

Report No: B 86-7
Project 3822 : HÅKANSBODA

Mineralization in the Håkansboda area.
Its geology, exploitation, exploration
and potential.
(Annual Report and Project Background 1985)

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1. SUMMARY AND RECOMMENDATIONS

This report describes the previous exploitation and exploration of the Håkansboda deposit up to 1982, when work at the site ceased. In addition the geology, mineralogy and exploration potential of the deposit and its immediate surroundings are reviewed, and the report forms the data base summary for the LKAB Prospektering-BP Minerals, Håkansboda Project.

Exploitation of the complex-copper rich sulphide deposit at Håkansboda ceased in the early 1900's. Exploration in the period 1971-1981 indicated a reserve of 300,000 tonnes of 1.9% Cu, 22 g/t Ag, 0.4 g/t Au, 0.06% Sb, 0.7% As and 0.04% Bi (in-situ grades) remaining under the old mine workings to a depth of 224 m below shaft collar. This is the absolute minimum reserve in the deposit. Surface drilling has proved mineralization to at least 600 metres, and at 450 metres below shaft collar one drillhole intersected 14.35 m with 1.09% Cu and 0.23% As. At least 370 metres of 'ore-shoot' vertical pitch length remains untested and the deposit is open to the south and in depth. With the same grades as above the 224 m level, a strike length of 140 m to a depth of 600 m a reserve of 1.8 million tonnes is possible. Previous detailed exploration was only concerned in assessing the copper potential and reserve to a depth of 200 metres. The full base, rare and precious metal potential of the deposit has not been realised. A limited number of analyses indicate drill intersections of 0.72% Co (over 2.89 m), 4.28% As (over 1.25 m), 0.3% Sb (over 14.00 metres), 1.99% Cu (over 10.00 metres) and 1.1 g/t Au (over 6.25 m).

There is potential for economic gold mineralization with currently very few Au analyses and no information on its distribution within and around the deposit. It is this which makes the prospect of economic interest.

Immediately south of the Håkansboda deposit, the same stratigraphic horizon contains further mineralization of the same or similar type. This is currently untested and indicates a potential 2.6 kms strike length of target geology. Immediately west of the Håkansboda deposit running parallel and 50-80 m 'up-stratigraphy', is a potential strike length of 2.5 kms of mixed calc-silicate and meta-volcanic rocks containing magnetite and a disseminated Pb-Sb-Ag mineralization. Grades up to 3.0% Pb and 350 g/t Ag over 0.5 metres have been recorded, but the zone has not been investigated systematically.

On a basis of the data presented here it is recommended that the LKAB-BP Håkansboda Project should:-

1. Assess fully all available data (completed with production of this report)
2. Investigate the metal content of the known mineralized intersections by re-analysing early drillcore for Cu, As, Bi, Sb, Co, Ni, Pb, Zn, Ga, Ge, Se, Te, Ag and Au.
3. Investigate the potential for economic gold mineralization.
4. Investigate the potential for economic silver-lead mineralization immediately west of the Håkansboda deposit

5. Undertake additional percussion and diamond drilling to test depth and southern extensions to the mineralization at Håkansboda and in the silver-lead zone.
6. Fully investigate the economic potential of the project area and indicate possible reserves and grades.

A more specific work programme is set out in section 9 of this report.

A project budget of 1.4 MSEK has been allocated for 1985-86, including drilling. A State grant (from Council for Technical Development) of 475.000 SEK has been obtained towards the cost of a percussion-diamond drilling programme (including equipment purchase by the drilling contractor).

2. INTRODUCTION

2.1 The Project

The Håkansboda Project of the LKAB-BP Joint Venture in Bergslagen, Central Sweden, commenced in October 1985. On October 4th, 1985, the State ratified an agreement between SSAB (Svenskt Stål AB) and LKAB-BP for the transfer of the mining licences held by SSAB over the Håkansboda mineral deposit and adjacent areas. These licences are now held by LKAB-BP on a 51%-49% basis respectively.

The project has as its main objective, a full assessment of the geology, mineralization and economic potential of the Håkansboda complex sulphide deposit. The project is also aimed at evaluating the economic potential of other sites of mineralization in the area immediately surrounding the Håkansboda deposit. Specifically, similar mineralization to the south in the Eriks and Gårds gruvor areas; and to the west, the Pb-Ag-Sb mineralization in the Luth, Konsthamn, Elizabeth, Bäcke and Östanbo mine areas.

A project budget of 1.4 MSEK has been agreed for 1985-86, including a drilling allocation.

The desire to try percussion drilling, little used in Sweden, has led to the testing of a combination percussion-diamond drilling system on a geological target. This equipment, mounted on a Diamec 260 drillrig is being used on the Håkansboda Project, and a State grant for 475.000 SEK has been obtained from Styrelsen för Teknisk Utveckling (Council for Technical Development) toward the costs of this project. Drilling is being undertaken by Geodrill, Stråssa.

2.2 Location

The Håkansboda Project area is located in western Bergslagen Central Sweden. (fig 1), 45 kms due south of Ludvika, in the former iron ore mining area around Stripa, Storå and Stråssa. (fig 2.).

The now abandoned and flooded Håkansboda mine lies on the western flank of a ridge of high ground on the east side of the Storå valley. The site is marked by water filled open pits, waste dumps and a more recent head frame over the 75 metre deep shaft, at a height of 190 m above sea-level, in a wooded area 1 km SW of Stråssa village.

The project area lies within the LKAB-BP JV Nora-Stråssa region, immediately NE and E of the Lovisa Project. It is located on topographic map sheet 11F SV (Lindesberg) at 1:50,000, and economic map sheet 11F 4d at 1:10,000 scale. The western parts of the project area fall on sheet 11F 4c.

3. PREVIOUS EXPLORATION AND EXPLOITATION

3.1 Exploration prior to 1900

It is not known when the copper rich complex sulphide mineralization, occurring in impure dolomitic and calcitic marbles was first discovered at Håkansboda. Copper was worked at the site in the 1400's by King Karl Knutsson, and reference occurs to mining in the 1540's and in 1551. (Tegengren 1924).

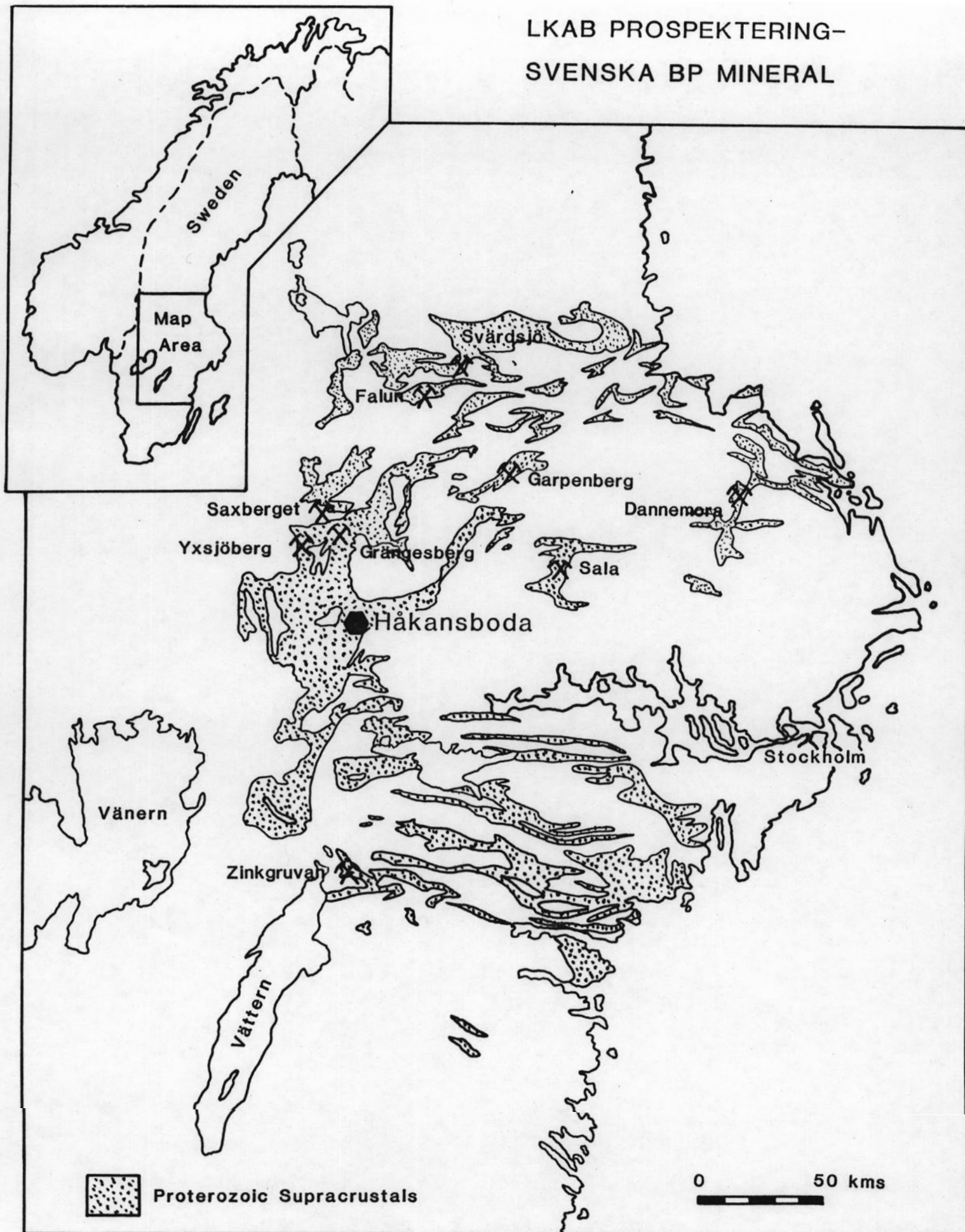


Fig.1. HÅKANSBODA PROJECT Regional location

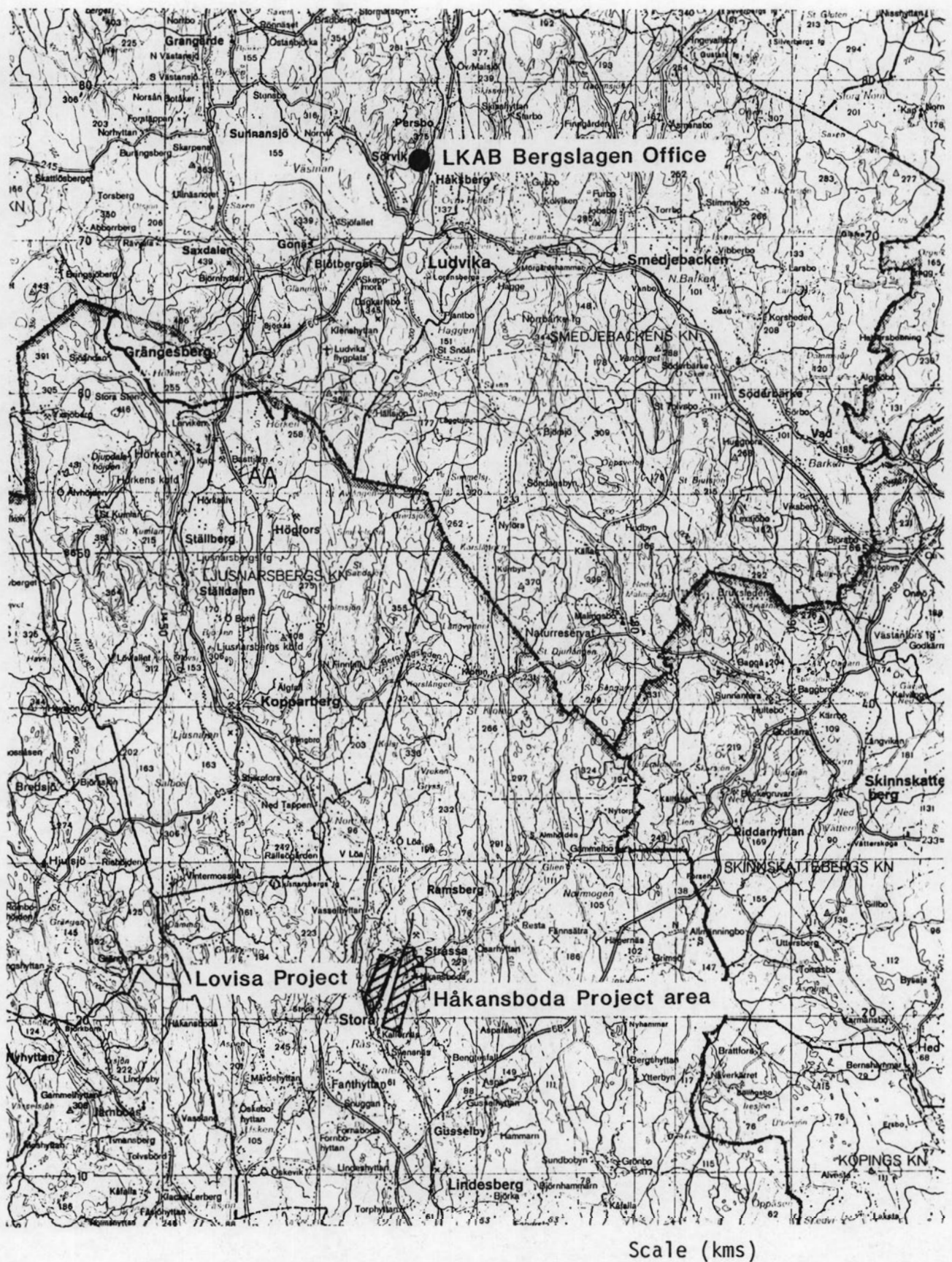


Fig.2. HÅKANSBODA AREA LOCATION.



The site was investigated again in 1627-1630, but the first main period of exploration took place in the first half of the 18th century. Between 1702-1738 mining was concentrated on the Norrgruvan deposit. This ore-shoot was worked to a depth of 32 metres before the copper grade dropped below then economic levels. Around 1738 attention moved to the Sörgruvan, which was then worked, with few breaks until 1830.

By the early 1800's work was taking place in a series of pits and galleries at shallow depth, working the richer portions of a zone of mineralization trending generally N-S through the site. Most of the work was taking place in the central 'ore shoots', particularly Märrgruvan (fig 3).

Ore was taken to the smelter at Flögfors, 2.5 kms NW of the mines, on the Storå river. During this period the cobalt and arsenic rich ores were noted as significant and 710 tonnes of cobalt rich ore were mined.

Around 1841 the Commerce or 'Kommers' ore-shoot was investigated, and proving high grade copper ore and lower cobalt contents it became the main ore of the Håkansboda mine sett. In 1849 the Commerce mine produced 608 tonnes of copper from 7,600 tons of ore (average grade 8% Cu) and by 1861 was 187 metres deep.

It is reported that ore grade decreased with depth (6% Cu at the 187 m level), and the mine continued working lower grade ores from the Commerce, Varp and Sör mines until 1873.

Between 1741-1873 the mines produced 2,108 tonnes of copper from an estimated 42,000 tonnes of ore (Table 1.).

The mines lay abandoned for 33 years.

3.2 Stora Kopparberg

The surface features of the Håkansboda mine are shown in fig 3. Ore had been excavated from a series of workings named, from north to south as the Norr, Lo, Smed, Kommers (Commerce), Cecilia, Märr, Varp and Sör mines. These were each an enriched portion of a N-S trending zone that was re-investigated in the early 1900's.

The mines were taken over by Stora Kopparberg in 1906, and the waste dumps were worked for copper bearing material. During 1916-1919, with the economic stimulus of the First World War, Stora Kopparbergs Bergslags AB dewatered the mine and undertook underground exploration and mining, producing 19,327 tonnes of ore from which 475 tonnes of copper were obtained (2.45% Cu).

Work ceased by 1920 and the mine was left to re-fill with water.

In 1952-1955 Stora Kopparberg looked again at the Håkansboda property. A limited amount of surface exploration was undertaken. Ground geophysics was followed up by drilling. The target was primarily the

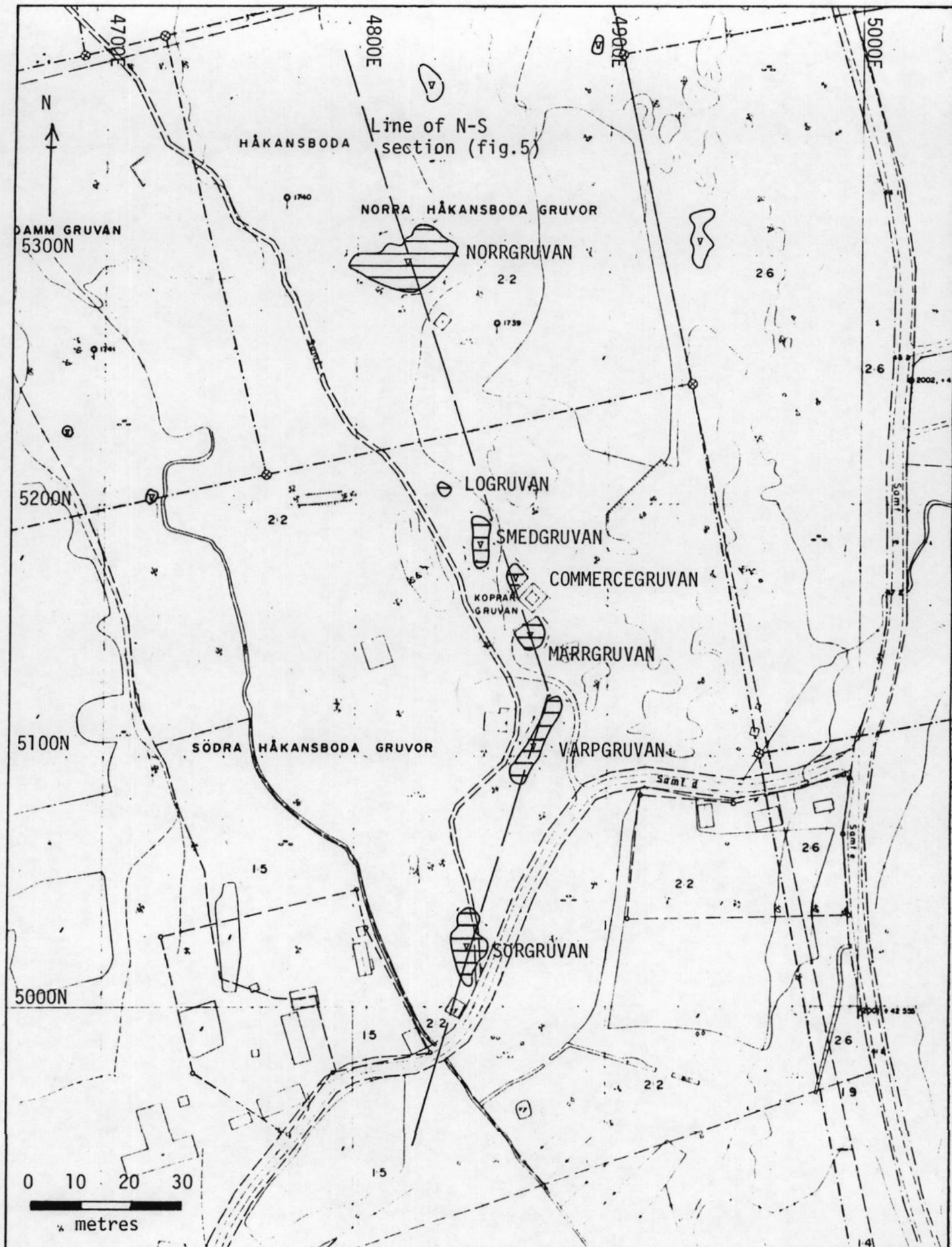


Fig.3. THE HAKANSBODA MINE - SURFACE FEATURES

TABLE 1.

COPPER PRODUCTION FROM HAKANSBODA MINE 1741-1873

<u>Period</u>	<u>Production (in tonnes metal)</u> <u>Recorded at Flögfors hytta</u>
1741-1749	54.62
1751-1767	48.89
1769-1784	43.22
1786-1789	11.40
1791-1806	56.58
1808-1811	18.29
1813-1832	318.00
1841-1873	1556.75
Total copper production:	2,107,75 tonnes

Estimated average grade

of 5% Cu suggests total ore production of: ca 42,000 tonnes ore.

the manganiferous iron-ores stratigraphically above the copper sulphide deposit. The mine was partly dewatered, an exploration drift made and underground drilling undertaken on the 71 m level, but no mining took place, and the mine was again left to flood.

A limited geophysical survey was undertaken in the early 1960's over the area.

3.3 Gränges International Mining

In 1970 the mining rights for the Håkansboda ore were transferred from Stora Kopparbergs Bergslags AB to Trafikaktiebolaget Grängesberg-Oxelösund (TGO). Through its daughter company, Gränges International Mining (GIM), TGO investigated the area in the early 1970's, and between 1974-77 engaged in a large exploration programme specifically to test the Håkansboda deposit. Drilling was undertaken in 1970-71 to test the manganiferous 'skarn iron ores' stratigraphically above and immediately west of the Håkansboda mine. However, in 1974 a surface drilling programme began, to test the sulphide mineralization. Work continued until 1977, by which time a total of 23 drill-holes and ca 6,600 metres of diamond drilling were completed, drilling to a maximum vertical depth of 665 metres (fig 16).

This work proved that the Håkansboda mineralization had not been 'bottomed' in the mine but continued to at least 600 metres below surface. A drill indicated reserve of 2 million tonnes of 1.2% Cu was estimated, and plans were made to investigate the deposit underground. It was the intention to open up the deposit by driving an exploration level from the tunnel connecting Stråssa and Blanka iron ore mines. This tunnel lies at a depth of 255 m below the surface at Stråssa, and the exploration tunnel to Håkansboda was expected to be 1.4 kms long, and enter the deposit at a depth of 200 metres below surface. At this depth it would connect with the lowest workings of Commercegruvan, (see section 4.1).

3.4 Svenskt Stål (SSAB)

In 1978 Svenskt Stål was formed taking over the TGO properties, including the Stråssa-Blanka-Håkansboda mines. It expressed no wish to continue or finance exploration at Håkansboda, but did, however, obtain a 5 MSEK grant from the Arbetsmarknadsstyrelsen to continue the work and investigations begun in 1974. This was particularly opportune as the Stråssa iron mine was under threat of closure and staff would be available for the proposed underground investigation of Håkansboda.

Between 1978-1981 the proposed exploration tunnel was driven from the Stråssa-Blanka level to Håkansboda, and the Håkansboda mine workings were dewatered.

The ca 1.4 km long tunnel from the Stråssa-Blanka level, entered the deposit at 199 metres below shaft collar, although it continued to be referred to as the '255 m level'. (see section 4.1).

From this level a total of ca 4,800 metres of diamond drilling was undertaken to investigate the central ore-shoots (Commerce, Cecilia, Varp and Mörr shoots) at the 199 m level and above to the base of the old workings (fig 17). Of the underground holes, 16 were drilled into the newly discovered downward continuation of the central ore-shoots on the 199 m level and 3 holes were drilled downwards from the 71 metre level. The Håkansboda shaft was refurbished to gain access to the 71 m level.

As a result of these detailed investigations a reserve of 270.000 tonnes of 1.9% Cu (in-situ grade) was outlined, with significant and economic quantities of cobalt, gold and silver. Very few Au analyses were made and As, Sb, and Bi were not systematically analyzed.

The results of a multielement bulk assay of the ore, calculated from bulk samples and drillcore intersections in 1981 is given in Table 2 together with the calculation made by Hübner in 1976 from the surface drillhole intersections. The results of the drillcore assays enabled Aronsson (SSAB 1981) to calculate the ore reserve noted above and further described in section 8.1,

Following the underground exploration results, the possible ways of working the deposit were examined, a planned third stage investigation of the deposit below the 199 m level was outlined, and a financial-feasibility study made (Gustafsson 1982).

As SSAB had already decided in 1978 not to become involved with mining the Håkansboda deposit, and the financial support had been used in the underground exploration programme, discussions were held with various parties with regard to the leasing or sale of the property.

Gränges International Mining, AB Statsgruvor (LKAB), Boliden and Outokumpu Oy examined the Håkansboda data and conducted their own assessments.

The ore reserve calculation performed by Månsson (AB Statsgruvor 1982 see section 8.1) stated that above a level 25 metres below the 199 m level (the '255 m level') to the base of the old workings (leaving a pillar above) a total of 300,000 tonnes of mineralized ground still stood in-situ with a run-of-mine grade of 1.4% Cu, 12 g/t Ag and 0.3 g/t Au (using a 1% Cu cut-off). AB Statsgruvor analyzed an additional 25 drillcore samples for As, Sb, Bi, Ag and Au to aid this ore reserve calculation. Unfortunately all the samples were from the central ore-zone on the 199 m level.

All the parties were of the opinion that the mine was sub-economic at the then prevailing metal prices, and all declined to take over the property. The tonnage and grade were regarded as too low. There was therefore no money to continue into a third stage of investigation below the 199 m level, and the project was terminated.

3.5 Recent activity

In March 1980, LKAB Prospektering discussed with SSAB the possibility of acquiring their mining licences (utmåls) in the Håkansboda area. 38 licences were subsequently transferred, but those over Håkansboda mine were retained by SSAB. This acquisition was part of LKAB Prospekterings increasing interest in the Nora-Stråssa area.

TABLE 2

ORE GRADE AND TONNAGE CALCULATIONS 1976-1981

Source:	Hübner (GIM) 1976	Aronsson (SSAB) 1981
Tonnage:	820,000	270,000
<u>Grade</u>		
Cu	1.40%	1.90 %
Co	0.04%	0.07 %
Ni	0.01%	0.005%
As	0.85%	0.75 %
Sb	0.38%	0.054%
Bi	0.06%	0.015%
Ag	28 g/t	21 g/t
Au	NA	0.5 g/t
Pb	0.14%	0.02 %
Zn	0.02%	0.02 %
Mo	NA	0.001%
Fe	4.69%	6.50 %
Mn	NA	0.29 %
Ba	NA	0.12 %

Both calculations are based on the in-situ tonnage and grade.

Hübners calculation is based on surface drill-intersections.

Aronssons calculation is the result of the 1978-81 underground exploration, and 1974-77 surface drilling, and is based on an in-situ volume of ore above the 199 m level to the base of the old workings.

Following the results of the 1978-81 exploration, the ore calculations and the general opinion that the Håkansboda deposit was sub-economic, SSAB were left holding the remaining mining licences. On 30th March 1983 Stråssa mine closed; however, the workings continued to be pumped dry and access to Håkansboda was still possible along the large (12 m² cross-section) exploration level made in 1978-81. The distance to Håkansboda from the Stråssa shaft along the '255'-199 m level is 1.3 kms to the junction with the Blanka tunnel, then a further 1.4 kms to Håkansboda; a total distance of 2.7 kms.

In April 1983 LKAB Prospektering again approached SSAB to discuss transfer of the Håkansboda mining licences. By this time the LKAB-BP Joint Venture had commenced and LKAB suggested that the Håkansboda area should be examined by the JV. Accordingly the Håkansboda mine was visited via the shaft to the 71 metre level in mid 1983.

In early 1984, at BPMIL's request, all the data pertaining to the Håkansboda deposit was briefly reviewed and a proposal made (Carlson 1984). The deposit was twice examined on the 199 m level. By February 1984 preparations had been made to plug the tunnel between Håkansboda and Stråssa.

Negotiations on the utmäls transfer appeared likely to take sometime, and the financial constraints of keeping Håkansboda pumped dry and commencing underground exploration were prohibitive. Accordingly the tunnel was plugged in summer 1984, on the Stråssa side of the Blanka-Håkansboda junction. The Håkansboda mining licence transfer was finally ratified by the State on October 4th 1985.

This project (LKAB-BP Håkansboda Project No 3822) commenced in October 1984. All data relating to the 1970-1982 exploration and assessment have been obtained from SSAB together with the drill data and remaining drillcores and sample pulps.

Currently, the Håkansboda mine is flooded from 17 m below shaft collar. It is no longer connected to Stråssa mine, but is connected to the Blanka iron ore workings.

4. MINE WORKINGS AND LAND HOLDING

4.1 Håkansboda Mine

The surface and underground workings of the Håkansboda mine are shown in plan and section in figs. 3, 4, 5 and 6. Early workings were pits excavated on the richest portions of the zone of sulphide mineralization passing N-S through the mine area. These pits were later extended into a series of workings on the main ore-shoots. From N-S these were the Norr, Lo, Smed, Commerce (Kommers), Mörr, Varp and Sör deposits (fig 3). Underground exploration located the Cecilia and 'Lill-Cecilia' ore-shoots in the hangingwall of the Commerce-Mörr-Varp zone.

The ore-shoots were not all mined to the same level, and the maximum depth of working on each shoot was as follows:-

Norrgruvan	: Surface to 71 metres
Logruvan	: Shallow surface excavation
Smedgruvan	: Surface to ca 50 metres
Commercegruvan	: Surface to 212 metres
Märrgruvan	: Surface to 168 metres
Varpgruvan	: Surface to 123 metres
Sörgruvan	: Surface to 95 metres
Cecilia	: 35-71 metres
'Lill-Cecilia': Worked on the 71 m level	

The ore shoots were contained within a zone, up to 60 m wide, of disseminated copper-iron sulphides within the host dolomitic marble and calc-silicates (see section 6.4).

The main workings were at a depth of 71 m, connected to surface by a shaft. This level was extended in the 1950's for the purpose of investigating the iron ores in the stratigraphic horizons above and to the west of the Håkansboda mine. Other main levels were driven at 19 m, 29 m and 88 metres below shaft collar, otherwise workings were confined to the ore-shoots (fig 4) and are of limited areal extent.

It is worthy of note here that confusion may arise from examining previous data. The 71 m level is often referred to as the 123 m level, and the 199 m exploration level driven in 1978-81 is constantly referred to as the '255 m level'.

Levels in the Håkansboda Mine in the 1971-81 investigations were related to the vertical position of the Stråssa Mine grid system origin which lies at 240 m above sea-level (asl).

The '255 m' exploration level was commenced at a depth of 255 m below the Stråssa grid origin. It entered the Håkansboda mine at a depth of 251 m below the Stråssa origin. As the Håkansboda shaft collar lies at a height 52 metres below the Stråssa origin, the '255' m level, at 251 m in the Stråssa grid at Håkansboda is actual only 199 m below the Håkansboda shaft collar. Similarly the "123 m level" lies at $(123-52) = 71$ m below shaft collar.

This relationship is shown graphically in Appendix 1.

Northings(x) and Eastings(y) in the project are referred to the N-S, E-W Stråssa grid system. Vertical positions (z) are referred to the Håkansboda shaft collar at 188 m asl.

The deepest level in the mine is at the bottom of Commercegruvan stopes at 212 m, 13 m below the 1978-81 exploration tunnel (fig 6). Mineralization 'blocked out' and drilled occurs above the 199 m level, to a maximum height of 76 metres to the base of Varpgruvan (fig 5). The only detailed and thorough ore-tonnage calculation for in-situ material is by Månsson (1982) down to 25 m below the 199 m level (see section 8.1).

The mine is currently water-filled and the rest water level lies approx. 17 m below shaft collar.

