CHAPTER XII.

Geological monuments of the *older* Pliocene period—Subapennine formations—Opinions of Brocchi—Different groups termed by him Subapennine are not all of the same age—Mineral composition of the Subapennine formations—Marls—Yellow sand and gravel—Subapennine beds how formed—Illustration derived from the Upper Val d'Arno—Organic remains of Subapennine hills—Older Pliocene strata at the base of the Maritime Alps—Genoa—Savona—Albenga—Nice—Conglomerate of Valley of Magnan—Its origin—Tertiary strata at the eastern extremity of the Pyrenees.

OLDER PLIOCENE FORMATIONS.

We must now carry back our retrospect one step farther, and treat of the monuments of the era immediately antecedent to that last considered. We defined in the fifth chapter *, the zoological characters by which the strata of the older Pliocene period may be distinguished, and we shall now proceed at once to describe some of the principal groups which answer to those characters.

Subapennine strata.—The Apennines, it is well known, are composed chiefly of secondary rocks, forming a chain which branches off from the Ligurian Alps and passes down the middle of the Italian peninsula. At the foot of these mountains, on the side both of the Adriatic and the Mediterranean, are found a series of tertiary strata, which form, for the most part, a line of low hills occupying the space between the older chain and the sea. Brocchi, the first Italian geologist who described this newer group in detail, gave it the name of the Subapennines, and he classed all the tertiary strata of Italy, from Piedmont to Calabria, as parts of the same system. Certain mineral characters, he observed, were common to the whole, for the strata consist generally of light brown or blue marl, covered by yellow calcareous sand and gravel. There are also,

* Above, p. 54.

he added, some species of fossil shells which are found in these deposits throughout the whole of Italy.

In a catalogue, published by Lamarck, of 500 species of fossil-shells of the Paris basin, a small number only were enumerated as identical with those of Italy, and only 20 as agreeing with living species. This result, said Brocchi, is wonderful, and very different from that derived from a comparison of the fossil-shells of Italy, *more than half of which* agree with species now living in the Mediterranean, or in other seas, chiefly of hotter climates *.

He also stated, that it appeared from the observations of Parkinson, that the clay of London, like that of the Subapennine hills, was covered by sand (alluding to the Crag), and that in that upper formation of sand in England the species of shells corresponded much more closely with those now living in the ocean than did the species of the subjacent clay. Hence he inferred that an interval of time had separated the origin of the two groups. But in Italy, he goes on to say, the shells found in the marl and superincumbent sand belong entirely to the same group, and must have been deposited under the same circumstances †.

Notwithstanding the correctness of these views, Brocchi conceived that the Italian tertiary strata, as a whole, might agree with those of the basins of Paris and London, and he endeavoured to explain the discordance of their fossil contents by remarking, that the testacea of the Mediterranean differ now from those living in the ocean ‡. In attempting thus to assimilate the age of these distinct groups, he was evidently influenced by his adherence to the anciently-received theory of the gradual fall of the level of the ocean, to which, and not to the successive rise of the land, he attributed the emergence of the tertiary strata, all of which he consequently imagined to have remained under water down to a comparatively recent period.

Brocchi was perfectly justified in affirming that there were

* Conch. Foss. Subap., tom. i. p. 148. † Ibid., p. 147. ‡ Ibid., p. 166.

some species of shells common to all the strata called by him Subapennine; but we have shown that this fact is not inconsistent with the conclusion, that the several deposits may have originated at different periods, for there are species of shells common to all the tertiary eras. He seems to have been aware, however, of the insufficiency of his data, for in giving a list of species universally distributed throughout Italy, he candidly admits his inability to determine whether the shells of Piedmont were all identical with those of Tuscany, and whether those of the northern and southern extremities of Italy corresponded *.

