OBSERVATIONS ON MANTLED POTASH FELDSPARS FROM THE VRÅDAL GRANITIC PLUTON, TELEMARK, NORWAY

By

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Large crystals of potash feldspar mantled with oligoclase were analysed for the mole per cent Or content. Mantled individuals had a higher content of Or in the core than in the zone nearer the mantle; unmantled crystals did not show such a distribution gradient.

The tendency for such feldspars to occur in basic rocks and their textural appearance under the microscope suggest that the plagioclase mantle is a reaction phenomenon. The material for the mantle is supplied in part by exsolution of Ab from the potash feldspar toward its margins, thereby leaving the core enriched in Or.

Description

Megacrysts of microcline up to five centimeters in length are commonly mantled with oligoclase in the Vrådal pluton which is located in the Precambrian terrain of central Telemark in southern Norway. These crystals, which have average lengths of three centimeters, are particularly abundant in the vicinity of basic rocks. The megacrysts, most of which are nearly euhedral, are typically twinned according to the Carlsbad law. Δ-values, as a measure of obliquity, are between 0.90 and 0.95.

As seen in thin section the characteristic microcline grid twinning is unevenly developed (Figure 1). Crystallographically oriented inclusions of plagioclase are common within the microcline crystals, particularly within those found in massive granite. Three types of perthite (O. Anderson, 1928) occur: (1) film, (2) vein, and (3) patch.

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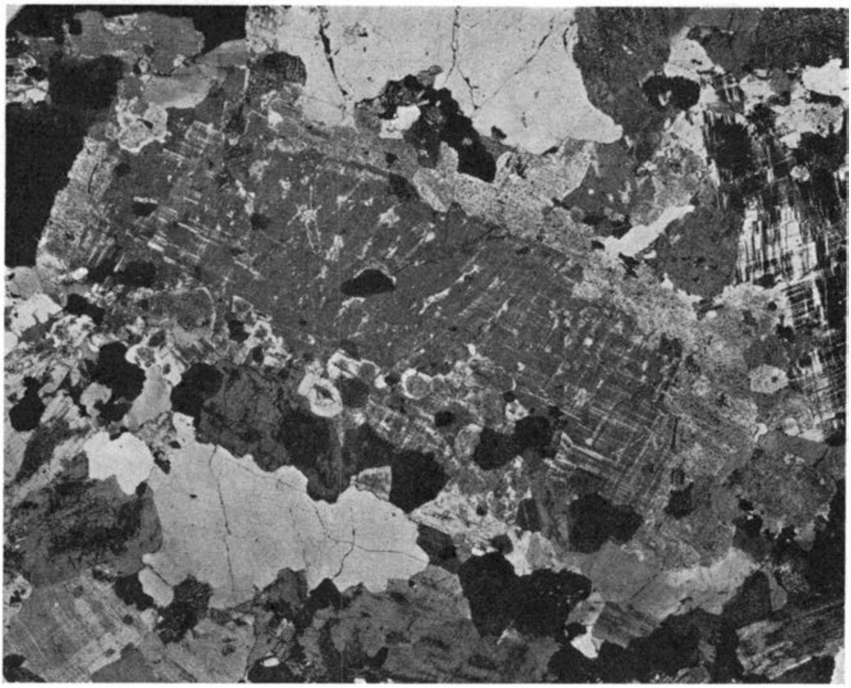

Figure 1. Megacryst of microcline partially surrounded by a sericitized oligoclase mantle. Not all portions of the mantle are in optical or crystallographic continuity. Length of crystal approx. 2.5 cm. Crossed nicols.

The mantles are in general thicker on the larger individuals than on the smaller ones. Typically they are sericitized even where the plagioclase of the host rock groundmass is not. The fine albite twinning of the oligoclase mantles commonly is parallel to the microcline-oligoclase interfaces; however, at the terminations of many of the microcline crystals it is parallel to the *c*-axis of the microcline. The actual contact between the two feldspars may be straight, but it is typically irregular (Figure 1).

