Citation:

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but the resulting apparent displacement can never surpass half the width of the line. (Whenever greater shifts are observed, pressure or magnetism or Doppler-effect certainly come into play).

The largest displacements observed by ADAMS occur with many lines of iron and nickel. From the point of view of our hypothesis this means, that near these lines the amount of anomalous dispersion of the mixture is most suitable for producing the phenomenon, neither too great, nor too small. Considerably smaller are the displacements for titanium, vanadium, and scandium — perhaps because those elements are less in evidence in the mixture of gases. That those iron lines, which are most strengthened at the limb, show smaller displacements than the average iron lines, also perfectly fits our point of view, for their asymmetry must be less conspicuous on account of their greater width. That the lines of the elements of very high atomic weight, such as lanthanum and cerium, show very small displacements, is easily accounted for if we assume their vapours to be extremely rare in the solar atmosphere. This explanation is certainly not less simple than the one proposed by ADAMS on p. 17 and 18 of his paper, [1]) where he has to find a way out of the discrepancy to which in this case the pressure hypothesis seems to lead.

Various other characteristics of ADAMS' interesting list of displacements (e. g. the special behaviour of the enhanced lines as a class) will be discussed on a later occasion, together with his equally valuable observations of the spectrum of sun-spots.

Geophysics. "*On the determination of the epicentre of earth-quakes by means of records at a single station*". By Dr. C. BRAAK. (Communicated by Dr. J. P. VAN DER STOK).

(Communicated in the meeting of April 29, 1909).

In working out seismograms of the WIECHERT-seismograph I was repeatedly struck by the fact that the azimuth of the epicentre could be determined with satisfactory results from the two components of the motion of the ground.

As informations relative to other stations are generally received at Batavia some time after the occurrence of earth-quakes, I have often used this method to come to a preliminary determination of the epicentre from the Batavia seismograms only. In this way e.g. informations concerning the *Korintji* earth-quake of June 4, 1909 could be

[1]) Astroph. Journ. 31, 46—47, 1910.

given when from Singapore and Banka telegrams about experienced earth-quakes were received.

The most important quakes of 1909 have now been worked out with a view of ascertaining the accuracy to be obtained in determining the azimuth.

In the mean time GALITZIN [1]) has applied the same method to records obtained by means of two seismographs set up at right angles to each other, the records being strongly magnified and the damping such as to make the vibrations aperiodic; in this way very satisfactory results were obtained.

As has been remarked above, the WIECHERT-seismograph may be used with success for the same inquiry.

The two components must be independent of each other, a condition that can be fulfilled by an accurate adjustment.

It is no inconvenience that the damping ratio is only 5 : 1 if we take this circumstance duly into account when calculating the period of vibration.

The most serious difficulty is experienced by the small magnification so that only earth-quakes of large amplitudes have been worked out

This difficulty can be overcome to some extent by measuring out not only the first, but also some of the next deflections, in so far as the two components show a perfect congruity.

When the free periods of the two pendulums are equal, or nearly equal, then we may, as a first approximation, apply the same calculation to these values as to the first deflection.

In order to calculate the true motion of the ground we have used the formula given by WIECHERT

$$W = \frac{V}{\sqrt{\left\{1-\left(\frac{T}{T_0}\right)^2\right\}^2 + 4\left(\frac{T_0}{2\pi\tau}\right)^2\left(\frac{T}{T_0}\right)^2}}$$

