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**A TECTONIC-BASED RAYLEIGH WAVE GROUP
VELOCITY MODEL FOR PREDICTION OF
DISPERSION CHARACTER THROUGH OCEAN
BASINS**

by

Frederick John Mauk

**A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Geology)
in The University of Michigan
1977**

Doctoral Committee:

**Professor James T. Wilson, chairman
Professor John A. Dorr
Professor Ivor McIvor
Professor Henry N. Pollack
Associate Professor Rob VanderVoo**

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LIST OF SYMBOLS

U	Group velocity
C	Phase velocity
λ	Wavelength
Φ_{Inst}	Instrumental phase delay
ω	Wave frequency
ω_o	Natural frequency of a seismometer
T_o	Natural period of a seismometer = $2\pi / \omega_o$
ω_g	Natural frequency of a galvanometer
T_g	Natural period of a galvanometer = $2\pi / \omega_o$
h_o	Seismometer damping factor
h_g	Galvanometer damping factor
s	Seismograph coupling factor
V_p	Compressional wave velocity
V_s	Shear wave velocity
$\bar{V}$	Rayleigh $5^\circ \times 5^\circ$ mean group velocity matrix values
T	Tectonic matrix, $5^\circ \times 5^\circ$ encoded percentages
V	Period-specific tectonic-specific mean group velocity matrix
$F_{(\theta, \phi)}$	any geophysical field function
θ	Colatitude
ϕ	East Longitude
A_{nm}	Cosine coefficients of spherical harmonic expansion
B_{nm}	Sine coefficients of spherical harmonic expansion
P_{nm}	fully normalized associated Legendre polynomial coefficients
$\bar{A}$	Mean value for spherical harmonic coefficients 4,0 through 12,12
$\bar{B}$	Mean value for spherical harmonic coefficients 4,0 through 12,12

WWSSN	World wide standard seismograph network
HGLP	High gain long period seismograph network
NEIS	National earthquake information service
ISC	International seismic center
RMS	Root mean square

INTRODUCTION

Analysis of earthquake and explosion generated Love and Rayleigh mode surface waves has contributed significantly to the elucidation of the crust and upper mantle structure of the earth. Although the dispersion of surface waves is determined by the average properties of the crust and mantle over a large depth range, sampling phase and group velocities of dispersed wave trains at a variety of periods has revealed fundamental structural differences between continents and oceans (Oliver, 1962). In addition, variations of observed continental surface wave dispersion character have been correlated convincingly with geological provinces (North, 1976; Goncz and Cleary, 1976; Fix, 1975; Teng, 1974; Biswas and Knopoff, 1974; Adams, 1974; Wu, 1972; James, 1971; Bolt and Niazi, 1964; Brune and Dorman, 1963; Brilliant and Ewing, 1954). Similar variations of oceanic surface wave dispersion character were recognized before sea floor spreading was introduced (Tarr, 1969; Sato and Santo, 1969; Santo, 1966a, 1966b, 1962, 1961a, 1961b, 1960; Papazachos, 1964; Brune and Major, 1962; Kovach, 1961; Shurbet, 1960; Berckhemer, 1956; Oliver, Ewing and Press, 1955; Jardetsky and Press, 1953; Wilson and Baykal, 1948), but without the plate tectonics and ocean floor evolution concepts, a rational differ-

entiation of observed dispersion into provinces was elusive.

The fundamental discovery that the sea floor is created at the ocean ridges and evolves both spatially and temporally provided the key to a rational categorization of the diverse dispersion characteristics previously observed in the ocean basins. The development of the ocean floor spreading framework from marine magnetic anomalies and deep sea drilling has enabled a chronologically detailed mapping of the world's oceans (Pitman, Larson, and Herron, 1974; Herron, Pitman and Dewey, 1974; Cooper, Marlow and Scholl, 1976; Johnson, Powell and Veevers, 1976). Equipped with this new information on the age of the ocean floor, and with improved techniques of dispersion analysis (Knopoff, 1972; Landisman, Dziewonski and Sato, 1969), Forsyth (1976, 1975), Yoshii (1975), Leeds (1975), Leeds, Knopoff and Kausel (1974a,b) and Knopoff, Schlue and Schwab (1970) have demonstrated the correlation between ocean floor age and variations in both Love and Rayleigh dispersion in the Pacific basins. The research presented in this dissertation is an extension of the characterization of Rayleigh group velocity dispersion in the ocean basins.

The purpose of this research is to construct an empirical model which can accurately predict Rayleigh group velocity dispersion characteristics for any path through the ocean basins. Inversion of the predictive velocity model to obtain a specific

crust and upper mantle velocity structure is not intended.

The principal model assumption is that Rayleigh group velocities are definable and constitute well-behaved functions in the tectonic evolutionary context of sea floor spreading. Global characterization of Rayleigh group velocities in a $5^{\circ} \times 5^{\circ}$ tectonics framework requires: first, a regionalized encoding of global tectonic units (e.g. Archean shield, 0-5 m.y. old crust, etc.), second, an assignment of a characteristic dispersion through each tectonic unit, and third, a merging of the $5^{\circ} \times 5^{\circ}$ encoded tectonics with the tectonic-specific group velocities to obtain a global representation of the period-specific Rayleigh group velocity fields.

Discrete-period predicted group velocities then are compared with moving window analyses of observed data for random paths across ocean basins to test the accuracy of the model. Model successes and failures are analyzed to determine possible model deficiencies and potential improvements. The modeled Rayleigh group velocity fields are compared with other geophysical fields such as surface and mantle heat flow, topography, gravity and sea floor spreading rates, for possible correlation. Finally, suggestions are made for revision of the modeling technique to better fit the observed data.

CHAPTER 1

CONSTRUCTION OF THE GLOBAL RAYLEIGH GROUP VELOCITY MATRIX

The Tectonic Matrix

A fundamental tectonic data matrix was created by dividing the surface of the earth into a grid of 2592 $5^{\circ} \times 5^{\circ}$ elements and encoding the tectonic information for each element derived from maps and published research. Although this grid does not yield elements of equivalent area (equatorial $\sim 308,715 \text{ km}^2$, polar $\sim 13,478 \text{ km}^2$), it does provide a convenient system for subsequent computational manipulation. Each of the grid elements is identified by the colatitude and east longitude coordinates of the northeast corner of the element. The seventy-two triangular elements surrounding the north pole are identified by the east longitude coordinates of their respective southeastern corners. Twelve continental and eight oceanic divisions were used for the matrix encoding. These are: Archean shield, Proterozoic shield, Precambrian undeformed, early Paleozoic orogeny, late Paleozoic orogeny, post-Precambrian undeformed, Mesozoic orogeny, Cenozoic folding, Cenozoic volcanics, intermontane

basin fill, Mesozoic volcanics, shelf sediments, anomaly 0-5, anomaly 5-6, anomaly 6-13, anomaly 13-25, late Cretaceous sea floor (63-100 m.y.), early Cretaceous sea floor (100-140 m.y.), Jurassic sea floor (older than 140 m.y.), island arcs.

The selection of these tectonic divisions is intended to reflect the basic assumption that the thermal perturbations of the crust and upper mantle are responsible for the observed scatter of Rayleigh group velocities about the mean continental and oceanic group velocity curves of Oliver (1962). Although many of the tectonic divisions might be subdivided further for specific regions, the selected larger scale designations could be universally recognized and were deemed sufficient for this global study.

The sources of the tectonic data are listed in table 1. Where possible, detailed tectonic data are used to supplement or to supersede older and/or more generalized data. The Indian Ocean data of Johnson, Powell and Veevers (1976), superseded the data of McKenzie and Sclater (1971), for example. This was the largest scale revision. More frequently, tectonic revisions involved only one or two element adjustments. The tectonic data matrix is amendable as new data become available. The latest update used in this study was March, 1976.

Generally, continental tectonic data are available in abund-

ance. Inaccessability (central Asia), or ice coverage (Greenland and Antarctica) may preclude detailed analysis of some regions, but a reasonable approximation of the tectonics could still be effected. Significant gaps in the coverage of the ocean floor do exist, however. Detailed tectonic data for the Arctic Ocean Basin, for example, are sparse. In this case, a postulated model for Arctic evolution proposed by Herron, Dewey and Pitman (1974) was used to fill the gap. Similarly, gaps in the ocean floor coverage in the equatorial Atlantic and Atlantic-Indian Basin are problematic. In these instances, where no direct data exist, tectonic patterns were inferred on the basis of immediately adjacent element coverage and other tectonic information such as seismicity and transform fault offsets. Finally, the marginal basins often are poorly dated. The majority of them, however, have deep sea drilling logs and/or subsequent detailed studies to reduce the uncertainty of tectonic assignment. These ill-defined ocean floor tectonics constitute the principal weakness of this aspect of this study. Future improvements in the data coverage should enhance the reliability of this analytic tool.

Figure 1 illustrates the method of encoding the grid elements; in this case an area in southeast Asia. Each $5^{\circ} \times 5^{\circ}$ element is inspected for the visually estimated percentage (to the nearest

Table 1 Sources of Tectonic Data

Continents

North America: Tectonic Map of North America (1969), United States Geological Survey, scale 1:5,000,000 compiled by P. B. King.

South America: Geologic Map of South America (1964), Commission of the Geologic Map of the World, scale 1:5,000,000, General coordinator A.R. Lamago; Tectonic Map of Brazil (1971), Ministry of Mines and Energy, National Department of Mineral Production, Brazil, scale 1:5,000,000, coordinator E.O. Ferreira.

Antarctica: Geologic Map of Antarctica (1971), American Geographical Society, scale 1:5,000,000, compiled by C. Craddock.

Africa: International Tectonic Map of Africa (1968), Association of African Geologic Surveys and United Nations Educational Scientific and Cultural Organization, scale 1:5,000,000, coordinator G. Choubert.

Australia: Tectonic Map of Australia and New Guinea (1971), Geological Society of Australia, scale 1:5,000,000, Sidney.

Europe and Asia: Tectonic Map of Eurasia (1966), Geologic Institute of the Academy of Sciences of the U.S.S.R., scale 1:5,000,000, chief editor A.L. Yanshin.

Oceans

General: Magnetic Lineations of the Oceans (1974), Geologic Society of America, compiled by W. C. Pitman III, R. L. Larson, and E. M. Herron.

Arctic: Herron, E. M., J. F. Dewey, and W. C. Pitman III (1974), 'Plate Tectonics Model for the Evolution of the Arctic', Geol. (2), p. 377-380.

Table 1 Sources of Tectonic Data continued

Indian: Johnson, B. D., C. Mca. Powell, and J. J. Veevers (1976), 'Spreading History of the Eastern Indian Ocean and Greater India's Northward Flight from Antarctica and Australia', Geol. Soc. Amer. Bull. (87), p. 1560-1566.

Marginal Basins: Sclater, J.G., U.G. Ritter, and F. S. Dixon (1972), 'Heat Flow in the Southwestern Pacific', Jour. Geophys. Res. (77), p. 5697-5704.; Sclater, J.G. (1972), 'Heat flow and Elevation of the Marginal Basins of the Western Pacific', Jour. Geophys. Res. (77), p. 5705-5719. ; Cooper, A.K., M.S. Marlow, and D.W. Scholl (1976), ' Mesozoic Magnetic Lineations in the Bearing Sea Marginal Basin', Jour. Geophys. Res. (81), p. 1916-1934.; Lawver, L. A., J. R. Curray, and D.G. Moore (1975), ' Magnetics in the Adaman Sea and the Effect of High Sedimentation Rates', E.O.S. (56), p.1064.; Packham, G.H., and D. A. Falvey (1971), 'An Hypothesis for the Formation of Marginal Seas in the Western Pacific', Tectonophys. (11), p. 79-110.; VanderVoo, R., F.J. Mauk, and R.B. French (1976), 'Permian Triassic Continental Configurations and the Origin of the Gulf of Mexico', Geol. (3), p. 177-179.; Initial Reports of the Deep Sea Drilling Project Volumes Prepared for the National Science Foundation under Contract C-482.

10%) of the enclosed tectonic divisions. In this example, three of the twenty tectonic divisions are present; shelf sediments 40 %, Mesozoic orogeny 30%, and post-Precambrian undeformed platform 30%. Each of these divisions is assigned a percentage of the total area of the scene and the weights are entered into the tectonic matrix; all other tectonic divisions are assigned weights of zero. The spatial distribution of the tectonic divisions within the grid element is not included in the matrix. This established a relative lower resolution limit of approximately the dimensions of the element itself which is attainable using this matrix. This is a linear limit of 550 kilometers and a spatial limit of $3.08 \times 10^5 \text{ km}^2$.

It is possible that a particular path through a grid element will sample only a portion of the enclosed tectonics, and therefore the actual path segment velocity may not be represented accurately by the tectonic-based $5^\circ \times 5^\circ$ element mean velocity. Since it is likely that a juxtaposition of two or more widely dissimilar tectonic divisions will result in a mutual reequilibration with time, the anomalous influence of the spatial aspect of the tectonic divisions seems remote, except when dealing with most recent tectono-thermal events. Similarly, if paths which are much greater in length than 500 kilometers are chosen for analysis, they will sample and average element tectonic influence

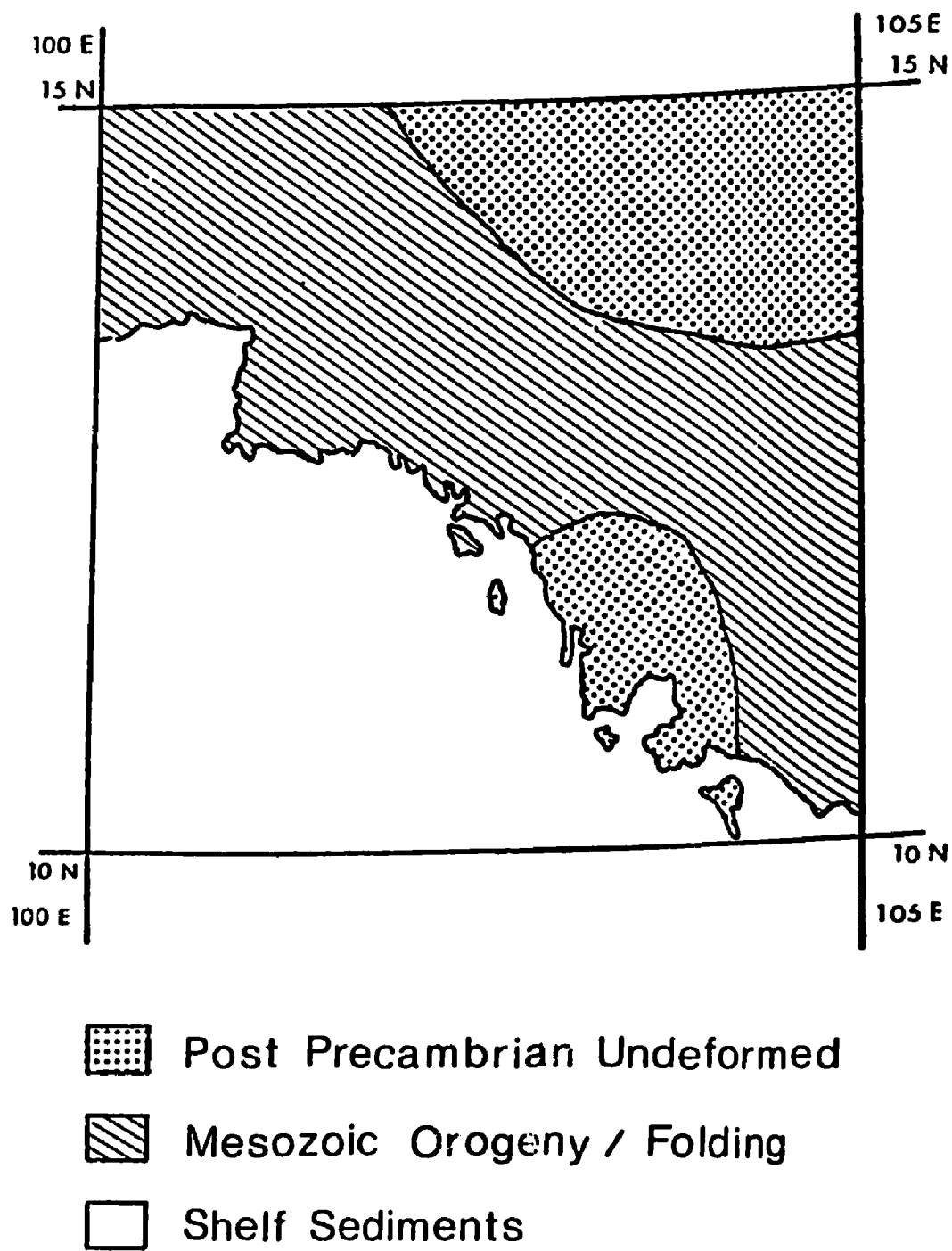


Figure 1.

over many elements. The chance of fortuitous local spatial distributions of tectonic divisions significantly perturbing results utilizing the tectonic matrix thus becomes less likely as path length increases.

The encoded data of the $36 \times 72 \times 20$ tectonic matrix are displayed in a series of 20 colatitude by east longitude maps in appendix I. The matrix itself is stored on computer cards and on magnetic tape for easy amendment and access.

Utilization of the tectonic matrix to predict Rayleigh wave group velocities requires the assignment of a group velocity dispersion characteristic to each of the tectonic divisions used in the encoding. One such method is to determine the characteristic dispersion empirically for a given area showing only one tectonic division and assume that the characteristic is relatively invariant.

Although this research is an examination of Rayleigh group velocities across ocean basins, many of the seismograph stations are located at continental margins. Assignment of continental group velocities is required, therefore, to suppress anomalous edge effects and unrealistic velocity gradients at these boundaries. In addition, spherical harmonic analyses of the predicted Rayleigh velocities are less meaningful when the data set is incomplete. Thus, the assignment of 'average' con-

tinental Rayleigh group velocities to all twelve continental divisions is unreasonable. The velocity transition from ocean to continent is significantly different for California versus New Jersey, for example. The group velocities for the twelve continental tectonic divisions are derived from published data. All phase velocity data have been converted to group velocities using the standard formulation:

$$U = C - \lambda dC/d\lambda$$

with λ the wavelength, U the group velocity, and C the phase velocity.

Frequently, group velocities assigned to a particular tectonic division are the result of several independent investigations throughout the world. Remarkably, the variations in Rayleigh wave group velocities for a given tectonic division generally differ by less than 0.02 km/sec for the period range 20 through 100 seconds. Although additional analyses may result in twelve distinct dispersion characteristics for these tectonic divisions, only six could be differentiated from the current literature. The Archean and Proterozoic shields were assigned the same velocities for the period range of 20 to 100 seconds based on the analyses of Brune and Dorman (1963) for the Canadian shield, Bolt and Niazi (1964) for the Australian shields, Bhattacharya (1974) for the Indian shield and Teng (1974) for the Asian shields.

Similarly, the Precambrian and post-Precambrian platforms and the shelf sediments were indistinguishable (Brilliant, 1954; Bolt and Niazi, 1964; Ocal, 1965; Knopoff and Mal, 1967; Biswas and Knopoff, 1974; Teng, 1974; Goncz, Hales and Muirhead, 1975; Goncz and Cleary, 1976). Mesozoic orogeny zones were assigned Rayleigh wave group velocities from the combined studies of Alexander (1963), James (1971), Knopoff (1972), Biswas and Knopoff (1974), Fix (1975), and North (1976). The intermontane basin fill division velocities were derived from three studies of the Basin and Range province of the western United States (Biswas and Knopoff, 1974; Braile, 1975; Keller, 1975). Cenozoic folding and volcanics group velocity assignments are from Knopoff (1972) and Biswas and Knopoff (1974). Finally, no data for the divisions early Paleozoic orogeny, late Paleozoic orogeny and Mesozoic volcanics could be found in the literature. Accordingly, these divisions were assigned mean continental group velocities from Oliver (1962). A summary of the assigned continental group velocities of the fundamental mode Rayleigh waves for the period range 20 to 100 seconds is given in table 2.

Table 2 Continental Elements

Tectonic Element	Rayleigh Wave Group Velocity (km/sec)									
	20 (sec)	30 (sec)	40 (sec)	50 (sec)	60 (sec)	70 (sec)	80 (sec)	90 (sec)	100 (sec)	100 (sec)
Archean Shield	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040	4.040
Proterozoic Shield	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040	4.040
Precambrian Un-deformed sediments	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950	3.950
Early Paleozoic Orogeny	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800	3.800
Late Paleozoic Orogeny	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800	3.800
Post-Precambrian Undeformed sediments	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950	3.950
Mesozoic Orogeny	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600	3.600
Cenozoic Folding	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800	3.800
Cenozoic Volcanics	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800	3.800
Intermontane Basin Fill	3.290	3.350	3.500	3.605	3.630	3.680	3.692	3.696	3.692	3.692
Mesozoic Volcanics	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800	3.800
Shelf Sediments	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950	3.950

Table 2 continued Oceanic Elements

Tectonic Element	Rayleigh Wave Group Velocity (km/sec)									
	20 (sec)	30 (sec)	40 (sec)	50 (sec)	60 (sec)	70 (sec)	80 (sec)	90 (sec)	100 (sec)	
Anomaly 0-5	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630	
Anomaly 5-6	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	15
Anomaly 6-13	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743	
Anomaly 13-25	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
Late Cretaceous										
Sea Floor 63-100 my	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
Early Cretaceous										
Sea Floor 100-140 my	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
Jurassic Sea Floor										
Older than 140 my	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840	
Island Arcs	3.500	3.680	3.760	3.780	3.810	3.800	3.800	3.750	3.740	

The Seismic Data Processing Technique

Data used to construct and to test the functional relationship between sea floor age and group velocities were selected from long period vertical component seismograms of WWSSN and HGLP stations. Ittek reproductions of the seismograms were digitized at an interval of 0.01 inches which corresponds to 0.56 seconds. The amplitude resolution of the digitized record is 0.06 mm. The data, collected on paper tape, then were reformatted to magnetic tape for subsequent computer processing. The length of each digitized seismogram is variable, depending on the dispersive character of the original record. In general, the total digitized record length is three times the length of the included dispersed Rayleigh train. This assures an adequate data length for the moving window analysis to be performed properly, and prevents partial loss of visually-obscure low amplitude initial group arrivals. One example of these digitized seismograms is illustrated in figure 2. All seismograms used to test the final model have been stored on magnetic tape (See appendix III).

Mapping of energy levels in a velocity versus logarithmic period space is accomplished by performing a moving window analysis (Landisman, Dziewonski and Sato, 1969) on each seismogram. The arrival time of the peak energy level of a wave

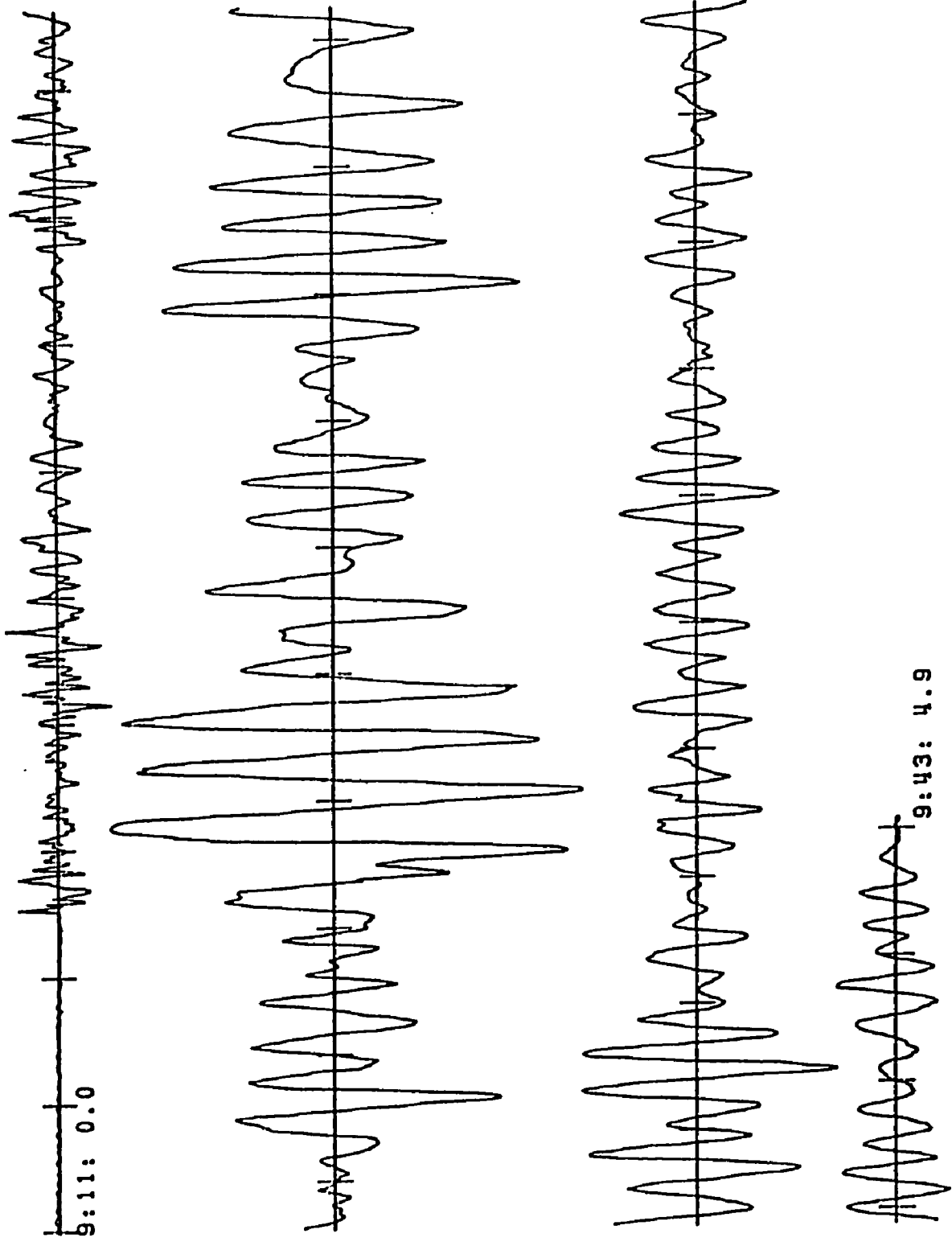
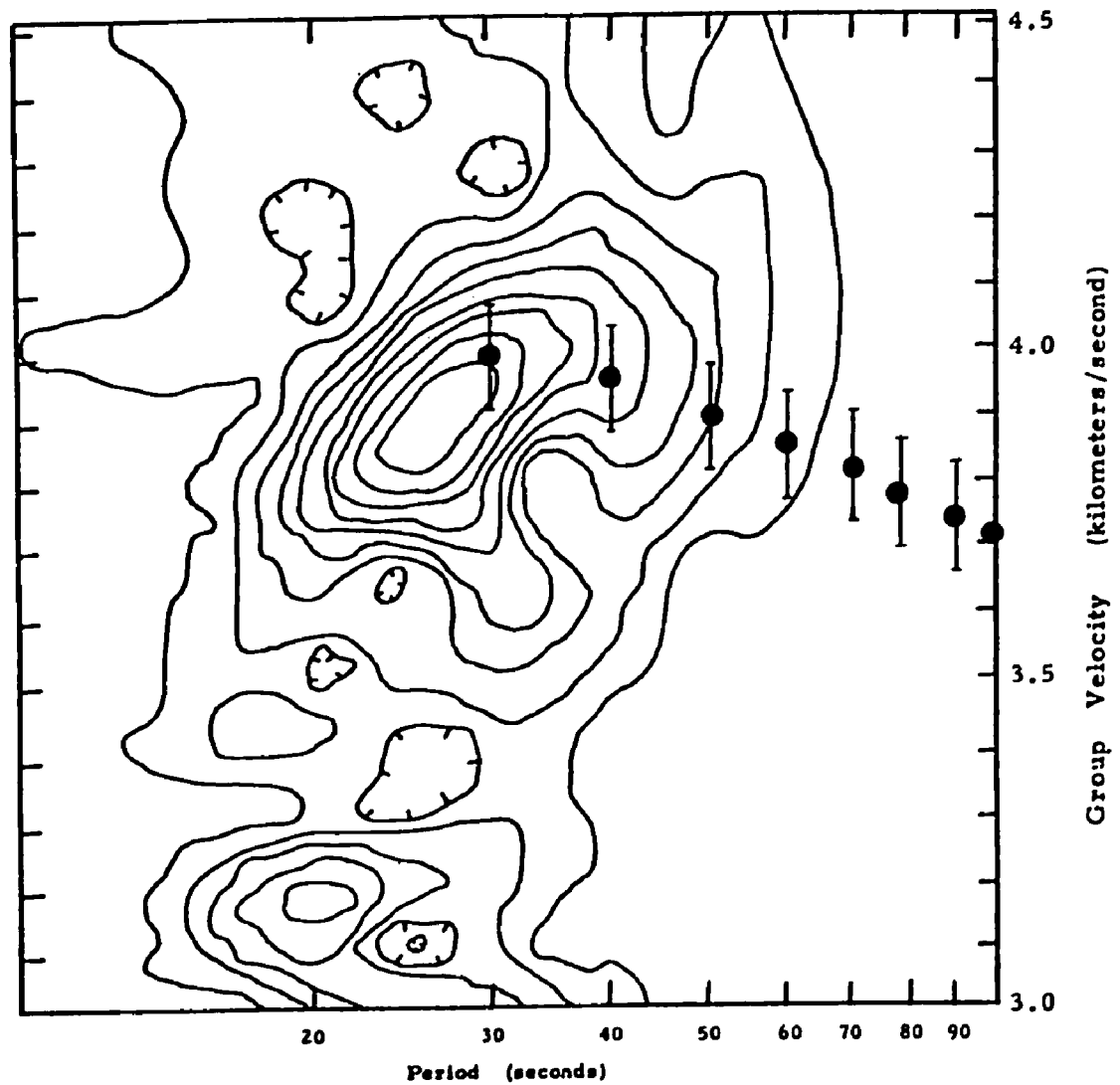


Figure 2.

packet gives the group velocity at that period when the data has been corrected for instrumental group delay. All records were analyzed using a cosine-squared window with length four times the period of interest. The contoured energy levels resulting from a moving window analysis of the seismogram in figure 2 are given in figure 3. Although the contoured dispersion analyses have been corrected for instrumental group delay, they are not corrected for instrumental magnification characteristics. Thus the greatest energy level nearly always corresponds to the center frequency of the seismograph system. There is not a great deal of significance to the exact amplitudes of the contours, therefore. The significance of these plots lies in the energy contour location and density in the velocity versus logarithmic-period space. The apparent reduction of resolution at longer periods in many of these plots is partly a characteristic of the cosine-squared window and partly a data defect. Canitez (1977) has overcome this problem in a few cases by using a sine-chirp filter. In his study, Canitez compared the two filtering techniques and has shown that even though the contours broaden at longer periods with a cosine-squared window, a line connecting the period-specific energy maxima is located at the same velocities as those velocities resolved by the sine-chirp window.



Philippine Plate Pacific Ocean Earthquake October 31, 1968
 09:06:36.4, 1.2 N, 126.3 E Recording Station MAT Epicentral
 distance 4093.7 kilometers.

Figure 3.

The uncertainty of locating the line joining the period-specific energy maxima is approximately 0.02 km/sec in the best cases, but may be as large as 0.10 km/sec at very poorly resolved long (greater than 80 seconds) periods. Other sources of error in velocity determination are discussed in the next section.

Error Analysis

In addition to the group velocity uncertainty caused by resolution difficulties of the moving window analysis, there are several other possible sources of error which contribute to the uncertainty of group velocity determinations. These are errors and corrections related to source, receiver, or transmission path. All errors are given in terms of velocity uncertainties by assuming a mean epicentral distance of 4000 kilometers, and a group velocity of 4.0 km/sec. Generally, smaller epicentral distances are subject to larger errors than are larger epicentral distances.

Errors due to Source

The determination of Rayleigh group velocities can be affected by earthquake source parameters which affect either the epicentral distance or the travel time. These are mislocation of the epicenter, incorrect assignment of origin time, and uncertainty of source mechanism which affects the initial phase assignment. Other source parameters such as fault length, rupture velocity and stress drop are difficult to evaluate quantitatively but have insignificantly small contribution to group velocity error at large epicentral distance.

Knopoff and Schwab (1968) demonstrated that surface wave velocity error resulting from misinterpretation of initial phase con-

dition is maximized at short epicentral distance (less than 1000 kilometers), long periods (greater than 100 seconds) and with focal mechanisms dipping 45° away from the receiver. Figure 4 (from Knopoff and Schwab, 1968) illustrates these relative effects for a complex earth model having a low velocity zone. The maximum error over the period range 20 to 200 seconds introduces a correction of 2.07 seconds in the apparent origin time or a correction in group velocity at 4000 kilometers of approximately 0.008 km/sec. Since all paths used in this study exceeded 2000 kilometers, the error introduced to the group velocity determination resulting from initial phase ambiguity is negligible.

The incorrect assignment of the origin time and/or mislocation of the epicenter are potentially the largest source of error. Since the hypocenter location and origin time are produced as solutions to a series of simultaneous equations in which the total RMS residuals are minimized, there is a certain trade-off between epicentral location and origin time errors, so the two error estimates are not truly independent. A comparison of solutions for the same event done by NEIS and ISC frequently illustrate this trade-off, particularly in regions where azimuthal control is limited. The seriousness of these solution errors is dependent on the number and distribution of stations used to locate the event. Although

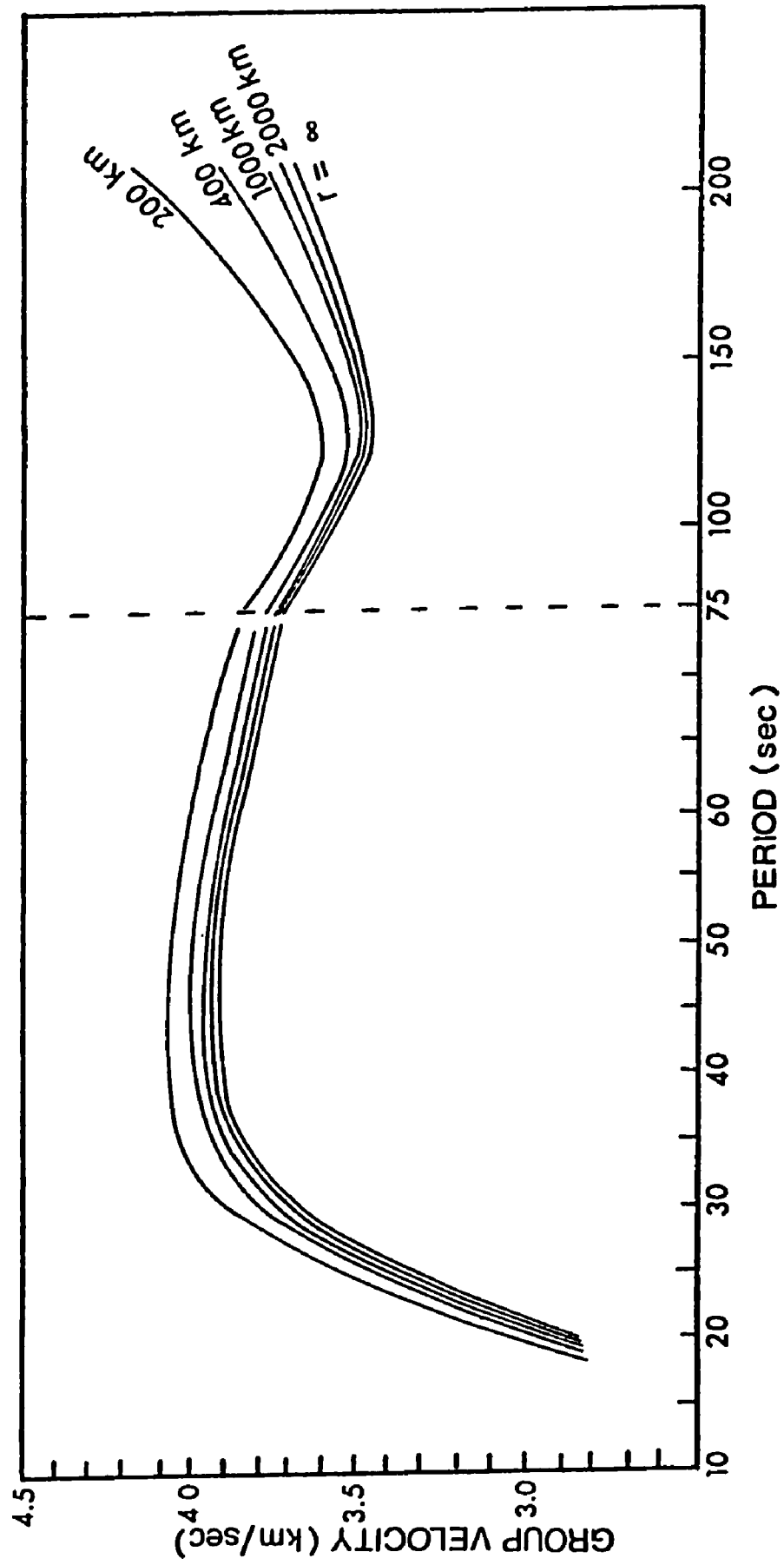


Figure 4.

precision estimates are published as part of the earthquake statistics by both NEIS and ISC, these estimates frequently reflect local residual minimizations and not a more regional residual estimate. This is a problem inherent to all epicenter location programs. An Atlantic-Indian Ridge earthquake, for example, may be located with an RMS spatial residual of ± 2 kilometers when in fact the location is incorrect by more than a degree (John Derr, personal communication). An epicenter mislocation by 20 kilometers in the direction of a station can result in a group velocity error of 0.02 km/sec at 4000 kilometers distance. Random mislocation and origin time errors for earthquakes from a given region will introduce scatter into the data acquired at a given station, but will not distort the mean dispersion curve. Systematic mislocation and origin time errors, however, will yield apparent dispersion curves which are incorrect. Unfortunately, systematic mislocation error estimates for the entire earth are not available and are usually discovered when analyses appear to be radically incorrect.

Errors due to Receiver

A small time correction must be subtracted from the travel time used to compute the velocities to account for the delay in response of the seismograph system to a disturbance. The instrumental phase response has been given by Hagiwara (1958) with subsequent correction by Brune (1962) as:

$$\Phi_{inst} = \arctan \left[\frac{\omega^4 - \omega_o^2 + \omega_g^2 + 4 h_o h_g (1-s^2) \omega^2 + \omega_o^2 \omega_g^2}{2(h_o \omega_g^2 + h_g \omega_o^2) \omega - 2(h_o + h_g) \omega^3} \right]$$

where the typical seismograph parameters used in this investigation are:

$$\begin{aligned} T_o &= 2\pi / \omega_o = \text{seismometer free period} &= 15 \text{ sec} \\ T_g &= 2\pi / \omega_g = \text{galvanometer free period} &= 100 \text{ sec} \\ h_o &= \text{seismometer damping factor} &= 0.8 \\ h_g &= \text{galvanometer damping factor} &= 1.0 \\ s &= \text{coupling factor} = \text{seis cpl} * \text{gal cpl} &= 0.0 \end{aligned}$$

The instrumental time delay for group velocity is the slope of the instrumental phase delay curve. The relative magnification, phase and group delays in seconds for this seismograph system are given for periods from 10 to 300 seconds in table 3. The size of this correction to the velocity is dependent on the period and the transit time or distance, but if the average epicentral distance is 4000 kilometers, then the average group velocity correction at a period of 20 seconds is approximately 0.02 km/sec and at a period of 100 seconds is approximately 0.07 km/sec. The formulation to correct for instrumental response is built

Seismograph Instrumental Correction WWSSN

SEIS PER	GAL PER	SEIS PC	GAL PC	SEIS CPL	GAL CPL
15.0000	100.0000	0.4000	1.0000	3.0	1.0000
PERIOD	MAG	PH DELAY	GP DELAY		
10.0000	0.5400	-2.8007	2.3105		
10.5776	0.5640	-2.7332	2.2162		
11.1807	0.5780	-3.0046	2.4333		
11.8150	0.5935	-3.3800	2.6611		
12.5107	0.6101	-3.1072	2.4982		
13.2411	0.6009	-3.2499	3.1407		
14.0008	0.6107	-3.3344	3.3851		
14.8160	0.6115	-3.4203	3.6300		
15.6719	0.6321	-3.5072	3.8745		
16.5772	0.6030	-3.5947	4.1140		
17.5308	0.5400	-3.6823	4.3500		
18.5473	0.5337	-3.7696	4.5803		
19.6192	0.5079	-3.8505	4.8062		
20.7526	0.5530	-3.9424	5.0289		
21.9519	0.5300	-4.0274	5.2506		
23.2195	0.5100	-4.1112	5.4738		
24.5608	0.4901	-4.1938	5.7015		
25.9796	0.4740	-4.2750	5.9363		
27.4804	0.4529	-4.3551	6.1835		
29.0679	0.4308	-4.4339	6.4440		
30.7471	0.4006	-4.5115	6.7234		
32.5233	0.3805	-4.5882	7.0233		
34.4020	0.3647	-4.6640	7.3473		
36.3824	0.3433	-4.7374	7.6981		
38.4615	0.3224	-4.8077	8.0781		
40.7151	0.3021	-4.8755	8.4902		
43.0671	0.2824	-4.9489	8.9303		
45.5547	0.2633	-5.0186	9.4182		
48.1806	0.2450	-5.0849	9.9373		
50.9702	0.2273	-5.1476	10.4947		
53.9146	0.2104	-5.2102	11.0906		
57.0291	0.1943	-5.2628	11.7254		
60.3235	0.1789	-5.3153	12.3984		
63.8003	0.1643	-5.3676	13.1083		
67.4634	0.1504	-5.4203	13.8535		
71.3133	0.1373	-5.4726	14.6314		
75.3516	0.1250	-5.5249	15.4389		
79.8800	0.1135	-5.5769	16.2722		
84.4945	0.1026	-5.6286	17.1277		
89.3755	0.0925	-5.6799	17.9980		
94.5346	0.0832	-5.7307	18.8816		
99.9945	0.0745	-5.7808	19.7706		
105.7700	0.0665	-5.8302	20.6591		
111.8377	0.0592	-5.8786	21.5447		
118.3525	0.0526	-5.9260	22.4173		
125.1673	0.0460	-5.9723	23.2747		
132.4131	0.0410	-6.0172	24.1112		
140.2036	0.0360	-6.0607	24.9226		
148.3673	0.0316	-6.1027	25.7051		
156.7139	0.0276	-6.1431	26.4550		
165.2722	0.0241	-6.1818	27.1714		
174.0494	0.0210	-6.2186	27.8591		
183.0777	0.0182	-6.2539	28.4921		
192.3725	0.0157	-6.2872	29.0902		
201.9521	0.0136	-6.3196	29.6611		
211.8344	0.0117	-6.3501	30.1999		
222.1252	0.0101	-6.3790	30.6775		
232.8645	0.0087	-6.4043	31.1370		
243.9746	0.0074	-6.4251	31.5481		
255.4744	0.0064	-6.4420	31.9130		
267.3712	0.0055	-6.4571	32.2007		
279.6712	0.0047	-6.4704	32.5011		

Table 3.

into the moving window analysis program (Landisman, Dziewonski and Sato, 1969) which was used to compute the dispersion curves of this dissertation. All dispersion curves have been corrected for instrumental response.

Errors due to Transmission Path

Discrimination of tectonic-related group velocity variations through ocean basins presupposes that other path-related velocity perturbations can be isolated and removed from the observed data. The effects of horizontal refraction and ocean depth, in fact, may obscure completely the actual group velocity variation due to sea floor evolution. A basic assumption necessary for the computation of the group velocities is that the surface waves travel a minimum distance (great circle) path. This assumption is strictly correct only when the medium is laterally homogeneous or when the great circle path is normal to the inhomogeneity boundaries. In a medium with lateral structural variations, however, it is possible that the least-time rather than least-distance path is responsible for an arrival on a particular seismogram. Generally the difference between the minimum-time and minimum-distance paths should be a second order effect for group velocities, since the higher velocity of the refracted path tends to be counterbalanced by the increased path length. When the path difference is significant, horizontal refraction effects are manifested as multiple energy arrivals (Capon, 1970, 1971), beating (Pilant and

Knopoff, 1964), or unusual amplitude fluctuations (McGarr, 1969).

A significant difference between a minimum-time and minimum-distance path occurs when the velocity gradient normal to the propagation path is large. High crustal and mantle velocity gradients can occur in ocean basins normal to ridge axes (Forsyth, 1975), proximal to unusual thermal perturbations (hot spots) (McGarr, 1969) and at continental margins (Capon, 1970).

The gradient normal to a ridge axis is at a maximum during the first fifteen million years of evolution and/or in basins where the spreading rate is low. The percentage of the sea floor where this can be a problem is relatively small, but may account for some of the unusual Atlantic Ocean test results. The influence can be reduced by selecting only paths nearly normal to the ridge axes. If there is significant velocity anisotropy associated with spreading directions (Bamford and Crampin, 1977; Fuchs, 1977; Schlue and Knopoff, 1977, Forsyth, 1975), then this technique resolves only the velocities in that direction which may not be representative of a more generalized path. The simplest solution to this problem is to avoid seismograms which are complicated by symptomatic beating and unusual amplitude fluctuations.

McGarr (1969) similarly has demonstrated that surface waves which have propagation paths near hot spots commonly exhibit refractive focusing and defocusing effects. Although this is less of

a spatial problem than are the ridge axes, it is a potential problem when the station is located on such a perturbation, for example KIP, or if the propagation path is aligned with the perturbed zone. In general, the effects of these small regions can be considered insignificant for all but the shortest periods (less than 20 seconds), if the propagation paths are chosen to avoid them.

Capon (1970) was able to show that surface waves can undergo considerable refraction at continental margins. The effect was at a maximum at LASA (Montana array) when the waves approached the margin at relatively low angles. The effect is negligible for coastal stations when the angle of approach is nearly ninety degrees.

In summary, the effects of horizontal refraction or departure from a minimum-distance path are difficult to evaluate. By selecting seismograms which exhibit few obvious multi-path characteristics and avoiding paths which are likely to create these effects, the combined horizontal refraction perturbations to group velocities can be considered insignificant.

The influence of the water layer on Rayleigh wave dispersion through ocean basins is perhaps the most significant correction which must be applied to the raw data. It could be argued that the increase in ocean depth with the thermal contrac -

tion of the crust and upper mantle is a correlative to the evolution of the oceanic lithosphere structure (Sclater and Francheteau, 1970; Sclater, Crowe and Anderson, 1976). However, there is significant scatter to the topography-age relationship. Failure to correct for ocean depth along a defined path tends to obscure rather than elucidate the continuous evolutionary aspect of the oceanic crust and upper mantle.

Modeling the absolute effect of increasing ocean depth in an evolving crust and upper mantle setting would be the preferred condition. Without a firm understanding of the exact structural evolution, however, this model is not tractable. Assuming a constant crust-upper mantle structure and varying only the thickness of the water layer does permit an evaluation of the relative influence of the water layer depth on Rayleigh phase and group velocity dispersion. To illustrate the effect of ocean depth, fundamental-mode Rayleigh phase and group velocities were calculated for seven ocean models. The basic crust and mantle structure used throughout the calculations is given in table 4. The models differ only in the thickness of the first layer which was varied stepwise from zero through six kilometers. The method of calculating phase and group velocity data is that of Harkrider (1964). The results of these calculations are given in table 5. The influence of the ocean layer

Oceanic Earth Model (Harkrider and Anderson)

Layer Thickness (kilometers)	V _p km/sec	V _s km/sec	Rho g/cm ³
5.0	1.52	0.0	1.03
1.0	2.10	1.00	2.10
2.50	6.41	3.70	3.06
2.50	6.411	3.702	3.07
3.0	8.11	4.61	3.40
5.5	8.12	4.61	3.40
17.5	8.12	4.61	3.40
20.0	8.01	4.56	3.37
20.0	7.95	4.56	3.37
20.0	7.71	4.40	3.37
20.0	7.68	4.34	3.33
20.0	7.77	4.34	3.33
20.0	7.85	4.34	3.33
20.0	8.10	4.45	3.33
20.0	8.12	4.45	3.33
20.0	8.12	4.45	3.35
20.0	8.12	4.45	3.36
20.0	8.12	4.45	3.37
20.0	8.12	4.45	3.38
20.0	8.24	4.45	3.39
10.0	8.30	4.53	3.44
20.0	8.36	4.56	3.50
25.0	8.75	4.795	3.68
20.0	9.15	5.04	3.88
10.0	9.43	5.217	3.90
20.0	9.76	5.40	3.92
25.0	9.77	5.40	3.93
25.0	9.78	5.40	3.95
25.0	9.78	5.40	3.96
25.0	9.78	5.40	3.99

Table 4.

on the phase and group velocities increases as the period decreases. Similarly, since group velocities are more sensitive to structural change than are phase velocities, they are significantly more perturbed than are the phase velocities at corresponding periods. Table 6 lists the percentage corrections to observed phase and group velocities necessary to eliminate the water layer influence. The group velocity corrections which must be added to the observed dispersion are also illustrated in figure 5. The correction becomes extremely non-linear as the period decreases, requiring a correction as large as 28% for deep oceans at a period of 20 seconds. Generally, the correction is less than five percent or 0.02 km/sec, but this is significant when the variation due to tectonics is of the order of 10%.

Although Sclater and Francheteau (1970) and Sclater, Bell and Anderson (1971) demonstrated a general increase in ocean depth with increase in age, the data scatter is sufficiently large that a bulk bathymetry correction based simply on sea floor age is not possible. For example, four late Cretaceous 'pure path' group velocity dispersion curves are illustrated in figure 6. The Samoa-KIP and Aleutians-KIP great circle paths traverse equivalent age sea floor. The Scotia-NAT path is somewhat younger. These instrumentally-corrected dis-

Ocean Depth in Kilometers

Period (sec)	0		1		2		3		4		5		6	
	km/sec C	U	km/sec C	U	km/sec C	U	km/sec C	U	km/sec C	U	km/sec C	U	km/sec C	U
20	4.083	4.036	4.069	4.005	4.053	3.966	4.033	3.911	4.005	3.817	3.961	3.625	3.873	3.138
25	4.089	4.037	4.078	4.063	4.066	4.036	4.052	4.001	4.035	3.952	4.014	3.077	3.982	3.745
30	4.086	4.013	4.077	4.095	4.068	4.074	4.057	4.049	4.045	4.017	4.031	3.974	4.013	3.912
35	4.081	4.123	4.073	4.107	4.065	4.090	4.057	4.071	4.047	4.048	4.036	4.019	4.024	3.981
40	4.075	4.121	4.069	4.108	4.062	4.093	4.054	4.078	4.046	4.060	4.037	4.038	4.028	4.011
45	4.070	4.112	4.064	4.100	4.058	4.089	4.051	4.075	4.044	4.060	4.037	4.043	4.029	4.023
50	4.066	4.100	4.060	4.090	4.055	4.079	4.049	4.067	4.043	4.055	4.036	4.040	4.030	4.024
55	4.063	4.086	4.058	4.077	4.053	4.067	4.048	4.057	4.042	4.046	4.036	4.033	4.030	4.019
60	4.062	4.071	4.057	4.063	4.052	4.054	4.047	4.045	4.042	4.034	4.037	4.024	4.031	4.012
65	4.062	4.056	4.057	4.048	4.053	4.040	4.048	4.031	4.043	4.022	4.038	4.013	4.033	4.012
70	4.063	4.041	4.058	4.033	4.054	4.025	4.050	4.018	4.045	4.009	4.041	4.001	4.036	3.991
75	4.065	4.025	4.061	4.018	4.057	4.011	4.052	4.003	4.048	3.996	4.044	3.988	4.039	3.979
80	4.068	4.020	4.064	4.002	4.060	3.995	4.056	3.903	4.052	3.981	4.048	3.974	4.044	3.966
85	4.072	3.991	4.069	3.985	4.065	3.979	4.061	3.973	4.057	3.966	4.053	3.959	4.049	3.952
90	4.078	3.974	4.074	3.968	4.071	3.962	4.067	3.957	4.063	3.950	4.059	3.944	4.056	3.937
95	4.084	3.956	4.081	3.951	4.077	3.945	4.074	3.940	4.070	3.934	4.067	3.928	4.063	3.922
100	4.092	3.937	4.088	3.932	4.085	3.927	4.081	3.922	4.078	3.916	4.075	3.911	4.071	3.905
105	4.100	3.918	4.077	3.913	4.094	3.908	4.090	3.903	4.067	3.898	4.064	3.893	4.080	3.887
110	4.110	3.898	4.107	3.894	4.103	3.889	4.100	3.884	4.097	3.879	4.094	3.874	4.090	3.869
115	4.120	3.878	4.117	3.874	4.114	3.870	4.111	3.865	4.108	3.860	4.105	3.856	4.101	3.851
120	4.132	3.858	4.129	3.854	4.126	3.850	4.123	3.845	4.120	3.841	4.117	3.837	4.113	3.832

Table 5 Rayleigh fundamental mode phase and group velocities of the Harkrider-Anderson ocean model with increasing ocean depth.

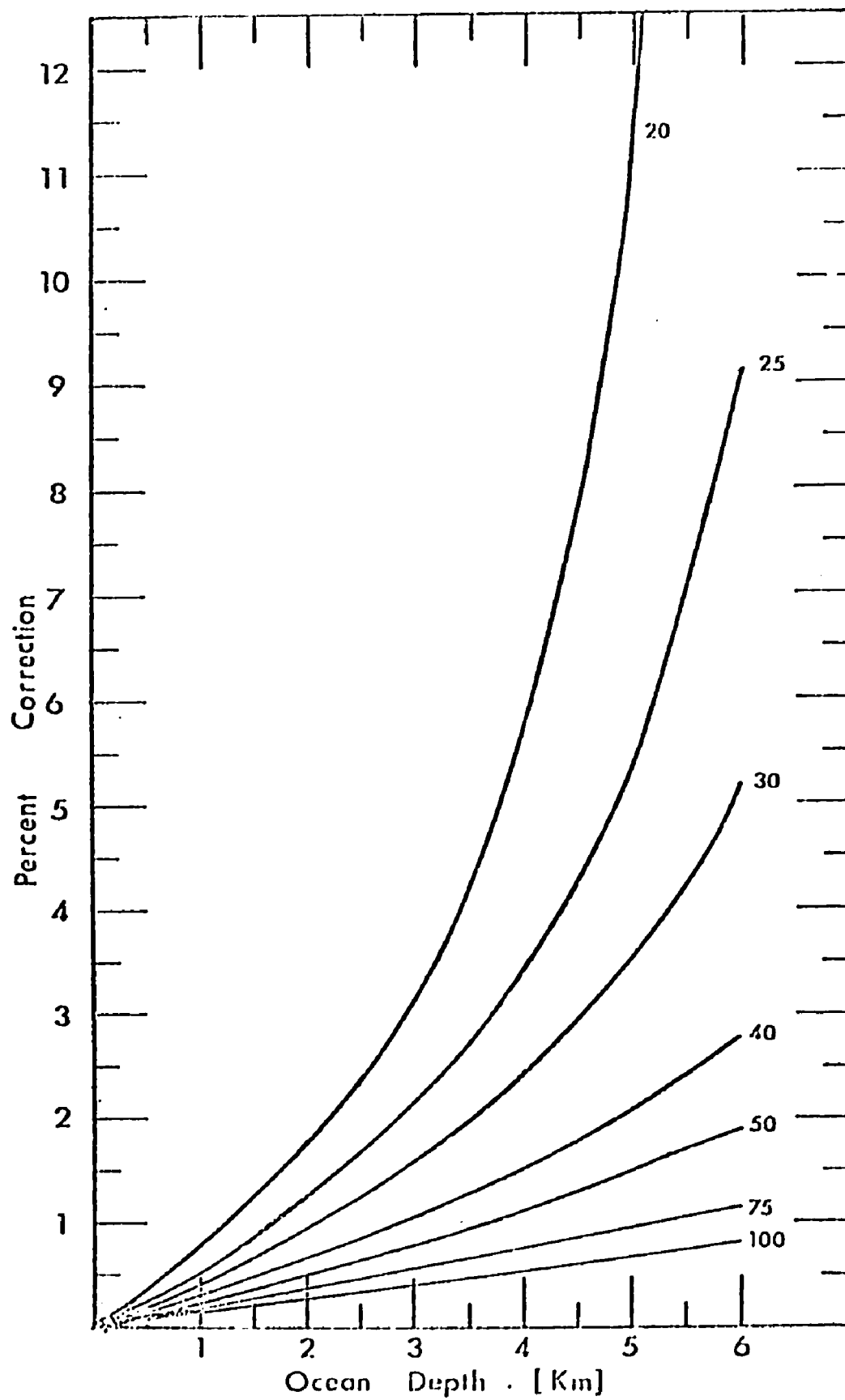


Figure 5.

Ocean Depth in Kilometers

Period (sec)	1		2		3		4		5		6	
	km/sec		km/sec		km/sec		km/sec		km/sec		km/sec	
	C	U	C	U	C	U	C	U	C	U	C	U
20	0.34	0.77	0.74	1.77	1.24	3.20	1.95	5.74	3.03	11.34	5.42	28.62
25	0.27	0.59	0.57	1.26	0.91	2.15	1.34	3.42	1.87	5.42	2.69	9.13
30	0.22	0.44	0.44	0.96	0.72	1.58	1.01	2.39	1.36	3.50	1.82	5.14
35	0.20	0.39	0.39	0.81	0.59	1.28	0.84	1.85	1.12	2.59	1.42	3.57
40	0.15	0.32	0.32	0.68	0.52	1.05	0.72	1.50	0.94	2.06	1.17	2.74
45	0.15	0.29	0.30	0.56	0.47	0.91	0.64	1.28	0.82	1.71	1.02	2.21
50	0.15	0.24	0.27	0.52	0.42	0.81	0.57	1.11	0.74	1.49	0.89	1.89
55	0.12	0.22	0.25	0.47	0.37	0.72	0.52	0.99	0.67	1.31	0.82	1.67
60	0.12	0.20	0.25	0.42	0.37	0.64	0.50	0.92	0.62	1.17	0.77	1.47
65	0.12	0.20	0.22	0.40	0.35	0.62	0.47	0.85	0.59	1.07	0.72	1.10
70	0.12	0.20	0.22	0.40	0.32	0.57	0.45	0.80	0.54	1.00	0.67	1.25
75	0.10	0.17	0.20	0.35	0.32	0.55	0.42	0.73	0.52	0.93	0.64	1.16
80	0.10	0.15	0.20	0.33	0.30	0.50	0.40	0.68	0.49	0.86	0.59	1.06
85	0.07	0.15	0.17	0.30	0.27	0.45	0.37	0.63	0.47	0.81	0.57	1.00
90	0.10	0.15	0.17	0.30	0.27	0.43	0.37	0.61	0.47	0.76	0.54	0.94
95	0.07	0.13	0.17	0.28	0.25	0.41	0.34	0.56	0.42	0.71	0.52	0.87
100	0.10	0.13	0.17	0.26	0.27	0.38	0.34	0.54	0.42	0.67	0.52	0.82
105	0.07	0.13	0.15	0.25	0.24	0.36	0.32	0.51	0.39	0.64	0.49	0.80
110	0.07	0.10	0.17	0.23	0.24	0.36	0.32	0.49	0.39	0.62	0.49	0.75
115	0.07	0.10	0.15	0.21	0.22	0.34	0.29	0.47	0.37	0.57	0.46	0.70
120	0.07	0.10	0.15	0.21	0.22	0.34	0.29	0.44	0.36	0.55	0.46	0.68

Table 6. Percent correction of observed Rayleigh phase and group velocities required to suppress water layer effects. All corrections are positive to observed data, negative to predicted data.

persion curves are quite similar but do show a considerable scatter at periods greater than 75 seconds and at periods less than 30 seconds. The average bathymetry for these chronologically similar paths , however, differs by more than a kilometer. When these data are path-corrected to zero ocean depth, indicated by the asterisks on figure 6 , the scatter of the data decreases to significantly less than one percent for the period range 20 to 80 seconds. The velocity scatter at periods greater than 80 seconds does not disappear, however, suggesting that there is a more deep seated discrepancy in the structure of these three regions.

All observed Rayleigh group velocity dispersions used in this dissertation have been corrected for mean great-circular path ocean depth. It was assumed that a mean depth correction would adequately represent a stepwise slowness correction, although this may not be a valid assumption under the condition of rapidly varying topography.

In summary, Rayleigh group velocity data, corrected for instrumental response and mean ocean depth, have a mean RMS residual uncertainty of the order of 0.03 km/sec. The most significant errors will be introduced by mislocation of the epicenter and/or incorrect assignment of origin time. Awareness of potential sources of horizontal refraction, and avoidance of clearly multipathed seismograms is the best safeguard against misinterpreting apparent group velocities as true group velocities.

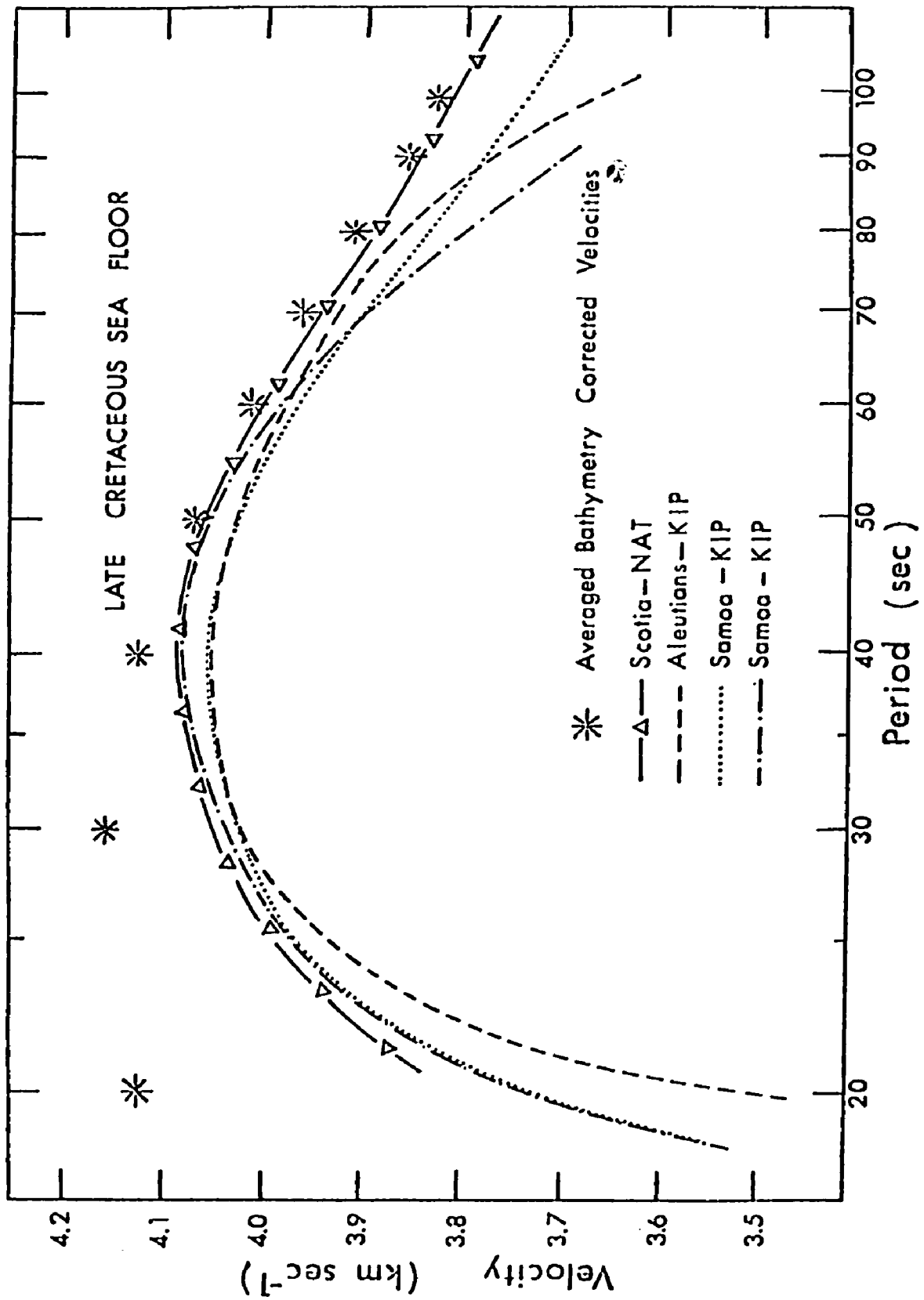


Figure 6.

Determination of the Group Velocity - Age Relationship

Rayleigh group velocity data used to create the group velocity versus age functions were derived from a combination of published dispersion data and some new paths. Dispersion data from the literature could be used only if they satisfied the following criteria: (1) the least-distance path had to be chronologically identifiable in terms of magnetic anomalies and/or deep sea drilling, and limited to a small deviation about the mean age to insure 'pure path' properties; (2) the seismograms had to be relatively free of significant apparent multi-path characteristics; (3) the dispersion curves must be computed by a moving window-type analysis which is clearly identifiable as instrumentally delay corrected; and (4) the 'pure path' data created by matrix least-squares reduction of mixed path data, such as those by Forsyth (1975), had to have demonstrably stable solutions with clearly stated error limits. A surprisingly small volume of data is available in the literature which meet these criteria. Table 7 lists the published dispersion analyses used in this study. Supplemental new analyses were done to spot check the reliability of the published results and to fill some age gaps. New analyses are listed in table 9. All data compiled were corrected for instrumental and ocean depth group delay.

Even though nearly all group velocity data used in the construction of the age-velocity functions are from the Pacific, where there

**Table 7 Published Data Used to Construct the Group Velocity
Versus Age Relationship**

Forsyth, D. W. (1975), The Early Structural Evolution and Anisotropy of the Oceanic Mantle, Geophys. Jour., 43, 103-162.

Kausel, E. G. (1972), Regionalization of the Lithosphere and Asthenosphere of the Pacific Ocean, Ph.D. Thesis, Columbia University, New York.

Knopoff, L., J. W. Schlue, and F. A. Schwab (1970), Phase Velocities of Rayleigh Waves across the East Pacific Rise, Tectonophys., 10, 321.

Kovach, R. L. and F. Press (1961), Rayleigh Wave Dispersion and Crustal Structure in the Eastern Pacific and Indian Oceans, Geophys. Jour., 4, 202.

Leeds, A. R., E. G. Kausel, and L. Knopoff (1974), Variations of Rayleigh Wave Phase Velocities across the Pacific Ocean, Sci., 186, 139.

Leeds, A. R. (1975), Lithospheric Thickness in the Western Pacific, Phys. Earth and Planet. Int., 11, 61.

Santo, T. A. (1961), Division of the Southwest Pacific into Several Regions in each of which Rayleigh Waves have the same Dispersive Character, Bull. Earthq. Res. Inst., 39, 309.

Yoshii, T. (1975), Regionality of Group Velocities of Rayleigh Waves in the Pacific and Thickening of the Plate, Ear. and Planet. Sci. Lett., 25, 305.

is a reasonable distribution of earthquakes and observatories and relatively wide isochronological sea floor segments, determination of mean velocities for a given sea floor age is difficult because of sampling bias in an anisotropic medium. The degree of seismic velocity anisotropy in the Pacific has been estimated to be between two and ten percent by several authors (Bamford and Crampin, 1977; Fuchs, 1977; Schlue and Knopoff, 1977; Forsyth, 1975). Velocity maxima are parallel with spreading directions and therefore they are normal to sea floor isochrons. Conversely, velocity minima are parallel with ridge axes and therefore are parallel to sea floor isochrons.

Unless an isochronological segment of sea floor is sampled at all azimuths, therefore, an apparent mean velocity will be biased by the particular azimuth-dependent velocities used in the mean computation. Forsyth (1975) determined mean surface wave velocities for temporal-restricted sea floor segments less than 30 million years old which are relatively free of anisotropy sampling bias. These mean results from the Nazca plate are used for the initial points on the age-velocity functions. All other data points are subject to anisotropy sampling bias which cannot be avoided for the majority of the Pacific basins.

Assuming that the surface wave velocity anisotropy of 2 % determined by Forsyth (1975) is representative, and that the anisotropy is restricted to the low velocity zone (LVZ) as suggested by Schlue and Knopoff (1977), it is possible to predict how specific observations

may be biased. In addition, since the vertical character of the LVZ is time-dependent, it should be possible to determine what specific wave periods have the highest probability of being affected. For example, the apparent mean surface wave velocities for sea floor (Nazca) older than 30 million years determined by Forsyth (1975) should be biased toward higher than true mean velocities because sampling must be restricted to paths nearly normal to the South American coastline to avoid significant horizontal refraction effects. Similarly, 'pure path' observations in the older portions of the Pacific (greater than 90 million years) are likely to be biased toward lower than true mean velocities because of the selection of paths which are subparallel to sea floor isochrons. In addition, since the LVZ is wider, less well defined, with a deeper lid to the LVZ than younger oceanic regions (Schlue and Knopoff, 1977), longer periods are more likely to be affected than short periods. Without absolute determination of the anisotropy correction necessary, however, it is not possible to make this correction to the data in advance.

Construction of functional relationships between sea floor age and period-specific apparent mean group velocity was accomplished by performing stepwise polynomial regressions on the data from table 7 at periods from 30 to 100 seconds in increments of 10 seconds. The results of these analyses are given in table 8 and figure 7. Although the polynomial regressions were able to fit the data with a high degree of precision, the physical sense of these functions is

Table 8 Statistics for Polynomial Regression Ages 2.5 to 155 M.Y.

