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A report on the geology of an area close to Anna Gruber.

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Sammendrag

Rapporten skildrer bergartene over og under Sulitjelmaamfibolitten rundt Anna gruve. Disse er stort sett kalkrike skifre, skifrig amfibolitt, metadoleritt, granitt og marmor. Litologi, strukturgeologi og metamorfosegrad er diskutert.

A report on the Geology of an area close to

ANNA GRUBER

JOHN. R. WAROLE

Summer 1978

CONTENTS

Introduction

The Sulitjelma Amphibolite outcrops south of Lang Vann as thin discontinous units that are involved in a complex relationship with the chlorite rich rocks of the Junction unit. Several authors have suggested that a thrust surface lies immeadiately above the Amphibolite.

The rocks above and below the Sulitjelma Amphibolite consist predominantly of Calc-schists with related schistose-amphibolite, meta-dolerite, Granite and Marble.

This report describes an area running E-W across the amphibolite through Anna Gruber. The succession has been divided up into upper- Junction- and lower- units after Henley (1970)

Lithological Succession

Lower unit.

The lower unit is made up entirely by the Furulund group in this area. This consists of a series of fine grained Calc-schists that frequently contain Garnet and Hornblende. They are grouped together as the Furulund schist.

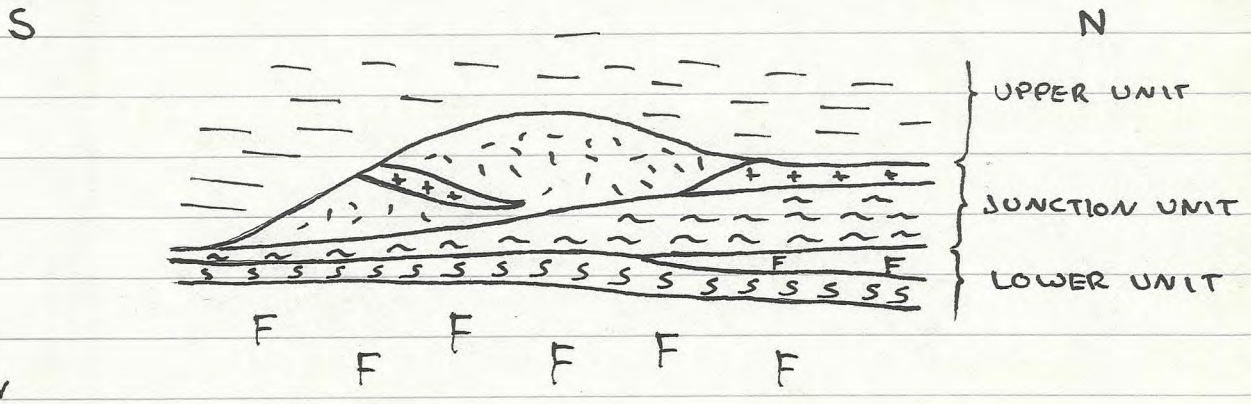
Isolated lenses of Amphibolite are found within the schist. They were originaly intrusive and seem to have been emplaced Pre-Schistosity. They are refered to as Meta-Dolerites.

Towards the top of the Furulund schist thin quartzite bands and a conglomerate are found. The conglomerate is discontinous and consists of metaquartzite pebbles in an amphibolite matrix. It reaches a maximum thickness 3m and is best exposed north of the area mapped.

The top of the Furulund schist is marked by the lower ore horizon, which in the north of the area is seperated from the Junction unit by a thin schist band. The lower ore horizon consists of ≈ 2m of a Quartz-Chalcopyrite-Pyrite-Pyrrhotite rock in the north of the area, but southwards the grade decreases until only a

Junction Unit

The Junction unit consists of:- Amphibolite, Chloritic Granite, Chloritic Breccia and the UPPER ore horizon. The relationships between them is illustrated by this diagrammatic section from north to south through the Junction unit.



KEY

- MIDDLE SCHIST
- AMPHIBOLITE
- CHLORITIC GRANITE
- UPPER ORE HORIZON
- LOWER ORE HORIZON
- F F FURULUND SCHIST

The upper ore horizon consists of ore enriched Chloritic Breccia that often contains significant amounts of amphibole. The commonest ore minerals present are:- Pyrite, Sphalerite, Chalcopyrite. They occur within quartz veins and lenses that are embedded in a Chlorite-Muscavite matrix. The upper ore horizon thins southwards but the grade of ore enrichment remains approximately constant. Minor ore minerals present include:- Bornite, Malachite, Covellite and Arseno-Pyrite.

