GRAVITY STUDIES OF THE LARVIKITE MASSIF SW OF THE LAKE GJERDINGEN, NORDMARKA*

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A gravity study of the larvikite massif SW of the lake Gjerdingen in Nordmarka shows that the disturbing body giving rise to a positive gravity anomaly of ca. 4 mgals, is only 900 m thick. This indicates that the massif is of a sheet or laccolithic type, or that the surrounding nordmarkite has a thin, sheet-like nature. A connection between the Gjerdingen massif and the larvikite-kjelsåsite massifs at the lake Katnosa is possible.

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Introduction

This study of the larvikite massif SW of the lake Gjerdingen (Fig. 1) is the result of one of the many geophysical studies in preparation in the Oslo region. Earlier gravity studies of the Permian Oslo region have been made by Smithson (1961).

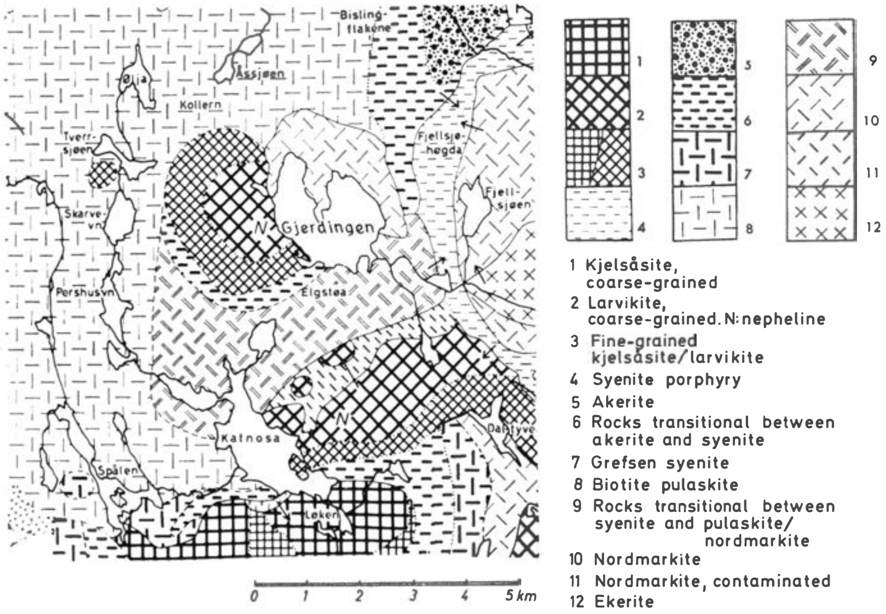

Fig. 1. Geologic map of the investigated area (from Sæther 1962).

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The Gjerdingen massif consists of a ring-formed 'plug' of small-grained larvikite (radius ca. 1 km) with a centre consisting of coarser larvikite containing nepheline (Sæther 1962). It lies on the supposed fissure (fracture) zone cutting the Oslo region (Oftedahl 1960). Most of the volcanic necks in the area are also situated on the same line. However, other ring complexes, which are normally zoned at the lake Katnosa (Fig. 1), Kikut and the basic sørkedalite also lie on the same fissure zone (Barth 1945, Oftedahl 1960, Bose 1969). The rocks surrounding the Gjerdingen massif consist mostly of nordmarkite and pulaskite (Fig. 1) (Sæther 1962).

The aim of this study was to try to solve the shape of the massif in order to shed light on the genesis of the rocks. Brøgger (1890) argued that the deep-seated intrusives of Nordmarka have a laccolithic structure, while Sæther (1962) seems to argue a batholithic origin, with the massif reaching its present position by stoping.

Other geophysical projects in the area of interest for this study include the regional gravity study by Ramberg (pers. comm.), the regional aero magnetic maps published by Norges Geologiske Undersøkelse (1963–1970) and a local magnetic study of Gjerdingen (Kristoffersen 1971).

The regional gravity map shows a general gravity high over the more mafic intrusives of Nordmarka (Ramberg op. cit.). The aero magnetic maps show a circular magnetic high over Gjerdingen which Kristoffersen (1971) maintains is mainly due to the high magnetization of the outer 'ring' of fine-grained larvikite.

The area was also chosen for practical reasons. Excellent maps (scale 1:5000, the economic map series of Norges Geografiske Oppmåling) were available, with height-determined spots of accuracy ± 1–1½ m. Measurements made previously were based on barometric heights with a mean error of ca. ± 5 m. The topography in the area is not too difficult; the mean elevation is ca. 450 m with hills and valleys of magnitude 450 ± 200 m. This together with the excellent maps made terrain corrections rather small and easy to do. The method of Hammer (1939) was used in zones A–G and outer zones were omitted. Because of the rather flat topography, the error due to the omission of the remaining zones will be small, ca. 1 mgal and about the same for all measurements.

The Bouguer gravity map (Fig. 2) is based on 161 spot measurements measured by the author in the summer of 1969. A Worden Master Model gravimeter was used, and the usual procedure of returning to base stations at least twice a day to correct for instrumental drift and tidal variations in gravity was followed. The accuracy of the measurements is ca. 1 mgal.

