LABORATORY MANUAL IN PHYSICAL GEOGRAPHY

HOPKINS — CLARK

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Laboratory Manual

IN

Physical Geography

BY

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SUGGESTIONS FOR THE TEACHER

THIS Manual, while prepared as a supplement to the text-book — "Elements of Physical Geography" — by the author, may be used with any other text-book or with any lecture course.

The manner in which the subject is taught and the experiments performed is governed to some extent by the place it occupies in the school curriculum. If it is in the third or fourth year of High School, after the pupil has had experimental work in Chemistry or Physics, the experiments need not be as elementary as if the pupil is doing his first laboratory work. For this reason more experiments are given than would probably be performed by one class in a year's work, and the teacher can select from these the ones best adapted to the grade of pupils.

It is supposed that most teachers will have some experiments which they prefer to some in the Manual, and which can be used as substitutes or as supplementary to those given. Further, the teacher is of course at liberty to change the wording of any of the experiments in any way that will adapt it the better to his class. The Manual, like the text-book, is intended only as a base on which the progressive teacher can build, and is intended to be suggestive rather than mandatory.

In all the laboratory work the pupil should be put as far as possible in the attitude of an original investigator. He should be led as far as possible to see things for himself and work out his own explanation, and thus acquire the scientific habit. He should be led to the knowledge that every effect has a cause and every cause has an effect, and that, conditions being the same, the same causes always produce the same effect.

In order to reach proper conclusions it is necessary to make accurate observations. One of the best aids in cultivating the seeing powers is in writing the description. Hence, insist on well-written descriptions.

While in general it will be found desirable to have the laboratory exercise accompany the recitation on the same subject, there is no objection, in fact there is some advantage, in taking up some laboratory exercises before the subject is taken up in recitation. Sometimes there is an advantage in taking up certain laboratory exercises some time after the class discussion. They then serve not only as a partial review, but test better the pupils' understanding of the subject. With the more difficult subjects it may be advisable, in fact it may be necessary, to have the laboratory exercises accompany the class work, as it will require both to give the pupil an insight into the subject.

As many of the principles as possible should be illustrated by field trips. Owing to the difficulty and expense of getting a class into the field, it is not feasible to visit the same locality several times to illustrate different principles as they are taken up in the class. It will be necessary to take up all the features in the locality at one trip. If the trip is taken to some valley to study stream erosion, there may be on the way good examples of rock weathering, protective influence of vegetation, outcrop of several kinds of rock, glacial striæ, glacial pebbles, etc., all of which should be carefully described in the note-book and referred to in the future as the topics come up for discussion in the class.

It will require constant effort and ingenuity of the teacher to prevent the work in the laboratory becoming mechanically routine work without the proper mental stimulus. This difficulty is greater with large classes than with small ones. With small sections the pupils can receive individual aid that will enable them to take up and work out complex problems that they could not do from general instructions given to the class. Hence the temptation to the teacher to keep the class on exercises involving a great deal of mechanical work in order to keep them busy and give them something they can do with little or no aid. This book is intended to assist the teacher in this difficulty. By placing a book in the hands of each pupil, each one can have something to do while the teacher passes from one to the other, giving suggestions and aiding them over obstructions.

The directions in each exercise are not intended to be exhaustive. They aim to be suggestive, and the pupil should be constantly encouraged to extend his study beyond the outline.

The authors would welcome suggestions from either teachers or pupils that would make future editions more serviceable. The suggestions may be in regard to changes in experiments already given or new ones that have proven valuable. The desire is to get a manual that will produce the best results.

CONTENTS

CHAPTER I

THE EARTH AS A PLANET

The principal aim in the study of this chapter should be to have the pupil try to get a proper idea of the size and shape of the earth and its relation in space to the other heavenly bodies, its rotation and revolution, and the relation of these to our division of time into days, months and years.

Besides the exercises given many others might be improvised by the teacher, but care should be taken not to unduly prolong the time on this chapter so as to limit it too much on the others. It would be easy to improvise constructive problems on the eclipses as suggested by fig. 4, or on latitude and longitude, as suggested by figs. 12 and 13 in the author's text-book.

A globe of some kind is essential, and if a globe with the plane of the ecliptic is not available, one should be made by cutting a circle the size of the globe from a piece of stiff cardboard and placing it on the globe. The B.-K. Solar Calculator sold by the L. E. Knott Apparatus Co., Boston, or the Solar Time Board, sold by the Central Supply Co., Chicago, will be found very helpful. Maps of different kinds illustrating the different methods of projection should be used in Ex. 5.

Ex. 1. The Phases of the Moon

Construct two circles to represent the orbit of the moon, one 8 and the other 7 inches in diameter, from the same center. On each of these construct twelve small circles $\frac{1}{2}$ inch in diameter equally distributed around the large circles; four of these will show new and full moon, and first and third quarter. Label them. Shade those on the outer circle to show the light and dark parts of the moon as seen from the sun. On the inner large circle shade the moon circles to show the light and dark parts as seen from the earth. The intermediate points between the quarters shade from observation.

Why do the horns of the moon sometimes point up, sometimes down?

What is the hunter's moon? What is the harvest moon?

Show by diagrams why there is sometimes a partial eclipse, sometimes a total eclipse, and sometimes no eclipse at the time of full moon. Why is there never an eclipse of the moon except at time of the full moon?

Ex. 2. Establishing a Meridian or a True North and South Line (p. 26 *)

A meridian line is a true north and south line which if prolonged on the surface of the earth would pass through the north and south poles of the earth and form half of a great circle around the earth at right angles to the equator and the parallels of latitude. For convenience half of a great circle, the part extending from pole to pole, constitutes a single meridian and is necessarily 180 degrees from the other half of the circle, which is another meridian. Notice on the globe that the meridian lines all converge to a point at the poles. On all maps (except the Mercator maps) of areas in the northern hemisphere the lines are closer together at the top of the map than at the bottom, and *vice versa* on maps of areas in the southern hemisphere.

* All pages and figures referred to in this manual apply to the author's text-book, *Elements of Physical Geography.*

(*a*) One method of determinating the direction of the meridian line at your school is to mark the magnetic north and south line as indicated by a magnetic needle or compass. Then by inquiry (from some local surveyor or civil engineer) learn the magnetic variation for the locality (Sec. 36, fig. 18) and by means of a protractor draw the true meridian crossing your magnetic line at the proper angle.

(*b*) A second method of determining a true north and south line is to find out by inquiry the difference between the standard time and true solar time (Secs. 33 and 34). Then at exactly true solar noon, which will be some minutes before or after 12 by your watch, trace on your paper the line of the shadow of a vertical pin or string (the shadow of a plumb line). This will be a meridian line. Why?

(*c*) To locate the meridian without knowing the solar time place a vertical peg on a horizontal paper or cardboard. Beginning a half hour before and continuing until a half hour after 12 o'clock mark the end of the shadow cast by the peg at intervals of five minutes. Draw a curve through these points. A straight line drawn from the center of the base of the peg to the nearest point on the curve will be the meridian. Why? The edge of a square box, as a crayon box, may be used in place of a peg.

(*d*) Place two pegs or points in line with the north star when the star is on the meridian. A line connecting the two points will be the meridian.

If possible two or more of the above methods should be tried by the pupils and the results compared. The line should be permanently recorded on the floor, window sill or a board firmly hinged to the window sill. All the data for this and the following experiment may be obtained from the World Almanac or the Nautical Almanac.

Ex. 3. Determination of Latitude (p. 25)

(*a*) By means of the north star. As explained in the text (p. 25 and fig. 15) the elevation of the north star above the horizon is approximately the latitude of places in the northern hemisphere. The angle of elevation may be measured by fastening two straight sticks together at or near the middle so that they will turn freely on the tack or nail. Fix one of the sticks vertically by means of a plumb line, and turn the other on the fastening until it points directly at the north star. The angle which the inclined stick makes with a horizontal plane will be the elevation of the star. It may be obtained by measuring with a protractor the center angle between the two sticks and subtracting it from 90 degrees.

The above method may be modified in many ways; for example, fasten or construct a protractor on the side of a straight-edged board. Hang a plumb line from the center of the protractor and turn the straight edge of the board to point toward the north star. The plumb line will then mark on the protractor the angle of elevation or the latitude.

Since the north star is not exactly on the north pole of the heavens, but revolves about it at a distance of about $1\frac{1}{4}$ degrees, results obtained by this method will vary at different times depending upon the position of the star with reference to the meridian.

(*b*) By observations of the sun. The elevation of the sun may be found in a similar manner to that of the north star in the preceding exercise, but as it is not well to look directly at the sun, the pointer must be adjusted without sighting along it as with the star. The angle may be found by marking the end of the shadow of a vertical peg on a horizontal paper, constructing the triangle and determining the angle by computation or by measurement with a protractor.

It must be kept in mind that the sun is vertical over the equator at only two periods in the year — the equinoxes. At these periods the elevation of the sun subtracted from 90 degrees will give the latitude; at any other period it will be necessary to add or subtract the angular distance of the sun from the equator. This angular distance or declination is given for each day in the year in the Nautical Almanac and in a few other almanacs.

Ex. 4. Problem of Eratosthenes

On cross-section paper construct a circle with a three-inch radius having the center on one of the horizontal lines at or near the middle of the paper. Draw two radii 20 degrees apart in the N.-E. quadrant, prolonging them beyond the circle. Measure with the protractor the angles made by the prolonged radii with the horizontal lines (the horizontal lines represent the rays of the sun). Does the difference between the two angles equal the angle between the radii (20 degrees)? Why? Does the distance between the radii on the circle equal $20/360 = 1/18$ of the circumference of the circle?

If the end of one radius were on the equator and the other on the Tropic of Cancer, what would be the angle of the rays of the sun with the horizon at each point at noon on June 21? on September 23?

This problem could be made more realistic if arrangements could be made with some other school at some distance away on or near the same meridian, that is directly north or south, to measure the angle of the sun's rays at noon on the same day. Then take the difference in the two angles, compute the distance between the two schools and see how much it varies from the difference as determined by the latitude of the two places.

Ex. 5. Comparative Map Study

A globe, a Mercator's map of the world, a map of the hemispheres; the last should be in your note-book, but if not, refer to a common school geography, atlas, or wall charts. (If possible obtain also for comparison a map of the world on Mollweide's projection.)

