CHAPTER XVI.

RIVERS OF UNITED STATES.

ALMOST the entire United States is tributary to seven large river systems (Fig. 479) and a series of smaller streams, most of which flow eastward or southward into the Atlantic and Gulf. The greatest amount of drainage is into the Atlantic, including the Mississippi, which drains two fifths of the whole country; next in area is the Pacific drainage; while a small section drains into the Arctic through the Red River of the North. As has been shown in previous chapters, the river systems have been highly important factors in the development of the country. They have been a source of food; they have supplied water power; and they have served as pathways of exploration and commerce. The present chapter considers this subject more specifically.

201. The Columbia. — The Columbia rises on the western slopes of the Rocky Mountains, flows across an arid region, and enters the sea in a region of abundant rainfall. Its length is 1400 miles, and it drains over 200,000 square miles. The lower Columbia is formed by the union of two rivers, the Columbia and Snake. From the Rocky Mountains to the Cascades, both the Snake from the south and the Columbia from the north flow across a vast lava plateau (p. 125). These rivers and their tributaries have cut young canyon valleys in this plateau (Fig. 476), in some places 2000 to 3000 feet deep, out of which it is impossible to lead the water for irrigation. There are many rapids and falls, including the Shoshone Falls, so that, throughout the greater part of their course, the rivers are unnavigable.

FIG. 476. — Relief map of Washington, showing the drowned coast at Puget Sound, the Cascade Ranges, and, farther east, the broad lava plateau through which the Columbia flows. The southern boundary of the state is the Columbia, where it crosses the Cascade Ranges. (Model by S. Shedd.)

FIG. 477. — Model of the Grand Canyon of the Colorado (by E. E. Howell, Washington, D.C.).

Instead of serving as pathways, these canyon valleys are barriers to passage; but in its lower course the Columbia is an important aid to travel, for it crosses both the Cascade and Coast Ranges, thus opening gaps across these mountains, which a railway follows. Sinking of the land has admitted the tide for over 100 miles, as far as Portland; and navigation by river boats is possible up the river even above the junction of the Columbia and Snake (Fig. 481).

Large numbers of salmon pass up this river to lay their eggs, or spawn; and the catching and canning of these fish is an important industry along the lower course of the Columbia.

Summary. — *The union of the Columbia and Snake rivers makes a great river system. In their upper parts these rivers occupy canyons in a broad lava plateau, and these valleys are barriers to travel; but the lower river is navigable, opening a pathway across the mountains, and admitting ocean boats for* 100 *miles, as far as Portland.*

202. The Sacramento. — The extensive fertile valley of California (Fig. 114), between the Sierra Nevada and Coast Ranges, is drained by the Sacramento River where it crosses the mountains at the Golden Gate. Sinking of the land has admitted the sea, forming San Francisco Bay and connecting the valley of California with the sea (Fig. 350). The Sacramento is 400 miles long and has a drainage area of about 58,000 square miles. It is made by the union of two rivers which extend along the great valley, — the Sacramento from the humid north, the San Joaquin from the arid south. For some distance each is navigable to small boats.

These rivers are fed by short streams from the inclosing mountains, where they occupy canyons. At the base of the mountains these tributaries are building low alluvial fans, and are engaged in slowly filling the great valley (p. 68). Over the alluvial fans the streams flow in shallow valleys, from which water is easily led for purposes of irrigation. The water of the mountain streams is also used in hydraulic mining for washing gold from the river gravels.

Summary. — *The Sacramento, formed by union of the San Joaquin and Sacramento, is fed by small mountain streams whose water is useful for irrigation and for hydraulic mining. Breaking through the Coast Ranges at the Golden Gate, this river connects the great California valley with the ocean.*

203. The Colorado.— The Colorado River, like the Nile, has its source among mountains which supply it with so much water that it is able to flow completely across a vast stretch of arid and desert country. Its length is about 2000 miles, and it drains about 225,000 square miles, being formed by the union of two large streams, — the Grand and Green. For fully half its length the Colorado flows in canyons cut in a high plateau, which in places is over 8000 feet above sea level. The depth of the canyons varies from a few hundred feet to over 6000 feet in the Grand Canyon, which is over 200 miles long (p. 82). At the lower end of the Grand Canyon the country becomes open and the river crosses fully 300 miles of desert to the Gulf of California. In its lower course the river flows over a floodplain and delta.

Without exception the Colorado is the most remarkable river in the world (Figs. 1, 139, 477, 478). No other canyon equals the Grand Canyon in size or grandeur. For long distances it is impossible to descend to its bottom over the precipitous sides, and the canyon forms an absolute barrier to travel. It would make an excellent boundary between countries. Only by undergoing the utmost hardships and dangers is it possible to pass through the canyon, and few explorations in America have been more daring than that of Major Powell's party, which made the first descent (Fig. 139).

