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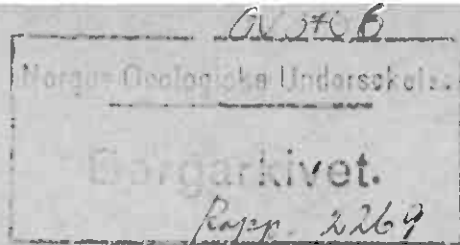
V. B. H. H. Smith

H. H.

REPORT

on

Ørsdalen Wolfram and Molybdenum Mines.



In supplement to my report of December 9, 1937, page 7 dealing with the Content of the Ore, I beg to state as follows on basis of analysis obtained in letters of December 10th and December 17th:

	A.	B.	C.
WO ₃	3.02 % (W 2.40%)	1.38 % (W 1.10%)	1.24 % (W 0.98%)
MoS ₂	0.26 (Mo 0.16%)	trace	trace
FeO	10.00	10.80	10.45
MnO	0.52	0.32	0.50
CaO	2.02	2.75	1.54
Al ₂ O ₃	9.00	8.10	10.70
MgO	2.55		
TiO ₂	0.58	0.83	0.66
SiO ₂	63.30	60.80	66.80
CuO	0.09		
Bi	0.00		
Moisture	0.18	0.18	0.20
Ignition loss	1.00		

Sample A. is the most important for which reason a very extensive analysis has been carried out on same.

As regards the results of the analyses I wish to state that they verify what I have stated in the report and confirm my opinion, namely, that one will have to look for the wolfram ore where the content of SiO₂ is high. The scheelite is met where the content of CaO is increasing and one may calculate with the presence of molybdenite at the same time. In some places the ore appeared to be fairly magnetic, which is proved by the high iron content, and a further proof hereof is the low content of manganese. Accordingly, the deposit should be excellently suited for geophysical ore sounding, and in such case the electro magnetic method should be used, to which I wish to draw attention.

Oslo, December 20, 1937.

(Sgd) H. H. Smith.

(Translation)

R E P O R T

on

Grsdalen Wolfram and Molybdenum Mines.

According to request, I inspected the mines from November 13th-17th, 1937, and beg to report as follows:

The Solicitor H. K. Schaanning, Egersund, has disposition of the deposits and he gave me "Map on Heia" by Mr. Per Överby, Sandmark, January 28, 1919, a very incomplete sketch of the places where work has now been carried out, and as both of them do not give much of an orientation it must be regretted in this case. Furthermore, I received a report dated October 15, 1934, by the Consulting Mining Engineer W. G. Tidemand, Kristiansand, together with a sketch. I was accompanied by two men from the parish who had worked at the mines the whole time and who knew all the places well. With the assistance of these two men and by help of lines stretched between bolts in the rock wall and a line around my waist, I succeeded in inspecting some of the places that had been worked in recent times. I had to show the greatest care all the time. I regret to say that the time of year was very inconvenient for an inspection and as the ground was frozen, had been covered with snow a few days before my visit, the inspection was really attended with great danger. For this reason I was unable to inspect the molybdenum mines whereas the wolfram mines were made accessible, and these were also the real object of my visit.

Situation:

The mines are situated in the open field of the farm Hovland in the mountain "Sigleknuten" in Ørsdalen in the district of Bjerkreim, Rogaland County. The height above the bottom of the valley calculated from the foot of the mountain, where the small brook is running, is 570 meters. The valley is about 70 meters above the Ørsdal Lake which is about 70 meters above sea level. The total height will thus be about 650-700 meters above sea level according to barometer measurements made by me.

