Bergvesenet

Postboks 3021, 7002 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
BV 1229			Trondheim	Fortrolig
Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:

Tittel

Mørkvassheiane molybdenite
Part 1 - Geology
Part 2 - Mining

Forfatter	Dato	Bedrift
John D. Trueman	mai 1961	B. M. Heede A/S

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Drangedal	Telemark	Østlandske	16134	

Fagområde	Dokument type	Forekomster
Drift-kalkyle		Mørkvasshei
Råstofftype	Emneord	
Malm/metall	Mo	

Sammendrag

Part 1 beskriver geologien og Mo-minraliseringen og konkluderer med at det er vanskelig og usikkert å anslå noe malmforåd, men det blir anslått ca. 260.000 tonn malm med 1% MoS2.

Part 2 inneholder kalkyler for en eventuell drift og konkluderer med nødvendigheten av fortsatte undersøkelser med prøvesprengninger i flere faser med lagring av malm.
Ved en eventuell drift foreslåes en malmbrytning på ca. 20.000 tonn pr. år.

MØRKVASSHEIANE MOLYBDENITE

PART 1 --- GEOLOGY

SITUATION Near Tørdal, Telemark, Southern Norway. About 7½ Kms. East of the Northern end of Lake Nisser, and 4 Kms. North of Gjuve on the Dragendal - Eidstod road. Mørkvassheiane is reached by taking the main Dragendal-Eidstod road 16 Kms. to near Hagfoss and then following the logging track 4½ Kms north through the mountains to Grytvatn. Here at the South-Easterly end of the lake the track stops and one proceeds on foot. A path on the North-Easterly side of the lake branches off Northwards, after ¾ Km. and winds up the flank of Mørkvassheiane. After a climb of about 1000' the plateau is reached.

The claims cover a rectangular area of approximately 400 x 200 metres (Appendix - item 1) and are contained within a "concession-promise" the boundaries of which are drawn on the attached map (item 2 in the Appendix). The concession measures approximately 3 Kms. NW-SE by 2¾ E-W.

TOPOGRAPHY The concession area is rugged mountain country much of it being over 700 metres above sea level. Three principal lakes fall within the area:- North and South Grytvatn to the South West and Morkvatn to the North East. The valleys containing these lakes are afforested but with increasing altitude the woods become less dense and the trees smaller until at about the 700 metres moorland and large areas of bare rock predominate.

That part of Mørkvassheiane upon which the claims are situated is an anvil shaped block bounded to the South West and to the North by steep scarps. These are clearly shown on the attached aerial photographs (stereoscopic pairs - item 3 in the Appendix) with an enlargement of the area marked in white, item 4 - a photo-geological map).

The anvil-shaped block has an overall declination to the South of 10° - 15° and has four hills which, to facilitate reference, are hereinafter described as North Hill, Cliff Hill, Morkvatn Hill and South Hill.

The topography of the anvil-block is best seen by studying the photo-geological map (Appendix, item 4), in conjunction with the Panorama (Appendix, item 5). The latter should be laid along the base of the map. The anvil-block and the rest of Mørkvassheiane constitute the foreground; Fagerlihei and Sletterfjell the middle-distance and the high ground to the South West of the Dragendal-Eidstod road (Blikfjell to Skardsfj) the far-distance.

The photographs of the Panorama (item 4) were taken from Mørkvatn Hill which is off the photo-geological map to the bottom. Its position relative to the other hills of the anvil-block can be seen by referring to the attached photo-map (Appendix, item 6).

Easily recognisable features are South Hill (left) with a large pond; cliff Hill Valley (left-centre) wooded and with a stream winding across boggy land; Cliff Hill (Centre-right) with its three small ponds grouped close together as apices of a triangle (only the two nearer ponds can be seen on the Panorama); and North Hill (right) sharply truncated by a deep valley (extreme right).

PREVIOUS WORK

Mr. Sverre Svinndal while Economic Geologist at Norsk Bergwerk's Pyrochlore Mine at Ulefoss first visited the claims on behalf of B.M. Heede A/S on August the 21st 1959 and has made a number of short return visits since then. He was present to show the writer over the claims when he commenced his survey on May the 5th 1961.

Mr. Svinndal's observations and recommendations constitute a seperate report which is contained in the Appendix as item 7.

