ATLAS OF LONGLINE CATCH RATES BY JAPANESE LONGLINERS IN THE PACIFIC OCEAN – 1962 TO 1985

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ATLAS OF LONGLINE CATCH RATES BY JAPANESE LONGLINERS IN THE PACIFIC OCEAN – 1962 TO 1985

1.0 INTRODUCTION

Knowledge of the spatial distribution of a fish stock and how it changes in response to exploitation is important both for assessing the status of the stock and for its management. With the advent of 200-mile Exclusive Economic Zones (EEZ), questions about spatial effects of fisheries on widely distributed species have become even more critical as fisheries managers in various countries have a need for assessing the potential resources within their EEZ and the effect on their resources of fisheries in other areas.

Longline fisheries for tuna are well established and widely dispersed throughout the entire tropical and temperate Pacific Ocean. Fortunately, long historical time series are available on the spatial distribution of the catch and effort that has occurred in these fisheries. An examination of spatial distribution of the catch per unit effort (CPUE) that has been obtained in this fishery should provide insights into the underlying spatial distribution of the exploitable stocks.

The purpose of the present report is to present a time series of contour plots of CPUE for Japanese longline vessels operating in the Pacific for the three major tuna species harvested by this fishery (Figures 1–6). These three species are yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*) and albacore (*Thunnus alalunga*). While other types of figures depicting the CPUE have been produced in scattered sources, the use of contour plots to represent the spatial pattern of CPUE has not been done for these data (nor for the data from most fisheries). The value of using a contour approach is that it provides a much clearer picture of the spatial patterns than previously used approaches. In addition, no single document exists which displays in a single format these complete time series of data for all these species, thus allowing the reader to compare the distributions between species and over time. The resultant pattern revealed in these plots suggests the existence of consistent and ecologically interesting patterns. The time series of contour plots should be considered as a first step in trying to understand the spatial distribution of the fishery and the underlying fish stocks.

2.0 DATA

The major source of data for the contour plots comes from annual reports of catch and effort statistics produced by the Fisheries Agency of Japan (1962, ... 1980).[1] These reports were discontinued after 1980.

The other source of data is from logsheets provided directly to countries within the South Pacific region as part of access agreements allowing vessels to fish within their 200-mile EEZs. These logsheets contain daily records of catch and effort information and are routinely processed by the SPC. The spatial coverage of the total longline fishery represented by these logsheet data is much smaller than that contained in the annual reports by the

[1] Fisheries Agency of Japan (1962, ... 1980). Annual report of effort and catch statistics by area on Japanese tuna longline fishery. Research Division, Fisheries Agency of Japan, Japan.

Fisheries Agency of Japan. Despite the lack of full coverage, these logsheet data have been used to produce contour plots for the years since 1980 in order to provide as complete a time series as possible for those areas which are covered by the logsheet data. The earliest logsheet data available to the TBAP are from 1978. However, the data for this year are very incomplete. In addition to the contour plots based on the published Japanese data, separate contour plots for 1979 and 1980 based on the logsheet data have been produced in order to be able to compare the results from the two different data sources.

3.0 PREPARATION OF PLOTS

The contour plots were produced using the program CONTR originally written by R.B. Lukas of the University of Hawaii and adapted for the HP1000 computer by G. Eldin of ORSTOM, Noumea, New Caledonia. The contour plots are based on annual estimates of the CPUE stratified by five degrees of latitude and longitude. Annual CPUE were calculated as the total number of fish caught within a geographic square divided by total number of hooks set in that square. CPUE has been scaled to the number of fish caught per hundred hooks set.

Only strata in which at least 10,000 hooks had been set were used in estimating the contour surface. In each contour plot, an dotted contour line has been plotted which represents the area in which there was at least 10,000 hooks of effort.

CPUE contours are drawn as solid lines. Contour levels were set to be evenly spaced with each contour line representing an increase of 0.2 fish per 100 hooks. The program CONTR allows for a number of smoothing options and some slight smoothing of the CPUE surfaces was done using Laplace interpolation. Also, the CPUE surface was extrapolated for one five-degree square in any direction to cover any minor holes in the data. It is because of this extrapolation that CPUE contours extend to and occasionally go beyond the dotted contour line which shows the limits of the data.

The axes of the plots represent longitude and latitude. The labels for these axes are given in degrees relative to the dateline and the Equator. Negative values for longitude represent values west of the dateline and positive values east of the dateline. Similarly, negative latitudes represent latitudes south of the Equator and positive values north of the Equator. The value of longitude and latitude used for any five-degree square was the value of the southwest corner. Thus, the CPUE level indicated by the contour lines refers to the catch rate in the five-degree square at the southwest corner as indicated by the labels on the axes.

4.0 AVERAGE PLOTS

Plots of the 'average' spatial distribution for the period from 1962 to 1980 are also presented (Figures 7–9) based on the published data from the Fisheries Agency of Japan. These average plots were prepared by scaling the catch rates for all five-degree squares within a year to sum to 1.0 so that the value for any square could be considered to represent an estimate of the proportion of that species found within that square during a given year. The value for these annual proportions within a square were averaged across all years to give an estimate of the average proportion for a square over the 19 years of data. The average proportions for a square were then contoured to provide a picture of the overall average relative spatial distribution for each species. In the final plots presented below, the average contours have been scaled by a factor equal to the average catch rate for a species across all years and all five-degree squares.

These overall average contour plots suggest a large amount of spatial segregation for these three tuna species, at least with respect to that portion of the populations which are vulnerable to longline gear. A manuscript with more detailed analyses and discussion of the spatial relationship among these three species is under preparation.

Figure 1. Contour plots of yellowfin catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.

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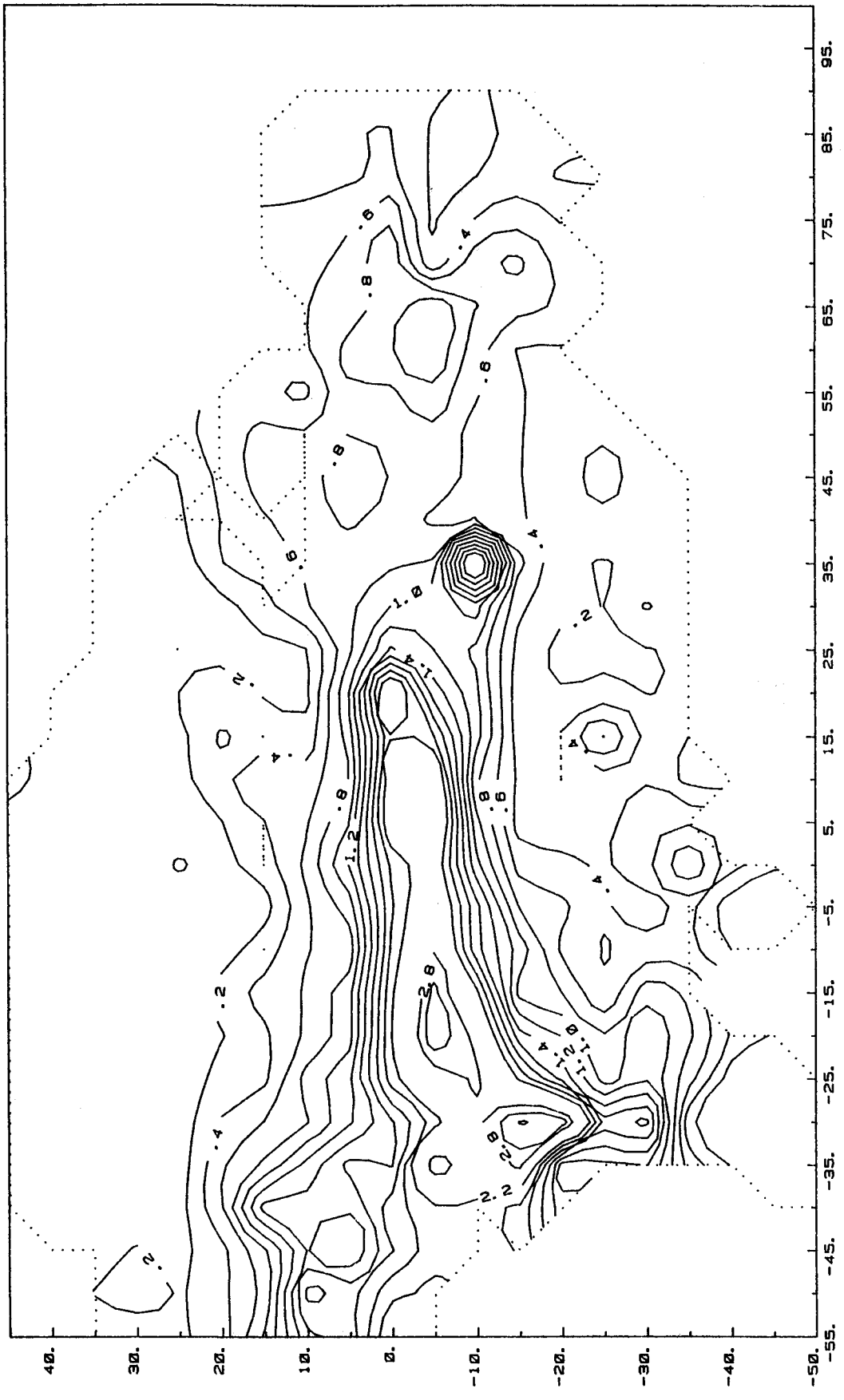

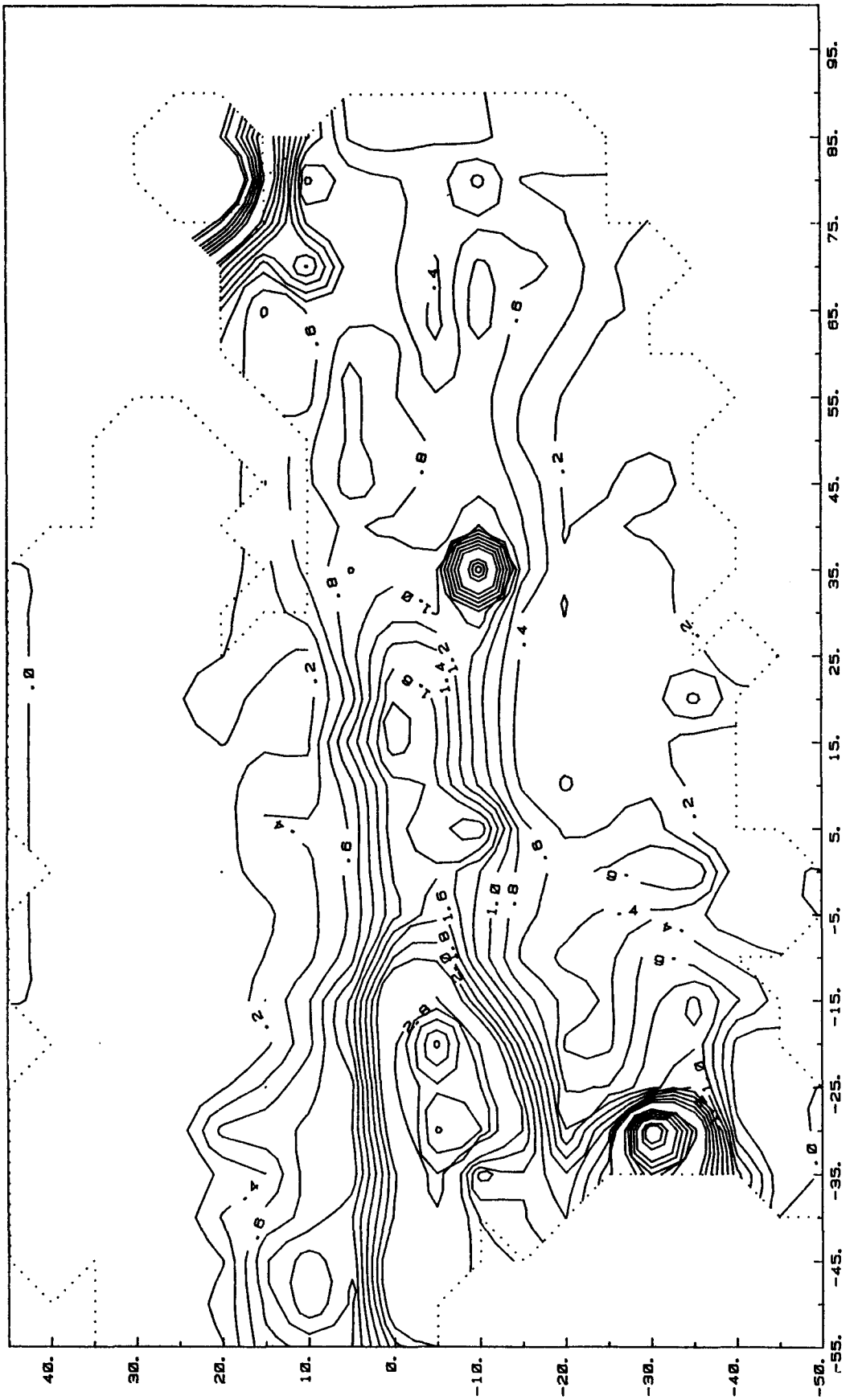

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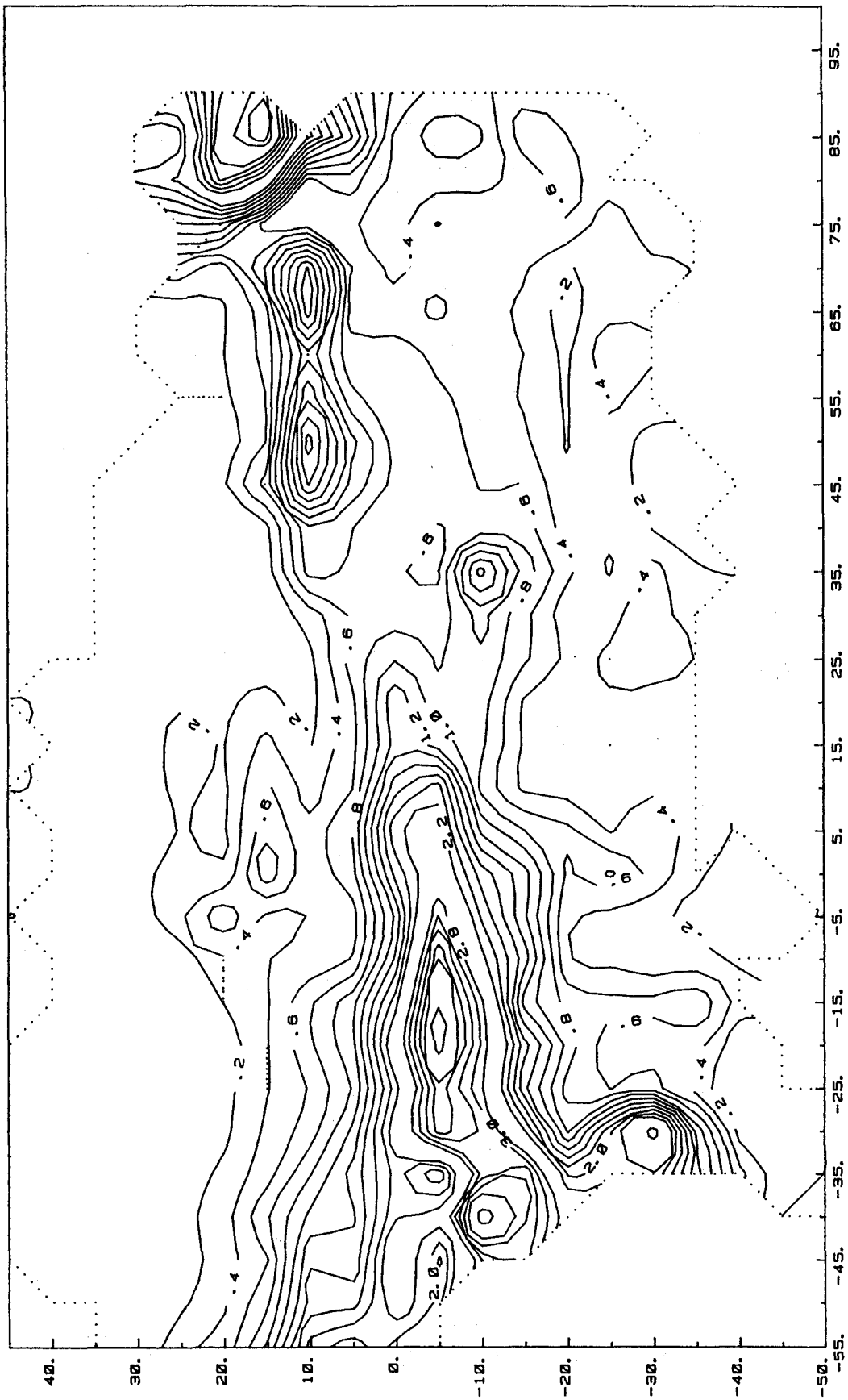

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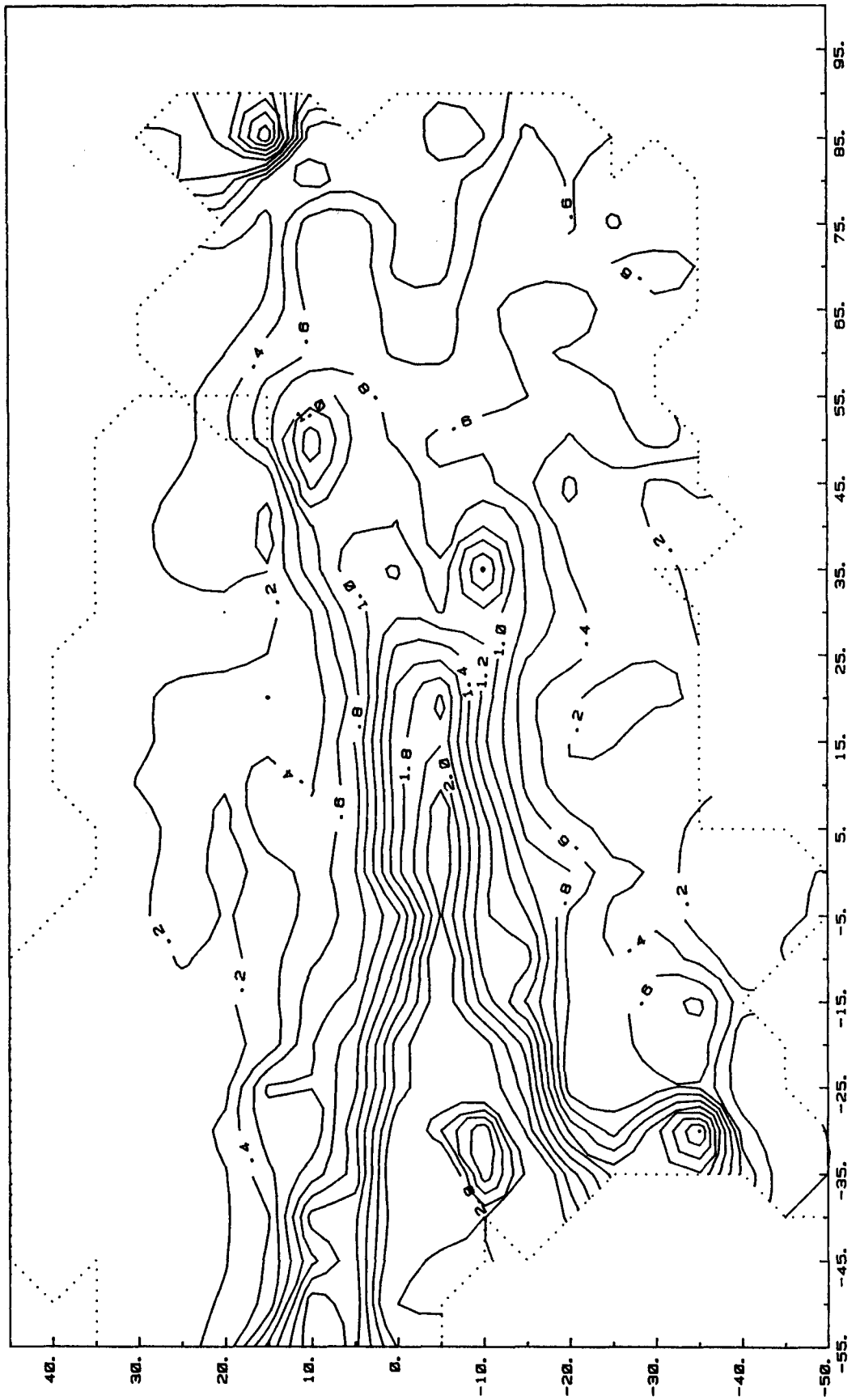

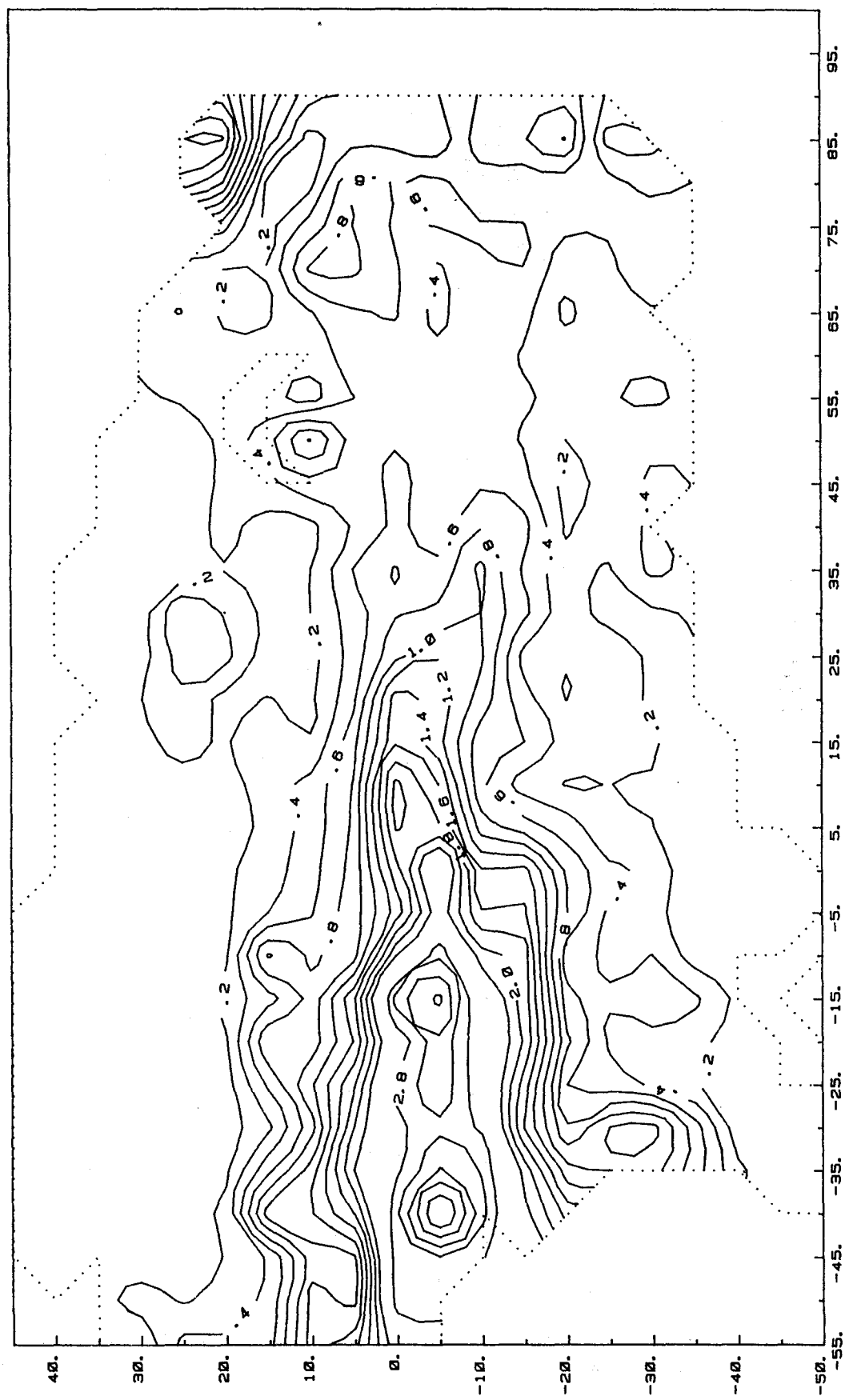
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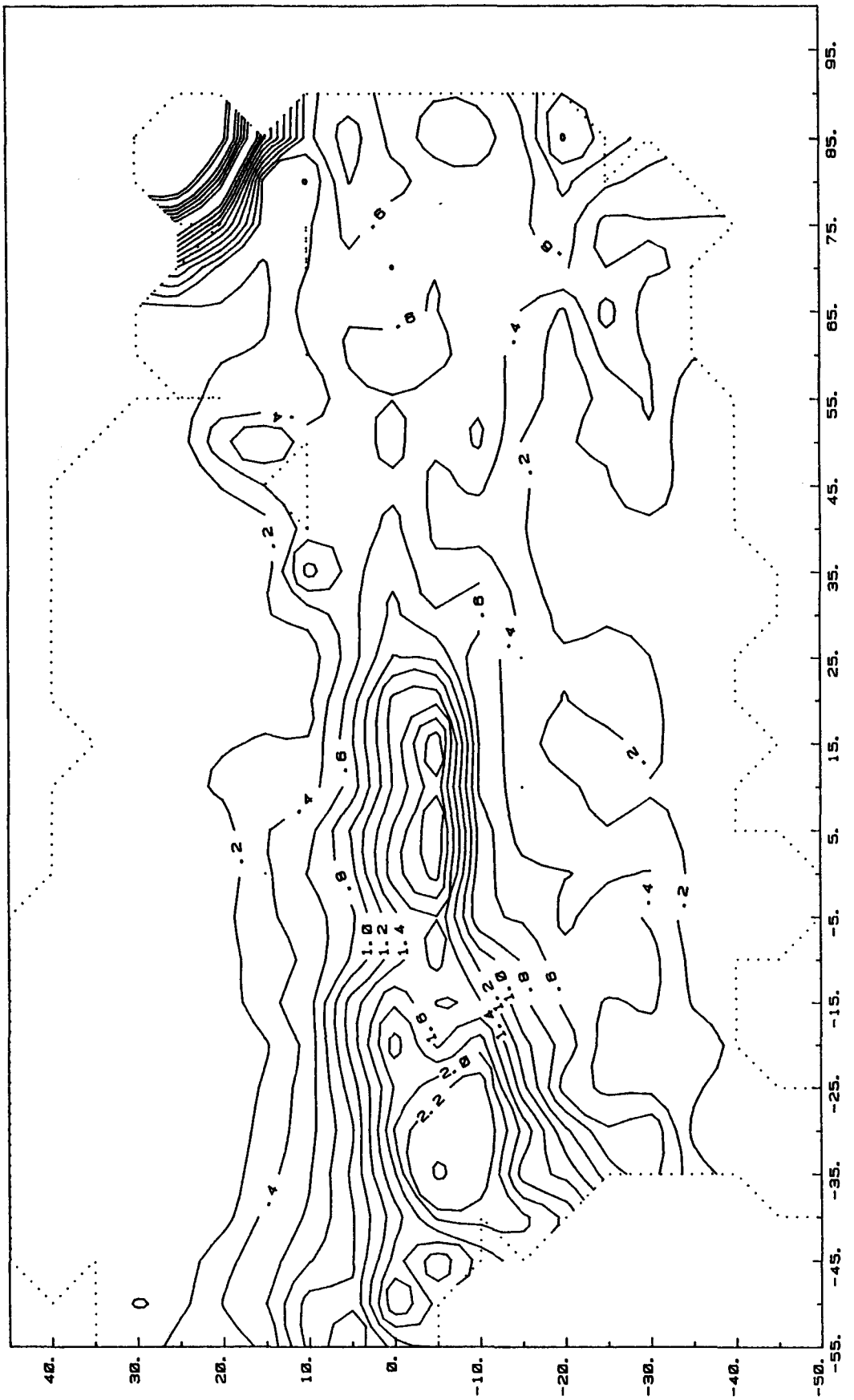
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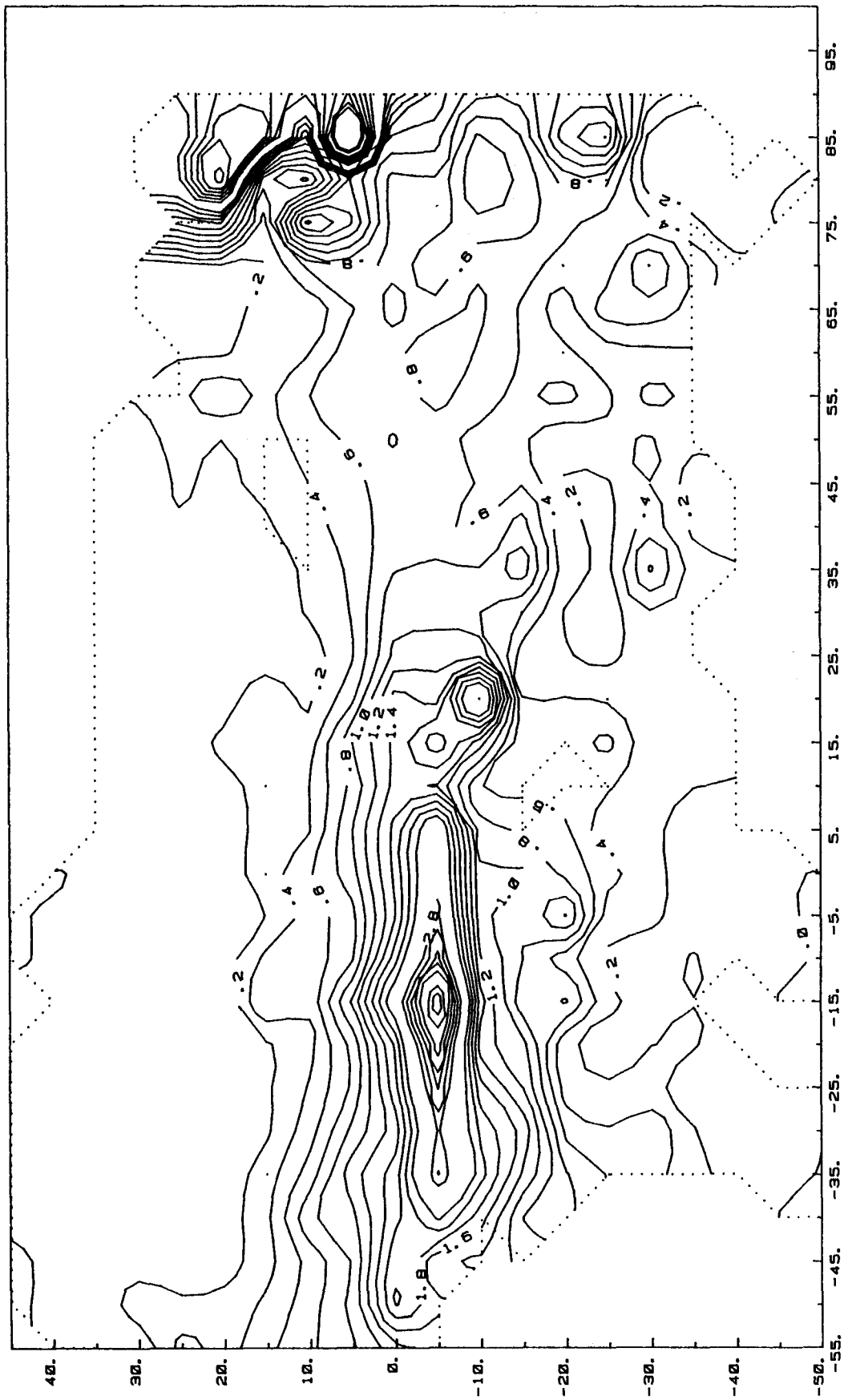

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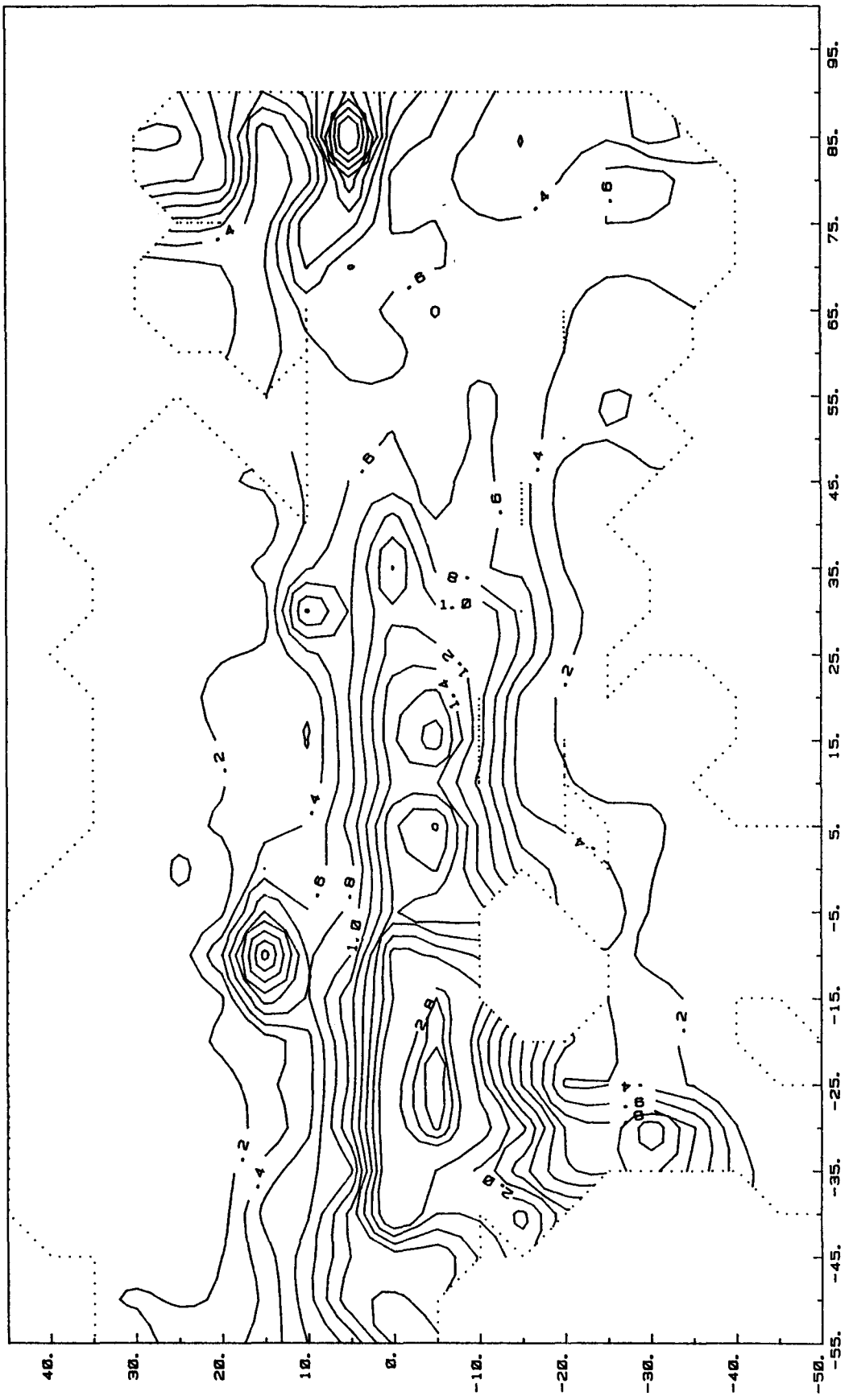

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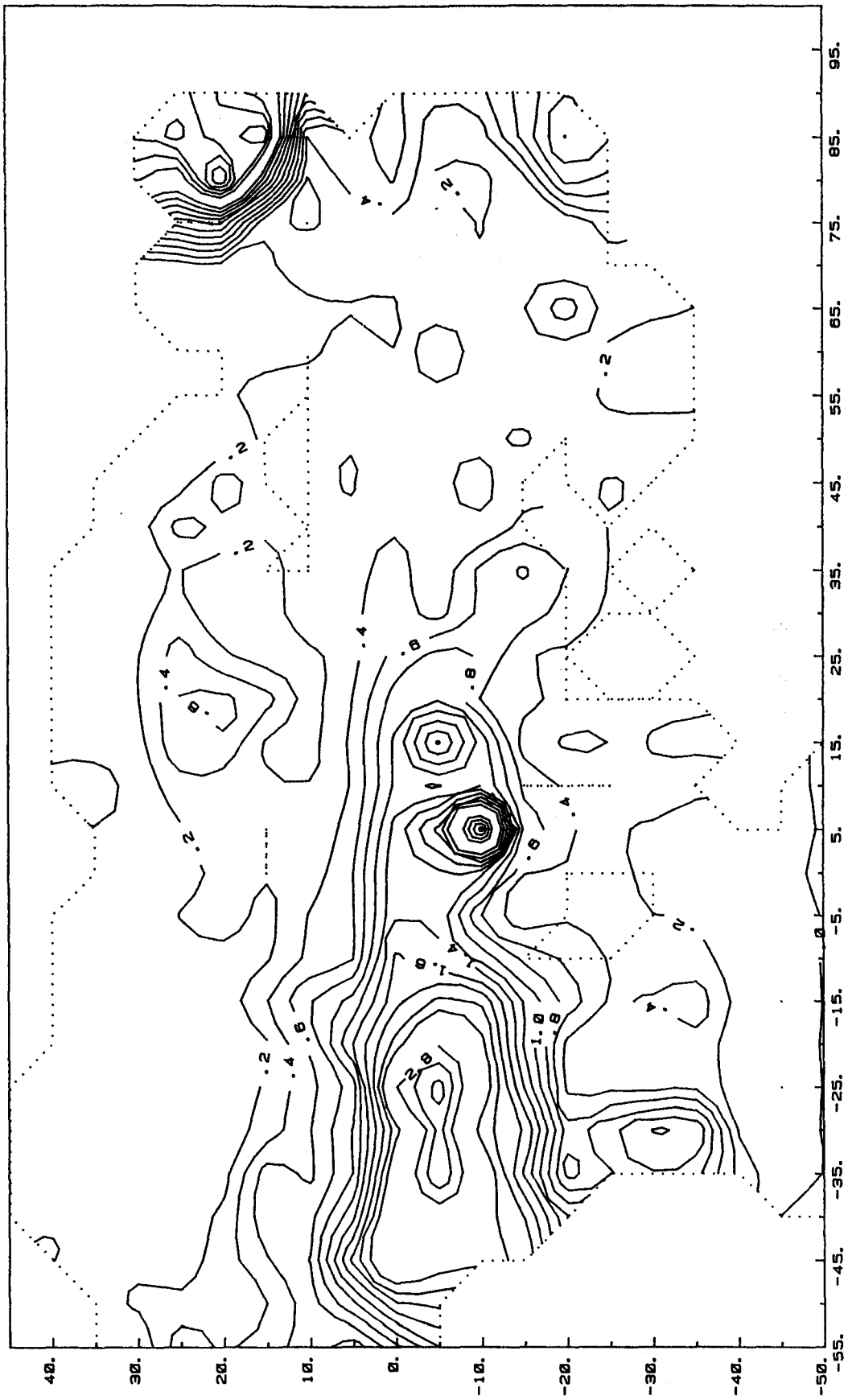

