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MAGNETIC CHART ERRORS AND SECULAR CHANGES IN THE INDIAN OCEAN

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In view of the exceptionally large errors in the most recent charts which are being disclosed in the Indian Ocean on the present cruise of the *Carnegie*, it was thought desirable to make early communication. Tables I and II give the values of the magnetic declination ("variation of the compass") with the geographic positions, as determined on the *Carnegie* from Cape Town to Colombo, Ceylon, thence to Mauritius, April to August, 1911; a future communication will give the results from Mauritius northward to the Arabian Sea, thence to Colombo and Batavia. While the present figures are not final, they are not likely to be changed by more than one-tenth degree.

The tables also give the corresponding values as scaled from the British Admiralty chart of 1907 (*B*); the German chart of 1910 (*G*); and the United States Hydrographic Office chart of 1910 (*U*); these chart values have been referred approximately to the time of our observations by applying the secular changes as indicated on the respective charts. The final three columns give the differences between the *Carnegie* values (*C*) and those of the various charts; the plus sign (+) means that the charts give west declinations too large, the minus sign (—) on the other hand signifying that the chart values are too low by the tabular amount.

It will be seen that, with the exception of a few values at the beginning of Table I, and at the end of Table II, the chart errors are always negative, and hence a value of west declination scaled from any one of the charts mentioned, as a rule, would have to be increased to make it correspond with that of the *Carnegie*. It will be noticed also that the errors run up at times to four degrees, and, for one of the charts, even to six degrees. These chart errors, while partly due to defective spacing of the lines of equal magnetic

declination, are to be referred chiefly to erroneous secular changes, applied to the previous data on which the charts depend; this is shown in Table III.*

The errors in the magnetic inclination reach a maximum of about three degrees, and in the horizontal intensity go up to a unit in the second decimal C. G. S. units.

TABLE I.

West Magnetic Declinations and Chart Errors, Cape Town to Colombo, May-June, 1911.

Date	Position		Carnegie	Chart Values			Chart Errors		
	Latitude	East Longitude		Brit.	Ger.	U. S.	Brit.	Ger.	U. S.
1911	°	'	°	°	°	°	°	°	°
Apr 28	38 26S	26 48	27.9	28.1	30.5	28.9	+0.2	+2.6	+1.0
30	39 55S	29 49	26.0	28.1	31.0	28.7	+2.1	+5.0	+2.7
May 3	39 47S	38 15	25.2	26.3	30.0	26.9	+1.1	+4.8	+1.7
10	40 16S	62 06	26.7	27.5	26.9	27.2	+0.8	+0.2	+0.5
10	40 18S	63 19	28.4	27.5	27.0	27.4	-0.9	-1.4	-1.0
11	40 18S	66 54	27.5	27.9	26.8	27.9	+0.4	-0.7	+0.4
11	40 15S	68 34	28.8	28.0	26.6	28.0	-0.8	-2.2	-0.8
12	39 52S	70 43	28.1	27.7	26.0	28.0	-0.4	-2.1	-0.1
12	39 26S	71 26	28.1	27.5	25.2	27.4	-0.6	-2.9	-0.7
13	39 13S	71 59	28.6	27.3	25.1	27.3	-1.3	-3.5	-1.3
13	39 17S	72 30	28.2	27.6	25.1	27.4	-0.6	-3.1	-0.8
14	39 23S	73 24	29.1	27.6	25.3	27.6	-1.5	-3.8	-1.5
15	39 50S	74 23	29.1	28.0	25.5	28.2	-1.1	-3.6	-0.9
17	38 36S	76 52	28.4	26.9	24.1	26.6	-1.5	-4.3	-1.8
19	35 16S	77 42	24.7	22.7	20.5	22.8	-2.0	-4.2	-1.9
20	34 09S	77 48	23.7	21.5	19.6	21.6	-2.2	-4.1	-2.1
21	32 08S	77 35	22.0	19.2	17.5	19.6	-2.8	-4.5	-2.4
22	28 54S	76 57	18.4	15.5	14.5	15.9	-2.9	-3.9	-2.5
24	24 16S	76 18	14.9	11.2	10.0	13.7	-3.7	-4.9	-1.2
25	21 22S	76 27	12.5	9.1	7.1	11.8	-3.4	-5.4	-0.7
26	19 16S	76 18	11.0	8.1	5.3	10.2	-2.9	-5.7	-0.8
26	19 06S	76 17	11.3	7.9	5.1	10.0	-3.4	-6.2	-1.3
27	18 45S	76 22	10.5	7.7	5.0	10.0	-2.8	-5.5	-0.5
27	17 52S	76 22	10.5	7.5	4.6	9.1	-3.0	-5.9	-1.4
28	16 02S	76 12	9.2	7.0	4.2	7.7	-2.2	-5.0	-1.5
28	14 56S	76 01	8.8	6.6	3.9	6.9	-2.2	-4.9	-1.9
29	13 03S	75 48	7.7	6.1	3.5	5.7	-1.6	-4.2	-2.0
29	11 53S	75 48	7.3	5.7	3.2	5.4	-1.6	-4.1	-1.9
30	10 36S	75 46	6.5	5.3	3.0	5.0	-1.2	-3.5	-1.5
30	9 38S	75 50	6.2	5.0	2.8	4.7	-1.2	-3.4	-1.5
31	8 03S	75 53	5.5	4.5	2.6	4.0	-1.0	-2.9	-1.5
31	6 54S	75 50	5.4	4.2	2.5	3.6	-1.2	-2.9	-1.8
Jun 1	4 50S	75 46	4.6	3.8	2.2	3.0	-0.8	-2.4	-1.6
2	3 22S	76 10	3.7	3.5	1.9	2.5	-0.2	-1.8	-1.2
2	2 17S	76 27	4.0	3.2	1.7	2.2	-0.8	-2.3	-1.8
3	0 39N	76 26	3.2	2.7	1.4	1.7	-0.5	-1.8	-1.5
5	3 39N	77 13	2.7	2.1	1.0	1.3	-0.6	-1.7	-1.4
6	5 16N	78 06	2.1	1.6	0.8	1.0	-0.5	-1.3	-1.1

