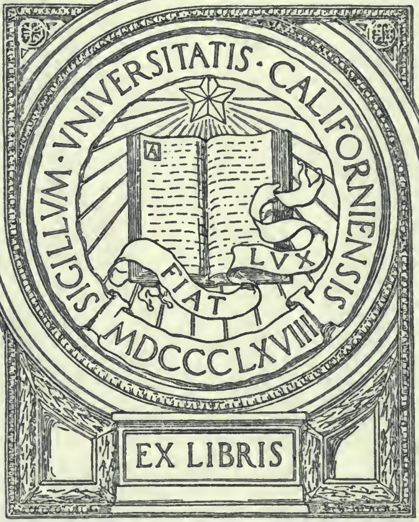
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The Reproduction of Geographical Forms

Redway

THE REPRODUCTION

OF

GEOGRAPHICAL FORMS

I. *SAND- AND CLAY-MODELLING WITH RESPECT TO GEOGRAPHICAL FORMS*

II. *MAP-DRAWING AND MAP-PROJECTION*

BY

JACQUES W. REDWAY

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OTHER WORKS BY THE SAME AUTHOR.

- A SERIES OF GEOGRAPHIES, DESCRIPTIVE AND PHYSICAL.
- A GEOGRAPHY OF PENNSYLVANIA.
- A GEOGRAPHY OF MASSACHUSETTS, CONNECTICUT, AND RHODE ISLAND.
- STUDIES IN PHYSIOGRAPHY (*In Press*).
- A TEACHER'S MANUAL OF GEOGRAPHY.

Gift of Professor J. B. Leighly

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FOREWORDS.

Sand- and clay-modelling with respect to topographical forms has become a legitimate and essential part of the course of instruction in the study of geography. But while much emphasis has been placed on the arbitrary order to *do*, little has been said on the subject of how and what to model, or how to interpret the forms when made. The moulding-board is intended not for the creation of forms, but for the reproduction of those already found in nature. A working plan whereby the more common types of geographical forms may be studied in the school-room, is therefore presented.

I have also added a few pages on the practical construction of maps and map-projections. To project and draw a 'scientific' map is often considered an unpardonable educational heresy. As a matter of fact, however, the 'scientific' projection is vastly easier, and requires less time than the bungling, meaningless diagram which commonly poses under the name of an 'aid' to map-drawing. I have therefore taken the liberty to present a few practical projections which are not beyond the comprehension of pupils in intermediate grades. There is also presented a solution of several of the more difficult projections which appear in school atlases.

J. W. R.

PART I.

HINTS TO TEACHERS.

I.

PRELIMINARY ORAL WORK.

It is hardly an exaggeration to say that the average child learns more of the science of geography in his rambles out of doors, before beginning the study in his school course, than he learns from the text-book after his school work in that study begins. The reason is that, in the one case he reads geography in nature, in the other from the printed page. No matter how well and how faithfully the teaching may be done, the disadvantages arising from the use of words and sentences instead of things in nature, are too great to be easily swept away. Within a few years the importance of this fact has been so widely recognized by primary teachers that, in a majority of schools, text-book work has been largely abandoned in primary grades, and oral lessons, aided by the moulding-board and the study of natural forms, have very properly taken its place.

The outline of the following course in oral primary geography was furnished at the author's request by Miss Mathilde E. Coffin, of the Millersville, Pa., State Normal School, as a basis for the preparation of this and the following chapter. It is intended as a list of topics for oral work rather than a systematic course of study. Much of the work discussed must necessarily be done out of doors. Children who like to make 'mud pies' will take equal delight in modelling natural forms in sand or in clay. Time ordinarily spent in aimless rambling will be gladly devoted to the collection and study of natural objects when once there is an incentive for it. In ungraded country schools the wise plan of keeping primary pupils out of doors at all times when they are not engaged in recitation is an excellent one, and these are the golden hours which the child may devote to the study of nature. The out-of-door work should of course be supplemented by the necessary developmental exercises, and lessons in oral expression in the school-room. Bear in mind, also, that while recitation-hearing is an easy matter, teaching children how to study and how to observe is a qualification demanding the highest capabilities of the teacher.

Form. — It is well, so far as possible, to acquire a knowledge of form from natural objects. Fruit, crystals, forms of leaves, shells, animals, and geometric forms will all furnish instructive lessons. At first the work must be wholly imitative, but, as skill is acquired, objects may be modelled from memory. With the modelling of geometric forms comes the necessary instruction in the use of descriptive terms, such as plane, curved, level, cubic, spherical, square, circular, slanting, vertical, angle or corner, solid, horizontal, etc. Inculcate with every step ideas of neatness in work and faithfulness to the copy.

Size. — Teach by actual measurement all the units of linear measure within the comprehension of the pupil. The latter should be taught to estimate the inch, foot, and yard with the eye. It will be found rather more difficult to estimate vertical than horizontal distances, especially if the eyesight be at all astigmatic. It is well to have a pupil learn the length of his ordinary step, so that he can pace either a rod or one hundred feet with reasonable accuracy. It is not a difficult matter to estimate a distance of one mile, but the estimate would better be made by reckoning the time required to walk it, rather than by the number of steps. The average adult takes about two thousand steps to the mile. Three and one half miles per hour is a fair, four miles a brisk, and five miles per hour a very rapid gait. Time that is spent in estimating and measuring the dimensions of objects is by no means wasted. The ability to estimate measurements accurately has a practical value to which every person in active business life will testify. The estimation of angular distance is also an excellent drill. By subdividing an arc which measures a right angle, into halves and thirds, almost any angle can be estimated to within two or three degrees.

Color. — The proper development of the color-sense is of no little importance to the student of nature. It is well, for many reasons, to make a special test of the color-sense of each pupil. About ten per cent of young children are deficient in color-vision. Of this proportion, some are deficient through physiological causes, others from a lack of development of the color-sense, and still others from ignorance of the names of colors. The two latter causes are remediable, and can be easily removed if the teacher will take a little extra pains with each individual pupil. Select at first, only bright, pronounced colors, and teach their names. Afterwards exercise every pupil in selecting graduated shades of each color. A pupil who is physiologically deficient in the color-sense will most likely fail in distinguishing the reds and greens. Use only well-known and standard names for the various shades and mixtures. Such names as 'ecru,' 'faded rose,' 'crushed strawberry,' etc., are whims of fancy only, and change with the fashions.

In teaching the primary colors it is best to use the classification which science has shown to be the true one, namely — *red*, *green*, and *violet*.[1]

Viewing bits of colored silk through pieces of colored glass is in many respects a useful exercise, and will be of material service in the development of the color-sense.

But the colors and the color-names that the pupil must familiarize himself most thoroughly with are those that he finds in nature. There are the various shades of red, as damask, crimson, and scarlet; the greens, as pistachio, apple-, and pea-green; the blues, as indigo, sky-, ultramarine, and cobalt-blue. There are also the various shades of lilac, pink, pearl, violet, salmon, fawn, sable or

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[1] The old scheme of red, yellow, and blue holds true in mixing a few colors, but fails lamentably in the majority of cases. The trouble arises from the fact that nearly all the red, blue, and yellow pigments are *mixed* or impure colors.

seal-brown, chestnut-brown, russet-brown, iron-gray, silver-white, lemon-yellow, golden-yellow, orange-yellow, straw-yellow, tan, and a host of others, all named from objects in nature, and all standard types of color. In the light of geography these are more important than the bright spectrum colors which are so largely used in the arts. If there is any doubt that many of these colors are unfamiliar save in name, let the teacher direct half a dozen pupils to select a fawn or a pistachio shade from a collection of colors. Besides these there are the various 'lustres,' such as vitreous, pearly, metallic, etc., all used in the description of minerals.

It may be objected that lessons on color belong to the domain of physics rather than to that of geography. This is possibly true, but we must also bear in mind that color is just as much a feature of nature as is the mountain, the plain, or the valley. Moreover, it is also a means of cultivating taste, and this of itself is quite as important a factor in child-culture as the study of geography.

Locality. — The sense of the knowledge of position and direction, which is practically the 'homing instinct' of animals, is rarely developed to any great extent in mankind, and it therefore becomes a necessary part of education. Develop a knowledge of the terms right and left, and up and down. Impress the fact that these are terms relating respectively to the human body and the centre of the earth. There are various schemes for developing an idea of the position of the cardinal points, but it is well to begin at once with the direction of the north star. The direction of the sun's rising and setting will be worth incidental mention, but these should be discussed as varying and not fixed points. The direction of the shadow at noon is an excellent point to use for illustration, and the ingenious teacher can easily manufacture a sun-dial which will show the time between eight o'clock A.M. and four o'clock P.M. with reasonable accuracy. This will be found an excellent device for encouraging pupils to observe the apparent motions of the sun, both daily and yearly.

It is an excellent plan to have the points of the compass charted on a clear part of the school-room floor, or perhaps on the ceiling.

In studying the various problems under this head, the use of the map must necessarily be taken up. Begin with a map or diagram of the school-room or the school-grounds, and extend the area mapped until it includes every part of the district with which the pupil is familiar. The location of the principal surroundings should be represented approximately to a scale, and the conventional terms and signs used in chartography should be explained and used. It will be a matter of surprise to the teacher who tries the experiment, what excellent results can be obtained in these first attempts at map-drawing.

II.

OUT-OF-DOOR LESSONS FOR PRIMARY AND INTERMEDIATE CLASSES.

THE out-of-door lessons in geography, through which the child should receive his first knowledge of the forces of nature, will of necessity be confined mainly to the neighborhood in which he lives. The method in which these are conducted must depend on the judgment of the teacher as modified by surroundings. But one direction can be given: namely, make the most of what physiographical features the district affords. Supplement this by the moulding-board, and by the use of whatever pictures, models, etc., can be obtained.

Earth-Sculpture. — If the surface of the neighborhood is uneven, hilly, or rugged, the probabilities are that the unevenness has been produced by unequal weathering or else by the direct action of water. In many instances a hill is formed because its substance is harder than the rock surrounding it. So, under the action of flowing water, ice, rain, and other weathering agents, the surface is unequally worn into hills and valleys. Often there are strata of rock which show the corrasive action of running water; or perhaps soil, masses of broken rock, etc., have been carried down the slope, and spread over the valley below. By a careful search one may nearly always find marks of the forces which have thus sculptured the earth. In walking along the slope of the hill during a hard rain, one may observe the process of earth-sculpture in actual operation. The drops of rain that fall on the hill-side are clear as crystal. When they reach the bottom, however, they are loaded with fine particles taken from the soil.

Direct the pupils to observe this, and develop by skilful questioning the effect of the process when long continued.

Cover a piece of clay with sand on the moulding-table. Incline the latter slightly, and pour water on it from a sprinkler. The sand is washed away, leaving a miniature hill of clay, and the process of hill-making is thus repeated on a small scale. In a similar manner place a small piece of slate or a thin piece of rock on the sand, and apply the water. The sand is washed out under the edges a little way, but the slate protects the great mass of it, while all around the sand is carried away. In this manner one may show the formation of cliffs and certain types of tablelands.

The study of the hill will lead to that of the mountain-range. The explanation of this will be a more difficult task, because the essential feature of a mountain-range lies in the fact that it is a fold or wrinkle made by a shrinking of the earth. The following expedient has been used by the author for want of a better illustration. Take a piece of cloth-covered elastic band, ten or fifteen inches in length, and stretch it moderately. Fasten several strips of differently colored cloth to the elastic by means of mucilage, and when nearly dry, allow the elastic to slowly contract. The pieces of colored cloth will wrinkle and crumple, producing an effect which, though not a striking resemblance to mountain-folding, is nevertheless a good illustration of the manner in which plication occurred. In studying the mountain, begin with the range, as directed in p. 25.

The examples of earth-sculpture which will appeal most strongly to the child are those which are the work of running water. The little rain-formed rill which trickles along the road cuts a deep rut in one place, and spreads out in a broad channel in another. Finally it joins another rill, or else pours its current into a pool of water, which is a miniature lake or sea. When the rivulet reaches its goal, it possibly divides into several streams, forming a delta, and perhaps builds a bar opposite to its mouth.

In such a stream the pupil can see the operation of all the laws which govern the conduct of the Mississippi or the Colorado. Develop by skilful questions, inductive and deductive, why the rill cuts a deep cañon in one place, and deposits silt in another; building its banks and bed higher than the surrounding land, and then breaking through them. Show why it forms a delta, a bar, or a spit, when it reaches its outlet. The effects of rain combined with the corrasion of running water may also be pointed out. Develop the fact that a rapidly flowing stream in a rainless region will cut deep cañons with almost vertical walls. If, on the contrary, the region is one of considerable rainfall, all the sharp, angular features will be worn and rounded in harmonious forms. This feature of erosion can be shown on the moulding-board, with the aid of a sprinkler.

It is well, also, to observe the effect of vegetation. The difference between the erosion of a grass-covered and a denuded slope is so marked that it will not fail to be observed and accounted for if the pupil's attention is called to it. Pictures of the *mauvaise terre* or 'bad-land' formation, of the Grand Cañon of the Colorado River, and of the rounded valleys of Oregon, can be made the subjects of impressive lessons. Develop the fact that vegetation is not only protective to the land, but that it also retards the collection of water in the channels which carry it off, thereby largely preventing 'freshets,' or floods.[1]

Throw a ridge of sand or mud across the channel of a rill, and make a miniature lake. By and by the basin fills, and the water runs over the lowest part of the rim. Now let the pupils observe carefully what occurs. At the inlet of the lake the current of the stream is checked, and the water begins to deposit silt, forming a little bar at the mouth. The stream issuing from the lake is likewise at work: it is cutting away the rim of the basin and lowering the level of the water. From these facts two good lessons may

[1] In Arizona and Nevada I have more than once seen a flood gather in a dry 'wash' or creek-bed so quickly, after a heavy rain, that the water rolled down the cañon almost like a solid wall. In two minutes a dry creek-bed would become an impetuous torrent. — J. W. R.

be deduced. First, that the stream flowing into a lake is always silting the basin. Secondly, the stream which flows from a lake is constantly cutting the rim of the basin lower, reducing its size, and draining the water away. These are the laws which prompted Gilbert to say, 'Rivers are the mortal enemies of lakes.'

When excursions can be made to the seacoast, impressive truths may be learned from the action of the waves. The water-worn cliffs show what can be accomplished by the continuous beating of the waves upon hard rock. The sand, examined by a magnifying glass, will show the effect of the never-ceasing surf. If one may have the fortune to visit the coast of the South Atlantic States, the long, narrow sand-spits formed by the combined action of rivers and waves, — one of which pushes the silt sea-ward, and the other land-ward, — may be made the subject of a most instructive lesson.

The different outlines of coast must not be forgotten. These will be found at the shore of almost any pond or stream of water. Indeed, the various types of coast outline may be profitably moulded at the shore if they do not occur there. Occasionally it will be necessary to obtain pictures or models of the different types, and reproduce the forms from these. Do not neglect to show that peninsulas are, in most instances, ranges of mountains extending into the sea, and that frequently a chain of islands, the partly covered summits of the range, lie beyond the point of the peninsula.

Do not neglect to instruct pupils in the application of technical names that pertain to a natural feature, and do not extemporize names where good ones already exist. The abuse of this privilege has already led to much unnecessary confusion.

Slopes. — The slopes of a body of land are commonly formed by mountain systems, but in many instances a low and almost imperceptible ridge of land separates two basins or watersheds. Steep or abrupt slopes can always be determined by the eye, and the positive slopes of the district should be invariably studied when the pupil is learning his first lessons in physical geography.

The gentle slopes of land, however, can be estimated naturally in only one way; namely, by observing the direction of the water-courses. So helpless is the eye in this respect that the most expert surveyors and topographers are often deceived. The slopes and hydrographic basins of large areas of land may be conveniently studied from both map and moulding-board. In using the map for this purpose, the boundaries of the various basins and slopes are found by drawing a light pencil-line so as to separate the sources of adjacent rivers and tributaries. In doing this the pupil will often discover the untruth of one of the oldest traditions of geography; namely, that the crests of mountain-ranges correspond with divides. A few moments' work with the pencil will show that the exception is true oftener than the rule.

Soil. — A knowledge of the various kinds of soil is not only a necessary part of the study of physical geography, but it has a practical value in education that will not be overestimated. The varieties of greatest practical use are sand, gravel, clay, and loam. Develop by observation and questioning that sand and gravel are results of running of water, and lead the pupil to discover how rough fragments of rock are converted into rounded pebbles. Do not make the mistake of teaching that the soil of deserts is composed of sand; for it is very rarely that sand is found in desert regions. Pure sand is composed of the mineral silica, and is a product of the seashore. The so-called sand of the desert may be composed of almost any kind of dry, pulverized earth.

Develop the idea that the loams are nearly always disintegrated or 'rotten' rock, finely pulverized, and mixed with decayed vegetable matter. In many instances loam has been deposited by rivers, but sometimes it has been found *in situ*. In the former case it is called *alluvial*, in the latter, *sedentary* soil. The formation of loam will be somewhat difficult of explanation, but it is not beyond the understanding of even the younger pupils. The action of the angle-, or earth-worm, which is constantly mixing and digesting rich, loamy soils within its alimentary canal, will make the subject of an excellent lesson.

In studying the properties of clay, it will be well to call attention to its imperviousness to water, and its extreme hardness when dry. Illustrate its commercial value in the manufacture of brick, pottery, etc., and its special value in holding near the surface of the earth much of the water that falls in the form of rain and snow.

Vegetation. — The first lessons on vegetable life should be of a very practical kind. The study of the germination of seeds, although hardly within the domain of geography, is an excellent exercise because it is an incentive to habits of observation. The flower-garden may be made almost as useful as the blackboard. There is no reason why the effects of heat and moisture on soil should not be as closely studied in the country school as in the higher school of learning. Almost every law which underlies the geographical distribution of plants may be illustrated in the school district.

Besides the grains, the fruits, and the vegetables of commercial value, it will be well to study the large class of plants ordinarily classed as 'weeds.' Nearly all of these have more or less value to mankind, or else they are positively baneful. A knowledge of the latter is just as important as that of the former; more especially is it necessary to learn how the seeds of the latter are distributed. The 'down' of the Canada thistle and the dandelion, and the winged seeds of the maple may be used to illustrate this.