History:

The first mining at the top of the high mountain "Gudlen" was started at the end of the year 1904 for the account of the British Molybdenite Co. The operating continued until 1909 when it was laid down. During this period greater constructions were made down in the valley to concentrate the ore and an adit 274 meters long was driven from the bottom of the valley. Some mining was also done in the mountain. In the years 1911, 1912, 1913, 1914 and till and including the year 1917 work was started by A/S Christiania Minekompani with a modest number of men and a small production of both wolfram, scheelite and molybdenite. In November 1917 the mines were taken over by a company organized under the name of "Ørsdalen Wolfram og Molybdængruber". At the end of 1917 a further company was formed for mining at Mjaasvasknuten, namely "A/S Hovland Molybdæn- & Wolfram-gruber", but the operations lasted only a short time and the production was insignificant. The working was stopped in 1918. In the autumn of 1918 Mr. Schønning made some investigations in the Khaasi Mine and Tollevaara V in "Gudlen" in the open field of the farm Hovland in Ørsdalen.

According to the statistics all work was discontinued in 1919, and from 1919 until to-day there is no public information in the matter.

Roads and Transports:

The nearest railway station is Klungland on the Flekkefjord-Stavanger Line, 11 km. from Egersund, 63 km. to Flekkefjord and 87 kilometers to Stavanger. The distance from Klungland to "Odlandsstø" at the lower end of the Ørsdale Lake is 14 kilometers. The road to Odlandsstø is a good driving road for automobiles. Across the lake, a distance of 17 km., there is boat three times in the week in connection with the automobile traffic. At Vasbø on the other side of the Ørsdal Lake, where the telephone station is, there is a good driving road, but a bridge must be repaired. From Vasbø it is 5 km. to Hovland and a further kilometer to the foot of the "Gudlen" mountain where a foot-path leads to the mines through a very steep and inaccessible part of the mountain. It takes about $2\frac{1}{2}$ hours to get up although the distance in a straight line from the valley measured by an old ropeway is not more than 2,2 km. The whole distance from Klungland to the foot of the mountain where the mine is situated will thus not be more than 37 kilometers. Adding the distance up the mountain, the total length will be about 39,2 km. and as compared with our other molybdenum mines, for instance Knaben, this must be said to be favourable.

Height, climate, vegetation, etc.:

The Ørsdale Lake is situated about 70 meters above sea level and the bottom of the valley rises gradually upwards. The valley is wide to start with, but narrows considerably at "Gudlen" on its south eastern side where, however, there are still sites for constructions. The mountains rise here almost perpendicular. There is not much forest in the valley, not even sufficient to meet the requirements of the population. Owing to the stony and shallow soil the farming does not yield more than barely enough for the popu-

lation. The climate is also very hard and windy. The mines are situated up on the very mountain and are exposed to all sorts of weather and wind and the operating should be planned in such a way that work in open cast, as has hitherto been the case, should be avoided as much as possible. I wish already here to mention my idea, namely, that future operating should be started in the valley and from there upwards and attacking at a height of about 200-300 meters. The men told me that ore has been found at the surface a little above the gravel-take in the slope of the mountain at this height. Because of the lack of maps I am not able to state anything definite, and the first thing which will have to be done is to survey here and at the deposits.

Geology:

At the Ürsdal Lake and up through the Ürsdal Valley the mountain sides are very precipitous and rise from 650 to 700 meters. The rock in the lower part of the valley and at the lake is norit or Labrador rock and regular stratified gneiss. Further up in the valley it shows a distinct form as benches, gets foliated and has in some places a flat fall whereupon the gneiss layers become steeper and steeper and finally the layers are vertical. Up in the "Sigdalknuden" the main rock is a granite containing microperthitic feldspar, quartz and rhombic pyroxene which is called "Birkremit" according to professor Kolderup. Other kinds of rock to be mentioned are: ordinary granite, gneiss, or perhaps gneiss-granite, mica schist, schistous dark rock, mainly hornblende with garnet and above all quartz veins. We are meeting these rocks in alternating layers. When we meet the coarse crystalline pegmatite vein deposit or vein with prevalent quartz in the Birkremit, then the wolfram ore appears either by itself or together with scheelite, if it has a strongly schistous character in cracked shape as fissures one meets chiefly scheelite and also wolfram, but

