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On potash feldspar megacrysts and their bearing on the petrogenesis of El-Ineigi granite rocks, Eastern Desert, Egypt

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ABSTRACT

The potash feldspar megacrysts of El-Ineigi granitic rocks include oriented and zonally arranged plagioclase crystals. These plagioclase inclusions are occasionally observed parallel to the re-entrant angles at the twin planes of the potash feldspar megacrysts. Biotite inclusions are similarly oriented. These observations, in addition to the shape and anorthite content of the plagioclase inclusions, suggest growth of the megacrysts in a silicate melt. Hence the magmatic origin of the potash feldspar megacrysts and their host granitic rocks is ascertained.

INTRODUCTION

Gabal El-Ineigi (Fig. 1) is one of several plutons which are widely distributed in the Eastern Desert of Egypt and are known collectively as Younger Granites (El-Ramly & Akaad 1960), as Late Orogenic Plutonites (Sabet 1961, 1972; El-Shazly 1964), and as Younger Granitoids (El-Ramly 1972). The geology of the El-Ineigi area has been recently studied by Heikal (1973). The El-Ineigi pluton is emplaced into country rocks of schists, serpentinites and dioritic rocks, all of which are traversed by some post-granite dykes, pegmatites and quartz veins. The typical granite of El-Ineigi is pink-red with less common buff varieties. The contact between the two varieties is imperceptible and they are not clearly separable in the field.

PETROGRAPHY

The petrographic studies of El-Ineigi granites show that they comprise two main types: porphyritic, and even-grained biotite granites. In both types, potash feldspars dominate over plagioclase. On the average, the volume percentages of minerals present are: 43% potash feldspars, 28% plagioclase, 25% quartz, 3% biotite and 1% accessory minerals.

The porphyritic varieties are characterized by a rather even distribution of essentially non-aligned potash feldspar megacrysts in a finer grained groundmass which consists of potash feldspar, plagioclase, quartz and biotite. Plagioclase (3 mm) and quartz (5 mm) may also occur as megacrysts which are smaller in size than those of the

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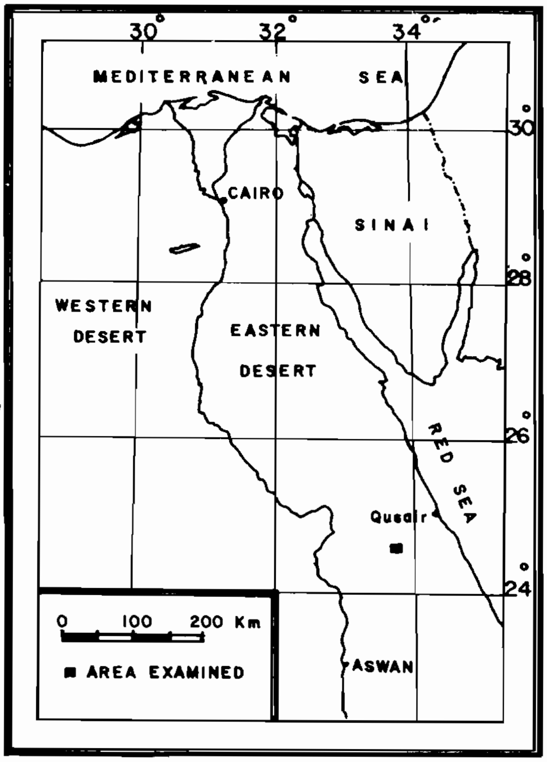

Fig. 1. Location map of the El-Ineigi granite pluton, Eastern Desert, Egypt.

potash feldspars. Potash feldspars occur in two generations: as megacrysts and in the groundmass. In thin sections, the megacrysts are ovoid to rectangular in shape, reaching up to 20 mm across. While the megacrysts as a whole generally have approximately euhedral outlines, the edges in detail are mainly irregular. In addition, the boundary surfaces between the megacrysts and the groundmass are often ragged. The potash feldspar megacrysts are commonly twinned on the Carlsbad law, although untwinned megacrysts are also present.

Sometimes, the outer portions of the megacrysts exhibit zoning marked by differences in extinction angles (Fig. 2) and/or variable concentrations of exsolved sodic plagioclase. This zoning may be caused by growths of concentric shells with slightly different optical orientation (Johannsen 1962). The inner portion is usually idiomorphic in shape while the outer portion is commonly xenomorphic with respect to the surroundings and is occasionally characterized by euhedral and drop-like quartz inclusions.

