The Geology of the Country round Chard.

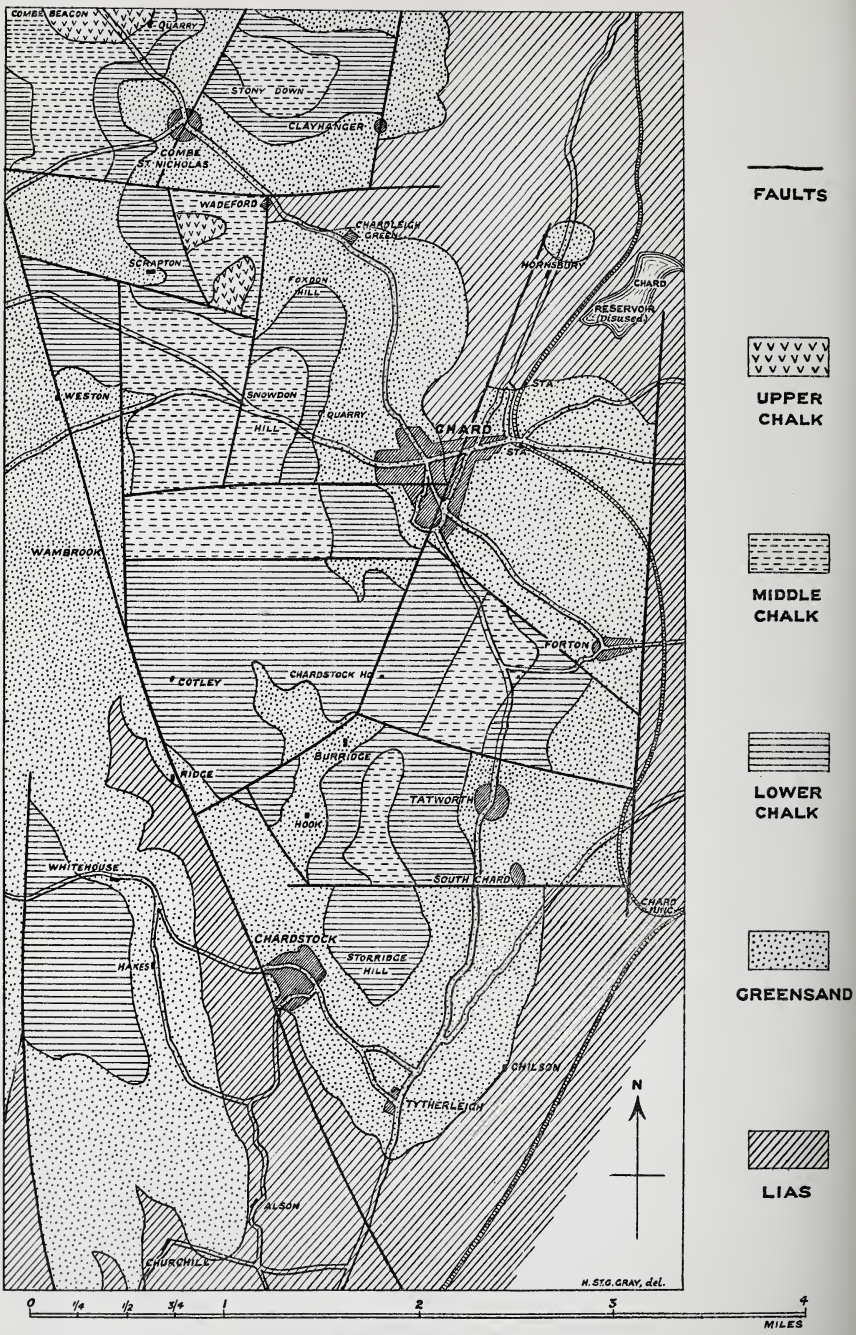
BY A. J. JUKES BROWNE, B.A., F.G.S.

(1) INTRODUCTORY REMARKS.

THE oldest rocks in the immediate neighbourhood of Chard are those belonging to the Liassic Series; these come to the surface in the valley east of Chard and occupy a large area to the northward round Ilminster and Broadway. Resting on the Lias are the Greensand and Chalk which together form the Upper Cretaceous Series, and it is these strata which underlie Chard and most of the surrounding country.

