NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

PRECAMBRIAN GEOLOGY OF THE SOUTHERN PART OF THE RINCON RANGE

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ABSTRACT

THE METAMORPHIC ROCKS OF THE MORA AREA HAVE BEEN DEFORMED DURING AT LEAST TWO PERIODS OF PRECAMBRIAN TECTONIC ACTIVITY. PERVASIVE SHEARING AND FLOWAGE ARE EXPRESSED BY THE STRUCTURES WHICH ARE OUTLINED BY PEGMATITE AND QUARTZOFELDSPATHIC BANDS IN THE GRANITIC GNEISS. THE FIRST AND MOST PROMINENT DEFORMATION PRODUCED NORTH-NORTHEAST TRENDING FOLDS, SOME OF WHICH ARE OVERTURNED TO THE WEST. THE SECOND DEFORMATION REORIENTED THE AXES OF THE FIRST DEFORMATION INTO SINUOUS TRACES. THE FOLD AXES OF THE SECOND DEFORMATION ARE ORIENTED ABOUT EAST-NORTHEAST WITH OVERTURNING TO THE SOUTH.

DURING THE FIRST DEFORMATION, THE CONDITIONS OF METAMORPHISM PRODUCED SOME ANATECTIC MELTING. MOST PEGMATITES APPEAR TO HAVE ORIGINATED AS A RESULT OF ANATEXIS OF THE GRANITIC GNEISS DURING THE FIRST PHASE OF DEFORMATION.

DURING THE SECOND PERIOD OF DEFORMATION THE METAMORPHIC GRADE WAS HIGH IN THE ALMANDINE-AMPHIBOLITE FACIES.

MUSCOVITE SCHIST BODIES ARE RANDOMLY DISTRIBUTED WITHIN THE GRANITIC GNEISS AND REPRESENT EITHER RELICTS OF PARTIALLY GRANITIZED XENOLITHS WITHIN THE ORIGINAL GRANITIC PLUTON OR METASOMATIZED GRANITIC GNEISS.

THE PRECAMBRIAN ROCKS OF THE MORA AREA ARE UNCONFORMABLY OVERLAIN BY PENNSYLVANIAN SEDIMENTS. THE WESTWARD DIP OF THESE SEDIMENTS SUGGESTS THAT THE AREA WAS SUBJECTED TO OROGENIC MOVEMENTS DURING POST-PENNSYLVANIAN TIME.

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LOCATION

THE MORA AREA IS SITUATED IN NORTH CENTRAL NEW MEXICO (PLATES 1 AND 2) NEAR THE VILLAGE OF MORA, AND FORMS PART OF THE SOUTHERN END OF THE RINCON RANGE OF THE SANGRE DE CRISTO MOUNTAINS.

THE SANGRE DE CRISTO MOUNTAINS ARE LOCATED BETWEEN THE RIO GRANDE BASIN ON THE WEST AND THE LAS VEGAS PLATEAU TO THE EAST.

THE RINCON RANGE, LYING BETWEEN THE CRESTON RANGE ON THE EAST AND THE ELK MOUNTAIN-MORA RANGE ON THE WEST, IS PART OF THE SANGRE DE CRISTO UPLIFT (OETKING, ET. AL., 1967).

THE VILLAGE OF MORA IS IN THE CENTRAL PART OF THE MAPPED AREA AND IS LOCATED APPROXIMATELY 28 MILES NORTH OF LAS VEGAS, NEW MEXICO, AT THE INTERSECTION OF NEW MEXICO HIGHWAYS 3 AND 38. THE MAP AREA LIES BETWEEN LATITUDES 35 DEGREES 57' 30" AND 36 DEGREES 02' 30" NORTH AND BETWEEN 105 DEGREES 15' 00" AND 105 DEGREES 22' 30" WEST, COMPRISING ABOUT 30 SQUARE MILES.

MORA, THE COUNTY SEAT OF MORA COUNTY, HAS A POPULATION OF ABOUT 1500 AND IS SAID TO BE ONE OF THE TWO COUNTY SEATS IN THE UNITED STATES STILL UNINCORPORATED.

THE LOWER HILLS OF THE MAPPED AREA ARE ACCESSIBLE BY FOUR MAJOR TRAILS WHICH ARE NEGOTIABLE VIA FOUR-WHEEL DRIVE VEHICLE OR MOTORIZED CYCLE. ONE TRAIL PROVIDES ACCESS TO LA TIERRA AMARILLA CANYON FROM HIGHWAY 38. ANOTHER TRAIL LEADS INTO THE AREA OF

COMANCHE CANYON FROM HIGHWAY 3. THE REMAINING TWO ARE LOCATED ON THE NORTH AND SOUTH SIDES OF CANADA DE LOS MAES AND LEAD EAST FROM A COUNTY ACCESS ROAD OVER TERRAIN UNDERLAIN BY PALEOZOIC SEDIMENTS. THE AREA BETWEEN THESE TRAILS WAS TRAVELED BY FOOT.

PHYSIOGRAPHY

ELEVATION IN THE AREA RANGES FROM 7109 FEET ON HIGHWAY 3 NEAR THE SOUTHERN BORDER OF THE MAP TO 9130 FEET AT THE PEAK IN THE MIDDLE OF THE MAP.

THE AREA UNDERLAIN BY PRECAMBRIAN ROCKS IS CHARACTERISTICALLY RUGGED WITH SHARP PEAKS AND MANY DEEPLY INCISED CANYONS OF INTERMITTENT, YOUTHFUL STREAMS. THIS IS IN SHARP CONTRAST TO THE TOPOGRAPHY OF THE AREA UNDERLAIN BY THE SEDIMENTARY ROCKS IN THE NORTHWEST CORNER OF THE MAP WHERE THE HILLS ARE SMOOTH AND ROUNDED.

THE SOUTHEAST FACING SLOPES, BELOW THE PHANEROZOIC-PRECAMBRIAN UNCONFORMITY ARE NOTICEABLY STEEPER AND MORE DENSELY VEGETATED THAN OTHER SLOPES. THESE SLOPES DO NOT SUFFER FROM AN INCREASED MOISTURE LOSS BECAUSE THEY ARE NOT SUBJECTED TO DIRECT SOLAR RADIATION DURING THE HOTTEST PART OF THE SUMMER DAYS. ALSO, THESE SLOPES ARE COLDER IN THE MORNING DUE TO LOW NIGHT TIME TEMPERATURES AND SUFFER LESS MOISTURE LOSS AS A RESULT. THUS WATER IS MORE PLENTIFUL ON THESE SLOPES FOR THE VEGETATION.

THE BRUSH ON THE SLOPES RANGES UP TO SIX FEET IN HEIGHT. THE PROMINANT TYPE OF BUSH IS SCRUB OAK; ON THE HIGH RIDGES AND HILLS UNDERLAIN BY PALEOZOIC SEDIMENTS ONE FINDS CONIFEROUS GROWTH SUCH AS JUNIPER, PINYON AND PONDEROSA PINE WHILE DECIDUOUS TREES SUCH

AS ASPEN AND COTTONWOOD ARE CONFINED TO THE STREAM VALLEYS, ALLUVIAL PLAINS, AND CANYON BOTTOMS WHERE WATER IS MORE PLENTIFUL.

IN THE MONTHS OF JULY AND AUGUST, MUCH PRECIPITATION COMES FROM THUNDERSTORMS, WHICH BUILD OVER THE HIGH MOUNTAINS TO THE WEST IN THE MORNING AND RELEASE THEIR LOAD OVER THE AREA IN THE AFTERNOON. OCCASIONALLY, REGIONAL WEATHER PATTERNS DEVELOP DURING THE SUMMER, WHICH CAUSE A MORE CONSTANT PATTERN OF PRECIPITATION, AND MAY NECESSITATE THE SUSPENSION OF FIELD WORK FOR ONE OR TWO DAYS.

PURPOSE OF THE INVESTIGATION

THE MORA AREA WAS SELECTED FOR ITS PROXIMITY TO PREVIOUSLY INVESTIGATED PRECAMBRIAN AREAS OF NEW MEXICO AND FOR ITS RELATIVE EASE OF ACCESSIBILITY.

THE PURPOSE WAS TO ACCUMULATE STRUCTURAL AND PETROLOGIC DATA FROM A PRECAMBRIAN COMPLEX AND TO ANALYZE THESE DATA WITH DIGITAL COMPUTER PROGRAMS TO REDUCE THE POSSIBILITY OF HUMAN ERROR AND TO DEVELOP TECHNIQUES IN STRUCTURAL PETROLOGY WHICH WILL YIELD REPRODUCIBLE RESULTS.

COMPUTER PROGRAMS WERE DEVELOPED TO PRODUCE SCHMIDT EQUAL AREA PROJECTIONS ON THE LOWER HEMISPHERE, CONVERT RAW PETROFABRIC DATA TO INFORMATION SUITABLE FOR THE EQUAL AREA PROGRAM, CONVERT VOLUMETRIC PERCENT TO WEIGHT PERCENT OF THE MINERALS AND NINE CATION OXIDES, AND CONSTRUCT MAPS OF LINEAR AND PLANAR ORIENTATION SYMBOLS USING THE IBM 360/44 COMPUTER RUNNING UNDER "PROGRAMMING SYSTEM" (PS). A CALCOMP 563 INCREMENTAL PLOTTER WAS USED TO PLOT

SOME OF THE GRAPHICAL DATA FOR THIS REPORT.

LISTINGS OF THE PROGRAMS USED IN PREPARING THE ANALYSES AND RESULTS PERTINENT TO THE INVESTIGATION ARE FOUND IN THE APPENDIX TOGETHER WITH A DESCRIPTION AND USER INSTRUCTIONS.

THE TEXT OF THIS REPORT WAS PREPARED ON COMPUTER CARDS AS A DATA DECK FOR A TEXT EDITOR PROGRAM, "TXTEDT" (H. STUCK, CIRCA 1967) AND WAS PRINTED ON THE IBM 1443 LINE PRINTER USING A 63 CHARACTER TYPEBAR. THIS PROCEDURE PROVED TO BE QUITE USEFUL IN MAKING CORRECTIONS TO SUCCESSIVE DRAFTS OF THE REPORT IN A MANNER SIMILAR TO THE PROCEDURE OF "CUT AND PASTE".

METHOD OF INVESTIGATION

THE GEOLOGIC MAPPING AND ACCUMULATION OF FIELD DATA AND SAMPLES WAS DONE DURING TWO WEEKS IN THE SUMMER OF 1967, AND THE THREE SUMMER MONTHS OF 1968. TRAVERSES WERE PLANNED ON THE BASIS OF OUTCROP AVAILABILITY AND GEOLOGICAL COMPLEXITY; A PREDETERMINED SAMPLING PATTERN WAS NOT EMPLOYED.

MORE THAN 100 SPECIMENS WERE COLLECTED, ABOUT 90% OF WHICH WERE MARKED WITH FIELD ORIENTATION.

TWENTY-SIX THINSECTIONS AND FOUR GRAIN MOUNTS WERE MADE FROM 16 ORIENTED SPECIMENS SELECTED TO REPRESENT THE STRUCTURAL DOMAINS AND PRECAMBRIAN LITHOLOGIC UNITS.

POINT COUNTS (OF 1000 POINTS PER THINSECTION) WERE MADE FROM TYPICAL PRECAMBRIAN UNITS WITH THE AID OF A J.S. SWIFT POINT COUNTER USING APPROXIMATELY 50 POINTS PER TRAVERSE ALONG THE SLIDE LENGTH.

A ZEISS 4-AXIS UNIVERSAL STAGE WAS USED TO DETERMINE PLAGIOCLASE COMPOSITION, USING THE RITTMAN ZONE AND A-NORMAL TECHNIQUES.

DATA FROM MODAL ANALYSES AND OPTICALLY DETERMINED COMPOSITIONS WERE PUNCHED ON I.B.M. COMPUTER CARDS TO SUPPLY DATA FOR THE PROGRAM "OXIDE" (SEE APPENDIX). THE "OXIDE" PROGRAM CONSTRUCTED TABLES 1, 3, AND 4 (OTHERS ARE SHOWN IN THE APPENDIX WITH THE PROGRAM).

ACKNOWLEDGEMENTS

SEVERAL PEOPLE AND ORGANIZATIONS HAVE CONTRIBUTED TO THIS INVESTIGATION IN VARIOUS WAYS.