We have already satisfactory evidence that the Subapennine beds of Brocchi belonged, at least, to three periods. To the Miocene we can refer a portion of the strata of Piedmont, those of the hill of the Superga, for example; to the older Pliocene belong the greater part of the strata of northern Italy and of Tuscany, and perhaps those of Rome; to the newer Pliocene, the tufaceous formations of Naples, the calcareous strata of Otranto, and probably the greater part of the tertiary beds of Calabria.

That there is a considerable correspondence in the arrangement and mineral composition of these different Italian groups is undeniable; but not that close resemblance which should lead us to assume an exact identity of age, even had the fossil remains been less dissimilar.

Very erroneous notions have been entertained respecting the contrast between the lithological characters of the Italian strata and certain groups of higher antiquity. Dr. Macculloch has treated of the Italian tertiary beds under the general title of 'elevated submarine alluvia,' and the overlying yellow sand and gravel may, according to him, be wholly, or in part, a terrestrial alluvium †. Had he visited Italy, we are persuaded that he would never have considered the tertiary strata of London and Paris as belonging to formations of a different order from the Subapennine groups, or as being more regu-

* Conch. Foss. Subap., tom. i. p. 143. † Syst. of Geol., vol. i. chap. xv.

larly stratified. He seems to have been misled by Brocchi's description, who contrasts the more crystalline and solid texture of the older secondary rocks of the Apennines with the loose and incoherent nature of the Subapennine beds, which resemble, he says, the mud and sand now deposited by the sea.

We have endeavoured, in the last chapter, to restrict within definite limits the meaning of the term *alluvium;* but if the Subapennine beds are to be designated 'marine alluvia,' the same name might, with equal propriety, be applied not only to the argillaceous and sandy groups of the London and Hampshire basins, but to a very great portion of our secondary series where the marls, clays, and sands are as imperfectly consolidated as the tertiary strata of Italy in general.

They who have been inclined to associate the idea of the more stony texture of stratified deposits with a comparatively higher antiquity, should consider how dissimilar, in this respect, are the tertiary groups of London and Paris, although admitted to be of contemporaneous date, or they should visit Sicily and behold a soft brown marl, identical in mineral character with that of the Subapennine beds, underlying a mass of solid and regularly-stratified limestone, rivalling the chalk of England in thickness. This Sicilian marl is older than the superincumbent limestone, but newer than the Subapennine marl of the north of Italy; for in the latter the extinct shells rather predominate over the recent, in the former the recent predominate almost to the exclusion of the extinct.

We shall now consider more particularly the characters of those Subapennine beds which we refer to the older Pliocene period.

Subapennine marls.—The most important member of the Subapennine formation is a marl which varies in colour from greyish brown to blue. It is very aluminous, and usually contains much calcareous matter and scales of mica. It often exhibits no lines of division throughout a considerable thickness, but in other places it is thinly laminated. Near Parma, for example, I have counted thirty distinct laminæ in

the thickness of an inch. In some of the hills near that city the marl attains, according to Signor Guidotti, a thickness of nearly 2000 feet, and is charged throughout with shells, many of which are such as inhabit a deep sea. They often occur in layers in such a manner as to indicate their slow and gradual accumulation. They are not flattened but are filled with marl. Beds of lignite are sometimes interstratified, as at Medesano, four leagues from Parma; subordinate beds of gypsum also occur in many places, as at Vigolano and Bargone, in the territory of Parma, where they are interstratified with shelly marl and sand. At Lezignano, in the Monte Cerio, the sulphate of lime is found in lenticular crystals, in which unaltered shells are sometimes included. Signor Guidotti, who showed me specimens of this gypsum, remarked, that the sulphuric acid must have been fully saturated with lime when the shells were enveloped, so that it could not act upon the shell. According to Brocchi, the marl sometimes passes from a soft and pulverulent substance into a compact limestone *, but it is rarely found in this solid form. It is also occasionally interstratified with sandstone.

