THE GRANITE WEATHERING PITS OF LUNDY

M. W. GRIFFIN

(*Middlesex Polytechnic, The Burroughs, Hendon NW4 4BT*)

INTRODUCTION

Small pit-like forms are commonly found on exposures of bedrock in the granite areas of Southwest England. These superficial hollows, also known as 'rock basins', have been compared with weathering pits from a wide range of latitudes. Pits in the Armorican granites of Southwest England are generally attributed to weathering processes (MacCulloch 1814; Worth 1930; Twidale 1971), although some early workers favoured hydrodynamic abrasion (Cleghorn 1857; Mackintosh 1867) and even excavation by Druids (Borlase 1756; Drake 1859). Chanter (1871) thought that the 'rock basins' of Lundy were of artificial origin and that they were similar to forms found on Dartmoor. Surprisingly little is known about the age and the precise mode of origin of the pits in Southwest England, while in the case of Lundy this lack of knowledge is a problem accentuated by the possible glaciated nature of the bedrock (Mitchell 1968).

This paper attempts to trace the origin and development of the Lundy pits on the basis of morphological observations collected during fieldwork on the island in 1976 and 1977. The work forms part of a larger study embracing all the granite areas of Southwest England.

GEOMORPHOLOGICAL BACKGROUND TO THE STUDY

Lundy is a composite block of Tertiary granite intruded into slates and itself crosscut by acid, intermediate and basic dykes. The two main granites consist of an Upper (G1) grey porphyritic biotite-muscovite variety, which was invaded by the Lower (G2) granite, a lithology characterised by quartz and feldspar crystals in a matrix of microgranite (Dollar 1941). Most of the land area is granite and microgranite, which form coastal features such as high cliffs, headlands and buttress tors. A relatively large proportion of the surface area is bare rock, particularly at the northern end of the island. Some of the bedrock may have been exposed by the burning away of the vegetation cover (Hall 1871; Langham and Langham 1970).

Little seems to have been written on the geomorphic evolution of Lundy. Nicholas Whitley (1869) suggested that during the 'Drift' period the island had been 'swept by ocean currents'. Whitley also described the plateau-like surface of Lundy, while Chanter (1871) and Page (1895) examined the tors and other features of the bedrock around the coast of the island. More recently, Gardner (1967) discussed Lundy in the context of former sea levels, and Mitchell (1968) visited the island and published evidence of Pleistocene glaciation. This evidence included a high erratic content in a suite of pebble gravels, bedrock smoothing in the form of roches moutonnées, and possible meltwater erosion channels. All of these features were located in the northern part of the island. Some of Mitchell's findings were reiterated by Taylor (1974), who also recognised evidence of high sea levels in the stepped cliffline.

METHODS

151 pits were located and measured on the horizontal surfaces of tors and other major exposures of granite. Observations were made of their morphological characteristics (long axis, width, depth and long axis orientation) and estimates made of the presence or absence of pit growan, the degree of bedrock bleaching and the extent of control by vertical and steeply-inclined joints over pit morphology (Tables 1 and 2). The orientations of overflow notches and channels—usually represented by a point around the rim of most pits out of which rainwater may flow—were also measured where these were present.

OBSERVATIONS

(a) Distribution

The island was subdivided for the purposes of this study into four overlapping areas defined by lithology and coastline. Pits were found scattered along both west and east coasts (Fig. 1), which were also characterised by abundant exposure of bedrock. Out of the sample of 151 pits located on Lundy, 87 were found on the west coast. A division on the basis of lithology is also feasible, although from Figure 1 it can be seen that the two main granite types do not exactly coincide with the coastline regions. The pits were more frequently located on the Upper (G1) granite, on which 91 were measured.

Pits were found over an altitudinal range of between 40 m O.D. to 125 m O.D., with the mean height being 92.6 m (std. dev. 21.2 m).

(b) Morphology

The mean values of Lundy pit dimensions are shown in Table 3. The difference between mean pit dimensions in each subdivision is relatively small. Pits situated along the west coast are only marginally deeper ($\bar{x} = 9{\cdot}25$ cm) than those of the east coast ($x = 9{\cdot}1$ cm). Similarly, there is only 0·68 cm difference between the mean depth of Upper granite and Lower granite pits. Histograms representing the frequency distributions of long axis, width and depth variables (Figure 2) are positively skewed. The long axis distribution is characterised by a spread-out mode, although this is not reflected by the other two histcgrams. Two large pits, measuring 167 cm × 112 cm × 10 cm and 144 cm × 111 cm × 12 cm are represented by the two outlying values in the width histogram (1·3% of the sample). The total sample of 151 depth observations falls into a range of only 30 cm (3 class intervals), 109 (72·1%) of which are shallower than 10 cm.

It is not clear which of the pit dimension variables gives the best representation of pit size, and for this reason the volume of each pit was calculated in order to seek a more rigorous definition. The volume was calculated using the expression:

$$0{\cdot}785\ (\text{l.w.d.}) = \text{Volume}$$

where l, w and d are the principal axes and 0·785 is a constant. This constant is a correction factor designed to compensate for the circularity of the pits and is derived from the difference between cubic and cylindrincal forms. 151 pit observations gave a mean value in the order of 19,600 cm^3 (see Table 4).

