nature of the Ore-shists.

Crosssections.

Orestreak a. 18 cm. Ore, of which 9 cm. in the hanging wall is pure and rich.

Hornslate ----- 140 cm.

Orestreak b. 4 cm. pure rich ore, 2 cm. slate with copper.

0.85 meter more ore to the North is the ore 6 cm. and the slate 4 cm. wide.

1.9 meter North of A. has the streak of pure ore only a width of 4 cm. and the length is 13 cm.

Farther North is for a short distance only Iron-ore.

Orestreak a. 5. cm pure rich ore.

Hornslate ----- 140 cm.

Orestreak b. 6 cm. Ironore with copper tapering out to the North.

Less copper to the South. At the foot wall is 7 cm. copperbearing slate and in the foot of this again 6 cm. mineral rich in Iron, forming a continuation of the streak to the North.

The strata are here cut by a small heave leaving 70° W.

Orestreak a. 4 to 5 cm. lean ore, principally Iron. North of the heave is no ore for a distance short. 2.7 meters North from ~~MARK C~~ is a streak a 6.5 cm. wide, and principally Ironore with very little copper. North and South of a band at this point has exploitations been carried on comparatively deep, indicating that the ore has been rich.

Hornslate ----- 143 cm.

Orestreak b. About 5 cm. ore.

Across a small band.

Orestreak a. 3 cm. pure rich ore 7 cm. leaner. This streak comes to the North obliquely cutting the planes of stratification in the enclosing Rock.

Hornslate -----60 cm.

Orestreak a. 4 cm Ironore.

Hornslate -----120 cm.

Orestreak b. 2 to 3 cm. Ironore.

Orestreak d. 7 cm Iron-ore with grains of Bornite.

Hornslate -----146 cm.

Orestreak a. About 5 cm. lean ore.

Orestreak d. 4 to 5 cm. pure rich ore. This is surrounded by a slate partly rich in Bornite at the foot wall 20 cm. and the hanging wall 7 cm wide.

Hornslate -----120 cm.

Orestreak a. 4 to 5 cm. comparatively lean.

The pure rich ore is a mixture of Magnetite, Bornite and copper-glance. The leaner of partly Magnetite with coppermineral and partly Hornslate with small lenses of Bornite a.s.o. As is shown by the crosssections the rich ore is at present to be found principally at both end of the trench but former exploitat<sup>ions</sup> seem to indicate that it also has occurred in the middle. A sample of rich ore from the North end gate by analysis 14.28 % and of the surrounding ore-bearing slate 5.45 % copper. A sample from the South end of the trench showed 27.72 % copper. Undoubtedly is the same vein as the one found 30 meters from the East mouth of the level and which in the description of the level is mentioned by d.

Ekenstam described this trench by the name of Zacharias Storgruva and gives the width of the orebearing vein to 7 or 8 inches, and a smaller one parallel to this on a distance of about 2 feet, to 3 inches. A sample is said to have shown 64 % copper and 2.72 "loa" silver pr. 100 Lbs received pure copper. An other 15.75 % refined copper.

JOHN SNÖGRUFVAN. In this about 11 meters long pit commences the vein in the South end about 1 meter below the open as a streak of Ironore about 5 cm. wide. 1.4 meter below the surface it is only 2 cm. and consists of Bornite with Ironore. In the stript surface of the Rock South of the pit is no visible ore, but there are two fissures of which one obliquely cuts the texture of the rock and the other follows it, and it is very likely that the orestreak follows one of these, if both are not orebearing.

The rock in and around the pit is a greyish black fine slate. The orebearing zone in the bottom of the pit is the same mineral. Sometimes richer in Mica and partly a mixture with quartz and some Epidote, besides which often appears a slate with very much Magnetite and small shists of lean Ironore. In the mixture of minerals appear stripes of partly pure Bornite of no great extension, but very often reoccurring. Sometimes they have a length of several decimeters and occasionally occur lenses of pure rich ore 5 to 10 cm. wide. The slate is also dotted with Bornite.

On account of the occurrence of the Ore and also because the rock at certain places being very clefity it has been difficult to distinctly define the borders of the orebearing layer. Following table ought however to give a pretty true conception of the extension of the vein.

The Bottom of Snöskärpningen.

Distance from South end in meter	Width of Orebearing layer in cm.	Nature of orebearing layer.
0.	2.	Bornite and Magnetite.
1.	50.	Streaks of Bornite.
2.	60.	Rich ore. Lens of pure rich Bornite 10 cm. wide.
3.	64.	
4.	119.	Nearest the hanging wall is the ore fairly rich on a width of 10 to 15 cm. and perfectly pure on 2 to 4 cm. Surroundings comparatively rich on 25 cm. The rest leaner.
4.30.	47.	
5.	22.	Almost pure ore 6 cm.
7.	60.	37 cm. rich ore. The rest lean or gauge.
8.	44.	The mineral is generally pretty lean ore.
9.70.	52.	At the foot wall 19 cm. At the hanging wall 13 cm. Ore gauge in the middle.
10.50.	40.	Almost pure ore 8 cm.
11.		Close to the North end of the Pit is a narrow vein of ore.

To make a true estimate of the amount of ore which could be taken from this lode - which probably is the best in the field - and to determine the quality of the ore, it would have been necessary to do some blasting on not too small scale. But as this not can be done during my visit at Sjangeli I must confine myself to be taking specimens of the ore obtained from a few blasts and this was done in the following manner.

The whole quality of ore was roughly dressed and gave 42 % first class ore and 58 % second. The first consisted of pieces varying between 1 and 20 cm. in length, / one piece of almost pure, firstclass ore weighed 27 Kgr. / . After crushing and dividing they showed:

1:st quality 18.50 % copper  
 2:nd " 5.69 % "

Both kinds could have been cleansed to a higher percentage of metal. It is obvious though that this ore ought not to be shipped in pieces, but should be concentrated, which easily accomplished as it carries very little Ironore.

JOHN FONDSKÄRPNINGEN About 15 meters NE from the new drift was last summer by foreman Lunquist commenced a trench on a supposed crevein, and he found fine almost pure finely grained Bornite. Stript to its full length it was found to have following dimensions.

Distance from the North end of the vein in meters.	Width of the crevein i cm.	Quality
0.	8.	Hornslate with Bornite impregnated and in veins
0.4	20.	" " " " " "
0.9	6.	Entirely pure Bornite.
1.3	7.	" " " " " "
1.5	12.	" " " Here isthe streak cut at righth angles by a fissure filled with Epidote and Bornite.
1.9	8.	Entirely pure Bornite.
2.4	3.	" " " " " In the foot wall is Bornite found in the

- |       |                                       |
|-------|---------------------------------------|
|       | enclosing Rock.                       |
| 3.04  | 2. Entirely pure Bornite.             |
| 3.29. | 4. " " " Here the vein seemed to end. |

By these measurements is seen that the ore is found in the shape of a very elongated lens slightly curved and possibly cutting the shists.

Upon the supposition that more ore lenses were laying in the neighbourhood, the blasting was continued for a distance in a northerly direction and 1.9 meter from the north end of this deposit on a depth of 1.5 meters below the surface was an other small streak, which however soon disappeared, but came back by going down 25 cm. more being there about 30 cm. long and 3.5 cm. wide. The Bornite contained here numerous crystals of Magnetite. Time allowed not the continuation of the search although it should have been of great interest, because if the vein has any greater extension it is on account of its purity of great value despite its small width. Analyse of a sample showed 44.37 % copper. It contains very small amount of magnetite generally so finely distributed that it is invisible.

JOHN ISAK STOLLEN. Already Ekenstam proposed to drive a level through the mountain from the East side to the West to obtain the ore from Rösskärpningen and it is possible that the small cut which is marked on the map just South of the Mouth of the presnet level has been commenced with this objet in view. To form an opinion about the quality of the ore deposit deeper down in the mountain Holmsen proposed the now finished stulm, which going in an Easterly direction from Stollgrufvan has a length of 62 meter and is 38 meters below the highest point in the field and 12 to 13 meters below the surface of the rock.

Examination of the dark walls in the Stulm is very timewasting work, particularly because the copperminerals are of almost the same colour as the rock. So as to not have to make this over again an other time, below is given a detailed description in which not only large but also unimportant, and as far as can be judged at present, valueless creveins are mentioned.

The measurements are taken from a plumbline in the East end of the Stulm and the letters refer to the detailed cross-section. / Fig. 8 Sheet IV /. The mineral is Hornslate in the stulm as well as in the Stollgrufvan.

Distance at the middle height of the stulm in meters

0.8-2.2 According to statement by the foreman were grains of Bornite found principally in the middle of the Stulm, and a quantity ore brought out from here contained numerous, about 1 cm. wide fissures filled with the same mineral.

1.79 South Wall Small Bornite occurrence.

2.8 " " Insignificant specks of Ironglance and possibly Bornite.

4.4-4.6 " " According to statement was by driving the level found Bornite impregnated in a zone 3 meters in width, and also a smaller ore lens.

5. North wall Within a zone 5 to 13 cm. wide is found Bornite partly fined impregnated as small collected streaks 0.5 cm. wide. Generally lean ore.

5.10 South wall Insignificant impregnation of Bornite.

5.24 " " "The wall" wall "Bornite" 3-4 cm. "lenses", dense

5.6 " " According to the foreman was during the work found lenses of Bornite near the North Wall and a very narrow streak was followed through the whole drift.

5.8 " " Bornite scarce impregnated in a 7 to 10 cm. wide zone. Richest in the neighborhood of a small crack filled with Epidote, and 3 to 8 cm.