Remnants of a still newer formation occur on some of the Chalk hills in the shape of gravel consisting of flint and chert pebbles mixed with reddish sand or clay: these beds are considered to be of the same age as the gravels which lie on the Chalk south and south-west of Dorchester, and belong to the Bagshot division of the Eocene Series. Finally on the lower slopes of some of the valleys are other gravels of much more recent date: these consist mainly of materials derived from the Greensand and Chalk, and are deposits formed by the action of rain and rivers during the excavation of the valleys to their present depth in Pleistocene times.

From the above brief description it will be seen that the strata which form the country near Chard belong to four different periods of geological history: the following table shows the subdivisions which are recognised and the average thickness of each.



GEOLOGICAL SKETCH-MAP OF THE COUNTRY ROUND CHARD AND CHARDSTOCK.

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Periods.	*Subdivisions.*	*Thickness.*
Pleistocene	Valley Gravels	Variable.
Eocene	Bagshot Gravels	Variable.
Upper Cretaceous	Upper Chalk	+100 feet.
	Middle Chalk	100 „
	Lower Chalk	60 „
	Selbornian	180 „
Liassic	Upper Lias	60 „
	Marlstone	260 „
	Lower Lias	480 „

Those members of the Society who are interested in the Lias and its fossils will find an account of all that is known about that formation in Mr. H. B. Woodward's memoir.[1]

The Cretaceous rocks are less well-known, and have not yet been completely surveyed, but I visited most of the quarries round Chard in 1892 and the observations then made have been published by the Geological Survey in a memoir on the Cretaceous Rocks of England, of which two volumes have been published. From these and from my notes on the Chalk Rock I have prepared a connected account of these rocks as developed in the neighbourhood of Chard.

If my readers will look at the sketch-map which accompanies this paper they will see where the different strata above mentioned come to the surface, and they will notice that while in some places the outcrops follow the natural features of the country with fair regularity, in other places they are terminated abruptly by straight or slightly curved lines. These lines are what geologists call faults, that is to say they are planes of fracture and dislocation,—cracks in the earth's crust along which differential movement has taken place, so that the strata on one side of the crack are higher than the corresponding beds on the other side. Such faults are very frequent round Chard; some of them are only small dislo-

1). *The Jurassic Rocks of Great Britain,* Vol. III (*Mem. Geol. Survey*).

cations such as those seen in the quarry on Snowdon Hill, while in other cases the vertical displacement amounts to 200 or 300 feet.

With this explanation we may proceed to describe the principal characteristics of the several members of the Cretaceous Series in Somerset.

(2) THE SELBORNIAN SANDS.

The Greensand of Chard and the Blackdown Hills is the equivalent of the Gault and Upper Greensand of Dorset, Wiltshire and more eastern counties. For this formation the single name *Selbornian* has recently been proposed, because it was found that when followed from east to west the argillaceous portion or Gault becomes more and more sandy till in West Dorset, Devon and Somerset, it is almost wholly composed of sand. Consequently it was desirable that this formation should receive a name which would be equally applicable to all its different local aspects or facies.

At and near Chard the Selbornian consists of the following beds, stated in descending order ;—

		Feet.
5.	Hard nodular calcareous grit, consisting of coarse quartz-sand and shell fragments: some fossils . . .	8
4.	Grey sand and sandstone, with layers and lumps of black chert, locally called "flints"	30
3.	Hard calcareous glauconitic sandstone .	8
2.	Green glauconitic sand with broken shells . . . . about	12
1.	Soft, fine-grained greenish-grey sand, weathering yellow; this consists of small grains of quartz and glauconite with some of mica in the lower part .	120
	About	178

VIEW OF THE QUARRY AT SNOWDON HILL, CHARD.

SHOWING THE JUNCTION OF THE CHALK AND THE SELBORNIAN SANDSTONES.

From a Photograph by H. St. George Gray.

