of a ball in various positions. Do the same with a cylinder; with a square. Which always shows one kind of outline? (4) A period devoted to the meaning of scale may be combined with a study of the size and distance of the members of the solar system. This can be done with profit by cutting disks out of brown paper to represent the planets (say on a scale of one inch for 5000 miles); and marking off distances in the school yard (say on a scale of one inch for 200,000 miles) to represent distances. (5) Take a string five feet long with a loop in the end. Put the loop over a nail driven in the floor. With a piece of chalk at the other end of the string draw a circle. Now drive another nail two inches from the first. Take a string ten feet long and tie the ends. Put it over the two nails, and with chalk held in the loop draw a figure as near a circle as you can. It will not be a circle, but an ellipse. If you put the two nails (the foci) farther apart, say six inches, the ellipse will be still less like a circle. (6) Rotate a globe or apple in front of a light to understand the cause of day and night. (7) Observe the stars of the Great Dipper and the North Star at 8, 9, and 10 o'clock. What changes do you notice? (8) Compare the movements of a planet in the heavens, say the evening "star," with that of a neighboring star. Why the difference? (9) With a telescope look for the moons of Jupiter and the rings of Saturn. (10) What are shooting stars and comets? (11) In some astronomy, read about the sun and the planets. (12) Find out what Aristotle, Magellan, and Galileo learned about the earth.

Reference Books. — *References to a few selected books are placed at the end of each chapter. Other reference books and magazines are listed in Appendix L.* NEWCOMB, *Elements of Astronomy*, American Book Co., New York, 1900, $1.00; YOUNG, *Manual of Astronomy*, Ginn & Co., Boston, 1902, $2.45; TODD, *New Astronomy*, American Book Co., New York, 1897, $1.30; LOCKYER, *The Chemistry of the Sun*, Macmillan Co., New York, 1887, $4.50.

CHAPTER II.

GENERAL FEATURES OF THE EARTH.[1]

THERE are three quite different parts of the earth: (1) the solid earth; (2) the liquid ocean which partially covers the solid earth; and (3) the gaseous envelope, or atmosphere.

8. The Atmosphere.[2] — There is some air at a height of 200 or 300 miles from the earth; but most of it is within a few miles of the surface. The air is a mixture of transparent gases, mainly oxygen and nitrogen, whose presence on every hand we hardly realize. Yet our every breath draws it in for the purpose of supplying life-giving oxygen. Though it cannot be seen, we feel its presence when the wind blows, or when moving rapidly through it.

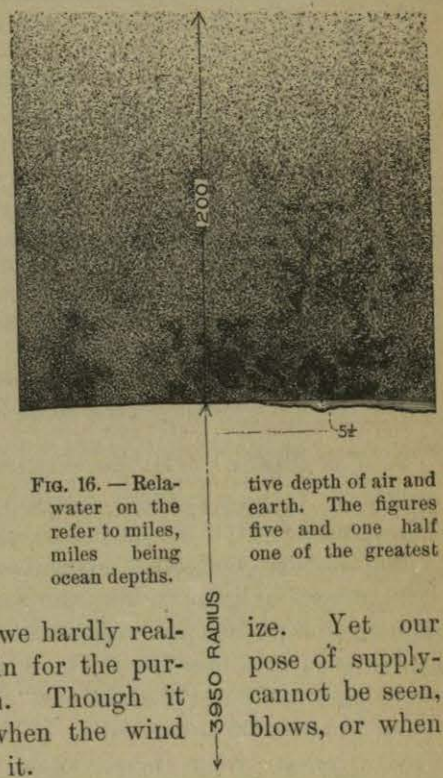

FIG. 16. — Relative depth of air and water on the earth. The figures refer to miles, five and one half miles being one of the greatest ocean depths.

There are many ways in which the air is of high importance. All plants and animals depend upon its gases for life. Its oxygen

[1] For latitude and longitude, see Appendix B; for maps, see Appendix I.
[2] See also Chapter XII.

causes fire to burn, and, by a slow combustion, causes decay of animal and plant tissues. It diffuses light and heat from the sun, and transmits the sound waves upon which hearing depends. Winds, which bear vapor and warm and cold air from place to place, are a result of its movement. For many centuries the wind has been used for driving ships through the water and for turning windmills on the land.

The surface of the earth itself is profoundly modified by the influence of the air. Winds move loose fragments about and wear the rocks away, especially in desert regions. Rains, made possible by vapor in the air, give rise to streams, which carve channels in the land and bear rock fragments to the sea. Waves, which winds form in the ocean, batter at the rocky seacoast. Even quiet air, by the action of its water vapor and oxygen, is causing the solid rock to slowly decay and crumble. This forms the soil upon which so many plants depend for food.

Summary. — *The air, composed chiefly of oxygen and nitrogen, extends 200 or 300 miles above the earth, but is mainly near the surface. Breathing, fire, decay, diffusion of light and heat, hearing, winds, rain, waves, and many changes of the land, including the formation of soil, are dependent on the atmosphere.*

9. The Oceans.[1] — If the earth were a perfect sphere, it would be entirely covered by water to a depth of several thousand feet; but the surface is so irregular that the ocean is not able to completely cover it, as the air does. It has been drawn by gravity into the depressions and rises high enough to cover only the continent margins (Fig. 316).

Nearly three fourths of the solid earth is hidden from view by this water mantle, the area of the oceans being about 145,000,000 square miles, of the lands about 52,000,000 square miles. Near their contact with the continents the oceans are shallow; but far from land the water is deep. One may sail, with no land in sight, for thousands of miles in water whose average depth is 10,000 to 15,000 feet. In

[1] See also Chapter X.

its deepest parts the ocean has a depth of over five and a half miles.

