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New Laboratory Methods for Instruction in Geography

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NEW LABORATORY METHODS FOR INSTRUCTION IN GEOGRAPHY

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I. MAP AND MODELING APPARATUS¹

Map contours, the notation of physiography. Until the student has become familiar with the idea and use of surface contours as employed on hypsometric maps, a very large part of the field of physiography remains closed to him. He is in the position of the student of music who is unfamiliar with musical notation. Thus in a strict sense he is debarred from making use of the great reference libraries of physiography; the topographic atlas sheets, until he has acquired the language in which they are printed. Some students, and those especially who possess what the Germans term *Vorstellungsgabe*, and we *visualizing power*, move rapidly toward an intelligent use of the map. Others will require every aid which can be afforded them before the grammar even of the subject is acquired. For many it will only be necessary to read with care the excellent and remarkably clear statements concerning the manner in which contours

¹ The greater part of this paper was first published in *School Science and Mathematics* in October, 1908. An outline of the subject was presented in August before the International Geographical Congress at Geneva, Switzerland; and although at that time in type for the pages of *School Science*, a request came from the editor of the *Scottish Geographic Magazine* to reprint it, and it accordingly appeared in that journal in December, 1908. Immediately upon the appearance of the paper in the last mentioned journal came a request from the editor of the JOURNAL OF GEOGRAPHY to allow it to be reprinted in the January number of this journal. Inasmuch, however, as the apparatus described had, in the meantime, been much improved, the paper is here republished with new cuts representing the later form, and with considerable modifications and additions to the text. The second part of the original contribution, which related to laboratory methods in geology, by request of the editor will appear in a succeeding number of this journal in a similarly modified form.—THE AUTHOR.

express elevation, which appear upon the inside of the covers of the United States Geologic Folios. Obviously it is not for such students that the aids hereinafter to be described were especially designed, though it is thought that even for them individual laboratory study with the apparatus will be distinctly advantageous.

Precise vs. accurate maps. A topographic contour map being always an approximation only to the correct representation of the configuration of the country, it may be described in terms (1) of the measure in which it assumes to approach a correct delineation, and, (2) the measure of warrant for the degree of correctness assumed. These contrasted ideas are embodied in the terms precision and accuracy. The measure of precision is afforded by the map in its scale and in its contour interval. A map printed on the scale of two inches to the mile and with a contour interval of ten feet, makes larger assumptions than one printed on the scale of two miles to the inch and with a contour interval of one hundred feet. Though more precise, the former may be no more accurate than the latter. Assuming, however, that the map has been intelligently, skillfully, and conscientiously made, its accuracy will depend chiefly upon how many points there are upon the map whose position and elevation have been determined, since these are the basis upon which the contours have been sketched.

Method of preparing maps. In the case of the most accurate of contour maps, the engineer by means of his transit locates and fixes the altitude of a very large number of points. He notes at each of these, or at such points as seem necessary for his purpose, the direction and the angle of the slope. Contour lines, representing as they do points on the same level, are horizontal, and hence at right angles to the direction of slope. The map makers' task is, therefore, completed by drawing his contour lines perpendicular to the lines of steepest slope, and at such distances from the points already located as the altitudes and angles of slope at each of the latter require. The simple apparatus to be described aims to put the student in the position of the engineer who makes the map, and when the map has been completed, to apply a simple test of its accuracy from the use of which the actual map maker is debarred.

Map and modeling apparatus for laboratory use—the tank. The apparatus for the purpose consists of a tank made from galvanized iron which is one foot square upon the bottom and five inches in depth (See Fig. 1), with a flange or rim at the top. On each of two opposite sides this rim is provided with a scale graduated into inches and quarters of an inch, and the distance between these flange scales may be accurately

adjusted by screw bolts which work in slots at the corners of the tank. The tank is further provided with a brass faucet on one side, set low enough to empty it of water to one-half inch from the bottom. A vertical scale four inches in length and graduated into half inches is set within the tank at the back, and short lines are provided on the three remaining sides of the tank at a height of four inches above the bottom. It is thus possible to roughly level the tank when filled with water to this depth. The vertical gauge is

FIG. 1. General View of Map and Modeling Apparatus

provided to permit of withdrawing water from the uppermost mark in successive half-inch layers.

The measuring attachment. The measuring attachment to the apparatus is simply a device for fixing the position in terms of three rectangular coördinates of any point within the tank. This attachment consists of three parts, namely, (a) *the sliding track*, (b) *the locating carriage*, and (c) *the altitude gauge*, all of which are made from brass and plated.

The sliding track (See Figs. 1, 2 and 5) consists of two brass bars one-quarter inch square in cross-section, which are joined at the ends through an intermediate short piece of the same material separating the two from each other and leaving a slot between them one-quarter inch in width and of the full length of the tank. The attachment when laid across

Fig. 2 The locating carriage and altitude gauge when the point of the gauge rests upon the bottom of the tank the reading is zero. When at an altitude of one half an inch the reading is 1, when at one inch the reading is 2, etc. The normal contour interval for the gauge is therefore one half inch, though it can, if desired, be made one fourth inch.

the tank from the graduated flange on one side to that upon the other, projects beyond each by about one quarter of an inch. A post fitted with thread and screw nut is set upon the under side and at each end of the attachment, so that it may be clamped to the flange in any desired position. It is thus a simple matter to slide the track to any required position (providing only it is kept parallel to the ungraduated rims of the tank), and there to clamp it firmly. The sliding track thus serves to fix definitely and in succession a series of parallel sections across the tank. For fixing the position of the locating carriage, a graduation into inches and quarters of an inch is borne upon one side of the sliding track.

