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REPORT ABOUT THE SUMMERWORK 1969
AT THE KNABEN MOLYBDENUM MINE

august, 1969
R. Baldé

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I Introduction

Fieldwork has been done during the months june, july and august for the A/S Knaben Molybdæn Grubor.

In june a geological map was made in the area of Litlådalen, map 00.151 bl.4; in july and august a geological map of the area between the Knaben I mine and the Kvina mine on map 00.151 bl.1. Both maps on a scale 1 : 5 000.

Besides the geological work there has been done also some statistical work during the time it was not possible, in consequence of the bad weather, to do fieldwork.

In this way the report consists of two subjects: a geological part and a statistical part.

II Geological report

a. Preface

It is rather difficult to distinguish in the field the red granite gneisses from the gray granite gneisses ("gang-fjell"). Mostly the rock surface is red-weathered to about 10-15 cm deep.

The most attention got the northern part of map 00.151 bl.1, the area between Knaben I and Kvina, especially the tectonical features.

b. Litlådalen map, 00.151 bl.4

South of the "Hommen fault" the mineralised fahlband-zone separate in two divergent other ones. The biggest one, the western fahlband, can be followed in the Litlådalen valley. A lot of "skjerps" has been found; most of them showed one or more spots of molybdenite. The eastern band, the smallest, can be followed to the "Skarne fjellan", where it disappears over a distance of 75 m. It comes back again at the top of the slope of the valley.

The rest of the area consists of red granite gneisses, on some places more or less porphyritic in others aplitic. Small quartz veins have a north-south direction, other quartz-lenses an east-west direction which sometimes are accompanied with pegmatites.

The "Hommen fault" itself is hardly to see as a fault s.s. There is no special difference with the other E.W.-directioned zones and dykes. Only just east of the Hommen mine is a disturbance visible; it gives the impression that the southern rocks are locally uplifted over a short distance.

There are measured some b-axes, special in, or near, big biotite-schist-bands. The general direction is N.-N.E., with a dipping of 0-30°.

c. Kvina map, 00.151 bl.1

In this area, the central zone with intense rusty bands is situated between the Knaben I mine and the Kvina mine. This mineralised zone shows (see geological map):

1. rusty bands (\curvearrowright); very often they changes in the strike direction in more or less biotite-rich bands, without that intense rusty coulor (green lines in the geological map).
2. big biotite-schist-inclusions; in the past they were mentioned amphibolites. Most of them appear in the mineralised zone; in the marginal zone they seem to form parts of an horizon. At some places the surrounding rocks have an augen-gneiss structure with big, white altered, eyes and a schlieric matrix. They indicate a tectonical moved area.
3. b-axes; the general direction is S.E., with a dip of $10-35^{\circ}$ (Litlådalen N.-N.E., with $0-30^{\circ}$ dipping).
4. milky quartz in veins, bands and geodes. A lot of this quartz can be found in a particular zone, which is situated south of Charles Lake, passes Smalvann and ends near the top of Grunnevassknoten.
5. molybdenite distribution in quartz veins, west of Grunnevassknoten. This zone can be followed to the south to the Sandtjerngruve. An occurrence, west of Sandtjernvannet can perhaps be followed to the south, passing the Knaben river near the dam. (For a good mapping is necessary a map, west of blad 1, blad 3, and a map south of blad 3 and west of blad 4).
6. the Smalvann-tectonical direction; first of all the remarkable bending direction of the mineralised zone west of the Knaben I mine, then the disturbed zone east of the Smalvann with the occurrence of rather a lot of copper-minerals. These copper-minerals are associated with a little bit of molybdenite in quartz bands.

