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# DISTRIBUTION OF SHORT PERIOD P-PHASE AMPLITUDES OVER LASA

9 JUNE 1967

Prepared For

AIR FORCE TECHNICAL APPLICATIONS CENTER  
Washington, D. C.

By

F. A. Klappenberger

TELEDYNE, INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY  
Nuclear Test Detection Office  
ARPA Order No. 624



DISTRIBUTION OF SHORT PERIOD  
P-PHASE AMPLITUDES OVER LASA

9 June 1967

SEISMIC DATA LABORATORY REPORT NO. 187

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## ABSTRACT

The behavior of short period p-phase amplitudes over LASA has been investigated for several earthquakes. It has been found that the distribution of the peak-to-peak amplitudes across a subarray approaches a log-normal distribution for those events studied.

## 1. INTRODUCTION

In the following, we will consider the distribution of the peak to peak (p-p) amplitudes for several events at LASA and show that this data approaches a log-normal distribution.

## 2. PROCEDURE

Plotting the p-p amplitudes of all SPZ seismometers at LASA for a single event against frequency of occurrence yields a graph which seems to have no familiar probability distribution. Figure 1, which shows the p-p amplitudes of an earthquake originating in N. Columbia is a typical graph of this type. However, if we inspect the p-p amplitudes that are associated with a given subarray, a pattern emerges. There is generally a modal clustering with a short tail toward decreasing values and a long tail toward increasing values suggesting that the data may come from a log-normal distribution (cf. Fig. 2). For this data, tests of log-normality of the population were performed by making graphs of several subarrays on log-normal probability paper (cf. Figs. 3-13). These graphs show that the data approximates a straight line rather well, and hence we conclude at least that the log-normality of the population should not be rejected, and hence subject to further evidence, we tentatively accept the hypothesis.

The validity of this hypothesis can be checked empirically by gathering considerably more data than is available from an individual subarray. Combining data recorded by all subarrays for several events will provide sufficient data for this purpose, however, a minor detour which we shall next discuss must be made before incorporating the data from different subarrays and different events into the same distribution study.

By observing Figures 14 through 21, it is clear that some subarrays exhibit a higher degree of sensitivity for events from one source region than for events from another. This characteristic is distinctly illustrated by Figure 22 which presents the consistency of order among subarray means for three closely grouped N. Columbia earthquakes and by Figure 23 which shows no similar strong ordering among more widely separated events. This phenomenon has been noted previously\* and is supported by findings in other work\*\*. In relation to this report, these consistencies indicate that the individual subarrays are biased in a certain sense due to the travel path of the source signal. Since the elements in each subarray are closely spaced, in comparison to the distance separating subarray centers, we can eliminate the individual subarray preference from all of the subarrays by considering each subarray as a sampling of the population of the p-p amplitudes and standardizing each sampling in the usual sense, i.e., if a subarray has a  $N(m,s)$  distribution describing the behavior of the observations  $x$ , then by the linear transformation  $y = \frac{m-x}{s}$  we have the standardized distribution  $N(0,1)$ . By applying this transformation to all subarrays over every event, we can pool all subarrays and all events and then investigate the properties of the entire pool. If the assumption that the logarithms of the p-p amplitudes in each subarray are normally distributed is valid, then the pooled distribution will also be normally distributed.

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\* D. E. Frankowski in a personal communication said that he has found a similar consistency for certain events from Mexico and from the Kurile Islands.

\*\* In a separate investigation by this writer, it has been found that a high correlation exists among the subarray averages of logarithms of the p-p amplitudes recorded at LASA for events originating very close together. The groups of events in this study came from widely separated areas and hence the generality of the assumption seems reasonable.



Eight events were selected (strictly on the basis of reasonable availability) for this investigation. Out of a possible 168 (i.e., 8 x 21) seismograms available, 11 had to be eliminated because of non-functioning instruments. The remaining 157 seismograms provided 3925 (i.e., 157 x 25) usable amplitude records (25 per seismograms) for final processing.

### 3. RESULTS

Reading, standardizing, and sorting the p-p amplitudes was performed on the 1604-CDC. Figure 24 presents a histogram showing the standardized distribution of the 3925 logarithms of the p-p amplitudes. A normal curve has been fitted over the histogram to illustrate the tendency toward normality of the logarithmic data. Figure 25 shows the same data plotted on normal probability graph paper. These figures give a visual indication regarding the normality of the data. Statistically, the distribution was  $\chi^2$ -tested for normality with the result that at the 5% level of significance the sample distribution is consistent with the hypothesis that the parent distribution is normal.

