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MAP OF THE WALKER LAKE 1° BY 2° QUADRANGLE, CALIFORNIA AND NEVADA SHOWING THE REGIONAL DISTRIBUTION OF LINEAR FEATURES

by

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INTRODUCTION

The importance of faults and fractures for influencing the deposition of precious- and base-metal deposits has been recognized in the Great Basin for many years (Jerome and Cook, 1967; Shawe, 1965; Shawe and Stewart, 1976). Although the geologic map of this quadrangle documents the location, extent, and in some cases, sense of displacement of faults (Stewart and others, 1982), the regional continuity of fracture zones with small or no perceptible displacement is commonly difficult to define, even when aerial photographs are used in conjunction with field studies.

Landsat Satellite Multispectral Scanner (MSS) images facilitate mapping of regional fracture zones, as well as most steeply dipping regional faults, because the multispectral synoptic coverage afforded by the satellite allows the continuity of spatially related linear features to be traced for great distances. In this study, linear features were mapped for the Walker Lake 1° by 2° quadrangle, California and Nevada on black and white MSS band 5 (0.6-0.7 μm) and band 7 (0.8-1.1 μm) images that had been digitally processed to enhance the image contrast for the eastern three-fourths of the quadrangle. In the western part of the quadrangle, a digitally enhanced color-infrared composite image was used because of the importance of vegetation distribution for detecting linear features in this area. The linear features were digitized for statistical analysis and plotting. For the purpose of digitizing, curvilinear features were divided into individual linear segments; topographic maps, Skylab photographs, and aerial photographs were used to exclude cultural features.

The objective of analyzing the linear features was to identify alinements that constitute lineaments. As used here, the term lineament refers to a "simple or composite linear feature of a surface, whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ distinctly from the patterns of adjacent features and presumably reflect a subsurface phenomenon" (O'Leary and others, 1976, p. 1467). In the Walker Lake quadrangle, most of the linear features which make up lineaments are stream segments, linear ridges, and escarpments. Although tonal anomalies representing linear bedrock exposures or vegetation are less common, they are locally important. All the lineaments described in this report are composite in that they consist of numerous linear features. Their distinctiveness usually derives from the presence of a higher areal density of linear features than is present in adjacent terrain; in some cases, the contrast is enhanced by the presence of several long linear features.

PREVIOUS STUDIES

No detailed, unified study of lineaments has been conducted previously in the Walker Lake quadrangle, but the Nevada part of the quadrangle was covered in a statewide analysis of MSS images conducted by Rowan and Wetlaufer (1973; 1975; 1979; 1981). Another important, though areally more limited, study was conducted by Lockwood and Moore (1979) in the Sierra Nevada part of the quadrangle using a combination of aerial photographs and field studies.

Although the statewide Nevada study was conducted at a smaller scale than used here and standard, rather than digitally enhanced, images were analyzed, several conclusions were reached that are pertinent to the analysis of lineaments in this quadrangle. Comparisons of the trends of the longest lineaments with diverse geological, geophysical, and geochemical data suggest the presence of three broad structural zones which were main zones of strike-slip displacement, at least since extension of the Great Basin began during the middle Miocene (Rowan and Wetlaufer, 1979; 1981). Southern and western Nevada are dominated by the northwest-oriented Walker Lane and the generally east-trending Southern Nevada structural zones, whereas northern Nevada is transected by the northeast-oriented Humbolt structural zone, which may extend northward into Montana. Field evidence clearly documents right-lateral, strike-slip displacement along the Walker Lane (Gianella and Callaghan, 1934; Locke and others, 1940; Longwell, 1960; Nielsen, 1965; Shawe, 1965; Albers, 1967; Stewart and others, 1968) and suggests dominantly left-lateral displacement within the east- and northeast-oriented structural zones (Slemmons, 1967; Ekren and others, 1976; Rowan and Wetlaufer, 1975; 1979; 1981). These three structural zones appear to have influenced the distribution of Cenozoic volcanic and related intrusive rocks (Stewart and Carlson, 1976; Stewart and others, 1977; Rowan and Wetlaufer, 1981), and most of the precious- and base-metal deposits are located within these zones (Rowan and Wetlaufer, 1979). Lineaments making up the Southern Nevada and Humbolt structural zones intersect the Walker Lane without perceptible displacement, implying that a conjugate shear relationship has prevailed since the middle Miocene similar to that proposed by Shawe (1965).

Lockwood and Moore (1979) also concluded that the eastern part of the Sierra Nevada is transected by a conjugate set of northwest- and northeast-oriented strike-slip microfaults; the sense of displacement is characteristically right-lateral and left-lateral, respectively. In general, the northeast-trending, left-lateral, strike-slip microfaults have greater displacement than the northwest-oriented microfaults, but the total extension of the eastern Sierra Nevada is estimated to be only about 2.3 percent (Lockwood and Moore, 1979) as opposed to roughly 30 percent in the Great Basin (Stewart, 1978). Nevertheless, these microfaults have guided the glacial and fluvial sculpturing of the eastern Sierra Nevada, and locally they are mineralized. They are expressed as lineaments on aerial photographs and, we believe, on Landsat MSS images.

STATISTICAL ANALYSIS OF LINEAMENT DATA

Although several long features are apparent in the map of linear features for the Walker Lake quadrangle (see accompanying map), the pattern was judged to be too complex to permit an objective visual analysis. Therefore, a statistical approach was employed for identifying the significant trends that might be present in the population of linear features (Sawatsky and Raines, 1981). Significant trends were determined on the basis of the frequency of distribution of the data (Sawatsky and Raines, 1981). The frequency of observation was weighted according to the length of the linear features, because we consider the long features to be of greater importance than the short features. Identification of the statistically significant trends was accomplished by determining the probability that the frequency for each class interval would occur in a uniform population of directions. Frequencies near the mean have low significance, and significance increases as the frequencies depart from the mean (Sawatsky and Raines, 1981). Thus, significant maxima and minima have high and low frequencies, respectively, that are far from the frequency mean. Selection of maxima and minima for further analysis is determined by the significance value used. Linear features of the statistically significant trends were plotted and contoured in order to determine the locations of lineaments.

The contouring procedure involved counting the number of linear features intersected by a counting cell that was moved incrementally across the gridded data. Because the counting cell is larger than this increment of movement, the data are smoothed (Knepper, 1979). These contour values were then normalized to the total number of linear features in order to obtain the percentage of total intersection counted for each cell and multiplied by 1,000.

Although the smoothing tends to emphasize the major features, it also causes minor inflections of contour lines that should not be used as rigorous boundaries. Therefore, we use the contour lines for placing general boundaries on the lineaments. In the plots of linear features (figs. 6, 7, 8, and 10 through 20) the contours are shown only in the case where lineaments are defined.

Statistically significant trends were identified using a significance value of 90.4. This value corresponds to length-weighted frequencies of 1,272 and 1,156 for the limiting boundaries of significant maxima and minima, respectively.

The frequency distribution of linear features for 1-degree-class intervals of azimuth is characterized by a high frequency of north- to east-oriented linear features and few west- to west-northwest-trending features (fig. 1). Six significant maxima were identified, each being separated by at least two 1 degree intervals that have a frequency less than the significant minima (fig. 1; table 1). The broadest significant maximum, N39°-89°E, was subdivided (fig.1; table 2) because the definition of lineaments was complicated by the large number of linear features with that azimuthal range. The basis used for the subdivision was that each of the azimuthal ranges of the subdivisions be separated from the adjacent range by two class intervals that lie in the nonsignificant field (fig. 1).

The statistical approach did not highlight several trends that were evident in the map of linear features. In such cases azimuthal ranges were specifically chosen to define these features. There were other cases where azimuthal ranges were plotted together because the combination enhanced features.

INTERPRETATION

Although the statistical approach provides an objective means for studying linear features and yields reproducible results, several factors influence the detectability and mapping of these features, including illumination conditions, scale and areal coverage of images, spectral reflectance of the surface materials, image quality, and several human factors (Wise, 1969; Siegal, 1977). The importance of some of these factors is easier to take into account than others. Operator or analyst variablility is very high with respect to delineation of individual linear features, but good agreement can be expected for definition of significant trends (Podwysocki, 1974; Podwysocki and others, 1975). Consequently, we define the lineaments in the Walker Lake quadrangle through the statistical approach described above, and attribute little importance to most individual linear features.

The effects of solar illumination conditions are particularly difficult to assess in this study because of the limited variations of solar azimuths and inclinations of the Landsat images. The range of solar azimuth and inclination of the Landsat images used in this study were 108°-138° and 46°-50° respectively. Under these illumination conditions, topographic linear features with valley wall slopes of 20-30 degrees would be enhanced when they were roughly orthogonal to the solar azimuth; conversely, linear topographic features that were parallel to the solar azimuth would be subdued. These conditions probably account largely for the large differences between the frequency distributions for linear features and faults shown on the geologic map for the quadrangle (figs. 1 and 2, respectively). Apparently, linear features related to the northwest-trending faults, many of which are located in the Walker Lane, are subdued in these images, whereas northeast-trending fault and fracture traces are enhanced. However, we believe that several other factors contribute to these differences.

In the Gabbs Valley Range, where the northwest-trending faults of the Walker Lane are so prominent, most of the long fault traces are marked at least locally by linear features. In general, where fault traces are not well expressed by linear topographic features or the relative relief along the linear topographic feature is low, linear features were not mapped. Another factor is that many of the faults are short and therefore were difficult to detect in Landsat images. As a result, we believe that the low frequency of northwest-trending linear features relative to the

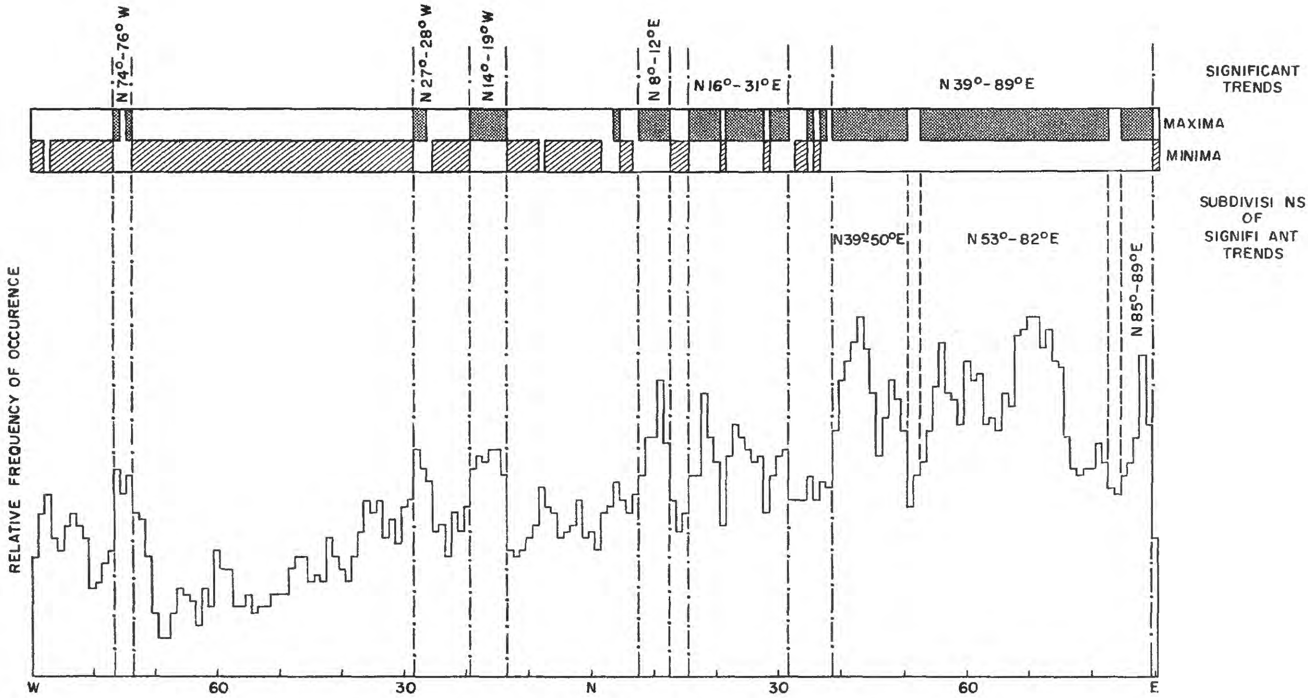


Figure 1.--Length-weighted strike-frequency plot of linear features mapped from Landsat Multispectral Scanner images for the Walker Lake 1° by 2° quadrangle, California and Nevada. Significant maxima and minima are indicated above the strike-frequency plot.

