Further Notes on "Geomagnetic Disturbance accompanying the High Altitude Nuclear Detonation at Johnston Island on July 9th 1962."

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Further Notes on "Geomagnetic Disturbance accompanying the High Altitude Nuclear Detonation at Johnston Island on July 9th, 1962."

By

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Abstracts

In the previous paper [1], the present authors had treated the propagation of the isotropic waves in the magnetosphere and calculated the travel-time curve of that wave emitted from a few kind of sources and compared it with the time of commencement of the geomagnetic disturbance accompanying the high altitude nuclear detonation at Johnston Island on July 9th, 1962. But since the observed delay time was too short, we had to conclude that the commencement of the geomagnetic record could not been considered as the arrivals of the hydromagnetic wave caused by the detonation.

In this paper, we examined again the later phase of the above mentioned geomagnetic records and found that the travel time-distance curve of the second phases of the distrubance had good agreement with the theoretical curve.

In the previous paper [1], we analyzed the geomagnetic disturbance accompanying the high altitude nuclear detonation at Johnston Island on July 9th, 1962, and concluded that the first impulses appearing on the magnetograms were not considered as the arrivals of the hydromagnetic space waves radiated from the source region of the detonation.

In this paper we studied again on this subject. Fig. 1 shows the arrival times of the first impulses of the geomagnetic disturbance recorded on the magnetograms of the various observatories.

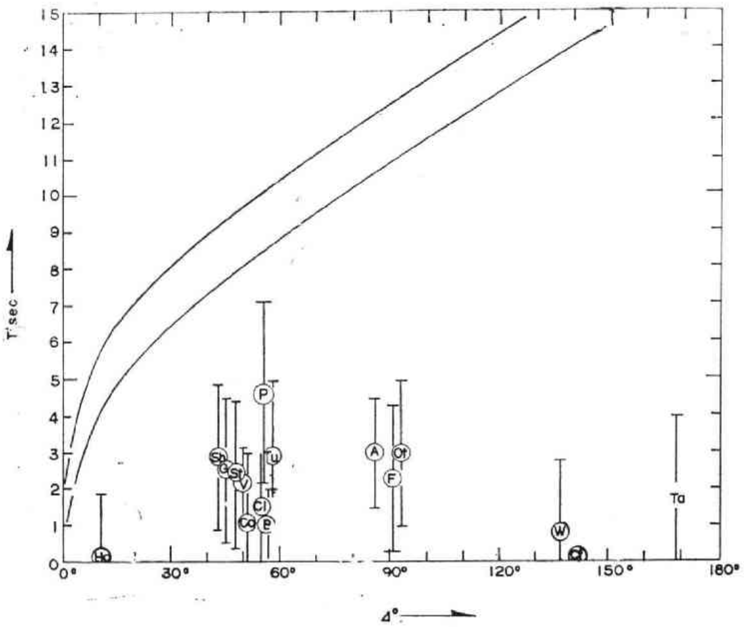
This figure which is reproduced from Fig. 5 of previous paper, shows these first impulses of the geomagnetic disturbance has a tendency to be in parallel with the distance from the source region.

That means, it may be considered that the arrivals of the first impulses at each stations are almost at the same time.

This tendency can never be consistent with the concept of *the hydromagnetic wave propagation*. Of course, the propagation of the hydromagnetic waves requires the time delays amounting to several seconds between the nearest station Honolulu and the furthest station Tamanrasset.

This may be rather preferable to the concept of *electromagnetic propagation* in or bellow the ionosphere.

Then we have stopped our work concerning the first impulses of this disturbance,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150°
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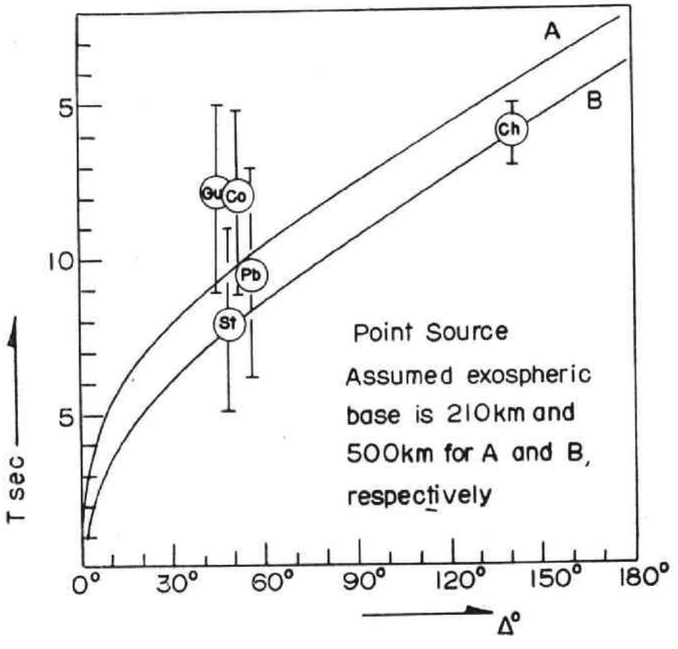
Fig. 1.


