MONOMINERALIC SYNNEUSIS IN ZIRCON

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Abstract

Synneusis, which is a diagnostic feature of the fabric of magmatic crystallisation, is strikingly exhibited by zircon. Various habits of zircon aggregates in 'monomineralic synneusis' relation are parallel growths, dumb-bell shaped or necked crystals, synneusis twins, interpenetration twins, overgrowths, fused aggregates of randomly oriented crystals, and odd shapes. Recognition of the various types of zircon in synneusis relation is useful in problems of provenance and petrogenesis.

Zircon in calc-alkaline rocks and in some of the alkaline rocks is of early crystallisation (Poldervaart[9], p. 550). These early-formed crystals, while moving about in the melt, come into contact with, and adhere to, growth surfaces of other crystals (Schermerhorn[14]). Such a clustering of the crystals of a mineral occurring in association with other minerals may be termed as "polymineralic synneusis", while the clustering of the crystals made up exclusively of one mineral could be termed as "monomineralic synneusis". Some investigators (Poldervaart[9], p. 547; Moorehouse[6]; Schermerhorn[14]; Vance[16], p. 22) have shown the preferential association of zircon with biotite, hornblende, and opaque ores. Instances of the clusters consisting exclusively of zircon crystals have also been cited by Morozewicz[7] (p. 16) and Larsen and Poldervaart[5] (p. 555).

Zircons, isolated from the black sand concentrates, occurring along the east and west coasts of South India and studied by Prasad[12], were used in the present study. Zircon crystals, in synneusis relation, are classified as: 1. Parallel synneusis; 2. Sub-parallel synneusis; 3. Random synneusis; 4. Synneusis twinning; and 5. Post-synneusis development comprising: (*a*) Over-growths; (*b*) Interpenetration twins; and (*c*) Odd-shaped crystals.

Parallel Synneusis

Parallel synneusis in zircon is commonly exhibited by parallel growths in which two or more zircons are joined with their long axes in parallel position (Figs. 1 to 4) and showing essentially parallel extinction. Such types have been referred to as "aggregate crystals" (Poldervaart and Eckelmann[11]). Parallel growth is a case of synneusis in which union of crystals takes place on (100) face. Another case of parallel synneusis is the union of crystals on the pyramidal face (Figs. 19 and 20). Such cases have been interpreted (Jocelyn and Pidgeon[2]) as "cases of central dislocations accompanied by slight displacement".

Dumb-Bell or Necked Crystals

Zircons with a constriction, or a narrow notch in the middle of a grain (Fig. 21), have been referred to as "dumb-bell" or "necked" crystals. In some grains, there may be more than one neck (Fig. 22). According to Murthy *et al.*[8] (p. 35) these types are common in metasomatised and migmatised rocks; while Verspyck[17] (p. 68) and Jocelyn and Piageon[2] (p. 593) consider them as resultant of corrosion. But the present writer believes that these necked-crystals are formed by the attachment of two or more well-developed crystals on their basal pinacoidal face (001) just like twinning in the hemimorphic form of a calamine crystal (Dana[1], p. 182; Fig. 413). But in the case of zircon, (001) is not a twin plane as the plane that is a symmetry plane in the individual crystal cannot become a twin plane. After the attachment of the crystals on (001) face, the grains may be rounded off due either to magmatic corrosion or to abrasion during sedimentary processes. Dana[1] states that cases have been described of the grouping of crystals of the same substance, in which a certain plane is common to the different individuals but which the normal laws of twinning cannot explain. Parallel synneusis in zircon is a case of this type.

Possible mechanisms, proposed by Vance[16] to explain parallel synneusis, involve minimising of interfacial energy by rotation of crystals after contact, or random collision with only those crystals uniting that are in the preferred orientation, or "long-range" forces orienting crystals before contact.

Although synneusis commonly involves union of crystals in parallel position, deviation from such regular grouping, referred to as "sub-parallel synneusis", is not uncommon (Figs. 5, 6 and 7).

Zircon also occurs as fused aggregates (Figs. 8, 9 and 10) which are reported to result from granulation and recrystallisation during ultrametamorphism [Poldervaart and Von Backstrom[10] (p. 467)]. But the present author believes that these fused aggregates are a case of random synneusis (Viola[18];

Kohler and Raaz[3]; Kraus[4]) in which the participating crystals have erratic orientation (Figs. 8, 9 and 10). The crystals in these cases must have been relatively large at the time of initial contact.

