UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

LINEAR FEATURE DATA
DERIVED FROM LANDSAT IMAGES OF SOUTHEASTERN MISSOURI

by

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Introduction

The material presented in this report is statistically analyzed and graphically represented data on linear features mapped from specially processed Landsat images of southeastern Missouri as part of the Conterminous United States Mineral Appraisal Project (CUSMAP) study of the Rolla, Missouri and Illinois 1 x 2 degree quadrangle. All discrete linear features (except obvious cultural features) were mapped on two Landsat scenes centered around the Rolla quadrangle (fig. 1). The linear feature data were digitized and statistically analyzed for length-frequency and strike-frequency (preferred orientation) by computer methods. Results of the statistical analyses are shown in Appendices A, B, and C and are summarized in the text. Computer-generated linear features maps (1:1,000,000) based on the results of the strike-frequency analyses were prepared for selected azimuthal trend intervals (Plates 1 to 7). Computer-generated contour maps (1:1,000,000) showing the areal density distribution of linear features in the selected trend intervals were prepared to help identify areas where the linear features are most abundant (Plates 8 to 14). These data are currently being geologically analyzed and integrated with available geological, geophysical, and geochemical data to find new geologic information pertinent to the Rolla quadrangle CUSMAP study.

In an earlier study of the same area, recently reported by Kisvarsanyi and Martin (1977) and previously summarized by Kisvarsanyi and Kisvarsanyi (1976a,b), a different approach to the study of linear features in Missouri was used. These investigators interpreted numerous

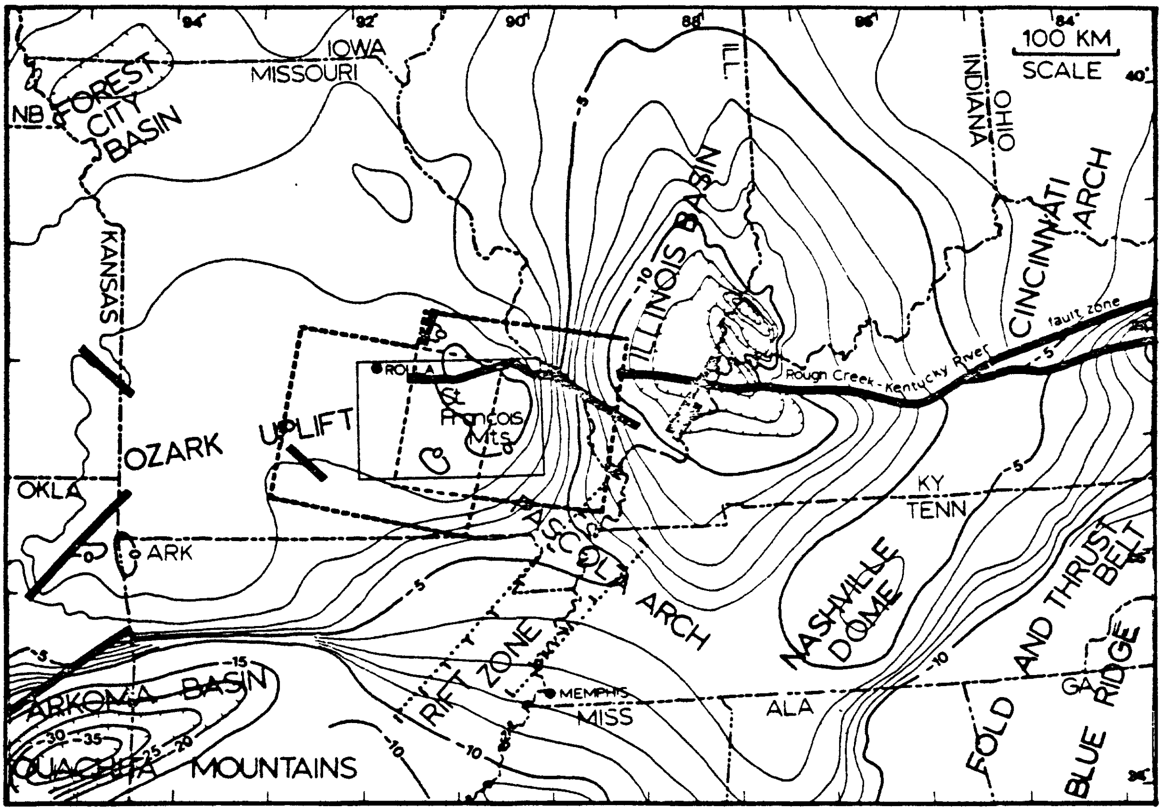

Figure 1.--Index map showing the location of the Rolla, Missouri and Illinois 1 x 2 degree quadrangle (solid line) and the area of the two Landsat scenes (dashed line) used in this study. Structure contour on the basement surface in thousands of feet from Bayley and Muehlberger, 1968. Location of rift zone from Hildenbrand and others, 1977.

long, straight lineaments observed on Landsat images and ancillary data as major crustal discontinuities that have produced an orthogonal pattern of basement blocks. Only linear features longer than 20 kilometers were considered and no statistical studies of the data were done.

In yet another approach to lineament analysis, Dennis O'Leary (U.S. Geological Survey) is examining geomorphic lineaments and alignments mapped from radar images, air photos, and Landsat images and other geomorphic data of the eastern Rolla 1 x 2-degree quadrangle/Mississippi embayment region as part of the Rolla quadrangle CUSMAP study. This work is aimed at determining how the geomorphic evolution of the terrain is related to its lithology and structure.

Landsat image processing

Digital image processing is a general term referring to any computer technique that prepares an image for human visual interpretation or extracts information from digital image data (Goetz and others, 1975, p. 13). Magnetic tapes of two overlapping Landsat scenes of southeastern Missouri (E-1215-16121 and E-1162-16173) were acquired from the U.S. Geological Survey EROS Data Center and digitally processed by contrast stretching (Rowan and others, 1974, p. 6). A 2-percent linear stretch was applied to each of the four bands of Landsat MSS data. The 2-percent linear stretch assigns the lowest and highest 2-percent of the data numbers (DN) to the minimum and maximum values of the system dynamic range (0 and 255, respectively), and linearly transforms the remaining DN values between these end points.

The stretched data were then run through a geometric rectification program and written to magnetic tapes. These tapes were used to prepare high quality black and white film transparencies (1:800,000), using an Optronics International System P-1700 photographic playback and scanning microdensitometer system.

Linear feature mapping

Images of each of the four Landsat spectral bands were studied for linear features and all the linear features observed were plotted on a common overlay. Obvious linear cultural features were not included on the map. Nearly all of the mapped linear features are narrow, elongated, topographically low areas or straight zones along which there is a prominent break in slope or change in topographic texture of the terrain. Only a few of the mapped linear features are expressed on the images by an abrupt change in image tone not caused by topography. From the inspection of available maps and the general orientations of these linear features, it was concluded that they are not man-made, so they were included in the analysis.

The completed linear features map was then digitized for computer analysis and plotting. Generally, linear features were straight enough that only the end points of the lines needed to be digitized to produce a good representation of the line. Curvilinear lines were digitzed in segments short enough to produce a good representation of the mapped line on the computer plots.

Statistical analysis

The Landsat linear features map of southeastern Missouri (Plate 1) is much too complex to evaluate by inspection alone. Some curvilinear and exceptionally long linear features are quite obvious, but regional patterns in the linear feature data are not readily apparent. The application of objective statistical techniques helps to characterize the linear feature data in ways that may be useful for geologic analysis. Length-frequency analysis expresses the lengths of the linear features as a function of frequency of observation. Strike-frequency analysis provides a measure of the nature and degree of preferred orientation in the data set. The details of these statistical techniques are discussed in Sawatzky and Raines (in press); a brief description is given below.

Length-frequency analysis

Length-frequency analysis uses a simple computer program that generates a histogram of length as a function of frequency of observation (Appendix A). In addition, the mean and modal lengths and standard deviation and variance of the data set are computed. Table 1 shows some results from the length-frequency analysis of the southeastern Missouri linear feature data set.

Table 1.--Some results from length-frequency analysis (Appendix A), southeastern Missouri linear feature data set

1. Longest linear feature = 28.0 km
2. Shortest linear feature = 200 m
3. Mean length = 3.0 km
4. Mode length = 1.8 km
5. Standard deviation = 2.3 km

The approximate log-normal distribution of the length-frequency histogram (Appendix A) appears to be typical of linear feature data mapped from Landsat images (D. H. Knepper, unpublished data; G. L. Raines, 1979, oral commun.) and air photos (Podwysocki, 1974). An abrupt, short length cut-on is caused by the Landsat system resolution (approximately an 80 m-square pixel ground resolution), although mapping scale and image quality may also have some effect on the shortest linear features that can be detected. Above the modal length, the number of linear features observed drops off exponentially with increasing length. At this time, the development of methods for extracting geologic information from these analyses is still in its infancy.

Strike-frequency analysis

The strike-frequency analysis procedure used in this study was described by Raines (1978, p. 52-53) and has recently been more fully detailed by Sawatzky and Raines (in press). Basically, the analysis program examines the number of linear features (frequency of occurrence) in each of 180 1-degree azimuthal trends and compares these frequencies to the mean frequency for the 180 1-degree classes. The significance value of any given frequency of occurrence is based on the probability that that frequency would occur in a data set of given size selected from a uniform population of directions. If the frequency of occurrence is near the mean frequency, it has a low significance value (significance value = 0 when frequency = mean frequency). As the frequency of occurrence deviates from the mean frequency, either positively or negatively, the significance value increases. Thus, maxima (high frequency of occurrence) can be defined at a range of significance values simply by extending the test to frequencies further from the mean frequency.

Results of unweighted and length-weighted strike-frequency analyses (Appendices B and C, respectively) of the linear features mapped from Landsat images of southeastern Missouri show definite preferred orientation at high significance values. Figure 2 is the unweighted strike-frequency histogram replotted from the results in Appendix B showing the highest maxima and minima significance values attained in the test. Where the curve rises above the 92.1 significance value (74 observations/1-degree interval), the corresponding 1-degree azimuthal trends are considered significant and a high degree of preferred orientation is indicated. Similarly, where the curve drops below the 94.0 significance value (45 observations/1-degree interval), a significant paucity of linear features at those corresponding 1-degree azimuthal trends is

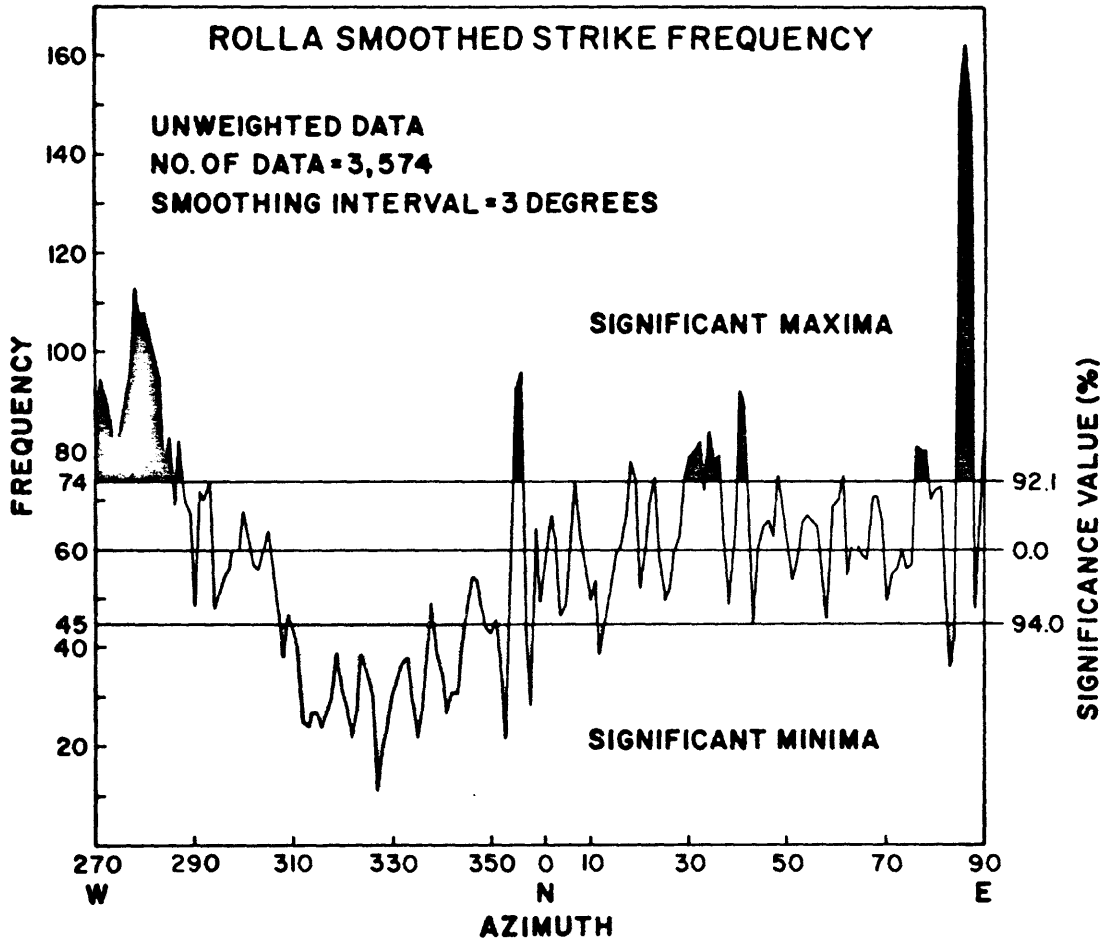

Figure 2.--Unweighted strike-frequency histogram of linear features of southeastern Missouri. Significant maximum and minimum significance value cut-offs and zero significance value shown by horizontal lines.

indicated. Between the maxima (92.1) and minima (94.0) significance value cut-offs the curve is in the non-significant field. Table 2 summarizes the significant maxima and minima azimuthal trends derived from the unweighted analysis.

Figure 3 is the replotted, length-weighted strike-frequency results from Appendix C. In this analysis, each linear feature was weighted proportional to its length to emphasize the potential importance of the longer linear features. The curve is read the same as figure 2. Table 3 summarizes the significant maxima and minima azimuthal trends resulting from the length-weighted analysis

Trend interval selection

Results of strike-frequency analysis often show several clusters of individual 1-degree maxima and minima that define relatively broad significant trend intervals in the linear feature data (Raines, 1978, p. 53; Knepper, unpublished data). The trend intervals composed of individual 1-degree significant maxima mark the directions in which there is a regional tendency for the development of sub-parallel linear features, that is, the nature of the preferred orientation in the data. The areal distribution patterns formed by these broad groups of sub-parallel linear features define domains of similar linear feature occurrence that help in recognizing important, often subtle, geologic differences in the terrain (Raines, 1978; Knepper, 1978; Raines, Offield, and Santos, 1978).