It is a good plan to encourage pupils to collect and prepare a herbarium for the use of the school, arranging and classifying the plants of the neighborhood more with reference to their commercial and economic value than with respect to their botanical places. Specimens of all the timber growing in the district may be profitably collected and preserved; one side of the specimen being left in its natural state, the other planed, and dressed with oil.

Animals. — The study of animal life is also an important factor in the legitimate work of geography. In many instances the study may be made observational. The habits and characteristics of domestic animals will furnish a fund of useful information. It will be well also to discriminate between wild animals that are useful and those that are hurtful to the husbandman. The study of the birds and insects with which the pupil is familiar will be one of great utility. If the pupils are encouraged to make a classified list of all the forms of animal life found in the district, the extent of the list will be a matter of surprise. When the list is discussed in detail, it will probably lead to the discovery that, in general, insects have the various forms of grub, chrysalis, and articulate stage.

Much may be done by reading stories about wild animals; in every case supplementing the story by pictures. The latter may be obtained in colors for a very small sum of money. Perhaps more can be done in the way of developmental work by skilful questioning than by observation and reading. The value of the list of questions given in Frye's 'Child and Nature,' pp. 112 and 113, will be manifest to every live teacher.

Minerals. — There are few districts which do not abound in mineral wealth. In the prairie states the list will be found to be surprisingly large, while in the rolling and mountainous regions the list may easily be extended beyond the limit of utility. The most important are, of course, the minerals of economic use. It will be well to have a collection of from fifty to one hundred of these, which should be labelled and mounted either on a block or a piece of stout card. It should comprise, among others, specimens of the different varieties of coal arranged in a series; several varieties of iron ore, notably hematite, limonite, magnetite, lodestone, and pyrites. Copper, zinc, nickel, lead, quicksilver, and tin ores may be obtained without much difficulty, and in every case the metal yielded by the ore should be exhibited. Native specimens of rock-salt, sulphur, gypsum, and the ochres may be obtained at a trifling expense. Equally important are the building stones, such as granite (syenite and gneiss), brown sandstone, white sandstone, marble, and other limestones, slate, clay, etc. It is best to have the pupils themselves collect or obtain the specimens. They should be labelled and mounted in as attractive a manner as possible.

The Atmosphere. — It is well to impress the fact that the atmosphere is just as much a part of the earth as the water or the solid rock. Do not allow the notion to be developed that all space is filled with air, and do not convey the idea that the earth 'floats in air.' Emphasize the fact that the air is the outer part of the earth, and moves with it in space.

That air has *weight* is always more or less difficult to demonstrate to a class, not because it may not be shown by simple experiments, but from the very common opinion that there is a force generally known as 'suction.' The boy's toy called the 'sucker,' a piece of thick, pliable leather, with a string fastened to the centre, is instructive as a means of illustration. When the sucker is saturated with water, and pushed firmly against a smooth board or a polished boulder, it requires considerable force to pull it away. The most convincing proof of the weight of air, however, may be found in the fact that a two-gallon glass jar, when exhausted by means of the air-pump, loses about half an ounce in weight.

It will be well, also, to develop the fact that the column of mercury in the barometer exactly balances or weighs a column of air of equal area. A serviceable barometer may be easily constructed by inverting a tube about thirty-six inches long, filled with quicksilver, so that the open end rests in a small vessel half full of the same metal. Measure the height of the quicksilver in the tube, and fasten upon it a paper scale of inches and tenths so as to mark the height of the column. The instrument thus constructed will show the changes in the pressure (weight) of the atmosphere with reasonable accuracy.

Show by any of the well-known experiments that air when heated expands in volume, therefore becoming, bulk for bulk, lighter than cold air. The boy's whirligig held over a hot stove at once acquires a rapid motion because of the ascending current of warm air. Do not allow the impression to obtain that hot air 'rises' because of its lightness. What really occurs is, that heavier cold air flows in and pushes it upwards.

The mutual but adverse motions of cold and warm currents of air may be best shown by the time-worn experiment of holding two lighted candles, one at the top, the other at the bottom of a door which opens into a heated room. In the study of the winds, it is not easy to find an illustration of wider application than this. It is an excellent plan to have pupils observe daily the motions of the winds, especially the direction of the wind which precedes storms and that with which the storm clears.

The *moisture* in the atmosphere may be shown in different ways. The 'drying up' of pools of water after a rain, the evaporation of water in an open vessel exposed to the air, and the disappearance of the dew after sunrise, may be made the subjects of extremely entertaining lessons. That moisture is present in the dry air of a room may be shown by filling a pitcher or other vessel with iced water. As the atmospheric moisture is condensed on the outside of the vessel, wipe the latter, and allow it to condense again, as a further proof. Lead, step by step, to the fact that when the temperature is lowered quickly, much of the vapor of water is changed to its ordinary liquid form, and appears as dew, mist, fog, cloud, or rain.

It will be an excellent plan to have pupils make daily observations on the winds, clouds, and general condition of the weather. Such observations may have but little worth in themselves, but they are direct means to a very valuable end. In many instances it will be practicable to have the daily weather indications displayed in the school-room, and in any case, good results will invariably come from keeping a daily weather-record.

Seasons. — Many instructive lessons may be drawn from the study of the astronomical side of geography. With primary pupils these will of necessity be fragmentary and incomplete. The pupil will, however, become familiar with many facts which will render the study of mathematical geography far easier in after years.

Have the pupils note the position of the sun at different times in the day, and explain to them the phenomena of its apparent motions. Note also the change in the position of the sun at rising or at setting during each month in the year. Measure the shadow of any fixed object at noon, during the successive months in the year. Some of these phenomena will be difficult of explanation to younger pupils, and it is perhaps better to attempt none — certainly none that will confuse. It will be practical, however, to connect the low noon sun and its northerly position at rising and setting, with the short days, long nights, and cold weather of winter. This, at least, can be understood by the most immature pupils.

The foregoing chapter, as is designated by its title, is intended to suggest a certain line of out-of-door work. Some of the ideas suggested are doubtless beyond the comprehension of very young pupils; others may be profitably repeated in a more systematic order when the pupil has reached advanced work in geography. The success of out-of-door work will depend mainly on the judgment of the teacher in selecting the material for the illustration of these object lessons. It will depend largely, also, upon the skill in interpreting natural phenomena, for any teacher who imagines that such work can be done without careful preparation will fail ignominiously in accomplishing tangible results. The teacher must not only acquaint himself with the study of physiography in general, but also with that of the district in detail in order to impart lessons that carry conviction.

During the period in which the out-of-door work is carried on, the more systematic in-door lessons should not be neglected. If a text-book is used, supplement and illustrate it with the moulding-board, with pictures, and with instructive stories from *authentic* books of travel.[1] If the mental pictures can be imprinted in the pupil's mind, almost any means will justify the end.

With the consideration of the foregoing topics, which may embrace a period of two years of time, there is a certain amount of

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[1] Do not forget that there is much worthless literature under the name of books of travel. The books and sketches of inexperienced tourists who make flying trips through foreign places may be entertaining, but they are generally incorrect with regard to geographical information.

other observational work which also is included in geography; namely, the study of people, their social life, government, religion, etc. Much of this must be done with the aid of pictures and books of travel. Still another feature that will constantly come to the foreground is the geography of commerce. In spite of sentiment, the commercial idea is the one upon which all study and mental development centres. The opinion as to 'what ought to be' will not change the cold facts of the case, and the study of the commercial side will always be the practical objective point of geography. We may as well open our eyes to the fact that all human energy is bent to the purpose of procuring food and shelter. The net-work of railways, the fleets of steamers and sailing vessels, the coal and iron mines, the thousands of factories, the entire energy of the husbandman, have but one end in view — to allay hunger. All the mechanical energies of man are devoted indirectly to the production and transportation of food. Is it singular then that there are a few hard-headed, unsentimental people who will persist in putting the study of geography on a commercial basis? A journey through a grocery store will make a subject for many excellent object lessons, and a history of the travels of a battered coin will make a subject for many a written exercise. A well-known teacher in Boston requires one or more pupils to board nearly every ship arriving at that city from a foreign port, in order to learn the character of its cargo. It is safe to affirm that the pupils of that school know something about the geography of commerce that cannot be learned from text-books.

In teaching younger pupils, it will be an excellent plan to display commercial products in their various stages of manufacture. For instance, the cotton industry may be illustrated by cotton in the boll, in the raw or unginned state, in the spun fibre, and in various textile fabrics. A similar plan may be adopted with other textile goods, with the common ores which yield useful metals, and with articles of ordinary food. The various grades of sugar, tea, coffee, etc., are well worth the acquaintance of the pupil; and the usual processes through which grain passes in its journey from the field to the table will be sources of instructive object lessons. If the teacher has any doubts about the value of the commercial importance of geography,[1] follow the commercial history of an illustrated school book from the time the raw materials employed in its manufacture are produced, until the finished volume is placed in the hands of the pupil. In the printer and binder's establishment alone, nearly one hundred distinct processes are necessary to produce an electrotyped book.

[1] 'In considering geography we deal with a subject particularly interesting because of its relations to man. It is the first of the elementary studies which teaches the child that he is part of a community, that the community is part of a nation, that the nation is part of the human race. He now learns how he differs from his European brothers in character, politics, society; and that these differences result from differences in the climate, the industries, and the geography of their respective countries. He begins to realize his dependence upon his fellow-beings. The coffee he drinks is prepared from beans gathered by savages in South America or in the East Indies. His tea is steeped from leaves dried by the Japanese or the Chinamen. Perhaps he sweetens his South Carolina rice with Cuban sugar. He eats mackerel caught in the fiords of Norway. Saginaw salt combines with India pepper to give relish to his Kentuckian sweet potato. Mediterranean sardines are served on slices of Californian lemons. His dime coined from silver mined in Nevada buys dates plucked from palms in Africa. Possibly he corks his ink bottle with a bit of bark from a tree growing in Spain. Thus every article of commerce testifies to the labor of his fellow-beings far and near. Distant countries are brought nearer by handling these commodities. But this dependence upon remote parts is due to climate; and climate depends upon altitude, latitude, forests, winds, rains, oceanic currents. These subjects are not treated upon in descriptive geography; hence to give satisfactory explanations, the teacher must understand physical geography, which in turn must be backed by natural philosophy. Indeed, a separation of descriptive and physical geography is impossible.' — Miss T. E. Reul, in *Wisconsin Journal of Education.*

III.

PICTURES AND MODELS WITH RESPECT TO GEOGRAPHICAL FORMS.

The diversified topography of the earth's surface may be summed up in the conventional term *relief*, and the study of the various types of relief, together with the laws which underlie it, practically comprise about all that is properly included in physical geography. Gravitation has given the earth, as well as similar heavenly bodies, a slightly modified spherical shape, but the relief features of the earth's surface are due to two agents which are continuous in operation and which are mutually opposed the one to the other. These agents are *secular cooling* and *solar heat.*

In parting with its heat, the earth follows the same law that governs other bodies, contracting in bulk as the loss of heat goes on. Moreover, as the loss of heat is relatively greater in the heated interior than in what is, for convenience, called the crust, the contraction of the interior mass is greater than that of the exterior crust, so that the latter, in fitting itself about a constantly shrinking mass, must of necessity become wrinkled and cockled. The operation of this law has raised the immense masses of land we call continents above the level of the sea, wrinkled and crumpled the surface into the long, corrugated folds we call mountain-ranges, and cockled level surfaces into plateaus or depressed them into basins. In short, all the great disturbances of level that are even now going on, are due mainly to the secular cooling of the earth.

The effect of solar heat upon the earth's surface is just the opposite. Lifting the water from the ocean as an invisible vapor, it pours it upon the land; and in the form of rain, frost, ice, or running streams, the water is constantly at work tearing away the mountains and levelling off the various inequalities of surface. By the action of this agent mountain-ranges are sculptured into *ridges*, and their flanks are re-formed into the *piedmont lands* about their bases; while the finer detritus is carried to the sea and cast along the shore in the form of *spits*, or spread over the valleys, forming wide alluvial *plains*. Cañons are cut in high plateaus, or, perhaps through mountain-ranges, and lake-basins are filled and levelled. So constant and persistent is the operation of this force that almost every passing shower leaves its visible mark on the earth's surface.

Now these changes do not come about hap-hazard, nor is each a law and type unto itself. On the contrary, just as we discern types in botany or in natural history,—just as the operation of certain laws will produce typical forms and structures,—so also the operations of the forces which most concern physical geography may be reduced to types, and these types are reasonably constant in form and in structure. Moreover, if we recognize physical geography as a science, we must recognize types of earth-sculpture, just as in the study of natural history we recognize types of organic structure.

The study of relief may be accomplished in various ways. The teacher may convey the concepts orally to the pupil, and if the former has been so fortunate as to have seen something of the world, and has the capability to vividly impart instruction, much excellent work may be accomplished. It is perhaps natural, under such circumstances, to resort to the use of pictures. Even with advanced classes the live teacher will find her pictorial scrap-book about as useful as the text-book. The various illustrated papers, especially such as Frank Leslie's, Harper's, the Scientific American, and the illustrated magazines, always contain a host of excellent illustrations. Generally, those pictures are the most valuable which present a broad stretch of country with considerable diversity of area. No other view of a landscape is so beautiful or so instructive as that which one obtains from a great elevation. One who has not beheld this vast abyss from some overhanging buttress of Point Sublime, cannot well comprehend the profound depths of the Grand Cañon of the Colorado; nor is it possible to appreciate the immensity of the Rocky Mountains without viewing the gigantic folds and sculptured peaks from some point like Bellevue, Sierra Blanca, or Gray's Peak.

And the reason is obvious. It is not merely a matter of height nor of depth, nor of the vast proportions of any one object. It is the far-reaching panoramic view which enables one not only to behold an individual feature, but also to measure and contrast it with all other features, that so delights the mind. It goes without saying that a well-chosen series of pictures is better than a volume on improved methods of teaching. Perhaps it would not be going too far to say that a skilful teacher of physical geography could do better work with a carefully selected series of pictures and models without the text, than by using a manual which was all text and no pictures.

In the use of pictures, success will largely depend on the judgment of the teacher in making the selections. The essential point is to take such as shall represent *types:* for use in political geography, these may be supplemented by a miscellaneous list which shall include modes of transportation, bird's-eye views of cities, and the various industries, and studies in social life. With respect to the classified types in physical geography, the following list will be found useful.[1]

Coast-forms. — The high, rock-bound shore, with deep indentations: The coasts of Maine, Scotland, Alaska, etc., are examples.

The cliff-girt coast with a low, sandy beach: The cliffs at Newport are examples.

The low, sandy shore partly enclosed by long, wave-formed islands, or sand-spits: The Jersey coast is an example.

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[1] Many excellent photographs representing the various types of earth-sculpture may be procured through Messrs. D. C. Heath & Co. A large number of finely colored views may be procured from the Prang Educational Company.

Capes, peninsulas, isthmuses, and islands may also be conveniently taught in considering the various forms of coast-outline. Each may be represented in any of the three forms. It is well, by all means, to obtain one or more pictures showing the effects of wave-beating. Almost any illustration of the scenery along the coasts of Norway, Scotland, or even the New England coast, will furnish an example. The pictured rocks of Lake Superior are admirable illustrations.

The various forms of littoral waters may also be studied in connection with coast-forms. These are as well studied from pictures as from the moulding-board.

Inequalities of Surface by Erosion. — A bird's-eye view of low hills rounded off by general erosion, the result of copious rains: The foot-hills and piedmont lands of the Alleghany Mountains are good examples.

A bird's-eye view showing hills and crags with sharp, angular outlines, the result of an arid climate: This type is finely exemplified in the ridges, peaks, and spires of the plateau region — especially in that part of the cañon of the Colorado River known as the 'Land of the Standing Rocks.'

Cliff-formation, showing how a layer of hard volcanic rock resting upon the top of softer stratified rock prevents erosion at the upper surface, while the edges, exposed by the corrasion of running streams, are eroded and sapped by rain: The mesas or table-lands of the Plains of the Columbia are examples.

Mauvaise-terre, or 'bad-land' formation, showing the effects of running water on light sedentary soils unprotected by vegetation: The Bad Lands of Dakota and Nebraska are fine examples.

A cañon with terraced, or with nearly vertical walls made by a stream flowing in an arid region: The cañon of the Colorado River and those of its tributaries are examples.

A wide valley with rounded sides and outlines. The result of a stream flowing through a region supplied with abundant rain, there is much general erosion and little stream-corrasion: This type of erosion may be observed in almost every stream that flows through undulating land.

A region formerly traversed by a glacier. The surface is worn into *roches moutonnées*, or 'sheep-backs,' and is strewn with rounded boulders. Long and narrow lakes showing lineal or radial arrangement are numerous: Almost any part of the New England States or northern New Jersey will furnish a good illustration.

Inequalities from Secular Contraction, Vulcanology, etc. A bird's-eye view of a mountain-range. (See note, p. 33.)

A bird's-eye view of a mountain-system, showing a group of folds constituting a highland.

A peak — not as an isolated butte, but as the part of the summit of a range, higher than the adjacent crest: Pictures of Rocky Mountain Scenery are usually prolific with respect to typical peaks.

A volcanic mountain as a whole: Illustrations (from photographs) of Mounts Shasta, Tacoma, or Hood will be admirable for this purpose.

A volcano in eruption: Instantaneous photographic views of Vesuvius in eruption may be procured. Engravings of the same may be found in several text-books.

The crater of a volcano: Photographs of the crater of Vesuvius, and also that of Kilauea, show the essential features of each volcano very vividly. A telescopic photograph of Copernicus, a lunar volcano, will greatly add to the value of the foregoing.

A lava flood: Photographs of this character may be easily procured; they are useful in showing the *texture* of different kinds of lava.

A series of pictures of Vesuvius between successive eruptions will be found highly instructive. Such a series may be found in Volcanoes and Earthquakes (MUNGO PONTON, — *T. Nelson & Co., London*).

A geyser in eruption: Photographs of Old Faithful, Castle Geyser and others in Yellowstone Park may be readily obtained.

The travertine and sinter deposits of mineral springs: The terraced basins of Mammoth Hot Springs, Yellowstone Park, are fine examples.

