TO: . . . . . .

FROM: . . . . . .

WITH COMPLIMENTS.

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THE CAVES OF THE ISLE OF PORTLAND

by

Trevor D. Ford, Ph.D. and Malcolm J. Hooper

Illustrations:

"The Caves of the Isle of Portland"

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Introduction:

On several visits to the stone quarries of the Isle of Portland, pieces of stalagmite have been picked up, and many gardens have been noted to have used stalagmite as rockery stone (e.g., Pennsylvania Hotel). Enquiry about the source of the stalagmite usually resulted in being shown filled in fissures in the quarry floors, occasionally reaching six inches in width. No cave was ever mentioned. It was, therefore, something of a surprise when in 1962 a geological student field party from the University of Leicester found a substantial cave system in one of the quarries in which were numerous stalagmites.

Turning to geological literature it was found that numerous bone-bearing fissures had been found in the latter part of the last century, but that most were not sufficiently located to be identified now and the original descriptions hardly mentioned the fissures themselves, only the finds.

Accordingly the writers and other members of the Leicester University Speleological Society have paid more visits to the Isle and the results are presented here together with a review of the salient points of the literature on the fissures and their fill.

The Isle of Portland and its Geology:

The "Isle" of Portland is about $3\frac{1}{2}$ miles long from north to south and $1\frac{1}{2}$ miles wide at its broadest (Fig. 1). It is linked to the mainland of Dorset by the shingle bank of Chesil Beach, so that it is strictly a peninsula rather than an island. The highest point is a little below 500 feet O.D. at the northern end, from which there is a gentle slope southwards to Portland Bill. The Isle is cut out of part of the southern limb of the Weymouth anticline which trends approximately east-west, so that the beds dip southwards or slightly east of south at an approximate average of $1\frac{3}{4}°$. Locally dips increase to 6° due to structural flexures, and to considerably more in the vicinity of landslips. The upper surface of the Isle is formed of the Portland Stone Series and overlying Lower Purbeck Beds of Upper Jurassic Age. The Portland Stone has been extensively quarried since the 17th century and it is estimated that between 50,000 and 100,000 tons of stone and stone products have left the Isle annually for the last three centuries. As this has all come from some 20-30 feet of beds only, nearly half the Isle is quarries, tips, stone works, etc... The rest of the Isle is occupied by the quarrymen's villages, by limited farm land (still partly in the strip field form) and by the Verne Fort (now a prison), a Borstal Institution and by Admiralty Property. The last three areas are "out-of-bounds" for speleological investigation.

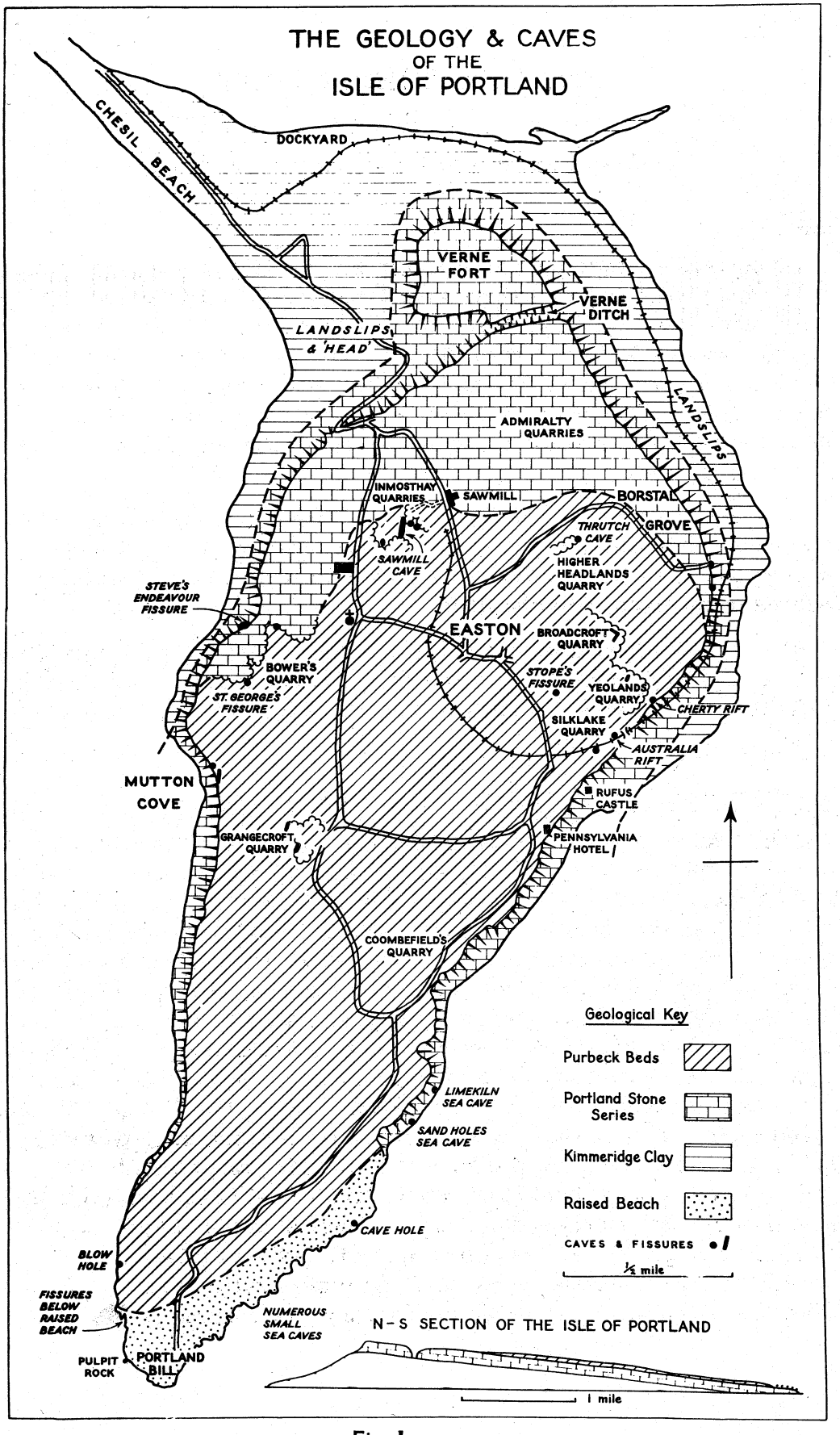

THE GEOLOGY & CAVES
OF THE
ISLE OF PORTLAND
CHESIL BEACH
DOCKYARD
VERNE FORT
VERNE DITCH
LANDSLIPS & 'HEAD'
ADMIRALTY QUARRIES
LANDSLIPS
INMOSTHAY QUARRIES
SAWMILL
BORSTAL
THRUTCH CAVE
GROVE
SAWMILL CAVE
HIGHER HEADLANDS QUARRY
STEVE'S ENDEAVOUR FISSURE
EASTON
BROADCROFT QUARRY
BOWER'S QUARRY
STOPE'S FISSURE
YEOLANDS QUARRY
ST. GEORGE'S FISSURE
CHERTY RIFT
SILKLAKE QUARRY
AUSTRALIA RIFT
MUTTON COVE
RUFUS CASTLE
GRANGECROFT QUARRY
PENNSYLVANIA HOTEL
COOMBEFIELD'S QUARRY
Geological Key
Purbeck Beds
Portland Stone Series
Kimmeridge Clay
Raised Beach
CAVES & FISSURES
½ mile
LIMEKILN SEA CAVE
SAND HOLES SEA CAVE
CAVE HOLE
BLOW HOLE
FISSURES BELOW RAISED BEACH
NUMEROUS SMALL SEA CAVES
PULPIT ROCK
PORTLAND BILL
N-S SECTION OF THE ISLE OF PORTLAND
1 mile

Fig. 1

The geology of the Isle has been described by Strahan (1898), Edmunds and Schaffer (1932), and Arkell (1947) and the stratigraphical succession below has been generalized from them.

Upper Jurassic		
Lower Purbeck	(Clay and Shingle	)
	(Slat	) variable about
	(Bacon Tier	) 20 feet
	(Aish	)
	(Soft Burr	1 foot
	(Dirt Bed	2-18 inches
	(Top Cap	5-15 feet
	(Skull Cap (Hard Cap)	$1\frac{1}{2}$-5 feet
Portland Limestone Series	(Roach	3-12 feet
	(Whit Bed	8-15 feet
	(Curf and Flinty Bed	up to 4 feet
	(Base Bed Roach	up to 3 feet
	(Base Bed	8-10 feet
	(Cherty Beds	60-70 feet
Portland Sand Series	(Clay	8-20 feet
	(Sands	100-125 feet
Kimmeridge Clay	Clay	over 200 feet seen

For full descriptions of these beds the authors quoted above should be consulted. For the present purpose it may be said that:

the Lower Purbeck Beds with the numerous local names as above are generally thin fissile limestones interbedded with light coloured shales, only the Caps being thick enough to be of importance. These are highly porous limestones largely of algal origin, with an appearance like tufa. They often contain what the quarrymen term "chaff holes" which are the casts of tree stumps once surrounded by algal tufa. (A well-known series forms the Fossil Forest on the cliffs east of Lulworth Cove). The Roach is a creamy oolitic limestone with occasional chert honeycombed with the moulds of fossil molluscs - highly significant in the origin of some of the caves. The Whit Bed is a buff to cream oolitic limestone, usually very evenly grained and forming a free-stone. It is the stone most used in building, although it may again have chert near the base, and locally has Roach-like layers of mould of fossil shells. The Curf is a soft chalky limestone, with or without a two foot Flinty Bed of Chert. The Base Bed is similar to the Whit Bed and is used in building to some extent; it also has a Roach Bed on top with numerous moulds of mollusc shells. The Cherty Beds are alternations of soft chalky or oolitic limestone with numerous chert nodules in layers. The Portland Clay is important in holding water up in the Portland Limestone Series above. The

Portland Sands are dark, green-grey and easily weathered, and together with the thick Kimmeridge Clays beneath are responsible for much of the landslipping.