on a small scale. In the last mentioned case we also meet molybdenite, but rather scarce. It is strange that it is only in this kind of rock, Birkremit, that the Wolfram ores are met in this country and the combination Wolfram-Molybdenite ore. When the schistous rock is impregnated with pyrites in the Birkremit and may be seen at a distance as gossan, this is the point where we discover the scheelite. Also Wolfram appears here, but only as small grains whereas in the first mentioned case it is met in parts of the veins as pure crystals in the size of a walnut, a fist and in lumps of up to 40 kgs. or more which was shown me. Similar to the here mentioned schistous rocks, we have also the more prominent quartz veins, one or more together, which then perhaps principally contain wolfram ores and less of molybdenum ore. This ore zone or vein zone, if I may call it so, appears in this way in the gneiss in the upper part with a general strike in a NW-50 direction and down towards the valley along the slope with a turn due West. This may be seen from the accompanying sketch. Please note that this is only a sketch for general orientation as all material in the way of maps is entirely lacking. In this sketch I have marked the recent working places and the figures state height above sea level according to barometer measurements. The length of the zone from The Wolfram Shaft ("Wolframsynken") in NW towards the precipice is about 500 meters, the width from a few meters to about 20 meters and perhaps to about 40 meters along the slope. It is impossible to state any figures here since the hanging wall of the zone is eroded and decomposed.

In the same ore zone but in SO direction there appears mainly molybdenite, and also some Wolfram and scheelite have been found. The area extends in length about 400-450 meters from "Wolframsynken" without stating any width, but I should think it is some meters wide. The molybdenite is met with in

fissures along the schist and in stripes of gneiss, less as impregnation but chiefly as roses, lumps and solid fillings, along the fissures in the schist it also appears as rich impregnation and in the shape of scales and leaves. To the West the molybdenite appears in a similar way and it has also been found in the lower levels of the recently mentioned big ore zone along the slope, and only to the West and North-West of same. I wish to repeat that here the molybdenite appears first and foremost together with the scheelite and some Wolfram.

In the eradicated remaining area down towards the valley and on the footwall where the working has now taken place, irregular greater and smaller lumps of wolfram were shown to me everywhere at the surface and also scheelite which, however, was not so prominent. I may perhaps classify this mode as irregular segregation of ore if they are not remnants of the previously stated pegmatite-quartz segregations.

In our other molybdenite deposits pneumatolytic minerals have been found and it is therefore thought that they have been formed by pneumatolytic processes during the crystallization of the magma, and the same is the case here, I should think, so much the more so as the wolfram ore is considered to be of pneumatolytic formation in the same way as tin with which it is met as a rule although not with us.

Mining Documents:

Mr. Schaanning showed me his exclusive permits, claim stakings and suspensions which go very far back in time. I got the impression that there were many, even a good deal too many, of the documents of more recent date. I have marked these in the sketch, number 1-14, as stated to me. Anyway, the deposits are well protected which is a good thing when one remembers all the

disputes there have been here in earlier days. As mentioned above, the area will have to be surveyed and mapped and then application for patents made. The present report suffers from lack of material in the way of maps and for this reason it is rather incomplete.

Description of the Mine:

All of the working places are located in the previously mentioned ore zone down the precipice on an incline of 60-75 degrees and I was able to inspect the following places: (See sketch).

Cutting no. 3, claim staking no. 6. This was a small working place into the rock which exposed layers of ore consisting of scheelite just at the beginning of the cut in a width of up to 7-10 cm. and the length of the cutting is about 3 meters. The striking direction was N 45 degrees V and the dip about 75 degrees NE. The operating should be continued due the footwall and thereafter opened along this strike. The situation is 611 meters above sea level and 83 meters below the "Wolframsynken".

