

XXVII. *On the present Situation of the Magnetic Lines of equal variation, and their Changes on the Terrestrial Surface.* By PETER BARLOW, Esq., F.R.S., Cor. Memb. Inst. France, and of the Imp. and Royal Academies of Petersburg, Brussels, &c.

Received May 6,—Read May 9, 1833.

THE great progress which has been made within a few years in establishing the laws of magnetic action, as subsisting between magnets on each other, and of these on iron, leads to a rational expectation that the still unknown and mysterious laws of terrestrial variation may by perseverance be likewise elicited.

This hope has induced me to undertake the task of collating and arranging all the valuable information recorded in several recent and important voyages and journeys of discovery, surveys, &c., undertaken by the British and by some foreign Governments. In all these cases the officers selected to conduct them have been of the highest scientific character: the subject of magnetism has been, during the time of their performance, the favourite pursuit of many highly talented philosophers in all parts of Europe. Instruments of the most perfect description have been employed, and more than ordinary care bestowed upon the magnetic observations.

Many of these have been made in regions, of all others, the most interesting in such an inquiry, namely, in the vicinity of a principal focus of magnetic energy; others are equally important from their extensive range. In the voyage under the command of Captain BEECHEY, more than 75,000 miles of the earth's surface were traversed, and, throughout, the errors from local attraction were carefully excluded. The surveys of the coast of Africa, America, and New Holland, by Captains OWEN and KING, and many others which might be enumerated, performed by officers in the British navy, and the circumnavigation of the southern pole by Captain BISCOE, have alone furnished an immense stock

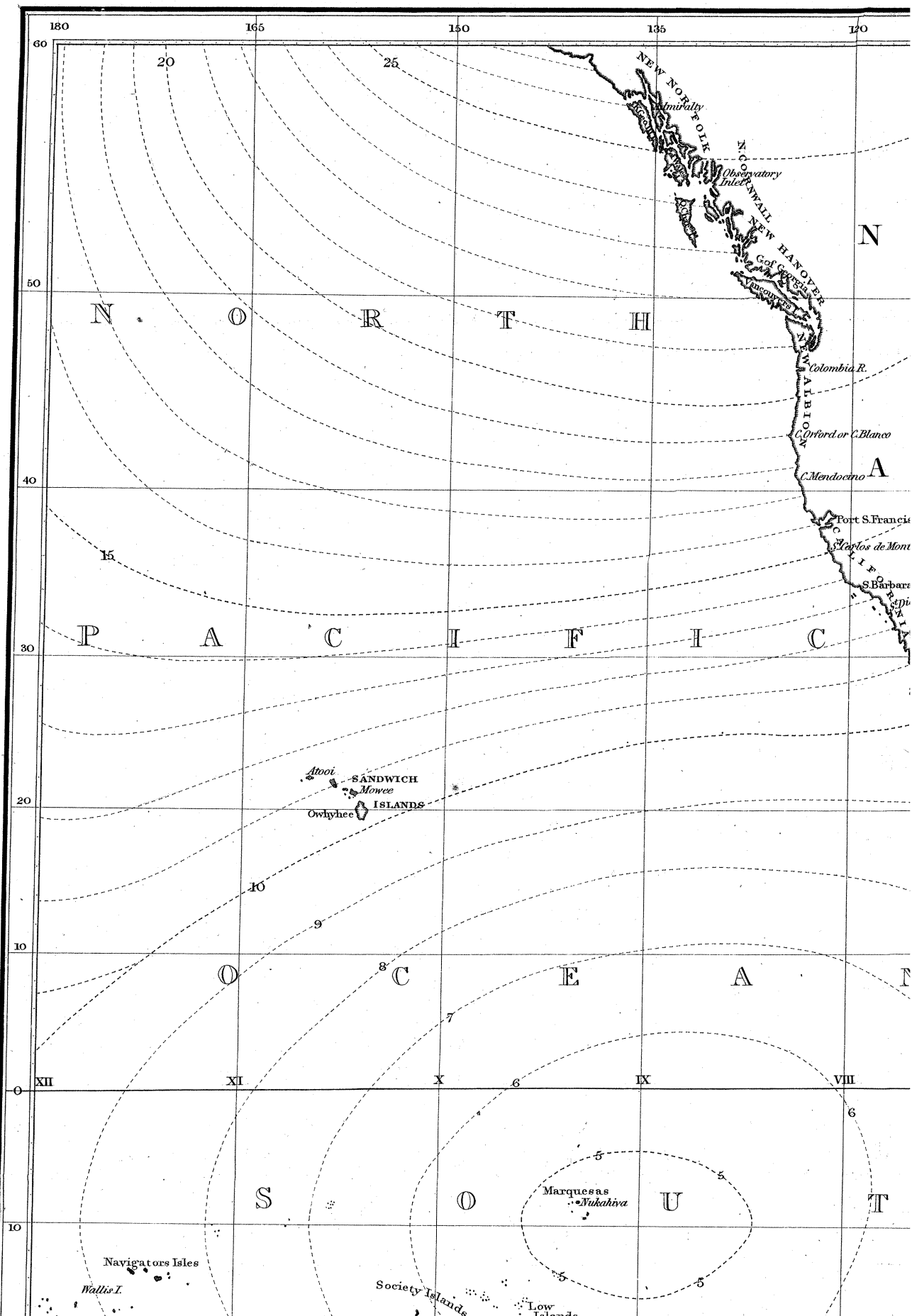
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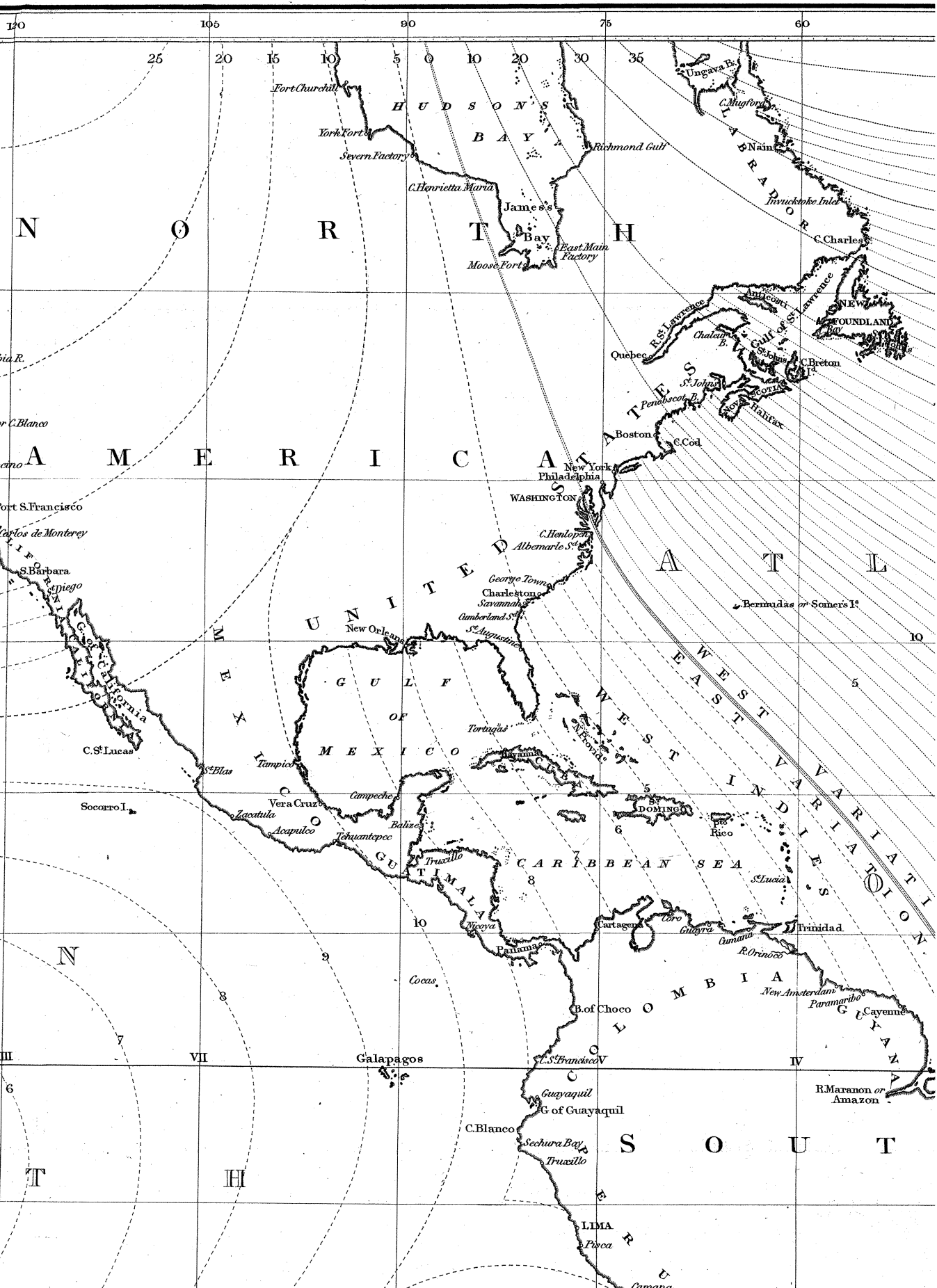
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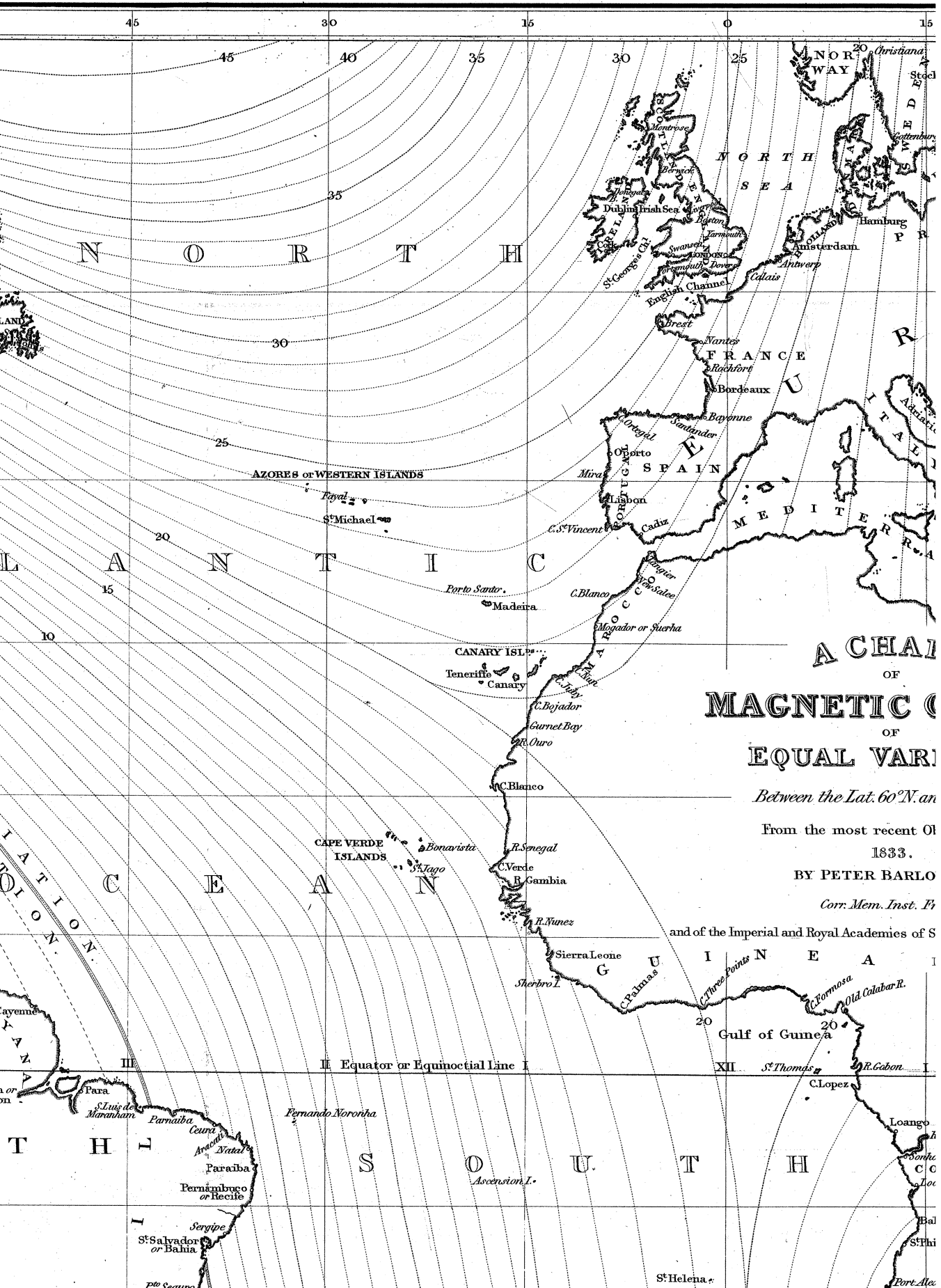
of valuable information; but to these we have to add the voyages by Captain LUTKE in the Russian service, of Captain DUPERRÉ in the French service, and the valuable references I have been enabled to obtain through the kindness of Captains BEAUFORT and HORSBURGH, recorded in their respective offices. These together formed such a mass of well-authenticated observations, as seemed to render it very desirable to collect and arrange them, so as at least to furnish a sure foundation for future comparison, if not for immediate investigation.

