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MAP MAKING AND MAP READING

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INTRODUCTION

IT was the privilege of the writer, during the past summer, to conduct a number of field excursions in geography with North Carolina teachers. At the outset, many of the teachers expressed the desire to undertake map making out of doors. Every one of the teachers had followed, to the best of her ability, the directions which her own school text-book and the supplementary books had yielded for mapping the schoolroom or school yard. They were not sure, however, that the result of their conscientious endeavors was the desirable one, nor were they sure why the books were insistent upon this exercise. Furthermore they were not certain when this work was done that any more in this line was demanded of them. They were not on familiar ground. A similar uncertainty exists among teachers generally, for nearly all are in doubt as to the advisability of even trying map drawing in school work.

The present condition is, in part, the result of lack of clearness and completeness in the statement of what is desired, and is a good illustration of the unfortunate period which often follows the promulgation of new ideas, between the time of a teacher's schooling and her assuming a teacher's responsibilities, when the medium for the transmission of the ideal of reform does not adequately enlighten. The best thing concerning map drawing has not been said. Along many lines of map work there are differences of opinion, and hence it is not strange that the teacher hesitates. The present article is not written to cover the whole field of map exercises, but to present certain helpful points in reference to a few fundamentals. The writer assumes the responsibility of no new ideal, but insists on a more careful plan and longer training in order to realize as far as possible the old. Its specific aim is to aid a number of teachers who have in times past sought aid, and it has been submitted for publication only in the belief that there is a general desire for help in this direction. No attempt will be made to divide the work according to the demands of the grades, but all of the suggestions are applicable to the work of the elementary schools.

FIRST STEPS

The first duty of a teacher is to lead the pupils to realize that the map is a reproduction, to scale, of a portion of the earth. This is

not altogether a simple task. The present-day judgment concerning the best method by which this idea may be inculcated finds its expression in the directions for map drawing in most elementary books on geography. The steps are three—reproduction, reproduction to scale, and an oriented reproduction to scale. The first introduces the child to symbols and may easily represent a lesson in drawing. A very crude rectangle, as a sign for the schoolroom, is the temporary goal. The second has for its object the sense of proportion. The third combines the sense of direction and location. Finished work cannot be expected during this stage, but the essentials should be strongly emphasized. Here may be ingrained neatness and care without which no success in map work may be attained. A very poor drawing in the elementary stage may be made with neatness and care.

SCALE

Passing over the elementary drill on the scale which is well discussed in many books, let us turn to another phase of the subject. Every map made by the pupils should have a scale appended. As a map of a locality, it is imperfect without one. Some maps used in the schools, such as the Mercator projections, because of an increase in the scale with an increase in latitude, do not lend themselves readily to an expression of distance or size. The scale may be stated in two ways, either by the number of feet or miles represented by one inch of the reproduction, or by stating the fractional part the reproduction is to the area itself. The former is the common method in school atlases to-day, and the scale is often expressed by a line segmented to the proper lengths. The latter is the method used by government surveys. The topographic maps of the United States Geological Survey, for instance, have their scale expressed as $\frac{1}{62,500}$, $\frac{1}{125,000}$, etc. The interpretation is simple. One inch, foot, or metre on the map is equivalent to 62,500 inches, feet, or metres on the surface of the earth. It expresses at once a ratio between the reproduction and the actual. It has a value beyond its simplicity. It is expressed in a universal language. The unit of measurement may be different as it is in the various nations, the language may be a strange one, but the fraction stating the scale of a map allows but one interpretation.

In mapping a school yard, using the pace as a unit of measurement, the scales of the maps of twenty pupils would tend to confuse rather than enlighten, and the teacher who has to correct the reproductions has no basis for comparison. In pacing, the pupil should be taught to walk naturally. To try to lengthen the step to a yard

is wearisome, often impossible for children, and certainly ungainly; and in much such pacing the steps are unconsciously shortened. Each pupil may ascertain the length of his natural step by walking over a measured distance a number of times and dividing the number of steps taken into the entire distance. This will serve as a unit of measurement for all out-of-door mapping. The transformation to the fractional scale is not difficult and may serve as a lesson during the mathematics period. It seems best to urge the use of this scale on all maps constructed by the pupils.