1. Note the scale of each map and of the globe. Is the scale the same on all parts of each map? on all parts of the globe? How do you explain the variation? The globe is the only correct representation of the surface of the earth.
2. How many miles apart are the meridians at the equator? at the poles? at 40 degrees latitude?
3. On the equator one degree longitude equals 69.652 miles. At 30° latitude one degree longitude equals 59.955 miles. At 40° latitude one degree longitude equals 53.431 miles. At 60° latitude one degree longitude equals 34.914 miles. At 90° latitude one degree longitude equals 0.000 miles. How then can you express the scale on Mercator's map?
4. Why are the polar regions not represented on Mercator's map?
5. What are the advantages and disadvantages of Mercator's map?
6. Compare the relative sizes of Greenland and South America on the globe and on Mercator's map.
7. In what respects are the maps of the hemispheres superior to the Mercator map of the world?

The area of Greenland is about 46,740 sq. mi. The area of South America is about 6,950,000 sq. mi. Greenland is about as large as New York State. South America is almost as large as North America.

Ex. 6. Contour Map Study

On a table, large board, or the floor have a nearly conical pile of moist sand or earth, some one-inch blocks and a long ruler. Make one or more valley-like depressions on the side of the mound, which should be steeper in some places than in others.

Place the ruler on one of the blocks and move them around the sand heap in such a way that the end of the ruler leaves a trace on the sand. This is a contour line and would mark the shore line or contour of the land if the water were one inch deep around the sand pile. Place a second block on the first and move the ruler as before, forming a second contour an inch above the first. Then a third, fourth, and so on until the ruler passes over the top of the heap.

Trace on a piece of paper the contour lines as seen from above, or as they would appear if the sand were removed and the lines sunk to the base of the heap.

Imagine that your sand heap is an island or a continent miles instead of inches in diameter, and the blocks are 10, 20, or 100 feet in diameter instead of an inch, and then your paper will represent a contour map similar to those made by government surveyors.

This exercise may be omitted for advanced students, but this or some other concrete method will be found helpful to elementary students.

Ex. 7a. Contour Map Study (p. 36) — Shasta, Cal., Special Map

Some other contour map may be substituted for the Shasta map by changing the wording of the questions.

1. What is the horizontal scale? the vertical scale? Why is this contour interval used?

2. If the Pacific Ocean were to rise 4000 feet, what part of the Shasta map would it cover? Would there be any islands on the map? Where would islands occur on the Shasta area if the water should rise to 4500 feet? to 5000 feet?

3. Trace with a soft pencil the contour line marked 7000. If the water should rise to this level, the area inside the line would be an island. How high would the island be? The pencil line would be the shore line or the contour of the land. Notice how the shore line would change if the water should rise 100 feet more, another 100 feet, and so on. We may then consider the contour lines as shore lines or real contours of the land bordered by a rising or sinking sea level.

4. Do the contour lines bend up or down in crossing a valley?

5. In a spur or radiating ridge do the contour lines bend toward or away from the summit of the central mountain peak?

6. How are the buttes and subsidiary cones on the mountain side represented by contours? How would a vertical cliff be represented?

7. On what parts of the map do you find the steepest slopes? How are they designated by contours?

8. On what parts of the map are there flat or nearly flat areas? How shown by the contours?

9. What is the difference in elevation between the top of Bear Butte and Red Butte? between Berryvale and Horse Camp? between the southeast and northeast corners of the map? How high is Wagon Camp above the harbor at San Francisco? Where would you look for the lowest point on the map? Make a profile across the summit of the mountain.

Ex. 7b. Contour Map Study

Make a cardboard model of some region, preferably the region in the vicinity of the school, from one of the United States Geological Survey contour sheets. The model may cover the whole or any portion of the area represented on the quadrangle.

To construct a cardboard model get a package of thin cardboard in which some of the sheets are as large as the outline of the model. Lay a sheet of carbon paper with the carbon side down on one of the cardboard sheets, on this place the contour map face up, and with a pencil trace on the map the lowest contour line. With a sharp penknife cut off the cardboard along the line left by the carbon paper. Do the same thing for each of the other contour lines in turn. Place these cardboard pieces on top of each other in the order in which they are cut, and the result will be a relief model of the region, and the edges of the cardboard correspond to the contour lines on the map.

The pieces of cardboard in the model can be tacked fast to a board, a shallow frame formed around them, and a plaster cast made, from which an indefinite number of models can be cast.* The plates cast can be exchanged with other schools until a collection of models of different areas is obtained.

Make profiles of some of the hills. Accustom the eye to picture in the mind the relief form of the hills from looking at the contour lines on the map.

Enumerate the advantages of a contour map over other maps.

Purchase a contour map of your home locality and use it until you are familiar with all the hills and valleys as they appear on the map.†

* Before making the cast from the cardboard it may be necessary to fill the cracks with wax to prevent the plaster from sticking. It will also be found helpful to coat the surface with linseed oil for the same reason. A thin coating of soapstone powder may be used in place of the oil.

† The contour map sheets may be purchased from the Director of the U. S. Geological Survey, Washington, D. C., at five cents each, or three dollars per hundred.

Ex. 8. Construction of a Contour Map

Make a contour map of a small area in the vicinity of your school building. If the building is on a flat area, extend your map far enough to include one or more hills or valleys.

Distances and elevations may be estimated by the class or they may be measured as follows: directions may be determined by a pocket compass; distances measured by pacing or by a bicycle; elevations measured by an aneroid barometer or a pocket level.

The maps should all be drawn to the same scale; one inch on the map representing 100 feet, 200 feet, 500 feet, or 1000 feet, depending upon the size of the area mapped. The contour interval may be 5 feet, 10 feet, or 20 feet, depending upon the height of the hills. If the hills are high and steep, use the large interval; if the hills are low, use the small interval.

Sketch a contour map of fig. 197, p. 279, in the text-book.

Ex. 9. Standard Time (p. 31)

On a small map of the United States draw with colored ink or pencil the 75th, 90th, 105th, and 120th meridians.

When it is noon in London, what time is it on the 75th? 90th? 105th? 120th meridians? The four principal time belts are based on these meridians. Draw light dotted lines on the $67\frac{1}{2}$, $82\frac{1}{2}$, $97\frac{1}{2}$, $112\frac{1}{2}$, and $127\frac{1}{2}$ meridians. Theoretically these should mark the standard time belts, but practically the limits are determined by the trunk line railways which make the hour changes at the ends of railway divisions at their convenience. (See fig. 17 in the text-book.)

The eastern limit of the Eastern time belt (75th M.) is the eastern boundary of Maine; Eastern Canada has Atlantic time (60th M.).

The division between Eastern and Central time is through Fort William, Lake Superior, Lake Huron to Detroit, to Buffalo, Erie, Pittsburg, Parkersburg, Asheville, Augusta, and Savannah.

The division between Central and Mountain time (90 and 105 M.) is through Broad View, Mandan, North Platte, Dodge City, and El Paso.

The division between Mountain and Pacific time is through Laggan, Kingsgate, Trout Creek, Huntington, Sparks, Caliente, Seligman, El Paso. From a large map of the United States locate these points approximately: connect them by a continuous line and shade alternate time belts (see fig. 17, p. 32). Which is the largest time belt? Which is the smallest? Why is Mountain time omitted in the southern United States? Why does the Central time belt extend so far west? Why do southern Georgia and Florida have Central rather than Eastern time? If a person should start from New York at 5 A.M. and it takes 18 hours to make the trip to Chicago, what time would he arrive?

CHAPTER II

GROUNDWATER AND RIVERS

Ex. 10. Solubility of Carbonate of Lime

1. Into a test tube or glass put a few fragments of limestone or marble and cover them with water. Pour in a little dilute hydrochloric acid. Describe what takes place. Pour in more acid and agitate until all the limestone is dissolved. Does any solid matter remain in the bottom of the tube? If there is any, it is the clay and sand impurities of the limestone that go to make up the soil over limestone areas. Pure limestone will all be dissolved, leaving a clear solution.

If carbonic acid in water is used in place of the hydrochloric acid, the same result will be obtained, but it is so much slower that effects are not noticeable unless watched for a long time.

2. Take some clear limewater in a glass vessel. (Limewater contains the hydroxide of lime, a combination of lime and water. Lime is made by heating limestone until the carbon dioxide is driven off.) With a piece of glass tubing or a straw blow through the limewater. What happens? The carbonic acid from the breath unites with the lime and forms carbonate of lime, which is not soluble in water. Continue blowing long enough, and the excess of CO_2 will dissolve the carbonate of lime or limestone as it does in the cave. (The limewater should be dilute or the precipitate will not all be dissolved in the experiment.) Will limestone be dissolved in pure water? What makes it dissolve? What makes it come out of solution?

3. If the clear solution obtained from the above is permitted to trickle very slowly over moss or excelsior, lime carbonate will be deposited like the calcareous tufa, or if it drops slowly, small stalactites may be formed.

This process is so very slow that it cannot be observed unless permitted to continue for several days.

How can you use *HCl* as a test for limestone to distinguish it from sandstone and granite?

Explain now in your own words (*a*) how caves are formed and (*b*) how stalactites and stalagmites are formed in caves.

What change takes place in the lime kiln?

What change takes place in mixing the mortar?

What change takes place in the mortar in the wall?

Ex. 11. Gullies and Deltas

These may be studied in one or more of several ways:

1. The delta table. No directions are needed where a delta table is available in the laboratory. A few experiments will suggest the best methods of use to teacher and student. The delta table consists of a water-tight box about 10 feet square and a foot deep, or, better, two such boxes, one about 8 feet square, inside of the other, arranged so that the water can be drawn off from the outer one at different levels. Several loads of clay, sand, and gravel should be available. Most of this can be used over again many times. (Reference: See paper by O. D. von Engeln in Bulletin No. 431, N. Y. State Science Teachers' Association, Albany, N. Y., 1908, p. 44.)

