JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol. 38, Dec. 1991, pp. 561-576.

Zircons from the Granitic Rocks of the Malani Igneous Suite : Morphological and Chemical Studies

NARESH KOCHHAR, G. VALLINAYAGAM AND L. N. GUPTA
Department of Geology, Panjab University, Chandigarh

Abstract : Zircons are hydrothermal or late-magmatic. The high UO_2 contents of the Tosham zircons reflect the high UO_2 of the host rocks. The Siwana granites, though high in Zr values, have very poor zircon yield. This is probably due to the peralkalinity of the Siwana magma.

Keywords : Malani igneous suite, zircon, Siwana granite, geochemistry, Rajasthan

INTRODUCTION

Zircon is an exceptionally significant common accessory mineral of granitic rocks. It has high melting point and is resistant to abrasion and weathering. It may survive through several cycles of crystallization and various stages of rock transformation. It exhibits considerable variation in shape, size, morphology, texture and trace element contents. Such variations may reflect (i) gradual or sudden changes in the external conditions of crystallization and in the composition of the crystallization medium and (ii) more than one generation of zircon growth during different igneous or metamorphic events. A systematic study of these variations may help in deciphering the petrogenetic processes involved during the crystallization of zircons and subsequent changes the rocks have undergone.

The present work is based on the study of zircons of the granitic rocks of the Malani igneous suite of the Tosham (Haryana), Jalor and Siwana areas, western Rajasthan, India (Fig.1). Physical characters, statistical parameters, EMP analyses have been studied to throw light on the petrogenesis of the above mentioned granitic rocks. Correlation of zircon data with field relationship and petrochemistry has been attempted.

MALANI IGNEOUS SUITE

The Malani Igneous Suite is comprised of acid volcanic and plutonic ring structures. The latter are of peralkaline to peraluminous nature, having A-type and high heat production (HHP) granites, with good potential for Sn, W, Mo, U, Th and REE. The emplacement of this suite was controlled by NE - SW trending lineaments and probably owed its origin to hot-spot tectonics (Kochhar, 1984., 1989).

SAMPLING

Large number of samples have been subjected to zircon separation. Tosham area - 5 samples ; from Jalor 2 out of 8 samples have yielded statistically reliable zircon crop (200 crystals). Siwana granites did not yield enough number of zircons for statistical analyses. The probable causes for the paucity of zircons in the Jalor and Siwana granites have also been discussed in the text.

 0016-7622/91/38-6-561/$1.00 © Geol. Soc. India

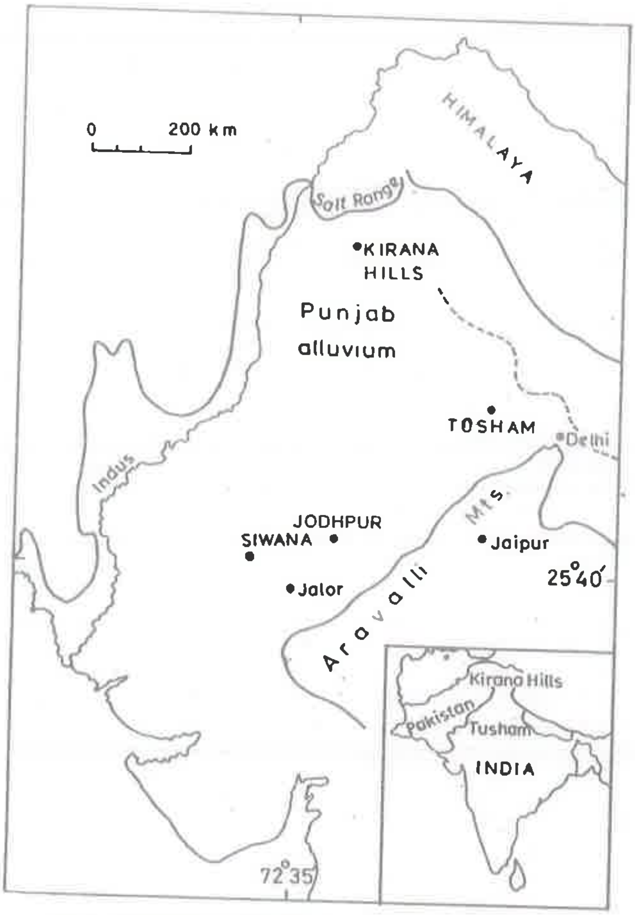

Fig. 1. Location map of the Tosham, Jalor and Siwana areas.

