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South-central United States Well-Bore Breakout-Data Catalog

By

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SOUTH-CENTRAL UNITED STATES WELL-BORE BREAKOUT DATA CATALOG

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INTRODUCTION

This catalog contains well-bore breakout data from a large number of selected wells located within Oklahoma and Arkansas and parts of Texas, Colorado, and Kansas. Because the data are from wells located over a broad area extending from the Texas Panhandle to the Mississippi River, the study area is subdivided into nine subareas that correspond approximately to different structural provinces (fig. 1).

A well-bore or borehole elongation is a symmetrical enlargement of the cross sectional geometry of the borehole primarily in one direction, extending vertically along the well bore for some distance. Vertical deviation of the borehole can cause well-bore elongations to be generated mechanically during drilling (Plumb and Hickman, 1985), and well-bore elongations can be induced by in-situ stress concentrations about the borehole (Bell and Gough, 1979, 1982; Zoback and others, 1985). Stress-induced well-bore elongations are referred to as "breakouts" (Bell and Gough, 1979; Gough and Bell, 1981). The preferentially oriented washout (POW), another kind of well-bore elongation, is thought to be a stress-related elliptical enlargement of the well bore whose extent of development is influenced by the action of circulating drilling fluids. POWs can also be indicators of stress orientations; however, they do have less well defined preferred orientatons than breakouts (Dart and Zoback, 1987). There is some indication from the data that a fourth type of oriented borehole enlargement might be drilling-induced hydrofractures. Drilling-induced hydrofractures may develope when hydrostatic pressures exceed horizontal compressive stresses about the well-bore. Discussions of breakouts as stress indicators can be found in Fordjor and others (1983), Plumb (1982), Mastin (1984), Teufel (1985), Haimson and Herrick (1985), Kaiser and others (1985), and Zoback and others (1986). The technique for locating and measuring breakouts on dipmeter and fracture identification well logs, as well as the statistical treatment of breakout data, is given in Dart (1985).

DATA PRESENTATION

Tables 1 and 2 list criteria for evaluating well-log and breakout data quality. Table 1 is a rather subjective ranking of well-log quality that takes into consideration log readability, degree of hole deviation from vertical, borehole smoothness, rate of tool rotation, and the quality of breakout development. Table 2 is an objective statistical rating of breakout data by well, based on the minimum number of breakouts read and the mean angular deviation of their orientations (Zoback and Zoback, 1987). The results of the application of these two quality ratings to the data are listed by well in tables 3-11.

Breakout data are treated statistically as circular normal distributions of two dimensional vectors, where breakout orientation is vector direction, and vector length can be either the number of individual breakouts with a given

TABLE 1.--Well-log quality

Rating	Conditions
Very good	Strong rotation; clean, distinct traces, well bore is smooth. Breakouts are distinct and terminate abruptly; they can be clearly distinguished from other types of well-bore elongation. Vertical deviation of the borehole is not a problem and very little scatter appears among breakout orientations.
Good	Good rotation; traces are clean and distinct; and the well bore is relatively smooth with some pitting. Most breakouts are distinct and terminate abruptly; zones of washout may occur in the vicinity of breakouts; although breakout orientations are fairly consistent, some of the data used may be pows, and some of the observed well-bore elongations may be deviation induced.
Fair	Trace quality is diminished. Very few, if any, distinct breakouts are seen, and most usable elongations are pows. Deviation-induced elongations and zones of washout may be common; the well bore can be pitted and irregular. Overall, usable data is limited but reliable. Some scatter or variation may exist among breakout orientations.
Poor	Very little usable data; usable elongations are pows. Deviation-induced elongations and zones of washout may be common. Useable data is of questionable reliability, and orientations may be random or strongly bimodal.

TABLE 2.--Well-bore breakout statistical quality data

Rating	Angular deviation (degrees)	Number of breakouts
A	$\leq$12	$\geq$6
B	>12-<22	$\geq$4
C	$\geq$22-$\leq$26	<4
D	>26-$\leq$30	Any number
No Good	>30	Do.

orientation or the total vertical feet of breakout at a given orientation. Statistical calculations of mean direction ($\overline{\theta}$), standard error of the mean (SE), and mean angular deviation (σ) for each well data set and subarea data composite are also given in tables 3-11. The appendix contains a discussion of the calculation of these statistics.

Mean angular deviation is a measure of the dispersion of observed breakout orientations about the mean direction. Mean angular deviation differs from standard deviation in that it is a calculation of dispersion of a circular distribution, not a linear distribution of data, although their results will be similar (Batchelet, 1965). With breakout data, where orientations are grouped in either 1° intervals for individual wells or 10° intervals for subarea composites, the mean angular deviation as calculated is the deviation of observations about a mean direction. Because the mean direction for a distribution of breakout data is calculated from a number of independent orientations each with its own mean angular deviation, standard error of the mean direction is calculated (tables 3-11).

Well-log data and breakout results for each of the nine subareas are presented in: (1) well-location base maps (figs. 2, 4, 6, 8, 10, 12, 14, 16, and 18), (2) tables of well-log data and breakout results (tables 3-11), and (3) rose diagrams of breakout frequency (figs. 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19, 21, 22, 24, 25, 27 and 28). In addition to the rose diagrams of breakout frequency for all individual wells, composite rose diagrams for each subarea, exclusive of data sets with angular deviations >26° ("D"-quality statistical data and data considered to be "no good") are included. These unused "D" and "no good" (NG) quality data sets generally have inconsistent, random data orientations. Bimodal, orthogonally oriented data sets will also likely have angular deviations >26° but are used. The most likely explanation for bimodal/orthogonally oriented trends in individual well or composite data sets is that one orientation corresponds to the minimum stress direction, the direction of true breakouts, and the other trend is the result of drilling-induced hydrofractures or natural fractures oriented in the maximum stress direction.

In tables 3-11, only "A" thru "C" quality data sets have orientations of S_{Hmax} listed. Scatter in breakout orientations in poorer quality data sets prevents the reliable evaluation of S_{Hmax}. Also, no orientation of S_{hmax} is given for bimodal/orthogonal data sets. Statistical calculations of mean direction, mean standard error, angular deviation, and S_{Hmax} listed in tables 3-11 are based on the totals of number of breakouts for individual wells and subarea composites (see Appendix). These statistical calculations are given in degrees.

The statistical qualities of some individual well data sets are down graded in tables 3-11 from the criteria listed in table 2. This happens in cases where only two breakouts are observed in the borehole. A "D" quality is given if the two breakouts agree in orientation but are not separated by more than 1,000 ft of well bore. Also, statistical qualities are lowered for some individual well data sets if their rose diagrams indicate that a greater degree of data scatter exists than that shown by the value of their angular deviations.

Because of possible logging-tool limitations of caliper pad-size and variability in tool-rotation rates, the detection of short breakouts and the measurement of their azimuthal orientations are questionable. For this reason, borehole elongations shorter than 8 ft in length are excluded.

RESULTS

Data from wells located across the central part of the study area between the Anadarko Basin and the Mississippi Embayment form a data set that is both consistent and of high quality. It is therefore possible to infer an east-northeast regional orientation of maximum horizontal stress (S_{Hmax}) from the data (fig. 29). This finding agrees well with a hydrofracture measurement from central Oklahoma of N. 65° E. (Zoback and Zoback, 1980) and the Texas Panhandle of N. 40°-60° E. (Gustavson and Budnik, 1985), and with the northeast-southwest compressive stress field inferred for the Midcontinent province (Zoback and Zoback, 1980).

Future publications will address attempts to resolve the apparent ambiguities in well-bore elongation orientations among wells in several subareas (Arkoma, Palo Duro-Dalhart, and Marietta-Ardmore Basins). Randomness in inferred stress directions (see well-location maps) and bimodal breakout orientations (see composite rose diagrams) may be associated with one or more of the following: (1) analyst error, (2) hyrofracturing of the well-bore (or opening of preexisting fractures oriented in the inferred S_{Hmax} direction) by elevated hydrostatic pressures due to drilling mud weights, (3) near-surface gravitational stresses resulting from local changes in topographic relief (Savage and others, 1985), and (4) a reorientation of the regional stress field in the vicinity of the ends of large en echelon strike-slip faults (Rodgers, 1984).

This catalog is a companion publication for two other reports currently being prepared: "Stress induced well-bore elongations in southern Oklahoma and the central Texas Panhandle--stress implications and stratigraphic relationships" (Dart) and "Stress orientations from borehole breakouts in the south-central United States" (Zoback and Dart). The analysis of this large data set is ongoing and future reports (currently in preparation) will discuss the results of this study more fully.

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Marathon Oil Co.
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Mesa Limited Partnership
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SOUTH-CENTRAL UNITED STATES DATA--SUBAREAS

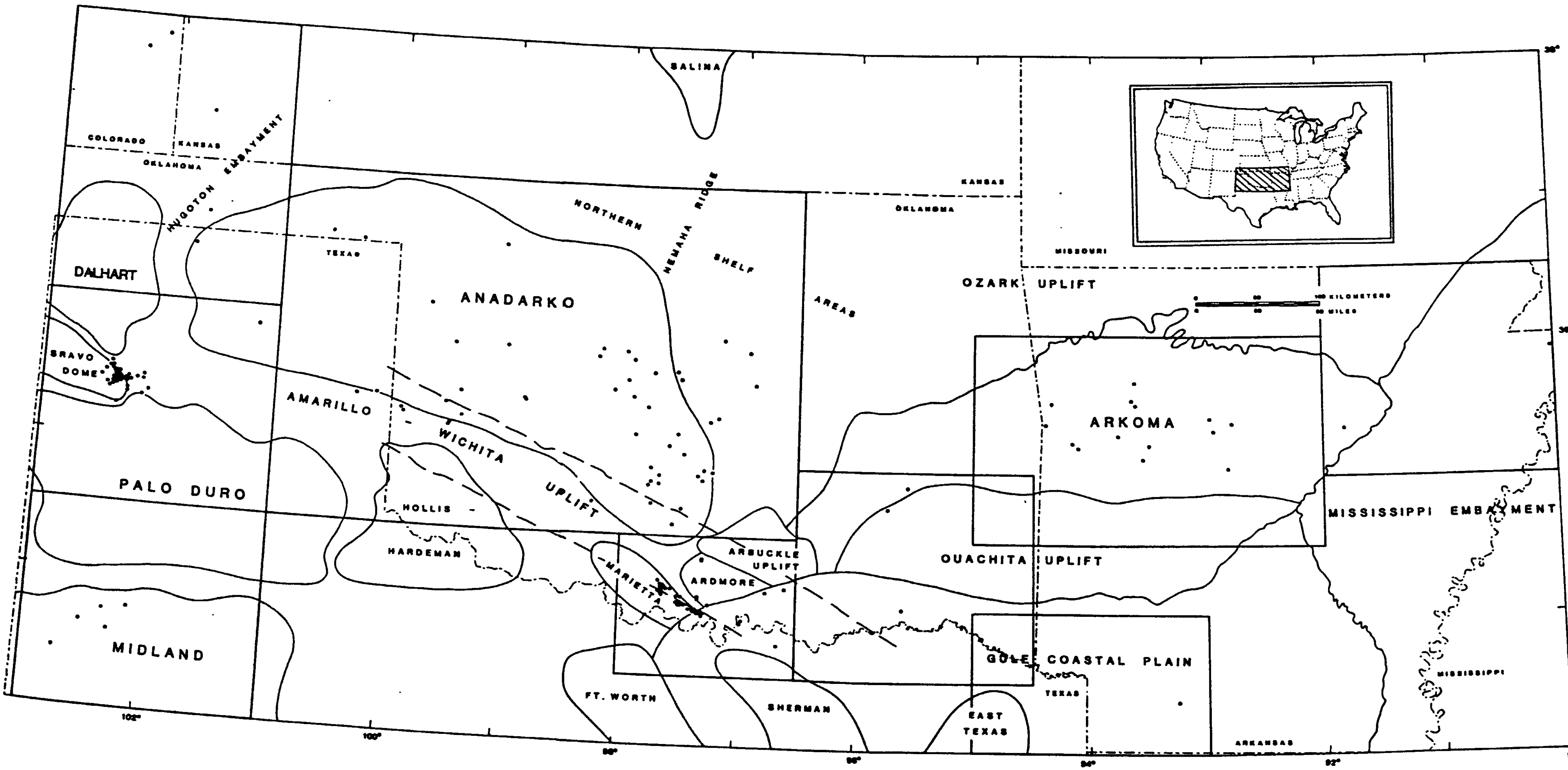


FIGURE 1.--Regional map of the study area. Well locations are solid dots. Heavy dashed lines are the boundaries of the southern Oklahoma aulacogen (after Chenoweth, 1983). Structural and physiographic province boundaries are heavy solid lines (after Nicholson, 1960; Morris, 1974; Haley and others; Johnson and others, 1972; and Petroleum Information Corp., 1983), and the study area subdivisions are outlined by thin solid lines.

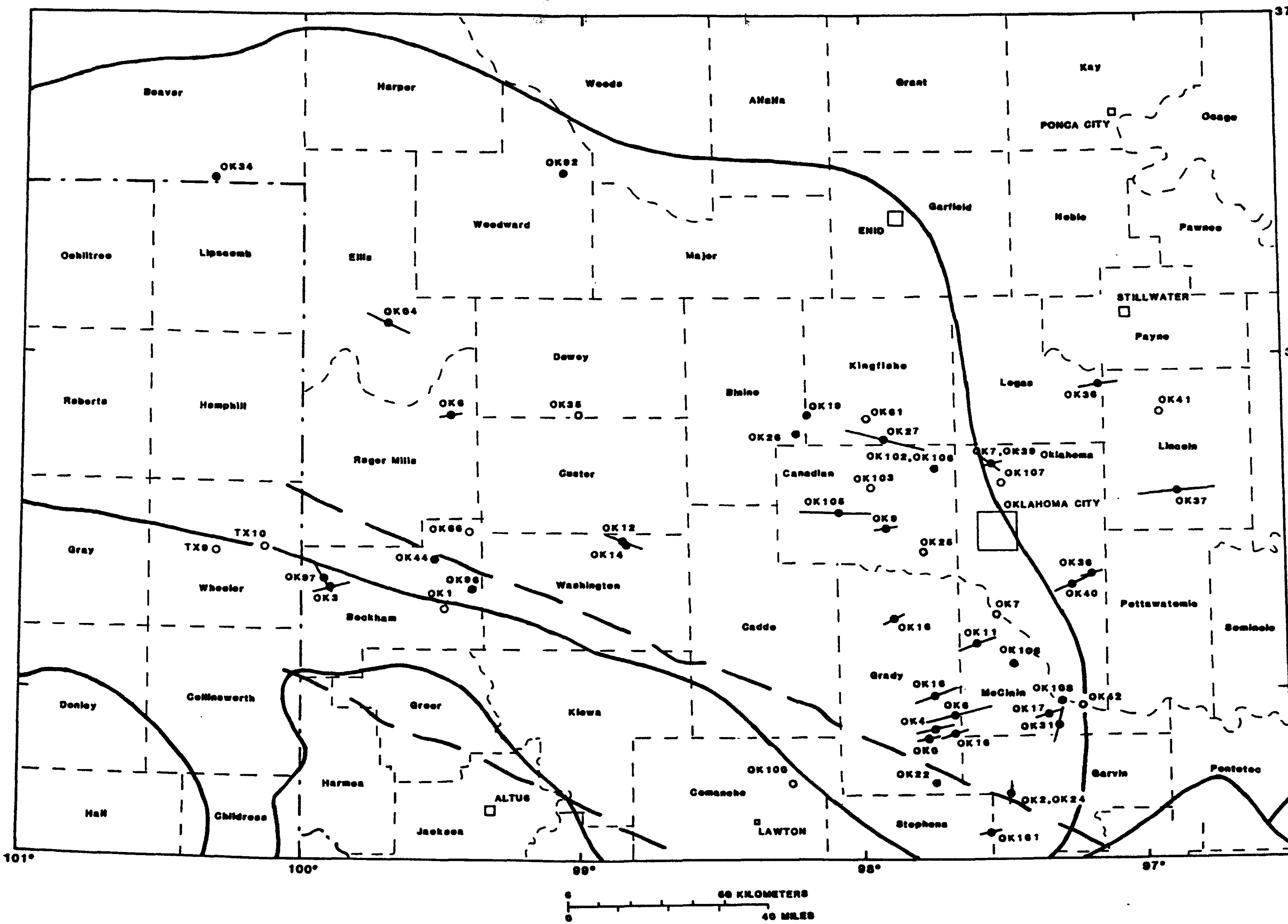


FIGURE 2.--Anadarko Basin well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines or dashed lines. State boundaries are outlined by heavy dashed-dot lines and county boundaries are thin solid-dashed lines. Well locations with two orientations of S_{Hmax} indicate two or more wells in close proximity.

TABLE 3.--Well-bore data for the Anadarko basin

Anadarko Basin

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	7919	129	—	-	170	2.2	26	80	Basin composite
OK1	Beckham	35.240	-99.475	1878	11008	8641-11003	1085-10913	20	1	Fair	NG	29	—	-	—	
OK2	Garvin	34.450	-97.402	1134	8054	6554-8024	7607-7611	70	1	Poor	NG	97	—	-	—	
OK3	Beckham	35.300	-99.879	1943	15338	7038-15238	12738-13724	372	5	Good	B	168	10.0	22	78	
OK4	Grady	34.887	-97.737	1064	13273	11213-13219	11213-13177	190	5	Good	B	163	7.0	16	73	
OK5	Grady	34.930	-97.668	1155	13390	8824-13355	11460-12666	45	4	Fair	B	164	4.8	10	74	
OK6	Roger Mills	35.812	-99.455	2054	16266	12326-16256	12676-16256	233	2	Fair	C	174	3.5	5	84	
OK7	Cleveland	35.224	-97.513	1120	8670	7610-8660	8444-8570	10	1	Fair	NG	37	—	-	—	
OK8	Grady	34.856	-97.756	1097	16092	14271-16071	14334-15976	178	2	Fair	C	166	1.8	3	76	
OK9	Canadian	35.485	-97.906	1342	12548	10038-12538	10586-12056	28	3	V.Good	C	162	12.6	22	72	
OK11	McClain	35.141	-97.585	1210	9877	5777-9877	7741-9758	481	9	Good	B	157	4.9	15	67	
OK12	Washita	35.443	-98.837	1570	16226	13201-16201	13219-14944	212	4	Good	B	16	8.6	17	106	
OK14	Washita	35.433	-98.828	1565	15939	14609-15919	15059-15705	188	2	Good	D	31	5.3	8	121	
OK15	Grady	34.985	-97.739	1070	13073	10415-13031	11641-12852	290	7	Fair	B	162	7.6	20	72	Bimodal/Questionable
OK16	Grady	35.216	-97.881	1242	12204	10544-12154	10990-11861	79	3	Good	C	143	8.4	15	53	
OK17	McClain	34.928	-97.337	1115	7894	5813-7863	5847-7753	101	3	Good	C	161	6.7	12	71	
OK18	Grady	34.872	-97.667	1003	12408	9308-12398	10918-11898	248	3	Fair	C	160	1.4	2	70	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

TABLE 3.--Well-bore data for the Anadarko basin--Continued

Anadarko Basin

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
OK19	Kingfisher	35.820	-98.187	1201	9288	6669-9287	7073-8217	250	9	Fair	D	3	8.9	26	93	
OK22	Grady	34.729	-97.732	1229	10059	3649-10059	3959-8844	533	9	Good	B	4	6.8	20	—	Bimodal/Orthogonal
OK24	Garvin	34.695	-97.472	1114	9138	6574-7774	6574-7584	372	3	Fair	NG	146	20.7	36	—	
OK25	Canadian	35.415	-97.777	1382	8205	6048-8192	7032-7896	36	1	Fair	NG	8	—	-	—	
OK26	BLaine	35.763	-98.220	1323	10171	7056-10170	7149-8678	68	4	Fair	D	13	14.9	30	—	Bimodal/Orthogonal
OK27	Kingfisher	35.749	-97.910	1091	8797	6092-8796	6092-7988	225	6	V.Good	A	14	2.5	6	104	
OK31	McClain	34.897	-97.299	1085	6448	4443-6443	5329-6125	80	3	Fair	B	103	8.4	15	13	
OK34	Beaver	36.508	-100.303	2808	7230	5180-7211	5232-6139	171	2	Poor	NG	34	23.2	33	—	Bimodal/Orthogonal
OK35	Dewey	35.816	-98.996	1855	13494	9323-13486	9600-13467	566	18	Fair	NG	101	8.4	36	—	
OK36	Logan	35.905	-97.146	902	4185	2161-4100	2446-3911	437	7	Good	B	166	4.8	13	76	
OK37	Lincoln	35.592	-96.876	962	4422	2378-4410	2458-3710	224	4	Fair	A	171	2.7	5	81	
OK38	Cleveland	35.346	-97.182	1205	5073	3033-5066	3132-4973	229	4	Poor	C	154	8.5	17	64	
OK39	Oklahoma	35.673	-97.533	1060	5526	3508-5519	4132-5368	135	3	Fair	C	165	3.6	6	75	
OK40	Cleveland	35.319	-97.246	1086	5522	3521-5521	3762-5186	375	4	Fair	B	158	5.2	11	68	
OK41	Lincoln	35.823	-96.927	916	3878	3372-3877	3392-3610	40	1	Fair	NG	177	—	-	—	
OK42	Cleveland	34.958	-97.217	1085	5641	4708-5640	4809-5024	17	1	Poor	NG	178	—	-	—	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

TABLE 3.--Well-bore data for the Anadarko basin--Continued

Anadarko Basin

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
OK44	Beckham	35.388	-99.513	2167	13268	11701-13267	11811-13078	215	5	Poor	NG	130	15.1	34	—	Bimodal/Orthogonal
OK91	Kingfisher	35.806	-97.976	1078	8129	6209-8128	7489-8062	8	1	Good	NG	13	—	-	—	
OK92	Woodward	36.348	-98.858	1775	7212	5195-7204	5325-6900	33	2	Poor	NG	135	28.7	41	—	Bimodal/Orthogonal
OK94	Ellis	36.084	-99.680	2473	12802	3535-12801	8752-9025	124	4	Good	B	21	4.2	8	111	
OK96	Beckham	35.472	-99.387	2074	19006	14268-19015	18483-18982	10	1	Good	NG	134	—	-	—	
OK97	Beckham	35.324	-99.899	2065	11700	12077-11615	10013-10731	81	6	Fair	B	58	5.5	13	148	
OK98	Beckham	35.295	-99.374	1830	14296	10282-12894	10594-12623	969	6	Poor	C	1	10.3	25	—	Bimodal/Orthogonal
OK100	Comanche	34.725	-98.240	1206	8978	1182-6832	3202-6727	579	5	Fair	NG	34	10.4	23	—	
OK101	Garvin	34.580	-97.541	1066	10197	476-10186	6615-8937	1206	3	Poor	C	167	12.5	22	77	
OK102	Canadian	35.659	-97.731	1250	—	5630-6880	5630-6707	433	3	Poor	D	15	16.7	29	105	Bimodal-questionable
OK103	Canadian	35.602	-97.956	1321	9361	+318-9330	6561-9134	45	1	Poor	NG	108	—	-	—	
OK105	Canadian	36.530	-99.052	1394	11491	9491-11468	10223-11362	357	7	Good	A	2	2.6	7	92	
OK106	McClain	35.531	-98.074	1140	7455	6444-7470	6444-7048	110	2	Good	D	173	3.5	5	83	
OK107	Oklahoma	35.618	-97.498	1116	5720	4970-5716	5092-5358	45	1	Poor	NG	168	—	-	—	
OK108	Canadian	35.660	-97.728	1200	6904	4934-6902	5084-5931	360	2	Good	D	178	0.0	1	88	
OK109	Cleveland	34.972	-97.286	1200	5995	3980-5981	4695-5470	167	2	Poor	D	153	10.5	15	63	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

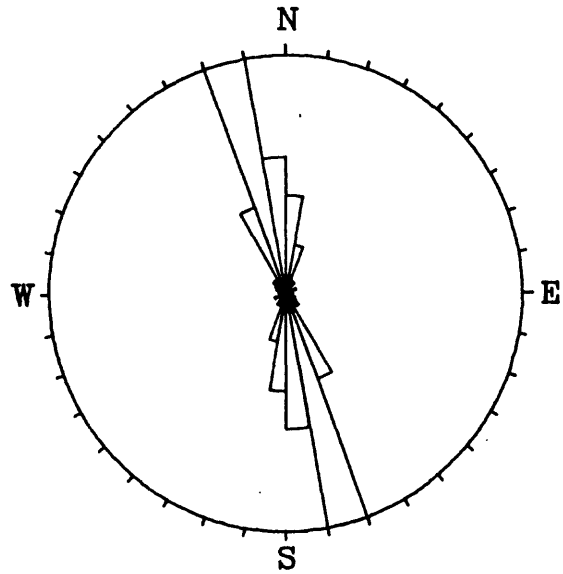
TABLE 3.--Well-bore data for the Anadarko basin--Continued

Anadarko Basin

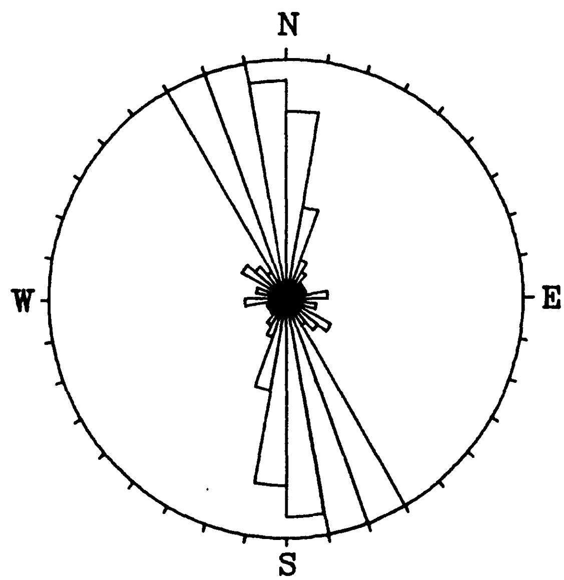
Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
TX9	Wheeler	35.405	-100.286	2624	11345	9200-11379	9250-11239	448	5	Fair	NG	90	13.7	31	—	
TX10	Wheeler	35.418	-100.116	2306	6273	9251-7973	8167-11239	97	1	Good	NG	104	—	-	—	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



Anadarko Basin (feet):
Composite
n= 7919.0
r= 2619.0
mean= 169.9 degrees
angular dev.= 19.3 degrees



Anadarko Basin (number):
Composite
n= 129.0
r= 23.0
mean= 169.6 degrees
angular dev.= 25.5 degrees

FIGURE 3.--Composite rose diagrams of Anadarko Basin breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basin in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

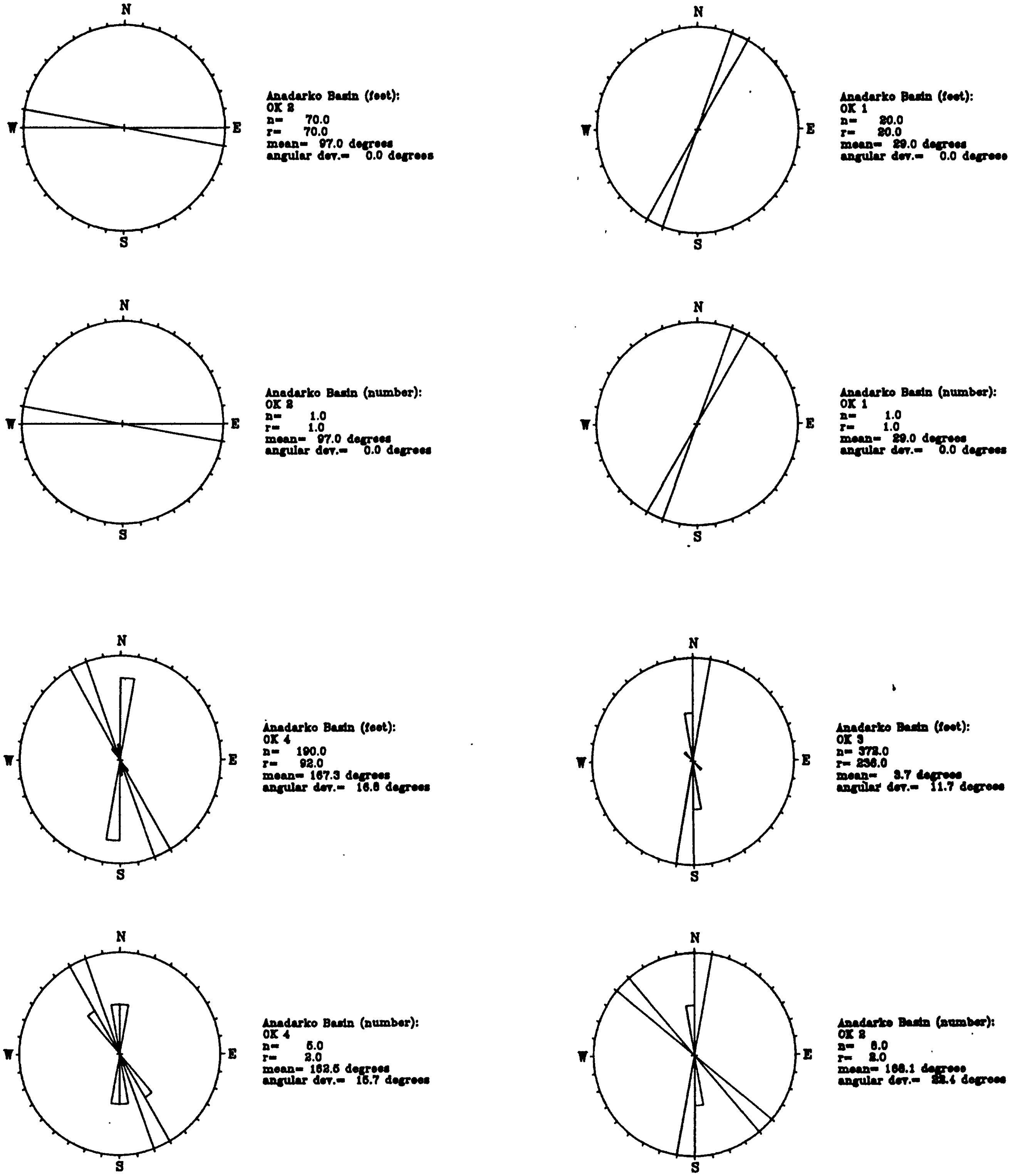
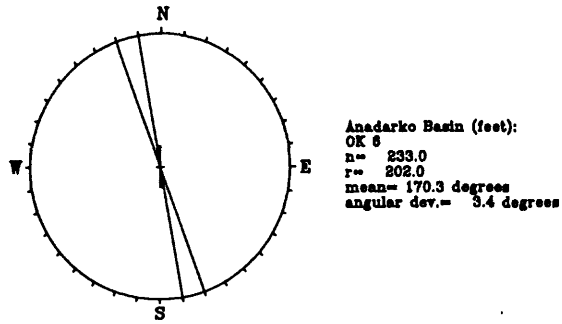
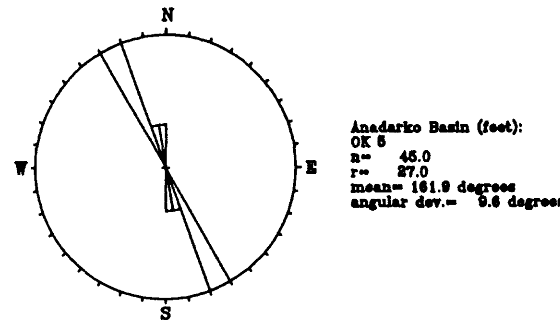
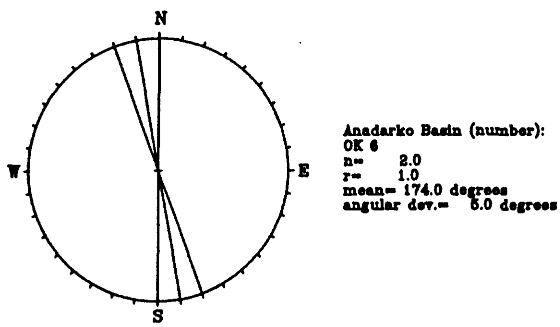
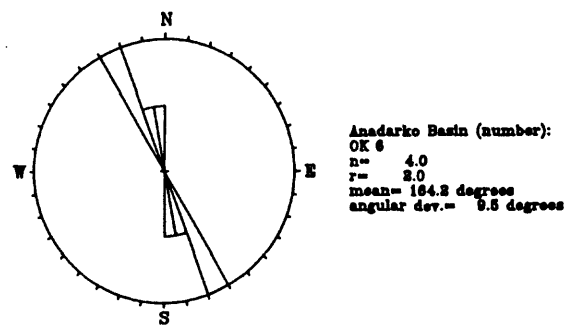


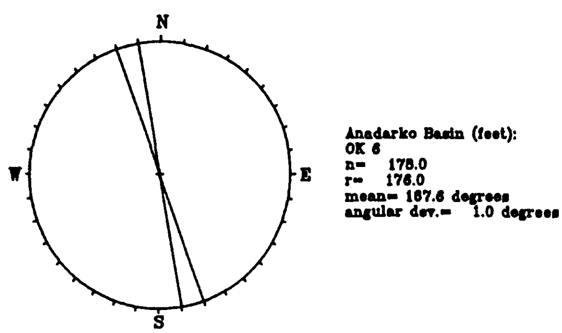
FIGURE 4.--Rose diagrams of Anadarko Basin breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basin in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

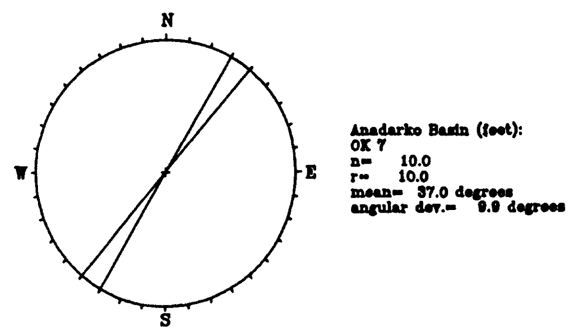


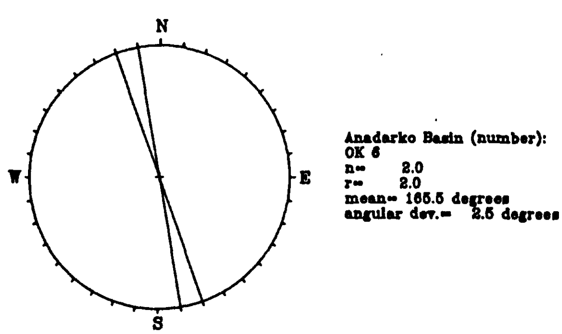












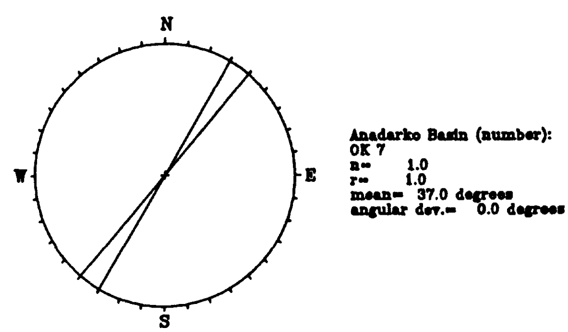


FIGURE 4.--Continued.