It will be seen that there are considerable local variations in the Limestone Series, and no two quarries present the same section in detail. The nature of this variation has not yet been studied.

Schaffer (Edmunds and Schaffer 1932) reported investigations on the weathering properties of Portland Stone in buildings. He found that the porosity was in two forms; macropores between the ooliths - which drained easily but if under exceptional conditions it was wetted and frozen it disintegrated the rock, and micropores within the ooliths themselves, which did not drain so easily. Variation in the micropore content was found to be largely responsible for variation in weathering properties both physical and chemical under normal conditions. It is thought that this variation may be partly responsible for the siting of caves at least in the initial stages. The distribution of the variation has not yet been studied.

Along the southeast coast of the Isle is the Portland Raised Beach, of Pleistocene date. Sand and shingle up to 20 feet thick rest on a wave-cut platform rising from 20 feet above O. D. in the south to nearly 60 feet about a mile to the north. The deposits fill fissures in the platform and in the old cliff behind where they are overlain by loam with land snails' shells, and these in turn by solifluxion "head" deposits.

No longer visible is the Portland Mammaliferous Drift recorded by Prestwich (1875) on the top of the Isle south of the Verne Fort, filling a trough to a depth of 10 to 20 feet running 200-300 yards in a NE-SW direction and 50 to 60 yards wide. Numerous mammal bones were found in the gravel at the base (see Arkell, 1947, p. 336; Carreck, 1955, pp. 164-188).

Previous Studies:

Fitton (1836) was the first to record fissures but he made little comment upon them. Neale (1852) was the first to note the occurrence of bones in the fissures. Gray (1861) gave a comprehensive account, probably the best of that period. He noted the constancy of direction of the fissures (not entirely supported by the present work) so that the quarrymen could tell the hour by the shadows cast in the fissures. He noted the occurrence of bones, land snails "like those in the [illegible] loess", and the general pattern of drainage with springs cast out above the Portland Clay in the Weare Cliffs. Gray also recorded a grotto 30 feet by 12 feet in Freeman's Quarry near the Church (St George, Reforme), with hundreds of stalactites and ornamental columns. In the Verne Ditch, then being dug, he saw fissures and a natural watercourse 3 feet by 2 feet full of layered sediment. He commented that the Whit Bed often differed in properties either side of fissures (interesting in view of Schaffer's comment on micropore variation). Gray also noted that the Raised Beach overlay some fissures.

In contrast to Gray's accurate observations, Allen (1863) entered into an acrimonious correspondence in "The Geologist" following the discovery of human remains with the bones of extinct mammals, in fissures which still had a roof of Lower Purbeck Beds. Allen argued that this proved that the bones both of mammals (mammoth, bison, etc.) and man were thus weathered out of the Portland Stone, and must be of Jurassic age ! This view was maintained in spite of other correspondents pointing out that the Portland Limestone was a marine sediment and that men and mammoths did not normally walk about the sea-floor ! Fisher (1861 and 1863), Pengelley (1863) and Jecks (1863) are also involved in this correspondence. Damon (1864 and 1884) noted the fissures and their contents - including "several cartloads of bones". He also noted that the fissures contained various artefacts from Roman and Civil War dates, and concluded that some of the human remains were interments. Boyd Dawkins (1869) listed some of the finds and soon afterwards Prestwich (1875) commented on their significance and noted the nature of the Mammaliferous Drift. Carreck (1955) has drawn together all the data on the fissures and their finds, and in particular concludes that the finds from different localities were mixed and that none of the early faunal lists is entirely reliable. His revised list includes:

Canis familiaris Linné (dog)
C. lupus Linné (wolf)
Apodemus ? (mouse)
Elephas primigenius Blumenbach (mammoth)
E. antiquus Falconer (straight-tusked elephant)
Equus caballus Linné (horse)
Sus scrofta Linné (pig)
Rangifer tarandus (Linné) (reindeer)
Capreolus capreolus (linné) (roe-deer)
Megaceros giganteus (blumenbach) (giant Irish deer)
Ovis aries Linné (goat)
Bison priscus (Bojanus) ("steppe" bison)
Bos primigenius Bojanus (urus or wild ox)
Bos longifrons Owen (celtic shorthorn)

It is a pity that most of these cannot be tied definitely to localities, nor to fissures as opposed to the Mammaliferous Drift, though it appears that both warm and cold Late Pleistocene mammals are present as well as post-glacial animals including domestic beasts.

In 1953 Stopes, Oakley and Wells recorded a fissure and its fill (now quarried away) in Silklake Quarries, N.G.R. SY/69737165; the fill included bones (some stalagmited) of man, goat, sheep, pig, ox and dog, as well as hammer stones. It was concluded from the scattered nature of the material that it was probably a sludged fill of early Bronze Age material.

Damon (1884), and Holmes (1884) recorded "dene holes" chiefly in the Kingbarrow Quarries and the Verne ditch, which were apparently artificial pits used as granaries in pre-historic times, probably Roman. Head (1898) recorded interment cists in Coombefields Quarry. Damon (1864 and 1884) and Woodward (1895) particularly noted stalagmite formations, then known to the quarrymen as "sugar-candy", "congealed water" or "fossil water".

From the above it will be seen that most of the fissures are not located, though most are known to have been found either in the Verne ditch (now partly turfed over and inaccessible as it forms part of the prison) or the adjoining quarries (long disused and largely back-filled). Except for Stopes et al (1953) the fissures are described only in the vaguest terms, such as "trending NNE-SSW, with smaller ones E-W, and about 60 to 70 feet apart"; the fill is hardly described at all.

A number of the fissures were recorded with a roof of Lower Purbeck Beds still in place across a gap in the Portland Stone, a fact which Allen (1863) used to prove that his human remains were contemporary with the Portland Stone itself, though other writers referred them to cambering with pulling apart of the harder beds and slipping of the softer.

It may be concluded that the fissures and their fills are of varied dates, and, with intermittent landslipping continuing to the present day, this is not surprising.

Descriptions of the Caves

The Sawmill Cave System (Fig. 2):

The entrance to the Sawmill Cave (N.G.R. 688725) is in the southern part of Inmosthay Quarry opposite the Sawmill Tavern and the stone sawmills, where working has only recently ceased. The main entrance has partly been obscured by blocks of freshly quarried stone, and can be found by following the remnants of the cave northeastwards through the quarry. The entrance is below and to the north of the point where the quarry lip changes direction from N-S to E-W. The cave is 429 feet long with a general N-S trend and most of it is high enough to walk through.

Squeezing between the entrance blocks one passes down a boulder slope for about 6 feet into a passage 5 feet in height and 4 feet wide running in a southerly direction, with a cross-section typical of the Isle. In the roof is a prominent joint, and the walls have a strong constriction about $1\frac{1}{2}$ feet above the floor (Plate I). The floor is of orange-brown mud rather higher in the centre, especially where the mud is 'laced' with calcite. This description is fairly typical of all the passages up to the second boulder choke. Variations that occur are in: the walls - calcite lined or bare stone often with scallop-markings, the number and position of constrictions; the floor - pure mud; calcited mud; boulders or flowstone. The roof may or may not have small straw stalactites up to 4 inches in length, and is generally in the lowest of the three roach lithology horizons seen in Inmosthay Quarry.

