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REPORT

OF

THE SUPERINTENDENT

OF THE

COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1862.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1864.

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developed a general extent of coast of over four thousand five hundred miles, and a shore-line of about twenty-three thousand miles, determining nine thousand four hundred and fifty-two geographical positions.

For longitude determinations, eighty-five stations had been occupied; for latitude, one hundred and twenty-seven, and for azimuth, eighty-four stations.

The topography had extended over an area of nearly seventeen thousand square miles, having a general coast line of four thousand miles, and over forty-two thousand two hundred miles of shore-line, measuring the indentations.

The hydrography extended over an area estimated at forty-six thousand square miles, in which one hundred and ninety-six thousand miles were run in soundings; six million three hundred and ninety-eight thousand soundings were made, and over eight thousand four hundred specimens of the bottom obtained.

The number of manuscript maps and charts constructed was two thousand one hundred and eighty-one, and of engraved maps, charts, and sketches there had been produced four hundred and ninety-three plates.

DISTRIBUTION OF ANNUAL REPORTS AND MAPS.

It has been judged expedient during the past year to hold still in abeyance the usual foreign distribution of the printed annual reports through the Smithsonian Institution, as was done during the year which ended with October, 1861, as was stated in my last annual report.

During the past year 4,028 copies of reports of various years have been distributed to institutions and individuals in the loyal States of the Union, leaving on hand a limited number of copies for the years from 1851 to 1860, inclusive. Of those remaining on the 1st of November there were of the report for 1851 two hundred and twenty copies; of that for 1855, four hundred and twenty copies, and of that for 1857, three hundred and twenty-eight copies left. Of the dates 1853, 1856, 1859, and 1860, the copies disposable for general distribution is larger. This decidedly unequal number of copies of the reports of various back years makes it necessary to discriminate carefully in their issue. It is also to be remembered that for the years 1859 and 1860 no copies have been sent to the States which now disavow their allegiance to the government of the Union, but which will at some future day feel interested, in common with the others, in the information which they embody. To provide for the best issue of these remaining reports (1851 to 1860) a circular has been sent to the principal libraries in the more important cities of the north, and to those of universities, colleges, and other institutions, to ascertain what reports may be needed in order to complete their series, so that entire sets may in future be within reach for purposes of reference in all the States to which they are now sent.

As already stated under the head of maps and charts, upwards of forty-four thousand copies of printed maps, charts, and sketches have been sent from the office since the date of my last report—a number more than double the distribution in the year 1861, and upwards of five times the average annual distribution of former years. This large and increasing issue of charts within the past two years has been due to the constant demands of the Navy and War Departments, every effort to supply which still continues to be made.

Besides the printing of charts by the transfer process, the production of the hydrographic memoirs of the coast with facility offers further proof of the advantage of establishing a lithographic division at the office, though induced as it was by the emergency of last year for copies of charts. The course taken in the preparation of the hydrographic notes was mentioned in my report of last year, and has also been alluded to in this, under the head of maps and charts. The testimonials from the different commanding officers as to their value have been numerous and emphatic.

A summary of the details of distribution of the annual reports, maps, charts, &c., is contained in the report from the miscellaneous division of the office, Appendix No. 11.

RECORDS AND RESULTS.

I call attention again to the fact that this publication is postponed for more auspicious times, as I have repeated applications for copies. The present appropriation merely enables us to prepare the materials for publication, but not to publish.

LONGITUDES.

