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Malm/metall	Cu

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

Hensikten med prosjektet beskrevet i rapporten, var en mer detaljert blokkleting, et mer nøyaktig magnetisk kart og en detaljert geologisk kartlegging.
Områdets forskjellige bergartstyper er beskrevet med detaljer i forhold til struktuerer og tektonikk. Bergartenes omvandling berøres.
Geofysisk vises til korrelasjon mellom magnetiske data og strukturene. Grafittskifrenes forhold til EM-bildet og sammenhengen med strukturene blir diskutert.
Den økonomiske geologi gås gjennom ut fra en drøftelse av forskjellige blotningsfunn og med referanse til utført diamantboring.
Det anbefales oppfølging av rike blokker nord for leiren og oppfølging av forkastningssonene som krisser Suovra-antiklinalen. Videre anbefales oppfølging av mineralisereingen utover fra Njivlle-Roavve.

SUOVRARAPPAT 1962.

Geologisk rapport utarbeidet av Barnet og Livgård
John C.

Contents:

I INTRODUCTION.

Previous examination of the Suovra area, from 1958 to 1961, indicated that there were copper deposits there of possibly economic interest.

Block-search, diamond-drilling and electro-magnetic surveys had already been employed but this year it was decided to undertake block-search in more detail, to produce a more accurate magnetic map, and to produce a detailed geological map.

The area covered by this geological map is on the eastern side of the Mollis sheet (sheet 1833 IV). It is bounded on the North by Gaiddavarre and Goarvvevarre, on the East by Salggevarre and Jägeloaivve, on the South by Njivlle-Roavre, and on the West by Sieidas.

II ROCK TYPES.

The Pre-Cambrian stratigraphy of this area consists in the lowest part of a series of so-called greenstones (layered tuffs, a few agglomeratic layers, and intrusive amphibolites). This greenstone series contains several layers of graphitic slate and a quartzitic fels, and is succeeded by an argillite band and a thick breccia/agglomerate. This in turn is succeeded by a broad series of argillites, which eventually gives way to the quartzite on Salggevarre and Jägeloaivve. Thus the succession youngs from West to East, on the Eastern limb of a main anticline.

There is much albite-carbonate metasomatism in the area, mainly confined to a kilometre-wide zone West of Jägelgielas and which extends southwards to Njivlle-Roavve. Lesser occurrences are found to the West of this zone. All occur in the greenstone series therefore . On the West side of Jägelgielas there is also an intrusive albite-carbonate dyke.

The Pre-Cambrian rocks are succeeded in the North and West by the Caledonides. In the North of the area the horizontal basal Cambrian conglomerate is seen to rest on the almost vertical quartzite of the Pre-Cambrian - in Sallejokka, North of Salggevarre.

The details of these rock types are described below:

a) Layered tuffs ('stratified greenstones)

These are extremely finely-layered, fine-grained and well stratified rocks, green in colour, with some grey banding. They are sometimes slaty.

Microscopic examination shows them to consist of irregular felspar laths, with their long axes orientated in the plane of the bedding, and which contain many small laths of chlorite. The felspar constitutes about 60% of the rock, the chlorite about 40%. Occasional layers contain irregular pyrite crystals.

The chlorite content was possibly originally derived from hornblende.

b) Green agglomerates.

These occur as a few thin impersistent layers in the albite-carbonatised greenstones West of Jägelgielas.

They are slightly schistose, with a dark green ground-mass containing rounded or lensoid fragments of light-green, or occasionally black colour.

These fragments are seen, under the microscope, to be composed of albite and carbonate crystals arranged at random, and the groundmass to consist of albite, calcite and large ragged chlorite crystals. Cubes of pyrite are scattered throughout.

c) Amphibolites (unstratified greenstones).

These rocks are usually medium-grained, sometimes coarse-grained, mottled light and dark green.

Microscopically they show ophitic texture - large irregular hornblende crystals which make up about 20% of the rock, containing randomly-arranged thin laths of felspar, scattered usually irregular crystals of pyrite and a little sphene.

These amphibolites are certainly intrusive - at least in many cases. In one case, for instance, an amphibolite cuts across several layers of stratified tuffs. Also, next to its boundary with an amphibolite, a layered tuff was seen to change from its normal unaltered state (see above) into a rock with alternating felspar-rich and hornblende-rich layers, with small chlorite crystals scattered throughout.