The elongation of each pit was calculated by dividing the long axis by the width. This gave a range of values where EI = 1 represents a near circular pit and EI = 2 represents a fairly elongated form. The mean elongation index of 1·529 (Table 4) implies that most pits are not circular but slightly elongated, although only 13·2% of the sample yielded values greater than 2.

The ratio between diameter and depth may be derived from the expression:

$$\frac{\left(\dfrac{\text{long axis} + \text{width}}{2}\right)}{\text{depth}} = \text{D/d ratio}$$

If the ratio is less than 1 the depth exceeds the mean diameter. The mean D/d ratio of 8·75 (std. dev. = 5·75) suggests that the Lundy pits are typically relatively shallow pan-like forms: in fact there were no cases where the depth exceeded the mean diameter (Fig. 3).

Product-moment correlation coefficients derived from long axis and width data are in all cases positive and highly significant (Table 5), such as the value of $r = +\ 0{\cdot}87$ ($N = 151$) for the total sample. This positive correlation is to some extent predictable, as both long axis and width are closely related and similarly derived variables. All other correlation coefficients for 1, w and d data are also positive.

(c) Orientation

Frequency distributions of pit directional data are shown graphically by means of rose diagrams. The frequency of pit long axes and overflows in each azimuthal class is plotted using a 10° class interval. Plots of long axis orientations result in 'mirror image' rose diagrams as each orientation cuts the circle at two points. This effect tends to amplify the strength of a preferred orientation. The rose diagrams of overflow data have the advantage that they indicate direction rather than orientation.

The rose diagrams of all the pit observations (Fig. 4) show scattered distributions around the principal SW, SE, SSW, NE and NW vectors. The overflow and long axis distributions appear to be similar, while in neither case are there any observations in the 080°-090° and 260°-270° classes. A comparison of East Lundy (Fig. 6) with West Lundy (Fig. 5) demonstrates that the principal trends in each case are dissimilar. For East Lundy, NNE-SSW and SW-NE vectors dominate the long axis distribution, while the overflows show a weak alignment in a SSW direction. West Lundy observations show NE-SW and NW-SE long axis orientations, together with NW, NE and SW overflow directions. These distributions indicate that pits on the east coast of Lundy have an orientation pattern different from those situated along the west coast, since none of the main vectors coincide. The Upper granite long axis sample (Fig. 8) reveals clearly defined NW-SE and NE-SW trends with a subordinate ESE-WNW trend; the overflow distribution reflects these with the exception of the ESE vector. The Lower granite sample is characterised by a NE overflow vector, while the long axes are orientated NE-SW with a secondary NE-SE trend. As the coastline and lithological divisions overlap, it is difficult to analyse which contributes most to the overall frequency distribution. It may be useful to further divide the sample into 4 distributions based on both coastline and rock types, such as observations drawn from exposure of the Upper granite along the west coast, although this would have the disadvantage of reducing the sample size.

(d) Jointing

Only 11·9% of the pits were found to be influenced or controlled by joints. The frequency of pits in each of the 5 selected classes of joint control is shown in Table 6. The degree of joint control seems to be relatively constant for both Upper granite and Lower granite samples.

(e) Growan and Bleaching

64·2% of the pits contained a deposit of growan, while 76·8% of the pits were thought to be bleached. There appears to be a strong relationship between growan and bleaching variables. This may be shown by correlation (Table 7), although the ordinal nature of the data suggests that this method may not be appropriate. For this reason cross-tabulation of the growan and bleaching observations is also shown (Table 8). The cross-tabulation method reveals that the highest proportions occur in the 0-0 class (zero-zero) (no growan and no bleaching), 1–1 class (some growan and some bleaching) and 2–2 class ('average' growan and bleaching). Bleaching was found to be present without growan (classes, 0–1 0–2 and 0–3) but only about 2% of the sample contained growan without any trace of bleaching (classes 1–0, 2–0 and 3–0).

DISCUSSION

(a) Evidence of weathering in the pits

Fieldwork showed that bleaching appears to indicate persistently damp granite surfaces which are probably vulnerable to subaerial weathering. Growan is derived from the floor and the lower walls of the pits, and in some cases feldspar crystals could be prised from the pit wall with the fingers. In this sense, growan might indicate granular disintegration of the rock fabric. Cross-tabulation of growan and bleaching data shows that growan rarely occurs in the absence of bleached surfaces. Bleaching, on the other hand, occurs in the absence of growan. This suggests that bleaching is the independent variable, and that growan may be a function of bleached, damp and therefore disintegrating rock surfaces.

It is less easy to rationalise the other pit observations in terms of weathering. The relatively normal frequency distributions of Lundy pit dimensions (Fig. 2) show a continuum of sizes, ranging from small, shallow depressions of 2–3 cm depth to the volumetrically larger forms at the other end of the scale. The difference in pit size may or may not be a function of their respective stages of development according to weathering processes. Interestingly enough, correlation analysis of the pit dimensions with the growan and bleaching observations produced results which were either non-significant or tended to confuse the concept of a weathering origin. For example, correlation of growan with pit depth (Table 7) gave values of r which are in all cases negative ($r = -0{\cdot}15$ for 151 pits is significant at the 5% level), which implies that growan decreases with increasing pit depth. This too could be a function of the stage of pit development, although other factors—such as enhanced growan removal due to increased overflow efficiency or wind deflation—could have been operative.