On both sides rise steep, impassable precipices, often from the water's edge; and the river tumbles over a succession of rapids, in which it is almost impossible for a boat to live. Here and there short tributaries enter, with slopes so steep that the occasional heavy rains wash large bowlders down them into the main stream. These form one of the chief causes for the rapids.

A mile of successive rock strata is revealed in this enormous

gash in the crust, and at their base is a buried mountain area, once dry land, now covered by a thick series of sedimentary strata. The river is flowing with so steep a slope that it is rapidly cutting its canyon deeper, and weathering is wasting back the cliffs, which form a multitude of irregular and rugged mesas, buttes, ridges, and spurs. Where hard rocks outcrop, there are steep cliffs; where weaker layers occur, the slopes are gentler; where the cliffs have wasted back, flat terraces often extend from their base; and everywhere there is a wonderful and varied coloring of the rock walls. In places, where the cliffs have wasted back, the canyon slope consists of a series of hard rock terraces with level tops and steep fronts. This is especially true of the older, upper portion where the cliffs have wasted farther back.

FIG. 478. — A view in the Marble Canyon, one of the canyons of the Colorado.

In this arid country few large tributaries enter the river, and these bring little water, for throughout most of the area the annual rainfall is less than 10 inches. All the larger tributaries are from the southern and eastern sides, because the river flows so near the edge of the arid Great Basin that tributaries from that side must be few and small. These tributaries themselves are in canyons, and between them are broad areas of tableland with many mesas and buttes, — a typical young, arid land plateau (p. 81).

Summary. — *The Colorado, fed by rains and snows from the Rocky Mountains, flows for nearly* 2000 *miles across an arid and,*

in places, a desert country, for a large part of the distance in deep canyons sunk in the plateau. The Grand Canyon has a depth of 6000 feet. Its steep sides are often impassable, and they are carved and sculptured into a great variety of forms. There are few large tributaries, and these bring little water.

204. The Great Basin. — The Great Basin, a region of interior drainage with an area of over 200,000 square miles, lies between the Rocky and Sierra Nevada mountains. It is bounded on the north by the Columbia plateau, and on the south by the Colorado plateau. A number of disconnected parts unite to form this general basin, one of them, Death Valley, being below sea level. The surface of the Great Basin is crossed by a number of short mountain ranges, known as the Basin Ranges.

The entire region is arid, and in places a true desert (Fig. 150). The short, mountain streams quickly disappear, either by evaporation or by percolation into the loose gravels of their alluvial fans. Some of the streams terminate in salt lakes, such as Great Salt Lake; others in alkali flats or playa lakes (p. 169).

There is too little water for extensive irrigation, and, consequently, most of the Great Basin is sparsely settled. The most thickly settled part is the fertile, irrigated region of which Salt Lake City (Fig. 133) is the center. If the rainfall were greater, water would gather in the basins, forming several hundred lakes. During the glacial period, when the climate of the Great Basin was moist, large fresh-water lakes filled some of these basins (p. 164).

Summary. — *The Great Basin is an arid region of interior drainage, consisting of a number of smaller basins. It is in places true desert, and, for the most part, sparsely settled.*

205. The Rio Grande. — This river resembles the Colorado in some respects. It is almost as long (1800 miles), and has a greater drainage area (240,000 square miles). Like the Colorado, the Rio Grande receives so large and permanent a water supply from its mountain sources that it is able to flow across an arid country to the sea. Like the Colorado, too, it has cut deep canyons in the plateau; but they are neither so deep, so long, nor so continuous as the canyons of the Colorado. In a number of sections the

