

CHAPTER XVI.

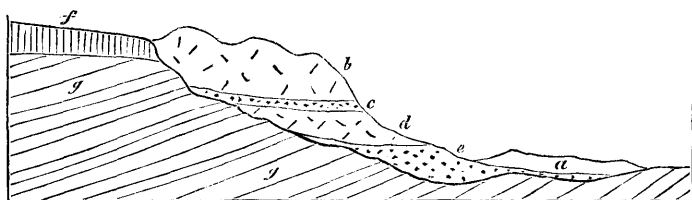
Miocene alluviums—Auvergne—Mont Perrier—Extinct quadrupeds—Velay—Orleanais—Alluviums contemporaneous with Faluns of Touraine—Miocene fresh-water formations—Upper Val d'Arno—Extinct mammalia—Coal of Cadibona—Miocene volcanic rocks—Hungary—Transylvania—Styria—Auvergne—Velay.

IN the present chapter we shall offer some observations on the alluviums and fresh-water formations of the Miocene era, and shall afterwards point out the countries in Europe where the volcanic rocks of the same period may be studied.

MIOCENE ALLUVIUMS.

Auvergne.—The annexed drawing will explain to the reader the position of two ancient beds of alluvium, *c* and *e*, in Au-

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Position of the Miocene alluviums of Mont Perrier (or Boulade).

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| <i>a</i> , Newer alluvium. | <i>e</i> , First Miocene alluvium with bones. |
| <i>b</i> , Second trachytic breccia. | <i>f</i> , Compact basalt. |
| <i>c</i> , Second Miocene alluvium with bones. | <i>g</i> , Eocene lacustrine strata. |
| <i>d</i> , First trachytic breccia. | |

vergne, in which the remains of several quadrupeds characteristic of the Miocene period have been obtained. In order to account for the situation of these beds of rounded pebbles and sand, we must suppose that after the tertiary strata *g*, covered by the basaltic lava *f*, had been disturbed and exposed to aqueous denudation, a valley was excavated, wherein the alluvium *e* accumulated, and in which the remains of quadrupeds

then inhabiting the country were buried. The trachytic breccia *d* was then superimposed; this breccia is an aggregate of shapeless and angular fragments of trachyte, cemented by volcanic tuff and pumice, resembling some of the breccias which enter into the composition of the neighbouring extinct volcano of Mont Dor in Auvergne, or those which are found in Etna. Upon this rests another alluvium *c*, which also contains the bones of Miocene species, and this is covered by another enormous mass of tufaceous breccia. We suppose the breccias to have resulted from the sudden rush of large bodies of water down the sides of an elevated volcano at its moments of eruption, when snow perhaps was melted by lava. Such floods occur in Iceland, sweeping away loose blocks of lava and ejections surrounding the crater, and then strewing the plains with fragments of igneous rocks, enveloped in mud or 'moya.' The abrupt escarpment presented by the above-described beds, *b*, *c*, *d*, *e*, towards the valley of the Couze, must have been caused by subsequent erosion, whereby a large portion of those masses has been carried away*.

In the alluviums *c* and *e*, MM. Croizet, Jobert, Chabriol, and Bouillet have discovered the remains of about forty species of extinct mammalia, the greater part of which are peculiar as yet to this locality; but some of them characteristic of the Miocene period, being common to the faluns of Touraine, and associated in other localities with marine Miocene strata. Among these species may be enumerated *Mastodon minor* and *M. arvernensis*, *Hippopotamus major*, *Rhinoceros leptorhinus* and *Tapir arvernensis*. The *Elephas primigenius*, a species common to so many tertiary periods, is also stated to accompany the rest. In some cases the remains are not sufficiently characteristic to indicate the exact species, but the following genera can be determined: the boar, horse, ox, *hyæna* (two species), *felis* (three or four species), bear (three

* For an account of the position and age of the volcanic breccias of Mont Perrier and Boulade, see Lyell and Murchison on the beds of Mont Perrier, Ed. New Phil. Journ., July, 1829, p. 15.

species), deer, a great variety, canis, otter, beaver, hare, and water-rat*.

Velay.—In Velay a somewhat similar group of mammiferous remains were found by Dr. Hibbert †, in a bed of volcanic scorix and tuff, inclosed between two beds of basaltic lava, at Saint-Privat d'Allier. Some of the bones were found adhering to the slaggy lava. Among the animals were *Rhinoceros leptorhinus*, *Hyæna spelæa*, and another species allied to the spotted hyæna of the Cape, together with four undetermined species of deer ‡.

At Cussac and Solilhac, one league from Puy en Velay, M. Robert discovered, in an ancient alluvium covered with lava, the remains of *Elephas primigenius*, *Rhinoceros leptorhinus*, *Tapir arvernensis*, horse (two species), deer (seven species), ox (two species), and an antelope.

