transported as ballast, but some are lying about, and a few remain \textit{in situ}. I have examined all of them, and find they are composed of that variety of oolite which has been named Buckingham or Forest Marble. Many of them are yellowish externally and bluish within, owing probably to a difference in the degree of the oxidation of the iron which has coloured them. The largest I have measured was about 3 feet by 4, very angular, being but little rounded; while the smaller ones, 30 inches by 20, whose corners had been modified and whose sides had been smoothed, were covered with scratches and grooves.

\textit{Section of Railway Cutting at Buckingham.}

1. Ochreous gravel, with boulders of forest marble, and with Gryphaea, Belemnites, and Ostrea.
2. Grey gravel.

The cutting (see fig.) is about fifty feet deep, and the boulders are sprinkled among gravel, sand, and clay, about ten or twelve feet below the surface; and are not found lower down among the earlier deposits of smaller pebbles, which must have come \textit{from all quarters}, judging from the variety of rocks they contain. Out of the latter I picked the fragment of fossil bone I sent you a day or two ago—possibly a portion of my old friend the Cetiosaurian, whose tail-bone I sent you some years ago, and which you reported to the Society at the time*.

I found one boulder only with perforations; whether the work of Pholades, or the impression of shells or wood, you will determine from the specimen I send you, taken from one of the largest blocks, and lying nearer the surface than any other.

The country around here is very undulating; scarcely two fields have a similar aspect or inclination, and the hills are capped with gravel, which makes it difficult to trace the stratification. The contortions of the gravel beds are very curious, being in some places almost vertical, and in others twisted like the letter \textit{S}, according as the bed is cut into obliquely or transversely. The gravel has been penetrated to the depth of eighty feet near the pit you saw at Foscot, in search of water, but without success.

Looking at the boulders still \textit{in situ}, I tried to make out from the \textit{scratches} from what direction they had come, but could not satisfy myself on that point.

2. \textit{On the Secondary District of Portugal which lies on the North of the Tagus.} By Daniel Sharpe, Esq., F.G.S.

\textit{General Sketch of Portugal.}—So little is known of the geology of Portugal that it may be interesting to give a general sketch of that country before proceeding to the details of the district which is to

Map of the Secondary District North of the Tagus.
form the subject of the following paper: this has been drawn up from my own observations and from a variety of sources mentioned in their places.

Commencing at the north with the Spanish province of Galicia, which has been described and roughly mapped by Schulz*, two-thirds of the surface of Galicia are formed of granite, gneiss, mica-schist, and other crystalline rocks, which cover nearly all the western and middle portions of the province: the eastern side is principally formed of slate, grauwacke, &c., classed by Schulz as Transition Rocks, among which we may expect future observers to find the Silurian and Devonian formations. The strike of the slates varies, but its mean appears to be about N.N.W. There are some small patches of secondary red sandstones and marls scattered over the province, of which the age has not been ascertained; here and there a small tertiary deposit occurs; and the bottoms of many of the valleys are filled up with thick deposits of gravel.

Passing southward into Portugal, we find the same formations continued in nearly the same direction: the greater part of the province of Minho and the western side of Traz os Montes consist principally of crystalline rocks; but the rest of Traz os Montes is mostly formed of slates, which are continuous with the same rocks lying on the east of Galicia.

With occasional interruptions of slates and other rocks, some of which may perhaps be of more modern date, the crystalline rocks are continued towards the S. or S.S.E., in a band forty or fifty miles wide, through the whole extent of Portugal, from the province of Minho to the banks of the Guadiana, including in their range the great mountainous district of the Serra de Estrella: in this course the granites, &c. gradually slope away from the Atlantic and approach the Spanish frontier, while the slates on their eastern flank slope down into Spain. The wild country occupied by the crystalline rocks offers few attractions to travellers, and I can meet with no information about it beyond a few notices in the Appendix to Link’s Travels†. The highly cultivated district of the Upper Douro, which supplies all the fine port-wines, has been described by Dr. Rebello de Carvalho‡; it is formed of slate-rocks, supposed by that author to belong to the Silurian system, which strike W.N.W. and are nearly surrounded by granitic mountains.

On the western side of Spanish Estremadura we find the continuation of the crystalline and slaty rocks, which strike about N.W. and are partially concealed by the tertiary deposits of the basin of the Upper Guadiana§.