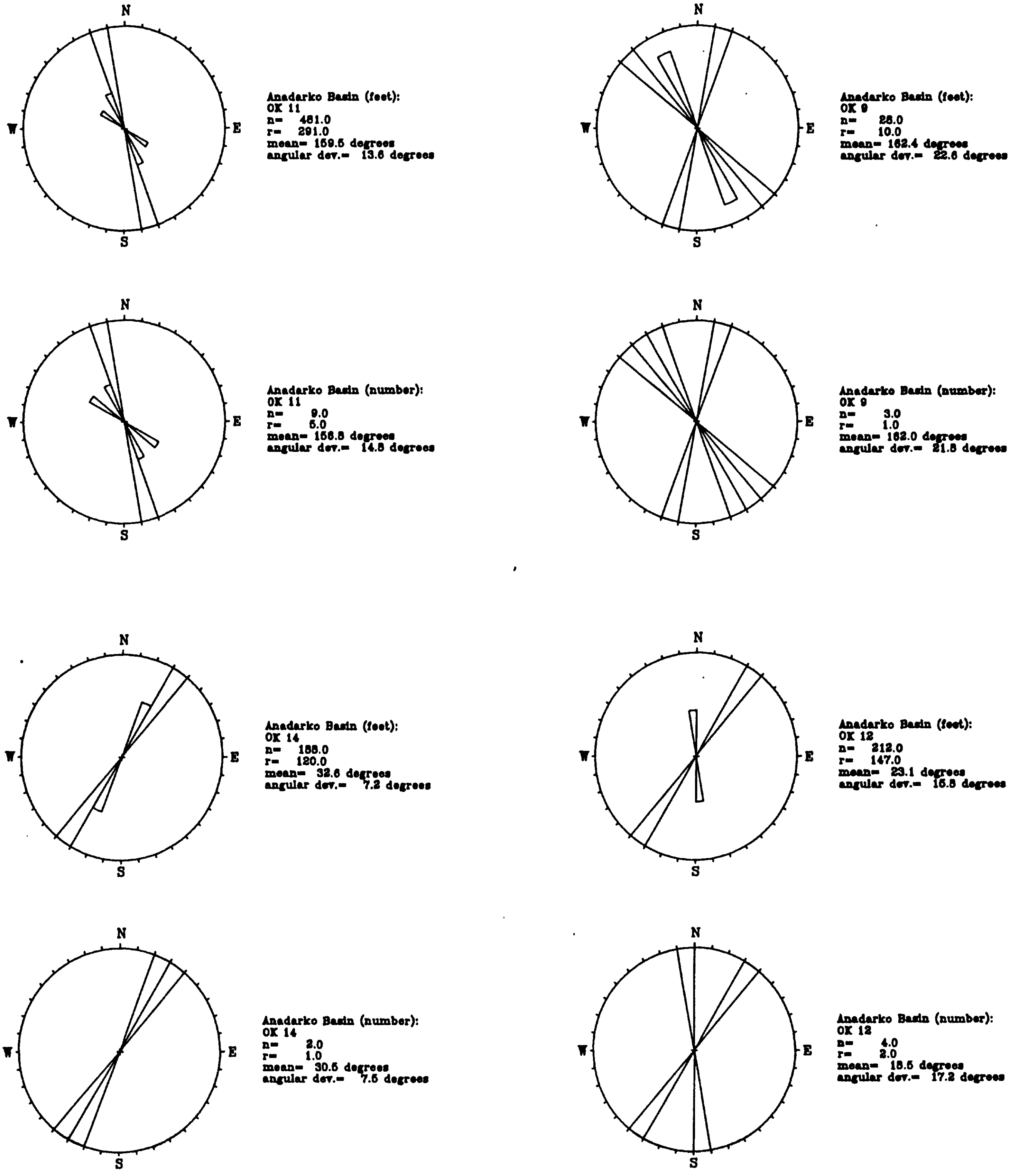


FIGURE 4.--Continued.

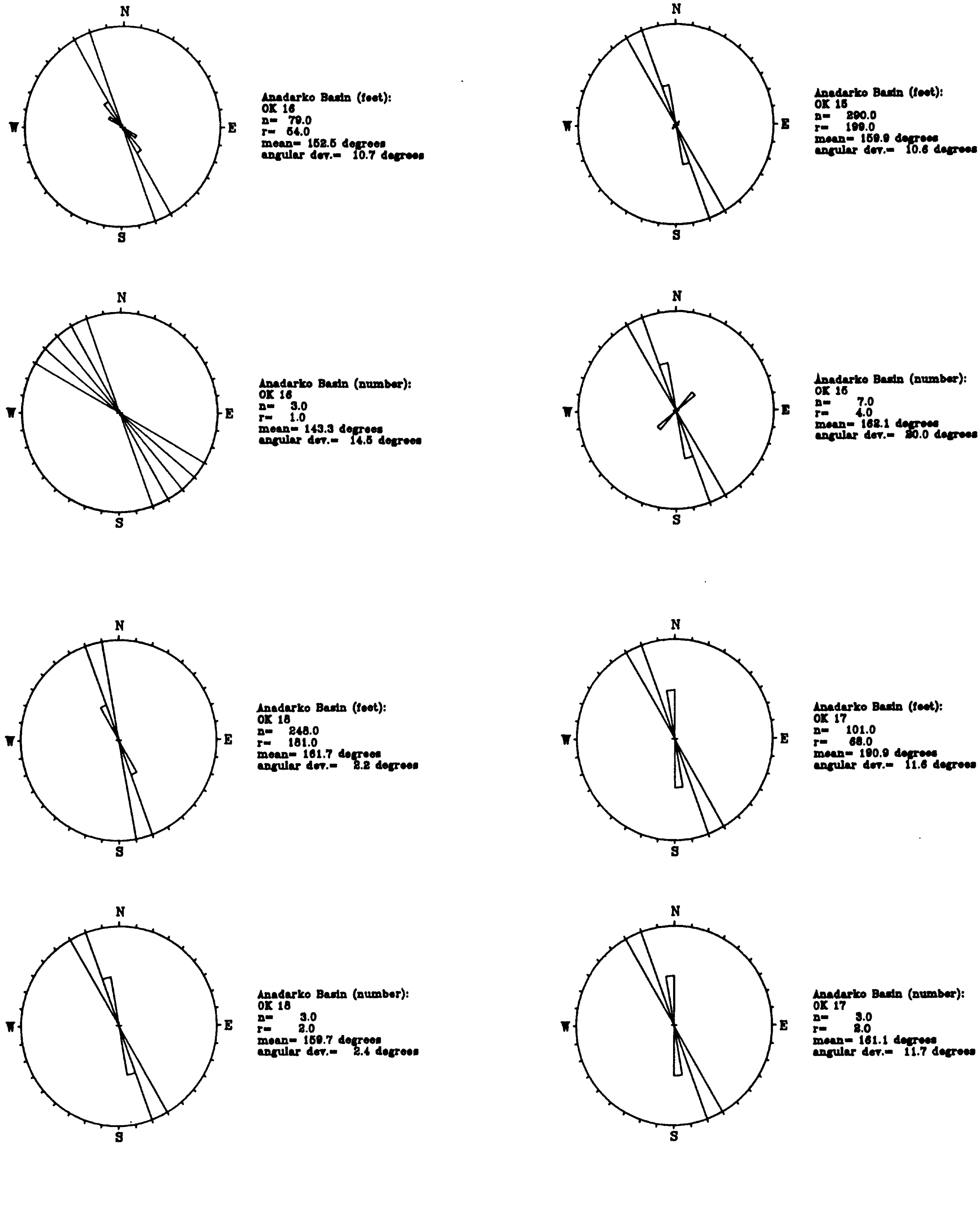


FIGURE 4.--Continued.

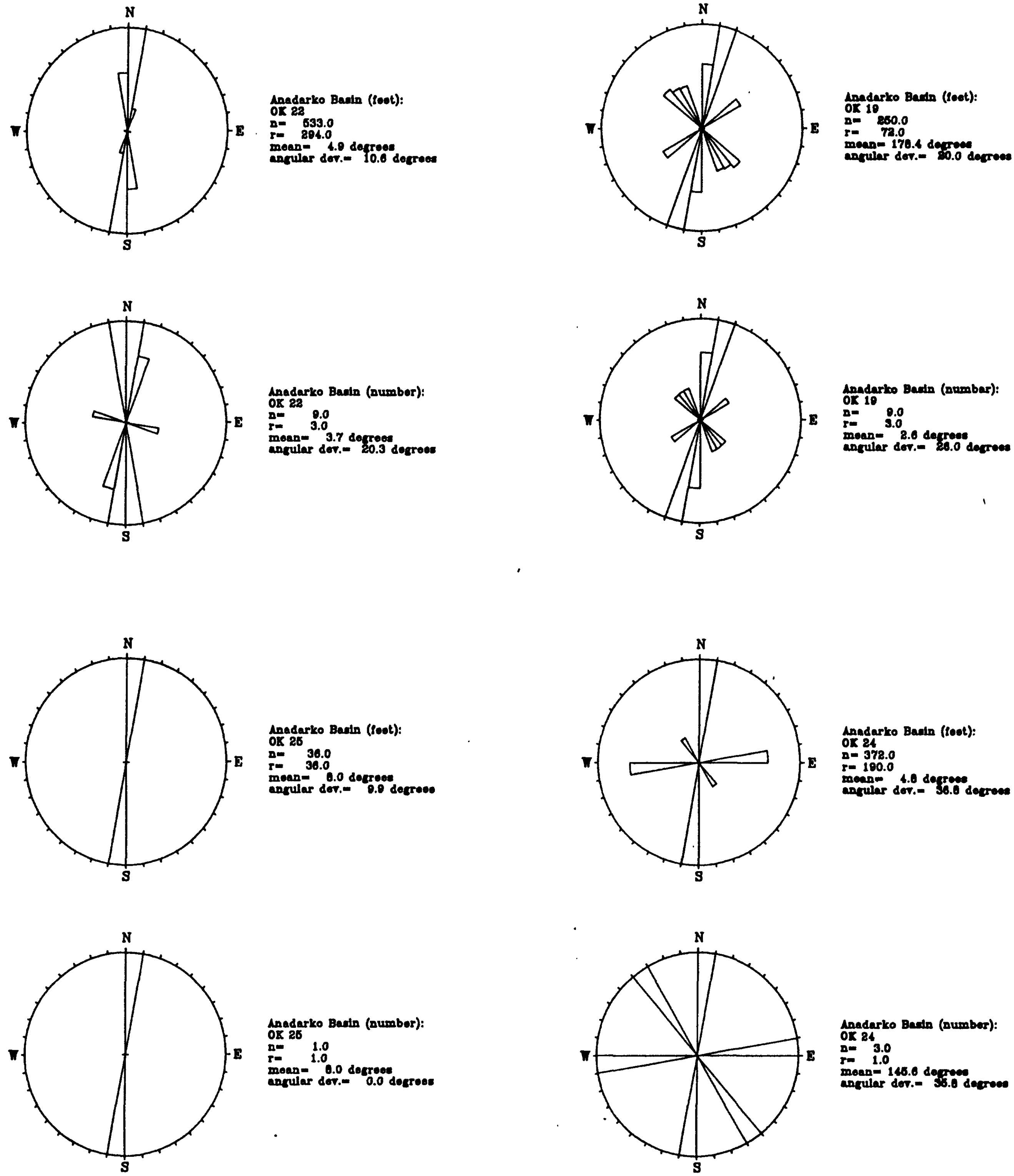


FIGURE 4.--Continued.

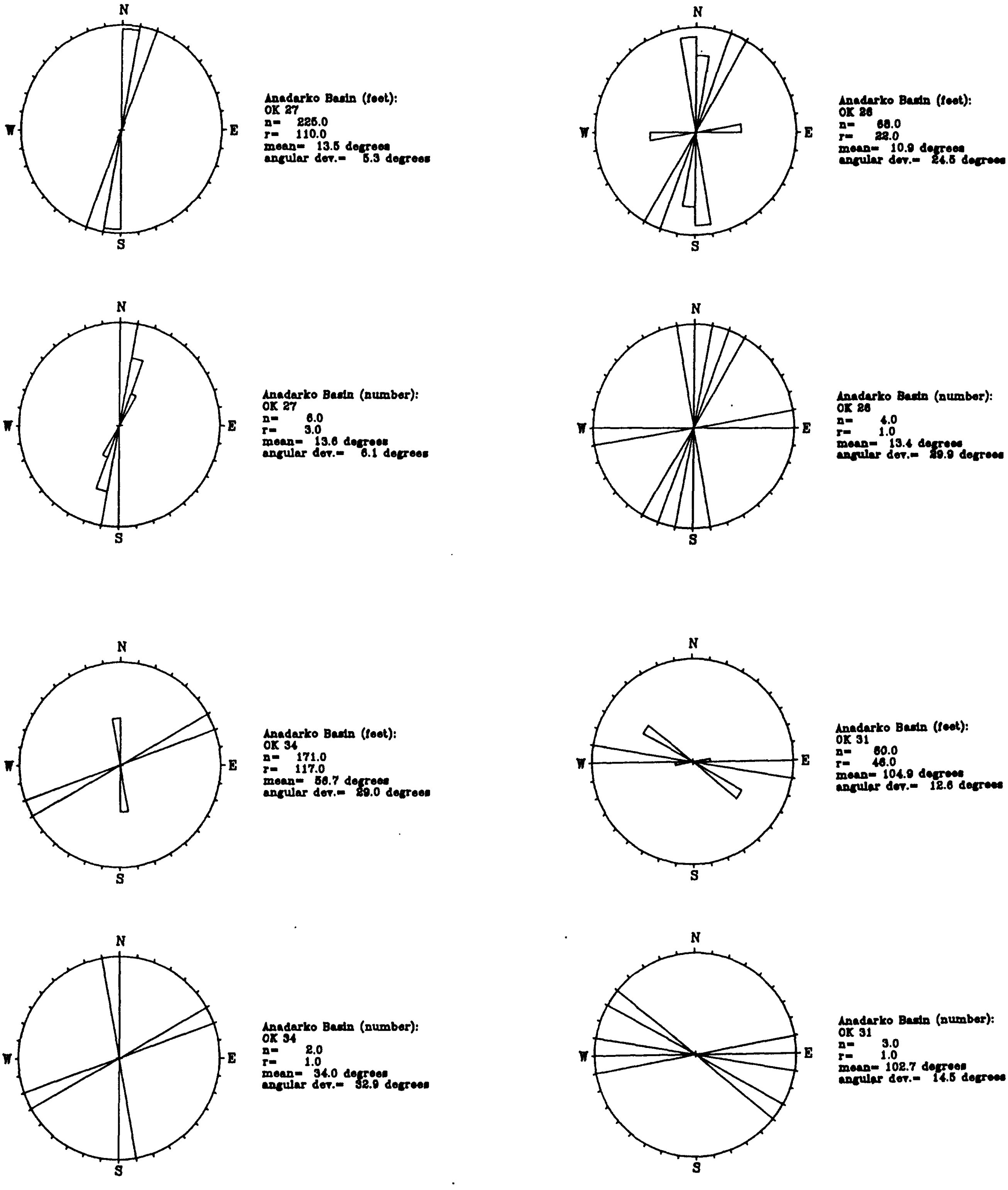


FIGURE 4.--Continued.

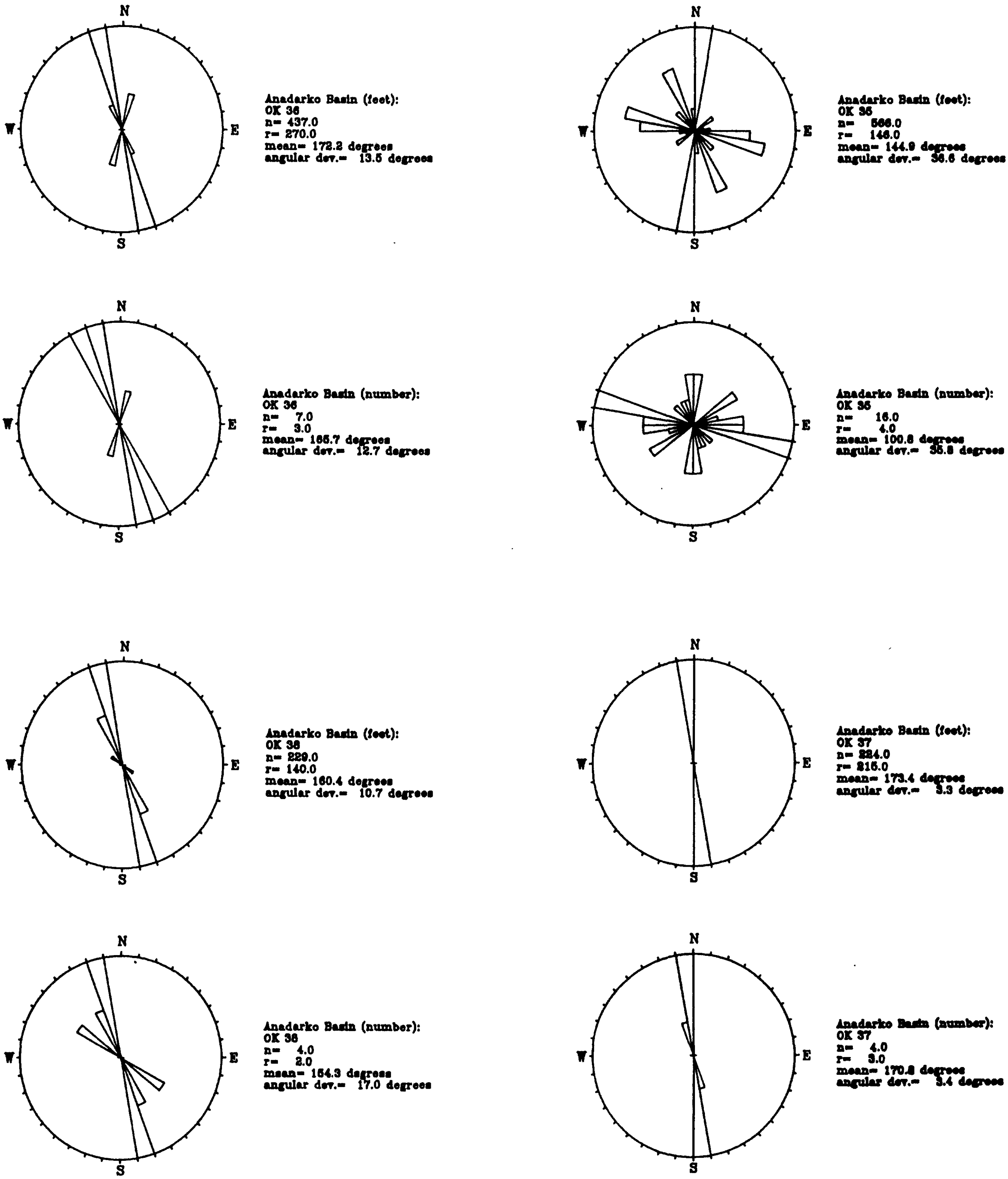


FIGURE 4.--Continued.

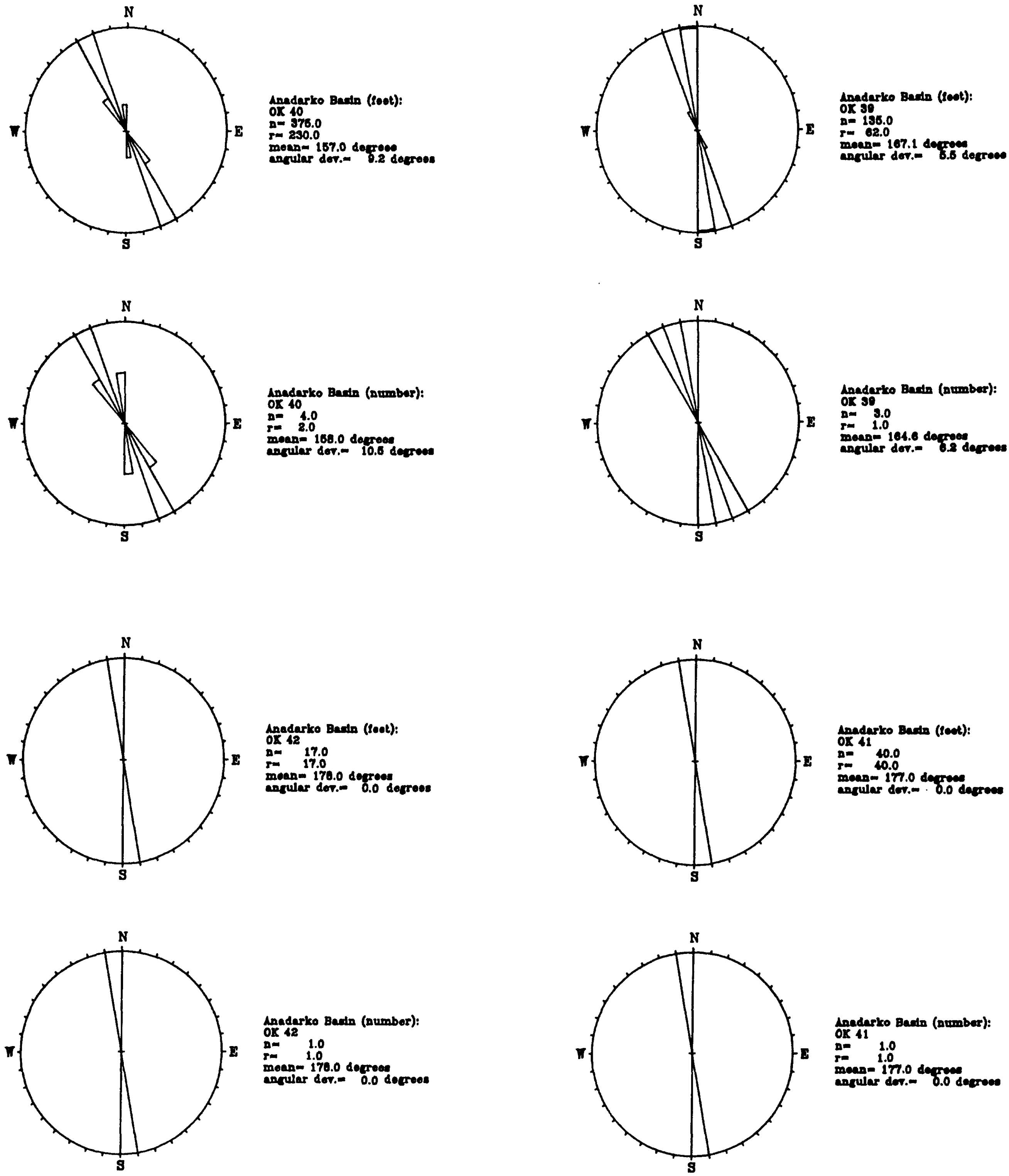


FIGURE 4.--Continued.

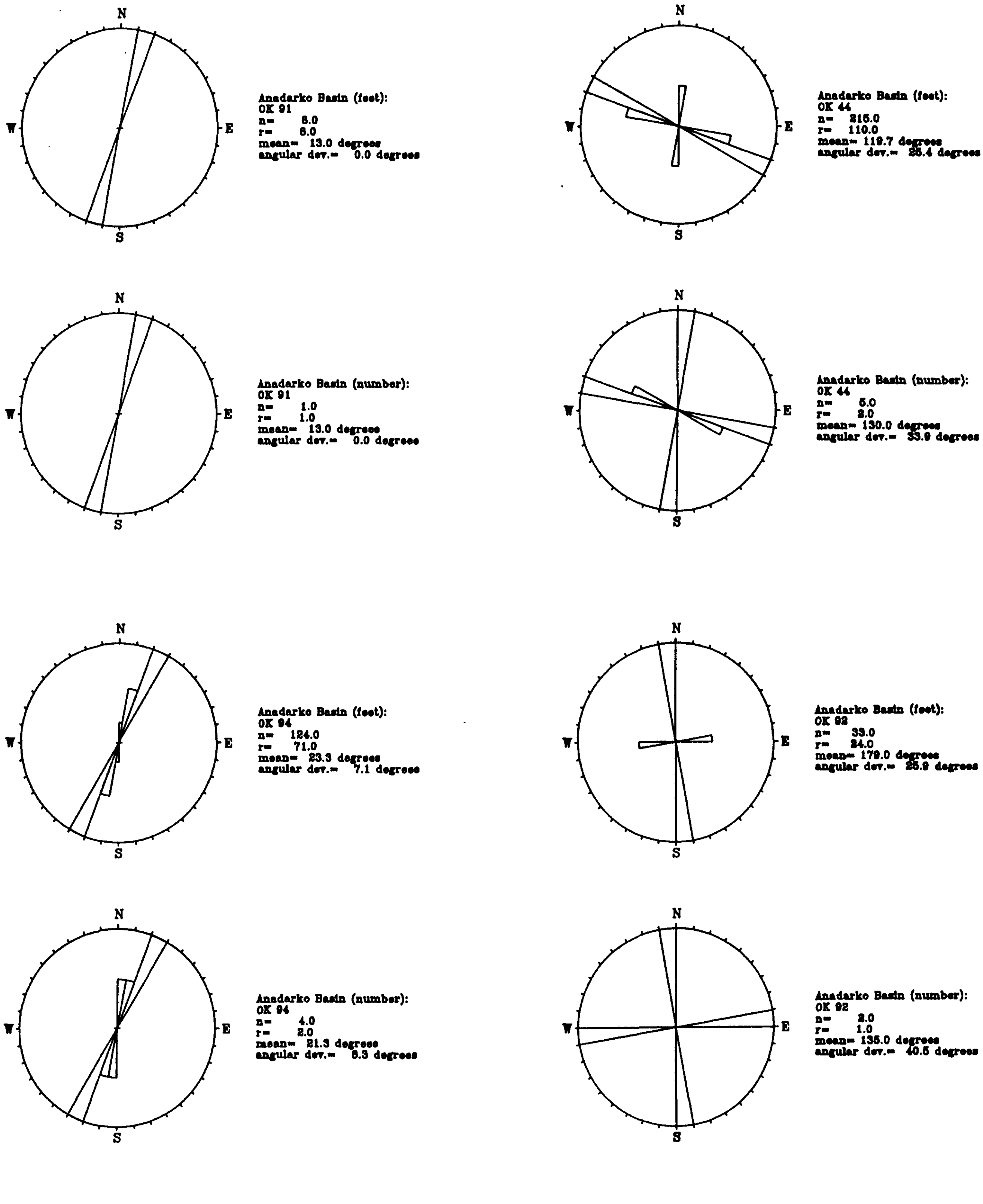
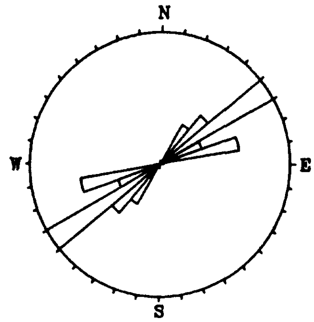
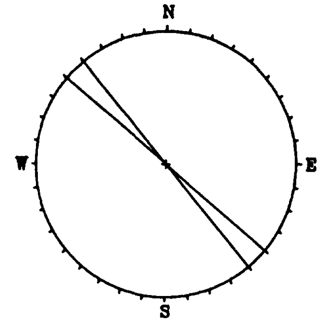


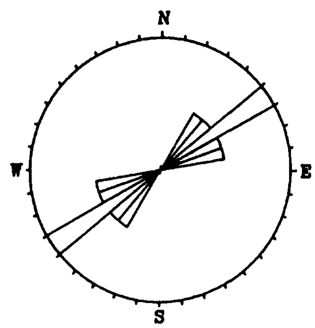
FIGURE 4.--Continued.



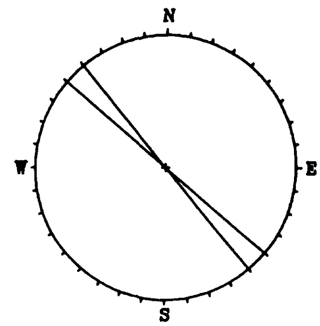
Anadarko Basin (feet):
OK 97
n= 81.0
r= 29.0
mean= 59.6 degrees
angular dev.= 13.5 degrees



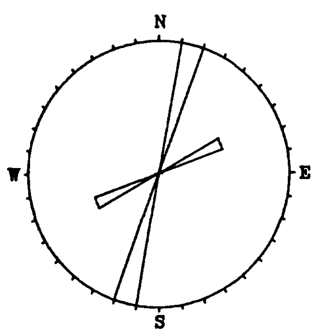
Anadarko Basin (feet):
OK 98
n= 10.0
r= 10.0
mean= 134.0 degrees
angular dev.= 1.4 degrees



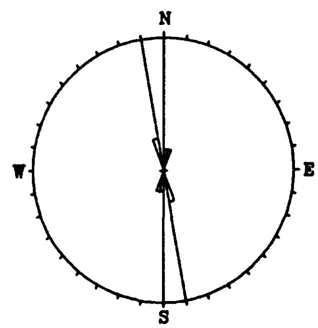
Anadarko Basin (number):
OK 97
n= 8.0
r= 2.0
mean= 58.2 degrees
angular dev.= 13.4 degrees



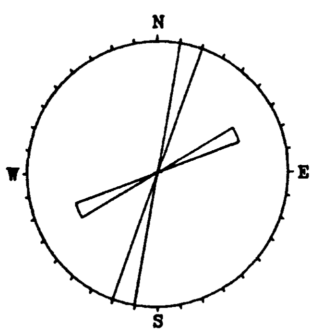
Anadarko Basin (number):
OK 98
n= 1.0
r= 1.0
mean= 134.0 degrees
angular dev.= 0.0 degrees



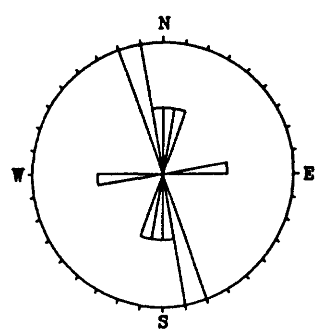
Anadarko Basin (feet):
OK 100
n= 579.0
r= 381.0
mean= 31.9 degrees
angular dev.= 22.3 degrees



Anadarko Basin (feet):
OK 98
n= 968.0
r= 810.0
mean= 179.9 degrees
angular dev.= 9.7 degrees



Anadarko Basin (number):
OK 100
n= 5.0
r= 3.0
mean= 34.4 degrees
angular dev.= 23.3 degrees



Anadarko Basin (number):
OK 98
n= 8.0
r= 2.0
mean= 1.4 degrees
angular dev.= 25.3 degrees

FIGURE 4.--Continued.

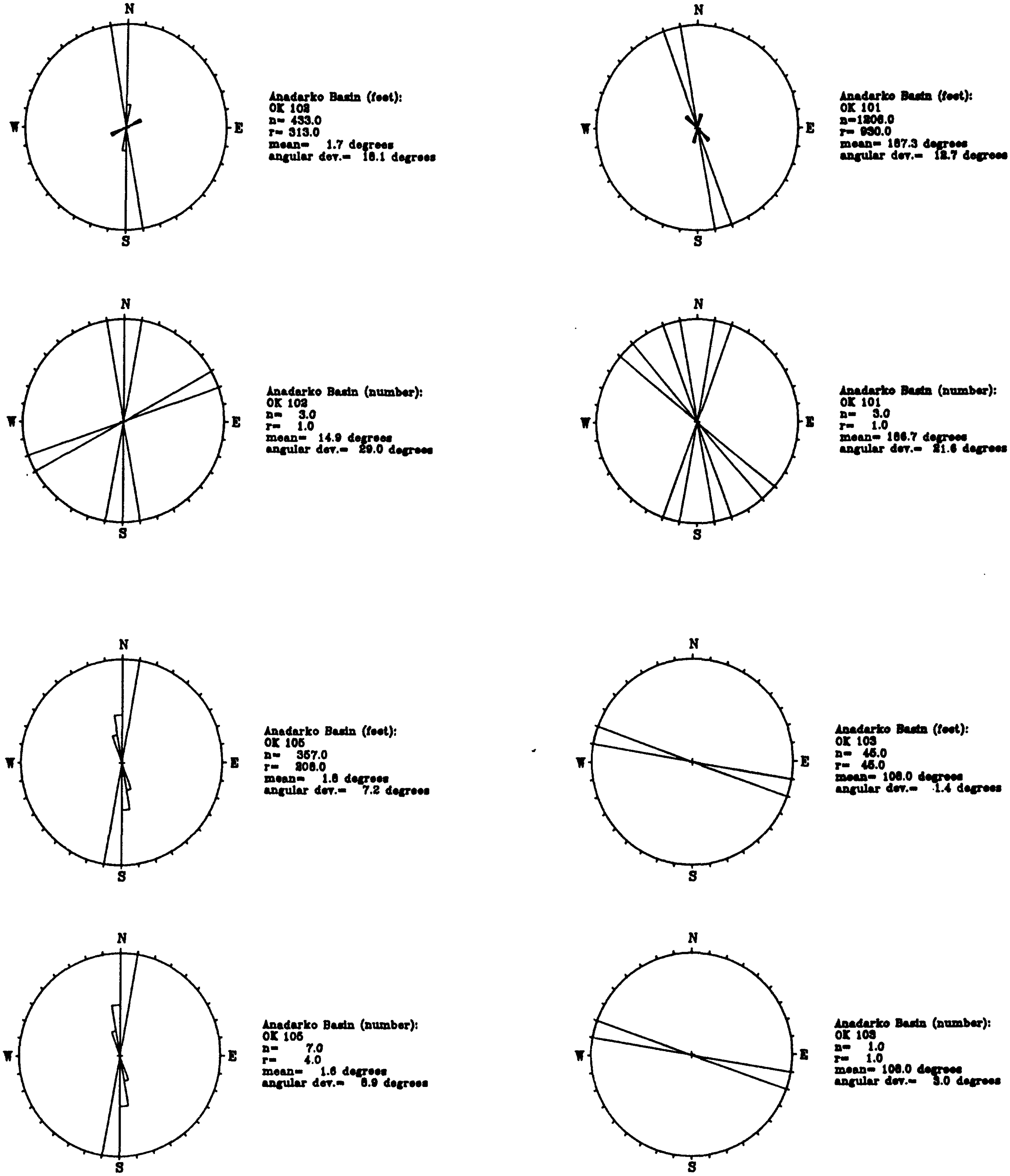


FIGURE 4.--Continued.

