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MARITIME DYNAMIC TRAFFIC GENERATOR. VOLUME III: DENSITY DATA ON WORLD MAPS

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MARITIME DYNAMIC TRAFFIC GENERATOR
Volume III: Density Data on World Maps

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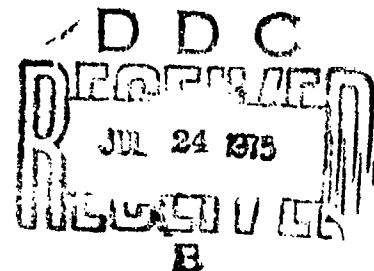Franklin D. MacKenzie

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16. Abstract

The 18,000 vessels whose weekly movements are tracked by the maritime
traffic generator represent 106 different countries. There are
4915 vessels five or less years old. The record for the week of
January 26, 1972 includes 11,789 arrivals, 10,896 departures, 10,843
vessels at sea and 4362 completed voyages. For the same period
there were 2 vessels sunk, 30 in collision, 86 with other forms of
emergencies, 22 aground and 1 suffered weather damage. This data
is summarized in Volume I:Summary Documentation. The processor
program is described in Volume II:Electronic Data Processing Program.
This volume contains the most generally useful data output from
the maritime generator in a compact form for use by analysts working
in the Maritime Field.

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PREFACE

The analytical tool described in this report was created in support of an overall program at the Transportation Systems Center to define and analyze requirements for navigation and communication services through a satellite for commercial vessels. This program is sponsored by the Department of Transportation, through the United States Coast Guard, Office of Research and Development. The program supports Government activities designed to promote maritime safety through improved communication service.

Vessel movements during the year 1972 were recorded and processed by the maritime dynamic traffic generator. The routes and the numbers of vessels in each five degree square were plotted on a world map. The objective of this work was to determine the number of potential users of a satellite communication service and the required satellite coverage to provide this service.

The processor program was designed by Paul J. Connolly,* Kentron Hawaii Ltd., assisted by J. Van Etten and T. Talbot, Kentron Hawaii Ltd.

*Now with DOT/Transportation Systems Center, Control and Simulation Branch.

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1. SUMMARY

1.1 PURPOSE

This report presents the most generally useful data output from the Maritime Dynamic Traffic Generator in a compact form for use by analysts working in the maritime field. It describes the source of the input data and the electronic data processor program used to create this data output. In addition, the assumptions in the program are given to provide the users with a basis for judging the validity of the data for use in their areas of interest.

1.2 SCOPE

Each week in 1972 the movements and latest reports of 18,000 merchant vessels listed in Lloyd's Shipping Index were processed through the Maritime Dynamic Traffic Generator. This electronic data processing program was designed to move the vessels along shipping lanes to their destination and keep statistical records of the ports visited, the occurence of casualties and the status of each vessel. The data output in this report is the daily average density displayed on a world map. There is one plot for each week of 1972.

1.3 CONCLUSIONS

The Maritime Dynamic Traffic Generator is a unique analytical tool to be used by satellite system engineers to determine maritime user distribution and satellite coverage requirements.

Its output has potential for satisfying requirements in related maritime areas. System analysts can use the output with confidence in its validity, provided the source of the data input, the assumptions in the processing program and the rationale for the data output formats are understood.

The most generally useful data output from the Maritime Dynamic Traffic Generator is the weekly plots of the daily density of maritime traffic on a world map.

1.4 RECOMMENDATIONS

The density plots should be validated after ten years or if there is a major change in the shipping routes, such as the opening of the Suez Canal.

For a detailed description of the method of creating the density plots, see the Maritime Dynamic Traffic Generator - EDP Program Description in volume 2 of this report.

To improve the accuracy of the shipping routes, the density data plots should be correlated with the Amver density data plots for the same periods.

2. BACKGROUND

The Navigation and Traffic Control Panel of the National Academy of Sciences, Summer Study on Space Applications concluded in 1969 (Ref. 1) that economic benefits to the maritime community from a satellite system providing traffic control and enroute navigation would exceed the cost of such a system. In October of that year, the NASA/Electronics Research Center plotted the routes of 400 randomly selected vessels from the Lloyd's Shipping Index on a world map (Ref. 2, 3, 4). The plot was done manually and was to be used as a method for determining the required coverage from a satellite antenna to provide a navigation and traffic control function. However, when tests of significance were applied to the 400 vessels, it was discovered that a minimum of 1600 vessels must be plotted before assumptions for the total fleet would be valid.

In November 1970 Automated Marine International published a report (Ref. 5) under contract to the U.S. Coast Guard which demonstrates the advantage of a satellite communication service to the maritime community.

In this report was a plot of the positions of 12,000 merchant vessels, 100 gross tons and over, and 10,000 fishing vessels on a world map.

In 1971, the DOT/Transportation Systems Center decided to create a series of world plots to display the positions of vessels, dynamically, as they change their routes in response to seasonal variations and economic pressures. The 18,000 vessels of the Lloyd's Shipping Index was chosen as the data input source. Each weekly issue of the Index for 1972 was photographed and enlarged, and the data was keypunched and stored on magnetic tape for automatic processing. A processor program was created to move the vessels along standard routes and to keep a statistical record of their positions. Subroutines to enable the input data to be filtered and display formats were designed to service the needs of

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the satellite system designed. In June of 1973, all the source
data had been processed and 52 weekly density distribution charts
were printed.

3. DENSITY DATA PLOTS

3.1 DESCRIPTION AND SCOPE

The density data on a world map is the most generally useful form of the output from the Maritime Dynamic Traffic Generator. Analysts in the maritime field can use this statistical data to extract area densities and seasonal fluctuations. The assumptions and a method to improve the quality of the data is given.

For each week in 1972, the generator processed the data input from the Index along standard shipping routes to their destinations. Each five degree square was a counter that kept track of the number of vessels passing through. At the end of each week, the total number of vessels would be divided by the number of days to calculate the daily average number of vessels. This number was printed on a world map in the corresponding five degree square.

3.1.1 Assumptions

The two assumptions that were used in the generator and have a direct impact on the density data plots are that vessels travel at 15 nautical miles and that they follow standard shipping routes. The impact of the first assumption is ameliorated if the vessel's data entry includes a "latest report" when it passes prominent landmarks. The vessel is placed at the location of the latest report on the correct date and the data in the generator is adjusted. The second assumption impacts the location of the vessels only when they are on high seas. Within the confluence areas, the vessels move along the shortest straight line path provided the path does not cross a land mass. On the high seas, the vessels move along routes selected from the Pilot Charts published by the Defense Mapping Agency Hydrographic Center for merchant shipping. Each month new charts for the North Atlantic and North Pacific are available, whose routes are changed to take advantage of the wind and currents and to avoid weather hazards. The charts for other areas change quarterly. Although the routes

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in the generator are fixed, the 5° squares are 300 nautical miles wide and encompass much of the variations.

3.1.2 Validity

All errors, mis-matched vessels, unknown ports, were designed to be less than 5 percent. Random checks on the input data verified that the errors were always less than 5 percent. From week to week, vessels were matched with their reports. If there was no match in flag, age, or tonnage, a new vessel was created. The number of new vessels was less than 2 percent of the total for the week. If a port was not listed in the port table, the generator would cause the name to be printed out. Manually, the port location would be looked up in Lloyd's Maritime Atlas. The port's coordinates, if available, would be used in the program. The number of ports which could not be located using this method was less than 15 per week.

3.1.3 Improvements

The density data averages can be accumulated to form monthly or yearly averages. This would smooth the data for worst case analysis. If more accurate position information is required, a generator with variable routes should be used. In addition, a time trend analysis can be done for important 5° squares. From this analysis, the seasonal effects on traffic density can be determined.

3.2 APPLICATION

There are many uses for this density data. The most important is the correlation between high density of vessels and the incidence of casualties. Analysts may wish to calculate the potential for casualties in confluence areas. Other analysts may wish to determine products' market potential as a function of trade routes or conduct other studies which depend on ship movement.

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3.2.1 Confluence Areas

As is seen in the casualty tabulation, the frequency of
emergencies is highest where the shipping densities are greatest,
particularly in confluence areas when the lanes cross, diverge and
converge. The major confluence areas are the English Channel, the
general Mediterranean, the approaches to the Northeastern United
States, the approaches to the Mediterranean, the North Sea area,
the United States Gulf Coast and the area around Japan. One-
third of the casualties happening beyond 32 miles from harbors
happen in these confluence areas. There is no ordered and regu-
lated traffic control in these areas today; however, there is an
increasing (voluntary) effort to maintain vessels in sea lanes in
outer and inner confluence areas. One study that is required is
the value of using satellites for surveillance in the outer con-
fluence area and issuing traffic advisories. But satellite sys-
tems not withstanding, any suggested solution to the confluence
area congestion problem - technical, operational or regulatory -
will require the data in the density plots.

3.2.2 Sea Routes

The daily number of vessels going from port to port and the
weekly and seasonal changes are important to analysts who service
the maritime interests. As an example, to answer a question of
the size of the potential market for a weather advisory service,
during the fall hurricane season (U.S.), an analyst can select
the appropriate weekly density charts and plot the known routes of
hurricanes. The number of vessels close to this track will allow
the analyst to size his market.

3.2.3 Studies

The maritime community has a definite need for a
satellite communications service. There are other areas in which
satellites can also be a benefit to the merchant vessels. The
areas of satellite position fixing as applied to the safety of
life and property at sea, and to search and rescue, as well as

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surveillance and traffic advisories for confluence areas are all candidates for studies to ascertain their need, feasibility and effectiveness. These studies will need the data in the density plots for the mission analysis and associated system definition.