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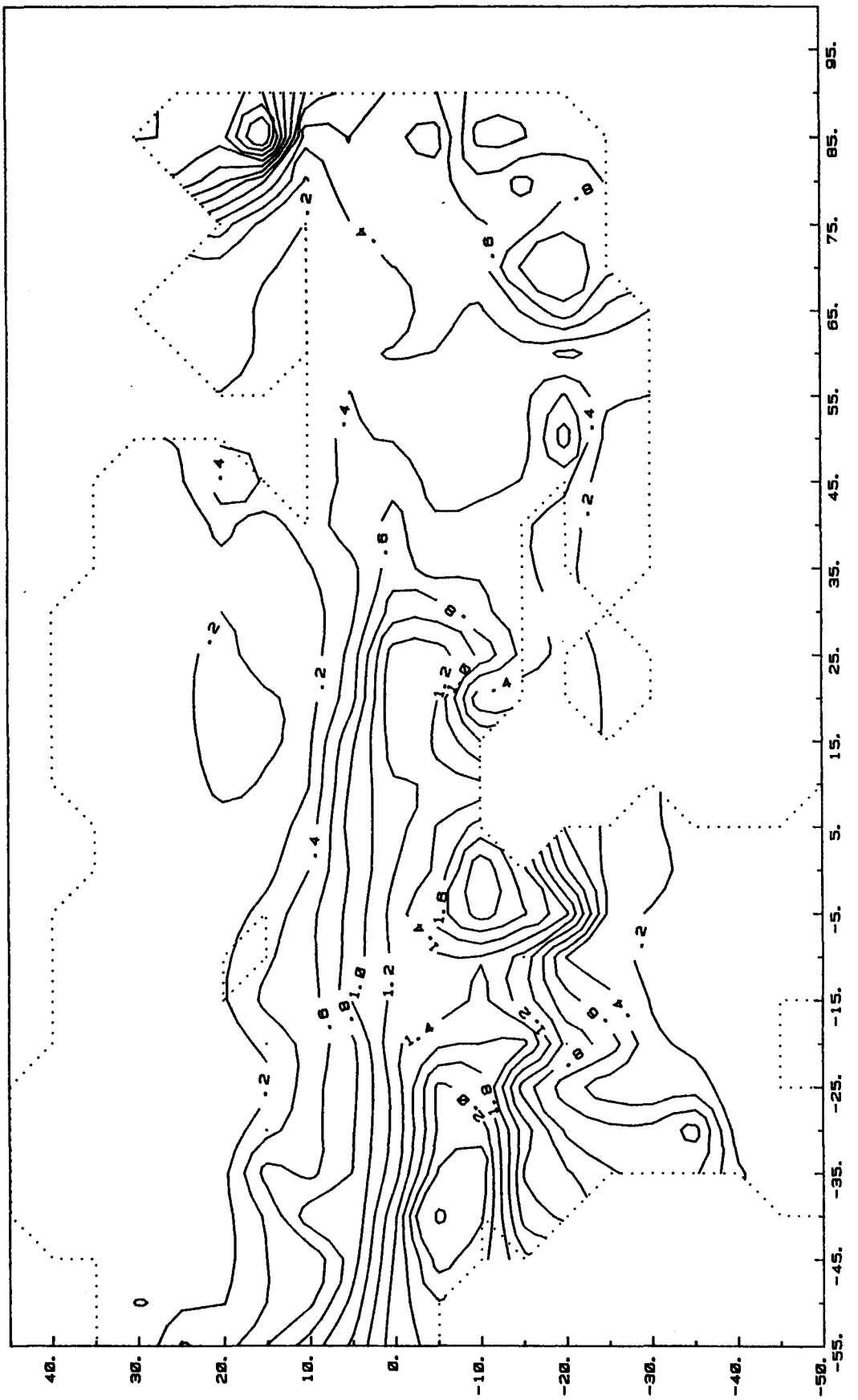
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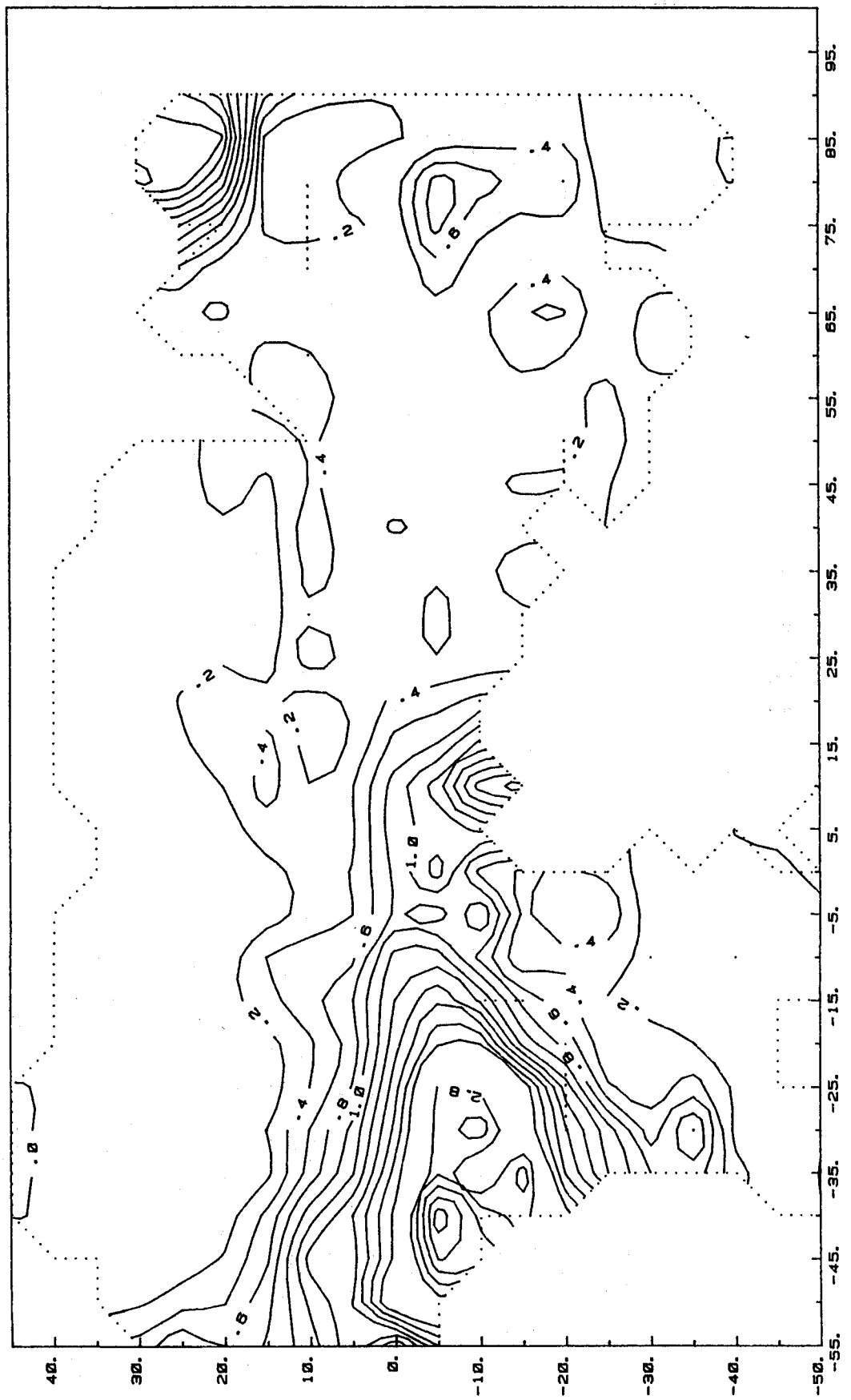
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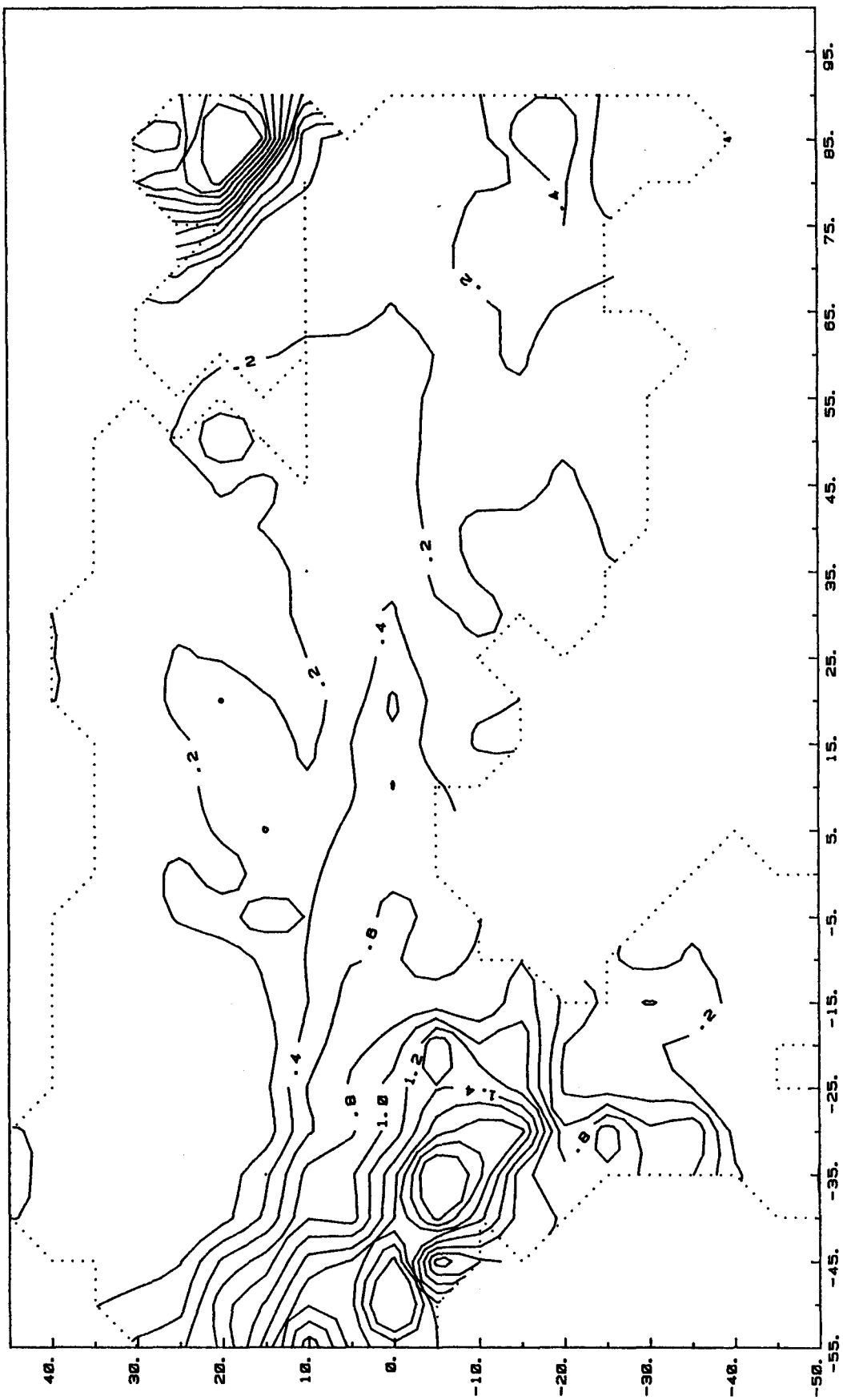
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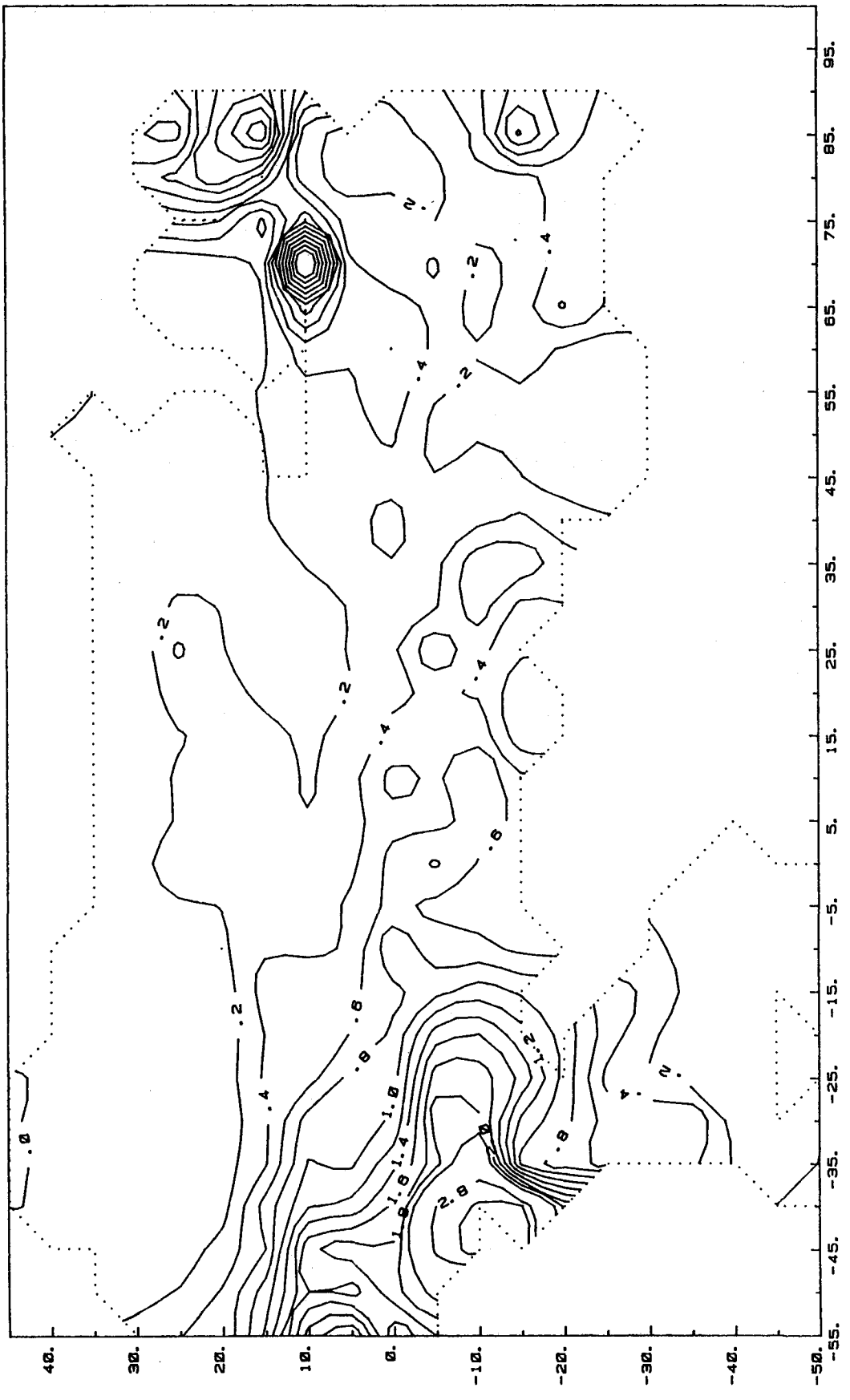

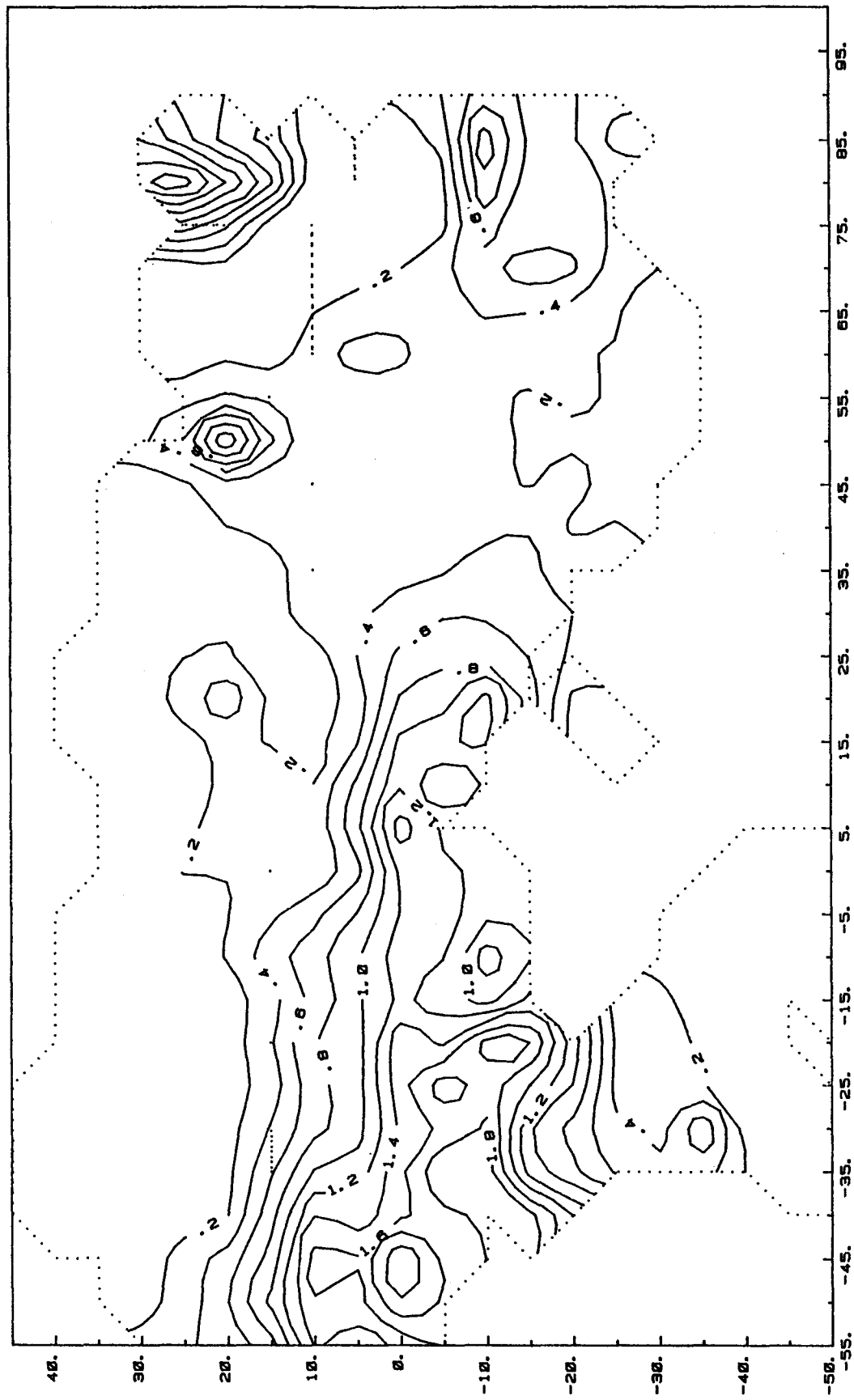
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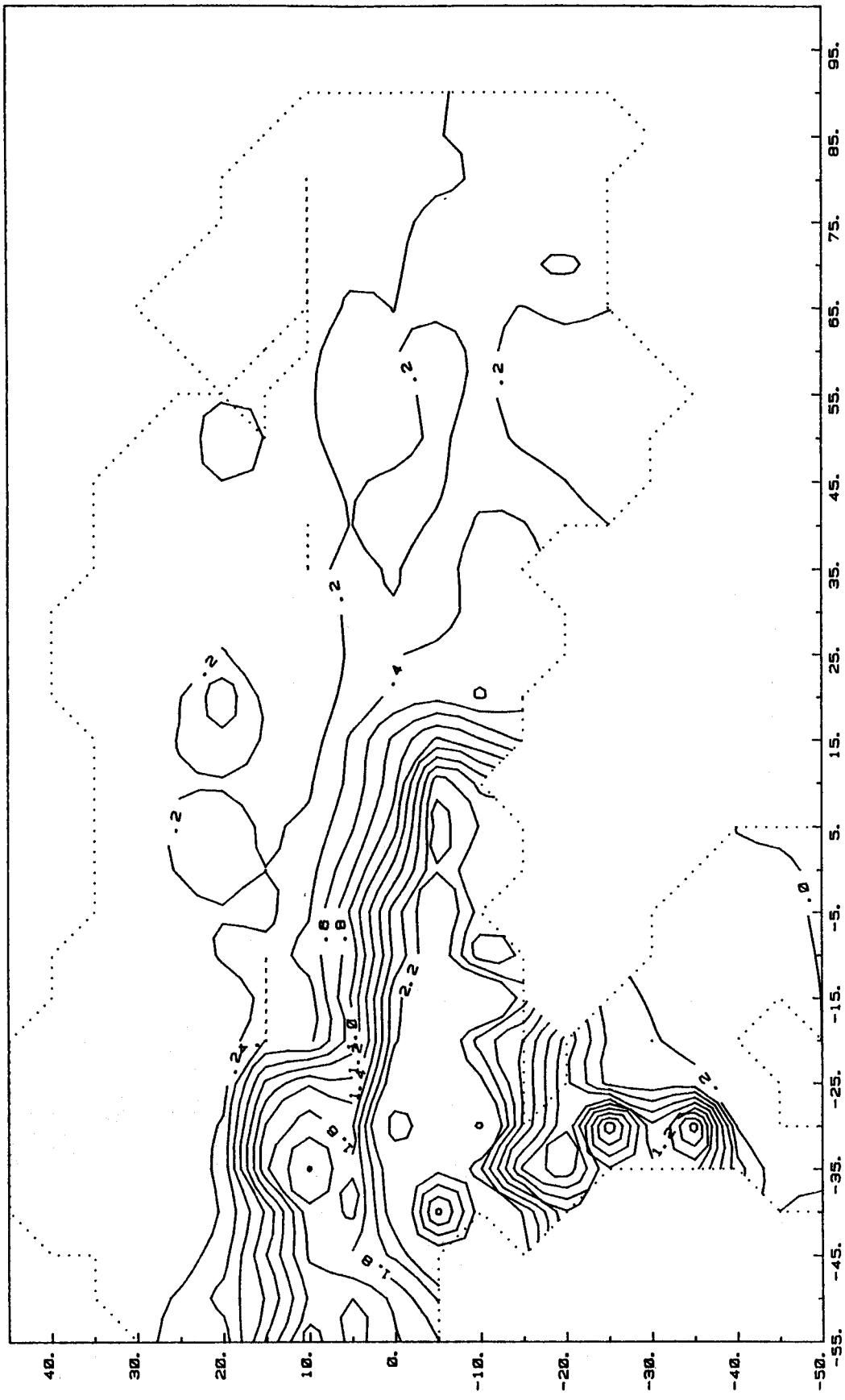
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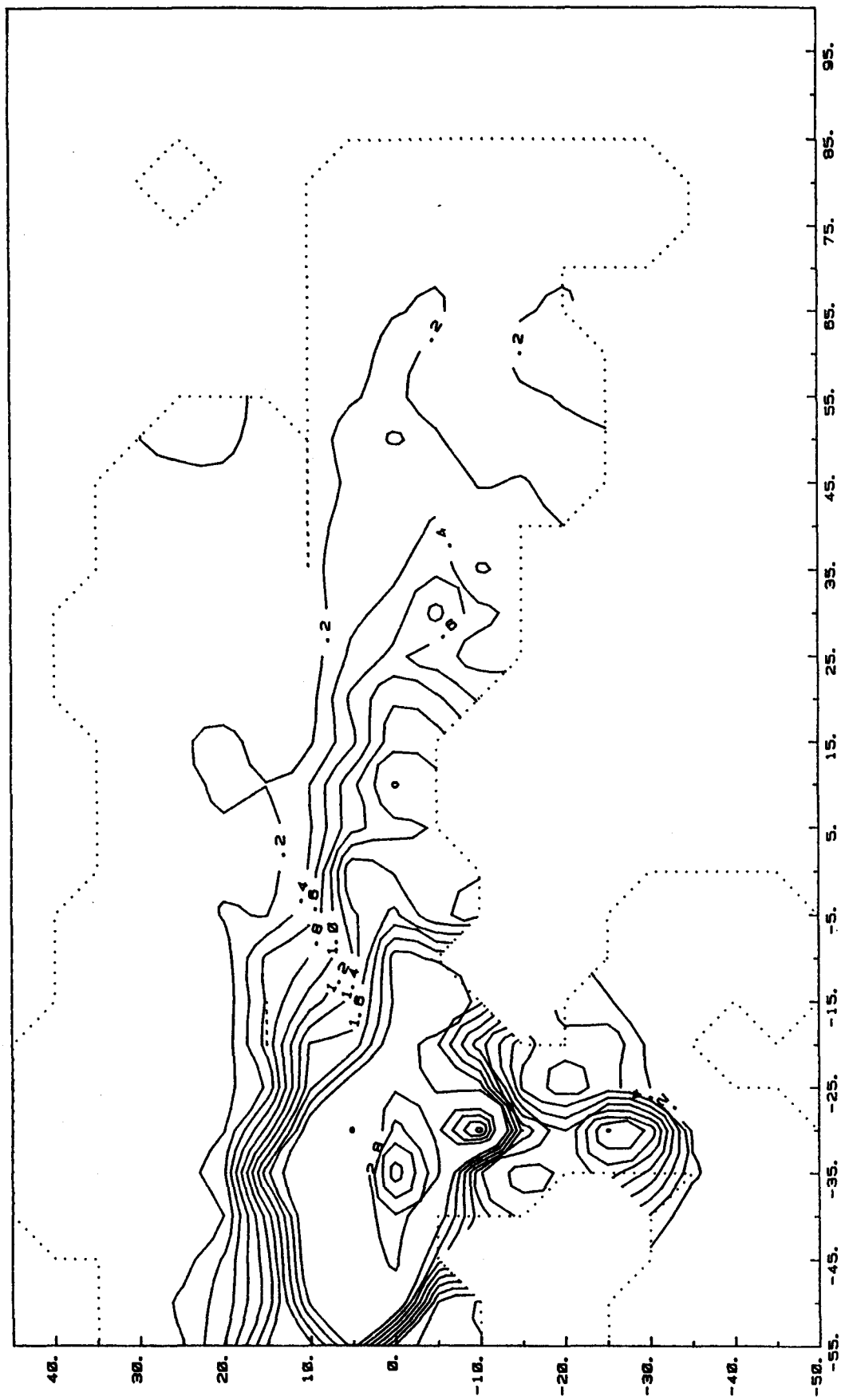
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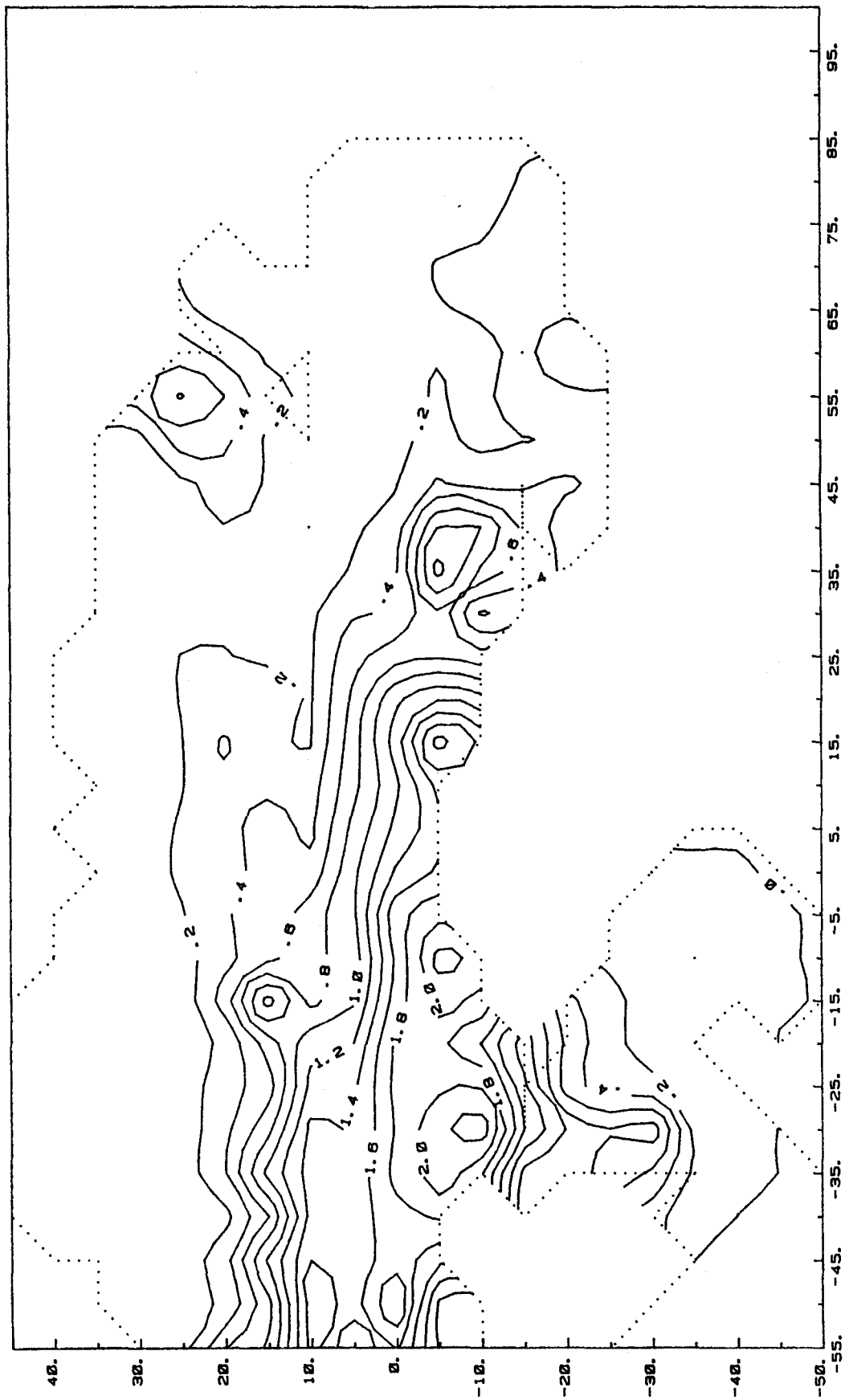
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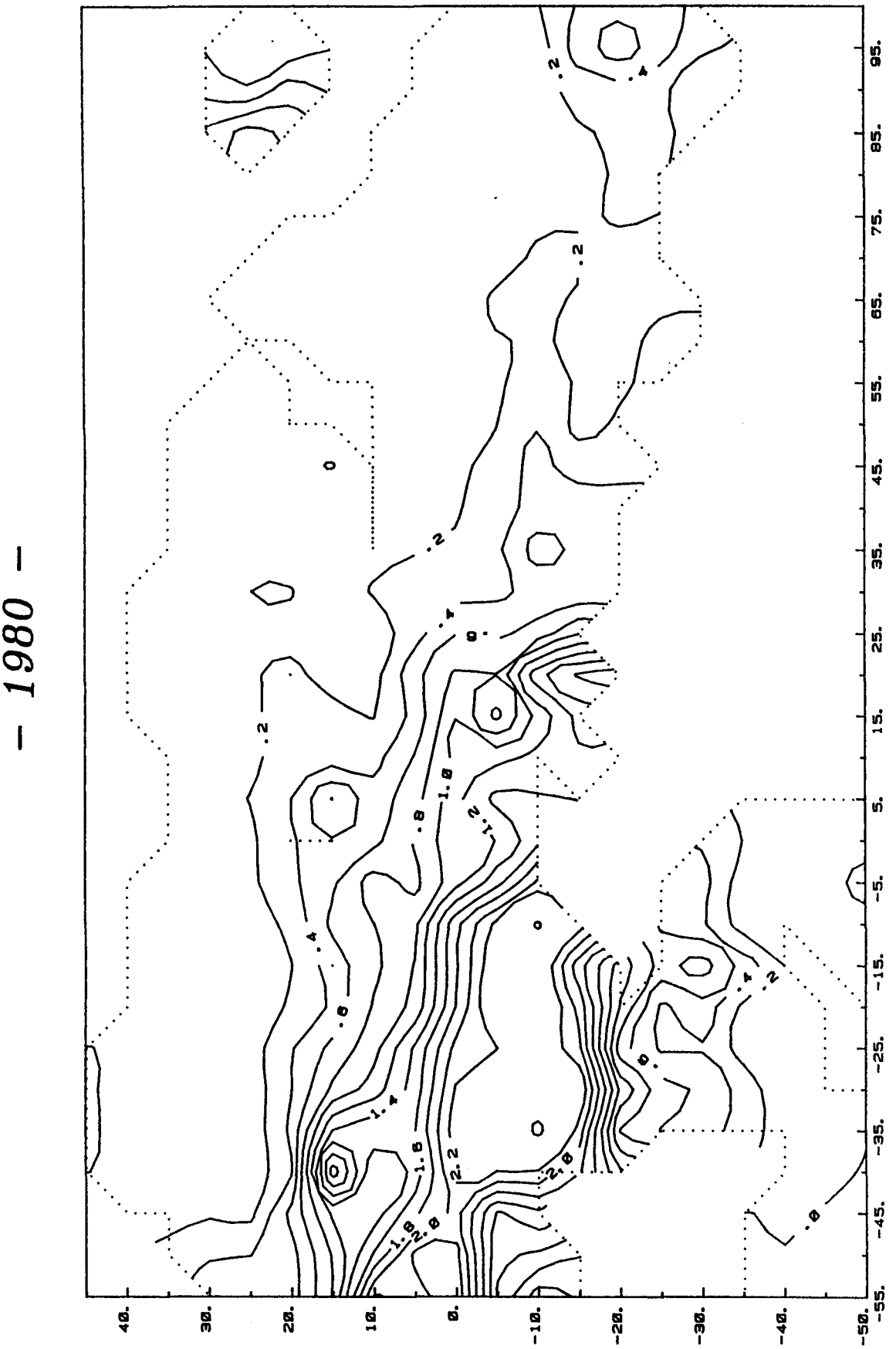
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Figure 2. Contour plots of yellowfin catch rates from 1979-1985 based on logsheet data available to the TBAP.

