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# The significance of zircons as a guide to the petrogenesis of granites from Ras Barud area, Eastern Desert, Egypt

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## ABSTRACT

The formation of elbow twin in the examined zircons suggests that they were crystallised from a melt which shows a sudden variation in the rate of crystallisation. The presence of parallel growth in these zircons suggested that a high proportion of zircons was crystallised early from a low viscous melt which permitted the movement and collision of growing zircon crystals. Necked zircon crystals are observed in some granites which indicate that a process of dissolution took place through a late stage of chemical corrosion during the formation of Ras Barud granites. The zircons of the examined granitic rocks are characterised by sharply bounded euhedral crystals, uniformity in crystal morphology and the elongation ratios which are mainly above two. It is evident that the previous characters of the zircons mainly suggest the magmatic origin of the host granites of Ras Barud area.

## INTRODUCTION

The investigated zircons are separated from Ras Barud granitic rocks which form one of the numerous granitic batholiths of the basement complex in the Eastern Desert of Egypt. In a previous paper (Hilmy *et al.* 1976), the textural properties of feldspars in Ras Barud granitic rocks were described, and the location map and geological map of the area were given. The present study deals with the morphological and mineralogical characters of zircons which give considerable information about the genesis of zircons and their host rocks. It is well known that the so-called heavy accessory minerals (especially zircons) generally exhibit more or less idiomorphic forms and hence are considered to represent the very earliest phase of crystallisation. Consequently zircons constitute a good criterion for the mode of formation of granites. Therefore, zircons are suitable for investigations of distribution phenomena of the minerals which are intimately related to the magmatic emplacement of granitic bodies.

## FIELD OBSERVATIONS

Ras Barud granitic batholith consists mainly of red, pink, buff, greyish-white and white granites, adamellites, grey granodiorites and quartz diorites. The sequence of

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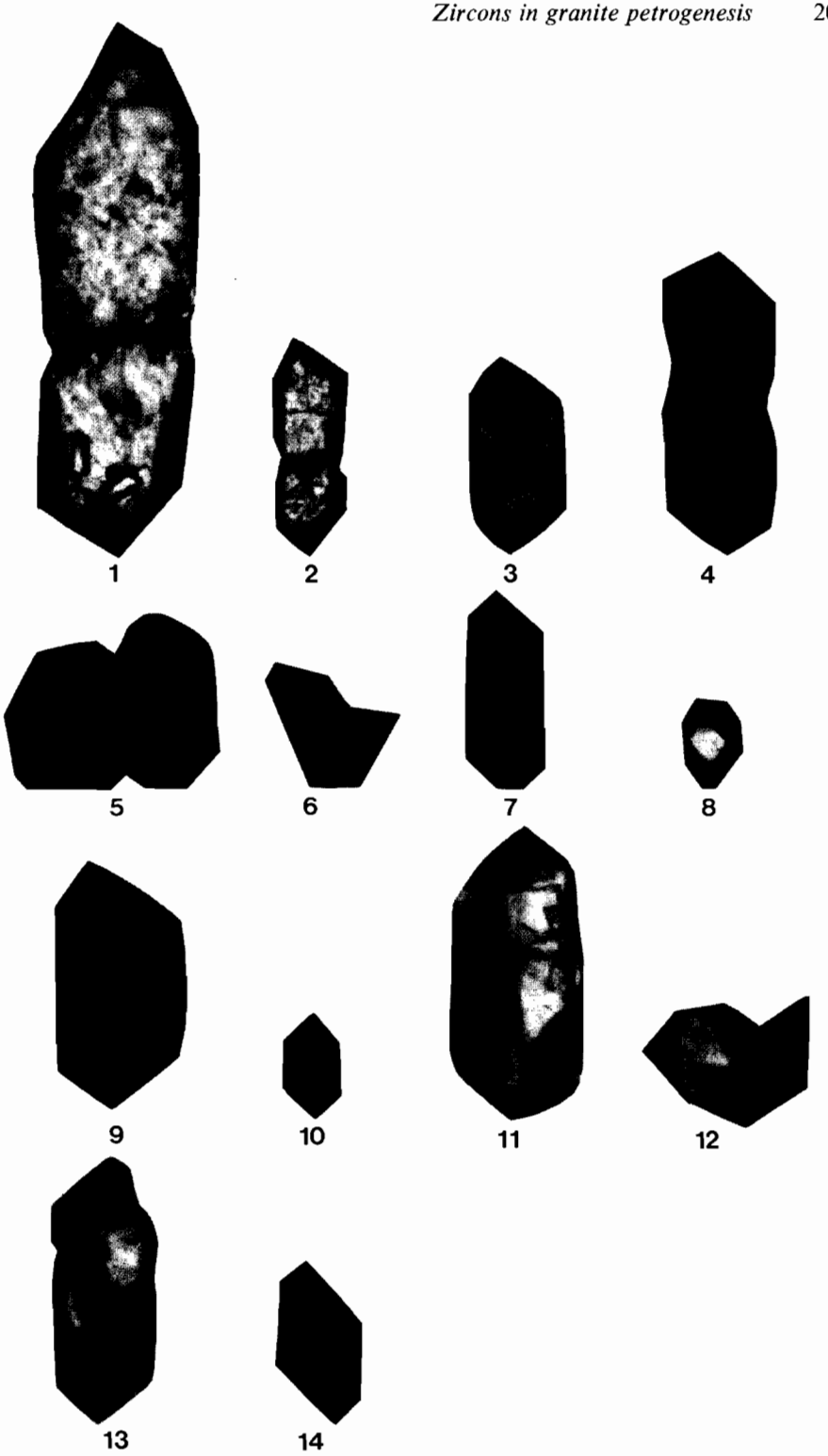
the granitic rock units is mostly homogeneous. A geological map of the granitic rocks of Ras Barud has been constructed on the basis of field observations. The granitic rocks show a very rough zonal form. The red granites occupy the core of the batholith, whereas the pink and buff granites surround the red type. Greyish-white and white granites crop out at the outer margins of the pink and buff granites. Sharp contacts between the different types are observed and chilled and gradational contacts are slightly recorded. Porphyritic varieties are easily recognized among the granitic rocks of Ras Barud. The granitic rocks are dissected by a few basic, intermediate and acidic post-granite dykes, and also by fair amounts of quartz, epidote and feldspar veins which run in different directions within the examined rocks.