The history of the determination of longitudes in connexion with the survey of the coast, from the law and plan of reorganization of 1844 to 1858, was given in my report for 1858, including the methods by astronomical observations, by the transportation of chronometers, and by the electrical telegraph. The

problem of longitudes by occultations of the Pleiades is described in the appendix of my report for 1856. Professor Peirce has been engaged since 1854 in stimulating observers to a new series of observations, by preparing predictions and charts of the occultations, as explained in my report for the year 1858. These observations were collected during the period from 1857 to 1861, or until the moon's path ceased to pass among those stars. While this new series of observations was in progress with modern instruments and methods, Professor Peirce was occupied in recomputing the older series, for the period 1838 to 1842, by the aid of the new lunar tables. The results are given in his report, which was printed as Appendix No. 17 in my report of last year. "The conformity of the observations with theory is quite remarkable, and shows that this, the most delicate of all the observations of the moon, demands and justifies the utmost precision of calculation. The final determination of the longitude will, undoubtedly, surpass all others in precision."

Some of the particulars of this interesting series of results are stated in the professor's report, Appendix No. 12. Certain of the occultations which were observed both in Europe and America will serve to determine the errors of the tables, and hence to compute with suitable corrections those which were observed only in America, and to obtain a second determination of the longitude. Professor Peirce remarks that "the various observations will also serve the subsidiary purpose of determining the relative longitudes of the different places which are upon the same continent either of Europe or America, and also to correct the places of the stars, and, finally, to determine the value of the lunar semi-diameter, and the necessity of having regard to the protuberances of the moon in the complete solution of the problem."

Professor Peirce has addressed to me a special letter in relation to the tables of the moon used in the reduction of the observations of the Pleiades, (Appendix No. 13.) The Professor gives his reasons for using Hansen's tables in the computations, and, referring to the "full and generous" statements of Mr. Lubbock, in the thirtieth volume of the Memoirs of the Royal Astronomical Society, in praise of the American tables prepared by Professor Peirce for the Nautical Almanac under the direction of Captain Davis, U. S. N., corrects some historical statements in reference to the labors of mathematicians who have been occupied with the important task of improving the lunar tables.

The observations made by telegraph for the difference of longitude between Macon, Ga., and Eufaula, Ala., in the working season of 1859–'60, have been discussed by Dr. B. A. Gould. He reports that the difference in time between the astronomical stations is, Eufaula 6*m*. 3.02*s*. west of Macon; which result, he adds, cannot be erroneous by more than five-hundredths of a second of time.

The detailed report on the results of the observations made in Georgia and Alabama is in course of preparation. I have placed in the Appendix No. 14 Dr. Gould's report on the progress which has been made in computing the results for all the stations between Calais and New Orleans.

MAGNETISM.

The publication of the results of a discussion of the Girard College observations, from the Smithsonian Contributions to Knowledge, commenced in my reports of 1859 and 1860, is continued in this, embracing the discussion of the observations of horizontal magnetic force. The difficulty which stands at the threshold of the discussion of these observations is the correction for temperature, the magnetic bars changing in their own intensity of force with changes of temperature. The attempts to obtain the value of this correction are fully stated, and their application is shown and verified in various ways, in Part IV of the memoir, (Appendix No. 15.) Tables of the results, reduced to a standard temperature of 63° Fahrenheit, are then obtained, and corrected for the progressive change in the readings of the magnets. The observations are next separated into regular and disturbed readings by the aid of Peirce's criterion, and the disturbances being taken out, there remain the normal results for the hour, day, and year. These show the same period of ten or eleven years in number and extent of disturbances which was deduced from the declination observations, corresponding with the period of change in the solar spots. The results agree very well with those obtained at Toronto, Canada. The curves of daily change of horizontal force come out very perfectly in each year's result, the curves showing two maxima and two minima in the course of the day, and the day changes being much more considerable than those of the night.

The next part of the memoir, Part V, (Appendix No. 16,) contains the investigation of the diurnal and annual variations of the horizontal magnetic force, from the means of the results for the five years of observation. The normal value of the horizontal intensity for the several hours of the day and months of the year of the five years is deduced, applying all the required corrections. The summer and winter results are compared in formulæ, and by curves, with the mean for the whole year. At 6 a. m. there is scarcely any change

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Archives and library.—The archives and library have continued under the care of *Mr. E. Fitzgerald.*

During the past year three hundred and ninety-nine volumes of original and duplicate records, one hundred and twelve volumes and cahiers of computations and reductions, one hundred and sixteen rolls from self-registering tide-gauges, and fifty-seven original topographical and hydrographical sheets, have been added to the archives of the survey; also one hundred and eighty-six sea-bottom specimens.