Table 1.--*Statistically significant maxima identified in the length-weighted strike-frequency plot of linear features (fig. 1) mapped in the Walker Lake 1^{o} x 2^{o} quadrangle*

Significant Maxima	Width (degrees)
N 8^{o}-12^{o}E	5
N16^{o}-31^{o}E	16
N39^{o}-89^{o}E	51
N14^{o}-19^{o}W	5
N27^{o}-28^{o}W	2
N74^{o}-76^{o}W	3

Table 2.--*Subdivisions of the N39^{o}-89^{o}E significant maximum (fig. 1; table 1)*

N39^{o}-50^{o}E	12
N53^{o}-82^{o}E	30
N85^{o}-89^{o}E	5

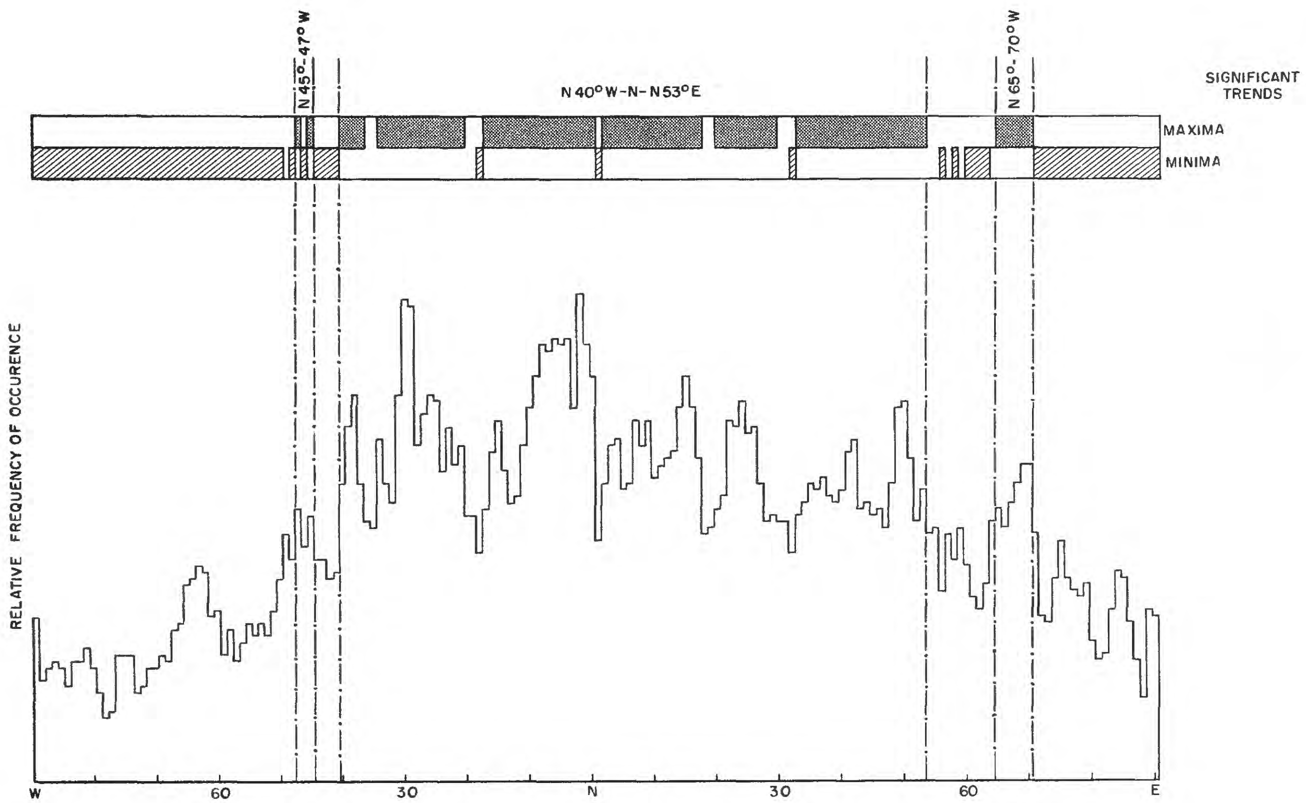


Figure 2.—Length-weighted strike-frequency plot of faults mapped in the Walker Lake 1° by 2° quadrangle, California and Nevada (from Stewart and others, 1982). Significant maxima and minima are indicated above the strike-frequency plot.

frequency of faults with this general orientation is related to a combination of factors, including nonlinear fault traces, the relatively short lengths of some of the fault traces, and the effects of the parallel orientations of the fault traces and solar illumination, particularly on features with low topographic relief.

The high frequency of northeast-oriented linear features is probably in part due to their generally orthogonal orientation with respect to the solar illumination, but we believe that the evidence presented below indicates that many of these features express the presence of fractures that have little displacement and are not mapped as faults. However, the complications arising from solar illumination effects and the other above mentioned factors stress the importance of using other data sets for analyzing the significance of lineaments identified in Landsat images. The supplemental data sets used to assess the information obtained in the lineament analysis were the geologic map (Stewart and others, 1982), total intensity aeromagnetic map (fig. 3), Bouguer gravity map (Plouff, 1983), and alteration map (fig. 4) (Rowan and Purdy, 1983).

DESCRIPTION OF LINEAMENTS

The analysis of linear features mapped in Landsat MSS images resulted in the identification of eleven lineaments (fig. 5; table 3). In the cases where the location of a lineament (fig. 5) coincides with an alteration belt (fig. 4) we have given them the same name.

N14°-19°W-Trending Linear Features

The contoured plots of the linear features belonging to the six significant maxima (table 1) were evaluated individually in order to identify lineaments that might be present. N14°-19°W-trending linear features are scattered throughout the quadrangle, but most of these features are concentrated in three areas located in the northwestern, west-central and north-central to northeastern parts of the quadrangle (fig. 6). Several lines of evidence indicate that the northeast-oriented zone of N14°-19°W-trending linear features located in the northwestern part of the quadrangle may reflect a zone of faults or fractures. Faults with this orientation are prominent in this area (Stewart and others, 1982), although their distribution does not suggest a northeast-trending zone. In addition, a large area of altered rocks near the center of the cluster of hydrothermally altered rocks in this part of the quadrangle is distinctly northwest-elongate (fig. 4). In the total intensity aeromagnetic map (fig. 3), northwest-trending anomalies appear to terminate abruptly in this area along a northeast-oriented line.

N14°-19°W- and N27°-28°W-Trending Linear Features

Pine Nut Creek lineament— The narrow azimuthal range of the N27°-28°W maximum contains only a small number of linear features, including several relatively long linear features in the northwestern part of the quadrangle (fig. 7), some of which reflect mapped faults (Stewart and others, 1982). Plotted together, the N14°-19°W- and N27°-28°W-trending features define the boundaries of the Pine Nut Creek lineament (fig. 8). Note that the lineament and the spatially associated Markleeville alteration belt span the Sierra Nevada-Great Basin boundary (figs. 4, 6, and 9). Within the quadrangle, this boundary, from northwest to southeast, extends from the eastern side of the Carson Range, along the western side of Antelope Valley, west of the Sweetwater Mountains, southward along Virginia Creek, to the west side of Mono Lake (fig. 9).

Whitecliff Peak lineament— This area of alined linear features is located south of the Pine Nut Creek lineament (fig. 8). It lies mostly within the Sierra Nevada but extends eastward of the Sierra Nevada-Great Basin boundary for roughly 12 km. North-northwest-trending faults are especially abundant in the northeastern part of the outlined area, and it is here that the linear features and faults coincide with the Wellington Hills alteration belt (figs. 4 and 8). We refer to this alinement of linear features as the Whitecliff Peak lineament rather than the Wellington Hills lineament in order to stress the fact that the lineament and alteration belt are only partially coincident.

Although the N14°-19°W-trending linear features located in the north-central to northeastern part of the quadrangle (fig. 6) commonly correspond to mapped faults (Stewart and others, 1982) and are coincident with a northwest-trending aeromagnetic anomaly (fig. 3), their linear pattern is due largely to the presence of the Walker River valley on the northeast side of the Wassuk Range and extensive areas of Quaternary deposits on the southwestern side (fig. 9; Stewart and others, 1982).

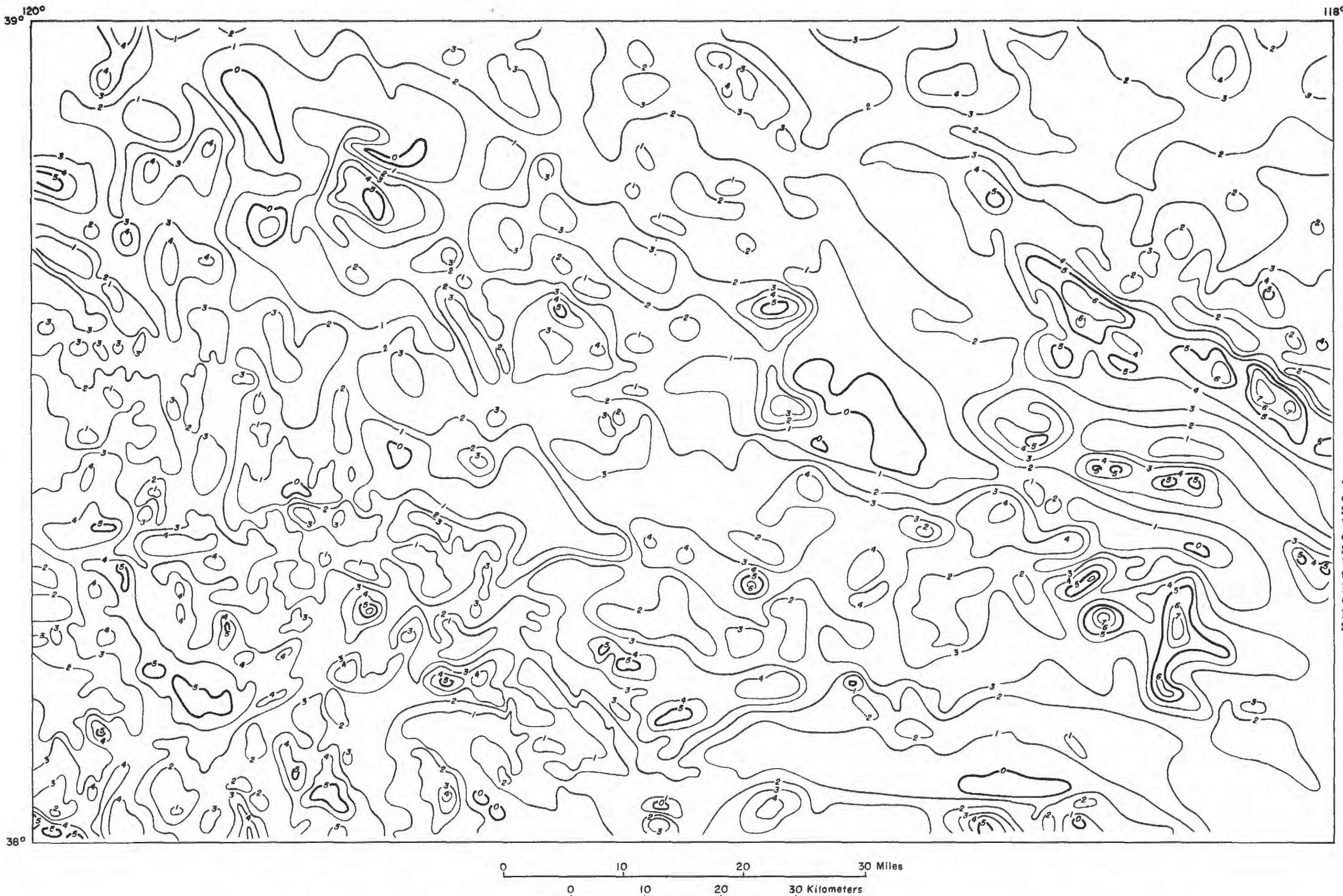
N30°-45°W-Trending Linear Features

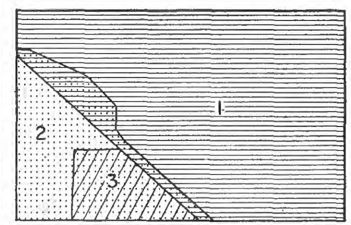
Walker Lane lineament—Linear features trending N14°-19°W and N27°-28°W are notably sparse in the area of the northwest-trending Walker Lane (fig. 8). Linear features that mark the traces of the Walker Lane faults are more westerly oriented and do not constitute a statistically significant maximum (fig. 1; table 1). These features are conspicuous in the map of linear features (accompanying map), however, and the Walker Lane lineament is well defined in the plot of N30°-45°W-trending features (fig. 10).

Wheeler Lake lineament— The plot of N30°-45°W-trending linear features also defines the northwest-trending Wheeler Lake lineament which is located at the western border of the quadrangle (fig. 10). There are no faults of this orientation mapped in this area (Stewart and others, 1982). The Wheeler Lake lineament parallels and lies just to the north of a northwest-elongate high on the total intensity aeromagnetic map (fig. 3). The linear features that lie to the east of this lineament in the plot of N30°-45°W-trending features appear to be associated with the Sierra Nevada front (fig. 10).

N74°-76°W-Trending Linear Features

N74°-76°W-trending linear features are not numerous owing to the narrow azimuthal range, but nearly all these features are concentrated in two general areas (fig. 11). The main area of concentration is located across the central part of the quadrangle extending from the Heenan Lake area in the Sierra Nevada to the eastern front of Buller Mountain (figs. 9 and 11). Faults with this orientation are not common in this broad area, except near the





The index map indicates sources of data used to compile the aeromagnetic map: 1) U.S. Geological Survey, 1971, Aeromagnetic map of parts of the Walker Lake, Reno, Chico and Sacramento 1° by 2° quadrangles, Nevada-California: U.S. Geological Survey Geophysical Investigations Map, GP-751; 2.) U.S. Geological Survey, Aeromagnetic map of parts of the Walker Lake and Mariposa 1° by 2° quadrangles, Nevada-California, unpublished data; 3.) U.S. Geological Survey, 1979, Aeromagnetic map of the Hoover-Walker Lake area, California: U.S. Geological Survey Open-File Report 79-1194.

