

facilities for maritime activity are exceptionally great. That so small a part of the total belongs to the Arctic Ocean, which lies ice-bound during many months of the year, and so large a part to the Mediterranean, with its comparative freedom from winter and storm, has been of no small importance to the progress of the European peoples.

The coast-line of Europe is in its general features very much the same as it was at the commencement of the true historic period; but when it is examined in detail it is found to have undergone a number of important local changes, some at least of which are due to causes that are at work over very extensive areas. These changes may be conveniently classified under four heads:—the formation of deltas by the alluvium of rivers; the increase of the land-surface due to upheaval; the advance of the sea by reason of its own erosive activity; and the advance of the sea through the subsidence of the land. The actual form of the coast, however, is frequently due to the simultaneous or successive action of several of the causes—sea and river and subterranean forces helping or resisting each other. Our information is naturally most complete in regard to the Mediterranean coasts, as these were the best known to our first book-writing nations. There we find that all the great rivers have been successfully at work—more especially the Rhone, the Ebro, and the Po. The activity of the Rhone, indeed, as a maker of new land, is really astonishing. The tower of St Louis, erected on the coast in 1737, is now upwards of four miles inland; the city of Arles is said to be nearly twice as far from the sea as it was in the Roman period. The present St Gilles was probably a harbour when the Greeks founded Marseilles, and Aigues Mortes, which took its place in the Middle Ages, was no longer on the coast in the time of St Louis. According to a calculation quoted by M. Reclus, the total alluvium of the river in the space of a year is 17,000,000 cubic metres, or 590,000,000 cubic feet; and this estimate is supported by M. Reybert, who found that the new land formed between 1841 and 1859 implied an annual deposit of nearly 19,000,000 cubic metres, or 671,000,000 cubic feet. The increase of the land is observable, not only in the immediate neighbourhood of the mouth, but round almost the whole of the gulf of Lyons, and is, of course, partly due to the alluvium of minor rivers. At the mouth of the Hérault, according to Fischer,¹ the coast advances at least two metres or about seven feet annually; and it requires great labour to keep the harbour of Cette from being silted up. The Po is even more efficient than the Rhone, if the size of its basin be taken into account. Were it not counteracted in some measure, it would soon, with the assistance of the Isonzo, the Adige, and the neighbouring streams, turn the northern part of the Adriatic into a plain. Ravenna, which was at one time an insular city like Venice, has now a wide stretch of downs partly covered with pine forest between it and the sea. Aquileia, one of the greatest seaports of the Mediterranean in the early centuries of the Christian era, is now 7 miles from the coast, and Adria, which gives its name to the sea, is 13. And this increase of the land has gone on in spite of the fact that both cities are on the northern part of an area of subsidence which apparently extends southwards along the whole Dalmatian coast. The islands on which Venice is built have sunk about three feet since the 16th century: the pavement of the square of St Mark's has frequently required to be raised, and the boring of a well has shown that a layer of vegetable remains, indicating a flora identical with that observed at present on the neighbouring mainland, exists at a depth of 400 feet below the alluvial deposits. At Zara ancient pavements and mosaics are found

¹ "Küstenveränderungen im Mittelmeergebiet," in *Ztschr. der Ges. für Erdkunde zu Berlin*, 1878.

below the sea-level, and the district at the mouth of the Narenta has been changed into a swamp by the advance of the sea. A process of elevation, on the other hand, is indicated along nearly all the coasts of Sicily, round the bay of Naples and the bay of Gaeta, at the southern end of Sardinia, the east of Corsica, and perhaps in the neighbourhood of Nice. The borings of pholads are found at a height of 600 feet on Monte Pellegrino; the ancient harbour which gave its name to Palermo (Panormus) is now nearly covered by the modern town; and the Grotto of San Ciro, which now lies 6000 feet inland, and at a height of more than 220 feet, must have had a direct communication with the sea during the period of human occupation. That the rise thus rendered evident is taking place over a wide area is shown by similar facts observed on the African coast. The Tunisian harbour of Porto Farina, which had a depth of 30 or 40 feet in last century, can hardly be trusted for 2; and this change can only be very partially due to the action of the Medjenda river, as it brings down but little alluvium. If the movement be maintained the Mediterranean will again be divided into two basins by the old ridge between Sicily and Africa whose existence has been posited to explain the present distribution of zoological fossils. Passing eastward to the Balkan peninsula, we find considerable changes on the coast-line of Greece; but as they are only repetitions on a smaller scale of the phenomena already described, it is sufficient to indicate the Gulf of Arta and the mouth of the Spercheus as two of the more important localities. The latter especially is interesting to the historian as well as to the geologist, as the river has greatly altered the physical features of one of the world's most famous scenes—the battle-field of Thermopylae.