On Mr. Svinndal's recommendations extensive dynamiting was carried out on North Hill (Svinndal's reference:- points 1 and 2A and claim 8) and on the South West flank of Cliff Hill at the "Hotel" and near the summit. (Svinndal's reference:- claim 1 point 4 and environs). Although Molybdenite mineralization was ubiquitous on the anvil-block two principal areas of mineralization were discovered and are recorded on the writer's photo-geological map in orange.

The writer's exposure references have been written on Mr. Svinndal's report as an aid to correlation and Mr. Svinndal's are recorded on the writer's field notes, contained in the Appendix to this report.

PRESENT WORK

The purpose of the writer's visit was to:-

a) Make a closer and more detailed examination of the claims on Mørkvassheiane and of the exploratory work so far carried out.

b) To continue and extend this exploratory work with the view to assessing:-

— the economic potential of the area.

— whether further proving-up and prospecting would be justified, and if so

— to make recommendations on how this should proceed. If results satisfactory

— the capital that would most likely be required for mining to commence and for the project to be placed on a viable basis.

— the main items of equipment most likely to be required and any outstanding difficulties (such as terrain) effecting installation of plant, choice of machinery, etc, which would need to be surmounted or which could prejudice the ultimate success of a new project.

Part 2 of this report entitled "MINING" includes a discussion on the further proving-up of the Mørkvassheiane Deposits and makes recommendations as to how this should be carried out. All aspects of the possible future mining of these deposits including provisional estimates on capital outlay and running costs are included in this section of the report.

Mørkvassheiane is part of the Telemark Granite which covers a large part of this region of Norway. The rock types are granite-gneisses (permeation and injection gneisses) or migmatites. Texture and mineral composition of these granitic rocks are of almost endless variety and a gradual and imperceptible transition usually occurs from one type to another. Thus gneiss passes laterally and/or vertically into aplite, coarse-grained granite, fine-grained granite, pegmatites and quartz veins.

However, some pegmatites and quartz veins are clearly of an intrusive origin having clear-cut contacts and cutting across the general foliation of the gneiss or granite-gneiss.

The granite-gneiss has an overall dip to the South of 20° - 30° on Cliff Hill and in the area of the "Hotel"; but on North Hill the dip becomes generally shallower travelling Northwards and changes in direction until at Point 1 it is 5° SE. Beyond Point 1 the Strata become horizontal and further to the North can be seen to incline gently North-Westwards. Travelling South East down dip from Point 1 to Point 2A the Strata increase in dip to about 15° - 20°. The declination of the Strata can, amongst other places, be clearly seen and measured (15° SE) in a dynamited exposure (No. 13) in the cliff on the Northside of the anvil-block.

The plateau which rises gently Northwards in a series of swells has an overall declination South, shallower than the regional foliation of the granite-gneiss.

As one traverses the ground from Cliff Hill Valley to Point 1 on North Hill lower and lower zones in the granite-gneiss are revealed. Proceeding South-Eastwards from Point 1 in the direction of Point 2A and Mørkvatn Hill higher and higher zones are crossed.

South Hill and Mørkvatn Hill are believed to be higher in the "sequence" still, the regional dip being 20° - 30° and 15° - 20° South and South East respectively.

The petrogenetic and structural record of the Mørkvassheiane migmatites appears highly involved and a detailed mineralogical, petrographic and structural study would no doubt reveal a more complex history than that obtained in the time given for this short survey.

An examination of the aerial photographs reveals a number of faults (marked with blue crayon) which have been recorded on the photo-geological map. The Telemark Granite, as a whole, exhibits block faulting and within the Concession this is amply illustrated.

The anvil-block is bounded on the North by a fault line which has given rise to the deep valley clearly shown on the aerial photographs and in the photo-geological map.

Another fault bounds the anvil-block on the South West but has not given rise to such a prominent feature. The magnitude of these two faults has not been determined but the one on the North Side of the block is believed to be the most important. Two other insignificant faults forming poor features and trending NE - SW have been recorded on the map. The effect of these faults on the Molybdenite mineralization is discussed later in this report. Mørkvatn and North and South Grytvatn probably lie in fault zones subsequently carved out by glaciation. (A typical mylonite was discovered on the lower slopes (Grytvatn side) of Mørkvassheiane exactly on a suspected fault zone observed on the aerial photographs.)