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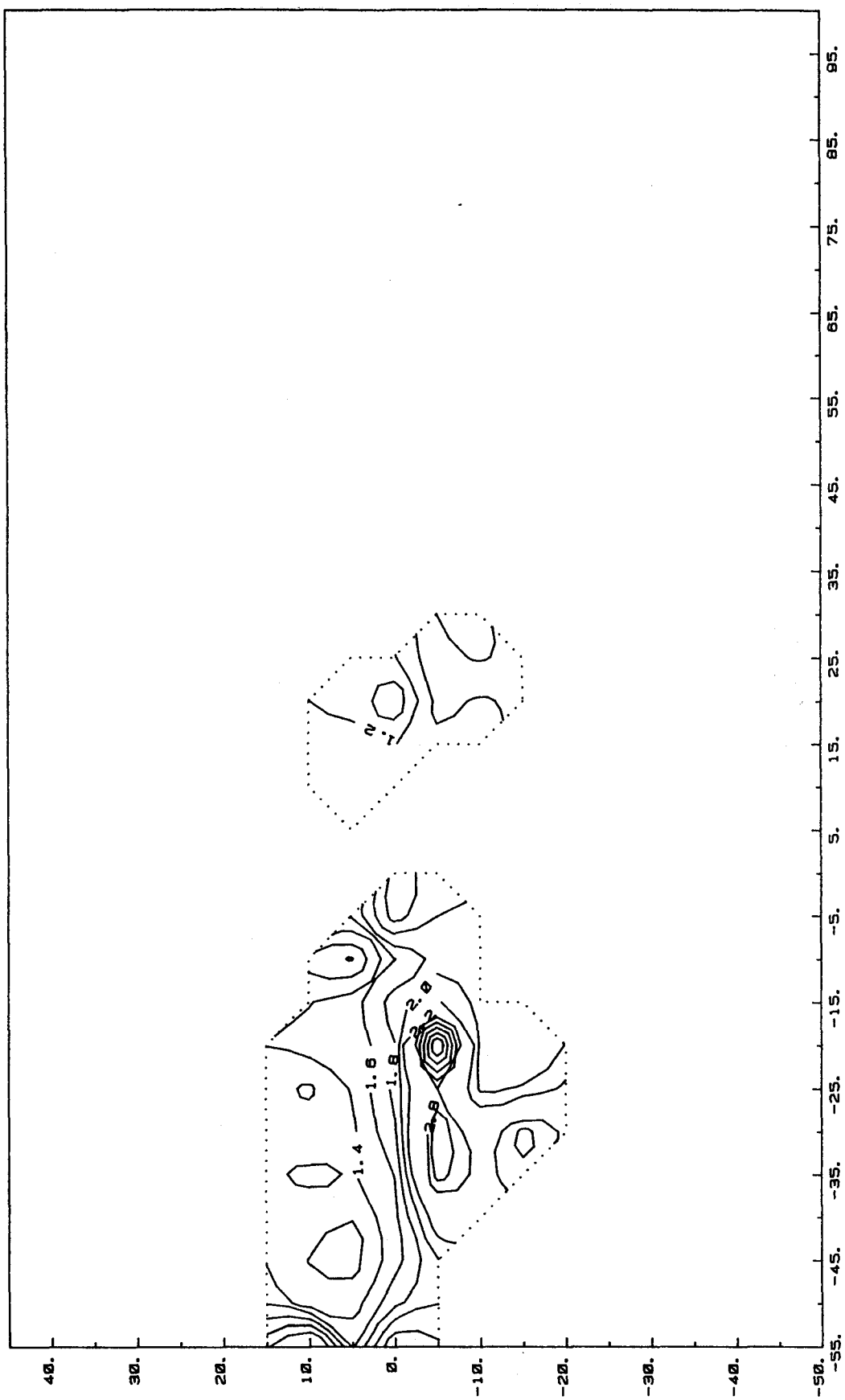
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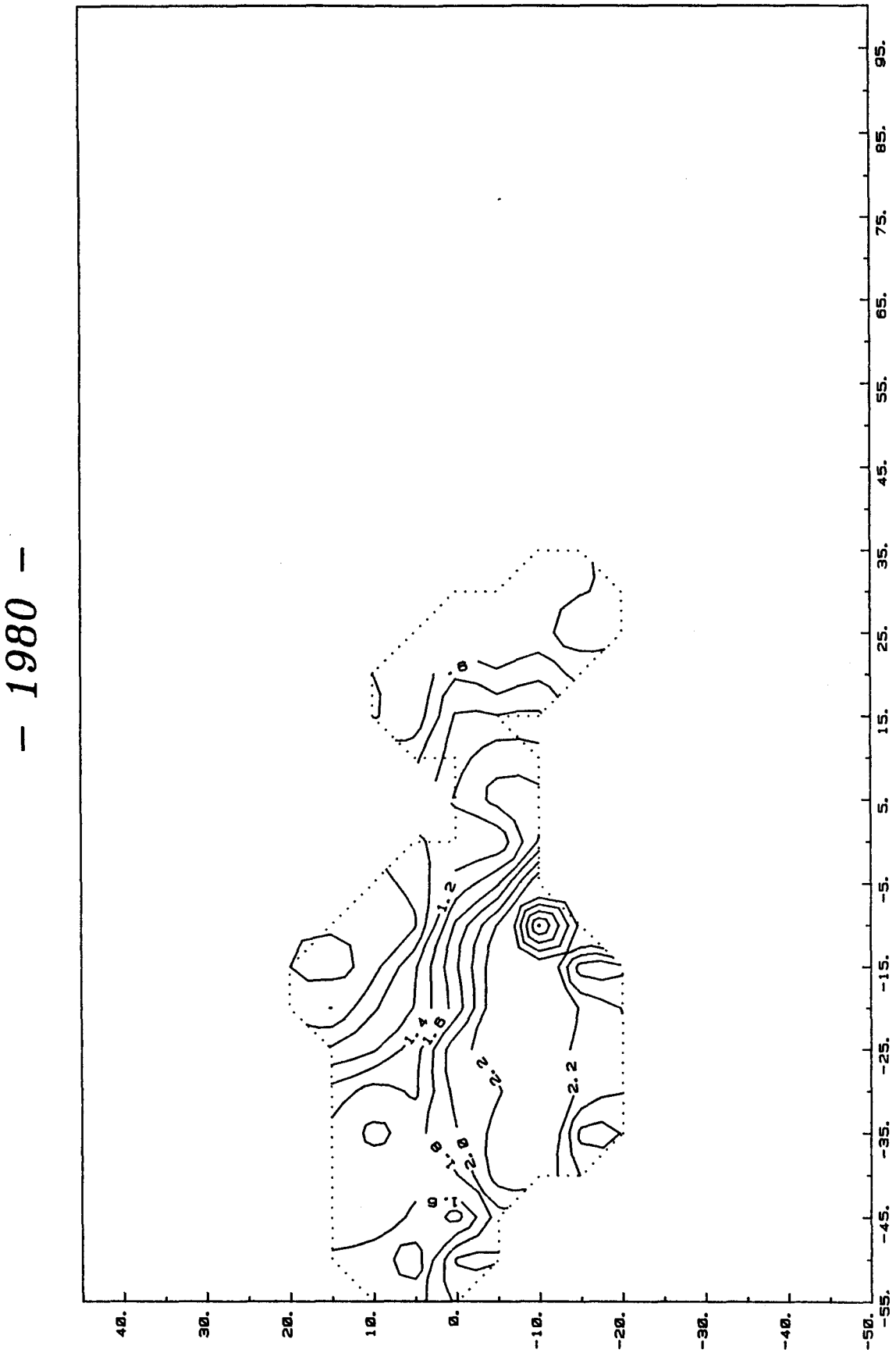
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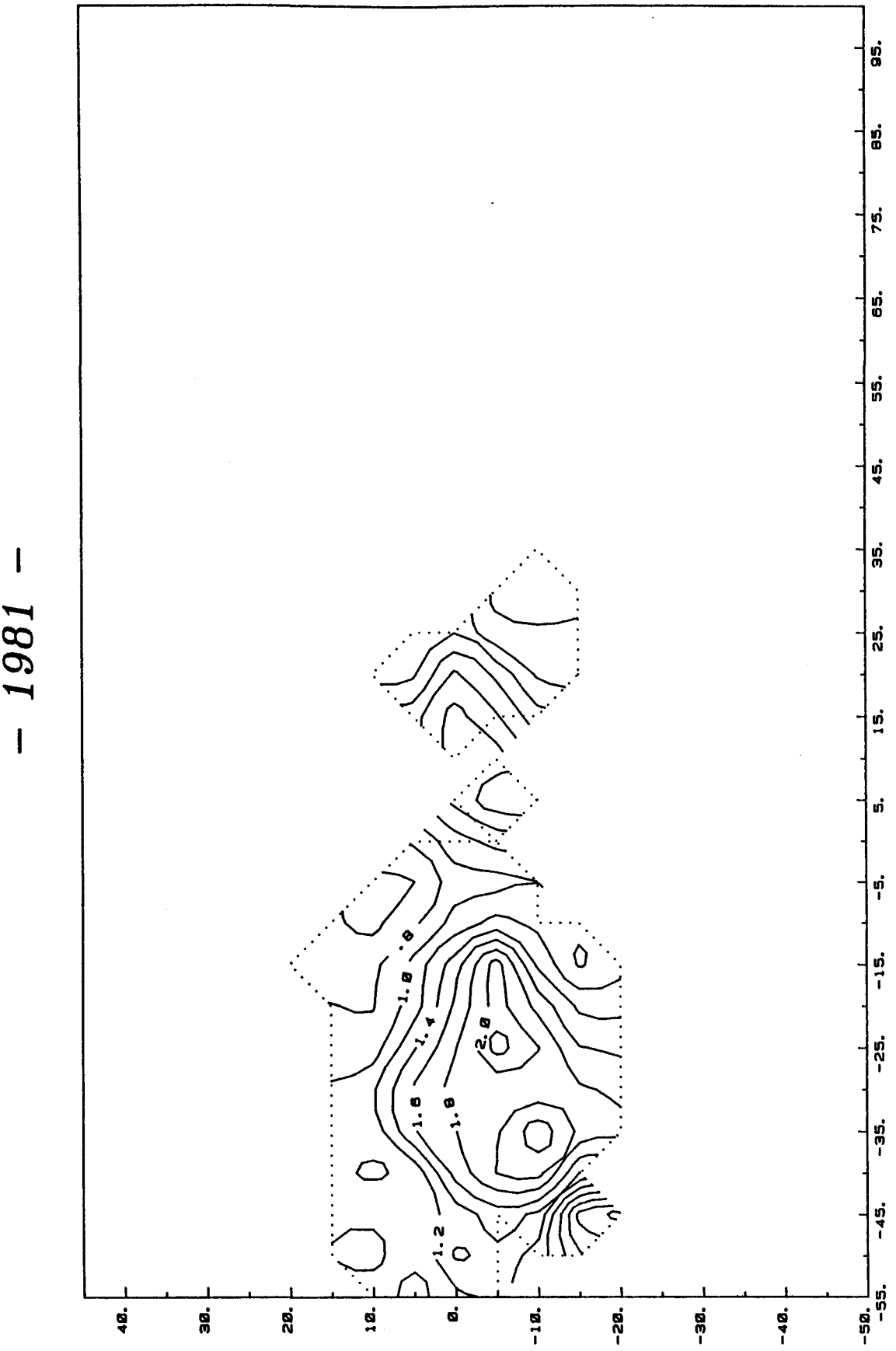
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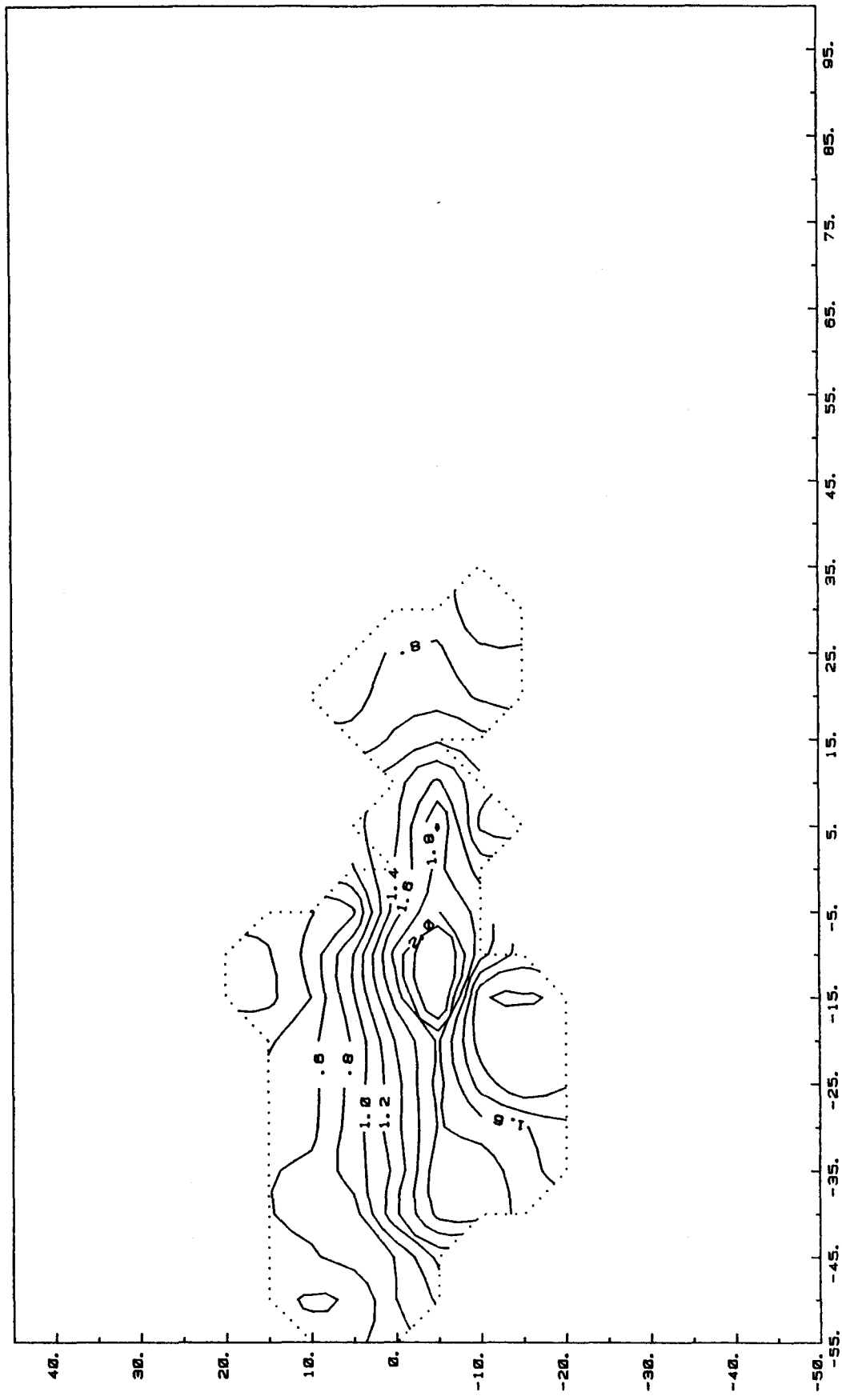
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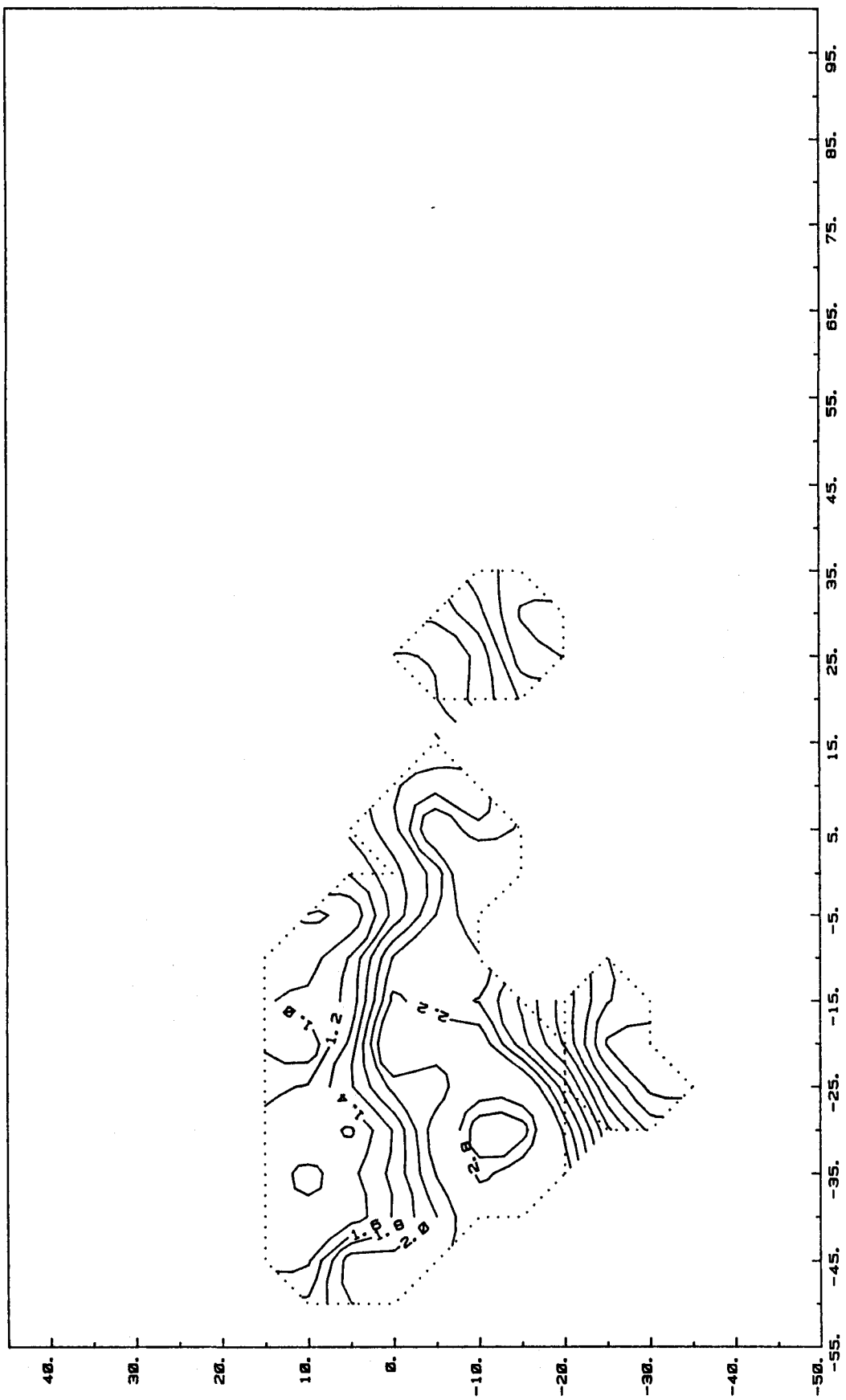
- 1983 -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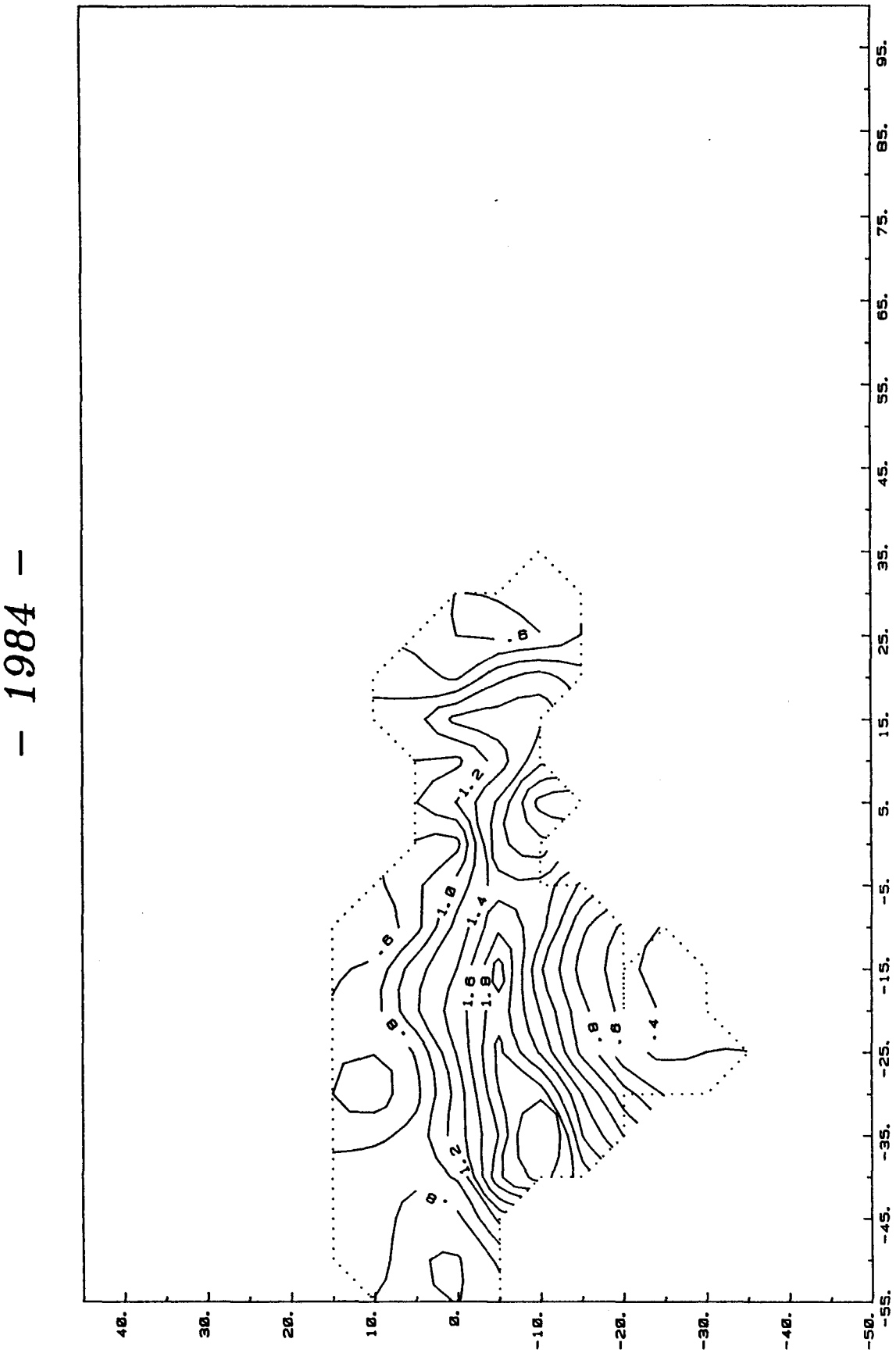
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- 1985 -

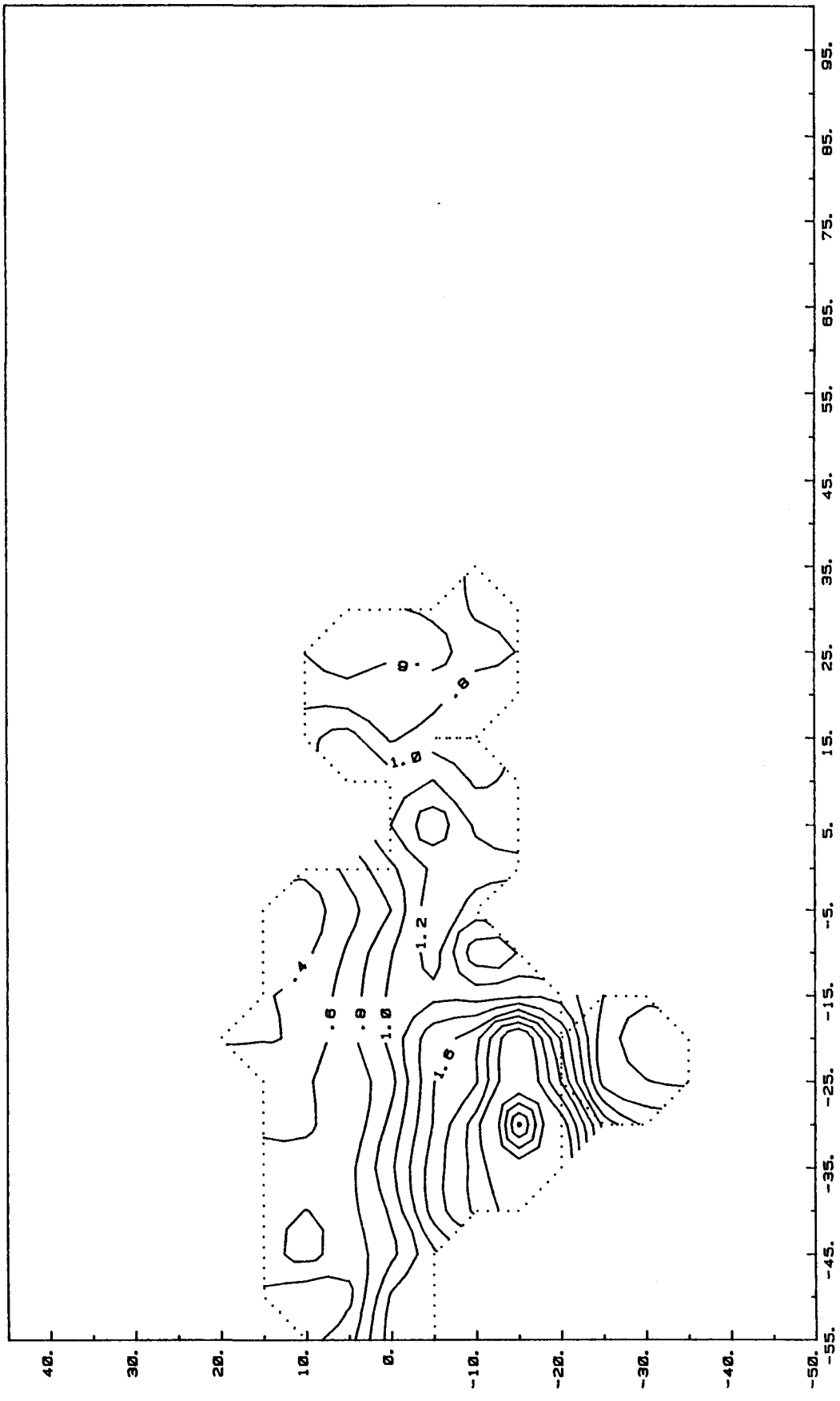
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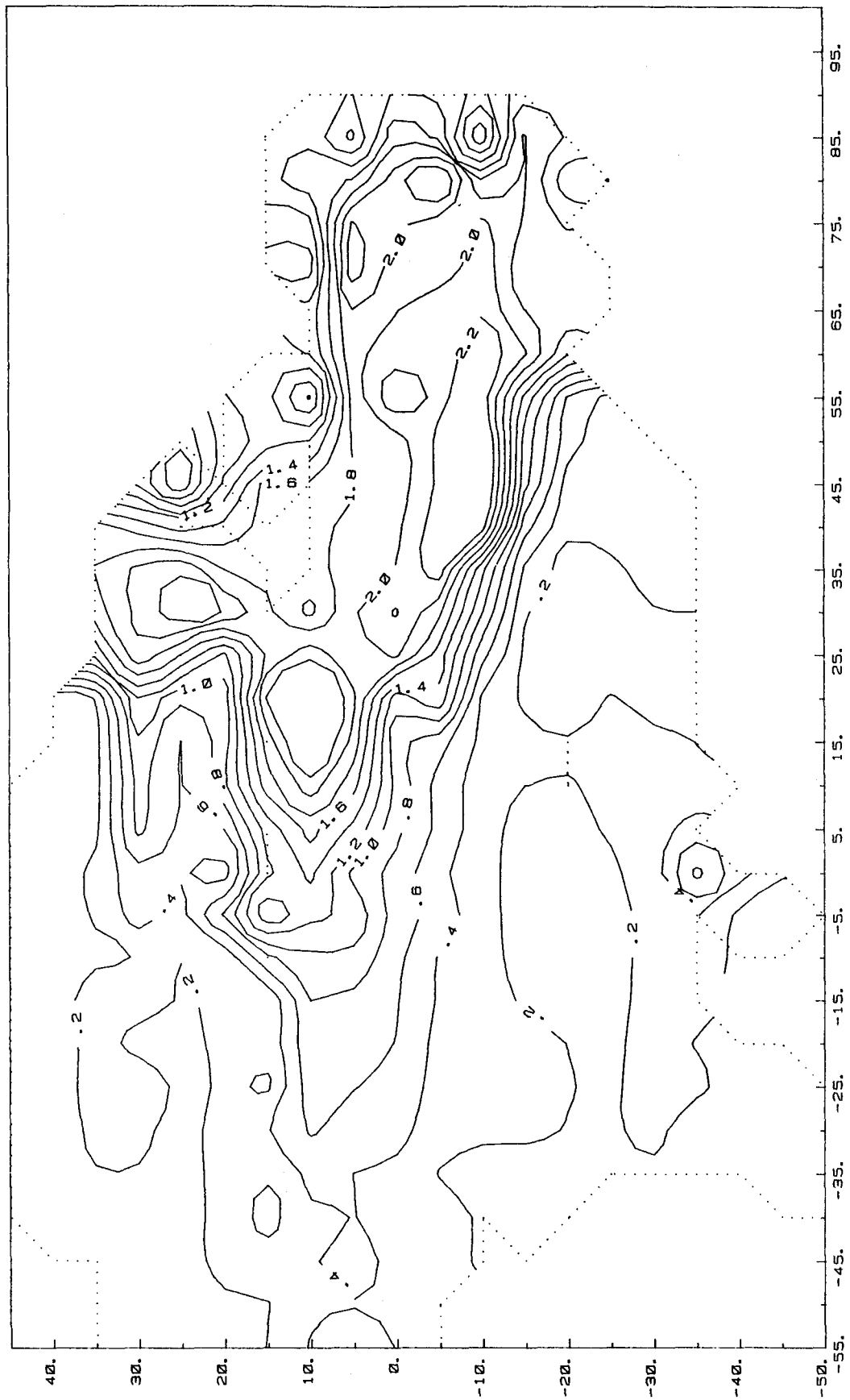
Figure 3. Contour plots of bigeye catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.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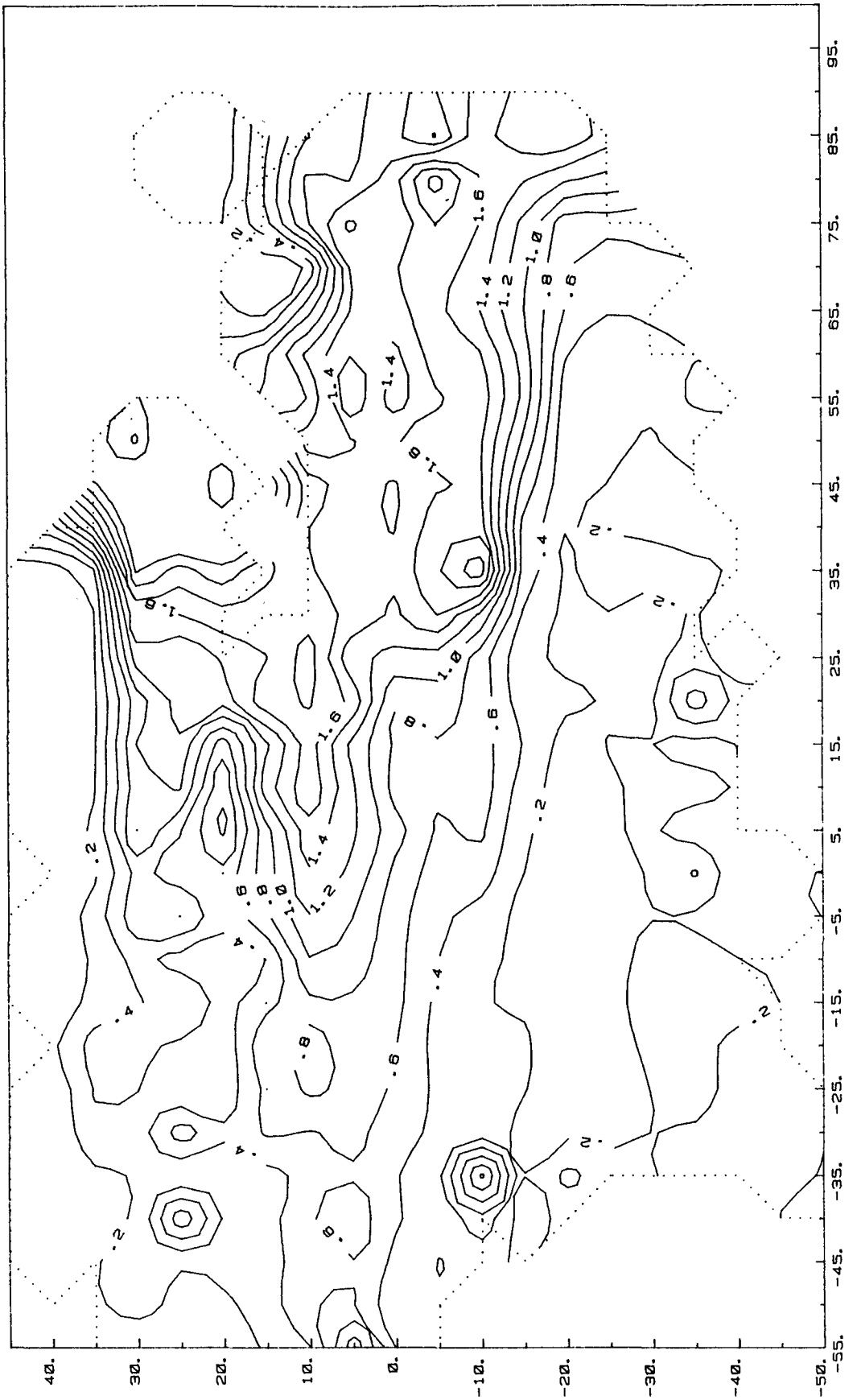
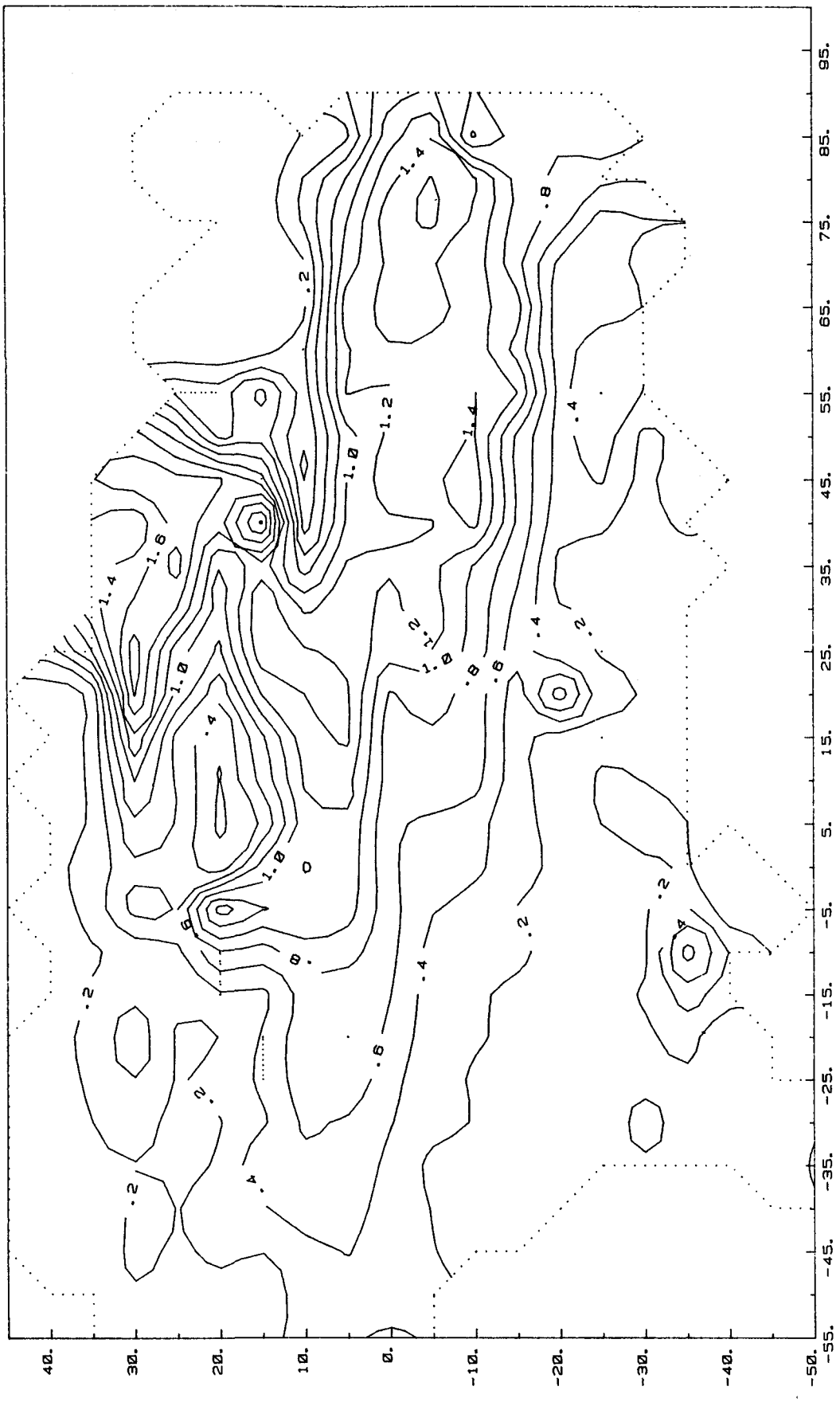
- 1963 -

