# A Note on the Pattern of the Sounding Wire in Some Hydrographic Casts

by

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**Abstract**

The patterns of the sounding wire are examined, using some of the data obtained by Kagoshima-maru in the western Equatorial Pacific. With the increasing wire length paid out, the incident angle decreases in some cases. The pattern of not all parts of the wire in a specified cast is convex to the sea surface in many cases, and the more deviation from a straight line is not always expected when the longer wire is paid out, independent of the variation of the incident angle.

## 1. Introduction

It is a well-known trouble that the pattern of the wire is unknown in any hydrographic cast. K. Hidaka and M. Sakata,[1] K. Hishida,[2] and K. Hata[3] discussed the pattern on the base of the observed values of depth obtained from protected and unprotected reversing thermometers, while T. Hirano[4] did on the base of the observed data of falling velocity of a messenger. These studies adopt such an assunption that all the patterns in every cast obey a respective single formula. On the other hand, K. Fukutomi[5] divided the situations into two cases, assuming (1) a vessel drifted by wind in no current and (2) a vessel drifted by current changing the velocity with depth. However, the more detailed studies are necessary, since the situations are not so simple and the individual patterns are so much various. The author examines the observed data obtained on board Kagoshima-maru in EQUAPAC and IGY cruises to get new knowledges concerning this problem. All the observing stations in the cruises are located in the western Equatorial Pacific.

## 2. Variation of incident angle with the increasing length of wire paid out.

In the research cruises stated above, several casts ~~was~~ were necessary at each station to complete the observations at the international standard levels because of some troubles concerning instruments and wire winch. Besides, the number of the casts in each station and the specified observing levels in individual casts are changed for different stations, saving time consumed by petty accidents. However, they are quite same, at the 19 stations, where five casts are made for the levels down to 100, 400, 600, 800 and 1000m respectively. These cases are employed here for discussion.

It was noticed during the observations that the variations of incident angle at the sea surface ($\theta$) with the increasing length of wire paid out ($l$) is not always monotonous in spite of little change of the weather and the currents. Plotting and inspecting the incident angle ($\theta$) against the wire length ($l$) from the data of the 19 stations, the relations between them can be classified into three groups, as shwon in Fig. 1.

The first group showing the increasing $\theta$ with $l$, which coincides with the common idea prevailing implicitly among oceanographers, consists of only 9 cases among the 19. On the other hand, in the second group consisting of 9 cases among the 19, $\theta$ decreases with $l$ between ca 400 and ca 600m, though it increases in both outer ranges above and below. In the third group (1 case), $\theta$ decrease with increasing $l$ for the value of $l$ exceeding ca 100m.

These facts should be attributed to the complex current system in the subsurface layer, since the wind velocity does not vary so much during the hours of observation at a specified station. Many cases belonging to the second group are based on stations located in the South Equatorial Current, where the current directions in the surface and the subsurface layers are opposite to each other, as stated by T. Takahashi.[6] It must be added that large incident angles of 40～60° are observed in some cases, when light wind of ca 3 m/sec prevails (St. Ka 809, Ka 810, Ka 811).

