pebbles and bed No. 3 seemed, however, to be below their place. The succession seemed, however, to be as above, and, if that be so, the beds below bed 1 are probably Bagshot Beds.

"The pit at the lower level has been already noticed in our Proceedings; cf. H. W. Monckton and R. S. Herries 'On some Bagshot Pebble Beds and Pebble Gravel,' *Proc. Geol. Assoc.*, vol. xi, p. 13, at p. 22. The pit has been worked farther back, and the clay is now in consequence thicker. Less of the underlying sand is exposed than it was in June, 1888.

"The casts of shells which occur in this sand were not abundant, but several were found by members of the party on a small heap of sand at the bottom of the pit."

Similarly disturbed strata were again observed in the excavation for the new reservoir close by. A few minutes were then profitably spent in examining Fryerning Church, and its carved Twelfth Century font, etc.

At the Spread Eagle a welcome tea awaited the party, which, after thanking the Director, returned by the 7.55 p.m. train to London.

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EXCURSION TO LYME REGIS, EASTER, 1906.

FROM APRIL 12TH TO APRIL 17TH.

Directors: HORACE B. WOODWARD, F.R.S., and G. W. YOUNG, F.G.S.

Excursion Secretary: G. W. YOUNG, F.G.S.

April 12th and 13th.

(Report by H. B. WOOWARD.)

SEVENTEEN years ago when the Association paid its first visit to Lyme Regis under the guidance of one of the present Directors, it was remarked that "hardly any place in the British Isles is richer in features of geological interest than Lyme Regis." The difficulties of access, and the difficulties (that naturally increase) of procuring the necessary accommodation for a large party, no doubt caused delay in visiting this classic locality, and the earlier visit was described as a "preliminary excursion."

The members then assembled at Lyme Regis on Thursday evening, April 18th, 1889, and departed on Monday morning for

SECTIONS OF THE DORSETSHIRE CLIFFS, FROM LYME REGIS TO BURTON BRADSTOCK.

Horizontal Scale one-and-a-half inches to a mile. Vertical Scale much exaggerated.

[This section, by H. B. Woodward, is reproduced from "Report on Erosion of Sea-Coasts," Brit. Assoc., 1885; and "Geology of England and Wales," Ed. 2, 1887.]

the "Easter Excursion" to 'Weymouth.* On the present occasion the members arrived in the evening of April 12th, and made their headquarters at the "Royal Lion" Hotel, their total strength being eighty-five members and friends.

The opening of the light railway to Lyme Regis had now reduced the time occupied on the journey, since the previous excursion, from a little over five hours to about four hours, when the train was punctual. If the means of access were much better, the hills were still as steep, but there was not the same anxiety in traversing them as was felt 150 or more years ago, when, as remarked by George Roberts, the Historian of Lyme Regis, no one ever thought of journeying out of Lyme Regis without having previously made his will.†

Friday, April 13th.

On Friday morning the members started at 9.15 a.m. along the Charmouth Road past the parish church, where a memorial window to Mary Anning (1799-1847), the famous fossil collector, had been erected by fellows of the Geological Society. Thence they ascended by Colway Gate to an old chert and sand pit on Timber Hill, an elevation of about 430 ft.

The Director remarked that the term "Selbornian" (named after the home of Gilbert White), had been given by Mr. Jukes-Browne to the united Upper Greensand and Gault. The formation in the far east at Burham in Kent is all Gault clay; in the neighbourhood of Selborne both sandy and clayey divisions are well represented, while in the far west, on the Blackdown and Haldon Hills, the formation is almost wholly of the cherty and sandy type, known as Upper Greensand.

In the quarry now visited the base of the Chert-beds was to be seen, with underlying band of green sand, which rests on the main mass of Foxmould sands and Cowstones. Mention was made of the work of previous observers, full references to whom are given in the *Survey Memoir* recently published.

The following are the local sub-divisions of the Selbornian group :

			Feet.
UPPER GREEN- SAND.	Zone of <i>Pecten asper</i> .	Sands with bands and nodules of chert ... Greenish sands	50
	Zone of <i>Ammonites</i> (<i>Schloenbachia</i>) <i>rostratus</i> .	Buff, brown, and white sands—the Fox- mould of De La Beche ... .. Cowstone Beds, sands with three bands of concretionary masses of calciferous sandstone	75 20
GAULT.	Zone of <i>Amm.</i> (<i>Hoplites</i>) <i>interruptus</i> .	Dark loamy and glauconitic sands and clays, with pebbly layer at base ...	25

* See *Proc. Geol. Assoc.*, vol. xi, p. 26.

† "History and Antiquities of the Borough of Lyme Regis and Charmouth," 1834, p. 155.

Mr. W. D. Lang, of the British Museum, who now joined the party, was invited to conduct the members to the sections of Upper Greensand and Gault, which he had specially studied. The following notes are contributed by him :

1. On the cutting above the roadway between Charmouth and Lyme.

In the Foxmould = upper part of the zone of *Schloenbachia rostrata*.

Exogyra conica, Sow.

Pecten (Neithea) quadricostata, Sow.

Notes.—Both these species were very abundant, especially the first-mentioned. They are very fragmentary, and, when fairly perfect, hard to extract from the sand without falling to pieces. Three fossil beds were observed (described as beds 10, 8 and 6 in *Geol. Mag.*, 1903, p. 390), but most specimens came from the top bed (10).

It was disappointing that more species were not found, but to obtain recognisable and good specimens it is necessary to pay frequent and longer visits to the spot. Mr. A. W. Clayden observed that the fossils occurred here exactly the same way as their representatives at Haldon Hill.

2. Below the roadway between Charmouth and Lyme.

(a) In the Cowstones = lower part of the zone of *Schloenbachia rostrata*.

Siphonia, Sp.

Vermicularia, concava, Sow.

Exogyra conica, Sow.