It is also interesting that there is only a minimal variation in the mean pit dimensions of both the West and East coast samples and the Upper and Lower granite samples (Table 3), whereas it may have been reasonable to expect a greater differential in weathering rates depending on lithology and aspect. On the other hand, these morphological characteristics can give little indication of the actual chemical, physical and perhaps biological weathering processes that may have been operative. The negative association between pit altitude and volume (Table 9) indicates that pits become smaller with increasing height. This could conceivably be attributable to weathering factors such as proximity to sea spray although again there is no straightforward explanation and the altitudinal range of only 85 m may be too small to be of any great significance. Similarly, the faint negative correlations calculated from pit altitude and pit elongation data must for the moment remain a matter for speculation as far as weathering processes are concerned.

It is no easier to explain the orientation patterns of the pits with reference to weathering. Following Ormerod's (1859) work on Dartmoor pits, it seems improbable that patterns of pit orientations can be directly related to climatic controls such as prevailing winds, and so other causal factors must be sought. The most obvious factor would seem to be lithology. Although only 11·9% of the pits were related to steeply-inclined or vertical joints in the granite (or the Q and S joints of Cloos 1936), it is possible that the horizontal joints in the granite (pseudobedding planes or L joints of Cloos 1936) may be indirectly responsible for the orientation distributions depicted in Figures 4 to 8. Subhorizontal joints encourage the initiation of the surfaces that appear favourable for the formation of the pits. This is seen particularly in localities where pseudobedding planes have facilitated the lenticular architecture of tors. The development of the pits may therefore be related to rain runoff controlled by the slope of the rock surface. This is an especially appropriate explanation where the overflow directions are concerned. If this is the case, then clearly the inclination of subhorizontal joint planes is of fundamental importance. The modal classes in the rose diagrams may thus reflect local or general trends in the horizontal joints of the Lundy granites, while subordinate vectors may represent secondary jointing. The significantly different distributions of the Upper granite and Lower granite samples suggests that there may be differences in the horizontal joint systems of the two granites. This is only a partial explanation as there are insufficient observations at this stage in the study to allow more confidence discussion of the effects of jointing.

(b) Other possible modes of origin

There can be little doubt that present-day weathering, as indicated by the strong relationship between bleaching and growan, is to some extent operative in the pits. However, it is by no means clear whether the rates of weathering have been constant over time, and different types of process may have been active according to the prevailing climatic conditions. There is also a possibility that processes other than weathering have been responsible for the origin or initial distribution of the pits. This alternative must be considered in the light of the probable geomorphic evolution of Lundy.

Few authors have discussed the possibility of fluvial action in the development of weathering pits. This is probably due to the occurrence of fluvial forms such as potholes in stream channels (Elston 1917), while the pits of Southwest England generally tend to occupy summit positions (Griffin 1977). On this basis alone it would seem unlikely that the pits on Lundy can be related to fluviatile processes, particularly as there seems to be an absence of major fluvial landforms on the island.

It is more difficult to assess the possibility of a marine erosion component in the pits. It seems likely that marine erosion has been operative at high levels on Lundy during the Pleistocene or earlier (Taylor 1974), although the extent and chronology of marine action is still open to question. If a marine origin is postulated for the pits, it is reasonable to assume that their morphology would show a distinct variation over altitude: for example, the lower altitude pits would conceivably be the most recent and therefore the best preserved. Field observations tended not to support this, and there was a general impression that no group of pits seemed more weathered or better preserved than any other group. Moreover, the negative correlation coefficients derived from pit volume and altitude data (Table 9) indicate that there is a trend for the pits to become smaller with increasing altitude. Another problem lies in the chronology of possible high level marine erosion on Lundy, as this infers a great age for the pits which may be seen as incompatible with the probable Pleistocene exhumation and fashioning of the tors (Palmer and Neilson 1962) on which many pits are situated. Linton (1955, p. 471) observed that the disposition of pit forms suggest that they postdate the acquisition of the basic tor morphology. Finally, there is no circumstantial evidence to suggest marine action in the Lundy pits, such as the percussion marks and rounded pebbles usually associated with marine hydrodynamic abrasion (Ljungner 1930).

Mitchell (1968) concluded that areas of Lundy below 107 m (350 ft) O.D. had been affected by ice of possible Wolstonian (Gipping) age. If this event is accepted it introduces another possible mode of pit origin. However, none of the pits (above or below 350 ft) displayed any of the morphological characteristics usually associated with fluvioglacial potholes, such as a considerable depth, spiralled walls, polishing and striae (Gjessing 1967), although admittedly such superficial features as polishing could easily have been effaced by subsequent weathering. That the pits are typically shallow pan-like forms is demonstrated by the mean diameter/depth ratio ($\bar{x} = 8{\cdot}75$) and also by the fact that none of the pits exhibited a diameter/depth ratio of less than 1. The modal NE–SW and NW–SE vectors in the long axis orientation distribution (Fig. 4) could be reconciled with possible ice movement but there is little evidence either way.