6.8-7.2 North Wall Impregnated Bornite in two zones not more than 15 cm. wide. These ore veins are undoubtedly the

7.7 According to the foreman was here found lenses of ore near the floor. The description of

12.5 According to the foreman was here found a narrow ore streak, various in the open an depth

15. "The wall" wall "Bornite" 3-4 cm. "lenses", dense

- 15.40 North Wall A 2 to 3 cm. wide fissure inclined 50° W can be followed nearly through the whole wall in the drift.
- 16-17 According to the foreman impregnated Bornite.
- 20.60 " " A narrow quartzvein with copperpyrites can be followed round the drift. During the work was according the statements found partly Bor nite and partly Copperpyrites, mostly in small quantities, in and around the quartzvein and also more westward.
- 21.9 " " Scarce impregnation of Bornite on a width of 0.2 to 0.3 meter.
- 22.6 " " In the direction of the course occurs Bornite but not very much.
- 23.1 " " Narrow streak of quartz with copperpyrites near the roof. Then impregnated Bornite and pyrites for 26.3 meters or somewhat farther.
- 26.8 " " Scarce spots of Bornite.
- 30.0 " " 4 to 10 cm. wide seam of Iron-ore which can be followed from the floor to the rroof, and also in the South wall Iron-ore 3-4 cm. thick; generally very narrow but at the foot rich in Bornite. Bornite occurs also in the foot wall as impregnated in the rock on a width of 4 to 5 cm. or somewhat wider. A little more Westward on a distance of 82 cm. in the North wall and 65 cm. in the South wall from above described orevein, is an other similar one 3 to 8 cm. wide. Both have an inclination of 70° W.

These Iron-ore veins are undoubtedly the same as those which have been exploited in Räs-skärpingen, and / in the description of this / is called a. and b.

They are very various in the open an depth regarding width and metallic percentage of copper.

47.8 North Wall

In a zone leaning 67°, 40 cm wide in the roof and after a new blast about 60 cm. wide at the floor, contains the Hornslate Bornite, partly as numerous streaks or small lenses, partly finely impregnated. This zone is not sharply defined, the slate around containing scattered grains of Bornite. By driving the level was, according to statements, found only small scattered grains of Bornite on a width of 1 to 2 meters in the South Wall, showing however that the orezone continues to here. By special blasting a sample was taken from the North wall and was divided in 1:st quality ore with continuous streaks of Bornite / 9 kg / and second quality with small lenses and grains. Analyses showed however no great difference in Copper. The first gave 6.50 % and the second 5.75 % copper.

50.0 North wall

A streak of Bornite 1 cm. wide is cut near the roof by a small cleft. In the foot wall are narrow streaks of Bornite on a width of 30 cm.

As is shown by the cross-section are probably crevins e. and f. and the mineral between a continuation of the ore in Skifferskärpningen. The streak of Bornite at f. in the level is undoubtedly the same as ~~is~~ the one in the cross-section of said trench marked a. The minerals are at both places very similar, consisting of thinly foliated green Hornslate, distinctly different from the surrounding harder slate. The whole width of the ore-carrying zone seems to be somewhat larger in the level.

55.6 South wall

Within a ~~width~~ zone 30 cm. wide leaning 67° W and followed nearly along the whole wall is the rock richly mixt with Bornite as streaks and lines. A dressed sample / 32 Kgr. / gave 13.09 % copper. In the direction of the course was now in the North wall found very little Bornite, but by driving the level was found fine ore.

JOHN. Narrow unopened vein of ore with Iron and Bornite.  
Probably the same crevice as No 63. Very fine ore but narrow. Not  
opened. If both these lodes are the same the vein is at least 29  
meter in length.

66 Four small trenches without any visible ore in any larger quan-  
tity. From one of these openings, or from another at present filled  
and located close to the small commenced drift South of the now fini-  
shed one, originate probably the small heaps of fine very peculiar  
ore which is lying a distance below the trenches.

CLAIM HELENA.

Only two very small ore lodes are known within this claim namely:  
Trench on a 6 cm wide streak of fine Iron-ore with Bornite. Not  
known on greater length than 2 meter.  
Small streak of Bornite and Hornslate.

CLAIM GUSTAF.

Very small vein of ore.

Trench in the South end of which are seen two layers of Iron-ore lean-  
ing in copper 5 cm. deep and on a distance of 5 cm. from each other.  
GUSTAFSKARENINGEN is located at the base of one to the NW steeply  
raising mountainslope, and is about 10 meter long, 1 to 5 meter wide  
and at the hanging wall hardly 3 meter deep.

The ore forms several well defined comparatively wide shisty  
bodies of which at least one seems to have a pretty large extension.  
This is probably the reason why the lode is well exploited although  
the percentage of copper is low. Fig. 3 Sheet IV shows the bottom  
of the cut. The rock is Hornslate mostly rich in Magnetite and within  
a certain zone, between the ore lodes in the South part of the opening,  
having numerous plain crystals of arsenikpyrites. Along the hanging  
wall runs a layer of limestone surrounded by a clefthy and shisty  
mineral, mostly consisting of Hornblende, some Chlorite and Lime-  
spar a.s.o. These layers show evident signs of having been strongly  
compressed.

The crevice, having a width seldom exceeding

20 cm. consists mainly of finely grained magnetic Iron-ore. In the South part of the bottom and in the South end wall, where several new streaks appear, contains the ore much copperpyrites and some sulphurpyrites which sometimes are evenly distributed, but often collected in small irregular lumps or netformed branchy veins in the middle of the orestreak. The same mineral occur here more or less in the surrounding slate. In a part of the East vein, close to and in the South end wall contains the ore, on a width of 8 cm. pretty much Bornite / on the drawing shown as pure ore /. The present extension of the rich ore is only 0.6 meter.

North of the trench are both of the limestone layer and the ore vein known on a length of 15 to 17 meters, the last having a width varying between 15 and 29 cm and consisting a partly Iron-ore and partly Iron-ore with copperpyrites. Farther North has the Ironore without pyrites been observed on two places viz: 30 and 42 meters from the North end of the trench.

A sample of the pyrite ore taken in this trench and freed from both gauge and pure Ironore showed by Analysis 4.25 % copper, Holmsens sample gave 5.63 %.

In the South wall was in a cleft found native copper in a small quantity.

From what is known from present, the ore in this lode is of two various nature to be exploited profitably, particularly as it seems to be generally lean, but because much work has been done there the trench has been accorded an extensive description.

Already Ekenstam dissuades further exploitations here. He states that a sample analysed at Bergskontoret in Helsingfors gave 12 % raw copper. Several others gave not fully 0.1 %.

Trench about 5 meters deep in Horns slate with numerous fine veins and small lenses of copper pyrites and Bornite, the last scarce. Any collected ore is not visible and both minerals seem to occur in pretty small quantities. Holmsens sample from here showed 4 7% copper.

#### CLAIM GABRIEL.

BORNITGANGEN. This lode was discovered by foreman Lundquist 1891.

It differs very materially from all others in the field. The ore

occurs here as veins and fissure veins generally abruptly cutting the texture of the enclosing rock, which consists of gray finely grained slate resembling Gneiss and is very different from the ordinary Hornslate. It slopes about 55° W.

At the base of the Mountain, which raises steeply westward, appear following veins and streaks shown on the map as Fig. 7 Sheet IV.

- a. Consists of apparently pure finely grained homogenous Bornite. At the lower end it is 5 cm. wide, higher up at one place 1 to 2 cm. and still higher, for a length of 0.5 meter 4 to 6 cm.; then again narrower. It contains at one place a little quartz.
- b. A small fissure filled with Bornite.
- c. In a small offset going in direction b-c appears pure fine Bornite in a lens shaped body 60 cm. long and at least 12 cm. wide. It seems to follow the planes of the shists and continues more or less wide to the highest branch of the vein. It may also be extended in the other direction.
- d. Could be followed in plain and in a small perpendicular wall for a length of over 3 meters. At the lowest point it was according to statement about 20 cm. wide and contained pieces of gauge. Higher up is pure singularly fine Bornite of a width not less than 27 cm., but sometimes exceeding 30 cm. or more. In the upper end it is divided into two branches which seem to taper out to nothing; the largest probably reappearing highest up. The lower part of the vein is hidden by the soil, which was not removed because it would have taken too long time.
- e. Stript for nearly 4 meters in the steep wall. Lowest down cutting the plans of stratification, but at the upper end showing a tendency to follow them. Consists in its upper part of at least 9 to 10 cm. wide lenses and small streaks of coarsely grained pure Bornite. In the lower part is a more continuous 2 to 3 cm wide vein of the same mineral. Small fissures, sometimes 2 to 3 cm. wide sometimes narrower filled with Bornite.

By this description is clearly shown that the Bornite appears as filling irregular fissures which not have any greater extension in an Easterly direction. To the West they are covered by the soil. The largest of these has a depth of 30 cm. or more and consists of fine Bornite with very high percentage of copper.

A sample by Holmsen showed 42,82 % and by C. Roberts 54,76 % copper. It would seem strange if the Bornite contained in such large fissures as these not should be connected with a larger body of ore, and it worth wile to investigate their nature and extension both in the field and on the depth.

Trench on a very fine ore consisting of copperglance, Bornite and Magnetite. In a losse piece the thickness was 15 cm. In the pit where the ore forms the middle body in a layer of Hornblende, Bornite and copperglance, the width could not be measured. South from here the width is about 10 cm. It is likely that the fine ore appears in lenses and that the orestreak connects with the one in 75.

A cleansed sample of the richest ore in the trench showed 19,34 % and one from the surrounding orebearing minerals 8,95 % copper. Holmsens specimen gave 12,67 % copper.

Trench with small streaks of Iron-ore in the South wall and bottom. In the North wall two 1 to 2,5 cm. wide veins of Bornite, wich run together when the vein gets a width of 3 to 4,5 meter for a distance of 0,5 meter. It runs then suddenly into Iron-ore.

78 Small trench in Hornslate impregnated scarce with copperpyrites and sulphurpyrites.

CLAIM THILDA.

Rather large trench in which at present is found very little copperpyrites impregnated in the rock.

In old Ore- and refuseheaps is found a little copperpyrates, small pieces of ~~iron~~ copperglance and some Bornite. On account of a statement that gold had been noticed a specimen was taken of the ore, which however showed no trace of gold and only 1,39 % copper.

Holmsen says that the orestreak consisting of Malachite, copperpyrites and Iron-ore is 4 to 5 inches wide; higher up in the Mountain 8 to 11 inches and has a large extension lengthways going in on Claim Gabriel. Ekenstam says taht the vein is 8 to 12 inches and about 100 to 120 feet long.

\*) A piece of ore brought by Lundquist 1891 showed 64,12 % copper which seems to indicate that this ore contains copperglance.

