

# Big boulders of tillite rock in Porsanger, Northern Norway

By  
*Sven Fjøn.*

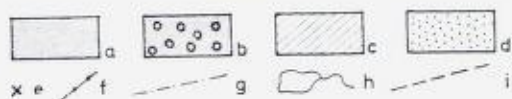
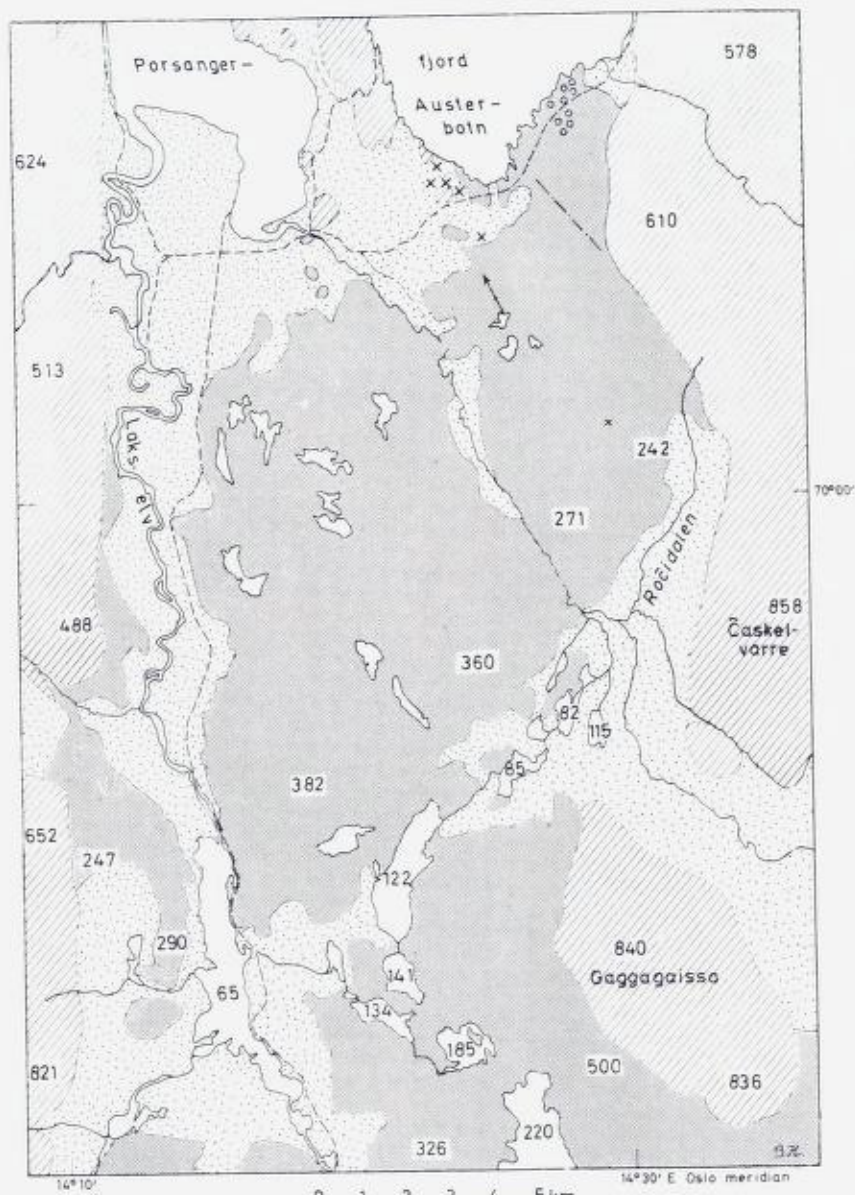
## Abstract

In 1959 numerous erratic boulders of tillite rock were discovered at the head of Austerbotn, the eastern arm of the Porsangerfjord. Some of the boulders are very big, having volumes of up to 20 m<sup>3</sup>. In 1965 another two boulders were found about 7 km to the south-east of the head of the fjord. The presence of the tillite boulders shows that Eocambrian tillite occurs - or at least has existed - in the Porsanger region. No deposits of tillite occurring in situ have, however, been reported from this district. The writer suggests that the source of the boulders is most probably in Ročidalen, a depression in the Precambrian surface of the broad Lakselv valley, about 10 km south of the head of the Porsangerfjord. As there are no rock exposures in the bottom of Ročidalen on account of the thick cover of Quaternary deposits, this theory can hardly be proved. Possible future finds of tillite boulders may bring other parts of the Lakselv valley into focus.