Figure 3.--Total intensity aeromagnetic map. Magnetic contours show total intensity magnetic field of the earth in gammas relative to an arbitrary datum. Contour interval 100 gammas.

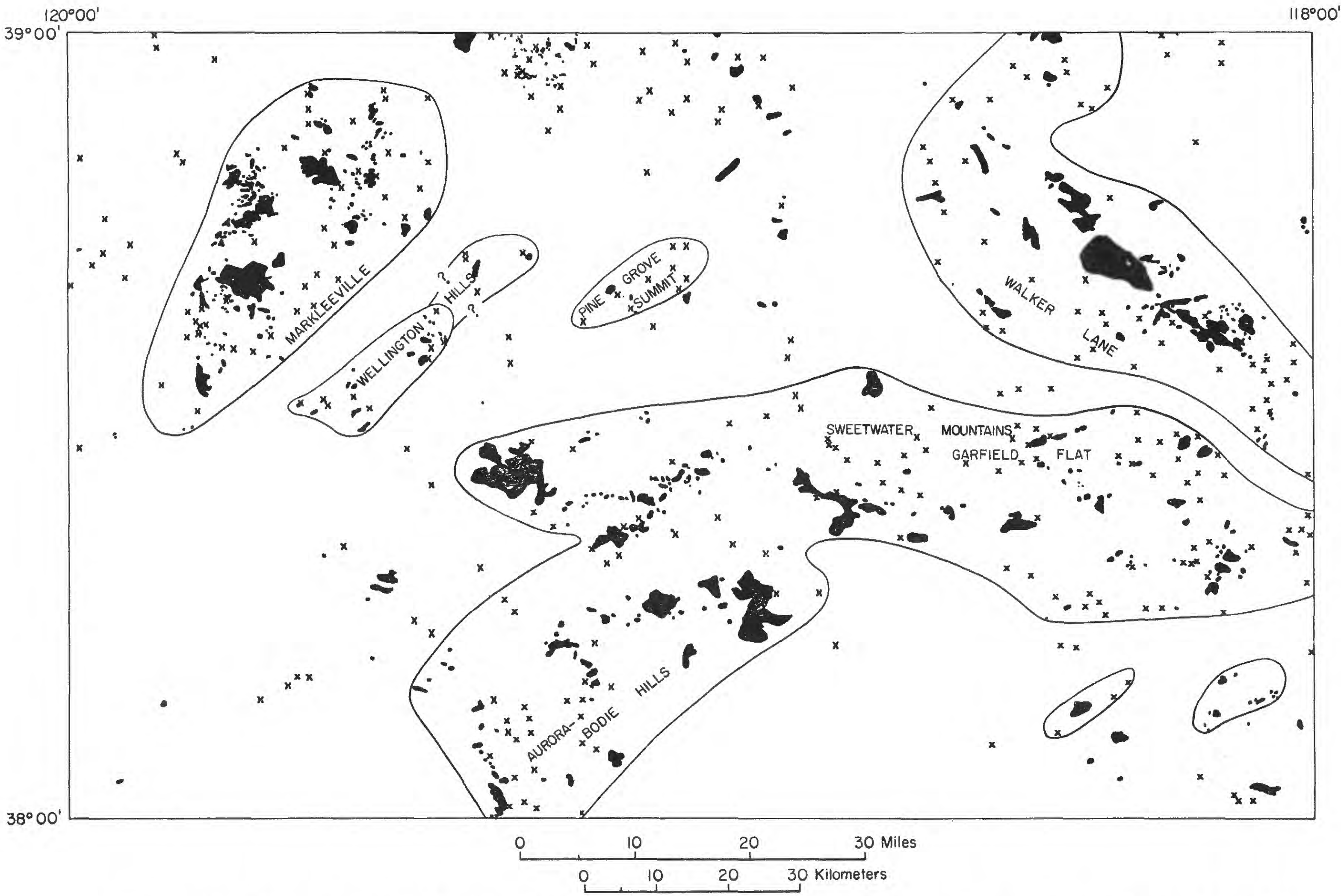


Figure 4.--Distribution of hydrothermally altered rocks, mines, and prospects where altered rocks were not mapped. Mines and prospects are indicated by X's on the map. Heavy lines define approximate boundaries of interpreted alteration belts named on the map.

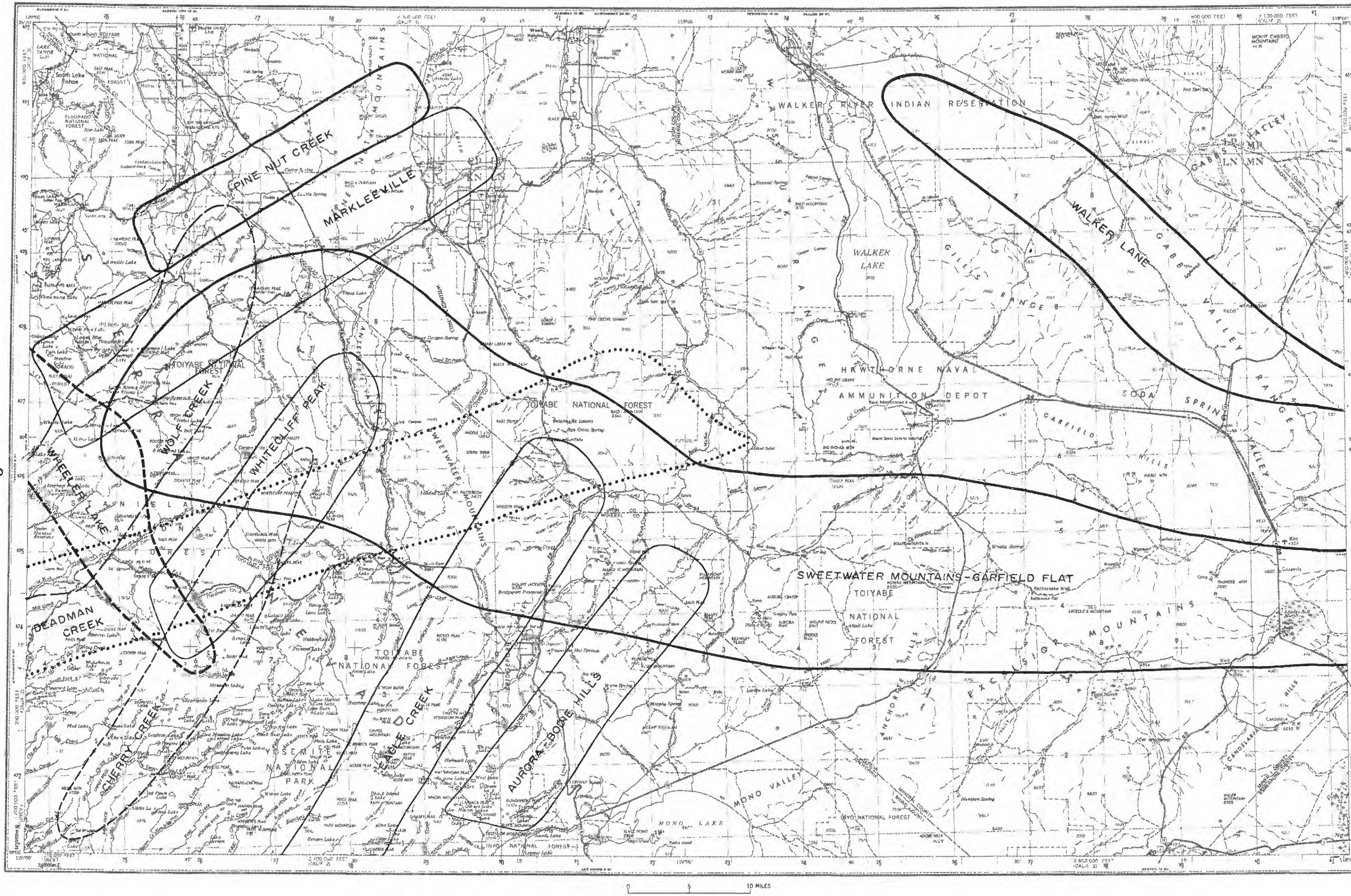


Figure 5.--Distribution of lineaments.

Table 3.-- *Characteristics of lineamants in the Walker Lake 1^{o} x 2^{o} quadrangle*

Lineament	Trend	Defining Azimuth Range	Associated mapped faults	Aeromagnetic expression	Gravity expression	Associated Alteration	Miscellaneous
Walker Lane	NW	N30°-45°W	high density of northwest-trending faults, some of which are coincident with linear features	lies just north of strong northwest-trending high	similar alignment of anomalies	coincident with, though narrower than, Walker Lane alteration belt	
Pine Nut Creek	NE	N14°-19°W, N27°-28°W	some of the linear features are coincidnet with mapped faults	northwest trending anomalies terminate abruptly at lineament	associated with northern part of Markleeville alteration belt	coincident with the northwestern part of the Markleeville alteration belt	transects boundary between Great Basin and Sierra Nevada provinces
Markleeville	NE	N53°-82°E	a few northwest-trending faults	none	none	generally coincident with the Markleeville alteration belt	transects boundary between Great Basin and Sierra Nevada provinces
Wolf Creek	NNE	N8°-12°E, N16°-31°E	north-northeast-trending faults dominate this area and some are coincident with linear features	weak	weak	coincident with Markleeville alteration belt, except in southwestern part of lineament	
Cherry Creek	NNE	N8°-12°E, N16°-31°E	none	similar alignment of anomalies	none	only alteration mapped in this area lies along this lineament	close spatial relationship with Whitecliff Peak lineament
Whitecliff Peak	NNE	N14°-19°W, N27°-28°W	north-northwest-trending faults are abundant in northeastern part of lineament	none	none	northeastern part of lineament is coincident with Wellington Hills alteration belt	transects boundary between Great Basin and Sierra Nevada provinces
Deadman Creek	ENE	N66°-75°E	northwestern end of lineament is dominated by northeast-trending faults	similar alignment of anomalies	none	intersects Sweetwater Mountains-Garfield Flat and Eagle Creek lineaments in viscinity Sweetwater Mountains, one of the largest altered areas	transects boundary between Great Basin and Sierra Nevada provinces
Sweetwater Mountains-Garfield Flat	WNW	N74°-76°W, N81°-88°W	various directions of faulting are present	similar alignments of anomalies	parallels northeastern border of large low	eastern two-thirds is generally coincident with Sweetwater Mountains-Garfield Flat alteration	transects boundary between the Great Basin and Sierra Nevada provinces
Aurora-Bodie Hills	NNE	N39°-50°E	scattered northeast- and northwest-trending faults	none	parallels eastern margin of northeast-trending low	coincident with central portion of Aurora-Bodie Hills alteration belt	
Eagle Creek	NNE	N39°-50°E	scattered northeast- and northwest-trending faults	none	parallels northwest side of northeast-trending low	intersects Sweetwater mountains-Garfield Flat and Deadman Creek lineaments in viscinity of Sweetwater Mountains, one of the largest altered areas	
Wheeler Lake	NW	N30°-45°W	none	parallels northeast side of high	none	several very small patches of alteration associated with this lineament	

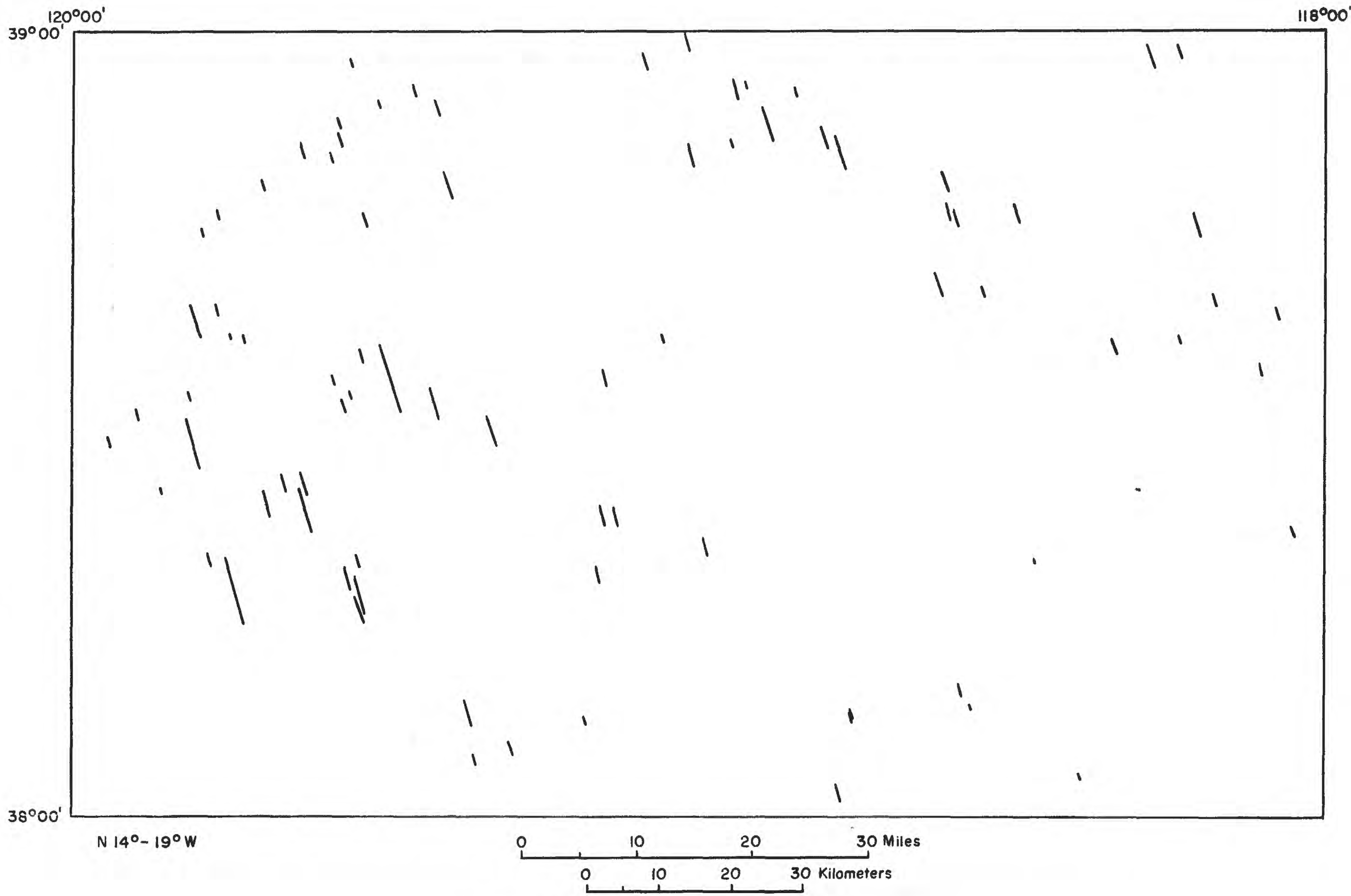


Figure 6.—N14°-19°W-trending linear features.

