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WEATHERING OF SYENITE IN KJOSE, VESTFOLD

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With 4 figures in the text.

During a trip through the forest of squire F. M. Treschow in the districts round the town Larvik, I got the occasion to look at the most comprehensive mechanical weathering of igneous rocks which I have ever seen as yet in Norway.

Because Fennoskandia so recently has been covered with ice, we do not expect to find layers of residual soils of any considerable thickness above the bedrock of our country. In the districts with Cambro-Silurian sedimentary rocks we have residual soils of the greatest economical importance. Here small areas covered with these soils are cultivated. In the mountain region loose materials derived in situ from the bedrock are often found scattered. This is of course a result especially of mechanical weathering. In Finnmark relatively thicker layers of residual soils from gabbro are known, and it has been maintained that here we have a weathering from pre- or inter-Glacial age. The find of special clay minerals in residual soils in Vest-Agder, too, constitutes an important contribution to the Quaternary history of Norway. Generally, however, when the bedrock is not covered with moraines, sedimentary deposits of some kind or organic materials, the Archean rocks and the younger igneous rocks in Norway are lying almost completely bare and naked.

From districts with igneous rocks of the Oslo region, I have found that gravel-pits in residual soils have earlier been mentioned in the literature. Schetelig (1918, p. 41) says that in several places of Sandar the larvikite is so loose that pickaxe and spade will make it crumble. Here the weathering has taken place along fissures where water from the surface has been able to trickle down. He adds that this weathering is pre-Glacial. Samuelsen (1933) mentions a deep gravel-pit in Holm, Hedrum. The rock in this place is a light red, medium fine-grained syenite. Further he has noticed some smaller gravel-pits of the same type along the road Gjone-Lysebø in Hedrum.

Fig. 1. Gravel-pit in residual soil. Roligrønningen, Kjose.

The parish of Kjose belongs to Brunlanes and is situated on the western side of the Farris lake, north-west of the town Larvik. This district, then, is situated north of the terminal moraine called the "Ra". On the 18th of May 1944 I visited this lonely tract, taking some trips through the forest in company with the state adviser, Mr. P. Thurmann-Moe and the district director of the forest, Mr. H. Austeen. The latter, — to whom these parts are particularly familiar — was able to tell many interesting details concerning the local forestry.

I then was rather astonished to find large areas of relatively deep soils derived from the bedrock by weathering in situ. Kjose is known as a forested district (see for instance Helland 1915, p. 671), and now I had the occasion to see that in the northern parts of the parish very fine woods of Norway spruce are growing on these residual soils. Besides, Mr. Austeen told me that, according to the latest estimation of volume and increment of the forest in this district, a large percentage of the wood of Strand was of a particularly good quality: no less than 19.5 % of the area yielded a production of more than 6.8 m^3 per hectar and year. Parts of the area of this quality here, as well as in

other places of the district, are situated on residual soils. Typical localities of these soils are for instance Strandsrønningen, Eikenesmoen, and the eastern parts of the wood of Bærug.

On hill slopes where moisture is percolating through the loose material, we generally find a luxuriant ground vegetation, consisting of eutraphent species of *Angiospermae, Pteridophyta, Bryales* and *Hepaticae;* the soil profiles belong to brown earth with the A stratum having a typical mould character. On horizontal ground, however, podsol profiles occur. It was said to be particularly difficult to regenerate the forest by planting, and partially the cause seemed to be the drying out of the upper layer of the soil.

Several farms in Kjose, for instance Elvestad, Moen, and Omsland had a large part of the cultivated area on residual soils. For the cultural plants, however, this ground generally was too dry. The meadows are said to yield small crops, especially when the summer is not wet, but raising of potato gives relatively better results. In this district the cultivating of rye still has a broad place — contrary to the trend in our country during the last decades. On an average the soils seemed to be poor in humus, and in old official papers (according to Berg 1911) is mentioned that several farms here have a dry ground.

In this region the roads have a striking pale red colour, owing to their cover being made of this loose material formed by weathering.