The great granitic band above-mentioned is flanked on its western

* Descripción Geognóstica del Reino de Galicia por Don Guilhermo Schulz. Madrid 1835.
† Geologische und mineralogische Bemerkungen auf einer Reise durch das südwestliche Europa, besonders Portugal, von F. Link, 1861.
‡ Considerações Geraes sobre a Constituição Geológica do Alto Douro, por Jozé Pinto Rebello de Carvalho. Porto, 1848.
§ An excellent account and map of this district have been published by Le Play, Annales des Mines, 3rd series, vol. vi. 1834.
side by various slaty and schistose rocks. I have already described to this Society a portion of these*, which beginning on the north at Esposende, line the coast as far as the Vouga, with the exception of a range of crystalline rocks, of which the granite of Oporto is the central axis. Near Vallongo a bed of anthracite coal underlies Lower Silurian slates, which form part of this series. From the mouth of the Vouga the schists run S.E., keeping on the north side of that river; they then turn southward, and after running along the Serra de Busaco, pass about four miles to the east of Coimbra, and continue along the little river Deuça, and then down the lower part of the Zezere to the Tagus near Abrantes. The district which lies between the schists just mentioned and the Atlantic, bounded on the south by the Tagus, and covered for the most part with secondary deposits, forms the subject of this memoir; but before entering on its description, I will carry this short summary through the South of Portugal.

Proceeding southward from Abrantes, we descend into the great tertiary basin, through which the Tagus and the Sado reach the sea; this tertiary area covers between 2000 and 3000 square miles, and is only interrupted by the ridge of secondary rocks extending from St. Ubes to Cape Espichel. Near the sea the tertiary deposits are all of marine origin, and the most important part of the series, called in my former paper† the Almada beds, has been shown by Mr. James Smith‡ to be of the miocene period. The Almada beds extend up the Tagus to Verdelha; about fifteen miles higher up the river, the hills on the north bank of the Tagus, rising to a height of perhaps 200 feet, consist of brown marl overlaid by soft rubbly limestone, containing Lymnaea longiscafa, Sow., a shell common to the freshwater beds of the eocene and miocene periods. I traced these beds of lacustrine limestone from Cartaxo by Santarem towards Golegão: they are not found near the mouth of the Tagus, and are perhaps the lacustrine equivalents of the marine Almada beds.

A little above Villa Franca I met with a bed of marl about fifty feet above the present level of the Tagus, containing the common Lutraria compressa, and in the marshy flat near Villa Nova da Rainha the same shell and a small variety of Cardium edule, both of which now live in abundance in the estuary of the Tagus near Lisbon; so that it is evident that this part of the country has been upheaved at least fifty feet within a comparatively recent period. The upper part of the tertiary basin forms a great marshy district, which will probably prove to consist of lacustrine or fluviatile deposits of very modern date.

On the north side of Lisbon a great area is covered with basalt, which separates the secondary from the tertiary formations. The

line of demarcation between these two great systems is as strongly marked in Portugal as it is in our own country.

On the south of the tertiary basin, the centre of the province of Alemtejo is covered by secondary beds, probably older than those to be described on the north of the Tagus, but the true age of which has not yet been determined: these are bounded on the south by the lofty chain of hills, called the Serra de Monchique and Serra de Caldeirão, which separate Alemtejo from Algarve, and which consist of schists and slates, with the exception of granite at the Cabeça de Monchique. Dr. Welwitsch has informed me that schists also occur along the coast of Alemtejo from Cape Serdão to Sines, and that the Cape of Sines is formed of syenite.

On the south of the chain of Monchique and Caldeirão lies the little kingdom of Algarve, which has been carefully surveyed by M. Bonnet, from whom we may hope to receive a geological description of it; that gentleman told me that a band of secondary rocks lies on the south flank of the schistose chain, which is again overlaid along the south coast by tertiary deposits. Considerable outbursts of trap near Cape St. Vincent are mentioned by Link.

Thus it appears that there are two districts of secondary and tertiary rocks in Portugal; the southern of which consists of the narrow strip of Algarve; the other commencing on the north side of the Algarve mountains extends up to the Vouga, forming a narrow triangle of which the base at the south is about forty miles long, and the height from north to south is about 200 miles: the secondary rocks of this latter area are divided into two parts by the tertiary basin of the Tagus and Sado. It is the northern division of this secondary district, viz. that which lies to the north of the Tagus (see fig. 1), which I now propose to describe.