## Introduction

Numerous erratic boulders of tillite rock occur west of the head of Austerbotn, the eastern arm of the Porsangerfjord (lat. 70° 4' N, long. 24° 68' E). The boulders are found mainly on the slope facing the sea, but also on the small hill north of the main road. No occurrence of tillite in solid rock has been reported from Porsanger. The nearest known in situ deposits of Eocambrian tillite are those south of Laksefjord more than 50 kilometres to the NE, and at Altafjord about 60 km to the west. As the only agent which can be responsible for their transport and present distribution is the glaciers of the Quaternary period, and since the ice movement was from a southerly direction, the boulders at the head of the Porsangerfjord cannot have been derived from either of the above-mentioned deposits.

The boulders were discovered by Prof. O. Holtedahl, Dr. P. Reitan and



the writer in 1959, during field preparation for the international geological excursion to Finnmark, 1960. In 1962 the present writer spent a few days in Porsanger in order to try to find the origin of the boulders.

### General geology

The geology of the region south of the Porsangerfjord is known from the work of Holtedahl (1931), Crowder (1959) - see the map Fig. 1 - and Skålvoll (the Quaternary deposits) (1960). In the Lakselv valley, which is the continuation of the Porsangerfjord depression, the rocks are Precambrian supracrustals, considered to belong to the Karelides. The steep sides of this broad valley consist mainly of the Porsanger sandstone formation (of late Precambrian age), which forms a nappe lying with thrust contact on beds of the Dividal group (= the "Hyolithus zone").

The Dividal group in Finnmark was formerly, in its entirety, ascribed to the Lower Cambrian. The lower part of it has recently been shown to be of Eocambrian\* age, being equivalent to the formation next to the upper tillite of eastern Finnmark (Føyn 1967).

### The Austerbotn area

At least a dozen of the boulders at Austerbotn have a diameter (or length) of more than one metre. Some of them have a volume of about 20 m<sup>3</sup>. The colour of the matrix is partly red-brown, partly grey. All the pebbles and

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\* The term Eocambrian is here applied in the "restricted" sense to the time beginning with the deposition of the lower tillite in Finnmark and ceasing at the base of conventional Lower Cambrian.

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Fig. 1. Geological map of the Lakselv valley area (p. 224).

- a) Precambrian crystalline rocks.
- b) Patches of conglomerate of the Dividal Group on the Precambrian surface east of Austerbotn.
- c) Caledonian rocks. (Dividal Group (= "Hyolithus zone") and Porsanger Sandstone Formation).
- d) Quaternary moraine, gravel and sand deposits and bogs.
- e) Localities with boulders of tillite rock.
- f) Main direction of Quaternary glacial striae.
- g) Fault.
- h) Lake and river, sea-shore.
- i) Road.

Geological boundaries largely after Crowder (1959).

boulders in the tillite consist of Precambrian crystalline rocks. The tillite shows practically no signs of tectonic deformation, its unshered character indicating that it is unlikely to have belonged to the rocks constituting the nappes. It is far more likely that the source has to be searched for close to the old Precambrian surface. Remnants of a tillite cover may perhaps have been preserved in depressions in the Precambrian surface, like the tillite deposits described by P. Holmsen from West-Finnmark (Holmsen 1956 and 1957).

In point of fact, the distance between the present position of the boulders and the old surface of the Precambrian basement is not large - both in the lateral and vertical sense. Outcrops of coarse, feldspathic sandstone and green and reddish shales show that the solid rock in the hill and along a part of the shore consists of beds belonging to the basal part of the Dividal group. Rocks belonging to the Precambrian basement crop out, however, only a few hundred metres east of the hill. Furthermore, in the bog on the southern side of the main road south of the hill, crags of Precambrian rocks are seen, and south of the bog, which is about 700 m broad, the Precambrian rocks are well exposed.