With regard to the mode of arrangement, the charts of HALLEY, YATES, HANSTEEN, &c., naturally led me to the idea of one of the same form, as given in the accompanying engravings (Plates XVII. and XVIII.); but feeling dissatisfied with the great distortion of the lines in the higher latitudes, and the necessary want of continuity on the two sides of the chart, I determined to begin *de novo*, and to lay the lines all down on a 15-inch globe, where they of course are exhibited in their natural situation, and in regular continuity, the latter condition being only attainable in the latter form; and I extremely regret that I am not able to publish the work in this form, being so much better calculated to elucidate the subject, than any chart that can be constructed. As I was desirous of keeping myself entirely free from any theoretical notions, my object being principally to fix the foundation for future views and comparisons, I have laid down such lines only as are drawn from actual observations, so that where these failed I have left the parts blank; this is chiefly observable about the south pole and over lands, except in Europe, where well observed variations have enabled me to continue them over both land and water. Having thus devoted the oceans to the variation lines, I had intended to have laid down the lines of equal dips upon the land: but after some consideration I have omitted these; they might, however, be introduced without confusing the lines of variation. On the globe I have coloured those oceans in which the variation is east, with a light green; and where it is west, with a light blue: in the same way, if the dip lines were introduced, those parts of the land and continents in which the dip is north, and where it is south, might be distinguished by a similar contrast of colour,—a plan which relieves the eye, and assists the mind in tracing the various configurations of the several lines.

On attentively examining these lines, either in the form of a chart, or on the globe, but particularly on the latter, it must, I think, be acknowledged, not-







A CHART
OF
MAGNETIC
OR
EQUAL VARIATION

Between the Lat. 60° N. and

From the most recent Observations
1833.

BY PETER BARLOW

Corr. Mem. Inst. Fr.