This vast expanse of water is of great importance in many ways. It is the seat of abundant life, many forms of which are of such value that ships are sent out to secure them. Cod, halibut, haddock, bluefish, salmon, shad, lobsters, oysters, clams, seals, whales, sponges, pearl oysters, and precious corals are among the ocean animals of importance to man.

For a long time the ocean was an almost impassable barrier to the spread of man; but as men learned to navigate and to build strong ships, it became a highway instead of a barrier. To-day the Atlantic is crossed with speed and comfort in five or six days; less than a century ago this journey required weeks and was one of peril. To-day communication between America and Europe is easier than between Rome and Athens at the time of the Roman Empire. Ships now cross the oceans in all directions, carrying merchandise and passengers to every quarter of the globe. The harbors from which these ships go forth have become the seats of great cities, prospering by their commerce and by the industries to which it gives rise. By means of the ocean highway, too, civilization has rapidly spread to all quarters of the globe.

It is the ocean that supplies the vapor for rain, upon which all land animals and plants depend. The ocean also profoundly influences the temperature of neighboring lands, moderating the heat of summer and the cold of winter. Therefore, lands reached by ocean winds, like the northwestern coast of United States and Europe, have far less extreme climates than lands in the same latitude, like central and eastern United States, where ocean winds are less common.

Summary. — *The ocean occupies depressions on the earth's surface, covering three fourths of the globe to an average depth of 10,000 to 15,000 feet. The ocean is of importance as a source of food-fishes and other valuable animals; as the seat of extensive navigation; as the source of vapor; and in modifying climate.*

10. The Solid Earth. — Near the continents the sea floor is covered with sediment washed from the land by rain, rivers, and waves. Farther out, it is mantled with the remains of animals that, on dying, have settled from the water above. Almost everywhere on the dry land there is a layer of loose rock fragments, the surface part of which is called *soil*. Thus nearly the entire earth is covered by loose materials.

In some places the soil has been brought by glaciers, in others by rivers; but most of it has been formed by the decay and crumbling of the rocks. Were it not for this soil most of the plants, which are of such use in supplying materials for food, clothing, and shelter, could not grow. The soil offers a chance for the roots to penetrate, seeking water and plant food, and also holding the plants upright.

FIG. 17. — Rock beneath the soil.

Wherever the soil mantle is penetrated to great enough depth, solid rock is found beneath it (Fig. 17). Sometimes the rock is several hundred feet beneath the surface; but it is usually found at a depth of a few feet or a score or two of feet. In places, especially among mountains or on other steep slopes, there is no soil-cover at all. As the rock decays in such situations, the fragments fall away so quickly that soil cannot accumulate.

The rock that is everywhere found beneath the soil varies greatly from place to place, often consisting of materials which are of great use to man. In some places it is sandstone or granite, useful for building purposes; in other places it is limestone, valuable for building, for making lime, or for use in blast furnaces. In various parts of the world, layers of coal are found bedded with the rocks; and there are deposits of iron ore, salt, and other substances; also veins of lead, zinc, silver, gold, and other metals.

Summary. — *The solid earth, like the air and ocean, is of great importance to man. It furnishes him with a home; it is almost everywhere covered with a soil mantle, in which food and other plants grow; everywhere beneath the soil mantle is found solid rock, from which many valuable mineral substances are obtained.*

11. The Earth's Interior. — From river valleys, tunnels, quarries, mines, and well borings many facts have been learned about the outer part of the solid earth. But this knowledge tells little about the great interior. However, astronomers have shown that, while the outer part of the earth is from 2 to 3 times as heavy as water, the interior is 5 to 10 times as heavy. It is perhaps made of metal.

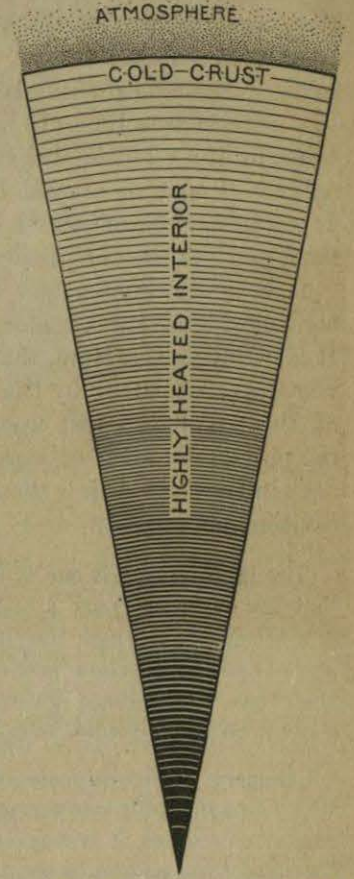

FIG. 18. — To show the relative thickness of the air and solid earth.

Several facts indicate that the interior is highly heated: there are hot springs; volcanoes erupt melted rock; and mines show an increase in temperature of 1° for every 50

or 60 feet of descent. If this increase continues, the melting point of rocks must be reached at no great depth.

It was formerly believed that beneath a thin outer crust the interior was molten; but it is now considered certain that, though very hot, the interior is solid. We still use the term *earth's crust*, however, for the cold outer portion of the earth. There are a number of reasons for the belief that the interior is solid: (1) if it were liquid there would be tides in it; (2) the behavior of the earth toward other spheres is that of a solid body; (3) earthquake shocks in Japan have been measured by delicate instruments in England, and the time of passage indicates a solid interior.