At the southern border of the bog one (rather small) boulder of the same sort of tillite rock as in the accumulation on the hill has been observed. The boulder had appeared from the Quaternary moraine below the peat, during a farmers digging of a drainage ditch.

The peneplain is fairly well preserved about 2 km NE of the head of Austerbotn (Holtedahl 1918, p. 134). The main road crosses an area where patches of the basal conglomerate of the Dividal group are seen on the surface of the Precambrian rocks, which there are mostly hornblende schists. The peneplain dips about  $3^\circ$  (angular measurements based on  $100^\circ$  scale) to the north-west. Between this area and that of the Dividal rocks west of Austerbotn, a block faulting must have taken place at a time later than the deposition of the Dividal beds. One of the fault lines is shown on the map Fig. 1 (see also Crowder's map (1959)). More parallel faults are evident, judging from the marked linear breaks in the landscape. The trend of these lines is  $N 50^\circ W$ , each south-western block having been raised slightly relative to its north-eastern counterpart.

In order to find more tillite boulders, if any, the writer made excursions in the area of the Precambrian rocks as far as about 10 km south of the head of the fjord. In this area a rather massive greenstone (hornblende diorite) is seen as solid rock. Boulders of this greenstone are also found west of Austerbotn together with those of the tillite and are of the same order of size as the latter. Their direction of transport corresponds to the main trend of the glacial striae,

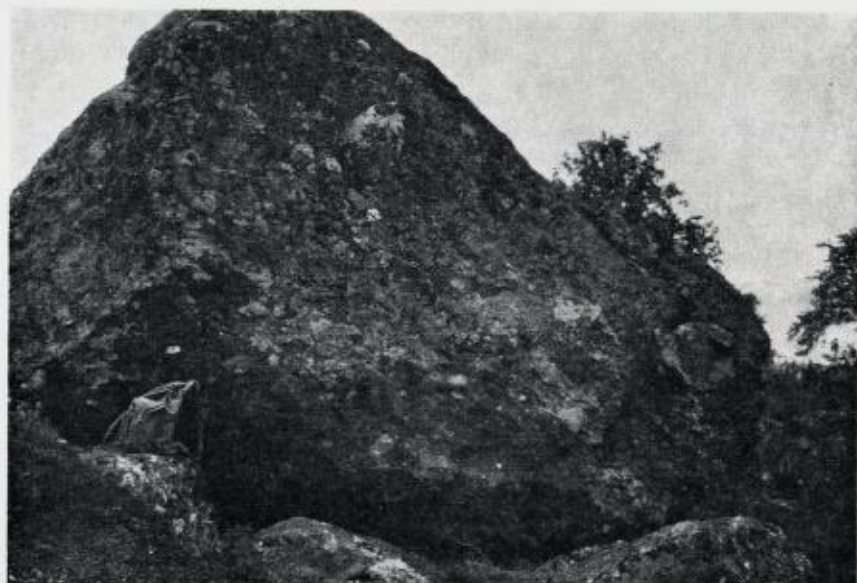


Fig. 2. Boulder of tillite rock west of the head of Austerbotn.

which is about  $N 30^{\circ} W$ . (Very locally, on the Precambrian surface south of the main road, at Austerbotn, a trend  $N 25^{\circ} E$  was observed). In spite of a rather thorough search, not a single block of tillite could be found in the area.

As a result of the investigations in 1962, the present writer concluded that the tillite boulders of the large, but local concentration at Austerbotn could hardly have been transported over any long distance. It was thought that, in all probability, the source must be just south-east of the hill, in the depression now occupied by the bog. This theory would also have accounted for the existence of the tillite boulder at the southern boundary of the bog.