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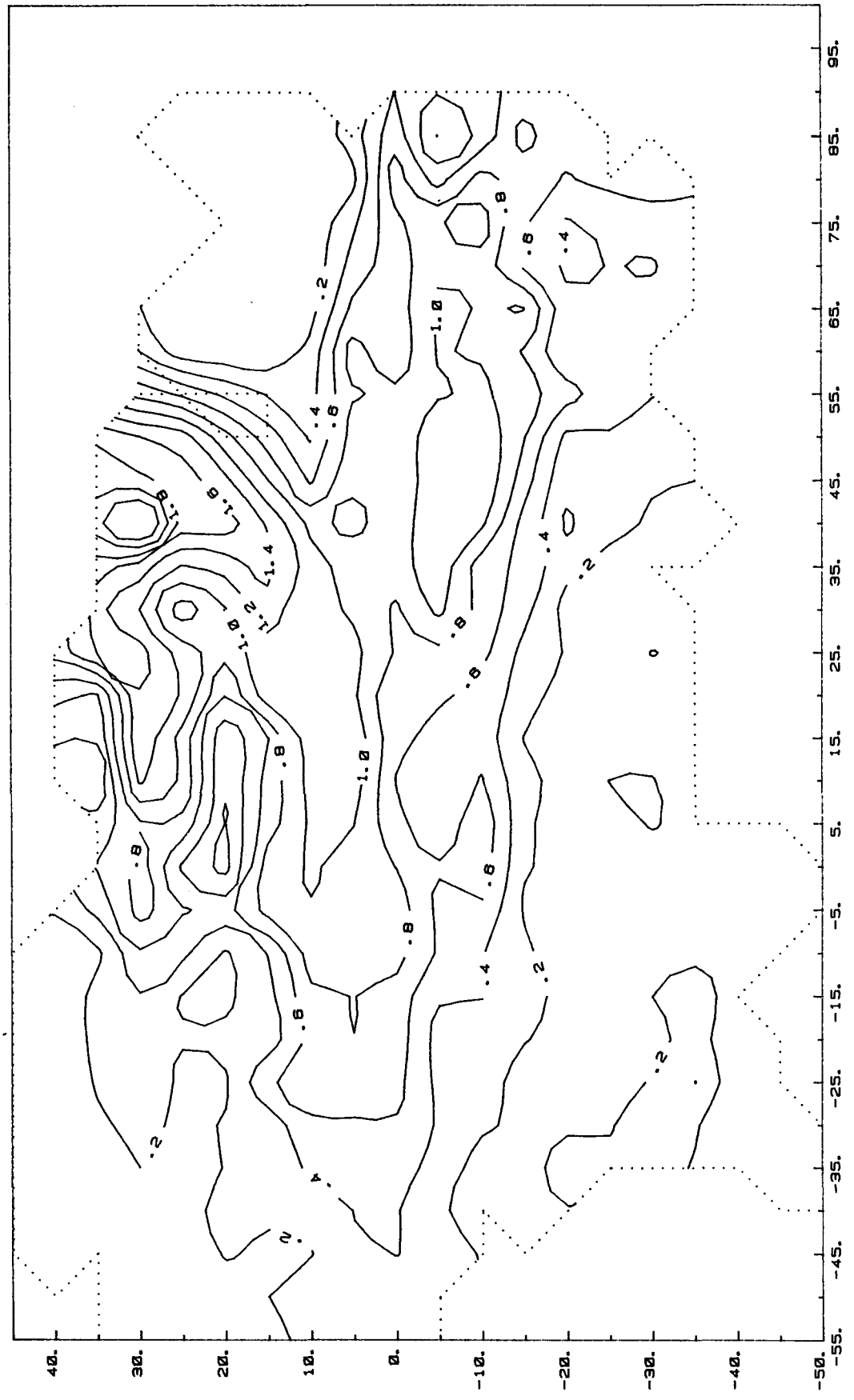
- 1965 -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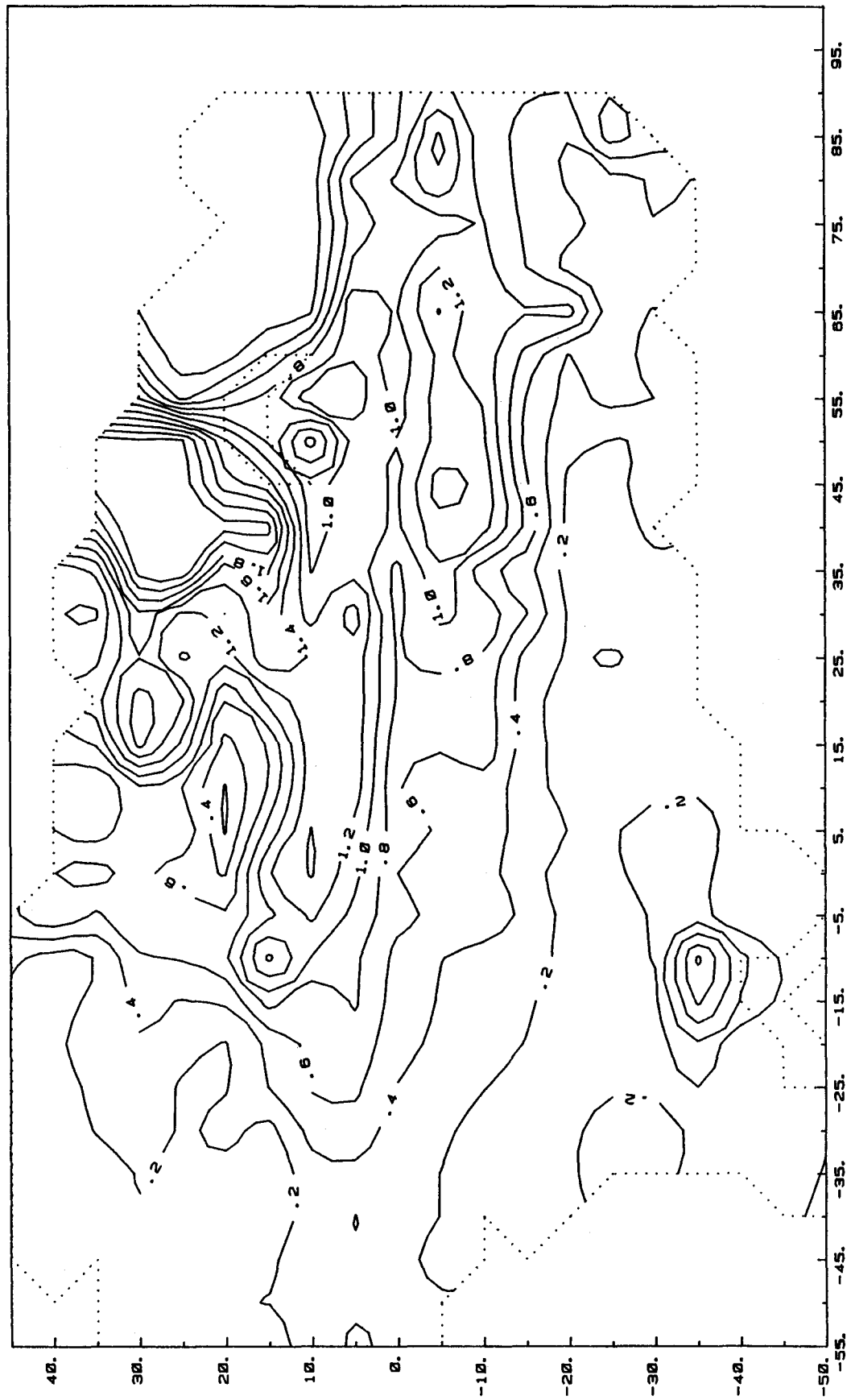
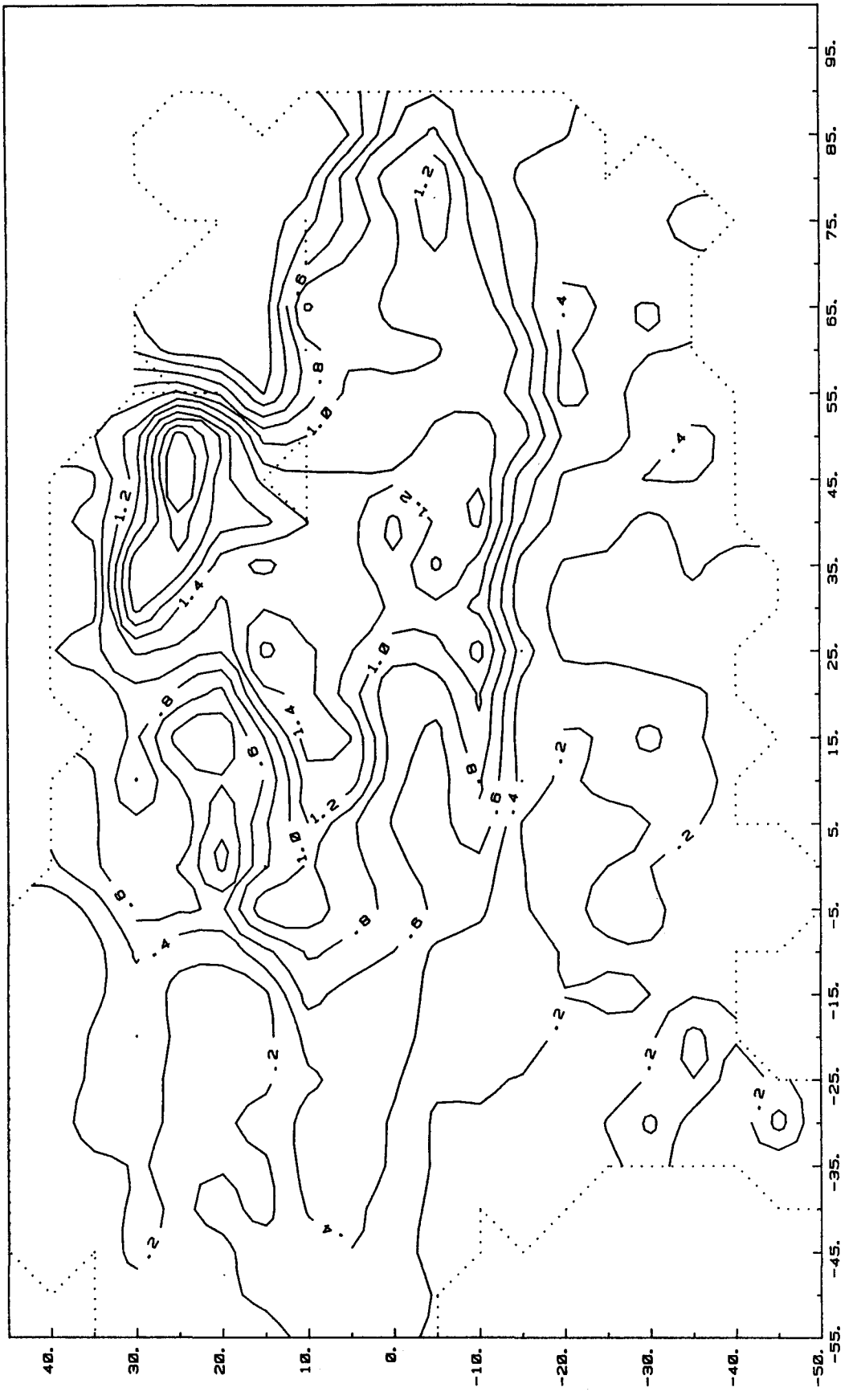


- 1966 -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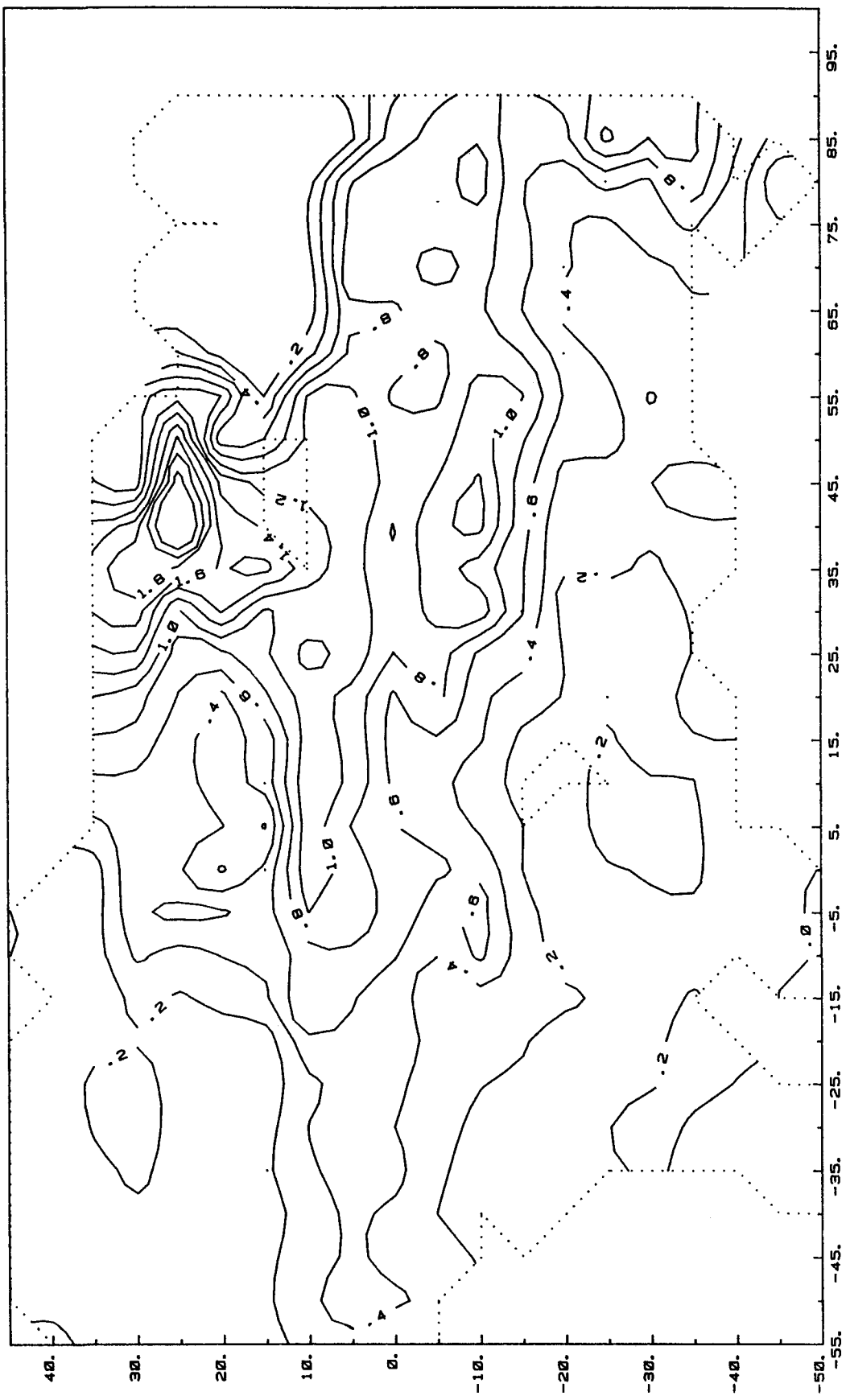
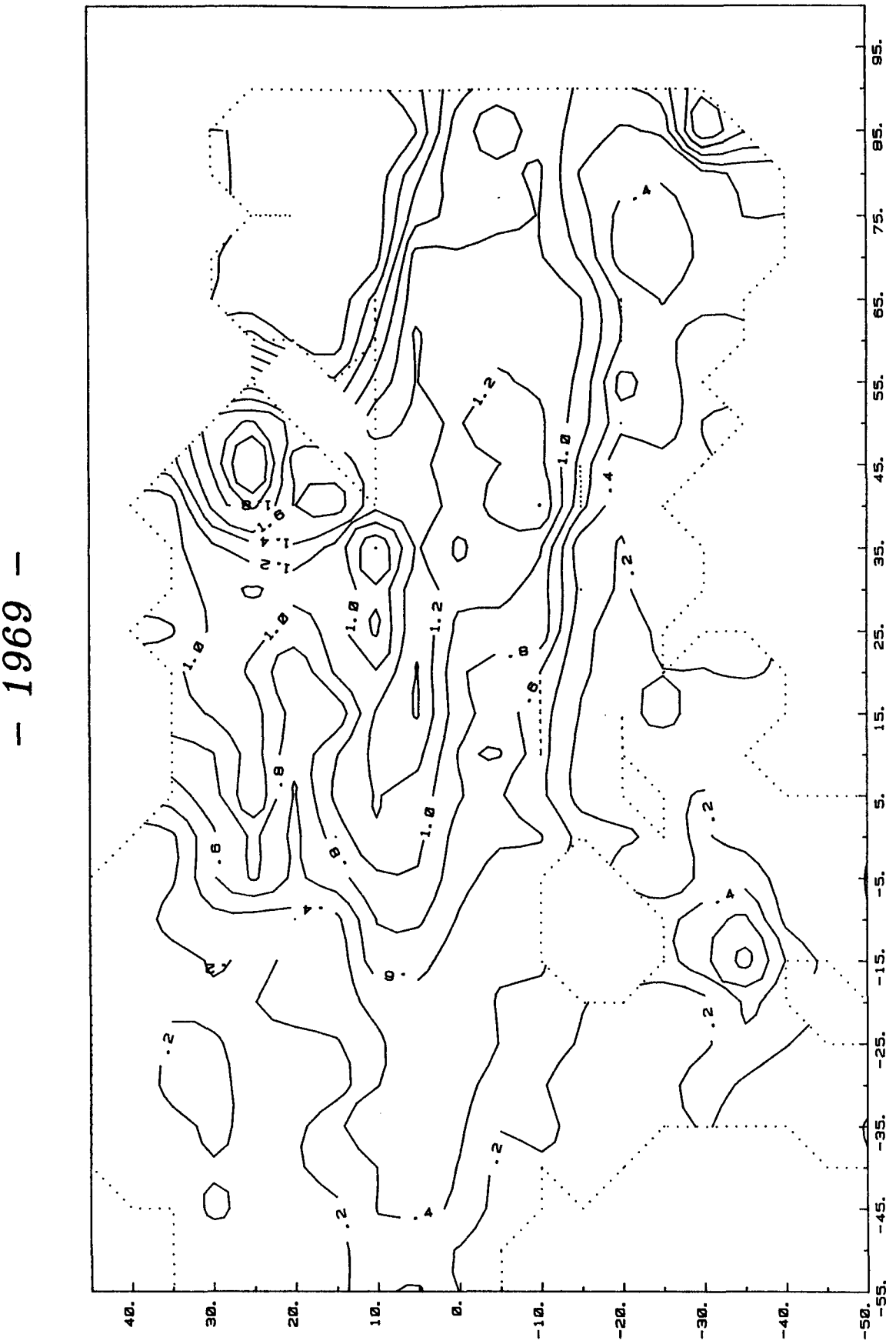
- 1968 -

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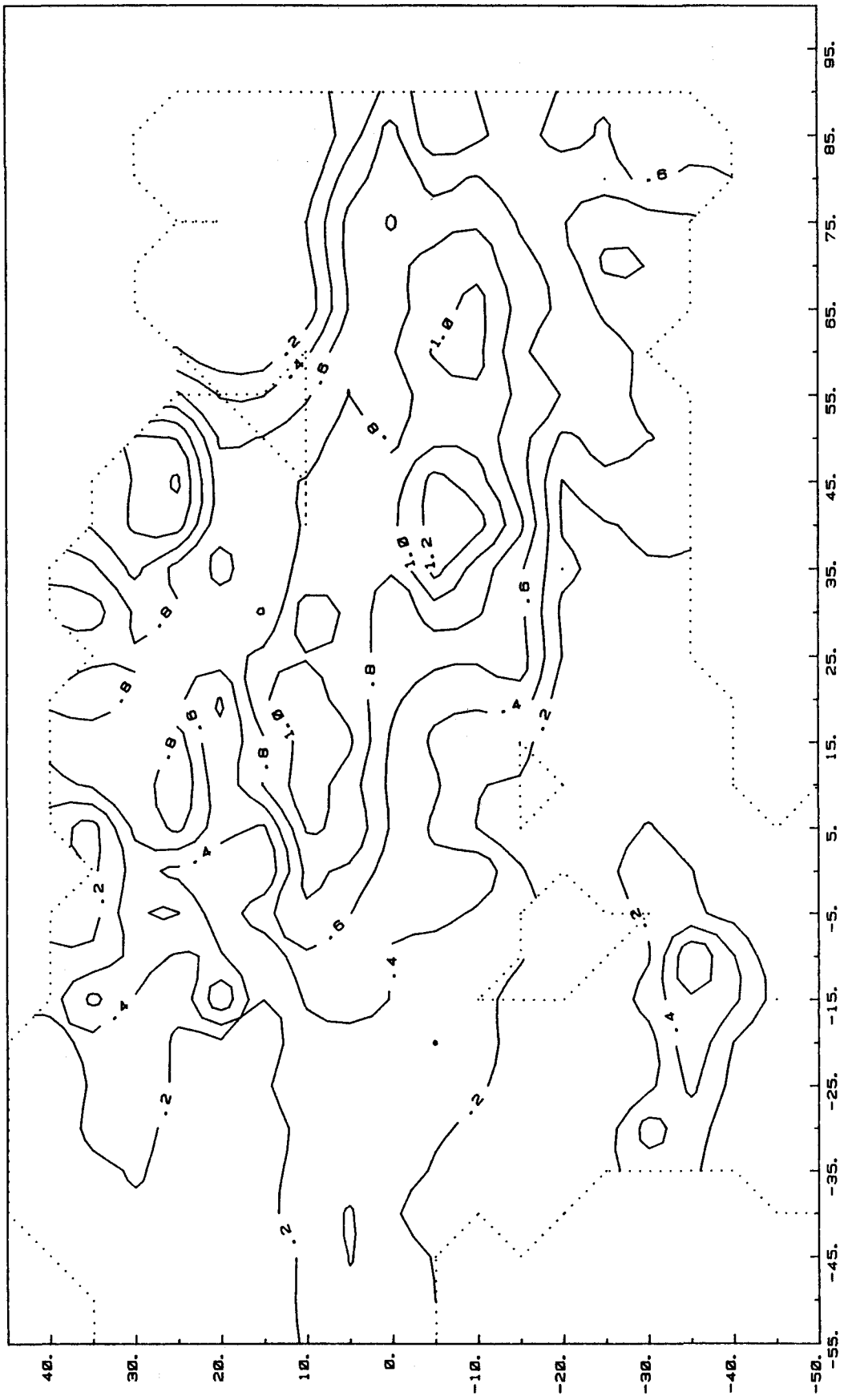
-45.
-55.

- 1970 -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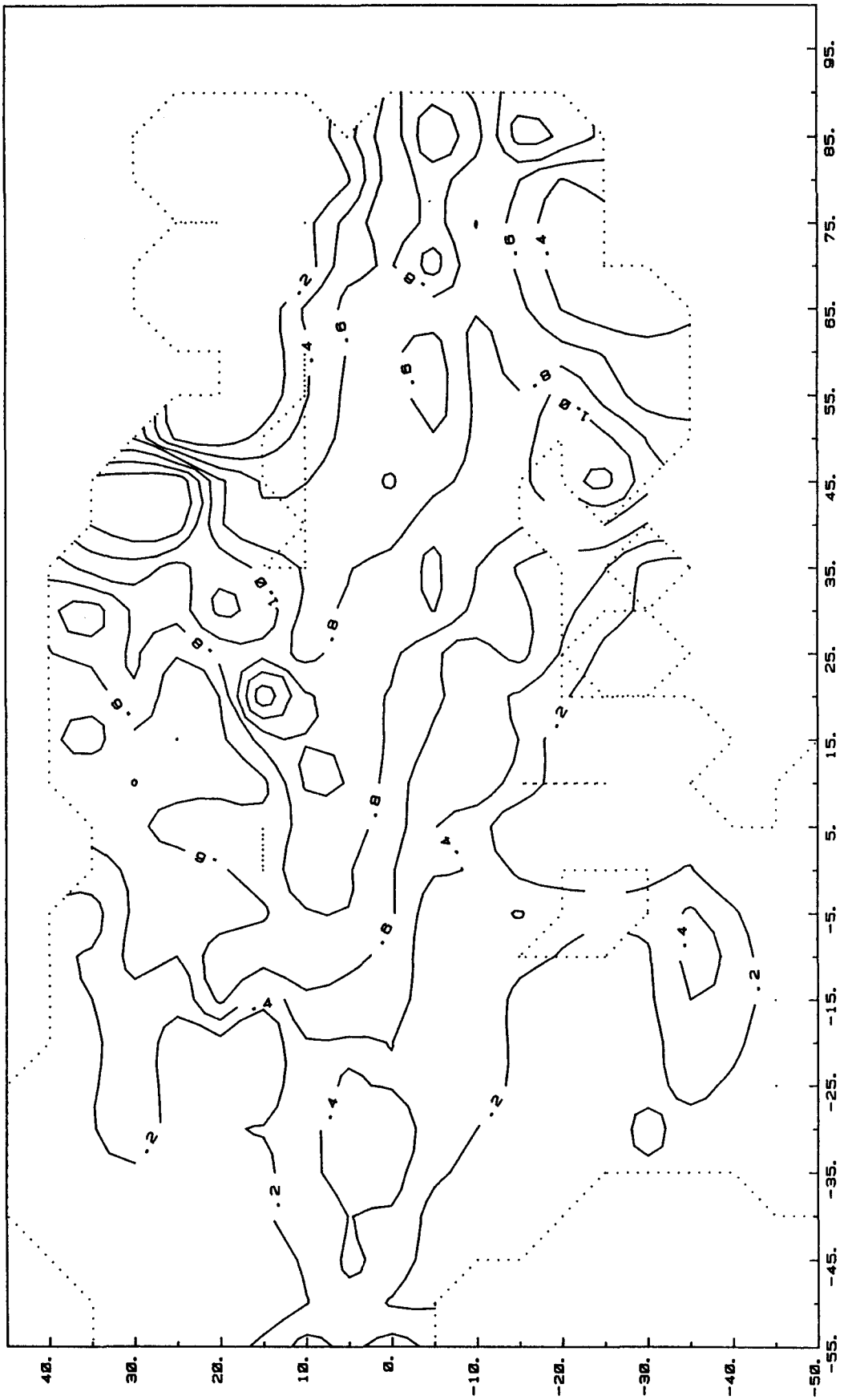
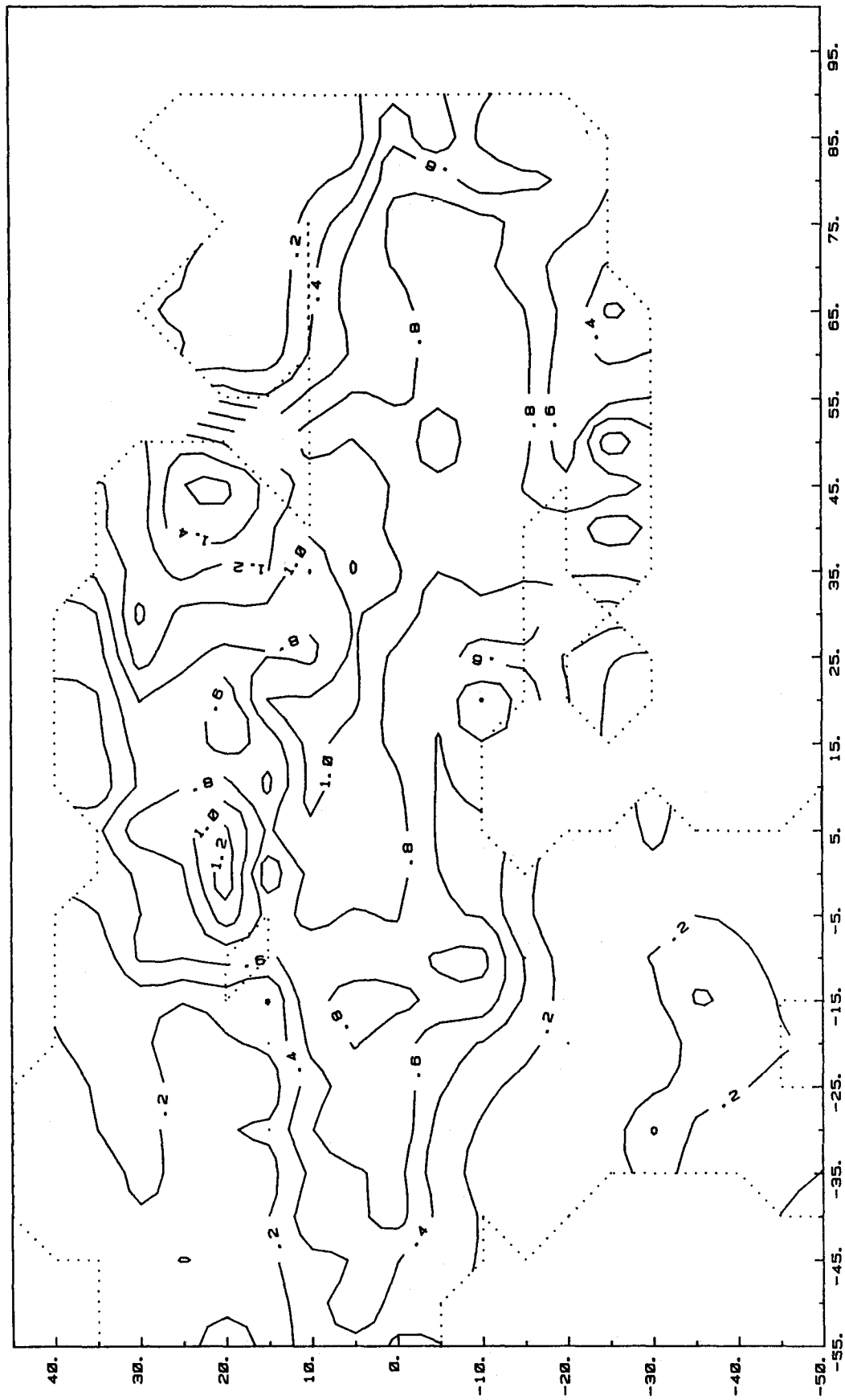
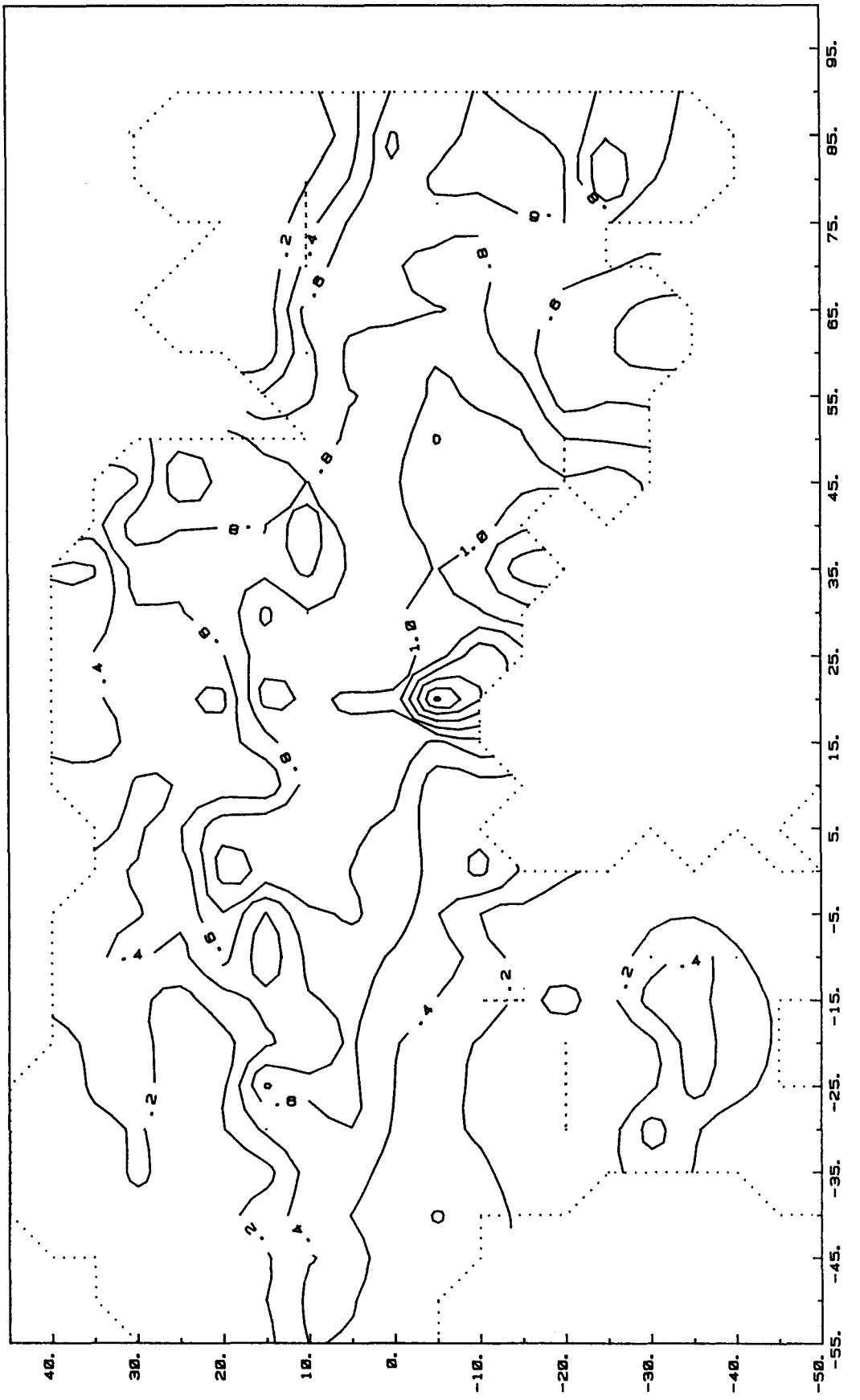
- 1971 -



- 1972 -

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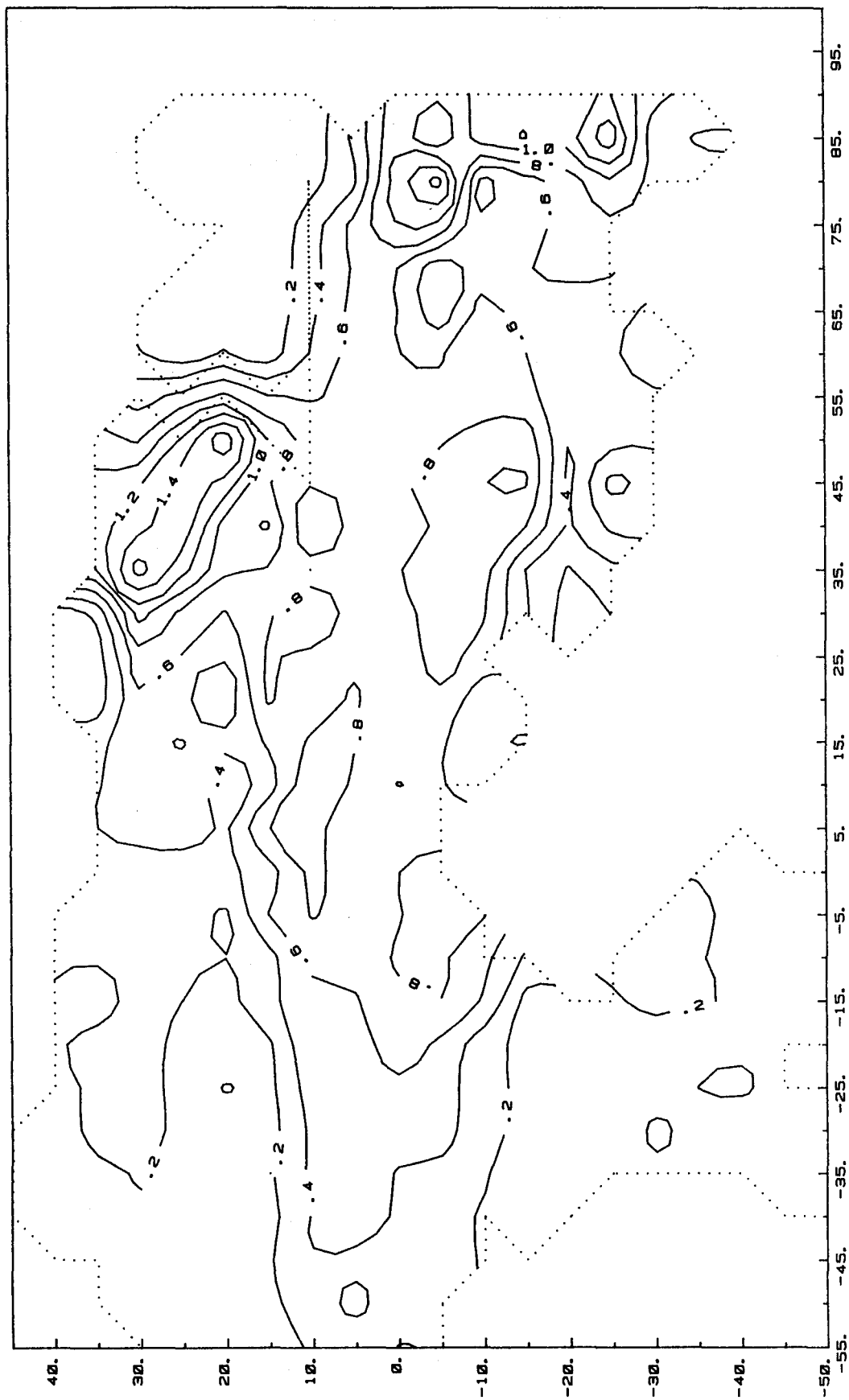
-55.