Strike-frequency analysis of the southeastern Missouri linear feature data set produced a high-frequency histogram curve that defined

Table 2.--Azimuthal trends of significant maxima and minima derived from the unweighted strike-frequency analysis. Maximum significanc^ value = 92.1; minimum significance value = 94.0

Maxima (degrees)	Angular Width (degrees)	Minima (degrees)	Angular Width (degrees)
271-285	15	308	1
287	1	310-337	28
293	1	339-344	6
355-356	2	349-350	2
7	1	352-353	2
18-19	2	357-359	3
23	1	12-13	2
29-32	4	43	1
34-36	3	83-84	2
40-41	2		
48	1		
61	1		
76-78	3		
85-87	3		
90	1		

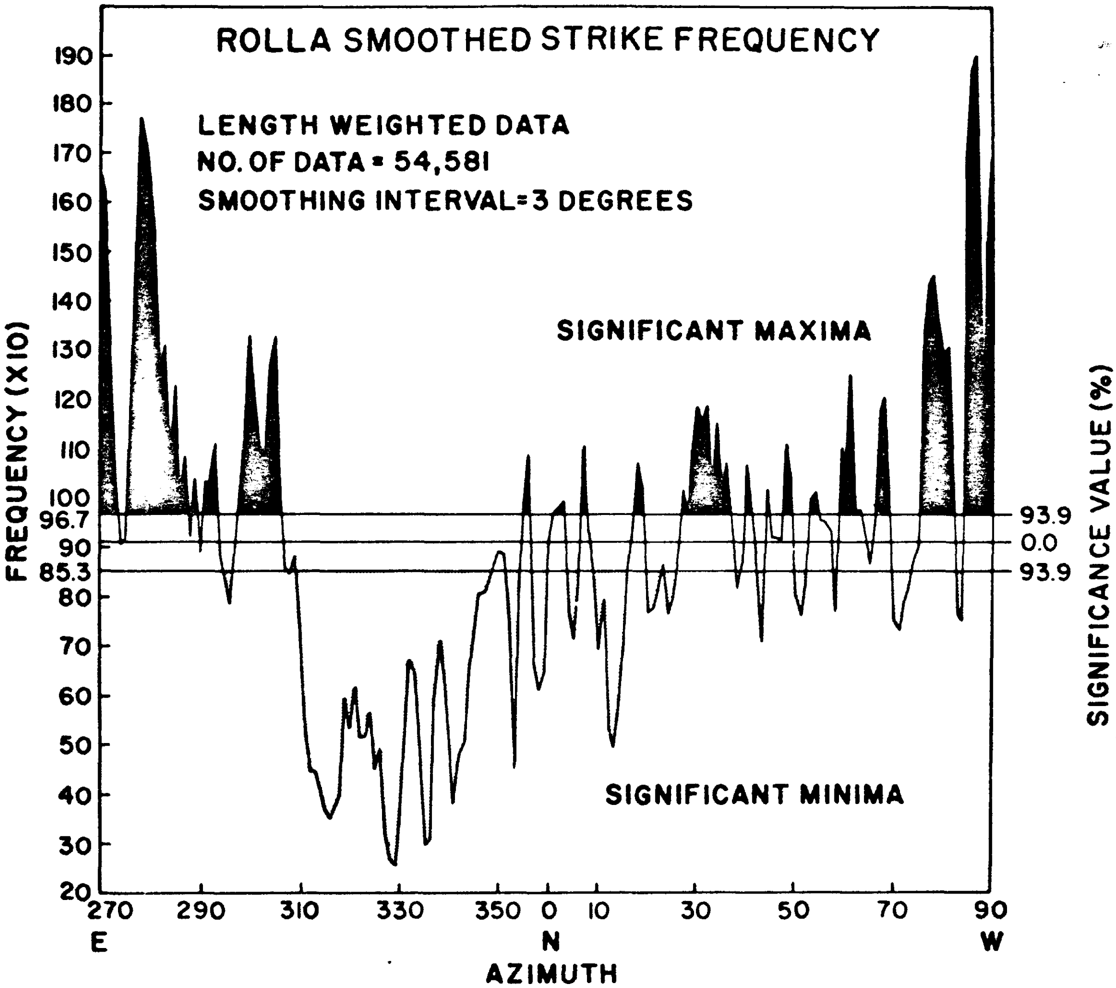

Figure 3.--Length-weighted strike-frequancy histogram of linear features of southeastern Missouri. Significant maximum and minimum significance values cut-offs and zero significance value shown by horizontal lines.

numerous, relatively narrow, significant trend intervals. The unweighted analysis defined 15 maximum and 9 minimum trend intervals in which 14 of the maxima are less than 5 degrees wide and 10 of these are less than 3 degrees wide (Table 2). Of the 9 minimum trend intervals, 6 are less than 3 degrees wide. The length-weighted analysis defined 19 maximum and 15 minimum trend intervals. Most of these, also, have relatively narrow angular widths (Table 3).

From inspection of the strike-frequency analysis results shown in Tables 2 and 3 and figures 2 and 3, it is not clear how the relatively narrow trend intervals could be grouped into a few relatively broad trend intervals that more generally characterize the preferred orientation in the linear feature data. However, by combining the results of the unweighted and length-weighted analyses, five prominent modal trend intervals were defined for subsequent distribution analysis. First, a summary diagram was made showing those 1-degree maxima and minima that are common to both analyses (fig. 4 and Table 4). The maxima on this diagram are 1-degree trends in which the frequency of occurrence is high and the individual linear features are relatively long. To the contrary, the minima are 1-degree trends which have few linear features and those that are present are relatively short. The remaining 1-degree trends are not statistically significant or statistically significant in only one analysis (non-significant field). Thus, only the strongest 1-degree maxima and minima were used to generally characterize the preferred orientation of the data set.

Table 3.-Azimuthal trends of significant maxima and minima derived from the length-weighted strike-frequency analysis. Maximum and minimum significance value = 93.9

Maxima (degrees)	Angular Width (degrees)	Minima (degrees)	Angular Width (degrees)
271-273	3	295-296	2
276-287	12	308	1
289	1	310-348	39
291-293	3	352-354	3
298-306	9	357-359	3
355-356	2	4-6	3
1-3	3	9-15	7
7	1	20-22	3
18-19	2	24-25	2
27	1	38	1
29-36	8	43	1
40-41	2	50-52	3
44	1	58	1
48-49	2	70-73	4
53-54	2	83-84	2
59-63	5		
67-69	3		
76-82	7		
85-90	9		

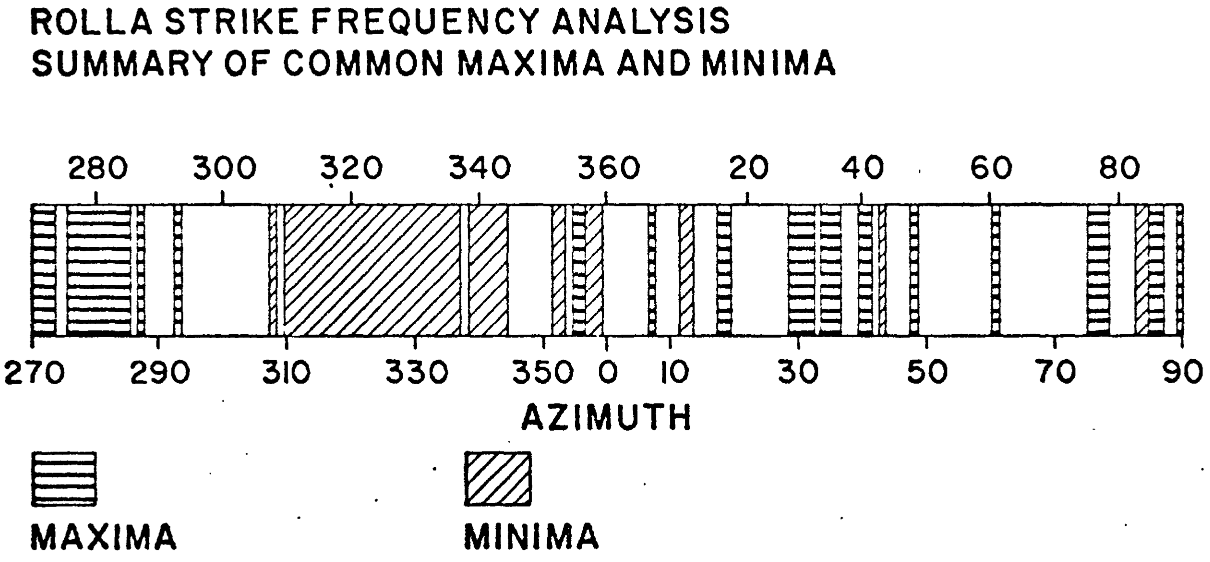

Figure 4.--Azimuthal plot of maxima and minima common to both the unweighted and length-weighted strike-frequency analyses. Non-significant field (white) includes those azimuthal trends that were non-significant in both analyses or significant in only one analysis.

Table 4.--Maxima and minima common to both the unweighted and length-weighted strike-frequency analyses

COMMON MAXIMA		COMMON MINIMA	
Azimuthal Range	Angular Width (degrees)	Azimuthal Range	Angular Width (degrees)
271-273	3	308	1
276-285	10	310-337	28
287	1	339-344	6
293	1	352-353	2
355-356	2	357-359	3
7	1	12-13	2
18-19	2	43	1
29-32	4	83-84	2
34-36	3		
40-41	2		
48	1		
61	1		
76-78	3		
85-87	3		
90 (270)	1		

Inspection of figure 4 suggests that there are five distinct clusters of significant 1-degree maxima, each separated by one or more minima. The endpoints of the maxima clusters were then selected according to the following criteria:

1) Where a maximum is directly adjacent to a minimum, the 1-degree maximum azimuthal trend closest to the adjacent minimum was selected as the endpoint.
2) Where the maximum is separated from the nearest minimum by a field of non-significant 1-degree trends, the 1-degree azimuthal trend one-half the angular distance between the minimum and maximum was chosen as the endpoint. When the difference in azimuth was an odd number of degrees, the extra 1-degree of azimuth was included in the maximum cluster.

The results of trend interval selection are summarized in figure 5 and Table 5.

Strike-frequency analyses give a detailed characterization of the nature and degree of preferred orientation within the linear feature data that can be probed for geologic information. The trend interval selection method used here generalizes these complex results into a few strong, relatively broad trend intervals that give a first approximation of the regional tendency for the occurrence of sub-parallel linear features in southeastern Missouri. However, the distribution patterns of the linear features within each of the generalized trend intervals must be studied as well.

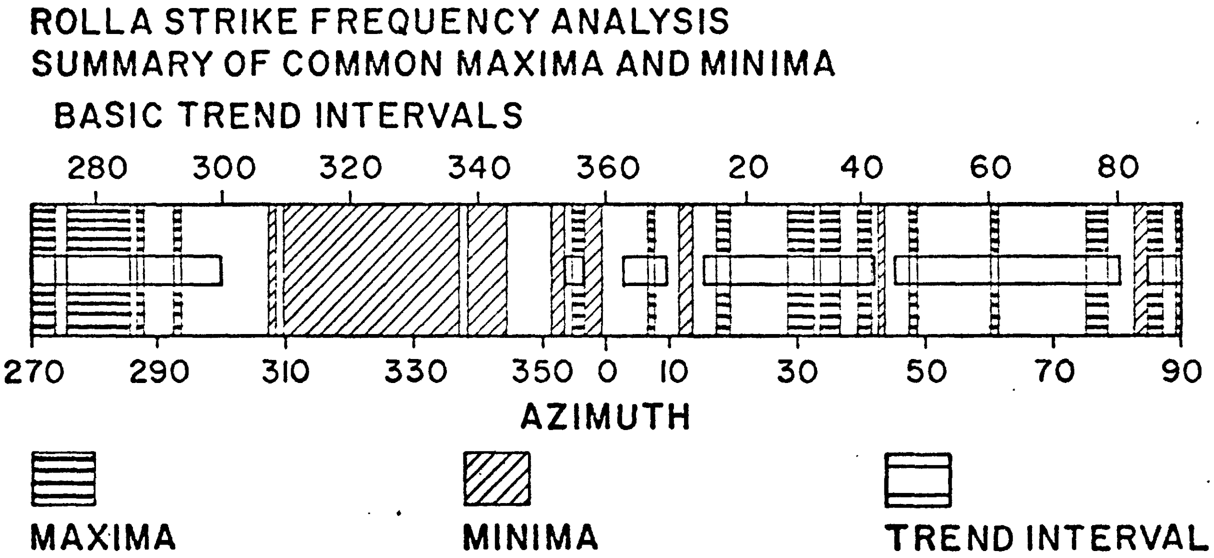

Figure 5.--Azimuthal plot of common maxima and minima showing the five trend intervals selected for distribution analysis.

Table 5.--Modal azimuthal trend intervals derived from maxima and minima common to both the unweighted and length-weighted strike-frequency analyses

Abbreviation	Azimuthal Range	Angular Width (degrees)
WNW	271-300, 85-90	36
NNW	354-356	3
NNE	4-10	7
NE	15-42	28
ENE	46-81	36

Linear feature distribution

Computer graphics provide an easy means of selectively plotting the linear features in any specified trend interval. The plots can be analyzed visually for obvious clusters, alignments, or other distribution patterns that are suggestive of possible geologic or tectonic conditions. Plate 1 is a computer plot of all of the southeastern Missouri linear features mapped from the Landsat images. Plates 2 through 6 show the linear features in the five broad trend intervals derived from the strike-frequency analyses. Those linear features not included in the five trend intervals (residuals) are plotted on Plate 7.

Computer-generated contour maps showing the concentration of linear features in the various trend intervals are useful aids in visualizing distribution patterns not apparent on the linear feature plots. Plates 8 through 14 are contour maps of the concentrations of the linear features plotted on Plates 1 thorugh 7, respectively.

The method of preparing linear feature concentration maps used in this study is described by Sawatzky and Raines (in press). Basically, the method has two steps: 1) preparation of a gridded computer file for which the relative frequency of linear features has been computed for each counting cell on the grid of the mapped area, and 2) contouring of the gridded data. The gridded computer file is derived by counting the number of linear features that intersect the counting cell at each position as it is moved in increments equal to the unit cell of the specified grid. These values are then normalized to a percentage of the total number of intersections counted per unit cell area and multiplied by 1,000. The area adjustment is made because the counting cell is usually larger than the unit cell of the grid so that some data smoothing is attained. In this study an 18-km^2 counting cell was moved in increments of 6 km. To facilitate identification of areas of very high concentrations of linear features, specific contours delineating the lower boundaries of the upper decile (10%) and upper fifth percentile (5%) of the relative frequency per unit area values are plotted on Plates 8 through 14.