COMPASS

The reproduced school yard is not complete without a symbol for orientation. The ordinary one in use is an arrow pointing towards the geographical pole. It is possible that the meridian line has been found by the sun, and a mark on the ground, or a chalk line on the bricks, exists as the class's determination of the north and south line. The introduction of the compass, in its proper time, on this line, will show the deviation between the geographical and magnetic meridians, and a second line across the first, parallel with the compass needle, will mark the direction of the magnetic pole. In the corner of the map may then be added, pointing in the proper directions, these two lines.

When the pupils are fairly sure of the meaning of orientation, a useful exercise may be given by passing out papers with the compass indicated and allow them to draw the map of the yard. On the ordinary atlas maps, meridians serve the office of the needle. The transformation from reading a map with a compass to reading a map with projected meridians has been slighted. The idea that up on the map is north, and right is east, introduces an error from which even the teachers of geography are not free. Pupils are not corrected for ignoring the meridian lines of a map. Many pupils are not taught to see them. Without the meridians, what is below is south. A distorted idea is thus gained. Take the map of North America, and, without consultation, let the teacher state for herself, or allow the pupils to tell, what city in the United States lies almost north of Havana. Few pupils are loath to name a city west of Albany, and in a gathering of half a dozen teachers, one with hesitation answered Buffalo. A few problems of this nature will show how essential is an emphasis on the meridian lines of a map, especially far to the east and west of the centrally-projected meridian. This difference between a map with a compass symbol and some meridian-marked maps should be fixed upon the attention as early as possible.

SYMBOLS

Map reading is an interpretation of symbols. From the very beginning of geography, the introduction of symbols is proper. "Conventionalization and symbolization seem to be an inborn trait of the human family." *

The first maps should be the means of introducing a few symbols. No generally accepted list of symbols for use is published. Text-books vary somewhat in the points, emphasized slightly up to this time. The topographic maps of the United States Geological Survey may be taken for a standard. At some time in the grade a familiarity with these maps is advisable, for the legend is simple and easy. There seems to be no argument against the use of a few of their conventional signs. In a district map, where roads, bridges, brooks, and buildings are used and plotted, some legend is demanded; the one that is to be used later, if within the comprehension of the pupil, is the proper one.

Writing on the maps should not be encouraged when the symbol is definite. The writing of "street" on the symbol for the same, "river" on its symbol, defeats the use of the sign language. If the sign is there, the word is superfluous. As long as a universal sign language for maps has not been accepted, a legend must be appended to every exercise. Some elementary books use as a symbol for "tree" a printed outline of a tree. Two objections may be raised to such kinds of symbols. In the first place the printed outline takes more room than the space marked out for the tree according to the scale of the map, and again it will not be easy to persuade the child that it is a symbol, not a picture; that the house cannot be pictured by its outline, a bridge by the same method; that a stone wall or a fence cannot be introduced in a similar way; that a pictorial plan is not a map.

Water and culture lines should be started early in the work. As soon as possible the relief lines should be begun. Reading relief from contour lines is a habit to be cultivated.

CROSS-SECTION

The topographic maps are superior to most maps in ordinary use. The maps are contoured for every 20, 50, or 100 feet of vertical height. The idea of contour lines is best obtained from a field exercise. If a locality is selected in which a hill rises sharply from a level base, the problem may be easily expounded. The base will be the zero line. For every foot of height, if the hill be low, a pebble may be placed on the slope. A line of pebbles around the hill will mark, then, the foot

* Redway, *New Basis of Geography*, page 139.

contour line. In mapping, plot the pebble lines as one would were they roads. While still in the field, a cross-section may be started. Standing to one side where a view of the hill, sharply outlined, may be had, sketch the outline. Then, by pacing, make the outline to scale. The steps to the drawing of a cross-section of one or two portions of a topographic map are then simple. A little of such work should be done; a great deal is a waste of time.

Cross-sections should always be drawn with the vertical scale and horizontal scales alike. The transposition of a 1500-foot contour to the scale of $\frac{1}{25000}$ should be practiced until it is made easily. One or two well-selected cross-sections will fix the insignificance of the irregularities of the earth. A section of the ocean depths from the mouth of the Amazon to Libreville in the French Congo, along the equator, is an excellent choice. The distance is approximately 60° of arc. With a 12-foot radius the irregularities of the ocean floor do not appear. The width of the thinnest line is then too wide to show the ocean depth.

A FEW ILLUSTRATIONS

For a first exercise in mapping—the preliminary consideration of scale being understood—the remnant of a hill was used. The locality was selected because the slope was prominent. The emphasis of the exercise was placed on compass readings and contour lines. Four points, *A*, *B*, *C*, and *D* (Figure 1), were selected as the corners of the area.

