

1. On the occurrence of thick beds of bituminous gneiss and mica schist in the Nullaberg, parish of Östmark, Province of Wermland, in Sweden.

By L. I. IGELSTRÖM.

The parish of Östmark, as well as other parts of western and northern Wermland, is filled with high and steep hills of hyperite, between which the common crystalline rocks, gneiss, hornblende, mica schist & others, intervene. The bituminous gneiss and mica schist occur interstratified in common reddish granit-gneiss at the western part of the high and precipitous Nullaberg, occupying a thickness of more than 20 fathoms, and extending along almost the whole side of the mountain. The dip of the strata is about  $70^{\circ}$  eastward, and they are covered first by a bed of hyperite and then with parallel strata of other granitoid rocks.

Generally, the bituminous substance is rather uniformly distributed through the range, in the gneiss as well as in the mica schist, and the entire mass has a black colour. The naked eye is hardly able to discern any particles of coal. When coarsely ground the rock resembles gunpowder, but when ground finer, it grows darker, either of the colour of soot, or resembling pyrolusite. When beaten with the hammer, it emits a bituminous smell, like anthraconite, and also when heated by the blowpipe; it then gives a flame. When calcining 5,32 grams in an open crucible of platinum, I was not able completely to burn the whole of the bituminous substance, even after adding several times nitric acid; a little coal always remaining unconsumed. The loss of weight, however, was 12,03 per cent; the ashes were gray. When heated, in a retort of thin iron plates, 12 pounds emitted much combustible gas,

while a yellow combustible oil, as well as a colourless incombustible fluid was collected in the recipient. When the gas was allowed to escape through a hole of one inch in diameter a fine and bright flame was obtained during four hours; during the fifth and sixth hour the flame grew more blue and fainter. The powder in the retort remained as black as before the distillation, though with rather a higher lustre. It had lost 15,6 per cent of its volume. — The specific gravity of the rock is 2,19.\*) It is so loose, that a man may in about half an hour sink in it a hole of 2 feet.

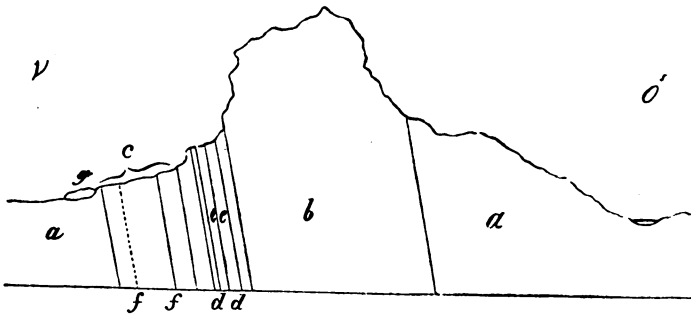
On a closer examination of the bituminous strata it is very difficult, from the general homogeneousness of the bed, to decide whether and where it is gneiss, or mica schist, that is impregnated with bitumen, but nevertheless one finds that both the above-named rocks, and also thin layers of chlorite schist constitute parts of the range. Thus, above the main bed and somewhat separate from it, I met with thin layers of common mica schist, alternating with layers of mica schist, more or less impregnated with bitumen. Silvery laminæ of mica also form thin seams in the main bed. With regard to the gneiss, on the other hand, one occasionally in the black bituminous rock meets with somewhat paler stripes and seams, showing that feldspar here forms the principal constituent of the mass. The stratification is, however, distinct enough to make evident that it is not a dike, but stratified gneiss and mica schist, conformable to the surrounding parts, we here see before us. At some parts the bituminous rock contains round, whitish, thinly interspersed particles of the size of a pea, as well as nodules of anthracite of about the same size. As I at first supposed the latter to be asphalt, I concluded, that the whole bed was impregnated with that substance; when, however, these nodules afterwards were proved, by experiments, to be anthracite, that supposition lost its foundation and yet I cannot decide what kind of bituminous substance it is, that to so

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\*) When weighed in the hand, it feels very light, compared with silicates in general.

large an extent impregnates the rock. It seems nevertheless to be fully decided, that the impregnation is analogous to that in alumslate, for instance, and that consequently our gneiss and mica schist must be removed from the place they occupy as "primitive rocks", to the series of sedimentary and fossiliferous strata, as limestone, alumslate &c.

The section below was made during a survey undertaken last summer in order to ascertain whether the beds might be of any practical value.



a. Common reddish granitoid gneiss. b. Hyperite. c. The main bed comprising bituminous gneiss together with bituminous mica schist. d. Thin slaty beds of bituminous mica schist overlying the main bed; from 1 to 2 feet in thickness. e. Rather fine grained gneiss, or mica schist. f. Thin, black, bituminous layers with silvery laminæ of mica. g. Drift.