Two mantled crystals of different sizes and from opposite sides of the granitic mass were selected for a detailed compositional study. The first crystal was sliced through the middle parallel to (010) (Figure 2). Eleven samples were selected for determination of the mol content of Or according to the method proposed by Orville (1959) [1].

[1] All samples were heated 48 hours at 1025 °C., mixed with $KBrO_3$, and run on a

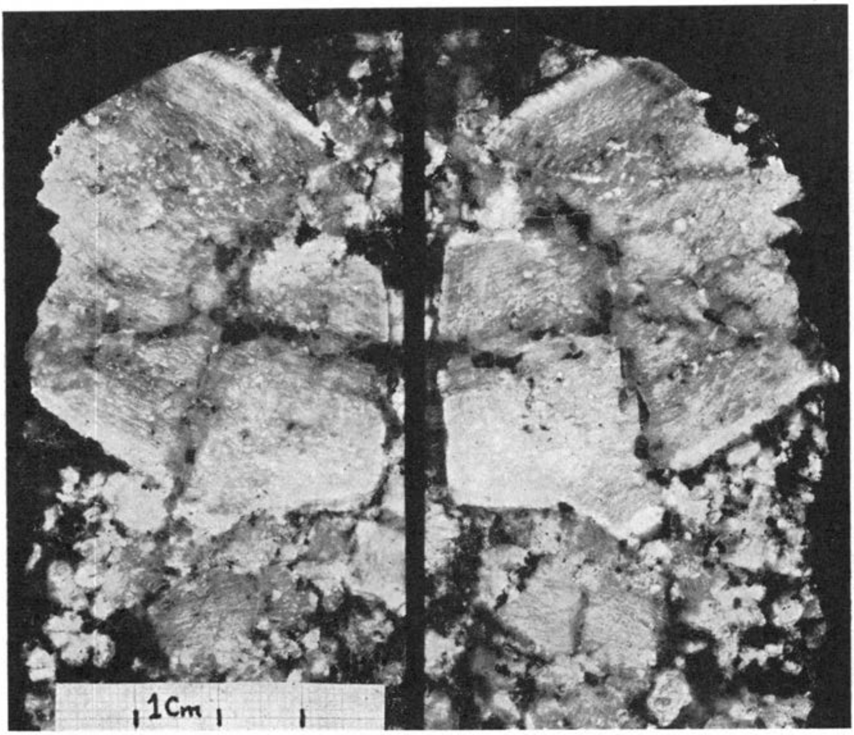

Figure 2. Two halves of granitic slab containing a mantled potash feldspar. The plane of the cut of the feldspar is very nearly parallel to (010).

The results show the Or content is greater in the core than it is nearer the margin of the crystal (Figure 3).

A three-dimensional study of the second, smaller crystal differed slightly in having a zone between the core and the marginal zone which was higher in Or content (Figure 4).

In general there is deficiency of Or molecule in proximity of the oligoclase mantle; or, conversely, this zone is high in *Ab* compared with the rest of the microcline. As a check, analyses were made of un-

11.46 cm. Guinier X-ray camera. Each sample was run four different times, and one set of films was measured by three different workers at the Geologisk Museum. The mean error is $\pm 1.0\,\%$, and the standard deviation is less than $0.5\,\%$.

The An content of the microcline was not determined. It is probably less than three per cent (e.g., Stewart (1956)). The An content of the oligoclase mantle (An_{18}) is less than that of the plagioclase of the groundmass (An_{24-28}).