The lower beds (Nos. 1 and 2) are the equivalents of the Blackdown Sands, but do not here contain the siliceous concretions which have been so long quarried for scythe-stones at the western end of the Blackdown Hills. The higher beds (Nos. 3 to 5) are the equivalents of the Chert Beds of the Isle of Wight and of Wiltshire, and belong to the zone of *Pecten asper*, though that fossil does not occur in them near Chard.

The lowest sands are exposed in a pit by the road to Crewkerne near the first milestone out of Chard, and the Greensand with broken shells is seen in a sand pit on Foxdon Hill north of Chard, but no perfect fossils have been found at either place. The glauconitic sandstone (No. 3) is visible in a small quarry at the south end of Storridge Hill, east of Chardstock, and the higher beds are well exposed in the large quarry on Snowdon Hill, west of Chard (see illustration), and also in a quarry half-a-mile east of Chaffcombe.

The topmost bed is chiefly remarkable for containing the remains of small crabs in some abundance, mostly in a broken state; some other fossils have also been found, notably *Lima clypeiformis*, a good specimen of which is in the Society's Museum, *Pecten* (*Neithea*) *quinquecostatus*, *Trigonia affinis*, and some Brachiopoda such as *Rhynchonella dimidiata*, *Rh. grasiana*, *Terebratula ovata* and *Terebrirostra lyra*.

The upper surface of this bed is a well-marked plane, which has been waterworn to some extent by the action of a current before the deposition of the overlying stratum.

(3) THE LOWER CHALK.

The Lower Chalk of England is the equivalent of the Cenomanian stage of French geologists. Near Chard this division is about 60 feet thick, and its basement bed is one of the most interesting and highly fossiliferous beds in the south-west of England. This bed is about a foot thick and consists of brownish phosphatic concretions and phosphatized fossils

embedded in a nodular buff-coloured sandy limestone, which in colour and consistency is not unlike mortar or cement. This fossiliferous conglomerate passes up into a whiter and more chalky limestone, which however is still hard and sandy, about two feet in thickness. Above this is lumpy glauconitic chalk, passing up into pure white chalk, of which from fifteen to twenty feet are seen in Snowdon quarry.

The sandy beds at the base may be regarded as the condensed equivalent of the Chalk Marl of the more eastern counties. The lowest stratum contains a large variety of fossils. Cephalopoda are abundant, including large species of *Nautilus* and *Ammonites*; *Schlænbachia varians, Acanthoceras rotomagensis*, and *Acanth. Mantelli* are the commonest species, the little boat-shaped *Scaplites æqualis* is abundant, and fragments of *Turrilites* are not rare. Among bivalve shells *Arca passyi*, *Cucullæa mailleana*, *Myoconcha cretacea*, *Cyprina quadrata*, *Unicardium ringmeriense* and *Pecten asper* are some of the most notable. Gasteropoda are more numerous than is usual in the Lower Chalk, and many of the species have not yet been described, but *Pleurotomaria mailleana*, *Pl. cassisiana*, *Turbo rotomagensis*, and *Avellana cassis* have been identified. Some few Echinoderms such as *Holaster subglobosus* and *Galerites castanea* are also common. All these and many other fossils are crowded together in the lower ten or twelve inches, but above that level fossils get rarer, though large *Holaster subglobosus* and *Discoidea cylindrica* occur for two feet above the basement-bed.

In the overlying soft whitish chalk very few fossils of any kind have been found, *Holaster trecensis* being the only one I saw; the thickness of this chalk is probably from thirty to thirty-five feet, but only the lower part is seen at Snowdon. The only place where I have seen the higher part of the Lower Chalk in this district is a quarry near Combe Wood, about two miles north-west of Chard; here the beds are dipping to the eastward and the section shows twenty-five to thirty feet

of whitish chalk, passing below soft grey marl, of which about twelve feet are seen. What is the full thickness of this grey marl, and what comes in above it, are points on which at present we have no information.

From Chard the Lower Chalk extends south-westward to Cotley, Hook, and Chardstock, but the quarries near these places are more or less overgrown. It is seen again at and near the village of Membury, where the lower part is soft and silty, the middle part harder with some rough and lumpy beds, and the total thickness seems to be about sixty feet. The basement bed is exposed in a quarry north of Membury, near Furley, but it is not so hard and conglomeratic as at Chard, though fossils are abundant and of the same species.