It is a well-known fact that greater heat is required to melt most substances under pressure than without pressure. It is believed, therefore, that the interior of the earth is prevented from melting by the tremendous weight, or pressure, of the rocks that rest upon it. At a depth of six miles the pressure is great enough to crush rocks; and, therefore, deep in the earth, below this upper portion, or *zone of fracture*, cavities cannot exist.

The interior heat is one of the arguments in favor of the belief that the earth was once a still hotter body (p. 9), probably part of a *nebula*, from which the sun, earth, moon, and the other members of the solar system have descended. The earth is still losing heat; but it is so large that many ages more will be required to make it completely cold, like the smaller moon.

Summary. — *Several facts indicate that the interior of the earth is highly heated, and it was formerly thought to be molten; but, for a number of reasons, it is now believed to be solid, though hot, being prevented from melting by the pressure upon it.*

12. Air, Water, and Rock. — At ordinary temperatures the air is a mixture of gases; but with great cold and pressure these gases may be changed to a liquid and even to a solid state. Water, ordinarily a liquid, changes at 32° to a solid,

and at 212° to a gas; in fact, some water-vapor gas rises from water at ordinary temperatures. Rock, as we know it, is a solid; but volcanoes show that under higher temperatures it becomes a liquid; and in the very hot sun, some of the rock elements are so hot that they are in the state of gases. From this it is seen that *the terms gas, liquid, and solid apply merely to states of matter.* When the conditions change, any one of these states of matter may be altered to one of the other states.

The three earth materials — air, water, and rock — have been spoken of as if they were quite separate; but really they are closely related and mingled. There is not much rock material in the atmosphere, though volcanic dust is often borne long distances in it; and the haziness of the air is partly due to dust blown up from the ground. Water vapor is mixed with all air, even that of the driest deserts.

Water also pervades the earth's crust, entering even the densest rocks. Wells reach it and supply drinking water; it slowly oozes from the ground in springs; miners find it far below the surface; and volcanic eruptions bring vast quantities of it to the surface. In cold climates it is frozen, changing the soil to a solid, rocklike mass. In northern Siberia the ground is permanently frozen to a depth of several hundred feet. That air also enters the ground is proved by the fact that many plants die for lack of it when their roots are submerged.

Air is also mixed with water. If a fish is placed in water from which the air has been expelled, it will die because there is no oxygen for it to breathe. All water, on the land or in the sea, bears mineral substances in solution; and rock fragments mingled in suspension are also present in water.

Summary. — *Air (gas), water (liquid), and rock (solid) may each be changed to one of the other states of matter. They are mingled: there is earth material and water vapor in the air; air and water in the earth; and air and rock material in the water.*

13. Irregularities of the Earth's Crust. — While the earth is a huge sphere flattened at the poles, its outline is far from

regular. Its surface is roughened by a series of continent elevations, between which are broad depressions, occupied by the oceans. The ocean depressions average 10,000 to 15,000 feet in depth; but the average height of the lands above sea level is only 2000 to 3000 feet. Fully three fourths of the ocean bottoms are broad expanses of plain; and much more than half the land is either plain or plateau (Figs. 19, 21).

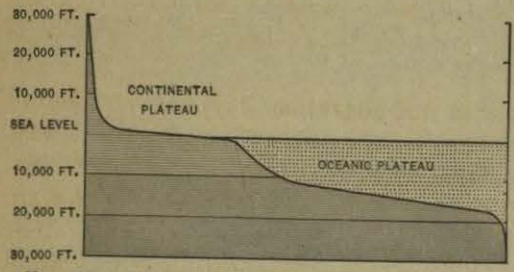

FIG. 19. — To show the proportion of continents and ocean basins between different levels.

Mountain chains and volcanoes rise high above the general level of both sea bottom and land. The Hawaiian Islands are volcanic cones on a submarine mountain fold fully 1500 miles in length; and the Japanese Islands, Philippines, and West Indies are also mountain chains rising from the sea floor.

It is among the mountain chains of the land that the greatest elevations on the globe are found. In the Andes there are peaks that are over 40,000 feet above the sea bottom 75 miles to the west. The highest mountain in the world, Mount Everest, is about $5\frac{1}{2}$ miles high; and the greatest ocean depth is about the same distance beneath the sea. Eleven miles is a great height as we look at it; but it is a very small amount compared to 7900 miles, the diameter of the earth.

These irregularities of the earth's surface are generally believed to result from the heated condition of the interior (p. 9). As the earth cools and shrinks, its crust wrinkles, causing some parts to rise, others to settle (p. 35). Such changes of level are even now in progress (p. 36), and there are many proofs that they have caused great change in the past. One of the most important facts in physical geography is that the earth's crust is in slow movement; for by reason of it, the outlines of the lands and oceans are ever varying.

Summary. — *The earth's surface has been roughened by the effects of shrinking of the heated interior. This has caused continent elevations and ocean depressions, and, on both of these, mountain chains and volcanoes. The average depth of the ocean is about five times the average height of the land; but the loftiest mountains are about as high as the greatest ocean depths, making a total difference in level of about eleven miles.*

14. Conflict of Erosion and Elevation. — Wherever land is exposed to the air, it is being attacked and slowly worn away. The weather causes the rocks to slowly crumble (p. 38); rivers carve valleys and carry the rock fragments off toward the sea (p. 52); glaciers scour the land over which they pass (p. 153); waves batter the shore, cutting cliffs, building beaches, and supplying rock fragments for removal by the currents (p. 210). The result of the work of these *agencies of erosion* is that the land surface is made very irregular.