CLAIM BERNDES.

Within this claim, located on the west part of the Mountainridge and extending over the low ground South of Sjangelitrasåk, are several oredeposits of which following have been examined more or less thoroughly.

In the North end of the Trench, located in the South slope of a mountain is a vein of Iron-ore with copper which however not forms a well defined shist, but appears as more or less impregnated in the enclosing rock. Bornite is also found in the fissures running across. About parallel with this vein is a quartz ledge 20 to 25 cm. wide.

A small trench on a Bornite-bearing shist of Hornslate 8 to 10 cm. wide, evidently being a continuation of the crevein in N:o 80. The ore is lean but its occurrence is of particular interest. The Bornite appears in small streaks within well defined shists although not parallel with these, but cutting them by an obtuse angle.

Small trenches in an orebearing zone about 20 to 25 cm. wide, which at present can be followed for 17 meters and probably has a still larger extension Northward and connects with the ore at 83 in Haparanda. After blasting South of point 82 the ore streak was found to consist of two resp: 6 and 10 cm. thick shists of ore, divided by an orebearing slate 9 cm. wide and bordered on one side by the same mineral. At some places was the width of the ore a little less than 9 cm. The vein consists of dense Iron-ore with various percentage of copper, here and there seemingly very high. Two samples showed only resp: 4.89 and 0.44 % copper. The first was taken from the North part of the vein and the other about 5 meters more to the South.

A sample brought by Holmsen / not known from which trench / showed 14.19 % and one by Roberts 5.68 % copper.

CLAIM HAPARANDA.

Trench on an at present insignificant crevein consisting of Epidote and Bornite in seams and fissures. The vein can be followed in a Southernly direction.

On a distance of 10 meters from 83 is a small trench on Iron-ore and fine Bornite in lenses and veins. If the crevein at 83 connects with the one at 82 it had a length of at least 45 meters and

there are every indication that they do.

Cut in slate without ore.

Within the claim are several outcrops which not have been examined and which seem to be of no value.

CLAIM ERIK.

Small trench on a very narrow vein of ore.

SECURED TERRITORIES

SELMA.

Within this territory has not been found ore of any quantity to speak of.

HERMAN.

Small trench in copperpyrites as a reticulated mass.

In the trench are several shists, the largest 18 cm wide. They show here and there impregnated copperpyrites, Bornite and, copper-glance and chrystals of magnetite.

Small trench in direction of hf the strike from N:o 87.

The rock in and around the trench, where some work has been done for defending the claims during 1894, consists of, partly Hornslate with small brown bodies of probably rich in Iron and partly of peculiar flinty mineral with numerous veins of Hornblende. Below the trench contains the Hornslate a not very thick layer showing the texture and properties of Mica.

The ore can be followed through the whole trench and consists of Magnetite and Bornite . The width can not be measured with ~~the~~ any accuracy but seems not to exceed 10 cm. While working in this trench during last summer was at N:o 90 and a little to the South from there found two lenses of Bornite. The size of these could not be determined. From one has however been taken a piece of almost pure mineral having a length of 30 cm. and a width of 11 cm. The deposit was very fine when the work was stopped, but the Bornite is likely to appear in lenses and seams not in a continuous vein.

Nearly 30 meters in direction ESE from this trench is another smaller cut in which the slate is somewhat impregnated with copperpyrites.

streaks. One is a hardly 1 cm. wide fissure vein of Bornite and the other a gray flinty mineral richly impregnated with Bornite in narrow net-formed lines. The width of these is, in the trench at present, hardly more than 10 cm., but on the oreheaps are found pieces with 25 cm wide rich ore, and according to statements should the Bornite-bearing layer at one time have been about 1 meter wide. About the extension in the field nothing can be known without further work. A preliminary analysis of this ore showed nearly 18 % copper.

In, and a little to the South of the trench is the porphyric Hornslate sometimes impregnated with Bornite and probably also copperglance for a width of about 15 meters, of which 30 cm. is fairly rich. The known length of this zone is about 30 meters. At the South end are several small parallel zones, making the whole width here about 6 to 6 meters. The deposit deserves to be more closely examined.

#### ELLEN.

Trench in a peculiar porphyric Hornslate with small brown flinty bodies somewhat impregnated with Bornite.

Bornite and copperglance with Ironore 10 to 20 or perhaps 30 cm. in width. The length unknown.

Trench in comparatively coarse Hornslate with some Bornite as a reticulated mass or small lenses or streaks.

A thinly foliated 0.5 to 1 meter wide stratum of Hornslate fairly richly impregnated with Bornite and copperglance.

7. On a distance about 9 meters from the borders against the Gabbro is a bed of Hornslate, at least 10 meter in length, impregnated with Bornite. In this was also found a lens of fairly pure Bornite about 3 cm. wide and 30 cm long.

#### JACOB

98. Small trench with no ore.

99. Trenches and workings in Hornslate without ore. Only very little Pyrites and a quartzlead have been uncovered.

#### ELSA.

100. Trench and work for keeping the Claim showing only some pyrites.

101. " " " " " with very little Bornite.

This point HAS NOT BEEN MARKED on the map with exactness.

ALVIN.

02. Trench and defending work through which a very small and lean vein with sulphurpyrites has been uncovered. Besides this was found grains of Bornite.

03. Trench and defending work for 1894 in the steep slope toward East. A very fine nearly pure sulphurpyrites has been uncovered on a length of about 2 meters and a width of 30 cm. or less. Analysis showed 40.16 % sulphur and traces of copper. Of gold was no sign.

SECURED TERRITORIES EAST OF THE REGULAR CLAIMS.

PERPETUUS.

04-105. Two trenches without any copperore to speak of.

MAXIMUS.

06. Trench and working measured by E.G. Lundquist who also brought a piece of ore, of which half was fine copperpyrites partly as a reticulated mass and partly as thin shists. He said also that the ore seemed to appear in lenses and streaks on a width of 5 to 10 cm.

07. The rock is for a small part richly impregnated with pyrites.

No work of any kind has been done.

ALMA.

108. The Hornslate contains a number of narrow shists of Iron-ore with some copperpyrites and possibly also Bornite. None of these looked very promising.

ANNA.

Narrow Bornitebearing orevein, probably continuous for a length of at least 65 mters. No blasting done. From one out, where work has been going on for defending the claim / the location unknown / in this territory, Lundquist brought pieces of hornslate with streaks and grains and Bornite. He also communicated that a lens of such mineral has been stript for a length of 1 meter and a width of 10 to 30 cm.

LUDVIG FREDRIK THEODOR.

As previously has been mentioned forms the Gabbro-mass, which runs from Claim Gabriel to the South end of the Ore-field a mountain

very steep on the East side. At the foot of this, high up on the slope, runs the Hornslate in the open and contains small shists of Ironore, which have been stript through a number of trenches within these territories.

In trench N:o 110 is the ore magnetic blueblack in colour, very porous and forms a veinshaped deposit 18 to 21 cm. wide which cuts the texture of the slate at a sharp angle.

At N:o 111 are narrow stripes of Magnetic Ironore in a rather thinly foliated layer of argillite. A compass gives very strong indications, but no collected ore has been found.

At 112 and 113 has been found a strongly ferruginous argillite.

At 114 are three or four shists of very fine dense and bright magnetic Ironore not more than 15 cm. wide laying parallel with the texture of the rock. They are branchy at the ends and gradually dwindling away.

At 115 appear in an about 4 meters wide opening in the soil several shists of fine magnetic Ironore. The largest is 36 cm. in width and the others only a few cm. The shists are branchy and disappear gradually in the Hornslate, which is of an apparent slaty texture.

At 116 is a body of argillite 25 to 30 cm. wide richly impregnated with Magnetite. Above the trench appears pretty much Malachite. On the surface of the rock which indicates that Copperore is to be found or has been found in the neighbourhood.

At 117 is a pretty strong compass-indication of magnetic ore. Any collected ore has not been found, but on a width of 1 meter the rock is very ferruginous.

In the trench in the soil at 118 are in the Hornslate several lenses of Magnetite and Hematite. One of these is about 2.5 meter and the other somewhat larger. The width varies between 5 and 50 cm. A part of the ore is very fine dense and bright.

At 119 are two shists of Hematite on a distance of 13 cm. from each other. One is 20 to 35, the other 11 cm. in thickness. The last tapers out to the South.

At 120 have been uncovered several beds of Magnetic Ironore of which the largest is 11 to 24 cm. wide. An other is about 8 cm. in

described trenches is very fine, but appears in all known deposits only in small quantities and are not of any value for mining.

There is no ground for a supposition that there may be found larger deposits of Ironore and the small lodes are at present particularly interesting only because they mostly have been found to carry Bornite and Copperglance and that they not seldom run into richer Copperores. This was shown during 1894 in the territory Ludvig where according to Lundquist was found an orebed 10 to 20 cm. wide which after stripping for a length of 3.20 meters showed besides Magnetite also Sulphurpyrites and Bornite. A piece brought home looked to be very rich in copper.

#### SNORRE.

Within this territory has not been found any collected ore. Only faint indications of Magnetite deposits by the Compass.

#### OREDEPOSITS in UNNA ALAKATS.

About 3.5 kilometer SSW from Grufberget in Sjangelj and South of the valley bordering Sjangelifjellet to the South are a few low hills at the foot of the small ridge called Unna Alakats. Here is a small territory which, on account of ores found within its boundaries, deserves to be mentioned. It belongs to Mr. Jacobi though three claims called Carl, Gustaf and Oskar. Within the territory appears partly Hornslate, distinctly different from the mineral found in Sjangelj and probably richer in Feldspar and partly perfectly massy fine to coarsely grained Babbro. These minerals belong undoubtedly to the same Geological age as the orebearing Hornslate in Sjangelj and are laying about in the direction of the strike from this or possibly somewhat lower in the stratification-series. In the low ground East of the Hills runs a bed of Limestone 75 to 100 meter wide, and East of this on the slope of Unna Alakats begin Hornslate and Gneis. In the valley NW of the territory a re Hornslate, massy Greenstone and small shists of Limestone laying in the open and in the Hornslate were found Malachite-coloured shists indicating that there is Copperore. Signs of prospecting in older

times is also found.