The aerial photographs also reveal other structural patterns (jointing and relict folding marked in blue crayon) including what is believed to be relict folding in the granite-gneiss near the "Hotel". Relict folding can also be seen on the flank of Cliff Hill above the "Hotel" but is too inaccessable for close study.

Molybdenite Mineralization:-

Molybdenite occurs principally as pods, discontinuous veins and as a coarse impregnation in coarse-grained granite and quartz veins.

As the result of glaciation and weathering Molybdenite, being a soft mineral, has often been removed from the surface rock although blasting will often show it to be present in the sub-surface layers. However, aids to prospecting are:-

1) Coarse-grained equigranular granitic texture.
2) Haematite staining which often colours Molybdenite-bearing rock a deep red-brown.
3) Copper mineralization - Chalcopyrite and various blue basic hydroxide copper minerals (probably Malachite and Azurite, but no positive identification has been carried out for these minerals) which often occur in close association with Molybdenite.
4) Molybdite (MoO_3) alteration which by itself imparts a yellow colour to the rock but when in conjunction with iron staining gives rise to a deep orange discolouration.

5) Pockets which are presumed once to have contained Molybdenite often occur in cliff walls where dynamiting has subsequently shown there to be strong Molybdenite mineralization. These have aided in prospecting but to a lesser extent than the preceeding indicators.

Although the Molybdenite can occur as pods, veins and stringers in gneiss and gneissic-granite far the most important host rock is a coarse-grained equigranular granite. This rock has pegmatitic affinities but is quite easily distinguished from the pegmatites-proper which have a very variable texture, quite often having individual crystals of quartz and feldspar up to 6 cms. in length. Clots and zones of aplitic material also are characteristic of the pegmatites-proper. Runic texture is also very common in these pegmatitic facies.

The coarse-grained granite is usually in veins, layers, lenses, irregular sheets and corridors and the Molybdenite may occur either as veins and pods within this rock or as a coarse impregnation.

Molybdenite, when found in blue or grey finely striped gneiss or in partially granitised gneiss, invariably forms platy crystals following the foliation; and furthermore, is never far removed from a coarse-granite host rock. Deposition has often been along the periphery of coarse-grained granite layers. In some areas where the sheet or layered configuration of the coarse-grained granite is poorly defined and intermediate rock types between blue gneiss and this granite predominate semi-continuous and discontinuous veins can be seen to pass through these various host rocks.

Well defined Molybdenite veins are usually 2-9 cms. in thickness, while pods may be up to 1 metre thick x 1 metre wide x 5 metres in length though usually they are smaller than this. Details on individual dynamited exposures are contained as "field notes" in the Appendix to this report.

Molybdenite deposition occurred during the course of granitization and there is some evidence for there being two waves of mineralization the last being of little significance and in quartz vein complexes which are for the most part discordant with the regional foliation of the granite-gneiss. Location No. 1 exhibits this.

The pegmatites-proper are believed to be barren of Molybdenite.

Dynamiting was carried out during this survey at the following places and with the following objectives in view:-

1) On the South West flank of Cliff Hill directly above the "Hotel" (Exposure No. 12), good ore had already been shot out here and also in the cliff near the "Hotel" but the vertical extent and lateral continuity of these ore-zones were unknown. The exposure was extended laterally to an overall length of 24 metres along the crest of the hill. By dynamiting further down the slope, directly above the "Hotel", it has been possible to fill in the gaps between exposures 8-9-10 and 12 and thus to obtain an almost unimpeded view of about 20 metres of the "Sequence". This area is fully described in the Appendix and is recorded on the photo-geological map in orange as having "proven strong surface Molybdenite mineralization".

2) Along the south and south-easterly base of Cliff Hill. A number of veins had been exposured by trenching at Point 7 (exposure No. 11) and by dynamiting a number of shallow pits these were traced around the base of the hill to Point 3A (exposure No. 14). The degree of mineralization decreases away from Point 7 and is only weakly developed at Point 3A. Pits and cuttings have been made at selected points all over Cliff Hill and Molybdenite was found in nearly all of them. Shallow pits to the East and North East of Point 3A, revealed virtually no Molybdenite.

3) In the cliff face bounding the Northern side of the anvil-block (exposure No. 13). In order to exposure the "Sequence" here a 15 metre vertical cut was made in the cliff face. This revealed a number of coarse-grained granite layers with pods and veins of Molybdenite; but the bottom few metres were barren.