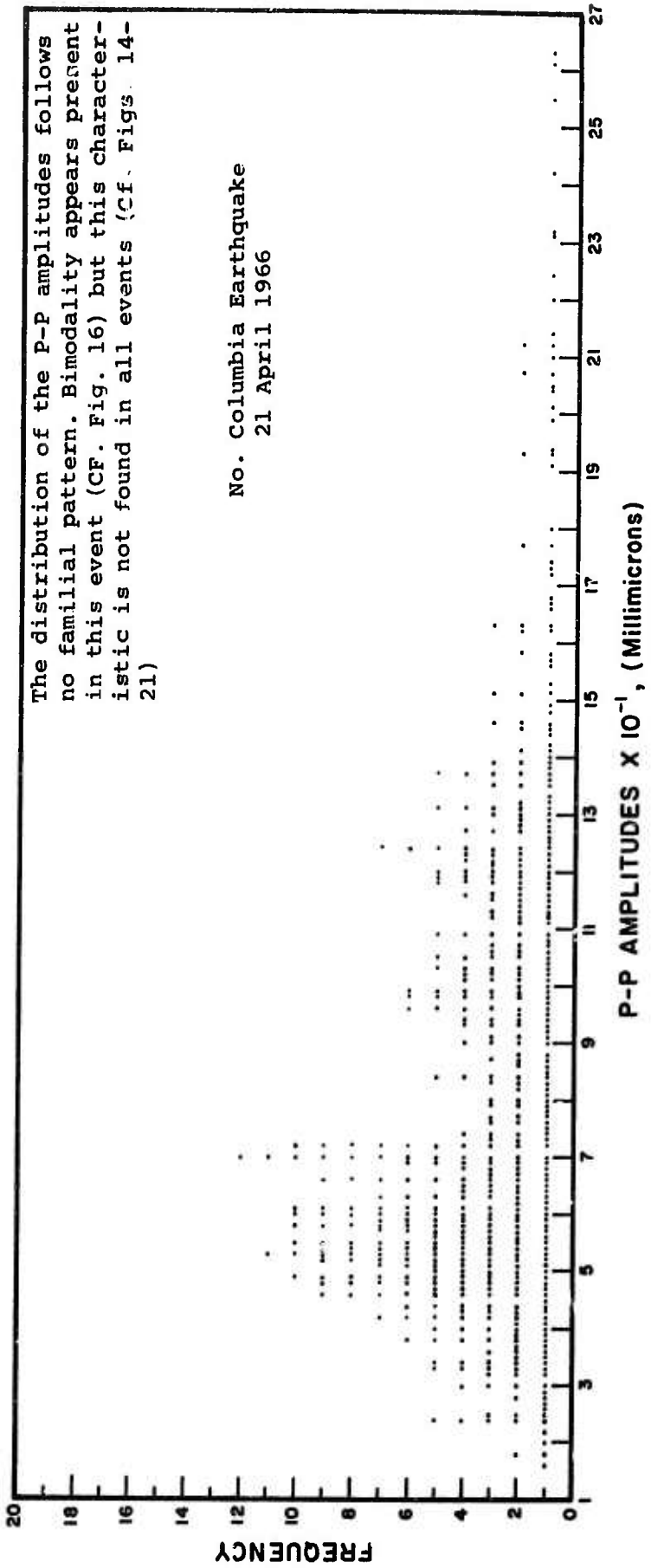


Figure 1

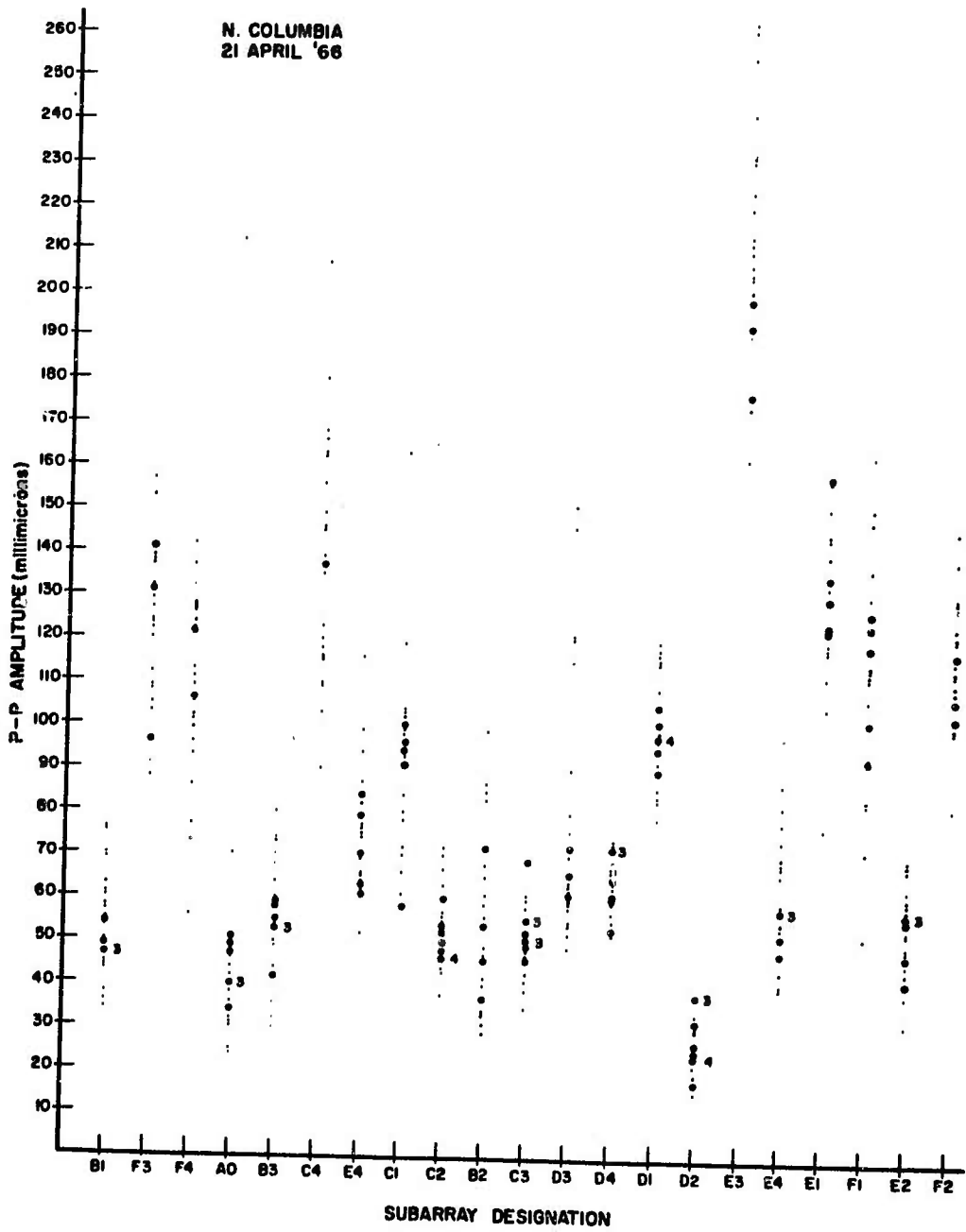


Figure 2

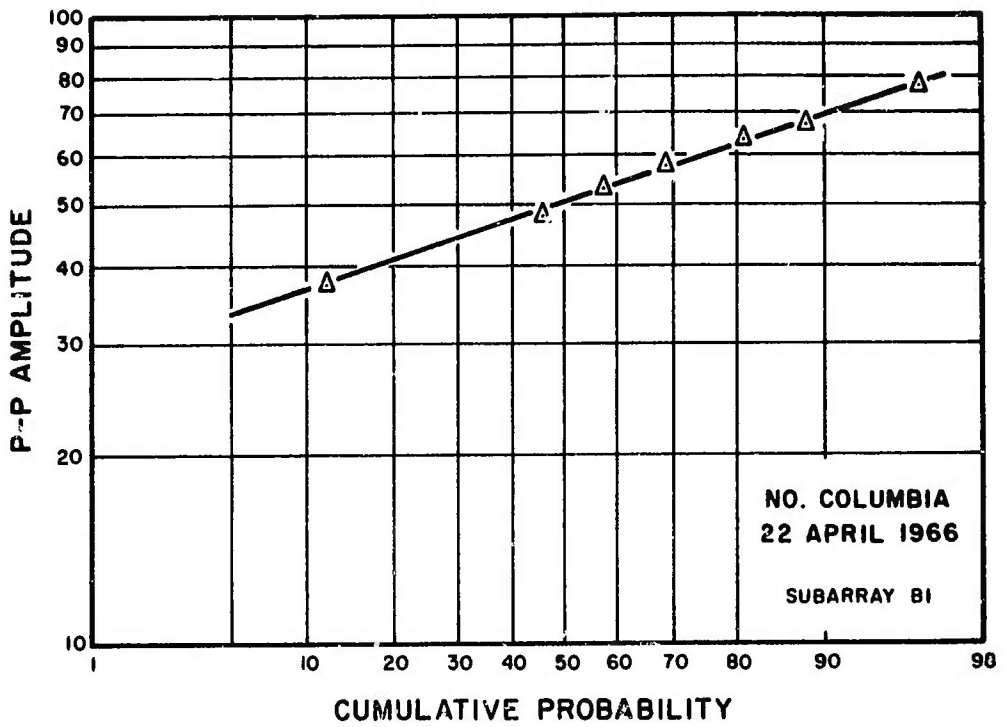


Figure 3

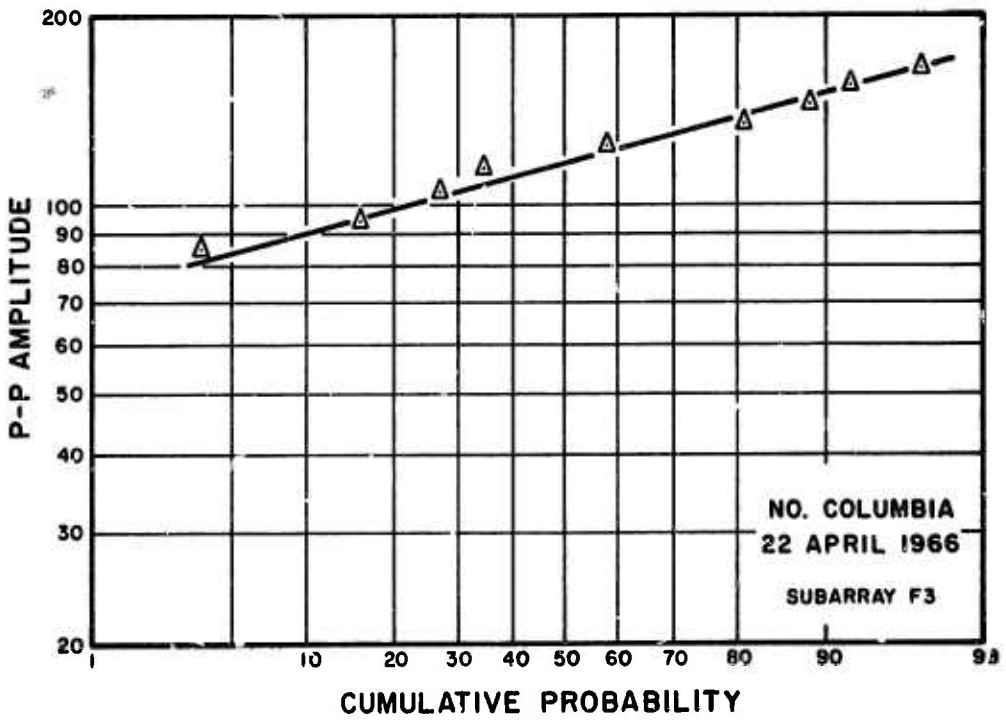


Figure 4

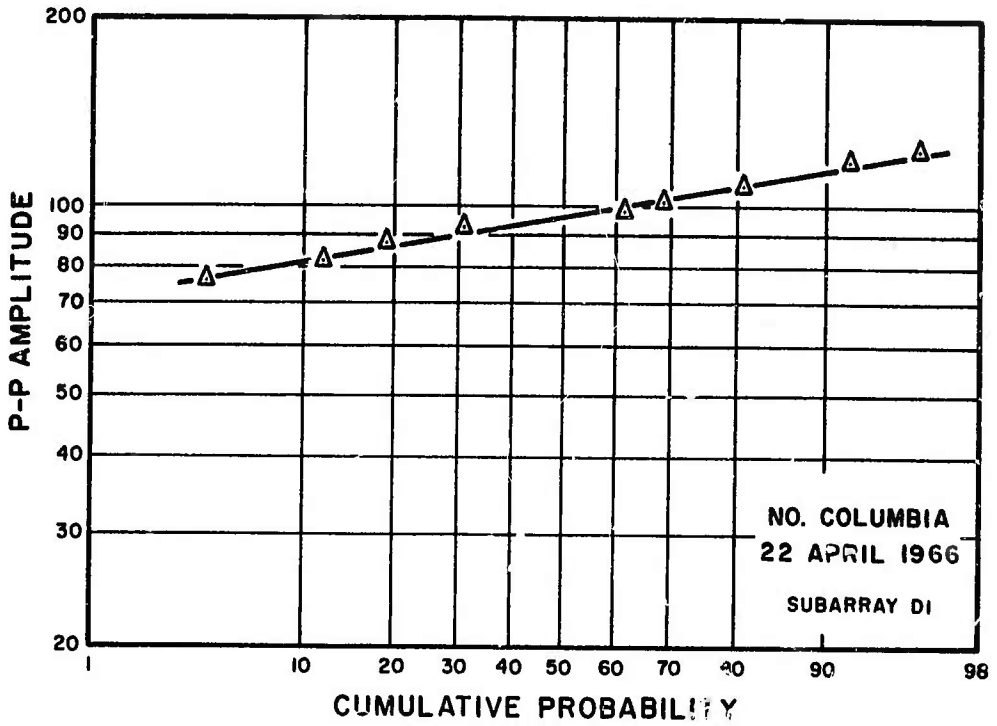


Figure 5

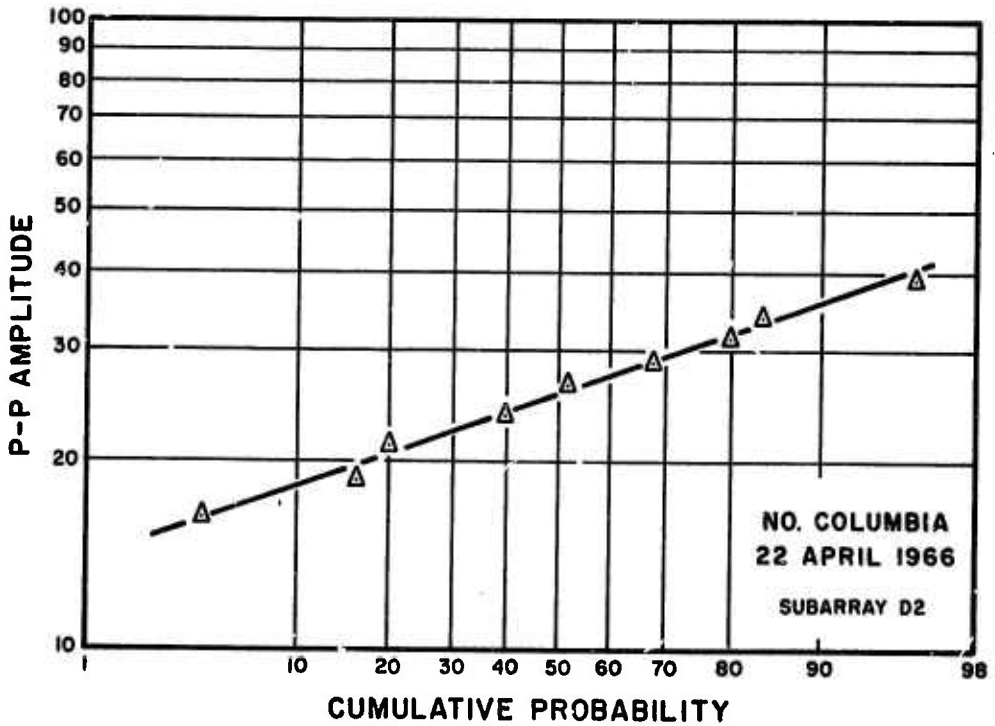