Only within the most Southern of the Territories, Carl, has been found any oredeposits worth mentioning. The finely grained Hornslate - somewhat mixed with Gneis - is here / in a trench Fig. Sheet IV / found to be rich in Bornite and possibly also Copperglance, which mineral appears as small shists or lenses and also as finely impregnated in the enclosing Rock.

Below are measurements giving the width of the orebearing zone, which is stript for a length of 10 meters.

At the North end of the trench	-----	1.35 meter
5 meters from " " " " " "	-----	1.35 "
" " " " " " " "	-----	1.40 "
" " " " " " " "	-----	1.00 "

The width is averaging 1.20 meters.

A quantity of Rock from here, measuring 17.5 cub-meters, was roughly dressed giving about 10 cub-meter ore. This was divided into 20 to 25 volume % Rich ore 80 " 75 " % Lean ore.

Large samples taken from these showed resp: 5.37 % and 3.24 % Copper.

The cleansing was done hurriedly and by men unaccustomed to the work, and much better results can likely be obtained. It should also be remembered that the ore is suitable for concentration.

The extension lengthways of the Orebearing zones is not known, but both North and South of the Trench is the rock on several places impregnated with Bornite and it seems well worth while to continue the search and find out the real value of the Orelofe.

OREDEPOSITS in RUOPSAKPAKTE ')

About 7 kilometer West of Sjangeli in Norway a few Kilometers from the frontier are several already known orelofes, on the slope of the mountain Ruopsakpakte, secured by Mr. Jacobi. Following are the most important.

\*) The name is by swedish workinmen said to be Rosokag but according to Dr. F. Svenonius probably the above.

NILS.

In a dark Hornsøate is a bed of magnetic Ironore striking North 20° and dipping steeply to the West. Having an average width of nearly two meters it can be followed for a length of 30 meters. The ore is generally lean, often with impregnated Copperpyrites, and fissures are on the surfaces coated with Malachite. In a new trench was at the foot wall found comparatively fine Copperpyrites.

ERIK.

A seam of Ironore 1.5 to 2.5 meters in thickness standing almost perpendicular and striking NE to SW - possibly being a continuation of the one described above - can be followed with the compass for a length of about 65 meters.

The Ironore within these territories is not particularly rich and on account of the Copper of still less value, but the deposits ought to be held in view on account of the connection which is found to exist in these regions between Iron- and Copper-ores. Besides are according to E.G. Lundquist, small lodes of copperores found within the territories Adam and Eva.

A little less than 1 km. South from above described Territories has an oredeposit been secured, consisting of magnetic pyrites, and examined in two trenches measuring according to E.G. Lundquist 3.6 and 3.3 meters in length with a width of resp: 0.20 and 0.80 meters. Together with this magnetic pyrites which not showed any sign of Nickel, is also found some Copperpyrites.

These and other smaller lodes in Ruopsakpakte are interesting mostly because they appear in minerals which are related to those in Sjangeli, thus indicating of ore shown by the compass arise from Iron in the Olivinstone which here forms the Rock. On surfaces in fissures has been found Magnetite in very small quantities.

IRONORE on RUOPOKJÄRVI.

In the neighbourhood of a small lake, not marked on the map, called Ruopokjärvi or Rosokjärvi, at the upper end of Ruopokjärvi nearly 2 kilometers in a north westerly direction

elton  
Gold

from Sjangeli tråsk has E.G. Lundquist noticed great inclinations of the magnetic needle for a length of about 100 meters and about 10 meters in width. This is occasioned by several beds of magnetic Ironore dipping steeply westward. The largest has at present been found to be 30 to 45 cm. in thickness. Of what at present is stript are shists 4 to 5 cm. in thickness fairly pure ore, but these alternate with seems of the surrounding Hornslate. Both the ore and enclosing Rock are often impregnated with copperpyrites but in too small quantities to be utilised.

From what is known at present this ore must be considered as valueless and only for the possibility of it latter running into Copperore may it excite some interest. There seems however not to exist any particular ground for such a supposition.

All samples brought by Dr. V. Petersson are, as before has been mentioned, as nearly as possible real specimens of the ore-quantities which could be mined at an eventual exploitation of the different deposits. They represent on the contrary not the average quality of the ore within the whole ore streak or deposit from where they have been taken, and it should be remembered that generally only small quantities were obtainable as specimens, causing perhaps the result of an exploitation to differ very materially from what may be anticipated. It is also obvious that the classification of the ore in rich and lean should not be given too great moment.

Holmsens samples are according to his own statement a number of typical pieces from every trench and Roberts' generally one or two pieces. But both these series of tests are however very interesting, because they give an idea of the quality of pieces obtainable.

To give a general view of the Richness in copper and silver of Sjangeli ores all known analyses are compiled in following table.

silv  
bold

Analyses of Ljungan Ore.

Number of Mounds in handwritten description.	Name of Claim	Name of tranche or mine	Samples taken 1894 by O. Peterson			Samples taken 1893 by Roberts		Samples taken 1891 by P. Holman		Samples taken 1844 by G. F. Kleinmann	
			% of copper	% of silver	Gold in grams per 100 lbs.	% of copper	% of copper	% of silver	% of copper		
1.	Lerrika	Lerrika skärp	7.16	0.0012		6.46	8.18	15.62	3 to 4 silver		
"	"	"				0.10		9.6	per 100 lbs.		
4	Tomborg	Tomborg skärp	9.49 <sup>xx)</sup>			17.97	13.26	0.006			
"	"	"	5.99								
7	Frederika	Anna Kajsa skärp	15.48			13.57	17.58				
"	"	"	11.95 <sup>xx)</sup>			1.70					
"	"	"	3.04 <sup>xx)</sup>			4.20					
8	"	"					2.05				
11.	"	"			0.16						
17	"	"									
19	Burman	"	11.82 <sup>xx)</sup>								
20	"	Burman skärp.				99.65	9.88	0.006	29.68		
"	"	"					10.42	0.006	29.60		
21	Carl	"	71.59 <sup>xx)</sup>								
31	Bergelius	"	6.74		absent	1.89					
32	"	"	17.13			10.83	14.98	0.005	52.07	0.0516% silver	
33	"	"	6.99						21.14	Traces of Gold	
33	"	"	5.53								
35.	"	"	16.57			13.49	17.47 <sup>xxx)</sup>				
39.	Loate	"	19.65								
43.	"	Stollgrufoan	12.50 <sup>xx)</sup>			15.14	27.04		29.09		
"	"	"	5.97 <sup>xx)</sup>			28.57			12.40		
44.	"	"					5.67				
46-47	"	Långgrufoan	19.49			10.87					
"	"	"	absent			Traces					
"	"	"	Traces								
48	"	Skiffer skärp.	2.01			13.05	28.26	0.009			
"	"	"	24.57								
"	"	"	2.48	0.005	Traces						
"	"	"	0.05								
"	"	"	3.96								
xxx)	From one of the tranches in		Bergelius, but no known article.								
xxi)											

Number of pieces  
Lundström's description

Name of Claim	Name of trench or mine	1894 by O. Pettersson			taken 1893 by Roberts		taken 1891 by P. Holman		1844 by G. F. Glenström	
		% of copper	% of silver	Gold in grams per 100 lbs.	% of copper	% of silver	% of copper	% of silver	% of copper	% of silver
1. Lennika	Lennika skärp	4.16	0.0012		6.46	8.18		15.62	3 toad silver per 100 lbs. copper.	
"	"				0.10			9.6		
4 Tomberg	Tomberg skärp	9.49 <sup>xx)</sup>			17.97	13.26	0.006			
"	"	5.94 <sup>xx)</sup>								
7 Frederika	Anna Kajsa skärp	15.48			13.57	17.58				
"	"	11.95 <sup>xx)</sup>			1.70					
"	"	3.04 <sup>xx)</sup>			4.20					
8	"					2.05				
11	"									
17	"			6.16						
19	Burman	11.82 <sup>xx)</sup>								
20	"				39.65	9.88	0.006	29.68		
"	Burman skärp					10.42	0.006	29.60		
21	Carl	71.59 <sup>xx)</sup>								
31	Bergelius	6.74		absent	1.89					
32	"	17.13			10.83	14.98	0.005	52.07	0.0516% silver	
33	"	6.99						21.14	Traces of gold	
38	"	5.53								
35	"	16.57			13.43	17.44 <sup>xx)</sup>				
39	Loak	17.65								
43	"				15.17	27.04		29.09		
"	Hollgrufovan	12.50			28.54			12.40		
"	"	5.94 <sup>xx)</sup>								
44	"					5.64				
46-47	"				10.24					
"	Långgrufovan	13.49								
"	"	absent								
"	"	Traces								
48	"				13.05	28.26	0.009			
"	Skiffer skärp.	2.01								
"	"	24.54								
"	"	2.48	0.005	Traces						
"	"	0.05								
"	"	3.46								

xxx) From one of the trenches in Bergelius, but not known in which.  
 xx) Samples in pieces  
 x) I and II indicate that analyses have been made on both sides and learn ore.

Name of mine	Name of branch or mine	Samples taken by 1894, H. Peterson			Samples taken 1893 by Robert	Sapls. taken 1891 by P. Holman		Samples taken 1894 by H. P. Ahrens	
		% of copper	% of silver	Gold in gram per 100 lbs.		% of copper	% of silver	% of copper	
					19.83	19.51	0.005		
					14.52				
					12.91	15.78			
					14.23			36.50	
								39.03	
								24.09	
John	Risckärpening	14.28 <sup>F</sup>						64.00	29.2 Lbs silver 100 lbs. copper
	"	5.45 <sup>F</sup>							
	"	24.92							15.45% refined copper
John	Soviskärpening	18.80 <sup>F</sup>							
	"	5.6 <sup>F</sup>							
	Fondsckärp.	44.3 <sup>F</sup>							
John. Gust.	Skulm G.	6.50 <sup>F</sup>							
	"	5.45 <sup>F</sup>							
	" g.	13.09							
Helena Gustaf		4.85		absent	2.40	16.20		55.63	13% raw copper 8.5% " " 0.062% silver
								5.22	One piece
								0.1	Several pieces.
Gabriel	Bornitgängen	64.12 <sup>⊙</sup>			54.86	41.84	0.001		
	"	19.34 <sup>F</sup>		absent		42.82	0.010		
	"	8.95 <sup>F</sup>				12.64			
Hilda Berndes		1.39		absent					
		4.89			5.68	4.19			
		0.44							
Herrmann Alwin		18.00		Julphina					
		Traces		40.16 absent					
one piece brought by		H. S. Lundqvist			1891				

These analyses show that there are ores at Sjangeli with a very high percentage of copper. If we only look at the more important deposits, which are No 1, 4, 7, 19, 33, 35, 43, 46, 48, 59, 60, 61, 73, 74, and Unna Alakats, we find following percentages of copper among 25 general specimens, and 4 samples consisting of one piece only.

