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*THE GENERAL CONFERENCE OF THE INTERNATIONAL GEODETIC ASSOCIATION AT STUTTGART, OCTOBER 3–12, 1898.**

THE International Geodetic Association is an organization for the measurement of the earth. Conferences are held every few years to consider projects, formulate methods and direct the execution of work by which the aforesaid object may be attained. Although the name as used in English does not necessarily imply the determination of the earth's size and shape, this is, nevertheless, the governing idea, and the Association follows loyally the lines marked out by the society of which it is the legitimate offspring, the German Gradmessung of 60 years ago. Now that the Association is firmly established on a permanent and international basis, it is worth while to seek the origin and trace its interesting course of development. In 1829 the Russian government expressed a desire to connect their triangulation with that of Prussia. Thus stimulated, the German work was given greater expansion, and in 1838 the work of Bessel and Baeyer, 'Gradmessung in Ostpreussen,' appeared. This developed into the 'Kustenvermessung,' and the work was continued under that name. In 1861 Baeyer sounded the keynote of the scientific spirit of the age when he proposed co-

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operation with other nations and laid the foundation for what was called the middle European 'Gradmessung.' These limits held until 1867 when the word 'middle' was dropped and the Association was enlarged to comprise representatives from all Europe. The extension seemed for a time to satisfy the energy everywhere manifest, but the fact soon became apparent that the work fell short of its full usefulness in that its bounds of activity were still too restricted. Perhaps the gigantic strides made by America and Australia in mental and material development had something to do with the change. At any rate, in 1886, the name was again changed; this time from the European 'Gradmessung' to the international 'Erdmessung.' A convention was drawn up for ten years. The powers of the League were considerably enlarged, old fetters were broken, and for the first time the Association reached its highest plane of usefulness and began to direct a homogeneous plan for the measurement of the earth.

The twelfth general conference was held at Stuttgart from the 3d to the 12th of October, 1898. Fifteen countries of the nineteen composing the Association were represented. Of the thirty-seven delegates present, fifteen came from Germany, five from France, three from Italy, two from Switzerland, two from Japan, and one each from Belgium, England, The Netherlands, Austria-Hungary, Russia, Sweden, Spain, Mexico and the United States. Each government has the privilege of sending as many delegates as it pleases, but in voting on questions coming before the conference for action but one ballot is allowed to each country. Besides the delegates, eighteen invited guests appeared, making a total of fifty-five persons present at the meetings. By far the greater part of the time was naturally taken up in reading the regular reports by the delegates on the geodetic work accomplished in their respective countries since the last general conference. Of special interest was the contribution by Professor Helmert on the activity of the Central Bureau of the Association at Potsdam. The following work was described:

I. The systematic deviations of the plumb line in connection with the European arc on the 52° of north latitude.

II. The international latitude service.

III. Absolute determinations of gravity.

Without going into details at this stage of our narrative, we may note in passing one or two points brought out. The connection between Switzerland and Italy is now satisfactorily made. It rests, however, on a single triangle, due to the fact that one of the points composing the quadrilateral proposed was not occupied identically by the two surveys.

The international latitude service will be inaugurated during the summer of 1899 at four stations under the direct control and at the expense of the Association. Observations at two additional stations will be undertaken, for which the Central Bureau will supply only a part of the funds necessary. Although the mathematical conditions are not essentially changed by the introduction of Cincinnati and Tschardjui, there is great advantage from the fact that any systematic errors in the regular stations will be more readily discovered. It is a fortunate coincidence that the observatory at Cincinnati happens to be precisely on the parallel of latitude chosen for this work, and it is, moreover, a matter for congratulation that Russia is ready and willing to aid in the undertaking, to the extent of establishing and superintending the station at Tschardjui.

The report also stated that in the absolute gravity work measurement of the length of the pendulum, the most difficult operation in the whole problem, can be effected both in a horizontal and vertical position.

The knife-edges can be illuminated in any direction by means of movable mirrors, and the field of view is kept at the same time uniformly lighted. Experiments with an electric magnet have shown that the earth's magnetic force only exercises a retarding influence on the swinging, without having any effect on the resulting length of the mathematical seconds pendulum. The possible slight movement of the agate plate, as well as the slip of the knives, is observed by a specially designed apparatus.