## 2. Note on the Mineral Character of the rock.

By A. E. NORDENSKIÖLD.

There are at *Nullaberg* two kinds of bituminous rocks, viz.:

a) a rock of a schistose structure, abounding in mica.

b) a rock, almost devoid of mica, and showing but slight appearance of layers in the arrangement of its ingredients.

As the diagram given by Mr IGELSTRÖM shows, these rocks alternate in parallel beds, with common mica schist, gneis, and hyperite. The principal ingredients are in *b*) greyish white orthoclase, in *a*) greyish-white orthoclase and silver-white mica; in both mingled with variable portions of a black carbonaceous or coallike substance. No quartz is to be discovered. When the mica prevails and the rock contains less of the carbonaceous substance, it has such a striking resemblance to ordinary mica-schist, that even the ablest geologist would mistake it for this common rock, and I should not wonder if such bituminous mixtures of mica and feldspar or bituminous mica schist were found to be abundant in almost all our districts of crystalline rocks. When the carbonaceous substance becomes more predominant, the silver-white colour passes into dark brown, and this colour totally prevails in the variety *b*, which at a superficial glance seems to be a quite homogenous, black or dark brown substance. A closer examination, however, shows, that this colour comes from innumerable small black, well defined grains, innixed in the greyish orthoclase. Some scales of mica, of the same aspect as the mica in the schistose variety, and small grains of calcite may also be discovered. Occasionally the felspar and calcite are concentrated into somewhat larger white nodules, free from the black mineral. — If the variety *b* — (*a* contains less of bitumen) — is heated in the air or in oxygen, the carbonaceous substance is destroyed, and the blackish colour changes into greyish-white. Before the piece is red-hot, a combustible gas is given off, enveloping the heated mineral in a flame, resembling the flame of burning hydrogen. Even when heated in a retort the rock gives much gas, in

this respect quite resembling bituminous coal. With boiling alkali a dark brown solution is obtained, which gives with muriatic acid a brown flocculent precipitate.

The carbonaceous substance is very brittle, and the rock is therefore more friable than common gneiss, not more, however, than might be presumed of a gneiss penetrated with cavities of the form and volume of the immixed coaly particles. But near the surface the rock is already much decomposed, and so brittle, that large pieces may be crumbled with a few blows. The grains of orthoclase, both in the altered and unaltered rock, break *along the cleavages of the felspar*, and the fracture of the rock is thus crystalline. Accordingly we have here not to do with a sandstone, but with a rock, probably originated by the solidification and crystallisation of a claylike sediment, consisting of organic substances and unorganic matter, of the same constituents as the common felspar. That a change in the relative position of the atoms, i. e. a crystallisation *in a solid mass* tending to a disposition of its molecules according to the best conditions of equilibrium, did take place, *without the aid of water or heat*, during the immense time that has elapsed since the gneiss period, seems not at all improbable, when we consider, that such a change often takes place, for instance in the axis of a locomotive in the course of a few years, in the monoclinic sulfur or the yellow jodide of mercury in a few seconds.

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### 3. Chemical analysis of the rock.

By F. L. EKMAN.

The following are the results of an analysis of various specimens of Nullaberg-rock from the mineralogical collection of the Royal Academy of Science in Stockholm.

The principal ingredient in this species of rock was felspar, a portion of which formed colourless stripes, coarser or finer, in the fracture of the dark stone. Even the dark material itself was chiefly composed of felspar, which however was so thickly overspread with small grains of organic, carbonaceous matter, as entirely to conceal the appearance of the felspar. These grains were in part visible to the naked eye, and when a little of the dark stone was crushed between glass plates under the microscope, the carbonaceous substance appeared as opaque, angular broken particles, and the felspar uncoloured; one or two flakes were slightly tinged with yellow.

Mica appeared thinly scattered in separate or conglomerate scales. Quartz I could not observe.

Carbonate of lime occurred together with felspar in the small round balls of white colour, copiously sprinkling some of the specimens, though in some instances it had been fretted out by the action of the air and water. It sometimes appeared, less visibly, mixed with the remaining mass, but was sometimes entirely absent.

In five specimens of different character I found the following proportions of organic matter (traces of water included) and carbonate of lime:

	1.	2.	3.	4.	5.
Organic matter .....	7.10,	10.67,	10.36,	5.44,	9.08.
Carbonate of lime .....	2.57	(0,07)	14.30	2.75	0.00.

The following is the analysis of the rock, when free from organic matter and carbonate of lime:

	1.	5.
Silica.....	65.03	65.25.
Alumina.....	19.61	
Red Oxyd of Iron.....	0.45	
Lime.....	0.19	
Magnesia.....	0.20	
Potash.....	14.46	
Soda.....	1.06	
	<u>101.00.</u>	

When larger quantities (40—80 grammes) were macerated at the ordinary temperature with diluted nitric acid, well determinable quantities were obtained of Phosphoric acid and Chlorine as also of Lime, the last even in the specimen 5 (in which, though 11 grammes were analyzed, no carbonic acid was found). Hence one may conclude that the rock contains a little Apatite. Traces of manganese and copper were also observed. The silicious ingredients of the rock were also a little dissolved, and it may perhaps be inferred, that the traces of silica were separated before testing for phosphoric acid.