The sea floor, on the other hand, is made more regular. Beyond the reach of the waves there is practically no erosion; but the deposit of rock fragments from the land is leveling the sea bottom.

Thus, on the one hand, movements of the crust are raising the land; on the other, the agencies of erosion are cutting into it and removing its fragments toward the sea. There is an opposition, or conflict, of two sets of forces, one set tending to raise, the other to lower the surface of the land. So far the forces of elevation have been more powerful; but the agencies of erosion have deeply sculptured the lands and have helped to level the sea floor.

This conflict has been in progress for many ages, and the present land surface, about which we are to study, is the result of it. The valleys, which our railways and canals follow; the mountains, which act as barriers to winds and to the spread of plants, animals, and men; the smooth

coastal plains; the interior plateaus; the harbors in which our shipping gathers; the sites of our leading cities; and many other land features are a result of the conflict between the forces of elevation and the agencies of erosion.

Summary. — *Agencies of erosion — weather, rivers, glaciers, waves, etc. — are cutting into the land and strewing the waste over the sea floor. On the other hand, forces of elevation are raising the land. This causes a conflict, in which the forces of elevation have so far been more potent. The present land surface, which so greatly influences man, is the result of this conflict.*

15. The Continents — (A) *Characteristics.* — A continent is a large upraised portion of the earth's crust nearly or quite surrounded by ocean. Usually the continent margin is submerged beneath the sea (Fig. 316), sometimes, as off eastern North America, for a distance of 50 to 100 miles from the coast. At its outer edge it is faced by a steep slope, called the *continental slope* (Fig. 116), which descends quickly to the deep sea bottom. Although the average elevation of the continents is but 2000 to 3000 feet above sea level, when measured from the base of the continental slope their average height is 10,000 to 15,000 feet. Some portions, for example the Dead Sea, are below sea level.

Continents consist of mountain ranges with connecting plains and plateaus (Figs, 20, 21). They are crossed by rivers, occupying valleys, which drain the land; but nearly one fourth of the land has no drainage to the sea. In these cases the water runs into *interior basins* or basins without outlet.

The outline of a continent seems to be determined by its mountain ranges; indeed, mountains have been called the skeletons of continents. From this standpoint the plains and plateaus may be called its tissues. In fact, the plains and plateaus have been built of rock fragments worn from the mountain skeleton.

To illustrate, off eastern Asia, from the Kurile Islands to the Philippines (Fig. 26), there is a mountain chain now rising. A large part of the rock waste worn from these mountains, and from

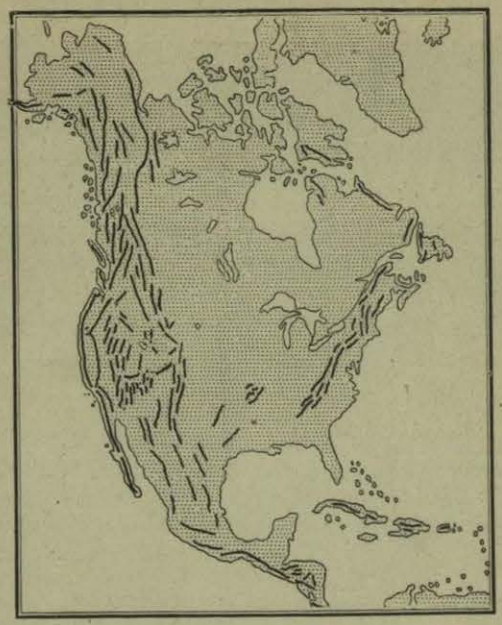

FIG. 20. — The main mountain axes of North America.

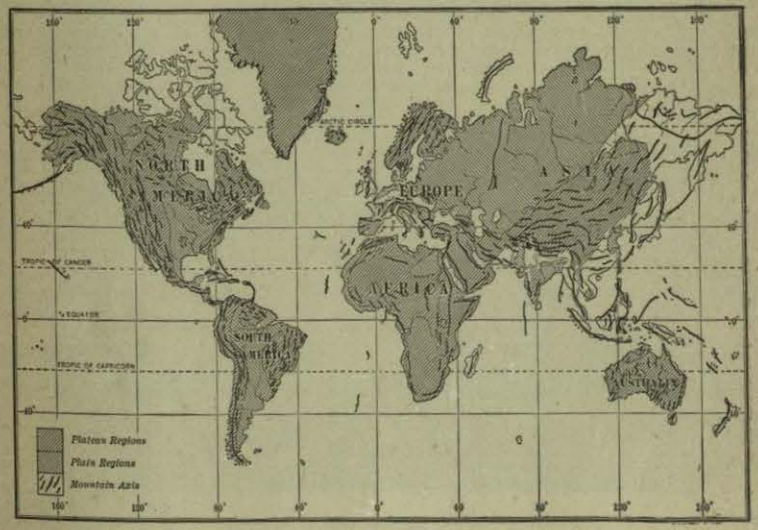

FIG. 21. — Diagram to show the general distribution of mountains, plains, and plateaus of the world.

FIG. 22. — Relief map of North America.

the mainland, is being deposited in the sea that separates the islands from the mainland. These deposits may in time fill the inclosed sea, and a slight uplift of the land may raise the smooth sea bottom plain, forming dry land, and thus joining the mountain islands to the coast of the mainland. It is by similar changes that continents have been made.

