

THOMAS LUNDQVIST

POTASH FELDSPAR MEGACRYSTS
OF A GRANITE AT SKAGS-
UDDE, CENTRAL SWEDEN



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ABSTRACT

The present study deals with the genesis of potash feldspar megacrysts in a synorogenic granite to granodiorite at Skagsudde, central Sweden. A complex history is outlined, involving synorogenic, post-magmatic blastesis, anorogenic recrystallization and growth of the megacrysts, and, finally, inversion to orthoclase in the thermal aureole of a dolerite. Aspects are also given on some general features of synorogenic intrusions occurring within aureoles of recrystallization around post-tectonic granite intrusions in the Svecokarelian orogenic belt.

Introduction

Västernorrland County, in which the Skagsudde area is situated (cf. Plate 1), is at present subject to a petrographical mapping carried out by the Geological Survey of Sweden. The results will be published as a map to the scale of 1:200 000 with description.

During the reconnaissance work for the petrographical map, attention was drawn to a peculiar granite (in part granodiorite), carrying potash feldspar megacrysts, at Skagsudde east of Örnsköldsvik. The distribution and size of the megacrysts were found to be different in comparison with related intrusions in this part of the County. Further, it was observed that the megacrysts had in some cases grown across the contacts of dikes of aplite and pegmatite belonging to the anorogenic Nordingrå granite. Their crystallization could therefore be shown to be, at least in part, later than normally in these Precambrian areas. The present study was undertaken in order to throw some light on the formation and history of the megacrysts.

Outlines of the Precambrian geology of Västernorrland County

Most of the Precambrian bedrock in Västernorrland County belongs to the Svecokarelian (or Svecofennian) orogenic belt (cf. Magnusson et al. 1960, where, however, the term Svionian cycle is used). The evolution started with the deposition of a thick sequence of greywackes with basalt intercalations on a basement which is not exposed at the present erosion level. During the Svecokarelian orogeny, the greywackes were transformed into different metamorphic derivatives. In certain areas the grade of metamorphism is low (greenschist or lower amphibolite facies of the low-pressure facies series). However, the greater part of the greywacke formation was transformed into gneisses, which have usually been migmatized to varying degrees. Veined gneisses represent a stage of moderate migmatization, whereas raft migmatites (Mehnert 1968) display the extreme stages of mobilization.

The basaltic intercalations have been transformed into fine-grained amphibolites.

In the earlier stages of the Svecokarelian orogeny, the supracrustal rocks were intruded by the synorogenic (synkinematic, primorogenic) magmas. The earliest among these formed gabbros, which were followed by diorites, quartz diorites, granodiorites and granites. In Västernorrland County the two last mentioned are the predominant representatives of this suite. A common feature is a porphyritic or porphyroblastic ("augen-granitic") development due to the occurrence of microcline megacrysts. Especially in the later stages of the Svecokarelian orogeny, when the metamorphic processes culminated in the formation of migmatites, the synorogenic intrusions acquired a more or less pronounced gneissosity (foliation or lineation). They were also migmatized, although in general they have been more resistant to this alteration than the greywackes.

In all evidence genetically linked with the migmatization are some granites intruded during or near after the later phases of the Svecokarelian orogeny. To these belongs the serorogenic (late-orogenic, late-kinematic) Härnö granite, accompanied by abundant pegmatite dikes and massifs. The Revsund granite intruded somewhat later than the Härnö granite, in a stage which is transitional between the serorogenic and post-orogenic.

In the Nordingrå massif, southwest of Skagsudde, occur anorogenic intrusions. The massif includes gabbro and anorthosite, which have been intruded by granite (Lundbohm 1899; Sobral 1913). The latter, named the Nordingrå granite, is porphyritic, with phenocrysts of perthitic alkali feldspar and plagioclase in a groundmass which is often granophyric. Rapakivi mantling of the perthite phenocrysts is not uncommon. The granite is, like other Fennoscandian granites of rapakivi type, only rarely accompanied by aplites and pegmatites. However, such late differentiates have been abundantly developed in the

Skagsudde area, where the northeasternmost parts of the granite massif are exposed.

Intrusions similar to those of the Nordingrå massif occur in the Ragunda area (c. 100 km west of Nordingrå) and near the town of Sundsvall (Rödön etc.). Cf. Magnusson et al. (1960).

The igneous rocks of the Nordingrå massif have been classed as sub-Jotnian, as they form the basement of a sandstone formation (with intercalations of shale) ascribed to the Jotnian (cf. e.g. Sobral 1913 and Magnusson et al. 1960). The sandstone usually shows a gentle southeasterly dip.

The latest magmatic event of the Nordingrå-Skagsudde region is the intrusion of an olivine dolerite, which is classed as Jotnian. It has intruded all the above mentioned rocks including the sandstone. In the latter, the dolerite formed a concordant sill, the roof of which has, however, generally been removed by erosion. Where the sandstone formation is missing, the dolerite forms a sheet in the sub-Jotnian intrusives or in the older Svecokarelian complex. Also in such cases the dolerite contact generally shows gentle southeasterly dips. In the dolerite, there occur layered intrusion structures such as rhythmic layering and igneous lamination. These structures are mostly flat-lying, and approximately conformable to the contacts.

Jotnian olivine dolerites are abundant also in other parts of Västernorrland County, and in Kopparberg, Jämtland and Gävleborg Counties, Central Sweden (cf. map of Magnusson et al. 1960). In Västernorrland, the intrusions mostly show gentle or medium dips, and their thickness varies between approximately ten and some hundred metres.

Radiometric age determinations have only to a limited extent been carried out on the above mentioned rocks. However, results from such dating of rock units from nearby areas can be adopted to give a general idea of the absolute ages.

Although the exact age of the deposition of the greywackes is unknown, it may be roughly 2 000 m.y. The synorogenic magmas presumably intruded at c. 1 950–1 850 m.y. (cf. Magnusson 1960 and Welin et al. 1970). The end of the regional migmatization and the intrusion of the Härnö granite occurred at approximately 1 800 m.y. (Welin and Blomqvist 1964; Magnusson 1960). Slightly younger (also from field evidence) is the Revsund granite (1 785 m.y.; see Welin et al. 1971).

Radiometric dating of the sub-Jotnian igneous rocks at Nordingrå is in progress. A Rb/Sr isochron of 1440 ± 30 m.y. has been obtained for the Nordingrå granite (Welin and Lundqvist, in preparation). Similar granites (of rapakivi type) and related volcanics, also referred to the sub-Jotnian, have been dated in Finland and Sweden. Their ages are higher, and fall between 1670 and 1700 m.y. (Kouvo 1964; Welin and Lundqvist 1969).

The Jotnian sandstones of the same type as those occurring at Nordingrå

show, according to K/Ar dating, a great spread in ages (cf. Lundqvist 1968). However, they may be considered to be roughly 1 100–1 300 m.y. Similar results have been obtained, by the same method, for Jotnian dolerites in Finland and Sweden (cf. Lundqvist, *op. cit.*). A Rb/Sr determination of the olivine dolerite in the Nordingrå region (S. Ulvön) has given a very approximate age of 1 300–1 400 m.y. (Welin et al. 1966; Welin 1966).

Petrology of the Skagsudde area

A petrographical map of the Skagsudde area is presented in Plate 1. The oldest unit here is a relatively low-metamorphic (non-migmatized) greywacke, which is found in a limited area in the western part of the map region. In the central part occurs a synorogenic intrusion with a composition ranging from granitic to (less frequently) granodioritic. As the granitic composition predominates within the massif, the intrusion will be referred to as granite below.

The predominating minerals of the synorogenic granite are quartz, potash feldspar and plagioclase. The latter is mostly an oligoclase with c. 20–30 % An, but more sodic compositions are noted, especially when the mineral shows a strong alteration to sericite, prehnite and epidote. Potash feldspar is found both as megacrysts and within the medium-grained matrix. The ratio between the two feldspars is roughly 1:1 (granitic composition according to Streckeisen 1967), but in some parts of the area plagioclase may predominate as much as to give granodioritic compositions. Biotite (brown in thin section) forms roughly 5–20 % of the rock, and may show an alteration to chlorite. Accessories are apatite, zircon, oxide, etc.

