PALEOCEANOGRAPHIC MAPPINT PROJECT
PROGRESS REPORT NO. 05-0985

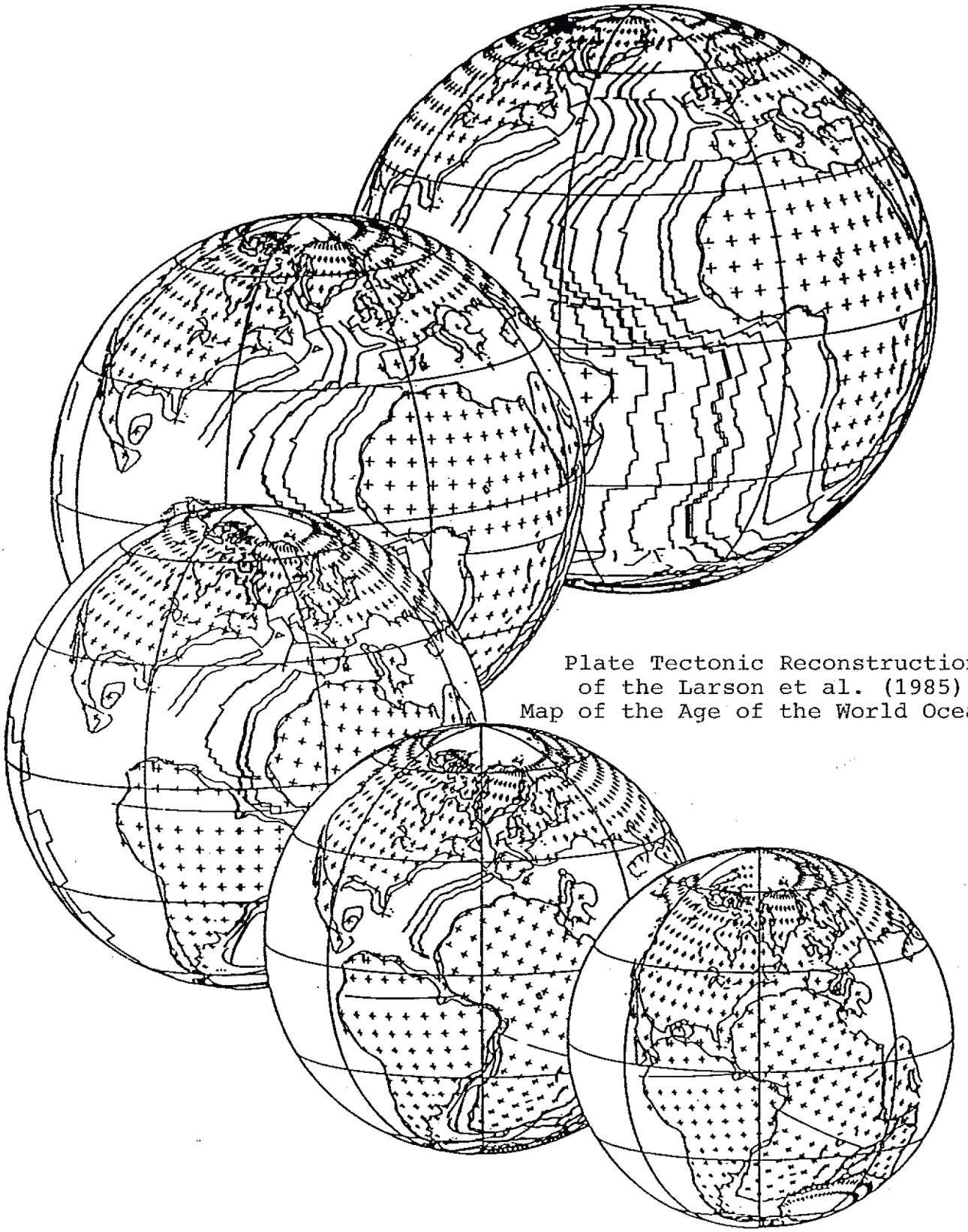

Plate Tectonic Reconstructions
of the Larson et al. (1985)
Map of the Age of the World Oceans

By
L. Gahagan, C.R. Scotese and R. Larson

University of Texas Institute for Geophysics Technical Report No. 53

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Paleoceanographic Mapping Project Report #05-0985

by

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Introduction

During the past 20 years, numerous oceanographic surveys have mapped the age of the ocean floor in great detail (NGDC data bank). Recently, two separate studies have compiled these results and have produced maps illustrating the age of the ocean basins on a global scale (Sclater and Parsons, 1981; Larson et al., 1985). This work has been done with the realization that in order to make accurate plate tectonic reconstructions, an accurate map of the age of the ocean floor is required. This report compares these two compilations and presents a new set of Mesozoic and Cenozoic plate reconstructions based on the magnetic isochrons of Larson et al. (1985).

A Comparison of the Sclater and Parsons (1980) and Larson et al. (1985) Isochron Maps.

Figures 1. and 2. are reduced versions of the Sclater and Parson (1980) and Larson et al. (1985) isochron maps. In Figure 3, these two data sets have been directly overlaid. Though the choice of different times for the isochrons used on each map makes direct comparison difficult, a few points can be made.

Similarities:

1. The pattern in the North, Central, and South Atlantic Oceans are very similar.
2. The treatment of the younger anomalies along the Southwest Indian Ridge is identical because both maps are based on the work of Sclater and Fisher, 1981.
3. The pattern in the Central Indian Ocean is similar due to the fact both groups base their interpretations on the work of Sclater and McKenzie (1971).
4. The pattern in the Eastern Pacific, as portrayed on both maps is fairly similar.

Differences:

(Overall)

1. The Sclater and Parsons (1980) compilation was finished before two important sources of new information were available: 1. the GEBCO bathymetric maps of the world oceans (published 1983), and 2. the exciting new results from SEASAT (Haxby et al., 1983). Many of the differences between these two maps are due to the fact that the more recent Larson et al. (1985) isochron map has incorporated data from these two sources.

2. The method in which the maps were made has also resulted in important differences. The Larson et al. (1985) isochron map was made by directly mapping the age of the ocean floor from exisiting pattern magnetic anomalies. Where no data were available, the boundaries of the isochrons were estimated. The Sclater and Parsons (1980) map on the other hand is based largely on plate tectonic models for each ocean basin. The isochrons were derived by rotating ridge axes about poles of rotation that "best fit" the observed magnetic lineations.

(Atlantic)

1. The Larson et al. (1985) map takes into account the evolution of the Jan Mayen micro-continent.

2. The Sclater and Parsons (1980) map does not show the correct position of the Charlie-Gibbs fracture zone.

3. The Larson et al. (1985) map correctly takes into account the ridge jump in the Cape Basin (SW Africa); the Sclater and Parson map does not.

(Indian)

1. Both maps show very different patterns for the isochrons that represent the early stages of rifting between India and Antarctica. (Both are likely to be incorrect.)

2. The Larson et al. (1985) map indicates that sea floor spreading in the Mozambique and Somali Basins ended at anomaly M10 time. More likely, it continued to anomaly M0 time.

3. On the Sclater and Parsons (1980) map the Prince Edward Fracture Zone (Southwest Indian Ridge) is shown to be a nearly continuous feature. The Larson et al. (1985) map suggests that the feature is discontinuous and has been interrupted by a phase of oblique spreading.

4. The Larson et al. (1985) map includes the work of Cande and Mutter (1982) which suggests Australia and Antarctica parted company in the Late Cretaceous.

5. The Sclater and Parsons (1980) map shows a small back arc basin opening between the Campbell plateau and the Macquarie Ridge.

6. The magnetic anomalies in the Weddell Sea run N-NW on the Sclater and Parsons map, whereas they run nearly E-W on the Larson et al. (1985) map. It is not clear which of these two interpretations are correct.