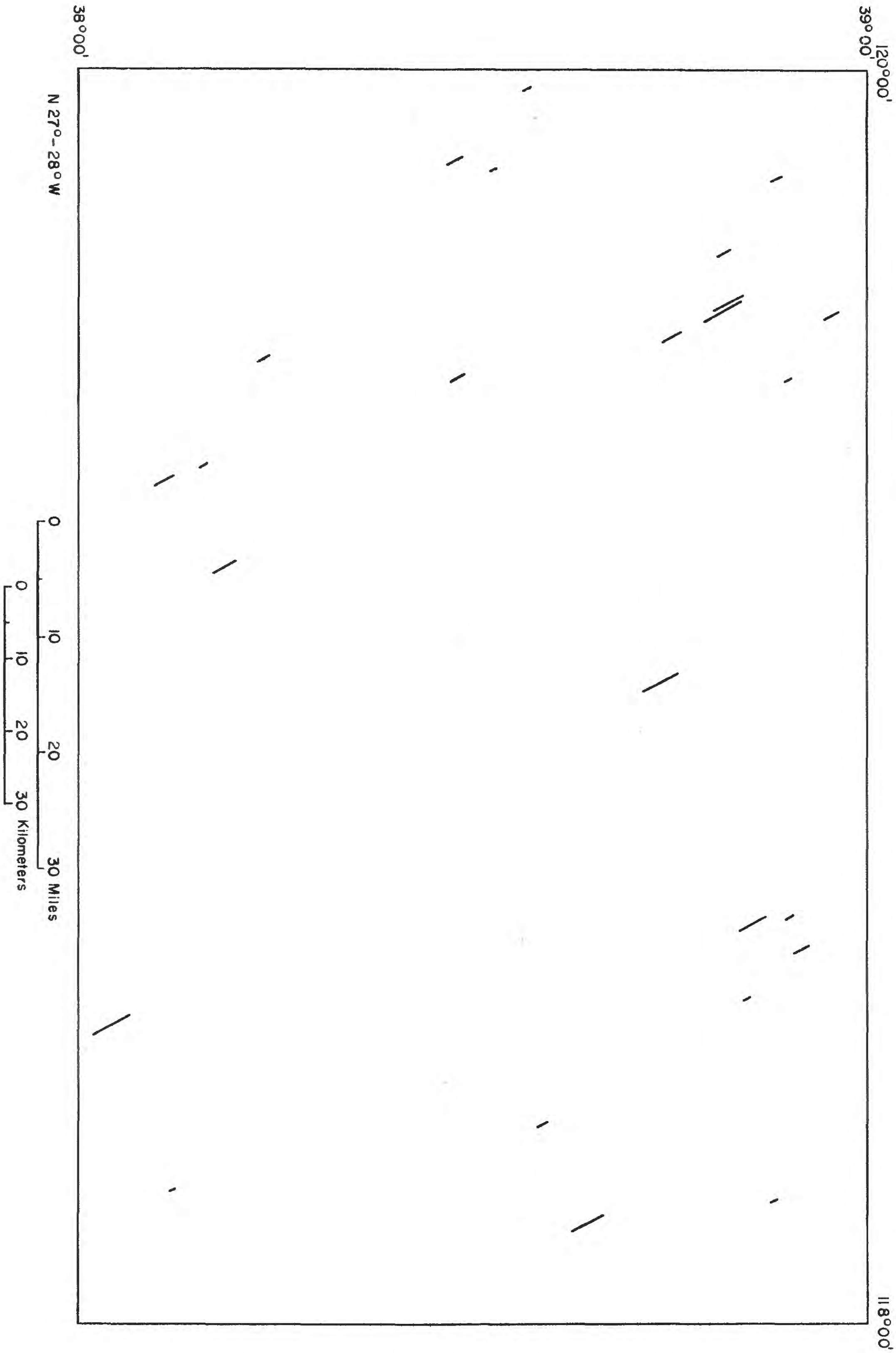


Figure 7.--N27°-28°W-trending linear features.

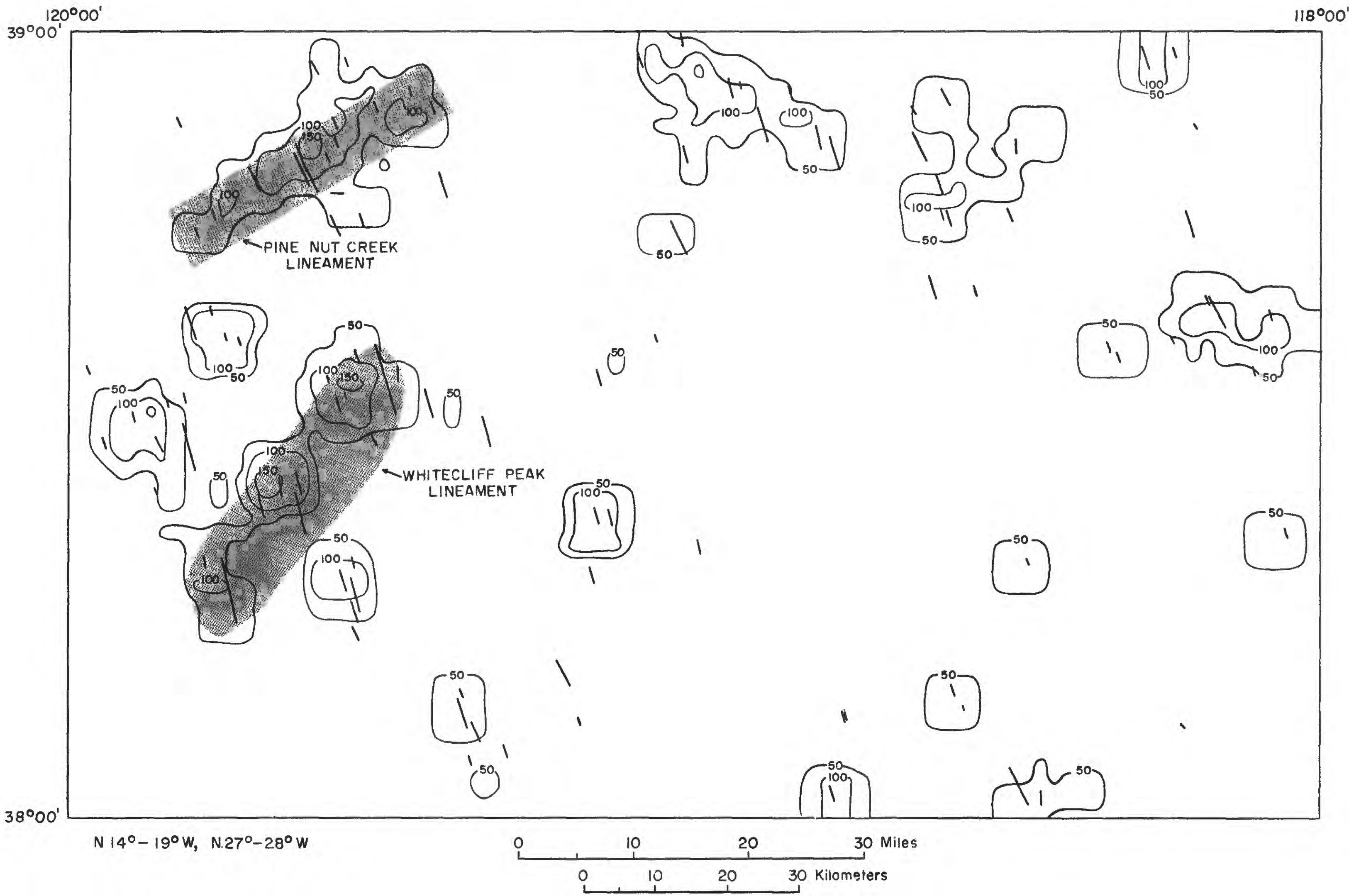


Figure 8.—N14°-19°W- and N27°-28°W-trending linear features.

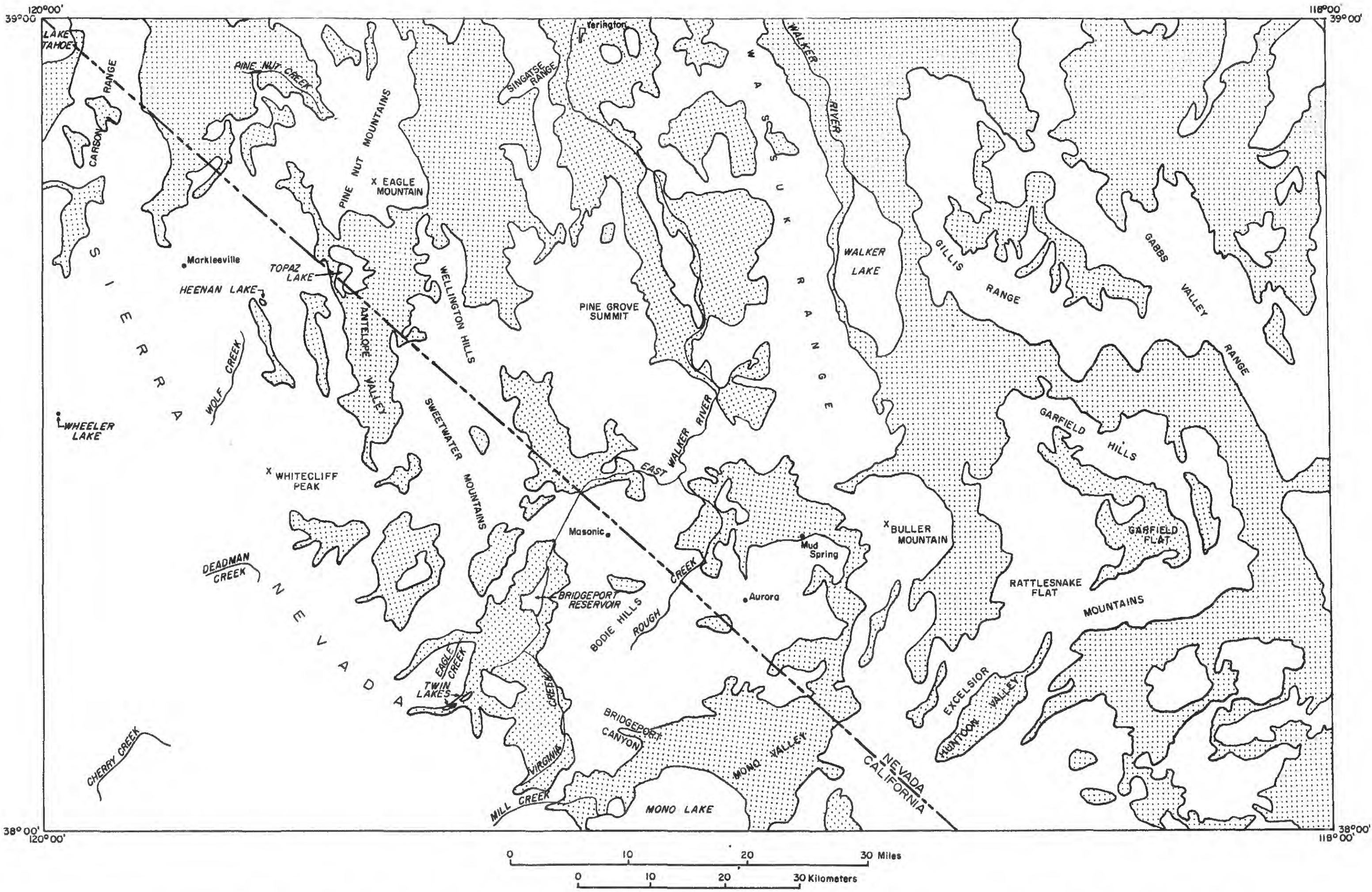


Figure 9.--Generalized distribution of alluvial deposits (stipple pattern). Cultural and topographic features referred to in the text are shown.