The new Adit:

This adit was started from the brook with a cutting 2.50 meters and continued inwards cutting quartz veins and schistous lode parties. A level along the strike is then driven in the lode carrying wolfram and scheelite in the direction of the strike N. 50 degrees NW and where the dip was 70-80 degrees due NE. The adit was 22 meters and continued inwards but was inaccessible, the width was two meters and more in some places and the height was the same but in the middle section it had been stoped to more than 5 meters. In several places the ore was shown to me, as formerly described, and the place where the big ^{ore} lump had been taken. I also saw some scheelite, but not much, and this as well as Wolfram appears quite irregularly. I may use the expres-

sion "as raisins in a pudding." The wolfram appears in the vein-walls as well in the hanging wall as in the foot wall. In the roof of the level in the strike some meters back from the breast in NW direction a cut had been made to the surface which gave access to it. It is situated 604 meters above sea level and 90 meters below the "Wolframsynken". The claim stakings nos. 1, 2, 3 and 4 cover the deposit. It gave me a favourable impression and I will recommend developing due the foot wall.

Adit No. 2 or Cutting No. 2. After a small cutting the adit is driven in the direction N 40 degrees W where the rock has a dip of 60-70 degrees NE. The length was 10 meters and continued further towards the precipice about 3 meters, inaccessible. In several places I saw lumps of wolfram in the bottom, in the roof, in the breast and in the walls of the adit, and the same was the case for scheelite, but perhaps not so frequently, it should be kept in mind, however, that the scheelite is met with almost always together with the wolfram. In the wall due West and down towards the bottom the molybdenite appears in some places, as previously stated, and perhaps more often together with the scheelite. At the other working places I have described, however, I did not see any molybdenite. The height is 589 meters above sea level and 105 meters below the "Wolframsynken". Outside the adit, in western direction, I was shown wolfram lumps in many places and this was also the case at the surface which I saw on my way down. It sounds perhaps as an exaggeration when I say that the wolfram is spotted quite casually all over this part of the surface which I have described here and I also saw the proof of this in the working places. The claim stakings Nos. 5, 9 and 10 indicate the place. I have a rather favourable impression of adit No. 2 and will recommend that the same developing be done here.

Point 11 on the sketch was indicated to me down in the mountain

slope but it was very dangerous to get at it and nobody wished to risk his life. The two men, who accompanied me all the time, have been there and there is no reason whatsoever to doubt that they have found ore there similar to what was shown me up here, this so much the more so as the rock seems to be of the same kind. I venture to accept their statement as to the presence of the ore. Everything they have told me so far have been in accordance with the actual facts.

The ore can also be traced down the mountain slope to the claims stakings Nos. 12, 13 and 14 from which samples of claimstaking were shown me and this will be 150-175 meters in length or more and perhaps further down to about 150 meters below the "Wolframsynken". It is from this point that I would continue the blasting-down at the surface of the ore zone as far as it is possible to do so. That which cannot be reached from this point, however, should be pointed out from the valley and up the hill. At the lowest level below the "Wolframsynken" and where the ore appears one should cut into the ore zone, start opening from this place and follow the ore upwards, but in the mine and not at the surface. There should only be made cross-cutting for ventilating purposes. I think the deposit should be attacked from below where the ore commences and not as hitherto up on the bare mountain and worked downwards. All operation and concentrating should take place down in the valley where there is ample space.

Minerals in the Deposit:

In the part of the deposit dealt with above, the wolfram ores are the chief minerals. We distinguish between wolframite of high manganese content, which is black, and wolframite of high iron content and distinguishable by its brown colour, both having a content of up to 75% WO_3 . They belong to the monocline system and the crystals are partly short pillar-shaped, partly slate-shaped

and generally with many surfaces. The lustre is a metallic diamond glance, one might even call it grease-lustre and the cleavage is uneven and in thin stalks. Some samples proved to be quite magnetic. Specific gravity 7.2 - 7.5 and hardness 5 - 5.5 and quite brittle. It appears both solid and disseminated.