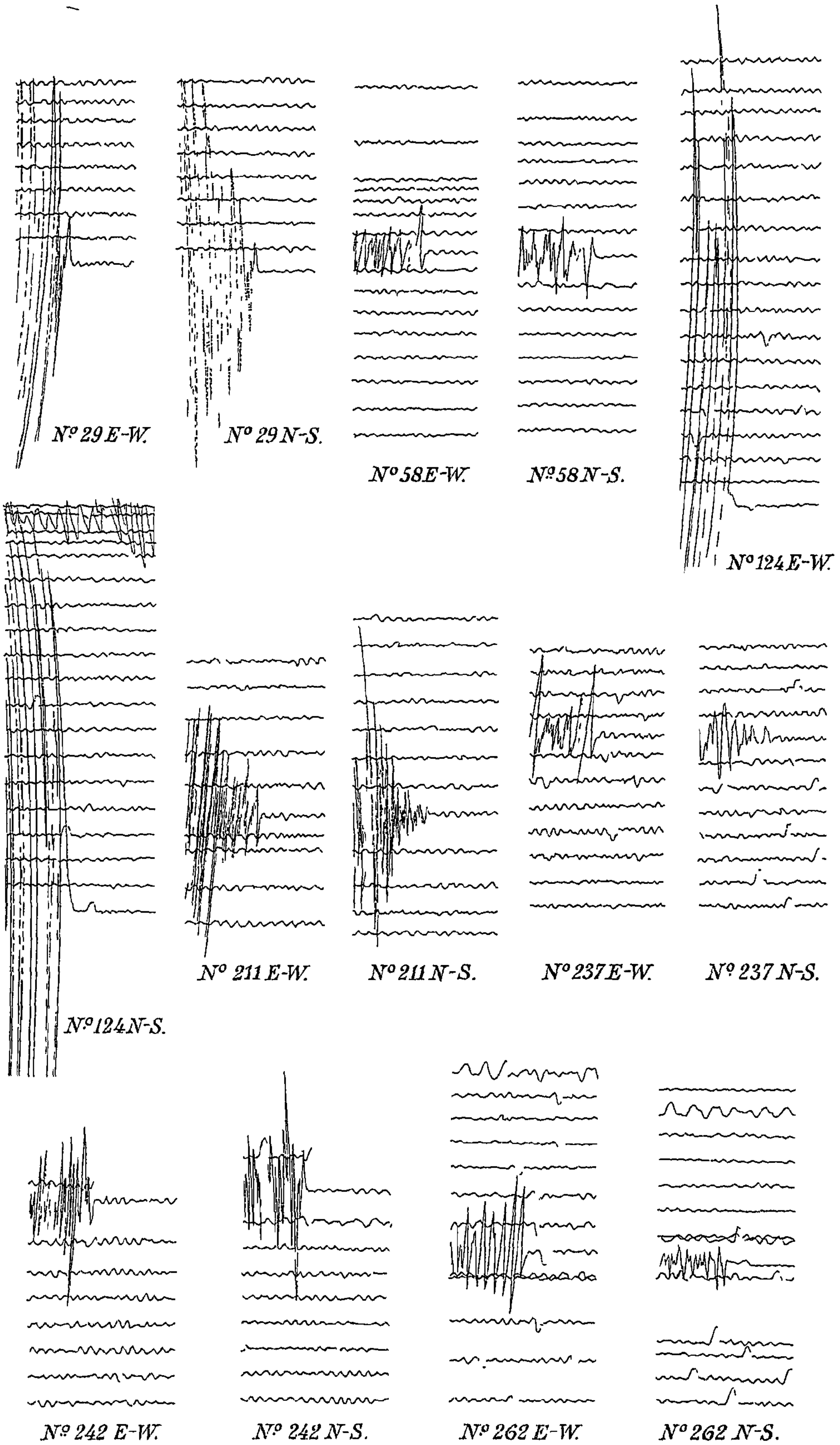
where

$$\left(\frac{T_0}{2\pi\tau}\right)^2 = \frac{(log\ nat.\ \varepsilon)^2}{\pi^2 + (log\ nat.\ \varepsilon)^2}$$

and

V = indicator-magnification.
T_0 = free period.
T = period of the motion of the ground.
ε = damping ratio.

[1]) Fürst B. GALITZIN. Zur Frage der Bestimmung des Azimuts des Epicentrums eines Bebens Bull. de l'Acad. Imp. d. Sc. de St. Pétersbourg, 1909.