The amphibolite is fine grained and massive. The regional schistosity is poorly developed and it has colour bands and lenses. The base of the amphibolite consists of amphibolitic Chloritic Breccia at many localities. It thins out southwards

and passes into the Chloritic-Granite northwards.

The chloritic-Granite is a Quartz-Feldspar rock that contains subordinate Chlorite and/or Biotite. At some localities it has a mylonitic texture. At one locality an outcrop of Amphibolite is found within the chloritic-Granite, and a vein of Chloritic-Granite is seen cutting through the main Amphibolite body.

Upper Unit

Above the Junction unit are a series of schists. The lowermost one is called the Middle schist. It is a Garnet-Mica schist of variable grain size that frequently contains Hornblende, and occasionaly contains Staurolite.

Running through the middle of it is a sill like body of coarse grained, Augen, 2 mica Granite that reaches a maximum thickness of ≈ 30m. It possesses the regional schistosity. The boundary between this Granite and the middle schist is gradational, passing through a wide zone of Granite schist.

Several discontinous outcrops of schistose amphibolite and a poorly exposed sugary marble are also found within the middle schist. The marble is exposed as a thin band ≈ 1m thick, minerals of the Tremolite-Actinolite series being associated with it.

Above the middle schist the rusty horizon occurs. This ≈20m thick and consists of alternating bands of phyllite and psammite of about 5cm thickness. The unit weathers to a rusty colour. It has a Gradational boundary with the calc schist. The Calc schist is a series of fine grained Calc schists that frequently contain Diopside and Kyanite. Distinct psammite bands upto 5m thick are common.

Cross cutting the regional schistosity of the calc-schist are a set of Microgranite dykes. They have an average width of 1m, and show chilled margins. The Diopsidic schist is restricted to a band that contains the majority of the dykes.

The calc-schist and Diopsidic-schist together are about 1800 m thick. The highest unit mapped is a coarse Kyanite-Garnet-Muscovite schist.

Structural Geology

No large-scale structures can be directly observed within this area. The regional schistosity has a N-S strike with a vasiable westerly dip.

The minor folds can be divided into three categories.

① Pre-schistosity Isoclinal folds. These are seen in the Furulund schist and the calc schist. They have variable fold axis values and are not seen to exceed 0.5m in width.

② Post-Schistosity folds with W to SW plunging fold axis. These are particularly common in the middle schist. Several Antiform-Synform pairs can be recognised with ≈ 300m between their fold axis.

③ Post-schistosity folds with N-S fold axis. These are variable in size and seem to be conjugate minor folds related to a major synform west of this area. They account largely for the variation in the dip of the ~~area~~ schistosity.

Large scale flatening has occured in the succession. This is indicated by the common occurance of, and Pinch and Swell structures. The main amphibolit body in the Junction unit is itself a large lens, and the outcrop pattesns of the meta-dolerik and the schistose amphibolit seem to be due to lensing. The ore body at Anna Gruber is a lens shaped body with a SW plunging long axis. The majority of this lens has however been removed by erosion. The variation in dip of the schistosity is also partly due to the schistosity bending around lens shaped bodies such as the main amphibolite.

There is a general tendancy for all the units to thin southwards. It is uncertain whether this is a structural or stratigraphical feature.

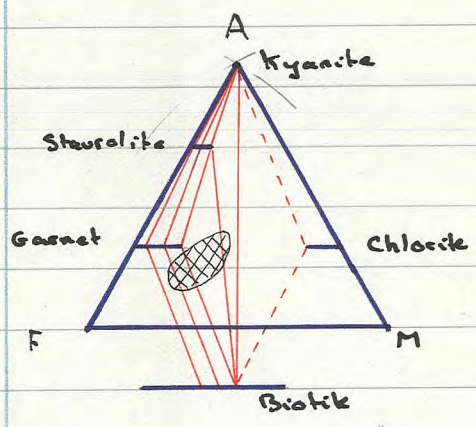
No significant faulting is seen in the area, though there is a set of near vertical master joints that have a strike of 315°.

Metamorphism

The whole succession has undergone regional metamorphism up to a high grade. Kyanite is common in the Calc schist and Staurolite, Hornblende and Garnet are found in the major units. Kyanite and Staurolite are more common to the west of the area, which indicates increasing metamorphic grade passing westwards.

