breakouts is expected to be radial for borehole deviations greater than about 20°, similar to the observations in this data set.

Figure 5. 95% confidence values for the three principal stresses from inversion of aftershocks, above 2 km, larger than Magnitude 1, in the Northridge area in 1994. (a) Events above 2 km (115 aftershocks used in inversion) yield a strike slip faulting stress regime with S_H slightly E of N and $\phi = 0.302$. (b) Events below 14 km (559 aftershocks) yield a thrust faulting stress regime with $\phi = 0.227$.

Supplementary data and figures.

Appendix I. (Figures 6-15). Plots showing details of data from well logs and resultant locations of breakouts identified in this study. The API number for each borehole is given in parentheses.

Figure 6: Data for Southern California Gas Aliso Canyon SFZU Mission Adrian (MA) 1b (04-037-21892-00). (a) Caliper measurements as a function of depth, with bit size shown as dotted line and positions of identified breakouts shown with open squares. Caliper scale is in inches. Depth scale for all logs is in distance along the borehole and does not correspond to true vertical depth. (b) Breakout azimuth as a function of depth. Note that the technique of breakout identification from 4-arm caliper data, used here, assumes that the breakouts are symmetric; thus, only azimuths from 0 to 180° are shown. Note that breakouts from 2100-2400', where the borehole deviation is < 8°, are reasonably well clustered along the radial (down-plunge) direction of the borehole. (c) Borehole azimuth (solid line) and bearing of pad 1 relative to high side of hole (dotted line). Note that tool rotation is visible between 6900' and 7200', in a region where the caliper measurements are equal to bit size, as often expected in zones lacking breakouts. (d) Borehole deviation from vertical as a function of depth.

Figure 7: Data for Southern California Gas Aliso Canyon SFZU MA 5-0 (04-037-22309-

01). All symbols are the same as in Figure 6. Three regions of the well (1700'-2000', 4100'-4400', 6800'-7000') were not able to be digitized due to the poor quality of our version of those sections of the log. The lack of breakouts between 7700' and 8000' is due to the borehole not being in gauge.

Figure 8: Data for Chevron Elsmere Margaret Bath 1 (04-037-22031-00). (a) Caliper measurements as a function of depth, with bit size shown as dotted line and positions of identified breakouts shown with open squares. Caliper scale is in inches. Depth scale for all logs is in distance along the borehole and does not correspond to true vertical depth. (b) Borehole azimuth (solid line) and bearing of pad 1 relative to high side of hole (dotted line). (c) Borehole deviation from vertical as a function of depth. This borehole is very near vertical, and features no identifiable breakouts.

Figure 9: Data for McCulloch Cascade Mission Visco 14 (04-037-21879-01). All symbols are the same as in Figure 6. This borehole is highly deviated, and the breakouts are predominantly along the radial (down-plunge) direction of the borehole.

Figure 10: Data for Chevron Pacoima 10 (04-037-22952-00). All symbols are the same as in Figure 6. The borehole bit size changes at 9400'. This borehole is highly deviated, and the breakouts are predominantly along the radial (down-plunge) direction of the borehole.

Figure 11: Data for Chevron Pacoima 4 (04-037-22356-00). All symbols are the same as in Figure 6. The bit size of the borehole changes at 8100'.

Figure 12: Data for Chevron Pacoima 5 (04-037-22709-00). All symbols are the same as in Figure 6. This borehole is highly deviated, and the breakouts are predominantly along the radial (down-plunge) direction of the borehole.

Figure 13: Data for Unocal San Fernando 1-9 (04-037-22050-00). All symbols are the same as in Figure 6. There are two distinct sections to this borehole. The near-vertical

section at log depths of less than 6000' primarily features breakouts with NE azimuths. The non-vertical section at log depths of greater than 6000' is more highly deviated and has breakouts predominantly along the radial (down-plunge) direction of the borehole.

Figure 14: Data for Southern California Gas Aliso Canyon SFZU SS 1-0 (04-037-22058-00). All symbols are the same as in Figure 6. This borehole is highly deviated below 6000', and the breakouts are predominantly along the radial (down-plunge) direction of the borehole.

Figure 15: Data for Chevron Placerita USL 6 (04-037-22337-00). All symbols are the same as in Figure 6. The borehole log features very few breakouts due to little caliper difference and frequent tool rotation.

Appendix II. (Figures 16-20). Plots showing details of inversion of the 1994 Northridge aftershock sequence for determining the stress tensor in this region, after the earthquake. Figures demonstrate 95% confidence values for each of the three principal stresses. Consult Table 2 for quantity of events used for each inversion.

Figure 16: Inversion of aftershocks from 2 to 4 km.

Figure 17: Inversion of aftershocks from 4 to 6 km.

Figure 18: Inversion of aftershocks from 6 to 8 km.

Figure 19: Inversion of aftershocks from 8 to 10 km.

Figure 20: Inversion of aftershocks from 10 to 12 km

Figure 21: Inversion of aftershocks from 12 to 14 km.

Figure 22: Inversion of all (3236) aftershocks.

Table 1
Average breakout orientations for each drill hole:

Operator	Field	Well Name	Breakout Azimuth (° East of North)	Breakout Length (ft)	(m)	σ of Mean (°)	Township/ Range	Section	Depth Range of Breakouts (ft)	(m)
S. Calif. Gas	Aliso Canyon	SFZU MA 1b	-25.7988	278	84.73	0.666101	3N/16W	34	2139-3838	651-1170
S. Calif. Gas	Aliso Canyon	SFZU MA 5-0	-71.102	228	69.49	0.17651	3N/16W	34	3524-8091	1074-2466
Chevron	Elsmere	Margaret Bath 1		no breakouts found			3N/16W	12	(depth of log: 233-1495')	
McCullough Oil	Cascade	Mission Visco 14	-43.7411	348	106.07	0.271471	3N/16W	25	1037-2790	316-850
Chevron	Pacoima	Pacoima 10	-82.9356	3814	1162.51	0.34839	2N/15W	15	2100-10404	640-3171
Chevron	Pacoima	Pacoima 4	51.0707	196	59.74	0.229556	2N/15W	15	4625-8229	1410-2508
Chevron	Pacoima	Pacoima 5	76.9564	149	45.42	0.171917	2N/15W	15	2562-6050	781-1844
Unocal	San Fernando Area	San Fernando 1-9	25.6176	2464	751.21	0.497287	2N/15W	9	240-7400	73-2256
S. Calif. Gas	Aliso Canyon	SFZU SS 1-0	-68.7491	2313	705.00	0.36233	3N/16W	28	4595-9822	1401-2994
Chevron	Placerita	USL 6	-29.5303	26	7.92	0.39711	3N/16W	1	248-1070	76-326
All segments with borehole deviation < 5°			43.1183	1665	507.49	0.377041				

Table 2
Inversion of 1994 Northridge earthquake focal mechanisms

Depth	Events	ϕ	Stress	Direction (°)	Plunge (°)
0 - 2	115	0.302			
			-1.112	-170.044	3.16
			.853	-79.877	4.10
			.259	62.275	84.76
2 - 4	297	0.249			
			-1.128	16.853	5.58
			.805	108.990	21.41
			.324	-86.930	67.75
4 - 6	364	0.141			
			-1.143	-159.987	0.46
			.442	-69.643	41.08
			.701	109.302	48.85
6-8	458	0.248			
			-1.168	-161.437	5.64
			.336	108.117	2.69
			.832	-7.222	83.68
8 - 10	485	0.240			
			-1.154	-157.621	5.10
			.340	111.042	12.74
			.814	-46.305	76.18
10 - 12	509	0.104			
			-1.065	-158.894	12.08
			.620	-49.645	57.05
			.445	103.805	30.07
12 - 14	463	0.231			
			-1.078	-159.763	9.23
			.327	106.429	21.26
			.750	-47.729	66.58
14 -	559	0.227			
			-1.132	-155.024	9.24
			.349	-62.173	17.32
			.783	87.908	70.17

Note:

Stress magnitudes are relative. Negative stress values are compressional.

