inter-office memo

MEMO TO: J. C. EDWARDS 2 August 1977

FROM: P. T. McCULLOUGH File: 1301.3

SUBJECT: Mapping of Limestone North of Houth Meadows

The accompanying report is a draft copy of field mapping in the limestone north of Houth Meadows on the 16 and 17 July 1977. The report is meant to provide some basic data for Beak's Hydrology study in addition to other field observations by G. Burnett and P. T. McCullough.

Because the information in the report is not directly applicable to the Mineral and Resource evaluation of Hat Creek and because of time constraints, the report will not be issued in final form.

PTMc:rak

cc: W. Alderton (2)
J. G. Alesi (1)
J. J. Fitzpatrick (1)

604H-M026

Mapping of Joints and Karst Features North of Houth Meadows, Hat Creek

Introduction:

The purpose of mapping the limestone north of Houth Meadows is:

1. To examine bedding orientations and jointing to determine if they may act as channels for the movement of groundwater toward Crown Lake.
2. To determine if there are any karst features as evidence of extensive groundwater movement.

The method employed was to conduct a traverse across the hillside recording bedding and fracture attitudes, depth of solution, width, length, and frequency of fractures in each outcrop area. As a result, most of the outcrops on the south and west sides of the hill from the Hat Creek road to the divide between Houth Meadows and Marble Canyon were examined. These areas are illustrated in Plate 1.

Results and Discussion:

For the most part the hills north of Houth Meadows are underlain by massive limestone; fractures are not extensive. The fracture attitudes are listed in Table 1 according to outcrop area. Depth and width of solution along the fracture, length of the fracture, and fracture frequency have also been recorded in Table 1.

TABLE I

ATTITUDES ON FRACTURES AND BEDDING
IN LIMESTONE NORTH OF HOUTH MEADOWS

STN.	ATTITUDE STRIKE	DIP	WIDTH[1]	DEPTH[2]	LENGTH[3]	DENSITY[4]	
1.	105	58 NE	5	5	2	2	
	097	68 NE	1	1	2	3	
	143	49 SW	-	-	-	5 to 1	BEDDING
	077	77 NW	5	5	3+	20 to 30	
	092	74 NE	15	20	1	10	
	083	74 SE	15	20	1	10	
	107	77 NE	Nil	Nil	2.5	3	
2.	130	29 SW	-	-	-	200 to 1	BEDDING
	142	62 SW	5	2 to 5	1 to 2	2	
	030	90	<20	2 to 5	3	>1	
	168	75 SW	3	2	10+	.3	
	030	5 SE	2	2	10+	>.3	FRACTURE ZONE
	056	86 NW	2	2	2+	<2	
	158	67 SW	10	5	1.5	4	
	155	64 SW	20	15	1	1	
	022	73 NW	3	3	1	15	
	081	68 NW	2	2	2	12	
	054	90	6	6	.4	20	
3.	143	59 SW	-	-	-	(locally thin)	BEDDING
	163	85 NE	2	2	.5	25	
	066	81 SE	3	3	.4	28	
	044	80 SE	2	2	1	30	
	070	48 E	30	25	3	6	
	077	88 SE	15	2	3	4	
	160	54 SW	40	40	8	20	
	109	63 NE	-	-	1	200	BEDDING

STN.	ATTITUDE STRIKE	DIP	WIDTH	DEPTH	LENGTH	DENSITY	
4.	122	36 SW	-	-	-	20 to 200	BEDDING
	016	60 NW	2	2	8	5 (locally)	
	079	32 SE	10	20	5	12	
	146	43 SW	10	7	4	5	
	095	73 NE	2	2	1	8	
	110	78 NE	4	3	2	3	
	008	43 NW	10	4	2	25	
	128	79 SW	5	12	3	6	
	118	72 NE	2	2	3	10	
5.	105	67 NE	-	1	30+	50	
	110	82 NE	2	2	5	3	
	058	60 NW	-	-	<1	200	
	040	26 SE	2	2	1	30 to 100	
	126	69 NE	-	-	10+	2	
	169	63 NE	1	1	2	15	
	142	47 NE	5	2	2.5	30	
	030	49 SW	20	6	3	25	
	108	63 NE	5	3	2	8	
	107	16 SW	-	-	-	5	BEDDING
	015	74 NW	50	50	1.5	2	
6.&7.	075	69 NW	-	-	1	70	
	132	83 SW	-	2	1	5	
	152	78 SW	5	1	1	18	
	069	81 NW	-	-	.7	20	
	110	65 NE	3	3	2.5	10	
	167	76 NW	2	3	.4	30	

STN.	ATTITUDE STRIKE	DIP	WIDTH	DEPTH	LENGTH	DENSITY	
6 & 7 (Cont'd)	045	81 SE	5	5	.4	25	
	059	78 NW	30	20	2	1	
	128	14 SW	25	10	1.3	1	
	077	75 NW	3	2	1.5	10	
	110	51 SW	2	1.5	5	4	
	110	39 SW	3	3	3	25	
7.	074	90	2	2	1	<2	
	119	49 NE	-	1	1	2 (locally)	
	158	62 SW	-	-	-	200	BEDDING?
	067	79 NW	5	5	2	4	
	174	26 NE	-	-	<1	5	
	091	63 NE	-	-	1	100	
	171	69 NE	-	-	-	<30 to 100	BEDDING?
	094	57 NE	-	-	2	50	
	157	78 SW	2	1	3	.2	
8.	167	52 NE	<1	<1	10+	.3	
	121	82 NE	-	-	6	1 to 3	
	112	57 NE	1	1	3+	2 to 30	
	013	78 NW	-	-	-	5 to 100	
	129	42 SW	2	2	1	<10	
	171	67 NE	1	1	.8	30	
	104	43 NE	3	3	1.2	10	
	173	75 SW	8	5	1.5	6	
	104	65 NE	3	3	8	15	
	063	54 NW	2	3	1.2	25	
	115	48 NE	6	4	1.5	13	BEDDING

STN.	ATTITUDE STRIKE	DIP	WIDTH	DEPTH	LENGTH	DENSITY	
8.(Cont'd)	040	64 NW	14	9	.7	2	
	067	49 NW	10	4	2.5	17	
	171	79 SW	8	4	4.5	12	
9.	009	64 NW	-	-	10+	2	
	074	65 NW	-	-	3+	2 to 100	
	034	25 NW	-	-	1	100	
	107	68 SW	-	-	7+	2 (irreg.)	
	050	87 NW	2	2	3+	10 to 30	
	140	72 SW	-	-	-	2	BEDDING?
	056	30 NW	2	2	.3	5	
	045	39 NW	-	-	-	25	BEDDING?
	005	60 NW	3	2	2	25	
	067	73 NW	3	2	1.5	35	
	105	29 NE	4	5	15	4	
	142	77 SW	4	4	3	7	
	060	58 NW	2	1	1	13	
10.	101	41 NE	3	5	.6	15	
	043	75 NW	4	2	.7	8	
11.	010	12 NW	6	3	2	1	
	018	85 NW	-	-	2+	2	
	049	88 NW	-	-	2+	2	
	100	84 SW	2	4	.8	18	
	069	46 NW	2	3	1	5	
	007	20 SE	8	6	.5	7	
	107	83 NE	6	6	2.5	20	

STN.	ATTITUDE STRIKE	DIP	WIDTH	DEPTH	LENGTH	DENSITY	
12.	046	85 SE	-	-	-	(irreg.)	BEDDING?
	014	78 SE	-	-	-	(irreg.)	BEDDING?
	060	45 NW	2	2	2	15	
	002	82 NW	3	3	.4	20	
13.	078	70 NW	-	-	20+	>2 (irreg.)	
	073	49 NW	-	-	20+	100	
	004	61 SE	-	-	20+	2	
	050	14 NW	300	300	50+	-	
	137	78 NE	-	-	4+	15 to 75	
	167	73 NE	-	-	30+	(irreg)	
	027	41 SE	-	-	30+	(irreg.)	
	031	83 SE	-	-	6+	25 to 200	
	084	71 NW	1	3	2	20	
	071	42 NW	2	1	5	10	
	165	63 NE	2	2	3.5	20	
	100	67 NE	2	2	2.5	15	
	148	51 NE	4	4	-	50	
	060	61 NW	1	2	6	45	
	020	37 SE	2	3	4	30	
	134	76 NE	3	5	.2	6	
	047	73 NW	1	5	1.2	18	
	070	35 NW	2	3	1.8	10	
	110	41 NE	1	1	1.2	6	
	031	70 SE	4	2	2.5	6	
	067	57 NW	2	2	.5	4	
	037	85 NW	2	2	1	10	

STN.	ATTITUDE STRIKE	DIP	WIDTH	DEPTH	LENGTH	DENSITY
14.	027	80 SE	-	-	.5	3 (locally)
	065	49 NW	4	3	1.1	7
	158	86 SW	3	3	.2	3

1. Width of fracture in millimeters.

2. Depth of fracture in millimeters.

3. Length of fracture in meters. A (+) sign indicates the length is greater than that tabulated, but it is obscured by overburden.

4. Number of fractures or bedding planes per meter.

The dominant fracture orientations are listed in Table 2 and are evident from the Pincus plot in Figure 1. The dominant fractures are steeply dipping, certainly at a steeper angle than the topographic surface. Few of the individual fractures found in outcrop extend for more than a few meters. (Table 1). The fractures that are throughgoing do not fall into any particular fracture group (ie. have a particular attitude) as is evident by comparing Tables 1 and 2. For clarity the fractures in each outcrop area (sites 1 to 14) are plotted on individual Pincus Plots. (Figures 2 to 15) The bedding attitudes are plotted in Figure 16.

From Figure 1 five dominant fracture sets were determined and labelled A through E beginning with the most dominant and progressing toward the least dominant of the group. The dominant bedding plane attitude has been labelled F. These dominant sets were plotted on a Wulff net and the plunges of the intersections noted as dominant directions of weakness in the rock and the directions most susceptible to percolation of groundwater. (Figure 17) It is noteworthy that most of these plunges are steep, however those associated with the bedding would provide the most appropriate direction for laterial movement of groundwater. Where solution has been effective in these rocks, as illustrated in Figures 18 and 19. The direction of most significant solution has been along the bedding planes.