Notes.—Fossils at this horizon are rare, most of those that are found occurring in the Cowstones themselves, the best known being the fossil lobsters (*Hoploparia*). From a fallen Cowstone the members obtained *Exogyra conica*, Sow., and *Vermicularia concava*, Sow., and from the sand above the lowest Cowstone layer a *Siphonia* was obtained.

(b) In the "Gault" = zone of *Hoplites interruptus*.

Vermicularia concava, Sow.

Pecten (Syncyclonema) orbicularis, Sow.

Lima gaultina, Woods.*

Perna tetragona, Sow.

Arca (Grammatodon) carinata, Sow.

Inoceramus concentricus, Park.

Hoplites interruptus, Brug.

Turritella vibrayana, d'Orb.

Notes.—The "Gault" was drier than usual, and the fossils consequently less easy to extract. Nevertheless the commoner Black Ven species were soon discovered. Of these *Pecten orbicularis* was the most abundant, and after this *Lima parallela* and worm tubes. By far the most interesting find was a fragment of *Hoplites interruptus*, the zonal fossil, which has never before been recorded from Black Ven. A few fragments of *H. splendens* have been found here before, but no other Ammonite. The specimen of *H. interruptus*, and the *Siphonia* mentioned above from the Cowstone sand, are now in the collection of the British Museum.

3. On the slope below the section showing the junction of the "Gault" with the Lias, = zone of *Ammonites (Liparoceras) capricornus*, there were obtained :

Small Ammonites, being the young of *Liparoceras latæcosta*, and of allied forms.

Fragments of Belemnite guards.

Pebbles from the Pebble-bed at the base of the "Gault."

* "The Common *Lima* found in the Gault on Black Ven, and hitherto identified as *L. Parallela*, d'Orbigny, has been shown by Woods (Mon. Pal. Soc., 1904, *Brit. Crét. Lam.*, vol. ii, part i, p. 31) not to be this species, but an unnamed form to which he has given the name *Lima (Mantellum) Gaultina*."—W. D. L.

Notes.—Unfortunately time did not allow much collecting to be done on this slope. Usually there are to be found many kinds of Lias fossils as well as specimens of *Vermicularia concava* washed from the "Gault" and Greensand above. The Lias fossils are interesting, as they are obviously within a few feet of their exact horizon, for they cannot have fallen from above the Gault junction, a few feet higher up. Many small pieces of Ammonites, portions of larger specimens of *Amm. (Liparoceras) latacosta*, and of *Amm. Loscombei*, as well as excellent specimens of *Straparollus aratus*, Tate, and of other species of *Straparollus* are generally to be found. About a foot below the edge of the precipice which truncates this slope, the "Belemnite stone" occurs, pieces of which some of the members succeeded in securing. This limestone was full of Belemnites, and in one piece a Reptilian bone was found.

4. Among the flints which strew the surface of the upper part of Black Ven, showing the former extension of the Chalk over the whole area, a worn specimen of a Chalk urchin was found.

While traversing the Charmouth Road the Director called attention to the great landslips that had occurred along this tract between Lyme Regis and Charmouth, conspicuous in three amphitheatre-like hollows whence the strata had broken away and foundered towards the sea-coast. On this account there were no "eligible building sites" along this portion of the sea front. The new high road made in 1825 had subsided a few years later in consequence of land slides.

A few remarks were also made on the newly-published Geological Survey Map, and on the association of the district with the great geological masters De la Beche, Buckland, and Conybeare. Allusion was also made to the work of fossil collectors, and especially to Mary Anning, who had been instrumental in discovering the *Ichthyosaurus*, *Plesiosaurus*, and *Dimorphodon* (Pterodactyl). A visit was paid to the home of Isaac Hunter, a zealous collector and dealer in fossils at Charmouth, who displayed many specimens, including a fine example of *Ichthyosaurus*.

The party now descended to the shore at Charmouth, whence a good view was obtained of the great clay cliffs of Black Ven. The mass of these clayey strata, nearly 300ft. thick, represented the zones of *Ammonites obtusus*, *A. oxynotus*, *A. raricostatus*, *A. armatus*, and *A. Jamesoni*, details of which are recorded in the Geological Survey Memoir just published.

The Director stated that anyone who desired to work at the zonal sequence should in the first instance draw a diagram of the stratigraphical divisions that are marked by prominent bands of rock, chiefly septaria or cement stones. Repeated observations were necessary, inasmuch as there were not only downwashes of greensand, but slipped masses of Lias on the cliff-fronts, and there were several faults. Moreover, the aspect of the strata varied, some layers being prominent where they had become weathered, while the harder intercalated bands were inconspicuous where masses had recently broken away. No serious

collecting should be attempted until the sequence was clearly recognised.

The great difficulty nowadays was to determine the names of the fossils.

The splitting up of genera of Ammonites had long been recognised as a palæontographical necessity, but the process had been overdone, and some of the generic names applied to characteristic zonal species had been changed four or five times. Hence it seemed necessary at present to retain the name *Ammonites*, together with the other more or less temporary generic names, for the benefit of those who could not keep in touch with the repeated changes of nomenclature. Among the puzzles unsolved was the cause of variation in the shells of the Ammonites, and the reason for the incoming and domination of species that were not the modified descendants of the forms they locally succeeded. The physical conditions remained comparatively uniform, except that the more calcareous sediments of the Blue Lias were followed by the more argillaceous sediments of the Black Marl. Otherwise the circumstances did not seem to warrant a change. Some of the larger forms, such as *Am. Bucklandi* occurred in the limestone group, but other immense forms, *Am. stellaris*, were found in the cement-stone nodules in the shale group. In his address to the Geological Society, 1878, Dr. P. Martin Duncan, in referring to Ammonites, observed, "It may be reasonably doubted whether the different ornamental and septal details are the evidence of a struggle, for it does not appear that they are of any vital importance."* It is fortunate that the variations are of so much geological value.