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APPENDIX

DENSITY DATA ON WORLD MAPS

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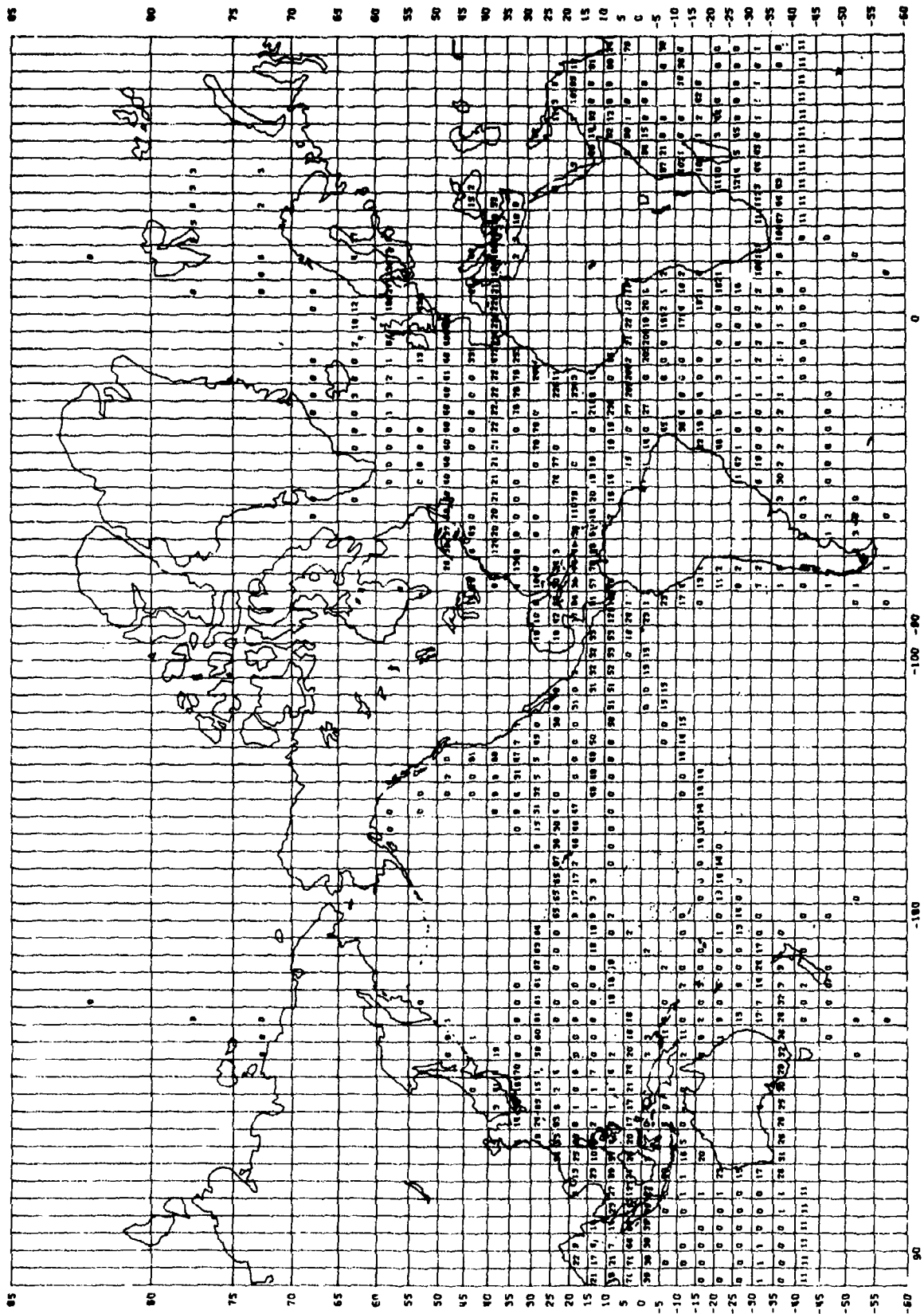
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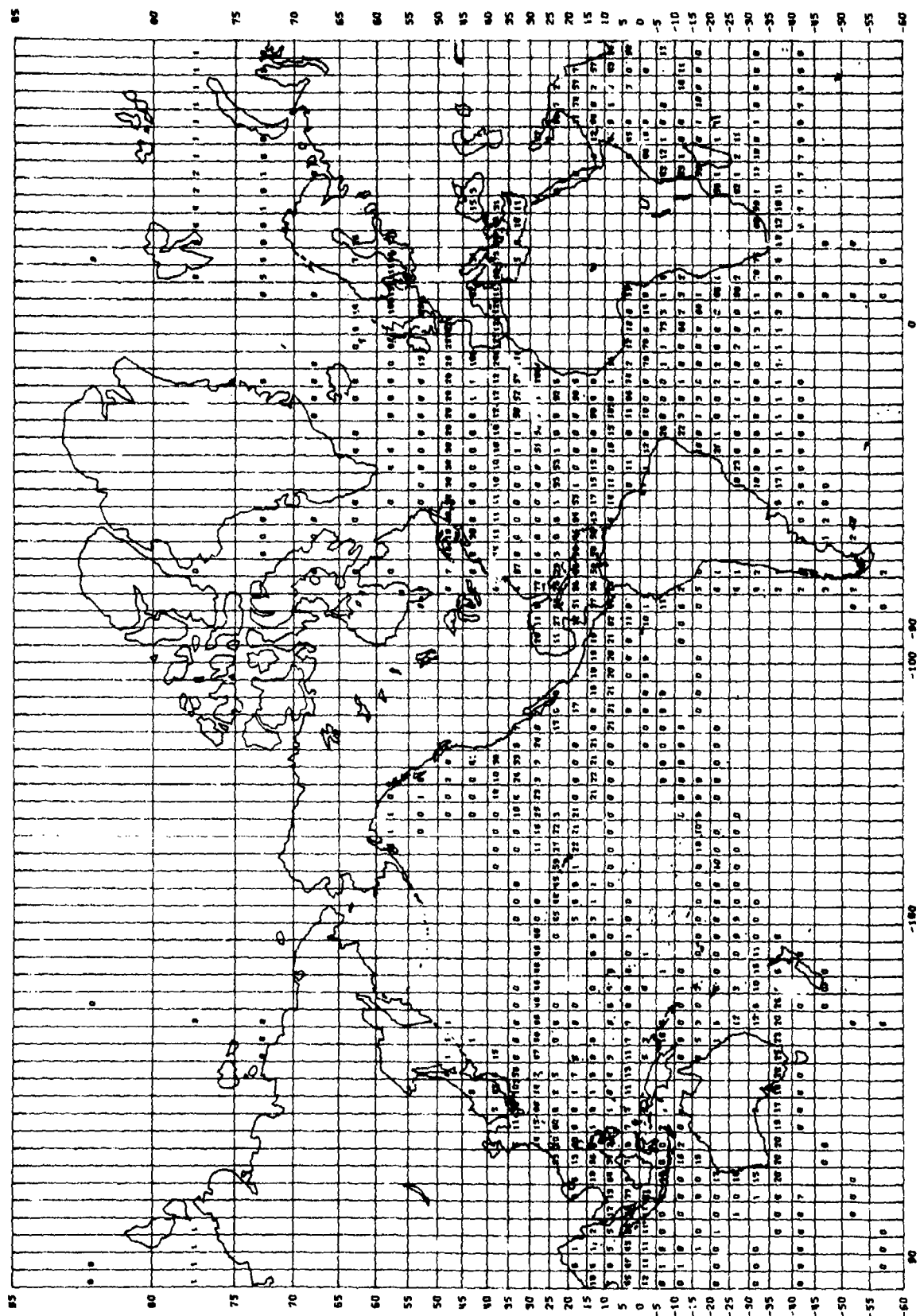
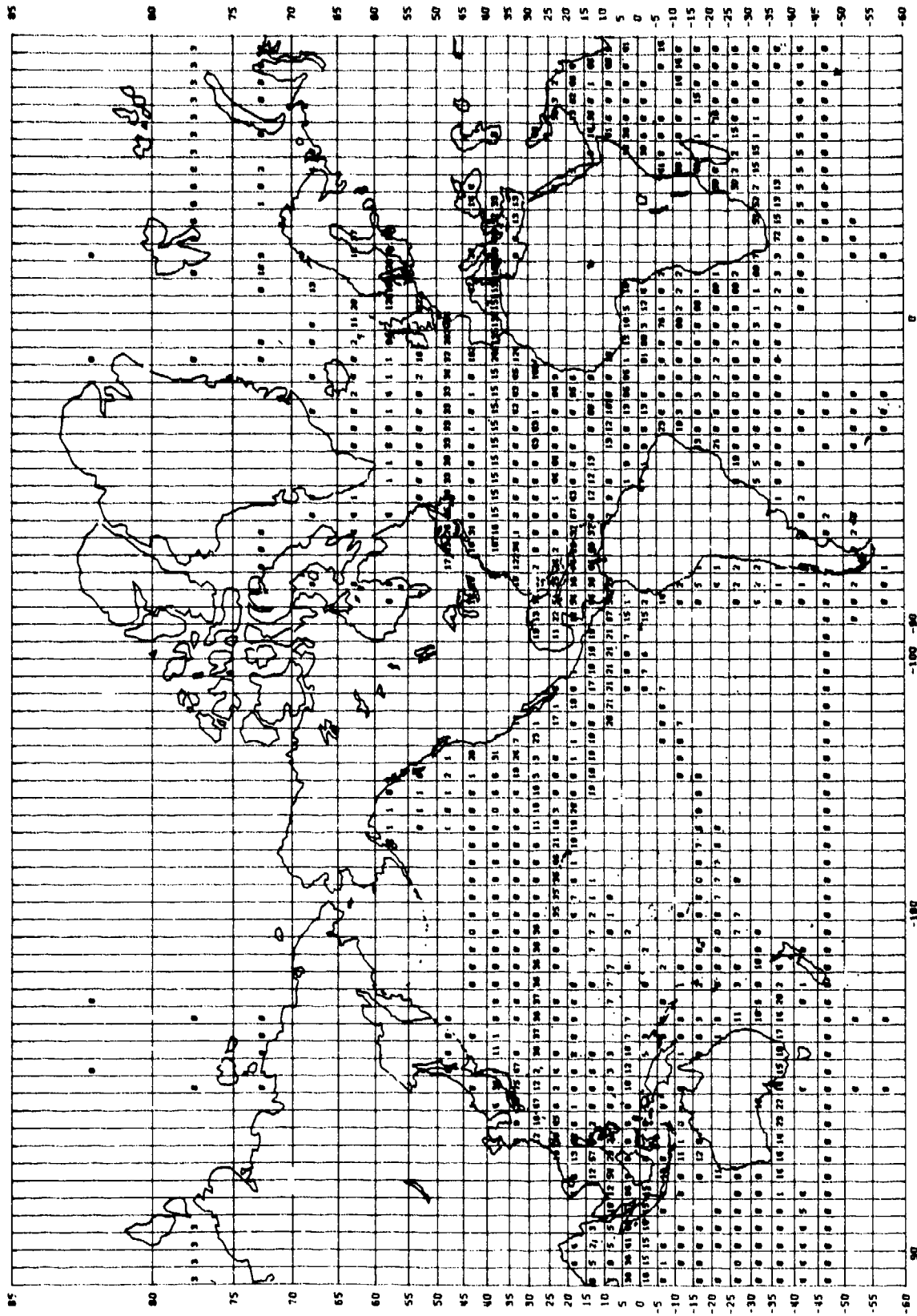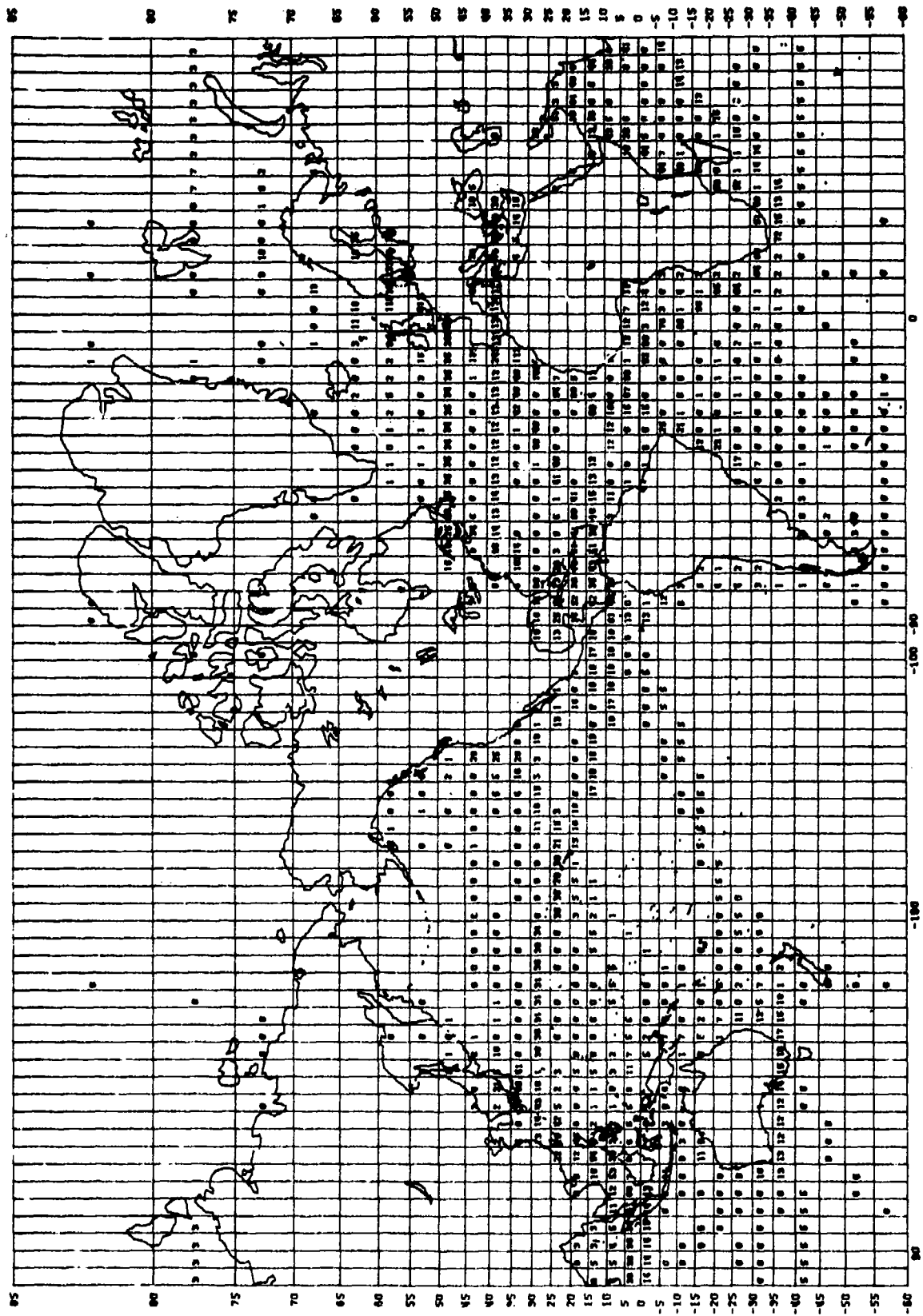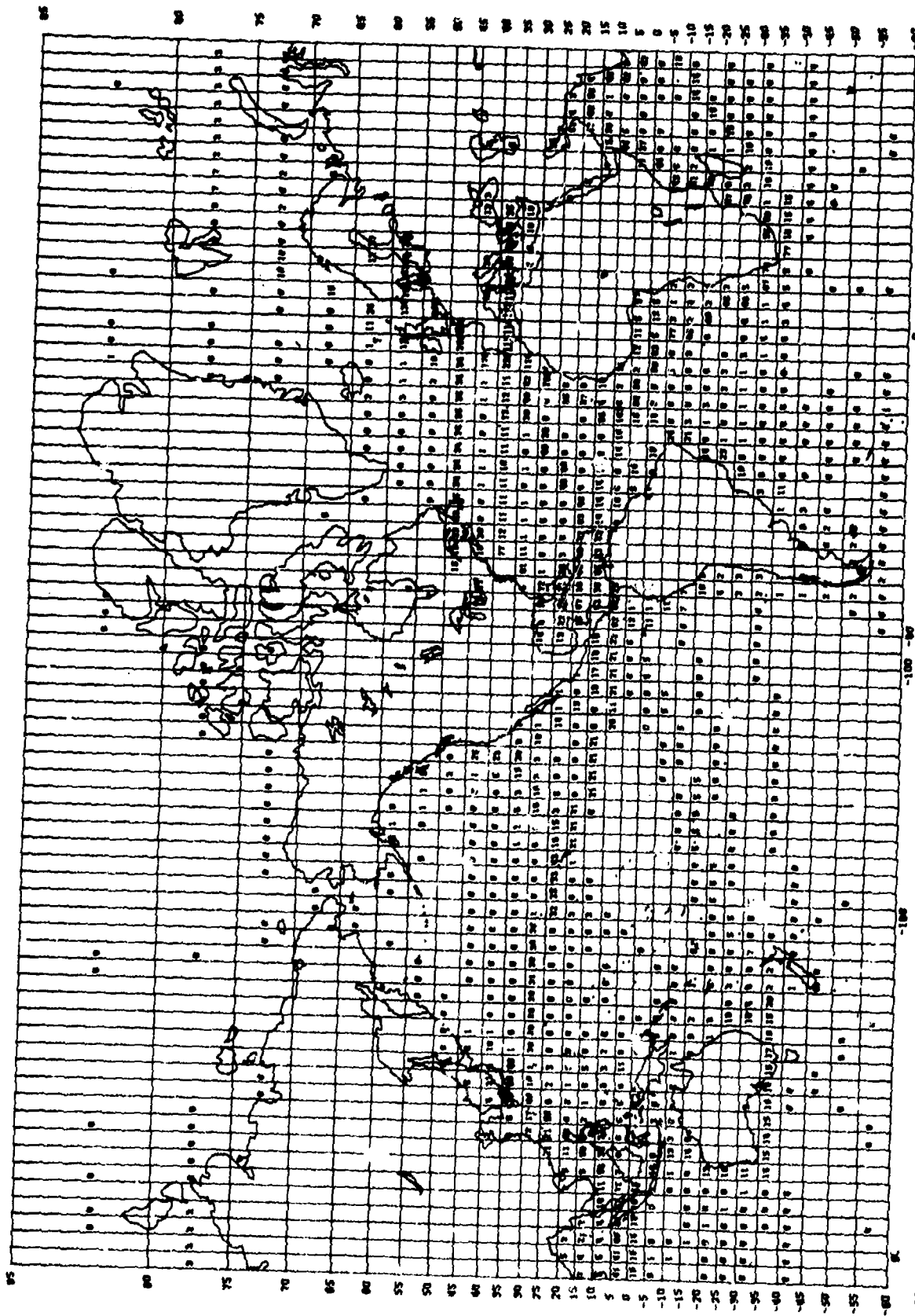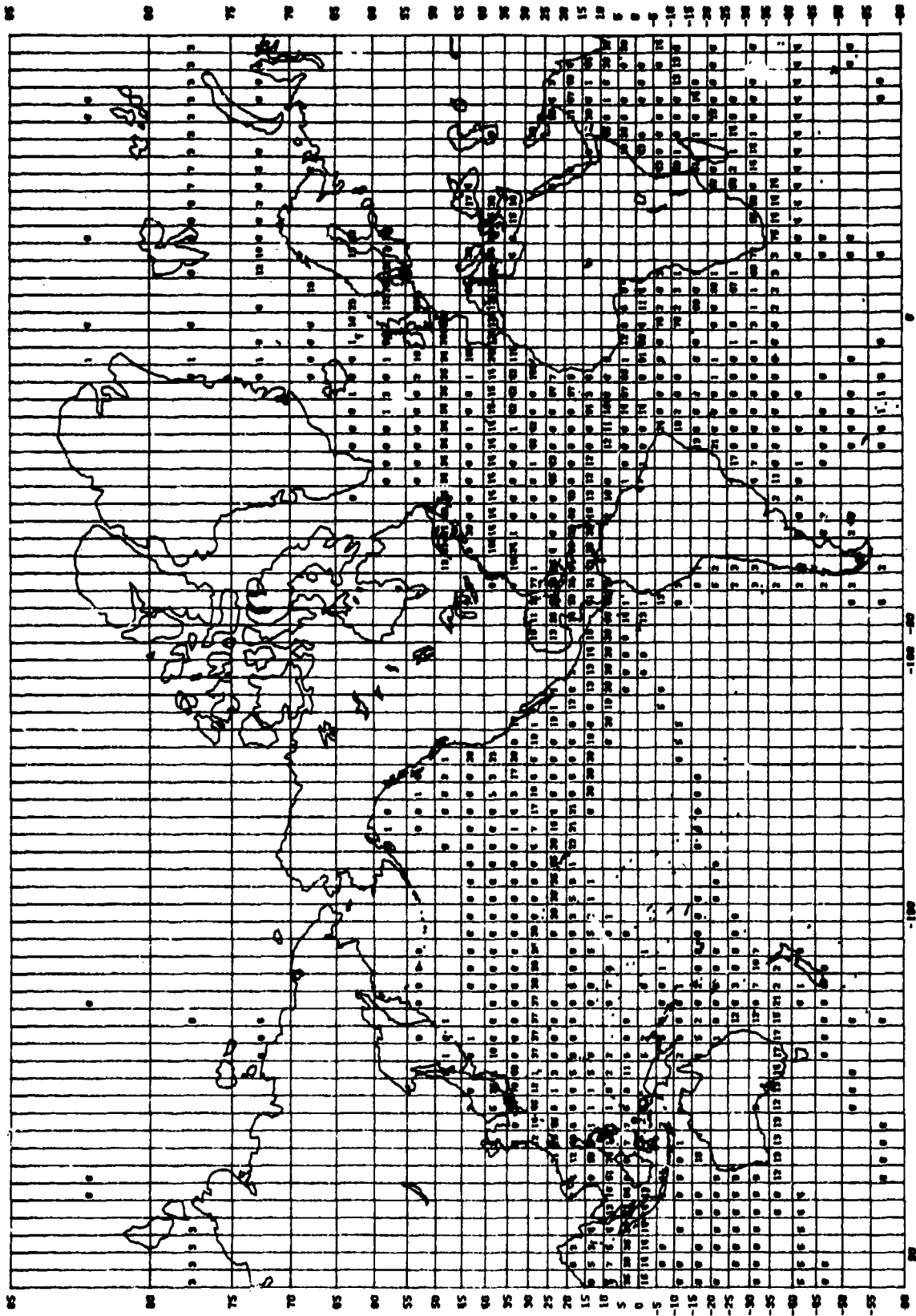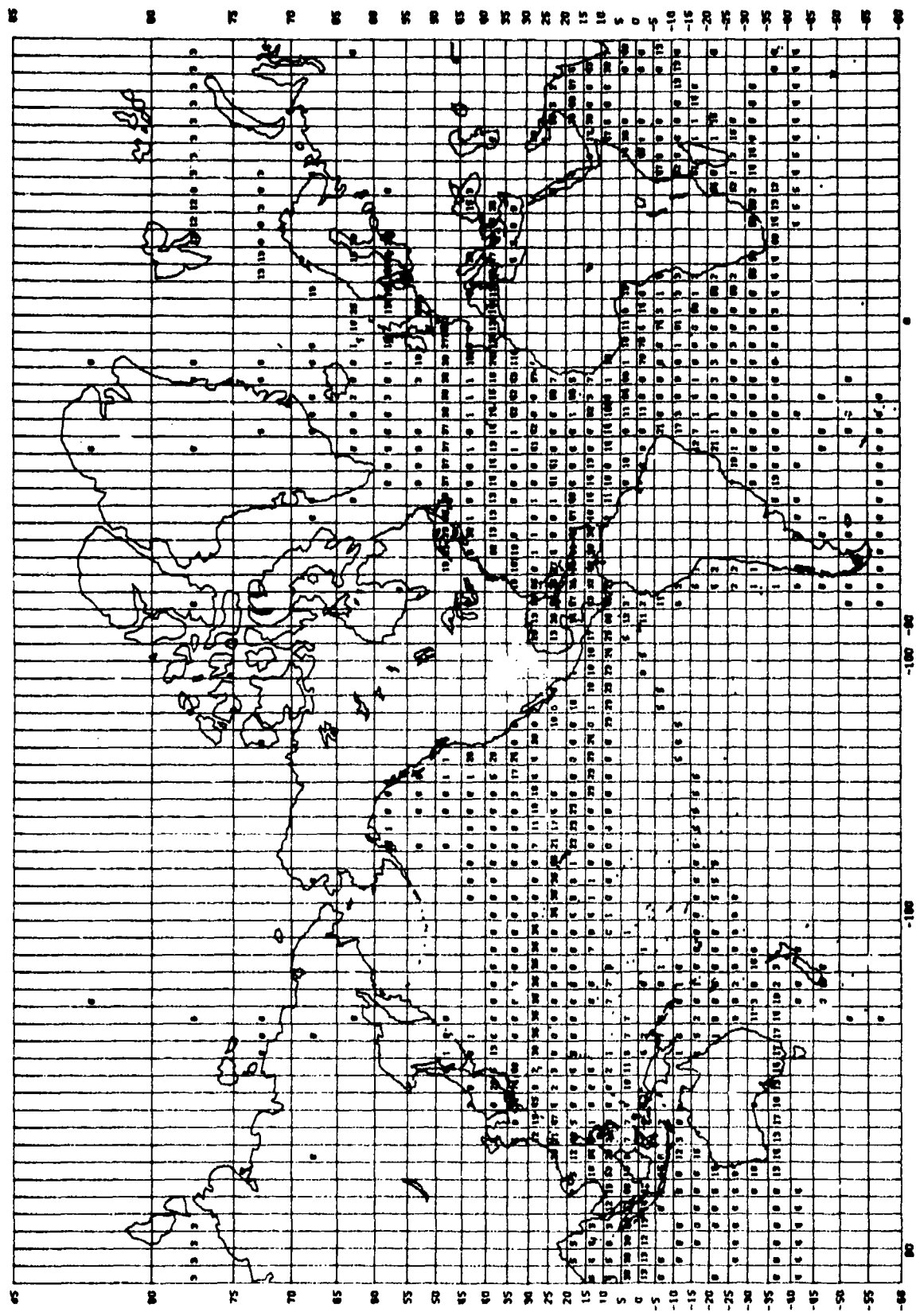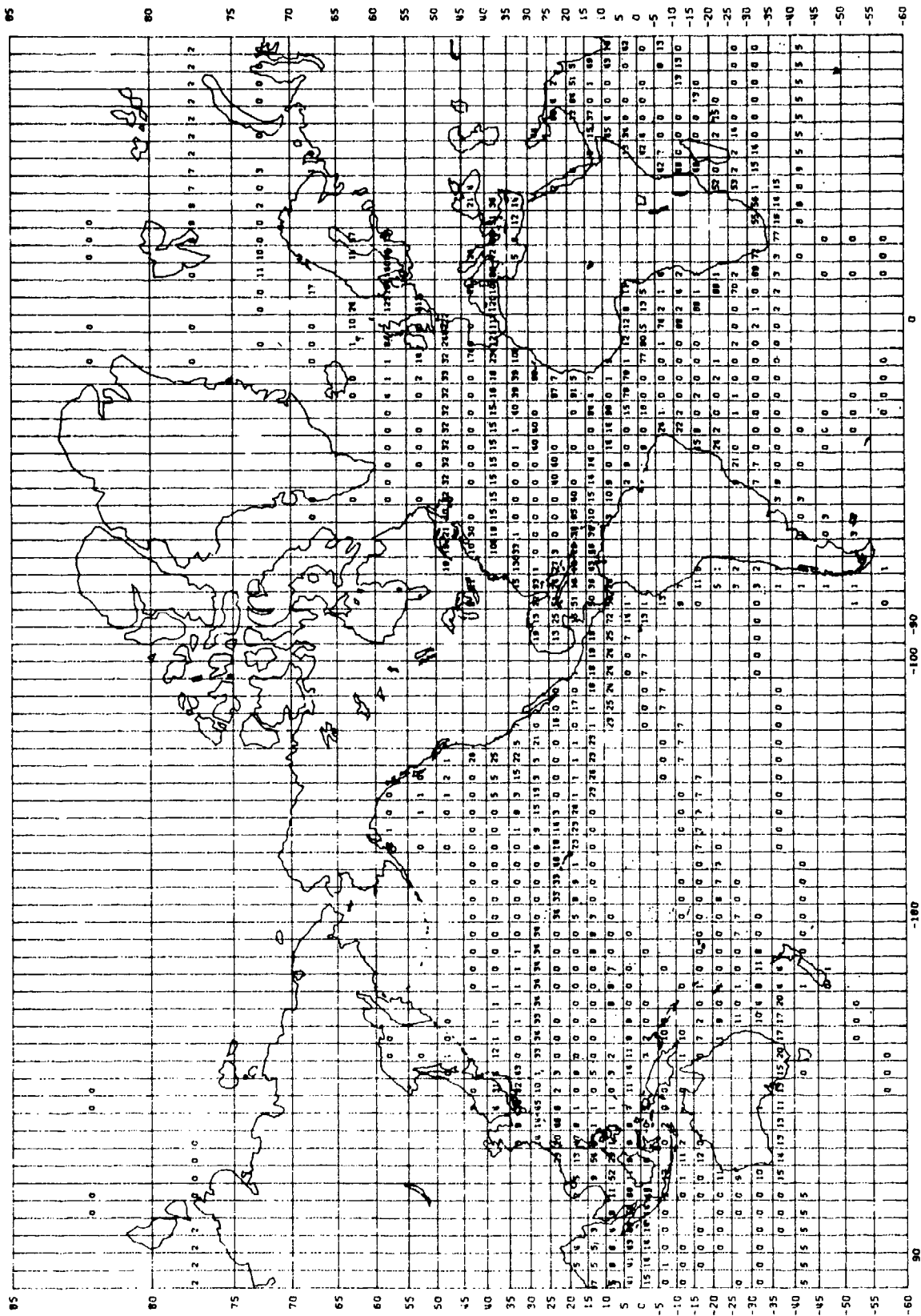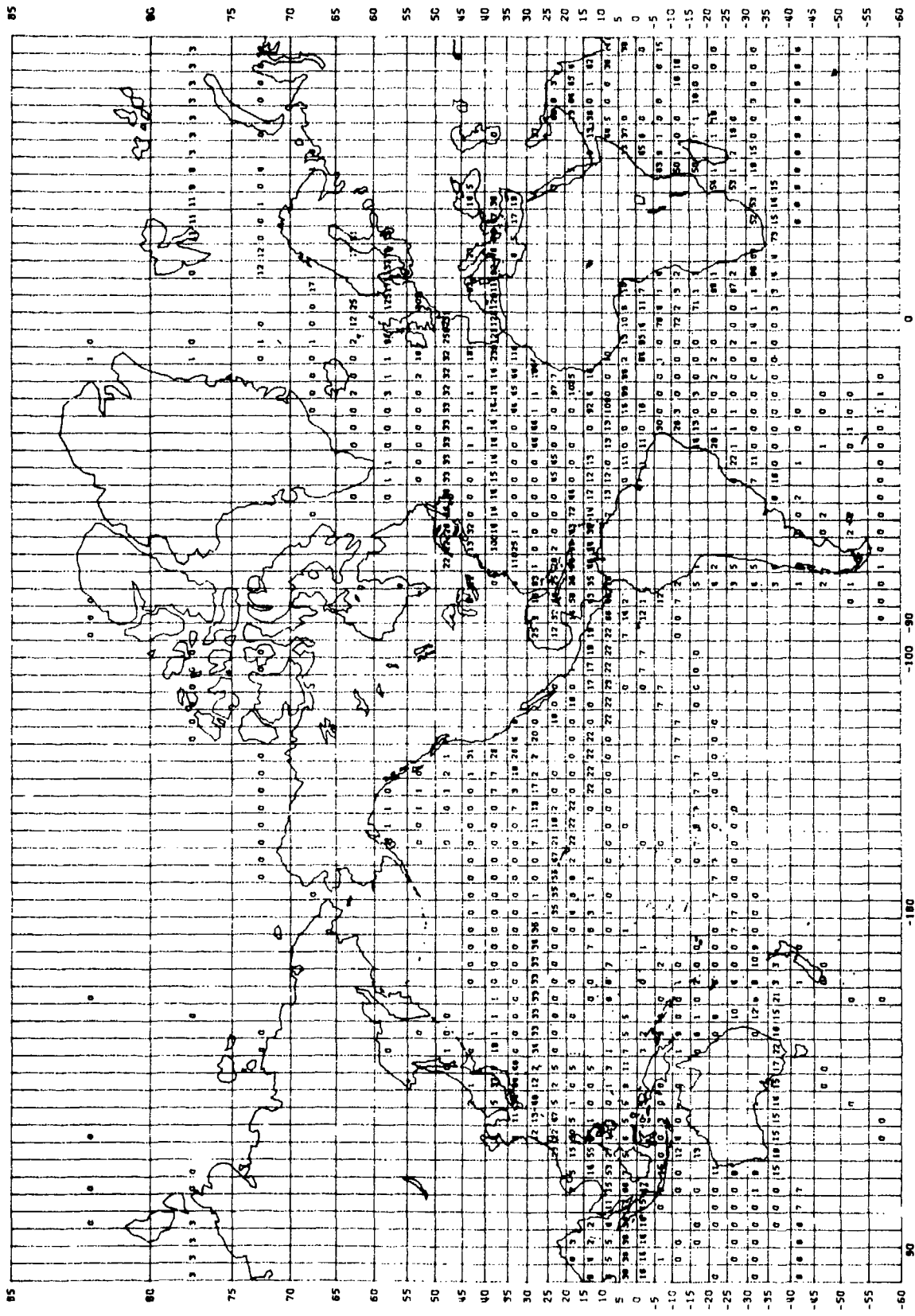VESSEL DATA REPORTED ON JAN 12   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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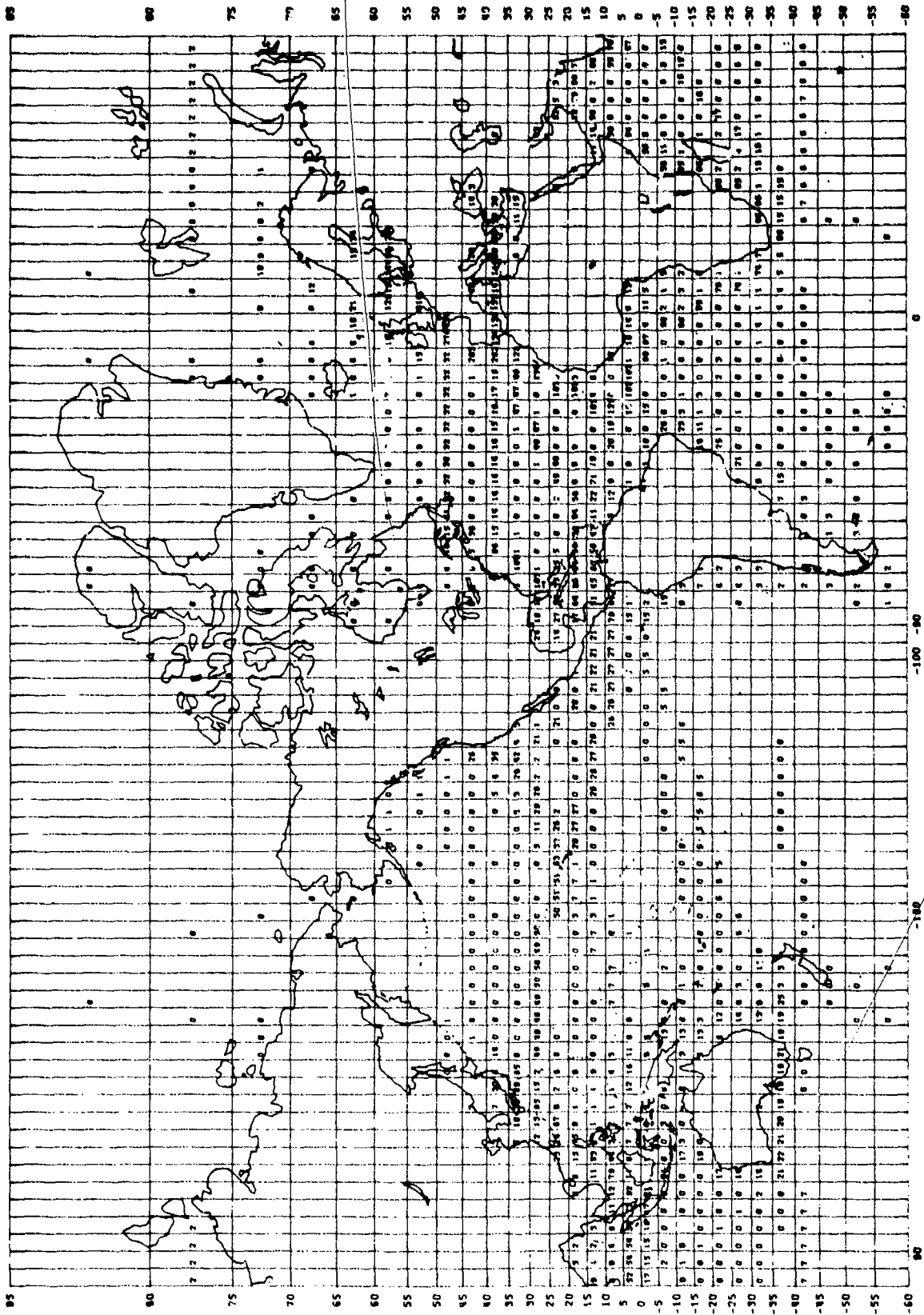
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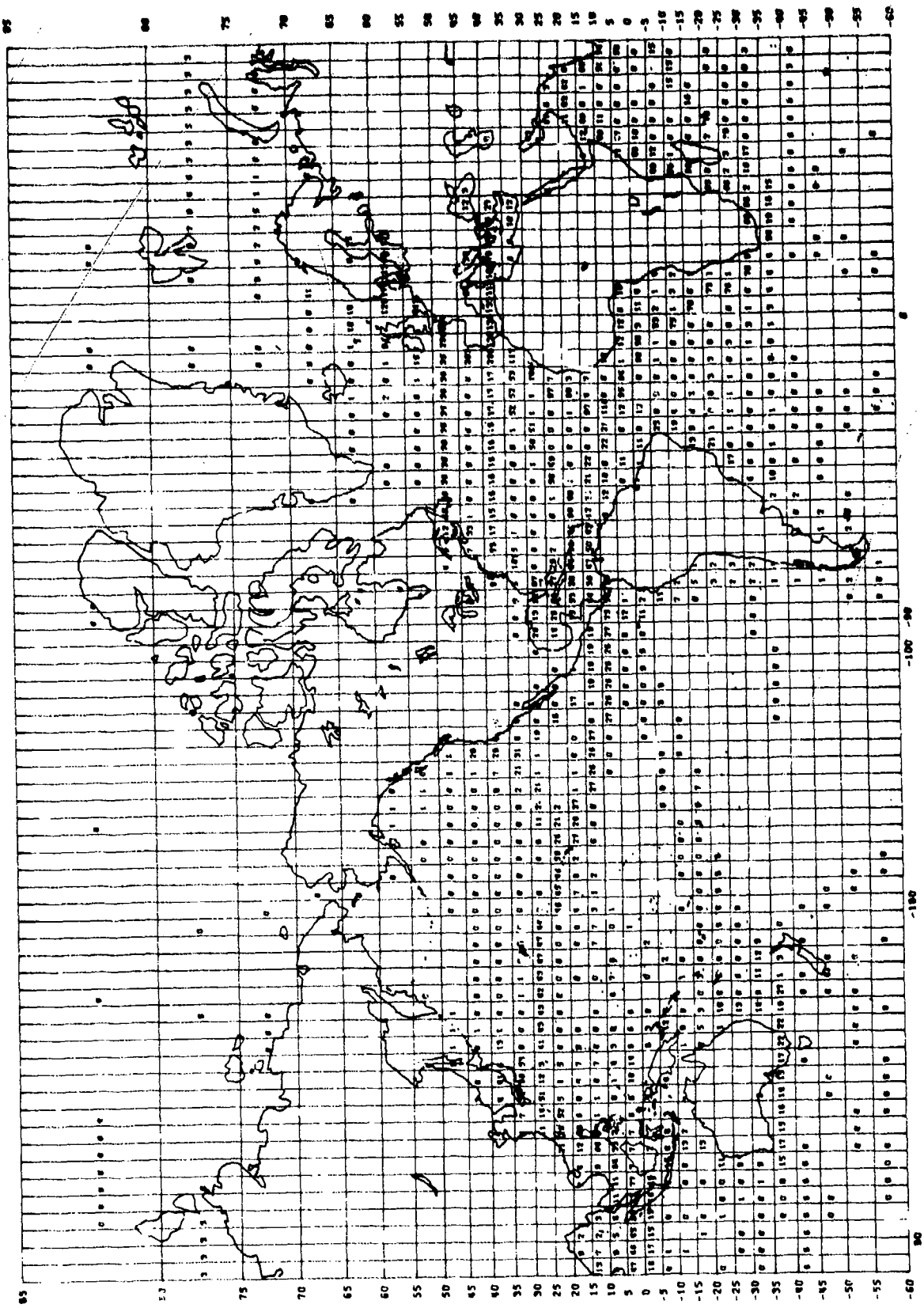
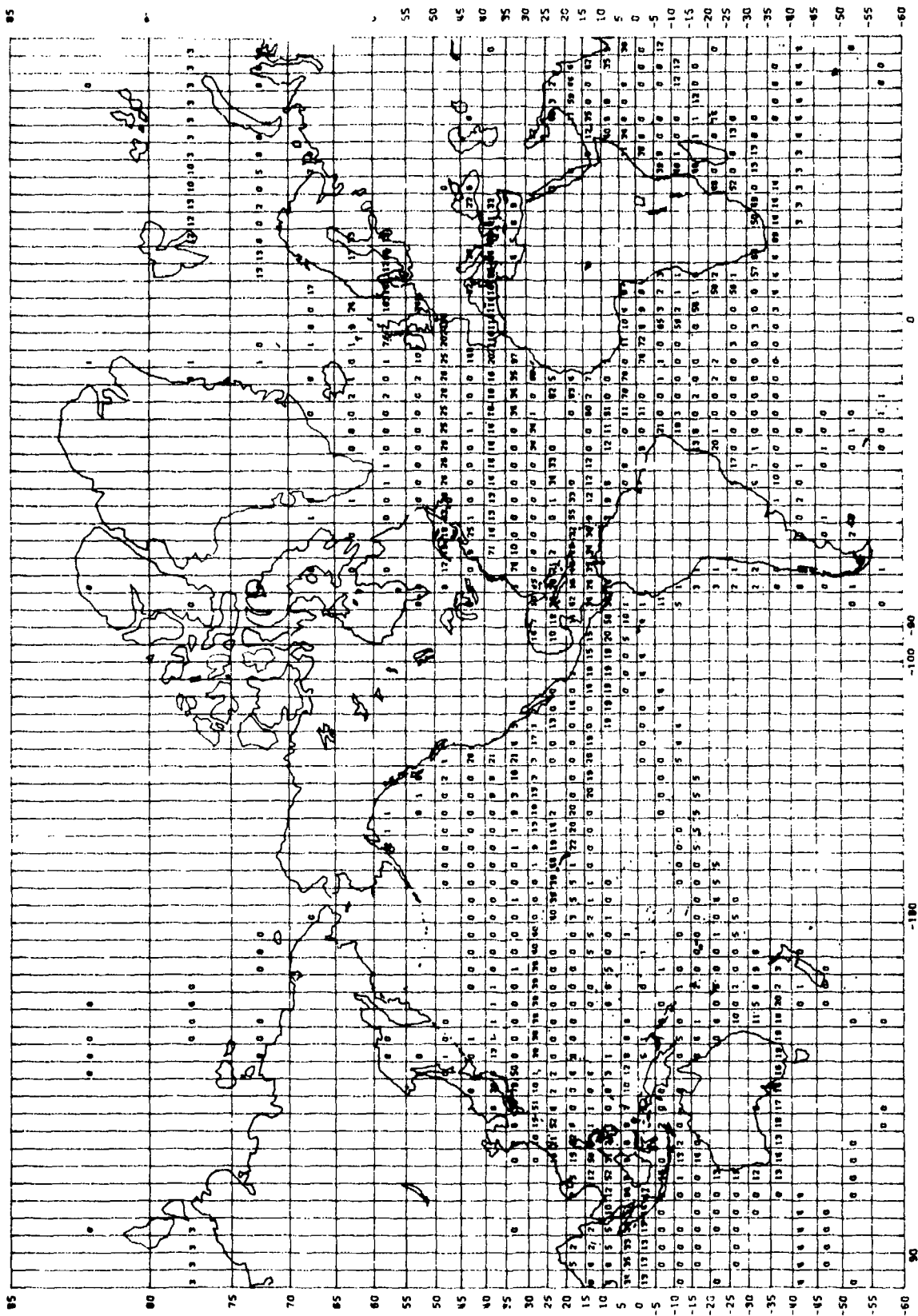VESSEL DATA REPORTED ON JAN 26   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE
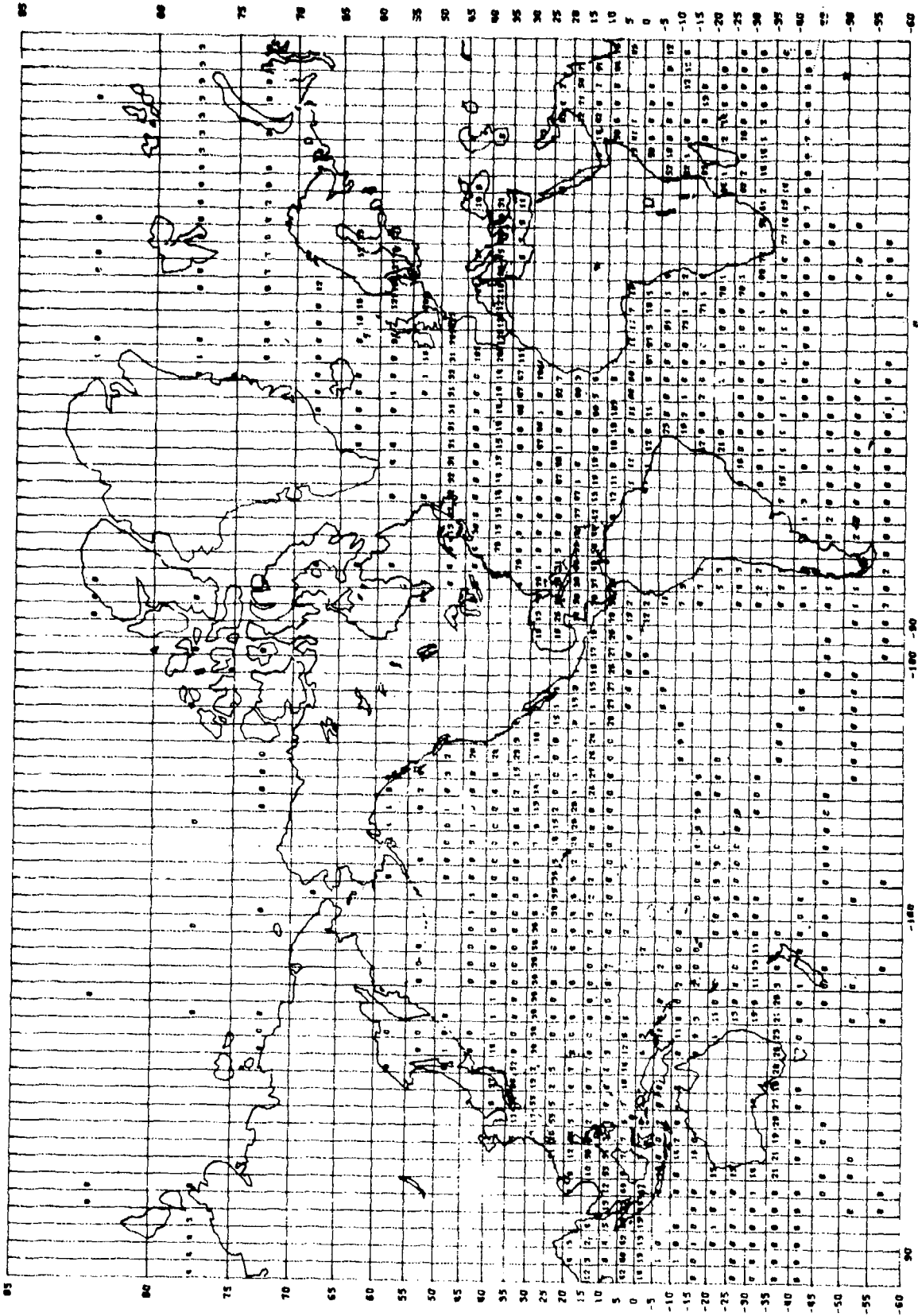
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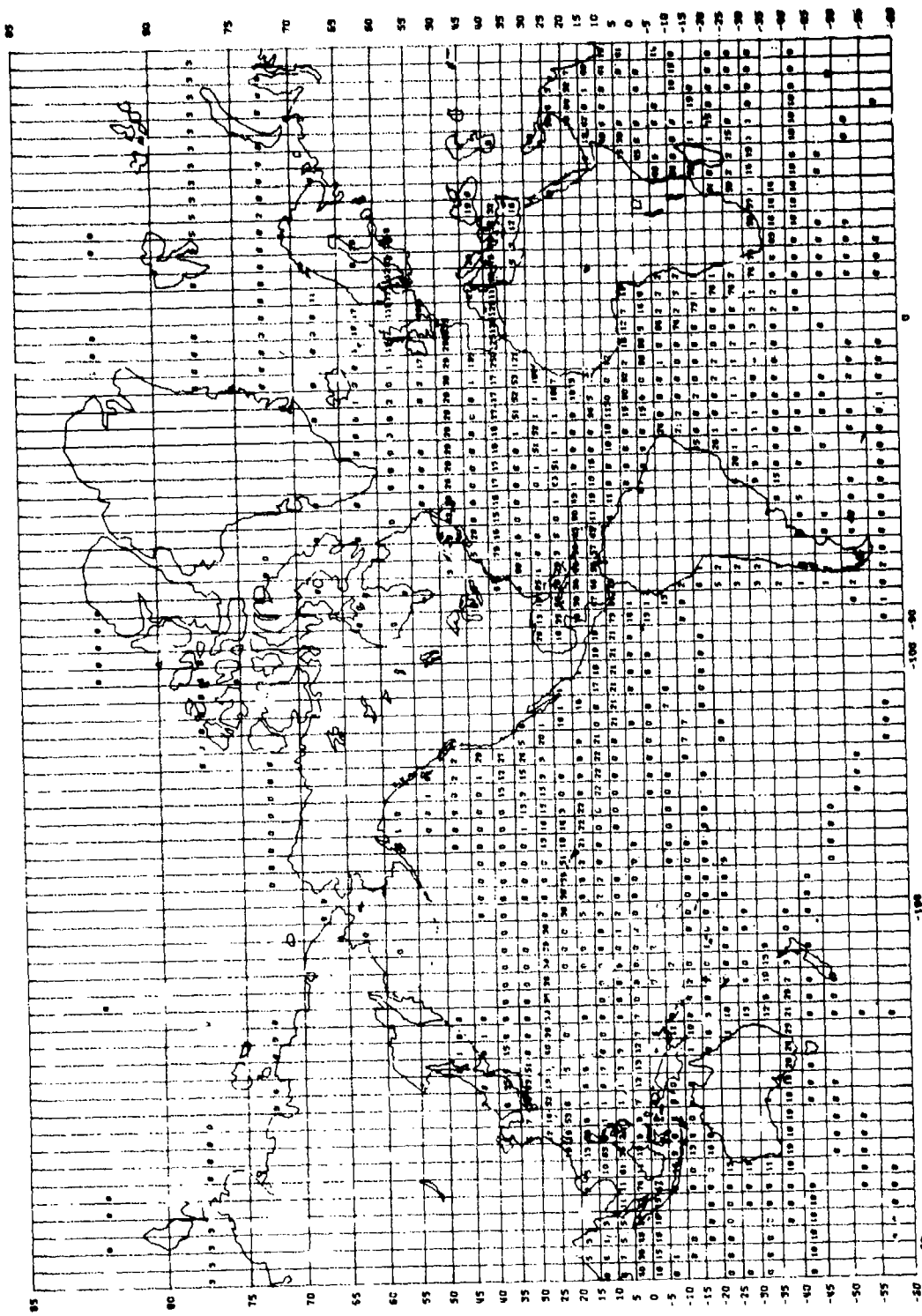
