Bergvesenet

Postboks 3021, 7002 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
BV 2213				**Fortrolig**
Kommer fra ..arkiv Sulitjelma Bergverk A/S	Ekstern rapport nr "522127001"	Oversendt fra	Fortrolig pga	Fortrolig fra dato:

Tittel

Detailed geological mapping around the Skofferdalen area. Geologi. Kartlegging.

Forfatter	Dato	Bedrift
ROBERTS G. / TAYLOR M.	1974	Sulitjelma Gruber A/S

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad

Fagområde	Dokument type	Forekomster
Råstofftype	Emneord	

Sammendrag

Detaljert geologisk kartlegging i Skofferdalen. Sulitjelma amfibolitten er her mektig og bestür av en nedre breksje-enhet og en övre skifrig amfibolitt. En 2 m mektig pyritt-rik klorittbreksje er püvist , med ukjent utstrekning. Ellers er Furulund og Lapphelleren skifrene skildret. Dessuten strukturgeologi med deformasjonshistorie. Geologi.

Detailed geological mapping around the Skofferdal area

1974

012.025

A/S Sulitjelma Gruber
Prospektering 1974
Prosjekt 7.402/D
Feltrapport

TSH/GR/KH
4/11-1974

Detailed geological mapping around the Skofferdal area (EG-214).

Contents

Abstract:

The Sulitjelma amphibolite here is thick and comprises a lower breccia unit and an upper schistose amphibolite unit. In one small area the breccia contains a 2 m thick sulphide-rich horizon.

1. INTRODUCTION

1.1 The area mapped covers about 2.5 sq.km around the perimeter of Skofferdalsvann which lies 10 km to the north west of Furulund Sulitjelma. The area is best reached from Ågifjell where a track leads to Lingås. From there a narrow path can be followed up to the huts at Skofferdalsvann.

1.2 The present work involved detailed outcrop mapping of the Sulitjelma amphibolite as it makes its way slowly up the mountains from Sulitjelma. The amphibolite was mapped from the point where mapping ended in 1973 (northing 2450) to the western edge of sheet EG 214. The only previous work in detail on the area was a preliminary stream-sediment sampling program in 1972.

For most of the area the cliffs are made of Lapphelleren schists and only in the south are amphibolites well exposed. This, together with a lack of outcrop in the valley, meant that the mapping was best done by geological profiles along the streams from the base of the cliffs to the edge of the lake. Altogether 13 geological profiles were completed of which 10 were in streams. All outcrops between profiles are marked on the map although few localities were made in these areas due to lack of time.

2. TOPOGRAPHY

Skofferdalsvann lies in a spectacular glacial corrie which is bounded on three sides by a series of steep cliffs up to 300 m in height. The valley floor has an average height of 550 m and the sides rise up to more than 900 m. At this height is a rolling plateau with much rock outcrop in the form of small scarps. Characteristic of this region are the many small lakes and the stunted vegetation of moss, heather and lichen. The line of cliffs is almost continuous, resulting in a series of waterfalls and can only be climbed in a few places. Beneath the cliffs are steep, grassy slopes often covered with scree and large boulders and genuine outcrops are rare. The valley floor is covered by glacial debris, mostly in the form of drumlins. Outcrops are scarce in the valley beneath the cliffs and are mostly restricted to stream cuttings. The valley floor to the west of Skofferdalsvann is an exception to this, as many outcrops of Furulund schist are seen as roche moutonnée. Close to the lake itself much of the ground is marsh or rough heathland, again with few outcrops.

3. PETROGRAPHY

3.1 The rock units which are present at Sulitjelma are also found at Skofferdal. They are:

	Thickness
Sulitjelma schists	-
Furulund "Granite"	0 - 150 m
Lapphelleren schists	< 300 m
Sulitjelma amphibolite	30- 150 m
Furulund schist	300 m +

3.2 Furulund schist

The Furulund schist forms the lowest unit mapped and petrographically it is identical to the type schists which crop out at Langvann. It is a medium to fine grained, slightly calcareous, mica schist with occasional garnet porphyroblasts and many boudinaged quartz veins. The contact with the overlying amphibolite is not sharp and there is a zone of a few metres in which both Furulund schist and schistose amphibolite are interbedded.

3.3 Sulitjelma Amphibolite

3.3.1 To the south of Skofferdal, Furulund schist passes up into a banded amphibolite unit which is the local base of the Sulitjelma amphibolite. Here (Y-4350 X-2500) is the only part of the area in which the amphibolite is well exposed in the cliffs. It appears to be very thick, perhaps up to 200 m, but some of the thickening may be due to folding.

The banded amphibolite is a medium to coarse grained, hornblende-felspar rock with a prominent uneven banding. The bands are 2-4 cm thick and are very conspicuous on the outcrop surface. This banded amphibolite appears to make up over half of the thickness of the entire amphibolite in the area, but it is not found further north. The remaining amphibolite in this southern area is predominantly fine grained schistose amphibolite although all gradations between these extremes are found. No chlorite breccia was observed in this area.

3.3.2 In the north of the area the outcrops of the amphibolite are few and far between. At the base of the cliffs the upper part of the amphibolite, as exposed in the streams, is always a schistose amphibolite. As such it is the most common aspect of the amphibolite throughout most of Skofferdal. Those outcrops which are found on the valley floor and hence low in the amphibolite unit, show the presence of coarser amphibolites and a chloritic breccia.

The breccia varies considerably in mineralogy, colour and texture but generally it consists of a dark, platy chlorite matrix with boudined, albite rich fragments. Hornblende, biotite and pyrite are common accessories and occasionally large quartz pebbles are present. The latters suggest an agglomeratic origin for this rock.

At one locality (202) a 2 m horizon of a massive pyrite rich (< 50%) chlorite breccia is found. The complex tectonics and the lack of outcrop did not allow this horizon to be followed further than the stream cutting. The other breccia localities (99, 222, 252-3, 255-6) had only moderate amounts of sulphides.

At the top of the amphibolite the schistose amphibolite has a gradational contact with the overlying schists. The rocks are layered but generally the proportion of biotite, muscovite and chlorite increases at the expense of hornblende so that the rocks are best described as hornblende mica schists. This zone often contains large numbers of crimson garnets and thin psammitic layers. It is difficult to know where to draw the boundary in such a situation, and in this work the boundary is drawn above the last definite schistose amphibolite band.

3.4 The Lapphelleren Schists

Above the amphibolite at Skofferdal lies a thick sequence of mica schists and psammites which are assigned to the Lapphelleren unit. These rocks form the majority of the cliffs around Skofferdalsvann. The base of the Lapphelleren usually consists of hornblende mica schists with, as mentioned above, sporadic garnets. On the north side of the valley an easily recognisable 2 m horizon of white quartzite occurs low down in the sequence about 10 m above the junction with the amphibolite. The Lapphelleren schists contain one or two rusty horizons which are caused by strange, almost pure, chlorite schist. Higher still in the cliffs can be seen a boudinaged horizon of a rusty psammite. These boudins are up to 15 m thick in the southern cliffs.

Generally the Lapphelleren schists are coarser and contain more quartz and felspar than they do above Sulitjelma and the sequence appears to be thicker. The mineralogy suggests that this is a meta-greywacke sequence.

3.5 The Furulund "Granite"

This unit was only mapped in the south where it appears above the Lapphelleren schists on the plateau above the cliffs. It appears to form a conformable horizon and it looks more like an acid tuff/agglomerate than it does a granite. It contains large quartz fragments, a high proportion of muscovite and small amounts of garnet.

3.6 The Sulitjelma Schists

Above the Furulund "granite" the Sulitjelma schists are developed as a series of fine grained mica schists. They were not mapped in detail.

4. STRUCTURE

The Skofferdal area is a part of a larger structural unit which has a regional strike of about 350° and an average dip of 30° to the N.E. Imposed upon this is an anticline which passes through Skofferdalsvann with a fold axis strike of 040°. This is a solitary fold with an amplitude of perhaps 500 m and a wavelength on the order of 2 km.

Associated with this larger fold and sharing the same regional fold axis are many smaller folds (e.g.247,228). These have wavelengths less than 200 m and locally they are very tight. These folds have the effect of scattering the strike and dip measurements taken in the field and cause the high dips which are recorded at some localities. The deformation which was associated with this folding has produced a crenulation folding on a cm scale in some micaceous schists (e.g.218,74) and a compression of the quartz boudins (e.g.74).

Seen particularly well in the heterogeneous schists and psammites of the Lapphelleren, is an earlier style of deformation very different to that described above. This is represented by reclined and recumbant folds which appear to have approximately the same fold axis direction as the open folds (e.g. 92 and Fig.1). These folds have axial surfaces which dip at angles of 15-20° to the S.E. This appears to have been a very intense "plastic" deformation which caused the production of the spectacular psammite boudins in the Lapphelleren schists (e.g.Fig.2) and the production of schistosity and boudinage in the Furulund schists. It must have had a very high shear component.

It is this first deformation which may be the cause of some of the variations in thickness of some of the lithological units. Repeated isoclinal folding may have increased the apparent thickness of some units.

In summary, the area has undergone a regional intensive deformation which has produced the planar fabric which can now be seen. This fabric has been refolded by a locally intense, non-plastic compression. The possible absence of major structures like the Skofferdal anticline in the vicinity implies that this structure may be a single kink-band.

5. MINERALISATION

The largest concentrations of sulphides are to be found in the breccia unit of the Sulitjelma amphibolite cropping out to the east and north of Skofferdalsvann. To the east (x-1025750, y-43250) sulphide rich layers within the breccia are present in stream outcrops. At localities 202A and 205D, layers containing up to 50% pyrite are present: these layers are continuous along strike and are presented in Figs.

To the north of Skofferdalsvann (x-1026000,y-445000) the breccia unit is again seen in small separated outcrops. However, no mineralisation was observed although most outcrops had small percentages (< 5%) of pyrite and weathered rustily.

At the top of the Sulitjelma amphibolite, within the schistose amphibolite facies, are two rusty-weathering schists horizons which contain occasional sulphide minerals and weather to iron hat (localities 85,87), but they are not continuous.

