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GEOMAGNETIC OBSERVATIONS ON FLETCHER'S ICE ISLAND (T-3), ARCTIC OCEAN

James C. G. Walker

LAMONT GEOLOGICAL OBSERVATORY
(Columbia University)
Palisades, New York

Project 8623
Task 862394

Scientific Report 5

Contract AF 19(604) 7442

November

1962

Prepared for

GEOPHYSICS RESEARCH DIRECTORATE
AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

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ABSTRACT

Measurements of the geomagnetic field made at magnetic latitude 69° N during the late summer of 1961 are described. The temporal behavior of the field is discussed, along with the mean daily variation of the total intensity and some of the properties of the one to thirty minute fluctuations.

- - - - -

A nuclear resonance magnetometer was operated on Fletcher's Ice Island (T-3) in the Arctic Ocean between late April and early September 1961. Only the data from the end of this period have been studied. During this whole period of recording, T-3 was aground on the continental shelf in water 40 m. deep 72° N, 160° W, about 80 miles west-northwest of Point Barrow, Alaska. This location corresponds to a geomagnetic latitude of 69° N, two degrees north of the auroral zone. Since T-3 was stationary, the data was not affected by spatial variations in the magnetic field.

A strip chart record of the total intensity of the magnetic field was made at a speed of four minutes to the inch and a sensitivity of approximately 11 gamma to the inch. To the author's knowledge, there has been no report in the literature on the use of an absolute instrument of this nature to study the temporal behavior of the magnetic field in the Arctic Ocean.

Temporal Behavior of the Total Intensity

Instantaneous hourly values of the total intensity are plotted in Fig. 1 against Greenwich Mean Time for the eight-week period, July 18 to September 11. Gaps in the data were caused by instrument breakdown. The international disturbed days are denoted by D and the five quiet days by Q. The double arrows indicate the times of sudden commencements reported by ten or more stations. The single arrows refer to those sudden commencements reported by fewer than ten stations (Lincoln 1961 and 1962).

There is no indication in the records of Figure 1 of the normal, low-latitude, storm-time morphology as illustrated, for example, in Chapman (1951, p. 80). Sudden commencements are not apparent, and there is little suggestion of the expected phases of even the widely reported storms. However, Leyhe (1962, Fig. 9) presents a figure of Vestine et al. (1959) which shows a weighted average of eleven storms as recorded by three observatories at comparable geomagnetic latitudes. The data show no sudden commencement but the north component is depressed by about 70 gamma during the main phase. Superimposed on the storm are large fluctuations with characteristic amplitudes of about 50 gamma and periods of about 20 hours. Evidently, at least the main and recovery phases are indeed present at these latitudes. They are so obscured by the large amplitude fluctuations that they can be detected only after these fluctuations have been eliminated, to some extent, by averaging.

The large amplitude fluctuations do exhibit some regularity whether or not they occur during world-wide magnetic storms. Inspection of Figure 1 reveals that the field is generally low before noon GMT and high after noon. This regularity is not apparent on the days when these large fluctuations

(of amplitude several hundred gamma) are absent (e.g., August 21, 22 or 24).

The mean daily variation of the total intensity during this eight-week period is plotted in Figure 2. No attempt has been made to separate the quiet and disturbed days. The mean daily variation is, of course, strongly influenced by the regularity in the behavior of the large amplitude fluctuations that has already been described. In order to facilitate the distinction between persistent effects and the effects of solitary large events, the mean diurnal variations are plotted separately for the four-week periods July 18-August 14 and August 15-September 11. For comparison we reproduce the annual mean daily variation of the vertical component of the field at Point Barrow (Chapman, 1951, p. 93), and the mean daily variation of the total intensity measured on Drift Station CHARLIE (78° N 165° W, geomagnetic latitude 73° N) during the period July-December 1959 (Hunkins et al., 1962).

Fluctuations in the Total Intensity

The disturbance has been estimated by measuring the range of the total intensity in the first 1, 3, 10 and 30 minutes after every hour, Greenwich Mean Time. The hourly range of the principal horizontal component has been used as an index of disturbance at high latitudes by Canadian and Russian workers (Whitham et al., 1960). The extension of this index to shorter periods provides a simple method to obtain a rough but reproducible spectral decomposition of the data.

The mean daily variation of these ranges is plotted in Figure 3, for the four-week period August 15 to September 11 as well as separately for the two-week periods August 15 to August 28 and August 29 to September 11. The data are not adequate to discuss the dependence of daily variation on period.