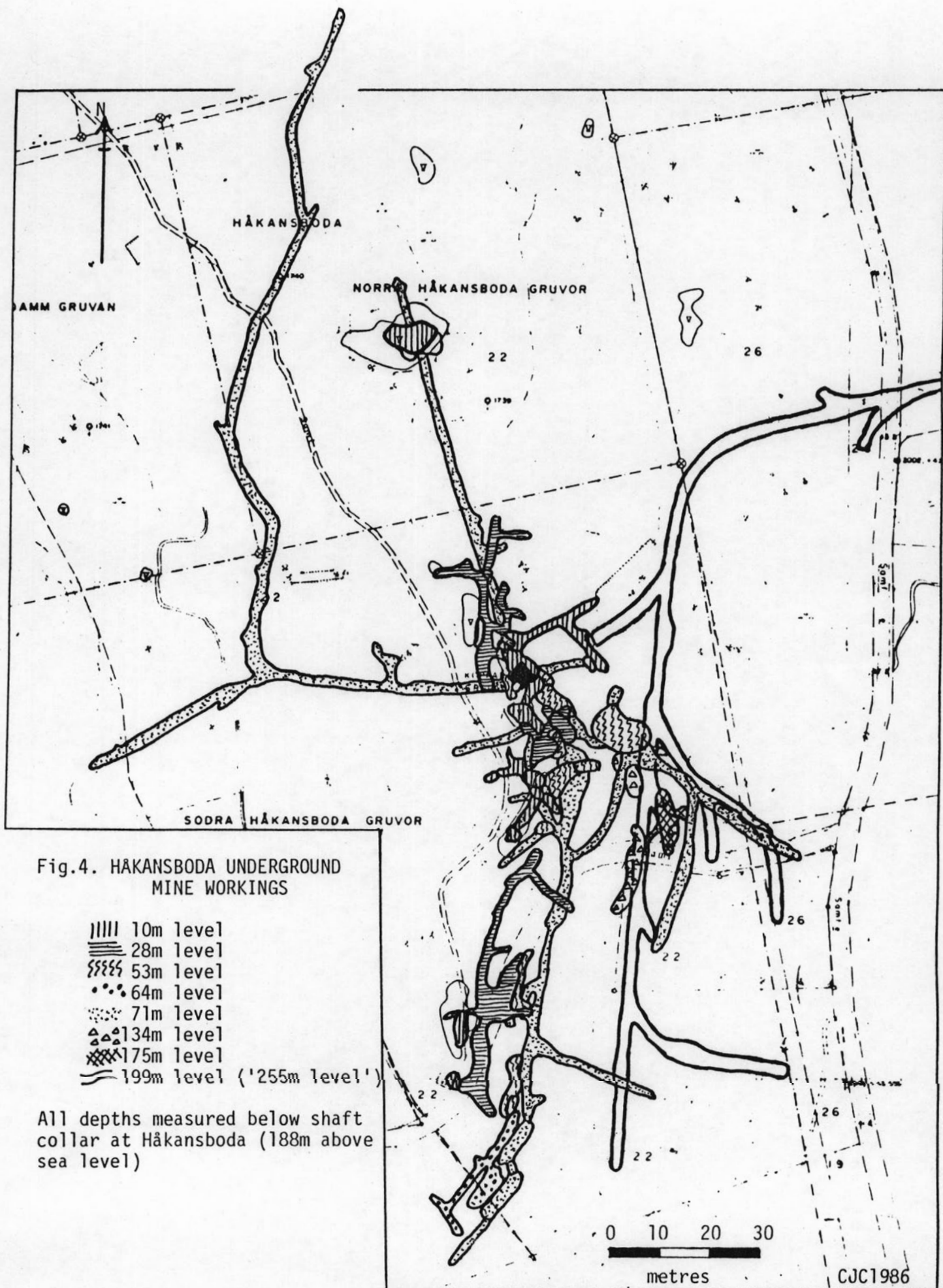


Fig.4. HÅKANSBODA UNDERGROUND
MINE WORKINGS

- |||| 10m level
- ==== 28m level
- ~~~~ 53m level
- 64m level
- ~~~~ 71m level
- △△ 134m level
- ×× 175m level
- 199m level ('255m level')

All depths measured below shaft
collar at Håkansboda (188m above
sea level)

0 10 20 30
metres

CJC1986

THE HAKANSBODA MINE-WORKINGS IN SECTION

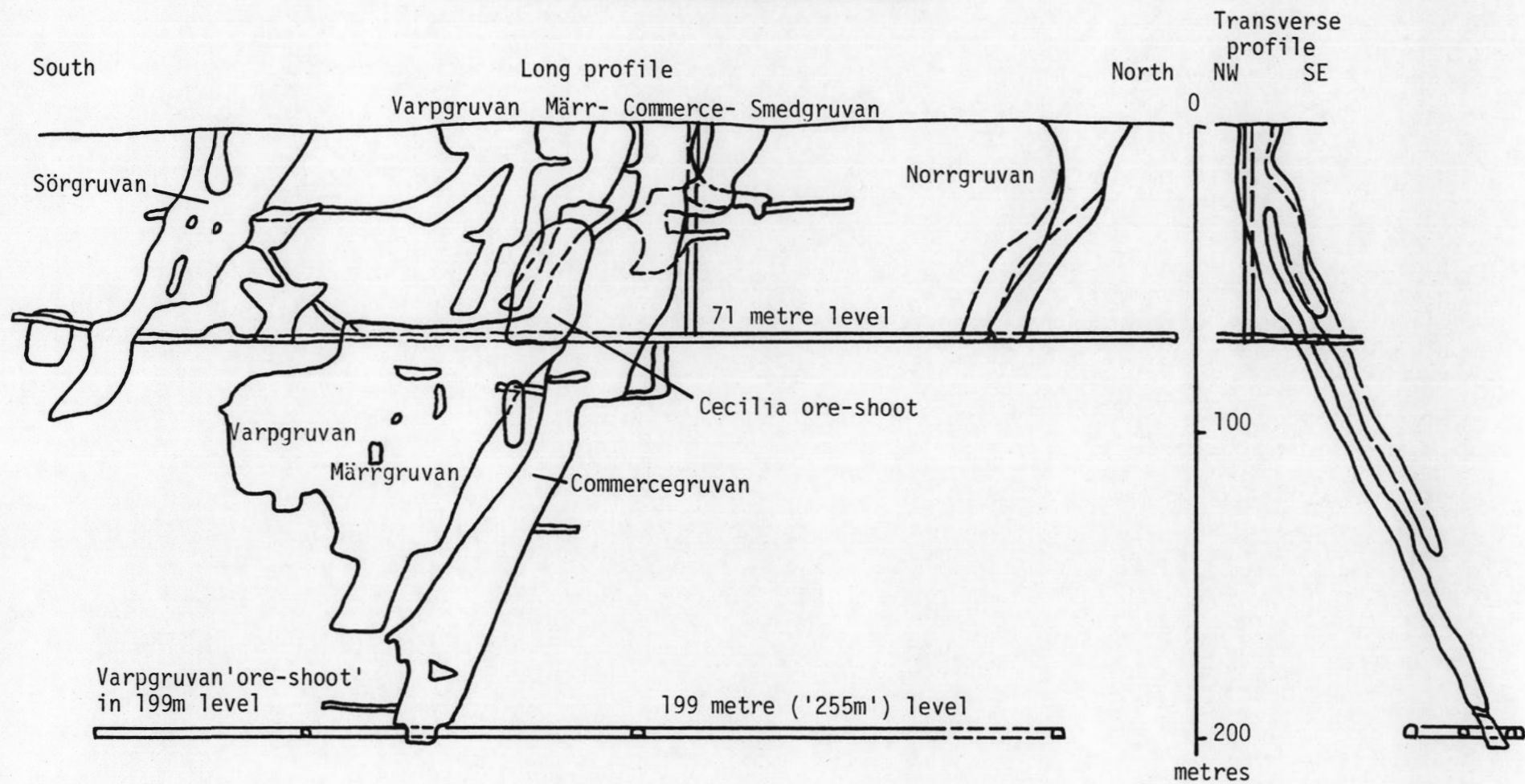


Fig.5. LONG AND TRANSVERSE PROFILES THROUGH THE
HAKANSBODA MINE-WORKINGS

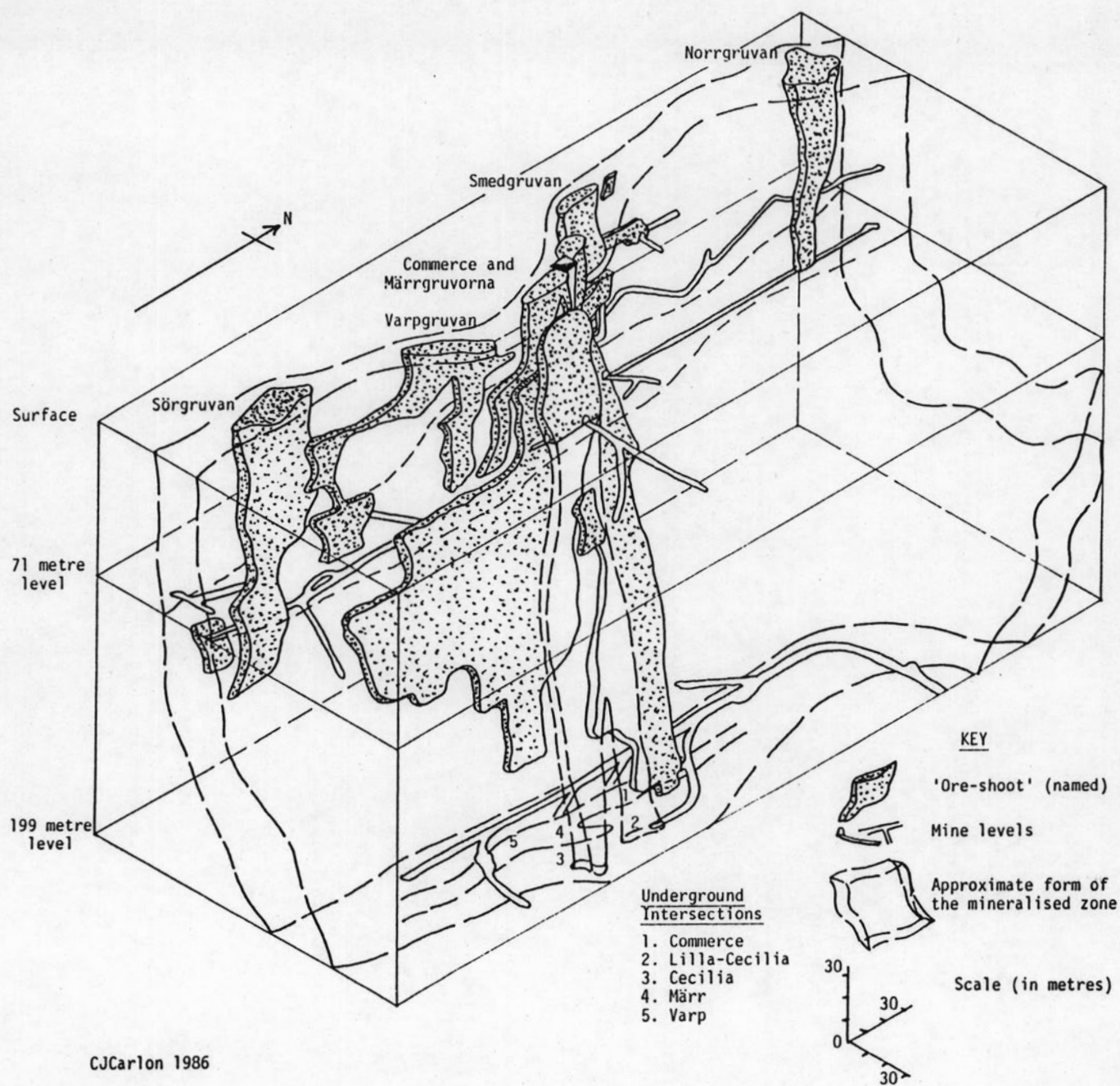


Fig.6. THREE DIMENSIONAL BLOCK DIAGRAM OF THE MINERALISED ZONE, THE MINE-WORKINGS AND THE UNDERGROUND INTERSECTIONS AT HÅKANSBODA

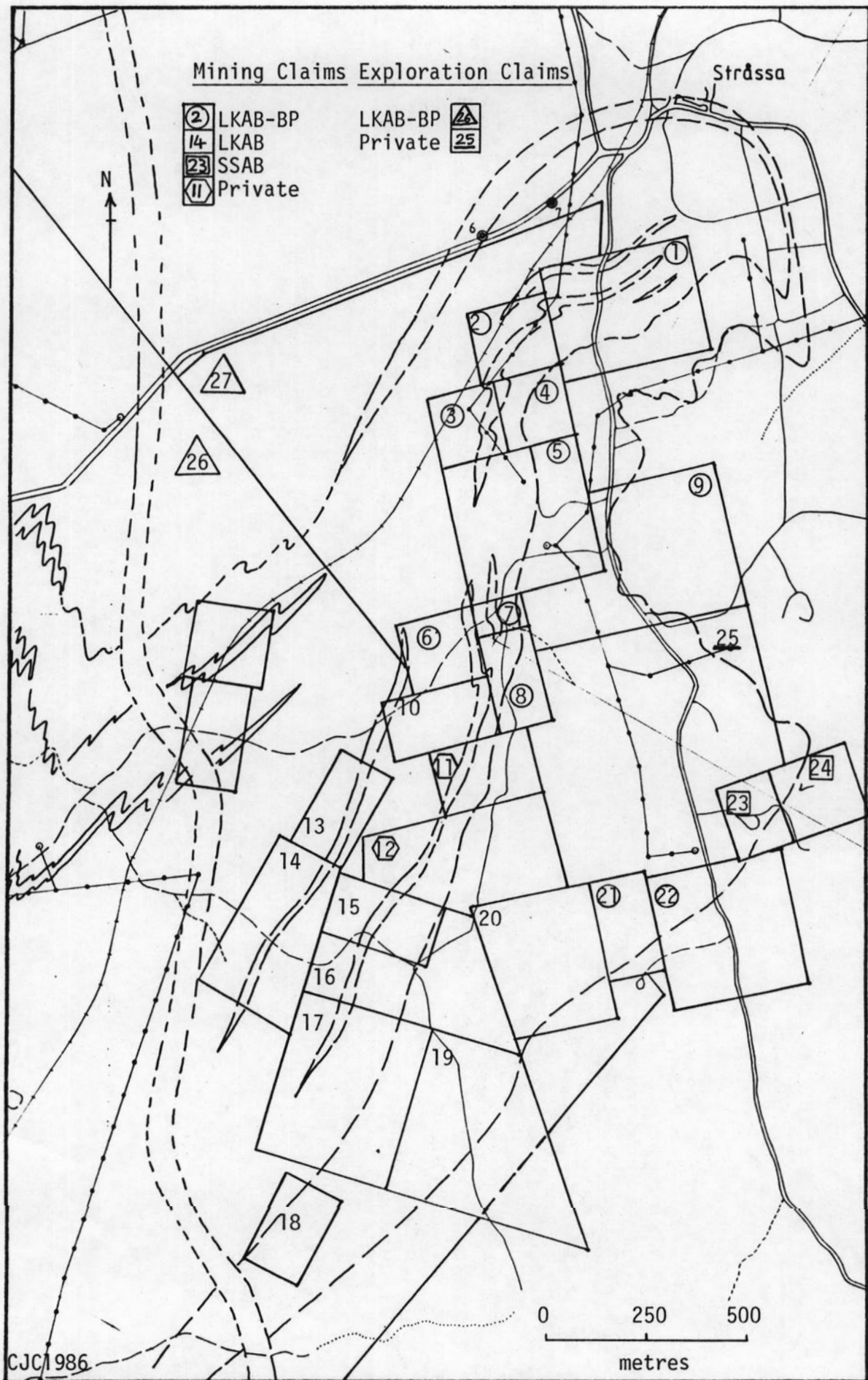


Fig.7. LAND HOLDING-CLAIM MAP. HÅKANSBODA-ÖSTANBO-LOVISA AREA

TABLE 3.

MINING AND EXPLORATION LICENCES HAKANSBODA-BACKADAHN AREA
(Locations are shown in fig 7).

A. Mining Licences

<u>Name</u>	<u>Owner</u>
1. Luthgruvan	LKAB-BP
2. Västra Långgruvan	-"-
3. Konstdammsgruvan	-"-
4. Norra Håkansboda Koppargruva	-"-
5. Södra Håkansboda or Tyskgruvan	"-
6. Knutsgruvan	-"-
7. Styckegruvan	-"-
8. Persbergsgruvan	-"-
9. Östergruvan nr 1	-"-
10. Elizabethgruvan	LKAB
11. Värdegruvan	G. Sundin
12. Gårdsgruvan	G. Sundin
13. Matildagruvan	LKAB
14. Nya Backedahlsgruvan	-"-
15. Bäckgruvan	-"-
16. N. Östanbogruvan	-"-
17. S. Östanbogruvan	-"-
18. Eriksgruvan	-"-
19. Backedalsgruvan	-"-
20. Västra Mariagruvan	-"-
21. Södra Mariagruvan	LKAB-BP
22. Tyskafallsgruvan	LKAB-BP
23. Ställbergsgruvan	SSAB
24. Rymningsgruvan	SSAB

B. Exploration Licences

25. Södra Håkansboda	Ragnar Muotka
26. Leja 3	LKAB-BP
27. Leja 4	LKAB-BP

4.2 Mining and Exploration Licences

The current status of landholding (exploration and mining licences) is shown in fig 7. and listed in Table 3. LKAB-BP hold most of the ground in 51%-49% mining licences (utmål) or 50%-50% exploration licences (inmutningar).

5. GEOLOGY, STRUCTURE AND METAMORPHISM

The most recent mapping of the area, and the most comprehensive description, has been produced by Wouter Bleeker (1983; 1984) for the LKAB-BP Joint Venture. The area has also been reviewed by Koark (1960) and by Koark in unpublished reports for GIM and SSAB. Mapping undertaken by Koark in the 1960's for GIM was later passed to SGU and forms the basis of the published geological survey map sheet 11F SV (Lindesberg). (Lundström 1983).

5.1 Geology

An outline geological map of the Håkansboda Project area is shown in fig 8. (after Bleeker 1984 with additions and alterations). Outcrops is reasonable in a region where glacial overburden can often be in excess of 20 metres. Outcrop observations, data from earlier drilling programmes and observations noted by W. Bleeker (1984) permit the following description.

The project area lies within a 1.9-1.8 Ga Lower Proterozoic supracrustal sequence, which in the Nora-Stråssa area has a general NE-SW strike. These rocks are intersected by a variety of infracrustal and plutonic acid to basic intrusives, and are metamorphosed to amphibolite facies. The supracrustal sequence forms a major fold structure (section 5.2) with a NE-SW axial trend, SW plunge and closure to the NE. From preserved 'way-up' criteria and comparisons with the supracrustal sequences elsewhere in C.Sweden, a younging direction from E-W across the project area is indicated. The major structure is synclinal, isoclinal, and overfolded to the east producing a more or less consistent steep easterly dip.

The regional stratigraphy is shown in fig 9. and can be summarized from E to W across the project area as follows.

The oldest rocks are a sequence of plagioclase (albite) phyric, sodic metavolcanics. These pass westwards (upwards) into fine grained pink or grey, potassic, massive metavolcanics (alkali-acid rhyolite/rhyodacite parents). Quartz phyric (quartz-eye), relict phenocrysts are common, within a fine grained quartzo-feldspathic matrix containing biotite-sericite, cordierite and occasionally sillimanite. Thickness estimates are difficult due to folding but these units are at least 1100 m thick.

Resting above the massive metavolcanics is a distinctive quartz rich haematitic chemical sediment, which can be traced in surface exposures trials and pits and the Stråssa and Blanka mines, from the east of the project area around the major fold structure to the mines west of the Storå valley. In areas of strong deformation haematite is transformed into magnetite.

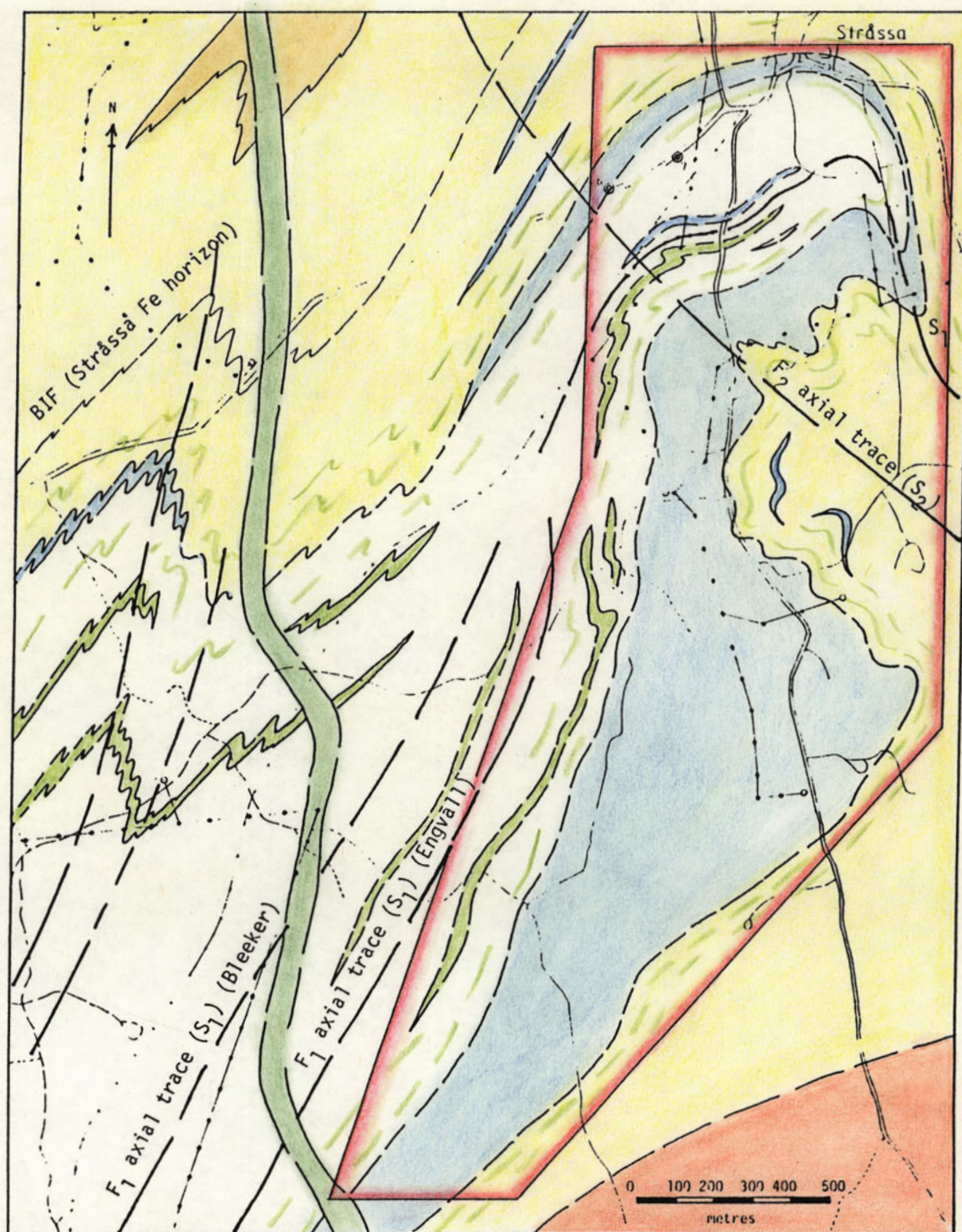


Fig.8. GEOLOGICAL MAP -
HAKANSBODA PROJECT



Outline of the
Håkansboda
Project area

Calc-silicate (skarn)
layers are shown as:



-  Dolerite dyke
-  Mainly metavolcanics.
-  Main carbonate Fm.
-  Meta-volcs/seds.
-  Rhyolitic metavolcanics.
-  Early orogenic granite.

Fig.9. Håkansboda Project

Regional Stratigraphy

PROJECT AREA STRATIGRAPHIC INTERVAL

MIXED META-
SEDIMENTS AND
VOLCANICS

MAIN CARBONATE
FORMATION

MIXED META-
SEDIMENTS AND
VOLCANICS

GREY PELITIC SCHISTS
(The Mårdshyttan Schists)

WATERLAIN TUFFS Minor to abundant Fe sulphide

RHYOLITIC (ACID) TUFFS Waterlain and including
a number of extensive skarn layers (calc-silicates)
particularly towards the base.

Qtz and carbonate Fe. Pb-Zn-Cu sulphides (LOVISA)

Cu-Co-Sb-As sulphides (HAKANSBODA)

MASSIVE AND BANDED DOLOMITIC MARBLE
Tuffs and skarns towards the base

FINE GRAINED TUFFS with abundant skarn Fe ores

Abundant Mn skarn Fe ores (= STÄLLDALEN ?)

RHYOLITIC TUFFS or META-RHYOLITE

RHYOLITIC TUFFS with minor skarns
Quartz-haematite Mn poor Fe ores (STRASSA)

MEDIUM GRAINED AND MASSIVE QUARTZ-EYE
RHYOLITIC METAVOLCANICS

QUARTZ-PHYRIC (QUARTZ-EYE) RICH METAVOLCANICS
Typically biotite-plagioclase phyric with
quartz-eye rich sections

200
100
0
metres

CJCarlon 1985

(Based on Bleeker 1984)

The strata above the haematitic marker formation are generally fine grained and represent a mixed sequence of volcanic and sedimentary detritus. They produce a sequence some 300-400 metres thick. Probable parent rocks were waterlain tuffs, reworked-resedimented volcanic detritus; impure carbonates, calcareous, ferruginous and argillaceous sediments; Mn-Fe chemical sediments and siliceous fine grained clastics.

Lithologies are represented by massive, quartz-eye bearing metavolcanics; banded fine grained 'quartzites' and granoblastic silicious layers (metatuffite?), and interbedded quartzo-feldspathic 'granulite', amphibole-diopside, feldspar-diopside, epidote-amphibole-quartz and olivine-diopside-amphibole rocks (calcareous and ferruginous mud rocks). Massive manganiferous magnetite and garnet-biotite, garnet-biotite-amphibole and coarse hornblende rocks represent iron rich silicate and iron oxide chemical sediments.

Dolomitic marbles, dolomite-opicalcite (serpentinite) and opicalcite-phlogopite rocks represent magnesium and calcium bearing impure and ferruginous carbonates with a potassium content, possibly reflecting early rock alteration.

Argillaceous rocks are represented by muscovite-biotite and garnet-biotite-cordierite gneiss. However, some rock types in the sequence may reflect rock alteration prior to metamorphism.

Quartz-sillimanite and quartz-chlorite-sericite rocks occur stratigraphically below the Håkansboda deposit. Sillimanite (as fibrolite) eyes are also seen in biotite schists and gneisses, and may reflect argillic alteration. Increases in iron, potassium and magnesium are often associated and indicated by phlogopite, olivine (forsterite), chlorite and sericite.

This mixed sequence of meta-volcanics and meta-sediments changes fairly abruptly into a distinct calcitic or dolomitic coarse grained crystalline marble, through dark grey marble into a variety of grey-green calc-silicate "skarn" layers, and varies in thickness from 60-250 metres. Thickness variation is primarily due to multiphase deformation and plastic 'flowage' developed in the less competent carbonate formation.

In the Håkansboda area, the main carbonate unit is a complex Fe-Mg-Ca carbonate with the following variants.

1. The main lithology is a dolomitic marble with ophitic forsterite-clinohumite crystals. These have been transformed by retrograde metamorphism into serpentinite producing a white-grey dolomitic marble crowded with serpentinite pseudomorphs (opicalcitic marble).
2. Opicalcitic marble with irregular patches and lenses of epidote, wollastonite, vesuvianite and garnet.
3. More or less concordant layers and laminae of monomineralic amphibole or diopside.
4. Amphibole and diopside ('skarn') layers.

5. Complex calc-silicate ('skarn') layers with amphibole, diopside, feldspar, olivine, grossular or andradite garnet, phlogopite, and some retrograde chlorite, tremolite and talc.
6. Thin siliceous, quartz-feldspathic and cordierite bearing layers. (Thin waterlain meta-tuffites?).

The main carbonate unit changes abruptly at its upper stratigraphic contact, into a well layered and banded calc-silicate and quartzo-feldspathic sequence, probably originating from a mixed impure carbonate, calcareous and siliceous mudstone and waterlain volcanic tuff sequence. The sequence passes upwards into fine-medium grained quartzo-feldspathic, granoblastic rocks of probable volcanic origin, re-sedimented in an aqueous environment, in which carbonate production occurred periodically, throttled frequently by clastic input. Within this environment manganiferous and ferruginous chemical sediments were deposited, now seen as distinctly banded and laminated magnetite-'chert', magnetite-carbonate and sulphide-magnetite -'chert'. These occur with actinolite amphibole-diopside rocks, monomineralic diopside 'skarn' layers, and quartz-feldspar-diopside rocks.

The magnetite-quartz and magnetite-carbonate layers, together with more massive magnetite laminae are 0.2-0.7 metres thick, and occur in spatical sequences between thicker quartzo-feldspathic (metavolcanic) units. The "skarn iron ores" noted above also contain laminae of sulphides, which are often, as noted by Bleeker (1984) usually small cross cutting veinlets all occurring at the same stratigraphic interval (normally a 1-2 cm thick laminae). Pyrite, pyrrhotite, chalcopyrite, galena, sphalerite and arsenopyrite are noted. In addition silver occurs as sulphides and up to 750 g/t has been recorded. These horizons occur immediately west of Håkansboda in the Luth, Konstdamm, Elizabeth, Bäck, Östanbo and Backadahl mines.

In summary, the stratigraphy displays a change from a volcanic dominated depositional environment, with sodic to potassic rhyolitic-rhyodacitic volcanism, into a mixed carbonate-clastic-chemical sediment, possible shallow sea-water environment. Volcanic detritus forms fine grained 'tuffs' (hällflinta) together with carbonate, calcareous, argillaceous and ferruginous sediments. Into this environment, it is proposed, a sub-seafloor hydrothermal system developed, producing massive sulphide deposition and rock alteration. The potassic magnesian and iron enrichment haloes, commonly associated with such mineralization may be present in the Håkansboda area, and will be investigated as an exploration tool.

A further comment on the origin of mineralization is made in section 9.1.

5.2 Structure

The Håkansboda Project area lies within a NE-SW trending belt of supracrustal rocks, up to 1.5 kms wide and 45 kms long. The belt forms an elongate, overfolded complex syncline, the Guldsmeshyttan Syncline. To the NE of Stråssa a culmination on this major fold produces a dome, and the lower, metavolcanic dominated sequence is exposed. The upper mixed metasedimentary-metavolcanic sequence reappears further to the NE in the Riddarhyttan area.

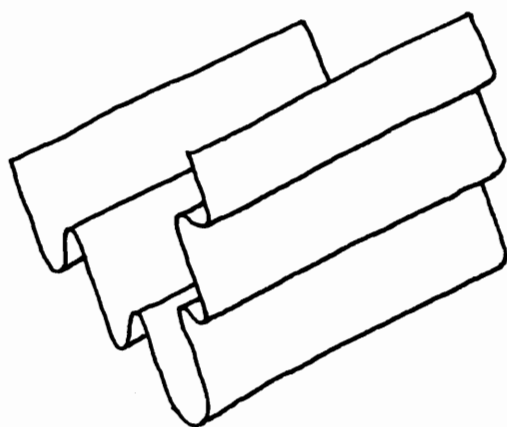
Regional airborne magnetic data, examined on the EBBA computer graphics system grey-scale image, suggests that the culmination NE of Stråssa overlies a NNW-SSE trending deep-seated granitic body, of younger syn-orogenic Fellingsbro type.

To the SW of this culmination and buried granitic body, the complex Guldsmedshyttan syncline plunges SW and is re-folded around later folds apparently displaying NNW-SSE trending axes. A parallelism with the buried granite, and possible genetic association is suggested.

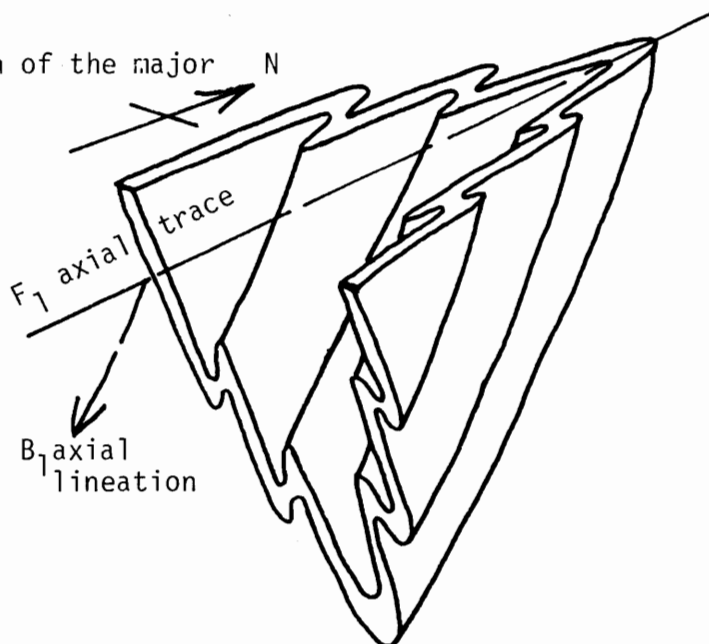
The following are the main structural features of the project area (based on the work of W. Bleeker 1983 -1984).

1. The Håkansboda Project area lies on the eastern, overturned limb of the major F_1 Guldsmedshyttan Syncline. Stratigraphic way-up is to the west and structurally downwards in the project area.
2. The major F_1 synclinal structure closes to the NE. It is isoclinally folded along NE-SW axes and plunges SW. The form of this structure is explained in fig 10a.
3. An S_1 penetrative axial plane foliation accompanies the F_1 structure (fig 10b).
4. In many outcrops isoclinal (parasitic) folding is indicated by parallelism between S_0 (original layering-banding) and S_1 (F_1 axial plane) foliations (fig 10c).
5. The tight folding produces transposition of bedding and problems in outcrop correlation (fig 10d).
6. Inconsistency of S_1 azimuth orientation indicates re-folding of F_1 structures. In some outcrops this second phase folding, F_2 , can be observed refolding F_1 structures (fig 11a).
7. All scales of F_1 - F_2 interference can be observed in the project area. The early F_1 , SW plunging, isoclinally folded, NE-SW trending syncline is refolded around F_2 , NW-SE and NNW-SSE trending steeply plunging folds. This is summarized in fig 11b.
8. The F_1 fold as defined by the subcrop of the main carbonate formation is refolded around a major F_2 axis immediately NE of Håkansboda.
9. F_1 parasitic fold axes (lineation B_1^0) plunge generally SW at 35-45°. Undulations in fold axis plunge and orientation occur (eg. Jonshyttan SSW of Lovisa), and domal structures produce NE plunging facing directions, possibly by F_2 interference.
10. A crenulation foliation is developed where S_1 axial penetrative foliation is refolded around F_2 structures.
11. Complex F_1 - F_2 interference folds are developed within the main carbonate unit, being the least competent lithology. B_1^0 axial lineations are rotated parallel to a SE steeply plunging B_2 lineation (fig 11).

Fig.10a. Diagrammatic representation of the major regional F_1 fold structure.



F_1 overturned isoclinal fold



F_1 SW plunging, overturned isoclinal syncline

Fig.10b. F_1 fold in plan with S_1 axial- penetrative foliation

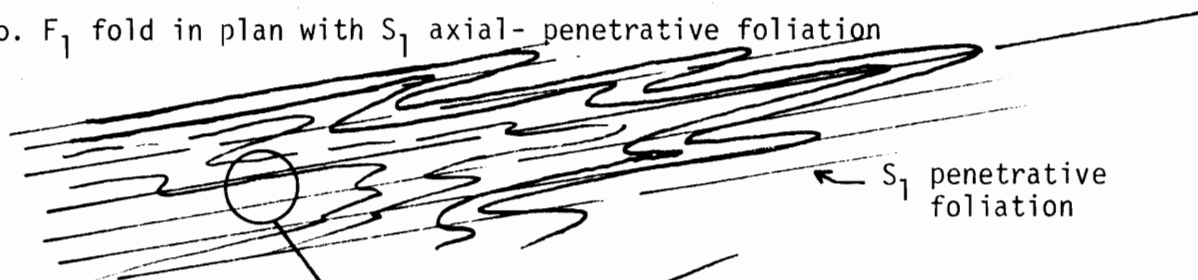


Fig.10c. Parallelism of S_0 and S_1 structures

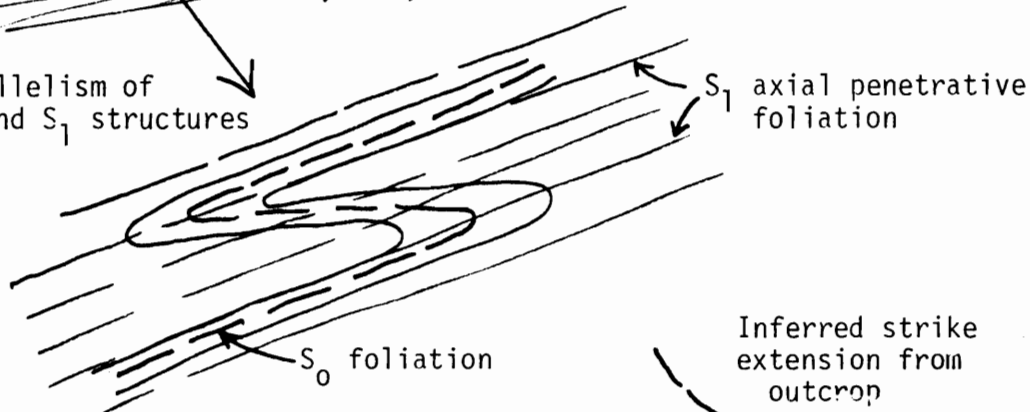


Fig.10. F_1 FOLD STRUCTURES

(Based on the work of Bleeker 1984)

Fig.10d.