## PETROGRAPHY

The petrographic studies of the field rock units gave rise to 45 varieties classified according to their mineral constituents. Under the microscope, the granitic rocks are holocrystalline with hypidiomorphic granular texture; some porphyritic varieties are also present. The granitic rocks consist mainly of quartz, orthoclase, microcline, albite, biotite, muscovite and hornblende. Quartz occurs as anhedral crystals, reaching up to 2·2 mm across and filling the interstices of the other minerals. Quartz is mainly clear and occasionally free of cracks. Orthoclase forms altered kaolinised crystals which were corroded by quartz. They vary from 1·2 to 2·2 mm in length and from 1·0 to 1·8 mm in breadth. Few microcline crystals are observed in association with small quartz grains. The microcline is mostly fresh and free of kaolinisation. The plagioclase forms anhedral tabular crystals ranging from albite to oligoclase ($Ab_{95}$ to $Ab_{80}$). The plagioclase plates vary from 1·3 to 2·5 mm in length and from 0·7 to 1·0 mm in breadth. Some plagioclases are clear and they show polysynthetic twinning. Small flakes of muscovite are present inside the plagioclase crystals which are sericitised. In some varieties of the greyish-white granite, the potassium and sodium feldspars are rimmed by myrmekite in the form of vermicular shapes. Perthite and microcline perthite are observed in the greyish-white varieties in which some samples show clear intergrowth between perthite and quartz rods. Green and brown flakes of biotite are present in many types of granites. The green variety is pleochroic, with X = pale yellow-green, Y = Z = dark green. The brown variety shows strong pleochroism, with X = straw-yellow, Y = Z = brown. Biotite forms irregular flakes attaining up to 3·6 mm in length and 1·4 mm in breadth. Some biotite flakes are corroded by quartz and feldspar and occasionally contain muscovite wisps with aggregates of epidote along their cleavage. Stout flakes of muscovite are present in fair amount in some of the greyish-white varieties. They vary from 1·3 to 2·1 mm in length and from 0·9 to 1·8 mm in breadth.