MEAN DAILY VARIATION

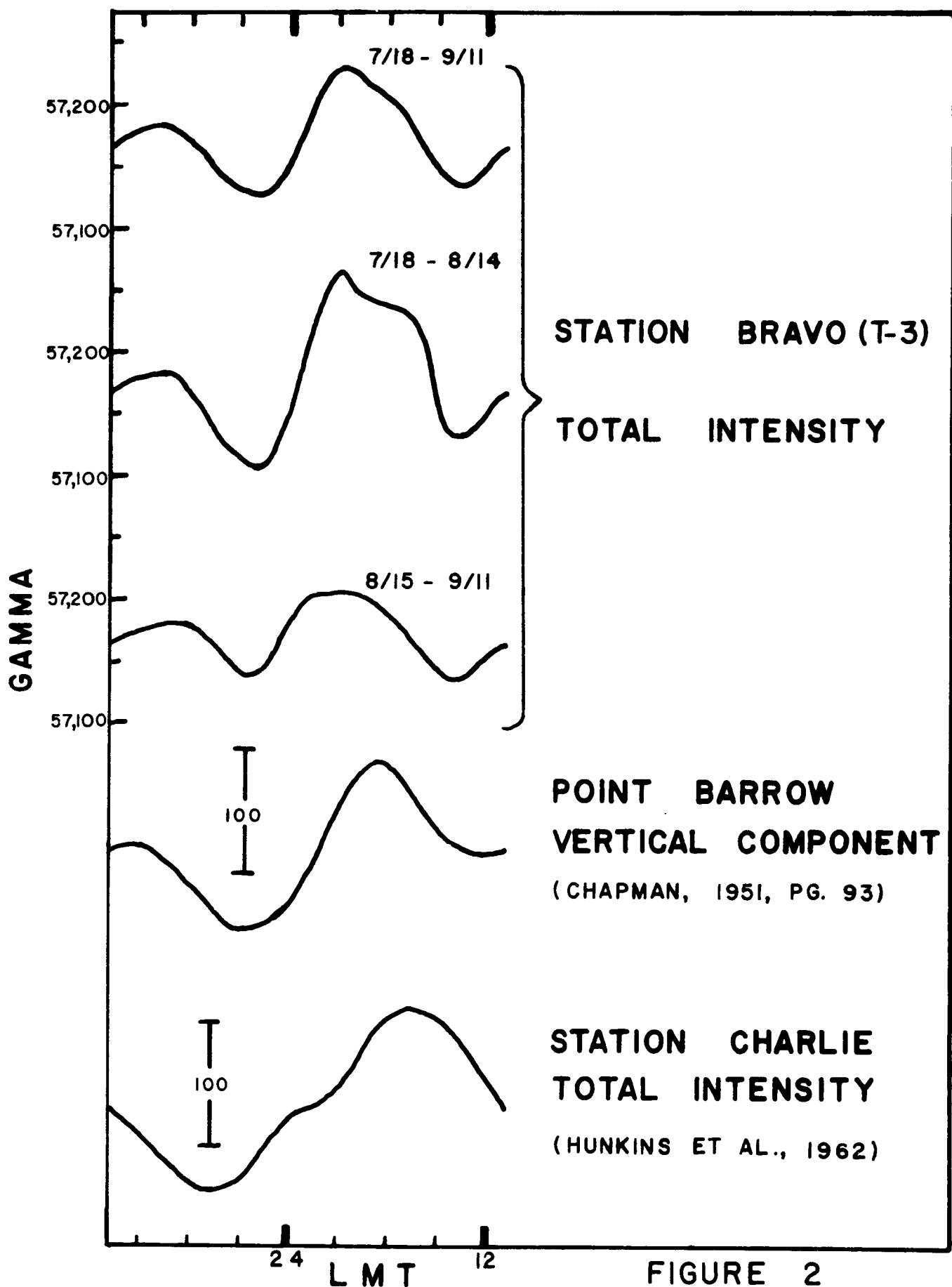


FIGURE 2

The disturbance shows consistent maxima at around midnight and 0700 local time. These correspond to the midnight and morning maxima common at high latitudes (see for example, Whitham et al., 1960). Most of the work on disturbance in the Arctic Ocean has been done by Russian workers. They conclude that, at geomagnetic latitude 69° N, the hourly range of the horizontal component peaks close to the times indicated by arrows in Figure 3. (See for example, Burdo, 1957. Burdo's plot of the loci of disturbance maxima is reproduced in Hope, 1961). The afternoon maximum is weakly indicated at about 1600 GMT in the data for August 29 to September 11, but is quite absent in the data for the preceding fortnight. The axis maximum described by Hope (1954) which should occur at 1600 GMT is not clearly present. Hope (1954) has pointed out that it appears to be indistinguishable from the morning maximum in the Point Barrow data.

These ranges have been averaged to obtain the mean range as a function of period plotted in Figure 4. It must be emphasized that this curve does not represent a spectrum. The ordinate is the average range over which the field fluctuates in a period of time given by the abscissa. These average values for the fortnight August 29 to September 11 are 1.5 times as great as the corresponding values for the fortnight August 15 to August 28. This is surprising since data plotted in Figure 1 suggest that the August 15-August 28 fortnight was the more disturbed. This may imply that hourly samples are too infrequent to obtain an adequate measure of the relative disturbance during periods as short as a fortnight.

The slopes of the curves in Figure 4 are very nearly the same. Our sample, then, may be large enough to give significance to this slope. If this is so, we conclude that

$$R \propto X^{.7}$$

where R is the mean range in X minutes.

