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of a proper magnetism of the earth; it also seems to change during the increase in intensity and situation. For the magnetic disturbance itself following immediately upon the initial impulse we must assume that especially extra terrestrial currents are the cause; at least for the magnetic after-disturbance as well as for the part that shows a regular daily variation I have made this probable<sup>1</sup>). Moreover the Aurora Borealis points to this. The magnetic vector of after-disturbance is the mean vector of disturbance deprived of its greater and smaller oscillations during the disturbance. It increases rapidly after the initial impulse and then slowly decreases.

As here the horizontal intensity just decreases we must conclude to a likewise W-E. current of negative electricity in these higher atmospheric layers. It remains an open question why the intra-terrestrial current at the outset and the extra-terrestrial current during the further course of the disturbance have both a constant East-West direction.

**Geophysics.** — "*Registration of the earth current at Batavia.*"

2<sup>nd</sup> part. By Dr. W. v. BEMMELÉN.

In my first paper on the registration of electric earth-currents at Batavia, to investigate the connection between the oscillations in earth-current and magnetic force, I had to point to several unanswered questions.

First of all the fact that the earth-current between Anjer and Batavia is four times greater than the one between Batavia and Cheribon. I hope soon to be able to measure the current between Batavia and a place E. and S. of Anjer to try to shed light on this abnormality.

Further more it remained a mystery why that connection with the magnetic force showed such a characteristic difference for the current between Semarang and Batavia with that for the current between Batavia and places closer by. That difference consisted chiefly in the fact, that when the duration of a magnetic oscillation becomes shorter, the amplitude of the earth-current increased much more for the long line than for the short one.

I pointed out, that perhaps an influence of the distance might

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<sup>1</sup>) Met. Zeitschrift 1895. p. 321. T. M. VIII p. 153.

have something to do with it and that a registration of the current at Semarang going over the distances Semarang—Cheribon and Semarang—Soerabaya would probably be able to enlighten us in that respect.

This idea I have, indeed, been able to realize by a visit to Semarang in the month of December 1907. At the Post- and Telegraph Office they kindly accommodated me for some days with a room where I could place the instruments used at Batavia. Though I had some delay by a slight accident, yet I could get excellent diagrams during two nights.

The result was definite, viz. *the current between Semarang—Soerabaja and Semarang—Cheribon corresponds in character and intensity to that between Batavia—Cheribon.*

Oscillation of the magnetic North component.		Amplitude of the earth current in Volt per K.M. Amplitude magnetic component in dynes.			
Half oscillation	Amplitude	Sem.-Cheribon	Sem.-Soerabaja	Batavia-Cheribon	Number of cases.
		18—19 December 1907.			
0.5 min.	1.2 γ	22.6	19.3	21.2	14
1.0 "	1.5 "	20.9	16.9	20.5	11
13.5 "	3.0 "	16.2	14.4	16.0	8
19—20 December 1907.					
0.6 min.	0.5 γ	26.3	23.6	23.0	33
1.4 "	1.1 "	23.4	20.0	20.5	16
9.5 "	2.4 "	20.3	16.7	16.5	19

So :

Duration of half an oscillation		Earth-current Batavia-Cheribon	Earth-current Batavia-Cheribon
		Earth-current Semarang-Cheribon	Earth-current Semarang-Soerabaja
$\frac{18-19}{XII}$ '07	0.5 min.	0.94	1.10
	1.0 "	0.98	1.21
	13.5 "	0.99	1.11
$\frac{19-20}{XII}$ '07	0.6 min.	0.87	0.97
	1.4 "	0.88	1.02
	9.5 "	0.81	0.99

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The registration of both nights together gives :

Duration of half an oscillation	Amplitude	Sem.-Cher.	Sem.-Soerabaja	Number of cases
0.36 min.	0.6 /	24.3	21.4	20
0.65 "	0.9	26.3	22.8	20
0.87 "	0.9	26.5	22.7	20
1.08 "	1.2	23.7	19.7	10
3.65 "	1.0	22.9	18.3	10
13.10 "	3.2	22.0	18.2	11

From these numbers we also find the initial increase of the earth-current amplitude for the (half) duration smaller than about 0.7 min. just as it was found for the currents Batavia—Cheribon and Batavia—Anjer.

