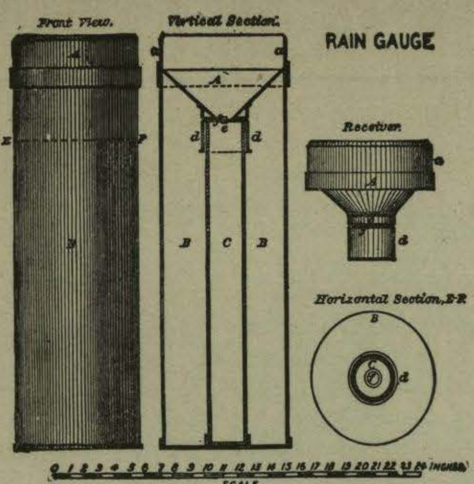

FIG. 561. — Rain gauge. *B*, outer cylinder; *C*, inner cylinder; *a*, *a* (and small right-hand figures), the funnel.

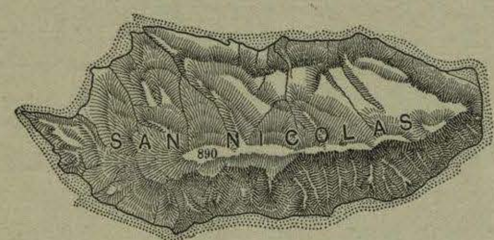

FIG. 562. — Hachure map from one of the United States Coast Survey charts.

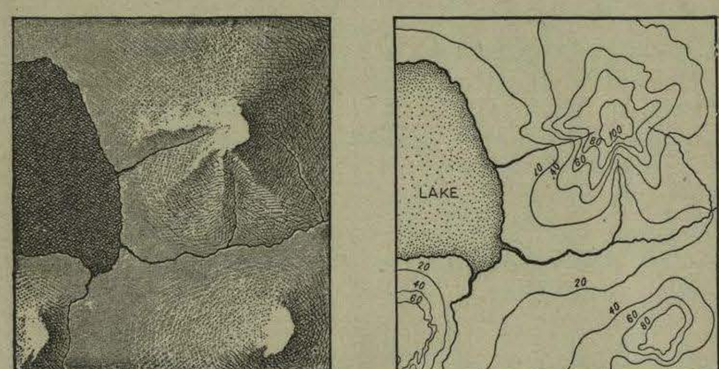

FIG. 563. — To illustrate the meaning of contours. On the left is a model; on the right the same topography is represented by contours.

tion, of 21°. West of the line of no variation, or no declination, the needle points to the east of true north, in northern Washington reaching an east declination of 23°. A map showing lines of equal magnetic declination is an *isogonic map* (Fig. 560).

The amount of declination slowly changes, so that a map made for one year is not strictly accurate for the next year; but the change is so slow that a long time is necessary to produce a marked difference. The cause for these changes, and even the cause for the magnetism of the earth, is unknown. It is some condition within the earth, far from the surface, possibly in some way connected with the heated interior. All that is positively known is that, for some reason, the earth acts as a great magnet.

The *aurora borealis*, or northern lights, is in some way connected with this magnetism. A similar phenomenon, the *aurora australis*, is found in the southern hemisphere. The aurora is not common in the United States, though sometimes it becomes visible, and even vivid. The northern sky is then aglow with an arch of strange light, with streamers darting to and fro. In the far north the aurora becomes much more vivid, and may be seen night after night. The cause of the aurora is unknown, though it seems to be due to faint electrical discharges in the upper air, resulting from some influence of the earth's magnetism.

SUGGESTIONS. — (1) Learn to read a compass (a small one is quite inexpensive). Determine the true north and south line. This can be done by setting up two poles in line with the north star. With a compass, observe the difference between true and magnetic north. (2) Place a bar of iron near a compass. Is the needle disturbed? Try the effect of a magnet. (3) If you have ever seen an aurora, describe it. Have you ever read a description of one in a book of Arctic travel?

APPENDIX G. METEOROLOGICAL INSTRUMENTS.

1. Thermometers. — The ordinary thermometer is a sealed glass tube with a cavity of small diameter, ending below in an expansion, or bulb, in which there is mercury. The mercury can rise and fall freely in the tube because there is no air in it. The principle of the thermometer is that liquids, like mercury, expand and require more space when warmed, but, when cooled, contract and take up less space. As the temperature changes, therefore, the mercury in the bulb causes a tiny thread of mercury to rise and fall in the tube. Other liquids may be used; in fact, alcohol is used when thermometers are to be exposed to cold greater than the freezing point of mercury (– 40°).

Thermometers are graduated in degrees, the division commonly used in America and England being the Fahrenheit (Fahr.) scale. In this, the boiling point of water is placed at 212° and its freezing point at 32°. This is not nearly so simple a scale as the Centigrade (Cent.) which is commonly used on the continent of Europe. In this, the freezing point is placed at 0° and the boiling point at 100°. To convert Centigrade to Fahrenheit, multiply by 1.8° and add 32°. Thus 10° Cent. equals 50° Fahr. (10° × 1.8° = 18° + 32° = 50°).

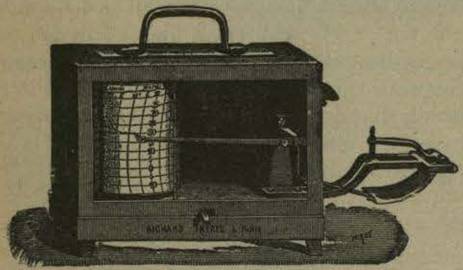

FIG. 564. — A thermograph.

Metals also expand when warmed and contract when cooled. Because of this fact, thermometers may be made of metal strips connected with a hand that moves over a graduated dial. Such thermometers may sometimes be seen in front of city stores. A metal thermometer may also be connected with an arm, bearing a pen, which is moved as the temperature changes. This pen may be so placed as to press against a piece of paper on a cylinder, revolved by clockwork. As the pen rises and falls, while the

cylinder regularly revolves, it writes a record of temperature changes for every minute of the day. Such a self-recording thermometer is called a *thermograph* (Fig. 564).

2. Barometers. — The weight, or pressure, of air will push liquid up into a tube having a vacuum in the top. It will push the liquid up until a column is formed that equals the weight of the air column pressing on it. It is because of this air pressure that water is pushed up from a well into the tube of a pump. The stroke of the pump exhausts air from the tube, thus tending to make a vacuum, into which the water may be pushed by the air pressure. Since a column of water about 30 feet high balances the air pressure, an ordinary pump could not possibly raise water from a fifty-foot well.

Years ago water, in tubes over 30 feet long, was used to measure air pressure. Mercury is now employed because it is so heavy that a column only thirty inches high balances the air pressure. An instrument containing such a mercury column is called a *barometer*.

Any one can make a rough barometer with a glass tube 35 inches long, sealed at one end. Fill it with mercury, and invert it, with the open end in a small dish of mercury, being careful not to allow the mercury to spill. The mercury will fall a few inches, and air pressure will keep it there. By fastening it to a standard to keep it upright, one may watch the mercury rise and fall from day to day. A scale of inches and tenths of inches may be marked on the glass with a piece of quartz or a glazier's diamond; or on the piece of wood to which the tube is fastened. By comparison with a barometer the scale may be made exact.

Ordinary mercury barometers are graduated in inches and tenths of inches, and a scale, called a *vernier*, enables readings to hundredths of inches. As storms come and go the air pressure varies, and with these changes the height of the mercury column changes. When the air is heavy the barometer column is high, and there is a *high barometer*; when the air is light the barometer column is low, and there is a *low barometer*. For example, 30.1 inches is a high barometer; 29.3 is a low barometer.

Since there is less air (and therefore less pressure) above highlands than lowlands, the barometer is low on highlands and high on lowlands. As this difference in pressure varies quite regularly, a barometer may be used to measure elevation; for a change of an inch in the mercury column represents a difference in elevation of a certain number of feet.