4) At Point 1 and beyond. Dynamiting had been carried out here previously and in order to obtain more information on the lateral and vertical continuity of the veins here revealed further cuttings were made exposing a total area of 33 metres in length x 1-5 metres in depth. Exposures 25A, B and C are fully described in the Appendix. Point 1 and its environs have good Molybdenite showings but further work will be required before they can be included on the map as an orange area. Additional blasting would most likely show that mineralization from "claim 8" (exposures 16 - 24) extends without interruption to Point 1 (exposures 25 A-B-C).

5) To the South of Cliff Hill, beyond the SW - NE trending fault on the path up from the valley. A number of pits and cuttings were made here to try and pick up the Southward dipping ore-belt. The upper cuts were barren but the bottom ones contained Molybdenite. The ore-belt is further down the hillside here than might be expected, but a small downward displacement of the "block" to the South of the fault would account for this.

6) On the round-topped hill to at the North East end of South Grytvatn. By extrapolation there appeared to be a good chance of picking up the Mørkvassheiane ore-belt again in this part of the valley. Three small pits made on the last day of the survey revealed showings of Molybdenite. The writer recommended that further exploration should be carried out on the top off and around the flanks of this hill. (To facilitate reference this will now on be called Grytvatn Hill).

Molybdenite was reported to have been seen on the island in South Grytvatn, on the South West side of the lake near the junction with North Grytvatn and also on the ridge of land actually between the two lakes. The writer inspected the showing on Grytvatn Island and decided further exploration should be carried out on the above areas. Some work by the men has already been done and two points designated V5 and V7 on Grytvatn Hill look the most promising.

15 new claims have been staked in this area and are recorded on the attached map (item in the Appendix).

No dynamiting has been carried out either during this survey or before on the North West flank of Cliff Hill, the South East flank of North Hill, on Mørkvatn of South Hills. While Molybdenite has been seen on the flank of North Hill and the ore-indicators are fair on North and Cliff Hills, Mørkvatn and South Hills are believed to be barren. No Molybdenite was seen during the course of this survey and there is no report of early prospectors having discovered it on these hills. However, Molybdenite is reported to occur to the North East of the ribbon lake which is about ¾ Km. North West of Point 1. A traverse was made across the plateau between Point 1 and the lake but no Molybdenite was discovered and the absence of ore indicators makes it unlikely that it will be found. If the ore-belt does continue beyond the ribbon lake and the regional declination of the Strata is similar to that on the anvil-block it would suggest that the block North of the fault is down thrown. Further survey work should take in this problem.

Molybdenite Ore Values and the Question of Ore Reserves:-

The Molybdenite occurs, as will be appreciated, in such a manner as to make ore-reserve calculations exceedingly difficult and subjective, in spite of the large amount of dynamiting on the top and round the flanks of the anvil-block.

The figures arrived at below should only be taken as a fairly reliable indication of overall values and reserves. Later in this report recommendations are made on what additional proving-up work should be carried out to establish more reliable figures. Samples of 5-10 lbs. in weight were taken from 6 different localities from ore already mined and lying on the surface. Only large lumps (12 cms. or so in length) were chosen and were selected as being representative of what in practice could be readily mined by hand-sorting without any cobbing.

The assay results are as on page 10.

Material	Exp. No.	Molybdenum		Molybdenum Disulphide
Rich Impregnation	3. P4.	0.80%	=	1.33%
Rich Pod Ore (Mostly Core)	12	1.35%	=	2.25%
Typical Vein Ore	8	0.25%	=	0.42%
Gneiss Uniform Impregnation	22	0.90%	=	1.5%
Typical Coarse-Granite Lens	26	0.20%	=	0.33%
Poor Pod Ore (Margin)	12	0.20%	=	0.33%

All samples reduced 50% by the analysts before crushing and assaying. No repeat assays carried out on any sample. Assays made on samples dried @ 212 °F.

From the above assays, the MoS_2 content of the hand-sorted ore averages 1%. (By hand-cobbing the MoS_2 content has been raised toas much as 27% --- see ore-dressing report, item 9 in the Appendix).

A study of exposures 8,9,10 and 26 above, at and below the "Hotel" on the South East flank of Cliff Hill and of exposure 13 in the Northern cliff of the anvil-block has shown that the percentage of ore to waste rock varies from just under 3% to over 10%. (For further particulars on these calculations please refer to Ore Estimation in the Appendix).

