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Zircons in the granitic rocks of southeastern South Australia

J. B. Colwell

A morphological study of zircons from the granitic rocks of southeastern South Australia has been made using reduced major axes, length/breadth ratios, colour, zoning and other features. In general, zircons in the biotite adamellites (Encounter Bay and Kingston areas) are more elongate, less euhedral and freer of inclusions and zoning than those occurring in the other granitic rocks of the region. Results suggest that the biotite adamellites are genetically related (they share the same zircon characteristics) and that they are unrelated to the more widespread 'eastern zone' of hornblende-biotite granite, quartz porphyry and hornblende and biotite microgranite. The rocks in the eastern zone share very similar zircons and appear to be related.

Introduction

Granitic rocks, which are apparently of Early Palaeozoic age, occur as discontinuous outcrops over a wide area of southeastern South Australia, and extend into Western Victoria (Fig. 1). They form part of the Padthaway Ridge, an area of shallow basement separating sediments of the Otway (Gambier Embayment) and Murray Basins. The rocks, which consist of rhyolite, quartz keratophyre, hornblende/biotite granite and microgranite, and biotite adamellite, have been described by Mawson and co-workers (1943 to 1945), Henstridge (1970), and Rochow (1971). They form a western zone extending along the eastern flank of the Mount Lofty metamorphic belt (including the "Encounter Bay Granites") and an eastern zone, the "Murray Bridge Granites", extending southeastwards from the metamorphic belt to Dergholm in western Victoria (Milnes & others, 1977).

This paper presents the results of a morphological study of zircon from the granitic rocks, work undertaken as part of an overall investigation of heavy minerals occurring in the late Cainozoic sediments, and igneous and other source rocks of the region (Colwell, 1979). The purpose of this paper was to see whether the various granitic rocks of the region could be correlated on the basis of their zircon fraction, the term correlated implying derivation from the same or closely related magmas.

A number of workers (for example, Poldervaart, 1956; Larsen & Poldervaart, 1957; Spotts, 1962) have noted that the relatively early formation and short range of crystallisation of zircon in granitic rocks commonly results in crystals of the mineral, in a single intrusive body or related intrusive bodies, having similar morphological or elongation characteristics. These characteristics can be relatively easily measured in grain mounts and the results expressed statistically as length/breadth ratios and reduced major axes.

Method of study

Samples were collected from outcrop at the sites shown in Figure 2. Samples were crushed in a jaw crusher and disc grinder, and the material split and sieved into –88, 88 to 177, and 177 to 500 micronsize fractions. Heavy minerals were separated from each fraction in bromoform. In all cases, most of the zircons were found to lie in the –88 micron fraction. Grain mounts of this fraction were prepared using "De Pex" as the mounting medium. Conclusions based on this work make the assumption that the –88 micron zircons are representative.

Two-hundred unbroken zircon crystals were examined for each sample, using a polarising microscope fitted with a mechanical stage. Colour, habit, zoning, overgrowths and inclusions were noted. Length and breadth measurements were made using a micrometer ocular, and the following values calculated: mean length ($\bar{x}$) of the zircons, mean breadth ($\bar{y}$), standard deviation of the length (s_x), standard deviation of the breadth