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Appendix A

Histogram from Length Analysis

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rdata.hist: Rolla Lineament  Lengths 3/27/78


START LINE    1;  START PIXEL    1;  NO. LINES 357; NO. PIXEL  10
LINE SKIP     0;  PIXEL SKIP     0

MIN GRAY LEVEL       0; MAX GRAY LEVEL   150;  MEAN GRAY LEVEL     15.2
MODE:    GRAY LEVEL      9 OCCURS           245. TIMES
TOTAL PIXELS TESTED             3570.
LOW PIXELS       0;  HIGH PIXELS      0
PIXELS USED IN HISTOGRAM        3570.

VARIANCE    131.674 STANDARD DEVIATION     11.475

FREQUENCY HISTOGRAM-NORMALIZED TO 50

       GRAYL    FREQ  CUM% 0        20        40        60        80       100
Length(km)                 +         +         +         +         +         +
           0      1.    0.0+         +         +         +         +         +
  0.2      1      3.    0.1*         +         +         +         +         +
           2     13.    0.5***       +         +         +         +         +
           3     41.    1.6********* +         +         +         +         +
           4     98.    4.4********************+         +         +         +
    1      5    151.    8.6*******************************         +         +
           6    216.   14.6********************************************      +
           7    228.   21.0***********************************************   +
           8    236.   27.6************************************************  +
           9    245.   34.5**************************************************+
    2     10    207.   40.3******************************************        +
          11    203.   46.0******************************************        +
          12    211.   51.9*******************************************       +
          13    187.   57.1**************************************  +         +
          14    137.   61.0****************************  +         +         +
    3     15    133.   64.7***************************   +         +         +
          16    118.   68.0************************      +         +         +
          17    129.   71.6***************************   +         +         +
          18    104.   74.5*********************         +         +         +
          19    100.   77.3*********************         +         +         +
    4     20     68.   79.2**************      +         +         +         +
          21     87.   81.7******************  +         +         +         +
          22     67.   83.6**************      +         +         +         +
          23     57.   85.2************        +         +         +         +
          24     56.   86.7************        +         +         +         +
    5     25     50.   88.1**********+         +         +         +         +
          26     31.   89.0*******   +         +         +         +         +
          27     39.   90.1********  +         +         +         +         +
          28     31.   91.0*******   +         +         +         +         +
          29     31.   91.8*******   +         +         +         +         +
    6     30     20.   92.4****      +         +         +         +         +
          31     28.   93.2******    +         +         +         +         +
          32     18.   93.7****      +         +         +         +         +
          33     11.   94.0**        +         +         +         +         +
          34     15.   94.4***       +         +         +         +         +
    7     35     13.   94.8***       +         +         +         +         +
          36     15.   95.2***       +         +         +         +         +
```

1 GRAYL = 200 METERS

RELATIVE FREQUENCY

(km)

```
        37   12.   95.5***     +        +        +        +        +
        38   12.   95.9***     +        +        +        +        +
        39    6.   96.0*       +        +        +        +        +
  8     40    6.   96.2*       +        +        +        +        +
        41   13.   96.6***     +        +        +        +        +
        42    6.   96.7*       +        +        +        +        +
        43    6.   96.9*       +        +        +        +        +
        44   10.   97.2**      +        +        +        +        +
  9     45    4.   97.3*       +        +        +        +        +
        46    9.   97.5**      +        +        +        +        +
        47    6.   97.7*       +        +        +        +        +
        48    6.   97.9*       +        +        +        +        +
        49    2.   97.9*       +        +        +        +        +
  10    50    7.   98.1**      +        +        +        +        +
        51    8.   98.3**      +        +        +        +        +
        52    8.   98.6**      +        +        +        +        +
        53    1.   98.6+       +        +        +        +        +
        54    1.   98.6+       +        +        +        +        +
        55    2.   98.7*       +        +        +        +        +
        56    1.   98.7+       +        +        +        +        +
        57    2.   98.8*       +        +        +        +        +
        58    3.   98.9*       +        +        +        +        +
        59    2.   98.9*       +        +        +        +        +
        60    1.   98.9+       +        +        +        +        +
        61    3.   99.0*       +        +        +        +        +
        62    2.   99.1*       +        +        +        +        +
        63    2.   99.1*       +        +        +        +        +
        64    2.   99.2*       +        +        +        +        +
        65    1.   99.2+       +        +        +        +        +
        66    1.   99.2+       +        +        +        +        +
        67    1.   99.3+       +        +        +        +        +
        68    1.   99.3+       +        +        +        +        +
        69    0.   99.3+       +        +        +        +        +
        70    1.   99.3+       +        +        +        +        +
        71    0.   99.3+       +        +        +        +        +
        72    1.   99.4+       +        +        +        +        +
        73    1.   99.4+       +        +        +        +        +
        74    1.   99.4+       +        +        +        +        +
  15    75    0.   99.4+       +        +        +        +        +
        76    1.   99.4+       +        +        +        +        +
        77    1.   99.5+       +        +        +        +        +
        78    1.   99.5+       +        +        +        +        +
        79    3.   99.6*       +        +        +        +        +
        80    1.   99.6+       +        +        +        +        +
        81    1.   99.6+       +        +        +        +        +
        82    1.   99.7+       +        +        +        +        +
        83    0.   99.7+       +        +        +        +        +
        84    0.   99.7+       +        +        +        +        +
        85    1.   99.7+       +        +        +        +        +
        86    3.   99.8*       +        +        +        +        +
        87    0.   99.8+       +        +        +        +        +
        88    0.   99.8+       +        +        +        +        +
        89    0.   99.8+       +        +        +        +        +
        90    0.   99.8+       +        +        +        +        +
        91    1.   99.8+       +        +        +        +        +
        92    1.   99.8+       +        +        +        +        +
        93    1.   99.9+       +        +        +        +        +
        94    0.   99.9+       +        +        +        +        +
        95    2.   99.9*       +        +        +        +        +
        96    0.   99.9+       +        +        +        +        +
```

```
(km)
          97     0.   99.9+       +         +         +         +         +
          98     1.   99.9+       +         +         +         +         +
          99     0.   99.9+       +         +         +         +         +
  20     100     0.   99.9+       +         +         +         +         +
         101     0.   99.9+       +         +         +         +         +
         102     0.   99.9+       +         +         +         +         +
         103     0.   99.9+       +         +         +         +         +
         104     0.   99.9+       +         +         +         +         +
         105     0.   99.9+       +         +         +         +         +
         106     1.  100.0+       +         +         +         +         +
         107     0.  100.0+       +         +         +         +         +
         108     0.  100.0+       +         +         +         +         +
         109     0.  100.0+       +         +         +         +         +
         110     0.  100.0+       +         +         +         +         +
         111     0.  100.0+       +         +         +         +         +
         112     0.  100.0+       +         +         +         +         +
         113     0.  100.0+       +         +         +         +         +
         114     0.  100.0+       +         +         +         +         +
         115     0.  100.0+       +         +         +         +         +
         116     0.  100.0+       +         +         +         +         +
         117     0.  100.0+       +         +         +         +         +
         118     0.  100.0+       +         +         +         +         +
         119     0.  100.0+       +         +         +         +         +
         120     0.  100.0+       +         +         +         +         +
         121     0.  100.0+       +         +         +         +         +
         122     0.  100.0+       +         +         +         +         +
         123     0.  100.0+       +         +         +         +         +
         124     0.  100.0+       +         +         +         +         +
         125     0.  100.0+       +         +         +         +         +
         126     0.  100.0+       +         +         +         +         +
         127     0.  100.0+       +         +         +         +         +
         128     0.  100.0+       +         +         +         +         +
         129     0.  100.0+       +         +         +         +         +
         130     0.  100.0+       +         +         +         +         +
         131     0.  100.0+       +         +         +         +         +
         132     0.  100.0+       +         +         +         +         +
         133     0.  100.0+       +         +         +         +         +
         134     0.  100.0+       +         +         +         +         +
         135     0.  100.0+       +         +         +         +         +
         136     0.  100.0+       +         +         +         +         +
         137     0.  100.0+       +         +         +         +         +
         138     0.  100.0+       +         +         +         +         +
         139     0.  100.0+       +         +         +         +         +
         140     1.  100.0+       +         +         +         +         +
         141     0.  100.0+       +         +         +         +         +
         142     0.  100.0+       +         +         +         +         +
         143     0.  100.0+       +         +         +         +         +
         144     0.  100.0+       +         +         +         +         +
         145     0.  100.0+       +         +         +         +         +
         146     0.  100.0+       +         +         +         +         +
         147     0.  100.0+       +         +         +         +         +
         148     0.  100.0+       +         +         +         +         +
         149     0.  100.0+       +         +         +         +         +
  30     150     0.  100.0+       +         +         +         +         +
```

Appendix B

Computer Printout

from Unweighted Strike-Frequency Analysis

```
ABSOLUTE STRIKE FREQUENCY ANALYSIS.

Rolla Lineaments 2

10 LEVELS OF FREQUENCY AT    13 PER LEVEL.

NO. OF DATA =   3574



              X   X                         X
  X X X   X   X X X X X X   X   X   X       X             X
  X X X X X X X X X X X X X X X X X X X X   X X X X X X X X X X X X X X X X X   X               X   X         X
  X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
 2734302227253932423333372038172624301622113920151323181527182321152224181514 92410 6 9 9 9 9 6131115 6 6101118 6 7 3 912
W                                                          60                                                          30


                                                  X
                                                  X
                                                  X X           X         X                     X       X X             X
    X X       X X X   X     X X X X X X X X X     X X     X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X X X
  X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  9131510 4 8151717 513 9 913181819171314161б 5 16131 4 91617172723131125262314201618 522241324302420 8332913172015252327
30                                                          N                                                          30
                                                                                                                X
                                                                                                                X
                                                                                                                X
                                                                                                                X
                                                                                                                X
                                                                                                                X
                      X                                     X                                 X                 X
  X   X   X         X X           X   X                     X               X                 X     X           X       X
  X X X X X X X X   X X     X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X   X X X   X X
  X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
 2924291936232019103349 8122524162621281913222420232319131442141922201920193220141625152021164420163422171 4 5242117102134
30                                                         60                                                           E
```

TABLE OF AZIMUTH VS FREQUENCY FOR PRECEDING STRIKE FREQUENCY PLOT

AZIM	BRNG	FREQ	AZIM	BRNG	FREQ	AZIM	BRNG	FREQ	AZIM	BRNG	FREQ
271	-89	27	316	-44	9	1	1	17	46	46	16
272	-88	34	317	-43	6	2	2	27	47	47	26
273	-87	30	318	-42	13	3	3	23	48	48	21
274	-86	22	319	-41	11	4	4	13	49	49	28
275	-85	27	320	-40	15	5	5	11	50	50	19
276	-84	25	321	-39	6	6	6	25	51	51	13
277	-83	39	322	-38	6	7	7	26	52	52	22
278	-82	32	323	-37	10	8	8	23	53	53	24
279	-81	42	324	-36	11	9	9	14	54	54	20
280	-80	33	325	-35	18	10	10	20	55	55	23
281	-79	33	326	-34	6	11	11	16	56	56	23
282	-78	37	327	-33	7	12	12	18	57	57	19
283	-77	20	328	-32	3	13	13	5	58	58	13
284	-76	38	329	-31	9	14	14	22	59	59	14
285	-75	17	330	-30	12	15	15	24	60	60	42
286	-74	28	331	-29	9	16	16	13	61	61	14
287	-73	24	332	-28	13	17	17	24	62	62	19
288	-72	30	333	-27	15	18	18	30	63	63	22
289	-71	16	334	-26	10	19	19	24	64	64	20
290	-70	22	335	-25	4	20	20	20	65	65	19
291	-69	11	336	-24	8	21	21	8	66	66	20
292	-68	39	337	-23	15	22	22	33	67	67	19
293	-67	20	338	-22	17	23	23	29	68	68	32
294	-66	15	339	-21	17	24	24	13	69	69	20
295	-65	13	340	-20	5	25	25	17	70	70	14
296	-64	23	341	-19	13	26	26	20	71	71	16
297	-63	18	342	-18	9	27	27	15	72	72	25
298	-62	15	343	-17	9	28	28	25	73	73	15
299	-61	27	344	-16	13	29	29	23	74	74	20
300	-60	18	345	-15	18	30	30	27	75	75	21
301	-59	23	346	-14	18	31	31	29	76	76	16
302	-58	21	347	-13	19	32	32	24	77	77	44
303	-57	13	348	-12	17	33	33	29	78	78	20
304	-56	22	349	-11	13	34	34	19	79	79	16
305	-55	24	350	-10	14	35	35	36	80	80	34
306	-54	18	351	-9	16	36	36	23	81	81	22
307	-53	15	352	-8	16	37	37	20	82	82	17
308	-52	14	353	-7	5	38	38	19	83	83	14
309	-51	9	354	-6	1	39	39	10	84	84	5
310	-50	24	355	-5	61	40	40	33	85	85	24
311	-49	10	356	-4	31	41	41	49	86	86	121
312	-48	6	357	-3	4	42	42	8	87	87	17
313	-47	9	358	-2	9	43	43	12	88	88	10
314	-46	9	359	-1	16	44	44	25	89	89	21
315	-45	9	360	0	17	45	45	24	90	90	34

```
EMPIRICAL STRIKE FREQUENCY ANALYSIS.