The marl constitutes very frequently the surface of the country, having no covering of sand. It is sometimes seen reposing immediately on the Apennine limestone; more rarely gravel intervenes, as in the hills of San Quirico †. Volcanic rocks are here and there superimposed, as at Radicofani, in Tuscany, where a hill composed of marl, with some few shells interspersed, is capped by basalt. Several of the volcanic tuffs in the same place are so interstratified with the marls as to show that the eruptions took place in the sea during the older Pliocene period. At Acquapendente, Viterbo, and other places, hills of the same formation are capped with trachytic lava, and with tuffs which appear evidently to have been subaqueous.

Yellow Sand.—The other member of the Subapennine group, the yellow sand and conglomerate, constitutes, in most

* Conch. Foss. Subap., tom. i. p. 82. † Ibid., p. 78.

of the places where I have seen it, a border formation near the junction of the tertiary and secondary rocks. In some cases, as near the town of Sienna, we see sand and calcareous gravel resting immediately on the Apennine limestone, without the intervention of any blue marl. Alternations are there seen of beds containing fluviatile shells, with others filled exclusively with marine species; and I observed oysters attached to many of the pebbles of limestone. This locality appears to have been a point where a river, flowing from the Apennines, entered the sea in which the tertiary strata were formed.

Between Florence and Poggibonsi, in Tuscany, there is a great range of conglomerate of the Subapennine beds, which is seen for eleven miles continuously from Casciano to the south of Barberino. The pebbles are chiefly of whitish limestone with some sandstone. On receding from the older Apennine rocks, the conglomerate passes into yellow sand and sandstone, with shells, the whole overlying blue marl. In such cases we may suppose the deltas of rivers and torrents to have gained upon the bed of a sea where blue marl had previously been deposited.

The upper arenaceous group above described sometimes passes into a calcareous sandstone, as at San Vignone. It contains lapidified shells more frequently than the marl, owing probably to the more free percolation of mineral waters, which often dissolve and carry away the original component elements of fossil bodies and substitute others in their place. In some cases the shells imbedded in this group are silicified, as at San Vitale, near Parma, from whence I saw two species, one fresh-water and the other marine (Limnea palustris, and Cytherea concentrica, Lamk.), both *recent* and perfectly converted into flint.

On the other hand, the shells of Monte Mario, near Rome, which are probably referrible to the same formation, are changed into calcareous spar, the form being preserved notwithstanding the crystallization of the carbonate of lime.

Mode of formation of the Subapennine beds.—The tertiary strata above described have resulted from the waste of the secondary rocks which now form the Apennines, and which

had become dry land before the older Pliocene beds were deposited. In the territory of Placentia we have an opportunity of observing the kind of sediment which the rivers are now bringing down from the Apennines. The tertiary marl of that district being too calcareous to be used for bricks or pottery, a substitute is obtained, by conveying into tanks the turbid waters of the rivers Braganza, Parma, Taro and Enza. In the course of a year a deposit of brown clay, much resembling some of the Subapennine marl, is procured, several feet in thickness, divided into thin laminæ of different shades of colour.

In regard to the sand and gravel, we see yellow sand thrown down by the Tiber near Rome, and by the Arno, at Florence. The northern part of the Apennines consists of a grey micaceous sandstone with an argillaceous base, alternating with shale, from the degradation of which brown clay and sand would result. If a river flow through such strata, and some one of its tributaries drains the ordinary limestone of the Apennines, the clay will become marly by the intermixture of calcareous matter. The sand is frequently yellow from being stained by oxide of iron, but this colour is by no means constant.

The similarity in composition of the tertiary strata in the basins of the Po, Arno, and Tiber, is merely such as might be expected to arise from their having been all derived from the disintegration of the same continuous chain of secondary rocks. But it does not follow that the latter rocks were all upheaved and exposed to degradation at the same time. The correspondence of the tertiary groups consists in their being all alike composed of marl, clay, and sand; but we might say the same of the London and Hampshire basins, although the English and Italian groups, thus compared, belong nearly to the two opposite extremes of the tertiary series.