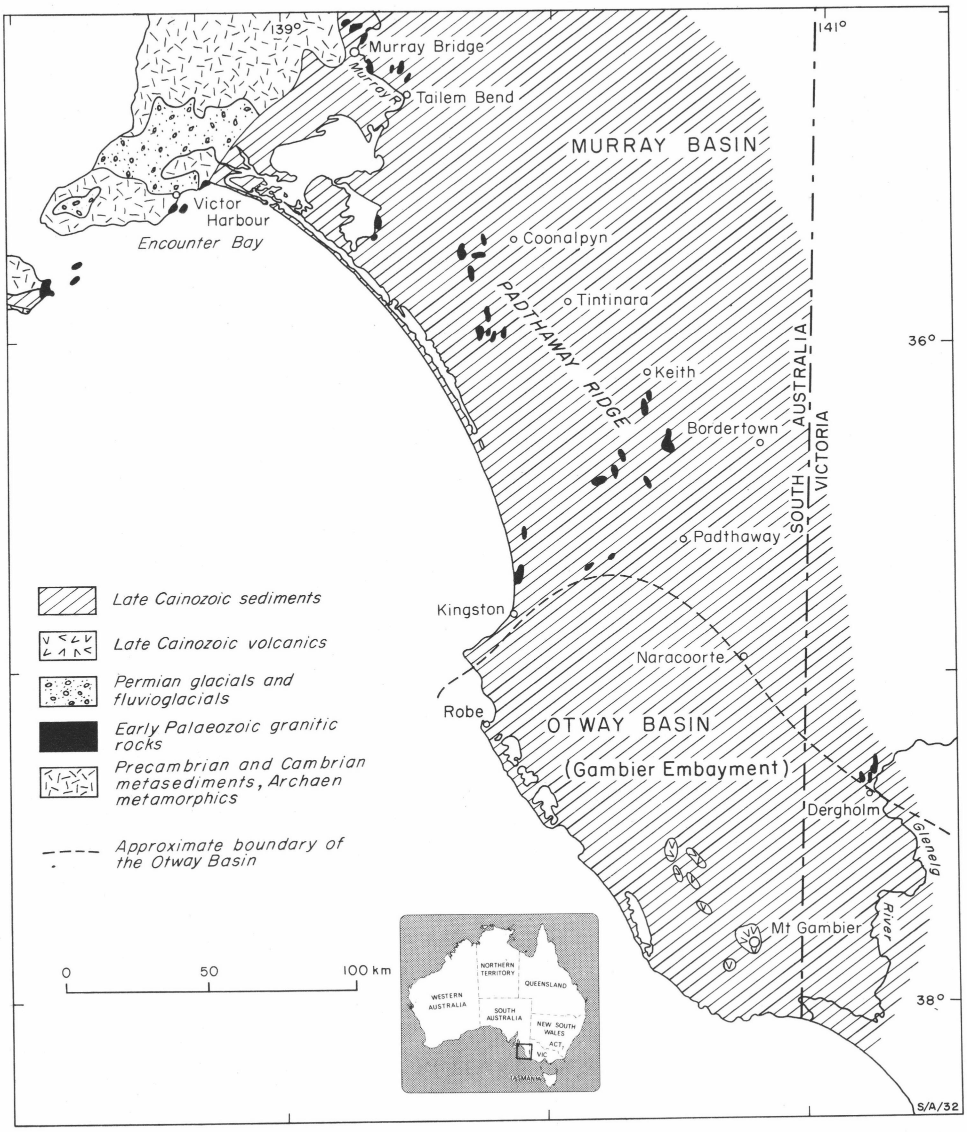

Figure 1. General geology of southeastern South Australia.

(s_y), and slope (a) (equal to s_y/s_x). Mean length and mean breadth were plotted as a point on a length-versus-breadth graph, and a straight line with a slope equal to the ratio (a) drawn through the point ($\bar{x}$, $\bar{y}$). This line is the reduced major axis (Kermack & Haldane, 1950) and represents the relative growth trend or pattern of crystal growth for the zircon sample (Spotts, 1962).

Comparisons of the plots of the reduced major axes were made by visual inspection. Further tests of elongation characteristics were made using elongation-frequency diagrams.

In all, 14 samples were used in the study: 4 of biotite adamellite, 2 of quartz porphyry, 3 of hornblende-biotite granite, 3 of biotite granite and 2 of hornblende granite. Petrographic descriptions of the samples are available (Colwell, 1976). A sample of rhyolite (Papineau Rocks) failed to provide sufficient zircons for study.

Results and discussion

Typical zircons extracted from the rocks are shown in Figure 3. Reduced major axes are plotted in Figure 4, and frequency polygons of zircon elongation in Figure 5. Colour, zoning, and other features of the zircons are summarised in Table 1.

The zircon data separate the biotite adamellite from the other rocks. In general, zircons in the biotite adamellite are more elongate, less euhedral, and freer of inclusions and zoning than those occurring in the other rocks. Crystal growth trends (indicated by reduced major axes) differ in a similar fashion. No separation is apparent between the biotite adamellite of the Encounter Bay area and occurrences farther south, northeast of Kingston.

The quartz porphyry (Mount Monster) and the hornblende, hornblende-biotite, and biotite granite and microgranite have the same or very similar zircon characteristics. This is consistent with general chemical and mineralogical similarities noted for the rocks by Mawson and coworkers (1943 to 1945).

Overall, the zircon study supports the view expressed by Mawson and coworkers, and others that the biotite adamellite bodies throughout the region are genetically related, and that they are unrelated to the more widespread 'eastern zone' of genetically related hornblende-biotite granite, quartz porphyry, and hornblende and biotite microgranite.

