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THE USE OF GOVERNMENTAL MAPS IN SCHOOLS

DAVIS KING COLLIE

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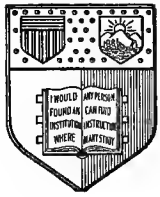

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REPORT ON

GOVERNMENTAL MAPS

FOR

USE IN SCHOOLS

Prepared by a Committee of the Conference on Geography held in Chicago, Ill., December, 1892

Cornell University,
Educational Museum.

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GOVERNMENTAL MAPS FOR USE IN SCHOOLS

At the conference on geography, held in Chicago, December 28, 29, and 30, 1892—one of several conferences held at the request of the "Committee of Ten" of the National Educational Association—the undersigned were appointed a committee to prepare a selected list of topographical maps published by our various governmental bureaus, making special mention of such sheets as might best illustrate the physical features of our country. It was the desire of the conference that the list thus prepared should be published and widely distributed among school superintendents and teachers, and that our high schools should then as far as possible secure the specified maps, together with the map of the district in which the school is situated (if such a map is yet published), and introduce them in the teaching of geography.

In accordance with these instructions, the committee has examined the maps published by the United States Geological Survey, the United States Coast and Geodetic Survey, and the Engineer Corps of the United States Army in the "Lake Survey," the Mississippi River Commission, and the Missouri River Commission. For the sake of completeness, attention was given also to the topographical maps of certain States, to the daily weather maps issued by the United States Weather Bureau, and to the Pilot Charts of the North Atlantic, published by the United States Hydrographic Office.

The list of selected maps thus prepared contains the names of over two hundred sheets, arranged under sixty-eight headings. The following abstract will sufficiently indicate its character. A general account is first given of the maps published by each of the several bureaus named above; including

mention of the style of the maps, their scale, the index maps, cost of single sheets, and address of officers to whom application should be made for them. Following these general accounts come specific lists of those sheets which in the judgment of the committee will be found of the most immediate service in geographical teaching. For example, among the topographical sheets selected from those prepared by the Geological Survey, there are illustrations of plains, plateaus, volcanoes, mountains of various patterns, valleys, shore lines, and so on. The charts selected from those published by the Coast Survey represent the fiords of Maine, the sand bars of the Carolina coast, the delta of the Mississippi, and other localities. Following the name of each map is a brief text, explanatory of the features there exhibited. The islands fringing the coast of Maine are explained as half-submerged hills; the estuary of the Thames below Norwich, Conn., is described as a partly submerged valley; the sand-bar capes of our southern coast are ascribed to the action of waves and currents; the narrow transverse valleys, or water-gaps, cut in the linear ridges of the Appalachians, as on the Harrisburg, Pa., sheet, are explained in their proper relation to the inner longitudinal valleys which they drain; the escarpments of the New Mexican plateaus are introduced as examples of retreating cliffs; the drift hills of southern Wisconsin are instanced as examples of glacial topography; and so on. It is believed that the specific illustration thus afforded of many geographical forms will prove serviceable in giving reality and clearness of understanding to the physical features characteristic of different parts of our country.

It is important to announce here, as well as in the report itself, that the cost of those maps for which some charge is made is very moderate. For example, the invaluable map of the alluvial plain of the Mississippi River, in eight large sheets, is sold for forty cents; or for ten cents a sheet, if the whole set is not purchased. The large scale sheets of the Mississippi,

minutely portraying its meanders, its cut-offs, and its ox-bow lakes, are priced at twenty cents a sheet. The illustrated catalogue of the charts published by the Coast Survey may be had *gratis* on application; while the large scale charts of the different parts of the coast are priced on an average at fifty cents each. Still more available are the topographical sheets issued by the Geological Survey: these will be furnished free of charge to teachers who specify the sheets that they wish and who satisfy the Director of the Survey that the maps are for actual use in teaching. If the demand for these sheets is large and the existing editions are exhausted, efforts will be made to enlarge the future editions so as to satisfy the educational demand, when the interest and the need of teachers are clearly made known.

It was expected, when the motion under which our report has been prepared was introduced at the geographical conference, that the cost of even a moderate number of selected sheets might amount to a considerable sum, which few schools could afford. The committee is therefore especially gratified to be able to announce, as above, that so many of the most useful maps can be had either without cost, or at a very low cost; and that a considerable equipment of this sort is consequently within the reach of every enterprising high school. All the officers in charge of the various bureaus by which the maps are published have expressed themselves ready to cooperate with the action of the conference in this direction, as far as their authority will allow; it being generally recognized that the need of the maps in the schools for educational purposes constitutes a claim which the bureaus should meet, as far as possible. It is therefore manifestly advisable that all applications should be made in due form, stating specifically the names or numbers of the desired maps and the use to which they will be put; and it may be well that the principals of schools should have their applications certified to by their city or county superintendent.

It is not expected that schools should provide themselves immediately with all the maps named in the list. Alternative maps are often mentioned under a single heading. It is, however, hoped that experiment will at once be made with a considerable number of maps in many schools. Beginning with such maps as may attract the interest of the teacher for one reason or another, the collection can be enlarged from year to year, until it becomes an effective and indispensable aid in geographical teaching. When the school appropriations do not suffice to buy those maps that are to be had by purchase only, the assistance of contributions from persons especially interested in the development of their local schools can often be secured. Graduating classes may leave pleasant memorials of their attendance by buying certain maps for presentation to the school collection.

In making choice of maps, the brief explanatory statements under each heading may be used as guides; but it is also intended that these statements should serve to indicate the character of the rational information that an intelligent study of the maps should convey to well-trained scholars in the high schools. If some of the explanatory statements contain matter unfamiliar to the teachers, and therefore perhaps at first not easy of comprehension (as for example, the accounts of old, worn-down mountains, sections 24, 25, 26), the committee would especially urge that the maps there referred to should be procured; not only because the explanations will be found much more comprehensible when map and explanation are studied together, but also because of the fundamental importance of the rational explanation of land-forms in the study of geography.

It is believed by the committee that many maps in the list might be usefully introduced in the grammar schools, to illustrate the more elementary lessons in geography. This is especially true of the map of the school district, which (if already prepared and published) should without fail be obtained at

once. A geographical excursion led by the teacher, or undertaken by a party of scholars, is greatly enlivened by the aid of such a map. Unfortunately, there are no topographical maps for the greater part of our country. It is in part to emphasize the loss suffered by the teachers in the unmapped States that the accounts of the State surveys are introduced. The example set by New Jersey and Rhode Island, in the liberal distribution of home maps to their public schools, should be followed throughout the country. Local maps in other States can probably be obtained, if published, by adding a request for the sheet containing the school district, when applying to the Director of the Geological Survey for such of the topographical sheets as are selected from the list. The index maps of the other surveys will also be useful to those residing within their limits, in selecting home maps not mentioned in the report. It must often happen that these home maps are not included in our lists, and hence that no particular account of them can be prepared beforehand. In such cases, it is suggested that teachers who desire information about them should address a member of the committee, who will endeavor to return such suggestions as may be useful.

As the greater number of maps are on sheets of medium or large size, it is important that they should be carefully kept and handled, to avoid injury by creasing or tearing. When possible, each sheet should be backed with light cotton cloth.* If this cannot be done, the two upper corners should be backed and small eyelets inserted, so as to prevent tearing when tacking up the sheets for study. The sheets are best kept in large folders of heavy brown paper. These should lie flat on a large table. When no storage space is available for them, they may be kept on a table that is in daily use, provided that an extra top is made for the table, under which the

* The backing is unfortunately more expensive than the maps. Mounting the smaller sheets will cost from 25 to 50 cents each ; the larger sheets, 75 cents to a dollar each.

folders may lie out of harm's way. The maps should be exhibited to the class only when the subjects that they illustrate are under consideration. In carrying them about, they should be held by the two diagonal corners, to avoid kinking the paper. It is, however, not enough that a school should simply store away a fine series of maps. Much care should be given to their effective use, and the following suggestions are offered as an aid toward this end: On receiving a series of maps, the teacher should examine each one to discover the various features that it illustrates. He may then enter marginal notes in his text-book at such paragraphs as treat of subjects illustrated on the maps; each map being perhaps entered at several places in the book. Before a lesson in which certain maps will thus be called for, the maps can be taken from their case and laid before the class for inspection in appropriate order. In this way the maps are not only introduced in proper connection with the text, but the labor of using them is greatly decreased; and as is well known to teachers, the usefulness of the maps will thus be proportionately increased. Much advantage comes from the repeated use of a single sheet, whereby its manifold features become familiar. It is also believed that the maps serve as more forcible illustrations if exhibited only when they bear directly on a lesson; instead of being always in sight on the wall, where they soon become stale.

As the brief explanatory notes offered with the maps are manifestly inadequate to bring out clearly all that the maps may teach, it is important, whenever possible, that the teacher should read fuller accounts of the districts represented. After the maps have thus been in use a year or more, and their various features have become familiar, the teacher may to advantage prepare brief written explanatory notes for each sheet, emphasizing such matters as seem to him most important, or as best illustrate the chapters of his text. These notes may be attached to the margin of the maps, for ready use.

Whenever a map is exhibited, the position of its area should be indicated on a general map of its state or of the whole country, by affixing a rectangle of white paper of suitable size at the proper place, or in some other simple way. The scale of the maps is so much larger than that of maps ordinarily seen in schools, that the local geographical details included on a single sheet do not suffice to indicate its proper place in the state. Even the towns and rivers included on a single sheet may afford no sufficient guide to its position in its state as a whole.

The extension elsewhere of the geographical features included on a map sheet should be described as fully as possible, generally by use of an ordinary wall or atlas map. For example, the ridges of Pennsylvania, Virginia, and Tennessee, exhibited minutely but in a fragmentary way on certain of the sheets named in the list, should be traced out in their general distribution on a good physical map of the United States: the glacial lakes, illustrated in sheets from Massachusetts and elsewhere, should be associated with their natural relatives in Canada, Scotland, Scandinavia; and so on.

Many of the names mentioned in the accounts of the maps are of little importance in themselves, but they serve to guide the student quickly to the examples referred to. They should become familiar by frequent reference to the localities to which they are attached, rather than by intentional memorizing of the names apart from the places. Emphasis should be given chiefly to the facts of form, to the meaning of these facts, and to their regions of occurrence. The relief of the land, so imperfectly represented on ordinary school maps, will thus be given its proper importance.

Scholars should be practiced in the art of reading maps. A general glance at a map of minute detail gives little more understanding of its full meaning than would be gained of the meaning of a printed page by running the eye over its lines. The different features of a map should be examined in due order; the best example of each feature should be selected and

carefully studied. In order to insure the correct perception of the facts represented on the maps, the scholars should be encouraged to describe them in the best language they can choose, much in the manner that they would describe the actual district in traveling over it, or in viewing it from some elevated point.

The results that may be expected from the introduction of the maps here described in our public schools are far-reaching. Undoubtedly the most important result will be found in the better appreciation of geographical lessons, and in the discovery of an unexpected richness of this subject. But the value of lessons from the maps will not stop here. The scholars will carry away from the schools an appreciation of the great teaching power of good maps. When they travel over the country, they will wish to travel, map in hand, so that they may see their land with a more searching eye. When they find that good maps are so few, they will demand the preparation of more; and thus from the use of such maps as we now have, the production of even better ones will follow. The committee therefore desires to close this introduction to its report by most seriously urging all teachers of geography in our high schools to procure at once as many of the maps named in the list as they can profitably use, and to begin the study and use of them immediately on their receipt. In order that the committee should have some measure of the result of their work, it is requested that the principals of schools who follow the suggestions here given should briefly inform the chairman of the committee of their action.