2. Where a delta table is not at hand a substitute may be made cheaply in the school yard if permission can be obtained from the proper authorities and there is a good supply of water at hand. A cart load of soft earth should be piled up in a fairly steep mound. If this is deluged

with water from a hose or one or more sprinkling pots, gullies will be formed down which the earth will be carried by the running water and built up into alluvial fans, provided the water all drains away promptly; or by building a mud dam at the mouth of the gully the material washed into the dam will form a delta. By means of a few pieces of boards set on edge and banked with clay a dam may be made entirely around the pile of earth, and deltas will be formed by all the gullies.

By cutting away one side of such a delta with a spade the arrangement of the material in the layers may be seen and described. The exercise may be varied by raising the dam after the deltas are formed and thus study the effect of a sinking land area, or a rising shore line. Or by making an opening in the dam and allowing the water to partly drain away the effect of a retreating shore line or a rising land area may be studied. It may be varied by having clay and sand in layers of varying thickness and positions.

3. In the absence of either the table in the laboratory or the earth pile in the school yard, the same phenomena may be studied in the gullies along the roadside or in a plowed field after a heavy rainstorm.

4. Where possible these exercises should be supplemented by a study of a large delta along a lake shore. The erosion along large gullies may be studied in any hilly country.

5. Study the delta of the Mississippi River on the Map of the Lower Mississippi by Mississippi River Commission; the delta of the St. Clair River, maps, diagrams and descriptions in the Michigan Geological Survey Report, Vol. IX, pt. I.

Ex. 12. River Profiles

On cross-section paper construct profiles of the following rivers from the data given. Select such a horizontal and vertical scale as will permit all the profiles to be put on one sheet for comparison. (See fig. 43 in text-book.)

DATA FOR THE CONSTRUCTION OF RIVER PROFILES

Mississippi River System

	Miles from Mouth	Feet above Sea Level
1. Mouth	0	0
2. Mouth of Red River	316	7
3. Vicksburg, Miss.	487	48
4. Mouth of Ohio River	1,090	275
5. Mouth of Missouri River	1,290	395
6. Burlington, Ia.	1,490	510
7. La Crosse, Wis.	1,790	630
8. St. Paul, Minn.	1,937	685
9. Minneapolis, Minn.	1,950	795
10. Lake Itasca (source)	2,295	1,460

Missouri River

1. Mouth	1,290	395
2. Jefferson City	1,340	525
3. Kansas City	1,680	715
4. Omaha	1,960	960
5. Sioux City	2,095	1,075
6. Bismarck	1,530	1,620
7. Great Falls	3,400	3,295
8. Three Forks	3,630	4,000

Ohio-Allegheny River

1. Mouth	1,100	275
2. New Albany, Ind.	1,475	365
3. Louisville	1,480	395
4. Cincinnati	1,610	430
5. Wheeling	1,970	620
6. Pittsburg	2,060	700
7. Source of Allegheny River	2,400	1,700

ARKANSAS RIVER

	Miles from Mouth	Feet above Sea Level
1. Mouth	690	115
2. Wichita	1,380	1,225
3. Pueblo	1,885	4,700
4. Source of Arkansas River	1,980	6,500
5. Tennessee Pass	2,050	10,400

NIAGARA RIVER

1. Mouth	0	250
2. Escarpment	7	270
3. Whirlpool	11	300
4. Below falls	14	360
5. Above falls	14	520
6. Head of rapids	15	550
7. Lake Erie	30	570

Where in each profile is the velocity greatest? Where least?

What would be the character of the sediment at the first place? at the second? Why?

Where would you expect to find the most meanders? How does the Niagara River profile differ from the others? Why is there such a sudden change in the Hudson River profile at Troy?

EX. 13. ALLUVIAL FANS

Alluvial fans may be studied in the field in many places where temporary streams have cut gullies on a steep hill-side. Where such gullies descend to a plain there will be a deposit of the material washed from the gully. There are many such through the Alleghany Plateau region and larger ones bordering the higher mountains of the western United States.

Good examples of large alluvial fans may be studied on the Cucamonga, Cal., sheet of the U. S. Topographic

Atlas, bound in Folio 2 of the Topographic Atlas, or it may be obtained separately.

Questions on Cucamonga sheet:

1. How many alluvial fans can you count on the sheet?
2. How many of the streams are permanent above the fan?
3. How many of the streams are temporary above the fan?
4. Can you give any reasons why some are permanent?
5. Why are there no surface streams below the canyons?
6. There are five towns and a thickly settled country. It is a prosperous fruit country. Where and how do the people obtain water?
7. What kind of soil is it in the mountains? south of the mountains?
8. Would you expect to find any rock outcrops south of the mountains? Where?
9. Make an ideal cross section along the county line between Los Angeles and San Bernardino Cos., prolonging it to the southwest corner of the map and indicating the kind and character of the rock material for some distance under the surface.

Ex. 14. An Area in Youth — Ottawa, Ill. and Fargo, S. D. Contour Sheets

These two sheets may be studied together as representing two types of youthful streams. Both occur in prairie regions covered with loose soil easily eroded. In the Ottawa area the master stream (the Illinois River) has cut a deep, wide trench through the prairie, giving a low base towards which the tributaries are cutting.

1. Note the difference between the highest and lowest points on each map.
2. Make a N.-S. profile through Ottawa on the meridian 88° 50′ and an E.-W. profile through the Fargo sheet on the parallel 46° 50′. Make both profiles on the same scale and note how much the stream channel is below the prairie in each case.
3. What effect will this difference have in the number of tribu-

taries, in the velocity of the water in the tributaries, in the rate at which the tributaries deepen and lengthen their valleys, in the per cent of rainfall that runs directly into the streams, and in the total erosion over the area?

4. The bluffs bordering the Illinois and Fox rivers are approaching maturity, while the banks of the Red River are in early youth. Buck Creek on the Ottawa sheet shows early youth in the northern part of the map and is approaching maturity near its confluence with the Fox River. What other streams show the same features?

5. Describe the probable future changes in topography on each map. Why will they be more pronounced on one area than on the other?

6. What reasons can you give for thinking that at one time all the Ottawa sheet was a prairie region? What parts are prairie now?

What is the probable occupation of most of the inhabitants of both areas? Reasons?

7. What are the directions of nearly all the roads?

8. Why are they placed so regularly? How do they differ from the location of roads in New York and Pennsylvania? Why? Why are they twice as far apart on the Ottawa sheet as on the Fargo sheet? (There should be a brief explanation of the method of surveying the land in the western states if it is not already understood.)

9. How do you account for the absence of lakes, waterfalls, and swamps (characteristic features of youth) from these youthful areas? Compare Niagara Falls, N. Y., and Eagle or Sun Prairie, Wis., sheets.

Ex. 15. An Area in Maturity — Charleston, W. Va., Contour Sheet.

1. Compare scale of this sheet with that of the Ottawa sheet. What is the approximate area of each in square miles?

2. What is the difference in vertical scale?

3. What would be the appearance of the Charleston sheet if it were made with a contour interval of 10 feet? Try it on a small portion of the map by inserting 9 extra contour lines between those on the map.

4. How would the Fargo sheet appear if made with the same contour interval as the Charleston sheet? What is the advantage of

using a different scale for different maps? Keep this in mind in comparing different maps.

5. How does the number of streams on this map compare with that on the Ottawa or Fargo map? Is there any considerable area on this map without a stream?

6. What do you find on this map to suggest that the area may at one time have been similar to the Fargo or the Ottawa areas?

7. How do the roads differ in number and direction from those on the Fargo and Ottawa areas? Why? Give two good reasons.

8. The streams on this area have reached maturity. Give the reasons, stating how they differ from the streams on the Ottawa and Fargo sheets. How are the divides different?

9. Describe the probable earlier condition of this area, and the future changes.

10. How does this area compare with the Ottawa and Fargo areas for agriculture? Reasons?

11. What can you infer concerning the probable industries of the inhabitants?

12. Draw a profile on the parallel 38° 10′, same scale as the one on the previous maps, and compare it with them.

13. Summarize all the characteristics of an area in maturity.

Ex. 16a. An Area in Old Age — Caldwell, Kansas, Sheet

1. Compare the horizontal and vertical scales with that of the maps previously studied.

2. Compare the relief features with Charleston sheet. If the contour interval were the same as on the Charleston sheet, how would the map differ in appearance? Is it as hilly as the Charleston area? as the Ottawa and Fargo areas? Are there as many streams? Is the current in the streams more or less rapid?

3. Compare the run-off with the other areas.

4. Compare the rate of erosion for the entire area with that on the other areas.

5. Compare the divides between the streams with that in the other areas.

6. Can you imagine that this area ever resembled the Charleston and Fargo areas in appearance?

7. Describe the distribution of roads, railways, and towns.

8. Is there any indication here of the density of the population or the occupation of the people?

9. Make a profile on the line T. 34 S. on the same scale as the Fargo and Charleston sheets, and point out the differences.

Ex. 16b. Lower Mississippi River

(For the features of the lower course of a large river study the Donaldsonville, La., sheet, and maps of the Mississippi River Commission.)

1. Explain why the land slopes away from rather than toward the river. What effect does this have on the tributaries?

2. Explain the numerous large swamp areas.

3. Describe the occurrence and distribution of the roads.

4. What peculiarities do you find about the direction of the contour lines?

5. Is the region thickly populated? How is the population distributed?

6. What can you infer concerning the industries?

7. Make a profile on meridian 90° 55′ on the maps of the Mississippi River Commission.

8. Determine the approximate length and width of the alluvial plain of the delta.

9. Locate some of the ox-bow lakes and describe the changes that have taken place in their vicinity.

10. Account for the parallel course of the Yazoo and many of the other tributaries of the Mississippi with the main river.

11. Describe the movement of the waters at the junction of the White, Arkansas, and Mississippi rivers, (*a*) when it is low water in the White River and high water in the Arkansas, (*b*) when it is low water in the Arkansas River and high water in the White, and (*c*) when it is low water in all three rivers.

12. Does all the water of the Red River flow into the Mississippi? Do you see what might be done to prevent any of it from entering the Mississippi?