Of rich ore 3 analyses lower than 5 % copper

5 " " " 5-10 % "

9 " " " 10-20 % "

2 " " " 20-30 % "

4 " " " 40-64 % "

Of lean ores 2 analyses lower than 5 % copper

4 " " " 5-10 % "

The silver varies in 10 specimens between 0.0812 and 0.010 % and in some are found traces of gold. In concentrated ores should the metallic percentage of course be considerably higher and the ore could undoubtedly be treated that way favourably if only the producing of the pure copper would be done electrolytically.

Regarding the quantities of ore which can be mined following abridgment may be made, with references to what has been said previously in the report.

(Regarding the quantities of ore which can be mined following)

The copper ores appear within an extensive territory, partly as numerous shisty bodies consisting of Bornite, copper glance and Magnetite, or Zones rich in copper glance within the Hornslate and partly although more exceptionally as ordinary veins and fissure veins. One part of the deposits are evidently very small and of no importance, others are comparatively extensive. Work formerly done at the field seems more to have been aiming at getting ore than to find out the extension and value of the different ore lodes and many of the best deposits have therefore only been superficially examined at all. As a consequence hereof, and because the different ore streaks are of very various width, is an examination of older pits apt to lead one to the belief that the ore occurs in very short lenses. Sometimes this may be the true conditions, but investigations during last year show however that several have

quite large extension lengthways, which by further exploitation undoubtedly shall be found to be still larger. The orestraks in Anna Kajsa skärpningen and 19 Burman are at present known for a length of resp: 42 and 36 meters and they are not yet stripped to their full length. The ore in Långgrufvan has during the work been followed for more than 80 meters. The orebearing zone of slate which has been mined in Skifferskärpningen has probably an extension of at least 50 meter and it has also been noticed in the Level on a depth of about 12 meters below the surface of the rock. The crevins in Berndes and Haparanda have probably a length of at least 45 meters and those in Henrika and Tornberg, at present known for a length of only 8 to 12 meter, have probably a much larger extension. The same can be said about others yet unexploited oredeposits.

The orestrak are generally narrow but several expetions exist, and the value of the ore is not so much depending on the width of the väina as the copperpercentage in the narrow ones is very high. To illustrate this, following figures may be quoted from the detailed description.

In Henrikaskärpningen is the ore at the average 12 cm. wide with 4.16 % copper Tornberg skärpningen 15 cm. wide with 19.49<sup>I</sup> % and 6.99<sup>II</sup> % copper. Anna Kajsa skärpningen 10 cm. wide with 15.48 %, 11.32<sup>I</sup> % and 3.04<sup>II</sup> % copper. N:o 19 Burman 13 cm. wide with 11.82 % copper. Stollgrufvan for a length of 3 meters at an average 40 cm. in width and 12.50<sup>I</sup> %, 5.97 %. Skifferskärpningen together 60 cm. with a copperpercentage in the different shists varying between 2.01, 2.48, 3.76, and 24.33 %. And on a depth of 12 meters / in the Level / is the percentage according to two proofs 6.50 and 5.75. In N:o 35 Berzelius carries the rock for a width of 1.5 meters about 16 % copper. The vein in Snäskärpningen known on a length of 11 m. is hardly visible in the open, but has at the bottom a width of 1.19 meters and is at an average 46 cm. wide with 11.80<sup>I</sup> and 5.69<sup>II</sup> % copper. The lately discovered ore in Fondskärpningen is for a length of 3.3 meters 8 cm. wide with 44.37 % and Bornitgängen in Gabriel known on a length of 3 meters is 20 to 30 cm. wide with 42.00 to

1) Numbers I and II indicate resp: Rich and Lean ore.

54.00 % copper. The very analogous orebodes N:o 33 Burman and Unna Alskats are on a known length of 10 meters resp: 41 and 120 cm. wide with resp: 5.53 % and 5.37<sup>I</sup> % 5.24<sup>II</sup> % copper.

In several of the orestreaks the copper-percentage is very various, being at one place very high and again a very short distance from there very low. Regarding the variations I must refer to what has been said on pages 9 to 12 and to the detailed descriptions

A true estimate of the quantity ore which could be mined in Sjangeli orefield can not be made on the basis of this or previous reports, because a great part of the more important oredeposits have not been examined to their whole length.

For determining the depth of the orebodes no other guide is yet at hand than what has been observed in the level. But according to my own opinion there is no cause for a supposition that the ore will diminish with the depth. It is much more probable that the oreveins are analogous both in direction of the strike and the dip, and that the veins deeper down show the same characteristics as in or near the open.

Last I cannot omit to mention that a regular exploitation of Sjangeli orefield would probably lead to the discovery of many more orebeds than those already known. One is lead to such a supposition because two veins / Fondskärpningen and Bornitegängen, both very rich in copper / have first been noticed during the last years, although the field has been examined several times before.

Further should it be remembered that Sjangeli orefield is located in a region very little known with regard to its Geological Conditions and there are good reasons to expect that there exist several more oredeposits or beds than those already known which almost all have been discovered more by chance than through search, and the whole region should therefor, in connection of the work <sup>at</sup> Sjangeli, be subjected to a thorough examination.

Regarding this proposed examination and also regarding the work which should be done to make an estimate of both the quantity of oredeposits in Sjangeli Mountain I shall state my views in a special Report.

Stockholm in April 1895.

REPORT

of

MESSRS. EDMOND SPARGO & SONS,  
Consulting Mining Engineers,  
LIVERPOOL.

E.S. & S. have executed important professional commissions in United States of America, Canada, Newfoundland, Germany, Russia, Austria, France, Italy, Bohemia, Hungary, Roumania, Bulgaria, Croatia, Belgium, Spain, Portugal, Sweden, Norway, and in the various Mining and Quarrying Districts throughout Great Britain and Ireland.

Bankers /since 1870/: National Provincial Bank of England  
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For relative Status and Experience-See the "Mining Journal's  
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in Mining and Metallurgy for 1908. See pages 86 and 87.

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MINING OFFICES -

3, CABLE STREET,

LIVERPOOL, 26th September, 1912.

THE PROPRIETORS OF THE SJANGELI UNITED COPPER OREFIELDS,  
STOCKHOLM,

Gentlemen,

SJANGELI UNITED COPPER MINES.

IN COMPLIANCE WITH your instructions we have visited and minutely examined all the principal superficial test openings and the deeper exploitations accessible, during our inspection at the end of July last, which, with the aid of horses, we effected during five long days at the mines.

THE MOST DIRECT and the quickest route to the mines is via Norvik, thence by setamer /two hours/ up the "Sjomen" fjord to the village of Elvegaard, whence the mines can be reached in thirteen hours on horseback.

THE JOURNEY FROM NEWCASTLE or Hull via Bergen, Christiansund, Trondhjem, Bodo, and Norvik to the mines occupying seven days.

THE ACCOMPANYING MAP indicates the route to and the geographical position of these extensive copper mining fields, which are located at altitudes varying from about 2,000 feet at the Unna,

AS ABOVE REFERRED TO, the Valfo River claims will probably be the last to receive practical mining attention, owing to their remoteness from the proposed concentration works, but there are several very promising vein exposures in this valley on both sides of the river, but mostly of a narrow width. The most interesting perhaps is the Martha, where there may be observed no less than five parallel veins, all dipping from 35 to 40 degrees within a distance of 80 yards. One of these veins is eighteen inches wide, composed mostly of magnetic iron, carrying rich bornite copper. Some of these veins have been explored for about 70 yards on their outcrops, but the bornite ore is more or less in places associated with the iron, therefore their separation would, we fear, be difficult to effect mechanically.

THERE ARE FIVE CLAIMS on the North and Nine on the South side of the Valfojokk river, where supplies of ore can be obtained, but as these claims are separated from those of Sjangeli by a deep valley, we do not /as before mentioned/ recommend carrying out any exploitations on this side until the success of the other three groups, or some of the lodes therein, have been definitely proved to be capable of profitable development.

IT WILL BE OBSERVED that the Sjangeli group embraces the largest number of claims /i.e., 33/ in which a considerable number of tests have been made, displaying many strings of rich ore-bearing rock, varying in thickness from half an inch or even less up to three or four inches, and extending in the aggregate-as indicated in the opencast excavation shown in No. 1 sketch-to ten or fifteen feet. The intervening rock also contains some copper, all of which maintain the same longitudinal strike and inclination as the ordinary embedding strata.

THE ORES OBTAINED from this opencast and the shaft sunk below it, are more or less high grade bornite of a bluish bronze and chocolate colour which seems to be the characteristic of ores obtained wherever it occurs in the darkgreen hornblende and serpentine or epidotic looking rock, in which all the ore-bearing veins worked or in any way prospected on the crown or apex of the Sjangeli mountain spur or ridge are embedded, and where this rock exists very little or no yellow copper pyrites or chalcopyrite ores are found.

THIS CLAIM, and the immediate surrounding or adjacent ones, yield this class of ore in more or less narrow solid veins, quite capable of being manually selected to give 10 to 25 per cent. metallic copper, while in many instances the adjacent more massive rock gives in highly appreciable quantities 2, 3, 4 and up to 5 per cent. of copper, as indicated by the quality of the various grades of ore deposited on the surrounding banks of the opencast, with the rich pile of selected bornite ore near the tip, as shown in our sketch No. 1.