Rolla Lineaments 2

10 LEVELS OF FREQUENCY AT    17 PER LEVEL.

PERCENT AZIMUTH FOR SMOOTHING = 1.67

NO. OF DATA =   3574


                 X X X X
   X X X     X X X X X X X X
   X X X X X X X X X X X X X X X X X X X   X X X             X
   X X X X X X X X X X X X X X X X X X X   X X X   X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X               X         X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X   X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  9591867974919613 7 8 3909575836982706849727074465154566060666257565964574738474340252427272428303932272222739353116192430
 W                                                          60                                                          30


                                                   X X
                                                   X X
                                                   X X                     X                     X X     X X           X X
                                 X X             X X X         X X X     X X X X   X     X X X X X X X X X X X   X X X X X
   X X X       X X X X       X X X X X X X X X   X X X X   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  3437382922227404939352731314049555449444346372267939644294250616763474962746357505439455159616778745261707559505260637579
30                                                           N                                                          30
                                                                                                                 X
                                                                                                               X X X
                                                                                                               X X X
                                                                                                               X X X
                                                                                                               X X X
                     X X                                                                                       X X X
   X X X X X X       X X X           X X                   X X X           X X               X X X X X X       X X X     X
   X X X X X X X   X X X X   X X X X X X X X X X X X X X   X X X X X X X X X X X   X X X X X X X X X X X X     X X X   X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  808272847879624962929069456165666375686054596667666555466970755561615958717166505556605657818080707273533643506246486582
30                                                          60                                                           E
```

```
TABLE OF AZIMUTH VS FREQUENCY FOR PRECEDING STRIKE FREQUENCY PLOT

     AZIM BRNG FREQ          AZIM BRNG FREQ          AZIM BRNG FREQ          AZIM BRNG FREQ
      271  -89   95           316  -44   24             1    1   61            46   46   66
      272  -88   91           317  -43   28             2    2   67            47   47   63
      273  -87   86           318  -42   30             3    3   63            48   48   75
      274  -86   79           319  -41   39             4    4   47            49   49   68
      275  -85   74           320  -40   32             5    5   49            50   50   60
      276  -84   91           321  -39   27             6    6   62            51   51   54
      277  -83   96           322  -38   22             7    7   74            52   52   59
      278  -82  113           323  -37   27             8    8   63            53   53   66
      279  -81  107           324  -36   39             9    9   57            54   54   67
      280  -80  108           325  -35   35            10   10   50            55   55   66
      281  -79  103           326  -34   31            11   11   54            56   56   65
      282  -78   90           327  -33   16            12   12   39            57   57   55
      283  -77   95           328  -32   19            13   13   45            58   58   46
      284  -76   75           329  -31   24            14   14   51            59   59   69
      285  -75   83           330  -30   30            15   15   59            60   60   70
      286  -74   69           331  -29   34            16   16   61            61   61   75
      287  -73   82           332  -28   37            17   17   67            62   62   55
      288  -72   70           333  -27   38            18   18   78            63   63   61
      289  -71   68           334  -26   29            19   19   74            64   64   61
      290  -70   49           335  -25   22            20   20   52            65   65   59
      291  -69   72           336  -24   27            21   21   61            66   66   58
      292  -68   70           337  -23   40            22   22   70            67   67   71
      293  -67   74           338  -22   49            23   23   75            68   68   71
      294  -66   48           339  -21   39            24   24   59            69   69   66
      295  -65   51           340  -20   35            25   25   50            70   70   50
      296  -64   54           341  -19   27            26   26   52            71   71   55
      297  -63   56           342  -18   31            27   27   60            72   72   56
      298  -62   60           343  -17   31            28   28   63            73   73   60
      299  -61   60           344  -16   40            29   29   75            74   74   56
      300  -60   68           345  -15   49            30   30   79            75   75   57
      301  -59   62           346  -14   55            31   31   80            76   76   81
      302  -58   57           347  -13   54            32   32   82            77   77   80
      303  -57   56           348  -12   49            33   33   72            78   78   80
      304  -56   59           349  -11   44            34   34   84            79   79   70
      305  -55   64           350  -10   43            35   35   78            80   80   72
      306  -54   57           351   -9   46            36   36   79            81   81   73
      307  -53   47           352   -8   37            37   37   62            82   82   53
      308  -52   38           353   -7   22            38   38   49            83   83   36
      309  -51   47           354   -6   67            39   39   62            84   84   43
      310  -50   43           355   -5   93            40   40   92            85   85  150
      311  -49   40           356   -4   96            41   41   90            86   86  162
      312  -48   25           357   -3   44            42   42   69            87   87  148
      313  -47   24           358   -2   29            43   43   45            88   88   48
      314  -46   27           359   -1   42            44   44   61            89   89   65
      315  -45   27           360    0   50            45   45   65            90   90   82
```

```
Rolla Lineaments 2

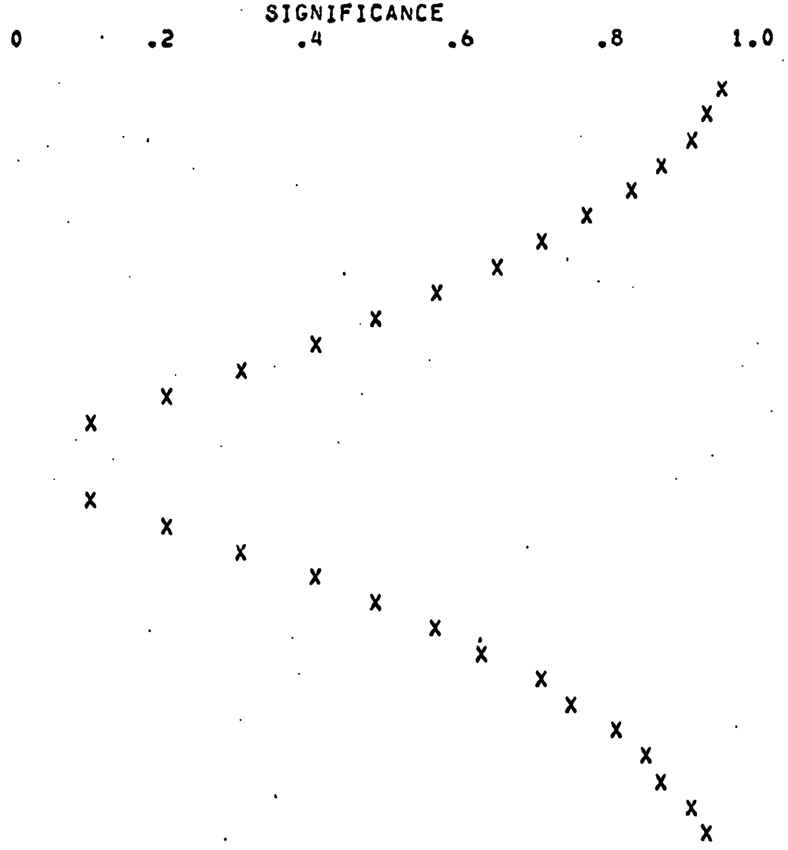
FREQUENCY PROBABILITY DATA

NO. OF DATA =  3574          EVENT PROB. = 0.017          PROB. LIMIT = 0.970

FREQUENCY MEAN =      59.6

EMP.  REL.    FREQ.      SIGNIF
FREQ. FREQ.   PROB.      VALUE

  45   1.8    0.008       94.0
  46   1.8    0.011       91.9
  47   1.8    0.014       89.1
  48   1.8    0.017       85.7
  49   1.9    0.021       81.6
  50   1.9    0.025       76.6
  51   1.9    0.029       70.8
  52   2.0    0.033       64.2
  53   2.0    0.038       56.8
  54   2.0    0.041       48.6
  55   2.0    0.045       39.7
  56   2.1    0.048       30.3
  57   2.1    0.050       20.4
  58   2.1    0.051       10.2
  59   2.2    0.052        0.0
  60   2.2    0.051        0.0
  61   2.2    0.050       10.4
  62   2.2    0.048       20.5
  63   2.3    0.046       30.2
  64   2.3    0.042       39.5
  65   2.3    0.039       48.0
  66   2.3    0.035       55.9
  67   2.4    0.031       63.0
  68   2.4    0.027       69.3
  69   2.4    0.024       74.8
  70   2.5    0.020       79.5
  71   2.5    0.017       83.6
  72   2.5    0.014       87.0
  73   2.5    0.011       89.8
  74   2.6    0.009       92.1
```



```
LOCATION OF MAXIMA AND THEIR SIGNIFICANCE VALUES.

        AZIMUTH  EMP. FREQ.  SIG. VALUE
          278       113         99.9
          280       108         99.9
          283        95         99.9
          285        83         99.9
          287        82         99.9
          291        72         87.0
          293        74         92.1
          300        68         69.3
          305        64         39.5
          356        96         99.9
            2        67         63.0
            7        74         92.1
           18        78         99.9
           23        75         99.9
           32        82         99.9
           34        84         99.9
           36        79         99.9
           40        92         99.9
           46        66         55.9
           48        75         99.9
           54        67         63.0
           61        75         99.9
           64        61         10.4
           68        71         83.6
           73        60          0.0
           76        81         99.9
           81        73         89.8
           86       162         99.9
```

Appendix C

Computer Printout

from Length-Weighted Strike-Frequency Analysis

```
ABSOLUTE STRIKE FREQUENCY ANALYSIS.

Rolla Lineaments 2 (length weighted)

10 LEVELS OF FREQUENCY AT   128 PER LEVEL.

NO. OF DATA =  54581



               X X X X   X   X                                 X
   X X         X X X X X X   X   X   X       X             X X X     X X
   X X X X X X X X X X X X X X X X X X X X   X X X   X X X X X X X X X X X   X X                     X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X       X   X   X X   X   X     X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  882253857163 82736475031681482326193707843156729902369321298228697977161 7875145433469401011 4652799 8 99811548651605841
 W                                                          60                                                          30


                                                   X
                                                   X                       X X                                       X   X
       X         X             X   X X X X X X     X X     X X X X X X   X X X   X         X   X X X X   X X     X   X X X
   X X X X     X X X   X   X X X X X X X X X X X   X X   X X X X X X X   X X X X X X X   X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  5247752961 6454526748726691075517784789127696817254318 793487547578821 698 03219453260 69699657433 331414385348049853092
30                                                           N                                                          30
                                                                                                                 X
                                                                                                                 X
                                                                                                                 X
                                                                                                                 X
                                                             X                                 X                 X       X
                       X                                     X               X                 X     X           X       X
   X   X   X           X       X     X                       X               X                 X X   X X         X     X X
   X X X X X X X X   X X   X X X   X X X X   X X X X X X X   X   X X   X X X X X     X   X X X X X X X X X X   X X X X X X
   X X X X X X X X X X X   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
   X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
  61982563629117287470248668588973608662875816592133 51910424854516354 8 055163072511020895959175582 897 33428907012206112
30                                                          60                                                           E
```

TABLE OF AZIMUTH VS FREQUENCY FOR PRECEDING STRIKE FREQUENCY PLOT

AZIM	BRNG	FREQ	AZIM	BRNG	FREQ	AZIM	BRNG	FREQ	AZIM	BRNG	FREQ
271	-89	488	316	-44	111	1	1	275	46	46	173
272	-88	422	317	-43	104	2	2	347	47	47	360
273	-87	353	318	-42	165	3	3	357	48	48	386
274	-86	285	319	-41	127	4	4	288	49	49	362
275	-85	271	320	-40	299	5	5	121	50	50	287
276	-84	363	321	-39	108	6	6	306	51	51	158
277	-83	608	322	-38	209	7	7	398	52	52	316
278	-82	527	323	-37	198	8	8	400	53	53	359
279	-81	636	324	-36	111	9	9	132	54	54	321
280	-80	547	325	-35	254	10	10	319	55	55	333
281	-79	450	326	-34	86	11	11	245	56	56	305
282	-78	531	327	-33	151	12	12	232	57	57	319
283	-77	268	328	-32	60	13	13	60	58	58	310
284	-76	514	329	-31	58	14	14	206	59	59	142
285	-75	282	330	-30	141	15	15	296	60	60	648
286	-74	432	331	-29	152	16	16	199	61	61	254
287	-73	261	332	-28	247	17	17	365	62	62	351
288	-72	393	333	-27	275	18	18	374	63	63	363
289	-71	270	334	-26	129	19	19	333	64	64	254
290	-70	378	335	-25	61	20	20	303	65	65	308
291	-69	243	336	-24	106	21	21	131	66	66	300
292	-68	415	337	-23	145	22	22	341	67	67	355
293	-67	367	338	-22	345	23	23	343	68	68	516
294	-66	329	339	-21	226	24	24	185	69	69	330
295	-65	190	340	-20	74	25	25	234	70	70	172
296	-64	323	341	-19	187	26	26	380	71	71	251
297	-63	269	342	-18	126	27	27	249	72	72	310
298	-62	332	343	-17	169	28	28	385	73	73	220
299	-61	412	344	-16	21[illegible]	29	29	330	74	74	289
300	-60	398	345	-15	275	30	30	392	75	75	359
301	-59	522	346	-14	251	31	31	461	76	76	259
302	-58	286	347	-13	277	32	32	298	77	77	717
303	-57	297	348	-12	284	33	33	425	78	78	455
304	-56	497	349	-11	278	34	34	263	79	79	282
305	-55	471	350	-10	291	35	35	462	80	80	608
306	-54	361	351	-9	327	36	36	291	81	81	397
307	-53	207	352	-8	269	37	37	317	82	82	303
308	-52	287	353	-7	168	38	38	328	83	83	334
309	-51	351	354	-6	17	39	39	174	84	84	128
310	-50	245	355	-5	625	40	40	370	85	85	290
311	-49	143	356	-4	343	41	41	524	86	86	1270
312	-48	134	357	-3	118	42	42	86	87	87	312
313	-47	169	358	-2	207	43	43	268	88	88	320
314	-46	140	359	-1	293	44	44	358	89	89	461
315	-45	110	360	0	348	45	45	389	90	90	712

```
EMPIRICAL STRIKE FREQUENCY ANALYSIS.

Rolla Lineaments 2 (length weighted)