#### **Another boulder locality**

It is now known, however, that this theory is not tenable, or at least, it does not accord with the full facts. In 1965 and 1966, geologist cand. real. Gunnar Juve conducted thorough investigations in the Precambrian area south of Porsangerfjord, with the ore mineralization as his main topic. When the writer visited the area in 1966, Juve drew attention to two big boulders of tillite rock, situated about 7 km south-east of the head of Austerbotn. The compass direction from these two boulders to the hill west of Austerbotn roughly coincides with the main direction of the glacial striae in the area.

The consequence of Mr. Juve's find of these two boulders is that the source of the tillite boulders must be farther to the south or SSE.

### Ročidalen - the place of origin of the tillite boulders?

As realized by Holtedahl (1931), the Precambrian surface of the Lakselv valley was bowed up in early Caledonian time into a ridge running SW-NE, about 15 km to 10 km south of the head of Porsangerfjord. The ridge has, on the whole, a gentle slope (about  $3^\circ$ ) towards the fjord, but is much steeper on its south-eastern side, after which a gentle rise of the Precambrian peneplain towards the south can be demonstrated. While the Caledonian thrust plane at and to the north of the ridge cuts the Dividal beds only ten or a few tens of metres above the basement surface, the thickness of the Dividal group south of the ridge is about 250 m.

Ročidalen is the north-eastern part of the depression south-east of the ridge. In this valley Quaternary deposits, probably of considerable thickness, entirely conceal the solid rock.

South of Ročidalen, along the south-western side of the mountains Časkelvarre and Halkkavarre\*) and around the mountains Gaggagaissa and Mellemfjellet\*), the contact between the Precambrian rocks and the basal beds of the Dividal group is exposed at several places. This area has been studied in detail by the geologist, mining engineer Bernt Røsholt and assistants, and the writer has also visited the area for a couple of days. No occurrences of tillitic rock have been observed.

Thus, Ročidalen seems to be the most probable place of origin of the tillite boulders, at least in the eastern part of the Lakselv valley. As mentioned above, no solid rock is visible, and because of this, proof of the possible existence of tillite below the Quaternary deposits is hardly expected to be forthcoming. If more tillite boulders were to be found north of the valley, especially on its very slope, this would be a useful and additional indication that the source of the boulders is hidden in the bottom of the valley.

Ročidalen, however, should not be looked upon as the only place likely to be concealing in situ tillite. Future finds of tillite boulders may bring a more south-western part of the Lakselv valley into focus. Concerning the boulders at Austerbotn, floating icebergs as a contributory transportation agent can not be left completely out of account (M. Marthinussen, personal communication).

The question of the source of the tillite boulders in Porsanger is not solved. Important as this kind of rock is as a source of knowledge of palaeoclimatology and palaeogeography, it would be of great interest to find the tillite as solid rock also in this part of Finnmark, or - if the deposits do not exist there any

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\*) Halkkavarre and Mellemfjellet are off the bottom right-hand corner of the map Fig. 1.

longer - to find more indications as to where the position of such deposits may have been.

The main purpose of this paper has been to call attention to the fact that Eocambrian tillite may occur - or has existed - in the Porsanger district. Any new finds of tillite boulders may bring the problem closer to its solution. Reports of such finds to Norges Geologiske Undersøkelse will, therefore, be very welcome.

#### Acknowledgements

I wish to thank Prof. O. Holtedahl, Mr. G. Juve and Mr. B. Røsholt for pleasant collaboration in the field and valuable discussions afterwards. I am also indebted to Mr. M. Marthinussen for critical reading of the manuscript and to Dr. D. Roberts for correcting the English.

#### Sammendrag

##### *Store flyttblokker av tillitt-bergart i Porsanger, Nord-Norge*

I 1959 ble det oppdaget et stort antall flyttblokker av tillitt-bergart (= morenekonglomerat) på den lave høyden og i skråningen mot sjøen like vest for den innerste ende av Austerbotn i Porsanger. Noen av blokkene er svært store, opp til 20 m<sup>3</sup> i volum, og minst et dusin har en diameter (eller lengde) på over en meter. Nok en blokk ble funnet (i 1962) i søndre del av myra på sydsiden av riksveien. I 1965 ble ytterligere to store blokker (1 m<sup>3</sup> og 2 m<sup>3</sup>) funnet ca. 7 km sørøst for fjordbotnen. Blokklokaltetene er merket med x på kartet fig. 1.