If we proceed to the Atlantic seaboard we observe, as we might expect, great modifications in the embouchures of the Garonne and the Loire, but by far the most remarkable oscillations of sea and land have taken place in what are emphatically the Low Countries of Europe. It is one of the familiar facts of geography that a large part of the soil of Holland with its villages and cities is many feet below the level of the sea; but it is not so generally known that about a fifth of the area of the country is thus situated. The story of the contest carried on along the coast between man and nature has often been told, and is well worth the telling. If success is to be measured by the amount of territory acquired, nature has hitherto had the best of the battle, and no wonder, if it be true that the very ground on which man has built his ramparts against the sea is slowly sinking under his feet. Such, at least, is the opinion of Élie de Beaumont and other geologists of note: in fact the whole maritime region from the Scheldt to the Weser is an area of subsidence. The Dutchman, however, does not intend to give up the contest. It was only in 1395 that he finally lost possession of the 500,000 hectares or 1,236,570 English acres of good land which are now covered by the Zuyder Zee; and he hopes to get the best part of it back again. A scheme has been proposed by which the whole southern portion, with an area of 195,000 hectares (481,872 acres) will be inclosed by a dyke extending from Enkhuizen to Kampen; and the feasibility of the enterprise is sufficiently attested by the brilliant success of the Haarlem engineers who, at a cost of less than £765,000, have recovered the area of the Haarlem Lake which had been lost in the 16th century. Further east along the coast, between the Elbe and the Eider, it is hard to say whether land or sea is gaining: on the one hand it is stated that the ruins of the castle of chlei are now covered by the sea, and that a forest of historic identity is totally destroyed; while on the other it is equally certain that the parish of Busum in the north part of Ditmarsh was made land-fast only in the 16th century, that the Friedrich Koog, an area of new alluvial land five

miles long and two miles broad, was endyked in 1853, and that islands are being formed further out towards the sea.

The Baltic shores of Germany display the same phenomena of local gain and loss; and there is more than a suspicion that the whole line lies along an area of subsidence. In the western section the inroads of the sea have been very extensive: the island of Rügen would no longer serve for the disembarkation of an army like that of Gustavus Adolphus; Wollin and Usedom are growing gradually less; large stretches of the mainland are fringed with submerged forests; and at intervals the site of well-known villages is occupied by the sea. Towards the east the great rivers are successfully working in the opposite direction. In the gulf of Dantzic the alluvial deposits of the Vistula cover an area of 1600 square kilometres or 615 square miles; in the 13th century the knights of Marienburg inclosed with dykes 900 sq. kil., or 346 sq. m., and 180 sq. kil., or 69 sq. m., were added in the course of the 14th. The Memel is silting up the Kurische Haff, which, like the Frische Haff, is separated from the open sea by a line of dunes comparable with those of the Landes in France.

A large amount of evidence has gradually accumulated in favour of the hypothesis that the Scandinavian peninsula is in process of elevation. Within the last two centuries fiords have been left dry or broken into lakes, reefs have been turned into islands, bays into pasture grounds. M. Reclus has pointed out that the presence of certain beds of oysters goes to show that the lakes Malar, Hjelmars, and Wener are remains of a channel which at no distant date communicated between the Baltic and the North Sea; but the facts of marine distribution, as stated by Forbes, are rather against the opinion of Celsius, that there was also a connexion with the Arctic Ocean as late as the time of the first Roman exploration. At Pitea, in the Gulf of Bothnia, the land is said to have gained a mile in 45 years, and at Lulea a mile in 28 years.¹

It is only right, however, to mention that the statements made in the preceding paragraphs in regard to areas of subsidence and elevation are by several geologists considered to be of very dubious validity. The data, they believe, are much too slight and fragmentary for the conclusions, and some of the most important are open to quite different interpretations. The so-called strand or coast-lines of the Scandinavian peninsula, for example, are still the subject of keen controversy among northern investigators, and a large polemical literature is the result. Till the question as to the origin of these remarkable appearances is finally settled, the recent elevation of the peninsula must be regarded as little more than a provisional hypothesis.²

The changes briefly indicated above take place so gradually for the most part that it requires careful observation and comparison of data to establish their reality. The Dutchman does not feel the subsidence of his well-defended flats, and the Norwegian is quite unconscious that he is being raised along with his pine-clad hills. It is very different with those changes which we usually ascribe to volcanic agency: they force themselves on the attention, and find a permanent place in the memory of the people. And yet it is only the scientific registration of the phenomena which gives any accurate idea of their frequency and extent. To the popular apprehension Europe is a fairly stable portion of *terra firma*, and we are accustomed to contrast the uncomfortable tendency to

¹ Compare Howorth "On Recent Elevations of the Earth's Surface in the Northern Circumpolar Region," in *Jour. Roy. Geog. Soc.*, 1873, and Adolf von Hoff, *Gesch. d. Veränd. d. Erdoberfläche*, 1822, 1823, 1834.