TABLE 2

Dominant Fracture Groups

Plane A - 071° - 57° NW

" B - 108° - 66° NE

" C - 150° - 70° SW

" D - 168° - 68° NE

" E - 012° - 72° NW

Plunge of Intersections:

A-B 331° @ 57°

A-C 304° @ 51°

A-D 017° @ 51°

A-E 342° @ 58°

B-C 311° @ 41°

B-D 041° @ 64°

B-E 338° @ 60°

C-D 159° @ 23°

C-E 250° @ 70°

D-E 002° @ 30°

Dominant Bedding Groups

Plane F - 138° - 44° SW

Plunge of Intersections with Fractures:

A-F 276° @ 32°

B-F 297° @ 21°

C-F 157° @ 18°

D-F 160° @ 20°

E-F 209° @ 43°

PINCUS PLOT

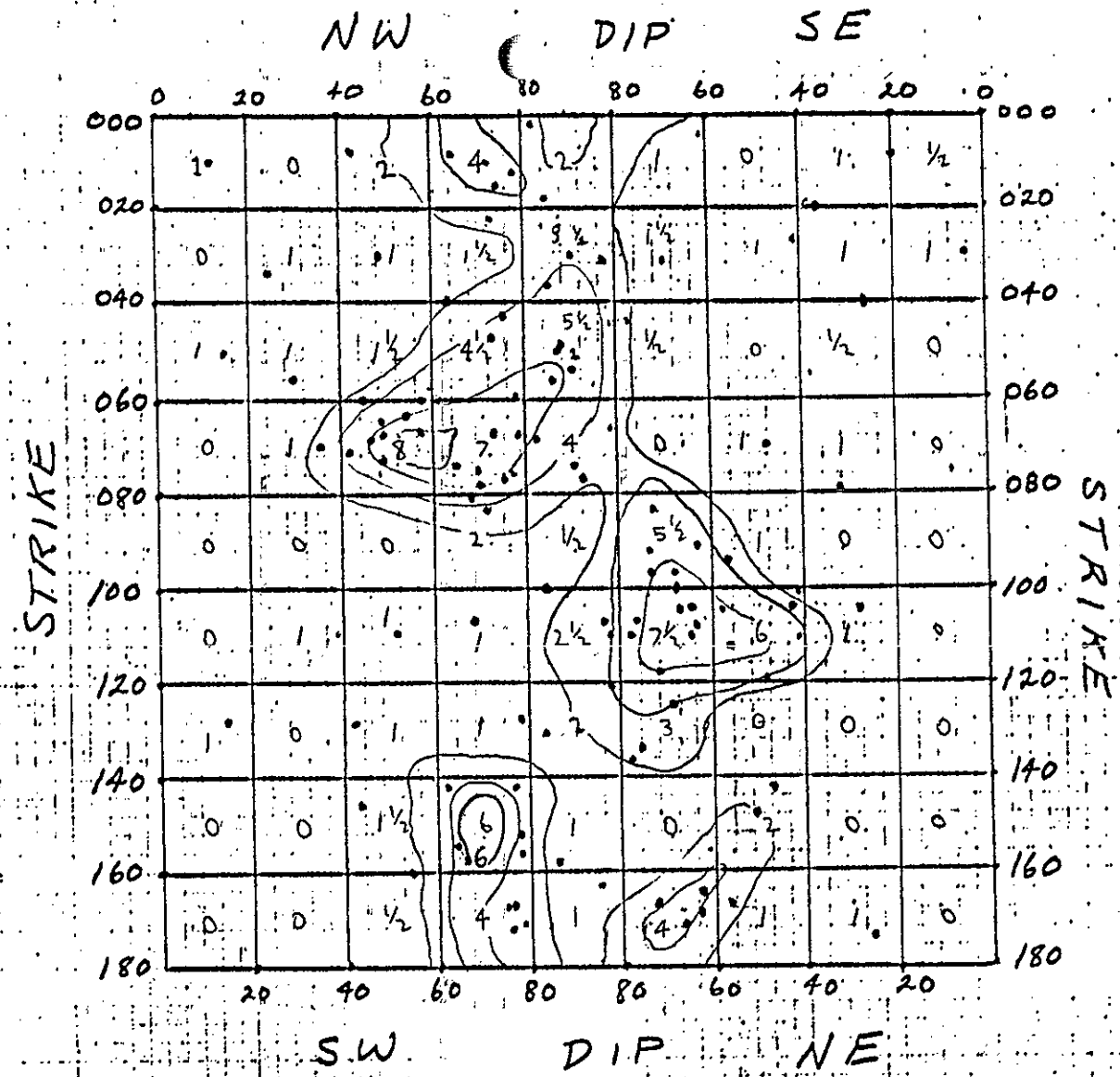


FIGURE I

ALL FRACTURES