It is worthy of mention in this connection that up to the present time nearly 1,400 gravity stations have been occupied, of which 1,228 are different. Austria heads the list with 698, Germany follows with 162, and the United States comes next with 88. The greater part of the remainder falls to Denmark, Russia, Switzerland, France and Italy. About fifteen different nationalities are represented in this work. The latest results from pendulum observations are with reference to changes of the force of gravity with elevation, and the derivation of a new formula for the length of the seconds pendulum at the sea-level. From a discussion of over 500 stations the conclusion is reached that what is usually known as continental attraction amounts practically to nothing, and that in general the change of the force of gravity at any point on the earth's surface depends purely and simply on the Newtonian law of the inverse square of the distance. The introduction of a spherical function of the third order in the formula for L, alluded to above, foreshadows the determination of a different curvature for the northern and southern hemispheres of the earth; yet tne coefficient appears so small that the inequality cannot as yet be safely predicted. The compression given is 1/297 and the equatorial value of the force of gravity is about 1/13,000 greater than that now accepted. The investigation of the relation between disturbances in the force of gravity and deviations of the plumb line is one of the most interesting problems of the near future.

The reports read by the different delegates need not be taken up here. Although full of interest to the geodesist and astronomer, they are too voluminous to be analyzed or discussed in the short space at our disposal. They will, however, be published in full, and will appear in the Proceedings of the conference, where they may be consulted and studied.

Three matters of universal interest were brought before the Association, and suitable action was had thereon. These were: I. 'The determination of the figure of the earth by the measurement of arcs and the determination of the force of gravity.' II. 'The remeasurement of the Peruvian arc.' III. 'The redetermination of the difference of longitude between Paris and Greenwich.' The first two subjects were introduced as resolutions by the United States delegate, and brought out interesting discussions. The first was proposed for the sake of directing the attention of the Association more specifically to the prime object of its existence. No one doubts the utility or necessity of a complete study of the law governing the changes of latitude, but its ultimate bearing is rather one of astronomy than geodesy. The funds of the Association are now being devoted largely to the latitude question, and the time seemed fitting to suggest work more directly in the line of its avowed purpose—the measurement of the earth. The object of the resolution was, therefore, in the nature of a recall to the original conception of its being, and bespoke in the interest of pure geodesy an application of its resources to a realization of the idea of its founders.

The remeasurement of the Peruvian arc now appears to be assured. It may be worth while just here to recall the essential features of this work. One hundred and

sixty years ago, when it was a disputed question whether the polar or equatorial diameter of the earth was the longer, the French Academy decided to make one supreme effort to settle the point. To this end, two arcs were measured: one on the equator (now known as the Peruvian arc, although it is really in Ecuador); and the other in Lapland, as near the pole as possible. These two arcs, confessedly inaccurate in the light of modern geodesy, have been employed continually in the determination of the earth's figure. Situated as they are, near the extremities of the quadrant, their influence is great on the shape deduced, so that one of the pressing needs of the day in the measurement of the earth is a redetermination of their lengths. France having made the first measure, by common consent, this country should be given the first chance to repeat the equatorial work. At the conference in Paris in 1889 the matter was brought up, but was left to be disposed of by France. Efforts were made to accomplish the task, the officers were in part designated, and arrangements for cooperation by the government of Ecuador were completed. At this juncture the revolution broke out in Ecuador and the matter came to an untimely end. It is now proposed to make a reconnaissance during the summer of 1899, report the results thereof to the Paris conference of 1900, and then decide definitely on the plans of final measurement. It is universally conceded that France should be given the first chance to act, not alone because the first measure was made by her, but also because the conference of 1889 relinquished in her interest further consideration of the subject.

The Russians and Swedes, in a quiet sort of way, are measuring an arc between the parallels of latitude $77\frac{1}{2}°$ and $81\frac{1}{2}°$ in Spitzbergen. The triangulation will require two summers and part of one winter, and will cost 100,000 Kronen ($27,500), exclusive of cost of vessels furnished by the governments. The field work will be finished in 1900 and the computations two years later. Fifty stations will be occupied. The sides range in length from ten to one hundred and thirty kilometers, and the bases, of which there will be only two, are to be measured with with Jaederin's steel tape line, 20 meters long.