INCLUSIONS OF THE POTASH FELDSPAR MEGACRYSTS

As inclusions, the potash feldspar megacrysts contain plagioclase, drop-like quartz, xenomorphic quartz, biotite, magnetite and zircon. Quartz inclusions may exhibit euhedral forms in the outer portion of the potash feldspar megacrysts. Xenomorphic

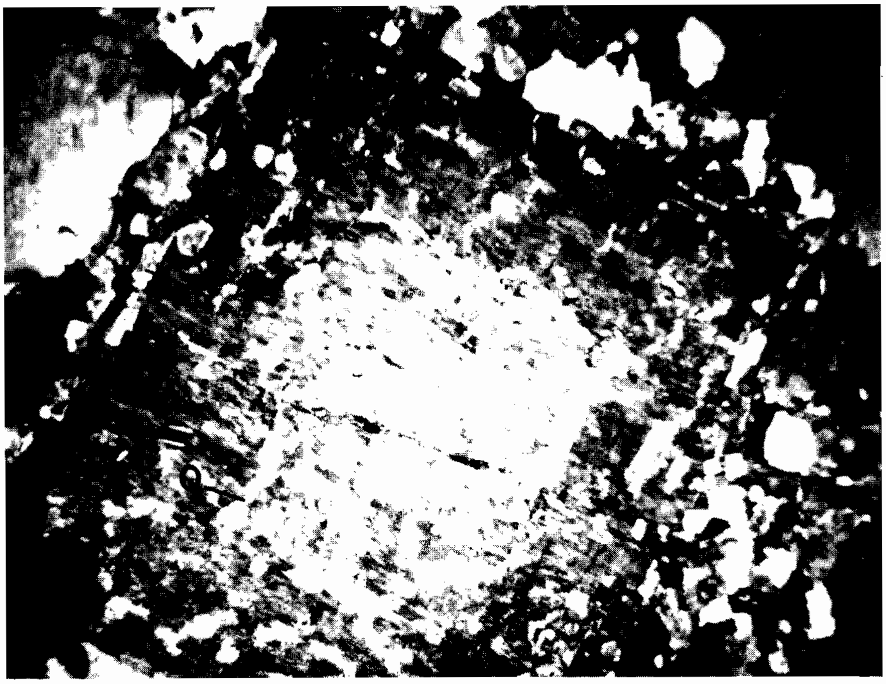

Fig. 2. Potash feldspar megacrysts with marked zoning and xenomorphic quartz (Q) between the inner and outer portions of the megacrysts. Plagioclase inclusions (P) are oriented with their long axes parallel to the megacryst periphery. Crossed polarizers × 10

quartz occurs between the idiomorphic core of the potash feldspar megacrysts and their outer rims (Fig. 2). This generation of quartz has been formed after the formation of the idiomorphic cores of the potash feldspar megacrysts, but before the development of their outer rims.

The plagioclase inclusions may reach up to 1 mm in their largest dimension. They are mostly systematically oriented with their longest dimension parallel to the outer boundary of the host potash feldspar megacrysts, or to their composition planes (Figs 3 and 4). Commonly, the plagioclase inclusions are also zonally arranged parallel to the outer boundary of the megacrysts (Fig. 3). Some of these inclusions lie partly within the host and partly within the groundmass (Fig. 3). In cases where the potash feldspar megacrysts show re-entrant angles, which are primary growth features (Vance 1961, p. 1102), the plagioclase inclusions roughly parallel the sides of these angles (Fig. 5). The majority of the plagioclase inclusions are euhedral to subhedral, while some have ragged and embayed margins. Such corrosion relations indicate that plagioclase inclusions are older than potash feldspar megacrysts. In composition, the plagioclase inclusions vary from An_0 to An_{15}, being mainly less than An_{10}. Their average composition is An_6. Biotite inclusions in the potash feldspar megacrysts are similarly oriented with reference to their cleavage planes (Fig. 6), adding other evidence for orientation of the inclusions. Such a systematic alignment of plagioclase crystals with respect to megacrysts of potash feldspar has been observed by several authors (e.g. Lawson 1893; Maucher 1943; Erdmannsdörffer 1949; Frasl 1954; Schermerhorn 1956a, b; Brodersen 1962; Hibbard 1962, 1965; Mehnert 1968). As far as the authors are aware, similar