10 LEVELS OF FREQUENCY AT   191 PER LEVEL.

PERCENT AZIMUTH FUR SMOOTHING = 1.67

NO. OF DATA =  54581
```

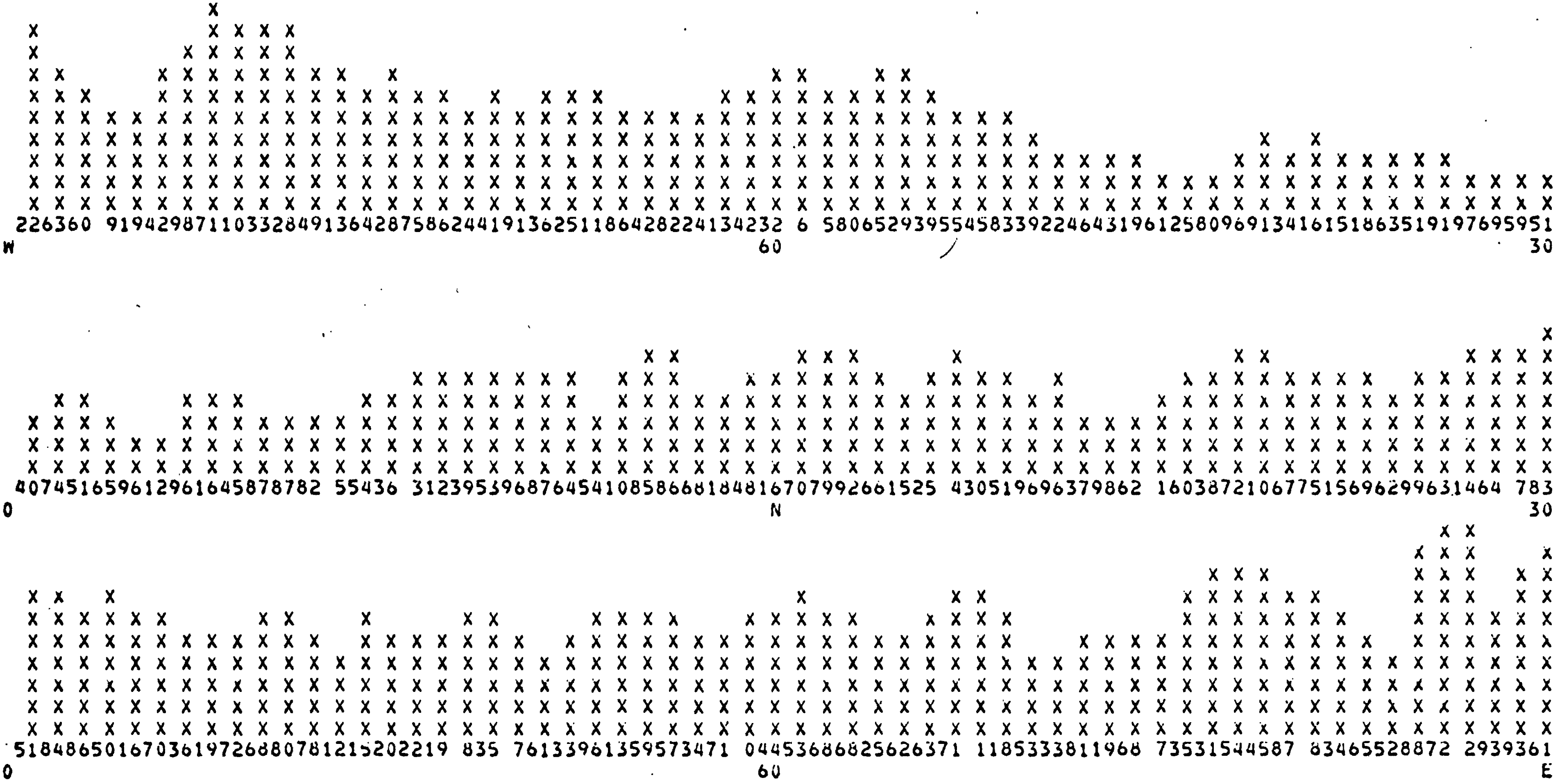


TABLE OF AZIMUTH VS FREQUENCY FOR PRECEDING STRIKE FREQUENCY PLOT

AZIM	BRNG	FREQ
271	-89	1622
272	-88	1263
273	-87	1060
274	-86	909
275	-85	919
276	-84	1242
277	-83	1498
278	-82	1771
279	-81	1710
280	-80	1653
281	-79	1528
282	-78	1249
283	-77	1313
284	-76	1064
285	-75	1228
286	-74	975
287	-73	1086
288	-72	924
289	-71	1041
290	-70	891
291	-69	1036
292	-68	1025
293	-67	1111
294	-66	806
295	-65	842
296	-64	782
297	-63	924
298	-62	1013
299	-61	1142
300	-60	1332
301	-59	1206
302	-58	1105
303	-57	1060
304	-56	1265
305	-55	1329
306	-54	1039
307	-53	855
308	-52	845
309	-51	863
310	-50	739
311	-49	522
312	-48	446
313	-47	443
314	-46	419
315	-45	361
316	-44	325
317	-43	360
318	-42	396
319	-41	591
320	-40	534
321	-39	616
322	-38	515
323	-37	518
324	-36	563
325	-35	451
326	-34	491
327	-33	297
328	-32	269
329	-31	259
330	-30	351
331	-29	540
332	-28	674
333	-27	651
334	-26	465
335	-25	296
336	-24	312
337	-23	596
338	-22	716
339	-21	645
340	-20	487
341	-19	387
342	-18	482
343	-17	505
344	-16	654
345	-15	736
346	-14	803
347	-13	812
348	-12	839
349	-11	853
350	-10	896
351	-9	887
352	-8	764
353	-7	454
354	-6	810
355	-5	965
356	-4	1086
357	-3	668
358	-2	618
359	-1	848
360	0	916
1	1	970
2	2	979
3	3	992
4	4	766
5	5	715
6	6	825
7	7	1104
8	8	930
9	9	851
10	10	696
11	11	796
12	12	537
13	13	498
14	14	562
15	15	701
16	16	860
17	17	938
18	18	1072
19	19	1010
20	20	767
21	21	775
22	22	815
23	23	869
24	24	762
25	25	799
26	26	863
27	27	1014
28	28	964
29	29	1107
30	30	1183
31	31	1151
32	32	1184
33	33	986
34	34	1150
35	35	1016
36	36	1070
37	37	936
38	38	819
39	39	872
40	40	1068
41	41	980
42	42	878
43	43	712
44	44	1015
45	45	920
46	46	922
47	47	919
48	48	1108
49	49	1035
50	50	807
51	51	761
52	52	833
53	53	996
54	54	1013
55	55	959
56	56	957
57	57	934
58	58	771
59	59	1100
60	60	1044
61	61	1253
62	62	968
63	63	968
64	64	925
65	65	862
66	66	963
67	67	1171
68	68	1201
69	69	1018
70	70	753
71	71	733
72	72	781
73	73	819
74	74	868
75	75	907
76	76	1335
77	77	1431
78	78	1454
79	79	1345
80	80	1287
81	81	1308
82	82	1034
83	83	765
84	84	752
85	85	1688
86	86	1872
87	87	1902
88	88	1093
89	89	1493
90	90	1661

Rolla Lineaments 2 (length weighted)

```
FREQUENCY PROBABILITY DATA

NO. OF DATA = 54581          EVENT PROB. = 0.017         PROB. LIMIT = 0.970

FREQUENCY MEAN =    909.7

EMP.  REL.    FREQ.       SIGNIF                       SIGNIFICANCE
FREQ. FREQ.   PROB.       VALUE        0        .2       .4        .6        .8       1.0

 853   2.1    0.002        93.9                                                      X
 854   2.1    0.002        93.5                                                      X
 855   2.1    0.003        93.0                                                     X
 856   2.1    0.003        92.4                                                     X
 857   2.1    0.003        91.8                                                     X
 858   2.1    0.003        91.2                                                     X
 859   2.1    0.003        90.6                                                    X
 860   2.1    0.003        89.9                                                    X
 861   2.1    0.004        89.2                                                    X
 862   2.1    0.004        88.4                                                   X
 863   2.1    0.004        87.6                                                   X
 864   2.1    0.004        86.8                                                  X
 865   2.1    0.004        85.9                                                  X
 866   2.1    0.005        84.9                                                 X
 867   2.1    0.005        84.0                                                 X
 868   2.1    0.005        82.9                                                X
 869   2.1    0.005        81.9                                                X
 870   2.1    0.006        80.7                                               X
 871   2.1    0.006        79.6                                               X
 872   2.1    0.006        78.3                                              X
 873   2.1    0.006        77.1                                              X
 874   2.1    0.007        75.7                                             X
 875   2.1    0.007        74.4                                            X
 876   2.1    0.007        72.9                                           X
 877   2.1    0.007        71.4                                           X
 878   2.1    0.008        69.9                                          X
 879   2.1    0.008        68.3                                         X
 880   2.1    0.008        66.6                                        X
 881   2.1    0.009        64.9                                       X
 882   2.1    0.009        63.2                                       X
 883   2.1    0.009        61.4                                      X
 884   2.1    0.009        59.5                                     X
 885   2.1    0.010        57.6                                    X
 886   2.1    0.010        55.6                                   X
 887   2.1    0.010        53.6                                  X
 888   2.1    0.010        51.6                                 X
 889   2.1    0.011        49.4                                X
 890   2.1    0.011        47.3                               X
 891   2.1    0.011        45.1                              X
 892   2.1    0.011        42.8                            X
 893   2.1    0.011        40.5                           X
 894   2.1    0.012        38.2                          X
 895   2.1    0.012        35.8                         X
 896   2.1    0.012        33.4                        X
 897   2.1    0.012        31.0                       X
 898   2.1    0.012        28.5                     X
 899   2.1    0.012        26.0                    X
 900   2.1    0.013        23.5                   X
 901   2.2    0.013        21.0                 X
```

```
902   2.2   0.013    18.4
903   2.2   0.013    15.8
904   2.2   0.013    13.2
905   2.2   0.013    10.6
906   2.2   0.013     7.9
907   2.2   0.013     5.3
908   2.2   0.013     2.6
909   2.2   0.013     0.0
910   2.2   0.013    -0.0
911   2.2   0.013     2.6
912   2.2   0.013     5.3
913   2.2   0.013     7.9
914   2.2   0.013    10.5
915   2.2   0.013    13.2
916   2.2   0.013    15.7
917   2.2   0.013    18.3
918   2.2   0.013    20.9
919   2.2   0.013    23.4
920   2.2   0.012    25.9
921   2.2   0.012    28.4
922   2.2   0.012    30.9
923   2.2   0.012    33.3
924   2.2   0.012    35.7
925   2.2   0.012    38.0
926   2.2   0.011    40.3
927   2.2   0.011    42.6
928   2.2   0.011    44.8
929   2.2   0.011    47.0
930   2.2   0.010    49.1
931   2.2   0.010    51.2
932   2.2   0.010    53.2
933   2.2   0.010    55.2
934   2.2   0.009    57.2
935   2.2   0.009    59.1
936   2.2   0.009    60.9
937   2.2   0.009    62.7
938   2.2   0.008    64.4
939   2.2   0.008    66.1
940   2.2   0.008    67.7
941   2.2   0.008    69.3
942   2.2   0.007    70.8
943   2.2   0.007    72.3
944   2.2   0.007    73.7
945   2.2   0.007    75.1
946   2.2   0.006    76.4
947   2.2   0.006    77.7
948   2.2   0.006    78.9
949   2.2   0.006    80.1
950   2.2   0.005    81.2
951   2.2   0.005    82.3
952   2.2   0.005    83.3
953   2.2   0.005    84.3
954   2.2   0.004    85.2
955   2.2   0.004    86.1
956   2.3   0.004    87.0
957   2.3   0.004    87.8
958   2.3   0.004    88.5
959   2.3   0.003    89.3
960   2.3   0.003    90.0
961   2.3   0.003    90.6
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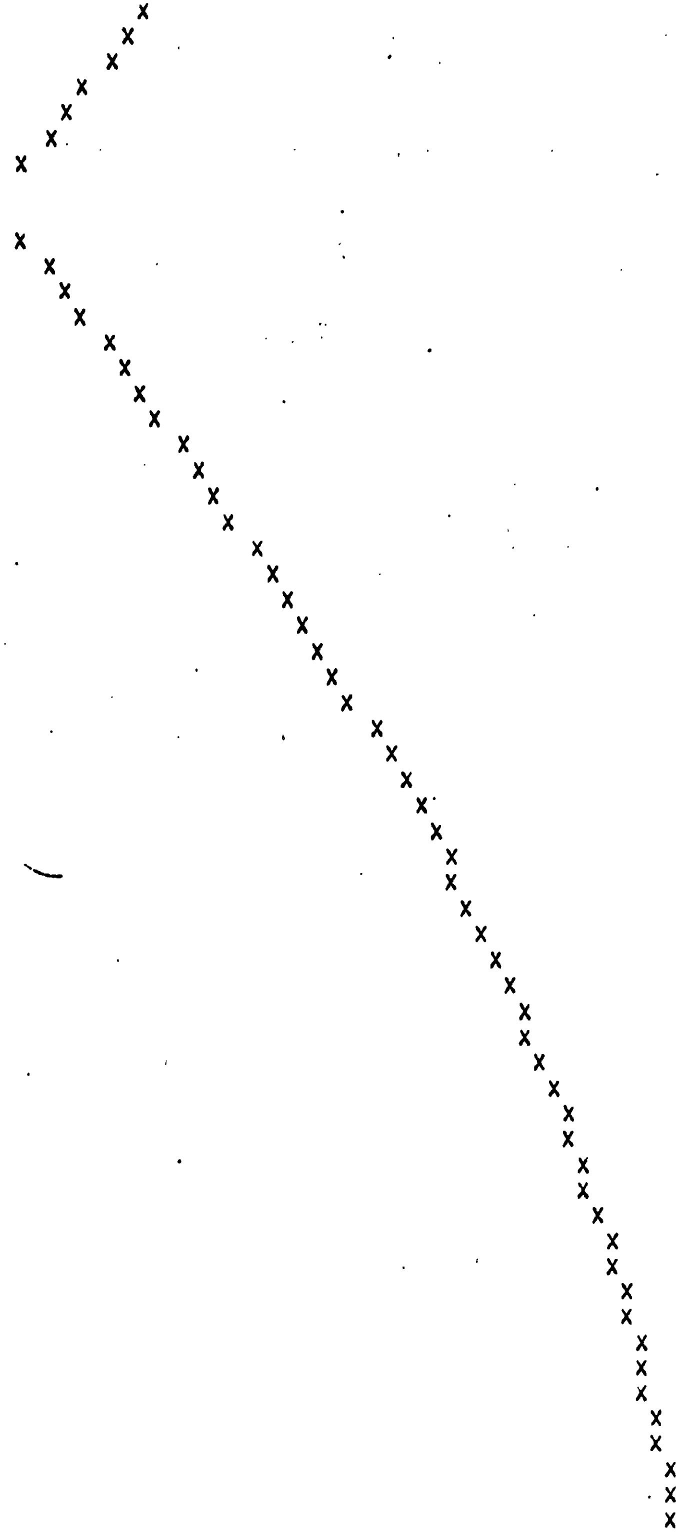

```
962   2.3   0.003    91.2                                                              X
963   2.3   0.003    91.8                                                              X
964   2.3   0.003    92.4                                                              X
965   2.3   0.002    92.9                                                              X
966   2.3   0.002    93.4                                                               X
967   2.3   0.002    93.9                                                               X
```

```
LOCATION OF MAXIMA AND THEIR SIGNIFICANCE VALUES.

        AZIMUTH  EMP. FREQ.  SIG. VALUE
          278       1771        99.9
          283       1313        99.9
          285       1228        99.9
          287       1086        99.9
          289       1041        99.9
          291       1036        99.9
          293       1111        99.9
          300       1332        99.9
          305       1329        99.9
          356       1086        99.9
            3        992        99.9
            7       1104        99.9
           18       1072        99.9
           27       1014        99.9
           30       1183        99.9
           32       1184        99.9
           34       1150        99.9
           36       1070        99.9
           40       1068        99.9
           44       1015        99.9
           46        922        30.9
           48       1108        99.9
           54       1013        99.9
           59       1100        99.9
           61       1253        99.9
           68       1201        99.9
           78       1454        99.9
           81       1308        99.9
```