(Pacific)

1. Neither compilation uses the more recent work of Klitgord and Mammerickx (1982) and Lonsdale and Klitgord (1981) for the Eastern Pacific.

2. The locations of the major fracture zones, as shown on the Sclater and Parson's map, are displaced 1-2 degrees from their actual positions.

3. The maps do not agree on the shape of the isochrons on the Nazca plate.

4. The shape of the isochrons in the Southwest Pacific at 170 W are very different. On the Sclater and Parsons (1981) map the fracture zones trend more N-S.

Discussion

A comparison of the two maps suggests that though similar, there are important differences. The most significant differences are summarized by the following list of "problem areas".

1. The evolution of the Jan Mayen microplate.
2*. The Late Jurassic -Early Cretaceous evolution of the Somali and Mozambique basins.
3*. The Evolution of the Southwest Indian Ridge in the vicinity of the Prince Edward Fracture Zone.
4*. The early rifting history between India and Antarctica.
5*. The evolution of the Weddell Sea.
6*. The evolution of the SW Pacific .
7. The evolution of the Nazca plate.

* indicates that special projects are underway to solve the problems in these areas.

Plate Tectonic Reconstructions of the Larson et al. (1985) Isochron Map

The reconstructions illustrated in Figures 4 - 12 attempt to "best fit" the isochrons drawn by Larson et al. (1985). In the first phase of the project, the isochrons were digitized and converted to spherical coordinates. Finite poles of rotation (see Appendix) were then calculated through the use of interactive computer graphics (Evans and Sutherland PS300). Maps were then plotted using the program PALEOMAP.