Characters such as crystal habit, colour, clouding, growth, crack, alteration, zoning, inclusion, corrosion, length and breadth have been noted. The statistical parameters such as elongation ratio, standard deviation in length and breadth, angle of slope etc. were determined with the UNICOMP computer ' The CHECK, For ' program was used. Several selected crystals showing typical characteristics have been subjected to chemical studies by the Cameca Electron Microprobe at the Mineralogical Institute, Hannover University, Hannover, Germany by L.N.G.

MORPHOLOGY

Crystal Habit : Majority of the zircon crystals in the Tosham and Jalor granites are euhedral and subhedral. The Tosham granites contain 52-70% euhedral zircon crystals whereas the Jalor granites contain 44-82% euhedral zircon crystals (Fig. 2a). The euhedral crystals are simple and few have complex unimodel prismatic habit; the main combinations involve (100), (110), (101) and (111).

Colour : The zircons are mainly of two different colours; grey and colourless (Fig. 2b). The zircons of Tosham granites are mostly grey in colour (58-75%) whereas those of the Jalor granites are colourless. Few pink and brown coloured grains are also observed in Tosham granites. Variations in colour can be attributed to an environmental or compositional control in the magma. It may be related to the oxidation state of iron and also may have been influenced by U and Th (Deer *et al.* 1982).