Throughout this paper I shall commence with the upper formations, and describe them in descending order under the following heads:—

Hippurite limestone, equivalent to our chalk.
Subcretaceous series.
Jurassic series.
Sandstones of undetermined age.

With the exception of certain deposits of sandstone last mentioned, no secondary rocks older than the lias have been seen in Portugal north of the Tagus; nor have any traces of the carboniferous series been met with in any part of Portugal.

_Hippurite Limestone; equivalent to the Chalk of the North of Europe._

The description of this formation will be found in my paper on the 'Geology of the Neighbourhood of Lisbon,' p. 115; and as this rock does not occur to the north of the district described in that memoir, I have little to add to the account there given of it.

The hippurite limestone is the uppermost of the secondary deposits, and near Lisbon is usually overlaid by basalt, which bursts out in great quantities in that neighbourhood in the interval between
the deposition of the secondary and tertiary formations, and which covers a large tract round Lisbon.

There are three separate patches of the hippurite limestone; one of these is on the west side of Lisbon and extends a few miles down the river to Belem; this mass of limestone has been thrown into a saddle, of which the axis runs down the valley of Alcantara, just outside the city, with a direction of about N. 30° W., on each side of which the beds dip away from the axis at angles of 5° to 10°; the limestone of many of the beds is shattered to a remarkable degree, and intersected by fissures which run in a direction parallel in the main to the line of the valley, but are waved and irregular. Several of these are sometimes seen in the thickness of a foot, while others are two or three feet apart. There are also three lines on which the beds have been unconformably deposited upon those below, and the fissures just mentioned commence above the lowest of these and end at the upper one; yet notwithstanding their unconformable deposition, the same species of shells are found through all the beds. Therefore the disturbing forces must have acted during the deposition of the formation.

The quarries on both sides of this valley furnish an inexhaustible supply of organic remains.

Another range of hippurite limestone extends from the shore of Cascaes Bay towards the north-east nearly to Loures, and also spreads out along the coast eastward beyond Passo d’Arcos: many of the hills of limestone are covered with detached masses of basalt, which is itself frequently capped by tertiary beds; and between Oeiras and Fort St. Julian the limestone is directly covered by a large patch of the Almada tertiary limestone full of its usual fossils.

The remaining line of hippurite limestone reaches from Montelavar and Pero Pinheiro to the hills immediately south of Bucellas, in which a good section is exposed in the ravine leading from Tojal towards Bucellas. At Pero Pinheiro the limestone has been largely quarried and organic remains are plentiful. To the south-west of this place a little correction is required in my map published in our 'Transactions,' vol. vi. pl. 14: the limestone instead of stopping at the farm of Quinta Granzea should be continued in a thin zone round the southern edge of the basalt, till it meets the sandstone on the north of Algeirão.

The hippurite limestone is laid down in the map just referred to between Villa Franca and Trancozo, and again as extending from Villa Franca to the north-west beyond Alenquer: this is an error in each case, into which I was led by the great resemblance in the mineral character of these limestones to that of the hippurite limestone, not having then collected many organic remains: subsequent examination has shown that the limestones in question belong to the lower part of the subcretaceous series, under which head they will be described in due course.

It appears therefore that the hippurite limestone is not to be seen to the north of Bucellas; nor have I seen it in situ anywhere beyond the neighbourhood of Lisbon; but it is probable that it occurs near
Seville, as the church of the Hospital de Sangre in that city is built of a rose-coloured marble closely resembling that of Pero Pinheiro, and full of the same species of Caprinula and Sphærulites as are found in the hippurite limestone near Lisbon.

I have only to add a list of the organic remains found in this formation, by which it will be seen that all the species known elsewhere belong to the chalk or greensand. Coupling with this the fact that the hippurite limestone is the uppermost bed of the secondary series in Portugal, we cannot hesitate to class it as the equivalent of the chalk of northern Europe.

It is remarkable that fifty-five per cent. of the species found in this formation are new, only forty-five per cent. being known to the north of the Pyrenees. It is also worthy of notice that no cephalopods nor brachiopods have been found in the hippurite limestone. I shall return to this subject before concluding. From the close proximity to Lisbon of the quarries in the valley of Alcantara, I had far more opportunities of collecting fossils from this than from any of the lower formations: the following table is therefore more nearly complete than any of the succeeding lists.