The granite shows a more or less pronounced gneissosity (foliation or lineation). In the southern parts of the massif the parallel structure is weak or altogether lacking. At Skeppsmalen, e.g., a weak lineation is observed, dipping c. 20–30° to the east. On the whole, the intensity of the gneissosity increases towards the north. It is most pronounced in the northeastern parts of the massif, where also the megacrysts have been deformed.

The granite contains numerous, in part sheet-like inclusions of greywacke gneiss, metagabbro etc. A conspicuous feature is the occurrence of megacrysts of potash feldspar with diameters which may exceed 10 cm. These are the subject of the present investigation and will be described separately below.

On the small islands of Österskär and Västerskär occur the northeasternmost exposures of the Nordingrå granite massif. The granite is here crowded with inclusions of metagreywacke, metabasalt, metagabbro and (synorogenic) granite with potash feldspar megacrysts (Figs. 1 and 2). The latter type of inclusion predominates on Österskär, whereas on Västerskär contact-metamorphosed (hypersthene-bearing) metagreywacke and metabasalt are the most abundant types of xenoliths. On the two islands mentioned, and on the main-



Fig. 1. Xenoliths of metagreywacke, metabasalt and (upper right) synorogenic, megacryst-bearing granite in Nordingrå granite. Västerskär, northern shore.

Inneslutningar av metagråvacka, metabasalt och (upptill t. h.) synorogen ögongranit i Nordingrågranit. Västerskär, norra stranden.



Fig. 2. Detail of the granite xenolith in Fig. 1. Length of penknife 9 cm.

Detalj av ögongranit-inneslutningen i fig. 1. Pennknivens längd 9 cm.

land around Skeppsmalen occur numerous dikes of reddish pegmatite and aplite belonging to the Nordingrå granite. In these pegmatites, a peculiar kind of porphyritic texture has been frequently developed, viz. large potash feldspar crystals lying in a medium- to coarse-grained quartz-feldspar matrix (Fig. 3). However, the Nordingrå aplites and pegmatites are not always easily distinguished from similar (although mostly white) serotogenic dikes.

The Jotnian olivine dolerite in the northern part of the map area (Plate 1) forms part of a large intrusion (the "Ulvö dolerite") which can be followed southwestwards to Nordingrå and finally to Storön northeast of Hemsön (cf. Sobral 1913). To the northeast it extends to some small islands south of Husum. Rhythmic layering in the Skagsudde area dips $10-50^\circ$, usually to the south or southeast (Fig. 4). Northeast of the map area of Plate 1 the upper (southern) dolerite contact against veined greywacke gneisses is exposed, showing in one locality dips of $20-70^\circ$ to the southeast, in another, 20° to the southwest. At the northern contact, the dolerite rests directly on greywacke migmatites etc.

The thickness of the Ulvö dolerite is in some localities well above 200 metres. Estimates of the thickness by extrapolation of dips known by field observation do not give very accurate results because of irregularities in the contacts. However, in the Skagsudde area a maximum thickness between 500 and 1 000 metres seems reasonable.

From Skagens kap., in the southern part of the big dolerite area of Plate 1,



Fig. 3. Detail of a dike of Nordingrå pegmatite. C. 1 km E of Skeppsmalens kap.
Detalj av gång av Nordingrågranitens pegmatit. C:a 1 km Ö Skeppsmalens kap.



Fig. 4. Rhythmic layering in dolerite. Långroudden, northern shore.
Rytmask eruptivlagring i diabas. Norra stranden av Långroudden.

the dolerite projects southwards to the island of Gråklubben. A possible underwater connection exists between the dolerite on the latter island and that on the skerries of Österbådan and Skaghällan, south of Skeppsmalen.

In some places the dolerite contains monzonitic to granitic differentiates. Such rocks are found on Österbådan, north of Tennviken and northeast of Skagens kap.

In addition to the big, flat-lying dolerite, there occur similarly composed, narrow dikes (width mostly below 3 m), which usually show an approximately east-west strike and a high dip. Such dikes have been observed to cut all the above mentioned pre-Jotnian rocks (metagreywacke, synorogenic granite and Nordingrå granite).

The potash feldspar megacrysts

GENERAL FEATURES

As mentioned above, the synorogenic granite contains numerous potash feldspar megacrysts all over the area (Figs. 5 and 6). The megacrysts show great variations in size, frequency, colour and shape. Their diameter may reach 10

Fig. 6. Megacrysts of potash feldspar in synorogenic granite to granodiorite. Note the zoning of some megacrysts. 1 300 m NE of Skrammelsand.

Kalifältspatögon i synorogen granit till granodiorit. Märk zoneringsen i en del ögon. 1 300 m NO Skrammelsand.

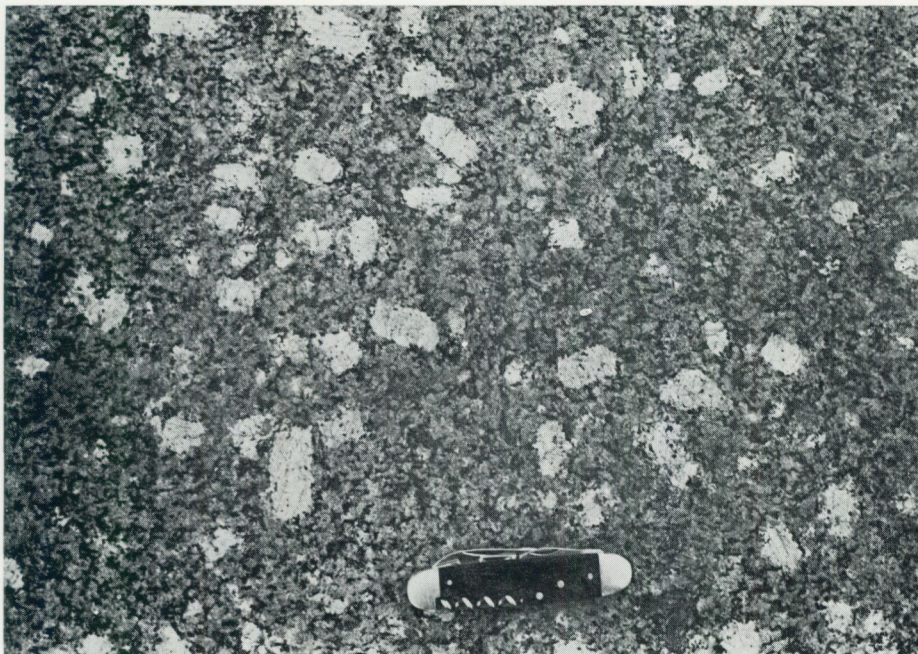


Fig. 5. Megacrysts of potash feldspar in relatively massive (recrystallized) synorogenic granite, 600 m SSE of Skeppsmalens kap. (close to sample no. 24).

Kalifältpatögon i relativt massformig (rekristalliserad) synorogen granit. 600 m SSO Skeppsmalens kap. (nära prov 24).



Fig. 6.



Fig. 7. Concentration of potash feldspar megacrysts around xenoliths within synorogenic granite to granodiorite. Aplite dike at lower left. Lill-Flasen.

Anhopning av kalifältspatögon runt inneslutningar i synorogen granit till granodiorit. Nedtill t. v. aplitgång. Lill-Flasen.

cm, occasionally even more. The frequency may vary, even within areas of a few square metres, but is usually 5–20 %. Higher concentrations occur, and may locally exceed 50 %. In such cases xenoliths are usually found within the granite (Fig. 7). The presence of xenoliths thus seems to have promoted the megacryst growth. Porphyroblasts of potash feldspar also occur within the xenoliths.