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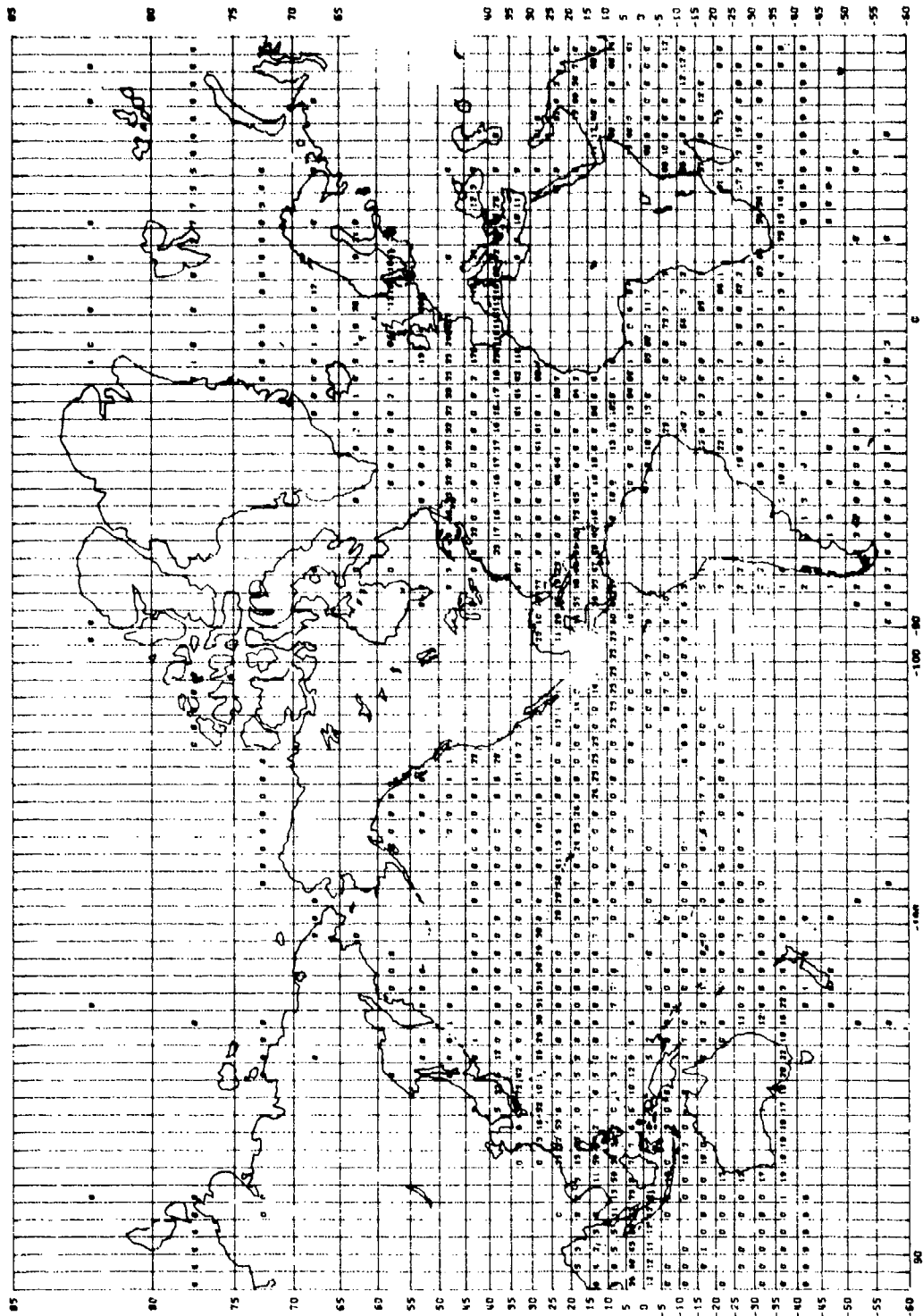
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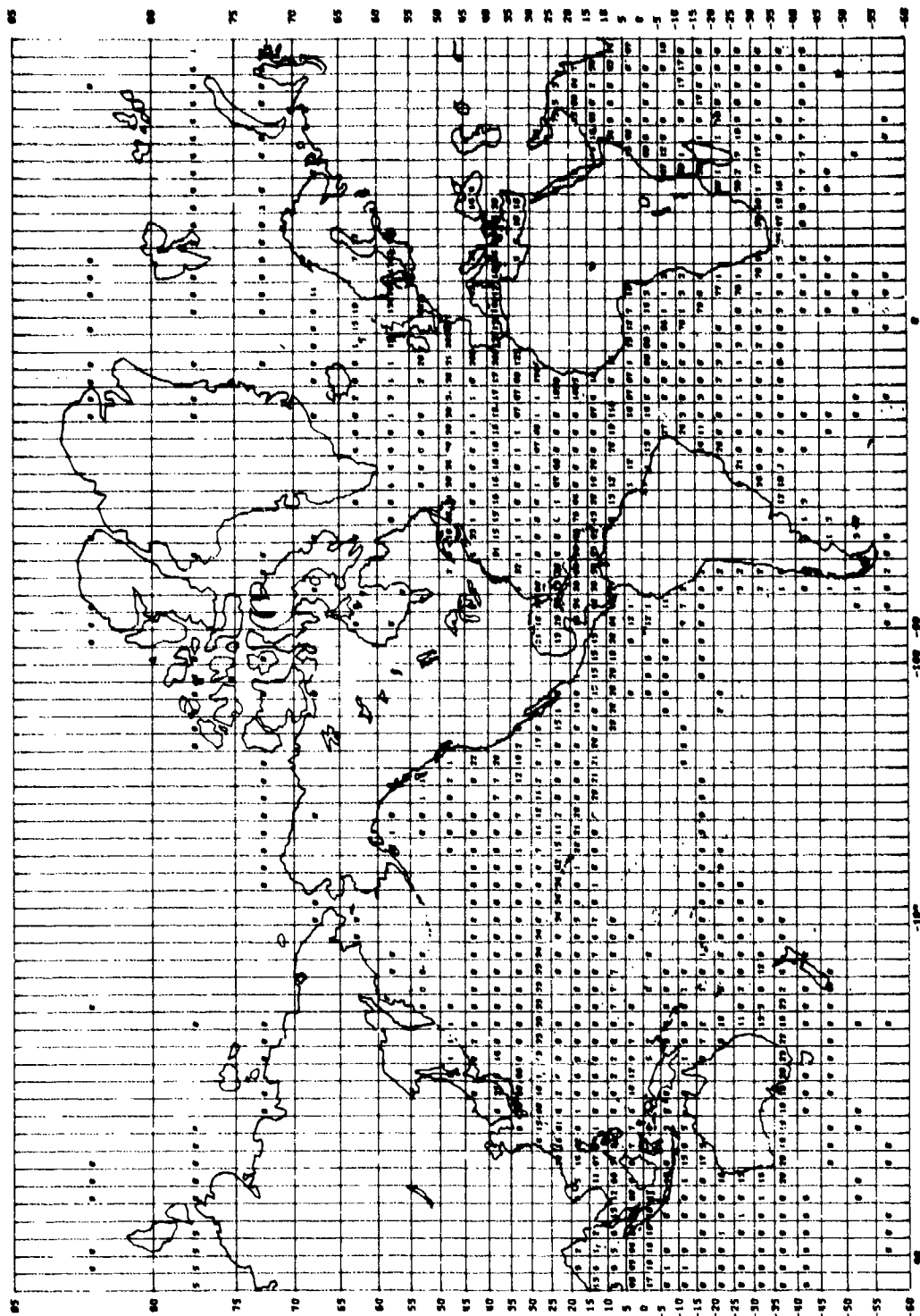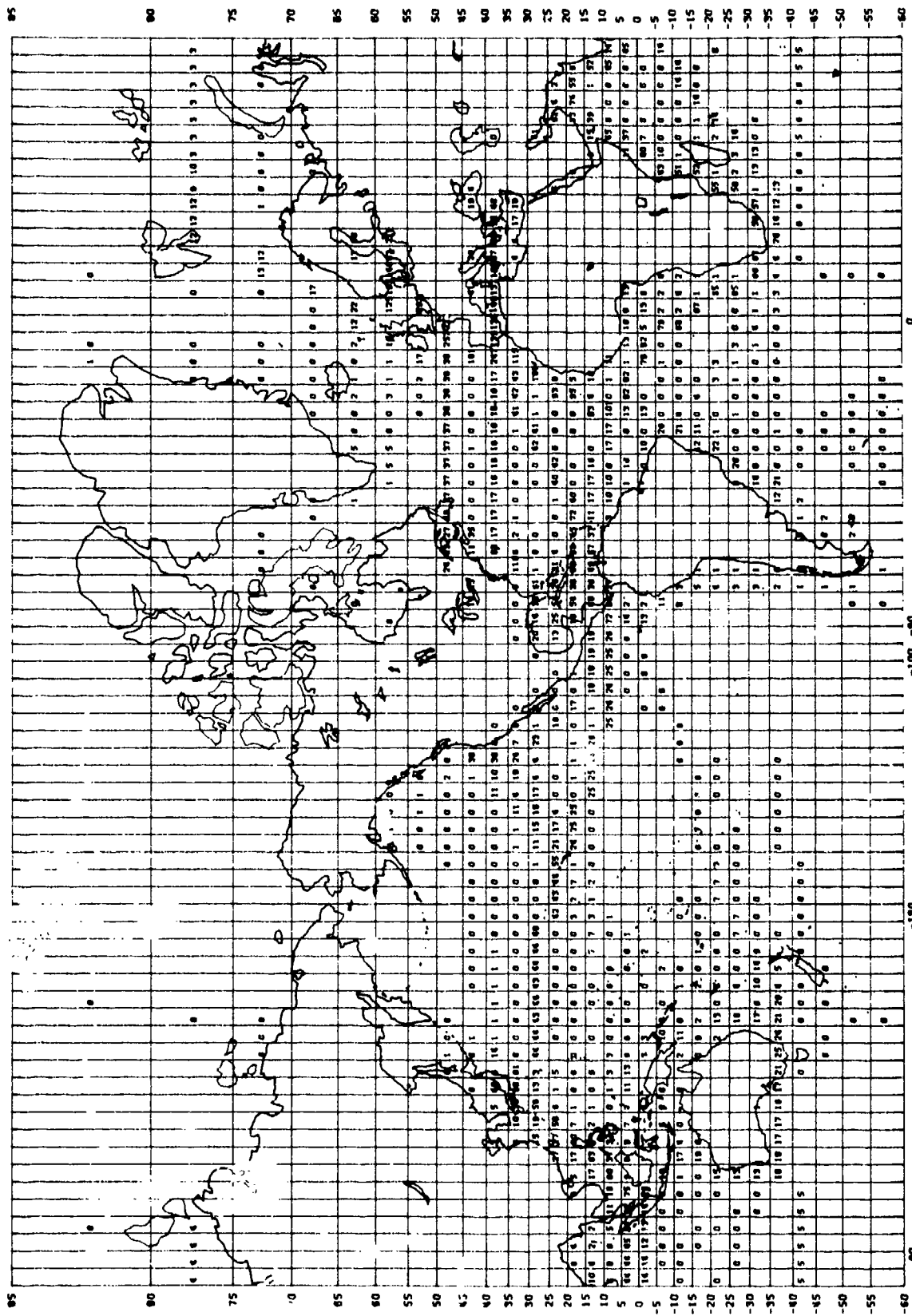
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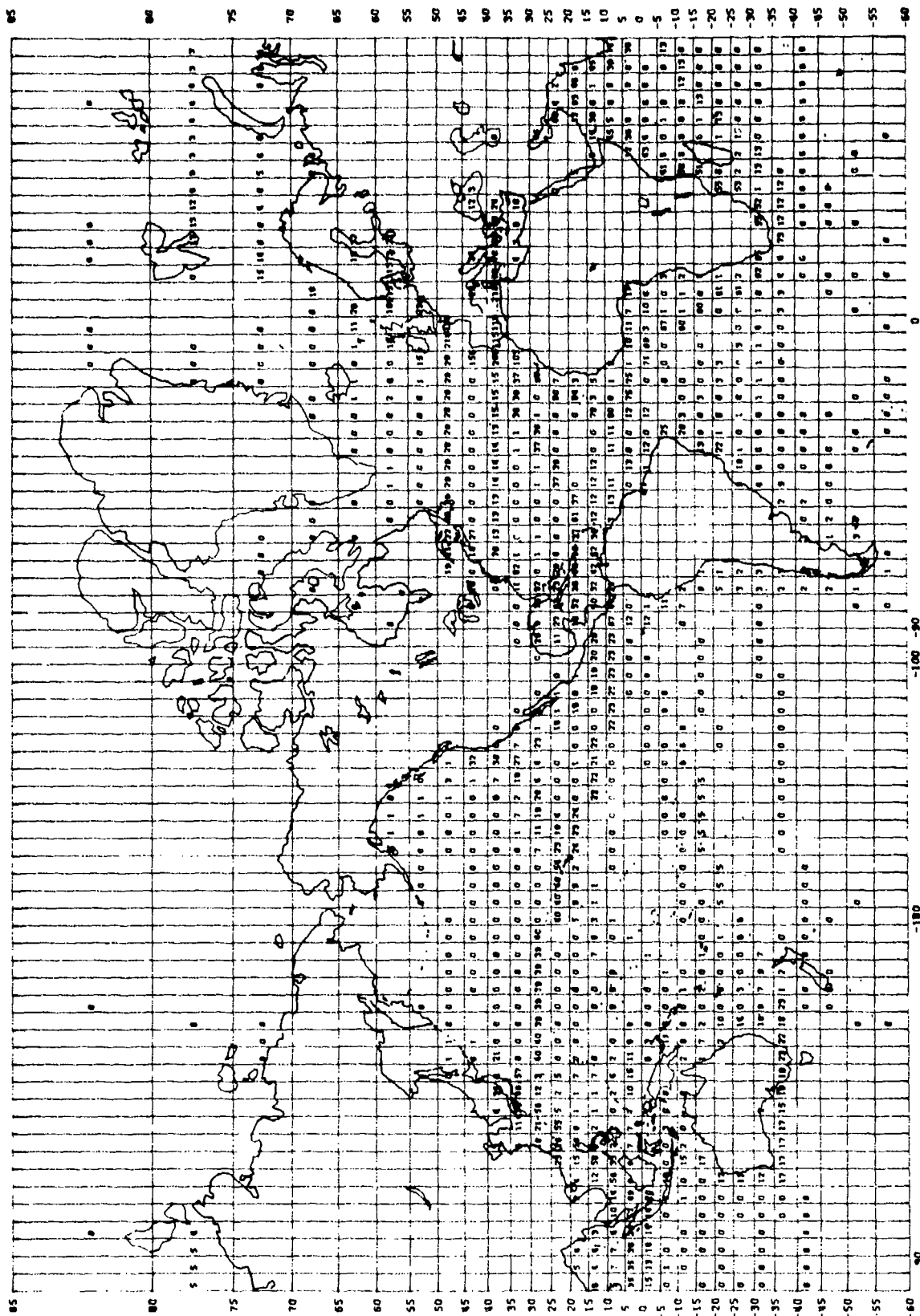
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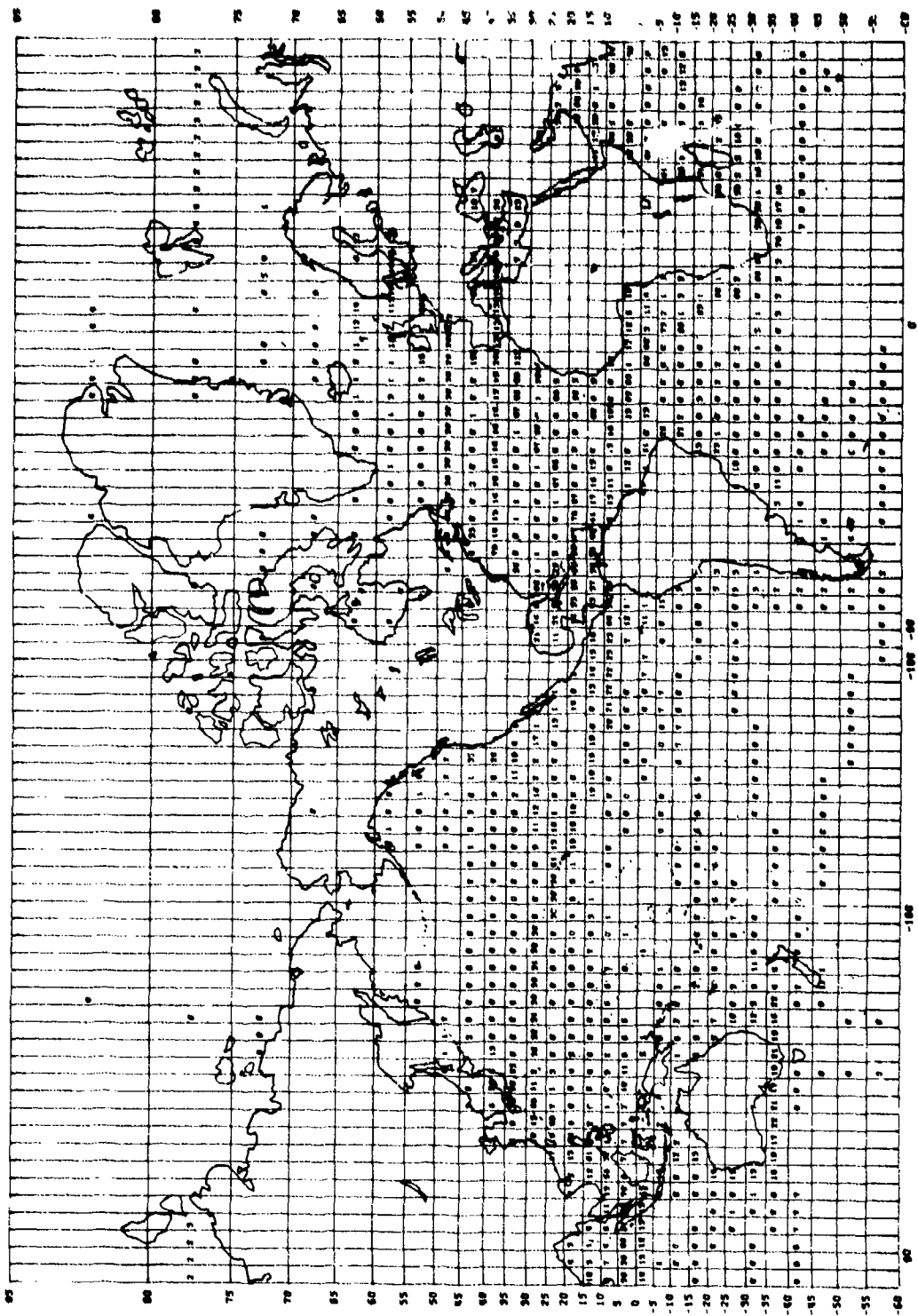
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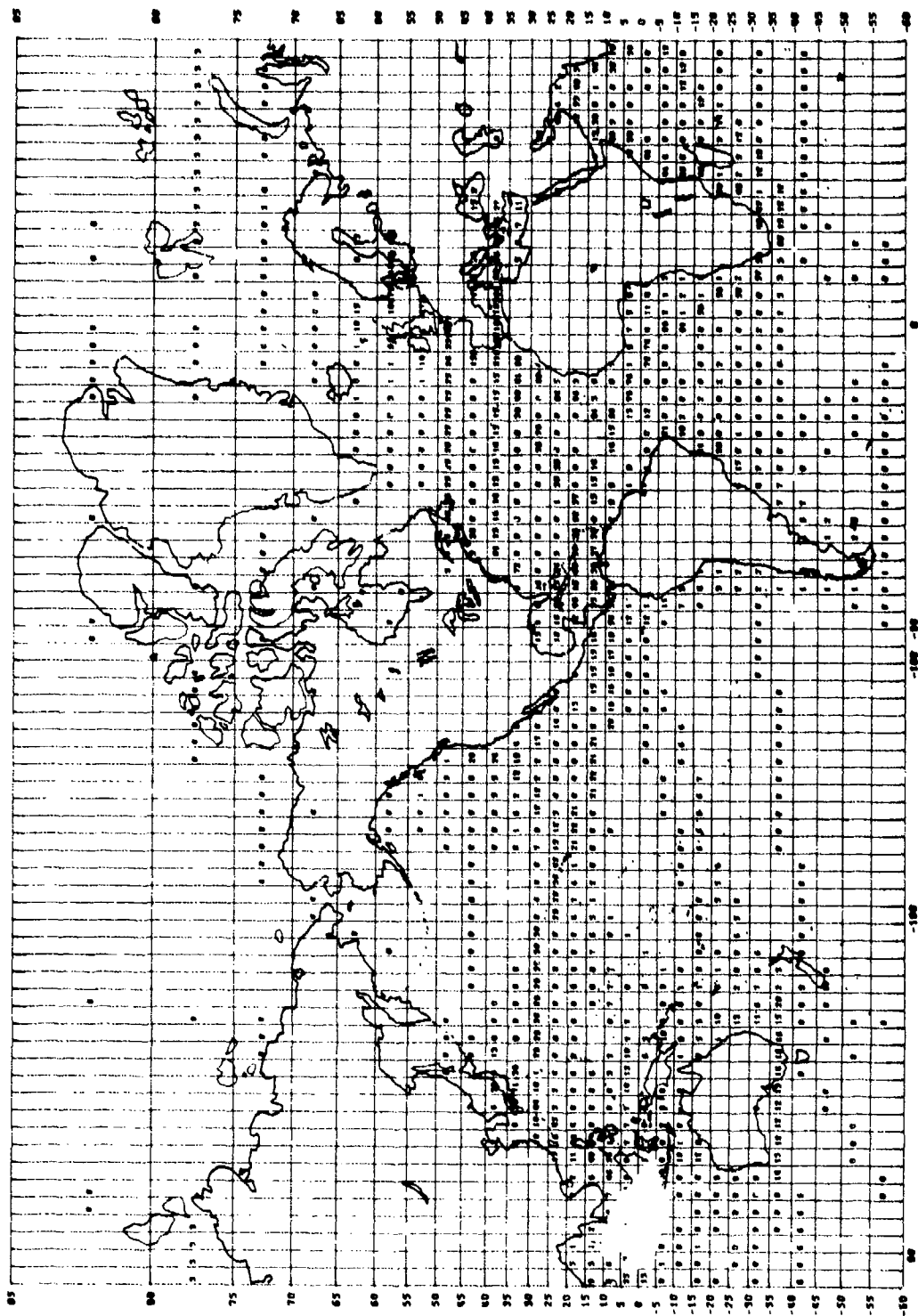
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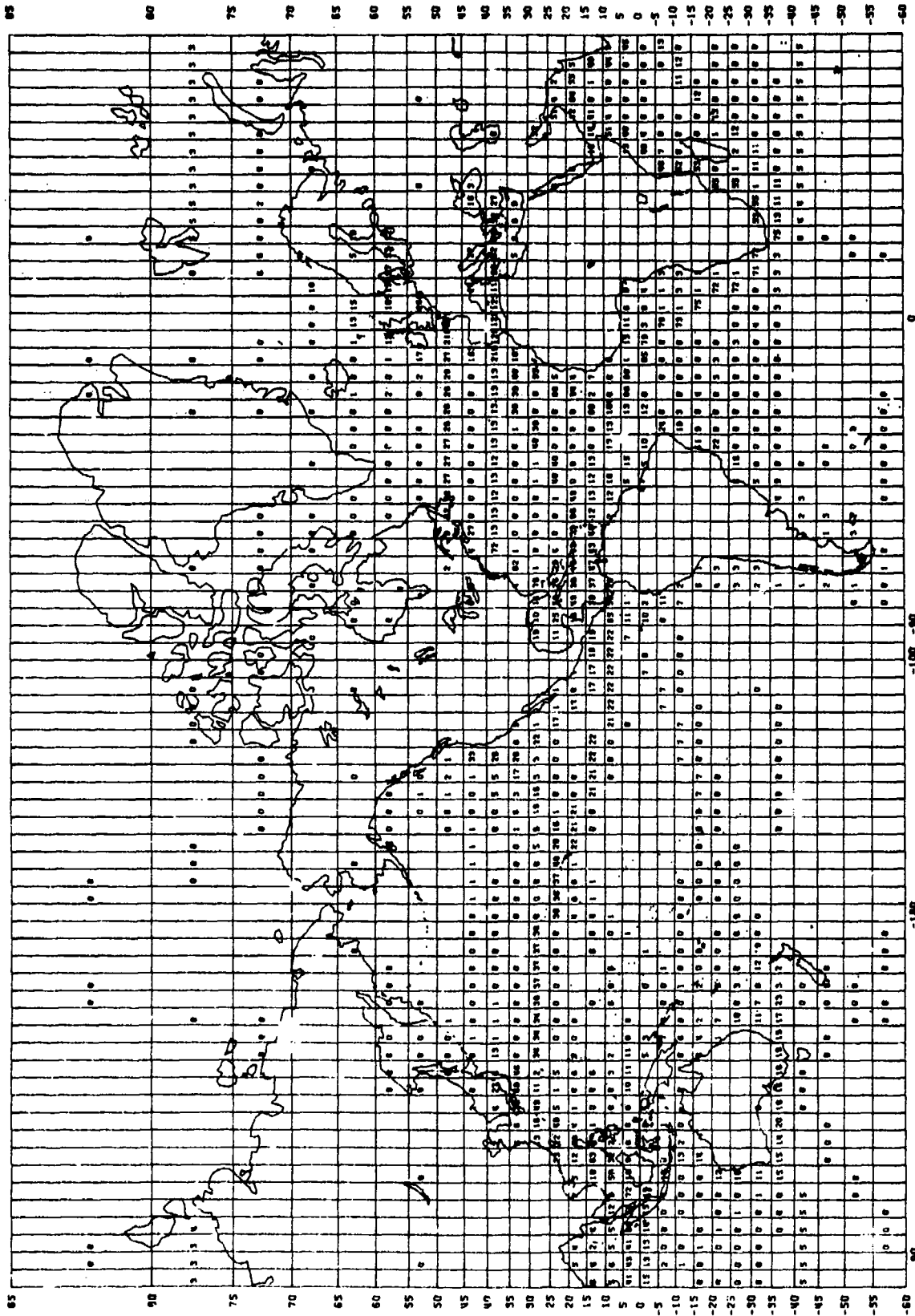
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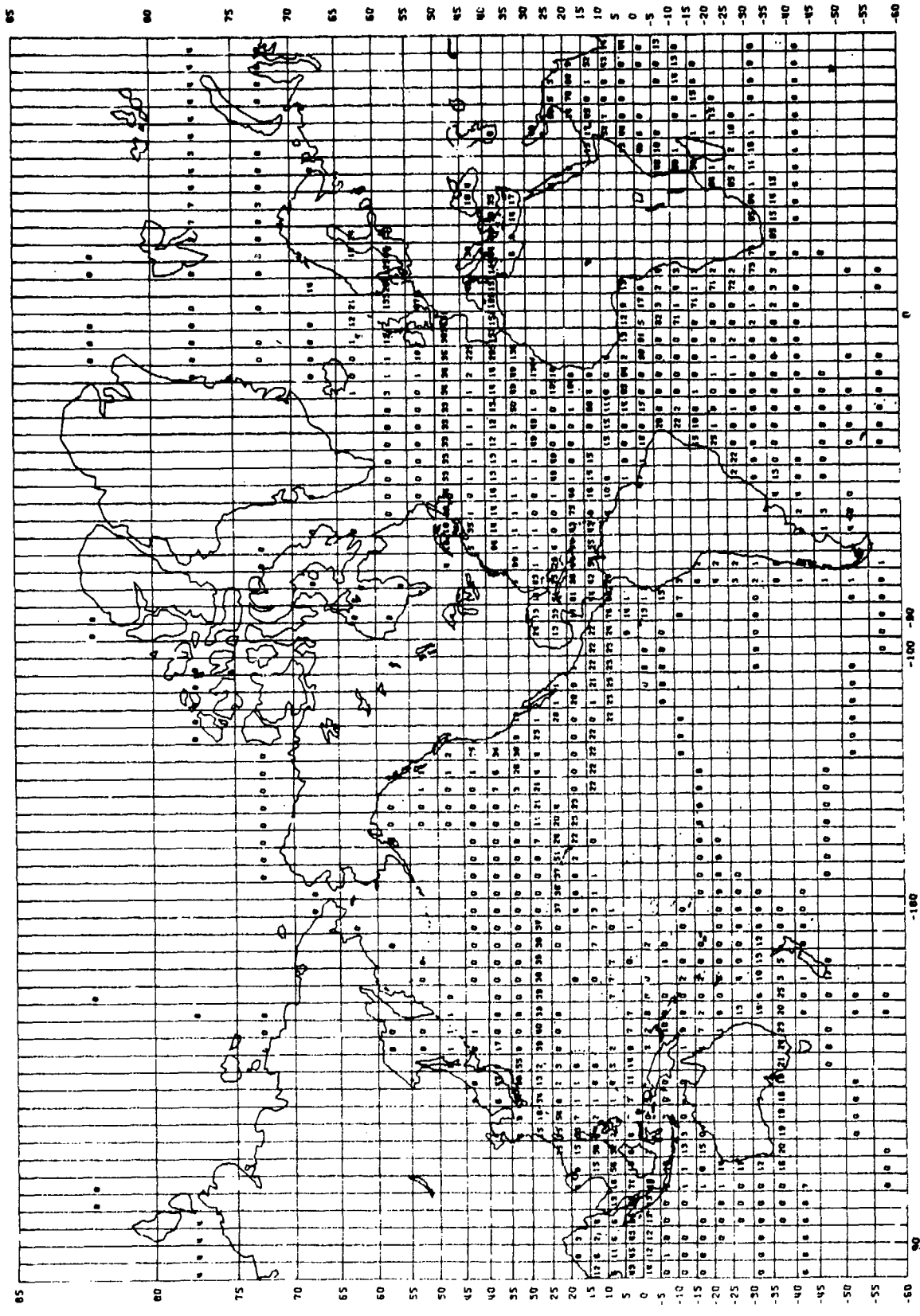
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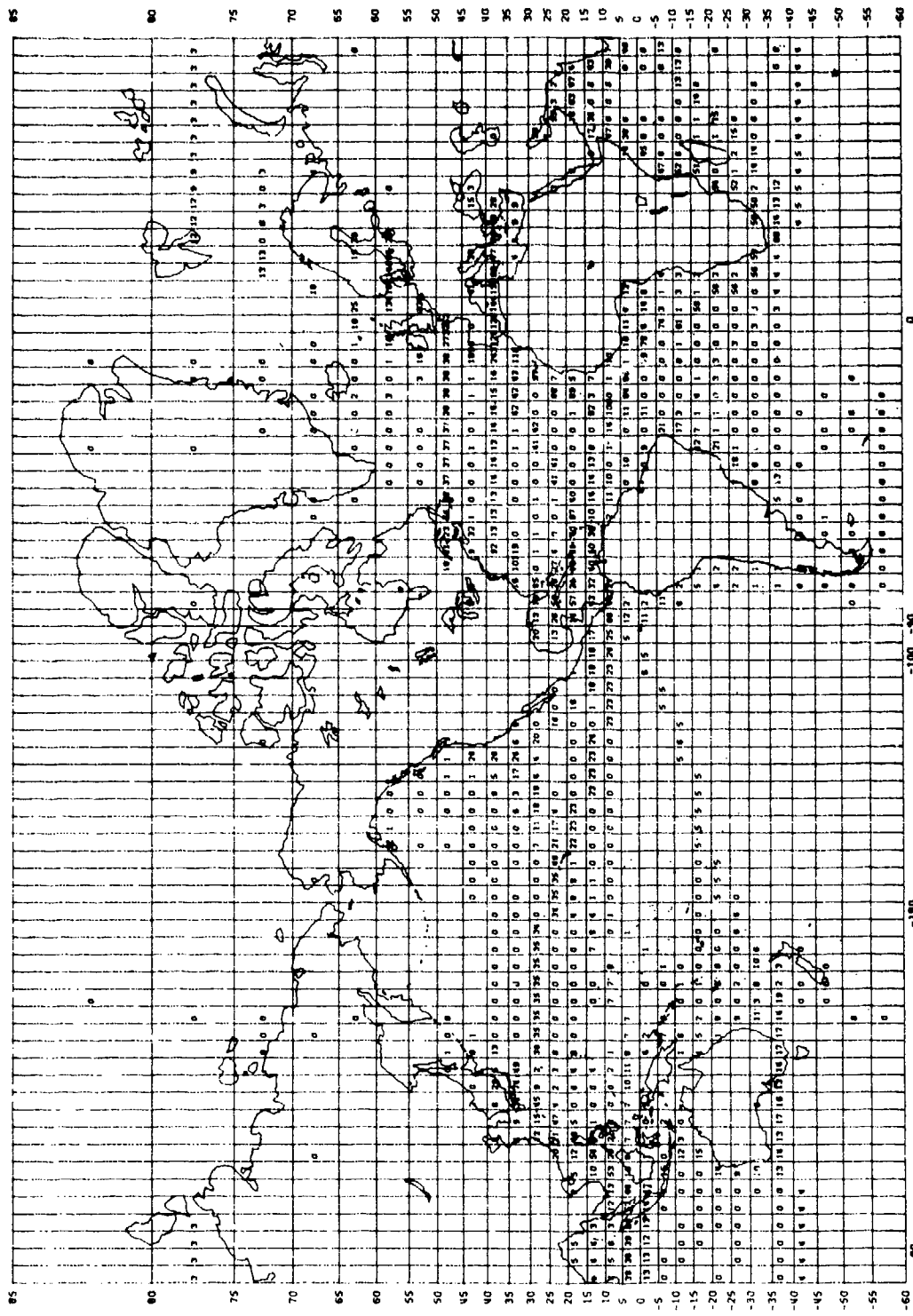
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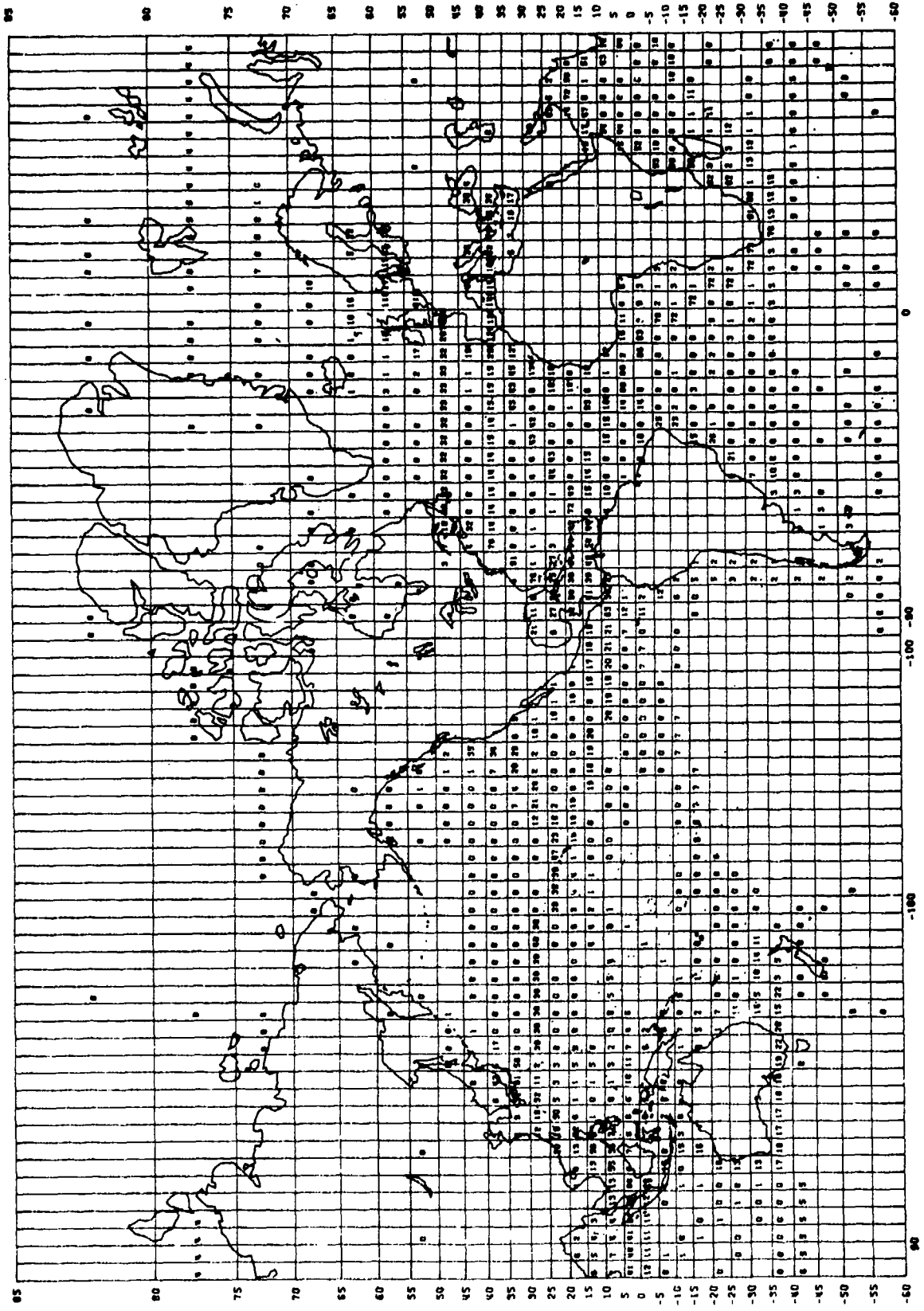
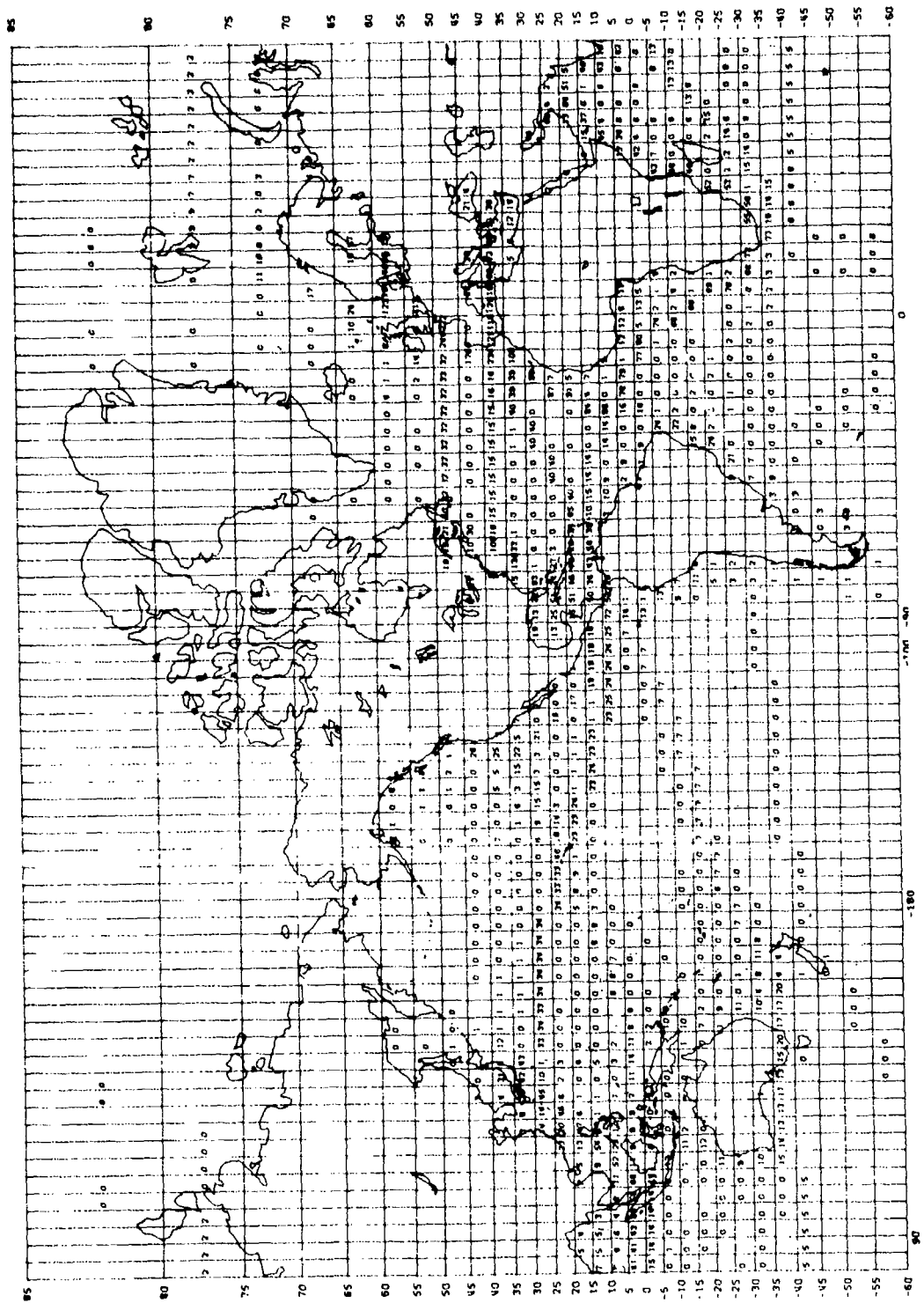VESSEL DATA REPORTED ON MAR 29   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE
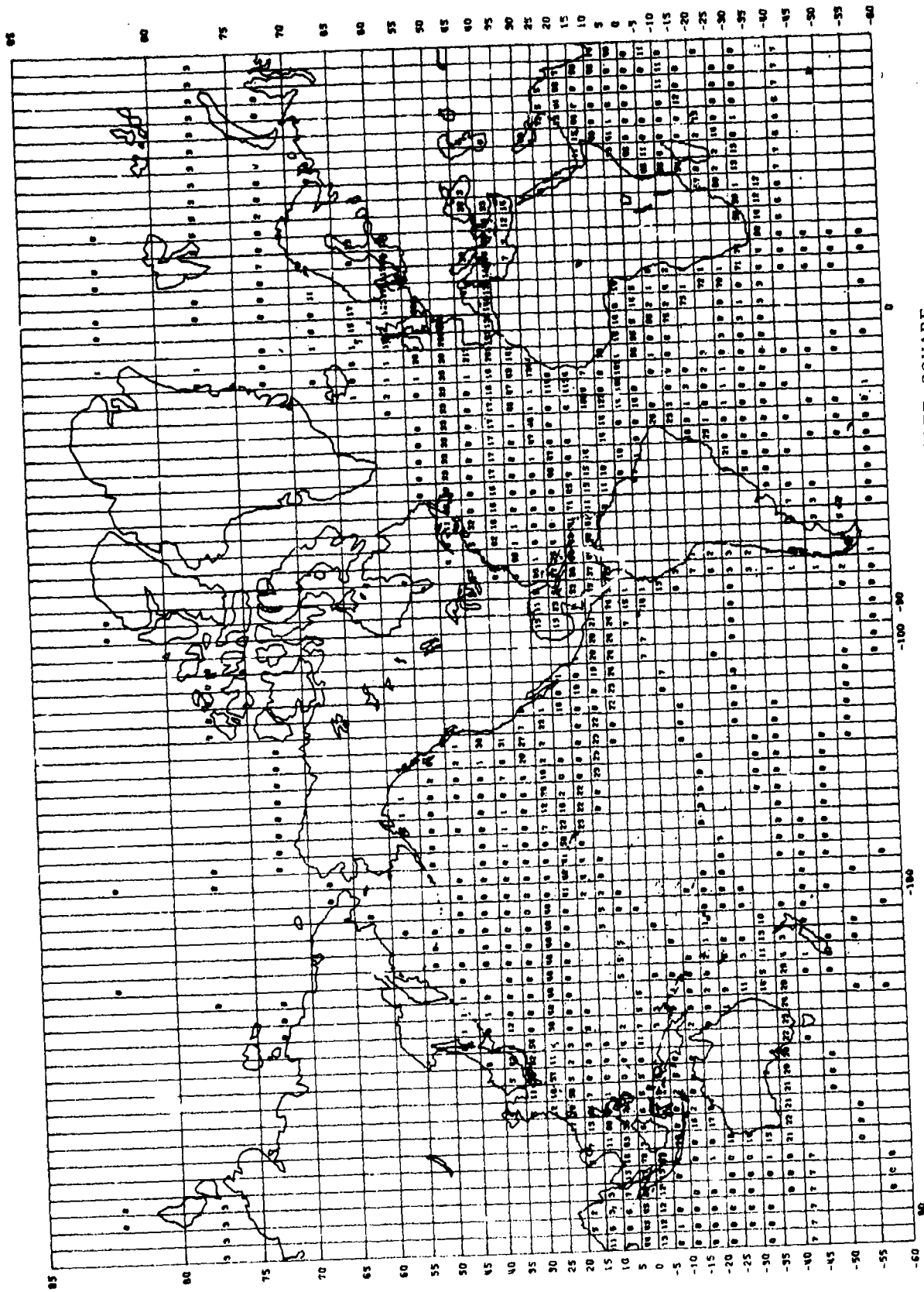
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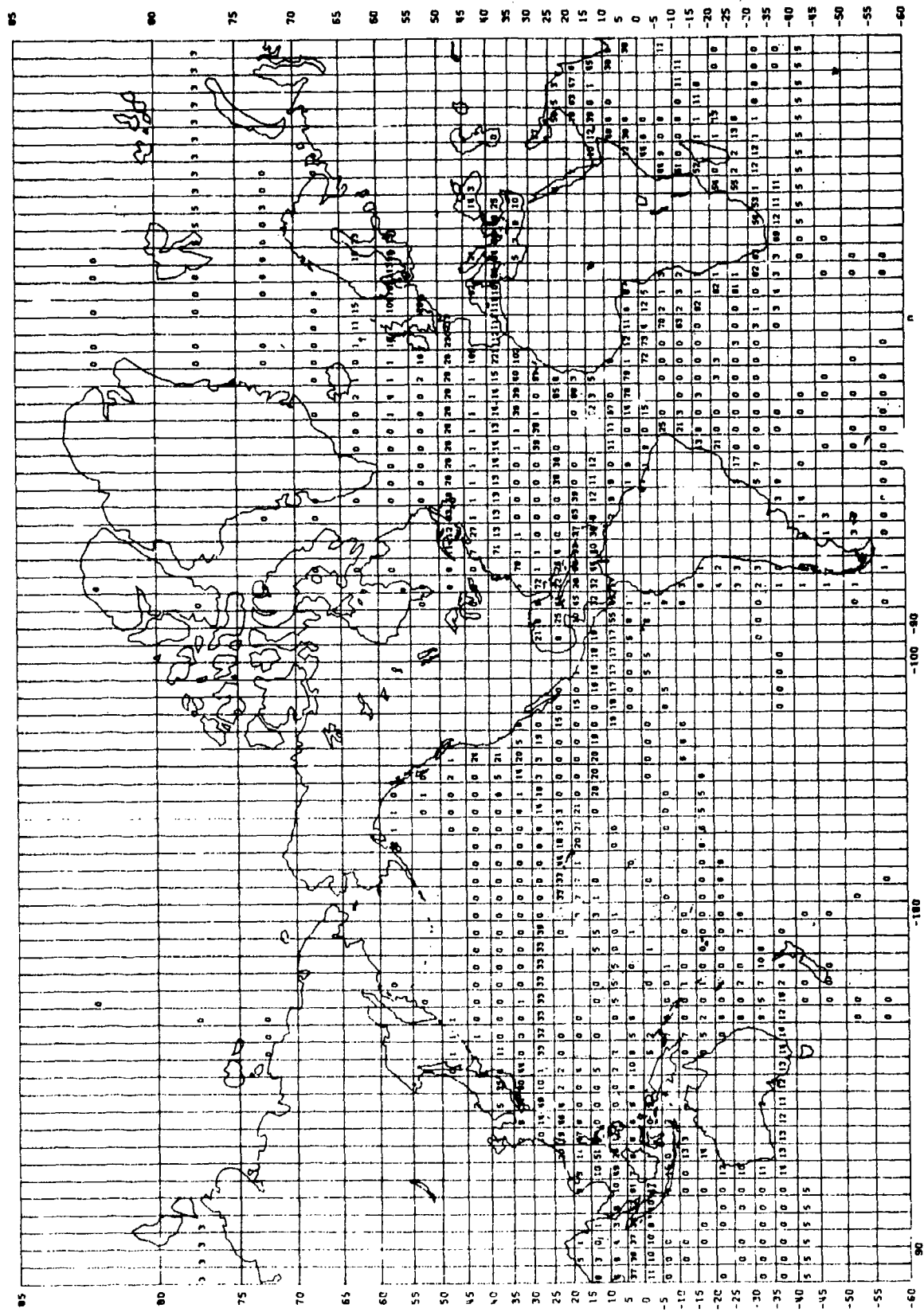