**Organic Remains of the Hippurite Limestone near Lisbon.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astræa? (one species)</td>
<td>Exogyra plicata, Lam.</td>
</tr>
<tr>
<td>Echinus Olisiponensis, n. s.</td>
<td>Isocardia cretacea?, Goldf.</td>
</tr>
<tr>
<td>Brissus scutiger, n. s.</td>
<td>Ostrea globosa, Sow.</td>
</tr>
<tr>
<td>Arca Moutoniana, D'Orb.</td>
<td>Pecten inconstans, n. s.</td>
</tr>
<tr>
<td>—— Olisiponensis, n. s.</td>
<td>—— striatocostatus, Goldf.</td>
</tr>
<tr>
<td>—— Passyana, D'Orb.</td>
<td>Perna fragilis, n. s.</td>
</tr>
<tr>
<td>Avicula Olisiponensis, n. s.</td>
<td>Pholadomya Ligeriensis, D'Orb.</td>
</tr>
<tr>
<td>Caprinula brevis, n. s.</td>
<td>Nerinea Eschweigi, n. s.</td>
</tr>
<tr>
<td>—— Boissyi, D'Orb.</td>
<td>—— nobilis, Goldf.</td>
</tr>
<tr>
<td>—— d'Orbignii, n. s.</td>
<td>—— Olisiponensis, n. s.</td>
</tr>
<tr>
<td>—— Doublieri, D'Orb. sp.</td>
<td>Tylostoma globosum, n. s.</td>
</tr>
<tr>
<td>Cardium corrugatum, n. s.</td>
<td>—— ovatum, n. s.</td>
</tr>
<tr>
<td>—— Olisiponense, n. s.</td>
<td>Sphærulites angeiodes, Lam.</td>
</tr>
<tr>
<td>Cyprina cordata, n. s.</td>
<td>—— cyindracea, Des Moulins.</td>
</tr>
<tr>
<td>—— globosa, n. s.</td>
<td>—— Ponsiana, D'Archiac.</td>
</tr>
<tr>
<td>Dicera Pavri, n. s.</td>
<td>—— Sauvagesii, D'Orb.</td>
</tr>
<tr>
<td>Exogyra Olisiponensis, n. s.</td>
<td>—— ventricosa, Lam.</td>
</tr>
</tbody>
</table>

**Lowest beds of the formation at Papel on the road from Lisbon to Cintra.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anomia convexa, Sow.</td>
<td>Artemis elegantula, n. s.</td>
</tr>
<tr>
<td>Arca Moutoniana, D'Orb.</td>
<td></td>
</tr>
</tbody>
</table>

**Lowest beds of the formation near Bucellas.**

Cardium corrugatum, n. s.

**Subcretaceous series, including the Red Sandstone Formation and the Espichel Limestone of my paper of 1839.**

The hippurite limestone rests, with a deceptive appearance of conformity, upon ferruginous sands belonging to different portions of a very extensive series of beds, which are here considered together,
since it has not been found practicable to subdivide them into separate formations, notwithstanding their great thickness and complexity. The series consist of various alternations of sands or sandstones with limestone, and appears to represent, on a far larger scale of development, the beds which in England lie between the chalk and the oolites.

Reaching from the Bay of Cascaes to the mouth of the Vouga, these subcretaceous rocks line the coast of Portugal for about 150 miles, except at the sea-board extremity of the Cintra Hills and the point of Cape Mondego. The breadth of country covered by them varies from twenty to forty miles. Throughout this district the continuity of the subcretaceous beds is occasionally interrupted; being broken through by the granite of Cintra and beds raised up in contact with that rock, by several great chains of limestone belonging to the oolitic series, upon which the subcretaceous beds rest unconformably, and by several local outbursts of trap. Nevertheless the subcretaceous rocks probably cover more than nine-tenths of the secondary district on the north of the Tagus.

The difficulty of subdividing this great series arises from the close resemblance of the different beds of limestone, and from the faint traces of bedding in the loose, incoherent, ferruginous sands. Where there are no beds of limestone, whole districts consist of great masses of sand and gravel, in which it is difficult to find the direction of the dip or to trace any clear order of superposition; the whole almost resembling a mass of diluvial gravel. Organic remains are very rare in the sandstones, but they are abundant in most of the beds of limestone belonging to this series, and they offer differences by means of which we obtain some idea of the relative ages of the beds seen in distant parts of the district: but it will require a farther examination of the country before all the difficulties connected with this formation can be solved.