Summary. — *Continents are uplifted blocks of earth's crust whose real margin is beneath sea level. They consist of plains, plateaus, and mountains, partly drained into interior basins. They owe their outline to mountain skeletons, connected by plains and plateaus, that have been built of rock fragments worn from the mountains.*

(B) *North America.* — In North America (Fig. 22) there are two great systems of mountains: (1) the Appalachian system, which extends southwestward from Labrador to Alabama; and (2) the great western system, or the *western Cordilleras*, which extends southeastward from Alaska to Central America (Fig. 20). A third system of low and very ancient mountains occupies the region from Labrador westward. The vast plateaus and plains that connect these mountains are largely made of rock fragments swept from the mountains in past ages. Fossil remains of marine animals prove that the rock strata were deposited in a sea, and were later raised by the forces of elevation to form dry land.

Its triangular mountain skeleton has given to North America its form. The continent is broad in the north and tapering in the south, because the mountains are spread farther apart in the north. Mountains have also caused some of the larger irregularities of the continent. For example, the Alaska and Labrador peninsulas are the northern extension of the western and eastern mountains (Fig. 22). Lower California is a southern extension of the Coast Ranges; and the Gulf of California is a depression not yet filled with the waste that is being washed from the bounding mountains. The peninsulas and islands which partly inclose the Gulf of Mexico and Caribbean Sea are also portions of mountain systems.

Sinking of the land, which allows the sea to enter the valleys, is another cause for irregularities in the outline of a continent. Such a sinking in northeastern America has submerged land valleys, forming Hudson Bay, the Bay of St. Lawrence, the Bay of Fundy, Long Island Sound, New York Harbor, Delaware Bay, Chesapeake Bay, and many thousands of smaller bays, estuaries, and harbors. Where the sea has risen so as to completely surround areas of higher land, islands have been formed, such as Long Island, Newfoundland, and the thousands of others along the northeastern and northwestern coasts of America.

Summary. — *North America owes its triangular shape to its mountain areas, spread apart in the north. The connecting plains and plateaus are made of rock waste derived from these mountain skeletons. The principal irregularities — peninsulas, bays, and islands — are due to two causes:* (1) *mountains;* (2) *sinking of the land.*

(C) *South America.* — South America resembles North America in its triangular form (Fig. 23). This outline is due to the great mountain backbone of the Andes in the west, and the less prominent mountain systems in the north and in eastern Brazil. South America is, however, far more regular than North America. The only irregularities caused by mountains are in the north, where the Andes system forms the Isthmus of Panama and the small peninsulas of Venezuela. The irregular southern coast is due to sinking of the land; but the coast of Peru and northern Chile is now rising (p. 36).

Summary. — *The mountains of South America have given it a triangular form and one or two peninsulas in the north; elsewhere the coast is very regular, excepting in the south, where there has been sinking.*

(D) *Africa.* — Like South America, Africa has a triangular form and regular outline (Fig. 24). Its outline is determined by mountain uplifts near the coast, which have so raised the interior that it is mainly a broad plateau. Only one eighth of the continent lies

FIG. 23. — Relief map of South America.

FIG. 24. — Relief map of Africa.

FIG. 25. — The island continent of Australia; also New Zealand, New Guinea, and several chains of islands which are parts of mountain chains in the sea.

Fig. 26. — The great continent of Eurasia.

below an elevation of 600 feet. Madagascar is part of a mountain chain; the peninsula of Tunis is the eastern extension of the Atlas Mountains; and the peninsula of Abyssinia is also due to mountain uplift. There are few harbors, because there has been no extensive sinking of the land.

Summary. — *Africa is a broad plateau, triangular in outline, with mountains near the coast. Its coast line is remarkably regular.*

(E) *Australia.* — The continent of Australia (Fig. 25) is a huge island. A mountain chain in the east, and others in the west, have helped determine its form; but the mountains are not so arranged as to develop a typical triangular shape. York peninsula in the northeast, and the peninsula of Victoria and the island of Tasmania in the southeast, are continuations of the eastern Australia mountains. A sinking of this continent has caused many small bays and excellent harbors.

Summary. — *The island continent of Australia has not the typical triangular form. Mountains and sinking of the land have caused a somewhat irregular coast.*

(F) *Eurasia.* — While the other continents stand out quite by themselves, Europe (Fig. 27) and Asia are so closely connected that they are often considered as one continent. Had the study of geography not started in Europe, it is probable that it would have been called a part of the immense continent of Eurasia (Fig. 26). This great land area has an irregular triangular form, one angle of the triangle being at Bering Strait, the second in Indo-China, and the third in Spain.

Eurasia is so mountainous a land, with mountains extending in so many directions, that its coast line is exceedingly irregular. Its great peninsulas — Kamchatka, Korea, Indo-China, India, Arabia, Greece, Italy, Spain, and Scandinavia — are all due to the presence of mountains. The numerous large islands, including the Philippines, the East Indies, Japan, Sicily, Corsica, Sardinia, and the British Isles, are also parts of mountains. Between these mountain uplifts are inclosed many bays, seas, and gulfs.

Parts of this land, especially northwestern Europe, have been lowered beneath the sea. This sinking has formed the fiords of Norway, the Baltic, North, and Irish seas, and a multitude of estuaries, small bays, and harbors. It has also separated the British Isles from the mainland.