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UNITED STATES GEOLOGICAL SURVEY.

Application for the following maps should be made, giving the name and state of each map desired, to the DIRECTOR, UNITED STATES GEOLOGICAL SURVEY, WASHINGTON, D. C., from whom the Committee has received in effect the following statement. The Survey will furnish gratis, to teachers and other school authorities, sheets of the topographic map of the United States for use in teaching geography in the schools, to the fullest extent which the appropriation for printing these sheets will permit. At present, the number printed of each sheet is commonly five hundred copies; and the edition could not be greatly increased under the current appropriations; but should a demand arise for the maps, it is probable that the appropriation for printing them may be increased in order to enable the Survey to supply them.

As the maps can be put to no better use than the one here proposed, it is hoped that teachers who desire to possess these invaluable aids to teaching will at once make their wish known to the Director of the Survey, in order that the present limited edition of the sheets may be increased to a number more nearly corresponding to that of the schools where use should be made of them.

Besides the large-scale sheets, of which many examples are given below, the three following maps deserve a more general use by teachers than they have yet received. All of these have been published within the last ten years:

A SINGLE-SHEET MAP OF THE UNITED STATES,* with nine shades of brown color to represent relief.

* Maps that give distinct illustration of simple features, and that may serve for use in the grammar schools, are indicated by an asterisk.

A SINGLE-SHEET MAP OF THE UNITED STATES,* with contour lines giving the general distribution of elevations; similar to the preceding, with lines instead of shades.

A NINE-SHEET MAP OF THE UNITED STATES; scale, 1 : 2,500,000, or about forty miles to an inch. Names and boundaries in black; contour lines in brown, rivers in blue. A very valuable map for the study of the general relief of the country; well adapted for use as an index map for the large-scale sheets of the following sections.

TOPOGRAPHICAL MAP OF THE UNITED STATES. The sheets of the topographical map of the United States have now been prepared to the number of several hundred. Many hundred more must be issued before the entire country is covered. Hitherto, they have been projected on scales of one, two, and four miles to an inch; but hereafter, only the one-mile scale is to be used. The boundaries, roads, towns, and names are printed in black, contour lines in brown, and rivers and lakes in blue. The sheets are named after the chief place within their borders, to which the name of the state is added. In the following notes, arranged according to a physical classification, the geographical features illustrated on the respective sheets are printed in bold-faced type, with the names of the sheets following. Cross-references are frequently made in parentheses by the number of the section.

1. Low marine plains. Glassboro,* N. J.

A portion of the low coastal plain of the Atlantic slope, of faint relief over great distances; drained by shallow marshy valleys (the ponds are all artificially constructed for water-powers). The streams branch and subdivide in various directions; determined at first by the slope of the country, and afterward by the slopes developed on the sides of the primary valleys. As far as the structure of the plain is concerned, there is nothing to guide the course of the streams, for the region consists of essentially horizontal layers of clays, sands,

and gravels, laid down when the whole district was under the sea.

Villages are located on the flat interstream spaces (Glassboro, Clayton, Vineland). Roads run in straight courses in almost any direction. Railroads follow straight "tangents" for long distances.

The features of the extensive lowland along our Atlantic coast from New Jersey, southward, and around the Gulf of Mexico, are illustrated by this map. Everywhere a low flat surface, slightly dissected by shallow valleys; once a smooth sea bottom, now recently emerged and faintly denuded.

2. Fluviatile Plains. Marysville, Cala.

The numerous rivers emerging from the valleys of the Sierra Nevada carry out much sediment, and on reaching the low levels of the valley of California deposit a large part of their burden, thus gradually building up a broad plain. The streams have variable courses across the plain, and give out distributaries (see 35), now and then abandoning an old course for a new one. The surface of the plain is extremely flat, not varying a hundred feet in height in thirty or forty miles. Roads and railroads follow straight courses; the former along the section lines of the original U. S. Land Office surveys; the latter running in long "tangents" from place to place.

In the midst of the plain shown on this sheet stand the Marysville buttes, the dissected remnants of a great volcanic cone, or group of cones.

The plains of Lombardy in northern Italy, and the Indo-Gangetic plains of northern India are fluviatile plains, like those of California (34).

3. Lacustrine Plains. Sierraville, Cala.

The broad plain of Sierra Valley marks the site of an inclosed basin within the Sierra Nevada mountains, probably formed by the dislocations of mountain growth and formerly occupied by a lake. The processes of filling the basin with

sediments, and lowering the lake surface by cutting down the outlet (Feather river) have now succeeded in extinguishing the lake, and revealing the bottom as a plain; still marshy in parts, but as a rule dry enough for occupation and cultivation. The little streams that descend from the mountains and that once entered the lake now serve to irrigate the fields.

The plain of the middle Rhine and the plain of Hungary are essentially similar to the Sierra Valley plain, although of much greater size. The formerly lacustrine valleys of the Rocky Mountains in Montana (22) are also related to this example, except that they are older, and their outlets are trenched even deeper than the lacustrine plains, so that the surface of the plains is now much destroyed by dissection and denudation.

4. Lacustrine Plains. Lassen Peak, Cala.

The southeastern quarter of this sheet contains a number of small, flat-bottomed valleys or "meadows" (Mountain meadows, Big meadows, etc.) which include all the good agricultural land of this rugged district. The meadows are all old lake bottoms. The lakes were formed by the obstruction of valleys by lava flows from the neighboring volcanoes; they were destroyed by the double process of filling the bottom with sediments and cutting down the outlet. Big meadows made the largest lake; its bottom is still in part so swampy as to be of little value for occupation (30).

5. Lacustrine Plains. Tooele Valley,* Utah; Disaster and Paradise, Nev.

The Great Basin of Utah and Nevada is a region of interior drainage, from which no rivers now escape to the sea. Its surface is diversified by many north and south mountain ranges (Stansbury, Oquirrh, Utah; Truckee, Pine Forest, Jackson, Santa Rosa, Nev.), and the waste from these mountains has accumulated to great depths in the depressions between them. The original mountains are thus buried to

their knees or waists by the detritus from their heads and shoulders. Although at present a dry region, the Great Basin has formerly enjoyed a more humid climate, and at that time the intermontane depressions were occupied by lakes; two of which were of great size, leaving well marked shore lines. Special names have been given to these extinct water bodies; "Bonneville" in Utah and "Lahontan" in Nevada. The fine deposits laid down in the lakes are now revealed as plains, since in the present dry climate the lakes have been for the most part dried away; Great Salt Lake in Utah, and Pyramid, Winnemucca, and other lakes in Nevada being diminished representatives of the former greater lakes. The sandy portions of the plains are deserts, except where irrigated; extensive areas are covered by sand dunes, heaped by the winds. The lower "mud flats" of finest silt are softened by winter rains into impassable morasses, and dried in summer to a hard baked surface, perfectly smooth for many miles.

Most of the streams, fed by snow or rain on the upper mountain slopes, wither away as they descend to the plains; although some may run fifty or more miles before they disappear in a "sink" or flat depression in the middle of a faintly concave plain (Quinn river, Nev.).

6. Glacial plains (prairies). Marion, Iowa.

A broad, gently rolling surface of glacial drift, smoothly spread out underneath an ice sheet of the glacial period, and since then very little modified, except where channeled slightly by streams. As drift of this character is known by the geological name of *till*, these plains may be called *till plains*. The prairie is so even that most of the roads follow the north and south, or east and west lines of the sections originally laid out by the Land Office surveys.

Large areas in the northern central States are represented by this sheet; the wide extent of plains of this origin warrants a much greater attention to the geographical products of

glacial action than is commonly allowed them in school teaching.

Many other prairies are lacustrine deposits, associated with the closing stages of the glacial period, when the presence of the wasting ice sheet obstructed the lines of drainage, so that numerous lakes were formed around its retreating margin (43). The fine silts there deposited now constitute some of the smoothest prairies of the northern central States.

7. Dissected plains. Spottsylvania,* Farmville, Palmyra, Va.; McCormick, Ga.; Clanton, Ala.

The inner part of the Atlantic coastal plain is more dissected by valleys than the lower part near the seacoast; partly because the former is higher, allowing the valleys a greater depth of cutting; partly because it is older—longer out of the sea—allowing the streams a longer time for advance in their work. But as the altitude is everywhere moderate, the relief is necessarily gentle; for valleys can never be cut by rivers deeper than sea-level. The whole country is open to occupation. The irregularly branching valleys occupy almost as much space as the interstream uplands, although the latter are sometimes smooth and continuous for several miles. The towns, roads, and railroads are generally placed on the uplands, or divides between the streams; but the larger and broader valleys also offer them good location.

8. Upland plains. Springfield and Fulton, Mo., and adjacent sheets.

The upland plain of Missouri possesses a gently undulating surface, which is broadly continuous between the headwaters of the larger streams (Springfield sheet), but which is strongly dissected near the larger rivers (Fulton sheet). The Missouri river here has a flood plain a mile or two wide, and 250 feet below the adjoining upland; and the lateral streams near by have opportunity to cut numerous deep valleys, even though their volume is small.

The settlements and roads in such a region are in nearly all cases on the broad interstream uplands at some distance from the deeper streams; the exceptions being on the flood plain of the Missouri. The names of villages and townships in a comparatively flat country like this are generally of personal, political, or historical origin; but they occasionally show a recognition of the natural features of the region, as *Nine Mile Prairie*, a township including an uncut portion of the upland, between streams north of the Missouri (Fulton sheet); *Coté Sans Dessein*, a township on the north bank of the Missouri (Fulton sheet), where the side streams have excavated a labyrinth of branching valleys, separated by an intricate system of subdividing spurs.

9. Elevated plains. Iola, Kan., and adjacent sheets.

Southeastern Kansas possesses a broad surface of slight relief at an elevation of about a thousand feet above the sea. Even the larger rivers here are so far from their discharge into the sea, and are so burdened by sand and silt, that their channels are as yet but little incised beneath the general upland surface. If the rocks of the region were firmer, so that less waste could be washed into the streams, the valleys would be cut deeper; but the region is largely composed of weak strata, whose waste is shed rapidly down the valley slopes, encumbering the streams with so heavy a load that they need a comparatively steep slope down which to run to the sea; hence the valleys are deepened but little below the plain.

In such a region, the villages are in nearly all cases on the uplands, away from the streams; roads and railroads traverse the country almost indifferently in any direction.

10. Plateaus. Fort Defiance, Ariz.

A broad rolling surface, 6000–7000 feet above the sea, but not yet deeply dissected by rivers. The rainfall is small, and

several intermittent streams wither away on the desert surface; they carry water only after rain-storms, and their length then depends on the amount of rainfall.

The occasional buttes and mesas that surmount the surface of the plateau bear witness to an extensive denudation of a once overlying mass; but it is reasonable to believe that this was done before the uplift of the region to its present great altitude. It seems to be an old lowland denudation, uplifted in late geological time, and as yet without age or means of dissection and deep denudation. Its climate being very dry, the plateau is almost a desert, and its population must remain very small.

11. Dissected plateaus. Mesa de Maya, Colo.; Marsh Pass, Ariz.

Under better conditions for erosion than the plateau of the Fort Defiance sheet, Ariz. (10), the plateaus here represented show the early stages of dissection in the production of long narrow branching canyons; the work of water, although dry for most of the year. As the process of deepening, branching, and widening continues, the canyons will change to large open valleys, and the plateau uplands will be dissected much in the same fashion as shown in Kentucky and West Virginia (14), but presumably with greater relief on account of their greater altitude.