Transposition of bedding in F_1

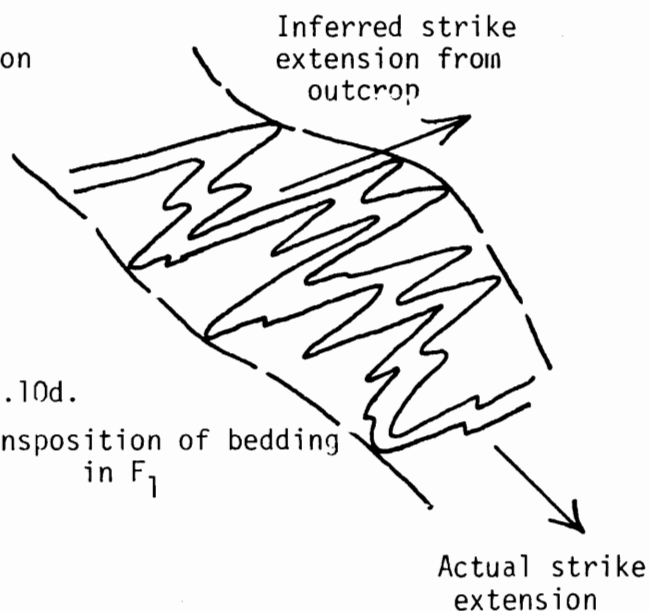


Fig.11a. Interference structure observed south of the project area at Fanthyttan.

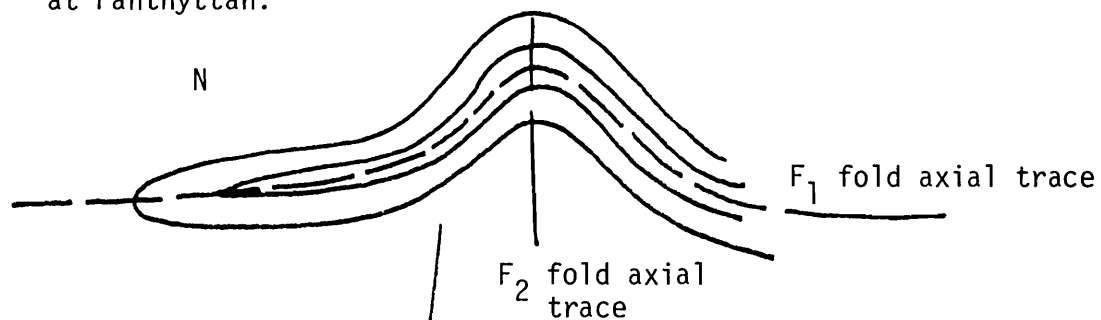


Fig.11b. Large scale interference

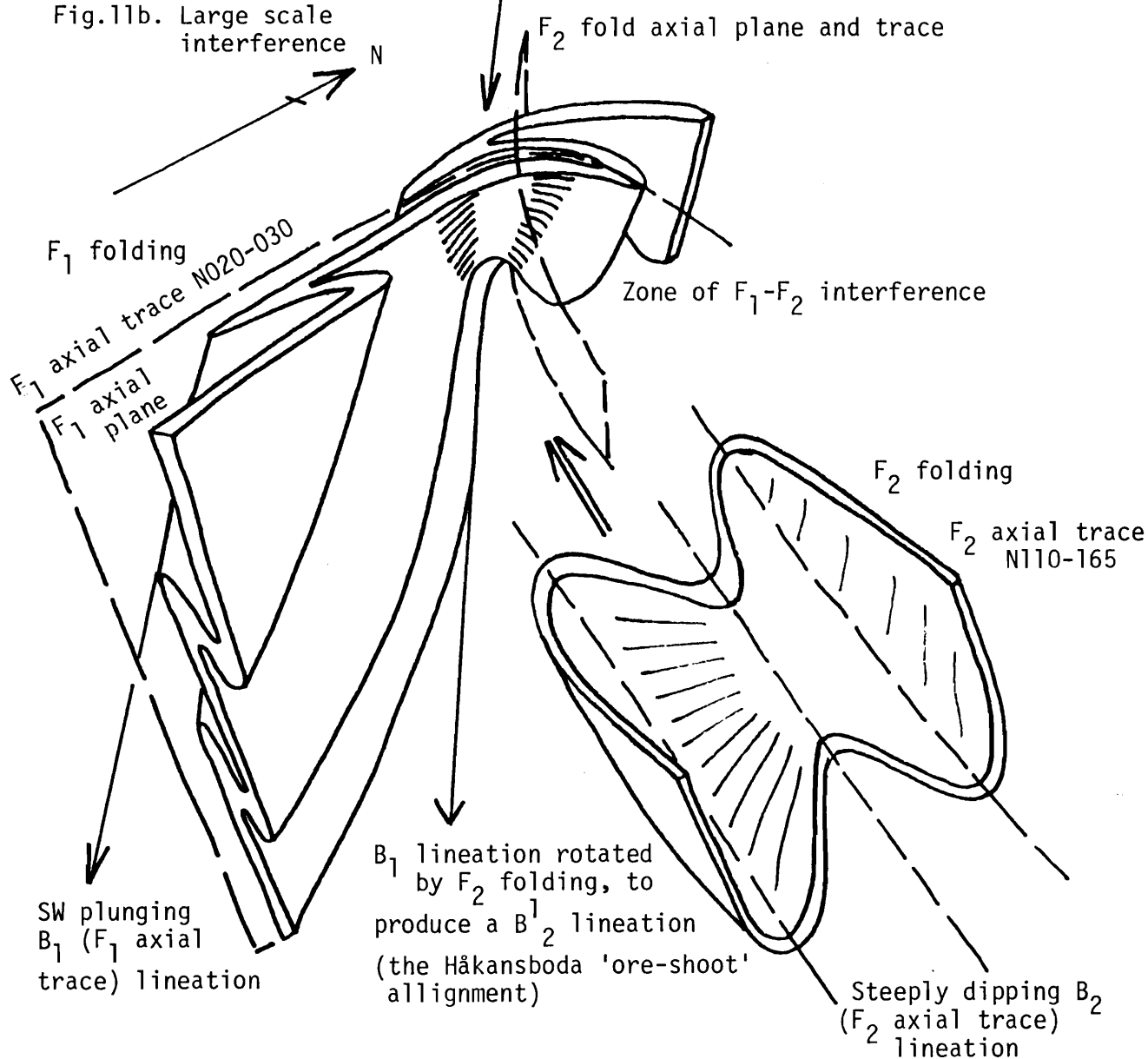
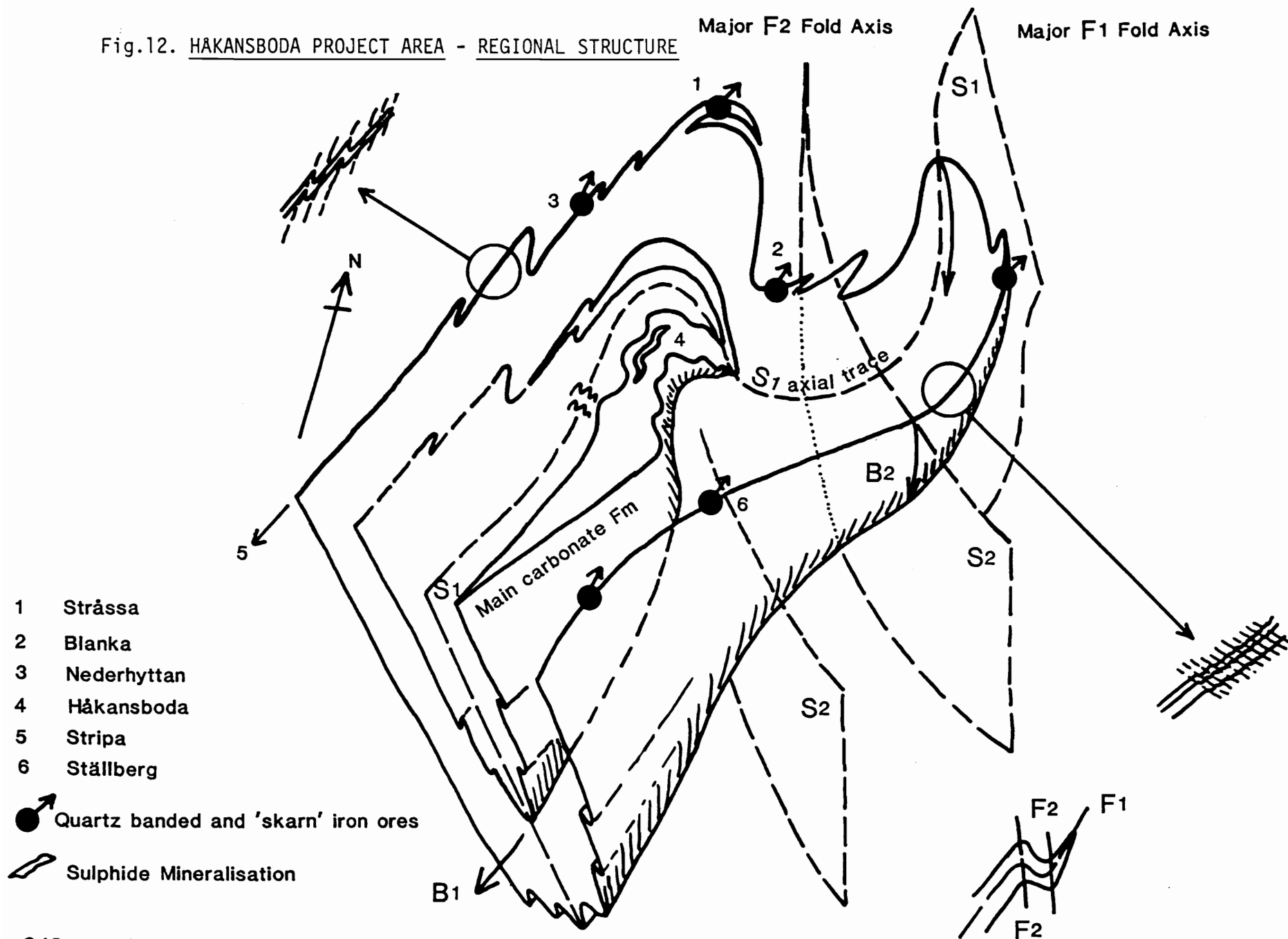


Fig.11. F₁-F₂ interference structures in the project area

Fig.12. HAKANSBODA PROJECT AREA - REGIONAL STRUCTURE



CJC1984 (after W.Bleeker)

12. The sulphide lenses in the Håkansboda deposit are in places seen to be folded around F_1 axes, and probably represent an early or primary depositional feature.
13. The orientation of the Håkansboda mineralization is in part structurally controlled. The mineralization lies on the southern flank of a major F_2 fold structure and the richer 'ore-shoots' are orientated down a B_1 - B_2 interference lineation ($B_2^{0,1}$) plunging steeply to the SE (figs 5 and 8). The deposit occurs in a zone of strong S_2 penetrative foliation.
14. The main carbonate formation reappears on the western limb of the major F_1 structure. However, by a combination of possible litho-stratigraphic facies variation and tectonic thinning-splitting and complex F_1 - F_2 interference folding is much thicker on the eastern limb of the fold.

Both Bleeker and Koark observe that a high percentage of fold axes are apparently localized by least competent rock types, eg. carbonate lenses and layers and sulphide mineralization.

Faulting is present in the area. To the immediate W. of the project area, drilled bad ground indicates NE-SW fracturing, which appears to off set metabasite intrusives. In the Håkansboda mine a number of small faults with decimetre-metre throws were observed. Otherwise little is known or recorded with regard to brittle fracturing.

In summary an elongate NE-SW non-cylindrical, isoclinally folded, overturned and easterly dipping syncline, with variable but generally SW plunge, has been refolded about NW-SE trending, SE steeply plunging folds, producing a variety of interference structures. The main structural elements are presented in fig 12.

5.3 Metamorphism

Rocks in the project area are metamorphosed to amphibolite facies and display variable, but generally high strain. Argillaceous parent rocks have produced sillimanite, cordierite, and garnet porphyroblastic mica gneisses. To the SW, stratigraphically higher metasediments (the Mårdshyttan Schists fig 9) are crowded with andalusite porphyroblasts. The change from andalusite to sillimanite from W to E could, as pointed out by Bleeker (1984), indicate increasing grade from W-E. This feature, together with the occurrence of abundant granite to the east, and the decrease in mineralization from W-E may be a function of increasing original crustal depth in the same direction.

However, the occurrence of sillimanite in the meta-volcanics and meta-sediments could be in response to hydrothermally induced argillic alteration associated with mineralization. Andalusite is in fact recorded from meta-tuffites immediately west of the Håkansboda deposit. In addition many of the 'skarn' occurrences could have been original metasomatic alteration products associated with mineralization. Such calc-silicates, where interbedded with meta-volcanic rocks are invariably boudinaged and produced prior to the main F_1 folding.

Porphyroblast growth, notably cordierite, indicates that regional metamorphism culminated syn or post F_2 , and note is made again of the apparent parallelism between a possible syn-orogenic buried granite to the NE, and the F_2 fold orientation. Metamorphism, however, may have commenced synchronous with mineralization and metasomatism related to sub-seafloor hydrothermal systems which formed the sulphide mineralization. This is further discussed in section 9.1.

In the east of the region, early orogenic granites occur. These are mainly quartz-feldspar-biotite rocks with a F_1 penetrative foliation. Within the project area, minor granitic and pegmatitic intrusives of the 'syn-orogenic' or 'younger' granite suite occurs. These intrusives accompanied F_2 folding and peak metamorphic conditions. There are apparently few meta-basite infracrustal intrusives in the project area.

6. MINERALIZATION

The numerous mineral occurrences within the project area fall into three broad divisions.

- i. Sulphide impregnations within stratiform iron rich layers in calc-silicate, mafic 'skarn' layers and quartzo-feldspathic host rocks below the main carbonate formation (Östergruvan and Tyskafallsgruvan).
- ii. Complex massive and disseminated sulphide mineralization within the main carbonate formation. (Håkansboda, Gårdsgruvan, Eriksgruvan).
- iii. Stratiform sulphide mineralization associated with magnetite bearing carbonate, calc-silicate and siliceous rocks immediately above the main carbonate formation. (Luth, West Lång, Konstdam, Elizabeth, Bäcke and Östanbogruvorna).

Surface distribution of these mineralized zones is shown in fig 13.

6.1 Mineralization below the main carbonate formation

Two occurrences lie within the project area. At Östergruvan, disseminated pyrite, pyrrhotite and chalcopyrite occur within magnetite-marble and magnetite-calc-silicate and iron silicate layers ("skarn magnetite iron ore") within the metavolcanic-metasedimentary sequence below the main carbonate formation.

Regional overburden geochemistry by LKAB has identified elevated Mn and Zn values in this area (section 7.2). Sphalerite is not seen on the Östergruvan dumps and the Zn values could relate to as yet undiscovered Zn mineralization. The area is, however, down ice direction from the Håkansboda subcrop where sphalerite is recorded.

At Tyskafallsgruvan magnetite rich marble and diopside calc-silicate layers contain disseminated pyrite, pyrrhotite and chalcopyrite. A probable metavolcanic rock is also seen, displaying hornblende or sericitic alteration with weak molybdenite mineralization.

Other sporadic sulphide occurrences associated with the same magnetite rich horizons occur outside the project area to the east.

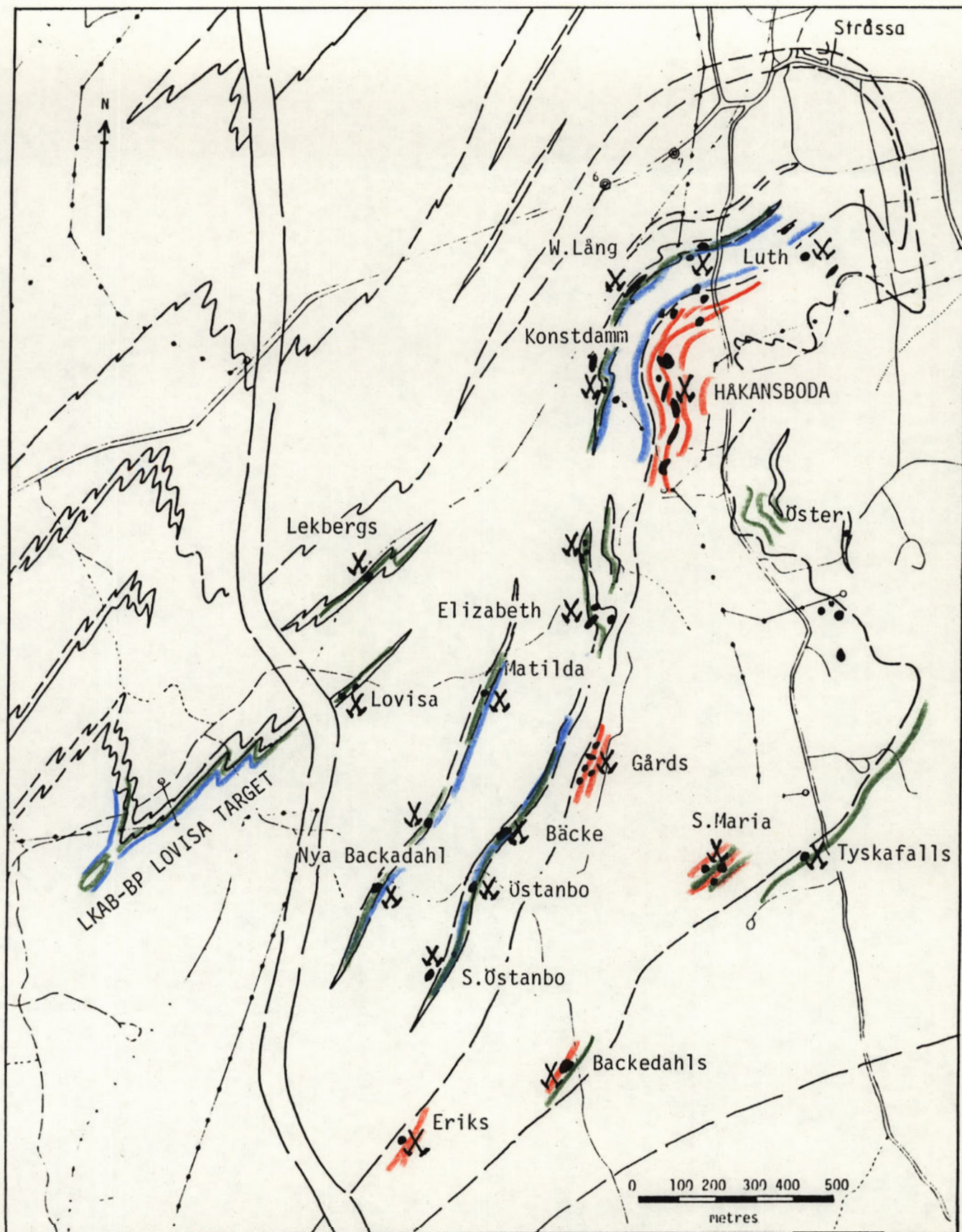


Fig.13. MINERALISED ZONES, MINERAL OCCURRENCES AND
MINERAL WORKINGS(abandoned): HAKANSBODA AREA

CJCarlon 1986

6.2 Mineralization in the main carbonate formation

Disseminated sulphide mineralization occurs sporadically throughout the full width of the carbonate formation, but is particularly common in its upper part (to the west). Known mineralization occurs around Luthgruvan, at Håkansboda, Värdegruvan, Gårdsgruvan and Eriksgruvan, a strike distance of 2.6 kms. The mineralization is typified by the largest known occurrence, at Håkansboda (section 6.3).

At Luthgruvan a siliceous horizon associated with diopside calc-silicate layers contains disseminated chalcopyrite-pyrite irregularly dispersed. Three pits were sunk on this mineralization.

South of Håkansboda, pits in the Gårdsgruvan area are excavated in ophicalcitic marble and diopside calc-silicate layers. Pyrrhotite-chalcopyrite disseminated mineralization occurs, together with coarser 'clots' of sulphide, chiefly in the marble.

The Eriksgruvan pits occur 1.1 kms further south. The same mineralization is observed, suggesting that a sporadic, along strike copper mineralization occurs at this stratigraphic level.

6.3 The Håkansboda complex sulphide deposit

The Håkansboda deposit is a zone of mineralization totally contained within, and occurring near the stratigraphic top of the main carbonate formation. This mineralized zone follows the strike and dip of the host ophicalcitic marbles and calc-silicates, trending generally N-S and dipping steeply eastwards at 60°-85°.

The mineralization has been traced at outcrop, in the mine workings and in drillholes for a strike length of at least 850 metres and to a depth of 600 metres. It is currently open to the south and in depth. A disseminated mineralization up to 50 m wide characterises the zone, within which richer ore-shoots 4-8 metres wide occur, and were previously mined in the Håkansboda workings. The deposit constitutes what Aronsson (1982) has referred to as the largest known sulphide accumulation in Central Sweden outside established and worked deposits.

Two mineral associations are noted:

- A. A main chalcopyrite-pyrrhotite-arsenopyrite-pyrite mineralization with subordinate magnetite, molybdenite, tennantite and cobaltite. This characterises the zone of mineralization and constitutes the major part of the more massive 'ore-shoots'.
- B. A superimposed galena-tetrahedrite-tennantite native bismuth-gold mineralization. This is apparently localized within the more massive type A mineralization. However, its distribution has not been fully investigated within the deposit.

Detailed examination of drillcore and thin and polished sections of the mineralization led Koark in the late 1970's and early 1980's to define four main ore types based on form and structure. His observations are expanded upon below.

i. Impregnation or disseminated mineralization

This defines the mineralized zone and is seen as a wide horizontal, vertical and elongate N-S heterogeneous dissemination of chalcopyrite and minor pyrrhotite grains. Occasionally the cobalt and cobalt-arsenic-iron sulphides danaite, glaucodot and cobaltite are seen.

Tegengren (1924) suggested that such mineralization contains 1-2% Cu over a wide area. Generally however, the grade is nearer 0.1% Cu, though substantial tonnages of 0.2-0.5% Cu are present.

ii. Schlieren or 'streaky' mineralization

Thin streaks of chalcopyrite with or without pyrrhotite; or chalcopyrite-tennantite, with arsenopyrite and cobaltite occur as cm or dm thick dm or m long streaks. Their abundance increases, defining a foliation in the host rock, into the main ore shoots, which are composed of the impregnation and schlieren 'ore' combined with more massive mineralization types iii and iv.

iii. 'Breccia' mineralization

'Clasts' or rounded fragments of the host rock, often containing disseminated chalcopyrite, are set in a 'vein-net' of chalcopyrite-pyrrhotite and chalcopyrite-tennantite. Arsenopyrite and cobaltite also occur.

iv. Compact or massive mineralization

Layers and flat lenses drawn out parallel with the schlieren mineralization and the host foliation occur in the main ore shoots. Compact layers are 0.2 to 1.5 metres thick and composed of massive chalcopyrite with or without pyrrhotite, or pyrrhotite with or without chalcopyrite. Arsenopyrite and cobaltite occur, and a 'ball-ore' texture is not uncommon.

The textures noted by Koark suggest stages of remobilisation of sulphide, pre-existing prior to strain and metamorphism, and altered by it. Mineralogical variation is not great across the various "structural ore types". However, early distribution features are preserved as some schlieren or streaky massive sulphides are clearly deformed around F_1 structures, which indicates what may be original S_0 foliation.

The main 'ore-shoots' are concentrations of schlieren, "breccia" and massive ore, forming zones up to 8 metres wide, sitting within a 'halo' of disseminated mineralization. Mined out portions contained high grade ore with up to 8% Cu, however it is apparent that compositional variation existed within the deposit.

All shoots are rich in chalcopyrite. Pyrite was common in Norrgruvan, pyrrhotite appears most common in the Varp, Märr and Commerce 'shoots', glaucodot was not uncommon in the Varp, Märr, Commerce and Smedgruvorna and cobaltite in Sörgruvan. At shallow depth most of the ore shoots were sphalerite and galena bearing, but sphalerite is less common at depth.

Analyses carried out by AB Statsgruvor, and observations made by Månsson (1982) suggest that in depth the Varp shoot is richer in Ag, Bi and Sb than the Commerce, Mörr and Cecilia shoots, but that the Mörr, Commerce and Lill-Cecilia shoots are richer in Au (more analyses would be needed to verify this distribution).

The orientation of the 'ore-shoots', dipping steeply eastwards at 60° - 85° , and plunging at 60° to the SE (fig 5) appears to be in response to an original S_0 or S_1 foliation plane with B_1 lineation re-orientated by F_2 folding to produce at steeply dipping B_2^0 , lineation running down the limb of the F_2 fold located immediately NE and E of the deposit (fig. 11b).

Such refolding possibly remobilised the mineralization in part to produce the structural types noted by Koark. Obviously much work could be done to check this.

The zone of mineralization, and the contained ore shoots, dips steeply to ca 180 m, reducing to 60° below this level. Most analyses of the deposit have been concerned mainly with copper content. A number of more 'multielement' analyses have been made, but not in a systematic manner. The deposit is characterized by Cu, Fe, Co, Ni, As, Sb, Bi, Ag and Au, and W, Se, Te, Sn, Ba, Mo and U occur.

The minerals so far identified (Table 4) have been partly investigated by Koark (1981, 1982).

These investigations have identified the second mineral association in the Håkansboda deposit.

Superimposed on the disseminated-massive, main Cu-Fe-As-Co mineralization is an apparently more localized (but poorly investigated) mineral association characterized by Pb-As-Sb-Cu-Bi-Ag and Au. Galena, tetrahedrite-tennantite ('grey-coppers'), native bismuth, and electrum have been found in cm to dm wide, schlieren or 'breccia' zones, with fragments of wallrock or chalcopyrite-pyrrhotite-tennantite mineralization veined and 'cemented' by Pb-As-Cu-Bi-Ag-Au mineral phases. Tellurides and as yet unidentified mineral phases are associated, and this superimposed, later (?) mineralization is notably poor in chalcopyrite, pyrrhotite and Co-As minerals.

Koark has examined the detailed mineralogy of the Håkansboda deposit by reflected light microscopy and microprobe analysis, particularly with regard to the Co-As-Fe phases (cobaltite, arsenopyrite, glaucodot and danaite); the Sb-As-Cu 'grey-coppers' (tetrahedrite, tennantite); and electrum (Ag-Au). The following notes (after Koark) are given here for completeness, though further work is required, particularly with reference to the gold and rare metal mineralization.

1. Glaucodot (Co,Fe)AsS and danaite (Fe,Co)AsS always occur as irregular grains and are possibly older, high temperature phases.
2. Arsenopyrite (FeAsS) and cobaltite (CoAsS) are usually well formed and possibly lower temperature phases.
3. Pyrrhotite occurs as both monoclinic and hexagonal polymorphs.

TABLE 4. THE MINERALOGY OF THE HAKANSBODA
DEPOSIT (after Koark 1981)

CHALCOPYRITE	CuFeS_2
PYRRHOTITE	Fe_{1-x}S
ARSENOPYRITE	FeAsS
PYRITE	FeS_2
MAGNETITE	Fe_3O_4
MOLYBDENITE	MoS_2
TENNANTITE	$(\text{Cu,Fe})_{12}\text{As}_4\text{S}_{13}$
TETRAHEDRITE	$(\text{Cu,Fe})_{12}\text{Sb}_4\text{S}_{13}$
Minor species :	
CUBANITE	CuFe_2S_3
LÖLLINGITE	FeAs_2
GALENA	PbS
SPHALERITE	ZnS
BREITHAUPITTE	NiSb
KALLILITE	$\text{Ni}(\text{Sb,Bi})\text{S}$
ELECTRUM	Au/Ag
NATIVE SILVER	Ag
NATIVE GOLD	Au
URANINITE	$\text{UO}_2(\text{etc})$
DANAITE	$(\text{Fe,Co})\text{AsS}$
GLAUCODOT	$(\text{Co,Fe})\text{AsS}$ (up to 14.2%Co)
COBALTITE	CoAsS
ARGENTITE	AgS

4. Cobalt occurs as cobaltite (containing 29.9-33.3% Co). It also occurs in glaucodot (12.9-14.2%), danaite (3-11%), arsenopyrite (1.6%) and pyrrhotite (0.3%), substituting for Fe in the crystal lattice.
5. Nickel contents in these minerals are low, (up to 1.7% in cobaltite).
6. Arsenic is high in most phases (45.-46.3% in arsenopyrite, 43.-45.7% in danaite, 44.4-46.0% in glaucodot, 39.6-43.0% in cobaltite, 0.14-0.46% in tetrahedrite, 0.11% in native bismuth).
7. Tetrahedrite analyzed in a few samples from the deposit contains 23.78-24.12% Sb and 0.27-0.44% Ag. Tellurium (0.01%) also occurs in tetrahedrite.
8. Tennantite is common in the main ore-shoots, while tetrahedrite appears to be more important peripheral to the main ores, and in the precious metal bearing later mineral association (with galena)
9. The highest Au values occur within the 'grey-coppers', chiefly the arsenic rich endmembers (tennantite). A grab sample from the 199 m level contained 742 g/t Ag and 7 g/t Au in a tennentite rich mineralization.
10. Electrum occurs as 5-10 μ grains containing 64% Au-27% Ag.

Mineralized intersections, grades and tonnages are discussed at length in sections 7.3., 7.4 and 8.1.

All the mineralogical variants and textures were intersected in the drillcores. Unfortunately very few Au, Sb, Bi or As analyses were made. Most of the Au analyses were made by Månsson (1982) and only for the central ore zone, the Varp, Mörr, Commerce, Cecilia and Lill-Cecilia 'ore-shoot' located below the earlier mine workings in the 199 m level.

Clearly more information from around the central area is required, (see section 9).

In summary, the Håkansboda deposit is a complex association of possibly an earlier multiphase chalcopyrite-pyrrhotite-arsenopyrite-pyrite-magnetite-cobaltite-molybdenite-tennantite mineralization and a superimposed, probably younger and lower temperature galena-tetrahedrite-native bismuth-gold-silver mineralization. Both groups of mineralization have been metamorphosed, strained and remobilised, and most textures currently observed are the result of remobilisation overprinting with F_1 - F_2 interference relationships, an earlier and partly original distribution.

6.4 Mineralization above the main carbonate formation

Lying stratigraphically above and immediately west of the main carbonate formation are the mixed metavolcanics and meta-sediments described in section 5.1.

Within this sequence, some 50-80 metres stratigraphically above the top of the carbonate formation, is a mixed metavolcanic, manganese magnetite-carbonate-calc-silicate group up to 30 metres thick. Individual magnetite bearing dolomitic marble or diopside calc-silicate layers are 0.5-2 metres thick. Thinner, massive magnetite rich layers 0.3-0.7 m thick also occur.

It has long been known and observed, that these 'skarn iron ores' often contain a low grade but persistent sulphide mineralization, characterized by pyrite, pyrrhotite, chalcopyrite, sphalerite and galena. The mineralization is seen in the pits and dumps of the Luth-, Konstdamm-, Elizabeth, Bäcke, Östanbo and South Östanbo mines, a strike length of at least 2,1 kms.

Separate horizons, or a repetition of the same horizon by folding along NE-SW axes (F_1), occur 200 m W. and parallel to the Elizabeth-Östanbo mines zone (the Backadahl-Matilda zone), and 300-400 metres west of this (the Lovisa-Jonshytten zone) (fig 13) (Engvall 1985). Only the Luthgruvan-Östanbo zone is considered within the Håkansboda Project.

The northern part of the Luthgruvan-Östanbo zone, between Luthgruvan and Konstdamm mines is seen in a number of small pits and outcrops, in dump material, and in underground holes drilled from the 71 m level in Håkansboda mine by Stora Kopparberg in the 1950's. In addition what appears to be the vertical continuation was intersected in DDH's 423, 428 and 429 drilled towards the NW and W from the 199 m exploration level in Håkansboda. Only one surface drillhole, DDH 247 intersects the NE extension of the zone, but similar mineralization was also intersected in the 199 m level exploration hole DDH 422, (figs 16, 17, 32, 33). The deep hole DDH 374 intersected the same mineralization at a depth of 686 m, but it was very low in Pb-Zn. The important feature of this mineralization is the silver content. Silver (native, sulphide and sulphosalt) accompanies the lead rich sulphide mineralization.

At Luthgruvan galena-chalcopyrite 'clots' occur in a diopside calc-silicate host rock together with disseminated galena within a magnetite-dolomite horizon. Pyrrhotite and chalcopyrite are also disseminated in the dolomite.

The same zone, intersected in Stora Kopparbergs underground hole No 27 (fig 17), proved 30% Pb and 350 g/t As over 0.5 metres. A grab sample from the Luthgruvan dumps contained 13.6% Pb and 575 g/t Ag, while DDH 247, drilled from surface in 1971 at Luthgruvan, intersected the same mineralization with up to 3.9% Pb and 250 g/t Ag. The width interval is unknown, but the drillcore has been obtained for re-analysis. Holes 422, 423, 428 and 429, drilled in 1980-81 from the 199 m level (fig 16) intersected the following:-

- DDH 422: 4.22 m with 0.89% Pb, 0.82% Zn, 34 g/t Ag
(NE extension of the zone)
- DDH 423: 2.71 m with 1.73% Pb, 60 g/t Ag (including 0.3 m with
3.6% Pb, 286 g/t Ag)
(see fig 31) 0.97 m with 1.9% Pb, 65 g/t Ag
- DDH 428: 0.97 m with 1.6% Pb, 59 g/t Ag and
2.75 m with 40 g/t Ag
- DDH 429: 1.70 m with negligible Pb (0.01%), 58 g/t Ag

Polished sections of the Luthgruvan sulphide mineralization display galena, native silver, tetrahedrite, freibergite (Ag-tetrahedrite), and a number of Ag-Sb sulpho-salts including pyrargyrite (ruby silver- Ag_3SbS_3) and stephanite (Ag_5SbS_4).

Further south, the dumps of Konstdam mine show disseminated galena within the same host rocks. At Elizabeth mine disseminated galena occurs in a magnetite rich dolomite marble, and a similar association, chiefly with magnetite-calc-silicate occurs at Bäck, Östanbo, Matilda and Backadahl mines. An investigation of the galena mineralization at Nya Backadahl (by Bleeker 1984) showed a similar mineralogy as noted above (Table 5).

Drilling from surface in 1970-71 immediately south of Håkansboda mine, intersected the magnetite zones stratigraphically above the main carbonate in the Elizabethgruvan area. (Holes DDH 231, 236, 244, 245 fig 16). Holes 236 and 231 intersected a 24 metre (true) thickness of magnetite bearing calc-silicate layers, massive magnetite and siliceous fine grained rocks of probable 'meta-tuff' origin. Chalcopyrite, arsenopyrite, and pyrrhotite were observed, but galena was strangely lacking. Analyzed only for Cu hole DDH 231 intersected 41 m with 0.37% Cu and DDH 366, in the same horizon 1.05 m with 0.75% Cu. The zone dips at 70° to the east. Hole 244, 130 metres further north, intersected similar, but not identical geology. However, thin magnetite bands had pyrite and chalcopyrite associated within calc-silicate horizons, in one 2.00 m section containing 0.17% Cu.

In summary, an apparently stratiform-stratabound chemical sediment characterized by magnetite rich carbonate and calc-silicate host rocks contains a persistent sulphide mineralization, which may be economically significant by virtue of its silver content. Arsenopyrite and other As-Sb minerals occur, but no gold analyses have been made.

7. EXPLORATION

This section reviews the results of previous exploration in the project area, undertaken since 1950 by Stora Kopparberg, Gränges (GIM), SSAB and LKAB Prospektering.