Summary. — *Europe is a part of the great Eurasian continent, which has a rough triangular form. The many peninsulas, bays, islands, etc., are due to mountain uplifts and to sinking of the land.*

(G) *Influence of Continent Forms on Man.* — The separation of the continents has interfered with the spread of man. Their low elevation has been very favorable to mankind. Had the average elevation (2000 to 3000 feet) been as great as the average depression of the oceans (12,000 to 15,000 feet), the greater part of each continent would be too high and cold to support a dense population. The development of men and nations has been influenced in many ways by the continent form, the outline of its coast, the inclosed bays and seas, the islands, and the distribution of mountains and plains.

An irregular coast line favors navigation; and it is an interesting fact that the inhabitants of continents that have regular outlines have advanced far less rapidly than those whose coast has many harbors and bays. Illustrations of these influences and others, on man, animals, and plants, will appear in later chapters.

Summary. — *The elevation, surface features, and coast line of continents have had important influence on man, animals, and plants.*

16. Form of the Oceans. — The continents are clustered around the north polar region, with tongues projecting southward: the ocean water is centered around the south polar region, with triangular tongues projecting northward between the continents (Fig. 29). In outline the oceans are very irregular, because the irregular continents form their boundaries.

We commonly recognize five oceans (Fig. 28). It is customary to choose an arbitrary boundary — the Antarctic circle — for the ice-laden *Antarctic Ocean;* but it is far better to consider as a great *Southern Ocean* (Fig. 29) all the

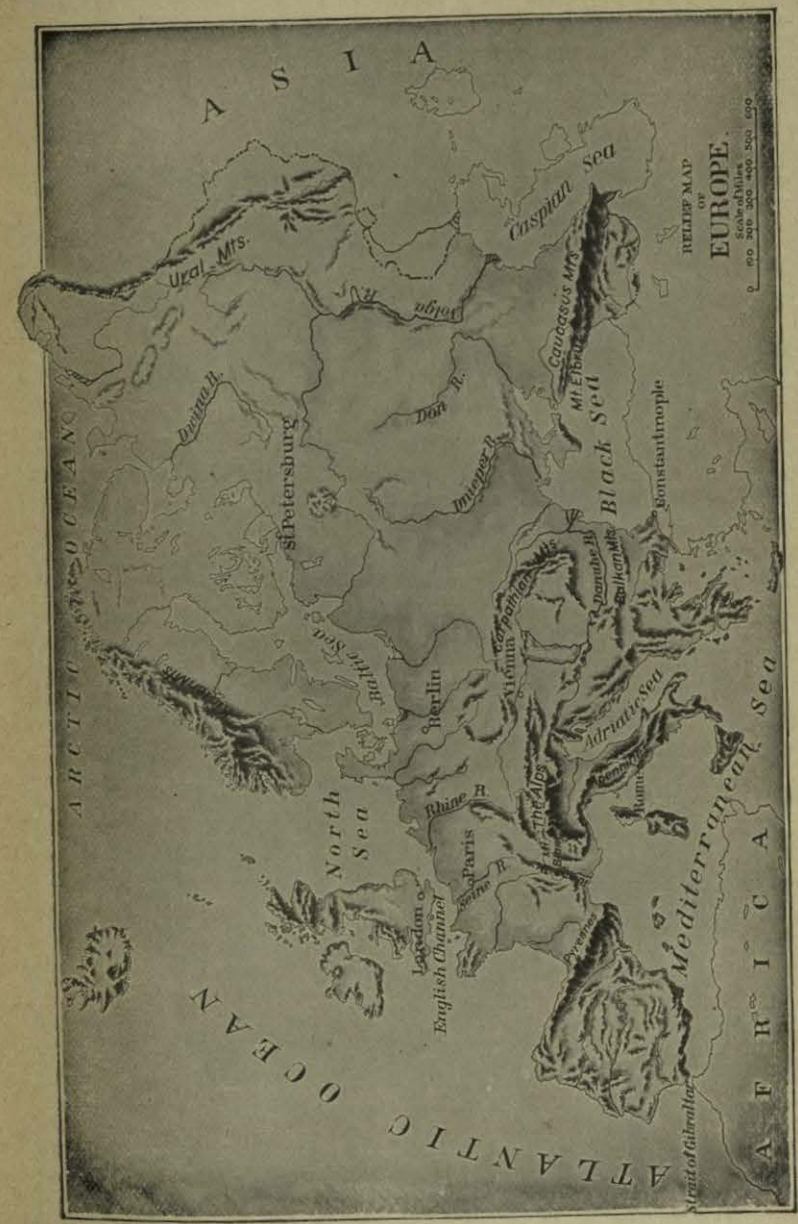

Fig. 27. — Europe.