When, however, we go still further south to the coast between Lyme Regis and Axmouth we find that the greater part of the Lower Chalk has thinned out and disappeared, the whole of it being represented by two or three feet of hard calcareous sandstone and quartziferous limestone, while at one place (Charton Bay) even this is absent. This rapid attenuation of the Lower Chalk is a unique phenomenon in England, though there is a similar case on the borders of France and Belgium. It indicates the proximity of a coast line to the south and south-west during the formation of the Lower Chalk. The sandy beds, seen at Wilmington and along the Devon coast, must have been formed in shallow water, and the materials must have been distributed by a strong current; while the chalk of Membury and Chard was deposited in deeper water, where no strong currents intruded themselves.

(4) THE MIDDLE CHALK.

The Middle division of the Chalk commences with beds of rough and rather hard nodular chalk, passing up into a looser lumpy kind of chalk, and this passes into firm white chalk containing scattered black flints. The lower, rougher part is known as the zone of *Rhynchonella Cuvieri*, and the higher

part as the zone of *Terebratulina*. The total thickness is probably from 80 to 100 feet, but owing to the frequent faults there are few places where an estimate can be formed. On the Devon coast it is from 120 to 140 feet thick.

The upper part of Snowdon Hill west of Chard consists of this chalk, and it runs some way down the western slope of the hill. It is exposed in a quarry on the south side of the Honiton road a little over a mile west of Chard, and here the characteristic Middle Chalk fossils have been found, *e.g.*, *Rhynchonella Cuvieri*, *Inoceramus mytiloides* and *Galerites subrotundus*. At Whitestaunton a small tract of this chalk has been let down between faults and a quarry is opened in it which has yielded the same fossils together with *Cardiaster pygmæus*.

South of Chard a tract of Middle Chalk comes in between Forton and Chardstock House. A quarry less than half-a-mile west of Forton exposes hard nodular chalk, passing up into loose nodular chalk which is crowded with shells of *Inoceramus mytiloides*. The outcrop of this hard chalk makes a fairly marked feature which can be traced southward toward Tatworth, and there is another large but rather shallow quarry opposite Tatworth Vicarage, where 12 to 14 feet of similar beds are exposed, but in a more rubbly and weathered condition. This chalk is cut off by a fault which runs from east to west a little south of the quarry and brings the Selbornian Sands up to its level.

The Middle Chalk however comes in again on the higher ground north-east of Chardstock, and is exposed in a small pit on the east side of the lane about two-thirds of a mile N.E. of the church. This exposure is small but important, because I obtained from it a specimen of the Ammonite, known as *Acanthoceras nodosoides*, a species which is not very common in England, and has only been found in the zone of *Rhynchonella Cuvieri*.

At Membury, the lower nodular part of this chalk is ex-

posed in an old quarry west of the church, and in the lanes which lead westward from the village; here beds belonging to the Middle Chalk can be traced through a height of more than 100 feet, so that (unlike the Lower Chalk) this division seems to thicken in a southerly direction. This inference is confirmed by measurements taken in the cliffs at Pinhay, near Lyme, where the Middle Chalk has a total thickness of 140 feet, 60 feet being assignable to the zone of *Rhynchonella Cuvieri* and about 80 feet to that of *Terebratulina.*

The higher zone has not been positively identified in any of the quarries near Chard, though two quarries near Wambrook show white chalk with scattered flints which may belong to it; and its highest beds are visible in the quarry on the hill north-west of Combe, ($2\frac{1}{2}$ miles from Chard).

The Middle Chalk is believed to have been formed in much deeper water than the Lower Chalk; its extension to the southward without any lithological change shows that subsidence had taken place, that the strong current had ceased to sweep over this part of the sea-floor, which was now covered by a deep sea, and inhabited by a very different assemblage of animals.

(5) THE UPPER CHALK.