Figure 6

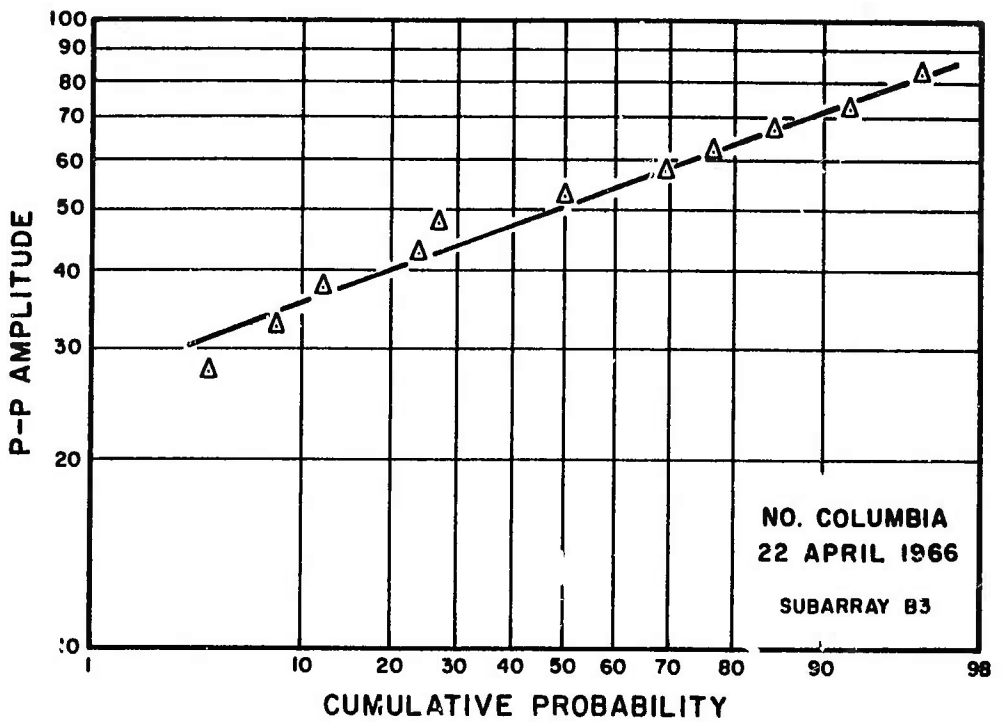


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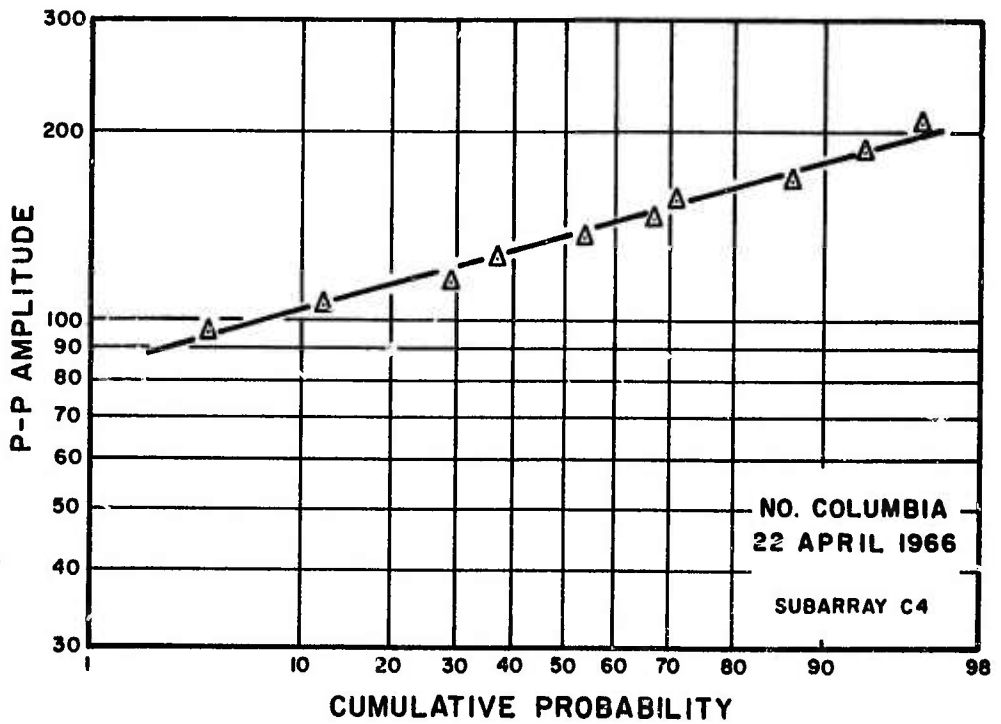


Figure 8

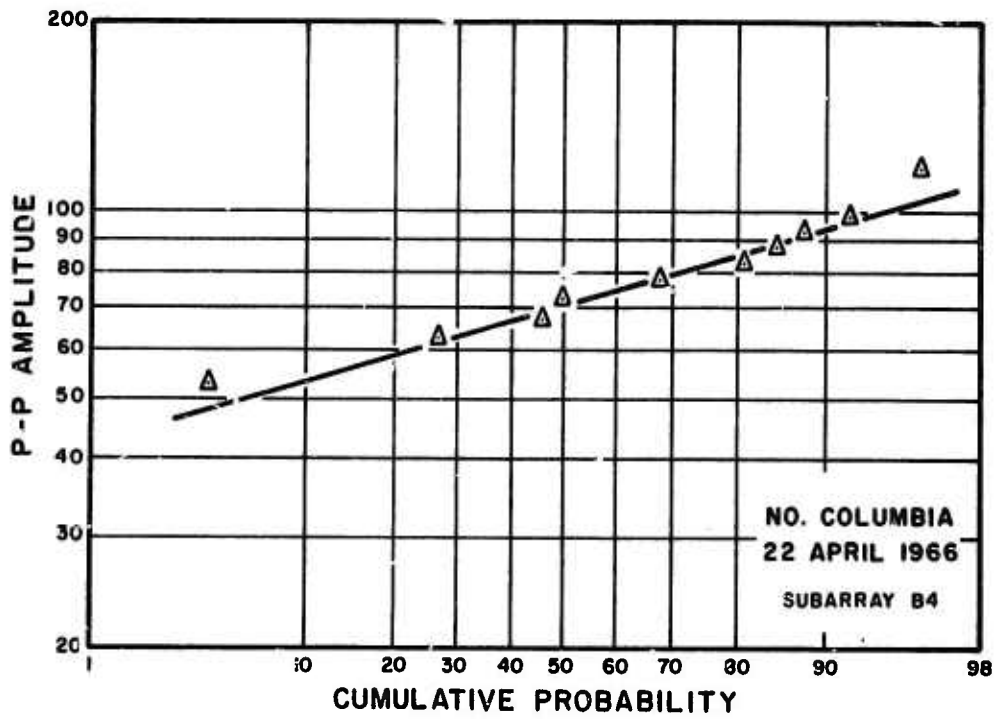


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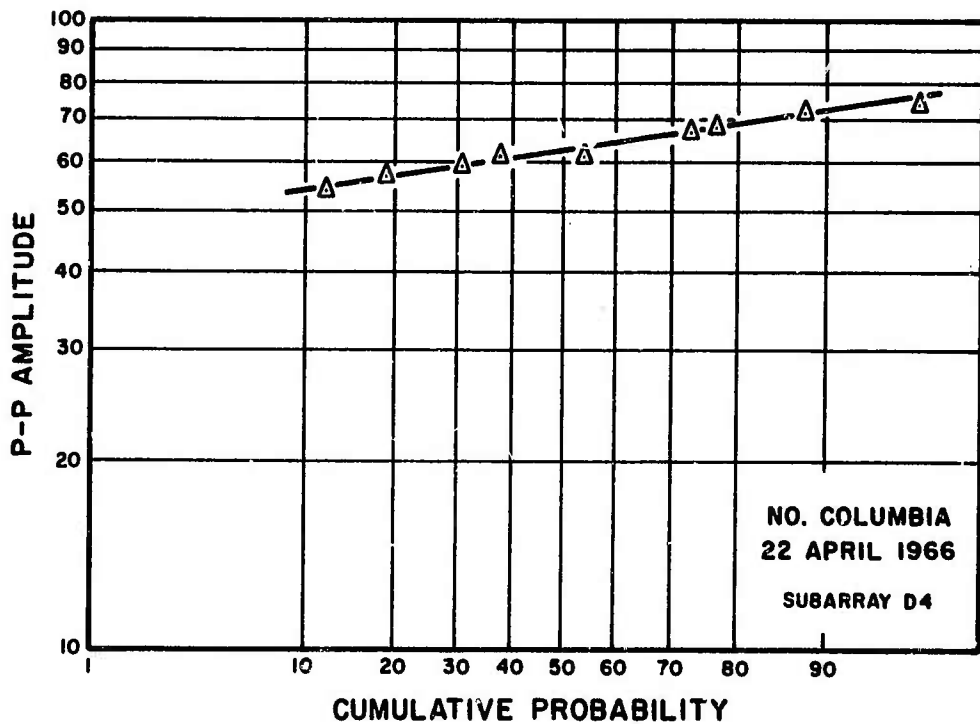