PINCUS PLOT

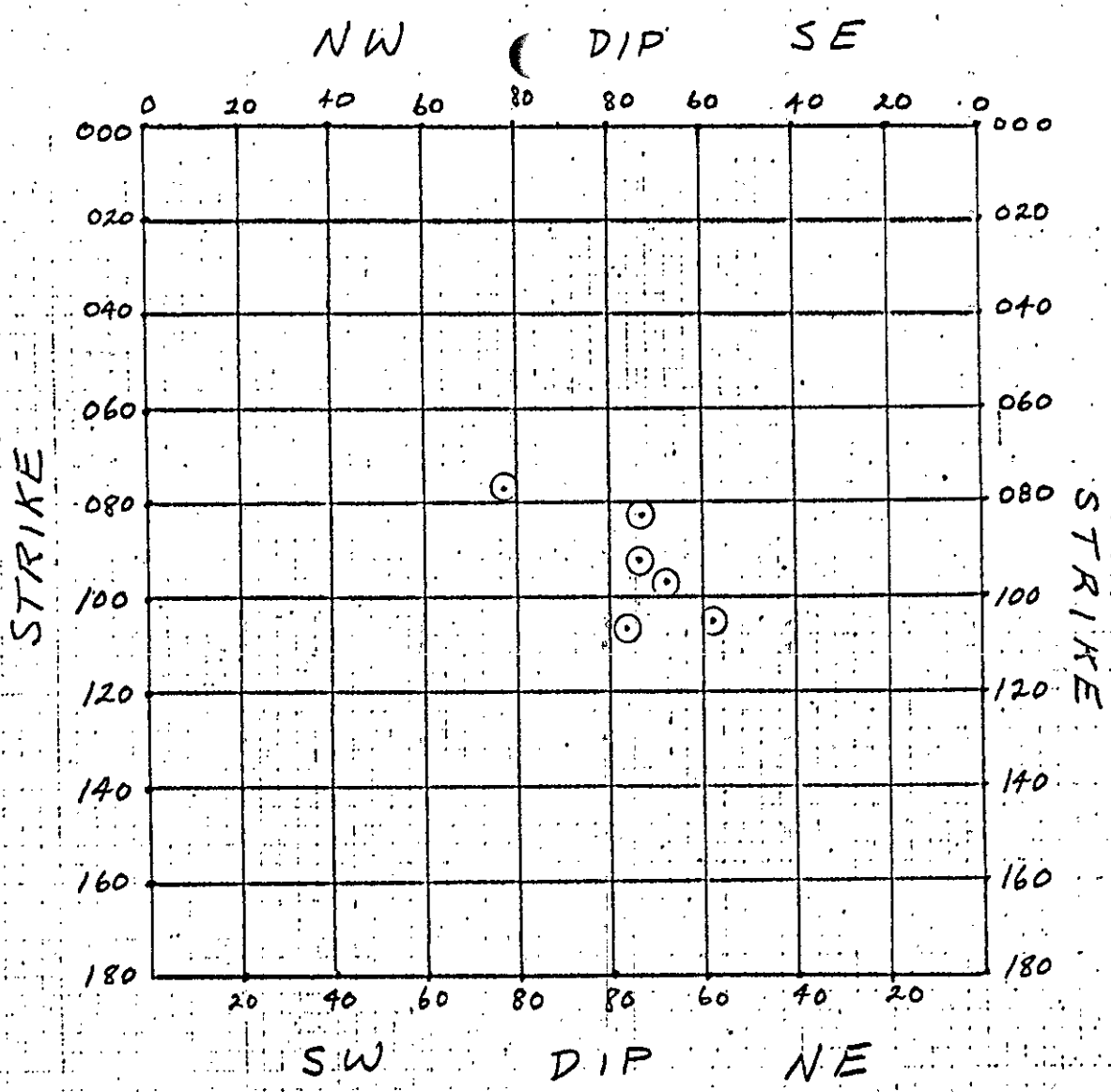


FIGURE 2

SITE 1

PINCUS PLOT

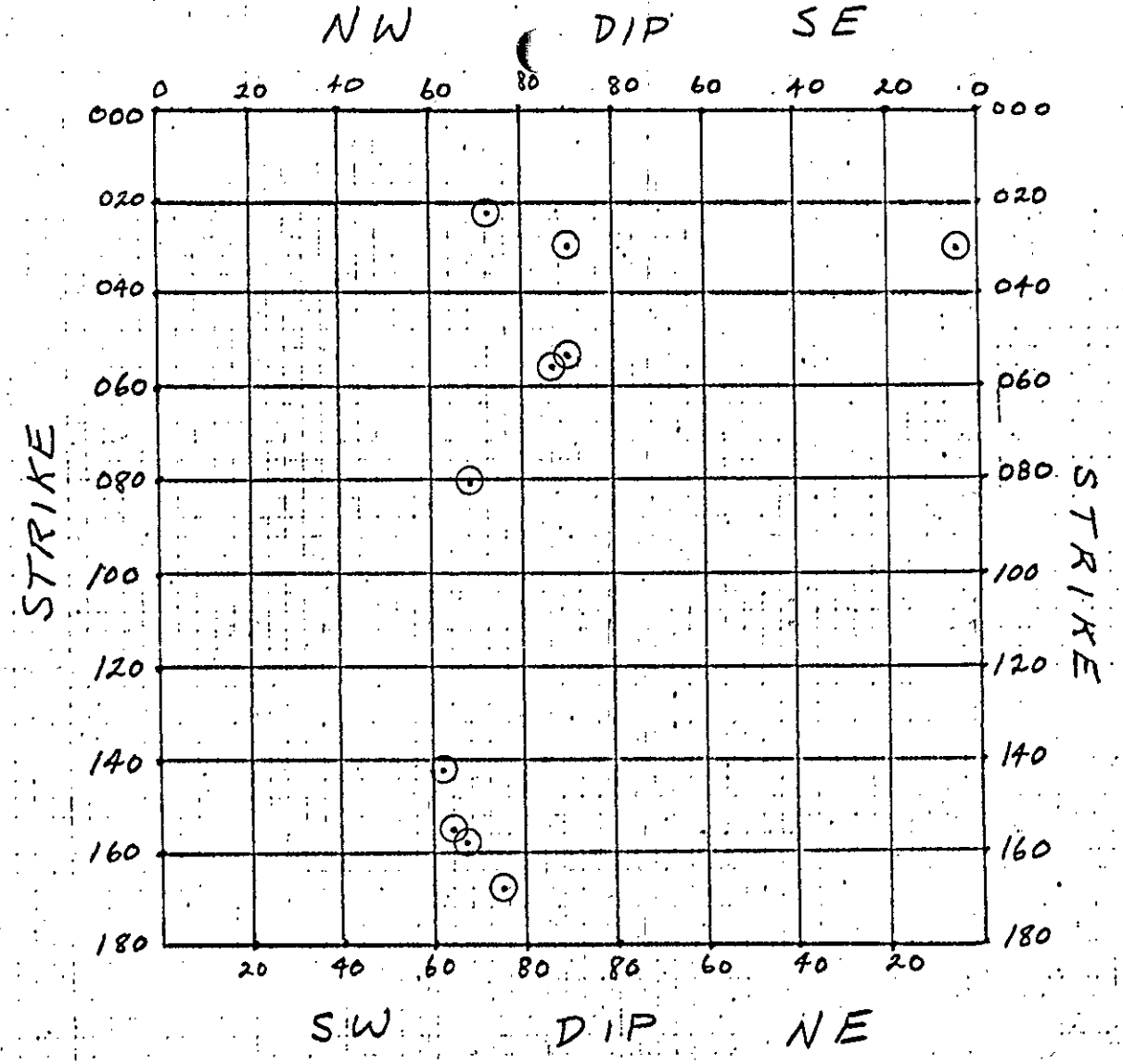


FIGURE 3

SITE 2

PINCUS PLOT

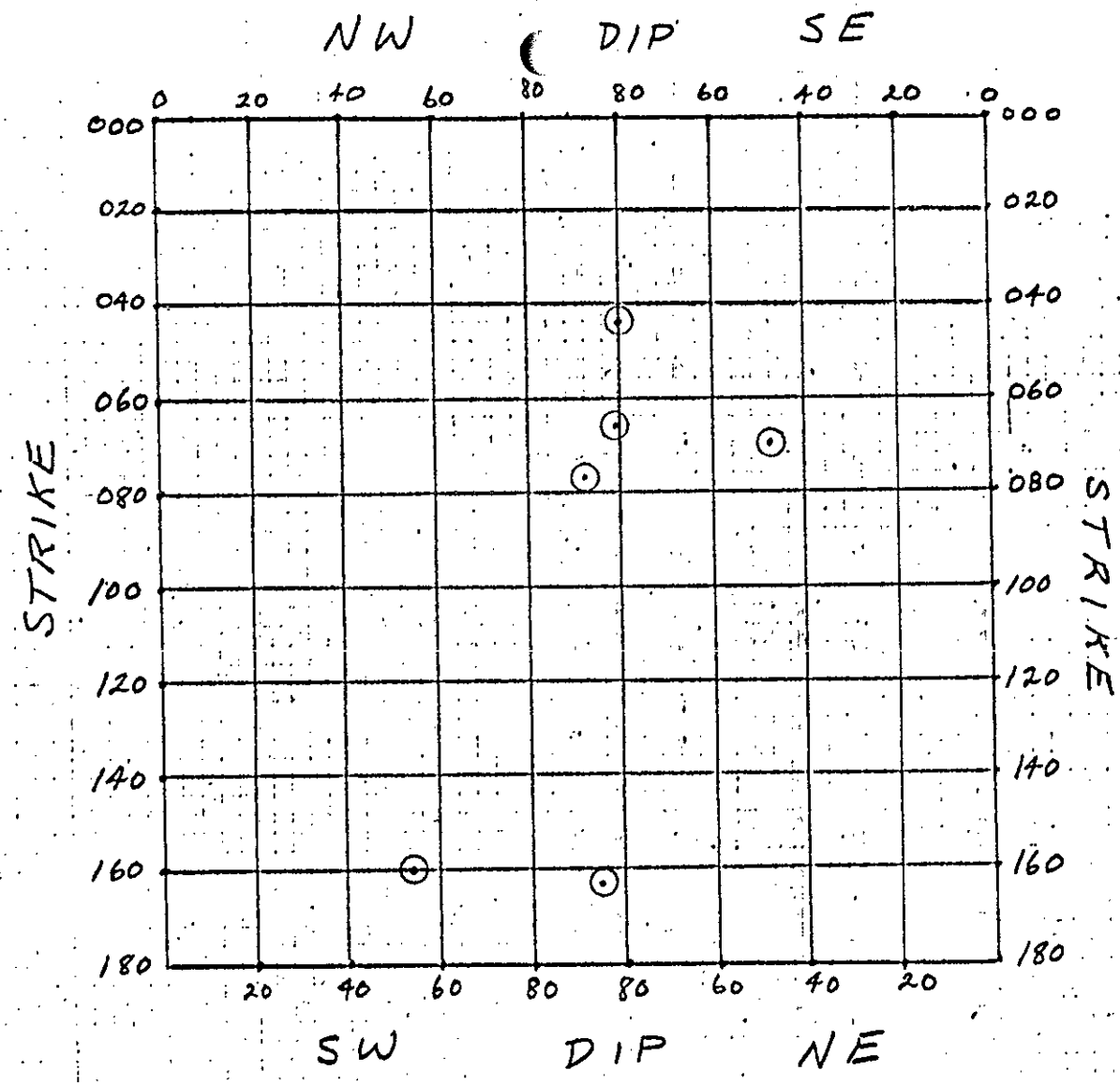


FIGURE 4

SITE 3

PINCUS PLOT

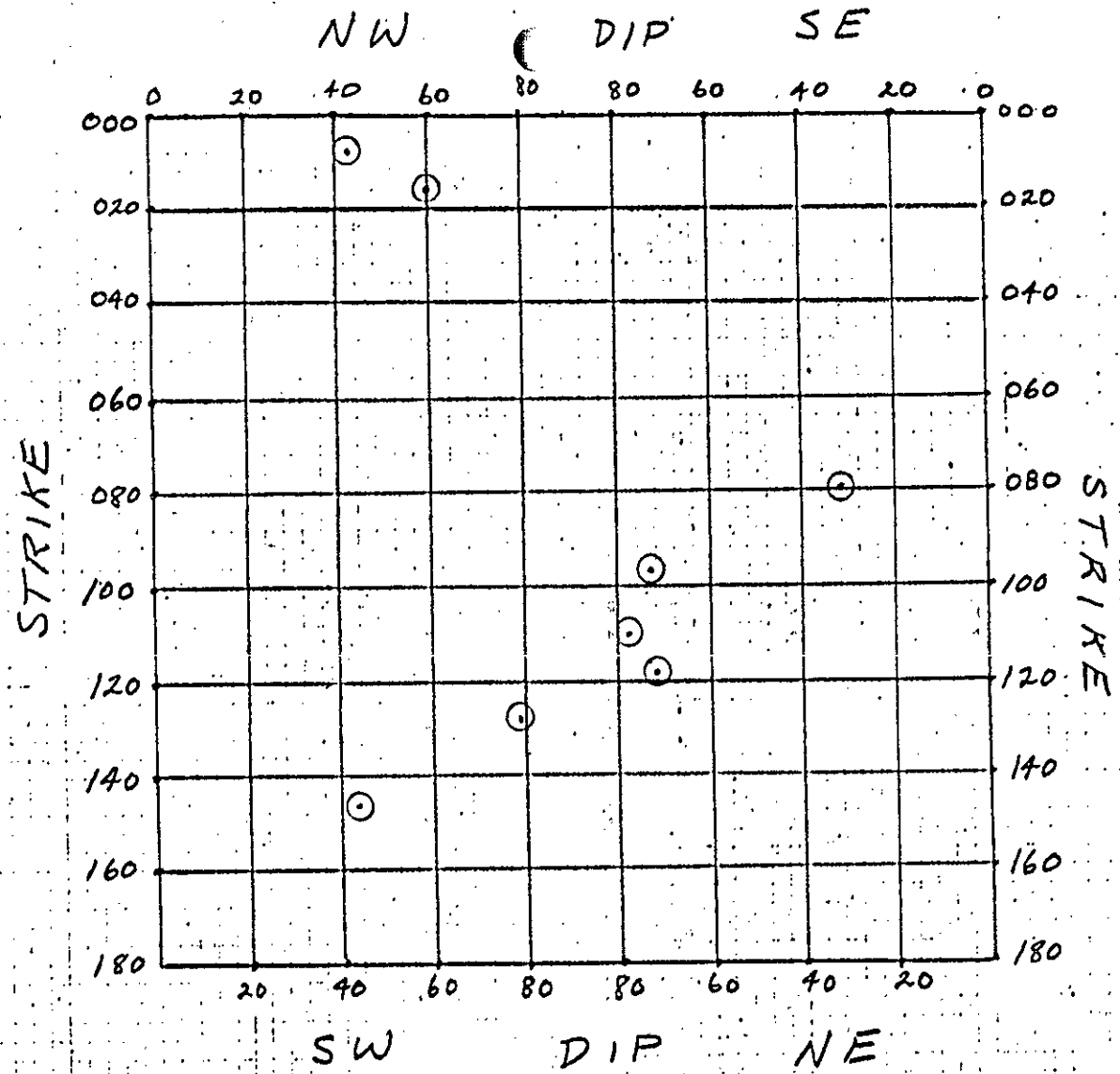