SOUTHWESTWARDS, the rock changes to a lighter colour and a somewhat softer schist, in which copper pyrites as well as the bronze colour and indigo blue bornite ores are observed.

THERE ARE SOME EXTENSIVE SHALLOW WORKINGS on the various claims Northeast of the Sjangeli office down to the Sjangeli river, whence some appreciable quantities of rich ore could be obtained from these claims on further exploitations being effected, which would be availed of if required to keep the proposed concentration works in constant operation. Both copper pyrites and high-class bornite and rich copper glance ores can be obtained from these claims, especially from the Fredrik and Burnan claims.

THE LODE is about eighteen inches wide. The workings on these claims are extensive, with shafts five or six yards to ten yards in depth, yielding mostly copper pyrites, all more or less beautifully stained and coated with blue and green carbonates, but carry also some strings or veins of bornite at various parts of the workings.

THE ELLEN AND HARMAN CLAIMS, /see plan/, display large ex-

Allakats and the Valfojokk group of claims, to about 3,000 feet at the Sjangeli and the Ruopsok claims; the Norwegian claims are located at still greater altitudes.

THE ELEVATION OF THE MINES is in no way exceptional for Norwegian mines, as some of the largest and best paying mines in Norway are at equal altitudes, and are now and have been in continuous operation for centuries. The only difference in the case of Sjangeli mines being their more Northern situation, rendering the winters somewhat more severe and of longer duration and a longer absence of daylight.

THE LATTER FACTS however cannot injuriously affect underground mining operations where, in any case, constant artificial illumination would have to be provided, as well as at the surface for six or seven months in the year. The inconvenience from these facts will be more or less obviated however by the creation of electric light generated on the spot by the abundance of water-power available, which, owing to the precipitous escarpment of the mountain, down which the river rushes from the Ruopsok and other lakes, giving great facilities for fully utilizing the water by comparatively short pipe lines, could be harnessed at a comparatively small outlay, so that the cost of all required illumination, throughout the internal workings as well as everywhere required at the surface, would be procured at a trifling cost beyond the first outlay for the electric installation.

AS A FURTHER PROOF that the climatic conditions should not be considered serious to the successful development of the Sjangeli mining proposition, may be mentioned the fact that the Lulea and Norvik railway, which is still further North, is worked throughout the year, with, so far as we are aware, no exceptional climatic inconveniences.

THE WHOLE OF THE CLAIMS have not only been well selected on the strike and inclination of the respective lodes, veins, or ore-bearing strata, but nearly the whole of the concessions—especially where natural outcrops are discernible—have been fairly well prospected, and in some instances actual mining has been effected, at many thousands of pounds outlay, fully demonstrating the implicit faith of the concessionaires in the future great value of the mines.

ALTHOUGH WE HAVE EXAMINED the whole of the principal tests—more or less—in the various claims, it would be superfluous to refer individually to the whole of them in detail.

BY WAY OF RENDERING OUR REPORT as comprehensive as possible, and in some degree in elucidation thereof, we have made the accompanying rough sectional sketches or plans of some of the more important explorations that have been effected on the claims referred to, which may be taken as generally typical of the whole of the claims, according to the local development facilities they afford, and the amount of prospecting work effected therein, which, in most instances, except a few of those located in the low-lying lands, such as in the Unna and the Valfojokks claims located in the vicinity of the two rivers, where the physical contours do not admit of intersecting them by day-levels to any appreciable depth.

THE CHIEF AND MOST RELIABLE evidence of the possible great value of this extensive ore-bearing district is convincingly demonstrated in the central claims of Isaac Adolf and John of the Sjangeli group, and further supported by the exploratory work carried out in the Southwestern claims Herman and Ellen, and in several of the intervening claims and the central Sjangeli concessions, and the still more Southern group /Unna Allakats/, especially in the Edward and Walle claims /plan 3 and sketch 2/.

THE STINA CLAIM test, in the Northern or Ruopsok group, shows exceedingly encouraging prospects /sketch 4/. Large quantities of smelting ores could be cheaply and quickly obtained from these claims.

interesting coatings of green and blue carbonate of copper/, as well as some ordinary copper pyrites, and there are several hundred tons of ore matrix and gangue stored in the vicinity of the trial openings, which seems to us to constitute a free smelting ore.

THESE TWO CLAIMS enjoy an exceedingly advantageous position, owing to the contours of the mountain admitting of their development to a great depth—at least 300 to 400 feet or more, we estimate --by daylevels driven in from the escarpment of the precipitous mountain, through which the two veins in these claims traverse, and about midway from the river and the present open cuttings. A SINGLE LEVEL from the foot of the mountain would suffice to develop these two mines either to the above named depth, or half the depth by a shorter tunnel, the produce of which could be run to the proposed ore concentrating works in the valley below an automatically worked aerial ropeway.

THE ORE BEARING VEIN in the Ellen mine has been exposed from the breast of the mountain for about 60 feet in length and about 18 feet in depth, displaying a lode some 10 feet in width, whence large quantities of ore could be obtained.

THE HERMAN tests are some 30 feet in length, and yield some copper glance and carbonate, with bornite. This lode seems to run and dip parallel with the Ellen vein and is only about 180 feet from the Ellen mine workings, and could be operated by crosscuts from the Ellen workings.

THE RUOPSOK GROUP. These claims and those over the frontier in Norway are the most elevated, displaying, so far as the tests have gone, most assuring prospects for future returns; especially is this the case as indicated in the Stina claim tests, shown in our sectional sketch.

THIS LODE has been proved by test openings to extend for 300 yards or more through the Stina and into the more elevated concession Butha.

THE STINA TRIAL, shown on plan, display a lode from 7 to 10 feet wide, inclining about 70 degrees toward the lake, as indicated on plan, and can be further exploited as hereafter suggested. The lode consists of crystalline schist on the footwall carrying copper pyrites, and hard dull-green hornblende Elvenite rock on the hanging-wall, with rich bornite ore, the two parts being in about equal divisions, constituting altogether quite a masterly looking lode, from the development of which highly profitable and large returns of ore, in our opinion, may be expected when sectioned out for stopping.

THIS LODE has been prospected up the mountain towards the Norwegian frontier for fully 300 yards, and although not so wide in some parts, it presents exceedingly promising signs of yielding large quantities of ore at deeper points.

THE BERTHE TEST, the nearest to the Norwegian frontier, displays a lode of about 5 to 6 feet wide, lying on a layer of carboniferous limestone, dipping 80% Westerly and carrying copper pyrites and some rich bornite ore in a hard hornblende gangue. It appears to be a well-defined lode, indicating both longitudinal and vertical persistence.

WE VISITED the Norwegian claims, in which we found the lodes to be quite regular in their strike and dip, but of narrow dimensions, some 15 inches in thickness, some of the prospecting trenches being 40 feet in length and from 1 or 2 to 4 or 5 in depth, the lodes being embedded in greyish Gniesses carrying chiefly copper pyrites, with occasional small threads of bornite, which together would furnish an 8 to 10 per cent, or for concentration.

THIS SMALL GROUP of mines is quite capable of contributing an appreciable quantity of ore for treatment at the proposed concentrating works, and could be connected with the Stina mines by an aerial ropeway for the transmission of their produce in con-

junction with the means that may be devised for transporting of the product of the Stina claims to the proposed smelting works in the valley.

WITH REGARD TO THE MAIN QUESTION of further demonstrating by actual mining, concentrating and marketing the ores of the various mines, so as to establish beyond doubt their profitable possibilities, we suggest in order to establish the permanency of the ore-bearing veins and ore matrix of the Sjangeli group that a level be cut at a few feet above the surface of the lake, and driven Southwards under the existing shaft sunk from the opencast, as outlined in sketch No. 1, and that levels on the course of the ore-bearing lode and rock matrix be driven right and left from point E. The Ellen and Herman workings should be extended in depth and along the course of the two lodes, which would no doubt produce a good supply of ore for concentration and show proof that these lodes would afford good profits when opened out at deeper points, by intersecting, and establishing their productiveness with the aid of the deep tunnel, or intermediate one, referred to above.

THE IMPORTANT AND PROMISING RUOPSOK CLAIMS should be further tested by first sinking a shaft on the dip of the lode from A, as shown on sketch 4, which, if found to continue to the depth of the proposed drainage level, then the latter should be cut so as to afford an outlet for the produce and the water, when development levels should be driven along the strike of the lode on each side of the shaft, and subsequently sectioned out for stopping in the usual manner.

THIS CLAIM, in our opinion, presents the strongest indications of permanency in depth as well as on the longitudinal strike of the lode or vein of any of the exploratory tests we examined.

THE WALLE CLAIM on the Unna Allakats group is most likely, in our opinion, to yield the most satisfactory results for the object in view, namely-to yield the largest quantity of ore, although possibly not the richest, for concentration of the ores from these claims, and at the same time give the quickest and most reliable evidence as to the permanency of the productiveness of the lodes or ore-bearing outcrops laid open to view by the numerous test effected in the lodes of this group.

THE EDWARD CLAIM yields more or less copper pyrites and is of special interest owing to the existence of the two cross-lodes, as indicated on No. 3 plan, which carry exceedingly rich bornite, and are of considerable width, as shown on plan.

THE MOST IMPORTANT QUESTION, next to demonstrating beyond doubt the continuance in depth of the productiveness of the principal ore-bearing lodes, must be the question of the concentration of the ores, first on the spot as suggested, which should be by some process not entirely mechanical.

WE HAVE NO DOUBT that they could be treated to the best advantage electrically, there being abundance of water power available just where it is required, as indicated on the accompanying plan.

WE THINK, with the aid of a small electric installation at or near the site indicated in the plan, with the preliminary developments we have suggested /approximately shown in our sketches/, with a cheap and proper means of transport for the produce of the mines provided to the concentration works, reliable evidence would soon be established to warrant the construction of the proposed railway to Elvegaard; and the establishment of a more elaborate and efficient electric smelting and refinery works and shipping quay there, or at the most convenient point on the Elve river, for the more effective utilisation of the immense and never-failing power the river affords.

