CHAPTER XVI.

DORSET—INLAND.

BY THE LATE W. H. HUDLESTON, F.R.S., F.G.S.

IT is with deep regret that we have to record the death of the author of the following chapter, on January 28th, 1909. The names of the fossils are those used in the original report, in our PROCEEDINGS, but at the request of the late Mr. Hudleston the following notes on these fossil-names were prepared for him by Mr. S. S. Buckman.

EDITORS.

NAMES USED IN THIS CHAPTER.	MR. S. S. BUCKMAN'S REMARKS.
<i>Harpoceras moorei</i> , Lycett	= <i>Dumortieria latescens</i> , S. Buckman, D. aff. <i>moorei</i> , Lycett, sp.
„ <i>radians</i> (Schlotheim).	= <i>Dumortieria pseudoradiosa</i> , Branco, sp.
<i>Humphriesianus</i> -zone	= <i>Blagdeni</i> and <i>Niortensis</i> zones.
Zone of <i>Stephanoceras</i>	= Zone of <i>Stepheoceras</i> .
<i>Parkinsoni</i> -zone	= Upper Beds of Inf. Ool.
Zone of <i>Cosmoceras</i>	= Zone of <i>Parkinsoni</i> .
<i>Harpoceras concavum</i>	= <i>Ludwigella concava</i> , J. de C. Sowerby, sp. <i>Graphoceras v-</i> <i>scriptum</i> , <i>G. stigmaticum</i> , <i>Lucya</i> <i>cavata</i> , <i>L. magna</i> , etc., S. Buck- man.
Section <i>Harpoceras</i>	= Family <i>Hildoceratidae</i> — Genera <i>Witchellia</i> , <i>Sonninia</i> , etc.
„ <i>Stephanoceras</i>	= <i>Stepheoceras</i> , <i>Teloceras</i> , <i>Cadomites</i> , <i>Normanites</i> , etc.
„ <i>Cosmoceras</i>	= <i>Parkinsonia</i> , etc.
Zone of <i>Cosmoceras parkinsoni</i>	= Zone of <i>Parkinsoni</i> = zones of <i>Garantiana garantiana</i> , <i>Strigo-</i> <i>ceras truelli</i> , <i>Zigzagoceras zigzag</i> .
Zone of <i>Stephanoceras humphriesianum</i>	= Zones of <i>Blagdeni</i> and <i>Niortensis</i> .
<i>Harpoceras sowerbyi</i>	= <i>Sonninia</i> of the <i>S. sowerbyi</i> type.
<i>Stephanoceras blagdeni</i>	= <i>Teloceras banksi</i> , Sow. <i>T. blag-</i> <i>deni</i> , Sow.
<i>Sphaeroceras sauzei</i>	= <i>Otoites sauzei</i> .
<i>Harpoceras edouardianum</i>	= <i>Dorsetensia edouardiana</i> .
„ <i>cycloides</i>	= <i>Pecilomorphus cycloides</i> .
„ <i>murchisonæ</i>	= <i>Ludwigia murchisonæ</i> .
<i>Perisphinctes martinsii</i>	= Same.
<i>Ammonites dorsetensis</i> , Wright	= <i>Parkinsonia dorsetensis</i> .
<i>Oppelia truelli</i>	= <i>Strigoceras truelli</i> .
<i>Sphaeroceras brongniarti</i>	= Same.
<i>Harpoceras adicrum</i> , Waagen	= <i>Sonninia acanthodes</i> and other spinous spp.
<i>Tytoceras confusum</i> , Buckman	= <i>Megalytoceras confusum</i> , S. Buck- man, sp.
<i>Harpoceras</i> -beds	= <i>Murchisonæ</i> , <i>bradfordensis</i> , <i>concava</i> , <i>discites</i> zones.
<i>H. var. bradfordensis</i> , Buckman	= <i>Brasilia bradfordensis</i> , S. Buck- man, sp.

a branch towards the village of Osborne, the escarpments face the west, but shortly after the fault is crossed it is seen that the escarpments are beginning to face the north, and that is entirely the case by the time that we reach Sherborne, where all the beds have a steady southerly dip, though, of course, a considerable amount of rolling and displacement may be noted.