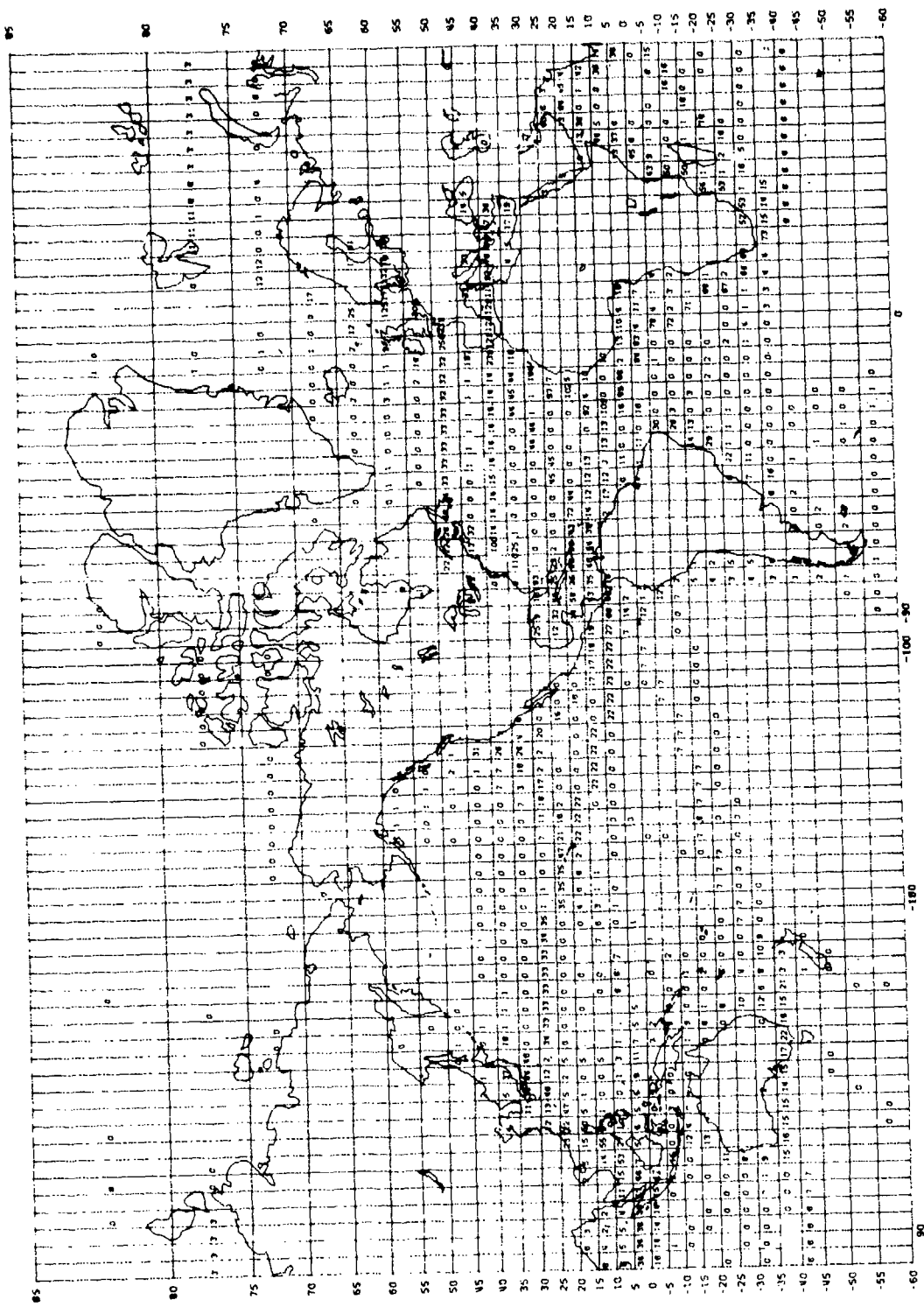VESSEL DATA REPORTED ON APR 12   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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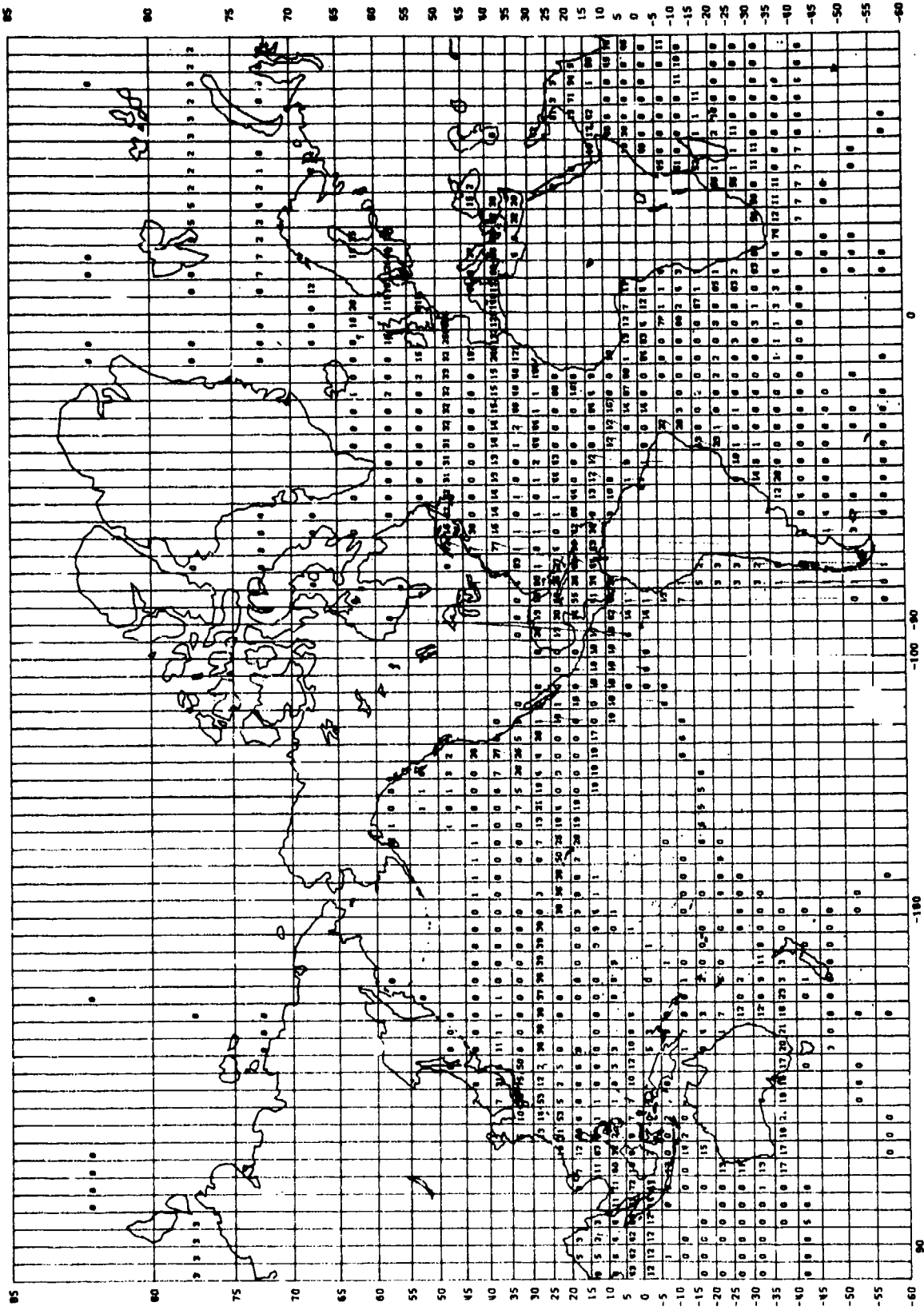
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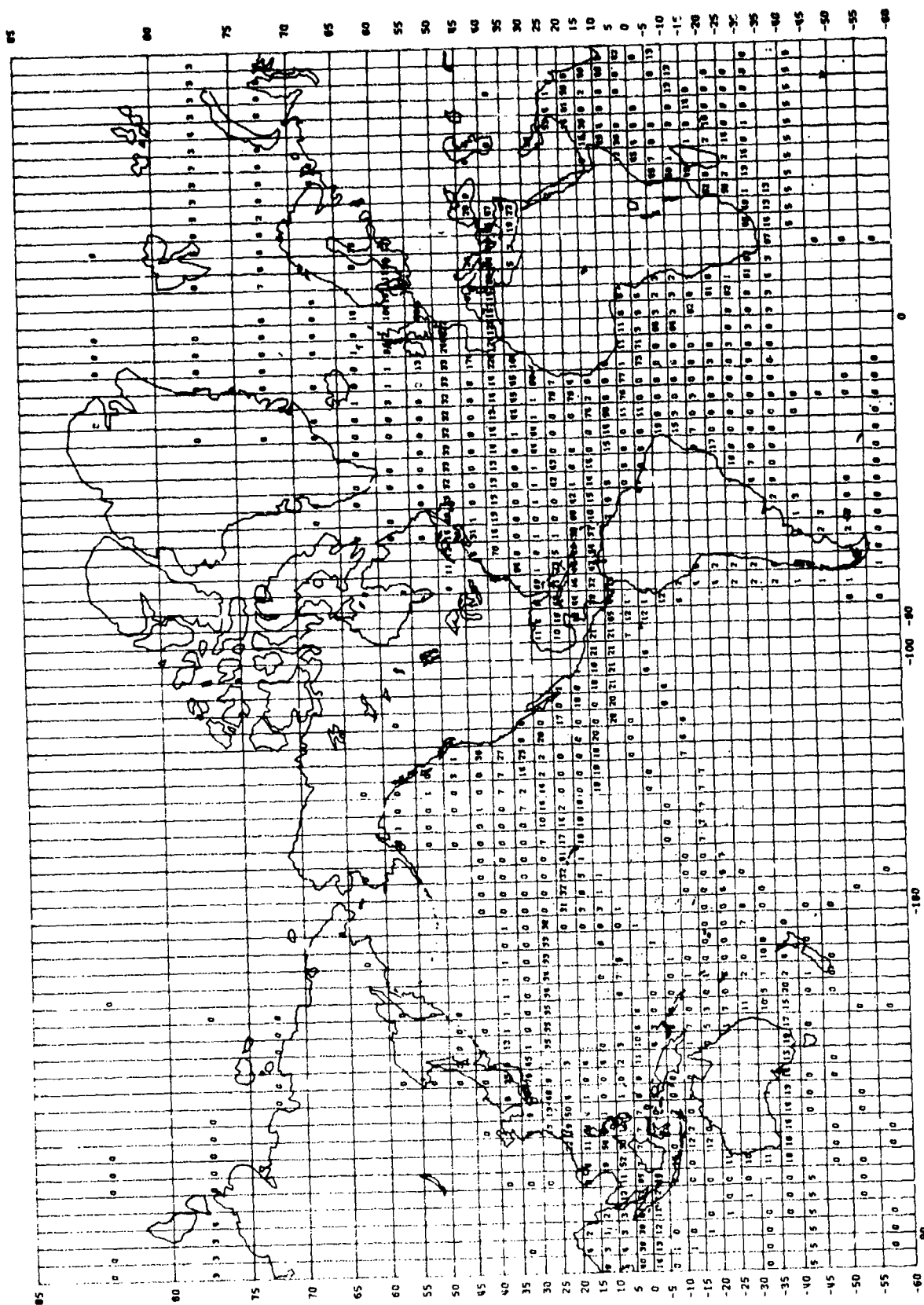
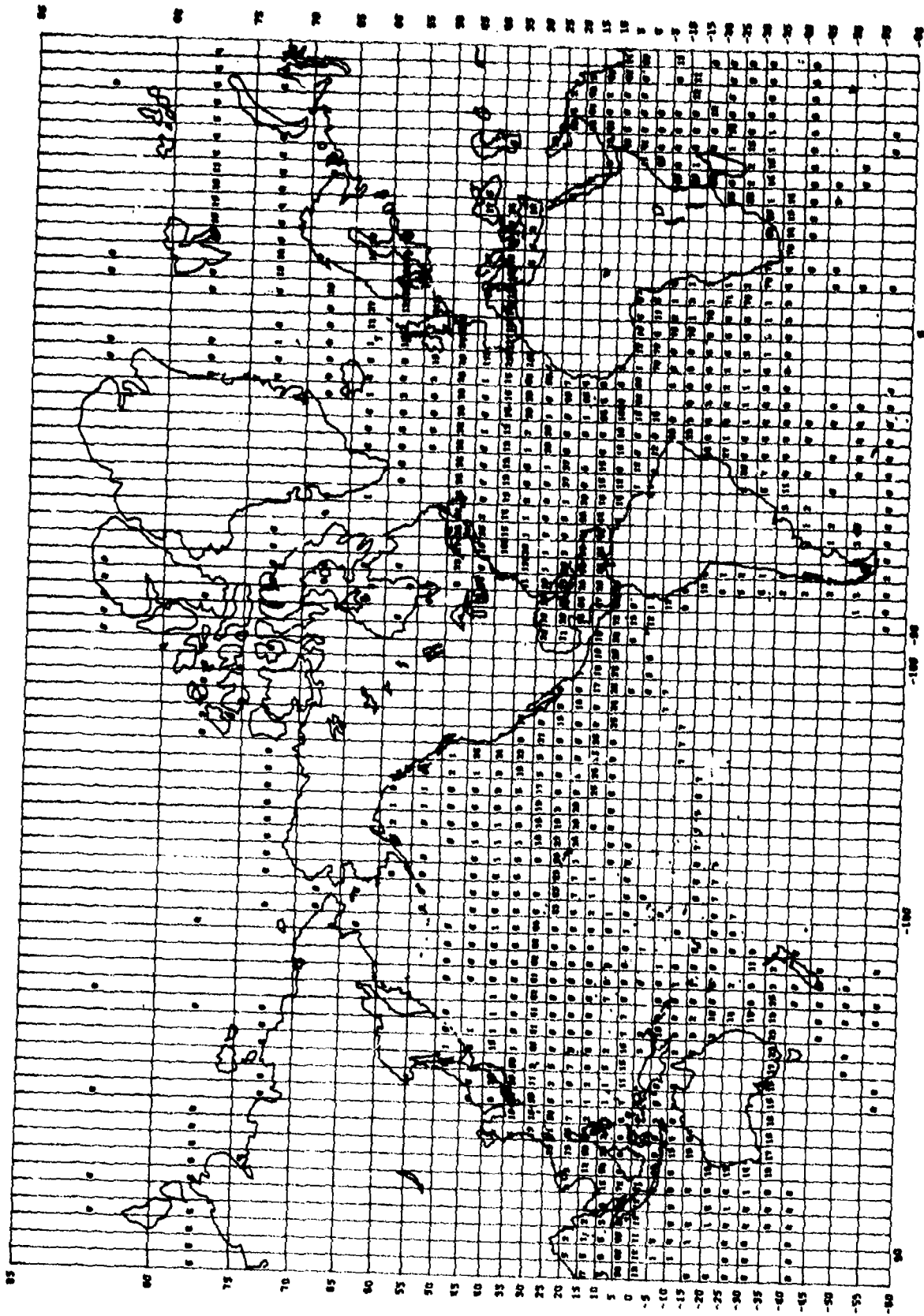VESSEL DATA REPORTED ON APR 26   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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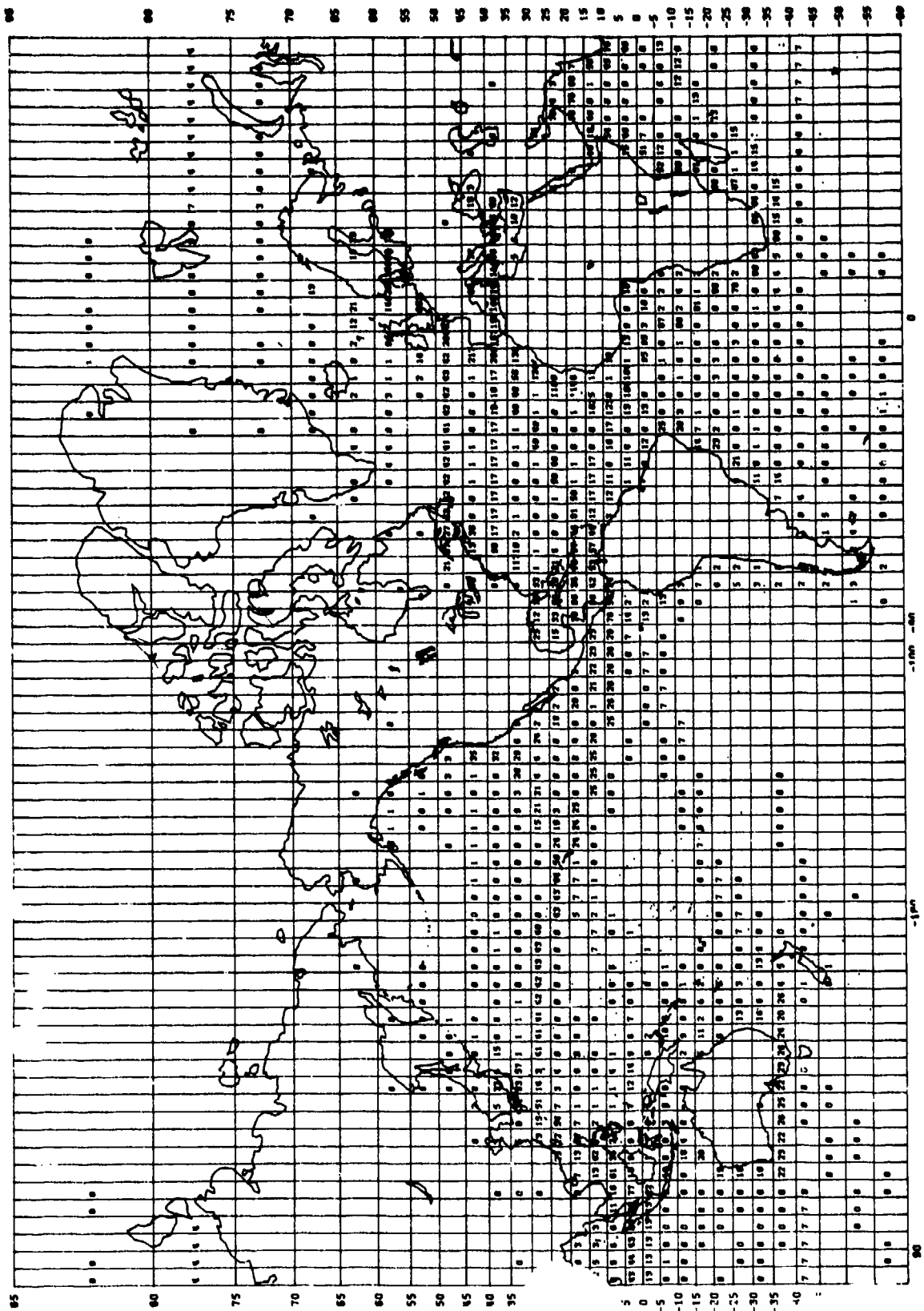
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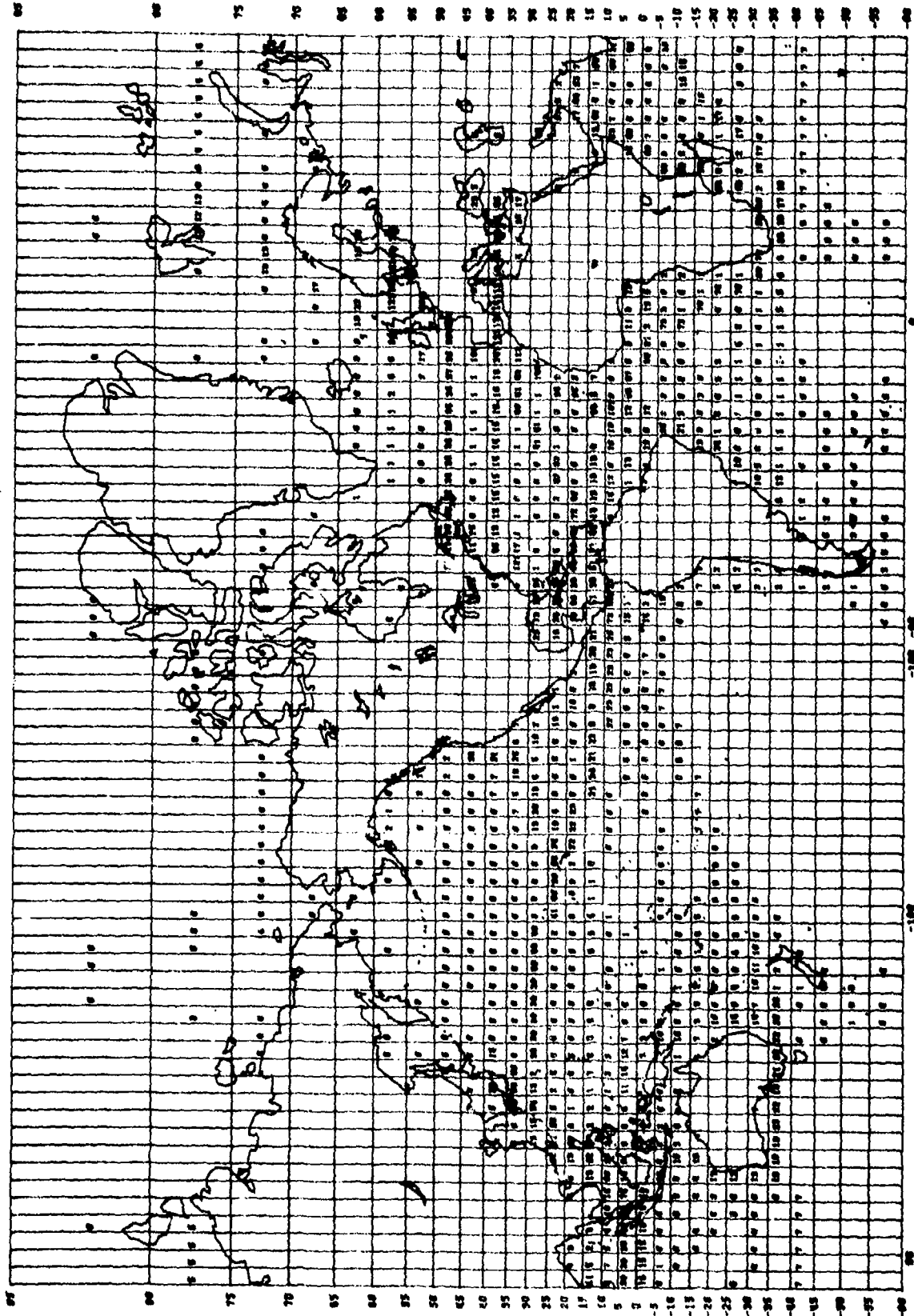
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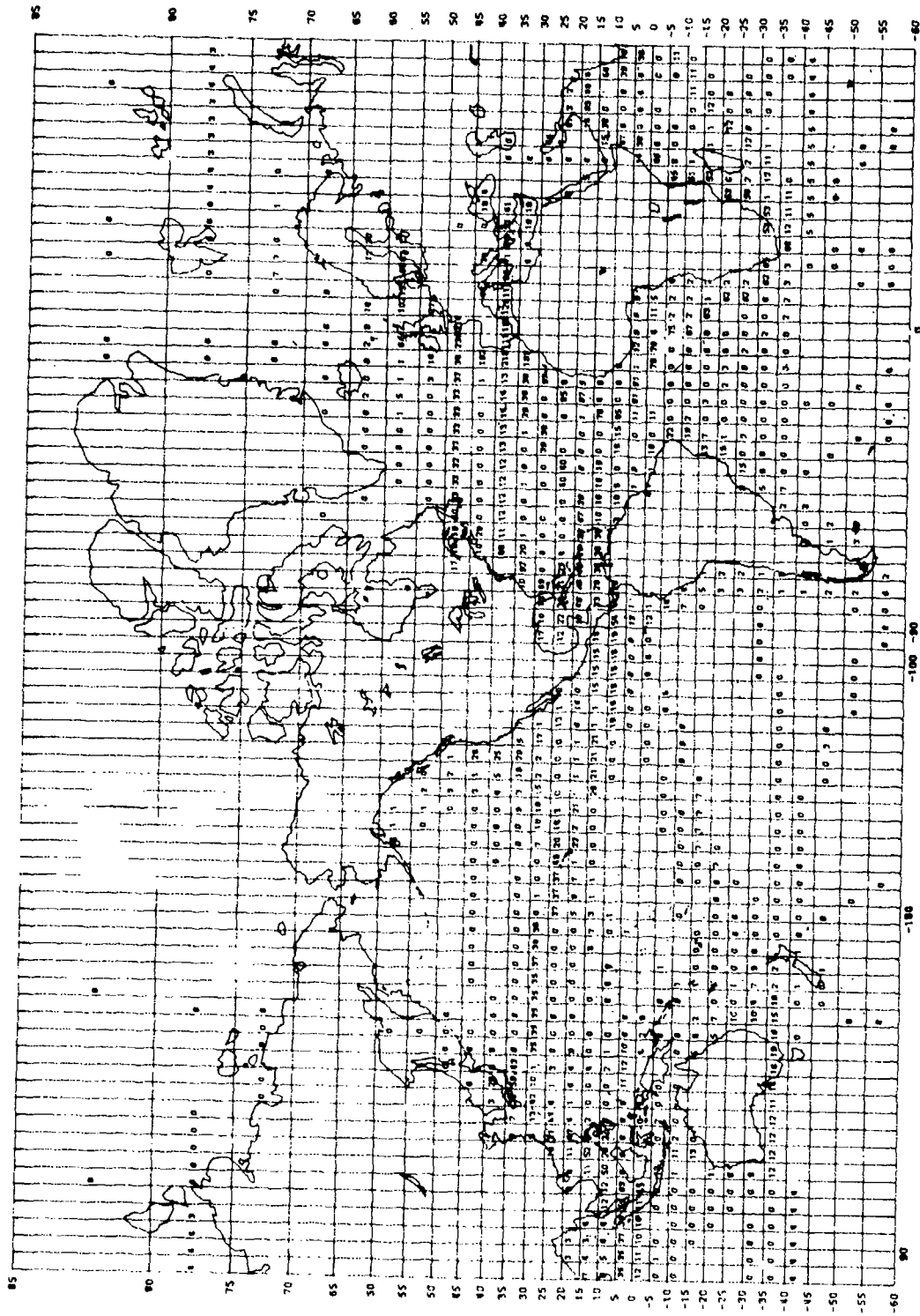
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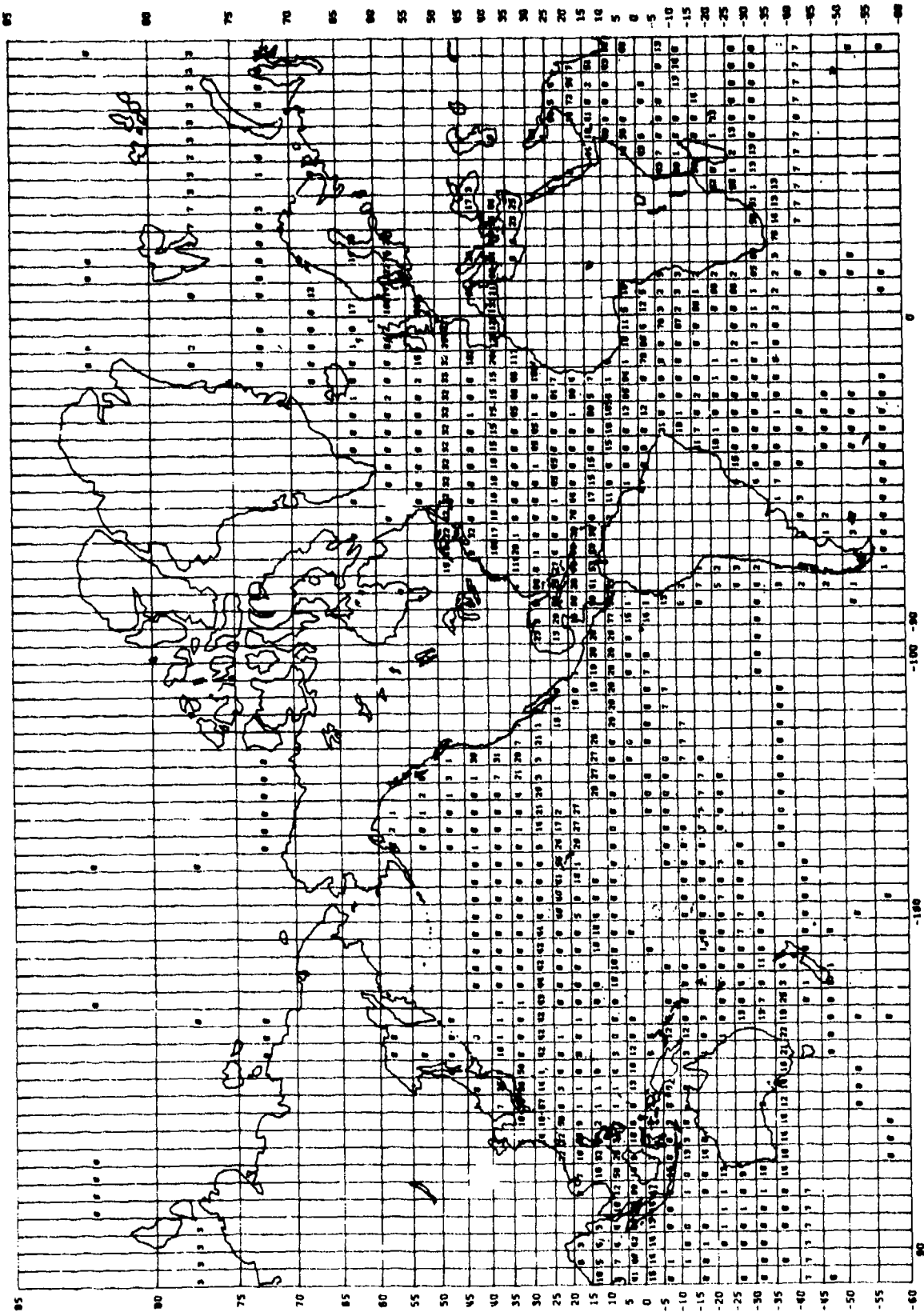
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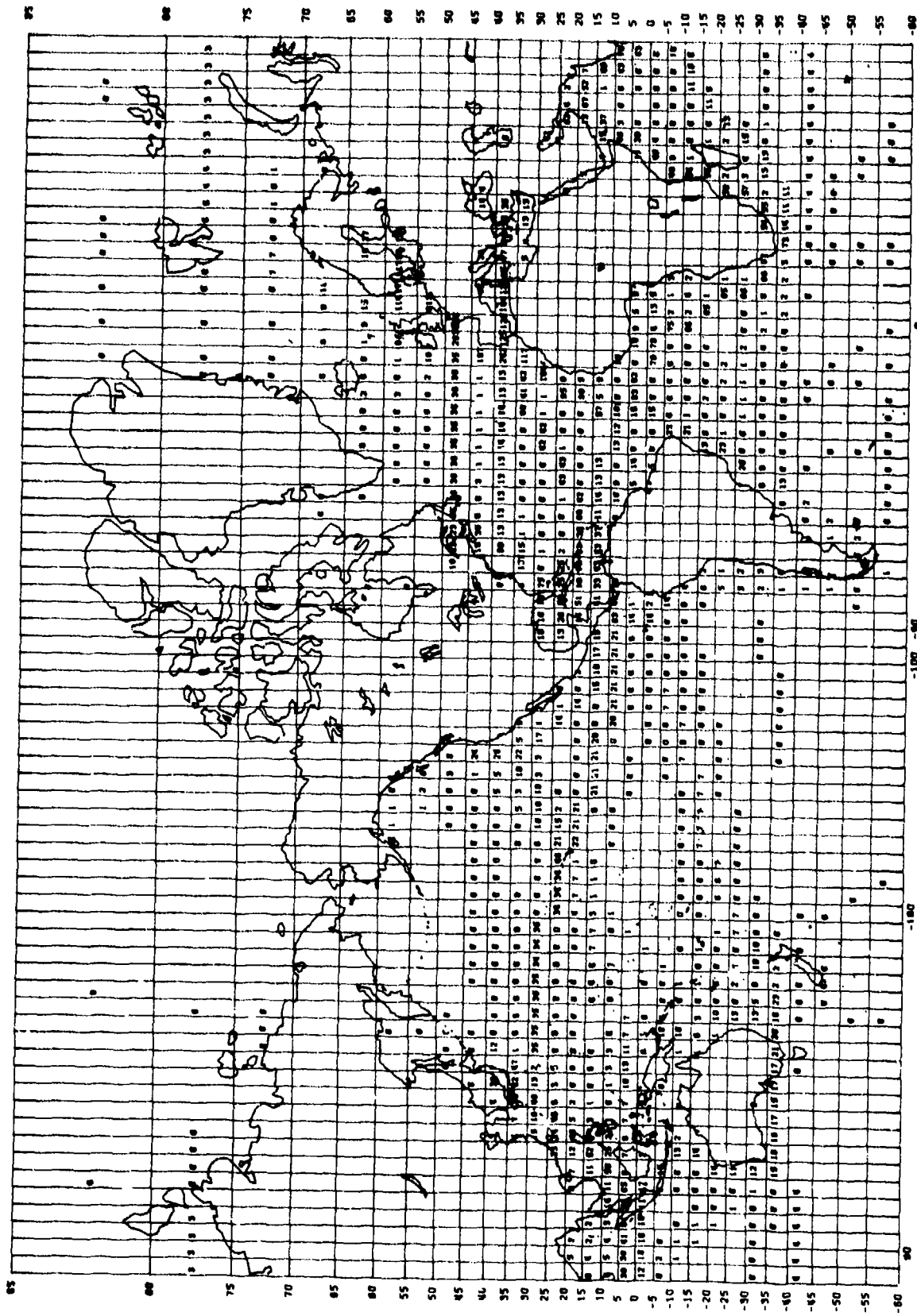
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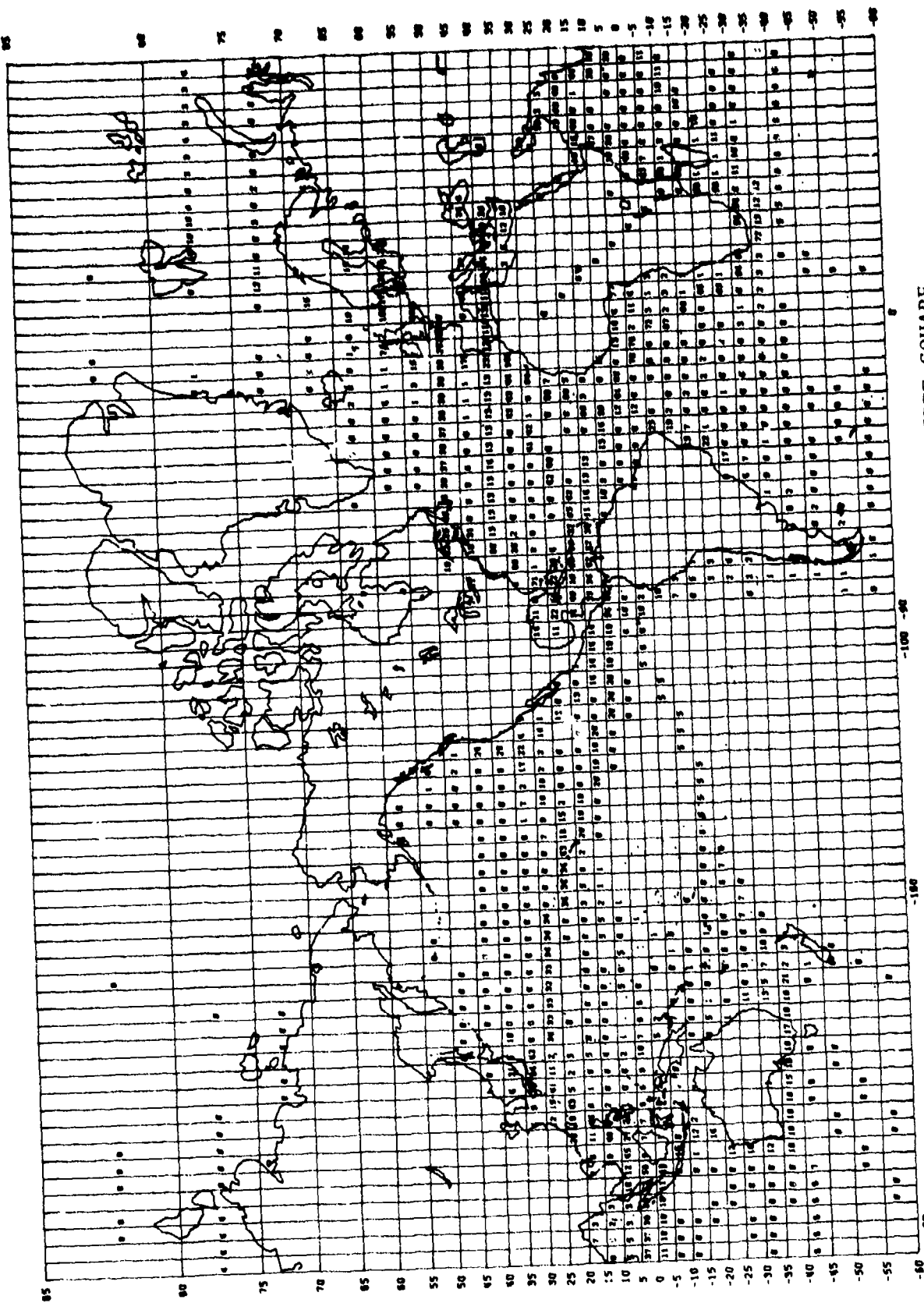
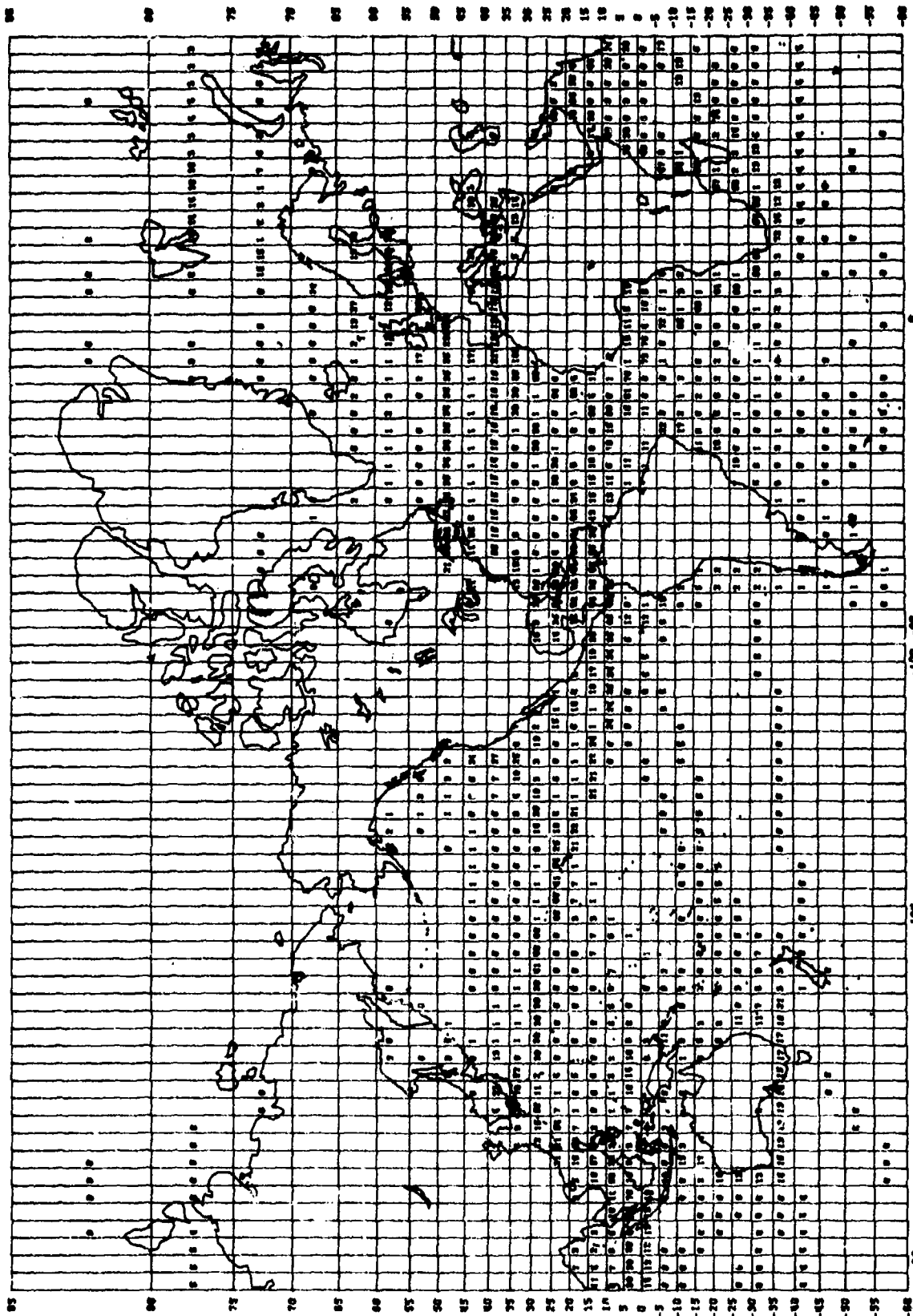VESSEL DATA REPORTED ON MAY 31   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE
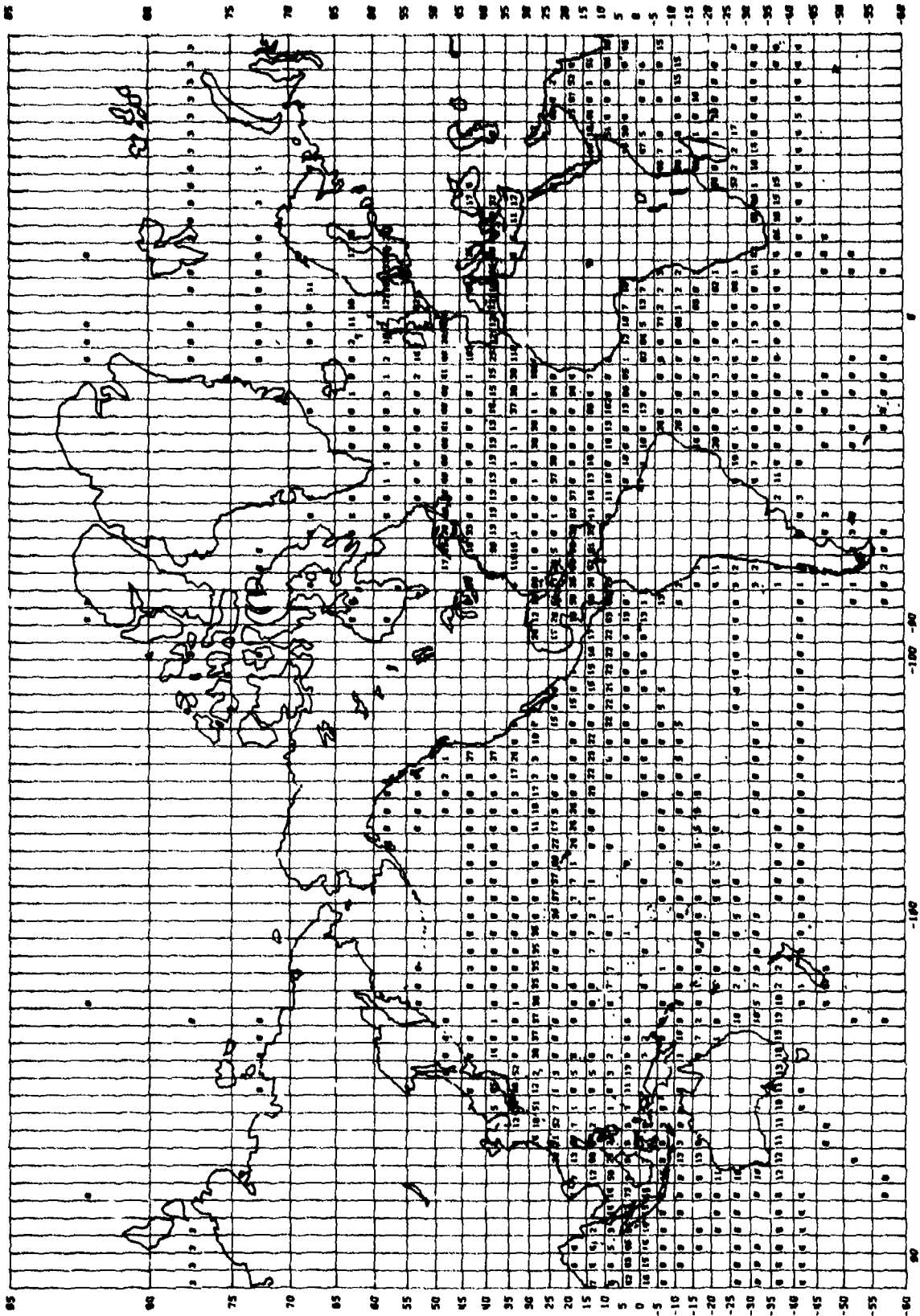