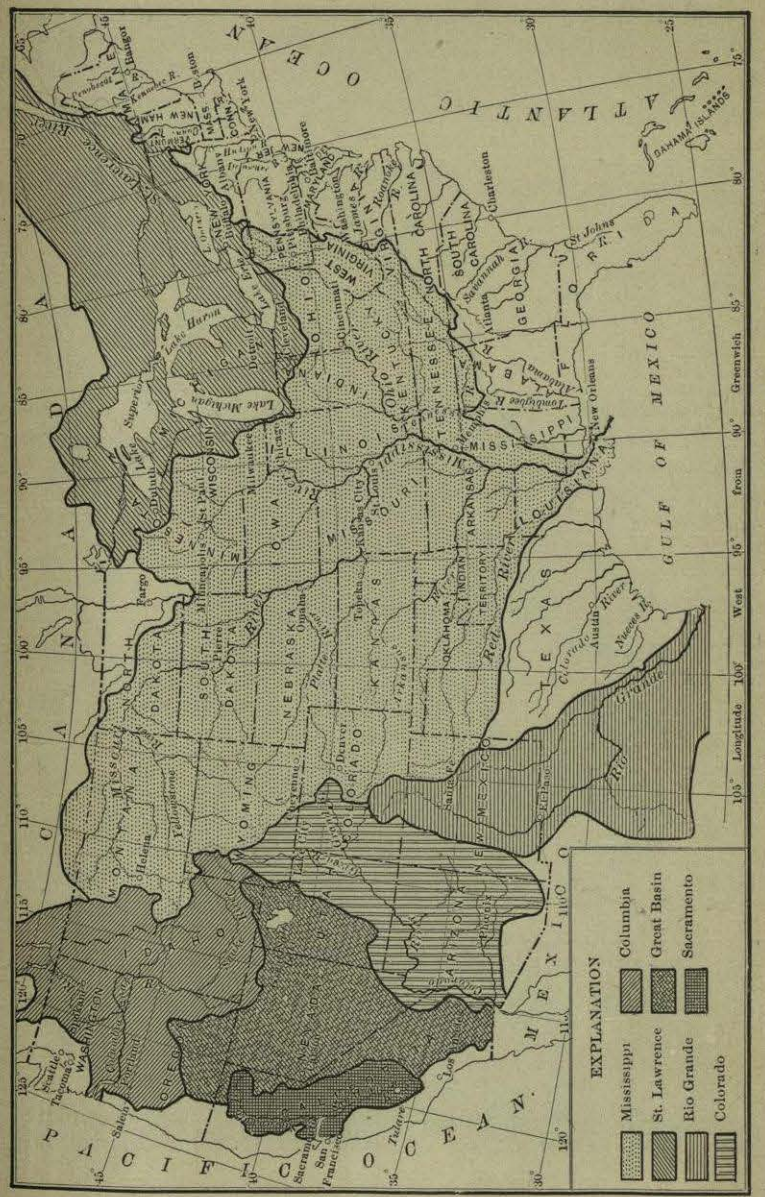

FIG. 479. — Main drainage basins of the United States.

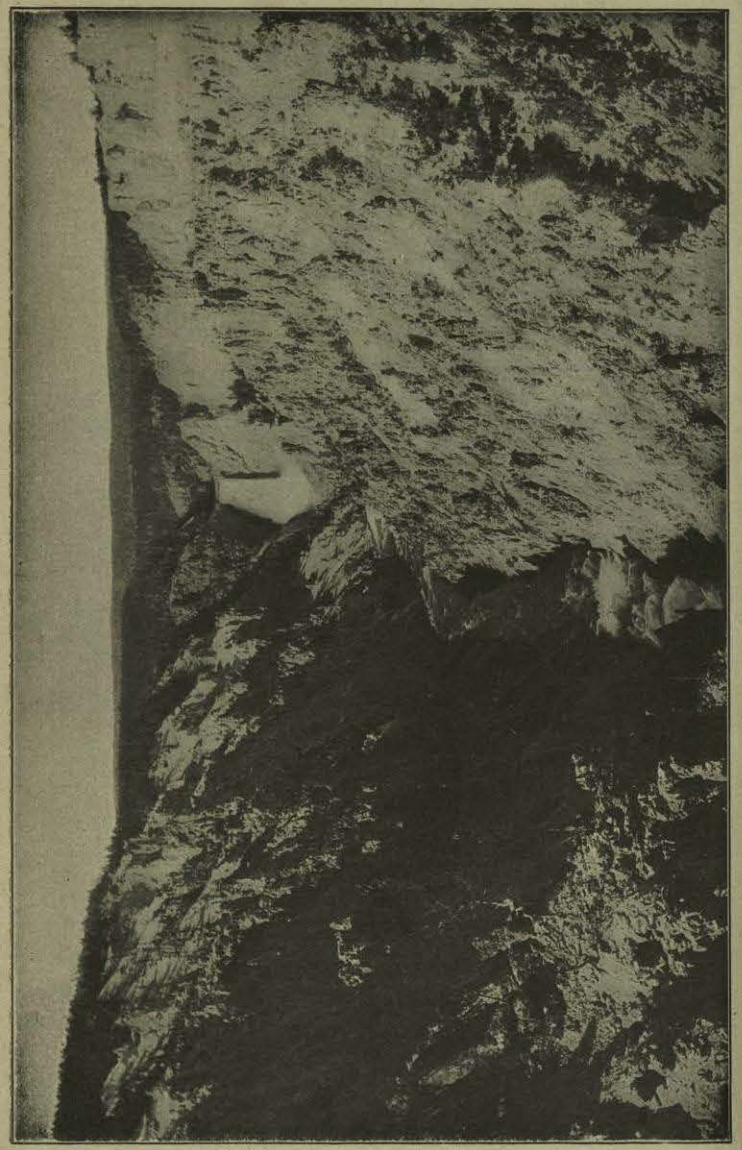

Fig. 480. — Yellowstone Falls and Canyon, cut in lava.

valley broadens, and is bordered by floodplains and low, terraced land, over which the river water is easily led for irrigation. Therefore, from Colorado to Mexico, there are many irrigated sections and numerous thriving towns and cities. The only large tributary is the Rio Pecos, which resembles the main river.