² Compare Keilhau *On the Rise of Land in Scandinavia*; Kjerulf, *Om Skrivingsmærke, &c., i Norge*, 1872; Sexe, *Om gamle Strandlinier & faste Klippe*, 1872.

oscillation exhibited by such a region as Colombia or Peru in South America. But it is not so stable as it appears. Besides the great outlying "hearth" of Iceland, there are four centres of volcanic activity in Europe—all of them, however, situated in the Mediterranean. Vesuvius on the western coast of Italy, Etna in the island of Sicily, and Stromboli in the Liparian group, have been familiarly known from the earliest historic times; but the fourth has only attracted particular attention since last century. It lies in the Archipelago, on the southern edge of the Cyclades, near the little group of islets called Santorin. The region was evidently highly volcanic at an earlier period, for Milo, one of the nearest of the islands, is simply a ruined crater still presenting smoking solfataras and other traces of former activity. The present crater of Santorin is subaqueous, but it has already raised a considerable mass of material above the surface. The devastations produced by the eruptions of the European volcanoes are usually confined within very narrow limits; and it is only at long intervals that any part of the continent is visited by a really formidable earthquake. There is little danger when the tremor has to be verified by glass cylinders on a sanded floor. Minor shocks, however, are exceedingly numerous. Dr Volger found that during the first fifty years of the 19th century the average number per annum was, in Switzerland, no less than fifty; and he indicates the following localities as *habituellen Stossgebiete* or areas of frequent disturbance:—(1) in the region of the Jura, the valley of the Birs to the S. of Basel, the valley of the Orbe, the Val de Travers, the valley of St Imier, the district at the confluence of the Aar and the Limmat, &c.; and (2) in the Alpine region, the valley of the Durance and the Drac, of the Arc and the Isère; nearly the whole line of the Arve, the upper valley of the Rhone almost without interruption to the Lake of Geneva, part of the valley of Adige to the S. of Trent, and the valleys of the Drave and the Gail to the W. of their confluence. A table drawn up by Dr Suess registers about 116 earthquakes in Lower Austria from 1021 down to 1870, and of these 53 belong to the present century.³ Of all European earthquakes in modern times, the most destructive are that of Lisbon in 1755, and that of Calabria in 1783; the devastation produced by the former has become a classical instance of such disasters in popular literature, and by the latter 100,000 people are said to have lost their lives. Calabria again suffered severely in 1865 and 1870.

If Russia be left out of account, Europe may be generally characterized as a mountainous region,—the ratio of highlands and lowlands being, according to Von Klöden's calculation, approximately as follows:

	Total Area. English sq. miles.	Highlands. English sq. miles.	Lowlands. English sq. miles.
Continental portion, without peninsulas and islands ... }	2,740,100	587,412	2,152,688
Greater peninsulas	835,715	641,286	194,429
Great Britain and Ireland.....	115,913	60,125	55,788
Other islands	64,738	47,857	16,881

In other words, the purely continental portion has 21.44 per cent. of highlands to 78.56 per cent. of lowlands; the peninsular portion 76.74 per cent. to 23.26 per cent.; Great Britain and Ireland 51.87 per cent. to 48.13 per cent.; and the remaining islands 73.92 to 26.08. There are none of the individual mountains that attain more than a moderate elevation if they are compared with the mountains of Asia and South America. Mont Blanc, the loftiest of all, has an altitude of only 15,781 feet, while M. Everest, in

³ See *Zeitschrift der K. Akademie zu Wien*, 1874 and 1875, and Petermann's *Mittheilungen*, 1856.

the Himalayas, is 29,000 feet high, and Chimborazo and Aconcagua, in the Andes, are respectively 20,677 and 23,910.

The whole continent is formed on a small scale of relief, though this scale is not so small as has usually been stated on the authority of Humboldt. The mean elevation of Asia, according to his calculations, was 351 metres (1151 E. ft.); of South America, 344 metres (1128 E. ft.); of North America, 227 metres (744 E. ft.); and of Europe only 204 metres (669 E. ft.). In 1874 Dr. Gustav Leipoldt published the results of a new calculation, which, being carefully conducted and based on a much more extensive collection of data, must replace the estimates of Humboldt. The following is a table of his principal findings, giving an average of 296.838 metres, or 973.7 English feet:—

Leipoldt's Table of Mean Elevation.

	Metres.	Eng. Ft.
Switzerland.....	1299.91	4264.74
Iberian Peninsula (Spain and Portugal).....	700.60	2298.52
Balkan Peninsula (Turkey and Greece).....	579.50	1901.21
Austria.....	517.87	1699.02
Apennine Peninsula (Italy).....	517.17	1696.73
Scandinavia.....	428.10	1404.51
France.....	393.84	1292.11
Roumania.....	282.28	926.19
Great Britain.....	217.70	714.22
German Empire.....	213.66	700.97
Russia.....	167.09	548.18
Belgium.....	163.36	535.95
Denmark.....	35.20	115.48
Netherlands, excluding Luxembourg and parts below sea-level.....	9.61	31.52

If the materials which are employed in producing the relief of the various countries were equally distributed over the surface of the continent, their respective contributions would arrange them in the following order:—

	Metres.	Eng. Ft.
Russia would raise the continent.....	90.46	296.7
The Iberian Peninsula.....	48.24	158.0
Scandinavia.....	33.22	108.9
Austria.....	32.87	107.8
The Peninsula of the Balkan.....	26.68	87.5
France.....	21.19	69.5
The Peninsula of the Apennines.....	15.62	51.2
The German Empire.....	11.91	39.0
Great Britain.....	7.05	23.1
Switzerland.....	5.40	17.7
Denmark and Iceland.....	5.11	16.7
Roumania.....	3.48	11.4
Belgium.....	0.49	1.6
Netherlands.....	0.19	0.6
Total.....	296.83	973.7

It is noticeable that Russia stands first on the list on account of its immense area, in spite of the fact that its mean elevation is less than that of nearly every other country.