This southerly dip may be gathered from a study of the section across the Valley of the Yeo (Fig. 58), to which the attention of the members was directed. The hills on the south side of the valley are thus formed by the escarpments of the Fuller's-Earth, the Fuller's-Earth Rock, the Upper-Fuller's-Earth, and the Forest Marble, whilst the hills on the north side of the valley are formed by the dip-slope of the Inferior Oolite ascending towards its escarpment, which attains along the line of section a height of about 500 ft. above sea-level. Owing to the change in outcrop previously noted the Inferior Oolite escarpment presents a noble sweep of high ground which embays the Vale of Somerset. From some of its salients magnificent views may be obtained, only bounded by the Mendips on the north and by the Quantocks on the west. The massif, which is formed by the Inferior Oolite and Sands, has been cut transversely about three or four miles west of the line of section, between Yeovil junction and the town of Yeovil, and through the gorge thus formed the drainage of the Upper Yeo finds its way into the low-lying basin of South Somerset. So much for the physiography of the country round Sherborne.

Perhaps the most characteristic formation of the district is one to which, without begging the question, the name of *Yeovil Sands* would best apply. Judging from wells and exposed sections, a thickness of 150 ft. had been roughly assigned to these sands, which vary somewhat in character according as the hard calciferous bands and doggers are plentiful or scarce. The Director had discovered a very rich shell-bed in these "Sands" in a quarry at Stoford, near Yeovil Junction. It was probably about 30 ft. or 40 ft. below the base of the Inferior Oolite Limestone. The section may be detailed as follows:—

SECTION IN THE "SANDS" AT STOFORD.

	ft.	in.
a. Soft yellowish sands in thick beds, separated by thinner bands of hard blue calciferous grit; no fossils seen.	30	0
b. A shell-bed like Forest Marble stone, with abundance of Monomyaria, and some Dimyaria. <i>Trigonia angulata</i> , <i>Tancredia</i> near to <i>donaciformis</i> —Univalves rare— <i>Harpoceras moorei</i> , Lyc. and <i>H. radians</i> , Schlot. are the prevailing Ammonites	2	0
Total in quarry	32	0

Without troubling themselves about any of the higher beds, the attention of the Members should, the Director said, be devoted to the Inferior Oolite Limestone, and he gave a short history of the various interpretations which had up to that time been suggested.

The Director stated he had obtained very clear evidence that the "fossil-bed" of North Dorset was on three entirely different horizons in such quarries as Osborne, $3\frac{1}{2}$ m. north-east; Half-way House, 3m. west; and Bradford Abbas, $4\frac{1}{2}$ m. west-south-west of Sherborne. At Osborne the principal "fossil bed" was in the *Humphriesianus*-zone, or in what he should prefer to call the zone of *Stephanoceras*,* and this was the case near Sherborne itself. At Half-way House the principal "fossil bed" was in the *Parkinsoni*-zone, or zone of *Cosmoceras*,* whilst at Bradford Abbas it was in the so-called *Sowerbyi*-subzone, characterised by an extraordinary abundance of *Harpoceras** *concauum*. Hence, if we are desirous of a local name for this rich but limited group, we might speak of the *concauus*-beds.

Now the evidence that he was about to adduce had the advantage of having been obtained from a very few feet of rock. Instead of the many hundreds of feet presented by the Inferior Oolite of Yorkshire, distended as it was with a quantity of estuarine shales and sandstones, instead of 230 ft. of mixed marine limestones at Leckhampton, only 70 miles off, we here have the Inferior Oolite comparatively in a nutshell, the whole thing having been "boiled down" as it were, so as to present a quarry face of very accessible dimensions. We must not always estimate the value of a thing by its volume; nay, this paucity of sediment is an actual advantage. There is a single bed in the Bradford Abbas quarry no more than two feet thick, which, to a palæontologist, is worth more than an entire section in the Cotteswolds. But this is only an example of similar beds on other horizons of the Inferior Oolite of this district, where the shells, instead of having been ground up under the influence of strong currents and breakers, seem to have been deposited side by side in waters of considerable tranquillity.

But what the Director especially desired to point out was the very great—the almost total—change undergone by the Ammonite fauna within very moderate thickness of rock. The extraordinary difference had been noted by several observers, and was known to all collectors and quarry-men; but some had set it down to nothing more than mere local change. If such was the case, it was curious that the same relative position of the three well-known groups should always be duly preserved. The beds which swarmed with the section *Harpoceras*, when visible, were always at the bottom. Those which were characterised by the section

* These were the names of the corresponding Ammonite sections at the time (1895). See Mr. Beckman's note at the beginning of this chapter.