In colour, the megacrysts vary between white and pink. At some places the pink colour deepens to a bright red. The shape is usually rectangular or rounded, the contours generally being irregular in detail. In the northeasternmost parts of the granite massif (south of Långroudden), the megacrysts are mostly deformed (Fig. 8), being lensoid and more or less elongated in the foliation plane (augen-gneiss structure).

There does not appear to exist any systematic variation in frequency and colour of the megacrysts, when the granite massif as a whole is regarded. As to size and shape, it should be noted that in the area south of Långroudden, the megacrysts are somewhat smaller than in the rest of the massif, and, as just mentioned, largely deformed.

The potash feldspar megacrysts usually display a poikiloblastic texture.

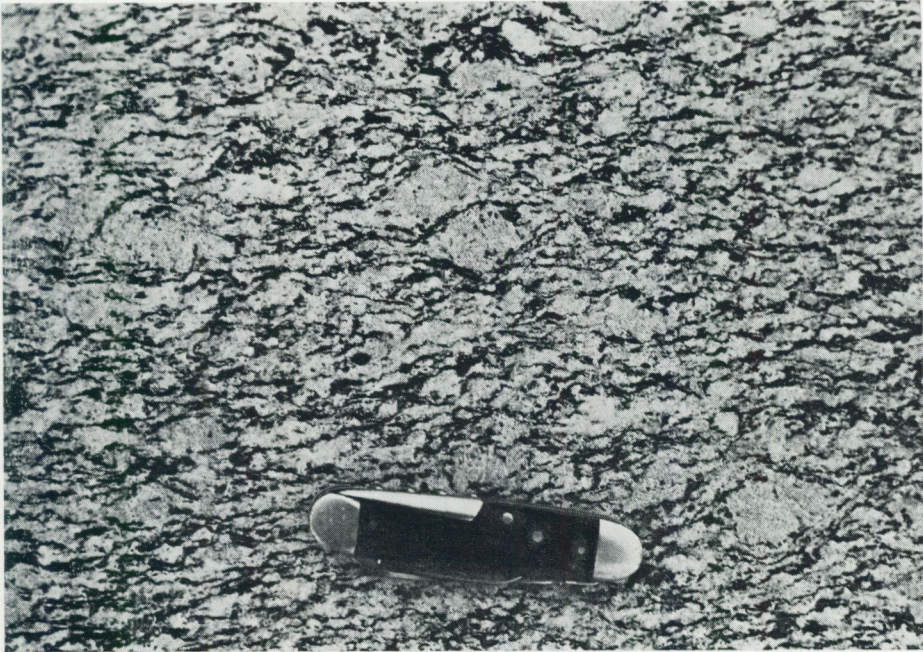


Fig. 8. Deformed potash feldspar megacrysts in strongly gneissose synorogenic granodiorite. C. 300 m S of Långroudden (close to sample no. 23).

Pressade kalifältspatögon i starkt förgnejsad synorogen granodiorit. C:a 300 m S Långroudden (nära prov 23).

Among the inclusions biotite, quartz and plagioclase are the most important. Sometimes a zonal structure has been developed, marked by variations in frequency of inclusions (cf. Fig. 6).

The following observations are relevant with regard to the chronological position of the megacryst growth. The megacrysts are usually undeformed, thus having a post-tectonic character, the exception being the area south of Långroudden, where the megacrysts must have crystallized largely before the development of a penetrative foliation (gneissosity). The foliation is probably serogenic, although clearly earlier than the intrusion of pegmatite and aplite dikes, also ascribed to the serogenic stage.

Especially at Skeppsmalen a rather common feature is that megacrysts of potash feldspar have grown across the contacts between the synorogenic granite and dikes of pink aplite and pegmatite belonging to the Nordingrå granite (Fig. 9). In the same area there are, however, also aplite dikes (greyish white in colour), which cut across the megacrysts. Although not readily identified as such, these aplites most probably also belong to the dikes connected with the Nordingrå granite. In one of these aplite dikes, which occurs in the area characterized by microcline megacrysts west of Gråklubben, the potash feldspar

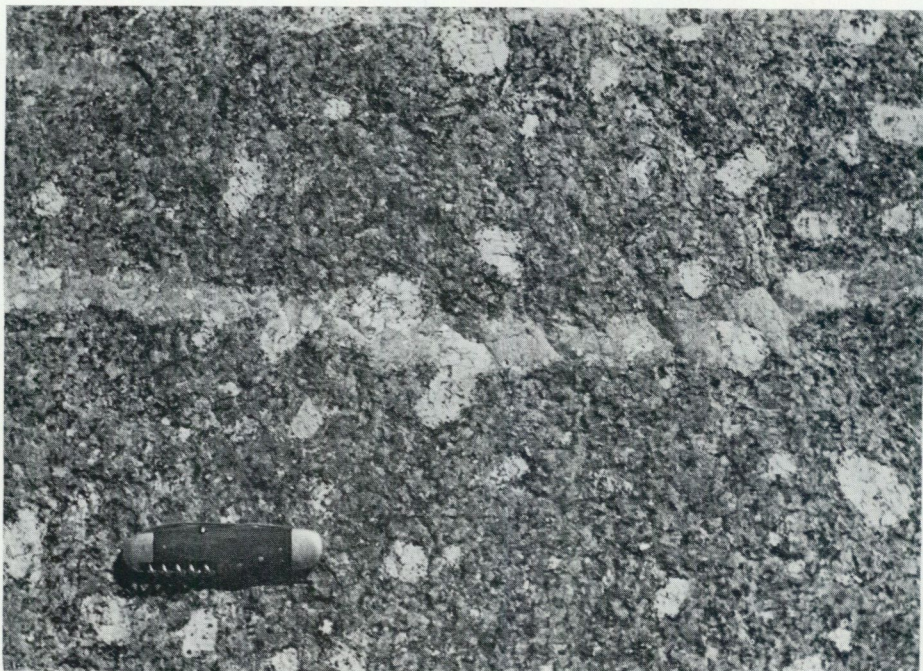


Fig. 9. Megacrysts of potash feldspar which have grown across the contact of a granitic dike (with central quartz zone) belonging to the Nordingrå granite. 500 m SSW of Skeppsmalens kap.

Kalifältspatögon övertvÄrande kontakten till granitisk gÄng (med centralkvarts) hörande till NordingrÄgraniten. 500 m SSV Skeppsmalens kap.

is a slightly oxide-pigmented microcline with a somewhat diffuse cross-hatching.

On VÄsterskÄr megacrysts are found in the breccia, crossing the contacts between megacryst-bearing granite xenoliths and NordingrÄ granite matrix. Clearly they have thus, at least in part, crystallized later than or contemporaneously with the intrusion of the NordingrÄ granite and its aplites and pegmatites.

The megacrysts probably grew before the intrusion of the Jotnian dolerite magma, as they have not been observed within the dolerite or crossing its contacts.

For the investigation of the potash feldspar megacrysts, the latter have been sampled at approximately equal intervals all over the granite massif (Plate 1). West of GrÄklubben the sampling points are more closely spaced along a line crossing the boundary between areas characterized by low and high triclinicity potash feldspars (cf. below).

The sample weights are approximately 1–5 g. Each sample comprises pieces from at least ten different megacrysts within an area of 1–2 m². The most closely

spaced samples from the mainland west of Gråklubben are taken within areas smaller than 0.3 m².

The results of the X-ray investigation are given below, together with chemical data for selected samples.

X-RAY DATA

The X-ray investigation was carried out on powdered material from the megacryst samples, with the aid of a Philips diffractometer, type PW 1051 (40 kV, 20 mA, CuK_α radiation). From the diffractometer curves, the triclinicity values (Δ) were calculated according to the method given by Goldsmith and Laves (1954). The results are given in Table 1 and Plate 1.