Next to their boundaries, amphibolites can often be seen to be finer-grained, and lighter in colour. This occurs on both boundaries of a particular layer in those cases where both boundaries are exposed.

d) Graphitic slate.

This is dark-grey or black, slaty and so fine-grained that the mineralogy cannot be observed by microscopy - except to indicate appreciable graphite content.

Layered tuffs often contain slightly graphitic bands.

e) Quartcitic fels.

This is a light-grey, fine-grained quartz-rich and fractured rock.

f) Argillite.

This is fine-grained, darkgrey and fissile.

g) Agglomerate / Breccia.

This rock has a reddish or yellowish carbonate ground-mass containing fragments of mainly felspar and also quartz and flakes of muscovite and a little fuchsite.

The weathered surface appears distinctly cindery as the softer carbonate is weathered away to expose the fragments which it contains.

On the western side of the outcrop it is obviously brecciated in many places, and where it lies against the argillite band on the West, the fragments it contains are almost exclusively of this argillite.

On the eastern side of the outcrop, however, it is distinctly agglomeratic.

Microscopic examination shows that this rock is coarse-grained, with fragments and crystals of albite, carbonate and a little mica, contained in a ground mass of albite and carbonate.

The proportions of albite and carbonate among the fragments, and in the ground-mass, are the same - 55 - 65 % albite, 35 - 45 % carbonate.

The albite fragments consists either of large, usually ir-

regular, crystals, up to ½ centimetre across, sometimes showing lamellar twinning, or of aggregates of small, irregular crystals.

The carbonate crystals are allotriomorphic. Fuchsite, muscorite and scattered, irregular pyrite crystals can also be seen under the microscope.

The outcrop of this rock is about 350 metres broad, apparently thinning both to the North, and to the South. It seems to be conformable, striking North-South.

h) Quartzite.

This is a grey medium-grained rock showing ripple marks and graded bedding. Pebbles of pink and white quartz are found in occasional lenses.

The ripple marks show that in the North and centre of the area, the succession is the right way up.

j) Albite-carbonate rocks.

As these are metasomatic, there are all gradations between them and ordinary non-metasomatised tuffs and amphibolites.

The rocks described under this section are representative of the more advanced products of this metasomatism.

Also described under this section are the albite-carbonate intrusion, and a carbonate vein.

I Albite-carbonate rock from North end of Suovrajavrre. This is a greyish, compact, medium-grained rock with dark pink layers.

Under the microscope it is seen to consist of small, allotriomorphic albite crystals (60%) and irregular hornblende crystals arranged randomly (40%). Pyrite is scattered throughout.

II Albite-carbonate rock from 600 m North of Suovrajavrre. This is a compact rock with fine layering - possibly relict stratification. It is yellowish-pink with green bands when fresh, but weathers to light brown on the surface.

It is very fine-grained, consisting of small allotriomorphic carbonate crystals (10-15%) in a ground mass of even smaller irregular crystals of albite. It also contains a few crystals of larger albite, and of hornblende and pyrite.

III Albite-carbonate rock from 50 metres South of southern termination of calcite vein.

This is a very fine-grained, compact rock, greyish with a few darker bands. It contains numerous rhombs of brown carbonate, about ½ cm across.

The ground-mass containing these calcite rhombs is composed of albite (90%), small aggregates of irregular calcite crystals, numerous small laths of chlorite and scattered irregular pyrite crystals.

IV Albite-carbonate intrusion from immediately West of breccia/agglomerate.

This intrusion is of very fine-grained compact reddish rock which weathers to light-brown on the surface.

It is composed of 50% albite and 50% carbonate in intermixed, irregular crystals, over most of its volume - although occasional crystals of coloured minerals are visible.

A few veinlets of carbonate occur.

The outcrop of this rock is 40 metres broad, in a curve striking East of North in the North, West of North in the South. It cuts across a band of argillite, thus revealing its intrusive nature.

The outcrops of all other albite-carbonate rocks are obviously variable in intensity and irregular in outcrop - owing to their metasomatic origin.

V Carbonate vein.