FIGURE 5

SITE 4

PINCUS PLOT

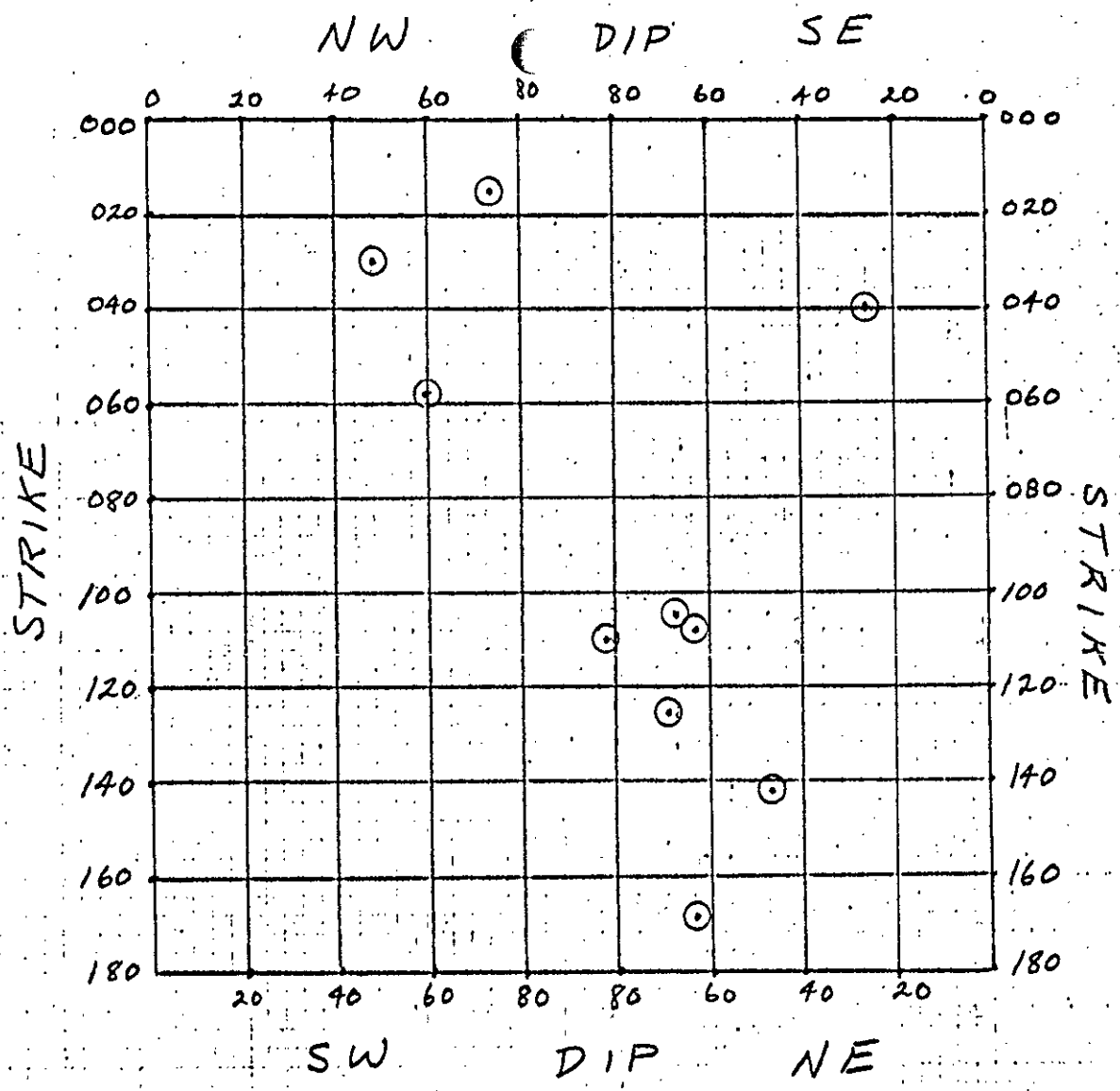


FIGURE 6

SITE 5

PINCUS PLOT

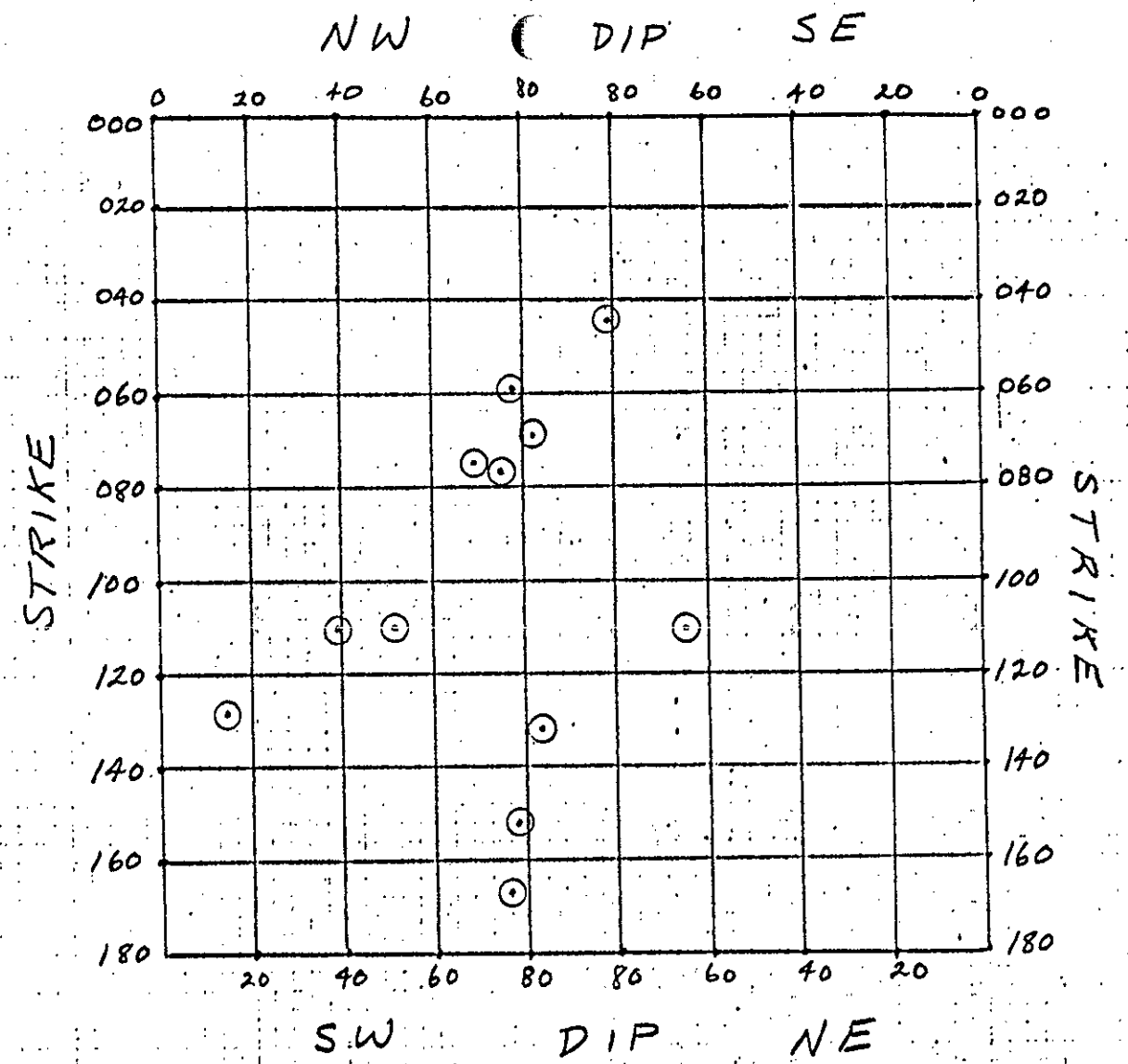


FIGURE 7

SITE 6

PINCUS PLOT

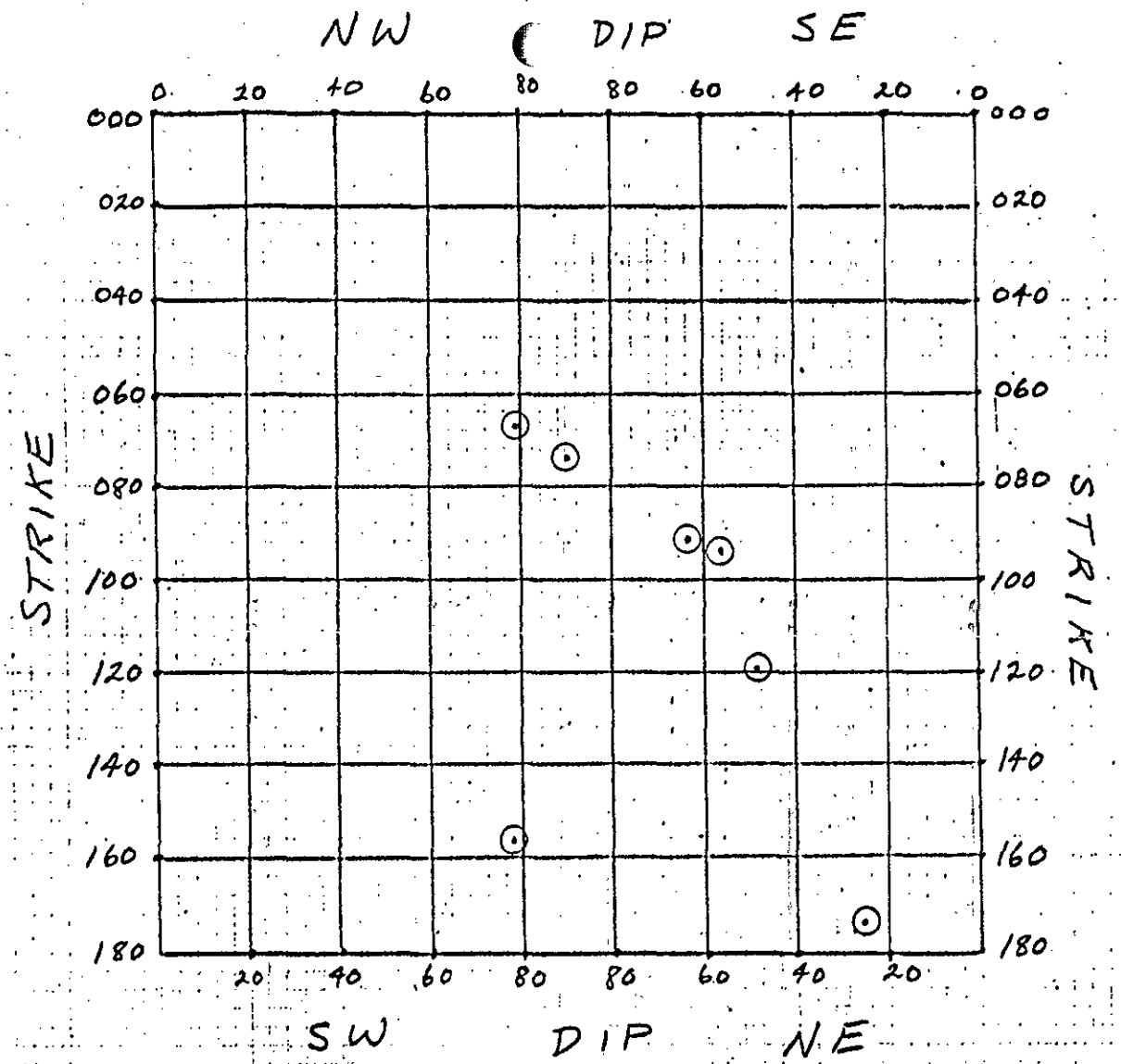


FIGURE 8

SITE 7

PINCUS PLOT

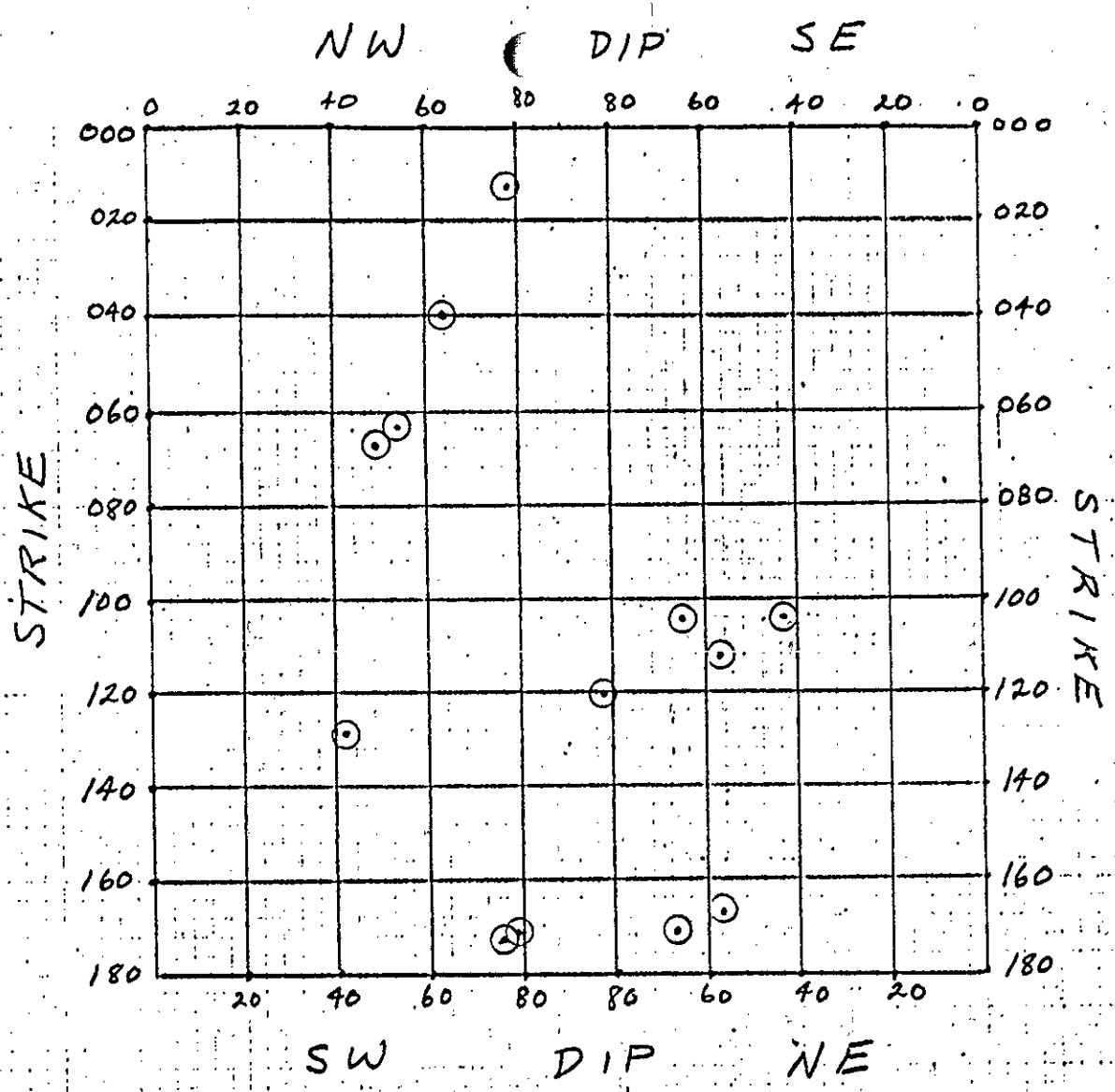