Flyttblokkene viser at tillitt fra eokambrisk tid forekommer — eller i det minste må ha eksistert — i Porsanger-området. En kjenner imidlertid ikke til noen forekomst av tillitt i fast berg i dette område. De nærmeste forekomster av tillitt i fast berg er sør for Laksefjorden, minst 50 km i luftlinje mot nordøst, og ved Alta, 60 km i luftlinje mot vest. Flyttblokkene kan ikke være kommet fra noen av de nevnte stedene, da transporten må være skjedd med isbreer under den kvartære istid, og i Lakselvdalen var brebevegelsen fra sørsørøst. Forfatteren av denne artikkel mener at Ročidalen må være det mest sannsynlige sted for opprinnelsen til tillittblokkene. Ročidalen er en senkning i grunnfjellsområdet i Lakselvdalen, ca. 10 km sør for Austerbotn. Uheldigvis (i denne forbindelse) er bunnen av Ročidalen fylt av løse avleiringer fra kvartærtiden, disse jordlagene er sannsynligvis svært tykke, og fast berg er ikke å se. En kan derfor ikke vente å få noen endelig avgjørelse på spørsmålet om det finnes tillitt i fast fjell liggende på grunnfjellet under jorddekket. Dersom det kunne

finnes flere blokker av tillitt nord for Ročidalen, særlig i selve dalsiden, ville det være til støtte for teorien om Ročidalen som opphavsområde for tillitt-blokkene.

En bør imidlertid ikke anse Ročidalen som det eneste mulige sted for opprinnelsen til tillitt-blokkene. Skulle det i fremtiden bli funnet blokker i andre deler av Lakselvdalen, kan også mer sørvestlige deler av denne komme på tale som opphavssted for blokkene.

Tillittbergartene er viktige som kilde for kjennskapet til paleoklimatologi og paleogeografi. Det ville derfor være av stor interesse å finne tillitt også i form av fast berg i Porsanger, eller å finne hvor eventuelle forekomster av tillitt en gang må ha ligget. Ethvert nytt funn av tillitt-blokker kan bringe løsningen av problemet nærmere. Norges geologiske undersøkelse er derfor interessert i å få opplysninger om slike eventuelle funn.

### References

- NGT Norsk Geologisk Tidsskrift.  
 NGU Norges Geologiske Undersøkelse.
- Crowder, Dwight F.*, 1959. The Precambrian schists and gneisses of Lakselv valley, northern Norway. NGU 205: 17-40.
- Føyn, S.*, 1967. Dividal-gruppen ("Hyalolithus-sonen") i Finnmark og dens forhold til de eokambrisk-kambriske formasjoner. (*Summary: The Dividal Group ("the Hyalolithus zone") in Finnmark and its relations to the Eocambrian-Cambrian formations.*) NGU 249 I. 84 p.
- Holmsen, P.*, 1956. Hyalolithus-sonens basale lag i Vest-Finnmark. (*Summary: The basal layers of the "Hyalolithus-zone" in western Finnmark.*) NGU 195: 65-72.
- 1957. De eokambriske lag under hyolithussonen mellom čarajavrre og časkias, Vestfinnmark. (*Summary: The Eocambrian beds below the Hyalolithus-zone between čarajavrre and časkias, Western Finnmark.*) NGU 200: 44-50.
- Holte dabl, O.*, 1918. Bidrag til Finmarkens geologi. (*Summary: Contributions to the Geology of Finmarken.*) NGU 84: 1-314.
- 1931. Additional observations on the rock formations of Finnmark. NGT 11: 241-279.
- Skålvoll, H.*, 1960. Noen kvartærgeologiske iakttagelser i Lakselvdalen, Finnmark. (*Summary: Some observations of Quaternary deposits in Lakselvdalen, Finnmark.*) NGU 211: 119-123.