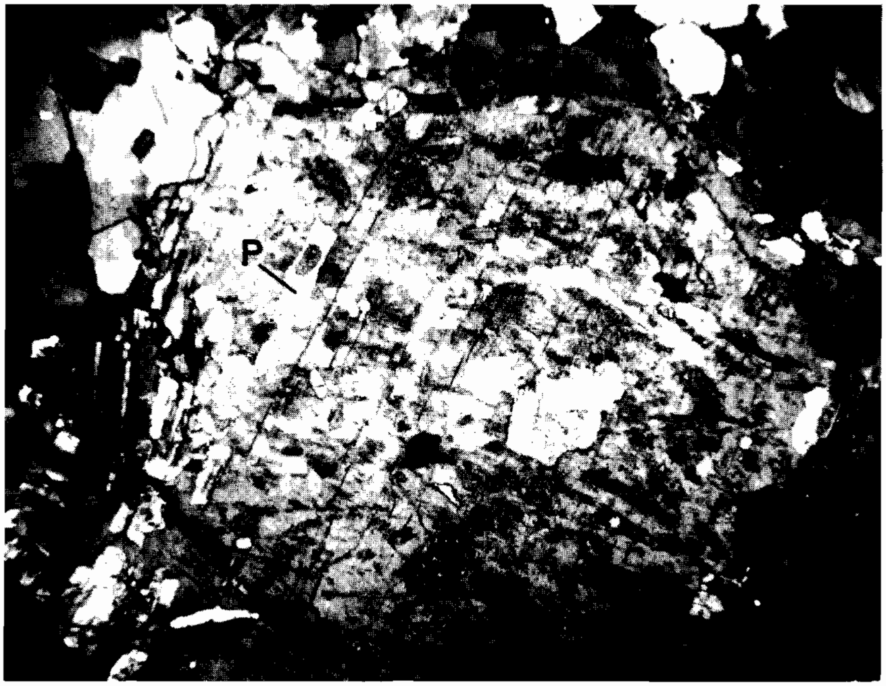

Fig. 3. Potash feldspar megacryst with oriented and zonally arranged plagioclase inclusions (P). A plagioclase crystal on the left side lies partly within the potash feldspar megacryst and partly within the groundmass. Crossed polarizers × 20

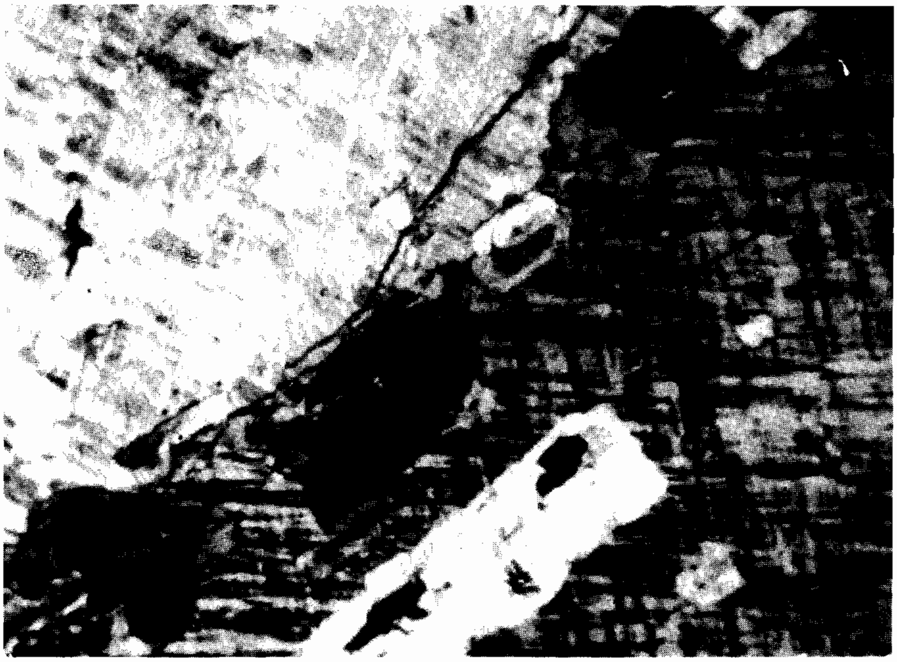

Fig. 4. Plagioclase crystals lying at the twinning boundary of a potash feldspar megacryst. Note that the twinning place of the potash feldspar megacryst roughly parallels the longer plagioclase faces. Crossed polarizers × 45