Orleanais.—In the Orleanais, at Avaray, Chevilly, les Aides, and les Barres, fossil land quadrupeds have been found associated with fluviatile shells and reptiles, identical with those found in the marine faluns of Touraine §. These are supposed, with great probability, by M. Desnoyers, to mark the passage of streams which flowed towards the sea in which the faluns were deposited. They bear the same relation to the Miocene strata of Touraine, as part of the ancient gravel and silt of England, containing the bones of elephants and other extinct animals, probably bear to the crag.

MIOCENE FRESH-WATER FORMATIONS.

Upper Val d'Arno.—There are a great number of isolated tertiary formations, of fresh-water origin, resting on primary and secondary rocks in different parts of Europe, in the same

* Recherches sur les Oss. Foss. du Dépt. du Puy de Dome, 4to., 1828.—Essai Geol. et Mineral. sur les Environs d'Issoire, Dépt. du Puy de Dome, folio, 1827.

† Edin. Journ. of Sci., No. 4, New Series, p. 276.

‡ Figures of some of these remains are given by M. Bertrand de Doue, Ann. de la Soc. d'Agricult. de Puy, 1828.

§ MM. Desnoyers and Lockart, Bulletin de la Soc. Géol., tom. ii. p. 336.

manner as we now find small lakes scattered over our continents and islands wherein deposits are forming, quite detached from all contemporary marine strata. To determine the age of such groups with reference to the great chronological series established for the marine strata, must often be a matter of difficulty, since we cannot always enjoy an opportunity of studying a locality where the fresh-water species are intermixed with marine shells, or where they occur in beds alternating with marine strata.

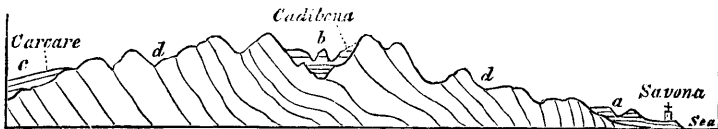
The deposit of the Upper Val d'Arno before alluded to, (p. 161) was evidently formed in an ancient lake; but although the fossil testaceous and mammiferous remains preserved therein are very numerous, it is scarcely possible, at present, to decide with certainty the precise era to which they belong. I collected six species of lacustrine shells, in an excellent state of preservation, from this basin belonging to the genera *Anodon*, *Paludina* and *Neritina*; but M. Deshayes was unable to identify them with any recent or fossil species known to him. If the beds belonged to the older Pliocene formations we might expect that several of the fossils would agree specifically with living testacea; and we are therefore disposed to believe that they belong to an older epoch. If we consider the terrestrial mammalia of the same beds, we immediately perceive that they cannot be assimilated to the Eocene type, as exhibited in the Paris basin, or in Auvergne and Velay: but some of them agree with Miocene species. Mr. Pentland has obligingly sent me the following list of the fossil mammifers of the Upper Val d'Arno which are in the museums of Paris.—*Feræ*.—*Ursus cultridens*, *Viverra Valdarnensis*, *Canis lupus*, and another of the size of the common fox. *Hyæna radiata*, *H. fossilis*. *Felis* (a new species of the size of the panther). *Rodentia*.—*Histrix*, nearly allied to *dorsalis*, *Castor*. *Pachydermata*.—*Elephas Italicus*, *Mastodon angustidens*, *M. Taperoides*, *Tapir*——, *Equus*——, *Sus scrofa*, *Rhinoceros leptorhinus*, *Hippopotamus major*, *fossilis*. *Ruminantia*.—

Cervus megaceros, (?) *C. Valdarnensis*, *C.* —, new species, *Bos, bubalo affinis*, *B. urus* and *B. taurus*.

Cuvier also mentions the remains of a species of *Iophiodon* as occurring among the bones in the Upper Val d'Arno*. The elephant of this locality has been called by Nesti† *meridionalis*, and is considered by him as distinct from the Siberian fossil species *E. primigenius*, with which, however, some eminent comparative anatomists regard it as identical. The skeletons of the hippopotamus are exceedingly abundant; no less than forty had been procured when I visited Florence in 1828. Remains of the elephant, stag, ox, and horse, are also extremely numerous. In winter the superficial degradation of the soil is so rapid, that bones which the year before were buried are seen to project from the surface of the soil, and are described by the peasants as growing. In this manner the tips of the horns of stags, or of the tusks of hippopotamuses often appear on the surface, and thus lead to the discovery of an entire head or skeleton.

Cadibona.—Another example of an isolated lacustrine deposit, belonging possibly to the Miocene period, is that which occurs at Cadibona, between Savona and Carcare. Its position is described in the annexed section, which does not however

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Section of the fresh-water formation of Cadibona.