This is largely composed of light-brown carbonate (possibly dolomite).

It shows fold-like contortions, in the nodes of which are talc and quartz bodies. These contortions look very like flow-structures of some kind, suggesting that it may possibly be intrusive.

It seems to be conformable to the general strike - North - South.

It is about 8 metres broad. On the West side, separated from the main vein by about one metre of layered tuffs, is a smaller vein of identical composition. Any junction between this and the main vein - if there is such a junction - is hidden by overburden.

It appears to die out just West of the North end of Jägelgielas. On Suovravarre, however, a similar vein - apparently in the same stratigraphic position with respect to the "greenstone" series etc. -

is intermittently traceable down to the West side of Suovrajavrre. This vein is certainly disconcordant.

A pink fels, which occurs in 2 places, is described under "Metasomatism".

III STRUCTURE.

A Folding.

The area mapped is mostly on the Eastern limb of a major anticline - the "Suovra anticline" - which plunges steeply southwards towards Suovravarre, where the Western limb is also well-exposed.

In the southern part of the area it appears to be overturned to the East as the stratigraphical expressions of the fold (i.e. convergence of the strike-lines, and repetition of beds on each limb) indicate that the axes of the fold is well west of the line where the dips change from East to West.

East of the camp-site the fold is fairly shallow - the rocks are evidently far deeper in the fold cross-section than those on Suovravarre. Further to the East, away from the fold axis, the dips become steeper. Indeed, in Salggejokka the beds are very slightly overturned. In Sallejokka, however, the ripple marks in the quartzite show the succession to be the right way up, so the overturning in Salggejokka must only be local.

Minor folds are very infrequent - occurring only near the main fold axis at the southern end of copper Valley, and in an isolated exposure North of Jägelgielas.

B Faulting.

There is a fault on the South East of the lake South of the camp, indicated by fault breccia in the bore-holes there, and which is probably traceable to a feature 1300 metres to the South East. This would suggest that the fault strikes at about 335°. On the West of the feature the strike of the layered tuffs is also about 335°, so the fault seems to be a strike fault at this point. Where it meets the lake south of the camp, however, the strike of a layered tuff nearby is about 305° - so it cannot still be a strike fault there. There is no evidence as to the extent or direction of movement of this fault.

Immediately to the East of the major fold axis is another fault striking North-South - the "Copper Valley Fault". This has a wide fault zone, judging from the feature it creates - a swampy valley about 30 metres wide (CopperValley). This is a right-handed fault, with about 10 metres displacement.

In the valley through Souvravarre is a right-handed fault striking at about 330°. This brecciates a graphite schist and bends it to the North on the Eastern side of the fault.

This fault is crossed by a second, left-handed fault, which must originally have been striking nearly North-South. Now, however, it has been off-set and drag-folded by the aforementioned fault.

The first-described fault on Suovravarre is subsequently referred to as the "first Suovravarre fault", and the second, as the "second Suovravarre fault".

On the Western side of the first Suovravarre fault, and on the North of the second, is a small left-handed fault striking at approximately 260°.

South of the copper occurrence "Geis I", is a left-handed fault striking at about 115°. This fault is probably associated with the copper-bearing solutions having come up the fault zone. The movement of this fault is only about 20-30 metres.

Near the southern termination of the carbonate vein in the North of the area, is a right-handed fault with about 10 metres displacement, striking at about 80°. This seems to continue to the West, with the strike changing slowly towards the south. This would probably be a tension fault, associated with the folding - in the beds having fractured at right - angles to the bedding.

The one detectable discordance among the amphibolite layers occurs in line with this supposed tension fault, thus supporting the suggestion that it <u>is</u> a tension fault, since any igneous disconcordance would be likely to follow this type of fault.

IV <u>METASOMATISM.</u>

Albite-carbonate rocks of all grades have been produced by Metasomatism - all gradations between amphibolites and albite-carbonate rocks, and layered tuffs and albite-carbonate rocks, can be seen. The

graphite slates, however, have been more resistant to metasomatic alteration.

The main "albite-carbonate series" - in a kilometre-wide band Est of Jägelgielas stretching southwards to Njivlle-Roavve - seems to be broadly concordant with the other rocks in the area. This is presumably due to the metasomatism having taken place along lines of strike-faulting. The amount of alteration, however, varies considerably along the strike, so that the rocks marked on the map as "albite-carbonate series" include unaltered greenstones in some places.