7. the end of the mineralised zone at the north is accompanied by tectonical movements, probably more or less in a lateral way. In the eastern part, rock structures as a result of a great pressure are found; in the western part, straight E.W. zones seem to represent openings as a result of this lateral movement.
 8. dykes, which have the same E.W.-direction as the above mentioned zones.
 9. pegmatites and quartz veins in the E.W.-direction; they have no molybdenite.
- d. Hypothesis about the geological history of the Knaben-area
- The original rocks were buried sediments, which formed a geosyncline. Increasing pressure and temperature changed these rocks in the greenschist-, and amphibolite facies (presumably not as far as the granulite facies). Metasomatism, anatexis and granitisation took place and the sediments became rather homogeneous granites.
- Karlsbad-twins indicate a high temperature during this process. A lineation of the latest formed minerals are the result of some stress or some movement. Special the quartz has a good direction and often it forms thin bands (2-3 mm), sometimes becoming bands with a thickness of 10-20 cm.
- B-axes have a direction to the centre, the Knaben II area; the north-eastern area shows rocks with a pressure-structure. Biotite-schist-lenses are more or less situated in "bands" or "horizons". They represent weak parts of the area (possible as a result of the sedimental structure) which has served as shear zones during the tectonical pressure.
- The main stress was in the centre of the lens-formed mineralised zone.

This zone consists further of the normal granitised rocks, which appears as reddish (altered?) coloured granite gneiss, as greyish (lixivated?) coloured granite gneiss, as porphyrical red granite, as pegmatite lenses or as aplites, often without feeders; this pegmatitisation represents a special kind of granitisation at greater depths (Barth).

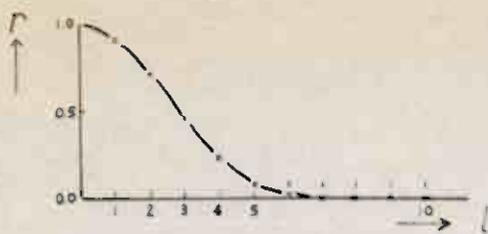
East-west directioned pegmatites and quartz veins are presumably of a later origin; they have no molybdenite. During the tectonical movement at this great depths, the plastical rocks of the eastern part shoved over the western part in a nappe-like way. The biotite-rich zones and the white weathered augen gneisses served as a kind of, nearly horizontal, shear planes.

It was at the end, or after, this movement, that the remobilised molybdenite penetrated the shear plane zone, the zone of weakness, and impregnated also the surrounding granite gneisses, special there where had been the main pressure, near the Knaben II area.

A convulsion of this big tectonical movement caused a disturbance: the Smalvann and parallel with this the disturbed zone east of Smalvann, with impregnation of molybdenite, coppersulfides and pyrite.

The latest movement caused E.N.E.-W.S.W. break lines; some of them are filled up with doleritic material.

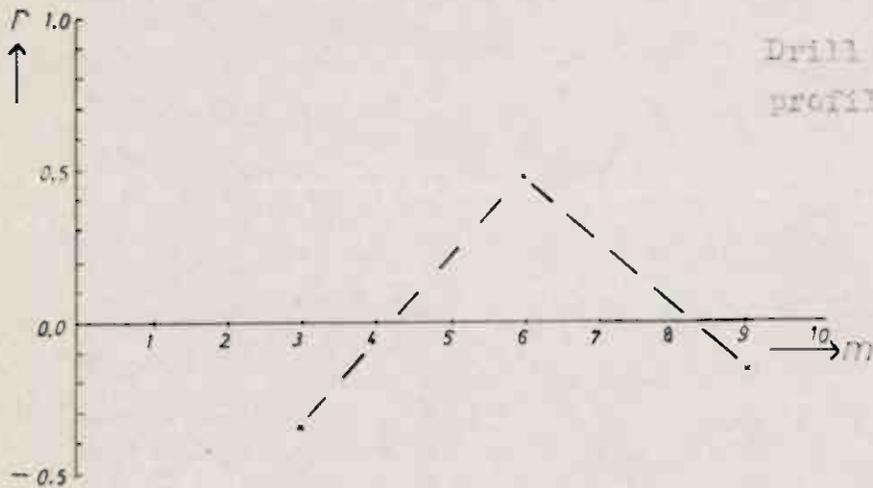
Conclusion: This hypothesis is based on facts of the ends of the so-called mineralised lens-zone and theoretical indoctrination of Barth, Haller and P. Michot. It would be interesting to work out all these facts, in a statistical way. Perhaps it is possible to find out a natural law, a succession of things that might be happened.