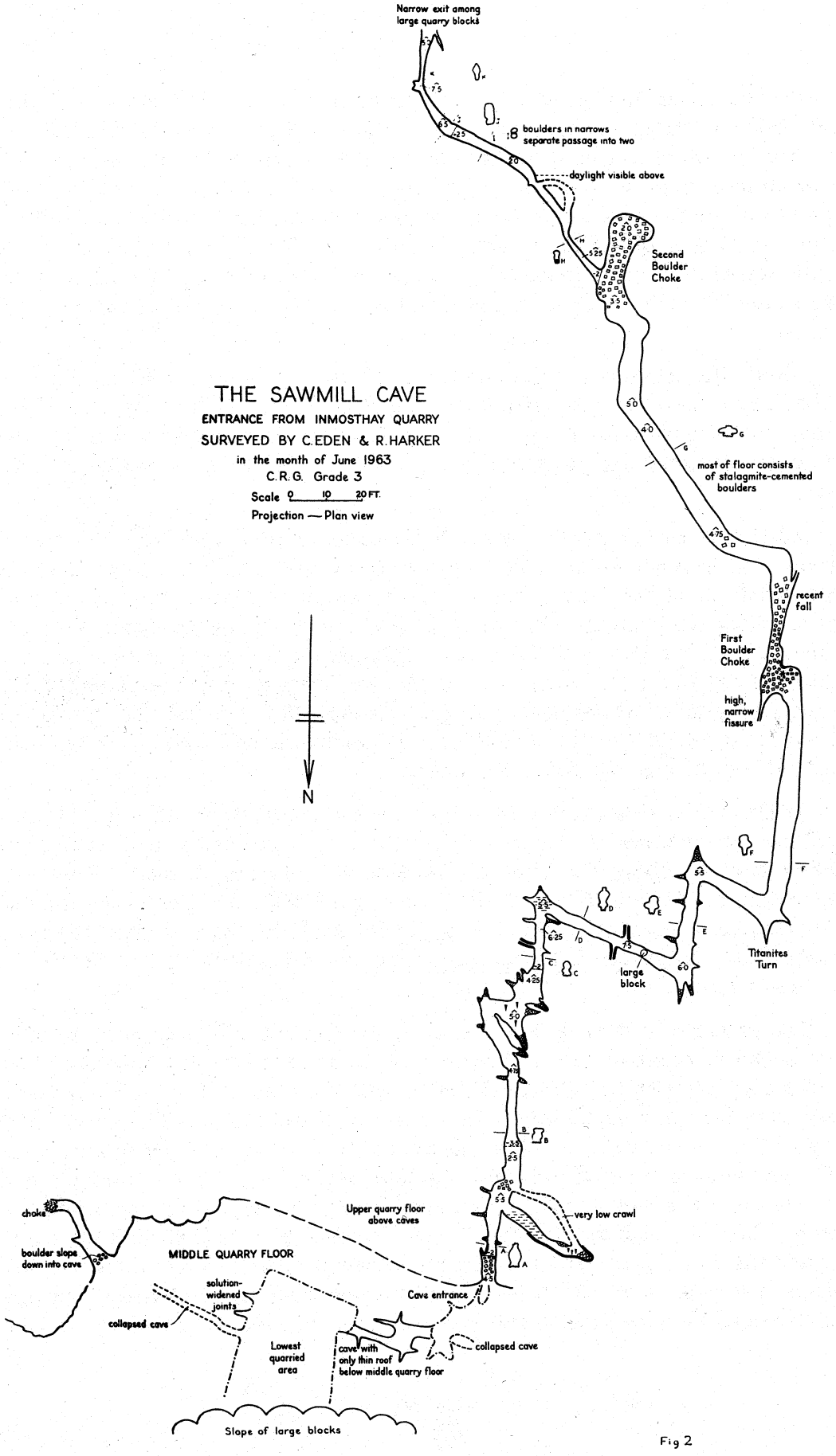

Narrow exit among large quarry blocks
boulders in narrows separate passage into two
daylight visible above
Second Boulder Choke
most of floor consists of stalagmite-cemented boulders
recent fall
First Boulder Choke
high, narrow fissure
Titanites Turn
large block
very low crawl
Upper quarry floor above caves
choke
boulder slope down into cave
MIDDLE QUARRY FLOOR
solution-widened joints
collapsed cave
Cave entrance
Lowest quarried area
cave with only thin roof below middle quarry floor
collapsed cave
Slope of large blocks
THE SAWMILL CAVE
ENTRANCE FROM INMOSTHAY QUARRY
SURVEYED BY C.EDEN & R.HARKER
in the month of June 1963
C.R.G. Grade 3
Scale 0 10 20 FT.
Projection — Plan view
N

Fig 2

Dissolved out joints can be seen cutting across the first stretch of passage in a WNW-ESE direction. These narrow rapidly 5 or 6 feet away from the main cave and are filled with either mud or flowstone. One of these fissures on the west side of the cave 20 feet from the entrance, just beyond the limit of penetrant daylight, is enlarged in a similar fashion to the main passage and can be followed for 15 feet to a small grotto 17 feet in length, 6 feet in width and 3 feet in height, where there are many attractive straw stalactites and rim stone pools. There is a small hole on the southern side through which it is just possible to rejoin the main passage, a few feet further on.

This side passage and the one leading from the second boulder choke, to be described later, are the only ones known on the Island. This is interesting as there are many opportunities for them to form; but, apart from these two exceptions at any joint intersection,only one joint is followed by the main cave as can be clearly seen on the plan.

After this rather sinuous stretch the cave continues south to broaden at the intersection of several joints. The main passage then continues in a WNW direction for 43 feet but about half way along one has to clamber over a large chockstone almost blocking the passage (Plate I). This stone being angular gives the appearance of having fallen from the roof although no adequate point of origin is apparent, nor could it have been transported along the passage for any distance by currents. It is cemented to the sides of the passage by flowstone. The two parallel joints some 9 inches apart in the roof could account for the shape of the block but it has been turned through 90° and suspended above the floor.

At the end of this section the cave turns abruptly south for 35 feet. There are two obvious constrictions in the cross-section, the basal one resulting in a gully about 1 to 2 feet in width giving the false impression of a stream channel. The height of the passage is nearly 6 feet. At the end it turns again WNW and continues for 25 feet before resuming a southerly direction at Titanites Turn, named after the large ammonite of the Portland series Titanites giganteus several good casts of which can be seen in the roof at this point.

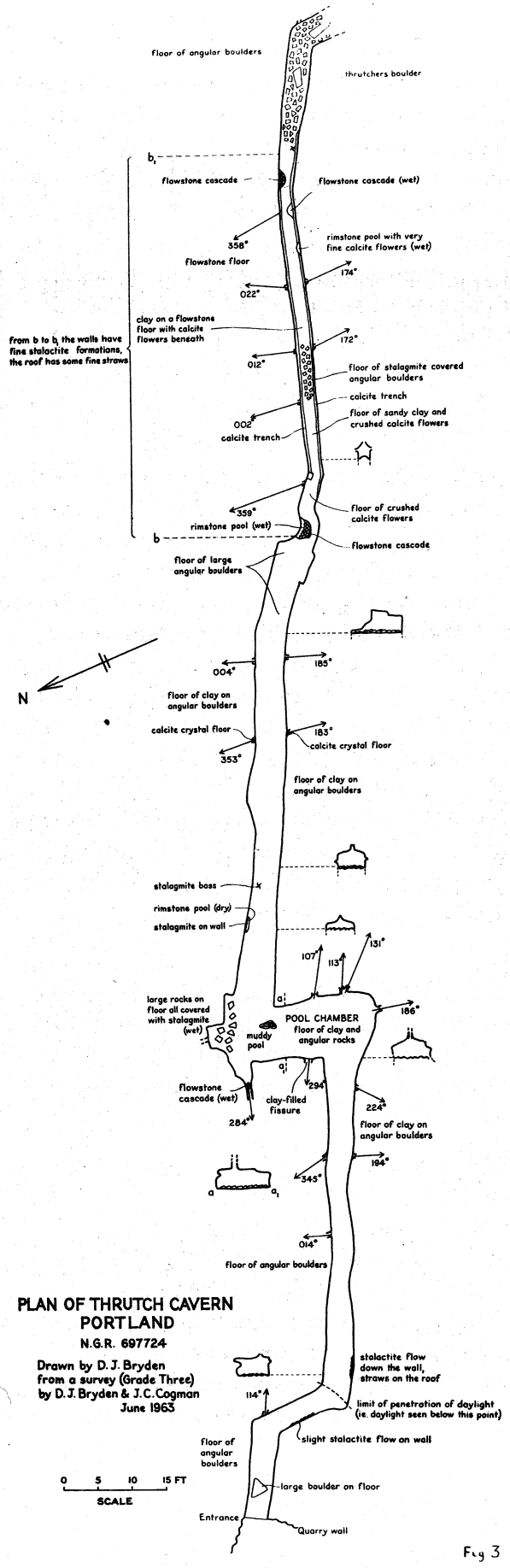
The passage continues in a southerly direction for 55 feet until a considerable boulder-choke is reached with a chert bed exposed in the roof. This first boulder-choke was cleared with little difficulty although much scrambling over boulders is still required for the next 37 feet. Here, where the passage again turns, is enscribed on the wall "J. Stone, 1928". This was probably written by a quarryman who entered from the end now used as an exit but was deterred from going any further by the boulder-choke. The passage then continues first in a southerly then a south-easterly direction with a low roof for 70 feet, finally turning south for 49 feet the passage widens and the floor becomes strewn with boulders ending in the second boulder-choke. It appears that this would possibly go on for some distance if cleared, but no extensive continuation can be hoped for as the cave here heads towards a quarry wall in which no

large entrances are known. A few feet before the second boulder-choke a side passage following a rather deep fissure leads off in a south-easterly direction. Seventeen feet along this a small passage leaves to rejoin 12 feet further on and at this junction light can be seen filtering down from the surface. The next 26 feet are rather interesting as the central constriction becomes very prominent and fallen debris completely cuts the passage into two. It is possible to crawl along either tube. Where they join, the passage again becomes south-easterly but is nearly 8 feet in height. Fourteen feet further on the passage turns due south and light entering from the boulder ruckle at the cave exit can be seen 20 feet away. A good deal of squirming is required to leave the cave by this exit which is impassable for well-built cavers. But if this is achieved one finds oneself in a narrow ravine (N. G. R. 688723) in a disused quarry after having covered 429 feet underground.

As mentioned above part of the cave system has been quarried away and both entrance and exit are in quarry faces. From the northern entrance in Inmosthay Quarry the collapsed remnants can be traced in a north-easterly direction for 18 feet where it is intercepted by a joint and the cave continues in an ESE direction underground for a further 20 feet before emerging into the lowest quarried area some 10 feet deeper than the main quarry. About half way along this section is a small chamber formed at a joint intersection. On the opposite side of the quarried area three entrances can be seen. Two penetrate only a few feet before becoming too tight and the most easterly one ends, after 8 feet, in a boulder-choke. The collapsed continuation can be traced on the middle quarry floor until it once again penetrates down into the quarry face as an obvious cave entrance. However, after 25 feet one again encounters a boulder-choke at the most easterly point of the Sawmill System. No continuation of the passage can be found in the area to the east, which is almost quarried away. It is suggested that the choke may be worth digging if only for conscience sake ! One of us has a recollection of seeing one of these passages only partly choked on his first visit in 1962.

The southern exit of the main cave is in an EW quarried rift. Following this in a westerly direction, for 25 feet, a deep quarry is reached with several flowstone-coated fissures and two cave entrances. These are in a Roach Bed some 8 feet higher than the small roach in the roof of the Sawmill Cave although they could possibly connect downwards with it.

