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Notes concerning the Geology of the Kvina Molybdenite Mine in Fjotland

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Notes concerning the Geology of Kvina Molybdenite Mine in Fjotland.

Derby & Co., Ltd.

INDEX.

INTRODUCTION.

This report is being written during the early production stages of the reopened mine at a time when a technical representative of Derby & Co. Ltd. of 11-12, St. Swithin's Lane, London, E.C.4 is present for a considerabel period. It is the product of a long and carefu examination.

The amount of material is considerable. In particular section(4) is bulky, this information is recorded so that the basis for the interpretation can be checked if desired and also because future working will destroy many of the present exposures. It is inevitable that some interpretation is included in (4), but in the main it is reserved for section(5).

The map of the workings contains the referense numbers which are usde throughout the report. The names given to certain drifts are employed where possible as their permanance is considerable.

All directions refer to the 1952 magnetic North.

THE MINE WORKINGS.

This section merely describes the shape of the workings for the benefit of those unfamilier with the mine, it contains no geological information.

The mine is situated on the side of a hill and is entered through a horizontal passage, Nilsens's stoll, through which the ore won is removed. The long dimension of the mine is perpendicular to the slope - the former is roughly N-S, the latter due East. In addition the workings drop from Primodighet's Drift by various stages to the Håbets stoll and Kvina stoll. The Kvina stoll emerges from the mine onto the surface of the hill at a point just above the level of the tailings lake, this means that all water enterring the mine will eventually flow by gravity alone out into the lake.

Gunnars drift deserves further mention as it is easy to visualise its shape from the maps or the table below. It slopes eastwards but at an angle steeper that the hill, the top end intersects the surface of the hill at (43), (44) and (57), but the lower end is some depth below the surface. The north end of Blågangen is in effect a quarry into the floor of Gunnars drift, the roof is over ten meters above the floor.

(30) is a chamber beneath Nilsens stoll. It has connections to Håkons drift, to Nilsens stoll by (37), and to Håkons drift by(38). (35) leads from (30) to the winze which connects Håkons drift to Kvina stoll and intersects it three-quarters of the way up.

Other areas can be most easily visualised by study of the map in conjunction with the table. Nilsens stoll is chosen as the arbitary zero level as it is level of ore removal.

TABLE CORRELATING LEVELS AND AREAS OF THE MINE.

Level(meters).	Area.
+8	Primodighets drift, Dagstrosse, (4), (7).
0	Olines drift, (26), Nilsens stoll, Håkons drift.
+7	Gunnars drift, (average), (30).
+14	Håkons drift, Lians drift/stoll, Blågangen, Andersens drift, (45).
+17	(63).
+26	Kvina stoll, Håbets stoll.

GEOLOGY OF THE AREA.

The Kvina mine appears to be in the marginal area of a large body of granite. There is much evidence to support this view. Hybrid rocks recognisable by thier characteristic fine textures and dark colours indicate sedimentary contamination. Xenoliths of para-schist and hornfels are the altered sediments themselves. The pegmatisation and especially the mineralisation itself are the best proof.

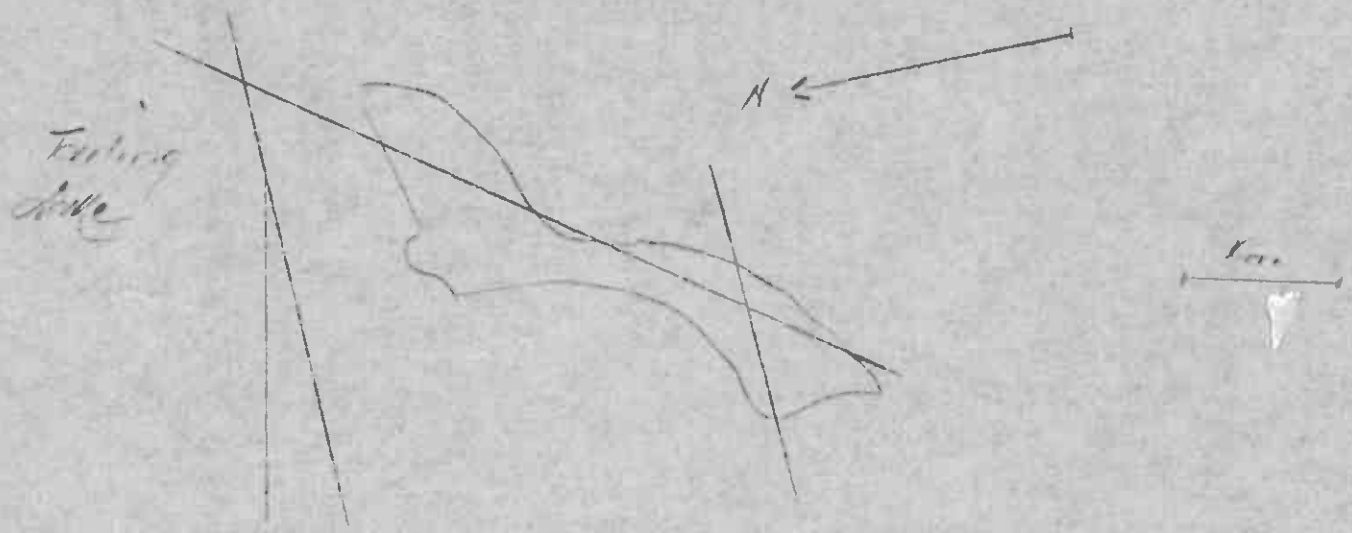
The area is cut by a strong set of vertical faults which run roughly ENE-WSW with individual faults averaging about a kilometre apart. The mine is almost exactly halfway between the faults. One is halfway between the mine and the South end of the main lake and the other, actually a double fault, is at the far end of the tailings lake. It is difficult to tell the direction of throw of the faults by study of the rocks, but the topography indicates the mine is in an upfaulted block. In addition there is a strong NNE-SSW fault along the length of the lake(for the shape of which it is responsible). The throw of this fault is also vertical as it cuts the other two without displacement of any of the tree. Topography indicates very clearly that the mine is on the downthrow side - the rock on the far side of the lake from the mine rising steeply from the water forms a very good fault-scarp.