The X-ray investigation showed that the following structurally different types of potash feldspar exist (cf. Fig. 10). One is highly triclinic (microcline), with a double 131 and $\bar{1}\bar{3}1$ peak and triclinicity values in the range 0.6–0.9. A second type is monoclinic (orthoclase), showing one distinct 131 peak. There also occur potash feldspars characterized by three peaks in the diffractometer curves. These can be described as mixtures of monoclinic and triclinic feldspars, with predominance for either of the two. For some samples it is only possible to give an approximate range of triclinicities, no distinct peaks appearing in the diffractograms.

Plate 1 gives the distribution of orthoclase and microcline within the granite massif. Subordinately occurring structural states are also indicated.

From Plate 1 it is evident that orthoclase occurs in zones of variable width along the contacts with the dolerite and in the area around Skeppsmalen. Especially in the latter case the megacrysts are often characterized by mixed structural states (orthoclase + microcline), similarly to the potash feldspars of the Nordingrå granite (cf. below). Orthoclase is also found on the small islands of Strömhällan and Stor-Flasen in the eastern part of the map area, and on Truten in the western part.

Apparently there does not exist any correlation between the distribution of triclinicity values and that of size, frequency, colour and shape of the megacrysts.

West of Gråklubben, sampling has taken place along a profile across the boundary between the fields of orthoclase and microcline. The triclinicity values for these samples are given in Fig. 11. From this figure it is seen that the transition zone between (nearly) pure orthoclase and pure microcline is c. 30–35 m broad and is characterized by a predominance of mixed orthoclase-microcline structural states, with great variations in the Δ values. It is also seen that the microcline component does not show a regular increase in triclinicity towards the "triclinic" area characterized by Δ values around 0.8. However, in the transition zone, Δ values for the triclinic component are usually somewhat lower (0.6–0.7). At one point (samples 98 and 117) a duplicate

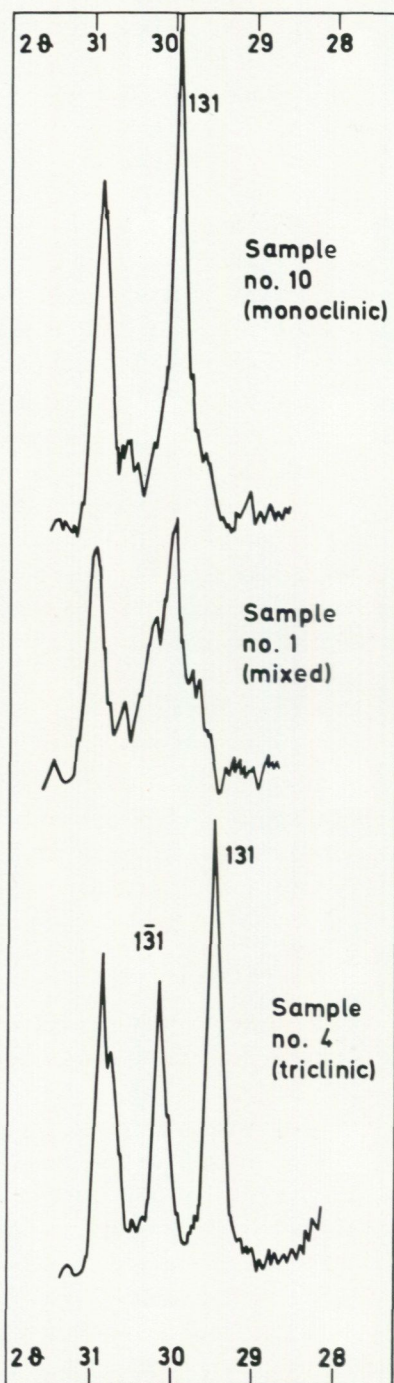


Fig. 10. Different reflection types from potash feldspar megacrysts. Numbers as in Table 1.
Olika typer av diffraktometerkurvor av kalifältspatögon. Provnnummer som i tab. 1.

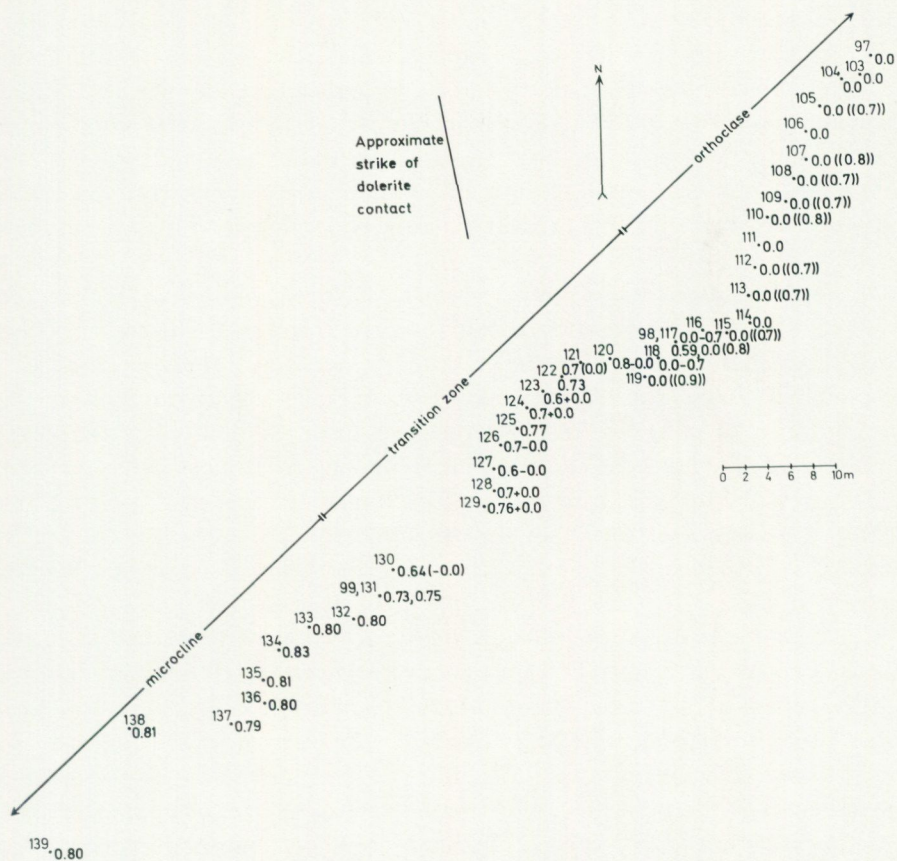


Fig. 11. Distribution of triclinicities at the border between the fields of microcline (left) and orthoclase. Sampling area west of Gråklubben (cf. Plate 1). Note that triclinicities given in double brackets are very approximate. Sample numbers as in Table 1.

Triklinitetens variationer vid gränsen mellan områden med mikroklin (t. v.) och ortoklas. Från området V om Gråklubben (jfr plansch 1). Observera att trikliniteter inom dubbla parenteser är mycket approximativa. Provnnummer som i tab. 1.

sample (within an area smaller than 0.3 m²) failed to reproduce the Δ value of the first sample. This means that great triclinicity variations occur between different megacrysts, and probably even between different parts of one megacryst. However, the present investigation has not involved a study of such small-scale variations in Δ . The variations in triclinicity within the transition zone indicate disequilibrium conditions (incomplete inversion of microcline to orthoclase).

OPTICAL DATA

Selected samples have been subject to optical studies. The latter include observations on twinning and exsolution (perthite) structures, as well as measure-

ment of the optical axial angle $2V_\alpha$ and the extinction angle $\alpha' \wedge (010)$ on (001).

The characteristic cross-hatch twinning of microcline is usually well developed in samples showing a high triclinicity. Exceptions are samples nos. 17 and 32, in which this type of twinning is sparse or absent. In orthoclase samples the cross-hatching has not been observed, although undulous extinction in some cases probably indicates that such twinning occurs on a submicroscopic scale. It should also be noted that Carlsbad twinning is developed all over the granite massif.