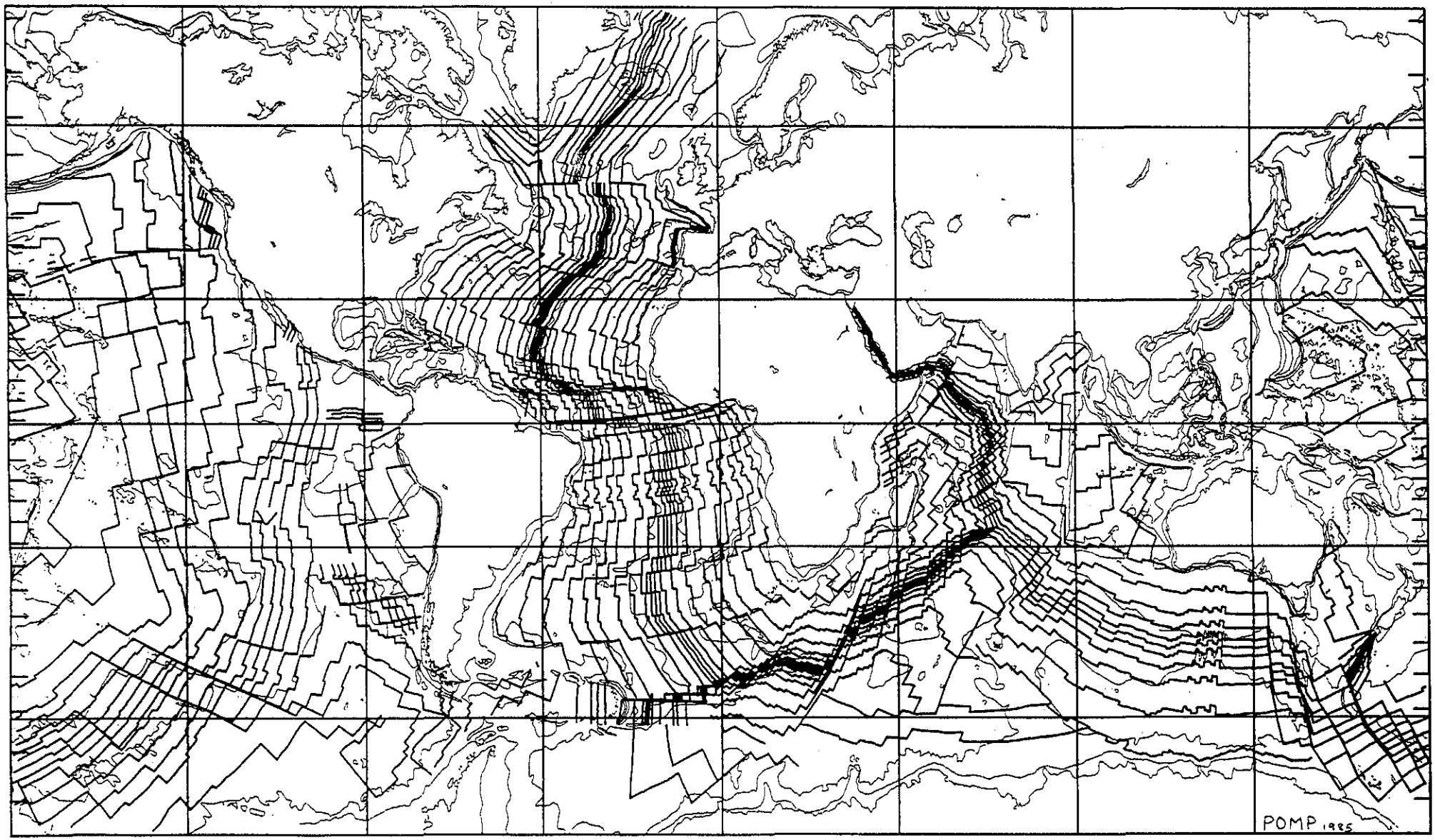


Figure 1. Sclater and Parsons (1980) Isochron Map

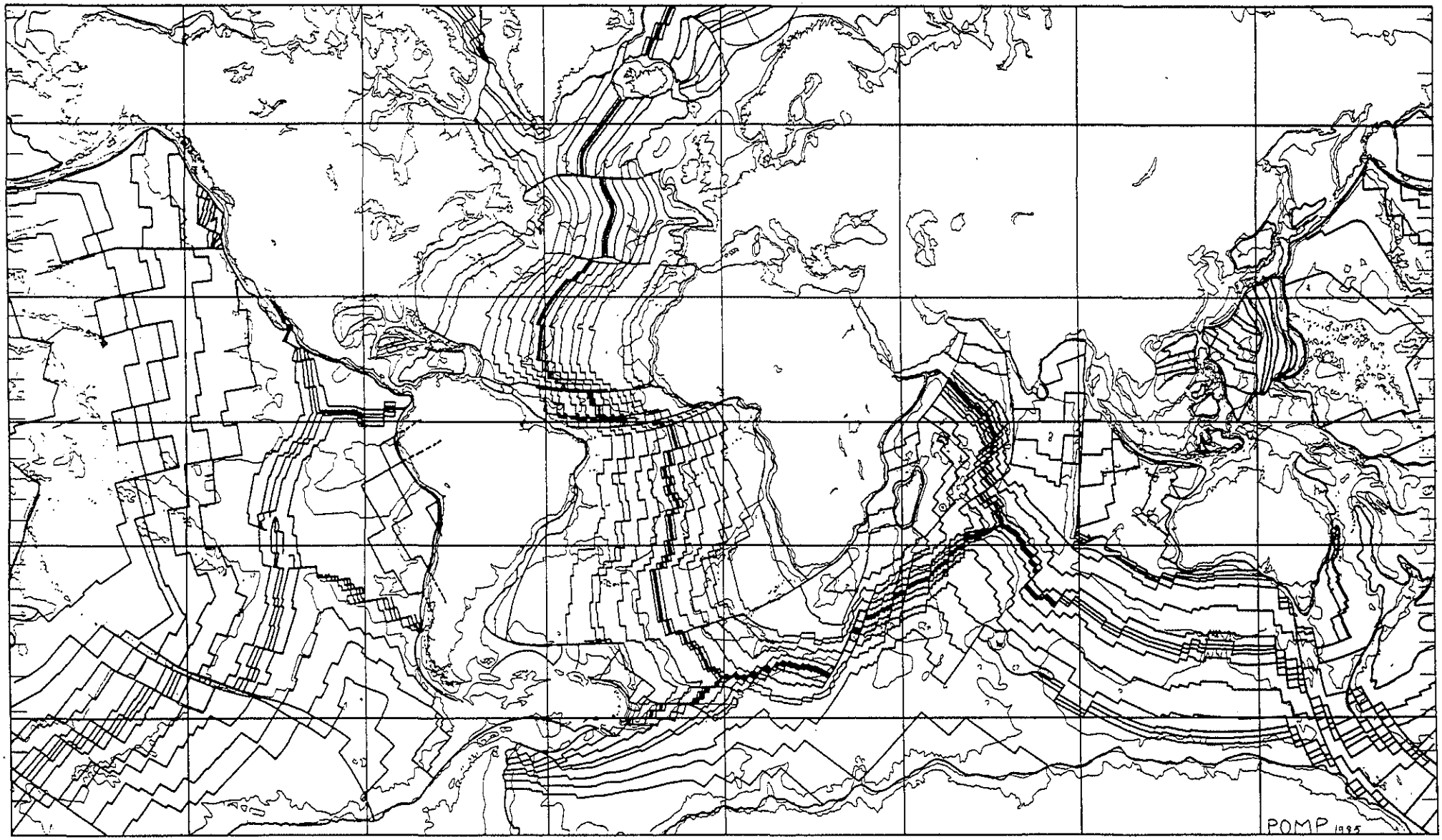


Figure 2. Larson et al. (1985) Isochron Map

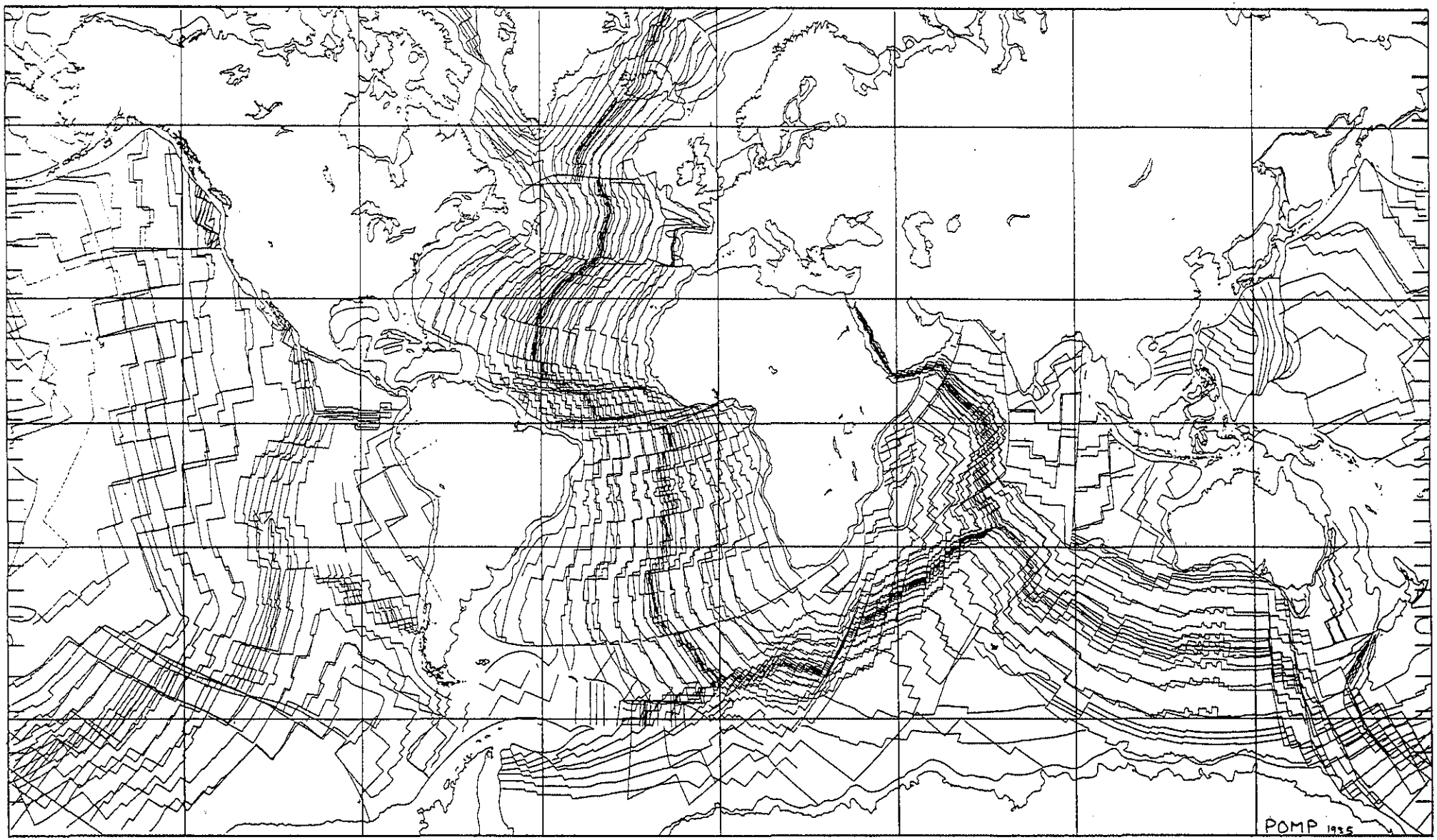
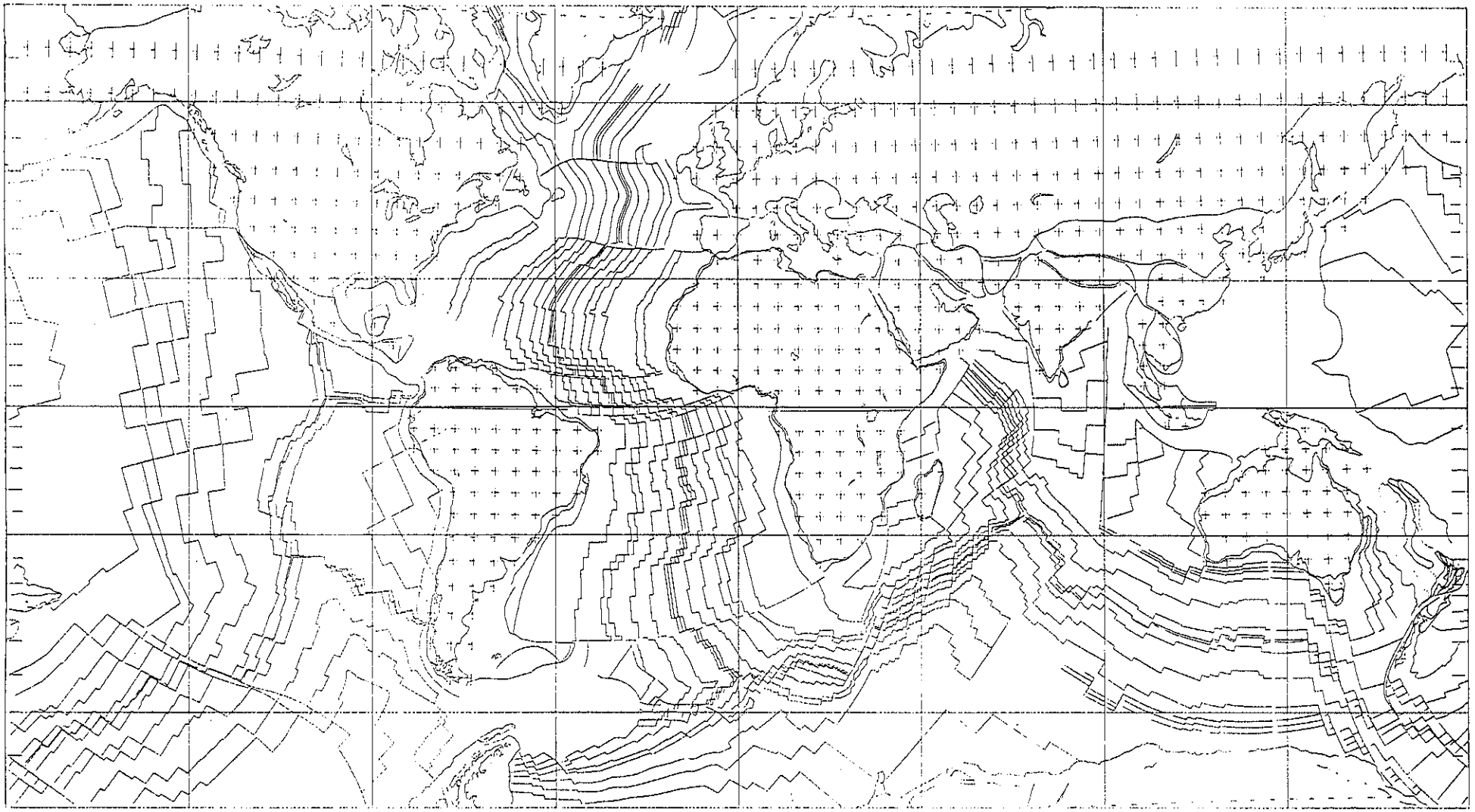