Mr. E. T. Newton then made some remarks upon certain of the commoner forms of Ammonites which occur near Lyme Regis. He would not undertake to explain the new generic names which had been given to these species; indeed, he agreed with the Director that it was difficult to say which name was the right one. Mr. Newton, however, explained some of the more salient features of the species from the Lower and Middle Lias which members had obtained, or were likely to find, during the excursion.

The Director pointed out that while the different species of Ammonites, as observed by Mr. Hudleston, are excellent "time-keepers," this was not the case with other forms of Mollusca that locally characterise horizons, such as *Cardinia*, *Hippopodium*, etc.

Some criticisms were made on the names locally applied to the main divisions of the strata—more especially to the "Green Ammonite beds." More appropriate names for local use would be the Lyme Regis Beds for the Blue Lias, the Black Ven† beds for the Black Marl, the Charmouth Beds for the Belemnite beds and Green Ammonite beds. Unfortunately the name

* *Quart. Journ. Geol. Soc.*, vol. xxxiv (Proc.), 68.

† The name Black Ven beds was used at one time by C. J. A. Meyer for the Gault. *Geol. Mag.* 1866, plate II.

"Charmouthian" had been applied as a chronological division to the Zones from *Am. armatus* to *A. spinatus*, thus including part of the Lower and the whole of the Middle Lias, a grouping not justified locally.

Turning to the broad local divisions, the Director pointed out that the pale grey Belemnite beds on which the Gault of Black Ven for the most part rests, form the upper of three clay terraces in that cliff, and also the more conspicuous portion of the Stonebarrow cliffs east of Charmouth. The mass of Black Ven was composed of the underlying dark shales and clays, with here and there a band or nodular layer of limestone. In these strata occur the "Watch stone beds," with fine examples of *Am. raricostatus*, also the metal-bed with much pyrites, the decomposition of which had given rise to the spontaneous combustion of bituminous shales. *Am. oxynotus* occurred lower, and then come beds with *A. Brookei*, *Extracrinus briareus*, *Am. Birchii*, and many small Ammonites.

Some remarks were made by Dr. Smith Woodward on the fish fauna of the Lower Lias, which includes *Acrodus*, *Hybodus*, *Dapedius*, and *Pholidophorus*.

The Director observed that many who come to Lyme Regis for a short time are apt to be disappointed in not easily finding *in situ* fine examples of fossils. Such specimens were not to be obtained readily, except perhaps in the cottage of Isaac Hunter at Charmouth. Time and labour were necessary in this as in most other famous localities for fossils. Many of the better specimens had been obtained from fallen blocks. It was hoped that the particulars of the strata given in the Survey Memoir might prove a basis for further detailed work, of which there was much to be done. We knew little of the precise horizons of the fishes, and the same might be said of the plant remains, although, as remarked by Mr. A. C. Seward, the majority of the British Liassic plants had been obtained from the Lower Lias at or near Lyme Regis.*

Despite the difficulties in collecting and in naming fossils, it was a comfort to read the stimulating words of the ex-President, Dr. A. S. Woodward, in his address of 1905. He then remarked, "The collector of fossils, in any case, even if he be confined to one small district, is just as important now as he ever was for the progress of Palæontology. The only difference is that, whereas in former days his chief interest centred in filling a cabinet with choice specimens, his present aim should be rather to illustrate certain definite problems and principles which modern research has formulated."

The members now proceeded along the shore in front of the Limestone series of the Church Cliffs.

* Catalogue of the Mesozoic Plants in Dept. Geol., British Museum. "The Jurassic Flora," II, 1904.

Attention was called to the varying nature of certain layers ; some known as " skulls " mimicking chalk-flints in the irregular character of the nodular bands, while in other cases there occurred smooth lenticular or ovoid masses of Limestone. This process of segregation of the more calcareous matter from the mud might have varied according to the pressure to which the bands were subjected by overlying deposits during consolidation. The Director maintained that the Limestone was largely detrital, derived not mainly from the grinding up or decay of the organic remains of the period, but largely from the waste of Limestone cliffs that bordered the Liassic seas.

Mr. A. W. Clayden remarked that he had always considered the Lias Limestones to be of detrital origin, as it seemed impossible to account for the alternating layers of Shale and Limestone on any other hypothesis. If we imagine the calcareous matter to be an organic deposit in a clear sea, we need a succession of alternating climates, which seems impossible, whether we attribute them to geographical or meteorological changes. The source of the calcareous matter would appear to have been most probably an eastward extension of the coral archipelago of Devonian times, the westward end of which is seen in Devon. This would be a more probable source of the Lyme Regis Limestones than the Carboniferous Limestone, as that formation under Dorsetshire would be more likely to resemble the Culm Limestones of Devon than the massive structures of the Mendips.

The Limestone series of the Church Cliffs included the zones from *Ammonites angulatus* to *A. semicostatus* (with *A. turneri*, as recorded by Dr. Wright), the upper limit being taken at the Hard Marl or Table Ledge, a conspicuous band (a little above the main mass of Limestones), which descended to the sea-shore at the foot of Black Ven.

The Director made a few remarks on denudation or erosion, due to subaerial, marine, and human agencies. Buckland, observing that the hills and valleys were abruptly terminated by the sea, recognised that marine action had no share in shaping them, and he had inferred that as the present streams appeared inadequate, diluvial waters had performed the task. With this view the Director was disposed to agree, to the extent that torrential action during the Glacial period had probably been a potent cause in the excavation of the valleys.

The waste of the coast by marine action was sufficiently evident, and it was mentioned that remnants of valley drift, with Mammoth and Rhinoceros, had existed on the lower part of the Church Cliffs in the early part of last century. This was, no doubt, a portion of the old valley of the Char, now obliterated by the encroachment of the sea.

The platforms of Limestone-rock exposed at low tide formed a plain of marine erosion. East of the Church Cliffs, where the

general dip of the Limestone strata was easterly, the bay had been excavated in the softer overlying clays and shales.