13. Explain the projections of the Mississippi River into the Gulf of Mexico.

14. What would you infer concerning the depth of the Gulf along the Louisiana coast?

Ex. 17. Water Gaps, Wind Gaps, Antecedent and Subsequent Streams — Harrisburg, Pa., Contour Sheet

1. In what part of Pennsylvania is this area? In what physiographic region?

2. Indicate the position of the ridges and valleys.

3. How do the hills differ from those on the Charleston sheet in height, in length, in steepness, in regularity?

4. How do the valleys differ on the two maps?

5. What is the direction of flow of the Susquehanna River with reference to the direction of the ridges? Through how many ridges has it cut water gaps?

6. Make a profile across the Susquehanna along the crest of Second Mountain, extending it three miles on each side of the river. Make another profile through Marysville, parallel to the first. Compare the two.

7. Are there any water gaps on the tributaries of the Susquehanna on the map? What striking differences do you find between the tributaries north of Blue Mountain and those south of it? Explain. Why are the first dependent upon the ridges and the second not? Is the course of the Susquehanna independent of the direction of the ridges? Why?

8. Why is Conodoguinet Creek so very crooked? Are the banks hard rock or alluvium? How can you tell? How, then, did the stream get such a very meandering course? (See text under Superimposed and Antecedent Streams.)

9. Can you suggest any reason why the crests of Blue Mountain and Second Mountain are more regular than the ridges in the Rocky Mountains? Why are they not even more regular than they are? Where are there any wind gaps?

10. How is the position of the roads and railroads influenced by the surface features?

11. What can you infer concerning the occupations of the inhabitants, the density of population, and the amount of rainfall? Would you expect the Susquehanna River to be navigable? Why?

CHAPTER III

LAKES, SWAMPS, AND WATERFALLS

Ex. 18. A Glacial Lake — Skaneateles, N. Y., Contour Sheet

Study one of the glacial finger lakes and its immediate surroundings.

This is one of a number of similar lakes, called finger lakes, of central and western New York. Note its relation to the others. They all drain northward through the Oswego River into Lake Ontario.

The basin of the lake is a portion of a former river valley which was probably made deeper and wider by the glacier. The accumulation of material in a terminal moraine of recession forms a dam across the valley at the village of Skaneateles. The lake is 300 feet deep near the middle.

1. What is the origin of the several points jutting into the lake? What kind of material occurs in them?

2. Make a cross section of the lake basin two miles from the north end, and one three miles from the south end. Compare the two as to the width of the lake, slope of the hills, and height of the hills.

3. Is the lake growing smaller? What evidence can you cite?

4. How do you explain the occurrence of Bear Swamp so far above the lake?

5. Account for the absence of a lake in Dutch Hollow Brook, which lies between Skaneateles and Owasco lakes and is nearly parallel to them.

6. Is it probable that the bottom of the lake is the bottom of the original valley? Why?

Ex. 19. A Delta Lake — Reconnaissance Map, Salton Sea, Cal. — U. S. Geological Survey

Locate on the map the various points mentioned in the text, p. 107.

1. Notice that some of the elevations are preceded by the minus sign. What does that signify?

2. Trace out with a light pencil line the former shore line of the Gulf of California when it extended north of Indio.

3. Trace with a dotted pencil line the approximate outline of the delta that cut off the north end of the Gulf.

4. How high must the water rise in Salton Sea until it again becomes part of the Gulf? If that should happen, where would the mouth of the Colorado River be? Where is it now? Where was it a few years ago?

5. If before the Salton Sea joins the Gulf the river should return to its old channel, would the water in Salton Sea be fresh or salt? Would it remain so? Reasons?

6. What can you infer regarding the fertility of the soil between the Salton Sea and the Gulf, and of the kind and character of the rock material?

7. Why doesn't the Salton Sea fill up and overflow?

Ex. 20. Study of a Waterfall — Niagara River and Vicinity Contour Sheet

(References: New York State Museum Bulletin No. 45, Niagara Falls, and Bull. 306 of the U. S. Geological Survey)

1. Make a profile of the river from lake to lake.

2. Describe the three sections (*a*) from Lake Erie to the falls, (*b*) from the falls to Lewiston, (*c*) thence to Lake Ontario, pointing out the differences in the width of the channel, height of the banks, velocity of the stream, and the number and size of the tributaries. Which sections are navigable?

3. What do the parallel contours east and west from Lewiston signify? Why do they not cross the river at Lewiston? Where do they cross the river? Why are hachures instead of contours used between the falls and Lewiston?

4. What is the character of the area on both sides of the river back to the margin of the map?

5. What inferences can you draw concerning the age of the river? Give your reasons.

6. Describe in your own words the past history of the river. Forecast the future changes.

Some of these questions are answered in the excellent description on the back of the map.

A good pictorial map of the river and falls is furnished in a folder by the Niagara Belt Line Railway.

CHAPTER IV

GLACIERS

Ex. 21. Alpine Glaciers — Shasta, Cal.; Glacier Peak, Wash.; Mt. Stuart, Wash.; and Cloud Peak, Wyoming, Contour Sheets

1. Note the elevation above sea level of the lower end of all of the glaciers on the above sheets. Is it the same in all the areas? Is it the same on any one area? How do you account for the differences? Do you know of any higher mountains than these without glaciers? Are the glaciers on the highest parts of the mountains? Explain.

2. These areas formerly contained more and larger glaciers than at present. What evidence do you find of their existence? Any moraines? cirques? hanging valleys? Nearly all the lakes on the Mt. Lyell sheet are in cirques. Note the U-shaped valleys.

Glacial features should be studied in the field wherever possible. In the northern United States many of the features are accessible to any school. The characteristic boulder clay, the ground moraine, is almost universally present. Drumlins, kames, and eskers are widely distributed. Terminal moraines and glacial boulders are widespread. The boulders should be compared with creek and talus boulders.

Ex. 22. Glacial Topography — Eagle, Wis., and Weedsport, N. Y., Sheets

The first map represents a terminal moraine, and the second a drumlin area.

1. Locate the moraine and its direction on the map. Indicate all morainal characteristics.

2. On what portions of the map are the kettle holes and how are they indicated?

3. How do you explain the variation in size and shape of the lakes?

4. What evidence can you give that some of the lakes were formerly larger (or smaller) than now? Why is this not true of all of them?

5. Are the streams young, mature, or old? Reasons?

6. In what way or ways does the topography influence the position of the railways, the wagon roads, and the villages?

7. Which way was the ice moving?

8. What inferences can you draw concerning the character of the soil, the density of the population, and the occupations?

9. Do you see any way or ways for increasing the value of the area for settlement? What?

10. What resemblances can you find in the topography of the Eagle and Weedsport areas? What striking differences?

11. What direction was the ice moving in each case?

12. Locate each area on a map of North America and state from which glacial center the ice was probably moving.

13. In what physiographic region is each area? See Chapter XII.

14. In what portions of the Weedsport area are drumlins abundant?

15. Why are the drumlins in the southeast part higher than those in the northwest part?

16. How do you account for the numerous loops on the Seneca River?

17. How have the drumlins influenced the directions of stream flow?

18. What is the average shape, direction or trend, and size, including length, width, and height of drumlins?

19. What is the relation of swamps, lakes, and kettle holes to each other and to the water table?

CHAPTER V

THE OCEAN

Ex. 23a. Study of Ocean Currents

On a Mercator's map of the world mark the warm and the cold ocean currents. The data may be obtained from fig. 136, p. 186, of the text-book, but better from a larger map giving greater details. Compare with a wind zone map (p. 368 of text-book).

1. What relations can you find between the two?
2. Describe and name the currents in each ocean, explaining as far as possible the causes for direction of movement in each case.
3. Explain what effect you would expect from each in turn on the bordering continents. Later in studying the climates in Chapter X refer to this exercise and see how your predictions are verified.

Ex. 23b. Study of Tides

From the data given below from the Tide Tables for 1908 by the Coast and Geodetic Survey construct a graph or diagram of the tides at Boston, Mass., for one month. Use cross-section paper and let each large space between the heavy lines from left to right the long way of the paper represent twelve hours, or two spaces represent one day. Let each one of the small spaces the short way of the paper represent one foot.

If a copy of Tide Tables is available, any other port and any other month would serve to illustrate as well as the one given on the next page.

1. When was the highest high tide, and the lowest low tide? What was the phase of the moon at the time?

2. What is the average interval of time between high tides? Between high and low tides? Where is the greatest variation from the average time? Why shouldn't the intervals be regular?

3. If the entrance to the harbor were shallow, how would the times of the sailings of vessels be influenced by the tide?

4. Why do vessels sometimes start on a voyage in the middle of the night?

5. If a set of tide tables are available for class use, compare the variations between the heights of high tides at the principal ports of the United States.

6. The time and height of high tide on March 1, 1908, at some of the ports are given below. Compare them with Boston and with each other.

TIME AND HEIGHT OF TIDE AT ATLANTIC PORTS

	Time	Height
St. Johns, Newfoundland	5:54	3.6
Halifax, N. S.	6:38	5.3
St. John, N. B.	10:20	24.
Portland, Me.	9:27	10.1
Newport, R. I.	6:18	4.3
New London, Conn.	8:00	2.9
Sandy Hook, N. J.	6:20	5.4
Baltimore, Md.	5:14	1.2
Washington, D. C.	6:50	2.7
Charleston, S. C.	6:38	6.
Key West, Fla.	7:55	1.
Galveston, Tex.	1:10	1.1
San Diego, Cal.	8:01	6.5
San Francisco, Cal.	9:55	5.8