Patches of albite-carbonate metasomatism occur also to the West of this main zone - notably on the west side of Suovravarre, where it can be seen to be associated with joint planes, and around the southern end of Copper Valley.

The altered rocks themselves (see section on rock types) often show relict stratification from their original, unaltered progenitors of layered tuff. There is considerable variation in the relative proportions of albite and carbonate contained in them. Rhombs of carbonate, one half to one centimetre across, are widespread. There are frequently small lenses and veins of carbonate in these rocks - the latter usually approximately following the bedding, but occasionally crossing it. The lenses, which are usually about 15 centimetres long, and 5 cm broad, are found in rows along particular bedding planes.

In two areas a pink "fels" has been produced from layered tuffs by metasomatism - just N. W. of Jägelgielas, where the alteration occurs over about 30 metres, and a somewhat larger area of alteration about 1½ km East of the camp-site.

The latter area demonstrates the stages in alteration very clearly. At first the normal layered tuff is altered to a rock with similar mineralogy (60% felspar, 40% chlorite) and appearance, but containing a little calcite. The crystals have been rearranged at random instead of in alignment as in the original tuff, however, and the felspar crystals are more idiomorphic.

The next stage is a medium-grained, finely pink and black layered rock with alternate pink felspar layers (almost 100% felspar) and black hornblende-rich layers. The felspathic layers are made up of small allotriomorphic crystals, the hornblendic layers of larger, but also allotrio-

morphic, crystals. Some large pyrite crystals are also present.

The final end-product is a pinkish compact rock with large lineation and scattered pyrite crystals, and is composed of 90% albite, in small irregular crystals, about 6% calcite and 4% hornblende. The pyrite is found in linear aggregations with larger felspar crystals. The final stage of the pink "fels" metasomatism North West of Jägelgielas is identical with that from 1½ kilometres west of the camp-site, just described.

V METAMORPHISM (apart from Metasomatism).

The metamorphic grade of the whole of the area mapped belongs to the chlorite zone.

VI CORRELATION WITH MAGNETIC DATA.

The magnetic data correlates very well with the structure revealed by geological mapping, and shows precisely the same position for the major fold axis.

VII CORRELATION WITH ELECTRO-MAGNETIC DATA.

The electro-magnetic data shows that the strong anomaly of the graphite schist, in the major anticline, suddenly swings through almost 360°. At first, in the western limb of the anticline, it shows up progressively further Northwards, then the aforementioned swing occurs, and it is subsequently traceable southwards for some distance.

From this it was deduced that there was a tight syncline in this area, just south of the lake south of the camp site. If this is so, the syncline must be isoclinal, as the dips on what would be its Western limb are to the West, instead of to the East as they would be in a normal syncline.

There are, however, two other possible explanations for this data.

The first of these is that the fault south of the camp lake, striking at 335°, could have dragged the graphite schist in the West limb of the anticline towards the South. This explanation assumes left-handed

movement for this fault.

The second possibility depends on a major fault running North-South along the line of the Cuovćajavret lakes. This is suggested by the electromagnetic data, and mentioned by Geis in his 1959 report. This fault could either be impregnated with magnetite, have dragged graphite schist into the fault zone, or contain water with heavy ion concentration - any of these might give a high anomaly.

There is insufficient evidence as yet to indicate whether either of these two latter explanations are correct, or if there is, in fact, an isoclinal syncline.

ECONOMIC GEOLOGY.

VIII MINERALOGY AND DEPOSIT.

A) Copper Mineralisation.

There are three types of mineralisation offering the possibility of deposits of economic grade and tonnage:

I) Fractured quartz-fels - fractured by faulting and mineralised with chalcocite, chalcopyrite and bornite.

II) Fault-brecciated and fractured albite-carbonate zones, mineralised with chalcopyrite.

III) Amphibolite impregnated with copper minerals.

I) Fractured quartz-fels.

The richest copper occurence known in Suovra is, of course, the brecciated, mineralised light-grey quartzitic fels which lies under the graphite schist in the Suovra anticline, East of the camp-site.