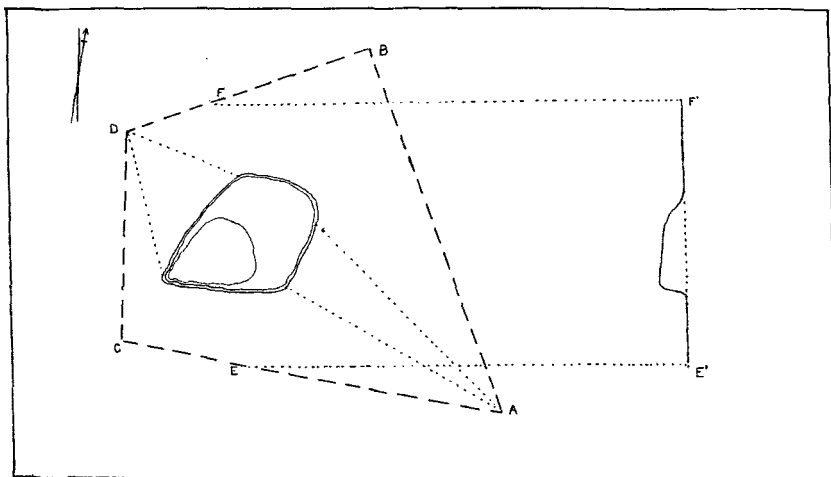


FIG. 1. Map and cross-section of a hill. Scale, $\frac{1}{500}$. ——— Contour lines; interval three feet.

The data, obtained by the pupils, were as follows:

From *A* *C* is N 80° W. 53 paces.

B is N 20° W. 53 paces.

SE base of hill is N 60° W. 34 paces.

NE base of hill is N 45° W. 36 paces.

From *D* *B* is N 70° E. 36 paces.

C is due S. 28 paces.

NW base of hill is S 70° E. 17 paces.

SW base of hill is S 15° E. 20 paces.

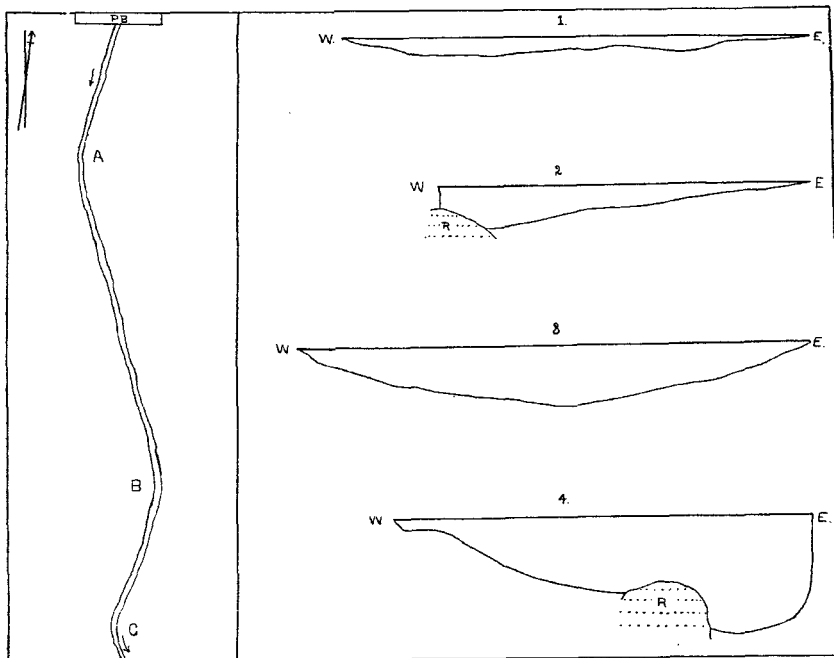


FIG. 2. Map and cross sections of brook. Scale of map, $\frac{1}{400}$. Scale of section, $\frac{1}{10}$.
R rock. P B park bridge.

Stations *B* and *C* are used to check the above readings. The contour lines may then be plotted from the stations at the base of the hill. The height is an average estimation, and the horizontal distances between the contours are determined in the same way. A cross-section is then added.

Another exercise, Figure 2, was undertaken along a neighboring brook. All distances along the brook were paced. All measurements of the width and depth of the brook were measured accurately.