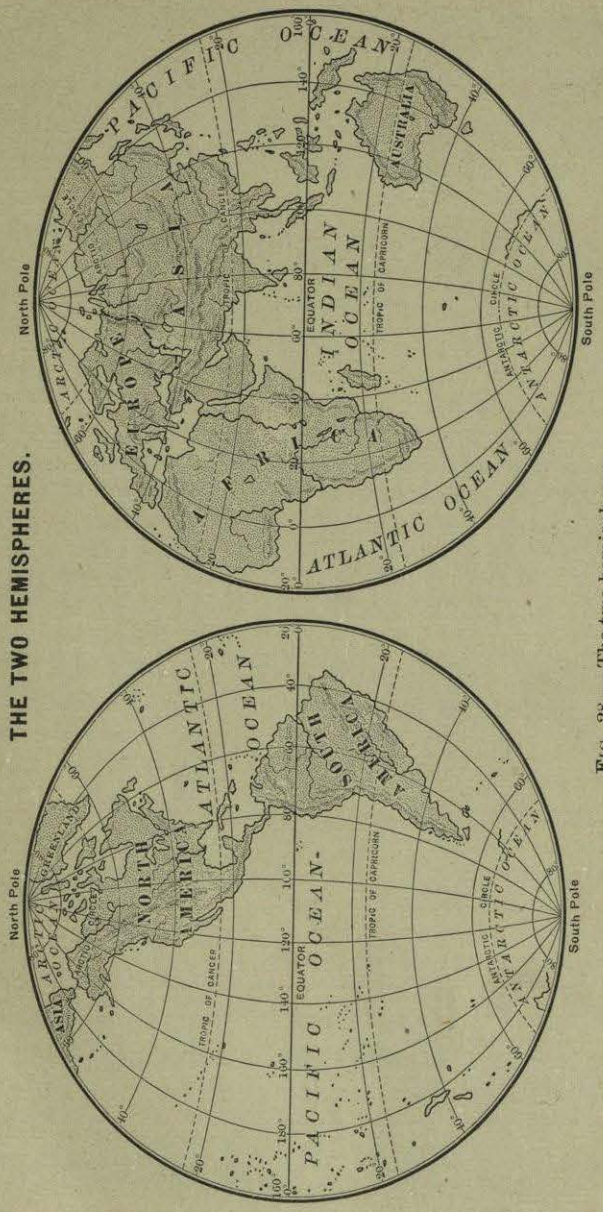

FIG. 28. — The two hemispheres.

water south of Australia, Africa, and South America. Three great ocean tongues extend northward from this Southern

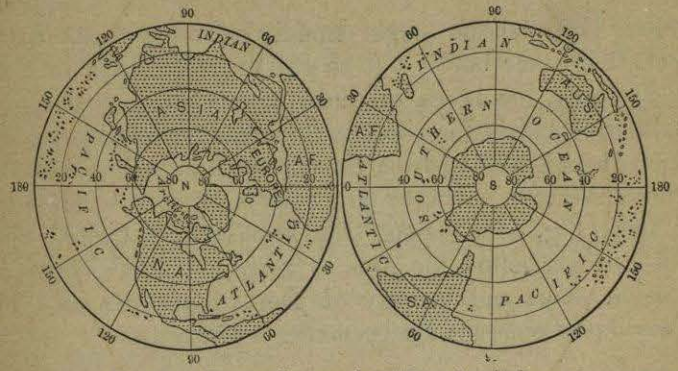

FIG. 29. — The northern and southern hemispheres.

Ocean: (1) the *Indian Ocean*, which reaches up to Asia between Australia and Africa; (2) the immense *Pacific*, which extends up between America, Australia, and Asia, to the point where America and Asia almost meet; and (3) the *Atlantic* tongue, bounded by the Americas on one side and Africa and Europe on the other. The Atlantic is given an hour-glass shape by the narrowing where the projection of South America reaches eastward toward that of Africa. The *Arctic Ocean* is an extension of the Atlantic; it is, in fact, an ice-covered bay, partly cut off from the Atlantic by Greenland and Iceland.

FIG. 30. — The land and water hemispheres.

The northern hemisphere contains the greater part of the land, while the southern hemisphere is essentially a water hemisphere (Fig. 29). By choosing the proper circle, it is possible to so divide the earth as

to have one hemisphere in which most of the land is placed, and the other with little land (Fig. 30). London is very near the center of the land hemisphere.

Now that men no longer timidly skirt the coasts in small boats, but steer boldly out to sea in great ships that visit every ocean, the needs of ocean navigation have led to the making of canals for short cuts across land barriers. Formerly, vessels sailing from Europe to India went all the way around Africa; now they take a short cut across the Isthmus of Suez (Fig. 535). Soon ships from eastern United States and Europe, bound for Asia or western United States, will make a short cut by way of the Isthmian Canal. Thus every day the oceans are becoming more useful.

Summary. — *Most of the ocean water is in the southern hemisphere, three triangular tongues extending from the great Southern ocean northward between the continents. The Arctic is a bay-like extension of the Atlantic.*

Topical Outline, Questions, and Suggestions.

Topical Outline. — 8. **The Atmosphere.** — Extent; composition; proof of its existence; importance, — life, fire, decay, diffusion of light and heat, hearing, winds, vapor, wind power; effects on land; soil.

9. **The Oceans.** — Distribution of water; area covered; depth; importance, — animal products, navigation, vapor supply, effect on climate.

10. **The Solid Earth.** — Covering of sea floor; of land; origin of soil; importance; depth; absence on steep slopes; condition beneath the soil mantle; valuable mineral substances.

11. **The Earth's Interior.** — Weight of material of outer part and of interior; proofs of interior heat; former belief; earth's crust; reasons for present belief; effects of pressure; former condition of earth; future.

12. **Air, Water, and Rock.** — (*a*) States of matter: air, water, and rock illustrate the three states; changes of each of these to the other two states. (*b*) Intermingling: rock and water in air; water and air in earth; air and rock material in water.

13. **Irregularities of the Earth's Crust.** — Average depth of ocean basins; average height of continents; proportion of plains; distribution of mountains and volcanoes; amount of irregularity of earth's surface; cause of irregularities; changes in level.

14. **Conflict of Erosion and Elevation.** — Nature of agencies of erosion; effect on land; on sea floor; conflict between erosion and elevation; importance of result upon man.