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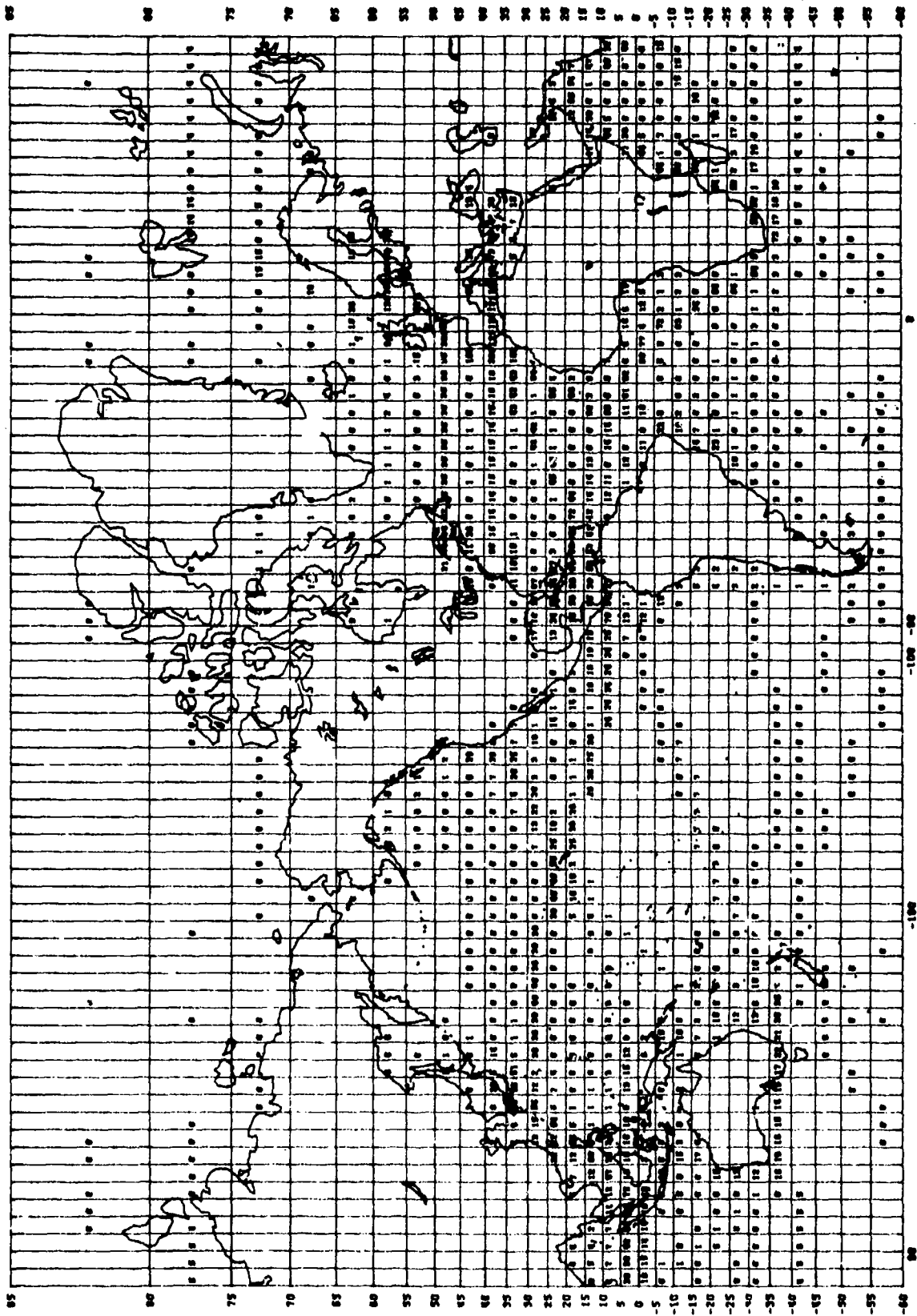
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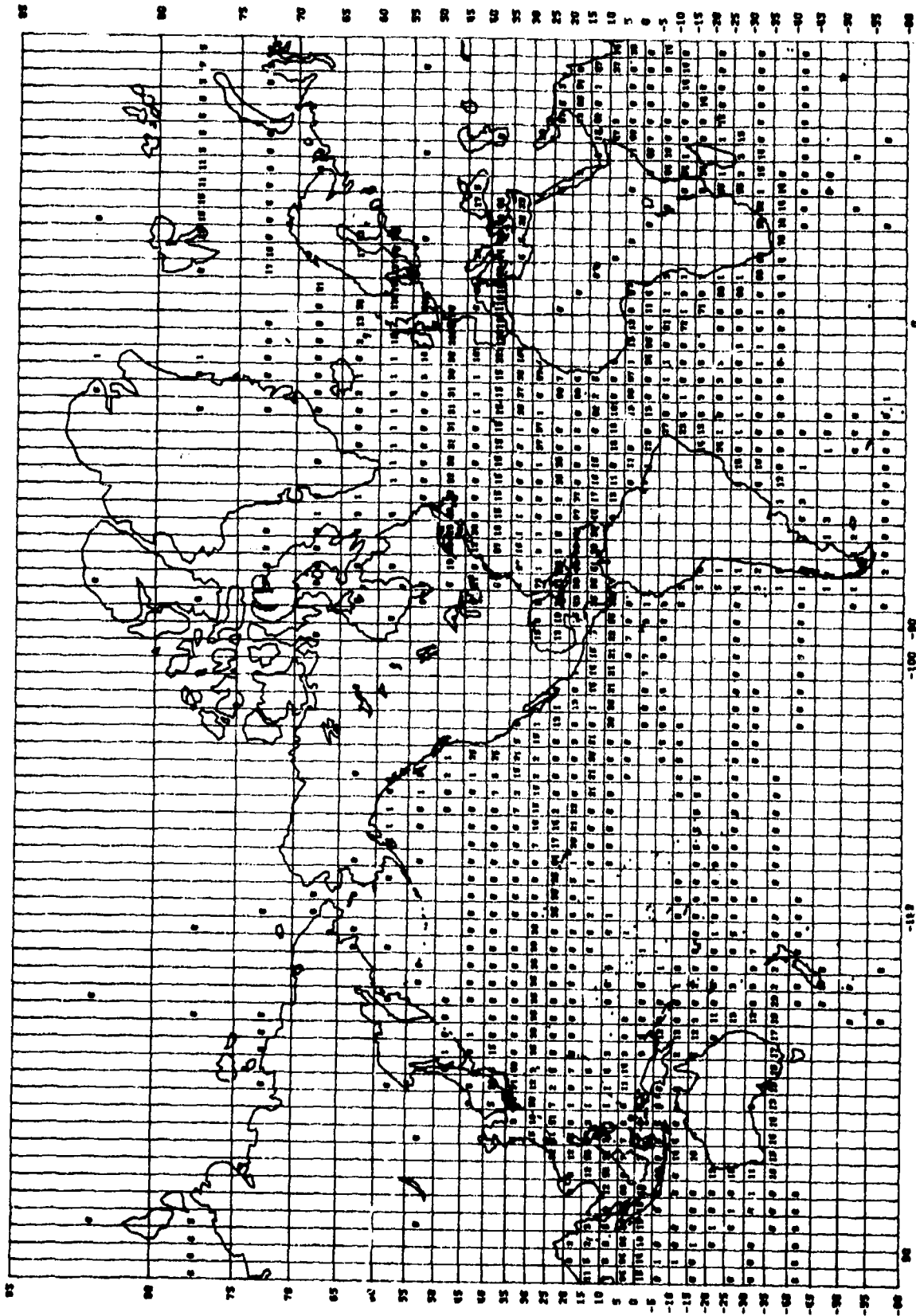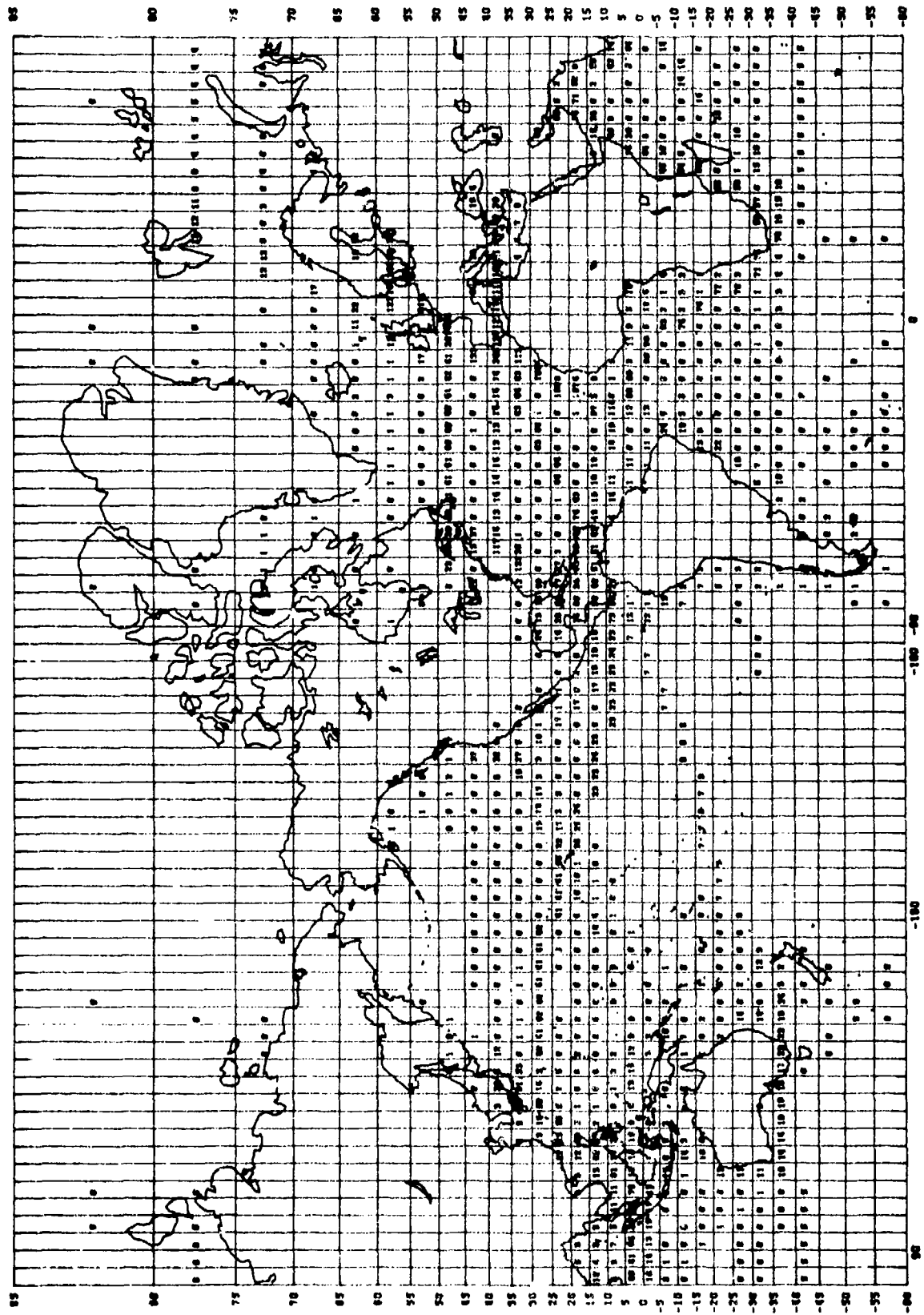VESSEL DATA REPORTED ON JULY 26   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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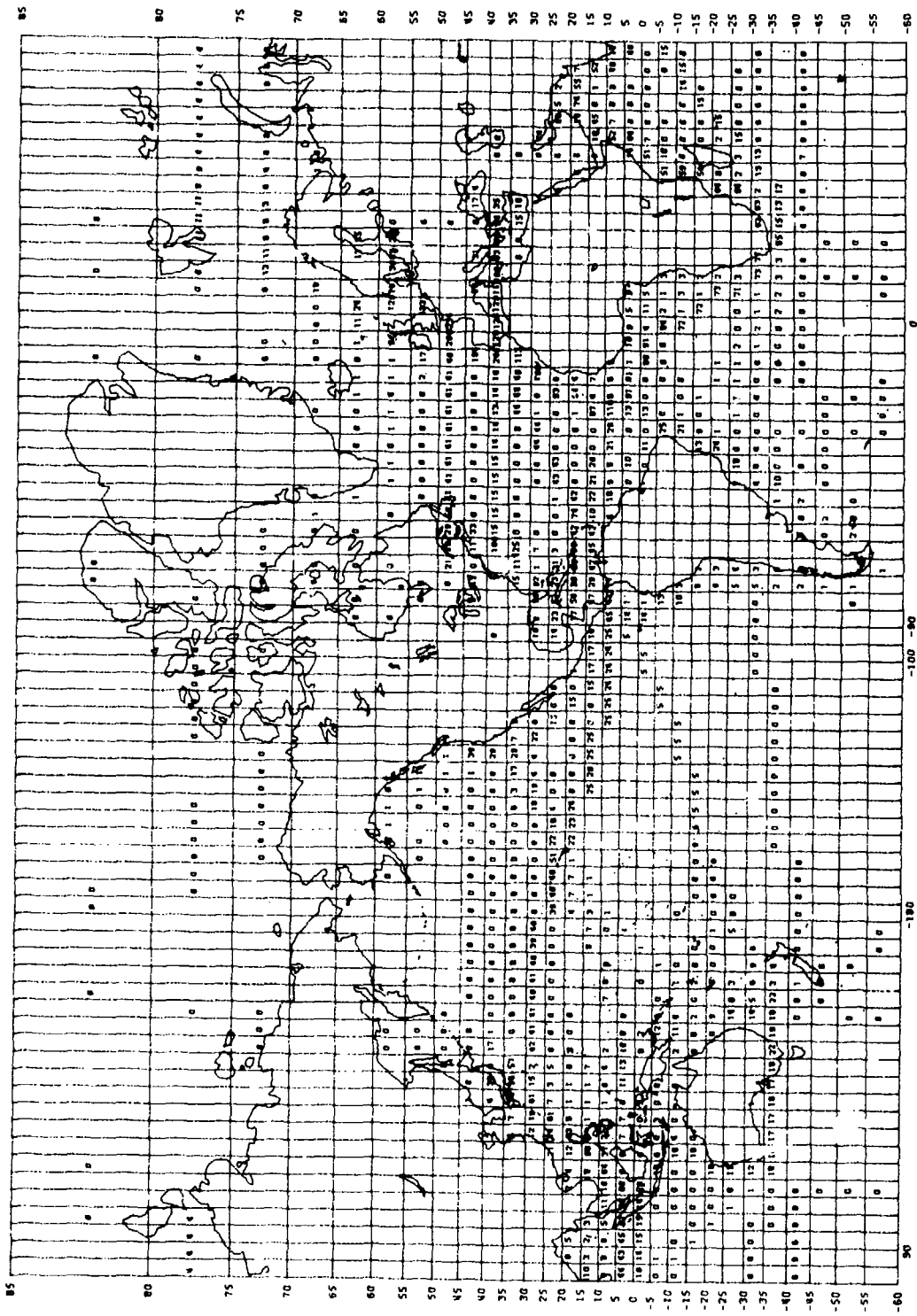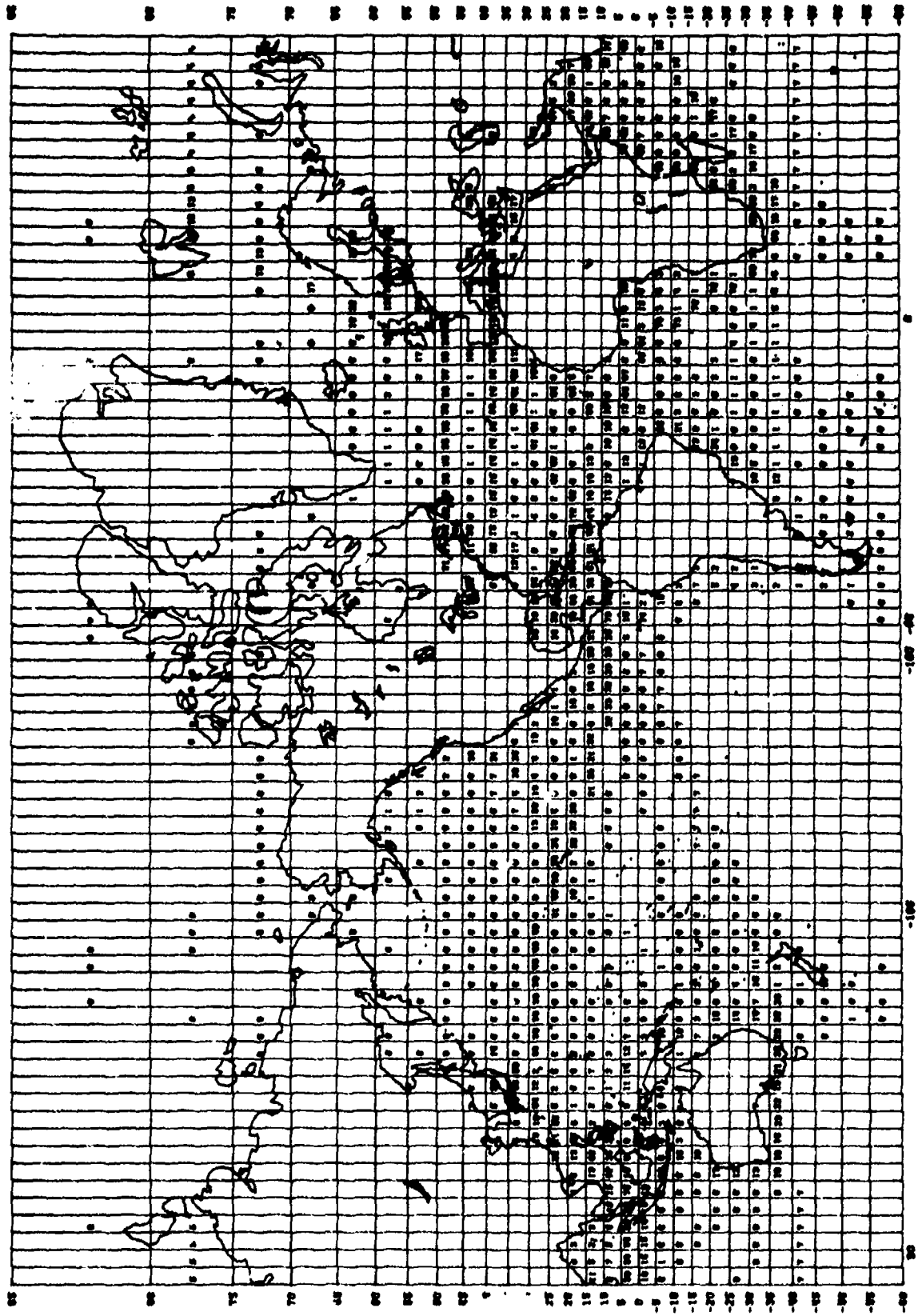
VESSEL DATA REPORTED ON AUG 2   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON AUG 9   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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VESSEL DATA REPORTED ON AUG 16   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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VESSEL DATA REPORTED ON AUG 23   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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VESSEL DATA REPORTED ON AUG 30   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON SEPT 6   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE
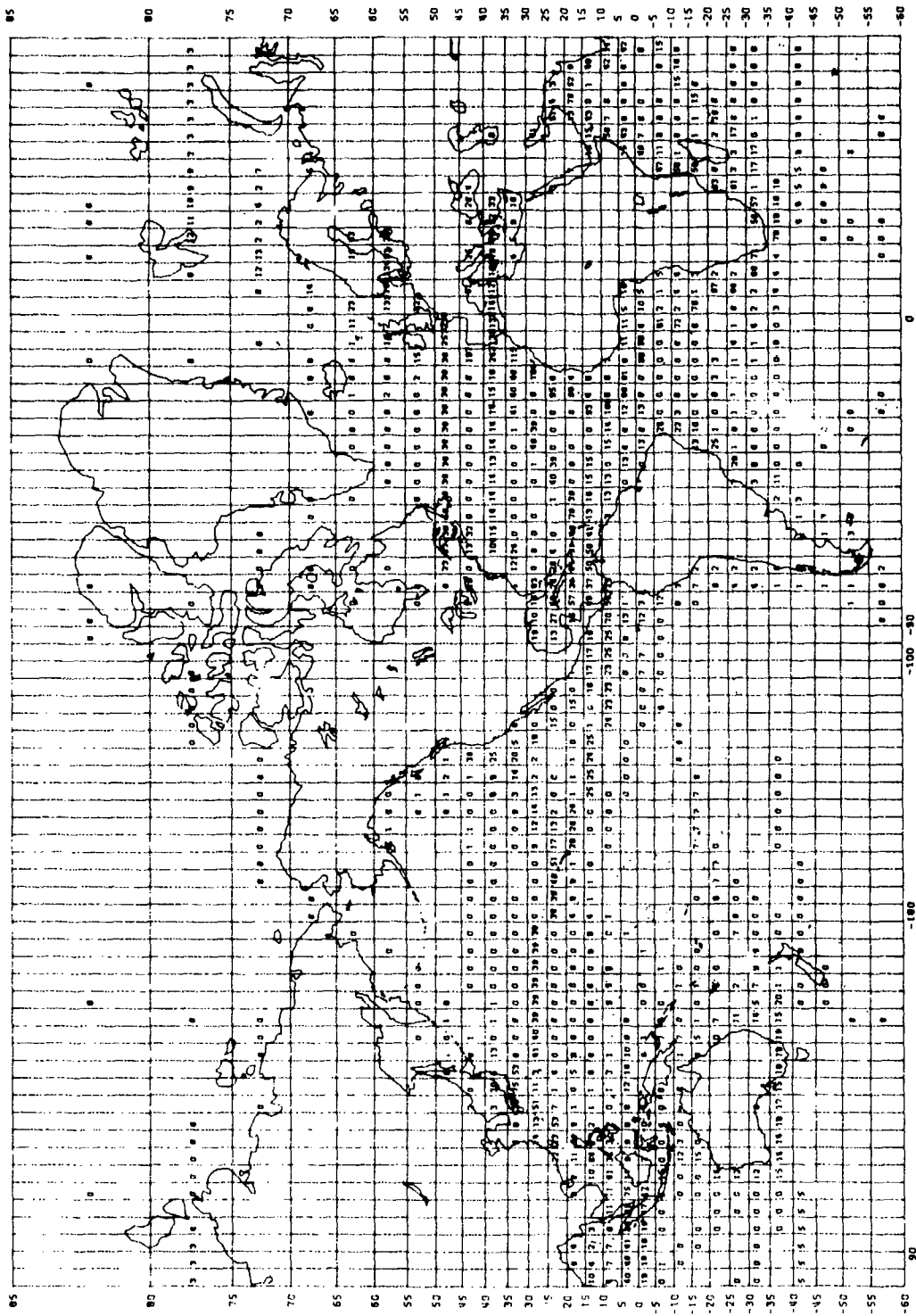
47