Synneusis Twins

The criteria, suggested by Vance[16], to distinguish between growth twins (Figs. 16 and 26) and synneusis twins (Figs. 23, 24 and 25) are briefly summarised in Table I.

Table I

Sl. No.	Feature	Growth Twin	Synneusis Twin
1.	Twinned Crystal	Only one crystal with a superior fit of the twin units	Two crystals with a misfit of the twin units
2.	Twin Units	Symmetrical	Assymmetrical
3.	Composition Plane	Regular, and parallel to the ideal crystallographic orientation	Irregular

It is significant to note that in some beach placers, the incidence of the frequency of the synneusis twins is more than that of the growth twins in zircon.

Post-Synneusis Development

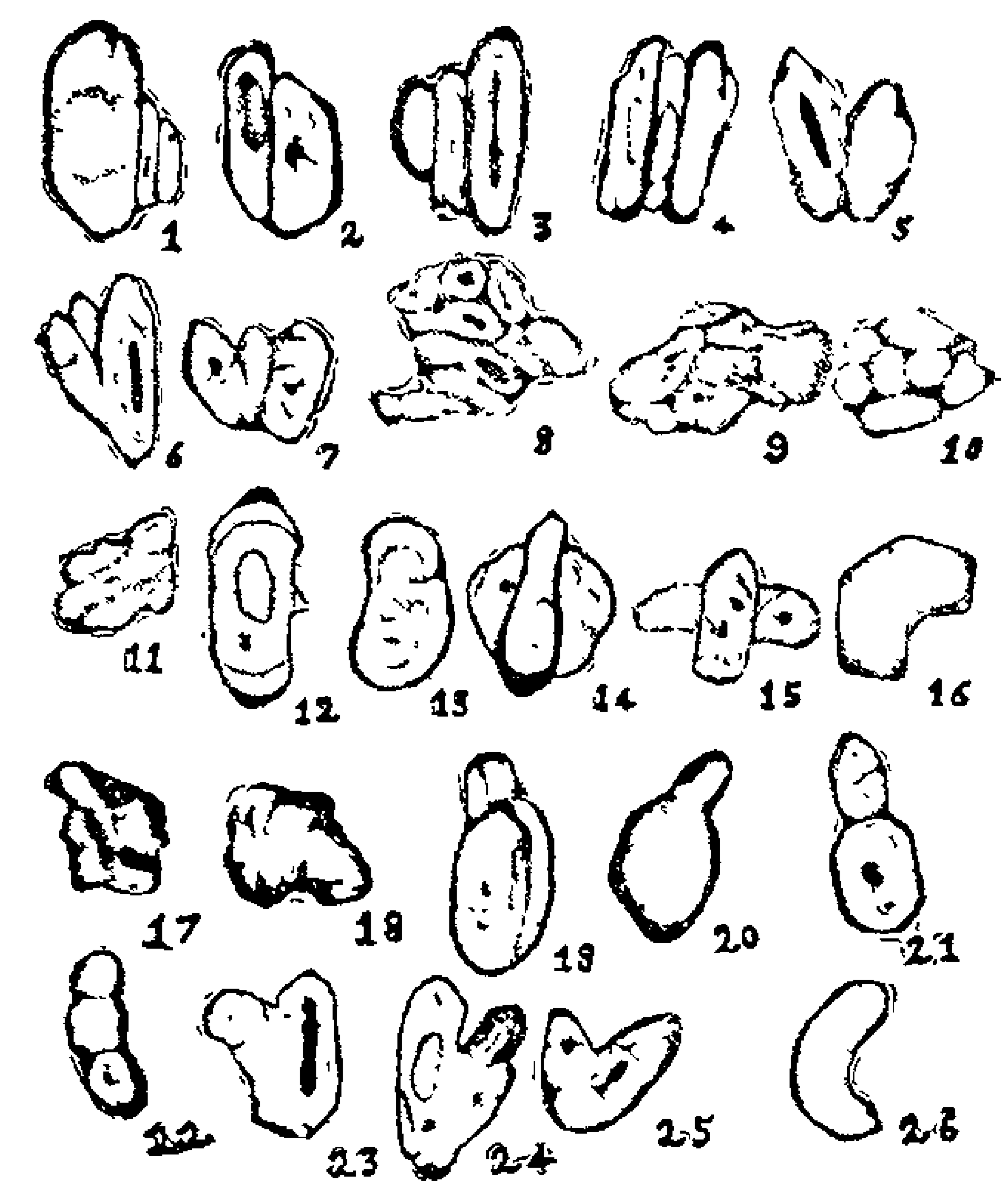
Post-synneusis development in zircon may be incremental or detrimental to the growth of the participating crystals. Post-synneusis developments, incremental to the growth of the crystals, comprise overgrowths and interpenetration twins.