The west side of this quarry (N. G. R. 687725) has a flowstone coated fissure which, when followed in a southerly direction for about 200 yards, leads one to another partially filled disused quarry. At the bottom of this is the 'Horseshoe' Cave with a single entrance to two muddy passages meeting again 35 feet in and closing up rapidly (N. G. R. 687724 Plate II). This is about 5 feet high and 10-15 feet in width and is in the same Roach bed as the Sawmill Cave and may have once been connected to it. The cave with hundreds of stalactites and ornamental columns mentioned by Gray (1861) was probably in this area although his description does not fit this chamber as there is very little flowstone. It therefore seems possible there was once more of



PLAN OF THRUTCH CAVERN PORTLAND

N.G.R. 697724

Drawn by D. J. Bryden
from a survey (Grade Three)
by D. J. Bryden & J. C. Cogman
June 1963

Fig 3

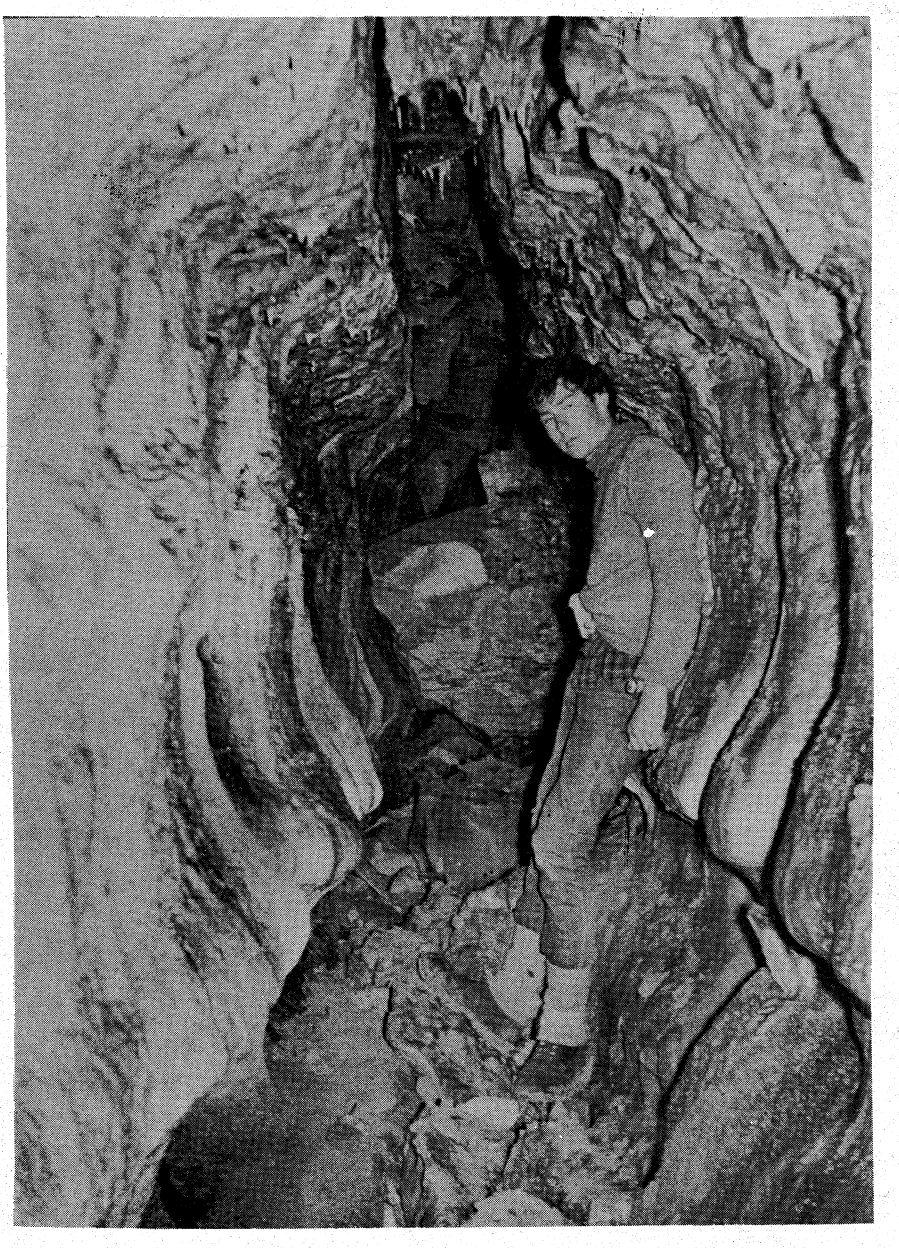


Plate I - Passage in Sawmill Cave showing solution-widening, particularly near Roach-bed (near head level), partially collapsed double joint in roof and the Chockstone (centre)

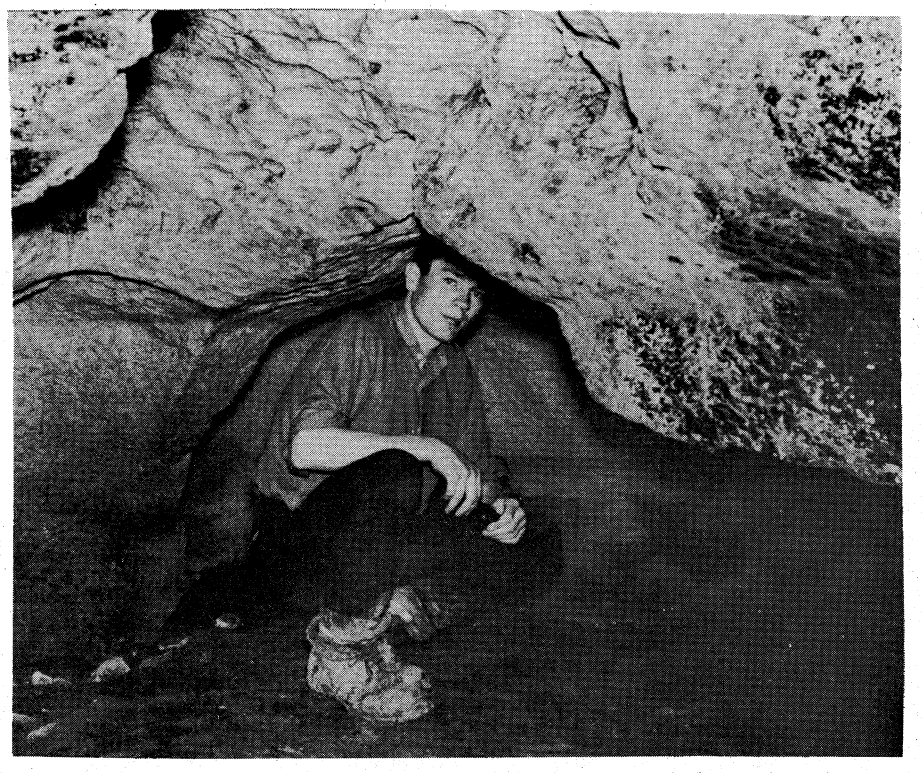


Plate II - Horseshoe Cave showing facetting and high-tide solution level (at head height)

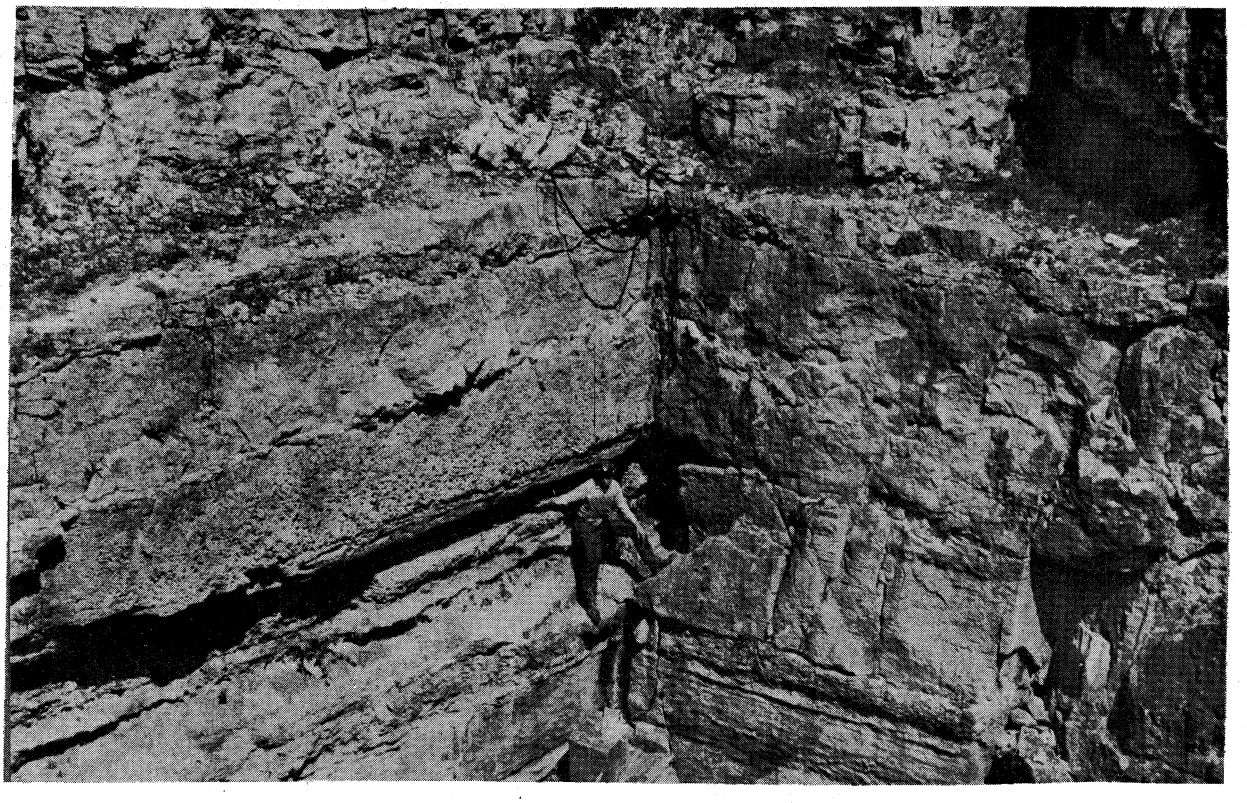


Plate III - Entrance to Thrutch Cave showing former continuation along quarry wall (to lower left) with dissolved-out fossil shell-holes in the bed above