All potash feldspar megacrysts are perthitic. In samples of orthoclase the exsolved albite forms a network of minute, more or less irregular bodies. Clear patches, which are non-perthitic or cryptoperthitic, occur. There is a tendency for the albite bodies and the network structure to be oriented roughly in the "murchisonite" parting ($\bar{1}502$). This tendency is more pronounced in microcline samples. Here the exsolved albite in part forms slender strings (string perthite, cf. Andersen 1928) in the "murchisonite" parting at an angle of c. 75° to (001). However, a considerable part of the exsolved albite is coarser, occurring in more or less irregular veins and patches (vein perthite and patch perthite; cf. Andersen 1928).

The axial angles have been determined in solid mounts of crushed material. In each sample c. five crystal fragments have been measured with the aid of a Leitz' 4-axis universal stage. The result is given in Table 2. A comparison with Table 1 shows that potash feldspars characterized by high triclinicities (microclines) have axial angles between 77 and 85° . The maximum variation within one sample is 6° . Low-triclinicity feldspars (orthoclases) are characterized by a great variation in the $2V_\alpha$ values. The latter are lower than in microcline, and fall in the range 33 – 73° . The maximum variation observed within one sample is 31° , and within one crystal fragment 22° . Usually the higher axial angles are found in strongly perthitic parts of the potash feldspars. Clear parts are generally characterized by relatively lower values of $2V_\alpha$. Thus, there is an interdependence between unmixing and optical properties, as stated by Marfunin (1961).

In all samples studied the optical axial plane is at right angles (orthoclase) or approximately at right angles (microcline) to the (010) cleavage.

In the cross-hatched microcline of sample no. 5 patches have been observed, in which no twinning can be discerned. These patches show a smaller axial angle (c. 56°) than the cross-hatched microcline. Thus, there probably exist small amounts of monoclinic potash feldspar in this sample, although this has not been revealed by the X-ray investigation.

There seems to be a slight tendency for orthoclase with subordinate amounts of microcline to show a higher axial angle than pure orthoclase. The definite verification of such a tendency must, however, be based on a statistical treatment of more comprehensive data than included in the present study.

The extinction angles $\alpha' \wedge (010)$ on (001) have been determined for nine samples (Table 3). Of these, nos. 1, 24 and 25 consist of mixtures of orthoclase (predominating) and microcline, nos. 9, 13 and 21 of pure orthoclase, and nos. 5, 17 and 32 of pure microcline. There is perfect agreement between the results of optical and X-ray determinations (cf. Lundqvist 1968, Table 8, where the agreement is not complete). Thus, the microclines show extinction angles of $15\text{--}17^\circ$ (cf., e.g., Tröger 1959), and the orthoclases 0° . The feldspars consisting of orthoclase with subordinate microcline in part show undulous extinction, and thus a somewhat greater spread in the measured values than pure orthoclase. The undulous extinction is probably due to the presence of submicroscopic triclinic domains with an incomplete balance between units in right- and left-hand position.

CHEMICAL DATA

Selected samples have been analysed for sodium, potassium, calcium, barium and strontium (Table 4). The analyses were carried out on material which had been separated by means of heavy liquids ($d < 2.605$, grain size $30\text{--}60 \mu$). After this separation there may still have remained minor amounts of quartz and plagioclase in the potash feldspar. However, the effect of this foreign material can be neglected for the following conclusions. The analytical error (σ) is for potassium $\pm 5\%$, for sodium and barium $\pm 10\%$, for calcium ± 0.1 wt. % and for strontium ± 20 ppm.

From the data of Table 4 it is evident that there is no significant difference in the chemical composition of orthoclase and microcline samples. This is true for all elements analysed.

Furthermore, the sodium content in solid solution in the potash feldspar has been determined. The d value for the line 400 of potash feldspar was calculated from diffractometer curves. Sodium chloride (the 220 line) was used as an internal standard. The d values are given in Table 5, together with the molecular percentages of albite in solid solution, according to the data for microcline given by Tröger (1967, p. 703).

From Table 5 follows that up to c. 10% albite, that is somewhat more than half of the total sodium content, may exist in solid solution with potash feldspar. No difference in this respect can be traced between monoclinic and triclinic feldspar. As the 400 peaks are often diffuse, the figures of Table 5 should be regarded as approximate.

Potash feldspars of other Precambrian rocks

According to the experience gained during the microscopic work for the mapping of the Precambrian of Västernorrland County, the potash feldspar is normally microcline in all rocks older than the sub-Jotnian. Thus, in the meta-supracrustals as well as in the synorogenic and serorogenic intrusions (including

the Revsund granite) the typical cross-hatched microcline occurs. Contrary to this, cross-hatching in the potash feldspars of sub-Jotnian and Jotnian intrusions is either lacking or poorly developed (undulous extinction). These relationships are similar to those found in the Los-Hamra region in Gävleborg County (Lundqvist 1968).

The potash feldspars of the sub-Jotnian Ragunda massif (between Östersund and Sollefteå in Jämtland and Västernorrland Counties) have been studied by Kornfält (1969). He found that potash feldspars in the granitic and syenitic rocks are characterized by different structural states varying from monoclinic (in the syenites) to near maximally triclinic (in pegmatites). Minor near-by intrusions related to those at Ragunda have been reported to contain potash feldspars of similar types (Gorbatshev 1972). In addition, Kornfält (1969) was able to show that in the Revsund granite surrounding the Ragunda massif, the microcline has been converted to orthoclase in a wide aureole. This was ascribed to heating caused by the magmas of the Ragunda granites and syenites (or of the associated gabbro). Similar observations have been made by Gorbatshev (1972, p. 226). Vormä (1972) reported that microcline was transformed to orthoclase in thermometamorphic aureoles around the Finnish Wiborg rapakivi massif and other related intrusions.

At present, no complete optical and X-ray study has been carried out on the potash feldspars of the Nordingrå granite and its dikes. However, in Table 6 (nos. 1–27) triclinicity data are given for granite samples from a number of localities distributed all over the massif, and from dikes in the surroundings. As in the Ragunda massif (Kornfält 1969, pp. 10–11) and in Finnish rapakivi granites (e.g. Vormä 1971) different structural states occur. Thus, there are one-peak types (orthoclase), two-peak types (microcline) and a number of structural states intermediate between the two. In the latter case there may exist three fairly distinct peaks. In Table 6 triclinicities corresponding to these peaks are given, although there may exist other, subordinate states intermediate between those indicated. Finally, the peaks may be diffuse (randomly disordered feldspars; cf. Christie 1962), and then the approximate range of triclinicity values is given in Table 6.

It should be noted that even samples taken only a few centimetres from each other may show differences in structural states (Table 6, nos. 7 and 8 as well as 22 and 23).

For comparison with the Nordingrå pegmatites, some samples of serorogenic pegmatite (nos. 28–30 of Table 6) have been included. The triclinicities fall between 0.81 and 0.95. A pegmatite of uncertain origin (serorogenic or belonging to the Nordingrå granite) is represented by no. 31, and shows a lower triclinicity value (0.70).

The potash feldspars in the differentiates of the Jotnian dolerite are similar

to those of the Nordingrå and Ragunda granites. The four samples examined (Table 6, nos. 32–35) are characterized by mixed monoclinic-triclinic structures, or (no. 34) by a fairly high triclinicity.

Discussion

The above data allow some conclusions concerning the formation and history of the megacrysts.

On pp. 5–6 the outlines of the Precambrian geological evolution in Väster-norrland County have been indicated. One important problem to be solved is at what stage in this evolution the growth of the megacrysts occurred. As the megacrysts are partially deformed and partially post-tectonic in character, their growth took place in at least two stages. In the northeastern part of the synorogenic granite massif (near Långroudden) the megacrysts have been affected by a deformation which is probably serorogenic. Their growth may therefore have occurred either in the synorogenic stage (magmatic crystallization followed by late- or post-magmatic blastesis after the solidification of the main part of the granite) or in connection with the regional migmatization in the earlier phases of the serorogenic stage. The former alternative is favoured here, as megacrysts related to migmatization according to regional knowledge only locally show deformation.