7. What is the reason for the extremely low tides at Key West and Galveston?

8. Why should the tide at Baltimore be less than at Washington and Sandy Hook?

TIDES AT BOSTON, MASS., MARCH, 1908

Moon	Day of— W.	Day of— Mo.	Time and Height of High and Low Water				Moon	Day of— W.	Day of— Mo.	Time and Height of High and Low Water			
P	S	1	3:50 —0. 2	10.00 10. 8	16:25 —1. 3	22:34 10. 0		M	16	4:15 0. 9	10:24 9. 4	16:42 0. 0	22:48 8. 9
●	M	2	4:42 —0. 7	10:55 11. 2	17:16 —1. 6	23:25 10. 4	○	Tu	17	4:56 0. 5	11:05 9. 6	17:18 —0. 2	23:25 9. 3
	Tu	3	5:34 —1. 1	11:48 11. 3	18:08 —1. 7	. . . . . .		W	18	5:35 0. 2	11:43 9. 8	17:55 —0. 2	. . . . . .
E	W	4	0:14 10. 7	6:24 —1. 3	12:38 11. 2	18:50 —1. 6	E	Th	19	0:05 9. 5	6:14 0. 0	12:20 9. 8	18:35 —0. 2
	Th	5	1:00 10. 8	7:16 —1. 3	13:28 10. 9	19:42 —1. 3		F	20	0:40 9. 7	6:55 —0. 2	13:00 9. 7	19:15 —0. 1
	F	6	1:50 10. 7	8:05 —1. 1	14:16 10. 4	20:30 —0. 9		S	21	1:20 9. 8	7:36 —0. 2	13:45 9. 5	19:54 0. 2
	S	7	2:40 10. 4	8:56 —0. 7	15:08 9. 8	21:16 —0. 3		S	22	2:00 9. 7	8:20 —0. 2	14:28 9. 3	20:38 0. 5
	S	8	3:30 10. 0	9:50 —0. 3	16:00 9. 2	22:10 0. 4		M	23	2:48 9. 6	9:10 0. 0	15:17 9. 0	21:25 0. 9
☽	M	9	4:22 9. 6	10:45 0. 2	16:55 8. 6	23:05 0. 9		Tu	24	3:36 9. 4	10:05 0. 1	16:10 8. 7	22:20 1. 1
	Tu	10	5:15 9. 2	11:42 0. 5	17:55 8. 1	23:58 1. 3	☾ S	W	25	4:35 9. 3	11:05 0. 3	17:10 8. 4	23:20 1. 3
N	W	11	6:15 8. 9	12:35 0. 9	18:54 7. 9	. . . . . .		Th	26	5:40 9. 3	12:08 0. 3	18:15 8. 4	. . . . . .
	Th	12	1:00 1. 5	7:10 8. 8	13:38 0. 9	19:52 7. 8		F	27	0:25 1. 2	6:45 9. 4	13:10 0. 1	19:20 8. 6
A	F	13	1:56 1. 6	8:07 8. 8	14:30 0. 8	20:45 7. 9		S	28	1:35 0. 8	7:46 9. 6	14:10 —0. 2	20:20 9. 0
	S	14	2:46 1. 4	8:56 9. 0	15:19 0. 5	21:32 8. 2	P	S	29	2:35 0. 3	3:48 10. 1	15:10 —0. 6	21:20 9. 5
	S	15	3.32 1. 2	9:44 9. 1	16:00 0. 3	22:10 8. 5		M	30	3:30 —0. 3	9:47 10. 5	16:05 —1. 0	22:15 10. 1
								Tu	31	4:28 —0. 9	10:40 10. 8	16:55 —1. 2	23:05 10. 6

Ex. 24. Ocean Routes

(Pilot charts of the North Atlantic and the North Pacific oceans for January and July (and other months if possible for comparison). Pilot charts are published by the Hydrographic Office, Washington, D. C., and sold at ten cents each.)

North Atlantic

1. Describe the sailing route from New York to the equator, and the reverse. Why the great difference?

2. Why are the east-bound routes different from the west-bound?

3. Why are there so many icebergs south of Newfoundland in July and none in January?

4. Why do so many of the sailing routes meet in mid-Atlantic southeast of Newfoundland in July?

5. What routes avoid the Gulf Stream current? What ones take advantage of it?

6. In what month are storms most abundant? In what part of the ocean?

7. In what month is fog most abundant? Reasons? How does this affect the sailing routes in the two months? Why are there more and larger icebergs in the Atlantic Ocean than in the Pacific?

North Pacific

8. On a globe stretch a string from San Francisco to Yokohama. How does its position compare with the great circle sailing route on the pilot chart? How does the distance differ from a straight line route on a Mercator map?

9. Note the difference in the position of the limits of the Trades in each month. Why different in the two months? Why are the southern trades north of the equator? What relations do you find existing between the direction of the wind and of the currents and between the two and the sailing routes?

CHAPTER VI

SHORE LINES

Ex. 25. Study of a Regular Shore Line — Atlantic City Contour Map and Coast Chart of Eastern New Jersey, No. 122

1. Give the geographical location of the area. In what physiographic region is it?

2. What separates the beaches from the mainland?

3. What name is given to the land forming the present beaches?

4. How were they formed? (See p. 212.)

5. Do the ends of the beaches hook towards the ocean or the mainland? Reason?

6. What is there on the map to indicate that there are passageways for boats between the beaches and the mainland?

7. How far is the present beach from the old beach?

8. What is likely to be the future history of the area between the old and the new beaches?

9. How many life-saving stations? Why are they so numerous?

10. What is the origin of the small hills on the present beach? Why is the sea side of the beach more regular than the land side?

11. Why is Atlantic City built so far out from the mainland?

12. Why are there no commercial cities along the New Jersey coast?

13. What are the industries along the coast?

14. What would be the effect on this shore line if the sea level should rise 10 feet? If it should sink 10 feet?

15. Construct a cross section from the northwest corner of the map extending five miles out into the ocean.

16. What can you infer concerning the industries and occupations of the inhabitants of this area?

Ex. 26. Study of an Irregular Shore Line — Boothbay, Me., Sheet or Any Other Part of the Coast of Maine

1. State the geographical position of the area.
2. Indicate what you think are the chief points of difference between this shore and that of the Atlantic City area.
3. What differences can you infer concerning the rocks?
4. Give reasons for thinking that this coast has sunk and is now a drowned shore line.
5. How does it compare with the Atlantic City shore in the number of lighthouses? in the number of life-saving stations? Why this great difference?
6. What do you know or what can you infer concerning the industries on this shore, and the density of population?
7. What can you infer concerning the future history of this shore?
8. Why is there not as much salt marsh land on the Maine coast as on the New Jersey coast? Is there any? How do you account for this difference in the two areas?
9. If the state of Maine were elevated 200 feet, what effect would it have on the shore line? on the harbors? on the streams? If it should sink 200 feet, what would be the effect?
10. What evidence do you find here of the former presence of glaciers?
11. Can you find a similar coast with deep fiords anywhere where the region has not been covered with a glacier or glaciers?

Ex. 27. Study of Lake Shores — Oswego, N.Y., Contour Map and Coast and Geodetic Survey Maps of Lake Ontario or Some of the Other Great Lakes

1. What evidence do you find that the area was once covered by a glacier?
2. What is the character of the material along the shore?
3. What evidence do you find of wave erosion on the shore? Notice the drumlins northeast of Little Sodus Bay.

4. What evidence do you find of deposition on the shore?

5. Explain how Blind Sodus Bay was formed. What becomes of the water that runs into it?

6. Account for the position of the breakwater at Oswego. Why west rather than east of the harbor? Why are there so many breakwaters?

7. What other modifications of the shore line do you find?

Study one or more of the large maps of the Great Lakes published by the Coast and Geodetic Survey, noting the modifications of the shore line now in progress, where it is being built up, and where torn away. Note especially the changes taking place at the west end of Lakes Ontario, Erie, and Superior.

Ex. 28. Pacific Coast — Oceanside, Cal., and Southern California No. 2 Contour Maps

1. Compare this coast with the New Jersey coast. What are the points of resemblance and points of difference?

2. Why are there no harbors on the Oceanside sheet?

3. San Diego has one of the best harbors on the Pacific coast. What are the topographic conditions there that produce it? What can you infer concerning the future of this harbor? Does it seem probable that there might have been at one time similar harbors on the Oceanside shore?

4. Why do none of the streams flow into the sea? Some do not even reach the lagoon. Why?

5. Is the shore line old or young? In the past has it been more regular than at present or less so, that is, is its present regularity due to youth or old age?

6. Are the rocks of this coast hard as on the Maine coast or soft as on the New Jersey coast?

7. With such a magnificent harbor why shouldn't there be a larger city at San Diego?

CHAPTER VII

THE LAND

Each school should have a collection of minerals and rocks, and the class should study some of both the rock-making minerals and the ores until they are able to recognize them and give their distinguishing properties. If the school does not possess a collection of minerals, a small collection of labeled specimens should be purchased, and to this should be added such minerals as can be found on the field trips in the vicinity of the school.*

Ex. 29. Physical Properties of Minerals

Each of the minerals should be studied with reference to all its physical properties, and emphasis should be placed upon the distinguishing properties for each.

1. Color of the mineral and color of the streak? The streak may be obtained by rubbing it on unglazed porcelain, by scratching with a file, or pounding a fragment with a hammer.
2. Is it transparent, translucent, or opaque?
3. Is it a crystal or is it crystalline? A crystal has regular geometric faces.
4. Cleavage is the tendency to split in certain definite directions, generally leaving a smooth bright surface. Galena, for example, cleaves in three directions, forming a cube. Mica cleaves in one direction into very thin flakes.

* A collection of forty common minerals or forty common rocks labeled and in trays can be purchased for two dollars per set from E. E. Howell, Washington, D. C.

5. Hardness — see scale of hardness (p. 240).

6. Is it brittle, flexible, elastic, malleable, or sectile?

7. The luster will be metallic or non-metallic and may also be vitreous, resinous, greasy, pearly, silky, opalescent, iridescent, dull, or earthy.

8. Specific gravity. In comparison with the other minerals determine whether each one is heavy, medium, or very heavy, light, medium, or very light.

9. Does it have any characteristic feel, odor, or taste?

10. Note especially which minerals it resembles and how it differs from them: for example, iron pyrite resembles gold and chalcopyrite in being yellow and having a bright metallic luster; it differs from them in being a lighter shade of yellow, more of a brassy yellow; it is harder than either of the others; it is brittle, while gold is malleable.

11. The name, composition, and uses of each mineral should be learned from the instructor or from a text-book on mineralogy.

Ex. 30. Study of Rocks

Each student should handle and be able to name most or all of the following rocks and state the characteristic properties of each: sand, clay, shale, sandstone, conglomerate, limestone, coal, gypsum; granite, syenite, diabase, gabbro, basalt, pumice, obsidian; slate, marble, schist, serpentine, gneiss, quartzite.