The beds of limestone are most prevalent between fifteen and forty miles north and west of Lisbon, and become more and more rare as we proceed northward; this may be partly due to differences in the age of the beds, but is probably also owing to irregularity in the deposition of the limestones, which seem to be local deposits intercalated in a great arenaceous formation; as the Kentish-rag limestone, in England, is a most variable and uncertain companion to sandstones of about the same age as those under consideration.

In travelling southward from the north of Portugal, the subcretaceous beds are first seen two or three miles to the south of the Vouga: their northern boundary runs from N.W. to S.E., nearly parallel to the course of that river: they consist of coarse incoherent sandstones and sands with little trace of bedding, and closely resemble the superficial gravel with which that part of the country is covered. The low plains round Aveiro are so completely covered with gravel that the northern edge of the sands is concealed near that city, but at Serdão they are seen dipping S.E. 5°, and resting unconformably on an older formation of red sandstone that dips at the line of junction S. 30°, and which is described in the sequel.
Some insignificant and nearly horizontal beds of limestone are seen interstratified with the sands near Mamarosa, about three leagues from Aveiro on the road to Coimbra; in these were found

Pecten quinquecostatus, Sow.
Exogyra conica, Sow.
Diadema Lusitanicum, n. s.

The first two, being common in the north of Europe in the upper greensand, show us that the limestones of Mamarosa belong to the uppermost part of the subcretaceous series. Below the limestones there is a repetition of coarse ferruginous sands and incoherent sandstones, all of which might be easily confounded with the modern gravel but for the guide afforded by the fossiliferous beds of limestone.

The position of the beds along this part of the country will be seen in section No. 1 (fig. 2), drawn from Aveiro to Coimbra.

At Vendas Novas, four leagues N.W. of Coimbra on the Aveiro road, and also at Mealhada, three leagues north of Coimbra on the Oporto road, beds of a grey argillaceous limestone, nearly horizontal, are seen below the sands of the subcretaceous series; these limestones contain fossils of the age of the lias which will be enumerated in their place; the limestones are of no great breadth, and on passing them we find again the same slightly ferruginous sands, occasionally containing some insignificant beds of limestone, which continue to the village of Sarjento-mór, about six miles north of Coimbra, where several thin beds of limestone, very full of shells, crop out with a slight dip N.W., resting on a loose sandstone.

The species found at this spot are the following:

- **Exogyra conica, Sow.**
- **Pecten quinquecostatus, Lam.**
- **Plecostula pectenoides, Sow.**
- **Natica bulimoides, Lamy.**
- **Nerinea cylindrica, Voltz.**

The first four species in this list are well-known shells of the greensand, and the first-named two species of *Tylostoma* are common in all the upper portions of the subcretaceous beds of Portugal, and are also found in the hippurite limestone at Lisbon; so that we may safely refer this limestone to the upper portion of the subcretaceous series, notwithstanding the presence of the *Nerinea cylindrica*, which in Germany is found in the Kimmeridgian clay.

This bed of limestone continues towards the S.W., and was seen again in that direction at San Fagundo, where I collected

- **Tylostoma ovatum, n. s.**
- **Tylostoma Torrubiae, n. s.;**

from thence it is probably continued southward to Condeixa, which stands on a horizontal bed of similar limestone, containing

- **Tylostoma ovatum, n. s.**
- **Tylostoma Torrubiae, n. s.;**

at both these two places the shells of the genus *Tylostoma* are excessively abundant.

Both at Condeixa and Sarjento-mór the bed of limestone just men-
Fig. 2.—Section No. 1. From Aveiro to Coimbra. (35 miles.)

Fig. 3.—Section No. 2. From the Ponte de Mayorca to Coimbra. (20 miles.)

Fig. 4.—Section No. 3. From Leiria to Thomar. (30 miles.)
Fig. 4.—Section No. 3. From Leiria to Thomar. (30 miles.)

W.N.W.  
Leiria.  

Fig. 6.—Section No. 5. Through Bucellas and Alenquer. (20 miles.)