Cracks and crevices formed by earthquakes: Instructive photographs of the Charleston earthquake may be obtained from the U. S. Geological Survey.

Meteorology, etc. — Typical forms of clouds: Many dealers in photographic views keep good specimens.

Forms of snowflakes: Most of the physical geographies have suitable illustrations.

Glaciers: Photographs of various European and American glaciers are readily attainable. If possible, select one that shows the origin and termination of the glacier. It is especially desirable to have at least one view showing the end of a glacier as the source of a river.

A glacier terminating at the sea, showing the formation of icebergs by 'calving': Photographs of Muir Glacier, Alaska, show this on a small scale. It is well illustrated by profile views in several of the manuals of geology — notably in Prestwich's Geology.

A cyclone with 'funnel-cloud': One or two good illustrations may be found in the publications of the U. S. Weather Bureau.

Waterspouts: Illustrations may be found in most physical geographies.

Drainage. — A river in its upper course: Any picture of a mountain torrent will answer.

A river in its middle course: Views along any large river will answer, the subject being selected, as far as possible, to show that it neither corrades its banks nor deposits silt at the ordinary stage of water.

A river along its lower course: The illustration should, if possible, be a bird's-eye view showing the sinuous windings of the river; the water not being able to carry its silt must deposit it, and thereafter flow around it.

A cataract: A photograph of Niagara, of Yosemite, or of the Yellowstone Falls will be an admirable illustration.

A variety of lake views: It would be well to have a map of the lake district of New York, showing the salient features of glacial lakes.

The foregoing indicate a few only of the various types of natural scenery. The miscellaneous collection should contain a goodly assortment of commercial and industrial views, such as factories, mines of every character, methods of transportation, plants of economic and industrial use, — in short, take any picture that will instruct and reject none that has a teaching value.

It is well to impress the fact that such a picture scrap-book cannot be compiled in a day.[1] On the contrary, it may require years to select illustrations of all the types described in this chapter. The teacher who compiles a book of this character must be content with many poor and faulty illustrations at first. These may be replaced from time to time with more suitable and better ones as the opportunity to procure them occurs. It is well, moreover, to have several pictures to illustrate the same type. In a single view the salient feature may be overshadowed, or it may not be prominently developed. But when the same feature is common to a number of illustrations it can hardly escape notice. Do not reject a picture because it is poorly printed or because it is coarsely engraved. Types of earth-sculpture, and not art-specimens, are the illustrations required, and a coarse, poorly-engraved picture may often have a teaching quality that will not be found in a beautifully engraved artist-proof. On the contrary, do not fail to reject a view that is untruthful or one that needlessly exaggerates nature. The illustrations of geographical scenery in such publications as Harper's, the Century, and Scribner's magazines are generally true to nature. In many instances they are photogravures, and often they are what is technically known as 'bleaches,' — that is, a pen- or brush-drawing over a partly

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[1] I think it required about two and a half years to gather the illustrations for my series of geographies. In all, I collected several hundred views. Some of these were selected in Europe; some came from Asia; and many were procured in travelling about the Western Cordilleras. — J. W. R.

bleached photograph. In either case the resulting picture will be fairly correct both in treatment and in texture.

Photographs, when they can be obtained, are undoubtedly the best guides, because of their fidelity to even the minutest details. They are somewhat expensive, it is true; but, on the other hand, they are usually not so difficult to obtain as the less expensive wood-cuts and photogravures. It is best to purchase photographs unmounted.

It is a good plan to mount all pictures on stout card-board, taking care to have the pieces uniform in size. In mounting, first trim the picture to the proper size; lay it for a few moments, face up, in a basin of water; when fully expanded, remove the superfluous water with blotting-paper; apply a good quality of mucilage, and set evenly on the card-board. If not mounted on card-board, photographs should be attached by their corners to the leaves of the scrap-book; under no circumstances should they be kept rolled. Card-board mountings are in every way preferable to scrap-books, owing to the facility with which they can be handled and exhibited. Should it be necessary to remove the picture from the card, soak the latter — it is not necessary to wet the picture — for some hours until it is thoroughly softened: the picture may then be removed without injury.

It must be kept in mind that merely exhibiting a picture is not teaching geography. To be of material use, the picture must be used as an object lesson, and the specific features of the type which it illustrates should be deduced by close and careful questioning.

The picture has some points of superiority over the model, but it also is not without demerits. It is lifelike and attractive; it appeals strongly to the imagination; and each particular scene or landscape has a harmony and an environment, giving what artists call *effect*, and adding no little to its teaching value. On the contrary, the lack of the third dimension is a defect which neither color nor effect can overcome. Even the stereoscopic view gives an impression which is tantalizing because of its unrealness; and, moreover, the subject can be viewed from but one point.

The Moulding-Board. — In order to supplement these defects, the moulding-board has within a few years become a very important auxiliary to the art of the school-room. This piece of apparatus is essentially a shallow box four feet by three, and about two inches in depth. It is most conveniently attached to a table thirty inches high, in such a manner that it may be inclined at any angle. A zinc-lined box or drawer for holding the sand may be fastened to the under side of the table. Moulders' sand, such as is used in iron-foundries, is the best for the purpose, but any clean sand will answer. Moulders' sand is naturally more or less cohesive: white sand needs to be dampened. Under all circumstances the sand should be closely covered when not in use, and should be sifted as occasion demands.

The moulding-board is primarily for the use of the teacher. It bears the same relation to the study of solid forms that the blackboard does to the study of outlines and surfaces. In order to be effective, the work must be skilfully and quickly done. Moreover, it requires practice and careful preparation. No instructor can hope to reproduce a form on the moulding-board without a thorough knowledge of the structure and features which the particular form typifies; nor can one expect to reproduce the form without practice. Without a knowledge of the subject to be studied, any attempt by the teacher at illustration will not only be barren of good results, but will be positively baneful to the pupils. It is very evident that to be of positive advantage the lesson of the teacher must be reproduced by the child. A thorough comprehension of relief can be acquired only by the study of relief-forms, guided by the sense of touch; at the same time one is never too old or too wise to dispense wholly with the third dimension. Concerning the value of the solid form, as exemplified in models of the continents, perhaps the best-known living scientist[1] writes to the author, 'Your relief-maps have given me a clearer conception of the relation of mountains to the continents

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[1] Professor John Tyndall.

whereon they lie than I had previously possessed.' If this be the experience of a scholar trained for years to the keenest use of the perceptive faculties, it certainly deserves emphasis in training the faculties of the child.

With very young pupils, the use of the moulding-board requires the best judgment and the utmost care on the part of the teacher. To attempt a systematic course such as is suggested in the foregoing list of types would not only be unwise, but could have no other result than failure. Only the simpler forms of district relief can be safely undertaken — the hills, valleys, ravines, and water-courses. Furthermore, these should not be taught so much for the things themselves, as to prepare the pupil for what is to be studied in the future. The pond is a type of the large lake, or even of the ocean. The brook is the miniature river. Any long ridge of land will furnish an object lesson from which to study the mountain-range. As is suggested in the preceding chapter, the study of the form as it occurs in nature should be followed by its reproduction by the pupil. For this purpose the desk moulding-board introduced by Professor Frye some years ago will be found of excellent service. It is essentially a shallow pan made of tin or thin sheet iron about twenty by fourteen inches in area, with a rim about half an inch in height.

It is well to bear in mind that the moulding-board is intended for the repetition of forms that actually occur in nature, and not for the creation of those which may have a fleeting existence in the imagination. Moreover, so far as primary work is concerned it is easy to carry the work of moulding beyond the limit of usefulness. At first the pupil repeats a form found in nature, not so much for the sake of the form itself, but mainly to acquire closer habits of observation, and subsequently to train the imagination to a conception of the forms which the great majority of pupils will see in pictures only. When this is accomplished, the habitual use of the moulding-board is no longer necessary; it should thereafter be called into use only when the pupil is unable to form a true conception without it. Just as there will be occasional demands for the use of the black-board, for the map, or for any piece of school apparatus, so also the moulding-board will now and then be required. It may be casually added that neither expanse of moulding-board, quantity of sand, nor skill in manipulation will cover deficiency in knowledge of the subject taught, or carelessness in preparation of the daily task. The moulding-board is only a tool, and excellence in the tool does not necessarily imply competency on the part of the artisan.

The first lessons that are likely to be taken up in connection with the moulding-board are elevations of land. The origin of the hill either by accumulation or by denudation, as explained on pp. 10 and 11, may be understood by even the youngest pupils. An explanation of the reason for the rugged crag on the one hand and the rounded form of the ordinary hill on the other may be discussed, — with older pupils it should not under any circumstances be omitted. In many instances it will be necessary to resort to the picture in order to gain a conception of the form to be moulded. In such cases the picture and the moulded form should be exhibited and studied together. Indeed, the picture-studies suggested in the foregoing pages will be extremely serviceable as studies for the moulding-board, to illustrate types in physical geography. In the study of the hill, do not fail to see that the terms top, or summit, base, side, slope, etc., are fully understood.

The consideration of the mountain-range will probably follow that of the hill. Do not permit the pupil to form the conception that the mountain is nothing more than a high hill. Plication or 'wrinkling' is the essential feature of mountains, and the *range*, not the peak, is the unit of structure. Isolated peaks are of rare occurrence, and in most instances they consist of the material heaped about a volcanic vent. Begin with the range, and teach it as a fold or wrinkle in the earth's crust, — not as a mass of earth or rock heaped up. Do not permit the conception that a mountain-range consists of a number of peaks ranged in a line. In all cases avoid the exaggeration of orographic features. Do not construct a range relatively fifty miles high, with slopes of sixty or seventy degrees. The slope rarely exceeds thirty degrees: it is seldom more than twelve. In the study of the range discuss the terms crest or summit, peak, base, cañon, pass, ridge, etc. Show that ridges are formed by the wearing away of strata *lengthwise* along the range, and that passes, cañons, and water-gaps result from erosion and corrasion *across* the range. Develop, also, the fact that the peaks of a range are the higher parts of the crest, and that they are usually formed by the unequal erosion of the latter.

The discussion of the range leads to the study of the system. The system comprises all the wrinkles or earth-folds which belong to the same series. Sometimes the folds are very nearly parallel, and are remarkable for their regularity. In general, however, there is much irregularity, and the ranges with their spurs extend in almost every direction.[1] Recollect that an individual range rarely extends the whole length of the system, and that the spurs and cross-ranges are often as marked as the principal ranges themselves. With the moulding of the mountain-system there will necessarily arise the consideration of longitudinal valleys. Longitudinal valleys, of which the Cumberland, Shenandoah, Willamette, and San Joaquin-Sacramento valleys are examples, are usually of wonderful fertility, and, because of their productiveness, densely populated. The soil which fills them has been worn by rains and snows from the adjacent mountain-slopes, and the valley has been levelled off by the action of running water. The mountains themselves, however, because of their rugged surfaces and extremes of climate, are remarkable mainly for their infertility and their sparseness of population.

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[1] I know of no picture that is a good illustration either of the range or of the system. Perhaps the best are those found in the relief-maps of Warren's New Physical, and in Swinton's, Butler's, and Monteith's descriptive geographies. The hachured maps drawn by Mr. Russell Hinman for the Eclectic Geographies will be found excellent guides in the moulding and modelling of mountain-systems. These maps are contoured, and are remarkably accurate in the dis-

The transverse valley, water-gap, or cañon, as it is variously called, will probably arrest the pupil's attention at some period or other in his work at the moulding-board. Why a river rising on one side of a mountain-system should traverse half a dozen ranges of mountains and pour its flood into the sea on the opposite side, will be apt to puzzle even the most thoughtful pupil. The explanation in such cases is that the river is older than the mountains, having always had the right of way there; and when the uplift of the system took place, the stream carved its channel through the mountain-mass in just the same manner that the saw cuts its way through the log that is moved against it.[1] The Rocky, Sierra Nevada, Appalachian, Andes, and Himalaya Mountains are all pierced by streams which have thus cut their masses in twain. It may be somewhat difficult for pupils to grasp this conception at first, especially when the ridiculous notion that range-summits are continental divides has been systematically inculcated. In the construction of such problems on the moulding-board, the difficulties may be considerably lessened by forming the general slope first, and then moulding the range or system on the slope. This method of procedure must not be considered a subterfuge to enable one to creep out of a difficulty: it is in a similar way that nature has solved the problem.

In the consideration of volcanoes, it may be well to impress the fact that the volcano is not necessarily a mountain. It may be, and it usually is, in or near a mountain-range, or it may be on a plain. Even when it occurs in a mountain-range, it is not *per se* a part of the range, although built upon it. The volcanic peak is commonly called a 'cinder-cone,' and it is composed of the sub-

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position of topographical features. Mr. Hinman's system of hachures is an admirable one in giving character to mountains.—J. W. R.

[1] In a few instances, it is possible that the head-waters of a stream rising in an abrupt slope may have carved a channel backwards until it has reached the opposite slope, even tapping and diverting the tributaries of rivers flowing in an opposite direction. This, however, could hardly have been the case with such streams as the Susquehanna and Green Rivers.

stances which, thrown out of the volcano, are piled around it. It will be an excellent plan to mould the volcanic peak with its crater and monticules on an enlarged scale. For this purpose Vesuvius perhaps is the best type. Several text-books of geography have illustrations of the Vesuvian eruption of 1872, reproduced from instantaneous photographs. These will be serviceable in showing the proper angular slope for the model; but the cuts on p. 88 of Le Conte's Geology will be found the best for illustrating the general structure of the peak, as these show the broken-down crater ramparts of former eruptions. A photograph of the crater of this volcano[1] will be an excellent guide in showing the texture of the crater, with its lava-cones, etc. In studying the volcano, see that the pupils understand the proper application of such terms as 'crater,' 'cinder-cone,' 'lava,' 'lava-cone,' 'rampart,' 'flow of lava,' 'eruption,' 'extinct,' 'active,' etc. Impress the fact that the *real* volcano is the channel opening from the reservoir of heated or molten matter, and that the mountain itself, which is commonly called the volcano, is composed of the materials ejected. In discussing volcanoes keen judgment must be used in order to avoid going beyond the comprehension of younger pupils. With young pupils the pardonable expedient of igniting at the crater of the moulded form an ounce or two of strontium or Bengal fire may possibly make the lesson more impressive.

Other hints concerning the nature of volcanoes will be found in Part II. of this book. After discussing their nature and structure, the distribution of volcanoes should be closely studied. When an extensive region, as a grand division, is to be moulded, it will be difficult to make any distinction between volcanic and other peaks.

In the study of coast-forms, land and water are necessarily to be studied together. Unfortunately, the elevations of coast described on p. 24 cannot be well reproduced in sand: it requires a finely executed clay model to show the details properly. The

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[1] From 'The Moon.' Nasmyth and Carpenter.

low, sandy coast with its bordering wave-formed islands may be readily shown, and between picture, moulding-board, and imagination, the other vertical forms may be studied.

Horizontal forms of coast may be readily reproduced on the moulding-board. If there are no natural forms to study, the picture scrap-book may be called upon to furnish models. As has been suggested on a previous page, the horizontal forms of coast may be represented in either of the three vertical types. Pupils who have been taught the conventionalities of maps may pursue the investigation of coast-forms still further. An inspection of any good map will show that a peninsula is frequently a range of mountains extending a considerable distance out into the sea, as, for instance, Italy, Aliaska, and Malacca. The same is true of the isthmus. Still better, the pupils may be led to observe that such chains of islands as occur in the Caribbean Sea, and along the eastern coast of Asia, consist of the higher summits of partly submerged mountain-ranges. The various forms of littoral waters will scarcely fail to obtrude themselves upon the pupil's notice. With younger pupils it will not be wise to attempt the finely drawn distinctions between gulf and bay, or inland sea and lake. A small fragment of glass, or, better still, a mirror, makes a very taking device whereby to illustrate inland lakes. The surface of the mirror represents the surface of the water, and the sand may be modelled about it to represent the shore. In case it is desirable to show an enlarged representation of a lake, the bottom of the latter may be first modelled to the proper form and depth. A sheet of glass placed upon the model will represent the surface of the water, and the sand may then be worked on the upper surface of the glass so as to represent the shore-line and the unfilled part of the basin.

The moulding-board is hardly suitable for the reproduction of the various types of inequalities of land produced by erosion and corrasion. Such forms are imperfectly reproduced at best by clay models, except when the latter are on an inconveniently large scale; even then the finer details of photography are necessary to study them closely. The moulding-board is to the finished model or relief what the off-hand sketch-map is to the finely engraved reproduction. In general, a relief surface that can be made in three minutes is the problem for the teacher to solve, and this can be done more readily by sand on the moulding-table than in any other way. Working with clay is too slow for the needs of class illustration, and the clay once dry must go through the tedious process of 'tempering' before it can again be used. The same objections will apply to putty, papier-maché, and similar substances.

For use in class demonstration, general form and not finish of detail is required, and the substance used must be clean, quickly manipulated, and always ready. The sand used by iron-moulders possesses all these qualities, and for easy, rapid work, nothing has yet been found that surpasses it.

For pupils' work, circumstances and occasions must govern the plans of the teacher. Usually the latter must compromise between what she wants and what she can get; and instances are not few where a teacher has purchased at personal expense, out of a starvation salary, materials that an over-conscientious board of directors has refused to provide. Where they can be procured, the modelling-pans recommended by Professor Frye will be of good service. Wet papier-maché is another excellent substance, and when it is available, the pupils' slates may be used as base-boards. Moreover, the reliefs when dry are stout and cohesive enough to bear rough handling. The pulp may be procured in almost any quantity from the paper mills. A fair substitute may be made by soaking old newspaper for several days and then 'shredding' until it is reduced to pulp.

The teacher of the country district school has undoubtedly the best facilities for sand-modelling, and, as the younger pupils are usually permitted to be out of doors when not at recitation, there are abundant opportunities for work of this character. They will need but little encouragement to reproduce a miniature relief of all the little world that environs them. Hills, valleys, streams, and forests will take shape; and roads, farms, and miniature fences will give rise to ideas from which the first ideas of political geography may be deduced.