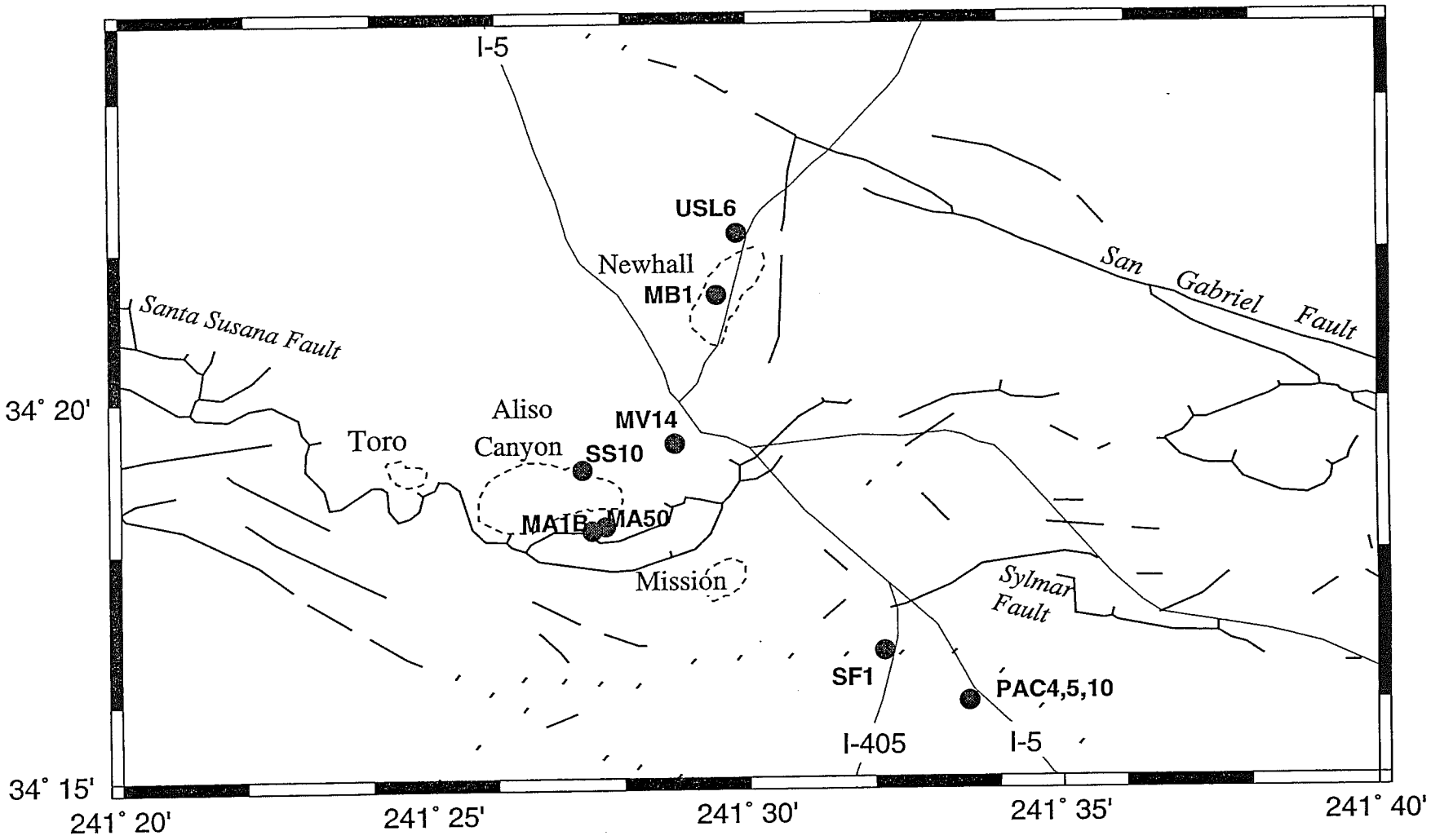

I-5
USL6
Newhall
MB1
San Gabriel Fault
Santa Susana Fault
34° 20'
Aliso
Canyon
MV14
SS10
Toro
MA1B
MA50
Mission
Sylmar
Fault
SF1
PAC4,5,10
I-405
I-5
34° 15'
241° 20'
241° 25'
241° 30'
241° 35'
241° 40'

Figure 1.

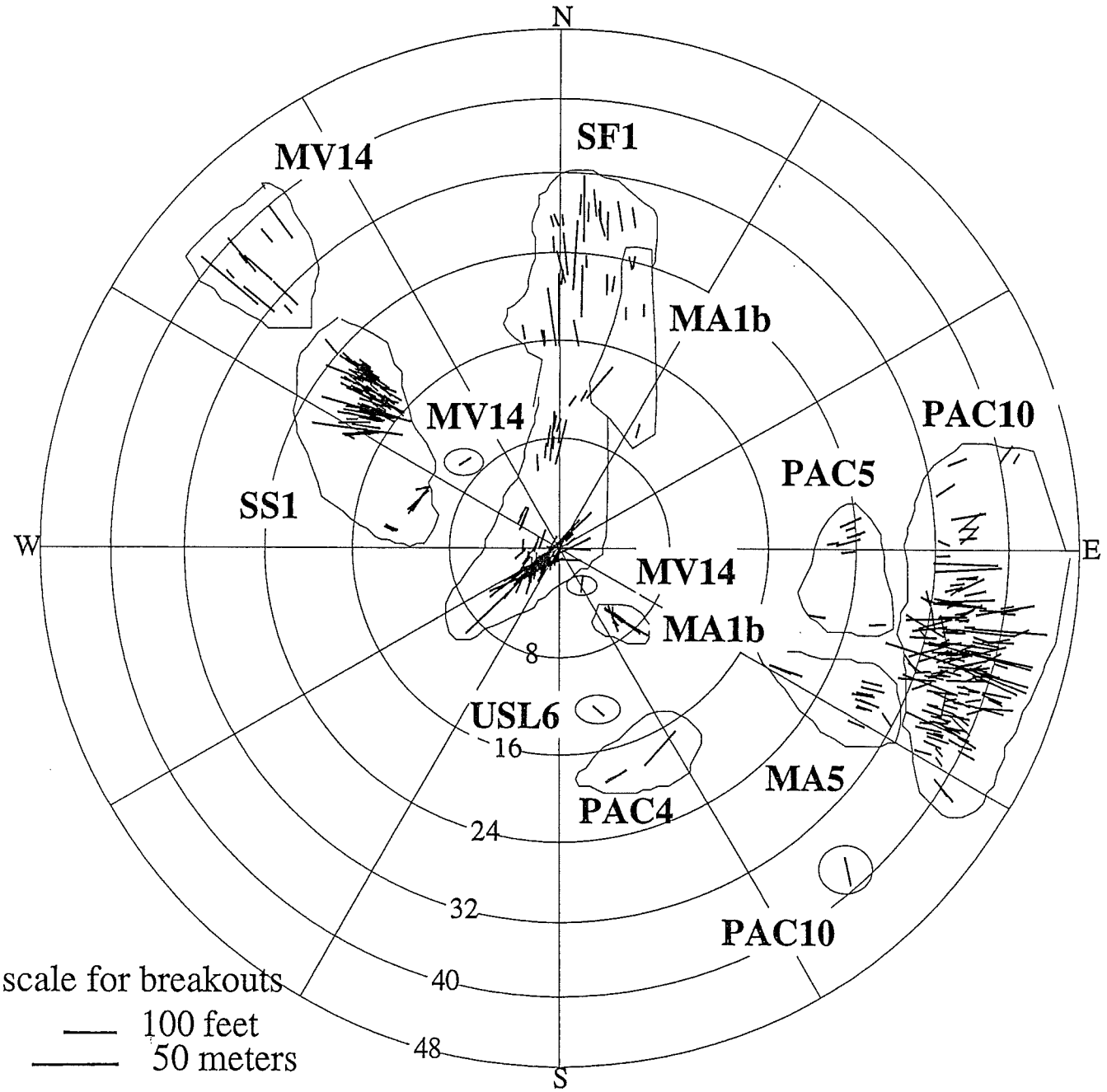

N
W
E
S
SF1
MV14
MA1b
MV14
PAC10
PAC5
SS1
MV14
MA1b
8
USL6
16
MA5
PAC4
24
32
PAC10
40
48
scale for breakouts
100 feet
50 meters

Figure 2.

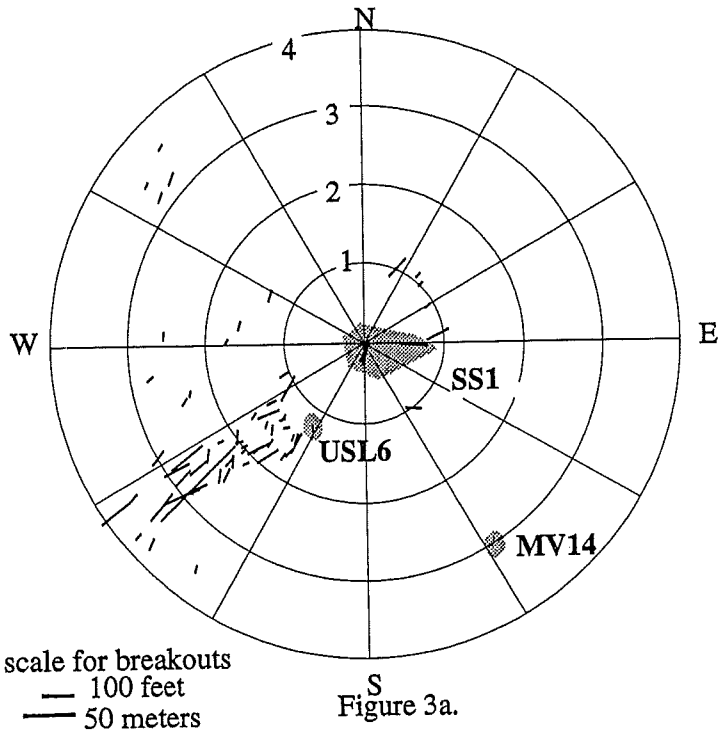


Figure 3a.