Stephanoceras, wherever they occurred—and they were frequently absent in the full development—were always above the *Harpoceras* Beds, but also always below the beds which were characterised by the section *Cosmoceras*. These facts, together with the wonderfully sharp and sudden change in the Ammonite fauna, he hoped to be able to prove in the quarries which the Members would visit in the afternoon.

The party drove to Frogden Quarry, Osborne, and the following is the reading of the section which was offered by the writer at that time:

SECTION AT FROGDEN QUARRY, OSBORNE, 1½ MILES N.E. OF SHERBORNE.

		ft. in.
ZONE OF COSMOCERAS PARKINSONI.	a. Soil and roots	1 0
	b. Pale fissile limestones	2 0
ZONE OF STEPHANO- CERAS	b. Courses of brown sandy limestone, with intervening soft-stuff	4 6
	c. "Top stone," or <i>Cadomensis</i> bed, a sandy, iron-shot oolite	5 0
HUMPHRIE- SIANUM.	d. Main beds of the <i>Humphriesianus</i> -zone, brown iron-shot oolites	5 0
SAUZEI BED.	e. Marl with green grains, <i>H. sowerbyi</i> and other species of <i>Harpoceras</i> in abundance; <i>Spharoceras sausei</i> occasionally; many univalves	0 6
Total in quarry		13 0

DETAILS OF THE BEDS.

a. *Cosmoceras parkinsoni* said to occur here, but probably rare. These are the commencement of the "freestones" which come on more extensively on the dip. In the quarry above Osborne village, on the opposite side of the valley, 18 ft. of massive limestones, with brownish sandy partings, may be seen on this horizon.

b. These beds divide as follows:

	ft. in.
Stone down to a shaly bed, with <i>Belemnites</i> , <i>Rhynchonella spinosa</i> , <i>Terebratula ferryi</i> , and <i>Ancyloceras</i>	1 7
Stone down to a shaly layer with small var. of <i>T. sphaeroidalis</i> , <i>Belemnites</i> , etc.	1 2
Stone to a bed of soft brown sandy limestone, which contains a peculiar form of <i>Cosmoceras</i> , and ? <i>Perisphinctes</i>	1 9
	4 6

c. "Top Stone" (*Sphaeroidalis* or *Cadomensis* bed), regarded usually as the highest bed of the *Humphriesianus*-zone; but there is a most curious assemblage of Ammonites. *Cosmoceras*, *Oppelia*, *Perisphinctes* predominate, though the true *Parkinsoni* probably hardly occurs. *Stephanoceras* not numerous, and usually small. It may be regarded as a true passage bed between the zones of *Parkinsoni* and *Hum-*

phriesianus. Numerous univalves, and many species of *Astarte*. *Monomyaria* not abundant.

d. "Main beds of the *Humphriesianus*-zone." Towards the centre a layer of the *Stephanoceras blagdeni* (on end); towards the base a layer of large *S. humphriesianum* (flat). *Stephanoceras* and *Spharoceras* in great abundance, with a few *Oppelia* and *Lytoceras*. *Harpoceras* rare, and very peculiar (one near to *H. edouardianum*); *H. cycloides*. *Gasteropoda* and *Lamellibranchiata* tolerably numerous. *Terebratulula sphaeroidalis* abundant.

e. "Marl with green grains." The matrix is favourable for the extraction of shells. *Gasteropoda* abundant, whence this is sometimes called the "univalve bed." It is largely made up of brownish iron-shot stone, which includes patches of marly stuff, with green grains. Amongst the *Ammonites* the section *Harpoceras* largely prevails. *Spharoceras saurei* occurs rarely. *Stephanoceras* and *Oppelia* small and infrequent. The fossils differ considerably from those of the so-called *Sowerbyi* bed at Bradford Abbas.

It has, however, since been recognised that this latter is a complete misnomer, and the great fossil-bed of Bradford Abbas is now generally known as the *concavus* bed.

The party then moved on to Halfway House, situated on the top of a sharp rise, where there had been extensive quarrying for many years past. Just before entering the main quarry the members had an opportunity of inspecting a fault which brings the basal beds of the Inferior Oolite Limestone against the "Sands." This exposure is valuable, as showing the bottom of the "Dew" bed, together with a few feet of the "Sands" on which it rests.

