

# A THREE-FOLD DIVISION OF THE 'FARSUNDITE' PLUTONIC COMPLEX AT FARSUND, SOUTHERN NORWAY

TORGEIR FALKUM & JON STEEN PETERSEN

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It has previously been shown that the so-called farsundite pluton consists of two separate intrusions – the Farsund charnockite and the Lyngdal hornblende granite. This paper presents evidence for further subdivision, as detailed field mapping reveals that a narrow zone of country rocks separates the 'Kleivan limb' from the Lyngdal hornblende granite. Mineralogical and chemical differences do not support a co-magmatic origin of these plutons. Consequently the complex consists of at least three different intrusions.

*T. Falkum & J. Steen Petersen, Laboratorium for Endogen Geologi, Geologisk Institut, Aarhus Universitet, 8000 Århus C, Denmark.*

The farsundite (Kolderup 1904) was discovered by Keilhau (1840) and investigated by Kolderup (1897), who suggested a comagmatic evolution from the anorthosite-norite complex to the farsundite.

More recent investigations, however, have shown that the hornblende granite to the east was emplaced before the charnockite (or farsundite *sensu stricto*), which was intruded into the western part of this hornblende granite. Furthermore, chemical analyses indicate that the two plutons were not comagmatic at all (Falkum et al. 1972).

Fieldwork by the present authors during the summer of 1972 also revealed that the northeastern limb (the Kleivan limb of Middlemost 1968) is separate from the hornblende granite (Fig. 1).

The northernmost pluton, here named 'Kleivan granite', has a different mineralogical composition compared with the hornblende granite to the south. Furthermore, a marked colour difference in the field makes the distinction more obvious. Detailed field and laboratory investigations proved the spatial, mineralogical, and chemical difference between the Kleivan granite and the hornblende granite. The former has been found to be complex in composition with a large variation across the whole body.

As a result of this new information we suggest a three-fold division of the intrusive granites of the Farsund area:

- The Farsund charnockite (in the west).
- The Lyngdal hornblende-granite.
- The Kleivan granite.

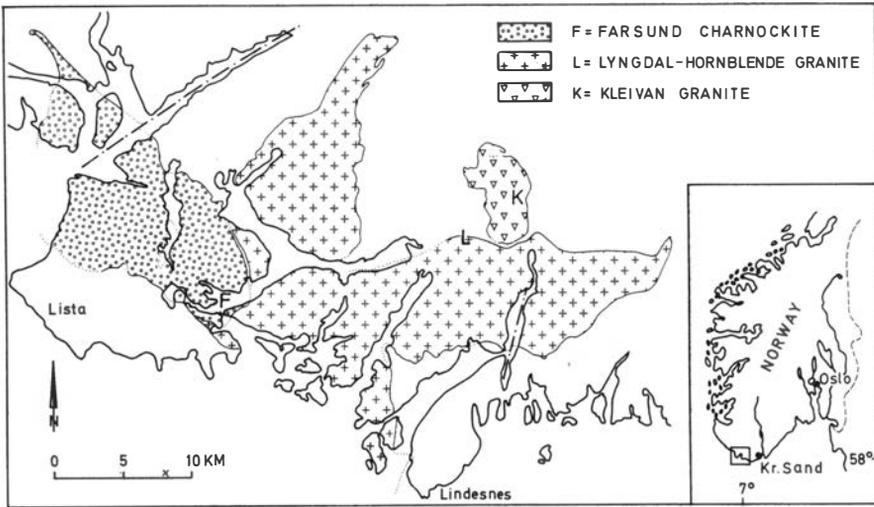


Fig. 1. Regional geological sketch map of the 'farsundite plutonic complex' showing subdivision into the Farsund charnockite, Lyngdal hornblende granite, and the Kleivan granite.

## Separation between the Lyngdal hornblende granite and the Kleivan granite

### FIELD EVIDENCE

The intervening area which separates the Kleivan granite from the Lyngdal hornblende granite is a narrow 2–300 m wide zone consisting of fine-grained mafic and felsic country rocks. The different mineralogy supports the tentative conclusion that there is no sub-surface connection.

Both bodies have sharp contacts with the country rocks, the latter being slightly different adjacent to the two granites (Fig. 2). The country rock north of the hornblende granite is a fine-grained, strongly foliated pyribole. Along the border in a 3–10 m wide zone it is broken into an agmatitic, banded rock which is strongly sheared close to the contact. Xenoliths of mafic rocks are abundant in the hornblende granite, especially near the boundary.

The contact of the Kleivan granite is also sharp, but the country rock along this boundary is a fine-grained leucocratic gneiss which bears biotite and occasional garnet. Foliation in this gneiss is parallel to the contact. Gneissic xenoliths are absent within the Kleivan granite. This fine-grained gneiss may be a border facies of the granite; alternatively, the absence of inclusions might be due to recrystallization, assimilation, or simply because no blocks of country rock were engulfed.