For the difference in phase was found out of 14 cases, Semarang—Cheribon  $17^{\circ}.5$ , Semarang—Soerabaja  $16^{\circ}.7$ , whilst for Batavia—Cheribon formerly  $22^{\circ}$  was found.

*So the registration at Semarang furnished a highly important confirmation of the results found for Batavia—Cheribon. And yet no conclusion could as yet be drawn for an influence of the distance on the amplitude.*

And indeed, new observations made at Batavia soon offered another view upon the subject. I heard that a connection with Semarang was possible at the same time along lines through the Northcoast plain and along the line already used round the South by the railroad.

Registration with these lines running between the *same* earthplates at Semarang and Batavia (observatory) gave the remarkable result that the current in both lines was unequal.

The Northline corresponded with results found before on the Batavia—Cheribon line, the Southline gave again the heightened increase of the earth-current amplitude when the duration of the oscillation decreased.

Duration of half an oscillation X	Amplitude Earth-current in Volt per K.M. Amplitude magnetic component in dynes		Number of cases
	Southline	Northline	
0.50 min.	62	28	20
0.77	48	29	20
1.53	50	34	20
5.53	24	27	20
8.60	23	27	10
21.77	13	20	1

## DIFFERENCE IN PHASE

Duration of half oscillation X	South-line	Number of cases	Duration of half oscillation X	Northline	Number of cases
0.8 min.	31°	39	1.3 min.	16°	68
6.8 "	31	18	6.5 "	18	40
16.4 "	31	20	17.0 "	26	23

So the difference in phase is different for the two lines. Extraordinary is here the increase of the difference in phase for the Northline, which is not found on the other lines.

Formerly was found for the difference in phase on the line Semarang—Batavia 36°. Whether the difference with the difference in phase now found of 31° is real must still be called doubtful.

These new results led to the conclusion that the difference in character found formerly might not be attributed to the greater distance, but to a peculiarity of the line itself. As the two lines round the South and the North were between the same earth-plates and possessed about the same resistance, I had to conclude to an appearance of electromotive force in the line itself. There are two possibilities for this:

- 1<sup>st</sup>. induction immediately in the wire;
- 2<sup>nd</sup>. contact with the ground.

Now it is very well possible that both causes are very different in the diluvial and alluvial plain of the Northcoast and the volcanic Southern regions.

To separate these two causes I have taken the following double experiment.

Batavia and Cheribon are connected by two parallel brass wires of the intercommunal telephone; there are likewise two telegraph wires on the same poles between Batavia and Soerabaja. Such a double line I connected with my galvanometer and switched on between galvanometer and earth a resistance which was great compared to that of the wire. (For Cheribon that resistance was 5000 Ohm, for Soerabaja 40.000 Ohm). I then left both wires connected with the galvanometer for some hours and then broke off the connection with *one* of the wires.

After a few hours I switched this wire on again, but broke the connection with the other one, and then finally I connected both wires again.

If now the earth-current were only a current from groundplate to groundplate then during these changes it might change but slightly in intensity, as the total resistance changed so little.

On the other hand, if the earth-current were for a part not originating from the plate, but was immediately caused by induction or an other influence (e.g. the catching of electrons moving in the atmosphere) then that part when connected with *one* wire would be half of that when connected with two wires and so a considerable difference in intensity of the current would be noticeable.

It might be possible that this influence differed with the duration of the oscillation of the magnetic component and were different in the coastregion from that in higher volcanic regions in South-Java; in this way the difference in character found above might be explained.

Before mentioning the results of this experiments I wish to consider what the influence is of the loss by isolation.