15. **The Continents.** — (*A*) *Characteristics:* definition; real boundaries; elevation; surface features; drainage; relation of mountains to continent form — illustration. (*B*) *North America:* mountain systems; relation to continent form; to plains and plateaus; to irregular outline; effect of sinking of the land. (*C*) *South America:* mountains; outline; irregularities. (*D*) *Africa:* outline; surface features; coast line. (*E*) *Australia:* position; form; coast line. (*F*) *Eurasia:* relation between Europe and Asia; form of Eurasia; effect of mountains on coast line; of sinking of the land. (*G*) *Influence of Continent Forms on Man:* effect of separation; of low elevation; of coast line.

16. **Form of the Oceans.** — General form and outline; subdivisions of the ocean waters; boundaries of each; land and water hemispheres; value of oceans for navigation.

Questions. — Section 8. What is the extent of the atmosphere? Name some important effects of the air.

9. What influence has gravity on the oceans? What is the area and depth of the oceans? Of what importance is the ocean for its animal products; for navigation; for its influence on climate?

10. What covers the sea floor? The land? What is the origin of soil? Of what value is it? What is beneath it? Why is it sometimes absent? What valuable materials come from the solid earth?

11. What reasons are there for believing the earth's interior to be highly heated? Why is it no longer believed to be molten? What prevents it from melting? What is the earth's crust?

12. How do the states of air, water, and rock vary? What are the three states of matter? How are air, water, and rock mingled?

13. Compare the ocean depths and continent elevations. What is the general condition of ocean bottoms and continents? Where are mountains found? How many times greater is the earth's diameter than the height of Mt. Everest? What is the cause of these irregularities?

14. What agencies are attacking the land? What effect has this attack on the land? On the sea floor? What conflict is there between opposing forces? How has this conflict been of importance to man?

15. (*A*) What are the characteristics of a continent? What relation do the mountains have to the continent form? Give an illustration. (*B*) Explain the general form of North America. Explain the irregularities of the outline. Give instances illustrating each of the two causes for irregularities. (*C*) What are the characteristics of South America? (*D*) Of Africa? (*E*) Of Australia? (*F*) What is the relation of

Europe to Asia? Explain the irregular outline of Eurasia. (*G*) How has the continent form influenced man?

16. State the distribution of the ocean water: its general distribution; the subdivisions, starting from the Southern Ocean; the meaning of land and water hemispheres. What obstacles have been overcome?

SUGGESTIONS. — (1) In a small jar seal up a plant, being careful to have it well watered, and see if it grows after the oxygen is exhausted. (2) Place a candle in a fruit jar, light it and see if it burns after the oxygen is used up. (3) Why are there holes beneath the flame of a lamp? (4) Have some oxygen generated in the chemical laboratory, and place in it a smouldering piece of cloth. Explain the change that occurs. (5) How deep is the soil in your vicinity? Find some cut — a cellar, railway cut, or stream valley, — where bed rock is seen beneath the soil. How thick is the soil? Of what is it composed? What kind of rock underlies it? Is the line between rock and soil a sharp line? (6) To illustrate the three states of matter: freeze some water. Melt the ice, then evaporate the water over the fire. Where does the water go? Place some water in a shallow pan in a room and watch it from day to day. Where does it go? What becomes of the water that you pour on plants? Of that sprinkled on the city pavements? (7) Stir mud and water together. Have you ever seen a stream resembling the muddy water? Where did the mud come from? Where was it being carried? (8) Carefully weigh a piece of chalk. Soak it in water and weigh it again. Why the difference? Most rocks will illustrate the same thing, but, being less porous, not so well as chalk. (9) Place some salt in water and stir it once in a while. Where has the salt gone? After twenty-four hours pour the water off and evaporate it. Do you find the salt? Chalk, marble, and many mineral substances will dissolve as the salt did, but in smaller quantities. (10) See if there are fossils in the rocks of your neighborhood. If so, find out if they once lived in the sea. What do they prove? (11) In a shallow pan of water build three ridges of pebbles and clay, as high as you can, forming a triangular outline to represent the mountain skeleton of North America. With a sprinkling pot wear them partly down. Draw off the water with a siphon, then make a sketch map of the miniature continent, marking on it the position of the mountain ridges. Compare it with an outline map of North America.

Reference Books. — See references at end of Chapters III, X, and XII; also MILL, *International Geography*, Appleton & Co., New York, $3.50.

CHAPTER III.

CHANGES IN THE EARTH'S CRUST.

17. Relation of Man to the Land. — In a railway journey from Atlantic City, east of Philadelphia, to Chicago a great variety of land forms may be seen. First the seashore; then a lowland plain; then a hilly country; then a wild mountain region, with long ridges separated by broad valleys; then a rugged plateau, with rivers deeply set between steeply rising, wooded banks; then the open plains. Besides these large features many smaller ones are noticeable — rivers, creeks, brooks, rapids, waterfalls, floodplains, lakes, narrow gorges, broad valleys; in fact, all the great variety of land forms to be found in a large area of diversified country.

The careful observer will also note the following facts regarding settlement and industry. The steeper hill and mountain sides are still forested (Fig. 85), and lumbering is the only industry on their rocky slopes. Few houses are seen in the narrow valleys, though here and there a fall has given the site to a mill, or even to a town; and, in a few places, there is some industry connected with the production of valuable minerals from the mountain rocks. On the other hand, the open plains and low hills, both to the east and west of the mountains, are everywhere inhabited; houses are almost always in sight, woods are scattered, farms are seen on every hand, and the land is dotted with villages, towns, and cities.

This route passes three of the largest eleven cities in the United States, — Chicago the second in size, Philadelphia the third, and Pittsburg the eleventh. One is a sea port, one a lake port, and one a river port.