The granite is variable in composition, but is usually very leucocratic with biotite as the only iiportant dark mineral. The muscovite content is lower than usual for the granite family. There is a substantial amount of a darger granitic rock, probably a hornblende-biotite-granodiorite although the exact rock type cannot be determined without knowing the plagioclase/orthoclase ratio. The spatial and petrogenetic relationship between the two types, of which every intermediate blend is displayed, is not clear and is not very important as the mineralisation clearly belongs to a later stage.

The leucocratic granite is sometimes banded. The bands are grey and white alternately and are due to changes in the colour of the felspar. The bands are quite horizontal and even in thickness, they are probably due to a magmatic effects such as gravitative settling- it is certainly not fluxion banding. Fluxion effects have been seen especially to the North of the mine, but not in the mine.

Much felspathization and pegmatisation of the granite has taken place. The pegmatites are this and usually close to the vertical. The thickest is to be seen forming the west wall of Olines drift and is about 3o cm. across. Pegmatisation was followed by the introduction of quarts, this phase produced the big quarts body in the mine. No other masses of the same magnitude have been found, but there are very many small xoutcrops. The quartz of the mine has a more or less complete layer of feltspar between itself and the granite. The layer is very variable in thickness, but it is persistant as it is seen at almost all the exposures. The solutions which deposited the qurarts contained molybdenite which was deposited in the secler granite and the borders of the quartz body itself. There is also very iiportant molybdenite deposited in the granite apparently away from any quarts. Thus Knaben there is a quarry working rich ore with no quartz visible. Nevertheless at Kvina the relationship of the quartz and molybdentie is intermite and clar.

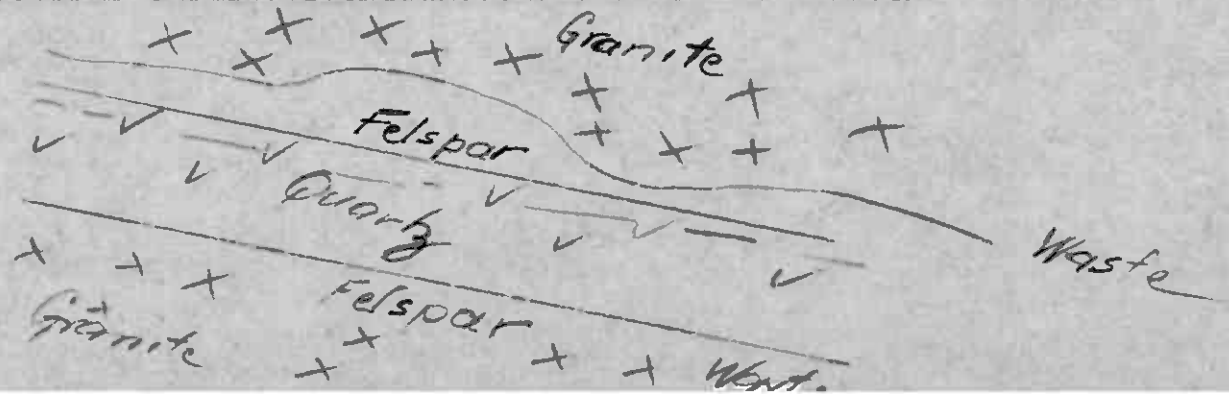
SKETCH MAP OF KVINA TO SHOW THE LOCATION OF THE FAULTS.



There are many traces of molybdenite on the side of the hill within a kilometre of the mine, some of these have been casually investigated by surface blasting, but at present too little work has been done to get any idea of their potential value. Still such indications are an encouragement and make it possible for development work to be carried out with a real degree of hope. It is possible that ore extends many hundreds of metres from the present workings and that the indications all belong to one large body, it is equally possible that the traces are merely traces and are of no importance.

The sketch below is an idealisde section of the quartz body in the area of the mine and demonstrates the rich zone of ore and the regular arrangement of the rock,types.

THEORETICAL SECTION OF THE KVINA QUARTZ AND ORE-BODY.



GEOLOGY OF THE MINE.

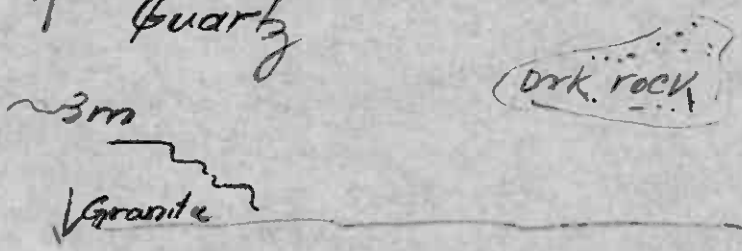
This section contains the details of the exposures in the mine. The order of study is the same as the order of numbering employed on the map. It is not worthwhile subdividing this section, as that tends to produce subdivided thinking on a continuous story, especially so as the description of a particular area is quickly found by using the numbering system.

Primodighets drift is horizontal and oasses from the floor of the Dagstrosse, it is the best example of a development heading in the mine. At the far end the rock is light granite with marked banding in places & the molybdenite content is quite good. In the roof at this point there is a felspar mass with molybdenete "blebs" at its borders. Nearer the Dagstrosse quartz apperrs in the roof, but the walls and floor are of granite. Nearer(1) the quartz-granite contact plane is seen to dip towards the NE so that it is high in one wall and low in the other. The granite at the contact is very rich in molybdenum and the marginal x quartz contains the mineral as well. The main mass of the quartz is low in molybdenite and may not be ore.