A
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5
10
5
0°
30°
60°
90°
120°
150°
180°
Gu
Co
Pb
St
Ch
Point Source
Assumed exospheric base is 210km and 500km for A and B, respectively

Fig. 2.

because our interest to the problem of high altitude nuclear detonation has lain in the hydromagnetic wave propagation by which we might be able to obtain the information of physical quantities of the lower magnetosphere, such as distribution of mass density.

However, beside the first impulses, we noted that there exist some different modes or phases on the magnetograms (for example, see Fig. 3). The arrivals of these later phases are not so clear as the first one, but the oscillating nature is rather well-defined. Furthermore the later phase, especially the second one, is rather clear and favourable to analyze them. As these magnetograms have clearly defined structure, we choose five data and read the beginning times of second phases which are shown by arrows (see Fig. 3 to Fig. 6).

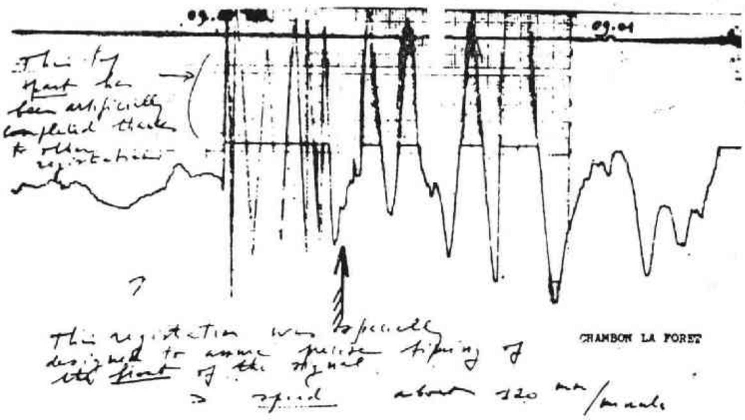


Fig. 3.

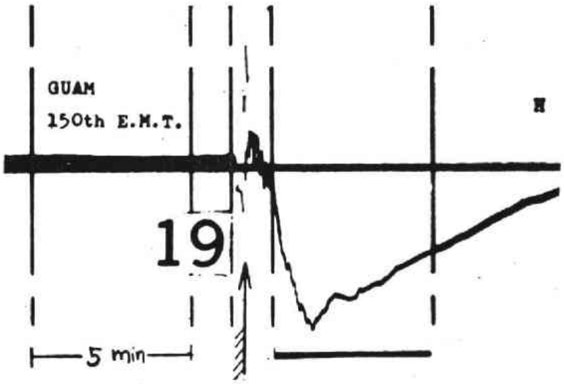


Fig. 4.

In Fig. 2 we show the observed arrival times of these second phases obtained from these magnetograms. A theoretical curve is also shown in this figure for comparison.

This theoretical curve is obtained under some assumptions mentioned in the previous paper.