The difference of longitude between Paris and Greenwich comes up again for investigation. This question has been a sort of thorn in the side of European geodesy for ten years. In 1872 the United States Coast Survey made a determination, in order to have a check on the telegraphic longitude of our trigonometric points as determined independently from Paris and Greenwich. This was followed in 1888 by two separate determinations, one on the part of England, the other on the part of France. The results differed by more than two-tenths of a second. Our own result falls between them, and it is a matter of congratulation to all Americans that the best determination to the present day of this important quantity is the work done by the United States Coast Survey, while incidentally checking its own longitude determinations. Nothing was done to improve the agreement until 1892, when the work was repeated, both by the French and English, only to yield results practically identical with those previously obtained, so the unfortunate discrepancy still remains, and the five direct determinations already made leave the work in an unsatisfactory condition. Six indirect results may be had from combinations of general European work, through Brest, Vienna, Berlin, Bonn and Leiden, the mean of which gives the same result as the mean of the direct determinations. Nothing seems to remain, therefore, but to study the conditions of the work of 1888 and 1892, and reconcile, if possible, the outstanding difference. The

matter has been referred by the International Geodetic Association to the directors of the two observatories, and a definite result will, doubtless, soon be made known.

The variation of the latitude seems to be at present an absorbing question before the Association, and there results from action taken at the Stuttgart meeting the following status:

Six stations will be established during the summer of 1899 on the parallel of latitude 39° 8′. These will be distributed in longitude as follows: one each in Japan, Turkestan and Italy, and three in the United States. The American ones will be located at Gaithersburg, Md.; Cincinnati, O., and Ukiah, Cal. This gives a preponderance of weight to the determination of the coordinate Y (X passing through Greenwich), but a station in Portugal, which may possibly be secured later, would essentially increase the accuracy of X. Tschardjui, in Russia, and Ukiah, in California, are nearly opposite, and Mizusawa, in Japan, is in the only remaining unoccupied quadrant. The scheme proposed is, therefore, a favorable one for the study of the motion of the pole. No one knows as yet how long it will be desirable to continue the observations. The period now provided for is five years, but it is proposed to buy the land upon which the observatories will be located, or lease it for one hundred years. It is evident that at least twenty-one years would be desirable, because during the seven years of observations already made the pole has returned nearly to its mean position, and three of these cycles should be completed before any definite idea can be had as to its mean path. The cost of the entire work will be about $10,000 annually. The visual method is to be followed regularly without, however, excluding the possibility of employing later the photographic one, which has already given excellent results. Twelve groups of stars, each comprising eight pairs, will be selected. Six pairs in each group are destined for the latitude determinations proper, while the two remaining pairs, having great zenith distances (about 60°), will, it is hoped, throw light on the question of refraction. The observing period for each night is four hours, and will vary from 7 p. m. to 3 a. m., depending on the situation of the group. The instrumental outfit will consist of a zenith telescope and astronomical clock for each station, except that of Japan. Here a chronometer will be substituted for the clock, on account of the frequency of earthquakes.

Although the object of the general conference was scientific discussion, a faithful historian cannot ignore the social and humanitarian side of the function. From our entrance into the beautiful capital of Wurttemberg until the time of our departure we were the recipients of the most cordial hospitality. The first session was devoted to addresses of welcome on the part of the government officials, and replies thereto by the officers of the Association. Cards of admission to the museums and public buildings were furnished, excursions to the fine old castles of the suburbs were given (always including a sumptuous lunch during the day at the expense of the government), and a final gala banquet marked the close of the convention. The official means of communication before the conference was either French or German. English, Spanish and Italian were sometimes heard during recess, but not during debate. The Japanese, Russians and Swedes spoke German; the Italians and Spanish, French; the Swiss, both. One delegate, in a moment of absent-mindedness, voted in his native tongue. The novelty of the proceeding seemed attractive, and forthwith each representative did likewise. This gave increased momentary interest to the balloting, which culminated in great hilarity when, the President, a distinguished Frenchman,

who had never been known to use anything but his native tongue at the meetings, responded 'Ja.'

Before closing the present paper, attention should be called to a few points of interest noted during the trip to Stuttgart and return. A flying visit was made to the Royal Observatory at Berlin, the Reichsanstalt at Charlottenburg, and the Geodetic Institute at Potsdam. At Paris the offices of the geographic service and the International Bureau of Weights and Measures were examined, and part of one day was devoted to the English Ordnance Survey at Southampton.

An interesting object at the Berlin observatory is the instrument with which Küstner discovered the variation of latitude. Not alone because of the splendid result achieved, but on account of the conditions under which the work was done. It is mounted on a pier more than twenty feet above ground, on a subsoil of sand, in the middle of a city, with bad atmospheric conditions and about one hundred feet from the public thoroughfares. In spite of these adverse circumstances a new fact was added to science, which had baffled the efforts of larger telescopes under immeasurably better conditions. There is much encouragement in this to investigators with scanty means at their disposal.