Clay-Modelling. — Modelling in clay[1] or other similar plastic substance has become a recognized factor and part of modern school-work. The average individual possesses hands as well as brain. Moreover, it is conceded that while the brain controls and directs, its integral existence and development depend in no small degree on the skill of the hands. Singularly, however, there are many educators who are aghast at the idea of the co-education of the hands and the brain. It is not the proper place, within these pages, to discuss the merits and demerits of manual training. The stereotyped objection that the public schools are not the place for teaching trades, is an objection easily disposed of. In the school, the training of the hands is not for the purpose of fitting an individual to be a servant of another, but to make him *the master of himself*. The object of clay-modelling in school-work is not to make sculptors, but to train pupils to habits of close observation in form and details of structure; and inasmuch as these are intimately connected with the science of geography, a limited amount of training in work of this character will amply repay for the time devoted to it.

For all ordinary purposes clay is perhaps preferable for modelling to any other material. Usually, the clay purchased for this purpose is ready for use after a slight moistening. The 'tempering' of the clay, upon which its quality largely depends, is produced by permitting it to remain covered with water for a day or more. By this treatment, dry clay which has not been baked will become cohesive. Modelled articles that are not to be preserved may be thus tempered, and the clay used a second time. In tempering clay do not stir or mix it — on the contrary, it should

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[1] An extensive series of topographical models, classifying the various types of earth-sculpture, will be shortly published by the Prang Educational Co. These models and relief-maps will consist of a reproduction of such forms, the knowledge of which largely makes the science of physical geography.

be 'wedged' or made as compact as possible. After tempering, pour off the water and allow the clay to dry somewhat on the surface. It may then be kneaded, and wrapped in wet cloths until used. It should not be too soft to retain its form when worked into shape, nor should it be so hard that it cannot be readily manipulated. A small ball held between the thumb and finger should yield readily without adhering to the hand.

All natural clays, however, are sticky, and it is best and cheapest in the long run to purchase prepared modelling clay, a mixture of tempered clay and sand. This preparation is sufficiently cohesive without being sticky, and it is not liable to crack and seam.

Putty is sometimes used in modelling. It is easy to manipulate and does not harden so quickly as clay. It has the disadvantage of being oily, and does not take so fine a finish as clay. It will frequently be available where clay cannot be procured, and for small relief-maps and models is an excellent substitute.

Papier-maché has already been mentioned. Its use is limited mainly to relief-maps. It does not take a sharp impression, nor can it be worked to a smooth, hard surface. Where an impression is to be taken from a metallic mould, a mixture of papier-maché and plaster of Paris makes an excellent cast. The latter does not need to be very thick, and it is much lighter and stronger than a plaster of Paris cast, while its outlines are equally sharp.

The ingenious teacher who has decided to undertake modelling for supplementary school-work will not fail to find some material for the purpose. In carrying out a course, much judgment must be used as to the *when*, the *what*, and the *how much*. The modelling of geographical forms cannot take the place of the study of geography; it can only supplement it. Sand-models and relief-maps will not cover up any deficiency in knowledge on the part of the teacher. None but a well-trained teacher whose knowledge of the science of geography extends beyond the text-book can do thorough work, and one who does not possess this qualification will find modelling a hindrance rather than a help.

About the only tools required are a thick board 12 × 16 inches and a 'shaper.' The latter may be a very narrow druggist's spatula, or a strip of flat steel $\frac{5}{16}$ of an inch wide, with one end square and the other diagonally cut. An old case-knife may be ground into the required shape.

With younger pupils it is well to spend some little time in preliminary work before attempting difficult geographical forms. Modelling fruit, leaves, the various forms the child sees in nature, and lastly crystals and geometric forms, are exercises that will of necessity suggest themselves.[1] At first, the model should be made with the natural form as a guide; after a little experience it may be repeated from memory. Recollect, also, that the object should be moulded into general shape by the hands, the shaper being used only in finishing those details which cannot be readily accomplished with the fingers. Keep in mind that *a knowledge of form, dimension, and proportion must be acquired through the senses of touch and sight.* Cutting a lump of clay by the use of a straight-edge and an inch rule is *not* modelling: it has no more disciplinary effect or developmental force than ingesting plaster of Paris into a hollow mould. It would be well to blindfold the modeller occasionally and thus test the development of the sense of touch unaided by that of sight. Bear in mind, also, that close observation, and correct judgment of form, constitute the end sought in work of this kind. The pupil who studies modelling and sculpture as an *art* will find the course of instruction in a technical school more advantageous for his purpose.

In the practical manipulation of the clay it is well to bear in mind that modelling is a somewhat broader art than sculpture. In many instances it will be necessary to model a study in separate parts and then arrange the latter in their proper positions. In topographical modelling this is especially essential. Topographical features cannot be easily sculptured from a flat surface

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[1] Thompson's Manual Training, Part II., *D. C. Heath & Co.*, will be found an excellent guide to the modelling of geometrical forms, decorative work, etc.

of clay as a base. It is true that this is mainly nature's method of making topography, but it is equally true that the modeller will economize time by adopting the plan of building up the details, putting bits of clay here and there and working them to the proper form with the finger and the shaper.

In modelling forms in clay the same directions should be observed as have been mentioned in speaking of sand-modelling. The clay model, however, requires more skill and finer finish of details. It will be necessary to work directly from the copy, and it will often be more convenient to work from a picture, photograph, or reduced model, than from nature. Usually work of this kind cannot be done in school hours, nor at the school-building. Moreover, although a most excellent discipline to the pupil, it is not essential to his progress in the study of geography. The completion of an artistically finished model may require all the spare time for several days, but if the time can be spared, the end will justify the means. Accuracy to nature is, of course, the first aim; artistic effect, the second. The former is a testimonial to the knowledge and energy of the pupil; the latter will be a source of delight to all who may see the finished work. But whether or not time can be spent in clay-modelling by the pupils, it may be safely asserted that the teacher should be able to do work of this kind skilfully and understandingly. No other study in the curriculum of common school-work is being so completely revolutionized and modernized as that of geography; and a few years hence ability to model geographical forms will be to the teacher, not an accomplishment, but an essential — a question, not of *may*, but of *must*. Throughout the whole course in modelling, faithfulness to nature is the one thing to be kept in view. A model untrue in this respect, no matter how artistic it may be, is worthless as a means of mental discipline. Reproduction, and not creation, should be the watchword. The model is the expression of form as it occurs in nature, and when the form and the reasons therefor are indelibly photographed upon the mind, the model and the moulding-board may be put aside.

Relief-Maps. —The relief-map is the outgrowth of the moulding-board. It is designed to illustrate what cannot possibly be shown on a flat surface. It naturally precedes the printed map for the same reason that we must study the physical geography of a region before we can properly comprehend its political, social, and industrial features. But the relief-map and the political map are the complements of each other; each displays features that cannot be well shown on the other. The black outlines of the political map give no conception of sandy shores or wave-beaten cliffs; the clumsy hachure-lines, especially those appearing on cheaply prepared maps, are equally inefficient in depicting topography. On the other hand, the relief-map, whether a stereographic model or a photogravure thereof, is useless in showing political divisions or the grouping of population, and unless it is a large and highly finished model it shows drainage very imperfectly. At the best, it shows little else besides topography; but even with respect to climate, population, life, and natural resources, it may be far more valuable than the flat political maps. So far as it is useful, there is no other device that can be substituted for it; but the success in this branch of science of a teacher whose resources in geography consist only of a method and a moulding-board will not be brilliant.

When the pupil has become acquainted with the more common forms of relief, it will be well to undertake the construction, in sand, of a relief-map of the district, or of some other area whose topography is well known. Usually this will be a rather more difficult task than it seems at first. It is not so easy a matter to group a number of different forms, even though roughly moulded, as it is to reproduce a single one minutely. In order to arrange the topographical features in their relative positions, it will be well first to construct a rough outline map of the district, indicating the positions of the various features. Then fix a number of pins, pegs, or similar devices as guide-marks to indicate the relative altitudes. The surface features may then be moulded to correspond to these.

The quickly prepared relief, moulded in sand, should always be used by the teacher to illustrate the general topography and physiography of a country, region, or grand division. It should always be moulded in the presence of the class, and each feature discussed, *pro* and *con*, as it is formed. There should be no attempt to show minute details — nothing but general and essential features: everything beyond this leads to confusion rather than to clearness.

But the finished relief-map is quite another thing. It should depict topography as truthfully as knowledge of the region will permit. The making of such a model, though not an essential part of the pupil's course, is nevertheless an accomplishment that the teacher should be master of, and the use to which it is put must depend on his judgment and common sense.

The making of such a map is a work requiring much labor and time; and if a finely finished, attractive model is desired, the modeller must possess not only good judgment and knowledge but skill and artistic taste as well. To such of the more advanced pupils as show aptitude in this work, the discipline and skill acquired in the construction of a relief-map will more than repay the expenditure of time and labor. The following directions will enable one to plan the work; the successful execution will depend on the skill, perseverance, and artistic taste of the modeller.

Let us suppose a relief-map of the United States is to be constructed. Draw an outline map of the United States on very thick paper, of such dimensions that the width east and west shall be about three feet. Enter with pencil line the position and trend of all the principal highlands, mountain-ranges, and divides. Procure from the United States Geological Survey a copy of Gannet's Dictionary of Altitudes, and pencil upon the map at equal or nearly equal distances the altitudes of the various localities. These bench marks may be about an inch and a half or two inches apart in the open plain regions, but will be necessarily closer in the highland regions. The map thus prepared is used as a memorandum for the relief work.

The base of the map should be made of 1½-inch boards matched closely and securely cleated on the under side to prevent warping. Lay the map on the surface of a large vessel of water, or else sponge the under side of the paper until the latter is thoroughly saturated, having previously cut away every part of the paper outside of the outline. When the paper is saturated, remove it from the water, place it face downwards on a large sheet of blotting-paper, and give it a coating of mucilage or bookbinder's paste. The surface of the board should be dampened, or, what is better, should receive a coating of paste on that part which will be covered by the map. Next, transfer the map to the board. Be careful that no air-bubbles are left between the paper and the board, and use the utmost care that no part of the paper is pulled out of shape. After transferring, place the board face down on a sheet of paper and allow it to dry for a day or two.

The next part of the process is to fix guiding pins for the altitudes. On a relief-map of the horizontal scale adopted, 20,000 feet to the inch will be found convenient for the vertical scale. Procure a paper of small pins, and set a pin vertically at each bench mark, the length of the pin above the surface being measured so as to represent the proportionate height of the surface. The clay, wet just enough to be cohesive, may then be worked upon the map, building it up to the level of the tops of the pins. Run narrow cylindrical rolls of clay along the mountain-ranges. Force them into shape with the fingers first, and work the ridges into shape with the shaper. Make the crests notched and irregular, and score the sides so as to break the regularity of the slopes. The weather-worn summits of the highlands are difficult of reproduction, but the views of Western scenery published by the various trans-continental railway companies will be of great service in suggesting the topographical features.

When the modelling is at last completed and the model is dry, there remain only the coloring and the finishing details of charting the watercourses, etc. If the color of the clay is not a pure white, it may be modified by carefully dusting finely ground plaster of Paris over the surface, any excess of material being blown off with a pair of small hand-bellows. The rivers may be most conveniently put in with a fine brush, using cobalt or ultramarine blue ground in oil. That part of the board which represents the sea-level should be sized, dusted with plaster of Paris, and, when dry, also colored blue.

Whenever contour maps can be procured, the work of modelling is made much easier. The contour lines being lines of equal elevation, it greatly reduces the work of establishing bench marks, and does away with the use of pins to mark altitudes. Sheets of pasteboard of uniform thickness are procured, each thickness of the board representing a certain number of feet. If the contours are 200 feet apart, the thickness of the pasteboard will represent a relief of 200 feet. The contour lines are first traced on thin paper, and afterwards transferred to the pasteboard. The latter is cut along the line, and, beginning with the lowest altitude, the contours are fastened to the base-board. The successive elevations are built on this step by step, as the contour lines follow one another, until the work is finished. The clay may now be moulded over this form, and finished as before. This method was followed by Mr. Cosmos Mindeleff, who made a series of models for the author a few years since. It is by far the most satisfactory way whenever a contour map can be procured.

'The filling-in process,' says Mr. Mindeleff, 'is the most important one in relief-map making; for it is here that the modeller must show his knowledge of, and feeling for, topographical forms. Some models seem to have been constructed with the idea that when the contours have been placed, the work of the modeller is practically done. This is a great mistake. The card-board contours are only a means of control, occupying somewhat the same relation to the relief-map that a core or base of bricks or a frame of wood does to other constructions, as, for example, an architectural ornament or a bust. It is sometimes necessary to cut away the contour card; for, as has already been explained, a map is more or less generalized, and a contour is frequently carried across a ravine instead of following it up as it would do if the map were on a larger scale. Such generalizing is of course perfectly proper in a map, but, with the same scale, we must expect more detail in a model. The modeller must have judgment enough and skill enough to read between the lines and to undo the generalizing of the topographer and draughtsman, thus supplying the material omitted from the map. This can be done without materially affecting the accuracy of the model, considered even as a copy of the contoured map.'[1]

In every case the vertical scale should be exaggerated as little as possible. If the area to be modelled is a country, or even a state, there need be no exaggeration whatever, or at the most it need not exceed 3 : 1. In the case of a grand division, the vertical scale may be raised as high as 10 : 1. Mr. Mindeleff's model of Europe, one of the finest works of the kind extant, has a scale of only 5 : 1. In a relief-map of a large area some vertical exaggeration is absolutely necessary, but to raise the scale to 100 : 1 or 500 : 1, as is often done in profiles and cheap relief-maps, is a gross abuse, for which there is no cause whatever. The relief-map is intended as a reproduction, not a caricature, of nature, and it is questionable whether one is justified in attempting to teach truth by the agency of a grave error.

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[1] From a lecture delivered before the National Geographical Society, Washington, D.C.

IV.

MAP-DRAWING AND MAP-MAKING.

Whenever we wish to learn the position of a place of which we know but little, the first impulse is always to consult the map. This we do, because in long years of time we have learned the true use of the map. The map not only tells us the position of the particular locality on the earth's surface, but also its position with relation to other places. In early life we seek the picture of the thing if we cannot have access to the thing itself; in many instances the picture is often more graphic than the thing — because it enables the mind to view a wider horizon. Thus, even in mature years, one can get a better idea of a city or a large area of country by consulting a 'bird's-eye view' than by travelling over the extent of country, or by wandering through the streets of the city.

Now, in the study of geography it is necessary to construct views which shall enable the eye to take in as much as half, or even the whole, of the earth's surface at once. This representation is the map. The map, of necessity, is not a picture. We cannot delineate as pictures any except very small areas, and have them true to nature. So we are forced to represent nature by the use of very arbitrary lines from which we are supposed to reproduce the object itself in the mind's eye. In other words, we make what we call a map to reproduce a mental image of the thing itself.

The most vigorous imagination, however, cannot see any resemblance between a round dot and a cluster of houses, or between the hachure lines of the map and a range of mountains. There may be a slight resemblance in the sinuous black line which serves to recall the actual river, but there is nothing in the shore-line of the maps to recall the low sandy beach or the wave-beaten cliffs that frown upon the sea. There is even less in the gaudily painted colors of the map to suggest the beautiful landscapes of nature. But the map, notwithstanding its innate ugliness and conventionalities, has a practical side to it which makes it intrinsically more valuable than all the picture-lessons we can possibly derive from nature, for without it foreign commerce would be almost an impossibility, and domestic commerce would be greatly crippled.

It goes without saying, that before the child sees or studies the map he should become acquainted with the things which the conventional lines on the map represent. The various forms and elevations of the earth's surface, such as mountains, islands, capes, bays, peninsulas, straits, etc., should be studied first from nature. Where this is not possible the moulding-board and the picture furnish the next best means. Simultaneously with these, the conventional outline may be drawn on the slate or on the blackboard, and thus the pupil takes his first lessons in map-drawing.

In the class-room, perhaps the most practical map-drawing is the hasty off-hand sketching of an area which the needs of the recitation demand. In such sketch-map only a general accuracy of outline is required, and not more than two or three minutes should be permitted in making it. If the pupil has been habitually trained to such work in the oral lessons on the moulding-board, there will be no difficulty in doing it quickly and with reasonable accuracy. The ability to make a rough sketch-map of a given area consistently and rapidly implies a great deal. It shows not only that the pupil has the outline photographed in his mind, but it is also proof positive of a kind of knowledge that is not readily forgotten. Beyond the disciplinary value of such work the outline itself is more valuable in its way than the wall- or the atlas-map. A few lines drawn in their proper places will show the continental divides which separate the great slopes and basins. On such a map these can be seen more clearly than on the atlas-map because there is no confusion of details to distract the attention from the particular features. There is a score of similar uses to which such a sketch-map may be put, any one of which will enable both teacher and pupil to do graphically and vividly what must otherwise be imperfectly done. One who has tried this expedient will not fail to acknowledge how much time and explanatory talk may be thereby saved.

The production of finished and artistically drawn maps is an art — and a science as well — which the majority of teachers look on with disfavor. It certainly is not an essential element in the education of the average pupil, and if such work is done, it would be better if done mainly out of school hours. But whatever may be the value of a knowledge of chartography to the pupil, it is a necessity to the teacher. The clumsy, unskilful devices commonly recommended as 'aids to map-drawing,' although they often reflect credit upon the ingenuity of the teacher, are not testimonials to his training in the study of geography.

Most likely the majority of teachers use a conventional system of construction-lines upon which the outlines of the land-area are to be drawn. This system sometimes, though rarely, serves a good purpose, and where a map is to be hastily sketched it is occasionally convenient. As a supplement to a correct system of map-drawing it is frequently desirable. But if the pupil's knowledge of the *science* of map-drawing is to stop at this point, it would be better that the knowledge were never acquired; it is always misleading, and usually erroneous. The object and essence of the map is that every geographical point should be in its proper place. With the ordinary construction-diagram no attempt whatever is made to show anything but an outline similar to the map copied. Neither is there anything to show the latitude and longitude of places, or even the general position of the area charted. For a map of a township, or even a county, such an outline might be useful; but for a large area, it is unscientific, incomplete, and erroneous.

Now and then some one discovers that a construction-diagram which answers admirably for, we will say, a map of North America as it appears in one book, will not answer at all for the same map as it is given in another. When such an awkward discovery is made, one of the maps (usually the one to which the construction-diagram will not fit) is declared incorrect.