SECTION AT HALFWAY HOUSE—QUARRY CLOSE TO HIGH ROAD ON THE NORTH.

		ft. in.
	Additional beds on south side of road, say	10 0
ZONE OF COSMOCERAS PARKINSONI.	a. Soil and top rubble.	3 6
	b. Alternations of freestones and dirty soft-stuff	9 6
	c. The "fossil bed." <i>C. parkinsoni</i> very large	2 0
? ZONE OF S.	d. "Soft shell-bed" with irony band below, variable, say	0 4
HUMPHRIE- SIANUM.		
ZONE OF H.	e. Upper <i>concavus</i> bed	2 0
MURCHI- SONÆ.	f. Lower <i>concavus</i> bed	2 2
	g. "Dew bed," a calciferous grit, variable, say	1 6
Total in quarry		21 0
Sands and calciferous grits to bottom of well, say		125 0

DETAILS OF THE BEDS.

* a. and b. There may be about 22 ft. of limestone and soft stuff above the "fossil bed." These freestones are not very fossiliferous,

* The letters a, b, &c., are not used to indicate the same beds as the a, b, &c., of the other quarries. Each quarry stands by itself as regards lettering.

but contain *Cosmoceras parkinsoni*, and *Perisphinctes martinii* occasionally, along with *Nautilus* (?) *latidorsatus*. Remains of Crustacea are sometimes found.

N.B.—In the "freestones" at Sherborne a fine specimen of *Megalosaurus bucklandi* was found on the occasion of the excursion. These beds help to form the great thickness of the Inferior Oolite at Sherborne.

c. There are two principal lines of *Cosmoceras parkinsoni*; the lower one contains the best specimens for cutting and polishing. This was the *A. dorsetensis* of Dr. Wright. It presents certain differences from the specimens in the Bridport district. Fine specimens of *Oppelia trucllii* likewise occur—also a small, fine-lined *S. humphriesianum*. The rock is a buff-coloured limestone sparingly ironshot, and the best in the quarry for univalves.

d. "The soft shell-bed," etc. The upper portion of d, i.e. to say, the "soft shell-bed" itself, seems to form part of the block in which the great *C. parkinsoni* occurs; without, however, belonging to it. The development is extremely variable, and its connection with a thin ferruginous band beneath is irregular and uncertain. The soft shell-bed is sometimes absent. The most common fossil is *Astarte obliqua*; it contains minute specimens of *Stephanoceras* near to *humphriesianum*, and a medium-sized *Sphæroceras brongniarti*, Sow., is characteristic.

At Wyke Park quarry $\frac{3}{4}$ mile south, the ferruginous beds, 8 in. thick, are believed by Mr. S. S. Buckman to represent the *Humphriesianum* bed of Sherborne, etc.

e. In this bed are fine specimens of *Harpoceras adicrum*, Waagen, in position. This is probably the "*Ammonites variabilis*" of some writers. *T. perovalis*, var. *ampla*, occurs. But few univalves.

f. The thick bed where we find *Amm. concavus*, and "*jurensis*." This latter is the *Lytoceras confusum* of S. S. Buckman; an enormous specimen may be seen (May, 1885) in position in the old quarry—*T. perovalis*, var. *ampla*, and *Rhynchonella ringens*. But few univalves.

g. The "dew bed," which forms the bottom of the limestones, or top of the sands, is at the base of the quarry, and occupies a lower horizon than the "dew bed" at Frogden Quarry, Osborne.

Very interesting exposures are obtained in an old quarry face which leads up towards the escarpment on the north, and where all the beds above detailed may be seen gradually cropping out, until the *Harpoceras* beds (here called the *concavus*-beds from the extraordinary profusion of *H. concavum*, Sow.) form the surface of the field.

A rapid drive from Halfway House brought the party to the celebrated quarry in Bradford Abbas parish, close to the house occupied for so many years by the late Professor Buckman,* a mile and a half south-south-west of Halfway House.

* When the Association visited this district 14 years previously Professor Buckman was one of the Directors. On the second day of the Excursion he conducted the party, which was quartered at Pen Mill, near Yeovil, through the Babylon Hill cutting, thence to Halfway House and Sherborne, and lastly to "a small quarry on his farm, where a quarryman exhumed with a pick in a few minutes great numbers of fine ammonites." Professor Buckman entertained the party at dinner, and afterwards expounded his views on the geology of the district. (See *Proc. Geol. Assoc.*, vol. ii, p. 249.) Mr. Hudleston, in replying to a vote of thanks for his services as one of the Directors of the later Excursion, alluded to the fact that he was the only member of the Association who had been present at both Excursions.