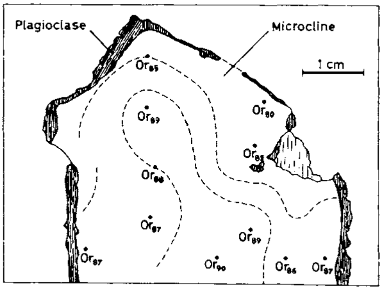

Figure 3. Or content of the right half of the crystal in Figure 2. Contours are diagramatic.

mantled crystals from the Vrådal pluton and from several other Norwegian granites and augen gneisses. None had distribution gradients like those in mantled individuals. This suggests that one should avoid using mantled potash feldspars for studies where a 5–10 percent variation for Or distribution within one crystal could be critical, e.g., areal application of the Barth two-feldspar geothermometer (Barth (1956); Dietrich (1961)).

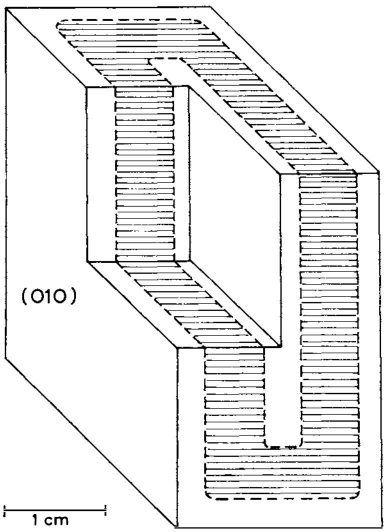

Figure 4. Diagram of a mantled potash feldspar with the mantle, top, and front of the crystal cut away. The ruled zone has a composition of Or_{80-83} and the unruled area a composition of Or_{76-79}. 41 samples were used for this determination.

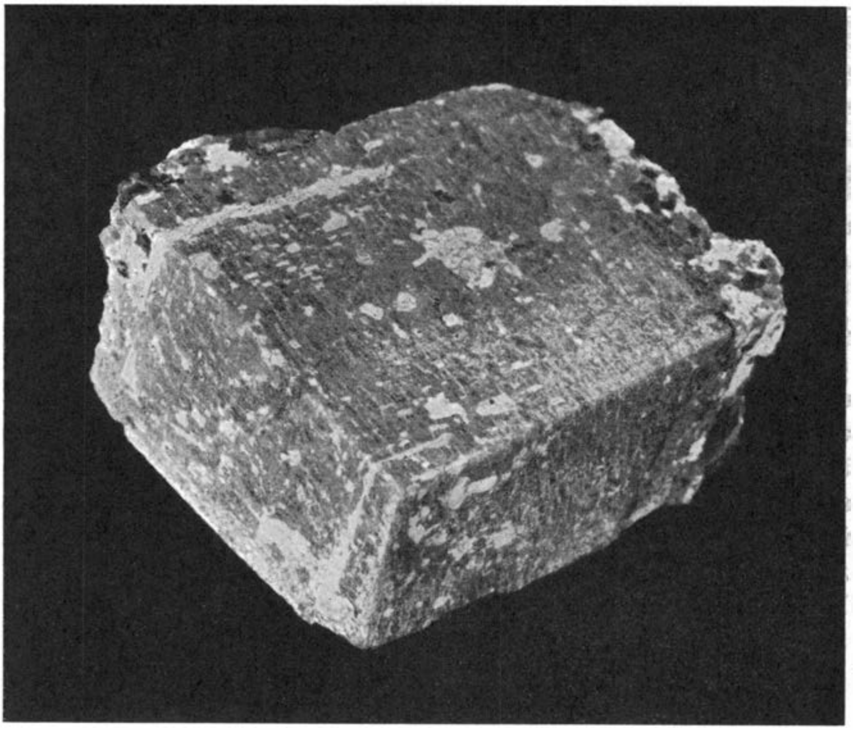

Figure 5. Crystal of unmantled microcline which has been stained with sodium cobaltinitrite solution. White, dimensionally oriented inclusions and "zones" of plagioclase are easily distinguished. Crystal ca. 2 cm. across.