Within the Lapphelleren schists are rust-weathering pods of psammite which occur high on the cliffs. They do not appear to contain sulphides.

Discussion and Comparison with the Stream Sediment Results.

During August 1972 a reconnaissance stream sediment sampling program was carried out by A/S Sulitjelma Gruber, and the samples were analysed by N.G.U., Trondheim, and a report prepared. Streams crossing the breccia outcrops to the east of Skofferdalsvann do not show any marked enrichment in any of the elements analysed for, even when the stream flowed over outcrops of 50% sulphide rock.

The stream sediment samples which do show high Cu, Pb and Zn values are for those streams flowing on Furulund schist. Unfortunately this fact was not known when the outcrop mapping was carried out, and only one locality (74) was made in this apparently interesting area. This observation (74) did not suggest any sulphide concentration, and we suggest that the presence of glacial debris on these slopes may be the source for the high p.p.m. of these elements as observed in the stream sediment samples.

6. EXPLORATION WORK

The most important area lies to the east of Skofferdalsvann on the valley floor. Here higher concentrations of sulphides were discovered in the breccia unit. Careful stream-sediment sampling of the stream network, especially where it dissects the breccia outcrop would be of great value. Soil-sampling would be of limited value because of the extensive covering of drift which probably reaches 10 m in thickness in places. Thus indirect methods of delineating the extent of the sulpide-rich breccia will have to be employed with special reference to electro-magnetic methods.

7. OTHER COMMENTS

The mapping was done using the "Geomap" system of describing localities. Because of a shortage of time a relatively small number of localities were made and a field note book was used to supplement the Geomap forms. The use of a field notebook greatly reduces the number of forms which need to be filled in and helps with the writing of the report.
Standardisation can still be achieved by the use of the Geomap forms,but in any given area there comes a time when the filling in of more forms becomes a waste of time. This could especially be true in an area in which there was little of economical interest.

Gareth Roberts

Michael Taylor

KEY 7.402/D

x 1027 000

EG 214 . 7.402/D

STRUCTURE AND STREAM NUMBERS

59 SULITJELMA SCHISTS

15 FORULUND GRANITE

62 LAPPHELLEREN SCHISTS

53 SULITJELMA AMPHIBOLITE

46 " " (BRECCIA)

6 FORULUND SCHISTS

54 OUTCROPS WITH LOCALITY NUMBERS

SMALL CLIFFS OR SCARPS

CLIFFS OVER 10 m HIGH

NOT MAPPED

STEEP GRASS SLOPES

MANY SMALL SCARPS

x 1026 000

KEY

15 DIP AND STRIKE

ANTICLINE

SYNCLINE

Strike of Fold axis

POSITION OF THE SKOFFEDAL ANTICLINE

(7) STREAM NUMBERS

SMALL CLIFFS

x 1025000

SKOFFEDAL

Geologisk blotningskart

EDB-nummer

A/S SULITJELMA GRUBER

Prospektering 1974

Prosjekt 7.402/D

Tegn.	MRT	5.8.74
Trac.	"	"
Kfr.	TSH	19.8.74

M: 1:10.000

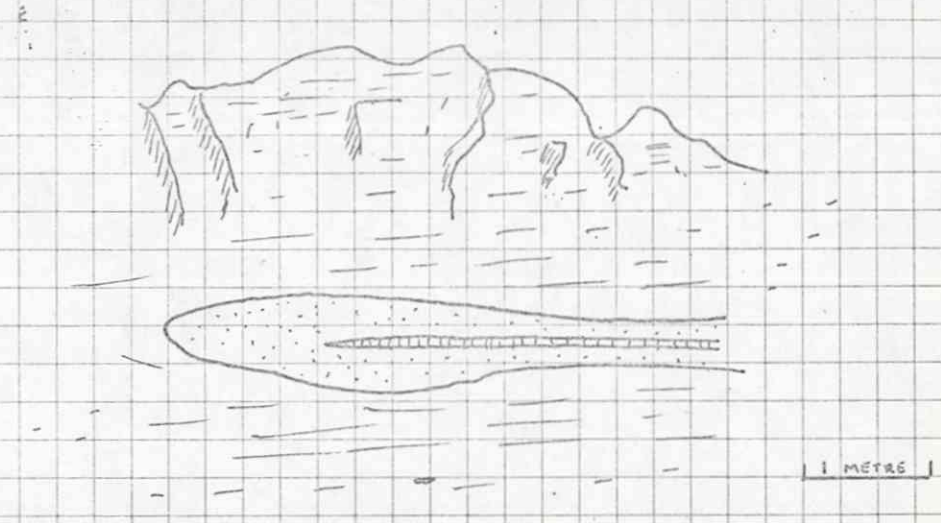


FIG 1 RECUMBANT ISOCLINAL FOLD OF RUSTY PSAMMITE IN MICA SCHIST LOC:- 9a

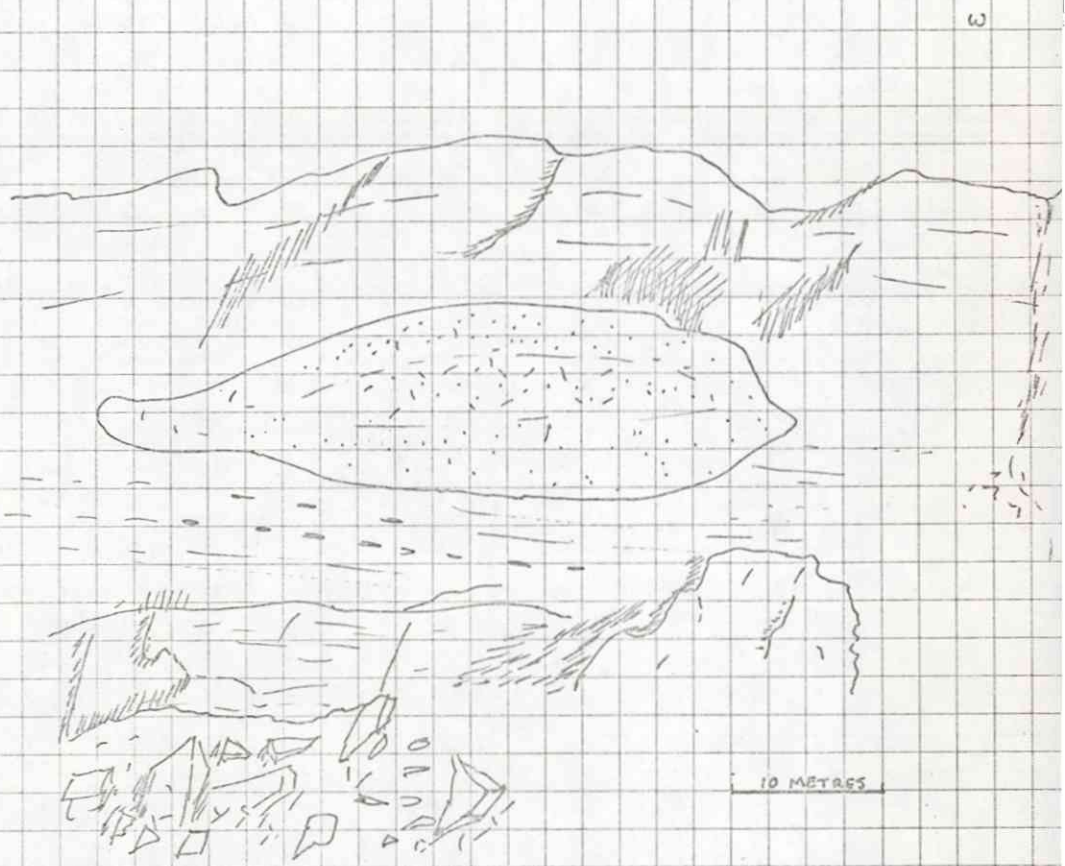


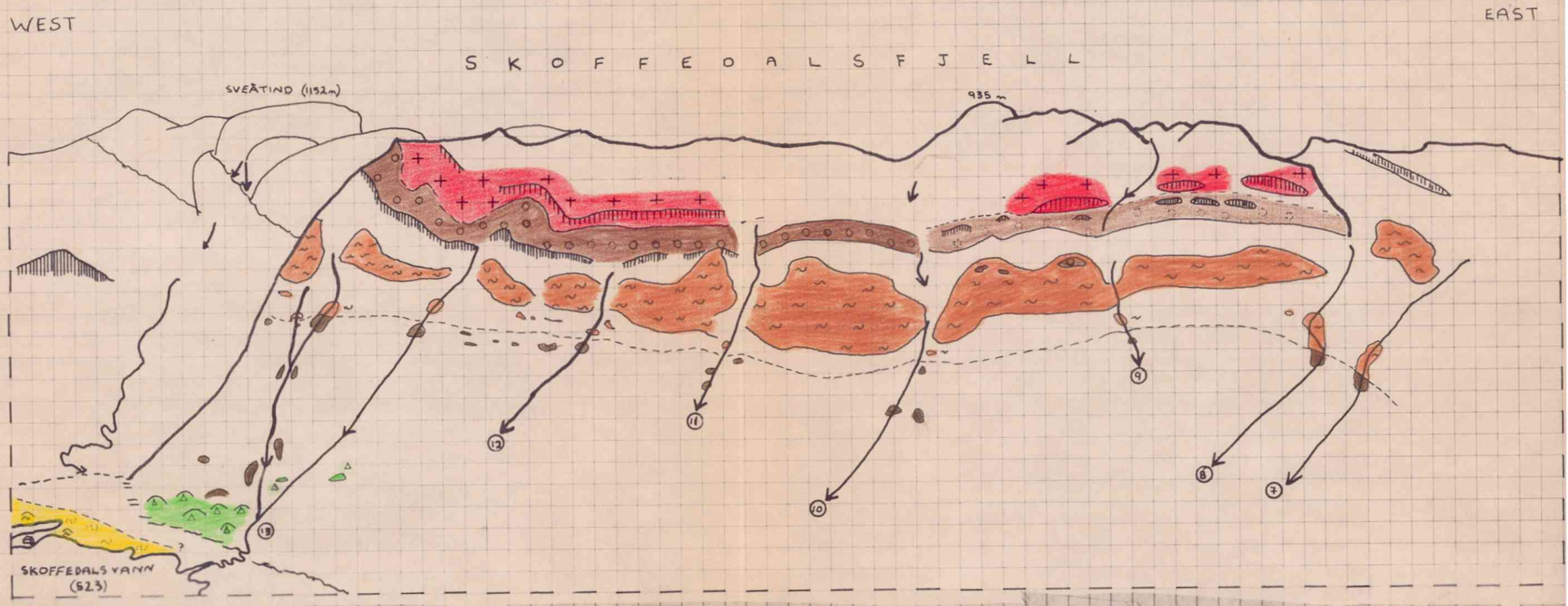
FIG 2.