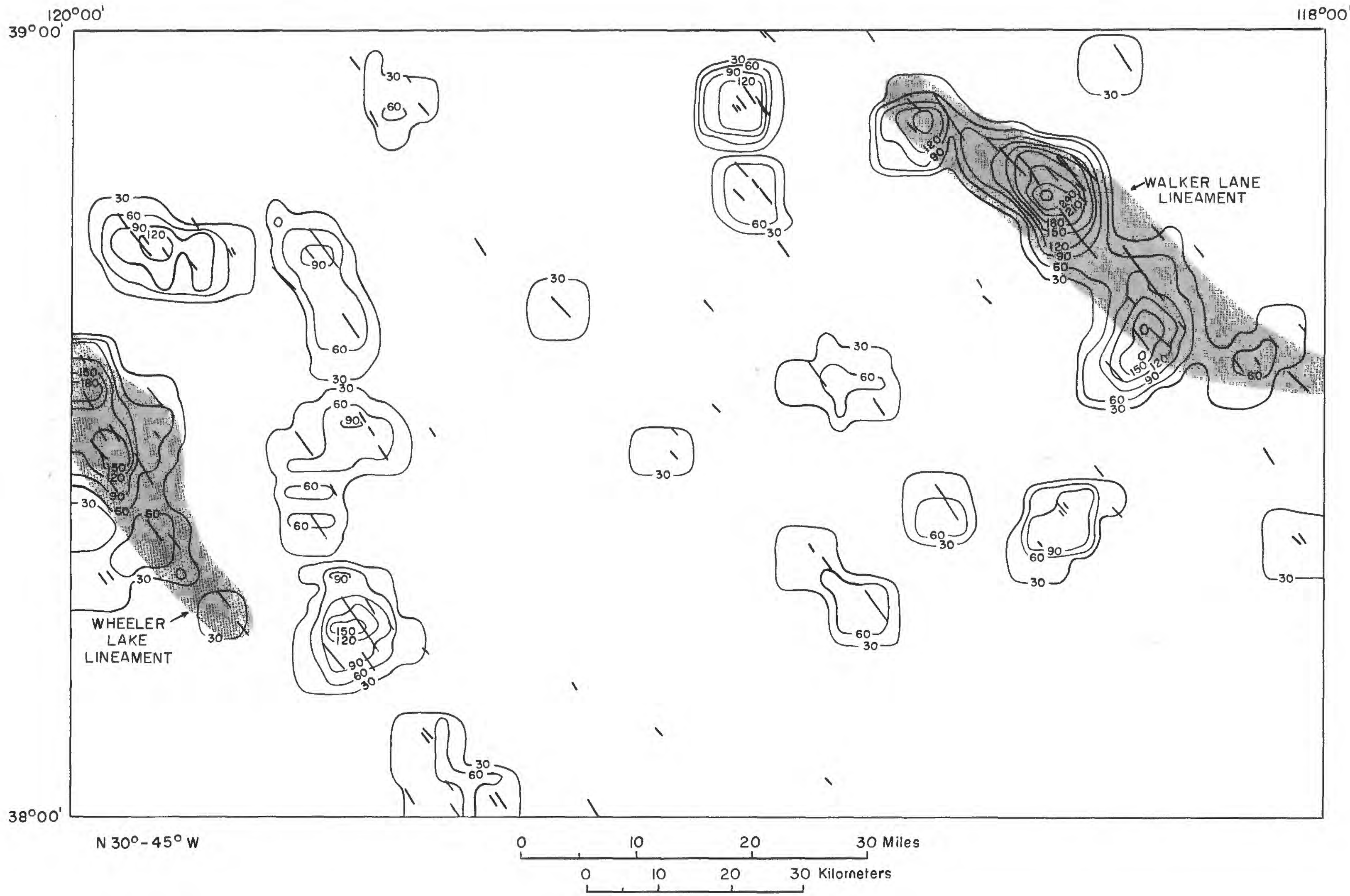


Figure 10.—N30°-45°W-trending linear features.

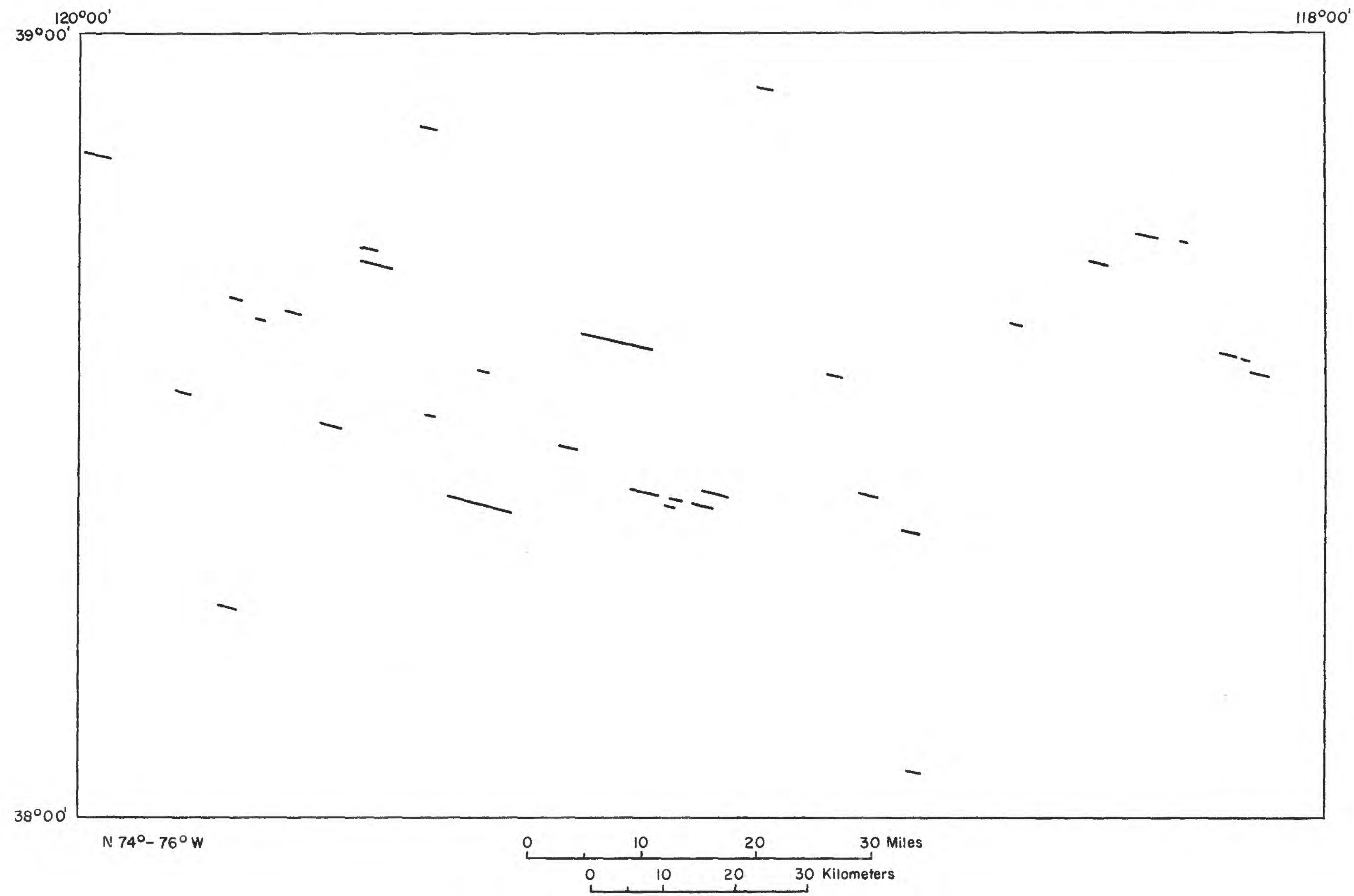


Figure 11.--N74°-76°W-trending linear features.

confluence of the East Walker River and Rough Creek where several linear features are coincident with mapped faults (figs. 9 and 11). Some of these linear features reflect tonal contrasts related to the linear alteration patterns in this part of the quadrangle (figs. 4 and 11).

N74°-76°W- and N81°-88°W-Trending Linear Features

Sweetwater Mountains-Garfield Flat lineament—Some of the altered areas comprising the Sweetwater Mountains-Garfield Flat alteration belt (fig. 4) are oriented slightly more westerly than N74°-76°W (fig. 11). Consequently, we plotted the linear features in the N81°-88°W range (fig. 12), even though the frequencies of occurrence in these class intervals lie within the non-significant and minimum fields (fig. 1). The areal distribution of the N81°-88°W-trending features is more scattered than that of the N74°-76°W-trending features, although there is a concentration of the former features in a zone across the central part of the quadrangle (fig. 12).

The contour pattern of the areal density of these two trends defines a slightly curvilinear lineament, the central and eastern part of which is generally coincident with the Sweetwater Mountains-Garfield Flat alteration belt (figs. 4 and 13). The central part of this lineament is disrupted by northeast-trending linear features (fig. 14). In addition, the eastern part of this lineament is disrupted by trends of the Walker Lane and the Pancake Range lineament. The Pancake Range lineament (Rowan and Wetlaufer, 1973; 1975; 1979; 1981; Ekren and others, 1976) is an east-trending feature defined by the termination and disruption of several mountain ranges. It extends from the Pancake Range, 160 km east of the Walker Lake quadrangle, to Mono Valley. An alinement of anomalies is evident in the total intensity aeromagnetic map (fig. 3) with an orientation similar to that of the Sweetwater Mountains-Garfield Flat lineament. This alinement of anomalies, like the alteration belt, extends to the eastern border of the quadrangle. In addition, this lineament parallels the northeastern boundary of a large Bouguer gravity low (Plouff, 1983). There is no indication of alined alteration along the Sweetwater Mountains-Garfield Flat lineament in the Sierra Nevada west of the Sweetwater Mountains (figs. 4 and 13).

N8°-12°E- and N16°-31°E-Trending Linear Features

Wolf Creek lineament—The distribution of N8°-12°E-trending linear features is relatively uniform across the western half of the quadrangle (fig. 15). Linear features oriented N16°-31°E are also more abundant in the western part of the quadrangle, particularly in the Sierra Nevada (fig. 16). Two lineaments are suggested by alinements of these features. The lineament located in the west-central part of the quadrangle is referred to as the Wolf Creek lineament. In the northern part of this lineament, north-northeast-trending faults are dominant and some of these are coincident with the linear features, but further south few faults of any orientation have been mapped (Stewart and others, 1982). Except for the southwestern part, the Wolf Creek lineament is situated along the central portion of the Markleeville alteration belt (figs. 4 and 16). However, north-northeast trends are only weakly expressed in this area in the total intensity aeromagnetic and Bouguer gravity maps (fig. 3; Plouff, 1983).

Cherry Creek lineament—The other lineament, named the Cherry Creek lineament, is located in the southwesten part of the quadrangle (fig. 16). No faults are mapped in this area (Stewart and others, 1982), but the southern part of this lineament is coincident with a north-northeast-oriented aeromagnetic anomaly (figs. 3 and 16). In addition, the only altered areas mapped in this part of the quadrangle lie along the lineament (fig. 4). Note the close spatial relationship between the Cherry Creek and Whitecliff Peak lineaments (figs. 8 and 16). The Wolf Creek lineament also has the same general northeast-trend as these two lineaments.

The concentrations of linear features located southeast of the Cherry Creek lineament are also noteworthy, even though these clusters do not have the length-to-width ratio characteristic of a lineament (fig. 16). They correlate with prominent canyons and ridges that appear to have been carved by glaciation along fractures.

N39°-89°E-Trending Linear Features

The plot of linear features belonging to the significant maximum spanning the N39°-89°E azimuthal range is complex because it contains a large number of features (fig. 14). Although several lineaments are suggested, some of these are due to the presence of numerous linear features in linear mountain ranges and a relatively small number of linear features in adjacent basins; the Wassuk Range near the north-central part of the quadrangle is the best example (figs. 9 and 14). In other cases, such as the Pine Nut Mountains and the Singatse Range, linear features with this trend are particularly numerous along the eastern range fronts (figs. 9 and 14). N39°-89°E-trending features are also common in the Sierra Nevada, especially along the western border of the quadrangle where the glaciated terrain is well exposed. In several areas in the eastern part of the quadrangle, high areal densities of linear features are clearly related to faults, including the area north of Rattlesnake Flat, in the southeastern part of the Gillis Range, and particularly in the southeastern part of the quadrangle (figs. 9 and 14; Stewart and others, 1982).

One of the most interesting areas in the map of N39°-89°E-trending features is in the south-central part of the quadrangle where the areal density is relatively high and at least two lineaments are suggested (fig. 14). However, definition of these, and perhaps other lineaments is difficult in this part of the plot. Consequently, we subdivided the N39°-89°E maximum into the azimuthal ranges listed in table 2. Each of these ranges is separated from the adjacent range by two class intervals that lie in the non-significant field (fig. 1).