87	1902	99.9
90	1661	99.9

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

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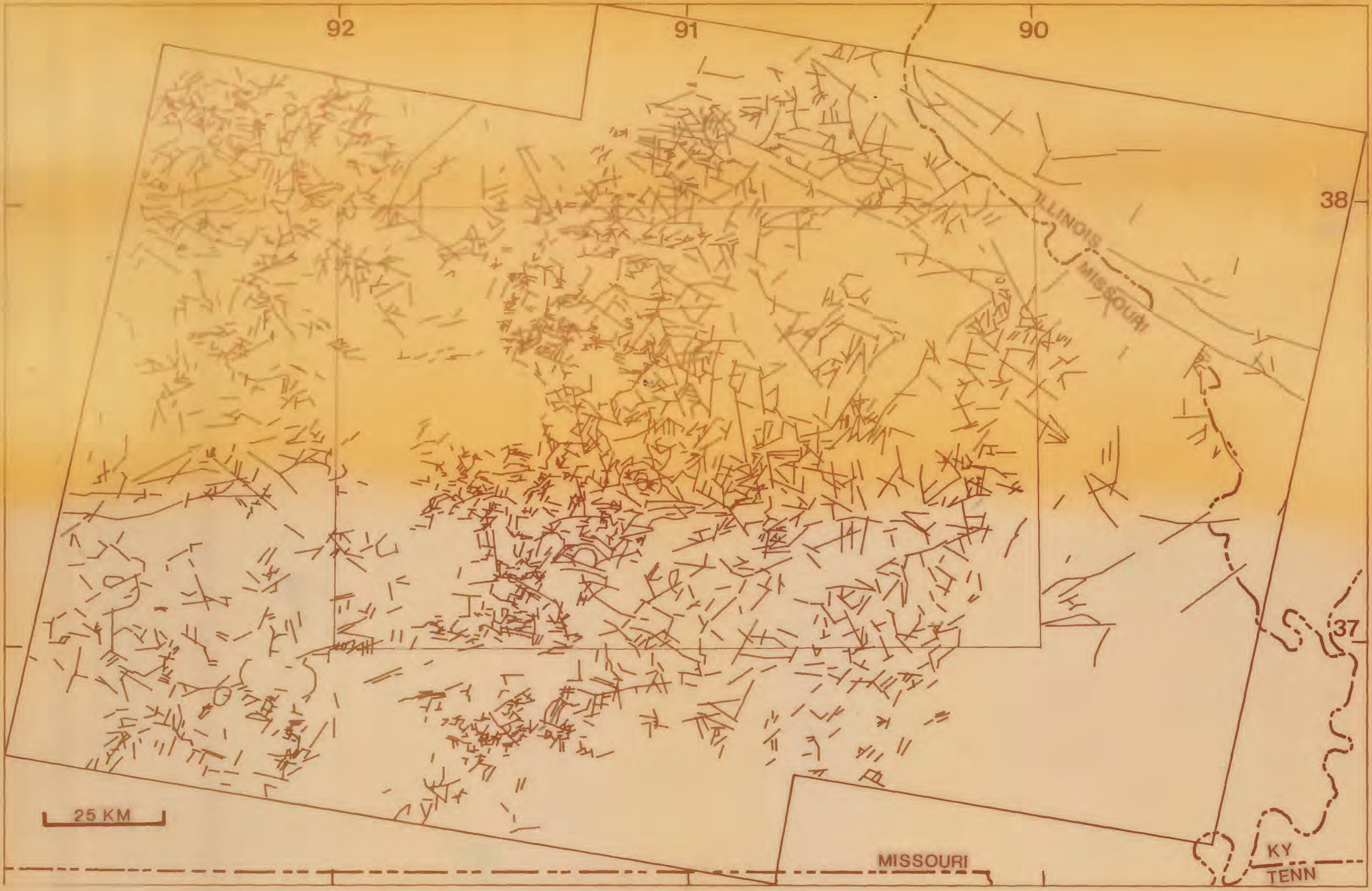
PLATE 1



Rolla Linear Features

Plate 1. Computer-generated map of digitized linear features interpreted from Landsat images of southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

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PLATE 10

NNW (354-356)

Plate 10. Computer-generated contour map of north-northwest trending linear feature concentrations (354°-356°), southeastern Missouri (1:1,000,000). Upper decile = 131 contour; upper fifth percentile = 160 contour. Plotted contours are 25, 50, 100, 131, 160, 200. This solid line is outline of the Rolla 1° x 2° sheet.

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UNITED STATES GEOLOGICAL SURVEY

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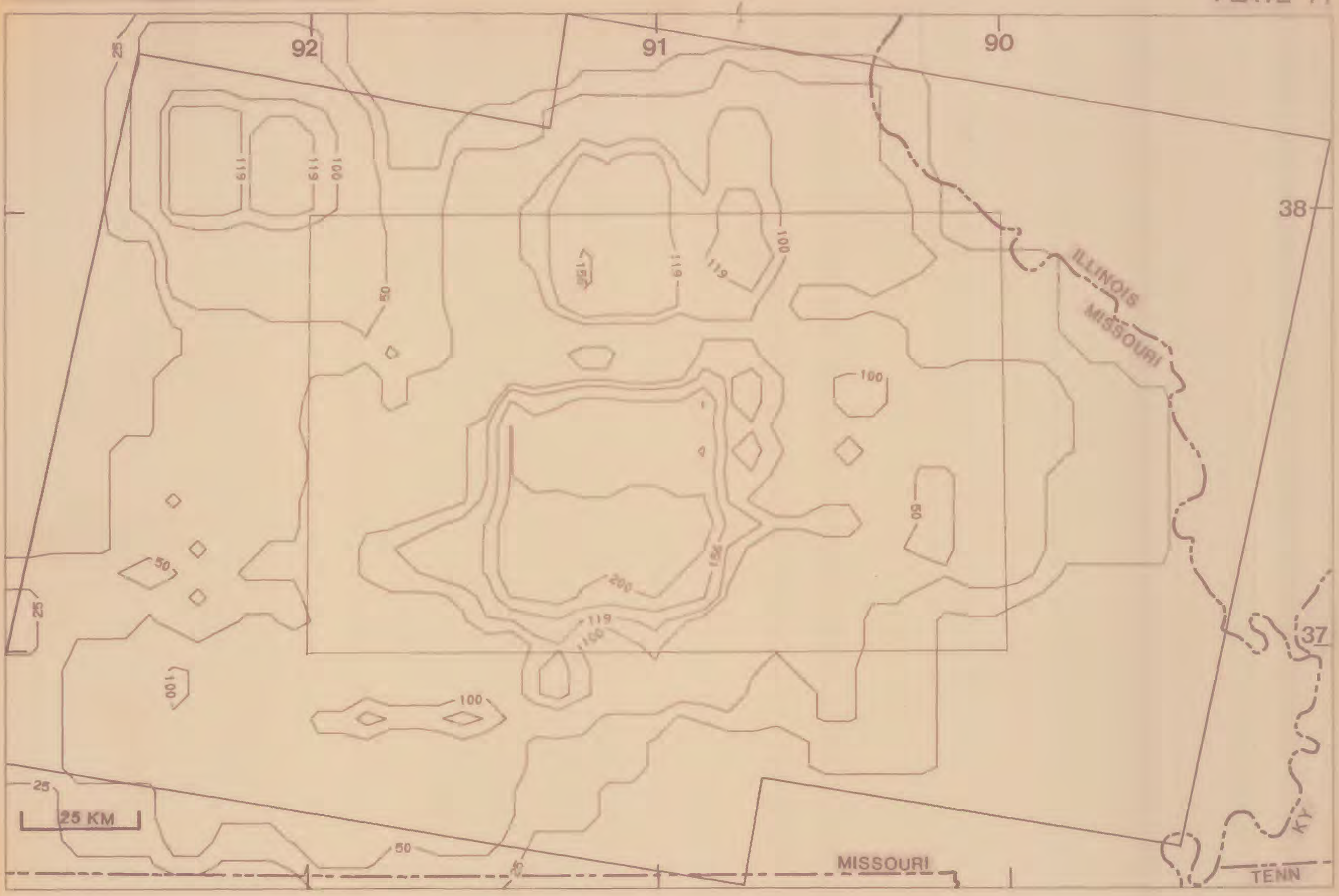
PLATE 11



NNE (4-10)

Plate 11. Computer-generated contour map of north-northeast trending linear feature concentrations (4°-10°), southeastern Missouri (1:1,000,000). Upper decile = 119 contour; upper fifth percentile = 156 contour. Plotted contours are 25, 50, 100, 119, 156, 200. Thin solid line is outline of the Rolla 1° x 2° sheet.

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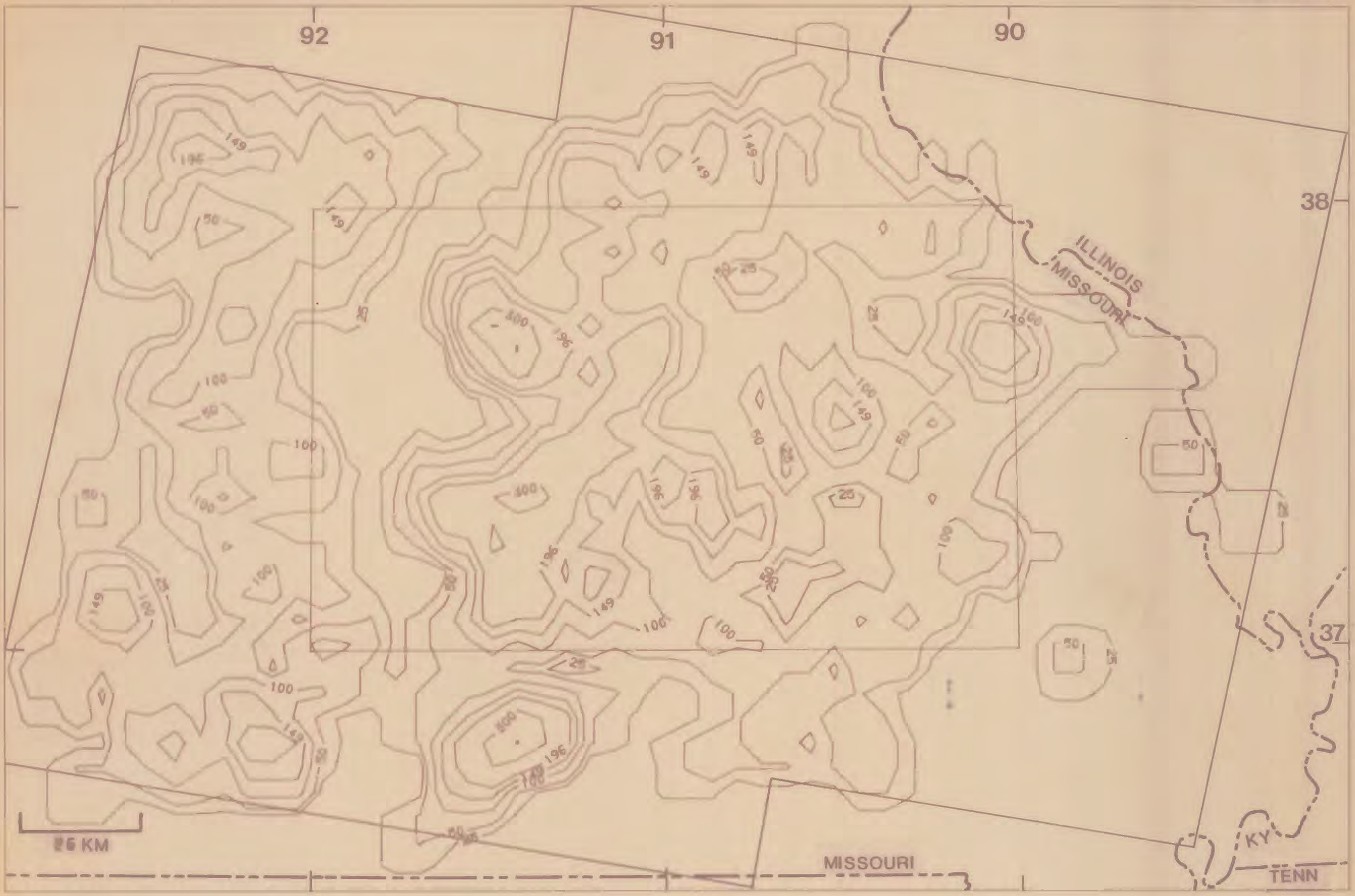
PLATE 12



NE (15-42)

Plate 12. Computer-generated contour map of northeast trending linear feature concentrations (15°-42°), southeastern Missouri (1:1,000,000). Upper decile = 149 contour; upper fifth percentile = 196 contour. Plotted contours are 25, 50, 100, 149, 196, 300, 400. Thin solid line is outline of the Rolla 1° x 2° sheet.

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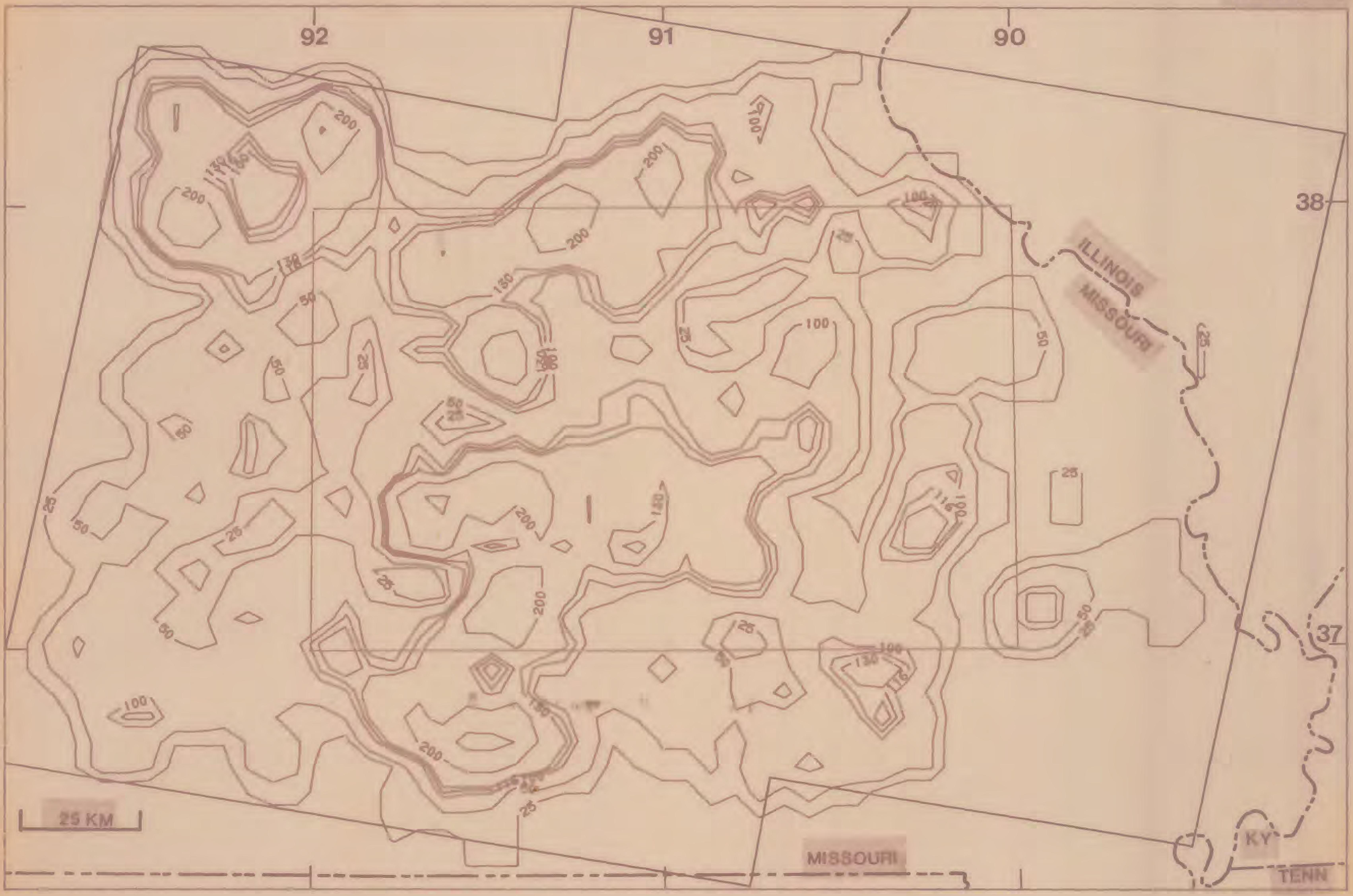
PLATE 13



ENE (46-81)

Plate 13. Computer-generated contour map of east-northeast trending linear feature concentrations (46°-81°), southeastern Missouri (1:1,000,000). Upper decile = 118 contour; upper fifth percentile = 130 contour. Plotted contours are 25, 50, 100, 118, 130, 200, 300. Thin solid line is outline of the Rolla 1° x 2° sheet.

