Zeitschrift: Schweizerische mineralogische und petrographische Mitteilungen = Bulletin suisse de minéralogie et pétrographie

Band: 41 (1961)

Heft: 1

Artikel: On the paper "Orthoclase, microcline and albite in granites" by L.J.G. Schermerhorn

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DOI: https://doi.org/10.5169/seals-31889

On the paper "Orthoclase, Microcline and Albite in Granites" by L. J. G. Schermerhorn

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Well, well. The cited paper of SCHERMERHORN indicates clearly, how obviously similar phenomena in petrology can be interpreted in perfectly different ways. He is a magmatically-thinking scientist and tries to find observations that fit into his theories. I myself also started my geological research as a magmatist. Later on, however, the progress in petrology, and my field observations caused me to change my mind in many respects.

Dr. SCHERMERHORN's undoubtedly sharp criticism is very welcome, because opposite opinions are just those which teach us to criticize ourselves. Still I was a little surprised that, in his paper, Dr. SCHERMERHORN categorically rejects every idea by myself, despite the fact that the only area referred to in his paper and studied by himself is in Portugal. My papers, on the contrary, deal with areas in Finland, West Africa and Marocco, not visited by SCHERMERHORN at the time he wrote his paper. Thus we are basing our statements on different observations.

May I make the following brief remarks:

1. SCHERMERHORN (p. 34): "Only rocks of granitic mode and norm which show low-temperature minerals in a relatively low-temperature texture (certain granoblastic quartz-microcline albite-mica assemblages) may *present difficulties in evaluating a possible magmatic origin.*" Here ist the point. Dr. SCHERMERHORN pays much attention to granite types, which are inessential for Fennoscandian or Sierra Leonean Precambrian areas. On the contrary, the vast majority of the granites taken as late-kinematic in Finland, are in full accordance with the SCHERMERHORN's description of "difficult granites" cited above and exactly similar are the granites forming the metasome of migmatites, as well as the late-kinematic granites of Sierra Leone, or the microcline-aplite veins often

cutting the Precambrian rapakivi and the post-kinematic Alpine granites. They are neither "occasional" nor "certain", but very common and wide-spread within the Precambrian areas of Fennoscandia, West-Africa and Canada.

All the statements ever made in my papers claim the presence of primary microcline, and non-magmatic emplacement preferably under hydrothermal conditions, *just and exclusively for such "problematic late-kinematic" granites.* The microcline is, in my opinion, also primary if formed during granitization (which *sometimes* may be almost the same as feldspathization) of syn-kinematic rocks, providing it took place at moderate temperature. Otherwise (or if the growth of crystals is less sluggish, as is the case if authigenic potash feldspar is formed in sediments) orthoclase will be formed. Because SCHERMERHORN pays but little attention to this, in my opinion very important, group of granites, he is probably less familiar with them, and this may also explain the sharpness of his criticism.

2. Concerning the primary microcline (SCHERMERHORN, p. 15): If the initial stage of a potash feldspar is monoclinic, but the growth of the crystal remains sufficiently slow, it transforms into the triclinic form *during growth.* This does not contradict the statements of LAVES and GOLDSMITH. The presence of intermediates between microcline and orthoclase are very common in the rapakivi and Alpine orthoclase granites but unusual in the true microcline granites. They may be understood, if the formation of potash feldspar has been either less sluggish or taken place at somewhat higher temperature. I have always stressed, that *both* the time *and* the temperature conditions must be considered.

If orthoclase granites are considered, there also two alternatives exist: either the microclinization took place after, or already during the growth of the crystals. These two alternatives cannot be distinguished petrologically. No theory for the development of cross-hatching has ever been given in my papers. Well cross-hatched microcline is also very common in rocks showing no evidence of stress. In such cases also it is usual for the triclinicity to be higher than 0.8, and in most cases examined by the present writer, it is more than 0.9. In the orthoclase-rich granites, this triclinicity is variable and much lower. The presence or absence of cross-hatching does not reflect the triclinicity. Unhatched microcline with $2V\alpha = 75—80°$ of triclinicity 0.9 is not uncommon, according to determinations made by means of the U-stage and X-rays (from Δd). It is not apparent from SCHERMERHORN's paper, how he determined the triclinicity.