12. Trenched plateaus. Kaibab* and Echo Cliffs, Ariz.

A broad plateau region, averaging over 6000 feet above sea level. The climate is arid, and the local rainfall forms no large streams; hence the general surface of the plateau is not deeply dissected; being in this respect like the adjacent example on the Fort Defiance sheet. But the Colorado river, fed in the mountains to the northeast, traverses the plateau on its way to the sea, and has cut down the Grand Canyon, 4000 to 5000 feet deep and four to six miles wide; its precipitous

walls being intricately dissected by labyrinthine side canyons and gigantic ravines.

Vast as is the work of denudation already accomplished in carving the canyon, it is manifest that the task of the river in carrying away the waste of the land is as yet only well begun. Much the greater part of the plateau mass still remains; but as the waste from the canyon walls is shed into the river and carried away, the canyon will widen into an open valley, the plateau will be consumed, and at last reduced even to a lowland of denudation. Great as is the work of denudation here exhibited in the present form of the canyon, a greater work is seen in our Appalachian highland, where the denudation only fairly begun in the Arizona plateaus has been advanced essentially to its completion (24).

The aridity of the plateau region is so great that its occasional springs are of much value to the explorer and are therefore located on the map (Kaibab plateau). The small amount of local rainfall has undoubtedly contributed to retard the widening of the canyon; but the chief cause of its narrowness is its geological youth; the date of the uplift of the plateau cannot be far back in geological time. Most of the smaller features of its upland surface were probably produced by denudation before the time of uplift, while it was still a lowland.

13. Dissected plateaus. Coldwater, Meade, Kan.

These and the adjoining sheets in southwestern Kansas represent an elevated plain or plateau, from 2000 to 2500 feet above sea level, in an almost mature stage of dissection by irregularly branching valleys, 200 to 300 feet deep. The streams branch in all directions, gnawing their way into the plateau, and thus producing interstream spurs of great variety of form when minutely examined, although much alike in general appearance. The Meade sheet includes some areas of unbroken upland, into which the valleys have not yet entered,

and on which numerous shallow basins hold temporary lakes in the wet season. The moderate depth of the valleys, in spite of the considerable elevation of the region, is controlled by the same conditions as those explained in sections 9 and 19.

14. Dissected plateaus. Hazard, Saylersville, Warfield, Ky.; Charleston,* Huntersville, Hinton, W. Va.

Any one of these sheets admirably illustrates what may be called the mature dissection of the Appalachian plateau, whose originally even upland stood at an altitude of 1500, 2000, or more feet; but in which the wandering rivers have now cut steep-sided valleys, 500 to 1000 feet deep, from which the side valleys have branched out and subdivided in all directions, completely and minutely dissecting the plateau. None of its original upland remains; there is no more room for ramifying streams; the hills branch out into intricately divided spurs; the region is a labyrinth of hills and valleys. No rainfall is delayed in its descent, as is the case on younger plateaus, where the uplands are less dissected; all the falling water is promptly carried down the slopes to the streams, and thence to the rivers and the sea. Still it is manifest that the process of denudation has not yet advanced as far as it may in time to come. The valleys will widen and consume the spurs and hills, and eventually produce open valley-lowlands and broad lowlands of denudation; but this is even further in the future than the originally even surface of the plateau is in the past.

In a region of this kind, the surface is so broken that occupation and movement are difficult. The hills are forested; the villages and roads occupy the crooked valleys, the latter occasionally passing from the head of one stream to that of another by a pass in the hills. The population is scattered, and of slow advance in the ways of modern civilization.

The Hinton sheet, W. Va., includes a part of the canyon of New river, 1500 feet deep beneath the overlooking uplands. The Huntersville sheet shows the transition from the branching

spurs of the Appalachian plateau to the parallel linear ridges of the Appalachian mountains; from the irregularly subdividing streams of the plateau region to the systematic longitudinal and transverse streams of the mountain belt (28).

15. Dissected plateaus. Scottsboro, Ala.; Sewanee, Tenn.; Marshall, Ark.

The broken uplands of these sheets differ from those of southeastern Kentucky and West Virginia not so much in the degree of advance in the work of dissection and denudation, as in the manner of progress of the work. In the examples from Kentucky and West Virginia, the structure of the region seems to have been such as to allow the dissection of the plateau even by small streams, thus producing the minutely divided hills and spurs of that region—what may be called a "fine textured topography." In northern Alabama, eastern-central Tennessee and northern Arkansas, the rocky strata of the plateau seem to be heavier and stronger, so that only the larger streams have formed valleys, leaving broad plateau masses between them. The Cumberland plateau of Alabama still preserves extensive upland areas of slight inequality at an altitude of about 1500 feet, while the floor of the broad valleys lies at about 600 feet. The descent from the plateaus to the valleys is first by a steep cliff at the top, and then by a long slope below. The plateau blocks are so isolated that they have as a rule few occupants; the villages and roads are in the valleys; but in Tennessee, some towns are on the uplands; Sewanee, the seat of the University of the South, is on a plateau block at an elevation of about 2000 feet, overlooking the lowlands a thousand feet beneath it.

16. Denuded plateaus: escarpments and outliers. Watrous and Corazon, N. Mex.

These are well denuded plateaus, composed, like all the forms of this geographical family, of horizontal strata of harder and softer rocks. When well denuded, their surface frequently

ascends from one level to another by bold step-like cliffs or escarpments, thus marking the wasting or retreating edges of especially thick and resistant strata which have been stripped off from the next lower level. On these two sheets, the southern area has an altitude of 5000 to 5500 feet; a bold cliff of 400 to 800 feet accomplishes most of the ascent to the next level of about 6500 feet altitude, the margin of this step being called the Carro and Yegua mesas. Further north, a second cliff marks a rise of similar height to about 7000 feet in the Cornudo hills. The fact that these cliffs are retreating escarpments is shown by the manner in which they are cut back by branching canyons (Conchas and Largo canyons); as well as by the occurrence of isolated outliers, of the same structure and of about the same elevation as the cliffs (Mesa Lauriano). The region is arid; most of the streams are intermittent. Shallow depressions in the upper levels are occupied by lakes in the wet season, but are evaporated almost or quite to dryness in the dry season.

17. Denuded plateaus: dissected escarpments. Price River, East Tavaputs, Utah.

The features of the preceding examples are here repeated on a colossal scale in Book and Roan cliffs, by which ascent is made from the denuded plateau of Price and Grand river valleys (5000 feet) to the higher Tavaputs plateau (9000 feet). By reason of their great height, these cliffs are cut into by vast ravines and gulleys, forming an impenetrable labyrinth of enormous spurs. The Tavaputs plateau slopes northward, but the Green river (the chief head branch of the Colorado) runs southward, against the slope, cutting Desolation canyon through the plateau. The smaller streams of the plateau run with its slope to the north. The recession of the cliffs, under the energetic attack of the steep southward flowing streams in the ravines, continually shortens or beheads the northward flowing streams (40).

Attention should be given to the curious course of Price river, where it cuts across Beckwith plateau on the way to Green river; while the railroad follows low and open ground a little further south.

18. Plateau outliers. Abilene, Brownwood, Tex.

As plateaus reach an advanced stage of denudation, the valley lowlands widen and consume the greater part of the intervening upland, leaving isolated remnants here and there, known as *outliers*, *table mountains*, or *mesas*. These outliers possess flat or gently rolling upland surfaces, terminated on all sides by irregular escarpments of greater or less height. Curiously enough, few of the examples of these forms on the sheets here referred to are given names; although names are generally given to the gaps or passes between them, through which the roads pass from one part of the lowland to another.

19. Plateaus: rolling uplands. Kit Carson,* Lamar, Granada, Colo.

These sheets illustrate the broadly rolling surface of the "Great Plains" in eastern Colorado. They are seen to possess a much greater variety of relief than their name would indicate. Their valleys are wide, and their hills and spurs are of large horizontal dimensions when compared to the minutely dissected plateau of Kentucky and West Virginia (14). The region is dry and the smaller streams are generally intermittent, flowing only after rainy weather. It is probable that this climatic factor has much to do with the large scale of the topographic features. Temporary lakes occur in shallow basins on the uplands and among the spurs of the hills.

The descent of the rivers across the Great Plains is comparatively rapid. The Arkansas, for example, descends here at a rate of about eight feet to the mile; a strong descent for so large a river. But it is so encumbered with sand and silt, as appears from its numerous islands, that its ability to deepen

its valley is almost lost. Only as the adjacent slopes are worn down, so that they will furnish waste to the river more slowly, can the further deepening of the valley be accomplished.

The dryness of the plains calls for the construction of irrigating canals, by which water is led from the larger rivers along the valley sides at a less rate of descent than that of the rivers; so that although the water in the canals continually descends, it gradually gains a relative elevation above the rivers (Arkansas valley canal, Colorado and Kansas canal). The water is then distributed from the canals by ditches on the slopes below them, bringing forth excellent pastures and harvests from fields that would naturally produce only a scanty growth. Elsewhere agriculture is chiefly limited to stock raising.

20. Mountain ranges. Tooele Valley,* Utah.

This and the other sheets named in Section 5 present good examples of isolated mountain ranges of moderate dimensions and relatively simple form. The several ranges are about parallel, trending north and south, as is the case with many others in the Great Basin. They illustrate the general features of mountains, such as crest line with peaks and passes, lateral spurs and valleys. Rising from level lacustrine plains, they attain a local relief of four or five thousand feet. They must once have had a stronger relief, before so much detritus was taken from their summits and upper slopes, and deposited to form the plains by which their bases are buried.

21. Rocky mountains in Colorado. Canyon City, Huerfano Park, Colo.

A part of the Front range of the Rocky Mountains is exhibited on these sheets. Blanca peak, 14,390 feet, is the highest summit in the United States, excepting Mt. Whitney in the Sierra Nevada in California. Many tarns, or small lakes formed by extinct glacial action, lie in its upper valleys. The Wet Mountains are a sharp crested range, with strong lateral

slopes, deeply carved by steep lateral valleys and trenched across by deep transverse valleys. The Arkansas river cuts its canyon in a highland north of these mountains. Passes among the mountains, between heads of streams flowing in opposite directions, are well shown (Veta pass, crossed by the Denver and Rio Grande railroad at an altitude of 9200 feet). A sloping plateau rises east of Bradford and terminates in a long ragged precipice. A park, or open valley among the mountains is seen west of Canyon City (Webster park).

A characteristic feature of mountains is the activity with which the rock waste from their decaying slopes creeps and washes down to the valleys, where it is carried away by the streams. The mountains are in this way degraded with comparative rapidity; and if time enough be allowed, they must be eventually reduced to lowlands of denudation. In the Rocky Mountains, the lower slopes and the margin of the Plains to the east are cluttered over with gravelly waste that has crept and washed down from the higher slopes.

22. Rocky mountains in Montana. Livingston,* Mont. The Absaroka, Gallatin, and Bridger ranges represent some of the irregular forms of the Rocky Mountains. The Bridger range is distinctly linear; a sharp dividing ridge with steep lateral valleys on either slope. The Absaroka broadens in the northeast, forming the Boulder plateau, cut into two parts by Boulder river. The Lake plateau, near by, contains a number of glacial tarns or small lakes of glacial origin.

The open valley of the Yellowstone, south of Livingston, drained northward through the "Lower Canyon," is a characteristic feature of the Rocky Mountains in this State. The valley depression and the range in which the lower canyon is cut appear to result from the deformation or warping of preexistent mountains; the present open valley was probably for a time a lake, with outlet where the canyon now passes. Many other upper branches of the Missouri river possess open

upper valleys among the mountains, with a similar discharge through canyons in the outer ranges. The upper valley of the Arkansas in Colorado bears this relation to the canyon of that river (21). The great plain, known as the valley of California, probably bears the same relation to its discharge by a valley through the Coast Range, now submerged to form the Golden Gate. These open inner valleys therefore do not bear the same relation to the narrow valleys by which they are discharged as that to be described between the inner longitudinal valleys and their discharging transverse valleys in the Appalachians of Pennsylvania (27).