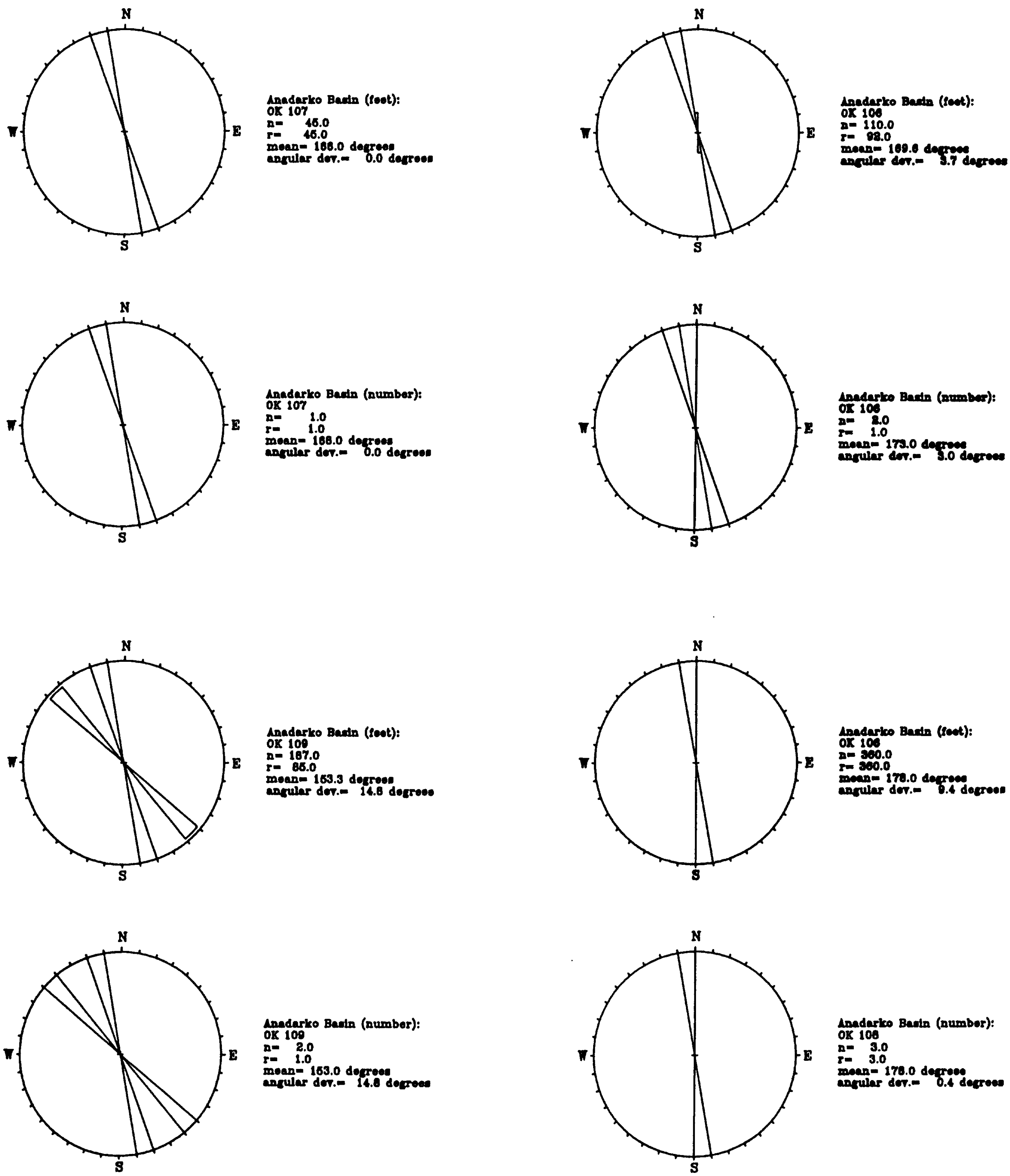
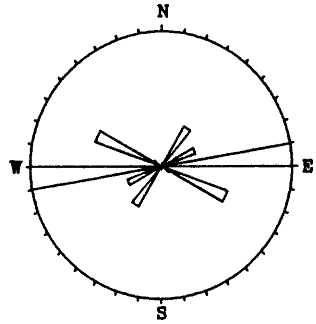
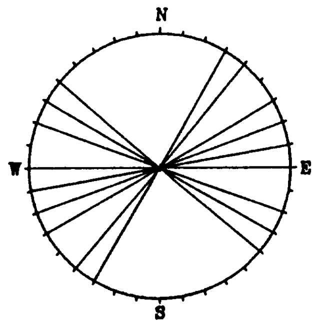


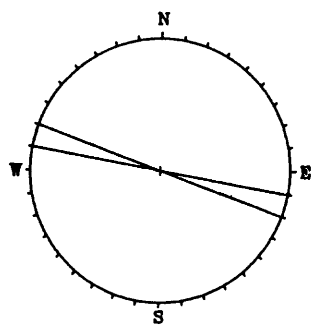
FIGURE 4.--Continued.



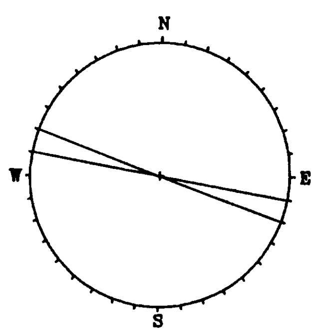
Anadarko Basin (feet):
TX 9
n= 448.0
r= 200.0
mean= 88.5 degrees
angular dev.= 24.8 degrees



Anadarko Basin (number):
TX 9
n= 6.0
r= 1.0
mean= 90.3 degrees
angular dev.= 30.8 degrees



Anadarko Basin (feet):
TX 10
n= 97.0
r= 97.0
mean= 109.0 degrees
angular dev.= 0.0 degrees



Anadarko Basin (number):
TX 10
n= 1.0
r= 1.0
mean= 109.0 degrees
angular dev.= 0.0 degrees

FIGURE 4.--Continued.

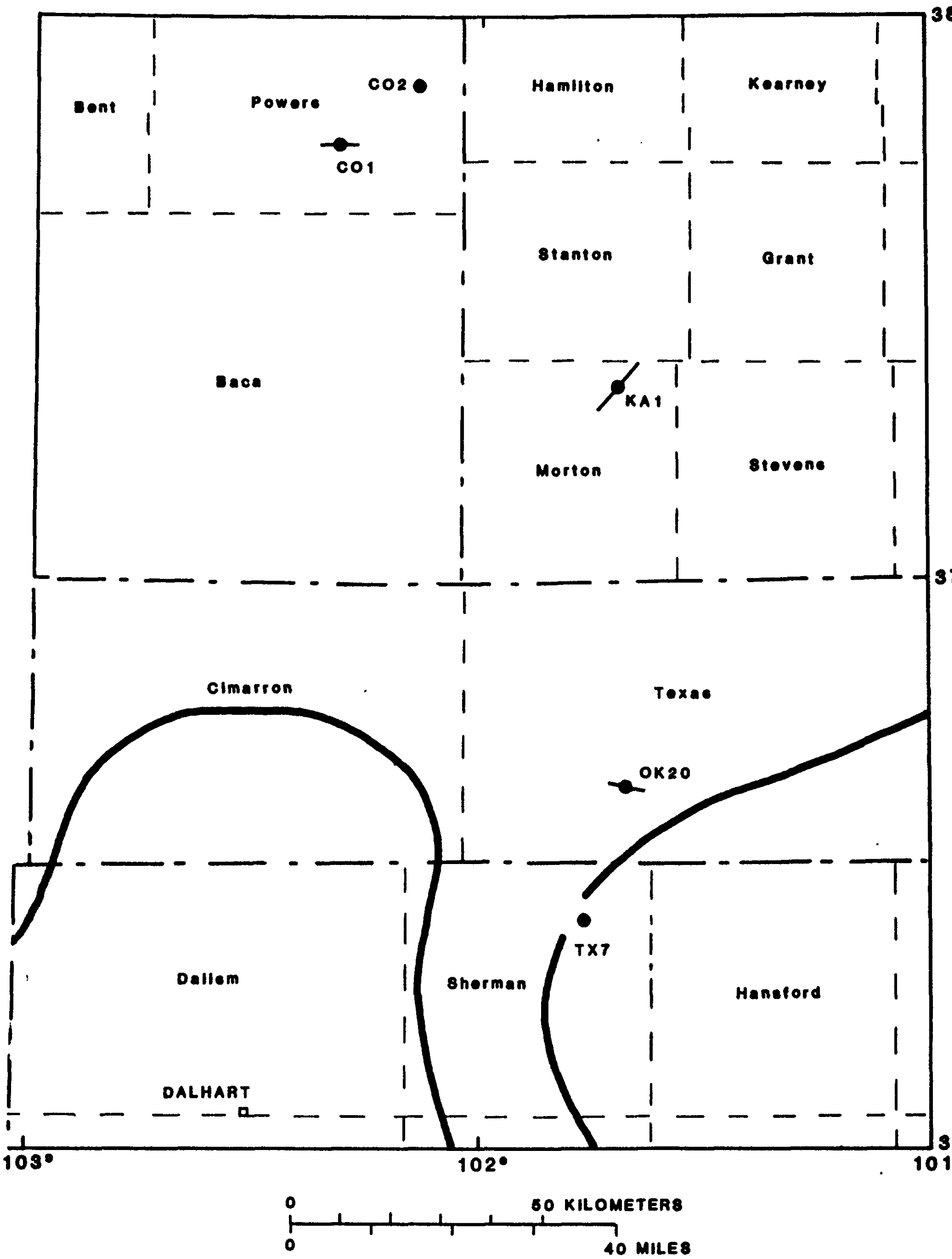


FIGURE 5.--Hugoton embayment well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines. The well location for TX50 can be found on figure 8.

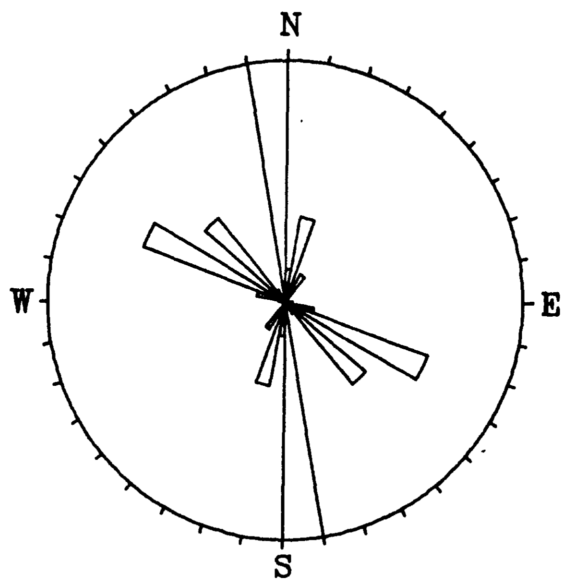
TABLE 4.--Well-bore data for the Hugoton embayment

Hugoton Embayment

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	420	13	—	-	167	8.4	30	77	Area composite
OK20	Texas	36.618	-101.658	3368	6988	812-2812	1078-2629	55	3	Good	C	10	4.7	8	100	
KA1	Morton	37.329	-101.683	3325	2363	+337-2355	1447-1933	100	4	Fair	B	128	8.2	16	38	
CO1	Powers	37.750	-102.316	3664	1803	1126-1756	1194-1616	132	3	Fair	C	178	1.4	2	89	
CO2	Powers	37.855	-102.134	3918	1713	+389-1699	1353-1533	90	2	Poor	D	80	0.0	0	170	
TX7	Sherman	36.386	-101.752	3426	3744	912-3741	2952-3340	41	2	Fair	D	38	8.8	12	128	
TX50	Hutchinson	35.853	-101.178	2922	3215	+1451-3215	+139-2075	133	3	Fair	NG	31	19.9	35	—	Bimodal/Orthogonal

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



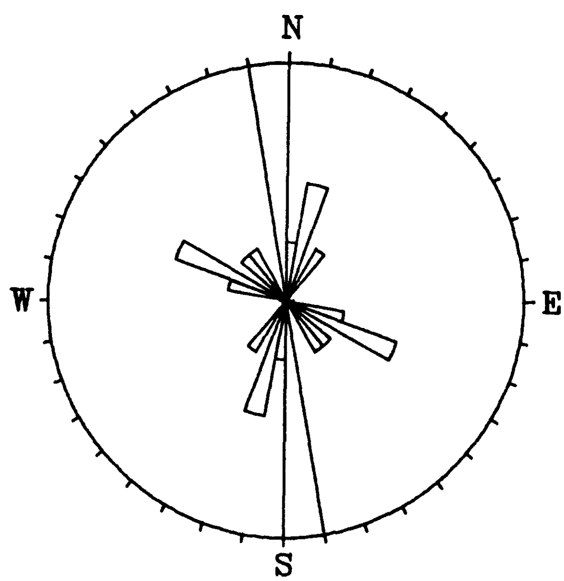


FIGURE 6.--Composite rose diagrams of Hugoton embayment breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

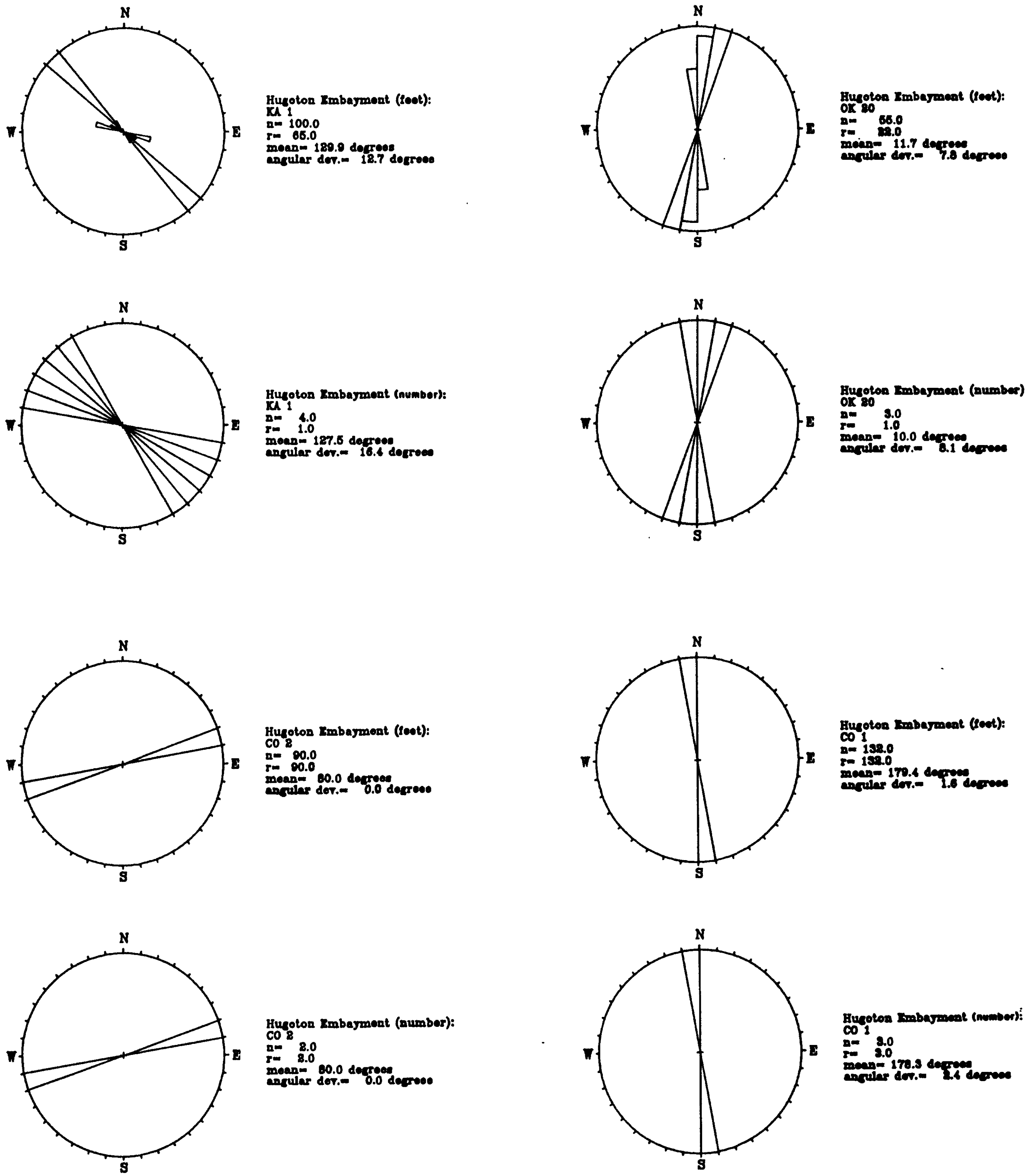


FIGURE 7.--Rose diagrams of Hugoton embayment breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

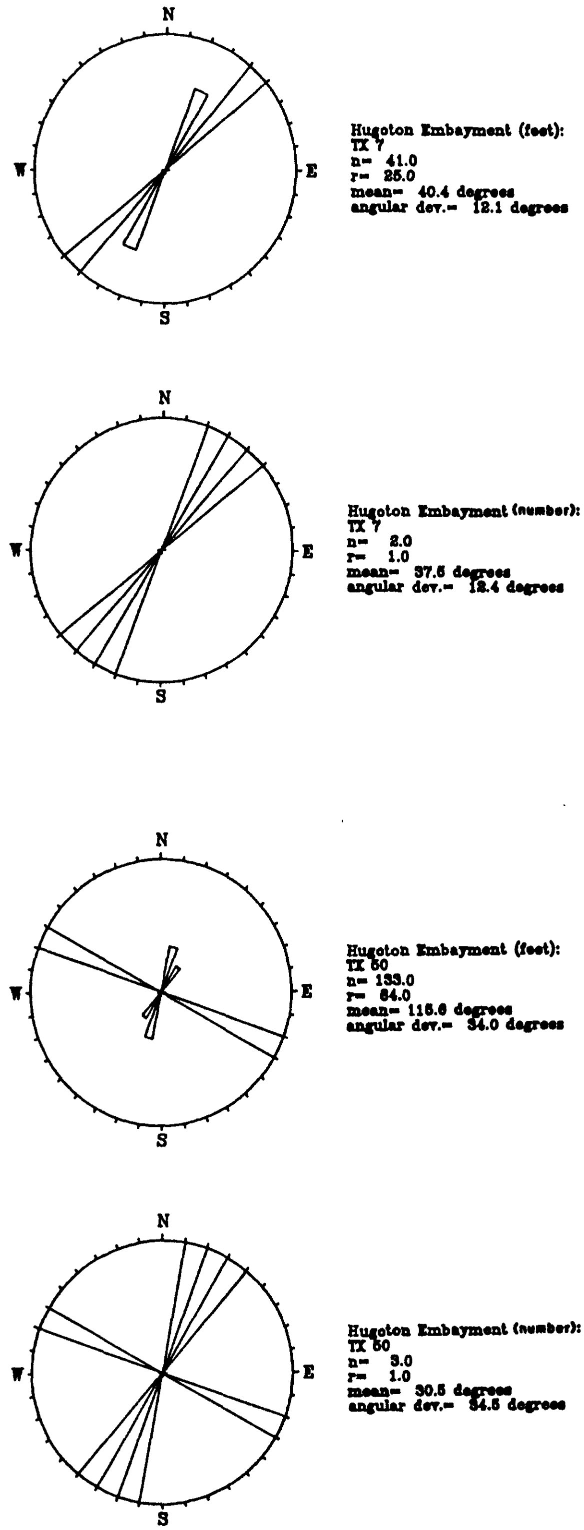


FIGURE 7.--Continued.

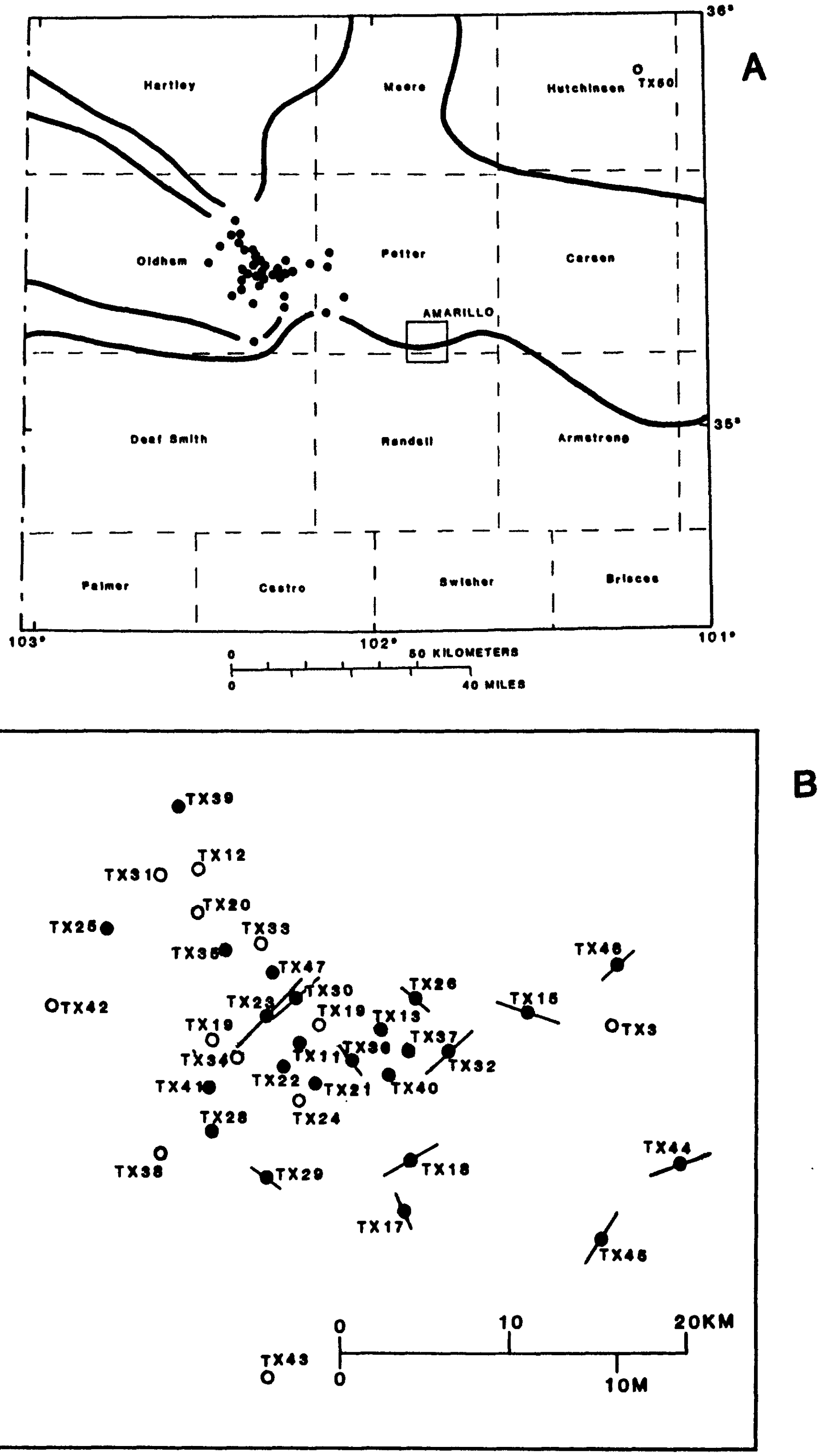


FIGURE 8.--Palo Duro-Dalhart Basins well-location maps A and B. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines. Map B is an enlargement of the area northwest of Amarillo, Texas.

TABLE 5.--Well-bore data for the Palo Duro-Dalhart basins

Palo Duro-Dalhart Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	2583	98	—	-	13	3.9	38	—	Basins composite
TX3	Potter	35.383	-102.110	3395	3393	1386-3386	2200-2615	76	3	Good	NG	135	19.1	33	—	Bimodal-questionable
TX11	Oldham	35.370	-102.306	3646	2192	2192-4198	2322-4062	192	9	Good	D	160	9.3	28	70	
TX12	Oldham	35.465	-102.372	3279	4867	2861-4864	2873-4393	434	12	Fair	NG	13	9.3	32	—	
TX13	Oldham	35.379	-102.260	3615	4475	2469-8094	2788-3747	240	7	Fair	NG	146	13.8	37	—	Bimodal/Orthogonal
TX15	Oldham	35.390	-102.163	3267	2771	1423-2769	2178-2601	166	4	Good	B	19	9.5	19	109	
TX16	Oldham	35.386	-102.298	3590	4007	1997-3843	2669-3843	144	3	Fair	NG	71	17.9	31	—	Bimodal/Orthogonal
TX17	Oldham	35.284	-102.241	3823	3706	2016-3421	2446-3041	115	5	Fair	C	69	11.1	25	159	
TX18	Oldham	35.316	-102.242	3627	3192	1662-3190	2296-3155	113	6	Good	B	151	5.1	13	61	
TX19	Oldham	35.377	-102.368	3550	3915	2038-3911	3007-3605	23	1	Good	NG	15	—	-	—	
TX20	Oldham	35.443	-102.379	3500	4757	2740-4747	3110-4100	85	4	Good	NG	87	18.3	37	—	Bimodal-questionable
TX21	Oldham	35.355	-102.301	3706	3733	2883-3583	2943-3530	40	2	Fair	D	8	18.7	27	98	Bimodal-questionable
TX22	Oldham	35.359	-102.325	3697	4083	493-4076	893-3911	383	11	Fair	D	153	9.0	30	63	Bimodal-questionable
TX23	Oldham	35.388	-102.331	3715	4076	2075-4075	2340-3321	55	4	Good	A	146	5.9	12	56	
TX24	Oldham	35.336	-102.311	3585	4004	1904-3982	1913-3542	63	7	Fair	NG	136	12.0	32	—	
TX25	Oldham	35.432	-102.432	3512	4379	2377-4377	2433-4065	39	3	Poor	NG	100	19.1	33	—	Bimodal/Orthogonal
TX26	Oldham	35.400	-102.239	3601	4537	2387-4537	2534-3965	243	7	Fair	C	40	10.0	26	130	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

TABLE 5.--Well-bore data for the Palo Duro-Dalhart basins--Continued

Palo Duro-Dalhart Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
TX28	Oldham	35.328	-102.368	3542	4097	1998-4096	2460-4052	128	6	Fair	NG	157	15.6	38	—	Bimodal/Orthogonal
TX29	Oldham	35.297	-102.335	3542	3235	1232-3232	1233-1744	128	4	Fair	C	37	11.7	23	127	
TX30	Oldham	35.398	-102.315	3716	4280	2074-4077	2975-3381	59	3	Fair	B	138	1.4	2	48	
TX31	Oldham	35.462	-102.402	3286	4304	2204-4270	2066-4056	34	3	Poor	NG	90	19.1	33	—	
TX32	Oldham	35.371	-102.213	3539	3751	1601-3740	2196-3627	61	5	Fair	B	137	7.5	17	47	
TX33	Oldham	35.426	-102.335	3465	7046	5042-7042	5376-6976	437	12	Poor	NG	125	10.8	37	—	
TX34	Oldham	35.369	-102.351	3550	3847	1840-3831	2292-3111	11	1	Fair	NG	120	—	-	—	
TX35	Oldham	35.424	-102.360	3470	5239	3219-5230	3360-5183	266	7	Good	D	105	11.2	30	15	Bimodal-questionable
TX36	Oldham	35.365	-102.278	3554	4688	2657-4682	2764-4563	248	6	Fair	C	62	8.9	22	152	
TX37	Oldham	35.366	-102.237	3590	3619	400-3618	826-3041	129	4	Fair	D	35	14.9	30	125	
TX38	Oldham	35.316	-102.399	3734	3886	656-3856	796-2897	125	4	Fair	NG	51	16.6	33	—	
TX39	Oldham	35.497	-102.390	3275	6262	4265-6260	4698-5939	231	6	Fair	D	118	12.1	30	28	
TX40	Oldham	35.355	-102.252	3642	3898	2348-3866	2520-3012	25	2	Fair	D	130	7.0	10	40	
TX41	Oldham	35.349	-102.370	3404	7098	5986-7096	6242-6764	32	2	Fair	D	120	3.5	5	30	
TX42	Oldham	35.396	-102.468	3693	3712	997-3703	1558-2358	8	1	Poor	NG	85	—	-	—	
TX43	Oldham	35.199	-102.329	4016	3774	2174-3716	3083-3244	58	1	Fair	NG	165	—	-	—	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

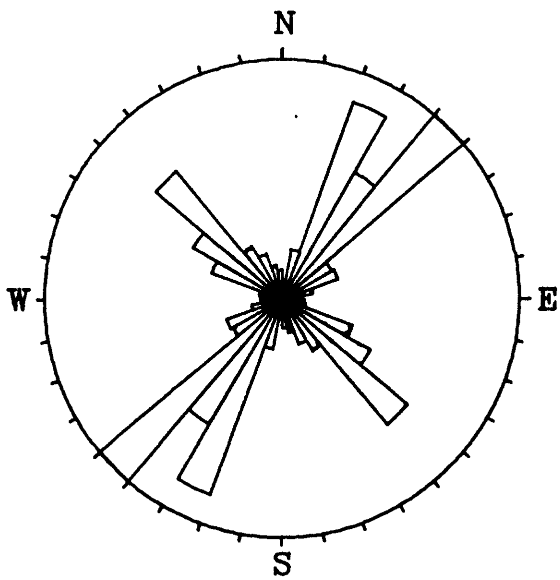
TABLE 5.--Well-bore data for the Palo Duro-Dalhart basins--Continued

Palo Duro-Dalhart Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
TX44	Potter	35.311	-102.064	3436	3577	1554-3576	1879-3367	80	4	Fair	B	163	9.8	20	73	
TX45	Potter	35.271	-102.115	3556	3787	634-3766	2191-2894	83	3	Fair	B	123	2.7	5	33	
TX46	Potter	35.417	-102.105	3218	3822	1772-3818	2968-3426	134	3	Good	C	150	8.0	14	60	
TX47	Oldham	35.404	-102.330	3451	6886	836-6841	1226-6355	547	25	Good	C	36	4.9	25	—	Bimodal/Orthogonal

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



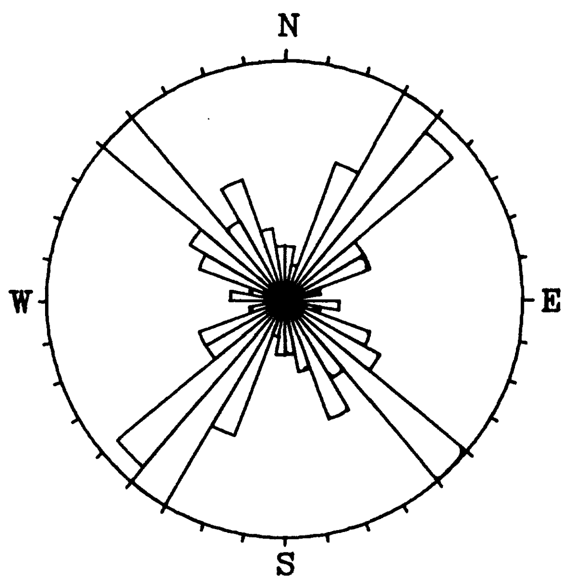


FIGURE 9.--Composite rose diagrams of Palo Duro-Dalhart Basins breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basins in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

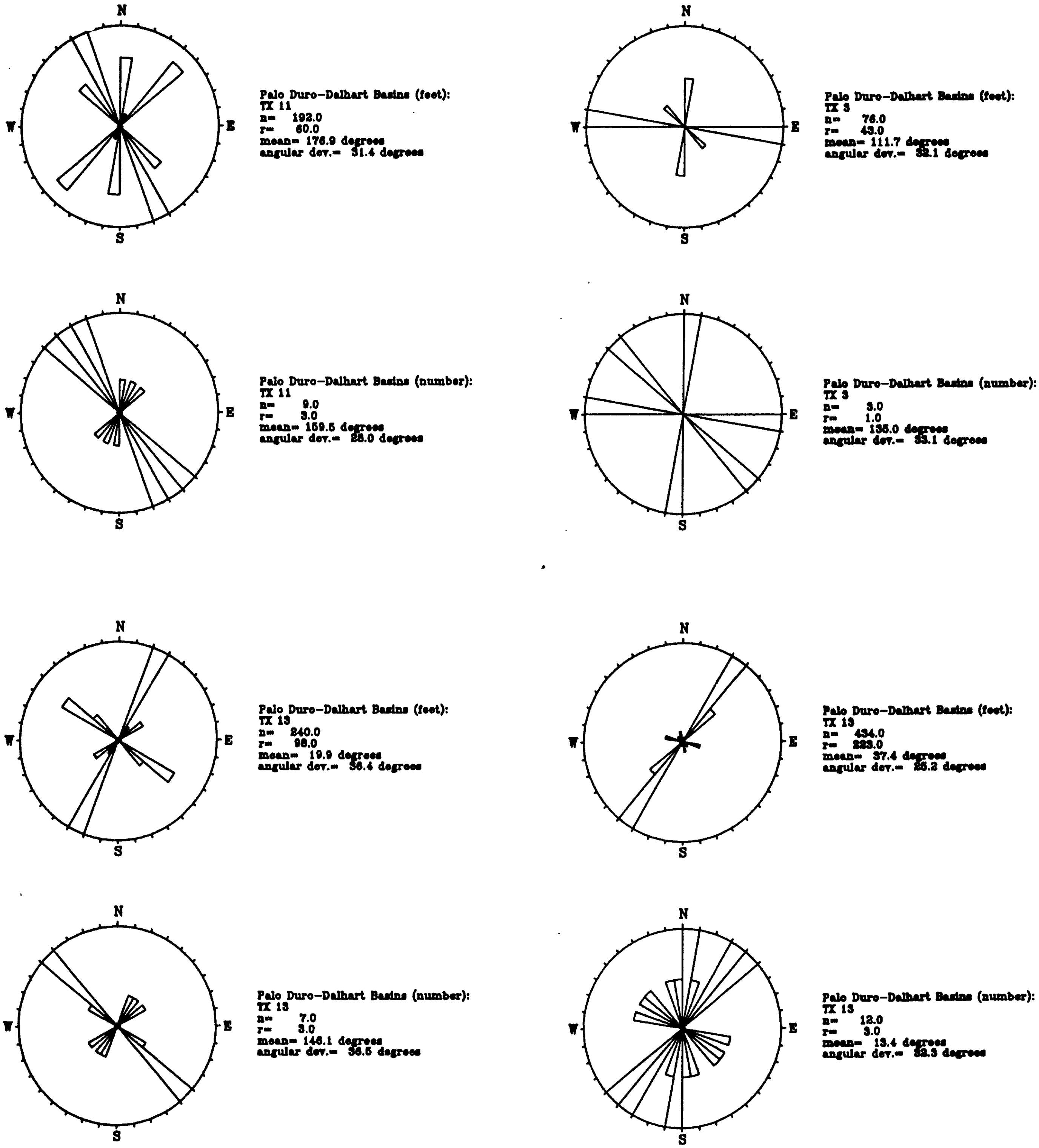


FIGURE 10.--Rose diagrams of Palo Duro-Dalhart Basins breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basins in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

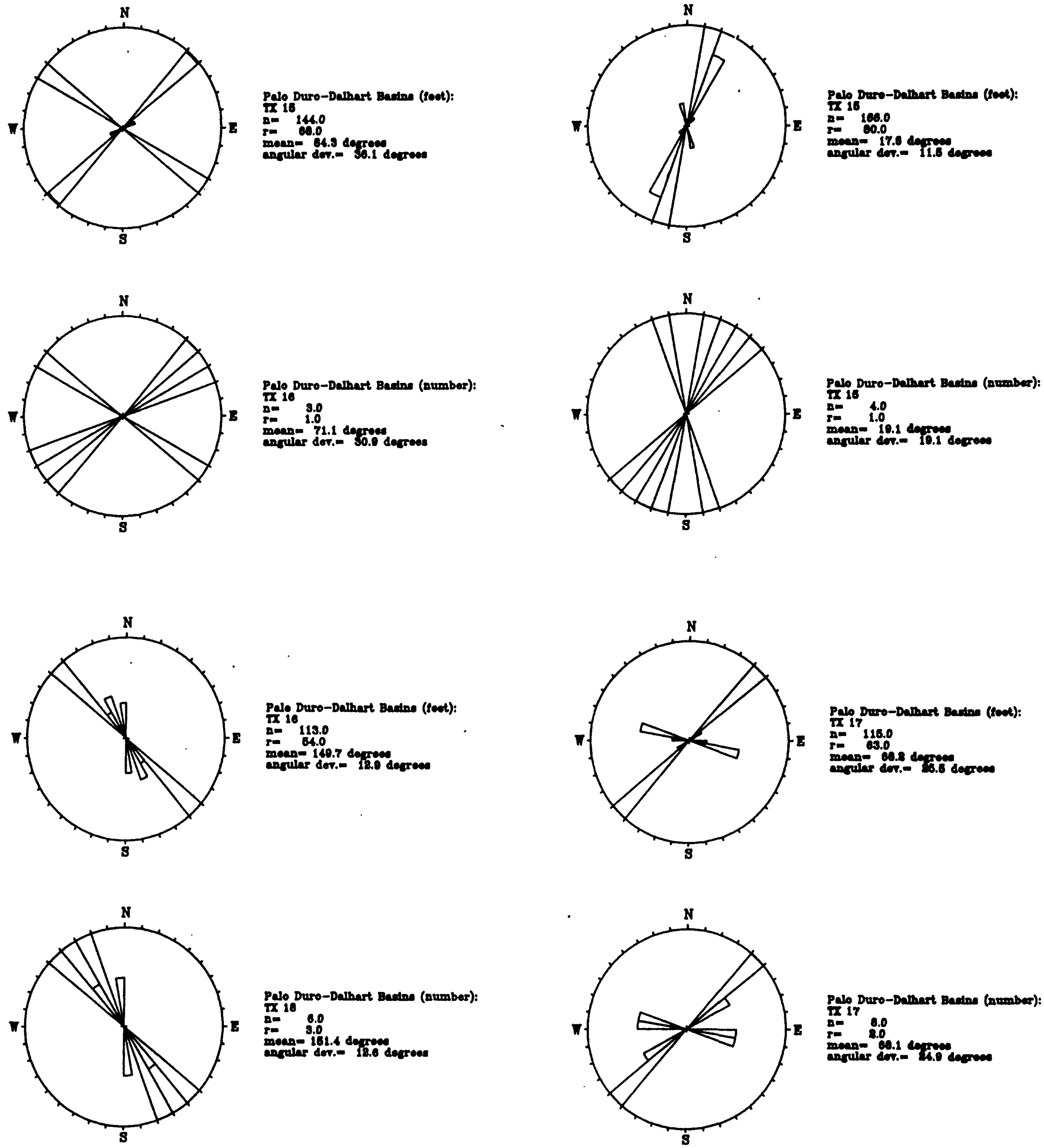


FIGURE 10.--Continued.