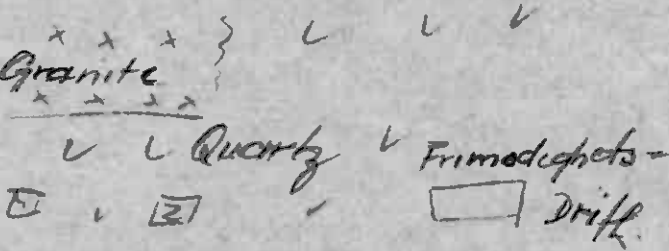
Shaft(1) passes through quartz from the surface to Primodighets drifts.

The NW side of the Dagstrosse shows one of the best examples of the irregularitees of the main quartz. Above the entrance to Primodighets drift the quartz extends to the surface, but above(2) and (3) there is granite. This irregularity is confirmed by rises(2) and (3). Rise(2) has a quartz roof and the Dagstrosse end, but the roof and walls at the top end are granite. Rise(3) passes at once into granite the top end is a light granite with some molybdenite. The S wall of the Dagstrosse shows the normal sequence of felspar and granite with much mo xnx molybdenite just below the quartz. The E wall is largely quartz as the mass dips in this direction. There is, however, a wedge of very dark rock, possibly the remains of a highly altered xenolith, in the quartz. The wedge is rich in molybdenite, but the surrounding quartz is poor- another example of how the molybdenite was deposited just away from the quartz.

SKETCH OF EAST WALL OF DAGSTROSSE



SKETCH TO SHOW IRREGULARITY OF QUARTZ IN DAGSTROSSE WALL



Area (4) is an eastward sloping chamber wich follows the lower quartz-granite contact. In places a few inches or more of granite remains and are strickingly rich in molybdenite, but the quantity of ore left is negligable. The pillar at the entrance to the Dagstrosse contains quartz on the Dagstrosse side, but the otther side and the adjacent pillar are of granite. Rises(5) and (6) follow the contact, both are very dusty, however, so it is difficult to determine the value of the ore. Further working up the slope schoud be very profitiable. The lower side of (4), that is to say the NE wall, has quartz near the Dagstrosse but the quartz-granite contact rises up the wall in the SW direction. In general the stope was made a little too high in the low end of (4) too much quartz was taken and some ore was left in the floor. The wall at the entrance to development passage (7) is banded felspar which may be promising. (7) itself followsthe quartz-granite contact fairly well

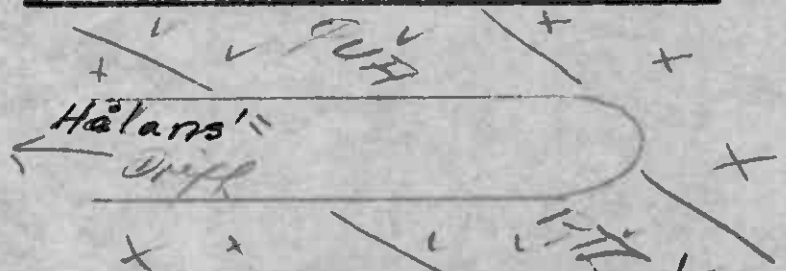
the quartz is high in the left wall(going in) and lower down in the right. The small rise(8) goes through quartz which is apparently free from molybdenite, but there is a patch of dark rock at the top. The latter is probably a xenolith, but it could be the upper surface of the quartz. Examination of the surface above(8) favours the former explanation. Rise(9) comes up to the surface through quartz. At its foot there is a curious spotted hornblende-felspar rock low in molybdenite, this one exposure is unique, but it is too small to determine its relationship to the granite. Rise(1o) has a quartz roof passing into dark granite and felspar. Near(9))10) becomes very confused. In places the roof is granite and the walls are of quartz and in addition there are felspar masses containing "blebs" of molybdenite. A possible explanation is that the quartz is locally splitting into two - the outcrop in the hill shows signs of there being two bends.

(11) is at a level about 3 m. below(7), it passes through a dark granite which looks very unpromising. The ore should occour some metres up in the roof. Near the entrance to (13) there is a striking 3" pegmatite which is slightly unusual in that it dips at 4o° towards the NE rather than vertically. The two openings which connect(4) with (1)have quartz at their ends and pass down into dark granite. Passage(12) is filled with rubbish and cannot be entered, this may indicate that it met only barren rock, but examination of the end might have thrown light on the confusion in (10). Rise (13) comes to the surface and intersects the quartz just below the top, but the lower part is dark granite with some felspar masses. The molybdenum content at the contact looks much below that at (4), but the area exposed is insufficient for a final estimate.

Passage(14) which rises very gently off(4) has quartz and a NE dipping mass of felspar at its far end. There is a very fine grained xenolith at this point. Near(4) the granite comes in and is extremely rich in molybdenite. It might be possible to get valuable ore following down the dip over the top of (11), but no ore remains on the W side.

Heading(15) runs horisontally off(11) where the letter meets Håkon's Drift, it cuts through the quartz and at the far end the upper quartz-granite contact is seen. The walls are very dustry, but evidence of copper(chalcopyrite) is to be seen. Molybdenite, on the other hand, appears to be low.

LONGITUDINAL SECTION OF HEADING(15).



Passage (16) is substantially below the quartz. It consists of granite along its entire lenght, but at the Håkons drift end, where it is only about two metres bellw the quartz, there is much pegmatisation, but with very little molybdenite. The granite is characterised by pink orthoclase, molybdenite seems to be entirely absent. The winzes which connect(16) with(4) are of the same rock. The far end (16) is filled with rubbish.