The success of the destructive forces of denudation in reducing mountains to lowlands is greatly interfered with by a renewal of mountain uplift, such as is referred to above. It is probable that all high mountains are of repeated growth, the uplift being in excess of the degradation. The reduction of mountains to lowlands of denudation is possible only after their upward growth has ceased (24, 26).

23. Southern Appalachian mountains. Mt. Mitchell,* N. C.; Dahlonega, Ga.

The Appalachians of the Carolinas and Georgia consist of a heavily forested group of irregular peaks, ridges, spurs, and knobs, of which the highest is Mt. Mitchell, 6711 feet, in the Black mountains. The larger and lower valleys are generally open enough for occupation and rough cultivation, but the valleys formed by lateral streams on the mountain slopes are too steep for settlement. The various relations of mountains to drainage lines are well exhibited on these sheets. There are main divides between large river systems (Blue Ridge, dividing Atlantic and Mississippi headwaters); sub-divides or spurs, between adjacent branches of a single river system; notches or gaps, used as passes for roads from one valley to the next (Swannanoa gap, crossed by the Western North Carolina railroad which ascends the valley of Mill creek on strongly

looped curves; Buck creek gap, in Blue Ridge, crossed by a county road, etc.).

These mountains are very old, compared to the Rocky Mountains, and it is to their age rather than to insufficient uplift at the time of their growth that they owe their present moderate relief. But for the excessive resistance of their rocks, they would have been ere now worn down to lowlands as the more northern members of the Appalachians have been (24).

24. Mountain highlands. Hawley, Chesterfield,* and Becket, Mass.; Cornwall and Derby, Conn., and adjacent sheets.

The Berkshire hills include that part of the Appalachian highlands that lies between the Connecticut and Housatonic valleys in western Massachusetts. They form an uneven upland, generally composed of resistant crystalline rocks, at an elevation of 1500 to 1700 feet; deeply cut by the narrow valleys of the Deerfield, Westfield, and Farmington rivers and their branches. This region is in brief the stump of an ancient mountain system. The mountains were once uplifted high, with disorderly structure; but the long progress of denudation reduced them to a lowland of faint relief, close to the sea-level of their time. Since then, the region has been rather evenly uplifted to its highland position, and as a consequence it is now dissected by the revived streams of its present valleys. When thus far developed, it was glaciated (44, 45); hence the occurrence of its occasional ponds and swamps.

This highland may be traced into New Hampshire, where numerous mountains, of which Mt. Monadnock is the type, rise above its upland surface. These "Monadnocks" are residuals of the ancient mountains, not entirely consumed by denudation when the region was generally reduced to a lowland, and now raised on its back to their present commanding altitude.

The mountain highland may be traced also southwestward

into Connecticut, southeastern New York (38), northern New Jersey (25) central Pennsylvania (27), central Maryland (26) and beyond. Its present upland altitude varies from place to place, because its uplift from its former lowland position was of unequal amount in different parts of the Atlantic slope; but as a rule it descends gently to the southeast. The valleys that have been eroded in its once nearly continuous surface since the time of uplift are further described in later sections.

25. Mountain highlands. Hackettstown, N. J.

These are uplands of the same kind as those of western Massachusetts (24) and the highlands of the Hudson (38), all belonging to the same uplifted lowland of denudation. The dissection of the New Jersey highlands is along well defined valleys of Appalachian trend. This sheet is of especial interest as its northern area has been glaciated, and therefore possesses ponds and swamps (44); while the southern half, if ever glaciated, has so long been free from such disturbances that its streams show no obstruction; it has no lakes or ponds.

The deep denudation that this region has suffered has revealed various mineral deposits that are not known to form among superficial rocks; thus the mining industry is here developed, as is often the case in old, worn-down mountain regions.

26. Mountain lowlands. Ellicott, Md.

The contradictory title given to this section is intended to impress the idea that old mountains are necessarily worn down into lowlands of denudation. When re-elevated and more or less dissected by new valleys, they may be called mountain highlands, of which several examples have already been given. When still lying low, or when but little elevated, no name seems so fit for them as mountain lowlands. Their rocks, both in kind and attitude, are such as are commonly associated with lofty mountains; yet here the country has the

appearance of a broad plain, dissected by valleys of moderate depth, giving it a relief of one or two hundred feet.

The region about Philadelphia is of this kind. Indeed all our inner Atlantic slope belongs in this family, having long ago been mountainous, having then been worn down to a mountain lowland of denudation, and having still later been elevated to greater or less height, in consequence of which new valleys have now been sunk below its surface. Where the lowland has been raised high, there the valleys are deep; where the lowland has been raised but little, there the valleys are shallow. Where the rocks of the uplifted lowland are hard and resistant, there the valleys are narrow, whether shallow or deep; where the rocks are weak and easily denuded, there the valleys are broadly opened, making new valley lowlands, whether much or little below the adjacent uplands of harder rocks (29). A great part of our Atlantic slope may be thus generalized.

27. Mountain ridges: Pennsylvania Appalachians. Lykens, Pine Grove, Pottsville, Harrisburg,* Hummelstown, Pa., and adjoining sheets.

The Appalachians of Pennsylvania consist of long even-crested ridges, generally straight (Blue, Second, and Third mountains, Harrisburg and Hummelstown sheets), sometimes turning in sharp curves (northeast end of Peter's mountain, Lykens sheet) or acute zigzags (west end of Big Lick and Coal mountains, Lykens sheet; northeast end of Mahantango mountain, Pine Grove sheet). All these mountains are located on tilted and folded strata of hard sandstone.

Southeast of the mountains lies the great Appalachian valley (29), a broad fertile lowland of slates and limestones, trenched by meandering streams (Swatara and Conedogwinet creeks). This valley extends from the Hudson river to Alabama. Between the sandstone mountain ridges lie longitudinal valleys of greater or less breadth, eroded on weaker shales and limestones, and sometimes containing coal, which is

extensively mined at Pottsville, Port Carbon, etc. All the settlements are in the valleys and valley lowlands, except occasional mining towns on the ridges. The course of roads is sharply defined by the course of the narrow valleys. The ridges are as a rule forested.

The inner longitudinal valleys are drained by transverse valleys or watergaps (the gaps of the Susquehanna, Harrisburg sheet; Manada, Indiantown, Swatara gaps, Hummelstown sheet).

The even crests of the ridges are thus explained: The ancient crushing by which the folded mountain structure was produced, uplifted the surface of that remote time to a mountainous altitude. Since then the region has been greatly denuded and reduced even to a lowland of faint relief. The lowland was then evenly uplifted with a gentle inclination to the southeast; and all its streams, thereby revived, proceeded again to deepen their valleys toward the new sea-level. The weaker rocks have thus wasted away in valleys and valley lowlands; while the harder strata retain in their even crest lines a rough measure of the altitude to which the whole ancient lowland was uplifted. Still later, an uplift of less amount gave origin to the narrow valleys by which the lowlands are now dissected. Such a succession of events as this is of common occurrence, and its recognition greatly assists in giving understanding to the geographical features of a country.

The relation of longitudinal and transverse valleys may be clearly perceived from an examination of the excellent examples on these sheets. It must be remembered that since the uplift of the lowland of denudation, as here described, the transverse gaps have been cut down only as fast as the deepening of the lower course of the valley progressed; and hence that the inner longitudinal valleys have been cut down only as fast as the deepening of the transverse gaps progressed. In no cases were the inner longitudinal valleys of this region formed before the cutting down of the transverse

valleys through which the waters escape. In every case the progressive deepening of the transverse valley across the hard sandstones gave permission for the deepening and widening of the inner longitudinal valleys along the weaker shales and limestones (see also 29).

28. Mountain ridges: Virginia Appalachians. Monterey, Franklin, Estillville, Va.

The mountains of east Tennessee and western Virginia are nearly all in the form of even crested ridges, generally rather straight or gently curved (Back Creek, North Fork, Clinch mountains), or locally sharp curved (Powell's mountain, Wallen's ridge); thus giving the whole district a distinct trend to northeast and southwest. The strong zigzag turns, so common in Pennsylvania, are imperfectly represented here. The ridges frequently extend for many miles with slight interruption, forming high separating walls between adjacent valleys. Roads generally follow the trend of the longitudinal valleys, and cross the ridges either at notches (Calfred gap in Alleghany Front mountain, Looney's gap in Clinch mountain), or in deep transverse valleys or water-gaps (Big Moccasin gap in Clinch mountain, Big Stone gap in Stone mountain). The relation of the longitudinal and transverse valleys is the same here as in Pennsylvania (27).

A flat limestone area near Cartertown, in the central part of Scott county, Estillville sheet, exhibits the peculiar sink-hole drainage, where the surface streams disappear in cavities leading to underground caverns; their waters reappearing elsewhere in large springs.

29. Valley lowland. Staunton, Harrisonburg, Va.

The Great Appalachian valley—here called the Shenandoah Valley—is a rolling lowland, between the linear ridges of the Virginia Appalachians on the west and the lofty summits of the Blue Ridge on the east. This great valley is not the product of local deformation and depression, like the great valley

of California, between the Sierra Nevada and the Coast Range; it is entirely the result of the more rapid denudation of its weak rocks than of the harder rocks on the east and west. As the valley surface was lowered, all its waste was carried out through narrow transverse valleys; to the Atlantic by the James and other rivers further north; to the Gulf of Mexico by the Kanawha and Tennessee rivers. Throughout its whole length, it is a most fertile agricultural region, between rugged and forested ridges and uplands.

The general relation of the Great Valley to the other features of the Atlantic slope is exhibited on the following maps, passing from west to east: Huntersville, W. Va., dissected Appalachian plateau (14); Monterey, Va., linear Appalachian ridges (28); Staunton, Va., Great Appalachian valley; Harrisonburg, Va., the Blue Ridge (23); Gordonsville, Va., piedmont hills and valley; Spottsylvania, Va., dissected coastal plain (7); Fredericksburg, Va., coastal lowland and estuaries (47).

30. Volcanoes. Shasta,* Cala.; San Francisco Mountain, Ariz.; Mt. Taylor, N. M.

The great volcanic cones of our western country have not the smooth form of young volcanoes. They have not been kept in good repair by recent eruptions; their sides are furrowed by numerous deep ravines, as shown in the three examples here named.

The growth of the great cone of Shasta inclosed a basin on the northwest; this is now known as Shasta valley, a plain among the surrounding elevations. The great plateau on which San Francisco mountain stands is deeply cut by the Colorado canyon (12), a small part of which is seen on the northwest corner of the sheet; but elsewhere it retains an elevation of 5000 feet. The mountain summit rises much higher, and amid its snows a number of plants have been found, identical with those collected from northern Greenland. Mount Taylor, the

highest of the San Mateo mountains—a dissected volcanic group—overlooks a great lava plateau (Sierra Chivoto, 8000 feet), whose bold escarpments in turn overlook a still broader plateau (7000 feet). A number of isolated peaks or buttes (Cabezon) on this plateau are eroded "volcanic necks"; that is, the lava-filling of tube-like outlets by which the lavas once rose from unknown depths beneath to unmeasured heights above the present level of the country.