The next wolfram mineral is scheelite CaO, WO_3 (tungsten) with a content of up to 80.50 % WO_3 . It belongs to the tetragonale system and has a grease-lustre and diamond glance with a dense and finely grained cleavage. The colour is grey, greenish and brown, specific gravity 5.9 - 6.2, hardness 4.5 - 5.

In this connection I wish to call attention to the following facts regarding these wolfram minerals. The wolfram is encircled by a casing, that is a ring or a brim. When this casing has a pale grey to greenish colour the scheelite is met with and then close to the wolfram and having a width of a few mm. to 5-10 mm. The casing may also consist of quartz, feldspar, some mica and scheelite and there are also some red garnets. It appears that these minerals, or a few of them, alternate with irregular bodies of wolfram and wolfram stalks. Care must be taken when determining the scheelite as this can be deceptively like the garnet and even calcite which I believe I have seen. Furthermore, I will emphasize that I have seen that the scheelite always encircles the wolfram but does ~~not~~ not appear in the small cracks, pockets or veins which lie in the wolfram.

Another mineral is Molybdenite, MoS_2 , it consists of 59 % Molybdenum and 41 % sulphur. At the surface one observes some Molybdenum-ocher, MoO_3 , with 66.7 % Molybdenum. We also meet some copper pyrites and iron pyrites, but in insignificant quantities and I only wish to mention them here. No

other minerals than the components of Birkremite have been observed.

However, I wish to mention once more the small red and greenish garnets embedded in the mica schist.

The Character of the Ore.

We have seen that the wolfram occurs in lumps of different sizes and one may, of course, sort these out by hand, or on the whole get quite pure ore which has been done. The same is the case for the scheelite but this is far too often accompanied by mica. Because the Wolfram ore is very brittle a great deal is lost by this handling which is also the case when they are mechanically crushed. One might think it would be easy to gain these ores in the wet way, but this is not the case even though the specific gravity is high. When the Wolfram is crushed it takes a very unfavourable character so it floats away. Information obtained from abroad, where similar types of ore have been treated, proves that flotation is the only effective method of handling. Moreover, according to experiences gained in this country, the accompanying mineral, molybdenite, requires treatment by flotation.

Output of Ore.

What is generally understood as output has not taken place at this mine which will also appear from the statistics of the present report. One never reached the stage of output. The work done by a few men during a few years was only on a very small scale. The output of these mines both of Wolfram and of Molybdenite, sometimes stating the content and sometimes not, will appear from the statistics and for this reason the statistics give only an idea of the output. I have previously given the name of the owners and the time each of them held the mines, so I will not repeat it here. From 1905 to 1920, during which period the operating was discontinued

for several years, the statistics gives the total output of Wolfram to be 30,667 Kgs. containing 40, 58, 60 and up to 75 per cent WO₃. Mr. Schaanning gives the following figures of output in his time:

1925	Gross	1,450 Kg.	Net	1,381.5	Analysis	68.3% WO ₃
1936	"	883	"	756	"	55.1% "
1937	"	754	"	685.4	"	51.9% "
1937	about	2,022				
		5,109 Kgs.				

From the start and up to the present day there has thus been produced a total quantity of about 35,776 Kgs. Wolfram ore. There has also, of course, been some Molybdenite, but the figures are far too misleading with respect to content so I will not mention them here.

For orientation I wish to give the following table which I have taken from Vol. 44 of "The Mineral Industry" for the year 1935 and from tables worked out by producers for the year 1936.