Fifty-eight volumes have been purchased for the library, and one hundred and five volumes, including thirty-three volumes of publications of the Royal Observatory, Greenwich, added by presentation during the same period.

The records of triangulation, astronomical, and magnetic work, executed under the superintendency of Mr. Hassler, have been re-arranged by Mr. Rumpf, of the computing division, and a new register made which greatly facilitates reference to them. With the assistance of Mr. Donegan, of the tidal division, the self-registering tide-gauge rolls have been arranged by stations and years, put up in separate packages and registered. The total number of self-registering tide-gauge rolls now in the archives, as shown by the register, is eleven hundred and twenty-eight. A new set of sketches showing the limits of all the registered topographical and hydrographical sheets, to take the place of the set now in use in the archives, which is nearly worn out, has been commenced and considerable progress made upon it.

Carpentry.—In the carpenters' shop, *Mr. A. Yeatman* remains in charge, as master carpenter, assisted by one workman and an apprentice. The work executed during the year consists of 54 fine new cases for instruments of various kinds, 6 cases for duplicate records, 2 large cases for Coast Survey charts, 2 large cases for copperplates, 3 cases for photographic negatives, woodwork complete for 2 new plane-tables, 8 new plane-table boards, 4 new stands for plane-tables, 3 stands for theodolites, 5 frames for photographic and 18 for electrotype purposes, 8 battery cells, and 5 vats, for electrotype division; 6 rods and 6 signal poles for field parties have been painted and graduated, and 20 tin cases for original sheets have been painted and numbered, 6 large paneled frames for backing purposes have been made, as also one writing table for office. A large amount of miscellaneous work has been done, and the woodwork of instruments returned from the field have been carefully repaired; 90 running feet of new fencing has been put up, and the office buildings kept in repair.

Instrument shop.—The force of this shop consists of *Mr. J. Vierbuchen*, master instrument-maker, three workmen, and two apprentices. During the year 4 sounding apparatus, 12 specimen cups for sea soundings, 1 winding machine for deep-sea soundings, 2 plane-tables complete, 26 metre scales, 2 theodolites, 4 reconnoitring telescopes, 2 heliotropes, 5 prismatic compasses, 2 beam compasses, 5 half-round protractors, 13 metre chains, and 1 clock for office, have been made; and all the repairs of instruments used during the year have been made, consisting in part of 2 sounding apparatus, 2 deep-sea thermometers, 5 self-registering tide-gauges, 27 sextants, 30 theodolites, 29 plane-tables, 6 reconnoitring telescopes, 11 heliotropes, 4 prismatic and 7 surveying compasses, 28 metre chains, 15 marine spy-glasses, 1 dividing machine, and 6 beam compasses, in addition to a variety of miscellaneous work for the use of the office and parties in the field.

APPENDIX No. 12.

REPORT OF PROFESSOR BENJAMIN PEIRCE, OF HARVARD, ON THE COMPUTATIONS OF THE OCCULTATIONS OF THE PLEIADES FOR LONGITUDE.

CAMBRIDGE, MASS., *November* 1, 1862.

SIR: The computation of the group of the occultations of the Pleiades, from 1838–1842, inclusive, and the corresponding determination of the longitude of America from Europe, are now far advanced, and several of the special reports upon the individual occultations will soon be sent to the office in their completed form. The conformity of the observations with theory is quite remarkable, and shows that this, the most delicate of all the observations of the moon, demands and justifies the utmost precision of calculation. The final determination of the longitude will, undoubtedly, surpass all other in precision.

There were eighteen different nights of occultation in the group of 1838–'42, which I will number in the inverse order of their occurrence.