Owing to the openness of parts of its valley, and the sandy nature of its bed, the Rio Grande loses much of its volume in crossing the arid country and is sometimes dry in summer. But in winter and spring it is a large river, rising especially high during the melting of the mountain snows. It is always heavily charged with sediment, and in places is aggrading its valley. At its mouth a delta is being built, causing a slight bulge in the coast line (Fig. 371). In its lower portion the Rio Grande is navigable to small boats; but at present this is of little use, since that region is arid and sparsely settled.

Summary. — *The Rio Grande, supplied with water from the Rocky Mountains, flows across an arid region to the sea, receiving only one large tributary, the Pecos. Its course is marked by alternate canyons and open valleys, which are irrigated and well settled.*

206. The Mississippi System. — This vast river system, the longest and one of the largest in the world, has a length, including the Missouri, of 4300 miles and a drainage area of 1,250,000 square miles. It receives a large number of tributaries, some very long, including the Red (1200 miles long), Arkansas (2170 miles), Missouri (3000 miles), and Ohio (975 miles). Each of these tributaries has large feeders, some of them great rivers; for example, the Platte (900 miles) and the Yellowstone (1100 miles) are tributaries of the Missouri. There are over 10,000 miles of navigable water in the Mississippi system (Fig. 481).

The Mississippi valley is a broad depression, a lowland left by the greater uplift of the land on either side. Most of the streams follow consequent courses down the slopes of these uplifted sides. This depression has existed for many ages, at first

as an interior sea, into which sediment was brought by streams from the neighboring highlands; later it was transformed by uplift to dry land plains.

As a whole, the Mississippi valley may be considered a mature valley, approaching old age in its lower parts and youth in its upper tributaries, where recent changes have rejuvenated the streams. The rejuvenation has caused many canyons, in which there are falls, like the Great Falls of the Missouri. One of the most noted canyons is that of the Yellowstone, at the head of which are Yellowstone Falls (Fig. 480), located in the lava plateau of Yellowstone National Park. In many places volcanic accidents and mountain uplift have rejuvenated the mountain tributaries. There are numerous instances where the rivers cut across mountain ranges; for example, the Missouri in Montana, and the Arkansas in Colorado, forming the famous Royal Gorge of the Arkansas.

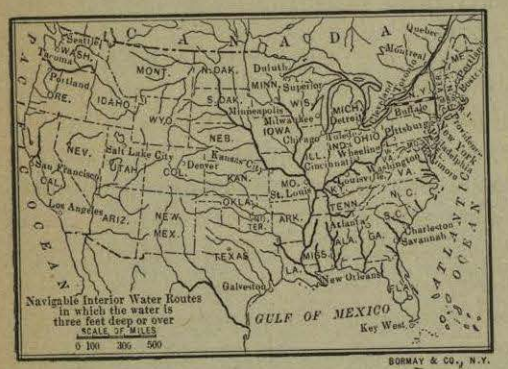

FIG. 481. — Sketch map showing (by heavy lines) the navigable rivers of United States.

Like the Colorado and Rio Grande, the western tributaries are supplied with abundant water from the mountains, especially in spring, when they become 20 or 30 times as high as at the low water stage of autumn. Only about one ninth of the rainfall is carried across the arid plains, so much are the streams reduced by evaporation. This water is of great value for irrigation, and, by storage, will make the plains still more valuable.

So much sediment is supplied to these rivers, and so much water for carrying it is lost by evaporation and seepage, that the streams

are all muddy. The Platte is so burdened that it is aggrading its bed, and doing it with such rapidity that the river is embarrassed in passing through its own deposits (Fig. 112). The Red River receives its name from the color of its sediment; and the turbid Missouri is often called the "Big Muddy." At their junction, the Mississippi has about as much water as the Missouri; but since it has less sediment, it is able to move down stream that which the Missouri brings.

The Ohio drains part of the Alleghany plateau on one side and of the Central Plains on the other. Since the climate of its valley is humid, with a rainfall of over 40 inches a year, the Ohio carries more water than the Missouri. The water supply varies greatly, being least during summer droughts, when the river may be only 2 or 3 feet deep, and most in spring when the snows are melting. It may then reach a depth of from 50 to 60 feet (Fig. 99).

The Ohio and most of its tributaries occupy mature valleys; but those in the plateau are deep and steep-sided, dissecting the plateau into the rugged condition of early maturity (p. 84). Throughout most of its course the Ohio is bordered by a floodplain, behind which bluffs rise to a height of 200 or 300 feet. This is an excellent farming country, and the valley is easily followed by railways. The river is navigable even above Pittsburg, though in some places rapids have made canals necessary.

The upper Mississippi resembles the Ohio in most important respects. In both cases the valleys have been seriously influenced by the glacier, which has caused rapids and falls. In its headwaters, the Mississippi passes through a series of lakes and swamps of glacial origin.

Below the junction of the Mississippi and Ohio at Cairo, the Mississippi flows in a floodplain which it is building up because it has more sediment than it can carry down the gentle grade. This floodplain, bordered by low bluffs, is about 600 miles long and from 20 to 75 miles wide. Mem-

phis and Vicksburg are situated on the eastern bluff, at points where the river swings against it. Over this immense, fertile floodplain the river swings in a series of meanders, often as much as 5 miles in diameter. These nearly double the length of the lower river.