For the greater part of the megacrysts, however, a post-tectonic or anorogenic growth must be assumed. The reason for this is that megacrysts have been developed across the contacts between the megacryst-bearing granite and the Nordingrå granite or its late differentiates (aplites and pegmatites). Theoretically, the growth of such megacrysts could have occurred in connection with the intrusion of either the Nordingrå granite or the dolerite, or unrelated to both. The third alternative, however, seems less likely, as it would involve blastesis without connection with either intrusion, regional metamorphism or deformation (cf. below). A potash feldspar blastesis accompanying the intrusion of the dolerite appears less likely than a growth of megacrysts initiated by the Nordingrå granite magma. Porphyroblastic crystallization of potash feldspar in the contact aureoles of porphyritic granites ("augen-granites") is not uncommon (cf., e.g., Lundqvist 1968, p. 69).

The Nordingrå granite is of the "dry" type, normally lacking aplite and pegmatite. The fact that such differentiates have developed abundantly in the Skagsudde area indicates that the magma here possessed a relatively high content of mineralizers, favourable for potash feldspar blastesis. On the other hand, the dolerite magma in all probability contained a very low percentage of mineralizers, and was also quickly chilled against the wall-rocks, as a very dense marginal facies usually developed. Furthermore, a blastesis caused by the dolerite magma would probably be most intense close to the dolerite contacts.

However, the potash feldspar augen near Långroudden have preserved their deformed (lensoid) shape close to the dolerite, and have thus not been affected by post-tectonic blastesis.

In the xenoliths of synorogenic granite in the Nordingrå granite breccia on Västerskär and Österskär the potash feldspar megacrysts are characterized by mixed structural states (Table 6, nos. 36 and 37). In this geological position it is very likely (cf. above, p. 14) that the (latest) megacryst growth is genetically linked with the intrusion of the Nordingrå granite magma. It therefore seems probable that mixed-structure megacrysts on the mainland near Skeppsmalen and on Truten have a similar origin. As the Nordingrå granite is probably a more deep-seated intrusion than the dolerite, the aureole of the granite can be expected to have cooled more slowly, which will be favourable for an inversion of orthoclase to microcline. This inversion may also have been promoted by mineralizers deriving from the granite magma (cf. above). At a greater distance from the Nordingrå granite, towards the northeast, microcline developed, probably by (complete) inversion of an originally monoclinic (metastable?) feldspar (cf. Laves 1950). The effect on the potash feldspars caused by the intrusion of the dolerite found on the skerries south of Skeppsmalen (Plate 1) is hard to assess. A contributing cause for the occurrence of orthoclase at Skeppsmalen may be heating by the dolerite magma.

At a first glance, the occurrence of post-tectonic megacrysts may seem unrelated also to the contacts of the Nordingrå granite. However, such megacrysts have not been developed in that part of the synorogenic granite massif (SW of Långroudden) which is situated at the greatest distance from outcrops of Nordingrå granite. This circumstance may point to some relationship between this granite and the post-tectonic megacrysts. The latter are found up to a (horizontal) distance of c. 5 km from the known contact with the Nordingrå granite. However, this is of course not necessarily the true distance to the granite contact, as the latter may be subhorizontal below the Skagsudde area. In this way there is possibly a connection between the Nordingrå granite massif and a similar granite (rapakivi type) on the small island of Bonden, c. 50 km northeast of Skagsudde (Gavelin 1955).

There remains the possibility that some post-tectonic megacrysts that do not cross the contacts of the Nordingrå aplite and pegmatite dikes have in fact crystallized before the Nordingrå granite intrusion. They would then probably be related to the serorogenic metamorphism. In areas where the synorogenic granite lacks a penetrative gneissosity (the southern part of the map area) a late- or post-magmatic synorogenic growth is also theoretically possible. However, it is not possible to prove the occurrence of such megacryst generations.

The intensity of potash feldspar blastesis was probably great in connection with the Nordingrå granite intrusion. This is indicated by the overall uneven

distribution of the megacrysts and their strong crowding around xenoliths, features that are foreign to related synorogenic intrusions of the region. Therefore, it seems safe to assume that synorogenic and/or serorogenic megacrysts occurring when the Nordingrå granite intruded, have been largely recrystallized and re-distributed at the time of this intrusion.

The possible role of metasomatism during the growth of the megacrysts is hard to assess, as the initial compositions of the different parts of the synorogenic intrusion are not precisely known. Migration of potassium etc., leading to local depletion or enrichment in potash feldspar megacrysts is certainly important, but probably does not involve a great overall metasomatism of the granite massif. This is supported by the fact that other synorogenic intrusions of the region show similar variations in composition.

The above discussion on the earlier history of the megacrysts is in part rather speculative. Contrary to this, the latest important event affecting the potash feldspars is rather evident. Plate 1 clearly shows that the occurrence of orthoclase is related to the dolerite contacts. Therefore, the formation of orthoclase must be ascribed to the thermal action of the dolerite magma, at least where dolerite occurs in the vicinity, according to field observation. The presence of orthoclase on Strömhällan is probably related to a nearby occurrence of dolerite, below sea level. In the area around Skeppsmalen, however, the situation is more complicated (cf. above, p. 22).

The transformation from microcline to orthoclase, which occurred in the contact aureole of the dolerite, in all evidence took place without solution-redeposition and essential changes in the shapes of the megacrysts (cf. above, p. 22). A homogenization was probably involved, as the exsolved albite occurs on a finer scale in orthoclase than in microcline (p. 18).

In normally microcline-bearing granitic rocks orthoclase has been found along dolerite contacts in several other localities in Västernorrland County (cf. Table 6, nos. 38–40). Orthoclase may thus be used as an indicator of a nearby large dolerite intrusion, which is of importance for the planning of rooms and tunnels in solid rocks (cf. Lundegårdh 1963, p. 47).

It should also be mentioned that Ljunggren (1959) found orthoclase within a partly melted gneiss xenolith in a hyperite (dolerite) in southern Sweden. The gneisses from which the xenolith was formed are normally microcline-bearing. Ljunggren concluded that the orthoclase was formed under the influence of heat from the hyperite magma.

It could perhaps be expected that the available data would allow a calculation of the temperature of inversion from microcline to orthoclase. However, for the following reasons the uncertainties attached to such a calculation appear to be too great even if additional sampling and mapping would yield more exact information on the width of the aureole and the position of the dolerite contacts. Observations on Jotnian dolerites intruding Svecokarelian migma-

tites etc. in Västernorrland County show that the contacts are often irregular. This is also the case at Skagsudde (cf. Plate 1), where, in addition, the orthoclase aureole shows a varying width. In the Jotnian sandstones, the contacts of the dolerite intrusions are on the other hand more regular, probably depending on an adaptation to the pronounced bedding of the sandstone formation.

If a constant orientation and thickness of the dolerite and the orthoclase aureole along certain sections is assumed, rough calculations of the inversion temperature can be made. The result is strongly depending on which section is chosen, but the best choice would perhaps be a NNW-trending profile between Tennviken and Tennåkern. Here the dolerite sheet is approximately 2 500 wide in the horizontal plane. Assuming a depth of intrusion of 1.2 km, an initial wall-rock temperature of 35°, and a dolerite magma temperature of 1 100–1 200°, the temperature of inversion would be roughly 600–700° according to Winkler (1967, p. 80) and Jaeger (1957). This is a considerably higher temperature than usually indicated (cf. Barth 1969). The cause of this is certainly to be found in divergences from the idealized model, in which a constant orientation and thickness is assumed (cf. Plate 1). As noted by Steiger and Hart (1967), the temperature distribution and therefore also the width of the aureole is, in addition, greatly influenced by the shape of the contact. Other complications in the calculation arise from the fact that the dolerite has undergone convective cooling, as evidenced by the occurrence of rhythmic layering (p. 9). Such a type of cooling will lead to higher maximum temperatures in the roof rocks (and, in the present case, to a still higher calculated inversion temperature) than in the case of non-convective cooling (cf. Steiger and Hart 1967).