7.1 Geophysics (Anders Engvall)

A number of different geophysical methods have been used on several occasions in the past, within the project area, and specifically over the Håkansboda deposit. Unfortunately most of the older results

TABLE 5. NYA BACKADAHN - SULPHIDE MINERALOGY
(With additional phases from the
Luthgruvan mineralisation)

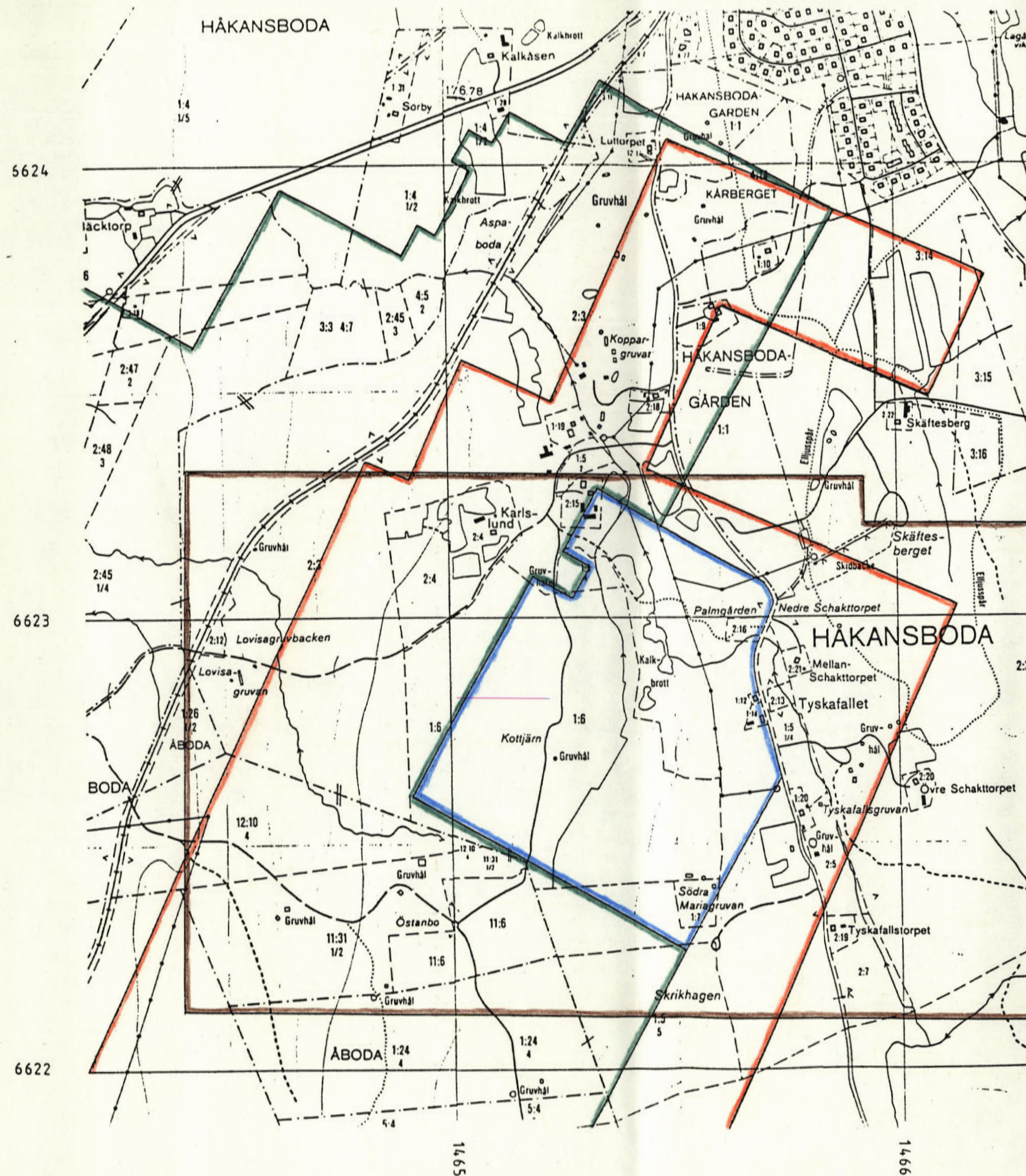
MAGNETITE	Fe_3O_4
PYRITE	FeS_2
PYRRHOTITE	Fe_{1-x}S
GALENA	PbS
SPHALERITE	ZnS
CHALCOPYRITE	CuFeS_2
TETRAHEDRITE	$(\text{Cu,Fe})_{12}\text{Sb}_4\text{S}_{13}$
GUDMUNDITE	FeSbS
NATIVE SILVER	Ag
ACANTHITE	AgS
DYSCRASITE	Ag_3Sb
ALLARGENTUM	$\text{Ag}_{1-x}\text{Sb}_x$
PYRAGYRITE	Ag_3SbS_3
STEPHANITE	Ag_5SbS_4 (Luthgruvan)
FREIBERGITE	$(\text{Ag,Cu})_{12}(\text{Sb,As})_4\text{S}_{13}$ (Luthgruvan)

remain only as anomaly maps without any information concerning instruments used, line and station spacing, zero levels and so on. These surveys can only be useful when they cover otherwise unsurveyed or 'blank' geophysical areas.

The surveys worth further attention whose area coverage is shown in fig 14 are the following:

1. (Delineated in green - fig 14)
The LKAB Prospektering magnetic (total field) survey with a line/station spacing of 80 m/5 m.
The main features of the magnetic pattern are the two persistent magnetic sequences known as the Backadahl and Östanbo horizons. As mentioned in Report B85-21 (Engvall 1985), these two sequences are thought to be one and the same, forming the two limbs of a trough with the main synclinal (F_1) axis located between them. The importance of the magnetic survey is based on the fact that magnetite horizons are invaluable stratigraphic and structural markers.
2. (Delineated in brown - fig 14)
A magnetic vertical field survey performed in 1961. In spite of the survey being relatively new, there is no information regarding station and line spacings, making the results almost impossible to handle. Since the area is of vital interest (it covers the southern extension of the Håkansboda Cu mineralized zone) any information is of interest. Hence, the total field survey is suggested to be extended eastwards as indicated in fig 14.
3. (Delineated in red - fig 14)
The combined slingram (1775 Hz/60 m) and VLF-H-mode (FU0) survey performed by Suomen Malmi Oy in 1974 is very good. In this case we have available contour maps with written station values as well as a map with interpreted conductors. The latter information presented in fig 13. It can be noted that there is no conductor indicated along the southern continuation of the Håkansboda mineralized zone. For this reason Max-Min EM traverses are planned in this area.
4. (Delineated in green - fig 14)
The VLF-H-mode (GBR) survey performed by LKAB Prospektering complements the above mentioned VLF survey. The northern parts are much disturbed by powerlines and artificial conductors, but some interesting anomalies are discernable. Complementary fieldwork is required.
5. (Delineated in green - fig 14)
The LKAB Prospektering IP/resistivity survey (Wenner array; $a=40$ m) resulted in several interesting IP anomalies. Since the results show anomalies in areas in proximity to or covered by mine dumps, it is of vital importance that the occurrences be carefully mapped. In this way non-significant anomalies can be excluded.

In the future project work downhole logging will be of major importance since there are a number of old boreholes drilled from surface in the area (fig 16). E-M surveys may be the most useful, but difficulties might arise with conductive materials left in the old mine workings.



The location of some Geophysical Surveys
in the H A K A N S B O D A area.

Author: L. Engvall
86

PA surveys.
Suggested extension of Magnetic survey.
Low quality Magnetic Z-field survey.
Women Malmi Oy. E - M surveys.

Scale  : 10 000

Fig. 14

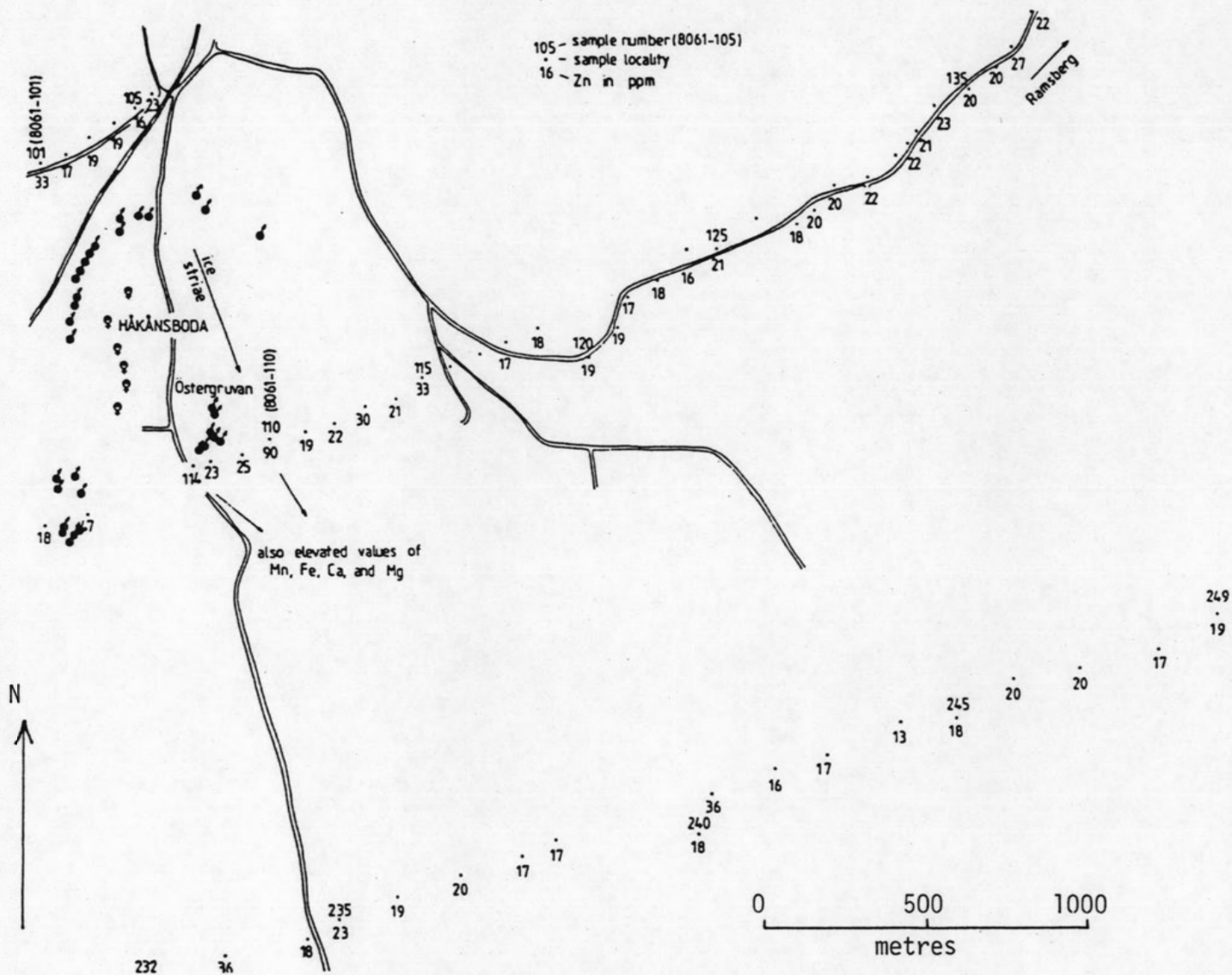


Fig.15. Overburden geochemical coverage
 (with Zn results)

Since LKAB Prospektering is not in possession of any downhole E-M equipment, this must be obtained externally.

7.2 Geochemistry

Two regional overburden sampling traverses have been made across the project area by LKAB Prospektering in the early 1980's. The location of these traverses is shown in fig. 15. Samples were analysed for Cu, Zn, Pb, Mn, Fe, Co, Cd, Y, La, W, Mg, Ca. In addition, a number of traverses were made to the east of the project area over the Blanka area. Only one anomalous Sb-Ba sample was noted and not followed up, SW of Blanka.

With regard to the traverses crossing the project area, only Mn and Zn proved anomalous, in samples collected down-ice from the Östergruvan occurrences. One Zn value of 114 ppm was obtained (fig 15).

It appears that these anomalies are locally derived, from the Östermine or from the Håkansboda zone. More overburden geochemistry may prove useful in the area, particularly south of Håkansboda. Overburden thickness is up to 6 m in the mine area, and 10-12 metres beyond. No till stratigraphy studies have been undertaken.

7.3 Surface Drilling. Results and intersections 1970-1981. Håkansboda

In the following summary the borehole results are considered from south to north, from hole DDH 231 to DDH 403. Drillhole location is shown in fig 16 and listed in Appendix 2. Drillhole parameters are shown in figs 18-38 and listed in Appendix 3. Drill sections together with underground hole data (where appropriate) are presented in figs 18-33.

The purpose of this section is to summarise the results of surface drilling undertaken in 1970-71 by GIM, primarily for the 'skarn iron ores' immediately west of Håkansboda, and the extensive 1974-1981 drilling programmes by GIM and SSAB specifically for the investigation of the Håkansboda sulphide deposit.

It is pertinent to note:- (see fig 16).

1. Holes DDH 231, 236, 244, 245 and 247, drilled into the footwall of the Håkansboda deposit, were located to test the manganiferous iron ores lying stratigraphically above the Håkansboda deposit. Disseminated sulphide of the type described in section 6.4 were intersected in all drillholes. Drilling was done by GIM in 1970-71.
2. All other holes were drilled to test the Håkansboda sulphide deposit, during 1974-1977 (GIM) and 1978-81 (SSAB). Most of the latter were underground holes discussed in section 7.4.
3. Holes DDH 379, 390, 402, 403 and 404 were drilled to test the northern continuation of the sulphide zone.
4. Holes DDH 362-366, 370-378 were drilled to test the eastern, down-dip extension of the known mineralization.
5. Hole DDH 420 was drilled to test the southern extension to the mineralization.

6. The main concern of the drilling programme 1974-1977, and to a lesser extent in 1978-81 was to prove the ore extension to north, south and in depth, primarily to ca 200 metres below Håkansboda shaft collar. A total of ca 6,600 metres of drilling was done, proving mineralization to 600 m below shaft collar. Results below 200 m were never followed up.
7. Most intersections were analysed for Cu, or Cu,Fe and S. Some sections were analysed in addition for As, Sb and rarely Bi. Very few Au analyses were made. No detailed geochemical analysis was made for any of the deeper intersections and many As mineralized sections were not tested for Ag, Au, Sb or Bi. In most cases it must be assumed that analyses other than Cu, unless stated, are to date lacking.

Data is here presented on borehole location and attitude; geology intersected; mineralization located; sections sampled and in-situ metal grades and intersections. Data is also presented in graphic form in 16 drill sections (figs 18-33). Location is in the Stråssa grid system (fig 16). Depths and thicknesses recorded are all downhole measurements unless otherwise stated.

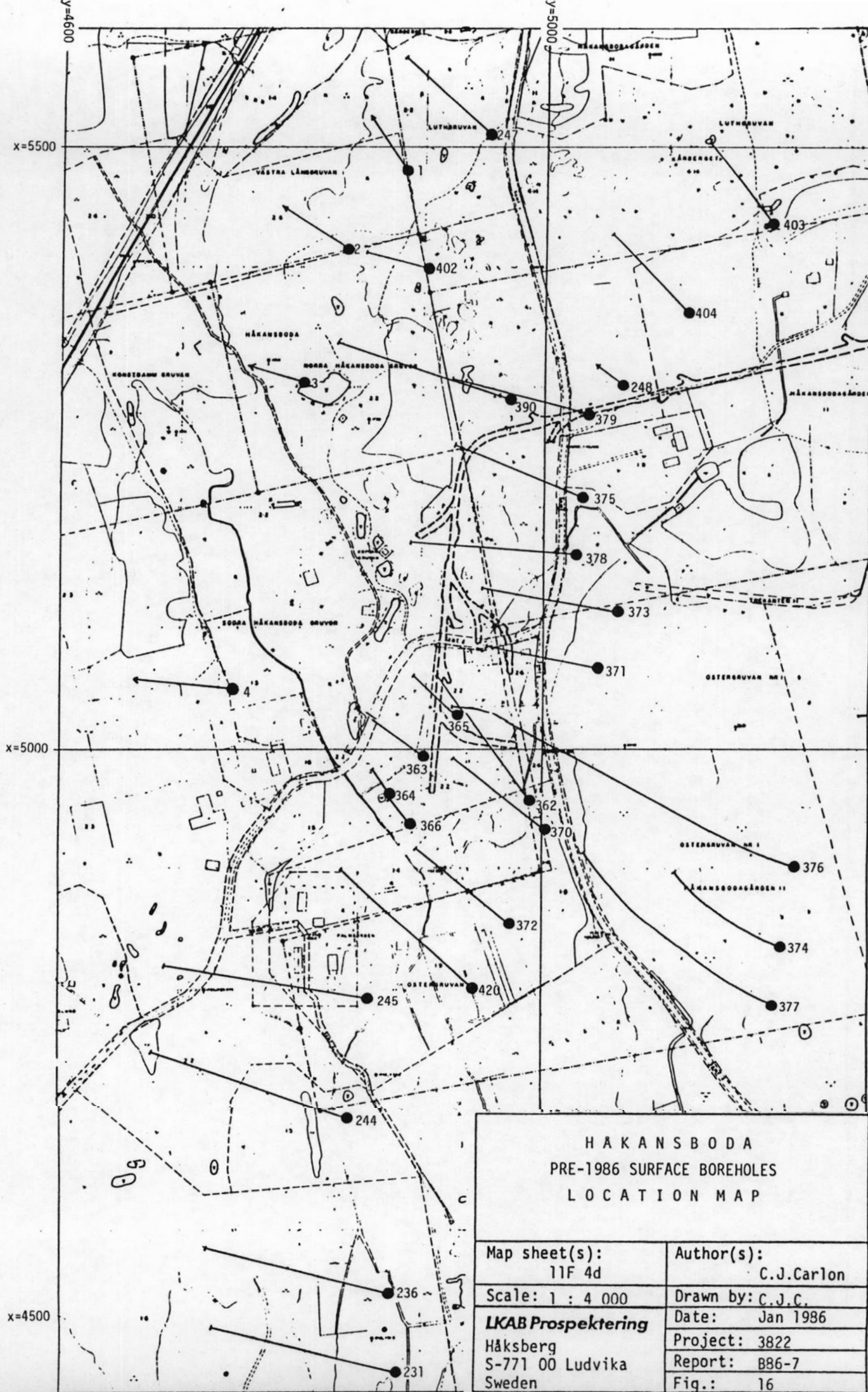
1. DDH 231 Location : 4483 north, 4880 east, 189.5 m asl
 Attitude : Drilled at 60° to N308.7° (fig 18)
 (TD) Total depth: 307.65 metres. (ca 265 m vertical depth)
 Purpose : To intersect the southern continuation
 of the Elizabethgruvan magnetite horizons
 in the footwall of the Håkansboda deposit

The hole passed through 147.50 metres of unmineralized dolomitic marbles and ophicalcitic marble of the main carbonate formation. No mineralization was recorded. From 147.50 m to TD metavolcanics thin garnet-amphibole calc-silicate and mafic silicate layers with magnetite were intersected. The main magnetite horizons occur between 232.00-257.00 metres and have associated sulphides. 0.37% Cu over 4.1 m was recorded at 253.45-257.55 m.
 No other base or precious metal analyses were made.

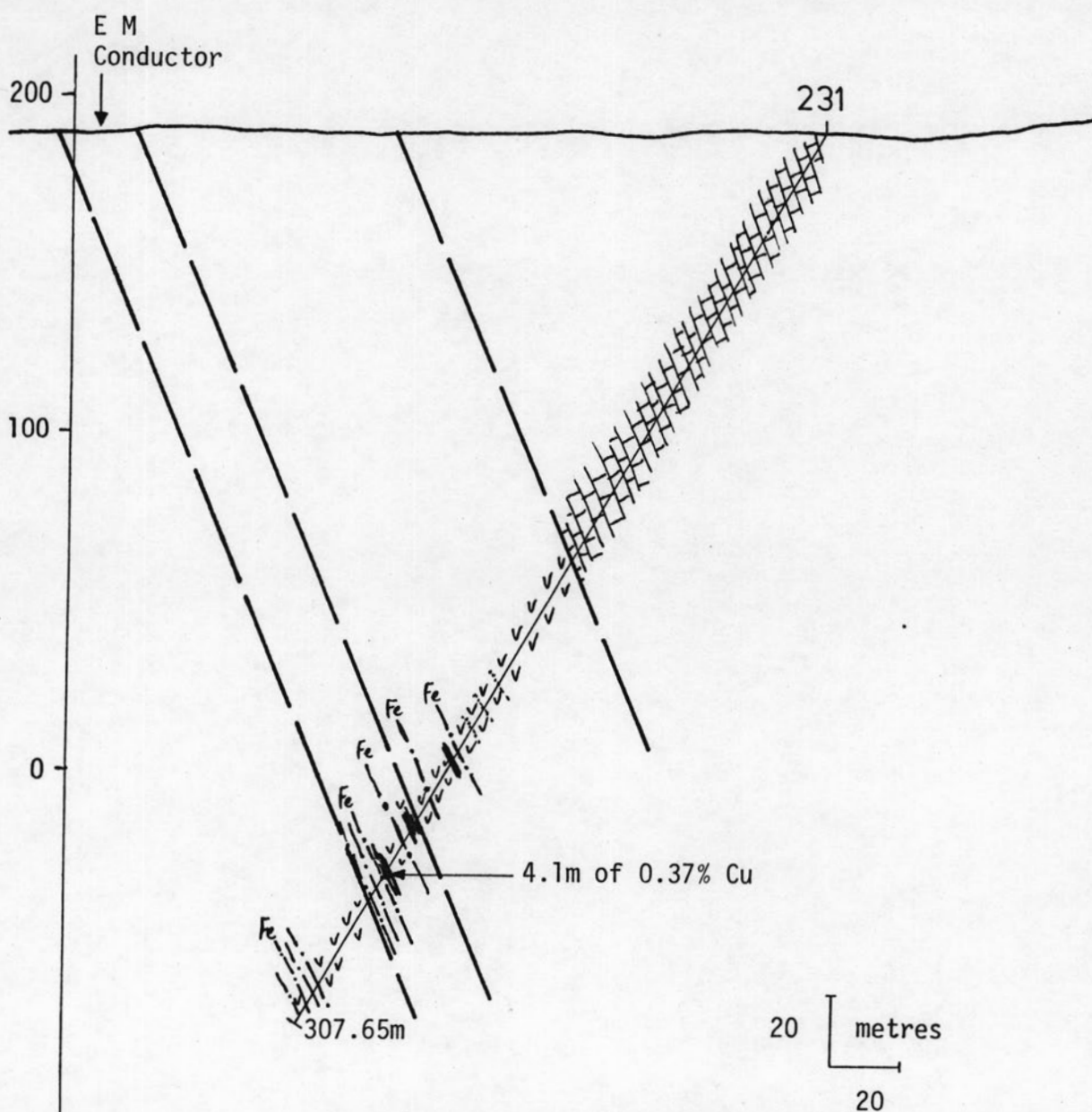
2. DDH 236 Location : 4548 north, 4874 east, 189.5 m asl
 Attitude : Drilled at 60° to N284.0° (fig 19)
 Total depth: 310.60 metres (ca 270 m vertical depth)
 Purpose : As 231.

The hole passed through the main carbonate to 109.55 m with no mineralization. From 109.55 m to TD mainly metavolcanics were intersected. Between 191.00-242.00 m several thin magnetite horizons were encountered. At 218.90-219.03 m, a magnetite bearing calc-silicate 'skarn' horizon containing pyrrhotite, chalcopyrite and arsenopyrite was intersected. However, sulphides were noted over a 27 metre intersection from 200.00-227.60 m. The interval 225.15-226.20 m (1.05 metres) contains 0.75% Cu in a magnetite-chalcopyrite bearing host. No other analyses were undertaken.

Both DDH 236 and 231 intersect the same horizon, with an apparent constant dip of 70° to the E. This horizon is that defined by the VLF-Slingram, Suomen Malmi survey as the Östanbo-Elizabethgruvan zone (sections 6.4 and 7.1).
 True thickness of the zone is 24 metres.



Height
ASL
(m)



Hole No: DDH 231

Dip: 60°

x = 4483.0

Azimuth: 309°

y = 4880.0

Total Depth: 307.65m

	Sulphide mineralisation
	Dolomitic and ophicalcitic marble
	Argillaceous metavolcanics
	Calc-silicate rocks ('Skarn')
	Magnetite

Map sheet
11F LINDESBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: / JG

LKAB Prospektering

Date: Jan 86

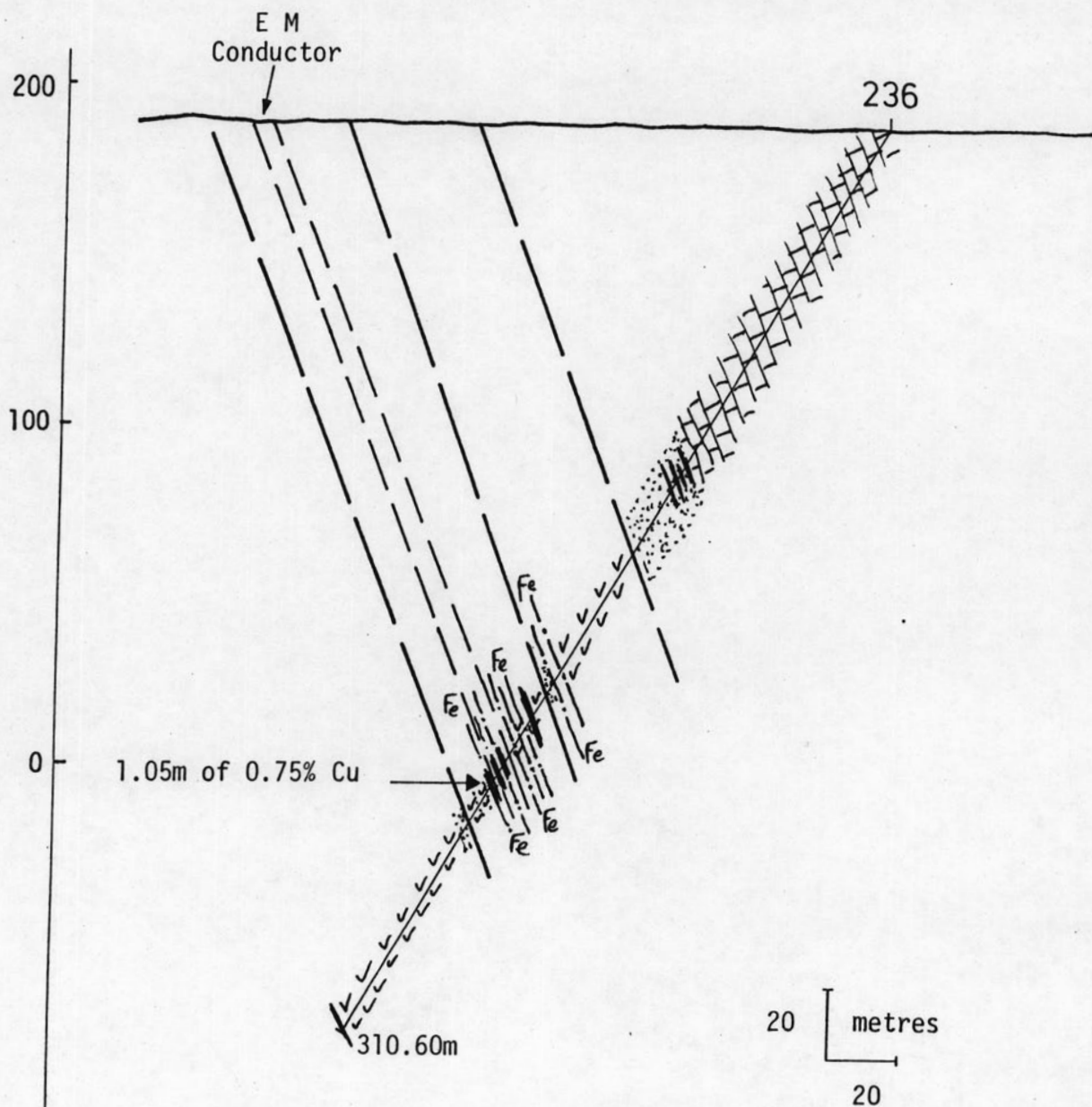
Häksberg
S-771 00 Ludvika
Sweden

Project: 3822

Report: B86-7

Fig.: 18

Height
ASL
(m)



Hole No: DDH 236

Dip: 60°

x = 4548.0

Azimuth: 284°

y = 4874.0

Total Depth: 310.60m

	Sulphide mineralisation
	Dolomitic and ophicalcitic marble
	Argillaceous metavolcanics
	Calc-silicate rocks ('Skarn')
	Magnetite

Map sheet
11F LINDESBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: / JG

LKAB Prospektering

Date: Jan 86

Hälsberg
S-771 00 Ludvika
Sweden

Project: 3822

Report: B86-7

Fig.: 19

3. DDH 244 Location : 4689.4 north, 4841.5 east, 188.3 m asl.
 Attitude : 60° to N289° (fig 20)
 Total depth: 341.40 m (ca 298 m vertical depth)
 Purpose : As DDH 231 and DDH 236 north of Elizabethgruvan

The hole passes through the main carbonate formation to 93.25 m. From 91.00-93.25 m a mixed calc-silicate zone at the stratigraphic top of the carbonate contained chalcopryrite and pyrite (not analyzed). The remainder of the hole passed through metavolcanics with thin calc-silicate layers and traces of chalcopryrite.

Magnetite horizons with chalcopryrite were recorded at:-

226.15-228.15 m: 2 metres of 0.17% Cu
 268.60-270.20 m: 1.6 m of 0.02% Cu
 variably between 303.15-315.60 (the main magnetite zone)

Sulphide was also intersected between 340.70-341.00 but was not analyzed.

Zn-Pb values were below 0.05%, but more analyses could have been made. The opinion was, that the above zone was not the same horizon as that drilled in holes 231 and 236, which was thought to run further to the west.

4. DDH 245 Location : 4793 north, 4857 east, 187.8 m asl.
 Attitude : Drilled at 60° to N279° (fig 21)
 Total depth: 341.60 m (ca 298 m vertical depth)
 Purpose : Some target as DDH 244

The hole intersected the main carbonate formation to 93.55 m, then mixed dolomite marble, ophicalcitic marble, calc-silicates and metavolcanics to 154.00 m. Below this metavolcanics, garnet-sillimanite or cordierite gneiss dominate, with thin magnetite horizons and minor dolomite layers.

Again sulphides occur with the magnetite at:-

152.00-152.45 m: 0.45 m of diopside calc-silicate with
 chalcopryrite (no analysis)
 298.00-298.65 m: 0.65 m with magnetite-chalcopryrite
 (0.015% Cu)

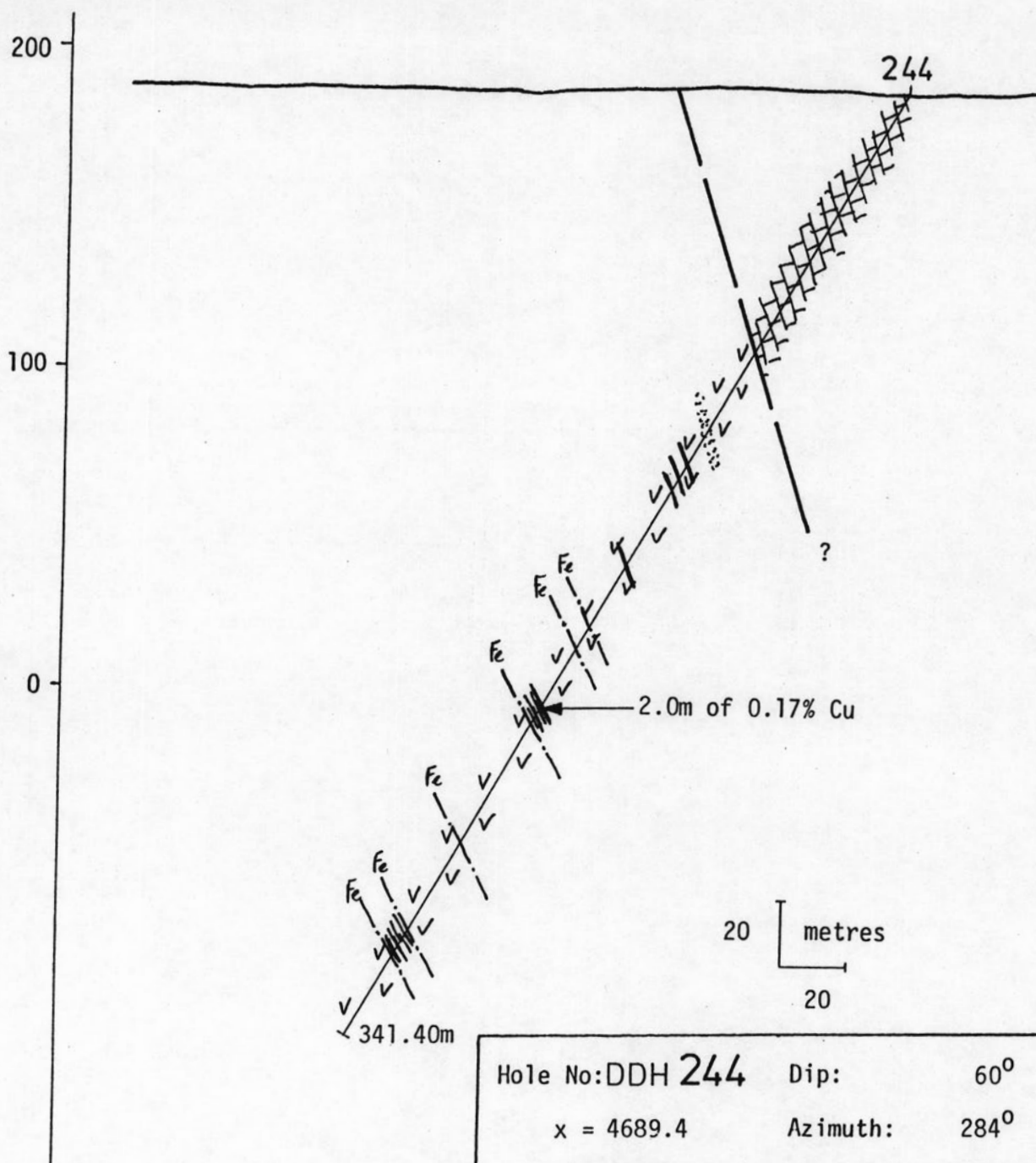
Both DDH 244 and DDH 245 are collared to the west of the indicated Håkansboda mineralization subcrop.

The remaining holes were drilled to test the Håkansboda sulphide deposit.