A mercurial barometer is too cumbersome, and too easily injured, to be carried about; therefore, for measuring elevations, an *aneroid barometer* is commonly used. An aneroid, which is so small that it may be carried in the pocket, has a metal diaphragm inside of a metal case. Differences in air pressure cause this diaphragm to move, and this movement is communicated to a hand which moves over a dial (Fig. 565). Since the dial is graduated in feet, one can tell at a glance how high he has climbed.

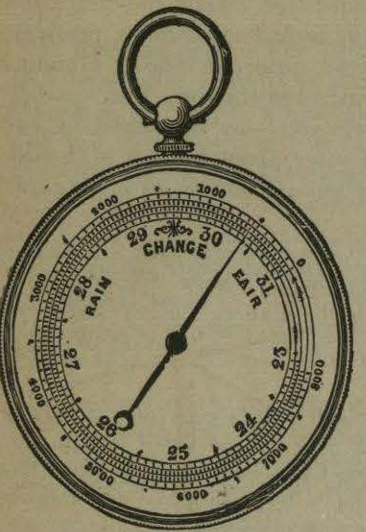

FIG. 565. — Aneroid barometer, graduated in feet (outside) and inches (inside).

One serious disadvantage in the use of the aneroid is that it is affected by *all* changes in air pressure. Thus, if a storm passes while the aneroid is being used to measure an elevation, the change in air pressure causes the hand to move, making an error in the observation. This can be corrected, however, by comparing its readings with those of another barometer kept at a fixed place.

As in the case of thermometers, there are self-recording barometers, or *barographs*. In these, as in thermographs, a pen point pressed against a roll of paper on a cylinder, revolved by clockwork, gives a continuous record of changes in pressure.

3. Anemometers. — Wind *direction* is determined by the ordinary *weather vane*, and the *rate* at which the air is moving by the *anemometer* (Fig. 566). The latter instrument consists of four metal cups on crossbars, revolved by the wind striking the hollow side of the cups. Each revolution is communicated

to a cog-wheel, which causes a hand to move on a dial, recording the velocity.

Wind velocity is measured in miles per hour, and the dial is so graduated that the hand indicates the number of miles the wind has moved. An anemometer may be connected by electric wire to a self-recording apparatus.

A slight breeze has a velocity of from 1 to 10 miles per hour; a strong wind from 20 to 30 miles; a gale from 40 to 60 miles; and a tornado wind even as much as 200 miles per hour.

4. Measurement of Vapor. — There are several instruments for determining the humidity of the air. One of these is the *hair hygrometer*, which consists of a bundle of hair robbed of its oil. Such hair will absorb vapor, changing in length as the amount of absorbed vapor varies. It is because of this fact that the hair of many people becomes straight in damp weather. In the hair hygrometer a hand is moved over a graduated scale, in one direction if the humidity is high, in the other if it is low.

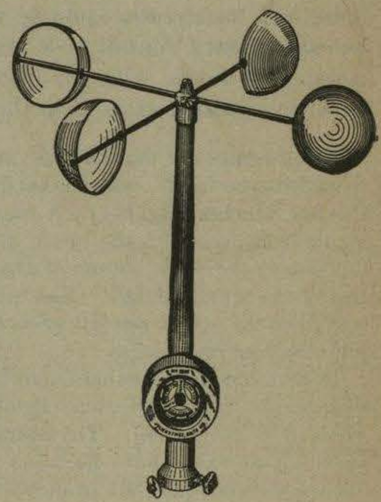

FIG. 566. — An anemometer.

Another instrument, the *sling psychrometer*, consists of two thermometers attached to a board, one having a piece of wet muslin around its bulb. Its use depends upon two facts: (1) That evaporation is more rapid in dry than in humid air; (2) that evaporation lowers the temperature.

Since evaporation is more rapid when the air is moving, the sling psychrometer is whirled around for a minute or two. If the air is saturated, there will be no evaporation from the wet muslin, and the two thermometers will, therefore, read the same; but if the air is dry, the wet bulb thermometer will register a perceptibly lower temperature. The United States Weather Bureau furnishes tables from which the relative humidity can be calculated, when the difference in temperature between the dry and wet bulb thermometers has been determined.

Various instruments are used for determining the *rate of evaporation*, which varies from day to day and from place to place. An *evaporating pan* consists of a dish of water in which is placed a ruler graduated in inches and tenths of inches. By this, one can tell how much is evaporated from the water surface in a given time. Rain should be prevented from falling into the pan, but it should be freely open to the air. It should not be exposed to the sun, because warming increases evaporation. It is best to place it in the ground with the top level with the surface.

5. Rainfall Measurement. — Rainfall is recorded in number of inches and tenths of inches that falls on a given surface. Any cylinder, as a tomato can, could be used as a *rain gauge*, or measurer; but an ordinary rainfall is so slight that it would be difficult to measure it unless some provision were made for collecting the water in a smaller space than the surface on which it fell.

Any tinsmith can make a rain gauge, with two cylinders, one inside of the other, the inside cylinder having an area of 2.53 inches, the outside one 8 inches (Fig. 561). A funnel fits over the outside cylinder, and a hole in it leads into the inside cylinder. The rain that falls on the funnel collects in the bottom of the inner cylinder to a depth ten times that of the actual rainfall. Measuring this with a ruler, and dividing by ten, gives the actual rainfall, even though it is slight. There are also self-recording rain gauges.

Instruments are sometimes used for measuring snowfall; but usually this can be fairly well done by measuring its depth in some place where it is not drifted. The average snowfall is about ten times the amount that would have fallen as rain. In weather records it is customary to record snowfall in inches of rain. Place snow in a cylinder, filling it to a depth of a foot, and melt it to see how much water it produces. Do not pack the snow down.

6. An Instrument Shelter. — In order to get good results, meteorological instruments must be placed where they are not influenced by local conditions. For example, two thermometers, one in the shade, the other exposed to the sun, will give very different readings. A simple *instrument shelter*, made of inclined, overlapping slabs, far enough apart to let the air circulate freely, and yet near enough together to keep the sun out, is easily made. It should be placed either on open ground or on the roof.

The barometer may be kept in the schoolroom, the rain gauge on open ground away from a building, and the anemometer on the roof; but the other instruments are best kept in an instrument shelter.

SUGGESTIONS. — For purchase of meteorological instruments, see p. 438. As indicated above, it is possible to make several of the common instruments, especially the barometer, psychrometer, evaporating pan, and rain gauge. This might easily be done in the manual training department. With these instruments daily records may be kept, and laboratory work of value done, especially for comparison with the study of weather maps and storms. Daily and seasonal temperature curves may also be made. If this work is carried along with the study of the atmosphere, the teacher will find many opportunities for connecting observations with facts in the book. For example, observe the humidity of the air near the ground when dew is forming and when it is not. When frost is forming, take the temperature of the ground and of the air 10 feet above it to see if radiation cools the ground. After the barometer begins to fall, does it rain? What change in wind direction then takes place? In temperature, etc.?

SUGGESTED RECORD.

	JANUARY 1, 1903.			JANUARY 2, 1903.			JANUARY 3, 1903.		
	8 A.M.	1 P.M.	8 P.M.	8 A.M.	1 P.M.	8 P.M.	8 A.M.	1 P.M.	8 P.M.
Temperature	5°	10°	2°	– 1°	20°	18°	17°	30°	31°
Barometer	30.0	30.0	30.1	30.1	30.0	29.9	29.8	29.7	29.6
Wind	West	West	Calm	Calm	S.W.	S.W.	South	S. E.	East
Wind Force	Moderate	Strong	Calm	Calm	Light	Breeze	Light	Strong	Gale
Sky	Clear	Cumulus	Clear	Clear	Clear	Cirrus	Cirrus	Cirro stratus	Stratus
Rainfall	0	0	0	0	0	0	0	.1 light snow	.3 heavy snow
Humidity	80	60	82	85	55	85	90	100	100

APPENDIX H. WEATHER MAPS.

The U. S. Weather Bureau issues daily maps showing weather conditions throughout the country. By application these can doubtless be secured for the school, and, being placed in the schoolroom, will serve as a valuable basis for laboratory study.