31. Lava plains and plateaus. Modoc Lava Beds, Cala.; Bisuka, Idaho.

Lava flows are sometimes poured out in great volume, flooding the lower ground for many miles about their vents and forming lava plains or plateaus, like those of northeastern California, Oregon, and Idaho. The flows often obstruct valleys and form lakes (Rhett and Little Klamath lakes, Modoc sheet, are presumably of this origin). Rivers take their course across such plains, according to their slopes (Pit river, Modoc sheet); and in time may cut deep canyons across them (Snake river, Bisuka sheet), exposing the lava flows in section. As the canyon widens into an open valley, the lava plateau is more and more dissected, until only shrunken remnants of its original extent are seen (Sierra Chivoto, sect. 30).

When the lava flows are freshly outpoured, they are barren and desert; but when older, a soil forms on their surface, supporting an abundant vegetation, if the climate is fitting.

32. Laccolite mountains. San Rafael, Henry Mountains, Utah.

In some cases, the lava that is forced upward from its deep source does not reach the surface and build volcanic cones or spread out in lava plains; but stops in its ascent and forces its way laterally among the rocks, blistering them up and accumulating in great underground reservoirs of lava; hence called *laccolites*. These harden, and in time, when revealed by denudation of the overlying mass, they are found to be more resist-

ant than the inclosing rocks; hence, while the latter waste away, the laccolites gain a relative relief, and appear as mountains. The Henry mountains (including Mounts Ellen, Pennell, Hillers, Holmes, and Ellsworth), are not only the best type of these peculiar structures, but were the first of the kind to receive adequate description.

These two sheets include remarkable illustrations of denuded plateaus, with retreating cliffs surrounding the San Rafael swell (plateau); and deep tortuous canyons of the upper Colorado river, with innumerable branching canyons.

33. Volcanic lakes. Ashland, Oregon.

Lakes of oval or circular outline are sometimes found in *calderas*, formed by the destruction of the central part of a volcanic cone by some kind of eruptive agency, leaving a deep depression, inclosed by precipitous walls. Crater lake, represented on this sheet, is a remarkable example of this kind; its waters being 2000 feet deep, while the inclosing walls rise 2000 feet or more above the lake. The valleys, descending on the outer slope of the volcano, notch the rim of the caldera; thus showing that they were formed before the cone was destroyed. Lakes of the same kind are known in Mexico, Azores, Italy, Sumatra, and elsewhere.

34. River flood plains. Donaldsonville, Mt. Airy, Point a la Hache, La.

Many physical features of rivers and valleys have already been described: shallow valleys (7) and canyons (12), irregular branches (14) and rectangular branches (27), intermittent (10, 11) and burdened rivers (19). Certain additional features of rivers remain to be illustrated.

The flood plains of large rivers are a little higher close along the river, where the heaviest deposits of silt are made at time of overflow, than further away on either side in the "back swamps." The slope of the plain toward the back swamps in the lower Mississippi is about five feet to a mile. The

settlements in such a district naturally choose the highest ground, so as best to escape injury by overflow, and are therefore located along the river margin, as shown on these sheets. Small streams frequently descend the slope of the flood plain, running away from the river (Bayou Conway, etc.) to the back swamps. Embankments (levees or dikes) are often constructed near the river to prevent its overflow. These are sometimes broken, or crevassed in time of flood; then the water pours out from the river, washing away the fine soil of the sloping plain, and flooding the back swamps, causing at the same time great damage to property and loss of plantation products. (Nita crevasse, Donaldson sheet.)

35. River distributaries. Gibson, Houma, La.

On account of the tendency of rivers to build up their flood plains fastest near their banks, especially in their deltas, it frequently happens that they give out branches, which therefore have been called distributaries, in contrast to the branches that are taken in (tributaries) further up stream. This feature is fairly well illustrated on these sheets, and still better on the map of the Mississippi delta, mentioned further on in the account of the Coast Survey charts.

36. River meanders on flood plains. Fort Payne, Ala.; St. Louis (east sheet), Independence, and Marshall,* Mo.; Junction City, Kan.

As a river cuts down its valley to so gentle a slope that its further deepening becomes very slow, its tendency to lateral cutting increases, and its valley is thus widened. Bluffs of greater or less distinctness inclose it on either side. As a flood plain is developed in a widening valley, the course of the river becomes sinuous; it is said to "meander." The Coosa (Ala.), Missouri, and Kansas rivers illustrate this feature very clearly. The meandering course of a river on a flood plain continually changes; the neck of a long meander or loop is often cut off, and the deserted part of the bend

becomes a crescentic or ox-bow lake (Horse-shoe, Grand Marais, Cahokia lakes, St. Louis, east sheet; Grand Pass, Davis, and Backbone lakes, Marshall sheet.)

The curves and the abandoned meanders of the Mississippi are wonderfully illustrated on various sheets of the map published by the Mississippi River Commission, described below.

37. Meandering river valleys. Versailles and Tuscumbia, Mo.; Palo Pinto and Granbury, Tex.

Rivers are sometimes found to meander, not on flat flood plains, but in sharply incised valleys, whose slopes descend close to the water's edge. This is the case with the Osage river of Missouri, and with part of the Brazos of Texas. It is believed that, in such examples, the meandering course of the river was partly attained when the upland, in which the meandering valley is incised, was a lowland, on which it would be natural for a river to meander; and that when the former lowland was uplifted to its present altitude, the river maintained or even increased the crookedness of its course, and cut down its new valley in meandering curves. The sheets here named offer remarkably fine illustrations of this peculiar feature.

38. Transverse valleys. West Point,* Tarrytown, Harlem, N. Y., and adjacent sheets.

The Appalachian highlands of hard rocks, already described (24), are here transected by the narrow gorge of the Hudson river, which carries the drainage of the New York portion of the Great Appalachian valley out to the Atlantic; just as the Delaware, Schuylkill, Susquehanna, Potomac, and James rivers drain their respective parts of the great valley through gorges in the highlands southeastward to the sea. All of these transverse valleys bear the relation to the Great Valley (an inner longitudinal valley opened on weak rocks) that has been explained in the account of the Pennsylvania Appalachians (27). The inner valley has been deepened only as fast as

the transverse valley has been deepened; the opening of the latter controlled the opening of the former.

The three sheets here named also exhibit the following features. The upland may be traced with increasing altitude from sea-level, at the coast near New York City, to 1400 feet, above West Point. The general northeast trend of the Appalachian structure appears in the oblique course of the smaller branches of the Hudson in the Highlands. The ridge of the Palisades, formed by a sheet of resistant lava tilted to the west, falls in a strong cliff down to the west bank of the Hudson, and descends by a long gentle slope on the other side; like the uplands, its crest rises from sea-level in Staten Island (not shown on these sheets) to 800 feet at Haverstraw. All this region has been glaciated, and possesses many lakes and swamps (44). Since the valley of the Hudson was cut down (after the elevation of the old lowland into its highland position—see 24) the land has been a little depressed, thus drowning the river and making it navigable for large vessels as far as Albany. The other great rivers of the Atlantic slope have been similarly drowned near their mouths, forming bays (47, 48), but their depression was not great enough to carry navigable water through the highlands in their upper valleys. The advantage thus given to the city of New York, aided by the construction of the Erie canal, determined the great growth of our metropolitan seaport.

39. Transverse valleys. Harper's Ferry,* Va.

The relation of the transverse gorge of the Potomac at Harper's Ferry to the (longitudinal) Great Appalachian valley, or Shenandoah valley, as it is here called, is well shown in this sheet. The Potomac comes from the mountains west of the valley, and maintains a tolerably direct southeast course to the sea. It has cut down its superb gorge across the Blue Ridge, and just as fast as this gorge was deepened, the Shenandoah river proceeded to cut down its longitudinal valley. The

gorge, being cut in hard crystalline rocks, retains steep walls; but the Shenandoah valley, being cut along the weak limestones and shales of the valley belt, has already widened into an open valley lowland, behind the hard rocks of the Blue Ridge on the southeast (29).

The relation of transverse and longitudinal valleys is also well shown by the Hiwassee river and its branches, Cleveland sheet, Tenn.; as well as on the sheets named in sections 27 and 28.

40. Migrating divides. Doylestown, Pa.

Many examples of river divides or watersheds may be found on the maps already described. When the divide between two streams has unequal slopes, it commonly wastes faster on the steeper slope, and thus the divide line is said to migrate. One valley then gains length at the expense of its opponent. For example, the short, steep, longitudinal streams, entering the Delaware at Point Pleasant and Lumberville, Pa., are probably slowly capturing drainage area from the longitudinal branches of Neshaminy creek (North branch and Pine run); the former are growing at the expense of the latter. In the same way, Warford creek, N. J., has a short, steep longitudinal course along some weak rock structure; and hence is rapidly gnawing its valley headward, and thus is about to capture the headwaters of Lockatong creek, which descends slowly to the Delaware by a longer, gentler slope on a transverse course, crossing various hard and soft rocks on its way.

A southwest longitudinal branch of Tinicum creek, Pa., is for the same reason about to capture the upper portion of the transverse Tohickon, at a point about a mile and a half south of Ottsville. Indeed, it is probable that the upper transverse (northwest to southeast) part of Tinicum creek once continued its course and joined the Tohickon, a mile and a half west of Wormansville; but that it has already been captured and led out to the Delaware by the growth of the lower longitudinal

part of Tinicum creek; the point of capture being at the sharp elbow a mile and a half northwest of Wormansville.

Deer Run, a longitudinal branch of Tohickon creek, seems to have successfully captured some head branches of the opposed longitudinal stream (Northeast branch of Perkiomen creek), for the present head branches of Deer run enter it in a backhanded direction, as if they had once belonged to a southwest-flowing stream.

These matters are comparatively small; they should not be introduced too early in school work; but they are of value in giving life and true meaning to geographical study.

41. Glacial hills: drumlins. Madison, Sun Prairie, Waterloo, Watertown, Oconomowoc, Wis.

During the glacial period, a broad and heavy ice sheet invaded our northern states from Canada, burying the country much as Greenland is now buried. The ice crept faster along the depressions, such as Lake Champlain, Lake Michigan, and Green bay, than over the intervening higher land; it spread out in lobes south of these depressions. The detrital materials that were dragged, washed, and carried to the margin of the lobes formed looped terminal moraines along the ice front. The material that was not carried so far was left, when the ice finally melted away, spread over the surface (bowlder clay, till, ground moraine), and sometimes formed large oval hills (drumlins) whose axes stand parallel to the movement of the ice, including a larger or smaller share of bedded gravels.

The five sheets above named (or the second, third, and fourth) display a large area covered by a great number of these hills, and exhibit their radial arrangement with relation to the axis of the Green bay glacial lobe in the most beautiful manner. No part of the world possesses a finer illustration of these remarkable forms. They exist in such numbers as to conceal the preglacial form of the land.

The Oconomowoc sheet includes a part of the terminal

moraine that was formed along the southeastern side of the Green bay glacial lobe. Numerous and large irregular lakes and occasional dry hollows are held among the morainic hills.

All these sheets illustrate very clearly the strong effect of the irregular deposition of the glacial detritus or drift in obstructing the drainage of the region, and leaving the lowlands "drowned." The small progress yet made by the streams in draining the marshes demonstrates the geological recency of the later phases of the glacial period.

Drumlins are well known elsewhere; as in southern New England and northwestern Ireland. In western New York, between Syracuse and Rochester, an elongated fluted form prevails.