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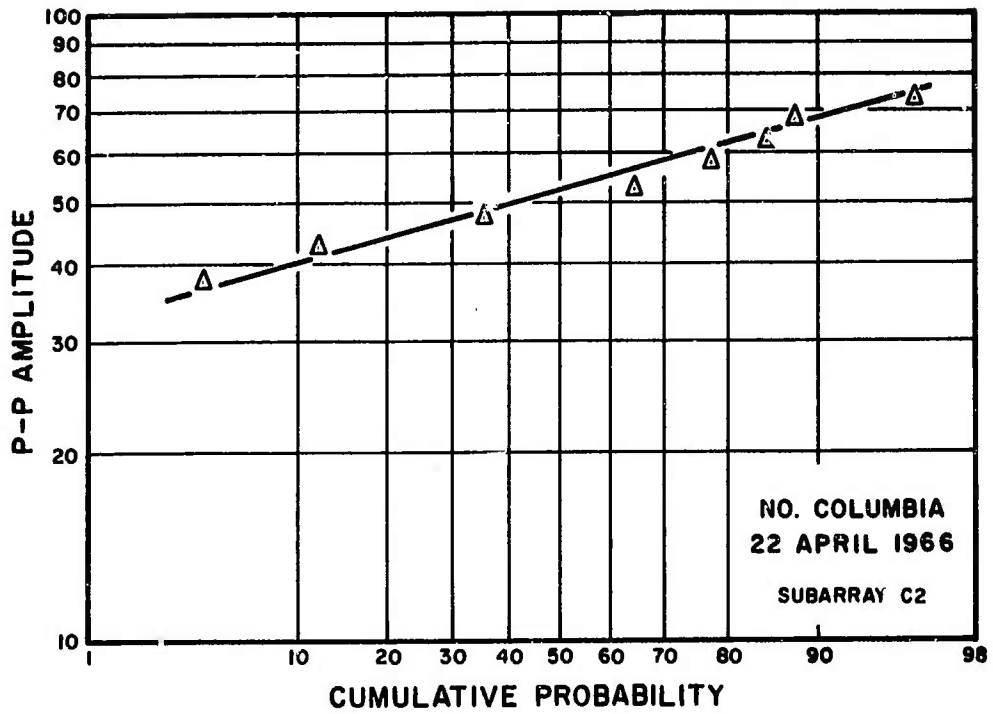


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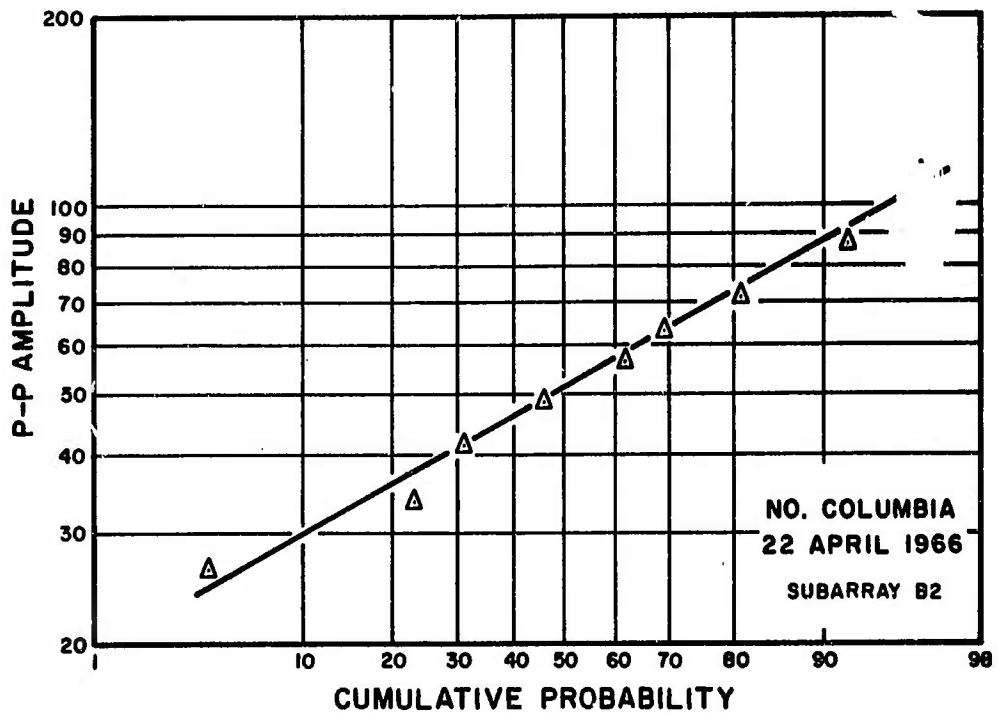


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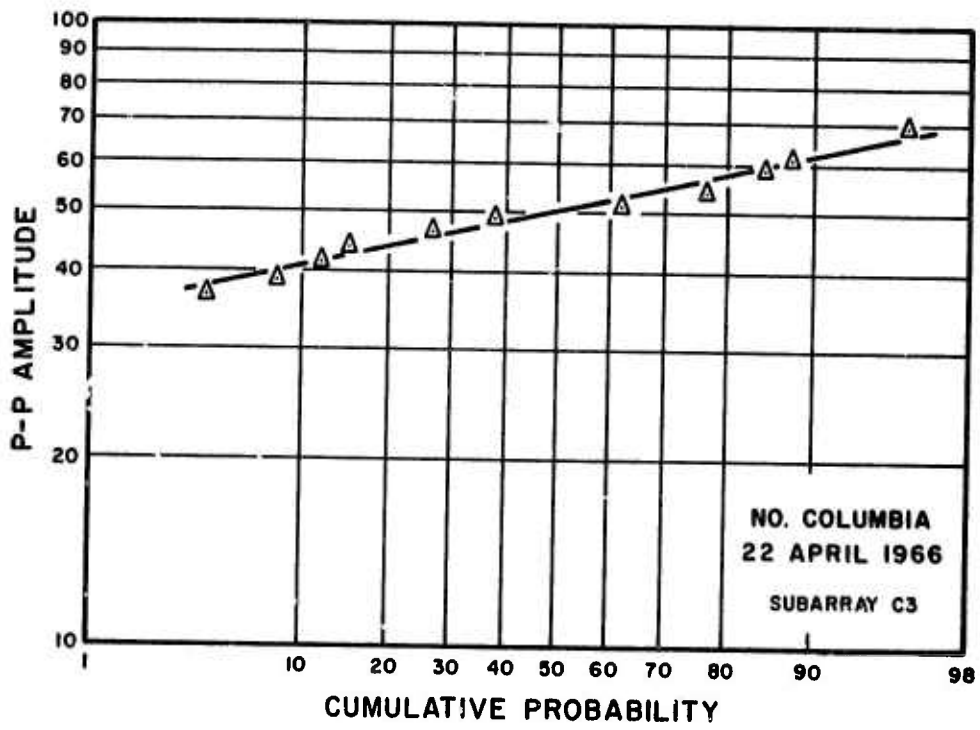