That construction-lines and diagrams are a necessity in map-drawing is certainly true, but why not use the ones originally designed for the purpose, and without which a map is useless? In other words, why not use the parallels and meridians themselves? They were devised for this purpose and, except in mariners' charts, have little or no other use. The professional map-draughtsman uses them and does not ever think of using any other device.

The advantage of using parallels and meridians is twofold. It is fully as easy to lay them off on paper as it is to draw a meaningless construction-diagram. The map when thus drawn is consistent, and expresses not only position, but also direction and relative distance. Without the parallels and meridians, it shows nothing but outline; and if the outline were one of a country or a region not well known, it might be difficult to decide how the map was to be read, or in which direction were the cardinal points.

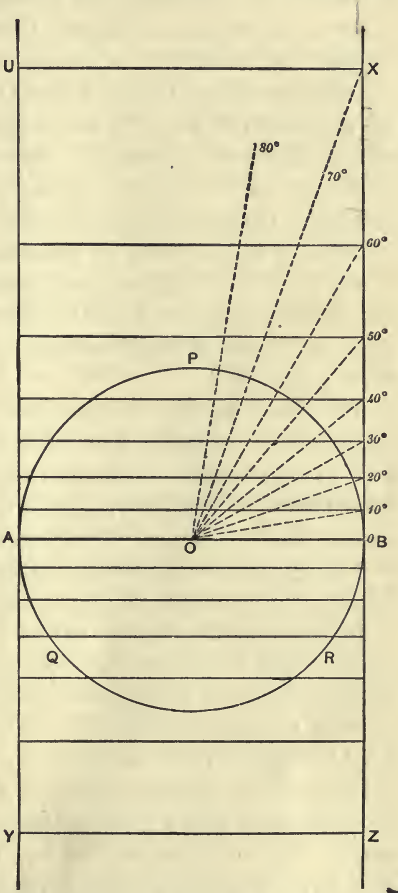
The chief difficulty is that both teacher and pupil are afraid to attempt drawing the parallels and meridians, for fear that they will not have the same appearance as those of the map copied. This fear may be dismissed with the assertion that they need not be similar. They may be drawn as straight lines if one chooses to draw them thus, and if they are properly numbered the map may be charted upon them. The result will be a *consistent* map, although in shape it may not absolutely resemble the one copied.

Pupils and teachers have been taught, or have imbibed the idea, that a map must of necessity be an exact outline of the continent, grand division, or state. This is a matter which must be unlearned. A map cannot, of necessity, be an exact outline, because it is impossible to represent the outline of a convex or rounded surface on a flat surface. The map-draughtsman must therefore be content with making the map as nearly correct as circumstances will permit, and must lay out his parallels and meridians accordingly. The platting of these is called 'projecting the map.' There are many projections used in map-drawing, but there are four which are very commonly used,—the Mercator, the conic, the polyconic, and the globular projection.

The Mercator Projection. — This projection receives its name from Kaufmann,[1] a geographer who first employed it in the charting of sailing-routes.

In the Mercator projection the earth is considered a cylinder, on the convex surface of which the outlines of the continents are drawn. If, now, we conceive the surface to be unrolled and laid flat, the result is a map projected on the Mercator plan.

But the north pole of the earth, which in reality is a point, becomes, in the Mercator projection, a circle equal in size to the circle of the equator. The land masses situated in high latitudes appear greatly distorted, therefore, in width. In order to obviate this, the distance between parallels constantly increases as the latitude increases, as will be seen in the accompanying diagram. These distances are not taken hap-hazard, to suit convenience, but are determined



Method by which Mercator Charts are projected.

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[1] Kaufmann is the German word for *merchant*, which in Latin is *mercator*.

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for a purpose, and their positions calculated with mathematical precision.

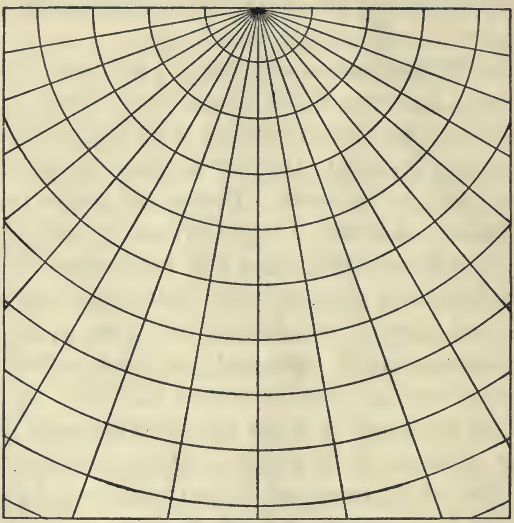
Technically speaking, the distance of each parallel from the equator is equal to the tangent of the angle of latitude. Let us imagine that UXYZ is a hollow cylinder of paper surrounding a terrestrial globe PQR. From O, the centre of the globe, lay off angles of 10°, 20°, 30°, etc., and draw lines until they meet the side of the paper cylinder. Now the points where these lines meet the surface of the cylinder will be the distances of the respective parallels from the equator. When we unroll the paper cylinder, it will be about $3\frac{1}{7}$ times the length of AB, the diameter of the globe. For all practical purposes the maps projected on the Mercator plan are limited to 80° N. and 60° S. latitude, as the land and all the navigable waters of the earth are situated between these parallels.

The chief objection to this plan of projecting a map is, that where large areas are to be shown, the size of those portions situated in high latitudes is greatly exaggerated. This objection, however, fails when small areas are to be charted, and for state and county maps it is an excellent projection. It is the only convenient projection, too, in which the entire surface of the earth can be shown on a single, continuous map.

Its greatest advantage lies in its use as a sailing-chart; for it is in maps of this projection only that all directions are measured in straight lines, and that parallel lines have the same direction in all parts of the map. Without the Mercator chart, deep-sea sailing would be out of the question, for any navigator who was not a good mathematician could not calculate the complex curves which on ordinary maps would represent straight lines on the surface of the earth. The 'commercial' maps of the world, which now form a part of most common-school geographies, are excellent specimens of the Mercator projection, although not always correctly projected.

It need not be inferred from this that the chartographer does not know how to project them. The reason is, that a correctly projected map, to include all the surface between 80° N. to 80° S., if a two-page map is required, would be about three feet in length from top to bottom. So it is customary to reduce the distance between parallels by any convenient but arbitrary scale, the latter depending upon the size of the page.

The Conic Projection. — The conic projection represents a part of the earth as drawn on the surface of a cone. Imagine a cone (or a part of the cone) covered with paper, on which the parallels are drawn parallel to the base of the cone, and the meridians from the apex to the base. If now the paper be removed and spread flat, we shall have a tolerably correct idea of the conic projection. This form of projection and the various modifications of it are much used in charting those grand divisions and areas which lie in the northern hemisphere. Obviously, the distortion will be the greatest towards polar and equatorial latitudes. If we bend the paper into a cone, and place the latter over a globe which shall just go inside of it, we can see what parts of the map are distorted or incorrect in outline. Along the circle where the sphere and cone touch, there will be no distortion. In polar latitudes there will be a north and south exaggeration, and in equatorial latitudes, an east and west enlargement. Where the area to be charted extends well into equatorial latitudes, the meridians instead of being straight lines are commonly curved inwardly so as to prevent too much lateral distortion. Maps of Asia and Europe are usually thus conventionalized. In fact, two of the best chartographers in the United States use ship-curves for projecting the meridians in the maps of these grand divisions. In using the ship-curve instead of the arc of a circle, their judgment is good. In a projection thus made, the northern regions, where there are but few details to be charted, are slightly contracted, while the southern parts, in which the details are numerous, are slightly enlarged. The parallels of a conic projection are always concentric arcs with the pole as a centre. The conic projection is one of the most convenient, and in many respects the best, for pupils' work. It is easily made, and requires no apparatus more costly than a pair of dividers with a long leg. The meridians may be straight lines, and the parallels, arcs drawn from the apex of the cone as a centre. The outline on p. 48 conveys a practical idea of this form of projection.



A Conic Projection.

Bonne's Projection. — This projection, which, in a modified form, is known also as *Flamsteed's*, is perhaps more extensively used in the maps of school geographies than any other. In many respects it is a difficult projection to construct, although the difficulty may be practically obviated by purchasing the meridian rules already made, or by using a flexible ruler.[1] In Bonne's projection the parallels are equidistant arcs drawn from the pole (or apex of the cone) as a centre; in Flamsteed's, they are straight lines. In the latter, each hemisphere (northern and south-

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[1] Both the meridians and the flexible ruler may be purchased of Williams & Brown, or of the Ball-Bennett Co., Philadelphia.

ern) is assumed to have a shape much like that of a boy's top, conical at the apex, but rounding off to a nearly hemispherical shape at the base. In Bonne's modification, however, the cone is slightly concave at the apex, resembling in form the dome of a pagoda. A better example may be found in the illustrated ace of spades which accompanies each pack of playing-cards, the curves of this figure being constructed in one or the other of these projections. The chief merit about these projections is that true proportion of areas is preserved. The disadvantages are distortion at the margin, and the very oblique angle at which the parallels and meridians intersect in high latitudes. In nearly all the school geographies, the maps of the grand divisions, and often the state sections, are drawn on the Bonne or the Flamsteed projection. Europe, Asia, North America and South America are generally constructed on the former; Africa and Australia on the latter.

Globular Projections. — The maps of the hemispheres which are found at the beginning of most geographies are drawn on what is commonly called a globular projection. One of these was planned by De la Hire about two hundred years ago, and a better one for the purpose was never made. Let us imagine a glass globe on which the parallels and meridians have been drawn, to be cut in two through the poles, and a sheet of half-transparent paper fastened over the cut edges. In the accompanying cut ABCDE is the hemisphere, and ADCE the sheet of paper. The observer stands directly in front of the flat side at a distance a little greater than the length of the axis of the sphere, the eye being at O, on the level of the equator. Now as one looks at the parallels[1] with the eye in the position shown at O, they seem to be curved lines; and if we could have each one drawn as it seems to fall on the flat surface ADCE, we should have a set of parallels as seen in the next figure. The meridians are usually drawn at equal distances apart. The expert chartographer does not need

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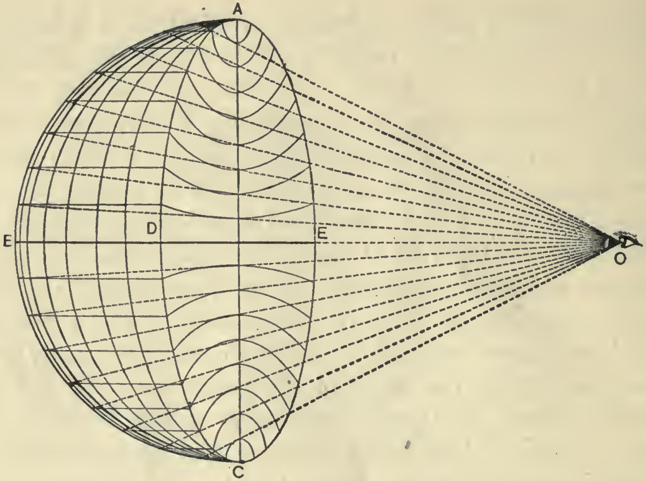
[1] The meridians are omitted in order to avoid crowding the figure with a confusion of lines.



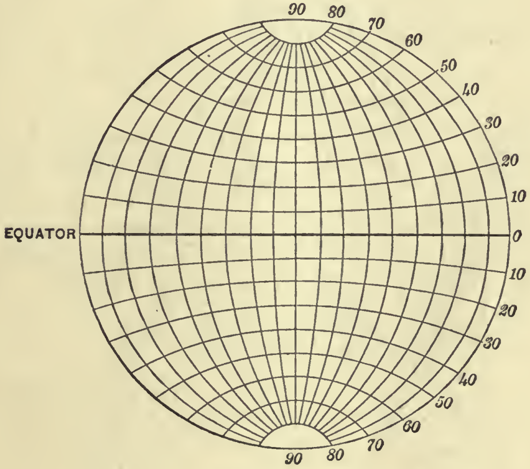
Method by which Globular Maps are projected.

to take this trouble to locate the position or to find the curvature of the parallels; he can calculate either much more easily.

In a projection of this kind, the distortion is chiefly at the margin of the map. On a globe the parallels must of course be equidistant, but in our globular projection they are much farther apart at the margins than along the central meridian. Not unfrequently the question arises, 'Why is there not a scale of miles on maps of the hemispheres?' Such a question is readily answered when we recognize the fact of this marginal exaggeration. A scale of miles which would be accurate on the central meridian would be very inaccurate at the margin. To represent a fairly correct scale each unit must be 1.57 as great for the marginal as for the central meridian.

It is evident that directions north and south, or east and west, are measured respectively along the meridians and parallels, no matter what may be the direction of these lines on the map. A straight line on the map must, therefore, in nearly every case be a curved line on the globe; it becomes not only a great inconvenience, but practically an impossibility for any but an expert mathematician to use such maps for sailing-charts. But inasmuch as a map projected for use as a sailing-chart has such exaggerated outlines as to be almost worthless for everything except rhumb lines and accuracy of direction, we must gracefully submit to the fact that two kinds of maps are necessary, — one for landsmen, and the other for seamen. We must also yield to the fact that while both are consistent, neither one is accurate, and that a perfect map cannot be made until we have a flat earth.

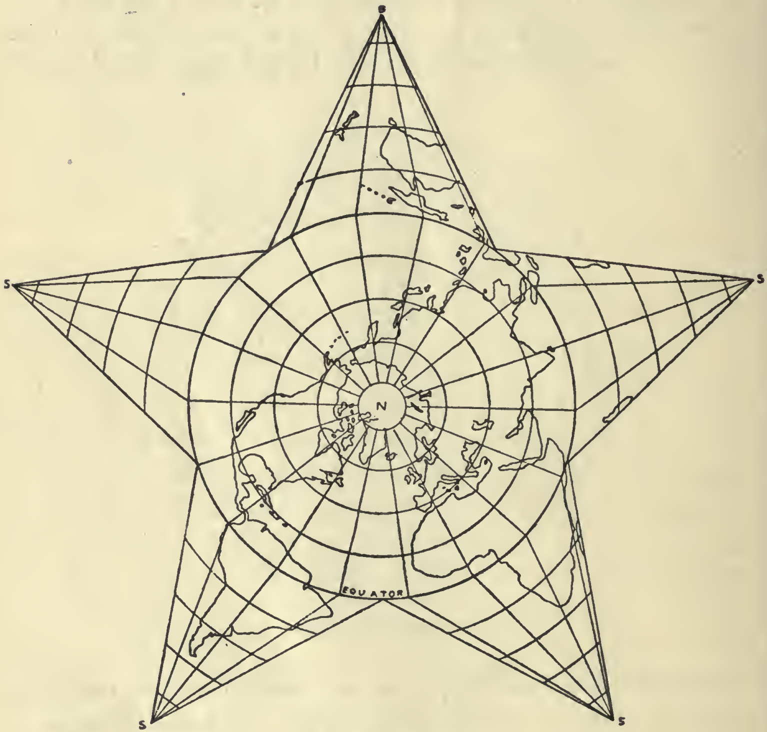
One of the difficulties in trying to fit a round earth to a flat map is frequently encountered in the United States Land Office.



The Completed Projection.

According to law a township must be bounded east and west by meridians, and must be six miles *square*. Now this is simply an impossibility. If, for instance, we survey two township lines northward from the 40th to the 41st parallel, we shall find that they have approached each other and are about two-thirds of a mile nearer at their northern than at their southern limits. In the system of land surveys adopted by the United States, standard parallels are surveyed every few miles apart, and these are taken as bases for new township surveys. The parallel taken for a new base is called a 'correction line.'

Various other globular projections are occasionally employed, most of which, like the one just described, are perspective drawings rather than true projections, inasmuch as they depend mainly upon the position of the observer's eye.



A Polar Projection.

The *Orthographic Projection*[1] is one in which the eye is supposed to be at an infinite distance from the hemisphere, and the plane

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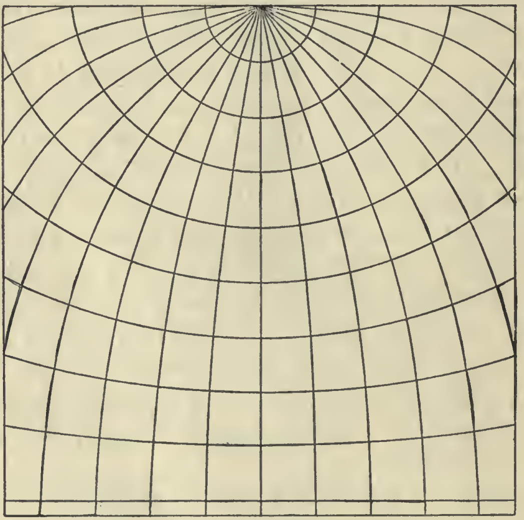
[1] Any true *perspective* view of a globe, the eye being situated at a distance, will be an orthographic projection.

of the projection perpendicular to the line of vision. The meridians, which are at normal distance apart at the centre of the map, are gradually crowded together at the edges. The parallels are straight lines, but unequally distant. Briefly stated, this is the form the lines of a globe would naturally take if the observer were to stand, say, five hundred feet from the globe, with the eye in the plane of the equator extended. The maps of the hemispheres in Warren's Geographies are drawn on this projection. An illustration in which the projection is made on the plane of a meridian is here given. (See also p. 76.)

The *Stereographic Projection* differs from the foregoing mainly in the position of the eye of the observer, which, instead of being at an infinite distance, is on the surface of the sphere, at the pole of a great circle. The maps of the hemispheres in the author's Complete and Elementary Geographies are on this projection. It makes a handsome map, but, though a very easy one to lay off, it is rarely used. If, however, the eye of the observer be shifted to the centre of the sphere, the resulting projection becomes *Gnomonic*, and, if the plane of the projection is tangent to a pole of the sphere, it does not differ greatly from any other polar projection. A good example of this projection may be seen in the cut facing p. 60. Here the earth is projected on a cube tangent to the sphere about which it is circumscribed. It will be hardly necessary to add that the meridians of a gnomonic projection will always be straight lines. This projection is nearly always used in star charts and celestial maps.