The hand of man had, however, grievously aided the destruction of the coast by the quarrying of the Limestone, and, as George Roberts had stated, by the tearing up of reefs and ledges on the foreshore, a process that has not been altogether abandoned.

A few remarks were made on the Lower Lias as a source of water supply; as a rule it yields only limited supplies near its outcrop. The great water-bearing strata of the district were the chert-beds and sands of the Upper Greensand, and from springs that issue from these strata, a little to the north of Timber Hill, Lyme Regis derived its supply.

The members eventually proceeded by the Gun Cliff to the Esplanade, and thence to the end of the Cobb.

April 14th.

(Report by H. B. WOODWARD.)

Starting at 9.15 the members were driven through Charmouth to Morecombelake.

The party was then conducted towards the summit of Hardown Hill, where in a lane-cutting the Director called attention to a fossiliferous band in the Foxmould sands beneath the chert-beds, which he had noted two years previously.

He observed that here, as in the case of the silicified fossils of the Blackdown Beds, the mineralisation was due probably to the decay of the overlying chert-beds and the transmission of soluble silica to replace the calcareous shells.

A number of the members were soon busily engaged in collecting fossils, and the following report of the results is kindly supplied by Mr. W. D. Lang:

1. A section in Verriott's Lane, north-east of Morecombelake, near the top of Hardown Hill, at about 540 ft.

In the Foxmould = upper part of the zone of *Schloenbachia rostrata*.

Exogyra conica (Sow.).

Exogyra, plicate form.*

Exogyra canaliculata (Sow.).

Pecten (*Neithea*) *quadricostata* (Sow.).

Ostrea, cp.

Serpula filiformis (Sow.).

Entalophora ramosissima (d'Orb.).

Notes.—As on Charmouth Cutting on Friday *Exogyra conica* and *Pecten* (*Neithea*) *quadricostata* were by far the commonest species. In addition to these two, *Exogyra canaliculata*, two or three of plicate form, a few *Serpula filiformis*, and a few fragments of *Entalophora ramosissima* were found. All

* "Wrongly identified as *Exogyra plicata* (Lamarck) in *Geol. Mag.* 1903, p. 391. Lamarck's *Ostrea plicata* is not an *Exogyra*. This plicate *Exogyra*, occurring with *E. conica*, Sowerby, is figured by d'Orbigny (1846, *Ter. Crét.*, vol. iii, pl. 478, figs. 5 & 6) and by Coquard (1869, *Monographie du Genre Ostrea*, Terrain Crétacé) as identical with *E. conica*. Mr. R. B. Newton, who has kindly examined the Black Ven specimens recorded in *Geol. Mag.* 1903, considers that the smooth specimens of *E. conica*, Sowerby, have lost the plications through wear and that they are only present on young shells."

—W. D. L.

these species have been obtained rarely in Charmouth Cutting, but the Association members were not fortunate enough to find them there on Friday.

2. In a parting of sand between beds of chert on the top of Hardown Hill at a height of more than 600 ft. In the zone of *Pecten asper*: *Rhynchonella*, sp.

In addition to the fossils already mentioned :

3. A single fish-vertebra was found near the chert quarry at the top of Hardown Hill in the zone of *Pecten asper*. An urchin was found in flint among those strewn about the top of Hardown Hill. The chert itself when weathered was often seen to consist of sponge-spicules.

The party now ascended to the summit of the hill, about 600 ft. (the highest point is 677 ft.), and attention was drawn to the chert-beds which had been quarried in many places for road metal. Here, as in a small quarry seen on the previous day near the Charmouth road-cutting, the dark and pale chert was in places much decomposed. It appeared to pass into a kind of white silica sand, a powdery material subsequently ascertained by Mr. H. H. Thomas to consist of finely divided silica. Associated with the decomposed rock there was a greenish sand and manganese-ore. A microscopical examination by Mr. Thomas of the material showed the presence of staurolite, of abundant tourmaline, of rutile, and a little cyanite. These mineral ingredients, as he has remarked, might be derived from the Triassic rocks, or directly from the parent source, in the region of Dartmoor.

Attention had been directed by Mr. Jukes-Browne to the disintegration of the chert-beds on this hill and to the settling down in mass of the harder portions, while the softer intervening materials were washed away by rain and springs.* The result has been to produce an appearance of "broken beds." Resting irregularly on the shattered chert-beds was an accumulation of whitish clay with sub-angular flints and chert and pebbles of quartz and quartzite, which occurred here and there on the flat-topped plateau. In the opinion of the Director this was a remnant of the accumulation similar to that observed by him at Combyne, and referred to the Bagshot Beds.

From the summit of Hardown Hill a fine view was obtained eastwards towards the Dorsetshire Downs and Portland, and it was mentioned that Mr. Clement Reid had pointed out the overlap of the Bagshot Beds beyond the limits of the older Eocene strata, when traced from east to west in Dorsetshire.† The gravel on Blackdown Hill (Hardy's Monument), above Portisham, referred by Mr. Reid to the Bagshot Series, was about thirteen miles distant from Hardown Hill.

In the intermediate area the land had been extensively eroded, and where unprotected by hard cappings of Inferior Oolite or Greensand chert, the hills of Bridport Sands or Middle Lias or Upper Greensand stood out as rounded knolls.

* "Cretaceous Rocks of Britain," vol. i, p. 191.

† *Quart. Journ. Geol. Soc.*, lii, 492.

The flat-topped hills that characterise the uplands were regarded by the Director as belonging mainly to a plain of sub-aerial erosion that had been intersected by the Eocene river and its tributaries (referred to by Mr. Reid). The actual distribution of the Eocene accumulations had yet to be determined, and this would form an interesting subject for investigation.

The extensive distribution of chert-detritus ("run of the hill") over the slopes bordering the valleys was well seen in the lane-cutting traversed in ascending the hill.