The similarity in mineral character of the lacustrine deposit of the Upper Val d'Arno, and the marine Subapennine hills of northern Italy, ought, we think, to serve as a caution

to the geologist, not to infer too hastily a contemporaneous origin from identity of mineral composition. The deposit of the Upper Val d'Arno occurs nearly at the bottom of a deep narrow valley, which is surrounded by precipitous rocks of secondary sandstone and shale (the macigno of the Italians and greywacke of the Germans). Hills of yellow sand, of considerable thickness, appear around the margin of the small basin, while, towards the central parts, where there has been considerable denudation, and where the Arno flows, blue clay is seen underlying the yellow sand. The shells are of freshwater origin, but we shall speak more particularly of them when we discuss the probable age of this formation in the sixteenth chapter. We desire, at present, to call the reader's attention to the fact, that we have here, in an isolated basin, such a formation as would result from the waste of the contiguous .secondary rocks of the Apennines, fragments of which rocks are found in the sand and conglomerate. We should expect that if the freshwater beds were removed, and the barrier of the lake-basin closed up again, similar sediment would be again deposited, for the aqueous agents would operate in the same manner, at whatever period they might be in activity. Now, the only difference, in mineral composition, between the lacustrine deposit above alluded to, and the ordinary marine strata of the Subapennine beds, consists in the absence of calcareous matter from the clay, the torrents flowing into the lake having passed over no limestone rocks.

The lithological character of the Subapennine beds varies in different parts of the peninsula both in colour and degree of solidity. The presence, also, or absence of lignite and gypsum, and the association or non-association of volcanic rocks, are causes of great local discrepancy. The superposition of the sand and conglomerate to the marl, on the other hand, is a general point of agreement, although there are exceptions to the rule, as at San Quirico before mentioned. The cause of this arrangement may be, as we before hinted, that the arenaceous groups were first formed on the coast where rivers entered, and when

these pushed their deltas farther out, they threw down the sand upon part of the bed of the sea already occupied by finer and more transportable mud.

Organic Remains.—I have been informed, by experienced collectors of the Subapennine fossils, that they invariably procure the greatest number in those winters when the rains are most abundant, an annual crop, as it were, being washed out of the soil to replace those which the action of moisture, frost, and the rays of the sun, soon reduce to dust upon the surface.

The shells in general are soft when first taken from the marl, but they become hard when dried. The superficial enamel is often well preserved, and many shells retain their pearly lustre, and even part of their external colour, and the ligament which unites the valves. No shells are more usually perfect than the microscopic, which abound near Sienna, where more than a thousand full-grown individuals are sometimes poured out of the interior of a single univalve of moderate dimensions. In some large tracts of yellow sand it is impossible to detect a single fossil, while in other places they occur in profusion.

The Subapennine testacea are referrible to species and families of which the habits are extremely diversified, some living in deep, others in shallow water, some in rivers or at their mouths. I have seen a specimen of a *fresh-water* univalve (Limnea palustris), taken from the blue marl near Parma, full of small *marine* shells. It may have been floated down by the same causes which carried wood and leaves into the ancient sea.

Blocks of Apennine limestone are found in this formation drilled by lithodomous shells. The remains not only of testacea and corals, but of fishes and crabs, are met with, as also those of cetacea, and even of terrestrial quadrupeds.

A considerable list of mammiferous species has been given by Brocchi and some other writers; and, although several mistakes have been made, and the bones of cetacea have sometimes been confounded with those of land animals, it is still indubitable that the latter were carried down into the sea when the Subapennine sand and marl were accumulated. The same

causes which drifted skeletons into lakes, such as that of the upper Val d'Arno, may have carried down others into firths or bays of the sea. The femur of an elephant has been disinterred with oysters attached to it, showing that it remained for some time exposed after it was drifted into the sea.