Period	Obs.No.	Polynom Degree	Intercept and Regress.Coeff.	Variance	Fisher F	Conf.
30	12	3	0.3788 0.1099E-1 -0.1052E-3 0.3353E-6	0.0074	76.4	99.5%
40	16	5	0.3678 0.2761E-1 -0.9043E-3 0.1387E-4 -0.9418E-7 0.2308E-9	0.00030	140.5	99.5%
50	15	4	0.3697 0.1086E-1 -0.1306E-3 0.8322E-6 -0.2121E-8	0.00083	65.1	99.5%
60	14	3	0.3640 0.1092E-1 -0.9939E-4 0.3020E-6	0.00032	206.1	99.5%
70	14	3	0.3623 0.9250E-2 -0.8034E-4 0.2387E-6	0.00056	102.2	99.5%
80	13	5	0.3653 -0.4520E-2 0.6582E-3 -0.1326E-4 0.9892E-7 -0.2521E-9	0.00124	20.2	99.5%
90	13	5	0.3647 -0.8755E-2 0.8861E-3 -0.1763E-4 0.1320E-6 -0.3382E-9	0.00197	9.8	97.5%
100	9	4	0.3639 -0.9914E-3 0.2716E-3 -0.3931E-5 0.1466E-7	0.00080	13.9	97.5%

APPARENT MEAN RAYLEIGH GROUP VELOCITY versus SEA FLOOR AGE

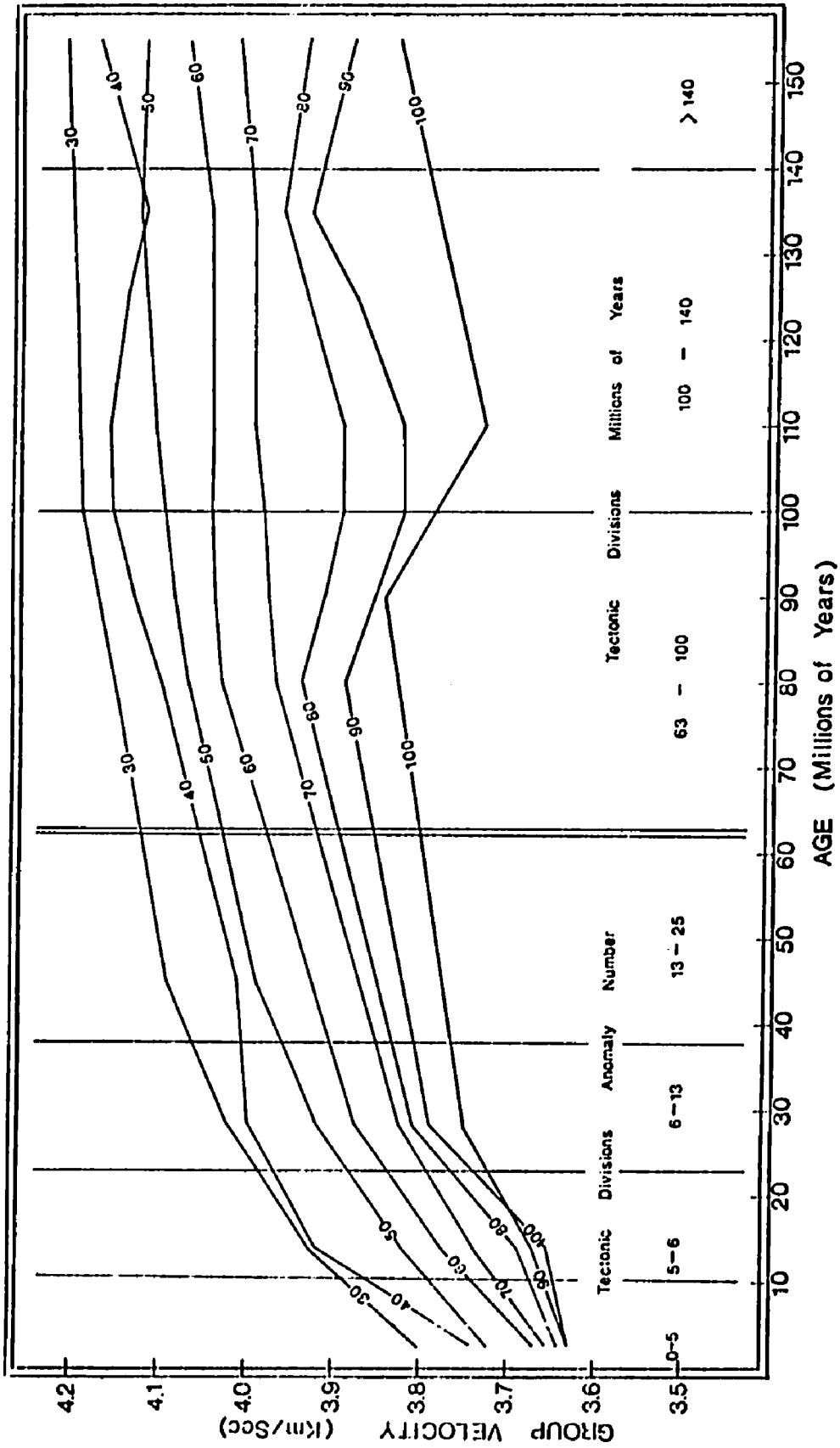


Figure 7.

questionable. The general trend of these functions is a smooth 'logarithmic-type' curve in which velocity increases with increase in age (30, 50, 60, 70 second curves). The cause of the 40 second period function aberrancy is unknown, but presumed to be a sampling problem since neither the 30 second nor the 50 second period functions behave in this erratic fashion. Although the excursions are well within the bounds of a 1-2% anisotropy deviation, preferential sampling of the anisotropic medium is not believed to be responsible for the fluctuations in the 40 second curve. On the other hand, the 1.3% reduction in the velocities of the 80, 90, and 100 second period curves in the crustal age region of 90 through 120 million years is believed to be caused by anisotropy sampling bias. All paths sampling sea floor in this age bracket are subparallel to sea floor isochrons.

The temporal limits of the seven oceanic tectonic divisions (other than island arcs) which are used in this study are indicated by the vertical lines on the age versus apparent mean group velocity functions of figure 7. A set of mean apparent group velocities for periods from 30 to 100 seconds is assigned to each tectonic division by averaging the apparent velocities within the division limits. The assigned apparent mean group velocities for each division are given in table 2. Although there is a set of velocities for a 20 second period, this function was too erratic to be considered meaningful.

The Global Rayleigh Group Velocity Matrix

Apparent mean Rayleigh group velocities through each 5° x 5° geographic block are derived by summing the products of the tectonic element percentages and the period-specific mean group velocities assigned to each tectonic element; or in matrix notation:

$$\bar{V} = \sum_{i=1}^n T_i V_i$$

where $\bar{V}$ is the period-specific mean group velocity matrix with dimensions 8 x 36 x 72, T is the tectonic matrix with dimensions 20 x 36 x 72 and V is the period-specific, tectonic-specific mean group velocity matrix with dimensions 8 x 20

The values of the $\bar{V}$ matrix are given in appendix II indexed by colatitude, east longitude, and period. The $\bar{V}$ and T matrices together with 5° x 5° surface heat flow (Chapman and Pollack, 1975, b), and mean topography have been stored on magnetic tape (see appendix III).

Eight Mercator conformal projections of the contoured mean Rayleigh wave group velocities for the periods 30 through 100 seconds were produced from the stored velocity matrix (See map pocket). These maps are a convenient data display providing both a base for nonautomatic 'ray tracing' testing of the model against observed data,

and simple visual comparison of the predicted Rayleigh wave group velocities with other geophysical data. The contour interval of the 30 and 60 second period maps is 0.10 km/sec. The remaining maps are contoured at an interval of 0.05 km/sec. Each map displays the velocity data from 75° north latitude to 75° south latitude. There is a duplication of 65° east longitude through 105° east longitude on the left and right hand margins. East longitudes 0°, 180°, and 270° and colatitudes 45°, 90°, and 135° provide a reference framework on all maps.

A general discussion of the predicted Rayleigh group velocity data and comparative analysis with other geophysical observations follows the section on model testing in chapter 2.

CHAPTER 2

TESTING OF THE RAYLEIGH GROUP VELOCITY PREDICTIVE MODEL

Pacific Ocean Basins

Knopoff (1969) demonstrated that group travel times in inhomogeneous dispersive media are equivalent to the sum of the group velocity delays within each homogeneous path segment. Ray tracing programs (North, 1976) which utilize this principle to determine phase velocities automatically were not available for these analyses in this dissertation; however, prediction of group velocity dispersion character is possible by hand using the included contour maps.

Generally, path segments limited by mapped successive velocity contours are defined as homogeneous divisions and assigned velocities equivalent to the mean of the bounding contours. Paths which cross no mapped velocity contours are assigned velocities dependent on the spatial configuration of the path within the contoured zone. Contoured areas with widths less than 1500 kilometers are assigned velocities equivalent to the mean of the bounding contours. On the other hand, contoured areas with widths exceeding 1500 kilometers, such as those of the western Pacific, are roughly divided into three subregions. The two marginal segments are assigned velocities equivalent to the nearest contour; the central segment is assigned a mean velocity. Thus, for example, a path subparallel to a 4.0 km/sec con-

tour, located in a wide iso-velocity region, and having the majority of its length within the one third proximal region would be assigned a velocity of 4.0 km/sec rather than a mean velocity.

In addition, implicit in these analyses is the assumption that all paths are least-distance, and that the composite group velocity along a given path is represented by the sum of the assigned segment group delays. Thus, by overlaying each of the eight Rayleigh velocity contour maps with correctly scaled Mercator conformal projections of least-distance paths, discrete-period, path-related dispersion curves are computed by summing the product of path segment group velocities and corresponding path length percentages over the total path length.

The predicted dispersion curves are then corrected for mean bathymetry by subtracting the percentages listed in table 2. These bathymetry-corrected predicted group velocities are directly comparable with the instrumental-delay-corrected observed group velocities which are determined for the same path by moving window analysis.

Source parameters for earthquakes used in testing the Rayleigh velocity prediction model are listed in table 9. All parameters were taken from the International Seismological Center (ISC) bulletin. Also listed in table 9 are the recording station codes and tape identification labels for retrieval of the digitized seismogram (see appendix III). The coordinates of all stations used in these analy-

Earthquakes (Model Tests)

Table 9

Date	Origin Time	Latitude	Longitude	Station	Tape Loc.
Pacific Ocean					
Jan. 08, 1968	21:54:20.8	14.80 S	174.83 W	KIP	KIP41
Apr. 20, 1968	12:25:10.1	15.68 S	172.64 W	KIP	KIP39
May 24, 1968	14:06:24.2	40.93 N	143.03 E	AFI	AFI29
Jun. 16, 1968	23:04:54.7	39.83 N	143.08 E	AFI	AFI30
Aug. 22, 1968	14:00:06.8	53.01 N	171.05 E	KIP	KIP99
Oct. 06, 1968	08:47:02.0	14.73 S	175.61 E	KIP	KIP42
Oct. 31, 1968	09:06:36.4	1.20 N	126.30 E	MAT GUA	MAT21 GUA21
Nov. 25, 1968	18:36:52.3	5.05 N	126.77 E	GUA	GUA22
Jun. 13, 1969	08:48:28.3	49.41 N	155.54 E	KIP	KIP13
Sep. 20, 1969	15:26:41.5	1.78 N	101.03 W	PEL	----
Nov. 01, 1969	11:08:24.3	23.19 N	107.99 W	RAR	----
Jun. 20, 1970	07:19:51.4	25.85 S	177.29 W	LON	----
Dec. 02, 1970	15:54:19.0	11.03 N	163.41 E	KIP	----
May 09, 1971	08:25:01.7	39.80 S	104.80 W	WEL	----
Oct. 23, 1974	06:14:52.1	8.40 S	154.03 E	LON	LON20
Nov. 09, 1974	12:59:49.8	12.50 S	77.80 W	KIP	KIP19
Indian Ocean					
May 04, 1970	18:53:21.0	41.65 S	79.87 E	MUN CHG	MUN8 CHG8
Jun. 01, 1973	07:22:57.5	47.92 S	99.69 E	KOD	KOD11
Jun. 25, 1974	17:22:19.3	26.10 S	84.30 E	LEM	LEM12
Arctic Ocean					
Jan. 28, 1967	17:42:01.5	52.40 N	169.41 W	NOR	NOR25

Earthquake (Model Tests) Continued

Date	Origin Time	Latitude	Longitude	Station	Tape Loc.
North Atlantic Ocean					
Jun. 19, 1970	14:25:22.0	15.34 N	45.92 W	TRN	TRN1
Aug. 05, 1971	01:58:53.2	00.85 S	22.07 W	AKU	AKU3
Jun. 12, 1974	16:25:47.6	10.56 N	63.38 W	TLO	TLO7
South Atlantic Ocean					
Nov. 29, 1970	06:01:18.6	11.67 S	14.00 W	NAT	NAT2
Oct. 14, 1971	22:36:34.8	54.40 S	2.50 E	NAT	NAT4
Apr. 07, 1973	12:22:49.3	58.50 S	13.60 W	SDB	SDB5

Table 10 Seismograph Stations Utilized

Station Code	Latitude	Longitude
AFI	13.909 S	171.777 W
AKU	65.687 N	18.107 W
CHG	18.790 N	98.977 E
GUA	13.538 N	144.912 E
KIP	21.423 N	158.015 W
KOD	10.233 N	77.467 E
LEM	6.833 S	107.617 E
LON	46.750 N	121.810 W
MAT	35.542 N	138.209 E
MUN	31.975 S	116.207 E
NAT	5.117 S	35.033 W
NOR	81.600 N	16.683 W
PEL	33.144 S	70.685 W
RAR	21.213 S	159.773 W
SDB	14.792 S	13.572 E
TLO	39.860 N	4.015 W
TRN	10.600 N	61.402 W
WEL	41.286 S	174.768 E

ses are listed in table 10.

Seventeen random paths were selected for the Pacific Ocean basins. These paths, listed in table 9 and illustrated in figure 8, collectively sample the Pacific basins in a non-preferential manner with respect to tectonics, possible anisotropy, and bathymetry. Rayleigh group velocities are predicted for each of these paths by the previously discussed technique. These predicted dispersion curves are compared with moving window analyses of path-equivalent observed dispersion curves in figures 9 through 20.

The six dispersion analyses of figure 9 are presented in a format unlike the subsequent comparative diagrams, to illustrate not only the comparison of the model and observed data, but also the comparison of this tectonic-based model with three other standard ocean models. Observed data, uncorrected for bathymetry effects, are illustrated by the open circles. Observed data, corrected for bathymetry effects, are shown by the closed circles. Solid lines represent dispersion analyses predicted by this model; dot-and-dash lines represent dispersion analysis of the Harkrider-Anderson ocean model (1964); dashed lines represent the dispersion analysis of standard ocean model CIT 11A (Kanamori and Abe, 1968); and dotted lines represent dispersion analysis of standard ocean model 8099 (Kanamori and Abe, 1968). Only in figure 9 is the bathymetry correction applied to the observed data. All other diagrams have the bathymetry correction applied to the predicted data to

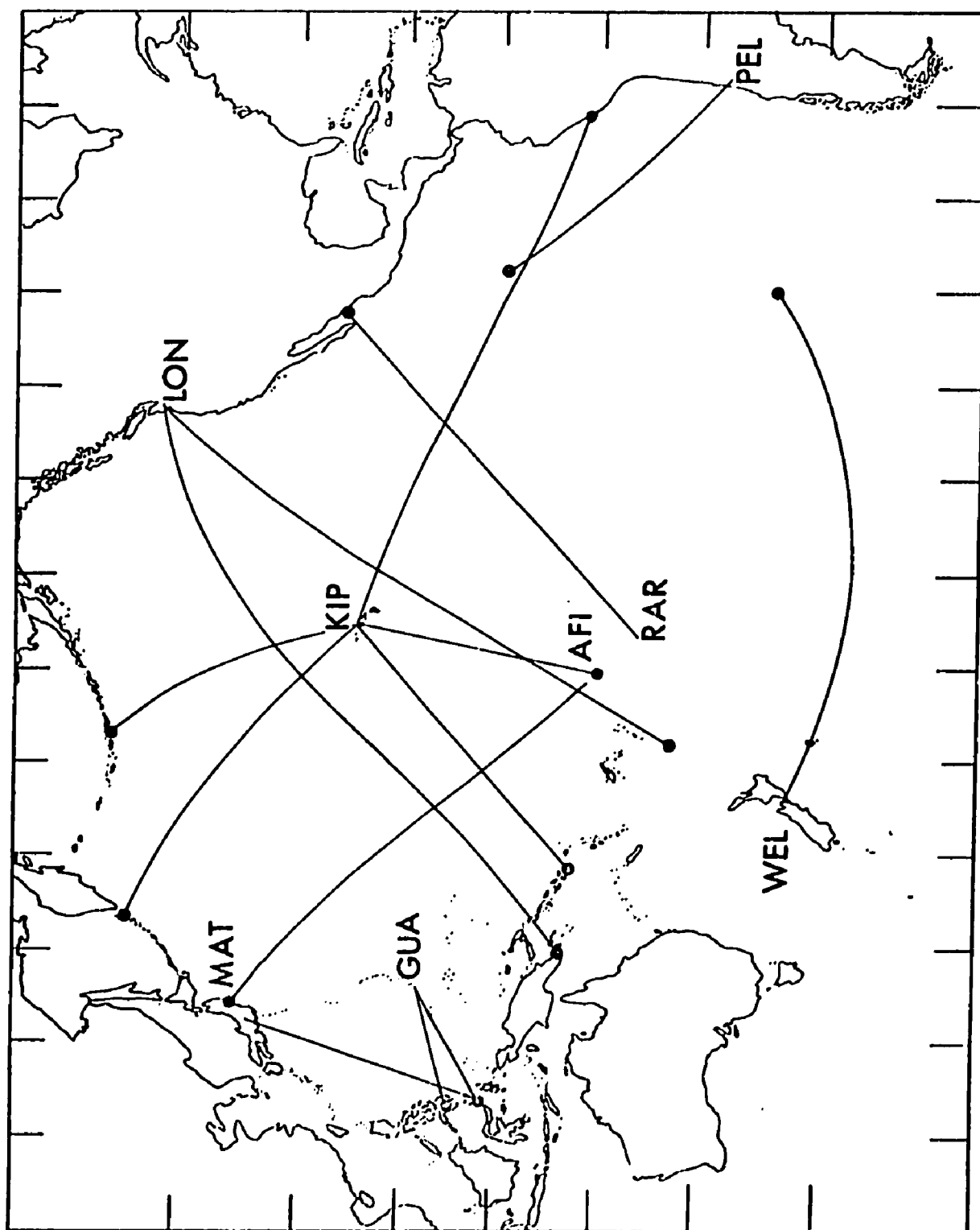


Figure 8.

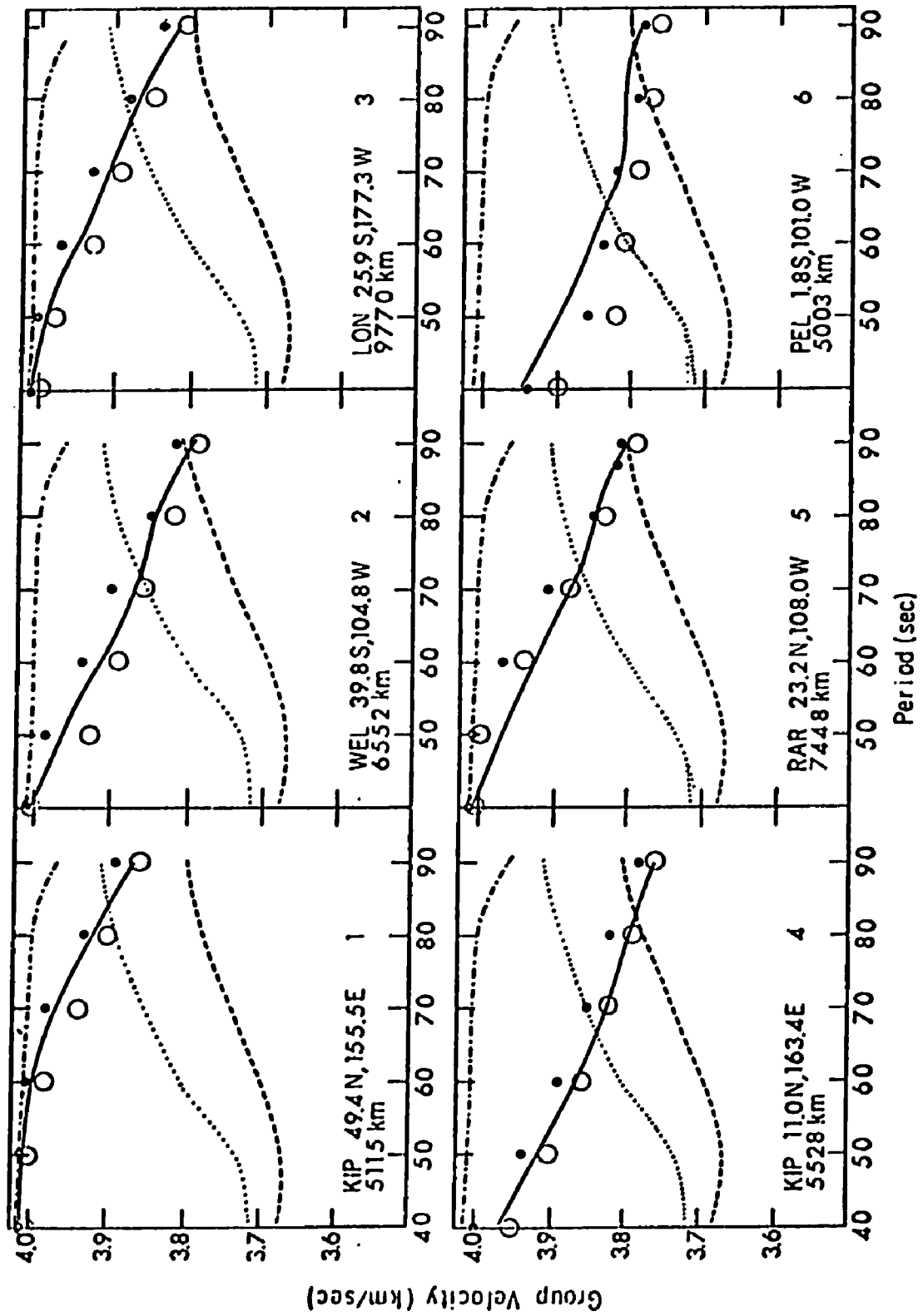


Figure 9.

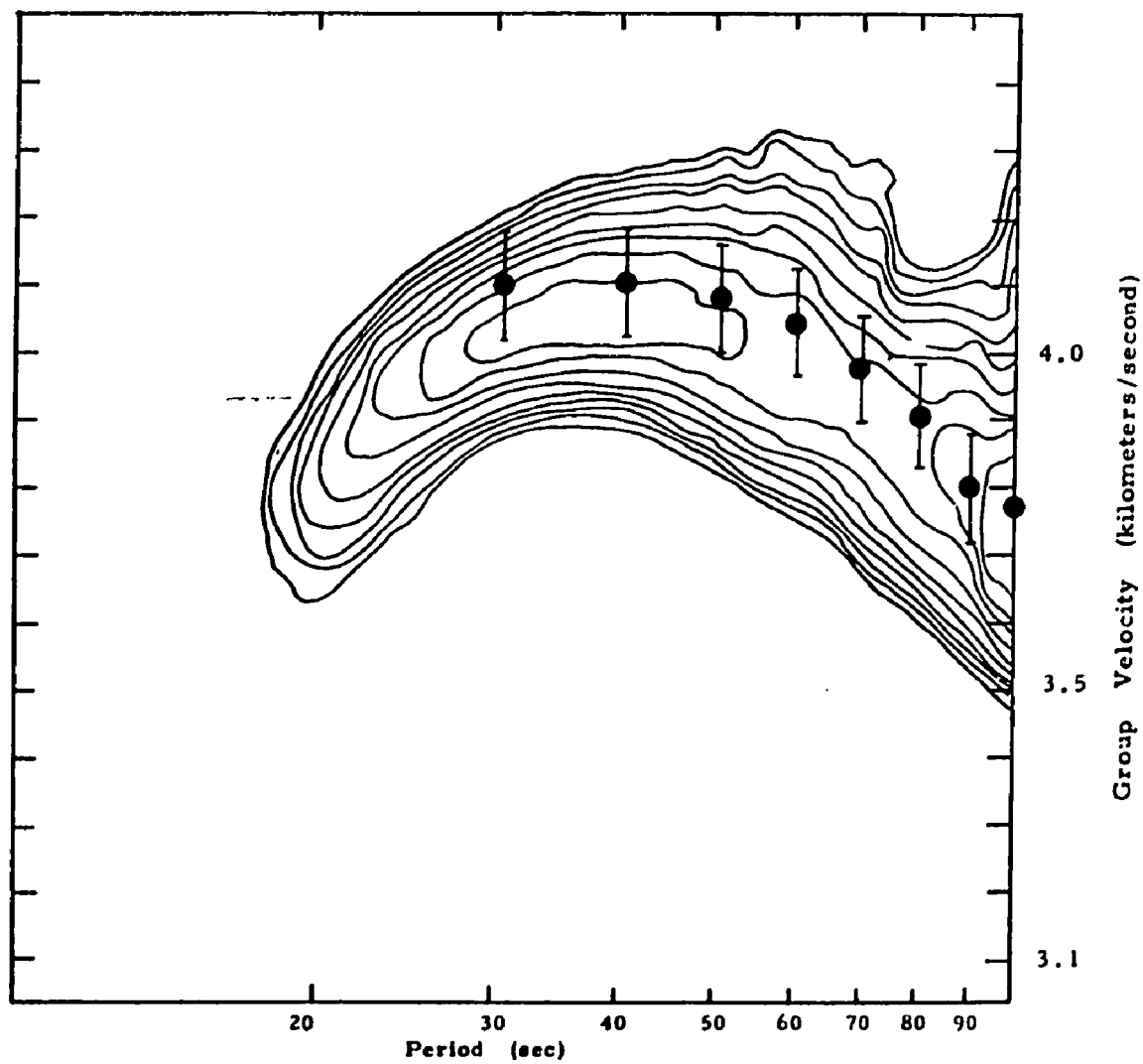
correctly locate it in the observed period versus group velocity space.

Figure 9 clearly demonstrates the inadequacy of previous fixed-structure ocean models to fit the Rayleigh group velocity data. Although the Harkrider-Anderson model may fit Rayleigh group velocity data for an old ocean basin (Figure 9, KIP1), with relatively small residuals, the model fails significantly for a younger oceanic region (Figure 9, PEL6). Similarly, fixed structure models like CIT 11A and 8099 may yield small residuals over a very limited spectral band, but fail to fit the observed data over a broader spectrum. On the other hand, the tectonic-based model has an implicitly evolving structure with time, albeit not explicitly defined, which permits it to fit both old and young ocean crust and mantle Rayleigh group velocities over a wide spectrum. This is clearly apparent in figure 9.

The remaining dispersion analyses in this dissertation compare the observed data to the tectonic-based model only. The observed data is presented as energy contours in an instrumental-group-delay-corrected group velocity versus log-period space. Although the entire region is capable of being contoured, only the most significant energy regions are contoured to reduce unnecessary cluttering of the diagrams. Depth-corrected predicted-mean-group velocity data for the same great-circular path are presented as solid circles. The diameter of the circle is approximately half

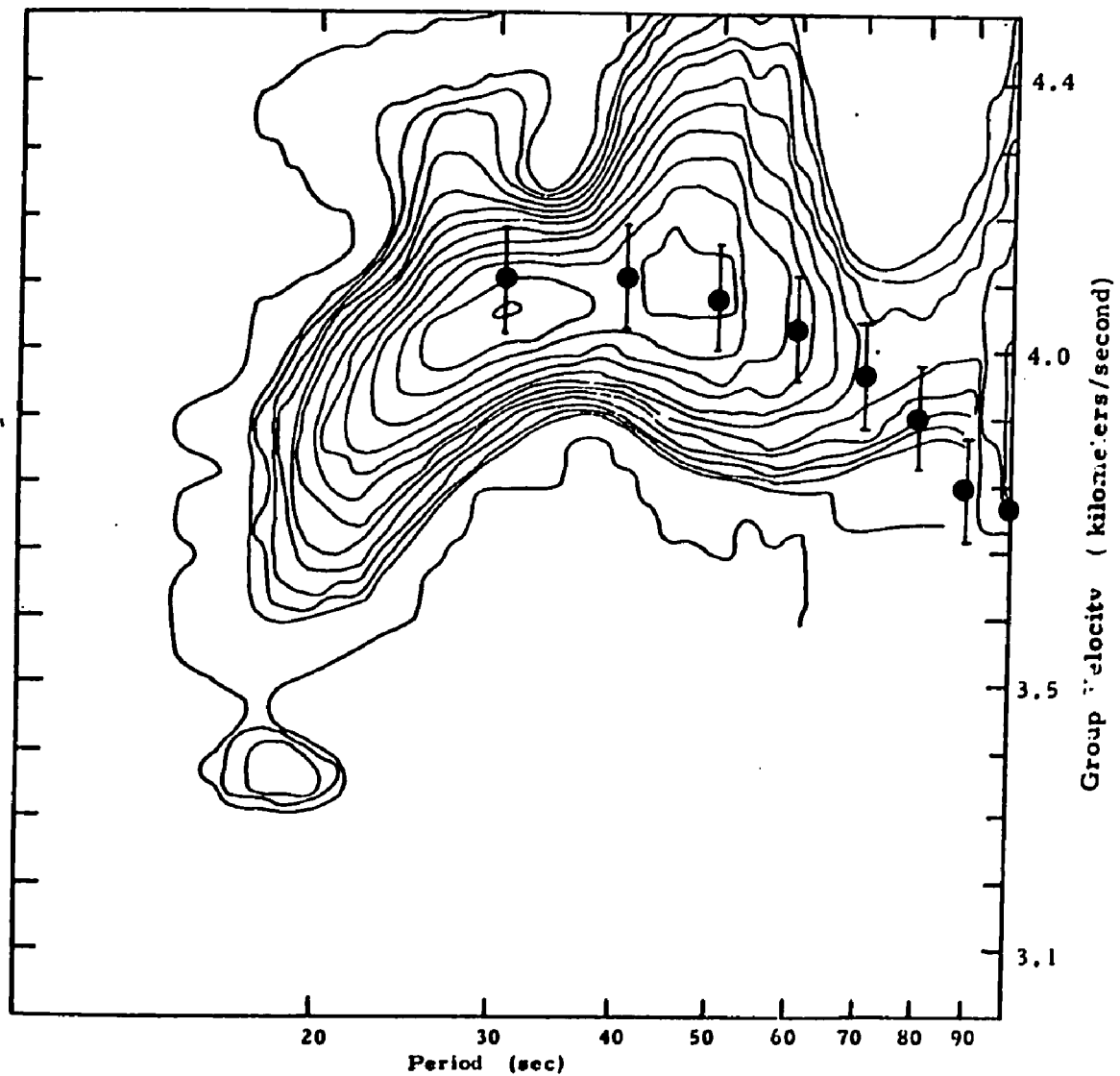
the RMS uncertainty of 0.03 km/sec for the determinations. The vertical bars extending from the mean velocities correspond to a 2% velocity uncertainty at 4.0 km/sec (0.08 km/sec). If the degree of surface wave velocity anisotropy in ocean basins does not exceed 2%, as suggested by Forsyth (1975), then these error bars should encompass the possible anisotropy-related scatter. Figure 10 through 20 illustrate the remaining Pacific Ocean tests.

Generally, the correspondence of the predicted and observed dispersion data is remarkably high. A systematic overestimation of the 30 and frequently 40 second period group velocity suggests that the depth correction by mean ocean depth may not be adequate. Alternatively, this could be a problem with the model, but without performing a stepwise depth correction, the source of this error is unknown. Excluding the Philippine plate tests momentarily, the greatest Pacific Ocean data misfit occurs with the May 24, 1968 earthquake recorded at station AFI (Figure 12). This path through the oldest oceanic region would apparently be better represented by the Harkrider-Anderson model than the tectonic-based model. The earthquake of June 16, 1968, on the other hand, also recorded at station AFI (Figure 13) should have an identical dispersion character, but it is more closely represented by the tectonic-based model. Since the two events have nearly identical source parameters and digitized data lengths, the source of this variation is unknown.



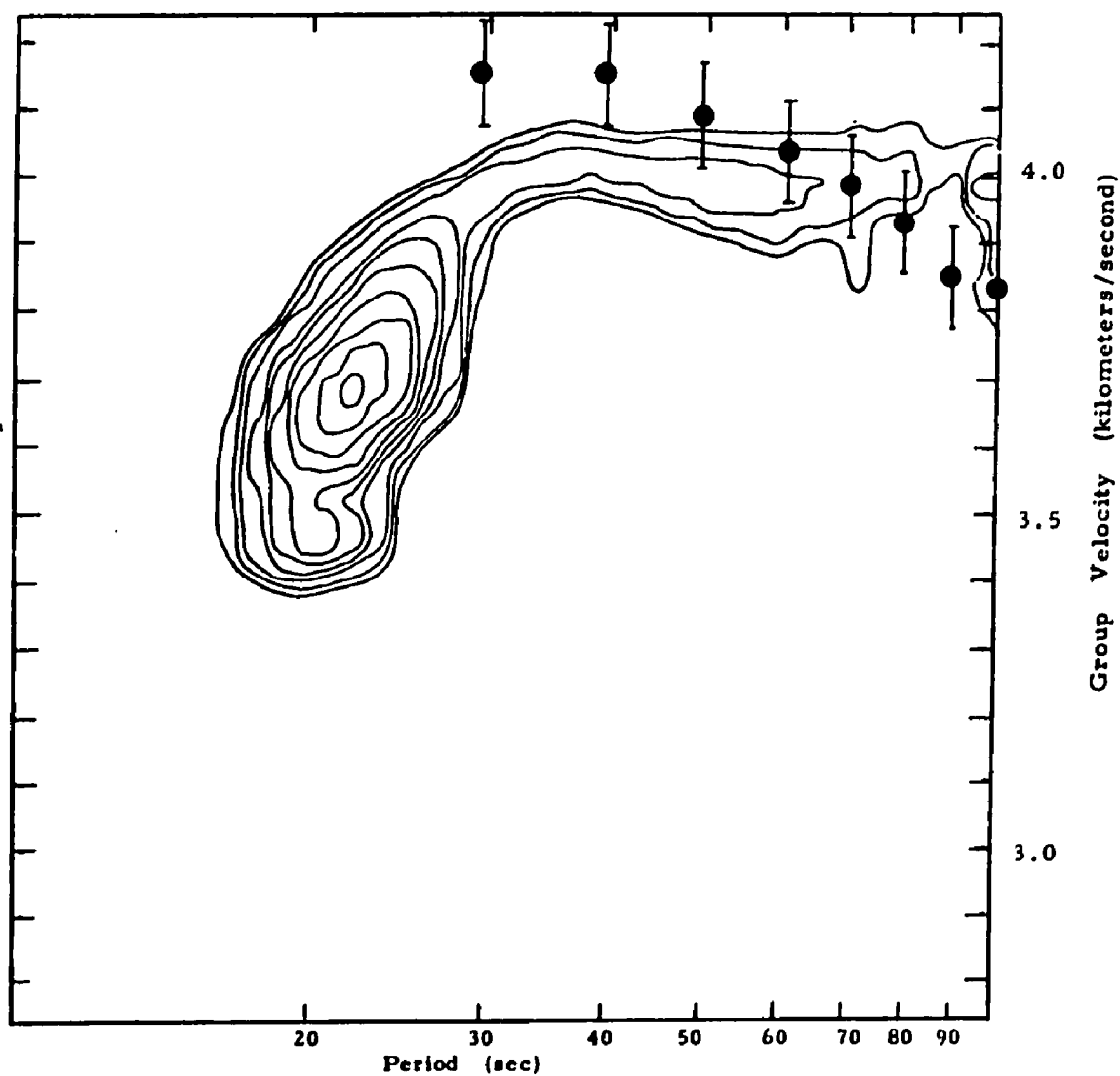
Pacific Ocean Earthquake Jan. 8, 1968 21:54:20.8, 14.80S 174.83 W
Recording Station KIP Epicentral distance 4400.4 kilometers.

Figure 10.



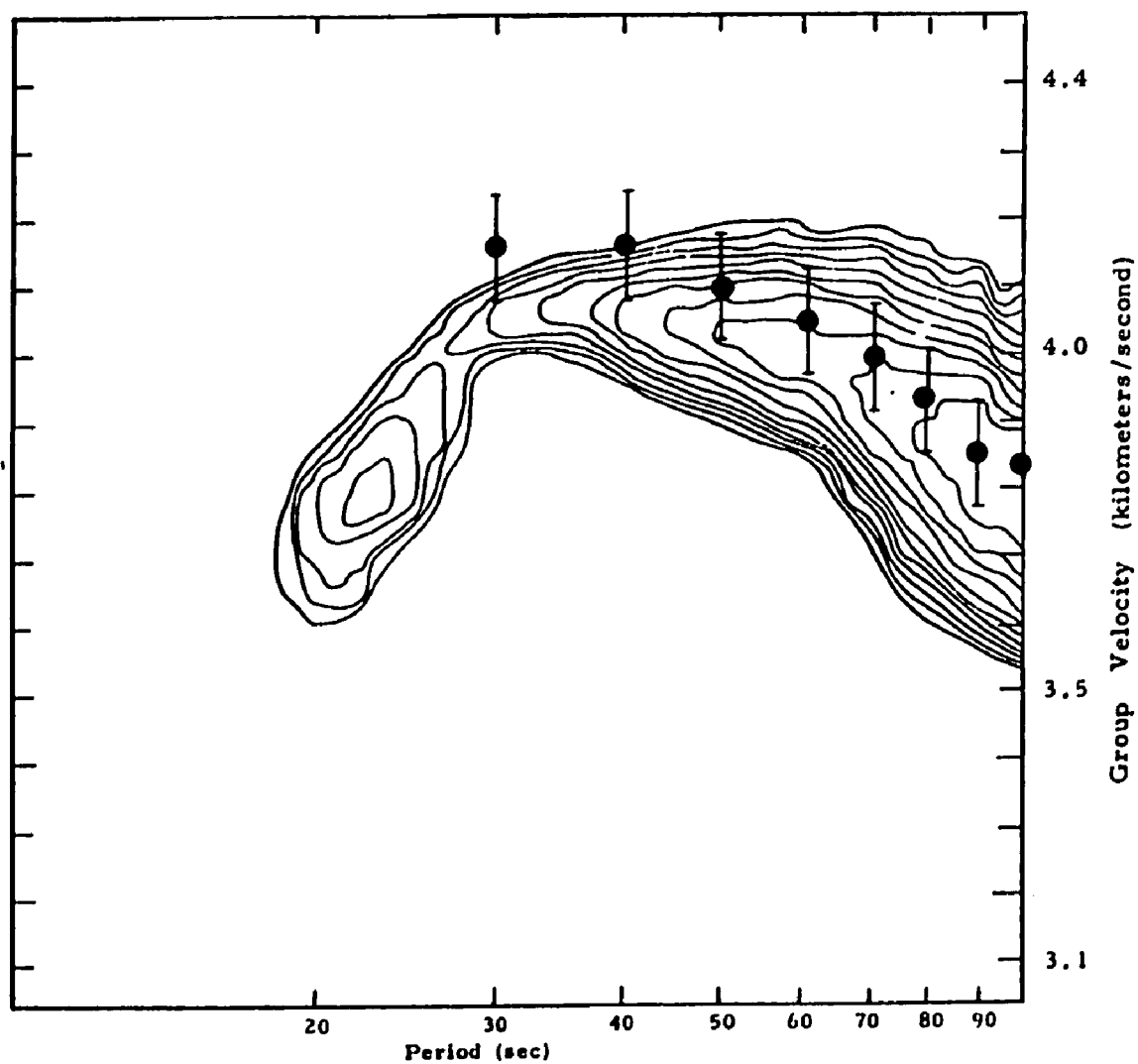
Pacific Ocean Earthquake Apr. 20, 1968, 12:25:10.1, 15.68 S, 172.64 W
Recording Station KIP Epicentral distance 4397.0 kilometers.

Figure 11.



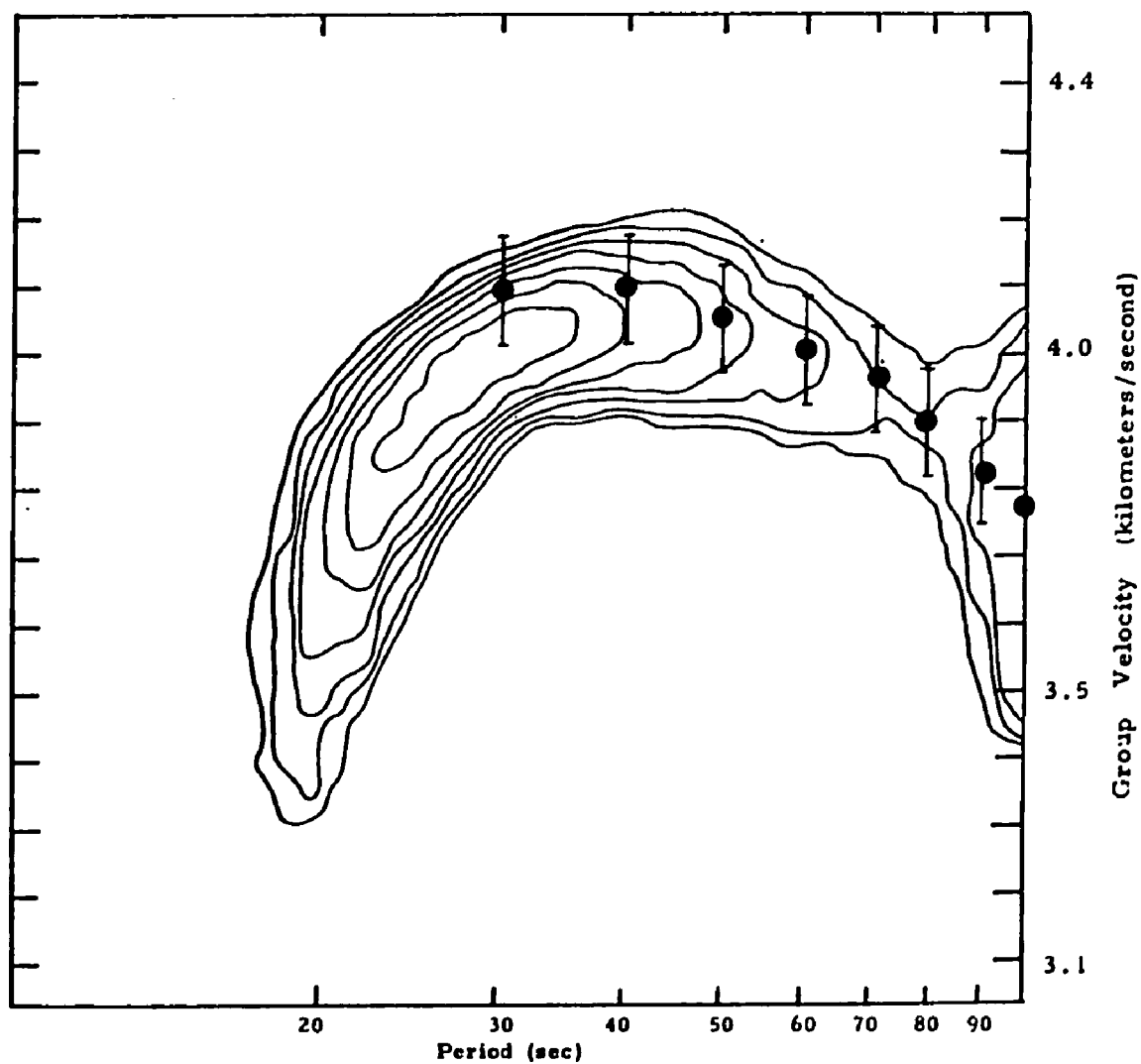
Pacific Ocean Earthquake May 24, 1968 14:06:24.2, 40.93 N, 143.03 E
Recording Station AFI Epicentral distance 7549.5 kilometers.

Figure 12.



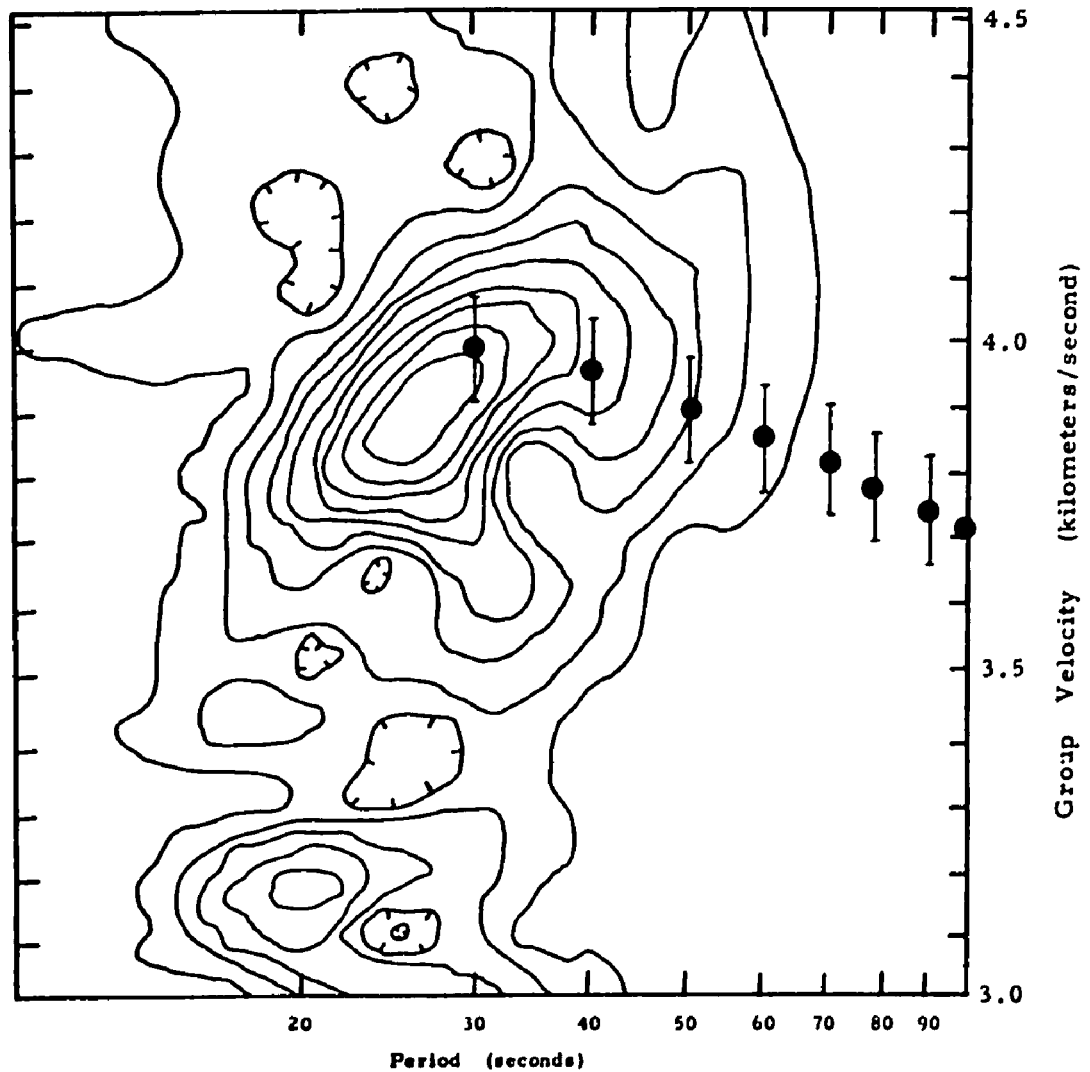
Pacific Ocean Earthquake June 16, 1968, 23:04:54.7, 39.83 N, 143.08 E
Recording Station AFI Epicentral distance 7552.8 kilometers.

Figure 13.



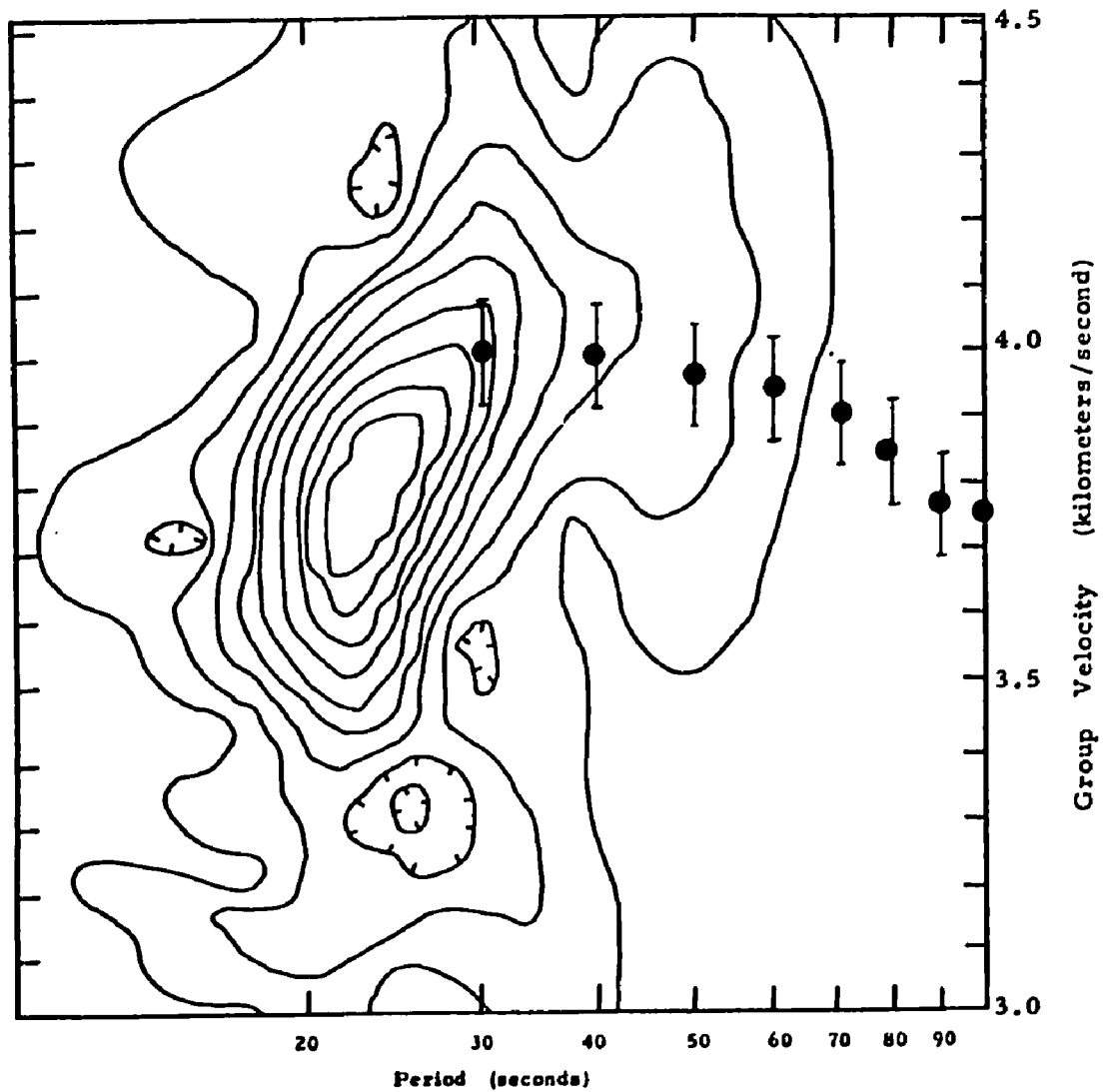
Pacific Ocean Earthquake Aug. 22, 1968 14:00:06.8, 53.01 N, 171.05 E
Recording station KIP Epicentral distance 4383.7 kilometers.

Figure 14.



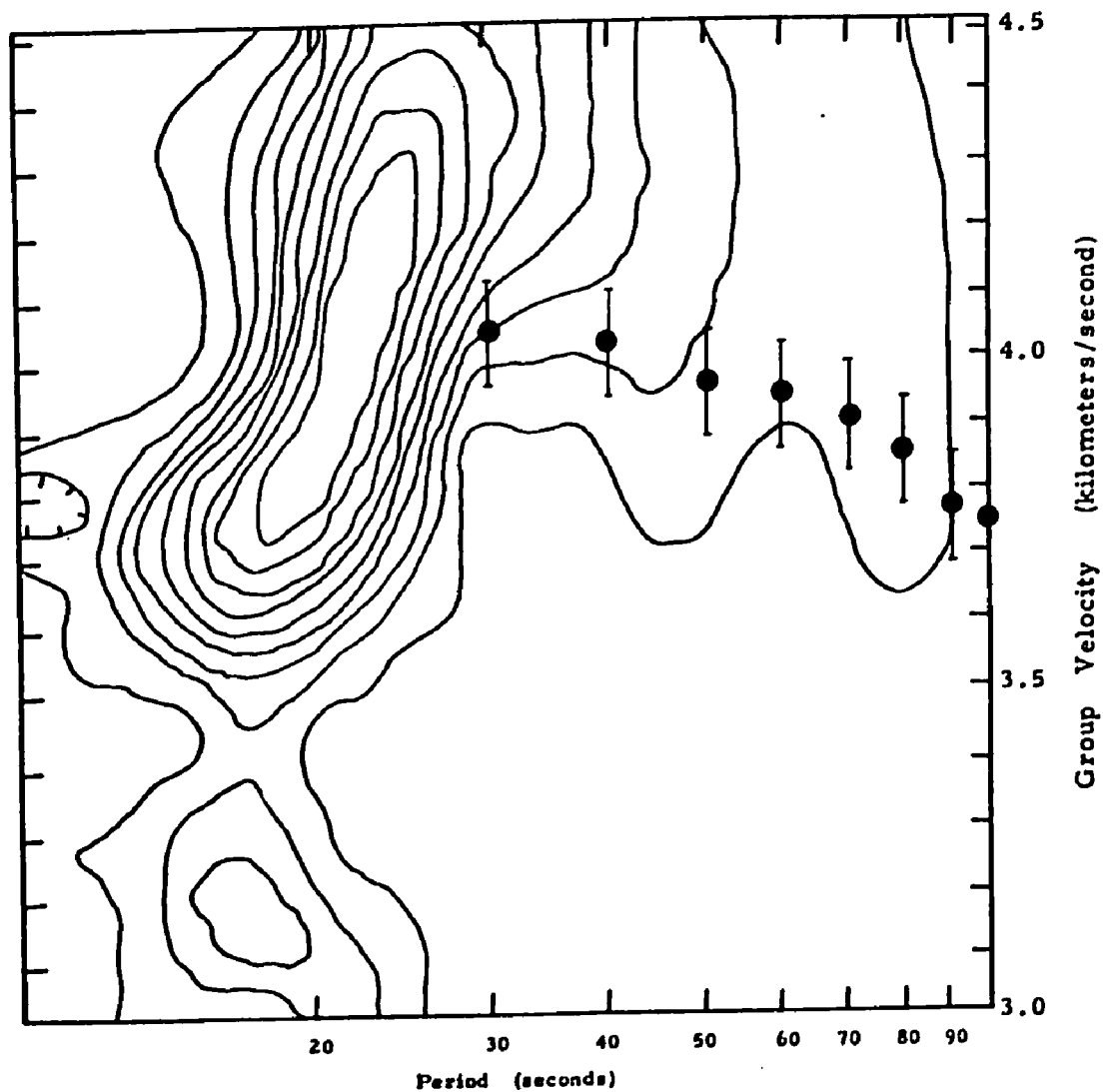
Philippine Plate Pacific Ocean Earthquake October 31, 1968
 09:06:36.4, 1.2 N, 126.3 E Recording Station MAT Epicentral
 distance 4093.7 kilometers.

Figure 15.



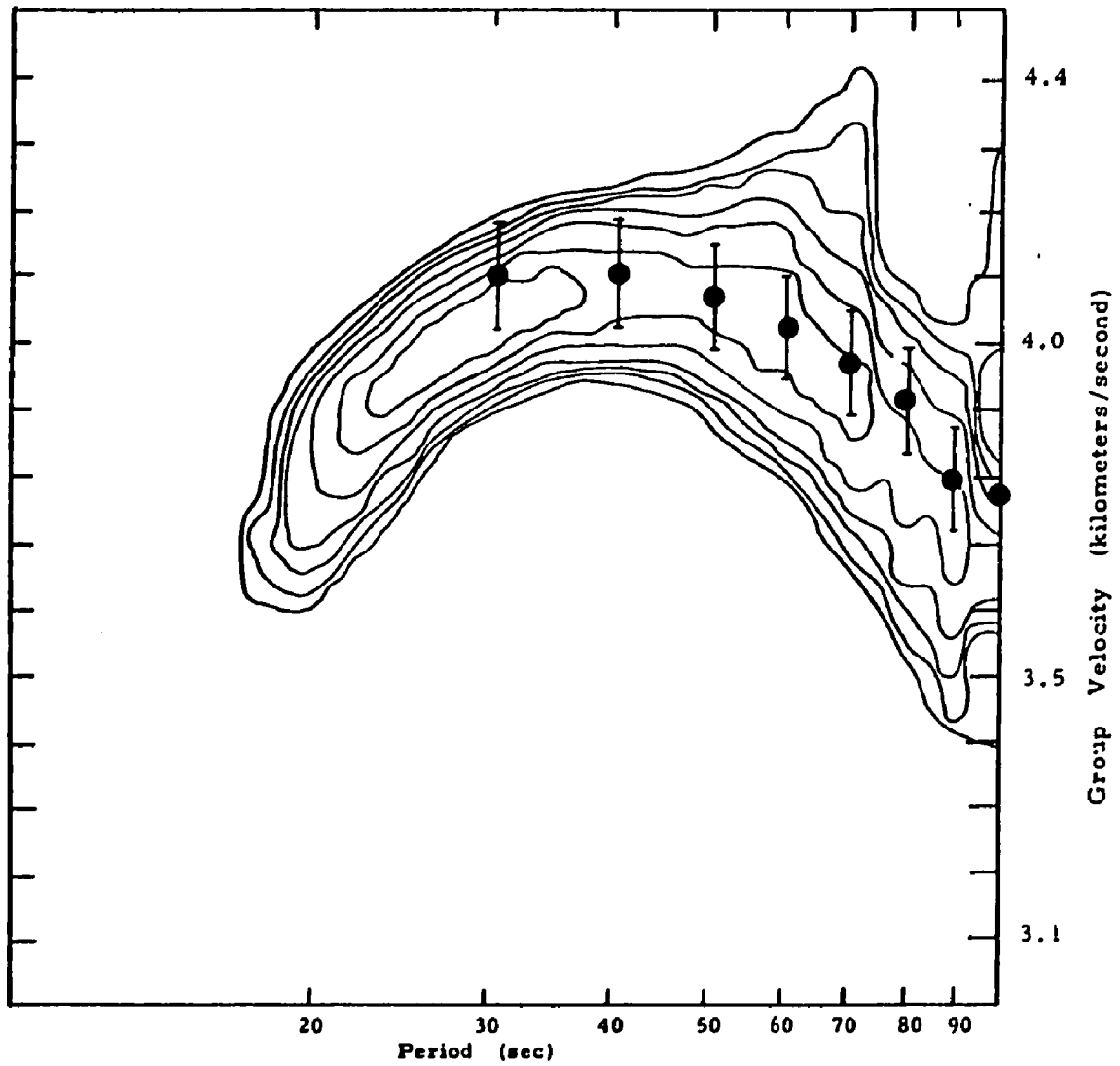
Philippine Plate Pacific Ocean Earthquake October 31, 1968 09:06:36.4
 1.2 N 126.3 E Recording Station GUA Epicentral distance 2454.6
 kilometers.

Figure 16.



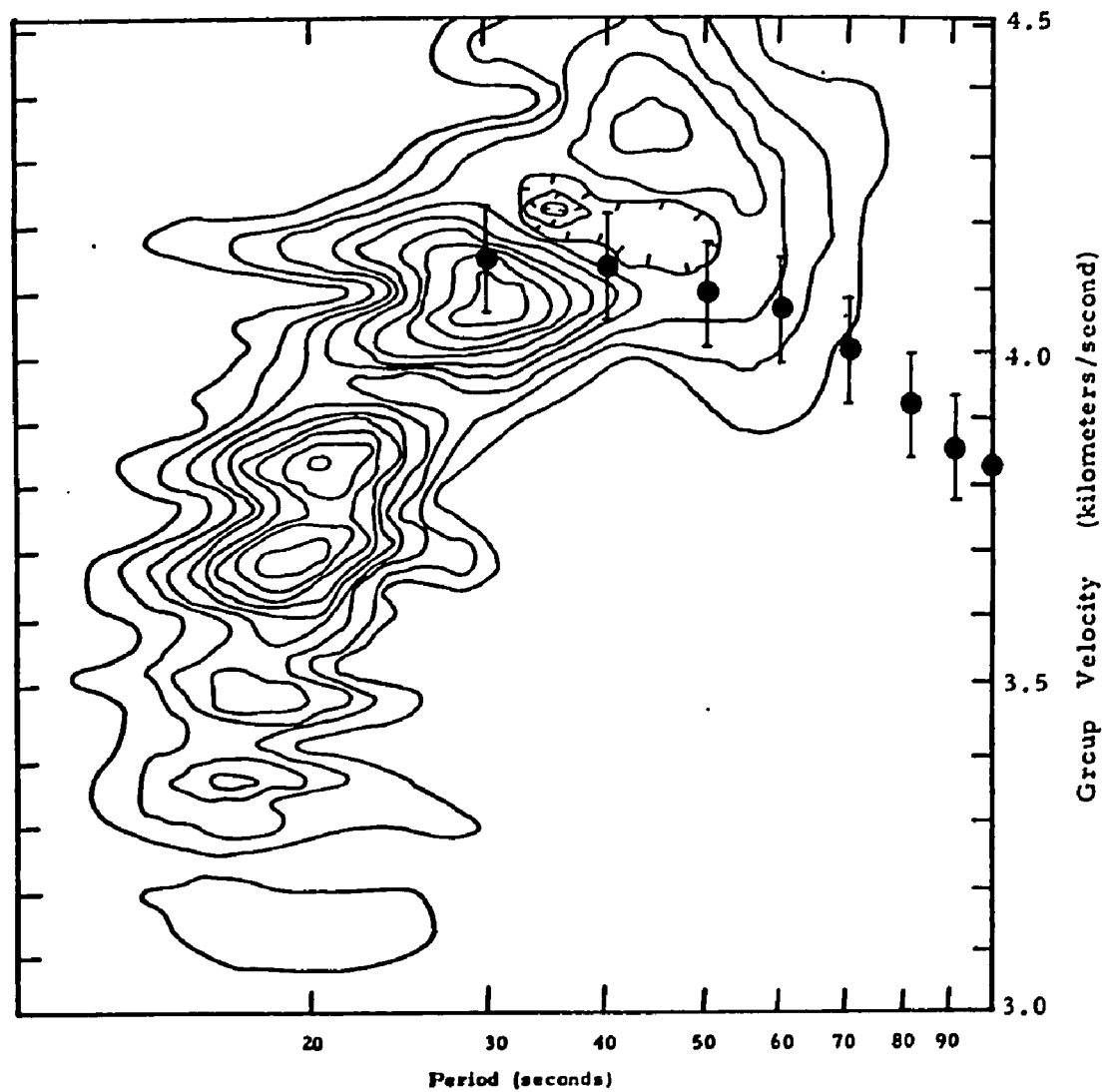
Philippine Plate Pacific Ocean Earthquake November 25, 1968,
5.05 N 126.77 E Recording Station GUA Epicentral distance
2197.9 kilometers.

Figure 17.



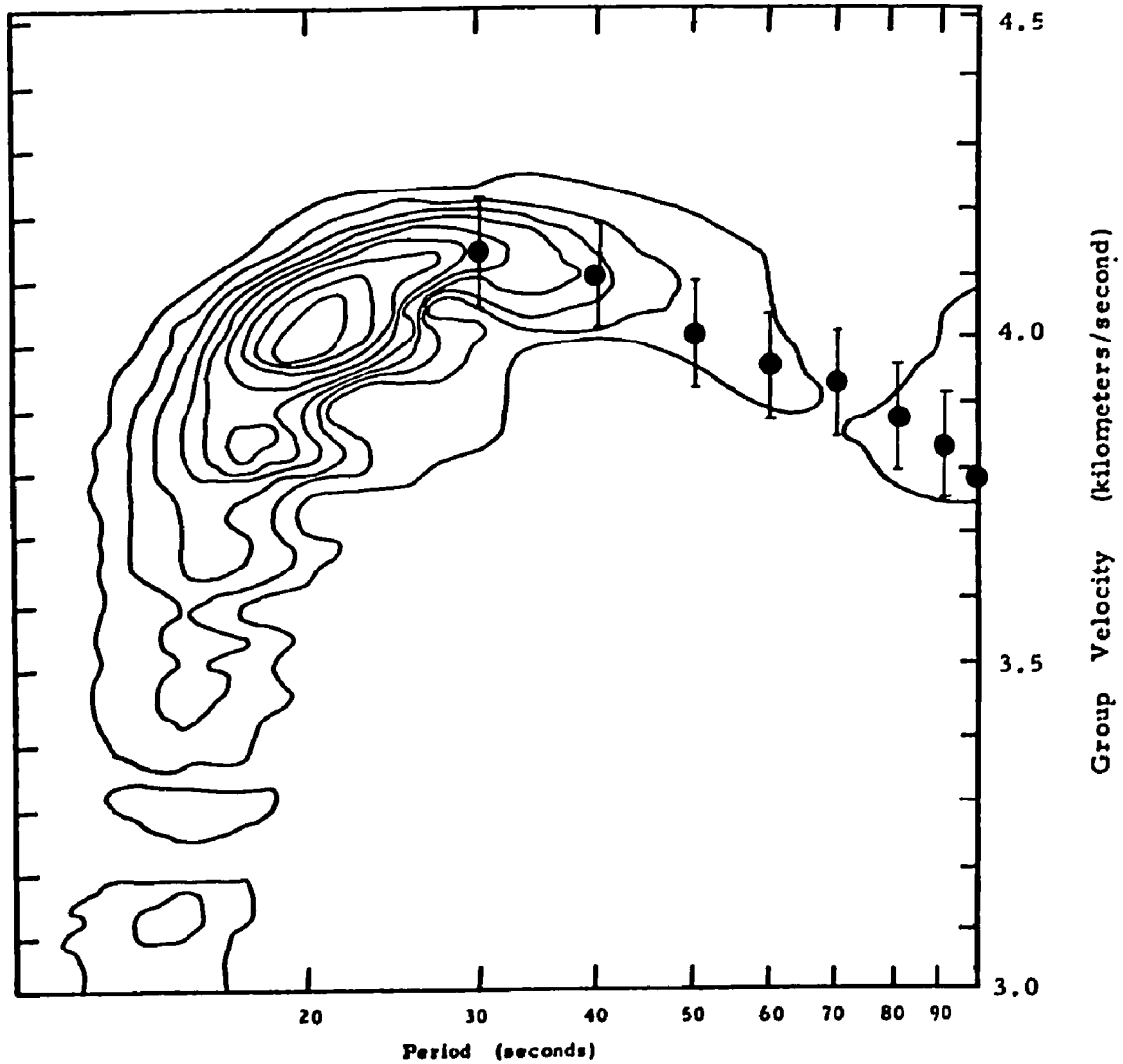
Pacific Ocean Earthquake Oct. 6, 1968, 08:47:02.0, 14.73 S, 175.61 E
Recording Station KIP. Epicentral distance 4429.4 kilometers.

Figure 18.



Pacific Ocean Earthquake October 23, 1974 06:14:52.1 8.40 S
 154.03 E Recording Station LON Epicentral distance 10230.8 kilo-
 meters.

Figure 19.



Pacific Ocean Earthquake November 9, 1974 12:59:49.8, 12.5 S
77.8 W Recording Station KIP Epicentral distance 9514 kilo-
meters.

Figure 20.

Dispersion curves for paths crossing the Philippine plate are illustrated in figures 15, 16, and 17. Two of the paths cross the width of the plate, the third crosses the length (see figure 8.). Although a predicted dispersion for these paths is derived, all three moving window analyses of the observed data are severely distorted. Energy contours at periods less than 40 seconds indicate the presence of spectral 'holes' and the resolving kernel at periods greater than 40 seconds is extremely broad, indicating severe attenuation of longer period waves. Studies by deBremaecker (1958), Hudson and Knopoff (1964), Pilant, Knopoff, and Schwab (1964), and Mal and Knopoff (1966) have shown that transmission and reflection of Rayleigh waves at corners can cause severe distortion of observed arrivals. The junction of the Bonin and Ryuku island arcs south of Honshu, Japan is an example of an abrupt velocity contrast constituting a corner. The interior angle formed by these two arc systems is approximately 50° to 60° , with station MAT located near the apex, exterior to the corner. De Bremaecker(1958) has shown that transmission of Rayleigh waves through a corner with interior angle of 55° to 60° is nearly at a minimum. Forty % of the incident energy is reflected, 55% converted to body waves, and only 5% of the incident energy is transmitted through the corner. It seem reasonable, therefore, that the combination of only 5% transmission and 55% reflection into interfering waves would sum to yield the spectral holes and

resolution difficulties of the October 31, 1968 earthquake, illustrated in figure 15. The earthquakes recorded at station GUA (figures 16, 17) display equivalent resolution problems. The interior angle of the Mariana arc inflection is approximately 120° . This is a second transmission-reflection critical point for Rayleigh waves (deBremaecker, 1958). Eighty % of incident Rayleigh energy is converted to body phases, 15% is transmitted, and 5% is reflected. In addition, McGarr and Alsop (1967) have shown that Rayleigh waves reflected from a vertical boundary, such as the Mariana island arc subduction zone, can interfere with the incident waves causing severe attenuation of the recorded signals. The lack of resolution on the Philippine plate, therefore, appears to be attributable to interference effects.