THE AREA WAS INITIALLY SUGGESTED BY DR. A.J. BUDDING WITHOUT WHOSE ADVICE AND CRITICISMS THIS REPORT COULD NOT HAVE BEEN COMPLETED. APPRECIATION IS GIVEN TO THE STAFF GEOLOGISTS AT THE NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES WHO SUPPLIED INFORMATION SO GRACIOUSLY. A SPECIAL THANKS IS GIVEN TO DRS. ROUSSEAU FLOWER, FRANK KOTTLOWSKI, JACQUES RENAULT, AND ROBERT WEBER AND TO MR. MAX WILLARD.

PART OF THIS RESEARCH COULD NOT HAVE BEEN ACCOMPLISHED WITHOUT THE ADVICE FROM THE STAFF OF THE NEW MEXICO TECH COMPUTER CENTER. FOR THEIR GENEROSITY IN THIS REGARD A VERY LARGE THANKS IS EXTENDED TO DRS. TOM NARKTER AND RALPH MCGEHEE AND TO MR. JIM FLEMMING FOR THEIR HELP.

FINANCIAL ASSISTANCE WAS PROVIDED FOR THIS INVESTIGATION BY THE NEW MEXICO GEOLOGICAL SOCIETY AND BY A GRANT-IN-AID OF RESEARCH FROM THE SOCIETY OF SIGMA XI.

TO MY WIFE, JUDY, AND DAUGHTER, ROBIN, I WISH TO EXTEND MY GRATITUDE FOR THEIR ENCOURAGEMENT AND UNDERSTANDING.

PRECAMBRIAN ROCKS

INTRODUCTION

THE PRECAMBRIAN ROCKS CROP OUT ACROSS A STRIP OF THE MAP ABOUT 1-1/2 MILES WIDE RUNNING FROM THE NORTHEAST TO THE SOUTHWEST. THE MAJOR ROCK TYPE IS GRANITIC GNEISS, WITH SMALLER BODIES OF MUSCOVITE SCHIST, MUSCOVITE QUARTZ SCHIST, PEGMATITE, AND QUARTZ VEINS.

THE MOST CONSPICUOUS PROPERTY OF THE GRANITIC GNEISS IS THE FOLIATION PRONOUNCED BY THE QUARTZOFELDSPATHIC BANDING. THE FOLIATION OF THE MUSCOVITE SCHIST IS MORE UNDULATORY THAN THAT OF THE GRANITIC GNEISS OR MUSCOVITE QUARTZ SCHIST.

PEGMATITE WAS FOUND EXPOSED ONLY IN THE GRANITIC GNEISS. THE OUTCROPS OF PEGMATITE VARY IN SIZE FROM A FEW INCHES TO SEVERAL FEET. A COMMON OCCURRENCE OF PEGMATITE IS IN THE HINGES OF THE FOLDS.

IN THE MORA AREA THE GRANITIC GNEISS HAS UNDERGONE AT LEAST TWO EVENTS OF REGIONAL DEFORMATION. THE FIRST SYSTEM OF FOLDS TRENDS NORTH-NORTHEAST. THE SECOND DEFORMATION HAS REORIENTED THE LINEAR FEATURES OF THE EARLIER FOLDING TOWARD THE EAST-NORTHEAST TREND OF THE LATER FOLDING.

THE CONTACTS BETWEEN THE GRANITIC GNEISS AND SCHIST UNITS ARE GRADATIONAL WITH THE MICA CONTENT INCREASING TOWARDS THE SCHISTS.

DEEP WEATHERING OF PRECAMBRIAN ROCKS MADE COLLECTION OF FRESH SAMPLES DIFFICULT.

GRANITIC GNEISS

THE PRINCIPAL PRECAMBRIAN ROCK TYPE IN THE AREA IS A MEDIUM TO COARSE GRAINED, PINK TO YELLOW BROWN GNEISS OF GRANITIC COMPOSITION.

QUARTZ, MICROCLINE, AND PLAGIOCLASE ARE THE MAJOR CONSTITUENTS WHICH COMPOSE THE GRANITIC GNEISS. THE MINOR MINERALS OF THE GNEISS ARE MUSCOVITE AND BIOTITE. ACCESSORY CONSTITUENTS ARE COMPRISED OF MAGNETITE, GARNET, ZIRCON, HEMATITE, AND OCCASIONALLY EPIDOTE.

THE GRANITIC GNEISS OF THE MORA AREA IS SIMILAR TO THE COMPOSITION OF THE GRANITIC GNEISS REPORTED BY BINGLER (1965) IN THE LA MADERA QUADRANGLE EXCEPT FOR THE HIGHER CONTENT OF MICA IN HIS SAMPLES. THE MODAL ANALYSES OF GRANITIC GNEISS FROM THE MORA AREA ARE SHOWN IN TABLE 1.

INCLUSIONS WITHIN THE MAJOR AND MINOR COMPONENTS CONSTITUTE THE LIST OF ALL MODAL MINERALS. THE ACCESSORY MINERALS RARELY CONTAIN INCLUSIONS.

COMPOSITIONAL BANDING, FIG. 1A, UNIVERSAL IN THE GRANITIC GNEISS, EMPHASIZES THE FOLIATION WITH 1/10 TO 3 INCH THICK QUARTZOFELDSPATHIC BANDS SEPARATED BY FINER GRAINED MICA-RICH BANDS WHICH ARE ABOUT EQUAL IN WIDTH. LOCALLY THE FOLIATION IS PRONOUNCED BY AN INCREASE IN MICA (USUALLY BIOTITE).

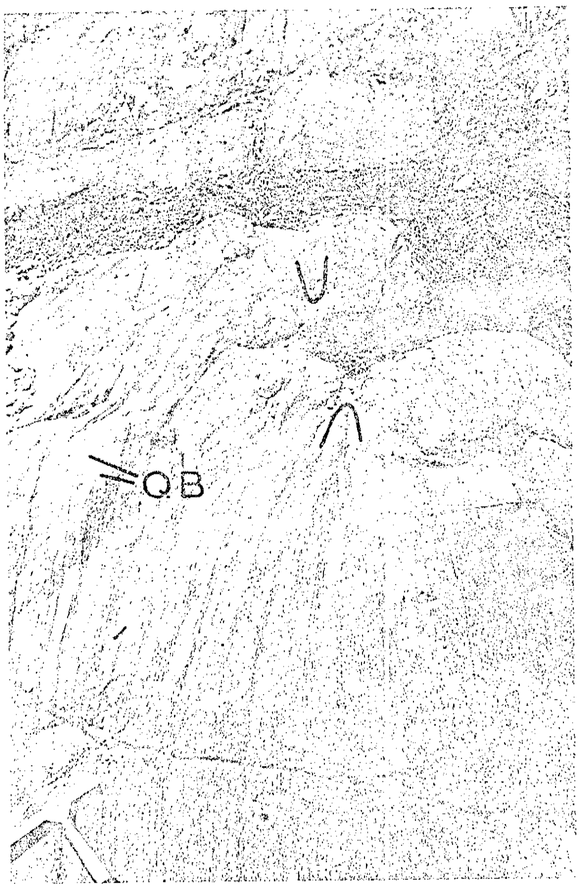
THE FOLIATION STRIKES GENERALLY IN A NORTHEAST DIRECTION AND DIPS SOUTHEAST.

NODULES OF MAGNETITE RANGING IN SIZE UP TO 3 INCHES IN DIAMETER,

TABLE 1.
POINT COUNT ANALYSES
VOLUMETRIC %

NO.	SPECIMEN	QUARTZ	K-SPAR	PLAGIOCLASE	MUSCOV.	BIOTITE	MAGNET.	HEMATITE	GARNET	ZIRCON
1	MUSC QTZ SCHIST	78.30	4.80	0.0	16.80	0.0	0.10	0.0	0.0	0.0
2	MUSC SCHIST	57.00	5.10	5.60	30.60	0.50	0.60	0.50	0.0	0.10
3	MUSC SCHIST	57.60	4.60	0.10	35.70	0.60	1.20	0.0	0.20	0.0
4	MUSC SCHIST	51.00	0.0	5.80	41.00	0.0	1.60	0.0	0.60	0.0
5	GRANITIC GNEISS	43.30	35.80	10.00	9.50	0.0	1.40	0.0	0.0	0.0 +
6	GRANITIC GNEISS	28.10	25.10	43.50	0.50	1.70	1.00	0.0	0.10	0.0
7	GRANITIC GNEISS	47.60	31.90	17.70	2.20	0.0	0.60	0.0	0.0	0.0
8	GRANITIC GNEISS	41.30	41.60	11.90	1.80	1.20	2.10	0.0	0.0	0.10 +
9	GRANITIC GNEISS	33.30	45.40	18.00	1.60	0.60	1.10	0.0	0.0	0.0
10	GRANITIC GNEISS	37.80	32.20	25.10	0.10	4.40	0.30	0.0	0.0	0.10
11	GRANITIC GNEISS	41.80	27.30	17.60	12.40	0.0	0.90	0.0	0.0	0.0
12	GRANITIC GNEISS	53.90	17.80	23.40	0.10	4.80	0.0	0.0	0.0	0.0 +
13	GRANITIC GNEISS	37.80	27.00	27.70	4.90	0.0	2.20	0.0	0.40	0.0 +
14	GRANITIC GNEISS	36.30	44.40	16.90	0.60	0.90	0.90	0.0	0.0	0.0 +
15	GRANITIC GNEISS	42.80	29.10	20.50	5.70	0.0	1.90	0.0	0.0	0.0 +
16	GRANITIC GNEISS	31.70	46.60	18.40	0.90	1.30	1.00	0.0	0.0	0.10 +

Trace amounts indicated as 0.0. + = epidote in sample.



A.

B.

Figure 1 A) Compositional banding in granitic gneiss in canyon near south end of section line B-B'. Quartzofeldspathic bands (QB) outlining folds, indicated by V's.

B) One-forth inch thick, magnetite bands (mb) in granitic gneiss south of section number 3.

WITH AN AVERAGE OF 1/20 OF AN INCH WEATHER OUT FROM THE GNEISS AT REGULAR INTERVALS. THE LARGER NODULES BEAR THIN BOOKS OF MICA. AS A RESULT OF THESE MAGNETITE CONCENTRATIONS IN THE GRÁNITIC GNEISS, COMPASS READINGS OF FOLIATION AND LINEATION ATTITUDES AS CLOSE AS 2 FEET FROM THE OUTCROP WERE OCCASIONALLY AFFECTED. AT THE WESTERN END OF COMANCHE CANYON THE GRANITIC GNEISS (SPECIMEN NO. 5) CONTAINS 1/4 INCH MAGNETITE-RICH BANDS, FIG. 1B, WHICH PARALLEL THE FOLIATION. OTHER SPECIMENS (NOS. 8, 13, AND 15) ALSO BEAR THESE MAGNETITE-RICH BANDS, BUT THESE BANDS WERE EVIDENT ONLY UNDER THE MICROSCOPE, SINCE THE CONCENTRATION OF MAGNETITE WAS NOT GREAT.

THE GRAIN SIZE OF QUARTZ RANGES FROM 0.1 TO 2.5 MM., WITH AN AVERAGE OF 1 MM. THE GRAINS ARE EQUANT IN HABIT AND USUALLY EXHIBIT MUTUAL ARTICULATION WITH NEIGHBORING GRAINS OF OTHER MINERALS. THE GRAIN BOUNDARIES BETWEEN ADJACENT QUARTZ GRAINS ARE SUTURED.

THE QUARTZ CONTENT RANGES FROM 28.1% TO 47.6%, WITH AN AVERAGE COMPOSITION OF 39.6%.

THE QUARTZ IN ALL SAMPLES EXAMINED SHOWS STRAIN. THE STRAIN DOMAIN BOUNDARIES, FIG. 2A, WERE OBSERVED TO BE NEARLY PARALLEL TO THE C-AXIS OF THE GRAINS.

MICROCLINE, THE SECOND MOST COMMON MINERAL, MAKES UP 33.7% OF THE GNEISS AND RANGES FROM 17.8% TO 46.6%, OCCASIONALLY EXCEEDING THE QUARTZ CONTENT.

THE MICROCLINE GRAINS ARE USUALLY THE LARGEST GRAINS IN THE GNEISS AND ARE AS MUCH AS 3 MM. IN LENGTH, WITH AN AVERAGE SIZE OF 0.9 MM.

Figure. 3

Structural domain map. Location of samples are indicated by arabic numbers and domain subdivisions are noted by roman numerals. A, B, and C indicate synthesized, homogeneous structural domains.

L_1 = maximum of fold axes of first deformation.

L_2 = maximum of fold axes of second deformation.

$L+$ = maximum of partially reoriented L_1 axes.

Structural symbols explained on plates 1 and 2.