* As some support to the last value of the table, it may be stated that west declination is at present increasing, as recorded at the Royal Alfred Observatory, Mauritius, at the rate of about two minutes per annum.

Secular Changes

From a comparison of the Carnegie values with those of the German Antarctic ship, the *Gauss*, made in 1903, by Dr. Bidlingmaier, the following values for the secular change result at points common to the two vessels.

The final three columns give the average annual change in the magnetic declination, first as resulting from a comparison of the results obtained on the *Gauss* (1902-3) and on the *Carnegie* (1911), next as shown, respectively, on the British Admiralty chart of 1907, and the United States Hydrographic Office chart of 1910—no values are found on the German chart. It will be seen that the charts give considerably smaller changes, and in the last case, of reversed sign.

TABLE II.

West Magnetic Declinations and Chart Errors, Colombo to Mauritius, June-August, 1911.

Date	Position		Carnegie	Chart Values			Chart Errors		
	Latitude	East Longitude		Brit.	Ger.	U. S.	Brit.	Ger.	U. S.
1911	° /	° /	°	°	°	°	°	°	°
Jul 8	5 25N	79 44	2.1	1.5	0.7	0.8	-0.6	-1.4	-1.3
8	4 49N	80 13	2.3	1.7	0.8	0.9	-0.6	-1.5	-1.4
9	4 05N	81 06	2.4	1.8	0.8	1.0	-0.6	-1.6	-1.4
10	2 24N	82 46	2.5	2.1	0.9	1.1	-0.4	-1.6	-1.4
10	1 40N	83 29	2.7	2.1	0.9	1.2	-0.6	-1.8	-1.5
11	1 10N	84 19	2.6	2.2	0.9	1.3	-0.4	-1.7	-1.3
12	0 54N	85 28	2.5	2.1	0.9	1.3	-0.4	-1.6	-1.2
13	1 10N	84 22	2.5	2.1	0.9	1.3	-0.4	-1.6	-1.2
14	1 07N	84 44	2.6	2.1	0.9	1.3	-0.5	-1.7	-1.3
15	0 34N	85 51	2.5	2.1	1.0	1.3	-0.4	-1.5	-1.2
16	0 02S	86 36	2.6	2.1	1.0	1.4	-0.5	-1.6	-1.2
17	1 22S	87 13	2.9	2.3	1.0	1.7	-0.6	-1.9	-1.2
18	2 52S	87 58	2.9	2.5	1.1	2.0	-0.4	-1.8	-0.9
19	3 49S	88 06	3.0	2.6	1.2	2.0	-0.4	-1.8	-1.0
21	6 32S	86 49	4.0	3.4	1.8	2.8	-0.6	-2.2	-1.2
22	8 52S	85 03	5.2	4.0	2.2	3.9	-1.2	-3.0	-1.3
23	11 02S	83 02	6.3	4.9	2.7	4.7	-1.4	-3.6	-1.6
24	12 51S	80 54	7.7	5.8	3.2	5.6	-1.9	-4.5	-2.1
25	14 58S	79 06	8.6	6.6	3.7	6.7	-2.0	-4.9	-1.9
26	16 55S	77 13	10.0	7.2	4.3	8.2	-2.8	-5.7	-1.8
27	18 26S	75 00	10.7	7.9	5.0	9.7	-2.8	-5.7	-1.0
28	20 16S	72 29	11.9	8.6	6.6	10.8	-3.3	-5.3	-1.1
29	21 29S	70 28	11.9	9.6	7.9	11.4	-2.3	-4.0	-0.5
30	23 07S	68 26	13.3	10.8	10.0	13.0	-2.5	-3.3	-0.3
31	24 00S	65 56	13.2	11.2	11.1	13.0	-2.0	-2.1	-0.2
31	24 18S	65 14	13.2	11.5	11.3	13.0	-1.7	-1.9	-0.2