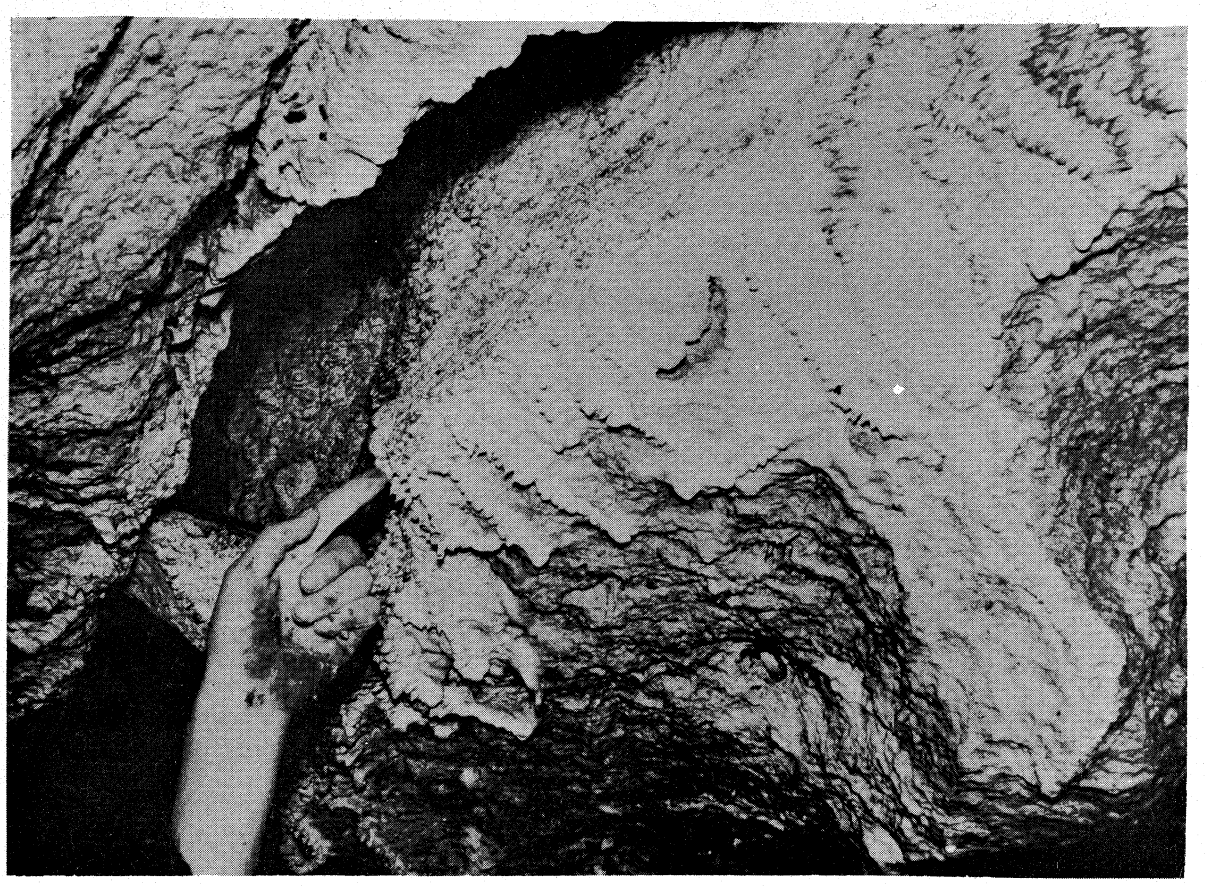


Plate IV - Toothed moon-milk formations in Thrutch Cave

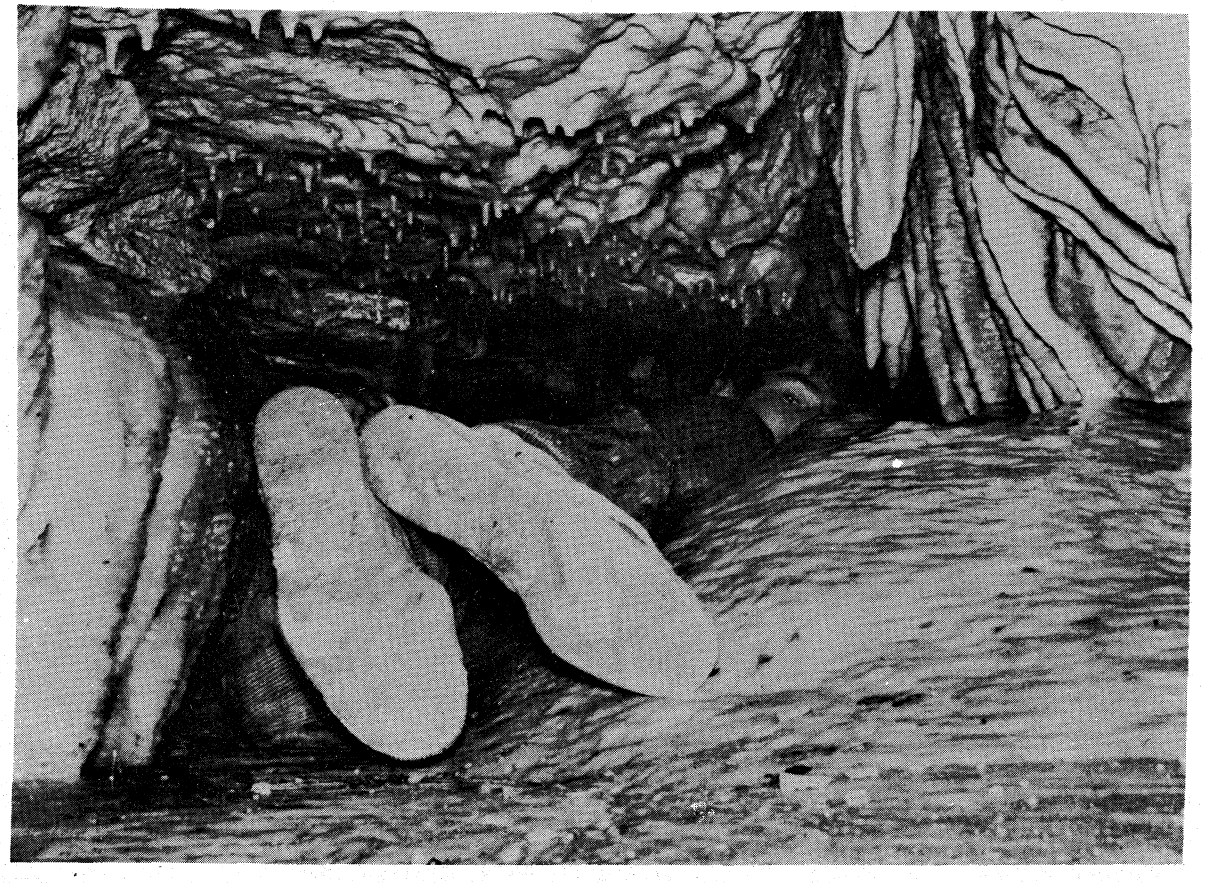


Plate V - Squeezing past the stalagmite boss at the inner end of Thrutch Cave

this system which is now lost.

Thrutch Cave (Fig. 3):

Thrutch Cave (N.G.R. 697724) is located in the most easterly corner of the long disused Higher Headlands Quarry. The entrance (Plate III) is about 8 feet above the quarry floor and can be reached by an interesting traverse of a bicycle frame, an old water tank and other rubbish.

On passing through the entrance, which is about $4\frac{1}{2}$ feet in height, one scrambles over a large boulder into the first stretch of passage 13 feet in length and controlled by an obvious joint trending in an ESE direction. The passage is similar to those of the Sawmill Cave although there is less flowstone. The floor is littered with large angular boulders, but the smoothly sculptured roof shows no apparent source for them. Intersecting joints are not as frequent, but generally more enlarged than in the Sawmill Cave and follow similar directions.

At the end of this first stretch one turns due south for 12 feet before resuming an ESE direction for 60 feet in a passage 4 feet wide and 3 feet in height. The floor is again composed of large angular boulders.

The passage ends in Pool Chamber ironically named after a very small muddy puddle. This chamber is 25 feet long, 7 feet wide and $3\frac{1}{2}$ feet in height, and it has some rather unusual toothed stalactites and curtains (Plate IV) of very crumbly white moon-milk along the N-S joint controlling the formation of the chamber. The roof is smooth whilst the floor is strewn with boulders covered in mud.

A passage leads from the NE corner, of which the first 72 feet are rather similar to those preceeding Pool Chamber, but it is lower and tends to be fairly liberally coated with flowstone. The character of the cave changes abruptly at the end of this stretch. The passage enlarges slightly giving the impression of a small chamber then continues over a large stalagmite which almost blocks the way (Plate V). The following 60 feet of passage is less than 3 feet high and markedly alters in character, being so richly endowed in stalactites that little bare rock can be seen. Both sides of the floor are lined with small rimstone pools containing magnificent, yellow calcite flowers. Between there is a low ridge which is 6 to 9 inches higher than the sides, consisting of calcite sand and crushed flowers.

The most beautiful formations seen on the island occur towards the end of this section. There is a large centrally situated stalagmite boss surmounted by intricately folded stalactite curtains. To one side a shelf contains a forest of columns and the roof is covered with straw stalactites.

This section ends in a boulder strewn floor continuing for a further 25 feet. Just over half way along one squeezes past the large Thrutchers' Boulder and the passage then broadens and turns in a southerly direction, to the point where the survey was discontinued due to shortage of time. The passage here takes a form of a

chamber only 2 feet in height but fairly broad and 25 feet in length. At the end of the chamber the passage turns ESE but entry is almost prohibited by large boulders. However, one can penetrate by a sinuous route into a very small chamber 1 foot 9 inches in height at the centre and 7 feet in circumference. The original entry into this chamber necessitated breaking some beautiful stalactite columns forming a barricade across it. At the far end the passage continues but is too low to penetrate. A very beautiful stalactite colonnade can be seen along this passage and at times a strong draught can be felt blowing into one's face.

(Since writing the above, excavation has allowed entry into another small chamber, with no further possibility of progress).

Fissure Caves

Although throughout the length of the Sawmill and Thrutch Caves joints are the dominant factor controlling the direction of the passages, these are true caves in the accepted sense of the word. However, most of the cavities of the Island are not caves but fissures - joints which have been tensionally opened and then slightly widened by solution through much, if not all of their height, by water moving down from the surface. Many of these are penetrateable only a few feet, after which they become too narrow, some however, can be entered for over 100 feet. At this stage only a few are known in any detail but others are known to exist or have existed before being blocked up by various Authorities.