The loss by isolation will chiefly take place along branches and poles accidentally touching the wire. The first influence will be irregular and in general for both lines alike.

With the second each telegraphpole will give an earth connection with great resistance for both wires at the same time, as the wires run across the same yokes.

Along this earth connection a current will run if the earth-potential at that place differs from that in the wire.

That current will then feel little influence of the fact whether *one* or both wires are connected with the galvanometer.

The result of the experiment for the lines to Cheribon as well as for those to Soerabaja was not ambiguous, as the figures below indicate.

Duration of half an oscillation		Amplitude earth-current in m.m. reading.		
		Amplitude	X	in m.m. reading.
Both lines	One line	both lines	one line	
1.0 min.	1.2 min	2.5	2.5	} Batavia- Cheribon
5.4 "	6.6 "	2.0	2.0	
0.6 min.	0.8 min.	6.1	5.7	} Batavia- Soerabaja
8.3 "	19.3 "	1.4	1.5	

This simple experiment is in my opinion of fundamental importance, as it shows *that no electromotoric force is roused in the line itself*, a fact that a priori cannot be called so improbable.

Nothing remained now but to assume that the difference in character of the current in the North-line and in the South-line is caused by the fact that by the loss by isolation the current is partly taken up out of the ground over which the line runs and that that current

was different in the Northcoastplain to that in the mountains. If this were so, then the earth-current in the Preanger country, where the Southline runs in a niveau of  $\pm 600$  M. between numerous volcanoes would have to show the same peculiarity. To prove this it was fortunately not necessary for me to remove with my instruments, but I could suffice by making the following connection.

Earth at Buitenzorg—Galvanometer—Observatory—Batavia—Buitenzorg—Tasikmalaja—Earth at that point. Buitenzorg is situated at the N.W.-foot of the mountains and Tasikmalaja at the East foot. Both places lie still at a height of  $\pm 300$  M. above the sea.

Loss by isolation along the poles on the there-and-back line Buitenzorg—Batavia—Buitenzorg could not bring the earth-current out of the plain between Buitenzorg and Batavia into the line, and could only cause a part of the Preangercurrent to flow away. That loss could thus not falsify the result.

The current between Buitenzorg and Tasikmalaja really proved to possess the above mentioned character, i.e. it showed a much stronger increase when the duration of the oscillation decreased than the

Northcoast lines Duration of half an oscillation	Batavia-Tasikmalaja	
	Ampl. Earth-current in Volt per K.M. Amplitude	X in dynes
0.4 min.		60
0.8 "		56
1.2 "		55
9 0 "		45

If loss by isolation is the cause of the inequality of the current between Batavia and Semarang round the North and the South, then that loss will be smaller in the dry season than in the wet one. And, indeed, I found that this was the case as the figures below will indicate.

18--21 Juni 1907				December 1907			
Duration of half an oscillation	Ampl. Sem.-Bat. current in Volt. p. K.M.			Duration of half an oscillation	Ampl. Sem.-Bat. current in Volt. per K.M.		
	Ampl.	X	in dynes		Ampl.	X	in dynes
0.6 min.		43		0.5 min.		62	
1.0 "		35		0.8 "		48	
1.4 "		31		1.5 "		50	
5.0 "		18		5.5 "		24	
11 5 "		13		8.6 "		23	
				21.8 "		13	

These characteristic differences treated above can perhaps afford an occasion to find an explanation of the nature and the cause of the

earth-currents, but more observations under other circumstances will undoubtedly be necessary.

It seemed important to me to investigate whether that great difference in earth-current is always incidental to difference in amplitude of the magnetic variations.

For, Buitenzorg lies on the edge of the volcanic Southernpart of Java, and Batavia lies in the Northcoastplain; moreover simultaneous registrations of the magnetic component are for both places available.

I have used the registration of the X-component at Batavia on the earth-current diagrams and of the TÖPFER-Unifilar of the X-component at Buitenzorg.