Figure 3. Sclater and Parsons (1980) and Larson et al. (1985) Isochrons combined

AN 02



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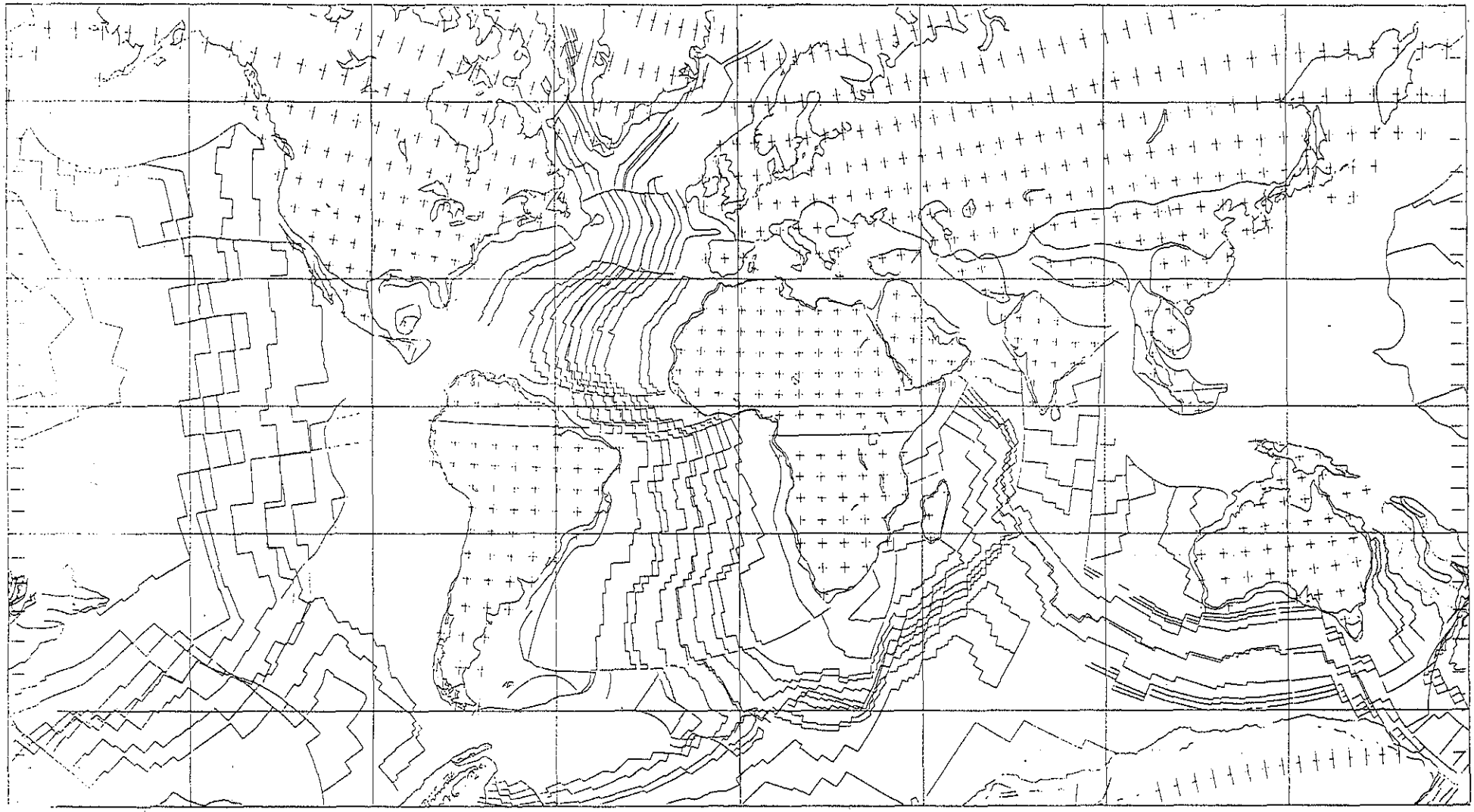

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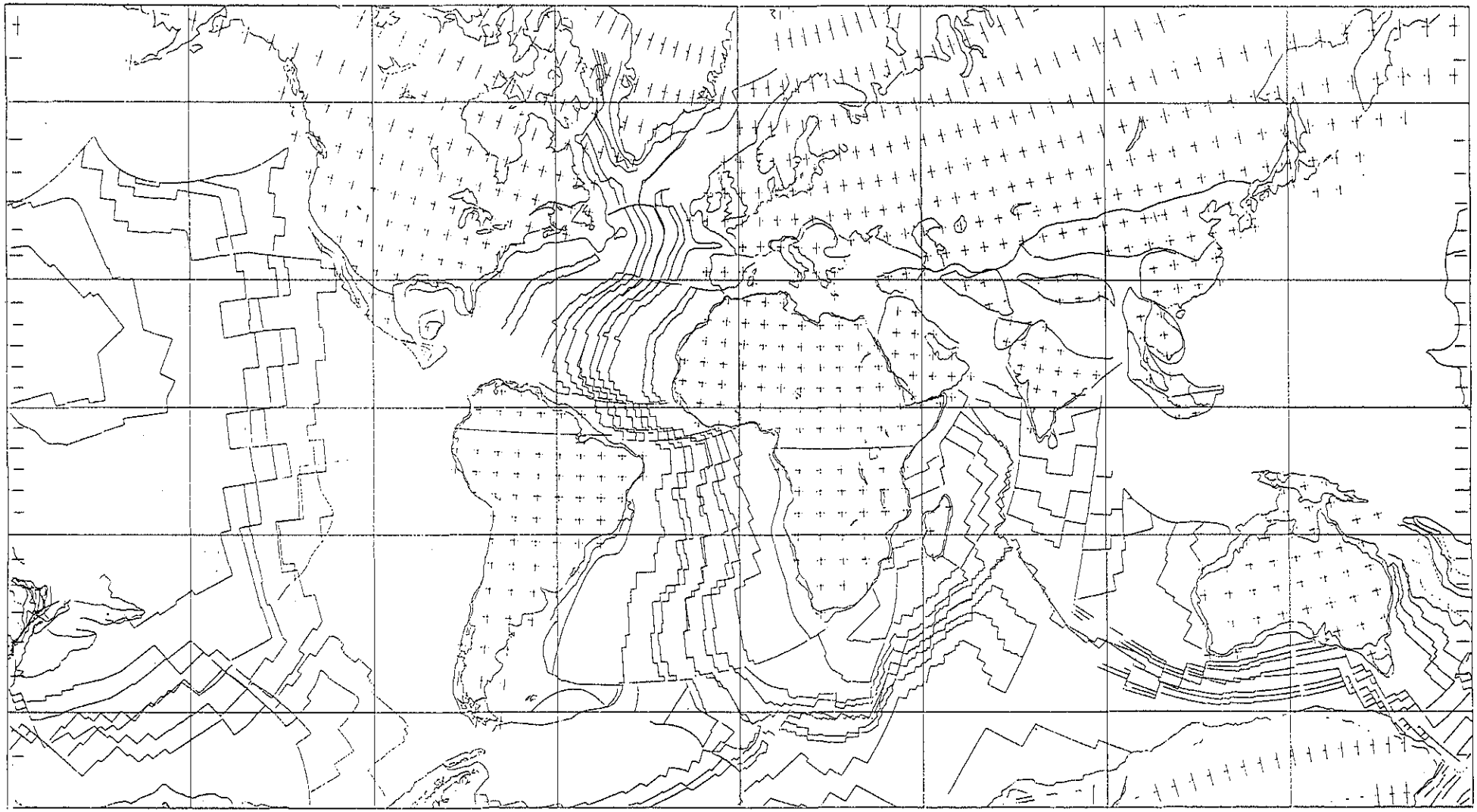