The weather maps are based upon reports telegraphed from Weather Bureau Stations in all sections of the country; and the facts regarding temperature, rainfall, and wind are placed in a table at the bottom of the map. On the basis of these reports, predictions for the next day are made at a central office.

On the map, which is an outline map of United States, the direction of the wind is indicated by arrows. At the ends of some of the arrows is the letter R, meaning rain, or S, meaning snow. Arrows that terminate in blank circles (↥○) mean clear weather; when crossed by a line (↥⊖), partly cloudy; and when occupied by a cross (↥⊗), cloudy. The centers of high and low pressure areas are indicated by the words *High* and *Low*. Dotted lines (*isothermal lines*) pass through places having equal temperatures, and continuous lines (*isobaric lines*) pass through places with equal air pressure. The barometric readings (29.8, 30.1, etc.) are all reduced to sea level; that is, made to read as they would if the station were at sea level.

Thus the weather maps, besides describing the weather conditions and predicting for the next day, contain a large amount of information concerning the weather of different sections. A study of the maps on several successive days will make their meaning plain, and will illustrate many points discussed in the book.

Sets of maps suitable for the work suggested below are easily obtained by keeping the maps for a year or two. Out of date sets may possibly be obtained from the Weather Bureau. Or the teacher could make large wall maps for class use, selecting typical sets, and sketching the weather conditions on a large outline map of United States.

Suggestions.— (1) Study a weather map to understand its meaning. Which isotherm passes nearest your home? What other places have the same temperature? What is the air pressure? What other places are on the same isobar? Is the weather at your home clear, cloudy, or rainy? What is the wind direction? How do these facts compare with your

own observations the previous day? Study the weather maps for the next two days. What differences are noticed? Do you find any explanation? (2) Select weather maps to illustrate a typical storm. Have each student make a copy of it on a blank map of United States. Have them tell in what parts the pressure is low, and where high. Shade between the isobars. Shade on the map the rainy or snowy sections. With another colored pencil, mark the cloudy areas. What is the direction of the winds in the different areas? What part of the storm area is warmest? What part coolest? What is the direction of the wind in each case? Can you find an explanation of any of the facts observed? (3) In the same way, study the weather maps for the next three days. Write a statement of the changes that have occurred. On an outline map draw the path followed by the storm center. Select some place on the map, and have the students describe the weather changes — pressure, temperature, wind, and rain — for the four days. (4) In the same way study a set of maps in which a typical high pressure area, or anticyclone, passes across the country. (5) On an outline map plot around the same central point the winds of three well-defined storms. Also three anticyclones. What about their direction? (6) Give to each student a map with a well-defined storm, and have him tell what he thinks the weather conditions were the day before, and what they were the next day. First remove the predictions from the map. After the predictions have been written down, show the actual maps. This practice may be continued until the class becomes fairly proficient in predictions. Toward the end of these exercises have the students sketch their predictions on outline maps; that is, upon the basis of their study of a map for a given day, let them make a weather map of the previous and succeeding days. Care should be taken to select well-defined storms that move regularly, otherwise the results may be poor. (7) Give out problems; many will be suggested by a study of a series of weather maps. For example, given a well-defined low at Chicago, temperature 34.5°: is it clear or rainy? Is the temperature probably higher or lower at Minneapolis? At Indianapolis? On a sketch map of United States indicate the area of probable snow. Of rain. What will the weather probably be next day at Chicago? At Cleveland? (8) Upon the basis of observations with instruments in the school make weather predictions. (9) Each day give the weather map to one of the students, and let him report the facts of barometer, temperature, position of highs and lows, etc.; or, better, sketch them on an outline map for the class to see. Then call for predictions from the class, and have them give their reasons. Then read the prediction on the map. Next day call for a statement of how nearly correct the prediction was.

APPENDIX I. MAPS.

VARIOUS methods are employed to represent the surface of the earth by maps. Among these are relief maps, hachure maps, and contour maps, all of much value in a study of physical geography.

1. **Relief Maps or Models.** — Ordinary maps are flat; and the usual political map makes little attempt to represent relief. Yet by shading, or by color, some are made to indicate the general distribution of highlands and lowlands. A far better means of representing a country is by relief map, or model, in which the surface is actually raised to represent irregularities of the land.

Owing to the small size of such maps, it is usually necessary to exaggerate the vertical, that is, make the scale of elevation, or vertical scale, different from the horizontal scale. Thus one inch vertically may represent 1000 feet, while in the horizontal scale an inch represents 10,000 or even 20,000 feet. To avoid wrong impressions from the use of such maps, care should be used to understand and make allowance for this exaggeration.

The great expense of making relief maps prevents their use in most school laboratories. Figures 22–26, 114, 460, 461, 464, 476, 477, and 485 are photographs of such models.

2. **Hachure Maps.** — The United States Coast Survey and the surveys of many European countries make use of *hachures* to represent irregularities of the surface of small sections. A hachure map is one in which the relief is brought out by shading, through the use of lines drawn more or less closely together, and all pointing in the direction of the slope (Fig. 562). Such a map is very graphic, and exceedingly useful in a study of the general form of the land. For some purposes its usefulness is lessened by the fact that, though it clearly brings out *differences* in elevation between adjoining regions, it does not tell the *actual* elevations.

3. **Contour Maps.** — The fact last mentioned has led other surveys, for example the U. S. Geological Survey, to adopt *contour lines*, or lines passing through places of equal elevation.

Imagine a rather irregular beach at low tide when there are no waves. The water marks a contour line, and extends up the depressions, or valleys, in the sand. This may be called the 0 contour; if the tide rises five feet, a new contour is marked five feet above the other. This might be called the five-foot contour.

In making contour maps, sea level is reckoned as 0, and each contour passes through all places on the map that are at the same level above sea; that is, places which the sea would touch if it rose that high. Every place through which the 100-foot contour passes is just 100 feet above sea level. On such maps, therefore, it is possible to tell the elevation of every place. Contour maps do not express relief so graphically as hachure maps, but, with a little study, one learns to quickly interpret from them the forms of the land. Plains have few contours, far apart; gorges have many, close together; rounded hills have contours of different shape from those on steep-sided hills, etc. Figures 78, 82, 121, 131, 137, 145, 192, and 193 are contour maps.

On the U. S. Geological Survey maps the horizontal scale is usually about one inch to the mile. The vertical scale, or *contour interval*, is usually 20 feet; that is, a contour is drawn for every 20 feet of elevation. Therefore, the vertical distance, or interval, between two contours is 20 feet. In sparsely settled or mountainous regions a contour interval of 100 feet is often chosen.

SUGGESTIONS. — (1) Find out if the U. S. Geological Survey (Washington, D.C.) has issued a contour map of your vicinity. If so, get a copy (cost 5 cents), mount it (p. 437), and carry it on your walks or bicycle rides. You will find it of great service. (2) Let the class have practice in making simple contour sketches; for example, have them make contours to show a round hill, a long hill, a hill steep on one end, two hills and a valley, a broad valley, a gorge, etc. Also draw simple contour sketches on the board (for example, a round hill), and have the class make cross sections of them; that is, sections to show the profile as if the hill were sliced through. Keep the class at this work until they understand how to do quickly what is given. (3) From some model select a section, and have the class sketch a contour map of it. (4) Obtain a series of contour maps, and have the class make cross sections along lines drawn on the map by the teacher. To make these sections, first draw a line on the paper equal in length to the line on the map. Then, for the vertical scale, draw, parallel to this, other lines $\frac{1}{16}$ inch apart.