It is an interesting fact that many foresters call this easily weathering rock tjosite. As geologists will know, tjosite is the name which Brøgger (1906, p. 128) has given to a dark, hypabyssal rock, belonging to the lardalite (nepheline syenite) series. Foresters who may have heard, or read, the name tjosite once or twice, however, naturally have applied it to this rock which distinguishes itself by weathering so easily. They are, of course, more interested in this rock from which vast areas of such extraordinary residual soils have been derived, than in the comparatively rare dyke-rocks of the lardalite series. On the old map of Brøgger (1898), as well as on the general view map of the Oslo region issued by Brøgger and Schetelig 1923, the rock here is designated as larvikite.

Professor dr. Tom. F. W. Barth has been so kind as to examine two specimens from the rock at Omsland in Kjose. He determined them as larvikite, but of a special type, consisting almost only of alkali feldspar. This feldspar is mostly a curious perthite with intergrowth

Fig. 2. Cultivated area and forest on residual soil. Roligrønningen, Kjose.

of potash feldspar and albite-oligoclase, and has cracks and fissures everywhere. There are very little dark minerals in the rock. Now only chlorite exists, which has a green colour and is almost perfectly isotropic with an index of refraction of about $n = 1.600$. The mineral, then, is supposed to be pennine. Barth suggests, moreover, that the clue of the weathering may be found in the fact that the dark minerals of the rock have been transformed to chlorite. This indicates a hydrothermal influence, — perhaps we are right to suppose an after-magmatic auto-metasomatism.

Further Professor Barth examined samples of residual soil from Omsland and found that they essentially consisted of material from mechanical weathering of the rock, and were very little influenced by chemical weathering. The finest fraction was composed of splinters of feldspar and flakes of chlorite frequently with a mantle of ferri-hydroxide. In addition there were a few thin, nearly invisible scales of a weathering mineral which may be either hydrous mica or beidellite. The index of refraction was about 1.54 and this circumstance should suggest beidellite rather than hydrous mica. But the material contained

so few and so small scales that a more exact determination was impossible.

In this connection the attention may be drawn to the fact that beidellite has been found in many samples from Vest-Agder (Barth 1939, 1940). It is to be mentioned, too, that of other clay products formed by weathering of rocks, kaolinite (Reusch 1901, Holtedahl 1939, Barth 1940), and laterite (Goldschmidt 1928) are found. The search for minerals of the montmorillonite group in our glacial clay, on the contrary, has not succeeded as yet (Hovden 1942, Rosenqvist 1942).

The table below gives some data for the amount of available plant nutrients in soil samples from Kjose (Nos. 3—5), and for comparison the analyses of three samples of other residual soils are reported. Sample No. 1 is taken from the area of basic kjelsåsite or Oslo-essexite (Brøgger 1933, Holtedahl 1943, p. 18, Barth 1945) at Kjelsås in the northern part of Sørkedalen, sample No. 2 from Kolbu is derived from black clay slate belonging to stage 3, and sample No. 6 is taken in the neighbourhood of the lake Store Daltyven in Nordmarka where the bedrock is larvikite. All the samples are almost completely free from humus, as they are taken in the C stratum of the profile.

Analyses of Samples from Residual Soils.
Analyser av prøver av forvitringsjord.

	Sample No. Prøve nr.					
	3	4	5	1	2	6
Lactate value (mg P_2O_5 per 100 g) .. Laktattall	7.5	8.5	0.6	1.5	0	0.6
M-value (mg K_2O per 100 g) ..... M-tall	2.2	4.0	3.6	25.0	6.0	-
Ca soluble in 10 % NH_4Cl, mg CaO per 100 g ..... NH_4Cl-oppl. Ca, mg CaO pr. 100 g	14	18	17	28	25	18
pH (in water) ..... pH (i vatn)	5.20	5.60	5.70	5.75	3.15	5.35
Base-mineral index ..... Basemineralindeks	-	-	29	58	-	-

Prøve nr. 3—5 forvitringsjord av en særegen larvikit-type i Kjose, Vestfold fylke. Nr. 1 forvitringsjord av basisk kjelsåsit eller Oslo-essexit ved Kjelsås, Sørkedalen. Nr. 2 forvitringsjord av svart leirskifer som hører til etasje 3 i Kolbu. Nr. 6 forvitringsjord av larvikit i nærheten av Store Daltyven i Nordmarka.