Taking the lowest percentage of ore as being 2.8% the tonnage of ore on the top of the anvil-block is estimated at 260,100 tons which having an MoS_2 content of 1% is valued (on current prices) at £1,748,000.

The reserves refer to the area A-B-C on the photo-geological map and do not take into consideration any Molybdenite occuring deeper in the ore-belt than a plane drawn between A, C and 60 metres below B; or on Grytvatn Hill and in neighbouring areas.

The Grytvatn mineralization is almost certainly an extension of the Mørkvassheiane deposits: the ore-belt has been traced at least 200 metres down the hill, South East of the "Hotel" andhas been exposed again by dynamiting at the base of the hill, (Exposure No. 2). The steepness of the hillside and the dense vegetation met with further down makes prospecting very difficult.

It is, therefore, reasonable to expect that further proving-up and exploration will enable a substantial upward revision of the writer's estimates to be achieved

FURTHER WORK

Before a final assessment of these deposits can be made and a decision to refrain from or to go ahead with mining and the erection of the necessary treatment plant, the following additional work should be carried out:-

1) Proving-up of the Plateau Deposits

Re-estimation and confirmation of ore-reserves and classification into Proven, Probable and Possible reserves having first studied in detail.

a) MoS_2 values in ore from different localities and in different host rocks.

b) Ratio of ore to waste in different localities.

c) Rate in tons per man hour of ore recovered by hand sorting from different localities (having different ratios of ore to waste).

d) Alternative methods to hand-sorting of ore such as Dense Medium Separation. An average of not less than 0.4%, MoS_2 is required for Molybdenite to be classified as an ore when hand-sorting is the mining method to be employed. Dense Medium Separation may enable lower MoS_2 value to be worked. (At Knaben, the Norwegian mine, 0.22% is the average MoS_2 content of the ore currently being mined. The deposit is a uniform impregnation and bulk mining methods are employed. The workings are wholly underground).

2) Exploration and Proving-up of the Valley Deposits.

3) Prospecting and General Surveying

Prospecting on other parts of Mørkvassheiane, in Grytvatn Valley and on Fagerliher and Sletterfjell should continue. As an aid to prospecting and to delineating subterranean ore reserves detailed mineralogical, petrological, structural and geochemical investigations might be helpful; but any further work on these lines should be given less priority to (1) and (2) above and should be judged strictly on a Cost-result basis.

The financial and practical consideration of (1) and (2) above are treated separately at the end of Part 2 - Mining of this report.

Diamond Drilling

Drilling has been considered as a means of exploring the Mørkvassheiane deposits at depth but has been rejected as being far too expensive. For the results to be conclusive drilling would need to be on a grid with 10 - 20 metre intervals between holes and to a depth of not less than 50 metres, At 135/-d per metre it puts it quite out of the question.

Trueman

John. D. Trueman.

Geologist.

MØRKVASSHEIANE MOLYBDENITE

PART 2 - MINING

(A preliminary investigation into the general economics of working the Mørkvassheiane deposits, capital and running costs of plant and equipment, communications, transport, siting of equipment, pilot mining, ore-dressing, proving-up of ore- reserves, etc.)

The basis of the following study has been:-

a) Production of 10 tons of 1% MoS_2 ore per hour by hand-sorting.

b) Removal of 100 - 250 tons of waste per hour.

c) 10 hour day for mine workers and for crushing and grinding section of the mill.

d) 24 hour operation of floatation plant; treatment of 500 tons of ore in a 5 day week.

e) 200 day year.

1) Communications

The logging track would need to be extended 1 Km. to the junction between North and South Grytvatn, the most suitable site for the Floatation Plant. At an anticipated £1.10.0d - £2.0.0d per metre the cost would be £1,500 —— £2,000. It is believed the greater part of this expense would be refunded by the Government.

2) Floatation Plant

Sited at the junction between North (412 metre level) and South (409 metre level) Grytvatn, water for the mill and floatation cells could be drawn from the upper lake. The minimum of pumping would be required as the great bulk of the water could be passed through the plant under gravity.

Tailings disposal:- in the lower lake, subject to local authorities approval.