LARGE PSAMMITE BOUDIN IN MICA SCHISTS NO LOCALITY

LAPPHELLEREN SCHIST IN CLIFFS SOUTH OF SKOFFEDALSVANN

B.B. 7.402/D

FIG. 3 SKETCH TO SHOW THE GEOLOGY OF THE NORTHERN VALLEY SIDE OF SKOFFEDAL



15 FURULUND GRANITE.

RUSTY PSAMMITE SCHISTS — LAPPHELLEREN SCHIST.

SCHISTOSE AMPHIBOLITE BRECCIA — SULITJELMA AMPHIBOLITE.

6 FURULUND SCHIST.

⑨ GEOLOGICAL PROFILE

FORMATION BOUNDARY

CLIFF

ROCK OUTCROP

STREAM

SCALE 0 250 500 m

SKOFFEDALSFJELL
Geologisk skisse

Tegn.	MRT	15/8.74
Trac.	"	"
Kfr.	TSH	19/8.74

M: ca. 1:8000

A/S SULITJELMA GRUBER
Prospektering 1974
Prosjekt 7.402/D

NW
NU

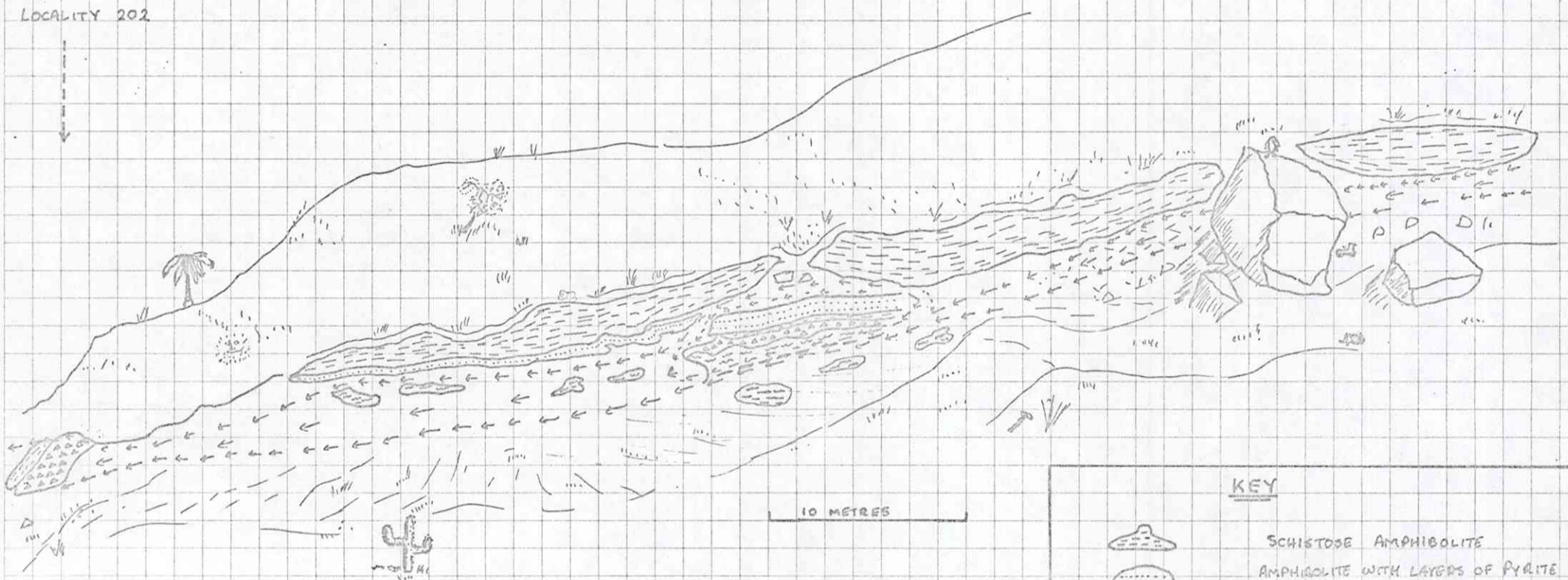
SE
SØ

LOCALITY 206

LOCALITY 205

LOCALITY 204

LOCALITY 202



KEY

SCHISTOSE AMPHIBOLITE

AMPHIBOLITE WITH LAYERS OF PYRITE

ORE HORIZON

DARK CHLORITE BRECCIA

BOUNDARIES OF STREAM

FIG 4 DIAGRAM OF STREAM PROFILE 4 (X-2560, Y-4320)

G.R. T.402/D

A/S Sulitjelma Gruber
Prospektering 1974
Prosjekt 7.402/D
Feltrapport

TSH/GR/KH
4/11-1974

Detailed geological mapping around the Skofferdal area (EG-214).

Contents

Abstract:

The Sulitjelma amphibolite here is thick and comprises a lower breccia unit and an upper schistose amphibolite unit. In one small area the breccia contains a 2 m thick sulphide-rich horizon.

1. INTRODUCTION

1.1 The area mapped covers about 2.5 sq.km around the perimeter of Skofferdalsvann which lies 10 km to the north west of Furulund Sulitjelma. The area is best reached from Ågifjell where a track leads to Lingås. From there a narrow path can be followed up to the huts at Skofferdalsvann.

1.2 The present work involved detailed outcrop mapping of the Sulitjelma amphibolite as it makes its way slowly up the mountains from Sulitjelma. The amphibolite was mapped from the point where mapping ended in 1973 (northing 2450) to the western edge of sheet EG 214. The only previous work in detail on the area was a preliminary stream-sediment sampling program in 1972.

For most of the area the cliffs are made of Lapphelleren schists and only in the south are amphibolites well exposed. This, together with a lack of outcrop in the valley, meant that the mapping was best done by geological profiles along the streams from the base of the cliffs to the edge of the lake. Altogether 13 geological profiles were completed of which 10 were in streams. All outcrops between profiles are marked on the map although few localities were made in these areas due to lack of time.

2. TOPOGRAPHY

Skofferdalsvann lies in a spectacular glacial corrie which is bounded on three sides by a series of steep cliffs up to 300 m in height. The valley floor has an average height of 550 m and the sides rise up to more than 900 m. At this height is a rolling plateau with much rock outcrop in the form of small scarps. Characteristic of this region are the many small lakes and the stunted vegetation of moss, heather and lichen. The line of cliffs is almost continuous, resulting in a series of waterfalls and can only be climbed in a few places. Beneath the cliffs are steep, grassy slopes often covered with scree and large boulders and genuine outcrops are rare. The valley floor is covered by glacial debris, mostly in the form of drumlins. Outcrops are scarce in the valley beneath the cliffs and are mostly restricted to stream cuttings. The valley floor to the west of Skofferdalsvann is an exception to this, as many outcrops of Furulund schist are seen as roche moutonnée. Close to the lake itself much of the ground is marsh or rough heathland, again with few outcrops.

3. PETROGRAPHY

3.1 The rock units which are present at Sulitjelma are also found at Skofferdal. They are:

	Thickness
Sulitjelma schists	-
Furulund "Granite"	0 - 150 m
Lapphelleren schists	< 300 m
Sulitjelma amphibolite	30- 150 m
Furulund schist	300 m +

3.2 Furulund schist

The Furulund schist forms the lowest unit mapped and petrographically it is identical to the type schists which crop out at Langvann. It is a medium to fine grained, slightly calcareous, mica schist with occasional garnet porphyroblasts and many boudinaged quartz veins. The contact with the overlying amphibolite is not sharp and there is a zone of a few metres in which both Furulund schist and schistose amphibolite are interbedded.

3.3 Sulitjelma Amphibolite

3.3.1 To the south of Skofferdal, Furulund schist passes up into a banded amphibolite unit which is the local base of the Sulitjelma amphibolite. Here (Y-4350 X-2500) is the only part of the area in which the amphibolite is well exposed in the cliffs. It appears to be very thick, perhaps up to 200 m, but some of the thickening may be due to folding.

The banded amphibolite is a medium to coarse grained, hornblende-felspar rock with a prominent uneven banding. The bands are 2-4 cm thick and are very conspicuous on the outcrop surface. This banded amphibolite appears to make up over half of the thickness of the entire amphibolite in the area, but it is not found further north. The remaining amphibolite in this southern area is predominantly fine grained schistose amphibolite although all gradations between these extremes are found. No chlorite breccia was observed in this area.

3.3.2 In the north of the area the outcrops of the amphibolite are few and far between. At the base of the cliffs the upper part of the amphibolite, as exposed in the streams, is always a schistose amphibolite. As such it is the most common aspect of the amphibolite throughout most of Skofferdal. Those outcrops which are found on the valley floor and hence low in the amphibolite unit, show the presence of coarser amphibolites and a chloritic breccia.

The breccia varies considerably in mineralogy, colour and texture but generally it consists of a dark, platy chlorite matrix with boudined, albite rich fragments. Hornblende, biotite and pyrite are common accessories and occasionally large quartz pebbles are present. The latters suggest an agglomeratic origin for this rock.

At one locality (202) a 2 m horizon of a massive pyrite rich ($< 50\%$) chlorite breccia is found. The complex tectonics and the lack of outcrop did not allow this horizon to be followed further than the stream cutting. The other breccia localities (99,222, 252-3, 255-6) had only moderate amounts of sulphides.