THE PRELIMINARY ELECTRIC SMELTERS INSTALLATION at the mines, even on a very small scale, would afford most valuable and reliable evidence of the intrinsic value of the entire proposition.

THIS WORK HOWEVER, would probably not be proceeded with until the permanency of the productiveness of some of the mines has been further assured. This should, not, we think, occupy more than 12 to 18 months, if sufficient and comfortable accommodation for the employees were provided near each of the mines to be tested.

WE THINK it advisable to expend at least £ 500 to £ 600 in defining and improving the road to the mines in many of the most precipitous parts from near Bogholm. In order to facilitate the transport of the necessary provisions to the employees, and the machinery and appliances for the electrical works, for effecting the preliminary tests contemplated.

WE CAN CERTAINLY SAY that there is abundance of ore capable of being obtained from each group of mines, and we believe at a profit, as what is lost through the comparative narrowness of the runs or loies is in most instances offset by the high percentage of the ores they yield, but we hardly see notwithstanding how this can be actually and satisfactorily demonstrated, without some kind of reduction works being erected near the mines. We think in any case a better mule road would have to be constructed for the purposes above mentioned.

THERE WOULD, in our opinion, be no appreciable advantage in carrying the proposed Elvegaard railway beyond the suggested smelting works site, approximately indicated on the accompanying plan, as the altitude of the Sjængeli and Ruopsek claims readily admit of their being connected with the proposed works in the Kamajokk Valley by automatically operated aerial wire ropeways.

OF COURSE, ANOTHER WAY of testing the market value of the ore, provided the exploratory works proved successful, would be to submit lots of five or ten tons to Elmore's or some of the various other ore concentrating works or electric smelting works.

IT MIGHT BE POSSIBLE satisfactorily to test many of the claims by effecting a series of borsholes. Thus a great deal might be effected in a single season, provided proper and powerful boring plant could be got on the ground in the early spring.

AS BEFORE MENTIONED, HOWEVER, the question of mining and concentrating the ore at a profit is the chief object to demonstrate. This can only be done, to satisfy everybody, by a fairly practical amount of mining and concentration operations carried out on the ground.

BY A PATENT ELECTRIC PROCESS of Mr. J. Scott Anderson, M.I.C.E., M. Inst., E.E., of Sheffield, it is claimed that with the aid of 600 horsepower and five to eight per cent, ore-matrix, pure electrolytic copper can be produced at £ 17 or £ 18 per ton, beyond the cost of the ore.

THERE WOULD BE NO DIFFICULTY, in our opinion, in obtaining 1,200 to 1,500 horse power at a very moderate outlay from the river Ruc sok, as indicated. Therefore it seems to us that this process would be the most advantageous to adopt. We have no doubt but that Mr. Anderson would be pleased to make all the preliminary tests of the ore necessary.

NOTWITHSTANDING THEIR SITUATION, we do not hesitate to say that these Kining fields, will, sooner or later, be found to rank with some of the most productive copper producing mines in Europe.

WE SHOULD MENTION that there is abundance of fluxing material in the vicinity of the proposed smelting works, such as iron and arboniferous limestone, obtainable at a very cheap rate.

THERE APPEARS TO BE a mountain of white marble, constituting the precipitous Western escarpment of the Kamajokk valley, just opposite the Unna Allakats claims, which, if the railway were made to Elvegaard, might possibly be profitably utilised for embellishing and decorative purposes.

THE PROPOSED RAILWAY from the mines to Elvegaard when constructed will traverse the base of and afford easy access to, several great mountain ranges, which would certainly lead to their being carefully investigated and explored for metallic ores and industrial minerals, which, especially in the vicinity of the junctions of the granitic, schistose, and calcareous formations—their is every reason to expect would result in important discoveries, which might lead to the extension of the line in various directions, consequently the future interest of the Company would be attended with immense potentialities. We estimate that fully 20,000 h.p. of water along the lower section of the proposed railway could easily and cheaply be procured, apart from the 5,000 h.p. at Bogholm.

WE ESTIMATE THAT AN OUTLAY of about £ 30,000 would be necessary to carry out the preliminary mining developments, with the local concentration works we have suggested.

THE PRELIMINARY OUTLAY above mentioned, if properly disbursed, would, in our opinion, afford sufficient proof, as to the future producing capabilities of these copper orefields, to justify the immediate construction of the projected railway to the confines of the SJOMEN FJORD, which, with shipping wharves and permanent ore concentration works, together with electric copper refineries thereat, in combination with the harnessing and utilisation of the 5,000 h.p. of water, available at Bogholm Falls, with complete electric and mechanical equipments at and for the most economical development of the mines, together with every requisite for establishing this undertaking upon thoroughly modern and up-to-date basis, a further capital of £ 350,000 would suffice and would in our opinion bring it into a progressive and highly profitable state of operation.

Yours faithfully,

/Signed/ EDMUND SPALJO & SONS.

1902

Norges Geologiske Undersøkelse

Bergarkivet

Rapport nr. 2592

Rapport

över

SJANGELI

af

Prof. Walfr. Petersson.

sambanhängande, ehuru den malmförande bergarten är dold af yngre aflägringar och det är vidare tydligt, att det malmförande området sträcker sig ännu längre mot N.O., under fjällen N.O. om Valfojokk. 25 km. N.O. om Valfojokks malmfält har också i den breda, genom de yngre fjällbergarterna nedskurna dalgången mellan Torne- och Riksgränsen samma malmförande bergart med samma slags kopparmalm som vid Sjangeli och Valfojokk anträffats, i Sjangeliskif- ferns strykningsriktning.

De ifrågavarande 3 malmfälten öfverensstämma i det väsentliga- ste såväl med hänsyn till malmens beskaffenhet som till densamma förekomstsätt, hvilket är helt naturligt, då de endast utgöra de- lar af samma malmförande streck.

De inom detta malmförande streck förekommande malmineralen äro kopparglans /grå kopparmalm, i rent tillstånd innehållande 79.8 % koppar/, bornit /brokig kopparmalm, i rent tillstånd inne- hållande 55.5 % koppar/ samt, ehuru i ganska ringa mängd, koppar- kis /i rent tillstånd innehållande 34.5 % koppar/.

Dessa malmineral förekomma

än utan inblandning af andra mineral, såsom utfyllningamassa i smalare eller bredare sprickor, som stundom inom smärre områden skära hvarandra ö olika riktningar

eller också såsom större eller mindre körtlar eller som smärre korn, insprängda i den inom malmfälten förherrskande berg- arten,

än förekomma de intimt blandade med magnetisk järnmalm i väx- lande proportioner, såsom lagerliknande partier med skarp gräns emot den omgifvande bergarten.

Den bergart, inom hvilken samtliga de vid dessa malmfält före-

Undertecknad, som under somrarna 1894, 1895, 1896 och 1897 utfört grufgeologiska undersökningar vid och i trakten af Sjangeli kopparmalmsfält och nu senast sommaren 1902 granskat de efter 1897 utförda sprängningsarbetena vid detta och angränsande malmfält, får härmed på begäran lämna följande generella utlåtande öfver Sjangeli, Unna Allakats och Valfojokks malmfält.

Malmfälten äro belägna i Jukkasjärvi socken af Norrbottens län, nära gränsen mot Norge på  $68^{\circ}10'$  N.B. och  $18^{\circ}0'$  Long. från Greenwich, cirka 48 kilometer från Sjomenfjord, en vik af Ofotenfjord.

Sjangeli malmfält omfattar 33 utmål, Unna Allakats malmfält 23 och Valfojokks malmfält 14 utmål. Hvarje utmål har i allmänhet en areal af 40,000 m<sup>2</sup>.

Sjangeli och Unna Allakats malmfält, hvilka åtskiljas endast af en dalgång, hafva en sammanlagd längd af 6 km; Valfojokks malmfält, som är beläget 2 km. N.O. om Sjangeli och från detta skiljdt af en bergkulle, är 1 km. långt. Den malmförande zonens bredd växlar mellan 300 och 600 m. Både den mot såväl S.V. som N.O. brant stupande bergkullens emellan Sjangeli och Valfojokk och den N.O. om Valfojokks malmfält belägna fjällkomplexen utgöres af i det närmaste horisontalt liggande yngre bergarter, som äro diskordant aflagrade öfver de cirka  $70^{\circ}$  N.V. stupande malmförande skiffrarne, och man kan såväl i N.O.:a delen af Sjangeli som i Valfojokksdalens begge sidor tydligt se, att nyssnämnda skiffrar fortsätta in i fjällen under yngre bergarterna. Det är sålunda tydligt, att Sjangeli och Valfojokks malmfält äro

kongande kopparmalmerna uppträda, är en hornblendeskiffer af särdeles karaktäristiskt utseende, benämnd Sjangeliskiffer; inom denna skiffer, som har N.O. - S.V. strykning och brant N.V. lig stupning, förekomma flera, större och mindre linseformiga partier af småfin-kornig gabbro, äfvonson smala lager af kalksten. Sjangeliskiffern underlagras af gneis och överlagras af hornblendeskiffer af annan art samt af delvis rikliga lager af dolomitisk, mycket oren kalksten. Samtliga dessa bergarter till-höra urberget.

Inom Sjangeli, Unna Aliakats och Valfojokke malmfält är i Sjangeliskiffern ett stort /till 250 å 300 uppgående/ antal malmfyndigheter anträffade i den blottade bergytan och åtskilliga af dessa hafva blifvit föremål för närmare undersökning i syfte att utrona dels deras storlek och dels huru rik malm man vid en grufbrytning härstädes kunde vinna genom enkel handskradning.

Resultaten af dessa undersökningar äro i kortnet följande:

Man kan skilja emellan 3 olika slag af malmförekomster, hvilka dock stundom förete öfvergångar emellan hvarandra.

1. Bornit, stundom jänte kopparkis i underordnad mängd, bildande gångar, körtlar och nätverk i Sjangeliskiffer.

Dessa gångar äro mycket varierande till såväl längd som bredd, den förra växlande mellan ett par decimeter upp till några meter, den senare mellan ett par mm. och 0.3 m.; bredden växlar i allmänhet mycket hastigt och gångarne te sig stundom som ett system af körtlar, liggande i närheten af hvarandra och förenade af smala,

bornitfyllda eller tomma sprickor. Förekomstssättet är således mycket ojämnt och endast undantagsvis förekomma sådana mera mäktiga gångar i rikligare mängd, såsom vid Gabriels bornitgruva på Sjangeli och i Victorgrufvan på Unna Allakats. Smärre körtlar af sådan malm uppträda emellertid ej sällan tillsammans med malmer af nedan nämnd typ 3.