Fig. 3. Cut through soil derived in situ from the bedrock by weathering. Omsland, Kjose.

The content of phosphorus (for the method of analysis see Egnér, Köhler und Nydahl 1938) in sample 3 and 4 is so large that the crops of cultural plants hardly would increase by fertilization with phosphate. Regarding potassium (Egnér 1940) the same conclusion pertains to sample No. 1, and here we also find the greatest content of calcium. The part of a sample with a specific gravity of more than 2.680 calculated in per cent of the weight is named base-mineral index (Tamm 1934). In the fraction 0.2—0.6 mm where the base-mineral index is determined, there is an enrichment of chlorite in sample No. 5. None of the few samples which have already been treated after this method in Norway, exibit such a great a value of the index as does No. 1. The rock from which this soil is derived, too, is a curious one. But important amounts of available phosphorus — as might be expected after studying the composition of the rock — are not found in this sample.

The result of a simple experiment made in order to examine the fixation of phosphorus, shall be reported. Amounts of potassium

dihydrophosphate corresponding to 10 and 50 mg P_2O_5 per 100 g soil were added to samples of the soils in such a concentration that the maximum water-capacity was overstepped with about 50 %. The samples were dried in 40° C after staying for 5 days at room temperature, and later analysed after the method of Egnér. By adding 10 mg per 100 g, phosphorus was found soluble in the following amounts: in sample No. 5 about 22 %, in No. 1 29 %, and in No. 2 only 1 %, and by 50 mg the values were of the same order of magnitude for the two samples mentioned first, but had increased a little in the case of No. 2. Results obtained with these methods are naturally not to be compared directly with results from studies on the water-soluble phosphorus. Here I only want to draw attention to the great difference of behaviour of the two extraction media relative to calcium phosphate. The fixation of the phosphorus in sample No. 2 must be seen in relation to the extremely acid reaction. On the other hand there are, as far as we know, a connection between low pH and the occurrence of pyrite in such a black clay slate.

SAMMENDRAG

Forvitring av syenit i Kjose, Vestfold fylke.

Det finnes lite forvitringsjord av grunnfjellbergarter og yngre eruptiver i Norge. Enkelte forekomster av tykkere lag av slik jord er omtalt i litteraturen, og har vært av betydning for drøftelse av landets kvartærgeologiske historie.

I skogbygda Kjose i Brunlanes, Vestfold fylke, er det til dels tykke lag forvitringsjord av en særegen type larvikit. Lokalkjente landbruksfolk har brukt betegnelsen tjosit om denne bergartstypen som utmerker seg ved å forvitre så lett. Men dette navnet er innført av Brøgger for en mørk gangbergart som hører til lardalitrekken.

Undersøkelser av prøver av forvitringsjorda viste at de var sammensatt av splinter av feldspat sammen med en del skjell av klorit som til dels hadde belegg av ferrihydroksyd. Dessuten fantes meget små mengder av hydroglimmer eller beidellit. Løsmaterialet var lite påvirket av kjemisk forvitring. Tabellen på s. 220 med forklaringer har noen tall for innholdet av lettoppløselig plantenæring og andre økonomisk viktige egenskaper. Den omfattende mekaniske forvitring bør rimeligvis sees i sammenheng med at de mørke mineraler i bergartprøver fra dette område synte seg å være omdannet til klorit.

Fig. 4. Norway spruce growing on residual soil. Bærug, Kjose.

Topografien har også her stor innflytelse på utviklingen av jordsmonnet. Typer av brunjord og podsolprofiler kan skilles ut.

Skogen er på sine steder ved takseringen satt til bonitet I.

Det har vært vanskeligheter med skogplanting, antakelig delvis fordi jorda så lett tørker ut i overflaten. Flere gårder har en stor del av det dyrkete areal på forvitringsjord. Ved valg av kulturplanter og omløp har en måttet ta hensyn til at denne jorda er tørr, og dette er vel hovedårsaken til at rugdyrkinga ennå spiller relativt stor rolle på disse gårdene.

Norges Landbrukshøgskole i Ås, December 1944.

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