At the top of the amphibolite the schistose amphibolite has a gradational contact with the overlying schists. The rocks are layered but generally the proportion of biotite, muscovite and chlorite increases at the expense of hornblende so that the rocks are best described as hornblende mica schists. This zone often contains large numbers of crimson garnets and thin psammitic layers. It is difficult to know where to draw the boundary in such a situation, and in this work the boundary is drawn above the last definite schistose amphibolite band.

3.4 The Lapphelleren Schists

Above the amphibolite at Skofferdal lies a thick sequence of mica schists and psammites which are assigned to the Lapphelleren unit. These rocks form the majority of the cliffs around Skofferdalsvann. The base of the Lapphelleren usually consists of hornblende mica schists with, as mentioned above, sporadic garnets. On the north side of the valley an easily recognisable 2 m horizon of white quartzite occurs low down in the sequence about 10 m above the junction with the amphibolite. The Lapphelleren schists contain one or two rusty horizons which are caused by strange, almost pure, chlorite schist. Higher still in the cliffs can be seen a boudinaged horizon of a rusty psammite. These boudins are up to 15 m thick in the southern cliffs.

Generally the Lapphelleren schists are coarser and contain more quartz and felspar than they do above Sulitjelma and the sequence appears to be thicker. The mineralogy suggests that this is a meta-greywacke sequence.

3.5 The Furulund "Granite"

This unit was only mapped in the south where it appears above the Lapphelleren schists on the plateau above the cliffs. It appears to form a conformable horizon and it looks more like an acid tuff/agglomerate than it does a granite. It contains large quartz fragments, a high proportion of muscovite and small amounts of garnet.

3.6 The Sulitjelma Schists

Above the Furulund "granite" the Sulitjelma schists are developed as a series of fine grained mica schists. They were not mapped in detail.

4. STRUCTURE

The Skofferdal area is a part of a larger structural unit which has a regional strike of about 350° and an average dip of 30° to the N.E. Imposed upon this is an anticline which passes through Skofferdalsvann with a fold axis strike of 040°. This is a solitary fold with an amplitude of perhaps 500 m and a wavelength on the order of 2 km.

Associated with this larger fold and sharing the same regional fold axis are many smaller folds (e.g.247,228). These have wavelengths less than 200 m and locally they are very tight. These folds have the effect of scattering the strike and dip measurements taken in the field and cause the high dips which are recorded at some localities. The deformation which was associated with this folding has produced a crenulation folding on a cm scale in some micaceous schists (e.g.218,74) and a compression of the quartz boudins (e.g.74).

Seen particularly well in the heterogeneous schists and psammites of the Lapphelleren, is an earlier style of deformation very different to that described above. This is represented by reclined and recumbant folds which appear to have approximately the same fold axis direction as the open folds (e.g. 92 and Fig.1). These folds have axial surfaces which dip at angles of 15-20° to the S.E. This appears to have been a very intense "plastic" deformation which caused the production of the spectacular psammite boudins in the Lapphelleren schists (e.g.Fig.2) and the production of schistosity and boudinage in the Furulund schists. It must have had a very high shear component.

It is this first deformation which may be the cause of some of the variations in thickness of some of the lithological units. Repeated isoclinal folding may have increased the apparent thickness of some units.

In summary, the area has undergone a regional intensive deformation which has produced the planar fabric which can now be seen. This fabric has been refolded by a locally intense, non-plastic compression. The possible absence of major structures like the Skofferdal anticline in the vicinity implies that this structure may be a single kink-band.

5. MINERALISATION

The largest concentrations of sulphides are to be found in the breccia unit of the Sulitjelma amphibolite cropping out to the east and north of Skofferdalsvann. To the east (x-1025750, y-43250) sulphide rich layers within the breccia are present in stream outcrops. At localities 202A and 205D, layers containing up to 50% pyrite are present: these layers are continuous along strike and are presented in Figs.

To the north of Skofferdalsvann (x-1026000,y-445000) the breccia unit is again seen in small separated outcrops. However, no mineralisation was observed although most outcrops had small percentages (< 5%) of pyrite and weathered rustily.

At the top of the Sulitjelma amphibolite, within the schistose amphibolite facies, are two rusty-weathering schists horizons which contain occasional sulphide minerals and weather to iron hat (localities 85,87), but they are not continuous.

Within the Lapphelleren schists are rust-weathering pods of psammite which occur high on the cliffs. They do not appear to contain sulphides.

Discussion and Comparison with the Stream Sediment Results.

During August 1972 a reconnaissance stream sediment sampling program was carried out by A/S Sulitjelma Gruber, and the samples were analysed by N.G.U., Trondheim, and a report prepared. Streams crossing the breccia outcrops to the east of Skofferdalsvann do not show any marked enrichment in any of the elements analysed for, even when the stream flowed over outcrops of 50% sulphide rock.

The stream sediment samples which do show high Cu, Pb and Zn values are for those streams flowing on Furulund schist. Unfortunately this fact was not known when the outcrop mapping was carried out, and only one locality (74) was made in this apparently interesting area. This observation (74) did not suggest any sulphide concentration, and we suggest that the presence of glacial debris on these slopes may be the source for the high p.p.m. of these elements as observed in the stream sediment samples.

6. EXPLORATION WORK

The most important area lies to the east of Skofferdalsvann on the valley floor. Here higher concentrations of sulphides were discovered in the breccia unit. Careful stream-sediment sampling of the stream network, especially where it dissects the breccia outcrop would be of great value. Soil-sampling would be of limited value because of the extensive covering of drift which probably reaches 10 m in thickness in places. Thus indirect methods of delineating the extent of the sulpide-rich breccia will have to be employed with special reference to electro-magnetic methods.

7. OTHER COMMENTS

The mapping was done using the "Geomap" system of describing localities. Because of a shortage of time a relatively small number of localities were made and a field note book was used to supplement the Geomap forms. The use of a field notebook greatly reduces the number of forms which need to be filled in and helps with the writing of the report.
Standardisation can still be achieved by the use of the Geomap forms,but in any given area there comes a time when the filling in of more forms becomes a waste of time. This could especially be true in an area in which there was little of economical interest.

Gareth Roberts

Michael Taylor

A/S Sulitjelma Gruber
Prospektering 1974
Prosjekt 7.402/D
Feltrapport

TSH/GR/KH
4/11-1974

Detailed geological mapping around the Skofferdal area (EG-214).

Contents

Abstract:

The Sulitjelma amphibolite here is thick and comprises a lower breccia unit and an upper schistose amphibolite unit. In one small area the breccia contains a 2 m thick sulphide-rich horizon.

1. INTRODUCTION

1.1 The area mapped covers about 2.5 sq.km around the perimeter of Skofferdalsvann which lies 10 km to the north west of Furulund Sulitjelma. The area is best reached from Ågifjell where a track leads to Lingås. From there a narrow path can be followed up to the huts at Skofferdalsvann.

1.2 The present work involved detailed outcrop mapping of the Sulitjelma amphibolite as it makes its way slowly up the mountains from Sulitjelma. The amphibolite was mapped from the point where mapping ended in 1973 (northing 2450) to the western edge of sheet EG 214. The only previous work in detail on the area was a preliminary stream-sediment sampling program in 1972.

For most of the area the cliffs are made of Lapphelleren schists and only in the south are amphibolites well exposed. This, together with a lack of outcrop in the valley, meant that the mapping was best done by geological profiles along the streams from the base of the cliffs to the edge of the lake. Altogether 13 geological profiles were completed of which 10 were in streams. All outcrops between profiles are marked on the map although few localities were made in these areas due to lack of time.

2. TOPOGRAPHY

Skofferdalsvann lies in a spectacular glacial corrie which is bounded on three sides by a series of steep cliffs up to 300 m in height. The valley floor has an average height of 550 m and the sides rise up to more than 900 m. At this height is a rolling plateau with much rock outcrop in the form of small scarps. Characteristic of this region are the many small lakes and the stunted vegetation of moss, heather and lichen. The line of cliffs is almost continuous, resulting in a series of waterfalls and can only be climbed in a few places. Beneath the cliffs are steep, grassy slopes often covered with scree and large boulders and genuine outcrops are rare. The valley floor is covered by glacial debris, mostly in the form of drumlins. Outcrops are scarce in the valley beneath the cliffs and are mostly restricted to stream cuttings. The valley floor to the west of Skofferdalsvann is an exception to this, as many outcrops of Furulund schist are seen as roche moutonnée. Close to the lake itself much of the ground is marsh or rough heathland, again with few outcrops.

3. PETROGRAPHY

3.1 The rock units which are present at Sulitjelma are also found at Skofferdal. They are:

	Thickness
Sulitjelma schists	-
Furulund "Granite"	0 - 150 m
Lapphelleren schists	< 300 m
Sulitjelma amphibolite	30- 150 m
Furulund schist	300 m +

3.2 Furulund schist

The Furulund schist forms the lowest unit mapped and petrographically it is identical to the type schists which crop out at Langvann. It is a medium to fine grained, slightly calcareous, mica schist with occasional garnet porphyroblasts and many boudinaged quartz veins. The contact with the overlying amphibolite is not sharp and there is a zone of a few metres in which both Furulund schist and schistose amphibolite are interbedded.

3.3 Sulitjelma Amphibolite

3.3.1 To the south of Skofferdal, Furulund schist passes up into a banded amphibolite unit which is the local base of the Sulitjelma amphibolite. Here (Y-4350 X-2500) is the only part of the area in which the amphibolite is well exposed in the cliffs. It appears to be very thick, perhaps up to 200 m, but some of the thickening may be due to folding.

The banded amphibolite is a medium to coarse grained, hornblende-felspar rock with a prominent uneven banding. The bands are 2-4 cm thick and are very conspicuous on the outcrop surface. This banded amphibolite appears to make up over half of the thickness of the entire amphibolite in the area, but it is not found further north. The remaining amphibolite in this southern area is predominantly fine grained schistose amphibolite although all gradations between these extremes are found. No chlorite breccia was observed in this area.

3.3.2 In the north of the area the outcrops of the amphibolite are few and far between. At the base of the cliffs the upper part of the amphibolite, as exposed in the streams, is always a schistose amphibolite. As such it is the most common aspect of the amphibolite throughout most of Skofferdal. Those outcrops which are found on the valley floor and hence low in the amphibolite unit, show the presence of coarser amphibolites and a chloritic breccia.

