ON THE LATE FORMATION OF PLAGIOCLASE IN GRANITIC ROCKS

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In most granites neogene plagioclase (in contrast to relict plagioclase) consists of two groups thought to be genetically different. The first one is the primary plagioclase, which in most cases shows patchy zoning, and therefore is considered to be crystallised from a melt (Vance, 1965; Mehnert, 1962). The second group comprises perthite lamellae, myrmekite, "secondary" albite etc., in other words all kinds of plagioclase in contact to potash feldspar, and therefore by most authors believed to be exolved from it (Tuttle, 1952; Ramberg, 1962; Shelley, 1964; and many others. See Widenfalk, 1969, for further references). The present author agrees with this view with modifications given later on.

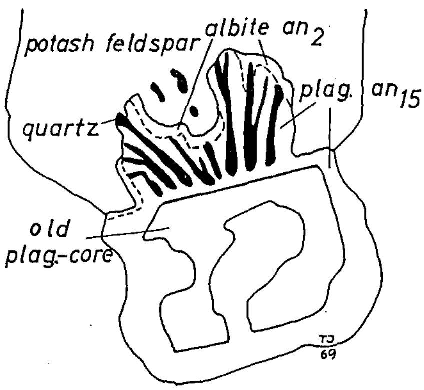

Fig. 1. Idealised grain of myrmekitic plagioclase showing three stages of formation. According to the shape and occurrence of the myrmekite, it must have grown into the potash feldspar from the surface of a formerly almost idiomorphic plagioclase grain. This is consistent with exsolution from the potash feldspar (stage 1). The relict quartz »droplets« and other structural details give strong indications, that the potash feldspar has resorbed the myrmekite in the next step (stage 2). In the end the partly resorbed myrmekite is overgrown by a younger rim of albite (stage 3).

The average an-content in the feldspars found by the author corresponds closely to the values given by Widenfalk (1969).

If the exsolution theory is correct, grains like the one shown in fig. 1 must be formed by two exsolution stages separated by a resorption stage. The resorption, which was recognised by Dresher-Kaden (1948) and used by him as a criterion for his myrmekite type 1, could possibly take place by metasomatic addition of alkali feldspar (Shelley, 1964). However, this view can be criticised, because myrmekitic plagioclase, which in all main features is exactly like that in fig. 1, is widely destributed in granitic rocks. It is not to be expected that the process of metasomatism will affect the granite in the same stage of development every time, and do it without considerable variation in intensity from one granite to another. The present author therefore finds it more reasonable to suggest some process which is connected to the chemistry of granitic rocks and their course of crystallisation.

The structure of the grain in fig. 1 immediately indicates a reaction origin of the albite according to the scheme:

$$\text{Plagioclase} + X = \text{Albite} + Y$$

(compare with well-known reaction rims, e.g. olivine mantled by pyroxene). The involved substances X and Y, one of them or both, must probably include potash feldspar and possibly other substances. The composition of the plagioclase and the albite suggests that the reaction is connected with the peristerite solvus. This is supported by the occurrence of basic myrmekites (about an_{30-40}) which do not have any rim of albite (Widenfalk, table 1, 1969). Three environments of reaction are distinguished:

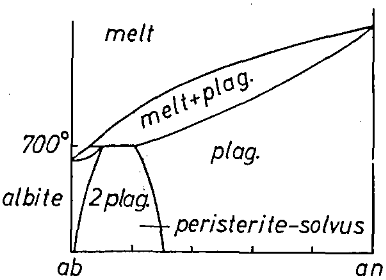

Fig. 2. This binary phase diagram is the principal base for the reaction: plagioclase + melt = albite ± melt ∓ plagioclase. If the diagram is regarded as a projection of the whole granitic multi-component system, the low temperature of the liquidus and solidus is understandable. The high temperature of the peristerite solvus is in accordance with experiments performed by Iiyama (1966), who found the top of the solvus at 730° C. Due to the abundance of potash feldspar dissolved in the melt, the compositions are more adequately projected on a ternary diagram (see fig. 3).

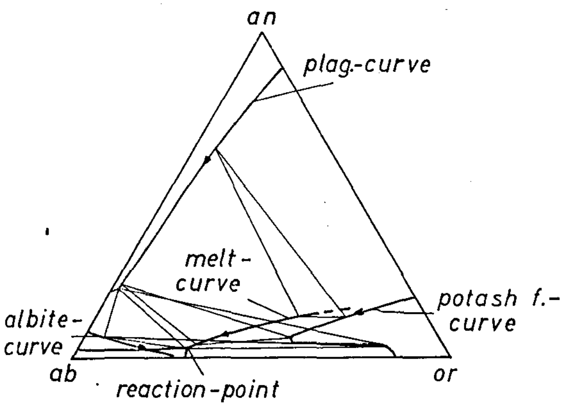

Fig. 3. To explain the petrographic observations (see fig. 1 and text) the polythermal projection must have the properties shown in this figure. The winding course of the or-rich feldspar composition during crystallisation is in fact possible in a multi-component system. The turn towards the or- corner may be caused by a late stage depression of the solidus surface due to an increase in gas pressure. It may also depend upon the instability of the Schwankte molecule (Ca $AlSi_3O_8$) which is probably stable in the high-T° alkali feldspar structure, but not in the structure of low-T°feldspars (Carman & Tuttle, 1963; Wyart & Sabatier, 1965).

1) A silicate melt is present
2) A gas or aqueous solution is present
3) Only solids are present

Here only the first possibility is considered, because of its relative simplicity, and because the notable agreement in composition of the exsolved plagioclase (not the albite) and the primary plagioclase indicates similar conditions of formation. See figs 2 and 3. According to the present theory both groups of plagioclase are formed simultaneously but through different processes.

Further work will be carried out to improve the reaction theory.

Dansk sammendrag

Nydannet (ikke-relikt) plagioklas i flertallet af graniter falder i to grupper, dels primær plagioklas, som på grund af uregelmæssig zonaritet anses for at være krystalliseret fra en smelte – og dels plagioklas som pertitlameller, myrmekit, »sekundær« albit m. m. i kontakt med kalifeldspat. Den sidste gruppe anses af mange for opstået ved afblanding fra kalifeldspaten. Forfatteren slutter sig til dette synspunkt, men mener, blandt andet på grund af den næsten ens kemiske sammensætning af de to plagioklasgrupper, at afblandingen kan være sket samtidig med udkrystallisationen af primær plagioklas.

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