and of the Imperial and Royal Academies of Sciences

of the Imperial and Royal Academies of Sciences

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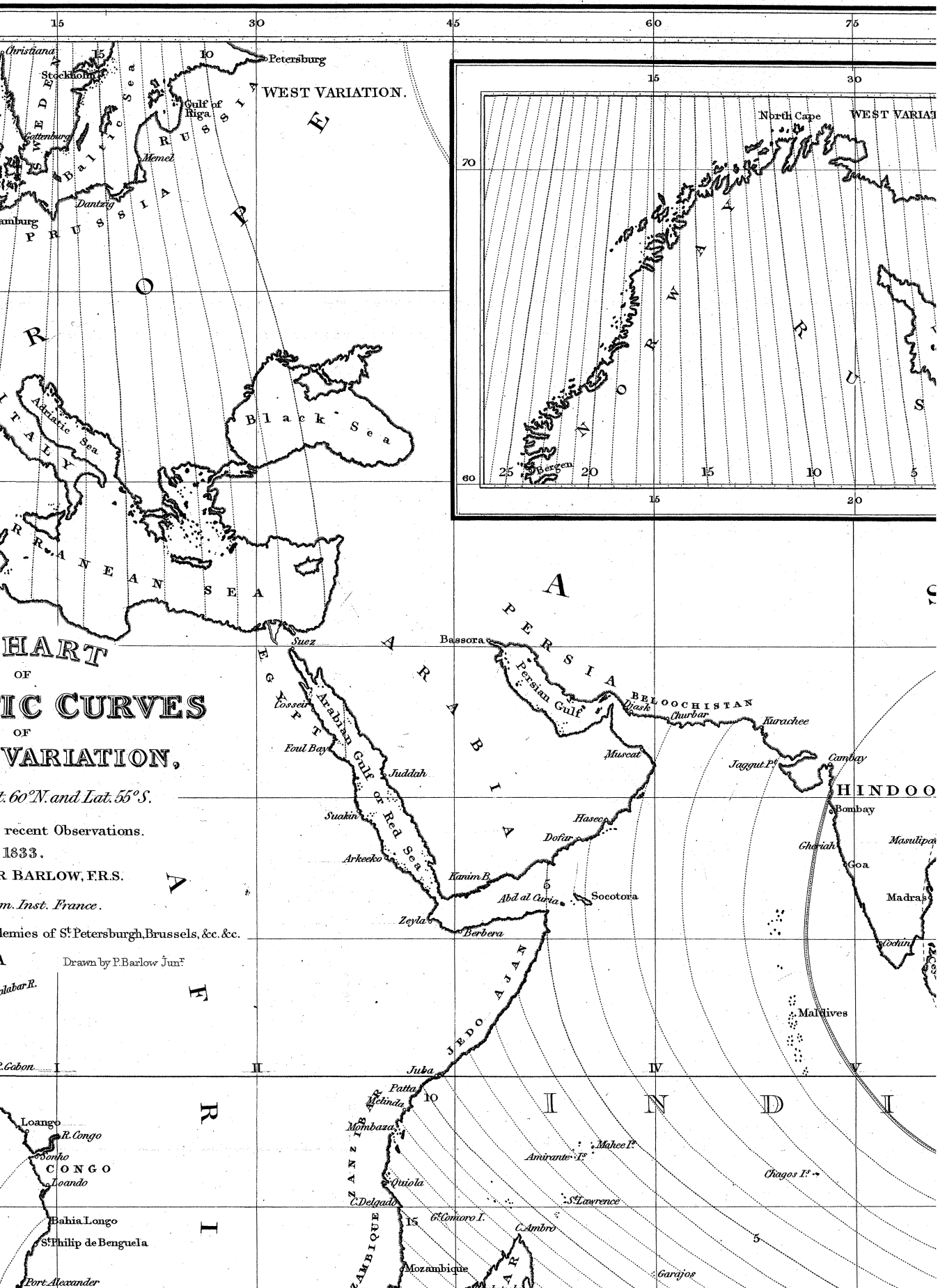
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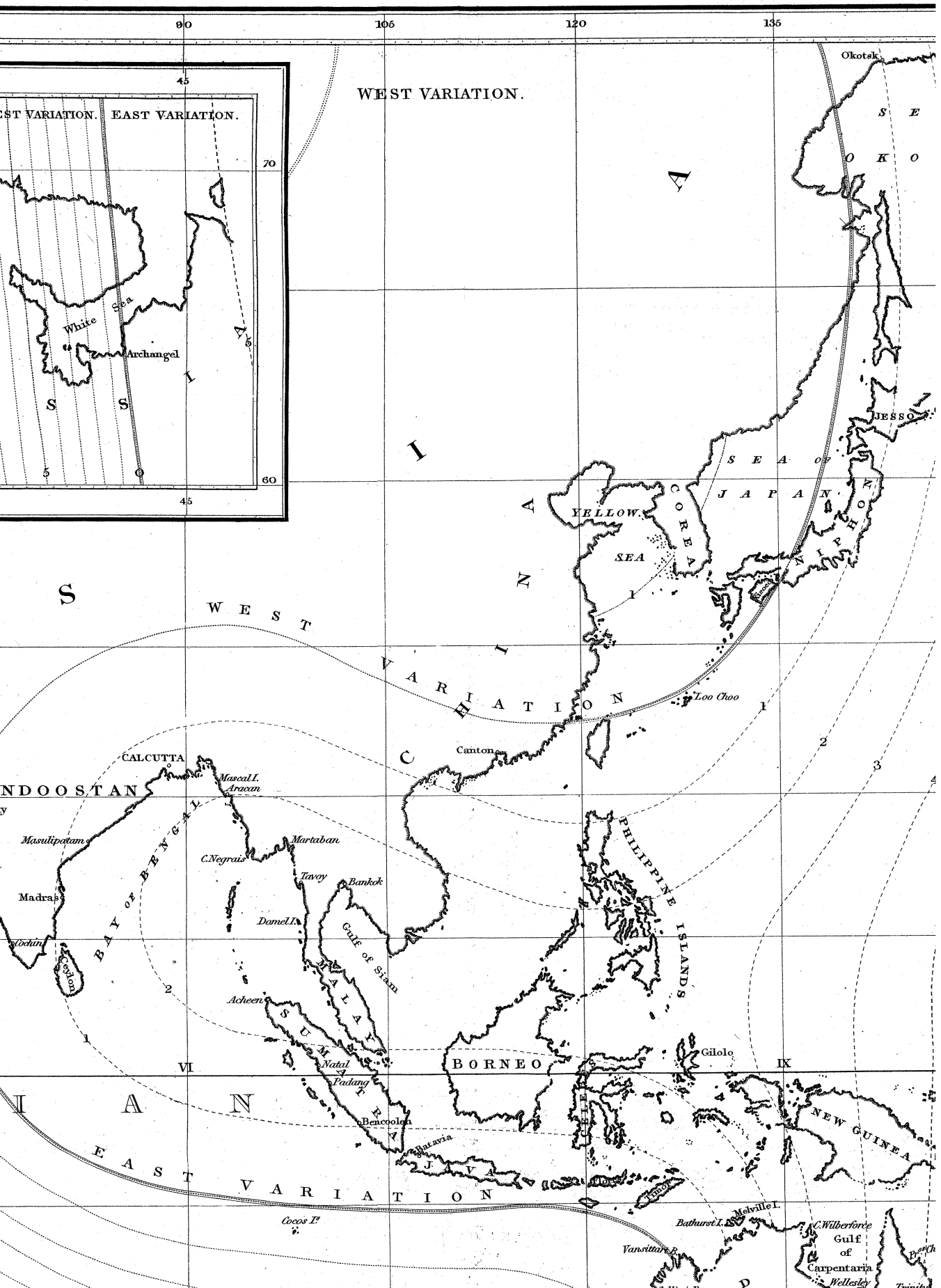