Data:

From Bridge (P. B.) brook runs S 12° W. 19 paces to Bend A.

From Bend A brook runs S 15° E. 45 paces to Bend B.

From Bend B brook runs S 20° W. 12 paces to Bend C.

From Bend C brook runs S 20° E, and on.

1. Cross-section in straight reach between A and B, depth expressed in cm., readings every 10 cm. from west to east.

0	1.4	3.6	3.5	3	2	2.8	2.5	1	0
Current swift.									

2. Same at Bend C.

5	(rock)	9	8.7	5.3	4.4	3.6	2.9	1.2	0
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3. Same in straight reach between B and C.

0	5.8	7.8	10.4	11.5	12.4	12.2	10.5	9.5	7	4.9	0
Current slow.											

4. Same at Bend B.

2	2.5	8.6	11.5	14.3	16	12.8	(rock)	26	25	19.9	(undercutting)
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A third exercise, Figure 3, was conducted along a strip of coast.

Data:

From A (rock) beach runs N 12° E.

Beach runs S 20° E to S 70 paces.

From S to B (rock) line runs S 45° W. 107 paces.

From B to T E. 57 paces.

From T to C (rock) S. 30 paces.

From C rock extends west 13 paces.

From C shore runs E to D (rock) and on.

In this exercise, as in the others, the data were supplemented by rough sketches and some attempt was made to incorporate into the maps the ideas expressed in the free-hand outline. Thus the slight irregularities in the curved coast line between A and B were observed and mapped.

INFERENCES FROM EXERCISES

The journey to the brook opened a number of interesting problems. These may be considered in papers presented by the pupils. It is very evident that in the bends of the stream one kind of cross-section obtains, while in the straight reaches the section was of a different type. Notes were made concerning the swiftest part of the current in each section; that this swiftest line of flow crossed the channel was among the conclusions. That is hardly a safe principle that would apply all the results of an investigation of 150 feet of a single stream to all streams. It is better to leave a few problems unsettled until

further investigation and observation allow a definite answer. Thus, from the stream measurement, it seems to be a natural deduction that the swifter parts of brooks have a shallower flow of water than the

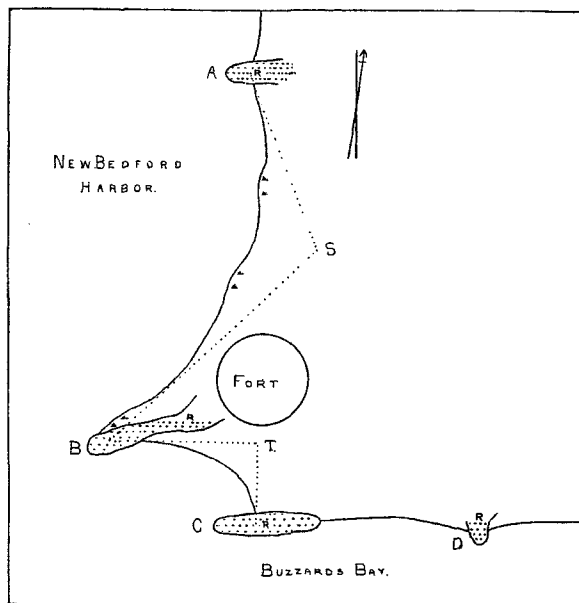


FIG. 3 Map of coast-line. Scale, $\frac{1}{4250}$. R rock.

slower portions. Some problems will be presented that can not be solved, either because of lack of time or because of insufficient data. It may be convenient to some members of the class to investigate the brook further and to present a more comprehensive report on one or more problems. At least it is well to leave the exercise in such a way that, either as an investigator of the physics of rivers, or as a casual observer, the pupil may approach a stream, not in the belief that all its ways are known, but with the inspiration from knowing something of its history, and the enthusiasm which the hope of discovery begets.

The conclusion from the shore map should be treated in a similar manner. A reserve of judgment is advised. In regard to the location studied, let the statements be definite. At the Fort (Figure 3), the salients are rocks, and between them the beaches are curved. That all salients are rocks might be a next step. Between A and B bunches of shore grass catch the sand and cause slight irregularities in the curve of this beach. The case is so evident in the field that it is remarked upon by a pupil. Perhaps, then, some other things besides rocks mark the salients of a coast. An island in the harbor, showing

the white line of a sand spit, reënforces the statement. At a later period these may enter the discussion and be investigated. For the present we know that rocks form salients, and are one cause at least for the irregularities of coast lines.