42. Glacial moraines. Charlestown and Westerly, R. I. One of our best defined belts of morainic hills, formed along the margin of the ice sheet during the glacial period, extends along the coast of Rhode Island, west of Narragansett bay. Its irregularity of form is indicated by extremely sinuous contour lines, and by numerous little ponds held among its hills. Its accumulation along the coast has obstructed the former southward course of several streams (Chipuxet, Usquebaug, Wood rivers, etc.) which now turn west behind the moraine, forming the Pawcatuck river, with several ponds (Wordens, Pasquiset) and large swamps (Great swamp, Indian Cedar swamp) on its way. The originally irregular outline of the morainic shore line has been smoothed by the sea waves (49), which have cut back the headlands and stretched long beaches between them, thus inclosing lagoons or ponds (Point Judith, Ninigret, Quonochontaug ponds).

43. Rivers: old lake outlets. Ottawa, Marseilles, Ill. During the retreat of the ice sheet that overspread so much of our northern country in the glacial period, the basins of the Great Lakes were gradually evacuated. For a great part of the time of retreat the present outlets of the lakes were obstructed

by the lingering ice, so that the lake waters had to stand high enough to overflow at the lowest depressions in the southern rim of their basins. In the case of Lake Michigan the overflow occurred at Chicago, cutting the southwestward channel now followed by the Desplaines and Illinois rivers. It is noticeable that in such cases the existing streams do not suffice to fill the channels that they follow. For example, the Illinois river at Marseilles and Ottawa wanders across a valley-plain a mile and a half wide, between steep bluffs that rise to the adjacent upland. But the Fox river, not much smaller than the present Illinois, flows in a narrow valley, with steep banks descending to the water's edge. It is therefore supposed that when the broad Illinois valley was formed by the lake overflow, it was as well fitted to the great volume of the river that then ran through it, as the narrow Fox valley is now fitted to its river.

Similar broad channels of former lake outlets, now occupied by relatively small rivers, are known in various parts of the country, but none of them are well mapped. The lake that covered the Red river plain of Minnesota and North Dakota, overflowed southward down the Minnesota valley. The western end of Lake Superior overflowed southwest down the St. Croix. Lake Erie overflowed southwest down the Wabash. Lake Ontario overflowed southeast down the Mohawk.

44. Glacial lakes. Webster,* Mass.

When a country that had a good drainage in preglacial time receives an irregular deposit of glacial drift, its streams are greatly obstructed and diverted. Ponds and lakes accumulate behind the obstructions, which here are shown in characteristic variety of outline, their area having been increased in several cases by artificial damming of the outlet for improvement of water powers.

The diversion of the streams to new courses frequently produces cascades and falls on which many industries depend.

The manufactures of Fall River, Mass., were begun on a fall of this kind, but have long since outgrown the power furnished by the fall.

Lakes and ponds of glacial origin are included on most of the maps of our more rugged northern States (24, 25, 38). They are extremely numerous in Canada, Scotland, and Finland.

45. Glacial lakes and swamps. Franklin, N. J.

Where the glacial obstruction of old valleys formed shallow lakes, they have frequently been already changed to swamps, or "drowned lands," by the combined action of filling the bottom and cutting down the outlets. Some of these swamps in New Jersey have been artificially drained, greatly improving the health of the district and extending the cultivable area.

46. River terraces. Springfield,* Mass.; Hartford, Conn.

Valleys that have been excavated under the lead of rivers are sometimes partly filled again with clays, sands, or gravels, burying the valley bottom to a depth of even several hundred feet, and forming a broad flood plain that abuts on either side against the valley slopes. These buried valleys may be at a still later time re-excavated, and terraces are formed during this process.

Many of our northern valleys are now in the terraced stage. They were originally excavated in preglacial times, and probably somewhat deepened by glacial scouring. As the ice retreated the valleys were more or less clogged with detritus, especially as their southward slope was then less than now. In postglacial time the supply of detritus has decreased, and the southward slope has increased on account of a rise of the land to the north; thus the clogged valleys are trenched and terraced.

The upper terrace plain is well shown east of the Connecticut about Springfield, and on either side of the river about Hart-

ford; several terraces at lower levels are not clearly shown in the maps. The side branches of the river (Westfield, Chicopee, Farmington, Scantic) have formed lateral terraces as fast as the deepening of the main stream allowed them.

In thus cleaning out the clogging of a valley, streams are liable to settle down on buried rocky spurs and ridges of the old valley floor, and waterfalls are thus created by which many of our manufacturing cities are now located (Chicopee Falls, Holyoke, Mass.).

47. Irregular shore lines: drowned valleys. Wicomico, Md.; Fredericksburg, Mt. Vernon, Va.

The margin of the dissected coastal plain of the Atlantic slope (7) has been submerged beneath the sea, "drowning" its valleys into bays or sounds (Delaware and Chesapeake bays, lower part of Potomac river, Albemarle and Pamlico sounds). The shore line, advancing on the uneven land surface, becomes extremely irregular; every little valley forming an inlet, while the rising ground between the valleys stands out as a cape or point. The name "river" is still given in many cases to the drowned part of the valleys, especially if it is comparatively narrow (Potomac, Wicomico: see also 38, 48). The head of these expanded "rivers," where the water is shallowest, gradually fills with tidal swamp (Zekiah and Gilbert swamps, Wicomico sheet).

The water body, fronting on the irregular coast here mapped, is of so moderate a breadth that its waves have as yet done little work in cutting cliffs on the headlands and building bars across the bays.

48. Drowned valleys: estuaries: islands. Norwich and New London, Conn.; Boothbay,* Me.

The Appalachian highland in New England, the higher part of which has already been described as constituting the Berkshire hills (24), slopes gently south and southeast to the sea. After the formation of the present valleys, that were cut in

the slanting highland in consequence of its uplift, it was slightly submerged. The shore line thus became very irregular. The interstream uplands stand out as promontories; the valleys are drowned by the sea, forming bays and estuaries, of which one of the finest is the Thames river, in southeastern Connecticut. Niantic river (New London sheet) is a smaller example of the same kind. Narragansett bay is a much larger example (see the Coast Survey sheets). The head of navigation in such bays or estuaries is nearly always chosen as a seat of settlement (Norwich, Conn.; Providence, R. I.)

When the relief of the submerged region is more varied, and the amount of the submergence is greater, the valleys are more broadly drowned or fiorded, and many hilltops are isolated as islands. The coast of Maine is a typical example of this kind, well illustrated about Boothbay.

49. Smoothed shore lines. Sandy Hook, Asbury Park, Barnegat, Long Beach, N. J.

A gently rolling lowland, with broad shallow valleys, has been here slightly depressed, thus producing a somewhat irregular shore line at the new sea-level; the interstream surfaces standing out as gentle headlands, while the valleys are submerged or drowned, forming bays or estuaries (Toms, Metedeconk, Navesink "rivers"). Since the submergence, the vigorous ocean waves have cut back some of the sandy headlands, forming low sea cliffs, as at Long Branch, and they have thrown bars almost across the intervening drowned valleys, forming lagoons (Shark and Manasquan "rivers"). The waves have also built long spits, northward (Sandy Hook), and southward from the sea cliff, and have thrown up long detached bars further south (Island beach, Long beach); the bars being separated by inlets (Barnegat inlet) which are held open by in- and out-flowing tidal currents. Long, quiet stretches of shallow water lie behind the bars (Barnegat, Manahawken bays). Numerous sand dunes have been built by the winds on the bars and spits.

High tide marshes are encroaching on the quiet water of the bays. Lighthouses and life-saving stations are established at various points along the shore. The cool cliffs and bars are now resorted to in the summer season by large numbers of people from the warm interior. The supply of fresh water on the bars is derived from deep artesian wells, which in turn gain their supply from inclined beds of sand that lead down the rainwater of the interior of New Jersey.

50. Smoothed shore lines and shore lagoons. Martha's Vineyard,* Gay Head, Mass.

The rolling surface of a strong morainic belt runs along the northwestern side of Martha's Vineyard; another morainic belt forms the Elizabeth islands. A broad plain of sand and gravel, washed southward from the Martha's Vineyard moraine during its accumulation, has been gently trenched by branching valleys, in which the sea has now entered, forming branching bays. The action of the Atlantic waves in southerly storms has cut back the headlands and thrown bars across the bays, inclosing ponds (Great Tisbury, Herring ponds), thus straightening what was at first a very irregular shore line. This latter feature is seldom better exhibited than on these sheets.

51. Sea cliffs and spits. Provincetown, Wellfleet, Chatham, and Yarmouth, Mass.

These sheets represent the outer part of Cape Cod, which consists for the most part of washed glacial deposits, on whose eastern side the ocean waves beat with much strength in easterly storms. The outer side or "back" of the Cape has thus been cut into a long smooth beach, of gently convex curve toward the sea, surmounted by a sea cliff, over a hundred feet high at Highland Light. Long sand spits have been built at either end of the cliff (Provincetown to northwest, Nauset beach to south) inclosing sheltered waters (Provincetown harbor, Nauset bay), between which there are some thirty miles of

unbroken coast, where coasting vessels find no inlet or refuge from storms. There are large areas covered by sand dunes about Provincetown.

There has been much less action of the sea waves on the south side of the Cape (Yarmouth sheet), where the outlying islands of Nantucket and Martha's Vineyard take the force of the ocean waves.

Whatever irregularity the eastern shore line of Cape Cod originally possessed, it has been completely extinguished by cutting back its headlands even behind the head of its bays. Comparing the Potomac (47), northern New Jersey (49), and Cape Cod shore lines, the expression of the first may be called "young," as it exhibits slight change of form since submergence; the second is "adolescent," as it clearly exhibits some action of the sea, yet retains some of its original irregularity; the third is "mature," its whole expression along the sea cliff being the result of wave and current work. In this example, the weakness of the unconsolidated sands and clays forming the shore have allowed the waves to advance in their work with comparative rapidity. On the rocky shores of Long Island sound and of northern New England (48), the work of the waves is relatively slow.

52. Shore cliffs. Port Washington, Wis.

Lake waves, like ocean waves, work on their shores, cutting cliffs and building bars; but their action is relatively slow.

The cliffs of Lake Michigan are here seen to be a hundred feet high near Milwaukee.

The extinct lakes, Bonneville and Lahontan (5), left strong cliffs and bars around their shores. The expanded waters of our Great Lakes, when the present outlets were obstructed by ice and their overflows followed other lines (43), marked their shores with distinct cliffs and bars in Michigan, Ohio, New York, etc.

53. Sand dunes. Kinsley, Kan.

On the semi-arid plains of the West (5), as well on the deserts in general and on sea (49) and lake shores, the action of the wind in drifting and heaping the loose sands is sometimes of great importance. Dunes cover extended surfaces on our western plains as far east as central Kansas; sand hills are there especially numerous on the eastern or leeward side of the larger rivers.

Dunes are also common on the abandoned deltas of the extinct glacial lake in which the plain of the Red River of the North was formed in Minnesota and North Dakota (43).

UNITED STATES COAST AND GEODETIC SURVEY

The publications of this survey include a large number of charts of our Atlantic, Gulf, and Pacific coasts. They are based on an extremely precise triangulation, and the surveys for the charts are of minute accuracy. As they are prepared for use in navigation, the topography of the land extends only about a mile inland from the shore line. The depth of water offshore is indicated by numerous soundings on the charts of larger scale. In many cases the borders of the charts do not run north and south.

The charts are for sale at the cost of publication; generally about fifty cents a sheet. All applications should be addressed to the SUPERINTENDENT OF THE UNITED STATES COAST AND GEODETIC SURVEY, WASHINGTON, D. C. The following paragraphs give accounts of such charts as will prove of most interest to teachers.

54. Illustrated Catalogue of Charts. Copies of this catalogue may be obtained by responsible persons, free of charge, on making application as above.