The green hornblende crystals are considered the sole mafic mineral in some varieties. They vary from 0·8 to 1·3 mm in length and from 0·6 to 1·1 mm in breadth

**Fig. 1.** Forms of zircon from granites of Ras Barud. Red granites: 1 and 2, euhedral prismatic necked zircon crystals, ((1) × 500 (2) × 250). Pink granites: 3, prismatic crystal with apatite inclusion (× 250); 4, necked zircon crystal (× 250). Buff granites: 5, parallel growth in short stubby zircon crystal (× 250); 6, elbow twinning in zircon crystal (× 50); 7, typical euhedral prismatic crystal (× 250); 8, short stubby zircon crystal (× 50); 9, euhedral prismatic crystal with opaque inclusions (× 250); 10, short stubby euhedral prismatic zircon crystal (× 50); 11, euhedral prismatic zircon crystal (× 250); 12, elbow twinning in zircon crystal (× 250); 13, necked zircon crystal with iron inclusions (× 250). Greyish white granites: 14, Tetragonal bipyramid zircon crystal (× 50).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and are strongly pleochroic, with X = pale yellow, Y = pale brownish-green, Z = dark greenish-brown. Simple twinning is common in some hornblende crystals. The hornblende crystals are mostly sieved by subrounded quartz grains. Graphic intergrowths are observed mainly in many types of granites. White granite shows, intergrowths in which fine radiating rods of quartz form spherulites which give rise to granophyric variety. Some varieties of white granite are free form mafic minerals and these give rise to leuco granite. Zircon, epidote and iron ore are present as accessory minerals,

## MORPHOLOGICAL STUDY OF ZIRCONS

The investigated zircons are separated from 25 varieties of granites which comprise red, pink, buff, greyish-white and white granites. The sample (about 200 g) is crushed and then passed through 100 mesh sieve (0·149 mm opening). The crushed powders were treated with bromoform to separate the light and dark fractions. Zircons were purified from the other heavy minerals by using isodynamic separator. The morphological characters of zircon indicate the origin of this mineral and the host rocks. The abundance of zircons through the five types of granites is marked. The buff and greyish