1. Name the class to which each belongs.

2. Name the color or colors.

3. State whether hard, soft, crumbly, granular, crystalline, porous, cellular, vesicular, or compact.

4. Is it massive or in thick or thin layers?

5. Is the fracture regular, irregular, splintery, or conchoidal?

6. If the rock is sedimentary, what evidence is there of stratification? What evidence is there of life, if any? Does the rock show any signs of weathering? What?

7. Do you think it would make a good building stone? Why?

8. What kind of soil do you think would result from its disintegration?

Ex. 31. Study of Soils

Collect samples of soil from different localities where it appears to be different. For example, get some (1) from under the leaves in the woods, (2) along some creek or river bottom, (3) from two or three different fields where it differs in color, (4) if in a glaciated region, some with boulders in it. Examine and compare them with reference to the percentage of, 1st, the organic matter; 2d, the sand; 3d, the clay; 4th, the rock fragments. The organic matter can be recognized by its dark color and by heating at a high temperature. The sand may be recognized by its gritty feeling in the fingers, and the clay by its odor. The sand and clay may be separated roughly by washing in a glass of water. Noting the locality where you collected each sample, what can you say concerning (1) its probable fertility, (2) its origin? From what rock or rocks and minerals do you think the bulk of the soil was derived in each case? To what class of mantle rock does it belong, — glacial, alluvial, residual, lacustrine, or marine?

Where the laboratory facilities will permit, test the relative fertility of the soils collected, by planting a few seeds in each kind, keeping it watered, and watching the results for a few weeks.

CHAPTER VIII

PHYSIOGRAPHIC AGENCIES

Ex. 32. Study of a Volcanic Mountain — Mt. Shasta, Cal., Contour Map

1. What is the elevation of the summit of Mt. Shasta above sea level? above its base? Are the slopes steep? Note the contour interval. Where are the steepest slopes?

2. What is the general shape of the mountain?

3. Notice the area marked "Lava Flow" northeast of the summit. Where do you find other lava flows on the map?

4. Would you infer that the mountain peak was built up by a succession of lava flows? Why?

5. Did all the lava flow come from the summit? Reasons?

6. Would lava flows build up a steep cone such as Shastina, Red Butte, or Cinder Cone, or Mt. Shasta?

The upper part of Mt. Vesuvius is an ash cone, the base is a mixed lava, cinder, and ash rock. The Hawaiian volcanoes are lava mountains with gentle slopes and very broad bases. (See text.)

7. How was Shasta built up? Is the disappearance of some of the creeks suggestive?

8. Make a profile of the mountain across the summit. Make a cross section of it by filling in the profile with the rocks as you imagine them to be.

9. Are there any wagon roads on the mountain? Where? Why not more? What is the age of Mt. Shasta as a volcanic mountain?

(See Mt. Shasta by Diller, in Physiography of the United States. By American Book Co.)

Ex. 33. Study of the Marysville Buttes—Marysville, Cal., Contour Map

1. Compare Marysville Buttes with Mt. Shasta as to area covered, height of mountain, steepness of slopes, form and symmetry of the mountains.

2. In your own words tell what there is on the map suggestive to you of the fact that the Marysville Buttes are volcanoes, or the remains of a volcano.

3. Does the area look like a new volcano or the remains of an old one? Reasons?

The Marysville area has many illustrative features on stream work which should not be overlooked.

For another type of volcanic mountain see Ex. 18, which might be reviewed for its volcanic features.

Ex. 34. Study of Earthquakes

If any of the following references are available, a laboratory study should be made of the diagrams, photographs, and maps of one or more of the following earthquakes:

The Charleston Earthquake, 1886.
The San Francisco Earthquake, 1906.
The Italian Earthquake, Dec., 1908.

1. The Charleston Earthquake, by C. E. Dutton, 9th An. Rept. U. S. Geol. Survey, pp. 209–360.

2. San Francisco Earthquake, Nat. Geog. Mag., May and June, 1906.

San Francisco Earthquake, Pop. Sci. Mo., August, 1906.

San Francisco Earthquake, Carnegie Institution, Washington, D. C.

3. Earthquakes, by W. H. Hobbs. D. Appleton & Co.

CHAPTER IX

PLAINS, PLATEAUS, MOUNTAINS

Ex. 35. Study of a Coastal Plain — Oceanside, Cal., Contour Sheet

The Pacific coast at Oceanside, Cal., has a very narrow coastal plain compared with the coast at Atlantic City or other areas along the Atlantic coast farther south. The Oceanside area is bordered by terraces. At what elevations above sea level are these terraces? Locate them on the map. What do they signify concerning movements of the land?

Can you infer from the map the character of the shore, whether it is hard rock or loose sand? Reason?

Explain the unique feature of the rivers, that they do not empty into the sea, but end on the land near the sea.

What is the cause of so many marshes?

How can you explain the occurrence of salt and fresh water marshes in the same valley?

If a chart of this portion of the coast is available, study the variations in depth from the shore outward. Since there is an increase in depth in passing seaward, what would be the probable inclination of the layers of the coastal plain if this portion of the continental shelf were elevated and added to the land? Would the same conditions be probable of the present land area near the shore?

Draw a cross section on parallel 33° 10′, and indicate your interpretation of the layers under the surface.

The Atlantic City sheet, Ex. 25, should be reviewed here. Other good contour maps of the Atlantic Coastal Plain are the Ocean City, Green Run, Nanticoke, and St. Michael's sheets, Maryland. The charts of the Coast and Geodetic Survey should also be studied.

For the study of a river flood plain review Ex. 16.

Ex. 36. Study of Plateaus — Kaibab and Bright Angel, Ariz., Charleston, W. Va., and Skaneateles, N. Y., Contour Maps

The Bright Angel sheet covers a small part of the area of the Kaibab sheet on a much larger scale, thus showing greater detail. Frequent comparisons should be made between these two maps to get familiar with the same region represented by different scales and between this area and the eastern area as showing the differences between canyons in arid and humid climates. The Skaneateles area was covered by the glacier, which accounts for many of the differences between it and the Charleston area.

The student should write a description of each area, which should cover at least most of the following points: (1) the physiographic region in which it is located, and its relation in size to the entire province of which it forms a part, (2) the evidence that the region is part of a plateau, (3) whether the general surface of the plateau is inclined, in what direction, and how much, (4) steepness of slopes, (5) relative number of tributary valleys, (6) stage of erosion, (7) relative density of population, and reasons, (8) probable industries of the region, (9) features in which the area differs from the other areas studied.

Ex. 37. Study of Mountains — Harrisburg, Pa., and West Canada Lakes, N. Y., Contour Maps

These two maps represent two types of mountains. Name the types. In what physiographic provinces do they occur? Compare them carefully as to regularity and continuity of ridges, relative abundance of peaks, and uniformity of level of mountain tops. Do either of these areas represent one or more peneplains? Explain.

Locate on the Harrisburg map water gaps and wind gaps, and explain how they were formed.

How do the streams on this sheet indicate which are areas of hard rock and which of soft? There are several parallel outcrops of the same layers. How might this be inferred from the map?

The ridges are all composed of sandstone. The valleys are in limestone and shale. What inference can you draw from this?

What inferences can you draw concerning the kinds and structure of the rocks in the West Canada Lakes area?

Ex. 38. Study of Mountains, *Continued* — Colorado Springs, Pikes Peak, Colo., and Kaaterskill, N. Y., Contour Maps

Two types of mountains different from those in Ex. 37 are here represented. These are examples of mountains in youth or early maturity, while those in Ex. 37 have passed maturity. Point out the differences.

The Colorado sheets show a portion of the Rocky Mountains with the eastern foothills bordering on the Great Plains.

Can you distinguish any sedimentary rocks on the map?

How and where? See figs. 307 and 308 in the text-book. Figure 308 is a view just west of Colorado Springs, and 307 is a view in Wyoming, but it is similar to places on the Colorado Springs sheet.

How do you account for so many intermittent streams on the Colorado Springs sheet, and the greater number of permanent streams on the Pikes Peak sheet?

What evidences do you see of volcanic rocks?

The Kaaterskill quadrangle covers a portion of the Catskill mountain area, which is the northeastern extremity of the Alleghany Plateau.

What characteristics of a plateau do you find on this sheet, and what is suggestive of mountains?

Compare the extreme eastern portion of the map with the remainder of the area. What can you infer regarding the structure of the rocks?

Why do the longest streams of the mountain plateau flow west? Explain the evidence of stream piracy on the Platteskill and Kaaterskill creeks.

What is the origin of the lakes in the area?

CHAPTER X

THE ATMOSPHERE

Daily weather maps, blank maps, the monthly weather reviews, and other charts and supplies can usually be secured from the nearest Weather Bureau office. Weather maps will be sent to schools daily upon request. Schools can sometimes obtain from the Weather Bureau necessary apparatus for the study of this chapter, on condition that systematic observations are made, recorded, and reported to the Weather Bureau.

Pupils should be induced to study the daily weather maps, and forecast the weather for themselves before reading the forecast underneath. They should also observe and record whether or not the predictions come true, and if not, try to find the reasons for the disagreement, and profit by them in future forecasting.

A complete file of the weather maps should be preserved for future use.

Ex. 39. Study of Weather Conditions

The collection of the data for this experiment can be made part of the regular class work for a month, and the final work may be covered in one or more laboratory periods. The experiment should be begun as soon as the pupils have studied the subject enough to know how to record the data. The teacher should keep a record of the data each year for future comparison. Some of the data below may have to be omitted, due to lack of apparatus, but the list should be made as comprehensive as possible.

Each pupil should keep for one month a weather record according to the following outline:

WEATHER RECORD FOR MONTH OF ______

Date	Barometric Pressure	Av. Temperature and Change for the 24 hours		Relative Humidity	Kinds of Clouds	Rain or Snow and Amount	Direction and Velocity of Wind	Direction of Nearest Low	Other Data
1									
2									
3									
*									
*									
30									

Each pupil should determine the different items as far as possible, but the humidity may be determined by a different group of students each day and placed on a bulletin board where the others can obtain it. In the last column should be recorded any important changes in the weather during the day. All readings should be taken at some fixed time. It may be the hour chosen by the Weather Bureau (8 A.M. Eastern time) in the record for the daily weather map; or better, if the class were divided into two sections, let one section keep the record for the morning and the other for the evening, and then combine the two records. Some of the data could be secured by the pupil on the way to school, and the remainder in the laboratory before the opening of school or during an intermission. Each pupil should see if the data collected agree with conditions on the weather map for that day.