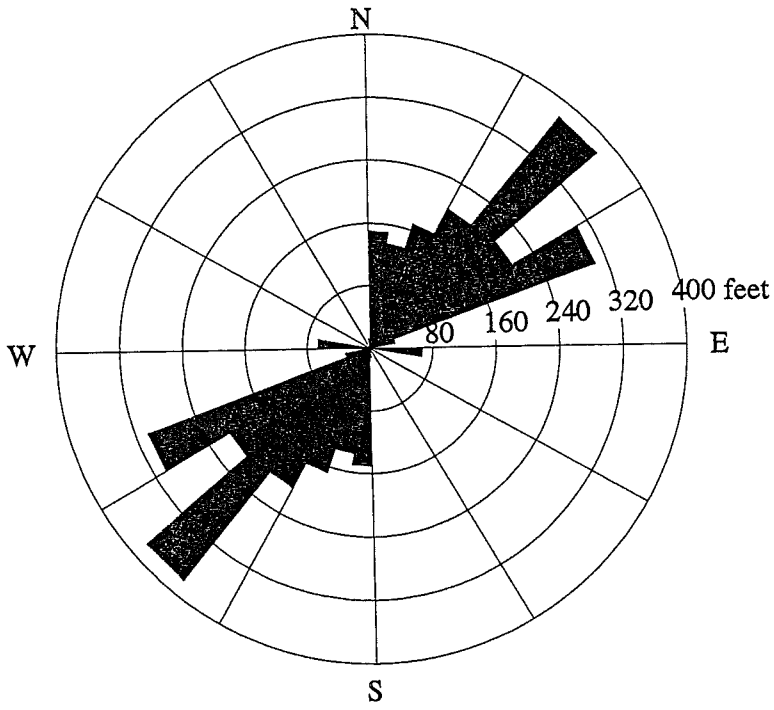
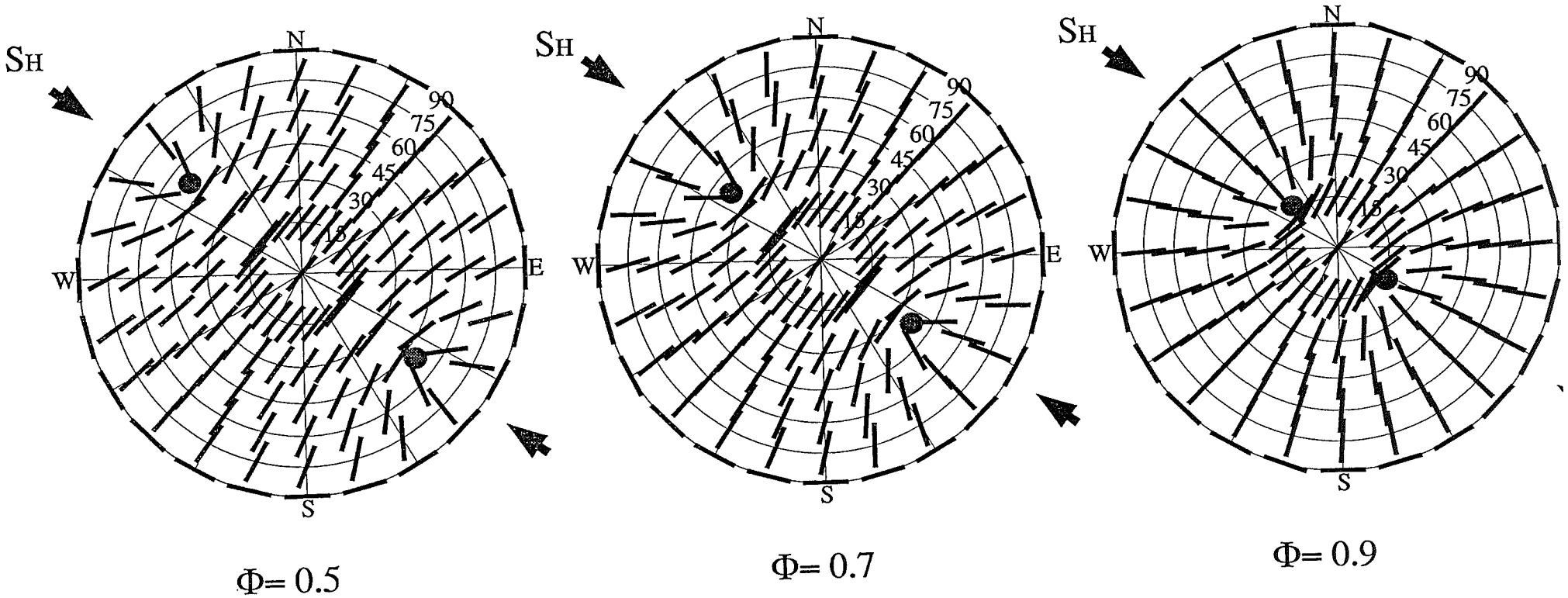


Figure 3b.


SH
N
W
E
S
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75
60
45
30
15
Φ= 0.5
SH
N
W
E
S
90
75
60
45
30
15
Φ= 0.7
SH
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W
S
90
75
60
45
30
15
Φ= 0.9

Fig. 4

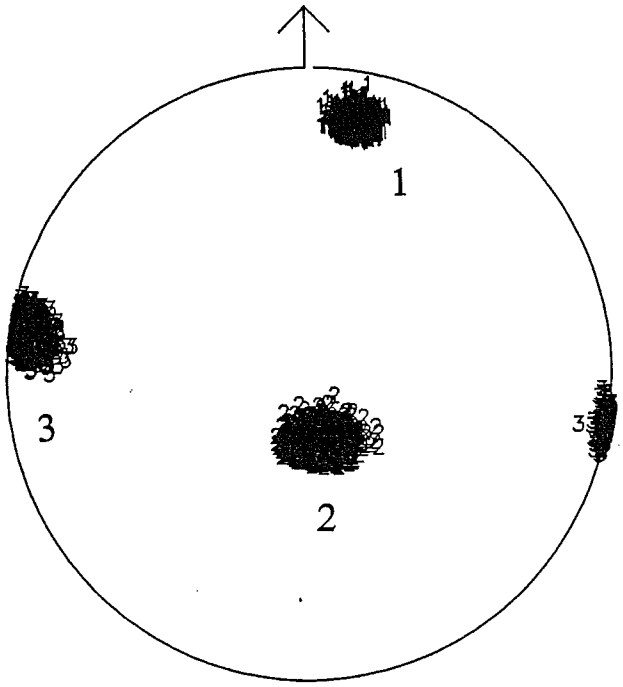


Figure 5a

Strike-Slip Stress Regime

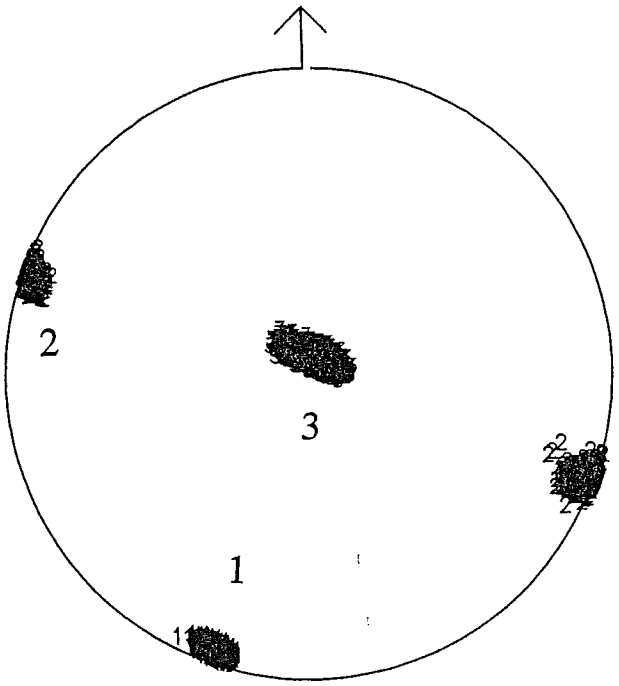
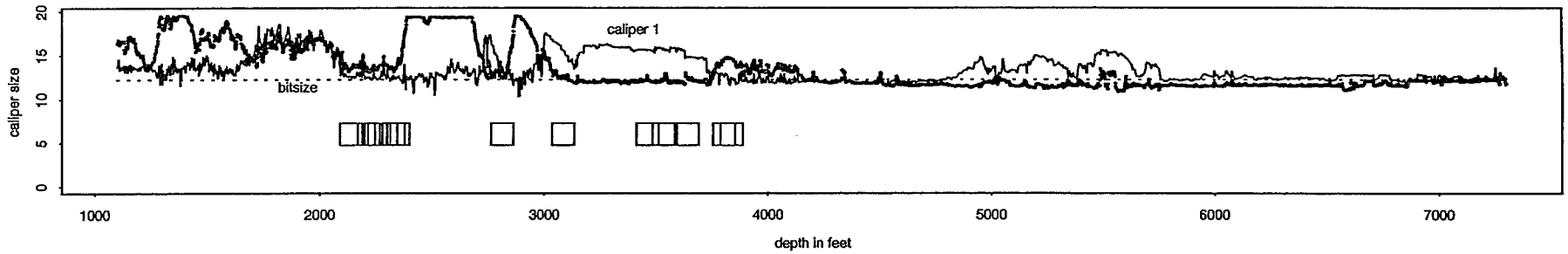
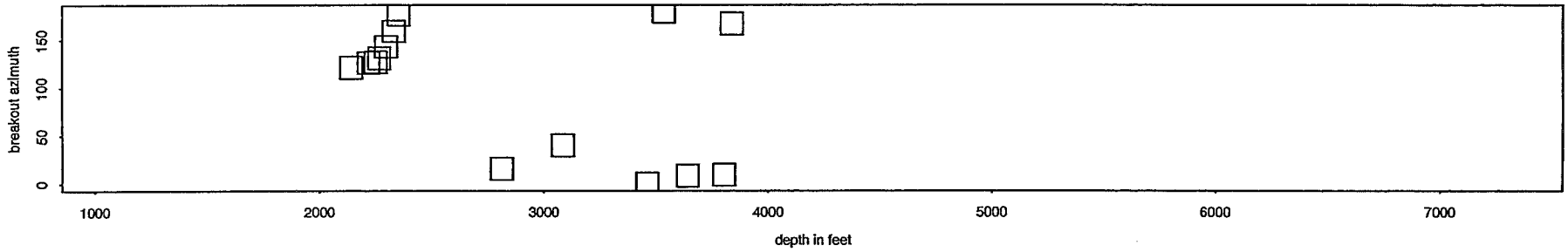