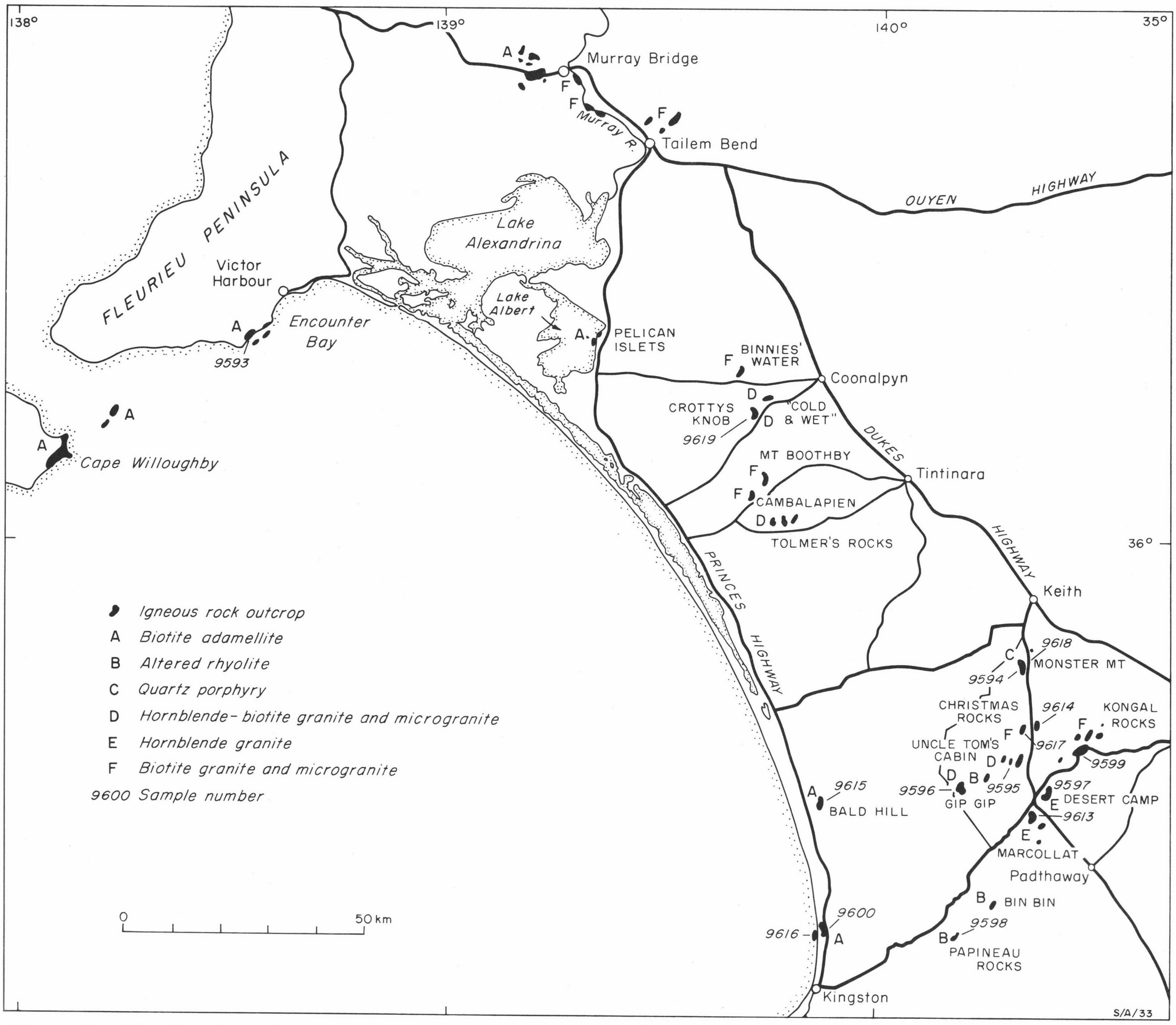

Figure 2. The location of the samples and the distribution of the different types of igneous rock.