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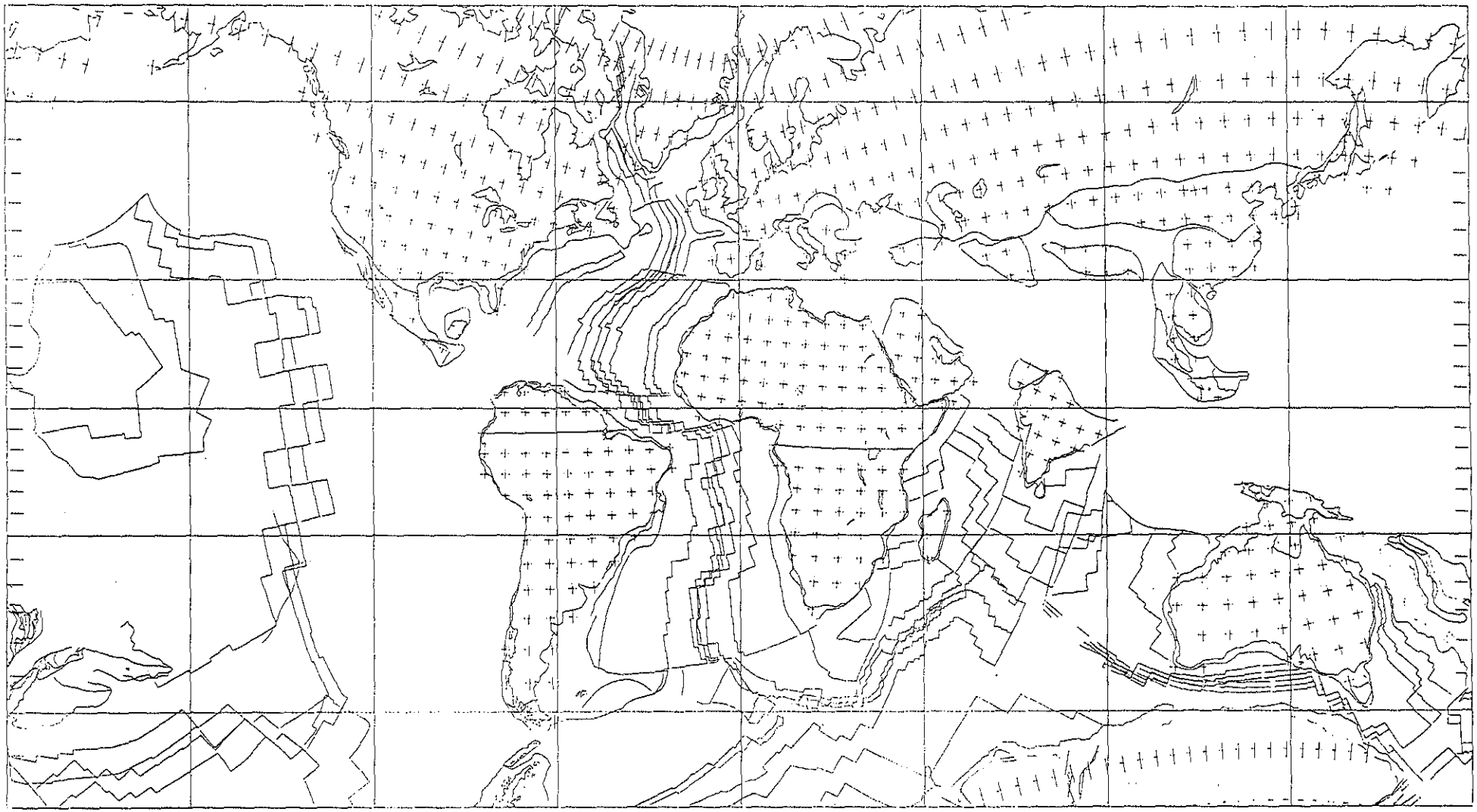

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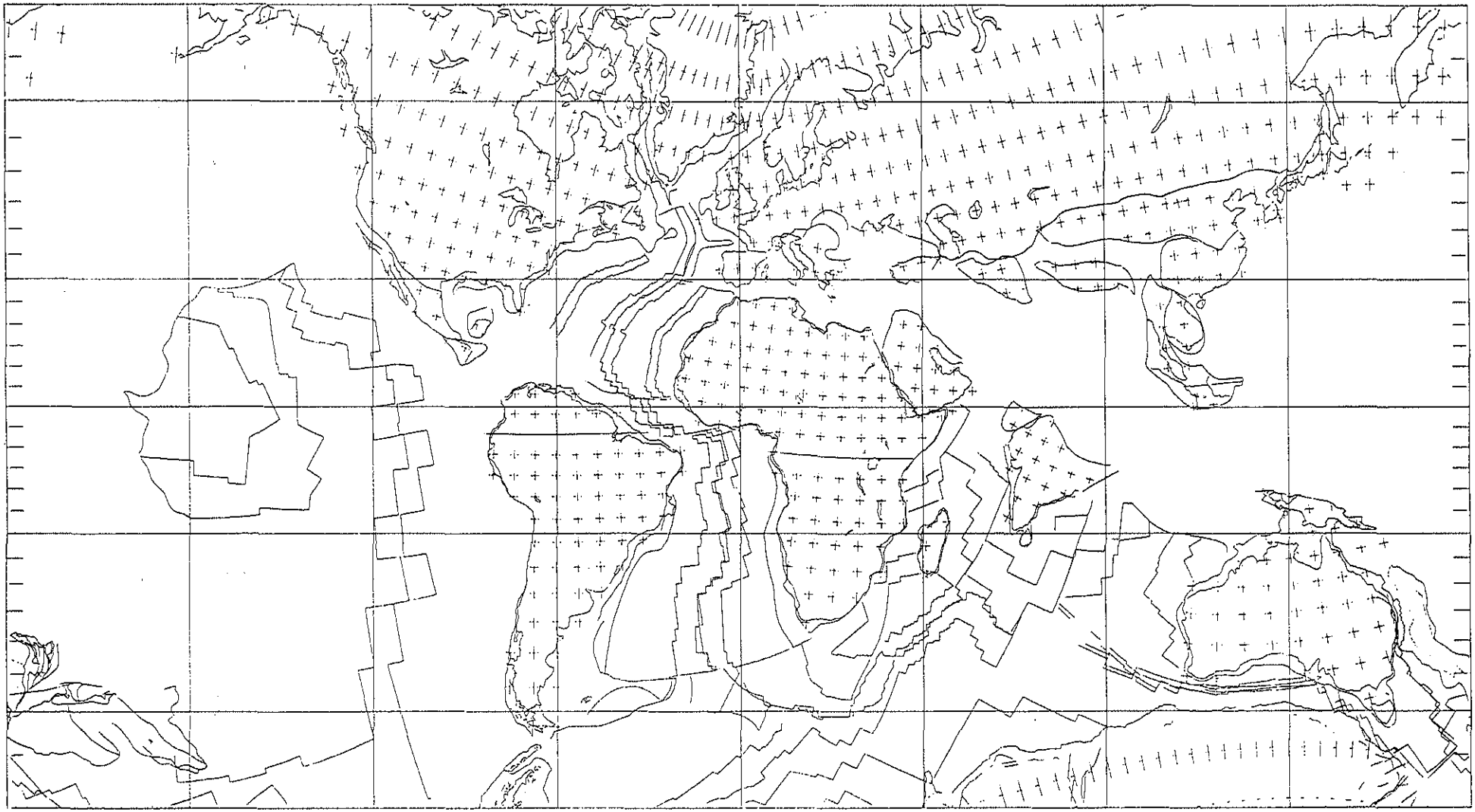