Discussing the question of mapping the soils, the Director pointed out that if the cherty soil were mapped it would afford little indication of the true agricultural value of the land, as it sometimes coated the Foxmould Sands, elsewhere the stiff Liassic clays, and farther west the Keuper Marls. It was most important to the agriculturist to know the nature of the subsoil or underlying geological formation.

The uplands formed heath-lands and tracts under tillage; the vales were for the most part grass lands and orchards, the vale of Marshwood being a district celebrated for Dorset cheese, butter, and cider. Reference was made to Mr. Jukes-Browne's views on the Origin of the Vale of Marshwood, as influenced by the dome-like or pericline structure exhibited by the strata.

Allusion was also made to the great accumulations of gravel that occur here and there in the valley of the Axe, as at Broom, between Chard Road station and Axminster, where palæolithic instruments fashioned out of chert had been obtained. Mr. F. W. Rudler kindly exhibited a specimen.

Much later evidences of man's existence, but still prehistoric so far as our own literature is concerned, were the earthworks that crown most of the prominent heights in the district—Hawkesbury, Musbury, Membury, Lambert's Castle, and Pillesden Pen. These take us back to early British times, to conflicts among various tribes, and to the Roman occupation.

Prof. Boyd Dawkins then gave an interesting address on the ancient inhabitants of Dorset, and on the prehistoric roads.

He pointed out that the population in the Neolithic Age were a small, dark non-Aryan stock, closely allied to the Iberians, whose features and complexion and physique generally are still possessed by the present inhabitants of Dorset and the south-western counties. They were followed by the tall, fair, bronze-using Goidels who represent the older branch of the Celtic race, whose language still survives in place names, such, for example, as Maiden Castle, near Dorchester (Magh=field, Dun=fortress), and the Cop (Gop=headland), and in river names, such as Axe and Exe. They in turn were invaded, in the Prehistoric Iron Age, by their Celtic cousins the Brythons, who have left their name in the island of Britain, and their language in innumerable place names in this district, such, for example, as Combe (Cwm) and Dor (Dwr) in "Dorchester." The population of this part of the country before the Roman conquest consisted of these three elements intermingled together.

The population was mainly massed on the hills and higher and drier

ground, because the valleys were covered by forests and impenetrable morasses. Their forts and villages were connected by roads along the lines of the ridges, constituting the ridgeways. These were at first tracks in the Neolithic Age; they were further developed in the age of Bronze, and in the prehistoric Iron Age were well-defined roads, which have been in use in many places ever since. They are distinguished by their winding course from the point-to-point Roman roads. The so-called "Roman Road" in this district was merely one of those used by the Romans.

The members now descended the hill, and proceeded by the Saints' Well (so marked on the Ordnance Survey map), where Professor Dawkins made some remarks on Holy Wells. The spring issues from the base of the Greensand, being thrown out either by Gault or Lias clay. Thence, by lane and footpath, the route was by the old village of St. Gabriel's, with its ruined church, to the sea-shore at Gabriel's Mouth. Here the little stream, after having cut a deep chine in the Lias clays, filters through the bank of shingle, and issues about mean-tide level.

The Director remarked that the cliffs to the west, at Stonebarrow and Westhay, showed the pale grey Belemnite Beds and overlying Green Ammonite Beds surmounted by the Greensand.

Golden Cap, which rises to a height of 619ft., was based on the Belemnite Beds, which were well shown at low tide beneath the highest portion of the cliffs, and they appeared at intervals, owing to undulating and small faults, in the cliffs a little above the level of the shingle, as well as in places between tide-marks where the shingle had been scoured away.

The lower cliff above the Belemnite Beds was formed of the marly clays of the Green Ammonite Beds, so named from the green-tinged calc-spar which often fills the chambers of the characteristic Ammonite (*A. latæcosta*); a feature well seen in cut and polished specimens.

Above the Green Ammonite Beds occur three bands of hard calcareous sandstone known as the "Three Tiers," which constitute the base of the Middle Lias, and form a prominent feature in Golden Cap.

Tumbled blocks have made a kind of headland mid-way between Gabriel's Mouth and Seatown, where the cliffs present their most impressive appearance, and where more tiers have been shed than at any other point along the coast. The dark Liassic clays and above them laminated clays and sands, and a hard band known as the Starfish Bed (part of the Middle Lias) rise to a little over 400ft., and these are surmounted by the pale buff and brown sands and chert-beds of the Upper Greensand, with a capping of flint and chert gravel. In wet weather streams of Liassic mud, both here and at Stonebarrow, slowly descend like mud-glaciers, while the chines and hollows are bordered by fantastic projections and peaks of the clay-cliffs. The erosion is

marked ; in due course Golden Cap will be lost, and Hardown Hill may replace it along the future coast-line.

Many Belemnites (*B. longissimus*, *B. elongatus*, *B. clavatus*, etc.) were to be seen in the Belemnite stone and underlying shales, while in the overlying marls *Ammonites latæcosta*, *A. loscombei*, *A. striatus*, and other fossils were obtained.

Tea was provided at the "Anchor Inn," at Seatown, after which some of the members crossed the little stream to examine the base of Down Cliffs, where the Middle Lias Clays with *Ammonites margaritatus*, that occur above the Three Tiers, were depressed by a fault to sea-level.* The party was then driven back through Chideock to Lyme Regis.

In the course of the evening Dr. Smith Woodward gave an eloquent and instructive address on the evolution of the Liassic Saurians.

April 15th.

(Report by H. B. WOODWARD.)

A small party started at 10 a.m. up the valley, by the borders of the little river Lym or Buddle, and past the site of the deep boring made for coal during 1901. This was on the left bank of the river, west of Colway Manor House. The boring was superintended by the late G. Haycraft, and it was carried to a depth of 1,302 ft., through about 173 ft. of Gravel, Blue Lias, and Rhætic Beds, and 1,129 ft. of Keuper Marls, with beds of gypsum. Full particulars had been published by Mr. Jukes-Browne.† Some of the cores were seen in an old cottage by Middle Hill Farm.