The breccia varies considerably in mineralogy, colour and texture but generally it consists of a dark, platy chlorite matrix with boudined, albite rich fragments. Hornblende, biotite and pyrite are common accessories and occasionally large quartz pebbles are present. The latters suggest an agglomeratic origin for this rock.

At one locality (202) a 2 m horizon of a massive pyrite rich (< 50%) chlorite breccia is found. The complex tectonics and the lack of outcrop did not allow this horizon to be followed further than the stream cutting. The other breccia localities (99,222, 252-3, 255-6) had only moderate amounts of sulphides.

At the top of the amphibolite the schistose amphibolite has a gradational contact with the overlying schists. The rocks are layered but generally the proportion of biotite, muscovite and chlorite increases at the expense of hornblende so that the rocks are best described as hornblende mica schists. This zone often contains large numbers of crimson garnets and thin psammitic layers. It is difficult to know where to draw the boundary in such a situation, and in this work the boundary is drawn above the last definite schistose amphibolite band.

3.4 The Lapphelleren Schists

Above the amphibolite at Skofferdal lies a thick sequence of mica schists and psammites which are assigned to the Lapphelleren unit. These rocks form the majority of the cliffs around Skofferdalsvann. The base of the Lapphelleren usually consists of hornblende mica schists with, as mentioned above, sporadic garnets. On the north side of the valley an easily recognisable 2 m horizon of white quartzite occurs low down in the sequence about 10 m above the junction with the amphibolite. The Lapphelleren schists contain one or two rusty horizons which are caused by strange, almost pure, chlorite schist. Higher still in the cliffs can be seen a boudinaged horizon of a rusty psammite. These boudins are up to 15 m thick in the southern cliffs.

Generally the Lapphelleren schists are coarser and contain more quartz and felspar than they do above Sulitjelma and the sequence appears to be thicker. The mineralogy suggests that this is a meta-greywacke sequence.

3.5 The Furulund "Granite"

This unit was only mapped in the south where it appears above the Lapphelleren schists on the plateau above the cliffs. It appears to form a conformable horizon and it looks more like an acid tuff/agglomerate than it does a granite. It contains large quartz fragments, a high proportion of muscovite and small amounts of garnet.

3.6 The Sulitjelma Schists

Above the Furulund "granite" the Sulitjelma schists are developed as a series of fine grained mica schists. They were not mapped in detail.

4. STRUCTURE

The Skofferdal area is a part of a larger structural unit which has a regional strike of about 350° and an average dip of 30° to the N.E. Imposed upon this is an anticline which passes through Skofferdalsvann with a fold axis strike of 040°. This is a solitary fold with an amplitude of perhaps 500 m and a wavelength on the order of 2 km.

Associated with this larger fold and sharing the same regional fold axis are many smaller folds (e.g.247,228). These have wavelengths less than 200 m and locally they are very tight. These folds have the effect of scattering the strike and dip measurements taken in the field and cause the high dips which are recorded at some localities. The deformation which was associated with this folding has produced a crenulation folding on a cm scale in some micaceous schists (e.g.218,74) and a compression of the quartz boudins (e.g.74).

Seen particularly well in the heterogeneous schists and psammites of the Lapphelleren, is an earlier style of deformation very different to that described above. This is represented by reclined and recumbant folds which appear to have approximately the same fold axis direction as the open folds (e.g. 92 and Fig.1). These folds have axial surfaces which dip at angles of 15-20° to the S.E. This appears to have been a very intense "plastic" deformation which caused the production of the spectacular psammite boudins in the Lapphelleren schists (e.g.Fig.2) and the production of schistosity and boudinage in the Furulund schists. It must have had a very high shear component.

It is this first deformation which may be the cause of some of the variations in thickness of some of the lithological units. Repeated isoclinal folding may have increased the apparent thickness of some units.

In summary, the area has undergone a regional intensive deformation which has produced the planar fabric which can now be seen. This fabric has been refolded by a locally intense, non-plastic compression. The possible absence of major structures like the Skofferdal anticline in the vicinity implies that this structure may be a single kink-band.

5. MINERALISATION

The largest concentrations of sulphides are to be found in the breccia unit of the Sulitjelma amphibolite cropping out to the east and north of Skofferdalsvann. To the east (x-1025750, y-43250) sulphide rich layers within the breccia are present in stream outcrops. At localities 202A and 205D, layers containing up to 50% pyrite are present: these layers are continuous along strike and are presented in Figs.

To the north of Skofferdalsvann (x-1026000,y-445000) the breccia unit is again seen in small separated outcrops. However, no mineralisation was observed although most outcrops had small percentages (< 5%) of pyrite and weathered rustily.

At the top of the Sulitjelma amphibolite, within the schistose amphibolite facies, are two rusty-weathering schists horizons which contain occasional sulphide minerals and weather to iron hat (localities 85,87), but they are not continuous.

Within the Lapphelleren schists are rust-weathering pods of psammite which occur high on the cliffs. They do not appear to contain sulphides.

Discussion and Comparison with the Stream Sediment Results.

During August 1972 a reconnaissance stream sediment sampling program was carried out by A/S Sulitjelma Gruber, and the samples were analysed by N.G.U., Trondheim, and a report prepared. Streams crossing the breccia outcrops to the east of Skofferdalsvann do not show any marked enrichment in any of the elements analysed for, even when the stream flowed over outcrops of 50% sulphide rock.

The stream sediment samples which do show high Cu, Pb and Zn values are for those streams flowing on Furulund schist. Unfortunately this fact was not known when the outcrop mapping was carried out, and only one locality (74) was made in this apparently interesting area. This observation (74) did not suggest any sulphide concentration, and we suggest that the presence of glacial debris on these slopes may be the source for the high p.p.m. of these elements as observed in the stream sediment samples.

6. EXPLORATION WORK

The most important area lies to the east of Skofferdalsvann on the valley floor. Here higher concentrations of sulphides were discovered in the breccia unit. Careful stream-sediment sampling of the stream network, especially where it dissects the breccia outcrop would be of great value. Soil-sampling would be of limited value because of the extensive covering of drift which probably reaches 10 m in thickness in places. Thus indirect methods of delineating the extent of the sulpide-rich breccia will have to be employed with special reference to electro-magnetic methods.

7. OTHER COMMENTS

The mapping was done using the "Geomap" system of describing localities. Because of a shortage of time a relatively small number of localities were made and a field note book was used to supplement the Geomap forms. The use of a field notebook greatly reduces the number of forms which need to be filled in and helps with the writing of the report.
Standardisation can still be achieved by the use of the Geomap forms,but in any given area there comes a time when the filling in of more forms becomes a waste of time. This could especially be true in an area in which there was little of economical interest.

Gareth Roberts

Michael Taylor

KEY 7.402/D

EG 214 . 7.402/D

STRUCTURE AND STREAM NUMBERS

x 1027 000

59 SULITJELMA SCHISTS

15 FORULUND GRANITE

62 LAPPHELLEREN SCHISTS

53 SULITJELMA AMPHIBOLITE

46 " " (BRECCIA)