The central ridge of Europe is formed by a complex of from thirty to fifty distinct *massifs*, which from time immemorial have borne the name of the Alps, or, if the usual etymology be correct, the White Mountains. They are closely grouped together over an area of about 74,000 or 75,000 square miles, extending from 5° to 16° E. long., and curving round from the Gulf of Lyons to the neighbourhood of Vienna. According to Dr. Leipoldt, if the material of which they are composed were equally distributed over the surface of the continent it would raise the level 27.23 metres, or 89 English feet. Mount St Gotthard, situated in 8° 36' E. long., is usually considered as the central *massif*; but instead of being, as was long supposed, the highest part of the system, and consequently of

the European continent, it is really overtopped by a large number of the other groups. The honour of being the loftiest summit is now, as already stated, assigned to Mont Blanc, which, in its terminal peak, named Dufour Spitz, in memory of the great surveyor of Switzerland, reaches a height of 15,781 feet. In general the mountains of the western parts of the range are loftier and more closely ranked, while those towards the east not only diminish in height but spread out over a wide area; and on the whole the southern sides are steeper than the northern. Full details of the intricate divisions of the Alps are given in a separate article. As the birth-place of its mightiest rivers, the natural barrier between its mightiest peoples, a prime factor in the distribution of its climates, and in modern times the noblest of all international "play-grounds," the Alps act a part of multifarious munificence in the economy of the continent.

With the exception of the Pyrenees and its dependencies, all the mountains of southern and central Europe may be regarded as secondary portions of the general Alpine system. If it were possible with more than human reach of sight to take an outlook northwards from some commanding peak on the northern skirts of the great chain, the whole country for two hundred miles and more would appear occupied by irregular lines and groupings of mountains and hills rising from a kind of table-land, and intersected by the deep-cut valleys of the larger rivers. Towards the north-west the most conspicuous heights are those of the Jura proper, which runs parallel with the Alps, and is only separated from them by the valleys of the Rhone and the Aar, the latter a main tributary of the Rhine. The German Jura trends north-east, the Black Forest north from the eastern extremity of the Jura proper, and fronting the Black Forest on the other side of the Rhine lie the Vosges. Further north the Rhine valley is defined on the west by the Harzt, the Hochwald, the Eifel, and the Ardennes; and on the east by the Odenwald, the Westerwald, and the Taunus. North of the German Jura lie the Franconian heights, which are separated by the valley of the Main from the Spessart, the Rhön, and the Thüringerwald. From the Thüringerwald south-east run the successive clusters of the Frankenwald and the Fichtelgebirge; and from this last *massif* eastward extends the Erzgebirge as far as the valley of the Elbe, and south-eastwards the Böhmerwald, along the valley of the Danube. Beyond the Elbe, and forming the eastern rim of the upper basin, are the Riesengebirge and the so-called Sudetic chain, which, by its southern extremity, approaches the Carpathian mountains; and these again, in company with the Transylvanian mountains, curve south and enclose the great Hungarian plain. The Balkan to the south of the Danube is practically on the one hand a continuation of the Transylvanian range, and on the other it is connected by the mountains of Carinthia, Dalmatia, Bosnia, and Servia with the eastern extremity of the Alps. The Apennines are still more closely connected with the western extremity, and the mountains of Auvergne and the Cevennes in France may also be regarded as outliers of the system.

Several of the ranges, however, are sufficiently distinct in position and general characteristics to be treated apart. The Apennines form an uninterrupted chain extending south to the Straits of Messina. Their mean height varies from 2600 feet in one part to 6400 in another; and among the loftiest peaks are Monte Cimone, 7060; Alpe di Camporaghena, 6537; Monte Sibilla, 7188; Gransasso, 9493; La Majella, 9314; Monte Pollino, 7441; and Aspromonte, 6375. The Carpathians are about 520 miles long, and attain their greatest elevation in Butschetie, which has an altitude of 9528 feet. The declivities of the range are steepest on the southern side. The Balkans, or Hamus, run 400 miles east and west to the south of the Danube valley.

Their mean elevation is about 5000–5600 feet; but it is only from the southern side that they present a really mountainous appearance; on the northern they gradually descend by a succession of terraces, and, with few exceptions, the summits have gently rounded contours. The culminating point is Tchar Dagh, which rises to a height of about 9700 feet. Connected with the Balkans by its western extremity is the range of the Despoto Dagh, or Rhodope, which stretches eastward along the north of the Ægean, and in some points reaches a height of 8000 feet. Nearly the whole country to the south in Thessaly and Greece is occupied by irregular groups and lines of mountains and hills, among which the most important are the Pindus and Olympus. Besides the Alpine system and the secondary systems which are grouped along with it, there are several others rendered quite distinct by their position and structure.

