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On the application of Darwin's method to some compound tides, in:
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If we consider, however, that the cyanhydrins, like their analogous halogen compounds, are readily decomposed by bases with loss of hydrogen cyanide and formation of the aldehyde, and that ammonia, not only in aqueous solution reacts as a base, but even without the presence of water can, like amines, abstract the acid, the reaction of ammonia (and amines) on the cyanhydrins may be reduced to that of hydrogen cyanide on the amino alcohols 1.1.

The equation then certainly indicates the endproducts, but the progressive change of the reaction, considering the properties of the substances, would be that NH_3 removes CNH from the cyanhydrins to form ammonium cyanide, which is for the greater part hydrolysed, while with NH_3 the liberated aldehyde yields the amino alcohol, which then reacts with CNH.

Geophysics. — *"On the application of* DARWIN's *method to some compound tides."* By M. H. VAN BERESTEYN. (Communicated by Dr. J. P. VAN DER STOK).

(Communicated in the meeting of October 29, 1910).

Sir G. H. DARWIN has given a method for reduction of tidal observations, which in the case of 24 hourly daily observations has been fully described in his "Scientific Papers" Vol. I, p.p. 216—257.

Briefly the method consists of evaluating a special hour corresponding to 12^h m. s. time of any day; taking the speed of the tide equal to $15° p$ $(p = 1.2 \ldots)$ for the hours $12 \ldots 0$ and $12 \ldots 23$; summing the observations arranged under the same special hour; then by harmonic analysis from those sums (24) both components of the tide can be found.

It appears from the table on p. 241 l. c. that this method is also applied to the compound tides MS, $2SM$, and $2MS$. As no mention has been made of disturbing influences, which these tides may undergo from others, it is of some importance to show, that these tides, when calculated after DARWIN's method, need a correction. Moreover as may appear from what follows, the two combining tides M_2, M_4 are in the same manner influenced resp. by MS $2SM$ and $2MS$.

Suppose the speed per m. s. hour of a tide to be $= p.\sigma$.

Then the speed of a compound tide (R_1, ζ_{r1}) consisting of one of the tides of this series and one of the S series. $(S_{2.4.6})$ is generally:

$$\sigma_1 = p\sigma + 15° q$$
$$(p = \pm 1 \pm 2 \ldots$$
$$q = \pm 1 \pm 2 \ldots)$$

For a special hour $\tau = \tau' - t$ we have after DARWIN's assumption:
$15^\circ(p+q)(\tau+\alpha) = (p\sigma + 15^\circ q)\,12 - 15^\circ(p+q)\,t + 24 p\sigma i - n.2\pi$, (1)
if τ' be the special hour corresponding to mean solar time: 12^h, day i; $\alpha = -0.5 \ldots +0.5$ spec.-hour and $n = 1.2 \ldots$

The observation entered in the column of this spec. hour τ is now that of m. s. time: $(12-t)^h$, day i.

At this date the influence of another compound tide (R_2, ζ_{r_2}) with speed per m. s. hour $\sigma_2 = kr.\sigma + ks.15^\circ$, where

$$k = \pm 1 \; r = \pm 1 \pm 2 \, .. \; s = \pm 1 \pm 2.$$

is

$$R_2 \cos\{(kr.\sigma + ks.15^\circ)(12-t) + 24\, kri\sigma - k\zeta_{r_2}\}$$

In connection with (1) this can be written

$$\begin{aligned} R_2 \cos[15^\circ(p+q)(\tau+\alpha) &+ \{\sigma(kr-p) + 15^\circ(ks-q)\}\,12 \\ &+ \{15^\circ(p+q-ks) - kr.\sigma\}\,t \\ &+ 24\,\sigma i\,(kr-p) \\ &- k\zeta_{r_2} \qquad]. \end{aligned}$$

If $kr = p$ i. e. the two compound tides R_1, R_2 are composed of the same tide R_p and one of the tides $S_{2,4,6}$ this influence of R_2 at special hour τ becomes.

$$R_2 \cos[15^\circ(p+q)(\tau+\alpha) + (ks-q)\pi + \{15^\circ(p+q-ks) - p\sigma\}\,t - k\zeta_{r_2}].$$

The number of observations being great, α varies from $-0.5 \ldots +0.5$ and t will assume all 24 integral values between $-11 \ldots +12$. Therefore the influence of R_2 on the mean sum of the R_1 arrangement at τ hour special time is:

$$\frac{1}{24}\sum_{t_1=-11}^{t_2=+12}\int_{\alpha_1=-0.5}^{\alpha_2=+0.5} R_2 \cos[15^\circ(p+q)(\tau+\alpha) + \{15^\circ(p+q-ks) - p\sigma\}t + (ks-q)\pi - k\zeta_{r_2}]\,d\alpha$$

or

$$= \frac{1}{F_{p+q}} \frac{\sin\{15^\circ(p+q-ks)-p\sigma\}\frac{24}{2}}{24\sin\{15^\circ(p+q-ks)-p\sigma\}\frac{1}{2}} R_2 \cos[15^\circ(p+q)\tau + $$

$$+ \tfrac{1}{2}\{15^\circ(p+q-ks) - p\sigma\} + (ks-q)\pi - k\zeta_{r_2}].$$

Where

$$F_{p+q} = \frac{(p+q)\,7^\circ.5}{\sin(p+q)\,7^\circ.5}.$$

If we put

$$a_{r_2} = \frac{1}{F_{p+q}} \frac{\sin\{15^\circ(p+q-ks)-p\sigma\}\frac{24}{2}}{24\sin\{15^\circ(p+q-ks)-p\sigma\}\frac{1}{2}}$$