Strata at the base of the Maritime Alps.—If we pass from the Italian peninsula, and, following the borders of the Mediterranean, examine the tertiary strata at the foot of the Maritime Alps, we find formations agreeing in zoological characters with the Subapennine beds, and presenting many points of analogy in their mineral composition. The Alps, it is well known, terminate abruptly in the sea, between Genoa and Nice, and the steep declivities of that bold coast are continuous below the waters, so that a depth of many hundred fathoms is often found within stone's-throw of the beach. Exceptions occur only where streams and torrents enter the sea, and at these points there is always a low level tract, intervening between the mouth of the stream and the precipitous escarpment of the mountains.

In travelling from France to Genoa, by the new coast-road, we are principally conveyed along a ledge excavated out of the side of a steep slope or precipice, in the same manner as on the roads which traverse the great interior passes of the Alps, such as the Simplon and Mont Cenis, the difference being that, in this case, the traveller has always the sea below him, instead of a river. But we are obliged occasionally to descend by a zig-zag course into those low plains before alluded to, which, when viewed from above, have the appearance of bays deserted by the sea. They are surrounded on three sides by rocky eminences, and the fourth is open to the sea.

These leading features in the physical geography of the country are intimately connected with its geological structure. The rocks composing the Alpine declivities consist partly of primary formations, but more generally of secondary, which have undergone immense disturbance; but when we examine the low tracts before-mentioned, we find the surface covered

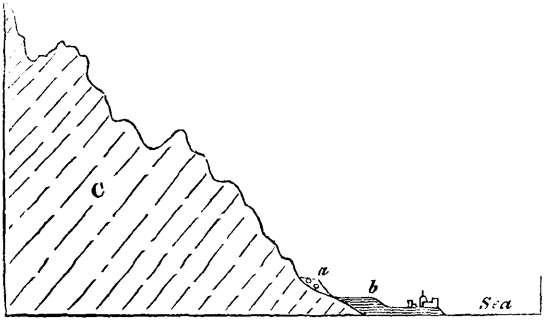
with great beds of gravel and sand, such as are now annually brought down by torrents and streams in the winter, and which are spread in such quantity over the wide and shifting river-channels as to render the roads for a season impassable. The first idea which naturally suggests itself, on viewing these plains, is to imagine them to be deltas or spaces converted into land by the accumulated sand and gravel brought down from the Alps by rivers. But, on closer inspection, we find that the apparent lowness of the plains, which at first glance might be supposed to be only just raised above the level of the sea, is a deception produced by contrast. The Alps rise suddenly to the height of several thousand feet with a bold and precipitous outline, while the country below is composed of horizontal strata, which have either a flat or gently-undulating surface. These strata consist of gravel, sand, and marl, filled with marine shells. They are considerably elevated, attaining sometimes the height of 200 feet, or even more, above the level of the sea; there must, therefore, have been a rise of the coast since they were deposited, and they are not mere deltas or spaces reclaimed from the sea by rivers. Why, then, are the strata found only at the points where rivers enter?

We must imagine that, after the coast had nearly acquired its present configuration, the streams which flowed down into the Mediterranean produced shoals opposite their mouths by the continual drifting in of gravel, sand, and mud. The Alps were afterwards raised to a sufficient height to cause these shoals to become land, while no perceptible alteration was produced on intervening parts of the coast, where the sea was of great depth near the shore.

The disturbing force appears to have acted very irregularly, and to have produced the least elevation towards the eastern extremity of the Maritime Alps, and a greater amount as we proceed westward. Thus we find the marine tertiary strata attaining the height of about 100 feet at Genoa, 200 and 300 feet farther westward, at Albenga, and 800 or 900 feet in the neighbourhood of Nice.

Genoa.—At Genoa the tertiary strata consist of blue marls like those of the northern Subapennines, and contain the same shells. On the immediate site of the town they rise to the height of only 20 feet above the sea, but they reach about 80 feet in some parts of the suburbs. At the base of a mountain not far from the suburbs there is an ancient

Monte d'Origina. No. 28.