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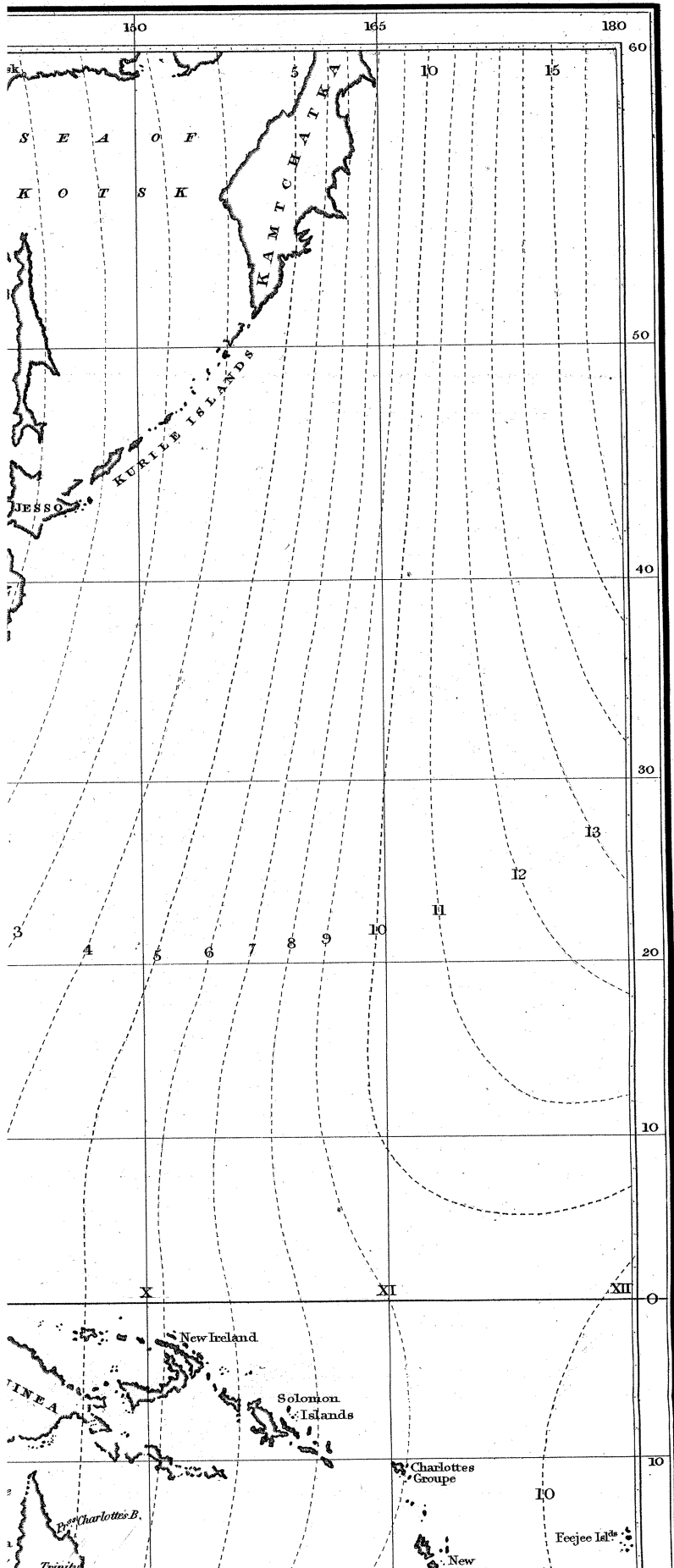
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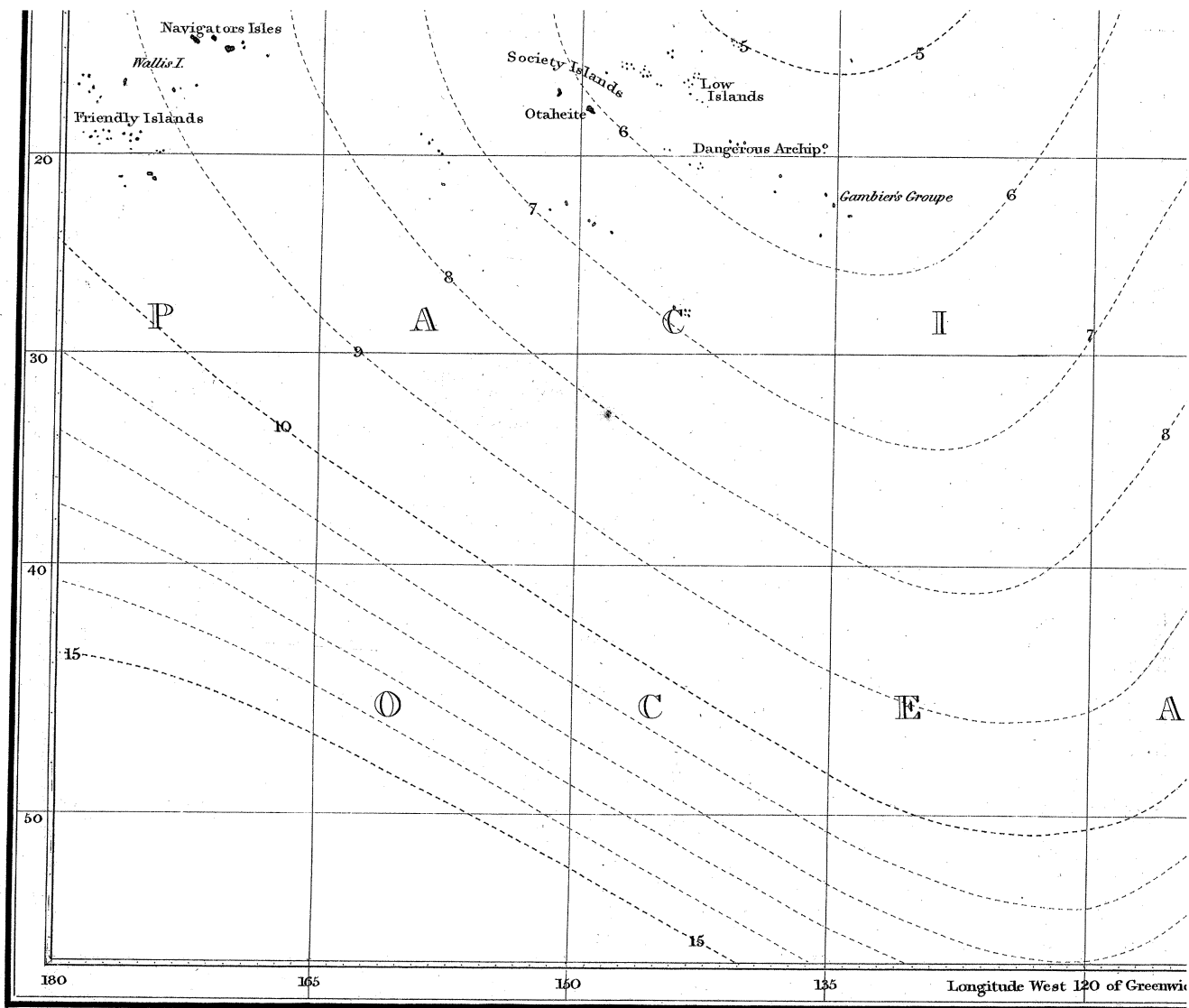
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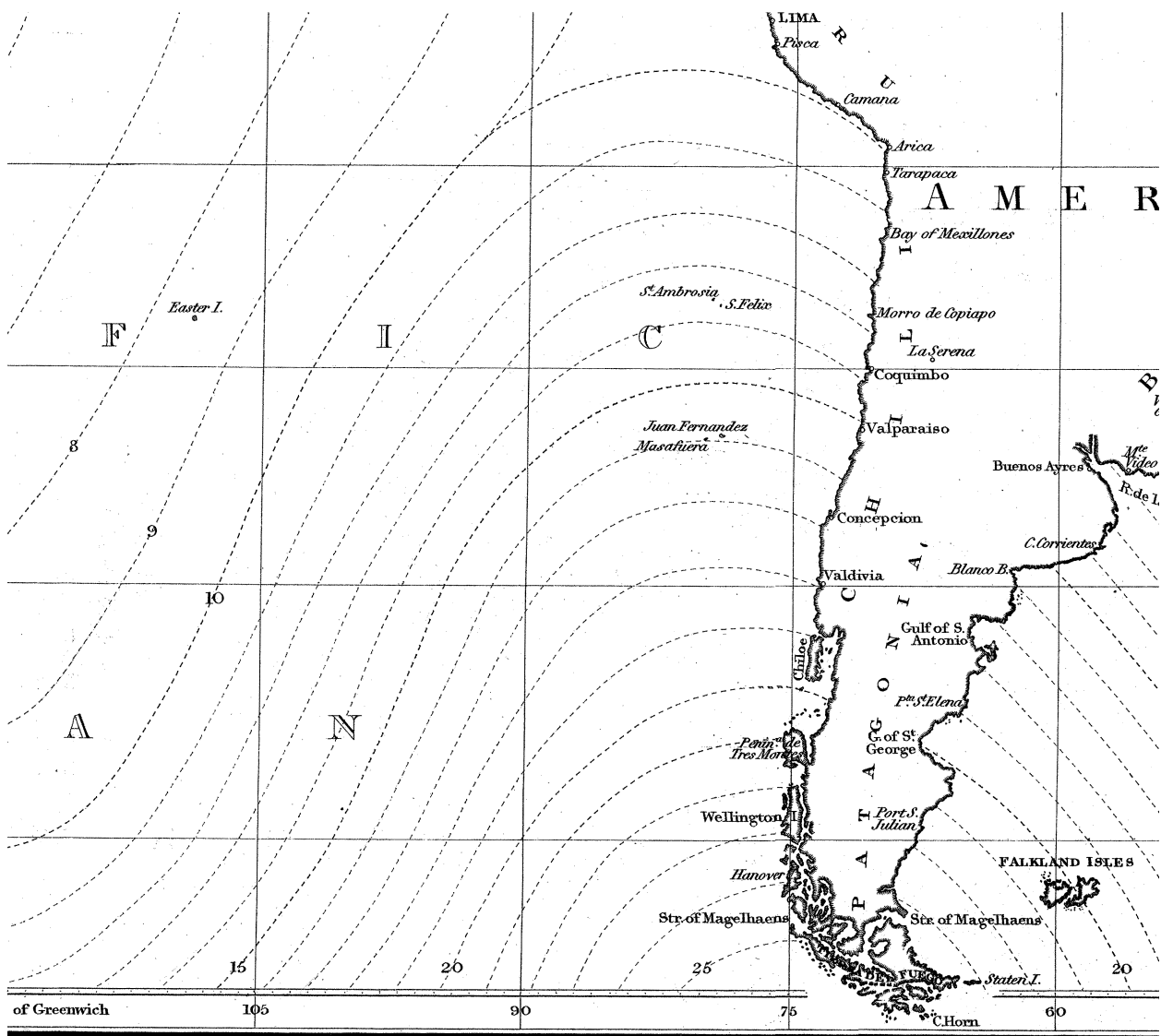
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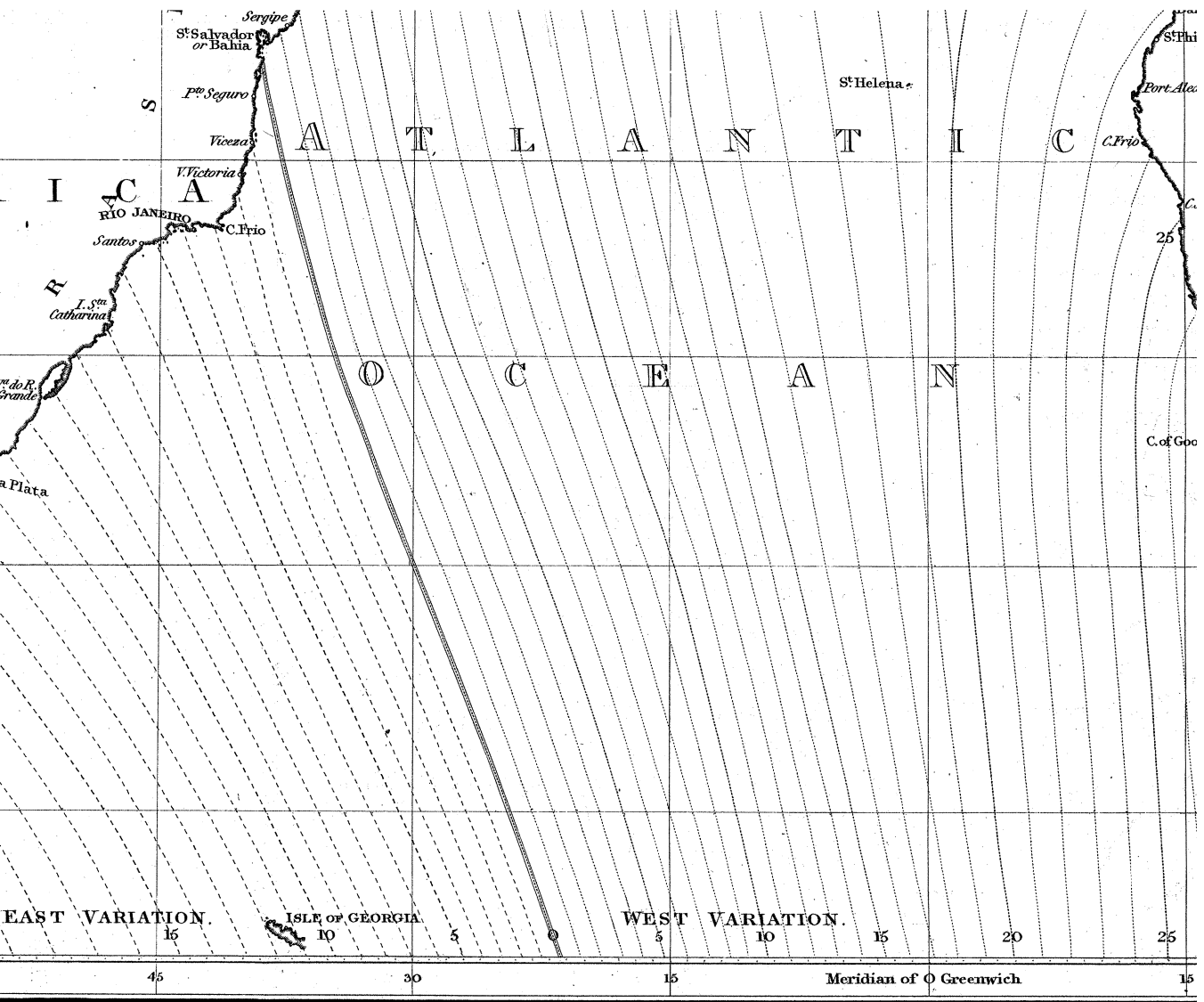