One further aspect of glaciation on Lundy is that the spatial distribution of the pits could be related to the movement of ice over the island's bedrock. A useful approach to this problem was to utilise Johnsson's (1956) method of referring supposed fluviogliacial potholes to the local and regional topography in formerly glaciated areas. This method, evolved in Scandinavia, assumes that preferential distal-side distributions are strongly suggestive of fluvioglacial action. A similar technique was applied to the Lundy pit sample and modified in that no assumptions were made concerning ice movement and distal (lee) sides. Three topographic scales were used: regional (based on generalised contours), local (based on a 25 ft contour interval) and detail (based on the morphology of individual tors or rock exposures). At the macro-scale the location of the pits is not indicative of a distal-side distribution in the major topography. However, the distribution of the pits at this scale may to some extent be explicable in terms of bedrock exposure frequency. The pits are essentially distributed along the edge of the plateau-like surface, which is delimited by the cliffline which in turn marks the occurrence of frequent exposures of bedrock, such as buttress tors. The availability of exposed bedrock is a limitation that becomes less effective at the more detailed levels of investigation, although in neither case was there any firm evidence to support a possible distal-side pit distribution.

CONCLUSION

On the basis of their morphology and distribution it seems likely that the 151 pit forms located on Lundy are attributable mainly to weathering of the granite bedrock. There is little evidence to support the hypothesis of a marine or fluvial hydrodynamic component in the pits. Similarly, the pits can be contrasted with fluvioglacial potholes observed in formerly glaciated regions. There can be little doubt that subaerial weathering is operative in the pits at the present time, and future work might be aimed at analysing the exact processes involved. The possibility of a subsurface weathering origin is a further aspect of the pits that could be approached by future studies.

ACKNOWLEDGEMENTS

I would like to thank all the people who gave me help and advice on Lundy, especially John Baldwin. I am grateful to Dr. N. R. Page for his valuable comments and for reading the text. I am also grateful to Frances Braund for drawing Figures 4 to 8.

REFERENCES

Borlase, W. 1756. Observations on the Ancient and Present State of the Islands of Scilly. *Priv. Publ., London.*

Chanter, J. R. 1871. A History of Lundy Island. *Trans. Devon Ass. Advmt. Sci.*, **4**, 553–611.

Cleghorn, J. 1857. On the Rock-Basins of Dartmoor. *Quart. J. geol. Soc. Lond.*, **13**, part 1, 231–233.

Cloos, H. 1936. Einfuhrüng in die Geologie. *Berlin.*

Dollar, A. T. J. 1941. The Lundy Complex; its petrology and tectonics. *Quart. J. geol. Soc. Lond.*, **97**, 39–77.

Drake, F. E. 1859. Artificial origin of rock-basins. *The Geologist*, **2**, 368–371.

Elston, E. D. 1917. Potholes: Their Variety, Origin and Significance. *Sci. Monthly*, **5**, 554–567.

Gardner, K. S. 1967. Lundy—A Mesolithic Peninsula? *Rep. Lundy Fld. Soc.*, **18**, 24–28.

Gjessing, J. 1967. Potholes in connection with plastic scouring forms. *Geogr. Annlr.*, **49A**, 178–187.

Griffin, M. W. 1977. A Study of Bedrock Micro-morphology in Southwest England. *Unpublished M.Phil. thesis* (2 *Volumes*), *Middlesex Polytechnic* (*CNAA* 1977).

Hall, T. M. 1871. Notes on the geology and mineralogy of the island of Lundy. *Trans. Devon Ass. Advmt. Sci.*, **4**, 612–624.

Johnsson, G. 1956. Glacialmorfologiska studier i Södra Sverige. *Meddn. Lunds geogr. Instn.*, **30**, 1–407.

Langham, A. & Langham, M. 1970. Lundy. *David and Charles, Newton Abbot and London.*

Linton, D. L. 1955. The Problem of Tors. *Geog. J.*, **121**, 470–487.

Ljungner, E. 1930. Spaltentektonik und morphologie der Schwedischen Skagerrack-Küste. *Bull. geol. Instn. Univ. Upsala*, **21**, 1–478.

MacCulloch, J. 1814. On the granite tors of Cornwall. *Trans. Geol. Soc.*, **2**, 62–78.

Mackintosh, D. 1867. Railway Geology. No. 1, from Exeter to Newton-Bushell and Moretonhampstead. *Geol. Mag.*, **5**, 390–401.

Mitchell, G. F. 1968. Glacial gravel on Lundy Island. *Trans. Roy. geol. Soc., Cornwall*, **20**, 65–69.

Ormerod, G. W. 1859. On the rock basins in the granite of the Dartmoor district, Devonshire. *Quart. J. geol. Soc. Lond.*, **15**, 16–29.

Page, J. L. W. 1895. The coasts of Devon and Lundy. *London*, 444 pp.

Palmer, J. & Neilson, R. A. 1962. The origin of granite tors on Dartmoor, Devonshire. *Proc. Yorks. Geol. Soc.*, **33**, 315–340.

Taylor, C. G. 1974. Some notes on the Pleistocene geomorphology of Lundy. *Rep. Lundy Fld. Soc.*, **25**, 65–68.

Twidale, C. R. 1971. Structural Landforms. *A.N.U. Press, Canberra*, 247 pp.

Whitley, N. 1869. The Geology of Lundy Island. *Trans. Roy. geol. Soc. Cornwall*, **9**, 71–73.

Worth, R. H. 1930. Address of the President. *Trans. Devon Ass. Advmt. Sci.*, **62**, 49–115.