SECTION AT BRADFORD ABBAS (EAST HILL QUARRY).

		ft. in.
ZONE OF COSMOCERAS PARKINSONI.	{ a. Whitish limestone in beds which are not very fossiliferous, though <i>C. parkinsoni</i> occurs rarely, and mostly towards the base	6 6
	{ b. Marl bed with <i>Terebratula morieri</i> and <i>Rhynchonella parvula</i>	0 6
? ZONE OF S. HUMPHRIE- SIANUM.	{ c. The "rotten bed" with large <i>Astarte</i> . Very small Ammonites, mostly <i>Stephanoceras</i> ; thickness variable, say	0 6
	SUB-ZONE OF H. CONCAVUM.	{ d. Irony stone
{ e. The great shell bed of Bradford Abbas with <i>H. concavum</i> in abundance. Full of univalves. A yellowish iron-shot oolite		2 0
{ f. The paving-stone or <i>Murchisonæ</i> bed proper		1 1
{ g. The "Dew bed"		1 2
Total in quarry		12 3

DETAILS OF THE BEDS.

c. There is an enormous number of bivalves, both *Astarte obliqua* and *A. excavata*, large *Modiola*, *Lima pecteniformis*, etc., *Terebratula phillipsii*. Towards the south end of quarry this bed is seen to increase on the dip, but, relatively to the thickness, the fossils are less abundant. It probably represents the "soft shell-bed" of Halfway House.

d. According to Mr. S. S. Buckman this may be the representative of the marl with green grains (*Sauzei* bed) of Osborne (*e* of that section).

e. More good fossils have been extracted from this bed than from an equal weight of any other stone in England.

f. The "paving-stone bed" is a slabby ironshot oolite, which comes off just above the "dew bed," and is used for gutters, etc. The true *Harpoceras murchisonæ* occurs here, as also the var. *Bradfordiensis*, S. S. Buckm. That author says of *H. murchisonæ* that it "marks a distinct zone, which is just on the top of the sands or passage-beds. This zone is about a foot thick at Bradford Abbas, but about 3 to 4 ft. at Corton and Hawthorn Downs." We have lately found the true *H. murchisonæ*, Sow., below the *concavus*, or "fossil bed," in the Wyke cutting, i.e. to say, in a position exactly corresponding to its place here. Small corals occur in this bed.

There was no time to visit the prolific little quarry at Stoford, just beyond Yeovil Junction Station, where the Inferior Oolite Limestone is worked; but it may be observed that the total thickness of Inferior Oolite Limestone between the "Sands" and the Fuller's Earth at this place does not much exceed 5 ft. As we have a complete section here, there is no question about loss of beds from denudation. This was the original develop-

ment, and thus we see that the Inferior Oolite Limestone has diminished from 35 or 40 ft. at Nethercombe, near Sherborne, to 5 ft. at Stoford, a distance of five miles west-south-west. At Stoford the *Parkinsoni*-zone is about 4 feet thick, with a shelly bed at base, which may represent something more than the *Parkinsoni*-zone, though there is no certain indication of the *Humphriesianus*-beds, which seem generally wanting when we reach any distance west of Sherborne. On the other hand, probably less than half of the Inferior Oolite in Stoford quarry belongs to the *Murchisona*-zone, or to the sub-zone of *H. concavum*. The fact is that the "fossil bed" corresponds pretty closely to one at Bradford Abbas. The peculiar fossil *Cirrus* is plentiful just above the "Dew-bed."

WAREHAM DISTRICT.

We pass now to the Wareham District in order to notice a recent boring which throws much light on the geological structure of the county.

Bovington Camp lies on the edge of Wool Heath and a mile or two from that village. Since the War Office was not satisfied with the water supply afforded by an ordinary well in the Bagshots, it was determined to bore through the Bagshots into the Chalk for an Artesian supply. The results were very satisfactory, from an economic point of view, whilst the operations afforded a favourable opportunity for studying the several formations in the upper part of the Dorset Syncline.*

The following is a summary of the results :

	ft. in.
Surface beds, chiefly Plateau-gravel	14 0
Bagshot beds	151 0
Lower Tertiaries (<i>i.e.</i> , London Clay and Reading beds)	115 0
Chalk	446 0
Total	726 0

The Bagshot Beds are much thinner here, near their outcrop, than they are likely to be lower down the country, say, on the meridian of Wareham.