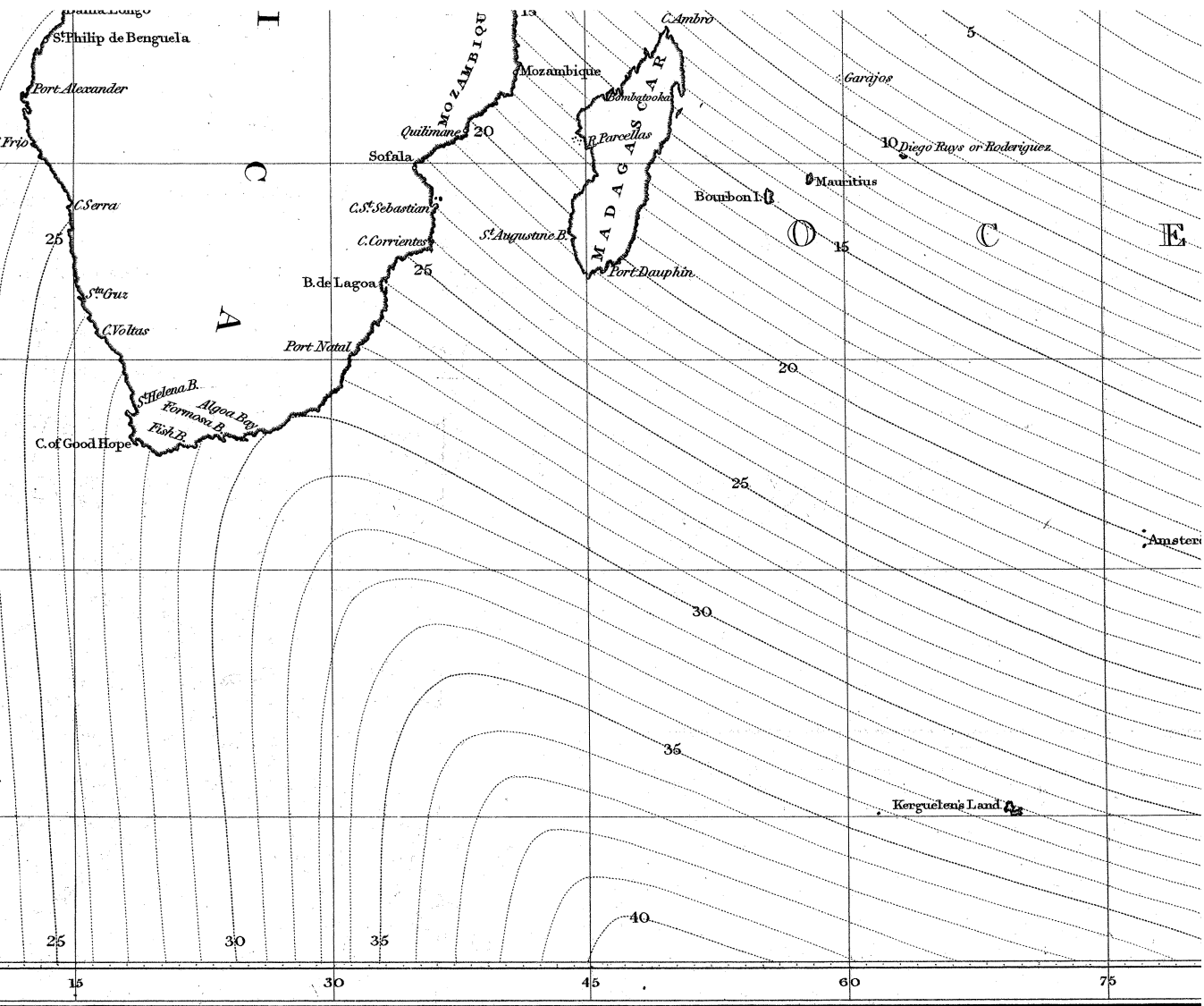


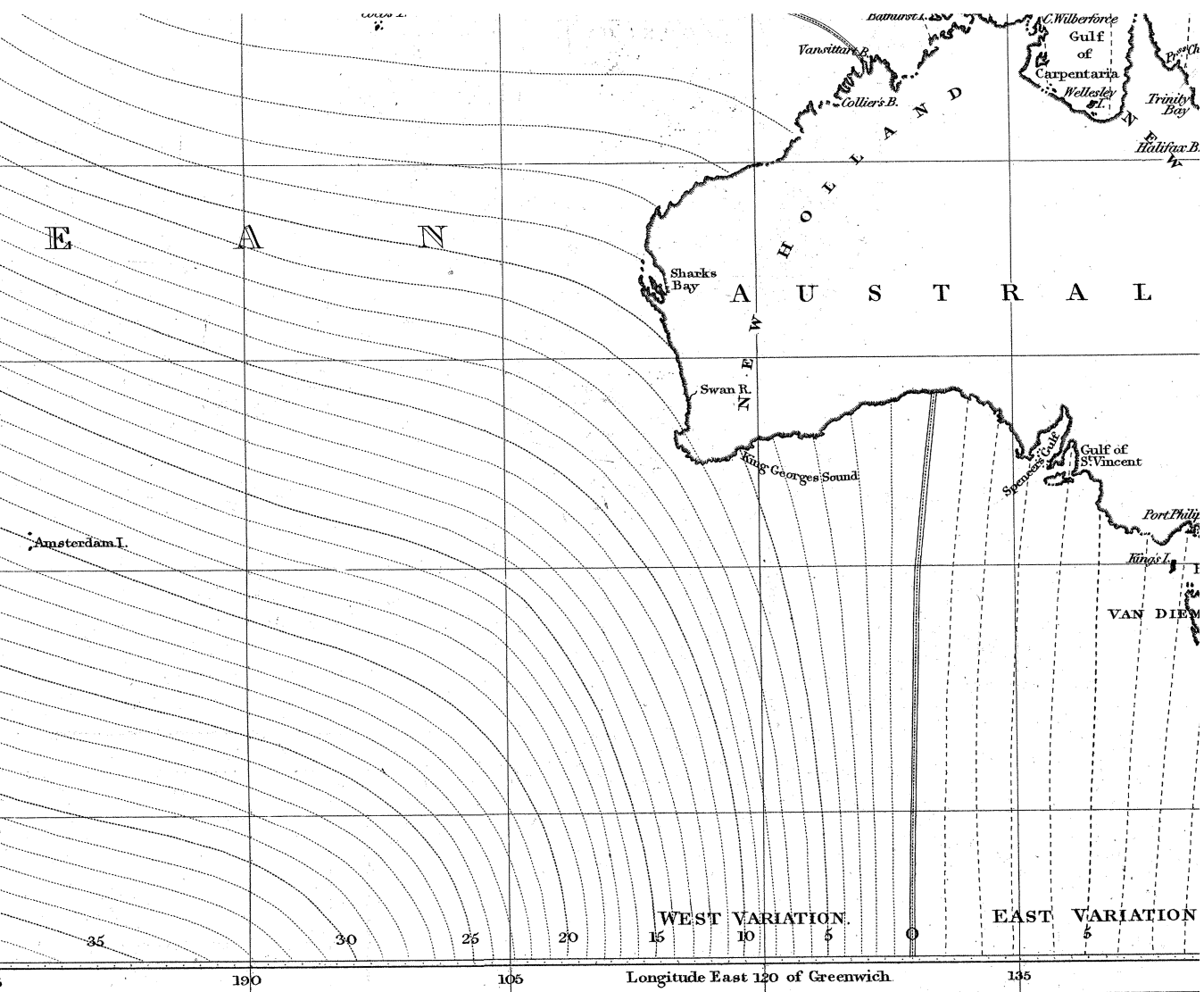


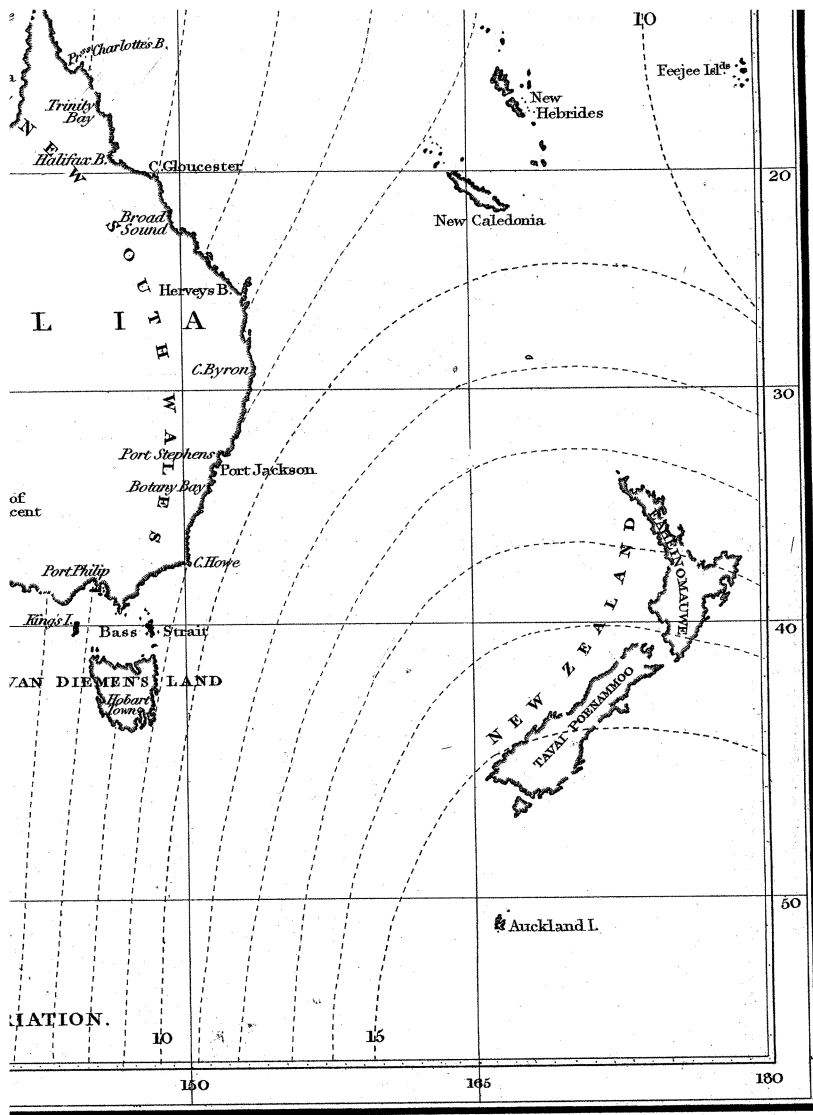












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A CHART OF MAGNETIC CURVES

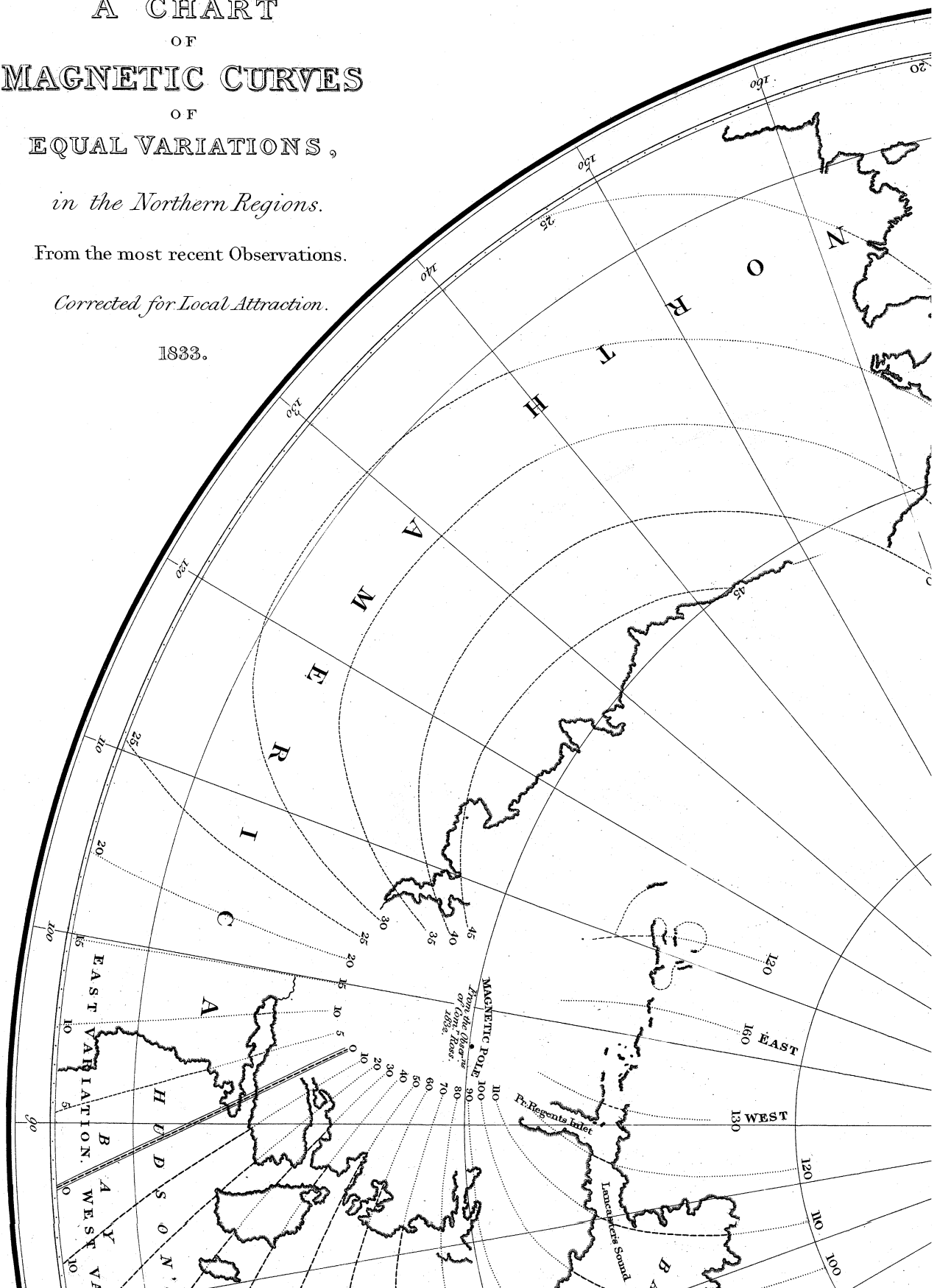