I. The immersions of April 13, 1842, which were observed at Edinburgh.

II. The immersions of January 21, 1842, which were observed at Washington and Cambridge in Massachusetts.

III. The immersions of November 27, 1841, which were observed at Cambridge in England and at Washington. These observations were made within seventeen hours of full moon, and I have thought that twenty-four hours from full moon was as near an approach to this phase as it would be safe to admit.

IV. The emersions of October 31, 1841, which were observed at Dorpat, Pulkova, Vienna, and Wilna. The moon was so nearly full that these observations are omitted.

V. The emersions of September 6, 1841, which were observed at Washington.

VI. The emersions of August 10, 1841, which were observed at Altona, Berlin, Copenhagen, Edinburgh, Geneva, Hamburgh, Leyden, and Pulkova.

VII. The immersions of February 27, 1841, which were observed at Edinburgh and Leyden.

VIII. The immersions of January 31, 1841, which were observed at Pulkova.

IX. The immersions of December 7, 1840, which were observed at Altona, Breslau, Copenhagen, Gottingen, Hamburgh, and Kremsmunster.

X. The emersions of October 13, 1840, which were observed at Ashurst, Breslau, Edinburgh, Greenwich, Vienna, Cambridge, (Mass.,) and Washington.

XI. The immersions of January 14, 1840, which were observed at Apenrade, Berlin, Bonn, Breslau, Cracow, Gera, Grisswald, Hamburgh, Konigsberg, Kremsmunster, Leyden, and Vienna.

XII. The occultations of November 20, 1839, which were observed at Cambridge, Leyden, St. Louis, Pulkova, Dorchester, Washington, and Port Royal, (Jamaica,) which occurred at the time of full moon, and are consequently omitted.

XIII. The emersions of September 26, 1839, which were observed at Ashurst, Berlin, Breslau, Greenwich, Rista, Cambridge, Philadelphia, Southwick, and Washington.

XIV. The emersions of August 30, 1839, which were observed at Breslau, Cambridge, (England,) Hamburgh, and Leyden.

XV. The emersions of July 6, 1839, which were observed at Hudson, Philadelphia, Washington, and Yorktown.

XVI. The immersions of March 19, 1839, which were observed at Ashurst, Cambridge, (England,) Dorpat, Greenwich, Konigsberg, and Leyden.

XVII. The immersions of December 27, 1839, which were observed at Ashurst, Breslau, Cambridge, (England,) Cracow, Dover, Edinburgh, Greenwich, Boston, Dorchester, Southwick, Princeton, and Philadelphia.

XVIII. The emersions of November 2, 1838, which were observed at Philadelphia, and may need to be neglected on account of the proximity to full moon.

Of these observations, therefore, III, IV, XII, and probably XVIII, will be rejected, and the other 14 occultations will be retained. The occultations X, XIII, and XVII were the only ones which were observed in Europe as well as in America, and which can be used independently of the others and without regard to the accuracy of the tables of the moon's longitude, for the determination of the longitude. These occultations, together with the others observed in Europe, namely, the I, VI, VII, VIII, IX, XI, and XIV, will serve to determine the errrors of the tables, and thence the corrections which must be applied to the tables, to compute the occultations II, V, XV, and XVIII, which were only observed in America, and thence to get a second determination of the longitude. The various observations will also serve the subsidiary purpose of determining the relative longitudes of the different places which are upon the same continent, either of Europe or America, and also to correct the places of the stars, and finally to determine the value of the lunar semidiameter and the necessity of having regard to the protuberances of the moon in the complete solution of the problem.

Although this plan of combining the occultations will be carefully followed, yet reports will be made upon the several occultations independently, and the equations of correction will be given for each as separate results.

Very respectfully,

BENJAMIN PEIRCE.

Professor A. D. BACHE,
Superintendent of the Coast Survey.

APPENDIX No. 13.