Aug 1	25 34S	63 52	14.0	12.6	12.7	13.9	-1.4	-1.3	-0.1
1	26 01S	63 15	14.1	13.1	13.0	14.1	-1.0	-1.1	0.0
2	25 51S	61 35	13.9	13.0	12.9	13.8	-0.9	-1.0	-0.1
2	25 36S	60 26	13.5	12.6	12.9	13.0	-0.9	-0.6	0.0
3	24 58S	58 38	12.6	12.4	12.9	12.5	-0.2	+0.3	-0.1
3	24 08S	58 01	12.3	11.9	12.6	11.9	-0.4	+0.3	-0.4
4	23 00S	57 55	10.8	11.0	11.3	10.8	+0.2	+0.5	0.0
5	20 35S	57 54	9.1	10.0	9.5	8.6	+0.9	+0.4	-0.5
5	20 02S	57 31	9.2	9.0	9.0	8.3	-0.2	-0.2	-0.9

The plus sign (+) attached to the secular change means west declination is at present increasing for the locality shown; the minus sign (—) meaning, of course, the reverse. The large changes and their rapid variation with geographic position should be especially noted.

Unfortunately the *Gauss* results were not published until but a short time ago, and were hence not available before the *Carnegie* set out from Cape Town for Colombo, otherwise her route could have been arranged to secure more common points with those of the *Gauss* than those for regions A and B. However, before leav-

TABLE III.

Some Secular Changes in the Magnetic Declination in the South-eastern Part of the Indian Ocean.

Year and decimal	Latitude South	Longitude East of Gr.	West Declination	Vessel	Average Annual Change		
					Carnegie —Gauss	Chart Values B '07	U '10
1902.45 1911.38	37 32 37 26	25 48 25 56	28.52 26.92	Gauss, mean of 10 stations Carnegie " " 5 "			
Region A	37 29	25 52			—10.9	—2.8	—2.2
1903.32 1911.38	35 17 35 16	74 47 74 44	22.84 24.61	Gauss, mean of 7 stations Carnegie, " " 12 "			
Region B	35 16	74 46			+13.2	+2.6	+2.5
1903.35 1911.58	25 14 25 19	60 36 60 35	12.65 13.34	Gauss, mean of 4 stations Carnegie, " " 6 "			
Region C	25 17	60 35			+ 5.4	—2.2	—2.3

ing Colombo for Mauritius, we fortunately had received the publication containing the valuable results obtained on board the *Gauss*,¹ and accordingly our route was changed sufficiently to secure observations in the region C, which, as shown in the above table, will assist materially in defining the locality where the secular change passes through a zero value and then changes sign.

*On Board the Carnegie,
Mauritius, August 6, 1911.*

¹ Deutsche Südpolar-Expedition, 1901-1903. V. Erdmagnetismus. I. Erdmagnetische Beobachtungen und anschließende Untersuchungen, von Dr. Friedrich Bidlingmaier. II. Teil, Deklination. Berlin, 1911.