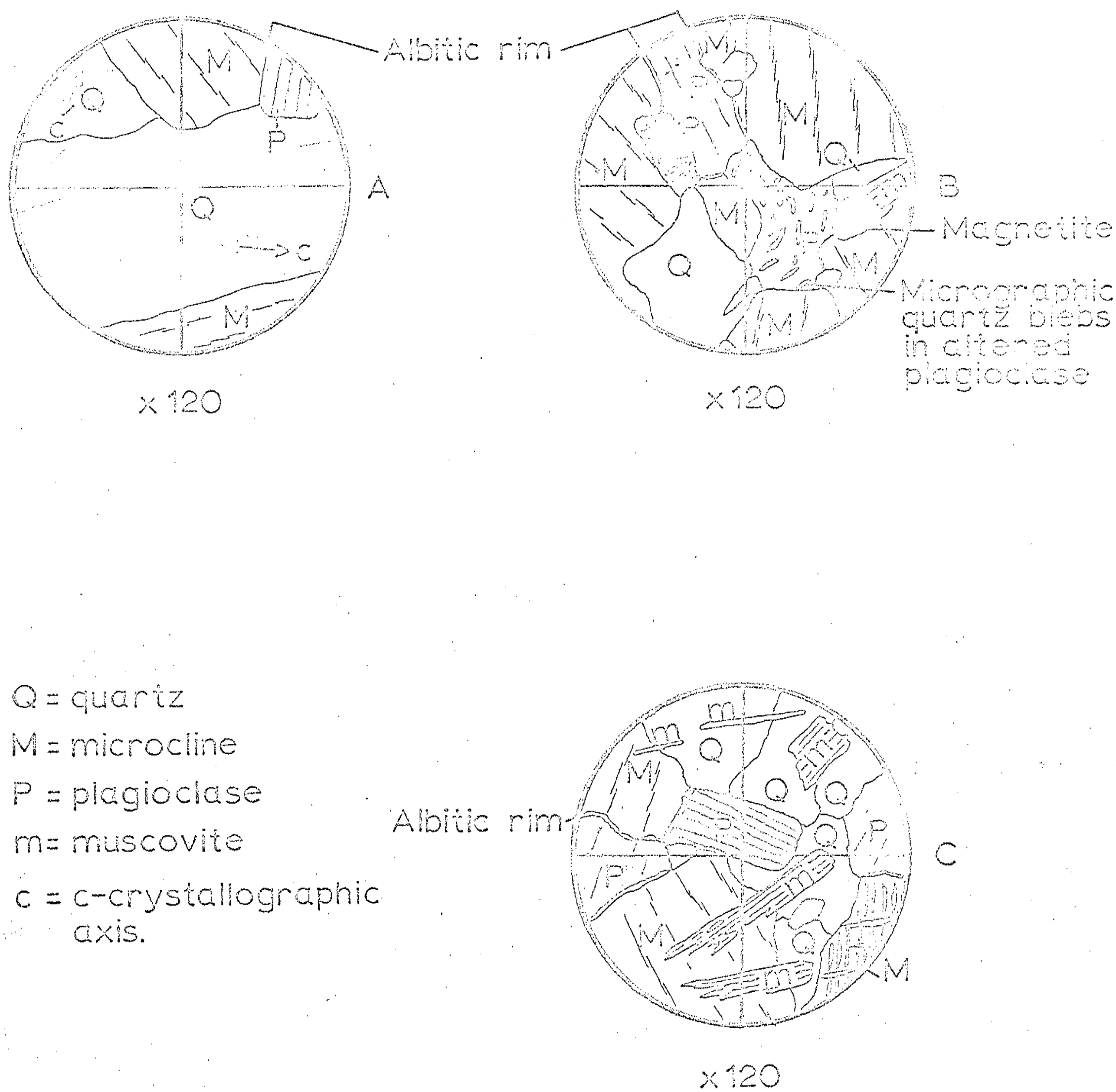
Figure 2

Mineral relationships in granitic gneiss. Note albitic rims of plagioclase adjacent to microcline.

A) Relation of quartz c-axis trace (arrow) and strain domain (shaded) boundaries.

B) Micrographic character of quartz blebs within plagioclase.

C) Muscovite-Microcline boundaries.



Albitic rim
Q
M
P
c
A
Q
→c
M
x 120
M
M
Q
B
M
Magnetite
Q
M
M
Micrographic quartz blebs in altered plagioclase
x120
Q = quartz
M = microcline
P = plagioclase
m= muscovite
c = c-crystallographic axis.
Albitic rim
m
m
M
Q
Q
Q
P
P
C
M
m
Q
m
M
x120

FIGURE 2

THE POTASSIUM FELDSPAR SHOWS REPEATED TWINNING ALONG THE (100) AND (010) DIRECTIONS, PRODUCING TARTAN TWINNING.

THE POTASSIUM FELDSPAR GRAINS OF AVERAGE SIZE ARE EQUANT IN SHAPE BUT THE LARGER GRAINS TEND TO BE IRREGULAR. SUTURED GRAINS OF MICROCLINE ARE RARE.

THE MUSCOVITE-MICROCLINE BOUNDARY WAS EXAMINED FOR EVIDENCE WHICH MIGHT SUGGEST THE DIRECTION OF THE REACTION BETWEEN THE TWO MINERALS. MOST LARGE MUSCOVITE GRAINS EXHIBIT THE RESULTS OF A CORROSIVE ATTACK BY THE MICROCLINE RESULTING IN AN INTERFACE CONCAVE TOWARD THE MICROCLINE, FIG. 2B AND C. BATEMAN (1959) HAS NOTED THIS CONFIGURATION IN ORE MINERALS AS INDICATIVE OF REPLACEMENT OF ONE MINERAL PHASE BY ANOTHER. SMALL AND THIN MUSCOVITE GRAINS TERMINATE IN THE MICROCLINE WITH MICACEOUS ARTICULATION.

THE GRAIN SIZE OF PLAGIOCLASE IS THE SMALLEST OF THE MAJOR CONSTITUENTS, RANGING FROM 0.1 TO 2 MM. WITH AN AVERAGE OF 0.7 MM. THE HABIT OF THE GRAINS IS EQUANT.

THE RANGE OF PLAGIOCLASE CONTENT IN THE GNEISS IS FROM 10% TO 43.5% WITH AN AVERAGE OF 20.9%.

THE COMPOSITION OF THE PLAGIOCLASE WAS DETERMINED BY THE RITTMAN ZONE AND A-NORMAL METHODS, USING THE EXTINCTION ANGLE CURVES FROM TROGER (1959, P.111). NEARLY ALL PLAGIOCLASE CRYSTALS SHOW NORMAL ZONING OF THE GRAINS (SEE TABLE 2). THE RIM CONTAINS ABOUT 5% ANORTHITE WHILE THE CORES, WHICH EXHIBIT LITTLE VARIATION IN THE ANORTHITE COMPOSITION, ARE ABOUT 23% AN. THUS THE AVERAGE COMPOSITION OF THE CORES IS OLIGOCLASE WHILE THE RIMS ARE ALBITIC.

TABLE 2 PLAGIOCLASE COMPOSITION

SPECIMEN	CORE AN %	RIM AN %
1 MUSCOVITE QUARTZ SCHIST	XXXX	XXXX
2 MUSCOVITE SCHIST	23.0	(?)
3 MUSCOVITE SCHIST	(?)	(?)
4 MUSCOVITE SCHIST	21.5	9.5(?)
5 GRANITIC GNEISS	24.0	2.0(?)
6 GRANITIC GNEISS	23.5	2.0
7 GRANITIC GNEISS	24.3	7.0
8 GRANITIC GNEISS	24.0	5.5
9 GRANITIC GNEISS	23.0	7.5
10 GRANITIC GNEISS	23.3	3.0
11 GRANITIC GNEISS	23.3	7.7
12 GRANITIC GNEISS	23.5	5.5
13 GRANITIC GNEISS	----	3.5
14 GRANITIC GNEISS	----	2.0
15 GRANITIC GNEISS	22.0	4.3
16 GRANITIC GNEISS	----	11.0(?)
MEAN VALUES FOR GRANITIC GNEISS	23.4	5.1
MEAN OF ABSOLUTE DEVIATIONS	0.5	2.3
MEAN VALUES FOR MUSCOVITE SCHIST	22.3	9.5(?)
MEAN OF ABSOLUTE DEVIATIONS	1.5	(?)

XXXX = NO PLAGIOCLASE
---- = TOO HIGHLY ALTERED TO MEASURE
(?) = QUESTIONABLE

THE RIMS ARE VERY THIN OR NONEXISTENT EVEN IN A SINGLE GRAIN EXCEPT WHERE THE PLAGIOCLASE IS IN CONTACT WITH THE MICROCLINE, FIG. 2B AND C. THE RIMS, THERFFORE, APPEAR TO BE THE RESULT OF DIFFUSION OF SODIUM FROM THE MICROCLINE LATTICE.

THE INCLUSIONS WITHIN PLAGIOCLASE CRYSTALS COMPRISE ALL OF THE MAJOR CONSTITUENTS. QUARTZ INCLUSIONS OCCASIONALLY PRODUCE MICROGRAPHIC INTERGROWTHS, FIG. 2B.

SERICITIZATION OF THE PLAGIOCLASE BEGINS ALONG THE (010) CLEAVAGES WITH THE SERICITE FLAKES ORIENTED PARALLEL TO THE (001) CLEAVAGE. THE CENTER OF THE GRAINS ARE ALWAYS MORE ALTERED THAN THE REGIONS NEARER TO THE RIMS, BUT THE RIMS SEEM TO BE UNAFFECTED.

MUSCOVITE GRAINS RANGE IN SIZE FROM 0.1 TO 3.0 MM. WITH AN AVERAGE SIZE OF 0.7 MM.

THE CONTENT OF MUSCOVITE IN GRANITIC GNEISS VARIES FROM 0.1% TO 12.4%, BUT THE MODAL AVERAGE IS 3.4%.

SOME GRAINS ARE SLIGHTLY PLEOCHROIC IN VERY PALE YELLOW COLORS.

MUSCOVITE GRAINS FROM SPECIMEN NUMBER 9 (TABLE 1) WERE SELECTED FOR FURTHER EXAMINATION. THE INDEX OF REFRACTION FOR THE Z DIRECTION IS 1.606 AND THE INDEX FOR THE Y DIRECTION WAS ABOUT THE SAME. THE AXIAL ANGLE, 2VX, EQUALS 35 DEGREES. VOLK'S (1939) GRAPH FOR THE OPTICAL PROPERTIES OF MUSCOVITE INDICATES THAT THIS MUSCOVITE IS RICH IN MAGNESIA.

THE ABOVE OPTICAL DATA SUGGESTS THAT THE COMPOSITION OF MUSCOVITE IS CLOSE TO K (MG,FE) AL6 SI6 O21 (OH)3 (LARSEN AND

BERMAN, 1964) AND CONTAINS 5.3% FERROUS OXIDE (FEO).

BIOTITE GRAINS RANGE IN SIZE FROM 0.1 TO 1.8 MM. IN LENGTH. THE AVERAGE GRAIN SIZE IS 0.4 MM.

BIOTITE IS A MINOR CONSTITUENT SELDOM AMOUNTING TO MORE THAN 4.4% OF THE ROCK AND AVERAGING ABOUT 1.2% AND IS COMMONLY INTERGROWN WITH MUSCOVITE.

BIOTITE, LIKE MUSCOVITE, IS USUALLY ORIENTED WITH THE (001) PLANE PARALLEL TO THE FOLIATION. OCCASIONALLY MICA GRAINS WERE FOUND ORIENTED ACROSS THE FOLIATION YIELDING "QUERGLIMMER" STRUCTURE.

THE PLEOCHROIC FORMULA FOR THIS BIOTITE IS X << Y </= Z. THE PLEOCHROIC COLORS WERE DETERMINED TO BE X = YELLOW-BROWN, Y = RED-BROWN, AND Z = DARK RED-BROWN. THESE DEEP PLEOCHROIC COLORS ARE APPARENTLY DUE TO THE INCORPORATION OF TITANIUM DIOXIDE (TIO2). USING HALL'S (1941) GRAPH TO DETERMINE THE TIO2 CONTENT OF BIOTITE, IT WAS FOUND THAT THE TIO2 WAS ABOUT 9%. DEER, HOWIE, AND ZUSSMAN (1966) POINT OUT THAT INCREASE OF METAMORPHIC GRADE IS CORRELATED WITH A DECREASE IN FERRIC (FE+3) AND FERROUS (FE+2) IRON AND MANGANESE (MN) AND AN INCREASE IN TITANIUM AND MAGNESIUM (MG) IN BIOTITE. A BIOTITE, DESCRIBED BY LARSEN AND BERMAN (1964) WITH SIMILAR OPTICAL CHARACTERISTICS CONTAINS 21.6% TOTAL IRON AND 4.3% TIO2. THE FORMULA FOR THIS BIOTITE IS GIVEN AS:
K2 (MG,FE)4 (AL,FE)4 SI6 O22 (OH)2.