The following are the details of the beds above the Chalk :

SUPERFICIAL.		Thickness.	Depth.
		ft. in.	ft. in.
Soil		1 0	
1. Marly clay		2 0	
2. Gravel. Plateau-gravel with yellow flints.		11 0	
			14 0

* Extracted from "Artesian Wells in Dorset and Elsewhere," *Proc. Dorset Field Club*, vol. xxviii (1907), p. 185.

FIG. 59.—TRANSVERSE SECTION THROUGH THE DORSET SYNCLINE, SHOWING THE GEOLOGICAL POSITION OF THE BOYINGTON BOREHOLE.—*W. H. Hudleston.*

	BAGSHOTS.	Thickness ft. in.	Depth. ft. in.
3.	Sand with loam bands. Coarse, yellowish sand of uniform sized grain invested with ferric oxide. The "loam bands" consist of fine white powdery loam	20 0	34 0
4.	Coloured clay and sand. Fine sediments, mostly discoloured and clayey	10 0	44 0
5.	Brown sand. Loose sugary sand	4 0	48 0
6.	Light grey sand	3 0	51 0
7.	Loose grey sand. Sharp quartzose, clean.	7 0	58 0
8.	Coloured sandy clay. Whitish clay, slightly stained with iron; sets hard	4 0	62 0
9.	Coarse sand. Loose, yellowish, coarse quartzose sand with small fragments of soft white silica, and one or two largish pebbles of lignite (See No. 17)	29 0	91 0
10.	Coloured clay and sand. "Two-ball" pipeclay	6 0	97 0
11.	Live sand. Loose yellowish sand, rather coarse and with specks of soft white silica	24 0	121 0
12.	Blue clay. A fine, unctuous, grey clay, like some of the grey pipeclays	12 0	133 0
13.	Coloured clay and sand	4 0	137 0
14.	Live, coarse sand. A very clean, angular quartzose grit, said to be full of water. Would make good building sand	18 0	155 0
15.	Brown coarse sand (live). Similar to the above, but dirty	10 0	165 0
	Total Bagshots	151 0	

[water-level 85]

LOWER TERTIARIES.

16.	Sand and pebbles. Coarse, dirty greyish sand with black flint pebbles (of the Blackheath type), and some small buff pebbles of another material	1 0	166 0
17.	Sand and wood. Fragments of lignite	0 6	166 6
18.	Clay, sand, and pebbles	4 6	171 0
19.	Dark sandy clay, hard	9 0	180 0
20.	Coloured clay and pebbles, reddish	5 0	185 0
21.	Dark sand and clay. Dries pale grey and sets rather stiff	42 0	227 0
22.	Dark clay and stones. The stones are of irregular shape (?) corroded flints.	1 0	228 0
23.	Live sand. Fine, pulverulent, grey sand, not very loose	19 0	247 0
24.	Coarse sand and pebbles, live (<i>i.e.</i> , water).	5 0	252 0
25.	Mottled clay. Light brown in colour	5 6	257 6
26.	Hard dark clay and sand	4 6	262 0
27.	Hard grey sand with some clay, sets like a sandstone	13 0	275 0
28.	Green sandy clay and flints at bottom. An earthy green-sand ranging from pale green to darker green; the flints are green-coated, mostly unworn and somewhat corroded.	5 0	280 0
	Total Lower Tertiaries	115 0	

Owing to the method of boring it was not possible to ascertain whether the Chalk is fossiliferous here so that no question as to horizon can be entertained. Assuming that the usual thickness of the Chalk in Dorset is about 900 ft., the bottom of the borehole is just half-way through that formation. There is no supply of water in the topmost Chalk until a depth of 70 ft. was reached, but the first great supply was obtained a little below 400 ft., when the water level rose to within 96 ft. of the surface. The artesian pressure, therefore, was equal to raising a column of water nearly 200 ft. into the Tertiaries in addition to 70 ft. of waterless Chalk. The War Office not being satisfied with the Upper Water Supply, boring was continued, when a lower and increased water supply was obtained, bringing up the total to 60,000 gallons per day, and the water level was raised to 93 ft. 6 in., below the surface. It should be noted here that hydrostatic pressure may, to a certain extent, be reduced by springs on the south side of the syncline, such as those outside Wool, which are about 75 ft. above O.D. Moreover in that direction the protective cap of Lower Tertiaries soon fails (see Fig. 59). The main water occurred between 675 ft. and 685 ft. from the surface.