Håkon's Drift and the area immediately to the West has a high roof of quartz. The quartz-granite contact, which has more of the characteristic felspar band than in the area of the Dagstrosse and (4), rises in a NW direction. In places, noticeable at the periphery of the breakthrough of the workings to the surface, some ore remains.

Passages(17) - (21) rise to intersect the quartz, but in all cases the rate of rise is too low even to reach the rich ore.(17) is ordinary granite at the top end, but some molybdenite is present in the roof at the low end where the passage is probably at its nearest point to the quartz.(18) has exellent molybdenite in the roof, but ordinary granite in the floor, clearly the passage is too low. Along)19) the rock becoms typical granite, again there may be good ore above. In(2o), which falls slightly towards(21), there is good molybdenite in the pillar, which is probably an offshoot from the main body. Passage(21) is granite along its entire lenght. Pillar(22) has molybdenite associated with some quartz exposed in the floor on the Dag side. There is also the main quartz body and ore at the top of the pillar. This is the first indication of the split in the quartz body which is discussed in the next section. Wall(25) at the east end of Håkon's drift has an extremely sharp quartz-granite contact near the roof and there is a further quartz vein about 6" thick with rich molybdenite in the floor. It is possible that the granite is a lens, but it is likely that the two quartzes of (22) have come together.

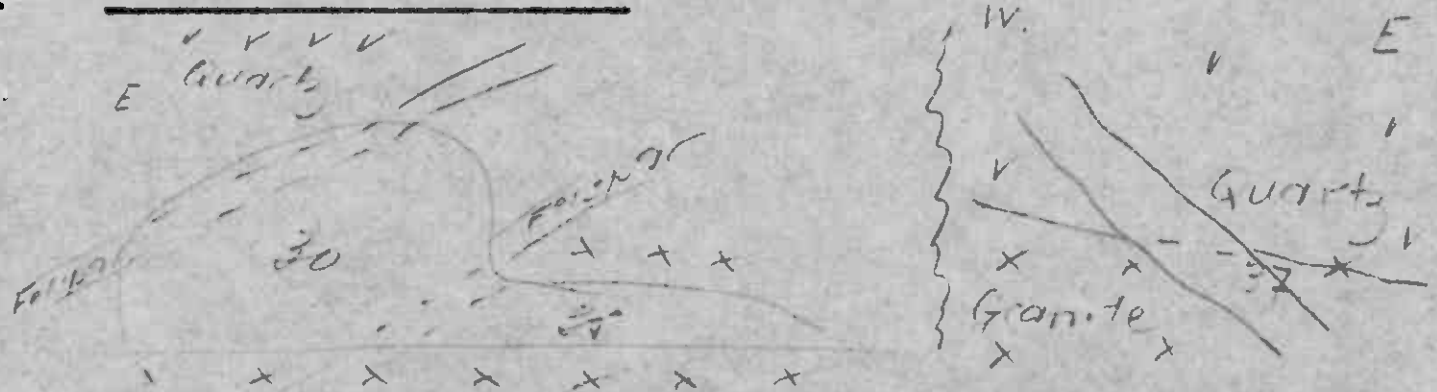
The general position in Olines drift is that high roof is quartz or just below the quartz-granite contact so that, although striking molybdenite is seen, no worthwhile ore is avaisble. Some ore is in the floor, but the intermediate rock is dark granite poor in molybdenite. The ore in the floor in not well exposed and its importance in unknown. The W wall of the drift between (22) and (23) is a curiosity it is a wall of vertical pegmatite, the right-hand wall looking W so that the full thickness of the pegmatite remains (see page 3). (23) itself rises very steeply, but does not reach the quartz passing trough granite only.

Area(26), the first area worked by the present management, has ore in the wall opposite(27) and the roof is granite with large felspar phenocrysts and contains some "blebs" of molybdenite. To the West generally the ore has been lost. (27) rises very steeply in the granite, but meets little molybdenite. There is molybdenite and chalcopyrite-$CuFeS_2$- at the entrance to (22), but inside this horizontal heading only sulphide-free granite, characterised by thin bands rich in biotite, is met.(29) is very dusty except at the top end which is in light granite free from molybdenite.

Nilsens stoll is in quartz from Olines drift to (41) at which point felspar comes in on the right side(coming out). A little nearer the surface granite comes in so that at the Dagåpning the sto l is entirely granite. The quartz body has been cut through, the molybdenite of the upper quartz-granite contact at the Dagåpning is not very good, but this is almost certainly a local effect as the same horizon has been worked. vigourously in the past in Gunnars drift. Passage(91) off Nilsens stoll is in quartz along its entire length.

Chamber (3o) is on the underside of the quartz. At the Håkon drift end it is above the contact, but is quickly drops to the true contact which is characterised by a thick development of the felspar.(31) is entirely in quartz as is (32) except for a pegmatite at the top end. At the foot of (31) and (32) a felspar lens is well exposed. Between (32) and (33) granite appears in the floor, but the molybdenite cintent looks low. (33) is in quartz. (34)rather surprisingly is in granite, but it may be local patch in the quartz, the relationship is not clear Passage (35) is in light granite with some ore in the roof.(36), which is parallel to (35), is likewise in a molybdenite-bearing light granite which has the occasional biotite-rich band. (3o) at this point has felspar in the E wall, roof and W wall. The felspar in the two walls are not the same and the true correlation is given in the sketch.

SECTION ACROSS CHAMBER(3o).