Australia Rift

The entrance of Australia Rift is on the north side of the Portland Railway Line 300 yards east of the road bridge near the Pennsylvania Castle Hotel and immediately west of the "Arch" foot bridge (N.G.R. 699714). It is not at first obvious from the railway track as it is high up on the cutting face and thickly overgrown by ivy; however, when located it can be reached by a 25 foot rock climb but is most easily entered by lowering a 30 foot ladder from above. This can be belayed to an iron fence-post. After scrambling through the ivy and brambles in the entrance one enters a fissure passage $2\frac{1}{2}$ feet wide and 10 feet in height trending a little east of north. An awkward scramble down and up large boulders for some 20 feet leads to a short cross-joint known as The Boudoir, some 12 feet high and 4 feet wide with beautiful yellow stalactite curtains up to a yard in length, which can be rung like bells (Plate VI). Immediately beyond the fissure continues, parallel to the entrance passage but offset about 4 feet, with a 25 foot pitch to the lower levels. The whole fissure can be done without ropes, but ladders are recommended for novices unused to chimneying techniques. From the foot of the Boudoir pitch the fissure may be explored at several levels although it is easiest to follow the floor down several short pitches till one reaches the base about 60 feet below the entrance. At the northern extremity the fissure narrows rapidly the full height here being about 80 feet. There is beautiful flowstone throughout the length of this fissure (about 150 feet), but the furthest point where

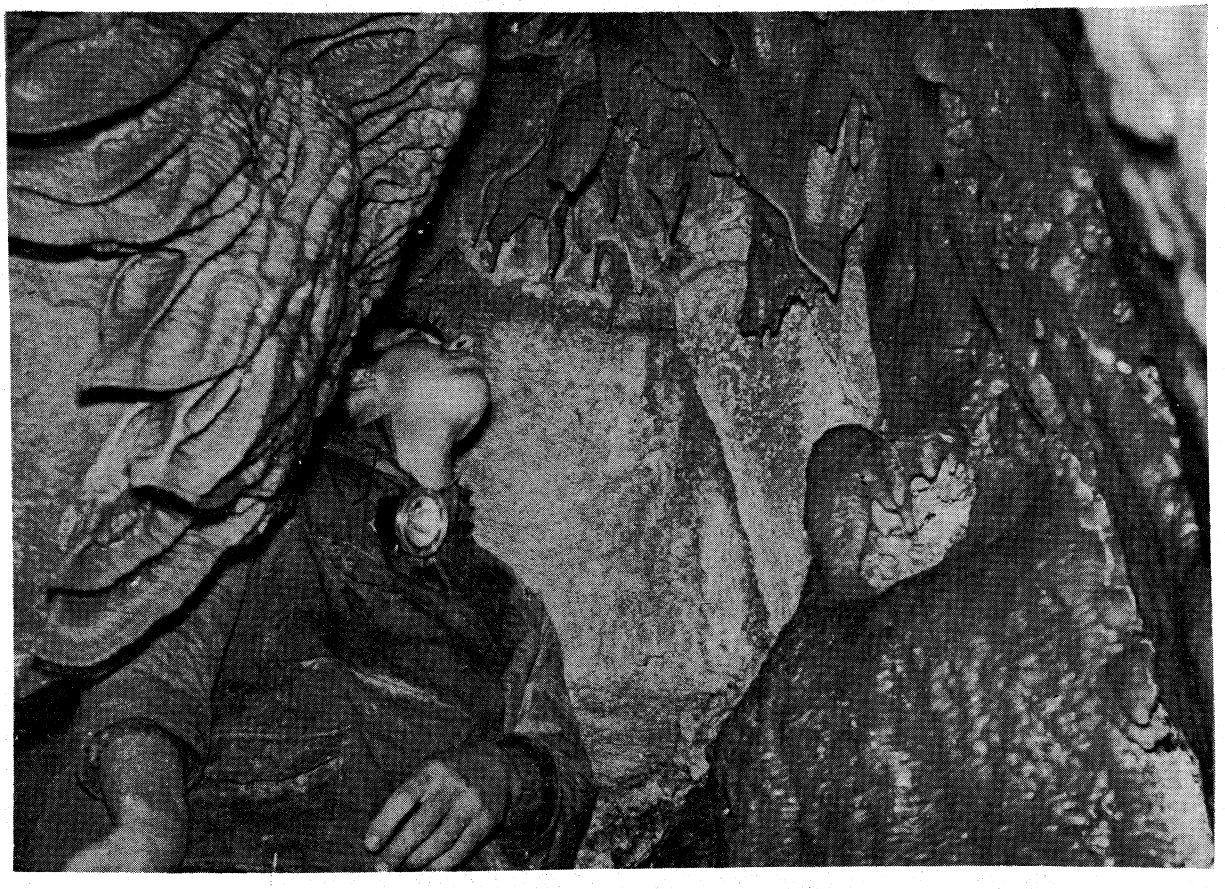


Plate VI - Australia Rift - curtain stalactites in the Boudoir

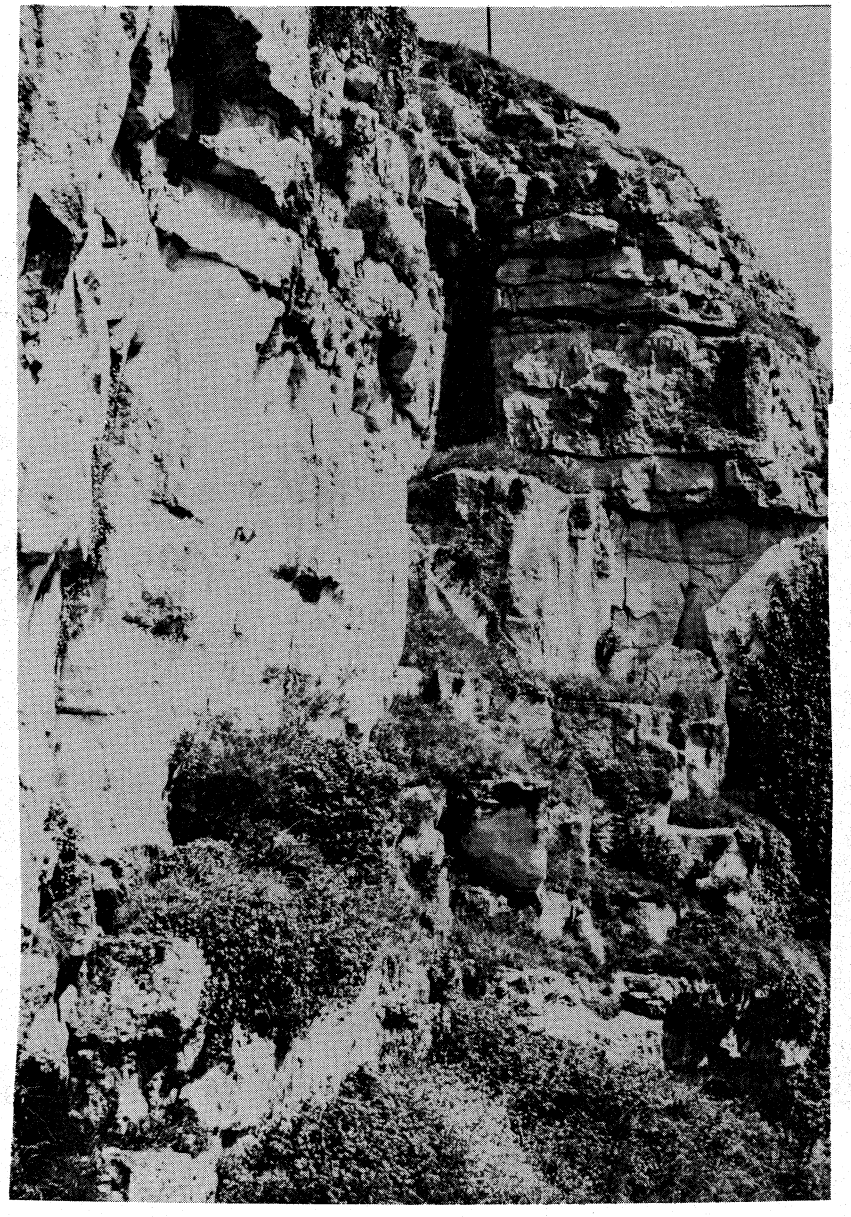


Plate VII - Entrance to the Cherty Rift. A few feet inside is a 25 ft pitch into the cherty beds of the Portland Series which outcrop under the vegetation in the foreground