After this table has been completed, the pupil should work out all the relationships possible between data in different columns. What relationship is there between (1) pressure and humidity, (2) pressure and state of sky, (3) humidity and state of sky, (4) temperature and wind direction, (5) pressure and wind direction, (6) precipitation and pressure of that day and the day following, (7) wind direction and kind of clouds, (8) wind direction and precipitation, (9) humidity and kind of clouds, (10) kind of clouds before, during, and after precipitation, and (11) location of approaching lows and highs to temperature, pressure, wind direction, humidity, kind of clouds, and precipitation, and kinds of clouds when there is no precipitation.

Make a summary at the end of the month for the maximum and minimum temperatures for the month, average temperature, prevailing wind direction, number of fair days, and number of days of precipitation.

The pupil should also plot on cross-section paper the temperature and pressure curves for the month.

Ex. 40. Construction of a Weather Map

Each pupil should be provided with a blank weather map. The teacher may give the class a list of data upon the temperature, pressure, wind direction, cloudiness, etc., for well-selected stations over the United States. The above data can be secured from one of the weather maps published in Washington. The data should be transferred to the blank map, putting the arrows in the circles so as to show the wind directions and shading the circles to show cloudiness. The temperatures should be put on and the isotherms drawn and labeled, and then the isobars, after which the high and low pressure areas can be marked. Different kinds of lines should be used for the isotherms and isobars to avoid confusion.

It is best to have the corresponding weather map for comparison after the maps are finished. Each pupil should correct his map by the one made by the Weather Bureau.

Forecast the weather for your town for that day.

Forecast the weather for the following day.

If time permits, tell the weather for different places, stating the place, temperature, cloudiness, wind direction, pressure, etc.

Ex. 41. Study of High and Low Pressure Areas

Each pupil should be provided with a weather map having well-defined high and low pressure areas. The Washington maps are better than the local ones for this experiment.

Notice the directions of the wind around each area. How do the directions in the highs differ from those in the lows?

Notice the bends in the isotherms. Which way do they bend in each case? Is there any relationship between the direction of the bends and the direction of the wind at the point? Explain.

In what part or quadrant of the area do the cloudy regions appear? Notice the maps of your neighbors and see if this is always true. In what part of the area do you find the precipitation? Is it always located in the same relative position?

What relation do the isotherms at this point bear to the kind of precipitation?

Notice again carefully the direction of the wind at each point around both high and low areas. Now tell in what part of which area you would be and what change you would expect in the weather (temperature, cloudiness, precipitation, direction of wind, etc.) if the wind is in the (1) S., (2) W., (3) N., (4) E., (5) S. W., (6) N. E., (7) S. E., and (8) N. W.

Suppose you have clear, cool weather with little, if any, wind, in what area and in what part of it would you be?

Would you expect a snowstorm in the winter if the wind is in the north? Why?

Why do they sometimes predict rain or snow without saying which one?

From observations, have you noticed any change in the direction or velocity of the wind just before a rainstorm?

These questions can be taken as the teacher sees fit and can be multiplied indefinitely, depending on the amount of time available for the exercise.

Ex. 42. Paths of Cyclones and Anticyclones

Each pupil should be provided with a blank weather map and also enough successive daily weather maps to show the paths of a cyclone and anticyclone across the country. These maps may be picked out from the regular supply received by the school, giving out maps for a week or more to each pupil.

Locate accurately on the blank map the centers of all high and low pressure areas found on the earliest map in your collection. These may be designated by H, H_1, H_2, etc., for the high-pressure areas or anticyclones, and by L, L_1, L_2, etc., for the low-pressure areas or cyclones. Examine the map in your collection for the following day, and find the new positions for each one of these areas, and label them in the same manner, also any new areas appearing on the map. Continue this until you have completed the maps in your set.

Now through the corresponding letters draw lines showing the paths of these areas across the country, using different kinds of lines for high and low areas and labeling each line properly.

Compare the paths of the cyclones and anticyclones on your map with others in the class and see if there is any relationship in the paths of different cyclones and anticyclones.

Does there seem to be any regular rate of advance for the areas?

How far do they move each day?

State briefly the results of your study.

Now study a map of the highs and lows for a month from the Monthly Weather Review, published by the Weather Bureau, and then study fig. 255 in the text-book.

Ex. 43. Wind Belts and Ocean Currents

On the world map draw carefully the wind belts, paying especial attention to the ocean areas. Put arrows in to show the direction of the wind in all parts of the ocean.

What effect does the continuous blowing of the wind have upon the surface of the ocean?

Which way would you expect the water to move at each point in all oceans?

Trace on the map faintly with your pencil the direction in which you would expect the ocean currents to flow if caused by the winds. Use arrows with long lines.

In what direction would each current be deflected as it strikes the continent it is approaching?

Compare this map with the one in the text-book (fig. 136) for the ocean currents and see if they agree. Correct any mistakes, and then draw in the lines with a different color from that used for the wind belts.

Is there any relation between the tropical calms and the Sargasso seas?

Is there any current in the northern part of the Indian Ocean directly under the Equatorial Calms?

Is there any relation between the paths of the cyclone or hurricane belts and those of the Gulf Stream and Japan Currents?

Ex. 44. Study of the Climate of the Home Region

Determine the climate of the region around your own town by locating it upon each of the kinds of maps mentioned below and determining the data for that place. (The pages refer to maps in the text-book by the author.) The maps to be consulted are the following: wind and rain belts for January and July (p. 369), mean annual temperature (p. 365), isothermal charts for January and July (p. 367), mean track of high and low pressure areas (p. 372), and rainfall map (p. 386). Notice if you are located near the boundaries of any of the areas shown on these maps.

Write a brief description of the climate of your home region from this date.

Another laboratory exercise may be made out of this also by now giving each pupil a different state or group of states; let him work out the climates for these regions and report the results to the class. This information can be used to excellent advantage later in the study of the distribution of plants, animals, and men, especially in regard to the different grain belts in the United States.

CHAPTER XI

GEOGRAPHY OF LIFE

Ex. 45a. Study of Life Regions — Interpret the Map of the World, p. 400 in the Text-book

1. Give geographical reasons for the location of the tropical forests.
2. Ditto for the great desert of northern Africa and southern Asia.
3. Ditto for the desert region of western Australia.
4. Ditto for the desert region of western South America and western Africa.
5. Ditto for the desert region of western United States.
6. Why are there heavier forests on the east side of Madagascar, South America, and Australia than on the west side?

Ex. 45b. Study of Zoölogical Provinces

On a Mercator's map of the world trace out and mark the zoölogical provinces (see fig. 289). Label each province.

Describe the boundaries of each province, stating the proportion of each that is land and the part that is water.

Why is the separation of the North and South American provinces not at the Isthmus of Panama?

Why is the northern part of Africa in a different province from the remainder of that continent? Is North Africa well or poorly connected with the province to which it belongs?

Why do not the Ural and the Caucasus mountains form a barrier and separate the Eurasian province into two?

In what province is Arabia? Why?

Why is the animal life of India different from that of China?

North America was at one time higher above sea level than it is at present. Bering Strait is only about 50 miles wide in one place, and the ocean is shallow. Why are there strong resemblances between the faunas of North America and northern Asia? Would it have been possible for the Indians and Mound Builders to have come to America from Asia?

What prevents the animals of southern South America mingling with those of northern North America, of southern Asia from northern Asia, of southern Africa from northern Europe?

Why are part of the Oceanic Islands in the Oriental province and part in the Australian province?

Ex. 46. Geographic Influences affecting Cities and Regions

1. Give geographic reasons, that is, climatic conditions, topographic relief, drainage, mineral resources, conditions for manufacturing or commerce, etc., for the location of the following cities:

St. Louis, Chicago, San Francisco, Leadville, Pittsburg, Harrisburg, New York, Buffalo, Syracuse, your home city.

2. Why is eastern Kansas more densely populated than western Kansas?

3. Why are Illinois and California more densely populated than Nevada?

4. Why are eastern and western Pennsylvania more thickly settled than central Pennsylvania?

5. Why is the population of central Pennsylvania confined to the valleys? In the Catskill Mountains of eastern New York and the Pocono Mountains of eastern Pennsylvania there are many people living in the mountains. Why not in central Pennsylvania?

6. Why does central Illinois have more railways than central Pennsylvania, central New York, central Florida, or central Wisconsin?

Ex. 47. Experiments with Plants and Seeds

When laboratory room is available, numerous experiments may be performed to illustrate the effect of varying percentages of moisture and elements of fertility on different seeds and plants.

Collect a half dozen or more distinct types of mantle rock and place in small boxes in the laboratory under uniform conditions of light and warmth. In one vessel have water only, and in another have sand from a stream channel; in another have fine gravel; in one muck from a swampy area; in another marl; in another some boulder clay or several varieties of boulder clay; if in a glacial locality, there should also be samples from fields of the vicinity. All should be carefully numbered and labeled and memoranda kept in a notebook by each pupil.

In these different soils a few seeds of different kinds, such as corn, beans, peas, potatoes, etc., should be planted and a record kept of them, such as noting the time of the first appearance of the plant above ground and its height obtained by measurement at intervals of a few days.

It may not be practical to keep the record long enough to follow the plants to maturity and ripening of the seeds, but a few weeks' time will be sufficient to show the effects of the relative fertility of the different kinds of soil. The seeds in the sand and those put in water in a shallow vessel will sprout as soon, possibly sooner, than the others, and will grow rapidly for a time, but they soon begin to show evidence of decline, and fail to reach maturity. The interest of some of the pupils will no doubt be aroused sufficiently to carry on some or all of the lines of experiment started in the laboratory at their homes in the summer months to see the effect of the different soils at maturity.

The effect of water may be shown by having a set of vessels with soil and seeds, and furnishing an excess of water from day to day to one, a reasonable amount to another, a limited amount at irregular intervals to another, to another, moisture at the start but no water added, and another with dry soil and no water added, and another with water only and no soil. A record kept of these for a few weeks will soon show how the plants are influenced by the percentage of moisture. The experiment will be made more valuable by adding some water plants.