Passage (37) rises from(3o) to Nilsens stoll and passes from granite into quartz as the angle of rise is greater than the dip of the quartz-granite contact(see sketch). The contact is sharp with little molybdenite, in this part of the mine generally the molybdenite seems to be developed when the felspar layer is present and only slightly when the latter is absent. (38) is horisontal at the end leading into (3o), but dips towards Håkons drift. At the top end quartz is intersected, but down the dip the contact is followed well - it is high in the left wall (looking towards(3o) and near the base of the right wall. There is a lens of hornblende-rich rock in the quartz at the point where the tunnel starts to dip. The contact is apparently not very rich in molybdenite, Passage (39) follows the quartz-granite contact quite well. Felspathisation has brought in "blebs" of molybdenite, but the granite is not well enough exposed to be assessed.(4o) rises into a confusion of quartz and felspar with striking ore, but its thickness is unknown, granite is in the floor at the lower end.

The workings in Gunnars drift is in the upper ore zone of the quartz body, the main chamber has come right to the surface at three points, (43), (44) and (57). The top end of (43) has a felspar floor and granite roof. This passes into(42) which has a quartz floor and a mixed, but dominantly granite roof. (44) has a quartz floor and walls due to the fact that the quartz rises more sharply than average at this point whereas (44) continues the angle of rise of(42). (57) repeats the story of (44).

Below the first line of pillars in (42) the floor drops sharply about a metre so that there is a ridge of felspar. The lower pillars are largely banded granite with varying amounts of visible molybdenite. The roof in places is too high to examine satisfactorily, but the tendency is for the high roof to be granite and for the lower to be mixed rock.

Heading (49A) has felspar in the S wall and the entrance with a granite roof - the felspar has some very rich patches of molybdenite. The top end of (49A) has quartz above felspar and a granite floor and (5o) wich is horizontal, has quartz resting on granite, this is a curious local reversion of order and is due to a lens of quartz extending off from the main body. The roof outside (49A) is very rich ore.

Area(45) is right in the granite above the quartz. It is difficult to tell how far it is above, but the evidence in rise(89), see below, suggests that it may not be more than a couple of metres. The granite is banded and contains some molybdenite. Sampling is nessary here as this could become an important area of workings. Towards the South in the wall between (48) and (49) and even some quartz in the pillar opposite(49). (46) contains water which cannot drain away, but inspection from the entrance indicates that it is entirely in granite. (49) is like wise in granite. (47) has a granite roof and felspar walls. (48) enters a felspar-rich granite.

Andersens drift is clearer to the quartz than (45) and indeed follows the contact uppwards in the same way as Gunnars drift. The E wall is of granite apparently

of granite apparently low in molybdenite, but the contact with the felspar - normally the richest zone - must be in the floor which is covered with loose stone. Area(51) rises from Andersens drift rather steeply between the pillar. The latter have quartz at their bases.
(51) is in granite which contains some concordant quartz bands, the general molybdenite content appears to be satisfactory. The molyddenite is especially good at the top of (52). (52) itself is entirely in granite, even the floor, which is quartz in (51) is granite. The top (west) wall of (51) is quartz overlain by banded granite with planes rich in molybdenite, felspar is absent. Rise(53) has quartz at the top and (apatch of felspar is at the very top) and granite, rich in"blebs of molybdenite where it joins(51). In(53) the quartz-granite contact is rising faster than floor but this is probably only a local trend as Gunnars drift and (51) show a less steep rise. Area(54) appears to be in a band of felspar below the charactristic band at the quartz-granite contact so that here, as for (53), the rate of rise of the ore-body is greater than of the floor. The top end of (54) is in quartz and there are signs of good molybdenite.

Heading(55) continues S from Andersens drift. It is very dusty, but appears to be in granite along its entire length and does not hit the felspar, there is, however, a patch of quartz in the NW wall at the far end. The dust prevent an examination of the ore potentialities, but there is very good ore in the roof at the entrance.

The Blågangen is entirely in the main mass of quartz. Molybdenite is present as "blebs", but the grade of ore as a whole looks marginal. It is important to get an assessment of this area as it is the largest mass of blocked-out, easily-won rock. The N end of the Blågangen, where it is quarrying the floor of Gunnars drift, shows signs of going into the granite beneath the quartz. The most obvious sign is the incoming of felspar. Felspar, this time indicating the approchhhh of the upper contact, is seen also in the roof at the SW corner of the S end.

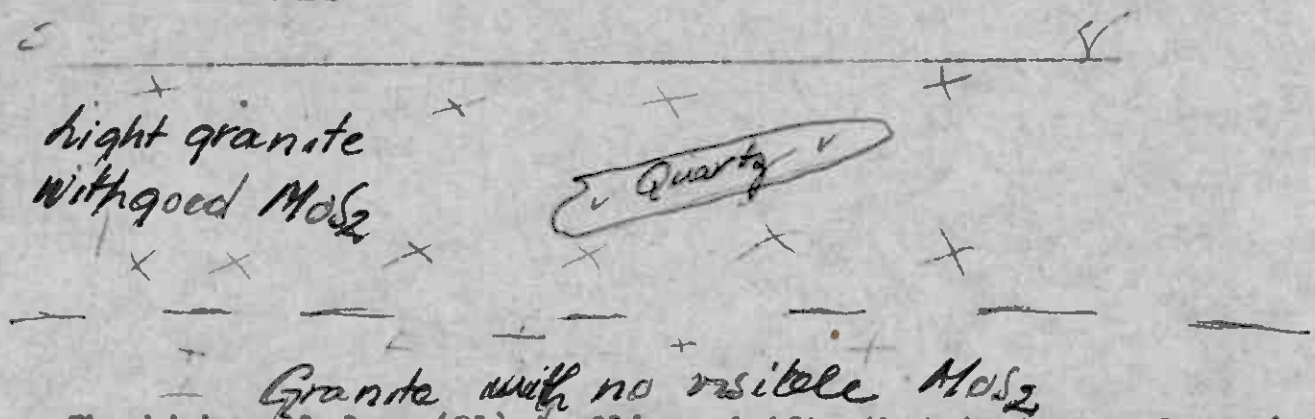
Crosscut (72), which connetes the Blågangen with håkons drift, consists of quartz at the former end, but felspar appears on the left and granite on the right going towards Håkons drift. The quartz-granite contact can be traced from (72) in the wall to (38), it rises slowly towards the latter. The molybdenite content looks poor.