At least two, and probably more, faults have brecciated this fels-bed and created open spaces, where copper minerals (chalcocite, chalcopyrite and bornite) have been deposited.

One of these known faults displaced the graphite schist sufficiently to show a discontinuity in the electromagnetic anomaly. The fault-zone of this fault has been intersected by drill-hole 500A, which gave the best copper values of any drillhole in the area.

The other fault is the "Copper Valley Fault". The fault zone of this fault has been explored by drill-hole 4-59, which gave the second-best copper values in the area.

As the whole of the body of rocks in this area have been under stress, it is probable that the fels has been fractured or brecciated along most of its length, with greater brecciation where faults have displaced it slightly. Therefore it is possible that the fels bed is mineralised throughout most of its length.

Even if this is so this bed, in the best circumstances, will only give small tonnages.

II) Fractures albite-carbonate zones.

The only significant occurrence of this type is Geis I, and there are 2 others of less importance.

a) Geis I (see map).

Outcrop A: This is made up of strongly fractured albite-carbonate, the fractures being filled with calcite and quartz. This vein material makes up about 5-10% of the outcrop. The veins contain a little pyrite and a few specks of chalcopyrite, but there is insufficient copper mineralisation here to be of interest.

A sample was taken of a block containing more mineralisation than average.

Outcrop B: This consist of blocks, which have probably not moved more than one metre from their original source, of strongly-fractured very fine-grained albite-carbonate rock. These fractures have to some extent been filled by chalcopyrite.

A sample was taken of these blocks.

The mineralisation at this point is not less than 40 centimetres, and could be several metres, wide.

Two metres to the West of these blocks, and also six metres to the East, there are outcrops of very albite-carbonatised layered tuffs, which, however, show no copper mineralisation.

Outcrop C:

This consists of albite-carbonate rock with graphite schist on the Western side.

Copper mineralisation is here mainly concentrated along

a layer, 60 cm wide, which is conformable to the bedding. It is about 4 metres long, dying out to the North, and disappearing under the overburden to the South, where it is much weaker.

It was sampled at its richest cross-section.

D: - loose blocks with chalcopyrite mineralisation.

Several dozen of these are scattered to the West and South of the mineralised outcrops.

One particular concentration of blocks (D^1 on map) was especially rich in chalcopyrite.

The source of these blocks cannot be ascertained, but it is possible that they did not come from the mineralised outcrops which are exposed at present, but from the South, which is the direction from which materials have been moved by the glacial ice in this area. The outcrops to the South which are exposed today, however, show no copper mineralisation.

A large, representative chip sample was taken from all these blocks.

Outcrop E:

This is an outcrop of albite-carbonate with graphite-schist on the Western side. It shows no mineralisation.

A fault, striking at 115°, passes to the South of the mineralised outcrops. The copperbearing solutions probably came up this fault.

b) Another occurence of this type is Geis VI: (Njivlle-Roavve)

An outcrop here shows layered tuffs and amphibolite, which have been altered in some places to albite-carbonate rock. Associated with these altered areas are a few lenses, up to 4-5 metres long and one metre broad, and which contain chalcopyrite.

These are unlikely to be of economic interest.

It seems possible that this occurrence lies immediately East of a southern extension of the second Suovravarre fault.

c) In the area South and slightly East of the camp-lake is a third occurrence of this type.

There are many blocks of albite-carbonate rock in this

area, and one probable outcrop, which lies on the hill overlooking the centre of the 3 lakes which make up Cuovéajavret, on the Eastern side of this lake.

Some of these blocks contain much pyrite, others much haematite. Three or four blocks, all found within a small area, contain up to 3% chalcopyrite.

The probable outcrop demonstrates that the albite-carbonate layer is very narrow, probably not more than two metres wide. It contains but few specks of chalcopyrite. This occurence can thus have no economic interest.

III) Amphibolite impregnated with copper minerals.

This has only been found in a number of transported blocks which form a block train immediately East of the camp-site, just North of the lake.

These are coated with 1-2 mm of Malachite and Azurite. Fresh surfaces show haematite and magnetite. They give high percentages of copper (up to 7%), but the copper mineral which gives these figures is as yet unidentified - it is probably chalcorite.

The source of these blocks is unknown, but would certainly seem to merit further search.