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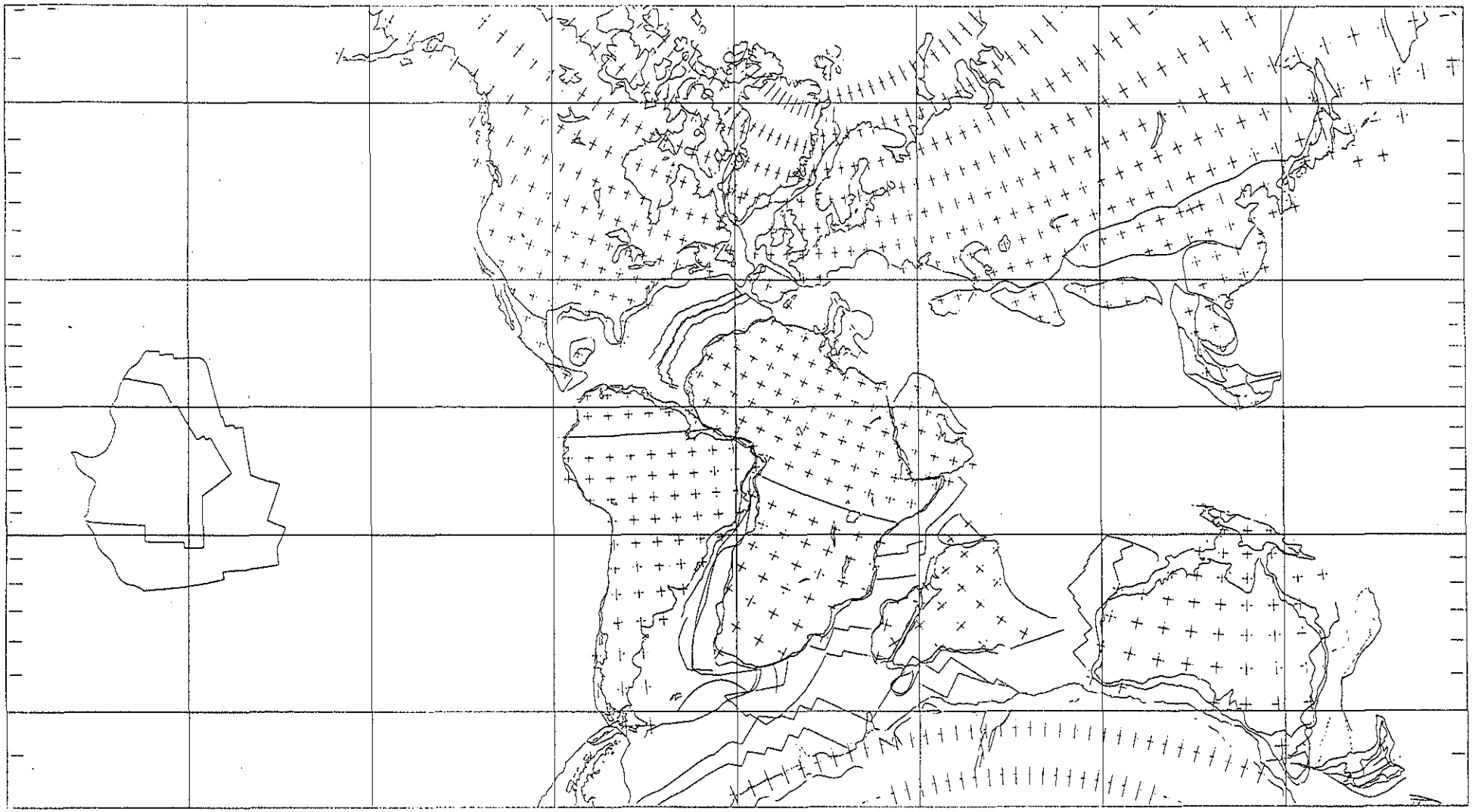

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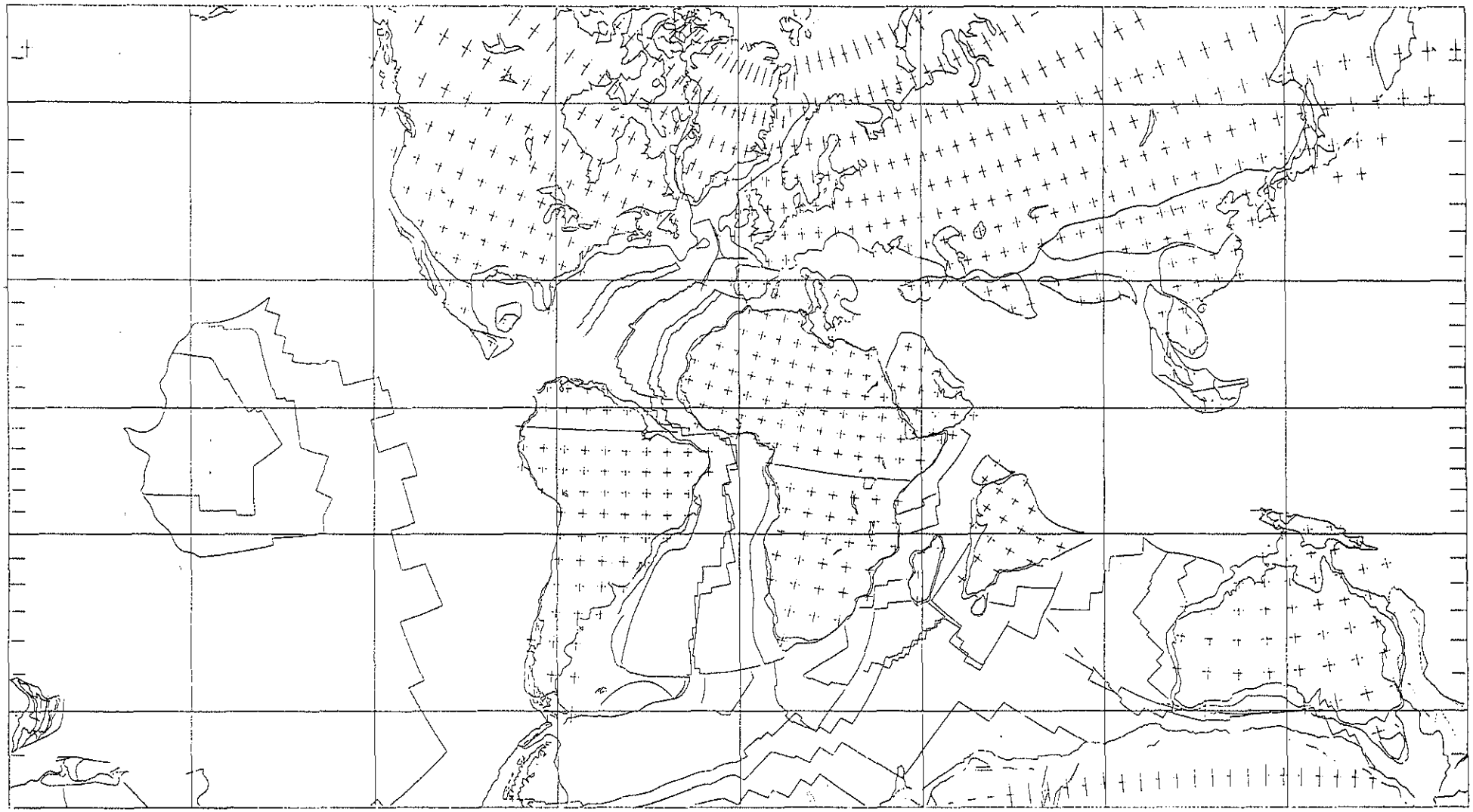