The organic ingredient may be easily obtained in a very pure state by washing, when a sufficient quantity of the rock is employed. The purest specimen that I obtained afforded after combustion only 3.17 % of a reddish ash, but still contained some mineral fragments. The ash, of which such fragments constituted perhaps the principal part, showed no reaction on Curcuma-paper. In a few centigrammes, collected after analysis, I found Gypsum, Oxyd of Iron, Silica (and Phosphoric acid?) apparently derived from the combustion of the organic matter.

The carbonaceous substance thus purified forms a light powder of a beautiful bluish black colour. It is but slightly hygroscopic and is not easily wetted with water. When heated, it concretes a little, but without melting or sensibly changing its state of aggregation, and produces a transient but brilliant flame; the remaining coal smolders very slowly out. The specific gravity I found to be 1.299; after the removal of all remaining stony mat-

ter, it would probably be about 1.27. Analysis by combustion gave the following results: (ash and water being supposed to be removed)

The carbonaceous substance obtained from

	N:o 3.	N:o 2.		Medium.
Carbon.....	88.68	88.79	—	88.74
Hydrogen.....	5.35	5.56	—	5.46
Azote.....	—	—	0.67	0.67
Oxygen.....	—	—	—	5.13

100.00.

The carbonaceous substance is generally but little affected by solvents. Spirit of 90 percent pure alcohol became yellow and dissolved scarcely one percent\*) of a substance, probably colourless when pure and easily soluble in alcohol; when heated it yielded a thick white vapour and slowly blackened. Aether dissolved  $\frac{1}{2}$  percent of a substance of the same nature but less coloured. Chloroform, like alcohol, was coloured deep yellow and left a similar residuum, the quantity of which was however not determined. Oil of Turpentine had no more dissolving effect than alcohol or aether. N.B.: The experiments with alcohol, aether and oil of turpentine were performed by boiling the substance in the solvents for several hours.

A warm solution of 1 part caustic potash in 20 or 6 parts water dissolved 5 percent and became black-brown. From this solution by the action of acids was obtained a very voluminous brown precipitate soluble in pure water. After the extraction of this 5 percent, the remainder was unalterable in a heated solution of caustic potash, though exposed for several hours to its action.

The following are the results of some experiments made with reference to the products of dry distillation, performed on a small scale, the presence of air being as much as possible avoided, and in an apparatus that permitted a bright red-heat. When rapidly heated the substance \*) gave Carbon 74 % and volatile products 26 %. When slowly heated it gave 11 % fluid products, of which about  $\frac{3}{4}$  consisted of a yellow neutral oil, lighter than water; the

\*) The substance always considered as free from ash.



gases developed were first acid, afterwards alkaline, and the water after distillation was strongly alkaline.

1 gramme of the substance gave, rapidly heated, 258 Cubic Centimetres of gas of 23° Centig. Temp., collected and measured over water. In the gas when fully purified from carbonic acid I found 2.7 vol. % of hydrocarbons absorbable by bromine. In another experiment, where the oils were for the most part decomposed during the distillation, 313 CC of gas were obtained from 1 gramme of the substance.

In the analysis of the organic substance no attention has been paid to the amount of sulphur contained. Even in the original rock, when melted with carbonate of soda, this element plainly shows itself, and in the carbonaceous substance, containing 3.17 % ash, I found no less than 0.81 %. Whether the iron remarked in the ash be there in sufficient quantity to bind the sulphur and compose pyrite, or whether, as is possible, there be an overplus of sulphur contained in the organic substance, is as yet undecided.

Finally I may remark, that I have found Mr BAHRS interesting statement of the stones containing Iodine confirmed. When 7.5 grammes of substance, containing 21.7 % of ash, were burned with 14 grammes of almost pure lime, the burned mass treated with water and nitric acid and the iodine transferred to silver and thence to cadmium, the little solution of cadmium showed strong signs of the presence of iodine. The iodine was recognized by receiving it first on chloroform, thence on silver again and lastly on starch.

When 12 grammes of the same kind of lime were dissolved with proper care in water and the same kind of nitric acid as that used in the experiment, the solution, when analogously treated, yielded a little chlorine but no trace of iodine. For the sake of brevity I do not here detail any operations caused by the substance's containing sulphur, especially as fuller details of the experiments will, after their completion, be published in the "Öfversigt af K. Vetenskaps-Akademiens förhandlingar".

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