Figure 13

N. COLUMBIA  
21 DEC. 1965

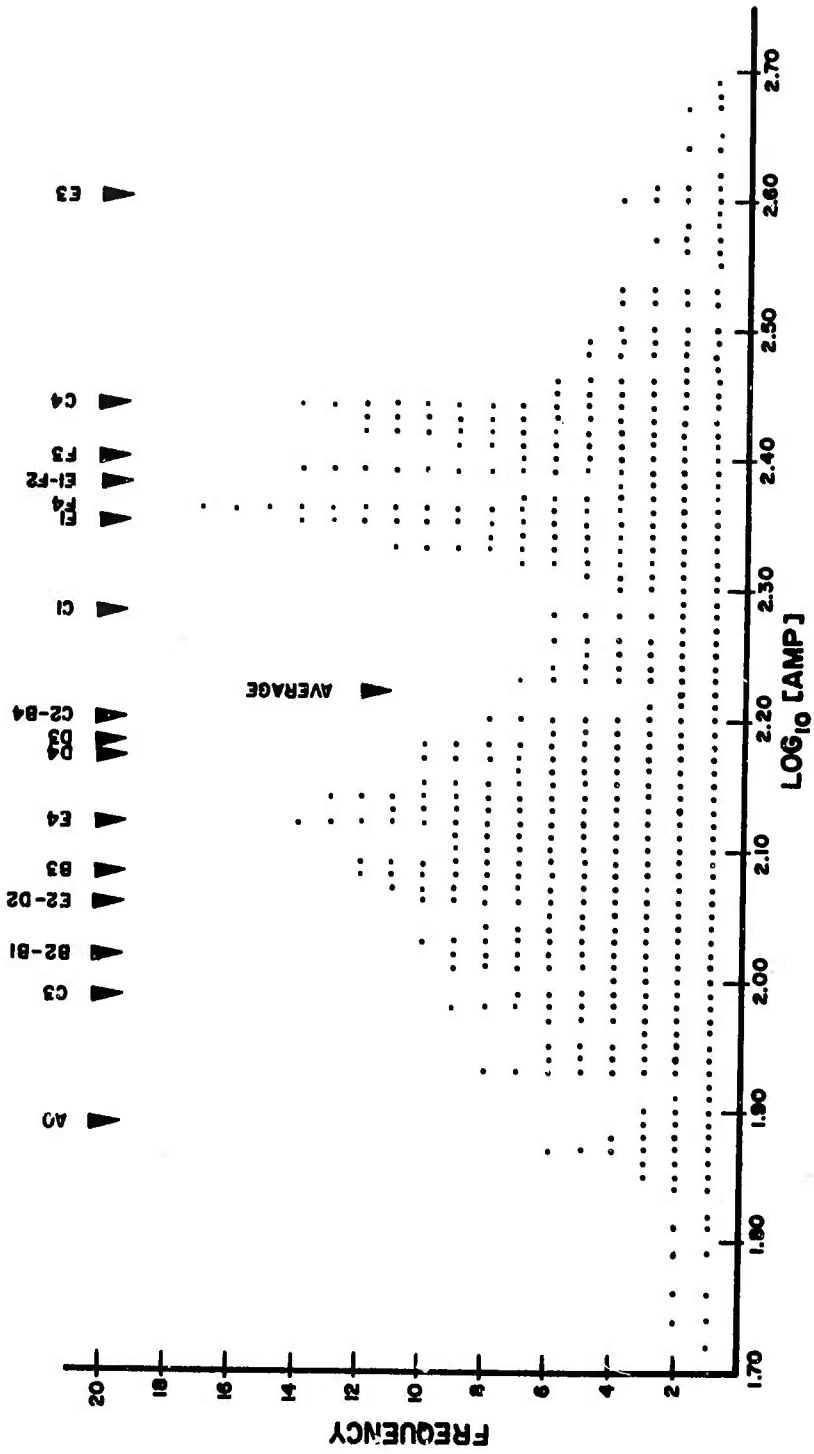


Figure 14

N. COLUMBIA  
12 JUNE 1966

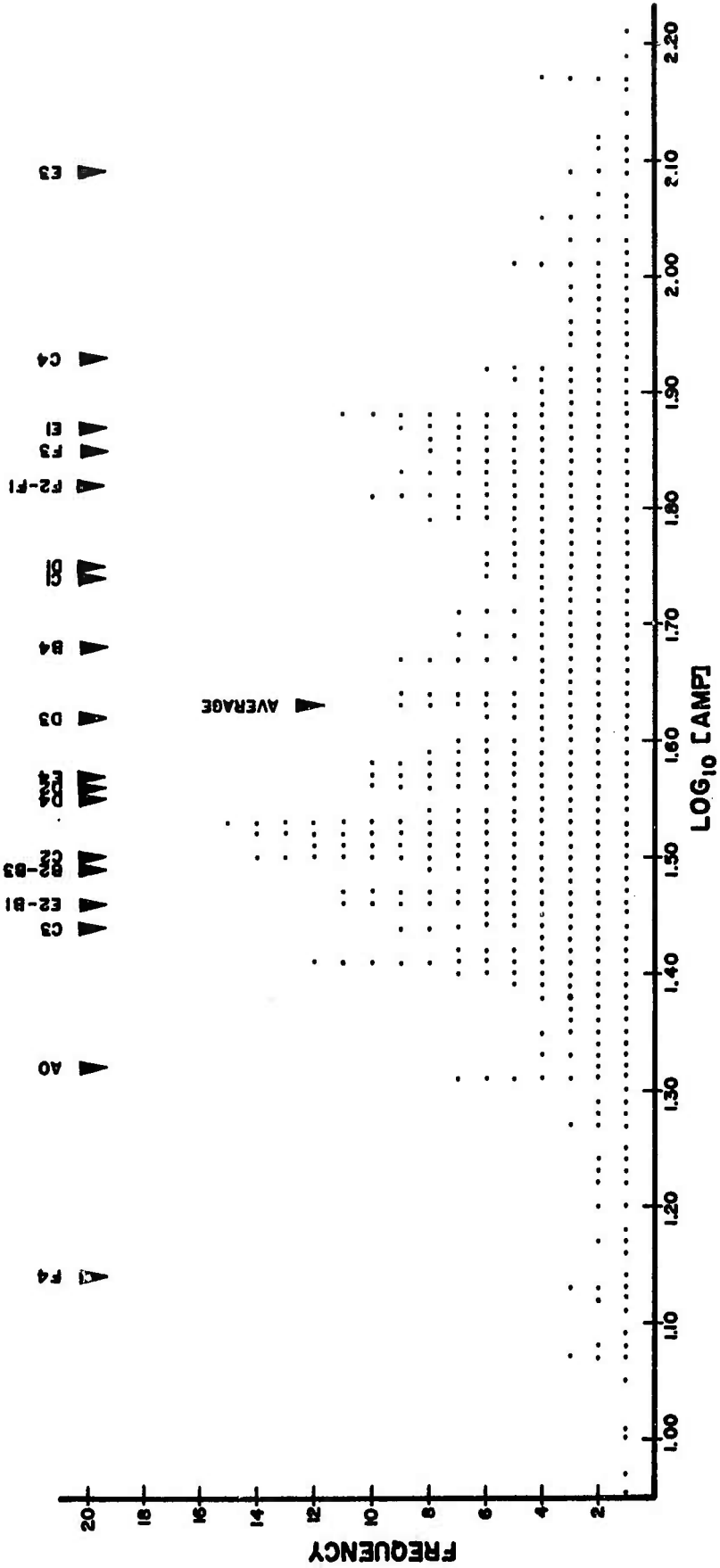


Figure 15

N. COLUMBIA  
21 APRIL 1966

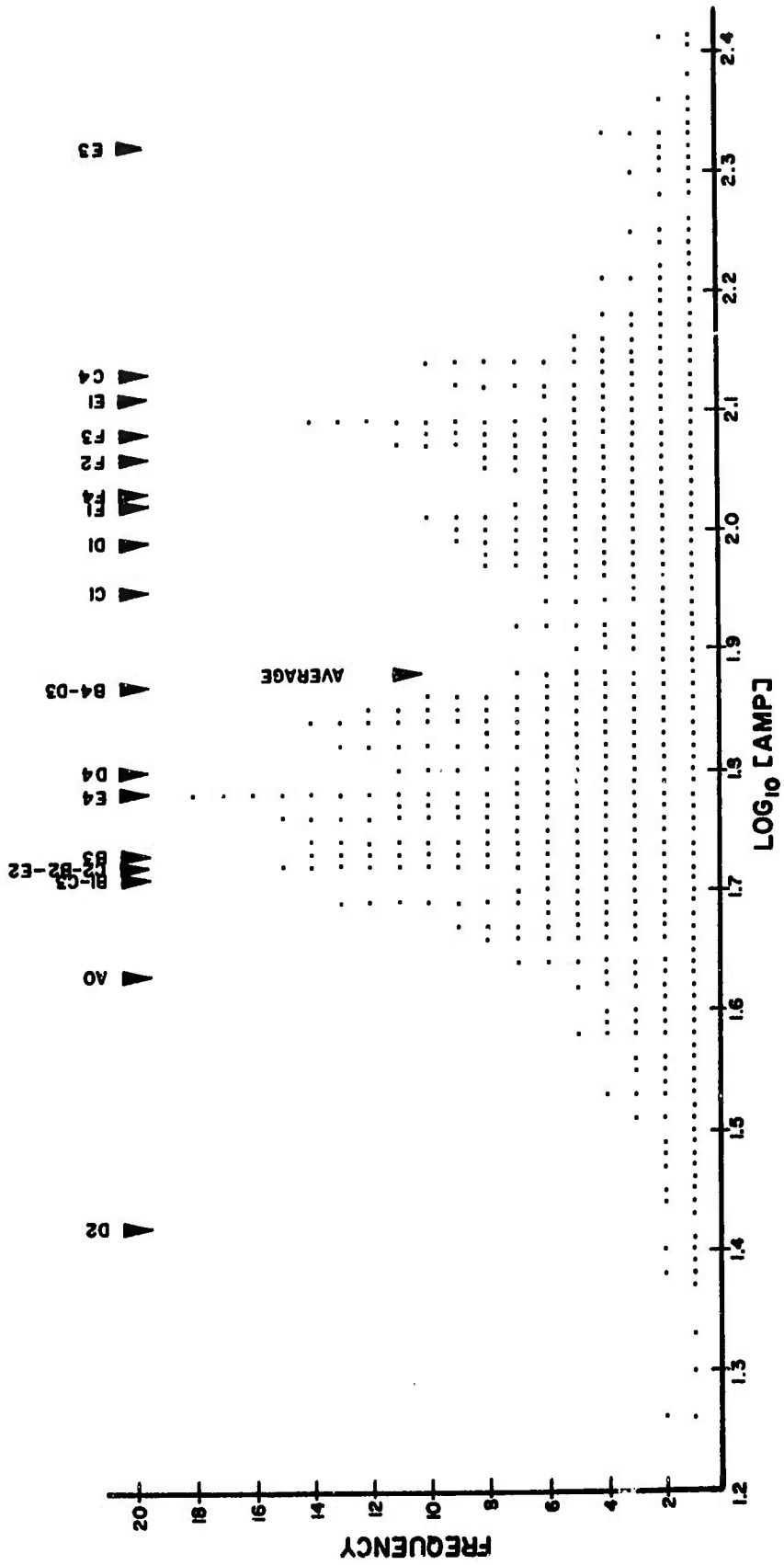


Figure 16

HOKKAIDO  
19 MARCH 1966