Position of Tertiary strata at Genoa.

a, Ancient sea-beach. *b*, Blue marl with shells.
C, Inclined secondary strata of sandstone, shale, &c.

beach, strewed with rounded blocks of Alpine rocks, some of which are drilled by the *Modiola lithophaga*, Lamk., the whole cemented into a conglomerate*, which marks the ancient sea-beach at the height of 100 feet above the present sea.

Savona.—At Savona, proceeding westwards, we find deposits of blue marl like those of Genoa, and occupying a corresponding geological position at the base of the mountains near the sea. The shells, collected from these marls by Mr. Murchison and myself, in 1828, were examined by Signor Bonelli, of Turin, and found to agree with Subapennine fossils.

Albenga.—At Albenga these formations occupy a more extensive tract, forming the plains around that town and the low hills of the neighbourhood, which reach in some spots an elevation of 300 feet. The encircling mountains recalled to my mind those which bound the plain and bay of Palermo, and

* I have to acknowledge the assistance of Professor Viviani and Dr. Sasso who called my attention to these phenomena when I visited Genoa in Jan. 1829.

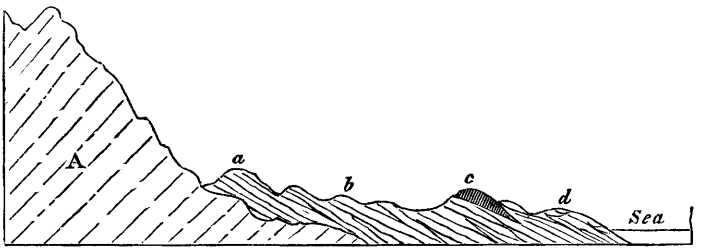
other bays of the Mediterranean, which are surrounded by bold rocky coasts.

The general resemblance of the Albenga strata to the Subapennine beds is very striking, the lowest division consisting of blue marl, which is covered by sand and yellow clay, and the highest by a mass of stratified shingle, sometimes consolidated into a conglomerate. Dr. Sasso has collected about 200 species of shells from these beds, and it appears, by his catalogue, that they agree, for the most part, with the northern Subapennine fossils, more than half of them belonging to recent species *.

Nice.—At Nice the tertiary strata are upraised to a much greater height, but they may still be said to lie at the base of the Alps which tower above them. Here, also, they consist principally of blue marl and yellow sand, which appear to have been deposited in submarine valleys previously existing in the inclined secondary strata. In one district, a few miles to the west of Nice, the tertiary beds are almost exclusively composed of conglomerate, from the point of their junction with the secondary strata to the sea.

The river Magnan flows in a deep valley which terminates at its upper extremity in a narrow ravine. Nearly vertical

Monte Calvo. No. 29.



Section from Monte Calvo to the sea by the valley of Magnan, near Nice.

A, Dolomite and sandstone. (Green-sand formation?)

a, b, d, Beds of gravel and sand.

c, Fine marl and sand of St. Madeleine.

* Giornale Ligustico, Genoa, 1827.

precipices are laid open on each side, varying from 200 to 600 feet in height, and composed of inclined beds of shingle, sometimes separated by layers of sand, and more rarely by blue micaceous marl. The pebbles in these stratified shingles agree in composition with those now brought down from the Alps by the Var and other rivers on this coast.

The dip of the strata is remarkably uniform, being always southwards, or towards the Mediterranean, at an angle of about 25°. In summer, when the bed of the river is dried up, the geologist has a good opportunity of examining a section of the strata, as the channel crosses for many miles the line of bearing of the beds, which may be traced to the base of Monte Calvo, a distance of about nine miles in a straight line from the Mediterranean *. It is usually impossible to determine the exact age of such accumulations of sand and gravel, in consequence of the total absence of organic remains. Their non-existence may depend chiefly on the disturbed state of the waters, where great beds of shingle are formed, which are known to prevent testacea and fishes from living in Alpine torrents, partly on the destruction of shells by the same friction which rounded the pebbles, and partly on the permeability of the matrix to water, which may carry away the elements of the decomposing fossil body, and substitute no others in their place which might retain a cast of their form.