5. DDH 420 Location : 4801.5 north, 4943.8 east, 185.35 m asl.
 Attitude : Drilled at 70° to N312.1° (fig 22)
 Total depth: 393.00 metres (ca 370 m vertical depth)
 Purpose : To test the southern continuation of the Håkansboda deposit

The hole penetrated the main carbonate formation with ophicalcitic marbles and diopside calc-silicate bands to 316.75 m, below which thin calc-silicate bands and metavolcanics continue to the bottom of the hole.

Height
ASL
(m)



Hole No: DDH 244

Dip: 60°

x = 4689.4

Azimuth: 284°

y = 4841.5

Total Depth: 341.40m

Map sheet
11F LINDESBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: / JG

LKAB Prospektering

Date: Jan 86

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Sweden

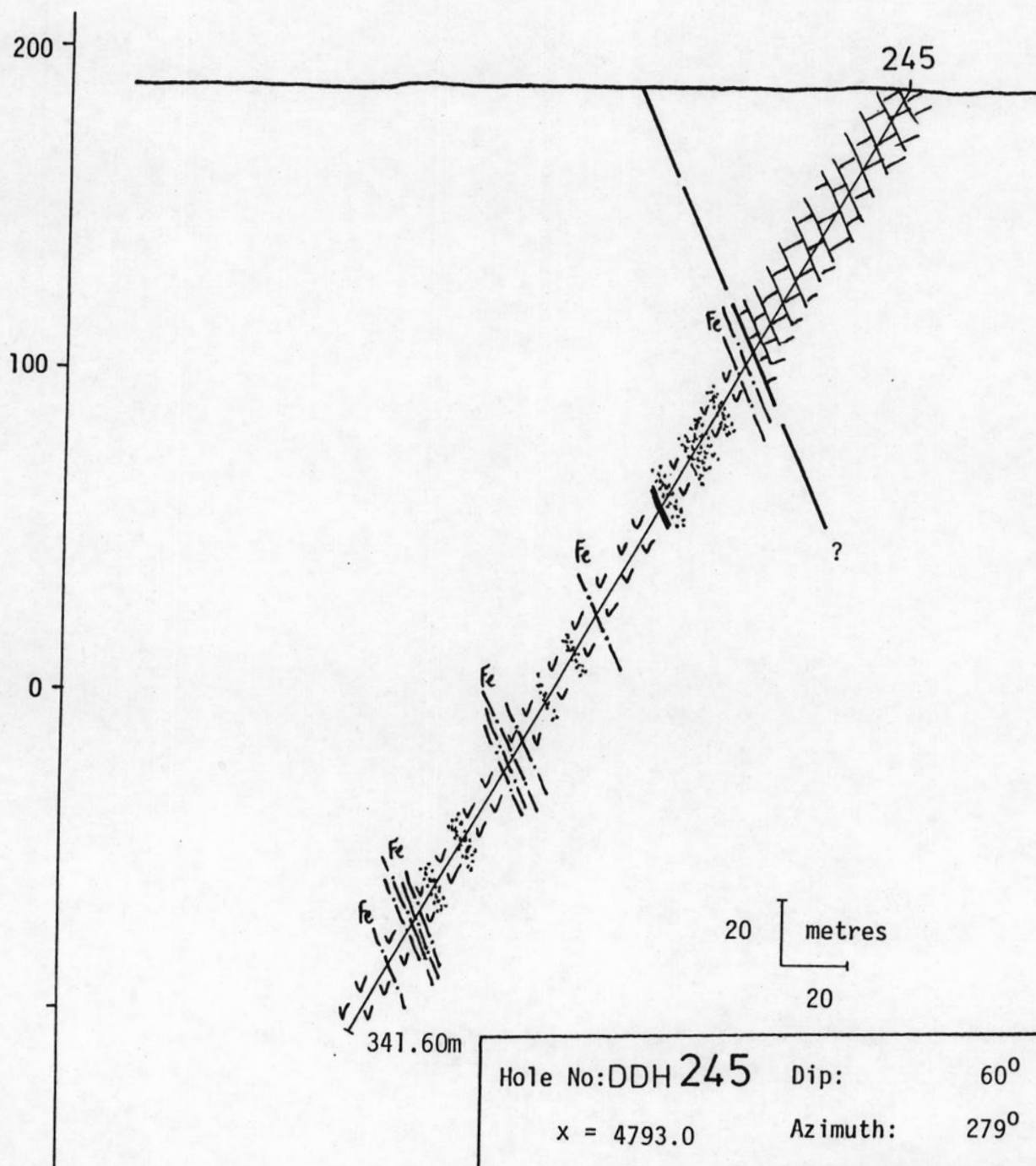
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Fig.: 20

- Sulphide mineralisation
- Dolomitic and ophicalcitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

Height
ASL
(m)



Hole No: DDH 245

Dip: 60°

x = 4793.0

Azimuth: 279°

y = 4857.1

Total Depth: 341.60m

Map sheet
11F LINDESBERG S.W.

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Scale: 1 : 2 000

Drawn by: / JG

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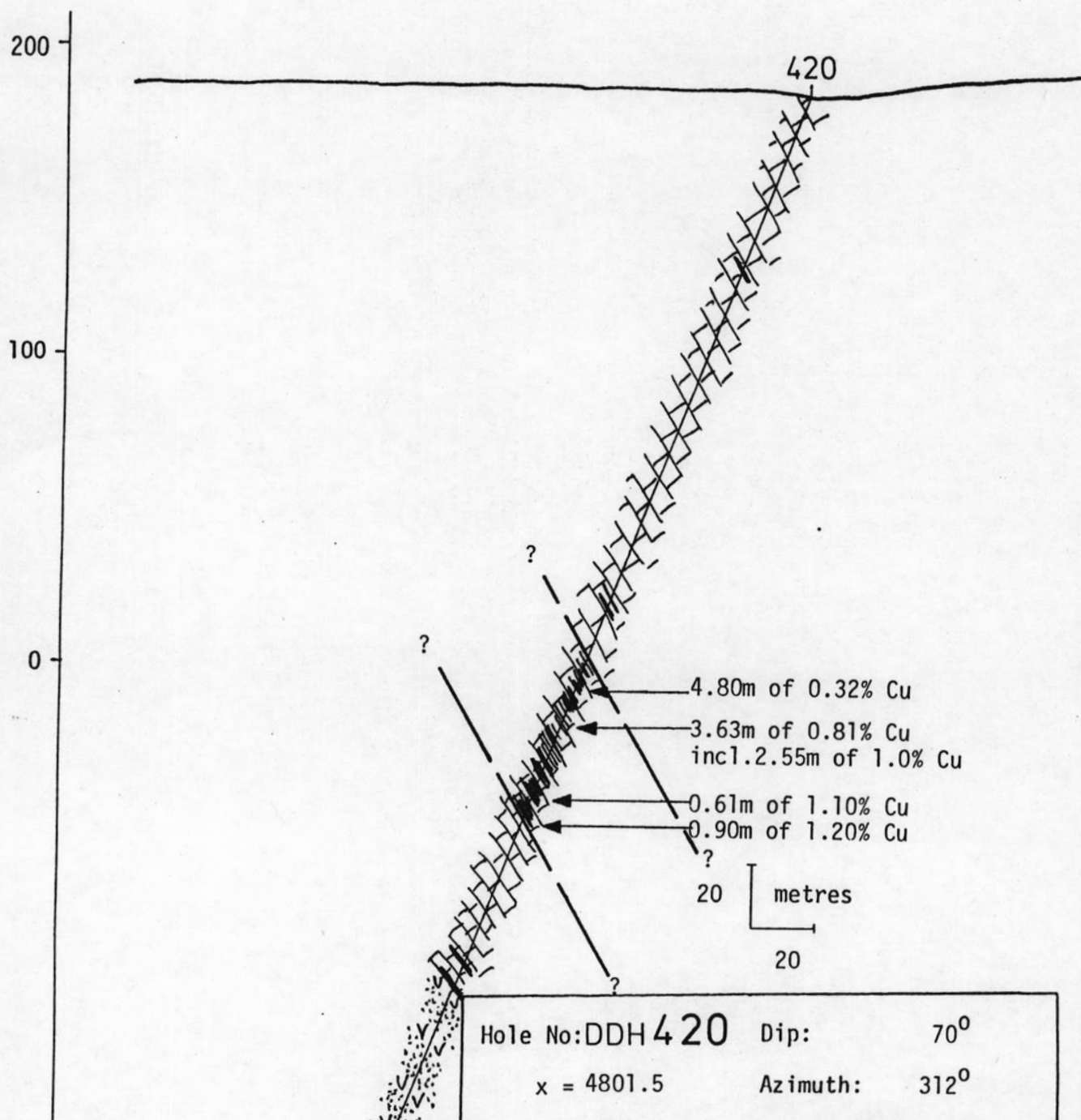
Project: 3822

Report: B86-7

Fig.: 21

-  Sulphide mineralisation
-  Dolomitic and ophicalcitic marble
-  Argillaceous metavolcanics
-  Calc-silicate rocks ('Skarn')
-  Magnetite

Height
ASL
(m)



Hole No: DDH 420 Dip: 70°
 x = 4801.5 Azimuth: 312°
 y = 4943.8 Total Depth: 393.00m

Map sheet(s):
11F LINDESBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: / JG

LKAB Prospektering

Date: Jan 86

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Sweden

Project: 3822

Report: B86-7

Fig.: 22

393.00m

- Sulphide mineralisation
- Dolomitic and ophicalcitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

Traces of chalcopyrite occur sporadically in the target carbonates, but the main intersection occurs between 198.39-251.07 m (a true thickness of ca 40-44 metres). This is the southernmost known occurrence of the Håkansboda zone, there is no outcrop or drill-data further south to-date.

The interval 188.65-252.65 was analysed for copper (64 metres down-hole thickness). Pyrite, pyrrhotite and chalcopyrite were particularly noted between 218.00-221.63 m (3.63 m) and analysis for Co, Cu, Pb, Zn, Mo and Bi was made.

Main intersections were:-

206.65-211.45 m: 4.80 m with 0.32% Cu
 218.00-221.63 m: 3.63 m with 0.81% Cu (trace Bi)
 (218.80-221.35 m: 2.55 m with 1.0 % Cu)
 245.12-245.73 m: 0.61 m with 1.1 % Cu
 251.75-252.65 m: 0.90 m with 1.2 % Cu

Other intersections were below 0.1% Cu

6. DDH 364 Location : 4961.6 north, 4873.3 east, 184.6 m asl
 Attitude : Drilled at 60° to N324° (fig 23)
 Total depth: 49.58 m (ca 43 m vertical depth)
 Purpose : To test the depth extension of the Sörgruvan ore-shoot

This hole was drilled into the main carbonate formation, and intersected disseminated mineralization before entering significant copper 'ore' of 32 m. A full width was not penetrated and the hole stopped still in mineralization. The interval 24.70-27.20 (2.50 m) and the main zone 32.68-49.58 (16.90 m) were analysed for Fe, S, Cu, Co, Ni, Bi, Zn, Pb, Mo, As and Sb. Co, Ni, Bi, Zn, Pb, Mo and Sb were low and displayed little or no variation.

The hole penetrated mineralization peripheral to the more massive ore mined from the Sörgruvan ore-shoot.
 As values vary between 0.26-0.52 %
 Cu values vary between 0.014-1.00 %

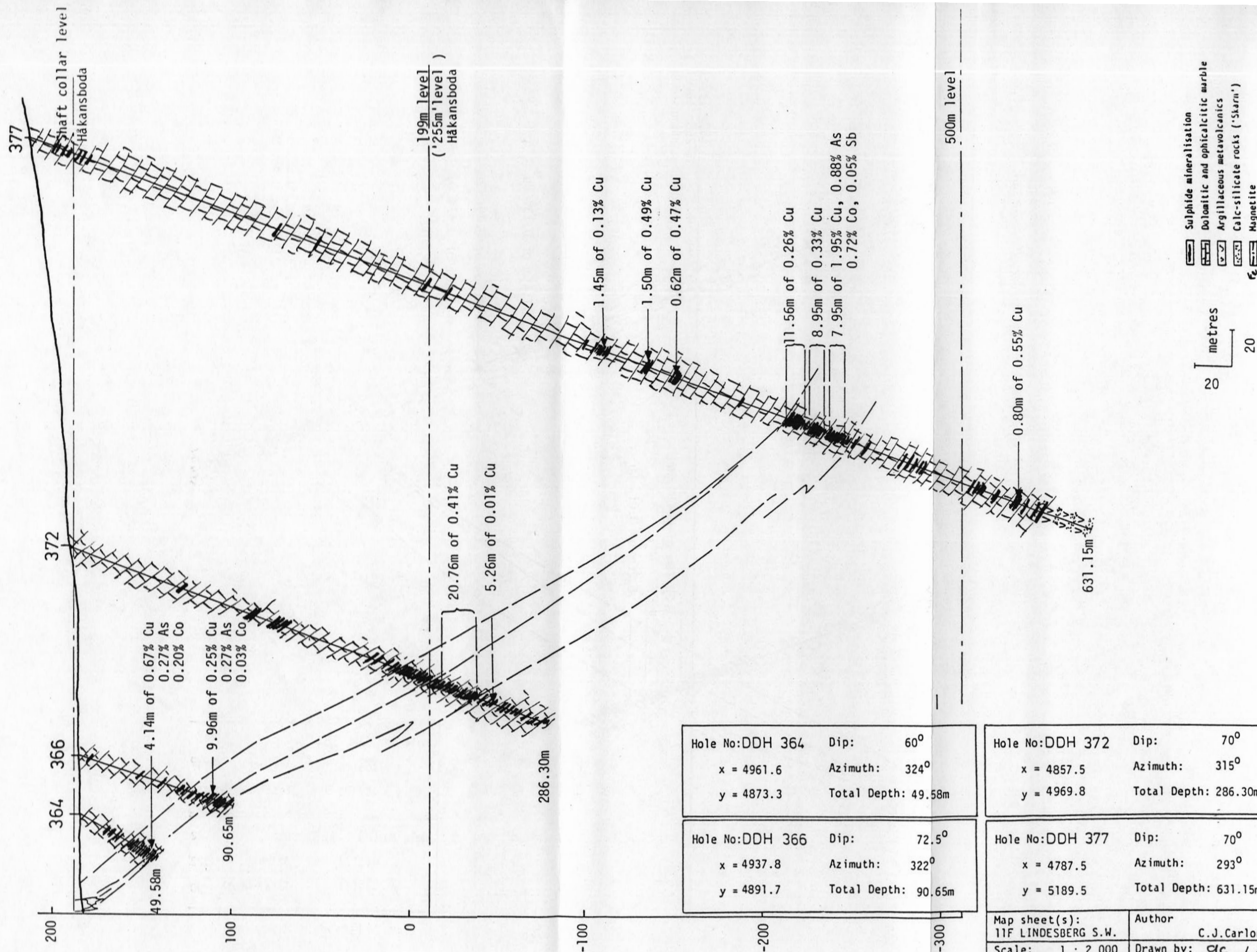
The main intersection:-

45.44-49.58 (bottom of hole): 4.14 m with 0.67% Cu, 0.27% As
 0.025% Co

7. DDH 366 Location : 4937.8 north, 4891.7 east, 184.6 m asl.
 Attitude : Drilled at 72.5° to N321.8° (fig 23)
 Total depth: 90.65 m (ca 88 m vertical depth)
 Purpose : To obtain a deeper intersection of the mineralization located in 364.

The hole passes through the main carbonate formation and stops within it. The mineralized zone was entered at 63.22 m and again the hole was stopped still in mineralization.
 An interval at 43.06-46.00 m (2.94 m) gave very low Cu-As values (0.026% Cu, 0.31% As).

Height
ASL
(m)



Map sheet(s): 11F LINDEBERG S.W.	Author C.J. Carlon
Scale: 1 : 2 000	Drawn by: gjc / JG
LKAB Prospektering Håksberg S-771 00 Ludvika Sweden	Date: Jan 86 Project: 3822 Report: B86-7 Fig.: 23

The main interval from 63.28 to the bottom of the hole at 90.65 m was continuously sampled for Fe, S, Cu, Co, Ni, Bi, Zn, Pb, Mo, As and Sb and as in hole DDH 364 Co, Ni, Bi, Zn, Pb, Mo, and Sb showed little or no variation. As values were in the range 0.29%-0.45%, Cu in the range 0.026-1.48%.

Main intersections:

71.44-81.40 m: 9.96 m of 0.25% Cu, 0.03% Co, 0.34% As including
78.75-81.40 m: 2.65 m of 0.58% Cu, 0.085% Co, 0.36% As which included 0.65 m of 1.48% Cu, 0.45% As

8. DDH 372 Location : 4857.5 north, 4969.8 east, 189.3 m asl
Attitude : Drilled at 70° to N315° (fig 23)
Total depth: 286.30 m (ca 270 m vertical depth)
Purpose : To obtain a section through the depth extension of the zone penetrated in holes DDH 364 and DDH 366

Only the main carbonate formation was drilled. Mineralization was seen from 108.90 m, the main disseminations occurring from 194.40 m to the bottom of the hole at 286.30 m.

The interval 17.88-21.00 metres, being an apparently 'clean' marble was analysed for major elements, indicating a dolomite composition (31.70% CaO, 18.90% MgO, 1.20% SiO₂).

The main mineralised sections:-

108.90-111.10 m: 2.2 m of up to 0.09% Cu
137.00-140.00 m: 3 m of trace copper
198.27-209.43 m: 11.16 m of up to 0.23 % Cu
211.90-214.85 m: 2.95 m of up to 0.23% Cu including 0.75 m of 0.5% As, 0.16% Cu
220.78-241.54 m: 20.76 m of 0.41% Cu including 0.66 m of 2.22% Cu, 0.28% As
252.54-257.80 m: 5.26 m of 0.078% Cu including 1.18 m of 0.2% Cu and 0.04% Sb
262.85-263.17 m: 0.32 m of 0.18% Cu
178.20-278.40 m: 0.20 m of 0.38% Cu

The interval 234.50-237.49 m contained 2.99 m of 1.31 % Cu.

9. DDH 377 Location : 4787.5 north, 5189.5 east, 212.0 m asl
Attitude : Drilled at 70° to N293.30. The hole deviated drastically.
Total depth: 631.15 m (ca 566 m vertical depth)
Purpose : To intersect a deeper continuation of the zone penetrated in holes DDH 364, 366, 372.

This deep hole was set out to N293.30°, it actual deviated N.310° being 60 metres NNE of its planned position at TD. The hole passes through the target carbonates to 605.40 m before passing down into the stratigraphically overlying metavolcanics and calc-silicates. The hole was drilled from a position on the southern flank of the F₂ fold NE-E of Håkansboda.

DDH 377 was collared near the base of the main carbonate, and appears to have passed into stratigraphically older rocks between 140-180 m before re-entering the main carbonate. The older rocks of the hangingwall are garnet-sillimanite (fibrolite) gneisses.

Sporadic mineralization was noted from 238.25, the main intersections occurring between 448.00-495.00 m. In all cases the mineralization occurs below the 199 m level and was never followed up.

Cu analyses were performed on the intervals:-

238.25-238.53
342.55-346.50
366.90-368.40
385.58-386.00
448.25-486.40
495.95-504.80
510.00-510.80

Only the intersection 476.50-480.55 was analyzed for Cu, As, Co, Sb.

Main intersections:

342.55-344.00: 1.45 m of 1.13 % Cu
366.90-368.40: 1.50 m of 0.49 % Cu
385.38-386.00: 0.62 m of 0.47 % Cu
451.20-462.76: 11.56 m of 0.26 % Cu
 including: 0.99 m of 0.67 % Cu
464.55-473.50: 8.95 m of 0.33 % Cu
 including: 2.83 m of 0.53 % Cu
476.50-484.45: 7.95 m of 0.93 % Cu
 including: 2.89 m of 1.95 % Cu, 0.88% As, 0.72% Co,
 0.05% Sb
this interval
also included: 1.64 m of 2.30 % Cu, 0.74% As, 1.20% Co,
 0.04% Sb.
590.85-591.65: 0.80 m of 0.55 % Cu

Holes DDH 364, 366, 372 and 377 are shown in fig 23. They indicate a 40 metre wide zone of mineralization to the south of the main ore shoots, within which are narrower, higher grade intervals. Holes DDH 364 and DDH 366 do not penetrate a full thickness of the mineralization. Hole DDH 372 contains weak mineralization below the main intersection. All four holes intersect narrow, weakly mineralized zones above the main target.

10. DDH 363 Location : 4993.8 north, 4902 east, 185.10 m asl.
Attitude : Drilled at 60° to N308.7° (fig 24)
Total depth: 135.50 m (ca 118 m vertical depth)
Purpose : To intersect the mineralized zone at depth in the Sörgruvan area.

The hole drilled the main carbonate formation, as opicalcitic and dolomitic marbles. The main mineralized intersection was located between 42.60-54.20 m downhole in opicalcite and diopside calc-silicates.

A thin calc-silicate layer at 64.00-64.45 was also mineralized and contained visible cobaltite.

All intersections were analysed for Cu, Co, Pb, Zn, Sb, Bi, As and Ag.

No gold analyses were made.

Main intersections:-

47.17-47.70 m: 0.53 m with 0.85% Cu, 0.02% Co, 0.04% Bi,
0.37% As, 0.07% Sb
49.09-49.53 m: 0.44 m with 0.92% Cu, 0.05% Co, 0.09% Sb,
0.11% Bi, 0.8% As and 20 g/t Ag
52.07-69.50 m: 17.43 m with 0.91% Cu (see below)
93.29-94.27 m: 0.98 m with 1.3 % Cu

Within the interval 52.07-69.50 m were:

53.34-54.22 m: 0.88 m with 2.61% Cu, 0.02% Co, 0.05% Pb
0.01% Zn, 0.07% Sb, 0.07% Bi
0.34% As, 16 g/t Ag
59.66-65.54 m: 5.88 m with 1.05% Cu
including 1.54 m with 2.83% Cu
and 0.45 m with 4.00% Cu, 0.22% Co, 2.1% As

Minor intervals were:

49.09-49.53 m: 0.44 m with 0.11% Bi
53.34-53.55 m: 0.23 m with 0.16% Bi, 1.7% Cu
59.66-59.85 m: 0.19 m with 0.13% Bi, 3.5% Cu

11. DDH 370 Location : 4932.1 north, 5000.9 east, 197.6 m asl
Attitude : Drilled at 70° to N.309.1° (fig 24)
Total depth: 280.55 m (ca 264 m vertical depth)
Purpose : To test the vertical (depth) extension
of the intersection in hole DDH 363

Hole DDH 370 was collared into sillimanite-cordierite schists and granoblastic rocks stratigraphically below the main carbonate formation. The main carbonate was entered at 24.00 metres, and drilled to the bottom of the hole.

Sporadic chalcopyrite, arsenopyrite and 'grey-coppers' were intersected from 54.12 m i.e. from near the base of the carbonate, and above a zone of rock alteration. These were not analysed, and neither were disseminated sulphides at 86.50, 99.00-102.00, 107, 110, 133, 143-147, 155, 167-173 and 188 metres downhole.

The main mineralization occurs between 203.68-254.25. It was continuously sampled between 213.00-249.20 and 249.25-268.00 and 272.00-280.55 was also sampled.

Mineralization was noted as chalcopyrite, arsenopyrite, cobaltite and pyrite.

Main intersections were:-

216.00-249.20 m: 33.20 m of 0.66% Cu

included in this intersection are:-

220.00-236.20 m: 16.20 m of 1.13% Cu
 224.50-226.40 m: 1.90 m of 3.4% Cu
 233.20-236.20 m: 3.00 m of 2.56% Cu, 0.04% Co
 235.55-236.20 m: 0.65 m of 7.20% Cu, 0.11% Co, 0.06% Ni
 249.25-255.80 m: 6.55 m of 0.69% Cu
 including
 253.35-255.80 m: 2.45 m of 1.1 % Cu, 0.03% Co

This intersection lies at the southern end of Varpgruvan ore shoot, and subsequently explored underground in the 199 m level. It indicates that the mineralized zone is continuous for at least 150 metres SSW, and a further 20 m below the blocked out area calculated by Månsson (1982) (see section 8.1).

12. DDH 374 Location : 4835.2 north, 5194.9 east, 213.2 m asl.
 Attitude : Drilled at 81° to N.291.6° (hole deviates)
 Total depth: 703.45 m (ca 692 m vertical depth)
 Purpose : To obtain a deep intersection of the mineralized zone in the area of the Commerce-Varp-Märr ore-shoots.

This was the deepest hole drilled in the 1974-1977 programme. It deviated, arcing to the south, but eventually finished only 15 m north of its planned position (fig 24).

The hole penetrated 295 metres of strata under the main carbonate. Thin ophicalcitic marbles, diopside-calc-silicate layers, siliceous 'meta-tuffites', sillimanite (fibrolite)-cordierite gneiss, rhyolitic meta-tuffs and micaceous metasediments.

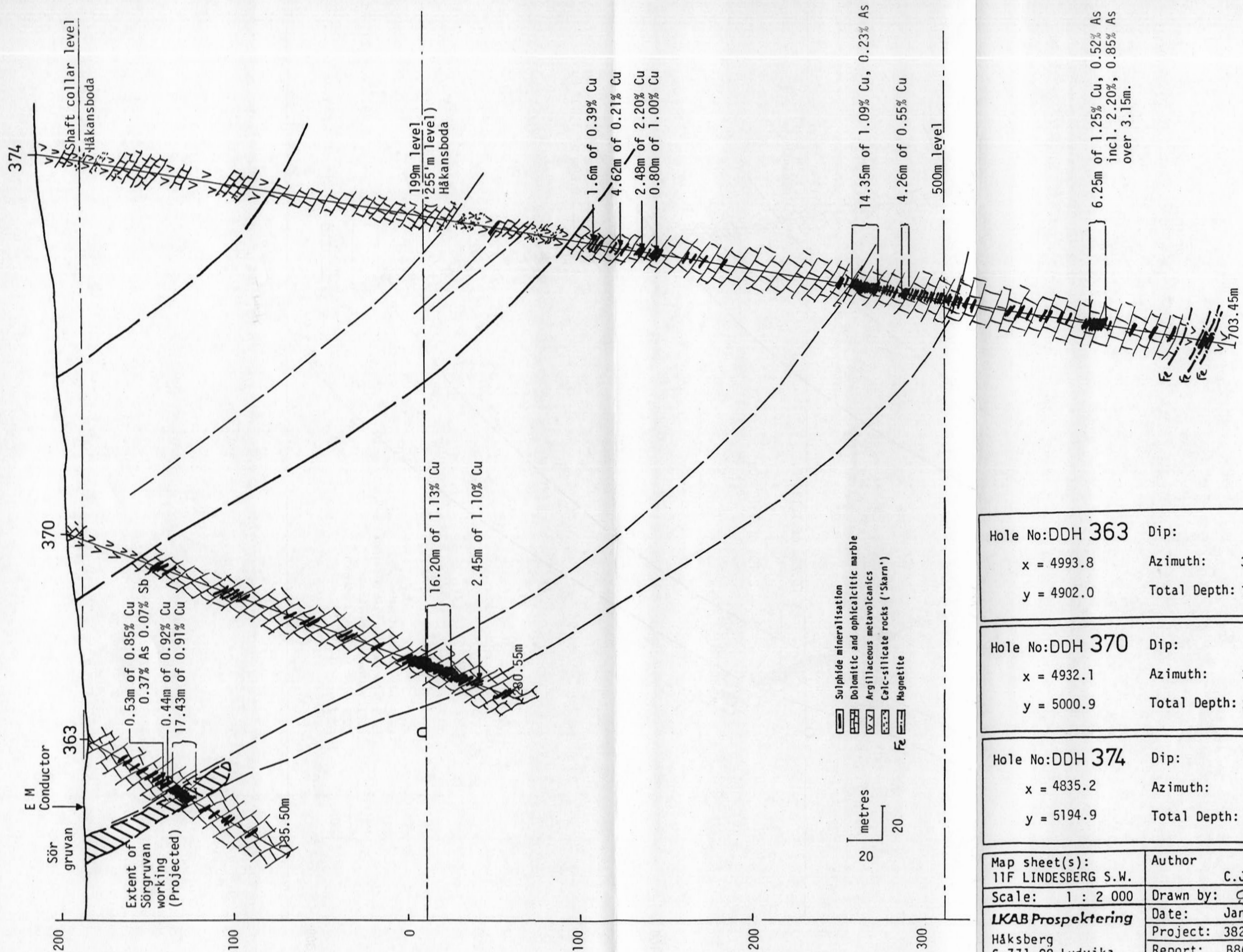
A full thickness of the main carbonate was intersected between 295.00-676.70 metres, indicating a 'true' thickness of ca 250 metres.

From 676.70-703.45 m at the bottom of the hole, calc-cilicates, metatuffites and magnetite laminae with minor sulphides occurring in the structural footwall were intersected.

Several zones of mineralization were intersected, all of them below the 199 m level, and none of these intersections were ever followed-up.

Mineralization was noted at:-

324.32-348.22 m: 23.90 m with chalcopyrite and pyrite
 354.24-369.90 m: 15.66 m with chalcopyrite, pyrite and occasional arsenopyrite, cobaltite, and molybdenite
 383.85-409.48 m: 25.63 m with disseminated chalcopyrite and pyrite
 470.20-556.00 m: 85.80 m the main intersection with chalcopyrite, pyrite, magnetite and arsenopyrite
 602.25-631.85 m: 29.60 m with chalcopyrite-arsenopyrite and pyrite
 686.00-693.20 m: 7.20 m magnetite with trace galena-sphalerite



Hole No: DDH 363 Dip: 60°
 x = 4993.8 Azimuth: 309°
 y = 4902.0 Total Depth: 135.50m

Hole No: DDH 370 Dip: 70°
 x = 4932.1 Azimuth: 309°
 y = 5000.9 Total Depth: 280.55m

Hole No: DDH 374 Dip: 80.85°
 x = 4835.2 Azimuth: 290°
 y = 5194.9 Total Depth: 703.45m

Map sheet(s): 11F LINDESBERG S.W.	Author C.J. Carlon
Scale: 1 : 2 000	Drawn by: <i>CK</i> / JG
LKAB Prospektering	Date: Jan 86
Hälsberg	Project: 3822
S-771 00 Ludvika	Report: B86-7
Sweden	Fig.: 24

All the mineralization in the main carbonate was analysed for Cu, Co, As and S; the magnetite-sulphide was analysed for Fe, Mn, P, Ba, S, Cu, Zn and Pb but not Ag.

Mineralized intervals:-

324.32-325.92 m:	1.6 m of 0.39% Cu, 0.07% Co
343.60-348.22 m:	4.62 m of 0.21% Cu
	including 0.45 m of 1.5 % Cu
354.93-357.41 m:	2.48 m of 2.2 % Cu, 0.09% Co, trace As
363.25-364.05 m:	0.80 m of 1.0 % Cu, trace Co, As

Mineralization around the main intersection indicated a rather wide zone of low grade mineralization.

The zone from 470.20 to 600.00, (129.80 metres) grades over 0.1% Cu. Within this ore:-

470.20-536.00 m:	65.80 m of 0.47% Cu
478.60-534.40 m:	55.80 m of 0.53% Cu
478.60-492.95 m:	14.35 m of 1.09 % Cu, 0.235% As, 0.04% Co
480.30-483.70 m:	3.40 m of 1.1 % Cu, 0.31% As and 0.02% Co
483.70-492.95 m:	9.25 m of 1.1 % Cu
488.60-492.95 m:	4.35 m of 1.54% Cu, 0.24% As and 0.065% Cu

Also the interval 478.60-502.66: 24.06 m contains 0.34% As and the interval 492.95-502.66: 9.71 m with 0.51 % As
This zone was not tested for Au.

Lower down the core were other intervals at:-

506.30-510.56 m:	4.26 m of 0.55% Cu
	including : 0.70 m of 1.50% Cu
615.30-621.55 m:	6.25 m of 1.26% Cu, 0.08% Co, 0.52% As
	including : 3.15 m of 2.20% Cu, 0.13% Co, 0.85% As

Again none of these intervals were analysed for gold and none were followed-up.

The magnetite-sulphide zone at 686.00-691.57 contained negligible Pb-Zn and was not analysed for Ag.

13. DDH 365 Location : 5029.4 north, 4928.9 east, 186.35 m asl
 Attitude : Drilled at 60° to N 312.75° (fig 25)
 Total depth: 98.67 m (ca 86 m vertical depth)
 Purpose : Down-dip continuation of the central ore-shoots

Hole DDH 365 was drilled entirely within the main carbonate formation, in the ophiolitic marbles, dolomitic marbles and diopside-amphibole calc-silicates.

Traces of chalcopyrite and minor magnetite-pyrite were noted, but the main intersection occurs between 77.05 to the bottom of the hole at 98.67 m. Again it appears that the full width of mineralization was not drilled. However, the mineralization intersected was peripheral to the main ore shoots and grades were low.

Intersections were:-

45.40-45.85 m: 0.45 m of 0.22% Cu, 0.05% Co
 77.05-91.00 m: 13.95 m of 0.25% Cu
 including 2.03 m of 0.60% Cu
 and 0.27 m of 0.91% Cu
 91.40-98.67 m: 7.27 m of 0.18% Cu

14. DDH 362 Location : 4954.9 north, 4988.3 east, 196.2 m asl.
 Attitude : Drilled at 70° to N 325.50° (fig 25)
 Total depth: 383.90m (ca 360 m vertical depth)
 Purpose : To intersect the mineralized zone at depth

The hole was collared into 23.17 metres of cordierite-biotite gneiss, amphibole-garnet calc-silicate and metavolcanics in the units stratigraphically below the main carbonate. The opicalcitic marbles and dolomitic marbles were then intersected to the bottom of the hole.

Due to the pitch of the ore shoots, the intersection in DDH 362, passes closer into the central ore-shoot than DDH 365.

Traces of mineralization were intersected at various depths in the hole, chiefly as chalcopryite with occasional galena, cobaltite and arsenopyrite. Disseminated chalcopryite occurs from 189.50 to 208.73, and chalcopryite, with cobaltite and arsenopyrite forms the main intersection from 208.73-247.54.

Mineralization was located at:-

16.90- 16.98 m: 0.08 m chalcopryite
 40.00- 54.00 m: 14.00 m chalcopryite, galena in opicalcite-dolomite
 105.00-106.00 m: 1.00 m chalcopryite in opicalcite
 137.00-145.00 m: 8.00 m chalcopryite
 180.40-180.60 m: 0.20 m chalcopryite, pyrite
 189.50-208.73 m: 19.23 m chalcopryite
 208.73-247.54 m: 38.81 m chalcopryite, cobaltite, arsenopyrite
 traces of mineralization also occurs below these depths.

All the samples taken were analysed for Cu, Zn, Pb, Co, Ni, Bi, Sb, Ag, Fe, S, As, W, and Mo. In addition the interval 217.10-219.50 (2.40 metres) was analysed for Hg, Se and Au.