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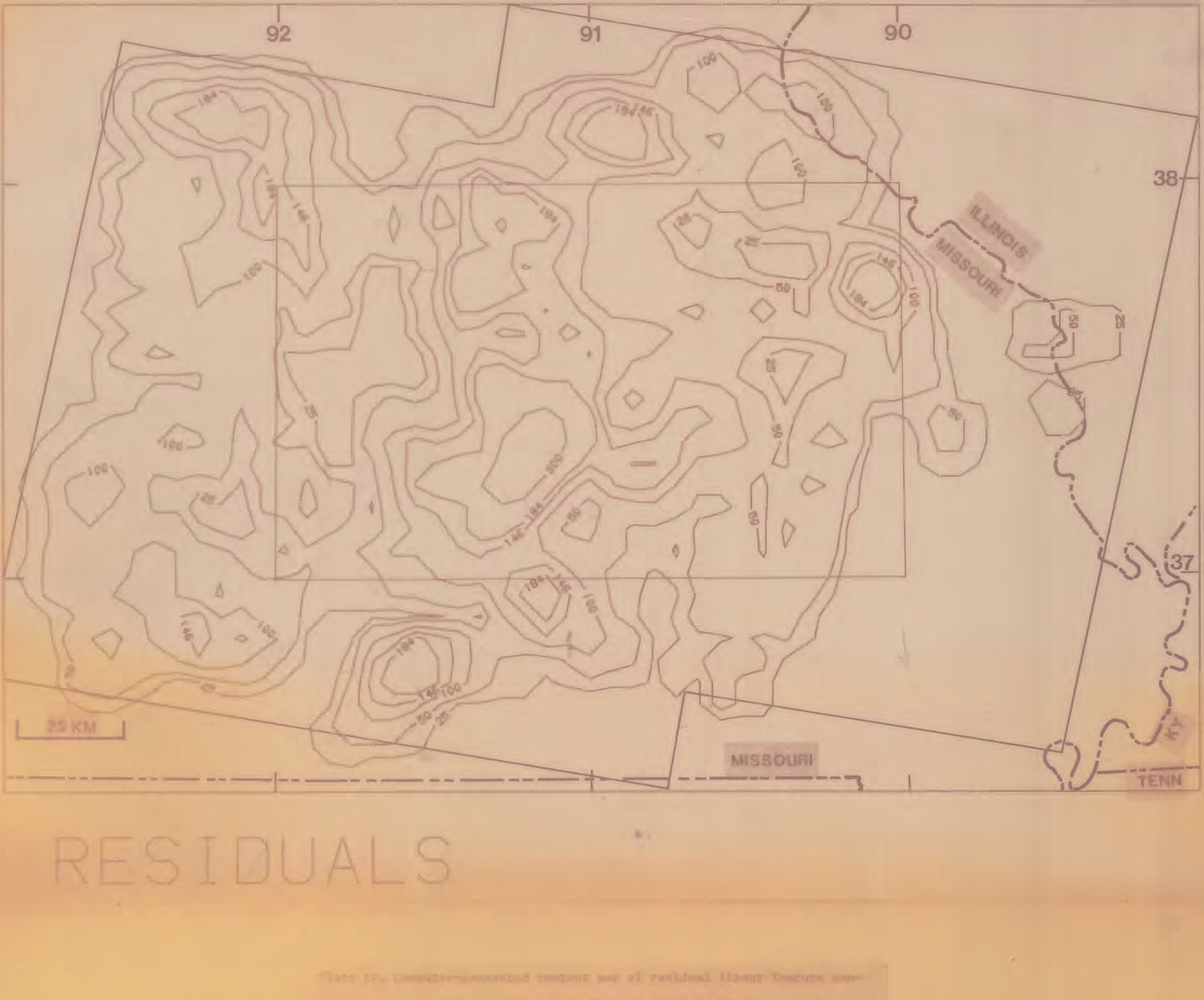
PLATE 14



RESIDUALS

Plate 14. Computer-generated contour map of residual linear feature concentrations, southeastern Missouri (1:1,000,000). Upper decile = 146 contour; upper fifth percentile = 184 contour. Plotted contours are 25, 50, 100, 146, 184, 200. Thin solid line is outline of the Rolla 1° x 2° sheet.

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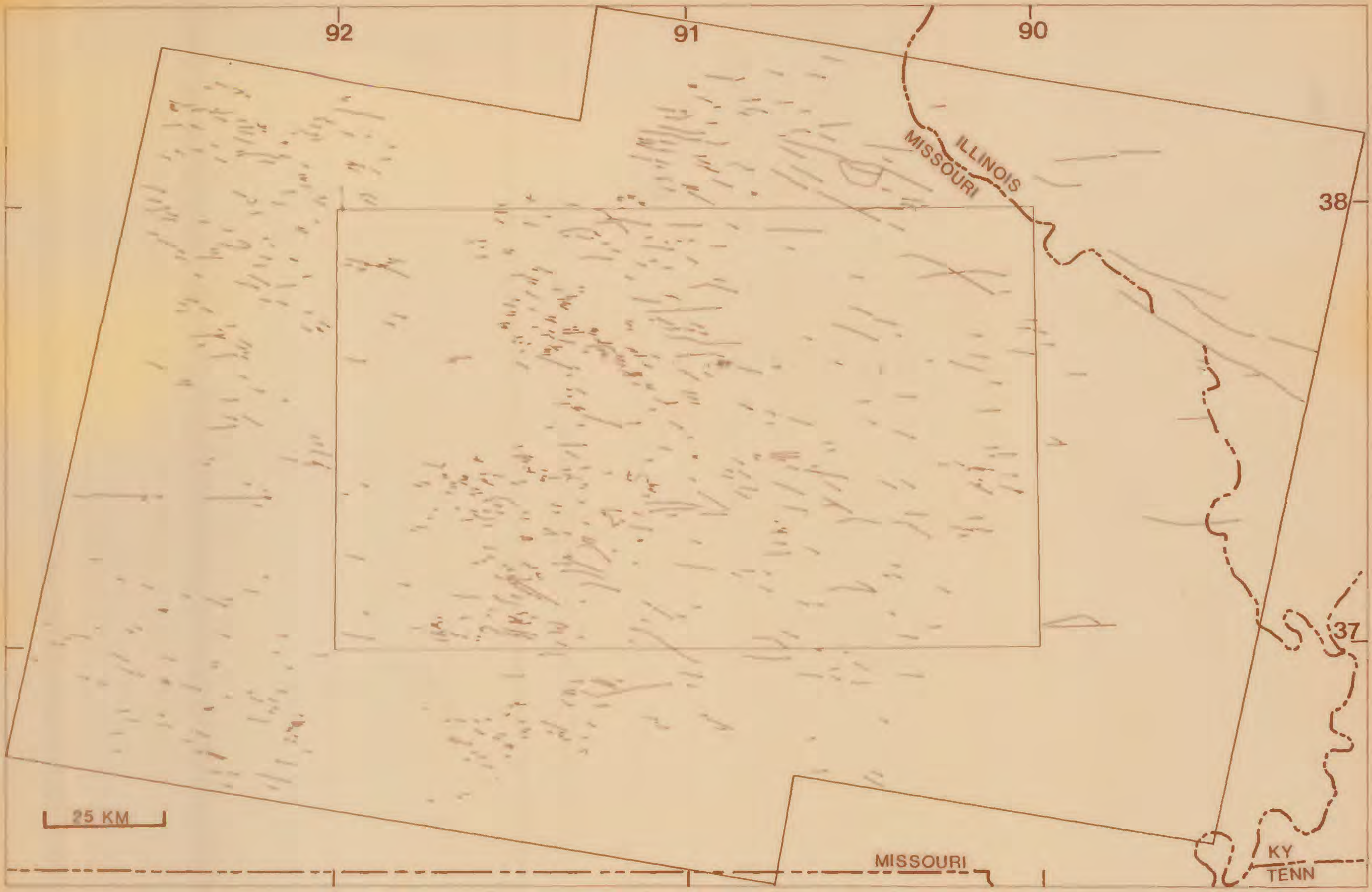
PLATE 2



WNW (271-300 and 85-90)

Plate 2. Computer-generated map of west-northwest trending linear features (271°-300° and 85°-90°), southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

DEPARTMENT OF THE INTERIOR

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PLATE 3

NNW (354-356)

Plate 3. Computer-generated map of north-northwest trending linear features (354°-356°), southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

DEPARTMENT OF THE INTERIOR

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PLATE 4

NNE (4-10)

Plate 4. Computer-generated map of north-northeast trending linear features (4°-10°), southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

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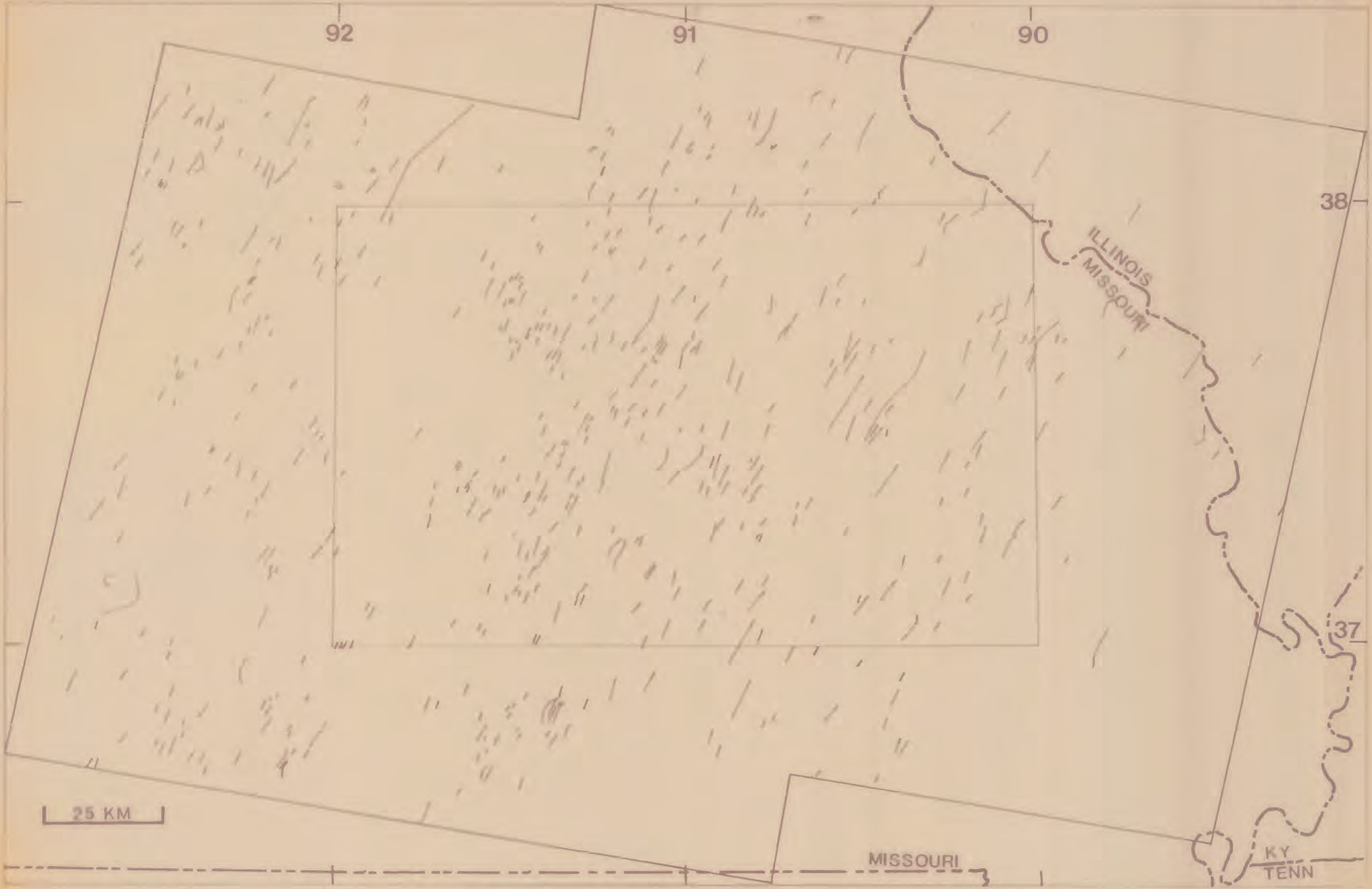
PLATE 5



NE (15-42)

Plate 5. Computer-generated map of northeast trending linear features (15°–42°), southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