The river is slowly changing its position in the floodplain, and, now and then, the neck of a meander is cut off and a ring-shaped ox-bow lake is left. There are many such lakes which are slowly being filled with sediment. Floods, seepage from the river, and lack of drainage on the level floodplain cause the abandoned channels, or *bayous*, and other low places, to remain either as lakes or swamps (Fig. 308); the higher parts are drier and make excellent farm land. At times of great flood, when the river may rise from 30 to 50 feet, the water sometimes opens gaps, or *crevasses*, in the levees which men have built to confine the river. Then the water tears away the levees, spreading over the floodplain and doing great damage. It is the deposits made during such inundations that are building up the floodplain.

Sediment, washed from the slopes of the entire Mississippi system, has built a large delta at its mouth (Fig. 105). This is still growing outward, for each year enough sediment is poured into the Gulf to build a pyramid a mile square at the base and 268 feet high. Most of the delta is too low, level, and marshy for habitation, and over it the river flows sluggishly through a series of distributaries. Sediment is constantly being deposited on the river bed, interfering with navigation, especially at the river mouth. To check this, *jetties*, or piers have been built at one of the mouths, or *passes*, in order to confine the current and cause it to flow rapidly enough to keep the channel open for large vessels.

Summary. — *The Mississippi, with its many large tributaries, occupies a valley left as a lowland by the greater uplift of the sides. It is, on the whole, mature; but rejuvenation, by volcanic action and by uplift, has occurred in many of its headwaters. The tributaries which cross the arid western plains are supplied with water from the mountains, which is of value for irrigation; they bring much sediment. The Ohio and upper Mississippi valleys are mature, have abundant rainfall, and are excellent agricultural regions. They have been affected by glaciation. Below Cairo is a broad floodplain, between bluffs, and farther down a delta, both made of sediment brought by the river. Where dry enough, both are excellent farm land.*

207. Smaller Streams of the East. — From the Rio Grande to northern Maine there are a large number of small streams, including the Colorado and Brazos of Texas, the Alabama, James, Potomac, Susquehanna, Delaware, Hudson, and Connecticut. South of the Hudson their lower courses are across the coastal plains, in shallow valleys consequent on the slope of the plains. Sinking of the land has made most of the larger streams navigable in their lower courses. In some cases, especially in the North, where sinking of the land has been greatest, vessels can pass far inland. The importance of this is well illustrated by the Chesapeake, Delaware, and Hudson valleys.

From Alabama northward the headwaters of the large streams are either in or west of the mountains. This fact has been of great importance in many cases, since it has opened water gaps into and across the mountains (pp. 309 and 391). North of New Jersey the streams have all been rejuvenated by the effects of the glacier, and their courses obstructed in places by rapids, falls, and lakes, the importance of which has already been pointed out.

Summary. — *As a result of sinking of the land, many of the small streams of the East are navigable in their lower courses; some furnish openings into and across the Appalachians; and in the North, glaciation has caused many rapids, falls, and lakes.*

208. The St. Lawrence System. — This remarkable river system includes five of the largest eight fresh-water lakes in the world (p. 162). These are connected by short rivers and straits, in several cases containing rapids or falls, including the wonderful Niagara. The lake basins are very deep (p. 161), the bottoms of all but Erie being below sea level.

The St. Lawrence flows out of Lake Ontario, not in a well-

defined valley, but straggling over a low, hilly land, the higher parts of which rise above the water as the so-called Thousand Islands. From this point down to Montreal the river consists of a series of broad, lake-like expanses, with intervening rapids around which canals have been built. The lowest, or the Lachine Rapids, are just above Montreal; and thence, onward to the sea, there is uninterrupted navigation through a broad valley, into which the tide has been admitted by sinking of the land. Below Quebec the valley is a broad bay, and ocean steamers ascend to Montreal. By means of canals around the rapids and falls, large ships may go on to the western end of Lake Superior (p. 311).

The exact preglacial condition of the St. Lawrence system is not yet fully known. It is certainly drowned at one end, and the continuation of its valley, between Nova Scotia and Newfoundland, may still be traced on the sea bottom. When this submerged valley was formed, northeastern North America was more than 1000 feet higher than now, and the mouth of the St. Lawrence was off Newfoundland at the edge of the continental shelf.

The inland continuation of this valley seems to have been not the present St. Lawrence, but Ottawa River, the only large tributary of the St. Lawrence system. Above Montreal the system appears to be made of parts of several systems, united by the effects of glacial erosion, dams of glacial drift, and land tilting. These processes have also transformed parts of the valleys into the deep, boat-shaped basins of the Great Lakes (p. 161). Neither the St. Lawrence above Montreal, nor the rivers and straits that connect the lakes, are in preglacial valleys of large streams.