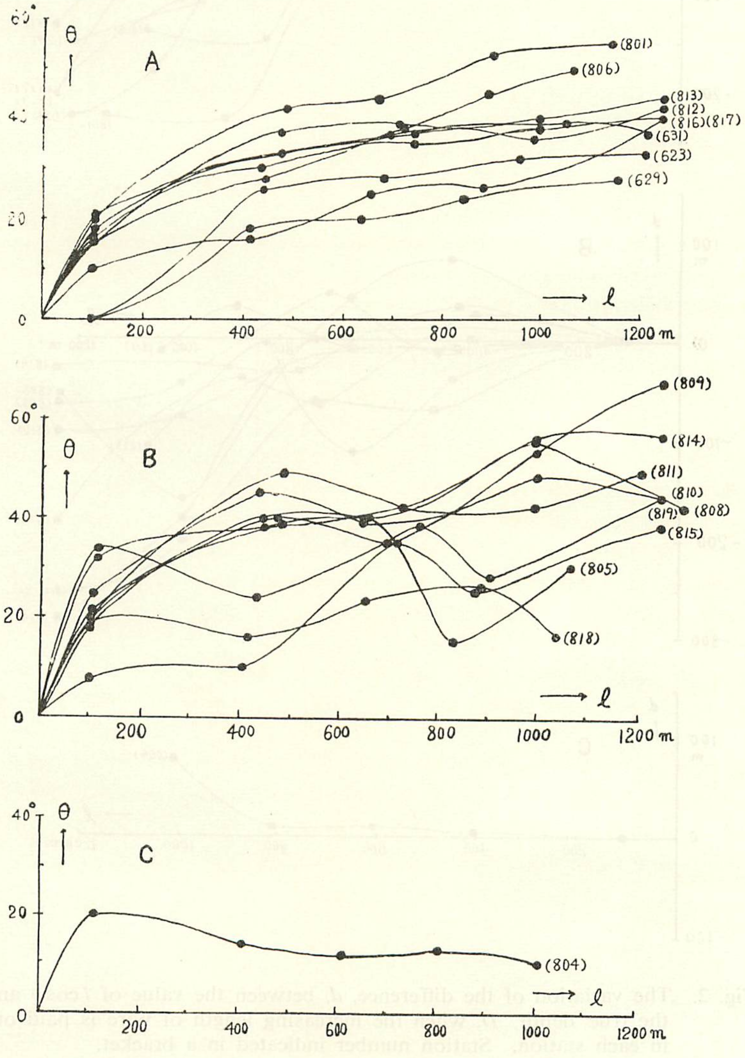


Fig. 1. The variation of the incident angle at the sea surface, $\theta$, with the increasing length of wire paid out, $l$, in each station. Station number indicated in a bracket. (A), the first group; (B), the second; (C), the third.

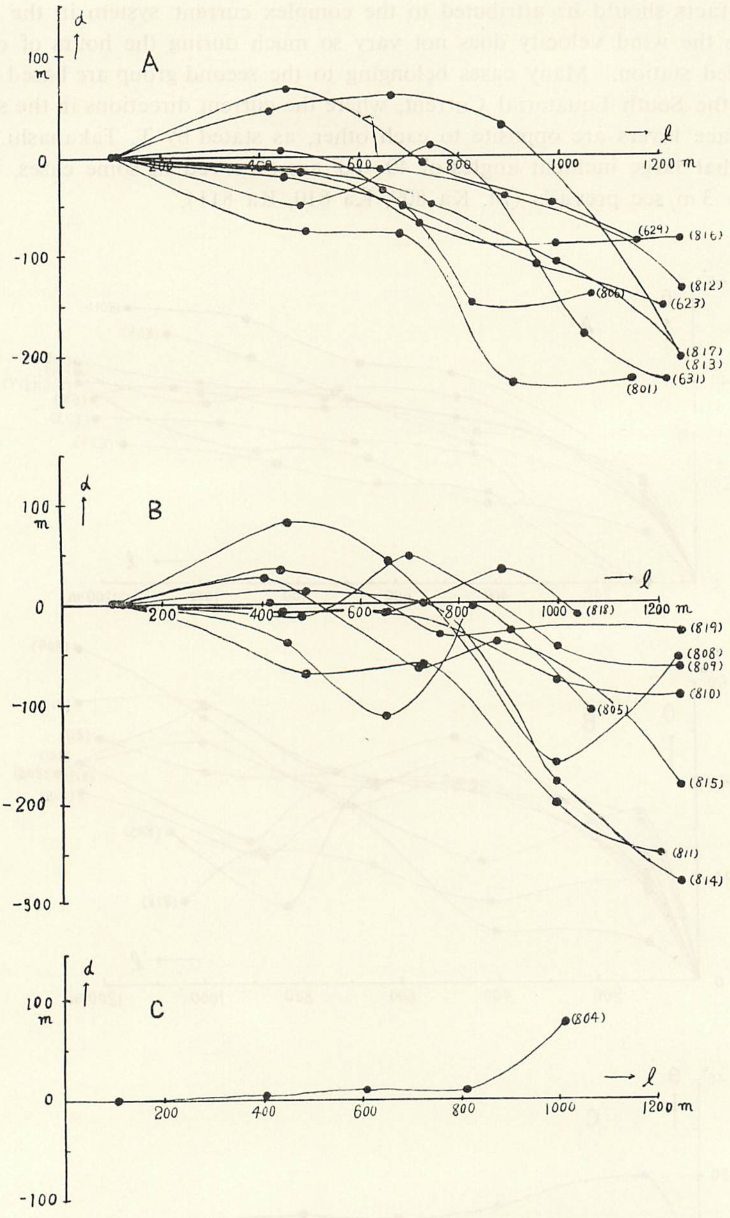


Fig. 2. The variation of the difference, $d$, between the value of $l \cos \theta$ and the true depth, $D$, when the increasing length of wire is paid out in each station. Station number indicated in a bracket. (A), the first group; (B), the second; (C), the third.