- 1974 -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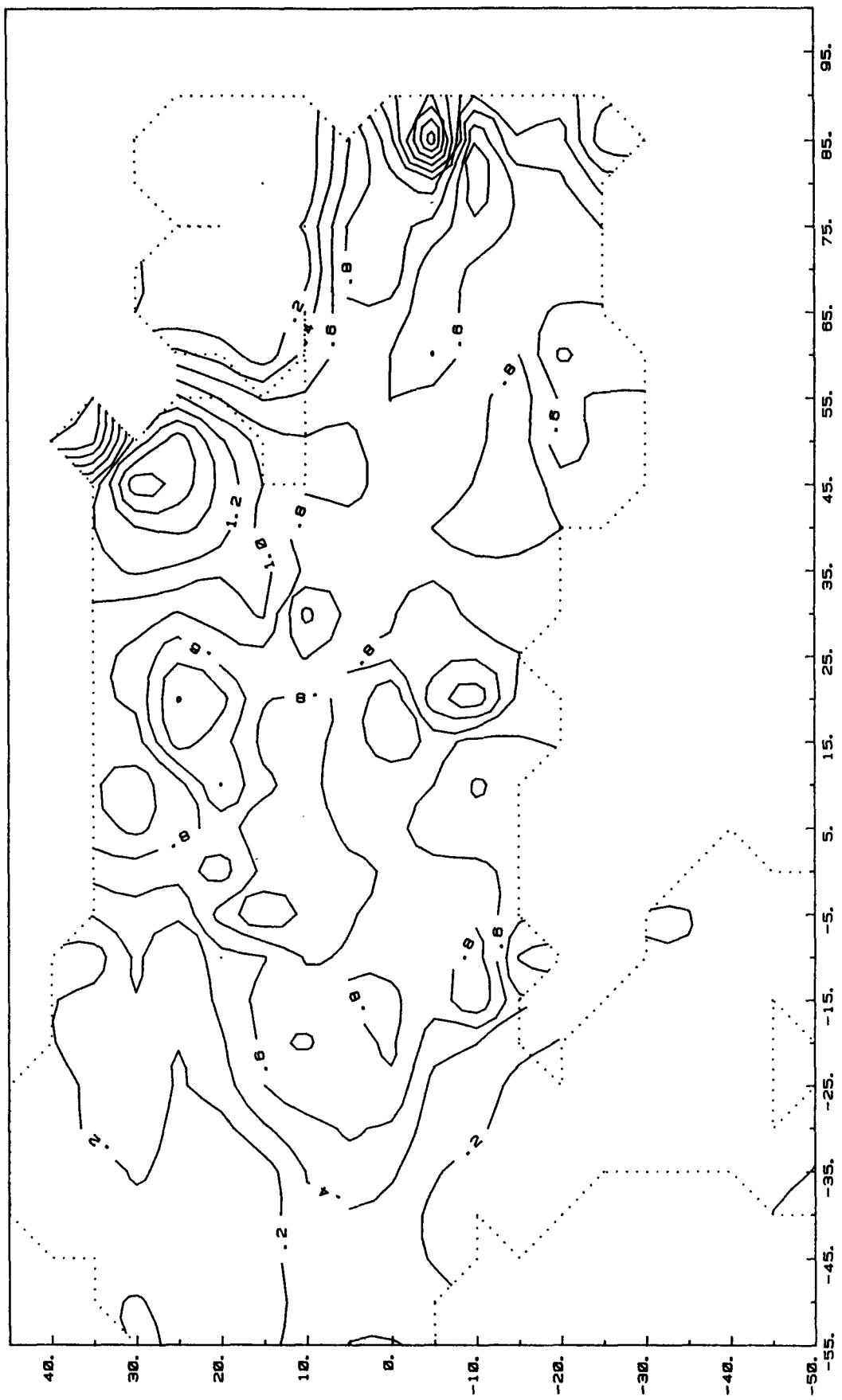
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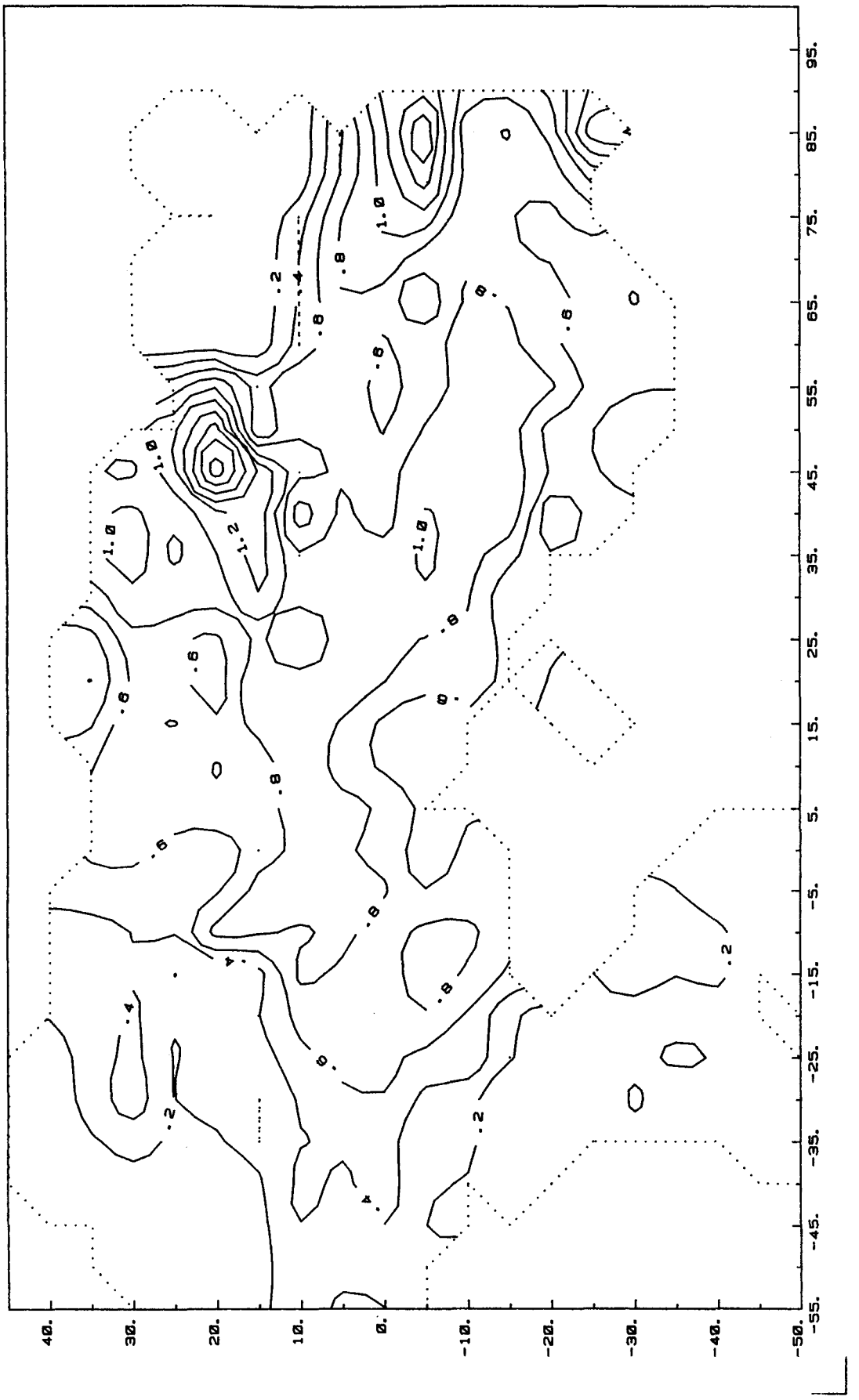
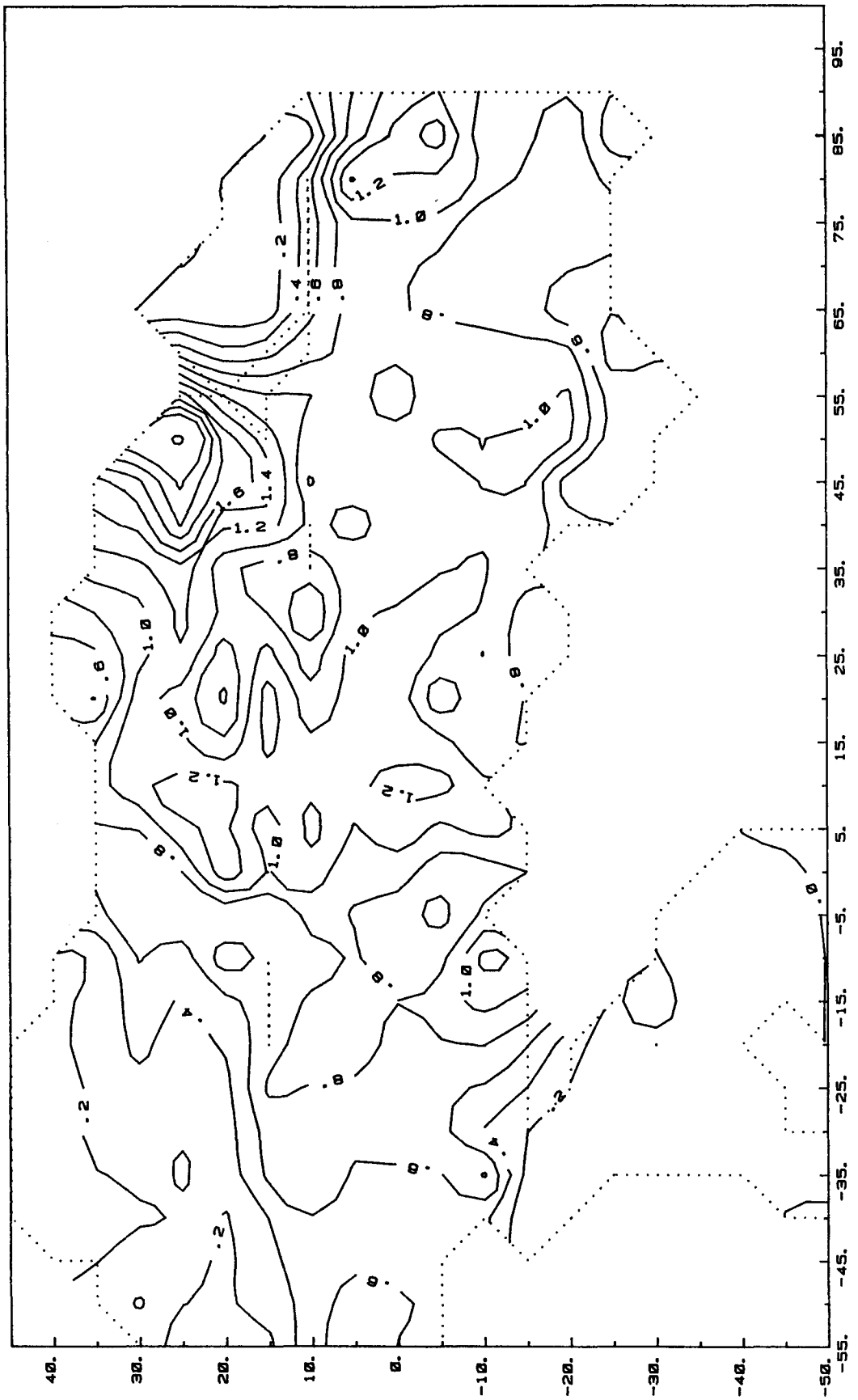
1.2

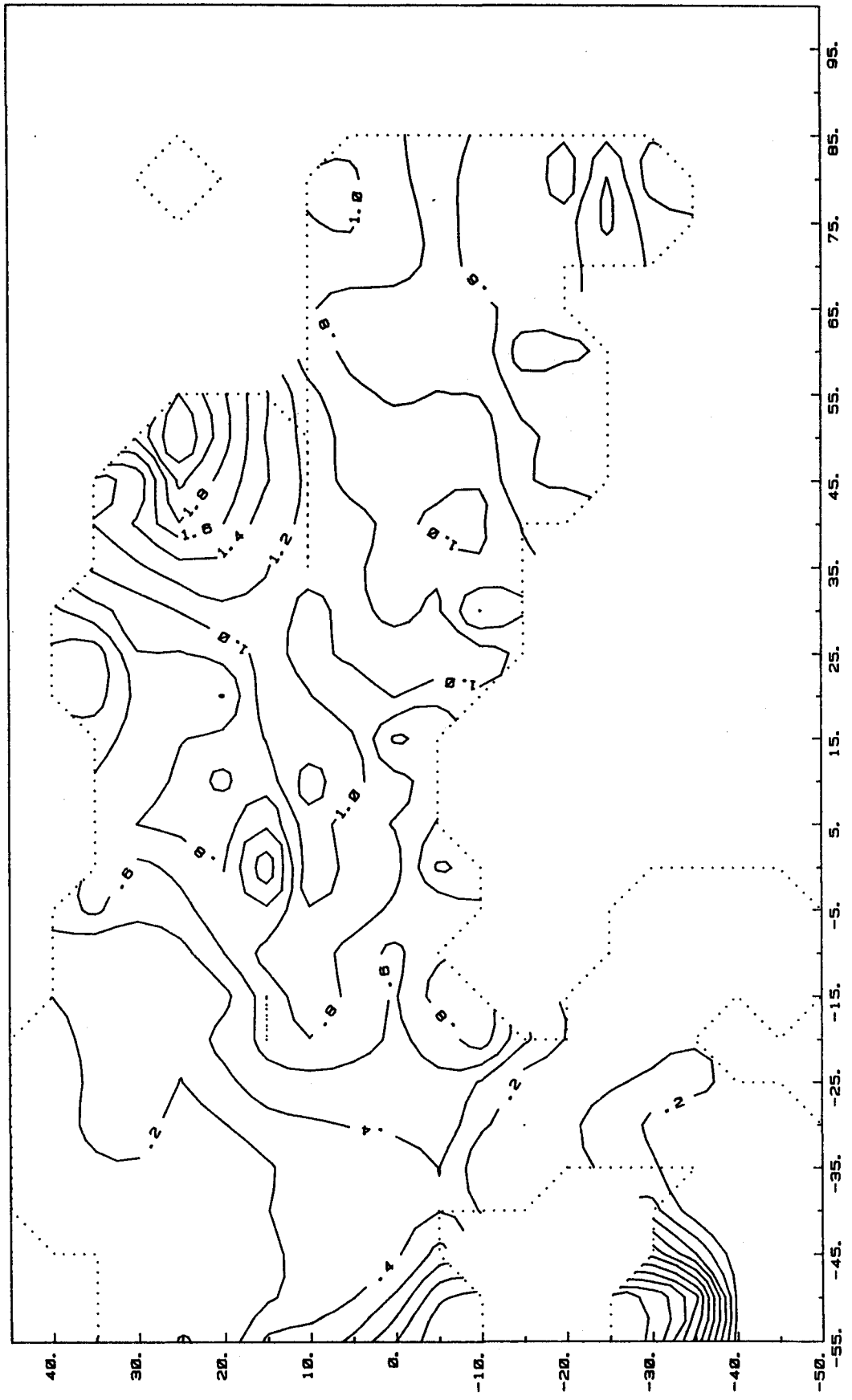
- 1975 -

- 1976 -





– 1977 –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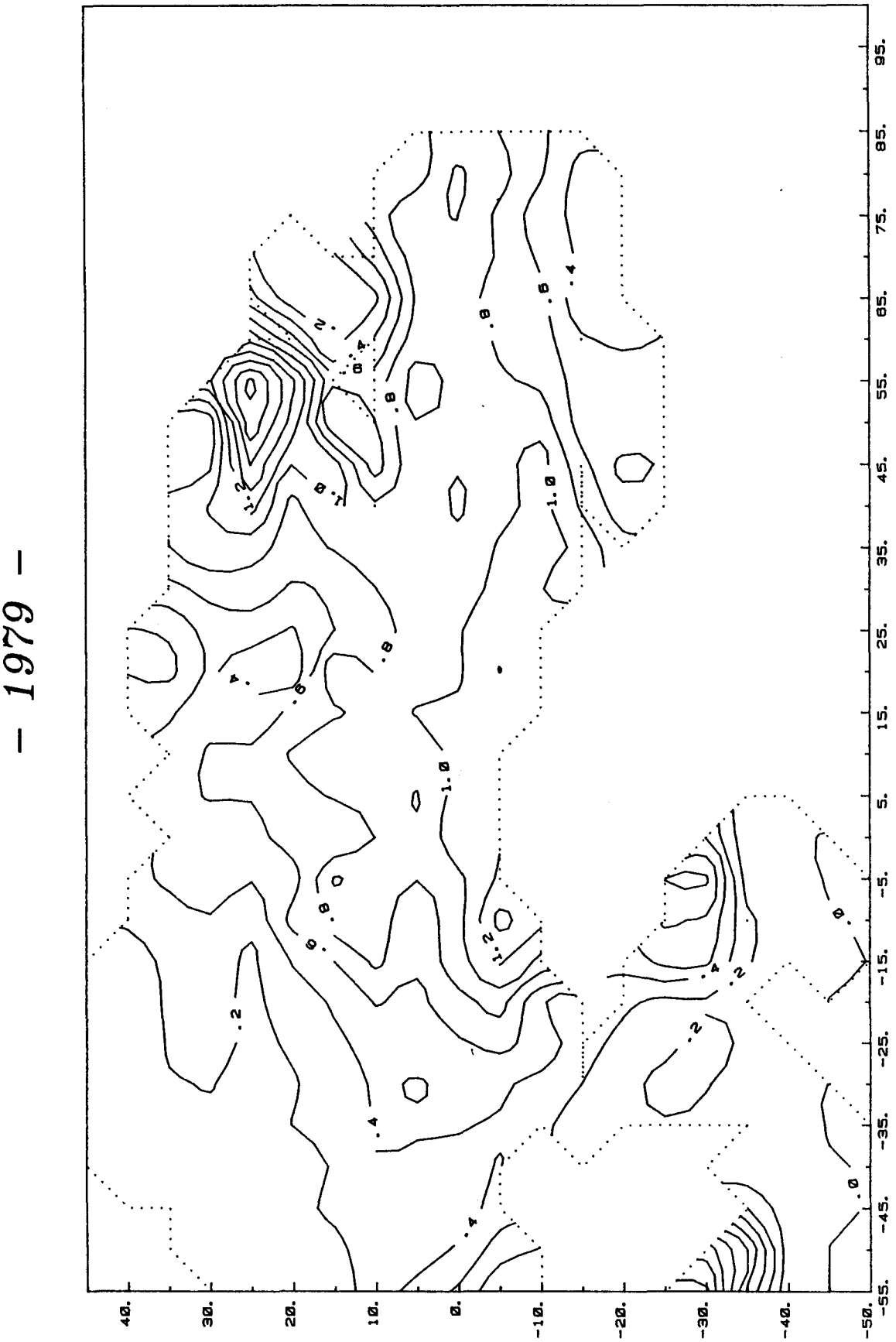
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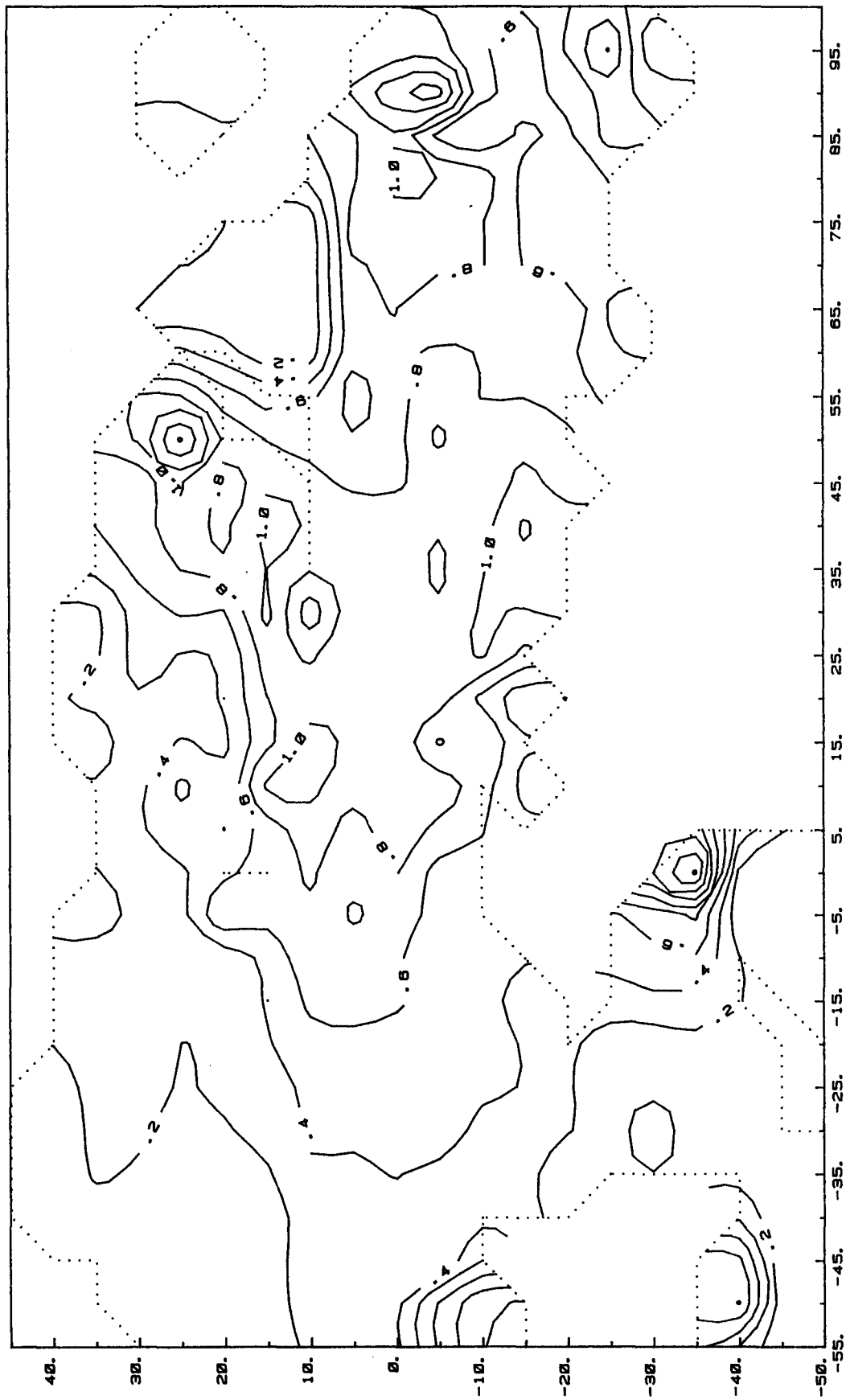
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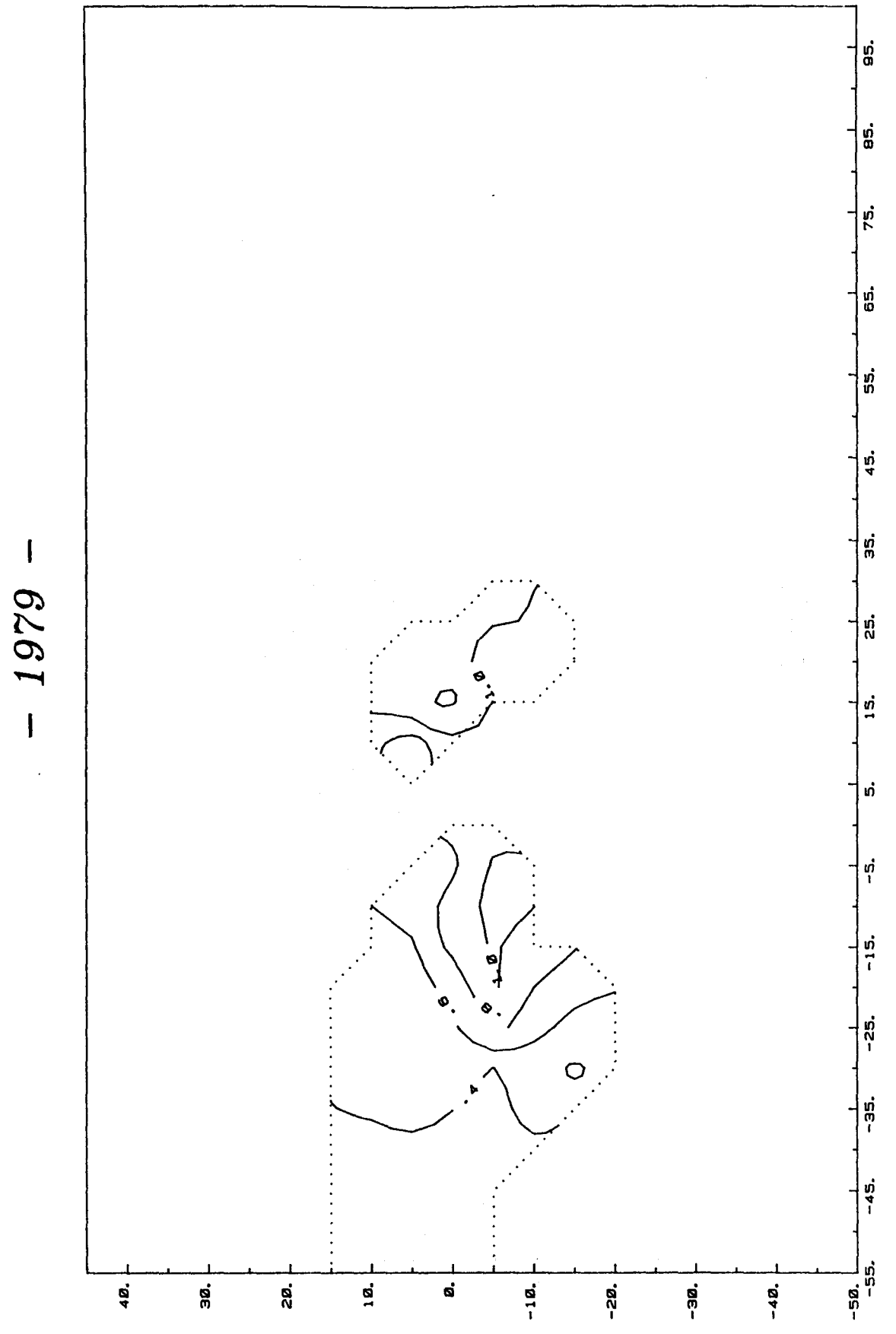
85.
95.

Figure 4. Contour plots of bigeye catch rates from 1979-1985 based on logsheet data available to the TBAP.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-10.
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-30.
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-50.
-55.
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-35.
-25.
-15.
-5.
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65.
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95.
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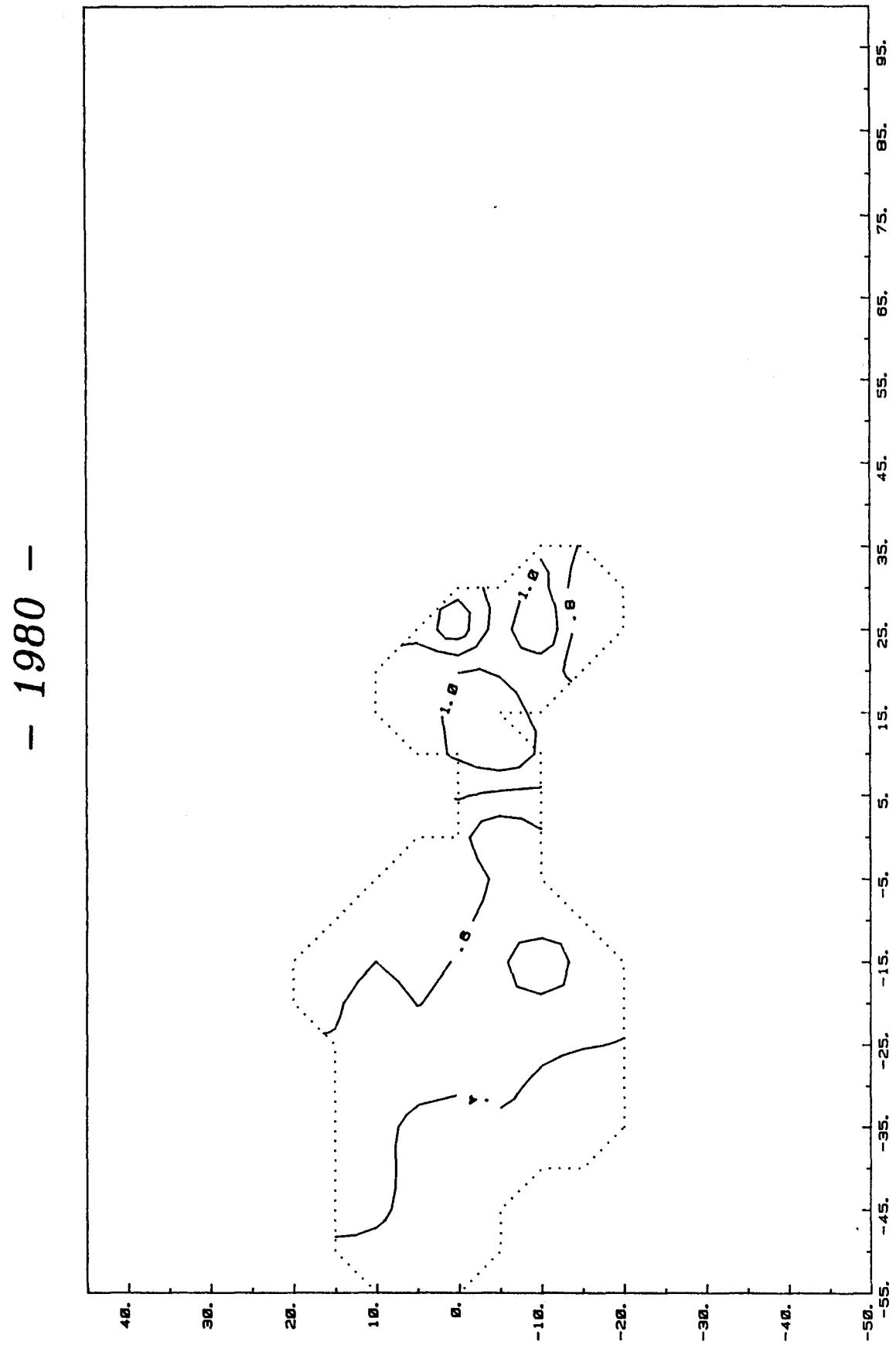
- 1980 -
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.6
1.0
1.0
.8
40.
30.
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10.
0.
-10.
-20.
-30.
-40.
-50.
-55.
-45.
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-5.
5.
15.
25.
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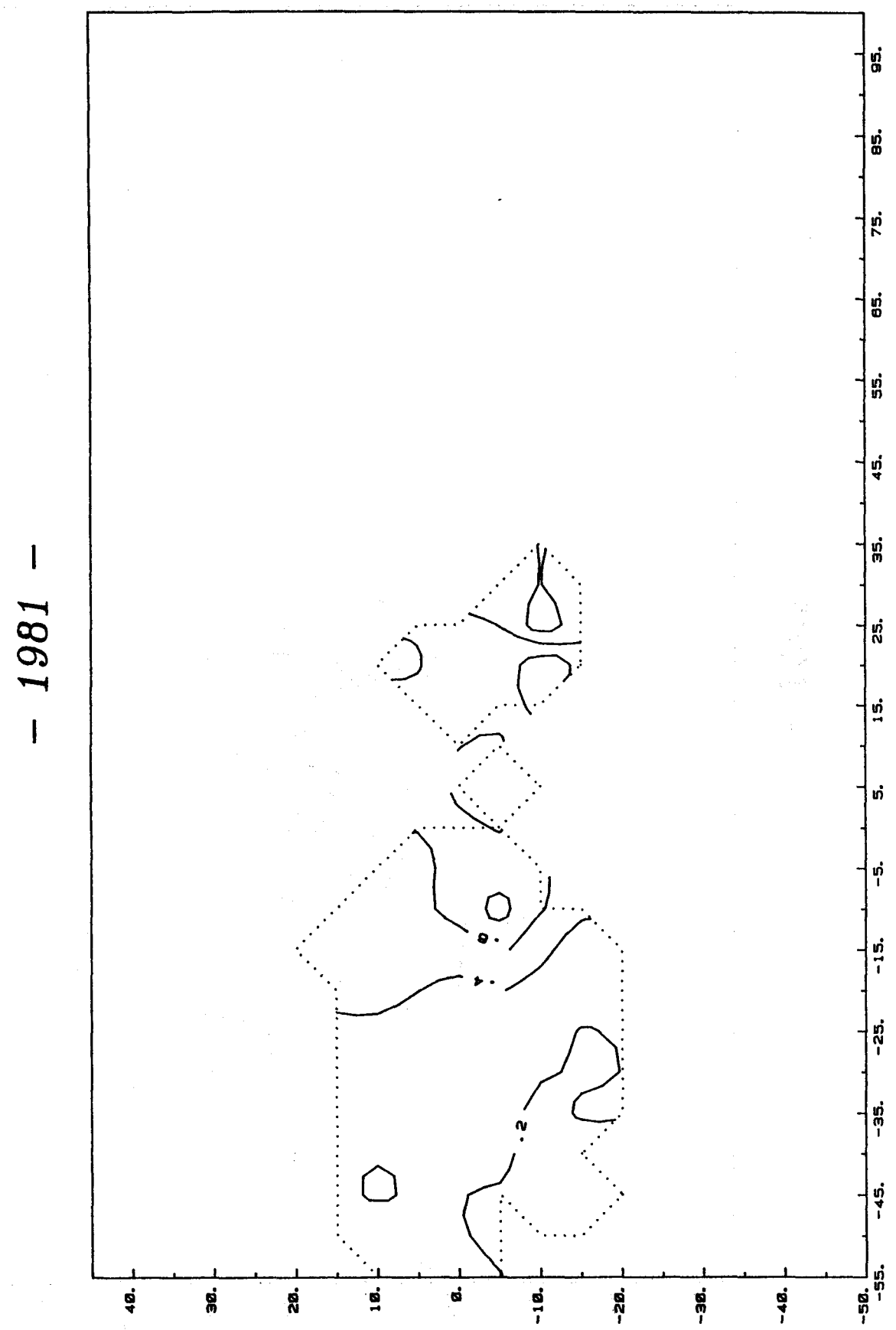
45.
55.
65.
75.
85.
95.


- 1981 -
.4
.2
40.
30.
20.
10.
0.
-10.
-20.
-30.
-40.
-50.
-55.
-45.
-35.
-25.
-15.
-5.
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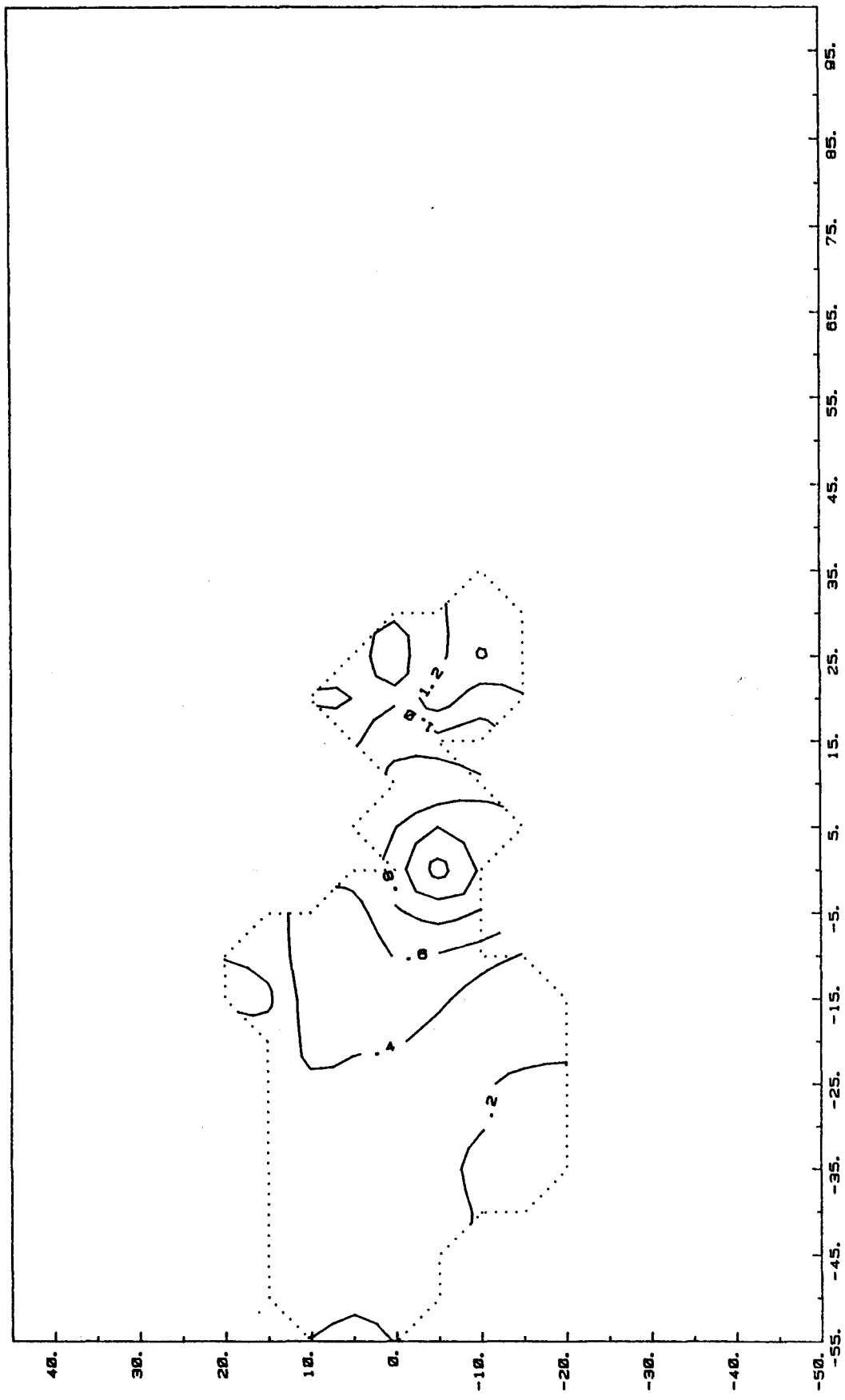
35.
45.
55.
65.
75.
85.
95.