With this information in hand, a check was made on the occurrence of the mantled microclines in the Vrådal pluton. As noted above such megacrysts are best developed near or within feldspathized basic rocks, whereas they have not been found where quartzite or older granite and gneiss have been affected by feldspathization. This fact suggests that the oligoclase mantle is a sort of "reaction mantle" which was formed in order to maintain "environmental equilibrium" within the basic rocks. The X-ray data further suggest that exsolution of *Ab* from the potash feldspar played a role in the formation of the mantle [2], since unman-

[2] Sahama (1960) described an analogous exsolution process in the lavas of Mt. Nyiragongo, Belgian Congo. He found that nepheline ($NaAlSiO_4$) exsolved from crystals of kalsilite ($KAlSiO_4$) to form a mantle.

tled crystals did not show the distribution gradient found in mantled ones.

It is believed by the writer that such an exsolution must be rapid, not only from the data of the metallurgists regarding mantle-forming processes (Edwards (1954), but also because intermediate stages were rarely seen. One does find, however, crystallographically oriented "zones" of oligoclase within the microcline crystals (Figure 5). The figured individual came from a portion of porphyritic granite where there are no nearby basic rocks.

As is the case with many granitic rocks that contain mantled feldspars, the porphyritic granite at Vrådal also contains unmantled individuals, and any hypothesis which attempts to explain the genesis of mantled crystals must also explain the presence of associated unmantled crystals. Field interrelationships suggest feldspathization of the country rocks was not immediate but must have occured over an indefinite period of time. If this is true, the environment of the growing feldspars became less and less basic, and the need to develop a "reaction mantle" of oligoclase might have become increasingly unnecessary. The final result of the felspathization, therefore, might be a mixture of mantled and unmantled potash feldspars as occurs in the Vrådal granitic pluton.

While the field interrelationships suggest that the mantles are formed by some sort of reaction, it would be interesting to know how important exsolution of *Ab* from the potash feldspar could be in such a process. Exsolution probably cannot account for formation of the whole mantle; a volume comparison of the larger microcline crystal and its mantle, respectively, would show that the microcline must have had a composition of Or_{40-50} to reach its present composition after exsolution. However, a small amount of exsolved material could trigger reaction at the border and subsequently cause the development of a "reaction mantle".

The literature contains abundant descriptions of the occurrence of mantled potash feldspars; now, data is needed from the laboratory on rates of exsolution and diffusion of *Ab* through microcline.

Acknowledgements: This investigation was supported by a Fulbright grant from the U.S. Educational Foundation in Norway. My colleagues at the Mineralogisk-Geologisk Museum offered both suggestions and criticism, and placed their equipment at my disposal. The aid of these institutions and individuals is gratefully acknowledged.

REFERENCES

ANDERSON, OLAF (1928): The genesis of some types of feldspar from granite pegmatites. Norsk geol. Tidsskr., vol. 10 (1928) pp. 116.

BARTH, T. F.W. (1956): Studies in gneiss and granite. I: Relation between temperature and the composition of the feldspars. Norske Vidensk.akad. Oslo, Skr. I, Mat. Nat.vidensk. kl. no. 1 (1956).

DIETRICH, R.V., (1961): Comments on the two feldspar geothermometer and K-feldspar obliquity. Instituto Lucas Mallada, Cursillos y Conferencias, Fasc. 8 (1961) pp. 15.

EDWARDS, A. B. (1954): Textures of the ore minerals and their significance. Australasian Institute of Mining and Metallurgy (1954) pp. 89.

ORVILLE, P. M.: (1960): Powder X-ray method for determination of (Ab+An) content of microcline (Abstract). Program Geol. Soc. Amer. Meeting, Denver, pp. 171.

SAHAMA, TH. G. (1960): Kalsilite in the lavas of Mt. Nyiragongo (Belgian Congo). Jour. Petrology, v. 1 (1960) no. 2, p. 146.

STEWART, D. B. (1956): Rapakivi texture. Annual Report, Director, Carnegie Inst. Wash., pp. 194.