Main intersections were:-

40.00-54.00 m: 14.00 m with 0.11% Cu, 0.16% Pb, 0.02% Co, 0.04% Bi, 0.30% Sb and 0.46% As
 No smaller interval samples were taken so no data is available for narrower sections.
 105.30-106.35 m: 1.05 m with 0.09% Cu, 0.17% Pb, 0.02% Co, 0.04% Bi, 0.30% Sb, and 0.46% As.
 217.97-229.60 m: 11.63 m with 3.07% Cu, 0.8% As, 0.51% Sb, and 0.06% Bi
 including:
 217.97-219.50 m: 1.53 m with 14.33% Cu, 5.52% As, 0.29% Zn, 1.70% Sb, 0.17% Co, 0.10% Bi, 1399 g/t Ag

218.28-219.00 m: 0.72 m with 21.1% Cu, 0.26% Co, 2.3% Sb
 217.10-219.50 m: 2.40 m with 1.6 g/t Au, 9.5 ppm Hg and
 1.7 ppm Se.

The wide zone around this rich mineralization was:-

212.50-238.30 m: 25.80 m with 1.54% Cu

This rather spectacular intersection was produced by the hole passing into the main ore shoot in the Varp-Märr zone at the position later investigated by the 199 m level in the central zone.

15. DDH 376 Location : 4881.6 north, 5209 east, 216.5 m asl.
 Attitude : Drilled at 60° to N 292.30°. Hole deviates.
 Total depth: 597.06 m (ca 504 m vertical depth).
 Purpose : A deep hole to test the main ore shoots
 in the central zone to depth.

Deviation of the hole carried it 25 m south of its proposed position at 597.06 m. However, mineralization within or immediately adjacent to the depth continuation of the 'ore-shoots' was intersected. The hole passed through 147.70 metres of diopside and amphibole calc-silicate and mafic rocks ('skarns'), ophicalcitic marble with some minor magnetite, cordierite-sillimanite gneiss and fine grained granoblastic metatuffites.

A full width of the main ophicalcitic and dolomitic carbonate formation was penetrated from 147.70 to 559.30 m. Below this, the stratigraphically younger metavolcanics and metasediments were intersected to the bottom of the hole. Phlogopite-diopside calc-silicate layers, garnetiferous calc-silicates and sillimanite-cordierite-garnet gneiss occur in this structurally lower series.

Traces of chalcopyrite mineralization were noted at 208, 213, 232, 246, 284-287 m downhole. Disseminations become more significant below 290 m, at 294-297.42, 302.30-306.38, 306.62-308.50, 309, 316, 321.70-326.94.

The main intersection occurs between 348.50-357.15, and from 376.60-405.00 m.

Mineralization continues downhole at 410.00-425.45, 435-440, 443, 446, 448.15, 449.00-452.85, 458, 470.50, 475, 479 to 485, 505, 508, 510, 521.00-522.25, 529 and 556 metres.

All intervals sampled were analyses only for Cu, Fe and S. There is no other element data, and as all main intersections occur below the 199 m level, they were never followed-up by underground exploration.

Main interval results were:-

351.10-351.70 m: 0.60 m of 1.1% Cu
 356.35-357.15 m: 0.80 m of 0.87% Cu
 387.00-400.15 m: 13.15 m of 1.40% Cu

including:

393.80-400.15 m: 6.35 m of 2.45% Cu
 393.80-397.00 m: 3.20 m of 3.60% Cu
 412.50-413.50 m: 1.00 m of 3.10% Cu

Hole DDH 365, 362 and 376 are shown in fig 25. In comparing the above data with fig 25 the following points should be noted:

1. The intersection in DDH 365 lies within the main plunging central ore-shoots, but in a lower grade upper portion
2. The intersection in DDH 362 lies within the plunging central ore-shoots
3. The intersection in DDH 376 lies close to, but probably below and to the north of the plunging shoots (see fig 35)
4. Plunge on fig 25 passes through the section, high up behind the section, plunging downwards through and in front of the section

The concept of plunging ore shoots must be kept in mind when considering the figs 18-33. In all these sections the ore-shoots dip from left (W) to right (E) and plunge from behind (north) to in front (south) of the section (see also fig 35).

16. DDH 371 Location : 5066.4 north, 5046.2 east, 200.3 m asl.
 Attitude : Drilled at 70° to N 281.34° (fig 26)
 Total depth: 276.00 m (ca 260 m vertical depth)
 Purpose : Depth intersection in the central ore-shoots (Commerce).

Drilled to intersect the Commerce 'ore-shoot', the hole passed through the central ore-shoots around 200 m below surface, where they were later explored and drilled from the 199 m exploration level.

Fig 26 also shows the intersections in hole DDH 445, subsequently drilled in the 1978-81 underground exploration programme.

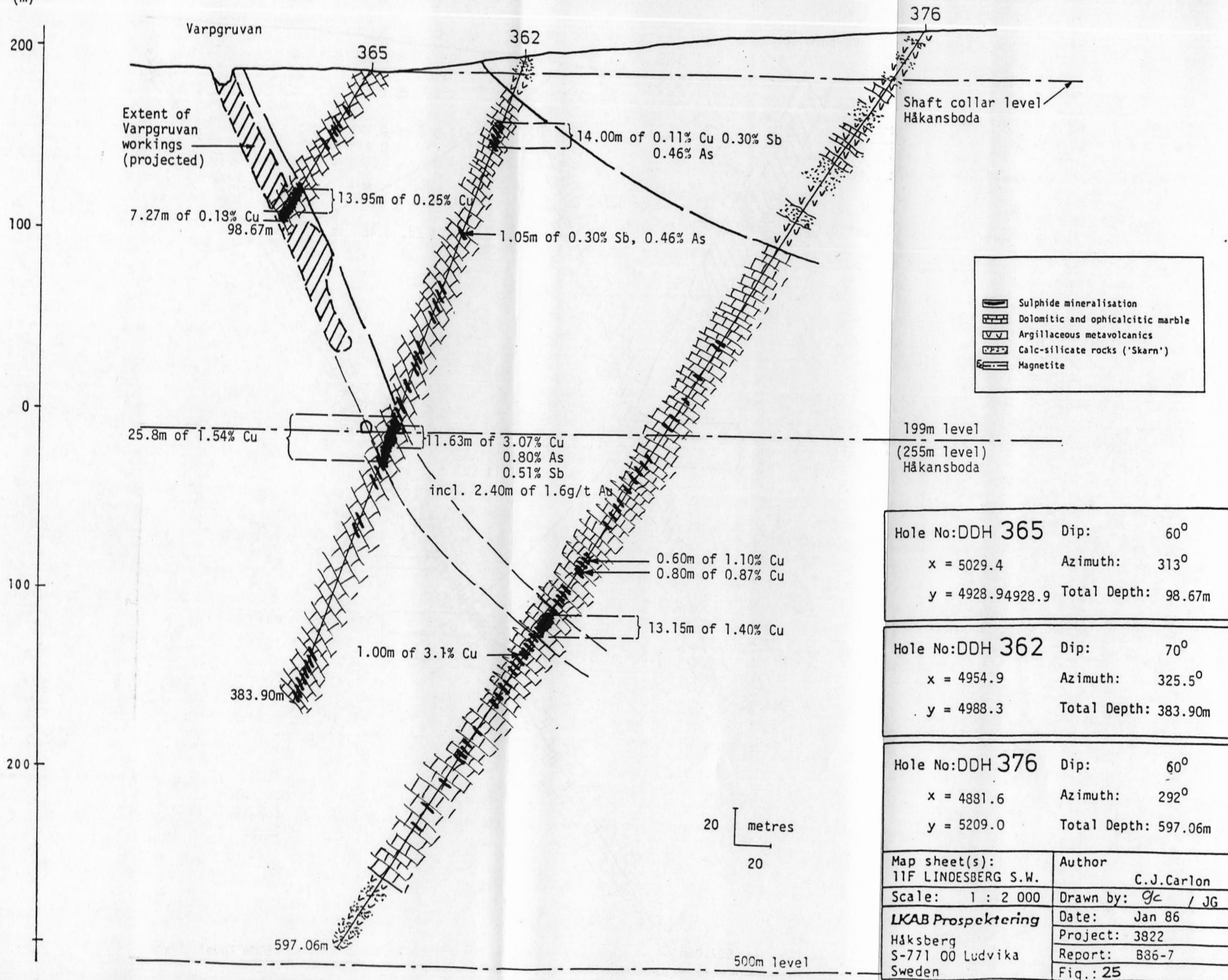
Down to around 100 m the hole penetrated older metavolcanics-metasediments in the hangingwall, continuing in dolomitic and ophi-calcitic marbles. Much mineralization was intersected, the main interval being from 171.10 m to the bottom of the hole at 276.00 m. A full intersection was therefore not drilled.

Most analyses were only for Cu, and the main intersections showed:-

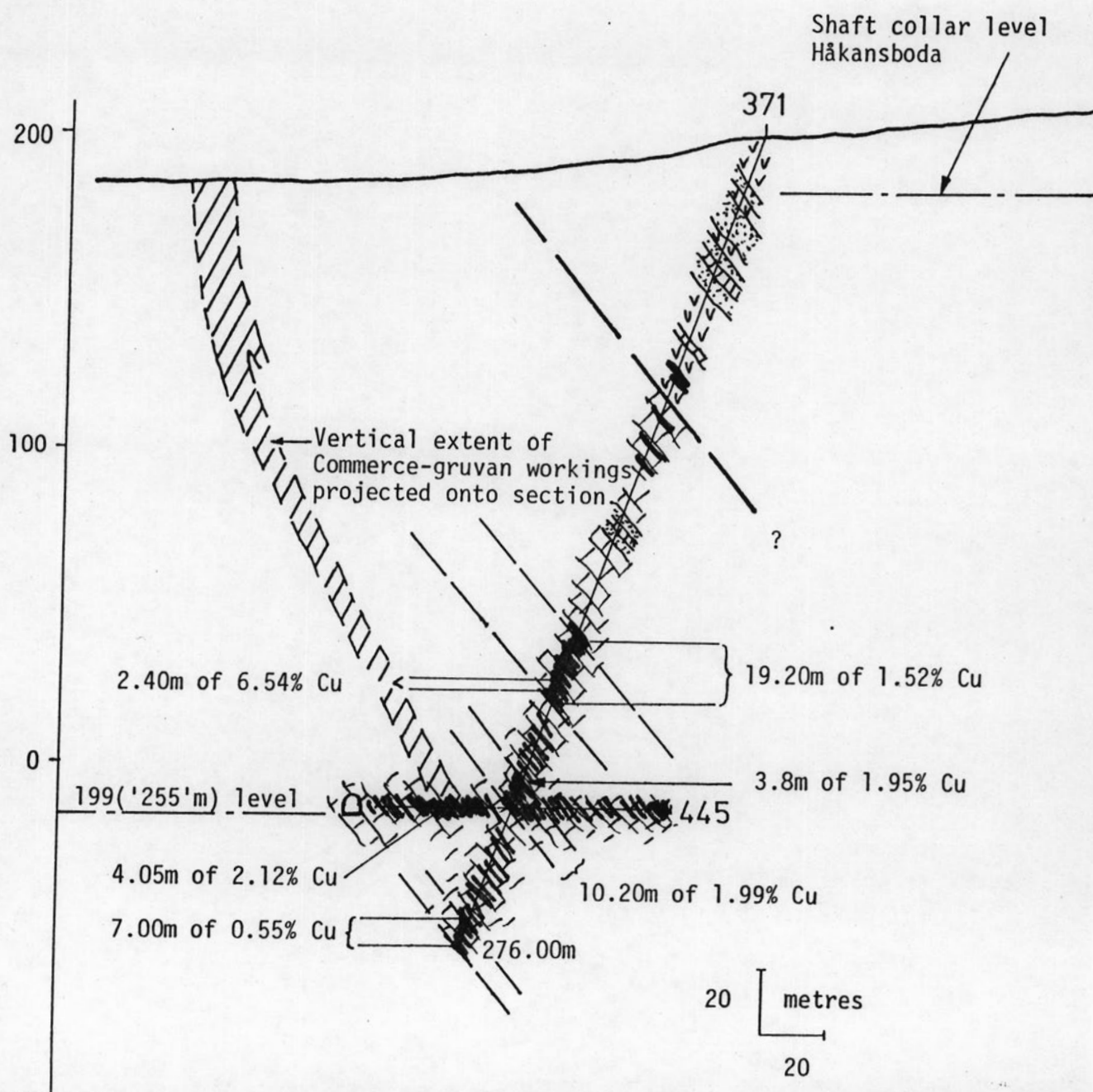
171.00-190.20 m: 19.20 m of 1.52% Cu
 including
 183.35-185.75 m: 2.40 m of 6.54% Cu
 219.00-222.85 m: 3.85 m of 1.95% Cu
 including
 219.-0-221.78 m: 2.78 m of 2.38% Cu, 0.07% Co. 1.13% As
 220.50-221.25 m: 0.75 m of 3.60% Cu, 0.29% Co. 2.40% As
 267.00-274.00 m: 7.00 m of 0.55% Cu
 including
 272.00-273.00 m: 1.00 m of 1.30% Cu

The interval 212.00-233.95 m, was 21.95 m of 0.64% Cu.

Height
ASL
(m)



Height
ASL
(m)



Hole No: DDH 445 Dip: Horizontal
x = 5085.7 Azimuth: 95°
y = 4920.2 Total Length: 97.00m

Hole No: DDH 371 Dip: 70°
x = 5066.4 Azimuth: 281.3°
y = 5046.2 Total Depth: 276.00m

- Sulphide mineralisation
- Dolomitic and ophicalcitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

Map sheet
11F LINDESBERG S.W.

Scale: 1 : 2 000

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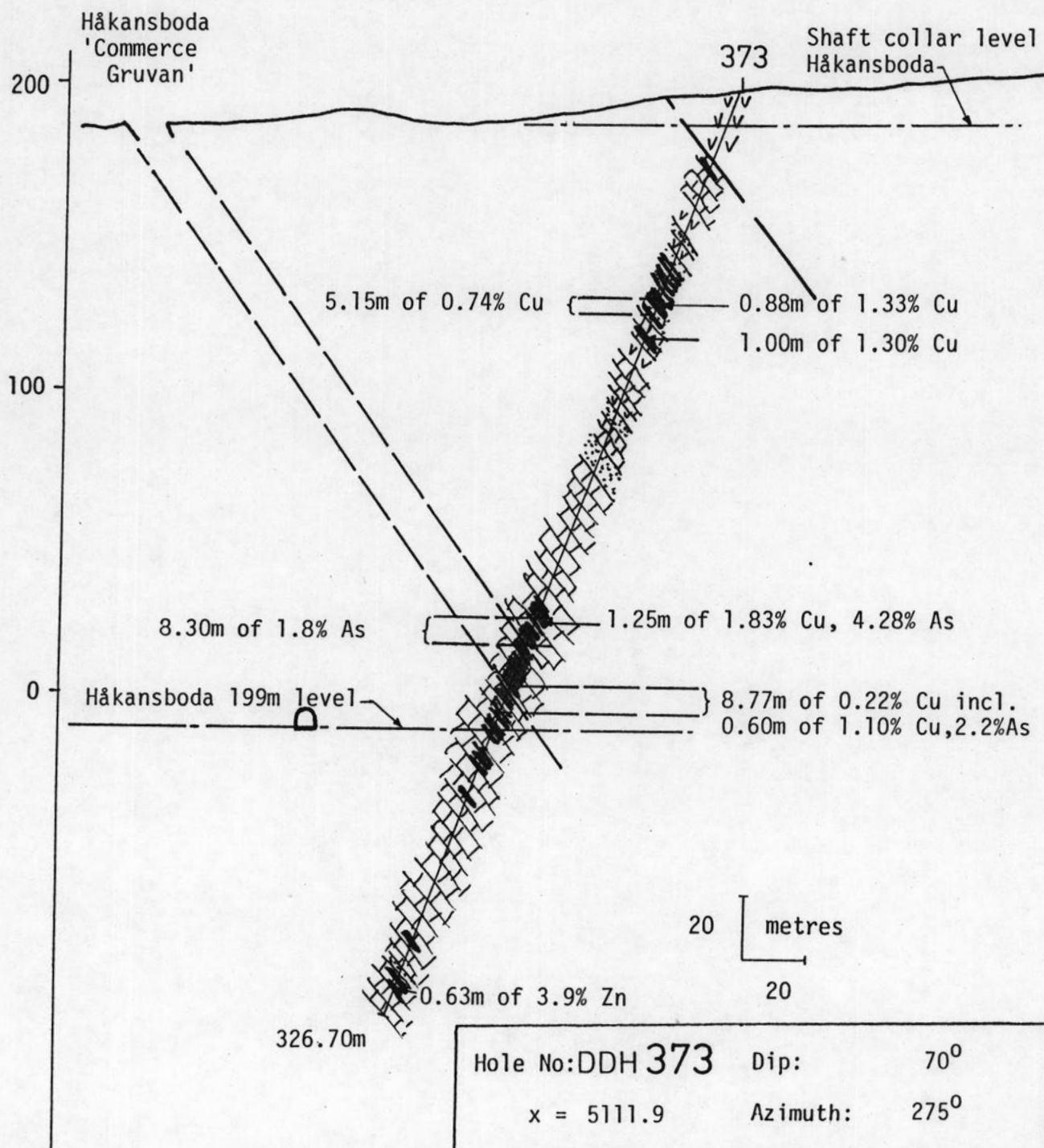
Date: Jan 86

Project: 3822

Report: B86-7

Fig.: 26

Height
ASL
(m)



Hole No: DDH 373

Dip: 70°

x = 5111.9

Azimuth: 275°

y = 5060.7

Total Depth: 326.70m

Map sheet
11F LINDEBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: JC / JG

LKAB Prospektering

Date: Jan 86

Håksberg
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Sweden

Project: 3822

Report: B86-7

Fig.: 27

- Sulphide mineralisation
- Dolomitic and ophicalcitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

17. DDH 373 Location : 5111.9 north, 5060.7 east, 199.5 m asl.
 Attitude : Drilled at 70° to N.275.2° (fig 27)
 Total depth: 326.70 m (ca 305 m vertical depth)
 Purpose : Intersection of central ore shoots around 200 m vertical depth.

Hole DDH 373 intersected a mixed sequence below the main carbonate. Cordierite-biotite gneiss, diopside rock, garnet-sillimanite gneiss, amphibole-diopside calc-silicate layers, opicalcitic marble, meta-tuffites and siliceous 'metavolcanics'. The base of the main carbonate is placed at 138.90 m and the hole then continued down to 326.70 m in the main target carbonate formation.

Between 62.46-79.95 fractures in the diopside calc-silicate and carbonate rocks under the main carbonate (but structurally above) are infilled with chalcopyrite, pyrrhotite and pyrite.

The main mineralization occurs in opicalcitic marbles and diopside calc-silicates between 185.00-225.40 m. This interval was subsequently investigated underground on the 199 m level.

In all analysed samples, only Cu, Co, As and S were tested and the main intervals were:

74.80- 79.95 m: 5.15 m of 0.74% Cu
 including
 76.33- 77.21 m: 0.88 m of 1.33 % Cu
 86.00- 87.00 m: 1.00 m of 1.30% Cu
 186.90-188.15 m: 1.25 m of 1.83% Cu, 4.28% As
 209.75-218.52 m: 8.77 m of 0.22% Cu
 including
 212.50-213.10 m: 0.60 m of 1.1 % Cu, 2.2% As

High arsenic values were found within the interval 185.90-193.50.

185.90-193.50 m: 8.30 m of 1.80% As
 186.90-191.50 m: 4.60 m of 2.72% As, 0.64% Cu
 186.90-189.40 m: 2.50 m of 3.74% As, 1.00% Cu

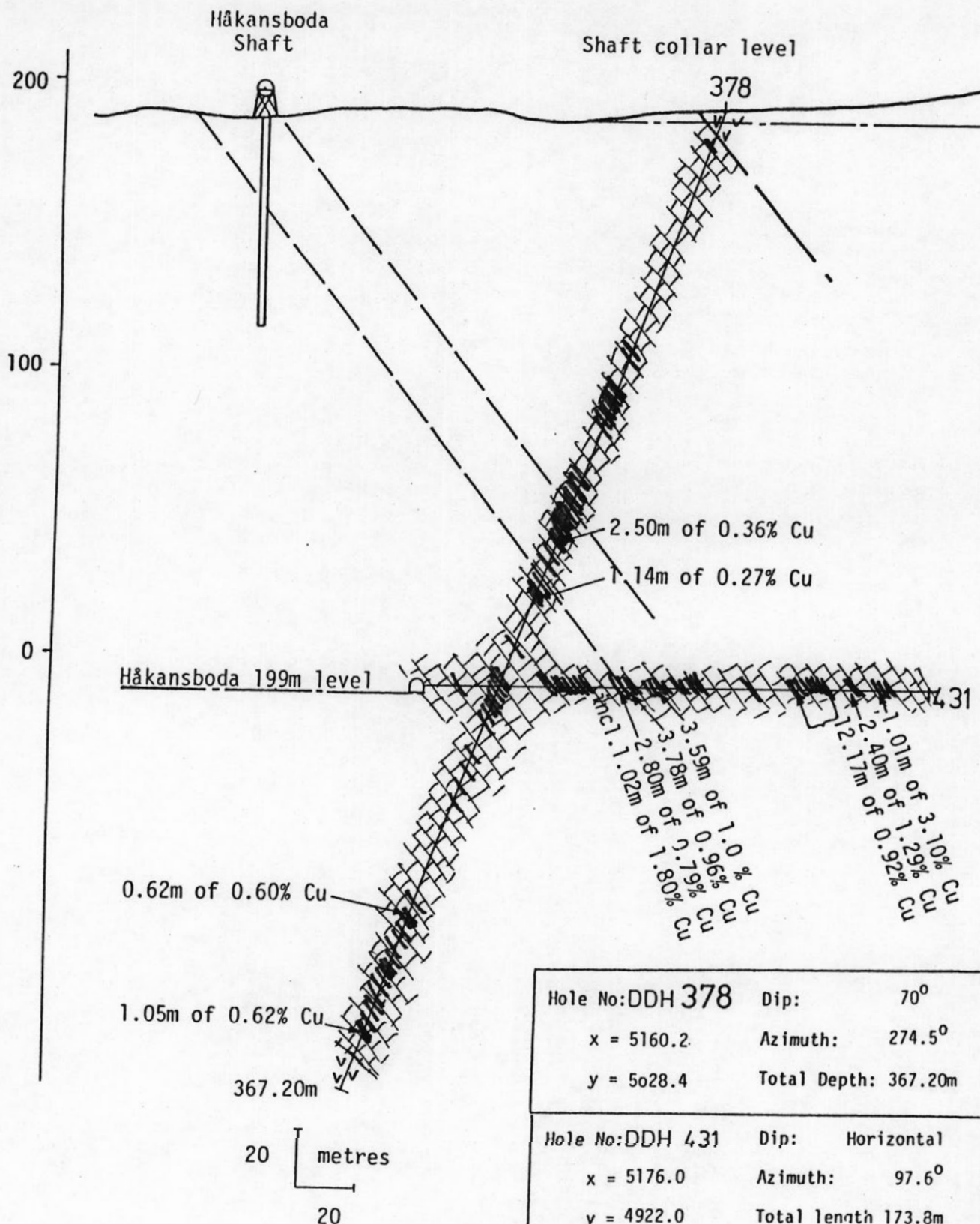
None of these intervals were analysed for Sb, Bi or Au.

18. DDH 378 Location: : 5160.2 north, 5028.4 east, 193.2 m asl.
 Attitude : Drilled at 70° to N 274.5° (fig 28)
 Total depth: 367.20 m (ca 340 m vertical depth)
 Purpose : Depth intersection in the N.Commerce and Smedgruvan shoots.

Hole DDH 378 passes through the main carbonates to 346.10 m., the last 20 m of the hole entering the overlying metasediments in the footwall. Four main zones of mineralization were intersected, three of which were identified by later underground drilling from the 199 m level in the north of the central ore zone (fig 17). DDH 431 is added to profile fig 28. for completeness.

The fourth zone, at a downhole depth of 312 m, some 90 m below the 199 m level was never followed up, and was not traced west of the exploration level of 199 m. It could well be the southern continuation of the Norrgruvan ore-shoot zone.

Height
ASL
(m)



	Sulphide mineralisation
	Dolomitic and ophicalcitic marble
	Argillaceous metavolcanics
	Calc-silicate rocks ('Skarn')
	Magnetite

Hole No: DDH 378	Dip: 70°
x = 5160.2	Azimuth: 274.5°
y = 5028.4	Total Depth: 367.20m
Hole No: DDH 431	Dip: Horizontal
x = 5176.0	Azimuth: 97.6°
y = 4922.0	Total length 173.8m
Map sheet(s): 11F LINDEBERG S.W.	Author: C.J. Carlon
Scale: 1 : 2 000	Drawn by: JC / JG
LKAB Prospektering	Date: Jan 86
Hälsberg	Project: 3822
S-771 00 Ludvika	Report: B86-7
Sweden	Fig.: 28

A large number of core lengths were analysed, but only for Cu, and in all cases, as the mineralization was peripheral to the main 'ore-shoots', was low grade:

Intersections were:-

141.27-146.05 m: 4.78 m of 0.17% Cu
 161.50-164.00 m: 2.50 m of 0.36% Cu
 183.00-184.14 m: 1.14 m of 0.27% Cu
 301.18-301.80 m: 0.62 m of 0.60% Cu
 343.20-344.25 m: 1.05 m of 0.62% Cu

The continuation of these zones was found in DDH 431, where grades were higher (fig 28).

19. DDH 375 Location : 5210.2 north, 5028 east, 194.9 m asl.
 Attitude : Drilled at 70° to N.293.4° (fig 29)
 Total depth: 330.30 m (ca 314 m vertical depth)
 Purpose : Northern extension to the mineralized zone towards Norrgruvan

The hole passed through the main carbonate formation with only sporadic mineralization from 90.00 m to the bottom of the hole. Of the intersections analysed, nearly all were below 0.1% Cu.

Main intersections:-

159.00-164.40 m: 5.40 m of 0.57 % Cu
 including
 162.17-163.58 m: 1.41 m of 0.85% Cu, 0.36% As

Cu, with only one or two Co, As analyses were made.

20. DDH 390 Location : 5290 north, 4970.2 east, 190.5 m asl.
 Attitude : Drilled at 50° to N 288.45 (fig 30)
 Total depth: 232.60 m (ca 178 m vertical depth)
 Purpose : To test the northern continuation of the Håkansboda mineralized zone

The hole penetrated 204.95 m of the main carbonate formation before passing into metavolcanics, garnet-amphibole-calc-silicates and cordierite gneiss in the footwall.

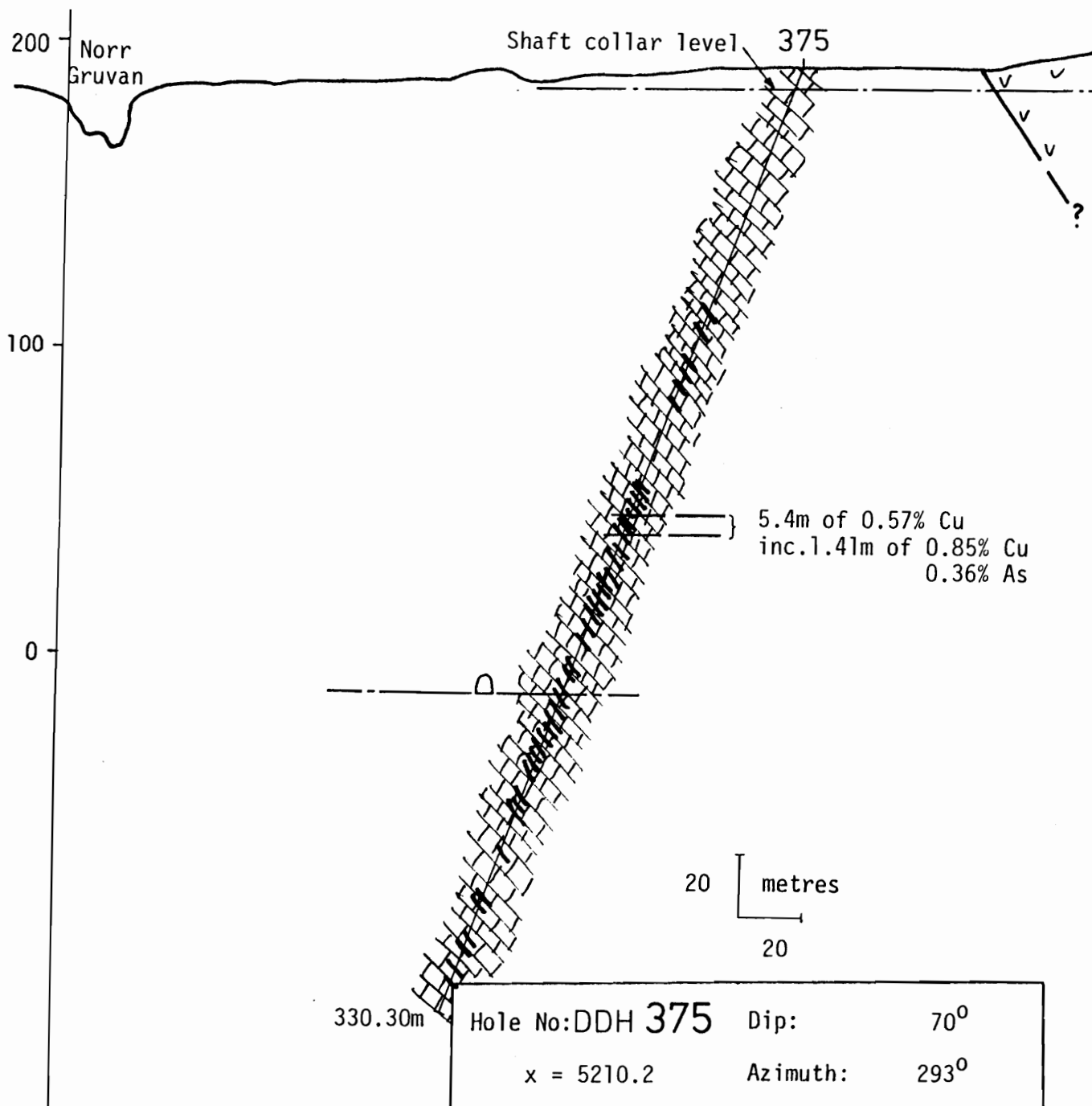
Weak mineralization was located at several positions in the core, mainly as visible pyrite-chalcopyrite.

Mineralization is observed at 14.83-25.15 m, 65.25-88.25, 89.25-90.70, 99.65-118.60, 120.00-126.00, 159.75-166.40, 194.46-204.15.

All previous analyses were for Cu, Co and As only.

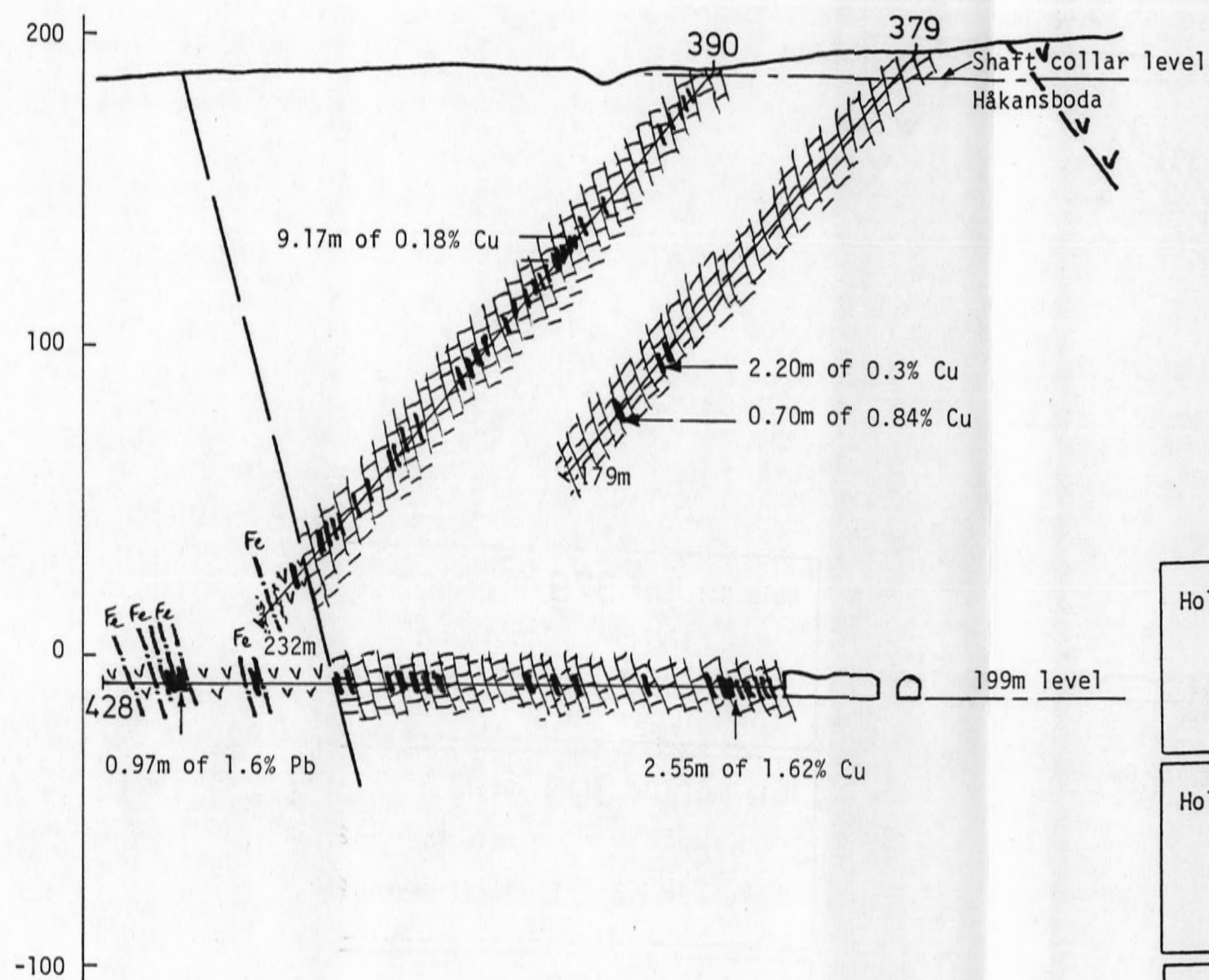
Grades were all below 0.1% Cu except: 71.90-81.07: 9.17 m of 0.18% Cu
 including: 77.55-81.07: 3.52 m of 0.29% Cu

Height
ASL
(m)



	Sulphide mineralisation
	Dolomitic and ophicalcitic marble
	Argillaceous metavolcanics
	Calc-silicate rocks ('Skarn')
	Magnetite

Hole No: DDH 375		Dip:	70°
x = 5210.2		Azimuth:	293°
y = 5028.0		Total Depth:	330.30m
Map sheet 11F LINDESBERG S.W.		Author C.J. Carlon	
Scale: 1 : 2 000		Drawn by: <i>gc</i> / JG	
LKAB Prospektering Håksberg S-771 00 Ludvika Sweden		Date: Jan 86	
		Project: 3822	
		Report: B86-7	
		Fig.: 29	



- Sulphide mineralisation
- Dolomitic and ophicalcitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

Hole No: DDH 379 Dip: 50°
 x = 5277.0 Azimuth: 284°
 y = 5036.0 Total Depth: 179.0m

Hole No: DDH 390 Dip: 50°
 x = 5290.0 Azimuth: 288°
 y = 4970.2 Total Depth: 232.6m

Hole No: DDH 428 Dip: Horizontal
 x = 5275.3 Azimuth: 274°
 y = 4991.4 Total Length: 218.70m

Map sheet(s):
 11F LINDEBERG S.W.