Notwithstanding the great volume of water, little erosion is being done along most of the St. Lawrence. The explanation of this is that the lakes, and other quiet stretches, rob the water of its sediment, therefore taking away its erosive power. Consequently, though young, most of the St. Lawrence streams flow, not in gorges, but in shallow valleys.

Niagara River, which furnishes the one striking exception

to this, has peculiar conditions. Leaving Lake Erie clear and free from sediment, the broad Niagara loiters along past Buffalo, almost on the surface of the plain (Fig. 483). At only one point in its upper course is there rapid water, where it crosses a ledge of rock near Buffalo. The river divides into two channels around the low Grand Island. The valley is so young and undeveloped that the channel on one side has not been deepened enough to rob the other of its water.

Just above Niagara Falls, 15 miles from Lake Erie, the stream is again divided, this time around Goat Island. Here the flow in each branch quickens, and soon the water is tumbling along tumultuously as a series of violent rapids. Then it drops as a great cataract, 160 feet high, divided by Goat Island into two parts, — the larger, or Horseshoe Fall, on the Canadian side, the smaller, or American Fall, on the American side. For 7 miles below the cataract the river rushes rapidly through a gorge 200 or more feet deep, and 200 or 300 yards wide (Fig. 485). In two parts of the gorge there are decided rapids, and at one point a whirlpool.

The top of the gorge is at the level of the plain over which the river flows from Buffalo to the Falls; and the gorge cut in this plain reveals its rock structure. It is made of nearly horizontal strata, some hard, some soft, dipping gently southward at the rate of about 35 feet a mile. The upper stratum in the gorge wall is massive limestone (Fig. 482), beneath which is a series of weak shales. It is these strata, also present under the cataract, that make the waterfall possible.

The plain ends toward the north in a steep slope, or escarpment (Fig. 485), faced by a plain about 200 feet lower. Emerging from its gorge at this escarpment, the river flows quietly over the lower plain to Lake Ontario.

An enormous quantity of water, estimated at 167,000,000 gallons a minute, falls over the Niagara limestone (Fig. 482), which forms the crest of the Falls. The underlying shales are being removed by the swirl of waters, and by

the grinding against them of great blocks of fallen limestone, by a kind of pot-hole action (p. 54). This undermines the limestone, causing huge blocks to occasionally break off, slowly changing the outline of the cataract.

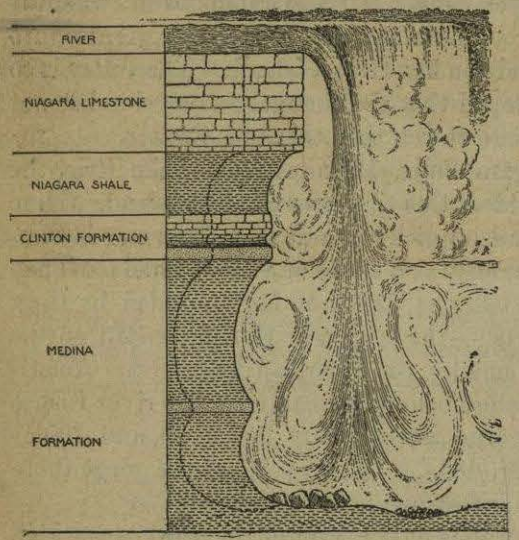

FIG. 482. — To illustrate the undercutting in progress at Niagara (modification of Gilbert's diagram).

There is too little water in the American Fall for such results; instead, the fallen blocks of limestone protect this fall from recession. Records kept since 1842 show that, while the Horseshoe Fall has receded at the rate of about five feet a year, the outline of the American Fall has scarcely changed. Long before the cataract has receded to Lake Erie, the southward dip of the shales will have carried them so far into the ground that there will no longer be an opportunity for the river to undermine the limestone. Then the waterfall will disappear.

There is clear evidence that when the ice sheet permitted Lake Erie to outflow over the plain toward Ontario, the Niagara cataract was born, falling over the edge of the escarpment. Since then the cataract has receded for seven miles, making the gorge. When the cutting of the gorge first began, the river occupied a broad valley on the upper plain, similar to the present valley above Goat Island. The river gravels and banks made at that time may still be clearly seen on the plain, 200 feet or more

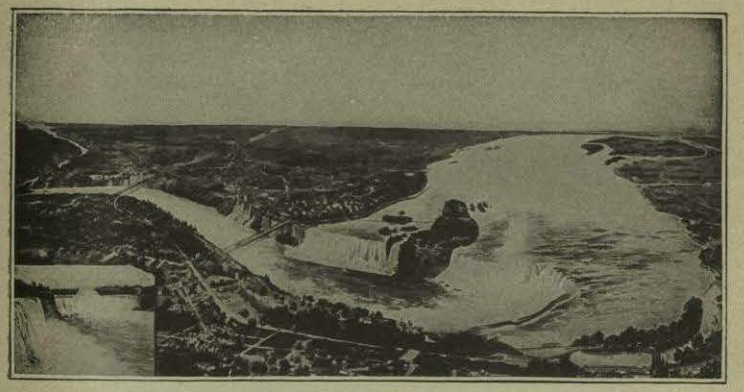

FIG. 483. — Bird's-eye view of Niagara River. Contrast the broad, shallow upper valley with the narrow, deep gorge below the falls.