The hydromagnetic disturbances accompanying the high altitude nuclear

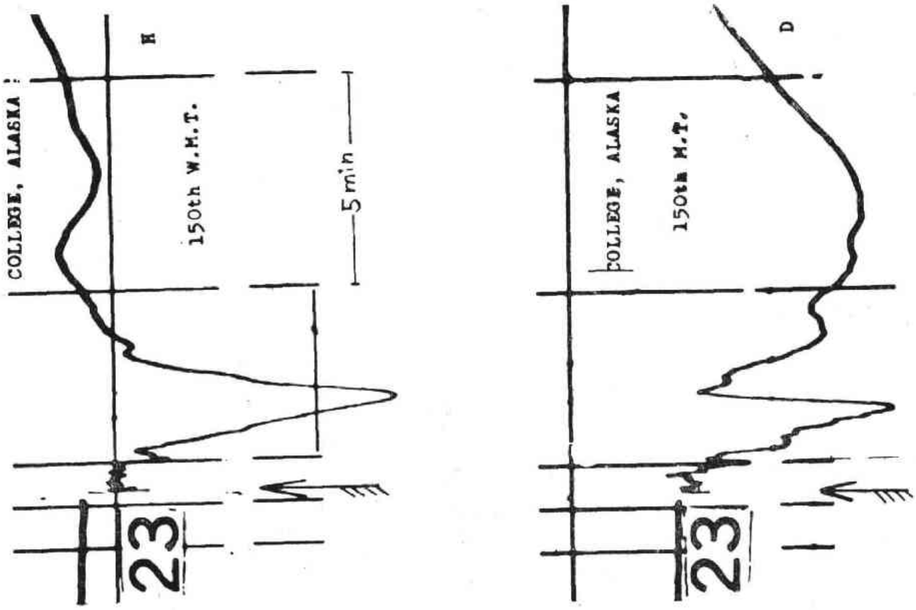
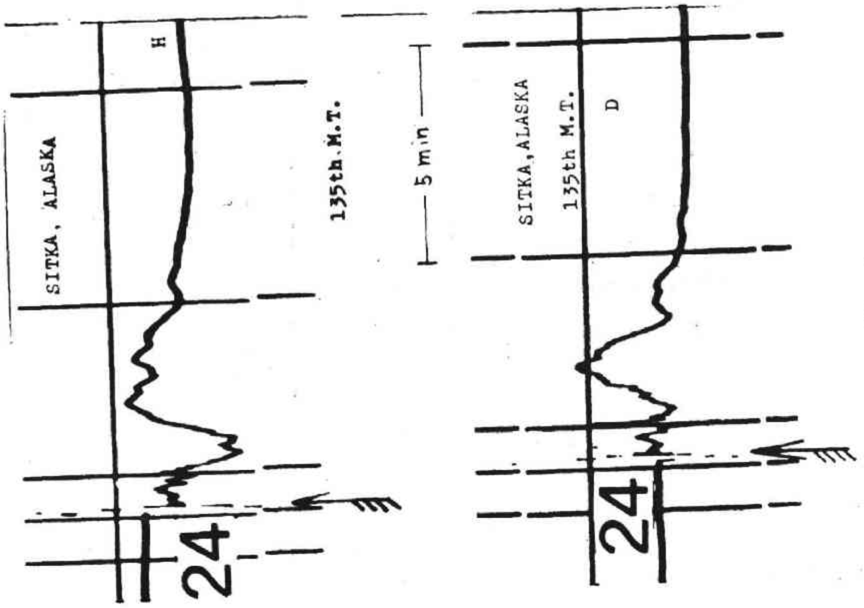

COLLEGE, ALASKA
H
150th W.M.T.
5 min
23
COLLEGE, ALASKA
150th M.T.
D
23

Fig. 5.


SITKA, ALASKA
H
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SITKA, ALASKA
135th M.T.
D
24

Fig. 6.

detonation will be radiated from the source region and propagate in the magnetosphere isotropically or along the lines of force, according to their modes, respectively. But the transverse mode which propagates along the lines of force can give influence in only narrow regions on the earth's surface, that is, the effect of transverse mode will be localized in the extent only in the neighbourhood of Hawai Island, or so, because the lines of force which pass through the source region penetrate into that region on the earth's surface.

Therefore the most important effect at distant stations is caused by the isotropic mode of hydromagnetic wave.

Then, we treated only the isotropic mode of hydromagnetic waves and calculated the travel time of its mode with some assumptions.

Fourtunately, since the lower magnetosphere is comparatively slowly varying inhomogeneous magnetoplasma, we can calculate the phase velocity of hydromagnetic wave i.e. $V_A = B_0/\sqrt{4\pi\rho_0}$ where B_0 is the magnitude of the imposed earth's magnetic field and ρ_0 is the mass density of the matter.

It is remarkable that the treatment of the hydromagnetic waves as the non-dispersive waves should be applied only in higher region where the neutral atoms have scarcely controlled the distribution of velocity of ions and electrons. Below this region, in the other word, in the ionosphere, the propagation of the wave will be complex. But the wavelength is considerablly large, so that the propagation through the ionosphere will be at instant.

Therefore, we can supose that the wave is transmitted electromagnetically onto the earth under the critical level which we named *assummed exospheric base*. At first we made a model atmosphere containing H^+, H_e^+, and O^+, and electrons under permissible assumptions as described in the previous paper. Height distribution of these constituents is shown in the Fig. 1 of the previous paper. We assumed B_0 is dipole field and we obtained the phase velosity of the hydromagnetic wave which is shown in Fig. 2 of the previous paper.

The calculation was done by a computing machine numerically for the different shapes of source or different assumed exospheric base.

The theoretical curve thus obtained, can be considered as the travel time curve of the isotropic mode of the hydromagnetic waves and is shown in Fig. 2.

As the figure shows there is considerably good agreement between the observed travel time-distance curve of the second phase of disturbance and that of the theoretical one. Although it needs more number of data to determine the phase velocity in the magnetosphere from the observed data, we can maintain that the second phase of the disturbance appearing on the magnetograms has been identified as the hydromagnetic wave.

Our attension to this problem has lain in determining the phase velocity distribution of hydromagnetic wave in the magnetosphere.

At this point, we could not be successfull, but we consider that the identification of the second phase will be valid to construct the view or concepts concerning the hydromagnetic wave and the magnetosphere.

References

1. Kato, Y. and Takei, S. Geomagnetic Disturbance Accompanying the High Altitude Nuclear Detonation at Johnston Island on July 9th, 1962. Sci. Rept. Tohoku Univ., 5, Geophys. 15, (1), 7–32, 1963.