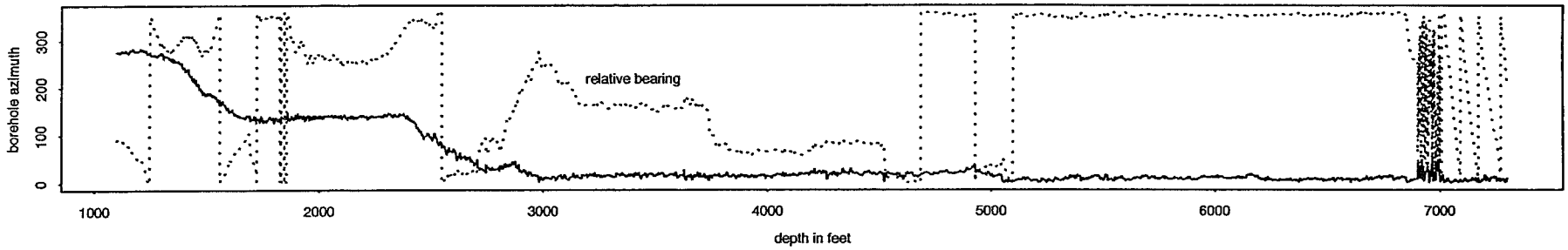
Figure 5b

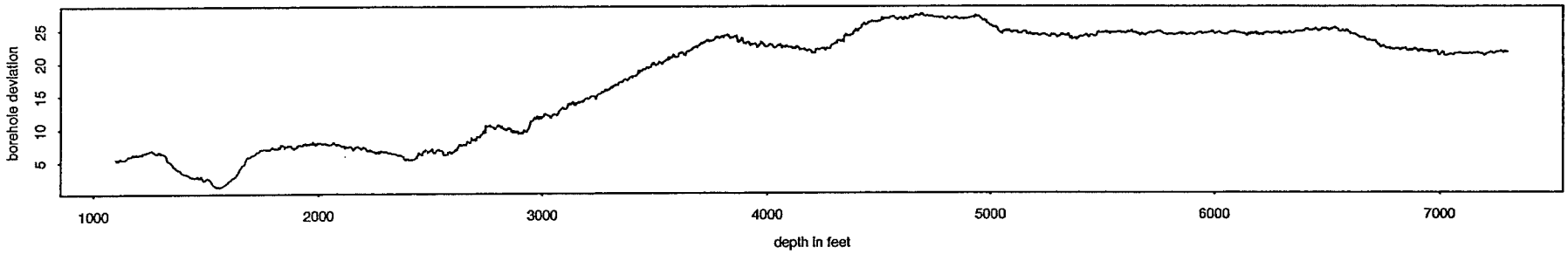
Thrust Faulting Stress Regime

Mission Adrian 1b

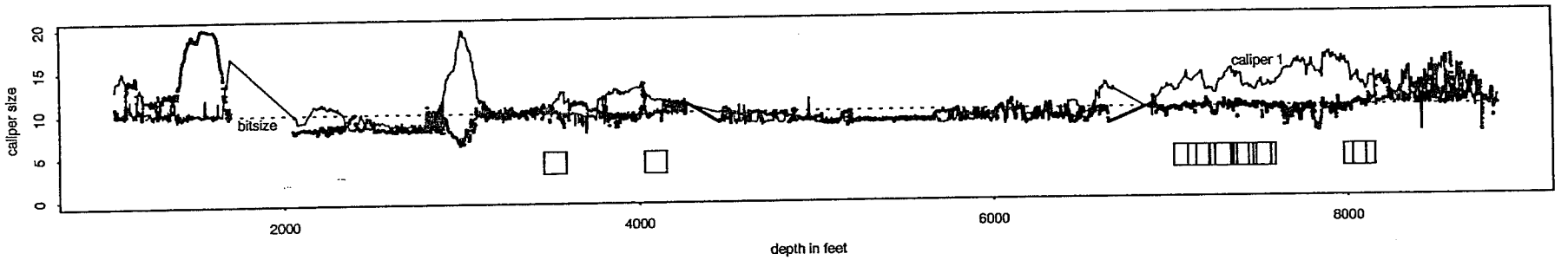


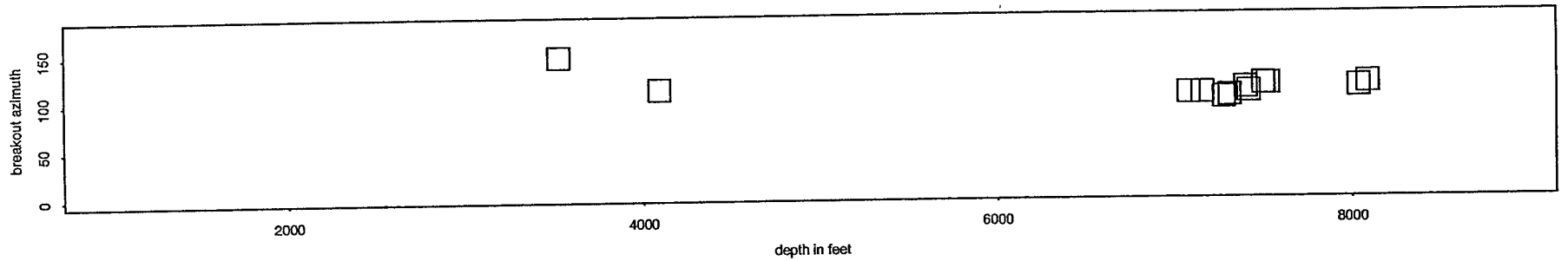


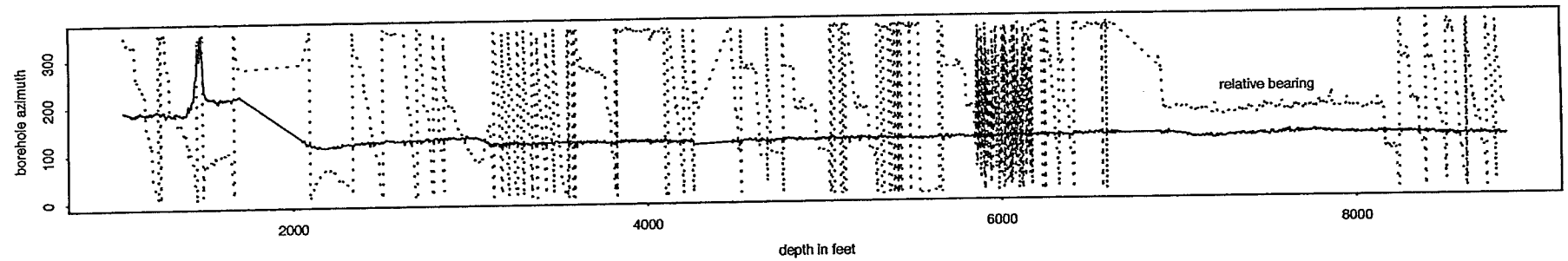


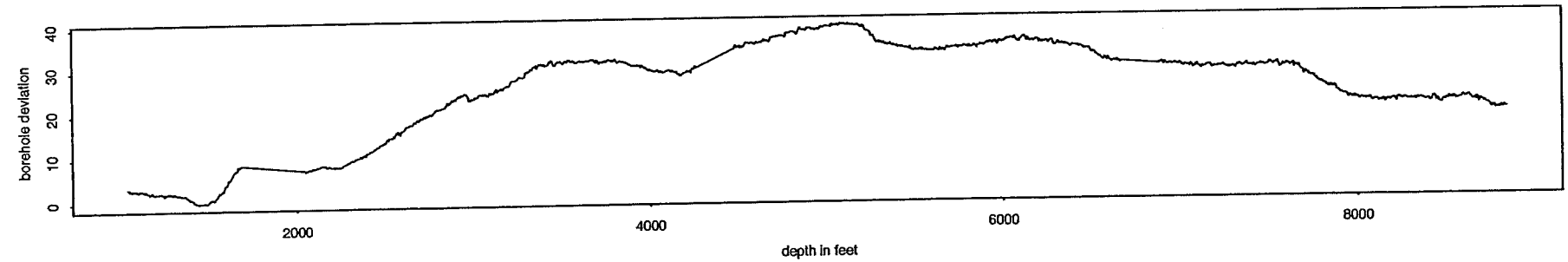


Mission Adrian 5

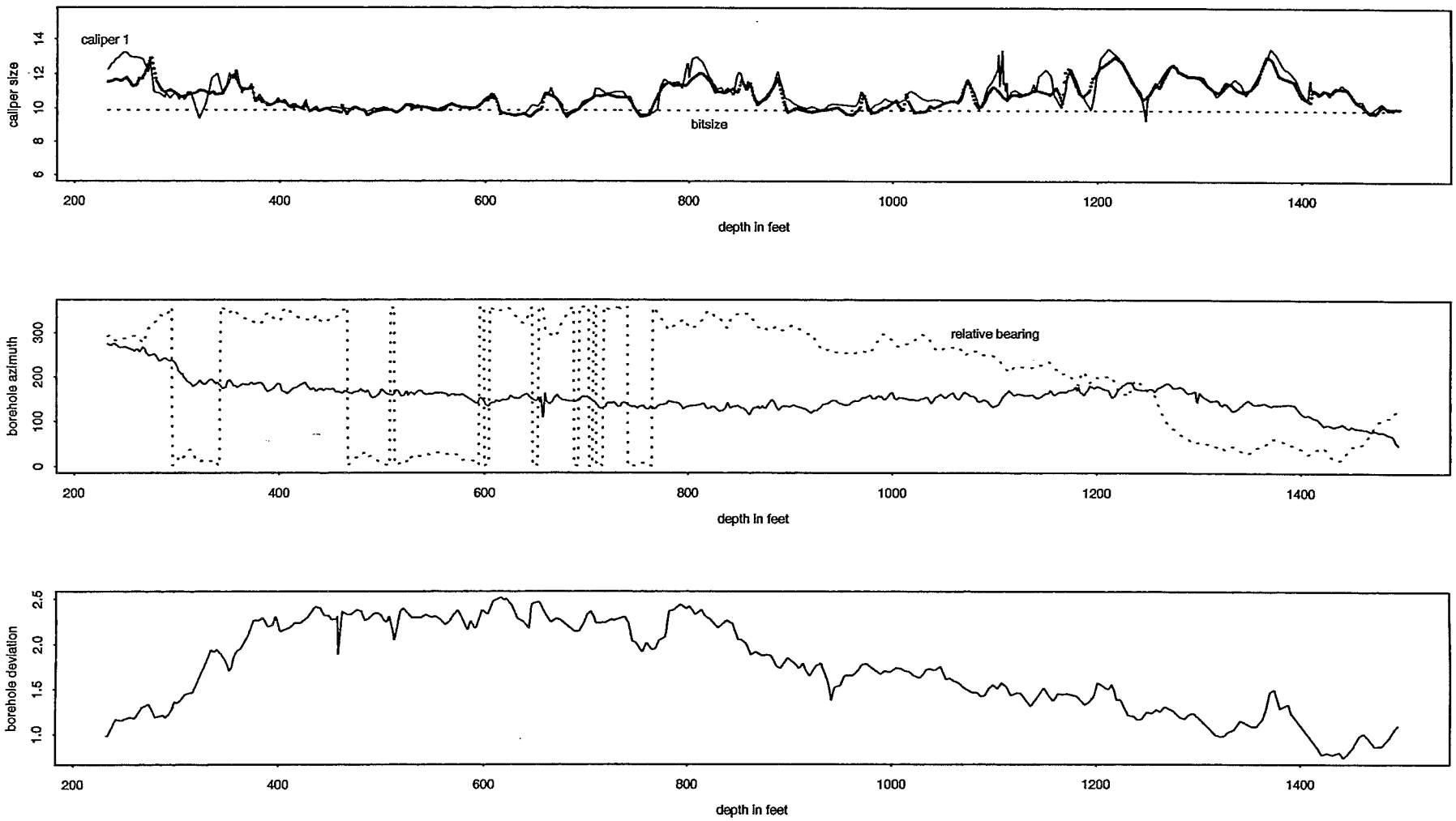




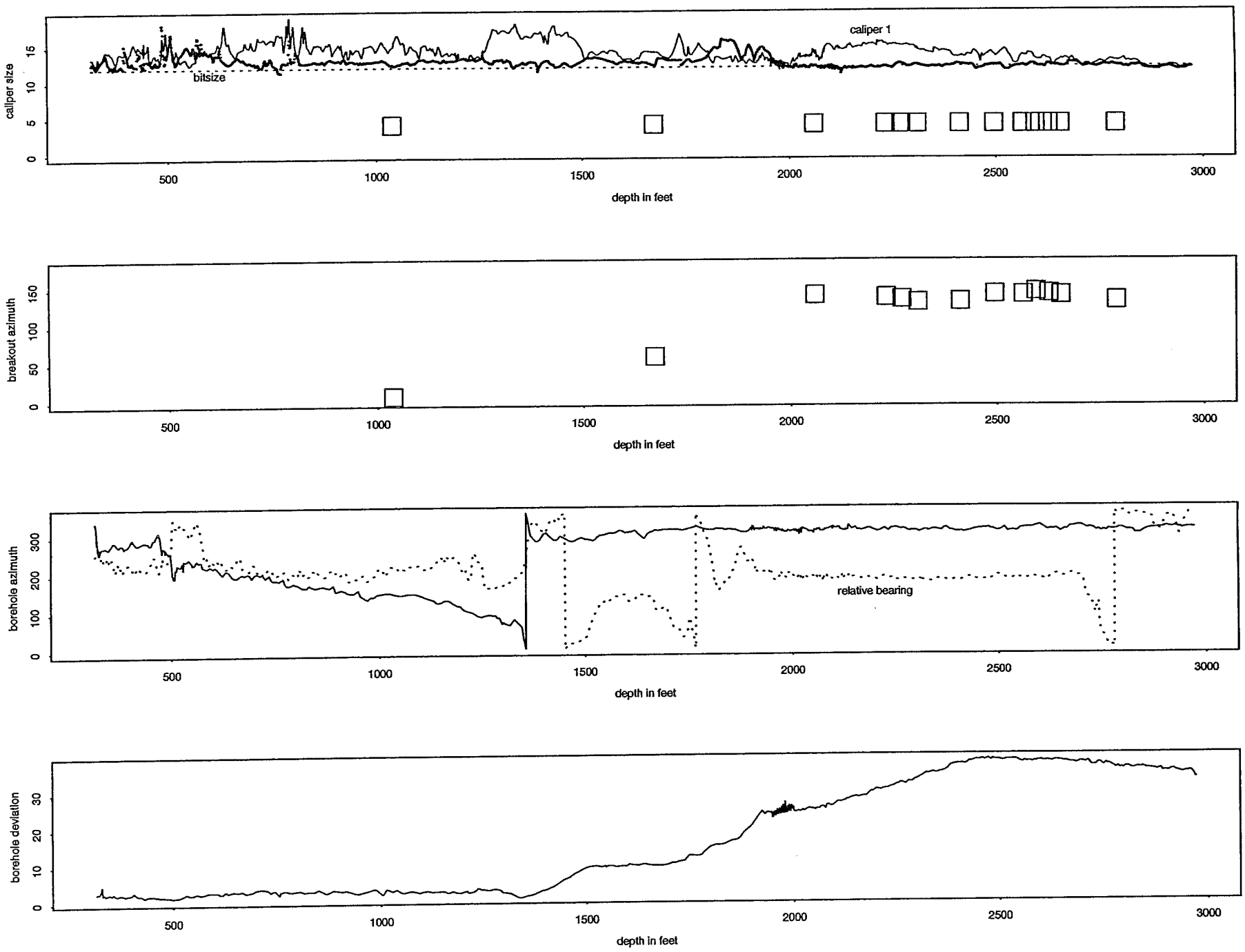




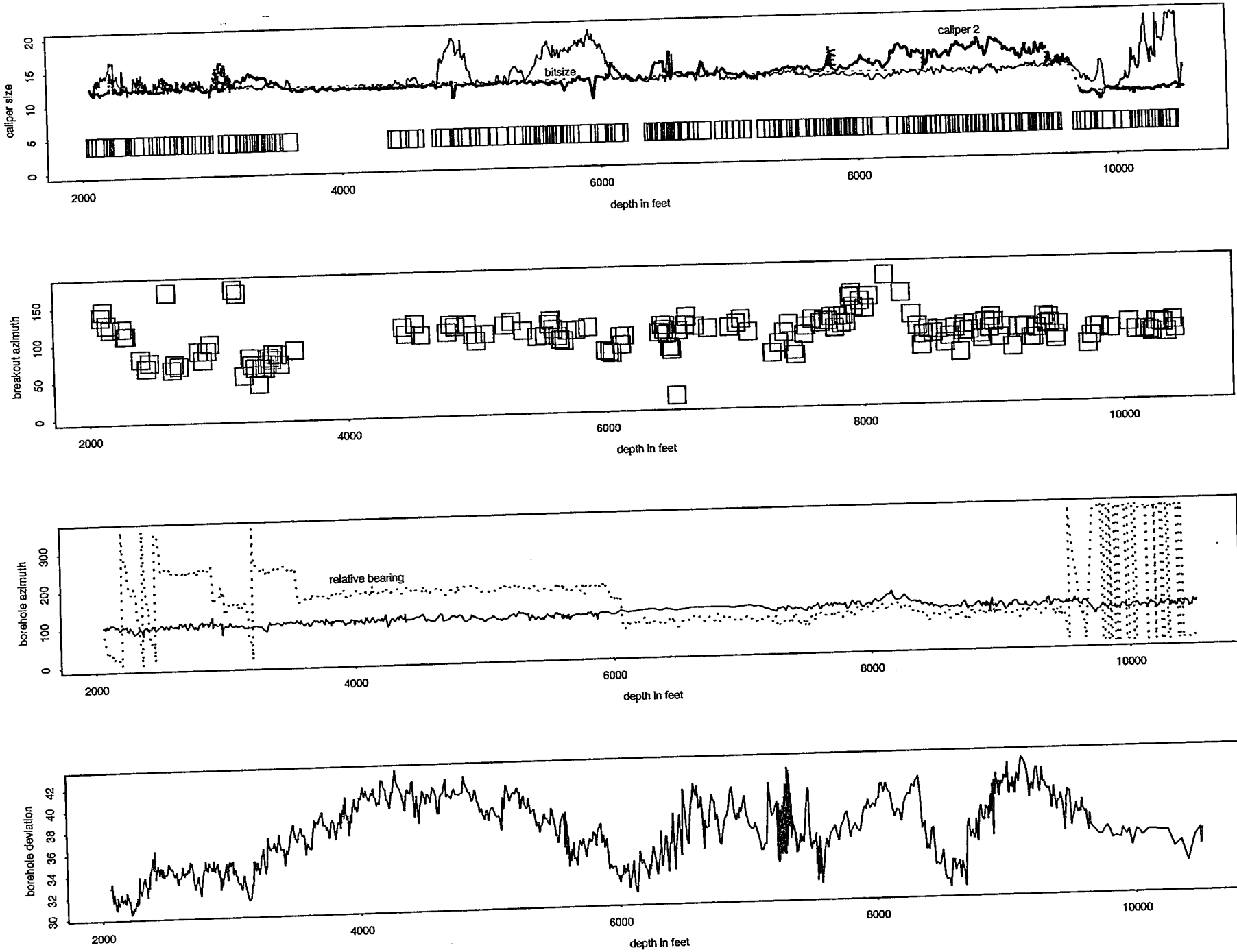
Margaret Bath 1



Mission Visco 14