Overgrowths

In this case, the initial misfit of the crystals in synneusis relation is eliminated by the preferential crystal growth along the re-entrant angles and steps thus eliminating the external morphological irregularities and eventually producing a single crystal (Fig. 12); further growth gives rise to the development of a shell or successive shells. Examination of the overgrowths under the microscope at high magnifications (× 300) reveals the presence of a core consisting of more than one grain (Fig. 13) indicating that the merger is not complete in certain cases.

Interpenetration Twins

Interpenetration twins in zircon (Figs. 14 and 15) have also been recorded by Subrahmanyam and Rao[15] (p. 275) and Jocelyn and Pidgeon[2] (Fig. 3 : 3, p. 590). Synneusis twinning arises through union of two crystals on a crystal face or a combination of faces. The composition surface is thus the planar surface of initial attachment. During continued crystallisation, after synneusis, the two individuals are intergrown as interpenetration twin. Jocelyn and Pidgeon[2] (p. 592) envisage such a form as a combination of synneusis and late growth-twinning.



Figs. 1–26. Monomineralic synneusis in zircon from the littoral black sand placers of South India. Figs. 1–4. Parallel synneusis on (100) face. Figs. 5, 6, and 7. Sub-parallel synneusis. Figs. 8–11. Fused aggregates in random synneusis. Figs. 12 and 13. Overgrowths. Figs. 14 and 15. Interpenetration twins. Figs. 16 and 26. Geniculate twins. Figs. 17 and 18. Odd-shaped grains. Figs. 19 and 20. Parallel synneusis on (111) face. Figs. 21 and 22. Necked crystals representing parallel synneusis on (001) face. Figs. 23, 24 and 25. Synneusis twins.

Zircons with Odd Shapes

Odd shapes in zircon are believed to be a result of post-synneusis development, detrimental to the growth of crystals. The boundaries between grains held in synneusis relation are surfaces of weaker bonding than crystallographic planes within single crystals. Hence many of the zircons in synneusis relation might have been detached mechanically producing odd shapes (Figs. 17 and 18). In necked crystals, the "necks" seem to be weaker than the other surfaces of synneusis relation, as the initial attachment of the grains on (001) is less stable than those of the parallel synneusis on (100) or twin orientations. The surfaces of parallel synneusis with attachment on (111) face are likewise weak mechanically. Paucity of the necked crystals and relatively common occurrence of odd-shaped zircon grains in the placers suggest that they have suffered mechanical breakage in the high energy beach environment.

In view of the undoubted igneous origin of synneusis, recognition of the various types of zircon in synneusis relation is of much value in problems of provenance, parentage, and petrogenesis.

ACKNOWLEDGEMENTS

The author is thankful to Prof. M. G. C. Naidu for providing the laboratory facilities and to Dr. K. V. Suryanarayana for going through the manuscript and for offering valuable suggestions. Mr. A. N. Vyasa Rao has kindly drawn the text-figures.

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EFFECTS OF SEED TREATMENT WITH ^{60}CO GAMMA RAYS AND MICRONUTRIENTS ON GERMINATION AND GROWTH OF CORN SEEDLINGS

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ABSTRACT

Gamma irradiation and soaking in solutions of some micronutrient elements, as presowing treatments of corn seeds, towards improving the germination of seeds, and increasing the growth of seedlings were investigated. The seeds were exposed to 12 irradiation doses of gamma rays ranging from 250–8000 R. It was found that stimulatory effects on the germination percentage and capacity of seeds as well as the height and the dry weight of seedlings were exerted only by the low irradiation doses from 500–1000 R. Soaking cornseeds, before sowing, in any of the 4 concentrations ranging from 250–1000 ppm of molybdenum, manganese and zinc indicated that molybdenum treatment increased plant height and the dry weight of seedlings; 500 ppm molybdenum gave the best effect. Irradiation of 500 ppm molybdenum soaked seeds with low doses of gamma rays stimulated the germination process and early growth of seedlings, with the 500 R dose being most effective.

INTRODUCTION

PRESOWING treatments of seeds with gamma rays was reported to enhance germination of seeds and to increase the growth of the seedlings (Woodstock and Justic, 1967 and Singh, 1970). However, such stimulatory effects were found to be induced by certain exposure doses which depends upon plant species (Kuzin, 1963).

Soaking of seeds prior to sowing in solutions containing certain micronutrients was also reported