MAP DRAWING

Before map reading is perfected, a conception of the error of the maps in constant use is necessary. It has been the general printed opinion that exercises in map projections, although ideally a desirable part of a child's knowledge, are best not considered in the grades. There are many things in projections that mature minds only can grasp; at the same time there are some elementary considerations in the subject which should be properly delegated to the geography teaching in the schools below the Secondary. The study of a globe follows naturally the construction of the maps of limited areas. The child may believe, as the human race did in its infancy, that the earth is flat. The introduction to a spherical earth at this time repeats the race history. At some later time in the grades the spherical maps and the flat maps must be considered in comparison. There is no better way than to have the child construct two or three types.

A Mercator map is not beyond the child's comprehension. With little difficulty, a figure, like Figure 4, may be made. The pupils should

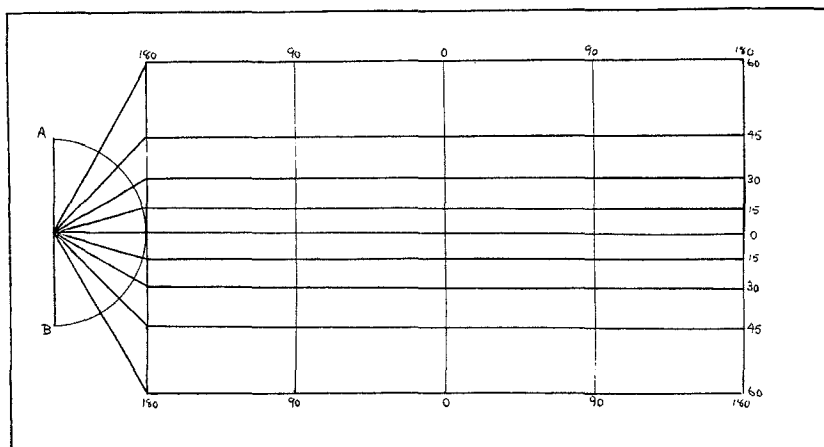


FIG. 4. Construction of Mercator Projection.

have the small hand globes. If the diameter, AB , is made equivalent to the diameter of the globe, the later comparisons are more obvious. The equator of the map should equal in length the circumference of the globe. When the diagram is made the map may be begun. It

is not necessary to complete the whole map of the world, but enough of it must be undertaken to show the distortion. It may be advisable to plot points only, as Cape Farewell and Christiania on the 60th parallel. Compare the plotted distance with the true. In like manner take locations nearer the equator. Then the latitudinal distortion may be proved in a similar manner, or a teacher may consider it wise to construct a map of North America after having plotted thirty or forty points around its coast. Here may be emphasized at the same time the preliminary steps of great circle directions. An investigation of the shortest distance between Mt. McKinley, Alaska, and St. Petersburg, on the globe, and on the Mercator projection, will easily show that the latitudinal direction is not the desirable one in point of distance.

Constructions of other projections would consume too much time. If, however, blank outlines of one or two projections in common use be furnished the pupil, a similar use may be made of them. It is advisable to have the circumference of the globe and the circumference of the projection alike at first, as direct comparisons may then be made without the confusion of a change of scale.

The plotting of points from a globe is beneficial, furthermore, because the pupil must say to himself the latitude and longitude of the localities plotted, a thing that map copying does not make necessary.

MAP READING

"Teaching words before ideas has the same effect as teaching a map without associating it with that which it represents. The problem of how to lead children to use maps properly, that is, to make a map a means of developing thought power, is an exceedingly serious and important one. All directions and suggestions, therefore, should tend toward this one purpose." So said Francis W. Parker.*

Stress has been laid, up to this time, on the construction of maps; not, however, as an end in itself, but as a means of acquiring some of the habits of map reading. If, in its proper time, there should be added to this foundation the knowledge of the wind belts and the ocean currents of the earth, a great deal of the text of a geography may be discovered by the pupil. In order that this work may be carried on safely, the best maps should be employed. A more intelligent understanding of geographic relationships may be attained from an increasing use of questions demanding judgment and reason. Further expansion of this would only repeat what has already been printed in this JOURNAL.†

* *How to Study Geography*, page 92.

† *Journal of Geography*, Vol. I, "The Use of Maps in the Teaching of Geography," page 97, 1903.