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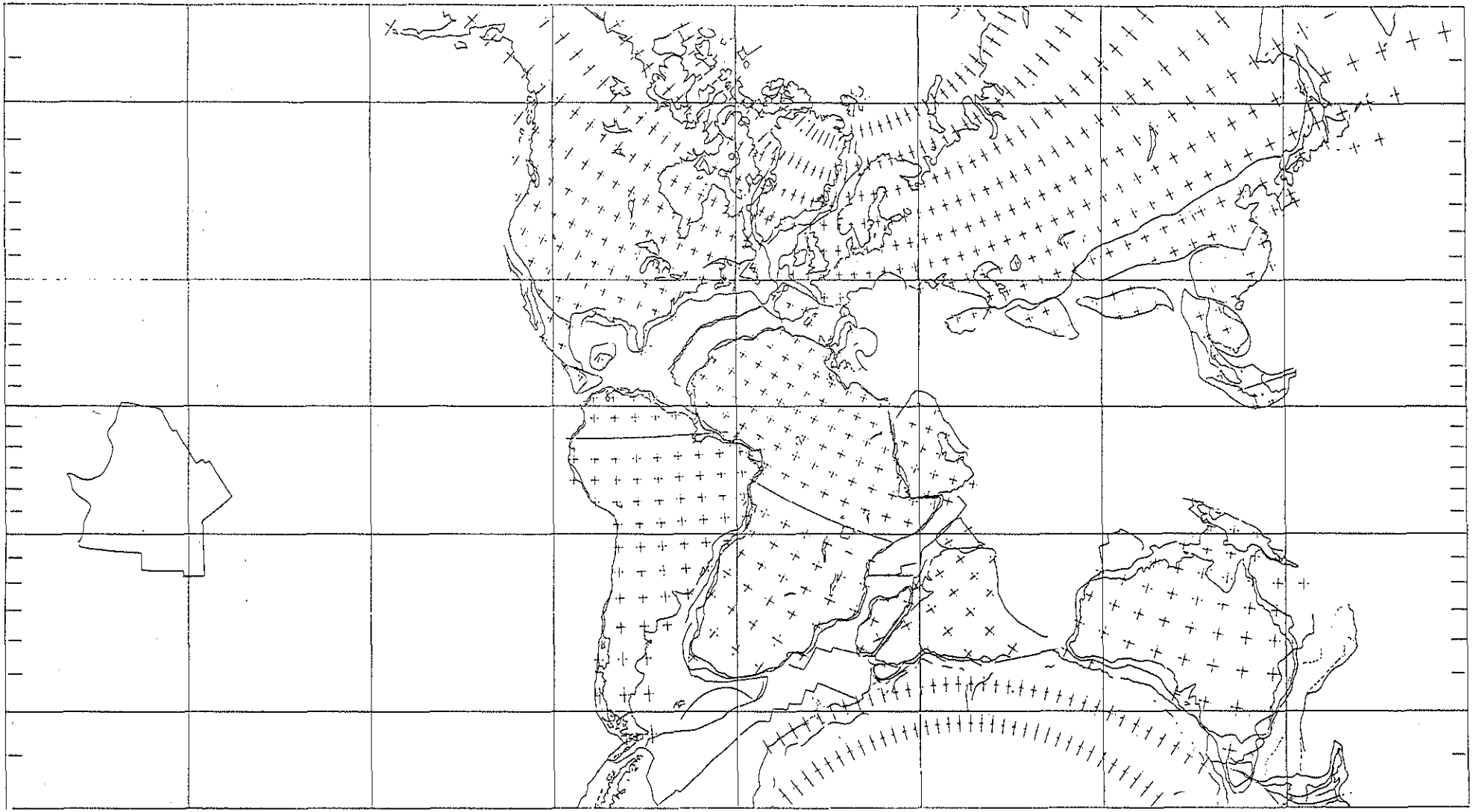