$$\Theta_{r_2} = \tfrac{1}{2}\{15^\circ(p+q-ks) - p\sigma\}$$

the influence of R_2 on the components of the tide R_1 arranged according to DARWIN's method, that is, on

$$\begin{matrix} A_{p+q} = \\ B_{p+q} = \end{matrix} \frac{1}{12}\left[h_\tau \begin{matrix} cos \\ sin \end{matrix} 15° (p+q)\tau \right]$$

is then

$$\begin{matrix} \delta A_{p+q} = \\ \delta B_{p+q} = \end{matrix} \alpha_{r_2} R_2 \begin{matrix} cos \\ sin \end{matrix} \left\{ k \zeta_{r_2} - \Theta r_2 - \pi (ks - q) \right\}.$$

For the compound tides $MS.$ $2\,SM.$ $2\,MS.$ we have

$$\sigma = 14°.4920521$$

Now for the required tide:

$M_2, p = 2 \;\; q = 0$; $MS, p = 2 \;\; q = 2$; $2\,SM, p = -2 \;\; q = 4$;

disturbing tide:

$MS, k=1 \;\; r=2 \;\; s=2$; $M_2, k=1 \;\; r=2 \;\; s=0$; $M_2, k=-1 \;\; r=2 \;\; s=0$; $2SM = -1 = -2 = 4$; $2SM = -1 = -2 = 4$; $MS = -1 = 2 = 2$;

required tide: $2\,MS, \; p = 4 \;\; q = -2$; $M_4, \; p = 4 \;\; q = 0$;

disturbing tide: M_4 ; $k = 1 \;\; r = 4 \;\; s = 0$; $2MS$; $k = 1 \;\; r = 4 \;\; s = -2$;

whilst: $ks - q = \pm 2n$, $n = 1, 2.$

With these data the values of α_{r_2} and Θ_{r_2} for these tides are as given in the following table.

	Influence of:					
	M_2	MS	$2SM$		M_4	$2MS$
on:	$k =$ —	1	-1	on:	$k =$ —	1
M_2	$\alpha =$ —	-0.0348	0.0171	M_4	$\alpha =$ —	0.0595
	$\Theta =$ —	$-14°.5$	$30°.5$		$\Theta =$ —	$16°.0$
	$k = 1$	—	-1		$k = 1$	—
MS	$\alpha = 0.0314$	—	0.0118	$2MS$	$\alpha = -0.0704$	—
	$\Theta = 15°.5$	—	$45°.5$		$\Theta = -14°.0$	—
	$k = -1$	-1	—			
$2SM$	$\alpha = -0.0177$	-0.0124	—			
	$\Theta = 29°.5$	$44°.5$	—			

It appears from the values of α_{r_2} that by applying DARWIN's method, the compound tides with the same absolute daily motion influence each other more or less. Equally, the combining tide is disturbed by them and inversely, independent of the hourly motion of the tide, provided the absolute daily motion be the same. When M_2 is great, compared with MS and $2SM$ the disturbance caused by it on the latter is important and a correction is necessary. These are for the components obtained from 24 hourly observations of

$$\left.\begin{aligned} MS: -\delta A_4 &= \\ -\delta B_4 &= \end{aligned}\right. -0.0314\, Rm_2 \left\{\begin{matrix} \cos. \\ \sin. \end{matrix}\right. (\zeta m_2 - 15°5)$$

$$\left.\begin{aligned} 2SM: -\delta A_2 &= + \\ -\delta B_2 &= - \end{aligned}\right. 0\,0177\, R_{m_2} \left\{\begin{matrix} \cos. \\ \sin. \end{matrix}\right. (\zeta m_2 + 29°.5)$$

where R_{m_2} and ζm_2 represent the amplitude and phase at the beginning of the treated year, which can be calculated with sufficient accuracy from A_{m_2}, B_{m_2}. In the table the influence of the tide of long period MSf, on the other tides with the same daily motion has not been inserted. On account of the smallness of this tide the disturbance may be neglected by the side of M_2.

Again, the tides M_4 and $2MS$ can only be separated from each other by solving A_{m_4}, B_{m_4}, A_{2ms}, and B_{2ms} from the 4 equations:

$$A_4 = A_{m_4} + 0.'595\,(2MS)\cos(\zeta_{2ms} - 16.0)$$
$$B_4 = B_{m_4} + 0.0595\,(2MS)\sin(\zeta_{2ms} - 16.0)$$
$$A_2 = A_{2ms} - 0.0704\, M_4 \cos(\zeta_{m_4} + 14.0)$$
$$B_2 = B_{2ms} - 0.0704\, M_4 \sin(\zeta_{m_4} + 14\;0).$$

where A_4 B_4 A_2 and B_2 are obtained from harmonic analysis of the arrangement of M and $2MS$.

It follows from what has been said above, that DARWIN's method of calculating these compound tides is not very suitable. A simpler and theoretically more accurate way for evaluating their components and those of the M series can however easily be computed from Dr. VAN DER STOK's arrangement of the observations at a same solar hour. In this way by a single arrangement all compound tides and principal tides are to be found.

Finally it may be noticed that only the mutual influence of the tides MS, $2SM$, $2MS$, M_2 and M_4 has been determined. For, though more compound tides of M and S may be proved to exist[1]), only those above mentioned have been frequently evaluated after DARWIN's method.

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1) Dr. VAN DER STOK's Etudes des Phénomènes de Marée sur les côtes néerlandaises. IV.