The lower quartz-granite contact is exposed in pillar(73) which has granite in the base with felspar and quartz above. At this point the contact is fairly flat-lying having a small dip to the SE. The nearby pillars (74), (75), etc. - confirm the observations in (73). Passage (76) passes through the edge of the quartz body and contains surprisingly good molybdenite, this probably decreases in the wall between (76) and the Blågangen and on the other side the ore has been worked out leaving only the pillar, which also have good molybdenite contents.

(77) and Lians drift have a quartz roof with felspar walls and mixed rock beneath - the contact is being followed well. The quartz is rising and is not seen on the west side of pillar(80). Passage(78) is in quartz along its entire length. The top part of the winze between Lians drift and (67) - the lower part is blocked with loose stone-is in mixed rock. There is quartz above (81) as can be seen in pillar(79), but there is also some quartz in the floor which may mean a second quartz body or else that the main mass has a substantial offshot. The granite in (81) shows signs of having been felspathised.(82) is in the same rock as (81), but it also contains patches of quartz and there is a band of quartz at the far end.

Wall(83), which is being worked at the present time, appears to be below the quartz although the width of the Lians drift chamber is sufficiently great for correlation across to be difficult. The lower part of the wall appears to be of poorer molybdenite content than the upper. There is a quartz band in the upper part near the entrance to (82). (It must be realized that this deschription only applies to the present face which may be very different in a few weeks time). The face is sketched on page 9.

SKETCH OF FACE(83).



The high wall from (81) to Olines drift, that is to say faces (86) and (87), is the most difficult area to examine and interpret. The fairly simple rock relationship in the other parts of the mine dø not manifest themselves so clerly here. Between(81) and (86) the floor is of quartz with granite above and a pink granite roof. IN(86), the shape of which has since been altered by blasting, there is again some quartz in the floor with the granite above. The very high roof is pegmatite-rich and variable in type. The signs of quartz in the floor diminish as the latter rises to the North towards Olines drift. The pillar to the W of the haulage incline, which runs from Nilsens drift to Håkon's drift past the entrances to(4o) and (39), mostly have quartz in their bases and roof with granite in between. The molybdenite content is variable along the main face but on the whole is promising.

The very low levels of the mine now remain to be described. The Kvina stoll will be dealt with first, then the håbets stoll complex, and finally the link between the Håbets stoll and Andersens drift, namely chamber(63).

Kvina stoll falls slightly from its W end at the foot of the winze from Håbets drift to the dag-opening just above the level of the tailings lake. It passes directly under and parallel to (35). At the top end the rock is granite of varying types - banded and unbanded, coarse and fine-grained - with a little molybdenite in a few places. Directly under Nilsens stoll there is a large xenolith parallel to the banding which is dipping about 15° to the SE. For a few metres the xenolith, which consist of altered paragneiss, forms a smooth roof as it has split cleanly along a plane of weakness. A. few meters the winze side of the Håbets stoll there is a concordant band of dark rock rich in felspar phenocrysts The granite along this section of (59) - Kvina stoll- shows no signs of meeting the main quartz body and is free from molybdenite. From the Håbet stoll junction to (6o) the granite is massive except for an occasional xenolith and thin vertical in (61) again only granite is exposed.

The top end of Håbets stoll sit,too, slopes very slightly like Kvina stoll), at (71) has cut into quartz and felspar in the roof and walls, these minerals are mixed with granite and only just exposed, but even so the molybdenite content looks very interesting. Between(71) and (7o) the rock is a darkish granite, but at the entrance to (7o) quartz and molybdenite again appears in the roof.(7o) seems to be free from quartz.(69) has rubbish oacked along its N wall, but the other wall and roof can be examined. They are chiefly ordinary granite, but there are patches of quartz with a little molybdenite. The steep rise towards the Lians stoll is in granite with almost no visible molybdenite. The Håbets stoll between(69) and (67) is in granite with a little quartz, but only a trace of molybdenite in a few places. Both (67) and (68) are filled with rubbish and cannot be examined, it must be assumed that they only meet barren rock as the stone disposal problem in Håbets stoll might have been so great that even valuable exposures could have been recovered temporarly. Between(67) and the ore loading chute from Andersens drift Håbets sto l cuts light granite at first, then a pegmatitic granite, and

finally a darker granite all apparently free from molybdenite. At the chute there is a unique rock - a muscovite-rich granite - in the lower part of the west wall, the muscovite shows a tendency to lie to parallel wall giving a pseudoschistosity. From this point to Kvina stoll the rock is a uniform medium granite with no visible molybdenite.

Rise(89), which connects the foot of Gunnars drift to Håbets drift is exceedingly interesting. It is ufortunastely half filled with loose ore so that it is difficult and not without danger to examine it. The foot of (89) is granite, but just below (9o) quartz appears in the roof. Above this point the roof and walls are felspar with good molybdenite (the quartz and its lower contact are poor in the mineral) and granite comes in at the top. (90) has a felspar floor with granite and quartz, it is a confused picture in detail, but is clearly the orebody. There is very good molybdenite especially in the roof at the entrance.

Finally the connection between Andersens drift and Håbets stoll via (63) remains to be described.(62), which falls from Andersens drift to (63), passes through medium granite.(63) consists of light, often very light, granite which contains small patches of quartz with molybdenite at their boders. The granite itself is poor in molybdenite.(64) has felspar in the floor at the end and may be approaching the quartz body.(65) cuts into a darker granite than the rest of (63) and is free from the quartz patches of the latter.(66) drops very steeply from (63) to Håbet stoll, it passes through a 4" band of quartz at the top.
This band is free from felspar, contains no molybdenite, and has very sharp contacts with the granite. The lower part of (66) is in granite.