UPON THE TABLES OF THE MOON, USED IN THE REDUCTION OF THE PLEIADES, BY PROFESSOR BENJAMIN PEIRCE, OF HARVARD.

NOVEMBER, 1862.

SIR: It is expedient that I should address you a special letter upon the tables of the moon used in the reduction of the observations of the Pleiades. They are those constructed by Hansen. I adopted them because they were the most recent, and had, therefore, the advantage of all previous experience. They purport to be the pure results of theory, and while, upon the one hand, I had full confidence in the accuracy and ability of their author, I was, upon the other hand, persuaded, from the use of the tables which I had myself constructed for the Nautical Almanac, under the direction of Captain Davis, that analysis without empiricism was adequate to the construction of the lunar theory and tables. The testimony to this point furnished by Lubbock, in a memoir *on the Lunar Theory* in the thirteenth volume of the *Memoirs of the Royal Astronomical Society*, is full and generous. The following passage occurs upon page 12 of his memoir:

"As it appeared to me that astronomers would view with greater confidence a comparison of places given by the American tables, made by persons who could have no interest in enhancing their value, I made application to Mr. Hind, the Superintendent of the *Nautical Almanac*, and in consequence he directed Mr. Farley to procure places of the moon from the *American Almanac* and compare them with the observations made at Greenwich for the years 1856, 1857, and 1858; and as Mr. Hind has kindly allowed me to publish them with this paper, any one can see at once how extremely accurate the places given by these tables are, and how much more so than places given by Burckhardt's tables."

Lubbock goes on to make claims upon these tables in the following passages:

"In these American tables, coefficients are employed, with very few exceptions, and those of no moment, founded upon our labors—that is, M. Plana's, M. de Pontécoulant's, and my own—and due to theory alone. I am confident, therefore, that a just posterity will give to us—that is, to Plana, Pontécoulant, and Lubbock, who in 1846 furnished the means of constructing tables of the moon without any empirical hypothesis—the credit of first bringing the errors of the lunar theory within the limits of the errors of observation, and thereby of bringing to perfection the solution of the problem of finding the longitude at sea by means of lunar observations."

The American tables were actually constructed, as they profess to be, "from Plana's theory, with Airy's and Longstreth's corrections, Hansen's two inequalities of Long period arising from the action of Venus, and Hansen's values of the secular variations of the mean motion and of the motion of the Perigee." But Lubbock contends that all of Longstreth's corrections of Plana were those of coefficients which had been designated as erroneous by Pontécoulant, "and in eight out of eleven instances the values of Pontécoulant were employed" instead of those of Plana. There is even a suspicion expressed that Longstreth had been unfair to Pontécoulant, and appropriated his corrections without acknowledgment. This suspicion, however, was expressed before having seen the original memoir of Longstreth, the examination of which instantly exonerates Longstreth from so unjust a charge, for Longstreth expressly says: "The coefficients deduced from theory by Damoiseau, Plana, Pontécoulant, and those deduced from observation by Burckhardt, (though differing considerably,) give the moon's place with nearly the same accuracy; when a difference exists, I have carefully compared them with observation, and deduced the most probable value." In the only three cases (see the note at the end) in which Longstreth has rejected Pontécoulant's terms, and thereby declared them to be wrong, the subsequent investigations of Pontécoulant himself, which are published by Lubbock, show that Pontécoulant was in error, although right in the other cases, and, consequently, the skill and accuracy of Longstreth's comparisons and the justness of his verdict are triumphantly sustained.

In regard to the decisions of posterity I may be mistaken; but it seems to me that the whole series of reductions of the lunar observations of Greenwich from 1750 to 1851, made under the direction of the astronomer royal, and of the comparisons with Plana's theory, demonstrate that to Plana alone will be given the credit of first bringing the lunar theory to a degree of perfection sufficient for the practical "solution of the problem of finding the longitude at sea by means of lunar observations."

