

**GEOGRAPHICAL AND
GEOLOGICAL SURVEYS. FROM
THE NORTH AMERICAN REVIEW
FOR JULY AND OCTOBER, 1875**

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J. D. WHITNEY

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GEOGRAPHICAL AND GEOLOGICAL SURVEYS.

I. GEOGRAPHICAL.

THERE was perhaps never a time when so much general interest was felt in geographical work as at the present. Geography is decidedly the fashionable science; that is to say, not exactly geography, but geographical exploration, or, in other words, the investigation of the yet unknown portions of the earth. All the European nations are vying with each other as to which shall be the lucky country to secure the honor of being the first to solve some one of the few great geographical problems which yet remain to be worked out. England soon starts her expedition to the farthest North, roused to action in this direction, after many years of waiting, by the successes of the Americans, the Swedes, and the Austrians. The Germans themselves are attacking the one great question which Africa has yet to offer, namely, the tracing of the mighty Congo River to its source; while an Englishman is also struggling — unless he has already succumbed to some one of the many dangers of African exploration — to follow the connection of the lakes about which Livingstone's last work was done, and which he believed to be the head of the Nile, but which are now known, almost to a certainty, to belong to the hydrographical basin of the Congo.

Geographical societies and journals were never more numerous in Europe, or more fully patronized, than they now are; geographical papers find their way into the quarterlies and monthly literary magazines; and the sale of photographs of scenery is rapidly increasing, and tending powerfully to develop an interest in all peculiar features of the earth's surface, and

thus leading to the study of comparative geography. All along the base of the great European chain of mountains, the Alps, and on both sides of it, clubs have been formed for the purpose of uniting the means and energies of the many in the work of exploring the unvisited portions of the range, and of thoroughly working out the details of that which is as yet only partially known. These clubs number their members by the hundreds, and their published volumes already form a goodly series.

But while all this and much more of the same kind is being done, indicating a lively interest on the part of the general public in those explorations which have, as the result to be attained, some brilliant discovery, or the settlement of some long-discussed problem, there is, at the same time, another class of geographical work always in progress and on a vastly greater scale and of vastly greater importance than that of mere exploration, but in regard to which the general public knows almost nothing, and to which the popular magazines hardly ever allude. We refer, of course, to the great topographical surveys which are being carried on in every civilized country in the world, almost without exception, and which have for their object the preparation of topographical maps of the regions surveyed. Such maps have as their essential features absolute accuracy and minuteness of detail; and in this respect they contrast strongly with the work of preliminary exploration, or of reconnoissance, as this sort of surveying is commonly called. By the work of a preliminary reconnoissance, the character of the dominant physical features of a previously unknown region is ascertained, a laudable curiosity satisfied, and the nature of certain great commercial problems indicated. The topographical survey, on the other hand, presupposes a country already settled, and having made considerable progress in civilization, art, and commerce, so that land has acquired a high value, thus rendering accuracy in the determination of its subdivisions a matter of pecuniary importance. The object of the writer of this paper is, to explain in a popular way, without the use of any more technical terms than are absolutely necessary, the difference between geographical exploration, or reconnoissances, and topographical surveys,

and also to show what the latter are intended for, and what other civilized nations are doing in this line. It will then be interesting to inquire what the United States, either in their collective capacity or singly, have been able to accomplish towards a complete mapping of their own territory, and to give some hints as to what yet remains for us to do, that we may be put on a par with other countries with which we are much in the habit of considering ourselves, if not a little superior, at least fully equal in point of general intellectual development. The recent discussion of this subject in the Legislature of the State of Massachusetts has very clearly brought out the fact that, in regard to the value and cost of a topographical survey, or, in other words, of a correct map, our law-makers and a good part of the general public are very much in the dark; and it is hoped that a careful setting forth of some of the principal facts, by one who has had considerable experience in this sort of work, under United States and State authority, may be of interest, and perhaps useful when the subject is again brought up for discussion.

Let us first consider in what way the surface of the earth may be delineated, so that the result may be available for use. Almost every one, even the youngest school-boy, has some general idea of what a map is, and how by certain conventional signs it is the aim of the map-maker to place before the eye a miniature representation of some portion of the earth's surface, so that the relative position of its natural features, and of the artificial constructions or lines drawn upon it, may be taken in at a glance. These natural features are rivers, lakes, oceans, mountains; the artificial constructions are streets, roads, buildings, railroads, canals, and the like; the artificial lines which need to be indicated are the boundaries between States and towns, and other similar subdivisions of public and private property. That the above-mentioned features can easily be indicated on a map by lines, when their position has been carefully ascertained by instrumental measurements, is not difficult to understand; but there is another important element which needs representation, but which can at best only be approximately shown, and in regard to the best method of doing which there is no clearly established opinion. This element is the

vertical, or the relative elevation of different portions of the surface, which we know exactly whenever we can ascertain the precise height of every point above some fixed datum line, and which can also be approximately indicated by conventional symbols, as will shortly be explained. As this is an important question in topographical surveys, and one not well understood by the general public, some little detail in regard to it may be acceptable.