FIG. 484. — The water escaping here is a small portion of that used for power at Niagara Falls. Yet only a very minute portion of the enormous power available is now used.

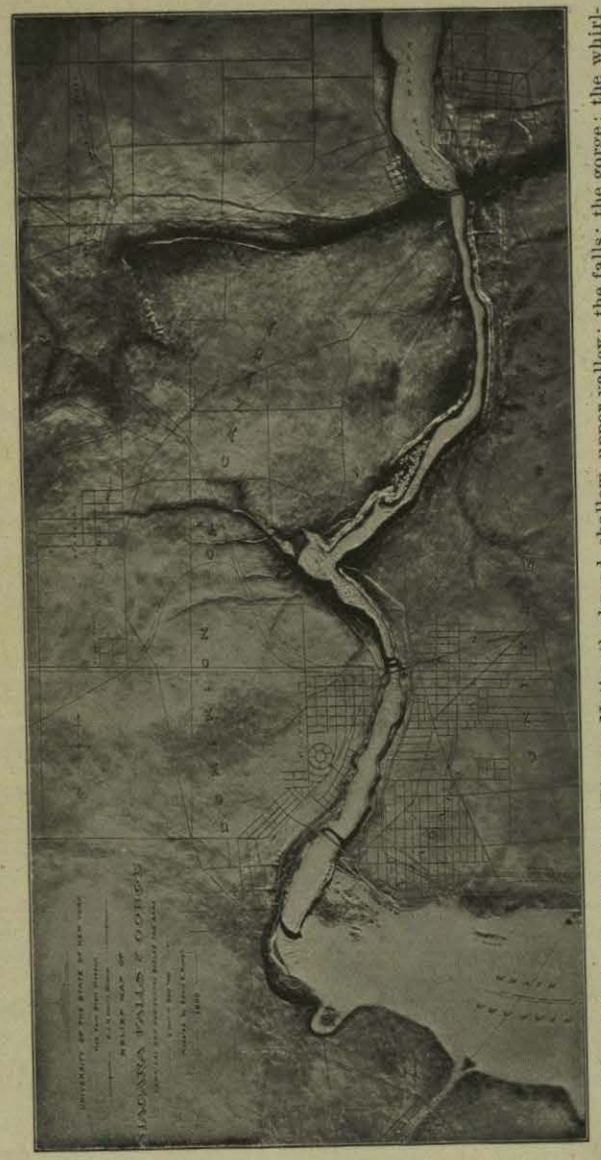

Fig. 485. — Relief map of Niagara River. Notice the broad, shallow, upper valley; the falls; the gorge; the whirlpool; the lower shallow valley; the escarpment separating the two plains; and the depression leading from the whirlpool to St. Davids, marking the site of the buried gorge which causes the whirlpool. (Model by E. E. Howell, Washington, D.C.)

above the present river. The gorge could not have existed then. Another proof that the gorge has been cut by river action is the existence of an abandoned fall, similar to the American Fall, at Foster Flats, more than halfway down the gorge.

As the cataract receded, it discovered a buried valley beneath the glacial drift; and where this buried valley leaves the gorge, at the whirlpool, there is a break in the otherwise continuous rock wall of the gorge. The removal of the glacial drift that filled this buried valley has formed the elbow in which the whirlpool is situated (Fig. 485).

It was formerly thought that Niagara gave a basis for telling the time in years since the close of the Glacial Period. Three important facts are known: (1) the length of the gorge; (2) the present rate of retreat of the cataract (five feet a year); (3) the cataract began as the ice was leaving. It therefore seemed simple to divide the distance by the present rate; but later studies show that there are many causes for variation in the rate of retreat, of which the following are most important: (1) the limestone is thinner at the northern end; (2) the time required to remove the loose drift in the buried gorge is unknown; (3) the volume of water has varied; indeed, at one time Niagara received the waters of Lake Erie only (Figs. 280, 281). Since it is impossible to tell just how much these variations have influenced the rate of retreat, the time that Niagara has taken to cut its gorge is not known positively; but there is reason for believing it to have been between 5000 and 10,000 years.

Summary. — *The St. Lawrence system is an immature river system made by the union, largely through glacial action, of parts of a number of rivers. It consists of* (1) *a drowned lower portion;* (2) *a middle section with a series of quiet, lake-like stretches and intervening rapids; and* (3) *an upper portion of great lakes, with connecting straits and rivers, interrupted by rapids and falls. Little erosion is being accomplished because the lakes rob the water of sediment for cutting-tools. Niagara is an exception to this because of the existence*

of weak shales beneath a massive limestone. At the Horseshoe Fall the removal of these shales is causing the cataract to retreat upstream, and there is good proof that it has receded through the seven miles of the gorge, requiring probably somewhere between 5000 *and* 10,000 *years for the work, which began at the close of the Glacial Period.*

Topical Outline and Review Questions.