Pacoima 10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15
20
caliper 2
bitsize
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4000
6000
8000
10000
depth in feet
breakout azimuth
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50
100
150
2000
4000
6000
8000
10000
depth in feet
borehole azimuth
0
100
200
300
relative bearing
2000
4000
6000
8000
10000
depth in feet
borehole deviation
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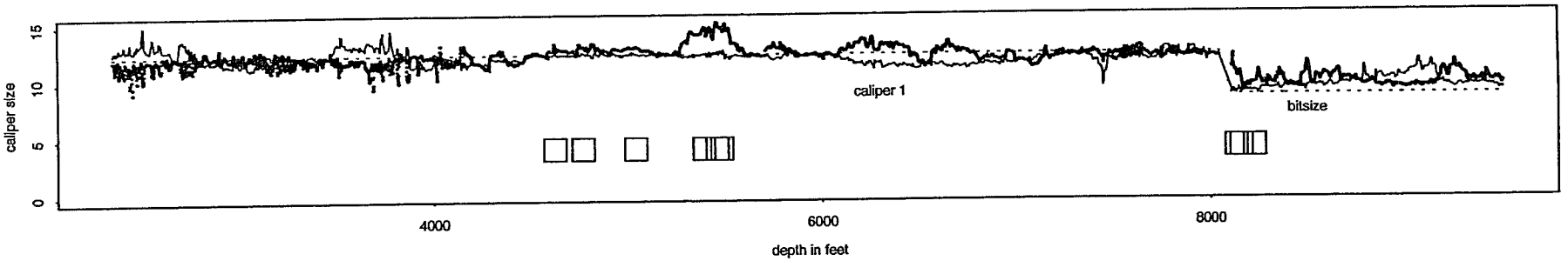
32
34
36
38
40
42
2000
4000
6000
8000
10000
depth in feet