N.B. During the typing of this section the deschription of Lians stoll was inadvertantly omitted. This is given below.

The remains of heading(84), which is at a level of about a metre above the floor of the main chamber, are in the quartz body, but the contact with the granite is seen near the floor - it has good molybdenit (85)is diappointing in that it rises in light granite with no visible molybdenite and does not reach, or show signs of reaching, the quartz. Lians stoll passes horizontally through light granite.

INTERPRETATION OF OBSERVATIONS.

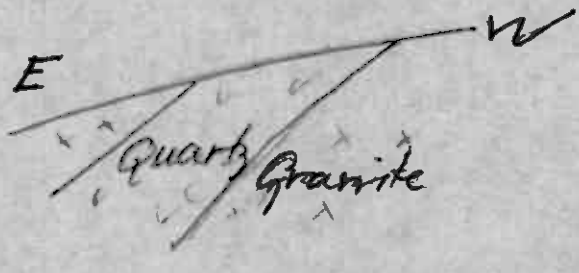
Certain directions for development work are so x obviously necessary that interpretations of the observations in the previous section are scarcely necessary. Nevertheless for longer range work interpretation, modified by the work's findings, is valuable.

The dominant result of this work is that the apparent confusion of granite, quartz, and felspar falls into place to give a remarkly simple relationship. There is only one quarts body in most of the mine, but a second, or at least a complication of the first, is indicated between Olines drift and Håkons drift. This quartz body has been worked at its upper and lower contacts with the granitex. The quartz dips at an average of about 2o° in a direction a few degrees to the South of East.

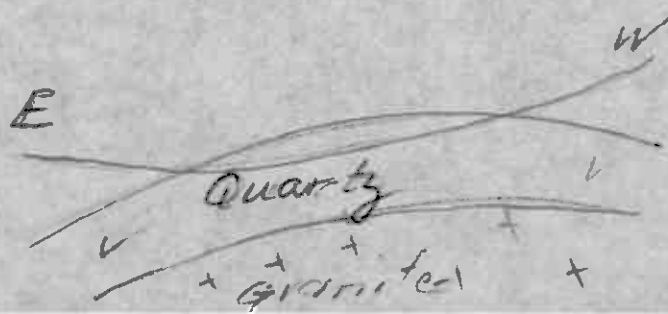
The quartz outcrops on the hill from N of Frimodighets drift to about loo metres S of Nilsens stoll passing just to the West of the Dagstrosse, (4), and Olines drift. It is difficult to decide whether this is the final westward extension of the quartz or whether it is an outcrop of the upper surface only. The two possibilities are sketched below.

INTERPRETATION OF THE QUARTZ OUTCROPS.

ONE.



TWO.



The evidence for one is as follows:

a, no quartz is seen in rises(2), (3), (5), (6), (19) and (21), all of which are within a few metres of the surface and without doubt below the quartz.

b, the rate of rise of the quartz is greater than the gradient of the hill in most places - this is best illustrated by Gunnars drift.

The evidence for two is as follows:

a, the quartz outcrop dies out southwards before reaching a point above the southernmost extension of the mine working where the quartz is known to ~~ex~~ exist, in this area the quartz must go into the hill or die out upwards reaching the surface.

b, quartz is seen in the Dagstrosse almost directly beneath the limit of the outcrop thus indicating(if one is correct) a sudden nearly vertical rise of the lower quartz-granite contact which is improbable.

Both cases have their merits and it may be that both are correct in part - one at the N end, the at the S end - as a small twist of the quartz body would be sufficient to make this possible.

The other major interpretation problem is the behaviour of the quartz body down dip to the east.

Kvina stoll is about 25 metres below the quartz at its west end at the foot of the winze from Håkons drift and along its entire length the quartz is not seen. Therefore the quartz is still above Kvina stoll at the point where the latter merges above the lake. Actually the quartz appears to outcrop on the hill at a level just above the ~~xxx~~ mill although mostly felspar is seen. Håbets stoll must also be under the quartz as it joins Kvina stoll and shows no signs of quartz except at its far end. Gunnars drift, on the other hand, clearly works the granite above the quartz.(89), which links Gunnars drift and Håbets stoll, is the key. The quartz seen in the upper part of (89) is the main quartz body in spite of its thinness - the high ratio of felspar to quartz is similar to the outcrop near the mill. Thus the quartz passes between(56) and Håbets stoll. The quartz should also be in the neighbourhood of (63). Andersens drift is above the quartz whereas Håbets stoll beneath this place is under the quartz. The two are connected by (62), (63) and (66), but the only quartz is seen at the top of (66) where there is a thin very uncharacteristic band - this may be the main quartz but it is an unsatisfactory explanation as the quartz is very thick at the not far distant Blågangen. The ore chute from (51) to Håbets stoll should be examined when emty as this, too, should intersect the quartz.

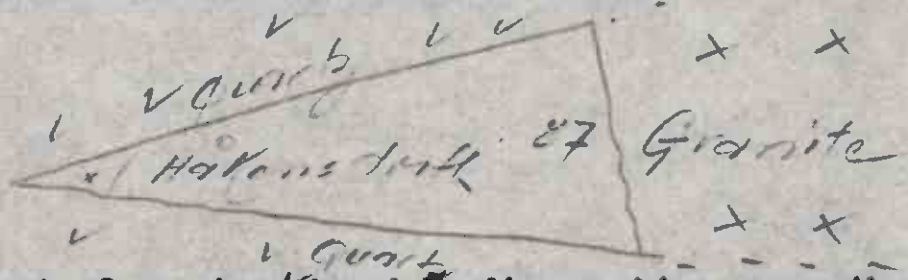
There is evidence that the quartz is splitting into two in the Lians drift and Håkons drift area, there are even signs of the same thing in Håkons drift. The split produces one band which runs westwards nearly horizontally(as far as the limited exposures allow one to tell) and the main body which continues upwards the surface. It is possible that there are two quartz bodies near together, but the evidence favours the splitting hypothesis as the point of junction is nearly exposed in Håkons drift.