Along the southwestern part of the Kleivan granite a contact agmatite occurs, consisting of a non-foliated, grey, medium-grained granite containing numerous angular pyribole fragments. The matrix is very similar to the Lyngdal hornblende granite, but the contact of the latter is always sharp towards this contact agmatite.

The Kleivan granite is homogeneous on the local scale, but on a regional scale it appears to be very heterogeneous with respect to mineralogy and chemistry. This is due to a continuous variation from charnockite in the extreme north to alkali granite in the south. A detailed description of the Kleivan granite is under preparation by one of us (J.S.P.). In the field, the granite can be divided into three essential parts:

Medium- to coarse-grained, dark green rock type (charnockite) in the north;

Brownish hornblende granite in the central part;

Very coarse-grained, pink biotite granite to the south.

In general, the granite has xenomorphic eugranular texture and the mafic minerals are often distributed in clusters causing a homogeneous 'spotted'

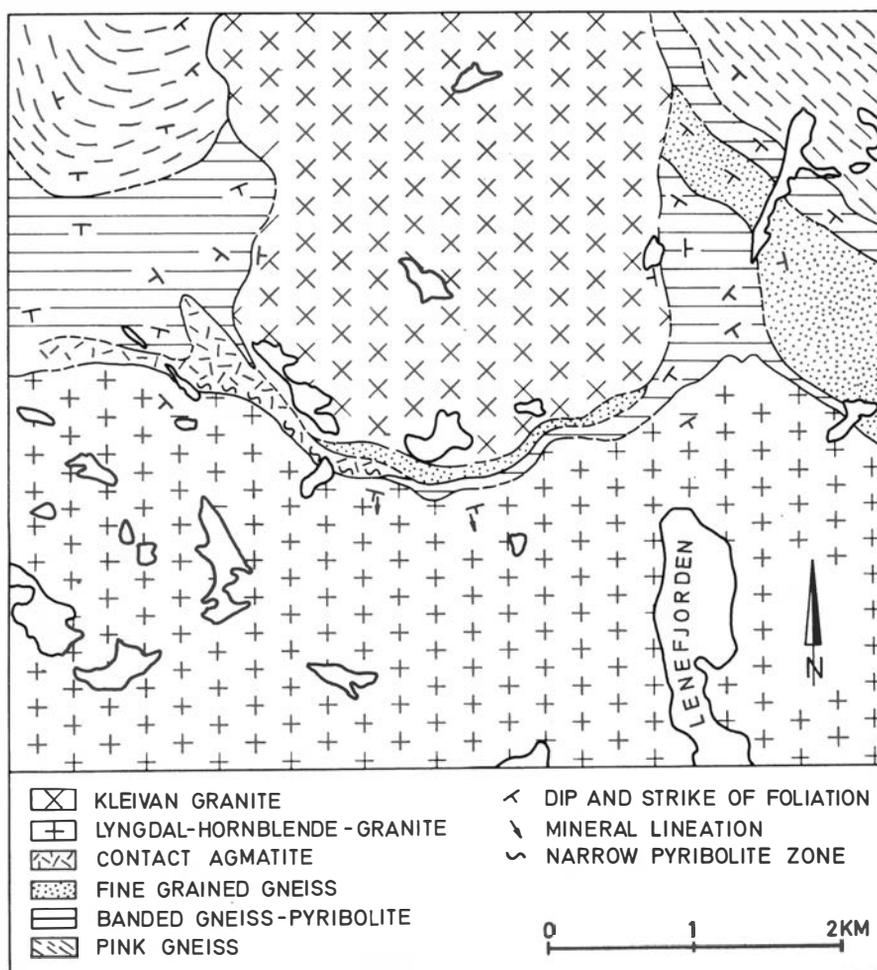


Fig. 2. Geological map of the contact relations between the Kleivan granite and the Lyngdal hornblende granite.

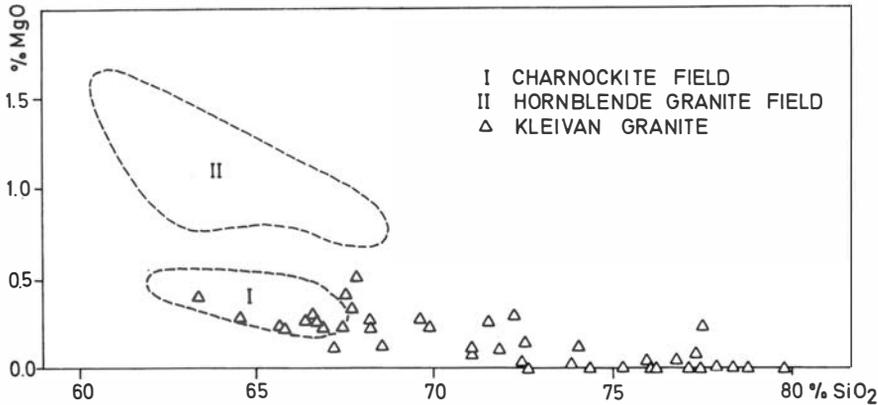


Fig. 3. MgO-SiO<sub>2</sub> plot.