But it fortunately happens, in this instance, that in some few seams of loamy marl, intervening between the pebble-beds, and near the middle of the section, shells have been preserved in a very perfect state of preservation, and these may furnish a zoological date to the whole mass. The principal of these interstratified masses of loam occurs near the church of St. Madeleine (at *c*, diagram No. 29), where the active researches of M. Risso have brought to light a great number of shells which agree perfectly with the species found in much greater abundance at a spot called La Trinità, and some other locali-

* I examined this section in company with Mr. Murchison in 1828.

ties nearer to Nice. From these fossils it clearly appears that the formation belongs to the older Pliocene era.

Such alternations of gravel and the usual thin layers of fine sediment may easily be explained, if we reflect that the rivers now flowing from the Maritime Alps are nearly dried up in summer, and have only strength to drift along fine mud to the sea; whereas, in winter, or on the melting of the snow, they roll along large quantities of pebbles. The thicker masses of loam, such as that of St. Madeleine, may have been produced during a longer interval, when the river shifted for a time the direction of its principal channel of discharge, so that nothing but fine mud was for a series of years conveyed to that point in the bed of the sea opposite the delta.

Uniform and continuous as the strata appear, on a general view, in the ravine of the Magnan, we discover, if we attempt to trace any one of them for some distance, that they thin out and are wedge-shaped. We believe that they were thrown down originally upon a steep slanting bank or talus, which advanced gradually from the base of Monte Calvo to the sea. The distance between these points is, as we have before mentioned, about nine miles, so that the accumulation of superimposed strata would be a great many miles in thickness, if they were placed horizontally upon one another. The strata nearest to Monte Calvo, which may be expressed by *a*, are certainly older than those at *b*, and the group *b* was formed before *c*. The aggregate thickness, in any one place, cannot be proved to amount to 1000 feet, although it may, perhaps, be much greater. But it may never exceed three or four thousand feet; whereas, if we did not suppose that the beds were originally deposited in an inclined position, we should be forced to imagine that a sea, many miles in depth, had been filled up by horizontal strata of pebbles thrown down one upon another.

At no great distance on this coast the Var is annually seen to sweep down into the sea a large quantity of gravel, which may be spread out by the waves and currents over a considerable space. The sea at the mouth of this river is now shallow,

but it may originally have been 3000 feet deep, as it is now close to the shore at Nice. Here, therefore, a formation resembling that of the Magnan above described may be in progress.

The time required for the accumulation of such a mass of conglomerate as we have just considered must be immense: on what ground such formations have been frequently referred to diluvial waves and to periods of great disturbance, we could never understand, for the causes now in diurnal action at the foot of the Maritime Alps and other analogous situations seem to us quite sufficient to explain their origin.

Tertiary strata at the eastern extremity of the Pyrenees.— We shall conclude this chapter with one more example derived from a region not far distant. On the borders of the Mediterranean at the eastern extremity of the Pyrenees, in the South of France, a considerable thickness of tertiary strata are seen in the valleys of the rivers Tech, Tet, and Gly. They bear much resemblance to those already described, consisting partly of a great thickness of conglomerate, and partly of clay and sand, with subordinate beds of lignite. They abut against the primary formation of the Pyrenees, which here consists of mica-schist. Between Ceret and Boulon these tertiary strata are seen inclined at an angle of between 20° and 30°. The shells which I procured from several localities were recognized by M. Deshayes as agreeing with Subapennine fossils.

Spain — Morea. — It appears from the recent observations of Colonel Silvertop, that marine strata of the older Pliocene period occur in patches at Malaga, and in Granada, in Spain. They have also been discovered by MM. Boblaye and Virlet in the Morea, and the names of many of the shells brought from thence are given in the Appendix No. I.