A very ingeniously constructed globular projection is shown on p. 58. Here the eye of the observer is at a slight distance above the north pole, and the largest continuous circle is the equator. If folded back, the rays of the star would meet at the south pole. This is a convenient projection for showing the distribution of land and water, and is a device much used by Mr. Russell Hinman.

Babinet's Equal-surface Projection. — This projection, as its name implies, is so called because the surface bounded by any given lines has an area equal to the surface bounded by the same lines on the sphere. The meridians are equidistant; the parallels are plotted so as to preserve the proportionality of areas as above described. The projection readily admits being extended so as to embrace the whole surface of the sphere, the bounding line then becoming an ellipse. It is an excellent substitute for the Mercator projection in showing the distribution of physical features, but it is a difficult one to make. Mr. Russell Hinman has shown a very excellent example on p. 13 of the Eclectic Geography. This projection is, perhaps, best known as a *homalographic* projection. (See p. 78.)



A Polyconic Projection.

Polyconic Projection. — This projection was probably conceived by F. R. Hassler, the first Superintendent of the U. S. Coast Survey. It conceives the earth to have a shape like that of a cone whose slant height is a convex instead of a straight line, — in other words, like that of the old-time sugar-loaf or beehive. Technically it employs a tangent cone for the development of every parallel, and this is its chief distinction when compared with the simple conic projection, where only one cone is employed. But in the conic projection the map is accurate only where the sphere touches the circumscribed cone, whereas in the polycone the map is accurate along each parallel, and distorted only between them. The parallels are arcs of circles drawn from different centres, each centre receding from the pole of the sphere until, at the equator, the radius is infinitely long, and the equator becomes a straight line. In the delineation of small areas this is decidedly the most accurate of all projections, but in very large areas there is considerable distortion at the east and west margins, especially in high latitudes. A very meritorious feature is that the meridians cut the parallels practically at right angles. The proportionality of areas is not exactly preserved, and in a map, say, of Eurasia, the area bounded by lines of equal angular distance is about 1¼ times as great at the margin as at the centre, along the same parallel. The polyconic projection is not a very difficult one to lay off; it is certainly not beyond the comprehension of any one possessing a fair knowledge of geometry. The curves of the meridians are scarcely more difficult to draw than arcs of a circle, in which respect the projection differs materially from most of the others. Excellent illustrations of this projection may be found in Appleton's Geography, map of Asia. It is also used for the maps of Asia and North America in the author's Complete Geography. (See p. 79.)

Occasionally the cry is raised that the maps of our geographies are objectionable because they contain too many details. Certainly the map should not contain so much matter as to be confusing, and all unnecessary lines and schemes are a source of evil rather than good. It is true that not every indentation of coast can be accurately shown, but it is equally certain that the character of the coast may be delineated; and if the map shows no difference between the coast-charting of Maine and Florida, it is not a true map. Mountains can be shown only in a conventional way, yet the character of highlands and cañons can be distinctively portrayed. If the hachure lines representing a mountain range, a plateau, a line of cliffs, and a cañon show no difference in texture, the map is untrue. It is a mechanical impossibility to enter the names of cities and towns on a map of a section of states, systematically, and in ratio to the population. The chartographer can only submit to what he cannot help, and use his best judgment. Now and then some one blindly proposes to introduce the names of a few of the larger cities only on each section map. Such a scheme is not only unnecessary, but misleading. It is unnecessary because in all the standard text-books of geography the greater centres of population are designated by larger type or by special symbols. It is misleading because it is untruthful. There is no more instructive lesson to be derived from the ordinary map than that shown by the distribution of population over an area of country, and the wise teacher will not fail to recognize this feature. Aside from this, the text-book map has a very important use as a reference map, and if all but the salient features are removed, the map has no value whatever beyond its class-room use.

Where maps containing only essential features are required they would best be drawn by the pupils themselves. For this purpose it is a good plan to take advantage of outline maps — that is, maps which have already been projected. The details, whether physical, political, or historical, may then be filled in progressively, using a different sheet for each purpose.[1] The plan of 'editing' a map will be found an invaluable discipline to the pupil. Indeed, it is doubtful if a better plan to judge graphically of the pupil's progress could be devised. Thus, an outline map of the world on the Mercator projection may be edited to illustrate the following: —

Drainage of river-systems.
Contours of elevation of the land and depth of the sea.
Magnetic variation.

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[1] The progressive outline maps sold by the publishers of this book will be found excellent for this purpose. I use them much in my private work, saving from a few hours to several days' time for each map edited. — J. W. R.

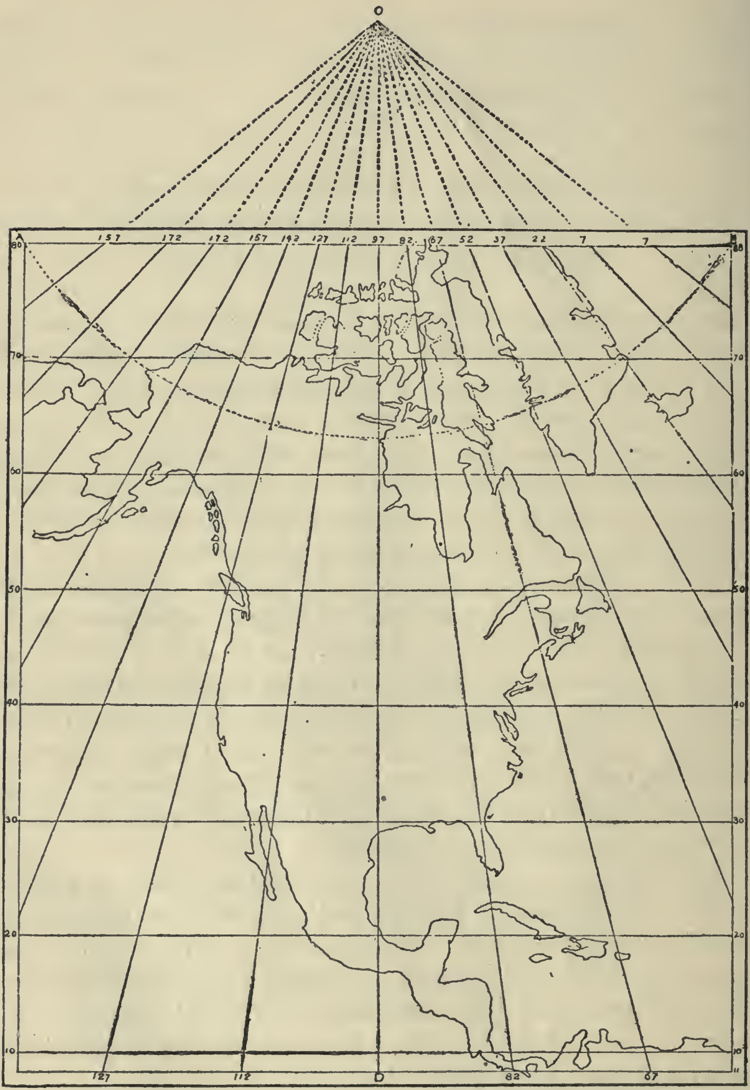
Ocean currents.
Cotidal lines.
Distribution of volcanoes.
Distribution of rain-fall.
Winds.
Isothermal zones — summer and winter, each.
Distribution of life — animal and vegetable.
Commercial routes — railway and marine.

The map of any grand division or other specified area may be treated in a similar manner. That a pupil should be taught to project and draw at least one or two maps will certainly be admitted as proper, but to compel him to draw every map he uses is quite another thing. It is a needless waste of time, that brings neither additional knowledge nor mental discipline. In the study of history, outline maps are a necessity, and no amount of memorizing or minute description answers as a substitute.

In most instances the ability to construct the strictly technical projections demands a knowledge of higher mathematics which the average pupil does not possess. In their construction an inconveniently large drawing-board and an expensive beam-compass are needed. Moreover, the student who investigates will find that the projections used in text-books are rarely constructed according to exact formulæ; on the contrary, they are commonly modified arbitrarily to suit the size and proportions of the paper on which the maps are to be printed.

The following projections will be found available for pupil's work. That of Asia is a conic, and that of North America a modified conic projection. The illustrations given do not differ from the strictly mathematical projections to any greater extent than the latter differ from one another. The only apparatus required is a pair of dividers with a long arm, a ruler or graduated paper scale, and a well-pointed lead-pencil.

North America. — Let us suppose a projection for a map of North America is to be made. First of all we must find its posi-



North America — a Projection of Convergent Meridians.

There is a slight, but intentional longitudinal distortion.

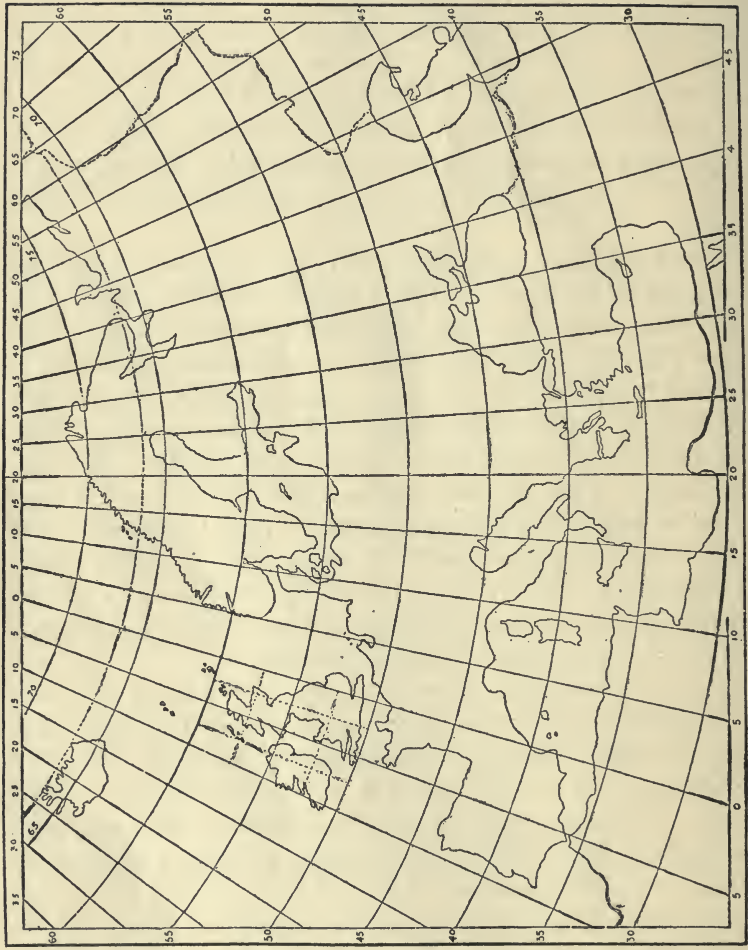
Not true conic

tion on the earth. An inspection of a globe (or map) shows that it is practically included between parallels 80° and 10° N., and meridians 20° and 180° W. (excepting the Aleutian Islands). Almost the whole of its area may be included in a rectangle having the proportions 6 : 5. A sheet of paper 14 × 12 will be suitable for the purpose, but the lines which form the border of the map need not be drawn until the projection is laid off. In projecting a grand division it is conventional in the majority of maps to lay the parallels ten and the meridians fifteen degrees apart.

Secure the paper to the board, and draw the line OD through the centre of the paper. At right angles to this line, and bisected by it, draw a line about one inch from the lower margin of the paper; this line should be about fifteen inches from O, the apex of the cone (practically the centre of a circle). On this line as a base, lay off the rectangle, 12 × 10, which shall enclose the map. Divide the lower twelve inches of the central meridian into eight equal parts and draw the parallels, eight in number, the top and bottom of the rectangle each forming a parallel. This division will make the parallels ten degrees apart. At any convenient distance from O, draw the arc AB. This arc is only for convenience in spacing off the distance between meridians, and should be erased when it has served the purpose for which it is drawn.

In the sketch on the opposite page there are seven meridians on each side of the central meridian, and this will be found a convenient number, though a greater number would not affect the consistency of the map. This will be obvious when we consider that the cone which conventionally represents the earth may have any angle of apex. The central meridian will have a longitude of about 97°. The meridians should be numbered so as to have an assumed though arbitrary angular distance of fifteen degrees apart.

In many of the school atlases the meridians are ten degrees apart, every even tenth being drawn. This plan will be no more difficult of projection than the foregoing. In this case it will be



EUROPE — DRAWN ON A CONIC PROJECTION.

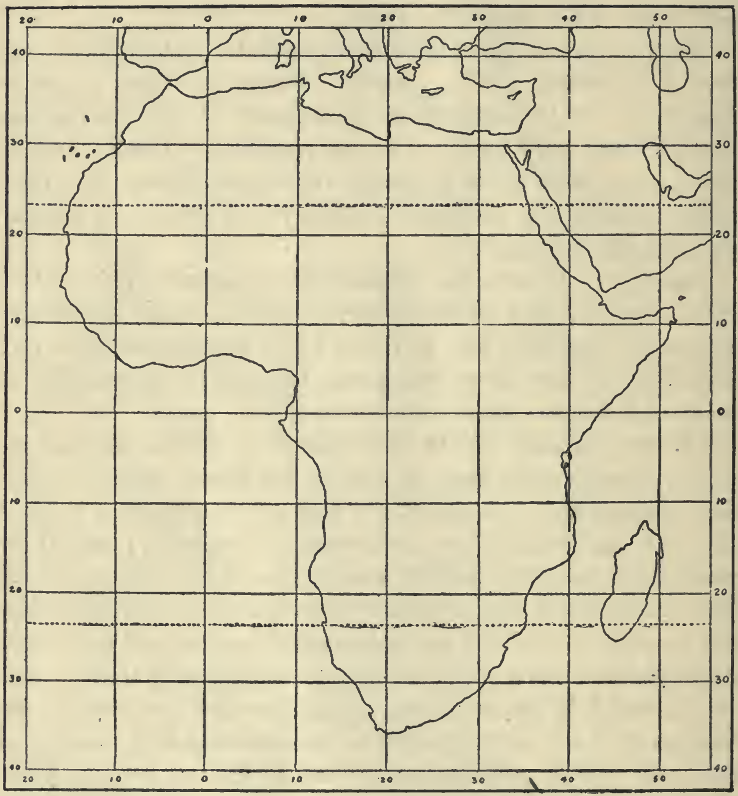
best after calculating the space required to draw the 90th and 100th meridians equidistant from OD. In general it is most convenient to lay off the parallels and meridians to correspond with those on the map to be copied.

When the projection is laid off in pencil, the coast-outlines may then be charted, also in pencil. Where the coast is greatly broken, it will be advisable to draw parts of the intermediate parallels and meridians as in the projection given. Indeed, where great accuracy is required, the chartographer may interpolate parallels and meridians for every even degree, or possibly for fractional degrees.

Establish by latitude and longitude the prominent points of the grand division, such as Point Barrow, Alaska, Cape Mendocino, Yucatan, Cape Sable, etc., and then fill in the intermediate parts of the coast. Next chart the islands, lakes, rivers, mountains, and political features in the order mentioned.

The pupil should not be discouraged if his outline does not exactly correspond in form to that in his atlas. As a matter of fact it should not. Accuracy in a map of a large area is theoretically an impossibility, but consistency is attainable; and if the pupil's map has been faithfully charted, it will not differ from the true mathematical projections any more than the latter differ from one another. Of course the judgment of teacher and pupil must determine as to how elaborate such a map may be: such a map as is planned in the foregoing paragraphs may be drawn in five minutes or in five weeks, — just as circumstances may require. If the pupil prefers, a projection similar to that of Europe, p. 66, may be employed for North America.

South America. — For this grand division a projection similar to that of Africa will be found suitable. The intersection of the 20th parallel with the 60th meridian is about the geographical centre, and from these lines as bases the other parallels and meridians may be spaced off ten degrees apart. There will be a slight but noticeable distortion in the southern part. If the distance between parallels be made about $1\frac{1}{8}$ times that between



AFRICA — DRAWN ON AN ARBITRARILY MODIFIED MERCATOR PROJECTION.

In this projection the parallels and meridians are equidistant. It is sometimes called the 'Projection of Equal Squares.'

meridians, the lateral distortion will be less apparent; a better plan, however, is to make the meridians converge towards the south.

Europe and Asia. — These divisions may be drawn singly or together. In either case an unmodified conic projection is perhaps preferable. If they are projected together, about all of this area is included between the meridians of 10° W. and 10° E., and between the parallels of 0° and 80° N. The intersection of the 40th parallel with the 90th meridian is practically the geographical centre. Notice that the parallels are arcs of concentric circles. If the size of the map is to be, say, 9 × 12 inches, the equator should be drawn with a radius of about twelve inches. From the centre of the map space off ten (or twelve) meridians on each side of the central meridian, and four parallels on each side of the central parallel. Then sketch in the outlines in the order as directed in North America. When a hastily drawn map is required, the alternate parallels and meridians may be omitted. If a sketch of Europe only is required to be drawn on the blackboard, the parallels may be drawn as straight lines.

Africa. — The Mercator projection is an excellent one for Africa, for, on account of its position, there is but little distortion. The intersection of the 20th meridian with the equator is about the geographical centre. Draw meridians and parallels for every tenth degree. It is well to include the Mediterranean Sea and the southern shores of Europe, and also Asia Minor and the Arabian coast. Locate the prominent coast-features first, and then complete the outline.

Oceania. — In projecting a map of this region, the draughtsman should first decide on how much is to be shown. A large map of Australia will of necessity exclude the greater part of the coral island groups; and conversely, a map which shall show all the groups from the Sunda to the Feejee group will show the Australian continent on a reduced scale. Use the Mercator projection, and after deciding upon the extent of the region to be shown, proceed as directed in the preceding cases.

PROGRESSIVE OUTLINE MAPS.—Drawn by J. C. Thompson, Providence, R. I. Copyright by J. C. Thompson, 1686.

Memory Map Name *Annie Turner*

North America — an ‘edited’ Progressive Outline Map.