LIST OF ILLUSTRATIONS

- Fig. 1 Hourly values of the magnetic field total intensity, July 18-September 11, 1961. Q & D denote international quiet and disturbed days. The double arrows indicate the times of sudden commencements reported by ten or more stations, while the single arrows indicate sudden commencements less widely reported.
- Fig. 2 Mean daily variation on T-3 compared with Point Barrow and Station Charlie.
- Fig. 3 Mean daily disturbance variation. The mean range of the field in the first 1, 3, 10 and 30 minutes after the hour is plotted against time of day.
- Fig. 4 The mean ranges for all times of day are plotted against the length of time within which the excursion occurs.

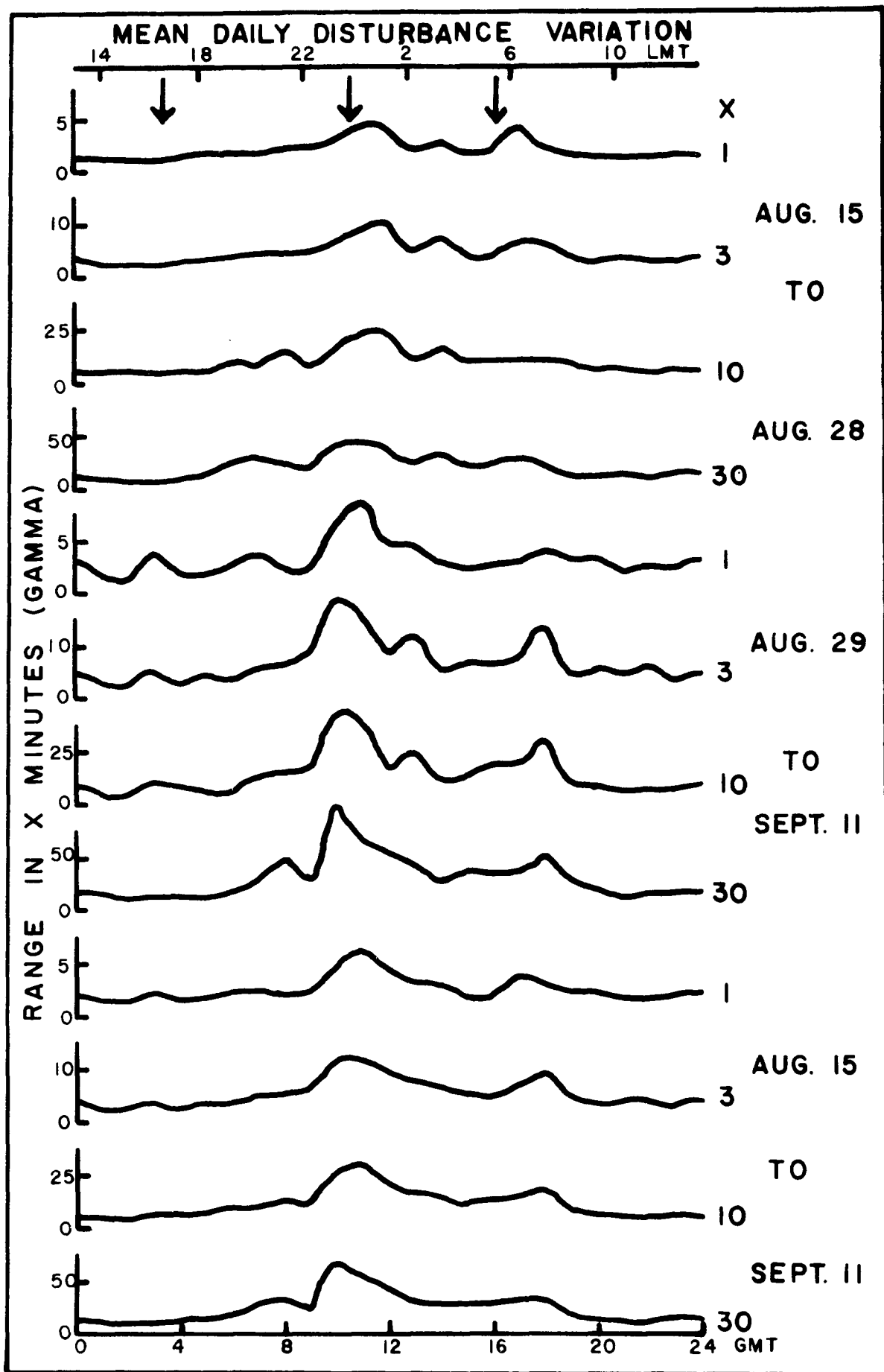


FIGURE 3

MEAN RANGE IN TIME X

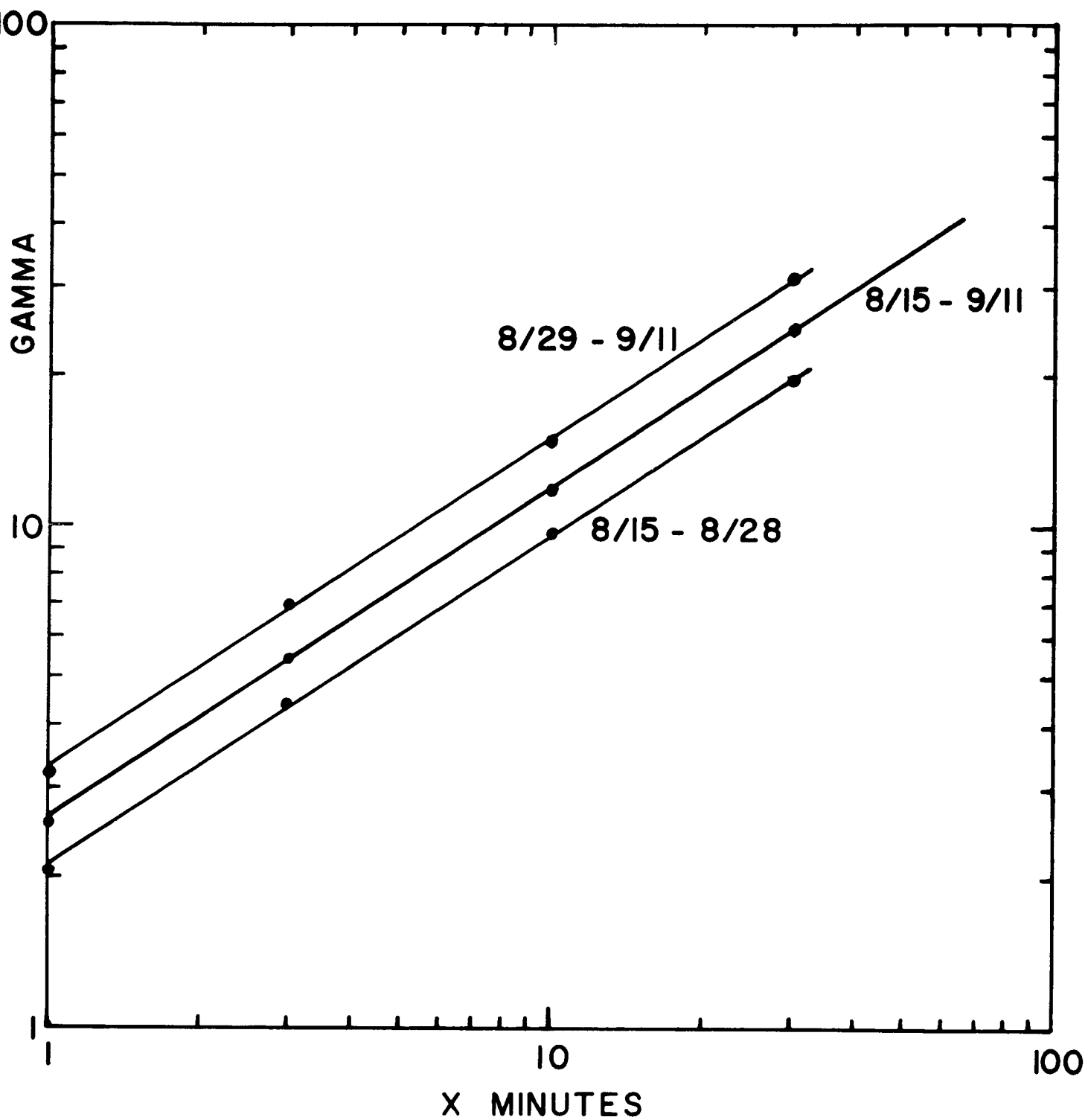


FIGURE 4

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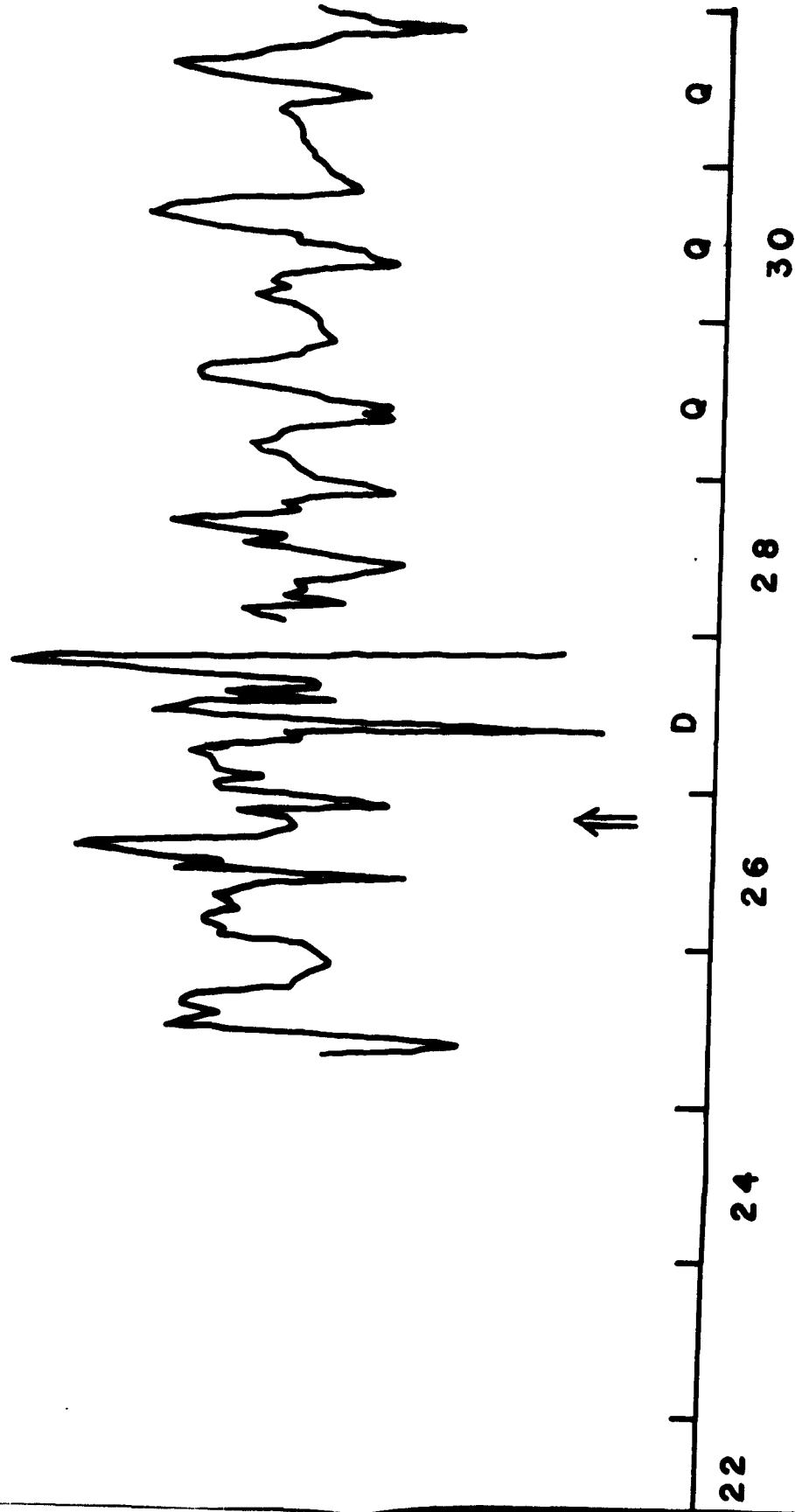