VESSEL DATA REPORTED ON SEPT 13   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

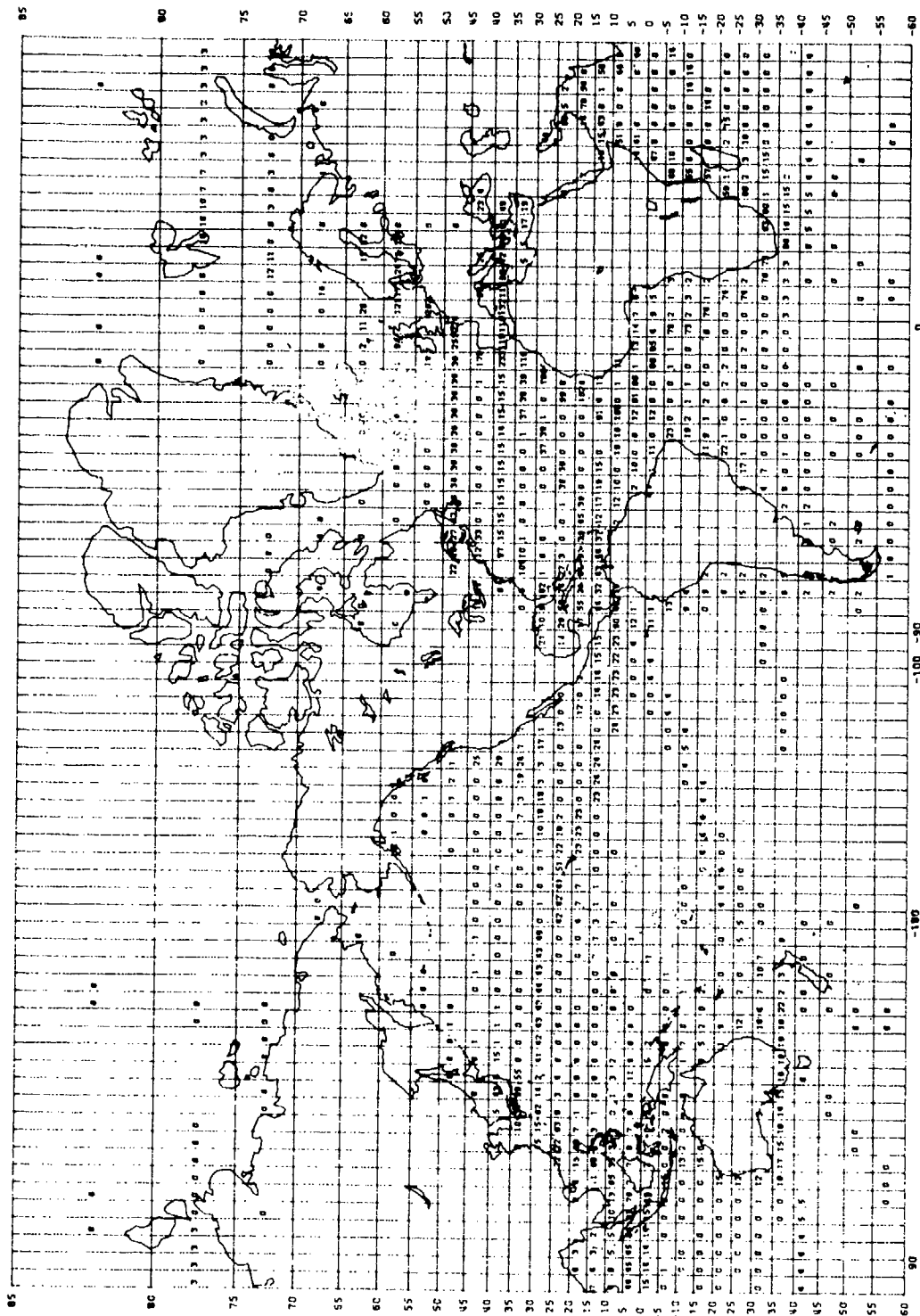VESSEL DATA REPORTED ON SEPT 20   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON SEPT 27 7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON OCT 4 7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON OCT 11 7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON OCT 18   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