J. Bytel lith. P. J. Mulder impr. Leiden

The value V was determined by direct measuring; this value as deduced by means of small weights being put on the pendulum and by determination of the period of vibration is hardly accurate owing to the sluggishness of the instrument, unless the weights remain on the cylinder for at least half an hour. During the whole year V has been equal

for the E—W component to 234,

for the N—S component to 186.

For T_0 and ε monthly mean values have been used as given in the following table.

	T_{0E}	T_{0N}	ε_E	ε_N
Jan.	10.3	10.2	4.8	5 1
Febr.	11.0	11 1	5.6	5 1
March	11.0	10.8	4.9	4.3
April	10.7	10.9	4.9	4 5
May	10.2	10.2	4 3	4 0
June	10.4	10 4	5.7	5.3
July	10.0	10.4	5.7	5 3
Aug.	10.1	10.3	5.8	5.5
Sept.	10.0	10.1	5 4	5.5
Oct.	9.6	9.8	5 4	4.4
Nov.	9.7	10.1	4.5	4.4
Dec.	9 6	10 0	4 3	5.0

In the first place a number of quakes will be treated where the amplitude of the first deflection was large enough to admit of an accurate measurement.

In the monthly bulletin these quakes are mentioned under the numbers 29, 58, 124, 211, 237, 242 and 262; copies of the diagrams are given in the adjoining plate.

The seismograph is set up so that the pointer moves downwards in the diagram when the pendulum has an E. and S. motion relative to the frame, which therefore occurs in the case of an impulse from W. or N.

After a slowly increasing motion, as observable on many diagrams, a small zigzag motion seems to indicate, at least on some diagrams, the arrival of the true impulse. The E.—W. component of N°. 124 clearly shows that the sharp turning corresponds with the beginning of the true first impulse.

In treating the first corresponding waves in either component, the distances of subsequent extreme positions being measured out, the following deflections were found.

No.	Date 1909	Deflections n mM.	$\frac{W_E}{W_N}$	Azimuth 1st deflection	Mean Azimuth	True Azimuth
29	3. II	E—W 7.5 25.6 43.9 53.7 56.7	1.24	N 54 W	N 56 W	N 60W
		N—S 4.4 13.8 26 2 26.0 31.1				
58	13. III	E—W 2.3 9.6 6.0 7.2 8 0	1.23	N 32 E	N 33 E	N 35 E
		N—S 2.9 5.5 5.9 9.9 12.3				
124	4. VI	E—W 63.2	1.24	N 48 W		N 51W
		N—S 46.0				
211	28. IX	E—W 4.2 8.4 10.2 14.1	1.25	S 75 W	S 72 W	S 73W
		N—S 0.9 2.4 3.2 4.3				
237	30. X	E—W 3 0 14 7	1.22	S 74 O	S 76 O	S 76 O
		N—S 0.7 2.6				
242	10. XI	E—W 3.9 15.6 15.9 9.8	1.28	N 27 E	N 27 E	N 32E
		N—S 5.9 22.7 23.7 15 2				
262	10. XII	E—W [4 0] 14.0 20.0 22.1 19.2 13.9	1.31	N 81 E	N 71 E	N 65 E
		N—S [0.5] 3.4 5.3 6.2 5.4 4.1				

In the fourth column the quotient is given of the magnifications of either component; it appears to be subject to small fluctuations only; the influence of period of vibration and damping is small and, consequently, inaccuracies in these quantities can exercise only an unimportant influence.

The azimuth was calculated separately from the first deflections and from all measurements taken together (column 6). If we disregard N°. 262, in which case the first deflection has obviously been disturbed, either method is found to lead to identical results within the limits of the preciseness of the observations. The latter method, which is serviceable also when the deflections are small, will in future be applied exclusively.

The true azimuth has been deduced, partially from earth-quake-informations from the Archipelago, partially by means of the records taken at Batavia, Manila, Zi-ka-wei and Osaka:

N°. 29, from the Lampong-districts, according to earth-quake-informations.