Let the distance between two of these lines represent 20 feet. Then proceed to draw the profile. (5) After some practice in cross-sectioning, select a series of maps and assign to each student part or all of a map to define the topography in words. This may well be followed by other maps. (6) The teacher may, possibly, deem it worth while to have the class make a map of a small area. With a tape line, an aneroid barometer, a level, and a compass, a rough map may easily be made. (7) If the teacher would each year have a model made by the class, the school would soon accumulate a valuable equipment. It is not very difficult to make a model. For the first one start with a simple region — say the Marion, Iowa, sheet. Find the lowest contour on the sheet and transfer it to tracing paper, then to a thin cardboard sheet the size of the map. Then cut the cardboard along the line. Tack it to a board, or thick cardboard, the size of the map. Do the same for the next highest contour, and tack this to the first. Continue until there is a pile of cardboards, one for each contour. Divided among many, this is not a very difficult task. With molding wax, smooth the surface so that no cardboard edges appear. After one or two trials a very satisfactory model will be made. On more complex sheets it is not necessary to trace every contour. An interesting model may be made by starting with a large number of sheets of the same map and, instead of tracing the contours, cut the map itself, and paste sheet on sheet until each contour is represented. To cut the sheets with an even edge, lay the map on a sheet of glass or zinc and cut it with a sharp knife.

Reference Book. — GANNETT, *Manual of Topographic Methods*, Monograph XXIV, U. S. Geological Survey, Washington, D.C., 1893, $1.00.

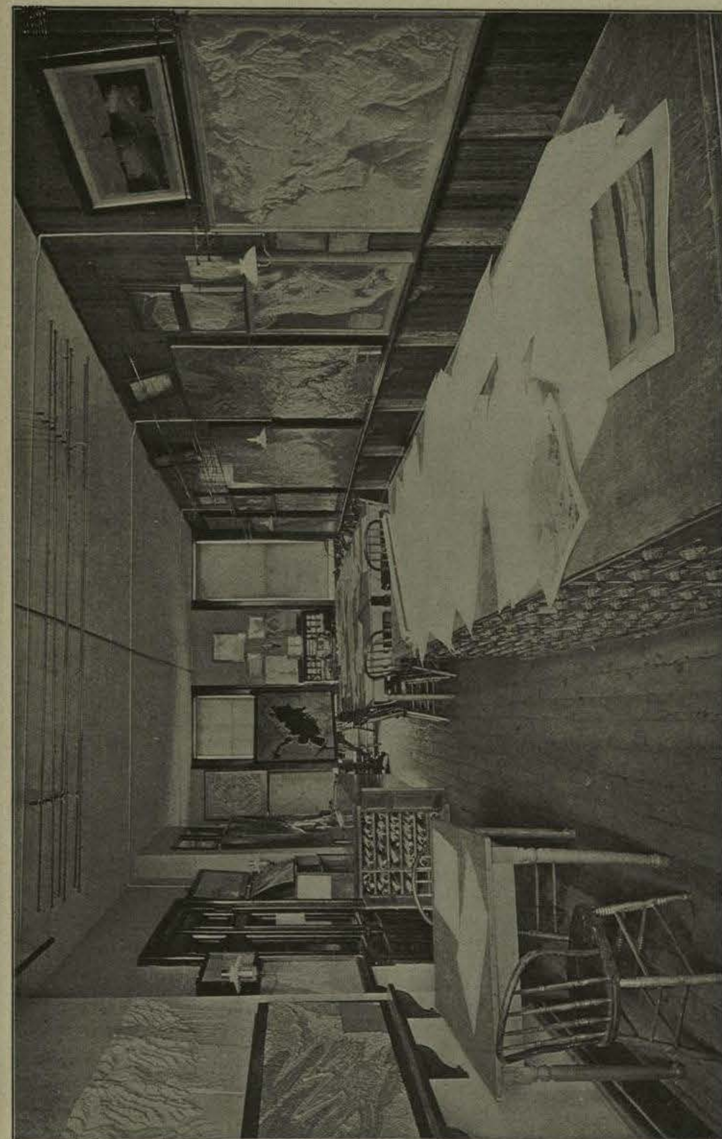

FIG. 567. — A physical geography laboratory. Models are attached to the walls, and over by the window is a frame (on rollers) containing two models. A case for flat maps is in the foreground, and one for rolled maps on the left near the door. Brass rods, for hanging maps, are placed over the models; and, suspended from the ceiling, are others which may be lowered by means of pulleys.

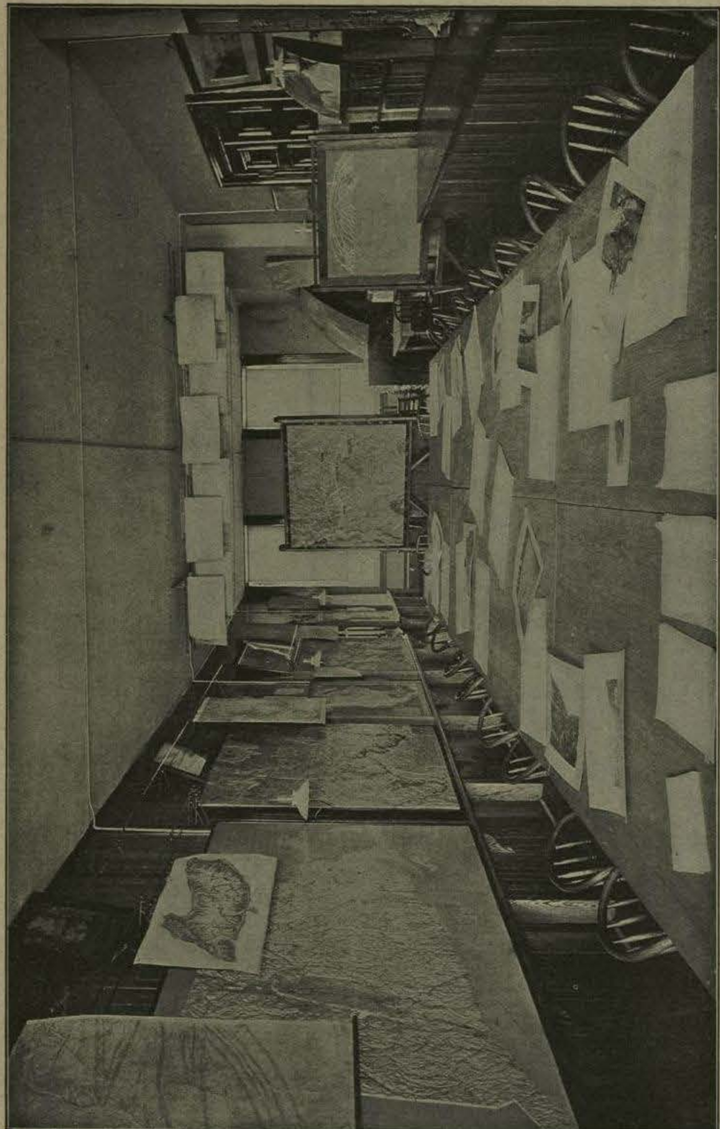

FIG. 568. — Same laboratory as 567, from other end, with maps hung on the rods. Those on the ceiling rods, in middle of room, may be lowered. Large table, made by grouping small tables, in foreground. Students are seated around this for map work. It is possible to assemble around this table a large assortment of models, maps, and photographs, for use during a laboratory period.

APPENDIX J. LABORATORY EQUIPMENT.

1. Models. — *E. E. Howell* (612 17th St., N.W., Washington, D.C.) has a number of models of great value in laboratory work. He also offers for sale large photographs of these. Catalogue sent on application. *G. C. Curtis* (64 Crawford St., Boston, Mass.) has a set of three excellent geographical models (*glaciers*, *volcanoes*, and *seacoast*). The *Harvard Geographical Models*, a set of three, are sold by Ginn & Co., Boston, for $20 a set. These last two sets should be in every laboratory of physical geography. The *Jones model* of the earth is very valuable (cost $50, A. H. Andrews & Co., Chicago). For construction of models from topographic maps, see page 430.

2. Maps. — The *Kiepert* and the *Habenicht & Sydow* relief maps of continents and parts of Europe are the best maps of this nature. The various government bureaus (see below) will on application send catalogues of their maps, from which the teacher may select those desired. The following lists have been carefully prepared to secure representative maps of various phenomena, and they may serve as the nucleus of a map collection for laboratory use. For further suggestions, see pamphlet by DAVIS, KING, and COLLIE, *The Use of Governmental Maps in Schools* (Henry Holt & Co., New York, 1894, $0.30); also DAVIS, *Journal of Geology*, Vol. IV, 1896, p. 484. Foreign maps may be imported through G. E. Stechert (9 East 16th St., New York).