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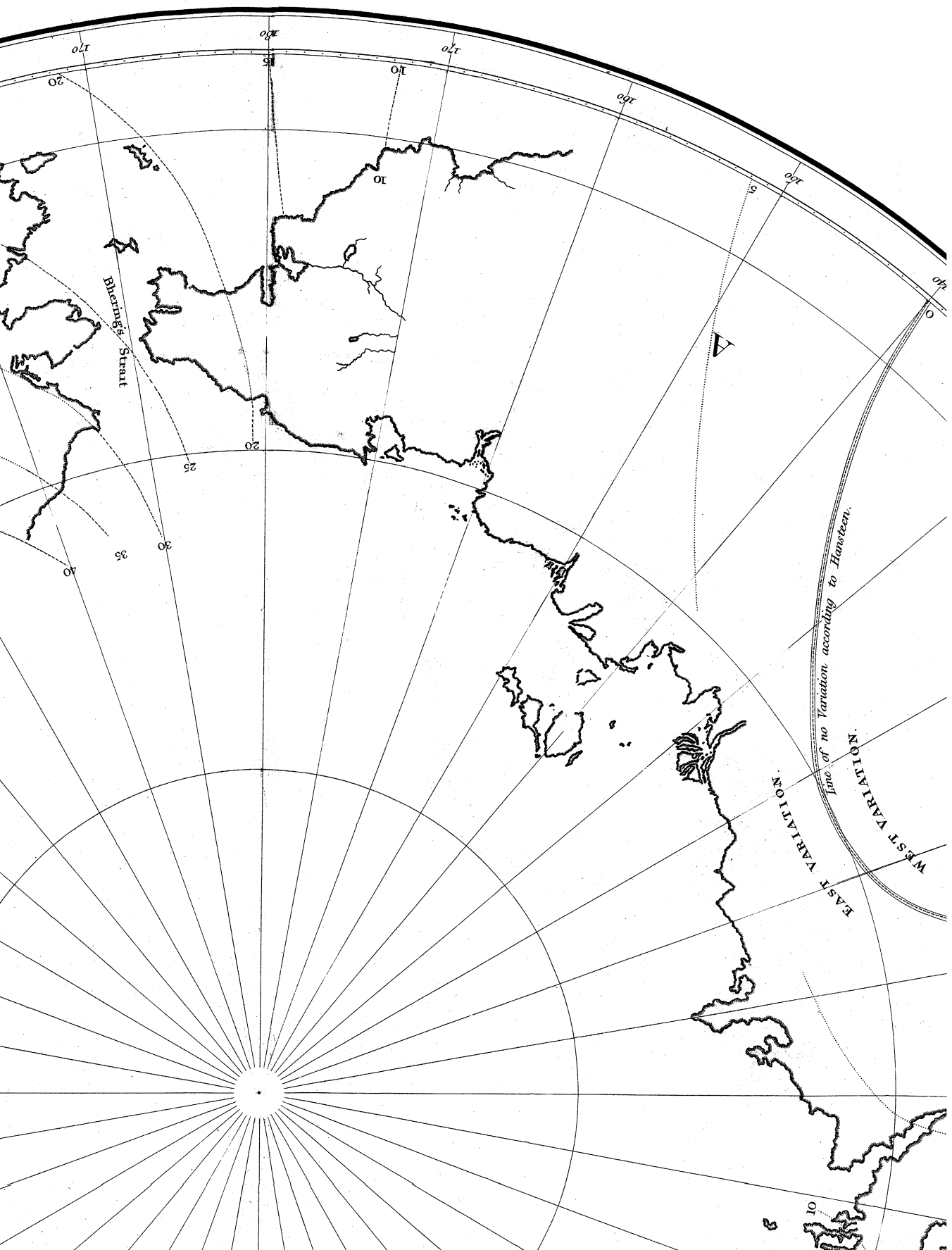
in the Northern Regions.

From the most recent Observations.

Corrected for Local Attraction.

1833.





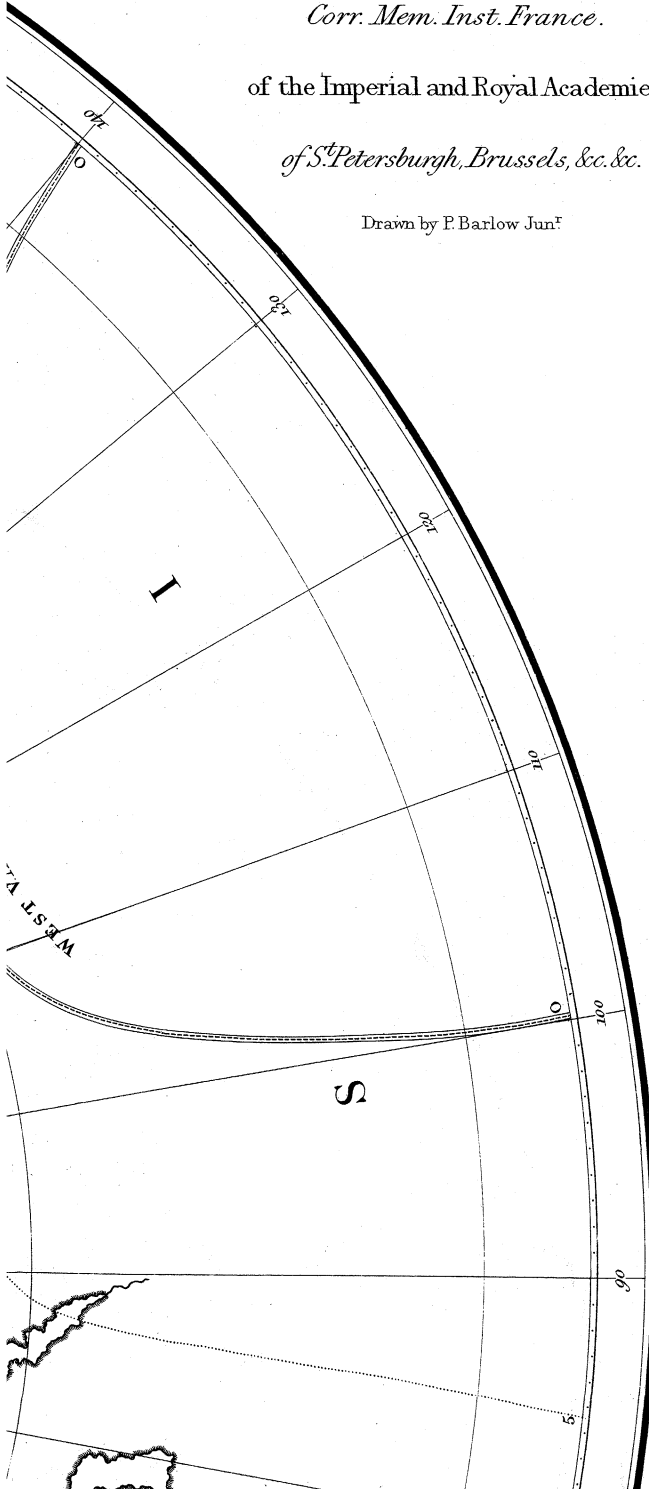
COLLATED
AND
ARRANGED
BY
PETER BARLOW, F.R.S.