FIGURE 9

SITE 8

PINCUS PLOT

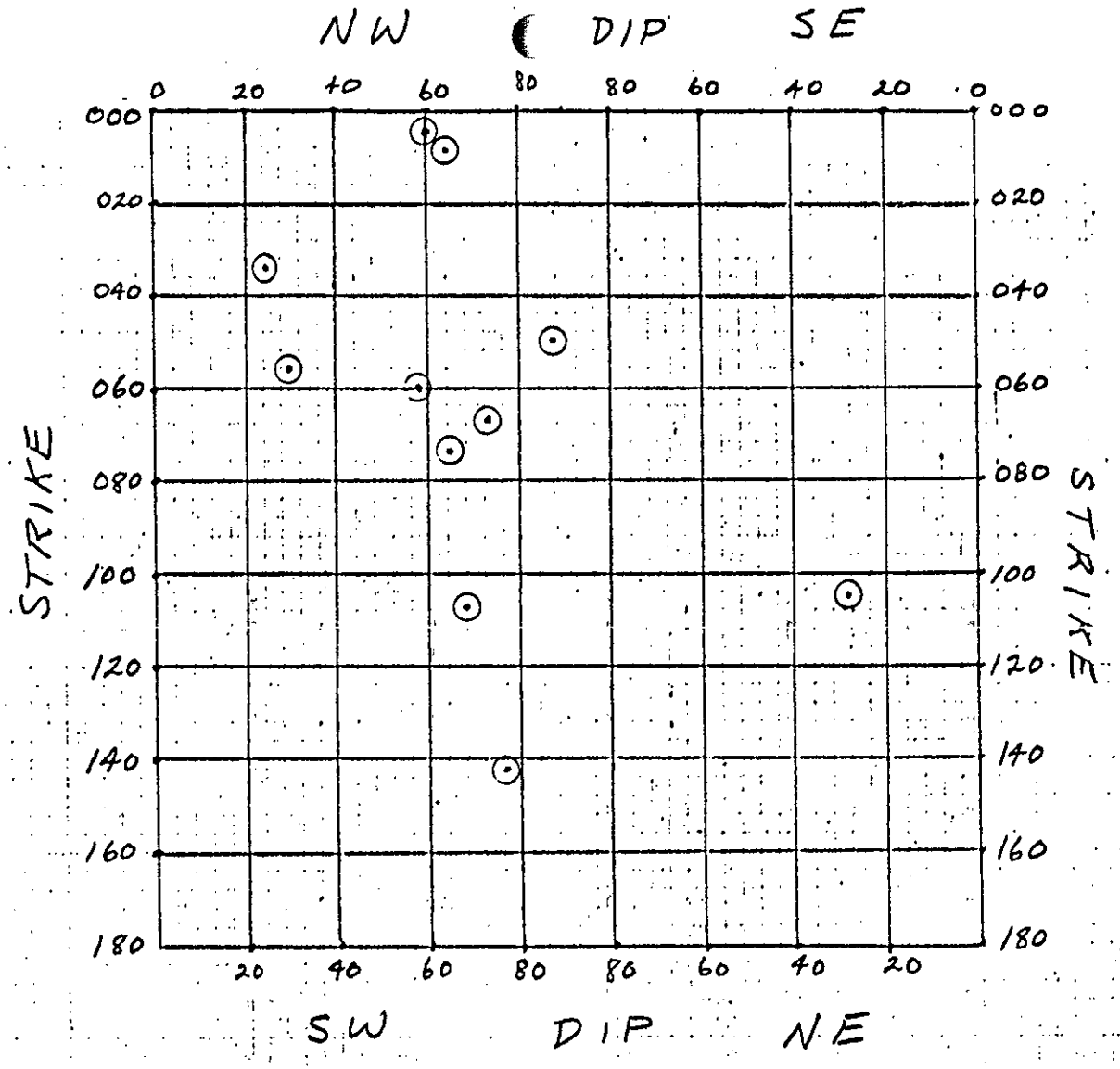


FIGURE 10

SITE 9

PINCUS PLOT

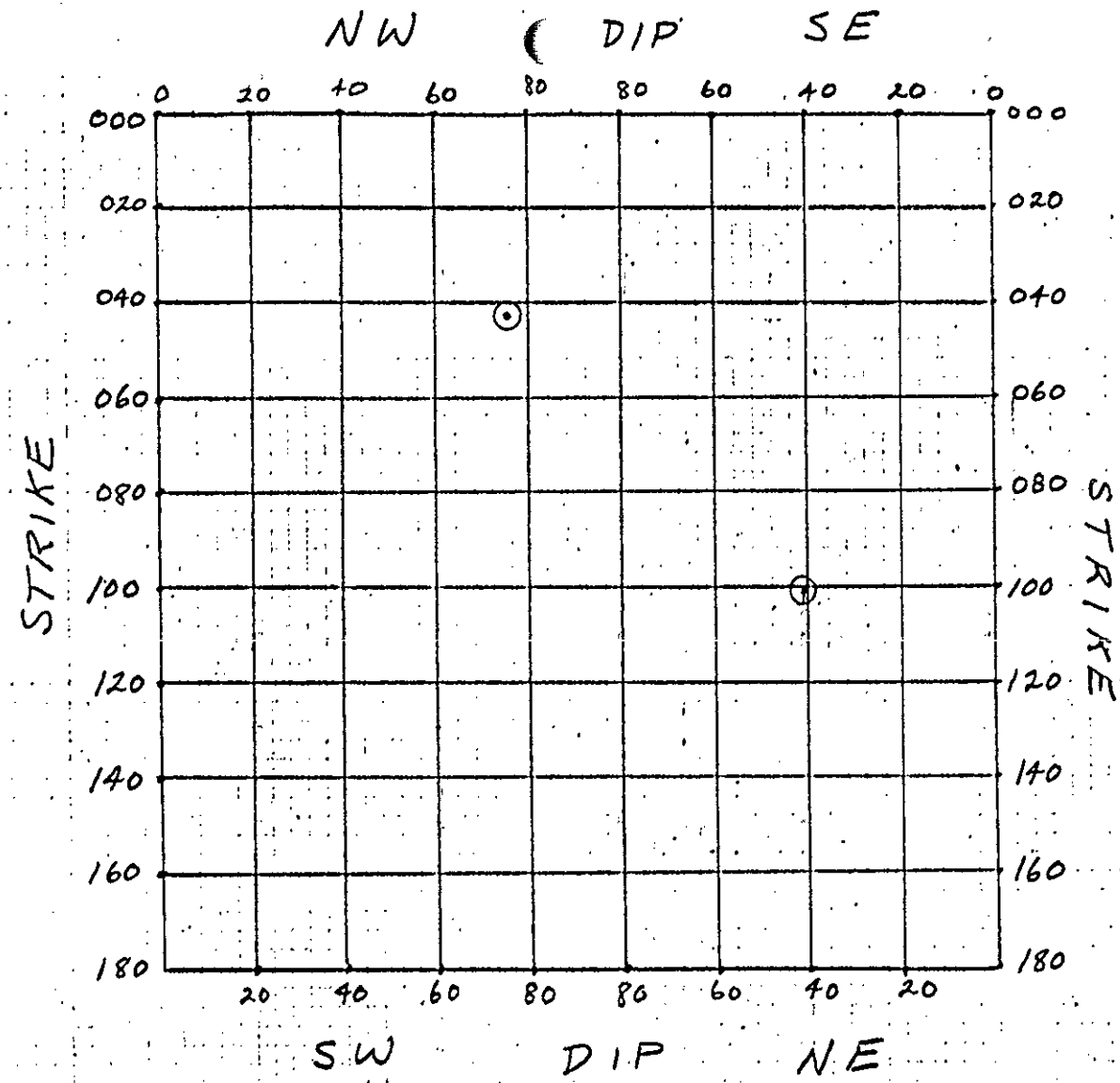


FIGURE 11

SITE 10

PINCUS PLOT

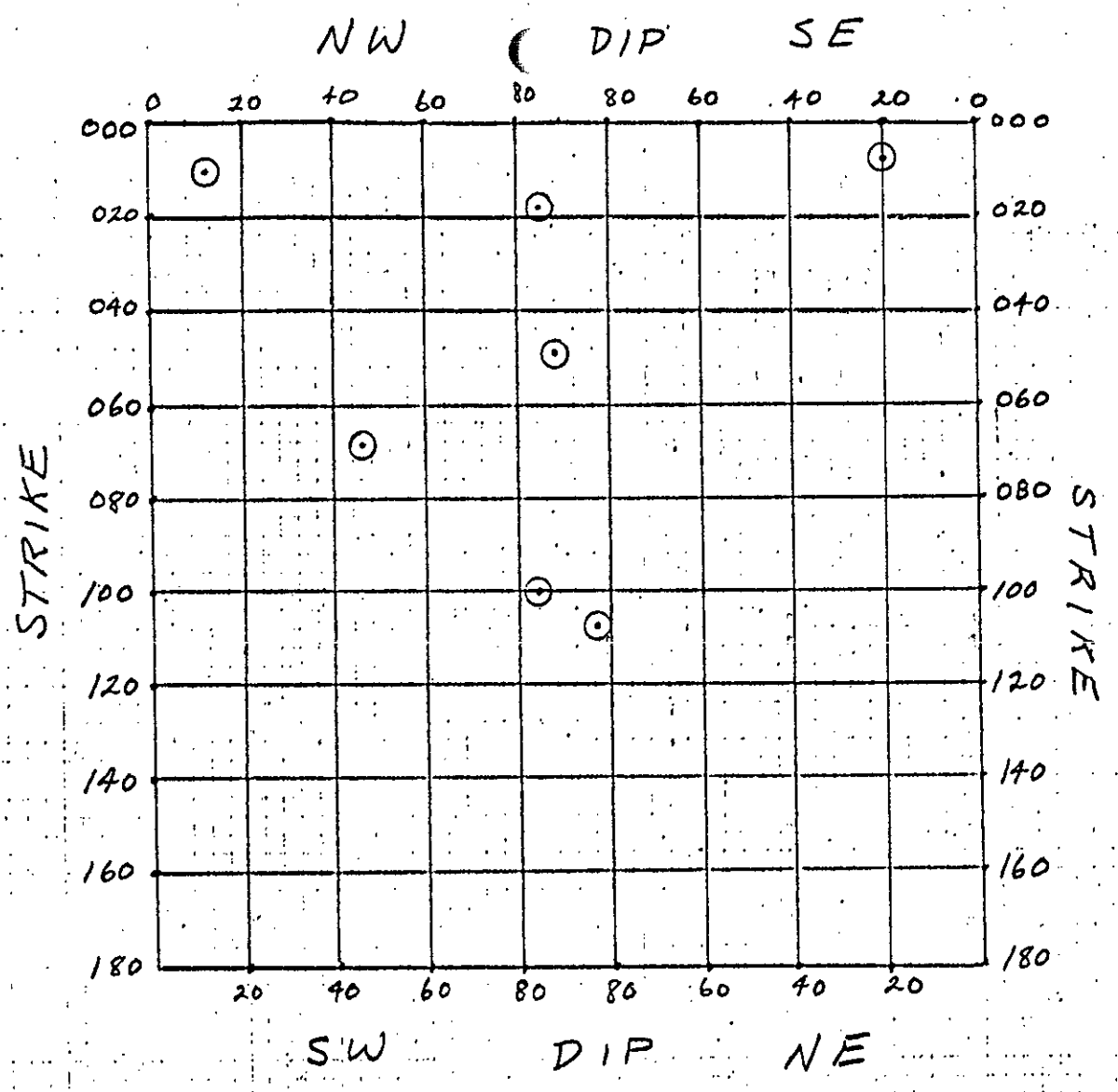


FIGURE 12

SITE 11

PINCUS PLOT

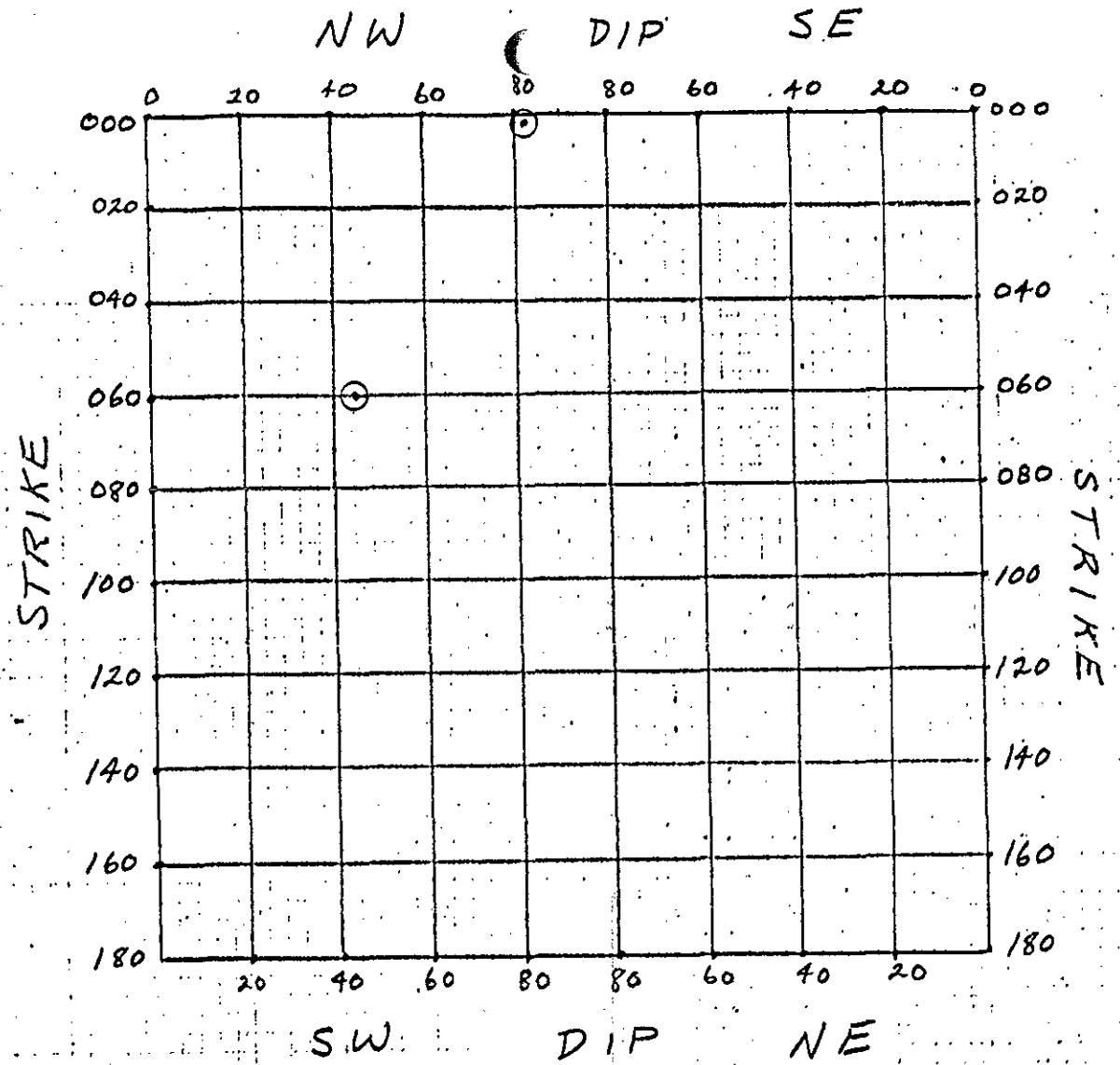