Pacoima 4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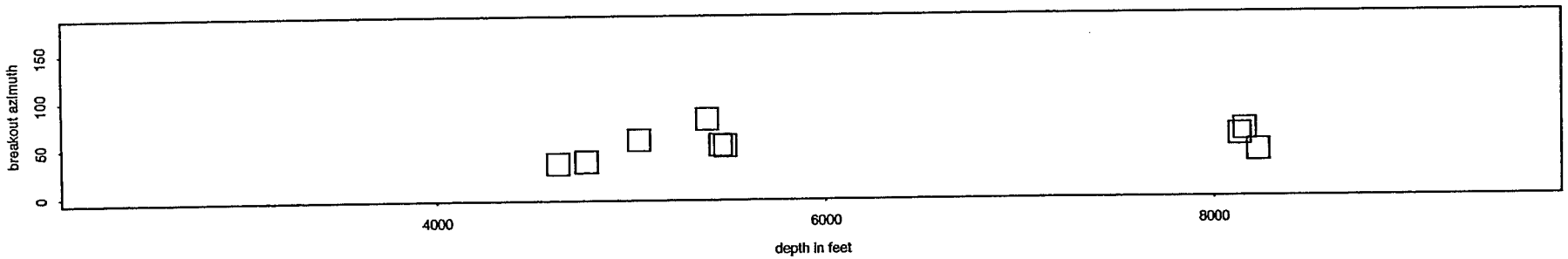
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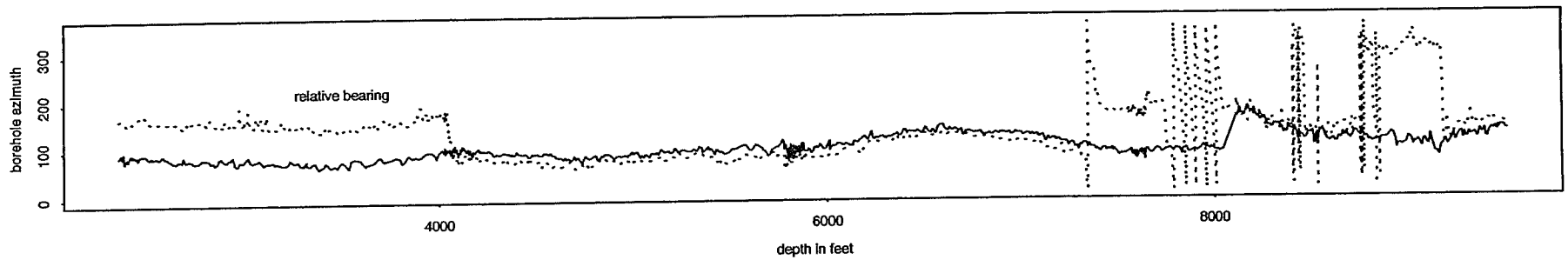
50
100
150
4000
6000
8000
depth in feet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300
relative bearing
4000
6000
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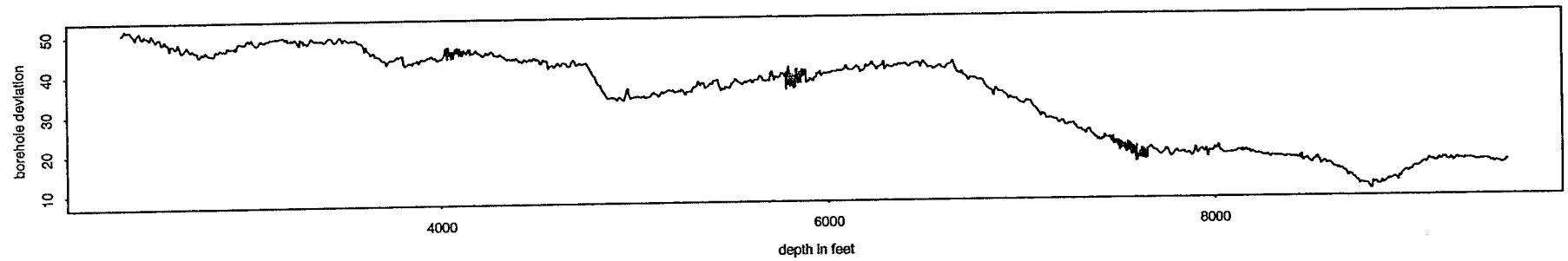
depth in feet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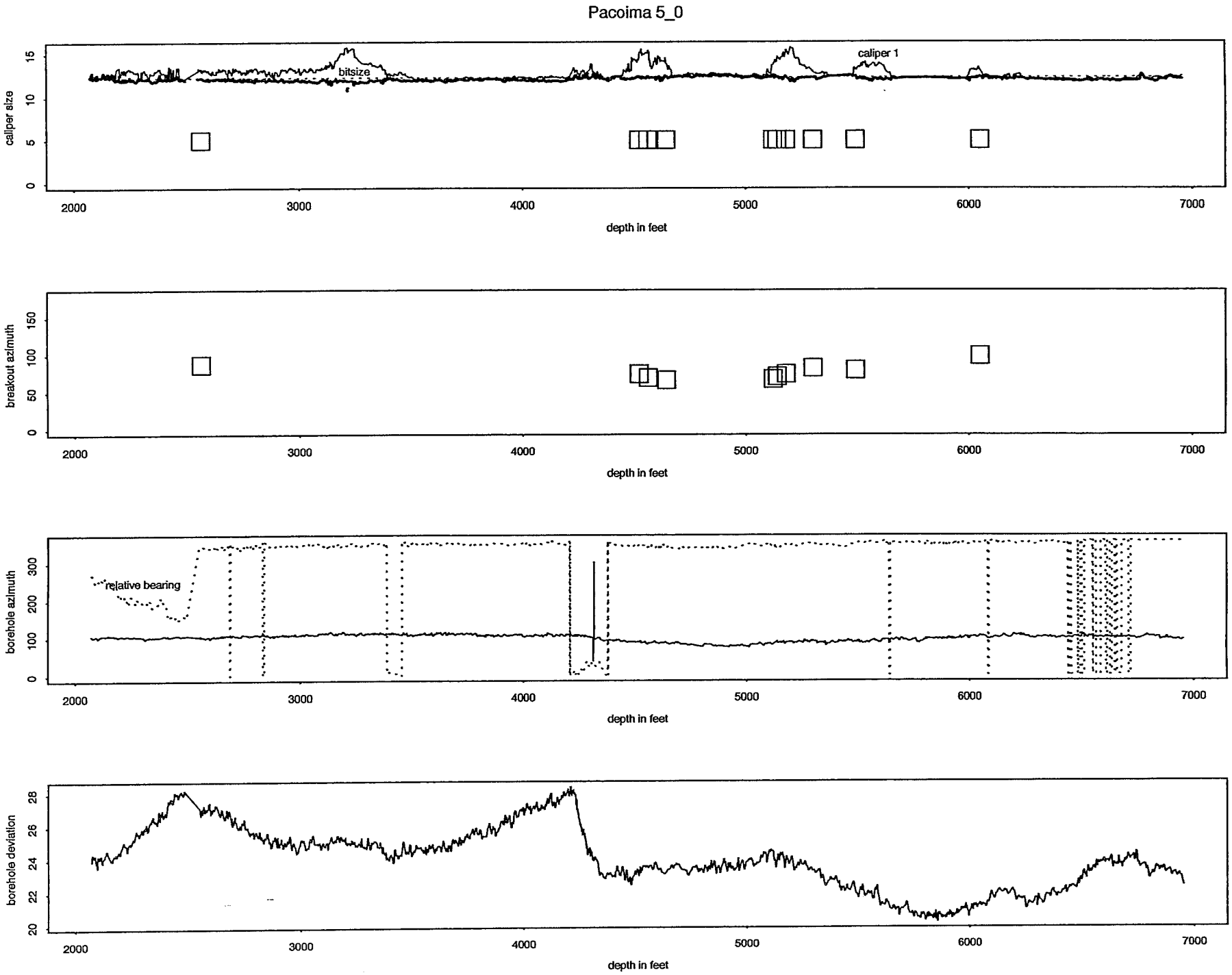
depth in feet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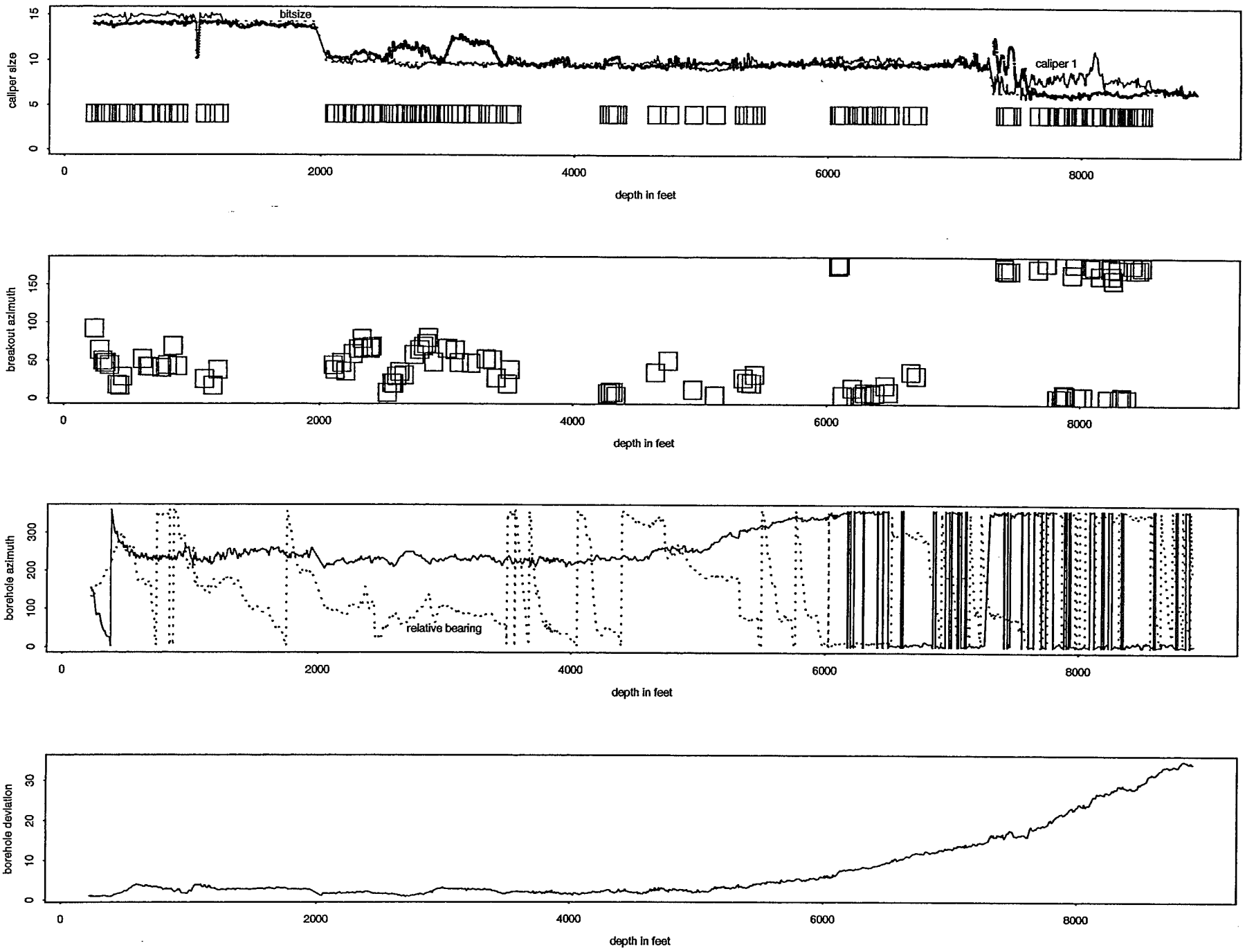
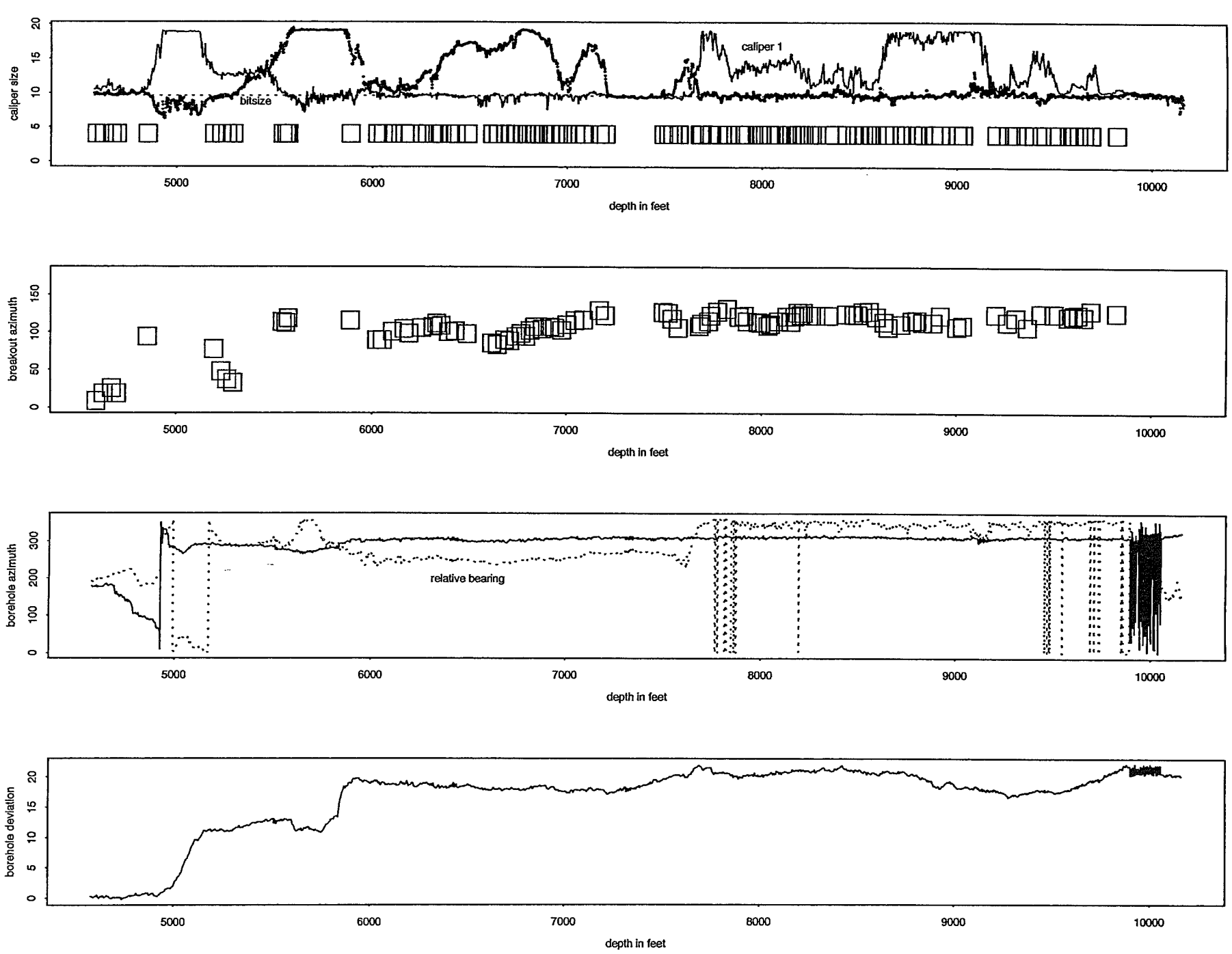
caliper 1
depth in feet
breakout azimuth
depth in feet
borehole azimuth
relative bearing
depth in feet
borehole deviation
depth in feet