According to the above discussion, the following history can be sketched for the potash feldspar megacrysts at Skagsudde. After the intrusion of the synorogenic granite, potash feldspar megacrysts developed, for the most part by late- or post-magmatic crystallization. Probably the megacrysts originated as phenocrysts in the magma, and continued to grow when the latter was largely solidified (cf. Lundqvist 1968; Welin et al. 1970). In the later phases of the Svecokarelian orogeny there was possibly a growth (largely involving a redistribution) of megacrysts, although direct evidence is lacking. In a post-magmatic stage following the intrusion of the anorogenic Nordingrå granite, there was probably an intense growth (redistribution) of potash feldspar megacrysts. The whole synorogenic granite massif was affected, with the exception of the northeasternmost parts.

In early Jotnian time there occurred megacrysts in the synorogenic granite, which were for the most part microcline. In the southwest, near the contact with the Nordingrå granite, there may also have existed monoclinic or mixed structural states. At the intrusion of the Jotnian dolerite magma, there was a heating of the wall-rock which caused a conversion of microcline to orthoclase in aureoles around the dolerite.

In addition to the orthoclase-bearing thermometamorphic aureoles surrounding sub-Jotnian granite intrusions of rapakivi type (Kornfält 1969; Vorma 1972; Gorbatshev 1972), there thus exist similar aureoles around the Jotnian dolerites. As the latter are largely sub-horizontal, the aureoles may extend over large areas, although their width is not great.

The already mentioned massive structure of the southern parts of the synorogenic granite massif at Skagsudde probably originated by recrystallization and blastesis under the influence of heat from the Nordingrå granite magma. Some broader aspects on this problem may be considered here, as a recrystallization of similar type in the opinion of the present author seems to be a rather common feature in the Precambrian of Sweden. The recrystallization has taken place around relatively dry (pegmatite-poor) and therefore high-temperature type granites with a post-tectonic position in relation to the Svecokarelian orogeny, and is above all prominent within synorogenic intrusions. It leads to a more or less complete obliteration of older deformation structures (lineation, foliation), and, in the case of megacryst-bearing intrusions, also to recrystallization and re-arrangement of the megacrysts. In some cases, the synorogenic intrusions have been transformed into rocks which are very similar to the granites intruding them. Naturally, great problems may in this way arise for geologists trying to map out the different units.

Phenomena of the above described type have been observed by the present author (unpublished investigations) in westernmost Medelpad and north-eastern Ångermanland, central Sweden. In both cases synorogenic granodiorites to granites have been affected by recrystallization in aureoles up to several kilometres from the nearest exposed contact with the strongly porphyritic Revsund granite. The resulting rocks are in many cases similar to the latter granite. Gavelin (1955) describes "porphyritic, Revsund-granite-like forms within Jörn granite areas" in Västerbotten County. These rocks, however, have no field connection with exposed Revsund granite. (The "Jörn granite" is a synorogenic granodiorite.) Lundegårdh (1967, p. 89) and Lundqvist (1968, p. 71) have made similar observations at the contact between the Rätan granite and synorogenic granites. S. Gavelin (personal communication) has noted phenomena of the same type in the Loftahammar granite near the Småland granites in the Väster-vik area, southeastern Sweden. Possibly, the Lemland and Måshaga (Moss-haga) granites in the archipelago of Åland (Ahvenanmaa) are synorogenic intrusions affected by recrystallization caused by the Åland rapakivi granite magma (cf. Frosterus 1892, 1894; Hausen 1964, pp. 49-52).

It should be noted that metasupracrustals at the contacts with the post-tectonic intrusions, although affected by contact metamorphism, do not (or perhaps only very locally) develop into medium- to coarse-grained granitic or granodioritic rocks which may be mistaken for the intrusions themselves. The process described above should therefore not be regarded as a "granitization",

but merely as a recrystallization during which the chemical composition remains essentially unchanged.

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**Table 1. Triclinicity values for potash feldspar megacrysts from the Skagsudde area.
For location of samples, see Plate 1.**

Sample no.	Triclinicity Δ ¹⁾	Sample no.	Triclinicity Δ ¹⁾	Sample no.	Triclinicity Δ ¹⁾
1	0.0 (0.7)	49	0.0	97	0.0
2	0.0 ((0.7))	50	0.0 (0.7)	98	0.59
3	0.0 ((0.7))	51	0.0 ((0.7))	99	0.73
4	0.86	52	0.0 ((0.6))	100	0.75
5	0.83	53	0.0	101	0.80
6	0.86	54	0.80	102	0.83
7	0.83 ((0))	55	0.0 ((0.7))	103	0.0
8	0.81	56	0.83	104	0.0
9	0.0	57	0.0 ((0.7))	105	0.0 ((0.7))
10	0.0	58	0.80 (0)	106	0.0
11	0.0	59	0.89	107	0.0 ((0.8))
12	0.0 ((0.8))	60	0.87	108	0.0 ((0.7))
13	0.0	61	0.83	109	0.0 ((0.7))
14	0.0	62	0.0	110	0.0 ((0.8))
15	0.89	63	0.0	111	0.0
16	0.89	64	0.0	112	0.0 ((0.7))
17	0.91	65	0.82	113	0.0 ((0.7))
18	0.88	66	0.83	114	0.0
19	0.87	67	0.77 ((0))	115	0.0 ((0.7))
20	0.0	68	0.0	116	0.0-0.7
21	0.0	69	0.80	117	0.0 (0.8)
22	0.0	70	0.87	118	0.0-0.7
23	0.0 ((0.9))	71	0.86	119	0.0 ((0.9))
24	0.0 (0.7)	72	0.82	120	0.8-0.0
25	0.0 (0.7)	73	0.0	121	0.7 (0.0)
26	0.0 ((0.7))	74	0.83	122	0.73
27	0.0	75	0.91	123	0.6+0.0
28	0.0 ((0.9))	76	0.76	124	0.7+0.0
29	0.84	77	0.0	125	0.77
30	0.89	78	0.88	126	0.7-0.0
31	0.85	79	0.0	127	0.6-0.0
32	0.90	80	0.0	128	0.7+0.0
33	0.81	81	0.0 ((0.8))	129	0.76+0.0
34	0.0	82	0.84	130	0.64 (-0.0)
35	0.0	83	0.0	131	0.75
36	0.0	84	0.80	132	0.80
37	0.0 ((0.7))	85	0.0	133	0.80
38	0.0 ((0.7))	86	0.0	134	0.83
39	0.84	87	0.0	135	0.81
40	0.78	88	0.82	136	0.80
41	0.0	89	0.0 ((0.7))	137	0.79
42	0.0	90	0.82	138	0.81
43	0.0 ((0.7))	91	0.0 ((0.8))	139	0.80
44	0.0	92	0.83		
45	0.0	93	0.0 ((0.6))		
46	0.87	94	0.0		
47	0.82	95	0.89		
48	0.84	96	0.0		

¹⁾ Brackets = subordinate amounts.
Double brackets = very small amounts.
Plus sign = subequal amounts.

Table 2. Optical axial angles $2V_{\alpha}$ for potash feldspar megacrysts from the Skagsudde area. In each sample c. five crystal fragments have been measured (see text). Estimated accuracy $\pm 1-2^{\circ}$. Numbers as in Table 1.

Sample no.	Variation in $2V_{\alpha}$ (degrees)	Average $2V_{\alpha}$ (degrees)	Sample no.	Variation in $2V_{\alpha}$ (degrees)	Average $2V_{\alpha}$ (degrees)
1	46-64	-	20	42-62	-
2	50-66	-	21	44-55	-
3	51-65	-	22	47-54	-
4	80-82	81	23	40-65	-
5	80-84 ¹⁾	82	24	45-69	-
6	82-84	83	25	44-73	-
7	80-84	82	26	40-64	-
8	77-82	80	27	44-69	-
9	38-64	-	28	49-70	-
10	33-64	-	29	79-82	80
11	42-61	-	30	80-83	81
12	43-63	-	31	81-82	82
13	41-54	-	32	79-83	82
14	45-60	-	33	80-82	81
15	82-85	84	34	44-63	-
16	82-84	83	35	44-61	-
17	82-84	83	36	44-66	-
18	79-85	82	37	44-66	-
19	79-84	81	38	47-68	-

¹⁾ Patches with $2V_{\alpha} = 56^{\circ}$.