FIGURE 13

SITE 12

PINCUS PLOT

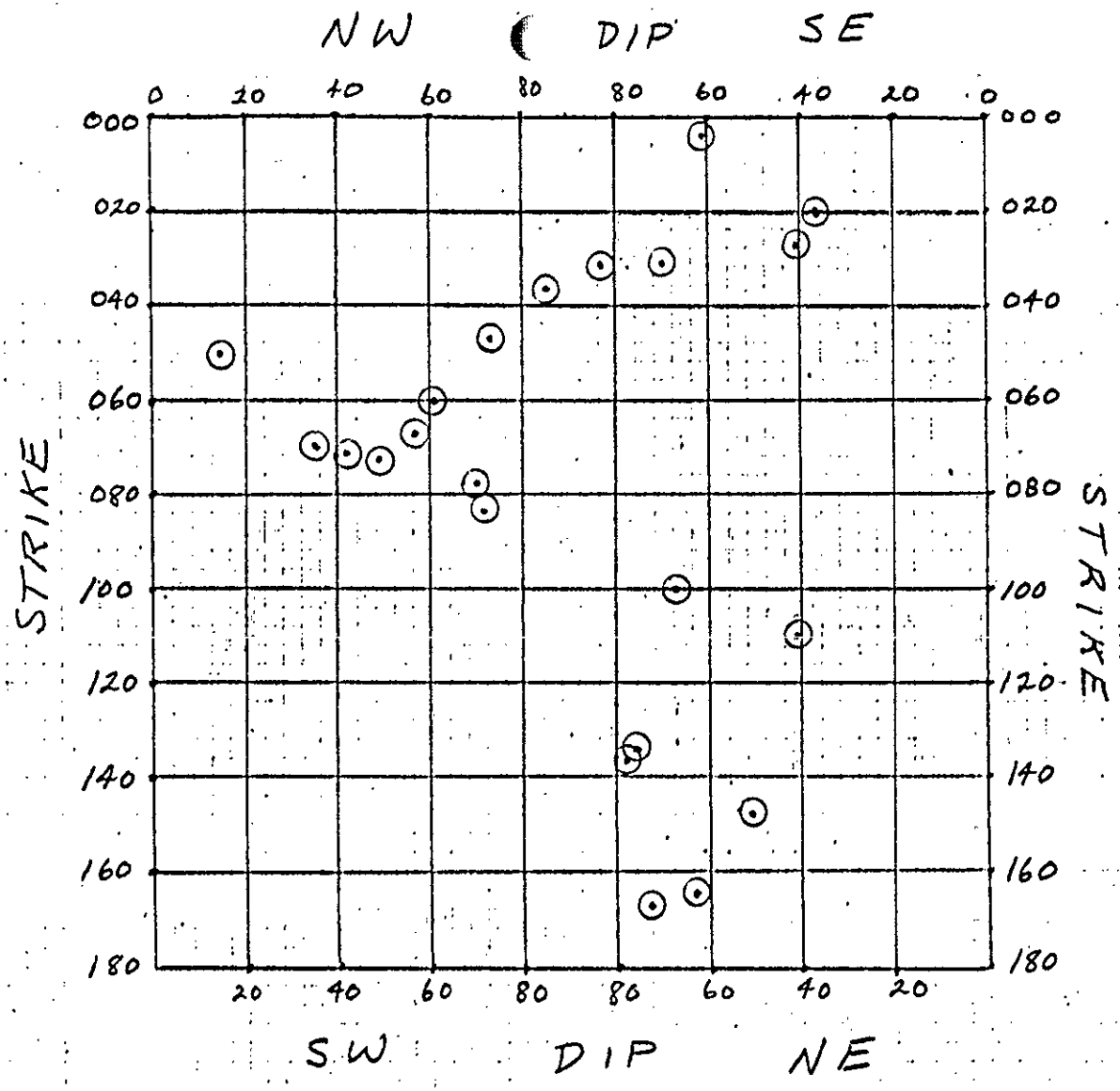


FIGURE 14

SITE 13

PINCUS PLOT

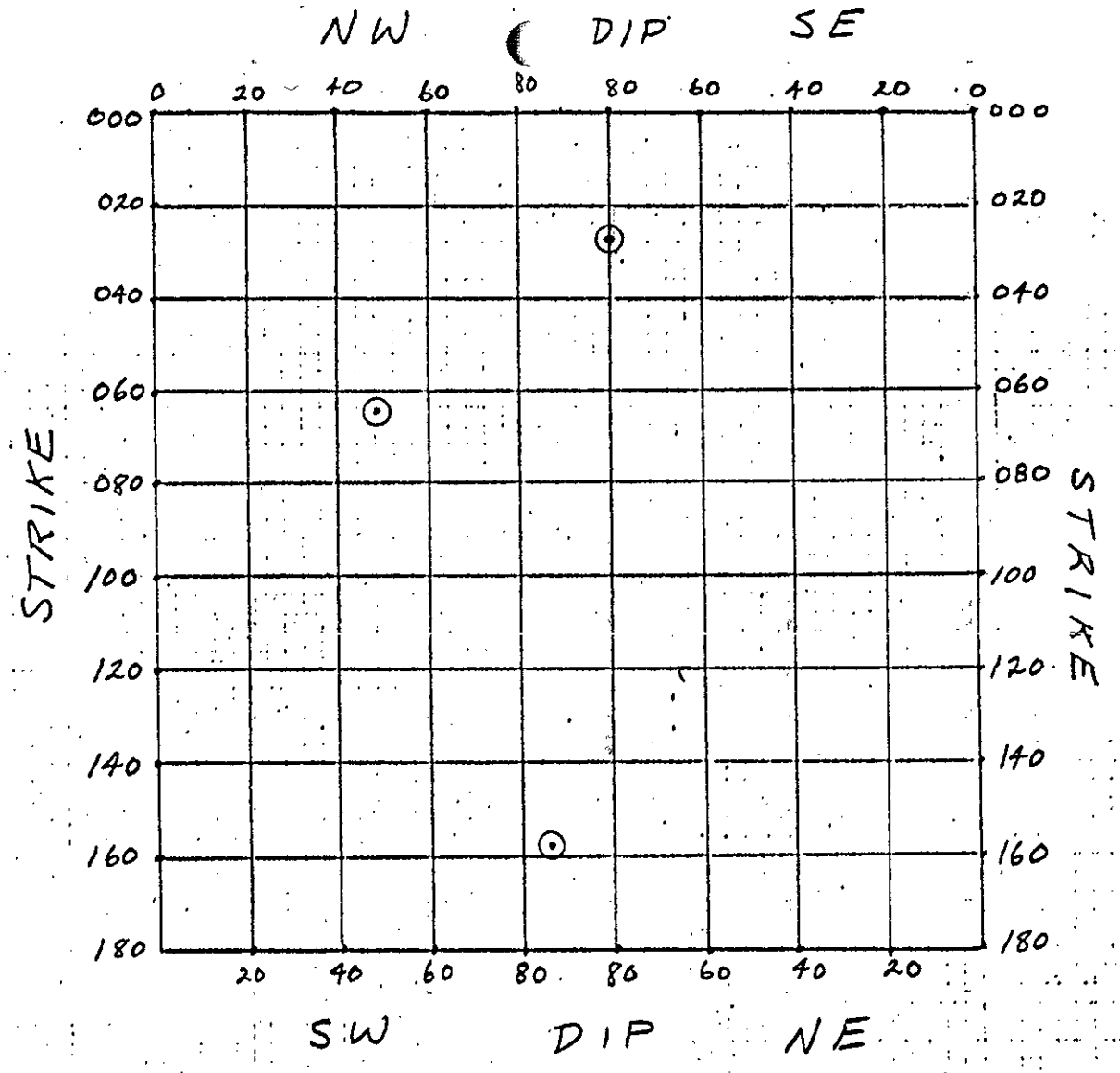


FIGURE 15

SITE 14

PINCUS PLOT

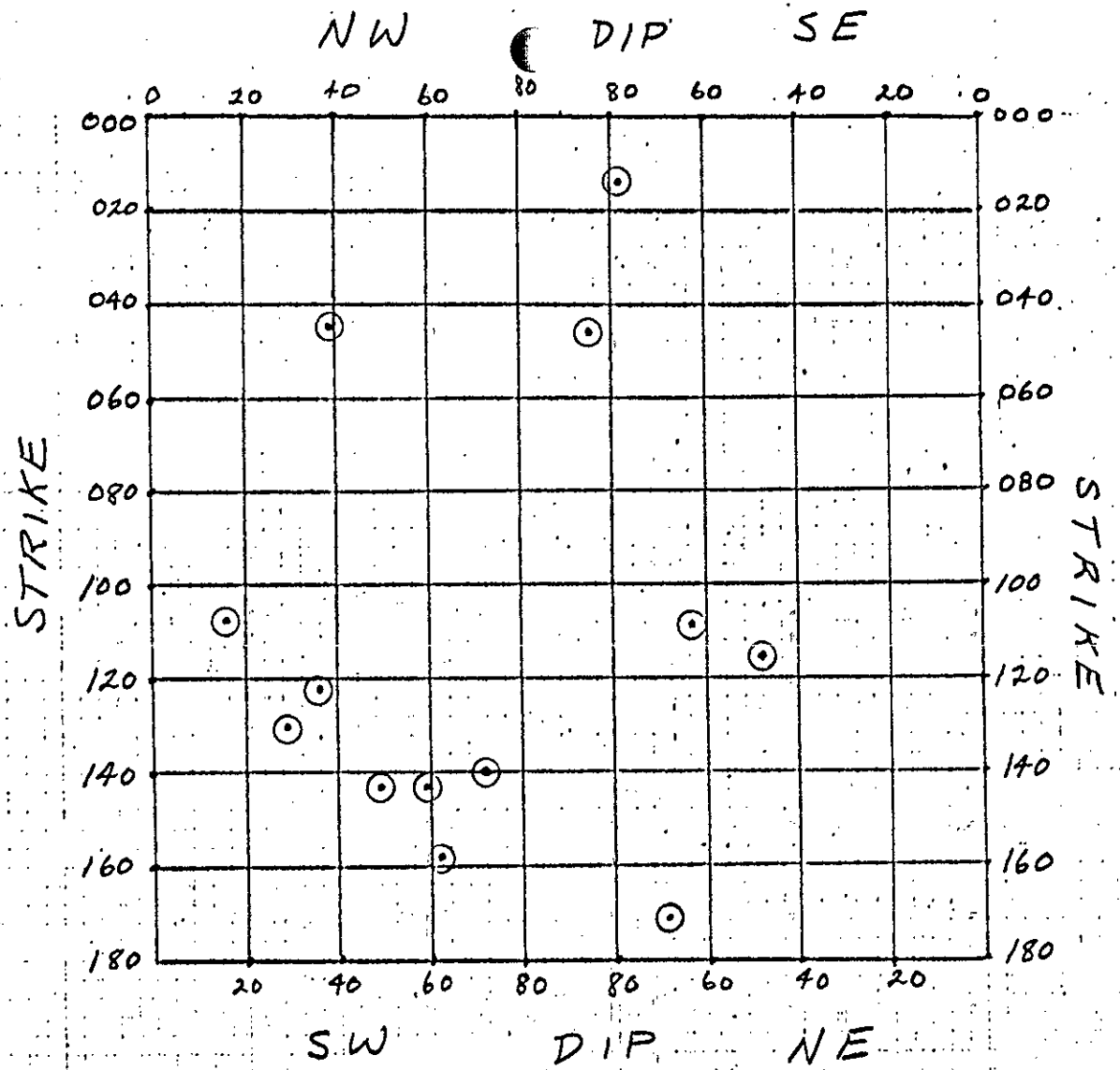
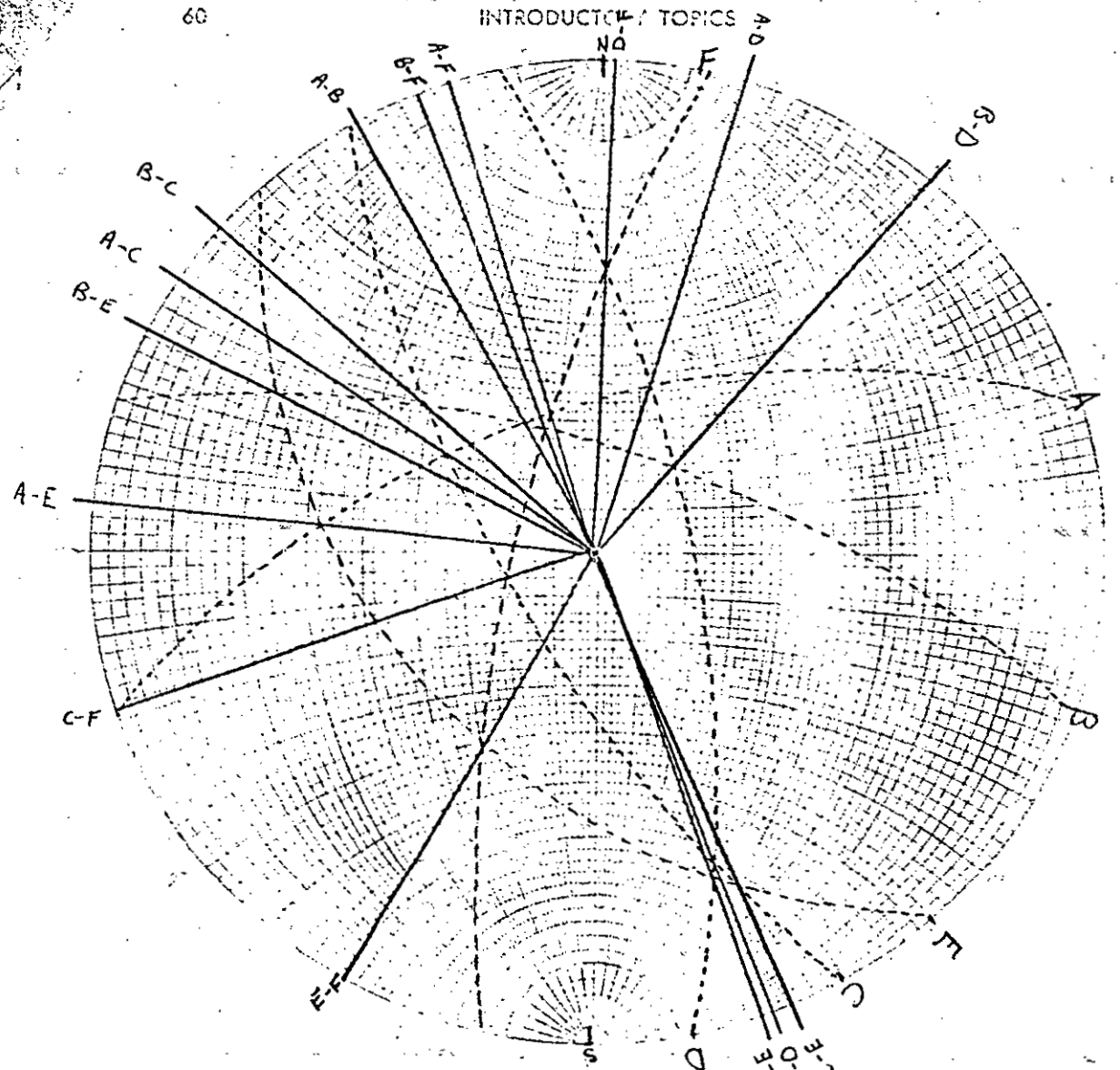