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403 165.0   80.00   100.00   20.00 301 !KOL-EUR
403 245.0   80.00   100.00   25.00 301 !KOL-EUR
205 -100     0.00     0.00    0.00 101 !YUC-NAM , 100 MY FUTURE
205 000.0    0.00     0.00    0.00 101 !YUC-NAM
205 143.0    0.00     0.00    0.00 101 !YUC-NAM
205 165.0   27.60   -85.50  -66.80 101 !YUC-NAM FIT
205 245.0   27.60   -85.50  -66.80 101 !ZIEGLER, SCOTESE & BARRETT (1983)
204 -100     0.00     0.00    0.00 104 !HON-MEX, 100 MY FUTURE
204 000.0    0.00     0.00    0.00 104 !HON-MEX
204 053.0  -39.70    87.90   15.10 104 !HON-MEX
204 127.0  -39.70    87.90   15.10 104 !HON-MEX
204 165.0  -39.70    87.90   31.10 104 !HON-MEX FIT
204 245.0  -39.70    87.90   31.10 104 !SCOTESE ET AL (1979)
106 -100     0.00     0.00    0.00 102 !ARC-GRN , 100 MY FUTURE
106 245.0    0.00     0.00    0.00 102 !KEPT FIXED TO GREENLAND
317 -100     0.00     0.00    0.00 301 !ERK-EUR, 100 MY FUTURE
317 000.0    0.00     0.00    0.00 301 !ERK-EUR
317 073.0    0.00     0.00    0.00 301 !ERK-EUR
317 095.0    3.60    96.80    3.70 301 !ERK-EUR FIT
317 245.0   73.60    96.80    3.70 301 !SCOTESE (1976)
806 -100     0.00     0.00    0.00 801 !NNZ-AUS, 100 MY FUTURE
806 000.0    0.00     0.00    0.00 801 !NNZ-AUS
806 060.0    0.00     0.00    0.00 801 !NNZ-AUS
806 065.0   31.20   136.90   -4.00 801 !NNZ-AUS
806 080.0   43.70   126.40   -7.70 801 !NNZ-AUS
806 090.0   24.19   -19.91   44.61 801 !NNZ-AUS FIT
806 245.0   24.19   -19.91   44.61 801 !SCOTESE & LAWVER (1986)
807 -100     0.00     0.00    0.00 804 !SNZ-MBL, 100 MY FUTURE
807    0.0   0.00     0.00    0.00 804 !SNZ-MBL
807    3.4  68.71   -98.50    1.88 804 !SNZ-MBL AN2
807   24.2  73.35   -62.84   16.62 804 !SNZ-MBL  AN6
807   37.7  74.97   -53.67   28.96 804 !SNZ-MBL  AN15
807   59.2 -72.79   127.36  -40.06 804 !SNZ-MBL  AN25
807   66.2  69.48   -36.51   59.31 804 !SNZ-MBL
807   84.0  65.14   -52.00   62.38 804 !SNZ-MBL FIT
807  245.0  65.14   -52.00   62.38 804 !SCOTESE & LAWVER (1986)
605 -100     0.00     0.00    0.00 601 !JAP-NCH, 100 MY INTO FUTURE
605 000.0    0.00     0.00    0.00 601 !JAP-NCH
605 011.0    0.00     0.00    0.00 601 !JAP-NCH
605 023.0  -13.70  -113.40   -7.50 601 !JAP-NCH FIT
605 245.0  -13.70  -113.40   -7.50 601 !SCOTESE (1976)
601 -100     0.00     0.00    0.00 301 !NCH-EUR 100 MY FUTURE
601 000.0    0.00     0.00    0.00 301 !NCH-EUR
601 215.0    0.00     0.00    0.00 301 !NCH-EUR
601 245.0    0.00     0.00    0.00 301 !TEMPORARILY FIXED TO EUROPE
602 -100     0.00     0.00    0.00 601 !SCH-NCH, 100 MY FUTURE
602 213.0    0.00     0.00    0.00 601 !SCH-NCH
602 245.0    0.00     0.00    0.00 601 !TEMPORARILY FIXED TO N CHINA
603 -100     0.00     0.00    0.00 602 !SEA-SCH, 100 MY FUTURE
603 213.0    0.00     0.00    0.00 602 !SEA-SCH
603 245.0    0.00     0.00    0.00 602 !TEMPORARILY FIXED TO S CHINA
604 -100     0.00     0.00    0.00 602 !ICH-SCH, 100 MY FUTURE
604 213.0    0.00     0.00    0.00 602 !ICH-SCH
604 245.0    0.00     0.00    0.00 602 !TEMPORARILY FIXED TO S CHINA
306 -100     0.00     0.00    0.00 304 !CSD-SPN, 100 MY FUTURE
306 006.0    0.00     0.00    0.00 304 !CSD-SPN
306 012.0  -50.85   178.46   26.17 304 !CSD-SPN FIT
306 245.0  -50.85   178.46   26.17 304 !SCOTESE ET AL (1979)
307 -100     0.00     0.00    0.00 301 !ITL-EUR, 100 MY FUTURE
307 000.0    0.00     0.00    0.00 301 !ITL-EUR
307 021.0    0.00     0.00    0.00 301 !ITL-EUR
307 065.0   40.00     7.00  -13.00 301 !ITL-EUR
307 065.0  -45.63   -60.67    5.57 701 !ITL-AFR
307 080.0   47.12    10.85  -20.00 701 !ITL-AFR
307 143.0   47.12    10.85  -41.40 701 !ITL-AFR
307 165.0  -49.21  -167.00   38.04 701 !ITL-AFR
307 165.0  -45.67  -173.30   67.12 304 !ITL-SPN FIT
307 245.0  -45.67  -173.30   67.12 304 !ZIEGLER, SCOTESE, & BARRETT (1983)
504 -100     0.00     0.00    0.00 301 !TRK-EUR, 100 MY FUTURE
504 000.0    0.00     0.00    0.00 301 !TRK-EUR
504 035.0   71.00    95.00   11.00 301 !TRK-EUR
504 190.0   71.00    95.00   11.00 301 !TRK-EUR FIT
504 245.0  -42.60  -151.40   30.00 301 !SCOTESE (1977)
505 -100     0.00     0.00    0.00 504 !IRN-TRK, 100 MY FUTURE
505 245.0    0.00     0.00    0.00 504 !IRAN FIXED TO TURKEY
308 -100     0.00     0.00    0.00 307 !GRK-ITL, 100 MY FUTURE
308 245.0    0.00     0.00    0.00 307 !GREECE FIXED TO ITALY
606 -100     0.00     0.00    0.00 601 !TIB-NCH, 100 MY FUTURE
606 000.0    0.00     0.00    0.00 601 !TIB-NCH
606 038.0  -48.10  -143.60    7.56 601 !TIB-NCH
606 215.0  -48.10  -143.60    7.56 601 !TIB-NCH
606 245.0  -59.70  -145.10   71.47 601 !SCOTESE (1977)
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502 -100     0.00     0.00     0.00 501 !CEY-IND, 100 MY FUTURE
502 000.0    0.00     0.00     0.00 501 !CEY-IND
502 120.0    0.00     0.00     0.00 501 !CEY-IND
502 130.0   -9.92   -97.85    29.54 501 !CEY-IND FIT
502 245.0   -9.92   -97.85    29.54 501 !SCOTESE & LAWVER (1986)
808 -100     0.00     0.00     0.00 804 !THR-MBL, 100 MY FUTURE
808 000.0    0.00     0.00     0.00 804 !THR-MBL
808 245.0    0.00     0.00     0.00 804 !THURSTON IS. KEPT FIXED TO MARIE BYRDLAND
809 -100     0.00     0.00     0.00 201 !WHT-SAM, 100 MY FUTURE
809 000.0    0.00     0.00     0.00 201 !SAME AS WAP-SAM
809 010.0    0.00     0.00     0.00 201 !THR-SAM
809 020.0  -66.70   -74.30    10.00 201 !THR-SAM
809 029.0  -81.50  -146.30    13.70 201 !THR-SAM
809 110.0  -68.80   -86.90    39.30 201 !THR-SAM
809 120.0  -60.97   169.98    15.00 201 !THR-SAM
809 140.0  -66.90   -92.80    25.20 201 !THR-SAM
809 165.0  -64.13   -79.86    89.32 201 !THR-SAM FIT
809 245.0  -64.13   -79.86    89.32 201 !SCOTESE AND LAWVER (1986)
810 -100     0.00     0.00     0.00 802 !BRK-ANT, 100 MY FUTURE
810 000.0    0.00     0.00     0.00 802 !BRK-ANT
810 245.0    0.00     0.00     0.00 802 !BERKNER IS. KEPT FIXED TO E ANTARCTICA
811 -100     0.00     0.00     0.00 803 !SSHT-WAP, 100 MY FUTURE
811 000.0    0.00     0.00     0.00 803 !SSHT-WAP
811 245.0    0.00     0.00     0.00 803 !S SHETLAND KEPT FIXED TO W ANT. PENNINSULA
812 -100     0.00     0.00     0.00 803 !SORK-WAP, 100 MY FUTURE
812 000.0    0.00     0.00     0.00 803 !SORK-WAP
812 245.0    0.00     0.00     0.00 803 !S ORKNEY IS. KEPT FIXED TO W ANT. PENNIN.
813 -100     0.00     0.00     0.00 807 !CHT-SNZ, 100 MY FUTURE
813 000.0    0.00     0.00     0.00 807 !CHT-SNZ
813 065.0    0.00     0.00     0.00 807 !CHT-SNZ
813 084.0   41.00   -15.90     7.47 807 !CHT-SNZ FIT
813 245.0   41.00   -15.90     7.47 807 !SCOTESE & LAWVER (1986)
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