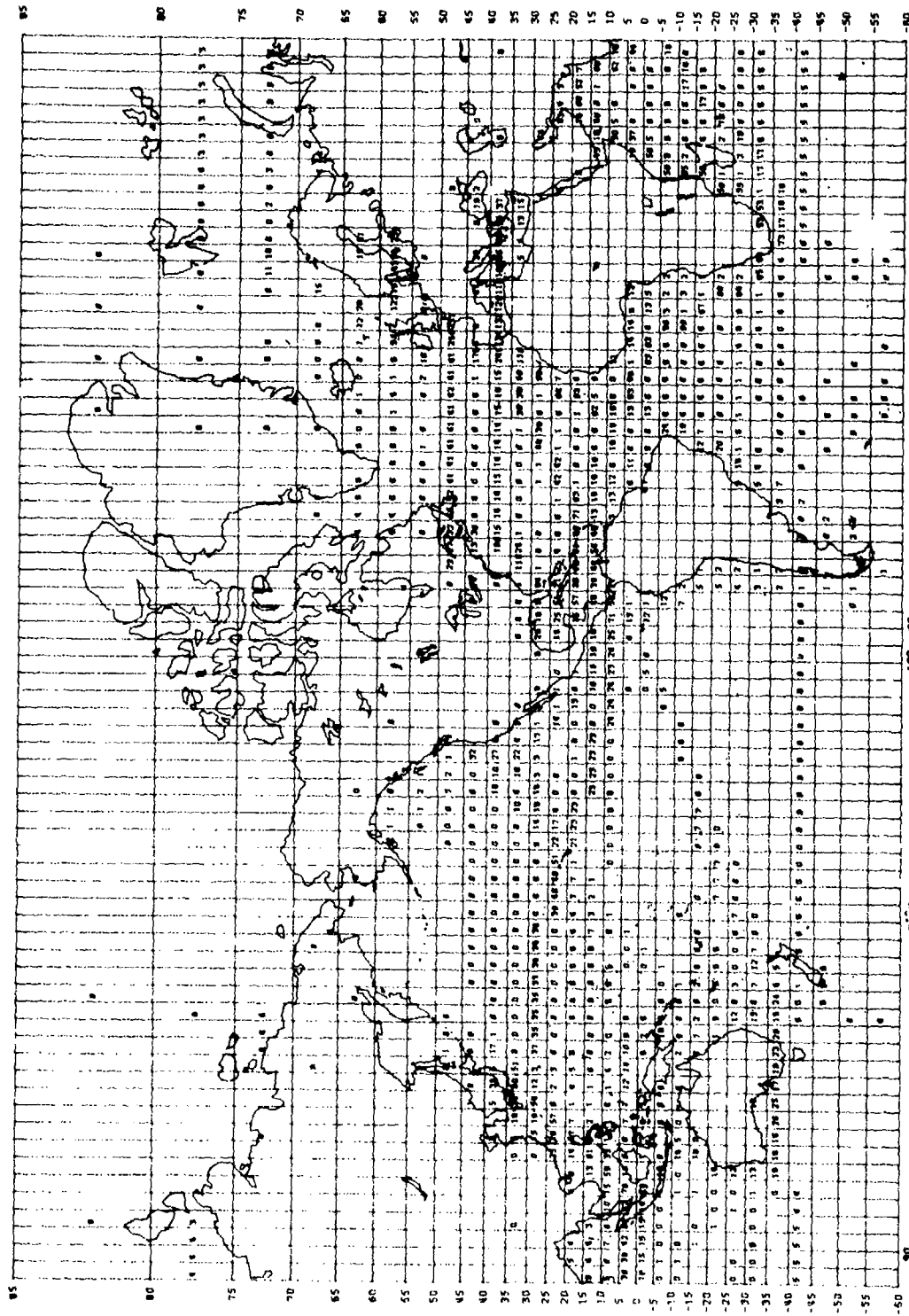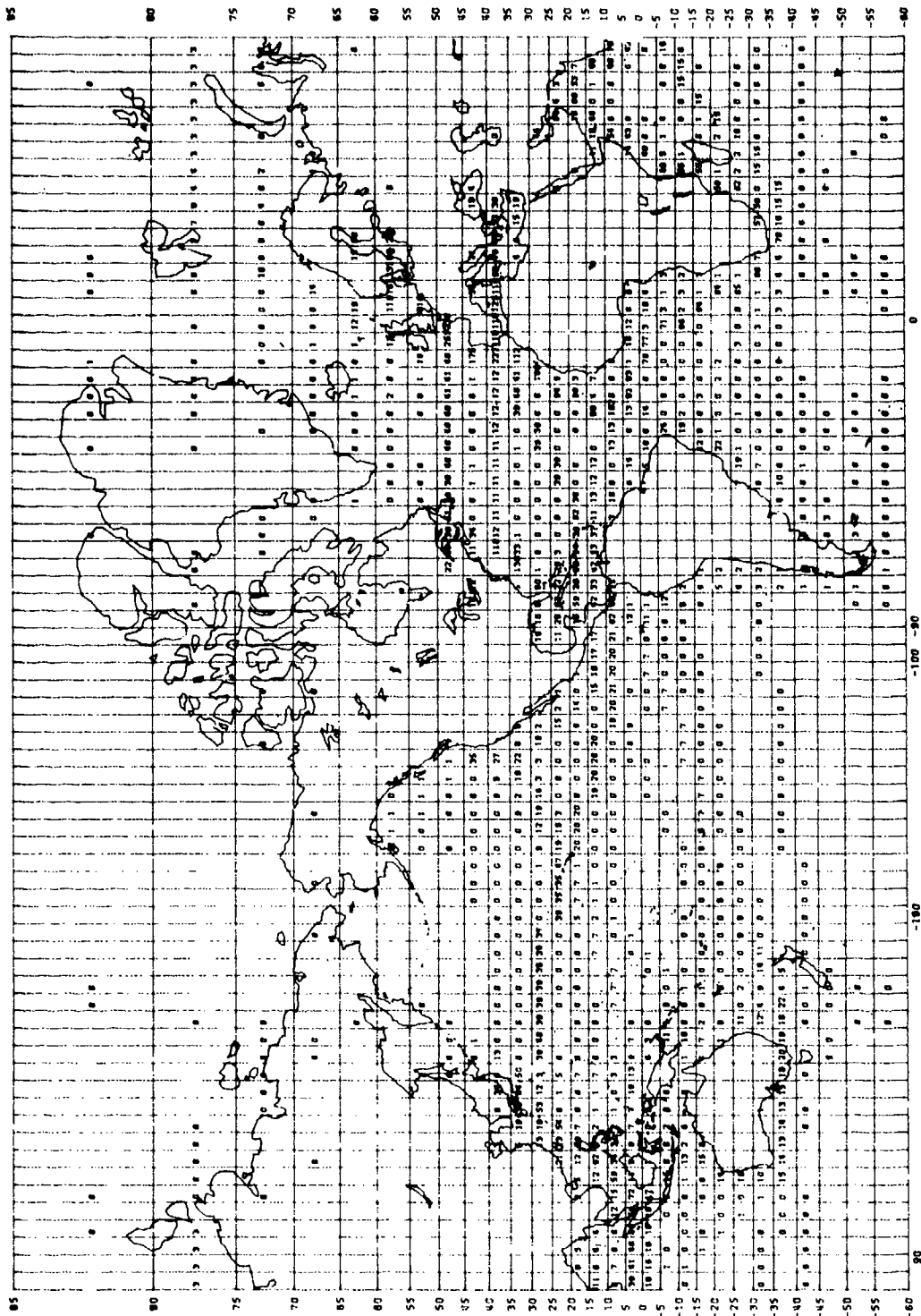VESSEL DATA REPORTED ON OCT 25   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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VESSEL DATA REPORTED ON NOV 1   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON NOV 8   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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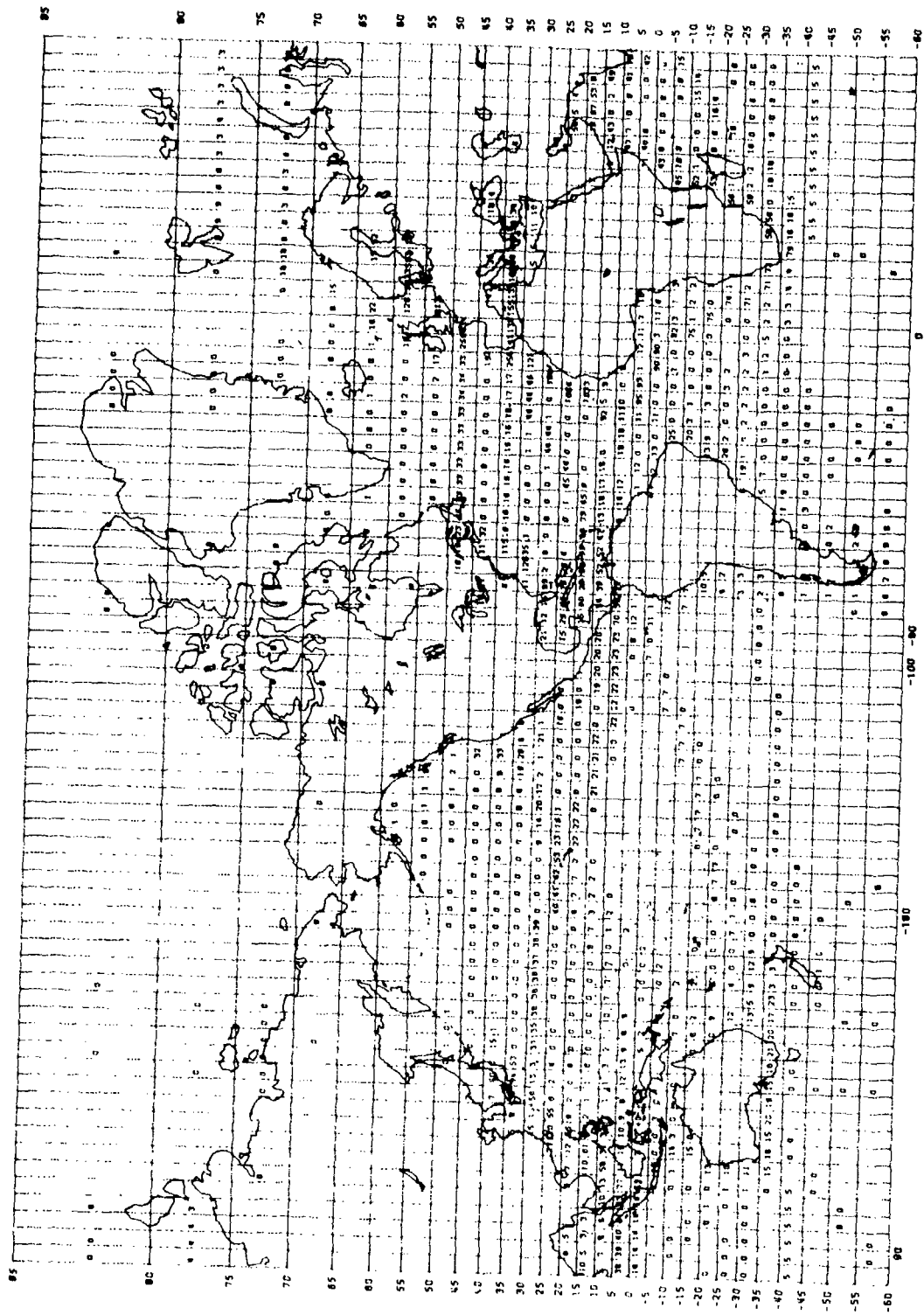VESSEL DATA REPORTED ON NOV 15   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