MAGNETITE IS A COMMON ACCESSORY CONSTITUENT OF THE GRANITIC GNEISS RANGING IN SIZE FROM DUST SIZE PARTICLES TO 2.0 MM. THE AVERAGE GRAIN SIZE OF MAGNETITE IN THINSECTION IS 0.3 MM.

MAGNETITE IS SUBHEDRAL TO ANHEDRAL AND AMOUNTS TO ABOUT 1% OF THE CONSTITUENTS, BUT LOCALLY EXCEEDS 2%.

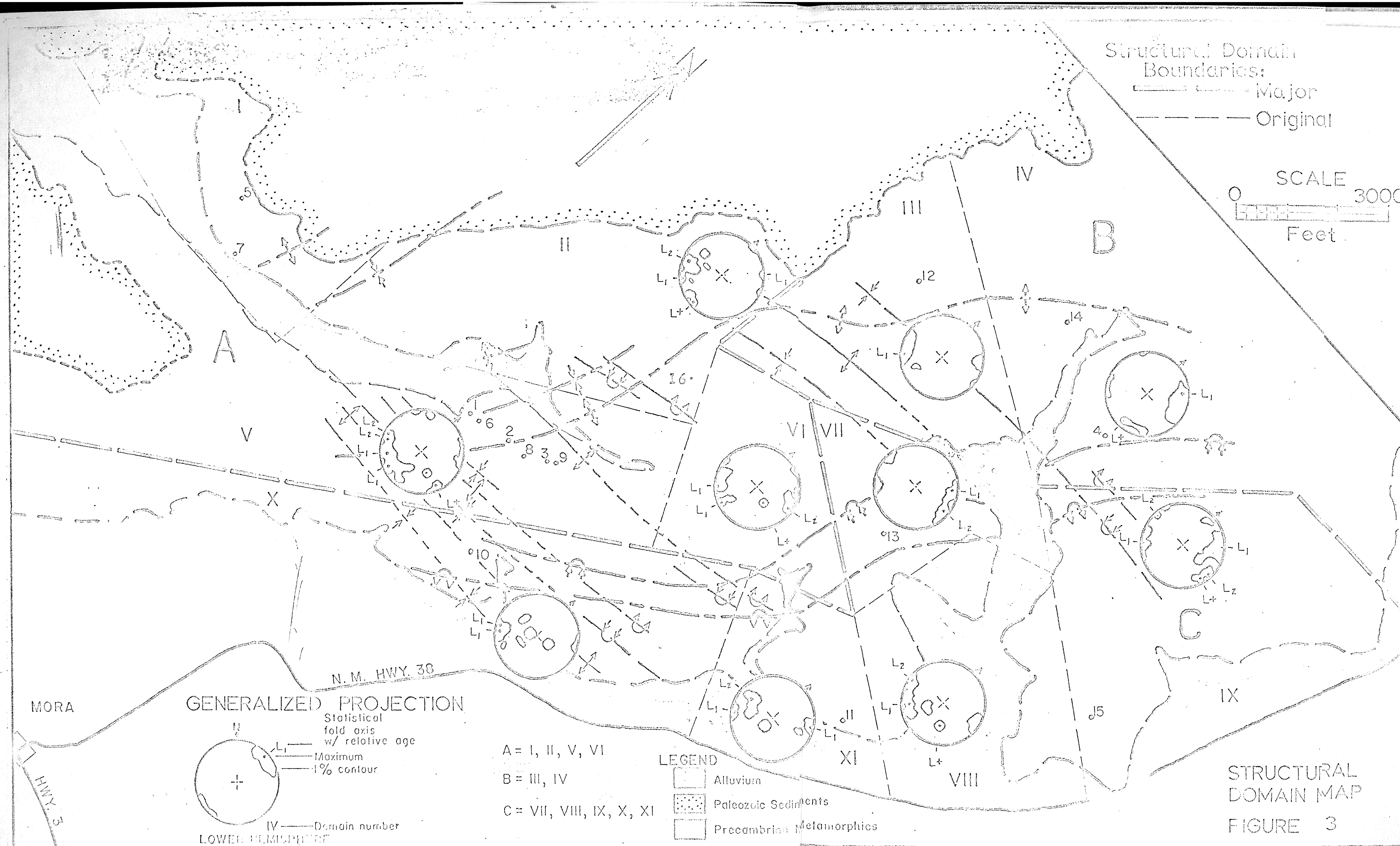
COLORLESS GARNET GRAINS HAVE AN AVERAGE SIZE OF 0.2 MM., BUT GRAINS 1.3 MM. ACROSS WERE MEASURED.

GARNET IS A VERY MINOR CONSTITUENT IN GRANITIC GNEISS AVERAGING 0.04%, MODALLY, AND DOES NOT EXCEED 0.4%.

ZIRCON AND HEMATITE ARE COMMON ACCESSARY CONSTITUENTS. ZIRCON WAS NEVER FOUND TO EXCEED 0.1% BY VOLUME AND AVERAGES 0.03%. HEMATITE OCCURS AS AN ALTERATION PRODUCT AROUND MAGNETITE AND BIOTITE.

EPIDOTE WAS FOUND IN TRACE AMOUNTS IN SPECIMENS 5, 8, 12, 13, 14, 15, AND 16. THE LOCATIONS OF THESE SPECIMENS (FIG. 3) IS NOT RELATED TO ANY SPECIFIC STRUCTURAL FEATURE AND THE ONLY PETROLOGIC SIMILARITY BETWEEN THEM IS THAT THE PLAGIOCLASE SEEMS SLIGHTLY MORE ALTERED IN THE SAMPLES CONTAINING EPIDOTE.

WINKLER (1965) HAS SUMMARIZED EXPERIMENTAL DATA FOR THE MINIMUM MELTING POINT OF GRANITES FOR DIFFERENT QUARTZ - ALBITE - ANORTHITE - ORTHOCLASE EUTECTIC COMPOSITIONS AT 2000 BARS (APPROXIMATELY 4.7 MILES OF DEPTH). FOR AN ALBITE TO ANORTHITE RATIO OF 3.8 AND EUTECTIC COMPOSITION OF QUARTZ (43%), ALBITE (21%), AND ORTHOCLASE (36%), HE INDICATES A MELTING TEMPERATURE OF 695 DEGREES CENTIGRADE. THIS COMPOSITION AGREES CLOSELY WITH THE AVERAGE OF THE GNEISSES FROM THE MORA AREA (AB:AN = 3.8, QUARTZ = 45.0%, ALBITE = 20.4%, AND POTASSIUM FELDSPAR = 34.6%) AND ARE SHOWN IN TABLE 3 AND FIG. 4.



STRUCTURAL DOMAIN MAP
FIGURE 3

TABLE 3

QUARTZ-ALBITE-ORTHOCLASE VALUES, BY WEIGHT %

NO.	SPECIMEN	* QTZ %	* AB%	* OR%	* AB/AN
1	MUSC QTZ SCHIST	* 94.41	* 0.34	* 5.26	*999.99
2	MUSC SCHIST	* 86.07	* 6.93	* 6.99	* 3.58
3	MUSC SCHIST	* 92.72	* 0.55	* 6.72	* 14.98
4	MUSC SCHIST	* 91.88	* 8.12	* 0.0	* 3.55
5	GRANITIC GNEISS	* 50.67	* 11.29	* 38.04	* 4.03
6	GRANITIC GNEISS	* 32.95	* 40.32	* 26.73	* 3.31
7	GRANITIC GNEISS	* 51.84	* 16.61	* 31.55	* 3.60
8	GRANITIC GNEISS	* 45.64	* 12.62	* 41.74	* 4.01
9	GRANITIC GNEISS	* 36.61	* 18.07	* 45.32	* 3.99
10	GRANITIC GNEISS	* 42.88	* 23.96	* 33.17	* 3.67
11	GRANITIC GNEISS	* 51.18	* 18.47	* 30.35	* 3.74
12	GRANITIC GNEISS	* 60.69	* 21.11	* 18.20	* 3.35
13	GRANITIC GNEISS	* 44.40	* 26.80	* 28.80	* 3.59
14	GRANITIC GNEISS	* 39.39	* 16.86	* 43.75	* 4.01
15	GRANITIC GNEISS	* 49.29	* 20.29	* 30.43	* 3.92
16	GRANITIC GNEISS	* 34.90	* 18.51	* 46.59	* 3.99
	Average of gneiss =	45.04	20.41	34.55	3.76

QTZ = Quartz

AB = Albite

AN = Anorthite

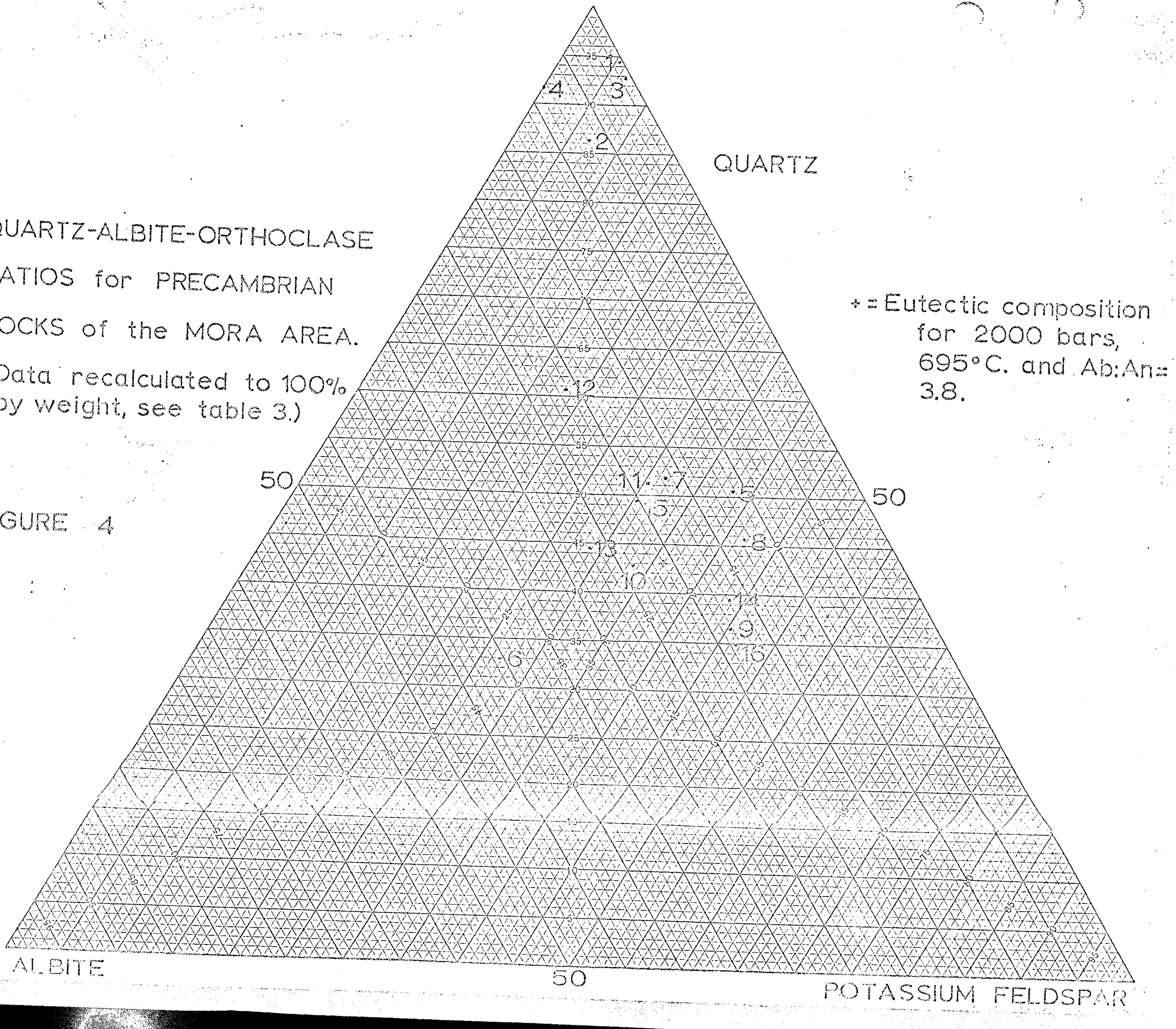
OR = Orthoclase

MUSC = Muscovite

QUARTZ-ALBITE-ORTHOCLASE RATIOS for PRECAMBRIAN ROCKS of the MORA AREA.