N39°-50°E-Trending Linear Features

The plot of N39°-50°E-trending linear features (fig. 17) displays a high areal density of features in the south-central part of the quadrangle, and several concentrations are present within this broad area. The very high density in the southeastern part is clearly related to the numerous youthful faults present south of Huntoon Valley (figs. 9 and 17; Stewart and others,

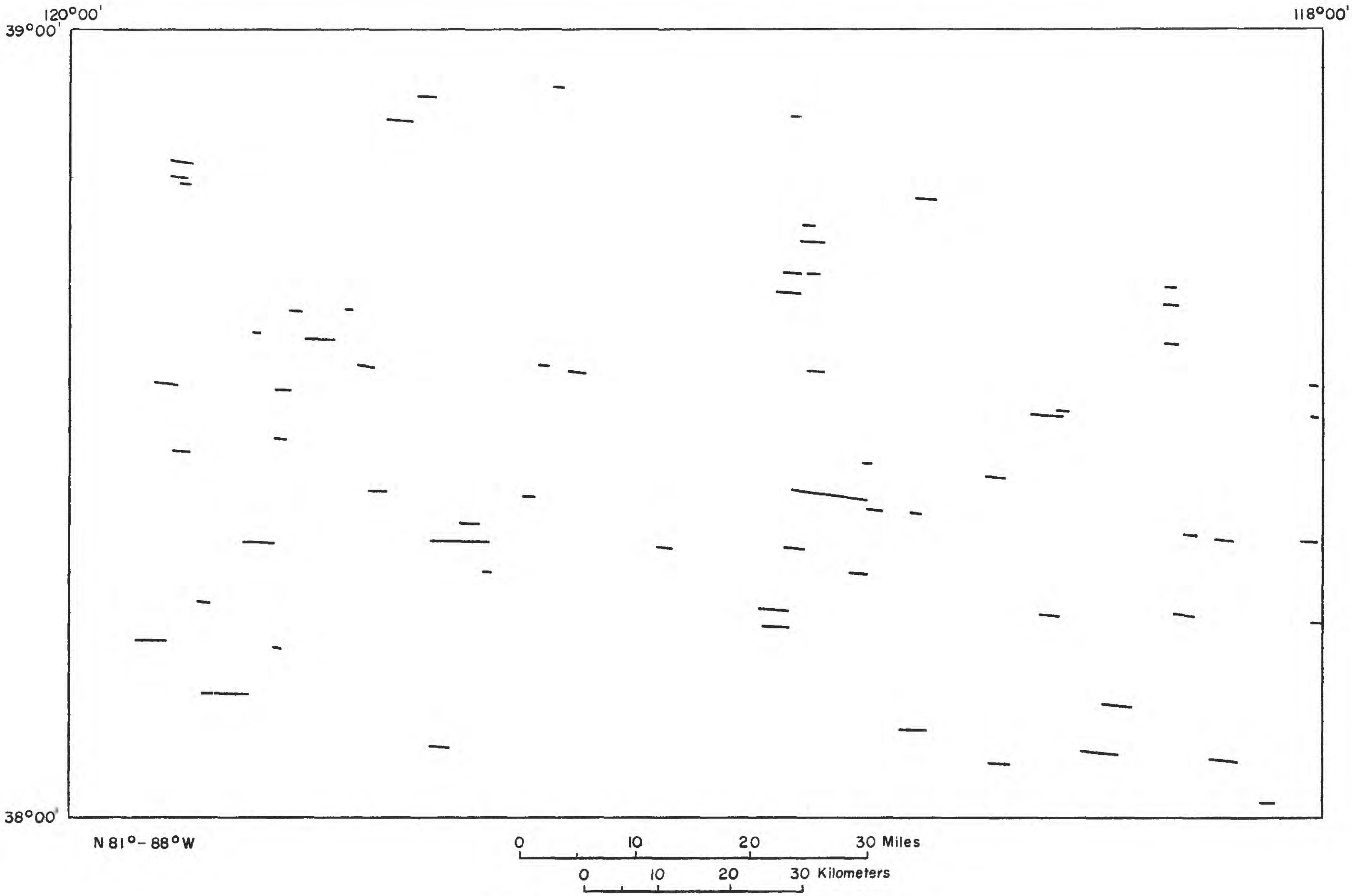


Figure 12.—N81°-88°W-trending linear features.

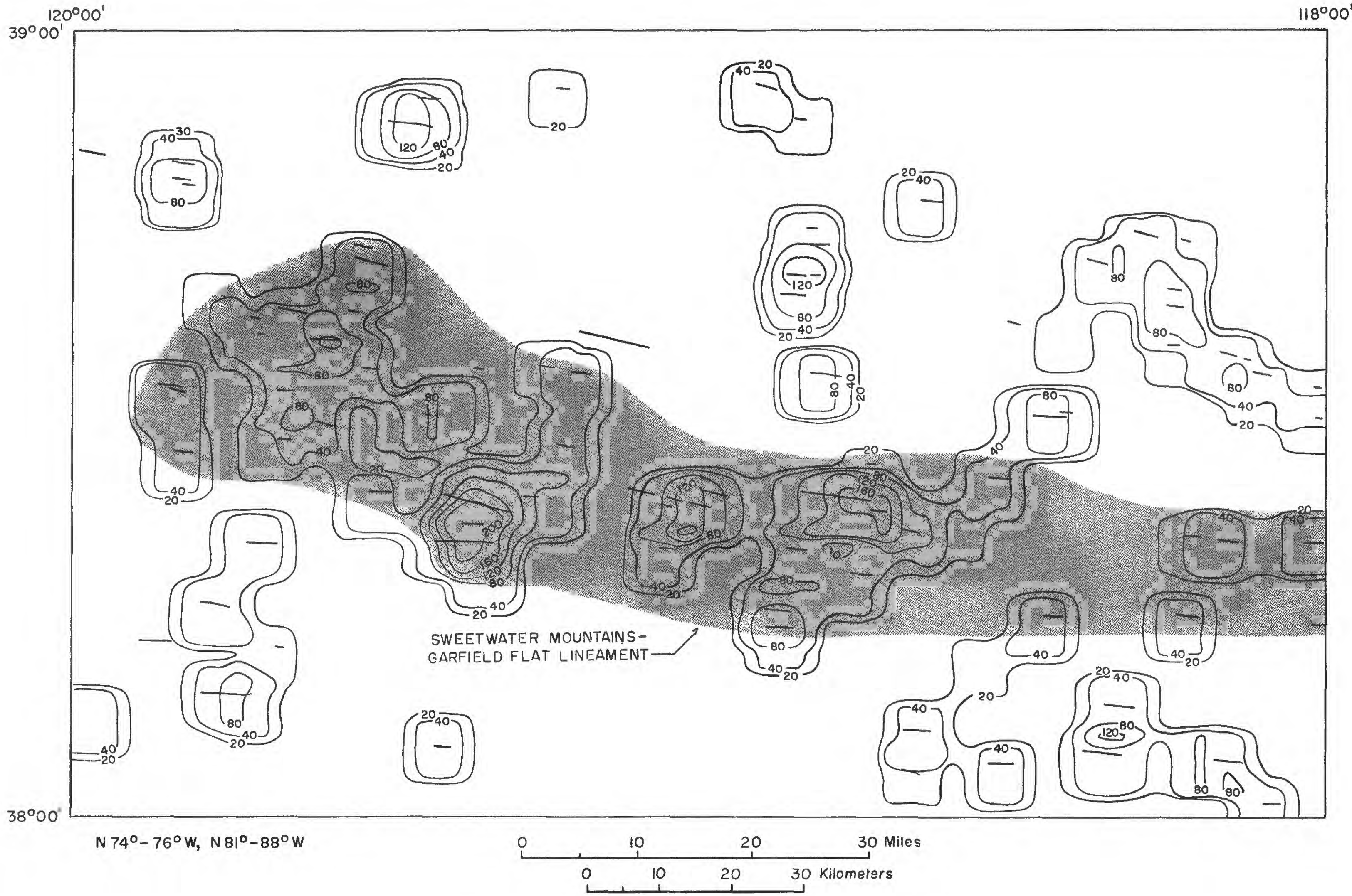


Figure 13.—N74°-76°W- and N81°-88°W-trending linear features.

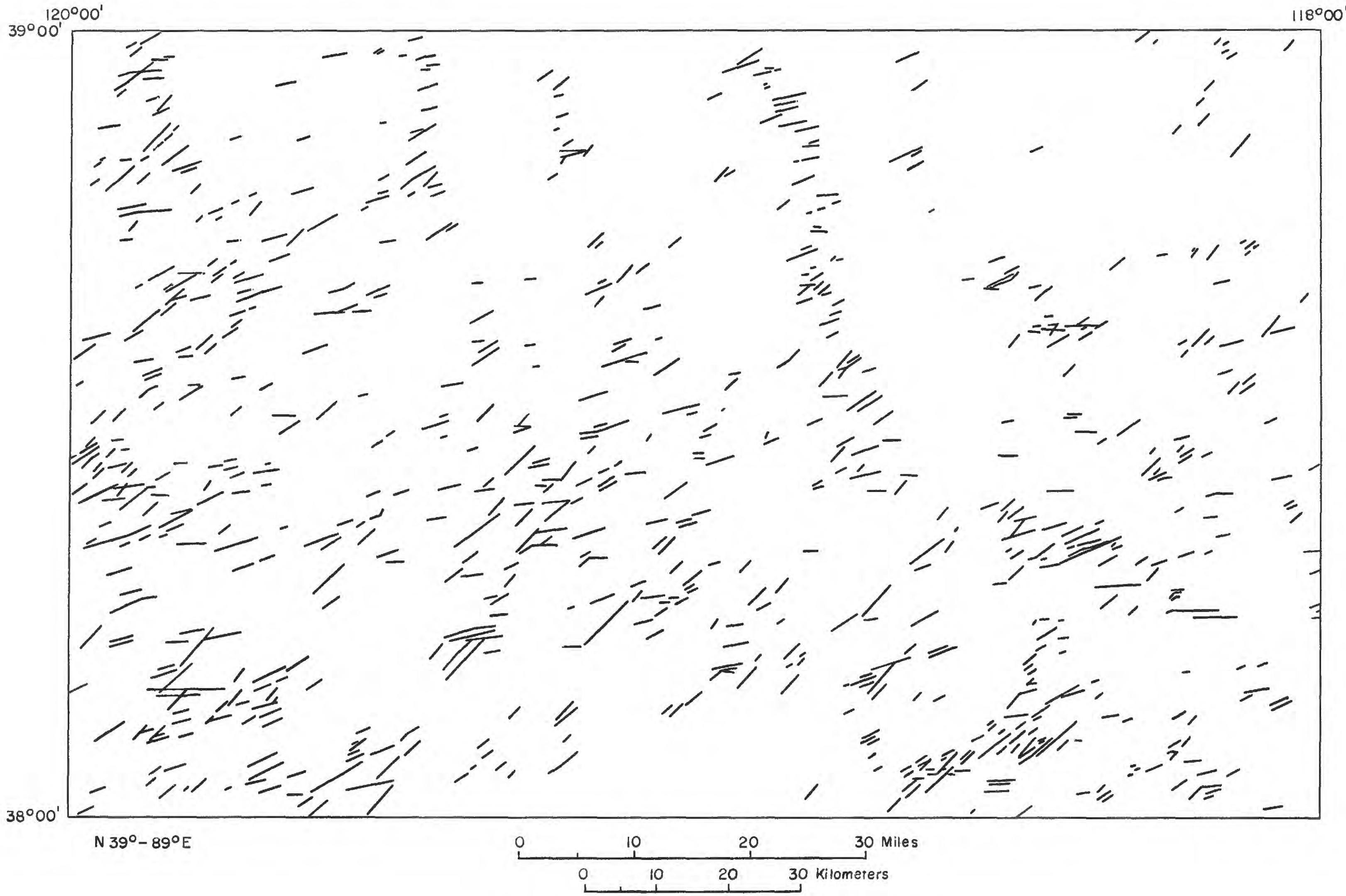


Figure 14.—N39°-89°E-trending linear features.