Ex. 48. Construction of a Crop Map of the United States

On a blank map of the United States locate the Oats, Wheat, Corn, Cotton, and Rye areas by different colors or different kinds of shading; for instance, represent the Oats belt by vertical parallel lines, Wheat by horizontal, Corn by lines inclined to the right, and Cotton by lines inclined to the left. Use the following data, or better, take from the census report if that is available. While the data is given by states, if you have any good reason for including only part of the state, do so and state the reason. For example, Kansas is one of the leading corn states, but very little corn is raised in the extreme western part, which lies in the semi-arid region.

Oats in Millions of Bushels, 1900

Illinois	180	Ohio	41
Iowa	168	New York	40
Wisconsin	82	Pennsylvania	39
Minnesota	73	Michigan	38
Nebraska	59	Indiana	37

Wheat in Millions of Bushels, 1900

Minnesota	90	Nebraska	25
North Dakota	60	Missouri	23
Ohio	50	Iowa	23
South Dakota	42	Washington	21
Kansas	38	Pennsylvania	20
California	36	Michigan	20
Indiana	35		

Corn in Millions of Bushels, 1900

Illinois	400	Indiana	180
Iowa	385	Ohio	155
Kansas	230	Texas	95
Nebraska	210	Kentucky	75
Missouri	208	Tennessee	55

Cotton in Millions of Dollars

Texas	$97	Arkansas	$28
Missouri	54	Louisiana	27
Georgia	48	North Carolina	17
Alabama	42	All other states	59

Rye in Millions of Bushels, 1900

Wisconsin	5	Nebraska	2
Pennsylvania	4	Minnesota	2
New York	2.5	Iowa	1
Michigan	2	Illinois	1

CHAPTER XII

PHYSIOGRAPHIC REGIONS OF THE UNITED STATES

Ex. 49. Study of Physiographic Areas

Study a few typical contour maps from those given in each of the following regions, or as many of them as time and the maps available will permit. This might be extended into a dozen or more experiments if desirable.

The following suggestive outline is given, but it is not necessary that this be followed literally. Such additions and changes may be made as suggest themselves under the different regions. Care should be taken in each region to get the typical and distinguishing features of that region, not only in the forms of relief, but also in the resources, the industries, occupations, and history as affected by the geographic features.

There is no objection to details if they supplement and are not substituted for the general features. Models, photographs, maps, and reference books should be used as far as available. See text-book for references. Interpretation of Topographic Maps by Salisbury and Atwood. Professional Paper No. 60, U. S. Geological Survey, a most valuable help on this subject, came out as this was going to press.

OUTLINE FOR THE STUDY OF REGIONAL MAPS

1. Write the name of the sheet, the horizontal and vertical scales. At the conclusion make a list of the different scales, and give reasons why different scales are used in different areas.

2. State the physical region represented on the map. Portions of what other regions are represented?

3. What is the elevation of the highest point? the lowest point?

4. Note location of the mountains and the kinds.

5. Are the mountains and hills ridges or peaks?

6. In what stage of the cycle of erosion is the area? What part or parts are the oldest? Which the youngest?

7. Which is the oldest stream in the area?

8. Which of the streams are antecedent?

9. Do you find any evidences of stream piracy?

10. What is the character of the divides?

11. What evidence do you find of recent elevation or depression of the area?

12. What can you infer concerning the rocks, soil, population, industries, and climate?

13. What geographical reasons can you assign for the distribution of the roads, railways, and towns on the area?

LIST OF CONTOUR MAPS ON DIFFERENT REGIONS

Atlantic Region:

1. Coastal Plain:

   Barnegat, Atlantic City, N. J.; Ocean City, Green Run, Md.; Norfolk, Va.; Edenton and Trent River, N. C.; one or more of the Coast and Geodetic Survey Charts.

2. New England Plateau:

   Augusta, Bingham, Me.; Boston, Salem, Fitchburg, Warwick, Mass.; Saybrook, Tolland, Conn.

3. Piedmont Plateau:

   Phœnixville, Pa.; Baltimore, Lynchburg, Appomattox, Md.; Statesville, Yadkinville, N. C.

4. Blue Ridge:

   Mt. Mitchell, Pisgah, N. C.; Lexington, Luray, Va.

5. Great Valley:

   Harrisburg, Carlisle, Pa.; Luray, Staunton, Va.; Greenville, Cleveland, Tenn.

Alleghany Ridges:

Lykens, Huntingdon, Pa.; Monterey, Va.; Frostburg, Md.

ALLEGHANY-CUMBERLAND PLATEAU:

Houtzdale, Kittanning, Tioga, Pa.; Cortlandt, Ithaca, Olean, N. Y.; Charleston, W. Va.; Locksport, Ky.; Standingstone, Tenn.

CATSKILL MOUNTAINS:

Catskill and Kaaterskill, N. Y.

ADIRONDACK MOUNTAINS:

Mt. Marcy, Big Moose, Thirteenth Lake, N. Y.

LAKE PLAINS:

Detroit, Toledo, Chicago, Milwaukee.

Mississippi Valley:

1. PRAIRIES:

   Marshall, Ill.; Iola, Kan.; Fargo, N. Dak.

2. GREAT WESTERN PLAINS:

   Big Spring, Catlin, Mesa de Maya, Colo.

3. WASHITA MOUNTAINS:

   Mt. Ida, Poteau Mt., Hot Springs, Ark.

4. BOSTON MOUNTAINS:

   Marshall and Mt. View, Ark.

5. OZARK PLATEAU:

   Harrison, Yellville, Ark.; Springfield, Mo.

6. BLACK HILLS:

   Harney Peak, Deadwood, S. Dak.

7. MISSISSIPPI FLOOD PLAIN:

   Donaldsonville, Point a la Hache, La.; Maps of the Mississippi River Commission.

8. GULF REGION:

   Williston, Dunnellton, Fla.; Flatonia, San Antonio, Uralde, Brackett, Tex.; Geography of Texas, by F. W. Simonds, and Folio No. 3, U. S. Topographic Atlas.

Western Interior Region:

1. STONY MOUNTAINS:
   Saypo, Livingstone, Mont.; Cloud Peak, Wyo.; Yellowstone National Park.
2. PARK MOUNTAINS:
   Denver, Castle Peak, Colorado Springs, Colo.
3. HOG BACKS:
   West Denver, Colo. See also Topographic Atlas.
4. WAHSATCH MOUNTAINS:
   Salt Lake, Utah.
5. COLORADO PLATEAU:
   Kaibab, Bright Angel, Ariz.
6. COLUMBIA PLATEAU:
   Bisuka, Idaho; Mitchell Butte, Ore.
7. INTERIOR BASIN:
   Amorgosa, St. Thomas, Nev.; Salton Sink, Cal.

Pacific Region:

1. SIERRA MOUNTAINS:
   Lassen Peak, Pyramid Peak, Cal.
2. CASCADE MOUNTAINS:
   Telocaset, Ore.; Glacier Peak, Wash.
3. GREAT VALLEY OF CALIFORNIA:
   Marysville, Cal.
4. COAST MOUNTAINS:
   Santa Cruz, San Mateo, Cal.

EX. 50. CONSTRUCTION OF A PHYSIOGRAPHIC MAP OF THE UNITED STATES

After a study of Chapter XII and some of the map sheets suggested in Ex. 49, each pupil should construct a physiographic map of the United States by drawing pencil lines around the different areas described, and coloring each one a different color or shade.

For this purpose it would be better to have a larger map than the ones in the notebook. A base map 18 × 30 inches in size published by the United States Geological Survey, which sells at ten cents each, would serve the purpose. An atlas, a wall map of the United States, or one in the large common school geographies would be helpful for reference.

After the preparation of the maps, they should be compared and criticised by the teacher. There will be considerable diversity in the size and location of the different regions, but the comparison and discussion of these boundaries will fix the true position and size in mind better than would the mere copying of a complete map. There should be some latitude allowed by the teacher in the number and names of the subdivisions where reasons are given. Each pupil should use his knowledge gained by reading and travel in addition to that gained in class.

FIELD EXCURSIONS

Only a few suggestions are offered on the subject of field excursions, because most of the problems and questions involved in such work are purely local and must be settled by the teacher.

Before taking a class on any excursion the teacher should first visit the locality and prepare a list of questions to be answered. The questions should involve descriptions of phenomena and statement of reason or causes, but with elementary classes the emphasis should be placed on the descriptions. People do not see things accurately until they are able to describe them. The pencil is the third eye and an important one.

In many cases photographs or drawings may be introduced to advantage, but in each case they should be accompanied by a careful explanation.

Such expressions as "This was very interesting," "This was a wonderful sight," are not descriptive and have no place in a notebook. A simple narrative of the trip has little value as an exercise in physical geography.

As far as possible the teacher should answer the student's questions in the field by the Yankee method of asking other questions; that is, by indirect questions lead the pupil to answer his own question.

The following outline used by the physical geography teachers of the Syracuse High School for a field trip to a certain limestone quarry could be used with a little modification for any other quarry:

No.: . Name: .

Date: .

Ex. 51. Field Study of Rocks — Britton's Quarries

What kinds of rocks occur in these quarries? What is the position of the layers? How many layers are exposed? How do they vary in thickness? How can you distinguish the different layers? What separates them? What are bedding planes? What is lamination?

How many sets of joint planes do you find? About how far apart are they? What is a joint plane? At what angle do the different sets meet? Of what use are the joint planes in quarrying the stone? Do they occur in all kinds of rocks? How do they affect the durability of rocks?

What is the material overlying the limestone in the quarry? Was it derived directly from the limestone? Reasons?

Where is limestone formed? What evidence can you find in this quarry that this was once the sea bottom? What mineral forms the bulk of the limestone? What evidence can you find of other materials mixed with this mineral in the limestone? How were the deposits on the sea bottom changed to hard rock? How do you explain the occurrence of the bed of sandstone between two layers of limestone?

What economic uses has limestone? Describe the limekiln at the quarry and the process by which the rock is changed to quicklime. What chemical change takes place in the limekiln? What happens to the quicklime on long exposure to the atmosphere?

Name and describe any other geographic features observed on this trip.