The entire United States coast is charted by the U. S. Coast Survey, and many parts of the country are mapped by the U. S. Geological Survey. All of New Jersey, Massachusetts, Connecticut, Rhode Island, and most of New York are now mapped, as well as portions of each of the other states. The Geological Survey topographic sheets may be ordered for $0.05 each, or at the rate of $0.02 a sheet if 100 or more are ordered. Money must be sent by money order *in advance*. The Geological Survey also issues special maps, for example a series of different scale maps of United States; also geological folios, — perhaps of your district.

Each school should have sets of the *United States Geological Survey Physiographic Folios*, especially the first two. They contain selected maps, with description, to illustrate physiographic types. Folios 1 and 2 cost $0.25 each; No. 3, $0.50.

3. Use of Topographic Maps. — The use made of topographic sheets will vary with the teacher, the time available, and the number and variety of sheets at hand. The following is the method adopted by one teacher, who has all the maps he needs, both American and foreign. After the students become familiar with the meaning and use of topographic maps (p. 429), a topic is chosen for a laboratory period, say glacial action, or one phase of it, and typical maps (combined sheets) illustrating the phenomena are hung about the room to be studied and interpreted, careful notes being taken. At the close of the period a review quiz is held by the teacher, with the object of correlating observations and bringing out points whose full significance may not have been apparent to the students. The lesson is definitely correlated with the text-book work, and generally covers a topic then being studied.

In addition to the wall maps, single sheets are placed in the hands of each student, each sheet clearly illustrating some one phase of the topic chosen. This illustration the student must discover by observation. The study proceeds somewhat as follows: (1) *Location:* (*a*) latitude; (*b*) longitude; (*c*) position on United States contour map; (*d*) physiographic relationships (*i.e.* on coastal plain, in Adirondacks, etc.). (2) *General physiography:* (*a*) highest elevation; (*b*) lowest section; (*c*) direction of rivers; (*d*) abundance or scarcity of tributaries; (*e*) humid or arid region; (*f*) form of valleys; (*g*) slopes; (*h*) nature of divides; (*i*) direction of roads; (*j*) influence of physiography on roads, railways, and settlement. (3) *Specific points* (for example, on Elmira, N.Y., sheet): (*a*) find morainic hills near Lower Pine Valley — the ice front stood there; (*b*) describe the valley south to Elmira and southwest to East Corning; (*c*) measure its width and compare with that occupied by the Chemung River west of Elmira; (*d*) what is a wash plain (see text-book)? (*e*) could this be a wash plain? If so, what change has it caused in the depth of the valley? Would it account for the broad, flat-bottomed valley followed by the railroad? Might it have raised the valley bottom so high that the Chemung could not follow its former course via Horseheads? This is what has happened.

The subject can be developed formally by mimeographing questions, or putting them on the blackboard; or, better, if the class is not too large, by giving general directions, then asking specific questions, either of the class as a whole or of individuals. Work done on individual sheets is included in the review at the end of the exercise.

By the above method, when plains are studied laboratory exercises may accompany the recitation work; the same with shore lines, lakes, mountains, etc. The student should not be allowed to be diverted by other phenomena than those directly bearing on the topic. The same

map may often be used in several periods to illustrate different phenomena. In this work the student is expected to look for comparisons and contrasts; for example, under "Plains," compare and contrast the the Fargo, N.D., Kaibab, Ariz., and Palmyra, N.Y., sheets.

Another method used is to study a sheet to detect all phenomena represented; but this lacks many of the advantages of a study by topics. In the absence of a regular laboratory manual, it is necessary for teachers to develop their own methods, and this Appendix is merely a hint as to one direction in which this may be done. It calls for sacrifice of time and energy on the part of the teacher; but all who are willing to make this sacrifice will be abundantly repaid by the improved work and greater interest of the class. Even if formal laboratory work is not given, the maps are of great use as illustrations of the text.

4. One Hundred Selected Sheets, United States Geological Survey, Topographic Map. — *These maps should be purchased by the hundred* ($2 a hundred); and it is desirable to provide enough sets for each student in the laboratory to have a copy of each, or, at least, to provide one for every two students. They should be mounted (p. 437).

(1) *Glassboro, N.J.;* (2) *Leonardtown, Md.;* (3) *Pt. Lookout, Md.;* (4) *Fargo, N.D.;* (5) *Hamlin, N.Y.;* (6) *Marion, Iowa;* (7) *Wichita, Kan.;* (8) *Butler, Mo.;* (9) *Marshall, Ark.;* (10) *Lamar, Colo.;* (11) *Brownwood, Tex.;* (12) *Coleman, Tex.;* (13) *Higbee, Colo.;* (14) *Kaibab, Ariz.;* (15) *Watrous, N.M.;* (16) *Boise, Idaho;* (17) *Modoc Lava Bed, Cal.;* (18) *Elmira, N.Y.;* (19) *Kaaterskill, N.Y.;* (20) *Gaines, Pa.;* (21) *Briceville, Tenn.;* (22) *Scottsboro, Ala.;* (23) *Salyersville, Ky.;* (24) *Huntington, W.Va.;* (25) *Pikeville, Tenn.;* (26) *Bisuka, Idaho;* (27) *Great Falls, Mont.;* (28) *St. Paul, Minn.;* (29) *Palo Pinto, Tex.;* (30) *Delaware Water Gap, Pa.;* (31) *West Point, N.Y.;* (32) *Jefferson City, Mo.;* (33) *Junction City, Kan.;* (34) *Kearney, Neb.;* (35) *Lexington, Neb.;* (36) *Donaldsonville, La.;* (37) *Point a la Hache, La.;* (38) *Cohoes, N.Y.;* (39) *Springfield, Mass.;* (40) *Alturas, Cal.;* (41) *Pikes Peak, Colo.;* (42) *Telluride, Colo.;* (43) *Platte Canyon, Colo.;* (44) *Huerfano Park, Colo.;* (45) *Livingston, Mont.;* (46) *Mt. Washington, N.H.;* (47) *Becket, Mass.;* (48) *Monadnock, N.H.;* (49) *Hartford, Conn.;* (50) *Mt. Marcy, N.Y.;* (51) *Monterey, Va.;* (52) *Fort Payne, Ala.;* (53) *Estillville, Ky.;* (54) *Franklin, W. Va.;* (55) *Maynardville, Tenn.;* (56) *Hazleton, Pa.;* (57) *Lykens, Pa.;* (58) *Atlanta, Ga.;* (59) *Lassen Peak, Cal.;* (60) *Shasta, Cal.;* (61) *Mt. Taylor, N.M.;* (62) *Marysville, Cal.;* (63) *Ashland, Ore.;* (64) *Henry Mountains, Utah;* (65) *Sierraville, Cal.;* (66) *Disaster, Nev.;* (67) *Paradise, Nev.;* (68) *Granite Range, Nev.;* (69) *Tooele Valley, Utah;* (70) *Salt Lake, Utah;* (71) *Boothbay, Me.;* (72) *Coos Bay, Ore.;* (73) *Seattle,*

Wash.; (74) *San Francisco, Cal.;* (75) *New Haven, Conn.;* (76) *Brooklyn, N.Y.;* (77) *Charlestown, R.I.;* (78) *New London, Conn.;* (79) *Duluth, Minn.;* (80) *Pulaski, N.Y.;* (81) *Marthas Vineyard, Mass.;* (82) *Atlantic City, N.J.;* (83) *Barnegat, N.J.;* (84) *Sandy Hook, N.J.;* (85) *Boston Bay, Mass.;* (86) *Mt. Lyell, Cal.;* (87) *Minneapolis, Minn.;* (88) *Plymouth, Mass.;* (89) *Stonington, Conn.;* (90) *Baldwinsville, N.Y.;* (91) *Newcomb, N.Y.;* (92) *Elizabethtown, N.Y.;* (93) *Plattsburg, N.Y.;* (94) *Skaneateles, N.Y.;* (95) *Ovid, N.Y.;* (96) *Lacon, Ill.;* (97) *Ottawa, Ill.;* (98) *Watertown, Wis.;* (99) *Weedsport, N.Y.;* (100) *Oswego, N.Y.*

The following must be ordered as *Special Sheets:* (A) *Norfolk Special,* $0.10; (B) *New York City and Vicinity Special,* $0.25; (C) *Rochester Special,* $0.10; (D) *Niagara River and Vicinity Special,* $0.10; (E) *St. Louis and Vicinity Special,* $0.10; (F) *Crater Lake Special,* $0.05.

