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Avskrift.

R I P P E R F J O R D

P r o f e s s o r H . L . V o g t .

24/8 - 07.

The Ripperfjord Copper - ore - field at the Ripperfjord

bay in Kvalsund, south of Hammerfest in Kvalsund, south of Hammerfest
in county of Finn-mark.

./ About location, transportation-conditions and communications is referred to the in the pamphlet issued by the Nordiske Grufaktiebolag - Ripperfjord mines (Østersund 1907) given relations. Here should only be compared:

The copper-ore-field is located about 40 kilom. S.E. of Hammerfest; the most "sparagmite-ore" lodes appear at a height of about 250-350 m. above the sea-level. Close by the Ripperfjord bay (near the fore-mens dwelling-house) good space is for the erection of an establishment; projected cable-tram-way from the Eriks mine to this place will have a length of 1 1/2 kilom. (and from the Johns mine, the Olles mine the distance in a straight line is about 1650 m. 1800 m. respectively). In the neighbourhood of the place for the proposed establishment resource is for water-power (by necessary embankment etc.). The mining at the main-lode (the "sparagmite"-ore) can for long time to come be carried on by stulm-work. Details regarding altitude-conditions, distance, starting-district etc. can be obtained from a map which the company at present is erecting in scale 1:4.000 but this map was, however, not completed at the time of my visit.

Geological review.

Near the shore of the inner part of the Ripperfjord bay, and from the Ulveryggen quite a distance in S. E.-erly direction very big deposits of quartz - sand - stone with conglomerate and "sparagmite" appear. At the Brathammer mine and the "slate-lode" in return a green, at times strongly slaty mineral appears, which likely is a transformed clay-slate; about this last I will, however, not express any positive opinion. These deposits belong to the formation which T. Dahll on its time named Raipas and of many is supposed to be of devonic age. At other places in the contiguous district, for instance in the neighbourhood of Næverfjorden bay and near the Altenfjorden bay at Porsa (N.B. not at the mines at Porsa) very rich dolomite appears. For a distance of, to judge by the eye, a little more than 1 kilom. in southeasterly direction from the Ulveryggen a field of serpentine appears. According

to what from earlier prospecting is known to me there are also large field of gabbro and granite on the peninsula with the Ripperfjord-valley in the east and the Altenfjorden bay in the west. The quartz - sand - stone with appertaining layers of conglomerate and sparagmite is a hard, compact somewhat transformed mineral, which, in general and in the whole, is of a rather monotonous quality. As a rule it is comparatively small-grained (c: with small grains of sand). At several places, however, layer of conglomerate or conglomerate-brecia (with only small edge-worned stones, at Ulveryggen often in size of a hazelnut, seldom larger) are seen and of sparagmite (c: layer with grains both of quartz and of field-spat). The ore at the Ulveryggen is in common speech called the sparagmite-ore. This name has most likely its source from that I, at my visit in 1903, here saw a quite small appearance of ore in the sparagmite; for this reason I at that time, called the ore "sparagmite-ore" but sparagmite is not the dominating mineral at the place. The ore could just as well be called "sand-stone-ore." At the Ulveryggen and the nearest surroundings the stretch is very regular about N.E. - S.W. - nearest N 35 or 40° E. - S. 35 or 40° W. and the encline is at the Ulveryggen steep towards N.W. The encline I measured, at the Erik's mine and the John's mine to about 75°, at the Olle's mine to 75 - 80° and in the pits a little in S.W. from the Olle's mine to 80 - 85°. The smaller variations in the observations here I do not find worth any consideration. The result is, that in the group of Erik's mine - John's mine - Olle's mine - the pits S.W. of the Olle's mine, stretch and encline are very regular. At other places consequently in profile pretty near the Ripperfjord, bay on the other hand quite strong foldings are seen with encline in various directions. The width of the quartz - sand - stone-division with belonging layer of conglomerate and sparagmite is quite large at least 250 m. probably considerable more. The time did not allow me - and topographical constitution was also wanting - to make up a geographical profile which, besides, at present time, not would be of any interest.

The divide between the sandstone and the green, often slaty mineral, at the slate-lode and the Brathammer mine, runs about 50 m. N.W. of the Brathammer mine.

Geological comments about the Copper-ore-lodes.

On the peninsula between the Ripperfjorden-bay- the Ripperfjord valley in the east, Altenfjorden - bay in the west and Kvaalesund sound

Rapporter.