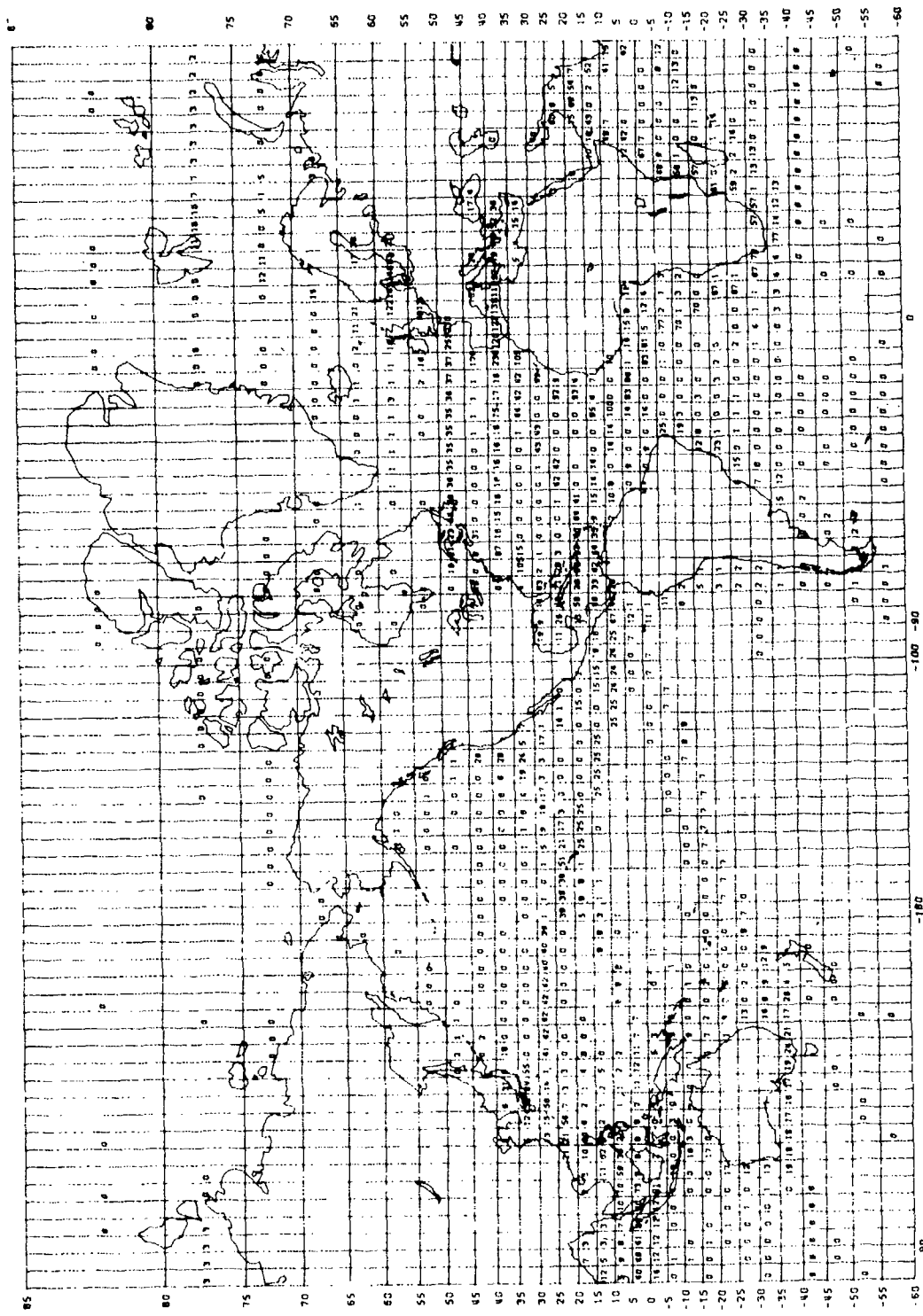VESSEL DATA REPORTED ON NOV 22   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

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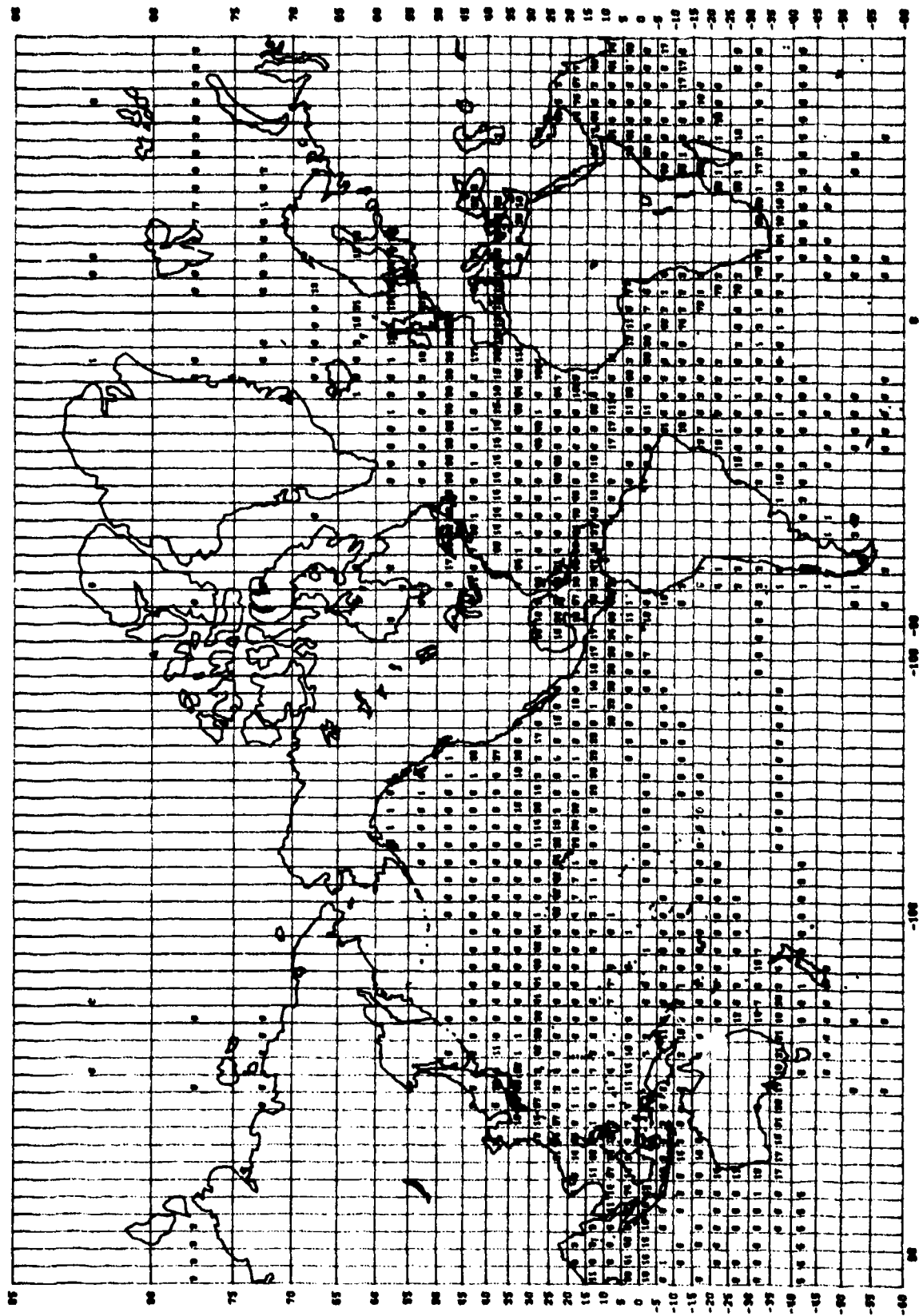VESSEL DATA REPORTED ON NOV 29   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE
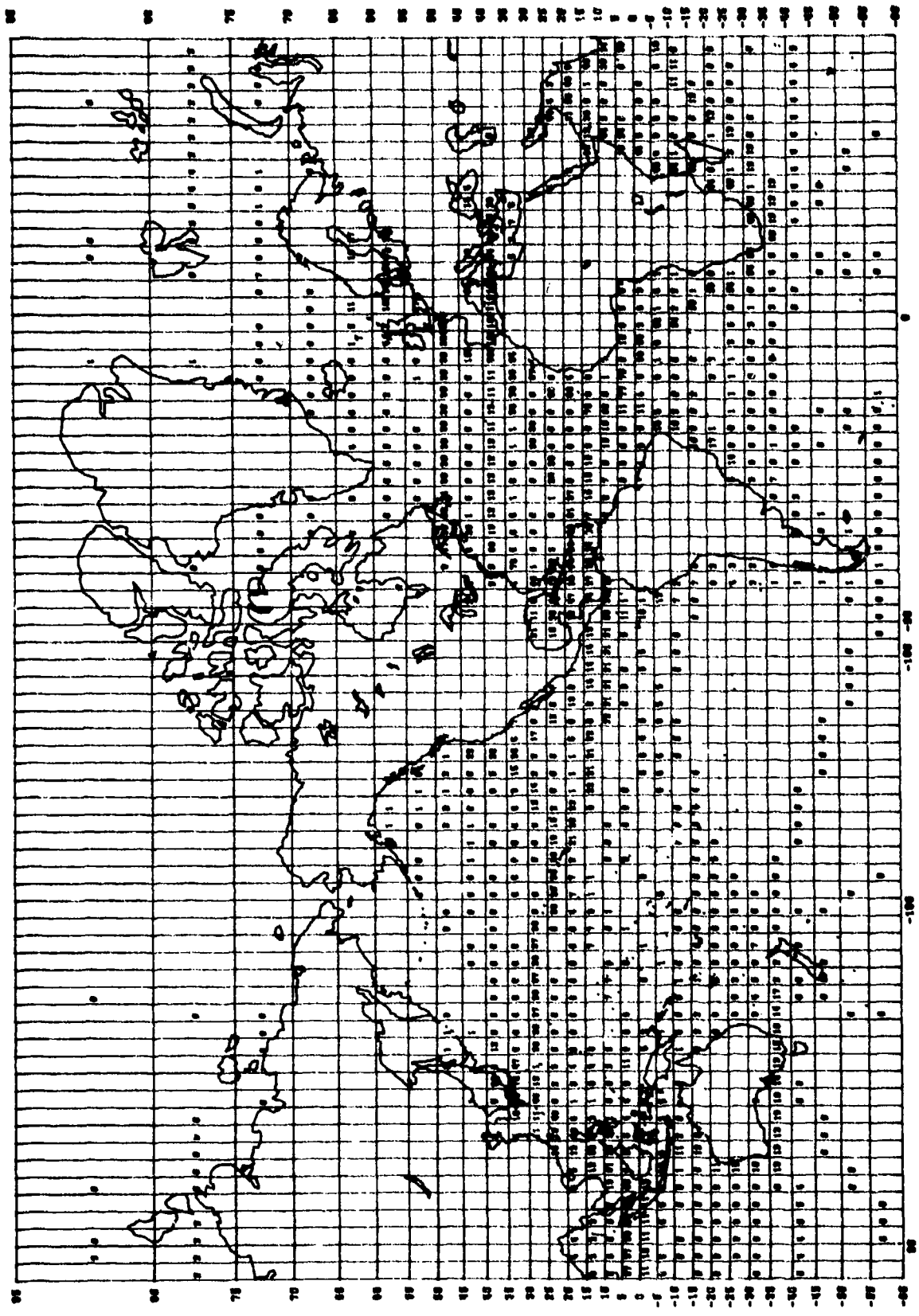
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VESSEL DATA REPORTED ON DEC 6   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON DEC 13   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON DEC 20   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE

VESSEL DATA REPORTED ON DEC 27   7 DAY AVERAGE FOR EACH FIVE DEGREE SQUARE