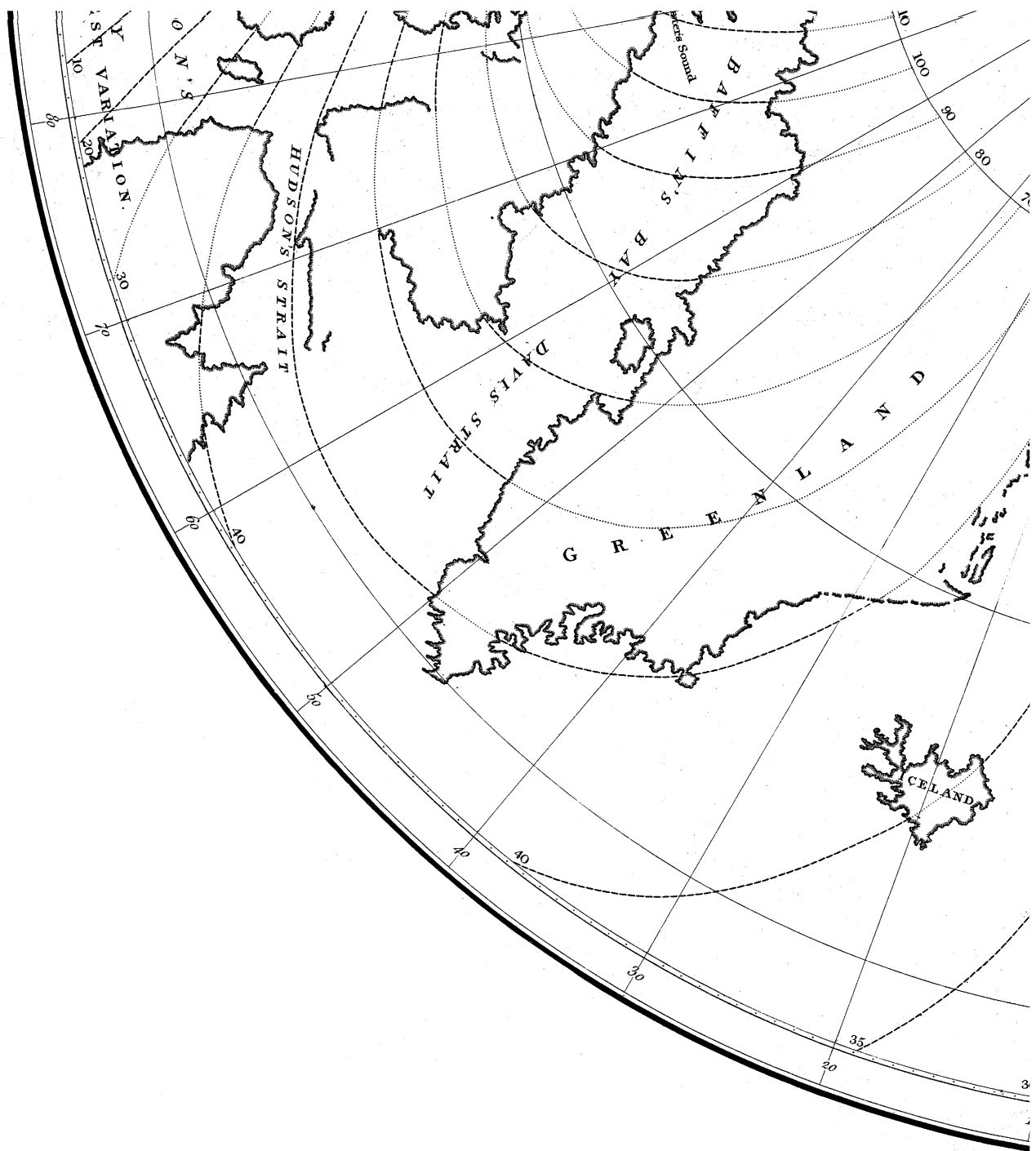
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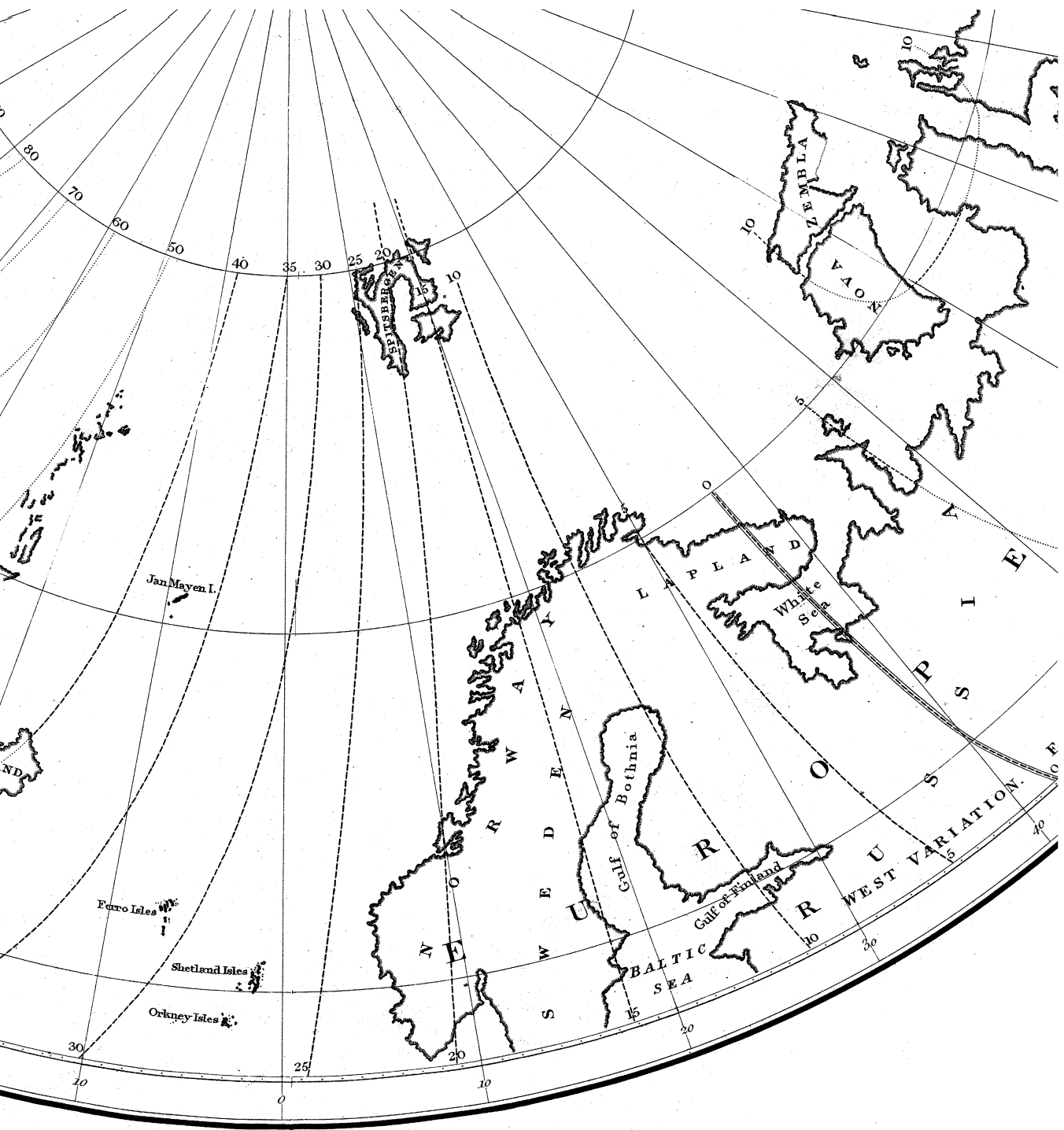
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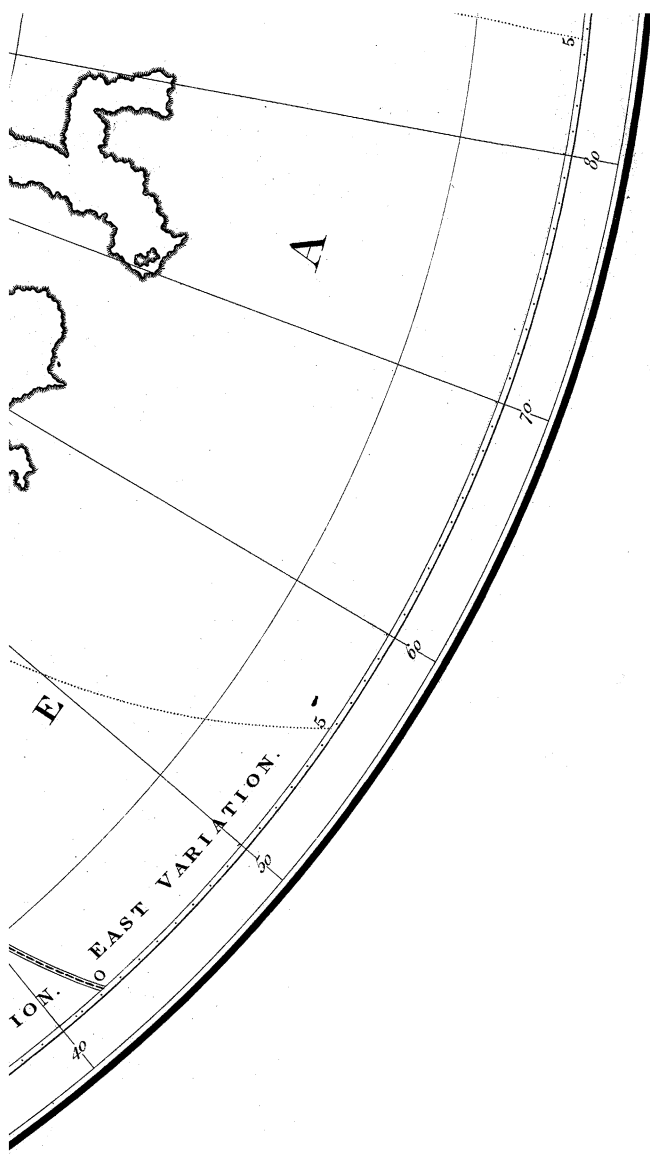
Drawn by P. Barlow Jun^r







J. Barrow sc.



withstanding their extraordinary curvatures, that they exhibit a character which indicates their being dependent on some law, however intricate and mysterious. If the variations were, as has been sometimes supposed, greatly influenced by parts immediately in their vicinity, we could not expect to find that regularity which is observable in so many, if not in all parts: throughout the Atlantic Ocean, for example, there is a continuity and softness of curvature, and unity of character quite inconsistent with such a supposition; still the lines there recorded are the legitimate deductions of a comparison of many hundred observations with each other.

Again, in the Indian Ocean we have a most extraordinary inflection of the curve of no variation, whereby we find, in traversing the earth's equator, that two thirds of it, or 240° , have easterly variation, while only 120° have westerly variation; and here again, in consequence of this extreme anomaly, I have taken particular pains, and have examined an immense number of observations, as recorded both by officers in the British navy, and in the East India Company's ships, with the greatest care, and there is no question whatever that the lines as laid down on the globe are an exact representation of those on the earth; but we see no such sudden interruptions of curvature as must occur if local causes were very influential. I may also remark, that the observations in these seas are by far more accordant and positive in their character than I generally found them in other parts,—a circumstance probably attributable to the very small dip in these seas, and the consequent high intensity of the horizontal needle, which rendered it by position less liable to disturbance from local attractions, and more determinate in its direction.