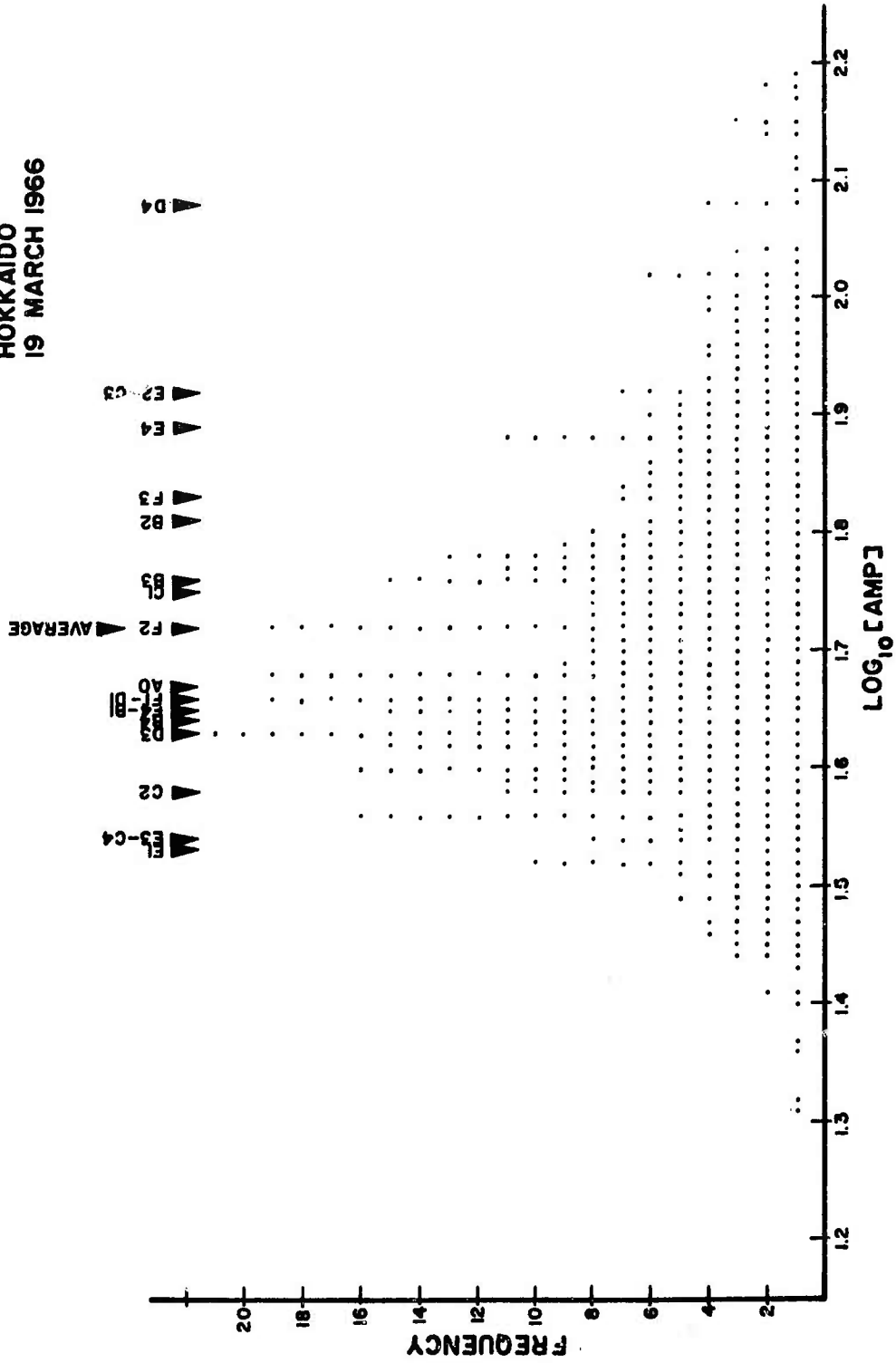


Figure 17

HOKKAIDO  
17 JUNE 1966

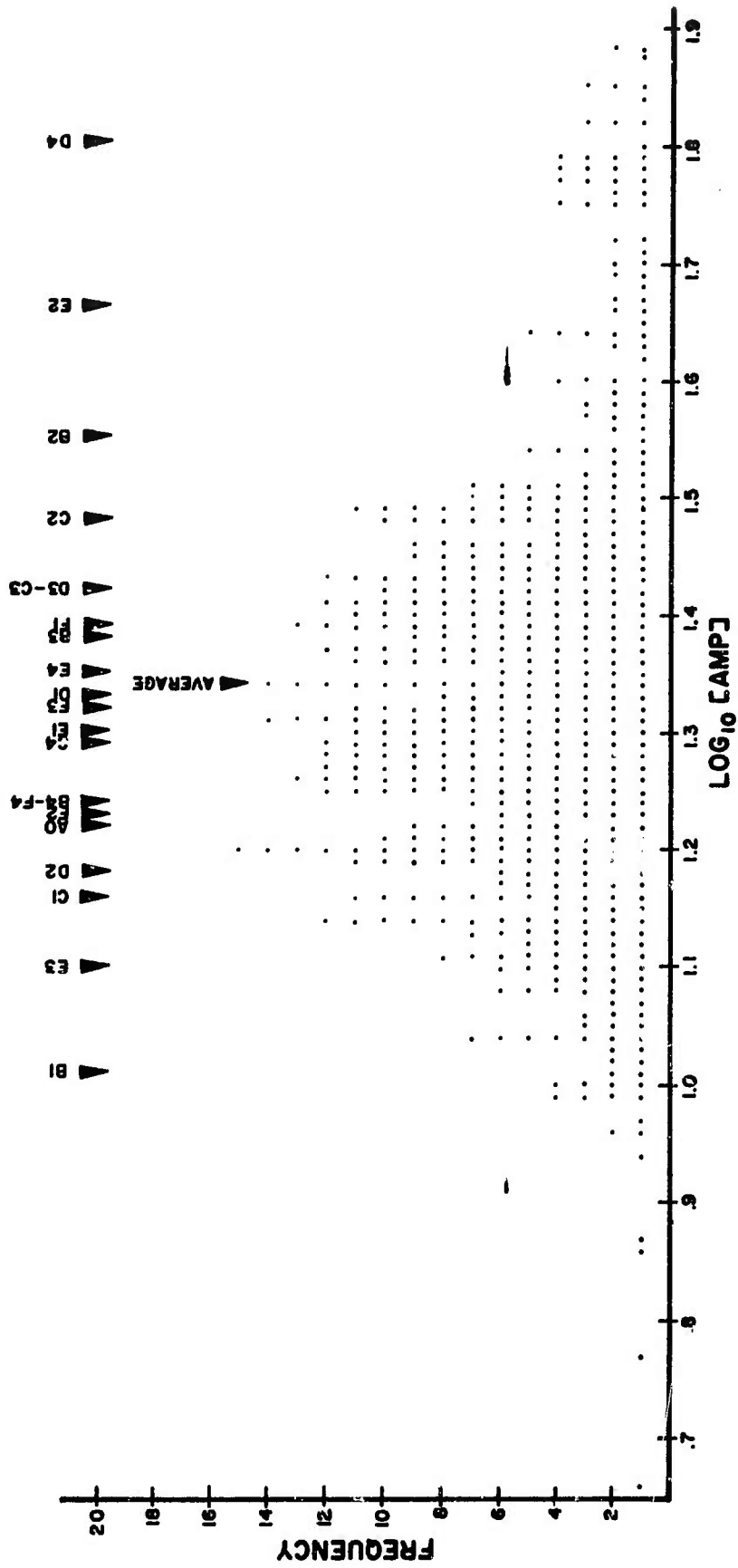


Figure 18

MARIANAS  
20 MAY 1966

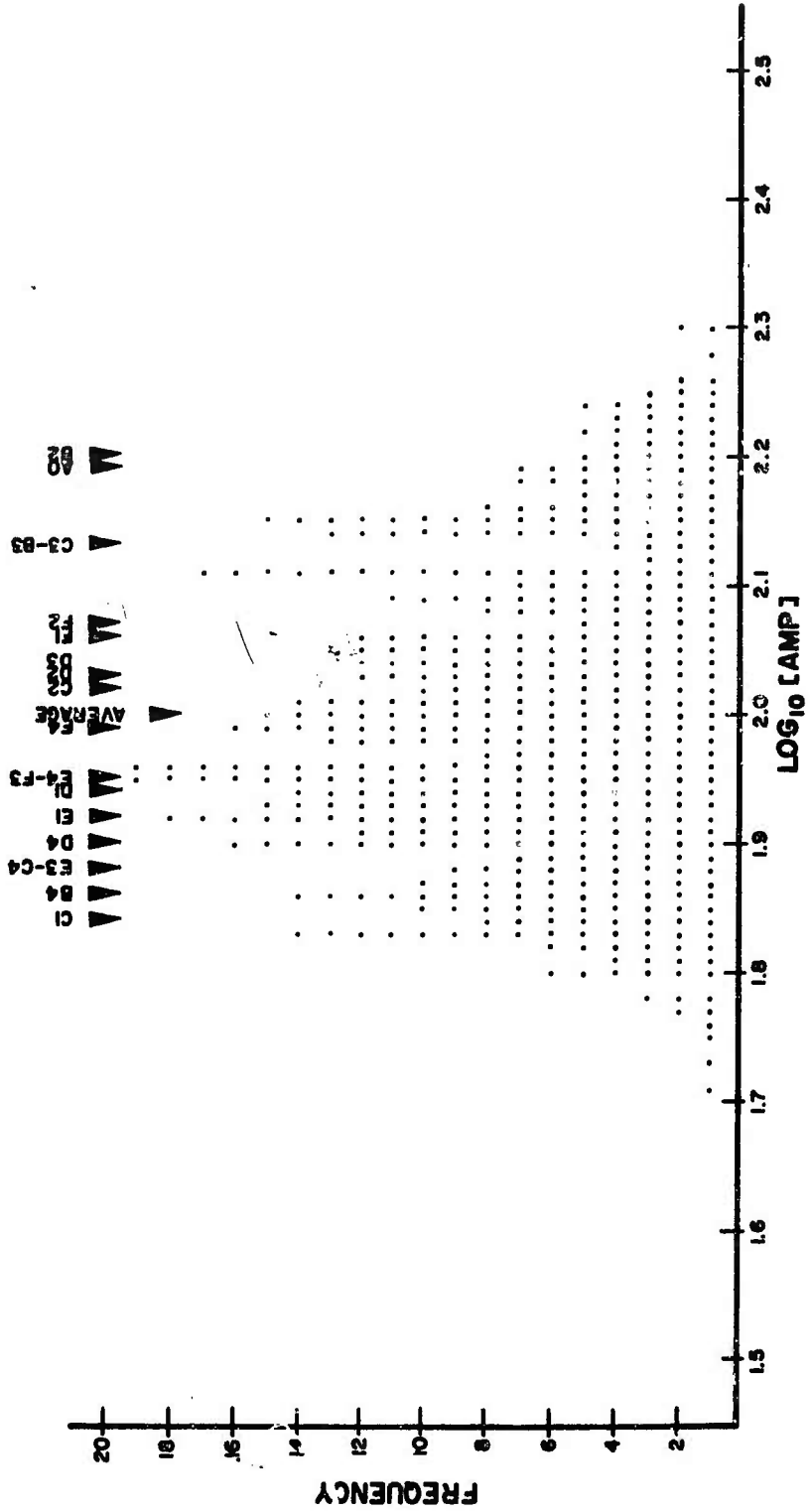


Figure 19

MARIANAS  
20 NOVEMBER 1965

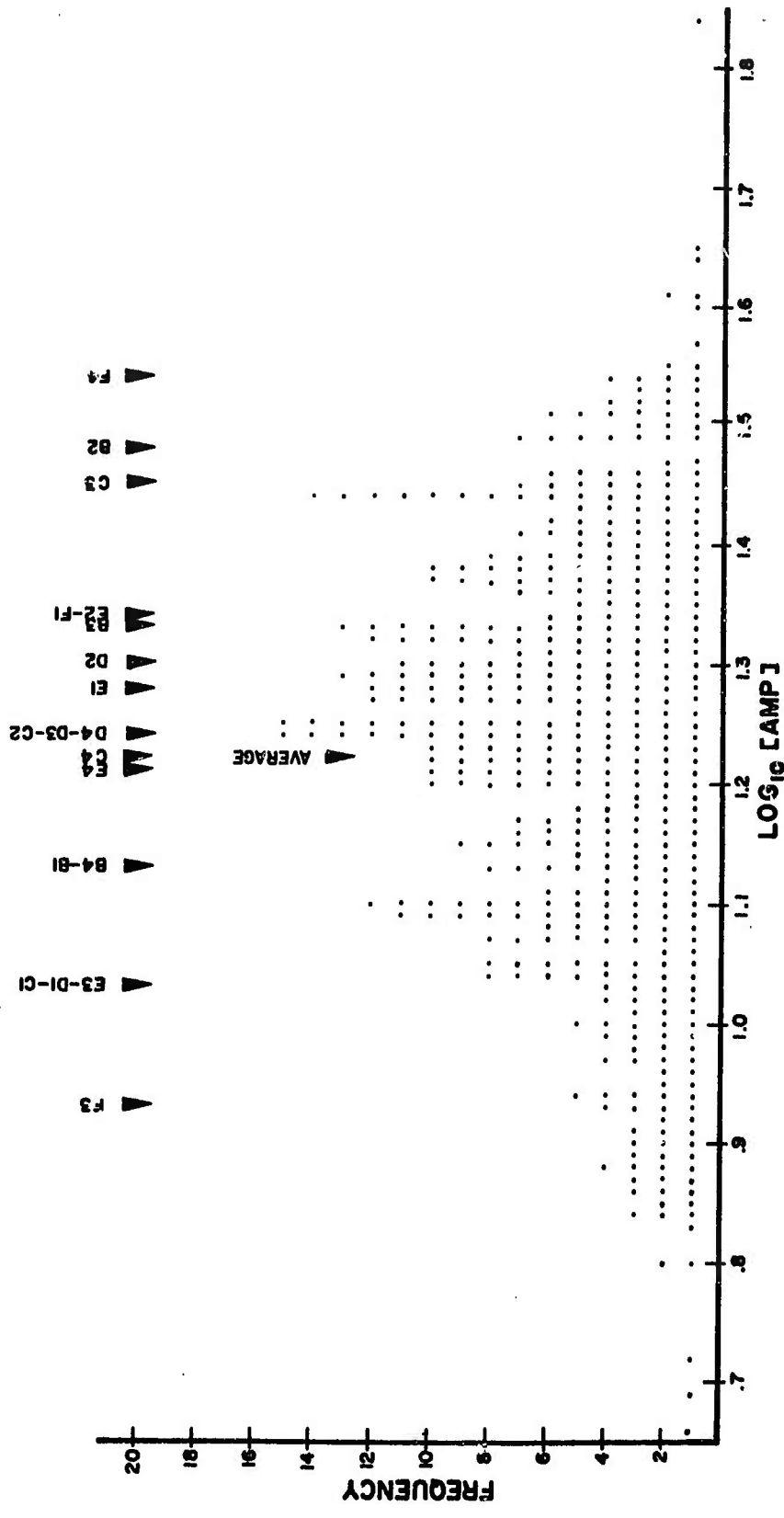