The Pyrenees are next to the Alps in elevation. They extend across the isthmus between France and Spain for a distance of 240 miles, and are practically continued by the Cantabrian Mountains for 260 miles more. The loftiest summit, Mont Perdu, has an altitude of 11,270 feet. The south side of the Pyrenees proper is the more rugged and precipitous; but the Cantabrian Mountains present their steepest face to the north. All the minor mountain ranges of Spain are connected with each other and with the Pyrenees. The highest is the Sierra Nevada in the south. The chain of the Dovre-Fjeld, Dofrines, or Scandinavian Alps is about 1000 miles in length, and has a general elevation of from 3000 to 6000 feet. Properly speaking, it is not so much a range of mountains as a plateau, broken up by deep-cut ravines and fords. The western side is precipitous, and the eastern descends gradually to the Gulf of Bothnia. The Urals extend from north to south through 20° of latitude, with a breadth of about 40 miles. They rise slowly from the plain on both sides, and at the place where they are crossed by the road from Moscow to Siberia the ascent and descent is hardly noticeable. A considerable proportion of the range lies between 3000 and 4000 feet above the sea; a few peaks attain an altitude of 5000; and one, Toll-pors, is not much under 5500.¹

If the European mountains are arranged according to their greatest elevations, they rank as follows:—(1) the Swiss Alps, with their highest peaks 15,000 feet or upwards; (2) the Sierra Nevada, the Pyrenees, and Etna, about 11,000 feet; (3) the Apennines, the Corsican Mountains, the Carpathians, the Balkans, and the Despoto Dagh, from 8000 to 9000; (4) the Guadarrama, the Scandinavian Alps, the Dinaric Alps, the Greek Mountains, and the Cevennes, between 6000 and 8000; (5) the mountains of Auvergne, the Jura, the Riesengebirge, the mountains of Sardinia, Majorca, Minorca, and the Crimea, the Black Forest, the Vosges, and the Scottish Highlands, from 4000 to 6000.

The table given on page 686 furnishes a comparative view of the principal European streams taken in the order of their length.

In various parts of Europe, more particularly in calcareous regions, there are subterranean or partially subterranean rivers. Of these the most remarkable are the Sorgue of Vaucluse, the Touvre of Angoulême, the Timavo of Istria, and the Poik or Planina. The first has been traced for 10 or 15 miles below ground; and the Timavo when it issues from the mountain is already navigable. Along the French coast several subterranean affluents of the Mediterranean have been discovered, and some of them are evidently of considerable size. The Garonne itself, which rises in the glaciers of Mount Maladetta, passes

¹ Cf. "Profil des Ural-Gebirges," in *Zeitschr. für Erdkunde zu Berlin*, 1858.

under Mont Poumar for a distance of 4 kilometres. The subterranean course of the streams is frequently indicated by peculiar vents or pits caused by the subsidence of the soil; they are popularly known in Greece as *cataothra*, in Carinthia as *dolinas*, and in France by a great number of local names, such as *embucs*, *gourgs*, *boit-tout*, *anselmons*, &c.²

Europe has no Niagara, and, indeed, few of its larger rivers present anything approaching to a real cataract. The Rhine takes a plunge of about 50 feet at Schaffhausen; and there are a series of rapids in the lower course of the Dnieper and the Dniester. In Sweden the Gotha-Elf falls 100 feet at Trollhata; the Hjommel Sayka or Hare's leap of the Lulea is 250 feet high; and the Riukan Fos or "Smoking Force" at Mjös vand is no less than 800. The famous Staubbach in the neighbourhood of Lauterbrunnen has a descent of 980 feet, but it is a mere brook, and in summer almost dries up; it takes its name, as is well known, from the dust-like appearance of the spray into which the water is changed by the tremendous descent.

Several of the more important rivers are of very irregular flow, and some are subject to really formidable floods. In 1877 there were disastrous inundations of the Danube: 12,000 people were rendered homeless in one of the suburbs of Buda Pesth, hundreds of houses were undermined, while villages were submerged, and large quantities of property were swept away. The floods in the Netherlands the same year were severe enough to necessitate Government help for the sufferers. Large areas in Saxony and Silesia were under water; the Elbe, the Vistula, the Nogat, and the Oder, all overflowed their banks or burst their dikes; it was feared that the whole line of railway between Thorn and Posen would be carried away; and in some districts there was considerable loss of life. If all the damage produced in this way since the beginning of the century could be calculated, it would be found to represent an enormous sum. The floods of the Loire alone, in 1856, carried off about £8,000,000 worth of property; and those in the south of France in 1875 caused a loss of about £3,000,000. In most Continental countries there have been consequently undertaken extensive engineering works, partly to prevent inundations, and partly to render the rivers more serviceable for navigation and irrigation. France has been especially active in this matter, several of her most important streams being very difficult to regulate. The Loire, for example, varies at Orieans from 25 cubic metres or 780 feet per second to 10,000 metres or 315,000 feet in the same time; the Saône, in 1855, varied from 3,825,450 cubic feet per minute to 174,036; and the Rhone at Geneva, in 1858, which was a minimum year, from 740,000 cubic feet to 195,000.³ The engineering works have been especially successful on the Seine and Yonne, where several new methods have been tested for storing the surplus water of one season, and utilizing it during the period of deficient supply.⁴ In Italy the Po, the Arno, and the Tiber are notorious for their floods; but the first two are now among the most striking examples of a satisfactory system of embankment. At Cremona, on the Po, which is 171 miles inland and 104 feet above sea-level, the flood of 1840 rose 18 feet, that of 1855 rose 19 feet, and that of 1857 20 feet, above summer low-water. On the last occasion the banks above Cremona were burst, and a vast area of country was submerged; but such a disaster is now comparatively rare. For the irrigation of the Lombard plain no less than 762,838 cubic feet per minute are drawn off by the canals.