The catalogue contains a series of outline maps, on which every chart published by the survey is indicated by a rectangle of proper size and position, with designating number. The size, scale, date, and price of the charts are tabulated on the pages opposite to the key maps.

For convenience of reference, the charts named below are placed in geographical order along the Atlantic and Pacific coasts. All of those having numbers between 100 and 300 are on a scale of 1 : 80,000.

55. General Charts of the Coast. The general features of the coast line are illustrated by charts of the following numbers on a scale of 1 : 400,000. No. 6, the fiorded coast of New England; 8, Long Island and New Jersey, with New York Harbor: 376, Delaware and Chesapeake bays (drowned valleys); 10 and 11, the bars, capes, and sounds of the Carolinas; 12, the sea-islands of South Carolina and Georgia; 13 and 14, the bars and lagoons ("rivers") of eastern Florida; 15, the coral islands of southern Florida; 18, the low shores of southern Alabama; 21, the bars and lagoons of Texas; 701, fiords and islands of Alaska (1 : 1,200,000). Schools located near the coast should have at least the chart of this series that includes their own district.

56. Coast Charts. The charts of this series are of particular interest. They are on a uniform scale of 1 : 80,000, and represent the entire Atlantic and Gulf coasts. The most useful examples are here named.

Charts 101 to 106. The bays and islands of the coast of Maine. Perhaps the most interesting of these are 103 and 104, which include Mt. Desert and Penobscot bay. *Harbor Charts* 309, 310, and 315 represent the swarms of islands in Penobscot and Casco bays (1 : 40,000). All of this part of the coast illustrates the effect of the moderate submergence of a rugged land, on which little wave work has been since done, by reason of the hardness of its rocks (48).

111, 112, 113. Cape Cod to Narragansett bay. As before, the irregularities of the shore line have been produced by moderate submergence; but as the land here consists for the most part of unconsolidated sands and gravels of the glacial period, much advance has been made by the waves in smoothing out the coast (50, 51).

353. Narragansett bay (1 : 40,000). A broad valley, submerged; several hills rise as islands. Sachuest island is tied to Newport island by two sandbars.

121, 122, 123. The coast of New Jersey. The transition from the nearly mature coast about Long Branch to the offshore bars further south is well shown. The contrast of this even coast with the irregular coast of Maine is very striking. The topographical maps of New Jersey (sect. 63, below) are however more suitable for school use, as they represent the inland areas as well as the coastal border.

127, 128, 129, 130. The eastern shore of Maryland and Virginia, from Cape Henlopen to Cape Charles; repeating with singular closeness the features of the New Jersey coast.

140, 141. Albemarle sound; a drowned branching valley, similar to Chesapeake bay.

142, 147, 150. The three pointed sand-bar capes, Hatteras, Lookout, and Fear. These capes appear to be formed by great back-set eddy currents between the Gulf stream and the coast. They are produced by currents moving to the southwest, and the sands of each concave bar are washed out from the cusp or cape, at its southern end, forming offshore shoals, sometimes guarded by light-ships.

154, 155. The sea-islands of South Carolina. A confused network of shallow channels separates the islands from one another and from the mainland. Much of their surface is marshy, being hardly above sea-level, and thus exposed to submergence by storm tides. These islands are contrasted with the rocky and hilly islands of Maine, and with the linear sand-bar islands of the greater part of our southern coast; it is chiefly on account of the greater strength of the tides here than at Hatteras, that no long sweeping bars are formed.

160, 161, 162, 163. Cape Canaveral and the bars and inlets to the north and south. Cape Canaveral (161) is of the same character as Hatteras and its fellows; being a cusp formed by the union of two sand bars; but it does not project so acutely into the sea. It is moreover peculiar in showing very distinctly a shift in its position · the apex of the cape having advanced some ten miles south of its former place; the stump

of the old cape being still easily recognized behind the newer bars.

167, 168, 169. The coral reefs of southern Florida. As the only representatives of such islands on our coast, these charts deserve especial attention. Key West (169) is perhaps the best example of the three.

188. Mobile bay. A young delta is forming at the head of the bay, while sand bars are stretching across its entrance.

194. The delta and mouths of the Mississippi river. This is one of the most interesting charts of the entire series; it deserves a place in every school. The digitate distributaries of the great river and the growth of the delta along the banks of the outbranching streams are shown to perfection (35).

210, 211, 212. Padre island, a long sand bar, inclosing the shallow Madre lagoon on the low coast of southern Texas. This sand bar is one of the longest in the world, extending nearly a hundred miles without a break. It is slightly convex on the south, where it approaches the projecting shore opposite the mouth of the Rio Grande; it swings on a long concave curve further north, with remarkable smoothness of outline.

675. San Francisco and Monterey bays, Cala. (1 : 200,000). The Golden Gate is of importance as the only break in the Coast Range for a great distance along the Pacific coast. The prevailing absence of deep bays, outlying islands, and linear sand bars distinguishes our Pacific coast from the Atlantic coast.

8100. Fiords and islands of southern Alaska. A coast of even greater irregularity than that of Maine; rivaling that of Norway in the depth of penetration of the land by long branching arms of the sea, and in the number of half-drowned hills and mountains that now appear as offshore islands of greater or less size.

MISSISSIPPI RIVER COMMISSION

Application for these maps should be made to the SECRETARY, MISSISSIPPI RIVER COMMISSION, ST. LOUIS, MO. Chartered colleges having permanent libraries may receive a set of the maps, free of charge. To others, the maps are for sale at a moderate price to cover the cost of paper and printing, as stated below. Remittances must be made at the time of sending the order, in funds current in St. Louis.

These maps have been prepared for the use of river pilots and engineers; and especially with regard to prevention of river overflow by the construction of levees. They are of great interest geographically, in showing with remarkable clearness the features characteristic of large rivers.

The surveys of the Commission are published in three series of maps.

57. Map of the Alluvial valley of the Mississippi river.* (1887.)

Eight large sheets; five miles to an inch. Price, forty cents for the set, or two cents per single sheet. The flood-plain area is tinted brown; land above flood levels, white. This gives a complete and most instructive picture of the great river from Cairo to the Gulf; exhibiting its meanders, cut-offs, and ox-bow lakes; its curving from one side of the broad flood plain to the other; the peculiar habit of the smaller streams on the flood plain, which flow obliquely away from the river, gathering in the lower part of the plain near the bluff of higher ground, and there running southward until the Mississippi swings across the plain and gathers them in (as for example the St. Francis, Yazoo). The distributaries of the lower course of the river and its digitate delta are clearly shown. Memphis, Helena, and Vicksburg are all located at points where

the river impinges against the bluffs at the margin of its flood plain.

58. Preliminary Map of the Mississippi river, below the mouth of the Ohio. (1881–85.)

Thirty-two small sheets; a mile to an inch; with three index sheets, ten miles to an inch, and a table of distances. Price $1.80 for the set, or five cents a sheet. The index sheets of this series give an excellent small-scale map of the river from Cairo to the Gulf; and the inch-to-a-mile sheets present additional detail in form best adapted to school use. The following sheets are of particular interest:

No. 8. Horn Lake, an abandoned and isolated meander, below Memphis.

9. Council bend; a cut-off meander, but not yet isolated by deposit of silt at the junction of its arms with the present river channel.

13. Remarkable meanders, and Beulah lake, the result of a cut-off that occurred in 1863.

17. Eagle lake, an isolated meander.

18. Palmyra lake, south of Vicksburg, an old meander on the west of the present cut-off channel. Davis island, inclosed by the lake, is claimed by the State of Mississippi, although on the west side of the present river.

20. Lake St. John and the double Lake Concordia; near Natchez.

22. Old River lake, an abandoned meander.

24. Fausse river cut-off and lake; the cut-off being dated 1722.

59. (Final) Survey of the Mississippi river, below St. Louis. (1879–80.)

Eighty-three large sheets, on a scale of 1:20,000 (about three inches to a mile), and two index charts. Price twenty cents a sheet. The large scale of these charts allows the represen-

tation of certain details, not shown on the maps of the preceding series; especially the accretion of land on the convex bank, and the indication of river depth by actual soundings. The following sheets are of interest; although for most school purposes, the maps of the preceding series may suffice.

No. 17. The river is here cutting into the bluff land on the eastern side of the flood plain; accretion of land is shown on the convex bank.

23. Horse lake, an abandoned meander, now isolated from the river.

24. Council bend, a cut-off meander, not yet isolated from the river.

36, 38, 39. Remarkable meanders of the river.

52. Lake Bruin, an ox-bow lake, isolated from the river.

55. Marengo bend, a strong meander, with narrowing neck; good illustration of accretion on the convex bank.

67. Double bend in the river; relation of depth of water to form of curve well shown.

MISSOURI RIVER COMMISSION

Application for these maps should be made to the SECRETARY, MISSOURI RIVER COMMISSION, ST. LOUIS, MO. Like the charts of the Mississippi River Commission, these have been prepared for professional use by pilots, engineers, and others, to whom they are distributed without charge. It has been the custom of the Commission to present them "to institutions of learning that would probably have actual use for them." If the sheets mentioned below are called for in considerable numbers by schools, it is to be expected that a moderate price will be set on them, comparable to that charged for the maps of the Mississippi River Commission.

Two series of maps are issued by this Commission.

60. A series of forty charts, from surveys made between 1878 and 1882, on a scale of an inch to a mile, representing the Missouri river from Fort Randall, S. D., to its confluence with the Mississippi. They are less detailed than the corresponding sheets of the Mississippi. With these go four index sheets, on a scale of 1:500,000.

61. A series of 83 charts, on a scale of an inch to a mile, from surveys later than 1890. Twenty-four of these sheets have now been issued. An index map in nine sheets will be prepared later.

The following charts of the first series may be named as affording illustrations of the features of the Missouri river, as well as of the features of large rivers in general.

Charts II to VIII represent the river in eastern Missouri, where its flood plain is relatively narrow between steep bluffs and its meanders are moderate.

XI and XIII in western Missouri show a wider flood plain and a greater irregularity of river course.

XVI in northwestern Missouri, includes several remarkable meanders and some ox-bow lakes in the neighborhood of St. Joseph. The same may be said of XXIII, which represents the river above and below Omaha.

XXXI to XXXVII represent the narrow flood plain of the river between strong bluffs in South Dakota above Yankton, where its course is greatly obstructed by sand bars.

SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES

This survey was carried on by the Engineer Corps, U. S. Army, from 1855 to 1880. Sixty-eight charts in all were published.

Application for these charts should be made to the UNITED STATES ENGINEER OFFICE, DETROIT, MICH. The charts are not issued free, but are sold at a uniform price of twenty cents a sheet. Remittance must be made by postal note before the sheets are sent; express charges to be paid by purchaser on receipt of charts. A catalogue of charts and an index map (1 : 1,600,000) are published.

Most of the maps of this series include little land topography, and are of value rather to the advanced student than to the teacher; but certain charts contain illustrations of features of general interest. A few of these are here mentioned.

62. St. Lawrence River, Chart No. 5; 1 : 30,000. The region of the Thousand Islands; a hilly valley-lowland, submerged by the outlet of Lake Ontario. Many channels among the island-hills, but as yet no one channel has been so much deepened as to draw the water away from its fellows.

Niagara Falls.* Special map on a scale of 1 : 20,000. This shows the broad river above the falls, the upper rapids, the two falls, the great pool below the falls with soundings of which the deepest is 189 feet, the whirlpool rapids, the whirlpool, and the lower gorge; but, unfortunately, the map does not include the front escarpment of the Niagara plateau. This, however, is shown for a little distance on either side of the river on Chart No. 5 of Lake Ontario, 1 : 80,000; the expanded lower part of the river, between the bluff and Lake Ontario, is also shown; a broad and deep channel, presumably somewhat

drowned as a result of the uplift of the northeastern outlet of the lake, whereby the waters at its southwestern end have been a little raised above their former level.