Indian Ocean Basin

Four paths across the Indian Ocean (figure 21.) have associated dispersion analyses illustrated in figures 22 through 25. Only the Rayleigh group velocity dispersion recorded at MUN from the May 4, 1970. earthquake (figure 23) has small residuals with respect to the model prediction. All other analyses consistently predict group velocities approximately 0.10 km/sec less than those actually observed. Although a consistent regional mislocation error cannot entirely be ruled out as the cause of this anomaly, the recording of the May 4, 1970 earthquake at CHG (figure 22) and MUN (figure 23) suggests that the error is

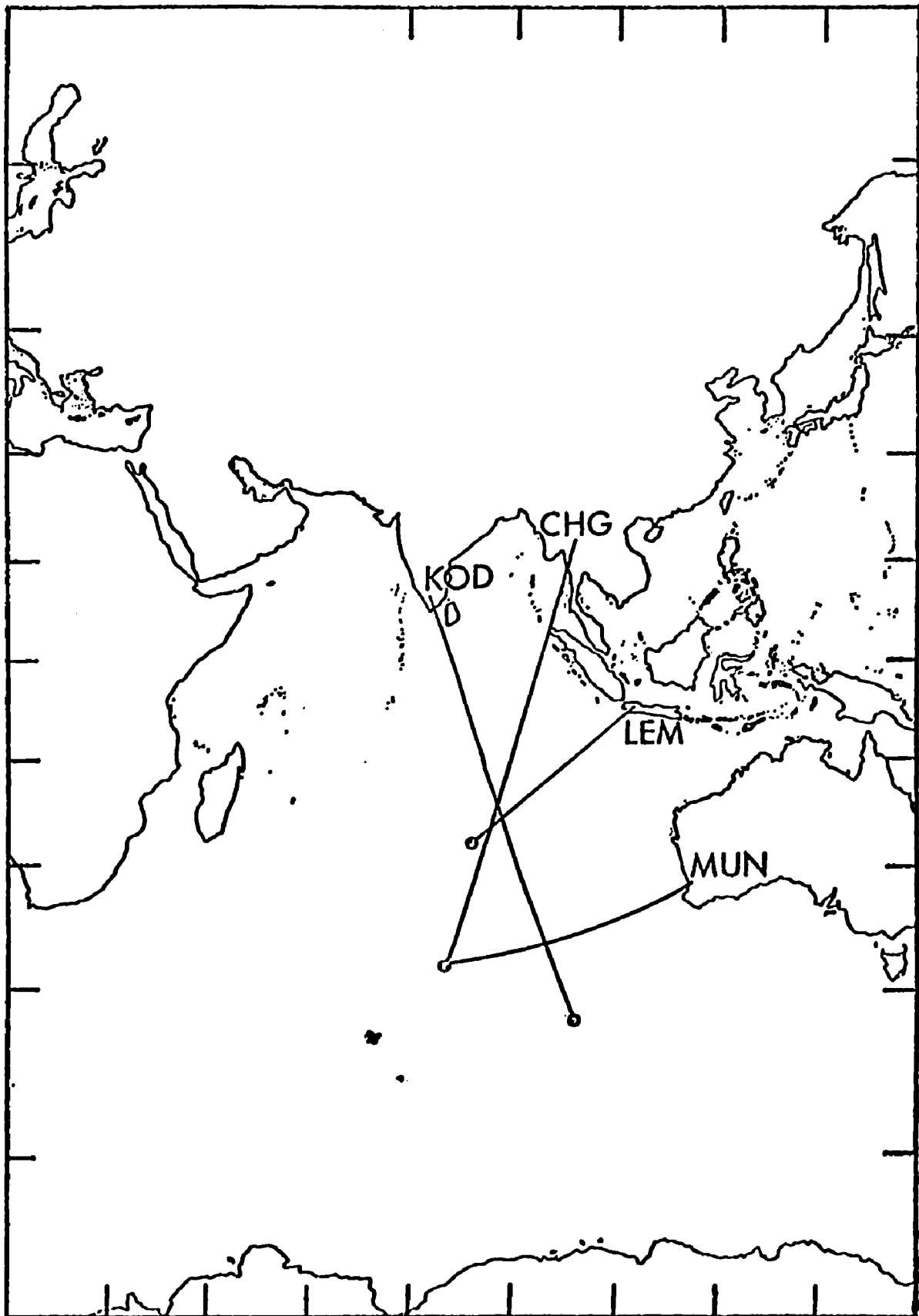
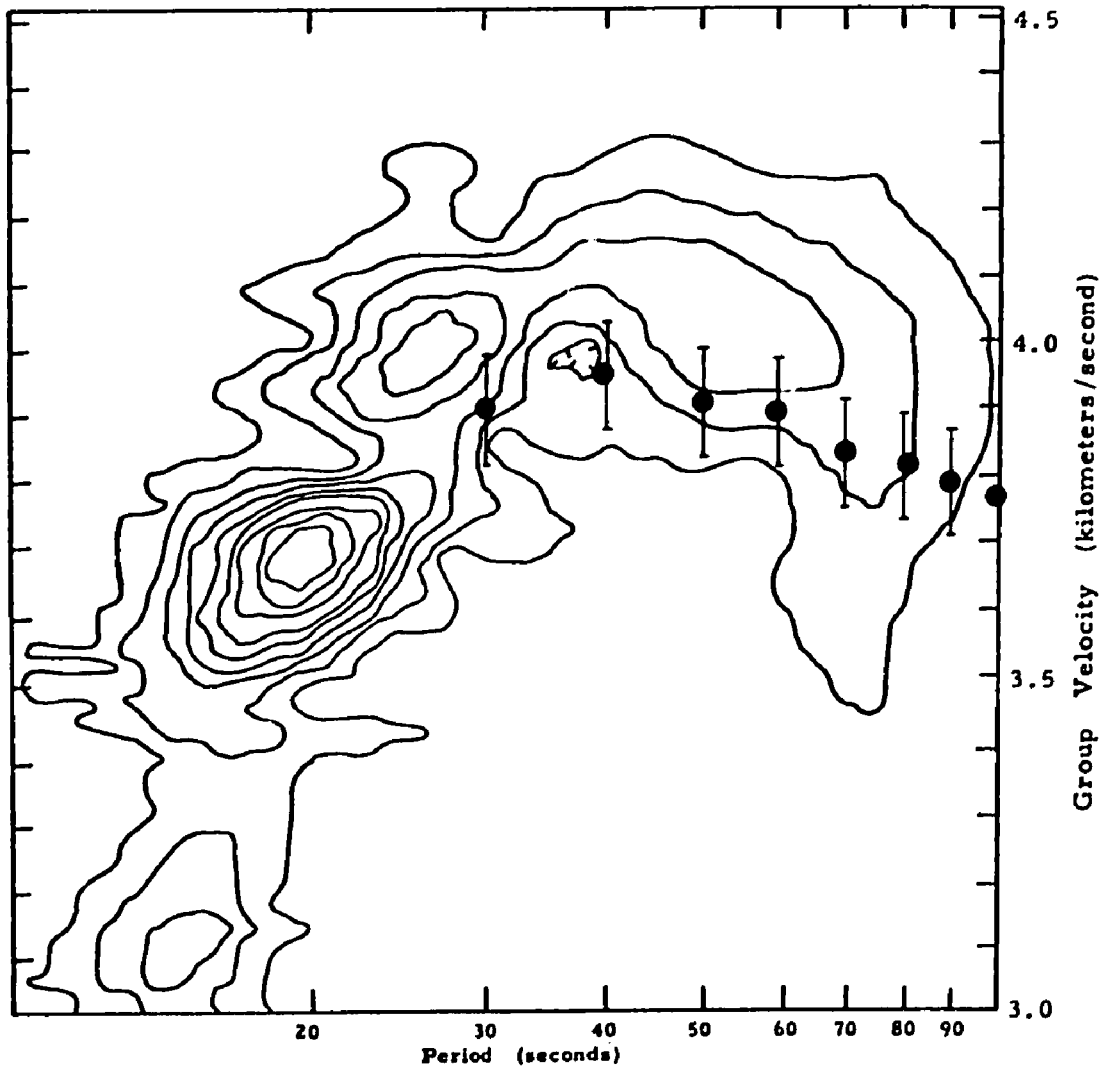
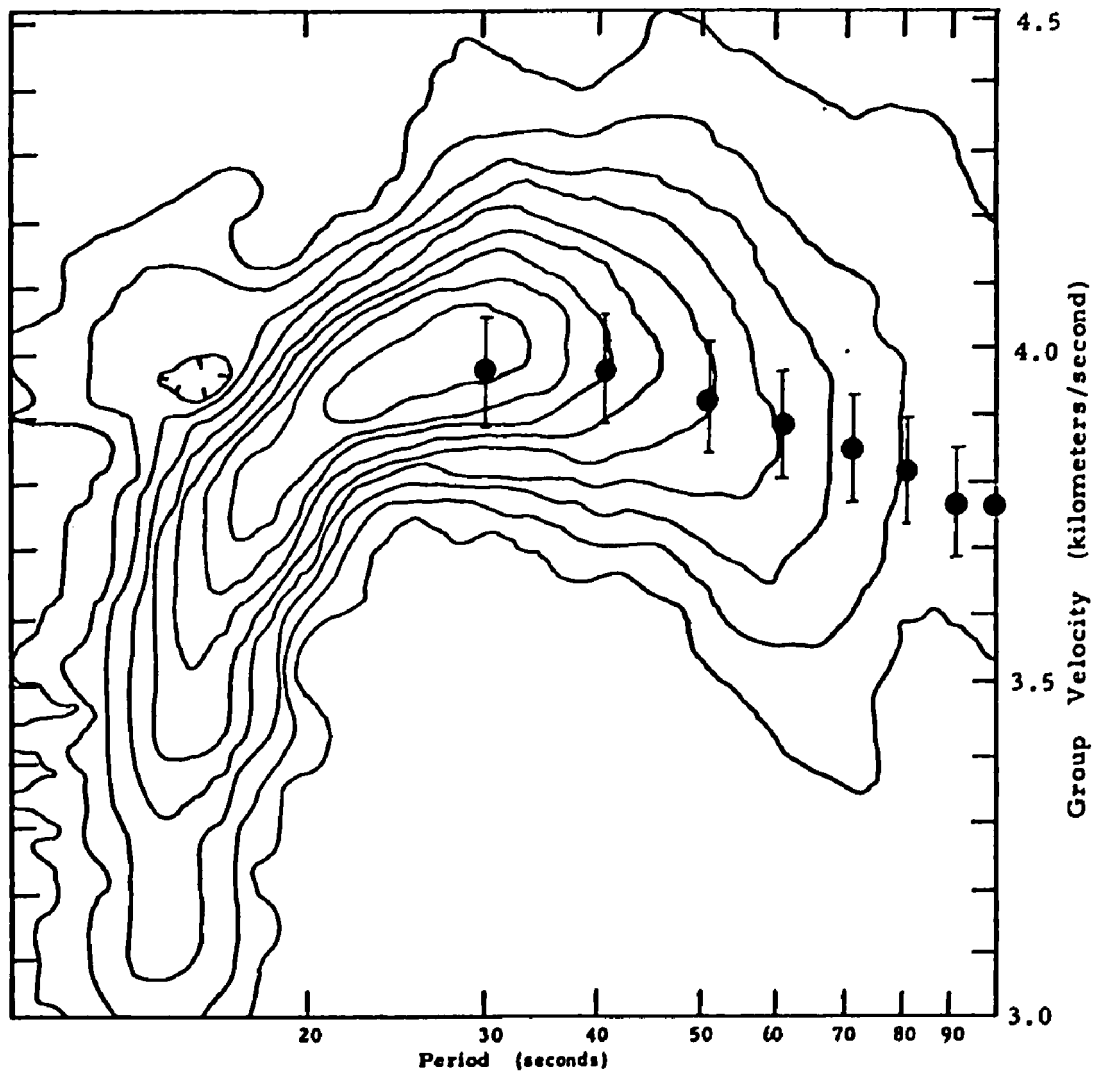


Figure 21.



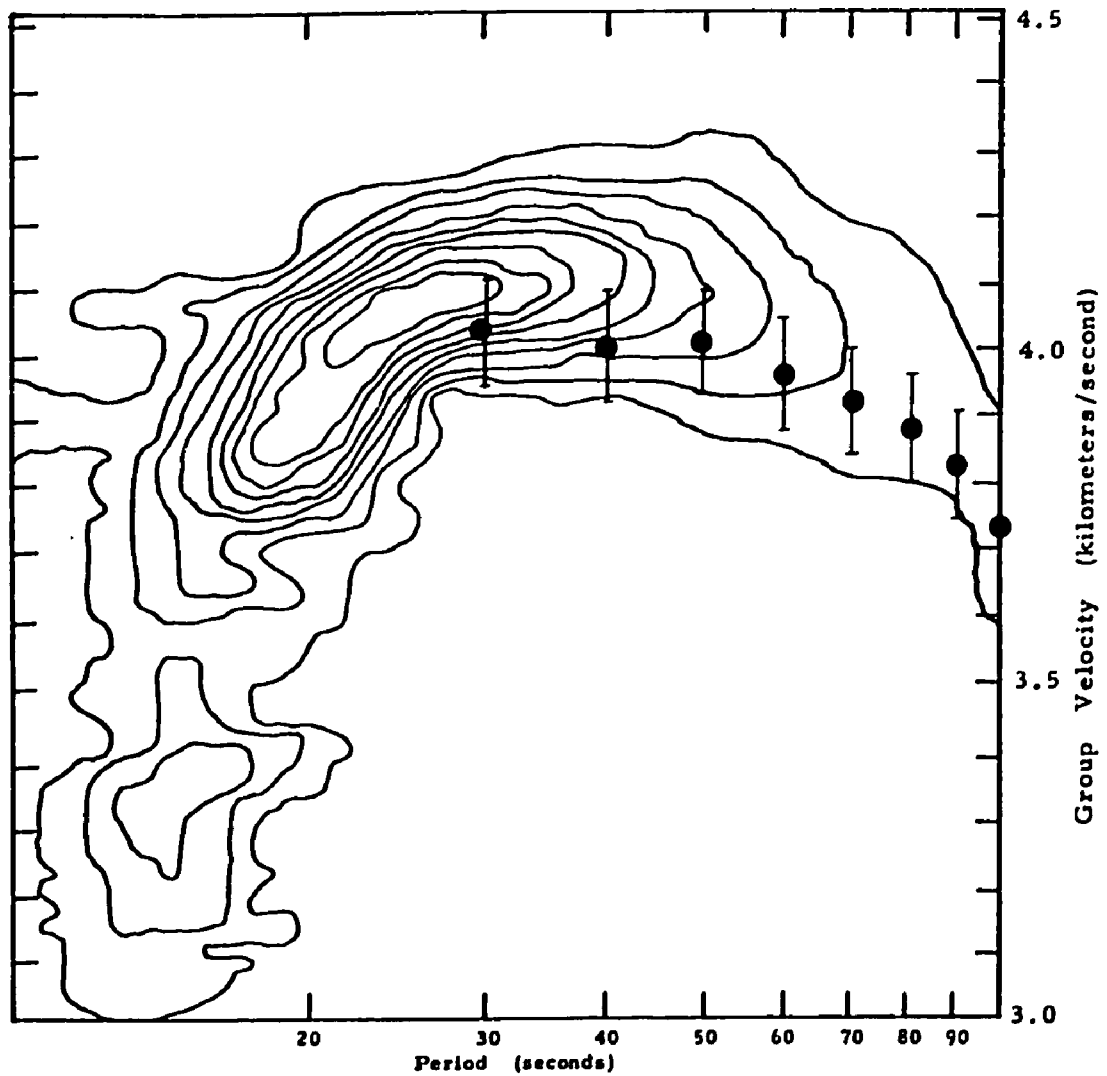
Indian Ocean Earthquake May 4, 1970 18:53:21.0, 41.65 S 79.87 E
Recording Station CHG Epicentral distance 6954.0 kilometers.

Figure 22.



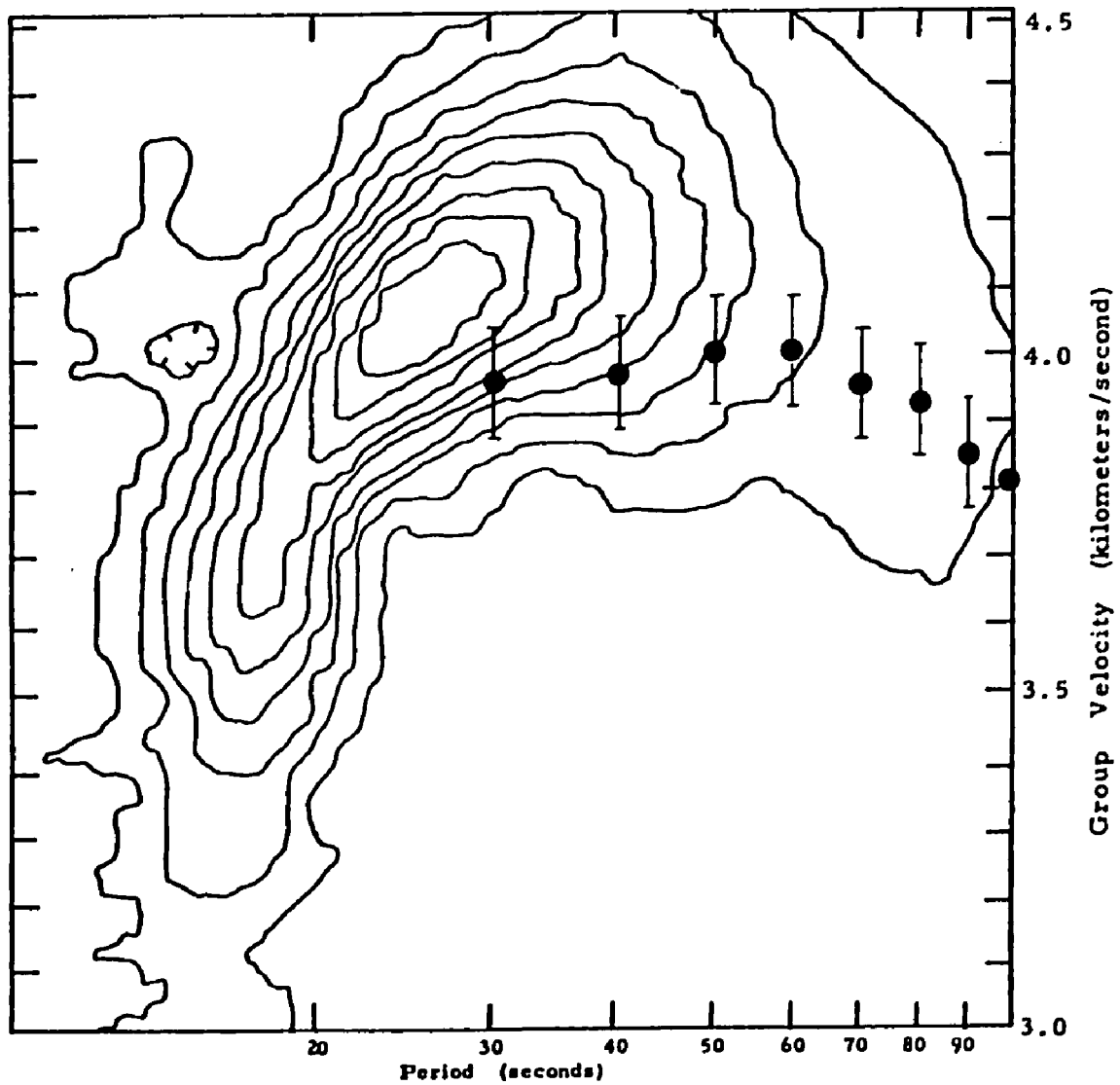
Indian Ocean Earthquake May 4, 1970 18:53:21.0, 41.65 S, 79.87 E
Recording Station MUN Epicentral distance 3384.0 kilometers.

Figure 23.



Indian Ocean Earthquake June 1, 1973 07:22:57.5, 47.92 S 99.69 E
Recording Station KOD Epicentral distance 6796.1 kilometers.

Figure 24.



Indian Ocean Earthquake June 25, 1974 17:22:19.3, 26.1 S 84.3 E
Recording Station LEM Epicentral distance 3261.0 kilometers.

Figure 25.

path related and not mislocation. Since the paths to CHG (figure 22), KOD (figure 24) and LEM (figure 25) sample relatively the same aged material (Johnson, Powell, and Veevers, 1976), it is possible that the relatively consistent positive velocity offset of the observed data from the predicted velocities is a result of incorrect age assignment. This is a relatively old section of crust, however, and the misassignment of age would have to be extreme to account for the magnitude of the error. Similarly, the magnitude of this error is too large to be the result of an incorrect depth correction. Further discussion of this systematic Indian Ocean anomaly is deferred to the next section.

Atlantic Ocean Basins

The three North Atlantic and three South Atlantic events (table 9) are illustrated in figure 26. The results of these analyses are given in figures 27 through 29 for the North Atlantic, and figures 30 through 32 for the South Atlantic.

The recording of the June 19, 1970 earthquake at TRN (figure 27) appears to be plagued with interference effects. Analyses of other mid-Atlantic ridge earthquakes recorded at TRN (Weidner, 1972) also consistently display this resolution deficiency. Trinidad, like MAT and GUA is located at the apex of a velocity structure corner which is formed by the junction of the Antilles arc with South America. The interior angle of this junction is approximately 120° , one of the

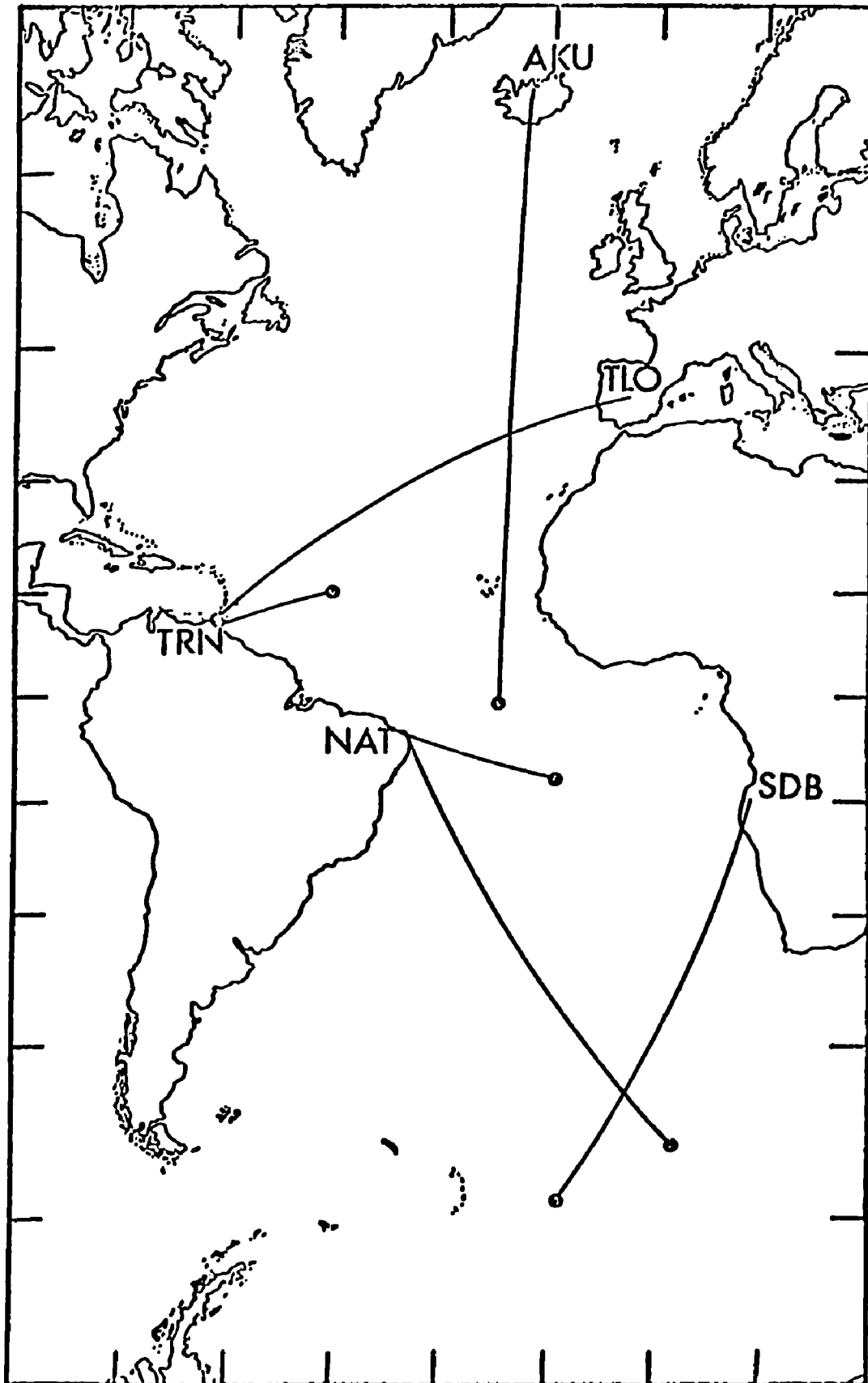
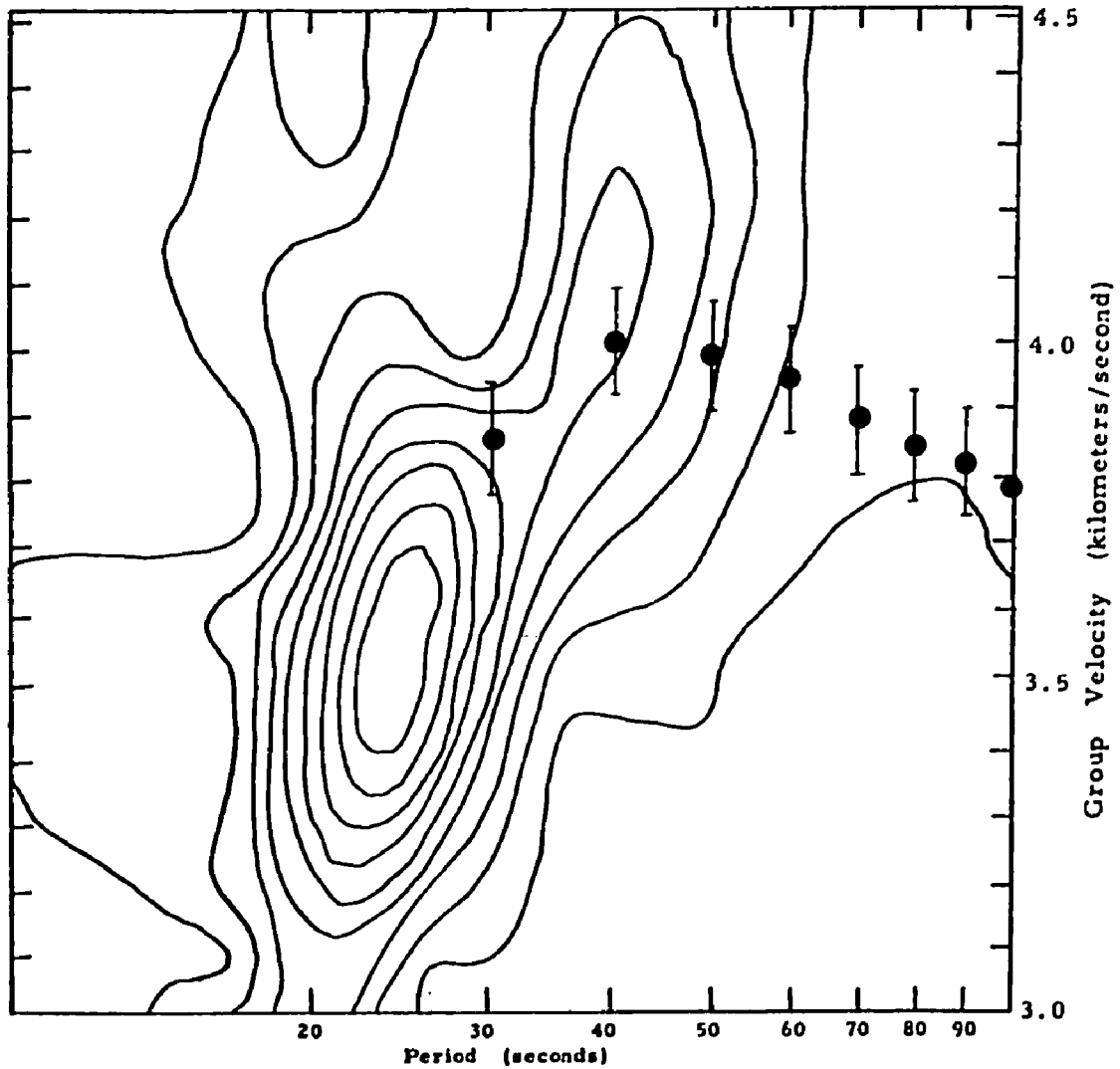
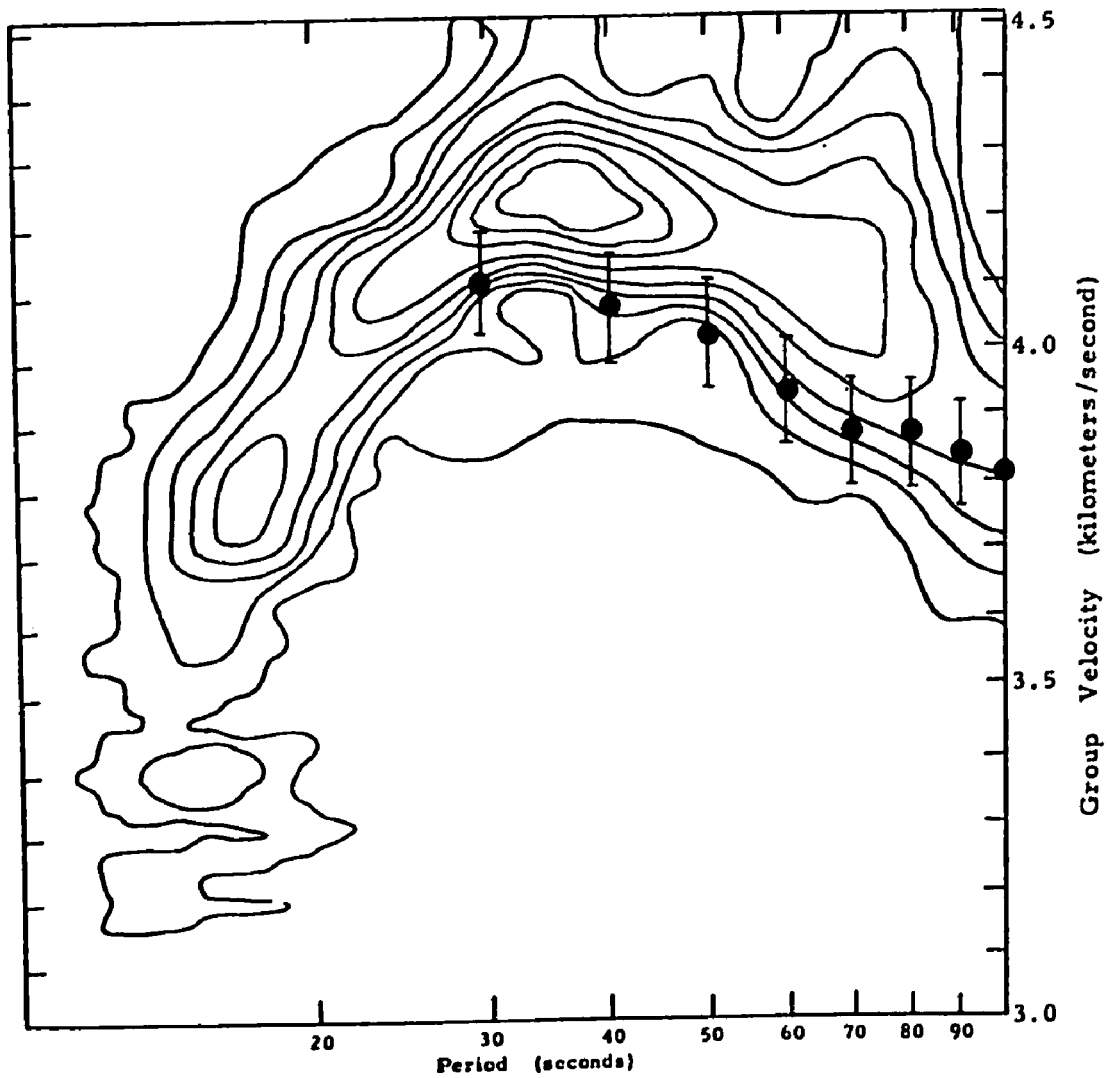


Figure 26.



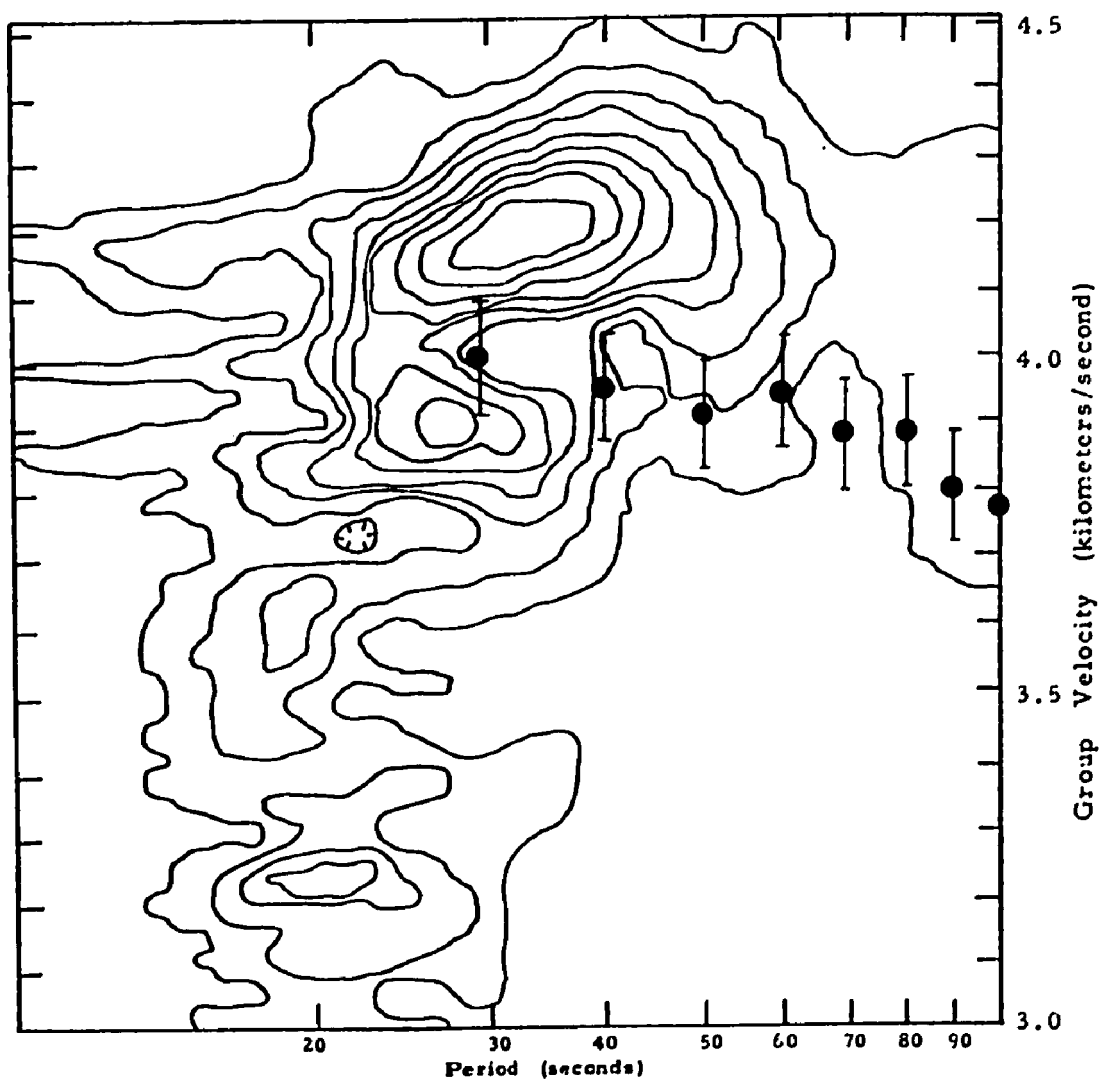
North Atlantic Ocean Earthquake June 19, 1970 14:25:22.0, 15.34 N
45.92 W Recording Station TRN Epicentral distance 1755.7 kilo-
meters.

Figure 27.



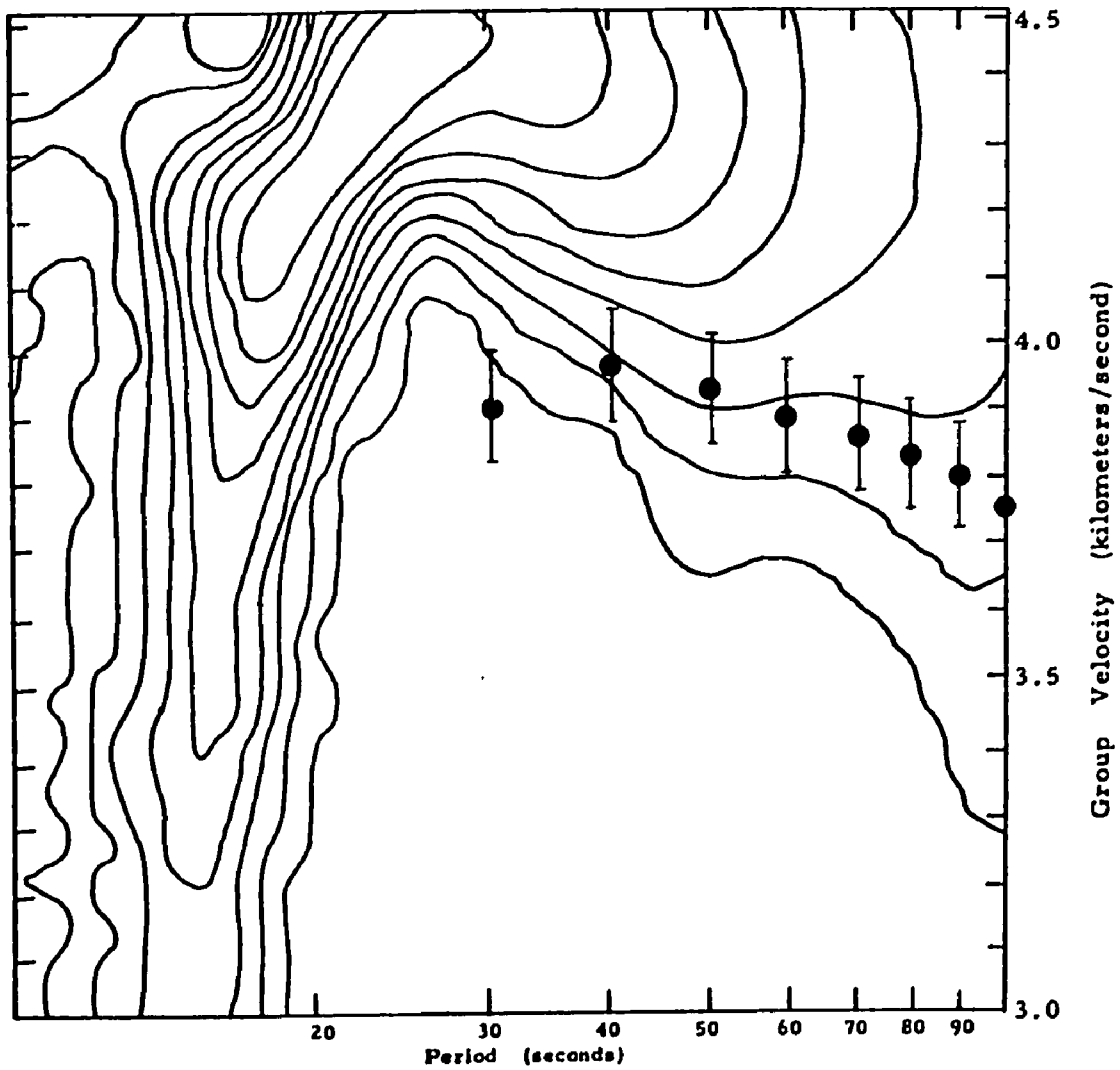
North Atlantic Ocean Earthquake August 5, 1971 01:58:53.2, 00.85 S
22.07 W Recording Station AKU Epicentral distance 7383.9 kilo-
meters.

Figure 28.



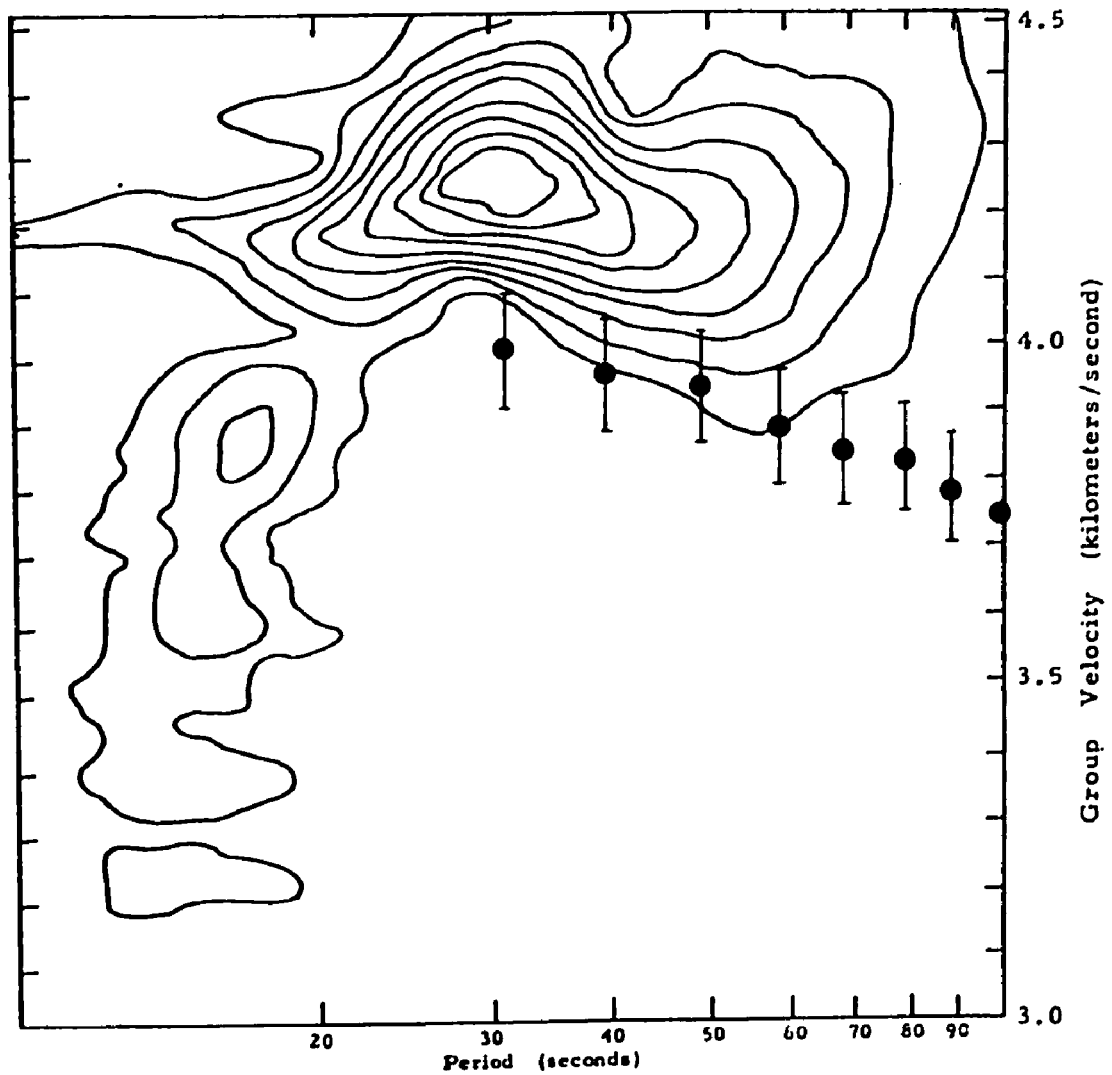
North Atlantic Ocean Earthquake June 12, 1974 16:25:47.6, 10.56 N
63.38 W Recording Station TLO Epicentral distance 6653.0 kilo-
meters.

Figure 29.



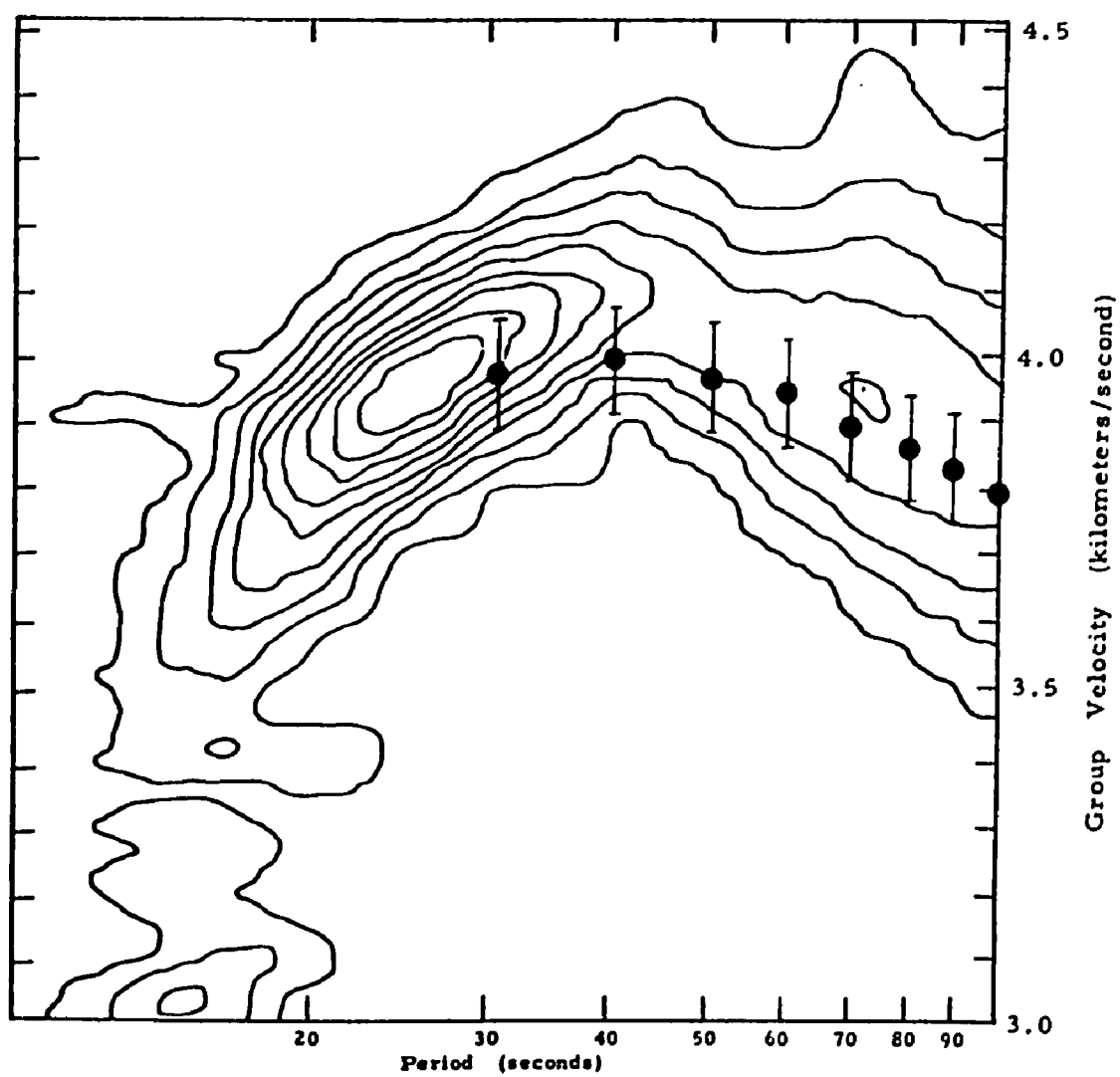
South Atlantic Ocean Earthquake November 29, 1970 06:01:18.6,
11.67 S 14.00 W Recording Station NAT Epicentral distance
2421.3 kilometers.

Figure 30.



South Atlantic Ocean Earthquake October 14, 1971 22:36:34.8, 54.4 S
2.5 E Recording Station NAT Epicentral distance 6416.1 kilo-
meters.

Figure 31.



South Atlantic Ocean Earthquake April 7, 1973 12:22:49.3, 58.5 S
13.6 W Recording Station SDB Epicentral distance 5307.0 kilometers.

Figure 32.

critical corner angles for Rayleigh waves.

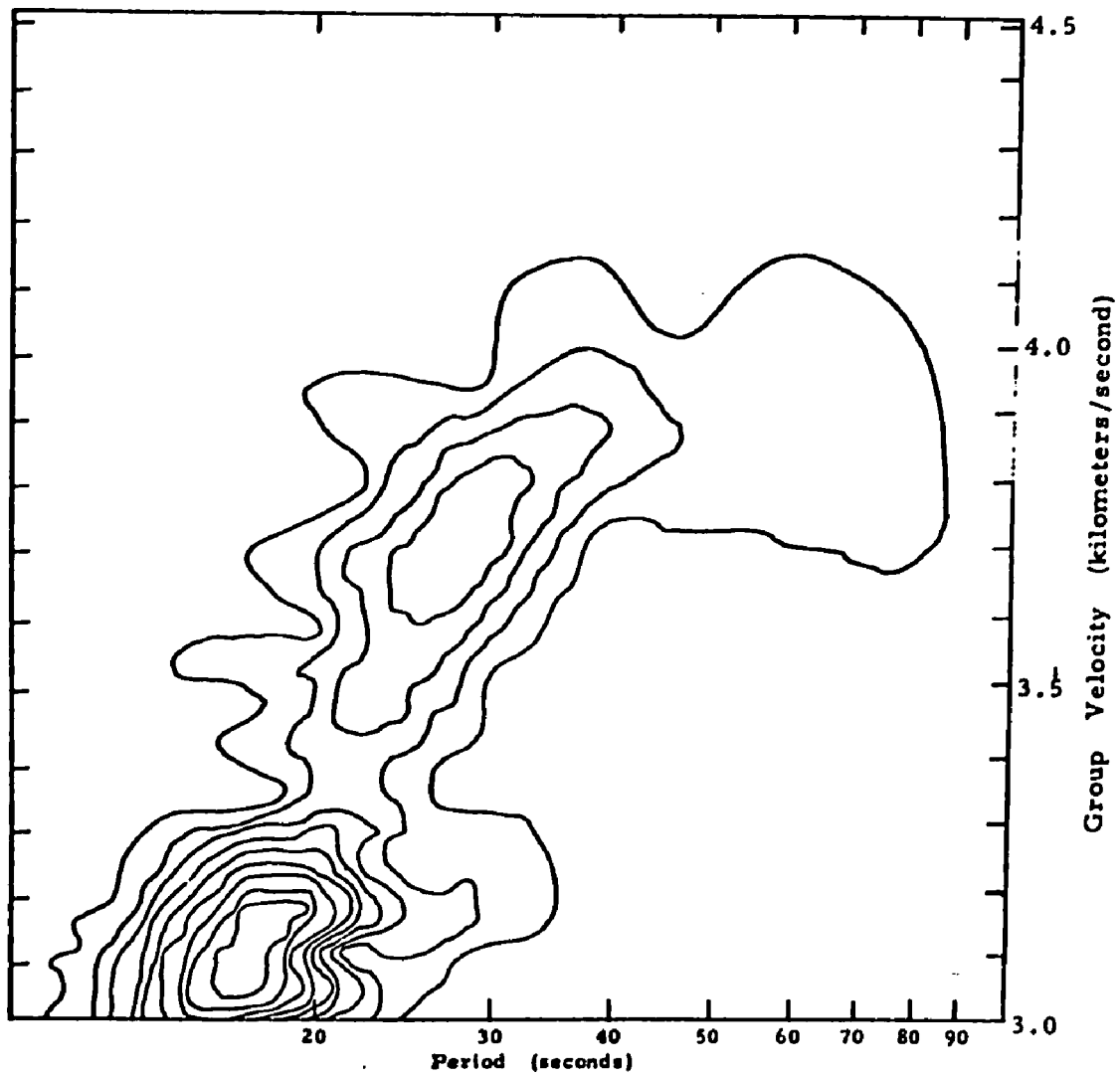
The other two analyses (figures 28, 29) are free of these interference effects. The path for the August 5, 1971 earthquake (figure 28) is subparallel to the mid-Atlantic ridge axis, whereas the path for the June 12, 1974 earthquake (figure 29) is subnormal to the axis. These events, like those previously discussed for the Indian Ocean, display consistently underestimated-predicted velocities. Since this occurs on paths both parallel and normal to the isochronological divisions, it is unlikely that lateral refraction effects can account for this discrepancy. Similarly, since the error is relatively equivalent parallel and normal to the isochrons, it is unlikely that this is an anisotropy effect. It is also unlikely that the earthquakes have been mislocated because of the excellent station coverage. The dispersion anomaly with respect to the predictive model is of the order of 0.10 to 0.20 km/sec. The possible cause of this North Atlantic anomaly is also discussed in the next section.

The South Atlantic test paths (figure 26) have analyses illustrated in figures 30, 31, and 32. The cause of the extremely large error of figures 30 and 31 is not known. Exhaustive re-evaluation of the parameters used in these analyses yielded no apparent flaws. Both of the seismograms were recorded at station NAT, and sampled the Brazil Basin. The dispersion

analysis illustrated in figure 30 is from a path confined almost entirely to the basin while the analysis illustrated in figure 31 is from a path only approximately 50% within the basin. Timing errors due to source and/or receiver can be discounted for both events because the P-wave travel times have only very small residuals. Since neither of these analyses have any apparent errors and because the path confined to the Brazil Basin exhibits larger anomalies than does the path only partly within it, the Brazil Basin is suspected as the source of these large velocity discrepancies. In addition, this is the largest anomaly discovered while testing the Rayleigh predictor model.

The final South Atlantic test (figure 32.) confirms the aberrancy of the previous NAT analyses. There is a small positive deviation of the observed dispersion curve from the predicted velocities by approximately 0.05 km/sec. Although this deviation can be related to epicentral mislocation, since inadequate station control exists for the South Atlantic, it is believed that this error, like the errors in the North Atlantic and Indian Oceans is a real systematic departure from the prediction model. The possible significance of this deviation is discussed in the next section.

One dispersion analysis is presented for the Arctic Ocean (figure 33). The significant lack of long period energies, however,



Arctic Ocean Earthquake January 28, 1967 17:42:01.5, 52.40 N
169.41 W Recording Station NOR Epicentral distance 5044.9 kilo-
meters.

Figure 33.

suggest that this path is not free of significant interference effects, so further analysis was not performed.

In summary, the tectonic-based Rayleigh group velocity prediction model has been tested for the major ocean basins. Although the model does not correct for possible anisotropy effects, it accurately predicts path dispersive character for group velocities having periods between 30 and 100 seconds for the Pacific basins. Systematic positive velocity anomalies of observed data with respect to predicted dispersion curves occur for paths in the Indian, North Atlantic, and South Atlantic Oceans. These anomalies are not apparently the result of sea floor age assignment, incorrect ocean depth correction, anisotropy, or departure from least-distance paths. The positive velocity anomaly is approximately 0.05 to 0.10 km/sec for the Indian and South Atlantic Oceans and 0.10 to 0.20 km/sec for the North Atlantic. Insufficient data has been collected to determine if the magnitude of the deviation is itself a time-dependent or time-invariant function.

Discussion

Tests of the predictive Rayleigh group velocity model clearly demonstrate that the first order variations in observed oceanic dispersion are related to sea floor age. There is a 10% increase in group velocity of Rayleigh waves with a period of 40 seconds over the span of 140 million years. Approximately 6% of this 10% increase occurs within the first 30 million years. In comparison, there is a 7% increase in group velocity of Rayleigh waves with a period of 90 seconds over the span of 140 million years, with only 3% of the 7% increase occurring within the first 30 million years. In contrast, the maximum Rayleigh group velocity variance introduced by changes in thickness of the ocean layer is approximately 2% at a period of 40 seconds, being relatively less important at longer periods. The world's oceans achieve their maximum mean depth within 80 million years, half of this within the first 30 million years (figure 35). Thus, the ocean depth corrections are nearly constant for Rayleigh periods greater than 30 seconds in the ocean basins. The Rayleigh group velocity variance introduced by anisotropy is also approximately 2 % with velocity maxima normal to spreading centers (Forsyth, 1975). If anisotropy is restricted to the low velocity zone (Schlue and Knopoff, 1977) then the importance of the anisotropy correction decreases with increasing period. Thus, although variable ocean depth and anisotropy contribute to the observed group velocities, their role

is relatively minor compared with the temporal evolution of the sea floor. The systematic discrepancies between the observed dispersion and the model in the North Atlantic, South Atlantic, and Indian Oceans do suggest, however, that a simple age versus velocity relationship may not be sufficient to predict Rayleigh dispersion for all ocean basins.

An insufficient number of paths through the Atlantic basins have been analyzed to ascertain the origin of the anomalous dispersive behavior. The observed deviations from the model are assumed to be real and not the result of uncorrected systematic errors since other workers (Weidner, 1975, 1972; Bravo and Udias, 1974; Taylor, 1972; Santo, 1966, 1962) have noted similar faster velocities through the Atlantic than through the Pacific.

Variations in velocity structure, integrated by Rayleigh waves, also are observable in travel times of body waves. Pn and Sn guided waves, for example, are characteristic indicators of lowermost crust/uppermost mantle velocities. Pn velocities have been reported to vary from 7.4 km/sec along ridge axes to 8.3 to 8.4 km/sec in older oceanic regions (Nuttli, 1963). Similar variations in Sn velocities have also been observed. Hart and Press (1973) determined Sn velocity distributions for the Atlantic Ocean to be 4.58 ± 0.02 km/sec for regions younger than fifty million years, and 4.71 ± 0.01 km/sec for regions older than fifty million years. In contrast, Schlue and Knopoff (1977) have

reported a maximum shear velocity of 4.65 km/sec for the older regions of the Pacific. This suggests that the North Atlantic may be characterized by Rayleigh velocities on the order of 0.05 km/sec faster than those of the Pacific. This study, however, indicates the North Atlantic is at least a factor of three greater than this, and, if the results of the Brazil Basin are correct, that basin is a factor of eight greater than 0.05 km/sec. Unfortunately, poor global representation of Pn and Sn velocities precludes a more definitive assessment of their correlation with the Rayleigh velocity model.

On the other hand, several geophysical fields are represented adequately on a global scale to permit a more comprehensive comparison with the Rayleigh model. These fields include: surface heat flow (Chapman and Pollack, 1975, b), mantle heat flow (Pollack and Chapman, 1977, a), topography (Balmino, Lambeck, and Kaula, 1973), and gravity (Gaposchkin, 1974). Although a visual comparison of these contoured geophysical data is often qualitatively elucidating, comparison of coefficients from spherical harmonic analysis of these complex fields is more quantitatively revealing.

Each of the 5° x 5° geophysical data sets can be represented by spherical harmonic expansions of the form:

$$F(\theta, \phi) = \sum_{n=1}^N \sum_{m=1}^n \left[A_{nm} \cos(m\phi) + B_{nm} \sin(m\phi) \right] P_{nm}(\cos \theta)$$

where F is the particular field, θ is the colatitude, ϕ is the longitude, A_{nm} and B_{nm} are the coefficients of the expansion, and P_{nm} is the fully-normalized associated Legendre functions such that:

$$\int_0^{2\pi} \int_0^{\pi} \left[P_{nm}(\cos \theta) \frac{\sin(m\phi)}{\cos} \right]^2 \sin \theta \, d\theta \, d\phi = 4\pi$$

The spherical harmonic coefficients A_{nm} and B_{nm} in table 11 are calculated by numerical integration of:

$$\begin{aligned} A_{nm} &= \frac{1}{4\pi} \int_0^{2\pi} \int_0^{\pi} F(\theta, \phi) \begin{pmatrix} \cos(m\phi) \\ \sin(m\phi) \end{pmatrix} P_{nm}(\cos \theta) \\ B_{nm} & \end{aligned}$$

to degree (n) and order (m) 12. Surface and mantle heat flow coefficients are in terms of mWm^{-2} , topography in meters, gravity in milligals, and Rayleigh velocities in km sec^{-1} .

For purposes of comparison, coefficients in table 11 are reduced by mean-detrending and scaled to the largest coefficient from order 4,0 through 12,12. The RMS values of these reduced coefficients for each order and number is given by:

$$\left[\left(\frac{A_{nm} - \bar{A}}{A_{\max}} \right)^2 + \left(\frac{B_{nm} - \bar{B}}{B_{\max}} \right)^2 \right]^{\frac{1}{2}}$$

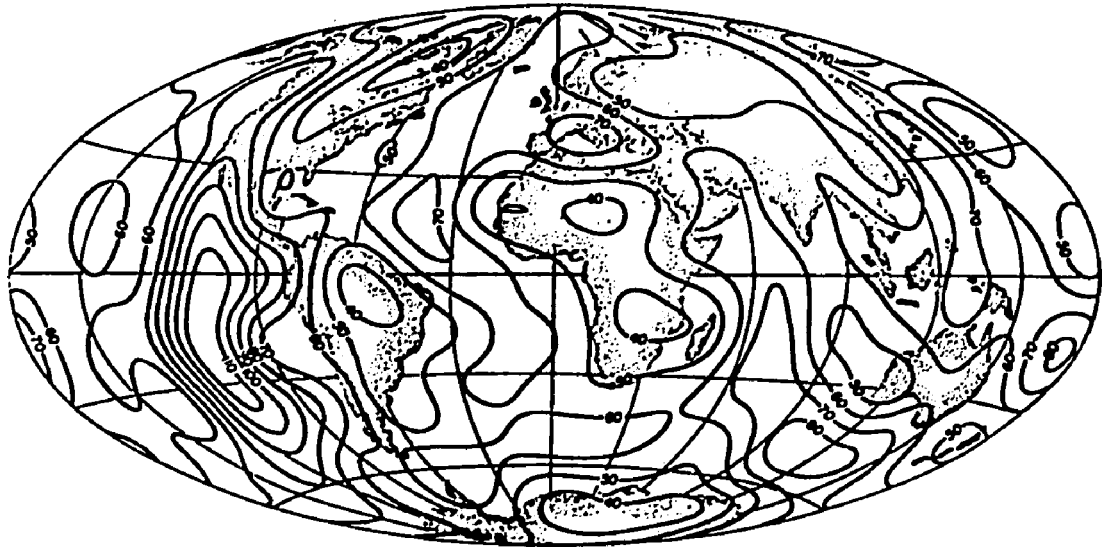
The reduced coefficients from order and number 4,0 through 12,12 are then directly comparable (figures 36,37,38,41,42,43) in identically scaled formats.

FULLY NORMALIZED SPHERICAL HARMONIC COEFFICIENTS

n	m	Heat flow-surface		Heat flow-mantle		Topography		Gravity		50 Sec Rayleigh		90 Sec Rayleigh	
		A _{nm}	B _{nm}	A _{nm}	B _{nm}	A _{nm}	B _{nm}	A _{nm}	B _{nm}	A _{nm}	B _{nm}	A _{nm}	B _{nm}
0	0	5.910E+1		4.039E+1		-2.299E+3		9.780E+2		3.912E+0		3.818E+0	
1	0	-1.754E+0		-5.064E+0		6.380E+2		5.102E+1		-1.852E-2		1.799E-2	
1	1	-3.006E+0	-1.407E+0	-4.614E+0	-3.108E+0	5.410E+2	4.075E+2			-2.071E-2	7.800E-4	2.199E-2	1.116E-2
2	0	-5.813E-1		-2.175E+0		5.184E+2		-8.842E-4		-1.887E-2		1.738E-2	
2	1	9.170E-1	7.282E-1	-1.482E-1	-6.749E-1	3.361E+2	3.049E+2			-1.427E-2	-2.409E-2	6.261E-3	-6.344E-3
2	2	-3.017E+0	1.380E+0	-1.660E+0	1.747E+0	-4.151E+2	-8.020E+1	2.379E+0	-1.365E-6	4.216E-2	1.398E-3	1.755E-2	-4.015E-3
3	0	1.322E+0		1.729E+0		-1.759E+2		9.604E-7		-2.751E-3		-5.96E-3	
3	1	-6.040E-1	-8.481E-1	1.187E-1	-1.028E+0	-1.350E+2	1.145E+2	1.997E-6	2.233E-7	1.497E-3	-7.261E-3	1.687E-3	-3.985E-3
3	2	9.020E-1	-6.412E-1	2.324E+0	-2.910E+0	-4.460E+2	4.579E+2	7.781E-7	-7.551E-7	8.843E-3	-1.950E-2	-8.530E-3	1.160E-2
3	3	1.991E+0	1.713E+0	1.119E+0	-2.188E-1	1.160E+2	5.455E+2	4.901E-7	1.528E-6	-2.717E-2	-2.519E-2	-1.359E-2	7.571E-3
4	0	-2.092E+0		-2.759E+0		3.748E+2		9.604E-7		-3.455E-3		2.361E-2	
4	1	1.864E-1	3.155E-1	1.191E+0	7.510E-1	-2.229E+2	-2.507E+2	-5.174E-7	-4.814E-7	6.448E-3	5.411E-4	1.501E-3	-5.095E-3
4	2	1.145E+0	7.600E-1	2.398E+0	3.145E-1	-3.822E+2	5.620E+1	3.424E-7	6.717E-7	9.477E-3	-5.322E-3	-1.470E-2	-1.348E-3
4	3	-2.775E-1	-1.179E-1	-1.140E+0	-1.061E+0	3.606E+2	-1.175E+2	1.019E-6	-1.192E-7	-1.311E-2	9.08E-3	2.310E-3	7.746E-3
4	4	1.497E-1	-2.890E+0	1.145E+0	-5.012E+0	-5.480E+2	4.490E+2	-1.051E-7	3.564E-7	7.775E-3	1.421E-3	-2.289E-3	1.201E-2
5	0	1.520E+0		3.400E+0		-5.541E+2		6.874E-8		1.185E-2		1.601E-2	
5	1	-4.702E-1	-3.244E-1	-2.944E-1	4.297E-2	-4.740E+1	-5.400E+1	-5.164E-8	-7.997E-7	8.045E-3	7.154E-3	9.948E-3	5.431E-3
5	2	2.079E+0	-1.492E-2	2.232E+0	7.723E-1	-1.310E+1	-1.585E+2	5.964E-7	-3.491E-7	-4.971E-3	1.451E-3	-1.142E-2	-6.586E-3
5	3	1.770E+0	-2.273E-1	1.219E+0	-9.696E-1	1.427E+2	2.540E+1	-5.842E-7	-1.631E-7	-1.102E-2	1.511E-4	-8.251E-3	7.397E-3
5	4	-2.609E+0	1.346E+0	-4.510E+0	1.829E+0	5.115E+2	-6.480E+1	-1.155E-7	-4.539E-8	-8.037E-3	-7.921E-3	2.189E-2	-1.327E-2
5	5	-1.475E+0	-1.805E+0	-1.265E+0	-2.100E+0	-6.710E+2	2.252E+2	1.358E-7	-8.684E-7	7.106E-3	-9.971E-3	5.071E-3	1.581E-2
6	0	-8.714E-1		-1.670E+0		2.364E+2		-1.530E-7		2.600E-3		1.391E-2	
6	1	1.086E+0	7.390E-1	1.078E+0	9.324E-1	-5.000E+1	-1.715E+2	-7.216E-8	1.775E-8	-4.981E-3	-8.490E-3	-1.428E-2	-8.660E-3
6	2	1.977E+0	-1.794E+0	1.920E+0	-1.628E+0	9.400E+0	-1.148E+2	2.447E-8	-4.065E-7	-6.119E-3	6.271E-3	-1.145E-2	1.577E-3
6	3	-5.070E-2	-2.179E-1	-4.811E-1	-1.127E+0	6.250E+1	1.936E+2	4.413E-9	2.565E-9	4.149E-3	-5.362E-3	-1.715E-3	7.148E-3
6	4	-8.637E-1	-1.773E+0	-1.070E+0	-1.016E+0	1.811E+2	-1.673E+2	-1.003E-7	-3.020E-7	-4.777E-3	7.548E-3	1.355E-3	2.170E-3
6	5	-3.418E-1	2.867E-1	6.469E-1	8.170E-1	-9.190E+1	-2.074E+2	-1.350E-7	-6.096E-7	9.821E-3	4.487E-3	7.448E-3	-6.161E-3
6	6	1.553E-1	1.118E+0	6.123E-2	1.162E+0	6.130E+1	2.050E+1	2.913E-8	-2.632E-7	-8.958E-3	8.975E-3	-4.615E-3	-2.189E-3
7	0	1.391E-1		1.301E+0		-2.662E+2		9.088E-8		6.646E-3		-6.710E-3	
7	1	-5.144E-1	-8.851E-1	-4.648E-1	-1.513E+0	4.760E+1	1.812E+2	2.353E-7	5.963E-8	2.609E-3	-1.477E-3	2.110E-3	1.126E-3
7	2	-6.717E-1	1.712E-1	-1.401E+0	2.226E-2	1.801E+2	2.400E+1	2.042E-7	1.752E-7	2.479E-3	1.752E-3	2.880E-3	6.726E-3
7	3	9.517E-1	-5.608E-1	1.110E+0	-8.731E-1	-7.810E+1	1.280E+2	2.199E-7	-3.464E-7	-7.531E-3	1.524E-3	-1.285E-2	4.528E-3
7	4	4.745E-1	7.245E-1	1.084E+0	-7.061E-1	-2.443E+2	4.450E+1	-2.861E-7	-2.771E-7	9.198E-3	7.164E-3	6.691E-3	-6.691E-3
7	5	-2.464E-2	8.927E-1	-5.878E-1	1.185E+0	1.900E+1	-4.200E+0	3.472E-8	8.701E-8	-7.198E-3	-2.479E-3	1.254E-3	-9.466E-3
7	6	2.741E-1	-2.803E-1	9.866E-2	7.741E-1	-5.200E+1	-1.043E+2	-2.749E-7	8.586E-7	2.306E-3	4.448E-3	1.915E-3	-7.975E-3
7	7	4.788E-2	-2.129E-1	2.017E-1	6.824E-1	-1.420E+1	-9.120E+1	-2.485E-8	-8.896E-8	2.118E-3	1.704E-3	-9.481E-3	-1.090E-3
8	0	1.174E-1		1.496E-1		2.000E+1		4.971E-8		4.971E-3		5.683E-3	
8	1	9.410E-2	1.505E+0	8.821E-2	1.745E+0	-2.100E+1	-7.460E+1	1.091E-8	4.842E-8	5.064E-3	-4.439E-3	-4.222E-3	-1.122E-3
8	2	1.914E+0	8.764E-1	1.316E+1	7.415E-1	1.219E+2	-1.500E+1	1.108E-7	1.015E-7	-1.109E-2	1.553E-3	-6.521E-3	8.994E-3
8	3	2.051E-2	-1.324E-1	-8.159E-2	-2.190E-1	1.250E+1	8.480E+1	-8.857E-8	-5.073E-8	4.626E-3	1.784E-3	4.641E-3	4.942E-3
8	4	-4.729E-1	5.548E-1	-7.000E-1	-1.564E-1	-1.700E+1	6.750E+1	-2.211E-7	2.651E-7	2.831E-3	-7.450E-3	5.141E-3	1.400E-3
8	5	8.690E-1	4.461E-1	7.837E-1	6.271E-1	-6.720E+1	-1.100E+1	1.511E-7	8.115E-8	-4.161E-3	-2.875E-3	-8.837E-3	-5.431E-3
8	6	8.791E-1	2.079E+0	6.152E-1	1.064E+0	9.100E+1	9.101E+1	-7.754E-7	2.808E-7	-7.827E-3	-6.557E-3	1.217E-3	1.656E-3
8	7	8.867E-2	-9.564E-2	1.846E-1	-5.864E-1	1.846E+1	5.101E+1	-2.049E-7	2.459E-7	-1.149E-2	-8.210E-3	1.711E-3	-2.191E-3
9	0	1.496E-1	-2.816E-1	1.171E-1	4.616E-2	-9.010E+1	-1.108E+2	1.691E-7	9.326E-8	8.479E-3	-1.360E-3	1.570E-3	-6.129E-3
9	1	6.880E-1	1.122E+0	1.663E-1	1.621E+0	-1.663E+1	1.531E+1	1.531E-7	1.531E-7	2.118E-3	2.118E-3	2.010E-3	
9	2	1.647E+0	-1.567E-1	1.471E+0	-1.621E-1	6.560E+1	7.500E+1	1.809E-7	6.109E-8	-1.114E-2	1.969E-3	-5.521E-3	7.450E-3
9	3	2.811E-1	1.013E-1	1.524E-1	1.524E-1	-2.701E+1	-1.400E+1	-2.201E-7	2.421E-7	-1.012E-2	1.148E-3	-1.881E-3	1.759E-3
9	4	-1.152E+0	-9.775E-1	-1.128E+0	-1.179E+0	-6.200E+0	5.100E+0	-9.925E-8	-2.300E-8	6.961E-3	1.577E-3	7.213E-3	2.093E-3
9	5	8.792E-2	-6.421E-1	4.624E-1	-1.084E+0	1.040E+1	5.720E+1	-9.065E-8	-3.852E-8	1.494E-3	1.901E-3	5.711E-3	7.027E-3
9	6	4.669E-1	-1.140E-1	1.762E-1	-3.145E-1	6.280E+1	8.150E+1	-5.875E-8	1.683E-8	-5.062E-3	-1.128E-3	6.714E-3	1.119E-3
9	7	1.077E+0	9.070E-1	6.599E+1	-9.682E-2	-1.370E+1	1.941E+2	4.881E-8	1.111E-7	-2.180E-3	-1.022E-3	-1.480E-3	2.111E-3
9	8	2.060E-1	-2.230E+0	-8.475E-2	-7.137E+0	-1.050E+1	-1.045E+2	-1.588E-7	-6.497E-7	5.822E-3	8.101E-3	1.514E-3	-9.775E-3
9	9	3.375E-1	1.520E+1	1.188E+1	1.291E+1	1.195E+2	8.102E+2	2.527E-7	9.415E-9	-1.041E-2	-9.721E-3	-4.414E-3	-4.190E-3
9	10	7.664E-1	1.601E+0	1.037E+0	1.752E+0	-2.380E+1	-8.460E+1	-3.451E-8	5.950E-8	6.914E-3	5.189E-3	2.871E-3	-1.890E-3
10	0	5.187E-1		9.166E-1		-5.570E+1		5.471E-8		9.826E-3		1.475E-3	
10	1	6.077E-1	2.667E-1	7.685E-1	-1.808E-2	6.210E+1	-6.090E+1	-8.900E-8	-6.015E-8	-6.162E-3	-7.431E-3	-4.451E-3	-1.805E-3
10	2	-1.961E-1	-5.045E-2	5.143E-1	1.241E-1	-1.669E+2	-8.790E+1	-1.725E-8	4.167E-8	4.732E-3	7.397E-3	-1.881E-3	-7.732E-3
10	3	7.171E-1	-2.112E-1	1.232E+0	1.449E-1	-1.070E+2	-7.500E+1	-1.310E-7	-7.272E-8	-1.963E-3	1.680E-3	-6.501E-3	9.528E-3
10	4	-9.001E-1	1.018E-2	-5.662E-1	5.629E-2	-9.250E+1	2.900E+1	-2.180E-7	-7.891E-8	5.961E-3	-2.44E-3	4.871E-3	-1.851E-3
10	5	2.791E-2	6.947E-2	2.450E-1	-2.195E-1	2.440E+1	1.150E+1	-1.150E-7	1.150E-7	6.965E-3	-2.115E-3	2.115E-3	-1.801E-3
10	6	-6.194E-1	1.254E-1	-1.128E+0	6.011E-1	8.501E+1	-6.191E+1	-9.814E-8	-1.172E-8	1.805E-3	8.617E-3	5.180E-3	9.121E-3
10	7	-5.925E-1	4.571E-1	-5.846E-1	2.145E+1	8.200E+1	5.120E+1	1.852E-7	2.165E-7	6.084E-3	-5.920E-3	1.829E-3	1.190E-3
10	8	-2.610E-1	1.869E-1	-5.745E-1	7.589E-1	5.410E+1	-9.140E+1	1.080E-7	7.078E-7	-6.446E-3	5.118E-3	-2.201E-3	-1.101E-3
10	9	1.259E+0	1.031E+0	9.547E+0	8.580E+0	1.461E+2	-1.180E+1	7.847E-7	5.618E-7	-1.076E-2	6.101E-3	5.901E-3	-5.489E-3
10	10	7.521E-1	-8.206E-1	-1.812E-1	-4.807E-1	7.890E+1	-5.790E+1	1.332E-7	9.891E-8	-5.107E-3	8.633E-3	-9.232E-3	1.123E-3
11	0	-4.074E-1		-1.102E-1		-5.002E+1		-4.505E-8		4.959E-3		4.461E-3	
11	1	-1.204E-1	6.597E-1	-1.126E+0	8.113E-1	1.169E+2	-1.510E+1	-1.219E-7	7.546E-8	-5.940E-3	1.531E-3	1.721E-3	-1.394E-3
11	2	2.110E-1	-1.784E-1	1.494E-1	-1.287E-1	-1.190E+1	-4.700E+1	-2.025E-7	-6.299E-8	-1.225E-3	6.852E-3	-1.081E-3	-1.070E-3
11	3	2.967E-2	-1.512E-1	2.201E-1	-2.075E-1	4.900E+0	-1.990E+1	-1.078E-7	-1.605E-7	8.217E-3	1.511E-3	1.201E-3	-4.851E-3
11	4	8.710E-2	-7.361E-1	-4.038E-2	-1.773E-1	5.410E+1	-7.880E+1	1.567E-7	-1.955E-7	-1.245E-3	5.822E-3	1.194E-3	-1.481E-3
11	5	-3.229E-1	9.510E-1	-6.598E-1	6.592E-1	6.150E+1	1.940E+1	-1.859E-7	6.111E-8	-1.435E-3	-9.24E-3	-2.522E-3	-4.178E-3
11	6	2.305E-1	-2.795E-1	1.214E-1	-6.011E-1	1.000E+0	2.000E+0						

Since the Rayleigh group velocity model is predicated on the tectono-thermal evolution of crustal materials, both continental and oceanic, it is expected that the model bears a strong resemblance to global heat flow. The degree 12 spherical harmonic representation of the surface global heat flow field based entirely on tectonic prediction (figure 34, top) and observed data supplemented with predicted heat flow values (figure 34, bottom) have been determined by Chapman and Pollack (1975, b). Generally, regions of highest heat flow also tend to exhibit the lowest Rayleigh group velocities and vice versa.

