

formation, and others considering the lenticulite limestone of Bayonne as tertiary, without pronouncing on the Biarritz strata. It appears on first examining these localities that the limestones forming cliffs between *la Chambre d'Amour* and Bidart are contemporaneous, although a closer examination proves that there are two distinct series of different ages, so that the almost continuous bed which forms the cliff between *la Chambre d'Amour* to about 1000 yards beyond the rock of Goulet, are newer than those which next make their appearance, and from which they are separated by a gap in the cliff. At this place it would seem there has been considerable disturbance, the beds displaced being nowhere conformable to the limestones, like those of Bidart, however nearly they resemble them; but the nummulitic limestone observed on the road from St. Pierre to Briscons is conformable to another compact and crystalline limestone which is made up of fragments of corals. These limestones are not found in the cliff, and they ought perhaps to appear in the spot where the fracture has produced a gap.

The nummulitic limestones of the Biarritz lighthouse, and of the neighbourhood of Bayonne, have, however, no relation with those of Bidart, for they differ from them both in structure and composition, besides being unconformable. The cretaceous strata of Bidart and of the whole district west of the Pyrenees have a general uniform inclination, due to the elevation of the mountain chain; but after this other disturbances have taken place, accompanied by the protrusion of igneous rock. The cretaceous beds of Bidart, St. Jean de Luz, and of the whole western Pyrenees, thus offer clear marks of a general elevation succeeded by partial disturbances; and the dislocations are most considerable where the limestones are nearest the volcanic centre. The case is quite different with respect to the beds of Bayonne and Biarritz. These are conformable to one another, and they are very nearly horizontal, except in the recently disturbed districts.

It results from these geological observations that all the beds of coarse sandy and marly limestone of Bayonne and Biarritz, as far as the mill of Sopite, following the line of cliff, belong to a lower tertiary group; and that those occurring a little further on, as far as and beyond Bidart, are of the cretaceous period.

D. T. A.

IV. *On the STRATIFIED ROCKS of the LOMBARDIC ALPS.* By
M. DE COLLEGNO.

[Read before the French Geological Society, Jan. 22. 1844.]

THIS memoir on the structure of the Lombardic Alps presents a minute detail of the geology of the district, and is accompanied by sections illustrating some of the more important points. The subject

is one of much interest as connected with the disturbances of the older and middle secondary period, and the elevation of the Alpine chain ; and, as M. de Collegno spent three summers in the country, and has been a careful and minute observer, an account of his paper will be of value to the English geologist, and more especially to the traveller crossing any of the principal passes of the Alps to visit the Italian lakes.

The sedimentary rocks appearing in the Lombardic Alps are of three geological periods; viz. the Oolitic (including the Lias), the Cretaceous, and the newer Tertiary. On crossing the Simplon or the Splügen passes the stratified rocks may be seen near the axis of the Alpine chain, apparently conformable, and even alternating with crystalline rock ; and the fossils (Belemnites, &c.) found in the beds thus associated with gneiss, show the oolitic origin of the formation, although there can be little doubt that the modifications of the oolites attain their greatest extent in this part of the chain. To the north of the Lake of Como, saccharoid limestones dip away at an angle of 60° or 70° to the south, and repose on, or even pass into the gneiss, the limestone containing a quantity of mica at the junction. Towards the west the appearance changes, and the dolomite becomes fossiliferous ; but here also the rocks in immediate contact with those sometimes called primitive (granite, gneiss, &c.) are unquestionably of the oolitic period.

1. *Oolitic Rocks (including Lias).*

The oolites of the district we are considering may be subdivided into five groups, the lowest of which (1.) is a red sandstone, passing into a conglomerate, and sometimes into a breccia, of the same colour : its thickness is very variable, and it often contains quartz flints and fragments of gneiss and granite, but no mark of organic remains.