INSTALLED CAPITAL COST:- £45,000 - £75,000

Please refer to Denver Equipment & Co. Limited, (item 10A and B) and Ferdinand Egeberg & Co's (item 11) estimates in the Appendix.

NOTE:-

Egeberg's flow sheet is incomplete (it stops with the floatation cells) and does not include a Thickener or Stove for drying the concentrates; an additional £5,000 has been added to their estimate to allow for these items.

Denver's estimate is on the high side and is due to the large mark-up between f.o.b. costs (£35,000) and installed costs (£75,000). The main differences between the quotations is in this mark-up. Egeberg's Civil engineering and installation costs are likely to be more reliable to Denver's which are based on a "Global figure". A plant could no doubt be installed for £50-£60,000 without undue economy on buildings.

RUNNING COSTS £1.1.-d. PER TON OF ORE TREATED

This is exclusive of amortization.

3) Cableway

To bring the ore down from the Plateau to the Floatation Plant an overhead Cableway would need to be installed having a capacity of 10 tons of ore per hour. It should also be suitable for transportation of men, and equipment to the Plateau.

Full particulars of a suitable Cableway are contained in a provisional estimate submitted by British Ropeway Engineering Co. Ltd., which is enclosed as item 12 in the Appendix. Accompanying plan (item 13) and drawings (item 14) should also be referred to.

The cableway described has a Skip which can be lowered and raised vertically thus making it possible for any ore discovered in the flanks of valley between Mørkvasaheiane and the Floatation Plant to be worked.

Reference should be made to photo-map (item 6) upon which is shown the most suitable site for a Floatation Plant (F) the traverse of the cableway (blue line) and planned extension of the logging track in the valley and construction of a mine-track on the Plateau (black dashes).

INSTALLED COSTS £37,350 - £42,000

(BASIS £28,000 F.O.B.)

RUNNING COSTS 2/9d PER TON CARRIED

Comments:-

It should be noted in British Ropeway Engineering Co. Ltd's tender that a maintenance fitter, labourer and greaser would be employed for only 25% of their working time. These men would most likely be otherwise employed at the Mill and with the exception of the fitter their full wages have already been accounted for under Mill Costs - see Denver's estimates. The fitter's job is referred to later under the section entitled Key Personnel.

4) Mining

The topography of the anvil-block and the general disposition of the ore-belt make open-cast mining the obvious choice. The most economic method of separating ore from waste is likely to be hand-sorting inconjunction with a Michigan Tractor Shovel for removal of waste and for transport of the ore to the bin feeding the overhead Cableway. An alternative method which should be closely examined is selective mining of ore zones in bulk and treatment by a Dense Medium Separation Unit sited on the Plateau. The D.M.S.U. would remove most of the gangue and produce a rougher concentrate for transportation to the Floatation Plant.

The rate of hand-sorting ore is expected to be ¼ - ½ ton per man hour depending on the ratio of ore to waste in the rock. Recovery would undoubtedly be less in the case of a low ratio of ore to waste. At an average rate of ⅓ ton per man hour and a wage of 5/-d per hour per man the cost per ton separated would be 15/-d. To this should be added 1/6d per ton to cover drilling, dynamiting and wages of two men thus employed; and 2/9d per ton for transportation of the ore to the bunker and disposal of waste. For this a Michigan Tractor Shovel model 175A is believed to be the most suitable. Please refer to Michigan (Great Britain) Ltd's estimates contained as item 15 in the Appendix.

Capital Costs:-

(D/D Tørdal)

	1 Michigan Tractor Shovel	Model 175A	£9,250	
or	2 Michigan Tractor Shovels	Model 55A	------	£11,050
	1 (Halifax Tool Co. Ltd's) Compressor		£1,500	
	1 (Halifax Tool Co. Ltd's) Drill and bits, etc.		£1,000	
			£11,750	£13,550

Running Costs:-

Miners wages at 5/-d per hour	15. 0d per ton
Drilling and dynamiting and wages (2 men)	1. 6d " "
Transportation (1 Michigan 175A)	2. 9d " "
	18. 9d " "

5) Key Personnel

Mine Manager (a Mining Engineer)	£2,000 p.a.
Plant Superintendent (an ore-dresser)	£2,000 p.a.
Mechanical Engineer (also as fitter for Cableway)	£1,000 p.a.
Electrical Engineer	£1,000 p.a.
Analyst	£ 800 p.a.
Other Personnel not yet accounted for:-	
Carpenter	£ 650 p.a.
	£7,450
Less 25% of Cableway fitters Salary	£ 162.10. 0d
	£7,287.10. 0d

COSTS PER TON OF ORE BASIS 20,000 TONS ANNUALLY - 7/4d

6) Housing for Key Personnel

Moelven Barracks (item 16) has been suggested as a suitable type of readily assembled, movable pre-fabricated wooden building. The price for the Model M has been selected as a basis for estimating housing costs for 5 Key Personnel.