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| Repparfjord. | 13/9 1955 | Peter Padget |
| Repparfjord. | 1913 | Otto Stalman |
| Repparfjord. | 24/8 1907 | Professor H. L. Vogt |

SKERUD BANK

in the north a whole serie of copper-ore-lodes of various geological (or morfological) character exists, the appearence of the ore is to an essential degree depending on the mechanical character of the surrounding minerals.

There are thus:

a) Typical lodes, namely limespat - quartz - lodes with pyrite of copper and pyrite of sulphur; example: the Brathammer mine near the Ripperfjorden - bay (and among others the Forsa-lodes)

b) so called "slate-lodes" namely impregnations (infiltrations) in slaty minerals or slaty zones within certain minerals.

c) so called "sparagmite-ore", in sand - stone - conglomerate - sparagmite - minerals.

It is easy to decide, that the copper - ore here every where in geological (genetic) respect is of a younger character and that it neither in the "slate-ore" nor in the "sparagmite-ore" was formed simultaneously with the minerals in question. What especially the "sparagmite-ore" is concerned, fine streaks of ore are all the time seen in every directing intersecting each other in the mineral indicating that the ore is infiltrated (or insifted) through the mineral after its formation. Geologically analogous lodes of ore infiltrated or insifted in sand-stone are found at divers places abroad. Larger lodes of this character are on the contrary, as far as can be remembered, not before known in Norway or Sweden. In the sand-stone which originally must have been a more or less porous mineral, the infiltrations quite often distribute themselves in the great number of pores all around in the whole mineral. I want distincthy to point out, that in dealing with the "sparagmite-ore" primary it is not dealt with a sedimentation of copper-ore but with a secondary infiltration. This is richest in certain lenticular confined parts, as far as known by the length-direction about the same as the minerals stretch and encline; but it is not to be so understood that there are certain levels or parts of the mineral which regularly for a long extension are characterized by the same copperpercentage.

The impregnation in the sandstone and so far at the Ulveryggen can be followed to a length (generally but not particular counted along the stretch of the mineral) of i kilom. or farther and there is occasionally - when also the quite poor ore is taken along a impregnation to a width (vertically on the stretch) of about 100 m. At the small pools and about S.W. of the pits in the continuation of the Ulveryggen near

the Olle's mine there is also found impregnation of sparagmite-ore at quite distance from the, at the Erik's - John's - Olle's mines in the Ulveryggen deminating, stretch. It is consequently herẽ dealt with an impregnation of "sparagmite-ore" of large extensions as to length and width. This impregnation took place in a geologically spoken, very early period, when the present surface was several kilom. lower than the surface at that time. The mineral-masses of several kilometers thickness, at that time laying over, are now eroded away. When the impregnation of the "sparagmite-ore" has so considerable dimensions in length and width and when the impregnation took place on the depth independently of the new existing surface the impregnation can not cease near underneats the present surface but must continue until greater depth. The particular, rich impregnation-lenses, which are found close to the surface, for instance in the stulms, will undoubtedly locally disappear or wedge themselves out; but the impregnation as such will continue with changing parts of rich and poor impregnation. A horizontal cut, for instance 100 m. or 200 m. below the present surface at the Ulveryggen will thus show the same general character as the present surface (or on level with, for instance, the Erik's stulm). At the Olle's stulm ore i struck at a depth of about 60 m. below the surface, and therefrom the conclusion is drawn that the ore, totally counted, continues towards the depth. It is of course a good thing to have an observation-proof for this, but personally I aserible the general conclusions, which can be drawn from the lodes geology, greater general signification.

About the Sparagmite-ore.

As from the work in the mines, as well as from the mining of the pits on the surface and the study of the assays, is proven, the large sand-stone deposit, in the Ulveryggen, (where the head-lodes are located) is to width which is measured of 100 m. or there about, all over, or at least pretly near all over, impregnated with ore namely checked copper which occasionally is accompanied of some copper-pyrite or copperglance. Most often the impregnation is poor; but locally there is richer impregnation, and of course, only these richer impregnations have a technical-economical interest. In order to give an idea about the character of the poor impregnation, some assays taken from

drill-holes from diamen-drilling at the Erik's mine are here copied; the drill-hole was 80 m. in depth and the drill-core for every fourth m. Namely for depth 3-4 m., 7-8 m. and so far to 79-80 m.) was assayed. The assays, given in succession, (for 3-4 m., 7-8 m., 11-12 m. etc.) showed:

0.09, 0.25, 0.11, 0.02, 0.85, 0.61, 0.94, 0.32, 0.13, 0.13
0.20, 0.10, 0.10, 0.12, 0.18, 0.28, 0.31, 0.08, 0.16, 0.10 %

of copper. Further a serie of assays from the Klem's stulm, also in the Erik's mine, which stulm in the essentiallest runs trough poor impregnation, is copied:

0.10, 0.12, 0.10, 0.06, 0.27, 0.09, 0.43, 0.18, 0.13, 0.10,
0.23, 0.19, 0.14, 0.19, 0.18, 0.52, 0.33, 0.48, 0.12, 0.38,
0.95, 0.99, 0.32, 1.37, 1.68, 0.13, 0.58, 0.33, 0.14 % copper.

All these assays together arranged according to copper-percentage:

0.02, 0.06, 0.08, 0.09, 0.09 % copper,
0.10, 0.10, 0.10, 0.10, 0.10, 0.10, 0.11, 0.12, 0.12, 0.12,
0.13, 0.13, 0.13, 0.13, 0.14, 0.14, 0.16, 0.18, 0.18, 0.18,
0.19, 0.19, % copper;
0.20, 0.23, 0.25, 0.27, 0.28 %;
0.31, 0.32, 0.32, 0.33, 0.33, 0.38 %;
0.43, 0.48 %;
0.52, 0.58 %;
0.81, 0.85, %; 0.94, 0.95, 0.99 %;
1.37, 1.68 %.

These ciphers seem to show that the copper-percentage in the poor impregnation - which, as a matter of course, in the praxis not will be mined- only exceptionally sinks below 0.10 % copper; most often the poor impregnation seems to hold a copper percentage changing between 0.10 and 0.50 %; with an average of about 0.20 % in copper. That is to say, if by working it should be so unfortunate, that some of the poor impregnation should be mixed with the goods going into the concentrater this poor impregnation, however, will pay its own concentration - expenses. The economical interest, will as already before is said, be concentrated on the richer impregnations. These appear in lentiform in the poor impregnation. At some particular stretches there are bulks, of so great dimensions that they can be worked separately by themselves, which hold more than 3 % in copper (average-samples of several meters length) and thus the Erik's and the John's

mines have shown: 3.19, 3.20, 3.24, 3.25, 3.43, 3.51, 3.60, 3.73, 4.10, 4.13, 4.17 % in copper. Outside of these richest parts Zones or belts came with lower copper-percentage at 2-3 % and later on at 1 - 2 % and lower. The work should be run on the following principles:

By preparatory work (running of stulms) the richer parts are pointed out; here the richest central parts with an average of 3 % copper or more can be worked separately. And likewise the middle-rich impregnation-zones can be worked by themselves. There is consequently at the working an opportunity to mine goods of a different copper-percentage. How low the copperpercentage should be allowed to go depends on the preparingexpenses and the conjunctures. I should suppose that it would not pay to handle goods lower than 1 % in copper, or probably a little below 1 % copper. The low-limit can, however, not yet be determined.

The sparagmite-ore is namely prospected at 3 mines (stulms) partly with field-stulms and cross-cuts (in the John's mine also by a shaft) in the Ulveryggen mountain; namely the Erik's, John's and Olle's mines (see the detail-maps). The distance between these mines is:

between the Erik's and John's mine 336 m.

" " John's " Olle's " 330 "

The stulm-plane in the John's mine is about 36 m., and in the Olle's mine about 20 m. above the Erik's mines stulm-plane. The three mines are situated after each other pretty near, but not exactly, on the stretch-direction. In each of these mines-outside of the poor impregnation-veins with richer impregnation with 3 % of copper an higher, and zones with middle-rich impregnation between 1 and 3% in copper have been ascertained. Hereabout a person can be easily convinews by going into the mine and knock out samples at different places. At the run of the stulms proceeded a serie of average-samples was taken and these are already assayed. In addition to this, a few months ago a very comprehensive serie of average-samples, representing pretty near every meter in the stulm was taken. These latter average-samples are though not yet assayed. When these assays are completed and marked in on the map, it will give a very good knowledge of the extension of the rich parts in the three mines (Erik's,

John's and Olle's). When the assays are completed and delivered to me I will give a more specified report. In the meantime I only want to explain that in the Ulveryggen mountain several fields are worth working holding more than 3 % in copper and also other fields which would pay to work carrying between 1 and 2 % in copper. A calculation has been laid before me showing that in the sparagmite-field already ore-areas have been ascertained:

| | |
|-----------------------------|----------------------|
| with at least 3 % of copper | 295 m ² . |
| " " " 2 % " " | 3150 " |
| " " " 1 % " " | 1585 " |

By studying the mining-maps, the up to this time made assays and, by walking around in mines, I get the decided opinion that here was not figured too high. But as in the near future detailed assays will be at hand, I wish to express myself about the ore-area and the production-material first when said assays are completed.