N°. 58, near Tokio, according to the papers.

N°. 124, in Korintji, according to earth-quake-informations.

N°. 211, in S.-Bantam, according to earth-quake-informations.

N°. 237, in the Carpentaria-gulf, according to records at Batavia, Manila and Zi-ka-wei.

N°. 242, near Kioe-sioe, according to records at Batavia, Manila, Zi-ka-wei and Osaka.

N°. 262, near the Caroline-islands, according to records at Batavia, Manila and Osaka.

Owing to incomplete informations, inaccurate data concerning the time of the first and second forerunners, and the total failing of indications about the time of the second forerunner, both methods often leave much to be desired. In calculating the distances from the available data the curves given by WIECHERT and ZÖPPRITZ were used.

It may be noticed that the quadrant, whence the vibrations travel, may, in by far the most cases, be indicated without ambiguity. It is an exception when the first impulse comes from the direction of the epicentre; in by far the most cases it came from the opposite side.

In this way the azimuth has been determined for a number of other earth-quakes; the results are given in the following table.

The deviations between the calculated and the true azimuths can be put only partially on account of errors in the azimuth as calculated; for tremors which have travelled over a great distance the deviations are small; for the quakes N°. 4, 27, 52, 114, 203 and 243, all coming from places situated not far off, the deviations are great, but they are, without doubt, principally due to incomplete informations concerning the true focus, and the locus of the epicentre, as calculated from the diagrams, is more reliable than that based on informations received.

No.	Data	Epicentre	Longitude E. from Gr.	Latitude	Azimuth calculated	Azimuth true
4	2 I	Preanger	107°6	7°.1 S	S 25° E	S 35° E
13	15 I	W. fr. Mindanas	132 2	5.4 N	N 65 E	N 65 E
19	23 I	Luristan	50 0	32.5 N	N 43 W	N 50 W
27	31 I	Cheribon	108.1	7.2 S	S 19 E	S 51 E
28	2 II	Celebes	119.7	0.7 S	N 63 E	N 67 E
29	3 II	S.-Sumatra	105.1	5.2 S	N 56 W	N 60 W
52	8 III	Banjoemas	109.2	7.2 S	S 26 E	S 66 E
56	13 III	E. from Tokio	140.7	34.5 N	N 33 E	N 35 E
58	13 III	E. from Tokio	140.7	34 5 N	N 33 E	N 35 E
59	17 III	Celebes	121.6	1.0 N	N 63 E	N 64 E
61	18 III	Celebes	121 5	1.2 S	N 69 E	N 71 E
85	15 IV	N. fr. Formosa	124.0	30.0 N	N 29 E	N 21 E
114	17 V	S.-Sumatra	103 2	4.0 S	N 75 W	N 60 W
120	31 V	Harafoera-see	135.0	10.8 S	S 78 E	S 80 E
124	4 VI	Korintji	101.6	2 1 S	N 48 W	N 51 W
143	15 VI	Preanger	107.4	7.0 S	S 33 E	S 40 E
155	8 VII	Samarkand	67.0	40 0 N	N 37 W	N 34 W
176	14 VIII	Japan	139 0	36.5 N	N 38 E	N 34 E
198	11 IX	Philippines	124 8	10.0 N	N 53 E	N 48 E
203	17 IX	S.-Sumatra	103 1	4.1 S	N 70 W	N 60 W
210	27 IX	Preanger	107.1	6.9 S	S 22 E	S 20 E
211	28 IX	Bantam	106.0	6.4 S	S 72 W	S 73 W
237	30 VIII	G. of Carpentaria	138.3	12.0 S	S 76 E	S 76 E
242	10 XI	W. fr. Kioe-sioe	131.0	31.0 N	N 27 E	N 32 E
243	10 XI	Cheribon	108.2	7.1 S	S 31 E	S 56 E
261	10 XII	Ceram	128.5	3.3 S	0	N 82 E
262	10 XII	Carolines	146.0	11.5 N	N 70 E	N 65 E