- a. Blue marl and yellow sand (older Pliocene).
- b. Sand, shale and coal of Cadibona (Miocene?).
- c. Green sand, &c. of the Bormida (Miocene).
- d. Chloritic and micaceous schist, serpentine, &c.

pretend to accuracy in regard to the relative heights of the different rocks, or the distances of the places from each other.

* *Oss. Foss.*, vol. v. p. 504.

† *Lettere sopra alcune Ossa Fossili del Val d'Arno, &c.* Pisa, 1825.

The lacustrine strata are composed of gravel, grit, and micaceous sandstone, of such materials as were derivable from the surrounding primary rocks; and so great is the thickness of this mass, that some valleys intersect it to the depth of seven or eight hundred feet without penetrating to the subjacent formations. In one part of the series, carbonaceous shales occur, and several seams of coal from two to six feet in thickness, but no impressions of plants of which the species could be determined, and no shells have been discovered. Many entire jaws and other bones of an extinct mammifer, called by Cuvier *Anthracotherium*, have been found in the coal-beds, the bone being itself changed into a kind of coal; but as this species does not occur elsewhere in association with organic remains of known date, it affords us no aid in our attempt to assign a place to the lignites of Cadibona*.

MIOCENE VOLCANIC ROCKS.

Hungary.—M. Beudant, in his elaborate work on Hungary, describes five distinct groups of volcanic rocks, which, although rarely of great extent, form striking features in the physical geography of that country, rising as they do abruptly from extensive plains composed of tertiary strata. They may have constituted islands in the ancient sea, as Santorin and Milo now do in the Grecian archipelago; and M. Beudant has remarked that the mineral products of the last-mentioned islands resemble remarkably those of the Hungarian extinct volcanos, where many of the same minerals, as opal, calcedony, resinous silex (*silex resinite*), pearlite, obsidian, and pitchstone abound.

The Hungarian lavas are chiefly felspathic, consisting of different varieties of trachyte; many are cellular and used as millstones; some so porous and even scoriform as to resemble those which have issued in the open air. Pumice occurs in great quantity, and there are conglomerates, or rather

* The author visited Cadibona in August, 1828, in company with Mr. Murchison.

breccias, wherein fragments of trachyte are bound together by pumiceous tuff or sometimes by silex.

It is probable that these rocks were permeated by the waters of hot springs, impregnated, like the Geysers, with silica ; or, in some instances perhaps, by aqueous vapours, which, like those of Lancerote, may have precipitated hydrate of silica*.

By the influence of such springs or vapours the trunks and branches of trees washed down during floods, and buried in tuffs on the flanks of the mountains, may have become silicified. It is scarcely possible, says M. Beudant, to dig into any of the pumiceous deposits of these mountains without meeting with opalized wood, and sometimes entire silicified trunks of trees of great size and weight.

It appears from the species of shells collected principally by M. Boué, and examined by M. Deshayes, that the fossil remains imbedded in the volcanic tuffs, and in strata alternating with them in Hungary, are of the Miocene type, and no identical, as was formerly supposed, with the fossils of the Paris basin.

Transylvania.—The igneous rocks of the eastern part of Transylvania described by M. Boué, are probably of the same age. They cover a considerable area, and bear a close resemblance to the Hungarian lavas, being chiefly trachytic. Several large craters, containing shallow lakes like the Maars of the Eifel, are met with in some regions ; and a rent in the trachytic mountains of Budoshagy exhales hot sulphureous vapours, which convert the trachyte into alum-stone, a change which that rock has undergone at remote periods in several parts of Hungary.

Styria.—Many of the volcanic groups of this country bear a similar relation to the Styrian tertiary deposits, as do the Hungarian rocks to the marine strata of that country. The shells are found imbedded in the volcanic tuffs in such a manner as to show that they lived in the sea when the volcanic eruptions were in progress, as many of the Val di Noto lavas

* See above, vol. i. chap. xxii.

in Sicily, before described, were shown to be contemporaneous with newer Pliocene strata*.

Auvergne—Velay.—We believe that part of the volcanic eruptions of Auvergne took place during the Miocene period; those, for example, which cover, or are interstratified with the alluviums mentioned in this chapter, and some of the ancient basaltic cappings of hills in Auvergne, which repose on gravel characterized by similar organic remains. A part also of the igneous rocks of Velay belong to this epoch, but to these we shall again refer when we treat more fully of the volcanic rocks of Central France; the older part of which are referrible to the Eocene period.

* Sedgwick and Murchison, Geol. Trans. Second Series, vol. iii. p. 400.—Daubeny, Extinct Volcanos, p. 92.