Very little of the Upper Chalk enters into the structure of the country round Chard, and only its basal beds belonging to the zone of *Holaster planus* are exposed. On the Devon coast near Lyme, this zone has a thickness of about forty feet and is succeeded by about fifty feet of the succeeding zone of *Micraster cortestudinarium.*

The zone of *Holaster planus* has at its base some beds of very hard cream-coloured limestone, which are known by the name of Chalk Rock. These beds have been traced from the county of Suffolk, all across England to the neighbourhood of Chard, which is the most westerly inland locality at which Upper Chalk occurs. It is only found to the north of Chard where there are two isolated patches or outliers of it.

One of these tracts caps the higher parts of a triangular area of Middle Chalk near Wadeford, which is let down by faults far below its normal level. There is no good exposure, but in an old pit, south-west of Wadeford House, fragments of the rock can be found, and the outcrop is traceable by similar fragments across the fields.

The other tract is an outlier on Combe Beacon Hill, and at a much higher level, the outcrop on the eastern side of this hill occurring at about 740 feet above the sea. A chalk-pit at the eastern end of the hill, half-a-mile N.W. of Combe St. Nicholas, showed the following section in 1892.

		Feet.
	Clay-with-flints, of irregular depth	3 to 7
Chalk Rock.	Hard chalky limestone, breaking up into small lumps and blocks, (some fossils), about	3
Middle Chalk	Nodular chalk, less hard than above	3
	More massive chalk, still rather nodular . . .	3
	White blocky chalk, largely covered by talus . .	16
	About	30

From the Chalk Rock the following fossils were obtained, *Solariella gemmata* (a cast), *Spondylus spinosus*, *Rhynchonella Cuvieri*, *Rh. reedensis*, and the cast of a coral *(Parasmilia)*. In the underlying nodular chalk *Plicatula Barroisi*, *Rhynchonella reedensis* and *Discoidea Dixoni* were found.

The Chalk Rock of this district does not seem to contain any layers of green-coated phosphatic nodules as it does further east, but it includes some small bits of brown phosphate and some greenish lumps, and some scattered grains of dark green glauconite are clearly visible. This recurrence of glauconite in the Chalk Rock throughout England is an inter-

esting fact, for no visible grains of this mineral occur in the white chalk below, or in that above.

It is also worthy of note that Chalk Rock has been quarried in many other counties for road-metal, and that it makes a very good road-bed, and even a good surface, if mixed with flints that are broken up into smaller pieces than those of the Rock.

As the summit of Beacon Hill is about 815 feet there must be some thickness of Upper Chalk upon it, probably sufficient to bring in the zone of *Micraster cortestudinarium*, but no other exposure was seen.

(6) THE EOCENE DEPOSITS.

These deposits have not yet been mapped by the Geological Survey in the country round Chard, and I was not concerned in examining them: probably only very small remnants of them are left, but I noticed in some places traces of gravel containing small rounded pebbles of flint and of quartz.

All the higher parts of the Chalk ridges are covered by a deep soil consisting of a brownish clay full of rough unworn flints; this deposit is known as the Clay-with-flints and its preservation is due to the gradual solution of the Chalk by the action of percolating rain-water: by such solution the whole surface of the Chalk has been lowered and eaten out into pits and hollows, in which the flints (being insoluble) have accumulated and have been mixed with the clayey portions of the Eocene Beds, which once spread over the surface of the Chalk. This clay-with-flints can be seen in the cutting for the main road on the top of Snowdon Hill, and in the quarry on Combe Beacon Hill.

(7) VALLEYS AND VALLEY-GRAVELS.

Valley-gravels are the deposits of the streams which have excavated the existing valleys out of the plateau which once connected the present hill-tops. They are the only remnants

of the material which once filled up the space between the opposing slopes of the valleys throughout their courses from the watershed to the sea; all the rest of this material having been carried down by the rivers and streams into the sea.

To explain this process of valley-erosion would be too long a story for embodiment in this paper, but there are many interesting considerations connected with it, and I may in the future be able to contribute some notes on this subject with especial application to the valleys of Devon and Somerset. At present I can only refer my readers to a paper on the "Origin of the Valleys in the Chalk Downs of North Dorset," published in the Proceedings of the Dorset Nat. Hist. and Ant. Field Club, vol. xvi, p. 5.