6 FORULUND SCHISTS

OUTCROPS WITH LOCALITY NUMBERS

SMALL CLIFFS OR SCARPS

CLIFFS OVER 10 m HIGH

NOT MAPPED

STEEP GRASS SLOPES

MANY SMALL SCARPS

x 1026 000

KEY

DIP AND STRIKE

ANTICLINE

SYNCLINE

Strike of Fold axis

Position of the SKOFFEDAL ANTICLINE

STREAM NUMBERS

SMALL CLIFFS

x 1025000

SKOFFEDAL

Geologisk blotningskart

EDB-nummer

Tegn.	MRT	5.8.74
Trac.	"	"
Kfr.	TSH	19.8.74

M: 1:10.000

A/S SULITJELMA GRUBER

Prospektering 1974

Prosjekt 7.402/D

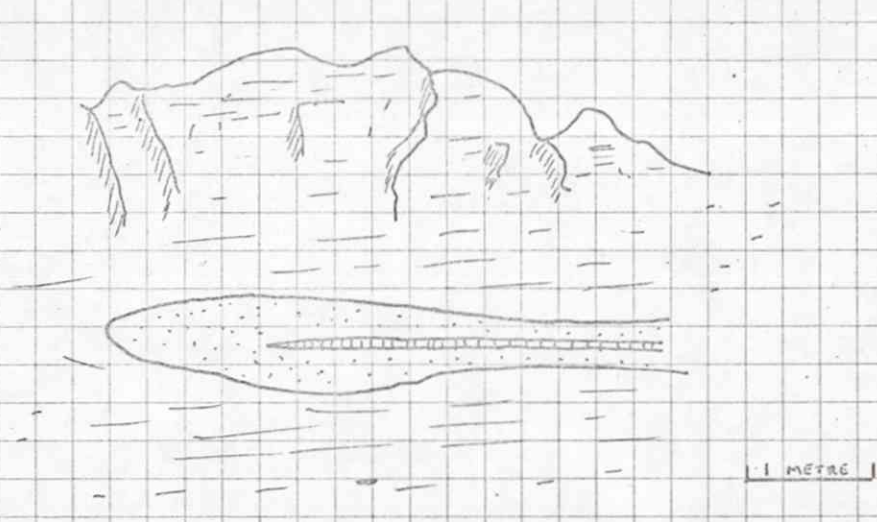


FIG 1 RECUMBANT ISOCLINAL FOLD OF RUSTY PSAMMITE IN MICA SCHIST LOC:- 94

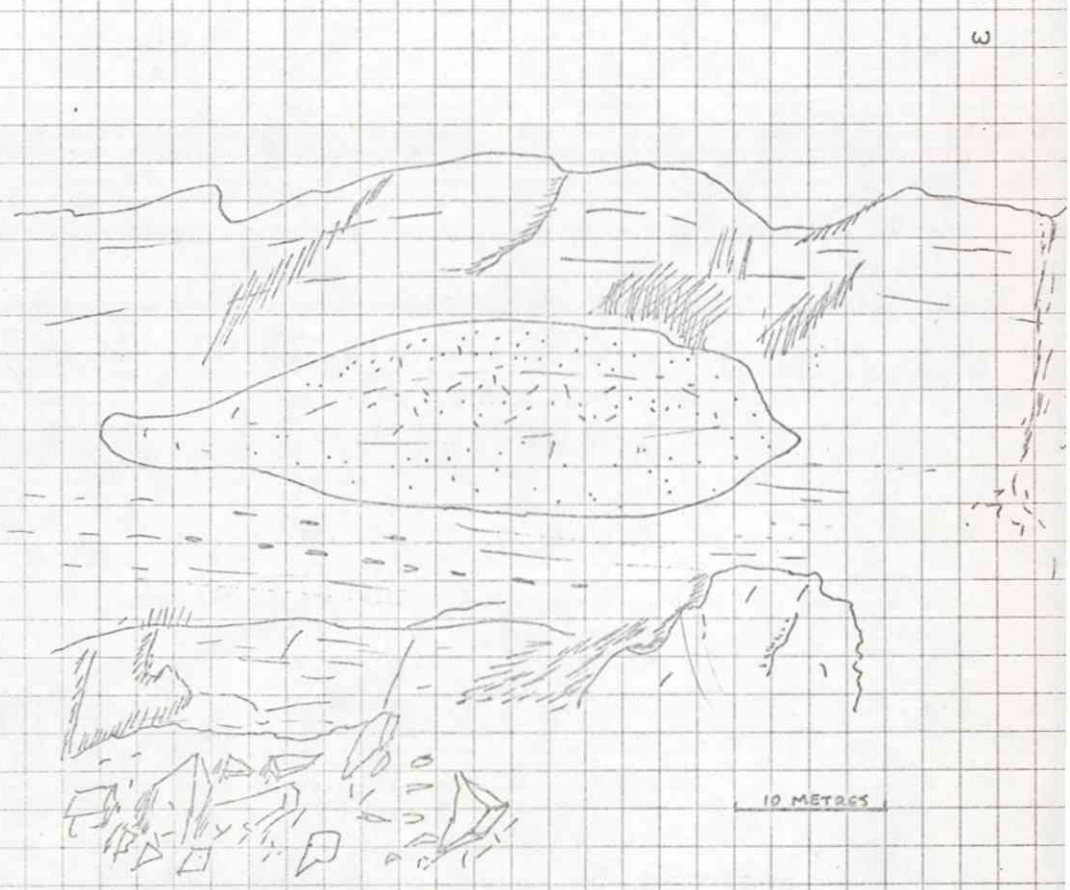


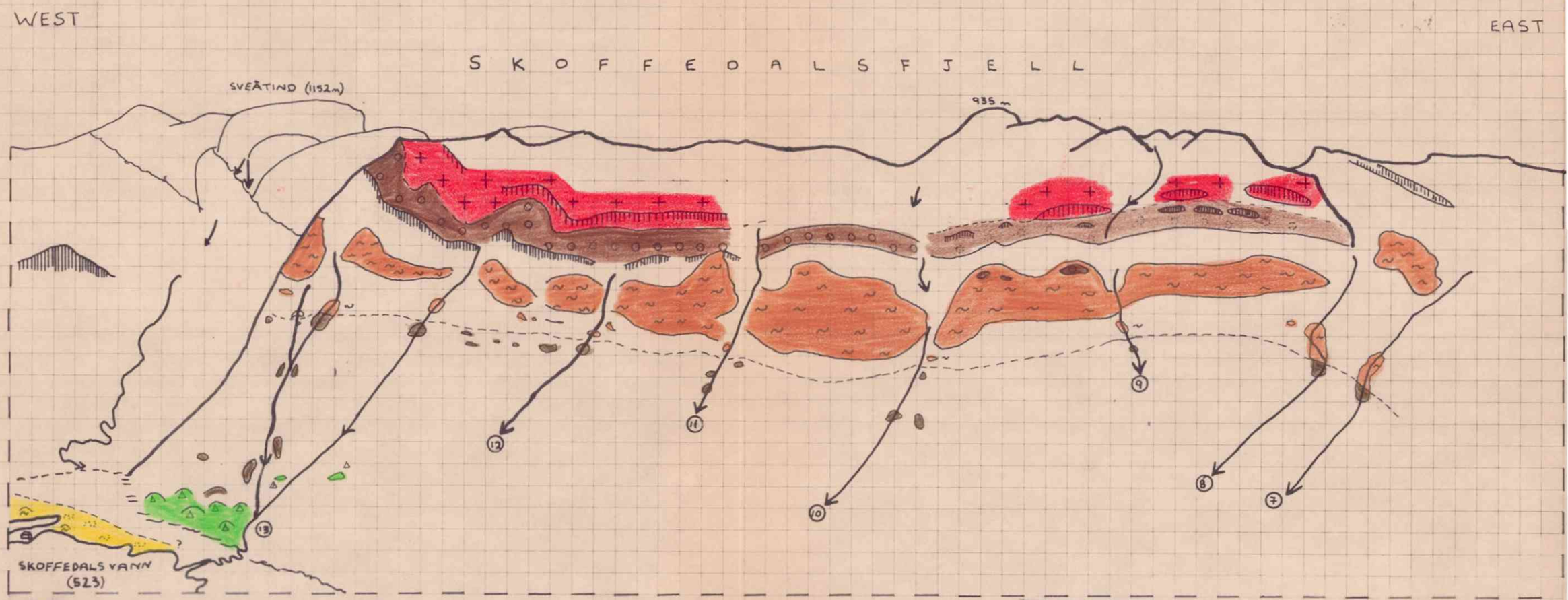
FIG 2.

LARGE PSAMMITE BOUDIN IN MICA SCHISTS NO LOCALITY

LAPPHELLEREN SCHIST IN CLIFFS SOUTH OF SKOFFERDALSVANN

R.G. 7.402/D

FIG. 3 SKETCH TO SHOW THE GEOLOGY OF THE NORTHERN VALLEY SIDE OF SKOFFEDAL



FURULUND GRANITE.

RUSTY PSAMMITE SCHISTS — LAPPHELLEREN SCHIST.

SCHISTOSE AMPHIBOLITE BRECCIA — SULITJELMA AMPHIBOLITE.

FURULUND SCHIST.

⑨ GEOLOGICAL PROFILE

FORMATION BOUNDARY

CLIFF

ROCK OUTCROP

STREAM

SCALE

0 250 500 m

SKOFFEDALSFJELL Geologisk skisse	Tegn.	MRT 15/8.74
	Trac.	" "
	Kfr.	TSH 19/8.74
	M: ca. 1:8000	
A/S SULITJELMA GRUBER Prospektering 1974 Prosjekt 7.402/D		

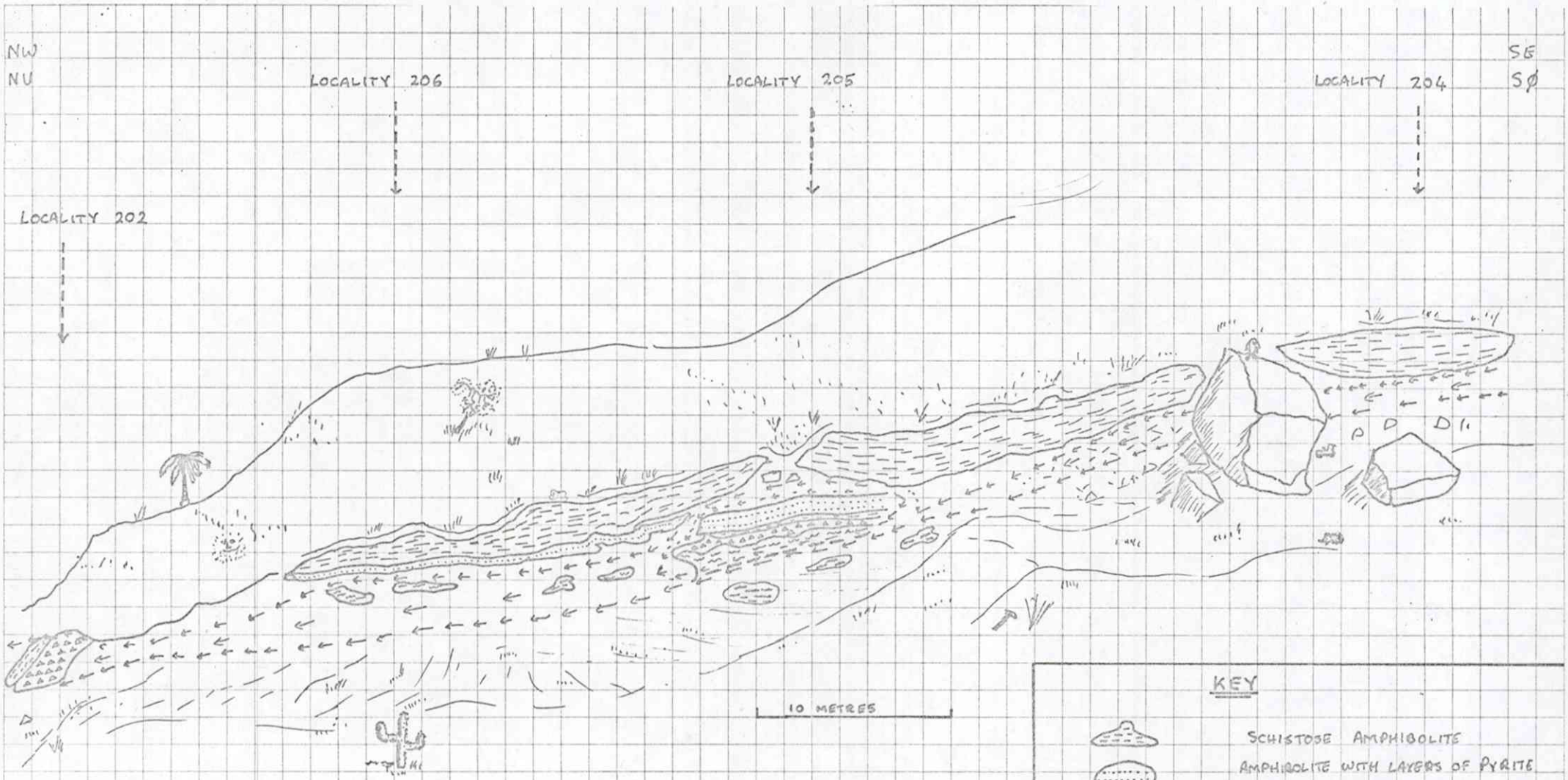


FIG 4 DIAGRAM OF STREAM PROFILE 4 (X-2560, Y-4320)