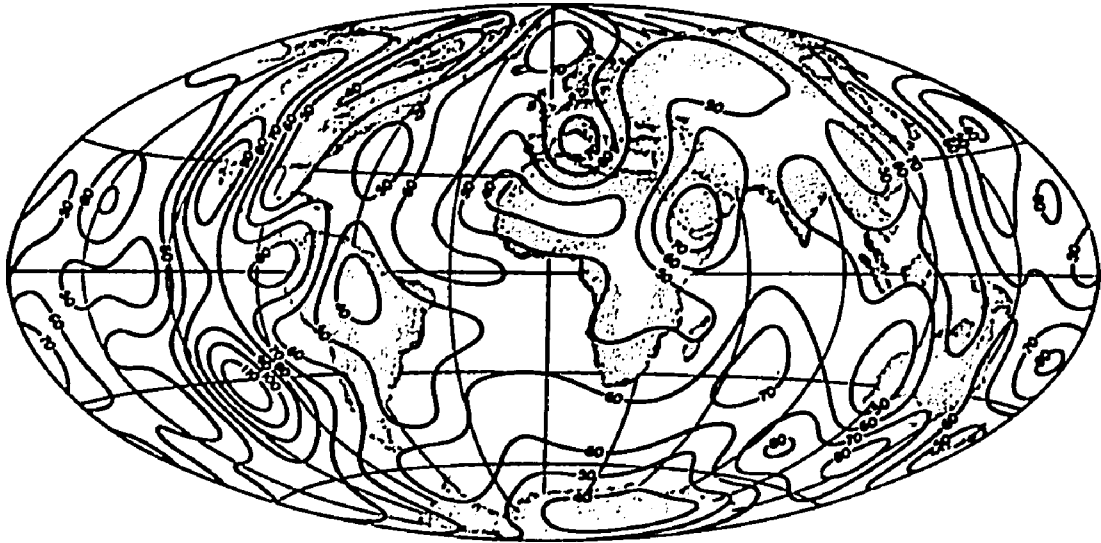
The resemblance of the surface heat flow field and the Rayleigh velocity fields is substantiated by comparing figure 36 with figures 42 and 43. The general correspondence of both 50 and 90 second Rayleigh velocity coefficients and the surface heat flow coefficients from spherical harmonic analysis between order 4,0 and 12,12 is quite remarkable. Prominant corresponding coefficient maxima occur at : (4,3), (5,2), (5,4), (6,2), (8,1), (9,1), and (9,3). Prominant corresponding coefficient minima occur at (4,1), (5,1), (5,3), (7,3), (9,2), and (9,4). Although the 50 second Rayleigh velocity coefficients are more prone to aberrancies with respect to the surface heat flow coefficients than are the 90 second Rayleigh velocity coefficients, the two samples of the global Rayleigh model clearly illustrate the interdependence of the Rayleigh velocities and heat flow.

GLOBAL HEAT FLOW

Units: mW m²

(top). Degree 12 spherical harmonic representation of global heat flow from predictor method only.

Figure 34.



Units: mW m²

(bottom). Degree 12 spherical harmonic representation of global heat flow from observations supplemented by predictor.

Pollack and Chapman (1977,a) have proposed a mantle heat flow model which is derived by removing crustal radioactive heat contributions from the surface heat flow values. The reduced spherical harmonic coefficients for the mantle heat flow model are illustrated in figure 37. Comparison of the surface heat flow (figure 36) and mantle heat flow (figure 37) reduced spherical harmonic coefficients reveals that the principal difference of the two heat flow data sets is a reduction of amplitudes of the higher order harmonics. The correlation of mantle heat flow coefficients (figure 37) and the 90 second Rayleigh wave velocity coefficients (figure 43) is quite convincing and indicates that the fundamental variations of Rayleigh group velocities are of thermal origin.

Utilizing the oceanic geotherms of Pollack and Chapman (1977,b) and the experimentally determined effects of temperature and pressure on proposed mantle constituent minerals (Anderson and Sammis, 1970), P and S velocity- structure models were constructed for a variety of temperature conditions and petrology. These models were then used to compute Rayleigh phase and group velocities using the techniques of Harkrider (1964). No models

yielded Rayleigh velocities similar to those observed. This suggests that either the velocity partial derivatives of Anderson and Sammis cannot be extrapolated to actual mantle conditions, or partial melting is the predominant effect of temperature. The latter condition is the preferred explanation. Unfortunately, ex-

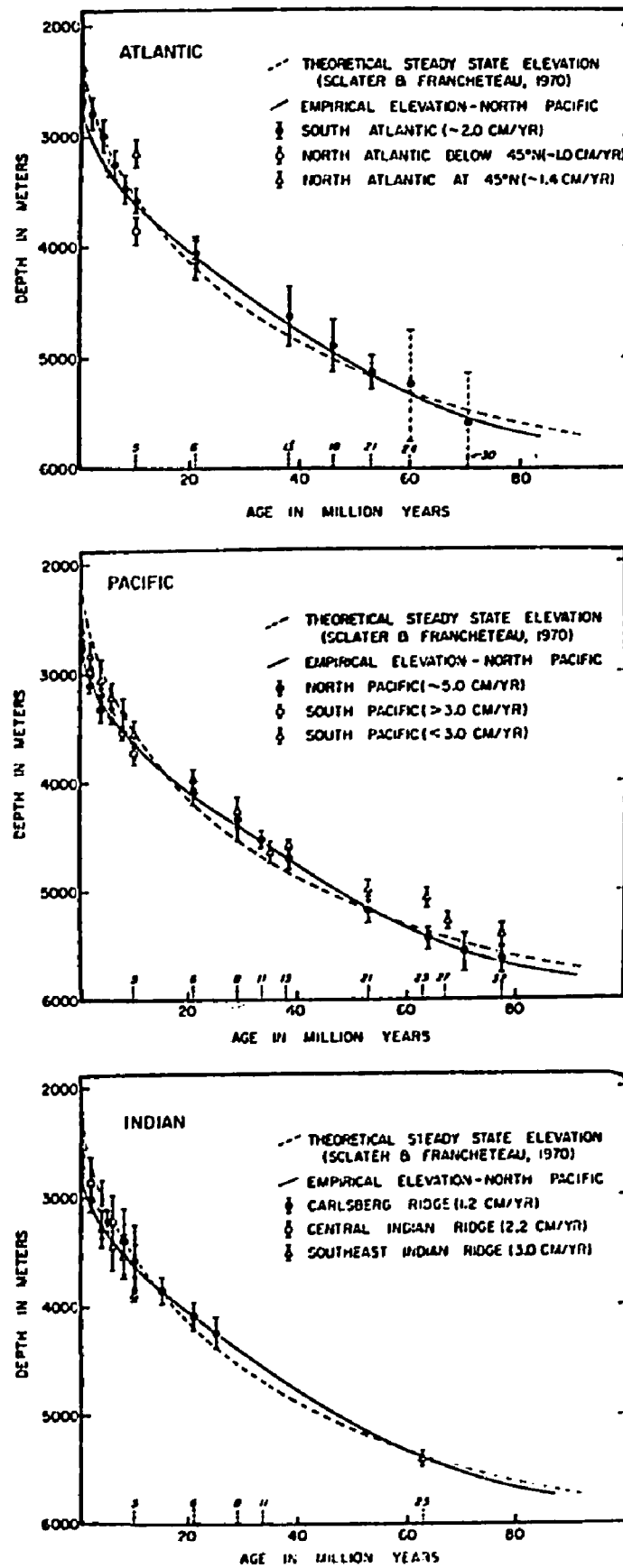
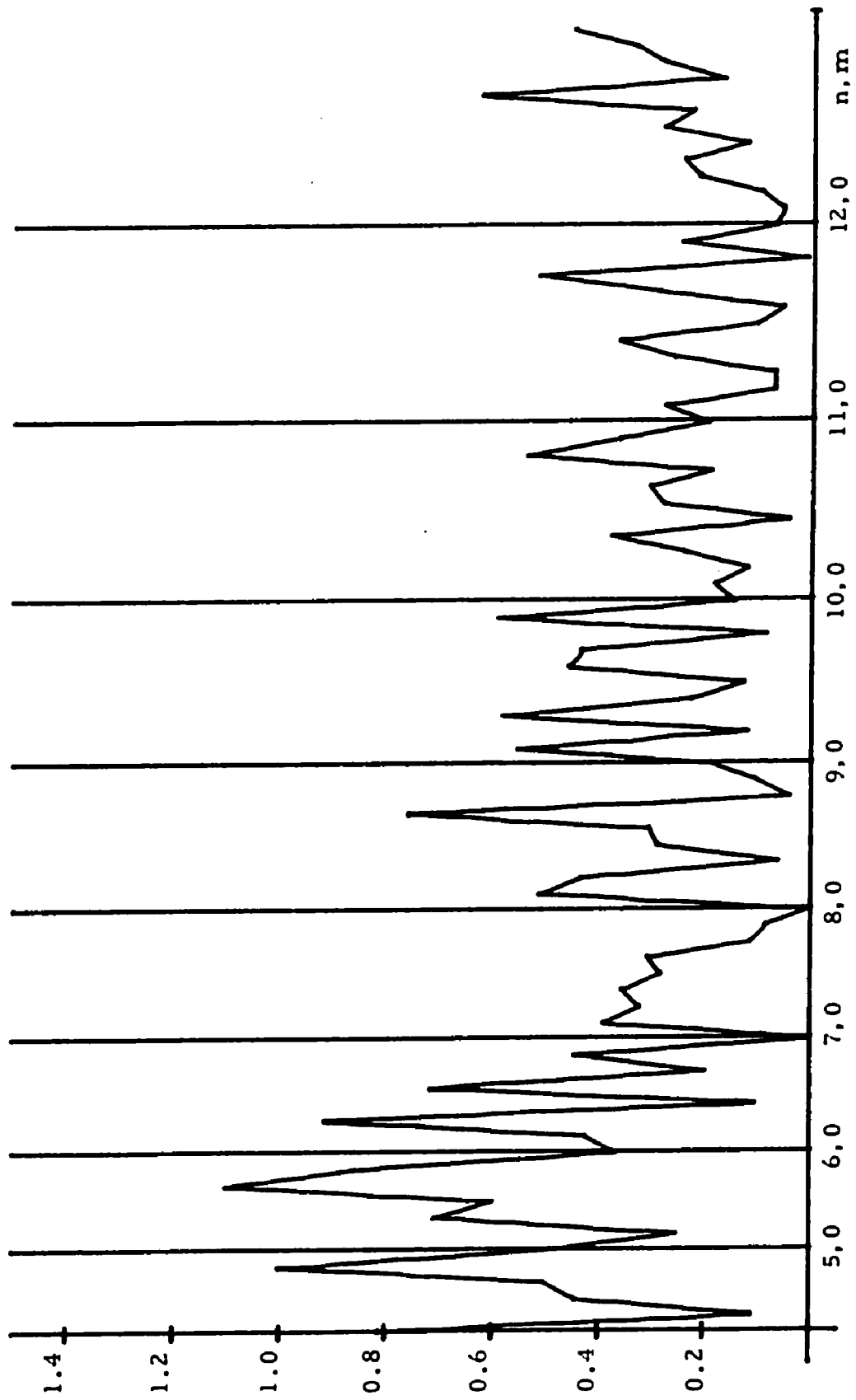


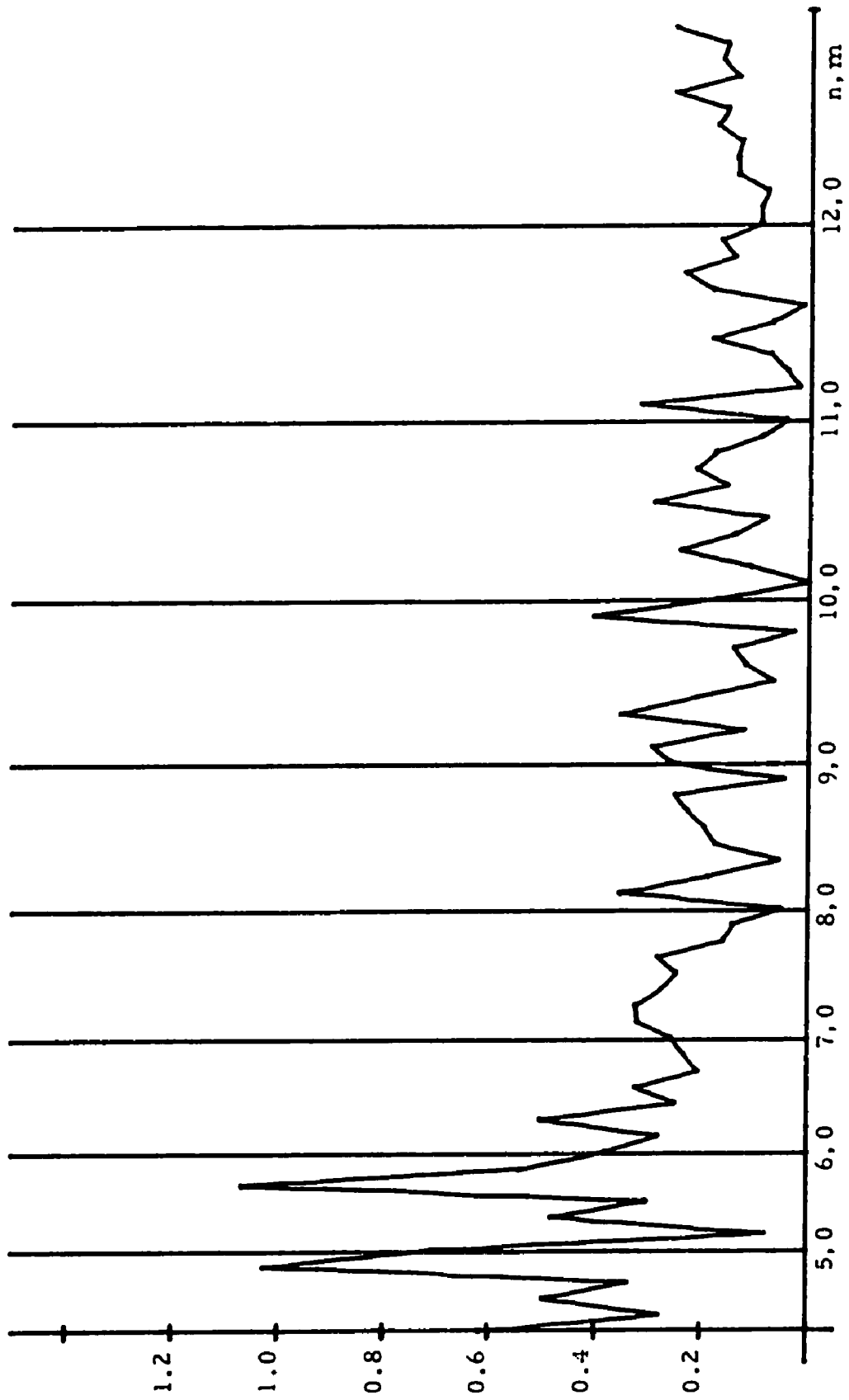
Figure 35.



Spherical Harmonic Coefficients Order and Number

SURFACE HEAT FLOW

Figure 36.



Spherical Harmonic Coefficients Order and Number

MANTLE HEAT FLOW

Figure 37.

periments to determine the effects of partial melting at mantle temperatures and pressures on seismic velocities have not been done.

It is intriguing to speculate that had the Rayleigh predictor been tied more directly to heat flow rather than age, the North Atlantic would probably seem less anomalous. Segments of ocean floor with equivalent age of 10-20 million years in the Pacific and Atlantic display disparate heat flow values of 93 versus 73 mWm^{-2} , for example. The discrepancies in heat flow values of equivalent age sea floor segments between the Pacific and Atlantic do decrease with increase in age, so the Brazil Basin would remain an anomaly even in a heat flow context. Chapman and Pollack (1975, a) have shown that incorrect prediction of heat flow based on tectonics can occur in regions which are being tectonically overprinted. It is believed, but not shown, that these areas will also yield Rayleigh velocity anomalies with respect to the model presented in this dissertation. In addition, since both the heat flow analysis of Chapman and Pollack (1975, b) and the Rayleigh group velocity predictor, presented here, are integrated effects over a $5^\circ \times 5^\circ$ area, perturbations like Hawaii tend to be suppressed even though they may exhibit profound interference effects on observed Rayleigh waves (McGarr, 1969).

The principal topographic relief of the sea floor has been demonstrably related to temperature (Sclater and Francheteau, 1970). The 'normal' thermal aspect of the sea floor also is related to age, thus it is expected that the topography of the ocean

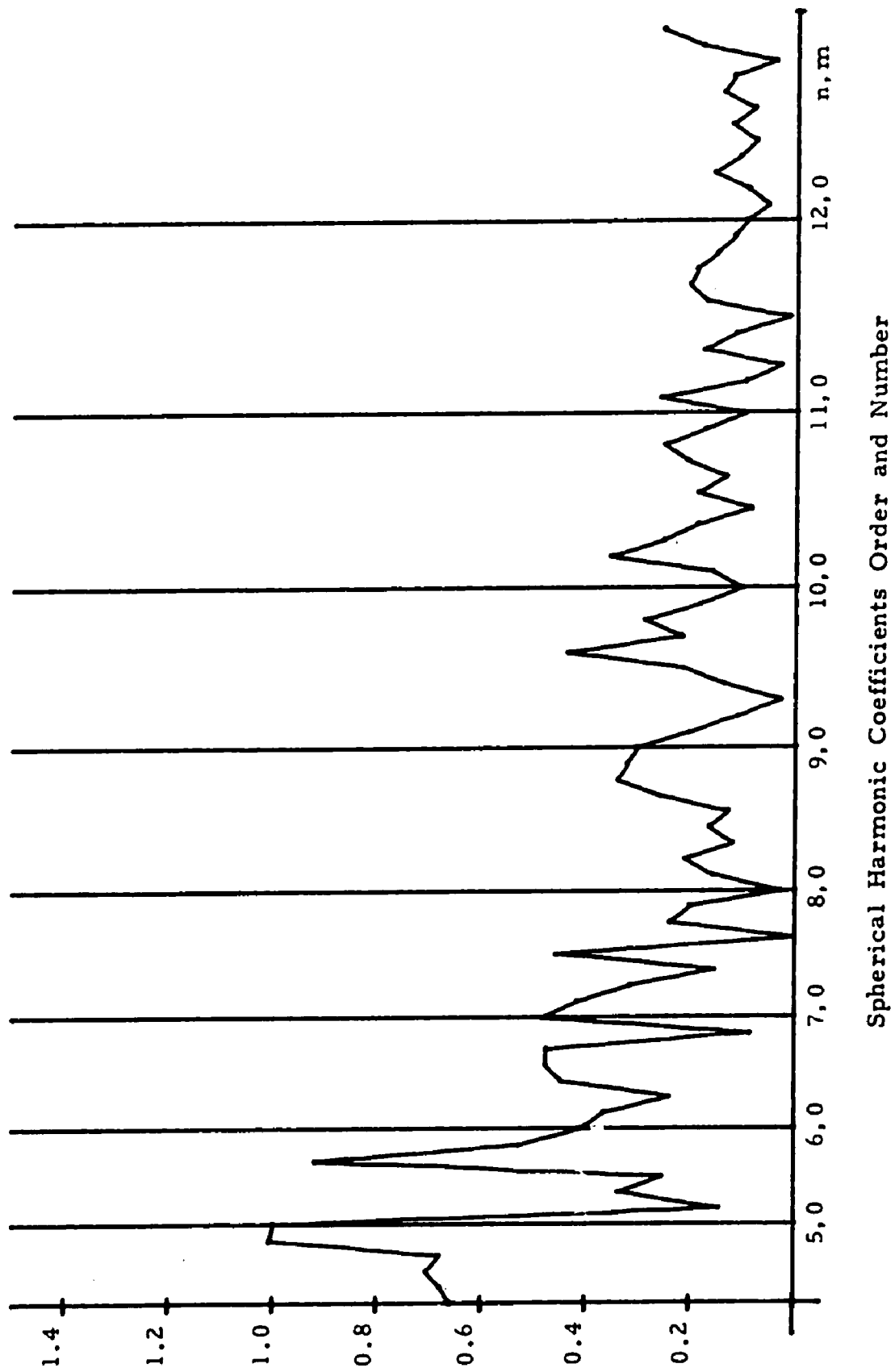
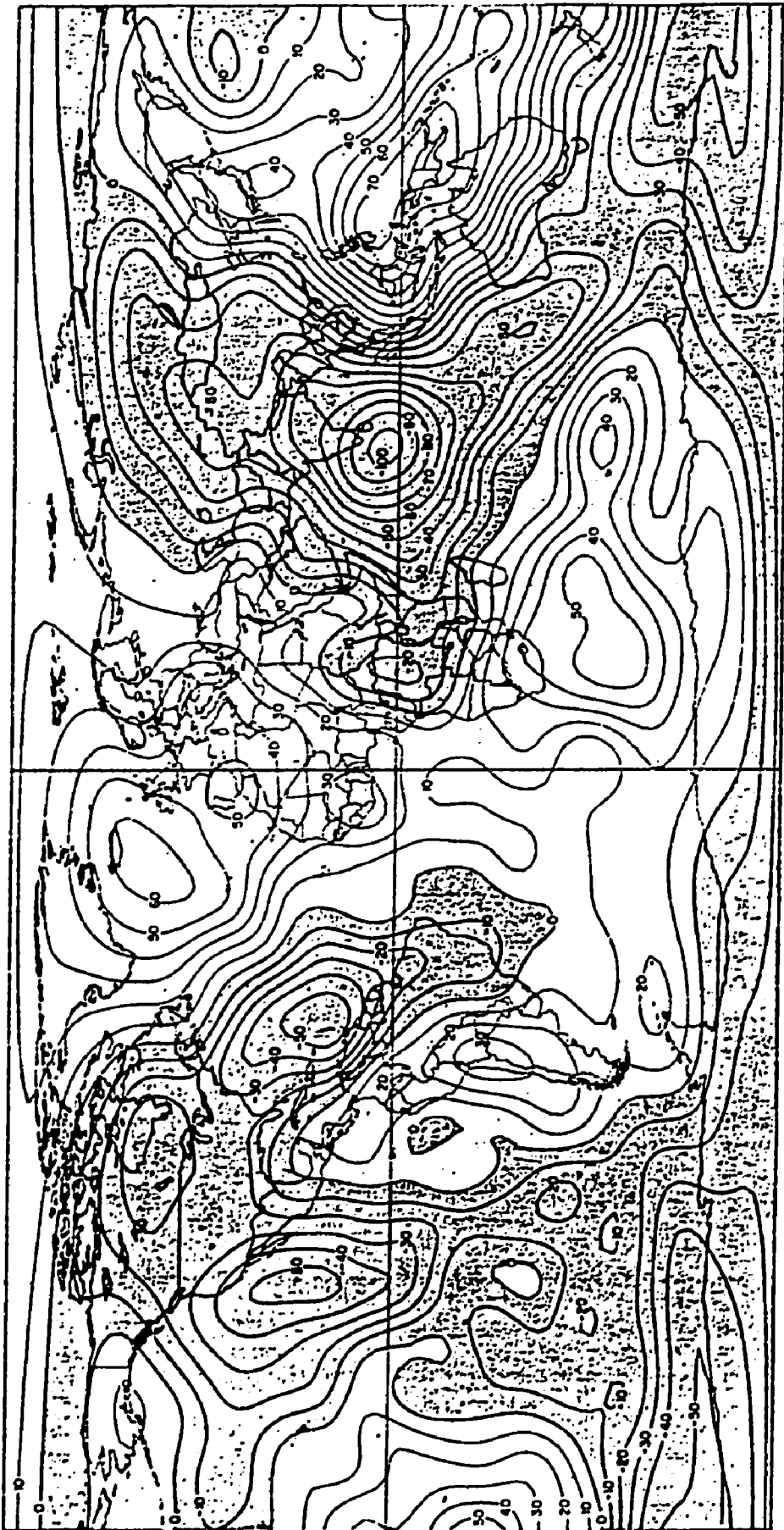


Figure 38.

TOPOGRAPHY

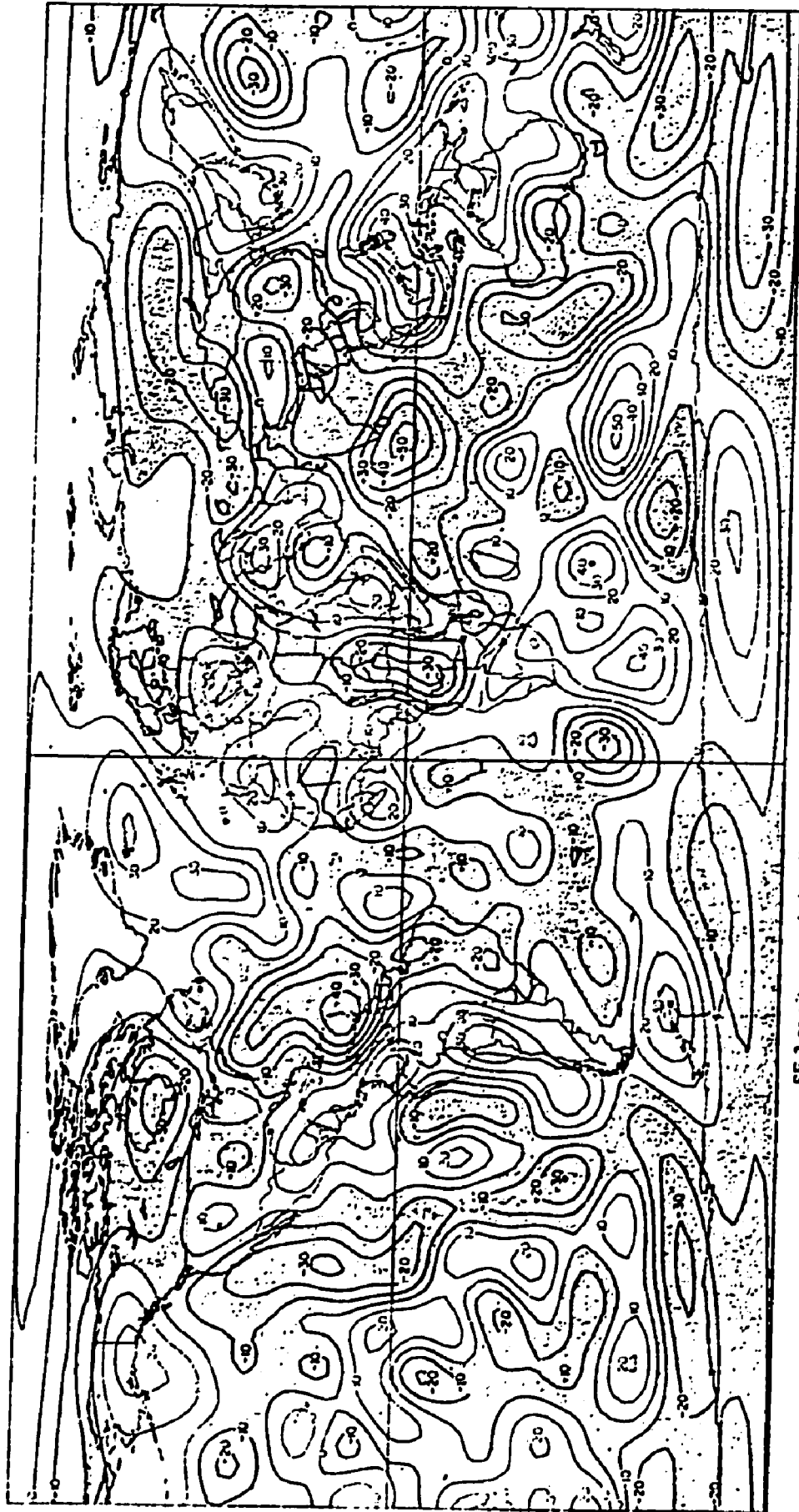
basins, like heat flow, will bear a striking resemblance to the Rayleigh velocity predictor. The observed and computed relationship of ocean depth and sea floor age (from Sclater, Anderson, and Bell 1971) is illustrated in figure 35. Generally, regions of elevated topography exhibit low Rayleigh velocities and vice versa. The reduced spherical harmonic coefficients from order and number 4, 0 through 12, 12 for topography are illustrated in figure 38. Although many of the principal maxima and minima discussed in the previous heat flow analyses are also present in the topography coefficients, the degree of correlation between the topography coefficients (figure 38) and the Rayleigh velocity coefficients (figures 42, 43) are not as great as the correlation with heat flow (figures 36, 37). This suggests that many elements of the topography are attributable to causes other than thermal perturbations. Similarly, since complete relaxation of the thermally perturbed sea floor is accomplished in less than 80 million years (over half in the first 30 million years) beyond which the Rayleigh velocities are continually changing, it is not surprising that the correlation fails at higher order spherical harmonic coefficients. There is no indication in the topography that the Atlantic should be different than the Pacific. All ocean basins appear to evolve topographically in the same manner (Sclater, Anderson, and Bell 1971) as indicated in figure 35.

Gravity fields in the form of geoid heights (figure 39) and



SE 3 geoid height in meters calculated with respect to the best-fitting ellipsoid, $f = 1/298.256$.

Figure 39.



SE 3 gravity anomaly in milligals calculated with respect to best-fitting ellipsoid, $f = 1/298.256$.

Figure 40.

gravity anomalies from the best fitting ellipsoid (figure 40) have been computed for spherical harmonic coefficients through degree and order 18 by Gaposchkin (1974). These coefficients through degree and order 12, 12 are listed in table 11, and are illustrated in reduced form in figure 41. The spherical harmonic coefficients of the gravity field bear the least resemblance to the Rayleigh velocity model of all the geophysical fields examined. The sixth and ninth order coefficients bear the closest correlation of the Rayleigh velocities and gravity fields. The interpretation to be placed on inverse correlations in some portions of the spectrum and direct correlations in other portions is questionable. Although some of the gravity field is a reflection of the Rayleigh velocity field, and therefore related to variations in the upper mantle at depths less than 400 kilometers, many components of the spectrum must be related to lateral inhomogeneities deeper than the Rayleigh waves sample.

In summary, the Rayleigh velocity model yields spherical harmonic coefficients which correlate well with similar coefficients of surface heat flow, mantle heat flow, topography, and gravity. The prominent coefficient amplitudes at 4,3 and 5,4 are obviously related to the continent-ocean transition. Interpretation of the finer structure of the spectra is less obvious. The high degree of spectral correlation between heat flow and the Rayleigh velocity model

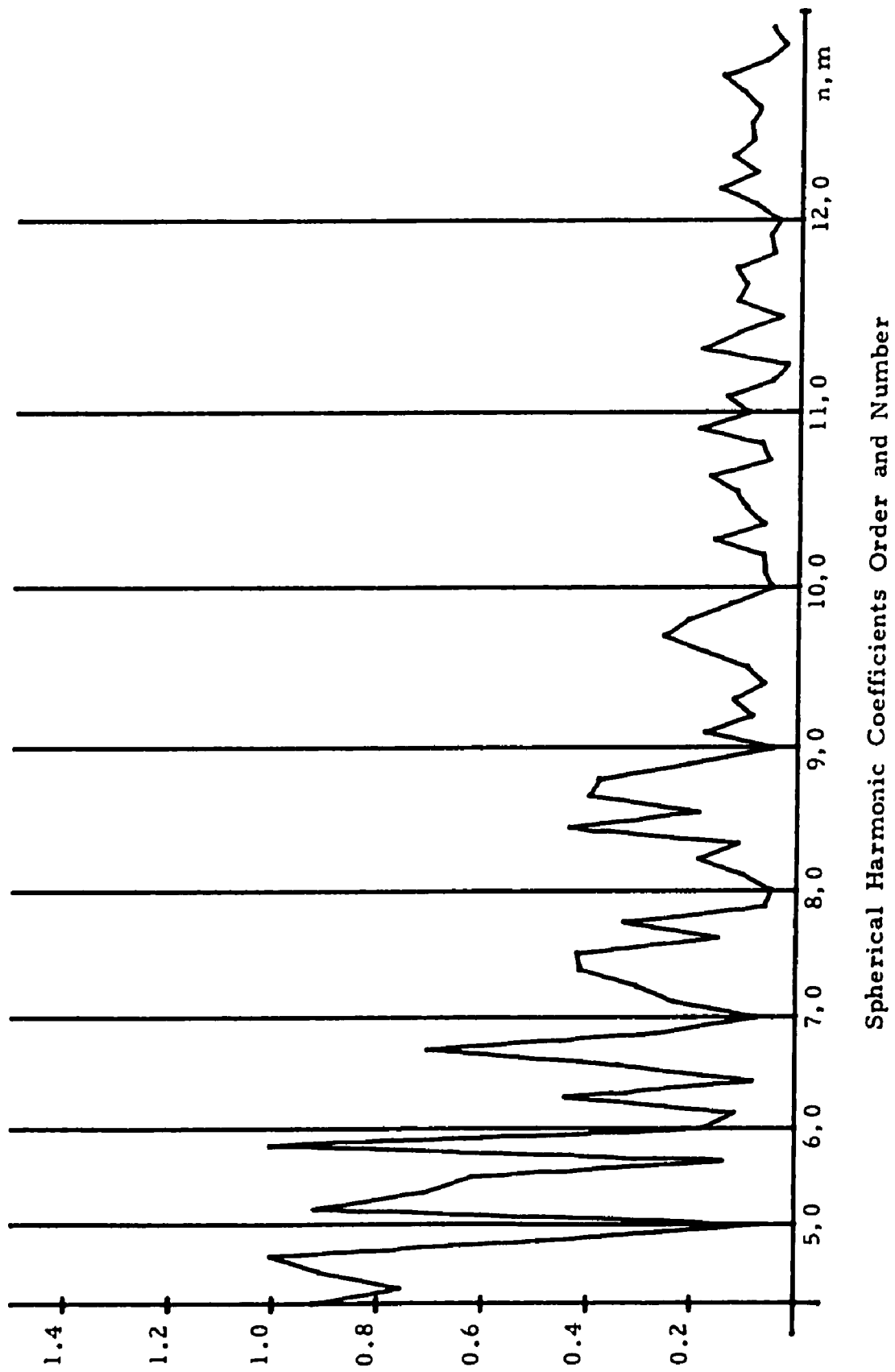
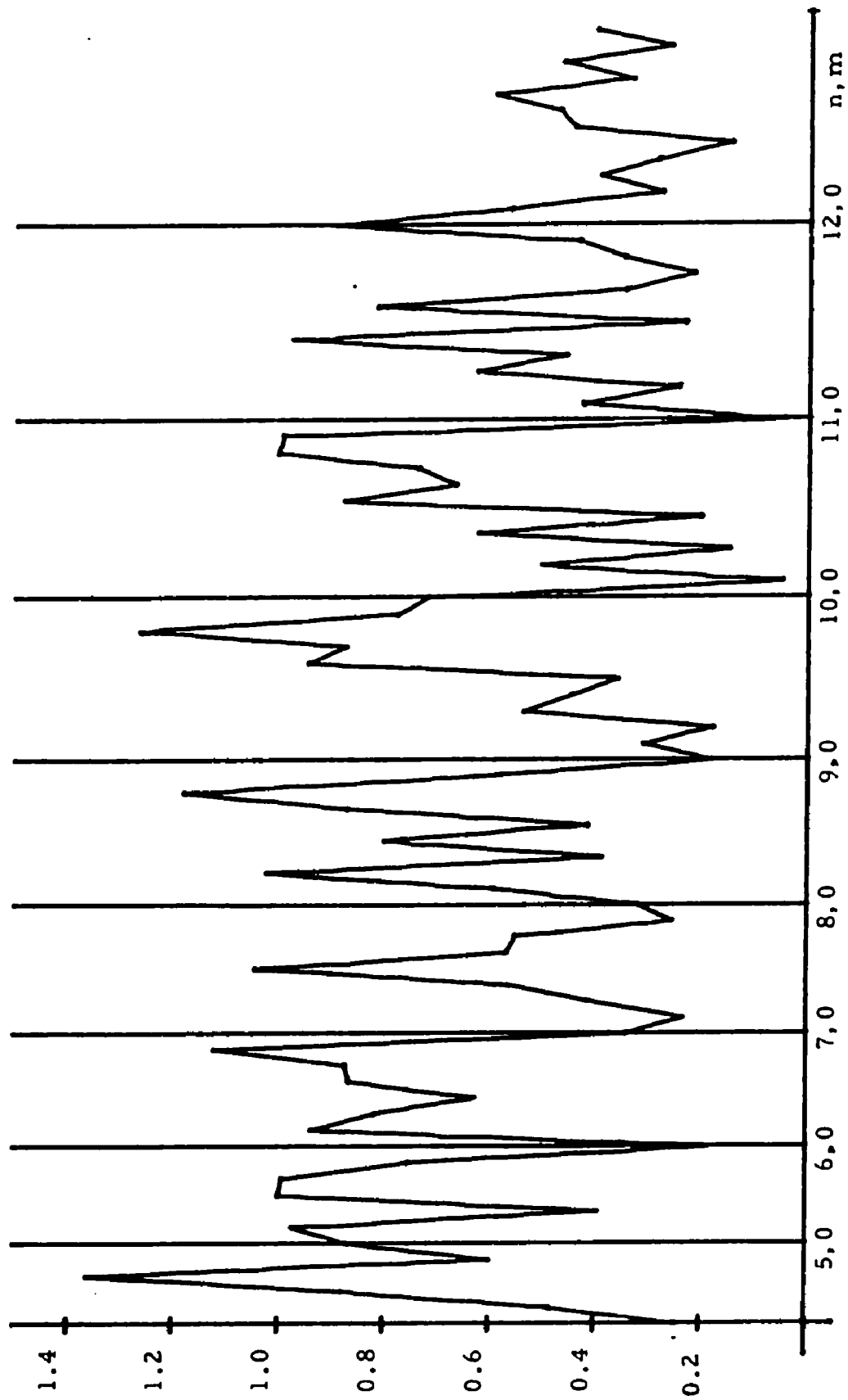


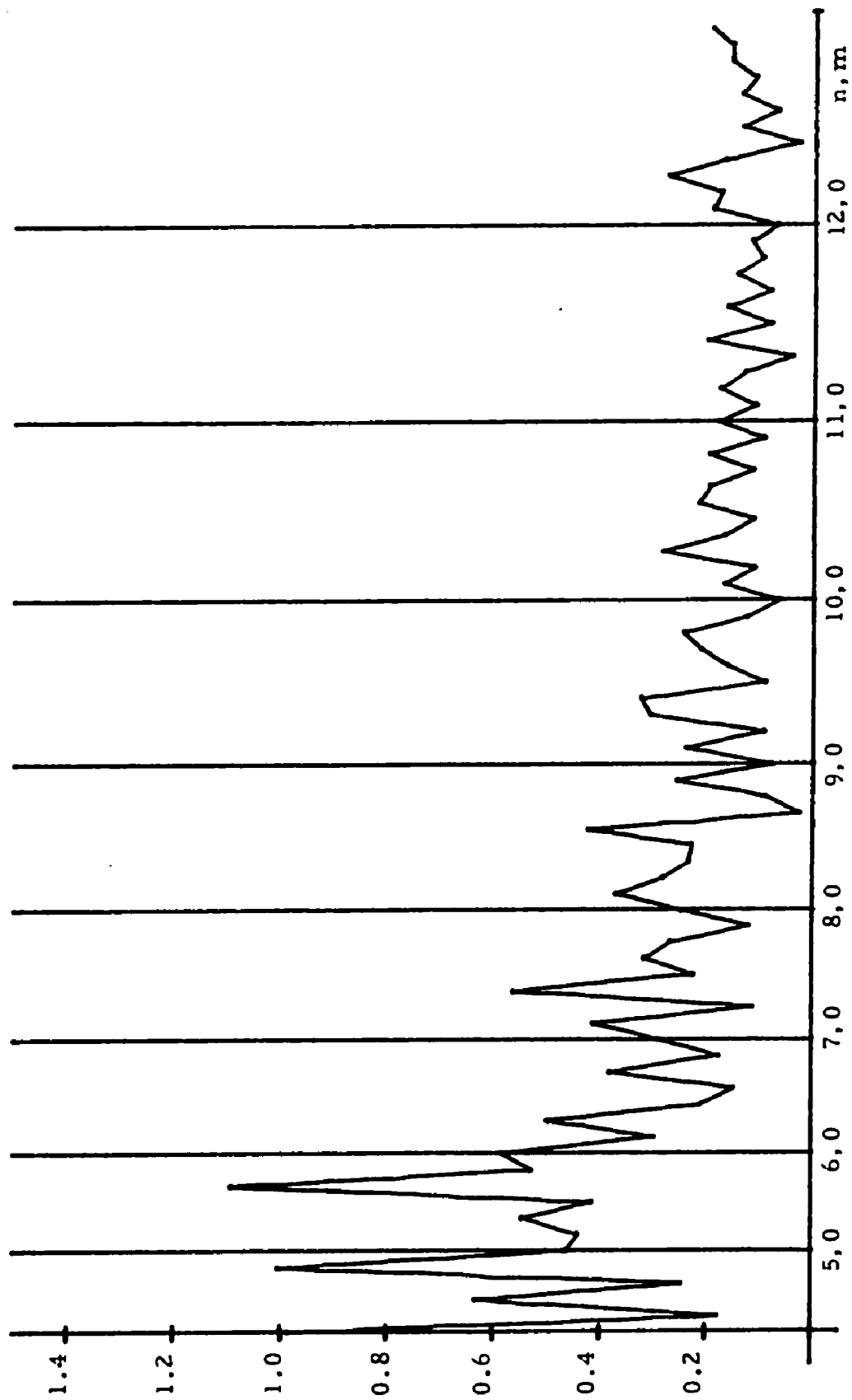
Figure 41.

GRAVITY



Spherical Harmonic Coefficients Order and Number

Figure 42. 50 SECOND RAYLEIGH WAVE VELOCITIES



Spherical Harmonic Coefficients Order and Number

Figure 43. 90 SECOND RAYLEIGH WAVE VELOCITIES

suggests that the variations in Rayleigh group velocities are a function of temperature. Of all the fields studied, the mantle heat flow field has the greatest potential to explain the discrepancies of the observed and predicted Rayleigh velocities in the Atlantic and Indian Oceans.

The higher Rayleigh velocities of the Atlantic and Indian Oceans may be related to dynamic rather than static aspects of sea floor spreading. Spreading rates about instantaneous poles of rotation, which indicate relative differential plate motions, have been computed by LePichon (1968), Pitman and Talwani (1972) and others. Because these rotation poles are not spatially or temporally fixed, assignment of relative spreading rates for given areas is quite involved. Gross approximations of spreading rates for the various ocean basins are; 7.0-9.0 cm/yr-Pacific, 4.0-5.0 cm/yr-South Atlantic and Indian, 2.0-3.0 cm/yr-North Atlantic, and 1.0-2.0 cm/yr-Arctic. Two dimensional modeling of thermal profiles derived from sea floor spreading at rates between 1.0 and 8.0 cm/yr (Bottinga, 1974) have not revealed significant differences in thermal profile evolution for suboceanic lithosphere, however. This thermal modelling technique, however, may not reflect the actual situation because of incorrect assumptions. Bottinga assumes a constant plate thickness and invariant thermal input at the base of the lithosphere, for example; in fact, neither of these assumptions

may be correct. If the spreading rate is a function of sublithospheric thermal flux, then it is possible that the oceanic geotherms in the Atlantic and Pacific may be quite different without affecting the observed thermal flux. In addition to a lower spreading rate, the Atlantic has been characterized by proximity to thick cold continental lithosphere throughout its evolution, while the Pacific has remained oceanic. Possibly by a thermal refraction effect, then, the Atlantic geotherms have been significantly altered from those of the Pacific. This would be most pronounced in the older portions of the Atlantic basins nearest the continents, and may account for the Brazil Basin anomaly.

In summary, a functional relationship between sea floor age and Rayleigh group velocity for periods from 30 to 100 seconds has been derived. Applications of a predictive model based on this functional relationship accurately model observed Rayleigh group velocity dispersion for paths in the Pacific. Application of the model in the Atlantic and Indian Oceans yields systematic positive anomalies, however. The model correlates well with P_n and S_n velocities, oceanic heat flux, and topography. It correlates less well with geoid heights or gravity anomalies.

The increase in Rayleigh group velocities (approximately 10%) with increase in sea floor age is believed to be entirely of thermal origin. The observed discrepancies of Atlantic and Indian Ocean data also are believed to be of thermal origin and may be related

to the cause of spreading rate variation. The cause of the very fast observed Rayleigh velocities through the Brazil Basin could not be determined and deserves further study. The principal deficiency of the model is the exclusion of known anisotropic effects. The precision of the model could be significantly improved if stepwise ocean depth and anisotropy corrections were made along each path of interest. Utilization of ray tracing programs would also improve the precision, permit horizontal refraction analyses and reduce the time required to apply the model to additional paths.

APPENDIX I

Encoded Tectonic Matrix by Tectonic Element

[illegible]

[illegible]

Appendix II

Mean $5^\circ \times 5^\circ$ Rayleigh group velocity matrix

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
0	0	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
0	5	3.998	4.054	4.016	3.955	3.914	3.859	3.851	3.791	3.765
0	10	3.982	4.035	3.999	3.937	3.895	3.842	3.833	3.779	3.753
0	15	3.967	4.017	3.982	3.919	3.876	3.824	3.815	3.766	3.742
0	20	3.935	3.931	3.948	3.883	3.838	3.790	3.778	3.741	3.720
0	25	3.935	3.931	3.948	3.883	3.838	3.790	3.778	3.741	3.720
0	30	3.935	3.931	3.948	3.883	3.838	3.790	3.778	3.741	3.720
0	35	3.935	3.931	3.948	3.883	3.838	3.790	3.778	3.741	3.720
0	40	3.959	4.007	3.975	3.911	3.868	3.816	3.805	3.761	3.738
0	45	3.959	4.007	3.975	3.911	3.868	3.816	3.805	3.761	3.738
0	50	3.943	3.989	3.958	3.893	3.849	3.799	3.787	3.749	3.726
0	55	3.943	3.989	3.958	3.893	3.849	3.799	3.787	3.749	3.726
0	60	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	65	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	70	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	75	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	80	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	85	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
0	90	3.911	3.954	3.920	3.855	3.808	3.764	3.751	3.721	3.702
0	95	3.911	3.954	3.920	3.855	3.808	3.764	3.751	3.721	3.702
0	100	3.943	3.989	3.958	3.893	3.849	3.799	3.787	3.749	3.726
0	105	3.943	3.989	3.958	3.893	3.849	3.799	3.787	3.749	3.726
0	110	3.982	4.035	3.999	3.937	3.895	3.842	3.833	3.779	3.753
0	115	3.982	4.035	3.999	3.937	3.895	3.842	3.833	3.779	3.753
0	120	4.022	4.082	4.019	3.981	3.941	3.884	3.879	3.808	3.781
0	125	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	130	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	135	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	140	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	145	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	150	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	155	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	160	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	165	2.799	3.386	3.669	3.773	3.894	3.952	3.955	3.958	3.938
0	170	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
0	175	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
0	180	3.994	4.074	4.064	4.035	4.006	3.966	3.918	3.866	3.840
0	185	3.994	4.074	4.064	4.035	4.006	3.966	3.918	3.866	3.840
0	190	3.973	4.063	4.052	4.021	3.994	3.953	3.915	3.859	3.833
0	195	3.973	4.063	4.052	4.021	3.994	3.953	3.915	3.859	3.833
0	200	3.973	4.063	4.052	4.021	3.994	3.953	3.915	3.859	3.833
0	205	3.973	4.063	4.052	4.021	3.994	3.953	3.915	3.859	3.833
0	210	3.983	4.068	4.058	4.028	4.000	3.959	3.916	3.863	3.836
0	215	3.983	4.068	4.058	4.028	4.000	3.959	3.916	3.863	3.836
0	220	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
0	225	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
0	230	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	235	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	240	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	245	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	250	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	255	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	260	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	265	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	270	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	275	3.952	4.051	4.040	4.007	3.981	3.939	3.912	3.852	3.825
0	280	2.799	3.386	3.669	3.773	3.894	3.952	3.955	3.958	3.938
0	285	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	290	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
0	295	2.789	3.380	3.663	3.766	3.888	3.945	3.954	3.955	3.934
0	300	3.760	3.942	3.966	3.946	3.942	3.910	3.910	3.848	3.822
0	305	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	310	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	315	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	320	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	325	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	330	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	335	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	340	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	345	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	350	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
0	355	4.030	4.093	4.046	3.990	3.950	3.892	3.888	3.813	3.785

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
5	0	3.265	3.610	3.751	3.779	3.824	3.839	3.837	3.831	3.814
5	5	3.265	3.610	3.751	3.779	3.824	3.839	3.837	3.831	3.814
5	10	3.328	3.691	3.823	3.852	3.902	3.909	3.910	3.884	3.861
5	15	3.328	3.691	3.823	3.852	3.902	3.909	3.910	3.884	3.861
5	20	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
5	25	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
5	30	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
5	35	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
5	40	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902
5	45	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902
5	50	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902
5	55	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902
5	60	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	65	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	70	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	75	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	80	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	85	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
5	90	3.058	3.531	3.743	3.809	3.895	3.927	3.932	3.920	3.897
5	95	3.058	3.531	3.743	3.809	3.895	3.927	3.932	3.920	3.897
5	100	3.189	3.601	3.780	3.827	3.895	3.914	3.916	3.900	3.877
5	105	3.189	3.601	3.780	3.827	3.895	3.914	3.916	3.900	3.877
5	110	3.451	3.743	3.849	3.860	3.891	3.887	3.895	3.857	3.833
5	115	3.705	3.875	3.912	3.885	3.879	3.852	3.845	3.809	3.785
5	120	3.935	3.981	3.948	3.983	3.838	3.790	3.778	3.741	3.720
5	125	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
5	130	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
5	135	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.709	3.691
5	140	4.022	4.082	4.039	3.981	3.941	3.894	3.879	3.808	3.781
5	145	3.344	3.701	3.836	3.869	3.919	3.925	3.929	3.894	3.870
5	150	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
5	155	3.247	3.644	3.817	3.871	3.936	3.957	3.941	3.924	3.901
5	160	3.844	3.938	4.014	4.002	3.992	3.964	3.922	3.878	3.852
5	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	180	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.925	3.798
5	185	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809
5	190	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
5	195	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
5	200	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
5	205	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
5	210	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
5	215	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
5	220	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	225	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	230	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	235	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	240	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	245	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
5	250	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
5	255	2.949	3.472	3.719	3.806	3.900	3.954	3.951	3.947	3.926
5	260	2.840	3.300	3.635	3.766	3.880	3.926	3.932	3.940	3.920
5	265	2.790	3.300	3.632	3.756	3.856	3.902	3.904	3.910	3.890
5	270	2.860	3.320	3.648	3.754	3.812	3.844	3.842	3.846	3.820
5	275	2.895	3.320	3.651	3.756	3.806	3.832	3.828	3.831	3.805
5	280	2.930	3.310	3.649	3.767	3.816	3.837	3.831	3.833	3.810
5	285	2.895	3.310	3.646	3.763	3.822	3.849	3.845	3.848	3.825
5	290	3.039	3.380	3.684	3.796	3.856	3.873	3.870	3.865	3.844
5	295	3.054	3.390	3.684	3.802	3.886	3.909	3.912	3.910	3.889
5	300	3.125	3.473	3.727	3.834	3.921	3.943	3.948	3.936	3.912
5	305	3.030	3.416	3.696	3.842	3.947	3.978	3.982	3.973	3.946
5	310	3.107	3.428	3.707	3.866	3.960	3.981	3.982	3.969	3.940
5	315	2.970	3.360	3.669	3.854	3.967	4.001	4.002	3.995	3.965
5	320	2.970	3.360	3.669	3.854	3.967	4.001	4.002	3.995	3.965
5	325	2.968	3.348	3.664	3.840	3.952	3.986	3.988	3.984	3.956
5	330	2.966	3.336	3.659	3.826	3.937	3.971	3.974	3.973	3.947
5	335	2.830	3.300	3.635	3.762	3.860	3.902	3.904	3.910	3.890
5	340	3.304	3.650	3.802	3.827	3.877	3.885	3.881	3.870	3.846
5	345	3.950	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
5	350	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
5	355	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	F. LONG	20	30	40	50	60	70	80	90	100
10	0	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.783
10	5	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
10	10	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	15	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	20	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	25	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	30	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	35	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	40	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	45	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	50	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	55	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	60	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
10	65	2.685	3.300	3.623	3.744	3.874	3.938	3.946	3.955	3.935
10	70	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	75	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	80	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	85	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	90	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
10	95	2.755	3.300	3.629	3.752	3.862	3.914	3.918	3.925	3.905
10	100	2.825	3.300	3.635	3.760	3.850	3.890	3.890	3.895	3.875
10	105	2.860	3.300	3.638	3.764	3.844	3.878	3.876	3.880	3.860
10	110	2.825	3.300	3.635	3.760	3.850	3.890	3.890	3.895	3.875
10	115	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	120	2.789	3.380	3.663	3.766	3.888	3.945	3.954	3.955	3.934
10	125	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
10	130	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
10	135	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
10	140	2.789	3.380	3.663	3.766	3.888	3.945	3.954	3.955	3.934
10	145	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	150	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	155	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	160	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	165	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	170	2.799	3.386	3.669	3.773	3.894	3.952	3.955	3.958	3.938
10	175	2.799	3.386	3.669	3.773	3.894	3.952	3.955	3.958	3.938
10	180	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
10	185	2.949	3.472	3.719	3.806	3.908	3.954	3.951	3.947	3.926
10	190	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
10	195	3.098	3.558	3.768	3.838	3.922	3.955	3.946	3.935	3.913
10	200	3.247	3.644	3.817	3.871	3.936	3.957	3.941	3.924	3.901
10	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
10	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
10	215	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
10	220	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
10	225	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
10	230	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
10	235	3.029	3.472	3.725	3.818	3.916	3.954	3.951	3.947	3.926
10	240	2.810	3.300	3.632	3.764	3.896	3.950	3.960	3.970	3.950
10	245	2.910	3.300	3.641	3.774	3.868	3.902	3.904	3.910	3.890
10	250	2.835	3.300	3.635	3.764	3.870	3.914	3.918	3.925	3.905
10	255	2.930	3.300	3.644	3.772	3.832	3.854	3.848	3.850	3.830
10	260	2.930	3.300	3.644	3.772	3.832	3.854	3.848	3.850	3.830
10	265	3.010	3.300	3.650	3.784	3.840	3.854	3.848	3.850	3.830
10	270	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
10	275	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
10	280	3.056	3.396	3.690	3.908	4.020	4.046	4.044	4.028	3.992
10	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	290	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	295	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	300	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	305	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	310	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	315	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	320	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	325	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	330	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
10	335	3.014	3.324	3.660	3.812	3.870	3.884	3.876	3.872	3.848
10	340	3.435	3.720	3.839	3.845	3.877	3.872	3.866	3.850	3.826
10	345	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
10	350	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
10	355	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
15	0	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
15	5	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
15	10	3.483	3.782	3.880	3.895	3.927	3.920	3.923	3.879	3.854
15	15	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	20	2.605	3.300	3.623	3.744	3.874	3.938	3.946	3.955	3.935
15	25	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
15	30	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	35	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	40	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	45	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	50	2.755	3.300	3.629	3.752	3.862	3.914	3.918	3.925	3.905
15	55	2.930	3.300	3.644	3.772	3.832	3.854	3.848	3.850	3.830
15	60	2.685	3.300	3.623	3.744	3.874	3.938	3.946	3.955	3.935
15	65	2.930	3.300	3.641	3.782	3.908	3.950	3.960	3.970	3.950
15	70	2.810	3.300	3.632	3.764	3.896	3.950	3.960	3.970	3.950
15	75	2.850	3.300	3.635	3.770	3.900	3.950	3.960	3.970	3.950
15	80	2.800	3.300	3.632	3.760	3.876	3.926	3.932	3.940	3.920
15	85	2.995	3.300	3.647	3.788	3.886	3.914	3.918	3.925	3.905
15	90	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
15	95	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
15	100	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
15	105	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
15	110	2.972	3.312	3.649	3.802	3.927	3.965	3.974	3.981	3.959
15	115	2.890	3.300	3.638	3.776	3.904	3.950	3.960	3.970	3.950
15	120	2.845	3.310	3.640	3.763	3.874	3.921	3.929	3.938	3.915
15	125	2.790	3.340	3.652	3.736	3.792	3.834	3.836	3.842	3.810
15	130	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
15	135	2.790	3.340	3.652	3.736	3.792	3.834	3.836	3.842	3.810
15	140	2.825	3.350	3.660	3.735	3.770	3.805	3.805	3.810	3.775
15	145	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
15	150	2.685	3.310	3.628	3.739	3.858	3.921	3.929	3.938	3.915
15	155	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	160	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	165	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	170	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	175	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	180	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	185	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	190	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	195	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
15	200	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
15	205	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
15	210	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
15	215	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
15	220	3.844	3.988	4.014	4.062	3.992	3.964	3.922	3.878	3.852
15	225	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
15	230	2.690	3.300	3.623	3.746	3.884	3.950	3.960	3.970	3.950
15	235	2.850	3.300	3.635	3.770	3.900	3.950	3.960	3.970	3.950
15	240	2.934	3.324	3.651	3.810	3.938	3.980	3.988	3.992	3.968
15	245	2.976	3.316	3.659	3.830	3.957	3.995	4.002	4.003	3.977
15	250	2.932	3.312	3.646	3.796	3.923	3.965	3.974	3.981	3.959
15	255	2.850	3.300	3.635	3.770	3.900	3.950	3.960	3.970	3.950
15	260	2.854	3.324	3.645	3.798	3.930	3.980	3.988	3.992	3.968
15	265	2.938	3.348	3.661	3.838	3.968	4.010	4.016	4.014	3.986
15	270	2.974	3.324	3.654	3.816	3.942	3.980	3.988	3.992	3.968
15	275	2.986	3.396	3.684	3.900	4.032	4.070	4.072	4.058	4.022
15	280	2.944	3.384	3.676	3.880	4.013	4.055	4.058	4.047	4.013
15	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	290	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	295	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	300	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	305	3.056	3.396	3.690	3.908	4.020	4.046	4.044	4.028	3.992
15	310	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	315	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	320	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	325	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
15	330	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
15	335	2.930	3.300	3.644	3.772	3.832	3.854	3.848	3.850	3.830
15	340	3.173	3.580	3.766	3.810	3.878	3.898	3.897	3.890	3.867
15	345	3.080	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
15	350	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
15	355	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
20	0	3.899	4.023	4.010	3.972	3.950	3.905	3.904	3.833	3.806
20	5	3.173	3.580	3.766	3.810	3.878	3.898	3.897	3.890	3.867
20	10	3.068	3.461	3.719	3.808	3.872	3.892	3.892	3.890	3.858
20	15	2.986	3.336	3.662	3.924	3.901	3.923	3.918	3.913	3.887
20	20	3.056	3.396	3.690	3.908	4.020	4.046	4.044	4.028	3.992
20	25	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	30	3.028	3.408	3.692	3.920	4.051	4.085	4.086	4.069	4.031
20	35	2.982	3.372	3.674	3.872	4.002	4.040	4.044	4.036	4.004
20	40	2.969	3.324	3.654	3.814	3.932	3.968	3.974	3.977	3.953
20	45	2.910	3.300	3.641	3.774	3.868	3.902	3.934	3.910	3.890
20	50	2.955	3.300	3.644	3.782	3.882	3.914	3.918	3.925	3.905
20	55	2.995	3.300	3.647	3.788	3.886	3.914	3.918	3.925	3.905
20	60	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
20	65	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	70	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	75	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	80	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	85	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	90	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
20	95	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
20	100	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
20	105	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
20	110	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	120	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
20	125	3.010	3.390	3.690	3.744	3.712	3.718	3.712	3.714	3.670
20	130	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
20	135	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
20	140	3.058	3.390	3.660	3.705	3.654	3.664	3.658	3.659	3.618
20	145	3.116	3.380	3.620	3.680	3.648	3.668	3.667	3.668	3.637
20	150	3.145	3.375	3.600	3.667	3.645	3.670	3.671	3.673	3.646
20	155	3.010	3.390	3.690	3.744	3.712	3.718	3.712	3.714	3.670
20	160	2.990	3.340	3.667	3.766	3.812	3.834	3.836	3.842	3.810
20	165	2.980	3.340	3.667	3.762	3.792	3.810	3.808	3.812	3.780
20	170	2.994	3.325	3.642	3.748	3.775	3.793	3.787	3.789	3.764
20	175	2.994	3.385	3.672	3.718	3.679	3.691	3.685	3.687	3.644
20	180	2.825	3.310	3.650	3.745	3.802	3.839	3.839	3.844	3.815
20	185	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
20	190	2.755	3.330	3.644	3.737	3.814	3.863	3.857	3.874	3.845
20	195	2.959	3.355	3.654	3.729	3.733	3.754	3.750	3.753	3.719
20	200	3.058	3.390	3.660	3.705	3.654	3.664	3.658	3.659	3.618
20	205	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
20	210	3.058	3.390	3.660	3.705	3.654	3.664	3.658	3.659	3.618
20	215	3.058	3.390	3.660	3.705	3.654	3.664	3.658	3.659	3.618
20	220	2.964	3.365	3.659	3.726	3.727	3.749	3.747	3.751	3.714
20	225	3.000	3.320	3.657	3.780	3.864	3.892	3.898	3.906	3.880
20	230	3.035	3.330	3.665	3.779	3.842	3.863	3.867	3.874	3.845
20	235	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
20	240	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
20	245	3.062	3.372	3.680	3.884	4.010	4.040	4.044	4.036	4.004
20	250	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
20	255	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
20	260	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
20	265	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	270	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
20	275	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	280	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	290	2.776	3.336	3.644	3.800	3.937	3.995	4.032	4.003	3.977
20	295	2.776	3.336	3.644	3.800	3.937	3.995	4.002	4.003	3.977
20	300	2.912	3.440	3.693	3.775	3.879	3.924	3.929	3.930	3.909
20	305	2.895	3.360	3.663	3.844	3.969	4.013	4.016	4.010	3.980
20	310	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	315	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
20	320	3.028	3.408	3.692	3.920	4.051	4.085	4.086	4.069	4.031
20	325	2.819	3.324	3.645	3.792	3.900	3.944	3.946	3.947	3.923
20	330	2.755	3.300	3.629	3.752	3.862	3.914	3.918	3.925	3.905
20	335	3.001	3.424	3.682	3.768	3.840	3.870	3.869	3.870	3.851
20	340	3.247	3.548	3.734	3.783	3.817	3.825	3.820	3.814	3.796
20	345	3.968	4.017	3.974	3.918	3.874	3.824	3.817	3.765	3.742
20	350	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
20	355	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
25	0	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902
25	5	2.909	3.324	3.651	3.800	3.888	3.920	3.918	3.917	3.893
25	10	2.984	3.324	3.657	3.810	3.886	3.908	3.904	3.902	3.878
25	15	1.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	20	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	25	3.068	3.408	3.695	3.926	4.055	4.095	4.086	4.069	4.031
25	30	3.064	3.384	3.645	3.898	4.025	4.055	4.058	4.047	4.013
25	35	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
25	40	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	45	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	50	3.030	3.300	3.650	3.792	3.890	3.902	3.904	3.910	3.890
25	55	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
25	60	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
25	65	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	70	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	75	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	80	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	85	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	90	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	95	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	100	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	105	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
25	110	3.058	3.348	3.670	3.856	3.940	4.010	4.016	4.014	3.986
25	115	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
25	120	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
25	125	3.041	3.366	3.680	3.921	3.997	3.908	3.909	3.907	3.872
25	130	3.034	3.364	3.680	3.900	3.846	3.864	3.864	3.864	3.828
25	135	3.015	3.370	3.685	3.751	3.738	3.747	3.743	3.746	3.705
25	140	3.000	3.380	3.670	3.740	3.692	3.678	3.684	3.684	3.640
25	145	3.000	3.380	3.690	3.740	3.692	3.694	3.684	3.684	3.640
25	150	3.000	3.380	3.690	3.740	3.692	3.694	3.684	3.684	3.640
25	155	2.930	3.370	3.679	3.737	3.720	3.735	3.729	3.731	3.690
25	160	2.940	3.320	3.654	3.766	3.820	3.844	3.842	3.846	3.820
25	165	2.965	3.300	3.647	3.776	3.826	3.842	3.834	3.835	3.815
25	170	2.979	3.305	3.629	3.762	3.853	3.887	3.891	3.898	3.879
25	175	3.024	3.381	3.648	3.750	3.817	3.845	3.845	3.839	3.822
25	180	2.735	3.318	3.634	3.744	3.873	3.935	3.944	3.948	3.929
25	185	2.685	3.310	3.628	3.739	3.858	3.921	3.929	3.938	3.915
25	190	2.749	3.315	3.616	3.725	3.833	3.894	3.902	3.911	3.889
25	195	3.017	3.355	3.619	3.699	3.711	3.741	3.742	3.745	3.718
25	200	3.000	3.380	3.690	3.740	3.692	3.694	3.684	3.684	3.640
25	205	3.116	3.340	3.600	3.700	3.712	3.736	3.735	3.736	3.717
25	210	2.965	3.370	3.632	3.741	3.714	3.723	3.715	3.716	3.675
25	215	3.029	3.365	3.665	3.732	3.705	3.713	3.705	3.706	3.669
25	220	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
25	225	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
25	230	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
25	235	3.030	3.340	3.670	3.772	3.816	3.834	3.836	3.842	3.810
25	240	3.054	3.324	3.660	3.828	3.950	3.980	3.908	3.992	3.968
25	245	3.066	3.316	3.690	3.912	4.040	4.070	4.072	4.058	4.022
25	250	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	255	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	260	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	265	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	270	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	275	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	280	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	290	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
25	295	2.841	3.348	3.677	3.793	3.913	3.967	3.969	3.969	3.947
25	300	3.504	3.793	3.872	3.909	3.939	3.934	3.926	3.886	3.862
25	305	3.470	3.737	3.860	3.929	3.976	3.970	3.971	3.927	3.897
25	310	2.906	3.396	3.684	3.900	4.032	4.070	4.072	4.058	4.022
25	315	3.180	3.533	3.755	3.912	4.010	4.030	4.032	4.006	3.972
25	320	3.760	3.942	3.966	3.946	3.942	3.910	3.910	3.848	3.822
25	325	3.960	4.007	3.967	3.910	3.866	3.816	3.807	3.760	3.737
25	330	3.884	3.912	3.871	3.819	3.764	3.731	3.719	3.697	3.683
25	335	3.938	3.978	3.936	3.882	3.836	3.791	3.781	3.741	3.721
25	340	4.022	4.062	4.019	3.981	3.941	3.894	3.879	3.808	3.781
25	345	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
25	350	3.344	1.701	3.836	3.869	3.919	3.925	3.929	3.874	3.870
25	355	3.066	3.541	3.750	3.817	3.903	3.935	3.941	3.924	3.902