East of the camp lake are found blocks of albite-carbonatised amphibolite with contained copper minerals. It is possible that these hail from the same body of mineralisation as those North of the lake.

There are several other occurrences of other types of mineralisation, none of which would seem to be of any economic interest :

IV) Geis occurrences II, III, IV and V.

These consist of small veins of quartz, containing a little chalcopyrite, the largest chalcopyrite body being about 10 centimetres wide and one metre long, the vein in which it occurs being continued some way to the South, with occasional smaller occurrences of chalcopyrite (Geis V occurrence). There is also one small chalcocite vein near this occurrence.

These mineral occurrences (Geis II-V) have no economic interest.

V) Occurence 1½ km East of campsite (9600 N, 7825 Ø).

Pink, metasomatic fels outcrops here, and is impregnated throughout with pyrite.

In a loose block South of this outcrop is a vein about 10 centimetres wide, and two metres long, in which there is a little chalcopyrite, as well as calcite, quartz and magnetite. This loose block has obviously not moved very far from where it was originally in situ.

Small veinlets of copper - usually chalcopyrite - occur in other parts of the area, notably along the sides of copper Valley fault. They are always accompanied by quartz.

Also just North of the first Suovravarre fault is a vein of quartz and carbonate in amphibolite. This contains some chalcopyrite and a little bornite.

The chalcopyrite, chalcocite and bornite, where they occur, are obviously hypogene. Malachite and occasionally, in blocks, azurite are secondarily associated with all these hypogene copper mineralisations.

B) Other Minerals.

a) Haematite.

This occurs, with quartz, in some small veins on the North-West part of Suovravarre, and also in a vein about two metres long and ten centimetres wide, about 100 metres West of where the broadest layer of graphite slate dies out southwards (presumably the graphite was wedged out of the apex of the Suovra anticline).

b) Magnetite.

This is very widespread as local impregnations in amphibolite - e.g., where, as small octahedra, it is found locally in the amphibolite which wedges out just South of where the broadest graphite slate also does so.

Also many veins contain a little magnetite, and in a patch of albite-carbonatised amphibolite just North of the first Suovravarre fault are appreciable amounts of massive and crystalline magnetite.

c) Pyrite.

This has ubiquitous distribution throughout the albite-carbonate and metasomatic fels rocks - sometimes in carbonate veins, forming crystal aggregates several centimetres across.

IX RECOMMENDATIONS.

a) Even if the quartz-fels in the Suovra anticline is well-mineralised, it can never provide more than a low tonnage of copper. To make any exploitation worthwhile, therefore, it must be supplemented by additional tonnages.

The most likely places to provide these additional tonnages would be the fault-zones which cross the quartz-fels bed, especially where they are relatively close to it.

These fault-zones should therefore be investigated by diamond-drilling, North and South of the fels-bed, at first close to it, and then, if results warrant further drilling, progrescively further away from it.

b) The copper-rich amphibolite boulders North of the camp lake have not yet been traced to their source. As they are very rounded, it is possible that they have been transported for some distance. On the other hand, however, this rounding could be due to extensive weathering before transport.

Although their source is so uncertain, they are so rich (up to 7%) that it might be worthwhile to drill on the east shore of the camp lake (or through the ice, during winter, on the eastern half of the lake) where there is a small magnetic anomaly. This anomaly might be caused by magnetite in the body of rocks which gave rise to the boulders, which themselves contain a little magnetite.

c) Geis VI - Njivlle-Roavve. This mineralisation exposed here at present is very small, and any extensive copper deposits would seem unlikely. Other mineralised areas might, however, be associated with this occurence, in the vicinity, therefore it would be advisable to conduct a detailed block-search in this area. If any indication of such associated mineralised areas was found, a detailed geological map of the outcrops here could be made.

d) Any additional tonnages provided by Geis I occurence are unlikely to be sufficient to raise the total copper yield, expected on present evidence in the area, to a large enough tonnage for commercial exploitation.

Therefore it would be wise to leave further examination of this occurrence until such time as other additional tonnages may be found in the Suovra anticline area. If such tonnages are found, drilling could be carried out in the boulder field south of the mineralised outcrops of Geis I, in order to determine the extent of the mineralisation.