The most accurate and, in some respects, the most satisfactory way of representing the surface of any region is, to make a model of it; that is, a copy, in relief, necessarily on a greatly diminished scale, by which all the natural features, including the vertical element, are represented. Such models are usually first worked out in clay, just as a statue is copied by a sculptor from a living model, and then cast in plaster; or it may be carved in wood, or cut in cork, or made by piling sheets of cardboard cut into the proper shape upon each other. The data for such models must, of course, be obtained by measurements on the earth's surface, just as they would have to be if a map were to be made. These topographical models are particularly interesting and valuable when they include regions covered by lofty and precipitous mountains; and such have been made for parts of Switzerland which are visited by great crowds of pleasure-travellers. One, in particular, at Geneva, is wonderful in its execution, and is studied with the greatest interest by thousands who have climbed or tarried with delight under the shadow of the "monarch of mountains." Such models, however, are not only extremely costly, but they are, as may well be imagined, very cumbrous and entirely unsuited for transportation; neither can they be duplicated without great cost, unless limited to very small areas and made on a small scale. Hence they are rarely used, unless in peculiar and exceptional cases. Thus, for instance, in laying out a park for a large city, where the work is all to be done at once, and where the amount of money to be expended is very great in proportion to the area of ground used, and where the vertical element is of great importance, a model may often be of great assistance and indeed almost indispensable.

A photograph from a model gives, if taken with skill, under

a suitable illumination, a wonderfully clear idea of the relief of the surface. One such, of the vicinity of Mont Blanc, done by a French artist, on a scale of 1 : 80,000, lies before us, and nothing can be more satisfactory than the way in which the form of the surface is brought out by it, so that the eye can appreciate, at a glance, the exact relative position and elevation of the different parts of that great mountain mass. There are obvious reasons, however, why such models and photographs from models cannot come into general use. They are too expensive and not sufficiently portable, — portability being a very essential element in the use of geographical material. They are well adapted, however, for many purposes in teaching, and especially for conveying the first general idea of forms of surface to the young; they are also invaluable for illustrating geological structure in difficult and complicated regions.

Paper is the material on which the topography of a country is usually exhibited; and maps drawn upon paper, or else engraved or lithographed and then printed on that material, are in almost universal use. Hence a map means a representation on paper of some part of the earth's surface. It is easy to see that the first question to be asked in constructing a map is, What shall be its scale? or, What proportion shall it bear to nature? The school-boy's map of a hemisphere can hardly be more than a hundred-millionth of the natural size of the part of the earth which it covers, since it must show half the world on one small piece of paper; while the British Ordnance Survey map of the city of London is on a scale of one-thousandth, and occupies no less than 821 sheets. The former hardly does more than roughly indicate the boundaries of a continent, and of the principal states into which it is divided; while the latter exhibits the exact form and position of every building and division line of the land in the city. It will be easily understood that, in order that small objects may find room on which to be represented, a large scale must be adopted. It will also be not difficult to perceive that, in order to be able to prepare a map on a large scale, the preliminary topographical work must have been done with a proportionate degree of accuracy and minuteness of detail. The amount of time and money which has to be expended on a work of this kind is

proportionate to the amount of information it is intended to exhibit, and that this expenditure should be proportional to the importance of the area to be surveyed, that is, to its wealth and the density of its population, seems evident; and this would lead us to infer that the mostly thickly settled and richest countries must have the most accurate maps. This, however, is not uniformly the case; the general intelligence of the people, or their rulers, their habits of thought, and their appreciation of the practical use to which scientifically accurate work may be put, are also important factors, as will perhaps be discovered from what is said further on in these pages.

The determination of the scale to be adopted in any topographical survey means, then, the determination of the accuracy with which it is to be conducted, or the amount of detail to be put into the work. And it does not appear difficult to understand that, in a large country or state, it may be advisable to employ several different scales, or to proportion the accuracy of the survey to the importance of any separate division. A country like Belgium, of very small area, and with a population about equally distributed over its surface, would naturally be satisfied with much less variety of scale than would be advisable in Norway or Sweden, some portions of whose territory are very thinly inhabited. The same considerations would apply still more forcibly to our own country, great areas of which are almost worthless, or at best of no importance, except as having to be passed over in order to get in the shortest way from one part to another of our extended territory. It is true, however, that the same country usually requires maps on more than one scale, even if the survey is to be equally accurate over the whole area. For local details and for ordinary practical use, a map on a large scale is needed; but this requires that the work shall occupy a great number of sheets, on each of which only a small area can be given; so that, for general geographical purposes, where the eye needs to have before it at one time a considerable extent of territory, in order to obtain a connected idea of its physical features, it is necessary that a compilation on a reduced scale should be made, by which a considerable number of sheets are compressed within the limits of one. Thus in the Ordnance Survey of Great Britain, maps