The following classified list calls attention to some of the principal features illustrated on the above maps. The teacher will find others.

Coastal Plain, 1–3, 82, 83, A; *Lake Plains (West),* 59, 65–70; *Lake Plains (Lake Agassiz),* 4; *Lake Plains (Ontario),* 5, C, D; *Lava Plains (Plateaus, West),* 16, 17, 26, 61; *Central Plains,* 6, 8, 32, 96, 97; *Great Plains (more or less dissected),* 7, 10, 12, 27, 29, 33, 35; *Dissected Arid Plateau,* 13, 14, 15, 61; *Escarpments,* 14, D; *Mesas,* 11, 13, 14, 15, 61; *Buttes,* 12, 13, 26; *Desert,* 66–70; *Desert Sand Dunes,* 66, 67; *Dissected Moist Plateaus,* 9, 18, 23, 25, 94, 95; *Catskills,* 19; *Immature Drainage,* 1, 83, A; *Post-glacial Young Streams,* 28, 38, 94, 95, 96, C, D; *Young Valleys,* 9, 13, 26, 27, 49; *Waterfalls,* 27, C, D; *Canyons,* 13, 14, 16, 26; *Mountain Gorges,* 43, 45; *Water Gaps,* 30, 31, 51, 52, 57; *Mature Valleys,* 18–24, 38, 39, 47–58, 75, 94, 95; *Arid Land Drainage,* 13–16, 40, 65–70; *Alluvial Fans,* 45, 65; *River-made Plains,* 60, 62; *Braided Course,* 34, 35, 66; *Floodplains,* 8, 9, 32, 34, 35, 87, 96, 97, E; *Bluffs,* 32, 35, E; *Levee,* 36; *Crevasse,* 36; *Meanders,* 8, 32, 33, 52, 53, 55, E; *Intrenched Meanders,* 23, 29; *Delta,* 93; *Terraces,* 38, 39, 49, 96; *Erie Canal,* 99; *Irrigation,* 10, 70; *Basin Ranges,* 40; *Coast Ranges,* 60, 72, 74; *Sierra Nevada,* 65; *Rocky Mountains,* 41–45; *Appalachians,* 21, 25, 30, 51–57; *Adirondacks,* 50, 91, 92; *New England Mountains,* 46–49, 75, 77; *Piedmont,* 58; *Young Mountains,* 40–45, 60, 65, 72, 74; *Mountains (early maturity),* 46; *Mature Mountains,* 30, 31, 39, 47, 57, 71, 75, 77, 78, 89, 91–93; *Mountain Ridges,* 51–57; *Old Mountains,* 58, 85; *Peneplain,* 58; *Monadnocks,* 48, 58; *Volcanoes,* 59–62, F; *Laccolites,* 64; *Trap Ridges,* 39, 75; *Palisades,* B; *Glaciers,* 60; *Cirques,* 86; *Moraines,* 76, 77, 81, 87–89; *Wash Plains,* 18, 76, 77, 81; *Moraine Kettles,* 88; *Kames (Pinnacle Hills),* C; *Drumlins,* 49, 85, 90, 98–100; *Glacial Lake Overflow Channels,* 90, 96, 97, 99; *Lake on Coastal Plain,* A; *Delta Lakes,* 37; *Ox-bow Lakes,* 8, 33, E; *Volcanic Lakes,* 59; *Crater Lakes,* 59, 63, F; *Glacial Lakes and Swamps,* 31, 45, 47, 48, 50, 77, 78, 85–94, 98–100; *Lake Champlain,* 93; *Finger Lakes,* 94, 95; *Coastal Plain Swamps,* 1, A; *River Swamps,* 1, 62, 87, 96, A; *Delta Swamps,* 36, 37; *Lake Swamps,* 80, 93, 100, C; *Alkali Flats and Playas,* 65, 66, 68; *Drowned Coastal Plain,* 2, 3, 83, 84, A; *Drowned Coast,* 71–78, 81, 85, 89, B; *Drowned Lake Coast,* 79, 80, 93, 100, C; *Harbors,* 73–75, 78, 79, A, B; *Wave-cut Cliffs,* 84, 100; *Wave-cut Islands,* 85; *Beaches,* 72; *Tied Islands,* 85; *Bars, shutting in Bays,* 77, 79–81, 85, 100, C; *Sand Bars,* 76, 78, 81, 88, 89; *Hooks,* 84; *Sand Dunes,* 72, 83, 84; *Offshore Bars, inclosing Lagoons,* 82–84, A; *Salt Marshes,* 74–76, 78, 82, 85, 89, A, B.

5. Thirty-five Grouped Sheets. — *The following groups of sheets are selected for mounting to make large maps* (see directions below). Each group illustrates well at least one phenomenon, and a number illustrate several. In addition, they all contain many important details worthy of study. It would also be desirable to secure and mount in a large map all the sheets in the vicinity of the home region. Nearly all of these sheets could be used singly if mounting in groups seems too difficult.

1. Colorado River and Vicinity — illustrating plateaus, mesas, buttes, canyons, volcanoes, arid drainage, the following sheets: (*Pioche, St. George, Kanab, Escalante, Henry Mountains,* **Utah**, *Marsh Pass, Echo Cliffs, Kaibab, Mt. Trumbull, St. Thomas, Camp Mohave, Diamond Creek, Chino, San Francisco Mt., Tusayan,* **Ariz.**). 2. Overburdened Platte River — also great plains (*Kearney, Wood River, Grand Island,* **Neb.**). 3. Same — (*Minden, Kenesaw,* **Neb.**). 4. Connecticut Valley — bordering upland, lowland, trap ridges, terraces, ox-bow lake (*Greenfield, Warwick, Northampton, Belchertown, Springfield, Palmer,* **Mass.**). 5. River Floodplain and Meanders — also great plains (*Kansas City, Oskaloosa, Olathe, Lawrence,* **Kan.**). 6. Mississippi Delta (*West Delta, East Delta,* **La.**). 7. Mississippi Delta and Floodplain — also location of New Orleans (*Bonnet Carre, Spanish Fort, Chef Menteur, Rigolets, Toulme, Bodreau, Shell Beach, St. Bernard, New Orleans, Hahnville, La Fortuna, Deine, Point a la Hache, Barataria, Cut Off, Forts, Quarantine, Ft. Livingston, Creole, Lake Felicity,* **La.**). 8. Alluvial Fans — arid region (*Pomona, Cucamonga, San Bernardino,* **Cal.**). 9. Coastal Plain — also shore lines, bars, marsh, etc. (*Bordentown, Cassville, Asbury Park, Pemberton, Whiting, Barnegat,* **N.J.**). 10. Coastal Plain — drowned, swampy (*Prince Frederick, Brandywine, Wicomico, Leonardtown,* **Md.**). 11. Coastal Plain — young drainage, lakes, and swamps (*Williston, Citra, Dunnellon, Ocala Isala, Aparka, Pana Soffkee,* **Fla.**). 12. Lake Plain — bed of Lake Agassiz (*Fargo, Casselton,* **N.D.**). 13. Great Plains (*Wichita, Cheney, Kingman, Wellington, Caldwell, Anthony,* **Kan.**). 14. Maturely Dissected Plateau (*Salyersville, Prestonsburg, Hazard,*