Table 1. Criteria for Visual Estimation of Growan and Bleaching in Pits

Class	Description
0	Growan/bleaching not present
1	Below average growan/bleaching
2	Average growan/bleaching
3	Above average growan/bleaching

Table 2. Criteria for a Visual Estimation of Joint Control of Pits

Class	Description
0	No observable joint control
1	Joints present—slight influence
2	Joints present—marked influence
3	Partial joint control
4	Total joint control

Table 3. Mean Pit Dimensions (in centimetres)

Area	*N*	Mean long axis	std. dev.	mean width	std. dev.	mean depth	std. dev.
Lundy Total	151	54·63	34·58	35·66	20·31	9·19	3·90
West Lundy	87	56·39	33·76	36·70	19·40	9·25	4·41
East Lundy	64	52·25	35·54	34·26	21·41	9·10	3·09
Lundy Lower Granite	60	50·43	37·19	34·45	23·05	9·60	4·42
Lundy Upper Granite	91	57·40	32·46	36·47	18·23	8·92	3·49

Table 4. Mean Volume and Elongation Indices

Area	*N*	Mean volume (cm^3)	std. dev.	Mean elongation index	std. dev.
Lundy Total	151	19608	26032	1·529	0·426
West Lundy	87	20170	23711	1·519	0·391
East Lundy	64	18844	28871	1·543	0·469
Lundy Lower Granite	60	20316	31477	1·458	0·358
Lundy Upper Granite	91	19141	21694	1·577	0·460

Table 5. Product-moment Correlation of Pit Dimension Variables

Area	*N*	r long axis with width	r long axis with depth	r width with depth
Lundy Total	151	+ 0·87	+ 0·14	+ 0·19
West Lundy	87	+ 0·86	+ 0·12	+ 0·17
East Lundy	64	+ 0·89	+ 0·19	+ 0·22
Lundy Lower Granite	60	+ 0·90	+ 0·16	+ 0·18
Lundy Upper Granite	91	+ 0·85	+ 0·15	+ 0·21

Table 6. Degree of Joint Control of the Pits (all figures are percentages)

Area	N	0	1	2	3	4
Lundy Total	151	88·07	5·29	0	1·98	4·63
West Lundy	87	81·6	8·04	0	3·44	6·89
East Lundy	64	96·87	1·56	0	0	1·56
Lundy Lower Granite	60	86·66	4·99	0	3·33	4·99
Lundy Upper Granite	91	89·01	5·49	0	1·09	3·62

Table 7. Product-moment Correlation of Growan with Pit Depth and Bleaching Variables

Area	N	r growan with pit depth	r growan with bleaching
Lundy Total	151	− 0·15	+ 0·45
West Lundy	87	− 0·13	+ 0·39
East Lundy	64	− 0·19	+ 0·50
Lundy Lower Granite	60	− 0·18	+ 0·51
Lundy Upper Granite	91	− 0·12	+ 0·42

Table 8. Cross-tabulation of Growan and Bleaching Variables (all values are percentages, $N = 151$)

BLEACHING

	Class	0	1	2	3	row total
GROWAN	0	21·19	5·29	7·96	1·32	35·76
	1	0	15·89	12·59	0·66	29·14
	2	1·98	3·32	19·86	0	25·16
	3	0	3·97	5·96	0	9·93
	Column total	23·17	28·47	46·37	1·98	100·00%

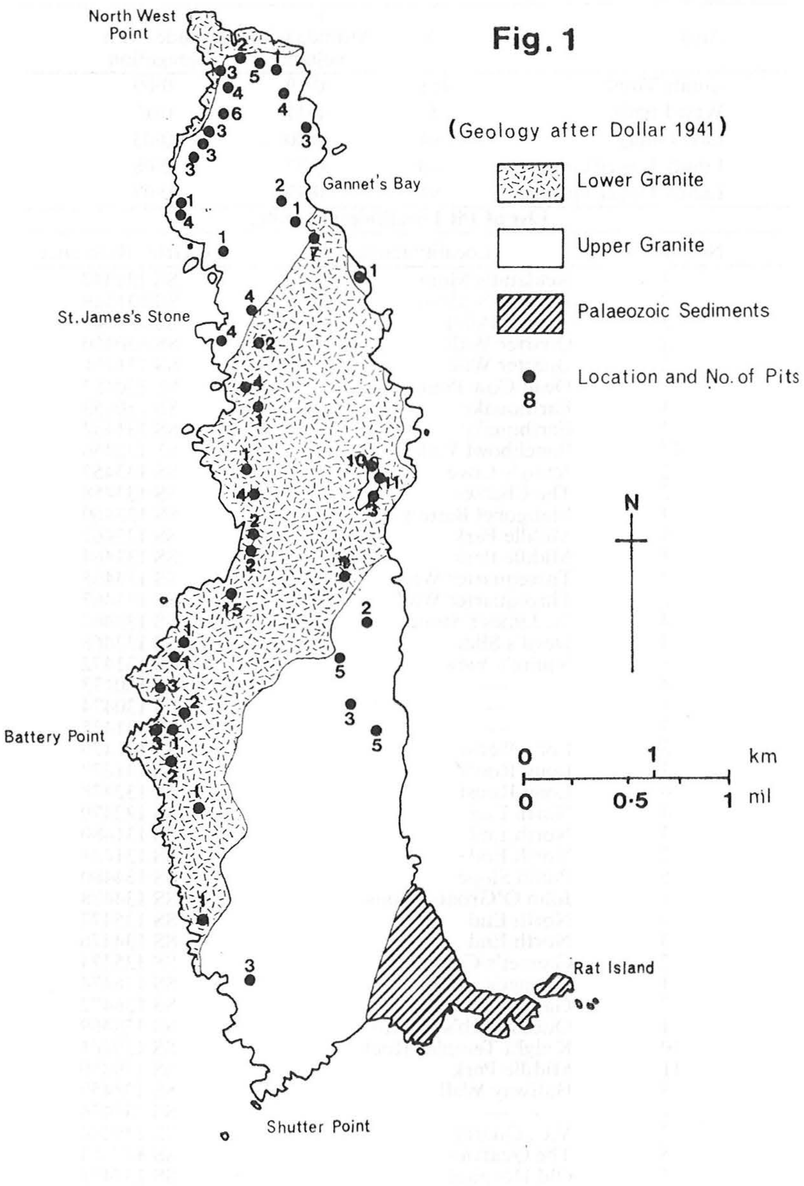
Table 9. Product-moment Correlation of Pit Altitude with Volume and Elongation