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
30	0	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
30	5	2.685	3.300	3.623	3.744	3.874	3.938	3.946	3.955	3.935
30	10	2.944	3.394	3.676	3.800	4.013	4.055	4.058	4.047	4.013
30	15	3.028	3.408	3.692	3.920	4.051	4.085	4.086	4.069	4.031
30	20	2.770	3.300	3.629	3.758	3.892	3.950	3.960	3.970	3.950
30	25	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	30	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	35	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	40	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	45	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	50	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	55	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.883	3.860
30	60	3.030	3.300	3.650	3.792	3.880	3.902	3.904	3.910	3.890
30	65	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	70	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	75	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	80	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	85	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
30	90	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
30	95	3.074	3.305	3.635	3.780	3.831	3.923	3.933	3.943	3.924
30	100	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	105	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	110	3.074	3.305	3.635	3.780	3.891	3.923	3.933	3.943	3.924
30	115	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
30	120	3.092	3.413	3.680	3.906	4.026	4.058	4.059	4.042	4.005
30	125	3.092	3.413	3.680	3.906	4.026	4.058	4.059	4.042	4.005
30	130	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	135	3.117	3.436	3.713	3.926	3.852	3.859	3.851	3.842	3.806
30	140	3.575	3.720	3.851	3.861	3.853	3.824	3.810	3.790	3.766
30	145	3.766	3.860	3.918	3.888	3.864	3.822	3.806	3.780	3.754
30	150	3.766	3.960	3.918	3.888	3.864	3.822	3.806	3.780	3.754
30	155	3.708	3.807	3.846	3.830	3.824	3.798	3.791	3.755	3.737
30	160	3.561	3.711	3.926	3.845	3.856	3.836	3.833	3.784	3.767
30	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
30	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
30	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
30	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
30	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
30	190	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
30	195	3.880	3.990	3.988	3.949	3.911	3.866	3.863	3.794	3.766
30	200	3.383	3.623	3.777	3.819	3.854	3.851	3.853	3.820	3.799
30	205	3.118	3.519	3.740	3.798	3.839	3.855	3.856	3.839	3.812
30	210	3.622	3.862	3.923	3.921	3.935	3.915	3.917	3.864	3.838
30	215	3.582	3.811	3.889	3.879	3.893	3.875	3.869	3.843	3.814
30	220	3.313	3.620	3.792	3.806	3.790	3.782	3.773	3.762	3.727
30	225	2.965	3.380	3.687	3.736	3.698	3.706	3.698	3.699	3.655
30	230	3.000	3.390	3.695	3.735	3.676	3.677	3.667	3.667	3.620
30	235	3.015	3.370	3.685	3.751	3.738	3.747	3.743	3.746	3.705
30	240	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
30	245	3.054	3.324	3.660	3.828	3.950	3.980	3.998	3.992	3.968
30	250	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
30	255	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	260	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	265	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	270	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	275	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	280	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	290	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
30	295	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
30	300	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
30	305	4.059	4.114	4.065	4.012	3.970	3.914	3.921	3.825	3.798
30	310	3.899	4.023	4.010	3.972	3.950	3.905	3.904	3.833	3.806
30	315	3.899	4.023	4.010	3.972	3.950	3.905	3.904	3.833	3.806
30	320	4.006	4.064	4.022	3.963	3.922	3.867	3.861	3.796	3.769
30	325	3.849	3.865	3.807	3.772	3.717	3.687	3.679	3.663	3.656
30	330	3.946	3.948	3.943	3.891	3.845	3.799	3.791	3.746	3.726
30	335	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
30	340	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
30	345	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
30	350	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
30	355	2.860	3.300	3.638	3.764	3.844	3.878	3.876	3.880	3.860

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
35	0	2.810	3.300	3.632	3.764	3.896	3.950	3.960	3.970	3.950
35	5	2.950	3.300	3.644	3.780	3.872	3.902	3.934	3.910	3.890
35	10	2.945	3.300	3.644	3.778	3.862	3.890	3.890	3.895	3.875
35	15	2.955	3.300	3.644	3.782	3.882	3.914	3.918	3.925	3.905
35	20	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
35	25	3.056	3.336	3.665	3.842	3.965	3.995	4.022	4.003	3.977
35	30	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	35	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	40	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	45	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	50	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	55	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
35	60	3.030	3.300	3.650	3.792	3.890	3.902	3.904	3.910	3.890
35	65	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
35	70	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
35	75	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
35	80	3.030	3.300	3.650	3.792	3.880	3.902	3.904	3.910	3.890
35	85	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
35	90	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
35	95	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
35	100	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
35	105	3.010	3.300	3.650	3.784	3.840	3.854	3.848	3.850	3.830
35	110	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
35	115	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
35	120	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
35	125	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
35	130	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
35	135	2.965	3.370	3.692	3.741	3.714	3.723	3.715	3.716	3.675
35	140	2.956	3.390	3.681	3.767	3.817	3.843	3.840	3.841	3.814
35	145	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
35	150	3.827	3.930	3.948	3.897	3.875	3.833	3.819	3.790	3.764
35	155	3.116	3.350	3.605	3.695	3.696	3.719	3.718	3.719	3.697
35	160	3.581	3.916	3.919	3.941	3.958	3.949	3.918	3.886	3.862
35	165	3.950	4.016	4.007	3.982	3.957	3.918	3.879	3.823	3.802
35	170	3.950	4.016	4.007	3.982	3.957	3.918	3.879	3.823	3.802
35	175	3.983	4.047	4.024	3.989	3.959	3.914	3.886	3.823	3.799
35	180	4.014	4.064	4.042	4.010	3.978	3.934	3.890	3.834	3.810
35	185	4.014	4.064	4.042	4.010	3.978	3.934	3.890	3.834	3.810
35	190	3.962	4.035	4.012	3.975	3.947	3.900	3.863	3.815	3.791
35	195	3.951	4.030	4.006	3.968	3.941	3.894	3.881	3.812	3.788
35	200	3.995	4.066	4.030	3.983	3.949	3.897	3.890	3.815	3.789
35	205	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
35	210	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
35	215	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
35	220	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
35	225	3.445	3.671	3.765	3.766	3.748	3.742	3.736	3.727	3.707
35	230	3.046	3.421	3.691	3.735	3.698	3.704	3.697	3.697	3.658
35	235	3.000	3.370	3.645	3.745	3.708	3.711	3.711	3.701	3.660
35	240	3.020	3.360	3.640	3.758	3.764	3.776	3.774	3.778	3.740
35	245	3.045	3.310	3.655	3.793	3.894	3.921	3.929	3.938	3.915
35	250	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
35	255	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
35	260	3.062	3.372	3.640	3.884	4.010	4.040	4.044	4.036	4.004
35	265	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	270	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	275	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	280	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	285	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	290	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	295	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
35	300	2.937	3.182	3.676	3.859	3.972	4.011	4.013	4.004	3.969
35	305	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
35	310	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805
35	315	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
35	320	3.959	4.007	3.975	3.911	3.868	3.816	3.805	3.761	3.738
35	325	3.870	3.894	3.846	3.800	3.748	3.713	3.703	3.683	3.672
35	330	4.030	4.093	4.046	3.990	3.950	3.892	3.886	3.813	3.785
35	335	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
35	340	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
35	345	4.040	4.131	4.083	4.033	3.989	3.934	3.935	3.816	3.809
35	350	2.939	3.386	3.681	3.789	3.870	3.904	3.899	3.898	3.878
35	355	2.965	3.300	3.647	3.776	3.826	3.842	3.834	3.835	3.815

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	P. LONG	20	30	40	50	60	70	80	90	100
40	0	3.030	3.300	3.650	3.792	3.880	3.902	3.904	3.910	3.890
40	5	3.010	3.300	3.650	3.784	3.840	3.854	3.848	3.850	3.830
40	10	3.093	3.362	3.673	3.786	3.825	3.832	3.823	3.822	3.803
40	15	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
40	20	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
40	25	3.041	3.336	3.665	3.836	3.935	3.959	3.960	3.958	3.932
40	30	3.286	3.514	3.765	3.904	3.992	4.005	4.000	3.981	3.956
40	35	3.264	3.502	3.760	3.882	3.937	3.942	3.930	3.910	3.887
40	40	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
40	45	3.165	3.339	3.700	3.831	3.933	3.955	3.959	3.959	3.939
40	50	3.290	3.478	3.750	3.862	3.947	3.960	3.958	3.948	3.929
40	55	3.030	3.300	3.650	3.792	3.880	3.902	3.904	3.910	3.890
40	60	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
40	65	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
40	70	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
40	75	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
40	80	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
40	85	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.860	3.860
40	90	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
40	95	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
40	100	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
40	105	3.087	3.315	3.605	3.727	3.763	3.785	3.782	3.783	3.768
40	110	3.087	3.315	3.605	3.727	3.763	3.785	3.782	3.783	3.768
40	115	3.087	3.315	3.605	3.727	3.763	3.785	3.782	3.783	3.768
40	120	3.107	3.315	3.605	3.735	3.803	3.833	3.838	3.843	3.828
40	125	3.049	3.305	3.635	3.770	3.841	3.863	3.863	3.868	3.849
40	130	3.058	3.340	3.635	3.730	3.734	3.749	3.743	3.744	3.718
40	135	2.959	3.345	3.649	3.734	3.749	3.771	3.767	3.770	3.739
40	140	2.921	3.370	3.668	3.773	3.855	3.889	3.888	3.890	3.869
40	145	3.559	3.764	3.844	3.839	3.856	3.840	3.833	3.804	3.783
40	150	3.577	3.757	3.830	3.836	3.854	3.839	3.832	3.787	3.772
40	155	3.990	4.036	4.013	4.011	3.981	3.940	3.905	3.827	3.813
40	160	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
40	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
40	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
40	175	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
40	180	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
40	185	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
40	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
40	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
40	200	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
40	205	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
40	210	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
40	215	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748
40	220	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723
40	225	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
40	230	3.643	3.764	3.781	3.764	3.727	3.710	3.703	3.691	3.678
40	235	2.994	3.345	3.652	3.738	3.743	3.759	3.753	3.755	3.724
40	240	3.029	3.365	3.665	3.732	3.705	3.713	3.705	3.706	3.669
40	245	3.049	3.355	3.660	3.745	3.761	3.778	3.778	3.783	3.749
40	250	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
40	255	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
40	260	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
40	265	3.068	3.408	3.695	3.926	4.055	4.085	4.086	4.069	4.031
40	270	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
40	275	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
40	280	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
40	285	3.054	3.384	3.685	3.894	4.005	4.031	4.030	4.017	3.983
40	290	3.014	3.324	3.660	3.812	3.870	3.884	3.876	3.872	3.848
40	295	2.835	3.300	3.635	3.764	3.870	3.914	3.918	3.925	3.905
40	300	2.790	3.300	3.632	3.756	3.856	3.902	3.904	3.910	3.890
40	305	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
40	310	3.425	3.744	3.885	3.925	3.967	3.975	3.955	3.915	3.897
40	315	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
40	320	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805
40	325	3.967	4.017	3.982	3.919	3.876	3.824	3.815	3.766	3.742
40	330	3.868	3.896	3.850	3.800	3.744	3.712	3.701	3.682	3.670
40	335	3.994	4.051	4.014	3.956	3.916	3.860	3.850	3.794	3.766
40	340	4.090	4.131	4.083	4.033	3.989	3.934	3.925	3.836	3.809
40	345	3.695	3.402	3.965	3.970	3.978	3.963	3.927	3.889	3.865
40	350	3.133	3.558	3.771	3.942	3.916	3.943	3.932	3.920	3.898
40	355	2.825	3.300	3.635	3.760	3.850	3.890	3.890	3.895	3.875

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
45	0	3.264	3.486	3.720	3.791	3.804	3.799	3.788	3.782	3.763
45	5	3.264	3.486	3.720	3.791	3.804	3.799	3.788	3.782	3.763
45	10	3.352	3.548	3.743	3.795	3.799	3.789	3.778	3.769	3.751
45	15	3.370	3.566	3.800	3.883	3.910	3.905	3.897	3.882	3.843
45	20	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
45	25	3.360	3.566	3.800	3.879	3.870	3.881	3.859	3.832	3.813
45	30	3.600	3.744	3.900	3.945	3.937	3.915	3.885	3.840	3.822
45	35	3.600	3.744	3.900	3.945	3.937	3.915	3.885	3.840	3.822
45	40	3.125	3.419	3.715	3.800	3.805	3.808	3.796	3.788	3.759
45	45	3.370	3.566	3.800	3.883	3.910	3.905	3.887	3.862	3.843
45	50	3.625	3.744	3.900	3.955	3.987	3.975	3.955	3.915	3.897
45	55	3.050	3.300	3.650	3.800	3.920	3.950	3.950	3.970	3.950
45	60	3.030	3.300	3.650	3.792	3.880	3.902	3.904	3.910	3.890
45	65	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
45	70	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
45	75	3.039	3.305	3.635	3.766	3.821	3.839	3.835	3.838	3.819
45	80	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
45	85	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
45	90	3.010	3.300	3.650	3.784	3.840	3.854	3.848	3.850	3.830
45	95	3.010	3.300	3.650	3.784	3.840	3.854	3.848	3.850	3.830
45	100	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
45	105	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
45	110	3.017	3.312	3.655	3.800	3.865	3.881	3.876	3.876	3.854
45	115	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
45	120	2.979	3.324	3.657	3.808	3.876	3.896	3.890	3.887	3.863
45	125	2.986	3.336	3.662	3.824	3.901	3.923	3.918	3.913	3.887
45	130	3.317	3.578	3.755	3.776	3.757	3.750	3.741	3.733	3.706
45	135	3.458	3.682	3.789	3.790	3.785	3.776	3.768	3.757	3.737
45	140	3.458	3.682	3.789	3.790	3.785	3.776	3.768	3.757	3.737
45	145	3.780	3.883	3.916	3.912	3.908	3.880	3.860	3.794	3.742
45	150	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
45	155	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
45	160	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	200	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
45	205	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
45	210	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
45	215	3.974	4.021	3.999	3.932	3.892	3.836	3.822	3.760	3.752
45	220	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
45	225	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
45	230	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
45	235	2.930	3.320	3.654	3.762	3.800	3.820	3.814	3.816	3.790
45	240	3.058	3.340	3.635	3.730	3.734	3.749	3.743	3.744	3.718
45	245	3.058	3.360	3.645	3.720	3.702	3.715	3.709	3.710	3.678
45	250	3.015	3.370	3.685	3.751	3.738	3.747	3.743	3.746	3.705
45	255	3.045	3.310	3.655	3.793	3.894	3.921	3.929	3.938	3.915
45	260	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
45	265	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
45	270	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
45	275	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
45	280	3.032	3.312	3.655	3.806	3.895	3.917	3.918	3.921	3.899
45	285	2.914	3.324	3.651	3.802	3.898	3.932	3.932	3.932	3.908
45	290	3.020	3.440	3.725	3.824	3.906	3.938	3.940	3.923	3.898
45	295	3.585	3.840	3.920	3.972	3.987	3.974	3.939	3.904	3.869
45	300	3.700	3.930	3.966	4.006	4.012	3.992	3.952	3.910	3.873
45	305	3.850	4.020	4.016	4.044	4.030	3.998	3.951	3.902	3.862
45	310	3.710	3.928	3.973	4.004	4.009	3.990	3.952	3.905	3.874
45	315	3.890	4.010	4.044	4.036	4.020	3.990	3.952	3.882	3.866
45	320	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
45	325	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
45	330	3.954	3.878	3.926	3.781	3.727	3.695	3.685	3.668	3.659
45	335	3.966	4.013	3.988	3.922	3.881	3.827	3.813	3.772	3.746
45	340	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805
45	345	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
45	350	2.974	3.386	3.684	3.793	3.864	3.892	3.885	3.883	3.863
45	355	2.930	3.300	3.644	3.772	3.832	3.854	3.848	3.850	3.830

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)									
COLAT	E. LONG	20	30	40	50	60	70	80	90	100	
50	0	3.352	3.548	3.743	3.795	3.799	3.789	3.778	3.769	3.751	
50	5	3.533	3.672	3.790	3.805	3.799	3.781	3.771	3.759	3.742	
50	10	3.292	3.548	3.737	3.791	3.831	3.837	3.834	3.829	3.811	
50	15	3.805	3.922	3.997	4.007	3.990	3.961	3.925	3.863	3.846	
50	20	3.480	3.655	3.850	3.912	3.914	3.898	3.872	3.836	3.818	
50	25	3.480	3.655	3.850	3.912	3.914	3.898	3.872	3.836	3.818	
50	30	3.240	3.478	3.750	3.846	3.867	3.864	3.846	3.828	3.809	
50	35	3.015	3.100	3.650	3.786	3.850	3.866	3.862	3.865	3.845	
50	40	3.015	3.100	3.650	3.786	3.850	3.866	3.862	3.865	3.845	
50	45	3.155	3.389	3.700	3.827	3.913	3.931	3.931	3.929	3.909	
50	50	3.620	3.744	3.900	3.953	3.977	3.963	3.941	3.900	3.882	
50	55	3.020	3.100	3.650	3.788	3.860	3.878	3.876	3.880	3.860	
50	60	3.045	3.100	3.650	3.798	3.910	3.938	3.946	3.955	3.935	
50	65	3.020	3.100	3.650	3.788	3.860	3.878	3.876	3.880	3.860	
50	70	3.000	3.100	3.650	3.780	3.820	3.830	3.820	3.820	3.800	
50	75	3.015	3.100	3.650	3.786	3.850	3.866	3.862	3.865	3.845	
50	80	3.030	3.100	3.650	3.792	3.880	3.902	3.904	3.910	3.890	
50	85	3.015	3.100	3.650	3.786	3.850	3.866	3.862	3.865	3.845	
50	90	3.005	3.120	3.660	3.772	3.798	3.808	3.800	3.801	3.775	
50	95	3.000	3.120	3.660	3.770	3.788	3.796	3.786	3.786	3.760	
50	100	3.000	3.110	3.655	3.775	3.804	3.813	3.803	3.803	3.780	
50	105	3.030	3.100	3.650	3.792	3.880	3.902	3.904	3.910	3.890	
50	110	3.060	3.160	3.675	3.870	3.995	4.025	4.030	4.025	3.995	
50	115	3.222	3.460	3.712	3.846	3.935	3.951	3.953	3.948	3.923	
50	120	3.637	3.770	3.828	3.855	3.859	3.840	3.830	3.809	3.787	
50	125	3.366	3.572	3.753	3.827	3.849	3.843	3.834	3.821	3.799	
50	130	3.804	3.872	3.858	3.810	3.776	3.742	3.732	3.704	3.690	
50	135	3.842	3.896	3.871	3.814	3.772	3.735	3.723	3.699	3.684	
50	140	3.500	3.680	3.760	3.780	3.810	3.800	3.800	3.750	3.740	
50	145	4.060	4.086	4.072	4.044	4.006	3.960	3.920	3.838	3.824	
50	150	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.863	3.845	
50	155	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	160	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	200	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817	
50	205	4.049	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794	
50	210	4.038	4.103	4.053	3.998	3.958	3.900	3.894	3.818	3.790	
50	215	3.959	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743	
50	220	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743	
50	225	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
50	230	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649	
50	235	3.223	3.521	3.714	3.751	3.749	3.757	3.753	3.748	3.723	
50	240	3.116	3.150	3.605	3.695	3.646	3.719	3.718	3.719	3.697	
50	245	3.078	3.130	3.630	3.743	3.740	3.814	3.816	3.821	3.798	
50	250	3.054	3.145	3.655	3.752	3.787	3.807	3.809	3.815	3.784	
50	255	3.050	3.100	3.650	3.800	3.920	3.950	3.960	3.970	3.950	
50	260	3.045	3.100	3.650	3.798	3.910	3.938	3.946	3.955	3.935	
50	265	3.030	3.100	3.650	3.792	3.880	3.902	3.904	3.910	3.890	
50	270	3.045	3.100	3.650	3.798	3.910	3.938	3.946	3.955	3.935	
50	275	3.025	3.100	3.650	3.790	3.870	3.890	3.890	3.895	3.875	
50	280	2.945	3.100	3.644	3.778	3.862	3.890	3.890	3.895	3.875	
50	285	3.590	3.840	3.920	3.974	3.997	3.986	3.953	3.919	3.884	
50	290	4.000	4.110	4.065	4.082	4.049	4.004	3.950	3.893	3.851	
50	295	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840	
50	300	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840	
50	305	4.155	4.199	4.118	4.115	4.067	4.009	3.949	3.882	3.840	
50	310	4.190	4.170	4.143	4.112	4.058	4.002	3.950	3.865	3.844	
50	315	4.141	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	320	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813	
50	325	3.959	4.009	3.971	3.909	3.865	3.815	3.806	3.758	3.736	
50	330	3.863	3.883	3.832	3.791	3.738	3.705	3.695	3.677	3.667	
50	335	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776	
50	340	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813	
50	345	4.141	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
50	350	3.124	3.472	3.734	3.826	3.878	3.894	3.881	3.872	3.851	
50	355	3.098	3.362	3.673	3.788	3.835	3.844	3.817	3.837	3.818	

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
55	0	3.064	3.305	3.635	3.776	3.871	3.899	3.925	3.913	3.894
55	5	3.088	3.310	3.620	3.757	3.842	3.872	3.878	3.885	3.868
55	10	3.131	3.424	3.691	3.790	3.872	3.894	3.897	3.900	3.881
55	15	3.970	4.010	4.050	4.048	4.028	3.990	3.952	3.882	3.866
55	20	3.740	3.833	3.950	3.986	4.001	3.990	3.954	3.904	3.887
55	25	3.735	3.833	3.950	3.984	3.991	3.968	3.940	3.889	3.872
55	30	3.735	3.833	3.950	3.984	3.991	3.968	3.940	3.889	3.872
55	35	3.140	3.389	3.700	3.821	3.883	3.895	3.839	3.884	3.864
55	40	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
55	45	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
55	50	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
55	55	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
55	60	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
55	65	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
55	70	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
55	75	3.010	3.310	3.655	3.779	3.824	3.837	3.831	3.833	3.810
55	80	3.017	3.342	3.670	3.785	3.817	3.830	3.825	3.825	3.794
55	85	3.035	3.330	3.665	3.779	3.842	3.863	3.867	3.874	3.845
55	90	3.020	3.360	3.680	3.758	3.764	3.776	3.774	3.778	3.740
55	95	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
55	100	3.010	3.360	3.680	3.754	3.744	3.752	3.746	3.748	3.710
55	105	3.034	3.324	3.660	3.820	3.910	3.932	3.932	3.932	3.908
55	110	3.034	3.324	3.660	3.820	3.910	3.932	3.932	3.932	3.908
55	115	3.027	3.312	3.655	3.804	3.885	3.905	3.904	3.906	3.884
55	120	3.528	3.672	3.790	3.903	3.769	3.769	3.757	3.744	3.727
55	125	3.804	3.872	3.858	3.810	3.776	3.742	3.732	3.704	3.690
55	130	3.690	3.800	3.821	3.799	3.789	3.764	3.757	3.721	3.709
55	135	3.804	3.872	3.858	3.910	3.776	3.742	3.732	3.704	3.690
55	140	3.835	3.938	3.944	3.948	3.936	3.903	3.875	3.812	3.791
55	145	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
55	150	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
55	155	4.165	4.196	4.125	4.117	4.064	4.007	3.949	3.877	3.841
55	160	4.185	4.192	4.139	4.113	4.059	4.003	3.950	3.867	3.843
55	165	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
55	170	4.171	4.174	4.131	4.089	4.037	3.934	3.931	3.957	3.836
55	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	215	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809
55	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
55	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
55	230	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
55	235	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
55	240	3.014	3.400	3.651	3.732	3.779	3.813	3.815	3.816	3.793
55	245	3.076	3.339	3.612	3.759	3.839	3.875	3.880	3.880	3.851
55	250	3.102	3.315	3.605	3.733	3.793	3.821	3.824	3.828	3.813
55	255	3.069	3.305	3.615	3.778	3.881	3.911	3.919	3.928	3.909
55	260	3.040	3.300	3.650	3.796	3.900	3.926	3.932	3.940	3.920
55	265	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
55	270	3.000	3.300	3.647	3.790	3.896	3.926	3.932	3.940	3.920
55	275	2.955	3.300	3.644	3.782	3.882	3.914	3.918	3.925	3.905
55	280	3.180	3.570	3.774	3.866	3.944	3.968	3.957	3.944	3.917
55	285	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
55	290	4.175	4.194	4.132	4.115	4.061	4.005	3.949	3.872	3.842
55	295	4.171	4.174	4.131	4.089	4.037	3.934	3.931	3.857	3.836
55	300	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	310	4.061	4.110	4.064	4.011	3.968	3.912	3.893	3.824	3.797
55	315	3.985	4.033	3.994	3.934	3.891	3.839	3.826	3.775	3.751
55	320	3.876	3.904	3.860	3.809	3.758	3.721	3.710	3.689	3.677
55	325	4.040	4.098	4.052	3.997	3.956	3.899	3.890	3.817	3.789
55	330	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
55	335	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
55	340	4.155	4.170	4.121	4.082	4.032	3.979	3.924	3.859	3.833
55	345	4.155	4.174	4.118	4.119	4.067	4.009	3.949	3.882	3.840
55	350	3.045	3.390	3.690	3.806	3.857	3.872	3.861	3.856	3.834
55	355	3.102	3.315	3.605	3.733	3.793	3.821	3.824	3.828	3.813

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
60	0	3.054	3.324	3.660	3.828	3.950	3.980	3.988	3.992	3.968
60	5	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
60	10	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
60	15	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
60	20	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
60	25	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
60	30	3.283	3.478	3.687	3.805	3.873	3.888	3.892	3.890	3.872
60	35	3.120	3.375	3.669	3.816	3.904	3.925	3.928	3.928	3.906
60	40	3.053	3.348	3.670	3.854	3.970	3.998	4.002	3.999	3.971
60	45	3.040	3.300	3.650	3.796	3.900	3.926	3.932	3.940	3.920
60	50	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
60	55	3.005	3.300	3.650	3.782	3.830	3.842	3.834	3.835	3.815
60	60	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
60	65	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
60	70	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
60	75	3.041	3.336	3.665	3.836	3.935	3.959	3.960	3.958	3.932
60	80	3.012	3.312	3.655	3.798	3.855	3.869	3.862	3.861	3.839
60	85	3.012	3.342	3.670	3.783	3.807	3.818	3.811	3.810	3.779
60	90	3.017	3.342	3.670	3.785	3.917	3.830	3.825	3.825	3.794
60	95	3.000	3.370	3.685	3.745	3.768	3.711	3.701	3.701	3.660
60	100	3.037	3.342	3.670	3.793	3.857	3.878	3.881	3.885	3.854
60	105	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
60	110	3.007	3.312	3.655	3.796	3.845	3.857	3.848	3.846	3.824
60	115	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
60	120	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
60	125	3.766	3.848	3.846	3.807	3.781	3.750	3.740	3.710	3.697
60	130	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
60	135	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
60	140	3.885	3.956	3.928	3.901	3.866	3.827	3.802	3.762	3.739
60	145	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
60	150	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
60	155	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
60	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
60	165	4.175	4.194	4.132	4.115	4.061	4.005	3.949	3.872	3.842
60	170	4.190	4.190	4.143	4.112	4.058	4.002	3.950	3.865	3.844
60	175	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
60	180	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
60	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	210	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
60	215	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
60	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
60	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
60	230	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748
60	235	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
60	240	3.673	3.816	3.881	3.851	3.844	3.818	3.808	3.787	3.765
60	245	2.918	3.320	3.613	3.728	3.790	3.831	3.833	3.838	3.818
60	250	3.052	3.315	3.602	3.723	3.769	3.797	3.796	3.798	3.783
60	255	3.087	3.355	3.625	3.707	3.699	3.717	3.714	3.715	3.688
60	260	2.890	3.300	3.638	3.776	3.904	3.950	3.960	3.970	3.950
60	265	3.590	3.840	3.920	3.974	3.997	3.986	3.953	3.919	3.884
60	270	3.590	3.840	3.920	3.974	3.997	3.986	3.953	3.919	3.884
60	275	2.920	3.390	3.678	3.796	3.911	3.956	3.959	3.961	3.939
60	280	2.950	3.480	3.719	3.816	3.918	3.962	3.958	3.953	3.928
60	285	4.160	4.198	4.122	4.118	4.065	4.008	3.949	3.880	3.841
60	290	4.149	4.163	4.117	4.072	4.023	3.971	3.917	3.855	3.830
60	295	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	300	4.141	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	305	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
60	310	3.944	3.988	3.950	3.892	3.847	3.799	3.789	3.747	3.726
60	315	3.868	3.896	3.850	3.800	3.748	3.712	3.701	3.682	3.670
60	320	4.040	4.098	4.052	3.997	3.956	3.899	3.890	3.817	3.789
60	325	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
60	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
60	335	4.149	4.163	4.117	4.072	4.023	3.971	3.917	3.855	3.830
60	340	3.775	3.929	3.976	4.013	3.948	3.967	3.924	3.878	3.841
60	345	2.929	3.324	3.651	3.808	3.928	3.968	3.974	3.977	3.953
60	350	3.049	3.348	3.670	3.852	3.960	3.986	3.988	3.984	3.956
60	355	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
65	0	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
65	5	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
65	10	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
65	15	3.044	3.324	3.660	3.824	3.930	3.956	3.960	3.962	3.938
65	20	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
65	25	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
65	30	3.062	3.372	3.680	3.884	4.010	4.040	4.044	4.036	4.004
65	35	3.435	3.605	3.715	3.816	3.842	3.845	3.842	3.829	3.811
65	40	3.056	3.346	3.690	3.908	4.020	4.046	4.044	4.028	3.992
65	45	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
65	50	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
65	55	3.076	3.351	3.656	3.782	3.870	3.895	3.900	3.906	3.888
65	60	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	65	3.213	3.558	3.777	3.854	3.924	3.943	3.932	3.920	3.898
65	70	2.994	3.324	3.657	3.814	3.906	3.932	3.932	3.932	3.908
65	75	3.019	3.324	3.660	3.814	3.880	3.896	3.890	3.887	3.863
65	80	3.059	3.384	3.685	3.896	4.015	4.043	4.044	4.032	3.998
65	85	2.938	3.348	3.661	3.838	3.968	4.010	4.016	4.014	3.986
65	90	2.945	3.300	3.644	3.778	3.862	3.890	3.890	3.895	3.875
65	95	3.000	3.380	3.690	3.740	3.692	3.694	3.684	3.684	3.640
65	100	3.005	3.390	3.695	3.737	3.686	3.689	3.681	3.662	3.635
65	105	2.950	3.310	3.649	3.775	3.856	3.885	3.887	3.893	3.870
65	110	2.860	3.300	3.638	3.764	3.844	3.878	3.876	3.880	3.860
65	115	2.685	3.300	3.623	3.744	3.874	3.938	3.946	3.955	3.935
65	120	3.715	3.849	3.877	3.867	3.869	3.840	3.839	3.777	3.760
65	125	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.864	3.776
65	130	3.990	4.046	4.005	3.945	3.903	3.850	3.842	3.783	3.758
65	135	4.006	4.064	4.022	3.963	3.922	3.867	3.861	3.796	3.769
65	140	3.856	3.963	3.954	3.947	3.932	3.893	3.874	3.811	3.785
65	145	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	150	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	155	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	165	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	170	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
65	175	4.195	4.189	4.146	4.111	4.056	4.001	3.950	3.862	3.844
65	180	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
65	185	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
65	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	210	4.111	4.143	4.095	4.047	4.001	3.948	3.928	3.844	3.817
65	215	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
65	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
65	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
65	230	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
65	235	3.958	4.000	3.905	3.915	3.875	3.820	3.823	3.770	3.743
65	240	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723
65	245	3.581	3.734	3.810	3.803	3.790	3.771	3.760	3.746	3.730
65	250	3.570	3.660	3.713	3.741	3.711	3.700	3.694	3.647	3.681
65	255	3.000	3.340	3.670	3.760	3.756	3.762	3.752	3.752	3.720
65	260	3.328	3.578	3.796	3.860	3.894	3.897	3.884	3.871	3.843
65	265	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	270	3.327	3.644	3.823	3.883	3.944	3.957	3.941	3.924	3.901
65	275	3.352	3.644	3.826	3.883	3.918	3.921	3.899	3.879	3.856
65	280	3.254	3.564	3.787	3.865	3.915	3.926	3.911	3.891	3.872
65	285	4.051	4.085	4.041	4.056	4.014	3.967	3.918	3.853	3.832
65	290	3.914	3.988	4.020	4.010	3.980	3.940	3.894	3.848	3.822
65	295	4.079	4.112	4.078	4.039	3.999	3.951	3.902	3.844	3.819
65	300	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	305	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
65	310	3.920	3.960	3.926	3.865	3.819	3.774	3.761	3.730	3.710
65	315	3.855	3.875	3.822	3.781	3.727	3.696	3.686	3.669	3.660
65	320	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
65	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
65	335	4.149	4.163	4.117	4.072	4.023	3.971	3.917	3.855	3.830
65	340	3.704	3.857	3.957	4.008	4.027	4.010	3.982	3.926	3.905
65	345	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
65	350	3.054	3.324	3.660	3.828	3.950	3.990	3.988	3.992	3.968
65	355	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
70	0	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
70	5	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
70	10	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
70	15	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
70	20	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
70	25	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
70	30	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
70	35	3.287	3.502	3.697	3.833	3.903	3.918	3.920	3.912	3.890
70	40	3.433	3.593	3.710	3.802	3.827	3.830	3.828	3.818	3.802
70	45	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
70	50	3.163	3.403	3.665	3.779	3.365	3.889	3.836	3.902	3.886
70	55	3.545	3.660	3.710	3.741	3.717	3.736	3.736	3.732	3.726
70	60	4.111	4.143	4.095	4.047	4.001	3.948	3.938	3.844	3.817
70	65	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
70	70	3.107	3.490	3.743	3.846	3.916	3.939	3.930	3.914	3.893
70	75	3.040	3.360	3.675	3.862	3.955	3.977	3.974	3.965	3.935
70	80	3.174	3.473	3.735	3.927	4.020	4.048	4.043	4.021	3.987
70	85	3.425	3.744	3.865	3.925	3.967	3.975	3.955	3.915	3.897
70	90	3.495	3.744	3.891	3.933	3.955	3.951	3.927	3.885	3.867
70	95	3.080	3.440	3.718	3.785	3.771	3.775	3.762	3.756	3.719
70	100	3.015	3.370	3.685	3.751	3.738	3.747	3.743	3.746	3.705
70	105	2.842	3.332	3.650	3.770	3.863	3.907	3.912	3.917	3.889
70	110	2.808	3.372	3.654	3.747	3.847	3.899	3.924	3.910	3.888
70	115	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
70	120	3.769	3.891	3.906	3.889	3.884	3.850	3.849	3.784	3.765
70	125	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
70	130	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
70	135	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
70	140	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
70	145	4.085	4.148	4.079	4.086	4.042	3.989	3.934	3.871	3.830
70	150	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
70	155	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
70	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
70	165	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
70	170	4.165	4.196	4.125	4.117	4.064	4.007	3.949	3.877	3.841
70	175	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
70	180	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
70	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	215	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	220	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
70	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
70	230	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.744	3.766
70	235	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
70	240	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
70	245	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
70	250	3.608	3.754	3.773	3.765	3.749	3.739	3.734	3.723	3.713
70	255	3.405	3.610	3.763	3.795	3.800	3.791	3.781	3.771	3.754
70	260	3.036	3.380	3.682	3.784	3.841	3.860	3.857	3.858	3.834
70	265	2.915	3.320	3.651	3.766	3.846	3.880	3.884	3.891	3.865
70	270	3.323	3.578	3.796	3.858	3.884	3.885	3.870	3.856	3.828
70	275	3.610	3.821	3.904	3.923	3.939	3.934	3.905	3.874	3.851
70	280	3.730	3.902	3.968	3.974	3.972	3.951	3.913	3.874	3.850
70	285	3.686	3.836	3.918	3.943	3.908	3.879	3.842	3.807	3.777
70	290	4.079	4.112	4.078	4.039	3.999	3.951	3.902	3.844	3.819
70	295	3.950	4.016	4.007	3.982	3.957	3.918	3.879	3.823	3.802
70	300	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	305	4.022	4.092	4.039	3.981	3.941	3.894	3.879	3.808	3.781
70	310	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
70	315	3.959	4.007	3.975	3.911	3.868	3.816	3.825	3.761	3.738
70	320	4.090	4.131	4.083	4.033	3.989	3.934	3.925	3.836	3.809
70	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
70	330	4.154	4.166	4.120	4.076	4.027	3.974	3.920	3.856	3.831
70	335	4.175	4.194	4.132	4.115	4.061	4.005	3.949	3.872	3.842
70	340	3.520	3.750	3.876	3.948	3.986	3.980	3.954	3.927	3.895
70	345	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
70	350	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
70	355	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
75	0	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
75	5	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
75	10	3.047	3.312	3.655	3.812	3.925	3.953	3.960	3.966	3.944
75	15	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
75	20	3.059	3.384	3.685	3.896	4.015	4.043	4.044	4.032	3.998
75	25	3.062	3.372	3.680	3.884	4.010	4.040	4.044	4.036	4.004
75	30	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
75	35	3.026	3.336	3.665	3.830	3.905	3.923	3.918	3.913	3.887
75	40	3.244	3.454	3.677	3.763	3.773	3.774	3.766	3.763	3.749
75	45	3.429	3.569	3.700	3.774	3.797	3.800	3.800	3.796	3.784
75	50	3.622	3.712	3.719	3.734	3.712	3.706	3.734	3.698	3.694
75	55	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
75	60	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	65	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	70	3.760	3.942	3.966	3.946	3.942	3.910	3.910	3.848	3.822
75	75	3.028	3.408	3.692	3.920	4.051	4.085	4.086	4.069	4.031
75	80	3.622	3.845	3.946	3.982	4.004	3.995	3.968	3.915	3.896
75	85	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
75	90	3.883	3.950	3.945	3.915	3.888	3.852	3.827	3.776	3.760
75	95	3.370	3.640	3.775	3.776	3.750	3.752	3.744	3.735	3.709
75	100	2.915	3.330	3.656	3.761	3.830	3.863	3.867	3.874	3.845
75	105	2.994	3.324	3.657	3.814	3.906	3.932	3.932	3.932	3.908
75	110	3.265	3.610	3.751	3.779	3.824	3.839	3.837	3.831	3.814
75	115	3.880	3.920	3.893	3.818	3.768	3.728	3.715	3.693	3.678
75	120	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
75	125	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	130	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	135	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	140	4.072	4.132	4.072	4.035	3.991	3.933	3.913	3.838	3.805
75	145	4.150	4.270	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	150	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	155	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	165	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	170	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
75	175	4.165	4.196	4.125	4.117	4.064	4.007	3.949	3.877	3.841
75	180	4.185	4.172	4.139	4.113	4.059	4.003	3.950	3.867	3.843
75	185	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
75	190	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
75	195	4.146	4.180	4.114	4.094	4.044	3.989	3.931	3.870	3.834
75	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
75	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
75	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
75	215	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
75	220	4.038	4.133	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	225	4.038	4.133	4.053	3.998	3.958	3.900	3.898	3.818	3.790
75	230	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
75	235	3.958	4.000	3.945	3.915	3.875	3.820	3.803	3.770	3.743
75	240	3.919	3.960	3.914	3.866	3.821	3.774	3.759	3.731	3.710
75	245	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
75	250	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668
75	255	3.828	3.846	3.769	3.744	3.686	3.662	3.655	3.643	3.640
75	260	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
75	265	3.665	3.795	3.866	3.853	3.845	3.820	3.809	3.789	3.764
75	270	3.310	3.578	3.756	3.803	3.836	3.836	3.830	3.813	3.794
75	275	3.332	3.639	3.784	3.833	3.883	3.898	3.887	3.864	3.846
75	280	3.884	3.988	4.017	4.008	3.996	3.964	3.922	3.878	3.852
75	285	3.511	3.740	3.880	3.915	3.936	3.930	3.905	3.880	3.854
75	290	3.471	3.740	3.877	3.909	3.932	3.930	3.905	3.880	3.854
75	295	3.586	3.816	3.919	3.943	3.968	3.961	3.932	3.901	3.877
75	300	4.014	4.064	4.042	4.010	3.978	3.934	3.890	3.834	3.810
75	305	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
75	310	4.053	4.099	4.057	4.002	3.960	3.904	3.883	3.819	3.792
75	315	3.890	3.923	3.885	3.828	3.779	3.739	3.726	3.703	3.688
75	320	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
75	325	3.985	4.033	3.974	3.934	3.891	3.839	3.826	3.775	3.751
75	330	4.085	4.117	4.075	4.023	3.979	3.925	3.888	3.831	3.803
75	335	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
75	340	3.666	3.816	3.925	3.955	3.976	3.961	3.932	3.901	3.877
75	345	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
75	350	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
75	355	3.064	3.394	3.685	3.898	4.025	4.055	4.058	4.047	4.013

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
80	0	3.024	3.384	3.692	3.892	4.021	4.055	4.058	4.047	4.013
80	5	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
80	10	3.059	3.384	3.685	3.896	4.015	4.043	4.044	4.032	3.998
80	15	3.062	3.372	3.680	3.884	4.010	4.040	4.044	4.036	4.004
80	20	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
80	25	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
80	30	3.039	3.324	3.660	3.822	3.920	3.944	3.946	3.947	3.923
80	35	3.014	3.324	3.660	3.812	3.870	3.884	3.876	3.872	3.848
80	40	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
80	45	3.010	3.300	3.647	3.794	3.916	3.950	3.960	3.970	3.950
80	50	3.802	3.954	3.974	3.966	3.961	3.925	3.924	3.859	3.831
80	55	3.901	3.931	3.880	3.935	3.786	3.748	3.739	3.708	3.694
80	60	3.828	3.836	3.769	3.744	3.696	3.662	3.655	3.643	3.640
80	65	4.025	4.043	3.992	3.949	3.899	3.855	3.819	3.778	3.758
80	70	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	75	2.924	3.413	3.692	3.821	3.929	3.973	3.973	3.966	3.942
80	80	3.551	3.780	3.909	3.985	4.024	4.020	3.997	3.948	3.924
80	85	4.200	4.138	4.150	4.110	4.055	4.000	3.950	3.860	3.845
80	90	3.633	3.854	3.933	3.944	3.959	3.945	3.928	3.874	3.855
80	95	3.335	3.630	3.767	3.777	3.780	3.781	3.775	3.767	3.744
80	100	2.720	3.320	3.636	3.738	3.836	3.892	3.898	3.906	3.880
80	105	2.773	3.362	3.646	3.748	3.864	3.928	3.935	3.942	3.923
80	110	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
80	115	3.616	3.734	3.813	3.807	3.784	3.759	3.746	3.731	3.715
80	120	3.728	3.824	3.834	3.803	3.785	3.757	3.749	3.716	3.703
80	125	3.769	3.891	3.906	3.889	3.884	3.850	3.849	3.784	3.765
80	130	3.791	3.911	3.919	3.913	3.906	3.872	3.859	3.797	3.775
80	135	3.942	4.009	3.963	3.961	3.925	3.844	3.852	3.800	3.773
80	140	4.016	4.046	3.985	3.962	3.907	3.864	3.825	3.783	3.756
80	145	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
80	150	4.083	4.123	4.040	4.041	3.987	3.937	3.887	3.834	3.798
80	155	4.083	4.121	4.040	4.041	3.987	3.937	3.887	3.834	3.798
80	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
80	165	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
80	170	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
80	175	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
80	180	4.185	4.192	4.139	4.113	4.059	4.033	3.950	3.867	3.843
80	185	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
80	190	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
80	195	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
80	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	215	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
80	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
80	230	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
80	235	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
80	240	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.708	3.691
80	245	3.880	3.920	3.893	3.818	3.768	3.728	3.715	3.693	3.678
80	250	3.880	3.920	3.893	3.818	3.768	3.728	3.715	3.693	3.678
80	255	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
80	260	3.888	3.928	3.893	3.828	3.779	3.737	3.724	3.701	3.684
80	265	3.942	3.984	3.965	3.896	3.854	3.802	3.785	3.755	3.730
80	270	3.942	3.984	3.965	3.896	3.854	3.802	3.785	3.755	3.730
80	275	3.263	3.464	3.755	3.803	3.839	3.844	3.838	3.830	3.809
80	280	3.137	3.450	3.716	3.800	3.857	3.871	3.870	3.868	3.844
80	285	3.020	3.360	3.680	3.758	3.764	3.776	3.774	3.778	3.740
80	290	3.051	3.346	3.670	3.935	3.939	3.966	3.971	3.971	3.942
80	295	3.008	3.348	3.667	3.846	3.956	3.986	3.988	3.984	3.956
80	300	3.262	3.522	3.790	3.890	3.968	3.985	3.974	3.957	3.931
80	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
80	310	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
80	315	3.935	3.978	3.951	3.884	3.840	3.791	3.777	3.744	3.722
80	320	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
80	325	3.876	3.904	3.860	3.809	3.758	3.721	3.710	3.689	3.677
80	330	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
80	335	4.101	4.137	4.089	4.040	3.995	3.941	3.937	3.840	3.813
80	340	4.122	4.149	4.101	4.054	4.009	3.954	3.910	3.848	3.820
80	345	3.522	3.766	3.890	3.964	4.007	4.004	3.978	3.945	3.916
80	350	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
80	355	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
05	0	3.994	4.074	4.064	4.035	4.006	3.966	3.918	3.866	3.840
05	5	3.770	3.902	3.971	3.980	3.976	3.951	3.913	3.874	3.850
05	10	3.068	3.408	3.695	3.726	4.055	4.035	4.086	4.069	4.031
05	15	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959
05	20	3.056	3.336	3.665	3.942	3.965	3.945	4.002	4.003	3.977
05	25	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
05	30	3.049	3.384	3.685	3.892	3.995	4.019	4.016	4.002	3.968
05	35	3.026	3.336	3.665	3.930	3.905	3.923	3.918	3.913	3.887
05	40	3.054	3.324	3.660	3.828	3.950	3.940	3.988	3.992	3.968
05	45	3.884	3.988	4.017	4.008	3.996	3.964	3.922	3.878	3.852
05	50	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.933	3.805
05	55	4.048	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
05	60	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
05	65	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
05	70	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	75	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
05	80	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.895	3.840
05	85	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
05	90	3.899	4.023	4.010	3.972	3.950	3.905	3.904	3.833	3.806
05	95	3.545	3.773	3.849	3.859	3.883	3.870	3.871	3.821	3.802
05	100	3.010	3.444	3.686	3.749	3.793	3.818	3.819	3.808	3.782
05	105	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
05	110	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
05	115	3.616	3.734	3.813	3.807	3.784	3.759	3.746	3.731	3.715
05	120	3.842	3.896	3.871	3.814	3.772	3.735	3.723	3.639	3.684
05	125	3.264	3.613	3.763	3.808	3.868	3.880	3.834	3.852	3.934
05	130	3.774	3.958	3.974	3.998	3.994	3.966	3.931	3.882	3.847
05	135	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
05	140	3.927	3.970	3.941	3.875	3.830	3.782	3.768	3.736	3.715
05	145	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
05	150	4.031	4.056	4.034	3.973	3.929	3.874	3.847	3.777	3.774
05	155	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
05	160	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
05	165	4.149	4.196	4.115	4.115	4.063	4.006	3.945	3.862	3.839
05	170	4.148	4.188	4.114	4.104	4.054	3.997	3.938	3.876	3.836
05	175	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
05	180	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
05	185	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
05	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
05	215	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
05	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
05	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
05	230	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
05	235	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
05	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
05	245	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
05	250	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
05	255	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
05	260	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
05	265	3.855	3.875	3.822	3.781	3.727	3.696	3.686	3.669	3.660
05	270	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
05	275	3.245	3.578	3.709	3.751	3.793	3.814	3.815	3.813	3.800
05	280	2.982	3.325	3.601	3.710	3.765	3.804	3.807	3.811	3.793
05	285	3.047	3.322	3.660	3.807	3.909	3.936	3.943	3.949	3.924
05	290	3.066	3.346	3.690	3.912	4.040	4.070	4.072	4.058	4.022
05	295	3.066	3.346	3.690	3.912	4.040	4.070	4.072	4.058	4.022
05	300	3.068	3.408	3.695	3.926	4.055	4.085	4.086	4.069	4.031
05	305	2.982	3.372	3.674	3.872	4.002	4.040	4.044	4.036	4.004
05	310	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
05	315	4.085	4.117	4.075	4.023	3.979	3.925	3.888	3.831	3.803
05	320	3.990	4.046	4.005	3.945	3.903	3.850	3.842	3.783	3.758
05	325	3.906	3.934	3.905	3.848	3.801	3.757	3.744	3.719	3.701
05	330	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
05	335	3.901	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
05	340	3.998	4.054	4.016	3.955	3.914	3.859	3.851	3.791	3.765
05	345	4.106	4.128	4.087	4.037	3.991	3.938	3.891	3.838	3.811
05	350	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809
05	355	4.143	4.160	4.113	4.068	4.020	3.960	3.913	3.855	3.828

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
90	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	5	3.884	3.988	4.017	4.008	3.996	3.964	3.922	3.878	3.852
90	10	3.016	3.316	3.662	3.836	3.961	3.995	4.062	4.003	3.977
90	15	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
90	20	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
90	25	3.052	3.372	3.680	3.880	3.990	4.016	4.016	4.006	3.974
90	30	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
90	35	3.045	3.360	3.675	3.964	3.965	3.989	3.988	3.980	3.950
90	40	3.775	3.902	3.971	3.982	3.986	3.963	3.927	3.899	3.865
90	45	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	50	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	55	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
90	60	4.005	4.049	4.000	3.949	3.903	3.854	3.839	3.782	3.759
90	65	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
90	70	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836
90	75	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	80	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	85	4.103	4.137	4.092	4.043	3.997	3.940	3.919	3.835	3.812
90	90	3.973	4.063	4.052	4.021	3.994	3.953	3.915	3.859	3.833
90	95	3.792	3.959	3.984	3.967	3.961	3.930	3.915	3.859	3.833
90	100	3.114	3.494	3.711	3.786	3.855	3.876	3.878	3.859	3.841
90	105	2.770	3.338	3.637	3.748	3.867	3.923	3.930	3.933	3.914
90	110	3.030	3.406	3.681	3.757	3.782	3.797	3.793	3.785	3.758
90	115	3.376	3.576	3.741	3.788	3.806	3.798	3.791	3.767	3.752
90	120	3.528	3.672	3.790	3.903	3.789	3.769	3.757	3.744	3.727
90	125	3.766	3.848	3.846	3.807	3.781	3.750	3.740	3.710	3.697
90	130	3.526	3.690	3.774	3.788	3.803	3.769	3.785	3.746	3.734
90	135	3.766	3.848	3.846	3.807	3.781	3.750	3.740	3.710	3.697
90	140	3.744	3.840	3.854	3.822	3.806	3.775	3.767	3.731	3.716
90	145	3.912	3.968	3.962	3.901	3.868	3.818	3.833	3.768	3.743
90	150	4.152	4.150	4.117	4.071	4.019	3.964	3.921	3.842	3.825
90	155	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	160	4.190	4.190	4.143	4.112	4.058	4.032	3.950	3.865	3.844
90	165	4.185	4.192	4.139	4.113	4.059	4.003	3.950	3.867	3.843
90	170	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	175	4.200	4.188	4.150	4.110	4.055	4.030	3.950	3.860	3.845
90	180	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	185	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
90	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
90	215	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
90	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
90	225	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
90	230	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
90	235	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
90	240	3.880	3.920	3.893	3.818	3.768	3.728	3.715	3.693	3.678
90	245	3.880	3.920	3.893	3.818	3.768	3.728	3.715	3.693	3.678
90	250	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
90	255	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
90	260	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673
90	265	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
90	270	3.881	3.917	3.879	3.818	3.768	3.729	3.716	3.694	3.680
90	275	3.509	3.762	3.830	3.802	3.768	3.746	3.735	3.720	3.696
90	280	3.152	3.347	3.585	3.703	3.714	3.765	3.767	3.767	3.750
90	285	3.032	3.312	3.655	3.806	3.895	3.917	3.918	3.921	3.899
90	290	3.051	3.336	3.665	3.840	3.955	3.983	3.998	3.988	3.962
90	295	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
90	300	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
90	305	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
90	310	2.972	3.312	3.649	3.802	3.927	3.965	3.974	3.941	3.959
90	315	3.268	3.553	3.770	3.861	3.938	3.950	3.955	3.935	3.911
90	320	3.607	3.806	3.899	3.941	3.969	3.950	3.951	3.901	3.872
90	325	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
90	330	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
90	335	3.921	3.964	3.920	3.863	3.815	3.771	3.762	3.724	3.707
90	340	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673
90	345	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668
90	350	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
90	355	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)									
COLAT	E. LONG	20	30	40	50	60	70	80	90	100	
95	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	10	3.451	3.668	3.842	3.929	3.986	3.987	3.969	3.946	3.919	
95	15	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950	
95	20	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995	
95	25	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935	
95	30	3.048	3.348	3.670	3.852	3.960	3.986	3.988	3.984	3.956	
95	35	3.022	3.372	3.677	3.878	4.006	4.040	4.044	4.036	4.004	
95	40	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	45	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	50	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	55	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	60	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659	
95	65	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649	
95	70	3.943	3.993	3.951	3.890	3.844	3.797	3.788	3.743	3.723	
95	75	4.103	4.137	4.092	4.043	3.997	3.940	3.919	3.835	3.812	
95	80	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	85	4.135	4.154	4.111	4.065	4.016	3.960	3.929	3.843	3.823	
95	90	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801	
95	95	4.070	4.120	4.072	4.020	3.977	3.920	3.908	3.826	3.801	
95	100	4.065	4.103	4.072	4.032	3.992	3.940	3.914	3.832	3.812	
95	105	3.889	3.956	3.949	3.924	3.897	3.859	3.834	3.779	3.763	
95	110	3.676	3.858	3.906	3.914	3.916	3.898	3.875	3.832	3.811	
95	115	3.766	3.848	3.846	3.807	3.781	3.750	3.740	3.710	3.697	
95	120	3.500	3.680	3.760	3.780	3.810	3.800	3.800	3.750	3.740	
95	125	3.652	3.776	3.809	3.795	3.733	3.771	3.766	3.727	3.715	
95	130	3.275	3.490	3.705	3.790	3.865	3.875	3.880	3.860	3.845	
95	135	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950	
95	140	3.265	3.490	3.705	3.786	3.845	3.851	3.852	3.830	3.815	
95	145	3.500	3.680	3.760	3.780	3.810	3.800	3.800	3.750	3.740	
95	150	3.821	3.904	3.917	3.874	3.855	3.814	3.802	3.764	3.742	
95	155	3.915	3.974	3.973	3.927	3.898	3.852	3.832	3.784	3.763	
95	160	4.060	4.086	4.072	4.044	4.006	3.960	3.920	3.838	3.824	
95	165	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	170	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	175	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	180	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	185	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
95	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	215	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809	
95	220	4.039	4.103	4.053	3.998	3.958	3.900	3.898	3.819	3.796	
95	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
95	230	3.958	4.000	3.985	3.915	3.875	3.820	3.833	3.770	3.743	
95	235	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723	
95	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
95	245	3.860	3.848	3.840	3.790	3.737	3.703	3.692	3.674	3.664	
95	250	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630	
95	255	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664	
95	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
95	265	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717	
95	270	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762	
95	275	3.686	3.867	3.911	3.907	3.910	3.888	3.890	3.836	3.812	
95	280	3.145	3.345	3.585	3.682	3.693	3.721	3.722	3.724	3.706	
95	285	3.122	3.315	3.605	3.741	3.833	3.869	3.880	3.888	3.873	
95	290	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959	
95	295	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986	
95	300	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995	
95	305	3.068	3.408	3.695	3.926	4.055	4.045	4.086	4.069	4.031	
95	310	3.051	3.336	3.665	3.840	3.955	3.983	3.988	3.988	3.962	
95	315	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986	
95	320	3.059	3.384	3.695	3.896	4.015	4.043	4.044	4.032	3.998	
95	325	3.670	3.840	3.935	3.983	4.006	3.991	3.960	3.923	3.895	
95	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
95	335	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776	
95	340	3.847	3.933	3.899	3.838	3.740	3.747	3.734	3.710	3.693	
95	345	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654	
95	350	4.014	4.072	4.033	3.973	3.931	3.876	3.869	3.804	3.776	
95	355	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
100	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	10	2.860	3.360	3.660	3.940	3.975	4.025	4.030	4.025	3.995
100	15	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
100	20	3.054	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
100	25	3.068	3.408	3.695	3.926	4.055	4.085	4.086	4.069	4.031
100	30	3.061	3.396	3.690	3.910	4.030	4.058	4.058	4.043	4.007
100	35	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022
100	40	3.812	3.934	4.002	4.023	4.015	3.988	3.953	3.889	3.870
100	45	3.424	3.679	3.654	3.936	3.976	3.976	3.956	3.918	3.896
100	50	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	55	3.847	3.867	3.811	3.771	3.716	3.646	3.677	3.661	3.654
100	60	3.854	3.878	3.826	3.781	3.727	3.695	3.695	3.669	3.659
100	65	3.880	3.920	3.883	3.814	3.768	3.728	3.715	3.693	3.678
100	70	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
100	75	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
100	80	4.087	4.128	4.082	4.032	3.987	3.930	3.914	3.831	3.806
100	85	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
100	90	4.070	4.120	4.072	4.020	3.977	3.920	3.908	3.826	3.801
100	95	4.168	4.171	4.131	4.088	4.036	3.980	3.940	3.852	3.834
100	100	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
100	105	4.165	4.196	4.125	4.117	4.064	4.007	3.949	3.877	3.841
100	110	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
100	115	4.150	4.200	4.115	4.120	4.068	4.010	3.949	3.885	3.840
100	120	3.105	3.414	3.677	3.782	3.879	3.905	3.912	3.904	3.887
100	125	3.014	3.404	3.720	3.772	3.742	3.748	3.740	3.736	3.688
100	130	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.059	4.022
100	135	3.060	3.360	3.675	3.970	3.995	4.025	4.030	4.025	3.995
100	140	2.974	3.324	3.654	3.916	3.942	3.940	3.988	3.972	3.968
100	145	3.912	3.968	3.962	3.901	3.868	3.818	3.803	3.768	3.743
100	150	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
100	155	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
100	160	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
100	165	3.936	3.799	3.583	3.926	3.893	3.842	3.831	3.782	3.757
100	170	3.976	4.016	3.998	3.930	3.889	3.835	3.814	3.778	3.751
100	175	3.995	4.032	4.011	3.946	3.904	3.850	3.825	3.787	3.760
100	180	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
100	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	215	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805
100	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
100	225	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
100	230	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
100	235	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
100	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
100	245	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
100	250	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
100	255	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
100	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
100	265	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
100	270	3.696	3.860	3.912	3.880	3.876	3.846	3.834	3.810	3.784
100	275	3.883	4.002	3.996	3.956	3.934	3.889	3.885	3.824	3.797
100	280	3.409	3.656	3.808	3.931	3.814	3.804	3.801	3.771	3.740
100	285	2.860	3.340	3.658	3.744	3.780	3.810	3.808	3.812	3.780
100	290	3.138	3.352	3.605	3.722	3.767	3.749	3.805	3.807	3.786
100	295	3.110	3.382	3.650	3.845	3.952	3.936	3.990	3.981	3.952
100	300	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
100	305	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
100	310	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
100	315	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
100	320	3.155	3.508	3.749	3.878	3.973	3.949	3.993	3.980	3.953
100	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
100	330	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
100	335	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
100	340	3.896	3.936	3.903	3.877	3.789	3.746	3.733	3.708	3.691
100	345	3.847	3.867	3.811	3.771	3.716	3.646	3.677	3.661	3.654
100	350	3.982	4.035	3.999	3.937	3.895	3.842	3.833	3.779	3.753
100	355	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)									
COLAT	E. LONG	20	30	40	50	60	70	80	90	100	
105	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	10	3.306	3.606	3.803	3.924	4.002	4.015	4.002	3.979	3.949	
105	15	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959	
105	20	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950	
105	25	3.058	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986	
105	30	3.066	3.396	3.690	3.912	4.040	4.070	4.072	4.058	4.022	
105	35	3.208	3.526	3.764	3.906	3.999	4.020	4.014	3.992	3.965	
105	40	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
105	45	2.982	3.372	3.674	3.872	4.002	4.040	4.044	4.036	4.004	
105	50	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.829	
105	55	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.798	
105	60	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659	
105	65	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668	
105	70	4.040	4.054	4.016	3.964	3.911	3.864	3.832	3.776	3.761	
105	75	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824	
105	80	4.048	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794	
105	85	4.103	4.137	4.092	4.043	3.997	3.940	3.919	3.835	3.812	
105	90	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
105	95	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845	
105	100	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.836	
105	105	4.179	4.185	4.136	4.104	4.051	3.996	3.942	3.864	3.841	
105	110	3.850	4.020	4.016	4.044	4.030	3.998	3.951	3.902	3.862	
105	115	2.950	3.480	3.719	3.816	3.918	3.962	3.958	3.953	3.928	
105	120	3.032	3.312	3.655	3.806	3.895	3.917	3.918	3.921	3.899	
105	125	3.047	3.372	3.680	3.878	3.980	4.004	4.002	3.991	3.959	
105	130	3.052	3.312	3.655	3.814	3.935	3.965	3.974	3.981	3.959	
105	135	3.130	3.363	3.625	3.797	3.893	3.929	3.936	3.932	3.909	
105	140	3.224	3.371	3.560	3.705	3.762	3.806	3.814	3.811	3.796	
105	145	2.734	3.324	3.636	3.780	3.918	3.980	3.988	3.992	3.968	
105	150	3.344	3.701	3.836	3.869	3.919	3.925	3.929	3.994	3.870	
105	155	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
105	160	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
105	165	3.922	4.008	3.988	3.946	3.920	3.872	3.869	3.800	3.775	
105	170	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743	
105	175	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743	
105	180	3.775	3.872	3.895	3.861	3.849	3.812	3.802	3.762	3.742	
105	185	4.014	4.064	4.042	4.010	3.978	3.934	3.890	3.834	3.810	
105	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	215	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
105	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790	
105	225	3.974	4.021	3.999	3.932	3.892	3.836	3.822	3.780	3.752	
105	230	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736	
105	235	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
105	240	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673	
105	245	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630	
105	250	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668	
105	255	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
105	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
105	265	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678	
105	270	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723	
105	275	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805	
105	280	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	285	3.380	3.641	3.818	3.853	3.849	3.836	3.831	3.800	3.771	
105	290	3.092	3.345	3.620	3.714	3.725	3.746	3.745	3.747	3.723	
105	295	3.039	3.354	3.675	3.807	3.872	3.893	3.895	3.896	3.863	
105	300	3.054	3.324	3.660	3.828	3.950	3.980	3.988	3.992	3.968	
105	305	3.044	3.324	3.660	3.824	3.930	3.956	3.960	3.962	3.938	
105	310	3.046	3.336	3.665	3.838	3.945	3.971	3.974	3.973	3.947	
105	315	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995	
105	320	3.031	3.484	3.730	3.832	3.911	3.969	3.965	3.958	3.935	
105	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828	
105	335	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820	
105	340	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762	
105	345	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704	
105	350	4.048	4.085	4.050	3.993	3.950	3.895	3.866	3.814	3.786	
105	355	4.145	4.172	4.114	4.084	4.034	3.981	3.924	3.864	3.832	

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
110	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	10	3.630	3.840	3.932	3.977	4.002	3.991	3.960	3.923	3.895
110	15	3.060	3.360	3.675	3.870	3.995	4.025	4.030	4.025	3.995
110	20	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
110	25	3.064	3.384	3.685	3.898	4.025	4.055	4.058	4.047	4.013
110	30	3.059	3.348	3.670	3.856	3.980	4.010	4.016	4.014	3.986
110	35	3.775	3.922	3.994	4.005	4.006	3.985	3.953	3.893	3.876
110	40	3.620	3.833	3.941	3.968	3.989	3.900	3.954	3.904	3.887
110	45	3.348	3.618	3.811	3.944	4.021	4.030	4.016	3.990	3.958
110	50	3.348	3.618	3.811	3.944	4.021	4.030	4.016	3.990	3.958
110	55	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	60	4.122	4.149	4.101	4.054	4.009	3.954	3.910	3.848	3.820
110	65	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
110	70	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
110	75	4.106	4.128	4.087	4.037	3.991	3.938	3.891	3.838	3.811
110	80	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	85	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	90	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
110	95	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
110	100	4.183	4.180	4.139	4.097	4.044	3.990	3.939	3.858	3.840
110	105	3.867	3.999	4.029	4.019	4.006	3.977	3.937	3.880	3.859
110	110	3.000	3.478	3.729	3.820	3.919	3.960	3.958	3.948	3.929
110	115	3.068	3.408	3.695	3.926	4.055	4.085	4.086	4.069	4.031
110	120	3.150	3.344	3.600	3.750	3.834	3.872	3.881	3.882	3.865
110	125	3.166	3.361	3.590	3.740	3.800	3.836	3.840	3.836	3.818
110	130	3.045	3.360	3.675	3.864	3.965	3.989	3.988	3.980	3.950
110	135	3.056	3.336	3.665	3.842	3.965	3.995	4.032	4.003	3.977
110	140	3.007	3.402	3.706	3.751	3.701	3.704	3.695	3.693	3.644
110	145	3.020	3.320	3.660	3.778	3.828	3.844	3.842	3.846	3.820
110	150	2.968	3.461	3.710	3.798	3.900	3.940	3.948	3.940	3.918
110	155	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.814	3.790
110	160	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
110	165	3.984	4.061	4.024	3.976	3.943	3.870	3.888	3.811	3.785
110	170	3.958	4.000	3.985	3.915	3.875	3.820	3.823	3.770	3.743
110	175	3.958	4.000	3.935	3.915	3.875	3.820	3.823	3.770	3.743
110	180	3.821	3.904	3.917	3.874	3.855	3.814	3.802	3.764	3.742
110	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	215	4.049	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
110	220	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
110	225	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
110	230	3.942	3.994	3.965	3.896	3.854	3.802	3.785	3.755	3.730
110	235	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
110	240	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
110	245	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
110	250	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.697	3.673
110	255	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
110	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
110	265	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
110	270	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
110	275	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
110	280	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
110	285	3.795	3.952	3.974	3.945	3.920	3.881	3.874	3.816	3.787
110	290	3.116	3.340	3.600	3.700	3.712	3.736	3.735	3.736	3.717
110	295	3.035	3.330	3.665	3.779	3.842	3.863	3.867	3.874	3.845
110	300	3.047	3.312	3.655	3.812	3.925	3.953	3.960	3.966	3.944
110	305	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
110	310	3.008	3.348	3.667	3.846	3.956	3.986	3.988	3.984	3.956
110	315	2.902	3.372	3.668	3.860	3.944	4.040	4.044	4.036	4.004
110	320	3.098	3.558	3.768	3.838	3.922	3.955	3.946	3.935	3.913
110	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
110	335	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
110	340	3.935	3.991	3.948	3.883	3.838	3.790	3.778	3.741	3.720
110	345	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
110	350	3.943	3.999	3.958	3.893	3.849	3.799	3.787	3.749	3.726
110	355	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
115	0	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
115	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	10	3.396	3.730	3.866	3.704	3.950	3.959	3.936	3.912	3.889
115	15	2.976	3.316	3.659	3.410	3.957	3.975	4.002	4.003	3.977
115	20	3.054	3.324	3.660	3.828	3.950	3.980	3.988	3.992	3.968
115	25	3.054	3.324	3.660	3.828	3.950	3.980	3.988	3.992	3.968
115	30	3.451	3.668	3.842	3.429	3.986	3.987	3.969	3.946	3.919
115	35	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	40	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	45	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	50	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	55	4.033	4.070	4.042	3.987	3.945	3.890	3.881	3.809	3.783
115	60	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
115	65	3.889	3.925	3.889	3.828	3.779	3.738	3.725	3.702	3.686
115	70	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
115	75	3.889	3.925	3.889	3.828	3.779	3.738	3.725	3.702	3.686
115	80	4.037	4.079	4.044	3.986	3.943	3.888	3.864	3.810	3.783
115	85	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
115	90	4.194	4.185	4.146	4.106	4.051	3.997	3.946	3.859	3.843
115	95	4.160	4.168	4.124	4.081	4.030	3.978	3.924	3.856	3.833
115	100	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	105	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	110	3.622	3.845	3.946	3.982	4.004	3.995	3.968	3.915	3.896
115	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
115	120	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
115	125	3.056	3.336	3.665	3.842	3.965	3.975	4.002	4.003	3.977
115	130	3.056	3.336	3.665	3.842	3.965	3.995	4.002	4.003	3.977
115	135	3.042	3.312	3.655	3.810	3.915	3.941	3.946	3.951	3.929
115	140	3.000	3.400	3.730	3.730	3.660	3.660	3.650	3.650	3.600
115	145	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
115	150	3.308	3.618	3.816	3.832	3.790	3.781	3.760	3.743	3.703
115	155	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	160	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
115	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	170	4.124	4.144	4.100	4.053	4.005	3.953	3.902	3.946	3.819
115	175	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
115	180	3.895	3.968	3.969	3.936	3.913	3.873	3.846	3.798	3.776
115	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	215	4.048	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
115	220	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
115	225	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
115	230	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
115	235	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
115	240	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673
115	245	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
115	250	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
115	255	3.880	3.920	3.883	3.818	3.768	3.724	3.715	3.693	3.678
115	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
115	265	3.980	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
115	270	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
115	275	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
115	280	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
115	285	3.553	3.782	3.886	3.903	3.915	3.876	3.895	3.849	3.824
115	290	3.025	3.300	3.650	3.790	3.870	3.890	3.890	3.895	3.875
115	295	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
115	300	3.045	3.300	3.650	3.798	3.910	3.938	3.946	3.955	3.935
115	305	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
115	310	2.720	3.300	3.626	3.748	3.868	3.926	3.932	3.940	3.920
115	315	2.949	3.472	3.719	3.806	3.908	3.954	3.951	3.947	3.926
115	320	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
115	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
115	335	4.022	4.092	4.019	3.981	3.941	3.884	3.879	3.808	3.781
115	340	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
115	345	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
115	350	3.927	3.970	3.941	3.975	3.830	3.782	3.768	3.736	3.715
115	355	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
120	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	10	3.994	4.074	4.064	4.035	4.006	3.966	3.918	3.866	3.840
120	15	3.364	3.656	3.831	3.901	3.953	3.960	3.941	3.920	3.895
120	20	3.000	3.300	3.647	3.790	3.896	3.926	3.932	3.940	3.920
120	25	3.154	3.386	3.696	3.825	3.920	3.940	3.941	3.943	3.923
120	30	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	35	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	40	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	45	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	50	4.005	4.029	3.984	3.934	3.884	3.840	3.806	3.768	3.748
120	55	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
120	60	3.952	4.001	3.954	3.899	3.853	3.806	3.799	3.749	3.729
120	65	4.051	4.104	4.058	4.004	3.962	3.906	3.891	3.821	3.793
120	70	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
120	75	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
120	80	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
120	85	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
120	90	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	95	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	100	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	105	4.160	4.168	4.124	4.081	4.030	3.978	3.924	3.856	3.833
120	110	3.718	3.713	3.640	3.586	3.542	3.495	3.442	3.391	3.371
120	115	3.028	3.408	3.692	3.920	4.051	4.085	4.086	4.069	4.031
120	120	2.982	3.372	3.674	3.872	4.002	4.040	4.044	4.036	4.008
120	125	2.930	3.300	3.641	3.782	3.908	3.950	3.960	3.970	3.950
120	130	3.024	3.384	3.682	3.892	4.021	4.055	4.058	4.047	4.013
120	135	3.031	3.336	3.665	3.832	3.915	3.935	3.932	3.928	3.902
120	140	3.042	3.312	3.655	3.810	3.915	3.941	3.946	3.951	3.929
120	145	3.015	3.300	3.650	3.786	3.850	3.866	3.862	3.865	3.845
120	150	3.283	3.588	3.798	3.847	3.864	3.868	3.853	3.839	3.808
120	155	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	160	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
120	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	170	4.042	4.080	4.052	4.009	3.970	3.922	3.880	3.827	3.802
120	175	4.087	4.112	4.075	4.022	3.976	3.924	3.880	3.829	3.802
120	180	3.886	3.968	3.972	3.953	3.936	3.901	3.868	3.813	3.793
120	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	215	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
120	220	4.022	4.082	4.039	3.981	3.911	3.844	3.879	3.808	3.781
120	225	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
120	230	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
120	235	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
120	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
120	245	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
120	250	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
120	255	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
120	260	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
120	265	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
120	270	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
120	275	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748
120	280	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
120	285	3.206	3.541	3.762	3.833	3.879	3.887	3.885	3.864	3.842
120	290	3.035	3.300	3.650	3.794	3.890	3.914	3.918	3.925	3.905
120	295	3.050	3.300	3.650	3.800	3.920	3.950	3.960	3.970	3.950
120	300	3.040	3.300	3.650	3.796	3.900	3.926	3.932	3.940	3.920
120	305	2.850	3.300	3.635	3.770	3.900	3.950	3.960	3.970	3.950
120	310	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
120	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
120	330	4.111	4.143	4.095	4.047	4.001	3.948	3.938	3.844	3.817
120	335	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
120	340	3.881	3.917	3.879	3.818	3.768	3.729	3.716	3.694	3.680
120	345	3.868	3.896	3.850	3.800	3.748	3.712	3.701	3.682	3.670
120	350	3.982	4.035	3.999	3.937	3.895	3.842	3.833	3.779	3.753
120	355	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
125	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	10	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	15	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	20	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	25	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	30	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	35	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	40	4.031	4.053	4.007	3.959	3.909	3.864	3.826	3.784	3.763
125	45	3.880	3.902	3.849	3.806	3.752	3.719	3.705	3.684	3.674
125	50	3.841	3.857	3.797	3.762	3.706	3.670	3.670	3.655	3.649
125	55	3.908	3.943	3.891	3.844	3.794	3.755	3.747	3.712	3.697
125	60	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
125	65	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
125	70	3.950	3.994	3.971	3.904	3.862	3.810	3.795	3.759	3.735
125	75	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
125	80	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
125	85	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.708	3.691
125	90	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
125	95	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723
125	100	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
125	105	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
125	110	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	115	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	120	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	125	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	130	3.826	3.972	4.002	3.987	3.977	3.950	3.911	3.869	3.844
125	135	3.285	3.621	3.799	3.855	3.919	3.930	3.935	3.909	3.886
125	140	2.960	3.300	3.644	3.784	3.892	3.926	3.932	3.940	3.920
125	145	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
125	150	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
125	155	4.101	4.137	4.089	4.040	3.995	3.941	3.927	3.840	3.813
125	160	4.143	4.150	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	165	4.048	4.109	4.059	4.005	3.964	3.907	3.819	3.822	3.794
125	170	3.657	3.862	3.926	3.925	3.929	3.903	3.903	3.849	3.823
125	175	3.579	3.738	3.820	3.838	3.853	3.837	3.825	3.778	3.764
125	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	215	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	220	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
125	225	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
125	230	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
125	235	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
125	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
125	245	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
125	250	3.834	3.846	3.793	3.753	3.696	3.670	3.662	3.649	3.644
125	255	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
125	260	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
125	265	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
125	270	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668
125	275	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
125	280	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
125	285	2.924	3.305	3.626	3.750	3.819	3.851	3.849	3.853	3.834
125	290	3.040	3.300	3.650	3.796	3.900	3.926	3.932	3.940	3.920
125	295	3.010	3.300	3.647	3.794	3.916	3.950	3.960	3.970	3.950
125	300	2.810	3.300	3.632	3.764	3.846	3.950	3.960	3.970	3.950
125	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	310	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
125	325	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
125	330	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
125	335	3.935	3.978	3.951	3.884	3.840	3.791	3.777	3.744	3.722
125	340	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
125	345	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
125	350	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
125	355	4.090	4.131	4.083	4.033	3.989	3.934	3.925	3.836	3.809