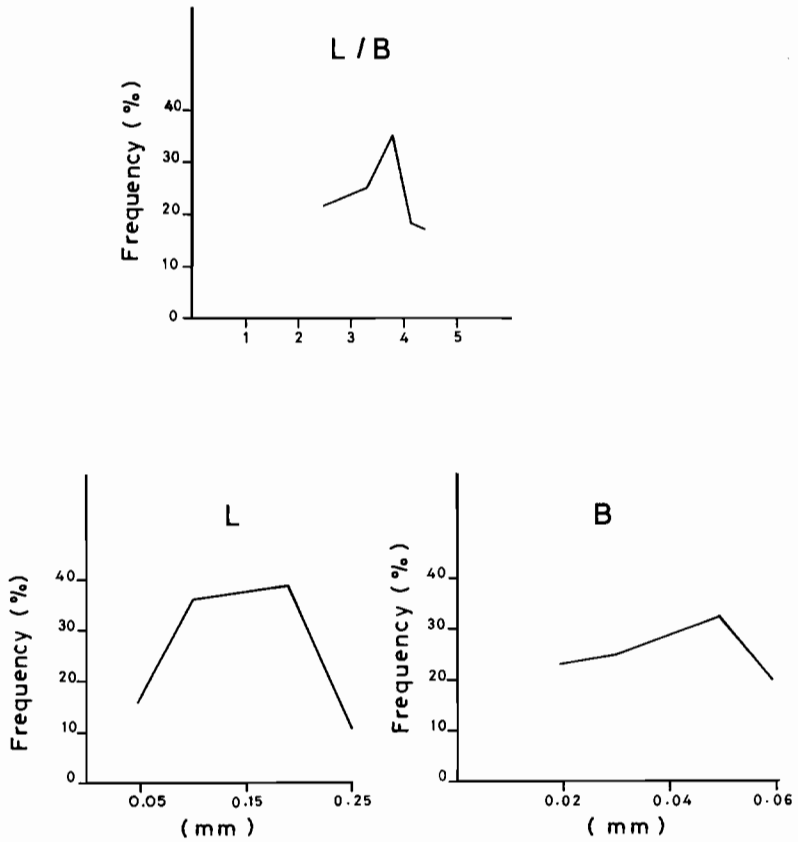


**Fig. 2.** Size frequency curves for zircon of red granites.

**Table 1.** Measurements and elongation of the investigated zircons

| Rock type | Frequencies (%) | | | Length in mm | Breadth in mm | Elongation |
|---|---|---|---|---|---|---|
| | L | B | L/B | L | B | L/B |
| Red granites | 38 | 32 | 35 | 0·19 | 0·05 | 3·8 |
| | 35 | 25 | 25 | 0·10 | 0·03 | 3·3 |
| | 16 | 23 | 22 | 0·05 | 0·02 | 2·5 |
| | 11 | 20 | 18 | 0·25 | 0·06 | 4·1 |
| Pink granites | 38 | 35 | 40 | 0·10 | 0·03 | 3·3 |
| | 30 | 30 | 25 | 0·13 | 0·05 | 2·6 |
| | 20 | 20 | 22 | 0·15 | 0·05 | 3·0 |
| | 12 | 15 | 13 | 0·09 | 0·04 | 2·2 |
| Buff granites | 50 | 60 | 45 | 0·13 | 0·05 | 2·6 |
| | 27 | 30 | 35 | 0·09 | 0·03 | 3·0 |
| | 23 | 10 | 20 | 0·18 | 0·06 | 3·0 |
| Greyish white granites | 34 | 40 | 30 | 0·11 | 0·05 | 2·2 |
| | 22 | 30 | 25 | 0·08 | 0·04 | 2·0 |
| | 17 | 15 | 20 | 0·14 | 0·06 | 2·3 |
| | 15 | 10 | 15 | 0·18 | 0·09 | 2·0 |
| | 12 | 5 | 10 | 0·05 | 0·02 | 2·5 |