San Fernando 1

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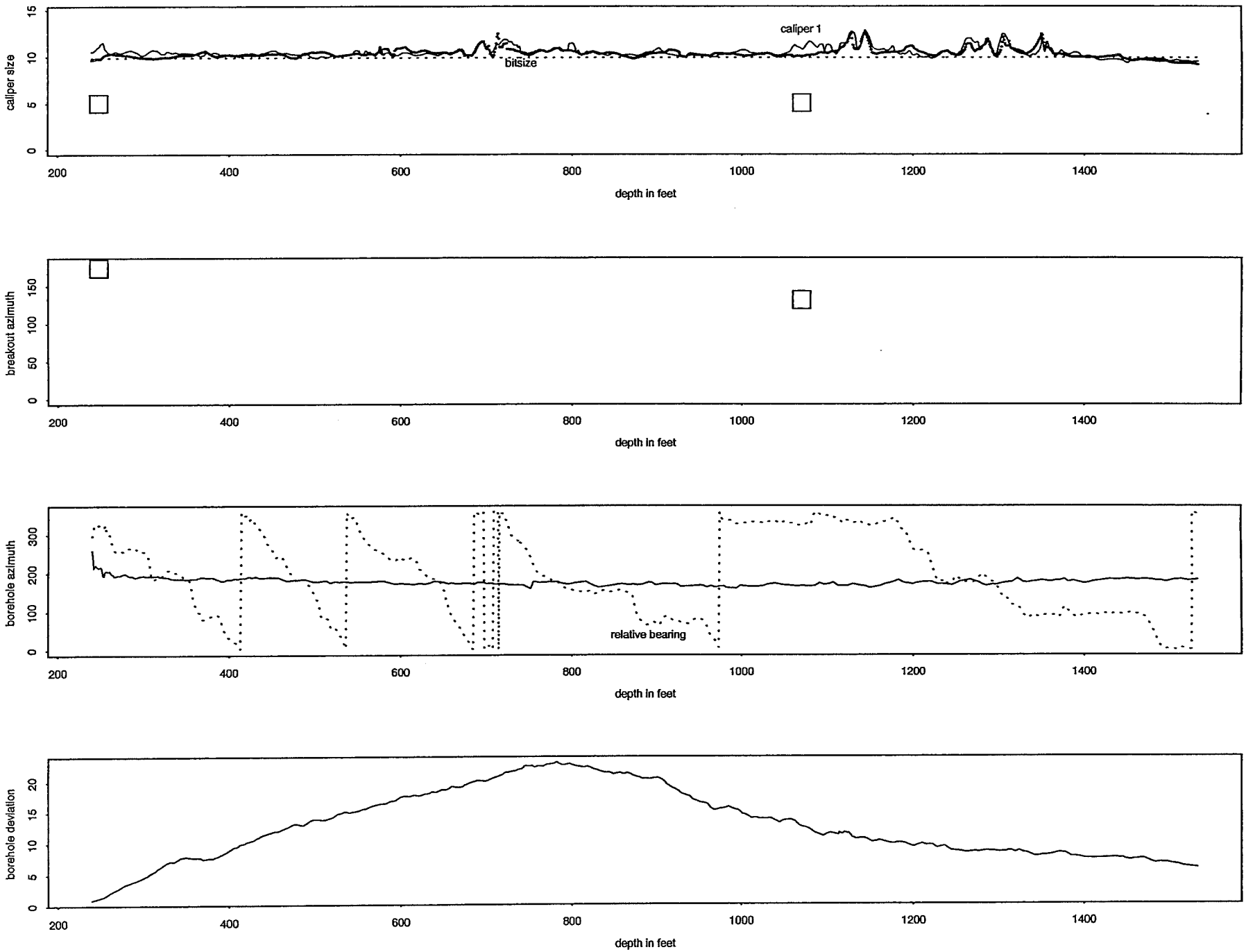
depth in feet