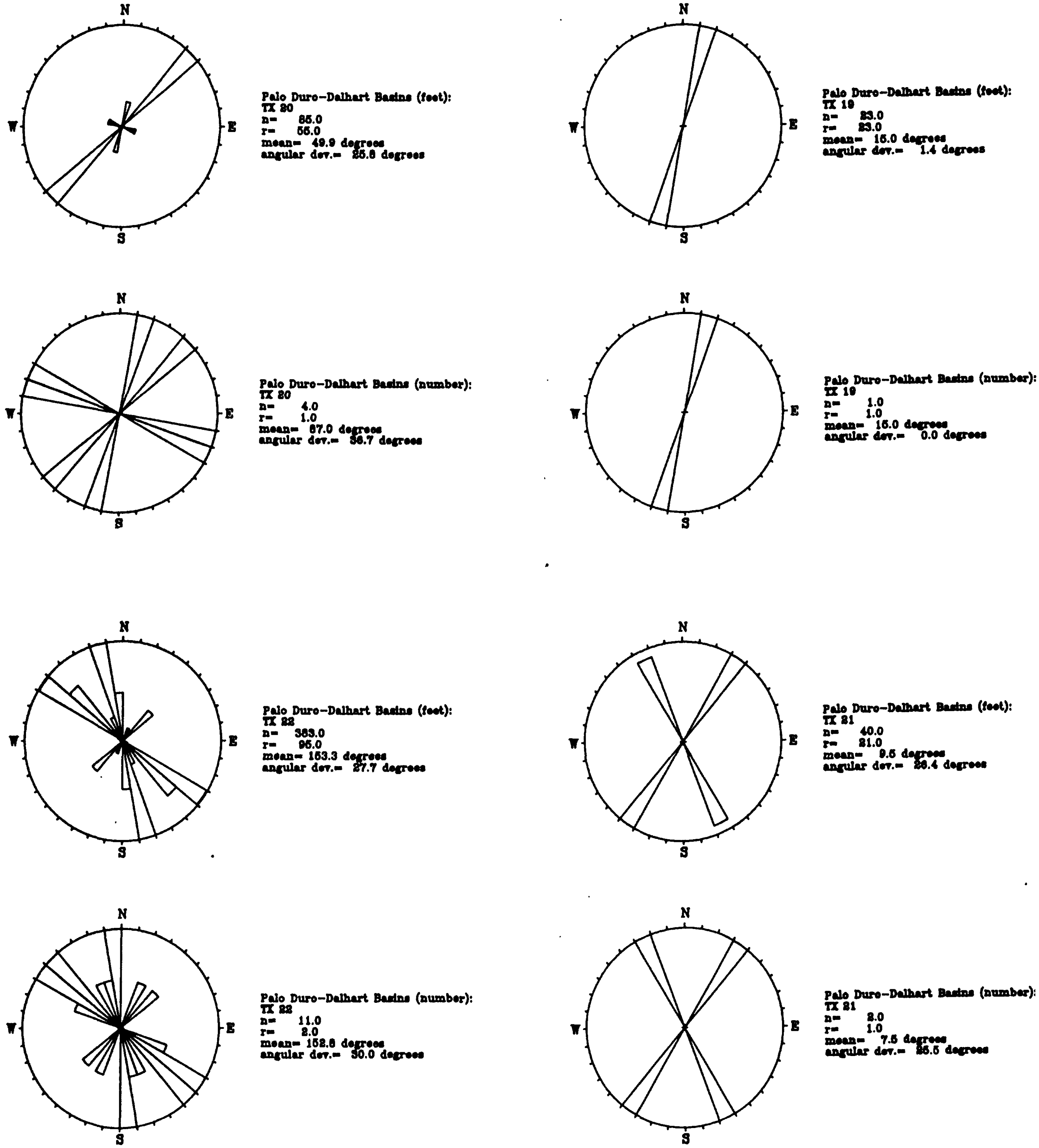
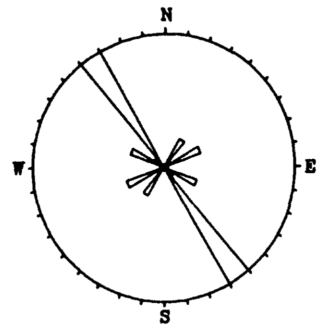
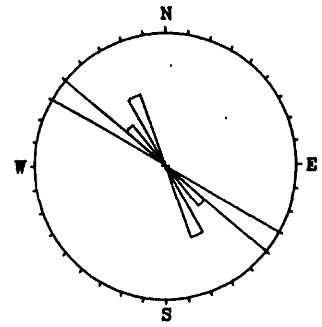


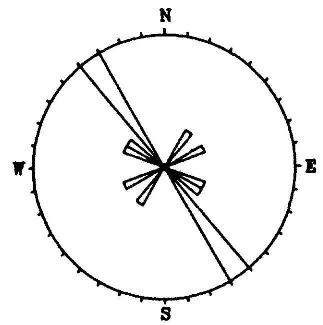
FIGURE 10.--Continued.



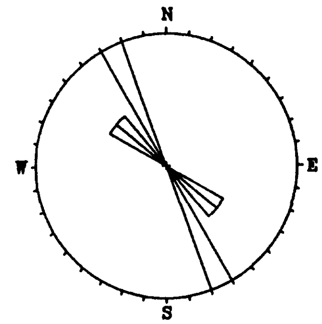
Palo Duro-Dalhart Basins (feet):
TX 24
n= 63.0
r= 33.0
mean= 140.5 degrees
angular dev.= 31.5 degrees



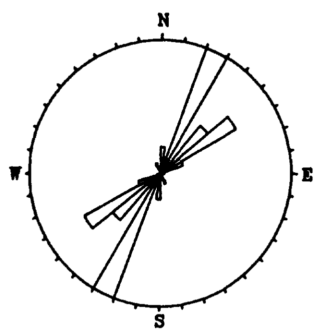
Palo Duro-Dalhart Basins (feet):
TX 23
n= 55.0
r= 28.0
mean= 139.8 degrees
angular dev.= 11.8 degrees



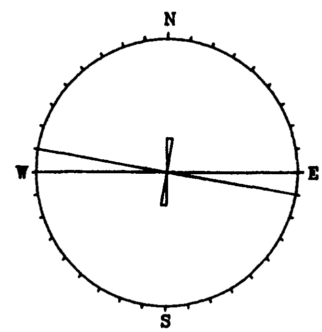
Palo Duro-Dalhart Basins (number):
TX 24
n= 7.0
r= 3.0
mean= 136.0 degrees
angular dev.= 31.7 degrees



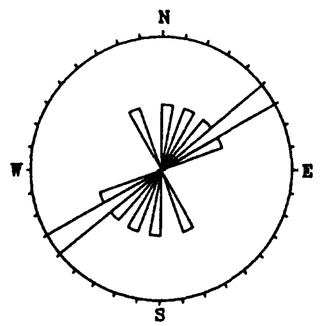
Palo Duro-Dalhart Basins (number):
TX 23
n= 4.0
r= 2.0
mean= 146.3 degrees
angular dev.= 11.6 degrees



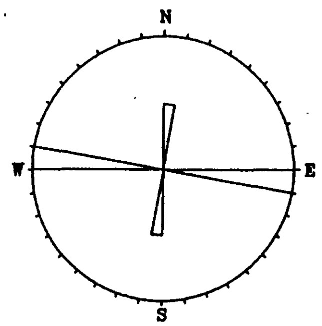
Palo Duro-Dalhart Basins (feet):
TX 26
n= 243.0
r= 93.0
mean= 39.6 degrees
angular dev.= 17.6 degrees



Palo Duro-Dalhart Basins (feet):
TX 28
n= 39.0
r= 31.0
mean= 100.0 degrees
angular dev.= 20.9 degrees

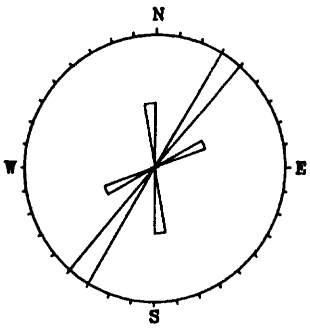


Palo Duro-Dalhart Basins (number):
TX 26
n= 7.0
r= 2.0
mean= 39.5 degrees
angular dev.= 36.3 degrees

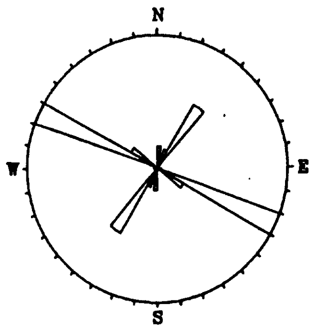


Palo Duro-Dalhart Basins (number):
TX 28
n= 3.0
r= 3.0
mean= 100.0 degrees
angular dev.= 33.1 degrees

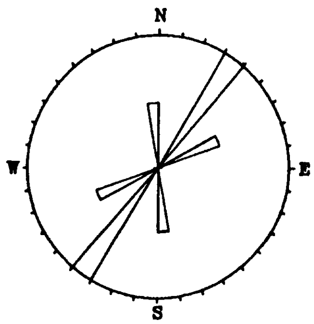
FIGURE 10.--Continued.



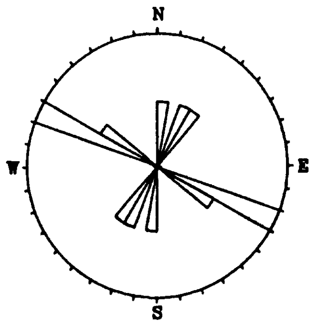
Palo Duro–Dalhart Basins (feet):
TX 29
n= 128.0
r= 71.0
mean= 37.6 degrees
angular dev.= 22.0 degrees



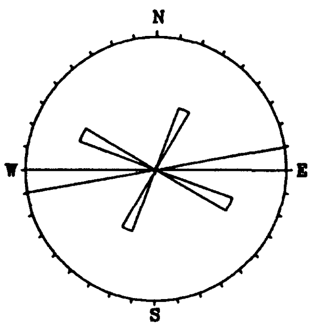
Palo Duro–Dalhart Basins (feet):
TX 28
n= 128.0
r= 61.0
mean= 121.6 degrees
angular dev.= 36.6 degrees



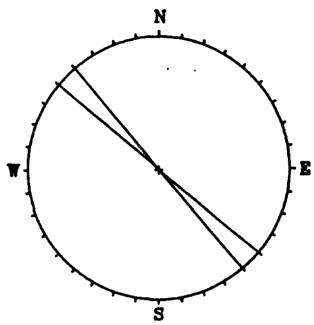
Palo Duro–Dalhart Basins (number):
TX 29
n= 4.0
r= 2.0
mean= 36.9 degrees
angular dev.= 23.3 degrees



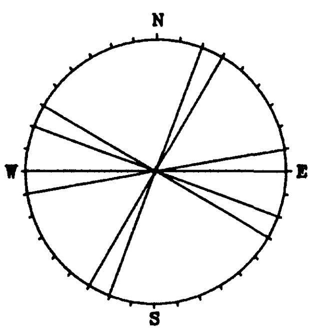
Palo Duro–Dalhart Basins (number):
TX 28
n= 6.0
r= 2.0
mean= 157.4 degrees
angular dev.= 35.2 degrees



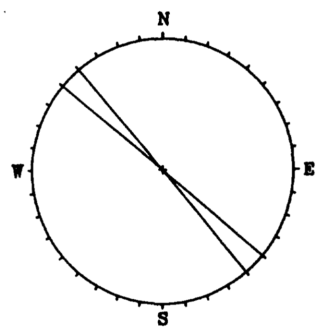
Palo Duro–Dalhart Basins (feet):
TX 31
n= 34.0
r= 16.0
mean= 92.9 degrees
angular dev.= 28.8 degrees



Palo Duro–Dalhart Basins (feet):
TX 30
n= 69.0
r= 59.0
mean= 139.3 degrees
angular dev.= 1.7 degrees

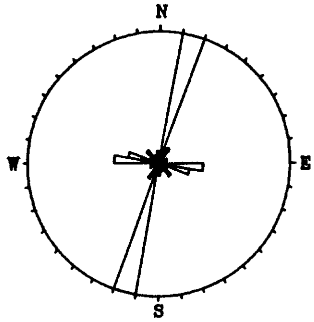


Palo Duro–Dalhart Basins (number):
TX 31
n= 3.0
r= 1.0
mean= 90.0 degrees
angular dev.= 33.1 degrees

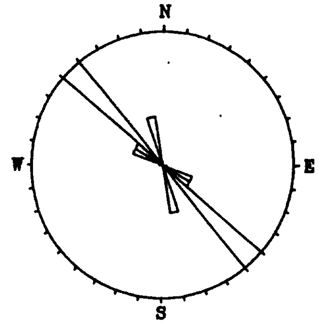


Palo Duro–Dalhart Basins (number):
TX 30
n= 3.0
r= 3.0
mean= 136.3 degrees
angular dev.= 2.4 degrees

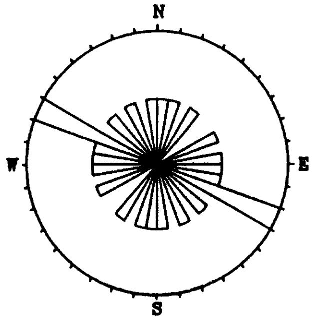
FIGURE 10.--Continued.



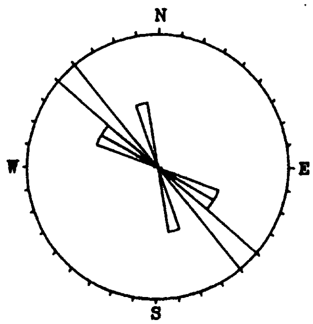
Palo Duro-Dalhart Basins (feet):
TX 33
n= 437.0
r= 192.0
mean= 24.4 degrees
angular dev.= 35.6 degrees



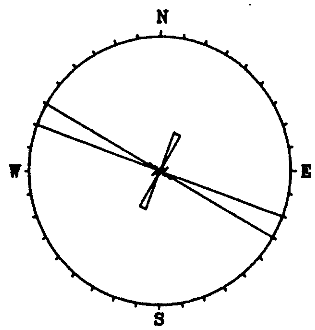
Palo Duro-Dalhart Basins (feet):
TX 32
n= 61.0
r= 33.0
mean= 139.9 degrees
angular dev.= 15.6 degrees



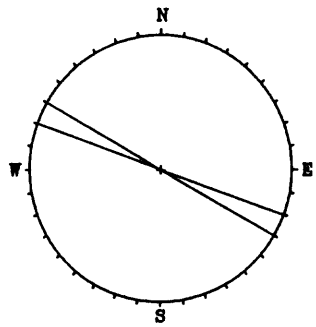
Palo Duro-Dalhart Basins (number):
TX 33
n= 12.0
r= 2.0
mean= 124.7 degrees
angular dev.= 37.3 degrees



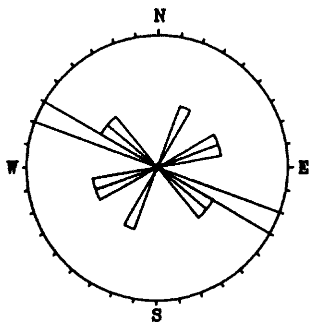
Palo Duro-Dalhart Basins (number):
TX 32
n= 6.0
r= 2.0
mean= 136.9 degrees
angular dev.= 16.6 degrees



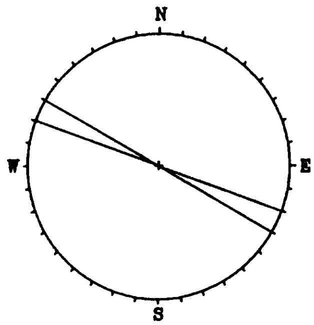
Palo Duro-Dalhart Basins (feet):
TX 35
n= 266.0
r= 170.0
mean= 111.7 degrees
angular dev.= 27.4 degrees



Palo Duro-Dalhart Basins (feet):
TX 34
n= 11.0
r= 11.0
mean= 120.0 degrees
angular dev.= 1.4 degrees

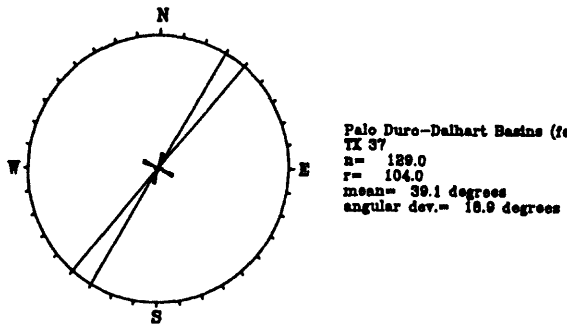


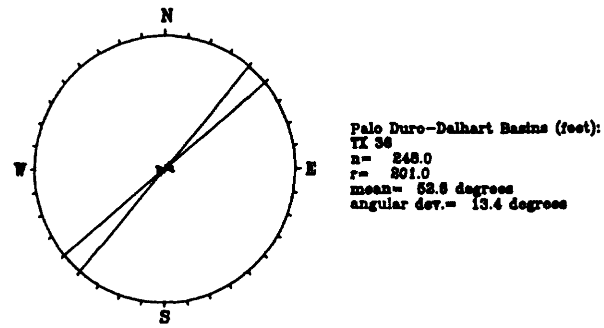
Palo Duro-Dalhart Basins (number):
TX 35
n= 7.0
r= 2.0
mean= 104.9 degrees
angular dev.= 29.6 degrees

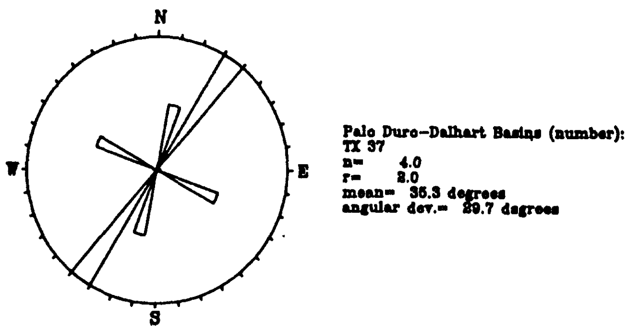


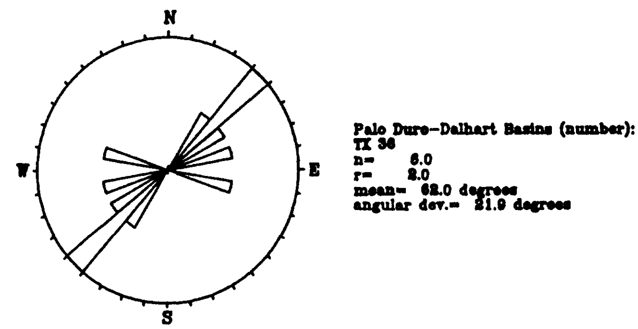
Palo Duro-Dalhart Basins (number):
TX 34
n= 1.0
r= 1.0
mean= 120.0 degrees
angular dev.= 0.0 degrees

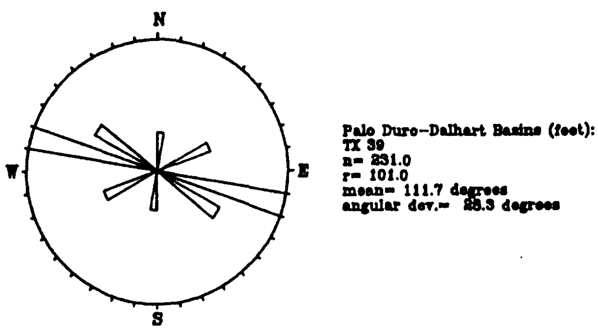
FIGURE 10.--Continued.

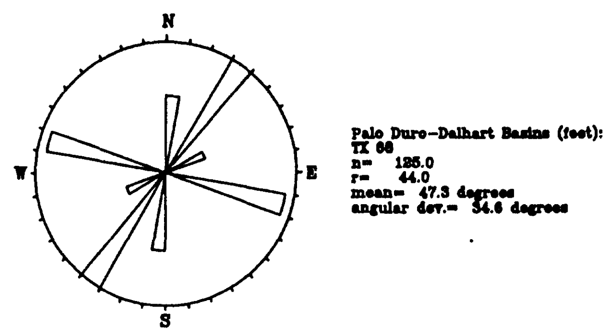


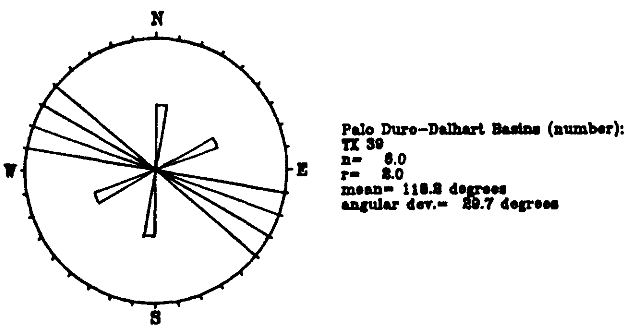












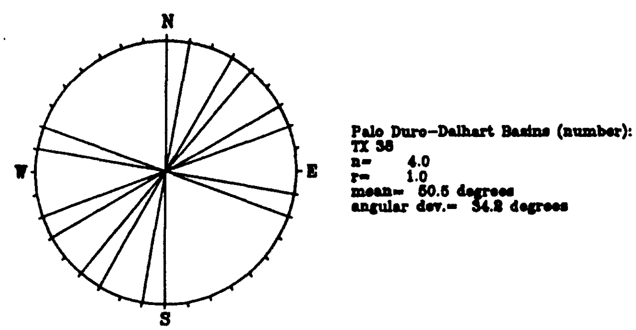
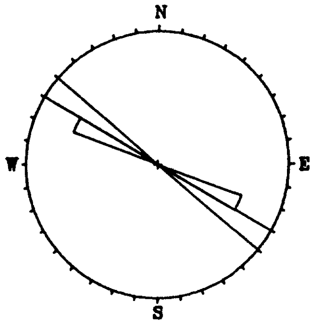
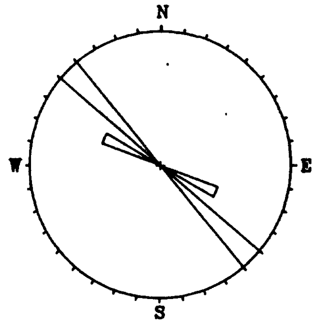


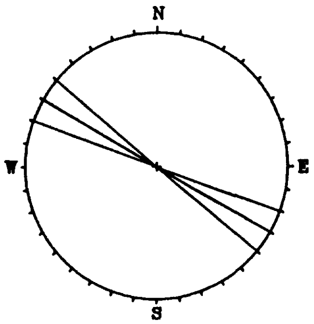
FIGURE 10.--Continued.



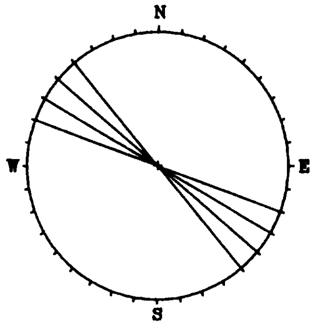
Palo Duro-Dalhart Basins (feet):
TX 41
n= 32.0
r= 19.0
mean= 120.9 degrees
angular dev.= 4.9 degrees



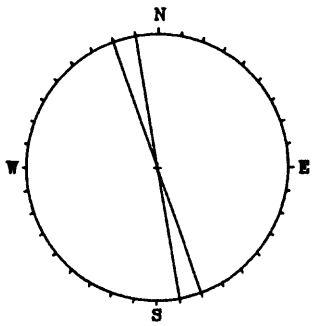
Palo Duro-Dalhart Basins (feet):
TX 40
n= 25.0
r= 17.0
mean= 133.7 degrees
angular dev.= 9.3 degrees



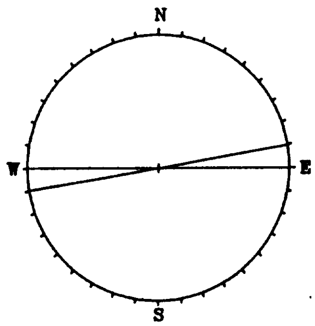
Palo Duro-Dalhart Basins (number):
TX 41
n= 2.0
r= 1.0
mean= 120.0 degrees
angular dev.= 5.0 degrees



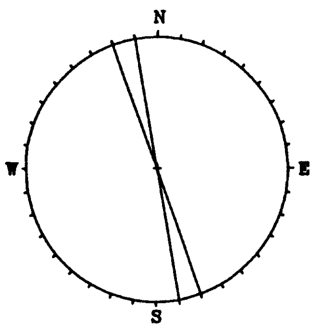
Palo Duro-Dalhart Basins (number):
TX 40
n= 2.0
r= 1.0
mean= 130.0 degrees
angular dev.= 9.9 degrees



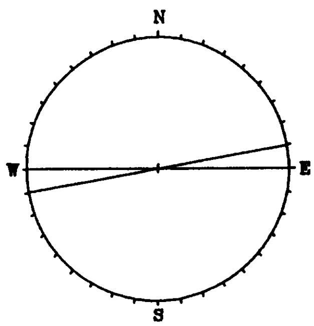
Palo Duro-Dalhart Basins (feet):
TX 43
n= 58.0
r= 58.0
mean= 165.0 degrees
angular dev.= 0.0 degrees



Palo Duro-Dalhart Basins (feet):
TX 42
n= 8.0
r= 8.0
mean= 85.0 degrees
angular dev.= 0.0 degrees

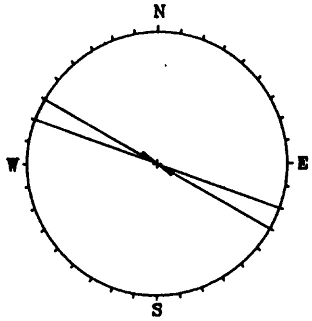


Palo Duro-Dalhart Basins (number):
TX 43
n= 1.0
r= 1.0
mean= 165.0 degrees
angular dev.= 0.0 degrees

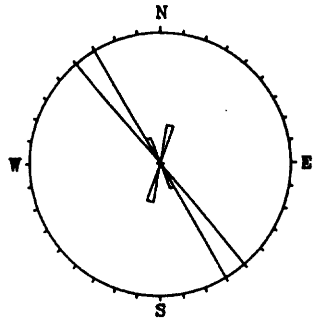


Palo Duro-Dalhart Basins (number):
TX 42
n= 1.0
r= 1.0
mean= 85.0 degrees
angular dev.= 0.0 degrees

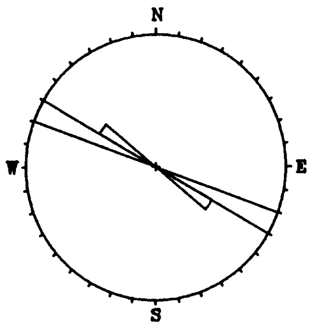
FIGURE 10.--Continued.



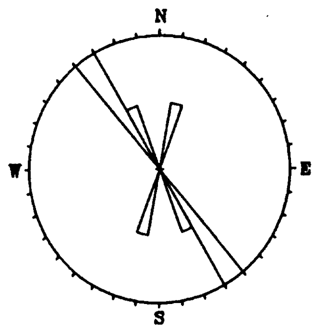
Palo Duro-Dalhart Basins (feet):
TX 45
n= 83.0
r= 73.0
mean= 121.2 degrees
angular dev.= 3.2 degrees



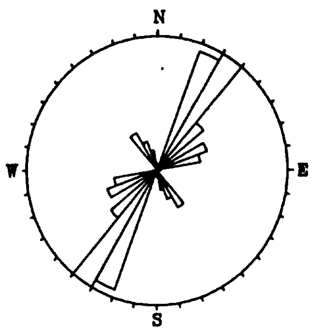
Palo Duro-Dalhart Basins (feet):
TX 44
n= 80.0
r= 63.0
mean= 158.9 degrees
angular dev.= 18.3 degrees



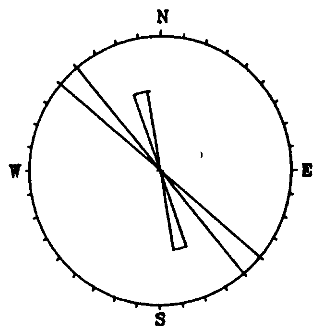
Palo Duro-Dalhart Basins (number):
TX 45
n= 3.0
r= 2.0
mean= 123.3 degrees
angular dev.= 4.7 degrees



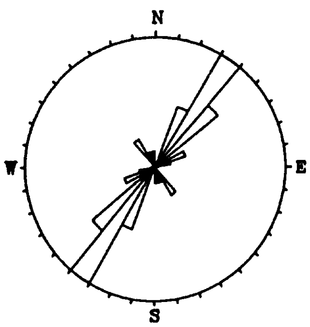
Palo Duro-Dalhart Basins (number):
TX 44
n= 4.0
r= 2.0
mean= 162.6 degrees
angular dev.= 19.6 degrees



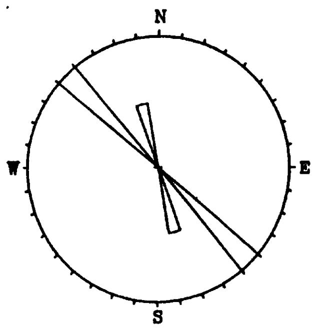
Palo Duro-Dalhart Basins (feet):
TX 47
n= 547.0
r= 140.0
mean= 38.2 degrees
angular dev.= 26.5 degrees



Palo Duro-Dalhart Basins (feet):
TX 46
n= 134.0
r= 120.0
mean= 142.7 degrees
angular dev.= 9.9 degrees



Palo Duro-Dalhart Basins (number):
TX 47
n= 25.0
r= 8.0
mean= 38.4 degrees
angular dev.= 24.5 degrees



Palo Duro-Dalhart Basins (number):
TX 46
n= 3.0
r= 2.0
mean= 149.6 degrees
angular dev.= 13.9 degrees

FIGURE 10.--Continued.