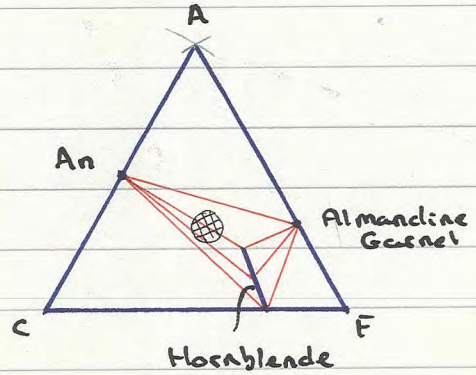
The metamorphism of the marble has caused the formation of Tremolite-Actinolite series minerals. The Arseno Pyrite in the ore horizon is pseudomorphing Pyrite. This may be due to metamorphism

The regional metamorphism of the Pelites has reached Kyanite grade and the amphibolites belong to Eskola's Amphibolite facies. So it is reasonable to assume that the metamorphism was of a Medium pressure Basic type.



AFM diagram to illustrate the mineral assemblages of the meta-pelites.

= area of observed mineral assemblages



ACF diagram to illustrate the mineral assemblages of the meta basites

NB: These diagrams are based on field observations only and can be taken as a guide only

The large amounts of chlorite in the Junction unit must be due to retrogressive chloritisation as chlorite is unstable at Kyanite grade.

The Diopside present in the calc schist is a contact metamorphic effect due to the intrusion of the micro-granite dyke complex. The limits of the Diopside schist cross cut the regional schistosity, which indicates that the dyke complex was intruded post schistosity

Discussion

Several authors have postulated thrusts in the Sulitjelma succession. Kautsky (1953) put one above, and one below the Sulitjelma amphibolite. But Henley (1970) modified this and suggested that a thrust was present only above the Sulitjelma amphibolite. In this area the Sulitjelma amphibolite is represented only by the main amphibolite lens. The presence of a thrust is suggested by the chloritic breccia, but this is found underneath or at the base of the amphibolite. So in this area a thrust can only be postulated between the Furulund schist and the amphibolite.

The origin of the Chloritic Breccia is problematical as it is uncertain whether it was produced solely by thrusting, or whether it was a primary fragmental rock. However, the presence of the amphibolite conglomerate in the Furulund schist suggests that a similar such rock may have been the origin for the chloritic breccia. It would have acted as a weak horizon that would have allowed thrusting to occur, and the amphibolite matrix would have been altered to the chlorite-Muscovite matrix in the Chloritic Breccia.

The amphibolite conglomerate itself may represent a metamorphosed volcanic conglomerate. The amphibole in the matrix could have been derived from a pyroxene rich ash.

The main amphibolite body possesses light coloured bands and clast shaped bodies. These may be evidence of a sedimentary origin for this amphibolite.

The Chloritic-Granite passes laterally into this amphibolite and it appears that it was formed by

the alteration of the amphibolite, presumably by thrusting.

The Genesis of the ore bodies is uncertain - They have a close relationship with the chloritic Breccia and it is likely that they formed Pre-Thrusting, with later alteration occuring.

Field observations do not give any good indication of the original environment of deposition, except that the presence of a conglomerate indicates shallow water. With the exception of the ⊕ Meta-Dolerites, the origin of the Amphibolites is at present unknown.

References

Henley K-J 1970 The structural and metamorphic History of the Sulitjelma region, Norway, With Specid reference to the Nappe Hypothesis. N.G.T Vol 50 pp 97-136

Kautsky G 1953 Der Geologische Bau des Sulitjelma S.G.U Ser C No. 528

JOHN. R. WARDLE
UNIVERSITY COLLEGE LONDON
31-8-78

APPENDIX

Log of Borehole no. 185

co-ordinates { X 1014 295
Y 39 323

Depth (m)	Lithology and mineralisation
0	Fine Biotite schist with frequent quartz veins
296·6	Coarse grained sugary marble
296·8	Biotite schist
299·7	Coarse grained sugary marble
300·0	Biotite schist
305·2	Granitic schist . Pyrite at 308·1
316·8	Schistose Granit. Has an Augen texture.
319·7	Granitic schist
350·0	Biotite schist.
380·0	Granitic schist . Pyrite at 399·0. Garnet at 390·7
400·0	Biotite schist.
411·5	Keratophyre. Resembles chloritic granite.
413·0	Biotite schist
	Garnetiferous Amphibolite at 422·7
	Pyrite at 432·0
	Pyrite and Chlorite at 449·0
461·4	Biotite schist with Pyrite. Magnetite at 462·2
465·7	Chloritic Breccia with: Magnetite, Pyrite, Chalcopyrite.
475·3	Fine Grained schist (Fundund?)
	Amphibolite at 480
490·0	