I am moreover convinced that a still higher claim can be established for Lubbock and Pontécoulant. The ordeal to which I have been subjecting the tables of Hansen is much more severe than that of meridian observations of the moon; and so far as I have gone, they have stood it wonderfully. The mean error of the

tables in longitude seems to be less than a second of arc, during the period embraced by my investigations. It is thought that more recent observations indicate wider discrepancies; but if this be so, I believe that it will be found to arise from some accidental cause of non-conformity which can be easily remedied. I am equally confident that when our American tables are revised, as they soon must be, the small differences between them and the corrected theories of Lubbock and Pontécoulant will disappear, and they will then assume the same degree of accuracy which I am now disposed to attribute to those of Hansen. The time, then, seems to be at hand when meridional observations of the moon will no longer serve to test the accuracy of the tables; when extra-meridional observations will be set aside as useless and cumbersome superfluity; when the observations of occultations on the dark limb of the moon will assume a new importance; and when it will be admitted that a single observation of an occultation reduced by the exclusive aid of the lunar tables without any use of simultaneous observations, will determine a longitude with a probable error not exceeding a second of time. The geometers to whom the final credit of this great result must be given are Lubbock and Pontécoulant. What test is reserved for the ultimate comparison of the theories of Pontécoulant, Hansen, and Delaunay?

Very respectfully,

BENJAMIN PEIRCE.

Professor A. D. BACHE,
Superintendent of the Coast Survey.

NOTE.—There is still a fourth coefficient, that of argument 22, in which Plana's coefficient of 3".309 was rejected, and Lubbock inconsiderately attributes to Longstreth the new coefficient 0".8, which is adopted in the American tables and attributed to Plana. But it was taken by me from Airy's table of coefficients in the *reduction of the Greenwich observations of the moon*, and no other origin of the coefficients of that table but PLANA is acknowledged in that work. The answer to the question of authority in this case must, therefore, be sought by Mr. LUBBOCK from the ASTRONOMER ROYAL.

APPENDIX No. 14.

REPORT OF DR. B. A. GOULD ON THE PROGRESS OF COMPUTATIONS FOR DEDUCING LONGITUDE FROM OBSERVATIONS BY TELEGRAPH BETWEEN CALAIS, ME., AND NEW ORLEANS, LA.

CAMBRIDGE, *November* 13, 1862.

DEAR SIR: During the last year the Coast Survey operations under my direction have consisted exclusively of computations and reductions, the field-work being suspended in consequence of the war. The same cause has acted to retard the progress of the reductions to a considerable extent, and but for the diminution of my party which it has occasioned, I might at present enjoy the satisfaction of reporting the whole of the longitude work as completely reduced. No small progress has, however, been made, and the work has been completed upon four of the campaigns, viz: Calais—Bangor; Apalachicola—Eufaula; Macon—Eufaula; Pensacola—Mobile.

The discussion of these observations, although extended and minute, has elicited few results of general scientific interest which have not been brought to light by the computation of former longitude measurements. The phenomena attending the transmission of signals have been similar in these and in former campaigns, showing in all approximately the same velocity of transmission, and the same dependence upon the position and strength of the batteries.

So, too, the same results have been deduced from the examination of the personal differences of observers; and it is now beyond question that, by the chronographic method, at least, the personal equations, although manifest, are very far from constant, varying greatly with external circumstances and with physical condition. Indeed, their variability is so decided as to lead me, in the discussion of the observations, to aim always at their elimination, rather than at their determination, contrary to the course originally pursued.

The mean error of observations appears to vary but little for the same observer, its average ranging, for different observers, between nine and fourteen hundredths of a second for a single tap.

The changes of azimuth during the period of observation have been referred to in previous reports, and constitute one of the most interesting and striking phenomena which the computations have brought to light. In all the telegraphic longitude measurements without exception, both in summer and winter, in the northern and the southern States, the transit instruments have been found affected by a motion in azimuth differing in

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