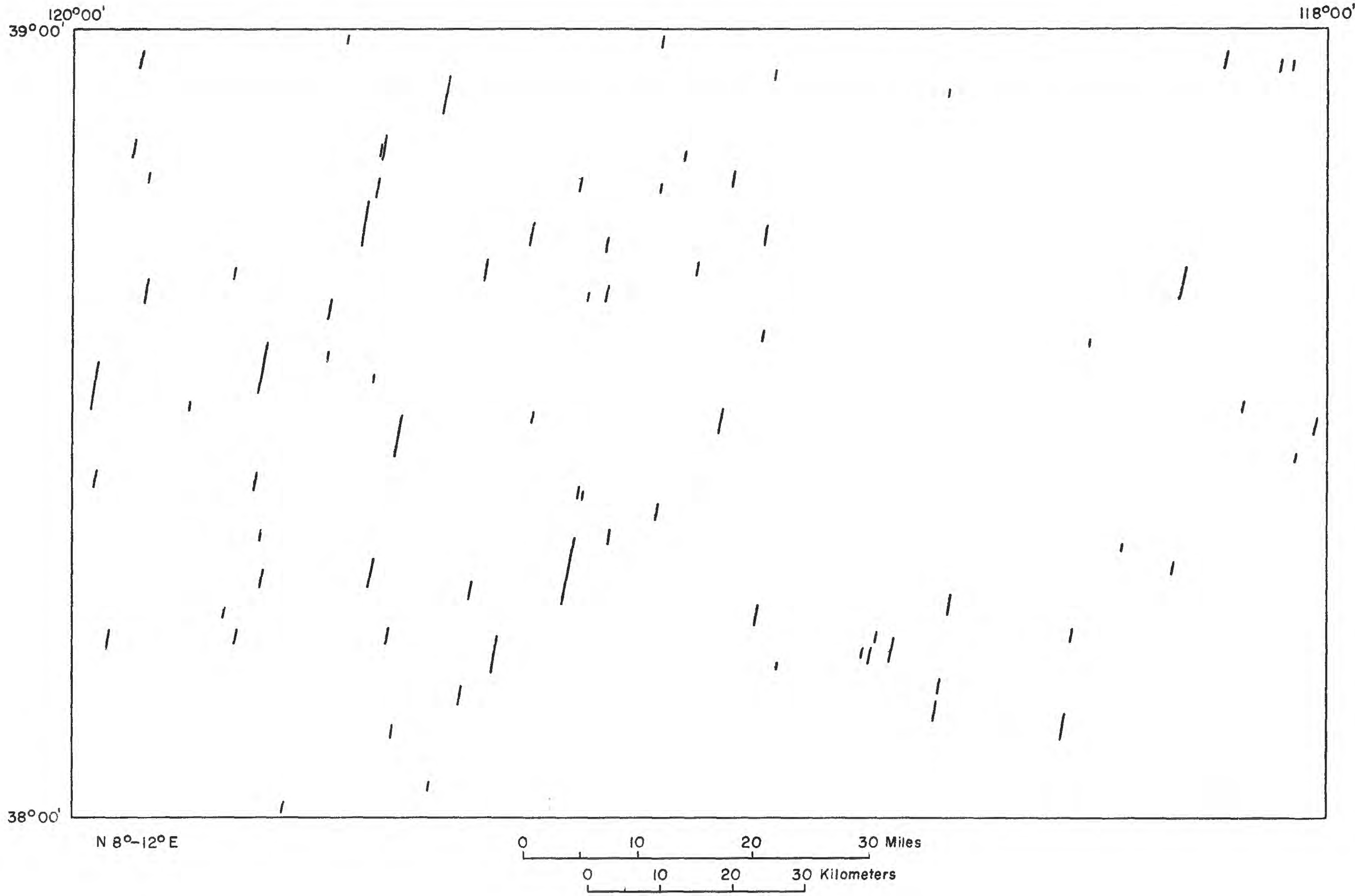


Figure 15.--N8°-12°E-trending linear features.

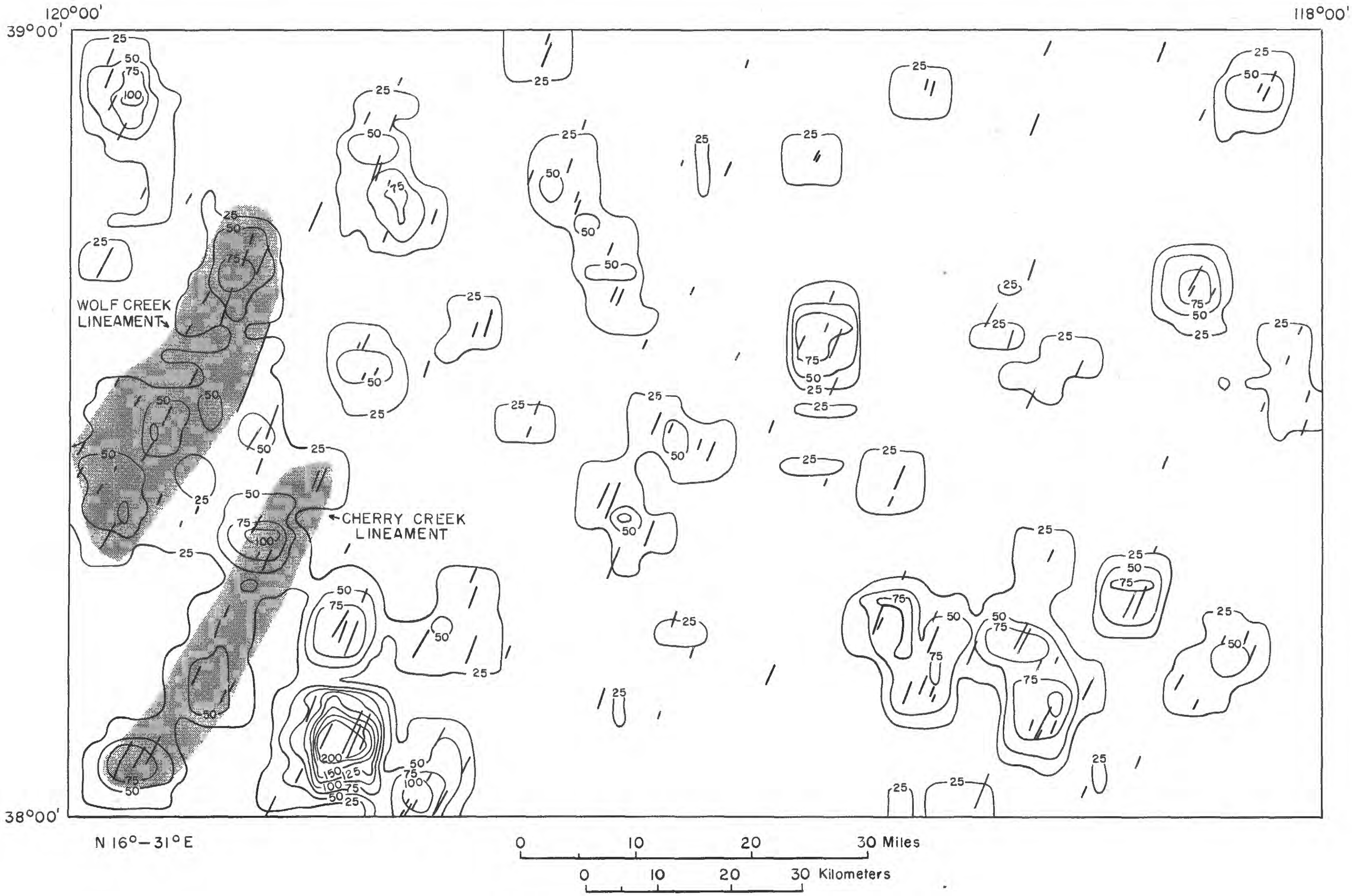


Figure 16.—N16°-31°E-trending linear features.

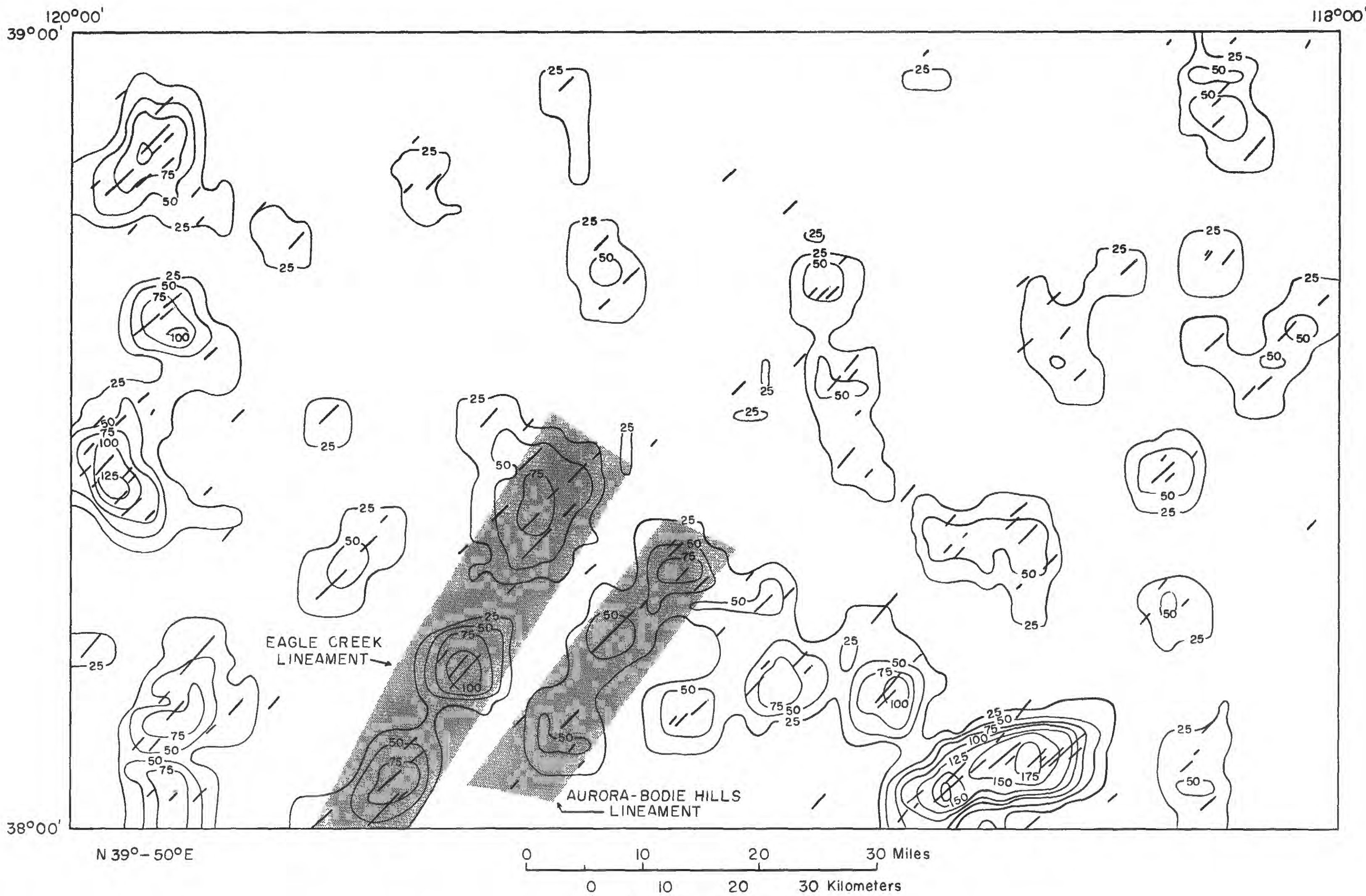


Figure 17.--N39°-50°E-trending linear features.

1982). Features making up the east-trending concentration northwest of this area also commonly represent fault traces, but the orientation of the concentration is probably largely due to the lack of linear features in the Quaternary deposits of Mono Valley (figs. 7 and 17).

The other two concentrations to the west are particularly important, because few faults have been mapped in the southern parts of these two concentrations (fig. 17) although the correlation between mapped faults (Stewart and others, 1982) and these linear features is very high in the northern parts. Because of the extent and northeast-orientation of the Aurora-Bodie Hills alteration belt (fig. 4), we suggest that northeast-trending zones of faults and fractures may extend well south of the mapped faults. The importance of northeast trends in this part of the quadrangle is emphasized by the presence of a marked rectangular low-gravity anomaly (Plouff, 1983) that is bounded on the northwest and southeast by these two concentrations of linear features.

Eagle Creek lineament—The linear features located along the northwestern side of the low gravity anomaly constitute the Eagle Creek lineament (fig. 17). This lineament intersects the Sweetwater Mountains-Garfield Flat lineament in the vicinity of the Sweetwater Mountains, one of the largest, and potentially important altered areas (figs. 4 and 5) (Rowan and Purdy, 1983).

Aurora-Bodie Hills lineament—The other concentration of features makes up the Aurora-Bodie Hills lineament (fig. 17). This lineament coincides with the central portion of the Aurora-Bodie Hills alteration belt (fig. 4). The importance of the northwest-trending faults and linear features in this area must be stressed, particularly along Bridgeport Canyon and Virginia Creek (figs. 9 and 17). In addition, altered areas appear to be alined along northwest trends between Mill Creek and Twin Lakes along the Sierra Nevada front. Northwest-, as well as northeast-trending linear features are concentrated in this area (accompanying map), although only few northwest-oriented faults have been mapped here (Stewart and others, 1982).

N53°-82°E-Trending Linear Features

Markleeville lineament—Linear features composing the N53°-82°E maximum were plotted in figure 18. In addition to alinements of these features that are related to ranges such as the Wassuk Range, two lineaments are suggested. The pattern in the northwestern part of the quadrangle is complicated by the high density of linear features along the eastern fronts of the Carson Range and Pine Nut Mountains (figs. 9 and 18), but the alinement that passes through Markleeville and Eagle Mountain in the Pine Nut Mountains (figs. 9 and 18) is not related to the probable topographic slope-sun angle orientation effect. This alinement, which we refer to as the Markleeville lineament, is readily apparent in the map of linear features (accompanying map) because of its continuity as it transects the Sierra Nevada and Great Basin terrains. Note that this and the Wolf Creek lineaments intersect near Markleeville, whereas the Pine Nut Creek lineament is situated immediately north of the Markleeville lineament (figs. 5 and 9).

Deadman Creek lineament—South of the Markleeville lineament, N53°-82°E-trending linear features are alined in a zone that extends eastward from the Sierra Nevada to the Sweetwater Mountains (fig. 18). This, the Deadman Creek lineament, is coincident along its entire length with an alinement of anomalies in the total intensity aeromagnetic map (fig. 3). Definition of the Deadman Creek lineament is improved in the plot of N66°-75°E-trending features (fig. 19).