- 1982 -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-35.
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-15.
-5.
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.2
.4
.6
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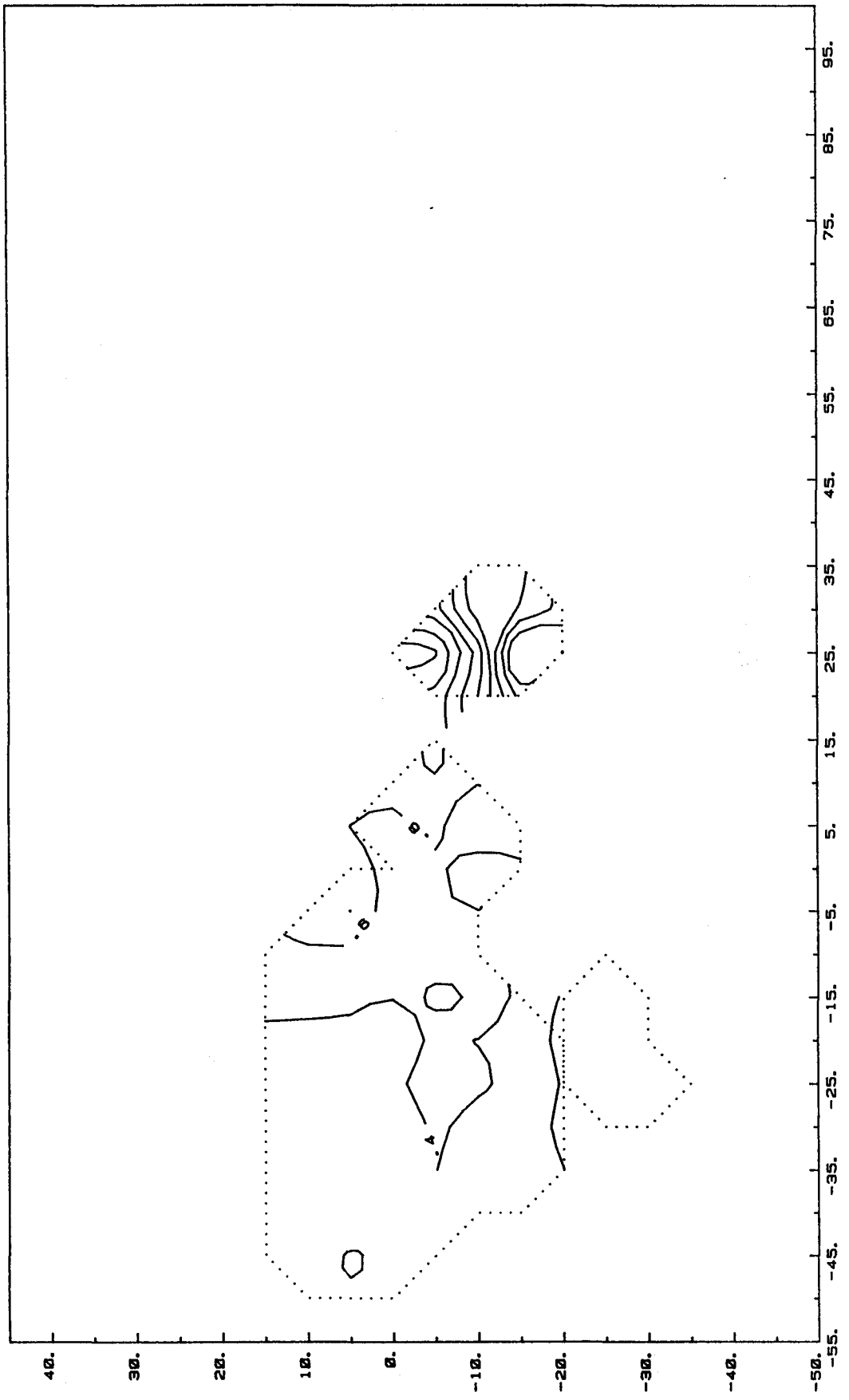
.1
1.2
0


- 1983 -
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-10.
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-30.
-40.
-50.
-55.
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-35.
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75.
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95.
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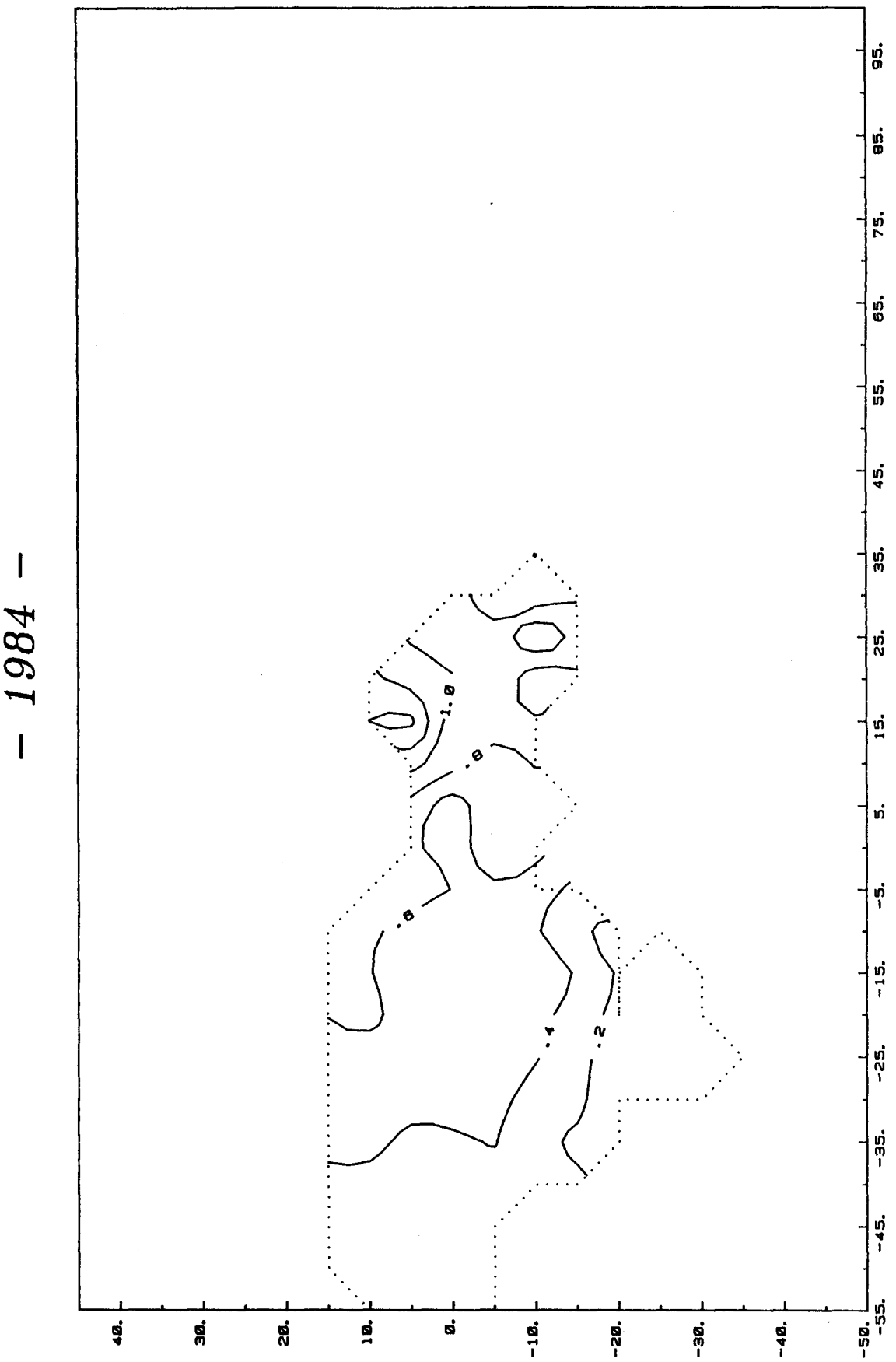
- 1984 -
1.0
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-30.
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-55.
-45.
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-15.
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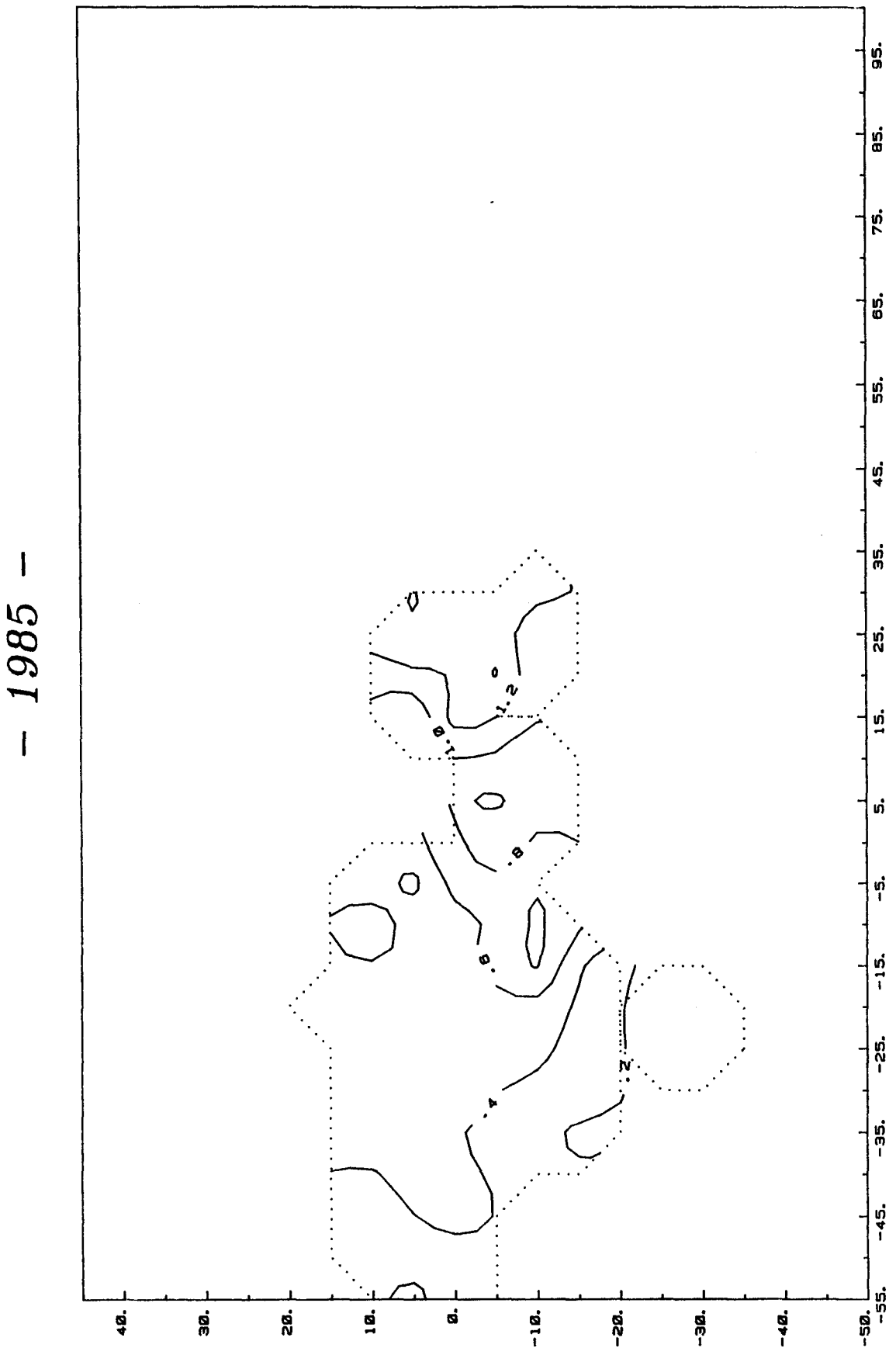
- 1985 -
95.
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-5.
-15.
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-55.
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-10.
-20.
-30.
-40.
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0
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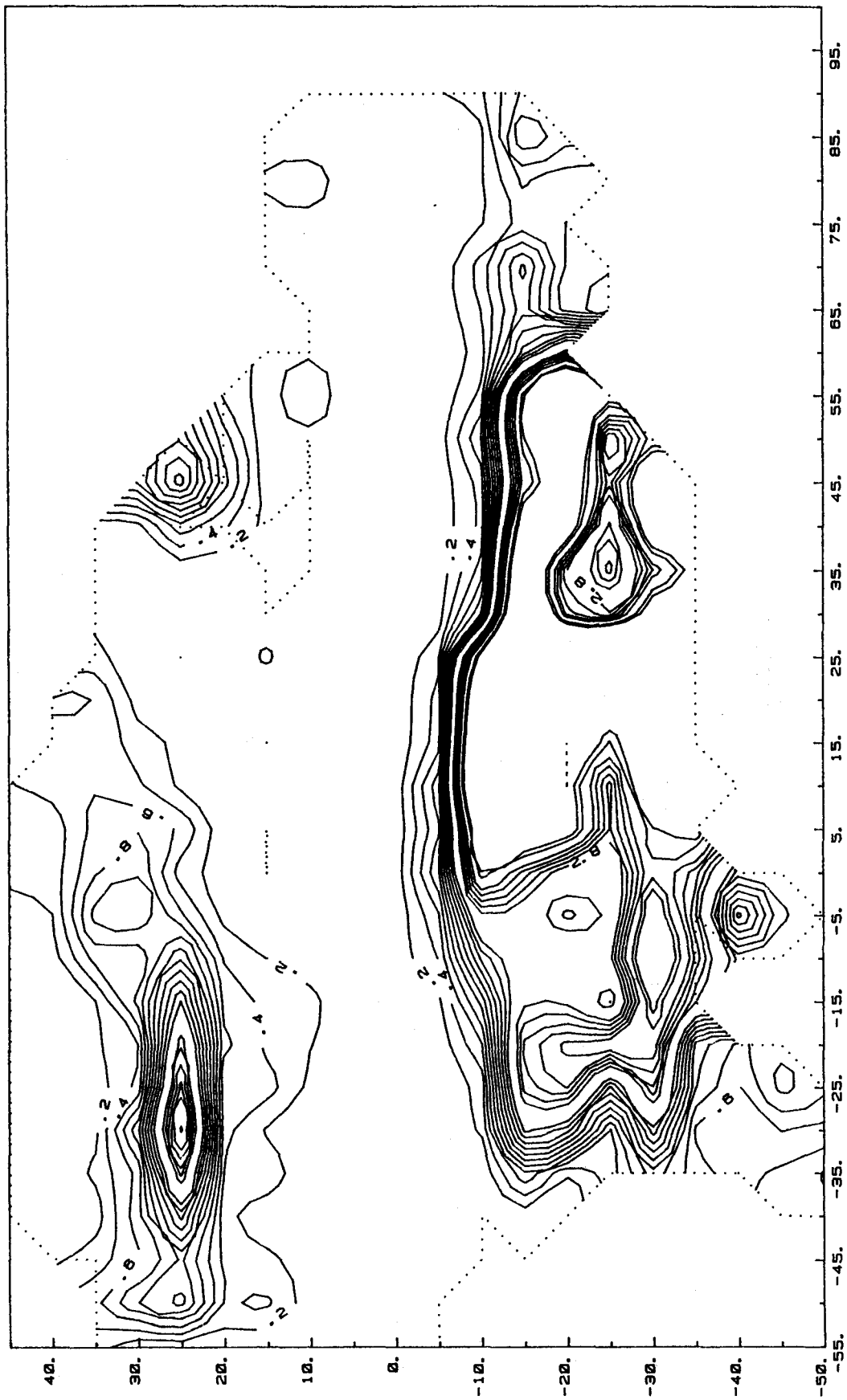
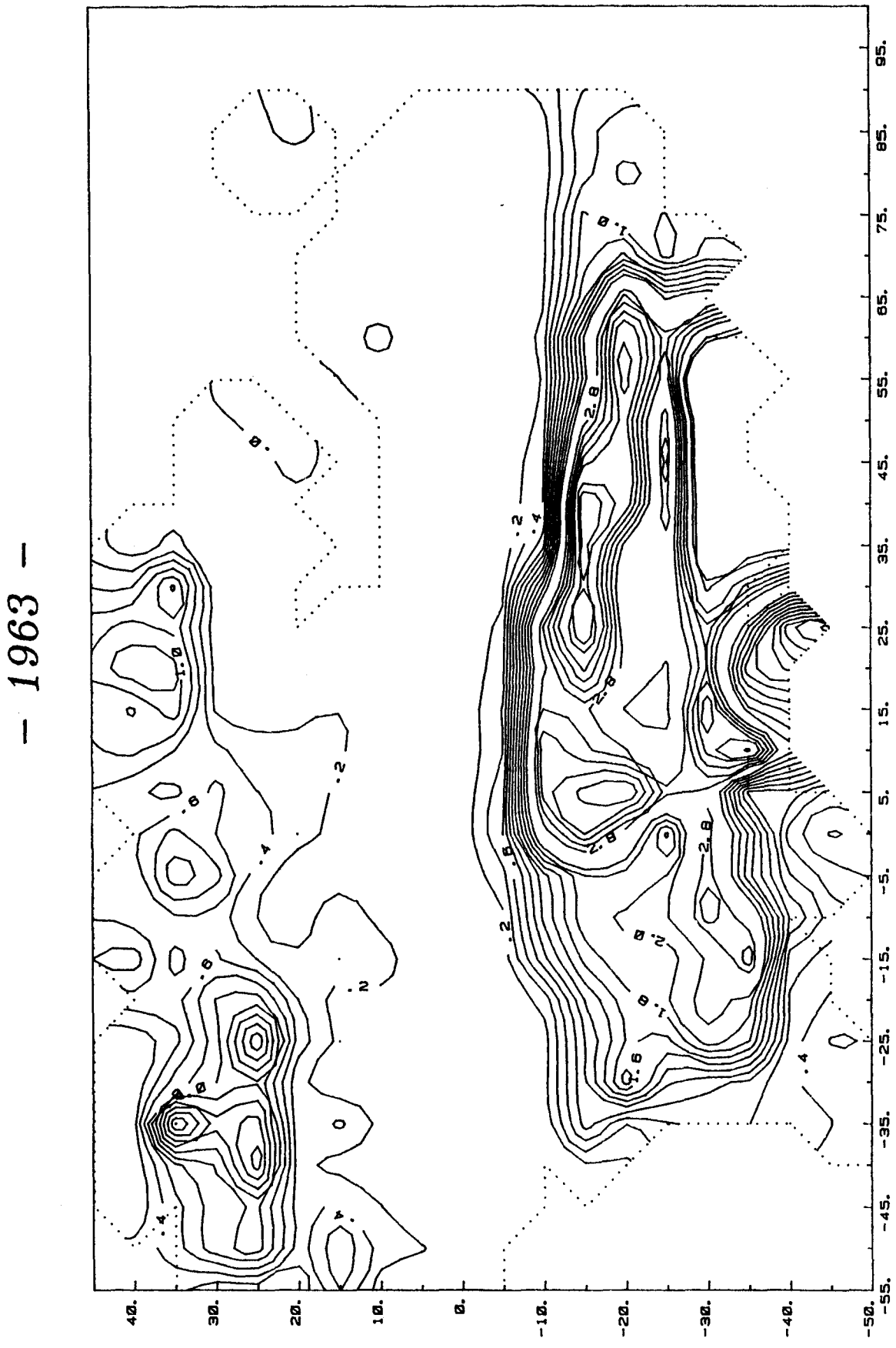
Figure 5. Contour plots of albacore catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.

- 1962 -




- 1963 -
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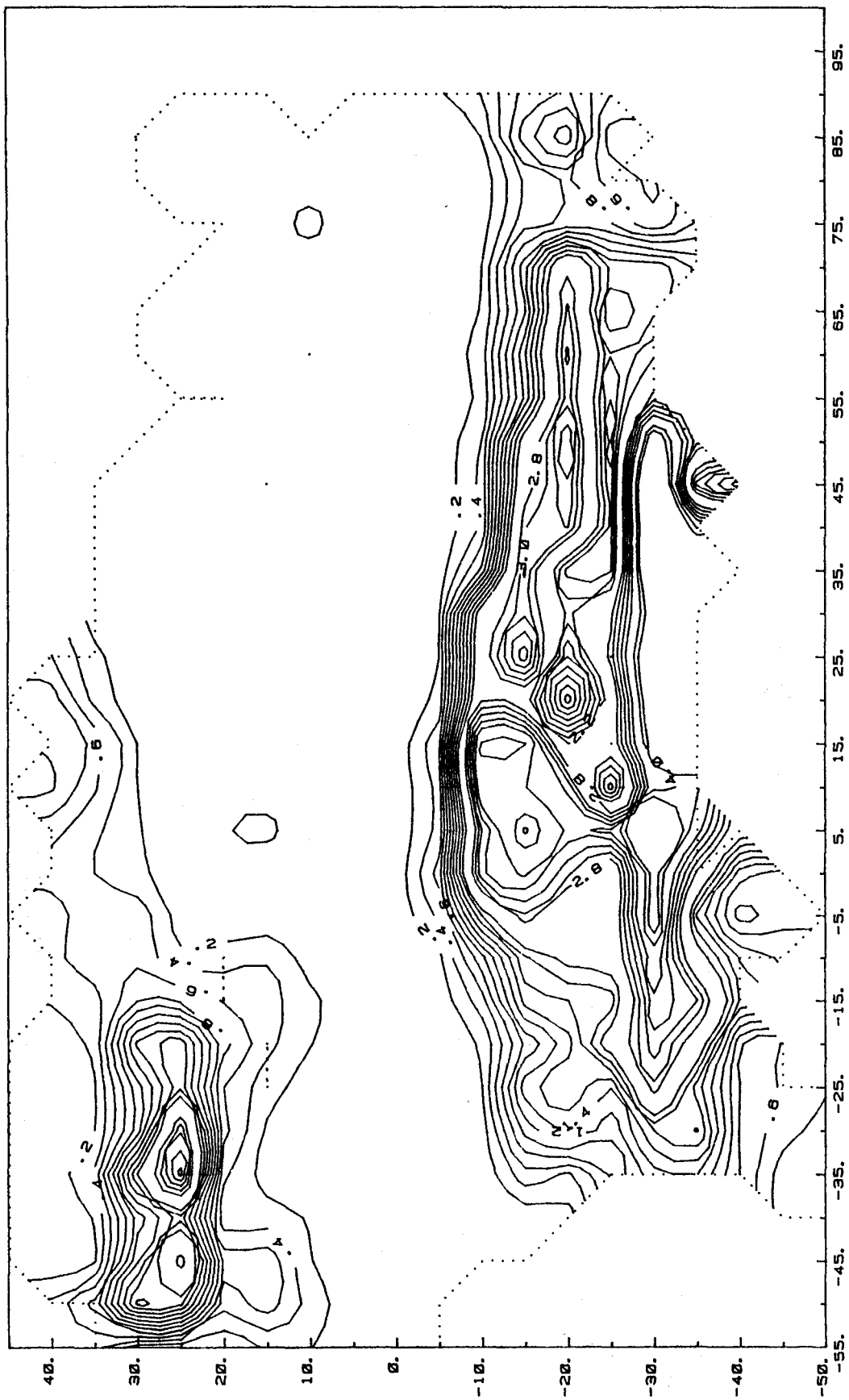
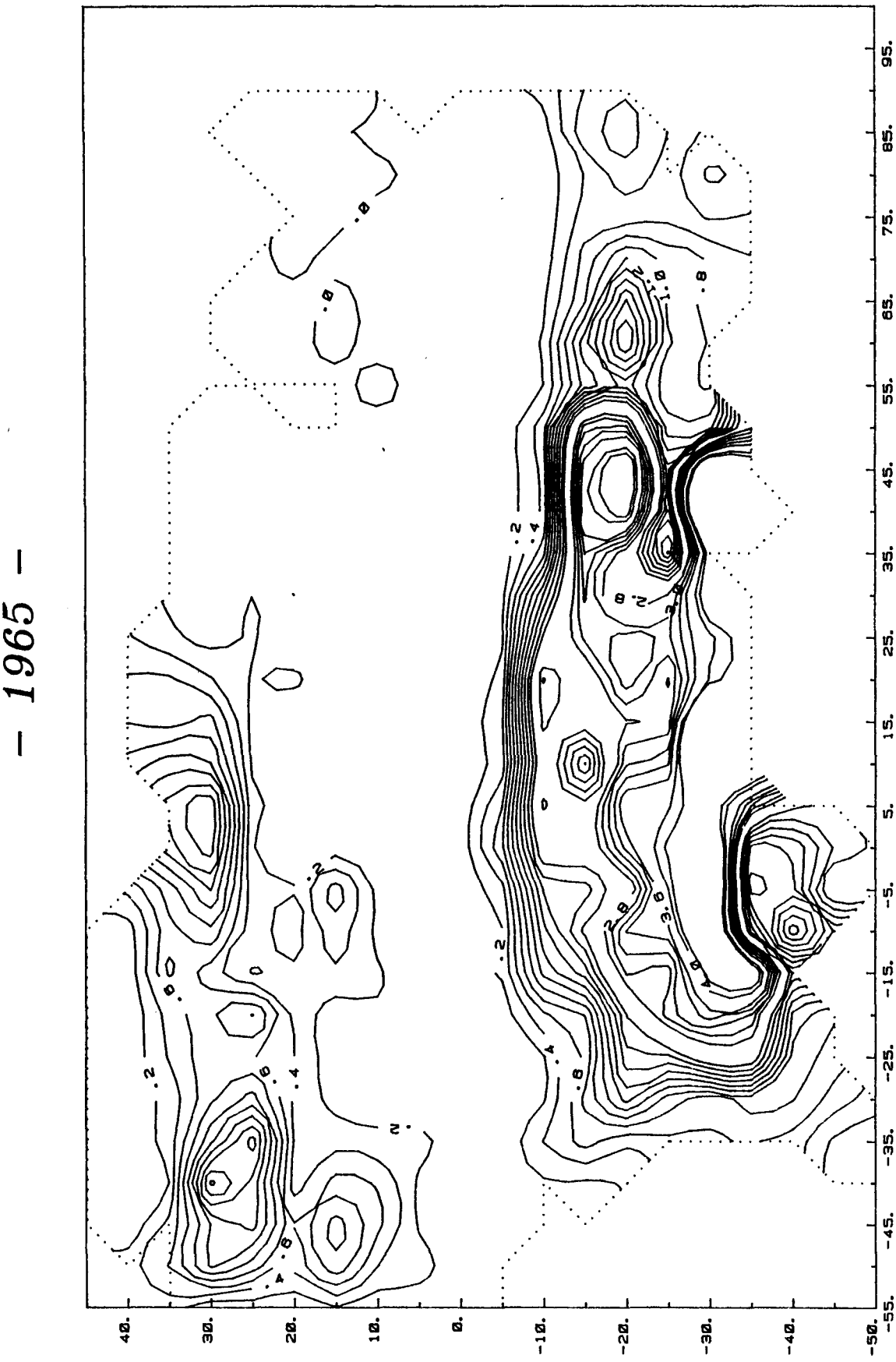
-40.
-50.

- 1964 -




- 1965 -
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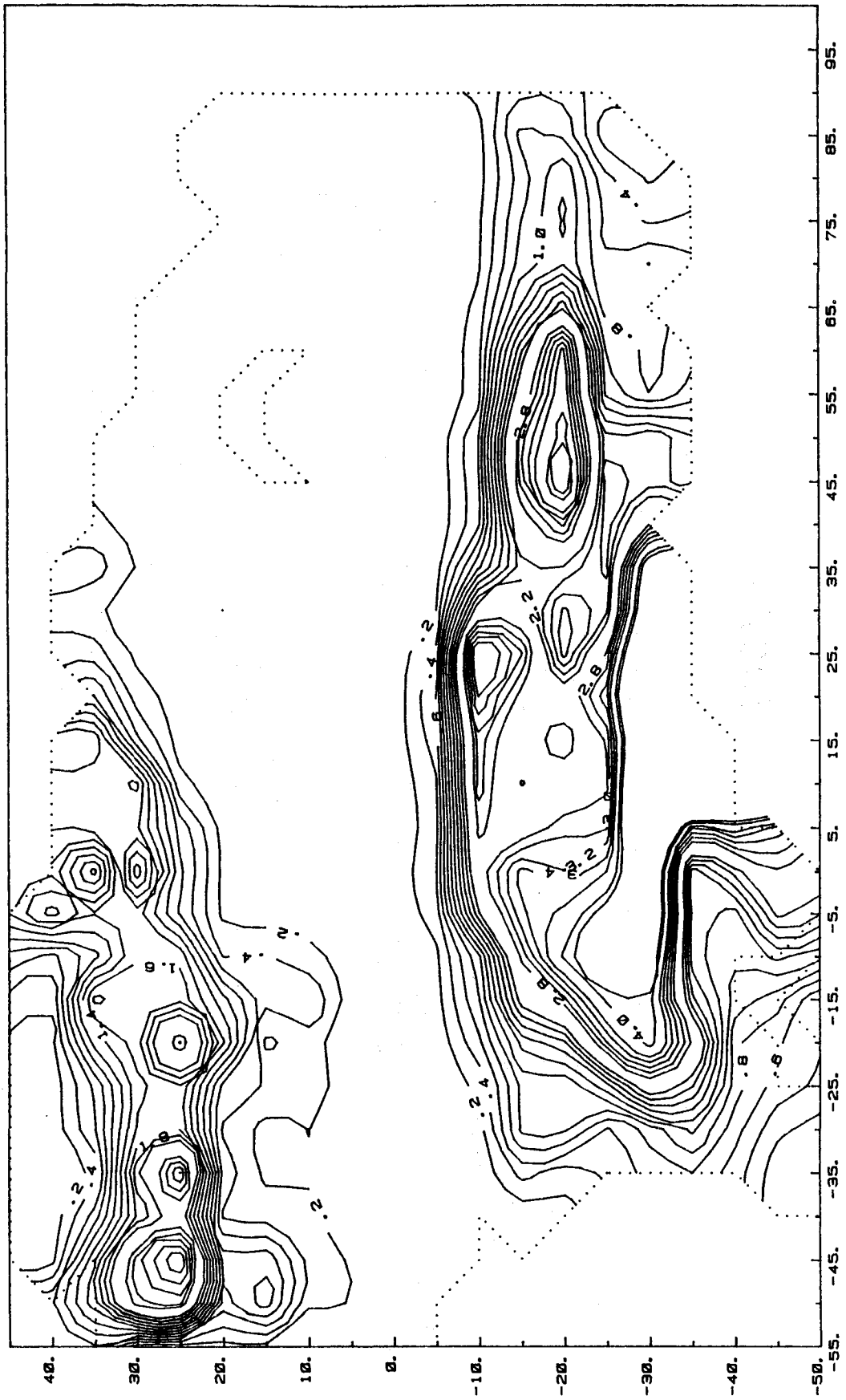
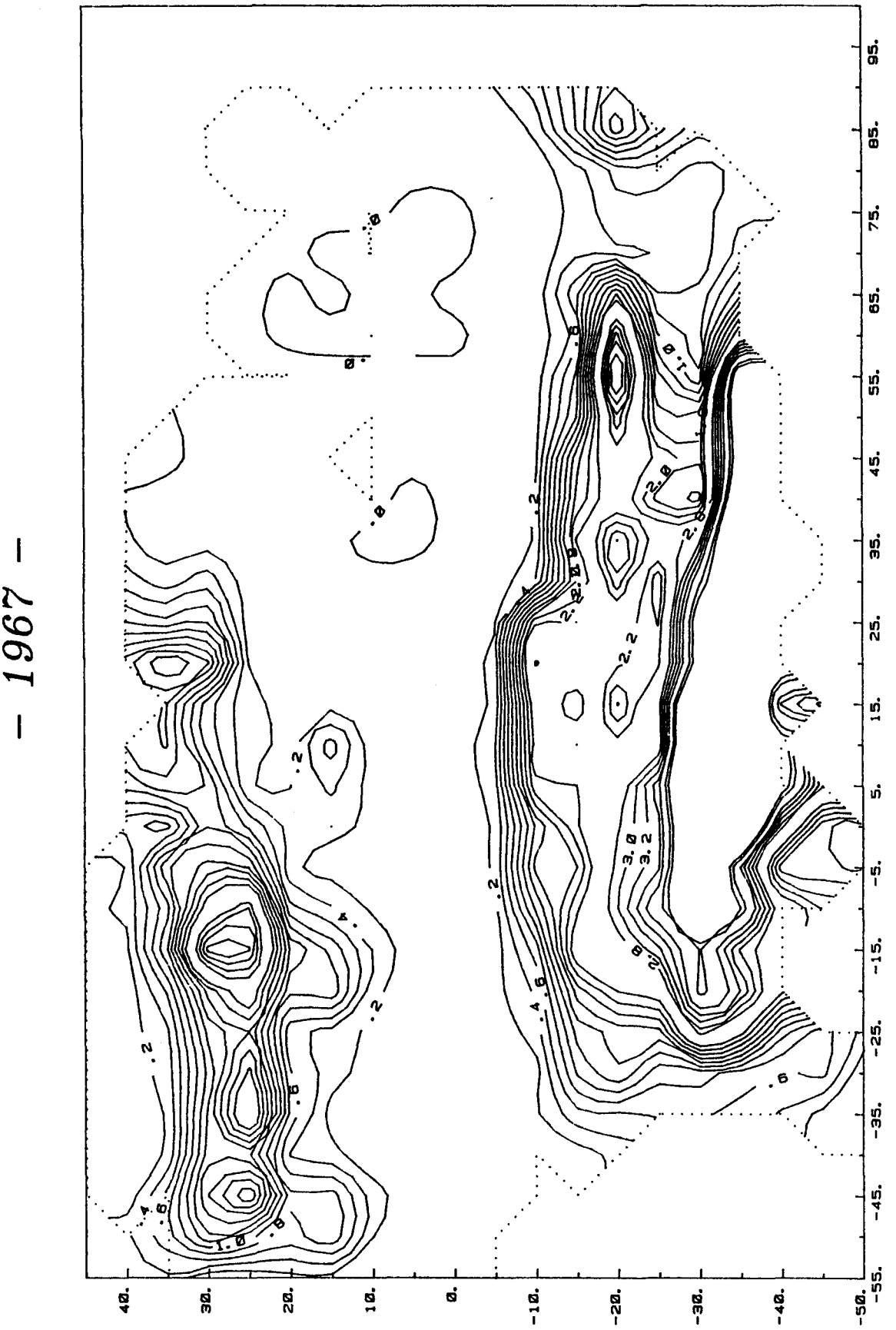
-35.
-45.
-55.