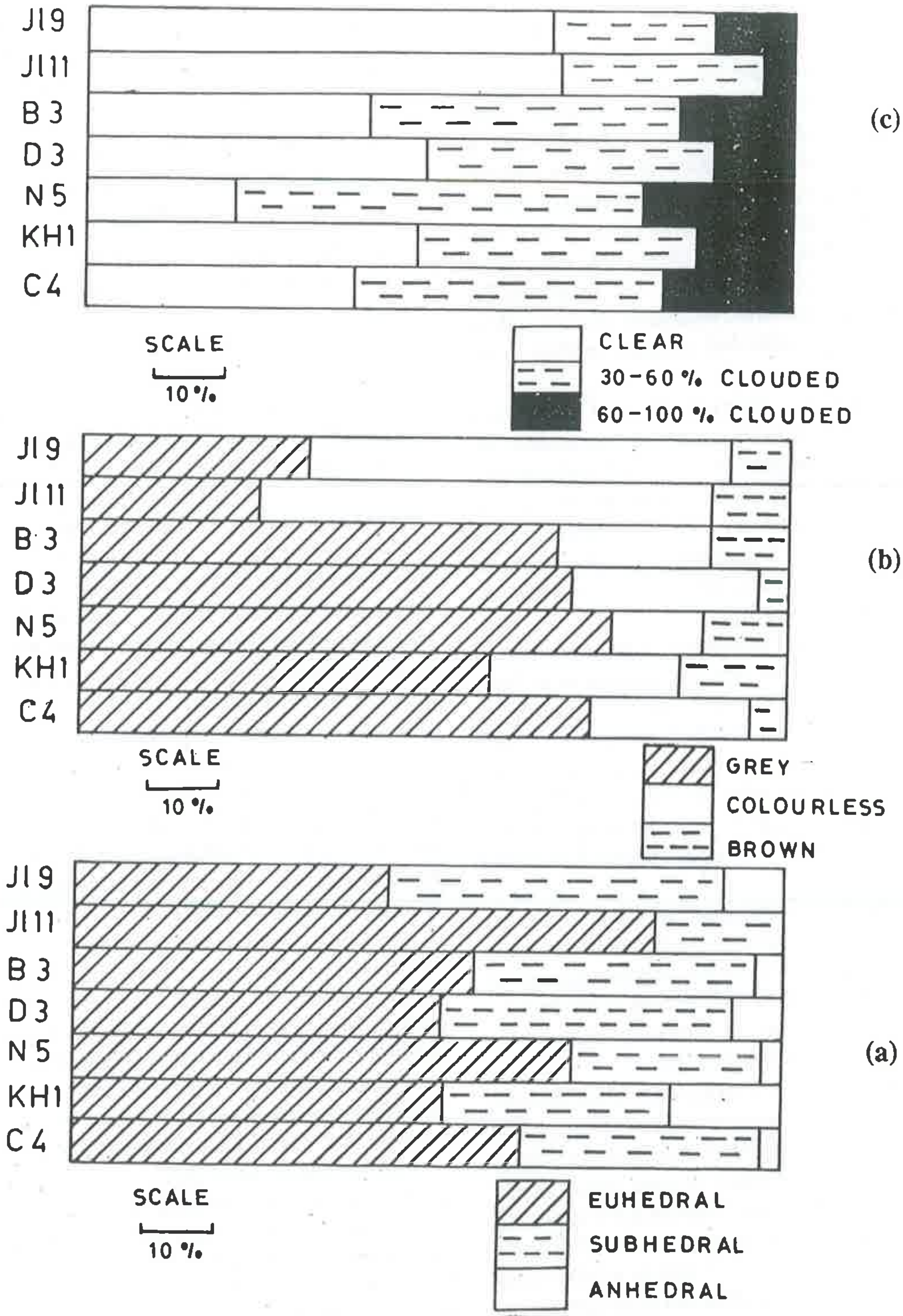

Fig. 2. Distribution of the (a) crystal habits, (b) colour and (c) clouding of the Tosham and Jalor zircons (Sample descriptions are given in Table I).

Clouding : Zircons are described as clouded when they contain unidentifiable inclusions. Zircons of the Tosham granites are more clouded than those of the Jalor granites (Fig. 2c). The Jalor granite zircons are mostly clear (65%). The clouding has been attributed either to hydrothermal alteration of granites (Brindly and Gupta, 1973) or partial melting of the host rocks (Gupta and Johannes, 1985). Jalor zircons show more inclusions (60%) than the Tosham zircons (30%) (Fig. 3c). The inclusions are probably due to the secondary alteration effect. The clear euhedral crystals contain more inclusions.

Growth : Overgrowth and outgrowth predominate in the zircons of Jalor granite (34-68%) as compared to those of Tosham granite (15-30%) (Fig. 3a). The twinning is considered to be due to primary crystallisation of zircon in magmatic rocks and is rare (Gupta, 1986). In the present case, twinning is observed in 4-5% of zircons (Fig. 3b).

Crack and alteration : Cracks are due to various stresses that the zircons have been subjected to during their history and also due to the concentration of radioactive elements. 80% of the Tosham zircons are cracked in contrast to those of the Jalor zircons (40%) (Fig. 3b). This may be due to high abundance of U in Tosham rocks. Tosham zircons are less altered (Fig. 3b).

Zoning : Zoning is revealed by slight differences in refractive index between zones of clear zircons or by regular pattern of inclusions. Nearly 30% zircons of the Tosham granites are zoned in contrast to those of the Jalor granites (5%) (Fig. 3c).

Corrosion : The partial resorption, dissolution, fusion, modification, or eating away of the outer part of early formed crystals by solvent action of the residual magma result in the formation of corroded borders. 5-6% zircons of the Tosham granites have corroded margins (Fig. 3a). The corroded zircons exhibit eaten edges or partial resorption, or embayed margins. Corrosion has resulted in the following features:

1. The degeneration of euhedral shapes to subhedral and anhedral.
2. The reduction of crystal length, in some cases, skeletal remains.
3. The lowering of refractive indices, accompanied by dull lustre and low to negligible birefringence.
4. The development of solution cavities often along cracks and zone margins.