² See E. Reclus, *La Terre*, vol. i.

³ See Beardmore's *Manual of Hydrography*, 1862.

⁴ See Blerzy, "Études sur les travaux publics," in *Revue des Deux Mondes*, 1876.

Comparative View of the Principal European Rivers taken in the Order of their Length. (Based on Glogau's Table.)

Name of River.	Source.	Mouth.	Direct distance of source from mouth.	Development. Eng. miles.	Basin Area. Eng. sq. miles.
1. Volga.....	Russia, Tver.....	Caspian Sea.....	1005	2130	517,272
2. Danube.....	Baden, Black Forest.....	Black Sea.....	1014	1613	299,435
3. Ural.....	Russia, Orenburg.....	Caspian Sea.....	604	1309	90,889
4. Dnieper.....	Russia, Smolensk.....	Black Sea.....	650	1272	193,195
5. Don.....	Russia, Tula.....	Sea of Azoff.....	470	1185	170,638
6. Petchora.....	Russia, Perm.....	Arctic Ocean.....	438	1120	117,996
7. Kama.....	Russia, Viatka.....	Volga.....	207	1050	188,795
8. Oka.....	Russia, Orel.....	Volga.....	428	931	87,168
9. Rhine.....	Switzerland, Grisons.....	North Sea.....	438	853	65,057
10. Theiss.....	Hungary, Marmaros.....	Danube.....	285	843	54,980
11. Dwina and Suchona.....	Russia, Vologda.....	White Sea.....	438	788	142,701
12. Elbe.....	Bohemia, Riesengebirge.....	North Sea.....	387	723	58,743
13. Vistula.....	Silesia, Teschen.....	Baltic.....	322	696	69,309
14. Dniester.....	Austria, Galicia.....	Black Sea.....	424	682	27,553
15. Viatka.....	Russia, Viatka.....	Kama.....	212	608	46,560
16. Weser.....	Hanover.....	North Sea.....	207	599	15,966
17. Desna.....	Russia, Smolensk.....	Dnieper.....	290	594	34,250
18. Loire.....	France, Ardeche.....	Bay of Biscay.....	345	594	41,670
19. Meuse.....	France, Haute Marne.....	North Sea.....	272	557	14,669
20. Oder.....	Austria, Moravia.....	Baltic.....	331	553	46,922
21. Khoper.....	Russia, Samotoff.....	Don.....	248	546	22,536
22. Marosch.....	Austria, Transylvania.....	Theiss.....	258	544	16,540
23. Tagus.....	Spain, Aragon.....	Atlantic.....	420	540	34,000
24. Ebro.....	Spain, Santander.....	Mediterranean.....	308	539	31,444
25. Rhone.....	Switzerland, Valais.....	Mediterranean.....	285	525	36,781
26. Dwina.....	Russia, Pskoff.....	Baltic.....	322	521	27,000
27. Guadiana.....	Spain, La Manche.....	Atlantic.....	276	511	23,322
28. Niemen.....	Russia, Minsk.....	Baltic.....	276	493	36,355
29. Southern Bug.....	Russia, Podolia.....	Black Sea.....	273	474	21,983
30. Drave.....	Austria, Tyrol.....	Danube.....	327	447	15,562
31. Douro.....	Spain, Soria.....	Atlantic.....	299	447	53,525
32. Save.....	Austria, Illyria.....	Black Sea.....	345	442	34,654
33. Seine.....	France, Côte d'Or.....	English Channel.....	253	438	26,767
34. Warthe.....	Russia, Poland.....	Oder.....	248	428	19,411
35. Sereth.....	Austria, Galicia.....	Danube.....	225	410	19,347
36. Western Bug.....	Austria, Galicia.....	Vistula.....	212	401	22,663
37. Pripiat.....	Russia, Volhynia.....	Dnieper.....	281	396	44,498
38. Po.....	Italy, Saluzzo.....	Adriatic.....	267	391	28,723
39. Pruth.....	Austria, Galicia.....	Danube.....	262	391	6,803
40. Donetz.....	Russia, Kursk.....	Don.....	303	373	38,481
41. Mesen.....	Russia, Vologda.....	Arctic Ocean.....	207	373	28,234
42. Guadalquivir.....	Spain, Jaen.....	Atlantic.....	202	364	19,836
43. Garonne.....	France, Hautes Pyrénées.....	Bay of Biscay.....	216	359	31,465
44. Mologa.....	Russia, Tver.....	Volga.....	156	336	60,805
45. Aluta.....	Austria, Transylvania.....	Danube.....	207	336	8,142
46. Laeselle.....	France, Vosges.....	Rhine.....	170	322	11,204
47. Inn.....	Switzerland, Grisons.....	Danube.....	230	313	9,397
48. Dal-Elf.....	Sweden, Koppaberg.....	Baltic.....	225	308	12,756
49. Maine.....	Bavaria, Upper Franconia.....	Rhine.....	156	304	10,205
50. Manytch.....	Russia, Astrakhan.....	Don.....	285	299	21,260
51. Glommen.....	Norway, South Drontheim.....	Skagerrack.....	235	299	18,220
52. Umeo.....	Sweden, Umeo-Lappmark.....	Gulf of Bothnia.....	143	290	11,098
53. San.....	Austria, Galicia.....	Vistula.....	119	290	6,123
54. Torneo.....	Sweden, Torneo-Lappmark.....	Gulf of Bothnia.....	235	281	8,823
55. Adige.....	Austria, Tyrol.....	Adriatic.....	147	281	5,038
56. Körösch.....	Austria, Transylvania.....	Theiss.....	147	276	8,355
57. Mur.....	Austria, Salzburg.....	Drave.....	175	272	5,655
58. Maritza.....	Turkey, Bulgaria.....	Ægean.....	156	267	19,839
59. Onega.....	Russia, Olonetz.....	Arctic Ocean.....	161	262	21,622
60. Moldau.....	Austria, Bohemia.....	Elbe.....	101	262	9,652
61. Ems.....	Lippe-Detmold.....	North Sea.....	133	258	4,719
62. Moskva.....	Russia, Smolensk.....	Oka.....	165	248	31,125
63. Clara-Elf.....	Norway, Hedemarken.....	Wener Lake.....	202	248	7,292
64. Waag.....	Hungary, Lipptau.....	Danube.....	115	248	2,912
65. Beresina.....	Russia, Minsk.....	Dnieper.....	189	244	8,504
66. Saône.....	France, Vosges.....	Rhone.....	170	239	10,247
67. Scheldt.....	France, Aisne.....	North Sea.....	183	239	7,526
68. Tiber.....	Italy, Tuscany.....	Mediterranean.....	180	230	6,122
69. Pitea.....	Sweden, Pitea-Lappmark.....	Baltic.....	193	225	15,668
70. Ljusna-Elf.....	Sweden, Jemtlands Lan.....	Baltic.....	184	225	8,822
71. Saale.....	Bavaria, Upper Franconia.....	Elbe.....	105	220	9,141
72. Neckar.....	Württemberg, Black Forest.....	Rhine.....	101	216	5,357
73. Morava.....	Austria, Moravia.....	Danube.....	138	211	10,034
74. Marava.....	Turkey, Bulgaria.....	Danube.....	170	207	6,390
75. Netze.....	Prussia, Poland.....	Warthe.....	170	207	4,613
73. Thames.....	England, Gloucester.....	German Ocean.....	110	202	5,102