Passing Uplyme Mill, the members proceeded by pleasant lanes and footpaths to Uplyme Church and the Yawl limekilns. Here the lower beds of the Lower Lias (zone of *Ammonites planorbis*, and portion of that of *A. angulatus*) were exposed, with the White Lias below. A few fossils were obtained, including *Ostrea liassica*, *Pleuromya*, and *Ammonites conybeari*.

After lunch the members proceeded again by footpath and lane to Wadley Hill, and thence, west of Holcombe, ascended the slope between the 400 and 500 foot contour-lines.

Here an unusually deep and dry gully attracted attention. It traversed the Greensand scarp above the level of the usual outlet for springs, as is the case with other stream-channels on the Greensand uplands. It was remarked by the Director that in heavy rains the waters held up by the clayey plateau drifts rapidly descend the slopes ; but that the permanent springs are given out at the base of the Greensand. In the present instance the

* A visit was paid to Seatown at Easter, 1898. See *Proc. Geol. Assoc.*, vol. xv, p. 293.

† *Quart. Journ. Geol. Soc.*, vol. lviii, p. 279.

LYME REGIS (RAIN GULLEY), WEST OF UPLYME
(LOOKING DOWN HILL).

Photo by W. P. Young.

PINHAY BAY, WEST OF LYME REGIS (BLUE AND WHITE LIAS).

Photo by H. W. Monckton.

channel had evidently been scoured out by a tumultuous flow of water—the ploughed field was strewn with blocks of chert, and at the bottom of the slope there was a considerable accumulation of them.

Mr. A. W. Clayden suggested that the phenomenon might have been produced by one of those heavy local falls of rain known in America as “cloud-bursts,” and he subsequently ascertained from Mr. C. W. Grover that this was the case. In the Records of the Observatory at Rousdon for 1886 Mr. Grover had entered the following statement :

“The heaviest gale and rainfall known in this district for many years occurred on December 26th. Rain was falling at 9 a.m. and continued moderate till about 4 p.m., when it descended in torrents, making with the wind a most deafening roar, everything being quickly flooded. The roads in many places were washed away, numerous trees of great age and size were uprooted and chasms were washed out, some of which were measured and found to be 10 ft. in depth. Many hundreds of tons of earth, chalk, and rock were washed down towards the sea. The total rainfall of the day was 2.65 ins.” Mr. Grover added that the gully in question was one of those referred to in the foregoing passage.

Proceeding across the fields to the eastern end of the Combyne cutting, the members walked along the railway to the station. The strata, referred to the Bagshot Beds by the Director, were not so distinctly shown as they had been when the western part of the cutting was examined by him, and there were indications that they occupied a gentle syncline—due, perhaps, as suggested by Mr. Whitaker, to dissolution of the Chalk which originally occurred beneath the strata. The depth of the beds had led the Director to conclude that they might here, as farther on, rest directly on the Greensand. Originally the western part of this cutting showed belts of grey, white, red, and mottled stony clays, and gravel made up largely of rough flint and chert stones with also many quartz pebbles and a few of quartzite.* Farther on, and to the north of the station, there are two cuttings where fine white sand and white pipe-clay had been observed. On the present occasion some red clay was found in the first of these cuttings, and in the second the beds were seen to rest irregularly on the Greensand. There they comprised white and grey clays and sands, with a conspicuous band of black earthy material, since determined by Mr. H. H. Thomas to be almost pure earthy oxide of manganese (Wad).

The party returned by Ware to Lyme Regis. In the course of the evening Mr. F. W. Rudler gave a vivid and most interesting account of Vesuvius, with especial reference to the recent eruption.

* “Summary of Progress of Geological Survey for 1901,” p. 53, and “Geology of Sidmouth and Lyme Regis, 1906,” p. 66.

Easter Monday, April 16th.

(Report mainly by G. W. YOUNG.)

In brilliant sunshine the party, reinforced by some visitors from Exeter, left the hotel at 9.15 a.m. under the leadership of Mr. G. W. Young, and proceeded along the Axmouth Road. Just beyond Cobb Road they took the path across the fields leading to the Warren. At the top of a steep ascent a fine view was obtained over the town and harbour. Here a halt was made, while the Director pointed out the physical features of the district.

Lyme Regis is situated in the trough of a gentle local syncline which carries down the limestones forming the base of the Lower Lias (Blue Lias) below sea level. These hard beds form the cliffs east and west of the town, while between them the valley of the Lym or Buddle has been excavated in the softer overlying Black Marls. The higher parts of the hills are of Upper Greensand, which immediately to the west is capped by a small outlier of Chalk, which latter was to be examined presently in detail. Overlying both these formations and forming the highest ground is a mass of "Clay with flints and chert." A glance at the newly-published One-inch Geological Map (Sheets 326 and 340) shows how closely the boundaries of this clay follow the outcrop of the Cretaceous Beds, the latter indeed sometimes appearing as a mere fringe around the clay. Each ridge and spur had its capping of clay, and the speaker thought it a good example of the protection afforded by "clay-covers" to porous beds which lie beneath them.

Going from east to west a remarkable over-step of the Upper Cretaceous Beds was found.* At Thorncombe Beacon, near Bridport, they lie on the Midford Sands, at Golden Cap on the upper beds of the Middle Lias, at Stonebarrow Cliff on the lower beds of the same, at Black Ven on the Belemnite Beds of the Lower Lias, at Pinhay on the Black Marls, and at Haven Cliff (Seaton), and beyond on the Keuper Marls of the Trias. As far as Beer they dip gently westward, while the underlying beds have a slight easterly dip, accentuated here and there by faults. West of Beer all the beds dip eastward, while at Beer itself there is a sharp syncline, evidently connected with the well-displayed fault at Seaton Hole.