- I Farsund charnockite (37 samples)  
 II Lyngdal hornblende granite (63 samples)  
 Δ Kleivan granite (42 samples)  
 Fields I and II taken from Falkum et al. (1972).

appearance. A planar fabric is encountered in a few localities near the contact and within a narrow zone in the central part of the pluton. Furthermore, pegmatites and aplites are absent, and country rock-xenoliths are only found along the NE boundary. The northern and southern contacts of the Kleivan granite are roughly concordant to the country rock structures although local discordances are seen, whereas the eastern and western contacts are highly discordant.

On the other hand, the hornblende granite, recently studied by Middlemost (1968), is coarse-grained, grey to reddish in colour, and occasionally with porphyritic texture. It is apparently rather homogeneous and exhibits a faintly developed s-surface in the vicinity of the contact, although observed up to 2 km inward from the boundary.

Xenoliths are commonly found, especially along the boundary, but are also present more distant from the contact. Examples of the latter can be seen in exposures along the E-18 main road at Lenefjord where zones with numerous xenoliths are present at several places. Pegmatites and aplites are relatively common in the hornblende granite in contrast to the Kleivan granite.

#### CHEMICAL EVIDENCE

In a recent paper Falkum et al. (1972) presented chemical data of the Farsund charnockite and the Lyngdal hornblende granite which do not support a comagmatic origin.

A quantitative geochemical study of the Kleivan granite has shown that similar arguments can be applied to the question concerning the relationship between the hornblende granite and the Kleivan granite (Fig. 3). Despite the presence of hypersthene in parts of the Kleivan granite, the content of MgO, among others, is significantly lower than in the hornblende granite. From

this diagram it can also be seen that a cogenetic relationship between the Farsund charnockite and the Kleivan granite cannot be excluded on the basis of the data presented here, as the Kleivan granite trend partly overlaps the 'charnockite field'. A strong differentiation in the Kleivan granite is evident from the large span of  $\text{SiO}_2$  values, and makes quantitative geochemical comparison hazardous. Qualitative comparison of mineralogical and chemical parameters, however, show that the dark type of the Kleivan granite is similar to the charnockite. The remaining part deviates considerably from both the charnockite and the hornblende granite.

### Conclusion

The present study thus reveals that the banatite of Kolderup (1897) can be divided into two separate intrusive plutons (the Lyngdal hornblende granite and the Kleivan granite). Previously it was demonstrated that the Farsund charnockite intruded the western part of the hornblende granite, and was chemically so different that a comagmatic origin was considered less probable (Falkum et al. 1972). Similar arguments are presented in order to demonstrate the difference between the Lyngdal hornblende granite and the Kleivan granite, and a comagmatic origin is considered unlikely. Consequently, both chemical and spatial relationships distinguish them as separate plutons emplaced relatively independently. However, on the basis of the field observations it has not yet been possible to establish the time relationship of their emplacement.

Despite the magmatic differentiation of the Kleivan granite, the charnockitic part has a certain chemical resemblance to the Farsund charnockite (Fig. 2). Whether this coincidence gives an indication as to the origin and time of emplacement will be studied in more detail during our continued investigation.

Thus, the present knowledge reveals that the rock complex, previously termed the farsundite (Kolderup 1904), consists of three separate intrusions emplaced within a short time interval. Furthermore, the hornblende granite does not appear to be comagmatic with the other two plutons. They are certainly not one single body (farsundite) of cogenetic origin, as previously suggested by Kolderup (1897, 1904), Barth (1935, 1960), and Middlemost (1968).

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### REFERENCES

- Barth, T. F. W. 1935: The large pre-Cambrian intrusive bodies in the southern part of Norway. *XVI Int. Geol. Congr. Wash.*, Vol. 1, 297–309.

- Barth, T. F. W. & Dons, J. A. 1960: Precambrian of southern Norway. In Holtedahl, O. (ed.), *Geology of Norway. Nor. Geol. Unders.* 208, 6–67.
- Falkum, T., Wilson, J. R., Annis, M. P., Fregerslev, S. & Zimmermann, H. D. 1972: The intrusive granites of the Farsund area, south Norway. *Nor. Geol. Tidsskr.* 52, 463–466.
- Keilhau, B. M. 1840: Reise i Lister- & Mandals-Amt, sommeren 1839. *Nyt mag. f. Nat. v. Bd.* 2, 333–400.
- Kolderup, C. F. 1897: Die labradorfelse des westlichen Norwegens I, Das labradorfelsegebiet bei Ekersund und Soggendal. *Bergens Mus. Aarbok* 1896, 5, 1–222.
- Middlemost, E. 1968: The granitic rocks of Farsund, south Norway. *Nor. Geol. Tidsskr.* 48, 81–99.