Length and breadth : These parameters have been given in Table I. The Tosham granite zircons have lengths between 0.052 - 0.501 mm and breadths between 0.018-0.180 mm (Fig. 4) whereas the Jalor granite zircons have lengths between 0.052-0.35 mm and breadths between 0.018-0.14 mm (Fig. 5). Thus the size of the zircons of the Jalor granites are less than the size of the zircons of Tosham granites which may indicate different source of magma. The larger size of the Tosham granite zircons may be due to the late-stage crystallization and to pronounced undercooling.

Elongation Ratio : The zircon elongation ratio (ER) is defined as the ratio between its length and breadth (l/b). The petrogenesis of different rocks is sometimes interpreted on the basis of zircon ER. Rocks of different origin have different ER maximum. The mean ER ratio for Tosham and Jalor zircons is 2.5-3 (Figs. 4 and 5) (Table I). The magmatic zircons have less ERS than metasomatic zircons (Gupta, 1968). Majority of zircons from magmatic granites have ERS 2-3. The more elongated zircons have crystallized during the later phase of magma crystallization (Brindly and Gupta, 1973). The elongation ratios of Tosham zircons are more than that of Jalor zircons (Table 1).

Reduced Major Axis (RMA) : A line drawn at a slope angle (Sy/Sx) through the point (Xm/Ym) is called a reduced major axis. Larsen and Poldervaart (1957) showed that the reduced major axis of a scatter plot of length and breadth measurements comes nearest to an expression of a trend of zircon growth in a particular

TABLE I

Statistical Parameters of Zircons of the Malani Igneous Suite

Sample No.	Xr	Xm	Sx	Yr	Ym	Sy	Em	a	G	Dd%	σ	r	Rock type and area
Tosham													
C_4	0.052-0.495	0.171	0.066	0.024-0.142	0.065	0.027	2.908	0.4005	21.50'	43.52	0.26	0.3798	Microcline oligoclase granite, Dulheri
KH1	0.052-0.501	0.149	0.059	0.018-0.175	0.060	0.063	2.994	1.0714	46.58'	66.48	0.07	0.2312	Granite porphyry (Coarse var.), Khanak
N_5	0.052-0.410	0.145	0.056	0.035-0.180	0.071	0.038	2.500	0.6753	47.47'	34.30	0.01	0.1065	Microcline oligoclase granite, Nigana
D_3	0.052-0.358	0.144	0.049	0.018-0.138	0.056	0.025	2.776	0.4930	26.14'	33.64	0.01	0.5579	Microcline oligoclase granite, Dharan
B_3	0.052-0.360	0.155	0.059	0.018-0.178	0.065	0.023	2.559	0.3846	21.10'	41.12	0.01	0.3846	Microcline oligoclase granite, Naya Gaon
Jalor													
J111	0.052-0.31	0.099	0.035	0.018-0.015	0.042	0.018	2.452	0.2673	15.02'	38.21	0.01	0.5511	Biotite hornblende granite, Jalor fort hill
J19	0.052-0.35	0.125	0.045	0.018-0.140	0.052	0.022	2.831	0.4961	26.25'	36.75'	0.01	0.5075	Biotite hornblende granite, Jalor fort hill

Xr = Range of zircon length (mm)

Xm = Mean length (mm)

Sx = Standard deviation of length

Yr = Range of zircon breadth (mm)

Ym = Mean breadth (mm)

Sy = Standard deviation of breadth

Em = Mean elongation ratio

G = Angle of slope, $\tan^{-1} a$

Dd = Coefficient of relative dispersion about the RMA = $100 \sqrt{\{2(1-r)(Sx^2 + Sy^2)/(Xm^2 + Ym^2)\}}$

$100\sqrt{2\{(1-r)(Sx^2 + Sy^2)/(Xm^2 + Ym^2)} = a\sqrt{\{(1-r)^2/(N-2)\}}$

σ = Standard error of slope = $a\sqrt{\{(1-r)^2/(N-2)\}}$

r = Coefficient of correlation $\Sigma (X - Xm)(Y - Ym) / \sqrt{\{\Sigma (X - Xm)^2 \, \Sigma (Y - Ym)^2\}}$