(Data recalculated to 100% by weight, see table 3.)

FIGURE 4



A STRIKING FEATURE OF THE GRANITIC GNEISS IS THE UNIFORM COMPOSITION OF THE PLAGIOCLASE CORES (22-24% ANORTHITE). THE HIGH DEGREE OF MOBILITY OF AN ALLOCHTHONOUS GRANITE MIGHT PRODUCE SUCH A UNIFORM PLAGIOCLASE DUE TO PHYSICAL MIXING OF THE CONSTITUENT ELEMENTS. THE LACK OF CHEMICAL UNIFORMITY VERTICALLY IN A SHALE SEQUENCE WOULD BE UNLIKELY TO PRODUCE THIS RESULT AND THEREFORE IS NOT CONSIDERED AS LIKELY TO BE THE PROGENITOR OF THE GRANITIC GNEISS.

FIGURE 5 IS CONSTRUCTED FROM TABLE 4, WHICH WAS SUPPLIED BY THE "OXIDE" PROGRAM, AND SHOWS THE RELATIONSHIP OF THE SAMPLES FROM THE MORA AREA ON A TERNARY DIAGRAM OF QUARTZ, PLAGIOCLASE, AND MICROCLINE. FIGURES 4 AND 5 SUGGEST THAT THE GRANITIC GNEISS IS AN ANATEXITE.

QUARTZ-MICROCLINE-PLAGIOCLASE

· = Mora area precambrian rocks.

+ = Woodson Mountain Granodiorite.

∘ = Roblar Granite.

⊙ = Pegmatite from Mora area.

FIGURE 5

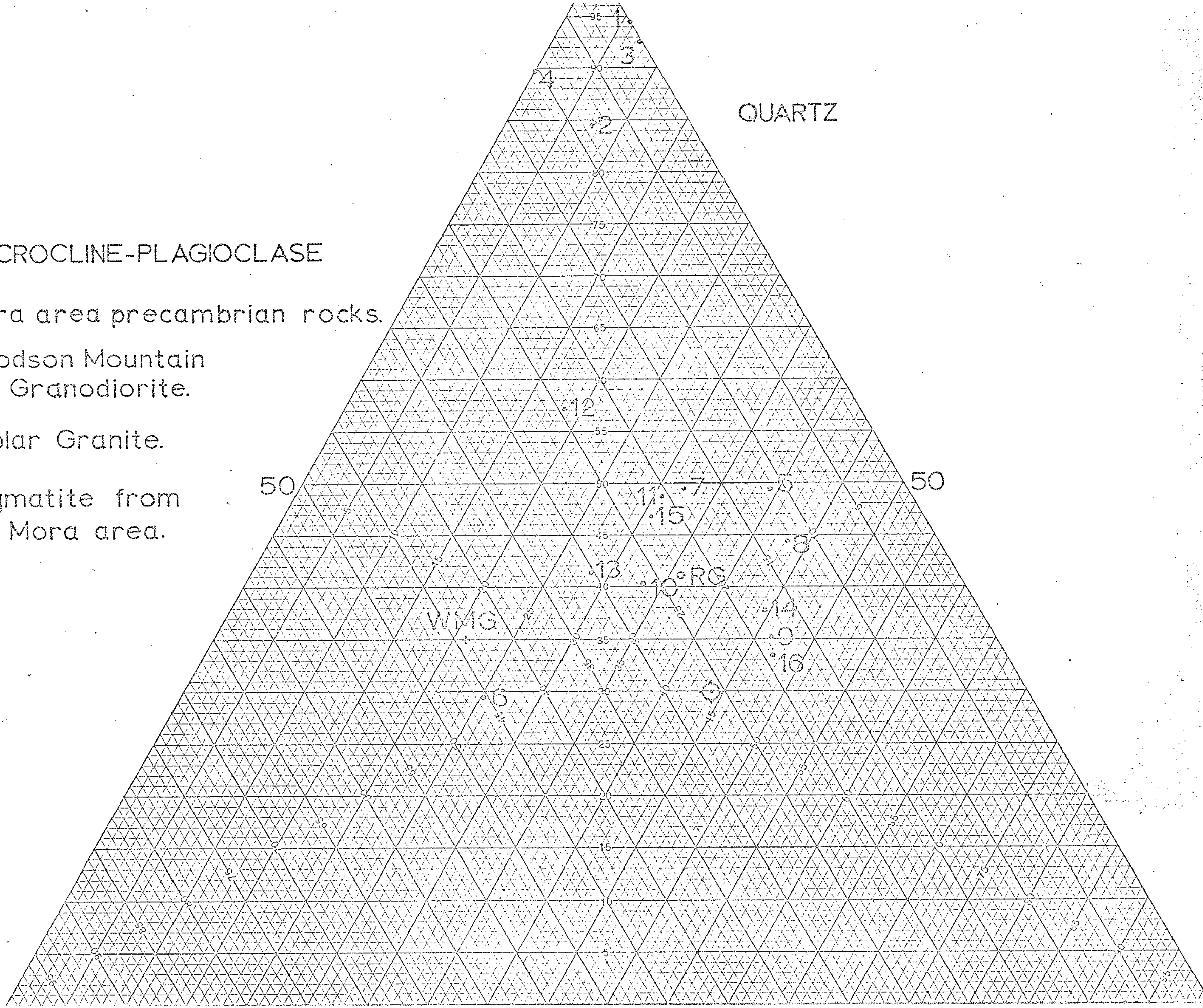


TABLE 4

QUARTZ-MICROCLINE-PLAGIOCLASE VALUES, BY WEIGHT %

NO.	SPECIMEN	* QUARTZ	* MICROCLINE	* PLAGIOCLASE
1	MUSC QTZ SCHIST	* 94.41	* 5.59	* 0.0
2	MUSC SCHIST	* 84.44	* 7.30	* 8.26
3	MUSC SCHIST	* 92.69	* 7.15	* 0.16
4	MUSC SCHIST	* 89.82	* 0.0	* 10.18
5	GRANITIC GNEISS	* 49.29	* 39.37	* 11.34
6	GRANITIC GNEISS	* 29.37	* 25.34	* 45.29
7	GRANITIC GNEISS	* 49.56	* 32.08	* 18.36
8	GRANITIC GNEISS	* 44.25	* 43.05	* 12.70
9	GRANITIC GNEISS	* 35.02	* 46.12	* 18.86
10	GRANITIC GNEISS	* 40.25	* 33.12	* 26.63
11	GRANITIC GNEISS	* 48.77	* 30.77	* 20.46
12	GRANITIC GNEISS	* 57.09	* 18.21	* 24.69
13	GRANITIC GNEISS	* 41.32	* 28.51	* 30.17
14	GRANITIC GNEISS	* 37.80	* 44.67	* 17.53
15	GRANITIC GNEISS	* 46.86	* 30.78	* 22.36
16	GRANITIC GNEISS	* 33.35	* 47.36	* 19.29

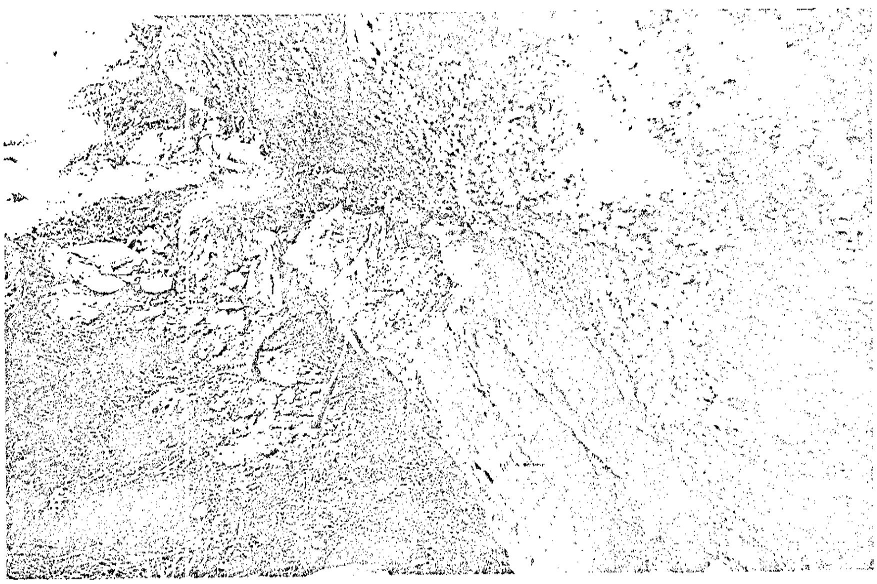
MUSCOVITE SCHIST

A GRAYISH GREEN MUSCOVITE SCHIST WITH QUARTZ LENSES, FIG. 6A AND B, MEASURING UP TO 9 INCHES ACROSS AND 2-1/2 INCHES THICK, CROPS OUT AS SMALL BODIES WITHIN THE GRANITIC GNEISS. THE MICA IS PARALLEL TO THE QUARTZ LENSES AS A RESULT OF FLOWAGE OF THE MORE PASSIVE MUSCOVITE AROUND THE COMPETENT QUARTZ. THE FOLIATION OF THE SCHIST IS PARALLEL TO THE FOLIATION OF THE SURROUNDING GRANITIC GNEISS. THESE SCHIST BODIES SELDOM EXCEED 50 FEET IN LENGTH. AN EXCEPTIONALLY LARGE OUTCROP OF THIS SCHIST OCCURS ON THE PEAK ABOVE THE ROCKSLIDE AREA (COLLUVIUM) IN LA TIERRA AMARILLA CANYON, WHERE THE MUSCOVITE SCHIST IS 150 FEET LONG BY 50 FEET WIDE.

MUSCOVITE SCHIST IS COMMONLY FOUND IN ASSOCIATION WITH PEGMATITES AND COARSE GRAINED, WIDE, CONCORDANT QUARTZOFELDSPATHIC BANDS WITHIN THE GRANITIC GNEISS. COMPOSITIONAL BANDING IN THE MUSCOVITE SCHIST IS DELICATE, WITH MUSCOVITE AND QUARTZ-RICH BANDS ABOUT 1 MM. THICK ALTERNATING IN A UNIFORM MANNER. THIS SCHIST SHOWS PROMINENT CRENULATIONS AND HAS A WELL DEFINED PARTING ALONG MICA-RICH LAYERS.

THE MUSCOVITE SCHIST CONTAINS GRAINS OF QUARTZ WHICH RANGE FROM 0.1 TO 2.0 MM. AND AVERAGE 0.7 MM. IN LENGTH. THE QUARTZ CONSTITUTES AN AVERAGE OF 55.2% OF THE SCHIST BUT THIS VALUE RANGES FROM 51.0% TO 57.6%.

MUSCOVITE GRAINS RANGE FROM 0.1 TO 1.5 MM. IN LENGTH AND ARE USUALLY 0.7 MM. LONG. THE SCHIST IS COMPOSED OF 30.6% TO 41.0% MUSCOVITE AND AVERAGES 35.8%. A GRAIN MOUNT OF MUSCOVITE WAS MADE



A.

B.

Figure 6

A) Steeply dipping muscovite schist.

B) Quartz body (Q) within muscovite schist indicates intrafolial folding (arrow).

Both photos from La Tierra Amarilla Canyon.

FROM SAMPLE 3 IN WHICH THE AXIAL ANGLE, 2VX, WAS FOUND TO BE 35 DEGREES. THE REFRACTIVE INDICES FOR THE MUSCOVITE WERE DETERMINED TO BE THE SAME AS FOR THE MUSCOVITE IN THE GRANITIC GNEISS.

PLAGIOCLASE GRAINS IN THE MUSCOVITE SCHIST AVERAGE 0.7 MM. IN LENGTH AND RANGE FROM 0.1 TO 2.0 MM. THE CONTENT OF PLAGIOCLASE IN THE SCHIST VARIES FROM 0.1% TO 5.8% WITH AN AVERAGE OF 3.8%.

MICROCLINE, WHEN IT OCCURS IN THE MUSCOVITE SCHIST, HAS THE LARGEST AVERAGE SIZE OF ANY OF THE MINERALS; 1.1 MM. LONG. THE MICROCLINE SIZE RANGE IS THE SAME AS THAT FOR QUARTZ.