N85°-89°E-Trending Linear Features

The other subdivision of the N39°-89°E significant maximum (table 2), N85°-89°E, is made up of linear features that are uniformly distributed in the quadrangle so that no lineaments of this trend are indicated (fig. 20).

SUMMARY

The analysis of linear features mapped in Landsat MSS images resulted in the identification of eleven lineaments (fig. 5; table 3) with the following trends: five north-northeast, two northeast, one east-northeast, one west-northwest, and two northwest.

Many of the linear features mapped in the Landsat MSS images correspond to mapped faults. There are some instances where the mapped faults might be extended on the basis of the linear features map. The correspondence between linear features and mapped faults is better in the Great Basin portion of the quadrangle than in the Sierra Nevada portion because of the paucity of mapped faults in the Sierra Nevada portion. The spatial density of linear features in the Great Basin is similar to that in the Sierra Nevada. The northeast trends of the linear features associated with the lineaments that span the Great Basin-Sierra Nevada boundary coincide with the trends of fractures and microfaults described by Lockwood and Moore (1979) in the Sierra Nevada. Displacement along these features may have been greater in the Great Basin than in the Sierra Nevada owing to the greater extension of the Great Basin. This would account for the fact that the spatial densities of linear features in the lineaments that span the Great Basin-Sierra Nevada boundary are similar in both provinces while the density of mapped faults is greater in the Great Basin portion.

There is a strong correlation between the locations of the lineaments (fig. 5) and the alteration belts mapped by Rowan and Purdy (1983) (fig. 4). The spatial relationships between the alteration belts and the lineaments suggest that the activity of hydrothermal fluids was localized along faults and fractures that are represented by the lineaments.

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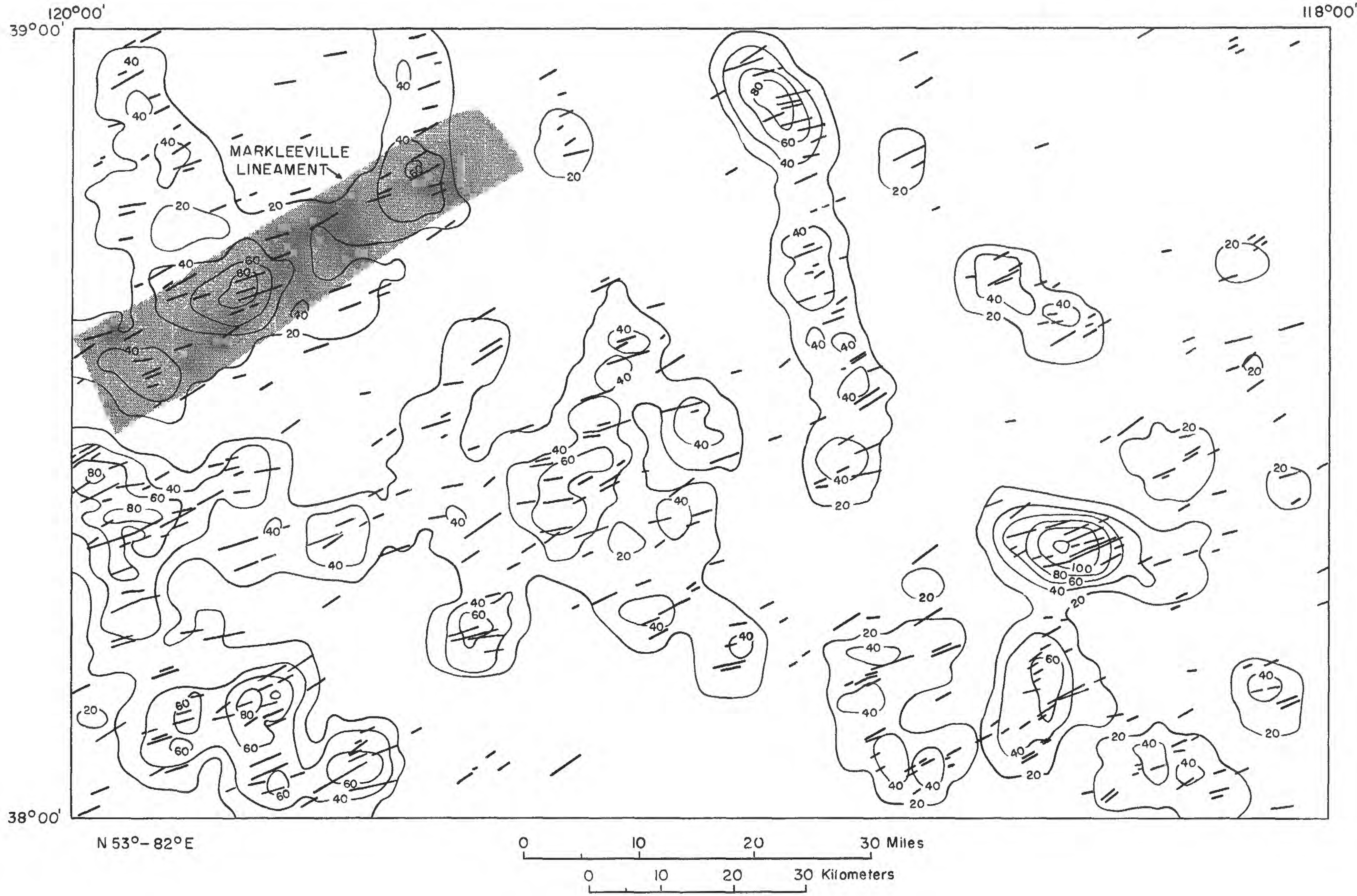

Figure 18.—N53°-82°E-trending linear features.

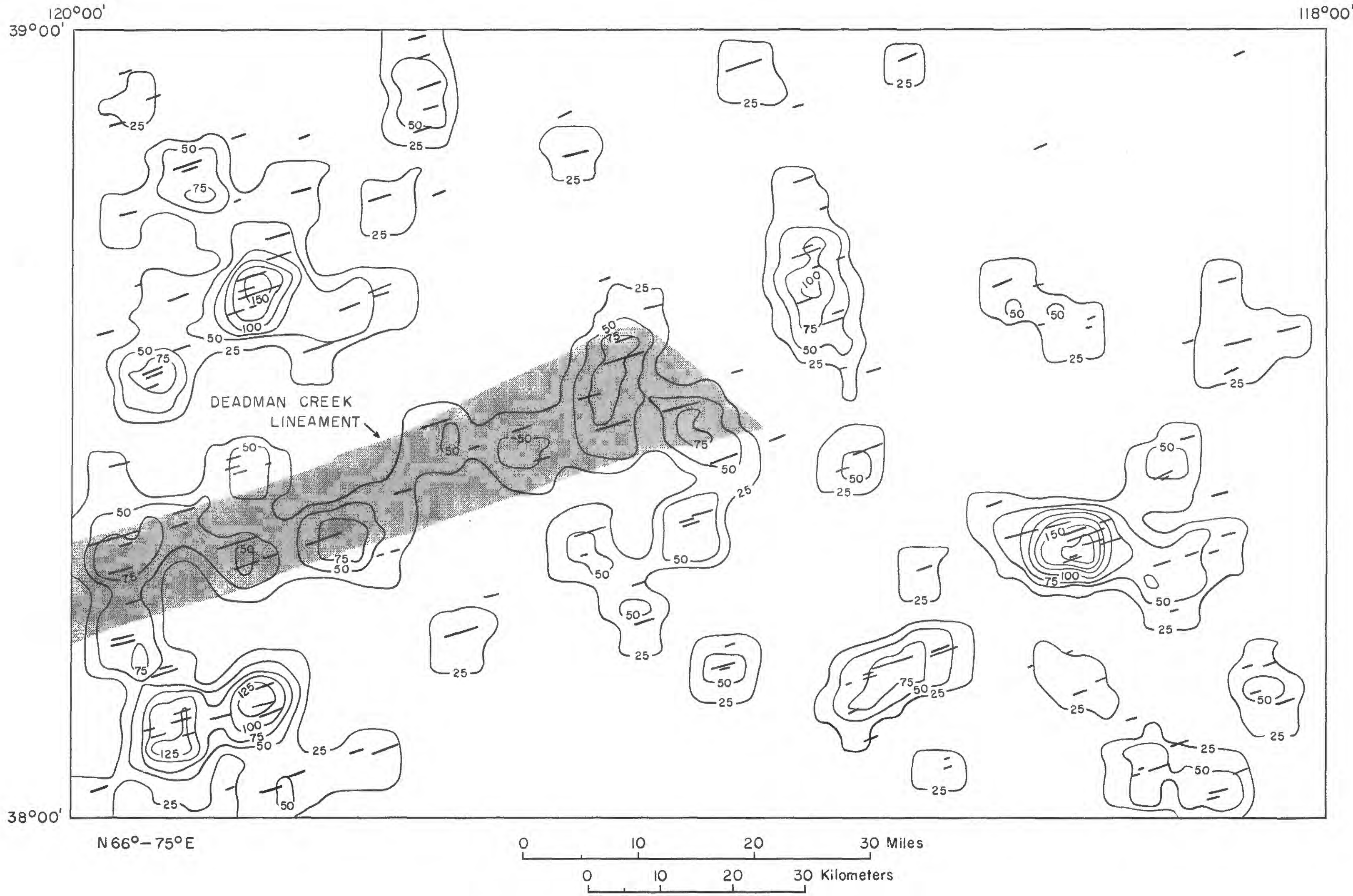

Figure 19.--N66°-75°E-trending linear features.

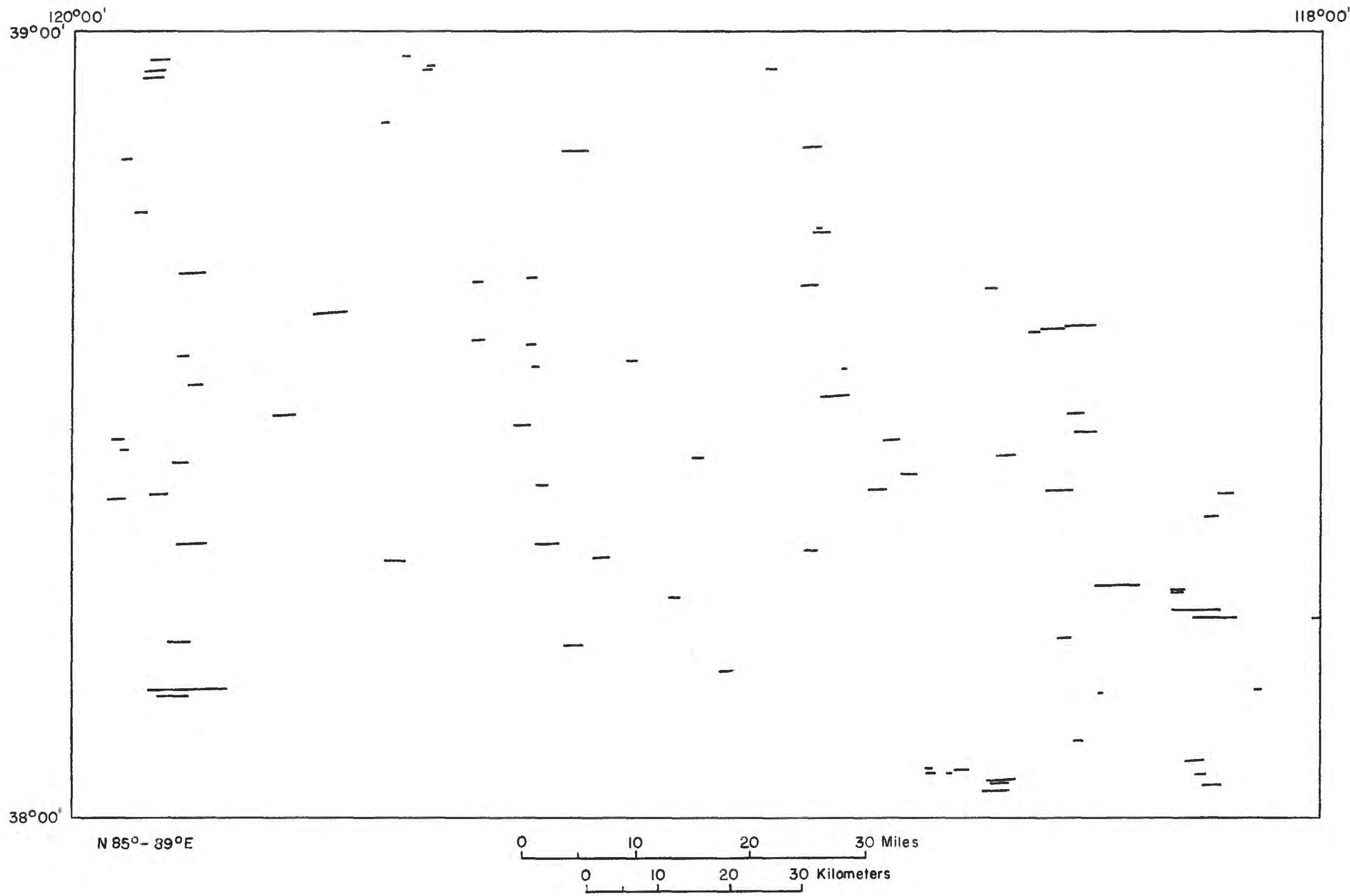

Figure 20.—N85°-89°E-trending linear features.

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