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PLATE 6

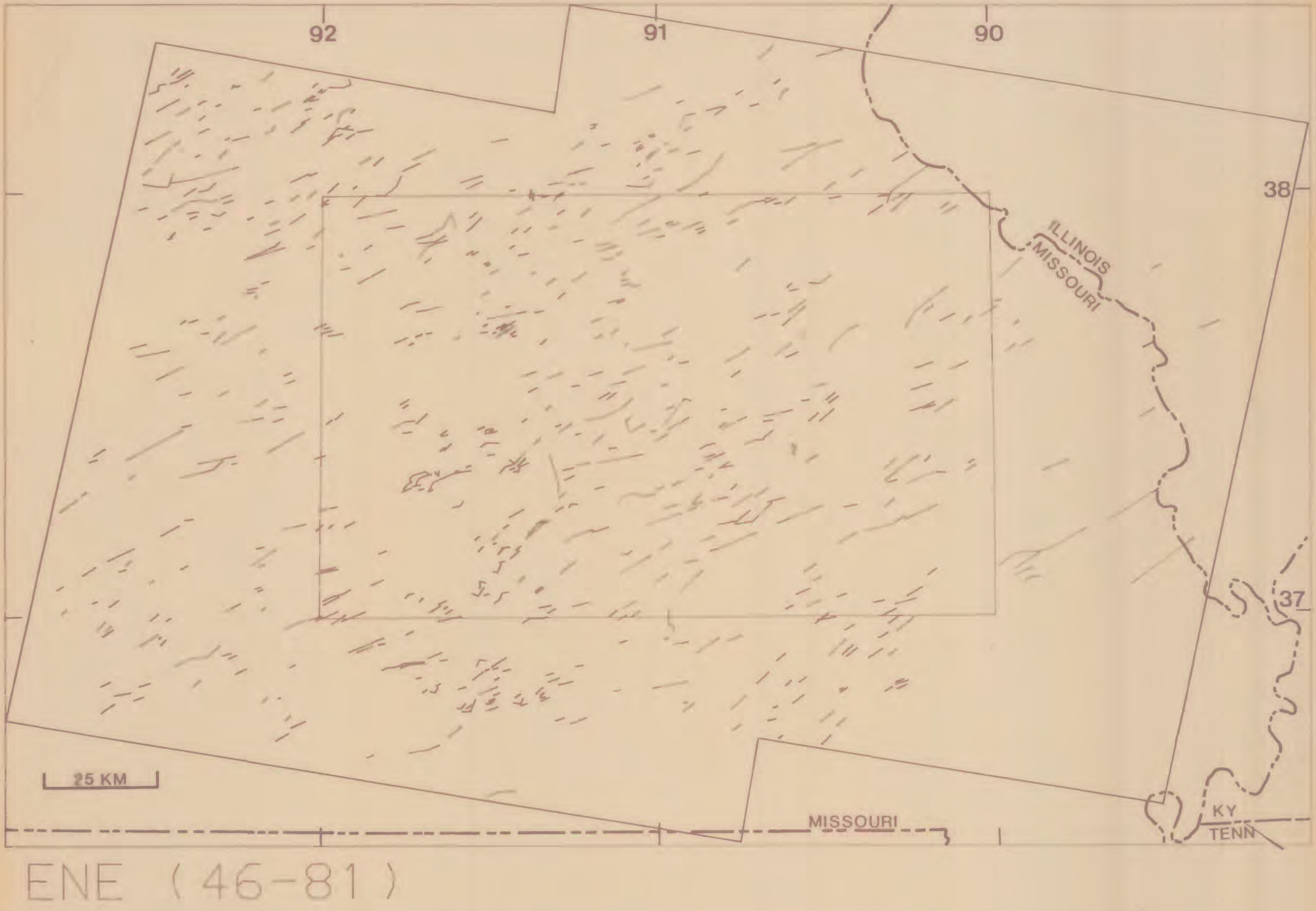

Plate 6. Computer-generated map of east-northeast trending linear features (46°-81°), southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

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PLATE 7

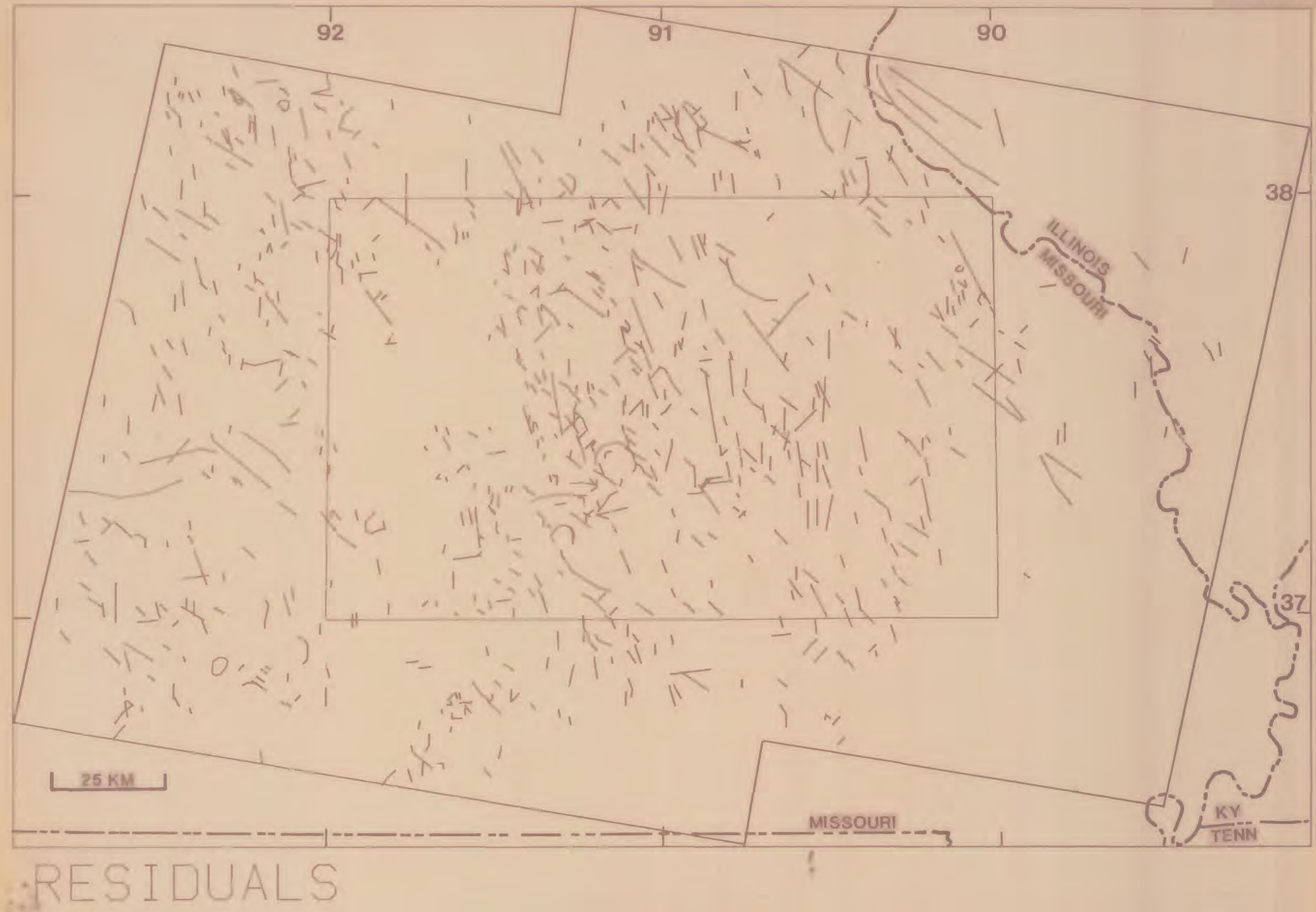

Plate 7. Computer-generated map of residual linear features, southeastern Missouri (1:1,000,000). Thin solid line is outline of the Rolla 1° x 2° sheet.

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UNITED STATES GEOLOGICAL SURVEY

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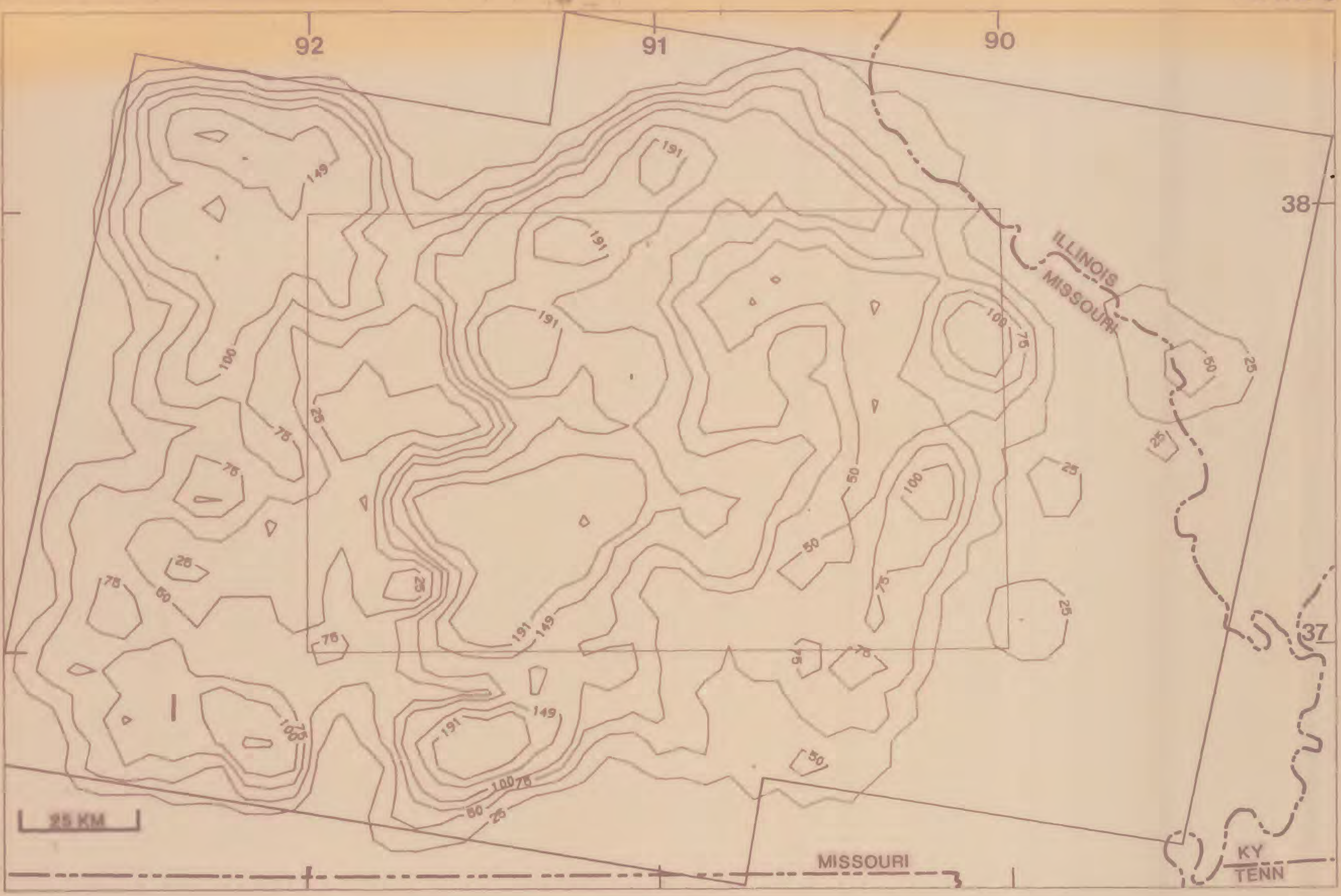
PLATE 8



All Linear Features

Plate 8. Computer-generated contour map of the concentration of all linear features mapped from Landsat images, southeastern Missouri (1:1,000,000). Upper decile = 149 contour; upper fifth percentile = 191 contour; contour interval = 25. Thin solid line is outline of the Rolla 1° x 2° sheet.

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

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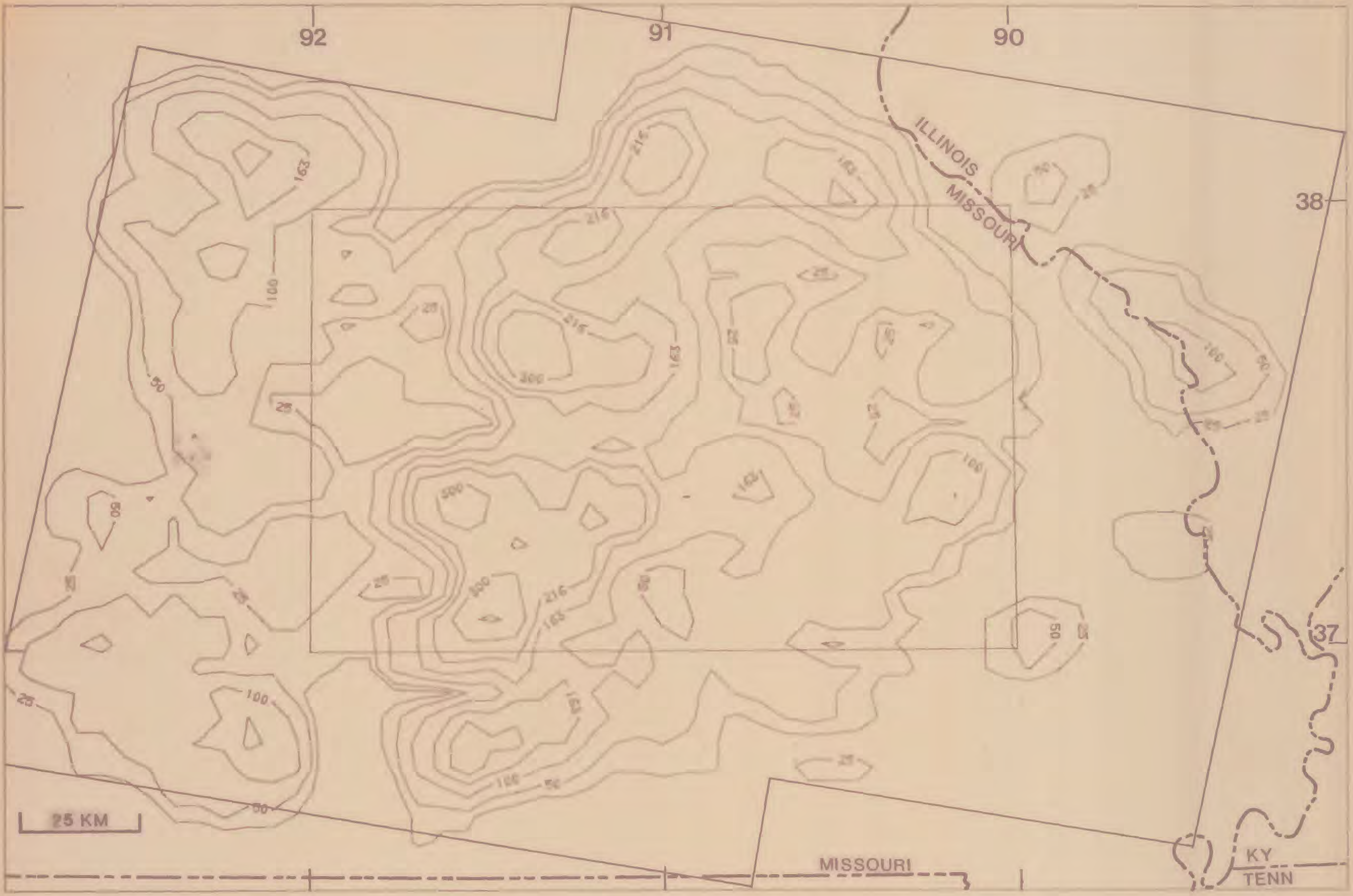
PLATE 9



WNW (271-300 and 85-90)

Plate 9. Computer-generated contour map of west-northwest trending linear feature concentrations (271°-300° and 85°-90°), southeastern Missouri (1:1,000,000). Upper decile = 163 contour; upper fifth percentile = 216 contour. Plotted contours are 25, 50, 100, 163, 216, 300, 400. Thin solid line is outline of Rolla 1° x 2° sheet.