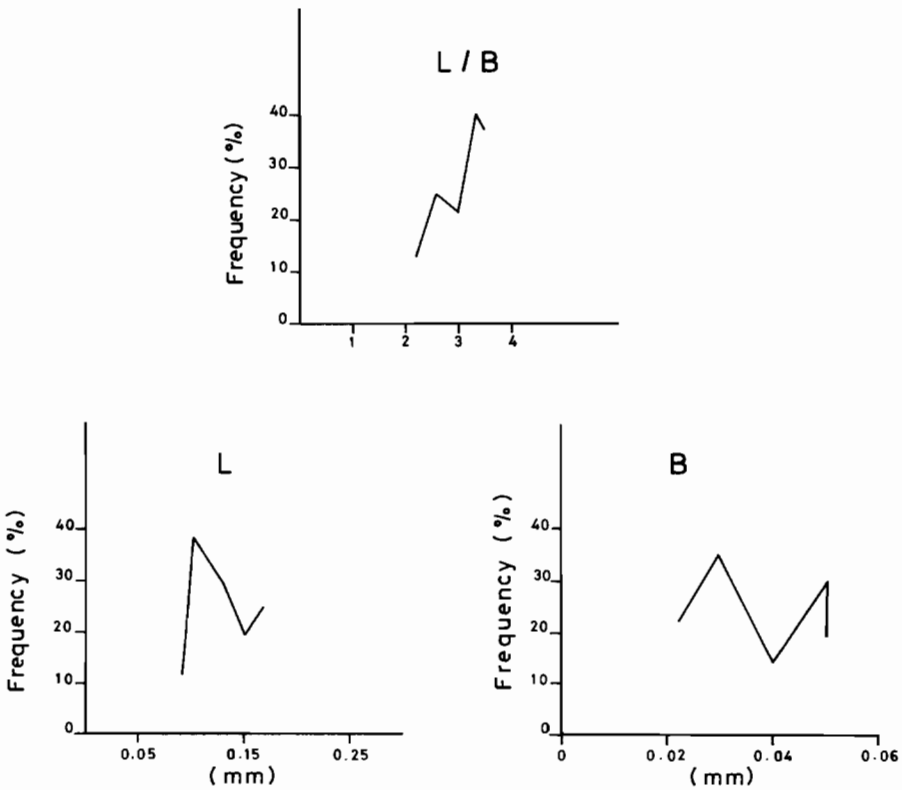


**Fig. 3.** Size frequency curves for zircon of pink granites.

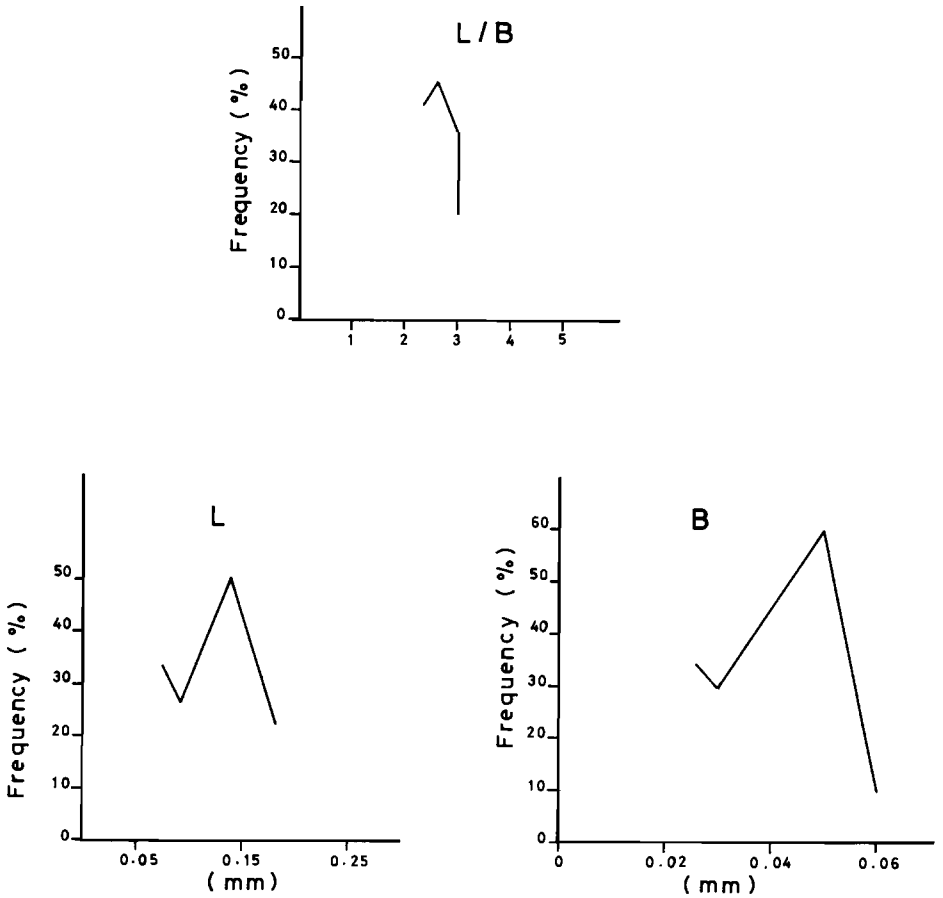


**Fig. 4.** Size frequency curves for zircon of buff granites.

white-granites contain fair amounts of zircons while the pink and red types contain less amounts of zircons. This mineral is nearly absent in the white granite. Most of the examined zircons are enclosed in biotites and quartz, which suggests the possibility of early crystallisation of zircon crystals (Alper & Poldervaart 1957). The zircons are mainly characterised by different colours such as brown, dark brown, pale pink, pale yellow and colourless. The study of the morphological characters of the zircons shows that most zircons form prismatic euhedral crystals which occur in different shapes comprising elongated longitudinal sections and square cross-sections. There are three dominant forms in the zircons including basal pinacoid, tetragonal prism and tetragonal bipyramid (Fig. 1). During the microscopic investigation of zircons the present authors observed twinned crystals in the buff granite. Typical elbow twinning of zircon is shown in Fig. 1 (6, 12). It is evident that twinning growth took place during physical and chemical changes under fluid magmatic conditions in addition to the presence of a consequence of crystal orientation.

Another form of twin growth which is termed parallel growth is observed in the zircons of the buff granite (Fig. 1 (5)). Such parallel growth describes two zircon