COMPOSITIONALLY MICROCLINE IS USUALLY LESS THAN PLAGIOCLASE, RANGING FROM ZERO PER CENT TO 5.1% WITH A MEAN OF 3.2%.

MAGNETITE, BIOTITE, GARNET, HEMATITE, AND ZIRCON COMPRISE THE ACCESSORY MINERALS OF THE MUSCOVITE SCHIST.

GRAINS OF MAGNETITE RANGE IN SIZE, WITHIN THE SCHIST, FROM 0.1 TO 1.0 MM. AND AVERAGE 0.4 MM. MAGNETITE IS THE MOST ABUNDANT OF THE ACCESSORY MINERALS WITH AN AVERAGE OF 1.2% AND A RANGE FROM 0.6% TO 1.6%.

BIOTITE GRANS ARE INTERGROWN WITH THE MUSCOVITE AND CONSTITUTE ONLY A TRACE CONSTITUENT IN THE SCHIST. THE MUSCOVITE SCHIST SAMPLES EXAMINED CONTAINED BIOTITE RANGING FROM NIL TO 0.6% WITH A MEAN OF 0.4%.

COLORLESS GARNETS OCCURRED IN EVERY SPECIMEN OF MUSCOVITE SCHIST. THE SIZE OF GARNETS WAS USUALLY QUITE SMALL, NEVER EXCEEDING 0.5 MM. AND THE AVERAGE SIZE WAS 0.2 MM. THE GARNETS COMPOSED FROM TRACE AMOUNTS TO 0.6% OF THE SCHIST. THE AVERAGE ABUNDANCE

WAS 0.3% BY VOLUME.

IN ONE SPECIMEN (NO. 4) GARNET CRYSTALS ARE RESTRICTED TO KINK BANDS, WHICH REPRESENT INCIPIENT SLIP CLEAVAGE. THE PRESENCE OF KINK BANDS INDICATES MORE THAN ONE DEFORMATION IN THE MUSCOVITE SCHIST.

SNOWBALL GARNETS WITH INCLUSIONS OCCUR RARELY.

REFRACTIVE INDEX MEASUREMENTS ON GARNETS FROM MUSCOVITE SCHIST SHOWED THE INDEX TO BE LARGER THAN 1.800 AND SMALLER THAN 1.850; THUS THE GARNET IS MOST LIKELY ALMANDINE (N = 1.830 ACCORDING TO DEER, HOWIE, AND ZUSSMAN, 1966).

OTHER ACCESSORY CONSTITUENTS ARE HEMATITE AND ZIRCON.

SOME OUTCROPS OF MUSCOVITE SCHIST ARE SPATIALLY RELATED TO BODIES OF PEGMATITE (SEE PLATES 1 AND 2) IN THE GRANITIC GNEISS. THIS RELATIONSHIP SUGGESTED TO JUST (1954) THAT FLUIDS RICH IN POTASSIUM AND SILICA, EMANATING FROM THE PEGMATITE, MAY HAVE SUPPLIED THESE ELEMENTS TO THE MUSCOVITE SCHIST.

THE LACK OF PALIMPSEST FEATURES IN THE MUSCOVITE SCHIST PREVENTS ANY POSITIVE STATEMENT REGARDING A SEDIMENTARY ORIGIN, BUT SUCH AN ORIGIN IS ATTRACTIVE, SINCE "JUICING UP" OF THE ROCK BY POTASSIUM BEARING METASOMATIC FLUIDS WOULD NOT HAVE HAD SUCH A LOCAL AFFECT.

MUSCOVITE QUARTZ SCHIST

MUSCOVITE QUARTZ SCHIST IS COMMONLY A SILVERY TAN TO GRAY COLOR AND CONTAINS NO QUARTZ LENSES. THE SCHISTOSITY IS DEFINED BY MUSCOVITE WHICH IS DISTRIBUTED THROUGHOUT THE ROCK, BUT THE LEPIDOBLASTIC BANDS ARE NOT WELL DEFINED. CONSEQUENTLY, THIS SCHIST DOES NOT PART AS WELL AS THE MUSCOVITE SCHIST. THE MAJOR MINERALS ARE QUARTZ AND MUSCOVITE.

QUARTZ GRAINS IN THE MUSCOVITE QUARTZ SCHIST RANGE FROM 0.1 MM. TO 4.0 MM. IN SIZE, WITH AN AVERAGE OF 2.5 MM. THE QUARTZ CONTENT MAKES UP ABOUT 78% OF THE MUSCOVITE QUARTZ SCHIST.

GRAIN SIZES OF MUSCOVITE RANGE FROM 0.05 MM. TO 1.5 MM. AND HAVE A MEAN LENGTH OF 0.9 MM. THE MUSCOVITE CONTENT (17%) IS NEARLY HALF AS MUCH AS IS USUALLY FOUND IN THE MUSCOVITE SCHIST.

THE GRAIN SIZE OF MICROCLINE RANGES UP TO 2.5 MM. WITH AN AVERAGE SIZE OF 1.3 MM. MICROCLINE CONSTITUTES NEARLY 5% OF THE VOLUME OF THIS SCHIST.

MAGNETITE, ZIRCON, BIOTITE, AND HEMATITE ARE ACCESSORY CONSTITUENTS.

BARKER (1958) HAS NOTED THAT ON LA JARITA MESA, SCHISTS NOT WITHIN CONTACT ZONES OF PEGMATITES, SELDOM CONTAIN MORE THAN 15% MUSCOVITE, BUT THOSE WITHIN THE AFFECTED RANGE OF THE PEGMATITES CONTAIN AS MUCH AS 40%.

THE LACK OF ASSOCIATION WITH PEGMATITE SUGGESTS THE POSSIBILITY THAT THE MUSCOVITE QUARTZ SCHISTS ARE ALTERED REMNANTS OF OLDER METAMORPHOSED SEDIMENTS IN THE GRANITIC GNEISS.

PEGMATITES AND QUARTZ VEINS

PEGMATITES OF VARIABLE MINERAL PROPORTIONS, BUT ALWAYS CONTAINING THE SAME MINERAL CONSTITUENTS, OCCUR THROUGHOUT THE GRANITIC GNEISS.

CRYSTALS OF QUARTZ IN THE PEGMATITES ARE AS LARGE AS 2-1/2 INCHES AND RANGE IN COLOR FROM CLEAR TO LIGHT GRAY.

FELDSPAR GRAINS ARE USUALLY SMALLER THAN THE QUARTZ GRAINS IN THE PEGMATITES AND THE COLOR RANGES FROM WHITE THROUGH PINK. BOTH ALKALI AND POTASSIUM RICH FELDSPARS HAVE ALTERED TO CLAY PRODUCTS IN VARYING DEGREES. THE LARGER GRAINS OF QUARTZ AND FELDSPAR ARE COMMONLY FRACTURED.

GRAYISH COLORED MUSCOVITE GRAINS RANGE IN SIZE FROM 1/8 TO 2 INCHES IN THE HAND SPECIMEN AND AVERAGE NEAR 1/4 INCH IN LENGTH. IN ONE OUTCROP, NEAR THE HEAD OF COMANCHE CANYON ON THE SOUTH RIM, MUSCOVITE BOOKS 2-1/2 FEET ACROSS WERE FOUND. THIS OUTCROP ALSO HAS A HIGH RATIO OF FELDSPAR TO QUARTZ.

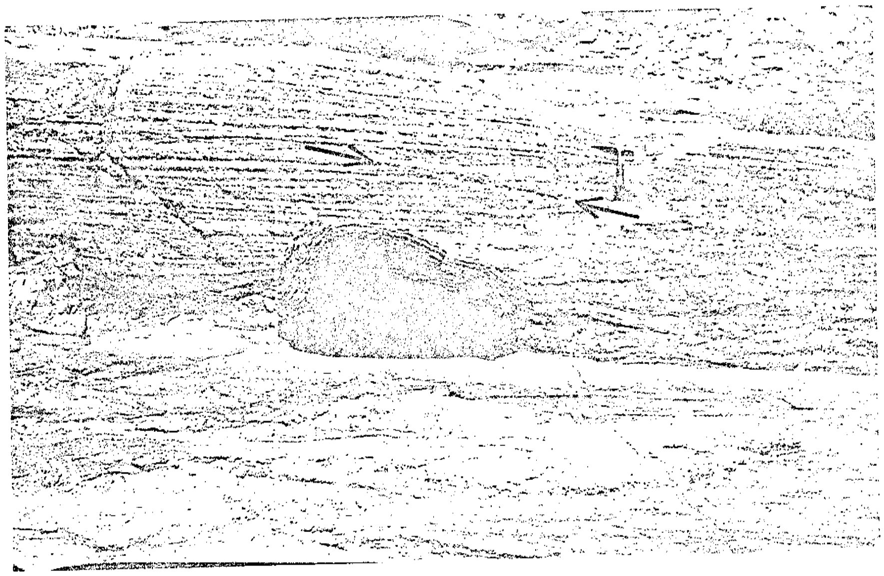
PEGMATITES ARE BOTH DISCORDANT AND CONCORDANT TO THE FOLIATION, FIG. 7 AND 8, RESPECTIVELY. DIKES OF PEGMATITIC MATERIAL RANGE FROM 1/2 INCH TO 2 FEET, FIG. 7B. SMALLER DISCORDANT VEINS OF PEGMATITE FORM ALONG PLANES OF WEAKNESS, FIG. 7A, AND SOMETIMES ARE ATTENDED BY PARASITIC FOLDS, FIG. 7C, INDICATING A FORCEFUL INTRUSION. THE LARGER DIKES EXHIBIT "PINCH AND SWELL" STRUCTURE, FIG. 7B, AND OCCASIONALLY THE "SWELLS" APPEAR ROTATED. THE THINNER DISCORDANT BODIES ARE USUALLY NOT VERY LONG, A FEW FEET AT MOST, AND MERGE WITH THE CONCORDANT PEGMATITES AT THEIR TERMINUSES.

Figure 7 Discordant pegmatites.
B and C from Camanche Canyon. A from canyon near south end of section B-B'.

A) Narrow pegmatite (arrows) crossing horizontal foliation.

B) Thick pegmatite dike (P) showing "pinch and swell" structure. Arrow indicates hammer for scale.

C) En echelon dikes (P) with forceable intrusion indicated by deformed foliation (broken line).



A.

B.

C.

FIGURE 7

Figure 8 Concordant pegmatite bodies in Comanche Canyon.

A) Quartzofeldspathic bands (QB) coalese into pegmatite bands (P) which thicken in the hinge of the fold.

B) Synform outlined by pegmatite (P). Note parasitic fold with shearing couple indicated.