Since the city of Rome has again become the capital of Italy the attention of the Italians has been specially turned to the Tiber, and several schemes of Herculean magnitude have been discussed. Garibaldi's project was adopted by both houses of the Parliament and sanctioned by the Government in 1875. During the present century the Danube, which is the most international of European rivers, has been greatly improved as a water-way, by the rectification of its course in the neighbourhood of Vienna, by the clearing of the passage of the Iron Gates, and by the maintenance of a proper channel at the delta. It is almost needless to mention the works that have been carried on for the deepening of the seaward section of all the greater rivers, and the removal of the bars at their mouths; perhaps in this department the most remarkable results are exhibited by the Clyde.

Lakes.

In the accompanying table, for which we are indebted to Glogau, the principal lakes of Europe are arranged according to their size. If we examine their distribution we find they can easily be classified into groups. The

Name of Lake.	Country.	Height above sea. English ft.	German sq. miles.	English sq. miles.	
Ladoga.....	Russia.....	...	413-00	8780-66	
Onega.....	".....	...	228-39	4855-73	
Wener.....	Sweden.....	140	39-30	2115-43	
Pelpus.....	Russia.....	96	21-31	1090-88	
Enare.....	".....	405	49-70	1056-65	
Saima.....	".....	256	47-30	1005-63	
Sivosh.....	".....	...	45-00	966-73	
Paiyanne.....	".....	261	42-28	898-47	
Weizer.....	Sweden.....	282	35-40	732-62	
Mälär.....	".....	123	25-25	536-83	
Ricel Ozero.....	Russia.....	33	21-40	454-97	
Segosero.....	".....	...	21-39	454-76	
Imandra.....	".....	...	19-90	423-08	
Pielis.....	".....	...	304	19-30	414-63
Wygosero.....	".....	...	19-10	406-07	
Platton.....	Hungary.....	...	457	18-00	582-69
Uleo.....	Russia.....	...	390	17-30	367-81
Ilmen.....	".....	...	107	16-79	336-96
Stora Luleo-Wattner.....	Sweden.....	...	16-30	330-86	
Stor Afvan.....	".....	...	843	14-90	3167-8
Pakoff.....	Russia.....	...	14-32	304-45	
Geneva.....	France and Switz-land.....	1230	11-20	238-11	
Torneo.....	Sweden.....	1342	9-60	204-10	
Stor Sjö.....	".....	984	9-10	193-47	
Boden-See.....	Germany.....	1305	8-92	189-64	
Hjelmar.....	Sweden.....	92	8-90	189-22	
Neargh.....	Ireland.....	545	8-20	174-33	
Garda.....	Italy.....	48	7-22	153-60	
Mjösen.....	Norway.....	227	6-60	140-32	
Neusiedler.....	Hungary.....	411	6-50	138-19	
Scutari.....	Turkey.....	367	5-50	116-92	
Virzyara.....	Russia.....	...	2-34	113-51	
Neufchatel.....	Switzerland.....	115	4-96	105-45	
Yalpukh.....	Roumania.....	1426	4-36	92-69	
Lago Maggiore.....	Italy.....	...	4-17	88-65	
Seliger.....	Russia.....	646	3-70	78-66	
Corrib.....	Ireland.....	918	3-62	76-56	
Lago di Como.....	Italy.....	30	3-20	68-03	
		700	2-90	61-65	