Figure 20



KODIAK  
22 APRIL 1966

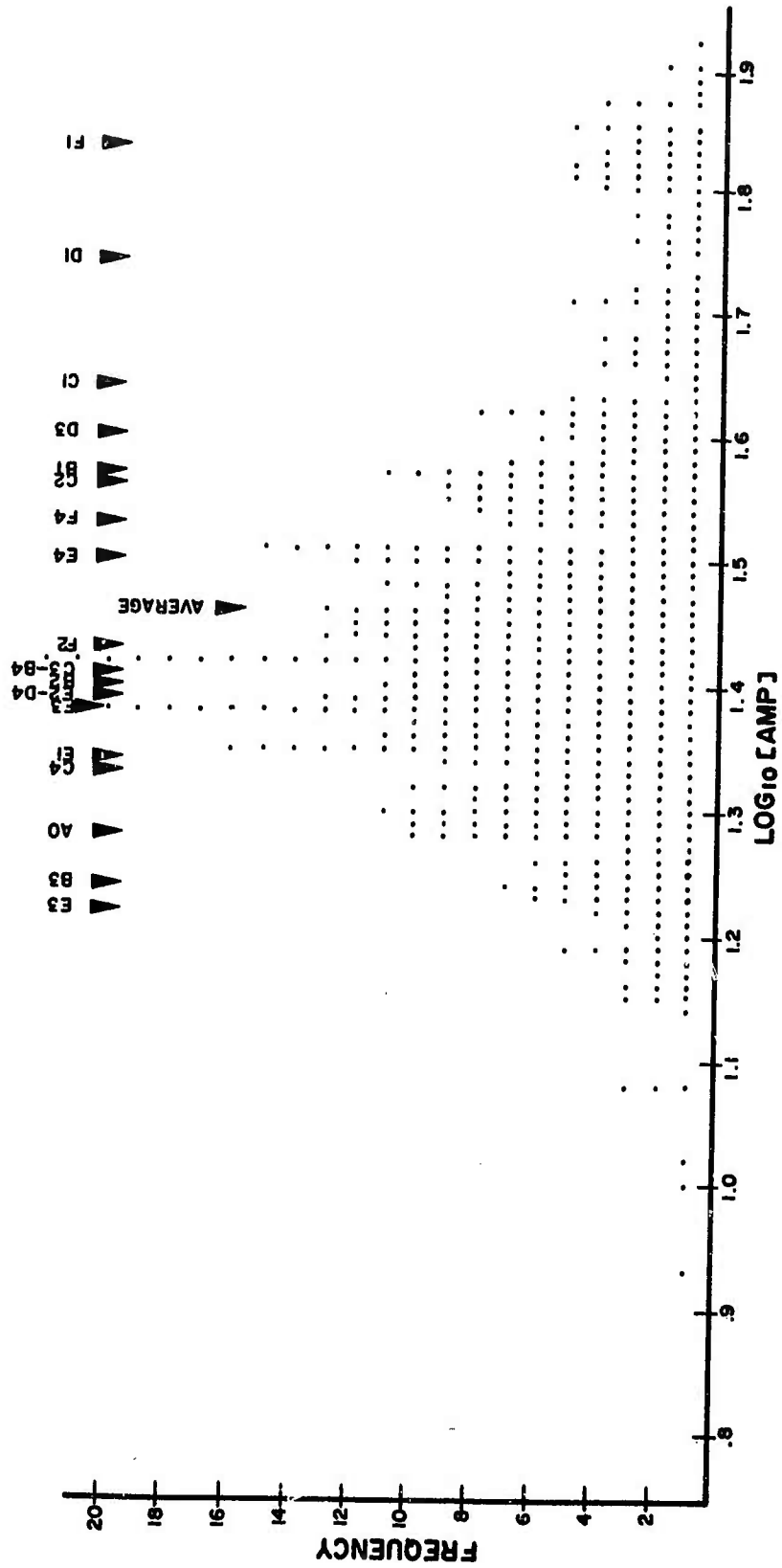


Figure 21

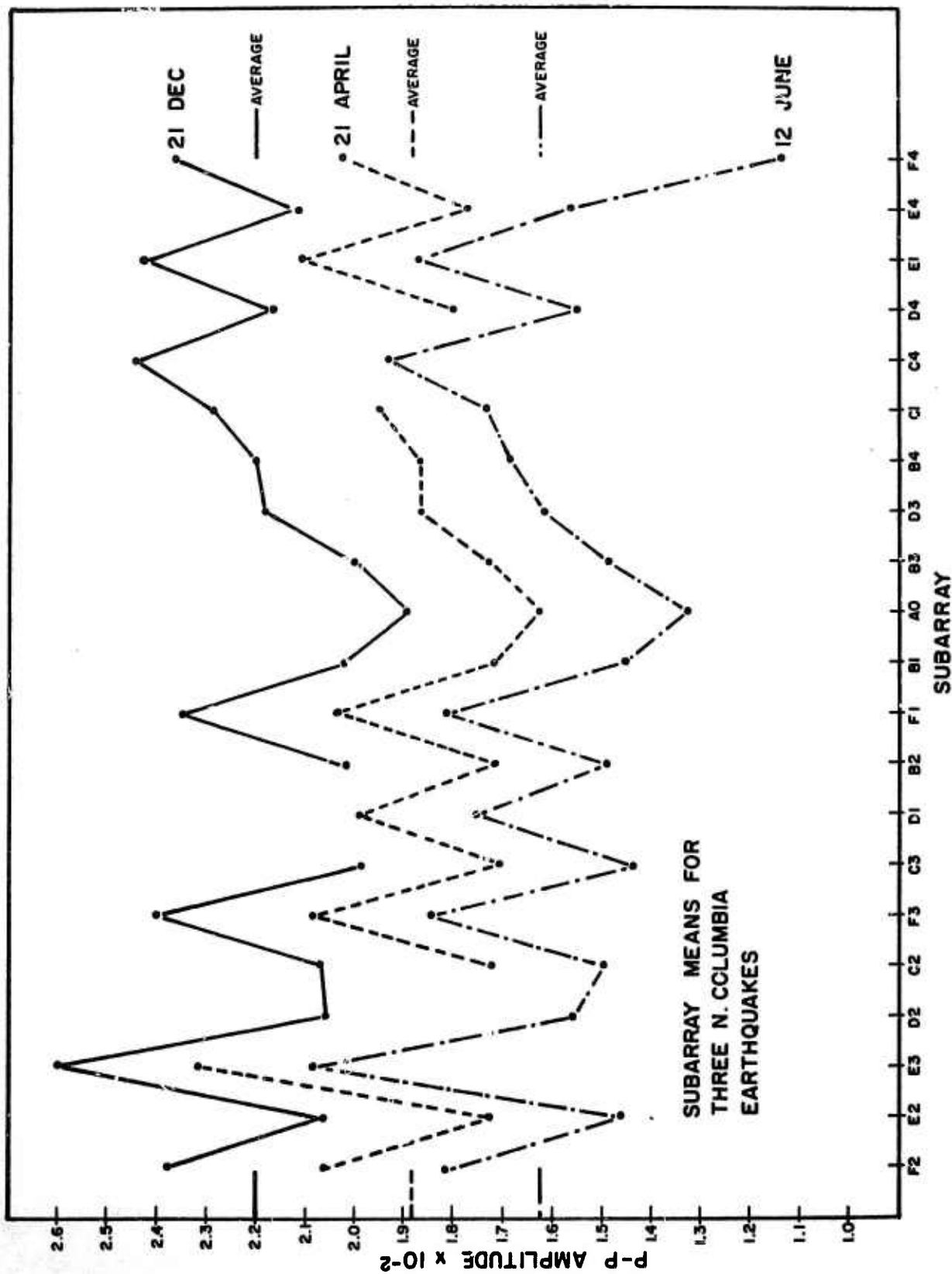


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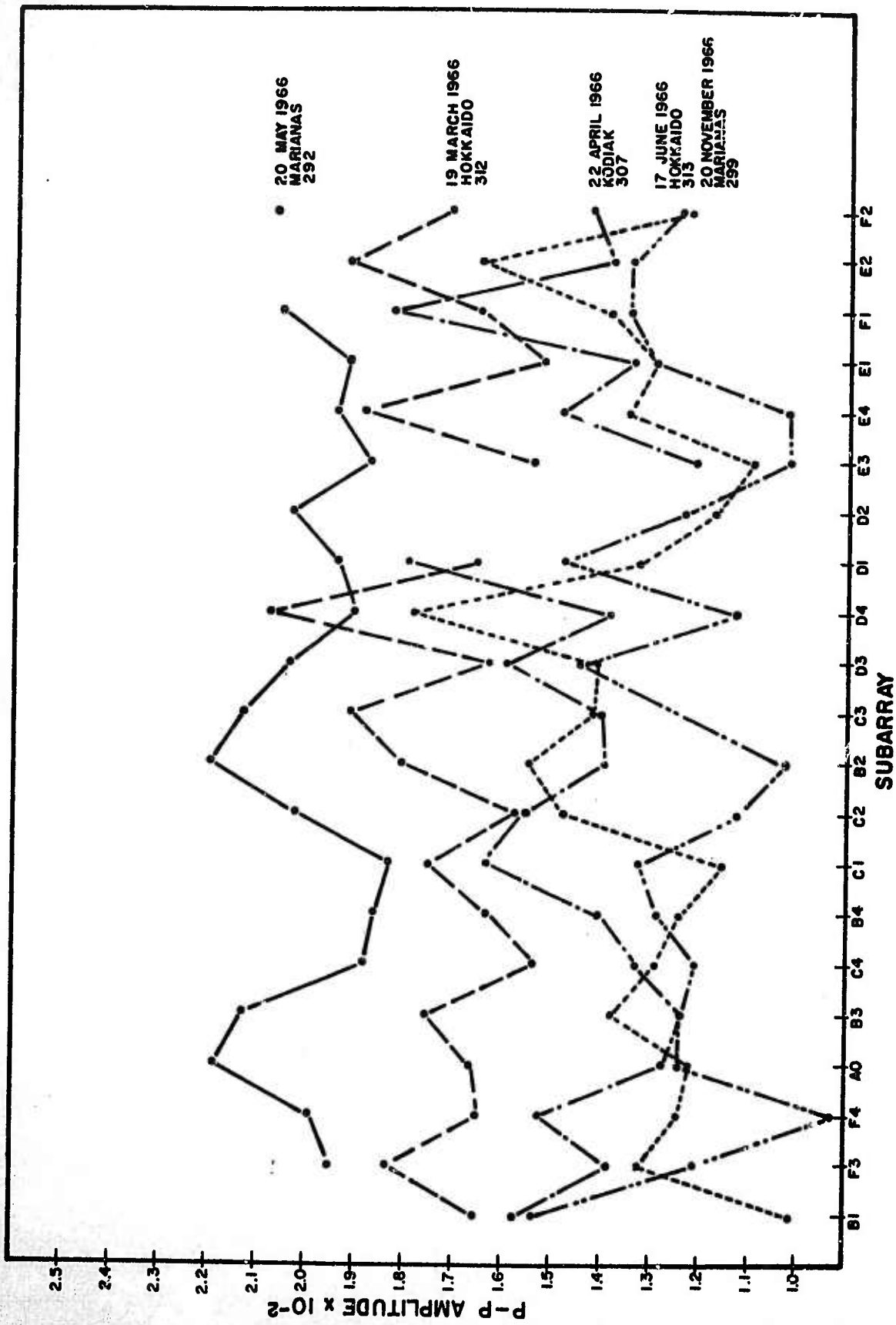


Figure 23

HISTOGRAM DERIVED FROM POOLING  