S.S.W.  
Subcretaceous formation—lower division.
tioned rests on red marl and ferruginous sands, also belonging apparently to the subcretaceous series, and resting unconformably on the jurassic limestone of Coimbra described farther on.

At Condeixa the subcretaceous beds are overlaid by an extensive deposit of travertine, which is spread out in irregular patches over the low country for many miles round that town; in many places the travertine is twenty or thirty feet thick; it consists of a variable mixture of sand and lime brought down by the streams of water which traverse the beds of sandstone and limestone of the neighbouring hills and break out in powerful springs at their base, the sand being rolled down by the streams and then united by a compact cement of lime which had been held in solution in the water.

The travertine appears to have been forming from a remote period down to the present time; in the neighbourhood of the springs it may be seen newly formed and quite soft; below this it forms a solid rock, and the lower and older beds are so hard that they are extensively quarried for millstones, which have a great reputation all over Portugal: some of the lower beds contain many stems and impressions of the leaves of dicotyledonous plants.

From Coimbra to the sea the Mondego runs through a broad marshy valley with many lateral branches of considerable extent; these, like the main valley, are on the line of great faults: hence the sections which may be observed in the hills enclosing the river have a want of regular connection. I followed the north bank along the line of section No. 2 (fig. 3).

The jurassic limestone of Coimbra is overlaid unconformably, as has been already mentioned, by red sands and marls with some subordinate beds of limestone, in one of which at San Fagundo three species of Tylostoma are abundant; this is covered to the westward by sands and loose sandstone, containing occasional beds of limestone, with a very slight dip westward: the only shell observed in these beds was Exogyra conica, which is very common in most of the limestones. Similar beds continue to Montemor-velho, where they are interrupted by a ridge of limestone hills running from the bank of the Mondego to the N.N.E., on which the subcretaceous beds rest unconformably with a dip of 3° W. The limestone of Montemor-velho is of the age of the lias or of the lower part of the oolitic series. On the west side of the Montemor ridge is a flat marsh, on a line of fault, beyond which we again come to the subcretaceous sandstones dipping N.W. 30°, and containing a bed of limestone about 100 feet thick with abundance of shells of the genus Tylostoma; this is probably the same bed as that seen near Coimbra at Condeixa and San Fagundo. Beyond the Ponte de Mayorca, which crosses a broad marsh following the line of an important fault, lies a thick formation of limestone near the village of Mayorca; this I failed to examine owing to the night coming on, but M. Bonnet, who had resided for some months in this part of the country, informed me that it is the continuation of the limestone of Cape Mondego, which I shall shortly show to belong to the middle of the oolitic period.

The limestone of Mayorca is overlaid by a thick deposit of ferru-
ginous sand and coarse sandstone striking nearly E. and W. which continues to Buarcos: this sandstone is overlaid by a formation of hard whitish argillaceous limestone between 100 and 200 feet thick which dips S.S.W. 15°, and forms the northern bank of the Mondego for about six miles, extending from the fort at the entrance of the river, and passing under the little town of Figueira to the first great bend of the river: during this course, the limestone rises from the water’s edge to the top of the hills which bound the river. If continued in the same direction to the eastward, the Figueira limestone would cross the Mondego and extend towards Soure, through a part of the country which I did not examine.

The Figueira limestone is rich in fossils, but it is so hard that they are not easily extracted; the following were found between the town and the fort:—

Exogyra conica, Sow.  
Gryphaea columna, Lam., very abundant.  
Pecten Dutemplei, D’Orb.  
Turritella Vibranaya, D’Orb.  
Turbo Mundae, n. s.  
Tylostaoma Torrubiae, n. s.  
Nerinae Mundae, n. s.  

Echinopsis subuculus, n. s.  
Cidaris leviuscula, Agassiz.  
Toxaster Couloni,?, Agassiz.  
Brius subdepressus, n. s.  
Scalaria, fragments.  
Turritella, fragments.

These species indicate that we are still in the upper portion of the subcretaeous series. The most abundant and characteristic shell in this locality is the Gryphaea columna, which I have not met with elsewhere in Portugal. In mineral character and in its greater thickness and compactness, the Figueira limestone differs from all the beds of subcretaeous limestone yet described, which, added to some difference in organic remains, makes it probable that it is a different bed.