Table 3. Extinction angles $\alpha' \wedge (010)$ on (001) and triclinicity values for potash feldspar megacrysts from the Skagsudde area. In each sample c. five crystal fragments have been measured. Numbers as in Table 1.

Sample no.	Triclinicity Δ ¹⁾	Extinction angle $\alpha' \wedge (010)$ on (001) Variation in degrees ²⁾
1	0.0 (0.7)	0-2
24	0.0 (0.7)	0
25	0.0 (0.7)	0-2
9	0.0	0
13	0.0	0
21	0.0	0
5	0.83	15-17
17	0.91	15-16
32	0.90	15-17

¹⁾ Brackets = subordinate amounts.

²⁾ Accuracy of measurement $\pm 1-2^{\circ}$.

**Table 4. Chemical analyses of potash feldspar megacrysts from the Skagsudde area.
Numbers as in Table 1.**

Sample no.	Structure ¹⁾	K (weight %)	Na (weight %)	Ca (weight %)	Ba (weight %)	Sr (ppm)	$\frac{100K}{K+Na}$ (at. prop.)
9	m	10.75	1.25	0.2	0.47	65	83.5
10	m	11.80	1.20	0.3	0.39	75	85.3
13	m	11.60	1.10	0.3	0.36	105	86.1
20	m	11.60	1.20	0.4	0.35	80	85.0
21	m	11.50	1.20	0.3	0.40	75	84.9
23	m ((t))	10.80	1.30	0.5	0.40	120	83.0
27	m	10.50	1.20	0.2	0.60	65	83.7
34	m	11.15	1.10	0.1	0.42	85	85.6
35	m	11.25	1.35	0.1	0.30	95	82.8
36	m	11.25	1.10	0.1	0.40	75	85.8
4	t	11.30	1.00	0.1	0.35	70	86.9
5	t	11.25	1.15	0.3	0.40	100	85.2
6	t	10.95	1.35	0.1	0.38	90	82.7
15	t	10.95	1.30	0.4	0.38	90	83.2
16	t	10.35	1.50	0.1	0.37	95	80.2
17	t	11.00	1.30	0.2	0.38	65	83.3
19	t	11.25	1.30	0.1	0.38	85	83.6
29	t	11.50	1.20	0.1	0.48	75	84.9
30	t	11.65	1.35	0.2	0.48	75	83.5
32	t	11.60	1.25	0.1	0.50	80	84.5

¹⁾ m = monoclinic; t = triclinic.
Double brackets = very small amounts.

Table 5. X-ray determination of the contents of albite in solid solution with potash feldspar (Tröger 1967, p. 703), assuming a d_{400} value of 1.927 for pure microcline (Laves 1952; Goldsmith and Laves 1961). Numbers as in Table 1.

Sample no.	2θ $\text{CuK}\alpha_1$	d_{400}	$d_{\text{pure microcline}} - d_{\text{sample}}$	Mol. % Ab
1	47.13	1.927	0.000	0
2	47.20	1.924	0.003	5
3	47.15	1.926	0.001	2
4	47.14	1.926	0.001	2
5	47.18	1.925	0.002	3
6	47.18	1.926	0.001	2
7	47.18	1.925	0.002	3
8	47.21	1.924	0.003	5
9	47.22	1.923	0.004	6
10	47.23	1.923	0.004	6
11	47.20	1.924	0.003	5
12	47.28	1.921	0.006	10
13	47.27	1.921	0.006	10
14	47.25	1.922	0.005	8
15	47.25	1.922	0.005	8
16	47.21	1.924	0.003	5
17	47.20	1.924	0.003	5
18	47.18	1.925	0.002	3
19	47.22	1.923	0.004	6
20	47.26	1.922	0.005	8
21	47.21	1.924	0.003	5
22	47.23	1.923	0.004	6
23	47.18	1.925	0.002	3
24	47.18	1.925	0.002	3
25	47.21	1.924	0.003	5
26	47.15	1.926	0.001	2
27	47.19	1.924	0.003	5
28	47.19	1.924	0.003	5
29	47.22	1.923	0.004	6
30	47.21	1.924	0.003	5
31	47.19	1.924	0.003	5
32	47.22	1.923	0.004	6
33	47.21	1.924	0.003	5
34	47.17	1.925	0.002	3
35	47.22	1.923	0.004	6
36	47.27	1.921	0.006	10
37	47.25	1.922	0.005	8
38	47.22	1.923	0.004	6

Table 6. Triclinicity values for potash feldspars from different Precambrian rocks in Västernorrland County.

Sample no.	Rock	Locality, with position in the Swedish National Coordinate System	Triclinicity Δ ¹⁾
1	Nordingrå granite	Mjällom 69890/16341	c. 0 (0.8)
2	Do.	" 69889/16313	c. 0
3	Do.	" 69882/16338	c. 0+0.7
4	Do.	" 69889/16351	c. 0 (0.6)
5	Do.	" 69888/16341	0 (0.8)
6	Do.	Önnskäret 69959/16390	0.78
7	Do.	" 69956/16392	0 (-0.8)
8	Do.	" 69956/16392	0-0.8
9	Do.	" 69960/16389	≤ 0.79
10	Do.	" 69868/16319	0
11	Do.	N. Ulvön 69950/16431	c. 0+0.6
12	Do.	Åskäret 69933/16449	c. 0+0.7
13	Do.	Docksta 69946/16275	c. 0-0.7
14	Do.	Österskär 70133/16596	c. 0+0.75
15	Do.	Trysunda 70069/16504	c. 0+0.6
16	Do.	Näske- bodarna 70020/16375	c. 0 (-0.7)
17	Do.	Magd- bäcken 70034/16305	0 (0.7)
18	Do.	Värdkall- berget 69940/16307	0.0
19	Do.	Berg 69993/16294	c. 0+0.7
20	Nordingrå pegmatite	Docksta 69946/16275	c. 0 (0.7)
21	Do.	Österskär 70133/16596	0.81
22	Do.	" 70133/16597	≤ 0.7
23	Do.	" 70133/16597	0-0.85
24	Do.	Skags- udde 70132/16626	0.59
25	Do.	" 70137/16603	0.7 (-0)
26	Do.	" 70127/16616	c. 0 (-0.7)
27	Do.	" 70127/16616	0.77
28	Serorogenic pegmatite, white	Ällön 70160/16646	0.95
29	Do.	Skags- udde 70135/16627	0.81
30	Do.	Skags- hamn 70155/16612	0.88
31	Serorogenic(?) pegmatite, red	" 70135/16627	0.70
32	Quartz-syenitic differentiate in dolerite	Kvarn- grönnan 69954/16471	c. 0 (-0.8)
33	Granitic differentiate in dolerite	Köpman- holmen 70087/16401	c. 0.8 (-0)
34	Do.	Hägg- dånger 69393/16035	0.79
35	Do.	" 69384/16036	0.72 (0)
36	Megacryst from xenolith of synorogenic granite in Nordingrå granite	Österskär 70132/16597	0 (0.7)
37	Do.	Västeskär 70137/16589	0 (0.7)
38	Synorogenic granite near dolerite contact	Täfteå 70293/16538	0+0.7
39	Do.	Orra- klinten 68956/15788	0.0 (0.7)
40	Serorogenic granite near dolerite contact	Sels-Vit- berget 69902/15899	0.0 (0.8)

¹⁾ Brackets = subordinate amounts.
Plus sign = subequal amounts.

PRISKLASS D

Distribution

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