The World Production of Wolfram Ores.
(Metr. tons 60 percent WO₃ concentrate)

	1918	1934	1935	1936
<u>North America:</u>				
1. The United States	4,573	1,865	2,177	2,365
2. Mexico	239	80	150	200
<u>South America:</u>				
3. Argentine	625	55	275	400
4. Bolivia	3,700	350	560	700
5. Peru	256			
<u>Europe:</u>				
6. England	325	150	125	150
7. France	212	15	65	80
8. Portugal	1,300	608	1,000	1,500
9. Saxony Bohemia	245		55	50
10. Spain	580	110	350	300
<u>Asia:</u>				
11. Birma	4,800	5,750	7,120	9,100
12. China	10,200	5,100	8,100	8,700
13. Fed. Malay States	362	1,880	2,100	2,450
14. Unfed. Malay States	1,170	212	250	300
15. French Ind. China	450	140	370	400
16. Japan and Colonies	1,700	190	250	400
17. Siam	185	45	50	50

	1918	1934	1935	1936
<u>Australia.</u>				
18. New South Wales	280	40	100	100
19. New Zealand	197	25	55	65
20. Northern Territory	275			
21. Queensland	358		85	100
22. Tasmania	440	35	210	224
	<hr/>			
Total world production	32,000	17,000	26,000	28,000
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Content of the Ore.

When examining the content of the ore I request that this be compared with my statements on page 4 of this Report dealing with the description of the mines and also the numbers 1-4 and 5-10 on the sketch for further orientation. The analyses of the samples taken during my inspection are quoted in a letter dated December 4th.

A. Adit No. 2. The sample was taken from three places across the breast from both ends of the adit, from the roof and from the middle of the adit.

The result is:

WO3	3.02 %	(W 2.40 %)
MoS2	0.26 %	(Mo 0.16 %)
Moisture	0.18 %	

B. The New Adit. The sample was taken from about the middle of the adit and from the roof. The result is:

WO3	1.38 %	(W 1.10 %)
MoS2	-	-
Moisture	0.18 %	

C. The New Adit. The sample was taken from three places across the breast and at the end towards N.W. The result is:

WO3	1.24 %	(W 0.98 %)
MoS2	-	-
Moisture	0.20 %	

Item A. is the most instructive of these samples, not because of

the favourable analysis but because it shows what the existing ore over a fairly large area may contain. I also wish to emphasize once more that the molybdenite appears at this level and upwards towards the footwall and then first and foremost in connection with scheelite. Here we find a favourable percentage of molybdenite whereas the other places only showed small quantities. What I have stated here can be studied further by inspection^{and} it may also prove that the results of the analysis are in accordance with the actual facts.

On basis of the results of the analysis I may state that I believe the workable part of the ore zone will contain approximately 1.50% - 2.0% WO_3 with about 0.25% MoS_2 . Although, as mentioned above, the conditions for making the inspection were very unfavourable, I am of the opinion that the ore carrying zone is very good.

General and Resumé.

At the present stage I do not intend to give a further description in this report than has been done already. Only mining of the entire deposit on a large scale in connection with an extensive sampling would form a reliable basis for future development of the deposit and an effective treatment of the ore. A further report on the content of the ore, quantity, production costs, etc., must therefore be postponed until such work has been done.

As mentioned already, the situation of the deposit, as compared with the surrounding district, is very unfavourable but this fact should not, and must not, discourage us if the basis for development and treatment be carried out as suggested in this report. Far too little work has been done to give a clear idea of the deposits but the work carried out this year with only a few men gives hope of a good result. I can recommend their

early investigation and exploitation with a view to operating which under the present circumstances might be quite considerable for this ore combination which is also fairly valuable under normal conditions as we have seen. It should be remembered that we will be able to produce two ores simultaneously at this mine, which ores are very much in demand and are always running parallel and influence each other on the markets. They are of great importance to the iron and steel markets and are necessary, if not quite indispensable to alloys. Our Wolfram ore, moreover, has the great advantage that it is not accompanied by other metals which have a detrimental effect. Norway comes as a good number two on the world market as far as molybdenite is concerned. Also as regards Wolfram Norway's production will perhaps be a factor that will have to be reckoned with in Europe. The rock "Birkremite" should not be forgotten either, but should be particularly mentioned as it indicates the possibility and hope of finding the ore combination wolfram-molybdenite perhaps even in the nearest vicinity to this deposit.

Oslo, December 9, 1927.

(Sgd) H. H. Smith.