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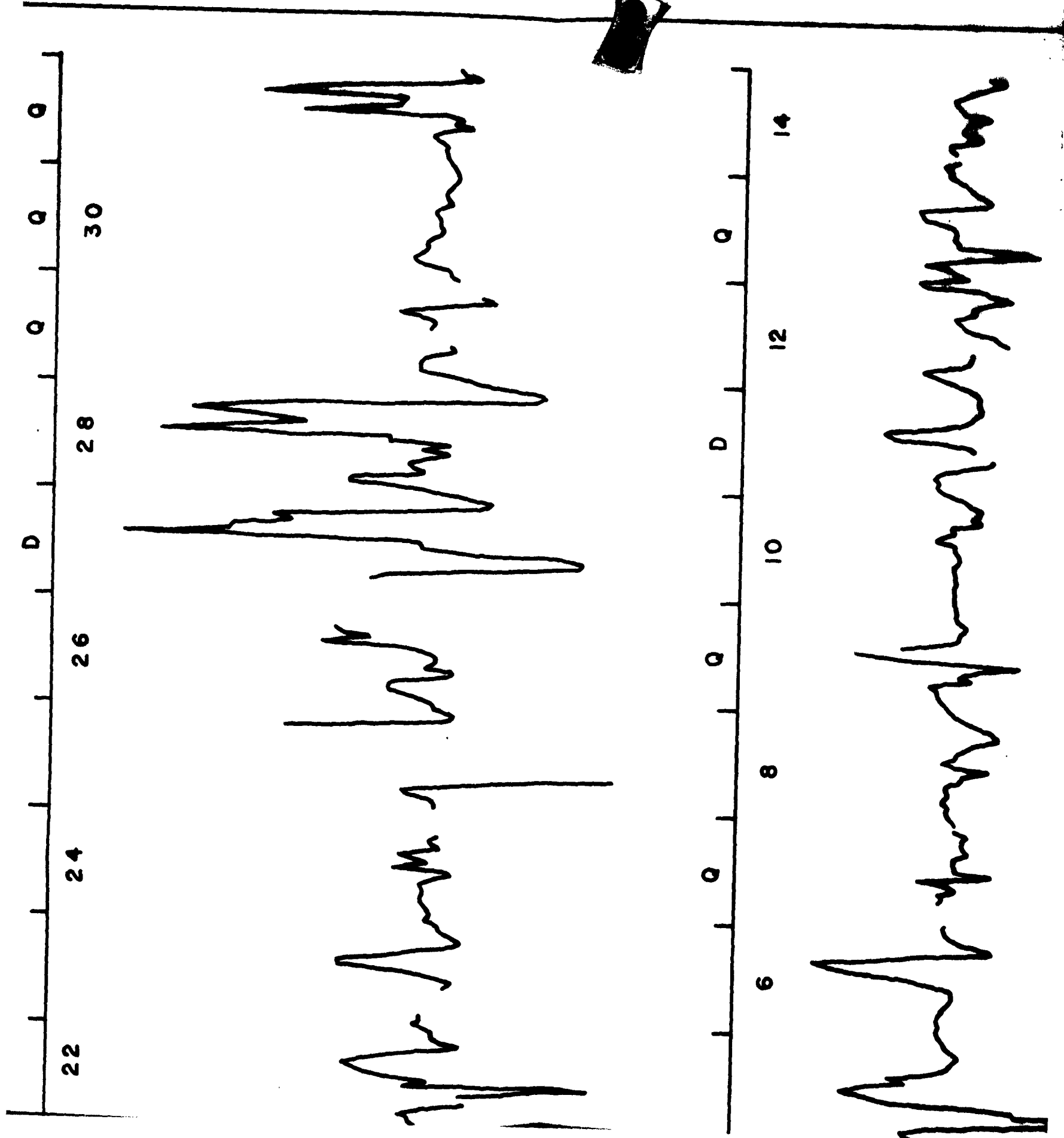
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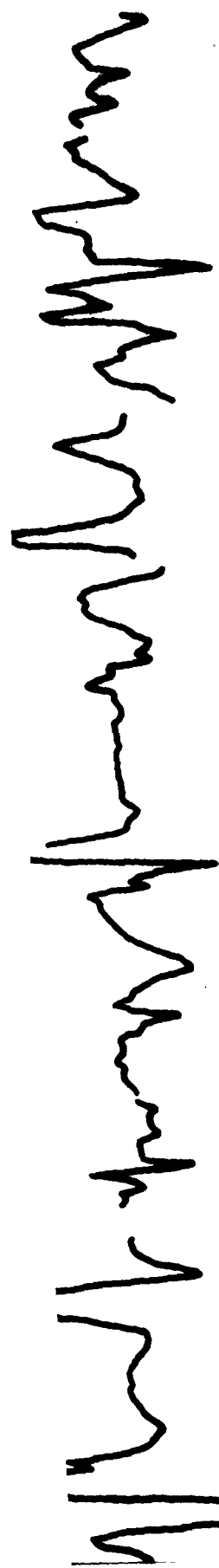
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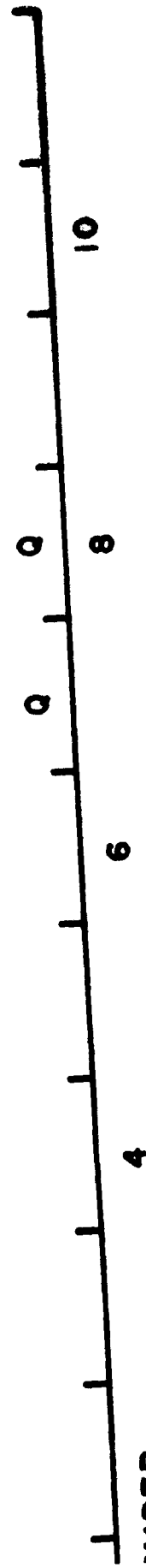
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FIGURE 1