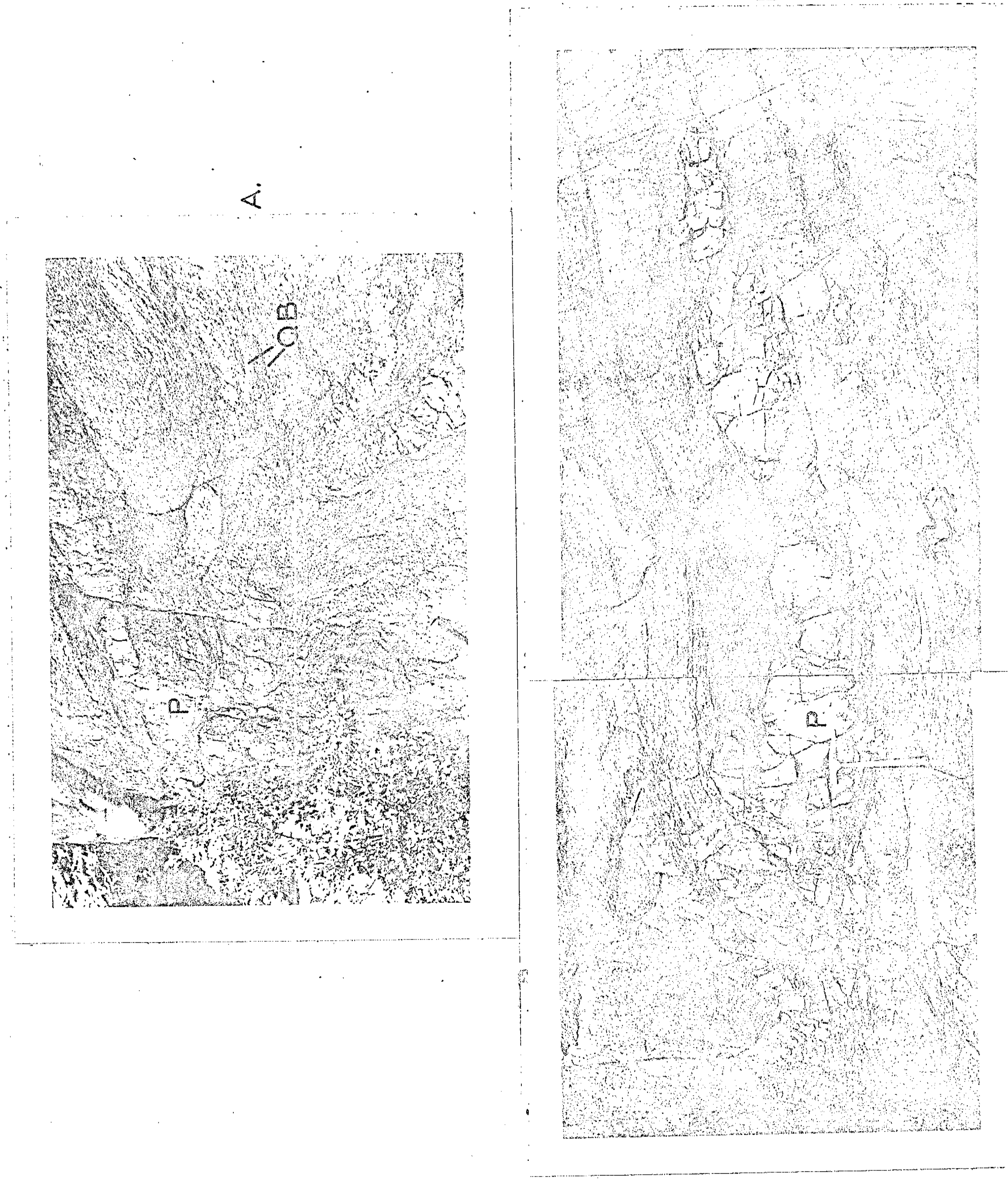


FIGURE 8

FIG. 8A. DIKES OF THICKER PEGMATITES WERE FOUND TO BE AT LEAST 100 FEET LONG.

CONCORDANT BODIES OF PEGMATITIC MATERIAL HAVE A RANGE OF THICKNESS ABOUT EQUAL TO THEIR DISCORDANT COUNTERPART. THE WIDTH OF THE CONCORDANT PEGMATITIC VEINS VARIES WITH RELATION TO FOLD AXES. THE THIN QUARTZOFELDSPATHIC BANDS PREDOMINATE, BUT AS THE AXIS IS APPROACHED THESE BANDS COALESCE INTO 2 TO 3 INCH PEGMATITIC BANDS, WHICH INCREASE IN THICKNESS TOWARD THE HINGE OF THE FOLD, FIG. 8A AND B.

IN THE HINGE THE AXIAL PLANE FOLIATION CUTS THROUGH THE THICKENED PEGMATITIC MATERIAL AND SMALLER BANDS OF THE PEGMATITE MAY EXTEND, CONCORDANTLY FROM THE CONVEX SIDE OF THE FOLD, FIG. 9.

THE COMPOSITION OF A 5 INCH THICK CONCORDANT PEGMATITE WAS DETERMINED USING 100 POINTS PER TRAVERSE, FIG. 10. THE MEAN GRAIN SIZE AND COMPOSITION ARE TABULATED BELOW:

MINERAL	GRAIN SIZE	COMPOSITION
QUARTZ	3.5 MM.	28.6%
ALKALI FELDAPAR	10.0 MM.	43.0%
PLAGIOCLASE	9.0 MM.	25.0%
MICA	1.5 MM.	4.4%

DISCRIMINATION BETWEEN THE FELDSPARS WAS MADE BY USING THE STAINING TECHNIQUE DESCRIBED BY BAILEY AND STEVENS (1960).

FROM THE LACK OF CONTACT AUREOLES IT IS CONCLUDED THAT AT

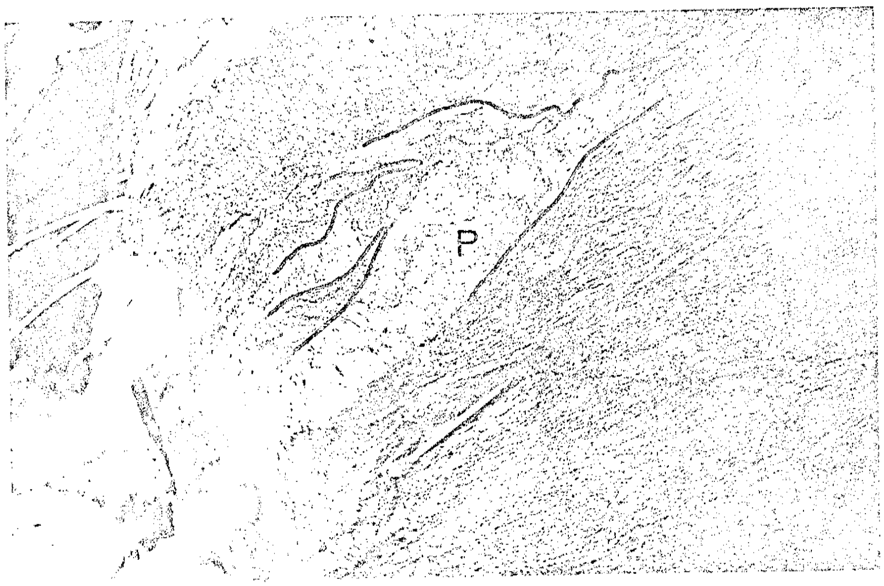


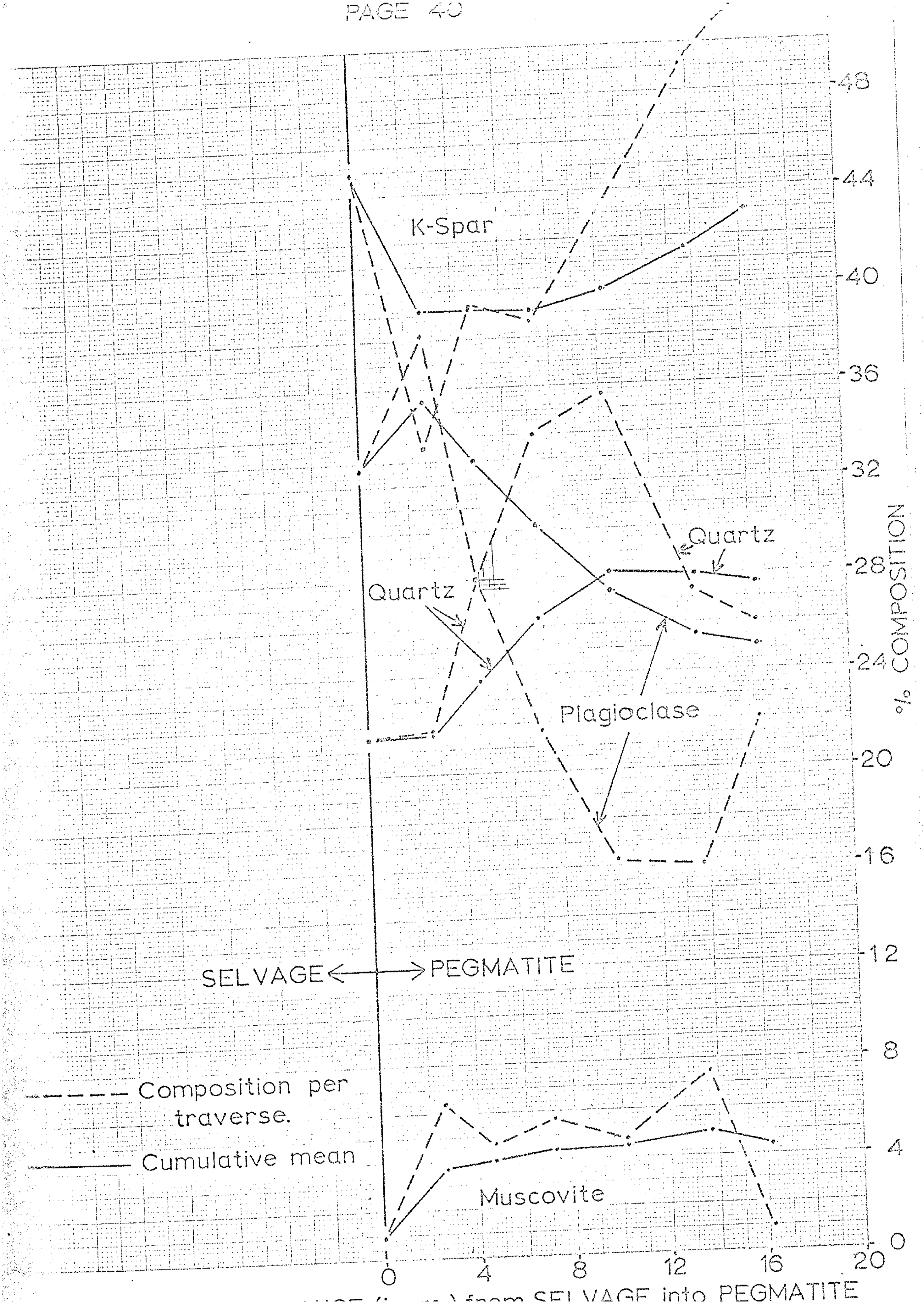
Figure 9

Pegmatite band (P) outlining mesoscopic antiform from Comanche Canyon.

Note the small pegmatite band extending from the convex side of the hinge.

Figure 10

Cumulative mean composition and composition per traverse of pegmatite vs. distance (in cm.) from the pegmatite-selvage boundary.


K-Spar
Quartz
Quartz
Plagioclase
SELVAGE ⟷ PEGMATITE
Composition per traverse.
Cumulative mean
Muscovite
48
44
40
36
32
28
24
20
16
12
8
4
0
% COMPOSITION
0
4
8
12
16
20
...NCE (in...) from SELVAGE into PEGMATITE

THE TIME OF THEIR EMPLACEMENT THE TEMPERATURE DIFFERENCE BETWEEN THE PEGMATITES AND THE HOST ROCK WAS NEGLIGIBLE. THIS CONCLUSION IS SUPPORTED BY THE LACK OF CHILLED BORDERS IN THE PEGMATITES.

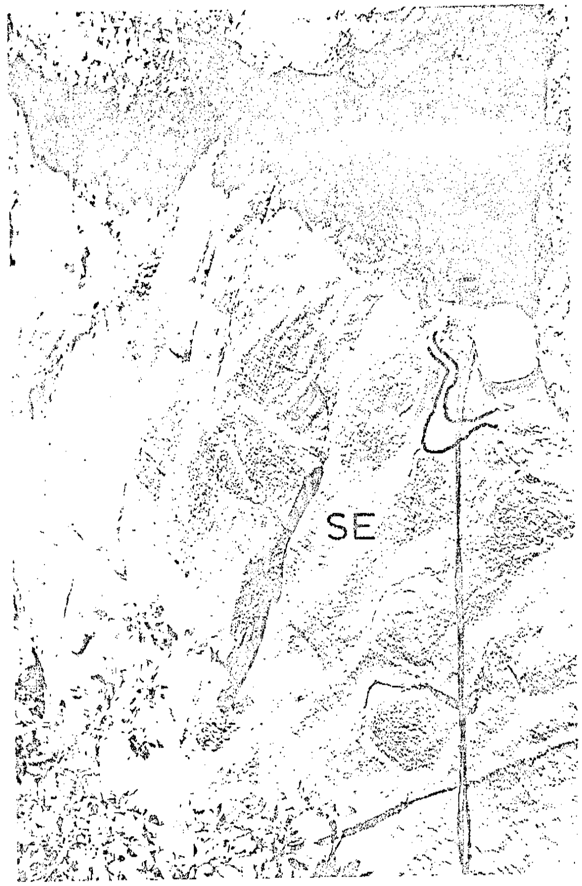
SELVAGES SOMETIMES EXIST ADJACENT TO THE PEGMATITE, FIG. 11A AND B, AND ARE COMPOSED PRIMARILY OF MUSCOVITE, ALKALI FELDSPAR, AND QUARTZ. THESE SELVAGES MAY BE THE RESULT OF POTASSIUM ENRICHMENT OF THE COUNTRY ROCK, IMMEDIATELY ADJACENT TO THE PEGMATITE. THE SOURCE FOR THIS POTASSIUM MAY BE THE PEGMATITE, WHICH SHOWS A NOTABLE IMPOVERISHMENT OF THIS ELEMENT IN THE OUTER ZONE, FIG. 10.