There is a good descending section along the coast from Figueira to Cape Mondego in the following order:—

Figueira limestone, dip S.S.W. 15°.  
Calcereous sandstone, dip S.S.W. 15° (a few feet only).  
Soft light brown sandstone, dip for about one mile S.S.W. 15°, then changing gradually to S.S.W. 10°; this sandstone passes into a hard, dark, ferruginous, calcereous conglomerate, and then into a hard red grit, dip S.S.W. 10°, on which stands the village of Buarcos.

West of Buarcos are various red sandstones of softer character, with occasional alternations of red marl, dipping first E.S.E. 15°, and then S.E. 40°; these rest on a series of beds of sandstone alternating with limestone, the organic remains of which belong to the upper part of the oolitic series; below this is the coal series of Cape Mondego resting on limestones indicative of the middle portion of the oolites, which will be described in detail farther on.

There is a gradual passage from the Figueira limestone down to the sandstone of Buarcos; so also there is a passage from the sandstone west of Buarcos down to the base of the jurassic series of Cape Mondego; and if this section alone were considered, it might be thought that we had here a passage from the subcretaeous to the jurassic formation; but this cannot be the case, for as we proceed southward we shall meet with subcretaeous beds of an older date.
than those of Figueira and Buarcos, and with jurassic limestones more modern than those of Cape Mondego. We must therefore presume that there is a complete break in the series at the line where the dip changes on the west of Buarcos, although the aspect of the country does not indicate any great change, and the sandstones on the two sides of the line of fault are not of very different character; and that this is a case, of which we shall meet other examples, where the resemblance of sandstones and sands of different ages, but in close contact, makes it difficult to draw the exact line between two formations, the difference of which is sufficiently marked at a moderate distance from the line of junction.

If we review the whole extent of the subcretaceous beds on the north of the Mondego, we see that (except near Figueira) they usually strike from N.N.E. to S.S.W. with a very slight dip to the W.N.W.: guided by this clue and by the light afforded by the organic remains, we may class the beds roughly in the following descending order:

Sand: in all the N.W. part of the district.
Sand and loose sandstone with alternations of thin beds of limestone, in which the commonest fossil is the *Exogyra conica*.
Sands and sandstone.
Limestone of Sarjento-mór, San Fagundo, Condeixa, and the hill west of Montemór, abounding with various species of *Tylostaema*, &c.
Red sands and red marls, round the Coimbra limestone.

The above form a connected series; below these we must place the following, leaving it doubtful whether there is any gap in this part of the series:

Limestone of Figueira, with *Gryphaea columba* and numerous other fossils.
Sandstones and grits between Figueira and Buarcos.

These include all the subcretaceous beds seen on the north of the Mondego.

Near Coimbra the various formations cross the Mondego with only a slight derangement of their course; and I have already described the continuation of the subcretaceous beds to Condeixa: to the west of the latter town they are separated from the great western expanse of the formation by a chain of jurassic limestone which reaches continuously for above sixty miles from near the Mondego to Monte Junto, about forty miles north of Lisbon, which will be described in its place. I did not follow the beds to the eastward of this chain below Condeixa, nor did I examine the hills along the south bank of the Mondego.

From the mouth of the Mondego opposite Figueira to Leiria, the road crosses a great extent of ferruginous sands and loose sandstones with very few beds of limestone, the whole covered by a considerable deposit of coarse gravel, which is both coarser and more abundant near the sea and diminishes as we proceed inland. This is a dreary district principally covered by barren heaths or pine woods. The beds are nearly horizontal with occasional changes of dip. This ap-
pears to be a repetition of the country lying to the south-west of Aveiro, and probably belongs like that to the uppermost part of the subcretaceous group. Between Leiria and Redinha, the road from Lisbon to Oporto crosses similar beds of ferruginous sand. Thus we have here lost the fossiliferous limestones seen on the north bank of the Mondego, and seem to begin again at the top of the subcretaceous series.

Leiria stands on a mass of trap which has thrown up and altered the beds in contact with it. On the east side of the town a bed of limestone, dipping E. 45°, rests on the trap.