(2.) A black bituminous limestone, more or less schistose, and often so compact as to be used for marble, rests on the red conglomerate. It has been greatly disturbed and cracked since its deposition, and its thickness cannot be well ascertained, but it appears to be considerable. This bed is sometimes dolomitic, sometimes so bituminous as to give out a strong odour when struck, and sometimes so argillaceous as to become fissile, and even slaty. It contains fossils, the remains of fishes having been found in it, and even fragments of reptiles allied to *Plesiosaurus*. Univalve shells, resembling *Melania*, have also been met with in great abundance near Esino.

(3.) A greyish limestone overlies the black limestone, and is much more uniform in its character. It is remarkable for generally containing siliceous or cherty bands and thin beds of sandy marl. The colour of the limestone rarely varies, except on exposure, when it sometimes changes to a decided white. It does not seem to attain a greater thickness than about 200 yards, but it

extends along the whole district, and may be seen in the suburbs of Como dipping S. 20° E., and covered up with diluvium.

(4.) The bed next succeeding is a marly limestone of a brick-red colour, deposited in very even layers, four or five inches thick, and remarkably uniform in its colour and general appearance, more especially in the lower part. Notwithstanding this, the bed in question occasionally passes into a mere calcareous marl containing silex, which is, however, sometimes fossiliferous, and in this way is determined to be of the age of the inferior oolite. It is perfectly conformable to the underlying grey limestone, and passes by insensible gradations into the overlying bed, locally called *majolica*. This is strikingly seen on the road between Solzago and Ponzate.

(5.) The bed which forms the upper part of the oolitic series, as exhibited in the Lombardic Alps, has been distinguished by continental geologists by the Italian names *majolica*, *scaglia*, &c. It is a white compact limestone, exhibiting conchoidal fracture, and often full of large cavities partly filled up with crystalline carbonate of lime. This rock is often traversed by very narrow blackish-coloured veins, and is marked throughout its entire thickness by the occasional presence of silex. The brilliant whiteness of this limestone is such that it can usually be seen from a great distance; but it is sometimes coloured, and occasionally converted into dolomite. It has been often mistaken for chalk.

Of these beds, the red marly limestone (4.) contains in some places a number of remains of Ammonites; and the bed thus characterised is very easily recognised in the Italian Alps, being found at several points in the Apennines of Tuscany and in the Papal States; so that it appears to mark throughout Italy a geological horizon of which it is important to fix the exact date. M. Alc. d'Orbigny has recognised the following Ammonites from one locality in which this bed appears; and it will be seen from this list how low down in the oolitic series it must be placed:—*Ammonites heterophyllus*, Sow. *A. elegans*, Sow. *A. fibulatus*, Sow. *A. Walcoti*, Sow. *A. insignis*, Zieten. *A. radians*, Schlott. *A. scipionianus*, D'Orb. *A. thouarensis*, D'Orb.; and *A. comensis*, described by M. Von Buch, is from the same locality.

2. Cretaceous Rocks.

There are four subdivisions of the cretaceous system developed on the south of the Alps, some of them agreeing with beds probably contemporaneous in the south of France, and others almost peculiar to the district. They are thus arranged in order of superposition:

4. Variegated red and blue marls.
3. Nummulitic limestone.
2. Sandstone, more or less argillaceous, with numerous impressions of fucoids.
1. A conglomerate, sometimes used for millstones, and containing occasionally remains of Hippurites.

(1.) The conglomerate which forms the lowest member of the cretaceous formation is generally composed of greyish flints, and black or greyish fragments of limestone, and seems entirely derived from the degradation of the oolitic rocks. There are 80 or 100 yards of these conglomerates.

(2.) Immediately overlying the conglomerate is a fine grained sandstone containing mica, cemented by argillaceous and calcareous marls, the sandy beds being separated by thin marls. The whole thickness of the sandy group probably exceeds 100 yards, but the different beds are thin. The colour varies from bluish grey to yellowish, and rounded lumps of easily decomposing pyrites are found occasionally in it.