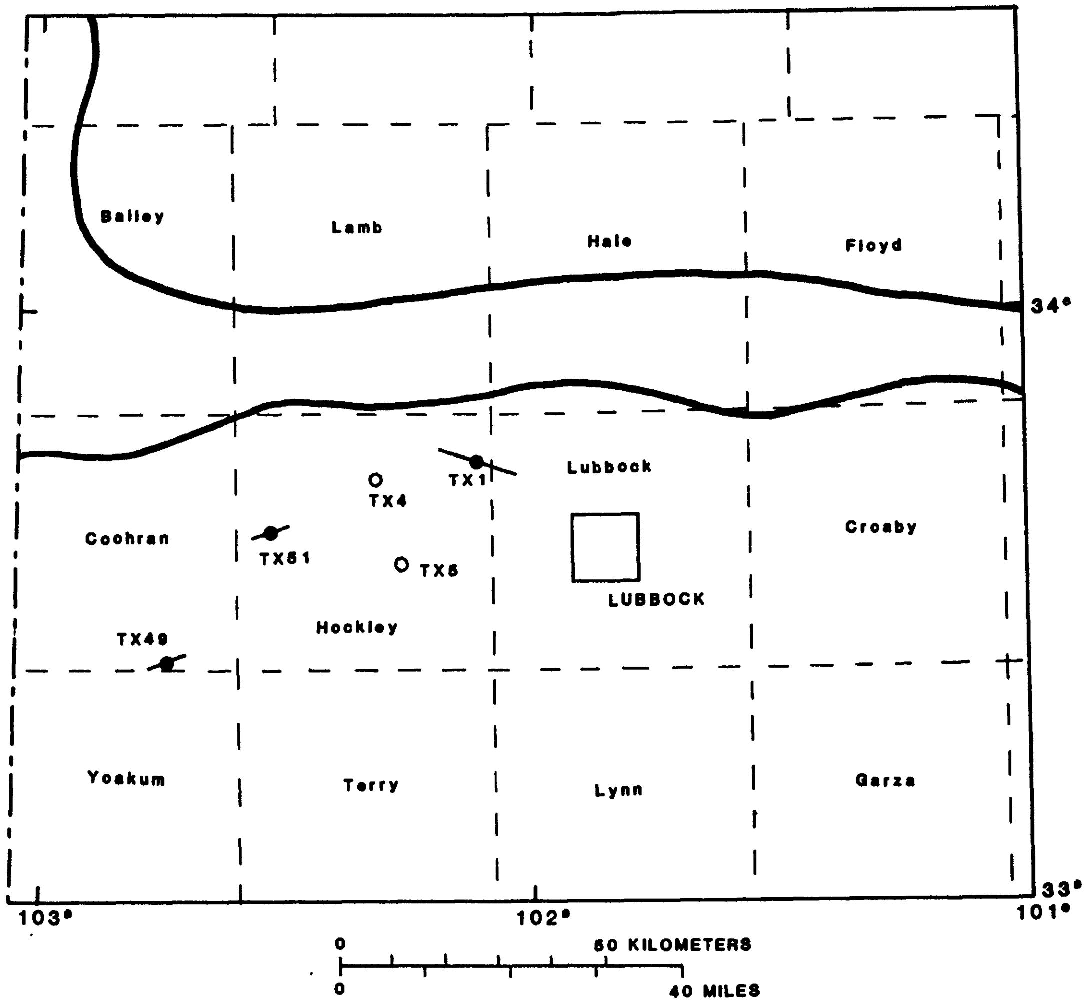


FIGURE 11.--Midland Basin well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines.

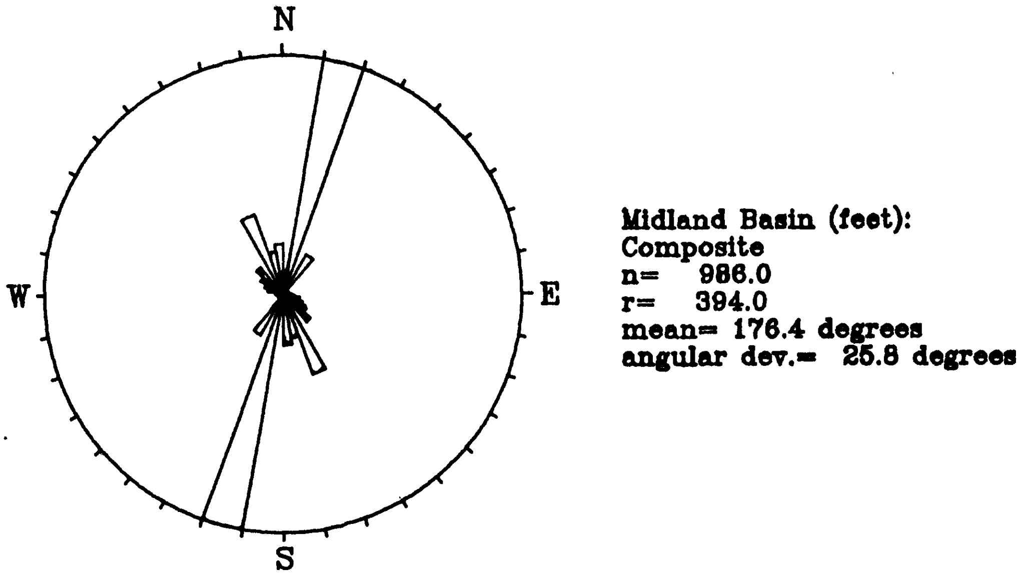
TABLE 6.--Well-bore data for the Midland basin

Midland Basin

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	986	24	—	-	166	5.3	26	76	Basin composite
TX1	Hockley	33.741	-102.092	3350	6735	4135-6685	4171-6353	430	5	Fair	B	17	5.8	13	107	
TX4	Hockley	33.713	-102.302	3489	6403	4396-6402	5043-5790	33	1	Fair	NG	25	—	-	—	
TX5	Hockley	33.568	-102.250	3442	7396	2546-7386	3416-6542	145	6	Good	NG	94	15.1	37	—	
TX49	Cochran	33.403	-102.723	3709	8409	1864-8407	2304-7929	408	14	Fair	C	161	6.9	26	71	
TX51	Hockley	33.622	-102.513	2654	8934	7432-8932	7492-8432	148	5	Fair	B	160	9.7	22	70	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



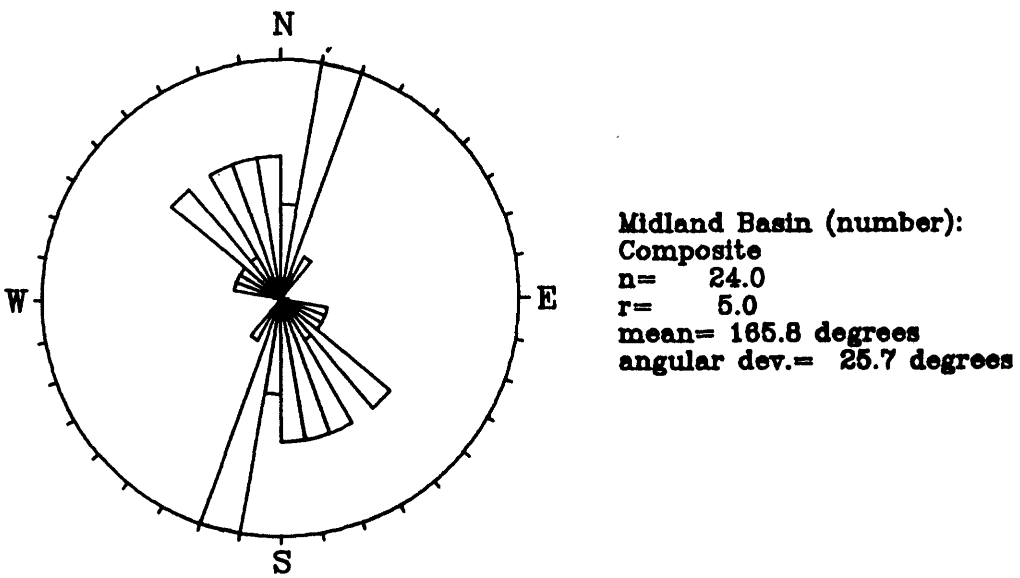


FIGURE 12.--Composite rose diagrams of Midland Basin breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basin in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

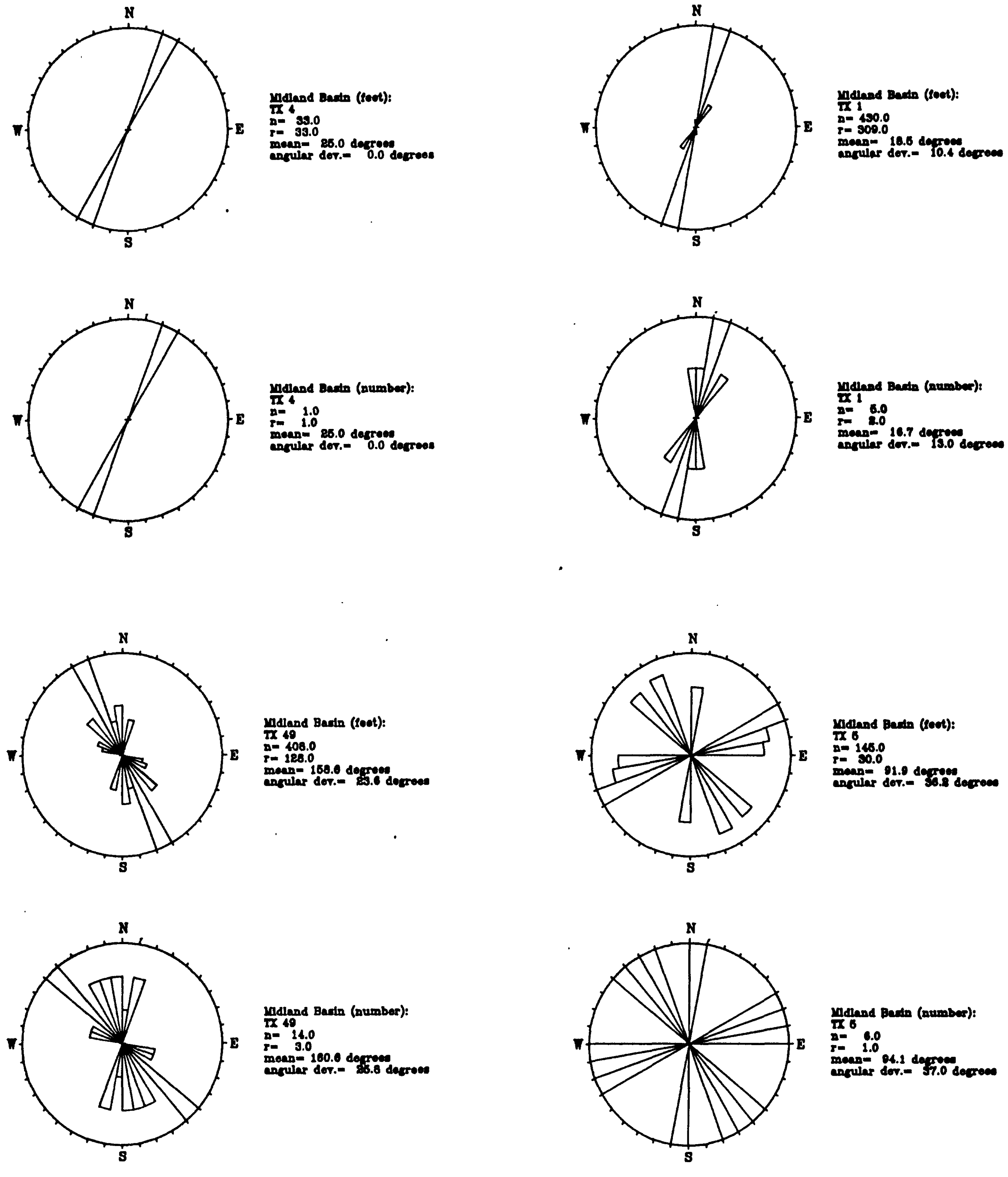
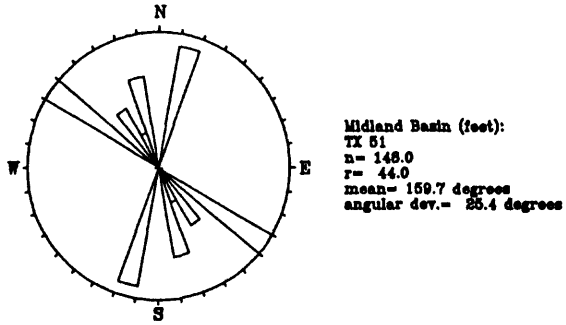


FIGURE 13.--Rose diagrams of Midland Basin breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the Basin in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.



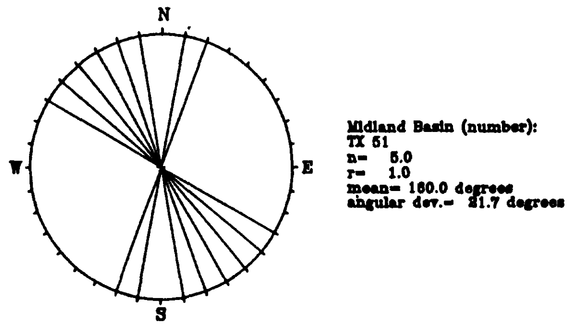


FIGURE 13.--Continued.

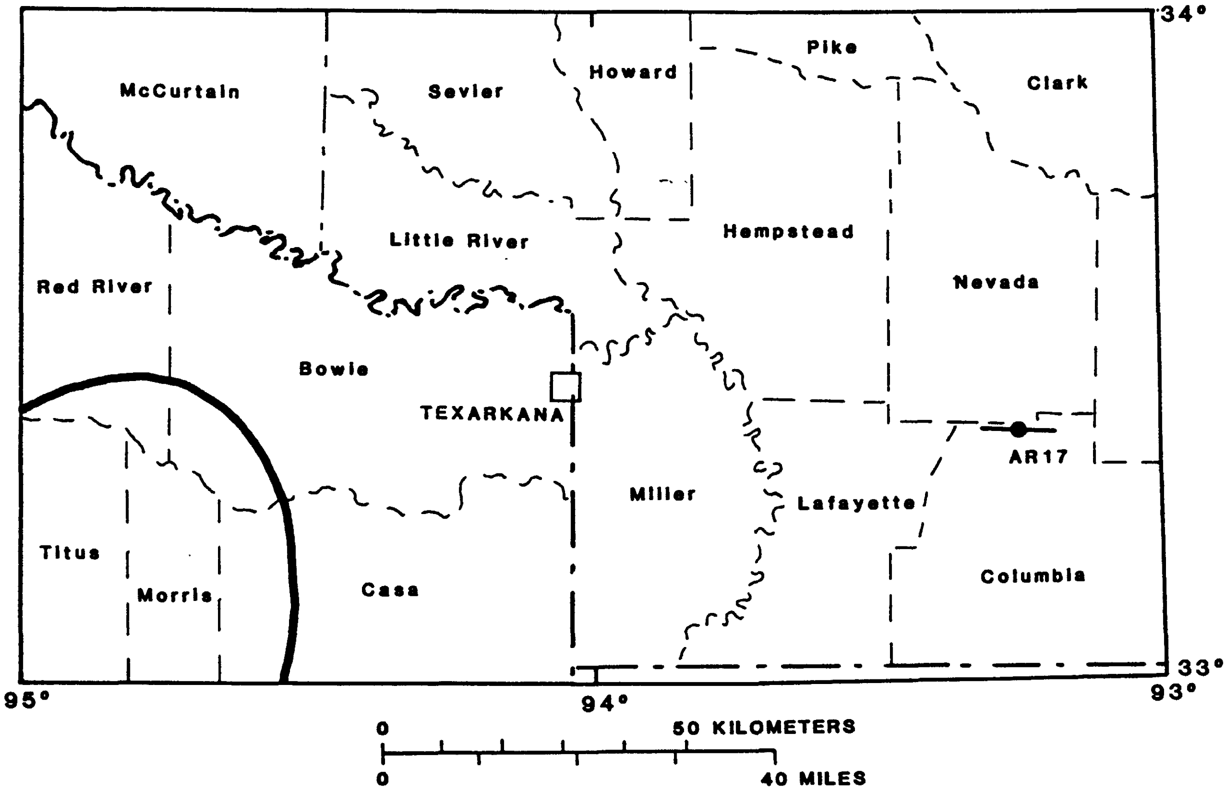


FIGURE 14.--Gulf Coastal Plain well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines. The well location for OK23 can be found on figure 22.

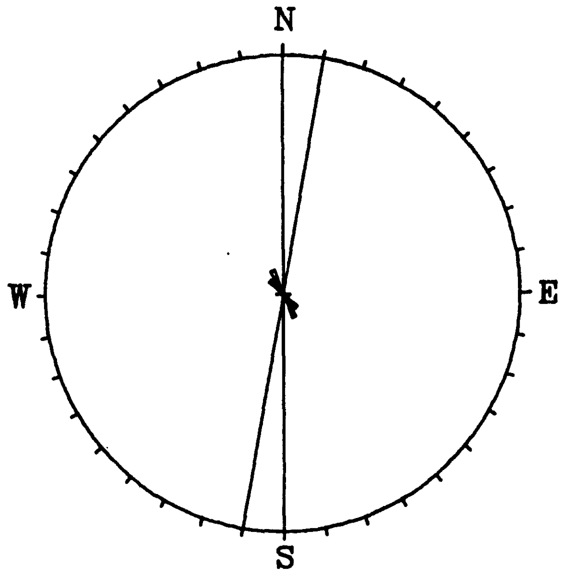
TABLE 7.--Well-bore data for the Gulf Coastal Plain

Gulf Coastal Plain

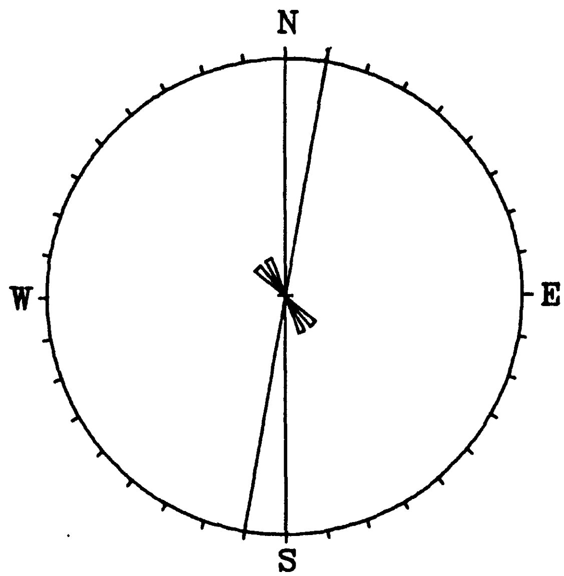
Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	445	8	—	-	176	5.9	17	86	Area composite
AR17	Columbia	33.373	-93.249	311	7351	2715-7350	5296-6971	445	8	Fair	B	179	6.4	18	89	
OK23	Choctaw	34.011	-95.598	450	4400	934-4398	3098-4374	332	4	Poor	NG	153	17.2	34	—	Bimodal-questionable

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



Gulf Coastal Plain (feet):
Composite
n= 445.0
r= 376.0
mean= 2.9 degrees
angular dev.= 13.2 degrees



Gulf Coastal Plain (number):
Composite
n= 8.0
r= 6.0
mean= 175.7 degrees
angular dev.= 16.8 degrees

FIGURE 15.--Composite rose diagrams of Gulf Coastal Plain breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10^{o} intervals. Listed are (1) the basin in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

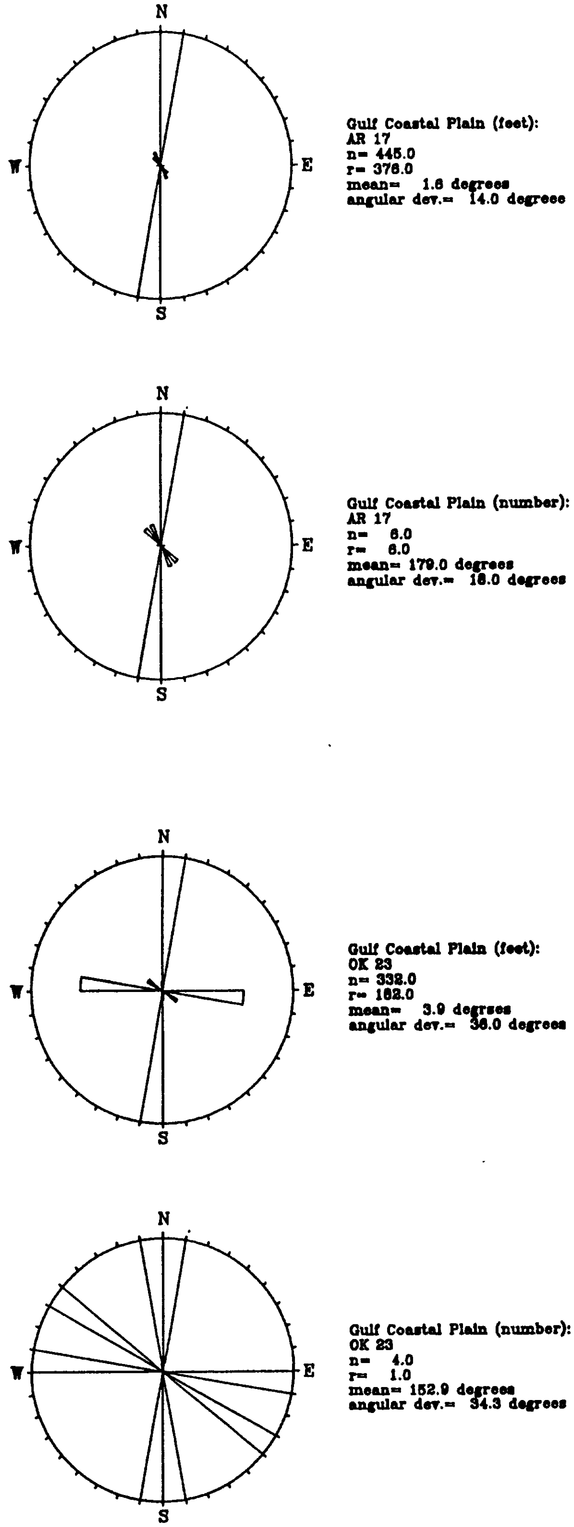


FIGURE 16.--Rose diagrams of Gulf Coastal Plain breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

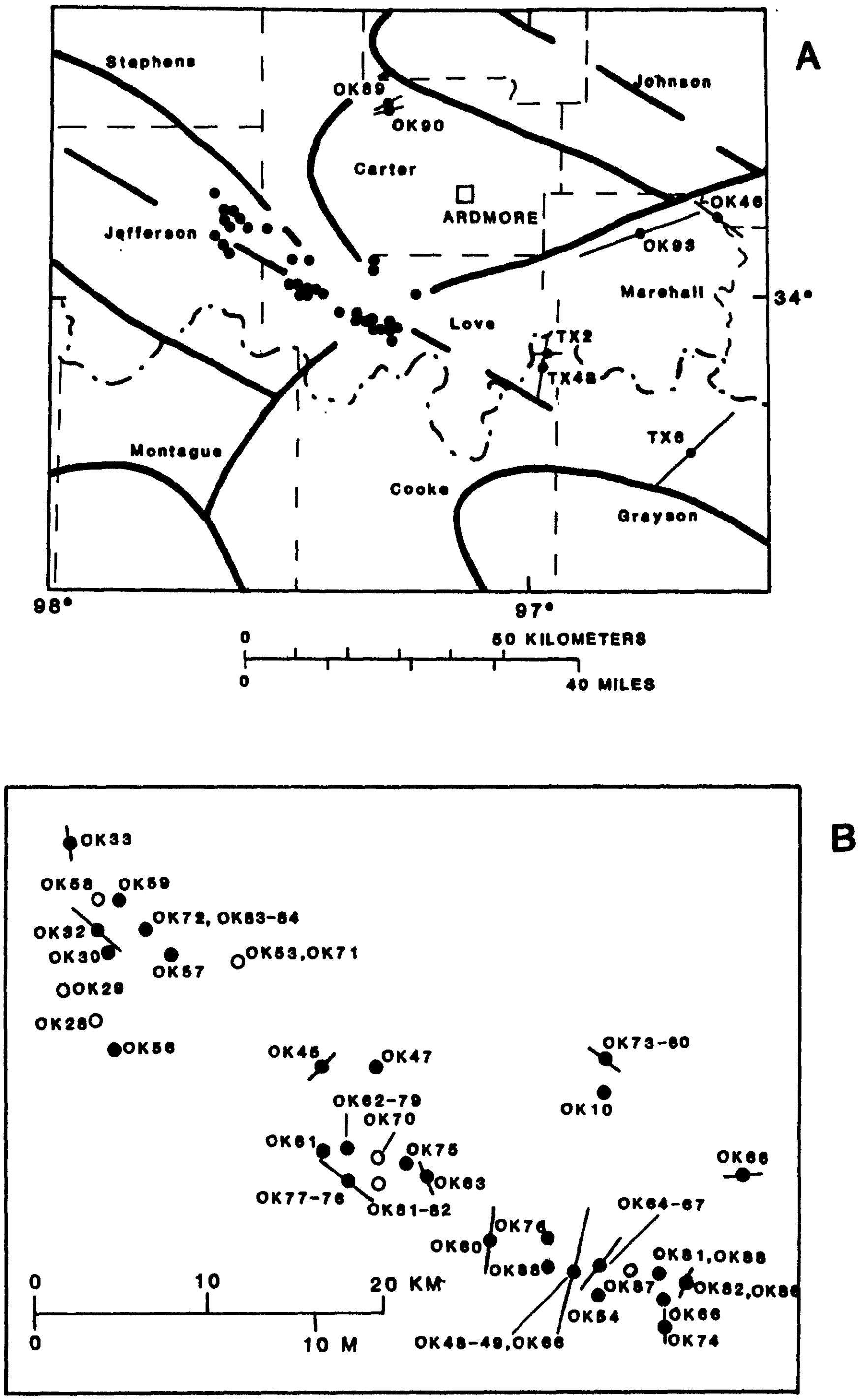


FIGURE 17.--Marietta-Ardmore Basins well-location maps A and B. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles with bars are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines or dashed lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines. Map B is an enlargement of the area southwest of Ardmore, Oklahoma. Well locations with two orientations of S_{Hmax} indicate two or more wells in close proximity.

TABLE 8.--Well-bore data for the Marietta-Ardmore basins

Marietta-Ardmore Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	5827	125	—	-	138	3.4	38	—	Basins composite
OK10	Love	34.047	-97.316	792	9170	6595-9095	7273-7401	58	2	Poor	NG	180	21.8	31	—	Bimodal/Orthogonal
OK28	Jefferson	34.092	-97.627	854	7121	4824-7120	5864-6684	14	1	Fair	NG	58	—	-	—	
OK29	Jefferson	34.107	-97.648	828	6768	4733-6786	5240-6394	171	3	Fair	NG	40	13.6	24	—	
OK30	Jefferson	34.118	-97.614	876	7704	5601-7691	6571-7405	93	2	Fair	NG	26	27.4	39	—	Bimodal/Orthogonal
OK32	McClain	34.135	-97.626	1085	6461	4456-6456	5342-6138	220	5	Good	B	55	8.0	18	145	
OK33	Jefferson	34.177	-97.648	816	6872	4672-6562	5988-6840	93	4	Fair	C	76	13.0	26	166	
OK45	Love	34.068	-97.486	923	9378	6062-9348	8202-9224	590	3	Poor	C	137	12.5	22	47	
OK46	Marshall	34.138	-96.598	727	5296	3061-5261	3471-3806	229	4	Fair	B	37	6.0	12	127	
OK47	Love	34.063	-97.453	931	10046	7546-9396	8540-8609	227	2	Poor	D	23	3.5	5	113	
OK48-49	Love	33.959	-97.333	846	8866	6841-8860	7884-8673	145	5	Good-Fair	NG	103	15.5	35	—	Bimodal-questionable
OK51	Love	33.962	-97.281	730	9934	7905-9933	9426-9592	31	2	Poor	D	63	3.5	5	153	
OK52	Love	33.949	-97.266	918	10547	8911-10516	8939-10341	116	4	Fair	NG	118	17.9	36	—	Bimodal/Orthogonal
OK53	Carter	34.122	-97.577	889	9899	6594-9891	7670-10726	251	10	Fair	NG	16	10.7	34	—	Bimodal-questionable
OK54	Love	33.943	-97.318	814	9281	8357-9217	8546-8871	84	2	Fair	D	88	3.5	5	178	
OK55	Love	33.959	-97.282	793	6519	5386-6506	5726-6446	344	10	Fair	NG	82	10.2	32	—	
OK56	Jefferson	34.079	-97.617	797	6682	6674-7361	6240-6548	38	2	Fair	D	48	7.0	10	138	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

TABLE 8.--Well-bore data for the Marietta-Ardmore basins--Continued

Marietta-Ardmore Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
OK57	Jefferson	34.119	-97.579	810	8349	7419-8347	7495-8075	194	4	Poor	NG	66	15.2	30	—	Bimodal/Orthogonal
OK58	Jefferson	34.151	-97.626	818	7159	6404-7158	6418-7123	22	1	Fair	NG	13	—	-	—	
OK59	Jefferson	34.148	-97.610	907	7664	6679-7671	7321-7556	18	2	Fair	D	148	7.0	10	58	
OK60	Love	33.976	-97.387	930	8123	5054-8100	5776-7924	218	4	Poor	B	97	9.4	19	7	
OK61	Love	34.023	-97.492	855	8028	6028-9771	7027-7998	179	9	Good	D	121	8.9	27	31	Bimodal-questionable
OK62-79	Love	34.022	-97.476	855	7781	5571-7766	5799-7636	594	15	Good-	D	142	7.5	29	52	
OK63	Love	34.006	-97.423	948	8190	6133-8160	7789-7937	39	3	Fair	C	81	13.6	24	171	
OK64-67	Love	33.963	-97.320	785	9127	6900-9126	7020-8851	300	8	Good Fair	B	124	4.7	13	34	
OK66	Love	33.956	-97.332	845	8799	5798-6739	8337-8641	191	5	Poor	A	107	4.9	11	17	
OK68	Love	33.947	-97.281	717	9405	7765-9385	8535-9359	120	4	Poor	D	146	14.4	29	56	Bimodal-questionable
OK70	Love	34.019	-97.454	890	7955	6924-7950	5925-7892	133	5	Fair	NG	160	18.0	40	—	Bimodal-questionable
OK71	Carter	34.119	-97.539	878	9751	6606-9729	7722-9283	193	3	Poor	NG	103	20.6	36	—	Bimodal-questionable
OK72	Jefferson	34.137	-97.595	839	7911	6948-7910	7100-7673	211	3	Fair	NG	146	18.3	32	—	
Ok73-80	Love	34.065	-97.315	868	10370	5873-10369	7210-8605	385	5	Fair-	C	46	3.9	9	136	
OK74	Love	33.928	-97.279	695	9290	6735-9289	7255-9128	121	3	Poor	C	102	10.0	17	12	
OK75	Love	34.019	-97.444	930	8193	7053-8192	7566-8108	54	2	Poor	D	88	10.5	15	178	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

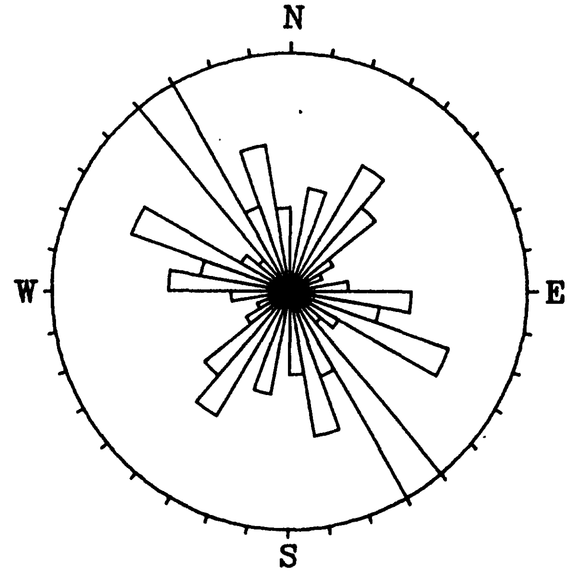
TABLE 8.--Well-bore data for the Marietta-Ardmore basins--Continued

Marietta-Ardmore Basins

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
OK76	Love	33.976	-97.351	868	8520	5920-8487	7408-8036	89	2	Poor	D	101	1.8	3	11	
OK77-78	Love	34.004	-97.474	900	7817	5685-7807	6886-7627	163	6	Fair-Good	B	41	8.9	21	131	Bimodal-questionable
OK81-82	Love	34.004	-97.452	875	8019	5911-7984	6123-7877	338	10	Good-Poor	NG	126	10.3	33	—	Bimodal-questionable
OK83-84	Jefferson	33.898	-97.557	895	7999	5789-7998	7049-7798	153	5	Fair-Good	D	136	12.1	27	—	Bimodal/Orthogonal
OK85	Love	33.960	-97.352	954	8399	6333-8383	7917-8188	135	3	Fair	D	129	17.3	30	39	
OK86	Love	33.695	-97.238	870	11716	7605-11715	7780-11572	148	3	Fair	C	103	6.2	11	13	
OK87	Love	33.946	-97.298	710	9198	7195-9195	7326-8969	98	6	Good	NG	112	13.2	33	—	
OK88	Love	34.008	-97.230	887	11228	6600-11227	9462-10724	151	2	Fair	C	163	10.	1	73	
OK89	Carter	34.337	-97.287	911	6627	1219-6014	1386-6483	253	11	Good	C	146	8.0	26	56	
OK90	Carter	34.326	-97.286	900	9179	6775-9179	6878-7045	216	3	Poor	C	165	7.1	12	75	
OK93	Marshall	34.108	-96.757	759	13575	11619-13437	11969-11983	206	7	Good	A	160	2.3	6	70	
TX2	Cooke	33.904	-96.948	700	15584	7174-15584	7174-15529	654	21	Good	C	179	5.2	24	89	
TX6	Grayson	33.732	-96.654	736	10012	5249-9977	6929-9487	928	5	Fair	A	137	4.4	10	47	
TX48	Cooke	33.879	-96.962	725	12670	10708-12663	10828-12266	108	6	Good	B	98	8.3	20	8	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



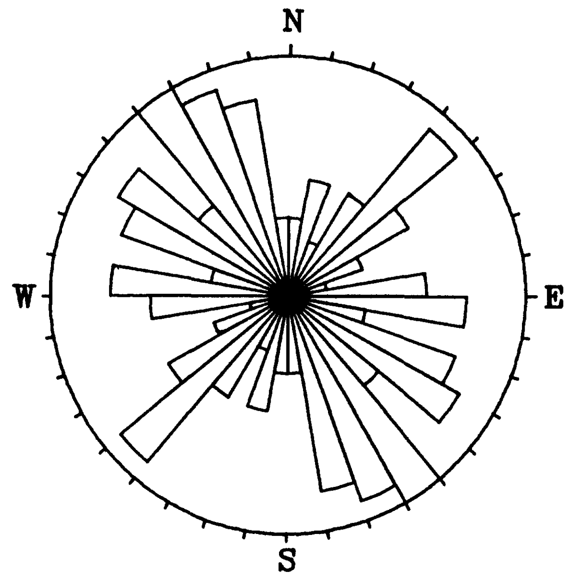


FIGURE 18.--Composite rose diagrams of Marietta-Ardmore Basins breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basins in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

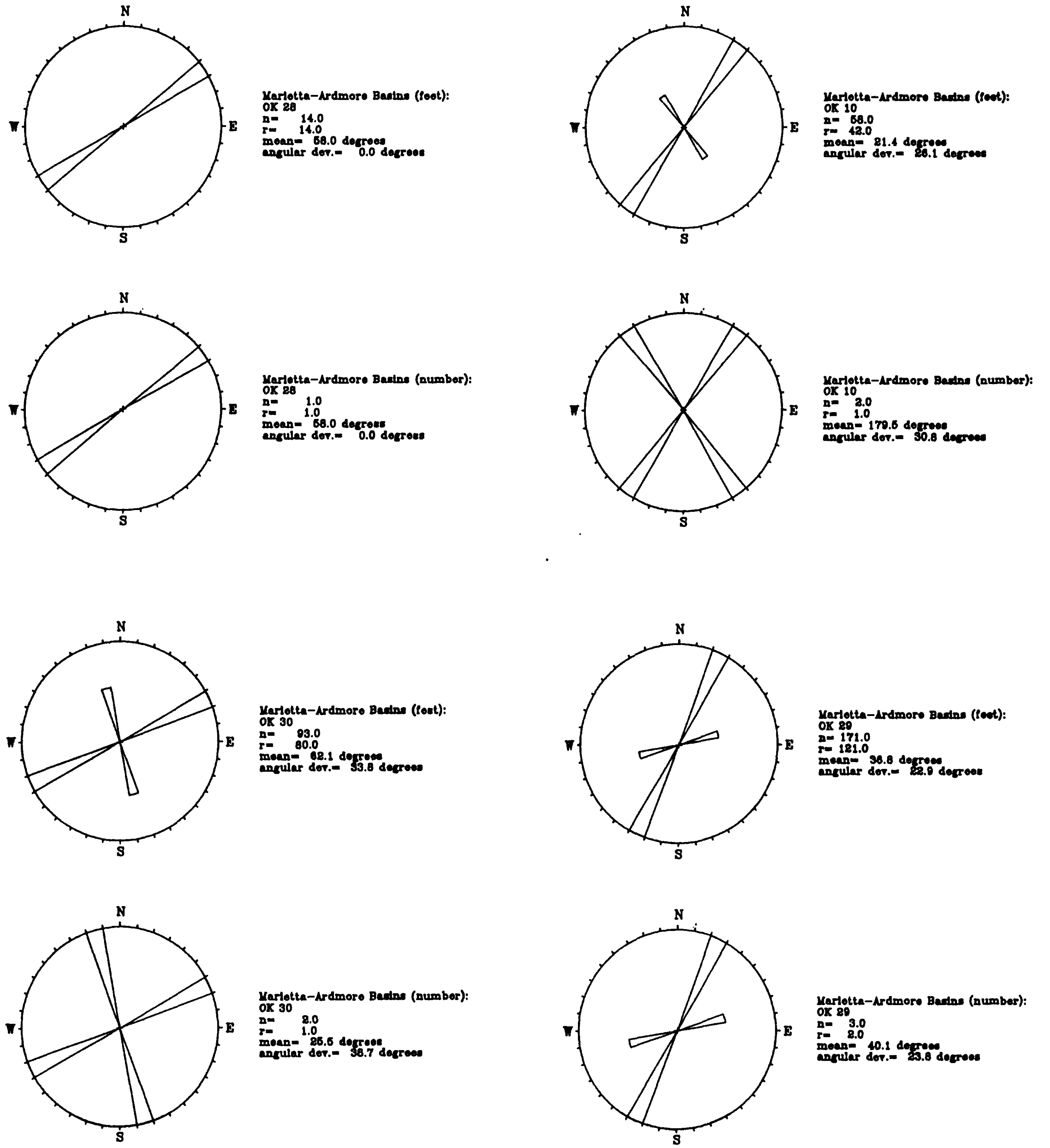


FIGURE 19.--Rose diagrams of Marietta-Ardmore Basins breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basins in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r.), (5) circular mean of the data, and (6) angular deviation of the data.