Author
 C.J. Carlon

Scale: 1 : 2 000

Drawn by: *gc* / JG

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Date: Jan 86

Project: 3822

Report: B86-7

Fig.: 30

21. DDH 379 Location : 5277 north, 5036 east, 197 m asl.
 Attitude : Drilled at 50° to N284° (fig 30)
 Total depth: 179 metres (ca 136 m vertical depth)
 Purpose : To test the northern continuation of the Håkansboda zone. Hole DDH 390 was subsequently drilled in the same profile.

The hole was continuously drilled in the main carbonate formation but intersected very little mineralization. All earlier analyses were for Cu only, and only two sections were analysed, 130.60-144.15, and 152.05-155.20 metres.

Results were:-

130.60-138.00 m: 7.40 m of 0.17% Cu
 including
 130.60-132.80 m: 2.20 m of 0.3 % Cu
 152.05-152.75 m: 0.70 m of 0.84% Cu

The 152.05-152.75 interval appears to correspond with the 71.90-81.07 m mineralization in hole DDH 390.

Underground hole DDH 428 was drilled in approximately the same profile (fig 30). The same mineralized zone appears to have been intersected immediately on the NW side of the 199 m level, with 2.55 m of 1.62 % Cu.

22. DDH 402 Location : 5399.5 north, 4903.5 east, 191.9 m asl.
 Attitude : Drilled at 60° to N 284.9° (fig 31)
 Total depth: 103.00 metres (ca 90 m vertical depth)
 Purpose : To test the northern continuation of the Håkansboda mineralized zone.

The hole penetrated the main carbonate formation to ca 82 metres, then the footwall metavolcanics and metasediments. Mineralization subcrops at the hole position, and was penetrated as the hole entered bedrock. Core was analysed for Cu, S and As; mineralization occurring at 2.00-14.85 m, 19.75-21.50 m, 24.87-34.20 m 73.95-74.45 m.

Intersections proved:-

3.48- 9.00 m: 5.52 m of 0.41% Cu
 including
 8.50- 9.00 m: 0.50 m of 1.90% Cu

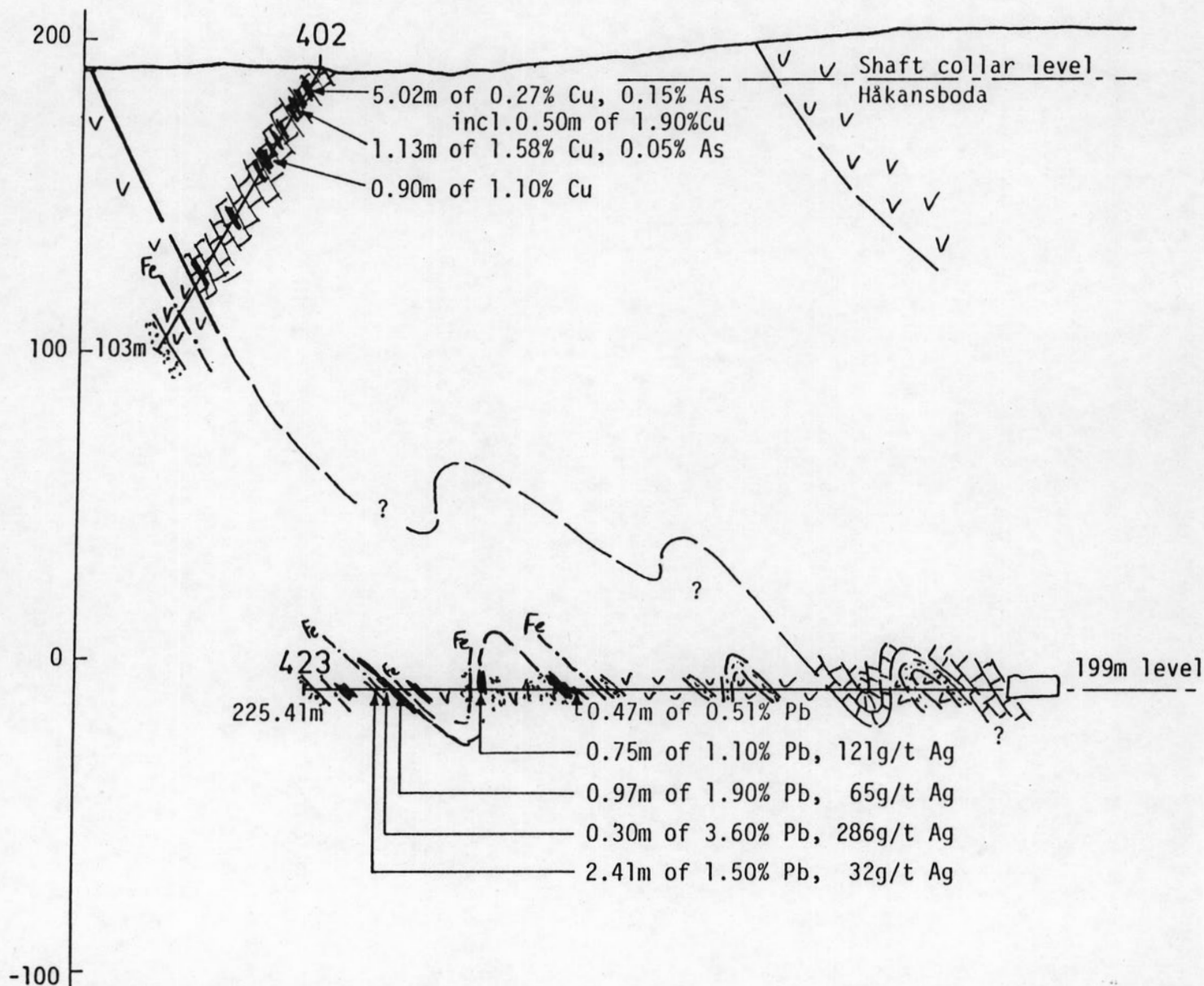
The interval 3.48-8.50 m: 5.02 m of 0.27% Cu contains also 0.15% As

9.17-14.85 m: 5.68 m of 0.48% Cu
 including
 12.22-13.35 m: 1.13 m of 1.58% Cu, 0.05% As
 31.30-32.30 m: 0.90 m of 1.1 % Cu

These intersections show that mineralization does extend beyond Norrgruvan to the N and NE over the F₂ axial zone. Generally the thickness and grade is reduced, but the intervals in DDH 402 are of interest as the full width of mineralization was not tested.

Note also (fig 31), that the hole stopped short of penetrating the Pb-As mineralization in the footwall of the Håkansboda zone. Hole DDH 423, drilled from the 199 m level did intersect this zone, apparently repeated by folding (see fig 31).

Height
ASL
(m)



Hole No: DDH 402	Dip: 60°
x = 5399.5	Azimuth: 285°
y = 4903.5	Total Depth: 103.00m

Hole No: DDH 423	Dip: Horizontal
x = 5309.0	Azimuth: 298.5°
y = 5110.0	Total Depth: 225.41m

	Sulphide mineralisation
	Dolomitic and ophiolitic marble
	Argillaceous metavolcanics
	Calc-silicate rocks ('Skarn')
	Magnetite

20 metres

Map sheet(s): 11F LINDESBERG S.W.	Author C.J. Carlon
Scale: 1 : 2 000	Drawn by: <i>CJC</i> / JG
LKAB Prospektering	Date: Jan 86
Håksberg	Project: 3822
S-771 00 Ludvika	Report: B86-7
Sweden	Fig.: 31

23. DDH 247 Location : 5512 north, 4952 east, 194.5 m asl.
 Attitude : Drilled at 40° to N 312° (fig 32)
 Total depth: 121.35 m (ca 78 metres vertical depth)
 Purpose : To test the 'skarn iron ore' at Luthgruvan

This hole, drilled in 1971, was collared into the footwall meta-volcanics and metasediment. Magnetite calc-silicate and magnetite-dolomitic and ophicalcitic marble was intersected as was a disseminated galena - Ag(?) mineralization. No analyses were made on the sulphide mineralization. The core has been obtained for sampling.

24. DDH 404 Location : 5362.8 north, 5118.2 east, 203.5 m asl.
 Attitude : Drilled at 60° to N 314.8° (fig 32)
 Total depth: 180.50 m (ca 152 m vertical depth)
 Purpose : To test the NE extension of the Håkansboda zone

The hole passed through 17.75 metres of cordierite-sillimanite (fibrolite) gneiss and fine grained siliceous 'metatuffite' stratigraphically below the main carbonate. From 17.75-157.18 metres a full thickness of the main carbonate was intersected (ca 132 m 'true' thickness). From 157.18 to 180.50 metres footwall metavolcanics and metasediment were cored.

Weak copper mineralization was intersected at 8-11 m, 17.07-17.13 m, 24.10-24.77 m, 37.85-38.08 m, and a main intersection between 105.70-109.12. Minor mineralization was seen also at 118.58-118.69 m, 121.34-121.45 and 121.82-127.41 m.

Core was analysed only for Cu and Co, with:-

24.10-24.77 m: 0.67 m of 0.11% Cu
 37.85-38.08 m: 0.23 m of 0.14% Cu
 107.77-109.12m: 1.35 m of 1.45% Cu

25. DDH 403 Location : 5433.2 north, 5186.7 east, 204.4 m asl.
 Attitude : Drilled at 60° to N322° (fig 33)
 Total depth: 170.90 m (ca 150 m vertical depth)
 Purpose : Most northerly (north-easterly) drill-section on the Håkansboda mineralized zone

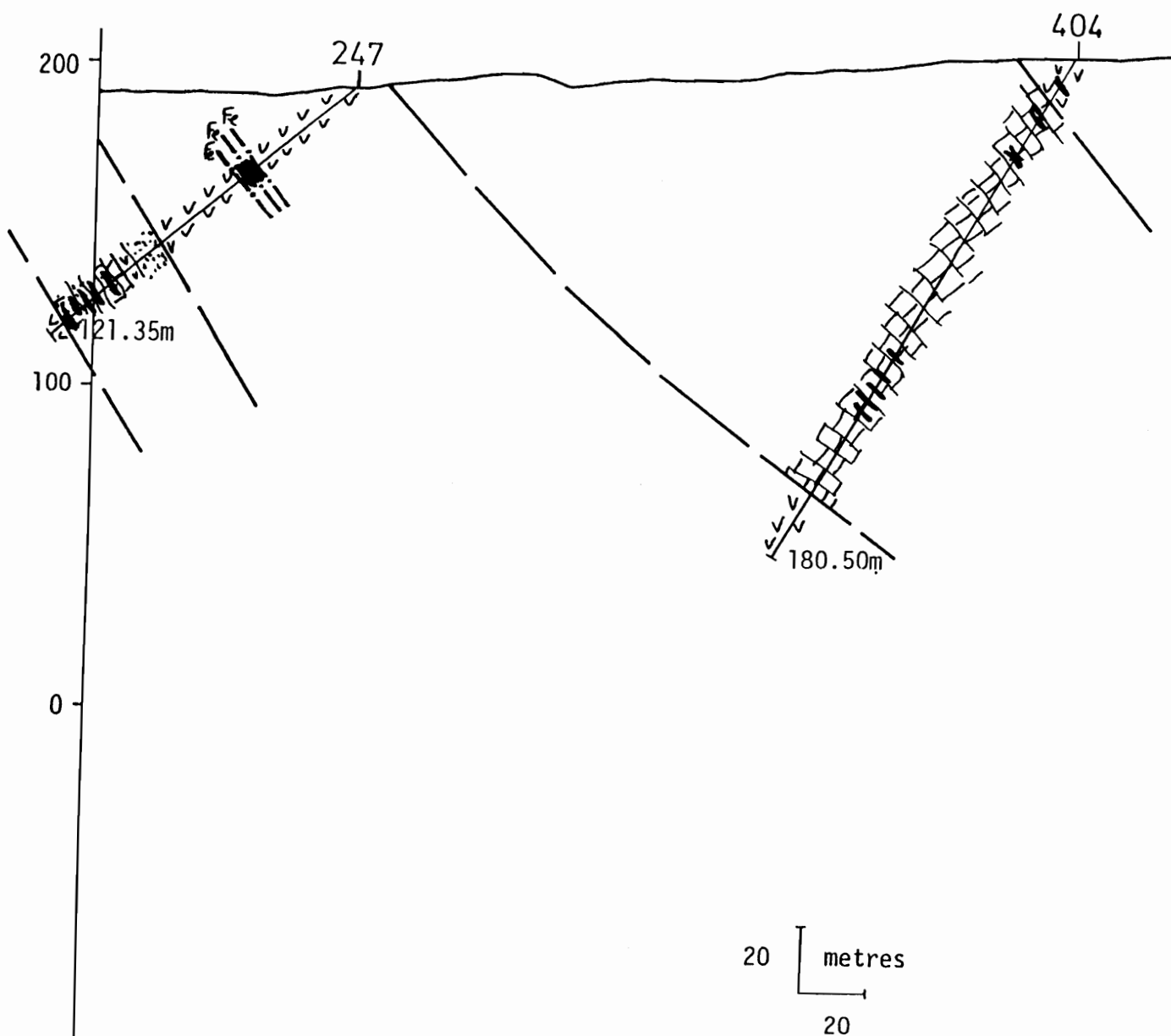
The hole penetrated the main carbonate formation to 114.70 m before entering cordierite-sillimanite gneiss in the footwall to 170.90 m.

Mineralization was intersected between 80.84-81.93, 83.87-84.03, 84.50-86.02 and sporadically between 97.50-108.57.

The only analyses were for Cu at: 84.50-86.03: 1.52 m of 0.13% Cu
 112.00-114.70: 2.70 m of 0.2% Cu

This is very weak mineralization at the northern limit of mineralization. However, higher grades were intersected below DDH 403 in DDH 422 (see fig 33).

Height
ASL
(m)



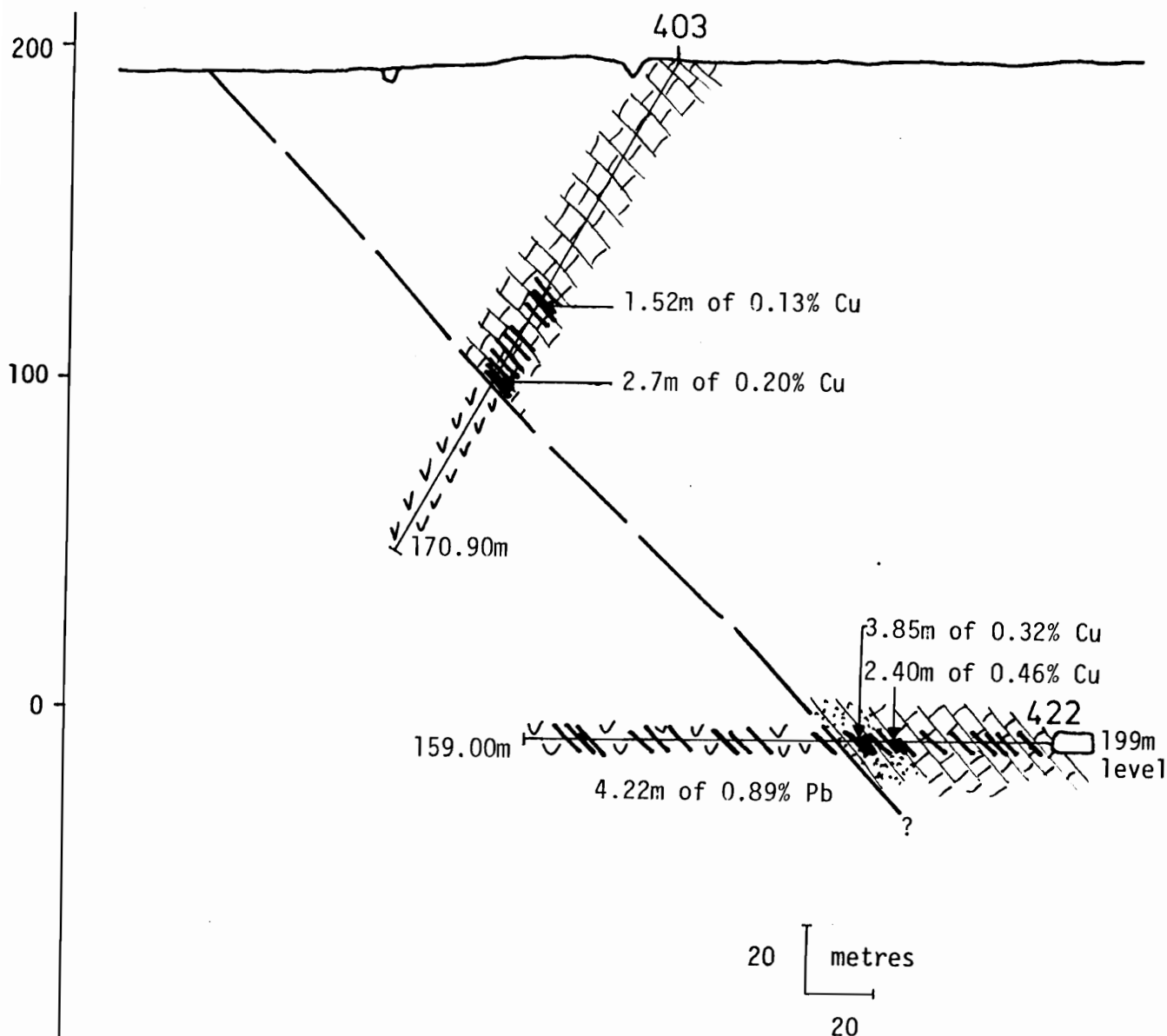
Hole No: DDH 404	Dip: 60°
x = 5362.8	Azimuth: 314.8°
y = 5118.2	Total Depth: 180.50m

Hole No: DDH 247	Dip: 40°
x = 5512.0	Azimuth: 312.00°
y = 4952.0	Total Depth: 121.35m

- Sulphide mineralisation
- Dolomitic and ophiolitic marble
- Argillaceous metavolcanics
- Calc-silicate rocks ('Skarn')
- Magnetite

Map sheet(s): 11F LINDESBERG S.W.	Author C.J. Carlon
Scale: 1 : 2 000	Drawn by: <i>gc</i> / JG
LKAB Prospektering	Date: Jan 86
Hälsberg	Project: 3822
S-771 00 Ludvika	Report: B86-7
Sweden	Fig.: 32

Height
ASL
(m)



Hole No: DDH 422 Dip: Horizontal
 x = 5344.0 Azimuth: 328°
 y = 5246.2 Total length 159.00m

Hole No: DDH 403 Dip: 60°
 x = 5433.2 Azimuth: 322°
 y = 5186.7 Total Depth: 170.90m

Sulphide mineralisation
 Dolomitic and ophicalcitic marble
 Argillaceous metavolcanics
 Calc-silicate rocks ('Skarn')
 Magnetite

Map sheet(s):
11F LINDBERG S.W.

Author
C.J. Carlon

Scale: 1 : 2 000

Drawn by: *gc* / JG

LKAB Prospektering

Date: Jan 86

Hälsberg
S-771 00 Ludvika
Sweden

Project: 3822

Report: B86-7

Fig.: 33

7.4 Underground drilling results and exploration 1978-1981 (Håkansboda)

Following surface drilling, an exploration level was driven for ca 1,400 metres from the 255 m Stråssa-Blanka level. Entering the Håkansboda area, at a depth of 199 m, the exploration level was used to investigate the 'central ore-zone' (the Varp, Mörr, Commerce and Cecilia shoots). 45 underground drillholes, amounting to ca 4,800 m of drilling, were made, chiefly in the central and northern parts of the mineralized zone. The distance underground from Stråssa to Håkansboda along the exploration level is 2.7 kms. Drillhole locations are shown in fig 17.

All the holes, with the exception of 8, were drilled either vertically up, or horizontally with the principal objective of proving ore above the 199 m level. 5 of the 8 noted above, were actually drilled downward into the 'ore-shoots' from the 71 m level.

Consequently nothing has been done to follow up the ore-shoots from 200 m to 600 m depth.

As most of the holes were close spaced and of short length into the ore-zone, holes DDH 445, 449 and 454 are taken here as representative of the central ore-zone on the 199 m level, and DDH:s 601, 602, 603 representative of the zone below the 71 m level, but above the 199 m level. Figs 26, 28, 30, 31 and 33 show other underground intersections from outside this central part.

Holes DDH 445, 449 and 454 (fig 17) were drilled horizontally to the east to intersect the main ore-shoots. Grades intersected were:-

Hole DDH 445: 13.00-30.00: 17.00m with 0.97% Cu
 inc. 22.00-26.05: 4.05m with 2.12% Cu
 47.80-58.00: 10.20m with 1.99% Cu
 inc. 51.00-54.05: 3.05m with 4.31% Cu

Hole DDH 449: 25.20-35.10: 9.90m with 2.4 % Cu
 inc. 32.00-35.10: 3.0 m with 5.42% Cu
 55.50-66.80: 11.30m with 2.08% Cu
 inc. 56.75-59.05: 2.30m with 5.30% Cu

Hole DDH 454: 6.20-15.60: 9.40m with 1.69% Cu
 inc. 14.35-15.60: 1.25m with 3.74% Cu
 16.55-22.15: 5.60m with 2.49% Cu
 inc. 18.70-19.90: 1.20m with 4.07% Cu

In none of the above holes were other element analyses made. Månsson (1982) records the results of As, Sb, Bi, Au and Ag analyses from holes 440, 444-451 and 454.

In the intervals noted above for holes 445, 449 and 454, the following can be stated for As, Sb, Bi, Au, Ag.

DDH 445: 20.65-26.05 : 5.40 m with 1.5% As, 0.03% Sb, 0.01% Bi,
0.3 g/t Au and 17 g/t Ag
47.80-54.05 : 6.25 m with 1.2% As, 0.03% Sb, 0.02% Bi,
1.1 g/t Au, 15 g/t Ag

DDH 449: 25.20-35.10 : 9.90 m with 1.4% As, 0.05% Sb, 0.02% Bi,
0.2 g/t Au, 23 g/t Ag

DDH 454: 16.55-22.15 : 5.60 m with 0.93% As, 0.31% Sb, 0.02% Bi,
0.6 g/t Au and 75 g/t Ag

In the same zone, Au analyses proved:-

DDG 450: 21.30-25.55 : 4.25 m with 0.49% As, 1 g/t Au and 119 g/t Ag

DDH 451: 51.85-55.40 : 3.55 m with 1.30% As, 0.9 g/t Au and 13 g/t Ag

'Ore' grades in-situ and tonnages for the underground drilling results are presented in section 8.1.

In addition to testing the Varp, Märr and Commerce 'ore-shoots', the final holes of the 1978-81 programme were drilled from the 71 metre level, with holes DDH 601, 602 and 603 being vertical (601) or to intersect the Cecilia 'blind' ore-host below the 71 metre level, but above the 199 m level. Some very high grades were obtained from mineralization still in situ.

Hole DDH 601 (fig 17). Vertical hole to 122.80 (drilled downwards)

5.45- 7.90 m: 2.45 m with 1.35% Cu
14.40-15.75 m: 1.35 m with 4.18% Cu
20.10-23.90 m: 3.80 m with 4.16% Cu
25.25-30.40 m: 5.15 m with 3.47% Cu

The interval 14.40-39.65: is 25.25 m with 1.91% Cu

70.10-72.40 m: 2.30 m with 3.4 % Cu

Hole DDH 602 (fig 17) was mineralized throughout. Chalcopyrite, arsenopyrite and grey-copper were noted. However, no Au analyses were done.

12.45-12.30 m: 0.27 m with 12.8% Cu
12.65-17.47 m: 4.82 m with 2.6 % Cu
21.92-28.08 m: 6.16 m with 1.62% Cu
30.50-32.75 m: 2.25 m with 3.50% Cu

There were other, >0.5 m/100 % Cu intersections.

Mineralization in DDH 603 (fig 17) occurs between 3.72-21.40 m with separate intervals of:-

1.88 m with 1% Cu, 1.45 m with 1.2% Cu, 3.81 m with 1.79% Cu
and 2.70 m with 2.92% Cu

8. ORE CALCULATIONS AND TRIALS

8.1 Ore reserve calculations

Brief mention has already been made in section 3.4 of some ore calculations. These can now be expanded.

Hübner (1976), following surface drilling by Gränges International Mining, calculated a drill indicated reserve for remaining ore in the Sör, Varp, Mörr, Commerce and Smed ore-shoots down to 200 m below shaft collar. His figure, 820,000 tonnes of 1.40% Cu is expanded in Table 2 with regard to in-situ metal contents. Extrapolated to 400 m these calculations indicated a total potential in excess of 3.6 million tonnes above a 1% economic cut off grade.

On completion of the underground exploration, and drilling above the 199 m level, an ore calculation was performed by Aronsson (1981). This calculation noted the following indicated in-situ reserves below the old mine workings to the 199 m level:

Cecilia	: 111,000 tonnes
Commerce, Mörr, Varp:	118,000 tonnes
Lill-Cecilia	: 41,000 tonnes

270,000 tonnes with a 1,9% Cu in-situ

grade. No account was taken of possible ore in the Norr and Sör 'ore-shoots', nor below the 199 m level. A general in-situ grade of the mineralization is given in Table 2.

Gustafsson (1982) took Aronsson's figures and recalculated with a 15% host rock dilution to produce the reserve:-

310,000 tonnes of 1.7% Cu, 0.07% Co, 21 g/t Ag, 0.5 g/t Au, 0.76% As (run of mine)

Gustafsson also calculated the economics of an operation at Håkansboda with this grade and tonnage and a 1% Cu cut off. Accordingly SSAB offered to sell or lease the property (section 3.4).

Månsson (1982) calculated an ore reserve based on all available data, plus an additional set of analyses, on behalf of AB Statsgruvor. Cores from the intersections made in the central part of the deposit from the 199 m level were analysed for Au, Ag, Sb, Bi and As (see Table 6).

The calculation was based on mineralization drill indicated on the 199 m level in the Varp, Mörr, Commerce, Cecilia and Lill-Cecilia shoots. Blocks were defined with a 1% Cu economic cut-off, and heights from the base of the old workings (leaving a pillar) to a position 25 metres below the 199 m level (fig 34). Height references in Månssons report relate to the z (height) co-ordinate in the Stråssa system. Using heights related to the Håkansboda shaft collar, the following blocks were defined:-

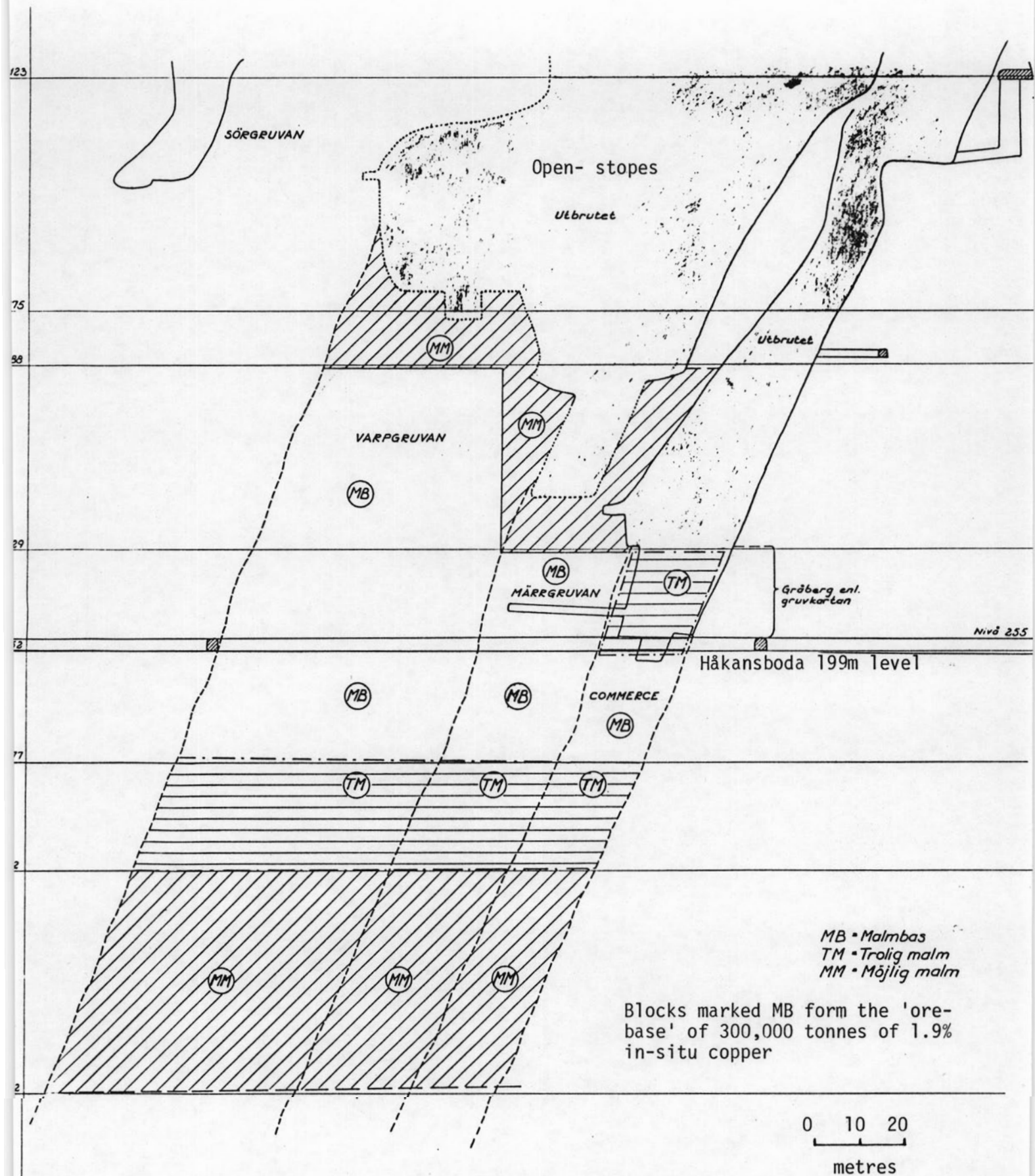


Fig.34. ORE BLOCKS CALCULATED BY MÅNSSON (1982)

HÅKANSBODA
Längdprofil S-F (enl. gruvkarta)
Skala 1:800
820322 Stefan Månsson.

TABLE 6.

GOLD INTERSECTIONS ANALYSED BY AB STATSGRUVOR 1982

Analysis of 25 samples for As, Sb, Bi, Au and Ag in mineralized intervals from the central zone at 199 m level gave the following range of concentrations:-

Au	0.1 - 1.1 g/t	} variable sample size
Ag	4 - 75 g/t	
As	0.06- 1.9 %	
Sb	0.02- 0.31%	
Bi	0.01- 0.05%	

Best Au intersections were:

Hole DDH 450	21.30-25.55:	4.25 m of 1.0 g/t Au
DDH 451	21.70-28.20:	6.50 m of 0.5 g/t Au
-"-	51.85-55.40:	3.55 m of 0.9 g/t Au, 1.3% As
DDH 454	10.00-15.60:	5.60 m of 0.5 g/t Au
-"-	16.55-22.15:	5.60 m of 0.6 g/t Au; 0.93% As; 0.31% Sb 75 g/t Ag
DDH 447	16.75-28.10:	11.35 m of 0.5 g/t Au, 0.45% As
including	22.00-28.10:	6.10 m of 0.8 g/t Au; 0.61% As, 69 g/t Ag
DDH 445	47.80-54.05:	6.25 m of 1.1 g/t Au; 1.2% As

Gold intersections from drillcore (pre-1982 holes and analyses)

Hole DDH 422	21.32-22.22:	0.90 m of 1.0 g/t Au in compact sulphide with 2.00% Cu, 9.4% As
DDH 362	217.10-219.50:	2.40 m of 1.6 g/t Au, 9.25% Cu; 3.70% As; 0.09% Bi; 1.20% Sb; 902 g/t Ag

THE HAKANSBODA MINE-WORKINGS IN SECTION

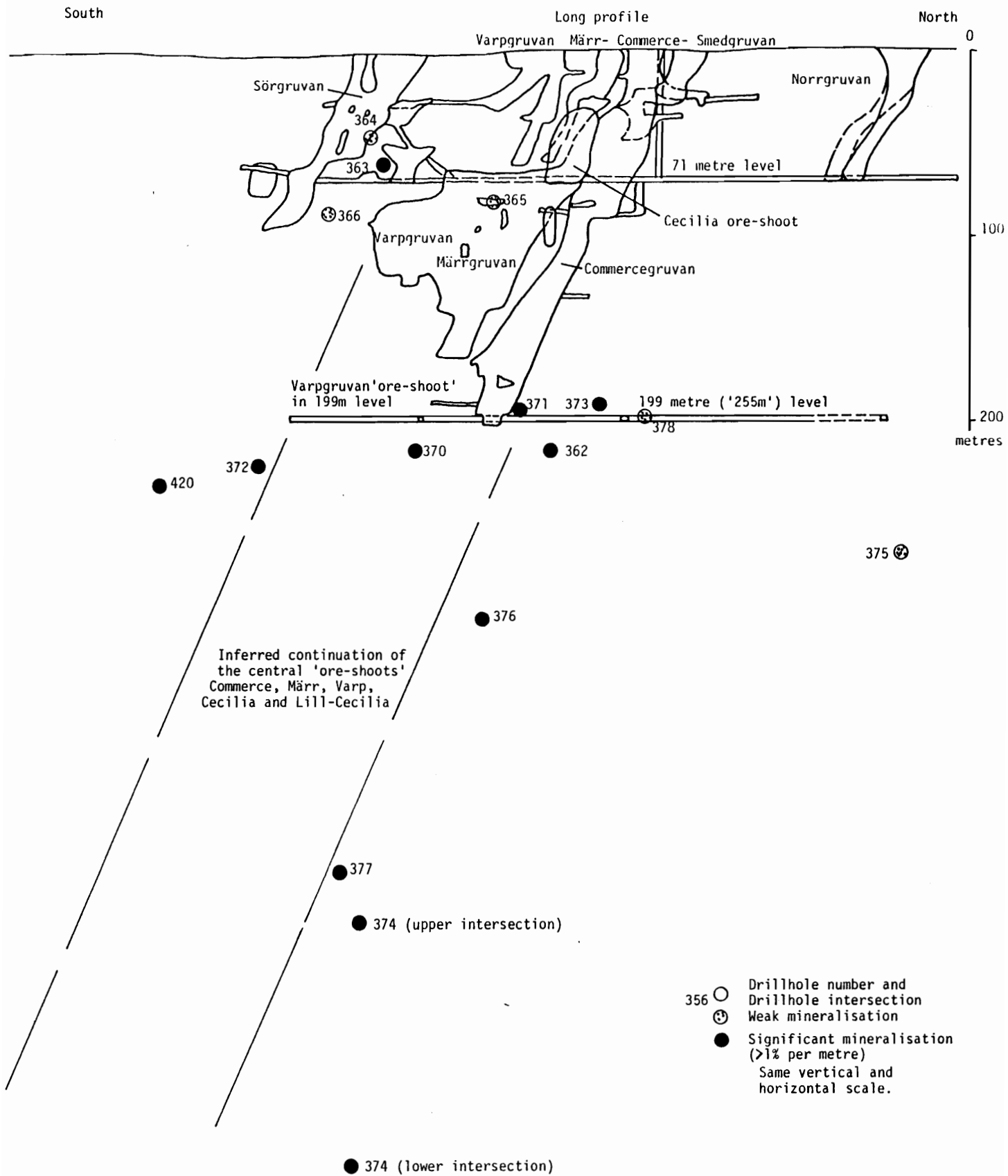


Fig.35. Drillhole intersections on the north - south mine profile

CJCarlon1986

<u>Ore shoot</u>	<u>Height</u>	<u>Width</u>	<u>Strike length</u>
Varp	: 136-224 m (88 metres)	av. 5 metres	70 metres
Märr	: 177-224 m (47 metres)	av. 5 metres	25 metres
Commerce	: 199-224 m (25 metres)	av. 5 metres	20 metres
Cecilia + Lill-Cecilia:	71-224 m (153 metres)	av. 5 metres	50 metres

In-situ grade was calculated at 1.9% Cu, 22 g/t Ag, 0.4 g/t Au, 0.06% Sb, 0.7% As and 0.04% Bi.