Theoretical example

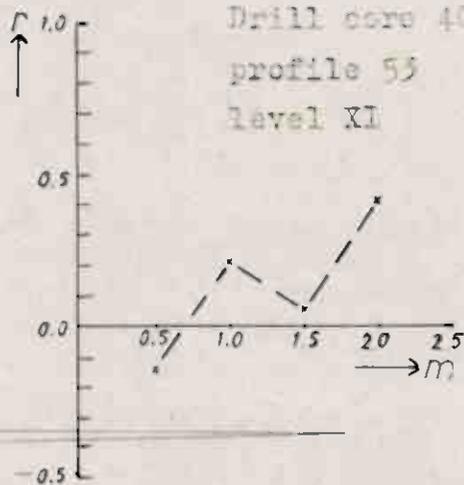
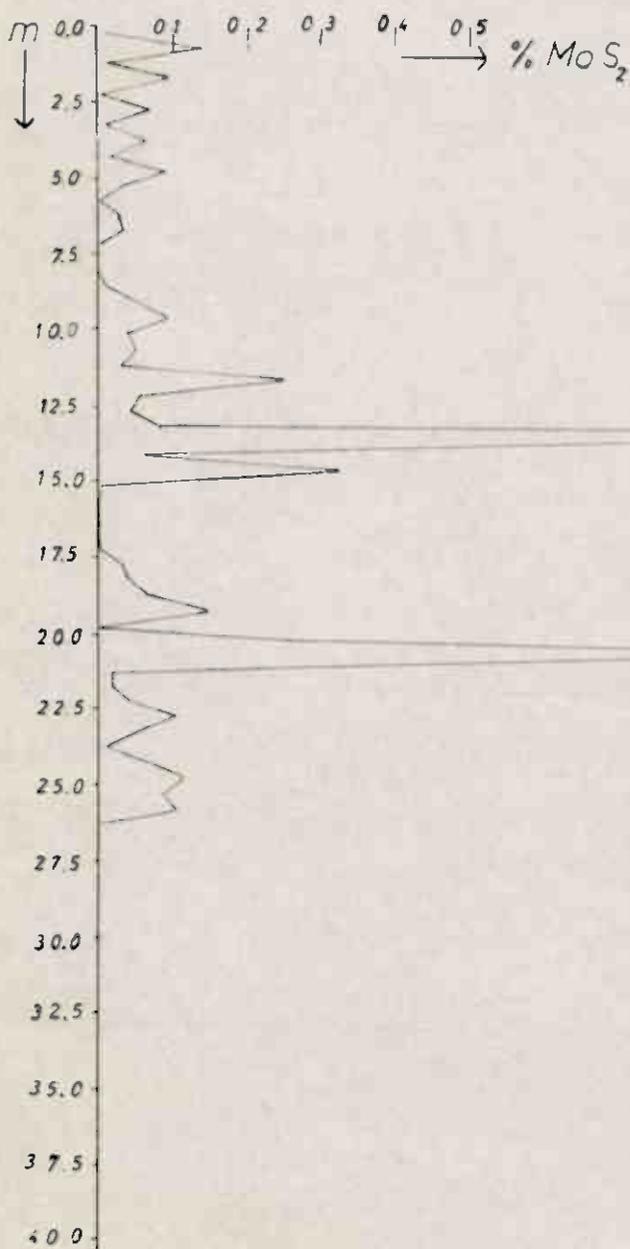
r = correlation coefficient