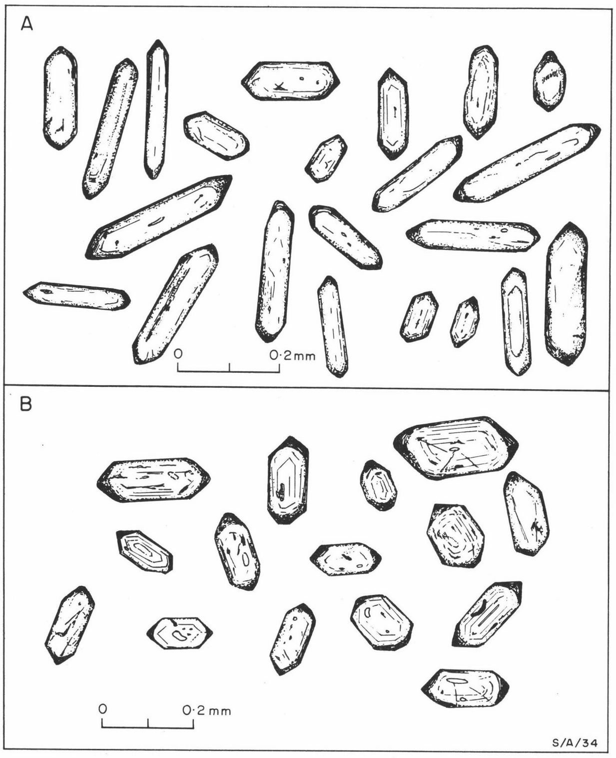

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Figure 3. Typical zircons in (A) the biotite adamellite, and (B) the hornblende/biotite granite, microgranite and quartz porphyry.

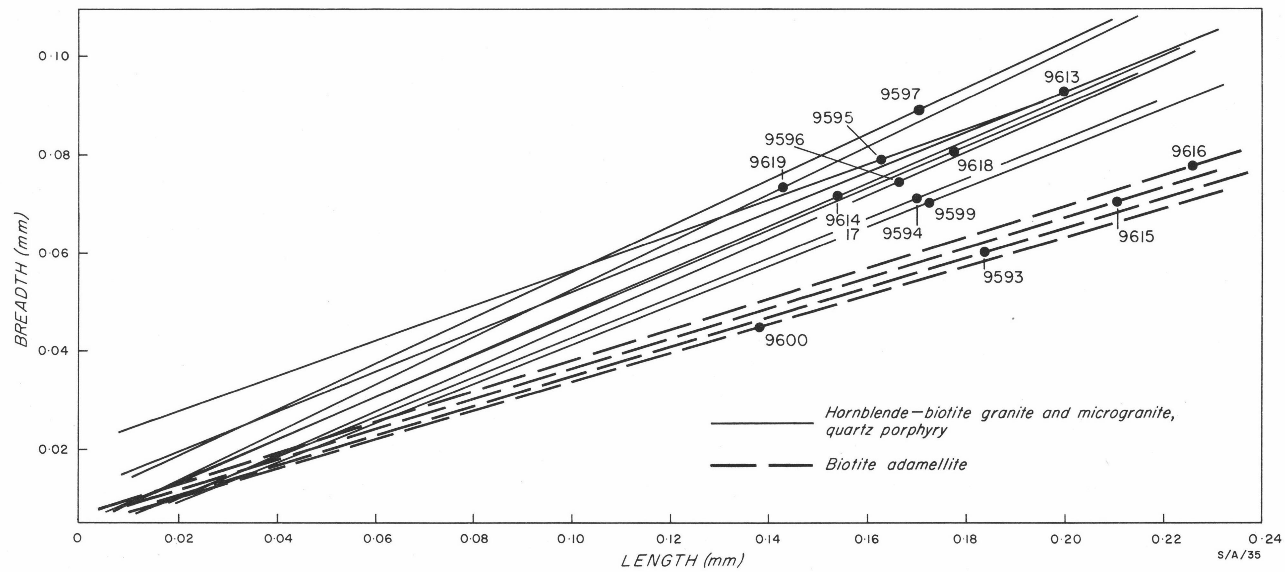

Figure 4. Reduced major axes.