Mr. Young next gave a short account of the way in which the Chalk had been divided by various authors, culminating in the zonal system now in vogue. In comparison with other districts the Chalk here is remarkably thin, being only 223 ft. thick (at Pinhay). Eastward, near Lulworth, it is 1053 ft. thick, but it is noteworthy that the thinning is due, not to the attenuation of the

* See Mr. H. B. Woodward's Sections, p. 327.

individual zones, but to the entire absence of others.* The zones present are those of :

				Feet. exposed.	
UPPER	{	<i>Micraster cor-testudinarium</i>	...	50	} ? possibly rather more.
CHALK.		<i>Holaster planus</i>	... ..	39½	
MIDDLE	{	<i>Terebratulina gracilis</i>	...	71½	
CHALK.		<i>Rhynchonella cuvieri</i>	...	59½	
LOWER	{	Cenomanian limestone	... ..	3	
CHALK.					
				223½	

The higher zones are absent, but near Lulworth they amount to 768½ ft. in thickness. Whether they were all once present is a matter for conjecture, but great denudation has certainly taken place. Flints containing fossils from some of these vanished zones are occasionally found on the surface. The Lower Chalk is represented only by the Cenomanian limestone, 2 to 3 ft. in thickness.

The party then proceeded through the Warren, a picturesque undercliff of broken ground lying at the foot of the inland Ware Cliffs. These are of Chalk and Upper Greensand, but are much overgrown and inaccessible. The face is almost obscured by the down wash of the clay with flints, but here and there patches of Chalk peep out. The Warren was a beautiful sight owing to the profusion of primroses and other wild flowers, and the woods were white with the blossom of the blackthorn and wild cherry.

The first available exposures of Chalk, the Pinhay Cliff and Chapel Rock, are situated in the grounds of Pinhay (formerly known as Clevelands), the residence of W. Allhusen, Esq., who had not only given permission to examine them, but had invited the whole party, 88 in number on this day, to luncheon and tea. At this spot the members were joined by Mr. and Mrs. Allhusen and some of their family, who took great interest in the subsequent proceedings.

The sections at Pinhay have been so well described by Dr. Rowe in the paper alluded to that little need be said here. The zones exposed are those of *Micraster cor-testudinarium*, *Holaster planus*, and *Terebratulina gracilis*, the latter in the main cliff only. The Chalk of the two first-named zones is hard and extremely nodular, weathering with a deeply fretted surface. The zonal junction lines and other salient features were identified, and considering the short time at disposal a satisfactory collection of fossils was made. These included some *Micrasters*, showing the typical variations proper to the zones in which they were found.† The members next repaired to the house, where a sumptuous luncheon was done full justice to.

* The following account is largely based on Dr. Rowe's admirable paper on the Chalk of this coast. See *Proc. Geol. Assoc.*, vol. xviii, p. 3.

† See Rowe, *Quart. Journ. Geol. Soc.*, vol. lv, p. 494.

After luncheon the way was taken westwards along the top of the cliff past the Chapel Rock. Seen from above the place from which it has slipped is very evident. On arriving at the Great Cleft Mr. Young gave a short account of its formation. It is a fissure running parallel to the face of the cliff, thus cutting off a thick slice of rock. The crack first started in 1886, had gradually widened year by year, but rather more rapidly of late than at first. The base is cut in Upper Greensand, the cherty nature of which was well displayed. Many fossils could be seen, but were somewhat difficult to extract. Next came the Genomanian limestone (Lower Chalk), about 3 ft. thick, and then Chalk of the zone of *Rhynchonella cuvieri*, 60 ft. thick, followed by 71 ft. of *Terebratulina gracilis*-zone.

The relative position of the beds at the Cleft with those at Pinhay Cliff are shown below.

Particular attention was drawn to the abnormally flinty character of the *T. gracilis*-zone, which as a rule contains

but few flints while here they are very abundant. To those who rely on lithological characters this would prove a stumbling-block, as they would naturally class it as Upper Chalk, but the fossils are a surer guide, and are unmistakably typical of this zone.

Mr. Newton then explained that the so-called "*Terebratulina gracilis*-zone" could no longer be called by that name, because the small Brachiopod there found was not the true *Terebratulina gracilis*, but another form, the true *T. gracilis* only having been met with in the higher beds of the chalk at Trimmingham, in Norfolk. The *Terebratulina* found in the Middle Chalk seemed to be the form named *Ter. lata* by Etheridge, but this required further examination. It was best, for the present, therefore, to call this zone of the Middle Chalk simply the "*Terebratulina*-zone."

Mr. Newton also spoke of the differences found in the genus *Micraster*, and explained (to some extent by means of specimens found during the excursion) how that in the lower bed of the Upper Chalk (lower part of *Holaster planus*-zone), and just below this, in the Middle Chalk, *Micrasters* were found which had the ambulacral grooves smooth or finely granular (*M. corbovis* and *M. leskei* were of this type), but this character was never found above the *H. planus*-zone. High up in this zone and extending into the *M. cor-testudinarius*-zone, there were *Micrasters* with ambulacral areas showing a zig-zag natural line, and this line became more and more marked in the *Micrasters* found in the higher parts of these zones, until in some cases the angles formed a series of rounded knobs. All these forms would be included in Dr. Rowe's *M. præcursor*, the more strongly marked being difficult to separate from the *M. cor-testudinarius*. Still higher in the chalk these suture lines were marked by a straight and deep groove, such as characterised *M. cor-anguinum*, the species which had given its name to the next higher zone. Other characters accompanied these changes in the ambulacral areas in *Micraster*, and one of these was the increased tuberculation of the entire test as we pass from lower to higher zones. With these characters of the *Micrasters* Dr. Rowe has shown us that it is possible to recognise most of the zones of the Upper Chalk.