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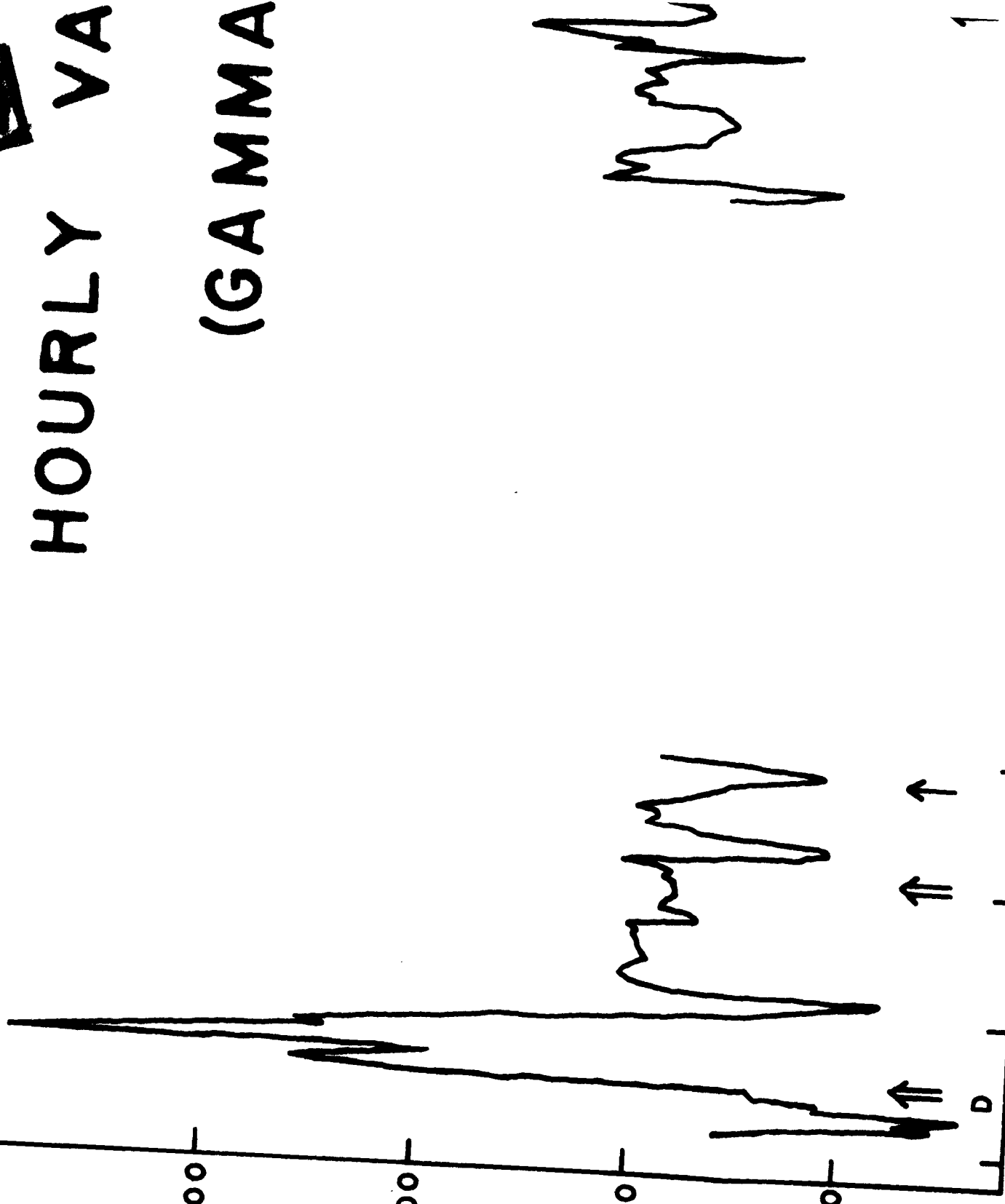
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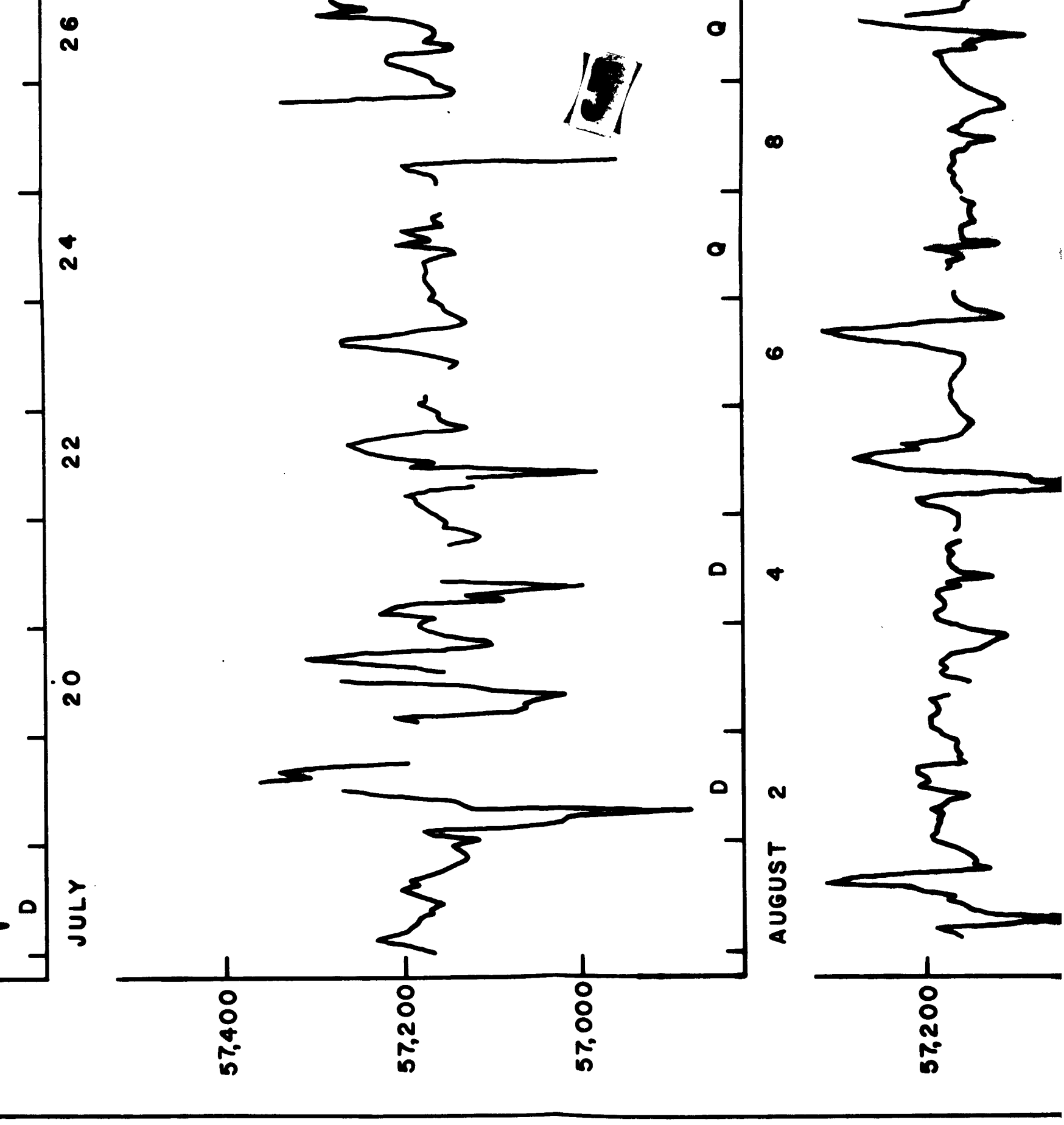