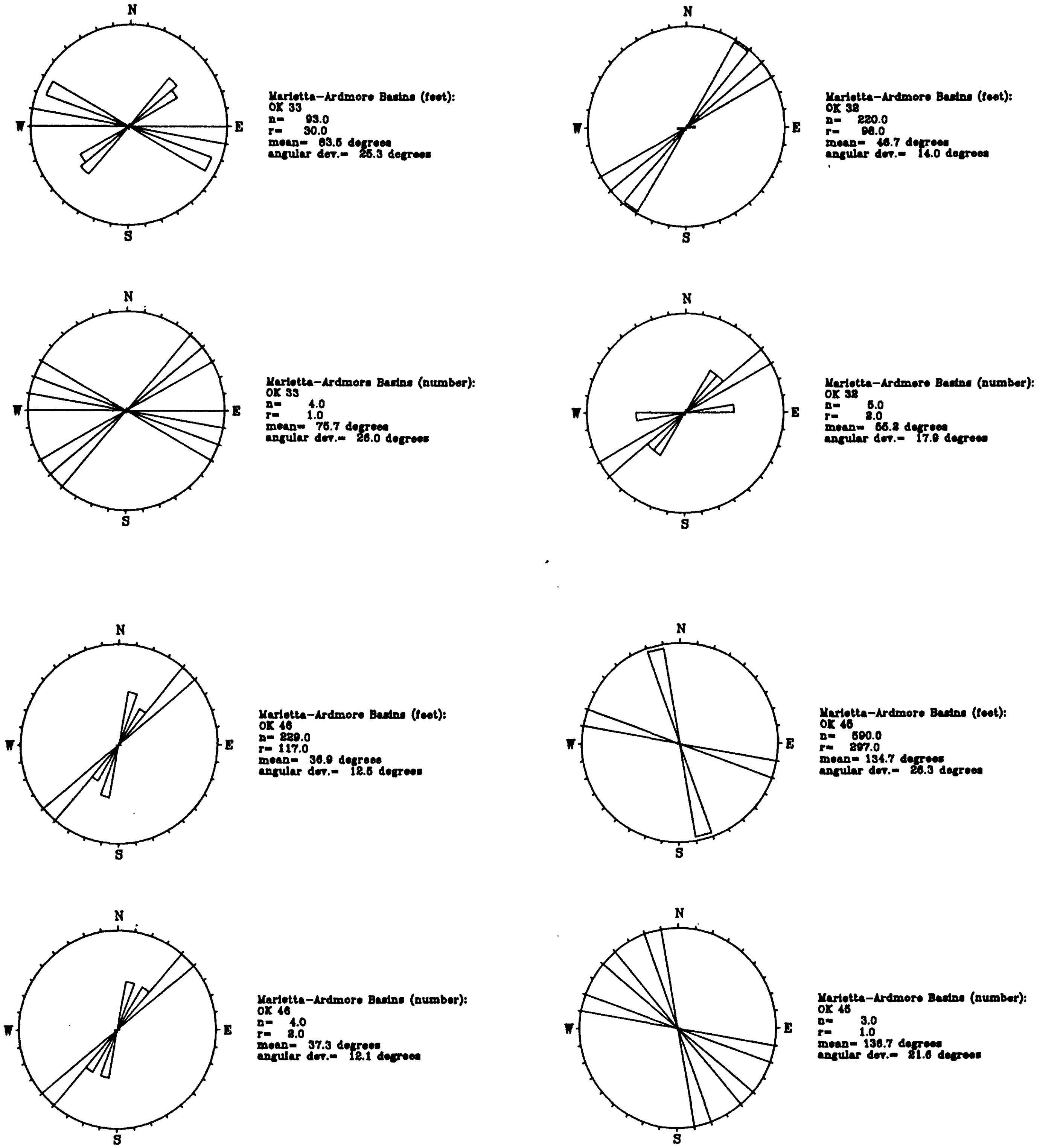


FIGURE 19.--Continued.

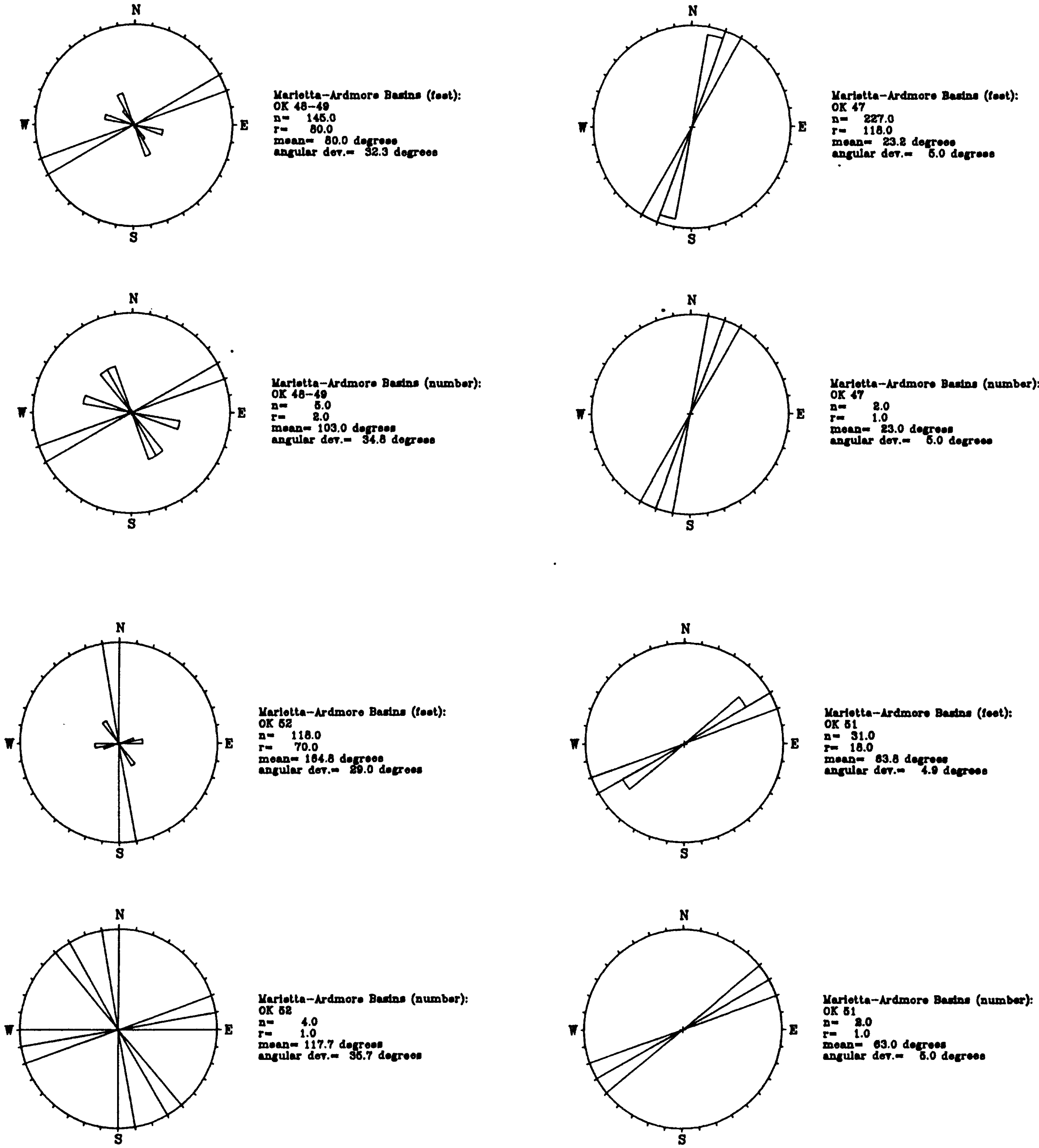


FIGURE 19.--Continued.

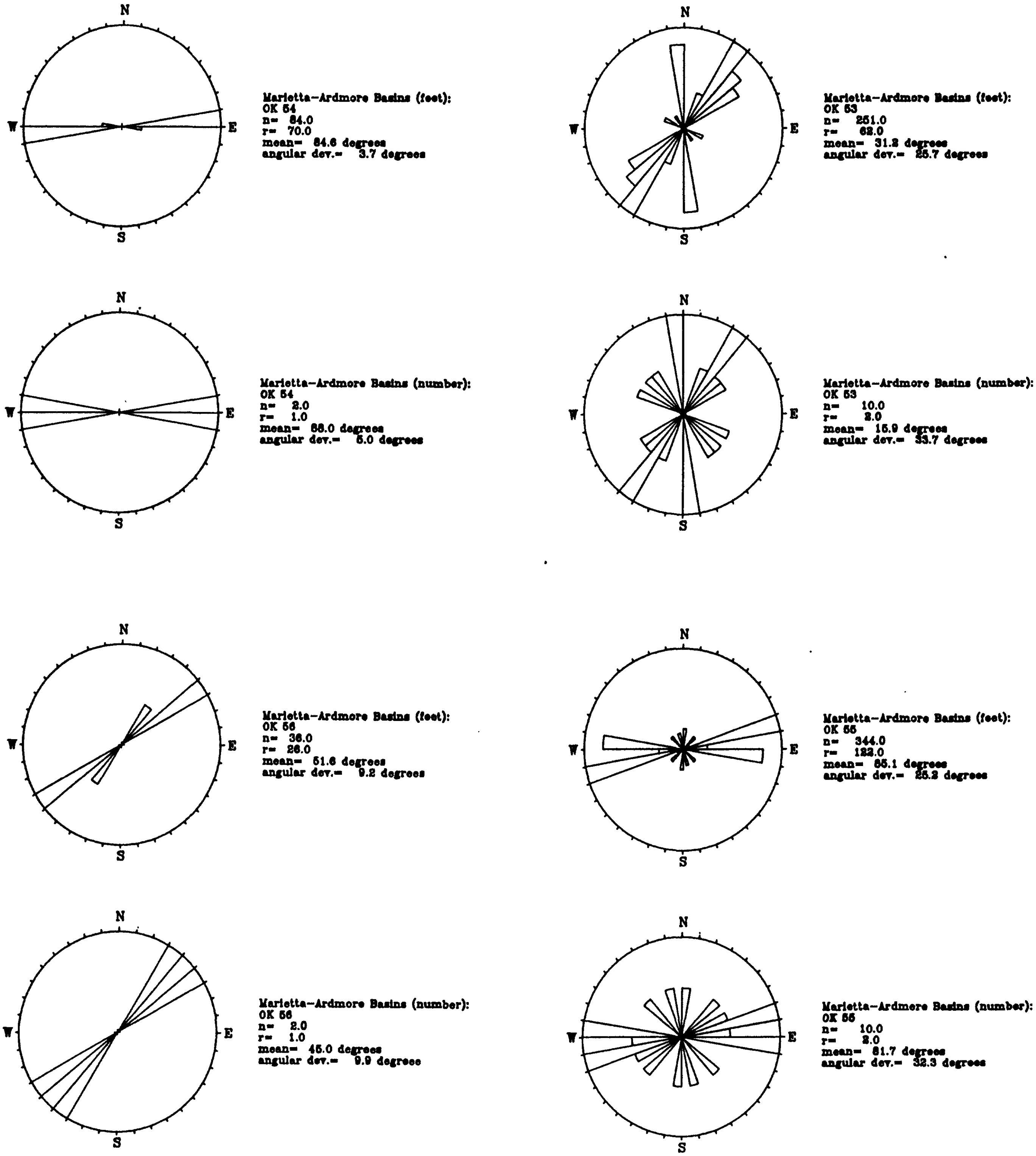
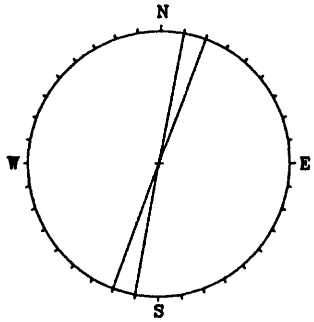
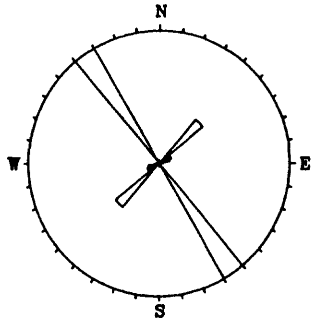


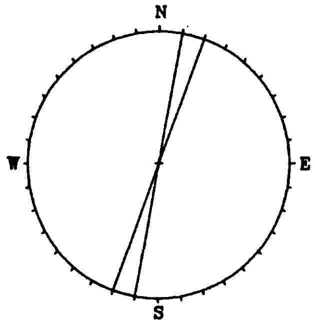
FIGURE 19.--Continued.



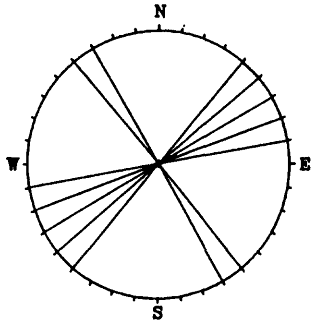
Marietta-Ardmore Basins (feet):
OK 58
n= 22.0
r= 22.0
mean= 13.0 degrees
angular dev.= 1.4 degrees



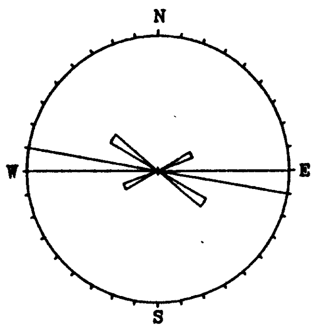
Marietta-Ardmore Basins (feet):
OK 57
n= 194.0
r= 120.0
mean= 153.1 degrees
angular dev.= 34.5 degrees



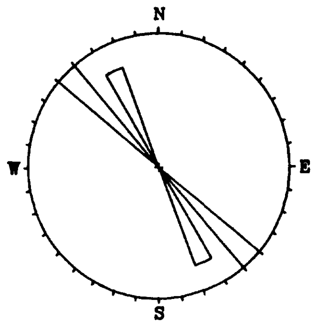
Marietta-Ardmore Basins (number):
OK 58
n= 1.0
r= 1.0
mean= 13.0 degrees
angular dev.= 0.0 degrees



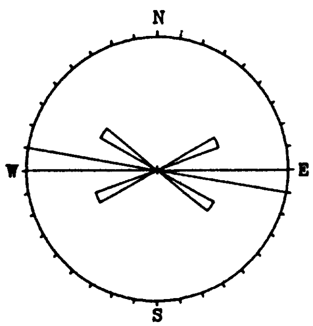
Marietta-Ardmore Basins (number):
OK 57
n= 4.0
r= 1.0
mean= 65.8 degrees
angular dev.= 30.3 degrees



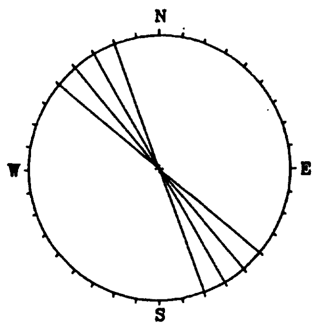
Marietta-Ardmore Basins (feet):
OK 60
n= 218.0
r= 128.0
mean= 99.8 degrees
angular dev.= 18.7 degrees



Marietta-Ardmore Basins (feet):
OK 59
n= 18.0
r= 10.0
mean= 146.8 degrees
angular dev.= 9.9 degrees

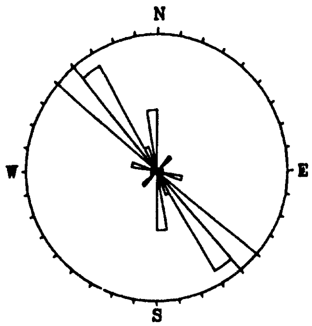


Marietta-Ardmore Basins (number):
OK 60
n= 4.0
r= 2.0
mean= 97.1 degrees
angular dev.= 18.7 degrees

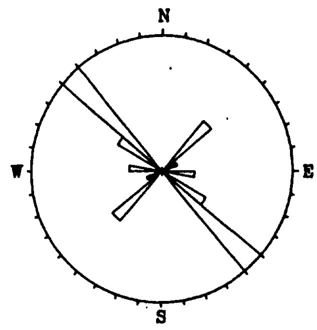


Marietta-Ardmore Basins (number):
OK 59
n= 2.0
r= 1.0
mean= 148.0 degrees
angular dev.= 9.9 degrees

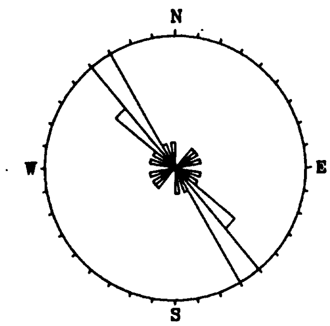
FIGURE 19.--Continued.



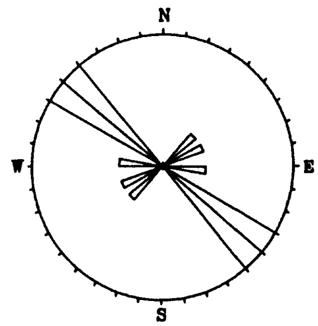
Marietta-Ardmore Basins (feet):
OK 62-79
n= 594.0
r= 196.0
mean= 146.0 degrees
angular dev.= 23.3 degrees



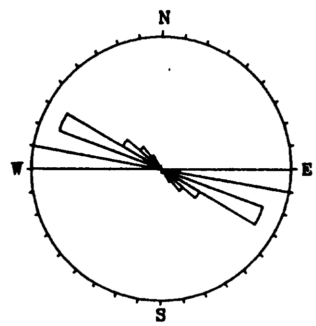
Marietta-Ardmore Basins (feet):
OK 61
n= 179.0
r= 79.0
mean= 122.1 degrees
angular dev.= 33.7 degrees



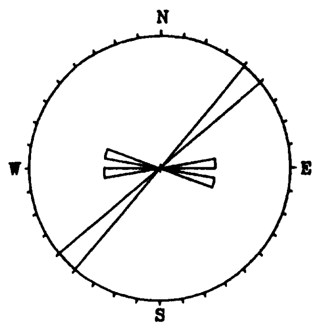
Marietta-Ardmore Basins (number):
OK 62-79
n= 16.0
r= 6.0
mean= 141.7 degrees
angular dev.= 26.8 degrees



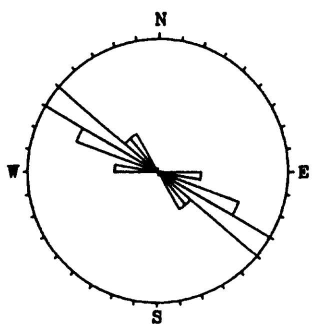
Marietta-Ardmore Basins (number):
OK 61
n= 9.0
r= 3.0
mean= 121.1 degrees
angular dev.= 26.8 degrees



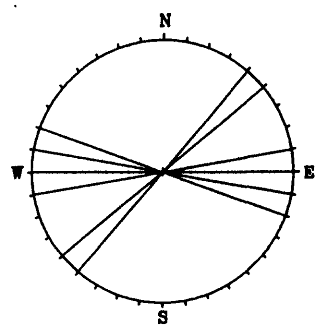
Marietta-Ardmore Basins (feet):
OK 64-67
n= 300.0
r= 119.0
mean= 112.7 degrees
angular dev.= 15.3 degrees



Marietta-Ardmore Basins (feet):
OK 63
n= 39.0
r= 21.0
mean= 67.8 degrees
angular dev.= 23.9 degrees

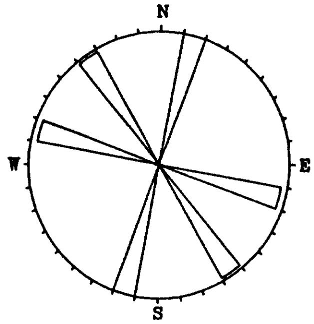


Marietta-Ardmore Basins (number):
OK 64-67
n= 6.0
r= 3.0
mean= 123.9 degrees
angular dev.= 13.4 degrees

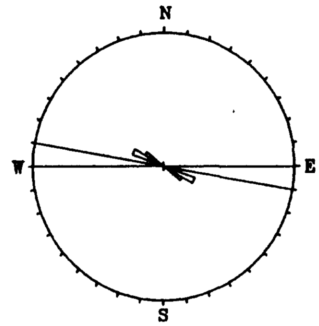


Marietta-Ardmore Basins (number):
OK 63
n= 3.0
r= 1.0
mean= 60.8 degrees
angular dev.= 23.5 degrees

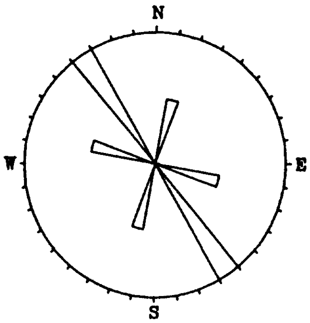
FIGURE 19.--Continued.



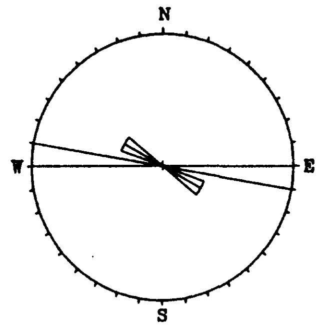
Marietta-Ardmore Basins (feet):
OK 66
n= 120.0
r= 41.0
mean= 145.9 degrees
angular dev.= 33.2 degrees



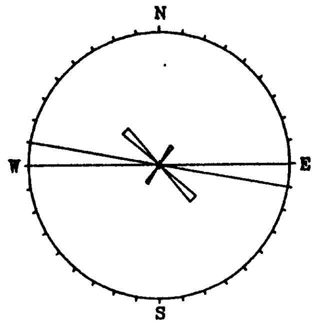
Marietta-Ardmore Basins (feet):
OK 66
n= 191.0
r= 136.0
mean= 104.2 degrees
angular dev.= 10.0 degrees



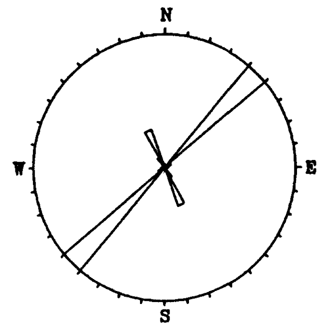
Marietta-Ardmore Basins (number):
OK 66
n= 4.0
r= 2.0
mean= 145.5 degrees
angular dev.= 28.7 degrees



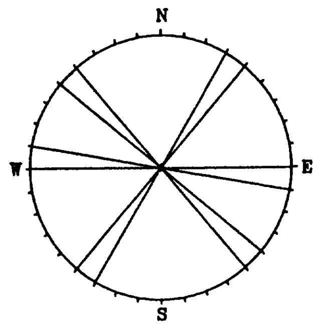
Marietta-Ardmore Basins (number):
OK 66
n= 5.0
r= 3.0
mean= 106.9 degrees
angular dev.= 11.0 degrees



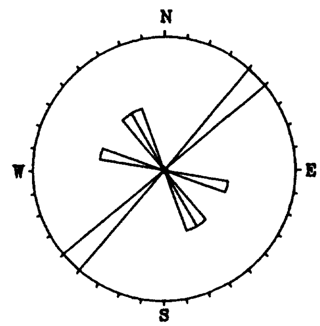
Marietta-Ardmore Basins (feet):
OK 71
n= 193.0
r= 126.0
mean= 104.2 degrees
angular dev.= 23.6 degrees



Marietta-Ardmore Basins (feet):
OK 70
n= 133.0
r= 92.0
mean= 40.7 degrees
angular dev.= 28.1 degrees



Marietta-Ardmore Basins (number):
OK 71
n= 3.0
r= 1.0
mean= 103.0 degrees
angular dev.= 35.6 degrees



Marietta-Ardmore Basins (number):
OK 70
n= 5.0
r= 2.0
mean= 159.7 degrees
angular dev.= 40.2 degrees

FIGURE 19.--Continued.

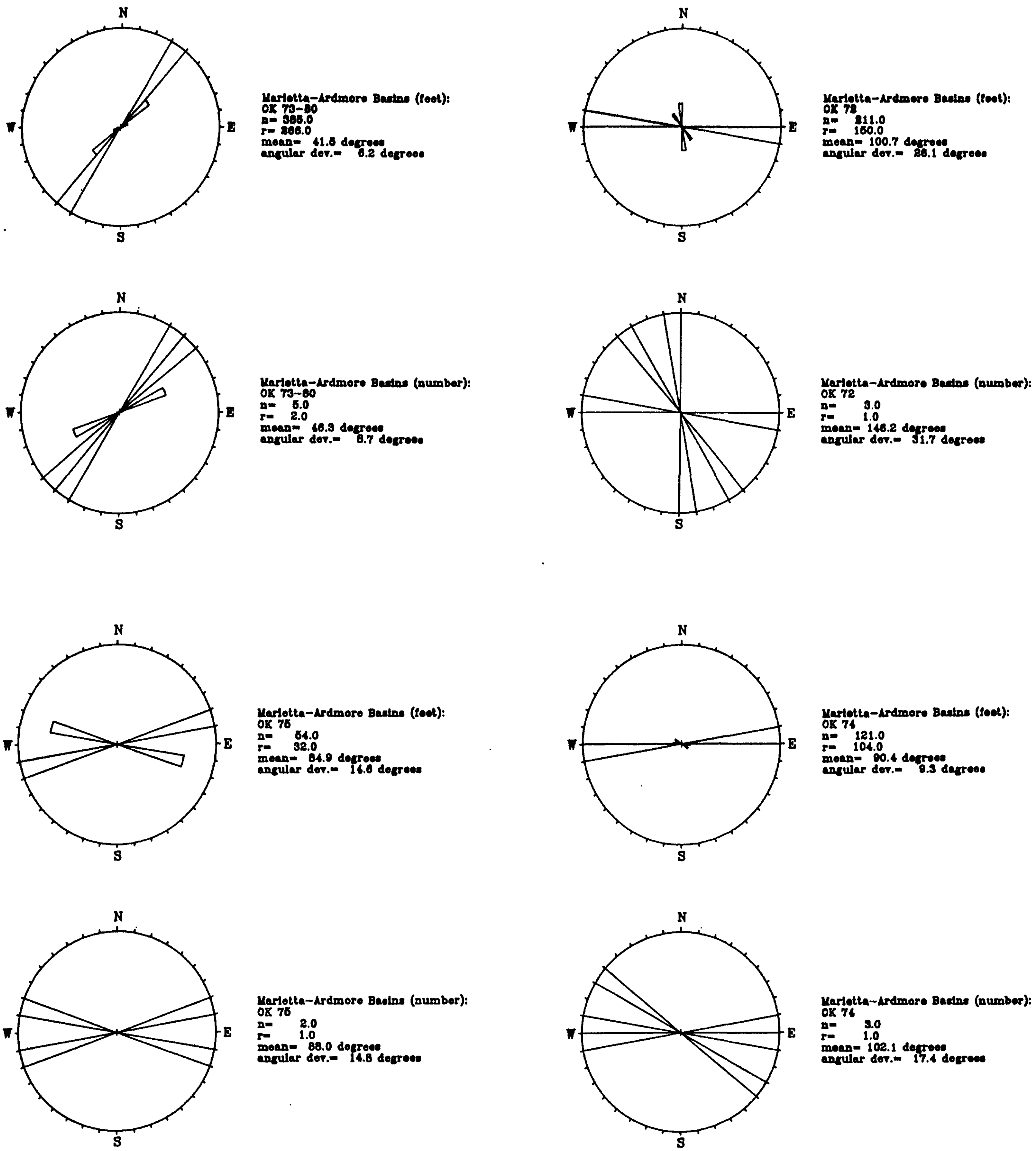


FIGURE 19.--Continued.