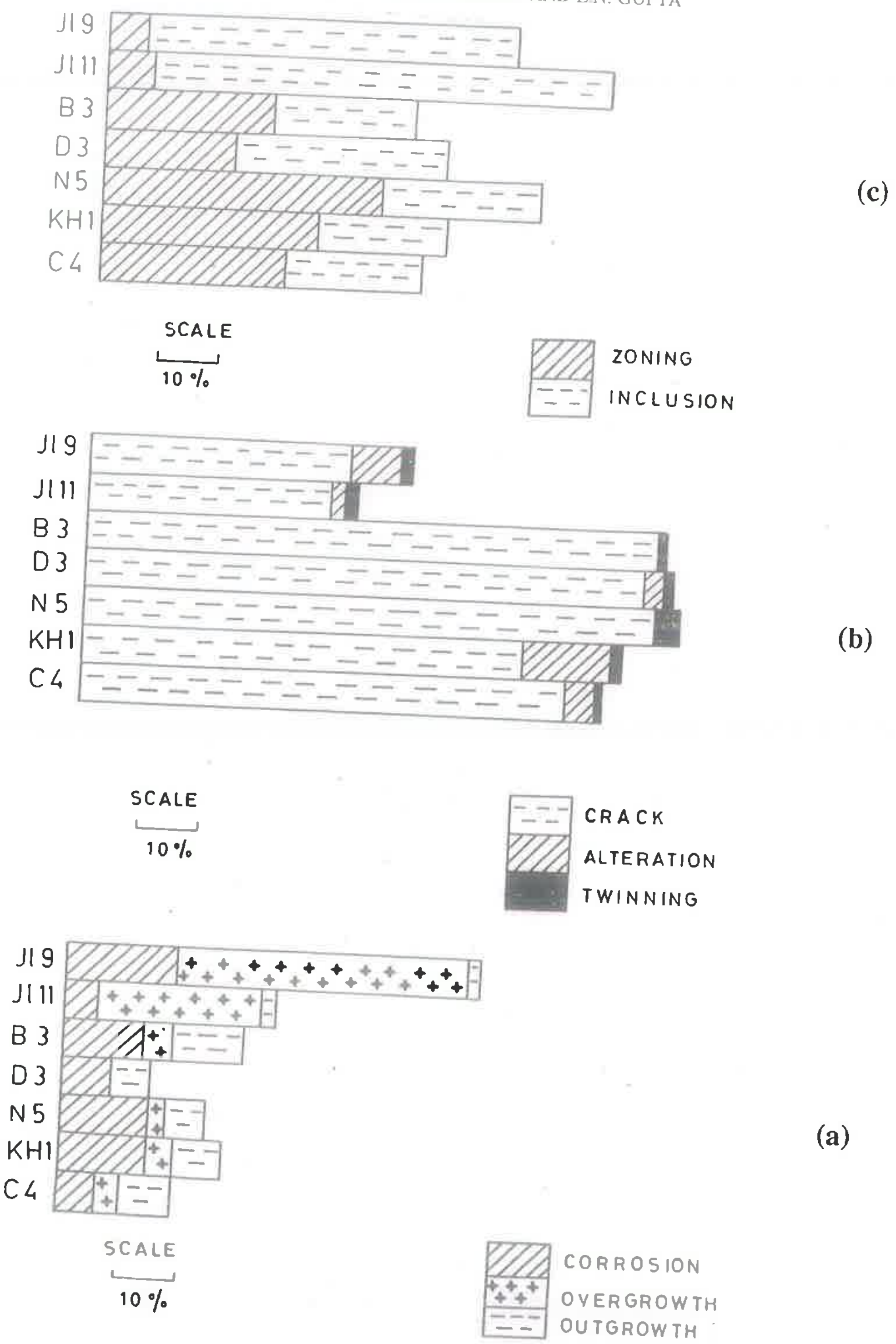

Fig. 3. Distribution of other morphological characters : a) carroded, overgrown and outgtown zircons; b) cracked, altered and twinned zircons; and c) zoned and clouded zircons.

