Review: The Oceanography of the "Valdivia"

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MATHEMATICAL GEOGRAPHY,

AZIMUTHS OF THE POLE STAR.

'Azimuths of the North Pole Star, Lat. 38° N. to Lat. 55° N., for use until the year 1915.' By Sidney A. Roberts (Dominion and Provincial Land Surveyor). Victoria, B.C.: Thos. R. Cusack. April, 1902. Price \$2.

As the pole-star is not situated exactly over the North Pole, or in a direct line with the Earth's axis of rotation, whenever it is used for the determination of latitude of azimuth, certain corrections have to be made, which add considerably to the work of computation. As regards latitude, the necessary corrections are given in the Nautical Almanac, and are readily applied to the observed altitude; but the surveyor who wishes to mark off accurately the north and south line by means of the star has hitherto had to go through a fair amount of figuring before he can do so, unless he has at hand some table of the azimuths of the star for certain hour angles and latitudes, such as that given in the French 'Connaissance des Temps.' This table, however, besides other disadvantages, is only correct for one year, and is not generally accessible. Realizing these facts, Mr. S. A. Roberts, a Dominion and Provincial land surveyor of British Columbia, four years ago published a table which gave the azimuths of the pole-star at certain intervals of time for the years 1899 and 1900, for use between lats. 48° and 54° N., which proved of considerable service. He has now issued a second edition, which is a great improvement upon the former, not only from the fact that the limit of latitude has been extended so that the table can be used between lats. 38° N. and 55° N., but on account of its being available for a considerable number of years—until 1915. The method by which this latter advantage has been secured is interesting and ingenious. First a table of azimuths of the star has been computed for different hour angles and every degree of latitude with an assumed polar distance of $1^{\circ} 11' 40''$, and then there are two tables from which corrections are obtained to be applied to the quantity taken from this general table, due to the difference between the assumed polar distance $1^{\circ} 11' 40''$, and that given in the Nautical Almanac for the date. The first of these latter tables gives the correction in azimuth for each degree of latitude for an hour angle of $5^h 59^m$, and then with the quantity thus obtained the second table is entered, and the required correction found for the hour angle of the star at the time of observation, and applied to the azimuth taken from the table computed with a polar distance of $1^{\circ} 11' 40''$.

The whole process does not take long, and after the hour angle of the pole-star has been computed, a surveyor can, in a very few moments, put his instrument in the true meridian with a fair amount of accuracy, although for astronomical work, such as the determination of longitude by moon culminating stars, it must only be considered as a first approximation, and the more exact methods, such as high and low stars, should be finally employed. The angles are given to the nearest tenth of a minute of arc instead of seconds.

There can be no doubt that Mr. Roberts' tables will be found of service to surveyors in Canada and the United States, for whose use they have been specially prepared; and, indeed, they could often be used with advantage in any part of the world included within the stated parallels of latitude.

OCEANOGRAPHY.

THE OCEANOGRAPHY OF THE "VALDIVIA."

'Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898-1899.' Im Auftrage des Reichsamtes des Innern herausgegeben

von Carl Chun. Erster Band. Oceanographie und Maritime Meteorologie. Im Auftrage des Reichs-Marine-Amtes bearbeitet von Dr. Gerhard Schott. Jena: Gustaf Fischer. 1902. Two vols. Text and Atlas.

All concerned in the production of these splendid volumes deserve credit for the result of their labours. Dr. Schott, who was the oceanographer, and later also the meteorologist, of the expedition on board the *Valdivia*, has had the good fortune of being charged with the discussion of the data he collected, and with seeing it printed on a spacious page giving full scope for the most luxurious tables and diagrams. He has been able to produce a series of maps showing the distribution of each element of the observations, to which the letterpress is subsidiary in importance. These maps utilize the work of the *Valdivia* only to supplement and correct previously ascertained data, hence they really give an epitome of existing knowledge regarding the oceanography of the Atlantic and Indian oceans; and as they are all drawn on an equivalent area projection, they are available for the calculation of relative areas by direct measurement.

The cruise of the *Valdivia* has been described in this *Journal* (vol. xii. 494, 569; xiii. 297, 336, 640), and a comprehensive preliminary paper by Dr. Schott on his department of the work has also appeared (vol. xiv. 518), so that it is unnecessary to recapitulate the incidents of the voyage, or its general results. We are presented here with a detailed account of the instrumental and mechanical equipment of the ship for oceanographical work, followed by clearly subdivided chapters on the Depths, Temperature, Salinity, etc., and Currents of the seas that were traversed, and also on the Meteorology of the cruise, these chapters supplying not only results, but also the actual observations set out in full, and expressed in curves and profiles as well as in figures. It is thus possible to see what the *Valdivia* did in each department, and how far her work adds to the sum of knowledge.