Hithörande fyndigheter gifva vid brytning en mycket rik malm: vid en försöksbrytning inom utmälet Gabriel erhöles genom grofskrädning af det brutna berget en prima malm med 55.06 % koppar, en sekunda malm med 27.46 %, en teriamalm med 6.10 % och en vaskmalm med 17.56 % koppar.

2. Kopparglans och bornit, i allmänhet intimt blandade sinsemellan och med magnetisk järnmalm, bildande lagerliknande partier med tillnärmelsevis samma strykning och stupning som den omgivande Sjangeliskiffern, mot hvilken gränsen är skarp.

Dessa s.k. bornitjärnmalmslager hafva mycket växlande längdsträckning, från några meter upp till mer än 100 meter och mäktigheten varierar emellan ett par cm. och upp till mer än 0.3 m. Såväl i horisontal som vertikal led växlar malmens beskaffenhet emellan vida gränser, i det att den än utgöres af öfvervägande kopparmalm, än af öfvervägande järnmalm. I prof tagna från olika delar af samma lager har sålunda kopparhalten visat sig vara än 0.0 än c:a 50 % och däröfver.

För att erhålla närmare kännedom om detta slag af malmförekomster hafva jämförelsevis omfattande undersökningsarbeten utförts vid några sådana och har det därvid visat sig, att kopparhalten

hos desamma igenomsnitt öfverstiger 10 % och ej sällan uppgår till 20-30 % och däröfver. Vid profskrädning vid sådana fyndigheter har erhållits prima malm med 23-12 % koppar och sekunda malm med 7.8 - 5.4 % koppar.

Ofta förekomma sådana bornitjärnmalm lager ganska nära hvarandra, så att de vid en grufbrytning kunna brytas gemensamt.

Utom den typiska bornitjärnmalmen, som förekommer på mycket talrika ställen i Sjangeli, förekommer ett med denna malmtyp analogt malmslag såväl i Sjangeli som i Valfojokk och Unna Allakats. Den skiljer sig från bornitjärnmalmen därutinnan, att den förutom kopparglans och bornit innehåller hornblende i riklig mängd tillsammans med och stundom istället för magnetit, hvartill kommer fältspat i underordnad mängd. Äfven denna malmvarietet har ofta skarp gräns mot den öfyndiga sidostenen, men stundom aftager kopparmalmhalten mot lagrets gränser och bildar sålunda denna malmvarietet en öfvergång emellan bornitjärnmalm och nästföljande malmtyp 3.

Vid detaljerad undersökning af fyndigheter af sistanfödda slag hafva de visat sig med hänsyn till malmmaltens storlek och fördelning äfvensom till utsträckning i horisontal och vertikal led i hufvudsak öfverensstämma med bornitjärnmalmfyndigheterna, men äga ofta större mäktighet, stundom uppgående till 1.2 m. och däröfver, /såsom t.ex. i Kathiegrufvan vid Valfojokk/.

3. Kopparglans eller bornit. /stundom kopparkis/, mer eller mindre fint insprängd eller såsom smärre körtlar i Sjangeliskiffer förekommer i stor utsträckning särskildt i Unna Allakats och Sjangeli, men äfven vid Valfojokks malmfält.

De malnhaltiga partierna hafva vanligtvis i stort sedt linsform; på flera ställen har iakttagits antydning till en fältstupning hos dessa malmförande partier brant mot S.V. och vanligen uppträda flera dylika malmpartier på ett lagbundet sätt stjänt om stjänt efter hvarandra. Längdutsträckningen hos dessa malmförande partier varierande och ofta svår att utan särskilda sprängningsarbeten bestämma. 30-50-100 m. långa linser och däröfver förekomma ganska rikligt och deras bredd växlar från några decimeter upp till 1-3-5 m. och uppgår någon gång till 10 meter.

Malhalten inom desamma är ganska växlande och i allmänhet är den större hos smalare, mindre hos bredare linser. I stort är smalare, men delvis mycket kopparrika partier mera vanliga å Sjangeli, medan bredare, mindre kopparrika partier hafva stor utbredning å Unna Allakats.

Dock är att märka, att inom de sistnämnda mera sparsamt kopparmalmsinsprängda partierna af och till uppträda mycket kopparrika partier, hvilka med lätthet kunna fränskrädas. Sålunda erhöles vid en föræcksbrytning vid Unna Allakats dels en relativt fattig malm med o:a 5 % koppar och dels en mindre mängd utskrädd malm med ända till 50 % koppar. De malmerikare skiffelpartierna hafva som nämnt vanligen mindre bredd än de nyssnämnda, men den uppgår dock ej sällan till 1.2 m. och däröfver. Vid undersökningar af flera sådana fyndigheter har genomsnittshalten uppgått till 5 - 6 % koppar och vid skrädning vunnits prima malm med 20.3 - 14.4 % koppar och sekunda malm med 9.3 - 5.5 % koppar.

Tillägges bör, att samtliga malmerna vid de ifrågavarande lår-  
ten äro fullständigt fria från skadliga föreningar, såsom arse-  
nik, visant, antimon, zink, bly, o.d. samt innehålla smärre mäng-  
der silfver, intill 0.010 %, och spår af guld.

Dessa olika slag af malmfyndigheter äro spridda öfver en stor  
areal, än enstaka här och där, än samlade i större mängd inom vis-  
sa områden. Genom de detaljerade undersökningar, som blifvit gjor-  
da vid dessa malmfält, har det framgått, att malmfyndigheterna fö-  
rekomma i så stort antal och så nära intill hvarandra, att de kun-  
na brytas gemensamt i samma öppna dagbrott eller i samma grufva,  
och att man vid brytning af dessa fyndigheter icke är uteslutande  
hänvisad att bearbeta hvarje malmlins eller malmlager särskildt.

Såsom exempel på sådana områden, inom hvilka de särskilda fyn-  
digheterna äro så tätt ansamlade, att de kunna brytas gemensamt,  
må anföras först och främst den s.k. Grufkullen, /utmålen Isak,  
Adolf, John/ och vidare Herman-Ellen-kullen, Gabriolkullen, Flera  
områden inom utmålen Berzelius, Carl, Burman och Fredrika på Sjan-  
geli, inom utmålen Kathie och Märtha vid Valfojokk samt inom utmä-  
len Gustaf, Karl, Walle o. Paulus vid Unna Allakats.

Af dessa har Grufkullen på Sjangeli under sommaren 1901 gjorts  
till föremål för en försöksbrytning medels en 6.5 m. bred, 7 m.  
djup sprängning in i den branta, mot norr stupande bergväggen och  
erhölls då af det brutna bergget cirka 20 % kopparmalm, med en kop-  
parhalt uppgående till i genomsnitt öfver 10 % och som genom skrad-

ning kan bringas mycket högre. I den blottade berghällan före sprängningen fanns blott en mindre kortel af bornitjárnmalin, men vid sprängningen framträdde flera större och mindre sådana kortlar af delvis mycket rik malin, äfvensom nätverk af bornitgångar och äro sådana anstående i sprängningens botten och sidor.

Då såsom af öfver fältet upprättade kartor synes, talrika malinfyndigheter äro iakttagna i bergytan inom hela Grufkullen och då detta större arbete liksom flera förut gjorda mindre undersökningsarbeten visat, att talrika sådana fyndigheter finnas, hvilka ej nå upp i dagen, är tydligt, att en brytning af hela Grufkullens bergmassa /t.ex. i öppet dagbrott/ komma att lämna ett godt utbyte af rik kopparmalin för jämförelsevis billig brytningskostnad. Det område, inom hvilket det synes sannolikt att man här inom utmälen Isak, Adolf och John vid en dylik brytning skulle vinna i genomsnitt 10 % oskrädd malin med cirka 10 % koppar, omfattar cirka 7500 m<sup>2</sup> med cirka 150 m. längd i N.O. - S.V. och cirka 50 m. medelbredd, och bör man sålunda redan genom brytning endast på detta ställe kunna erhålla en betydande malinfångst.

Vid de öfriga ofvan anförda områdena äro försöksarbeten ej utförda i den omfattning som på Grufkullen men förhållandena i bergytan tyda på ett analogt förhållande vid dessa.

Min uppfattning om Sjängeli och angränsande malinfält är sålunda:

att tillgångarna på kopparmalin inom desamma äro mycket stora,  
att visserligen många af de särskilda fyndigheterna äro af alltför liten utsträckning att hvar för sig brytas med ekonomisk fördel, men

att på flera större områden fyndigheterna äro så tätt hopade, att en brytning af dem gemensamt i större arbetsrum i dagen eller under jord kan ske, hvarigenom en betydande kopparmalmsproduktion vid dessa fält möjliggöres.

Den malmförande bergartens beskaffenhet och geologiska uppträdande äfvensom dess betydande längdutsträckning berättiga till antagandet, att dess utsträckning mot djupet ar betydande. Som ett stöd härför kan äfven anföras den omständigheten, att bergarten är malmförande likaväl på 700 m. nivå o.h. /vid Unna Allakats/, som på 950 m. /vid Sjangeli/.

I samband härmed må påpekas, att på 2 a 3 km. afstånd N.V. om nu nämnda Sjangeliskifferstreck anstå ännu två streck af samma bergart, äfvenledes innehållande kopparmalm af samma slag som vid Sjangeli, nämligen inom Ruopsuoks malmfält i Norge, Ruopsuokjaure, Sjangelitjåkko och Öfre Valfojokks malmfält i Sverige. På dessa malmfält dels äro föga undersökta och dels i topografiskt hänseende mindre gynsamt belägna än Sjangeli, Unna Allakats och Valfojokks malmfält, tages ej här någon hänsyn till desamma kopparmalmstillgångar.

Stockholm den 26 November 1902.

Walfr. Petersson.