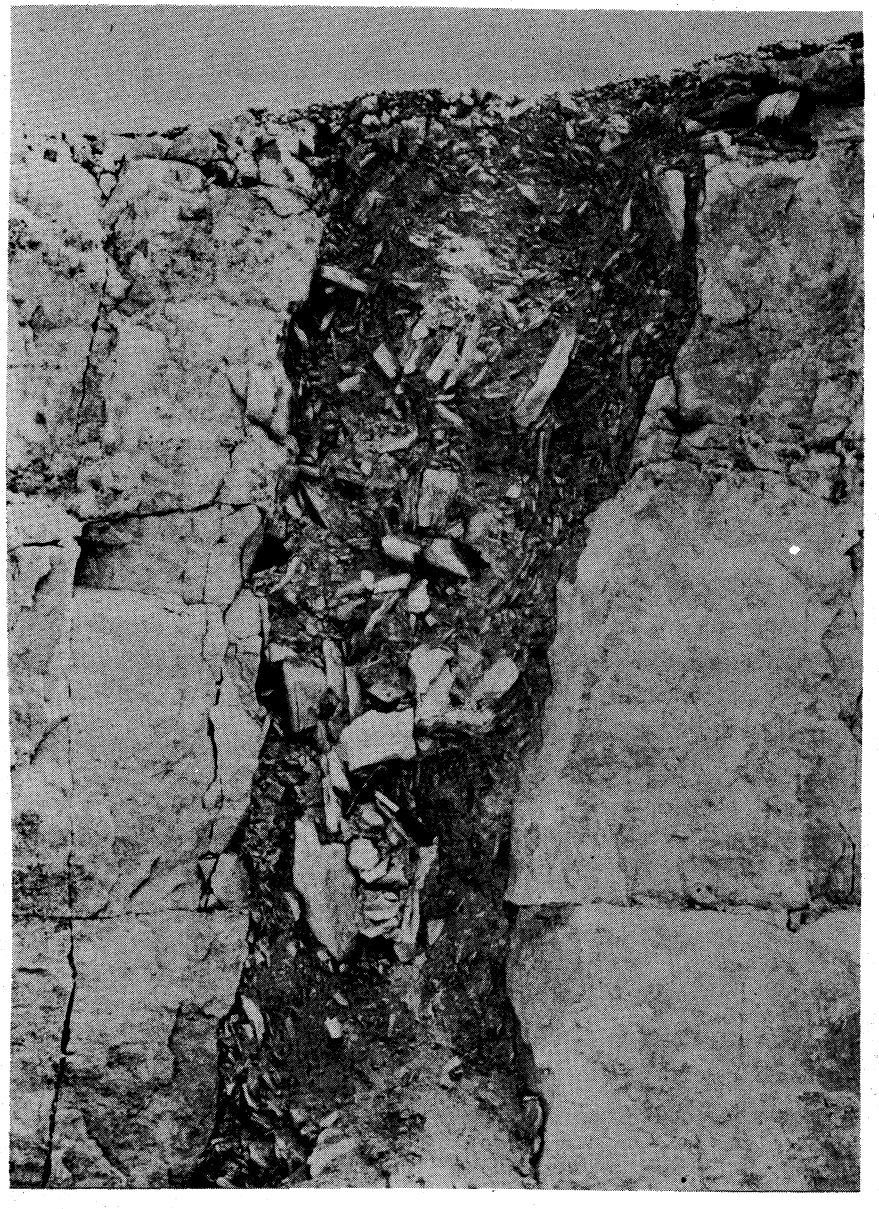


Plate VIII - Yeolands Quarry Fissure. An open fissure in Portland Limestone filled with sludged Purbeck Shales and thin limestones. This fissure is said to have yielded bones and is typical of the fills that have yielded remains from Pleistocene to Cromwellian times. The overburden has been removed in preparation for quarrying

stalactite cascades issue from a small orifice in the roof is particularly beautiful. Much loose debris from the overlying Purbeck Beds litters the floor or is wedged between the walls, where it is dangerously unstable. The accumulation on the floor appears to be similar if not identical to the fissure fillings discussed later and a weathered fill can be seen below the entrance in the railway cutting.

The continuation of the fissure on the south side of the railway cutting has been bricked in but in a quarry 25 feet further away the same fissure diminishes to a mere few inches in width.

The 'Cherty Rift' (N. G. R. 701716)

This fissure is about 200 yards to the east of Australia Rift on the opposite side of a small foot-bridge crossing the cutting. Although the entrance is high up (Plate VII) it is obvious from the railway line. This is parallel and similar to Australia Rift although there is very little stalactite. Twenty five feet in from the entrance we found the only ladder pitch (25 feet), but it has since collapsed and an unstable boulder slope allows a descent to the floor. The whole lower part of the cave is in the Cherty Series and numerous chert nodules project from the walls. The rift closes up after about 150 feet. In places it is about 80 feet high.

Other Fissure Caves

Grove Cliff (N. G. R. 704721)

A number of short fissure caves extend into the Portland Cherty Series in this area, but the longest extends only some 60 feet under the road on the cliff top. "Stalactites" of tar have come through a hole in the roof, and traffic can be heard plainly. Dissolved out bedding planes are present in the sides but are too small to follow. One section is walled up though it is not known whether, as rumour has it, this is a former extension under the Borstal, or merely a means of supporting the road. Some fissures further south along the Grove Cliff and in the cliffs south of the east end of the Verne Ditch can be penetrated for a few feet but are little more than the gaps left by parts of the cliff pealing off.

Rufus Castle (N. G. R. 697712) has a narrow joint passage in the Portland Stone by the footpath. A thin man can edge along sideways for some 20 feet. Stones dropped down the 6 inch wide gap at the end fell a long way.

Broadcroft and Yeolands Quarries, Easton (around N. G. R. 700719.) These working quarries have exposed a number of beautifully decorated open joints, with pendant stalactites, flowstone, crystal flowers etc., but none has been seen which is penetrable for more than a few feet. One joint in Yeolands Quarry is 2 feet wide but completely filled with a partly stalactite-cemented breccia of slabs of the Purbeck Beds, etc. (Plate VIII). The quarrymen said that bones had been found but none were seen during our visit.

Silklake Quarries, Easton, (N. G. R. 69737165), contained Stopes' fissures which is now quarried away. Nothing else of significance was found. A short fissure cave was found about 100 yards west of Australia Rift in the South wall of the railway cutting. Some weathered stalagmite was seen on the opposite wall.

In Grangecroft Quarries (N. G. R. 684709) two parallel flowstone covered joints, trending a little east of north, bounded the western walls of these disused quarries. Holes at the south-west and north-west corners become impenetrable after a few feet.

Mutton Cove (N. G. R. 680713) on the west coast has a small quarry, long disused, at the top and one wall of this is a fine flowstone sheet some 30 feet high and wide, along a joint trending a little east of north. On the other side of the quarry, to the west an open cave could be penetrated some 30 feet by climbing on wedged boulders. Both these and the roof appeared to be very unstable due to the block of cliffs to the west starting to move away. Strong draughts came up through the floor owing to the wind blowing against the cliffs below.

St George's Fissure is in Bowers Quarries (682717) to the north of Mutton Cove. It is a strong open joint apparently in line with one of those in Mutton Cove, and trending about 15° east of north along the east wall of the quarry where masses of old flowstone can be seen. A pitch immediately inside the entrance allows a descent by chimneying for some 25 feet over miscellaneous unpleasant rubbish. At the time of the visit (in wet weather) there was 2 feet of water on the floor, which cannot be far above the Portland Clay, but a ledge 15 feet up allowed a dry traverse for about 70 feet to a flowstone wall. A hole at the base leads into a continuation of the fissure, with rimstone pools and small dark calcite flowers, but after 20 feet it becomes too narrow for further progress. The total length is about 100 feet and the greatest height about 40 feet. The fissure is up to 4 feet wide, averaging 2 feet.

Steve's Endeavour Fissure (N. G. R. 681720) is in the cliffs some 200 yards to the north of the last named, but can only be reached by traversing the top of the scree slopes below the cliffs from either Chesilton or Mutton Cove. A small entrance leads immediately to a 30 feet ladder pitch to the base of a fissure parallel to the cliff face. To the south this stops abruptly after a few feet, but it can be followed over unstable boulders for about 150 feet in the other direction, where it appears to swing inland (eastwards) before becoming too narrow. The height is up to 50 feet. The floor is very dry and dusty and contains plant debris, snail shells, etc...

Other stalactite-filled joints were seen and are too numerous to discuss individually. The joint pattern is described below.

Fissures open in the Portland Stone but with a continuous roof of Lower Purbeck Beds were looked for, and found in the railway cutting near Australia Rift, in Broadcroft and Yeolands Quarries. Except for one short fissure cave in the cutting the fissures were not wide enough to enter, or were filled with a breccia of Purbeck Limestone slabs and shale. Among the latter was the filled fissure in Yeolands Quarry

noted above, which had its roof removed by bull-dozing before we arrived (Plate VIII). The Lower Purbeck Beds were seen to sag into the fissures in some cases, and, although it could not be seen on the surface this appeared to be the cause of the debris in Australia Rift. Clearly the opening of joints in the competent Portland Stone Series, whether tectonic or by cambering and landslipping, allows the softer and more plastic Purbeck Beds to remain in place, at least along part of the length of the fissure. Collapse at intervals allows the various remains to come in, and a mixture of sideways slipping and the vagaries of where the quarries meet the fissures, explain the varied nature and ages (Late Pleistocene to 16th century) of the remains.