Outside of the three mines further a whole suit of excavations across the lodes stretch towards S.W. in the Ulveryggen is performed. Hereby is ascertained that the lode is at least 1 kilom. in length. The Erik's mine situated furthest towards N.E. in the Ulveryggen seems not to belong to the richest parts of the lode. In the more central parts at the John's and the Olle's mine, and at the pits S.W. of the Olle's mine, the copper-percentage, counted in average appears to be higher than at the Erik's mine. It is here dealt with a large field of which I have the best hope. The ore can be delivered cheap.

The miningwork will certainly be burdened with a considerable length of prospect-stulms but the very mining of the ore will become cheap. To what price a ton of ore should be counted at, will principally depend on how low grade in copper that can be taken along. If goods as I believe, clear down to 1 % copper or probably still lower should be taken the mining-expenses will come very low. I wish, however, to postpone with expressing any opinion about the estimates until the assays are fully ready, as it than will be better informations as to the ore-area and the mining-relations.

Preliminary remarks

about the treatment of the ore.

The mining-work should and can be so arranged, that, the richer goods with in average 3 % in copper (or probably a little higher)

and the poorer goods, with an average of from 3 % in copper and down to 1 % in copper (and probably a little below are kept separately the rich goods I count at an average of 3 % in copper and the poor goods at an average of 1 1/2 % in copper. There will undoubtedly be much more of the poor goods than of the rich. I will first refer the different hitherto gathered estimates and tests performed.

Chloeous roasting and extraction.

Test performed at Talun, under the management of K.A. Aakerblom (since many years superintendent of the Falu Extractionworks) showed:

| | |
|--|------------------|
| The ingoing ore held | 2,17 % of copper |
| The refuse held | 0,17 " " " |
| The loss in the refuse was consequently - 8 %. | |

With a supposed yearly production of 100.000 tons of ingoing goods K.A. Aakerblom calculated the construction - expenses for extractionwork to 1 million Norwegian crowns and the running-expenses (inclusive amortization, engineerwages etc. etc). to 10 crowns pr ton. With a supposed yearly production of 10.000 tons of ingoing goods Aakerblom counted the construction-expenses (inclusive amortization etc.) at 17 crowns pr ton. The condition for this estimate is that the copper is delivered ready, as refined copper. An eventual small any economical consequence worth mentioning, is not taken into consideration at the income-calculations.

The Ellmore - process.

A test (certainly, in proportion, in small style) with sparagmite - ore showed:

| | |
|----------------------|------------------|
| The ingoing ore held | 2,47 % of copper |
| " refuse held | 0,40 % " " |
| " concentrate held | 23,56 % " " |

This concentrate will later have to be treated for the production of metallic copper. An other test, not with sparagmite - ore, but with slate-ore showed:

| | |
|-------------------------------|------------------|
| The ingoing ore held | 0,69 % of copper |
| " refuse held, at the highest | 0,19 " " " |
| " concentrate held | 17,29 % " " |

The loss at the very Ellmore-process, can in accordance with these tests, be put at 15 - 20 % of the copper-substance in the raw-ore, to this the loss at the treatment of the concentrate for producing metallic copper will come. The total loss of metal should certainly be put at 25 % - 1/4 of the copper-substance in the ingoing goods; very likely the loss should be put still a little higher. A prospect on a yearly production of 100.000 tons of raw-ore (without any consideration to the miningwork) gives a construction-cost of crowns 325.000 and running-expenses pr ton, at the highest cr. 4.50. To this though the expenses for the treatment of the concentrate into metallic copper will be added; if a smelter is built at this place I figure this expense to about cr. 150 pr ton copper (the cost is besides to a high degree pending on the copper-substance in the concentrate). If, in order to reduce the loss of copper at the Ellmore-process, a concentrate with lower copper-substance should be taken for good, the expenses at the later treatment will be distinctly higher; for ore with 6 - 7 % in copper the smelterexpenses, with the conditions as they are at the Ripperfjord, can be put at 300 pr ton copper. Experiments with the Siemen - Halske's electrolytic process are now going on, but any results are as yet not known.

My personal remarks about this.