(3.) The Nummulite limestone is often compact, and its fracture sometimes conchoidal; but it more frequently contains marly fragments, and even becomes a breccia. Fossils abound in this limestone, but are not easily recognised, with the exception of the Nummulites, which are distinctly seen on the weathered surfaces. The thickness of the nummulite beds varies from half a yard to two or three yards, and the whole thickness of the series is about 80 yards.

(4.) The marls, which in Lombardy form the uppermost beds of the cretaceous series, are of a red or blue colour, and either very fissile and slaty, or more compact and solid, passing in the latter case into a red marly limestone, of which the mineralogical character resembles that of the red limestone of the oolitic series. The total thickness of these variegated marls is between fifty and sixty yards.

It is worthy of notice, with regard to the subdivisions of the cretaceous formation in Lombardy, that the Hippurite beds, and those containing fucoids, which in the south of France belong especially to the lower part of the series, are in Brianza intimately united with the nummulitic limestones, which in the maritime Alps are upper cretaceous rocks. It may hence be concluded, that the Monte Viso system of disturbances of M. E. de Beaumont has not extended to the meridian of Milan, so that the deposition has therefore been uninterrupted from the Hippurite to the Nummulite period; and M. Constant Prevot has already noticed this contemporaneity of Hippurites and Nummulites in Sicily. It is also to be remarked, that since the Nummulitic limestone of the southern Alps has suffered the dislocations of the Apennine system, there is this additional proof of the bed being of the true cretaceous period. The cretaceous beds above described exhibit amongst themselves no strongly marked separations, but seem to pass insensibly into one another.

3. *Tertiary Rocks.*

The only indications of marine tertiaries in Northern Lombardy consist of small patches of blue marl in the neighbourhood of Varese. The best known of these is exhibited in horizontal

layers on the banks of the Olona, and contains numerous well-preserved sub-apennine species of fossil shells and large fragments of semi-carbonised wood. The fossils mark the pliocene origin of the strata. Besides these marine beds there is one of fresh-water origin, found on the banks of the Lake of Como and consisting chiefly of clay used in the manufacture of tiles and pottery, and others of the same date are found in the neighbourhood. Fossils are very rare throughout these strata.

The existence of small patches of tertiary marls in these localities is interesting, as marking points on the northern shores of the ancient pliocene sea, traces of which shores had been previously indicated by several geologists. They prove also that the general configuration of the Lake of Como was not much unlike what we now see, before the last disturbances took place, which have affected some of the lacustrine marls of Villa.

In conclusion, it is interesting to notice the general direction of the successive dislocations which have produced the actual *contour* of this district. These appear to be two in number, one of them having for its mean the direction of E.S.E., the general strike of the conglomerate and black limestones of the Val Sasina, of the dolomitic limestones of Menaggio, and of the cretaceous beds between the Lago Maggiore and the Adda. The other is exhibited in the oolitic formations west of the Lake of Como, and runs almost constantly E. 16° N.

D. T. A.

V. *A Description of certain BELEMNITES, preserved, with a great Proportion of their Soft Parts, in the Oxford Clay at Christian Malford, Wilts.* By RICHARD OWEN, Esq. F.R.S. &c.

[Read before the Royal Society, March 21. 1844.]

THE fossil shell called *Belemnite* has long exercised the ingenuity and research of the interpreters of ancient nature; and although sufficient evidence has, for some time, been obtained to determine both the ordinal and family affinities of the organisation of the animal constructing this singular compound shell, many additional and important facts have been arrived at by the examination of the well-preserved specimens from the Oxford clay, described in this paper.

In the compound shell of these specimens, the following parts are recognisable:—

1st. The terminal guard or sheath, resembling the head of a dart or javelin, whence the name *Belemnite* was first given to this part (which alone is generally well preserved), although it is now extended to the animal.

2d. The chambered or siphonated part of the shell called the