Alpine lakes break up into a southern and northern subdivision—the former consisting of Lago Maggiore, Lago di Como, Lago d'Isèo, and Lago di Garda, all connected by affluents with the system of the Po; and the latter the lake of Geneva threaded by the Rhone, Lakes Constance, Zurich, Neufchatel, Biel, and other Swiss lakes belonging to the basin of the Rhine, and a few of minor importance belonging to the Danube. As factors in the historical development of the Alpine countries the first rank must be assigned to Geneva, Constance, and Como. Next in interest to the Alpine group comes the Swedish—Wener, Wetter, Mälär, and Hjelmar, lying between the Baltic Sea and the Skagerrack, and nearly as famous as their Scotch and English rivals for the beauty of their scenery. The North Russian lakes, Ladoga, Onega, &c., are mainly noticeable as the largest members of what in some respects is the most remarkable system of lakes in the continent—the Finno-Russian, which consists of an almost countless number of comparatively small irregular basins formed in the surface of a granitic plateau. In Finland proper they occupy no less than a twelfth of the total area. It is impossible to take individual

account of the multitudinous small lakes that diversify the surface of every country in Europe, with the partial exception of Spain; but their influence on the climate and hydrography of the continent must not be overlooked. All of them help to increase the area of evaporation, and many even of those which are almost nameless act as reservoirs for rivers. Nearly all the rivers of Sweden, for example, have their origin in a lake or tarn; and the same is the case with many of the streams of the northern Pyrenees. The total area of the lakes given in the table is no less than 28,450 square miles, or about the united area of the Netherlands and Switzerland.

A few of the number are very shallow. The Neusiedler See, for example (the Peiso Lacus of the Latins and Fertótava of the Hungarians), completely dried up in 1864, and left its bed covered for the most part with a deposit of salt.¹ Others not mentioned in the table have been partially or completely drained by human labour. The Copais in Bœotia was attacked by Greek engineers as early as the time of Alexander the Great; but the tunnels which they constructed to carry off its waters have been choked up, and the lake is again in a state of nature. Lake Fucino or Lago Celano, in the Abruzzo in Italy, was doomed to destruction by the emperor Claudius; but the works which he constructed proved ineffectual, and it was not till 1862 that a large part of the basin was turned into dry land. The progress of agriculture has greatly diminished the quantity of marsh land in Europe, and there are only one or two really extensive regions which deserve the name. Most important of all are the Minsk marshes in Russia, and on these large encroachments are gradually being made. The draining of the Pomptine marshes in Italy made Pope Pius VII. famous in the 18th century; and at the present moment those of Ferrara are sharing the same fate.

Geologists have as yet come to no agreement regarding the origin of the principal mountain ranges, and still less do they furnish a consistent and connected history of the shaping of the continent. It will consequently be sufficient to indicate the general distribution of the various formations, and the more important basins of deposition for the sedimentary rocks.² The typical basin is that which takes its name from Paris: in it the successive stratifications are arranged in an exceptionally symmetrical manner. To the south-east lies the basin of Bordeaux, separated by a plateau of granite and gneiss; to the north, on the other side of the Channel, the London basin; and to the north-east the basin of the lower Rhine. Further east comes the basin of the lower Weser, divided into two almost independent portions by the Harz mountains; and to the south-east is the Prague basin, which presents only fragmentary remains of its sedimentary deposits. Nearly the half of European Russia belongs to the Moscow basin, which, in the south-east, is conterminous with the probably more modern basin of the Caspian. The whole of the south of the continent, from the Pyrenees to the Caucasus, belongs to the Mediterranean basin, which is one of the greatest in the world, and has its northern limit marked by the Cevennes, the Jura, the Thüringerwald, the Böhmerwald, and the Arratynne plateau. The total surface area occupied by the plutonic and metamorphic rocks is far from inconsiderable; but, with the exception of the great mass of the Scandinavian peninsula, Finland, and Lapland, and the long line of the Urals, the individual portions are of comparatively small extent. In the Spanish peninsula they stretch from Corunna south to the Tagus, appear again in the neighbourhood of Evora, form the western part of the Sierra Guadarrama, and rise in islets above the Silu-

Geological formations.

¹ See Ascherson, "Die Austrocknung des Neusiedler Sees," in Z. der Ges. für Erdkunde zu Berlin, 1865.
² See map in Petermann's Mittheilungen, 1873.