Area	*N*	r Altitude with volume	r Altitude with elongation
Lundy Total	151	− 0·19	− 0·09
West Lundy	87	− 0·17	− 0·17
East Lundy	64	− 0·20	− 0·03
Lundy Lower Granite	60	− 0·27	− 0·08
Lundy Upper Granite	91	− 0·17	− 0·08

List of Pit Localities on Lundy

No. of pits	Locality name	Grid Reference
1	Ackland's Moor	SS 131447
2	Ackland's Moor	SS 131449
3	Battery Point	SS 129449
1	Quarter Wall	SS 130450
2	Quarter Wall	SS 131451
3	Dead Cow Point	SS 130452
1	Earthquake	SS 130453
1	Earthquake	SS 131454
15	Punchbowl Valley	SS 132456
2	Jenny's Cove	SS 133457
2	The Cheeses	SS 133458
4	Mangonel Battery	SS 133460
1	Middle Park	SS 133461
1	Middle Park	SS 133464
4	Threequarter Wall	SS 133465
2	Threequarter Wall	SS 133467
4	St. James's Stone	SS 132467
4	Devil's Slide	SS 133468
1	Squire's View	SS 131472
4	—	SS 130473
1	—	SS 130474
3	—	SS 131475
3	Long Roost	SS 131476
3	Long Roost	SS 131477
6	Long Roost	SS 132478
4	North End	SS 132479
3	North End	SS 131480
2	North End	SS 131481
5	Puffin Slope	SS 134480
1	John O'Groats' House	SS 134478
4	North End	SS 135477
3	North End	SS 134476
2	Gannet's Combe	SS 135474
1	Gannet's Combe	SS 136474
7	Gannet's Combe	SS 136472
1	Queen Mab's Grotto	SS 138469
10	Knight Templar Rock	SS 139461
11	Middle Park	SS 139460
3	Halfway Wall	SS 138459
1	—	SS 137456
2	V.C. Quarry	SS 139454
5	The Quarries	SS 137454
3	Old Hospital	SS 137451
5	Quarterwall Cottages	SS 138449
3	South West Field	SS 132438
1	West Side Land	SS 131442

Fig. 1



LOCATION OF PIT SITES ON LUNDY

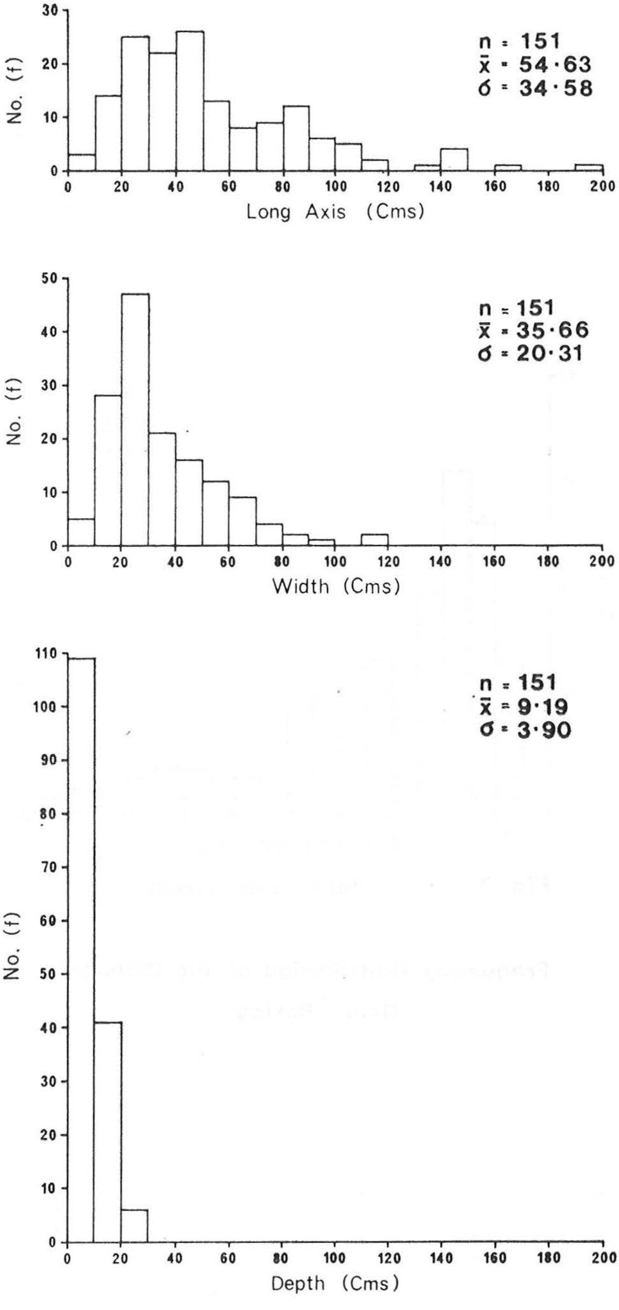


Fig. 2 Frequency Distribution of Pit Dimensions (Lundy)