The United States. — The United States may be drawn on a true conic projection, or on the modified form like that of North America. A Mercator projection, however, will not show an excessive distortion. If the conic projection be employed, it is necessary to use skill in preserving an approximately constant value to the scale of miles. In most geographies the parallels and meridians are each five degrees apart. But while the value of a degree of longitude is very nearly 60 miles along the 30th, it is less than 45.5 miles along the 49th parallel. That is, the convergence of the meridians is such that along the northern boundary of the United States the distance between meridians is only three-fourths that along the 30th parallel. Moreover, the distance between meridians along the 30th parallel is only five-sixths that between adjacent parallels, and if the map is to be consistent, this must be taken into account in the projection. It is true that maps are sometimes constructed having one scale for latitudinal and another for longitudinal measurements, but such maps are rare, and when employed they do not purport to be anything more than what they really are. For convenience to the student a table has been prepared (p. 82) showing the value of a degree of longitude at each degree of latitude. A brief calculation will show the relative amount of convergence of the meridians.

State and Section Maps. — Such areas are conveniently charted on a projection similar to that of North America, but if the student is the fortunate possessor of a beam-compass, a true conic projection will be better. Calculate the position of the area to be charted, and then determine the scale and proportions of the map. For instance, suppose a map of Colorado is to be projected. First determine its position as to latitude and longitude. An approximate measurement shows that its proportions are about 7 : 5. This will be useful in determining the dimensions of the paper, allowing, of course, for an untrimmed margin of about two inches, and about half as much for the bordering states. By reference to the table it will be seen that the value of a degree of longitude on the 37th parallel is about 55 miles, and on the 41st, about 52 miles. This will give a proportion of about 12.1 inches for the northern boundary to 12.8 for the southern. A similar calculation will show that the distance between adjacent parallels is about 1.3 times that between the meridians along the southern boundary. Once fixing these proportions, the charting of rivers, county boundaries, etc., will be easy to accomplish.

Every pupil should learn to sketch a map from memory, and such a sketch placed on the blackboard should not take more than three or four minutes' time. But to do this well requires instruction on the part of the teacher as well as practice by the pupil. In the author's experience no better or surer method of accomplishing this can be devised than that of first teaching a pupil how to project a map. With the same amount of practice on the part of the pupil, far better results can be attained in rapid off-hand sketching than by the use of the usual subterfuges.

The production of a highly finished map is not an essential part of common school work. The teacher of geography, however, should be master of the situation, and the time that may be devoted to one or two maps of this character will repay good interest. Furthermore, if the pupils have the time to spare, such an exercise will not be barren of disciplinary results. It will inculcate a desire for accuracy in detail, skill in handling the pen, and neatness in work. The pupil may either make his own projection or use an outline map. In either case it will be best to temporarily interpolate additional parallels and meridians quite thickly. All work should be first done in lead-pencil, and no ink should touch the map until the colors have been applied.

In the application of the colors several brushes are required, one of which should be used with clear water. A very fine, small brush is required for coast work. Four or five colors are required, — black, Indian yellow, blue, and pink.

The remaining colors are best made by mixing. Pink and yellow make a very attractive buff; blue and yellow, green; blue and pink, the draughtsman's purple. Carmine will be required only when railway lines are to appear on the map. All colors, except as noted, should be diluted until only a very delicate shade appears on the paper: if greater strength of tone is required, it should be obtained by successive applications of the color. In general, never apply a color until the surface has been wet with clear water: by observing this direction, uniformity of shade may be insured.

First, apply the blue, which conventionally represents the water. The color strip should not be more than a quarter of an inch wide: half that width will be better. With the fine brush apply the color a second time quite close to the coast-line, being careful to keep the paper wet ahead of the work. In the same manner color the various political and other boundaries. The black work may then be entered in India ink, and last of all the mountains should be hachured. For this purpose brown is the best: a good color can be made by mixing pink and yellow of full strength. The texture of hachure lines is somewhat difficult, and requires much practice before it can be well done.

The lettering, unless well done, will spoil an otherwise artistically drawn map. Do not attempt to use ordinary Roman letters. Unless one is an expert, such letters always look bad. Except where it is impossible, the names of towns should always be in alignment with the parallels. Names of countries, oceans, etc., are best drawn in graceful curves. The following scheme of typography will be found the least difficult, though not the most artistic: —

COUNTRIES, OCEANS, etc.
Capitals
Large Cities
Mountains
Smaller Bodies of Water
Rivers
Cities and Towns

In general, it is best to distribute the name of an area across its broadest extent, so that there shall be no doubt as to the territory included. The distribution of the names requires, moreover, judgment, skill, and artistic ability. It is best to have names of towns and of areas that are regular in shape conform to the direction of parallels. Where this is inexpedient, the name should be laid off on a graceful curve. Clean the map first with india-rubber, and then with moderately fresh bread-crumbs, and, last of all, trim the margin to within about one inch of the border. The map is then ready for inspection.

The maps in nearly all of leading geographies have been projected and drawn either by Mr. Jacob Wells of New York, or by Mr. W. H. Holmes of Philadelphia. Both of these gentlemen are widely known as geographers as well as trained chartographers, and if their maps in school text-books are open to the criticism of inconsistency, or inartistic appearance, the fault rests, not with the chartographer, but with the employer. It is not conducive to the personal comfort of the draughtsman to be ordered to distort a projection in order to fit a certain size of paper, or to sacrifice accuracy in order to harmonize a map to some one's pet theory; yet this has been deliberately done in more than one instance. The charge for the original drawing of a map, such as appears in the recent school geographies, varies from $75 to $125 per page, and, considering the quality of the work, these prices are not unreasonable. Publishers, nowadays, are willing to pay well for first-class work. The cost for engraving such maps is about $200 per page. Nearly all the maps in school geographies are engraved and printed by Struthers & Co., New York, or by Matthews & Northrup, Buffalo. In most instances the map requires six printings, viz., black, blue, pink, yellow, brown (for the mountains), and carmine (for railway lines). All other colors are produced by variously combining pink, blue, and yellow in the printing. It is no more than justice to say that the maps of American geographies are not equalled by those in any European textbook.

The most important thing about a map, however, is the ability to read it correctly. Perhaps any expression of doubt concerning this subject will provoke a smile on the part of the reader. Nevertheless the assertion may be broadly made, that no one can read a map correctly who has not learned to project it. Let any one who feels inclined to smile make the following tests — upon himself.

On the map of North America, draw a line which shall represent the shortest distance between Iceland and Bering Strait. On a map of the Western Hemisphere draw a similar line from Cape Farewell, Greenland, to the mouth of the Amazon. Trace similar lines on a globe, and notice whether or not the lines pass through the same points.

Is a straight line on a map always the shortest distance between two points?

Does a line drawn towards the top of the map always extend north and south? On the map of a hemisphere can you draw two short parallel lines, one of which shall point north and south, the other east and west?

On page 4 of Swinton's Geography are three maps, each showing the grand division of North America. They all differ in shape, yet each is accurately drawn. Explain the reason.

On a state map, such as is found in the supplement of most school geographies, can you find the latitude and longitude of a place to within three minutes of arc — or to within three statute miles of its proper position? The map contains all the information necessary to locate a point much more closely.

If you superimpose the map of North America in Swinton's Geography upon the map of the same division in the author's Complete Geography, you will find that nowhere is there coincidence of outline, yet both maps are on the same scale, and each is strictly correct. Explain why.

Can you construct a scale of miles for any ordinary map? The map contains all the information necessary.

Can you tell the meaning of the following? — Nat. scale = 1 : 633,600.

Can you tell by inspecting a map whether it is possible to make a scale of miles that shall be accurate in all parts of the map? The map will show this at a glance.

Can you tell whether the parallels and meridians are so drawn as to preserve true proportionate distances, or whether there is distortion in any part of the map?

Can you tell the direction of the slope of the land by an inspection of the map? The map bears the information on its face.

Can you trace the summit of a divide that separates adjacent river-basins?

On a map of a grand division, can you draw at least one line that shall pass through all places having the same level?

Unless the student of geography can do all this, — and a great deal more, — he can read or interpret maps very imperfectly, at the best.

V.

THE TECHNICAL CONSTRUCTION OF PROJECTIONS.

The teacher or pupil who wishes to undertake the construction of any of the mathematical projections described will find the following tables and formulæ necessary. Generally speaking, the process, aside from planning the size, extent, and scale of the map, is wholly mechanical, and after a little practice the projection may be easily and quickly laid off. Usually the draughtsman must choose between true proportion of area with distortion of outline, and true outline with distortion of area. A drawing-board, draughting-instruments, two or three engineer's paper scales, and a flexible rule are needed. The whole need not cost more than five or six dollars.

p51
diag
wron

Mercator's Projection. — In the solution of the projection on page 51, it is assumed that the earth is a sphere. For a spheroid earth, it is necessary to use the following table. The length of one degree at the equator, 60 minutes of arc, is taken as the unit of measurement. The distance of each parallel will be as follows:

10°	599′	60°	4507′
20°	1217′	65°	5158′
30°	1877′	70°	5944′
40°	2608′	75°	6948′
50°	3457′	80°	8352′

Correct

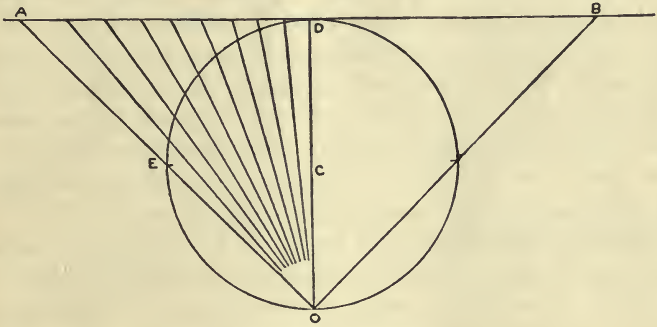
The fact that either formula gives a projection that is contracted in the part where, in physical maps, the details are most numerous, is a very great objection. The teacher or pupil therefore who desires a more convenient map for such purposes may use the following plan: Draw the meridians one hour (15 degrees) apart. Take two-thirds of this value for the distance to the 10th parallel, 80 8.75

and use this distance as a unit. Lay off the 20th parallel a a distance of 1.25, the 30th 2.5, the 40th 3.75, the 50th 5.0, units from the equator, etc. Of course such a projection is worthless for sailing purposes, but it is far more practical for a map showing the distribution of physical features.

Projection of Convergent Meridians. — A moment's inspection will show that the column of 'Radii for Parallels,' Table I, may be used to find the common point at which the meridians will intersect. Thus the line OD, page ~~60~~ 64, will be 325 units in length, on the supposition that the map extends to the 10th parallel.

An Orthographic Projection.

The Orthographic Projection. — Draw a circle of the size required. Draw the equator, and at right angles thereto, the axis, which is also the central meridian. On the supposition that the parallels are ten degrees apart, divide each quadrant into nine equal parts, and draw the parallels through these points, as in the cut on page 76. (It will be proper to say here that one-half of each parallel, that is, the perpendicular distance from the end of the arc to the central meridian, is technically the cosine of the angle of latitude. This is usually expressed as $\cos \phi$, in which ϕ may be any given latitude.) On the equator, on each side of the central meridian, lay off distances equal to the distance from the equator to the successive parallels. Through each of the points thus determined, a meridian must be passed, terminating at the poles. Each meridian is a semi-ellipse whose major axis is the central meridian, and whose minor axis is the distance from the central meridian to the point through which the meridian is to be drawn. Technically the minor axis equals $2 \sin \phi$.



A Stereographic Projection.

The divisions of AD and DB show the points through which the meridians are to be drawn.

The Stereographic Projection. — The above figure will illustrate the construction of this projection. AB is the equator of a hemisphere. Draw any circle OED tangent to AB at its middle point, and divide its upper semi-circumference into as many parts as there are to be meridians. From O, the point of vision, draw lines through these points until they cut A, B. These are points through which the meridians pass. To construct the meridians, with AB as a diameter, draw the circumference of the circle which bounds the hemisphere. Draw arcs which shall pass through both poles of the hemisphere, and each through its proper point on the equator. The centre of each arc is most quickly found by trial. To construct the parallels, divide the arc of each quadrant into as many parts as there are parallels required, and in the same manner divide the central meridian. Draw arcs of circles with a radius of such length that each arc shall cut the central meridian at its proper point, and meet the circumference of the hemisphere at corresponding points.

An arbitrary, but very serviceable modification of this projection may be made by subdividing the equator equally, and passing the meridians through these points. This modification does not differ greatly from De la Hire's projection.

The Babinet Homolographic Projection. — Lay off the circle, equator, and central meridian. Then, if the parallels are ten degrees apart, beginning at the pole, divide each half of the central meridian in the proportion of $1\frac{1}{9}$, $1\frac{2}{9}$, $1\frac{1}{3}$, $1\frac{4}{9}$, $1\frac{5}{9}$, $1\frac{2}{3}$, $1\frac{7}{9}$, $1\frac{8}{9}$, 2.[1] Space off, say 20, equal distances along the equator for the meridians. Then each meridian will be a semi-ellipse whose major axis is the central meridian, and whose minor axis is the distance from the central meridian to the one to be projected.

The Conic Projection. — In laying off a conic projection the chartographer may construct one in which the cone is tangent to the sphere at the middle parallel of latitude, but it is better on the whole to conceive that the cone cuts or pares off a part of the surface of the sphere, thereby becoming an 'intersecting' cone. This is done practically by drawing the parallels each with a radius slightly shorter than that given, but spacing off the longitudinal distances, according to the table. For instance in the map of Europe if we assume that the cone is tangent at the 50th parallel, then (Table I.) the radius for drawing the parallels is 48.08 units; but if we take an intersecting cone which cuts the sphere at lat. 40°,

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[1] This is only an approximation. The following formula gives the exact distance. Let ϕ = the latitude of the parallel to be determined, h = the distance from the equator, and $\pi = 3.1416$. Then $\sin \phi = \frac{1}{\pi}(2h + \sin 2h)$.

the radius is 68.3 units. For a map of a grand division it is well to follow the scheme laid down on page 00, but in projecting the map of a state or any other small area, careful, mechanical measurements will give a better result. Suppose the map to be that of Pennsylvania. Determine the size of the map and draw the central meridian. From Table II. lay off the points where the 40th, 41st, and 42d parallels cross it. With a radius of 68.28 units (Table I.) draw an arc for the 40th parallel, and from the same centre draw the 41st and 42d parallels each through its proper point on the central meridian. On this parallel of 40° lay off the degrees of longitude, each 53.06 miles in length; and on the 42d parallel space off the degrees 51.48 miles each. Draw the meridians each through its proper series of points.

Bonne's Projection. — The parallels are drawn from the same centre, using a length of radius according to Table I. The meridian distances may be laid off from either table and the meridians drawn with a flexible rule, or they may be drawn by means of curves made for the purpose. A set of three or four 'ship-curves' will answer all practical purposes.

For **Flamsteed's** modification, make the parallels equidistant straight lines, space off the meridian distances according to Table I., and through each set of points draw the meridian with a flexible rule.

From the foregoing it may be inferred that while the map is theoretically projected on a tangent cone, the meridians are spaced off as if the cone were spheroidal. It is for this reason, also, that on a projection for a large area, a meridian, instead of cutting the parallels at right angles, may cut them at very oblique angles, — acute in high, and obtuse in low latitudes.

The Polyconic Projection. — Determine the extent and scale of the map, and lay off the central meridian. Along the central meridian lay off divisions through which the parallels are to be drawn, five, ten, or any number of degrees apart, as may be desired. The parallels may then be laid off from Table I. On the supposition that the distance between meridians at the equator is ten units (each, say, $\frac{1}{8}$ of an inch, or any value the draughtsman adopts), the radius for drawing the parallel of ten degrees is 324.9 units in length; for the parallel of twenty degrees, 157.4 units, etc.

The distance between adjacent meridians may then be spaced off. Referring to the same table, the distance at the equator is 10 units; on the tenth parallel, 9.84 units; on the twentieth parallel, 9.39 units, etc., throughout the extent of the map. With the flexible rule, draw curved lines which shall pass, each through a set of points thus established. The second column of Table I. has been constructed on the hypothesis of a spherical earth. A slightly more accurate result may be obtained by dividing each member of the second column of Table II. by 69.172; the quotients will be ordinates for each degree of a geoid. As a matter of fact, this table is used in spacing off the meridian distances on the maps published by the U. S. Coast Survey. It is practically a table of cosines; and the radii by which the parallels are drawn from a table of natural cotangents, each member being multiplied by a constant factor N. In Table I. this factor is 57.296. It is deduced as follows: If the cosine of an arc of 1° of a great circle of a sphere is 1.000, then the radius of that sphere is 57.296+. The formula for the radius of the developed parallel is, therefore, $R = N \cot \phi$.

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TABLE I. — FOR THE CONSTRUCTION OF POLYCONIC PROJECTIONS.

LAT.	DEG. OF LONG.	RADIUS FOR PARALLEL.	LAT.	DEG. OF LONG.	RADIUS FOR PARALLEL.	LAT.	DEG. OF LONG.	RADIUS FOR PARALLEL.
0°	1.000	∞	31°	.857	95.356	62°	.469	30.465
1°	.999	3282.473	32°	.848	91.962	63°	.454	27.945
2°	.999	1640.736	33°	.838	88.228	64°	.438	26.717
3°	.998	1093.268	34°	.829	84.944	**65°**	**.423**	**26.717**
4°	.997	819.368	**35°**	**.819**	**81.827**	66°	.407	25.510
5°	**.996**	**654.894**	36°	.809	78.861	67°	.391	24.321
6°	.994	545.133	37°	.799	76.034	68°	.374	23.149
7°	.992	466.637	38°	.788	73.335	69°	.358	21.194
8°	.990	407.681	39°	.777	70.254	**70°**	**.342**	**20.854**
9°	.987	361.751	**40°**	**.766**	**68 282**	71°	.325	19.729
10°	**.984**	**324.940**	41°	.755	65.911	72°	.309	18.617
11°	.981	294.761	42°	.743	63.633	73°	.292	17.517
12°	.978	269.556	43°	.731	61.442	74°	.275	16.429
13°	.974	248.175	44°	.719	59.332	**75°**	**.259**	**15.352**
14°	.970	229.801	**45°**	**.707**	**57.296**	76°	.242	14.285
15°	**.965**	**213.831**	46°	.694	55.330	77°	.225	13.228
16°	.961	199.814	47°	.682	53.429	78°	.208	12.179
17°	.956	187.406	48°	.669	51.589	79°	.191	11.137
18°	.951	176.338	49°	.656	49.806	**80°**	**.174**	**10.103**
19°	.945	166.399	**50°**	**.643**	**48.077**	81°	.156	9.075
20°	**.939**	**157.419**	51°	.629	46.397	82°	.139	8.052
21°	.933	149.261	52°	.615	44.764	83°	.122	7.035
22°	.927	141.812	53°	.602	43.175	84°	.104	6.022
23°	.920	134.980	54°	.588	41.628	**85°**	**.087**	**5.013**
24°	.913	128.688	**55°**	**.573**	**40.119**	86°	.070	4.007
25°	**.906**	**122.871**	56°	.559	38.646	87°	.052	3.001
26°	.899	117.474	57°	.544	37.208	88°	.035	2.001
27°	.891	112.449	58°	.529	35.802	89°	.017	1.000
28°	.883	107.758	59°	.515	34.427	**90°**	**.000**	**0.000**
29°	.874	103.364	**60°**	**.500**	**33.080**			
30°	**.866**	**99.239**	61°	.485	31.760			

TABLE II. — THE LENGTHS OF ONE DEGREE OF LONGITUDE IN DIFFERENT LATITUDES.