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
130	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	10	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	15	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	20	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	25	4.117	4.136	4.090	4.043	3.995	3.944	3.893	3.839	3.813
130	30	3.979	4.005	3.961	3.909	3.858	3.816	3.787	3.751	3.733
130	35	3.854	3.878	3.826	3.781	3.727	3.675	3.685	3.668	3.659
130	40	3.920	3.947	3.900	3.849	3.798	3.759	3.740	3.713	3.698
130	45	3.979	4.005	3.961	3.909	3.858	3.816	3.787	3.751	3.733
130	50	4.011	4.040	3.998	3.943	3.894	3.848	3.814	3.774	3.753
130	55	4.160	4.168	4.124	4.081	4.030	3.978	3.924	3.856	3.833
130	60	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	65	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	70	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	75	3.876	3.904	3.860	3.809	3.758	3.721	3.710	3.689	3.677
130	80	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
130	85	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
130	90	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
130	95	3.867	3.899	3.854	3.799	3.747	3.711	3.730	3.683	3.668
130	100	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
130	105	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
130	110	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
130	115	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
130	120	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
130	125	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
130	130	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
130	135	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748
130	140	3.950	3.992	3.975	3.905	3.864	3.811	3.794	3.762	3.736
130	145	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
130	150	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
130	155	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
130	160	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
130	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	170	3.543	3.710	3.833	3.866	3.876	3.859	3.840	3.802	3.784
130	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	210	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	215	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	220	4.080	4.126	4.077	4.026	3.983	3.927	3.904	3.833	3.805
130	225	4.038	4.103	4.053	3.998	3.958	3.900	3.838	3.818	3.790
130	230	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.756
130	235	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
130	240	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
130	245	3.821	3.825	3.754	3.734	3.675	3.653	3.647	3.636	3.635
130	250	3.860	3.888	3.840	3.790	3.737	3.703	3.672	3.674	3.664
130	255	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
130	260	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
130	265	3.999	3.928	3.891	3.839	3.791	3.749	3.736	3.713	3.696
130	270	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
130	275	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
130	280	3.659	3.817	3.857	3.832	3.823	3.801	3.792	3.773	3.754
130	285	3.068	3.310	3.620	3.749	3.802	3.824	3.822	3.825	3.808
130	290	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
130	295	2.690	3.300	3.623	3.746	3.884	3.950	3.960	3.970	3.950
130	300	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
130	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	310	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
130	325	4.090	4.131	4.093	4.033	3.989	3.934	3.905	3.836	3.809
130	330	4.038	4.103	4.053	3.998	3.956	3.900	3.848	3.818	3.790
130	335	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
130	340	3.860	3.888	3.840	3.790	3.737	3.703	3.672	3.674	3.664
130	345	3.860	3.888	3.840	3.790	3.737	3.703	3.672	3.674	3.664
130	350	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
130	355	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
135	0	4.033	4.071	4.026	3.972	3.926	3.876	3.849	3.795	3.772
135	5	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.798
135	10	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.799
135	15	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.798
135	20	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.798
135	25	4.090	4.112	4.067	4.018	3.970	3.920	3.873	3.823	3.798
135	30	3.939	3.960	3.909	3.865	3.813	3.775	3.752	3.723	3.709
135	35	4.038	4.064	4.021	3.968	3.919	3.872	3.834	3.790	3.768
135	40	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
135	45	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
135	50	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
135	55	4.183	4.180	4.139	4.097	4.044	3.990	3.939	3.858	3.840
135	60	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	65	4.149	4.163	4.117	4.072	4.023	3.971	3.917	3.855	3.830
135	70	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	75	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
135	80	3.951	3.997	3.968	3.902	3.859	3.808	3.796	3.756	3.731
135	85	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
135	90	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
135	95	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
135	100	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644
135	105	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
135	110	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
135	115	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
135	120	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
135	125	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
135	130	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
135	135	3.867	3.899	3.854	3.799	3.747	3.711	3.700	3.680	3.668
135	140	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
135	145	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
135	150	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
135	155	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
135	160	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809
135	165	3.707	3.834	3.890	3.895	3.895	3.870	3.847	3.799	3.781
135	170	4.079	4.112	4.078	4.039	3.999	3.951	3.902	3.844	3.819
135	175	4.143	4.160	4.113	4.068	4.020	3.968	3.911	3.855	3.828
135	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	195	4.122	4.144	4.101	4.054	4.008	3.954	3.910	3.848	3.820
135	200	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
135	205	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
135	210	4.082	4.121	4.076	4.025	3.981	3.926	3.896	3.832	3.804
135	215	4.111	4.143	4.095	4.047	4.001	3.948	3.908	3.844	3.817
135	220	4.049	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
135	225	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
135	230	3.942	3.994	3.965	3.896	3.854	3.802	3.795	3.755	3.730
135	235	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.709	3.691
135	240	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
135	245	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
135	250	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673
135	255	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.708	3.691
135	260	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
135	265	3.992	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
135	270	3.950	3.994	3.971	3.904	3.862	3.810	3.795	3.759	3.735
135	275	3.888	3.928	3.893	3.828	3.779	3.737	3.724	3.701	3.684
135	280	2.896	3.424	3.673	3.756	3.858	3.906	3.911	3.915	3.896
135	285	3.020	3.300	3.650	3.788	3.860	3.878	3.876	3.880	3.860
135	290	2.920	3.300	3.641	3.778	3.888	3.926	3.932	3.940	3.920
135	295	2.650	3.370	3.620	3.740	3.880	3.950	3.960	3.970	3.950
135	300	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
135	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	310	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
135	325	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
135	330	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
135	335	3.935	3.976	3.954	3.886	3.843	3.792	3.777	3.747	3.723
135	340	3.868	3.896	3.850	3.800	3.748	3.712	3.701	3.682	3.670
135	345	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
135	350	3.928	3.970	3.933	3.874	3.828	3.782	3.770	3.735	3.715
135	355	4.006	4.064	4.022	3.963	3.922	3.867	3.861	3.796	3.769

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
140	0	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	5	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	10	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	15	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	20	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	25	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	30	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	35	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	40	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
140	45	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
140	50	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
140	55	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
140	60	4.135	4.154	4.111	4.065	4.016	3.960	3.929	3.843	3.823
140	65	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
140	70	4.183	4.180	4.139	4.097	4.044	3.990	3.939	3.858	3.840
140	75	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	80	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	85	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
140	90	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
140	95	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
140	100	3.889	3.925	3.889	3.828	3.779	3.738	3.725	3.702	3.686
140	105	3.868	3.896	3.856	3.800	3.748	3.712	3.701	3.682	3.670
140	110	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
140	115	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
140	120	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
140	125	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
140	130	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
140	135	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
140	140	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	145	3.943	3.989	3.958	3.993	3.849	3.799	3.787	3.749	3.726
140	150	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
140	155	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
140	160	3.958	4.000	3.945	3.915	3.875	3.820	3.803	3.770	3.743
140	165	4.050	4.089	4.049	3.991	3.947	3.894	3.858	3.812	3.785
140	170	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	175	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	180	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	185	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	190	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
140	195	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
140	200	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
140	205	3.967	4.017	3.982	3.919	3.876	3.824	3.815	3.766	3.742
140	210	3.927	3.968	3.944	3.876	3.832	3.783	3.768	3.739	3.717
140	215	3.905	3.944	3.906	3.846	3.798	3.755	3.743	3.715	3.697
140	220	3.930	3.972	3.922	3.871	3.823	3.780	3.773	3.730	3.713
140	225	3.922	3.957	3.922	3.866	3.820	3.775	3.762	3.731	3.712
140	230	3.897	3.933	3.899	3.838	3.790	3.747	3.734	3.710	3.693
140	235	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
140	240	3.815	3.815	3.740	3.725	3.665	3.645	3.640	3.630	3.630
140	245	3.873	3.909	3.869	3.809	3.758	3.720	3.707	3.687	3.673
140	250	3.880	3.920	3.883	3.818	3.768	3.728	3.715	3.693	3.678
140	255	3.942	3.984	3.965	3.896	3.854	3.802	3.785	3.755	3.710
140	260	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
140	265	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
140	270	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
140	275	3.990	4.041	4.012	3.948	3.908	3.852	3.841	3.789	3.762
140	280	3.435	3.720	3.839	3.845	3.877	3.872	3.866	3.850	3.826
140	285	2.955	3.300	3.644	3.782	3.882	3.914	3.918	3.925	3.905
140	290	2.795	3.300	3.632	3.758	3.866	3.914	3.918	3.925	3.905
140	295	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
140	300	3.247	3.644	3.817	3.971	3.936	3.957	3.941	3.924	3.901
140	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	310	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
140	330	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
140	335	4.048	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
140	340	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
140	345	3.903	3.944	3.914	3.847	3.800	3.756	3.741	3.716	3.697
140	350	3.841	3.857	3.797	3.762	3.706	3.678	3.670	3.655	3.649
140	355	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
145	0	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	10	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	15	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	20	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	25	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	30	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	35	4.171	4.174	4.131	4.089	4.047	3.984	3.931	3.857	3.816
145	40	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
145	45	4.171	4.174	4.131	4.089	4.037	3.984	3.931	3.857	3.816
145	50	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
145	55	4.200	4.188	4.150	4.110	4.055	4.000	3.950	3.860	3.845
145	60	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	65	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	70	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	75	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	80	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	85	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	90	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
145	95	4.111	4.143	4.095	4.047	4.001	3.948	3.903	3.844	3.817
145	100	4.090	4.131	4.083	4.033	3.989	3.934	3.905	3.836	3.809
145	105	3.974	4.021	3.999	3.932	3.892	3.836	3.822	3.780	3.752
145	110	3.966	4.010	3.992	3.923	3.883	3.828	3.812	3.775	3.748
145	115	3.958	4.002	3.982	3.914	3.873	3.819	3.804	3.767	3.741
145	120	3.958	4.002	3.982	3.914	3.873	3.819	3.804	3.767	3.741
145	125	3.950	3.994	3.971	3.904	3.862	3.810	3.795	3.759	3.735
145	130	3.950	3.994	3.971	3.904	3.862	3.810	3.795	3.759	3.735
145	135	3.943	3.986	3.961	3.904	3.851	3.800	3.786	3.752	3.728
145	140	3.868	3.896	3.850	3.800	3.748	3.712	3.701	3.682	3.670
145	145	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
145	150	3.889	3.925	3.889	3.828	3.779	3.738	3.725	3.702	3.686
145	155	3.896	3.936	3.903	3.837	3.789	3.746	3.733	3.708	3.691
145	160	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	165	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	170	4.132	4.154	4.107	4.061	4.014	3.961	3.911	3.851	3.824
145	175	4.101	4.137	4.089	4.040	3.995	3.941	3.907	3.840	3.813
145	180	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
145	185	4.048	4.109	4.059	4.005	3.964	3.907	3.899	3.822	3.794
145	190	4.022	4.092	4.039	3.981	3.941	3.884	3.879	3.808	3.781
145	195	3.974	4.023	3.995	3.930	3.889	3.835	3.823	3.777	3.751
145	200	3.911	3.952	3.924	3.857	3.811	3.765	3.750	3.724	3.704
145	205	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
145	210	3.828	3.836	3.769	3.744	3.686	3.662	3.655	3.643	3.640
145	215	3.854	3.878	3.826	3.781	3.727	3.695	3.685	3.668	3.659
145	220	3.876	3.904	3.860	3.809	3.758	3.721	3.710	3.689	3.677
145	225	3.889	3.925	3.889	3.828	3.779	3.738	3.725	3.702	3.686
145	230	3.907	3.936	3.901	3.848	3.801	3.758	3.745	3.720	3.703
145	235	3.922	3.957	3.922	3.866	3.820	3.775	3.762	3.731	3.712
145	240	3.938	3.980	3.933	3.881	3.834	3.789	3.782	3.738	3.720
145	245	3.911	3.954	3.920	3.855	3.808	3.764	3.751	3.721	3.702
145	250	3.943	3.986	3.961	3.894	3.851	3.800	3.786	3.752	3.728
145	255	3.982	4.031	4.005	3.940	3.900	3.844	3.831	3.784	3.757
145	260	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.918	3.790
145	265	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
145	270	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
145	275	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
145	280	3.998	4.051	4.019	3.956	3.916	3.860	3.850	3.794	3.766
145	285	3.696	3.860	3.912	3.880	3.876	3.846	3.834	3.810	3.784
145	290	3.459	3.751	3.859	3.870	3.902	3.896	3.894	3.864	3.840
145	295	3.958	4.000	3.985	3.915	3.875	3.820	3.803	3.770	3.743
145	300	4.117	4.136	4.090	4.043	3.995	3.944	3.893	3.839	3.813
145	305	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	310	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	315	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
145	330	3.863	3.912	3.884	3.857	3.821	3.789	3.769	3.734	3.721
145	335	4.069	4.120	4.071	4.019	3.977	3.920	3.902	3.829	3.801
145	340	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
145	345	3.919	3.960	3.934	3.866	3.821	3.774	3.759	3.731	3.710
145	350	3.860	3.898	3.840	3.790	3.717	3.703	3.692	3.674	3.664
145	355	3.834	3.846	3.783	3.753	3.696	3.670	3.662	3.649	3.644

ELEMENT LOCATION		VELOCITY IN		KILOMETERS/SEC		FOR DESIGNATED PERIODS (SEC)				
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
150	0	4.143	4.160	4.113	4.068	4.020	3.958	3.913	3.855	3.828
150	5	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	10	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	15	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	20	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	25	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	30	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	35	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	40	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	45	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	50	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	55	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	60	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	65	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	70	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	75	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	80	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	85	4.200	4.198	4.150	4.110	4.055	4.000	3.950	3.860	3.845
150	90	2.949	3.472	3.719	3.806	3.908	3.954	3.951	3.947	3.926
150	95	3.098	3.558	3.768	3.838	3.922	3.955	3.946	3.935	3.913
150	100	3.395	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
150	105	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
150	110	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
150	115	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
150	120	3.844	3.988	4.014	4.002	3.992	3.954	3.922	3.878	3.852
150	125	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
150	130	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
150	135	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
150	140	3.883	4.002	3.996	3.956	3.934	3.889	3.885	3.824	3.797
150	145	3.982	4.033	4.002	3.938	3.897	3.843	3.832	3.791	3.755
150	150	3.890	3.923	3.835	3.828	3.779	3.739	3.726	3.703	3.688
150	155	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
150	160	3.860	3.888	3.840	3.790	3.737	3.703	3.692	3.674	3.664
150	165	4.006	4.045	4.006	3.948	3.903	3.853	3.829	3.782	3.758
150	170	4.008	4.057	4.025	3.963	3.923	3.867	3.852	3.798	3.770
150	175	4.006	4.062	4.026	3.965	3.925	3.868	3.860	3.799	3.771
150	180	3.943	3.991	3.954	3.891	3.846	3.798	3.787	3.746	3.725
150	185	3.908	3.941	3.894	3.845	3.796	3.756	3.747	3.714	3.699
150	190	3.863	3.883	3.832	3.791	3.738	3.705	3.695	3.677	3.667
150	195	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
150	200	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
150	205	3.847	3.867	3.811	3.771	3.716	3.686	3.677	3.661	3.654
150	210	3.873	3.909	3.869	3.809	3.759	3.720	3.707	3.687	3.673
150	215	3.896	3.936	3.903	3.837	3.784	3.746	3.733	3.708	3.691
150	220	3.966	4.013	3.988	3.922	3.881	3.827	3.813	3.772	3.746
150	225	4.014	4.072	4.033	3.973	3.933	3.876	3.869	3.804	3.776
150	230	4.030	4.093	4.046	3.990	3.950	3.892	3.888	3.813	3.785
150	235	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
150	240	4.059	4.114	4.065	4.012	3.970	3.914	3.901	3.825	3.798
150	245	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
150	250	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
150	255	4.122	4.149	4.101	4.054	4.008	3.954	3.910	3.848	3.820
150	260	4.111	4.143	4.095	4.047	4.001	3.948	3.900	3.844	3.817
150	265	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	270	4.090	4.131	4.083	4.033	3.987	3.914	3.905	3.936	3.809
150	275	4.038	4.103	4.053	3.998	3.958	3.900	3.898	3.818	3.790
150	280	4.022	4.082	4.039	3.981	3.941	3.884	3.879	3.808	3.781
150	285	3.835	3.940	3.955	3.906	3.884	3.841	3.828	3.795	3.768
150	290	3.281	3.626	3.772	3.798	3.845	3.857	3.855	3.847	3.827
150	295	3.335	3.630	3.767	3.777	3.780	3.781	3.775	3.767	3.744
150	300	2.755	3.320	3.639	3.742	3.830	3.880	3.884	3.891	3.865
150	305	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
150	310	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
150	315	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
150	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	325	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	330	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	335	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	340	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	345	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	350	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
150	355	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
155	0	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	5	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	10	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	15	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	20	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	25	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	30	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	35	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	40	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
155	45	2.902	3.372	3.668	3.860	3.994	4.040	4.044	4.036	4.004
155	50	2.986	3.396	3.684	3.900	4.032	4.070	4.072	4.058	4.022
155	55	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	60	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
155	65	2.818	3.348	3.652	3.820	3.956	4.010	4.016	4.014	3.986
155	70	2.734	3.324	3.636	3.780	3.918	3.980	3.988	3.992	3.968
155	75	2.734	3.324	3.636	3.780	3.918	3.980	3.988	3.992	3.968
155	80	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
155	85	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
155	90	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	95	2.986	3.396	3.684	3.900	4.032	4.070	4.072	4.058	4.022
155	100	2.986	3.396	3.684	3.900	4.032	4.070	4.072	4.058	4.022
155	105	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	110	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	115	2.902	3.372	3.668	3.860	3.994	4.040	4.044	4.036	4.004
155	120	2.902	3.372	3.668	3.860	3.994	4.040	4.044	4.036	4.004
155	125	2.902	3.372	3.668	3.860	3.994	4.040	4.044	4.036	4.004
155	130	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	135	2.944	3.384	3.676	3.880	4.011	4.055	4.058	4.047	4.013
155	140	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
155	145	2.818	3.348	3.652	3.820	3.956	4.010	4.016	4.014	3.986
155	150	3.038	3.476	3.717	3.835	3.936	3.969	3.971	3.963	3.936
155	155	3.111	3.518	3.725	3.813	3.895	3.923	3.923	3.917	3.893
155	160	3.019	3.486	3.699	3.763	3.846	3.883	3.886	3.887	3.868
155	165	2.773	3.362	3.646	3.748	3.869	3.928	3.935	3.942	3.923
155	170	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	175	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	180	2.766	3.351	3.632	3.738	3.858	3.919	3.928	3.936	3.918
155	185	3.122	3.516	3.682	3.743	3.804	3.836	3.839	3.840	3.827
155	190	3.012	3.475	3.685	3.754	3.836	3.875	3.879	3.881	3.864
155	195	2.896	3.424	3.673	3.756	3.858	3.906	3.911	3.915	3.896
155	200	2.773	3.362	3.646	3.748	3.869	3.928	3.935	3.942	3.923
155	205	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	210	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	215	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	220	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	225	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	230	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	235	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	240	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	245	2.799	3.386	3.669	3.773	3.894	3.952	3.955	3.958	3.938
155	250	3.098	3.558	3.748	3.838	3.922	3.955	3.946	3.935	3.913
155	255	3.396	3.730	3.866	3.904	3.950	3.959	3.936	3.912	3.889
155	260	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.887	3.865
155	265	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
155	270	3.695	3.902	3.965	3.970	3.978	3.963	3.927	3.889	3.865
155	275	3.386	3.724	3.860	3.897	3.944	3.952	3.935	3.907	3.885
155	280	2.912	3.440	3.693	3.775	3.879	3.924	3.929	3.930	3.909
155	285	2.781	3.370	3.656	3.757	3.879	3.937	3.944	3.950	3.929
155	290	2.825	3.350	3.660	3.735	3.770	3.805	3.835	3.810	3.775
155	295	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
155	300	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	305	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	310	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
155	315	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
155	320	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
155	325	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
155	330	4.143	4.160	4.113	4.068	4.020	3.968	3.911	3.855	3.828
155	335	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
155	340	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
155	345	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
155	350	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
155	355	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
160	0	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	5	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	10	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	15	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	20	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	25	2.860	3.360	3.660	3.840	3.975	4.025	4.030	4.025	3.995
160	30	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	35	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	40	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	45	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	50	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	55	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	60	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	65	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	70	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	75	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	80	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	85	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	90	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	95	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	100	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	105	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	110	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	120	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	125	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	130	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	135	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	140	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
160	145	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
160	150	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
160	155	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
160	160	3.007	3.342	3.670	3.781	3.797	3.806	3.797	3.795	3.764
160	165	2.881	3.336	3.653	3.712	3.719	3.759	3.960	3.958	3.932
160	170	3.396	3.710	3.866	3.904	3.950	3.959	3.936	3.912	3.889
160	175	3.396	3.710	3.866	3.904	3.950	3.959	3.936	3.912	3.889
160	180	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
160	185	3.546	3.816	3.916	3.937	3.964	3.961	3.932	3.901	3.877
160	190	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
160	195	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
160	200	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
160	205	4.143	4.160	4.113	4.068	4.020	3.968	3.913	3.855	3.828
160	210	3.994	4.074	4.064	4.035	4.006	3.966	3.918	3.866	3.840
160	215	3.844	3.988	4.014	4.002	3.992	3.964	3.922	3.878	3.852
160	220	3.431	3.730	3.869	3.908	3.944	3.947	3.922	3.897	3.874
160	225	3.431	3.730	3.869	3.908	3.944	3.947	3.922	3.897	3.874
160	230	3.168	3.558	3.774	3.846	3.910	3.931	3.918	3.905	3.883
160	235	3.168	3.558	3.774	3.846	3.910	3.931	3.918	3.905	3.883
160	240	3.054	3.502	3.743	3.803	3.842	3.867	3.858	3.851	3.821
160	245	3.054	3.502	3.743	3.803	3.842	3.867	3.858	3.851	3.821
160	250	2.904	3.416	3.643	3.770	3.828	3.865	3.862	3.862	3.833
160	255	2.860	3.330	3.653	3.749	3.796	3.827	3.825	3.829	3.800
160	260	2.860	3.330	3.653	3.749	3.796	3.827	3.825	3.829	3.800
160	265	2.860	3.330	3.653	3.749	3.796	3.827	3.825	3.829	3.800
160	270	2.790	3.340	3.652	3.736	3.792	3.834	3.836	3.842	3.810
160	275	2.790	3.340	3.652	3.736	3.792	3.834	3.836	3.842	3.810
160	280	2.790	3.340	3.652	3.736	3.792	3.834	3.836	3.842	3.810
160	285	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
160	290	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
160	295	3.000	3.400	3.700	3.730	3.660	3.660	3.650	3.650	3.600
160	300	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
160	305	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
160	310	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
160	315	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
160	320	2.928	3.461	3.707	3.792	3.896	3.940	3.948	3.940	3.918
160	325	2.650	3.300	3.620	3.740	3.880	3.950	3.960	3.970	3.950
160	330	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
160	335	3.205	3.621	3.793	3.843	3.911	3.930	3.935	3.909	3.886
160	340	2.839	3.324	3.645	3.792	3.900	3.944	3.946	3.947	3.923
160	345	2.839	3.324	3.645	3.792	3.900	3.944	3.946	3.947	3.923
160	350	3.028	3.348	3.670	3.844	3.920	3.938	3.932	3.924	3.896
160	355	3.028	3.348	3.670	3.844	3.920	3.938	3.932	3.924	3.896

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
165	0	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	5	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	10	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	15	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	20	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	25	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	30	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	35	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	40	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	45	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	50	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	55	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	60	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	65	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	70	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	75	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	80	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	85	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	90	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	95	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	100	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	105	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	110	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	120	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	125	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	130	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	135	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	140	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	145	3.035	3.360	3.675	3.860	3.945	3.965	3.960	3.950	3.920
165	150	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
165	155	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
165	160	2.895	3.300	3.641	3.768	3.838	3.866	3.862	3.865	3.845
165	165	2.825	3.330	3.650	3.745	3.802	3.839	3.839	3.844	3.815
165	170	2.790	3.300	3.632	3.756	3.856	3.902	3.904	3.910	3.890
165	175	2.790	3.300	3.632	3.756	3.856	3.902	3.904	3.910	3.890
165	180	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
165	185	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
165	190	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
165	195	2.755	3.330	3.644	3.737	3.814	3.863	3.867	3.874	3.845
165	200	2.825	3.350	3.660	3.735	3.770	3.805	3.805	3.810	3.775
165	205	2.860	3.360	3.668	3.734	3.748	3.776	3.774	3.774	3.740
165	210	2.930	3.380	3.684	3.732	3.704	3.718	3.712	3.714	3.670
165	215	2.930	3.380	3.684	3.732	3.704	3.718	3.712	3.714	3.670
165	220	3.000	3.370	3.685	3.745	3.708	3.711	3.701	3.701	3.660
165	225	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	230	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	235	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	240	3.000	3.320	3.660	3.770	3.788	3.786	3.786	3.786	3.760
165	245	3.000	3.320	3.660	3.770	3.788	3.786	3.786	3.786	3.760
165	250	3.000	3.390	3.690	3.740	3.692	3.694	3.684	3.684	3.640
165	255	3.000	3.370	3.685	3.745	3.708	3.711	3.701	3.701	3.660
165	260	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
165	265	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
165	270	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
165	275	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
165	280	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
165	285	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
165	290	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
165	295	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
165	300	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
165	305	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	310	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	315	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
165	320	3.000	3.360	3.680	3.750	3.724	3.728	3.718	3.718	3.680
165	325	3.000	3.360	3.680	3.750	3.724	3.728	3.718	3.718	3.680
165	330	3.058	3.310	3.620	3.745	3.782	3.800	3.794	3.795	3.778
165	335	3.042	3.372	3.680	3.876	3.770	3.492	3.498	3.496	3.444
165	340	3.028	3.348	3.670	3.844	3.920	3.938	3.932	3.924	3.896
165	345	3.028	3.348	3.670	3.844	3.920	3.938	3.932	3.924	3.896
165	350	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
165	355	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC					FOR DESIGNATED PERIODS (SEC)			
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
170	0	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	5	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	10	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	15	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	20	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	25	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	30	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	35	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	40	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	45	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	50	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	55	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	60	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	65	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	70	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	75	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	80	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	85	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	90	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	95	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	100	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	105	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	110	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	120	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	125	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	130	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	135	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	140	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	145	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	150	3.007	3.312	3.655	3.796	3.845	3.857	3.848	3.846	3.824
170	155	3.014	3.324	3.660	3.812	3.870	3.884	3.876	3.872	3.848
170	160	3.014	3.324	3.660	3.812	3.870	3.884	3.876	3.872	3.848
170	165	3.021	3.316	3.665	3.828	3.895	3.911	3.904	3.898	3.872
170	170	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	175	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	180	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	185	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	190	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	195	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	200	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	205	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	210	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	215	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	220	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	225	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	230	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	235	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	240	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	245	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
170	250	3.000	3.340	3.670	3.760	3.756	3.762	3.752	3.752	3.720
170	255	3.000	3.340	3.670	3.760	3.756	3.762	3.752	3.752	3.720
170	260	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	265	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	270	3.010	3.330	3.665	3.769	3.792	3.803	3.797	3.799	3.770
170	275	3.010	3.330	3.665	3.769	3.792	3.803	3.797	3.799	3.770
170	280	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	285	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	290	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	295	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	300	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	305	3.000	3.350	3.675	3.755	3.740	3.745	3.735	3.735	3.700
170	310	3.000	3.310	3.665	3.765	3.772	3.779	3.769	3.769	3.740
170	315	3.000	3.310	3.665	3.765	3.772	3.779	3.769	3.769	3.740
170	320	3.056	3.406	3.695	3.803	4.004	4.029	4.027	4.011	3.972
170	325	3.056	3.406	3.695	3.803	4.004	4.029	4.027	4.011	3.972
170	330	3.021	3.336	3.665	3.828	3.895	3.911	3.904	3.898	3.872
170	335	3.049	3.344	3.685	3.892	3.995	4.019	4.016	4.002	3.968
170	340	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	345	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	350	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
170	355	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040

ELEMENT LOCATION		VELOCITY IN KILOMETERS/SEC FOR DESIGNATED PERIODS (SEC)								
COLAT	E. LONG	20	30	40	50	60	70	80	90	100
175	0	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	5	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	10	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	15	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	20	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	25	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	30	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	35	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	40	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	45	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	50	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	55	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	60	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	65	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	70	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	75	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	80	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	85	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	90	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	95	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	100	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	105	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	110	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	115	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	120	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	125	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	130	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	135	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	140	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	145	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	150	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	155	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	160	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	165	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
175	170	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
175	175	3.000	3.320	3.660	3.770	3.788	3.796	3.786	3.786	3.760
175	180	3.000	3.310	3.655	3.775	3.804	3.813	3.803	3.803	3.780
175	185	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	190	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	195	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	200	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	205	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	210	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	215	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	220	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	225	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	230	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	235	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	240	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	245	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	250	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	255	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	260	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	265	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	270	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	275	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	280	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	285	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	290	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	295	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	300	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	305	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	310	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	315	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	320	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	325	3.000	3.300	3.650	3.780	3.820	3.830	3.820	3.820	3.800
175	330	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	335	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	340	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	345	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	350	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040
175	355	3.070	3.420	3.700	3.940	4.070	4.100	4.100	4.080	4.040

Appendix III

The Digitized Seismogram Tape

Currently, twenty-three digitized seismograms used to test the Rayleigh velocity model are compiled as sequential labeled files on tape C4166. The tape is universal formatted, nine track, 1600 BPI density with volume name 'T1'. The statistics of the labeled files are given in table AIII1. The files are of variable length, but all begin with a two record header which contains the following information:

Year, month, day, hour, minute, second of the earthquake

Latitude, Longitude, depth and magnitude of the earthquake

Recording station code and distance in degrees to the event

Hour, minute, and second of the initial digitization point.

Digitizing increment as number of points/second and total number of data points.

Linear trend and DC offset correction factors for detrending the data set, and vertical digitizing increment in millimeters.

Station gain, T_o , T_g , Itak magnification, and data format.

The header records are formatted as:

(1X, 5I2, F4.1, F5.2, A1, F6.2, A1, I3, F3.1, A3, F6.2, 2I2, F4.1, F5.2, I5, E10.3/E10.3, F4.1, I7, I2, I3, F7.4, 3A4)

The header records are followed by the digitized data in a format given by the last header entry. Although the data can have a variable format, all data is structured as 25F5.0 followed by a trail 9999. entry.

The 5° x 5° Data Tape

The 5° x 5° encoded tectonic data, mean Rayleigh group velocities, mean heat flow and topography are available on labeled tape C4212. This is a formatted 9 track, 1600 BPI density tape with volume name 'DATA'. The data are in file 'TSIS' with fixed block format FB(6984,97). The file consists of 36 colatitude blocks, with records formatted as:

(2(I3,1X),20Z1,2X,9(F5.3,1X),2X,F4.0,2X,I5)

Each record begins with the colatitude and east longitude coordinates of the northwestern corner of the 5° x 5° element.

This is followed by the encoded tectonic percentages (hexadecimal format) in the following order:

archean shield, proterozoic shield, precambrian undeformed, early paleozoic orogeny/folding, late paleozoic orogeny/folding, post precambrian undeformed, mesozoic orogeny/folding, cenozoic folding, cenozoic volcanics, intermountain basin fill, shelf sediments, mesozoic volcanics, anomaly 0-5 (0-10 m.y.), anomaly 5-6 (10-23 m.y.), anomaly 6-13 (23-38 m.y.), anomaly 13-25 (38-63 m.y.), late cretaceous sea floor (63-100 m.y.), sea floor older than 140 m.y., island arcs, early cretaceous sea floor (100-140 m.y.).

The mean Rayleigh wave group velocities for periods 20, 30, 40, 50, 60, 70, 80, 90, and 100 seconds through each of the 5° x 5°

elements are the next tape entry, followed by the mean heat flow in milliwatts-meter⁻² and the mean topography in meters from sea level.

Table A III 1. Seismogram Tape 'T1' Statistics

File Name	Block Count	Tape Length (ft)
TRN1	115	8.24
AKU3	135	9.41
NAT4	183	12.34
NAT2	177	11.97
SDB5	86	6.41
KOD11	129	9.04
LEM12	90	6.66
TLO7	102	7.39
MUN8	125	8.80
CHG8	168	11.42
NOR25	111	7.94
MAT21	134	9.34
GUA22	168	11.43
GUA21	129	9.04
KIP19	153	10.51
LON20	129	9.04
KIP39	63	5.01
KIP41	63	5.01
KIP42	63	5.01
AFI29	65	5.13
AFI30	82	6.17
KIP99	80	6.05

Total tape length 181.36 ft.

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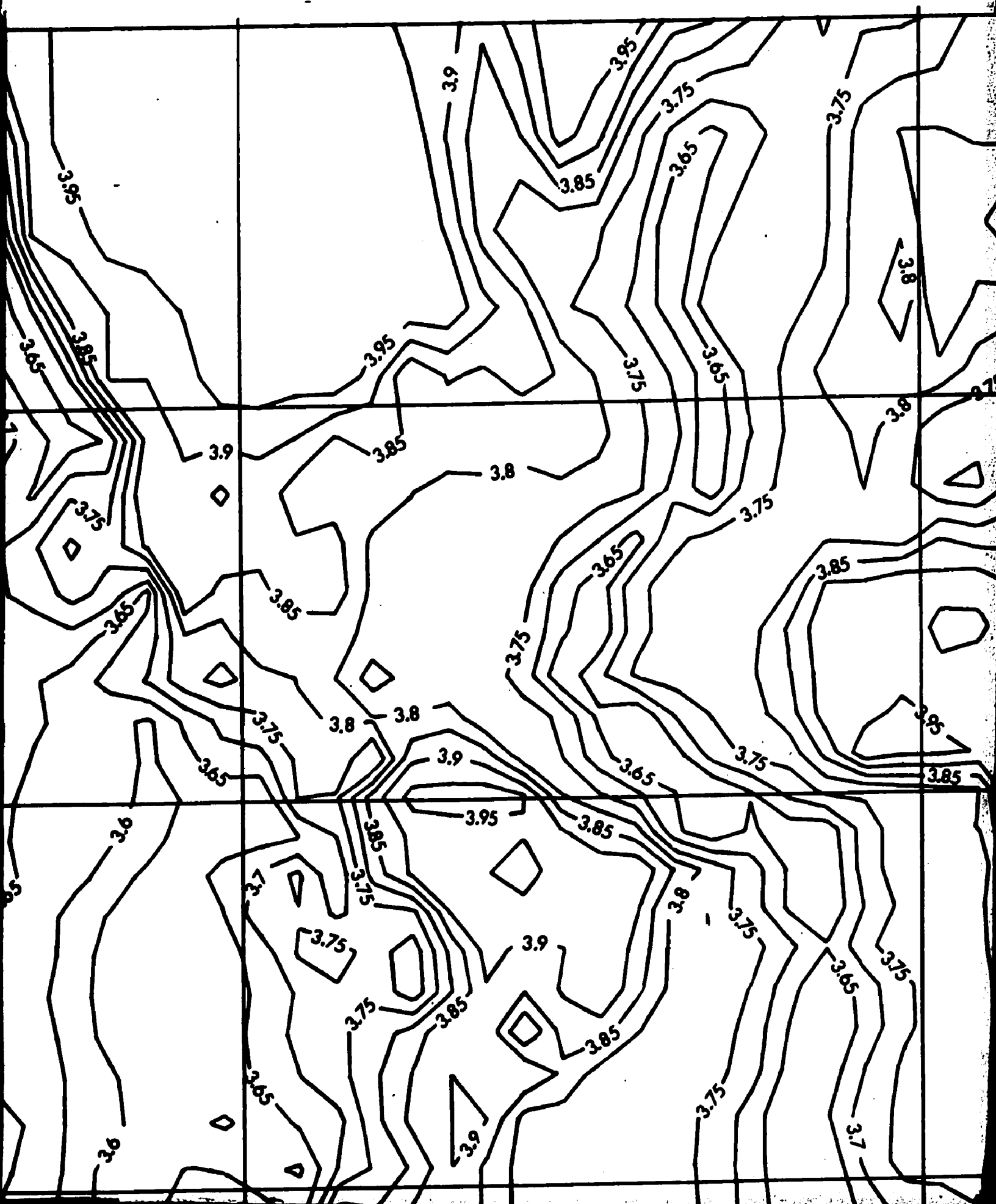
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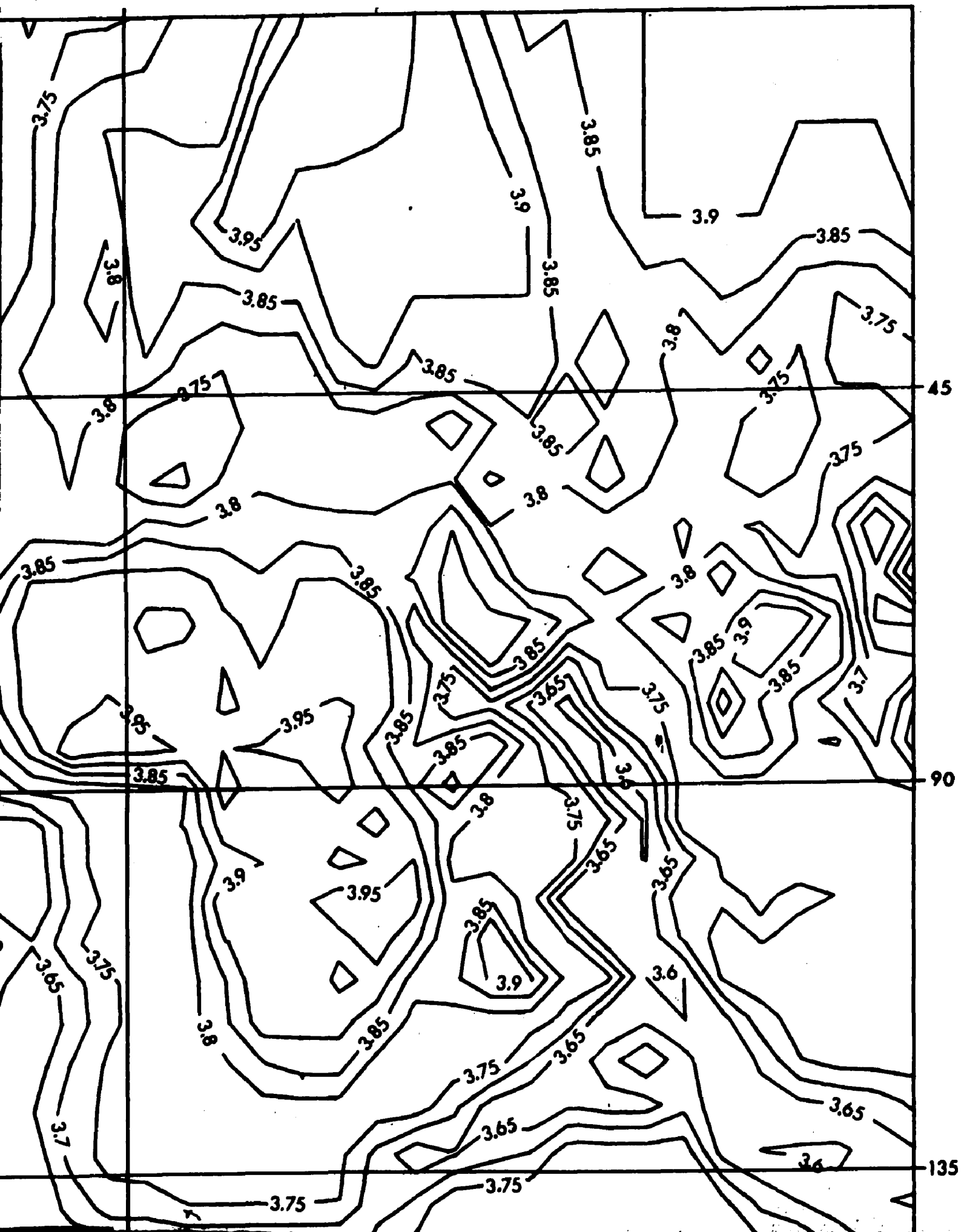


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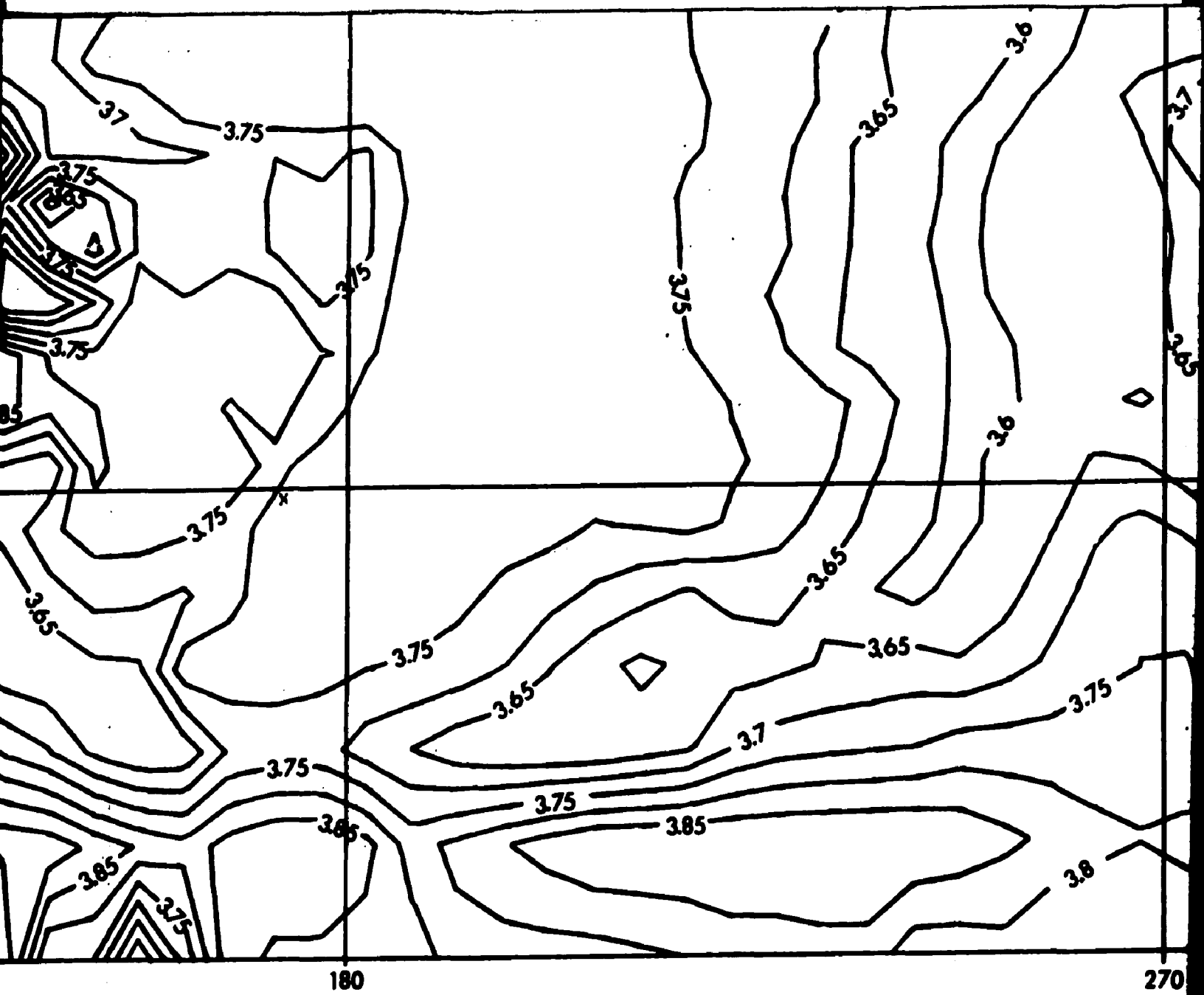


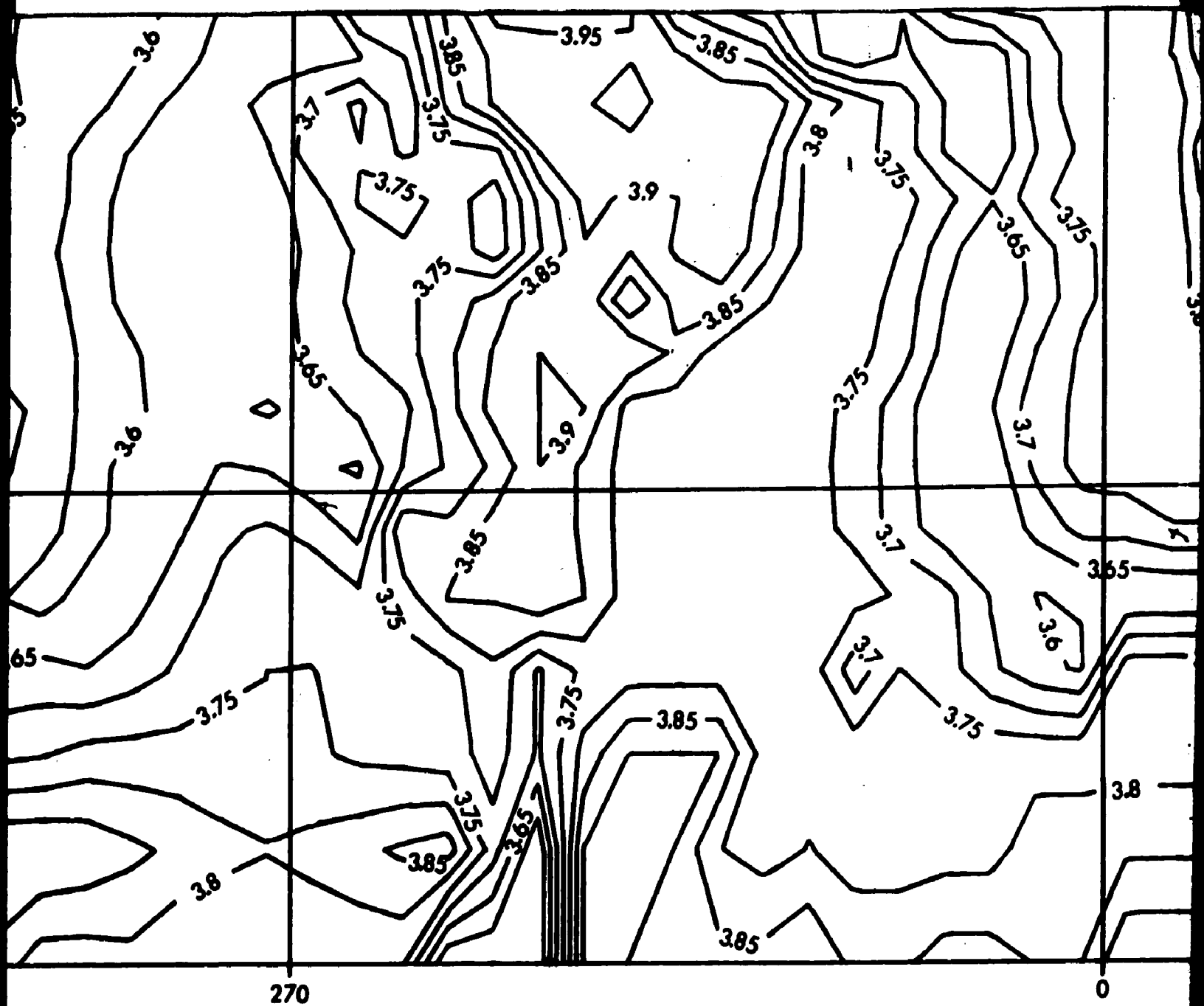
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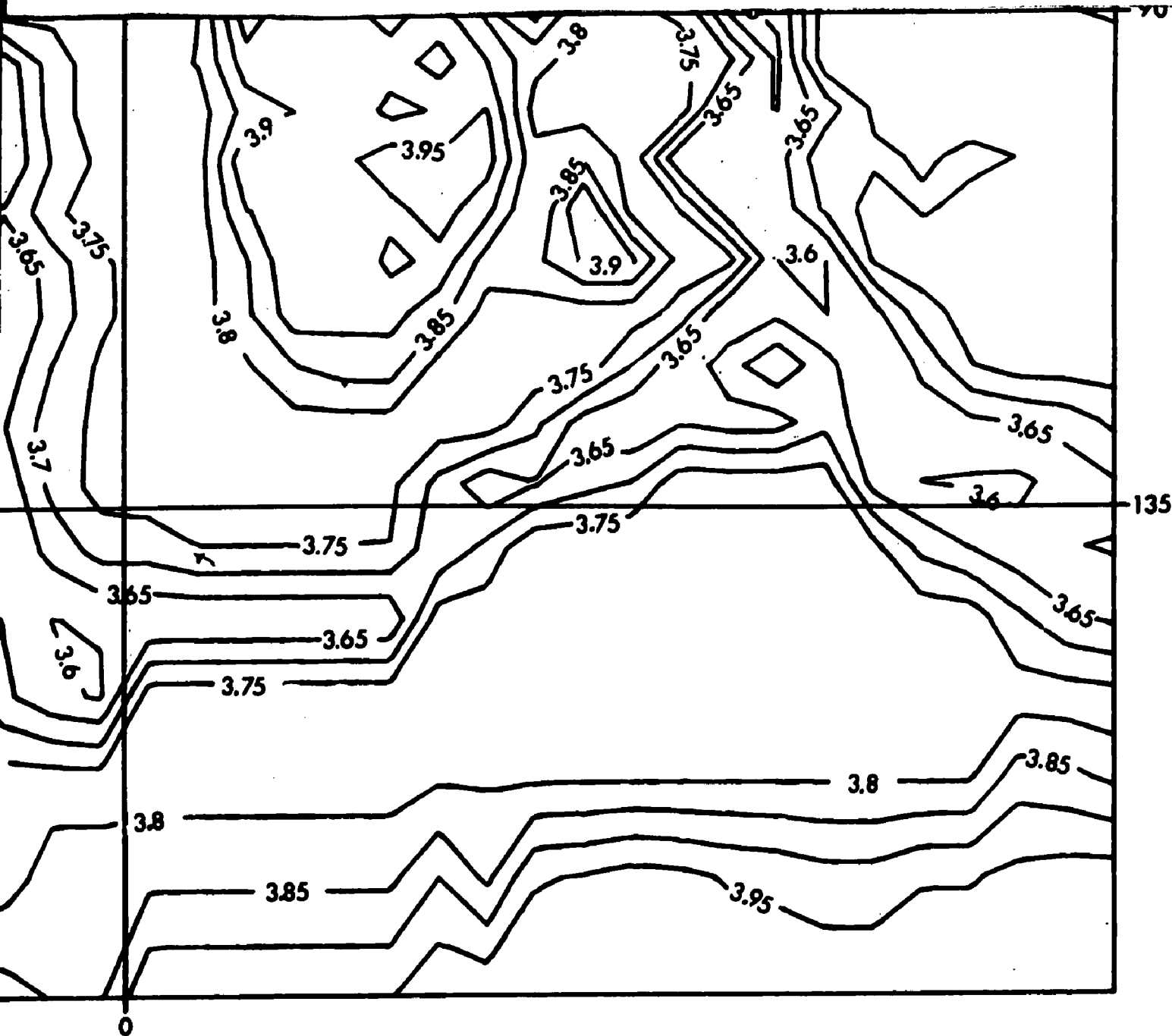










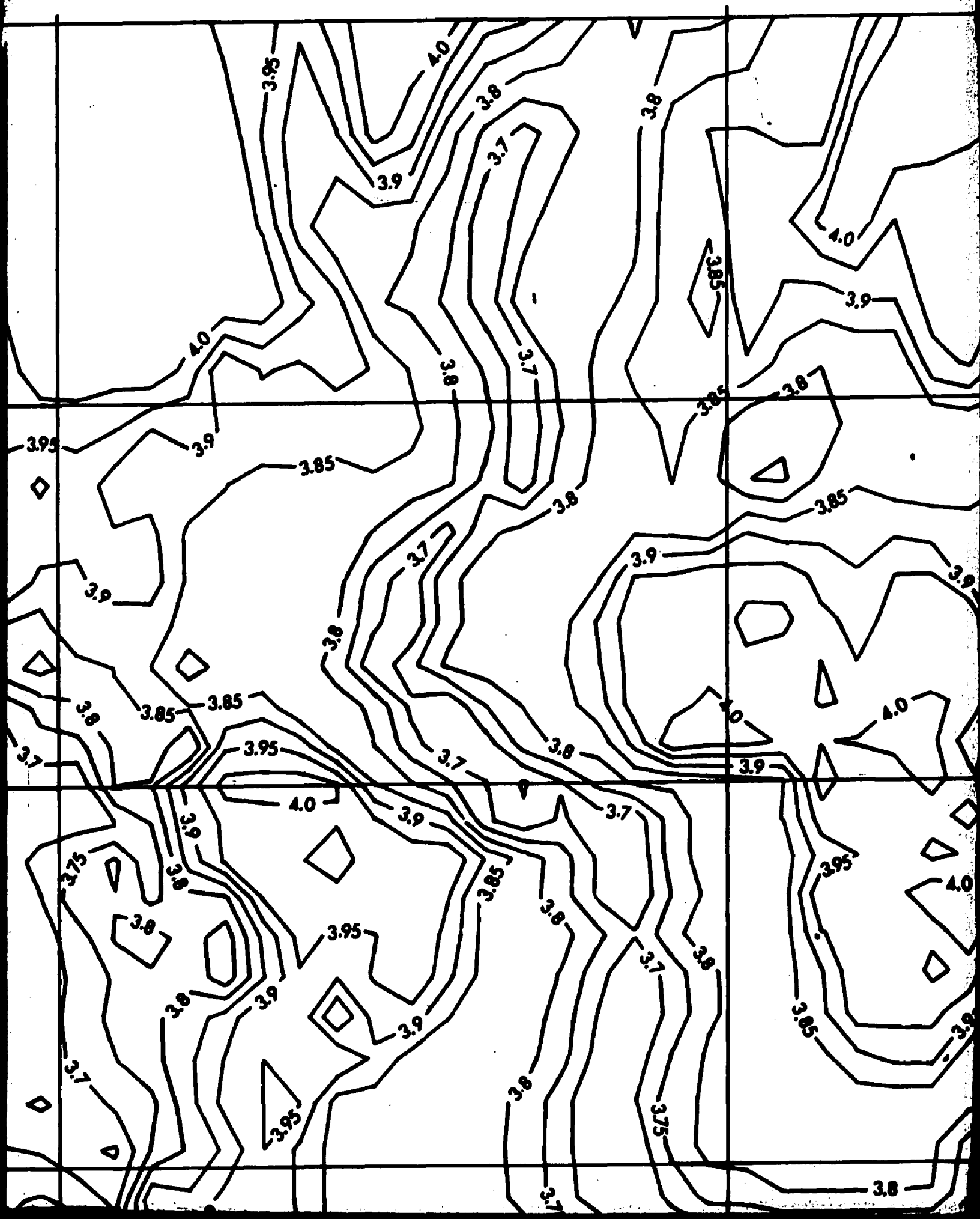




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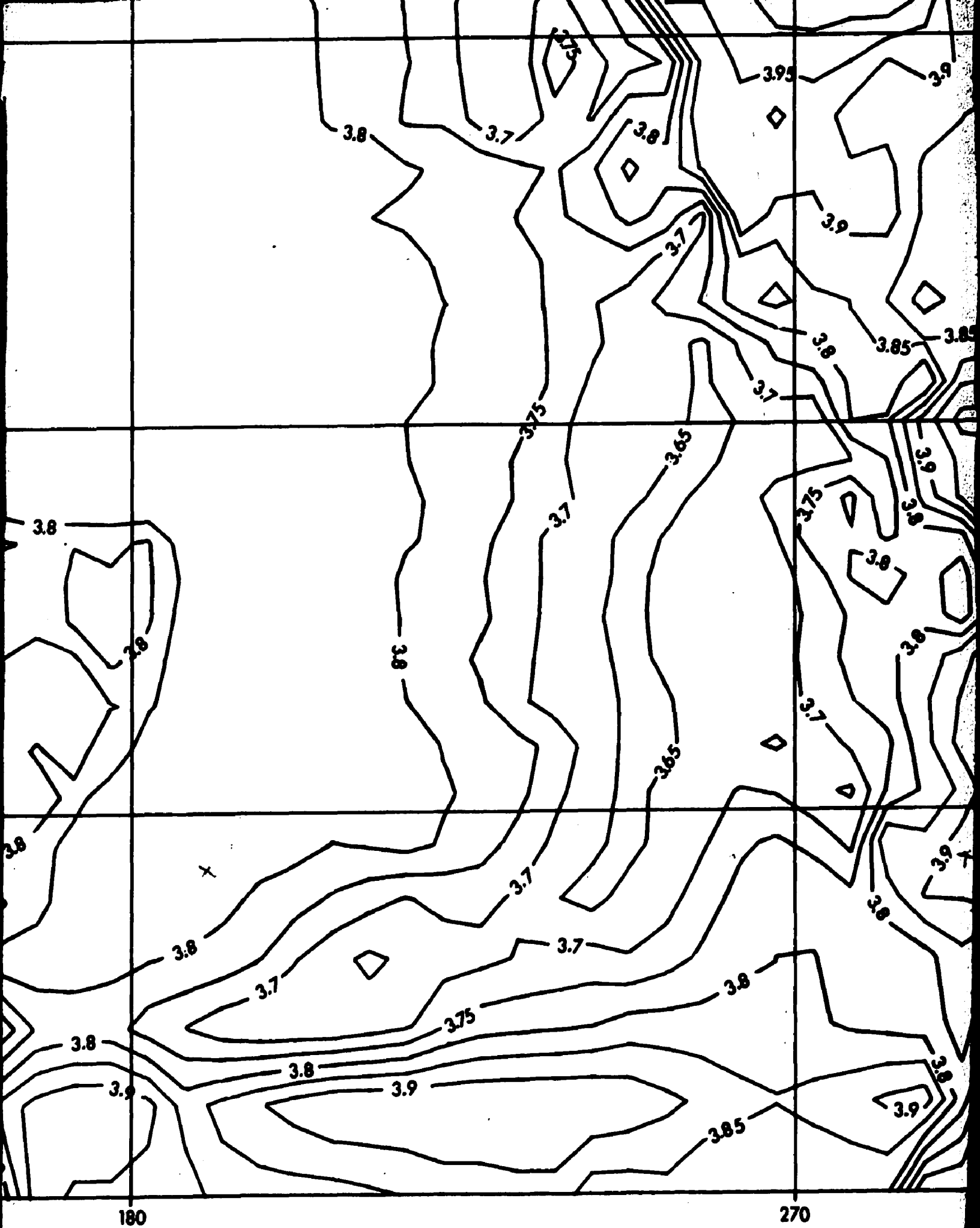


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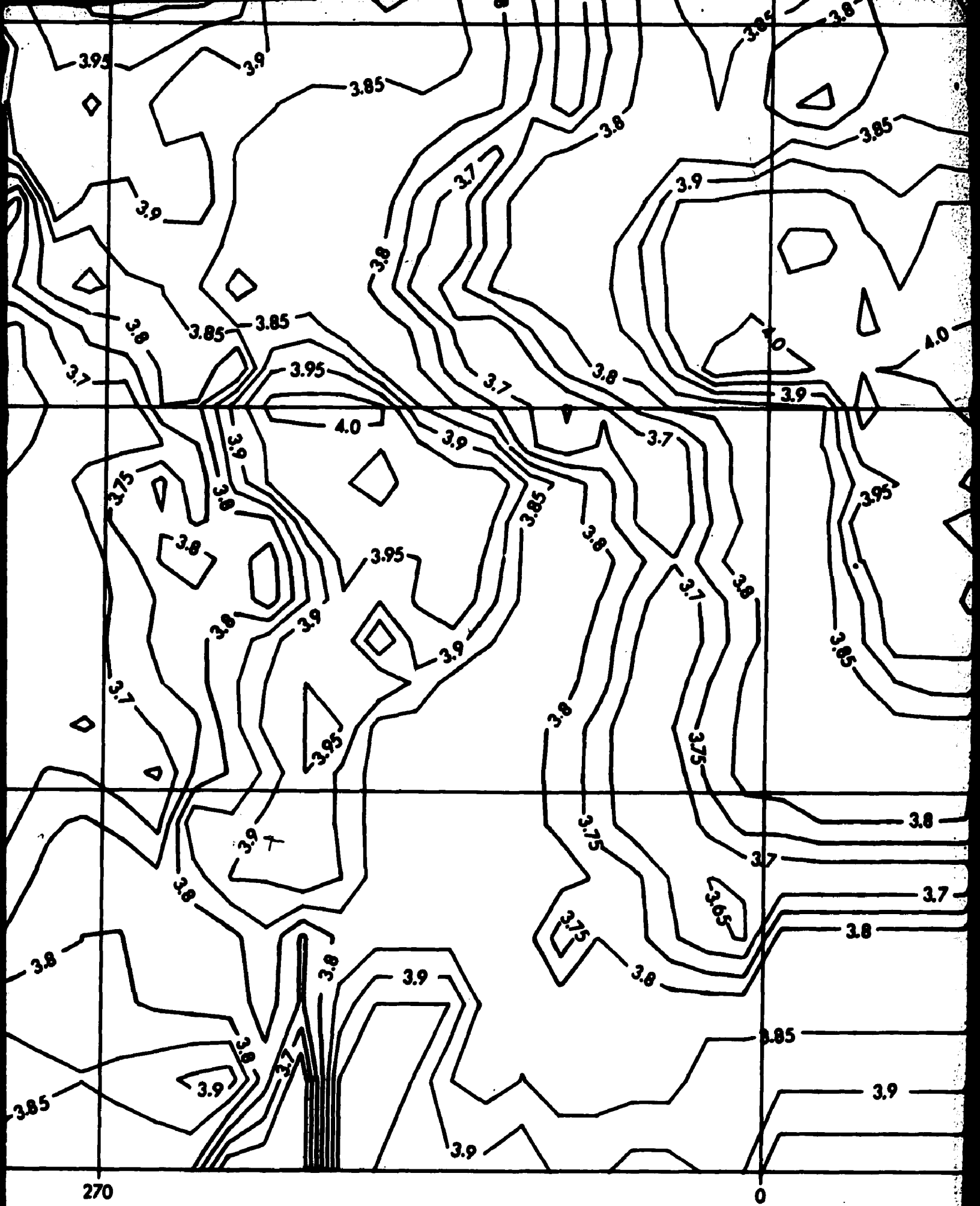