The Sea Caves

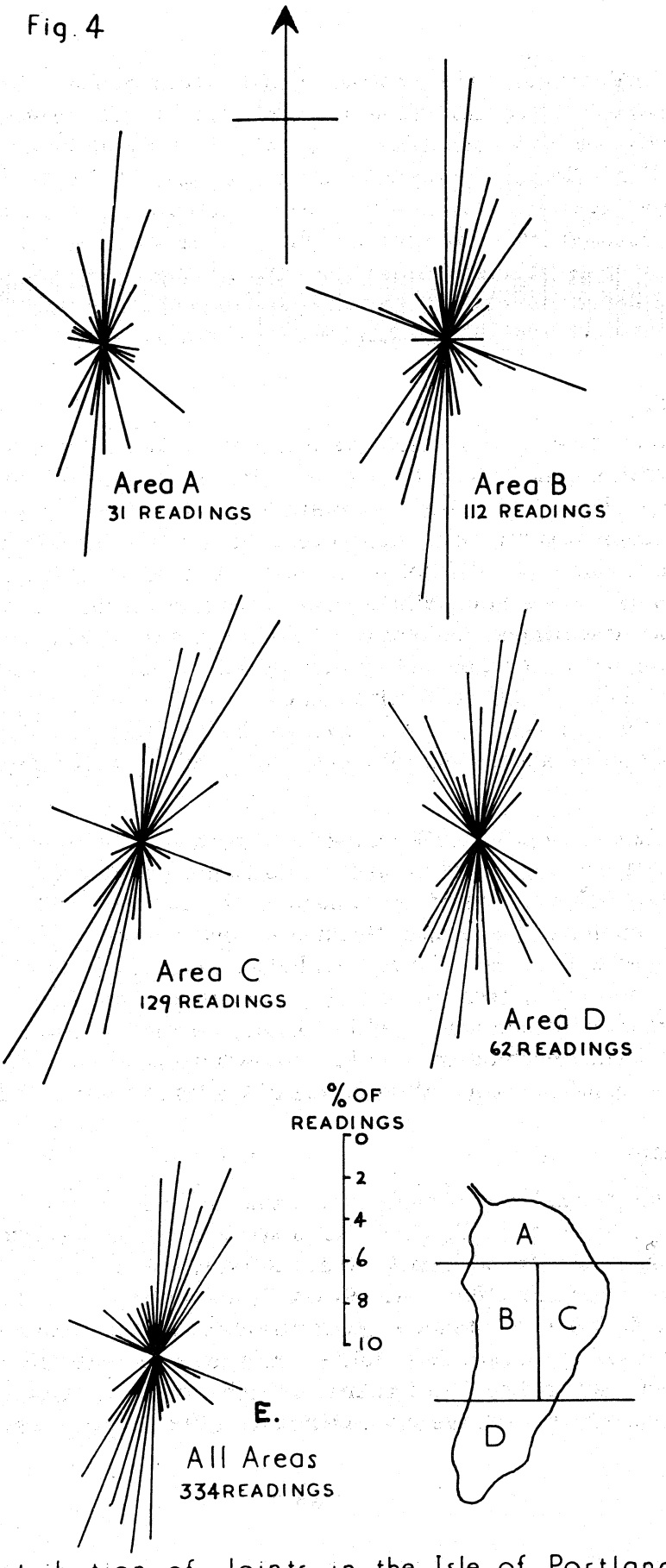
Caves penetrated by the sea are confined to the southern end of the Isle, particularly around Portland Bill. Most of the active ones are difficult to enter except in calm weather at low spring tides. Numerous arches and sea caves along bedding planes were found along the south-eastcoasteast of the Bill. Cave Hole (N.G.R. 686690) extends under the cliff for some 50 feet and has a hole formed by collapse of the surface above (now sealed with an iron grill in concrete). At Sand Holes (N.G.R. 688695) the sea has invaded and enlarged what was once a joint cave only, and is now sufficiently high to be reached only by the highest tides. The entrance is 4 feet square over angular boulders, but it soon opens into a large chamber 60 feet long up to 20 feet wide and 12 feet high, with rounded boulders on the otherwise muddy floor. Limekiln's Cave was another similar cave found below Longstone Ope Quarry (N.G.R. 688693).

Immediately west of the Portland Bill lighthouse the area around Pulpit Rock (N.G.R. 675684) has a number of open joints running a little east of north, indeed one of these cuts off the rock itself. One hundred yards or so north of Pulpit Rock, below the Admiralty enclosure, are open fissures extending into the cliff. At low tide these could be reached with the aid of a 30 foot ladder but owing to lack of time they were not explored. However, from the cliff top one can see that the two open fissures have stalactite-cemented boulders wedged in the top, covered in turn by Raised Beach shingle with rounded pebbles and shells. Elsewhere near the Bill the Raised Beach deposits are covered by loam with terrestrial shells and with solifluxion deposits.

The Joint Pattern:

A cursory inspection of the plans of the Portland Caves is sufficient to show a regularity of passage branching and direction. This is due to joint control, which is clearly observable within the caves, where strong, open, tension-joints can be seen along the roofs. Strahan (1898), Arkell (1947) and others have observed (but not discussed in detail) a consistency in joint directions, noting strong NE-SW or NNE-SSW joints crossed by weaker E-W joints. Edmunds and Schaffer (1932) noted NNE-SSW joints known as "gullies" and relatively tight "east-westers" plus "rangers" scattered between them. These were attributed either to the local tectonics or to

Fig. 4



Distribution of Joints in the Isle of Portland

cambering of the competent Portland Series over the incompetent Kimmeridge Clay, after the separation of Portland as an Island, with ensuing landslipping. To investigate these hypotheses, data was collected from 329 joints and plotted on rose diagrams, one for each of four areas (Fig. 4):

A - north - north of grid northing line 725

B - west central - south of grid northing line 725 - west of 690

C - east central - south of grid northing line 725 - east of 690

D - South - south of grid northing line 700

The rose diagram shown in Fig. 4e is assembled from all the bearings and gives a general picture throughout the Isle. It shows that NNE-SSW and ESE-WNW joints are the most strongly developed, a point in keeping with the tectonic hypothesis as noted below. However, there is also a considerable and regular scatter of joints between these bearings probably due to the cambering effect.

The two salient directions are approximately parallel, and at right-angles to the axis of the Weymouth Anticline (ESE-WNW). Tension fractures such as these, are usually found parallel to an anticlinal axis and at right-angles to a synclinal axis; thus it would appear that both structures are present on the Isle. This is probably the case for, although Portland is on the southern limb of the Weymouth Anticline, the Isle has a slight synclinal flexure giving the greater development of NNE-SSW joints; the weaker development of ESE-WNW joints being due to either minor anticlinal flexures or, more likely, a phase in the folding of the Weymouth Anticline which occurred at a slightly different date.

The fissure caves appear to be normal joints particularly those trending NNE-SSW. They are locally modified by water filtering from the surface giving either solutional enlargement along bedding or more often partial flowstone fills.

Insufficient data has been gathered for a significant regional analysis, but it may be noted that in the north (area A) strong N-S joints predominate whereas the south-east (areas C and D) they are less predominant and trend more NE-SW. The E-W joints are more accurately described as ESE-WNW, although they again are less obvious in the south, and are more nearly SE-NW in the north. These variations in direction are reflected in both the shape of the Isle and its landslips and in the disposition of the fissure caves. They suggest a tectonic origin amplified by cambering and landslipping.

No comparison with the Portland Stone of the main Dorset area has been attempted. The outcrops north of Weymouth and Lulworth are generally of small extent and, owing to the steep dips north of the anticline, they are relatively narrow. The larger outcrops in the Isle of Purbeck to the east contains the Tilly Whim Caves (N. G. R.

40/031770) which are abandoned underground stone quarries now partly commercialized, as well as numerous other underground workings in both Portland and Purbeck stones which are mostly uncharted. Only a cursory survey has been attempted here and no mention of natural caves has been found in either the literature or by questioning quarrymen.

The Origin of the Solution Caves:

At first glance the Sawmill and Thrutch Caves appear to be rather like the Yorkshire stream passages, with their cross-profiles of recessed beds and constrictions, but on closer inspection this resemblance is found to be an illusion as no undoubted features typical of a cave formed by running water have been found.

The general sequence of events may be described in dealing with the features of these caves as follows, and an attempt will be made afterwards to fit them into the geological history of the area.

(1) Throughout the Isle of Portland there is clear evidence of ground-water solution of fossil shells from the Roach and from the roach-like beds in the Portland Stone below. These shells were largely of animals known to secrete aragonite rather than calcite, which explains the preferential solution. Whilst some such solution is still going on in exposed places as part of present-day weathering, it is reasonable to deduce that the bulk of it was done beneath the water-table, as an initial stage in cave formation.

(2) The solution of fossils in the Roach can be seen in numerous quarries to be most complete in the vicinity of joints.

(3) Thus the intersections of joints and Roach beds are preferred zones for cave development, and by the usual pattern of phreatic cave development a net-work of roach-joint tubes probably arose, but did not grow far enough to be penetrable caves.

(4) The restriction of cave development to the Sawmill and Thrutch Caves (and others still undiscovered, inaccessible or destroyed) is problematical, although Schaffer's micropore variation may be significant particularly since the former has a north-south trend and the latter an east-west trend. Both are, however, at roughly the same altitude (350 feet O.D.) and if it is allowed that they are both probably relics of much larger systems the discrepancy in trend may not be significant. The reason proposed for the restriction of cave development to certain places is that it took place during a period of falling water-table so that phreatic water-flow occured just below the water-table and that certain roach-joint intersections were picked out preferentially either because of an increased thickness of roach or because of the occurrence of

double-joints or both. The lack of a catchment area with streams bringing sand in may explain the lack of vadose features. A former standing water-level and irregular facets are clearly visible in Horseshoe Cave (Plate II).

(5) The angular boulders on the floor contrasting with solution facets of the walls suggests a phase of solutional enlargement by the detachment of blocks from between the double joints, at least partly contemporary with a phase of surface solution of the walls themselves by percolating water draining down and cutting elongate facets, after the draining of the caves. By this means it is thought possible to have solutional modification by corrosion of the walls going on at the same time as angular boulders accumulate on the floor, out of reach of slowly percolating water.

(6) A decrease of the rate of flow of percolating water allowed it to pick up more $CaCO_3$ from the overlying rocks and in turn the reduced flow on the cave walls permitted greater discharge of CO_2 (and evaporation in places) thus caused stalactite growth. The vagaries of where flow is reduced, and where it is not, would allow solutional corrosion of the walls, with detachment of blocks, in one place and stalactite growth in another, the two places being perhaps no more than a few yards apart.

The Relationship of the Caves to the Geological History:

Phase (A), equivalent to (1), (2) and (3) of the above sequence, could have been at any time from the end of the Jurassic to early Pleistocene, but was probably largely during and after the Alpine orogenic movements in mid-Tertiary times.

Phase (B), equivalent to (4) of the above sequence, must have taken place whilst the water-table was still above 350 feet O. D. Sparks (1952) was unable to find much evidence of erosion surfaces on the Isle, but by reference to the Weymouth hinterland he suggested that the Isle was separated by the time of the 430 ft platform, and this separation was dated as late Pliocene or early Pleistocene. The phase must thus be dated as during one of the periods of falling water-table during the early Pleistocene.

Phase (C), equivalent to (5) and (6) of the above sequence, can be dated at any time since the early or Middle Pleistocene, as the Portland Raised Beach is regarded as Last Interglacial in age with sea-level not more than 60 feet higher than at present. The Phase probably occurred in several sub-phases with alternations of increased percolation with solutional breakdown and periods of stalactite growth. No evidence on which to separate these has been found.

Leicester, March, 1964.

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