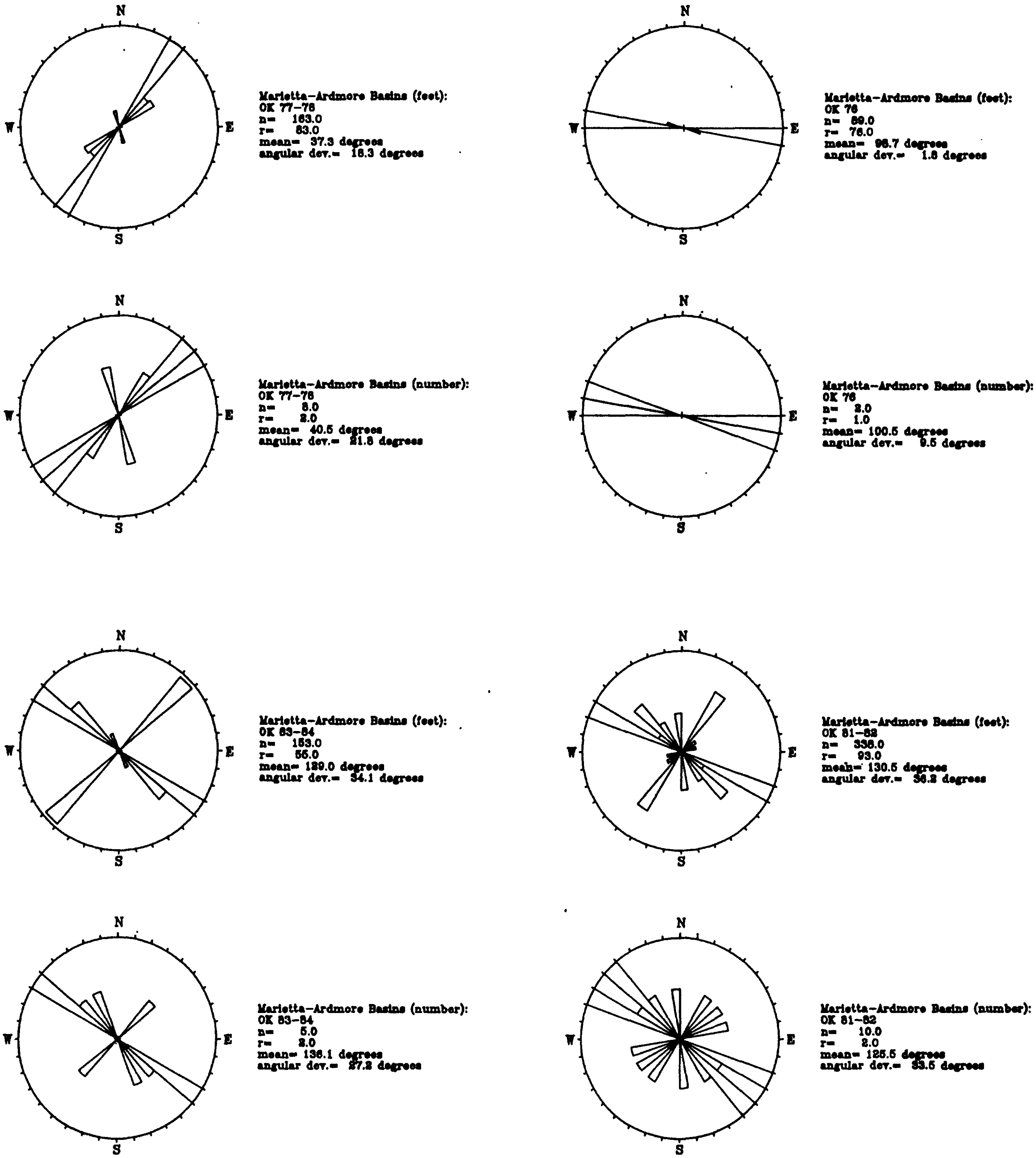
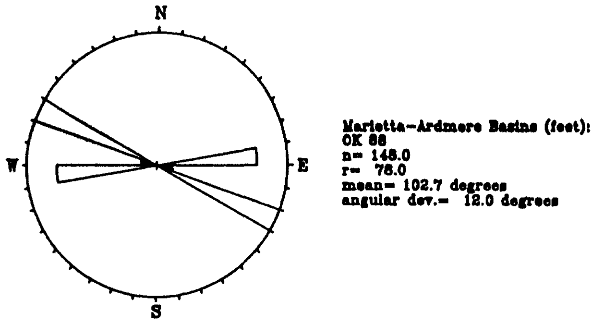
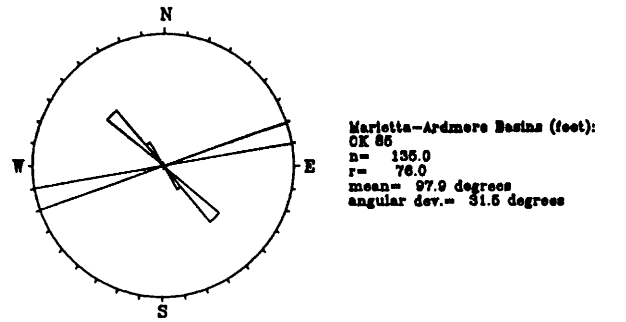
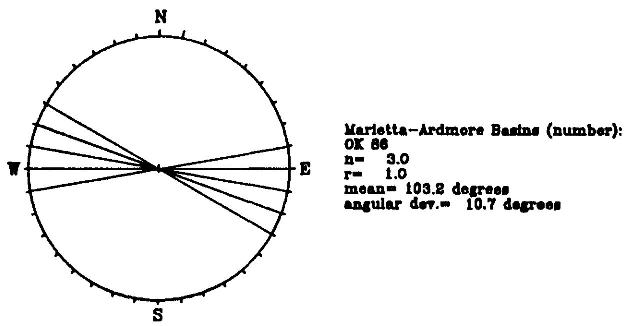
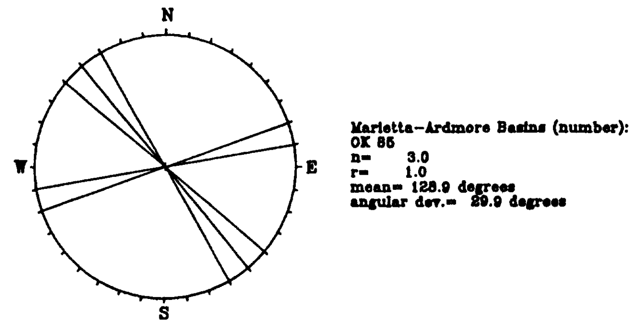


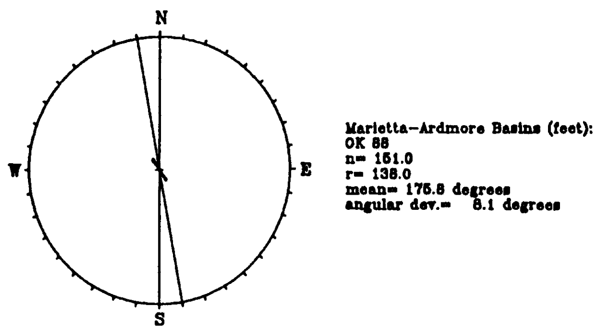
FIGURE 19.--Continued.

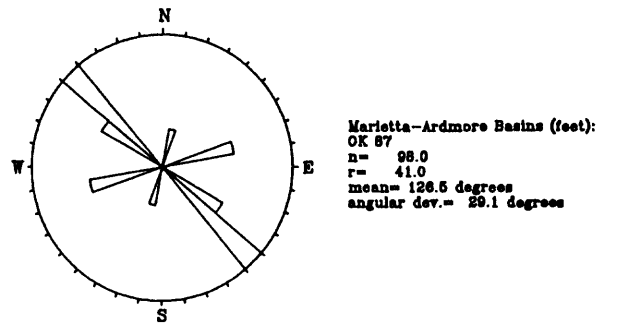


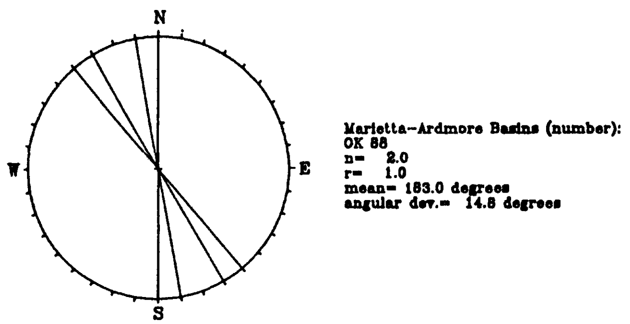












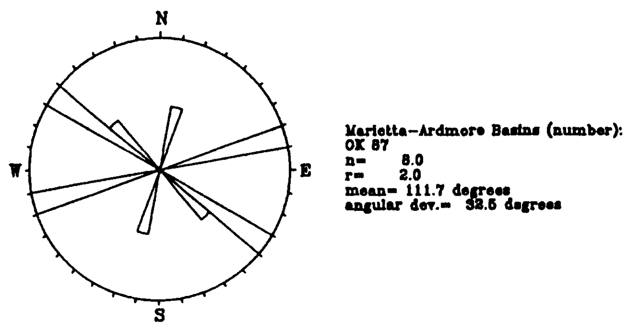
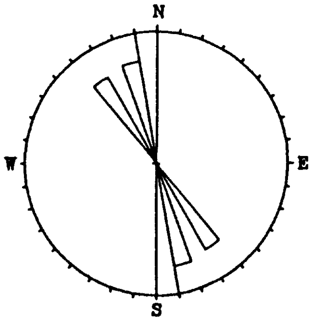
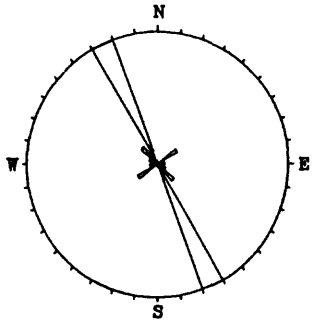


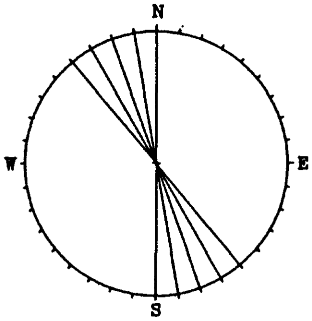
FIGURE 19.--Continued.



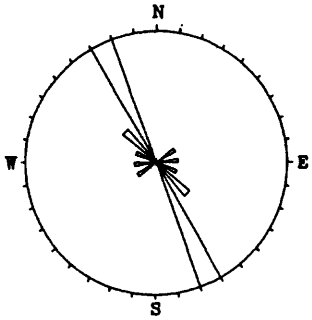
Marietta-Ardmore Basins (feet):
OK 90
n= 218.0
r= 85.0
mean= 166.2 degrees
angular dev.= 12.2 degrees



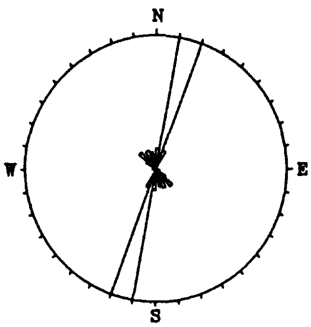
Marietta-Ardmore Basins (feet):
OK 89
n= 253.0
r= 172.0
mean= 153.2 degrees
angular dev.= 24.5 degrees



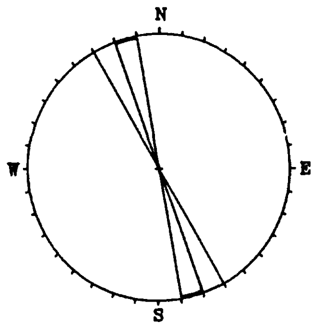
Marietta-Ardmore Basins (number):
OK 90
n= 3.0
r= 1.0
mean= 184.8 degrees
angular dev.= 12.3 degrees



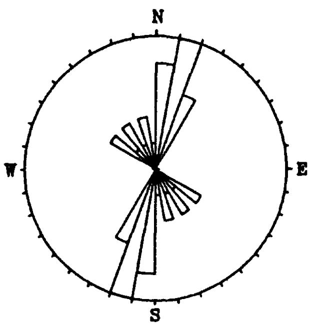
Marietta-Ardmore Basins (number):
OK 89
n= 11.0
r= 6.0
mean= 146.1 degrees
angular dev.= 26.4 degrees



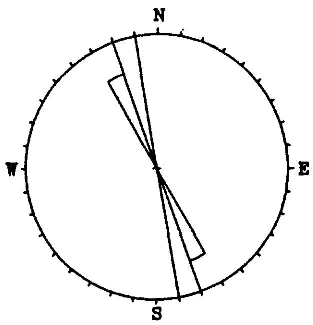
Marietta-Ardmore Basins (feet):
TX 2
n= 664.0
r= 326.0
mean= 3.9 degrees
angular dev.= 22.3 degrees



Marietta-Ardmore Basins (feet):
OK 93
n= 206.0
r= 104.0
mean= 159.7 degrees
angular dev.= 6.8 degrees



Marietta-Ardmore Basins (number):
TX 2
n= 21.0
r= 5.0
mean= 178.6 degrees
angular dev.= 23.9 degrees



Marietta-Ardmore Basins (number):
OK 93
n= 7.0
r= 4.0
mean= 160.3 degrees
angular dev.= 6.2 degrees

FIGURE 19.--Continued.

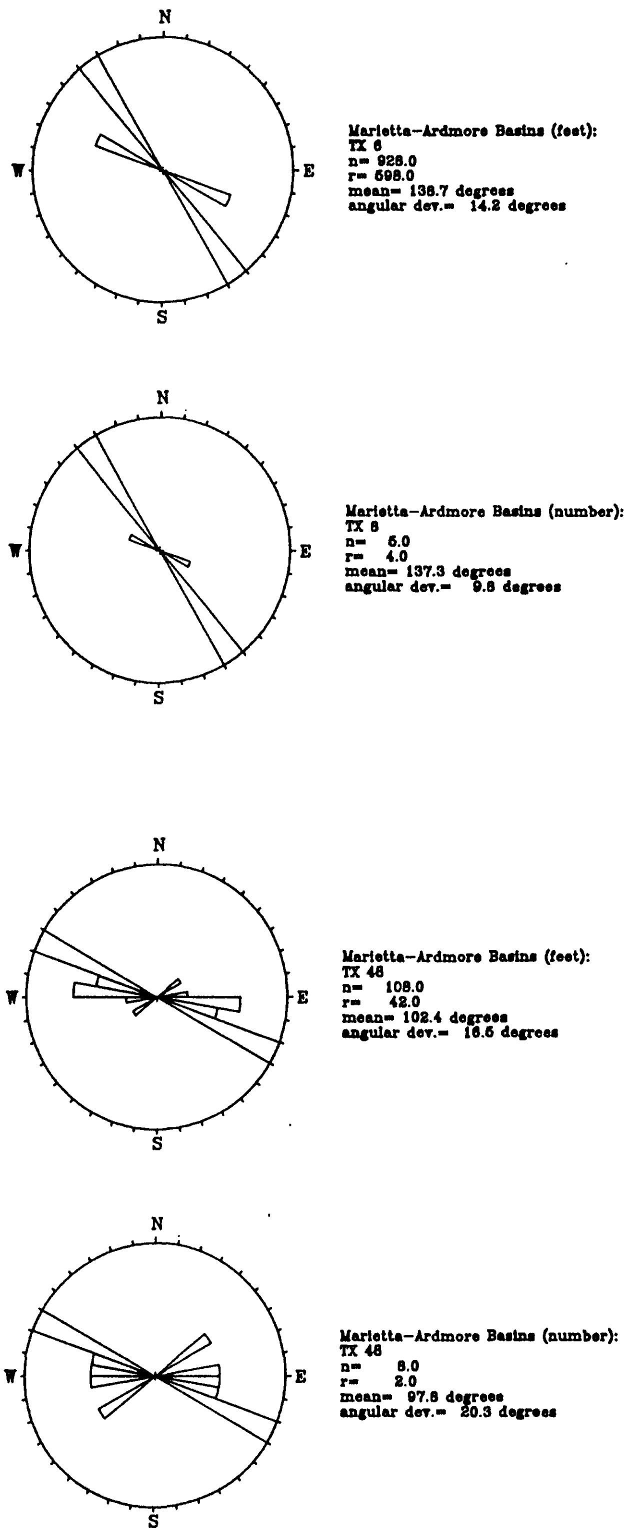


FIGURE 19.--Continued.

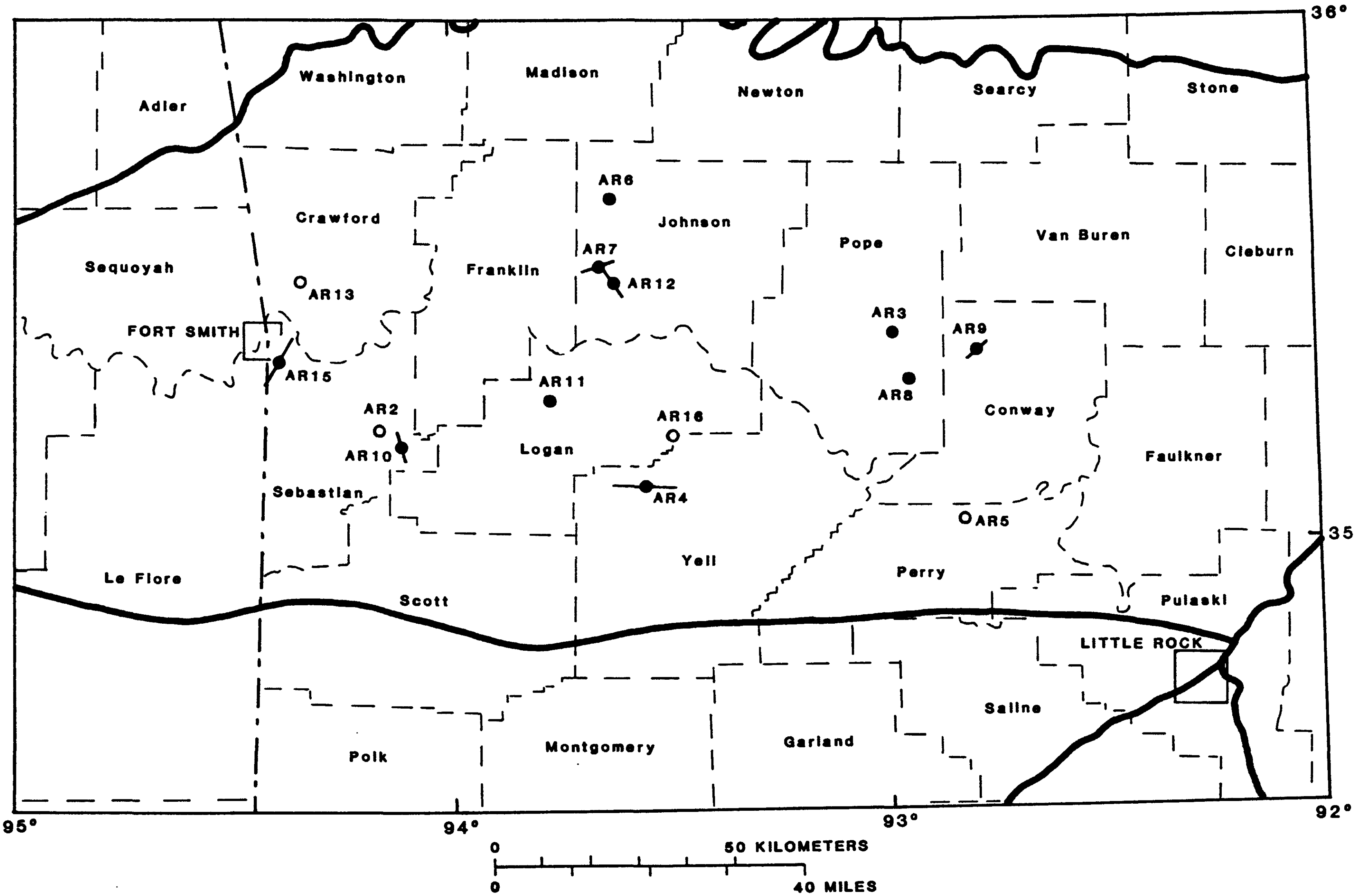


FIGURE 20.--Arkoma Basin well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars, and open circles with bars are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines.

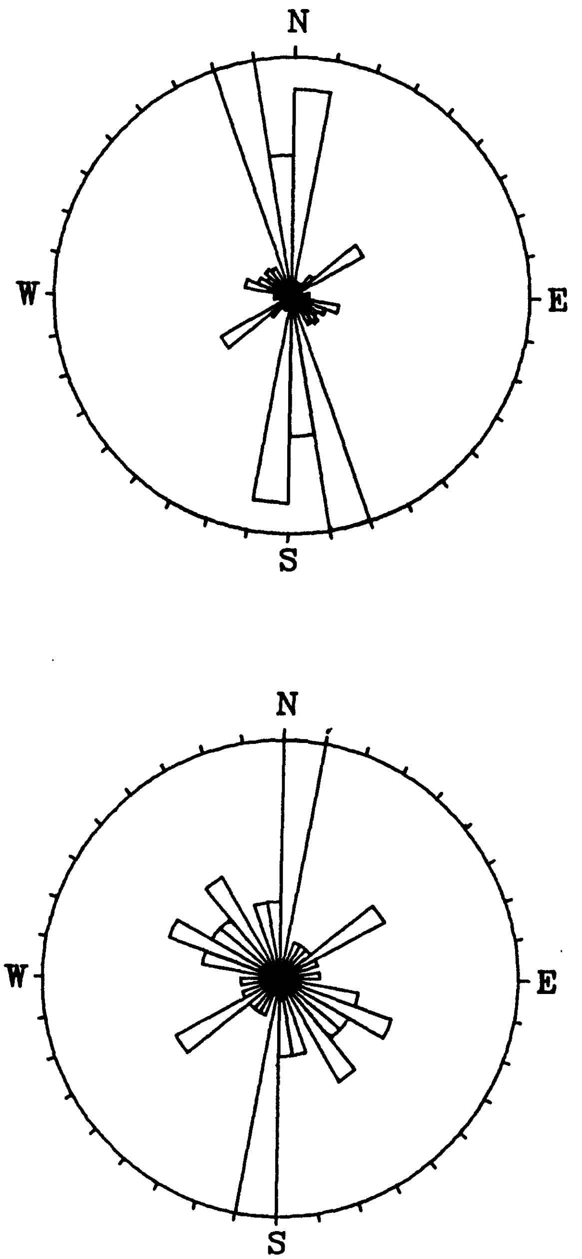
TABLE 9.--Well-bore data for the Arkoma basin

Arkoma Basin

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	1710	30	—	-	160	6.6	36	70	Basin composite
AR2	Sebastian	35.224	-94.159	547	6742	5641-6341	5821-6347	18	1	Fair	NG	0	—	-	—	
AR3	Pope	35.402	-92.974	856	4634	2529-4619	3525-4267	148	6	Fair	D	158	2.3	30	68	Bimodal-questionable
AR4	Yell	35.113	-93.545	383	12189	9069-12175	9385-11981	1065	10	Fair	B	5	3.7	12	95	
AR5	Perry	35.045	-92.816	404	11364	9548-11353	10848-10932	166	2	Fair	NG	120	17.1	24	—	
AR6	Johnson	35.663	-93.616	1330	+40	+1015-+41	+686-+564	83	2	Good	D	28	15.2	22	118	
AR7	Johnson	35.536	-93.646	610	4649	1475-4636	3177-4576	108	4	Good	C	155	13.0	26	65	
AR8	Pope	35.312	-92.941	337	7645	478-7640	5735-7241	86	2	Fair	D	35	7.0	10	125	
AR9	Conway	35.366	-92.783	650	3135	+115-3123	1940-2795	70	3	Good	C	132	10.0	17	42	
AR10	Sebastian	35.193	-94.107	596	12136	5145-12119	7141-12119	41	2	Good	C	73	8.8	12	163	
AR11	Logan	35.278	-93.762	929	9976	7404-9976	7698-9876	66	2	Fair	D	166	20.3	29	76	
AR12	Johnson	35.499	-93.611	452	4669	3083-4667	3136-4468	243	5	Poor	C	60	10.3	23	150	
AR13	Crawford	35.510	-94.335	70	2157	+213-2157	1759-1777	18	1	Poor	NG	146	—	-	—	
AR15	Sebastian	35.356	-94.386	528	6199	4058-6198	4871-5844	183	6	V.Good	B	123	6.4	16	33	
AR16	Logan	35.208	-93.491	1265	9303	961-9283	4143-7911	717	7	Fair	NG	140	11.7	31	—	Bimodal-questionable

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.



Arkoma Basin (feet):
Composite
n= 1710.0
r= 438.0
mean= 172.0 degrees
angular dev.= 28.7 degrees

Arkoma Basin (number):
Composite
n= 30.0
r= 6.0
mean= 160.0 degrees
angular dev.= 36.2 degrees

FIGURE 21.--Composite rose diagrams of Arkoma Basin breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basin in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

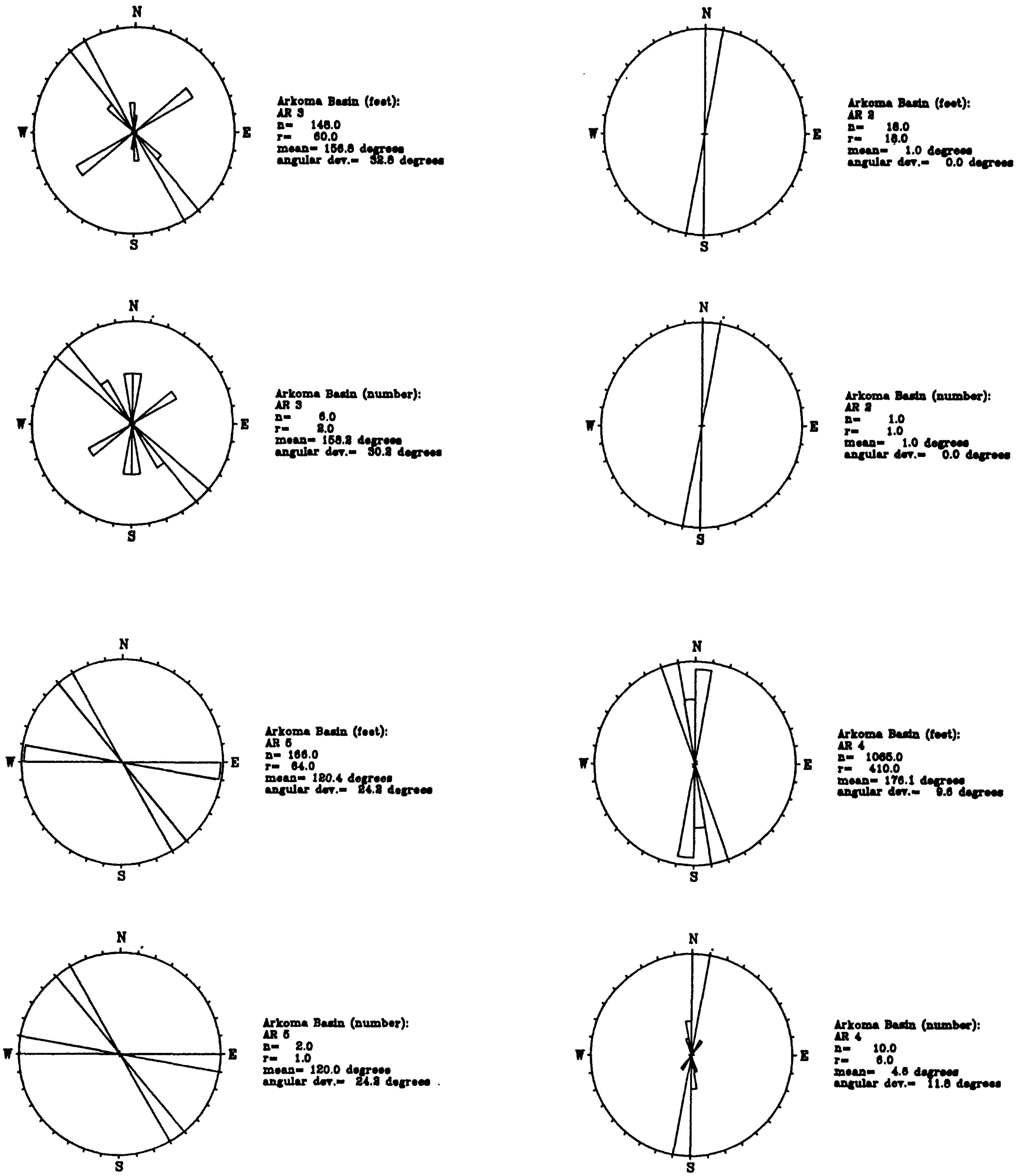


FIGURE 22.--Rose diagrams of Arkoma Basin breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the basin in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

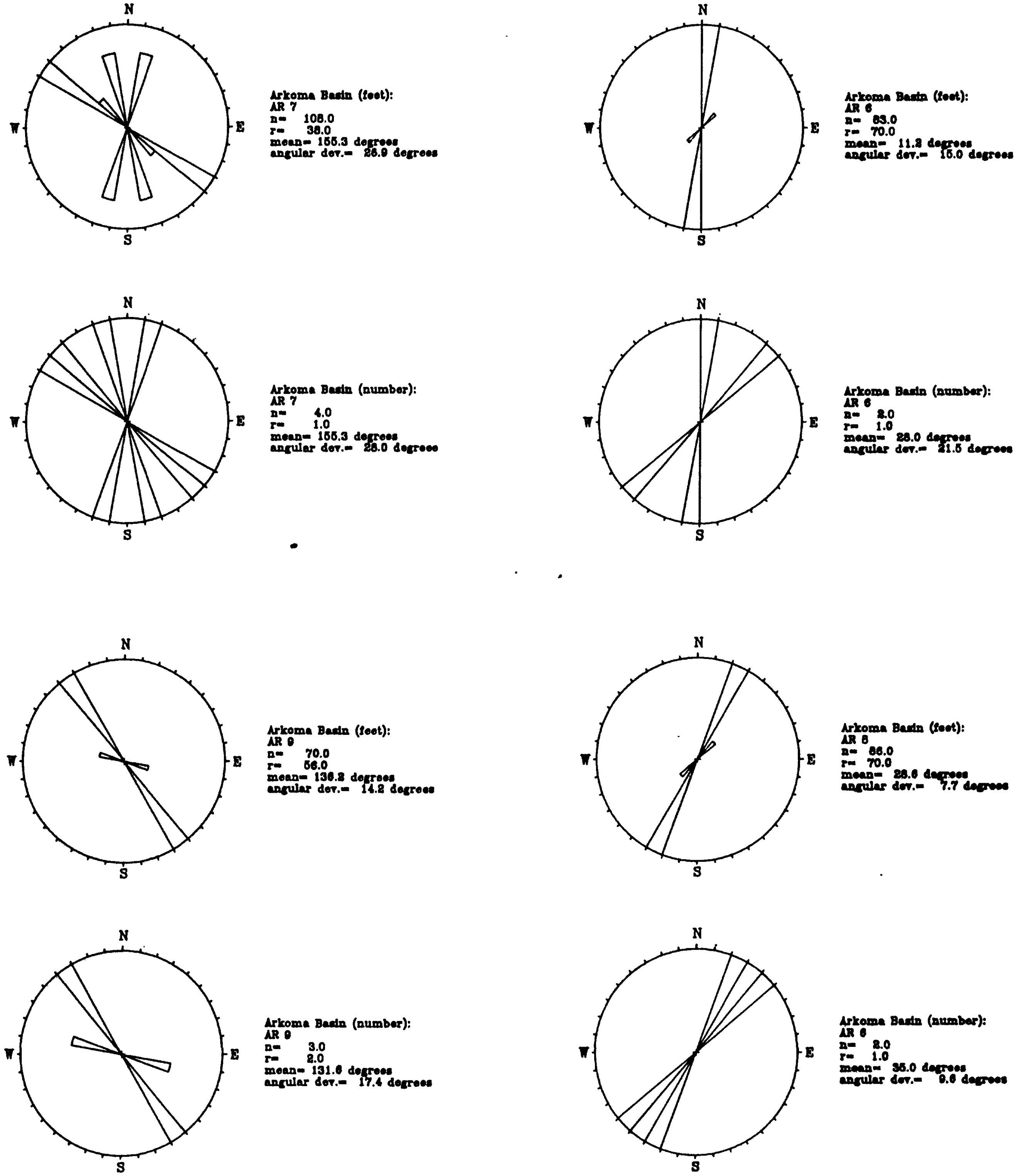
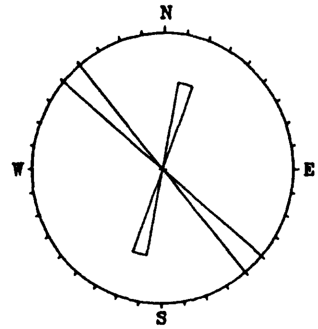
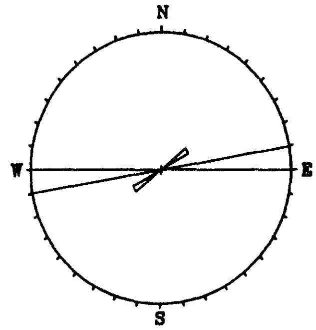


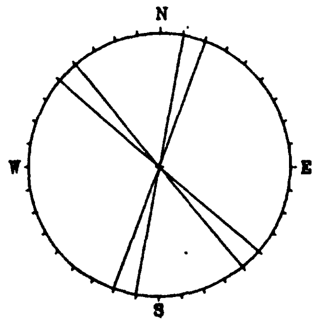
FIGURE 10.--Continued.



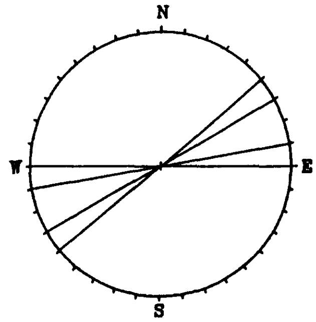
Arkoma Basin (feet):
AR 11
n= 66.0
r= 40.0
mean= 155.9 degrees
angular dev.= 27.7 degrees



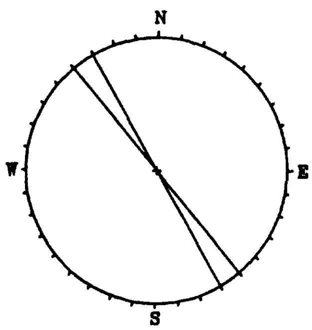
Arkoma Basin (feet):
AR 10
n= 41.0
r= 33.0
mean= 80.4 degrees
angular dev.= 9.7 degrees



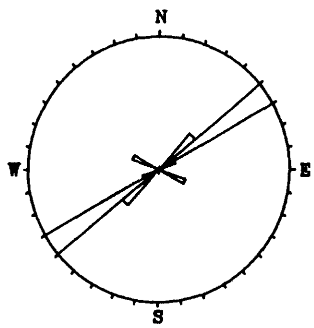
Arkoma Basin (number):
AR 11
n= 2.0
r= 1.0
msan= 166.0 degrees
angular dev.= 28.6 degrees



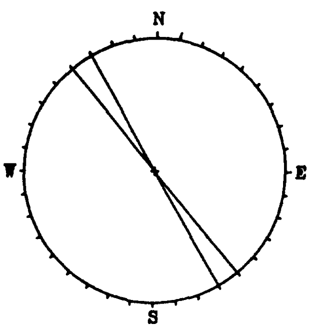
Arkoma Basin (number):
AR 10
n= 2.0
r= 1.0
mean= 72.6 degrees
angular dev.= 12.4 degrees



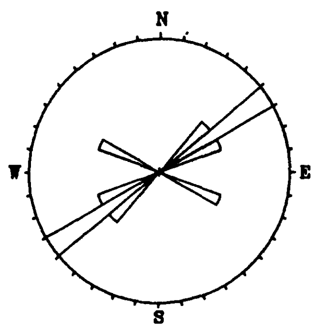
Arkoma Basin (feet):
AR 13
n= 16.0
r= 16.0
mean= 146.0 degrees
angular dev.= 9.9 degrees



Arkoma Basin (feet):
AR 12
n= 243.0
r= 142.0
mean= 54.7 degrees
angular dev.= 16.9 degrees

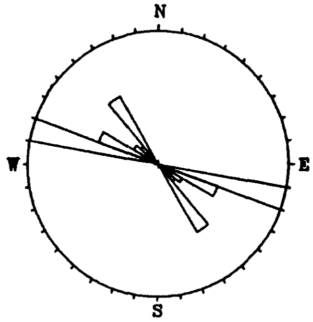


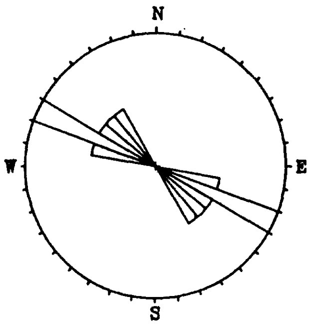
Arkoma Basin (number):
AR 13
n= 1.0
r= 1.0
mean= 146.0 degrees
angular dev.= 0.0 degrees

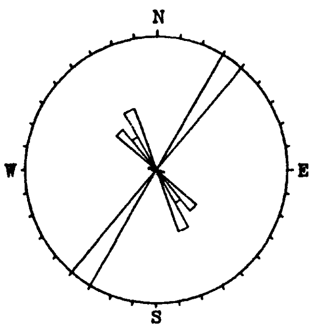


Arkoma Basin (number):
AR 12
n= 5.0
r= 2.0
mean= 60.4 degrees
angular dev.= 23.0 degrees

FIGURE 22.--Continued.