The last important point is that ore exposed at the west face of Lians drift at (83) is a very good impregnation of granite by molybdenite. This is the type of ore seen in large quantities at Knaben and is said to be better than the "blebby" ore at the quartz-granite contact. At (83) the quartz appears to be higher than the roof - at any rate it is not contact-type ore - so it is possible that an area of ore largely independent of the quartz has been encountered.

This section can be concluded with a general statement. The key to the molybdenum ore is the granite at the quartz contacts. Thus the behaviour of the quartz body will largely determine the direction and shape of the workings. To the N the quartz as explored rises to the surface, but it may go into the hill again to the W. To the ~~xxxxx~~ E the quartz in places comes out into the hill, but the S, SE and SW its behaviour is lettle known.

It is in these directions that the main reserves may well lie, especially so as the workings get deeper this way and avoid the cramped nature of the workings to the north where the E-W dimension of the orebody is small.

SKETCH TO SHOW SPLITTING OF QUARTZ AT HÅKONS DRIFT.



FUTURE WORKINGS.

The procurement of an air-motored loading machine means that development work needs to be carried out with the mode of action of the loader in mind. The machine advances along prelaid rails into a pile of ore which has been blasted to fall on top of the rails. Thus a heading just under the ore is desireable so that the roof can be blasted and loaded with speed and ease. The next best alternative is to stope upwards steeply so that the ore will fall by gravity to the machine. The more speculative development work, of course, must seek the richest ore regardless of loading considerations.

The most important development work now is to prepare a working place for the machine in Liens drift. A heading due west into face(83) horisontally will tend to go low into the ore body if the normal dip is manifest. A parallel heading in face(86) with crosscuts would block out a large quantity of ore. If these two headings meet little ore low-grade ore they should be directed upwards towards the main quartz.

The second job is the completion of the Håbets stoll development already begun. The intention here is to use(89) as a haulage incline from Håbets stoll to Nilsens stoll. By connecting(69) with Liens stoll through circulation of air is achived - Important aid to remove dynamite fumes rapidly. The ore in the chute from Andersens drift can be removed at once, by clearing (67) an alternative route for removing ore from Liens drift is achieved. Finally a circular rotation of wagons could be arranged.

Development along the upper quartz-granite contact in (51) should show wether it is possible to obtain ore by working here in a fashion similar to that carried out in the past in Gunnars drift. The first heading should be parallel to (53) or the latter could be used. Extension of (53) would prove the ore possibilities of the same horizon in a southerly direction.

Ore-seeking development in Håbets stoll should be primarily utwards to locate the lower quartz-granite contact. Ar the far end the amount of ore exposed is so small that it is not possible to select a direction of advance with confidence. Under the circumstances to avoid water drainage problems it is probably the best thing to continue the stoll in its present direction. For the upward development a point near the ore chute is as good as any - an easterly component in the rise is disirable.

At the N end of the mine it appears that there is less likely chance of finding large reserves of ore, especially, if alternative one, (page 11) is correct. Ore is probably present at the horizon worked by (4) - the lower quartz-granite contact - in an easterly direction down the dip slope from(4), certainly it is present in (7) which could be used as a basis for development. The disadvantage of this is that loading is a problem as there is no obvious schme to get gravity-aided flow of rock.

Such places as chamber(3o), the Dagstrosse, and Primodighets drift have ore possibilities, but in all these are severe transport problems. In view of the fact that a development programme, by its very nature, must be flexible and that the results of the work suggested in the above paragraphs will lead to its own further development plans, it is unwise to advise on these more remote areas at present.

One development job of a special nature needs to be done. It is the determ nation of wheter the quartz itself is ore. It vertainly looks very poor in molybdenite in most places, but the very large excavations in Blågangen shows that, in this areas at least, it was at one time an economic proposition. The only possible way to assess its value is to pass many tons through the plant and even then the nature of this rock is such that the figure will be of importance only for a local area. If the main mass of the quartz is an ore proposition the proved reserves of the m ne become very large.

SUMMARY.

The molybdenite of Kvina Gruber is estimately connected with a large mass of quartz which was deposited by the residual solutions ofthe granite into which the quartz is deposited. There is evidense that the mine is near the margin of the granite. The whole area is faulted. Traces of molybdenite are outcroping in many places within a kilometre of the mine, their significance cannot yet be judged but they are a hopeful sign.

Working in the mine has been almost entirely along the upper and lower contacts of the granite against the quartz mass. Gunnars drift and Andersens drift work the upper contact. The Dagstrosse,(3o), (4), Håkons drift, Olines drift, Haakons drift, and Lians drift all work the lower contact. The Blågangen, a sole exception, works the quartz itself.

A detailed study of the entyre mine, of which a full description is given, shows that the quartz passes between(3o) and Nilsens stoll and between (45) and Håbets stoll. In Haakons drift and to the N and S a second body of quartz is seen, it is probably an offshoot of the main mass.

The following development work is suggested:

(i) westwards horizontally from Lians drift into(83) with a parallel heading into(86).

(ii) opening up of incline(89) and connection of (69) with Lians stoll - this work, preveously suggested, has been begun.

(iii) westwards and upwards in (51) and southwards in (55).

(iv) upwards and in the middle of Håbets stoll and southwards at the end.

(v) the lower quartz-granite contact at the end of the m ine to be followed.

(vi) determination of the ore possibilities of the mx quartz itself.

MEP/Aug. 1952.