- 1966 -

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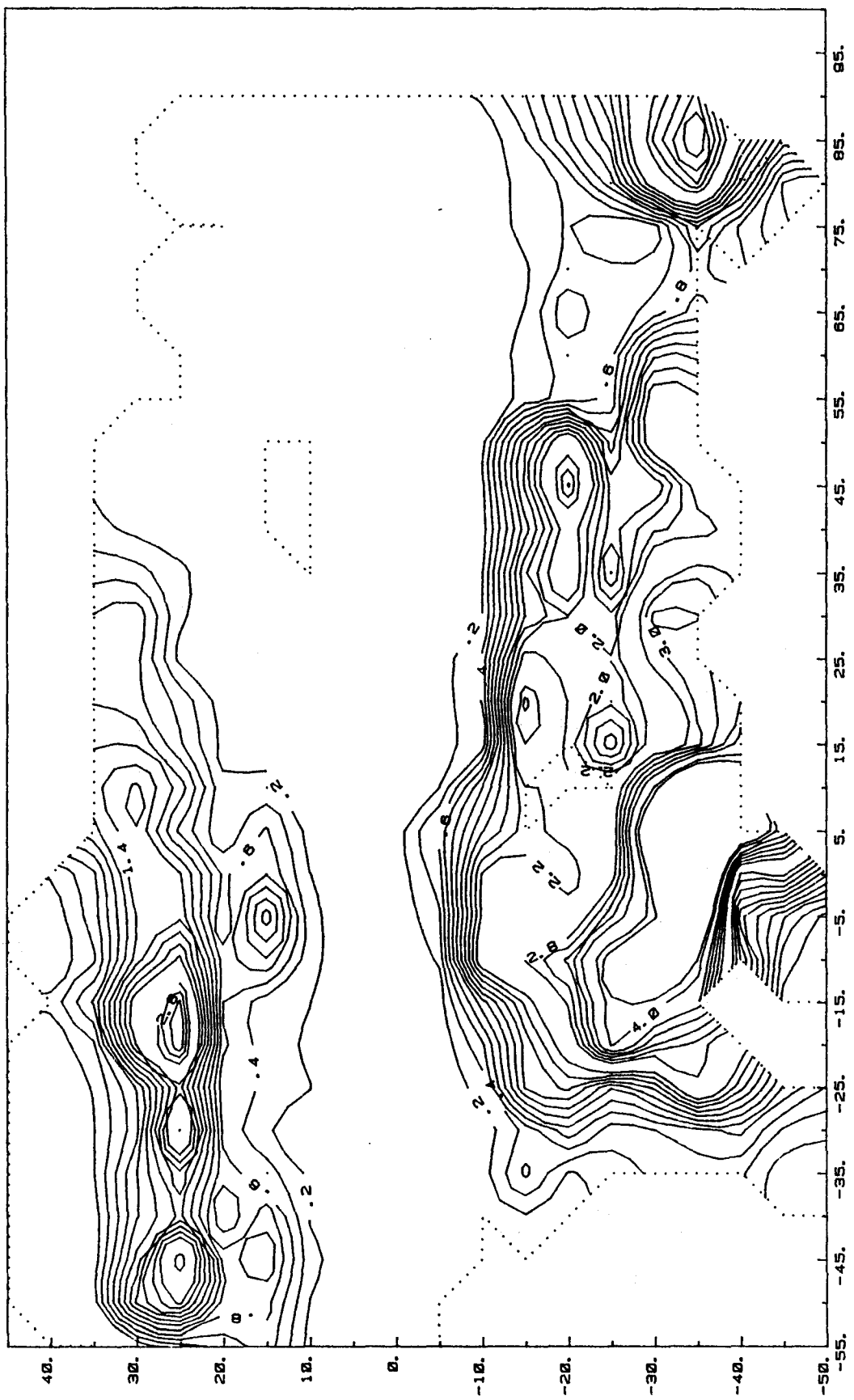
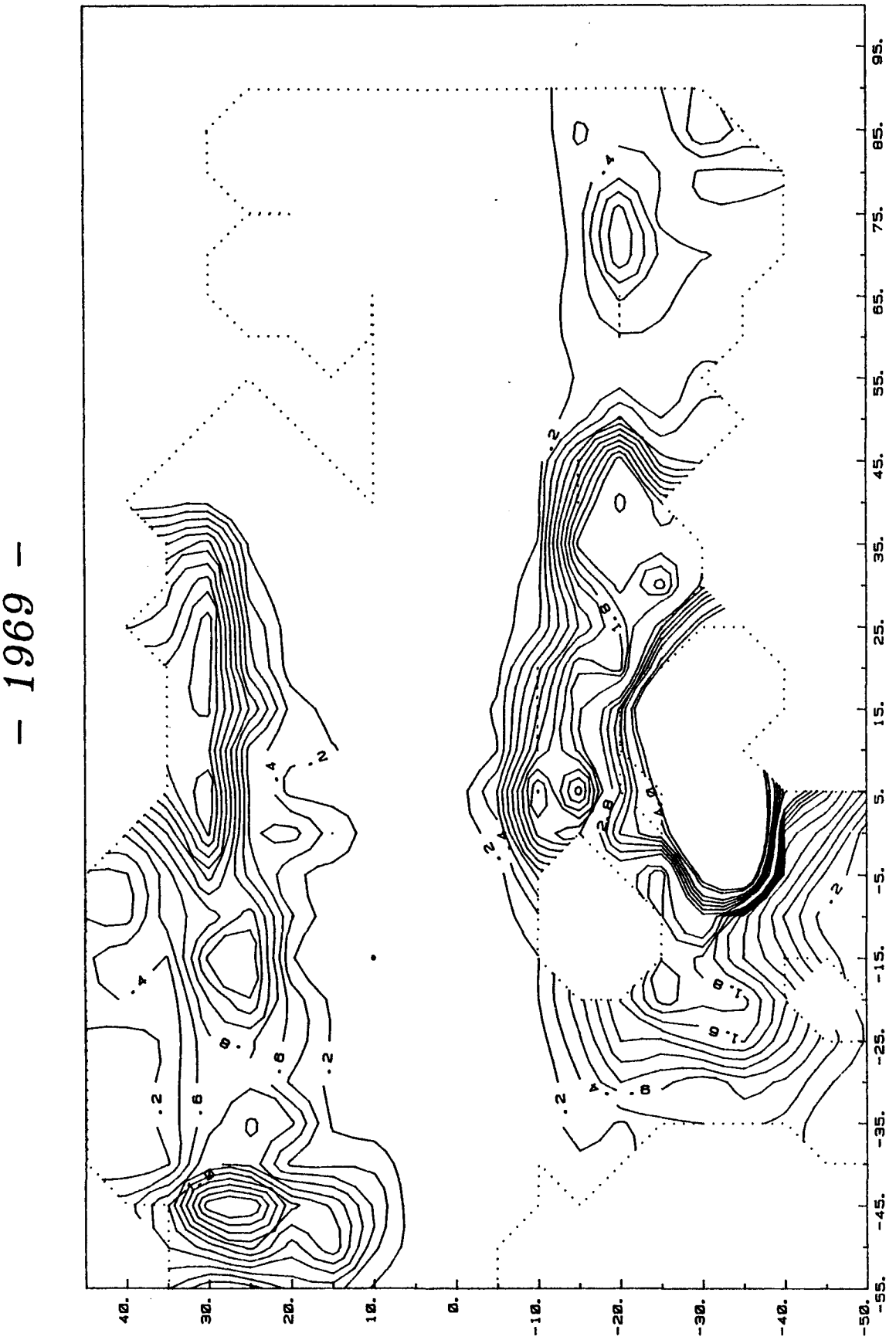
- 1968 -

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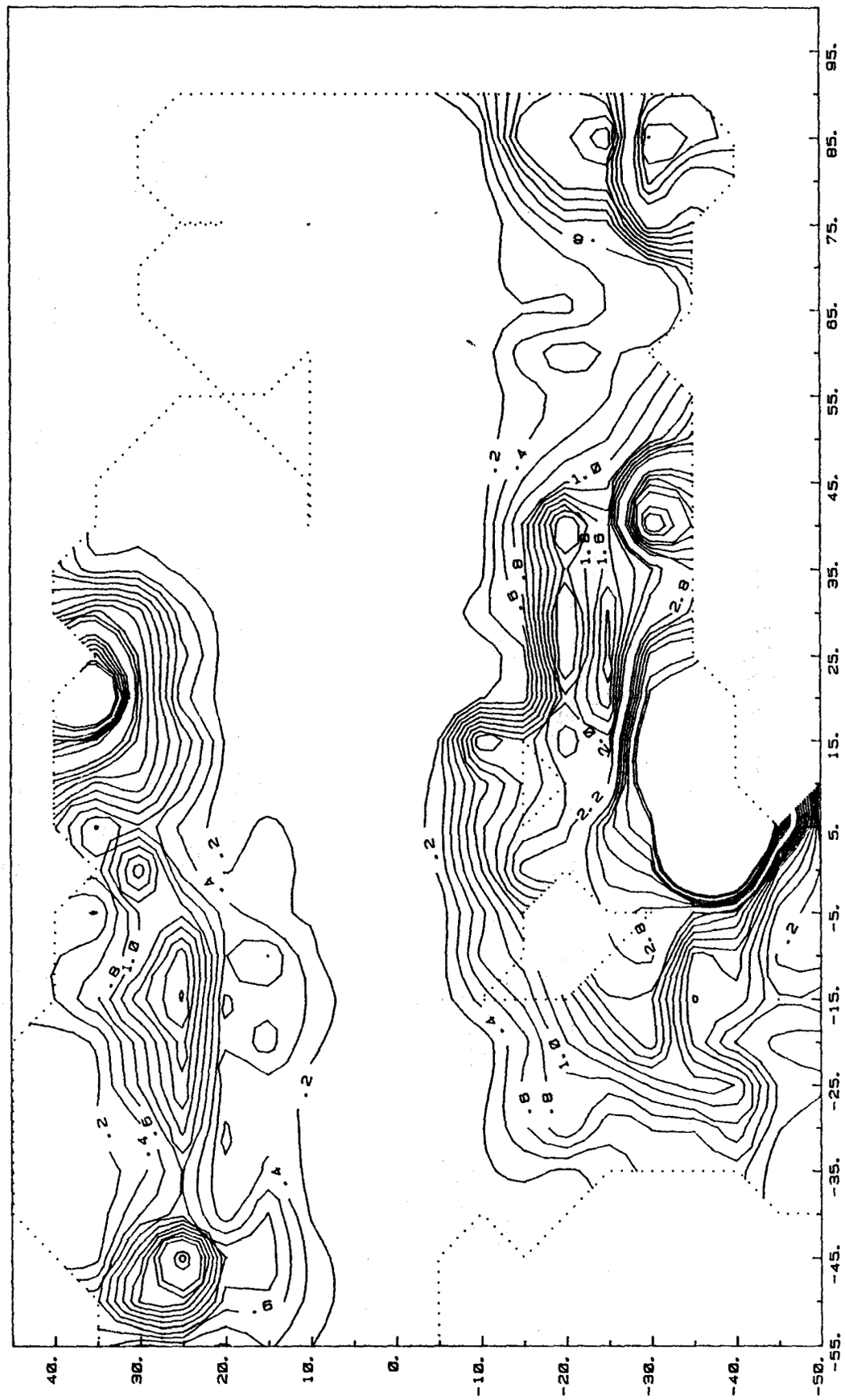
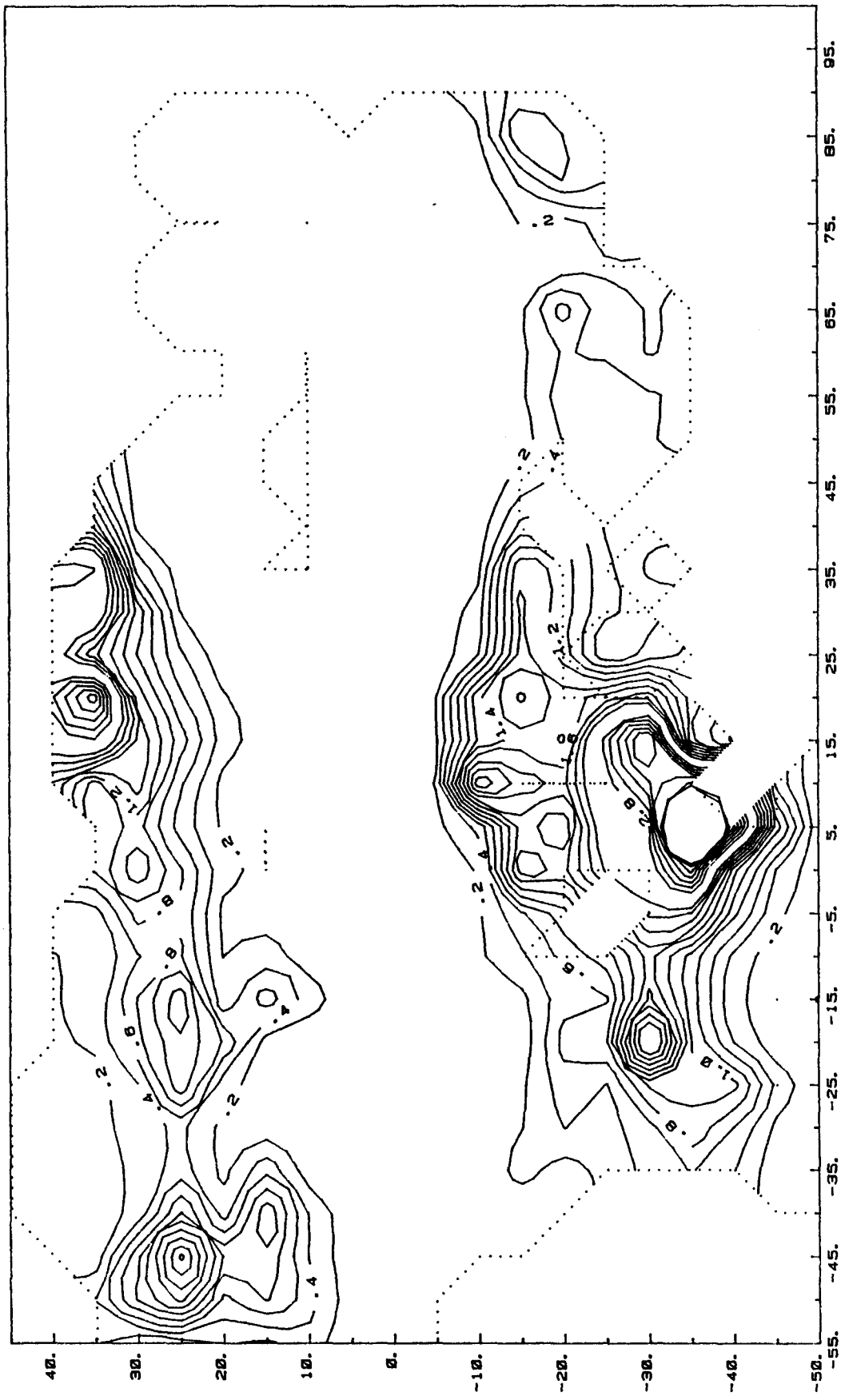
45.
55.
65.
75.
85.
95.

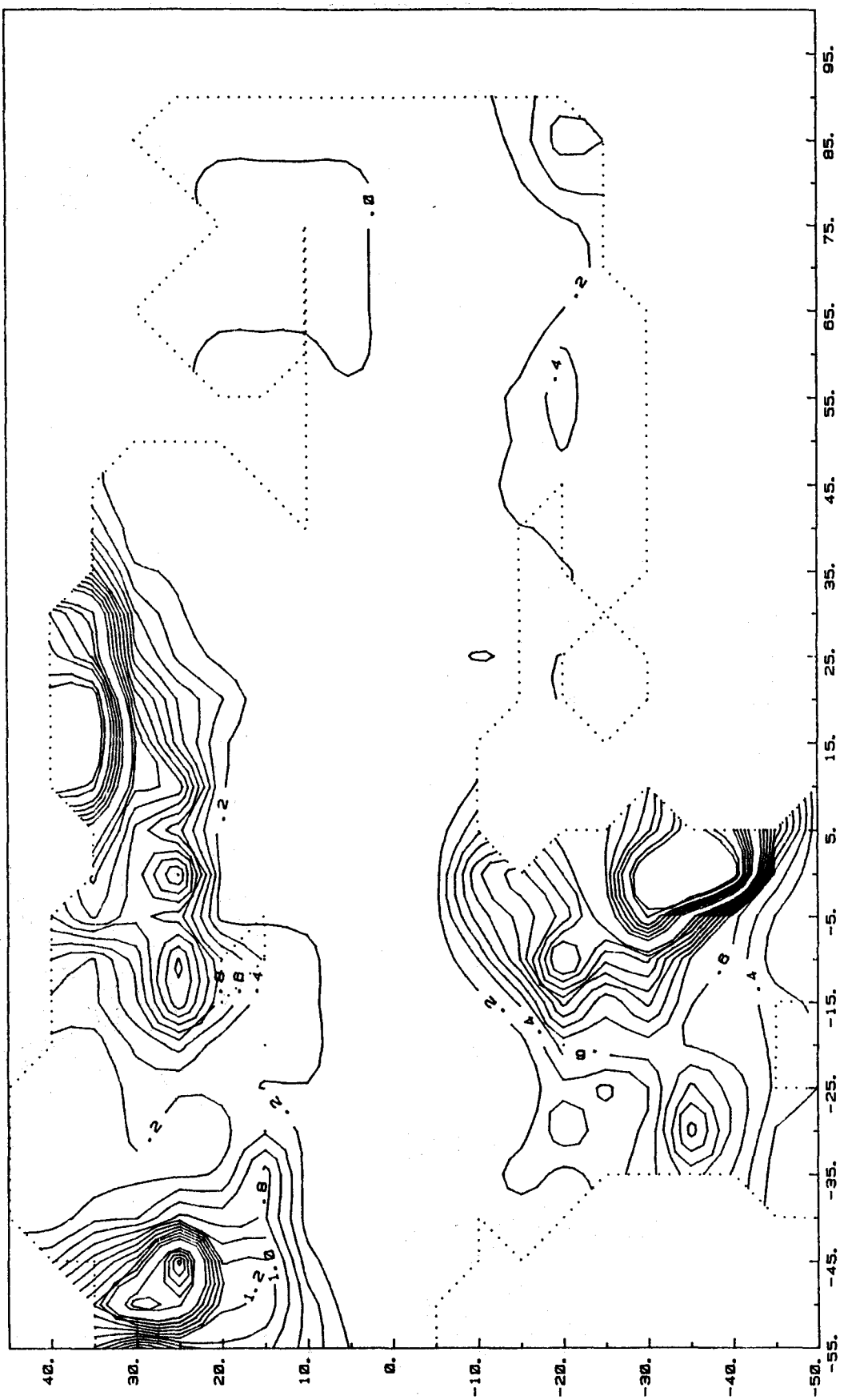
- 1970 -



- 1971 -



- 1972 -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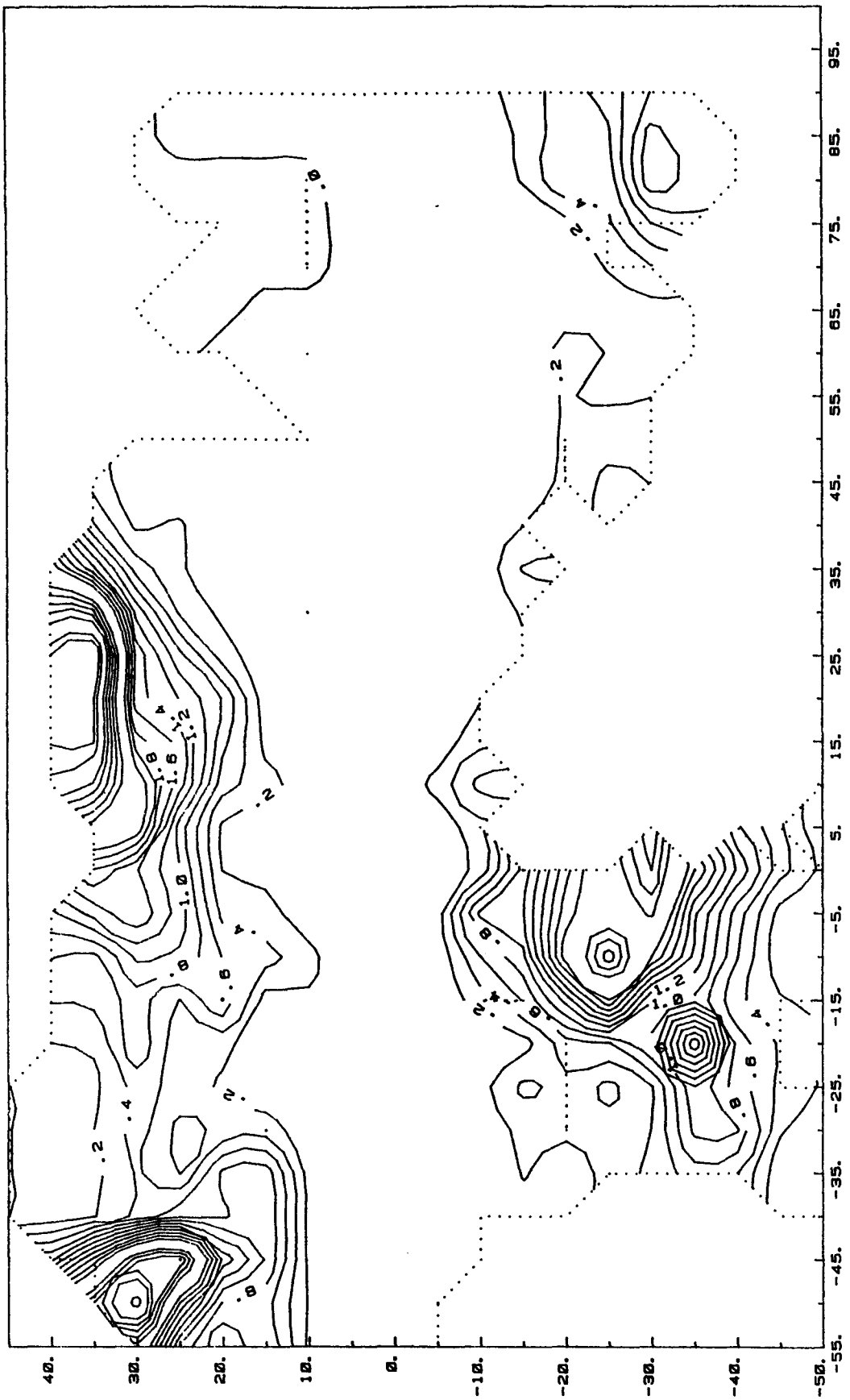
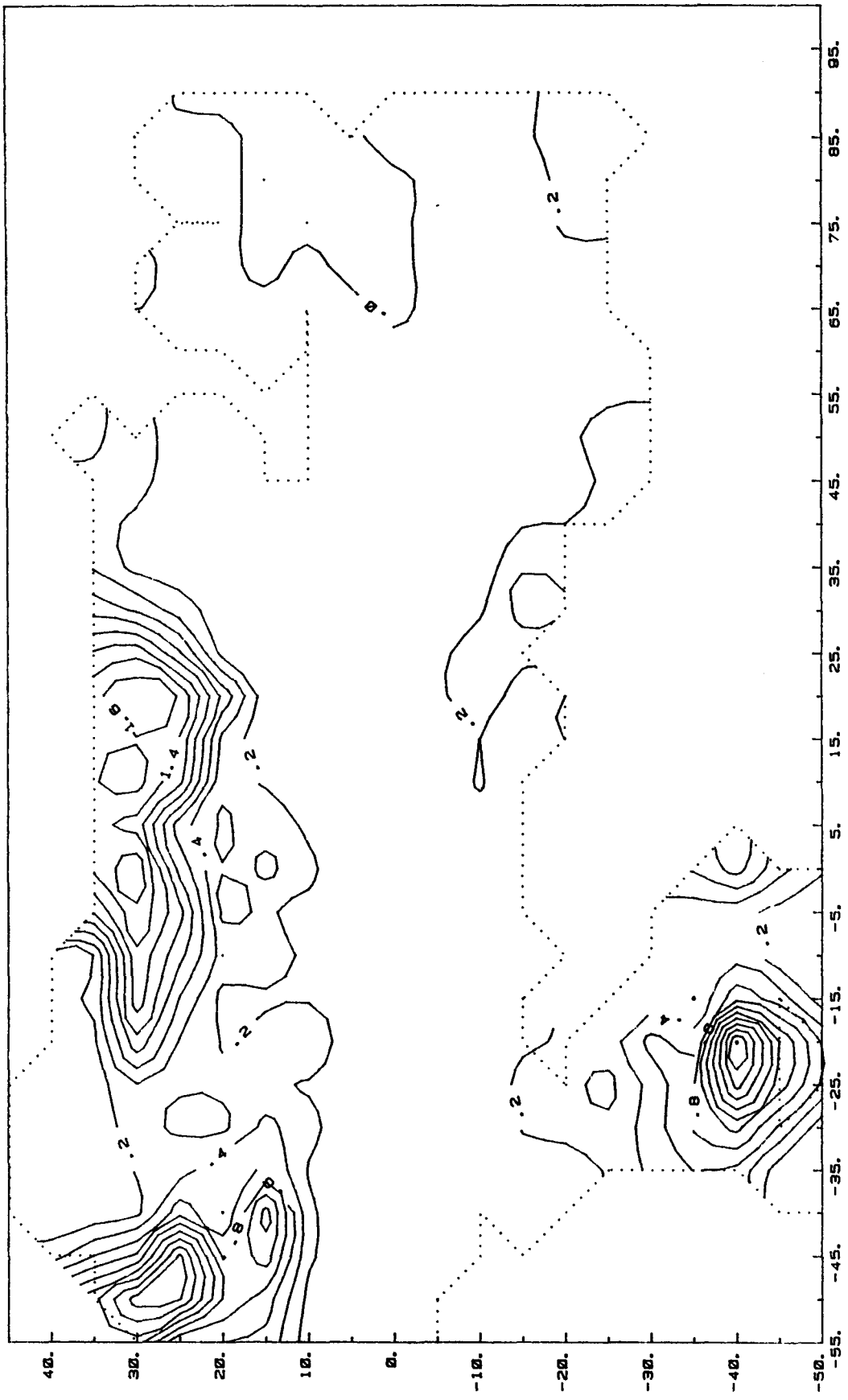
-50.

- 1973 -



- 1974 -

- 1975 -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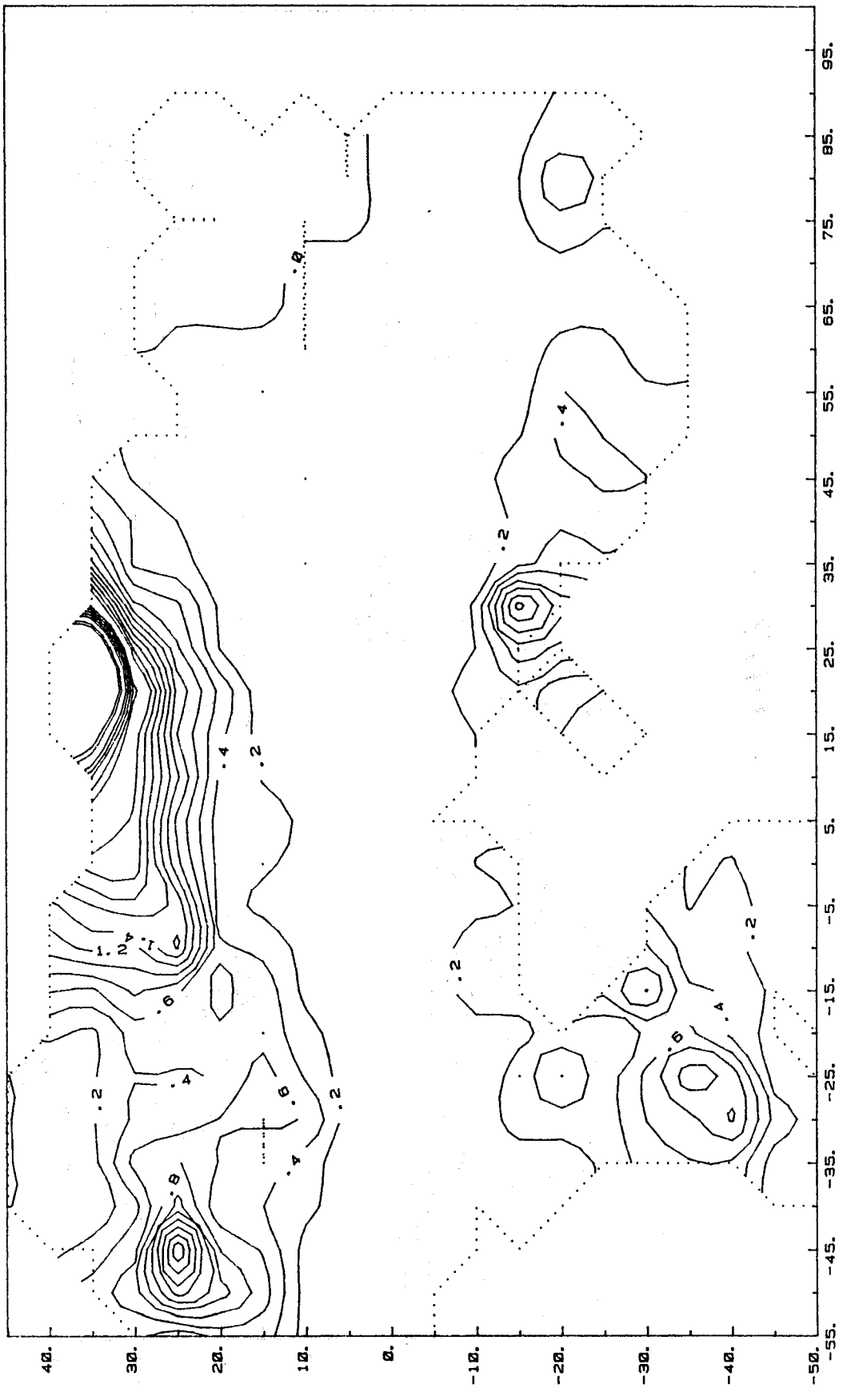
-50.

- 1976 -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-15.
-5.
5.
15.
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65.
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35.
25.
15.
5.
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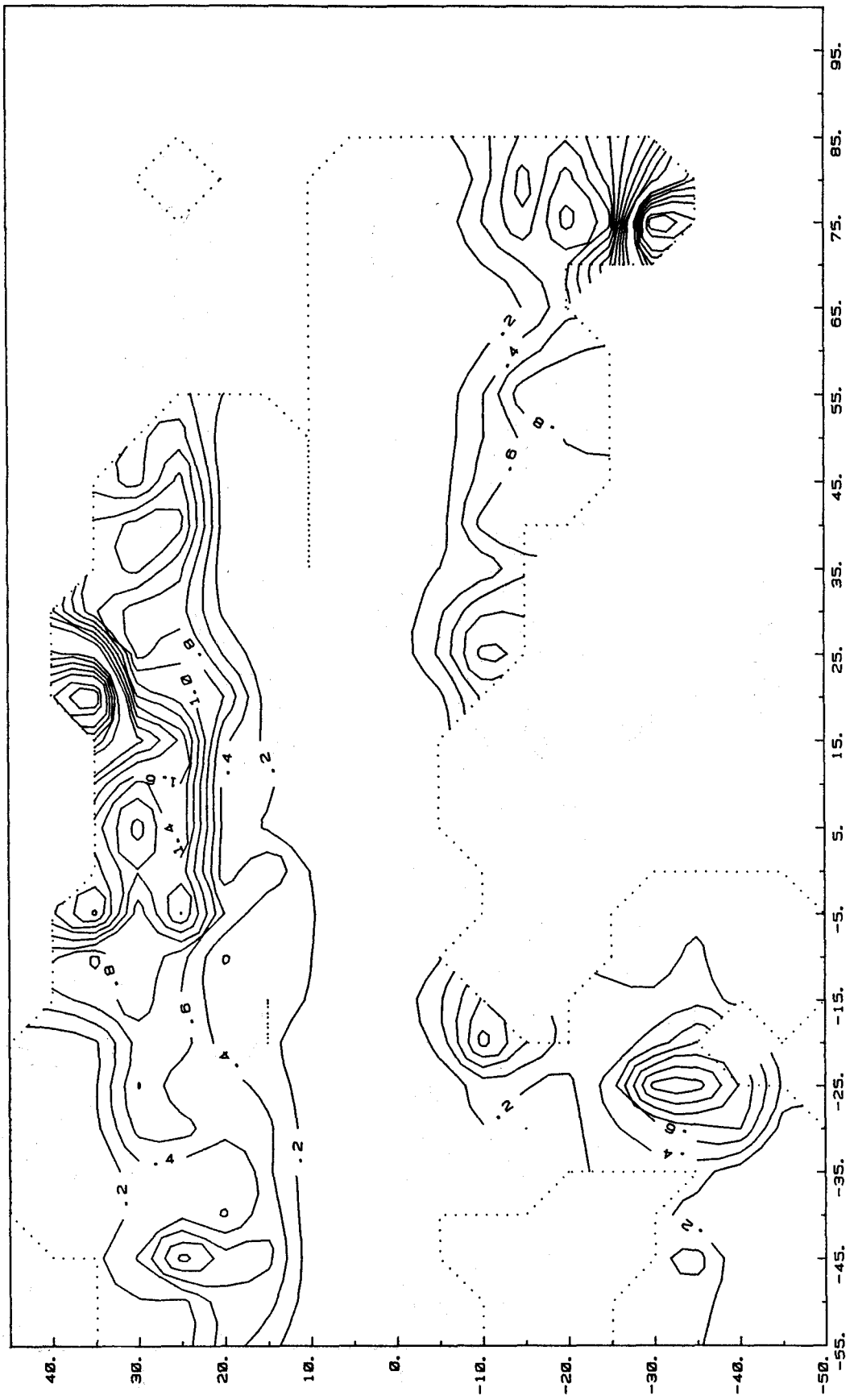
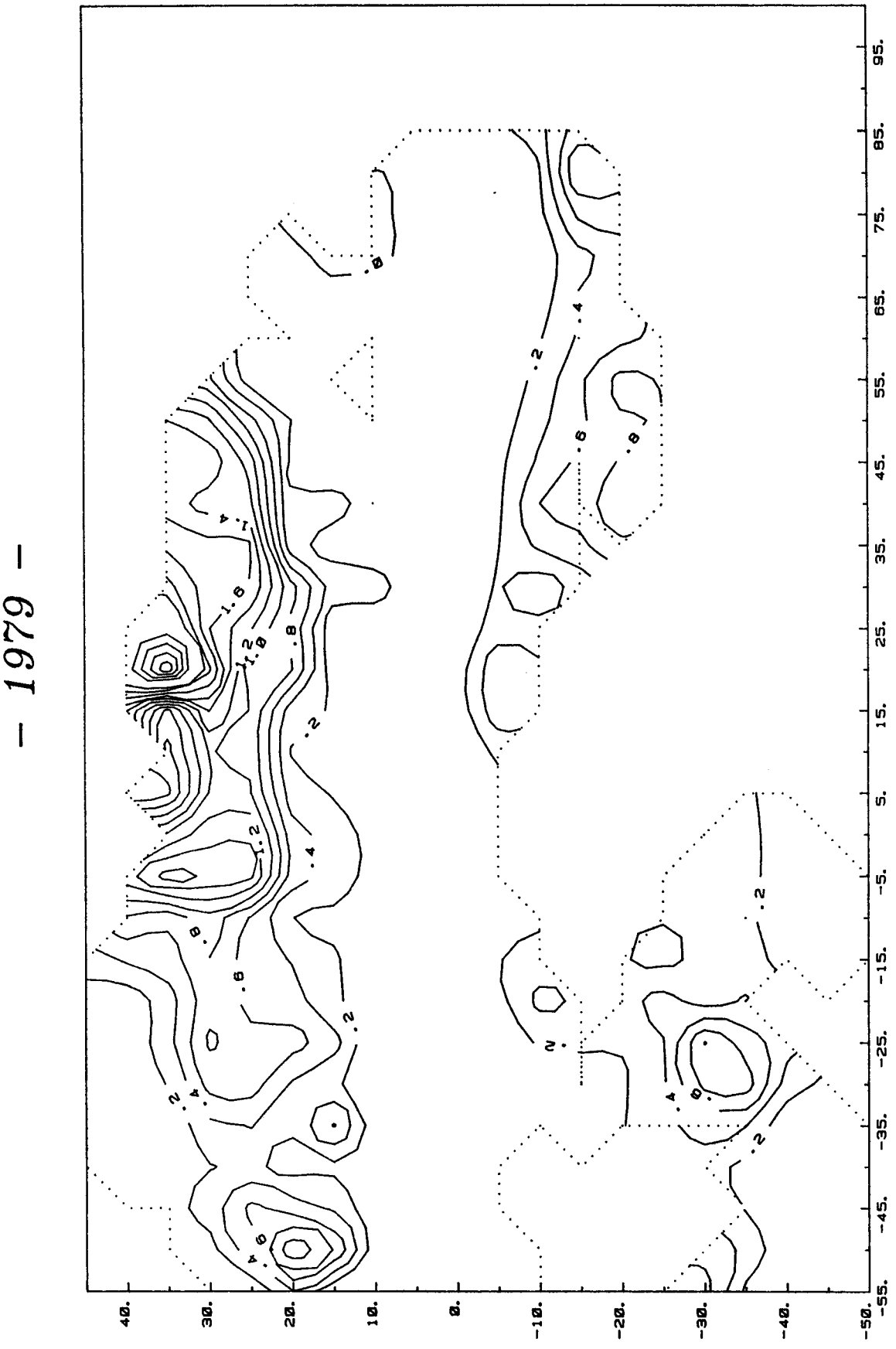
1.6

– 1977 –



- 1978 -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15.
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-5.
-15.
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-35.
-45.
-55.

- 1980 -

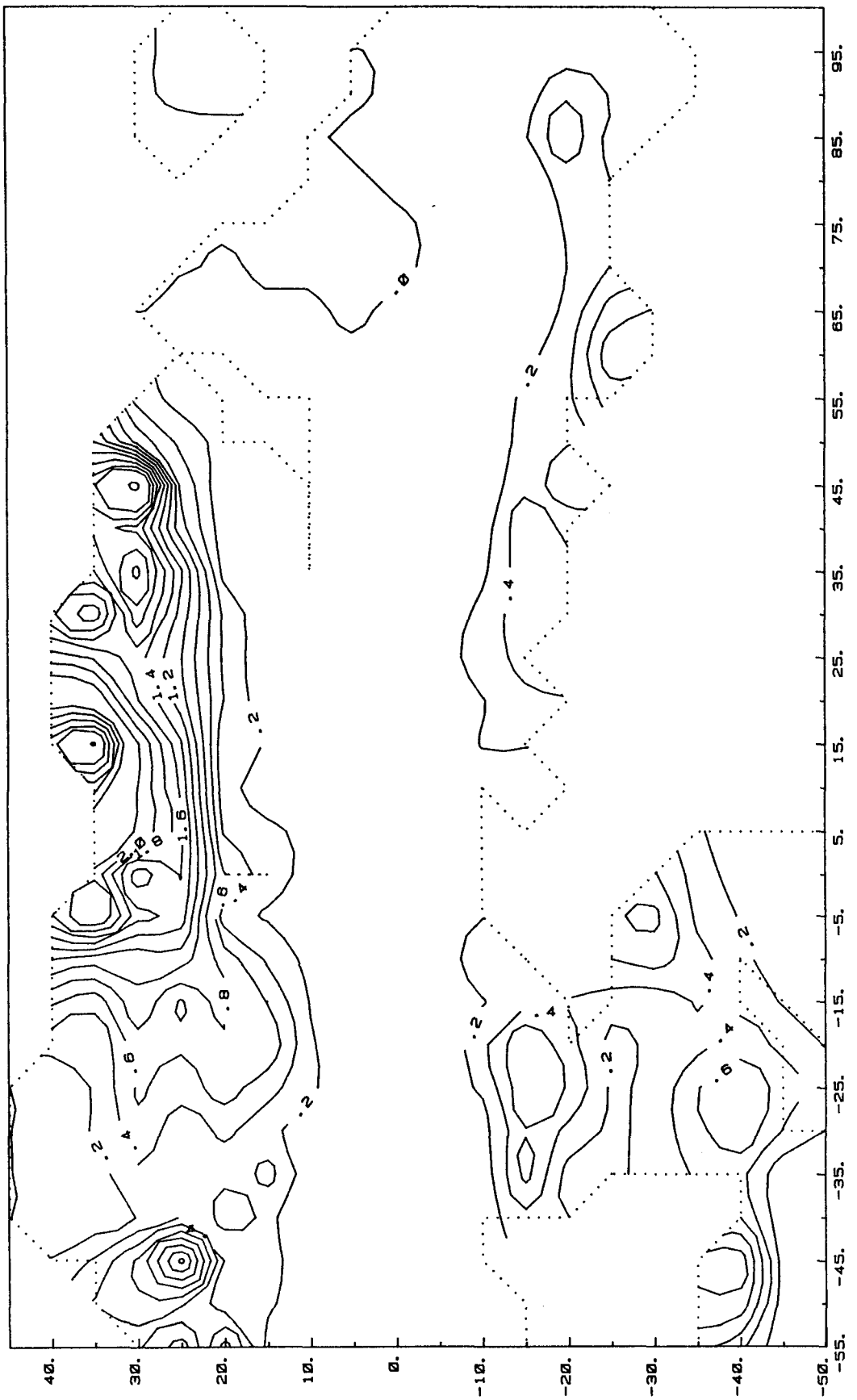
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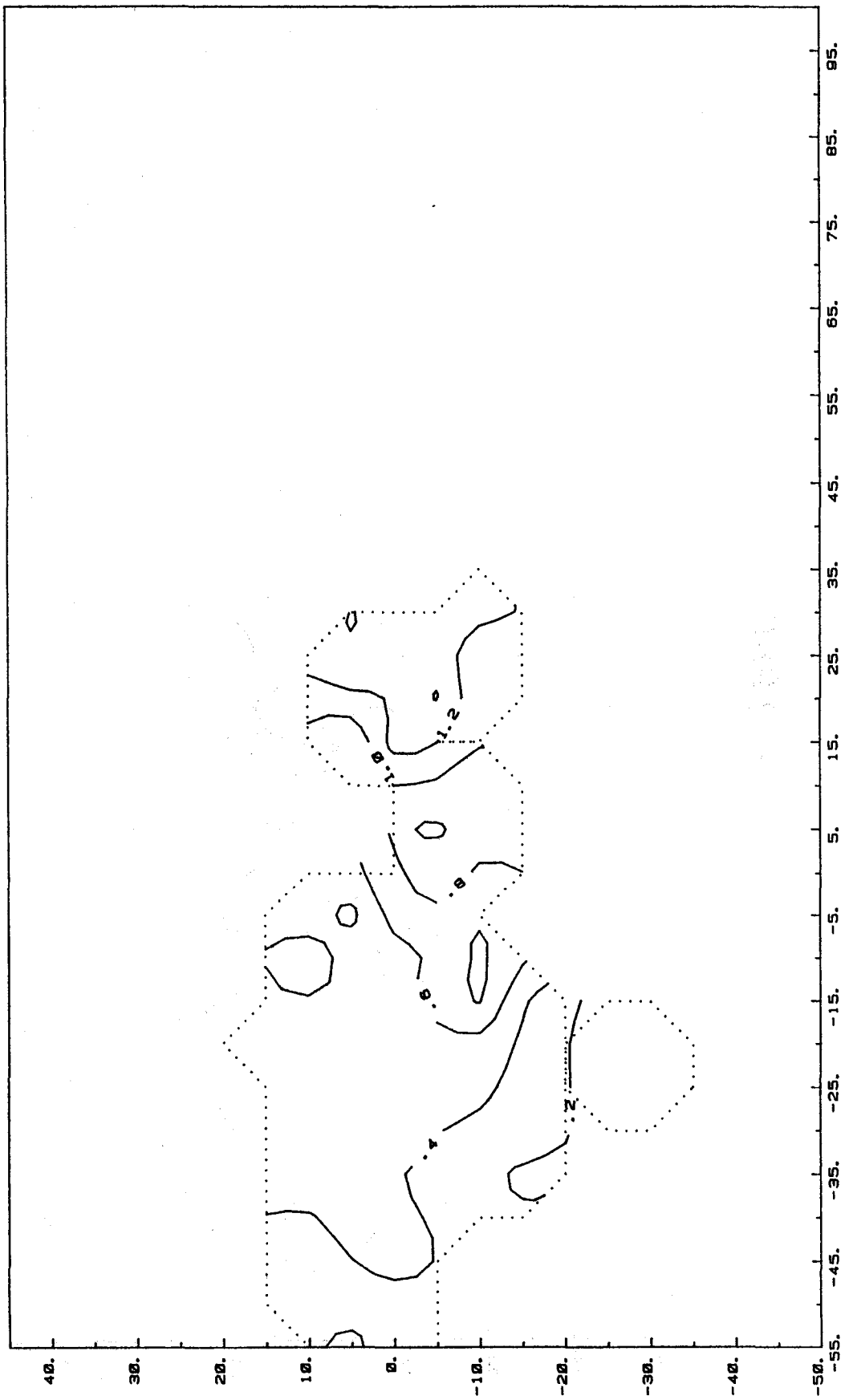
Figure 6. Contour plots of albacore catch rates from 1979-1985 based on logsheet data available to the TBAP.