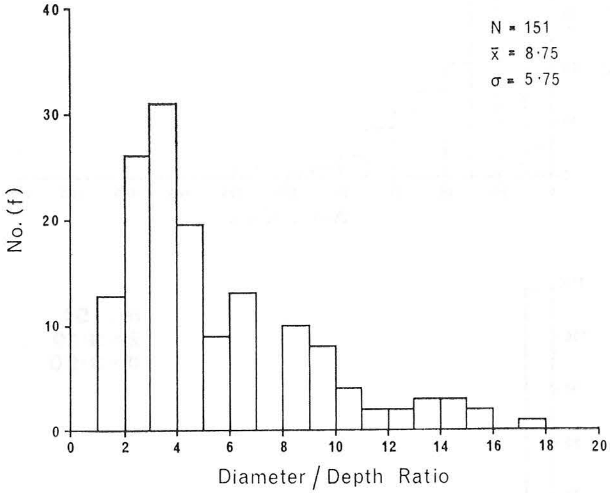
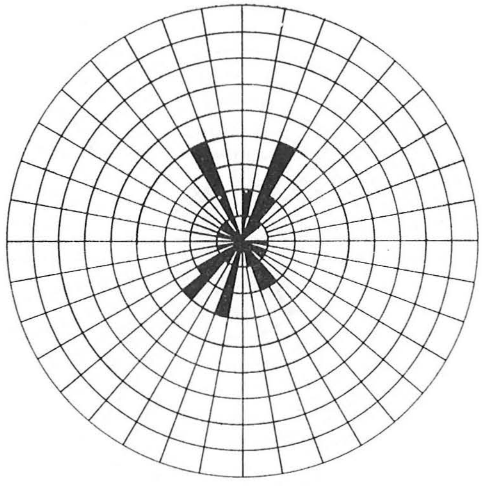
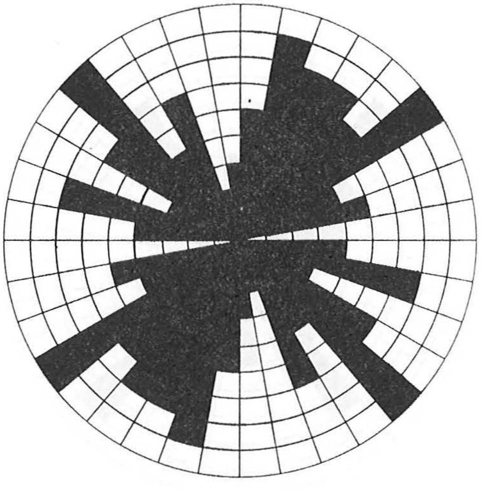


Fig. 3 Total Lundy Sample

Frequency Distribution of Pit Diameter – Depth Ratios



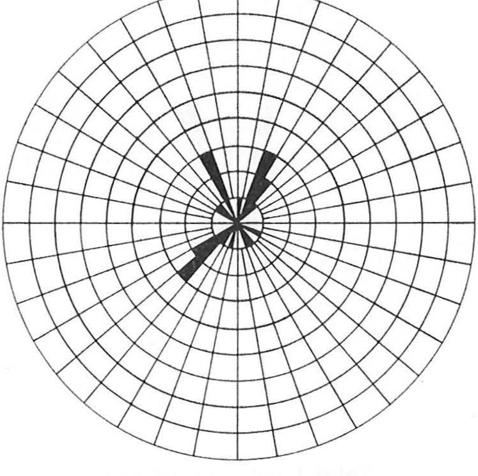
Total Lundy - Overflows



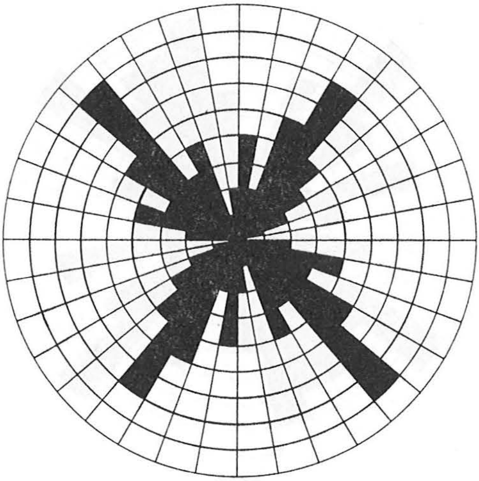
Total Lundy - Long Axes

Fig. 4 PIT ORIENTATIONS

(Scale in all rose diagrams:
1 radial unit = 1 observation)