The *locating carriage*, whose form and construction will be sufficiently clear from Fig. 5, is of brass and moves easily along the attachment to any desired point, determined by the graduation upon the track. The purpose of the carriage is to supply a second coördinate in the measurement and thus to complete the *location* in the *plan* of any point which is within the tank.

The *altitude gauge* (See Figs. 2 and 5) is a bar of brass of circular cross section brought to a dull point at its lower end and graduated into quarters of an inch. A simple spring in the locating carriage supports it at any desired altitude within the limits of its length, and the graduation is so made that

Models of typical land forms. Mr. Irving D. Scott, instructor in Physiographical Geology at the University of Michigan, has prepared a series of six waterproof plaster models adapted for use in connection with the above described apparatus. Each of these models is made eleven inches square, so as to fit easily within the tank and also be easily removed (See Fig. 3). Care has been taken that the amount of relief in these models is such as to secure the best results, and the details of the modeling are made relatively simple. When not in use with the map apparatus this series of models serves to illustrate typical land forms for classes in physical geography. A series of models used in this way are: 1, a mesa and dis-

sected plateau; 2, a river flood plain with terraces; 3, an embayed coast; 4, Scottish glens (glacier-carved valleys); 5, a group of drumlins; 6, a group of volcanoes.

Use of the apparatus in map making. To prepare a contour map of any desired model, the latter is placed on the bottom of the tank, and

FIG. 3. A Model for use with the Map Apparatus

the sliding track of the attachment is fixed in position one inch from the left-hand ungraduated rim. In this position the point of the altitude gauge is allowed to traverse a section one-half inch within the left-hand margin of the model. Measurements are now made successively at suitable intervals along this first section of the model's surface, and the readings are recorded at the corresponding points upon special cross-section paper (See Fig. 4). One section completed, the sliding track is moved forward one inch, a like series of measurements carried out, and so on successively until all sections have been covered.

With the model still before him the student now begins drawing in the contours (See Fig. 4). After such corrections as the instructor can suggest have been made, the tank is filled with water to the 4-inch mark and roughly leveled. This water is now drawn off in successive half-inch

layers and each contour of the map is in turn compared with the temporary shore line of the model to which it should correspond. (See Fig. 5.)

The association of a definite form of model with each map which the student prepares, tends to supply the form element to the map in a way not possible where no similarly comprehensive view of surface form is

FIG. 4. A Student's Map on Special Section Paper of Crater Lake

obtained. The section paper used in the exercises being chosen with a unit of one half inch for each inch upon the model, affords further the fundamental idea of map scale. If alternate contours be first drawn in, a comparison of this preliminary map with the completed one will show how the shorter contour interval adds detail to the map.

Each apparatus is usually provided with two measuring attachments and so made available for use at the same time by a group of four students, two of whom record the measurements which the others record. The

sliding tracks may be quickly removed from the tank and reversed in position, which allows the students working upon one side to be free from interference from those working upon the other. The special map sheets are numbered in both directions in order to facilitate this double use of the apparatus. With six tanks a laboratory section of twenty-four students can thus be accommodated.

Use of the tank in modeling. To use the tank as a modeling ap-

FIG. 5. The Apparatus in use for Testing the Contours of the Student's Map
(In order to photograph the water-layer a little milk has here been added to the water)

paratus a piece of stout board eleven inches square is placed in the bottom and wedged in position by small blocks on all sides, the method used in fixing the position of models. A second tank may be fitted with a similar board and the contour map which it is desired to model, fastened to its upper surface by thumb tacks. For the time being the two tanks may be designated the model tank and the map tank respectively, and each is used with one measuring attachment only.

The process of modeling is in principle very simple. The attachment of each tank is set at the distance of one inch from the margin, and beginning in the usual way the altitude gauge of the map tank is set at the crossing of the first heavy contour. The altitude gauge of the model tank

is set in the same position upon its track and given the height demanded by the contour in question. Composite clay or other modeling material is built up to this height upon the board and shaped in approximate correspondence with the topography in the vicinity. The altitude gauges are then moved forward to the next crossing point of a heavy contour line (or as far as seems necessary) and the same process repeated. It is now possible to correct the model in the course traversed by the altitude gauge, and roughly to shape the country in advance. One section of the model completed in this fashion, the tracks are each moved forward one inch, or as far as is consistent with practical working, and the same procedure continued until the model is completed.

With use of a single tank essentially the same process may be carried out by use of a glass or celluloid plate a foot square on which a network of lines repeating in varying depths, quarter, half, and full inch intervals in either direction, has been drawn. Thumb tacks passing through perforations at the corners of this plate insure that its position is not changed in reference to the map while the work is in progress.

NOTE.—The apparatus above described is now manufactured and sold by Eberbach & Son Company of Ann Arbor, Mich.

EXHIBIT OF FOREIGN MAPS, ATLASES AND TEXTS.—The American Geographical Society will exhibit at their rooms, 15 West 81st Street, New York City, from December 21, 1908, to January 29, 1909, an interesting collection of foreign maps, and atlases, with a few texts.

This collection has been received from Germany, Austria-Hungary, France, Belgium, Switzerland and the United Kingdom and is representative of the best in the way of foreign wall maps and atlases.

After the close of the exhibit the American Geographical Society will loan the collection to any institution that will pay the freight on it from the previous place of exhibit. Here is a chance that ought to appeal to local geographical societies and normal schools.

The Society has published a sixteen-page annotated catalogue that will show the character of the collection. The Society should be addressed as above indicated.