Eastward of Leiria is a continuation of the ferruginous sands and gravels for about four miles, where they overlie a limestone nearly 100 feet thick, dipping N.W. 5°, and containing Exogyra plicata, Lam., Ostrea, &c. Eastward of this for several miles the country consists of hills of coarse sand, gravel, and sandstone, with some few beds of limestone. Towards Aldeia da Cruz and Ourem the limestones are rather more important, dipping westward 2° or 3°. The old town of Ourem stands on a conical hill of sand and gravel capped by a bed of compact white limestone nearly horizontal, and containing

Exogyra plicata, Lam.  
Cidaris.  
Mytilus ornatus, D'Orb.

The gravel below the limestone exactly resembles the modern superficial drift which covers the low country near the sea, but fortunately the overlying limestone with its cretaceous fossils preserves us from error on this head, and enables us to estimate the age of other similar gravel beds in the district.

For five or six miles farther east are beds of ferruginous sand, similar to those so often described, containing some insignificant beds of limestone, and dipping W. 3°.

The preceding series rests on the jurassic rocks of the great limestone chain already mentioned, which here dip E.S.E. 10°, consisting of a compact white limestone of great thickness, resting on soft ferruginous sandstones alternating with limestone, which latter beds are but slightly exposed on the western flank of the chain. The section No. 3 (fig. 4) explains the position of the beds along the line just described.

From the mouth of the Mondego to the boundary of the formation beyond Ourem, we appear to have a gradually descending series of beds; but from their very slight inclination they may be of no great total thickness, notwithstanding their covering a considerable extent of country: the whole appear to belong to the upper part of the subcretaceous series. The Exogyra plicata here takes the place of the Exogyra conica, which is so abundant north of the Mondego: as we proceed southward we lose the latter species, and the E. plicata becomes more abundant, and is throughout a large district round Lisbon the most characteristic shell of the cretaceous and upper half of the subcretaceous series.

To the south of Leiria the principal rock is still a coarse ferruginous sand, but the alternations of limestone are more frequent; all the beds are much disturbed, and there are frequent changes of dip,
caused apparently by the eruption of igneous rocks to which the trap of Leiria belongs: one mile south of the town are some beds of grey argillaceous limestone, dipping E.S.E. 30°; a little farther south the road crosses several beds of limestone alternating with sandstone, dip S.S.E. 45°. Some of the limestones are full of a small oyster, others are almost entirely composed of the shells of *Perna rugosa*, Goldfuss, a shell found in Germany among the oolites: perhaps a jurassic bed of limestone is here thrown up to the surface, among the sandstones of the subcretaceous series. Near Batalha we escape from the disturbing influence of the trap, and the beds resume their more usual dip. of N.N.W. 10°; among some other small shells, I found between Leiria and Batalha *Corbula carinata*, D'Orbigny, a greensand species. Some considerable beds of limestone pass through Aljubarota, running S.S.W. with a dip varying between S.W. 10° and N.E. 5°: they contain

*Perna lanceolata*, Geinitz.  
*Lithodomus praelongus*?, D'Orb.  
*Trigonia*, a fragment.  
*Corals*, various.

Below this to the eastward are the usual sands, with a thick bed of limestone near Candieiros, containing

*Terebra* *T. Moutoniana*, D'Orb.

These fossils show that the beds all belong to the subcretaceous series.*

From Carvalhos near Batalha to the southern extremity of Monte Junto, the subcretaceous beds rest unconformably and at a low angle on the base of the high ridge of hills of jurassic limestone already alluded to, in which the beds, dipping to the east or west in different parts of their courses, are frequently highly inclined and much disturbed.

The country between the jurassic limestone beds just mentioned and the sea consists for the most part of sand and sandstone, and for many miles round Caldas da Rainha there is scarcely a trace of limestone: the sand beds in that neighbourhood probably belong to the upper part of the series, which is everywhere principally composed of ferruginous sands†.

The subcretaceous beds continue to cover the country to the southward, but I am not able to give a connected account of them in that direction, and must pass on to the country covered by them to the north-west of Lisbon and north of Cintra.

The uppermost beds of the subcretaceous series near Lisbon are the ferruginous sands which come out from below the hippurite limestone along a line reaching from the coast of the Bay of Cascaes nearly to Loures, usually with a considerable dip to the S.W.; these

* Some additional specimens since received make it probable that the limestones of Leiria and Aljubarota belong to the lowest part of the subcretaceous series, and may be identical with the limestones seen between Sobral and Torres Vedras and at Alenquer.

† A bed of asphalte has been found in this part of the series to the west of Alcabaça, but I can give no details respecting it, as I did not visit the spot.