Topical Outline. — 201. **The Columbia.** — Climate; length; area; two large branches; valleys in lava plateau; effect of these canyons; lower valley, — crossing mountains, navigation, fishing.

202. **The Sacramento.** — Position; outlet; size; large tributaries; navigation; small mountain tributaries; uses of water.

203. **The Colorado.** — Source of water; size; inclosing plateau; canyon valleys; lower course; Grand Canyon, — barrier, difficulties of passage, rapids, canyon walls; tributaries; young plateau.

204. **The Great Basin.** — Area; situation; minor basins; Basin Ranges; rainfall; streams; irrigation; former lakes.

205. **The Rio Grande.** — Compare with Colorado; irrigation; tributaries; variation in volume; sediment load; delta; navigation.

206. **The Mississippi System.** — (a) *The system:* length; area; principal tributaries; navigation. (b) *The valley:* origin of lowland; ancient sea; mature condition; rejuvenation; mountain gorges. (c) *Western tributaries:* water supply; floods; loss of water; irrigation; sediment, — cause, Platte, Red, Missouri. (d) *Ohio:* rainfall; floods; mature valley; floodplains; farming; navigation. (e) *Glacial influence:* rapids and falls; upper Mississippi. (f) *Floodplain of lower Mississippi:* cause; area; bluffs; meanders; changes in river position; lakes, bayous, and swamps; floods; levees; deposits. (g) *Delta:* outward growth; swampy surface; distributaries; jetties; passes.

207. **Smaller Streams of the East.** — Names of principal ones; condition on Coastal Plain; effect of land sinking; pathways across mountains; effects of glacier.

208. **The St. Lawrence System.** — (a) *Description:* lakes; connection of lakes; Thousand Islands; rapids below the lakes; drowned lower course; navigation. (b) *Preglacial condition:* submerged valley; former elevation of continent; Ottawa River; effect of glacier on river; on lakes. (c) *Erosion:* absence of sediment; effect on valley form. (d) *Niagara:* near Buffalo; Grand Island; Goat Island; rapids; two falls; gorge; upper plain; rocks in gorge wall; escarpment; condition below escarpment. (e) *Recession of falls:* cause of retreat; condition in American Fall; rate in Horseshoe Fall; future of falls. (f) *History of Niagara:* birth of falls; cause of gorge; proofs of this; cause of whirlpool. (g) *Age of gorge*: facts known; causes for variation; probable age.

Review Questions. — 201. What is the situation of the Columbia? Its length and drainage area? What are the two great branches? What is the condition in the upper part? In the lower part?

202. Describe the Sacramento Valley; its situation; lower portion; size; large branches; small tributaries; uses of water.

203. State the general features of the Colorado: source of water; size; canyons; lower portion. Describe the Grand Canyon. Why are there few tributaries? What is the condition between them?

204. What are the surface features of the Great Basin? What is the climate? What effects has this on the region?

205. Compare the Rio Grande with the Colorado. How do they differ? Why is there so much irrigation? How does the volume vary? What is the condition in the lower course?

206. What is the size of the Mississippi and its largest tributaries? What is the origin and form of its valley? What is the condition in the headwaters? What is the condition of the water supply in the western tributaries? Of the sediment? What are the principal characteristics of the Ohio? What effects have been produced by glaciation? What are the characteristics of the floodplain: area; bluffs; meanders; floods; swamps; farm land; levees? What is the condition on the delta?

207. Name the principal small streams in the East. What are their main characteristics? In what ways are they important?

208. What is the general condition of the system? What is the condition below Lake Ontario? What was the preglacial condition? Why is there little erosion? Describe Niagara River. What is the rock structure of the gorge walls? How, and at what rate, is the cataract caused to recede? What will happen as the fall recedes farther? What proofs are there that the gorge was formed by the river? Explain the whirlpool. What is known of the length of postglacial time?

Reference Books. — Gilbert, *Niagara Falls, National Geographic Monographs*, American Book Co., New York, 1895, $2.50; Tarr, Chapters VII, VIII, and IX, *Physical Geography of New York State*, Macmillan Co., New York, 1902, $3.50; Dryer, *Studies in Indiana Geography*, Inland Printing Co., Terre Haute, Ind., 1897, $1.25; Powell, *Exploration of the Colorado River*, Washington, 1875 (out of print); *Canyons of the Colorado*, Flood and Vincent, Meadville, Pa., 1895, $10.00; Dutton, *History of the Grand Canyon District*, Monograph II, U. S. Geological Survey, $10.00; Grabau, *Niagara Falls and Vicinity*, Bull. 45, New York State Museum, Albany, 1901, $0.65.