8

Anna

KEY TO MAP

MAIN UNITS

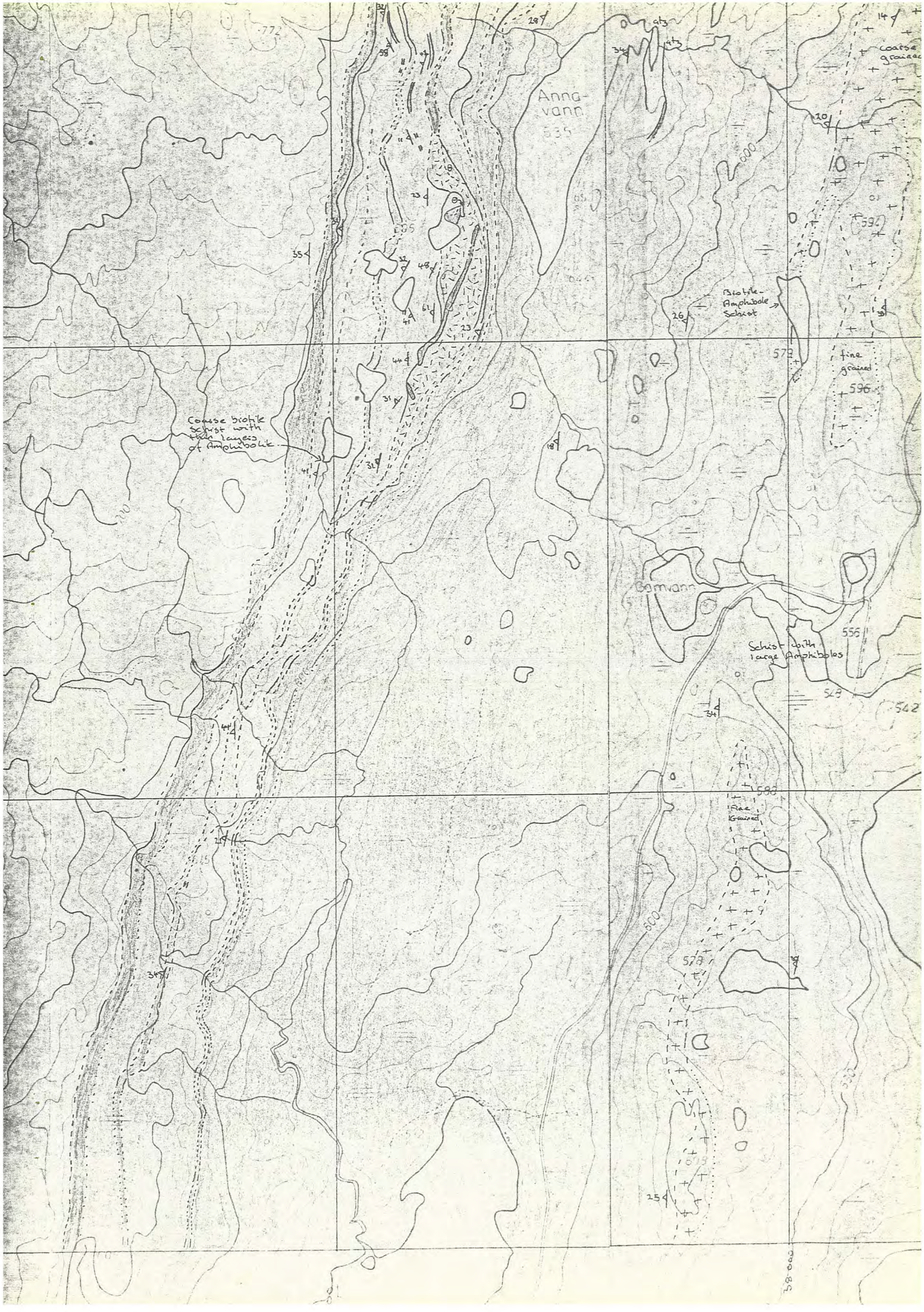
- KYANITE SCHIST
- BANDED CALC SCHIST
- CALC SCHIST
- DIOPSIDIC SCHIST
- RUSTY HORIZON
- MIDDLE SCHIST
- AUGEN GRANITE
- MASSIVE AMPHIBOLITE
- CHLORITIC GRANITE
- UPPER ORE HORIZON
- Rusty Schist. / ore — LOWER ORE HORIZON
- FURULUND SCHIST
- META DOLERITE