3. Orthoclase and microcline granites (p. 30): When I said "orthoclase granite", I meant a granite which predominantly contains orthoclase, but always some microcline, also. Such granites are very common in the Alpine chains, and there invariably contain *a very perthitic* orthoclase and microcline, but also some *younger* microcline of very high triclinicity, non-perthitic and occurring as very minute veinlets cutting both the (partly microclinized) orthoclase insets and the matrix. Exactly the same applies to the Precambrian rapakivi granite, which both in Finland and the Ukraine is emplaced in an old Precambrian basement. For Alpine granites this has been described by GYSIN, for instance, in several of his papers on the orthoclase granites of the Alps and Himalayas, by MARMO and PERMINGEAT for Marocco, and by various authors for many other Mesozoic granites in Europe including the granite of Skye mentioned by SCHERMERHORN (p. 31) as a "rare" type. The same is true for the orthoclase granites and syenites of the Andes, and also of the Urals, where this has been observed by myself when visiting some localities there.

In the Precambrian, such granites are less common, but they still occur. Besides rapakivi and those mentioned by SCHERMERHORN (p. 30), there are still others. They do not, however, confirm SCHERMERHORN's view that they prove the monoclinic ancestry of all microclines. They merely indicate, that the orthoclase could be formed (elevated temperature or less sluggish emplacement) in the basement also, and well survive being microclinized though to a minor extend only.

Concerning p. 31 of SCHERMERHORN: "The rapakivis... The preservation of orthoclase is here due to freezing." Why have common aplite veins cutting rapakivis, both in Finland and the Ukraine, not "frozen", but nevertheless contain cross-hatched homogeneous microcline of perfect triclinicity, but no orthoclase?

4. Late- and post-kinematic granites (p. 32): I have never concluded from the nature of the potash feldspar whether some granite is late- or post-kinematic. SCHERMERHORN refers to the papers of ESKOLA. I would merely add that for Finland I have used the classification worked out by ESKOLA himself, and for Sierra Leone, the field-work experience obtained from him. As regards the Alpine post-kinematic granites, ESKOLA also considers them as post-kinematic.

5. Decalcification of albite in granites (p. 33): How can a total expulsion of calcium from a "decalcified" granite be explained on a sufficiently large scale as to cause a body several kilometers in the width and length completely and homogeneously to lose its calcium? Albitized

rocks (including granites) are well known. There the calcium has gone to form new minerals (e. g. epidote). But there exist large bodies of granites (those I am mainly dealing with in my papers) which contain more than 4% Na_2O, and only 0.5—0.7% CaO. A really albitized "albitite" adjoining the chromite body at Kemi, Finland, on the other hand, contains albite with 1—2% An, but the whole rock has as much as 4% CaO. SCHERMERHORN (p. 24): "Ca and Al expelled may either go to form epidote-zoisite or *else migrate altogether in which case their fate may be obscure.*" Is this a logical conclusion? Ca and Al do not move very easily, as compared with the alkalis; and as mentioned above, they usually stay in the rock even if it is albitized. This question has been dealt with in another of my papers to be issued in 1961 (Bull. Comm. géol. Finlande).

6. All that I have tried to say in my papers, may be resumed as follows:

— Granoblastic granites containing microcline of high triclinicity and albite, and often tending to be aplitic, include a large majority of the Precambrian late-kinematic granites, as well as the aplites often cutting the orthoclase granites. They cannot be of magmatic origin, but probably have been emplaced under hydrothermal conditions and accumulated slowly.

— The granites containing mainly orthoclase include very many post-kinematic granites (rapakivi, Alpine granites etc.). They may be of magmatic origin, but they may also have been formed in a similar way as microcline-granites, but at higher temperatures and more rapidly.

— If the granitization proceeds at high temperature, orthoclase may likewise be formed.