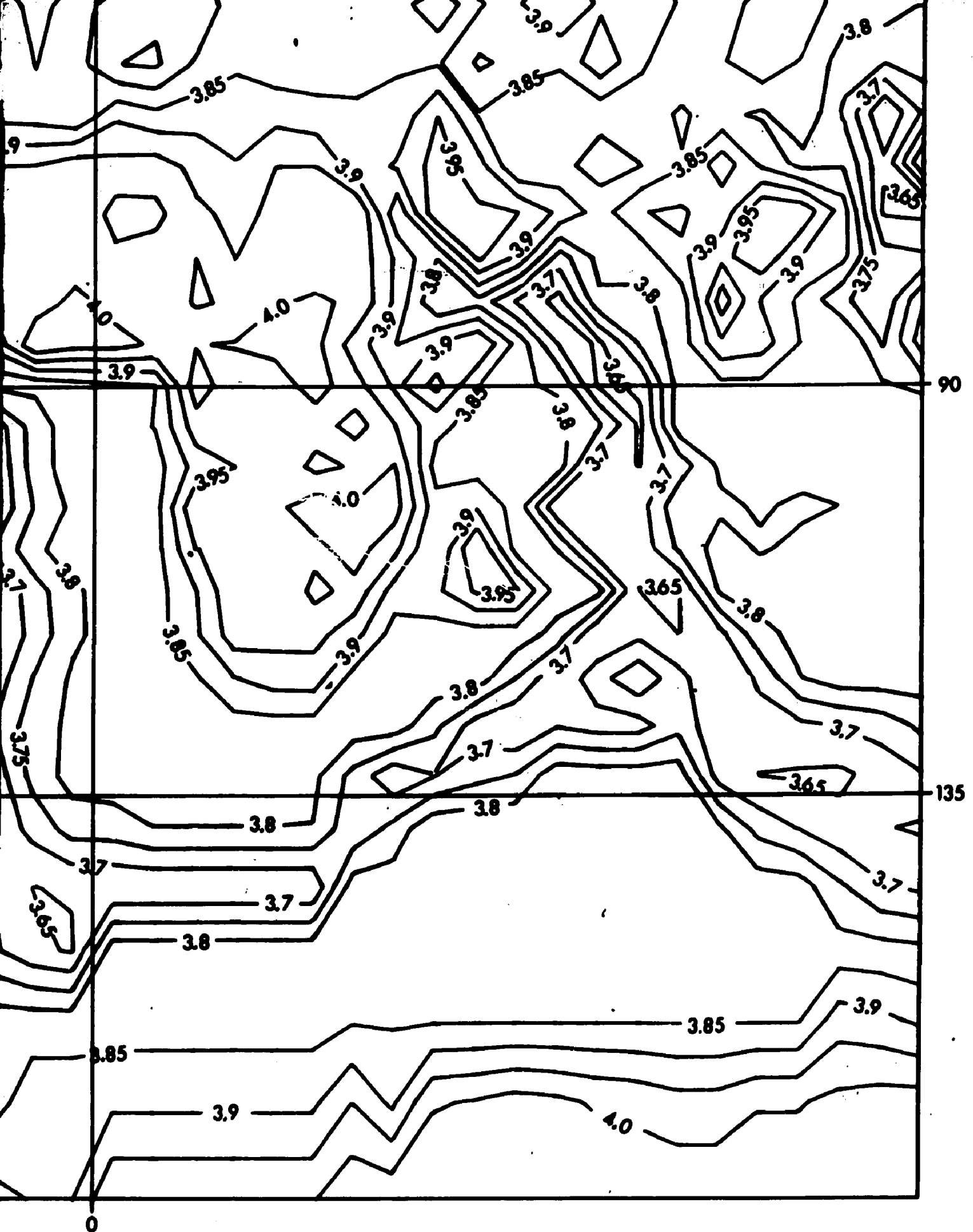




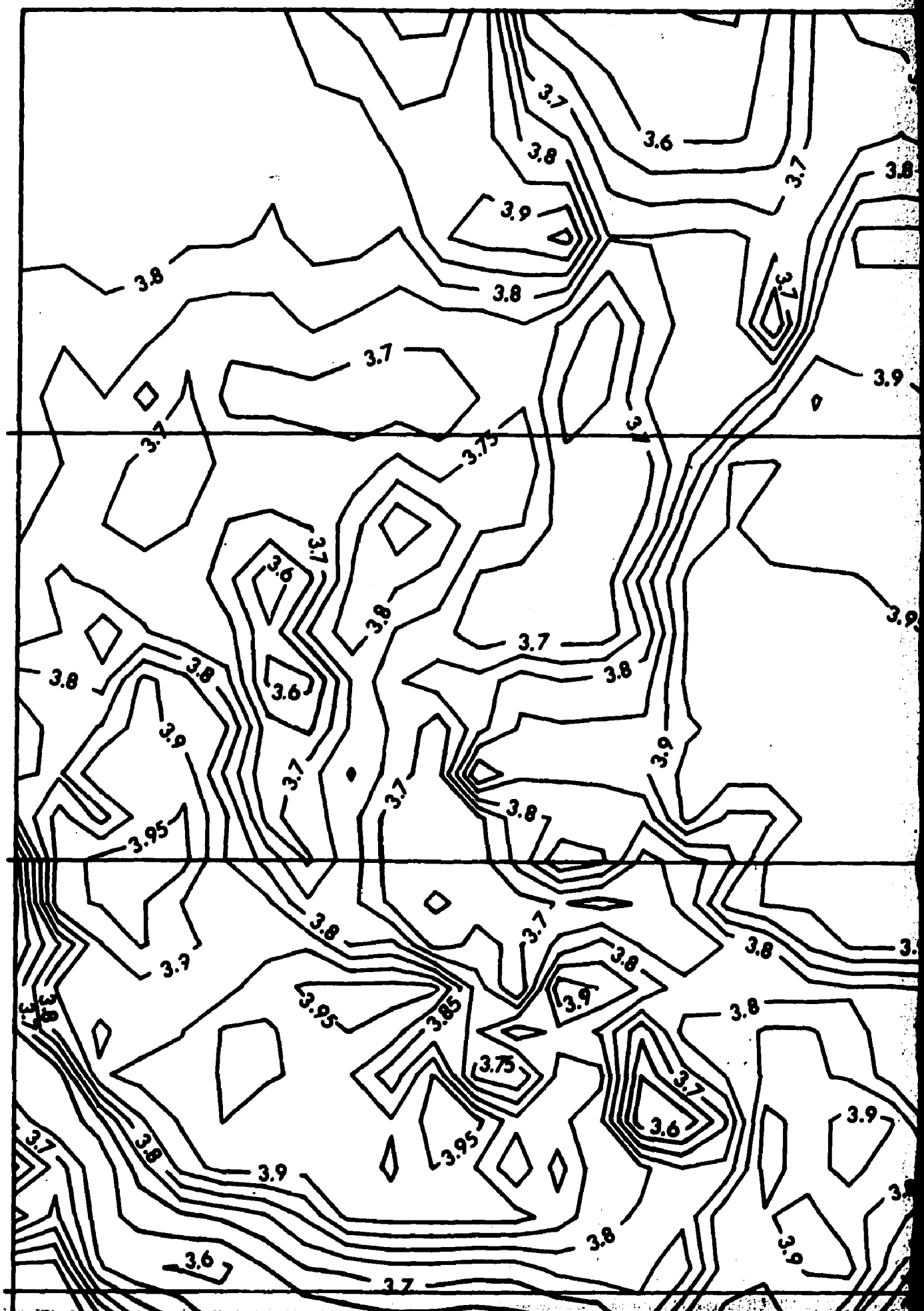
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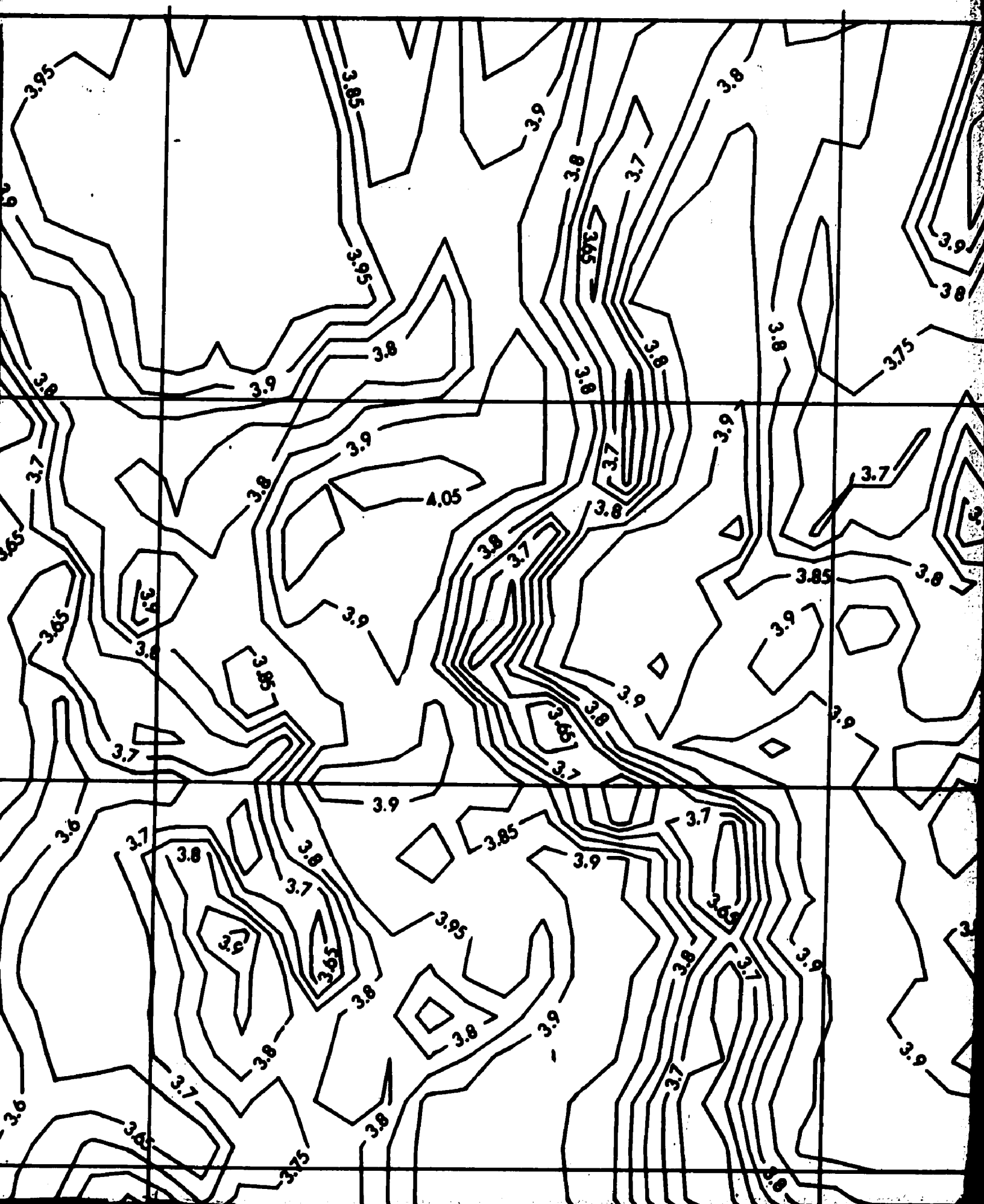
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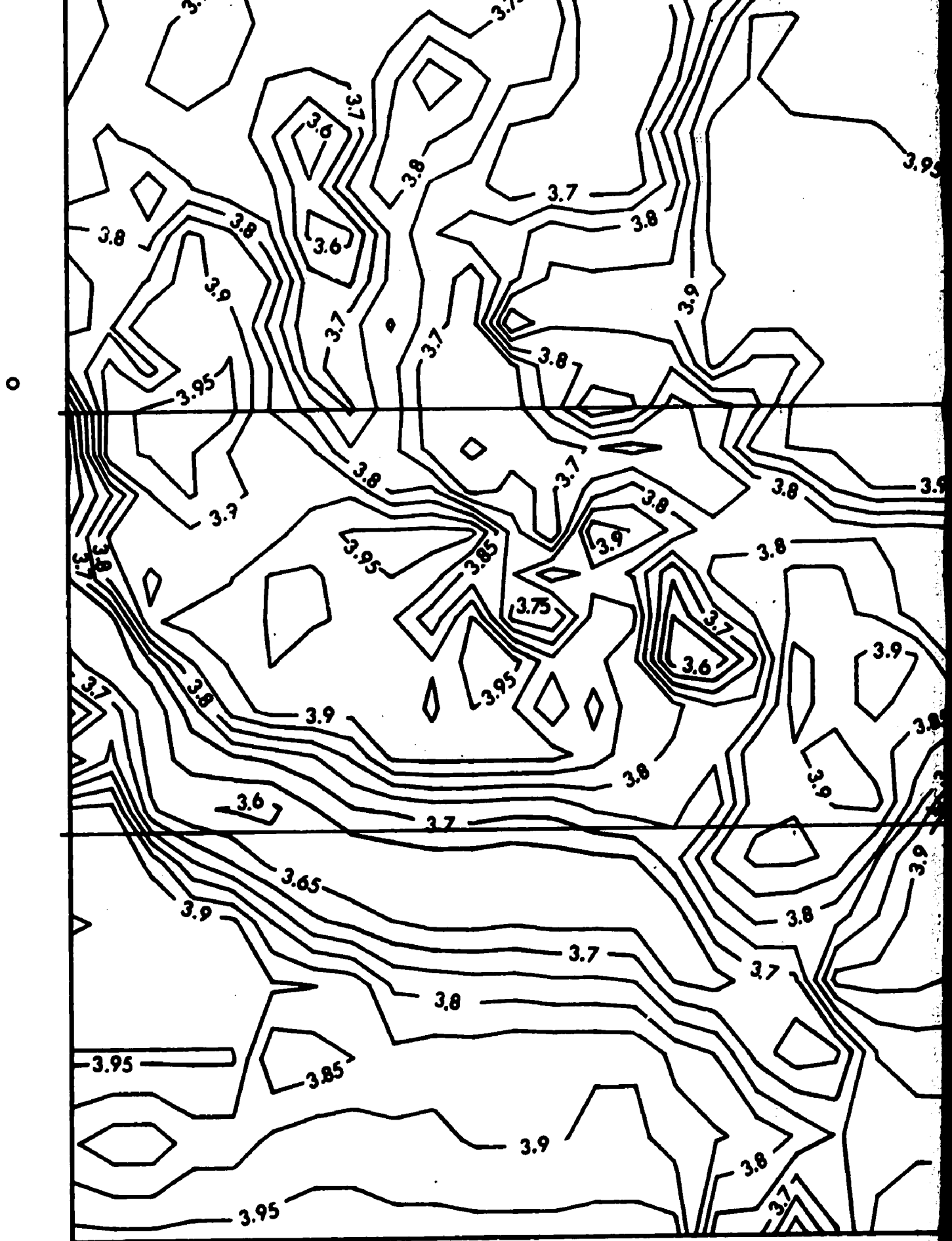
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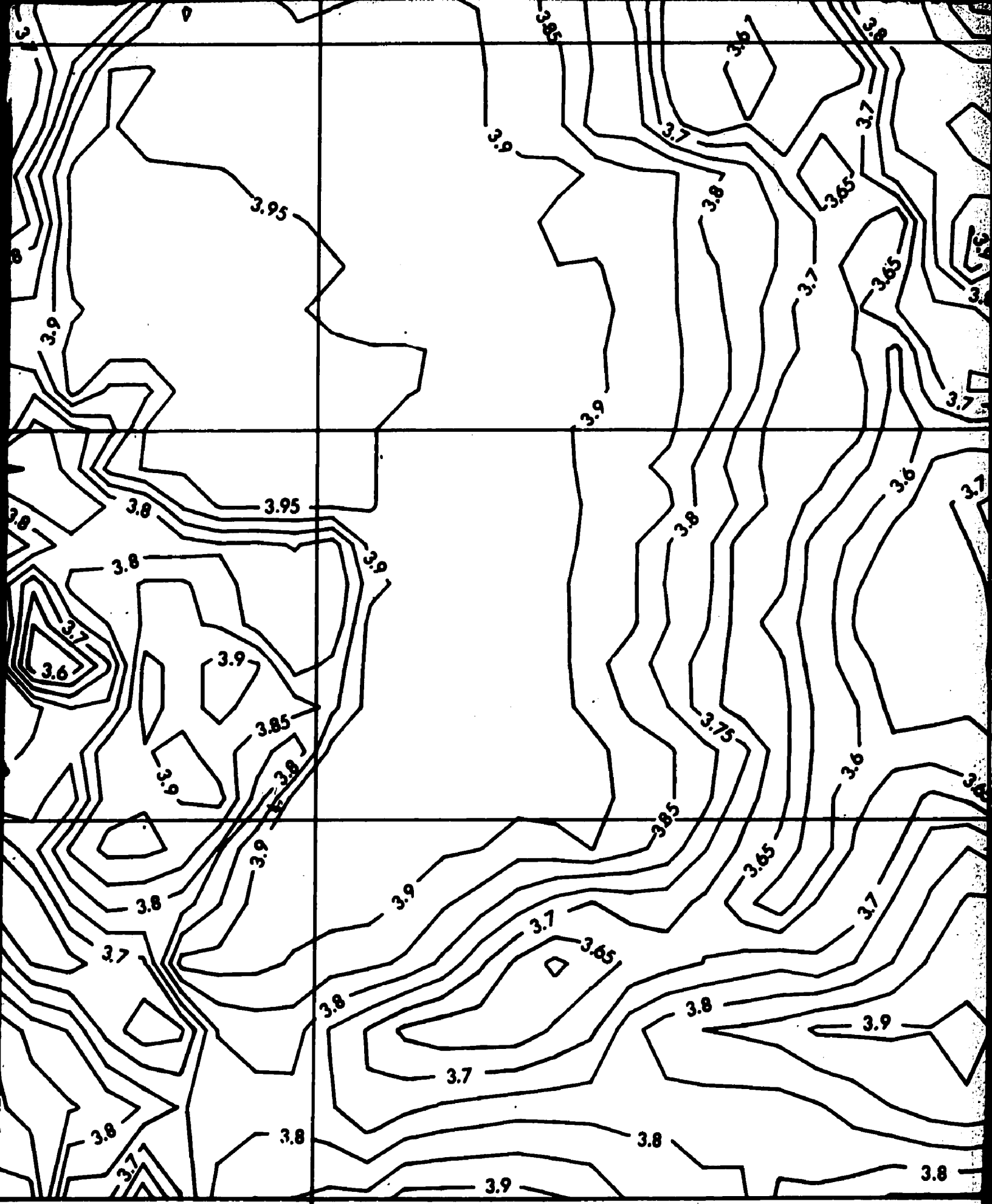


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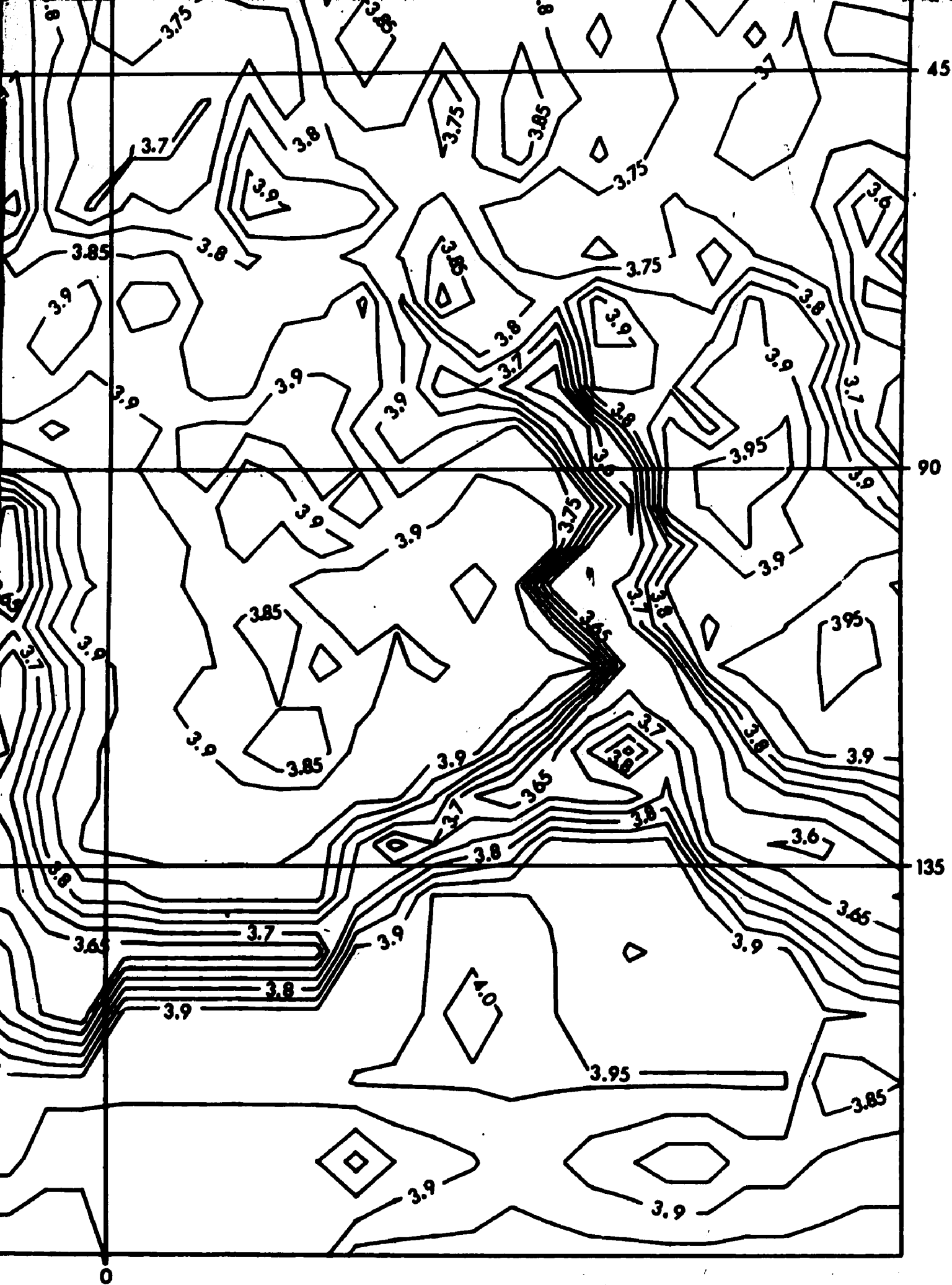


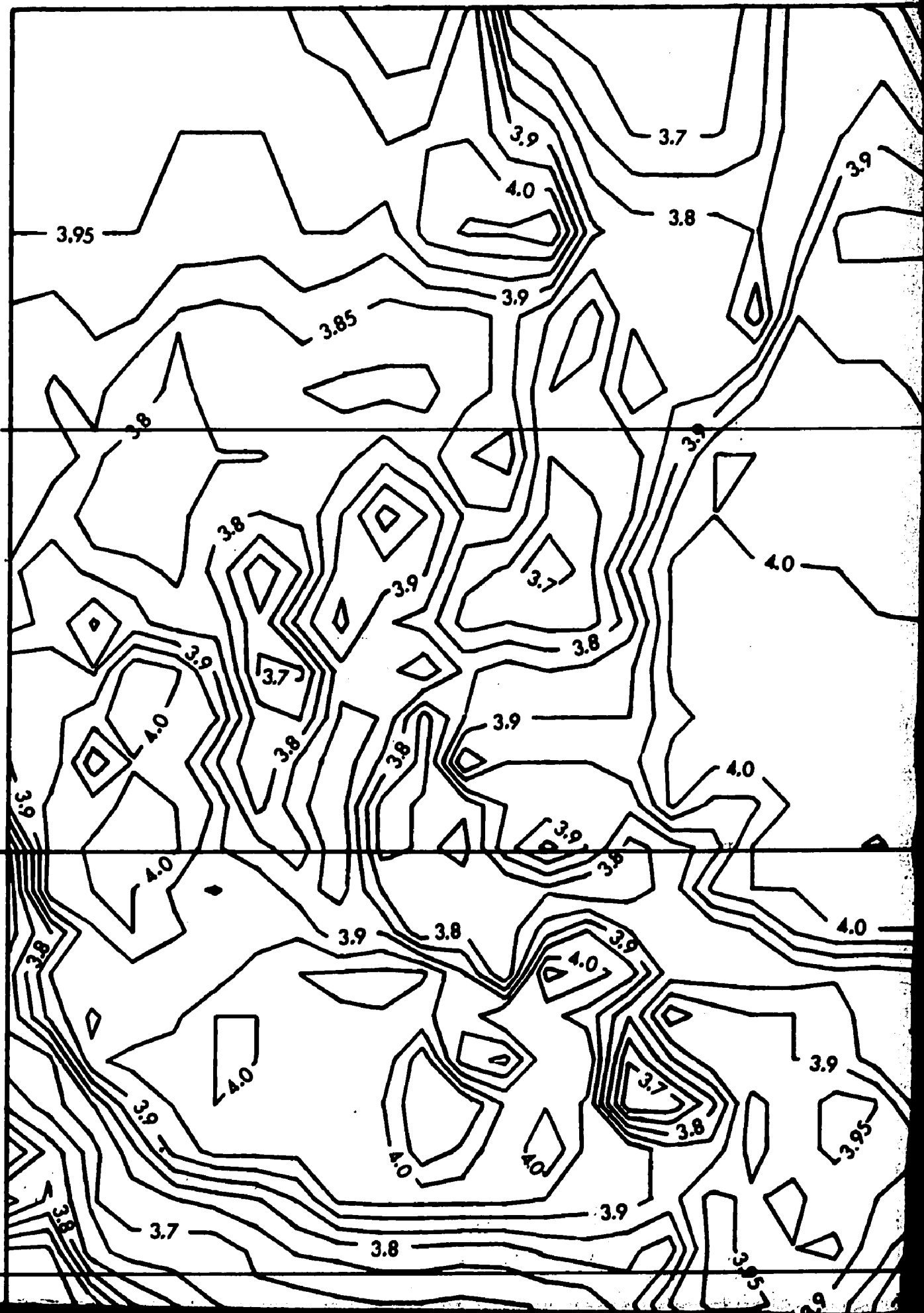




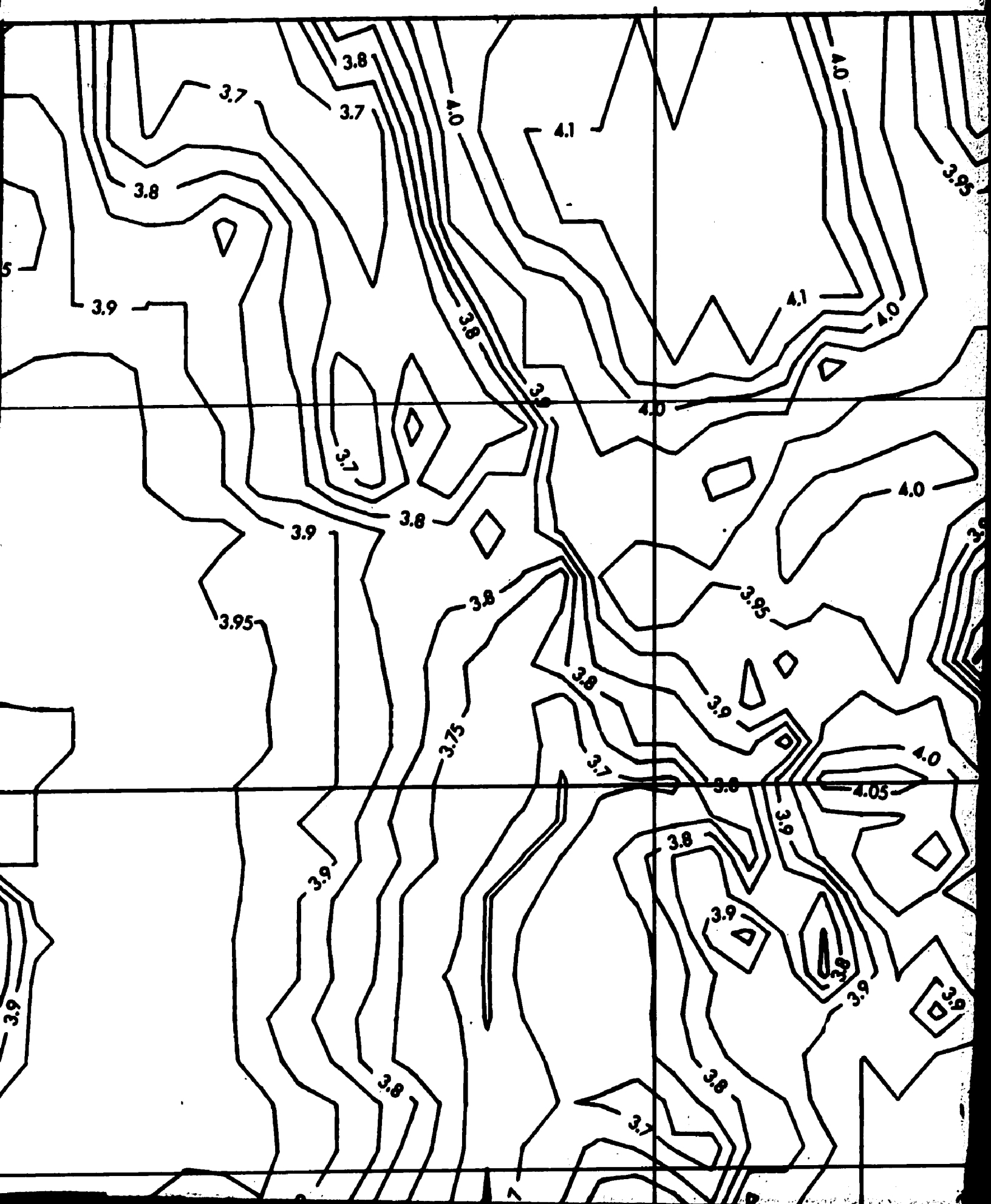




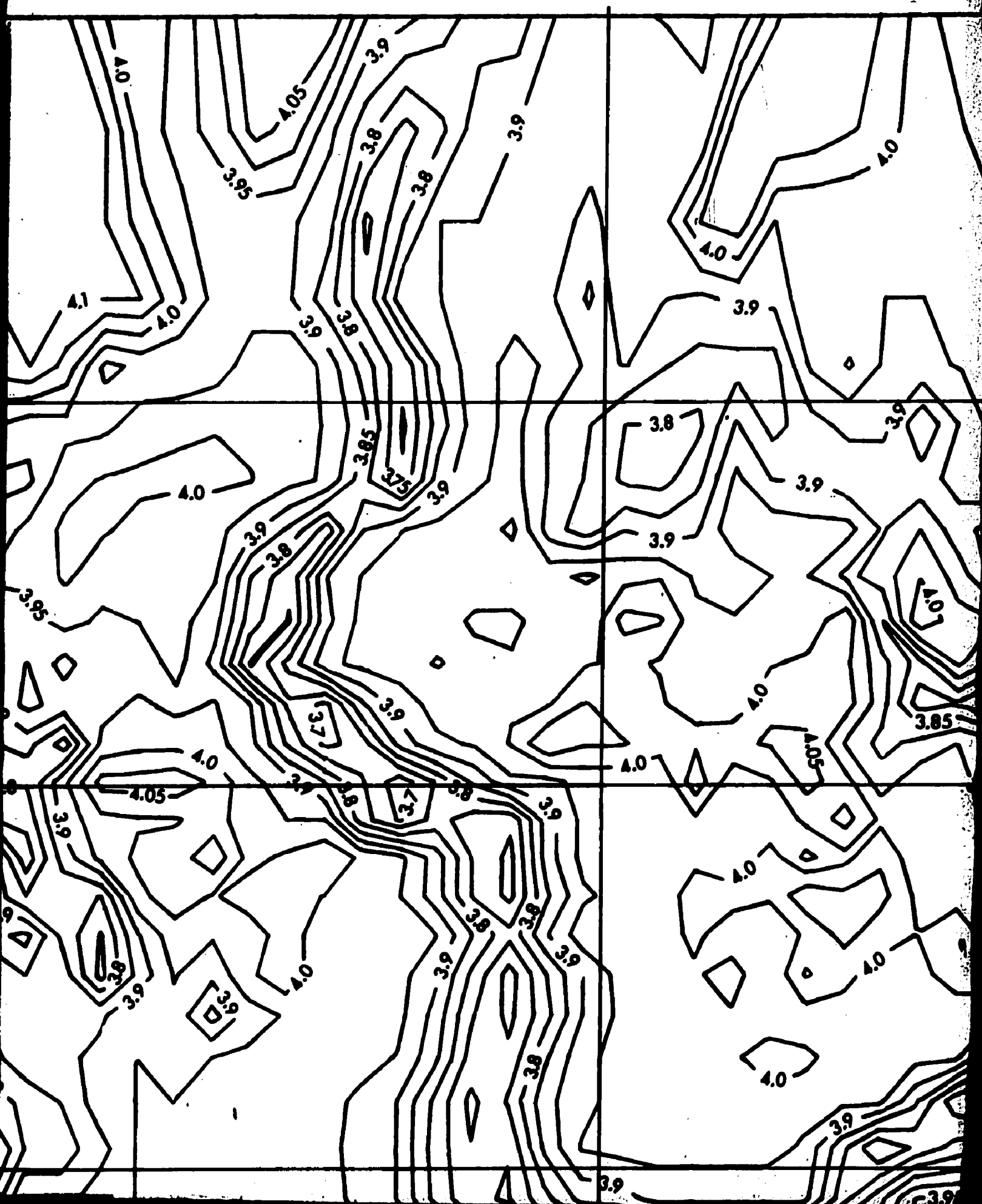




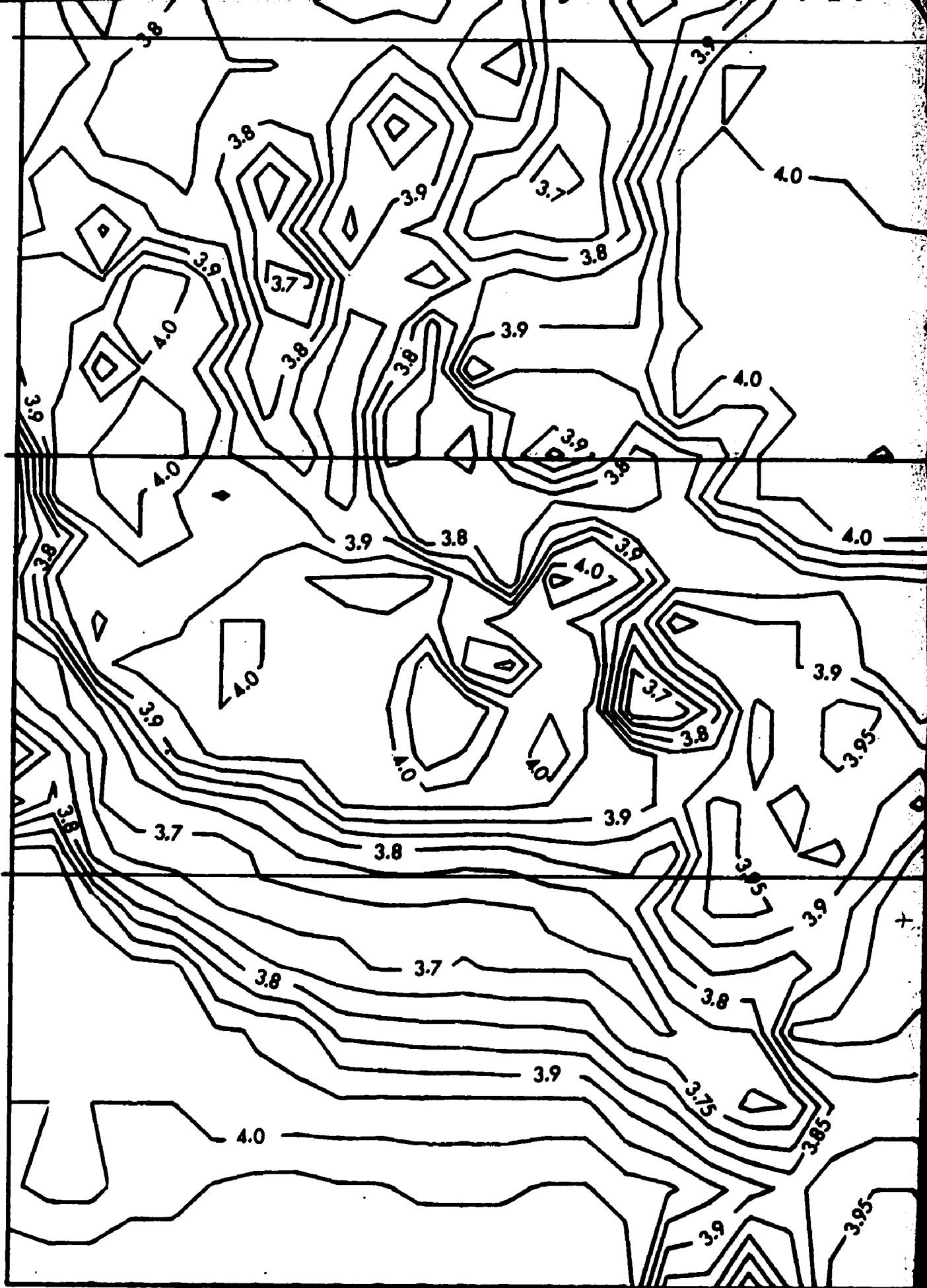
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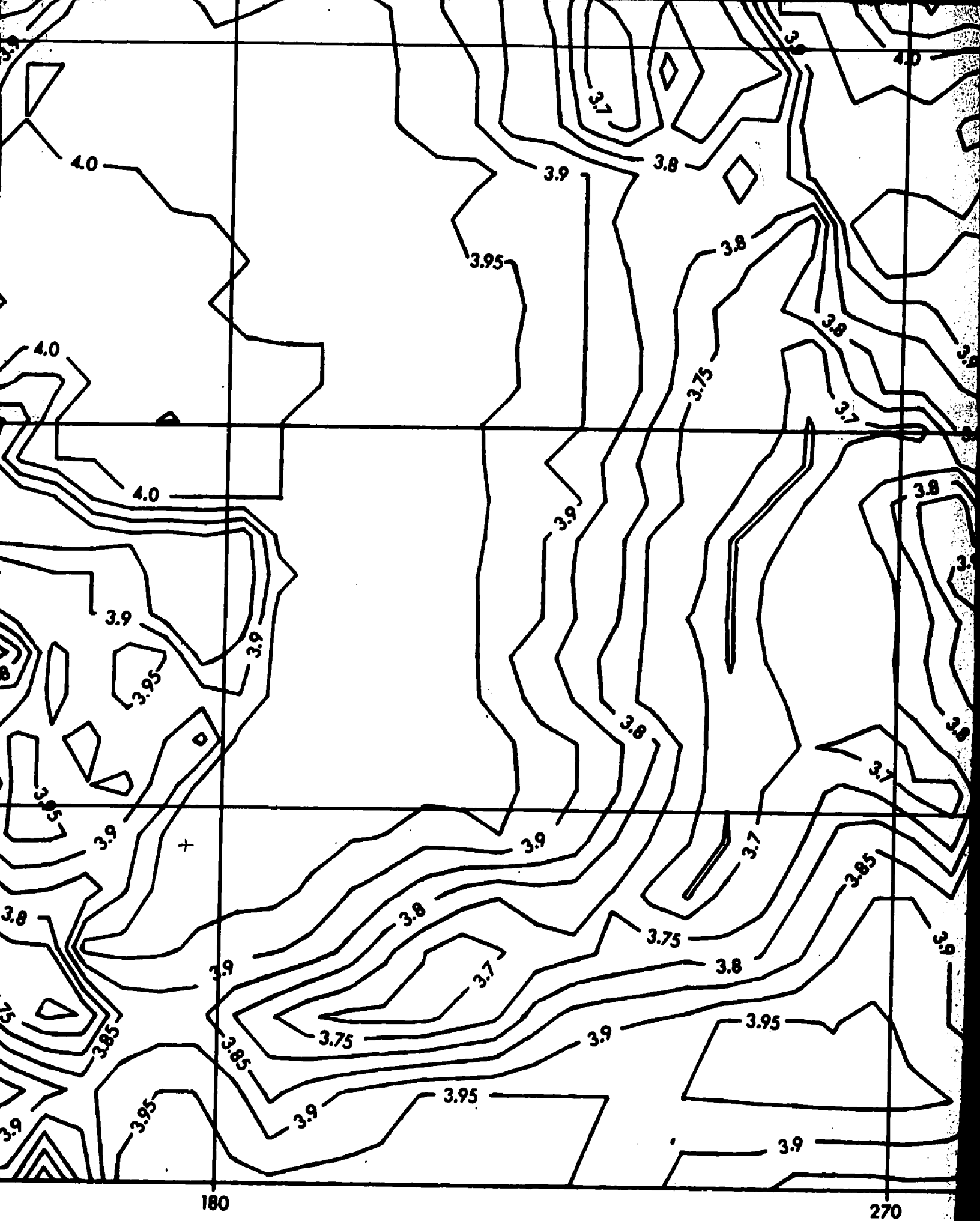


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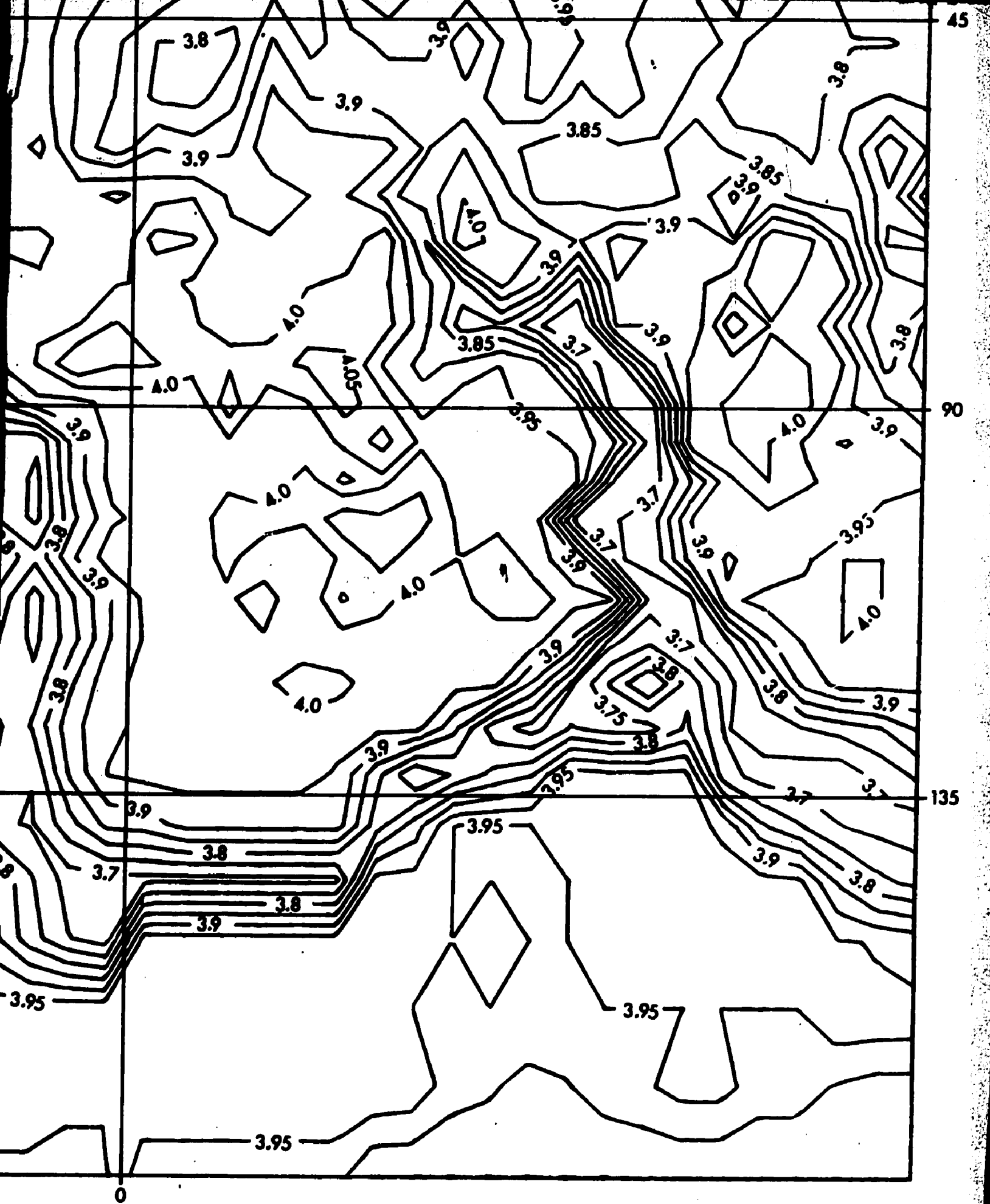


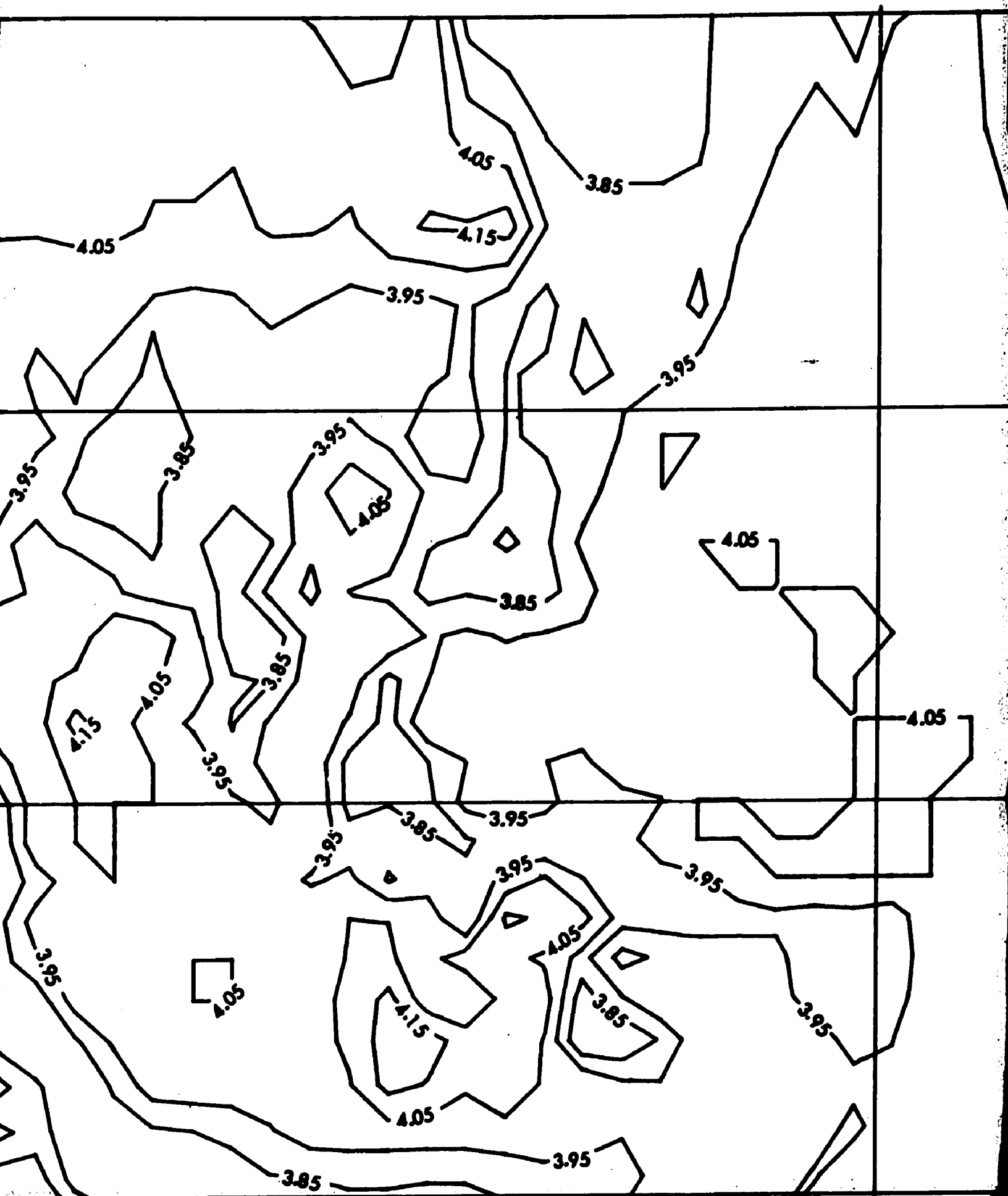




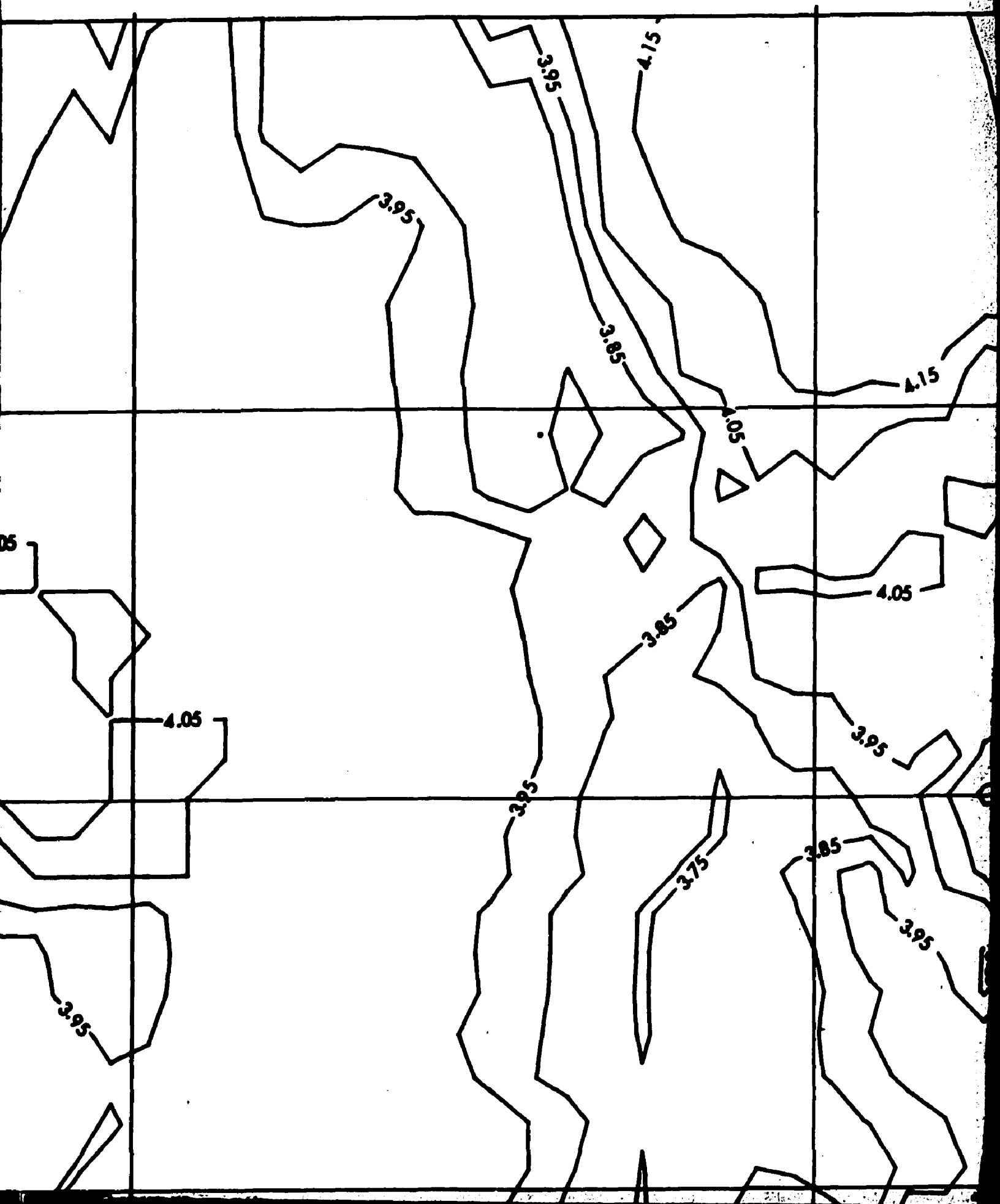




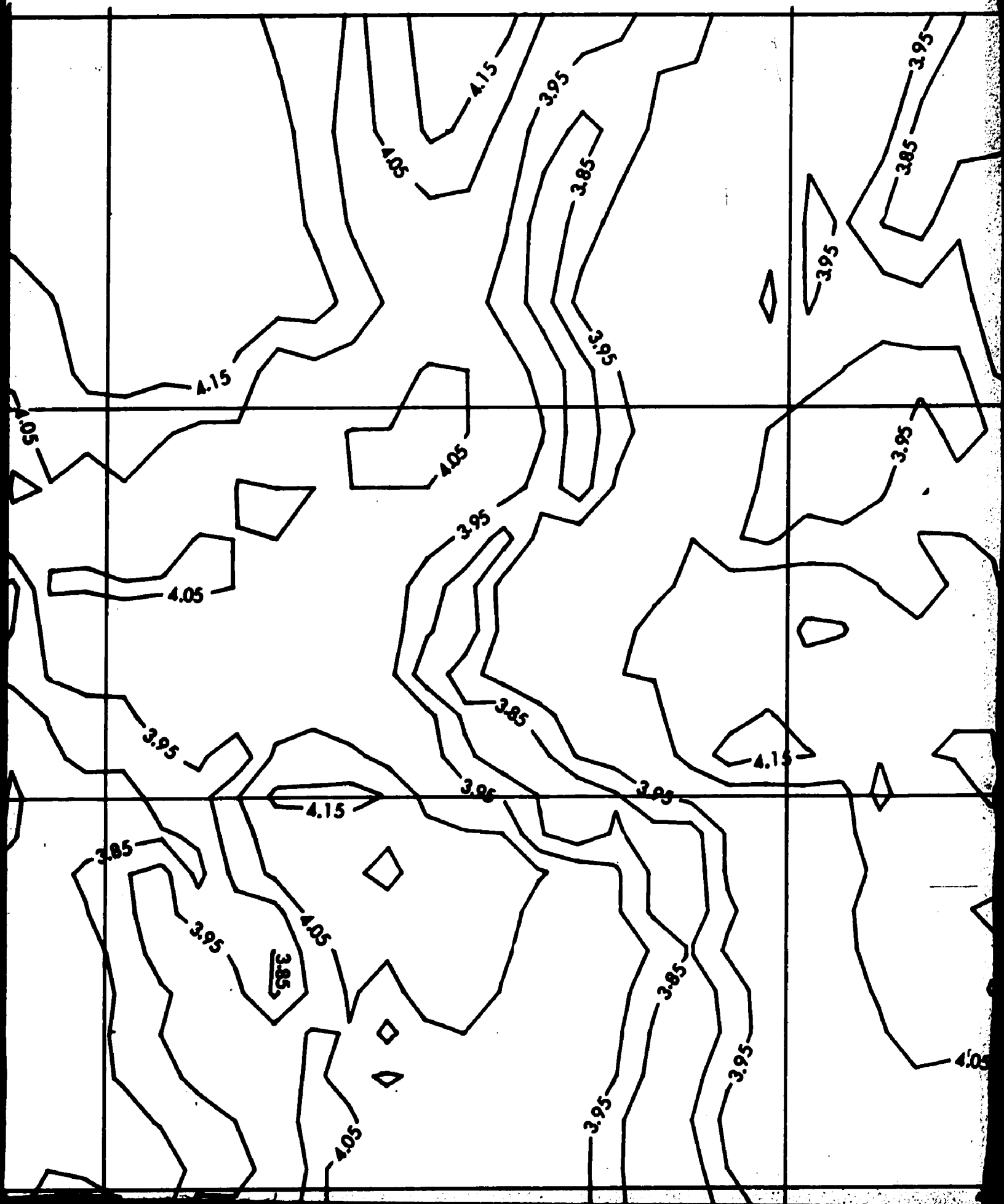


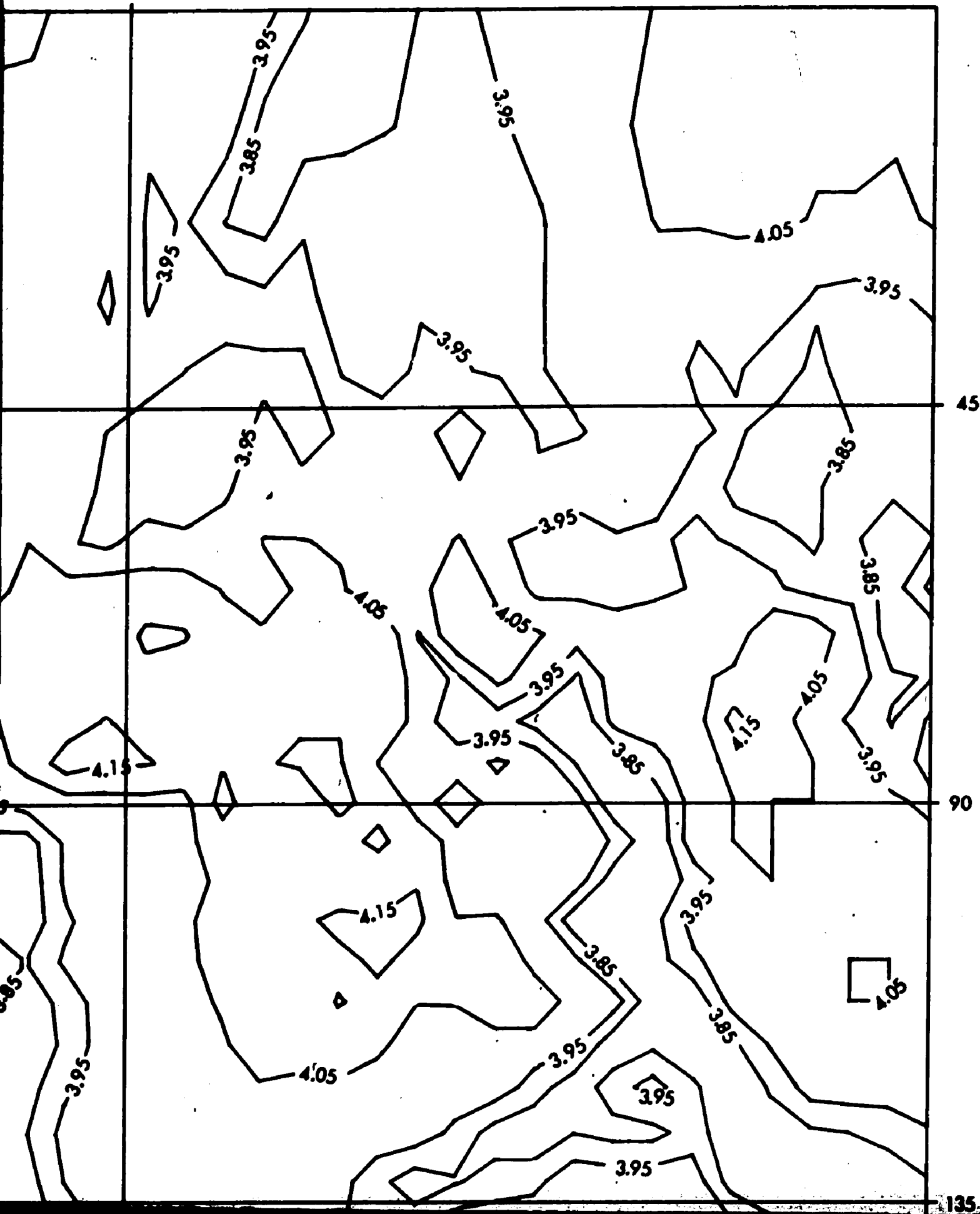


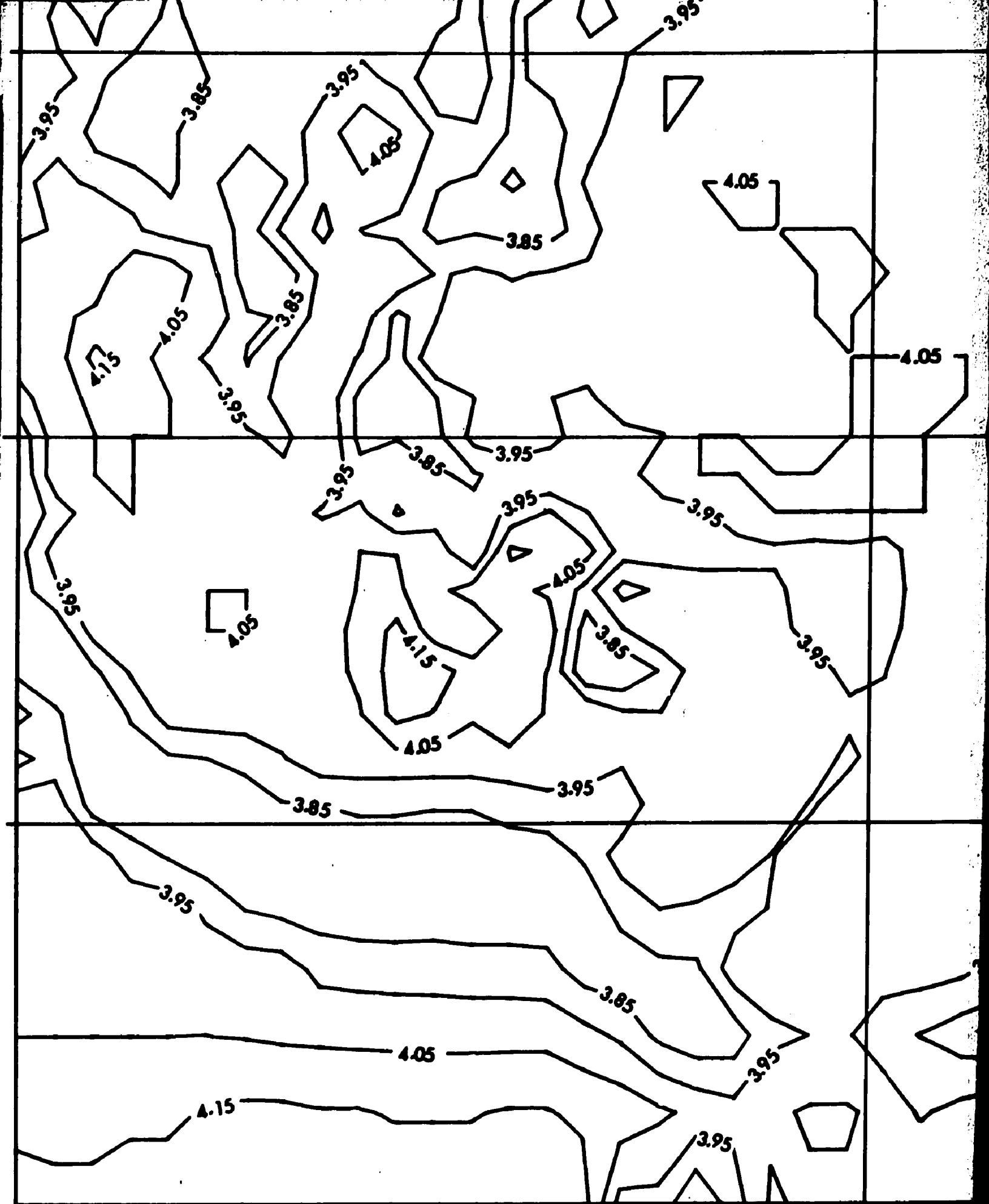
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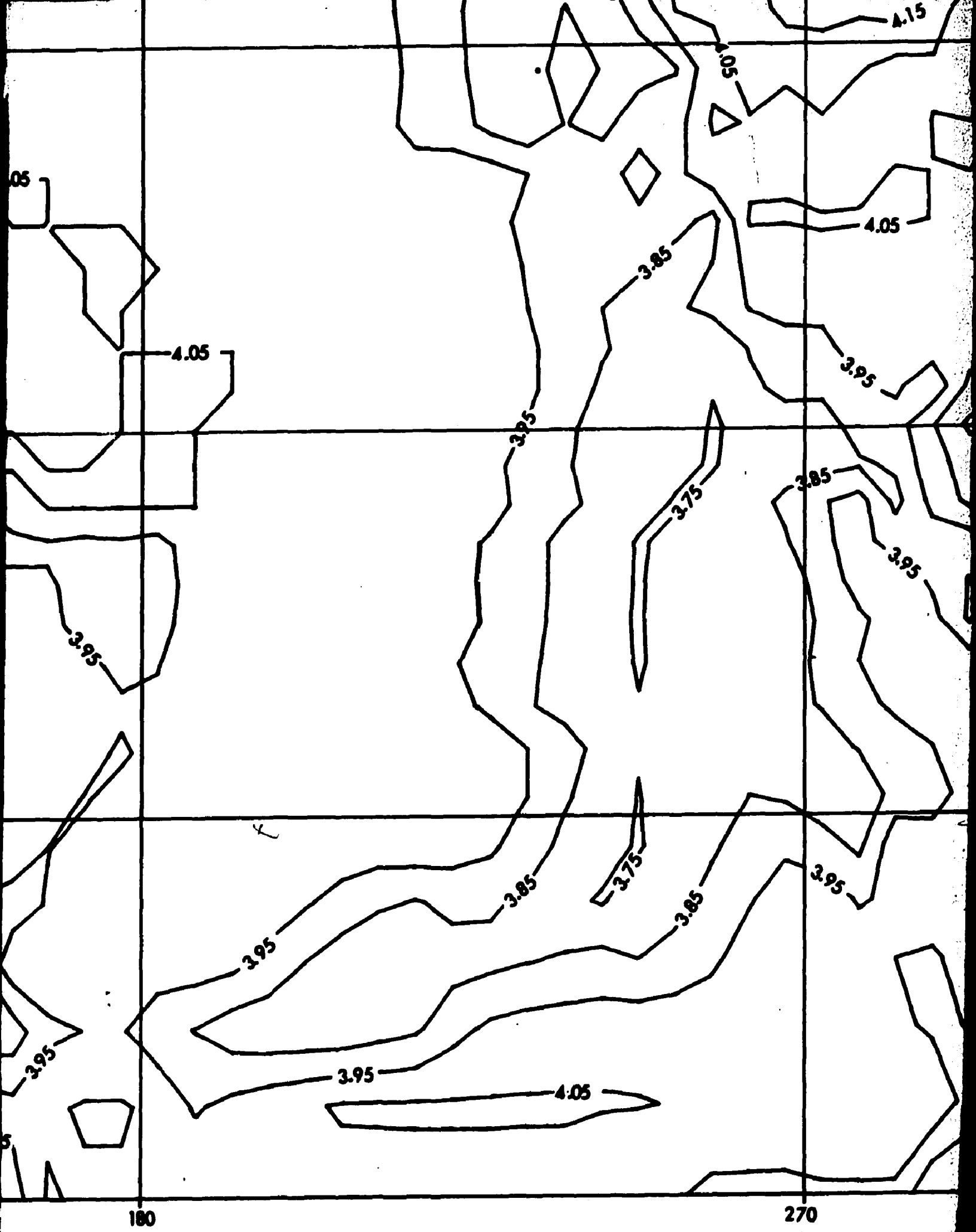


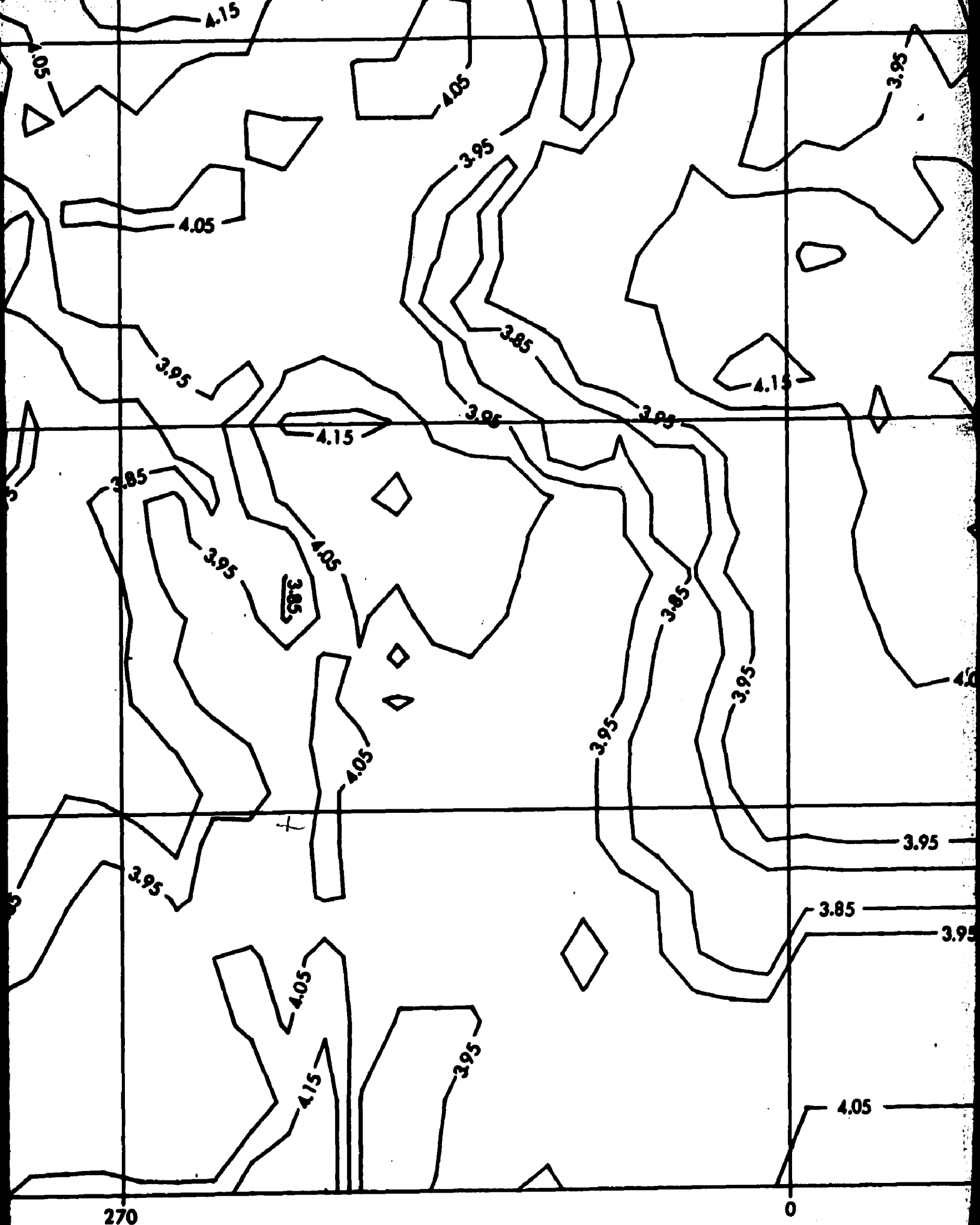
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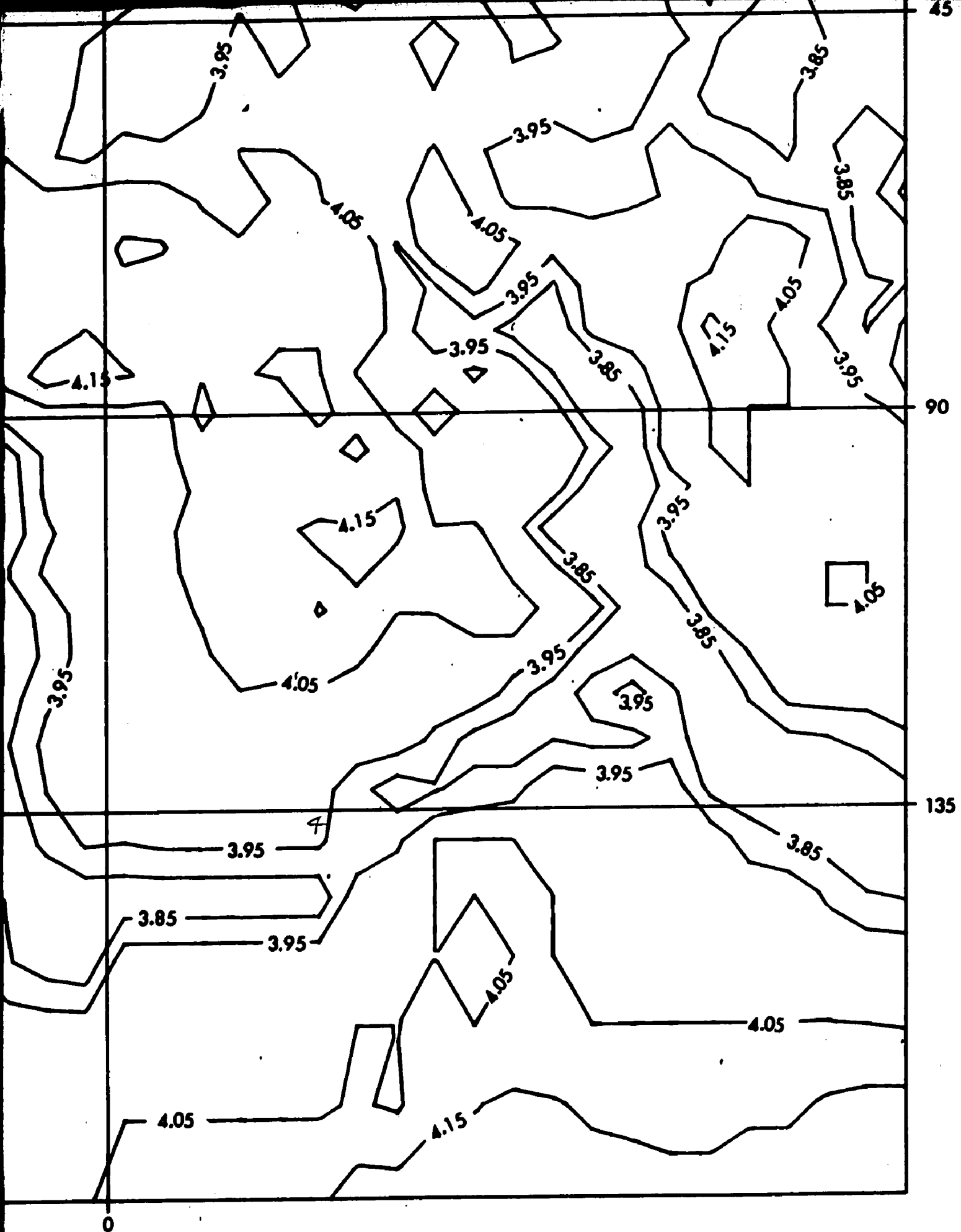