When we come to study the geological position of the Bovington Borehole, the measurements of the Borehole section, in conjunction with the surface plotting based upon the ascertained contours, enable us to obtain a fairly accurate conception of the prevailing conditions. The true axis of the tectonic syncline (see Fig. 59), can only be fixed approximately, but in this case it probably almost coincides with the axis of the Frome valley, which here runs very nearly in the trough of the syncline. On the meridian of Worgret, near Wareham, on the other hand the bed of the Frome lies a long way south of the synclinal axis. Generally speaking, the southern limb of the Dorset syncline is shorter, and, therefore, steeper than the northern limb. In this case a northerly dip of 6° is assigned to the south limb above Burton Cross, on the strength of dips observed in the Chalk near Wool. According to certain calculations, there is reason to believe that the northern limb in the neighbourhood of the Borehole has a dip from 1.5° to 2° southwards, taking a sort of average, although there may be subsidiary folds within the general syncline. This is in conformity with the general rule that the dip of the northern limb is at a lower angle than that of the southern one.

From the Bovington Borehole to the margin of the Chalk escarpment near Bulbarrow is a distance of about 12 miles in a northerly direction, and if we deduct 3 miles for areas covered by Tertiaries along this line, there remains 9 miles of Chalk outcrop on which the rain may fall directly to feed its underground waters. It is well known that a large percentage of the

water which falls on this absorbent formation sinks into it instead of flowing over the surface as is the case with clays. Moreover, the rainfall on the North Dorset downs is much heavier than in the Frome valley, and still more so in comparison with Weymouth. Hence, there is an abundant supply in the region lying to the north of the Borehole, and assuming the preponderance of the southerly dip, which may be taken for granted, this water in its underground passage is bound to find its way south until its progress is arrested by the pressure of water from the opposite limb of the syncline. Meanwhile, it is kept down by Tertiary Beds, &c., having a thickness of 280 ft. Yet, notwithstanding these advantages, the pressure can only be regarded as sub-artesian, since the water fails to reach the surface by some 93 ft.

We may conclude the present chapter with a short notice of the very interesting hill named Creechbarrow, though it has not, up to now, been visited by the Association.

This hill is a very prominent object throughout the northern half of the Isle of Purbeck and is especially conspicuous from the neighbourhood of Wareham, where it stands out in front of the long Chalk range running through the centre of the so-called "Isle." It is composed entirely of Tertiary Beds, and this circumstance renders the hill all the more peculiar, since it rises rapidly from the 300 ft. contour to an elevation of 637 ft., almost equalling that of the highest part of the Chalk ridge behind it. Except in this one spot the Tertiary Beds of the Isle, which lie on the dip slope of the Chalk ridge, do not as a rule exceed 300 ft. in elevation, and thus the exceptional elevation of this subconical hill constitutes a topographical anomaly for which it was difficult to account.

The first Geological Surveyors, recognising the difficulty of explaining these facts, represented the area occupied by the hill as consisting of London Clay enclosed in a kind of forked fault with just a capping of Bagshots at the summit. According to the more recent survey the whole area is coloured as Bagshot, and no faults are shown. This latter plan is more in accordance with the facts, but neither the map nor the accompanying memoir afford us much information as to the causes which have led to the formation of this very peculiar hill.

On the 21st August, 1901, the members of the Dorset Field Club had an excursion to West Purbeck, when the writer, after pointing out the anomalous character of the hill, offered some remarks as to its possible origin, and promised further to investigate the subject.

With the kind consent of the owner of the property, Mr. Bond, this work was undertaken in the following October, when it was discovered that the summit of Creechbarrow consists of an indigenous tufaceous limestone, containing some fresh-water fossils, and associated with beds of fine sedimentary material.

human interference with such a prominent feature of the landscape, the limestone rock stood out like a needle, or tooth, above the encompassing greensward. This limestone forms the summit of Creechbarrow, and it is terminated towards the south by what may be regarded as an escarpment, of which the annexed figure is a generalised section.

From a series of observations, the dip of the beds on the summit was fixed at from 10° - 12° approximately north-north-east. The following sequence at or near the actual summit may be accepted as fairly correct :

	ft. in.
1. Tufaceous limestone	7 0
2. Softish tufaceous limestone	2 6
3. Passing downwards into sands full of calcareous concretions	4 0
4. Band of yellow clayey sand	0 6
5. Loose buff-coloured sands	5 10
6. Layer of large flints of the Creechbarrow type	1 0
7. Pale buff-coloured sands (not bottomed)	4 0
Total	<hr/> 24 10 <hr/>

When followed on the dip the above divisions cannot be identified, and there is no doubt that considerable local changes take place within short distances. There are indications that the limestone has been worked for marl towards the north, usually near the 500 ft. contour, and no limestone has been found below this elevation. Moreover, it is a curious circumstance that, although flints of the Creechbarrow Series are found on the lower slopes in such numbers as to give rise to the erroneous idea that they had been derived from Plateau-gravel, yet no fragments of the limestone occur on the surface of the lower slopes nor yet in any of the adjacent buildings.