Lake St. Clair, 1 : 50,000. A remarkably perfect illustration of a delta, formed in the shallow, quiet waters of the lake by the river of the same name, which gathered material for the delta in cutting down the discharge channel of Lake Huron.

General charts of the several lakes are published on a smaller scale; as of Lake Erie, 1 : 400,000. The soundings indicate that the lake bottom is an exceptionally level plain, submerged to a depth of twelve or fourteen fathoms.

STATE TOPOGRAPHICAL SURVEYS

Topographical surveys of New Jersey, Massachusetts, Rhode Island, and Connecticut have been completed by the co-operation of the United States Geological Survey and special Commissions in the several states concerned; the expense of the work being shared between national and state funds. The triangulation on which the topographical work depends has been done in whole or in part by the United States Coast Survey. The maps issued by the states in atlas form are, with the exception of those of New Jersey, similar to those issued by the national Geological Survey, many of which have already been described; but certain advantages regarding the distribution of the maps to teachers are gained or may hereafter be gained through the state editions. It is thought that the account of the state surveys here introduced may not only serve to bring them to the notice of teachers in their respective states, but may also serve to advance the preparation of good maps in other states, by showing teachers there how much they lose in having no sufficient surveys of their home district.

63. Topographical Atlas of New Jersey.—An atlas of twenty large sheets published by the GEOLOGICAL SURVEY OF NEW JERSEY, TRENTON, N. J. Price $5 for the whole series of sheets, or 25 cents a sheet.

This atlas includes a general map of New Jersey, a relief map, and a geological map of the state, all on a scale of five miles to an inch; and seventeen large topographical sheets on a scale of a mile to an inch, with contours every ten or twenty feet.

This state survey is of historical interest as being the first

large-scale map of a state published in this country. It is, moreover, one of the best surveys of the kind that we have. A special edition of the atlas, with sheets mounted on cloth, was distributed to all the public schools of New Jersey at the expense of the State Board of Education. This example of educational enterprise might well be followed by other states as their maps are completed.

Outside of New Jersey the small-sheet edition of the New Jersey map by the United States Geological Survey, of which examples have already been cited, will suffice for general use, except that the relief map of New Jersey deserves a wide distribution. It is the only state map of the kind yet published in this country on the basis of accurate surveys, and is extremely instructive regarding the relations of altitude from the coastal plain into the Appalachian highlands. (See sections 1 and 25, U. S. Geol. Survey maps.) All teachers of geography in the eastern part of the country should possess it. It represents the coastal lowlands, with their offshore sand bars and their branching estuaries; the lava ridges of the Triassic belt in the piedmont district; the rugged highland of crystalline rocks, here representing the Blue Ridge of Virginia; the great Appalachian valley further inland, drained through the highlands by the transverse valley of the Delaware; and Kittatinny mountain, the continuation of North or Blue Mountain of Pennsylvania, the outermost of the even-crested Appalachian ridges, through which the Delaware has cut a passage at the Delaware water-gap, the type of many similar gaps further southwest.

64. Topographical Atlas of Massachusetts.—An atlas of fifty-four sheets, with index map and cover, published by the COMMISSIONERS OF THE TOPOGRAPHICAL SURVEY OF MASSACHUSETTS, BOSTON, MASS. Price $6, or fifteen cents a sheet.

The maps of this atlas are essentially the same as those

issued by the Geological Survey, and are here mentioned chiefly to inform New England teachers about them. United action of the teachers of Massachusetts might result in securing the distribution of the atlas to the schools, or at least to the high schools, through the State Board of Education or by special legislative appropriation, as has been done in New Jersey and Rhode Island.

In the use of these maps for teaching home geography it is advisable to have a number of adjoining sheets mounted together on cloth so as to include a considerable area of the state. Thus the sheets representing the Berkshire plateau and valley, the Connecticut valley, the central plateau, the eastern hills and coast, and the southeastern lowland, cape and islands, may be made into wall maps, giving excellent pictures of the several areas. Grouped maps of this kind should certainly be provided for all the high schools in the state. The wall map of Rhode Island, described under the next heading, illustrates the value of such a grouping of separate sheets.

65. Topographical Survey of Rhode Island. The map of this state is issued in two forms. 1. As an atlas in ten sheets, of the same style as those issued by the Geological Survey but differently arranged; price $3.50. 2. A wall map of the state mounted on cloth with rollers: price $2.00. The latter is the more convenient form for school use. These maps are to be obtained of J. C. THOMPSON, 269 WESTMINSTER STREET, PROVIDENCE, R. I.

The wall map of the state has been distributed to all public schools and libraries in Rhode Island, by special appropriation of the Legislature. Although covering but a small area, it is of value in all our eastern schools from the clear illustration that it gives of various geographical features. For example, the gradual descent of the New England highland to the sea; the dissection of the highland by numerous valleys; the partial submergence of the valleys, forming bays of greater or

less size and isolating many ranges of hills as islands; the obstruction of certain valleys by glacial drift producing numerous ponds and marshes; the terminal glacial moraine along the southern coast; the action of the sea in forming sand bars and inclosing lagoons. Several of these features have already been referred to in the account of the maps of the United States Geological Survey.

This wall map is also of value in illustrating the use that grouped sheets may be put to, in representing a considerable area of country on a large scale in convenient form for school use. While it would not be practicable for other states to include their whole area in a single wall map, it is entirely possible to prepare wall maps of the several districts into which a state may be divided, as is suggested in the account of the Massachusetts Survey; and the schools of each district might then be provided with the appropriate map.

A single sheet map of Rhode Island has also been prepared on a scale of 1 : 250,000, with contours every 100 feet. This has been issued in two forms; one serving as an index to the atlas sheets and illustrating the triangulation on which the detailed mapping is based; the other indicating the forest areas of the state, which are, as a rule, confined to the higher ground, while the farms and villages lie in the valleys and along the coast. This makes an excellent illustration in connection with allusions to forestry.

66. Topographical Survey of Connecticut. The atlas of this survey is now about completed and will probably be issued during the current year (1894). It will consist of twenty-five or thirty sheets similar to those of the Massachusetts atlas. These will be sold at a moderate price. No plan for the distribution of the maps to the schools in the state is yet announced.

A map of the state in two sheets, on a scale of two miles

to an inch with 100-foot contours, is also prepared. It is intended to be mounted as a wall map. Further information concerning these maps may be obtained from the COMMISSIONERS OF THE STATE TOPOGRAPHICAL SURVEY, NEW HAVEN, CONN.

The two-sheet map of Connecticut exhibits very clearly the division of the state into an eastern and a western plateau, separated by a broad lowland. Each plateau slopes southward to the sea, its surface being dissected by many narrow valleys and its coast being indented by many narrow bays. The lowland is interrupted by linear ridges, the resistant edges of tilted ancient lava flows. The Connecticut river enters this lowland from a similar lowland in Massachusetts; but instead of following the lowland to the sea at New Haven, the river enters the eastern plateau at Middletown, and runs through a narrow gorge to the shore; being in this respect much like the Hudson, which departs from the great Appalachian valley, and passes through the highlands in a deep gorge.

UNITED STATES WEATHER BUREAU

67. Weather Maps. All applications for these maps should be addressed to the CHIEF OF THE WEATHER BUREAU, WASHINGTON, D. C.

The weather maps are issued twice daily (with certain exceptions on Sundays and holidays) and represent the temporary weather conditions over the whole of the United States. A lithographed edition is published at the central office in Washington, with full data and superior execution. Local editions of the map, with fewer data and less distinct printing, are prepared at many of the larger cities throughout the country. For purposes of study, the Washington maps are more satisfactory; but when it is intended to follow current weather changes, the maps should be procured from the nearest publishing office.

These maps are primarily published to be displayed for the information of the public; and any teacher who can engage to expose the maps promptly in some public place where they can be inspected conveniently by the people, as at the entrance to a large school centrally situated in a city or town, can probably be supplied from the nearest local publishing office, without charge. Teachers who are not situated so that they can comply with these requirements, can frequently make arrangements to receive the maps from some business office, bank, or hotel in their town or city, where they are displayed, after they have been superseded by the receipt of a map of later date.

As the temperature lines, wind-arrows, etc., are generally too faint to be seen by a class, it is advisable to strengthen them with inks of different colors. For elementary teaching, it is best to strengthen the lines of one element only (as tem-

perature, wind, cloudiness, etc.) on each map. This can be neatly done by the scholars after a little practice, and a valuable collection of different weather types may thus be made. The collection should ultimately include examples in winter and summer of the following types: Cyclonic and anticyclonic areas passing across the northern, central, or southern part of the country, and exhibiting their characteristic control over pressure, winds, temperature, cloudiness, and precipitation. If a special map is devoted to each one of the last-named five elements, the collection might include nearly a hundred maps.

Besides the daily weather maps, the Weather Bureau publishes maps in several other forms. The weekly Weather Crop Bulletin, issued during the growing and harvesting seasons, contains effective illustrations of the peculiar character of the advancing year; the Monthly Weather Review presents maps of the monthly values of various climatic elements, of much value as illustrations of the subject; it occasionally includes diagrams of special storms. The Lake Storm Bulletin is devoted to storms of particular severity on the Great Lakes. The Monthly Weather Review is sent to voluntary observers, who contribute records to the Bureau, and among whom many schools might well be included. The Crop Bulletin and the Lake Bulletin are very generally distributed.

UNITED STATES HYDROGRAPHIC OFFICE

68. Pilot Charts of the North Atlantic; published monthly by the United States Hydrographic Office, Washington, D. C., for the information of masters of vessels, to whom they are distributed free of charge. Schools in maritime cities can frequently make arrangements to be supplied with superseded charts by owners of vessels.

Application for these charts should be made to the HYDROGRAPHER, UNITED STATES NAVY, WASHINGTON, D. C., who authorizes the statement that copies of undistributed back numbers of the charts, remaining in store, will be supplied free of charge to principals of schools, for use in teaching. It is suggested that a pair of charts representing opposite seasons of the year should be asked for, in order to illustrate the change of conditions between winter and summer, or spring and autumn. The year of issue is of less importance than the month in this respect.

The charts contain, in black, the coast lines, meridians, and parallels; in blue, indications of the probable strength and direction of the wind in different parts of the ocean for the coming month; these data being based on the average of numerous observations for the same month in many previous years. They contain, in red, a variety of information gathered during the month just past concerning storms, "derelicts" or abandoned wrecks drifting on the open ocean, sometimes traced in their course for many months, notes on the use of oil to diminish the force of waves in storms, etc. Many lessons may be improved and enlivened by the information and illustrations drawn from these charts. As far as general study goes, the superseded maps are as useful as those just issued.

Besides general and special accounts of hurricanes (as in the

issues for August, September, October, 1886, July and August, 1890), hurricane tracks (August, September, October, of various years), water-spouts, drifting wrecks, etc., given on these charts, a number of supplementary sheets have been issued; for example: The Hurricane of November 21–28, 1888; the St. Thomas-Hatteras hurricane of September 3–12, 1889; the Drift of bottle papers in the North Atlantic (showing the movement of surface waters as indicated by the paths of floating bottles); Ice in the North Atlantic, season of 1889–90 (indicating the southward advance of icebergs from Greenland); Wreck chart of the North Atlantic (showing the tracks of abandoned wrecks). These are all more or less fully illustrated by diagrams or charts, and present facts of interest in a very effective manner.