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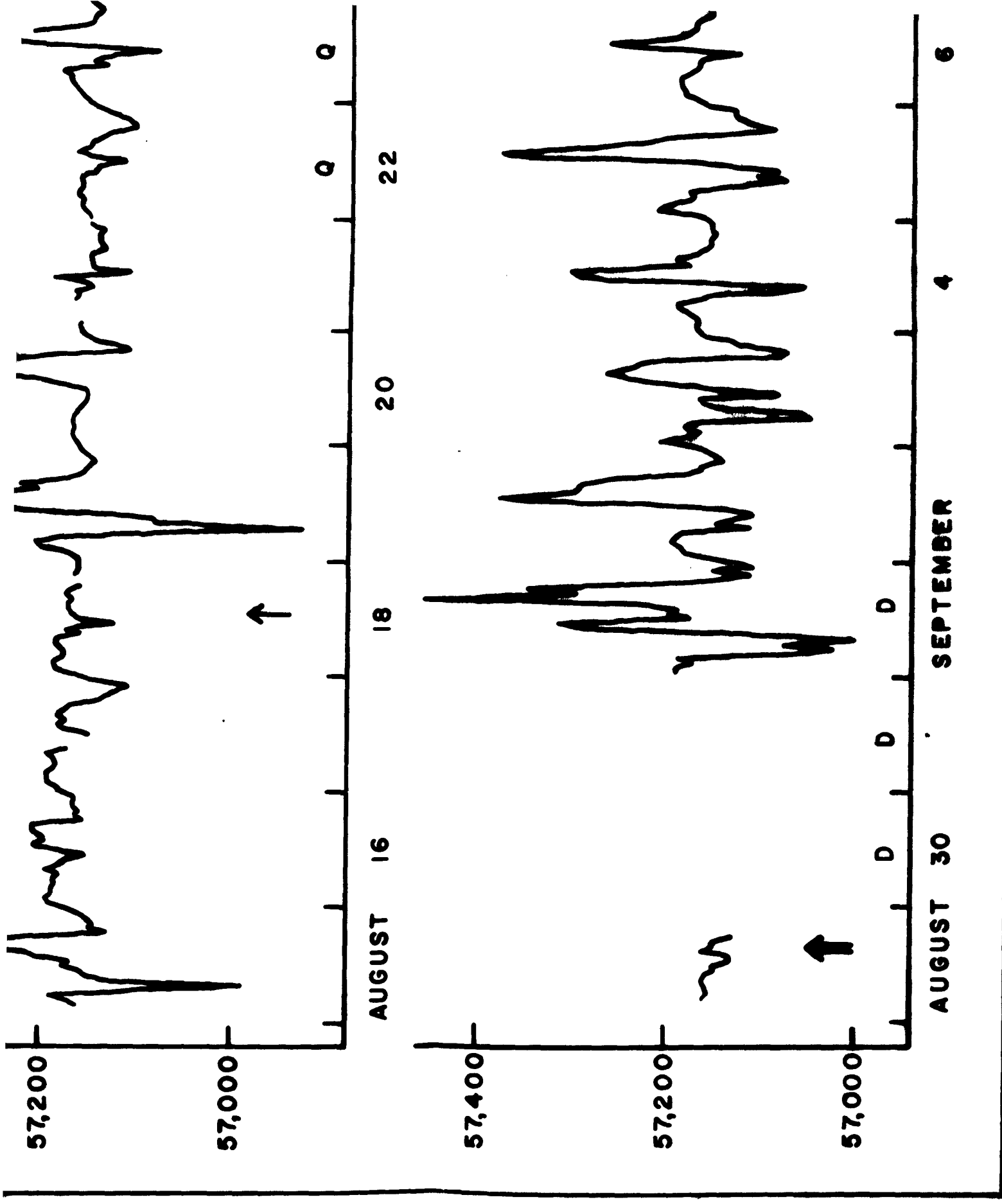
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FIGURE