The Bouguer gravity map

The gravity values were reduced to a reference plane at the same level as the lake Gjerdingen (449 m). The more common method of reducing to sea level was not done because the study is local, and since a great part of the heavy

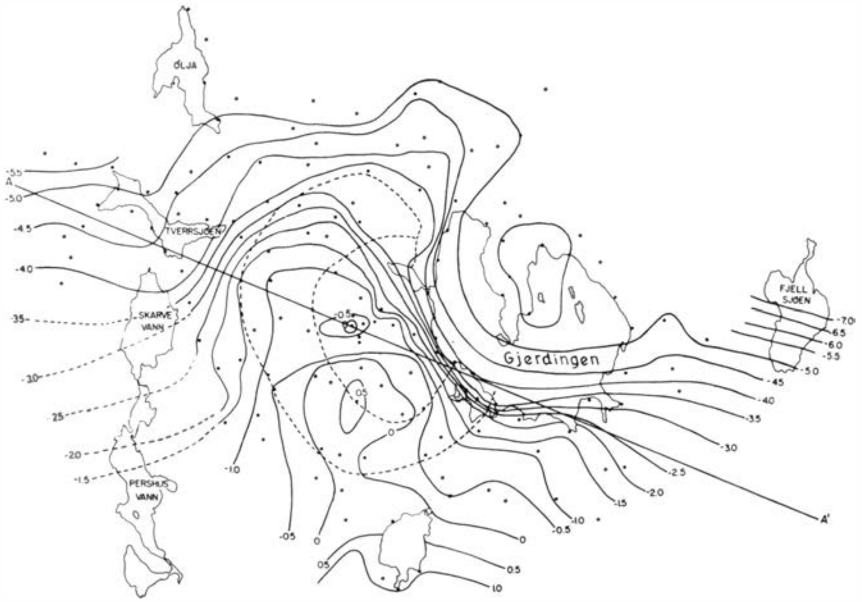

Fig. 2. Bouguer anomaly map of Gjerdingen, Nordmarka. Contour interval 0.5 mgal, $\rho=2.61$, terrain corrections zone A-G included. AA': profile shown in Fig. 3. Dashed lines are boundaries between nordmarkite and fine-grained larvikite, and fine- and coarse-grained larvikite.

masses that caused the anomaly were situated between sea level and the level of the lake Gjerdingen. A density of 2.61 which is a mean for the surrounding alkalic syenitic rocks (nordmarkite, pulaskite) was used in the data reduction (Ramberg op. cit., and author's own measurements).

The map shows a flat topped gravity high of maximum 0.5 mgal situated over the larvikite massif. This high seems to continue SSE towards the lake Katnosa. NE of the lake Gjerdingen is a gravity low with a minimum value of –5.5 mgals, which is obviously associated with the low-density nordmarkite massif (Fig. 1). A mean density of 2.57 was found for this nordmarkite.

The regional gravity gradient of the map is rather smooth and decreasing towards the north. A profile AA' almost normal to the regional decreasing trend shows quite clearly the high associated with the larvikite (Fig. 3).

Model and calculations

When subtracting the supposed regional field (dashed in Fig. 3) from the observed field we get the residual field which is due to the larvikite massif. The separation of regional and residual field can often be difficult, but is rather obvious in this case.

A three-dimensional model using the method of Talwani & Ewing (1960) was constructed giving a theoretical field fitting well with the observed residual field (Fig. 3). Densities based on field specimens giving a density con-

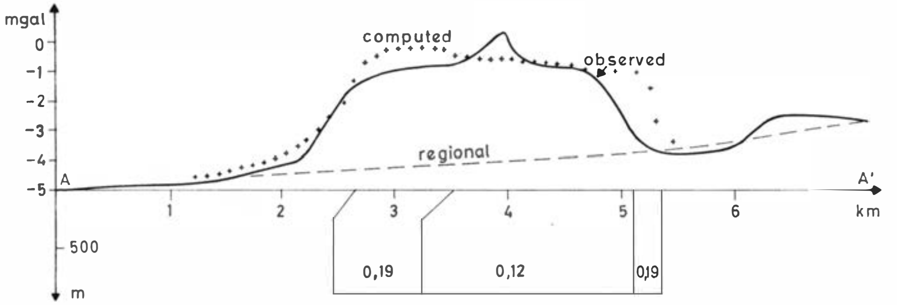

Fig. 3. Profile showing observed gravity, assumed regional gravity and model with computed gravity effect.

trast of 0.19 (larvikite – surrounding rocks) and 0.12 (larvikite with nepheline – surrounding rocks) were used. The model shows that a thin slab only 0.9 km thick can explain the gravity high. In order to explain the difference in observed and computed gravity towards the lake, the water effect was calculated and added. The discrepancy that still exists towards the lake is probably due to a large pegmatite dyke (Kristoffersen 1971). The peak anomaly in the nepheline zone is due to a mass at shallow depth which could be a small body of fine-grained larvikite intruded at a shallow depth (100–200 m).

Discussion

A gravity model like the one presented here deals only with density contrasts between rock types from which the residual anomaly comes. It is therefore impossible to say anything final about the shape and genesis of the massif, but two models seem to fit.

A batholithic structure is possible. This, however, requires a widening of the massif at a depth of 900 m, indicating that the neighbouring nordmarkite/pulaskite massifs in this area have a shallow sheet-like character (900 m thick). A continuation of the massif towards the kjelsåsite-larvikite massifs around the lake Katnosa is very likely because of the gravity high going in that direction, and supports this hypothesis (Fig. 2 and Ramberg, op. cit.).

The other possible interpretation is that the larvikite massif is an isolated 900 m thick sheet or laccolith.

The larvikite massif being of a plug type cannot be the case, since the anomaly is much too small for this (Ramberg 1964).

The main thing this study shows is that the traditionally accepted view that all the intrusive rocks of the Oslo region are large bodies extending downwards to great depths must be revised. A larvikite massif reaching down to 3–4 km would cause an easily resolved gravity anomaly 2–3 times larger than the observed anomaly.

Unfortunately from gravity interpretation alone, it is not possible to determine what the major rock type underlying the area is. This study strongly suggests that petrologic interpretations cannot be made based solely on surface exposures of plutonic rocks in the Oslo igneous province.

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