STANDARDIZED SUBARRAYS FROM  
EIGHT EVENTS. DATA CONSISTS OF  
3925 LOGARITHMS OF PEAK TO  
PEAK AMPLITUDES.

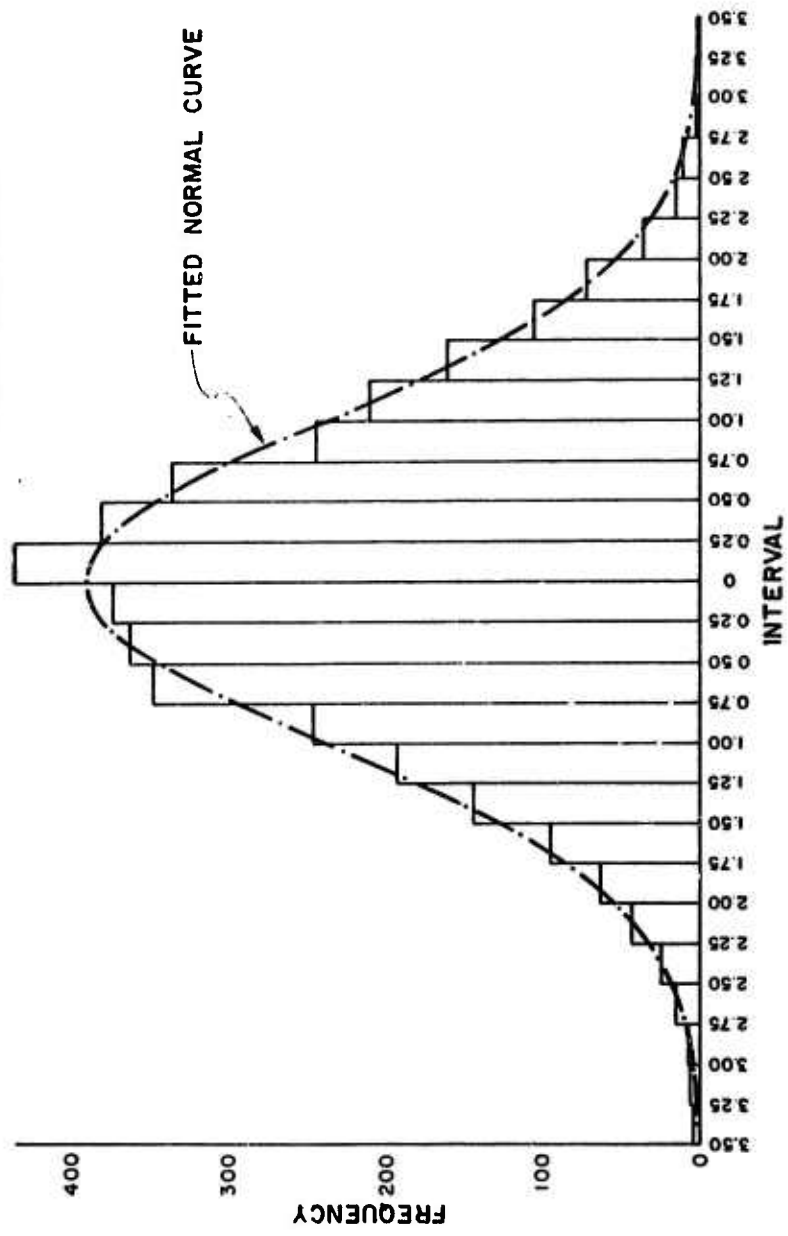


Figure 24

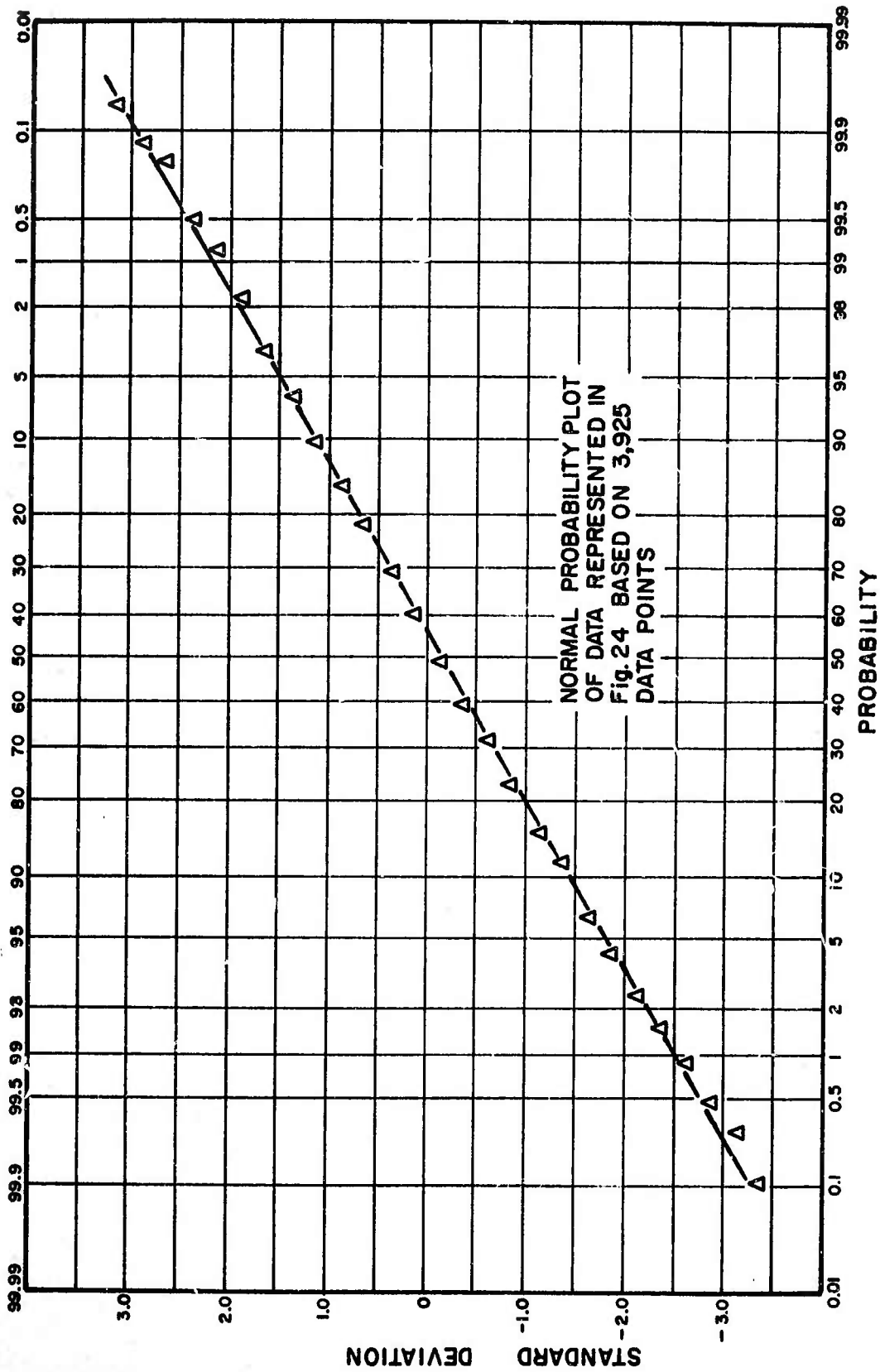


Figure 25

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