Whitesburg, **Ky.**). 15. SAME (*Huntington, Charleston, Kanawha Falls, Warfield, Oceana, Raleigh*, **W.Va.**). 16. MATURE MOUNTAINS AND PLATEAU (*Chattanooga, Sewanee, Ringgols, Stevenson*, **Tenn.**). 17. DISSECTED ARID LAND PLATEAU — canyons, mesas, buttes, etc. (*Higbee, Timpas, Apishapa, Mt. Carrizo, Mesa de Maya, El Moro*, **Colo.**). 18. MESAS, BUTTES, VOLCANOES, ARID DRAINAGE (*Wingate, Mt. Taylor*, **N.M.**). 19. APPALACHIAN RIDGES — Susquehanna, water gaps, broad valleys, etc. (*Sunbury, Shamokin, Millersburg, Lykens, Harrisburg, Hummelstown*, **Pa.**). 20. SOUTHERN APPALACHIANS (*Greenville, Roan Mt., Ashville, Mt. Mitchell*, **N.C.**). 21. SOUTHERN APPALACHIANS (*Staunton, Monterey, Huntersville, Lexington, Natural Bridge, Lewisburg*, **Va.**, **W. Va.**). 22. MOUNTAIN RIDGES — river meanders, Shenandoah valley (*Harper's Ferry, Winchester, Romney, Warrenton, Luray, Woodstock*, **Va.**). 23. NEW ENGLAND MOUNTAINS — even-topped upland, Monadnock (*Peterboro, Monadnock, Keene*, **N.H.**, *Fitchburg, Winchendon, Warwick*, **Mass.**). 24. ADIRONDACKS — part of Lake Champlain, glacial lakes (*Lake Placid, Ausable, Willsboro, Mt. Marcy, Elizabethtown, Port Henry, Schroon Lake, Paradox Lake, Ticonderoga*, **N.Y.**). 25. APPALACHIANS AND VIRGINIA PIEDMONT (*Goochland, Palmyra, Buckingham, Amelia, Farmville, Appomattox*, **Va.**). 26. PIEDMONT AND COASTAL PLAIN — location of Philadelphia (*Germantown, Norristown, Chester, Philadelphia*, **Pa.**). 27. DRUMLINS — glacial lakes, cities on river with rapids due to glacial action, also beaches and salt marshes (*Haverhill, Newburyport, Lawrence, Salem*, **Mass.**). 28. FINGER LAKES — mature plateau, post-glacial gorges, lake deltas (*Geneva, Auburn, Skaneateles, Ovid, Genoa, Moravia, Watkins, Ithaca, Dryden*, **N.Y.**). 29. DRUMLINS — drainage interfered with by drift, overflow channels, lake shores (*Oswego, Sodus Bay, Pultneyville, Weedsport, Clyde, Palmyra, Auburn, Geneva, Phelps*, **N.Y.**). 30. DRUMLINS — glacial lakes and swamps (*Madison, Sun Prairie, Waterloo, Watertown, Evansville, Stoughton, Koshkonong, Whitewater*, **Wis.**). 31. DROWNED COAST (*Gardiner, Wiscasset, Boothbay, Bath*, **Me.**). 32. SAME (*Boothbay, Bath, Freeport, Gray, Small Point, Casco Bay, Portland*, **Me.**). 33. BAYS, — bars, wave-cut cliffs, moraine, wash plain (*Marthas Vineyard, Gay Head*, **Mass.**). 34. CAPE COD — bars, wave-cut cliffs, sand dunes, moraine, morainic lakes (*Provincetown, Wellfleet, Chatham, Yarmouth, Barnstable*, **Mass.**). 35. YELLOWSTONE PARK (*Gallatin, Canyon, Lake, Shoshone*, **Wy.**).

6. Thirty Selected Sheets, United States Coast Survey, illustrating Typical Coast Lines. — (Washington, D.C. $0.50 each; catalogue free; order by number.) 6 *General Chart, coast of Maine and Massachusetts*); 103, 104, 105, 106 (*Maine coast, more detailed*); 108 (*Coast from southern Maine to Cape Ann*); 109 (*Boston Bay*); 8 (*Approaches to New York, Gay Head to Cape Henlopen*); 113 (*Narragansett Bay*); 52 (*Montauk

Point to New York, with Long Island Sound*); 119 (*Southern shore of Long Island*); 121, 122, 123 (*New Jersey coast, Sandy Hook to Cape May*); 376 (*Delaware and Chesapeake bays*); 11 (*Cape Hatteras to Cape Romain*); 142 (*Cape Hatteras*); 147 (*Cape Lookout*); 15 (*Straits of Florida, Coral Reefs*); 170 (*Key West and Vicinity, Coral Reefs*); 1007 (*General Chart, Gulf of Mexico*); 188 (*Mobile Bay*); 19 (*Mississippi Delta and vicinity*); 194 (*Mississippi Delta*); 21 (*Galveston to the Rio Grande*); 212 (*Bar from Rio Grande northward*); 5400, 5500 (*California coast*); 3089, 8100 (*Drowned Alaskan coast*).

7. River and Lake Maps. — *The Mississippi River Commission* (*St. Louis*), and the *Missouri River Commission* (*St. Louis*) issue charts of these rivers, of which the following are especially useful. *Map of Alluvial Valley of Mississippi*, 8 *sheets* ($1 per set); *Upper Mississippi*, 4 *sheets* ($0.70 per set); *Mississippi, Charts* 8, 22, 35, 36, 38, 39, 52 of the map on scale of 1 : 20,000, showing meanders, oxbows, etc. ($0.26 per sheet). If the school is located on the river, the sheets of that vicinity should be secured.

Charts of the Great Lakes (*United States Engineer's Office, Detroit, Mich.*) illustrate many shore-line phenomena. *Nos.* 1, 5, 6; also *Lake Ontario, Niagara River, Lake Erie*, and *Lake St. Clair* are especially valuable. If the school is on the lakes, much use should be made of the lake charts, especially those near by.

8. Mounting Maps. — It is real economy to have all maps backed with cloth. This will be done by many bookbinders, or it can be done in the school, using a thin, bleached, white cotton cloth of ordinary width for single sheets; extra width for grouped sheets. Use ordinary flour paste, which costs very little if purchased from a paper hanger. For successful map mounting have a smooth surface (a large drawing board or table top) on which to tack the cloth. Stretch the cloth and tack it firmly on all sides, then thoroughly wet it. Apply paste to the back of the map and allow it to lie until thoroughly limp, then put it on the cloth, which must not be too wet. Carefully press the map to the cloth with a piece of clean cloth or a photographic roller. Leave until thoroughly dry (at least 24 hours).

Combined sheets must first be trimmed, leaving on alternate sheets a margin of $\frac{1}{4}$ inch for adjoining sheets to overlap. For trimming, to secure an even cut, place the map on a sheet of zinc (tacked to a board), and, with a sharp knife, cut along a metal straightedge placed on the map. If a map is not complete, blank spaces may be filled with white paper.

Large maps should be rolled, and a wood turner will supply rollers at small cost; also strips for the top of the map. Curtain rings may be screwed into the wooden strip for hanging the map, which, for class use, may be hung to brass rods ($\frac{3}{8}$ inch in diameter) along the sides of the room. A curtain hanger will make hooks to hang over the rods. If single sheets are also hung, Dennison gummed-cloth suspension rings may be used.

Single sheets are best kept in a case of shallow drawers, using care not to put too many in a drawer, for they are then difficult to handle. Rolled maps are best preserved when kept in a case with shallow partitions, allowing the rolled map to lie horizontally. A cabinet-maker will build a combined case for rolled and flat maps.

9. Minerals and Rocks. — *E. E. Howell*, 612 17th St., N.W., Washington, and *Ward's Natural Science Establishment*, Rochester, N.Y., offer cheap sets of minerals and rocks suitable for laboratory use in connection with Tarr's Geology or Physical Geography. *G. B. Frazer*, West Medford, Mass., is another reliable dealer.