- 1979 -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75.
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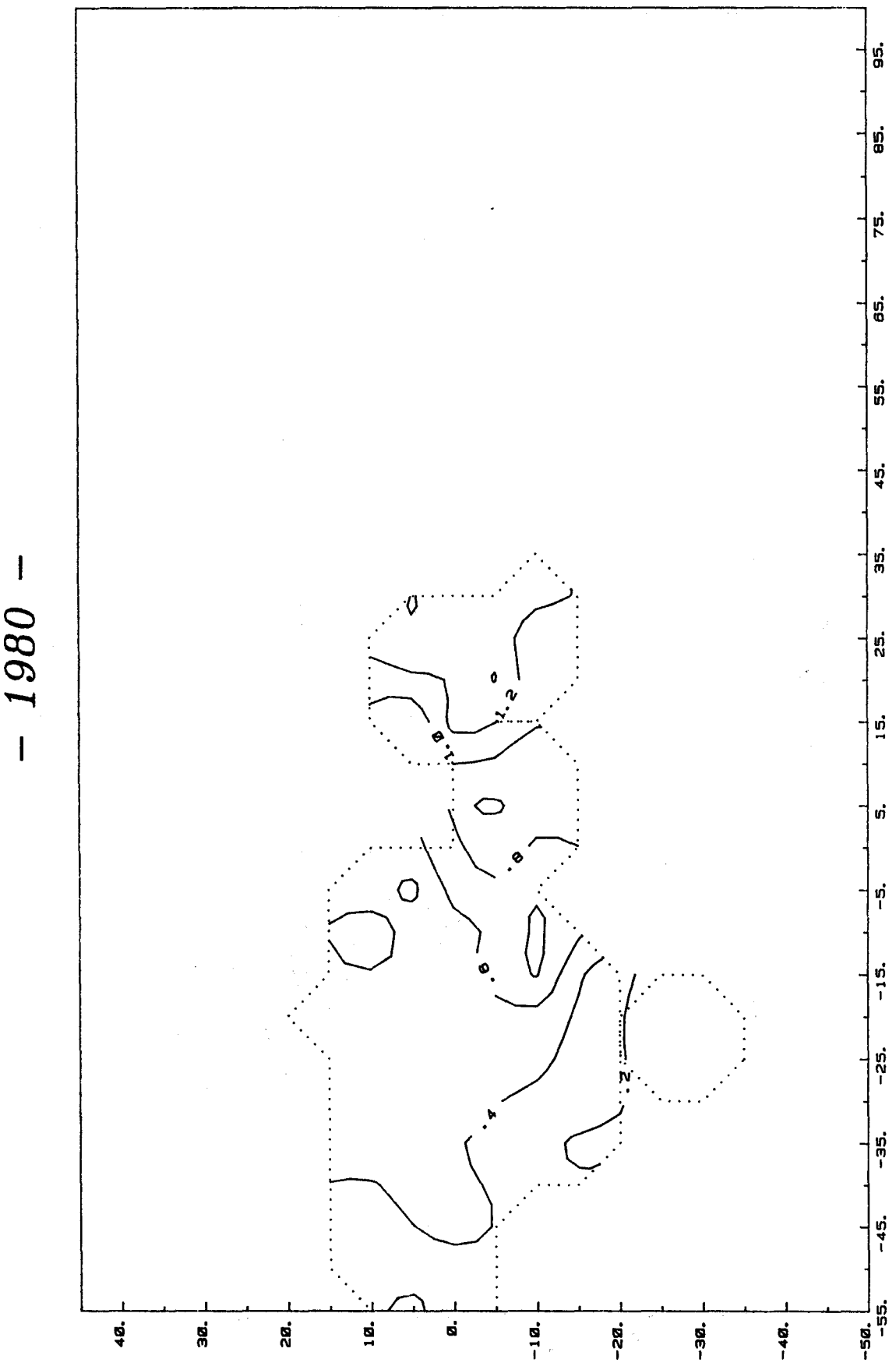
95.


- 1980 -
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40.
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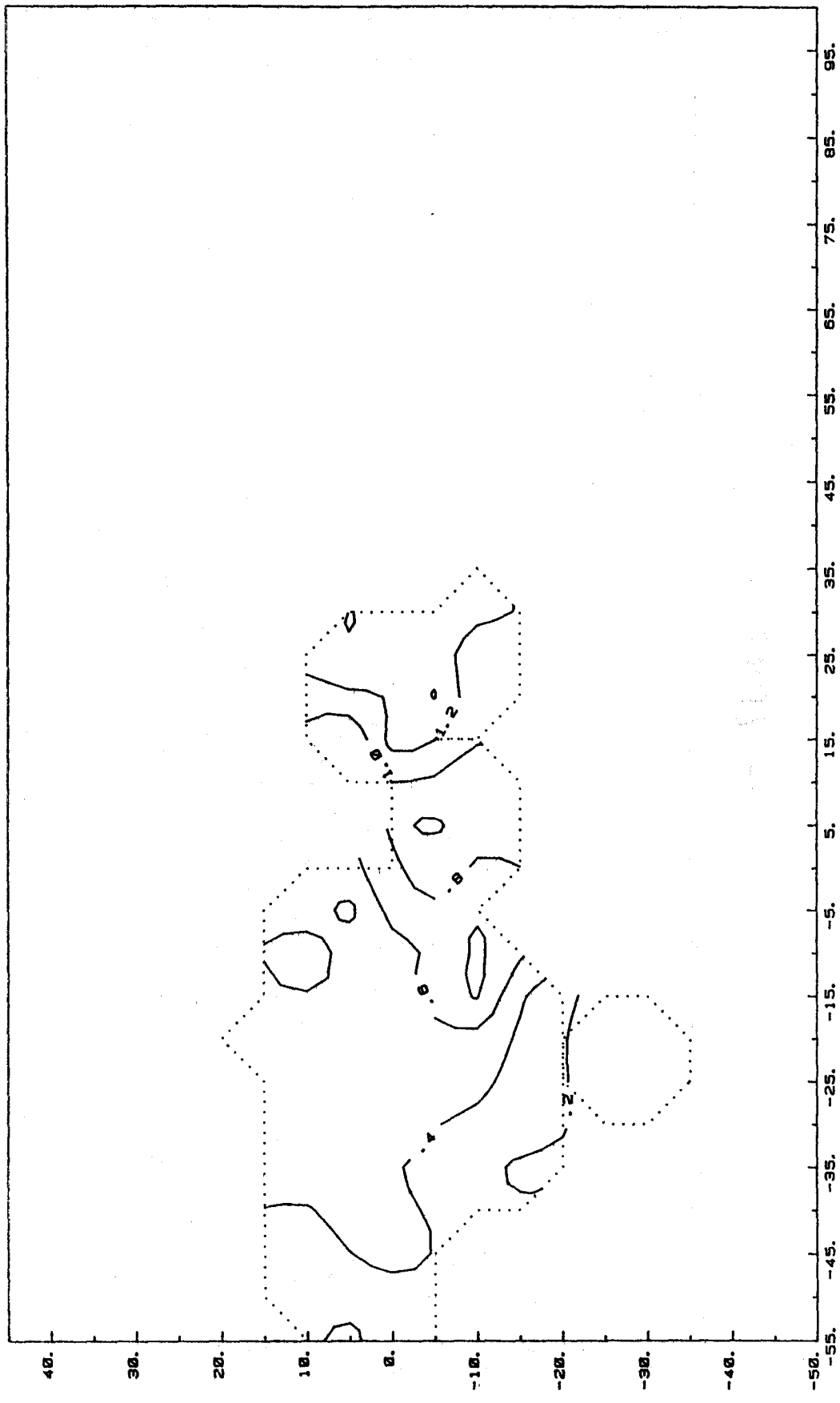
1.0
1.2

- 1981 -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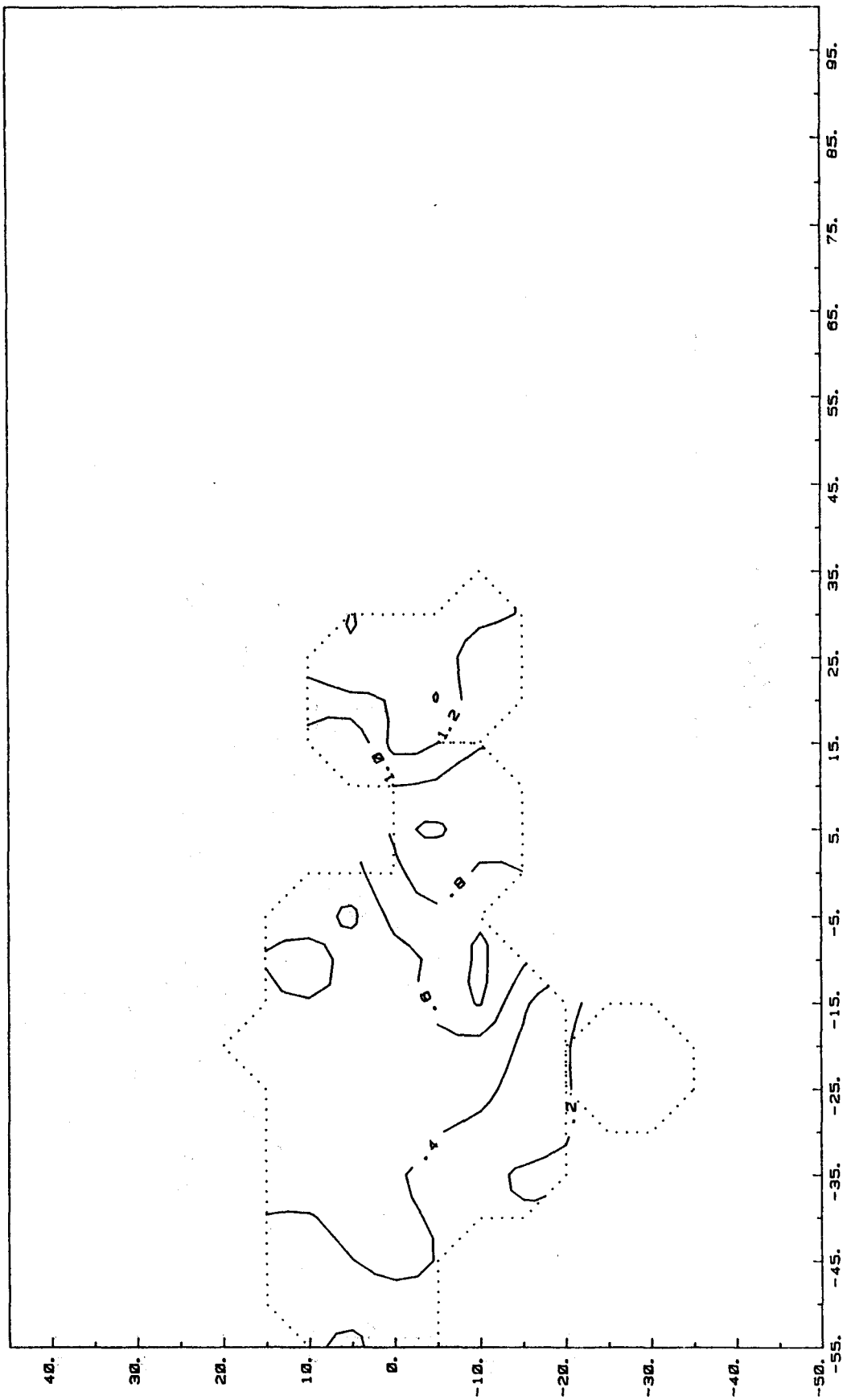
- 1982 -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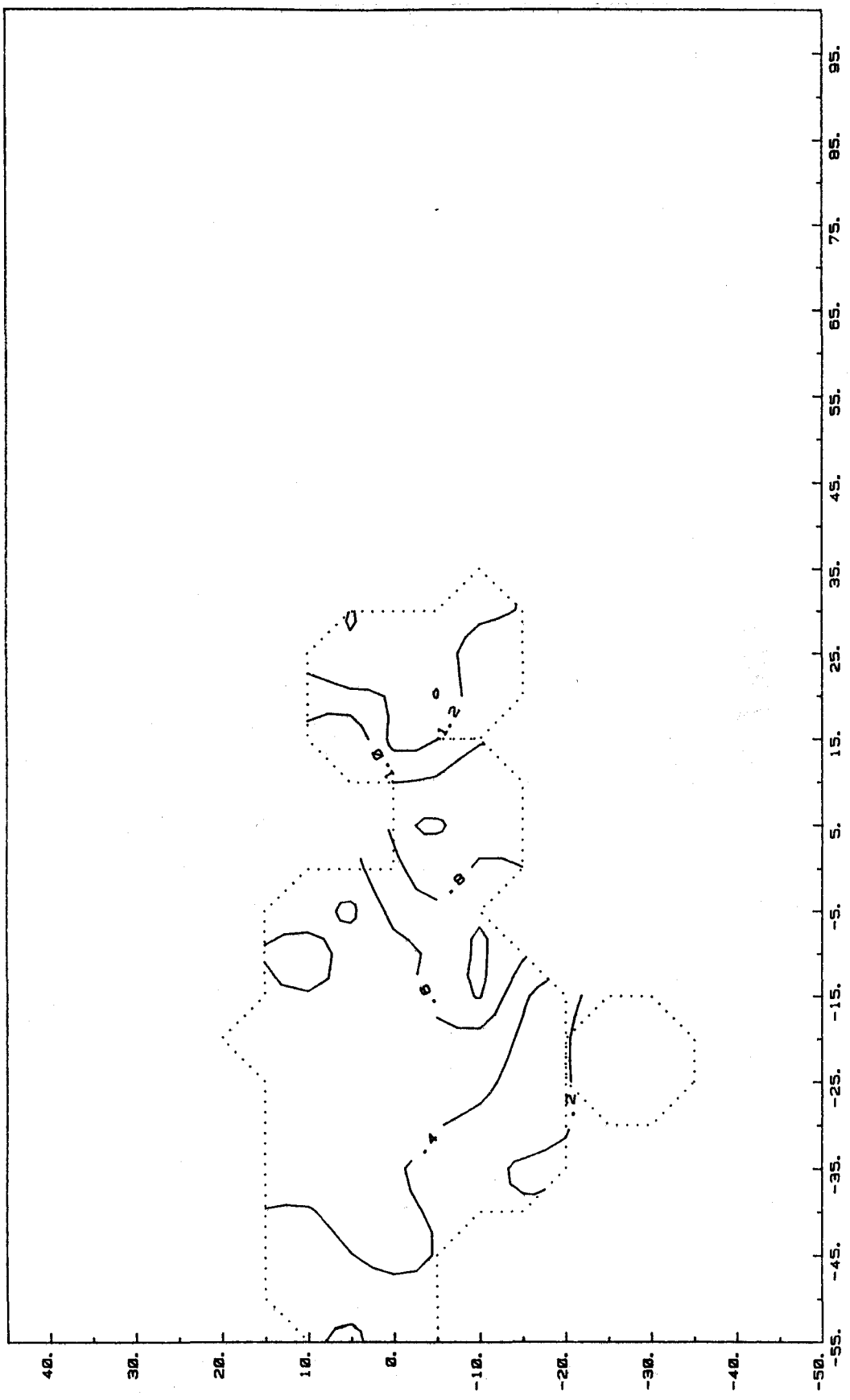
1.2
0


- 1983 -
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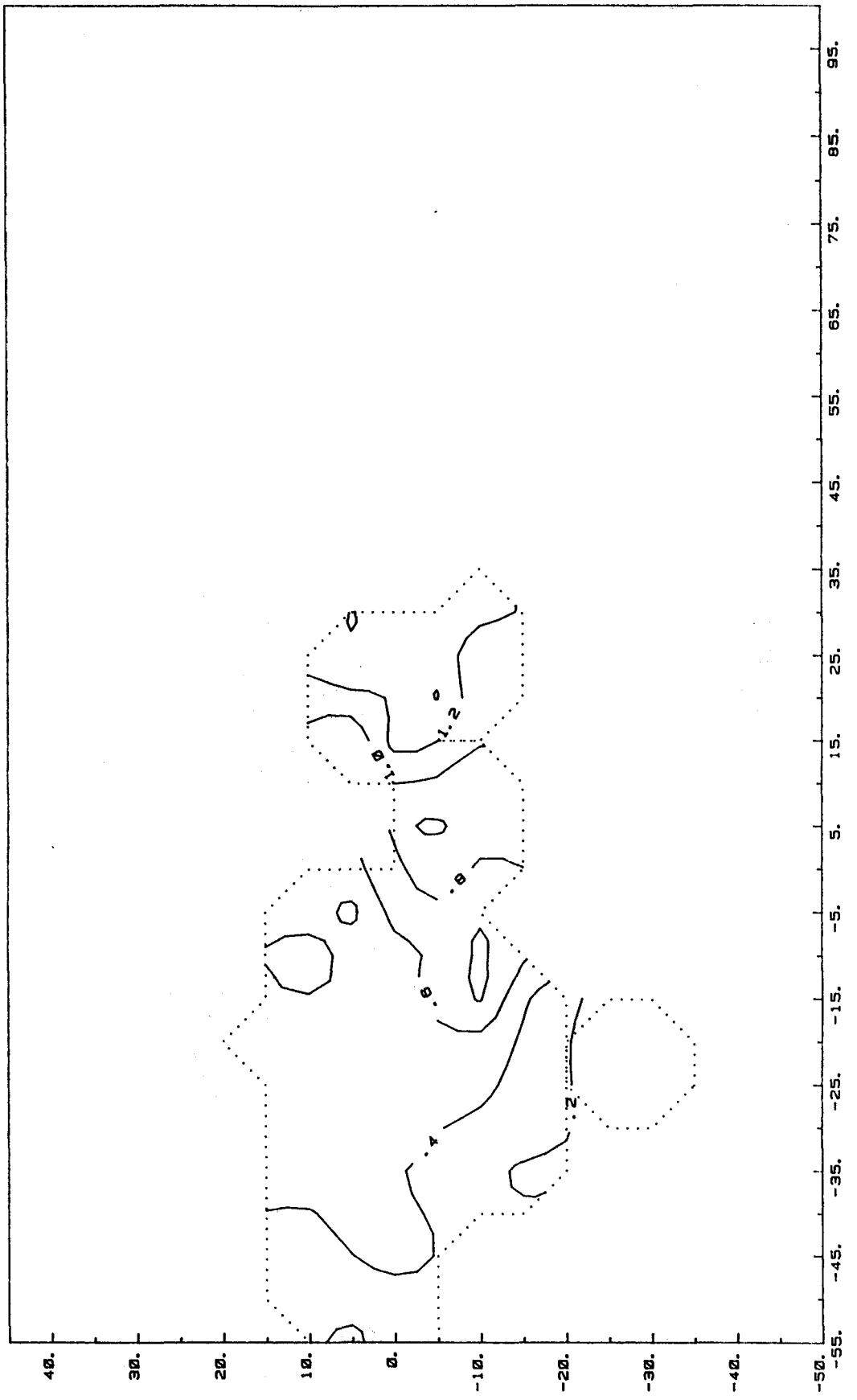
95.

- 1984 -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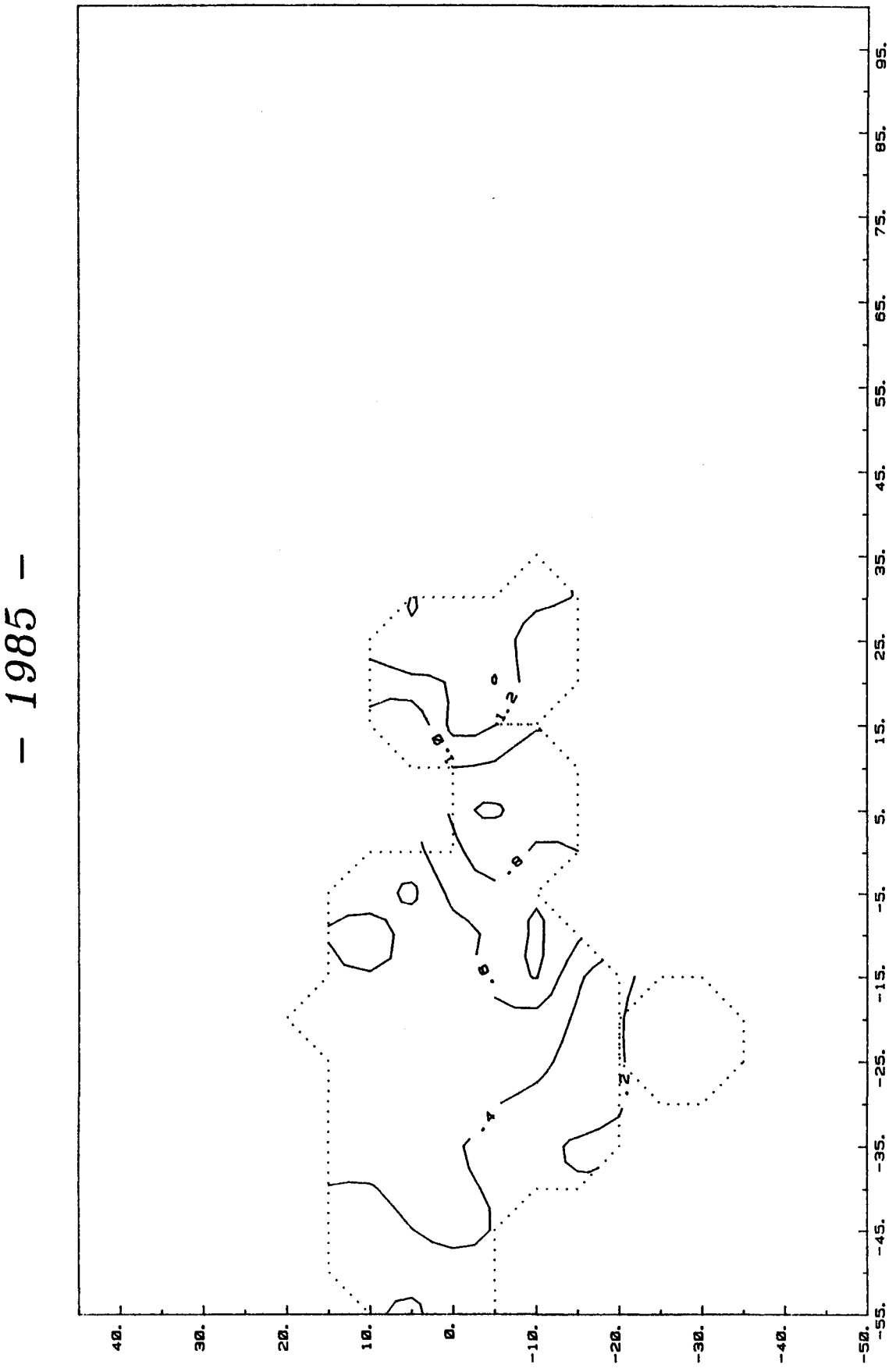
- 1985 -
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Figure 7. Overall average contour plots of yellowfin catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.

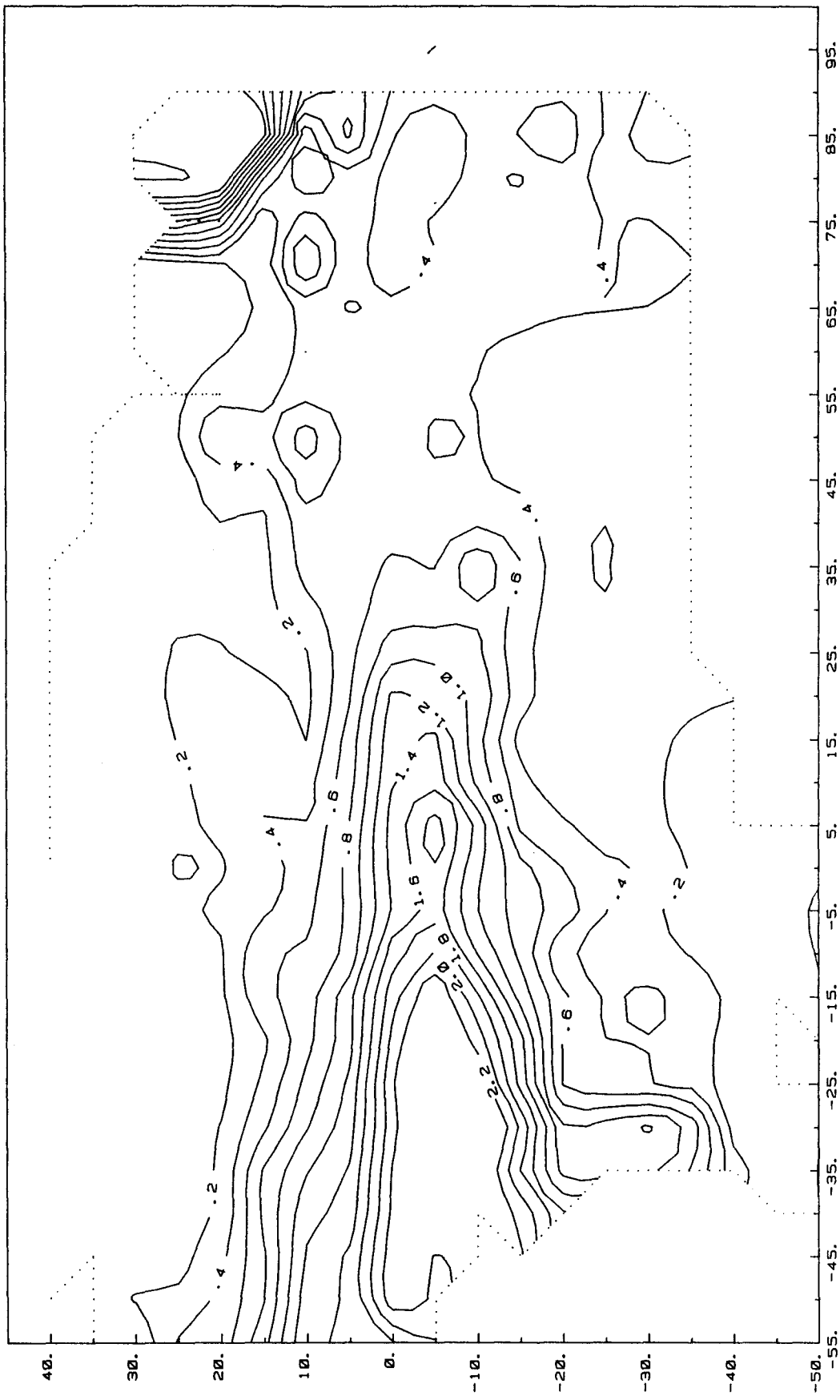
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Figure 8. Overall average contour plots of bigeye catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.

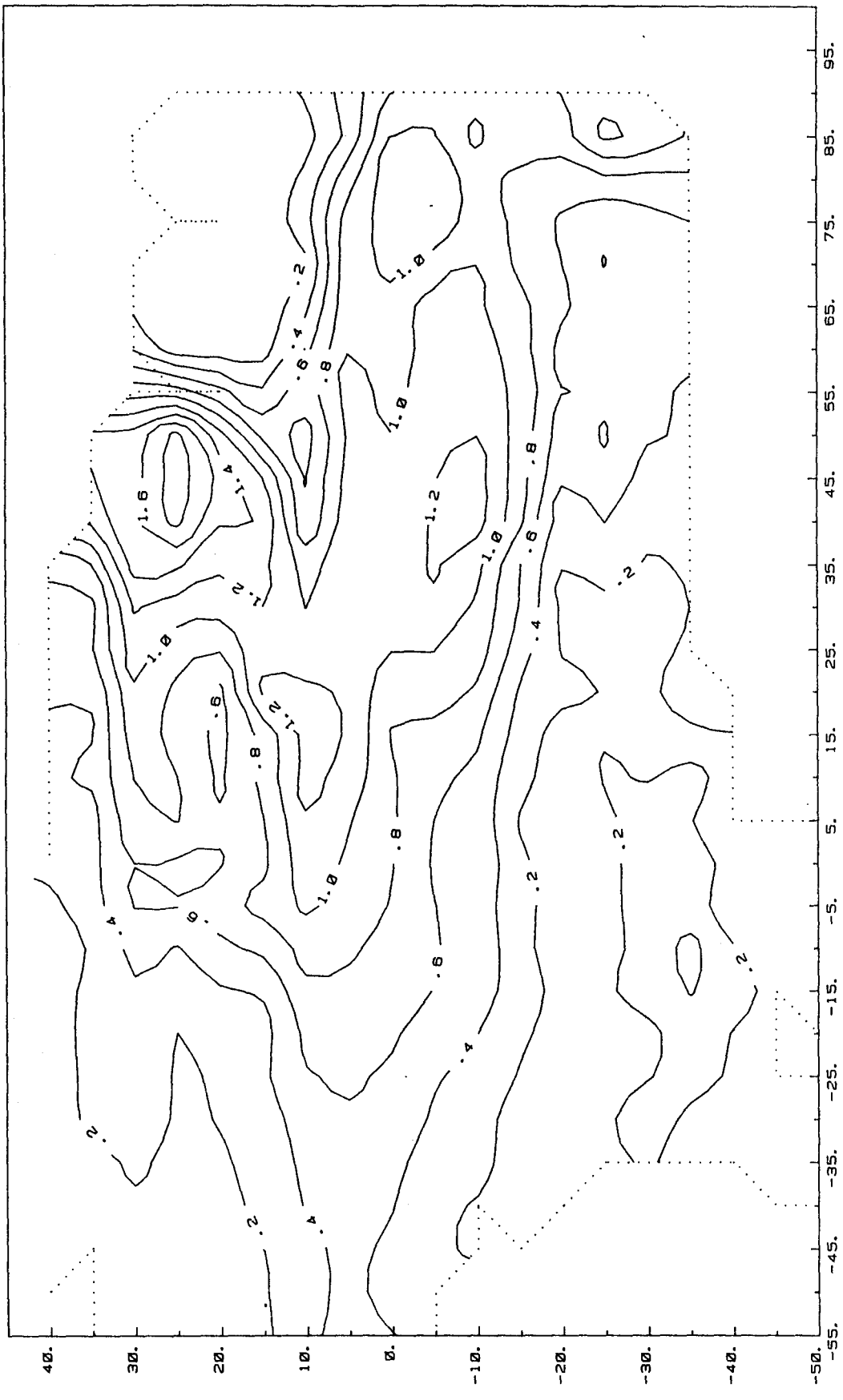
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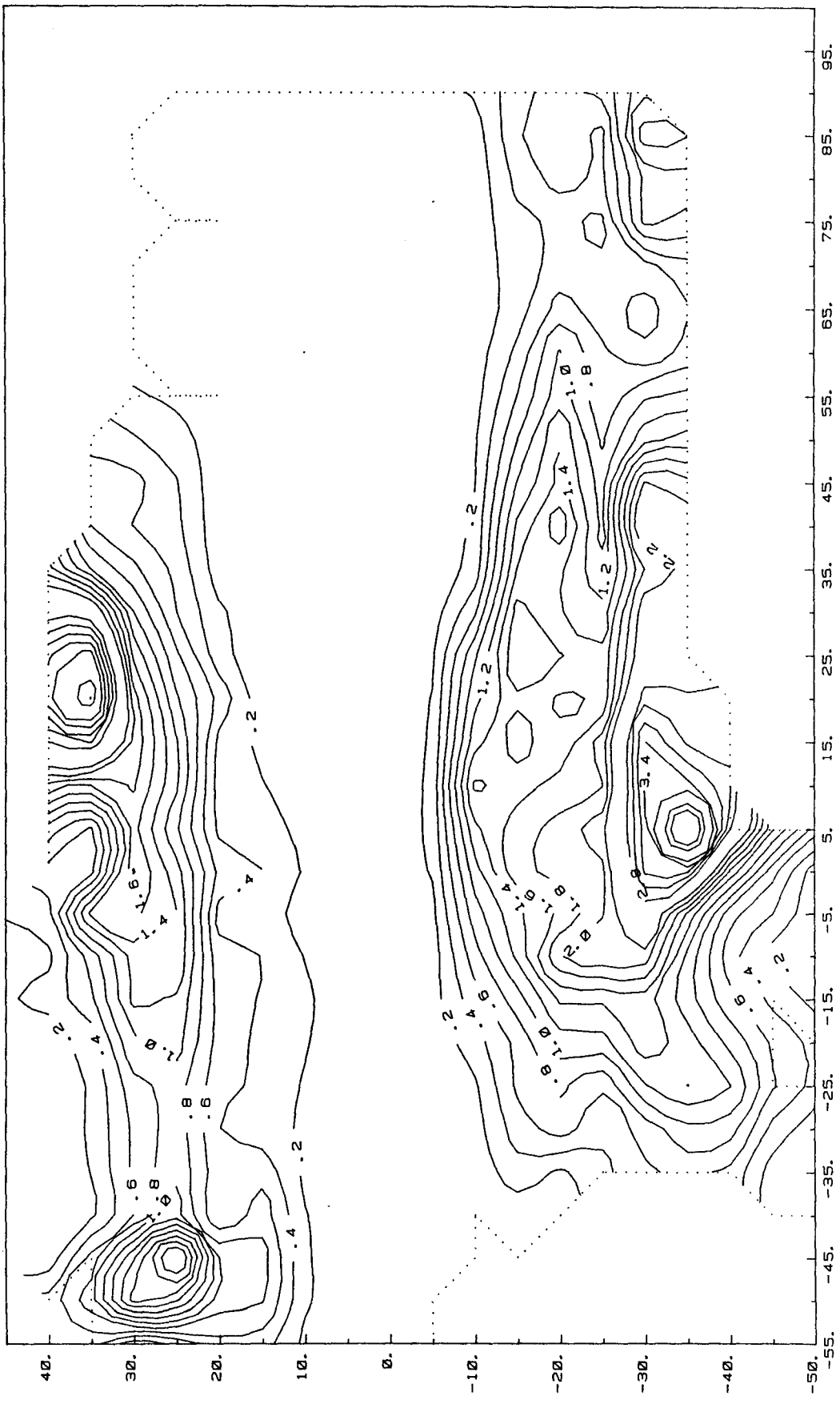
Figure 9. Overall average contour plots of albacore catch rates from 1962-1980 based on published data by the Fisheries Agency of Japan.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