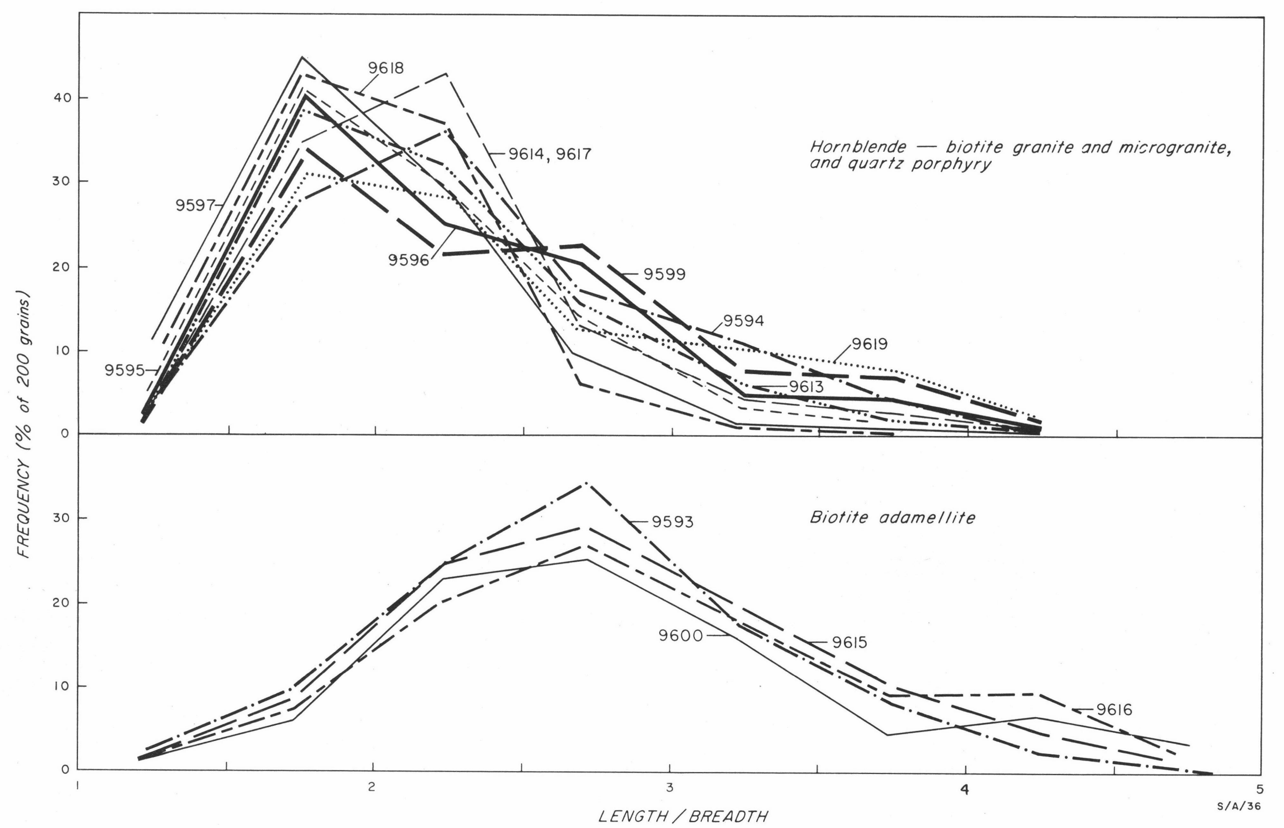

Figure 5. Frequency polygons of zircon elongation.

Sample No.		*9593*	*9616*	*9600*	*9615*	*9594*	*9618*	*9595*	*9619*	*9596*	*9599*	*9614 & 9617*	*9597*	*9613*
Rock type		*Adamellite*	*Adamellite*	*Adamellite*	*Adamellite*	*Quartz porphyry*	*Quartz porphyry*	*Hornblende-biotite granite*	*Hornblende-biotite granite*	*Hornblende-biotite granite*	*Biotite granite*	*Biotite granite*	*Hornblende granite*	*Hornblende granite*
		%	%	%	%	%	%	%	%	%	%	%	%	%
Colour	Colourless	90	94	97	95	96	98	93	94	92	92	93	97	99
	Pale yellow	10	6	3	5	4	2	5	6	5	8	7	3	1
	Pink	0	0	0	0	0	0	2	0	3	0	0	0	0
Habit	Euhedral	61	54	57	58	88	90	86	77	81	80	84	78	78
	Slightly rounded	31	32	30	27	10	9	12	16	15	14	14	18	18
	Corroded	8	14	13	15	2	1	2	7	4	6	2	4	4
Zoning	Moderate to well-developed	36	35	37	32	61	54	64	58	27	44	69	67	22
	Poorly developed	10	23	19	24	20	10	12	14	30	12	16	15	23
	Absent	54	42	44	44	19	36	24	28	43	44	15	18	55
Zircon overgrowths	Present	8	3	2	1	2	1	3	2	5	4	3	2	1
Inclusions	Absent or very rare	44	31	37	45	13	10	9	21	16	22	15	29	31

Table 1. Features of the zircons. %: percentage of the 200 zircons examined in each sample. Sample numbers are prefixed 7563.

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