GR. 7.402/D

50977

FJELLANGER WIDERØE A-S
INGENIØR- OG ARKITEKTFIRMA

Fotogrammetrisk konstruksjon 1971

N.G.O.s höyder og koordinatsystem

EF 215	EG 215	EH 215
EF 214	EG 214	EH 214
EF 213	EG 213	EH 213

Tegn.	L/C	-73
Trac.	"	"
Kfr.	TSH	

A/S SULITJELMA GRUBER
PROSPEKTERING 1973
PROSJEKT 7.301

SULITJELMA M 1:10000 EKV. 10 M
SKOFFEDALEN
Geologisk blotningskart – Lokalitetsnr. EDB

KEY

E.G 214 . 7.402/D

STRUCTURE AND STREAM NUMBERS

x 1027 000

59 SULITJELMA SCHISTS

15 FORULUND GRANITE

62 LAPPHELLEREN SCHISTS

53 SULITJELMA AMPHIBOLITE

46 " " (BRECCIA)

6 FORULUND SCHISTS

54 OUTCROPS WITH LOCALITY NUMBERS

SMALL CLIFFS OR SCARPS

CLIFFS OVER 10 m HIGH

NOT MAPPED

STEEP GRASS SLOPES

MANY SMALL SCARPS

x 1026 000

KEY

15 DIP AND STRIKE

ANTICLINE

SYNCLINE

Strike of Fold axis

Position of the SKOFFEDAL ANTICLINE

(9) STREAM NUMBERS

SMALL CLIFFS

x 1025000

SKOFFEDAL

Geologisk blotningskart

EDB-nummer

A/S SULITJELMA GRUBER

Prospektering 1974

Prosjekt 7.402/D

Tegn.	MRT	5.8.74
Trac.	"	"
Kfr.	TSH	19.8.74

M : 1:10.000

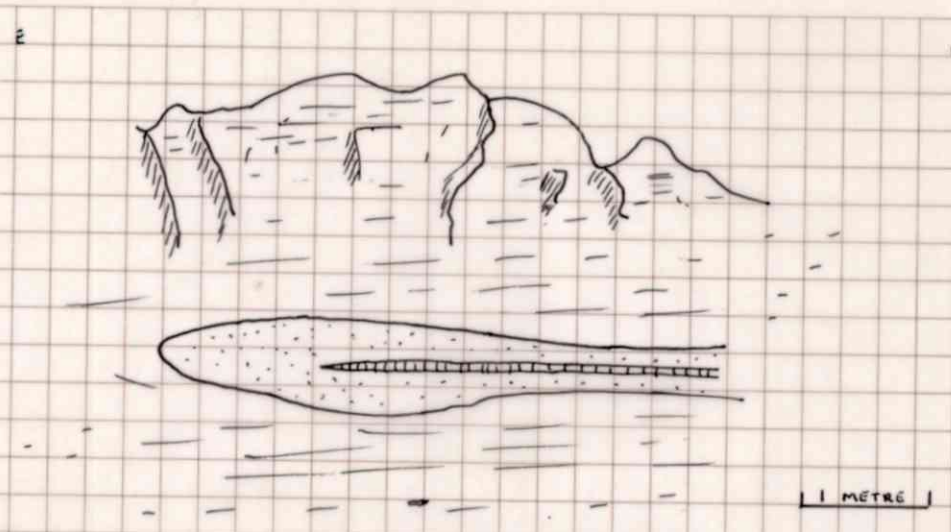


FIG 1 RECUMBANT ISOCLINAL FOLD OF RUSTY PSAMMITE IN MICA SCHIST LOC:- 94

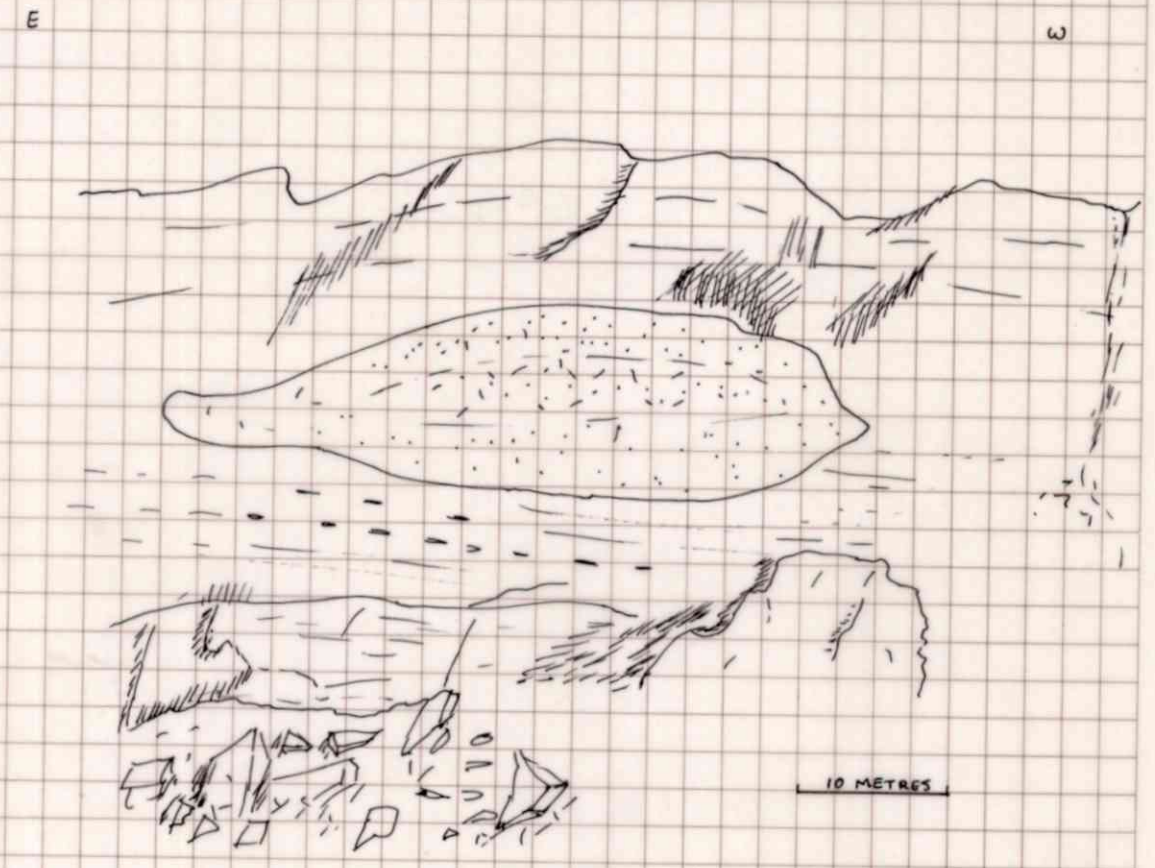


FIG 2.

LARGE PSAMMITE BOUDIN IN MICA SCHISTS NO LOCALITY

LAPPHELLEREN SCHIST IN CLIFFS SOUTH OF SKOFFEDALSVANN

R.R. 7.402/D

NW
NU

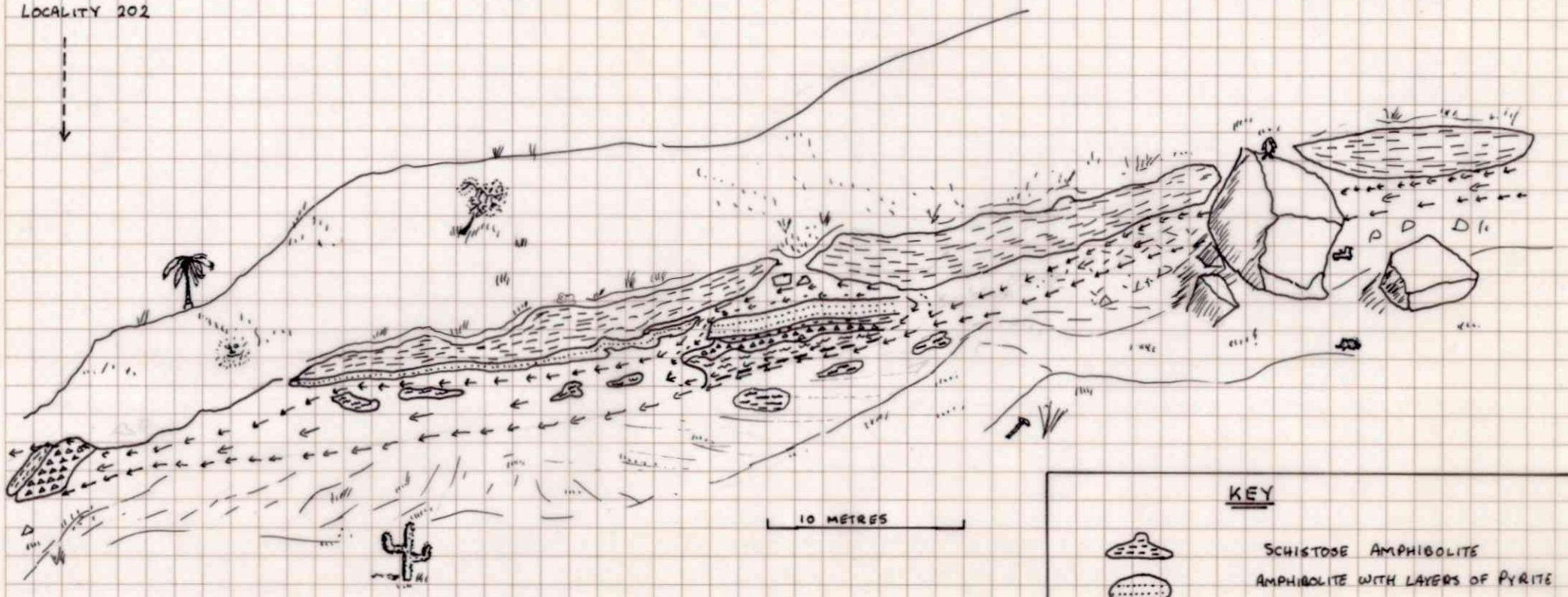
SE
SØ

LOCALITY 206

LOCALITY 205

LOCALITY 204

LOCALITY 202



KEY

SCHISTOSE AMPHIBOLITE

AMPHIBOLITE WITH LAYERS OF PYRITE

ORE HORIZON

DARK CHLORITE BRECCIA

BOUNDARIES OF STREAM

FIG 4 DIAGRAM OF STREAM PROFILE 4 (X·2560, Y·4320)