The chloreous roasting with the subsequent extraction (in order to be short this will in the following be called the Falu-process) works empirical with small loss of copper (about 8 - 10 % of the in-

going goods) but the cost pr. ton comes high. The project is, with a yearly producing of 100.000 tons of raw-ore, crowns 10, and with 10.000 tons of raw-ore crowns 17 pr. ton. The cost by Siemen-Halske's process will probably also come up to these figures. When the "sparagmite-ore" principally contains quartz (silicid acid) and when the copper-percentage of the ore is comparatively low, a smelting of the ore copper- mat etc. is out of the question.

It would be useless to work with any trials about this. I consider it impossible to use a metallurgic process which always will come comparatively high counted pr. ton ingoing goods of such low-graded (but in mining-expenses cheap) ore which can be counted on in the "sparagmite-ore". The bulk of the raw-ore will hold comparatively low copper-percentage below 2 % probably nearer 1 1/2 % and such ore requires for preparatory treatment a cheap mechanical process for preliminary production of concentrate. The older preparatory methods cost pr. ton ingoing goods a couple of crowns, but give - with so fine an impregnated ore, which here is dealt with - very considerable loss of copper in the refuse. The oil-processes are somewhat more expensive, (a prospect gives the costs at the highest to 4 1/2 crowns pr. ton raw-ore) but has the advantage that it works with smaller loss of metal. I have confidence in the oil-process and I go out from this being the most rational at the Ripperfjord (N.B. there is at present a whole serie of oil-processes, which of those should be selected, is hard for me to tell as I have not had any experience in the different methods. The question should be ^cwarefully vintilated).

My position is thus:

Oil-process for the poor goods. It may be that it also would be the most ration to use the oil-process even for the rich goods with 3 % copper or higher. I consider it though more probably that it would pay best - to avoid the, with the oil-process connected not so v very small loss of copper - for the rich ore to use a metallurgic process although it is more expensive pr. ton raw-ore. There might be to choose between the Falu-process, which is an it its details well known, working - method and the Siemens - Halske's electrolytic process, which, however, up to date is very little worked up. Of direct smelting of the "sparagmite-ore" it can not be any question. In order to closer investigate this question tests in a greater style

should be made with:

The oil-process with raw-ore holding about 1 1/2 % in copper.

The Falu-process (or the Siemen-Halske's process) with raw-ore holding 3 % in copper.

More than one test with the Falu-process would hardly be needed.

The Brathammer mine and the slate - vein.

The Brathammer mine is, counted by the high-way, situated about 5 - 6 kilom. from the bay or about 6 - 7 kilom. from the proposed location of the smelter. The vein is an "ore-vein", cutting through the enclosing mineral's slatynessplan. This stands pretty near vertically (encline 85° towards S.E.) while the vein lies with an encline of about 30° towards S.E. The vein is run to a length of 50 - 60 m. and towards 40 m. along the encline. The thickness of the vein is in the middle-parts 0,6 - 0,8 m. but gets narrower towards the ends (in horizontal direction) and is here 0,1 - 0,2 m. The vein is a calcareous spar-quartz-vein carrying some copperpyrites and sulphur-pyrites. Some ore holding 7 % in copper has been picked. But the vein is comparatively short in length (stretch), not very wide and not carrying particularly much copper. The adjoining so called "slate-vein" carries checked copper appearing partly in quartz-noduls and partly impregnated in the slate. The vein has been uncovered at quite a few places to a length of about 450 meters but the different impregnations are not found on the same level. There are at the different slatyness-zones, which to a high degree will complicate the work. When hereto comes that the impregnation is irregular, and in my opinion, taken as a whole, very poor, I ascribe this vein little or none technical - economical value.

From the Brathammer mine now a stulm is run to the slatevein (Witt's shaft which now is 112 m. deep). According to miningchart this stulm shall in a straight line be 155,2 m. long and it shall come in to a depth of 34,7 m. below the surface (= 22,7 m. below the bottom of the Witt's shaft). At my visit the stulm (with bends counted in) was about 130 m. long. Consequently about 25 - 30 m. remain before the slate-vein is reached. Each meter of stulm costs (with timbering, rails etc.) about cr. 80:-.

The remaining costs will thus be crowns 2.000 - 2.500. In my opinion there is no reason for that this stulm should be continued. When there are great, promising lodes, work and capital should not be splitted by simultaneously prospecting in lodes which in my opinion give small promises.

Johan H.L. Vogt
Professor.

Christiania Aug. 24th 1907.