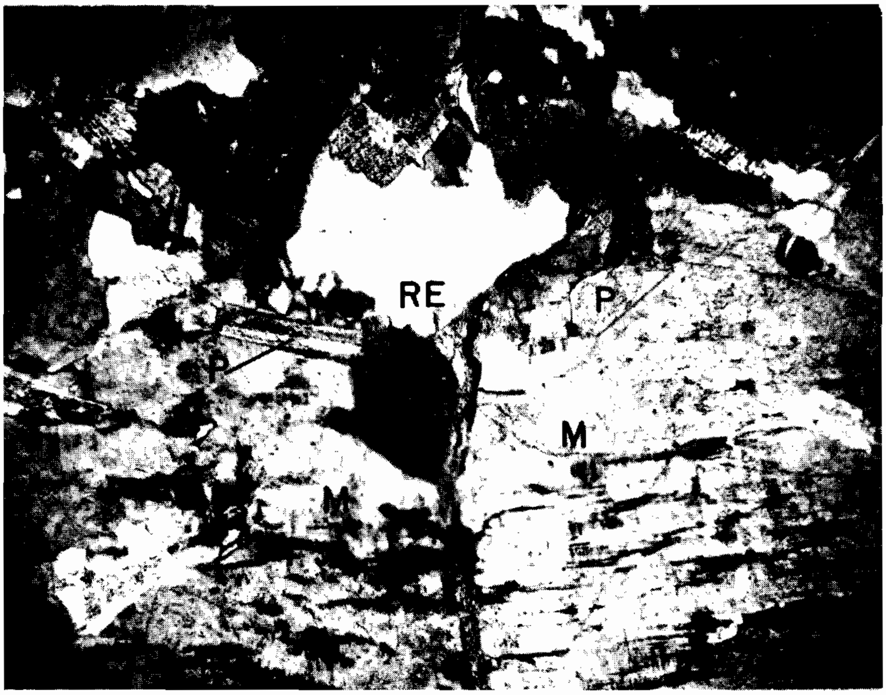

Fig. 5. Potash feldspar megacryst (M) showing re-entrant angle (RE) along the Carlsbad composition plane. Note that the plagioclase inclusions (P) roughly parallel the re-entrant angle. Crossed polarizers ×80

Fig. 6. Oriented biotite (B) and plagioclase (P) inclusions within a potash feldspar megacryst. Crossed polarizers ×80

fabrics have not been recognized among Egyptian granites. Nevertheless, a similar fabric has been recorded by Habib (1968) in Wadi Barud granitic gneisses of the Eastern Desert.

PETROGENETIC INTERPRETATION

The oriented inclusions of the potash feldspar megacrysts of the El-Ineigi granites can be explained by a process of alignment of pre-existing plagioclase and biotite crystals with the growing faces of the potash feldspar magacrysts. It cannot be explained by exsolution of the plagioclase, since plagioclase crystals included within the potash feldspar megacrysts are identical in composition and other features to the plagioclase crystals in the groundmass. This is also indicated by the fact that some plagioclase inclusions are lying partly within the potash feldspar megacrysts and partly within the groundmass. The interpretation of the plagioclase inclusions as incompletely replaced crystals cannot be accepted, since these inclusions are not in optical continuity with each other. Also the twin lamellae could not be correlated from one inclusion to another. Moreover, the occurrence of re-entrant angles at the twin planes of the potash feldspar megacrysts is interpreted as a primary feature following Vance (1961). He stated that 'A mysterious diminution in volume of part of the crystal—an exceedingly unlikely occurrence—must be invoked if these re-entrant angles are considered to be of secondary origin, i.e., formed later than the formation of the crystal'. The orientation of the plagioclase inclusions parallel to these re-entrant angles indicates their formation before the crystallization of the megacrysts and indicates that they have been incorporated and oriented later by the growing potash feldspar megacrysts.

The random disposition of the biotite flakes occurring in the groundmass, and their orientation in the potash feldspar megacrysts, readily support the overall process of orientation of inclusions. The euhedral form of quartz in the outer portions of the potash feldspar megacrysts most probably implies freedom of quartz growth. The process of attachment and inclusions of the small plagioclase crystals within the potash feldspar megacrysts can best be explained as a result of the magmatic growth of the latter. The growing faces of the megacrysts pushed the small plagioclase crystals aside. When the (010) faces of the plagioclase crystals came in contact with the growing potash feldspar faces, a position of mechanical stability and least surface energy, they became permanently attached to it and then incorporated, partially or completely, within the megacrysts by further growth.

The same interpretations for similar textures were also given by Maucher (1943), Frasl (1954), Schermerhorn (1956a, b), Wallace (1956), Brodersen (1962), and Hibbard (1962, 1965).

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دراسة عن بلورات الفلسبار البوتاسي الكبيرة
في صخور العنيجي الجرانيتية بالصحراء الشرقية
المصرية ودلالتها بالنسبة لنشأة هذه الصخور

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خلاصة

يتواجد الفلسبار البوتاسي في صخور العنيجي الجرانيتية على هيئة بلورات كبيرة الحجم وبها محتويات من بلورات البلاجيوكلاز مرتبة في نطاقات موازية للاسطح البلورية الخارجية للفلسبار البوتاسي . كما تتواجد هذه المحتويات احيانا موازية لضلعي الزاوية الحادة المتكونة على امتداد السطح التوأمي لبلورات الفلسبار البوتاسي . تتواجد بعض المحتويات من البيوتيت مرتبة نفس الترتيب . تدل هذه المشاهدات ـ بالاضافة الى شكل معدن البلاجيوكلاز وتركيبه الكيميائي ـ على أن بلورات الفلسبار البوتاسي قد نمت في صهير سليسي وهذا بالتالي يدل على نشأة الصخور الجرانيتية نفسها من الصهير .

* العنوان الدائم : هيئة المواد النووية ، بريد الطاقة الذرية ، القاهرة ، ج . م . ع .