At the Aichungs-Kommission a balance was shown which easily determines the weight of a kilogram with an error of 1/200 of a milligram, being 1/200,000,000 part of the quantity sought. They have also a complete series of weights in quartz from 1/2 gram to one kilogram, and thermometers giving the temperature by estimation to 1/1000 of a degree Centigrade.

At Charlottenburg the most striking feature was the extension and perfection of the organization. Nine buildings in all, of which the two larger are devoted, one to theory and the other to practice, have cost, together with the running expenses since 1887, 3,000,000 Marks. The annual outlay is at present about $90,000.

The Geodetic Institute at Potsdam has been much less expensive, and presents many admirable points of arrangement and administration. Among the details may be cited: the clock room, always maintained at a temperature between 20° and 21° Centigrade; the pendulum room, artifically heated on all sides, including the floor; a pillar over fifty feet high, and correspondingly thick, with meridian marks several miles away, to study changes in azimuth and the movement of the earth's crust; and finally a small photographic instrument, by means of which the occupation of a station only requires 8 minutes, and gives a determination of the geographical position in latitude within two seconds of arc. The subsoil, as at Berlin, is nothing but sand.

At Sevres, near Paris, several interesting instruments were seen, among which may be especially mentioned that designed for the comparison of the metre with the wavelength of light following Michelson's method, and the apparatus for the determination of coefficients of expansion according to the method of Fizeau. Some recent experiments have been made on a composition containing 36% nickel and 64% steel. It appears that the expansion from heat is thus reduced to about 1/50 of what we should expect from the individual components. This discovery will simplify enormously the solution of problems where the temperature question has thus far been the great difficulty. It will, for example, be a comparatively easy matter to make pendulum clocks run with a daily correction of about 1/10 of a second per day under varying temperature conditions.

At the office of the geographic service of the army a noteworthy feature was the publication of charts. Six presses, each

capable of turning out six hundred maps per hour, are continually at work. Each year there are printed and distributed 1,200,000 maps, about as many as the Coast and Geodetic Survey has published since it came into existence. At Southampton, where the office of the English Ordnance Survey is located, the personnel consists of about nine hundred persons, of which probably one hundred belong to the army. The map printing establishment has even greater capacity than that at Paris, 3,000,000 maps being delivered annually. Although the great trigonometric work may be considered as finished in England, nevertheless, the topographic work goes on, and the effort is made to cover the whole kingdom once in twenty years with a new map on a scale of 1/2,500, and once in fifteen years with one on 1/10,000. Of course, the latter is made from the former by making blue prints, tracing in black the detail required, and photographing again, which leaves out everything in blue on the original sheet.

E. D. PRESTON,
Delegate on the part of the United States.
U. S. COAST AND GEODETIC SURVEY.

THE ANNUAL REPORT OF THE SECRETARY OF AGRICULTURE.

THE Report of the Secretary of Agriculture for 1898, just issued, is of interest as showing the growth of the technical and scientific work of the Department. This national agency for the promotion of agriculture now consists of two bureaus, two offices and fourteen divisions, most of which are engaged in scientific inquiries. A few of the more salient features of the work of the Department during the last year may serve to indicate the lines in which it is making progress.

The Weather Bureau has greatly increased the efficiency of its forecast service by the establishment of a considerable number of observation stations in the West Indies and additional stations in the more arid regions of the West. A climate and crop service has also been begun in Alaska.

The Bureau of Animal Industry has had great success in its experiments for the repression of hog cholera by the use of specially prepared serum. The experiments in dipping cattle to kill the ticks which cause Texas fever have also been successfully conducted on a large scale.

The work of the Division of Chemistry on the composition and adulteration of foods and on sugar beets has been quite extensive. Studies of typical soils in the vegetation house by the Division have shown that "Meteoric influences other than those relating to precipitation have a great influence on crop production. The solar influences are evidently of great importance, and the distribution of solar heat is a factor not to be neglected."

Among the more important investigations of the Division of Entomology have been those on the Morelos orange fruit worm, the Mexican cotton-boll weevil, chinch bug, Hessian fly and San José scale.

The Biological Survey is energetically pushing its researches on the life zones of the United States.

The Division of Vegetable Physiology and Pathology has made interesting investigations relative to increasing the sugar and starch producing power of plants and the effect of soil foods on their growth and productiveness. A large amount of hybridizing has also been done with oranges and other citrus fruits, pineapples, pears, wheat and other crops.

Our knowledge of the native forage plants of the Great West has been considerably enlarged by the recent work of the Division of Agrostology, which has added nearly 3,000 sheets of specimens to the National Herbarium during the year.

The Division of Soils has perfected and cheapened its electrical apparatus for the