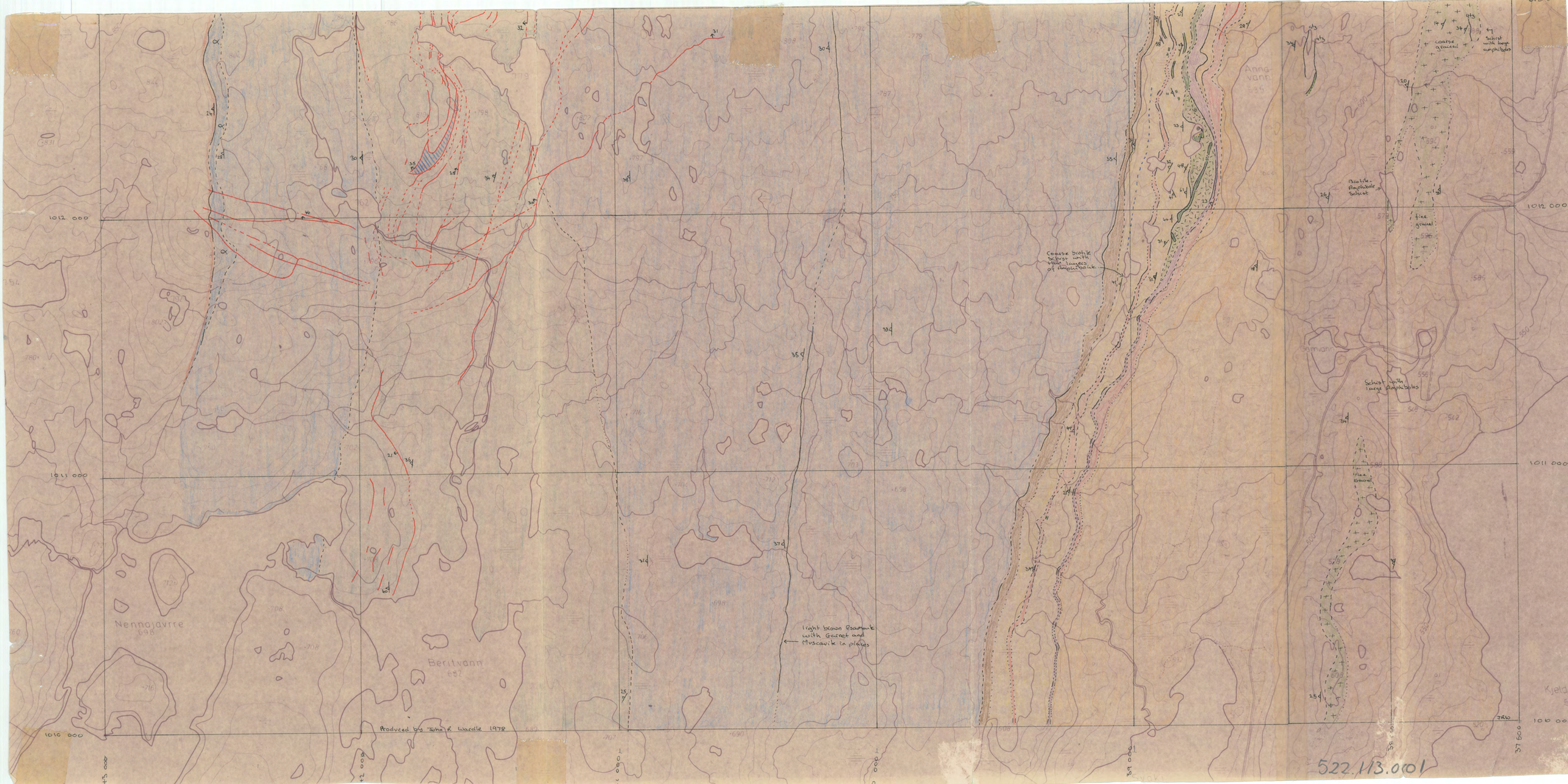
Other lithological units.

- continous exposure / discontinous " } Microgranite Dyke
- Granite/Schist Complex
- Marble
- Schistose Amphibolite
- Chloritic Breccia in Amphibolite.

Symbols

- 43 — Dip and strike of Schistosity
- 21 — Dip of Granite dyke


Anng-
vann
535
Biotite-
Amphibole
Schist
coarse
grained
fine
grained
Coarse biotite
schist with
thin layers
of Amphibolite
Bomvann
Schist with
large Amphiboles
Fine
Grained


1012 000
1011 000
1010 000
Nennajavrre
698
Beritvann
652
Produced by John R Wardle 1978
Light brown Roanmk with Garnet and Muscovite in places
Coarse biotite Schist with thin layers of Amphibolite
Biotite-Amphibole Schist
coarse grained
Schist with large amphiboles
fine grained
Schist with coarse amphiboles
fine grained
Anna vann
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