5 BARRACKS AT £412 £2,060

Analysts laboratory, Carpenters shop and Engineers Workshop could probably be housed within the main Floatation Plant building and are, therefore, not treated as separate items.

7) Power Supplies

Please refer to the attached map (item 17) which illustrates the present Grid in the Dragendal-Tørdal District. An extension of the grid 4½ Kms. to the Floatation Plant would take 2/3 months. A 2,000 Kilowatt power line would cost £750 per Kilometre making a total of £3,375 for the job. Please note, however, that the estimated power requirements would be in the region of 150 KW. and the costs of installing a suitable cable might be less than the figure given. Electricity would cost about 3 øre per KWH. Only 200 KW could be supplied immediately from the Grid . Additional quantities would entail installation of a transformer (taking 9 months).

8) Transportation of Equipment to the Plateau

For Pilot Mining to commence on the Plateau before the installation of a Cableway all equipment would have to be flown in by helicopter (or dropped from an aeroplane). Helicopter Service A/S charges on a minimum 50 ton load are £18.10.0d per metric ton with a maximum flight load of 350 Kgs.

All equipment would have to be taken up in parts and assembled on the Plateau. In the case of the Michigan 175A this would be a problem. Models 55A are, however, easily knocked down into small loads. For a load of 15 metric tons, Helicopter Service A/S are expected to charge £20 per ton. The Capital Cost of lifting machinery to the Plateau would, therefore, be £300.

NOTE:- The Norwegian Airforce has larger helicopters capable of carrying heavier loads. They might be prepared, as a Military exercise, to fly in one or two of the heavier parts, such as the wheels of the Michigan 175A. Otherwise a small plane would need to be used, the charges for which would be about £25 per 3/400 kilos.

9) Total Estimated Capital and Running Costs

a) Capital Costs

Electric Cable	3,375		
Extension of logging track	1,500	-	2,000
Floatation Plant	50,000	-	60,000
Cableway	37,350	-	42,000
Mining Machinery	11,750	-	13,550
Transportation of Machinery	300		
Housing	2,060		
	£106,335	-	123,285

b) Running Costs (per ton of ore)

Floatation	£1	1	0d.
Cableway		2	9
Mining, including depreciation on Tractor Shovel		18	9
Key Personnel		7	4
	£2	9	10
Amortization of £102,160 (not included above) within 5 years	1	0	6
	£3	10	4d.

Ore-Dressing

Please find enclosed ore-dressing report (item 18). No difficulties are engisaged in treating the Morkvassheiane ore and a concentrate of 90% recovery. As part of the proving-up programme further ore-dressing should be carried out on 1-2 cwt. of ore made up of 50 lb. samples from different localities.

10) The Molybdenite Market

The current Metal Bulletin price for 85% Molybdenite Concentrate is 10/-d. per lb. of Mo contained f.o.b. (U.S.A.) which is equivalent to 6/-d. per lb. of MoS_2 contained f.o.b. A price increase of 10% has recently been made raising the price to its present level.

Molybdenum is one of the 7 "Atomic Age" metals for which greatly increased demand is anticipated in the next 10 years. A general price increase is sure to follow.

11) General Economics

20,000 tons of 1% ore treated annually with 90% recovery would yield 180 tons of MoS_2 valued at £120,960.

Total costs on 20,000 tons of ore

a) First 5 years at £3.10.4d. per ton = £70,333 p.a.
Total estimated gross profit £50,627

b) After 5 years at £2.9.10d. per ton = £49,833 p.a.
Total estimated gross profit £71,137

NOTE: Transport costs from Mill to Kragerø would be about £3-400 for 180 tons of Concentrates and in view of the marginal cost has been ignored in this calculation.