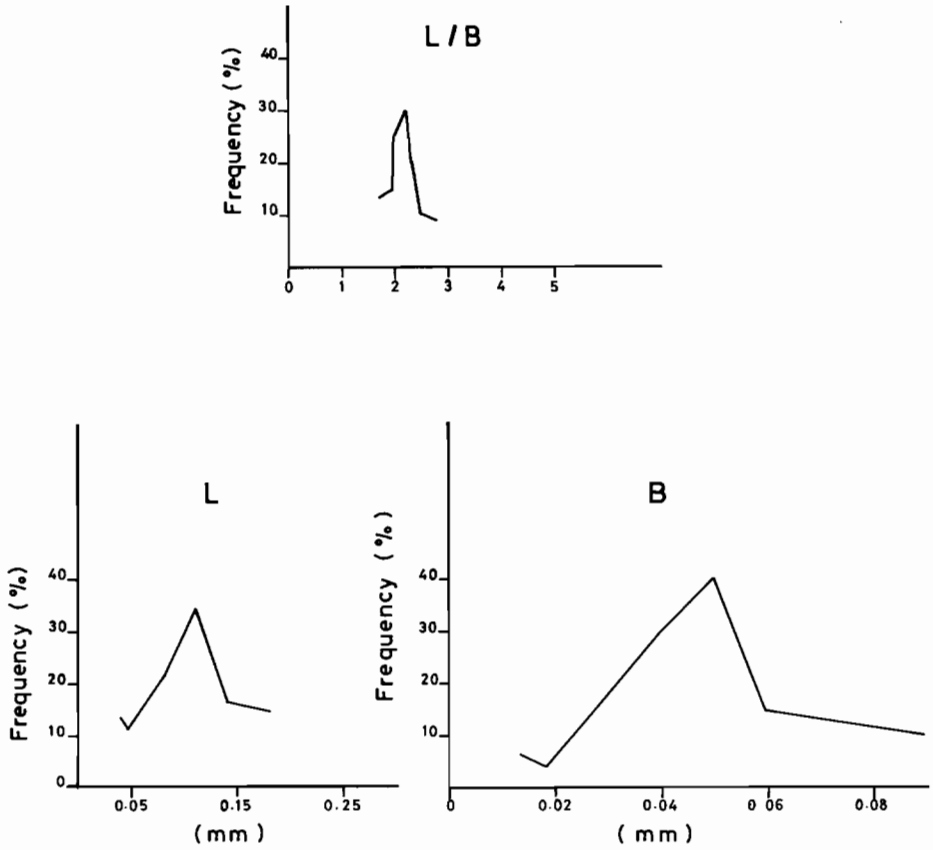


**Fig. 5.** Size frequency curves for zircon of greyish-white granites.

crystals contacted in parallel arrangement showing essentially parallel extinction. A necked crystal form is observed in the zircons of the red, pink and buff granites (Fig. 1 (1, 2, 4, 13)). The necked crystal is expressed as a concentric constriction associated with a distinct intense black line. The presence of elbow twin suggests that these zircons were crystallised from a melt characterised by sudden variation in the rate of crystallisation. The formation of parallel growth suggests that a high proportion of zircon crystals crystallised early from a melt of low viscosity which permitted the movement and collision of growing zircon crystals. The presence of necked crystals indicates that a process of dissolution took place due to a late stage of chemical corrosion accompanied by brittle fracturing during the granite-forming events. Zoning is not common in the examined zircons. The different types of twinning in zircons from other localities have been studied by many authors including Gupia (1973) and Jocelyn & Pidgeon (1974).

The length (L) and breadth (B) measurements and the elongation data of the investigated zircons are presented in Table 1. Figs. 2–5 show the length, breadth and elongation frequencies of the zircons in the red, pink, buff and greyish-white granites. The frequency curves indicate that the zircons have the following elongations:

1. Red granite 2·5–4·1
2. Pink granite 2·2–3·3
3. Buff granite 2·6–3·0
4. Greyish white granite 2·0–2·5

The examined zircons in the four types of granite from Ras Barud show uniformity of elongation varying from 2·0 in the greyish-white granite to 4·1 in the red granite. It is evident that zircons from the granites of Ras Barud batholith exhibit morphological uniformity, i.e. uniformity in crystal habit and elongation. This uniformity throughout all granite types is the most convincing evidence of the early crystallisation of zircon and of the relative homogeneity of the granite batholith. The relative homogeneity is, however, an argument in favour of the magmatic theory of granite formation. Therefore, the uniformity in the crystal habit and elongation of the zircons suggest a magmatic origin for the host rocks in addition to the early crystallization of these zircons (Poldervaart 1956; Clifford *et al.* 1962).

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# دلالة معدن الزيركون فى الارشاد
# عن أصل الصخور الجرانيتية
# لمنطقة راس بارود ـ بالصحراء الشرقية المصرية

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## خلاصـــــة

إن وجود التوأمية فى معدن الزيركون يوضح أن هذا المعدن قد تبلور من صهير حدثت له تغيرات مفاجئة فى معدل تبلوره ، كما أن ظهور النمو الموازى فى معدن الزيركون يوضح أنه قد تبلور مبكرا من صهير ذى لزوجة منخفضة ، مما ساعد على سهولة حركة بلورات الزيركون ، وبالتالى سهولة نموها متوازية .

إن وجود معدن الزيركون المحزز يوضح حدوث عملية ذوبان فى مرحلة متأخرة ، مما أدى إلى تآكل كيمائى لبعض معادن الزيركون . لقد أوضحت الدراسة المورفولوجية لمعادن الزيركون أنها تتميز ببلورات متجانسة كاملة الأوجـــه ، بالاضافـــة إلى أن نسبـــة الاستطالـــة فى هذه المعـــادن تزيد دائما على ٢ ، وعليه فان كل الاستنتاجات السابقة تدعم الأصل الصهيرى للصخور الجرانيتية الحاملة لمعدن الزيركون .

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