Applying a 15% rock dilution and a mysterious '0.9 correction factor', the run-of-mine grade and tonnage, using a 1% Cu cut off is:-

300,000 tonnes of 1.4% Cu, 12 g/t Ag and 0.3 g/t Au, the highest grade material being 100,000 tonnes of 1.5% Cu, 25 g/t Ag and 0.3 g/t Au in the Varpgruvan ore-shoot.

There has been no calculation of the possible tonnage and grade below the 199 m level, or specifically below the 224 m position. Månssons calculation produced 300,000 tonnes for a vertical shoot height of about 60 metres. Assuming a similar grade and thickness for a block of 120 metres strike length in the central 'ore-zone', and continuing this zone to 600 m (DDH 374 fig 24), then a very approximate tonnage can be obtained, of 1.8 million tonnes. This includes the Cecilia-Lill-Cecilia mineralization, but not the Norr or Sör mineralization. The distance between the Norr and Sörgruvorna at surface is a strike length of 280 metres.

Intersections made by surface drilling, projected on to a N-S profile though the mineralization are shown in fig 35, indicating extension of the ore-shoots to the SSE.

8.2 Beneficiation ore-trials

In early 1982, Min-Pro Stråssa investigated three test samples of Håkansboda mineralization, 'normal' copper ore, tennantite-tetrahedrite rich ore and a cobalt rich ore.

Two tests were made; a selective flotation of copper minerals in a mixture of potassiumamylxanthate, oil (pineoil?) and $\text{Ca}(\text{OH})_2$ at a pH of 11.5, and a bulk flotation of the sulphide minerals in potassiumamylxanthate, oil and sulphuric acid at a pH of 6.5.

The normal ore contained:-

2.1% Cu, 0.03% Co, 0.8% As, 0.27% Sb, 0.02% Bi, 62 g/t Ag, and 0.5 g/t Au.

Selective flotation produced a concentrate with:-

15.6% Cu, 0.11% Co, 4.5% As, 1.9% Sb, 0.1% Bi, 467 g/t Ag, and 3 g/t Au.

Recovery percentages were:-

95% Cu, 30.4% Co, 71.2% As, 91.7% Sb, 56.3% Bi, 91.5% Ag, and 65.5% Au.

Bulk flotation produced a concentrate with:-

15.5% Cu, 0.16% Co, 4.9% As, 1.9% Sb, 0.1% Bi, 461 g/t Ag, and 4.6 g/t Au

Recovery percentages were:-

94.1% Cu, 49.3% Co, 74.2% As, 90.9% Sb, 54.9% Bi, 90.4% Ag, and 72.1% Au.

The 'grey-copper' ore contained:-

12.6% Cu, 0.37% Co, 5.2% As, 425 g/t Ag, and 3.5 g/t Au.

Selective flotation produced a concentrate with:-

31.0% Cu, 0.12% Co, 1090 g/t Ag, and 5.5 g/t Au

Recovery percentages were:-

96.6% Cu, 13.6% Co, 94.1% Ag and 76.3% Au

Cobalt recovery was increased to:

1.4% content, 23.5% recovery by re-flotation in a third cell

Bulk flotation produced a concentrate with:-

28.0% Cu, 0.26% Co, 978 g/t Ag, and 3.8 g/t Au

Recovery percentages were:-

96.2% Cu, 31.0% Co, 92.3% Ag, and 50.3% Au

Poor cobalt recovery was enhanced by re-flotation in a third cell.

The cobalt rich ore contained:-

8.4% Cu, 1.8% Co, 5.4% As, 260 g/t Ag, and 2.1 g/t Au

Selective flotation produced a concentrate with:-

26.1% Cu, 0.75% Co, 769 g/t Ag, and 3 g/t Au

Recovery percentages were:-

96.1% Cu, 13.4% Co, 91.6% Ag, and 51.6% Au

Note, however, cobalt content of the sink tailings was 2.3% Co a recovery of 79.7% Co.

Bulk flotation produced a concentrate with:-

24.5% Cu, 0.74% Co, 725 g/t Ag, and 3.5 g/t Au

Recovery percentages were:

96.2% Cu, 14.3% Co, 91.6% Ag and 60.1% Au

Again most of the cobalt came out in the sink tailings with 2.1% Co content a recovery of 75.2%.

In addition to the three sample test, a bulk sample of mineralization from DDH's 440, 445, 447-451 and 454 intersecting the central ore zone on the 199 m level, was subject to a flotation concentration test. The sample contained 1.9% Cu, 0.066% Co, 22 g/t Ag and 0.4 g/t Au. No difficulties were met separating and concentrating the copper, but it was felt that a fine grind would be necessary prior to flotation.

A single pass through a flotation unit produced a concentrate with 94% copper recovery, 75% silver recovery and about 40% gold recovery. 75% of the cobalt and arsenic content went into the sink tailings together with 55% of the gold.

The 'first pass' copper concentrate contained 25% copper, but after a second pass through the cell a 30% Cu concentrate was produced. The concentrate contained about 0.5% each of arsenic and antimony. The concentrate analysis showed that 95% of the copper was present as chalcopyrite, and 5% as 'grey-copper' wherein lay the As-Sb "impurities"

Table 7 lists the compositions of the concentration produced in this test. Ore-treatment of the Håkansboda ore seems to have produced very favourable results.

TABLE 7

RESULTS OF A BULK ORE SAMPLE BENEFICIATION TEST - HÅKANSBODA

Metal contents	Copper Concentrate after 2 'passes'	Copper Concentrate after 3 'passes'	'Slimes' analysis
Cu %	24.6	31.0	10.5
Co %	0.062	0.023	0.15
Ag g/t	226	290	83
Au g/t	1.4	1.3	1.7
As %	0.71	0.44	1.3
Sb %	0.45	0.59	0.14
Bi %	0.04	0.05	0.02
Zn %	0.09	0.11	0.06
Pb %	0.03	0.02	0.04
Fe %	25.00	28.00	18.30
S %	23.70	28.10	13.80
Cd %	0.001	0.001	0.001
Ni %	0.01	0.01	0.02
Hg ppm	4.0	3.9	4.1
SiO ₂ %	10.4	3.9	24.8
CaO %	2.9	1.6	5.8
MgO %	2.1	0.95	4.5
Al ₂ O ₃ %	0.43	0.19	0.96

9. THE LKAB-BP PROJECT (3822)

9.1 Objectives - ore deposit model and exploration

The exploration model for the Håkansboda Project area can be summarized as follows:-

1. The scattered mineral occurrences form a pattern of mineralization related to three zones of mineralization, below, within and above a main carbonate formation. All three zones are considered prospective.
2. It is proposed that mineralization is the result of lower Proterozoic sub-seafloor hydrothermal activity, resulting in rock alteration and deposition of sulphides below the sediment-water interface, and possibly immediately below or at this interface. Replacement, open-space infilling, veined, sediment hosted (proximal vent) and stratiform (proximal-distal vent) deposits have resulted.
3. A hydrothermal cell may have centred upon the area now the site of the Håkansboda deposit. In the project area stratigraphic 'down' is to the east. stratigraphic 'up' to the west. Hydrothermal solutions are envisaged as rising up (now from the east) through mixed meta-sediments-metavolcanics, inducing argillic alteration and silification, producing metal deposition chiefly in a zone of mixing near the top of the main carbonate formation. The Eriksgruvan, Värdegruvan and Gårdsgruvan occurrences can be along strike extensions or separate minor systems.
4. The massive ore-shoots in the Håkansboda mine may be the result of partial remobilisation in a high strain zone caused by the interference of an earlier (F_1) and later (F_2) folding.
5. Alteration around and associated with the original hydrothermal systems produced argillic altered assemblages enriched in Fe, Mg, K and probably Rb, Sc, Na, Zn, As, Cu, Pb, and Sb. These altered rocks and associated mineralization have been metamorphosed to amphibolite facies producing 'impure' and dolomitic marbles (Mg,Fe addition?), a range of Fe, Mg, Ca, K bearing 'skarn' mineral layers and units (typically massive, coarse grained monomineralic amphibole or diopside rocks), sillimanite (fibrolite) and cordierite-biotite-garnet assemblages, and within the quartzo-feldspathic metavolcanics, alteration to quartz-sericite and quartz-sillimanite rocks.
6. The main Håkansboda deposit, a disseminated Cu-Fe-As-S mineralization, occurs like Eriksgruvan and Gårdsgruvan, near the top of the main carbonate. It is unclear why deposition did not take place at the base of the carbonate as the ascending fluids entered the formation. It may be that deposition occurred in a zone of mixing at or close to the sediment - water interface, and Mg enrichment (dolomite) may reflect this 'mixing'. Associated Fe-Ca with Mg and F may have caused early metasomatic 'skarns', transformed by later metamorphism into the dolomite, forsterite, clinohumite and amphibole-diopside rocks of the host carbonate formation.

7. The disseminated mineralization at Håkansboda has not been analysed for gold, neither have the 'argillic altered' rocks, if that is what they are, of the stratigraphic 'footwall' under the deposit.
Peripheral occurrences also have not been tested for Au, ie. Gårdsgruvan and Eriksgruvan.
8. Chemical sediments overlying the main carbonate, interbedded with metavolcanics and clastic-carbonate metasediments may reflect the venting of the hydrothermal system into a syn-sedimentary environment. Metal contents are similar in both the 'Håkansboda' and 'Luthgruvan' types of mineralization (copper dominant Fe-As-Sb-Ag-Co-Au as sulphide; lead-zinc dominant Fe-As-Sb-Ag sulphide-oxide respectively). Interbedded volcanic tuffs in the overlying sequence are often biotitic or with phlogopite (Fe, K addition?), and sillimanite bearing. This may reflect periodic influx of fine grained volcanic detritus into a clastic-carbonate environment where hydrothermal activity was continuous. Mineralization then reflects still-stands in the cycle of mineralization versus sedimentation, mineralization occurring at slow quiescent periods of sedimentation.

Based on this model the following targets become the main objectives of the exploration project.

1. A through investigation of the massive and disseminated mineralization at Håkansboda. Its vertical and southern extension, its volume, tonnage and grade. The principal objective is to define the deposit as an economic target or sub-economic prospect.
2. To re-examine the metal grades and contents, with particular attention to
 - a) Gold content and distribution
 - b) Proven intersections so far untested for multielement or precious metal contents
 - c) 'Altered' footwall (stratigraphically below the Håkansboda deposit) for precious metals associated with hydrothermal activity in the meta-volcanics, meta-sediment and basal carbonates below the Håkansboda deposit (Previously untested).
 - d) Along strike disseminated mineralization
3. To obtain more information on mineral content and possible mineral zone continuation to the south, and between earlier intersections in depth between 200 and 600 metres below shaft collar.
4. To thoroughly investigate the Pb-Ag-Sb mineralization lying stratigraphically above the Håkansboda deposit.
5. To investigate occurrences in the Gårdsgruvan-Eriksgruvan zone, and the Östanbo-Elizabethgruvan zone (fig 13).

Methods of achieving the above objectives are listed below and from the basis of the Håkansboda Project.

9.2 Intersection Re-analysis

1. Reanalysis of mineralized intersections from earlier drilling for Cu, As, Bi, Sb, Pb, Zn, Ni, Co, Ga, Ge, Se, Te, Ag and Au. Particular attention will be paid to intersections outside the central ore-shoot zone on or around the 200 m level, notably the deep intersection in holes DDH 374, 376 and 377, 420, the holes east of the deposit and high grade intersections not previously analysed for these metals.
2. In conjunction with section reanalysis, selective cores will be re-logged and Koarks 'structural type' investigated to better understand:-
 1. Ore types
 2. Ore associates
 3. Precious metal distribution
3. Initial testing of lab pulps versus chip samples versus drillcore analytical data to define the best sampling medium.

9.3 Lithogeochemistry

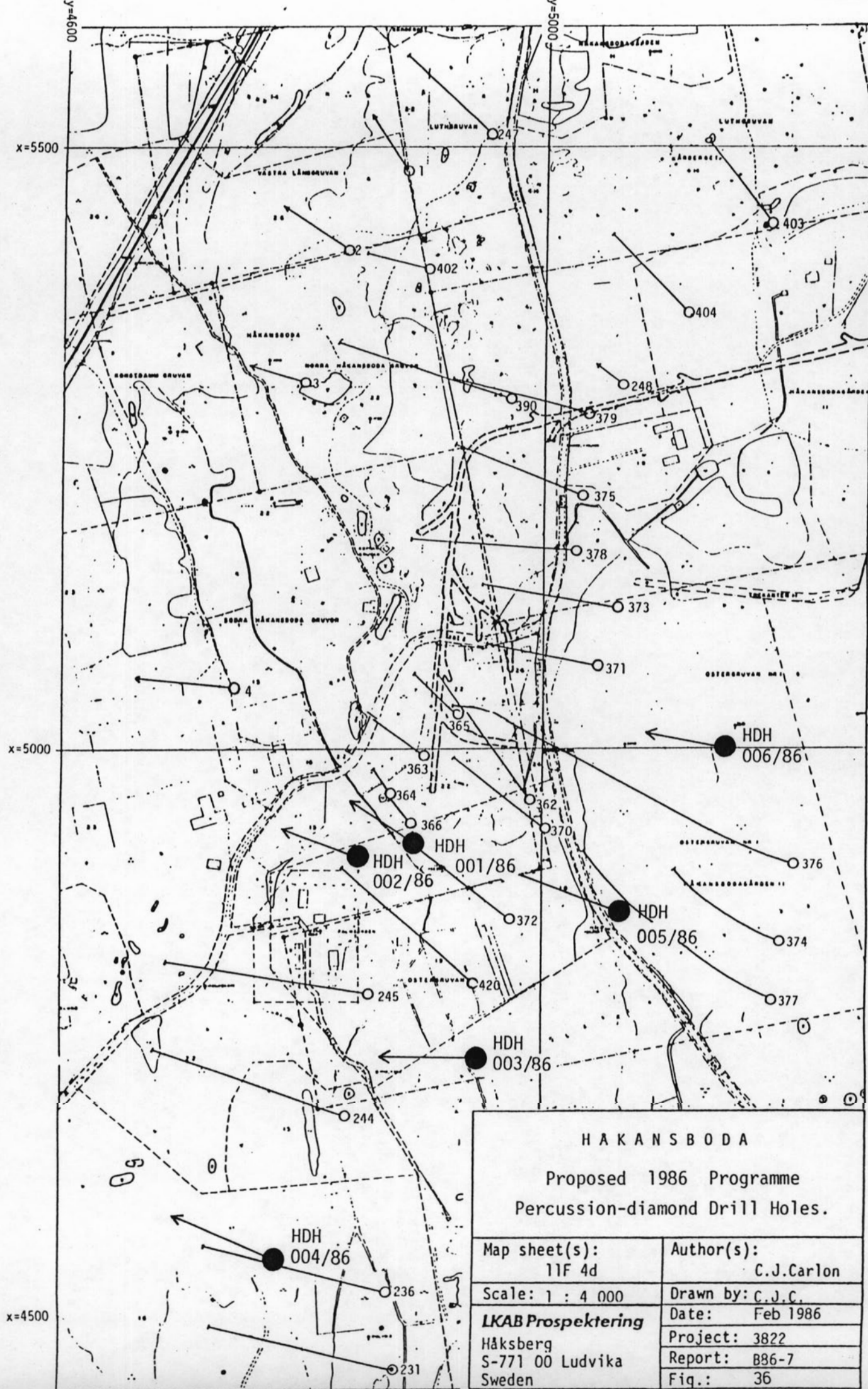
1. 2-3 drillcores will be systematically sampled to define major and trace element distribution patterns to identify, if present, a characteristic 'alteration' or dispersion halo around the deposit.
2. Limited surface sampling to define distribution patterns south of the deposit in the Gårds-Eriksgruvan zone.

9.4 Surface Investigations

1. Ground magnetics, Max-Min EM and IP to better define disseminated and more massive conductors and magnetic horizons and mineralization within the target zones.
2. Downhole logging of earlier drillholes with a time-domain EM-system to identify peripheral conductors, especially important where holes run proximal to possible shoot extensions.
3. Possible overburden geochemistry to define target subcrop
4. Examination of mineralization and dump material from earlier workings to deduce mineralogy and geochemistry within the target zones.

9.5 Drilling and sampling programme

1. The testing of a combination percussion-diamond drilling on the Håkansboda target, and drilling cost study.
2. An investigation on the usefulness of chip samples versus core samples with regard to geological information.
3. The testing of the southern extension of the Håkansboda zone; the intermediate depth continuation of the main ore zone and mineralization in the north Håkansboda and Elizabethgruvan areas (Stage 1, 6 drillhole programme).
4. Investigation with regard to sampling methods, homogeneity of samples, sample preparation for percussion samples.



HAKANSBODA

Proposed 1986 Programme Percussion-diamond Drill Holes.

Map sheet(s): 11F 4d	Author(s): C.J.Carlon
Scale: 1 : 4 000	Drawn by: C.J.C.
LKAB Prospektering	Date: Feb 1986
Håksberg	Project: 3822
S-771 00 Ludvika	Report: B86-7
Sweden	Fig.: 36

The drilling programme commenced Jan. 23rd 1985. Stage 1 (first 6) drill locations are shown in fig 36.

10. CONCLUSIONS

1. The Håkansboda deposit as currently investigated contains in the order of 2 million tonnes of mineralization with a 1% Cu cut-off to a depth of 600 metres.
2. A possible, drill indicated reserve of 300,000 tonnes of 1.9% Cu lies in-situ and accessible from the 199 m level.
3. There is no thorough investigation of the precious metal content of the mineralized zone and many previous drill intersections were untested except for Cu content.
4. Extensions exist in depth, along strike to the south, and in the Norr and Sör 'ore-shoots' for mineralization
5. Areas for testing for precious metals are the Håkansboda zone, its stratigraphic continuation to the south, its underlying 'alteration system' to the east, and stratiform horizons, stratigraphically above.

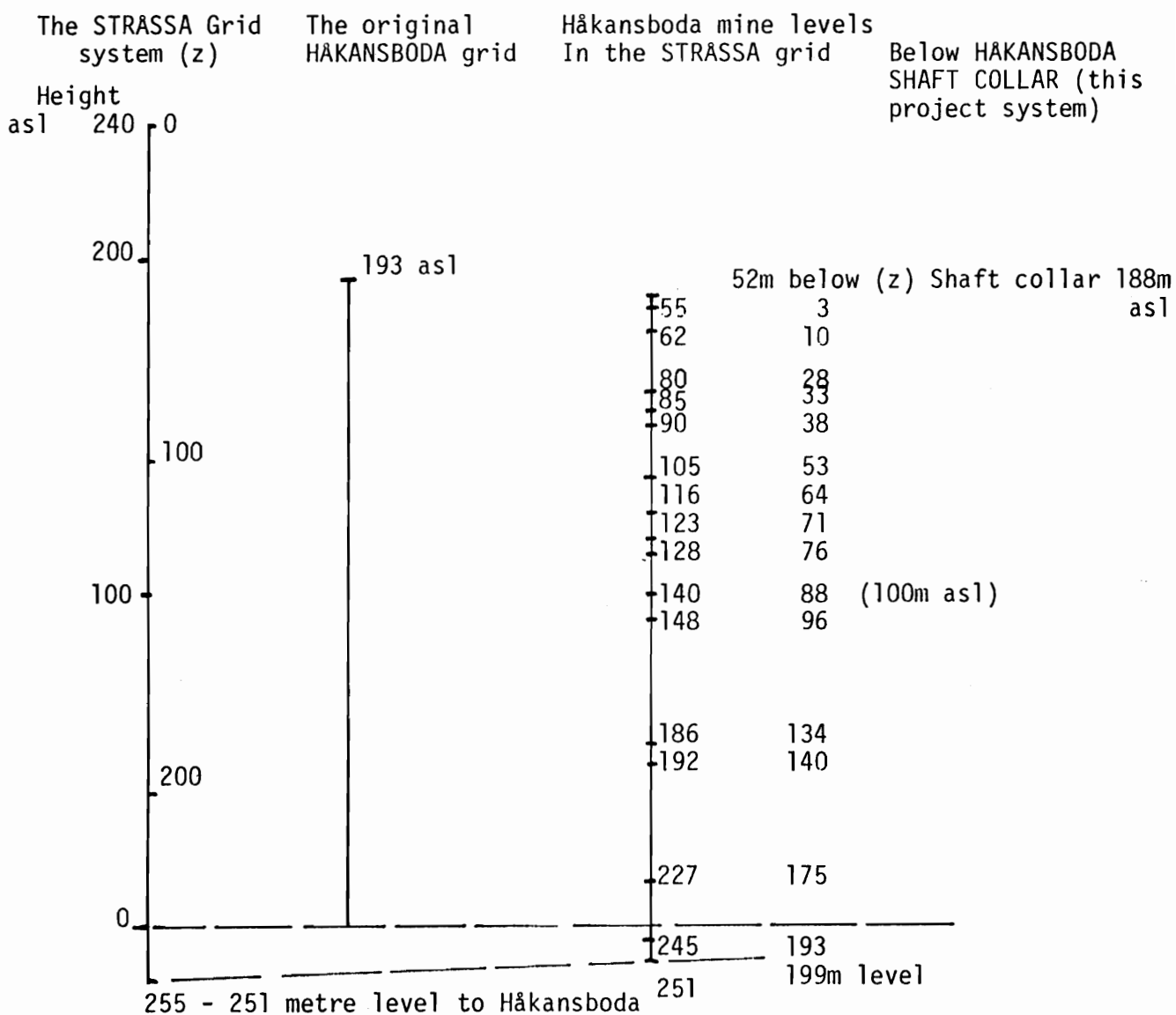
The project will seek to test these zones for economic grade and tonnage.

REFERENCES

- Aronsson, P. 1981 HÅKANSBODAMALMEN. Uppslutande undersökningsarbeten inom de centrala delarna av Håkansboda-fyndigheten. (The Håkansboda ore. Final report on the investigation work in the central parts of the Håkansboda discovery). Confidential SSAB Report
- Aronsson, P. 1983 HÅKANSBODA KOPPARGRUVA
Confidential SSAB Report
- Aronsson, P. 1985 Beskrivning till karta över undersökningsort mot Håkansboda Koppargruva från förbindelseorten Stråssa gruva - Blanka gruva.
(Description to the map over the exploration level to Håkansboda Copper mine from the connecting level between Stråssa-Blanka mines).
Report to Mines Inspector. SSAB Report.
- Bleeker, W. 1983 The Geology of the Stråssa-Torrsjöboda area, 11F 4d-e.
LKAB-BP report
- Bleeker, W. 1984 Geology of the Stråssa-Torrsjöboda area and the Håkansboda-Ingelshyttan area, map sheets 11F 4c, 11F 4d, 11F 4e.
LKAB-BP report No B85-12. Project 3812 Stråssa.
- Carlson, C.J. 1984 Håkansboda - A synthesis of the data.
LKAB-BP report No. Bsg 84-339.
- Engvall, A. 1985 The structural geology of the northern part of the Guldsmedshytte Syncline.
LKAB-BP Report No. B85-21. Project No 3812
- Geiger, P. 1927 Stråssa och Blanka järnmalmsfält.
SGU Ser. Ca. No 20.
- Grip, E. et al. 1983 Malmstyrande strukturer i Bergslagen.
Svenska Gruvföreningen (pp. 42-46).
- Gränges 1974 The Stråssa Mine
- Gustafsson, K. 1982 Förslag till undersökningsprojekt gällande Håkansboda Koppargruva.
(Proposal to validate the investigation project at Håkansboda Copper mine. Feasibility costing).
SSAB Report.
- Hübner, H. 1976 Håkansboda malMBERÄKNING (ore calculation).
GIM Report.

- Koark, H.J. 1960 The Geology of the Stråssa, Blanka and Håkansboda Districts. A brief outline on the occasion of the XXI International Geological Congress 1960.
Grängesbergbolaget. Stråssa.
- Koark, H.J. 1981a Om undersökningsläget av Cu-Co and Pb-Ag mineraliseringarna vid Håkansboda.
(On the investigation of the Cu-Co and Pb-Ag mineralizations at Håkansboda).
Unpublished note.
- Koark, H.J. 1981b Kort översikt över Håkansboda-malmernas mineralogiska sammansättning och strukturella utträdande. (Short note on Håkansboda ores mineralogy - summary and structural appearance).
Unpublished note.
- Koark, H.J. 1982 Om den aktuella situationen av prospektering och exploatering inom Stråssaregionen.
(On the actual situation of prospecting and exploration in the Stråssa region).
SSAB report.
- Lundström, I. 1983 Beskrivning till Berggrundskartan. Lindesberg SV. Sveriges Geologiska Undersökning Serie Af-Nr 126.
(Description to the bedrock map - Lindesberg SW).
- Magnusson, N.H. 1970 The origin of the iron ores in Central Sweden and the History of their Alterations.
SGU Serie C. Nr 643 Pt.1. (pp 43-44).
- Månsson, S. 1982 Håkansboda Malmberäkning (ore calculation).
AB Statsgruvor Report.
- Tegengren, F.R. 1924 Sveriges ädlare malmer och bergverk.
SGU Ser.Ca.No 17 (pp 233-234, 238).
- Welin, E. 1964 Pitchblende-bearing vein fillings in the Stripa and Blanka iron ores.
GFF Vol. 86 pp 257-270

APPENDIX 1. REFERENCE AND CROSS- REFERENCE DEPTHS USED IN
THE CURRENT AND EARLIER REPORTS: HÅKANSBODA



Vertical scale 1cm= 20m (1:2,000)

All heights are shown in metres

asl = heights above sea-level

SYSTEM REFERENCE POINTS : Stråssa (z) origin : 240m asl
Håkansboda shaft collar : 52m below Stråssa origin (z)
188m asl
'255m level' : At 251m below the (z) origin at Håkansboda

APPENDIX 2

DRILLHOLE LOCATION (1970-1978 SURFACE DRILLING) HAKANSBODA

<u>HOLE NO</u>	<u>STRÄSSA GRID CO-ORDINATES</u>			<u>HEIGHT ABOVE</u>
	<u>Northings(x)</u>	<u>Eastings(y)</u>	<u>Height(z)</u>	<u>Sea level(asl) Hole collar</u>
DDH 231	4483.0	4880.0	50.50	189.5
236	4548.0	4874.0	50.50	189.5
244	4689.4	4841.5	51.70	188.3
245	4793.0	4857.1	52.20	187.8
247	5512.0	4952.0	45.50	194.5
362	4954.9	4988.3	43.80	196.2
363	4993.8	4902.0	54.94	185.1
364	4961.6	4873.3	55.34	184.6
365	5029.4	4928.9	53.65	186.35
366	4937.8	4891.7	55.42	184.6
370	4932.1	5000.9	42.42	197.6
371	5066.4	5046.2	39.70	200.3
372	4857.5	4969.8	50.66	189.3
373	5111.9	5060.7	40.50	199.5
374	4835.2	5194.9	26.80	213.2
375	5210.2	5028.0	45.10	194.9
376	4881.6	5209.0	23.50	216.5
377	4787.5	5189.5	28.00	212.0
378	5160.2	5028.4	46.80	193.2
379	5277.0	5036.0	43.00	197.0
390	5290.0	4970.2	49.50	190.5
402	5399.5	4903.5	48.10	191.9
403	5433.2	5186.7	35.60	204.4
404	5362.8	5118.2	36.50	203.5
420	4801.5	4943.8	54.65	185.35

Stråssa origin = 240 m asl.

Håkansboda shaft collar = 188 m asl.

APPENDIX 3

DRILLHOLE PARAMETERS 1970-1978 SURFACE, DRILLHOLES HAKANSBODA

<u>HOLE NO.</u>	<u>AZIMUTH^g</u>	<u>AZIMUTH^o</u>	<u>DIP^o</u>	<u>TOTAL DEPTH</u> <u>(metres)</u>	<u>DATE DRILLED</u>
DDH 231	342.97	308.70	60	307.65	1970
236	312.40	284.00	60	310.60	1971
244	321.10	289.00	60	341.40	1971
245	310.00	279.00	60	341.60	1971
247	347.00	312.00	40	121.35	1971
362	361.70	325.50	70	383.90	1975
363	343.00	308.70	60	135.50	1975
364	360.00	324.00	60	49.58	1975
365	347.50	312.75	60	98.67	1975
366	357.60	321.80	72.5	90.65	1975
370	343.50	309.10	70	280.55	1976
371	312.60	281.34	70	276.00	1976
372	350.00	315.00	70	286.30	1976
373	305.77	275.20	70	326.70	1976
374	324.00*	291.60*	81*	703.45	1976
375	326.00	293.40	70	330.30	1976
376	324.80*	292.30*	60*	597.06	1976
377	325.94*	293.30*	70*	631.15	1977
378	305.00	274.50	70	367.20	1977
379	315.24	284.00	50	179.00	1977
390	320.50	288.45	50	232.60	1977
402	316.55	284.90	60	103.00	1977
403	358.00	322.20	60	170.90	1978
404	349.75	314.77	60	180.50	1978
420	346.75	312.10	70	393.00	1980

*Hole deviates (See fig 16).

APPENDIX 4

UNDERGROUND DRILLHOLES. LOCATION - ORIENTATION PARAMETERS. HAKANSBODA 1978-1981

DRILLHOLE NO.	LOCATION		"HEIGHT" (metres)	ORIENTATION		LENGTH (metres)	DRILLED
	x(northings)	y(eastings)		Azimuth	Dip		
DDH 421	5344	5247	199	346.5 ⁰	Horiz.	150.40	1980
422	5344	5246	199	328.4 ⁰	-"	159.00	1980
423	5309	5110	199	298.5 ⁰	-"	225.10	1980
424	5306	5116	199	7.2 ⁰	-"	151.55	1980
425	5269	5015	199	257.5 ⁰	-"	79.00	1981
426	5257	5006	199	238.1 ⁰	-"	110.00	1981
427	5273	4993	199	254.1 ⁰	-"	27.50	1981
428	5275	4991	199	273.9 ⁰	-"	218.00	1981
429	5276	4991	199	312.4 ⁰	-"	220.00	1981
430	5173	4929	199	184.0 ⁰	25 ⁰ up	63.40	1981
431	5176	4922	199	97.6 ⁰	Horiz.	173.80	1981
432	5174	4931	199	134.3 ⁰	-"	129.00	1981
433	5174	4930	199	159.7 ⁰	-"	185.60	1981
434	5176	4931	199	94.9 ⁰	30 ⁰ up	121.05	1981
435	5174	4931	199	119.0 ⁰	Horiz.	177.50	1981
436	5177	4931	199	73.0 ⁰	-"	185.50	1981
437	5176	4922	199	352.3 ⁰	-"	75.80	1981
438	c. 5309	c. 5110	199	?	-"	165.00	1981
439	5310	5110	199	320.5 ⁰	-"	184.50	1981
440	c. 5063	c. 4920	199	94.5 ⁰	-"	176.00	1981
441	5061	4921	199	Vertical	90 ⁰ up	111.00	1981
442	5060	4921	199	105.4 ⁰	45 ⁰ up	87.50	1981
443	c. 5061	c. 4921	199	137.2 ⁰	Horiz.	116.60	1981
444	5052	4913	199	139.5 ⁰	-"	50.20	1981
445	5085	4920	199	95.0 ⁰	-"	77.70	1981
446	5114	4926	199	95.0 ⁰	-"	79.25	1981
447	5031	4916	199	94.8 ⁰	-"	56.50	1981
448	5040	4916	199	95.0 ⁰	-"	104.95	1981
449	5051	4917	199	95.0 ⁰	-"	99.20	1981
450	5073	4919	199	95.0 ⁰	-"	83.25	1981
451	5094	4921	199	95.0 ⁰	-"	88.40	1981
452	5129	4917	199	274.8 ⁰	-"	89.00	1981
453	5150	4920	199	275 ⁰	-"	60.50	1981

Appendix 4 (contd.)

DRILLHOLE NO.	LOCATION		"HEIGHT" (metres)	ORIENTATION		LENGTH (metres)	DRILLED
	<u>x(northings)</u>	<u>y(eastings)</u>		<u>Azimuth</u>	<u>Dip</u>		
DDH 454	5021	4922	199	94.8 ⁰	Horiz.	35.15	1981
455	5026	4919	199	26.8 ⁰	35 ⁰ up	103.55	1981
456	?	?	199	?	50 ⁰ up	100.40	1981
457	?	?	199	?	Horiz.	83.00	1981
458	?	?	199	?	Horiz.	84.20	1981
459	5002	4940	199	299.5 ⁰	73 ⁰ down	70.65	1981
460	5005	4973	199	40 ⁰	40 ⁰ down	80.50	1982
601	5117	4938	71	Vertical	90 ⁰ down	120.80	1982
602	5117	4938	71	327.0 ⁰	60 ⁰ down	89.45	1982
603	5117	4938	71	319 ⁰	30 ⁰ down	24.60	1982
604	?	?	71	?	30 ⁰ down	31.40	1982
605	?	?	71	?	20 ⁰ down	46.00	1982

Entries marked? : No information can be found in the data obtained from SSAB.

"HEIGHT": As marked either on the 199 or 71 m levels below Håkansboda shaft collar (11 m below and 117 m above sea level respectively). See appendix 1.