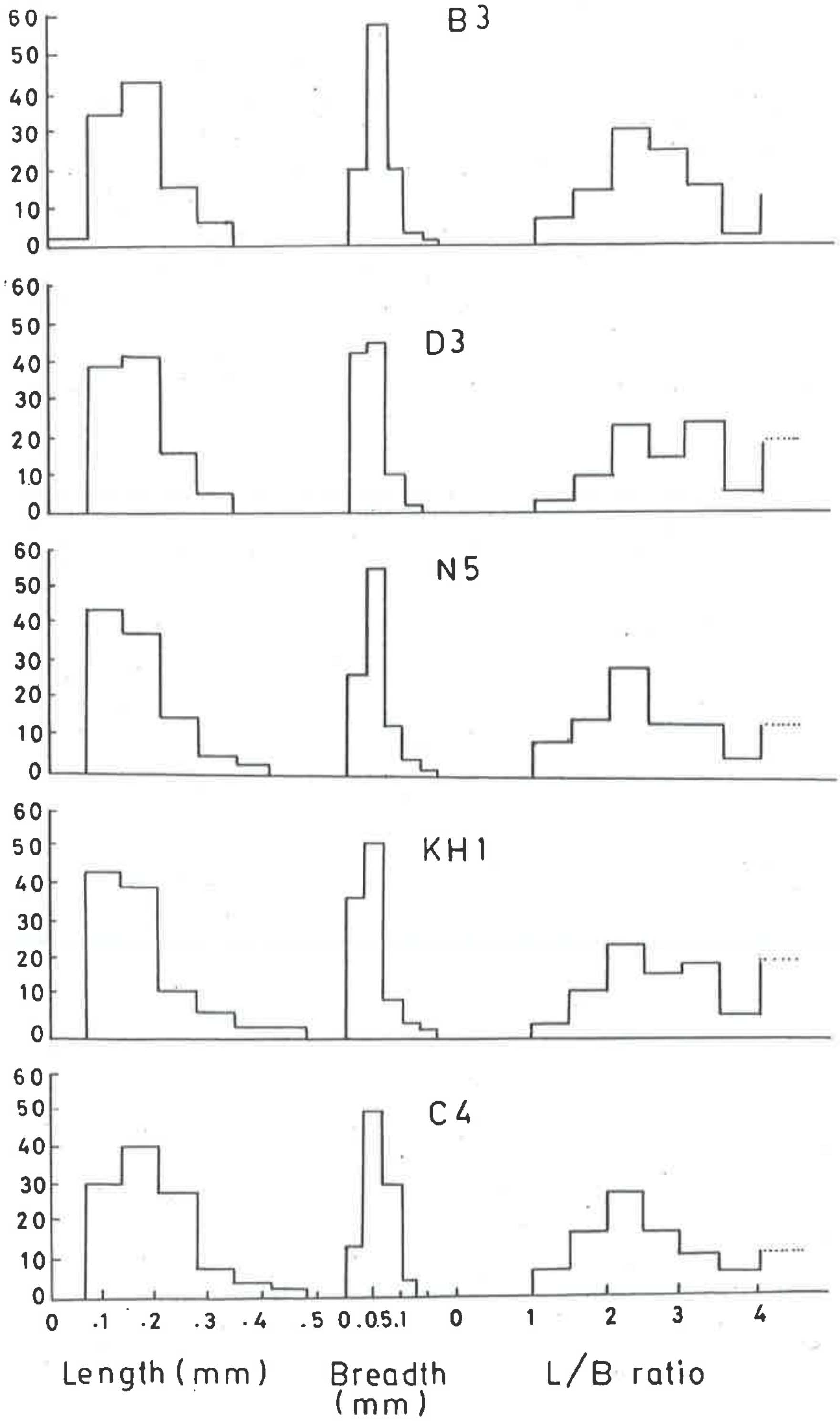

Fig. 4. Length, breadth and elongation ratio histograms for the Tosham zircons