FIGURE 16

BEDDING



3–9 Stereographic meridian projection. The stereonet, with meridians and parallels are circular arcs in this projection (after G. Wulff, 1902.)

FIGURE 17
STEREOGRAPHIC PROJECTION OF
FRACTURE GROUPS AND BEDDING

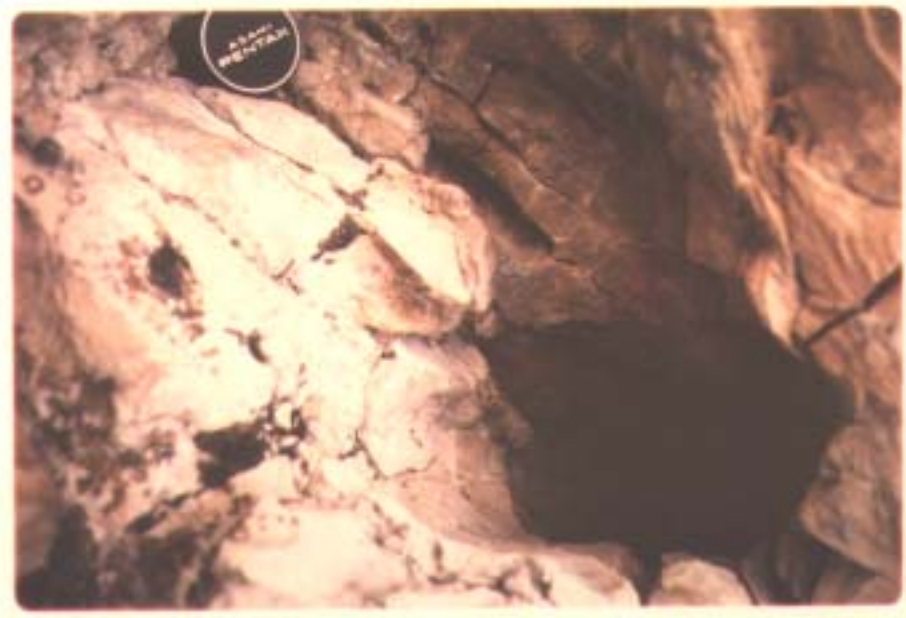


Figure 18 - Numerous solution cavities 0.2 to 0.3 meters deep at site 3.

Figure 19- Brecciated limestone with numerous extensive fractures and a few shallow solution features.

Air photo interpretation drilling and a magnetic survey were used to supplement the mapping of the limestone north of Houth Meadows. The results are summarized in Table 3. The Medicine Creek and Lower Hat Creek Faults correspond to fracture group A. The Ambusten Creek and Bounding Faults in No. 2 deposit correspond to fracture group B. The orientation of bedding in Marble Canyon is comparable to the orientation in the Limestone North of Houth Meadows.

Air photo interpretation and the presence of depression contours on the topographic maps indicate the presence of depressions characteristic of solution features. One of these closed depressions lies in the divide north of the lake in Houth Meadows; the depression is shallow with gently sloping walls and no outcrop.

Discussions were held with the manager of Steel Brothers' quarry. He indicated that they had found no appreciable cavernous limestone. Their well which is in limestone "makes" sufficient water to meet their needs indicating that there is significant water flow through the limestone.

A few caves in the Marble Canyon area have been examined, but were found to penetrate only a short distance into the rock.

Conclusions:

1. No appreciable karst features have been found in the area.
2. Fractures are steeply dipping and few sets are extensive.
3. The probability of penetrating a steeply dipping fracture with a borehole to conduct pumping or falling head tests appears remote.

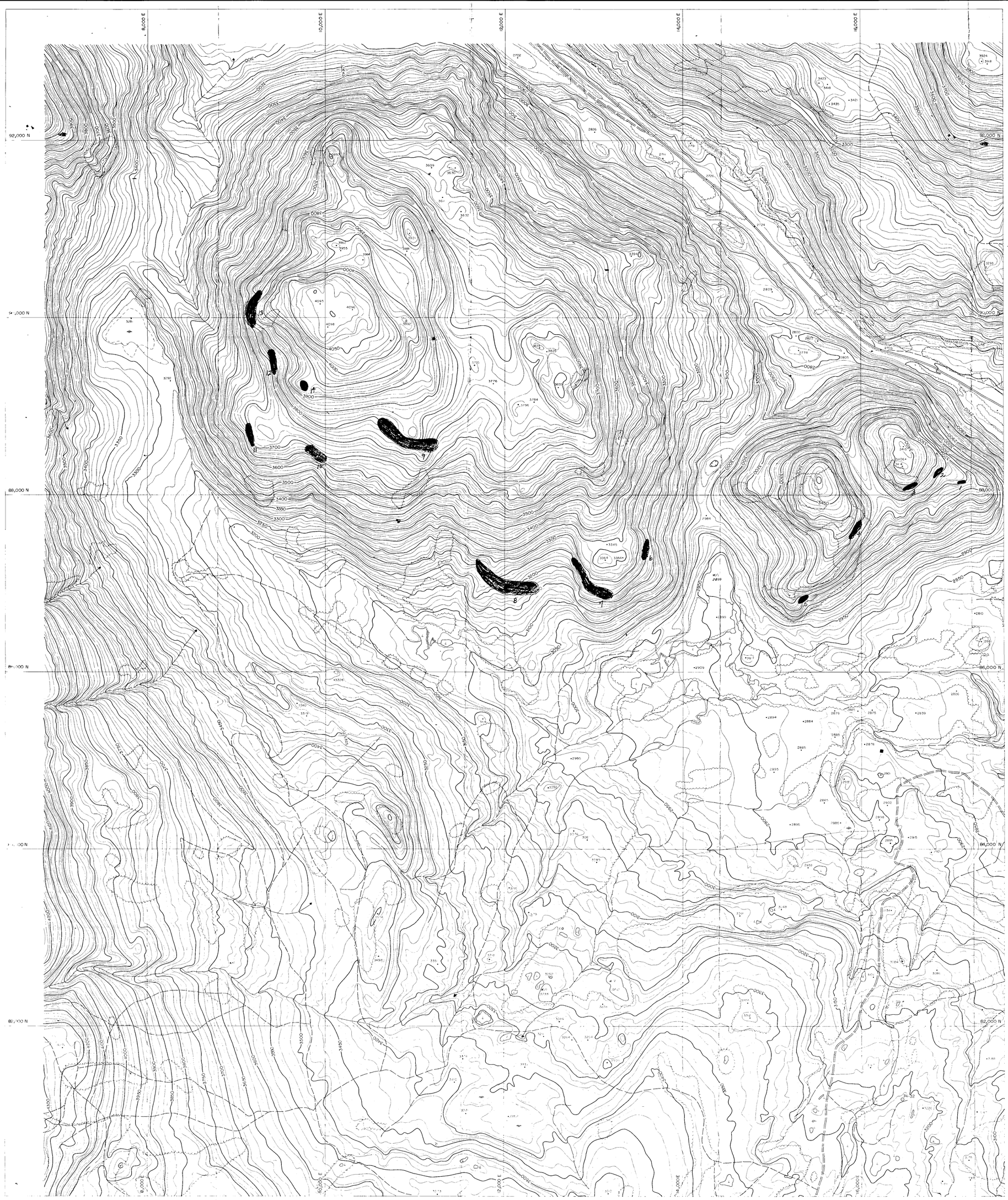
TABLE 3

Fracture Orientation Based on Air Photo Interpretation:

Medicine Creek Fault	070°
Lower Hat Creek Fault	070° (approx.)
Crown Lakes Fault(?)	125°
West Ridge Fault	025°
Trig Fault	025°
Ambusten Creek Fault	156°
Bounding Fault No. 2 Deposit	156°
East Boundary Fault	000° (approx.)
West Boundary Fault	000° (approx.)

Regional Bedding Orientation Based on Air Photo Interpretation:

Bedding (in Marble Canyon)	143°



Outcrop Areas
12

COMPILATION NOTE

This map was compiled by McELHANNEY SURVEYING & ENGINEERING LTD. from aerial photography taken May 13, 1975 at an approximate scale of 1 inch to 2000 feet.

CONTROL NOTE

Mapping is based on ground control surveys established to 3rd order accuracy.

Coordinate origin is based on the prior D.C.A. drill hole survey with addition of 70,000 feet to Northings and 10,000 feet to Eastings.

Grid bearing is astronomic north through station 6259.

Horizontal distances are reduced to 3,000 foot elevation datum.

Elevation datum is geodetic, established from Geodetic Bench Mark 563J at Coquille.

SHEET INDEX

8	7
6	5
4	3
2	1

LEGEND

Photo centre — L2 | 6364
Horizontal control — △6258
Drill hole — ⊙75-64
Bench Mark (position approx) — BM 157
Spot elevation — +3473
Main road
Secondary road
Track or trail
Buildings
Fence — x

Lake
Creeks
Swamp
Ditch
Contours - Index — 3650
Intermediate
Depression
Trees
Dams - Earth
Beaver

B. C. HYDRO & POWER AUTHORITY

DOLMAGE CAMPBELL & ASSOCIATES LTD.

HAT CREEK PROJECT

SCALE :- 1 INCH TO 400 FEET

400 0 400 800 1200 1600 FT.

CONTOUR INTERVAL 10 FEET

M.S.E.L. REF. NO. 06185-0

M026 (1) SHEET No. - 8 Plate1