10. Meteorological Maps, etc. — Application should be made to *have the weather map sent regularly to the school*; and duplicates of out of date maps may possibly be secured on application. Meteorological instruments (see p. 420) may be purchased of *J. P. Friez*, Baltimore, Md., or *H. J. Green*, Brooklyn, N.Y.

11. Lantern Slides. — Various firms now supply lanterns for schools, the most satisfactory being electric lanterns. A set of lantern slides, selected by Prof. W. M. Davis, is sold by *E. E. Howell* (address above); *T. H. McAllister* (49 Nassau St., New York) has a series of geographical slides, and *H. W. Fairbanks* (Berkeley, Cal.) has a set of western slides for sale. *The Geography Supply Bureau* (Ithaca, N.Y.) has a selected set of about a thousand of Professor Tarr's best negatives from which slides will be made on order. These slides were selected with the advice and assistance of Professor Tarr, and with special reference to their adaptation to use in schools. The set includes practically all the phenomena of Physical Geography. A printed catalogue, with description of each slide and suggestions, and outline questions for its use, will be sent on application.

APPENDIX K. FIELD WORK.

The value of field work is such that every course in physical geography ought to be accompanied by at least some. No laboratory or text-book work can take the place of well-conducted field work; it is worth undertaking even if Saturday is the only time available for it. But a progressive school should provide regular periods for out-of-door work.

Directions for field work of sufficient explicitness to be useful as a guide cannot be given without taking up far more space than is available in this book. What kind of work to give is a question which can be settled only by local conditions; therefore the teacher must develop his own outline. There is no region without some good physiographic phenomena within easy reach.

Properly to make use of these field opportunities demands personal knowledge of methods on the part of the teacher. There are, of course, many teachers of physical geography who have not had the training necessary for this work; for even the universities have been giving regularly organized field courses only in the past few years. Most summer schools in large universities offer instruction in this direction, and any teacher who desires to give field work, but lacks the necessary training, can secure it easily and at slight expense. Knowing how field work is conducted in one region, any real teacher can adapt the same methods to his own needs.

It is by the introduction of laboratory work, indoors and out, that physical geography is gaining for itself a rank which is placing it on a par with other science courses in the secondary school curriculum. Ten years ago scarcely a secondary school in the country, and very few normal schools and universities, gave organized laboratory and field work in physical geography. Now many of the better secondary schools provide for it and have specially equipped laboratories. The normal school or university course that does not include such work is now considered weak and unsatisfactory. If the next ten years witnesses an advance equal to that of the last ten, the same will be true of physical geography in the secondary schools. A course in chemistry and physics that is solely a text-book course is now considered ridiculous; the same should be true of physical geography. The fact that it is likely to be so considered within ten years should spur on every teacher of the subject to the effort to prepare himself for the work and provide for it. The task is not a great one, and the reward is well worth the effort.

The following are some of the phenomena that are likely to be found within easy reach of a school. (1) *Illustrations of weathering:* cliffs, ledges, bowlders, old stone or brick buildings. (2) *Nature of country rock:* in river valleys, railway cuts, quarries. In such places stratification, joint planes, folding and faulting, and fossils may possibly be found. (3) *The soil:* for characteristics and depth, look in cuts, as in (2). Is it a soil of rock decay or transported? If the former, study its origin in the cut. If the latter, how transported? (4) *River transportation:* road gutters, plowed fields, small wet-weather streams, — nature of work, load carried, disposition of load, result of removal. Fine examples of young stream valleys, alluvial fans, deltas, and waterfalls (over pebbles) are very often found in a road, field, or railway cut. (5) *River work and valley formation:* source of water; variation in volume; sediment load; variation; source of sediment; temporary disposal of it, — on stream bed, in bars, in floodplains, etc.; place of final deposit of sediment; effect of removal of sediment on valley form. The entire subject of river work and life history of valleys may be built up around one or two field excursions to a near-by stream. It is not necessary to have grand waterfalls or broad floodplains. A meadow brook has its full lesson. (6) *Shore lines:* a lake shore or the sea shore; even a river bank or the shore of a pond may serve. What are the waves doing? What work have they accomplished? Why are the pebbles round? Where has the ground-off material gone? What is the source of the pebbles or sand? Which way are they moving? Are there bars, wave-cut cliffs, small stream deltas, shore swamps? Perhaps there are all, possibly only one; in the latter case study that, even though it may seem very insignificant. (7) *Glacial phenomena:* striæ; till banks, — in railway or other cuts; nature of material; scratched stones, etc. Are the pebbles or bowlders foreign, *i.e.* unlike the country rock? Is the till unstratified? Why? Find cuts of stratified drift — evidence of water action. There may be moraines, kames, eskers, or drumlins.

Besides these there may be plains, or mountains, or plateaus, or volcanic phenomena. If so, so much the better; but profitable field work does not necessarily demand grand features. It will be well to have most of the excursions devoted to details and the study of principles; hence a seemingly small illustration may be of the very highest value. At the same time, the field work should not entirely ignore the broad, general features. A very profitable excursion may be conducted in a high tower, or on a high hill overlooking the surrounding country.

Field excursions should be made for the purpose of showing the relationship between physiographic phenomena and human interests. They may often be combined with the other excursion suggested above. For example, an excursion might well consider the reason for the location and the nature of work in a quarry; the location and the difficulties in the way of laying a railway, *i.e.* the cuts, tunnels, etc., necessary; the differences in the soil and their relation to plant life, and especially to crops; the location of mills, etc. Here again the broad influences of physiographic conditions should not be overlooked. By all means, the field work should show clearly the significance of the location and development of the home town and its industries.

APPENDIX L. REFERENCE BOOKS.

THE reference books listed at the end of each chapter deal in part, if not entirely, with the topic treated in that chapter. There are a number of general books, some of which are included in those lists, which should be in every physical geography laboratory. Among these are most of the following: —

MILL, *International Geography*, Appleton & Co., N.Y., 1902, $3.50; HUXLEY, *Physiography*, Macmillan Co., N. Y., 1891, $1.80; GEIKIE, *Scenery of Scotland*, Macmillan Co., N. Y., 1901, $3.25; TARR, *Physical Geography of New York State*, Macmillan Co., N.Y., 1902, $3.50; LUBBOCK (Lord Avebury), *Scenery of England*, Macmillan Co., N.Y., 1902, $2.50; *National Geographic Monographs, Physiography of the United States*, American Book Co., N.Y., 1895, $2.50; SHALER, *Outline of the Earth's History*, Appleton & Co., N. Y., 1898, $1.75; SHALER, *Aspects of the Earth*, Scribner's Sons, N.Y., 1890, $2.50; GEIKIE, *Fragments of Earth Lore*, John Bartholomew, Edinburgh, 1893, 12*s*. 6*d*.; BONNEY, *Story of Our Planet*, Cassell, London, 1898, 7*s*. 6*d*.; GEIKIE, *Earth Sculpture*, Putnam's Sons, N.Y., 1898, $2.00; MARR, *The Scientific Study of Scenery*, Methuen & Co., London, 1900, 6*s*.; SALISBURY, *Physical Geography of New Jersey*, Vol. IV, Final Report, New Jersey Geological Survey, Trenton, 1902; DRYER, *Studies in Indiana Geography*, Inland Printing Co., Terre Haute, Ind., 1897, $1.25; POWELL, *Geology of the Uintah Mountains*, Department of the Interior, Washington, 1876 (out of print); GILBERT, *Geology of the Henry Mountains*, Department of the Interior, Washington, 1877 (out of print).

The following are leading magazines of geography, at least one of which it is desirable to have in the school: *Journal of Geography*, Chicago, Ill., $1.50; *National Geographic Magazine*, Washington, D.C., $2.50; *Bulletin of the American Geographical Society*, New York, $4.00; *Geographical Journal*, London, $6.00; *Scottish Geographical Magazine*, Edinburgh, $5.00.

The United States Geological Survey publishes Bulletins, Annual Reports, Professional Papers, Monographs, Folios, and Irrigation Papers, many of which contain valuable physiographic material, possibly relating to your own region.

INDEX.

A.