The 186 deep-sea soundings are placed on a map on which all other accessible data had been inserted in metres to the nearest hundred. The isobaths were then drawn so as to yield what is really a new bathymetrical chart of the whole Atlantic and Indian oceans. The only part left blank for want of data is the region east of South Georgia, where the *Antarctic* and *Scotia* are now at work. Perhaps the most interesting feature added to the Atlantic is the *Valdivia* bank on the Walfisch ridge (as Schott terms it), which gives new definiteness to the separation between the West African and the South African depressions, the latter itself also rendered far more definite by the *Valdivia's* soundings on her way to Bouvet island. In the Southern ocean the great extension of the deep sea was an important gain; but there is no use at present speculating on the configuration of that region, as the *Gauss* and *Discovery* have already added to and modified the *Valdivia's* results. It may possibly be that the Marion and Crozet islands will be found to be connected by a ridge, or at least by a less deep part of the ocean. Dr. Schott believes that the great Indian-Antarctic basin, discovered by the *Valdivia*, indicates an extension of very deep water far within the antarctic circle. The *Gauss* will certainly throw light on this point. The mean depth of the South Indian ocean, so far as it can be arrived at, is twice as great as Karstens estimated it in 1894. Considerable additions have been made to our knowledge of the detailed configuration of the Indian ocean, the structure of which, once believed to be very simple and uniform, is gradually being shown to be extremely varied and complex.

Many plates in the atlas are devoted to the mapping of the temperature of the water, and those form, perhaps, its most important part. As one turns over sheet after sheet one realizes more and more fully how the voyage of the *Valdivia* has furnished an opportunity for increasing the data of oceanography.

Besides a map of mean surface isotherms of the two oceans, there are isothermal maps for the depths of 50, 100, 150, 200, 400, 600 and 800 metres. Similar maps are familiar to readers of Dr. A. Buchan's discussion of oceanic circulation in the *Challenger* Reports; but these were for different intervals of depth, and Dr. Schott has drawn his maps *de novo* from the original material. It would be interesting to compare the two sets of maps and to discuss the necessity of duplicating so vast a mass of recent work; but it is just here that we in the British Isles feel the effects of our scientific isolation. We cling to our fathoms and our Fahrenheit degrees because they are familiar to us, and we try to justify the attitude by pointing out certain inherent elements of superiority they possess over meters and Centigrade degrees. As far as reaching the attention of continental men of science is concerned, we might as well write in Gaelic; and Dr. Schott, rather than attempt to interpret the existing maps, has translated all the original temperatures and depths to the continental standards and mapped them afresh. In the present case the diversity of notations (a far greater barrier than the diversity of languages) is the more to be deplored because the author gives a flat denial to some of the conclusions which Dr. Buchan believed he had fully established, and looked upon as of great importance. Dr. Schott also complains that the 1000 temperature observations of the German ship *Gazelle* were not utilized in preparing the *Challenger* charts. In any case, and for whatever reason, we are confronted with the fact that a great piece of scientific work has been done twice over. Careful comparison will doubtless reveal more confirmation than contradiction in the results of each.

There are also maps showing the position in depth of several of the more important isotherms over the oceans, and a detailed study of the upwelling of deep water along various parts of the African coast, which seems to be remarkably well done. We note, by the way, with some satisfaction that Dr. Schott cannot find two German words which shall distinguish between water of different origin homogeneously mixed together and water of different origin flowing in separate though contiguous and inter-crossing streams. It is rarely that the English language yields readier terms for confluent phenomena than German can supply, but in this case we could at least distinguish the waters as *mixed* in one case and *intermingled* in the other.

The temperature data are also expressed in curves and profiles, some of which are of very great interest. Those in the far south, where the alternate layers of warmer and colder water characteristic of the Antarctic regions appear, will attract particular attention. Judging from the appearance of the curves of change of temperature with depth, the observations made on board the *Valdivia* seem to have been of satisfactory accuracy.

In applying his results to the question of the cause of oceanic circulation, Dr. Schott finds that the movement of the surface of the sea is the cause of the movements at all depths, for as Varenus, with his mastery of principles and his terseness of expression, put it centuries ago, *Si pars oceani movetur, totus oceanus movetur*.

There are many problems touched on in this volume and atlas to which we would like to refer. Amongst them we may note the discussion of the influence exercised on the respective oceans from the outflow of the Mediterranean and the Red sea, and of the cooling influence exercised by the Antarctic seas on the waters of all the oceans. Space, however, forbids further comment, nor will it permit more than a mention of the beautiful maps of salinity and of density, and the discussion of the meteorological observations. We must end as we began, by congratulating Dr. Schott on the way in which he has taken advantage of his opportunities of work afloat and of study ashore, and on the admirable result he has achieved.

H. R. M.