It can readily be seen that if the MoS_2 content of the ore were to fall to below 0.5% operations would become uneconomic, unless sufficiently great ore-reserves were subsequently proven, increasing the life of the mine, and making it possible to accept a slower rate of amortization than that allowed for here. A lower limit of 0.4% MoS_2 might, therefore, be acceptable.

No figure for the degree of recovery of Molybdenite by hand-sorting can be estimated but quite a lot of ore will inevitably be lost through being overlooked. As the tonnage estimates have been made for Molybdenite contained in readily recognisable ore, and no allowance has been made for MoS_2 values in the country rock; the life of the mine, in present figures, is calculated at 13 years.

12) Winter Conditions

The above estimates have been based on a 200 day year as it is not yet certain whether sufficient ore could be stockpiled satisfactorily for the Floatation Plant to be run through the Winter. This will require further study.

Open-cast mining will certainly have to be discontinued in the Winter months.

Underground mining is unlikely ever to be a proposition (unless an area of continuously high MoS_2 values is discovered) and is, therefore, not considered in this report. The driving of exploratory adits might conceivably be justified as a means of proving-up the ore-belt and for retaining staff during the Winter months. This, also, will require further study.

13) Further Exploration and Proving-Up

Please refer to the last paragraphs of Part 1 - GEOLOGY.

The first and most important thing to be carried out is a Topographical Survey of 1) the anvil-block and 2) the area of MoS_2 mineralization in the valley - Grytvatn Hill, etc.

This Topographical Survey should be carried out on a scale of about 1 - 1500 and the map should be such as to form an adequate base for geological map.

The Grytvatn Hill mineralization should be thoroughly dynamited and geologically surveyed. If the prospects are sufficiently promising further proving-up should follow. It is recommended that these should take the same form prescribed as follows for the Mørkvassheiane area:-

a) More dynamiting around the flanks of the anvil-block and on the top where trenching and pitting has been insufficient to give a definite picture of the degree of mineralization.

b) Small Scale Pilot Mining Trials (without machinery). To obtain rate at which a man can sort ore from different localities having different ore/waste ratios.

b) For the purpose of calculating percentage of ore to waste; the MoS_2 contents of different rock types, their average value and associated minerals; Probable ore Reserves etc.

If these investigations prove encouraging to:-

c) Repeat Pilot Mining on Large Scale: (i.e. 50-100% of the scale that would be necessary if a mill were in operation) (using a Michigan etc.) and stock-piling the ore.

The aim of this final stage of proving-up should, of course, be the confirmation of stage 1 and the accumulation of stock-piles of sufficient ore to amortise the Plant and Machinery.

Stage 1 (including Topographical Survey)
5 men for 12 weeks supervised and carried through by an Economic Geologist.

Estimated Cost	£1665
Ore accumulated	Ca 600 tons
Effective value	Ca £3629

Stage 2

	(a)	or (b)
	17 men for 12 weeks Michigan 55 A.Drill and Compresser	17 men for 14.8 weeks Michigan 55A Drill and Compressor
Estimated Cost	£11375	£20,675
Ore accumulated	Ca 3000	Ca 12,000 tons
Effective value	Ca £18145	£72580

or (c)
32 men for 48 weeks
Michigan 175A
Drill and Compressor

Estimated Cost	£ 35,650
Ore accumulated	Ca24,000 tons
Effective value	£145,160

N.B. The above estimates do not include:-

(a) Analyses costs.
(b) Professional fees and costs.
(c) Transportation of the machinery to the Plateau by helicopter costing £200-300.

Comments:-

Stage 2 should be supervised and carried through by an Economic Geologist and Mining Engineer. Pilot Mining could be discontinued at any stage with the minimum of capital loss should progress prove unsatisfactory; or, continued long enough for sufficient ore to be accumulated to amortize the plant.

Ore-dressing experiments and investigations into Dense Medium Seperation should be carried out concurrently with stage 2 so that phasing in of a mill might be achieved without delay at any time when it was decided sufficient proving-up had been done.

Stage 1 on both the Valley and Plateau deposits should be completed and assessed before Stage 2 is commenced. If the Valley deposits are of sufficient interest to warrant Pilot Mining this ought to be carried out first for if mining-proper could be started in the Valley there would be a considerable saving in capital outlay. The erection of a cableway and the mining of the Plateau deposits could be financed out of the profits from the Valley operations.

John D. Truman.

Geologist.