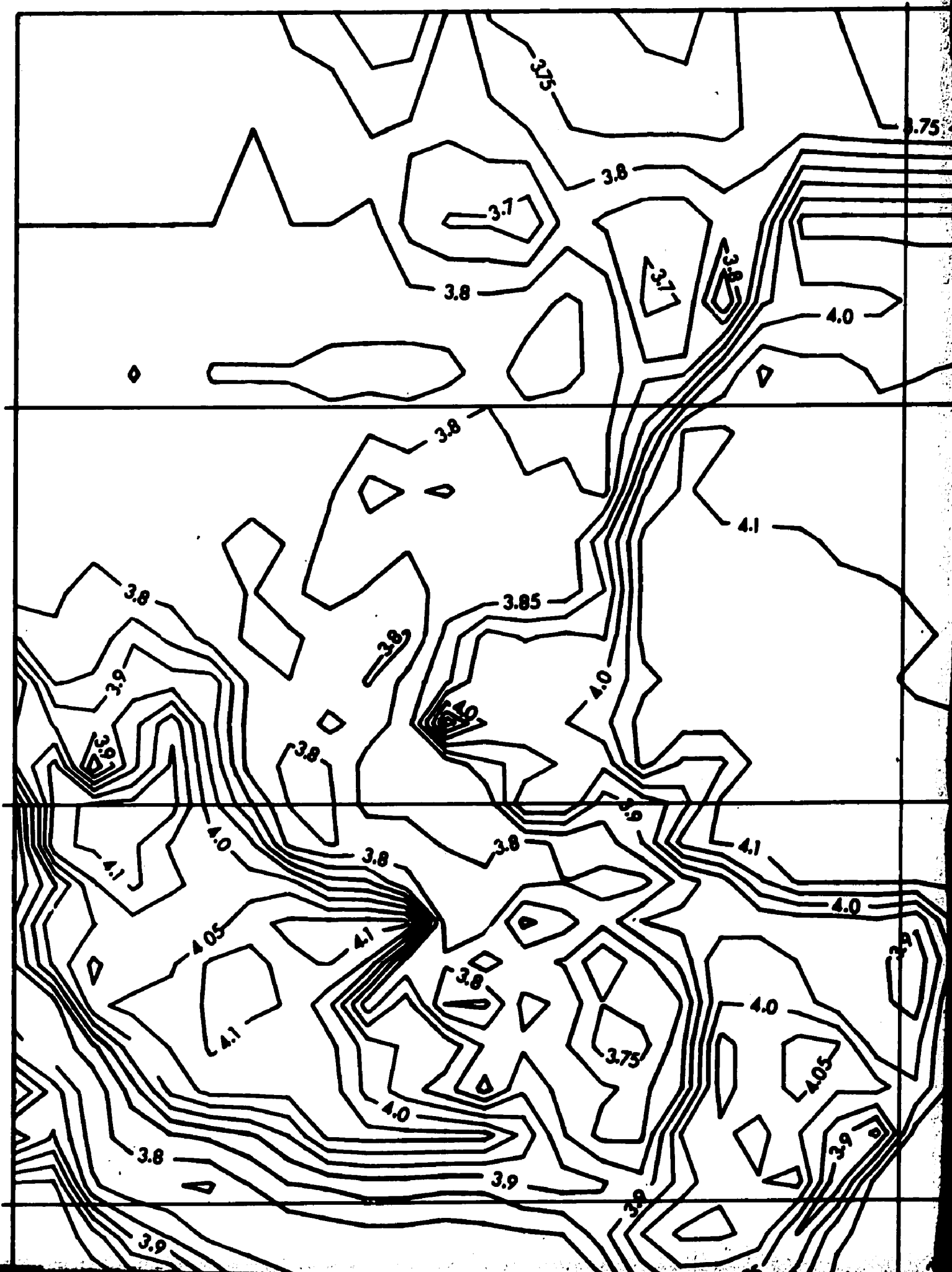




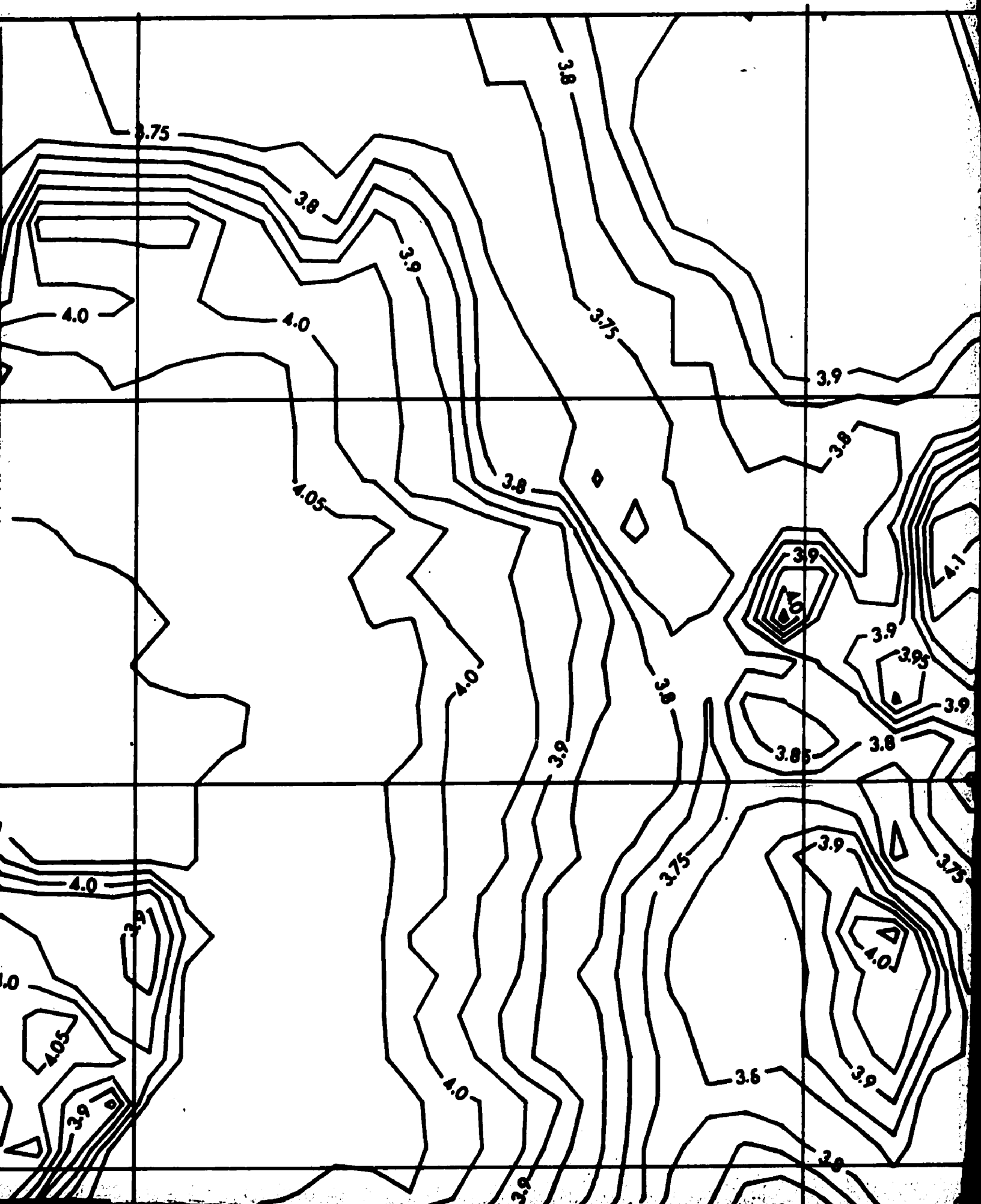




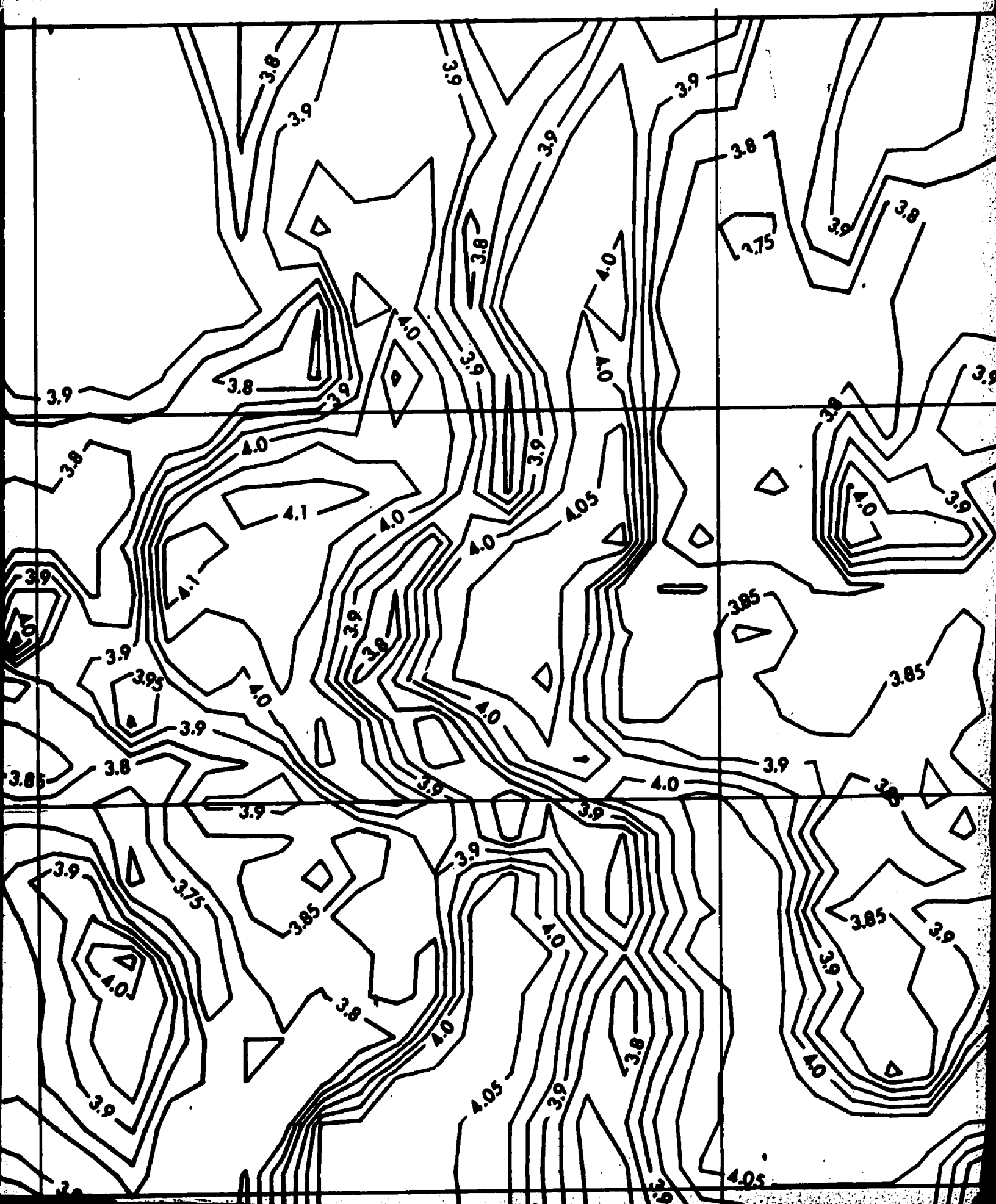




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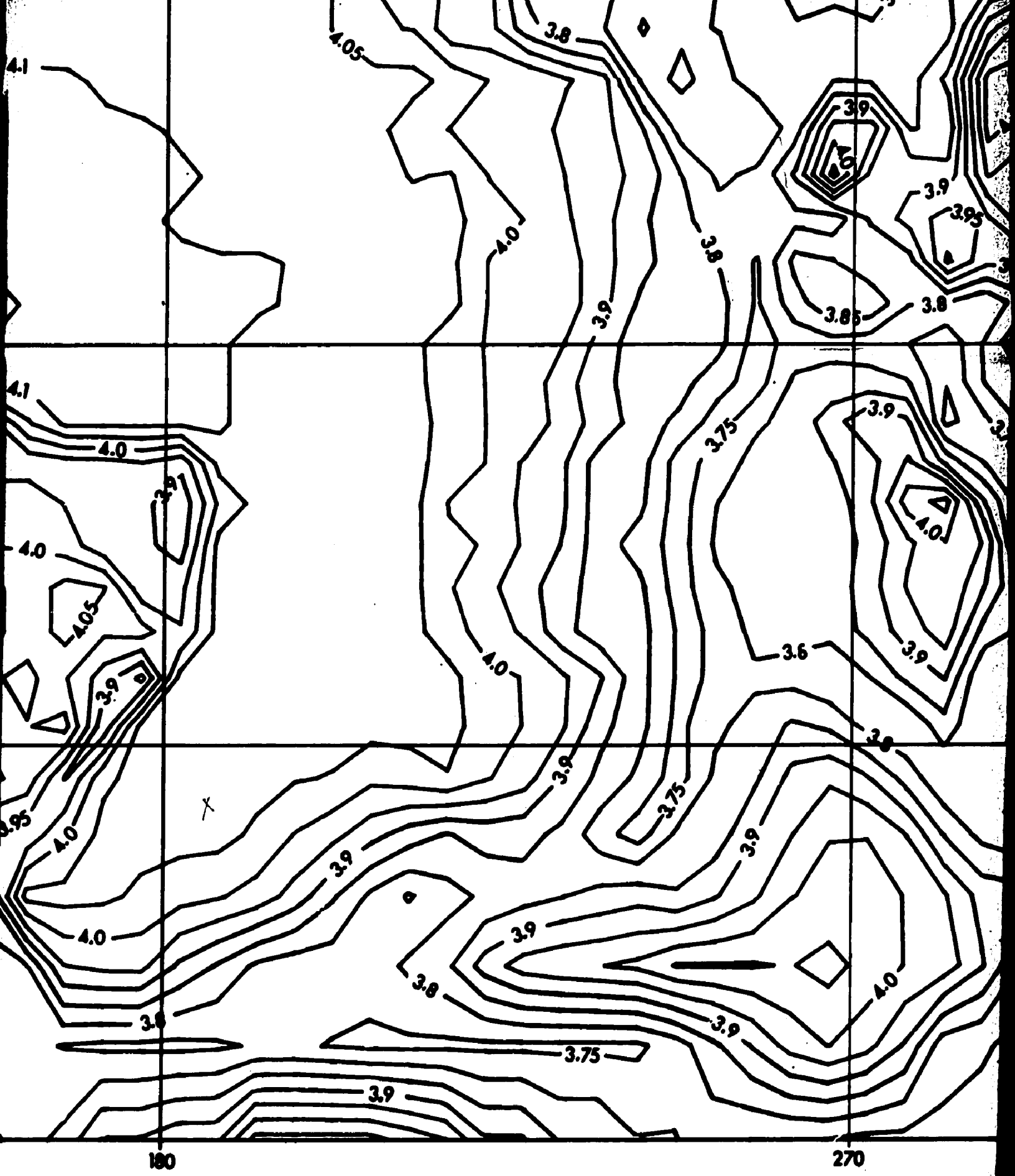


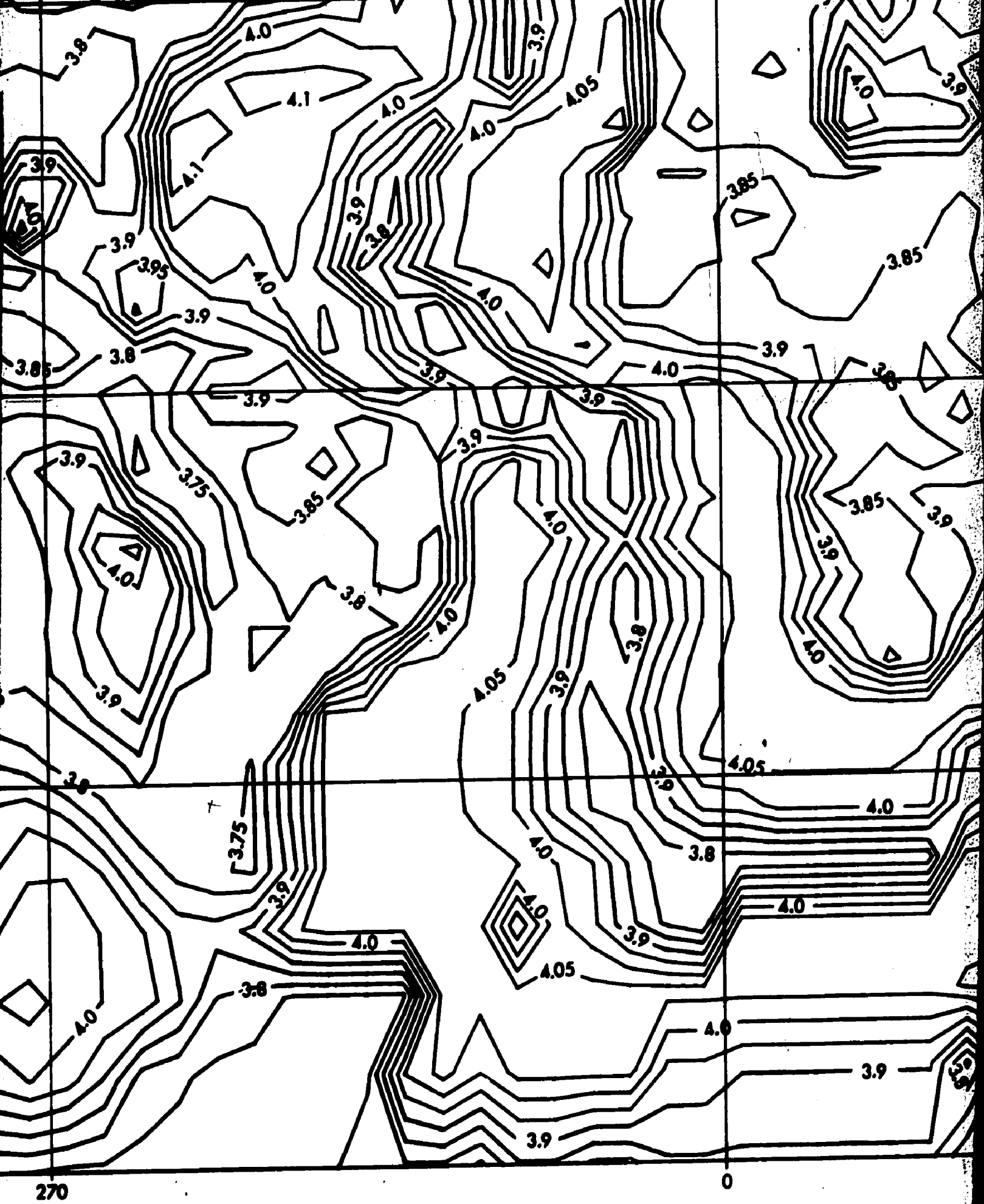
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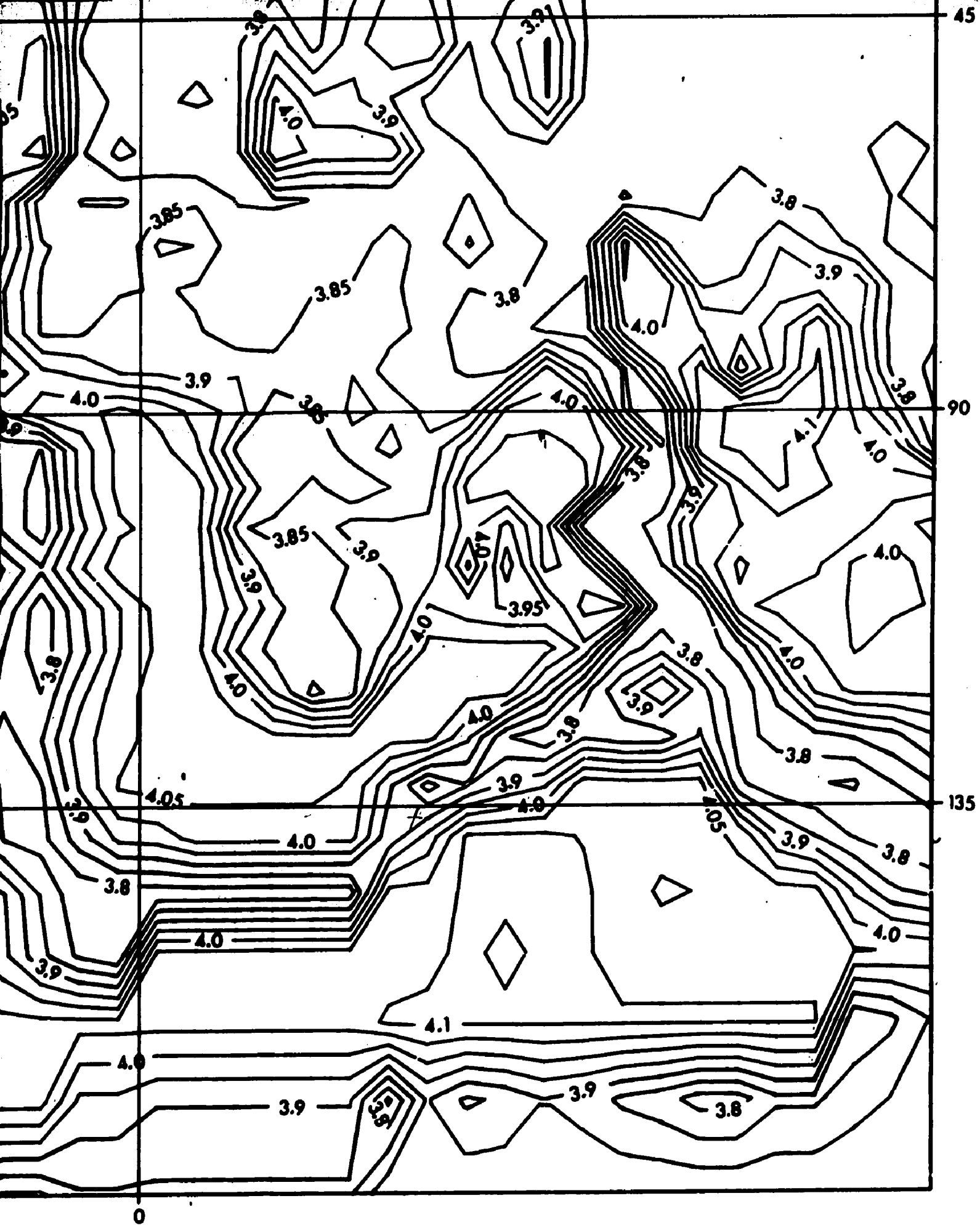


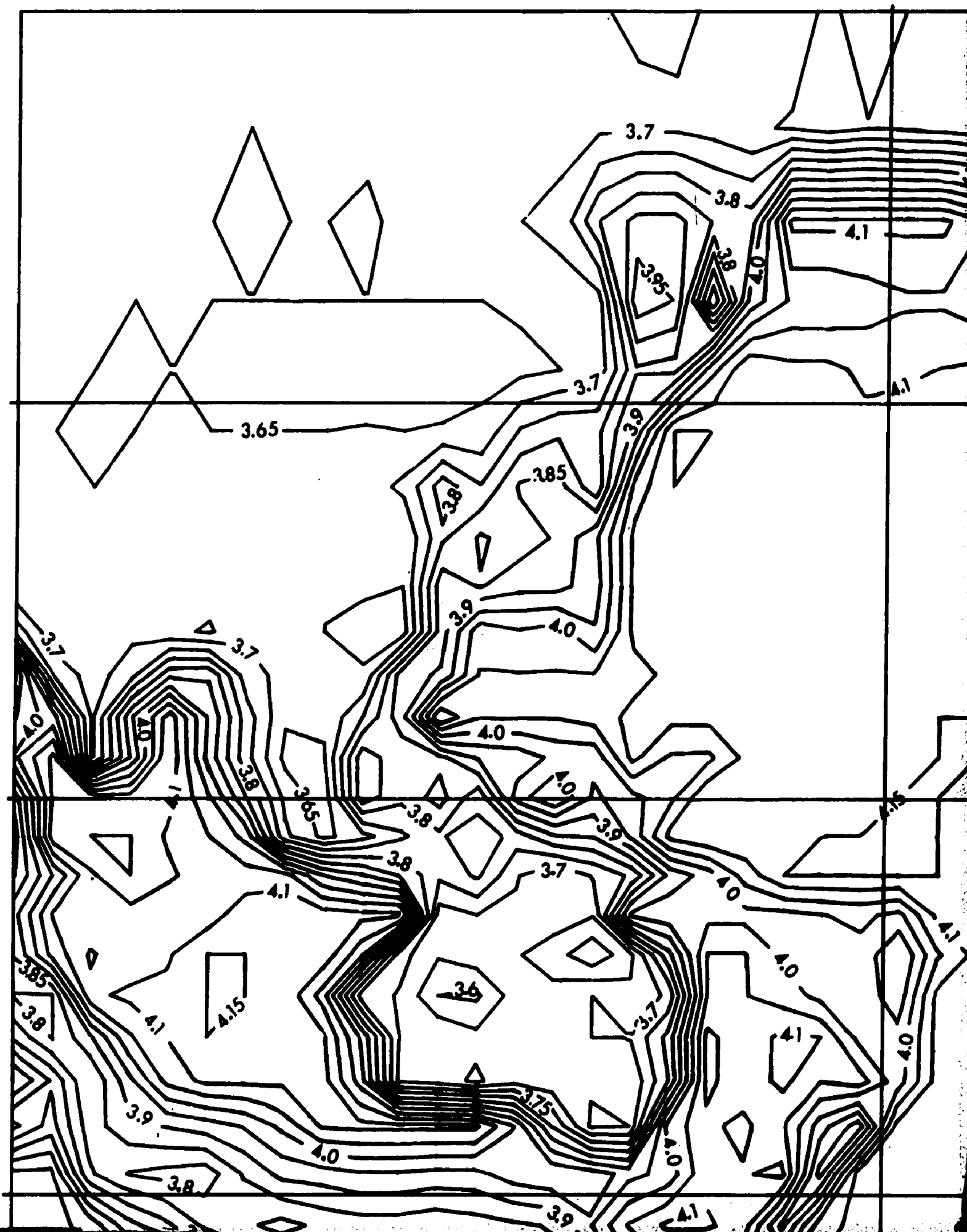




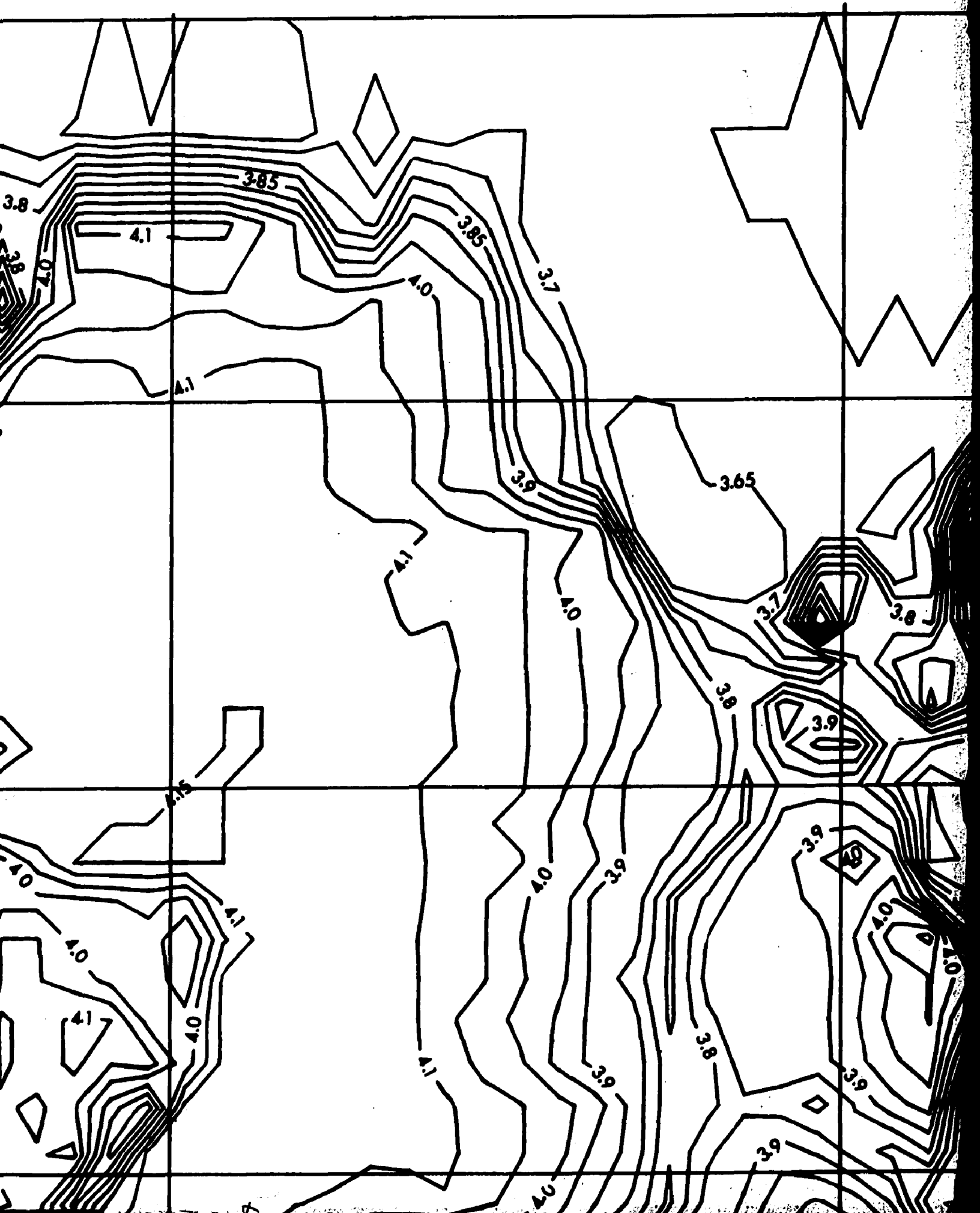




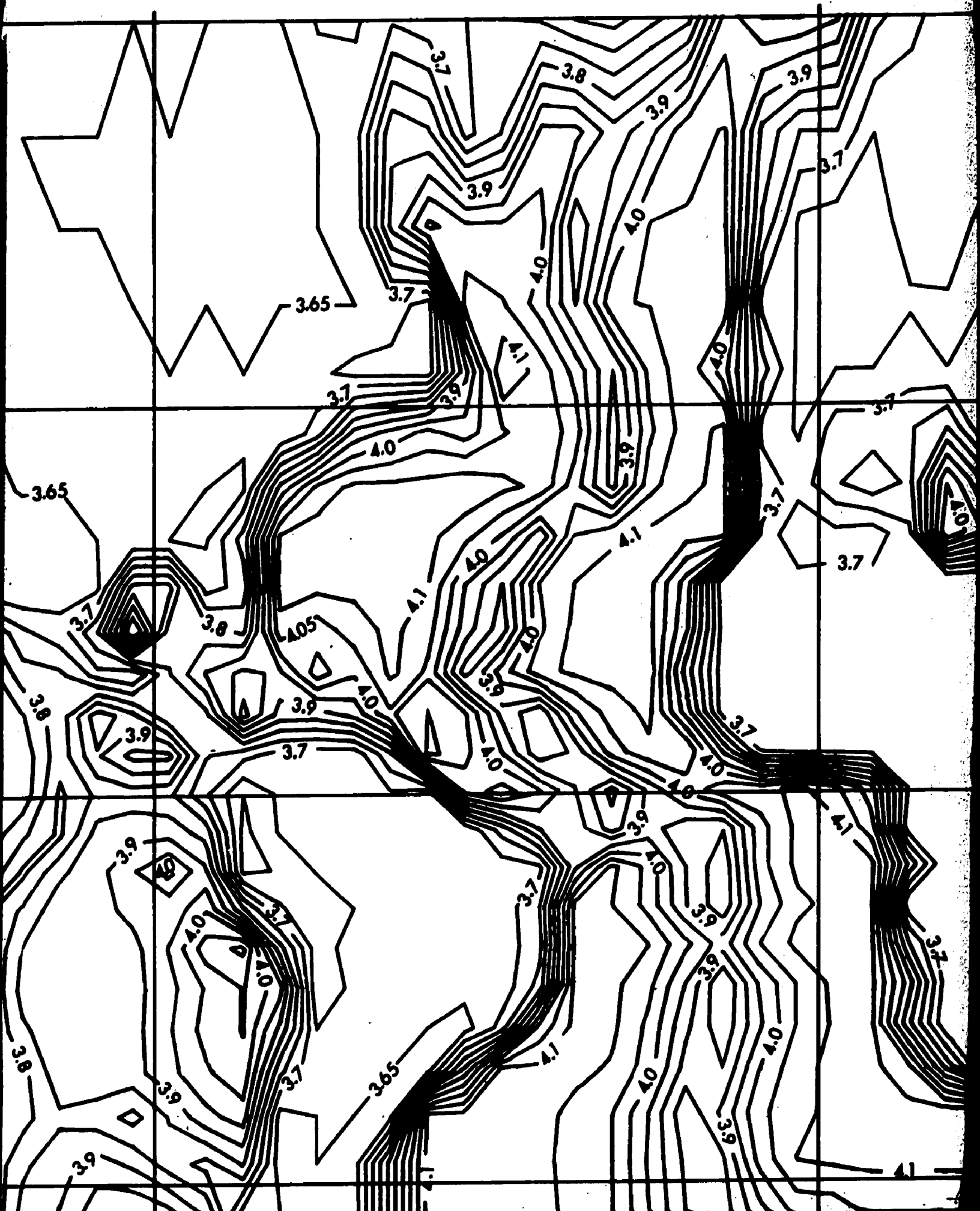


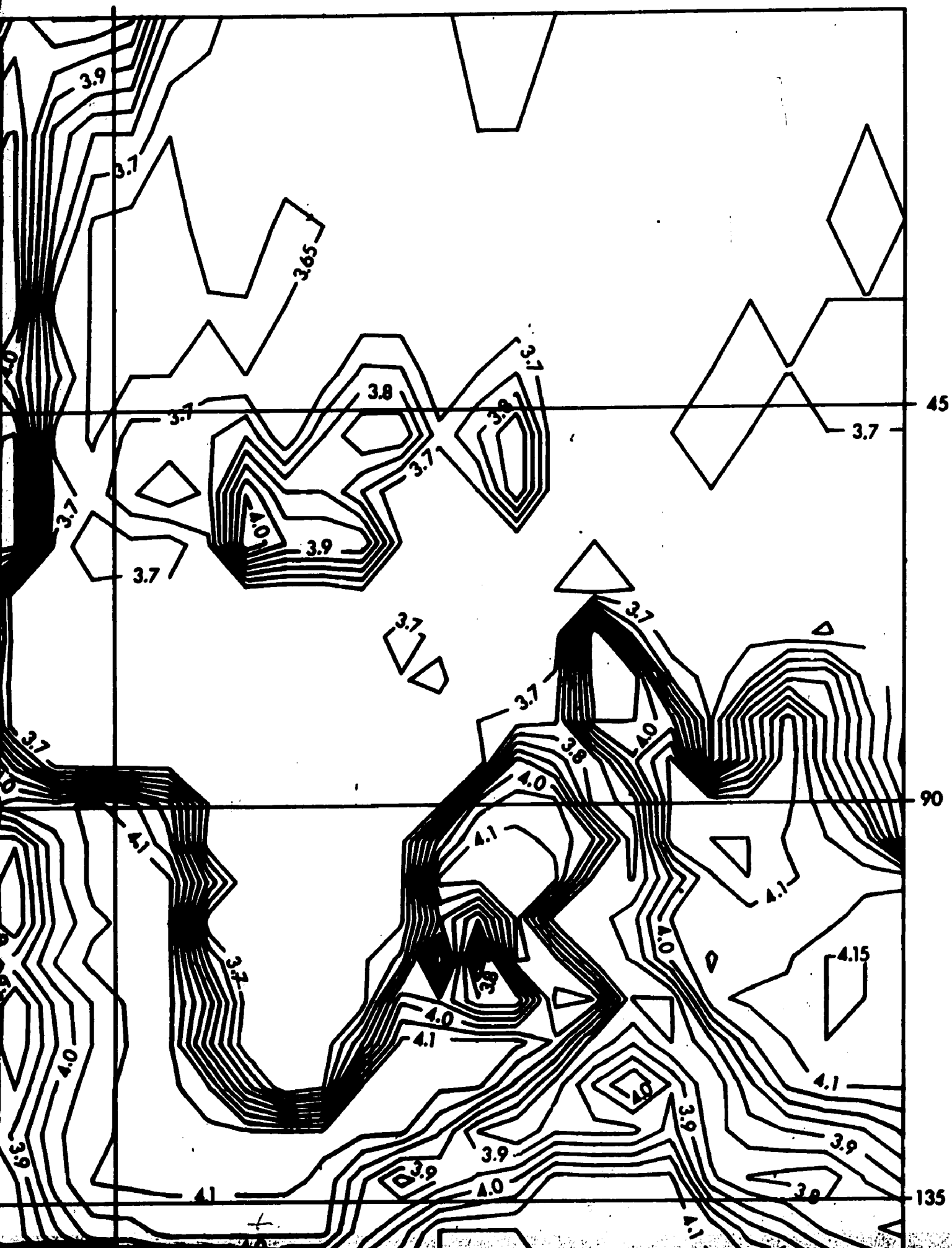


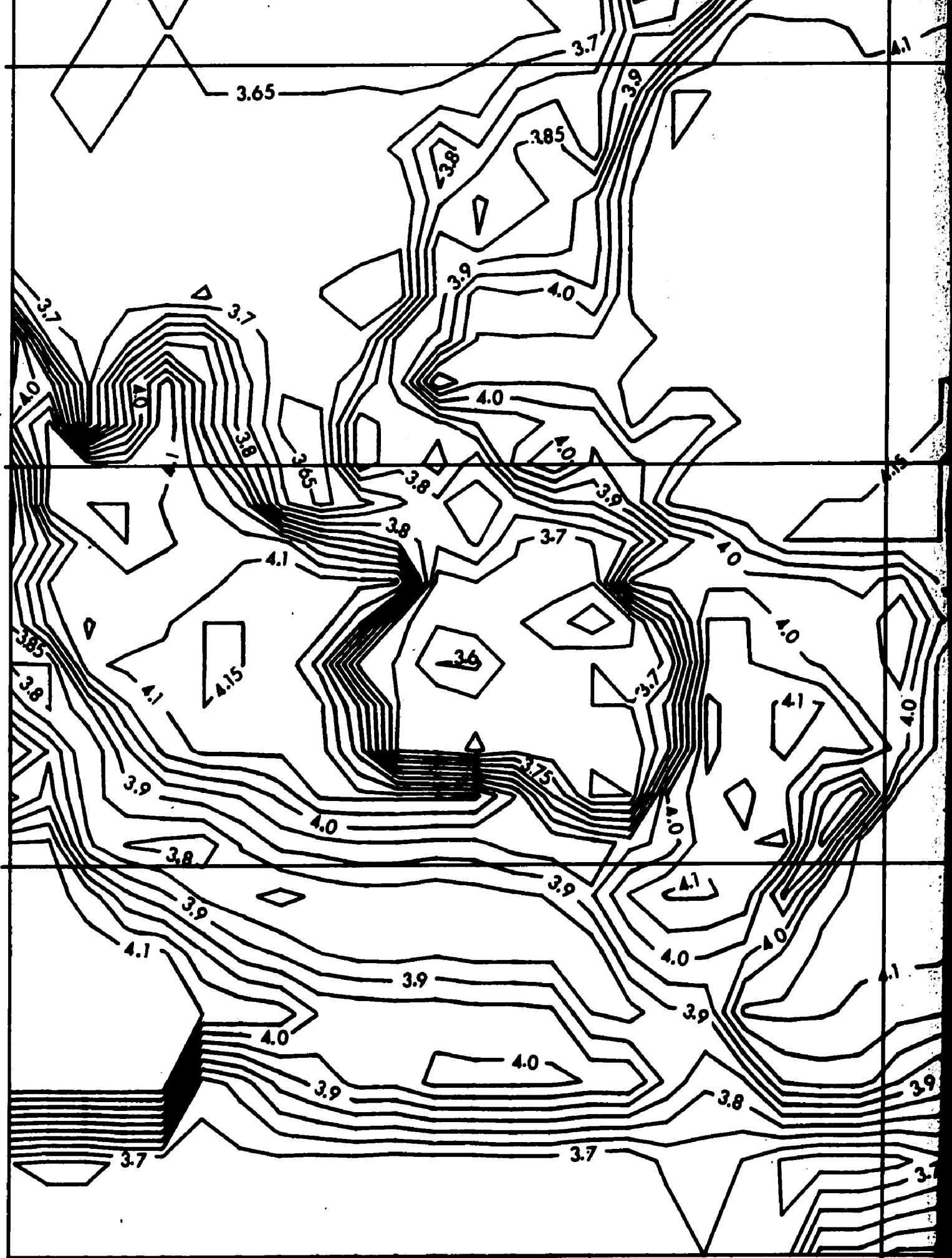
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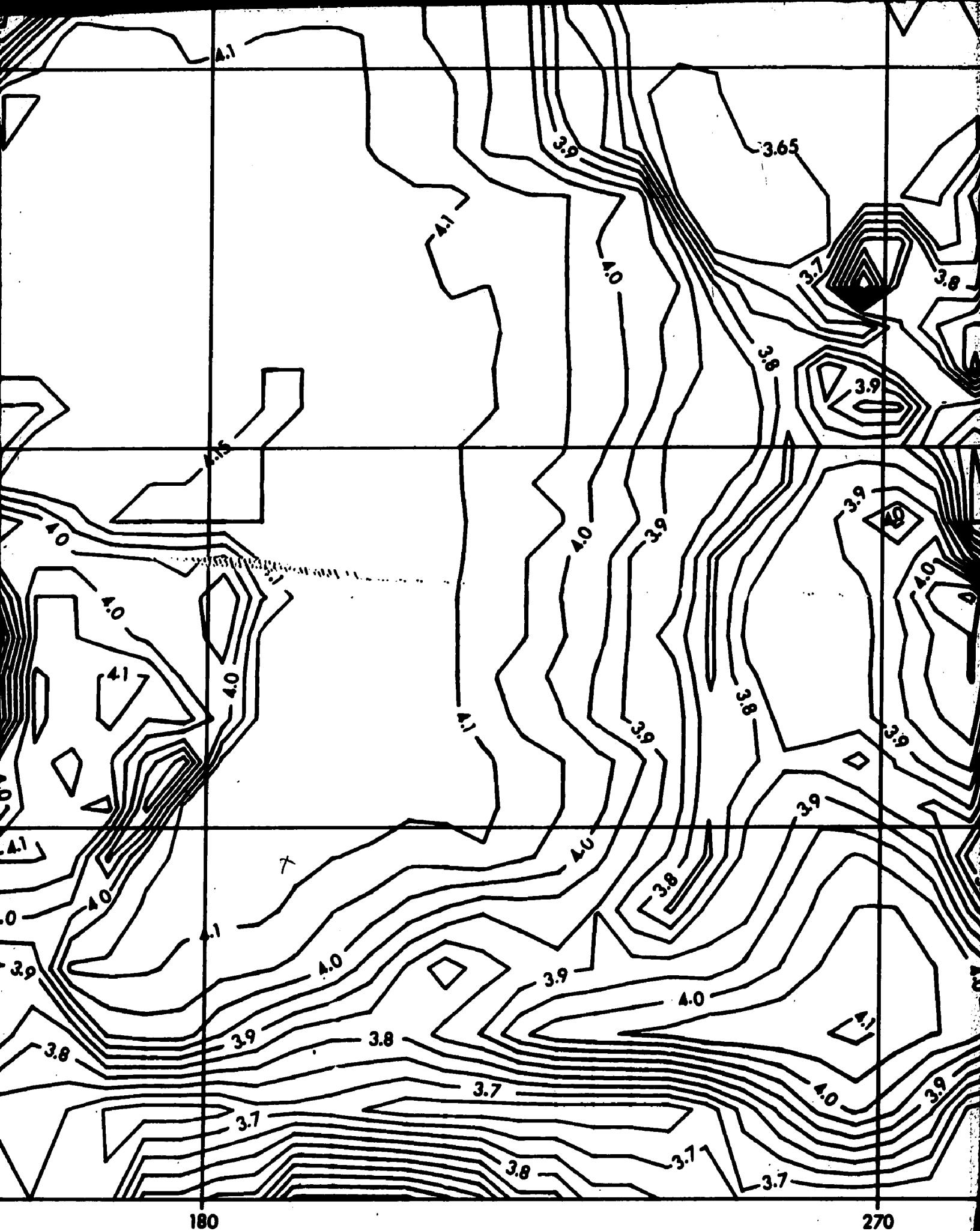


RAYLEIGH WAVE GROUP VELOCITIES



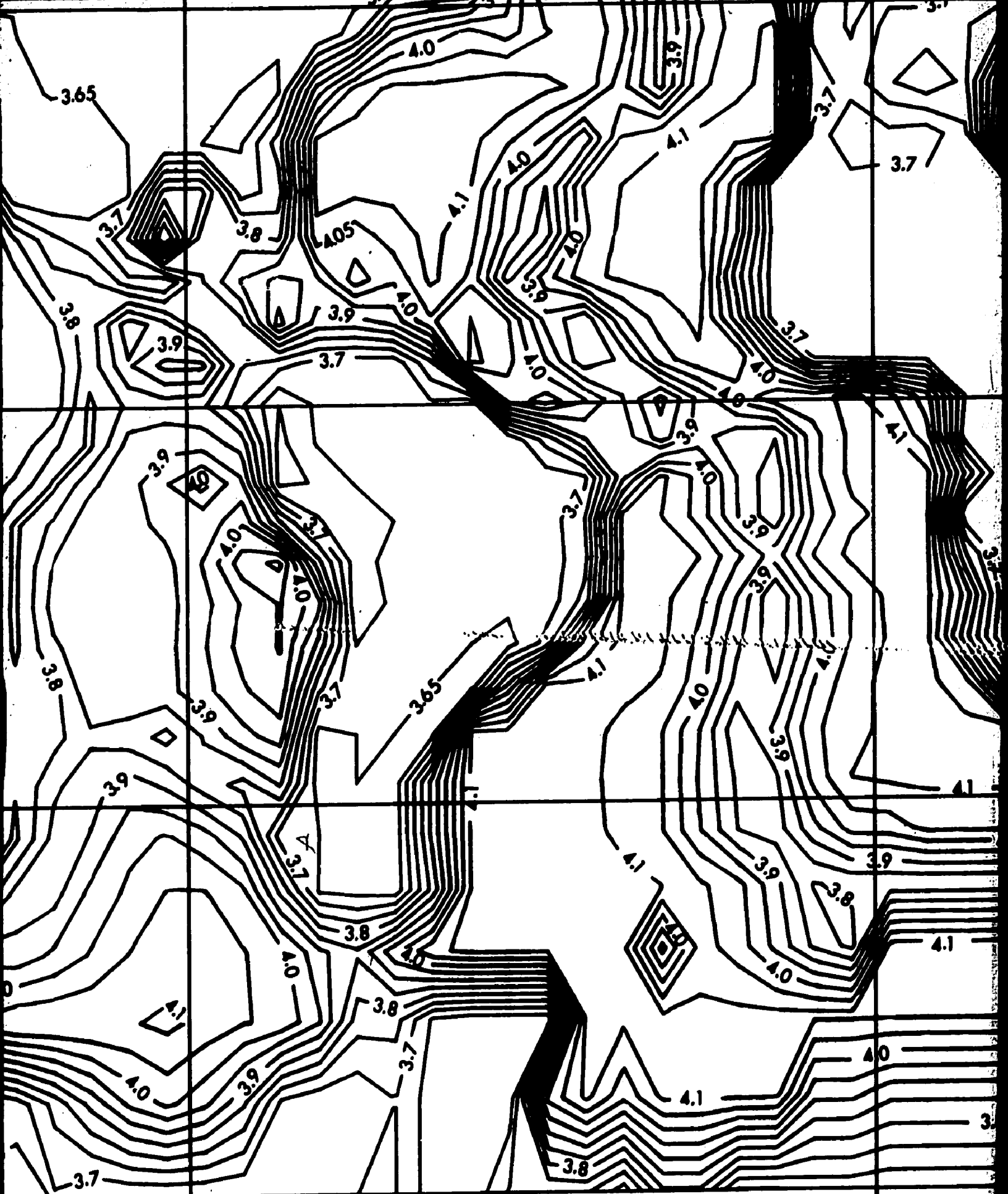






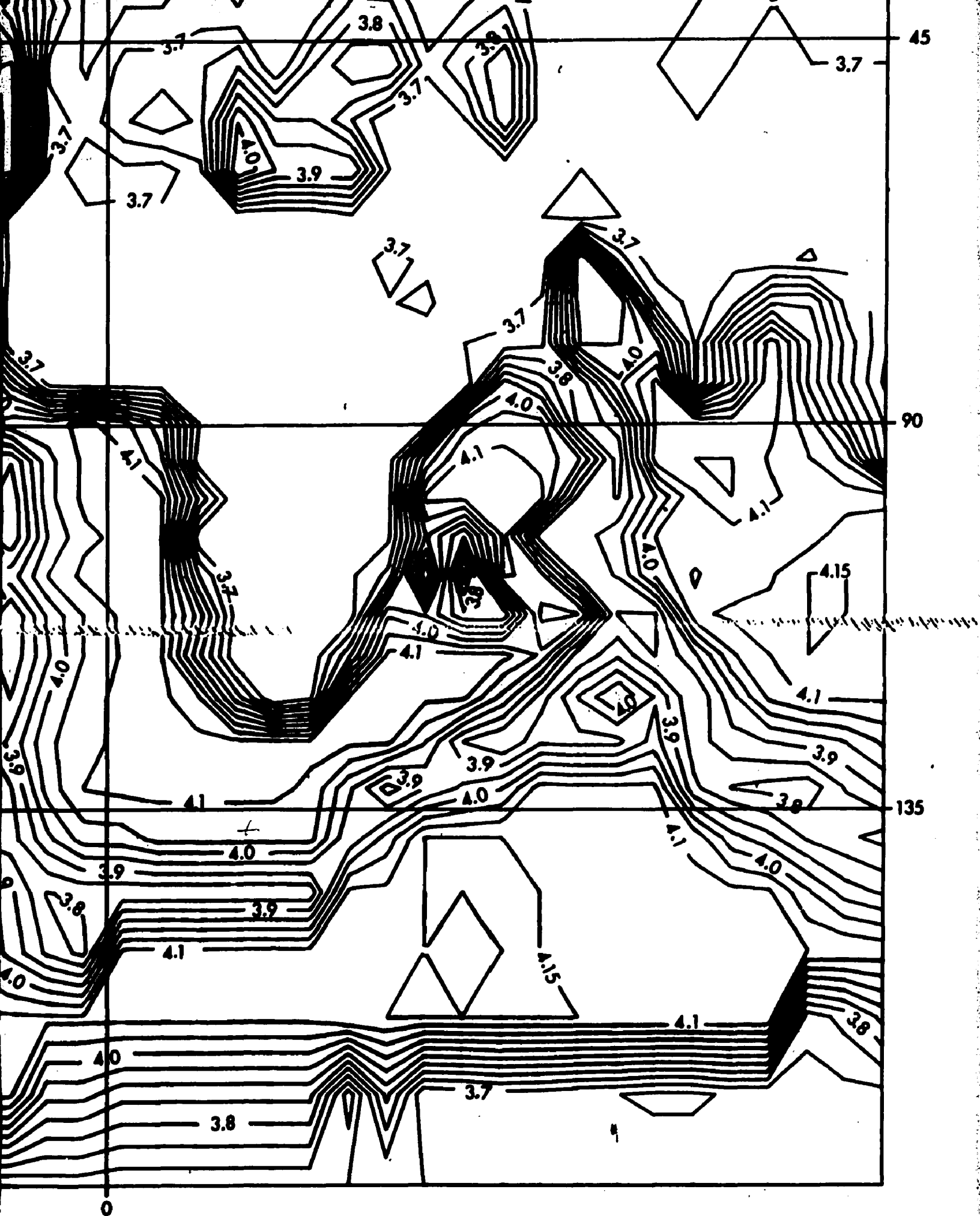
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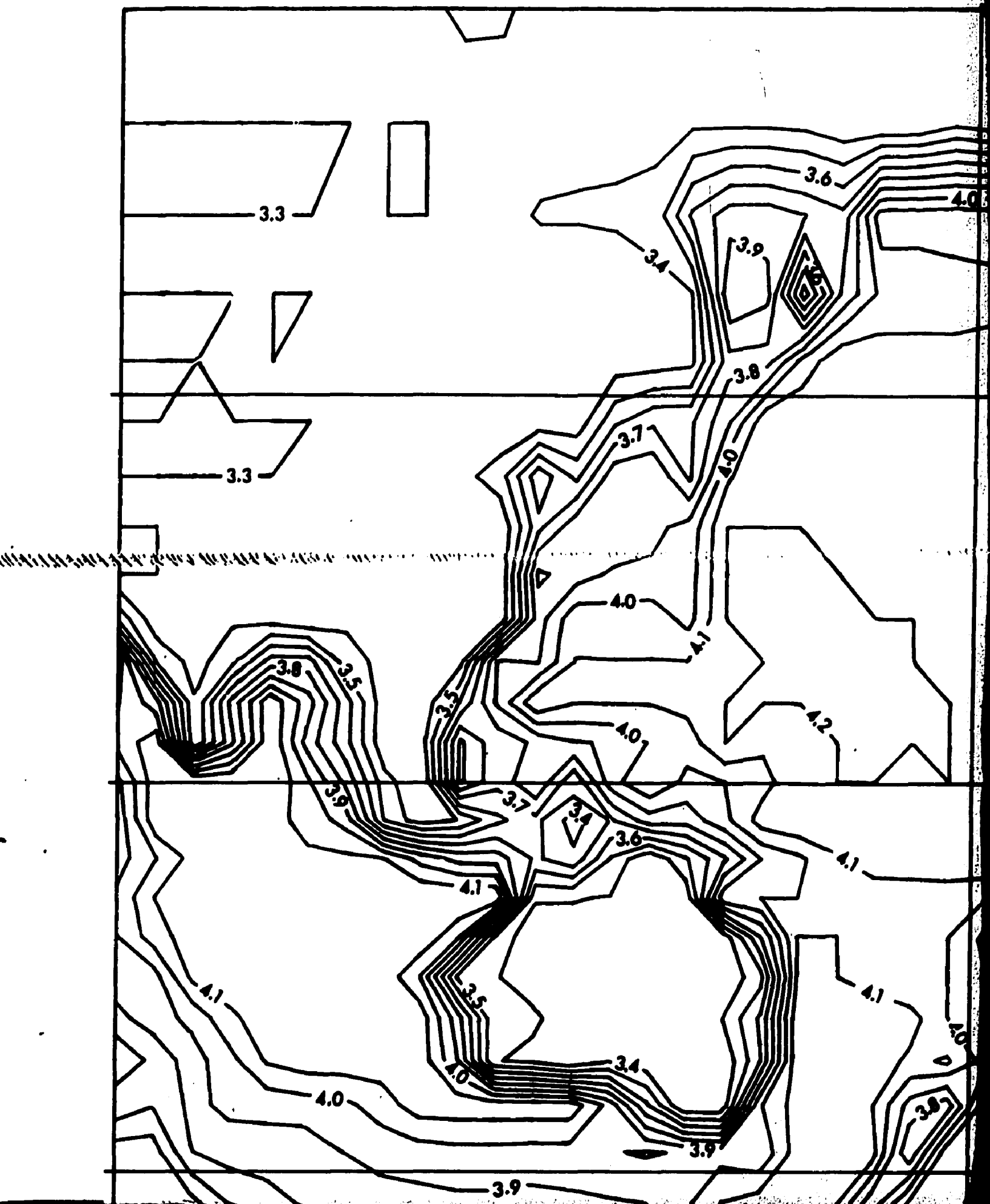
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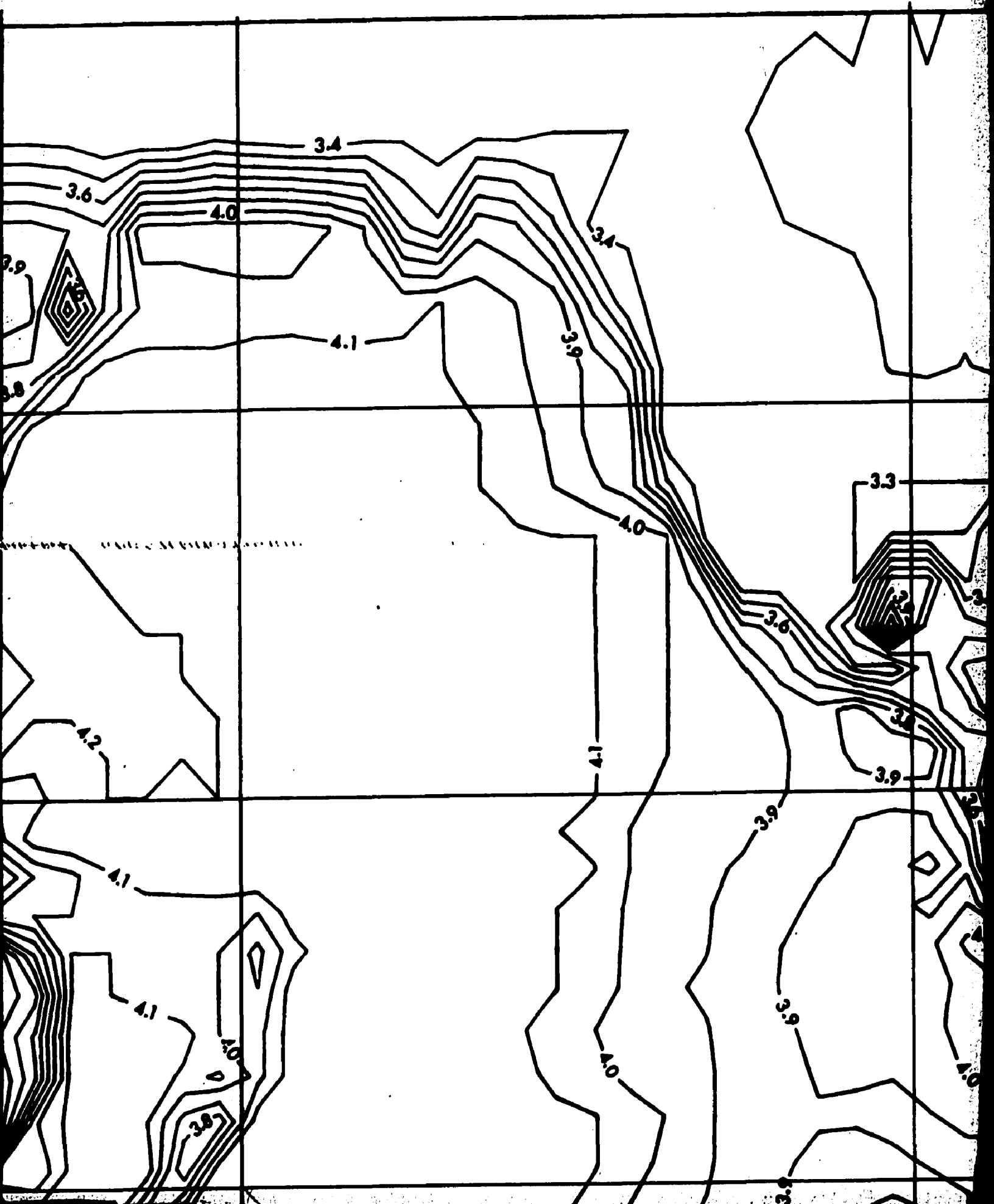
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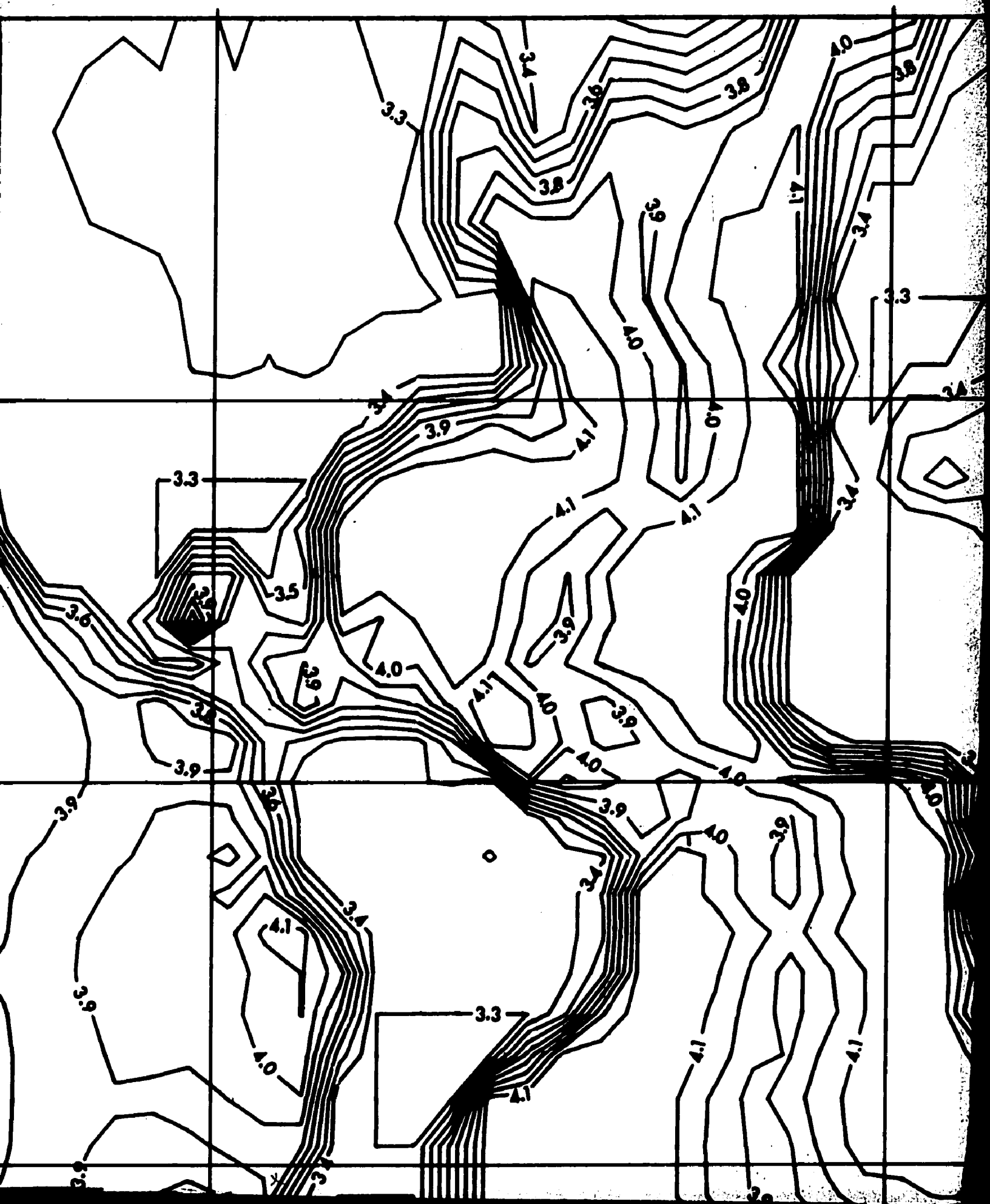


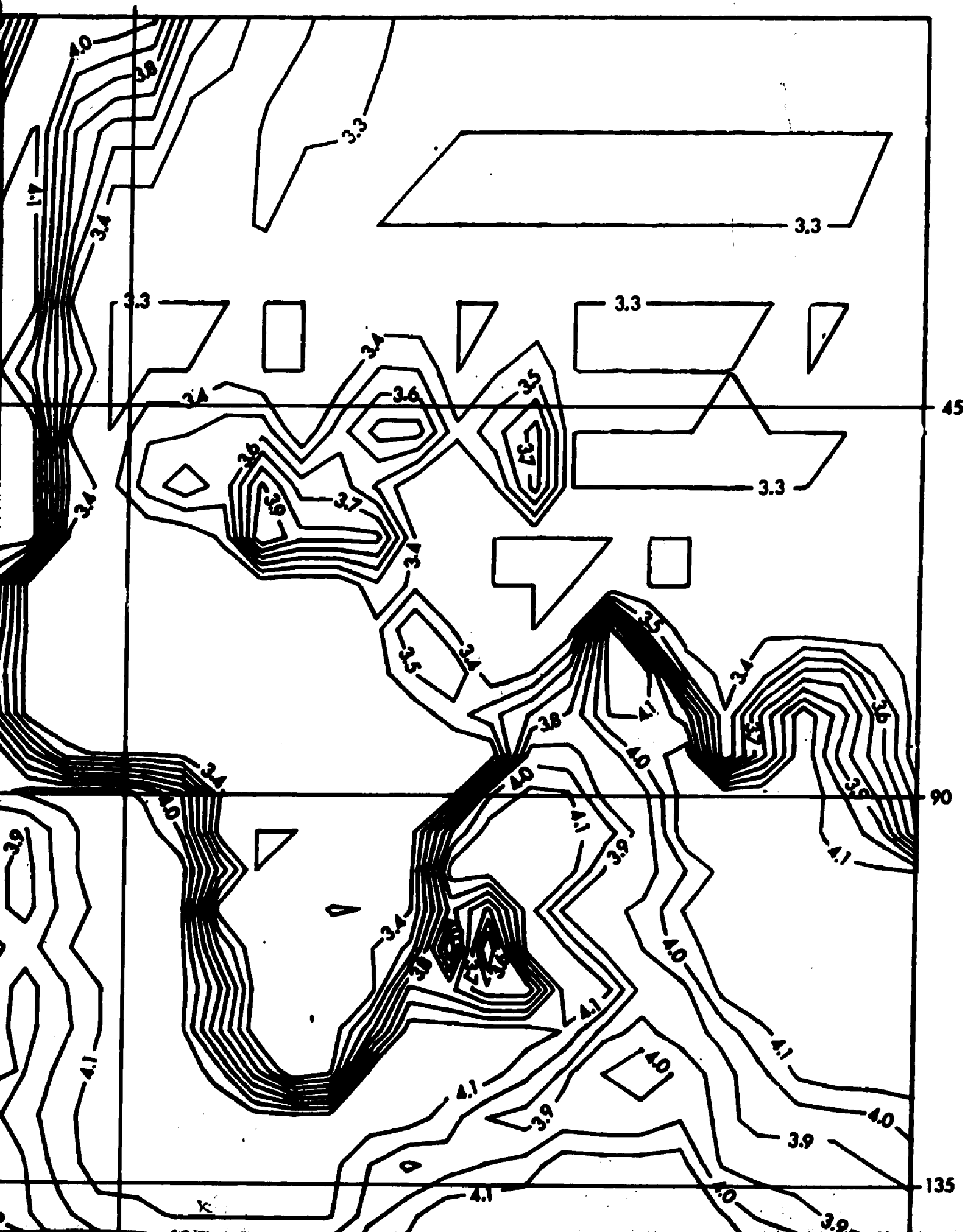


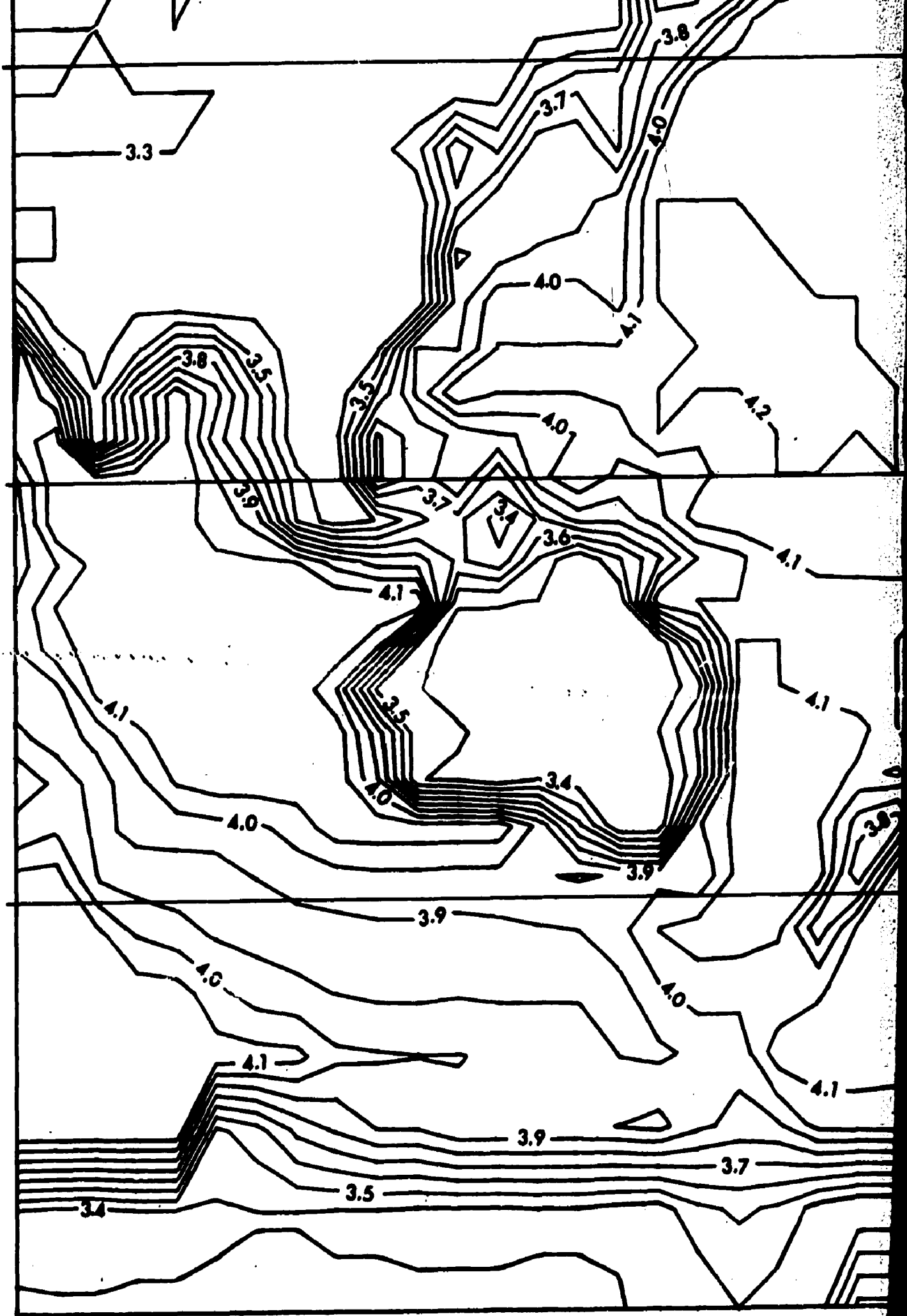
30 SECOND RAYLEIGH WAV

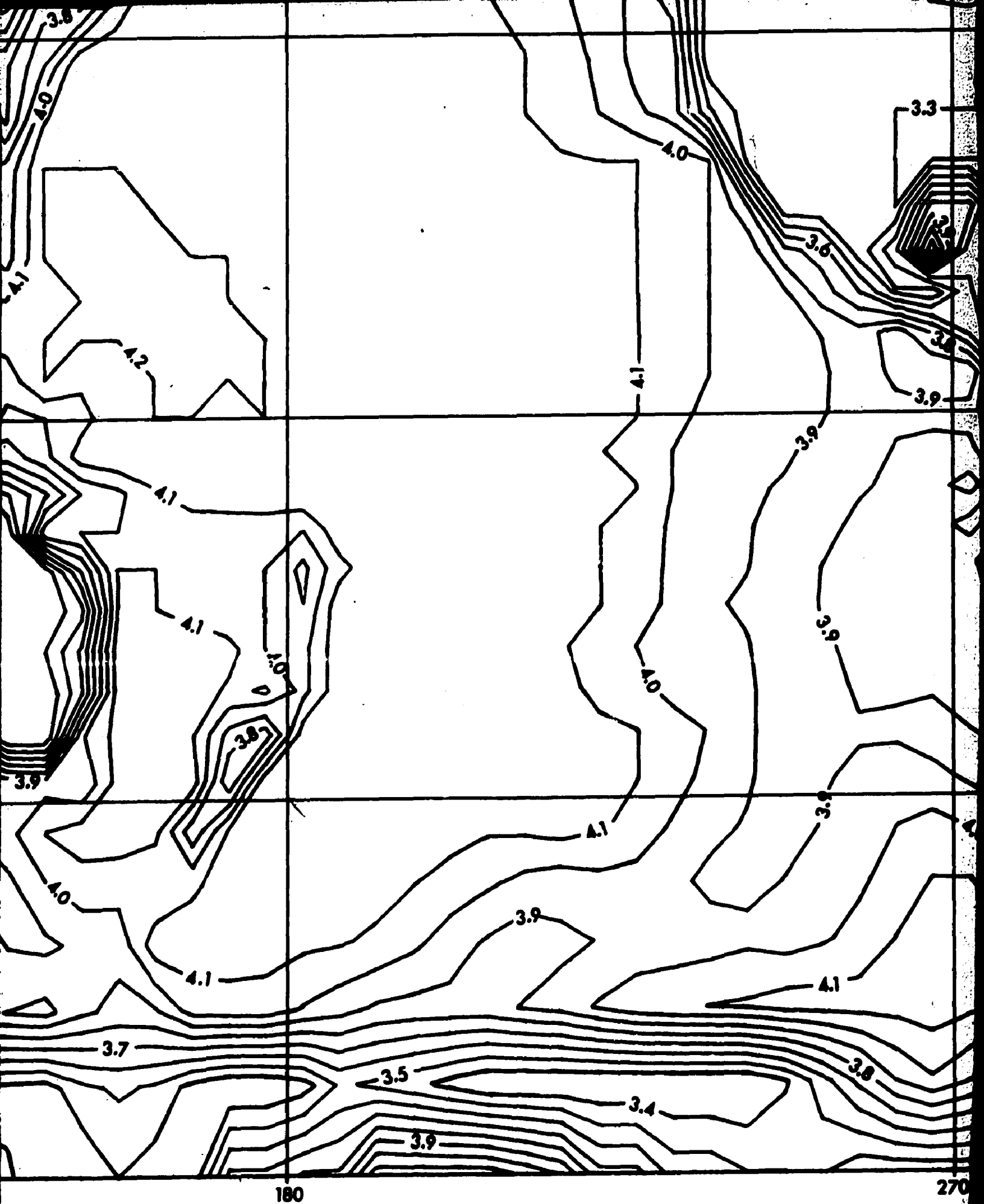


RAYLEIGH WAVE GROUP VELOCITIES









180

270