USL 6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600
800
1000
1200
1400
depth in feet
borehole azimuth
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100
200
300
relative bearing
200
400
600
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depth in feet

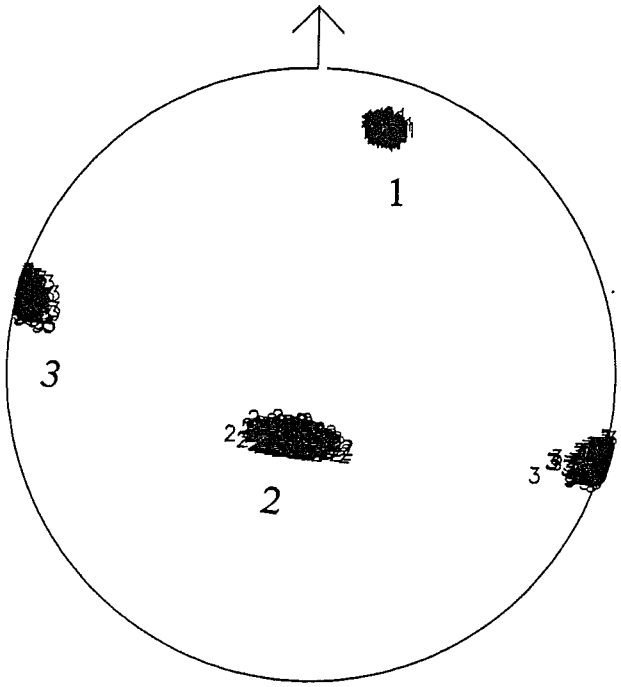

Figure 16

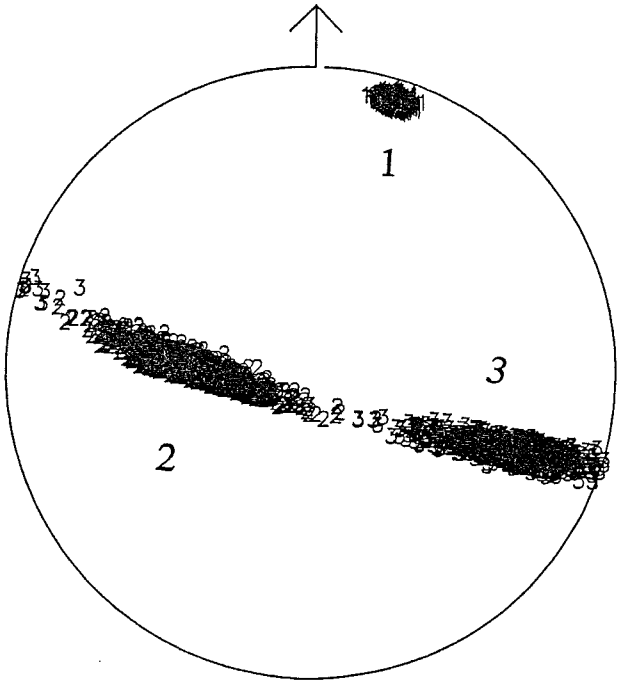

Figure 17

Transitional

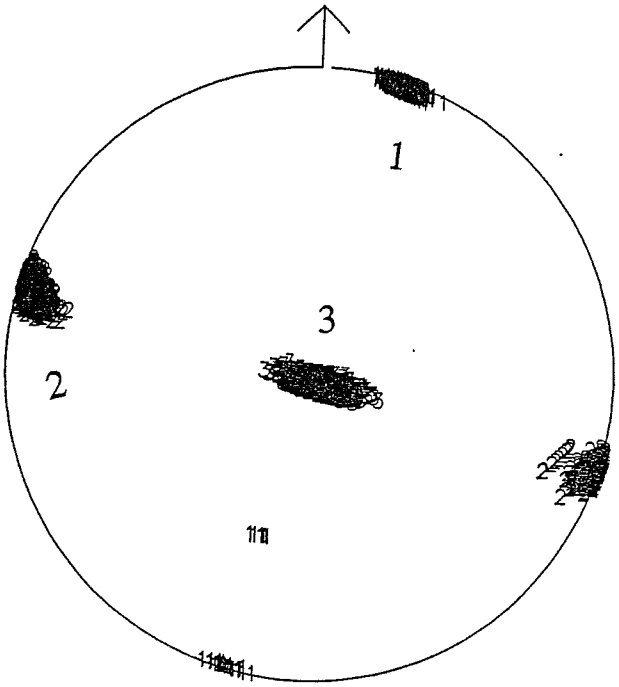

Figure 18

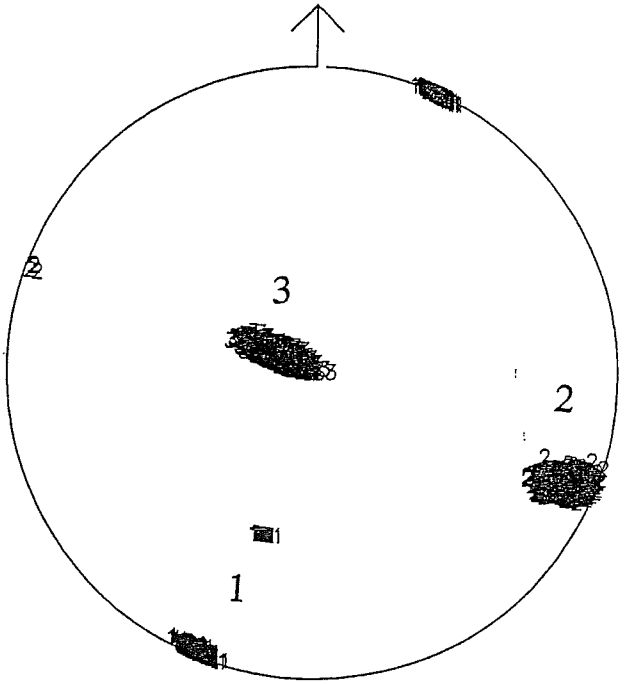

Figure 19

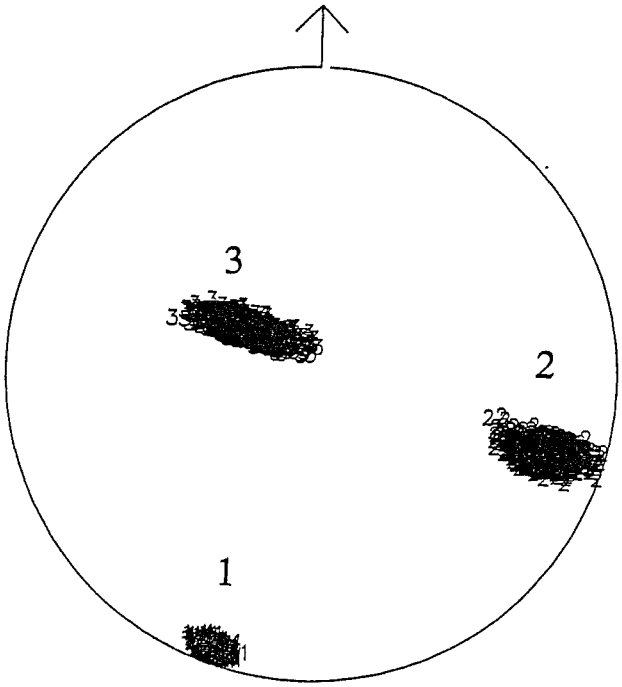

Figure 20

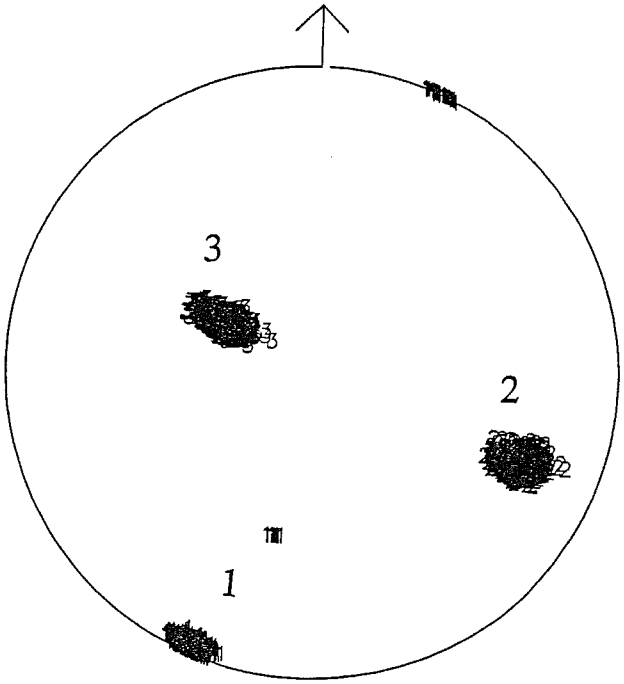

Figure 21