LAT.	STAT. MI.	LAT.	STAT. MI.	LAT.	STAT. MI.	LAT.	STAT. MI.
0°	**69.164**	23°	63.695	46°	48.124	69°	24.860
1°	69.145	24°	63.216	47°	47.253	**70°**	**23.725**
2°	69.122	**25°**	**62.718**	48°	46.363	71°	22.584
3°	69.072	26°	62.202	49°	45.462	72°	21.437
4°	68.998	27°	61.666	**50°**	**44.545**	73°	20.284
5°	**68.901**	28°	61.113	51°	43.614	74°	19.124
6°	68.785	29°	60.537	52°	42.670	**75°**	**17.957**
7°	68.652	**30°**	**59.947**	53°	41.713	76°	16.784
8°	68.496	31°	59.333	54°	40.743	77°	15.608
9°	68.315	32°	58.711	**55°**	**39.760**	78°	14.427
10°	**68.117**	33°	58.065	56°	38.765	79°	13.240
11°	67.900	34°	57.397	57°	37.758	**80°**	**12.049**
12°	67.661	**35°**	**56.714**	58°	36.740	81°	10.854
13°	67.402	36°	56.018	59°	35.710	82°	9.656
14°	67.121	37°	55.308	**60°**	**34.669**	83°	8.456
15°	**66.821**	38°	54.570	61°	33.617	84°	7.253
16°	66.499	39°	53.819	62°	32.555	**85°**	**6.048**
17°	66.163	**40°**	**53.053**	63°	31.483	86°	4.840
18°	65.798	41°	52.269	64°	30.402	87°	3.631
19°	65.419	42°	51.476	**65°**	**29.310**	88°	2.421
20°	**65.014**	43°	50.660	66°	28.210	89°	1.211
21°	64.589	44°	49.830	67°	27.101	**90°**	**0.000**
22°	64.156	**45°**	**48.982**	68°	25.985		

GEOGRAPHY.

Progressive Outline Maps.

North America; South America; Europe; Central and Western Europe*; Asia; Africa; Australia; United States; New England; Middle Atlantic States; Southern States, Eastern Division; Southern States, Western Division; Central States, Eastern Division; Central States, Western Division; Pacific States; the Great Lakes; New York; Ohio; Washington; Pennsylvania; British Isles*; England*; the World on Mercator's Projection*; Greece*; Italy*; Palestine*; and Ancient History*(the world as known to the Ancients). Printed on substantial drawing paper, adapted to lead-pencil or to ink. 10 x 12 inches. U. S. and Mercator's Projection, 12 x 20 inches. Price by mail 2 cents each; **$1.50 per hundred. Map of Ancient History, 3 cents each; $2.50 per hundred.**

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THESE outlines are for the use of the pupil, and are based on the assumption that map-drawing should be taught as a means, and not as an end; that its purpose is to assist the mind in acquiring and fixing geographical facts, and that to memorize the construction lines of other methods and the hundreds of nameless projections and indentations of a tortuous coast-line is a waste of time and of nervous energy which would be better employed in studying important and interesting particulars concerning the physical features, climate, products, etc., of the interior.

In *tracing the outline*, the pupil acquires a correct knowledge of the form of the country, and, as each day's lesson proceeds, he can fill in his map to correspond with the detailed knowledge gained.

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1. **Economy of time.** By using the **Progressive Outline Maps** all the practical benefits of map-drawing are secured. By tracing the dim outline, and then developing a continent along such special lines as the teacher may direct, every *important* feature is clearly fixed in the mind of the pupil, in as little time as is ordinarily consumed in memorizing the construction lines and diagrams of other systems; and the still longer time required to memorize the irregularities of a contour can be devoted to the study of the more important topics.

2. **Accuracy.** They keep a *correct* form of the country under consideration constantly before the pupil.

3. **General usefulness.** (*a*) These maps may be used to indicate, besides the usual facts of indentations, projections, mountains, rivers, countries, states, towns, etc., the location of areas of mineral deposits, of forest growth, of prairies, deserts, plateaus, of the various kinds of soil, of staple productions, of dense population, of manufacturing districts, etc.

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(*c*) In connection with the study of Ancient History, these maps may be used to represent the location of ancient tribes and barbarous hordes of men, the provinces of ancient empires, the distribution of territory after conquests, etc., etc.

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No time can be spared in History for *practice* in map-drawing.

(*e*) For rapid and thorough tests of pupil's knowledge of Political, Descriptive, and Physical Geography, and of many facts in History, no series of questions and answers can equal in three hours what may be ascertained, practically, of their knowledge of these subjects by the Outlines in thirty minutes. Such a map can be easily and rapidly inspected by the examiner.

4. **Economy in price.** These maps cost the pupil two cents each. Several times that amount is usually expended for paper required for the practice in producing a satisfactory map by other methods.

For opinions, other than the following, from teachers and school officers who have used, or carefully examined the maps, see special circular which is sent free on application.

Albert G. Boyden, *Prin. State Normal School, Bridgewater, Mass.:* They are admirable, and greatly facilitate the study of geography and history. We use them with much satisfaction for history as well as geography.

Geo. H. Martin, *Agent Mass. State Board of Education:* Both the idea and execution commend themselves fully to my judgement. If they can be made to displace the old "systems" of map-drawing, they will be a boon.

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A list indicating the uses of the series in the teaching of the World as a Whole, or Globe Lessons, is given in a special circular on these maps.

Historical Outline Map of England.

For the Use of Students. By THOMAS C. RONEY, Chicago. 19 x 24 inches. Retail price, 5 cents each. Introduction price, $4.00 per hundred.

THIS map is especially valuable for showing the vital relation between Geography and History, and for illustrating the historic sequence of events. The skillful teacher will make it serve many other subordinate uses. It is an admirable help to the study of English Literature.

The outlines of the counties of modern England and Wales, and of the earldoms and vassal kingdoms of England in the tenth and eleventh centuries are indicated, and suggestions and illustrations as to the use of the map are given on it.

Outline Maps of the United States.

Prepared by EDWARD CHANNING and ALBERT B. HART, Assistant Professors in History in Harvard College. The **Large Map** is on strong white paper, in four sections, each 26 x 42 inches. Price, 15 cents per section; 50 cents complete. Mounted, $3.00. The **Small Map** is on tough white paper, in blue ink, and 11½ x 18 inches. Price, 2 cents each; $1.50 per hundred.

THE sections of the large maps are divided by the 95th meridian and the 37th parallel. They may be used separately or pasted together. The location of the principal cities is indicated by dots and there is no lettering on the map except the numbering of the parallels and meridians. These maps are suitable for large classes or for public lectures as they can be clearly seen for a distance of more than forty feet. By the simple use of shading and colors they may be made to serve in place of elaborate maps of various kinds; physical, geological, political, etc., with the further advantage of allowing teachers to exercise their individual knowledge.

The small map has a broad margin on the right hand side which furnishes space for written comments. The names of the principal rivers and the numbers of the parallels and meridians are printed on these maps. They are useful to the teacher or lecturer, where a map may be passed from hand to hand, and convenient for recording geographic facts in graphic form, and for copying rare or expensive maps. They may serve well for a great variety of exercises in Political History, Economics, Meteorology, Geology, and Physical Geography.

In use at Harvard, Johns Hopkins, University of Pennsylvania, etc., etc. Special circular, more fully describing the method of using these maps, sent free on application.

The Educational Courant, *Louisville, Ky.:* Map drawing is one of the best methods possible in teaching geography, but has not been used by teachers generally on account of the time necessary to teach children how to make outlines. This series of maps, which embraces all that any class will need to use, does away with that stumbling block. If you see them you will use them.

School Education, *Minneapolis, Minn.:* Many teachers whose time is limited are deterred from map sketching by the labor of drawing details. Here we have maps faultlessly proportioned and ready for names. The advantage of such work is incalculable. The larger sectional maps of the United States are also in blank ready for a large historical wall map which will grow in completeness as events are unfolded during the progress of the term's work in history. Each student may work up his own map, or one may be made by the class in common.

Historical Outline Map of Europe.

Printed on bond paper, 12 x 18 inches, in black outline. Price by mail, 3 cents each; $2.25 per hundred.

THIS map, though belonging to the *Progressive Outline Map* Series, is especially intended for the use of classes in History or Science, as fully described under the *Historical Outline Map of the United States* (see page 170).

In addition to the outline of the continent, the principal mountain ranges are also given.

Topics in Geography.

BY W. F. NICHOLS, Principal of Hamilton School, Holyoke, Mass. Cloth. 176 pages. Retail Price, 65 cents.

THIS book contains a comprehensive outline of all geographical facts usually taught in our best primary and grammar schools, together with many excellent suggestions for increasing the interest of pupils by object lessons and language work in geography.

In preparing the Topics the author has aimed: to increase the value of geographical study, to shorten the time usually spent on the study, to give a brief outline for the scientific study of any continent as based upon structure or slope, to deal sparingly or not at all with statistics, but rather to have all areas taught by comparison, to make more prominent the natural curiosities and wonders, and to combine language and geography. It is a practical guide, containing much information concisely stated. A list of books for reference, including many interesting and reliable tales of travel is added.

G. R. Showhan, *Co. Supt. Schools, Urbana, Ill.:* I believe it will be a very useful auxiliary to teachers of our common schools. They do not so much need to be told what to teach as how to teach; as how to select from the great mass of geographical facts those which will prove to be most useful. Your little work will certainly prove to be a valuable guide.

Isaac H. Stout, *lately of Dept. of Instruction, Geneva, N. Y.:* I have examined it carefully and am much pleased with it, believing that it is directly in the line of what so many of our teachers need for their work in the school-room.

E. S. Kirtland, *recently Supt., Holyoke, Mass.:* The Topics in Geography were made in and for our schools, and have been used long enough to prove their value; indeed, I regard the little book as the most useful school-room work that has ever been given to this department.

Miss A. G. Baldwin, *Teacher in Hampden Nor. and Agri. Inst., Va.:* It seems to me admirably fitted for the purpose for which it was intended.

Lessons in the New Geography.

By Spencer Trotter, Professor of Biology and Geology in Swarthmore College, Pa. Cloth. 192 pages. Retail price, $1.00.

THE New Geography is new in the sense that its point of view is essentially *human.* The old methods of geography teaching dealt almost exclusively in the hard facts and dry detail of surface features, political divisions, — an endless, meaningless collection of names, with little if any reference to the true value of geographical conditions as factors in the development of man. As the earth is the theatre of human action, *the true study of geography is a study of human life under the varied conditions of existence imposed by the different regions of the earth.* It is thus synonymous with History. One object of these "Lessons" is to bring this view of the study of Geography, — with a fresh and living interest to the mind of every teacher and student.

Not the least important feature of geographical study, as of all study, is the extent to which the imagination is brought into play in forming *ideas of things.* A mental picture must be created in the child's brain; and the teacher is successful in so far as he or she is able to form this picture in his or her own mind, and vividly reflect it to the pupil. So with a book: its words and sentences must convey *living ideals.* To the extent that it does this will it be interesting, instructive, and valuable as an educational factor.

These "Lessons" aim to fulfil these two phases of the study, — the human and the imaginative. The purpose of the book is to present an outline sketch, suggestive and stimulating, and it is intended as a Reader to supplement the regular work of the teacher and the class.

The various subjects presented in the chapters and lessons are not to be viewed as special and separate treatises. They are brought forward simply to indicate their *relationships* to the whole subject. This is especially true of the lessons dealing with the elementary questions of climate and geology. The book does *not* aim to *train* the student, but to stimulate interest in the *wider relations* of Geography.

From our special circular on this book we quote the following:

R. S. Tarr, *Prof. of Geology, Cornell Univ., Ithaca N.Y.:* The book is well conceived, well prepared, and published in an excellent manner. It is interestingly written, and it deals with matter which ought to be learned by all pupils.

Manual of Geography.

Modern Facts and Ancient Fancies in Geography. A book for teachers. By JACQUES W. REDWAY. Cloth. 175 pages. Retail price, 65 cents.

BEING a world-wide traveller and professional geographer, as well as a practical teacher, Mr. Redway is excellently fitted to make fresh and original suggestions on the study of this subject. His book renders the latest discoveries in Geography available for the use of teachers. Chapters on Out-of-door Lessons, Clay and Sand-modelling and Map-drawing are full of interesting information elsewhere unpublished.

The most striking part of the work is devoted to the discussion of the time-worn traditions that still cumber many even of the most recent text-books. The facts given concerning volcanoes, storms, deserts, sea-depths, ocean-currents, glaciers, etc., etc., have never before found their way into modern school-books, and will be a surprise to most teachers. It is full of useful hints to teachers, and of bright, interesting information for the general reader.

Alex. E. Frye, *Author of "Frye's Geographies:"* I consider it a very valuable contribution to geographical literature. It should be in the hands of all progressive teachers. Its *Hints to Teachers* are invaluable; while its chapters on *Modern Facts and Ancient Fancies* will be a revelation to many.

The work is stimulating, logical and practical; and reflects much credit upon the scholarly attainments of its author.

J. M. Greenwood, *Supt. of Pub. Instruction, Kansas City, Mo.:* One of the most suggestive hand-books for teachers I have ever read. I will recommend it to our teachers.

J. P. Welch, *recently Inst. in State Normal School, West Chester, Pa.:* I read it with much pleasure and profit, and was not surprised at its excellence, because I know the author to be the best informed man, on that subject, that I ever knew.

Miss E. M. Reed, *Prin. Springfield Training School, Mass.:* I think it will be cordially received by teachers. It is very suggestive and covers ground that must have required a lifetime, nearly, to become acquainted with.

Wisconsin Journal of Education: It helps where help is most needed, in effecting a change from mechanical to rational teaching of geography. It is not a dull manual of directions, but an interesting and suggestive treatment of modern pedagogical views in geography. We venture to affirm that teachers of geography will find in it much that is new to them, and plans of work, with practical discussions of ways and means for realizing them, which if followed will make elementary geography a new branch to them and their pupils. The book is thus a manual of methods and matter, the sort of a book which a good geography teacher will want always at hand until familiar with every paragraph in it.

The Reproduction of Geographical Forms.

I. Sand and Clay-Modelling with Reference to Geographical Forms. II. Map-Drawing and Map Projection. By JACQUES W. REDWAY, author of " A Manual of Geography." Illustrated. Paper, 84 pages. Retail price, 30 cents.

THE object of this pamphlet is to group the various forms and outlines of relief into types. The pupil is taught to classify the various types of relief and earth-sculpture, and to reproduce them in sand or in clay, either from pictures or photographs, or from a study of the form as it occurs in nature. By this method the modelling of geographical forms becomes a *science* instead of an aimless expenditure of energy. In the chapter on Map-projection the pupil is taught not only how to *draw* a map, but also how to *project* it as well. A number of easy projections, requiring no more elaborate apparatus than a pair of dividers and a straight-edge, are plotted for the practical use of the pupil. The very important question of how to read and interpret a map is also discussed.

Schoolmaster, *London, Eng.*: This book is full of practical suggestions. We have nowhere seen collected so many hints as to the best methods of modelling in sand and clay, and of utilizing out-door lessons in acquiring the essential facts and principles of geographical study. We commend this work to our readers.

Educational Journal of Va.: This is emphatically a *working* book, and we have seen nothing which so fully accords with our ideas on the subjects treated.

Wisconsin Journal of Education: The single chapter on out-of door lessons is full of suggestions which would enable any intelligent teacher to substitute something better for the text-book memorizing now so common. There are few teachers who would not learn much from this little manual.

Iowa Nor. Monthly : Teachers in primary as well as in grammar grades will find this little book very helpful. The cuts are such as will enable the teacher to fully understand the work in hand.

Intermediate Outline Map of the United States.

For Historical and Geographical Study. Prepared by William A. Mowry, Editor of " Education " and " Common School." 28 x 40 inches. Price, each 30 cents; per set of four, $1.00.

WITH this map colored pencils should be used to fill in the history as it occurred and as fast as the lessons develop the facts. For a full course of U. S. history four maps should be used : (1) Discoveries and explorations to 1763 ; (2) through the Revolution to 1783 ; (3) development and growth to 1861 ; (4) the War of Secession.

The Earth in Space;

Or, a Fortnight in Astronomical Geography. By EDWARD P. JACKSON, Instructor in Science at the Boston Latin School. Illustrated. Cloth. 80 pages. Retail price, 40 cents. Special price for class use.

TO many persons otherwise well informed, this subject is an ever-perplexing mystery. Familiar with the topography, geology, and political history of the world they inhabit, they know little of it as a *unit*, in its relation to other worlds. This book presents, in a few simple lessons, the main features of this important branch of Geography. It is adapted to grammar and intermediate schools.

The following is the Table of Contents: How we know that the earth is spherical; How we know that the earth is flattened at the poles; Latitude and Longitude; Zones; Dimensions and Distances: How we know these; Gradual changes in light and heat during the day and the year; How we know that the earth rotates; Apparent daily motion of the heavens; How we know that the earth revolves; The inclination of the axis; The sun's declinations; The change of seasons; The variation in the length of day and night; Appendix.

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