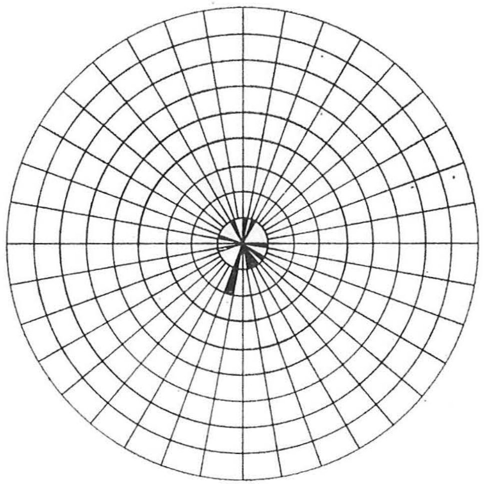


West Lundy - Overflows

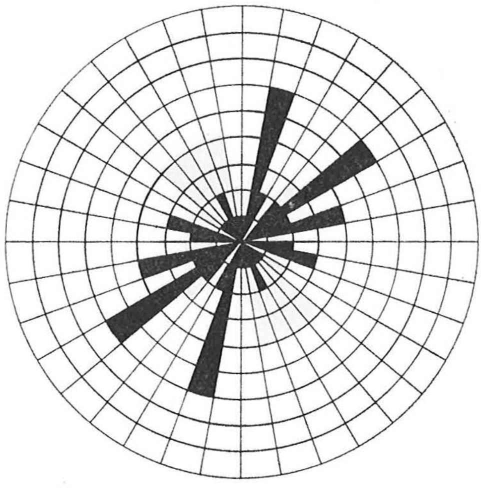


West Lundy - Long Axes

Fig. 5 PIT ORIENTATIONS

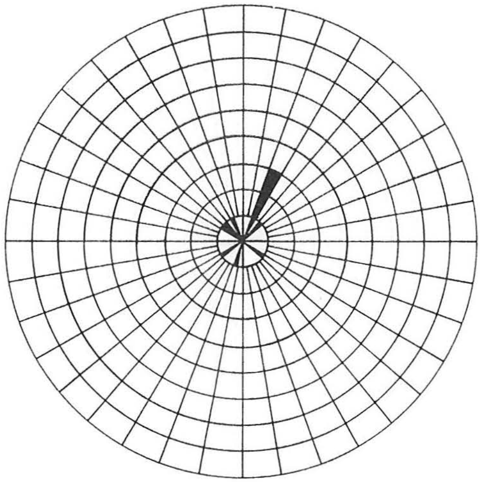


East Lundy - Overflows

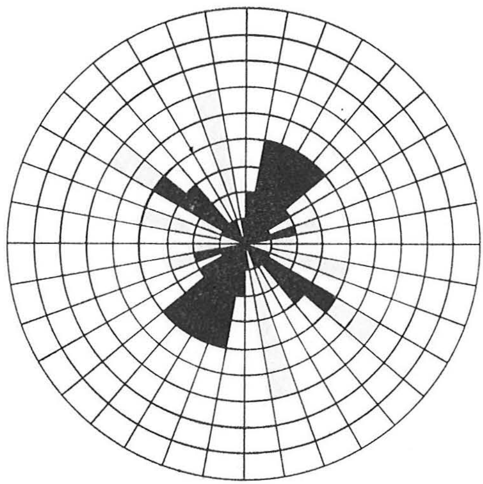


East Lundy - Long Axes

Fig. 6 PIT ORIENTATIONS

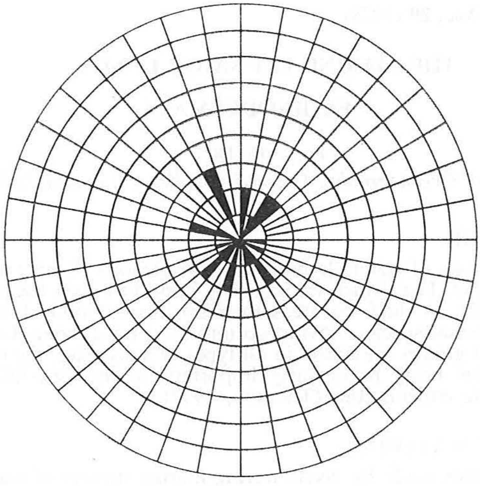


Lundy Lower Granite - Overflows

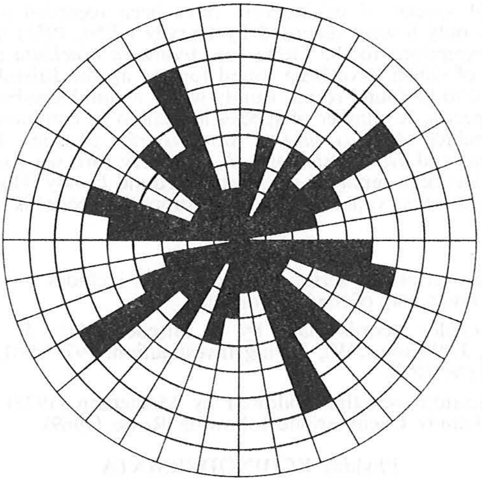


Lundy Lower Granite - Long Axes

Fig. 7 PIT ORIENTATIONS



Lundy Upper Granite - Overflows



Lundy Upper Granite - Long Axes

Fig. 8 PIT ORIENTATIONS