GR. 7·402/D

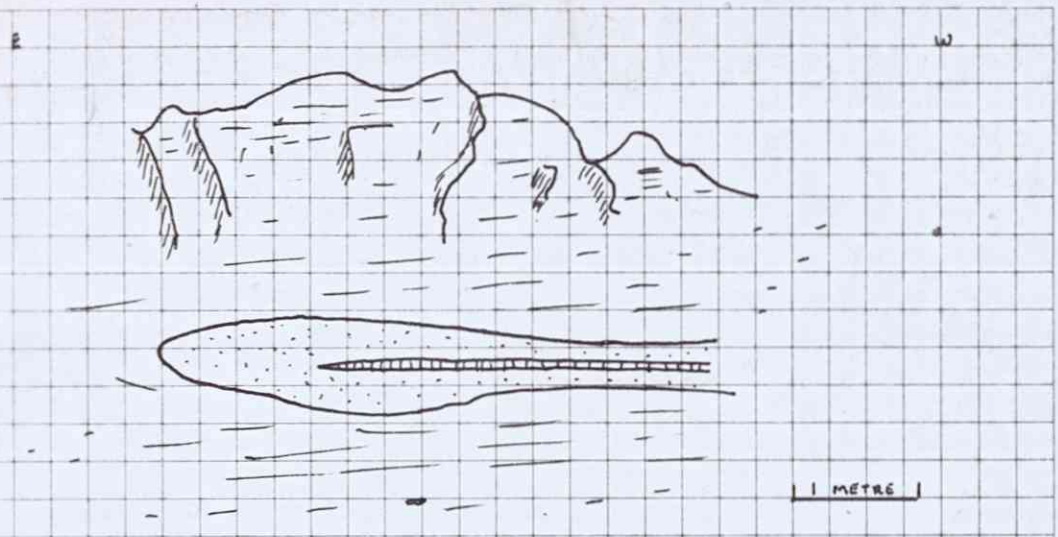


FIG 1 RECUMBANT ISOCLINAL FOLD OF RUSTY PSAMMITTE IN MICA SCHIST. LOC:- 94

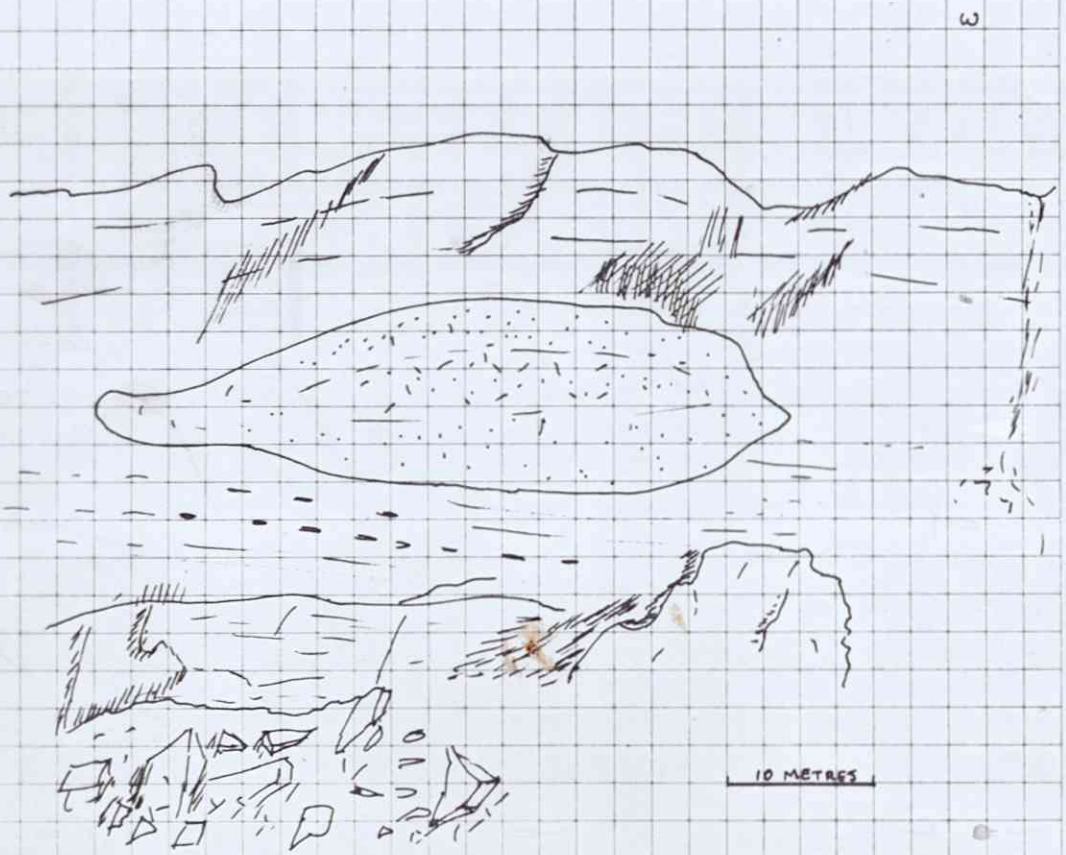


FIG 2.

LARGE PSAMMITE BOUDIN IN MICA SCHISTS NO LOCALITY

LAPPHELLEREN SCHIST IN CLIFFS SOUTH OF SKOFFGÅLSVANN

B.B. 7.602/D

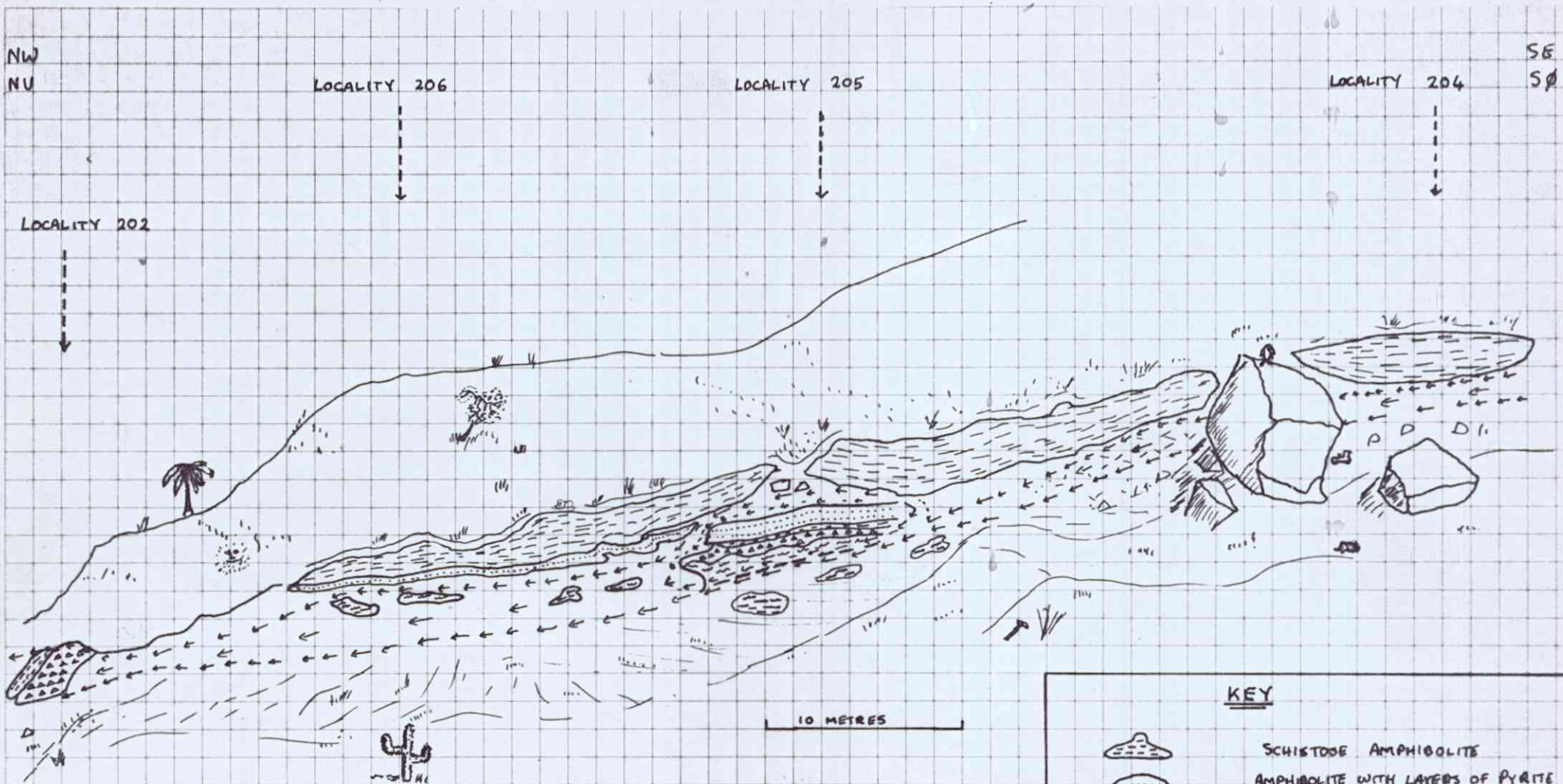


FIG 4 DIAGRAM OF STREAM PROFILE 4 (X-2560, Y-4320)

PR. 7402/D