Another marked peculiarity in this ocean is, that for forty degrees the line of no variation runs nearly parallel to the equator, and then for another forty degrees down a meridian; and as in cases of no variation the magnetic pole, as we commonly understand the term, must be on the meridian of the place, it follows that the pole must also range through forty degrees, or be coincident with the pole of the world; either of which conditions is equally inconsistent with the notion that all these phenomena are due to the action of four or more magnetic poles.

Again, referring to the remarkable curves in the great Pacific Ocean, there is, notwithstanding their peculiar character, no appearance of uncertain and

anomalous attractions: the whole seems to form a system by itself. The lines, instead of extending towards the poles, as in most other parts, return upon themselves in similar, though not in regular figures: and here again I can see no possible position of four poles which can lead to such configuration.

These lines differ very considerably from those of former charts; but they are drawn from a careful examination of observations, not so numerous, certainly, as in some other parts, but still in all probability much exceeding those on which former charts in this ocean have been constructed.

Many other peculiarities will occur to any person carefully examining the several curvatures, particularly that remarkable one found in crossing the Continent of Asia; but as I have not had an opportunity of consulting the original authorities on which these lines are founded, I shall not offer any remark upon them, except to state that they rest on the authority of a most able and indefatigable observer, Professor HANSTEEN, only that a slight change was rendered necessary by the recent observations of Captain LUTKE on the coasts of Nova Zembla and the North of Europe.

The foregoing remarks have reference to the present state of the magnetic lines; but their progressive change of situation and configuration is another important feature in terrestrial magnetism. The first notice I can find of the variation itself occurs in the year 1269, in a letter from PETRI PEREGRINI to a friend, where the author states that after several careful experiments he found it amounted to 5° east in Italy; but the method of observation at that time was very unsatisfactory: it consisted only in touching an iron needle with the loadstone, and observing its bearing before its power was lost. In 1580 the variation was certainly $11\frac{1}{4}^{\circ}$ east in London: about 1658 it was zero, the needle pointing then due north. In 1700 it was about 8 degrees west, at which time it was zero on the coast of America in the vicinity of New York, and it has remained at the latter place nearly the same ever since.

It follows, therefore, that about the year 1660, the line of no variation must have crossed the Atlantic nearly at right angles to the meridians, as it does now in the Indian Ocean.

From that time it has been gradually descending towards the south and west, and at present crosses some way inland on the eastern point of South America.

We have not such early authority for that line of no variation which passes through Australia, but since that country has been pretty well known, at least for 60 years, very little if any change has taken place, and it seems probable the variation about this spot is as fixed as in that on the coast of America.

I refer to these two cases because they differ very considerably from all others in which a line of no variation has been known to cross; the motion for some years before and after the actual passage of that line being generally very rapid, whereas in these it is stationary or nearly so. Thus in London, the variation was $11^{\circ} 15'$ east in 1580; in 1658 the line of no variation passed our meridian, and in 1698 it was about 8° west, giving a change of 20° in a little more than 100 years; and the same is observed in all other places where the passage of the line is well determined, while in the two places referred to, it has experienced no change, or very little, in the one, for more than 130 years, and in the other probably for as long a time, but certainly for more than 60 years.

In the West Indies, the Bermudas, and a few other places, where the variation is small, the change has also been very inconsiderable; but I believe no case occurs where the variation is large and stationary,—a peculiarity which ought to be well considered in attempting a theory of these motions. Another circumstance equally remarkable is, that in all cases in which sufficient registers of variation have been made, and where the motion or change has been considerable, we may always reduce that motion to a circular rotation of a certain assumed magnetic pole about the pole of the earth: that is, we may, by assuming for each place its own pole, revolving at a given uniform rate, compute the variation of the needle at any period so as to agree very nearly with observation.

CHURCHMAN, in his Atlas, I think, was the first to make this assumption, and to compute the consequent variations in London for every ten years from 1622 to 1800; which he afterwards compared with actual observed variations, and in every case the error between the two is very inconsiderable.

In the second edition of my Essay on Magnetic Attractions, I have made a similar comparison, not by assuming the place of the pole, but by computing it from the dip and variation; and the errors or differences in this case, though certainly not so small, are still by no means considerable.

In the Article "MAGNETISM" in the *Encyclopædia Metropolitana*, I have

made similar computations for Paris and Copenhagen, the only two places besides London where observations are recorded for any length of time, and in both these the agreements between the computed and observed variations are still more approximate than in London.

Now it must be considered very extraordinary that such remarkable agreements as these should obtain in three places, between the computed and observed variations, through more than thirty degrees of change, or for a period of 170 years, if the hypothesis of a polar revolution were not founded in fact. Assuming then, that, from whatever cause it may proceed, such a revolution does take place, how are we to account for those stationary, or nearly stationary, points of no variation to which reference has been made?

The only reply to this question appears to be, that there is no determinate pole to which all needles point, but that every place has its own particular pole and polar revolution, governed probably by some one general but at present unknown cause. Should this be the case, and the magnetic pole of any place be nearly coincident with the terrestrial pole, the line of no variation, notwithstanding the rotation, must remain nearly stationary; but such stationary position is impossible where the variation is considerable, although the change ought to be very slow on this hypothesis while it is passing through its maximum.

I have offered these few remarks without any intention of their being considered as illustrations of a particular theory. My only object has been in this undertaking to give an exact representation, as far as it was possible, of the present state of terrestrial magnetism, and in this I have every reason to hope I have succeeded.

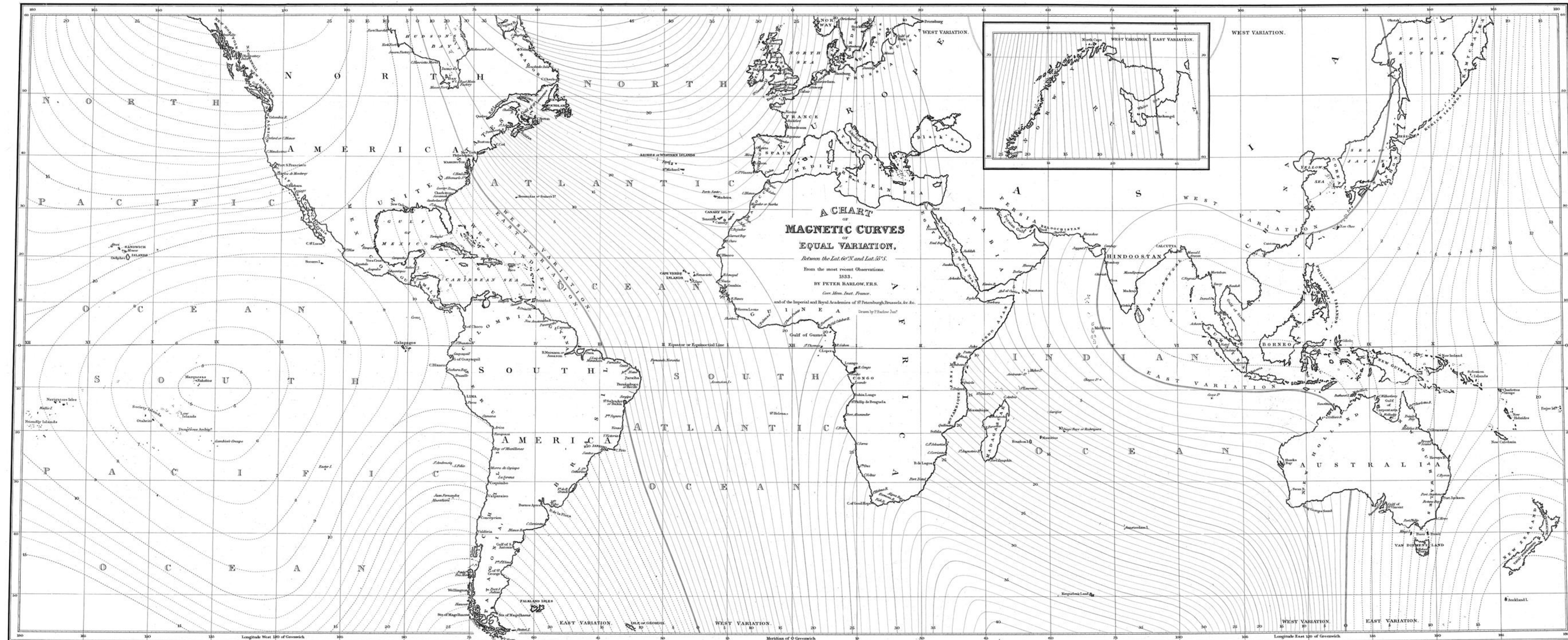
In the performance of this task, which has required several months of close application, I have been greatly assisted by my son, who has executed with great accuracy the whole of the graphical part, and aided in the comparison of many thousand observations; and I shall be most happy if our joint labour should furnish the requisite data for either a present or future development of those mysterious laws which govern the magnetism of the terrestrial globe,—an object as interesting in philosophy as it is important in navigation.

Woolwich,

May 1st, 1833.

November 18th, 1833.

P.S. Since this paper was read, and the globe and chart referred to in this article were drawn, Captain Ross has returned from his long and adventurous voyage. It will be seen by a reference to the polar chart, that, although I was enabled to lay down the curves of equal variation to within a few degrees of their point of concurrence, yet they are all terminated before arriving at it, for want of sufficient data. These are now supplied ; and it is very gratifying to me, as I hope it may be also to Captain Ross and to Commander JAMES Ross, to find that the very spot in which they have found the needle perpendicular,—that is, the pole itself,—is precisely that point on my globe and chart in which, by supposing all the lines to meet, the several curves would best preserve their unity of character, both separately, and conjointly as a system. By some delay in engraving the chart, I am able to add to it the exact place of the pole, as obtained from the numerous and admirably arranged observations of Commander Ross, which I have had the pleasure and satisfaction of examining, and which I hope, in the ensuing session, will be laid before the Royal Society.



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