Whilst referring to the changes which occur in the Creechbarrow Beds, attention might be drawn to their development on the eastern spur of the hill. This spur is a conspicuous object from the north-east side, since it breaks the regularity of the conical outline as seen from Furzebrook :

PIT ON THE EASTERN SPUR OF CREECHBARROW.

	ft. in.
a. Sandy earth with flints	0 6
b. Flint gravel	3 6
c. Buff, ferruginous sand with manganese nodules	2 6
Total section	<hr/> 6 6 <hr/>

The flint-gravel (*b*) of this section is the thickest deposit of the peculiar gravel of Tertiary age as yet discovered on Creech-

barrow. To anyone accustomed to the extremely fine deposits of the neighbouring Bagshots (including the Pipeclay) such a mass of bedded coarse material must come as a surprise; but the manganese concretions in the ferruginous sand below are still more extraordinary. Here the most beautiful botryoidal masses of the black oxide are common and of great variety in form. One of these has a length of five inches and its specific gravity exceeds that of the manganese nodules which are figured in the description of the voyage of the "Challenger." In other respects there is a general resemblance, the chief difference being that in this case ordinary quartzose sand functions as the material caught up by the mineral instead of fine pumice and volcanic fragments, as is the case of those found at the bottom of the Pacific.

A word as to the nature and fossil contents of the Creechbarrow limestone must conclude the descriptive part of this notice. There are considerable varieties, ranging from a soft, marly deposit, which soils the fingers like whitening, to a hard compact rock, which takes a good polish. The more compact and denser limestones, which prevail near the summit, may be roughly divided into non-pisolitic and pisolitic rocks. The latter are in some cases so peculiar as to call for special notice. There are, for instance, certain enigmatical bodies which, though obviously concretionary, were very puzzling in section, having more or less the shape of a horse-shoe. At last, by good luck, we stumbled on a still more curious body, which is perhaps the most perfect pisolite ever discovered. In this case we perceive a pisolitic concretion with an interior like a very small egg, of which the shell, represented by the concentric layers of brown calcite, is developed so obliquely that it is quite thick on one side and quite thin on the other side. This specimen has been broken in such a fortunate manner that we recognised our horse-shoe section at once with the (included) matrix in the form of an egg projecting from the unequally developed circle.

The difficulty of identifying the fossil shells is greatly increased by concretionary incrustation, but there is good reason for stating that species closely resembling *Paludina lenta* and *Melanopsis brevis* are far from uncommon in the tufaceous limestone of the summit pit, which limestone exhibits no trace of bedding.

The above is a brief account of the facts observed whilst investigating the beds which constitute the upper 250 ft. of Creechbarrow Hill. These beds are totally different from the Bagshot pipeclays and sands by which they are partially surrounded, nor is it by any means certain what their stratigraphical relationship to the Bagshot Beds may be. Where one series begins and the other ends it is as yet (1908) impossible to say, although the writer has had the assistance of Mr. Leonard Pike, when-

ever boring for pipeclay seemed to throw any light on this obscure subject. The palæontology, so far as it goes, and also the presence of the "egg-like body," are rather in favour of the limestone being of Bembridge age; but are there any beds associated with the Bembridge Limestone analogous to those containing the big flints, to the local accumulations of flint gravel, or to the strange manganese sands, all of which are, in one place or another, associated with the Creechbarrow Limestone?*

* For further details see "Creechbarrow: An Essay in Purbeck Geology," by W. H. Hudleston, *Proc. Dorset Nat. Hist. and Antiquarian F.C.*, vol. xxiii (1902), p. 146; and *Geol. Mag.*, dec. 4, vol. ix (1902), p. 241; and vol. x (1903), pp. 149 and 197. [Since this chapter has been in print a paper has appeared by Mr. H. Keeping in which he states that in his opinion there is no doubt of the Bembridge age of the Creechbarrow Limestone. *Geol. Mag.*, dec. 5, vol. vi (1909), p. 555.]