In January, February, March, July, August, September the magnetic variation-instrument registered on the earth-current diagrams the magnetic component perpendicular to the direction Batavia—Anjer, i. e. N4°E. The difference in direction with that on TÖPFER's instrument with which the X-component was registered, can be neglected.

On each diagram I compared the amplitude of a variation of short and of long duration, as much as possible at an equal distance from the basis. In this way I was independent of differences in values of the scale division and other differences.

I got as average case in 30 cases in the months of January—March '07 and 24 cases in the months of June—September '07 :

Average Amplitude of the			
Variations of short duration.		Variations of long duration.	
Buitenzorg	Batavia	Buitenzorg	Batavia
1.44 m.m.	13.21 m.m.	2.68 m.m.	21.27 m.m.
1.01 "	8.71 "	2.93 "	24.03 "
1.25 m.m.	11.21 m.m.	2.79 m.m.	22.49 m.m.

Whilst thus the longer variations give a proportion  $\frac{22.49}{11.21} = 2.01$ ,

the short pulsations give  $\frac{2.79}{1.25} = 2.24$ .

That difference of 10% I believe must be ascribed to the following circumstance :

According to the image of the earth-current diagrams, on which the pulsations are large and easy to see, the points of reversion are pointed. On the Buitenzorgdiagrams on a  $\pm$  ten times smaller scale those sharp points are blunted and we obtain a too small amplitude.

That shortening can be estimated at a tenth millimeter, i. e just 10% of the amplitude.



With the oscillations of long duration that inaccuracy in the registration does of course not appear.

So we come to the conclusion *that the oscillations of short and of long duration of the magnetic force at Batavia and at Buitenzorg have the same ratio of amplitude and that they therefore cannot be caused, or only for a small part, by the current running through the outer crust of the earth.*

By far the greater part of the influence of the earth-currents must therefore come from currents at greater depths and of greater extension, and more equal in intensity.

**Chemistry.** — “*On the Tri-para-Halogen-Substitution-Products of Triphenylmethane and Triphenylcarbinol.*” By Dr. F. M. JAEGER. (Communicated by Prof. A. P. N. FRANCHIMONT).

(Communicated in the meeting of March 28, 1908).

§ 1. Some years ago, I investigated <sup>1)</sup> crystals of *Tri-p-Chloro-Triphenylmethane*, from different preparations which had been obtained by Dr. P. J. MONTAGNE in two different ways, namely from *p*-leucaniline by diazotation and subsequent introduction of the three chlorine atoms and from tetrachlorobenzopinacoline by intramolecular rearrangement.

I then gave a detailed description of the remarkable optical behaviour of the compound in convergent polarised light and endeavoured to elucidate the same by a coloured figure.

Wishing to extend this research also to the other halogen-derivatives, I have first of all prepared the tribromoderivative of *p*-leucaniline by the method proposed by O. FISCHER and W. HESS. <sup>2)</sup> Afterwards I received from Prof. FISCHER a small quantity of each of the three halogen derivatives, which enabled me to prepare the three corresponding trihalogen-carbinols by oxydation with chromic acid in acetic acid solution, so that these three substances could be included also in this investigation. I will not omit to thank this savant once more for his kind assistance.

Of *Tri-p-Bromotriphenylmethane* <sup>3)</sup> I gave a description a short time ago in the *Zeits. f. Kryst.* **44**, 57—58. (1907). The habit of the crystals is quite analogous to that of the chloro-compound; they are more compact of form and generally much larger, but at the same time they cannot be measured so accurately, owing to a curving

<sup>1)</sup> *Receuil* **24**, 124, 131. (1905).

<sup>2)</sup> O. FISCHER und W. HESS, *Berl. Ber.* **38**, 336. (1905).

<sup>3)</sup> F. M. JAEGER, *Zeits. f. Kryst. und Miner.* Bd. **44**, 57. (1907).