The party then divided, those who wished to have longer time on the shore going down with Mr. H. B. Woodward, whilst those who were returning to Pinhay for tea began collecting fossils in earnest. Most of them scrambled up through the cleft to the top, and were rewarded by finding many characteristic fossils, especially *T. gracilis*, which were plentiful and well weathered out.

After tea the President moved a cordial vote of thanks to Mr. and Mrs. Allhusen for their very kind hospitality, which was carried with acclamation, and then a descent was made to join the others on the shore in Pinhay Bay.

Here Mr. Woodward took charge of the party, and explained that east of the ravine along which the descent was made to the shore, the White Lias was well seen beneath the Blue Lias, dipping gently eastwards until it disappears beneath sea-level. The ravine coincides with a fault, having a downthrow of about 40 ft. on the west. This dislocation brings the Lower Lias against the White Lias, and there is another small fault a little farther east.

On the present occasion the members were fortunate in

finding some good exposures of the black *Avicula-contorta* shales on the foreshore, and examples of *A. contorta*, *Cardium rhaticum*, and *Pecten valoniensis* were obtained. The Cotham Marble was not exposed, owing no doubt to coverings of beach shingle and boulders. It had been observed at Charton Bay and Culverhole, near Axmouth.

Professor Boyd Dawkins pointed out that the Black Shales of the *Avicula-contorta*-zone on this coast are physically identical with those which he studied many years ago in West Somerset, at Blue Anchor, Watchet, and the adjacent coast.* The same holds good with regard to the White Lias.

The Rev. H. H. Winwood also made a few remarks in reference to the labours of Charles Moore, who first worked out the fauna of the White Lias.

On the route along the shore to Lyme Regis the various bands of Lower Lias, from the basement beds with *Ostrea liassica* to the zone of *Ammonites Bucklandi* were successively traversed. Numerous fossils were to be seen, notably *A. Bucklandi*, *A. Charmassei*, and *Nautilus*. Many examples of *A. semicostatus* were observed in blocks that had fallen from higher portions of the cliffs, and some of these fossils appeared to occur in chambers of large Ammonites.

Further on by West Cliff the tumbled blocks of rock are utilised for the lime-works, and when necessary portions of the cliff have been blasted to obtain limestone for the kilns.

Along this part of the coast the Blue Lias Limestone-series, which comprises about 100 ft. of strata, can be best studied in detail. It is, however, desirable to keep at a little distance from the cliffs between Pinhay Bay and Devonshire Point, as small and large blocks are liable to fall at any moment.

In the evening after dinner the President moved the usual votes of thanks to the Directors, and also to Mr. G. W. Young, in his capacity as Secretary to the excursion.

April 17th.

(Report by H. B. WOODWARD and G. W. YOUNG.)

The members proceeded by train at 9.40 a.m. to Combpynne Station, and thence walked to Charton. Here Mr. C. W. Grover, who had assisted in the previous excursion of the Association to Lyme Regis, joined the party with his son, and offered on behalf of the Hon. Lady Peek and Sir Wilfrid Peek a welcome to the members, and permission to wander over the lands of Rousdon.

The party then descended by Charton Goyle to Charton Bay,

* *Quart. Journ. Geol. Soc.*, vol. **xx**, 1864, p. 396.

where a fine section was seen of the Grey Marls that occur beneath the Black Rhætic Shales and above the red and variegated Keuper Marls. These Grey Marls have formed a debatable ground between Rhætic and Keuper, and they may appropriately be regarded as passage-beds.

Attempts to find the bone-bed *in situ* were not successful owing to slips, but some slabs with fish-remains were picked up.

Mr. Grover and his son then conducted the members towards the great landslip, but a halt was first made for lunch that had been prepared in the broken ground east of the cliff cottage, Dowlands.

After lunch the party divided, some accompanying Mr. G. W. Young to the top of the inland cliff at Dowlands in order to see the landslip from above. After examining an exposure in the *T. gracilis*-zone, where the representative fossil was found in astonishing abundance and beauty, a walk along the cliff edge afforded a most impressive view of the chasm. The great size of the slipped mass and the nature and extent of the slipping can perhaps be better realised from above than from below. Noticeable also at the east end are some detached masses, of which those that are capped with turf at the summit have the flat top of their original surface, while others which have lost that protection are worn to a knife edge. Descending the cliff by a steep path they rejoined the main party which by that time had assembled in the chasm, having been conducted by Mr. A. W. Clayden.

Mr. Woodward then gave a brief account of the landslip, the effects of which had been so beautifully depicted by Mrs. Buckland in the great *Memoir* written by W. D. Conybeare and William Dawson, with the co-operation of William Buckland, in 1840. Two copies of this work had been exhibited at the hotel at Lyme Regis, one having been kindly brought by Mr. Clayden.

At the western end of the landslip* the cliff path was taken, and here Mr. H. B. Woodward, who was returning to Lyme Regis, took leave of the party amid a spontaneous and hearty burst of cheering. A short walk across the golf links on Haven Cliff ending in a descent past the coast guard station, brought the members to the mouth of the River Axe, with Seaton station just beyond.

There being plenty of time before the departure of the train, Mr. Whitaker, indefatigable as ever, led a party to examine the Triassic Marls at the base of Haven Cliff, while Mr. Young pointed out to the remainder the position of the conspicuous fault at Seaton Hole, and the sharply dipping-beds of the Beer

* The Excursion at Easter, 1899, advanced eastwards as far as this point. See *Proc. Geol. Assoc.*, vol. xvi, p. 134.

syncline displayed in the bold headland of Whitecliff. The abrupt easterly bend of the River Axe just as it reaches the beach, due to the shifting of its mouth, caused by the travel of the shingle, was noted and commented on.

Reassembling at the station the 3.52 p.m. train was taken and the proceedings terminated.

The unbroken fineness of the weather, the diversified beauty of the coast, the interesting character of the geology, and the large numbers attending, all contributed to make this excursion a great success.

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