l = sampling distance



Drill core 370

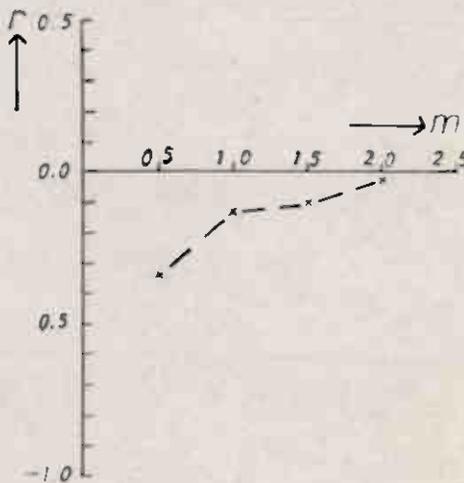
profile 32, level XIII



Drill core 402

profile 53

level XI



III Statistical report

There can be distinguished three area's in which they have drilled.

- a. Kvina area : drilling results are negative. The drill cores are just partly analysed; the data showed no economical possible mining.
- b. Knaben I area : there are no data at all of analyses of drill segments.
- c. Knaben II area: special the southern area, near the "Hommen fault" got the most attention.

1. sampling distance

The Knaben mine company uses a sampling distance of three meter (each core segment of three meter gives one analysed data). It is interesting to know if this distance is correct in a statistical sense.

With help of the autocorrelation coefficients it is possible to find the PRobability INdependent Cell (=PRINCE). This unit represents the minimum sampling distance in a three dimensional way.

By placing the autocorrelation coefficients in serie in a diagram, it gives you a serial correlation diagram. In the figure, there is an illustration of a theoretical example. Each sampling interval (l), in a certain direction, gives a correlation coefficient (r).

The independant distance in this direction is reached after six intervals.

Trying to find out the independant sampling distance for drill core 370, profile 32, level XIII, with a sampling interval of three meter, you get a serial correlation diagram as is showed in the figure.

It has no resemblance with the curve in the theoretical example; the data do not depend on each other.

Drill core 402, profile 53, level XI, is analysed on each segment of half a meter. The figure on the left side shows the molybdenite distribution. After twenty-six meters there has been analysed no molybdenite.

The upper most serial correlation diagram at the right side is taken of the first twenty-seven data, which indicate hardly molybdenite. Also this diagram does not give a dependency of the data.

The second serial correlation diagram is calculated of the data twenty-two to forty-eight, which represent a part of the rocks with rather a lot of molybdenite.

Now, the diagram does show a resemblance with the theoretical curve; there is a dependency among the data. The independent distance is just reached after two meters.

Conclusion: the three meter sampling distance of the analysed core-segments come up with the statistical requirement of independancy.

2. the distribution of molybdenite

The MoS_2 distribution diagram of drill core 370, profile 32, level XIII, has an a-symmetrical form. It was not possible to normalize this curve with help of logarithmic paper, either with an equation of the second degree. It is necessary to normalize the distribution curve before you can standardize this distribution (The statistical tables are made for a standard-normal distribution). In the future I hope to find out the mathematical way to normalize such a distribution curve.

Further I have made the whole distribution profiles 32 and 33. It shows that most of the molybdenite is con-

centrated with quartz-veins below level XI (+ 550 m). These profiles are the most elementary data to calculate the quantity of molybdenite in each room.

Another point for the future is to find out the mathematical way to calculate the molybdenite quantity for each room out of such a pair of profiles; I want to know the way to find out a three-dimensional quantity out of two-dimensional profiles.

Conclusion: the usage of the data of the drill cores in a statistical way is still a question.

Nevertheless it interests me highly, because I believe that in this way you have to calculate the geological reserve. Out of this reserve you can calculate the probable- and possible technical reserve and the ultimate real commercial reserve.

IV Appendix:

1. geological map 00.150 bl.1.
2. geological map 00.150 bl.4.
3. in Utrecht:
3. calculations drill core 370, profile 32, level XIII.
4. calculations drill core 402, profile 53, level XI.
5. profile 32.
6. profile 33.
7. data of drill cores 9, 7a, 7, 6a, 6, 6b, 5a, 5,
near the "Hommen fault".