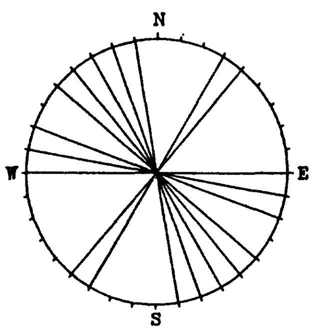


FIGURE 22.--Continued.

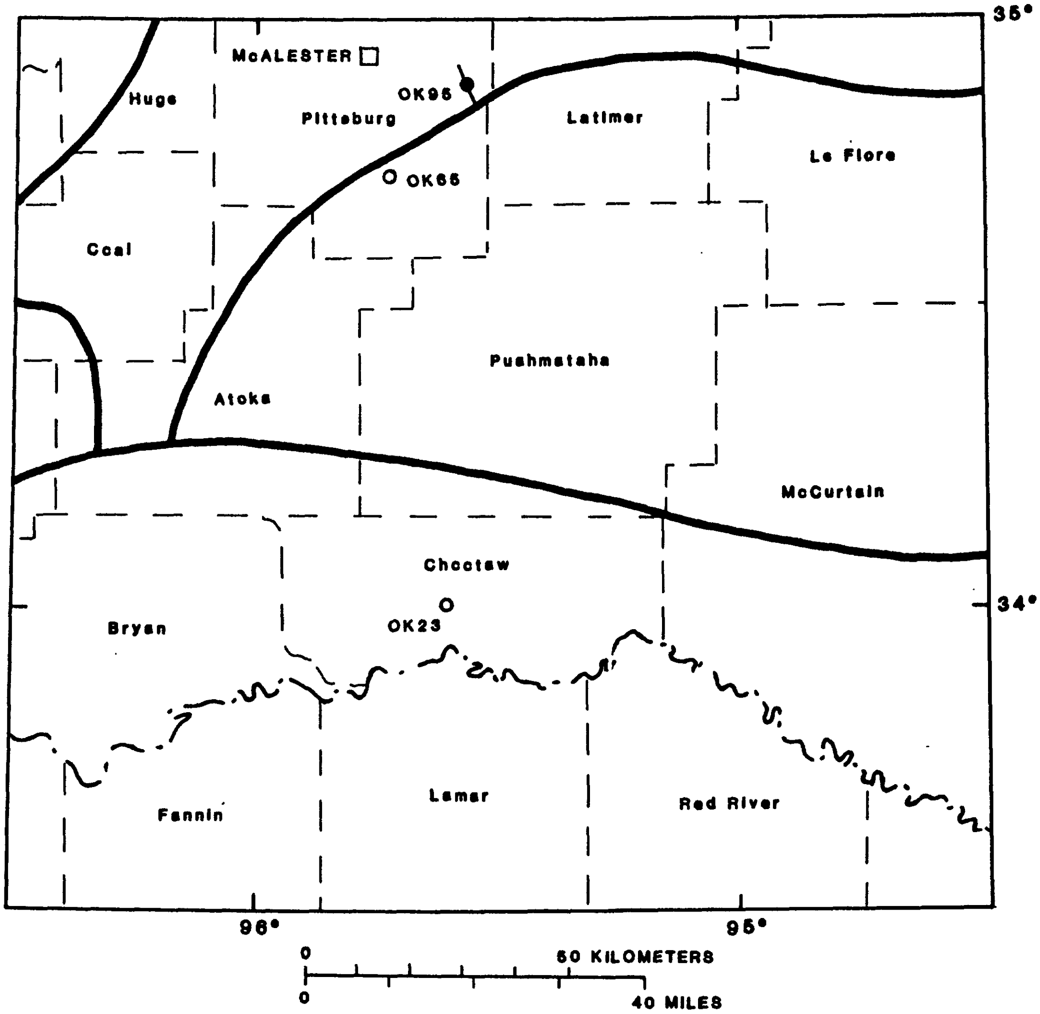


FIGURE 23.--Ouachita fold belt well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars and open circles with bars are well locations with data sets that were "no good." Only wells having statistiacl data qualities of "A" thru "C" are plotted with stress orientations. Wells having "D" quality data are solid dots. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid-dashed lines.

TABLE 10.--Well-bore data for the Ouachita fold belt

Ouachita Uplift

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	64	4	—	-	66	8.9	18	156	Area composite
OK65	Pittsburg	34.730	-95.723	793	1305	5146-13032	5176-11708	1383	7	Fair	NG	140	12.8	34	—	
OK95	Pittsburg	34.888	-95.554	666	9861	1028-9836	8325-9502	64	4	Fair	C	65	9.0	18	155	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

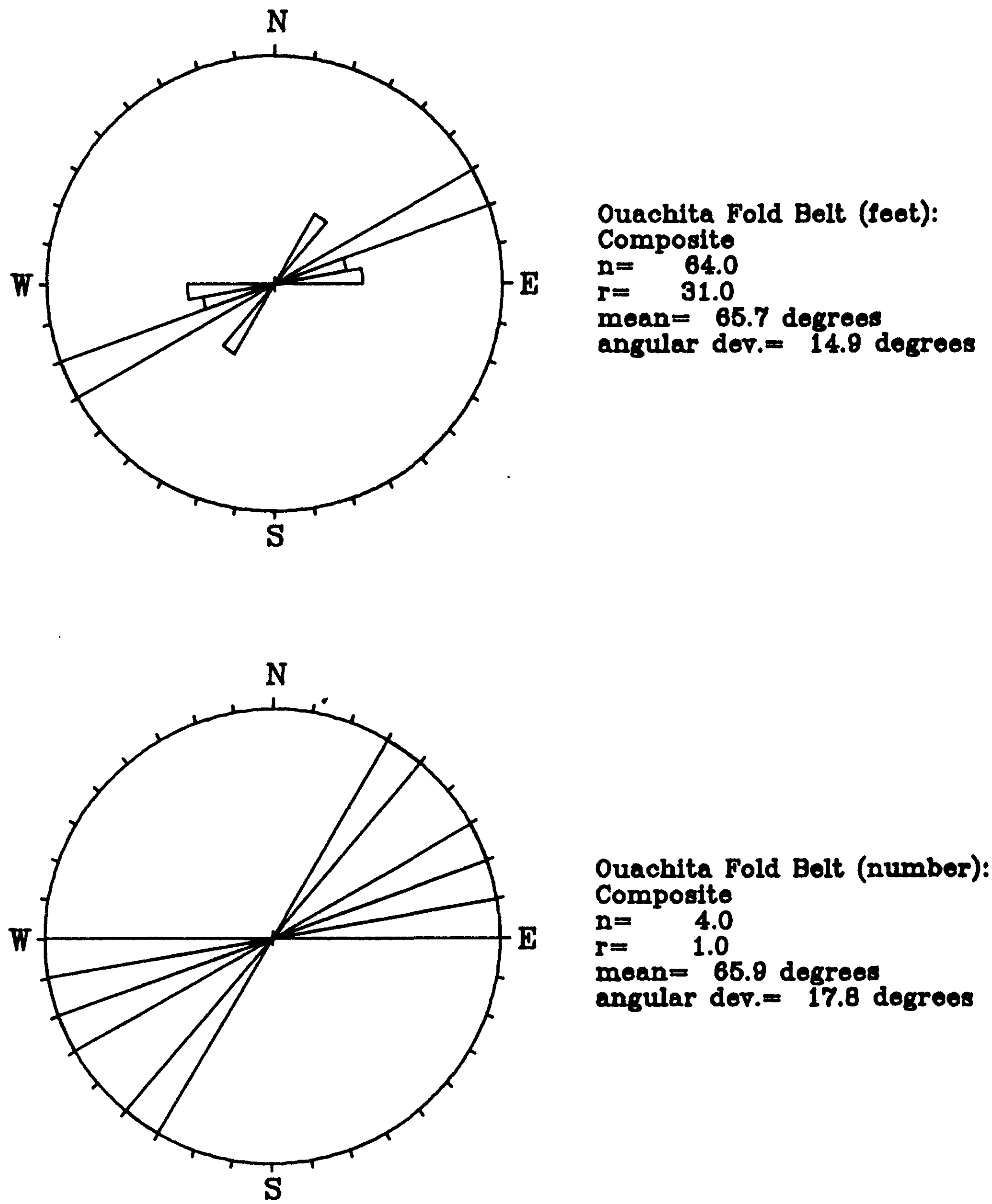


FIGURE 24.--Composite rose diagrams of Ouachita fold belt breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

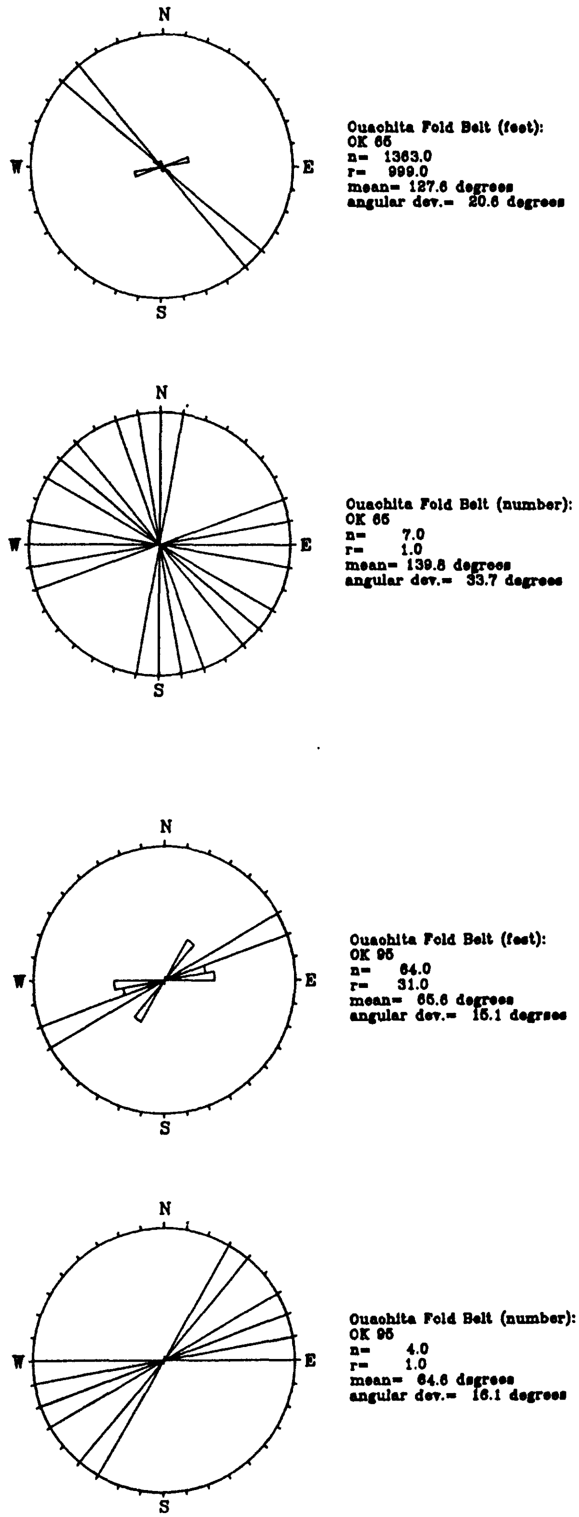


FIGURE 25.--Rose diagrams of Ouachita fold belt breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

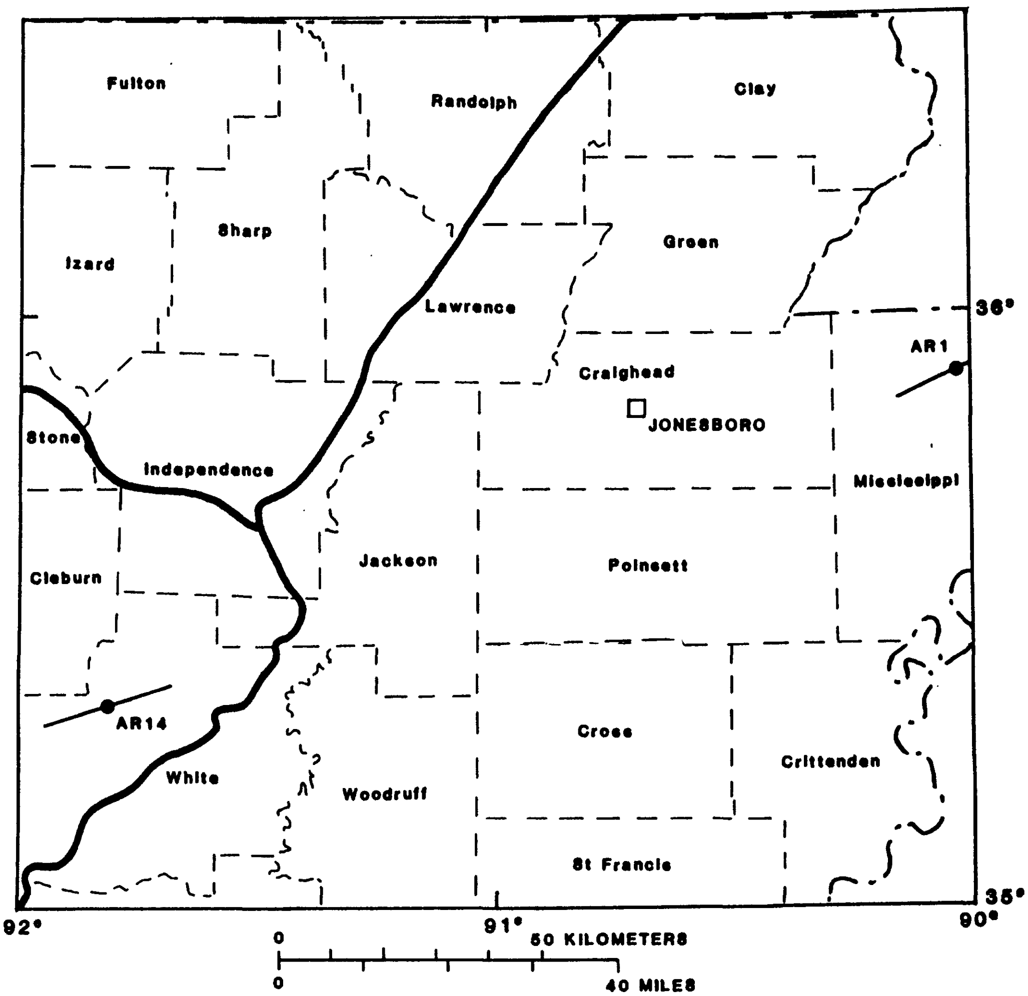


FIGURE 26.--Mississippi embayment well-location map. Well locations with inferred orientations of S_{Hmax} are solid dots with bars. Only wells having statistical data qualities of "A" and "C" are plotted with stress orientations. S_{Hmax} orientations are weighted by length, "A" qualities are the longest and "C" qualities the shortest. Structural and physiographic provinces are heavy solid lines. State boundaries are dashed-dot lines and county boundaries are thin solid dashed-lines.

TABLE 11.--Well-bore data for the Mississippi embayment

Mississippi Embayment

Well Name	County	Lat.	Long.	Ground Level (ft)	Well Depth (ft)	Logged/ Interval (ft)	Data Interval (ft)	Breakout Feet	Breakout Number	Log Quality	Statistical Quality	Mean Direction	Standard Error	Angular Deviation	S_{Hmax}	Comments
Comp.	—	—	—	—	—	— —	— —	1957	19	—	-	163	2.0	9	73	Area composite
AR1	Mississippi	35.898	-90.034	239	9450	3947-9418	5816-9370	1784	11	Good	A	163	3.1	10	73	
AR14	White	35.339	-91.818	250	7736	4216-7696	4216-7100	173	8	V.Good	A	165	3.0	9	75	

Depths are in feet below sea level unless otherwise stated.

Dashes indicate no data available.

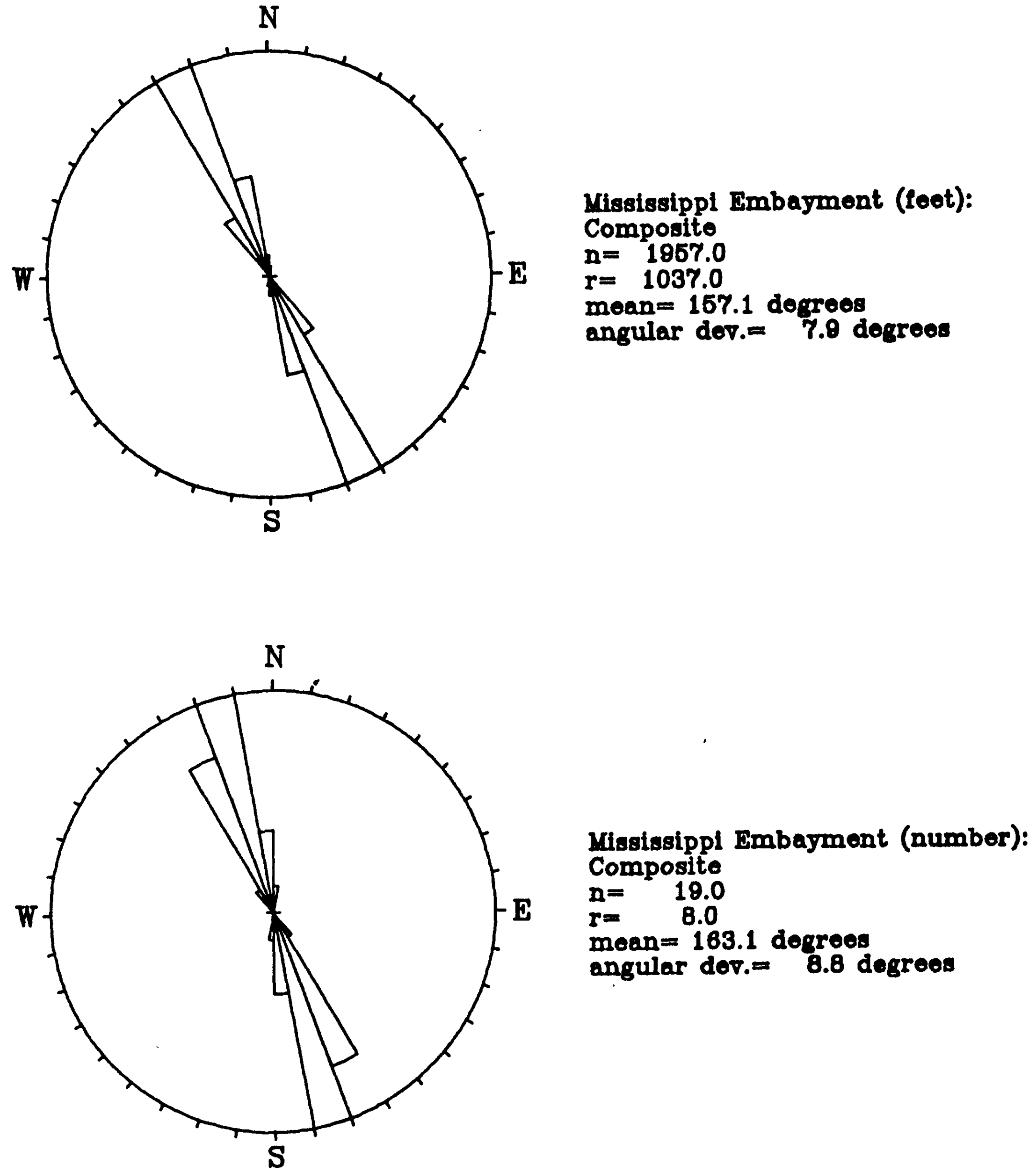


FIGURE 27.--Composite rose diagrams of Mississippi embayment breakout orientations. The rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the wells are located, (2) the composite identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

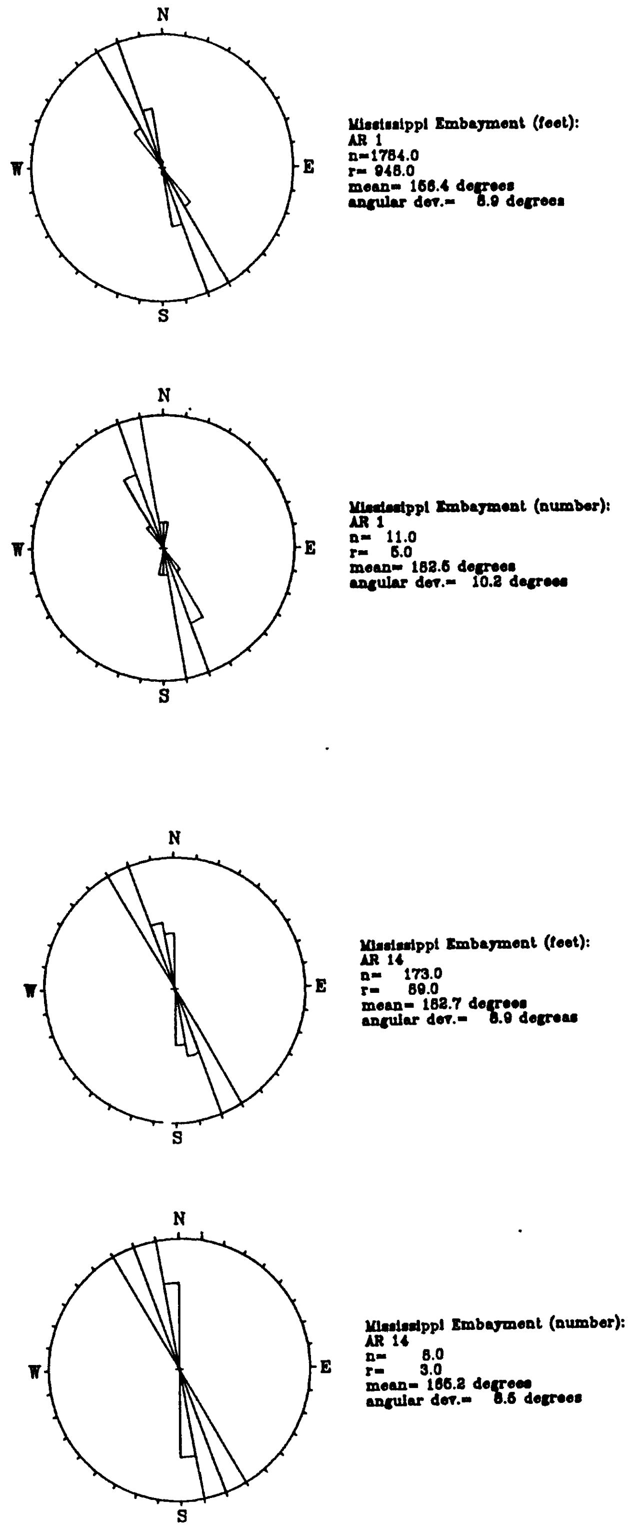


FIGURE 28.--Rose diagrams of Mississippi embayment breakout orientations. For each well, the rose diagram for total feet of breakout is positioned above the diagram for total number of breakouts. Diagrams are scaled in 10° intervals. Listed are (1) the area in which the well is located, (2) the individual well identification, (3) totals of feet (n) and number (n), (4) the radius or maximum frequency (r), (5) circular mean of the data, and (6) angular deviation of the data.

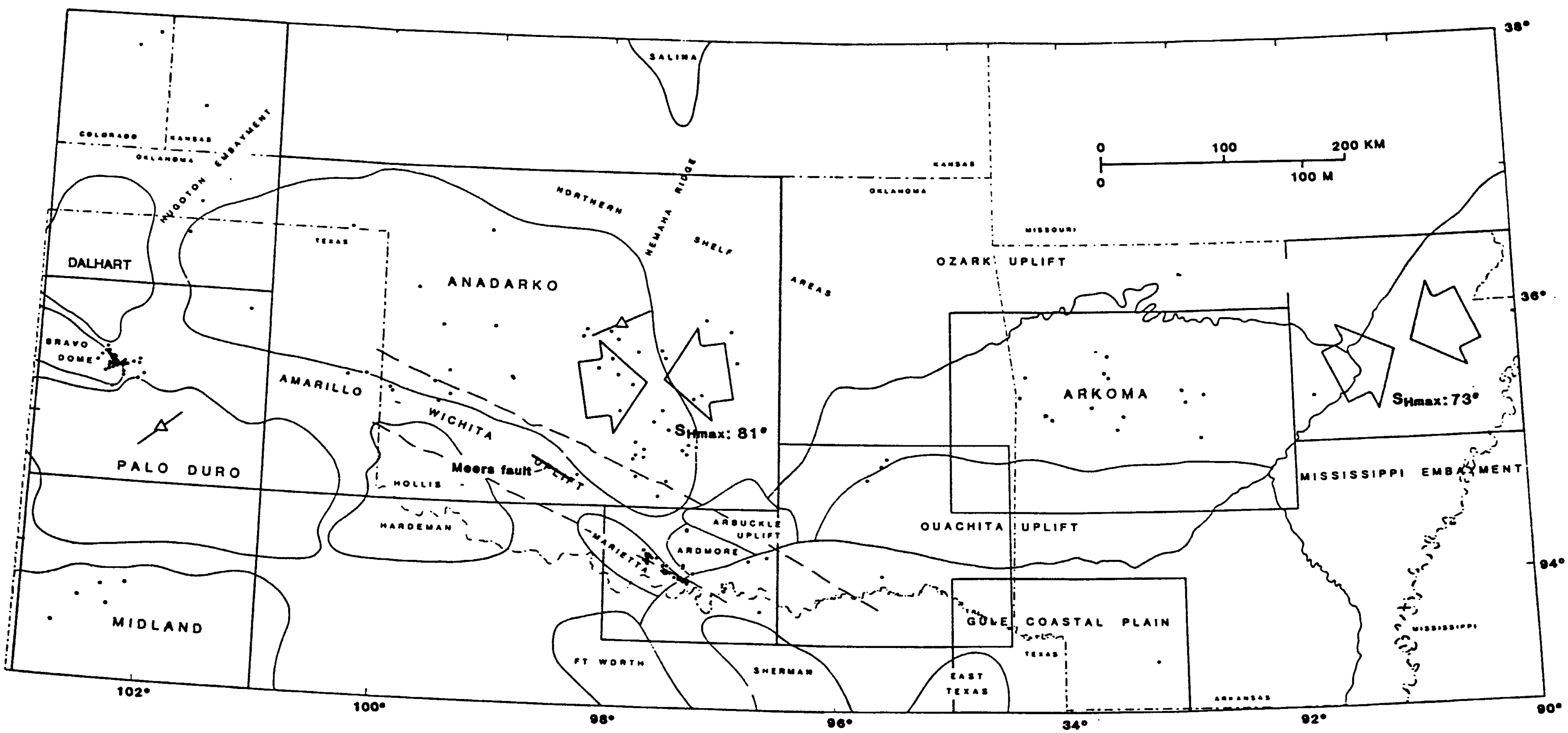


FIGURE 29.--Study area well location map with inferred S_{Hmax} orientations from borehole breakouts. Large open arrows indicated the inferred orientations of S_{Hmax} from data composites for several subareas. The open triangle with the bar is the location and S_{Hmax} orientation of a well in which a hydrofracture measurement was made (Zoback and Zoback, 1980; Gustavson and Budnik, 1985, 1985).

APPENDIX

STATISTICAL CALCULATIONS OF BREAKOUT DATA

Statistical values (mean direction, standard error of the mean, and angular deviation of a data distribution) can be calculated for each well and subarea data set by either using (1) the total number of individual breakouts as the population size, each breakout being a discrete observation; (2) the total of feet of breakout as the population size, each vertical foot of breakout within the well bore being a discrete observation; or (3) both number and feet of breakout, each breakout being a discrete observation that is weighted according to its length (feet). The frequency or number of observations at a given orientation (1°-180°) or within a degree interval (1°-10°, 11°-20°, etc.) is the number of breakouts, feet of breakout, or weighted number of breakouts at that orientation. The results presented in this report are based on statistical calculations using number of breakouts (tables and rose diagrams) and feet of breakout (rose diagrams). Conclusions about inferred stress orientations are based on number of breakouts. For the following reasons, statistics using number of breakouts seem to be most accurate for calculating true mean, standard error, and angular deviation of this type of data.

The observed overall length or extent of vertical elongation of an individual breakout within the well bore may be influenced by a number of arbitrary variables that include lithology, fracture history, rock fabric, horizontal stress difference about the well bore, and the elapse time between drilling completion and logging. The extent to which each of these variables affects breakout length has not been fully documented; however, a number of studies have included references to the general influence of one or more of these factors: Bancock, 1978; Bell and Gough, 1982; Hickman and others, 1985; Haimson and Herrick, 1985; Kaiser and others, 1985; Zoback and others, 1985; Plumb and Hickman, 1985; Dart and Zoback, 1987; and Paillet and Kim, 1987. It may be correct to assume that all or several of these variables may function together to promote or limit breakout lengthening.

Whereas breakout length (feet of breakout) appears to be subject to the influences of a number of variables, breakout occurrence (number of breakouts) is closely related to rock strength and the in situ stress annulas about the borehole (Haimson and Herrick, 1985; Zoback and others, 1985). Statistical calculations based on feet of breakout could bias the results favoring longer breakouts. These results may or may not be an accurate reflection of the true state of stress; however, statistics resulting from calculations based on number of breakouts may also have certain limitations. Paillet and Kim (1987) observed that breakout formation is "discontinuous" in intervals within boreholes where fractures, cooling joints, or vesicles were present and that "continuous" breakouts appeared to be associated with intervals with few fractures. Thus, fractures within the well bore may promote the formation of more individual breakouts, increasing breakout number.

The preferred orientation of a set of discrete breakouts, regardless of length, generally appears to be most reliable in calculating breakout statistics. However, the apparent consistency between mean breakout directions based on number of breakouts and on feet of breakout for most data sets in this report (see rose diagrams) supports the idea that among the wells sampled, breakout length is arbitrary. Statistics based on breakout length do not necessarily present a distorted evaluation of stress orientations.

Calculation of Mean Direction

The north-south and east-west trigonometric components of the mean vector are:

$$\text{N-S component} = \Sigma(f_i \cdot \cos 2\theta_i)$$

$$\text{E-W component} = \Sigma(f_i \cdot \sin 2\theta_i)$$

Where f_i is the frequency (number of breakouts or feet of breakout) for a given 1° or 10° interval, θ_i is the midpoint of the degree interval (vector angle). Breakout data, whether feet or number, are considered as a circular distribution of two-dimensional vectors that are axially symmetric. In order to avoid the two symmetrical halves of the distribution canceling one another and thereby producing a nonsymmetric periodic distribution, only half the circular distribution (1°-180°) is considered (Curray, 1956). By doubling the vector angles (θ_i), as shown above, the data is thus distributed over the full 360° period of the unit circle. The angle $2\theta_i$ is converted to radians.

Subsequently, Cartesian or rectangular coordinates ($\bar{C}$ and $\bar{S}$) of the mean vector can be determined:

$$\bar{C} = \Sigma(f_i \cdot \cos 2\theta_i)/\Sigma f_i$$

$$\bar{S} = \Sigma(f_i \cdot \sin 2\theta_i)/\Sigma f_i$$

The length ($\bar{R}$) of the mean vector is then calculated as:

$$\bar{R} = \sqrt{\bar{C}^2 + \bar{S}^2}$$

$\bar{R}$ is a measure of the concentration or dispersion of the data about the mean vector (Batschelet, 1965). If the value of $\bar{R}$ is close to 1.0, then the amount of dispersion is small. It is necessary to correct the value of $\bar{R}$ if the data are divided into degree intervals greater than 1°, otherwise the value of the angular deviation will be inaccurate. The corrected value (R_c) can be found by:

$$\bar{R}_c = \bar{R}\,\frac{\beta}{\sin\beta}$$

where β is half the arc of the degree interval in radians (Batschelet, 1965). If the degree interval is 20°, then β = 10° 0.1745 radians.

Finally, the angle of the mean vector ($\bar{\theta}$) or the mean direction can be calculated:

$$\sin 2\bar{\theta} = \bar{S}/\bar{R} \text{ or } \sin 2\bar{\theta} = \bar{S}/\bar{R}_c\ ,$$

$$\cos 2\bar{\theta} = \bar{C}/\bar{R} \text{ or } \cos 2\bar{\theta} = \bar{S}/\bar{R}_c\ ,$$

and

$$\bar{\theta} = \tfrac{1}{2}\,(\arcsin(\sin 2\bar{\theta}))\ ,$$

$$\bar{\theta} = \tfrac{1}{2}\,(\arccos(\cos 2\bar{\theta}))\ .$$

Convert $\bar{\theta}$ to degrees. If $\sin 2\bar{\theta}$ is a negative value, then

$$\bar{\theta} = 180° - \bar{\theta}$$

Calculation of Angular Deviation

The angular deviation (σ) is the dispersion of the data about the mean direction. When the amount of angular deviation is <50°, 67 percent of the data will lie within $\pm\sigma°$ of the mean direction (Batschelet, 1965):

$$\sigma = \tfrac{1}{2}\sqrt{2\,(1-\bar{R})} \text{ or } \sigma_c = \tfrac{1}{2}\sqrt{2\,(1-\bar{R}_c)} \quad .$$

Convert the value (σ) from radians to degrees.

Calculation of the Standard Error of the Mean

The standard error of the mean for distributions with large (≥ 30) or small populations is given by Spiegel (1961) as follows:

$$SE = \frac{\sigma}{\sqrt{N}} \quad ,$$

where SE is the standard error and N is the population size (number of breakouts or total feet of breakout in the data set).