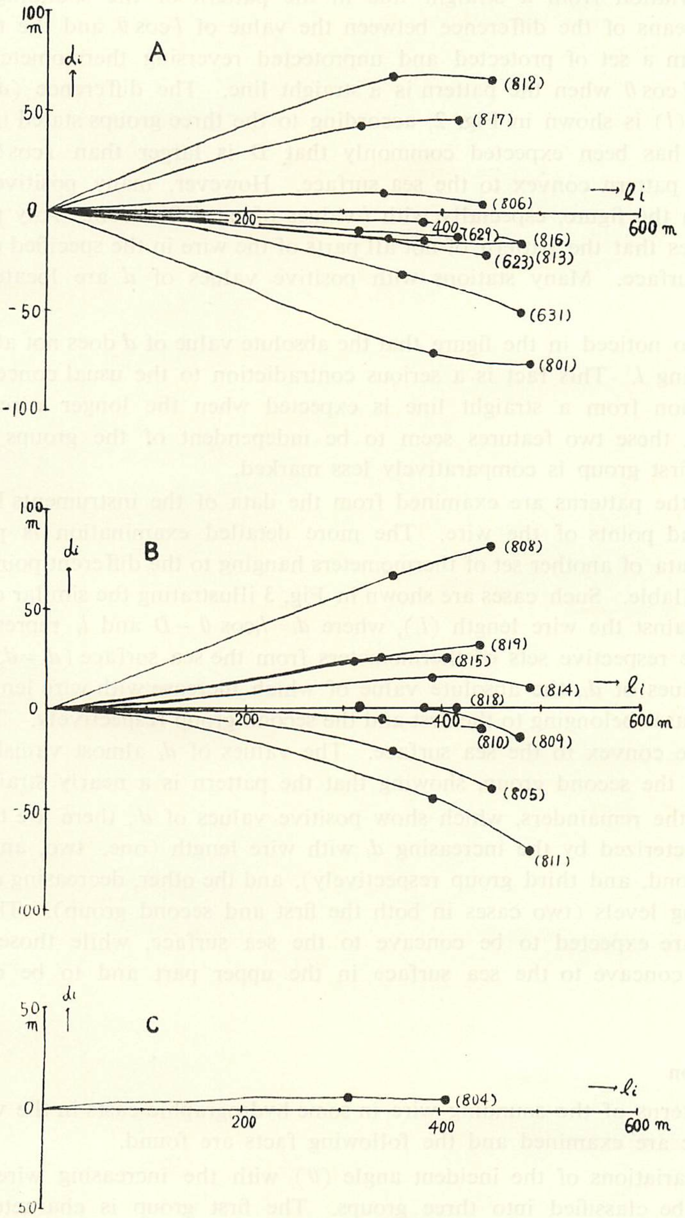


Fig. 3. The difference, $d_i$, between the value of $l_i \cos\theta$ and the true depth, $D$, against the wire length to the respective sets thermometers, $l_i$, in an individual cast. Station number indicated in a bracket. (A), the first group; (B), the second; (C), the third.

### 3. Deviation from a straight line

The deviation from a straight line in the pattern of the sounding wire can be shown by means of the difference between the value of $l\cos\theta$ and the true depth $D$ obtained from a set of protected and unprotected reversing thermometers, because $D$ is equal to $l\cos\theta$ when the pattern is a straight line. The difference ($d$) against the wire length ($l$) is shown in Fig. 2, according to the three groups stated in the previous section. It has been expected commonly that $D$ is larger than $l\cos\theta$, i. e. $d<0$, showing the pattern convex to the sea surface. However, many positive values of $d$ are found in the figure, especially with $l$-values of ca 400~800m. Any positive value of $d$ indicates that the pattern of not all parts of the wire in the specified cast is convex to the sea surface. Many stations with positive values of $d$ are located quite near the Equator.

It is also noticed in the figure that the absolute value of $d$ does not always increase with increasing $l$. This fact is a serious contradiction to the usual conception that the more deviation from a straight line is expected when the longer wire is paid out. Furthermore, these two features seem to be independent of the groups stated above, though the first group is comparatively less marked.

So far, the patterns are examined from the data of the instruments hanging to the respective end points of the wire. The more detailed examination is possible when additional data of another set of thermometers hanging to the different point on the same wire are available. Such cases are shown in Fig. 3 illustrating the similar difference ($d_i$) as before against the wire length ($l_i$), where $d_i=l_i\cos\theta-D$ and $l_i$ represents the wire length to the respective sets of thermometers from the sea surface ($d_i=d$, when $l_i=l$). Negative values of $d_i$, the absolute value of which increase with wire length, are found in 6 and 4 cases belonging to the first and the second group respectively. These patterns are of course convex to the sea surface. The values of $d_i$ almost vanish in one case belonging to the second group, showing that the pattern is a nearly straight line.

Among the remainders, which show positive values of $d_i$, there are two types; the one is characterized by the increasing $d_i$ with wire length (one, two, and one case in the first, second, and third group respectively), and the other, decreasing $d_i$ between the two observing levels (two cases in both the first and second group). The patterns of the former are expected to be concave to the sea surface, while those of the latter seems to be concave to the sea surface in the upper part and to be convex in the lower part.

### 4. Conclusion

The patterns of the sounding wire in some hydrographic casts in the western Equatorial Pacific are examined and the following facts are found.

(1) The variations of the incident angle ($\theta$) with the increasing wire length paid out ($l$) can be classified into three groups. The first group is characterized by the increasing $\theta$ with $l$; the second, the decreasing $\theta$ with $l$ between ca 400 and ca 600m; the third, the decreasing $\theta$ with $l$ more than ca 100m.

(2) It is concluded that the pattern of not all parts of the wire in a specified cast is convex to the sea surface in many cases and that the more deviation from a straight line is not always expected when the longer wire is paid out, on the base of the difference between the value of $l\cos\theta$ and the true depth $D$. These features seems to be independent of the variations of the incident angle with $l$.

(3) According to the two level observations in individual casts, four types of the pattern are found; i. e., a nearly straight line, a curve concave to the sea surface, a curve convex to the sea surface, and a curve concave in the upper part and convex in the lower part.

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