SPORADICALLY OCCURRING MILKY QUARTZ VEINS CROP OUT IN THE GRANITIC GNEISS, FIG. 12, AND MAY IN RARE CASES BE TRACED CONTINUOUSLY FOR SEVERAL YARDS. THE COARSE SIZE OF THE QUARTZ, INCORPORATION OF SMALL AMOUNTS OF PINK FELDSPAR AND MUSCOVITE, AND THE MICA SELVAGES SUGGEST THAT THE QUARTZ VEINS ARE CLOSELY RELATED TO THE PEGMATITE.

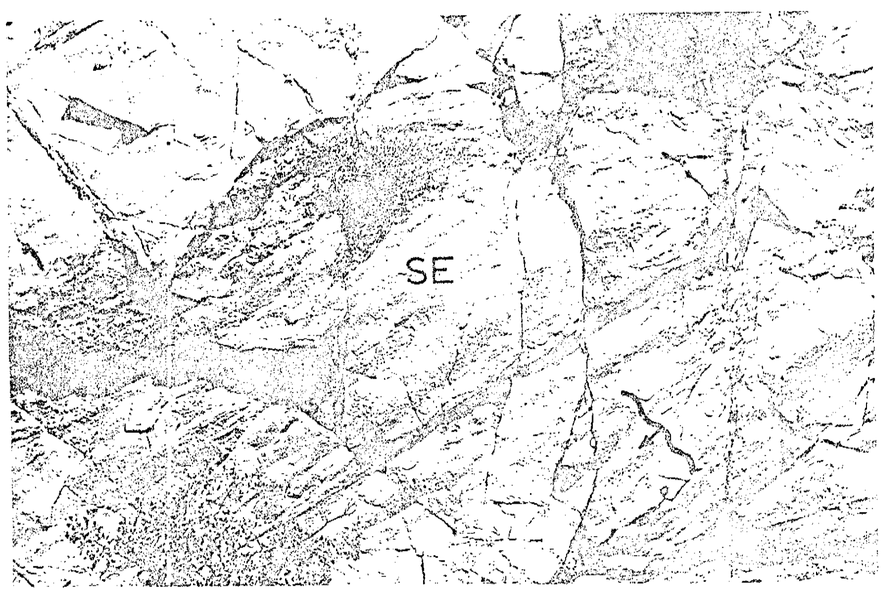
Figure 11 Pegmatite Selvage (SE) from outcrop at Southeast end of West ridge of La Tierra Amarilla Canyon.

A) Rind (outlined with solid line) of selvage (SE) on one foot thick concordant pegmatite (P). Light meter for scale.

B) Illustrates steeply plunging crenulations bearing Southwest.
Crenulation symbol equivalent to one foot.



A.



B.

FIGURE 11

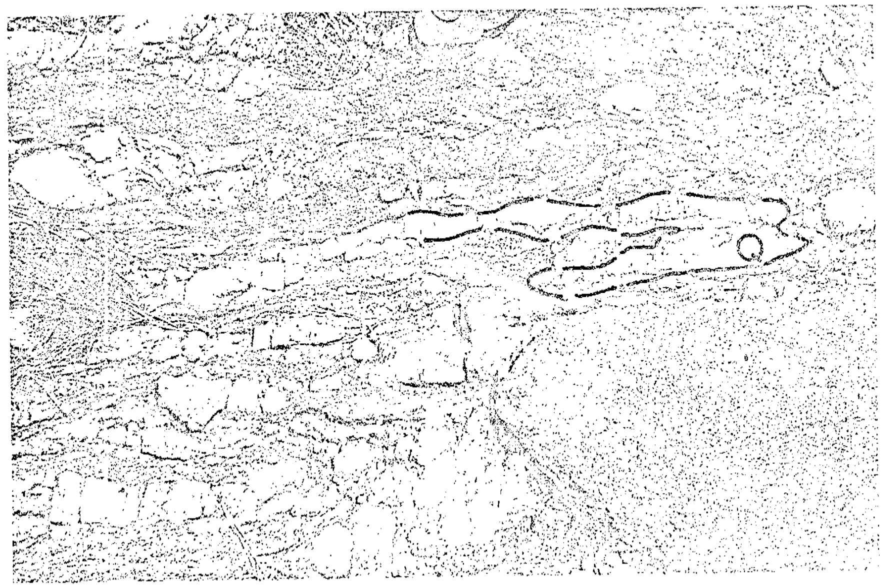


Figure 12
Quartz bodies (Q) in granitic gneiss in the canyon near the south end of cross-section B-B'.
Cane shaped fold (broken line) has been subjected to transposition.

METAMORPHISM

SEVERAL OBSERVATIONS INDICATE THAT REGIONAL METAMORPHISM OF THE PRECAMBRIAN ROCKS OF THE MORA AREA REACHED THE CONDITIONS OF THE ALMANDINE-AMPHIBOLITE FACIES (TURNER AND VERHOOGEN, 1960).

THE EVIDENCE FOR THE GRADE OF METAMORPHISM FROM THE FIRST DEFORMATION COMES FROM THE QUARTZOFELDSPATHIC AND PEGMATITIC BANDING, WHICH OUTLINES THE FOLDS OF THE FIRST DEFORMATION IN THE GRANITIC GNEISS. SINCE THE GRANITIC GNEISS WAS PROBABLY CREATED FROM A GRANITIC PLUTON, THEN TWO POSSIBLE ORIGINS EXIST FOR THE PEGMATITIC-QUARTZOFELDSPATHIC BANDING:

1) THESE BANDS MAY BE THE RESULT OF IGNEOUS INTRUSIONS OF GRANITIC MATERIAL DURING THE FIRST DEFORMATION. THIS IS CONSIDERED TO BE LEAST LIKELY, SINCE FEEDER CHANNELS FOR THE PEGMATITES HAVE NOT BEEN RECOGNIZED (SUCH INTRUSIONS WOULD NOT BE AS UNIVERSAL AND PERVASIVE AS THEY ARE). ALSO, THE SOURCE WOULD LIKELY HAVE BEEN FROM THE SAME MAGMA CHAMBER AS THE ORIGINAL PLUTON AND ONE WOULD EXPECT A HIGHER QUARTZ CONTENT THAN WAS FOUND IN THE PEGMATITE.

2) THE BANDS MAY BE THE RESULT OF LOCAL ANATEXIS OF THE ORIGINAL GRANITE. THIS WOULD EXPLAIN THE PERVASIVE CHARACTER OF THESE BANDS.

THUS DURING THE FIRST DEFORMATION, THE PRECAMBRIAN ROCKS PROBABLY SUFFERED THE CONDITIONS OF THE SILLIMANITE - ALMANDINE - ORTHOCLASE SUBFACIES OF THE ALMANDINE - AMPHIBOLITE FACIES OF REGIONAL METAMORPHISM. LOCALLY, WHERE THE BREAKDOWN OF MUSCOVITE

TO POTASSIUM FELDSPAR RELEASED ADDITIONAL WATER INTO THE SYSTEM AND WHERE THE ANORTHITE CONTENT WAS LOW, THE GRANITE BEGAN TO MELT. ACCORDING TO WINKLER (1965) THE TEMPERATURE-PRESSURE (H2O) RANGE FOR ANATEXIS IS 700 DEGREES C. AT 2000 BARS TO 670 DEGREES C. AT 4000 BARS. THIS PRESSURE RANGE CORRESPONDS TO ABOUT 4.7 TO 9 MILES OF BURIAL DEPTH. INTERPOLATING ON THIS P-T RANGE FOR A TEMPERATURE OF 695 DEGREES C., SUGGESTS THAT THE DEPTH OF BURIAL WAS ABOUT 5.4 MILES, DURING THE FIRST DEFORMATION.

THE METAMORPHISM, DURING THE LAST PHASE OF DEFORMATION, PROBABLY OUTLASTED THE TECTONIC EVENTS, SINCE NO EVIDENCE OF CATACLASTIC TEXTURES WAS OBSERVED.

WHEN THE CONDITIONS OF THE SILLIMANITE - ALMANDINE - ORTHOCLASE SUBFACIES OF THE ALMANDINE - AMPHIBOLOTE FACIES WERE REACHED THE FOLLOWING REACTION PROBABLY OCCURRED:

MUSCOVITE + BIOTITE + 3 SIO2<=>ALMANDINE + 2 K-FELDSPAR + 2 H2O.

THIS REACTION WOULD EXPLAIN THE ABSENCE OF KYANITE AND SILLIMANITE IN THE GRANITIC GNEISS.

THE CONVERSION OF ORTHOCLASE TO MICROCLINE IN THE GRANITIC GNEISS MUST HAVE TAKEN PLACE DURING THE WANING STAGES OF THE REGIONAL METAMORPHISM.

THE SNOWBALL GARNETS INDICATE THAT THIS MINERAL GREW DURING THE METAMORPHISM. THUS THE CONDITIONS OF METAMORPHISM WERE AT LEAST AS HIGH AS THE QUARTZ - ALBITE - EPIDOTE - ALMANDINE SUBFACIES OF THE GREENSCHIST FACIES.

THE LARGE AMOUNT OF TITANIUM IN THE BIOTITE (PAGE 22) AND

HE GROWTH OF MICROCLINE AT THE EXPENSE OF MUSCOVITE (PAGE 19) LSO INDICATE A HIGH GRADE OF METAMORPHISM.

FROM THE ABOVE EVIDENCE IT MAY BE CONCLUDED THAT DURING THE AST STAGE OF METAMORPHISM THE CONDITIONS OF THE SILLIMANITE - LMANDINE - ORTHOCLASE SUBFACIES WERE ALSO PREVALENT.

PENNSYLVANIAN ROCKS

INTRODUCTION

THE ROWE-MORA BASIN, OF WHICH THE AREA FORMS A PART IS LOCATED BETWEEN THE UNCOMPAGRE UPLIFT ON THE WEST AND THE SIERRA GRANDE UPLIFT TO THE EAST AND SOUTHEAST.

READ AND WOOD (1947) HAVE EXAMINED THE PENNSYLVANIAN SEDIMENTS OF NORTH CENTRAL NEW MEXICO. THEY CONCLUDED THAT THE SEDIMENTATION WAS OF MARINE AND CONTINENTAL NATURE AND THAT SEDIMENT ACCUMULATION IN THE BASINS EXCEEDED THEIR SUBSIDENCE. FURTHERMORE, THEIR EVIDENCE SHOWS THAT CLASTIC SEDIMENTS ARE MORE ABUNDANT IN THE NORTHERN PART OF THE ROWE-MORA BASIN.

THE CORRELATION WITHIN THE PENNSYLVANIAN OF NORTHERN NEW MEXICO IS , AGAIN ACCORDING TO READ AND WOOD, COMPLICATED BY THE MIXING OF CLASTIC SEDIMENTS FROM SEVERAL SOURCES. KOTTLOWSKI (1962) RETAINS THE CLASSICAL DIVISION OF THE MAGDELENA GROUP INTO A BASAL CLASTIC DEPOSIT CALLED THE SANDIA FORMATION AND AN UPPER PART, THE MADERA LIMESTONE.

IN HIS SUMMARY OF PENNSYLVANIAN ROCKS OF THE SANGRE DE CRISTO MOUNTAINS, KOTTLOWSKI(1962) FINDS 2240 FEET OF PENNSYLVANIAN SEDIMENTS IN THE PECOS RIVER AREA. THERE THE GRAY TO BROWN SANDSTONES, SHALES WITH THIN LIMESTONE BEDS AND LOCAL CONGLOMERATES OF THE SANDIA FORMATION TOTAL 375 FEET. THE SANDIA FORMATION IS OVERLAIN BY THE LOWER GRAY LIMESTONE MEMBER OF THE MADERA LIMESTONE WHICH IS COMPOSED OF DARK GRAY CHERTY LIMESTONE WITH DARK GRAY SHALE IN THE UPPER PART AND PEBBLY SANDSTONE IN THE LOWER BEDS. THIS UNIT

IS 635 FEET THICK IN THE PECOS RIVER AREA. OVERLYING THIS IS 1230 FEET OF THE ARKOSIC MEMBER OF THE MADERA LIMESTONE. THIS UPPER MEMBER IS COMPOSED OF GRAY TO LIGHT GRAY ARKOSE AND ARKOSIC LIMESTONE WITH INTERBEDDED SHALES. THE ARKOSES BECOME RED TOWARD THE TOP OF THIS UNIT.

READ AND WOOD (1947) DATED THE UNITS IN THE PECOS RIVER AREA. THE LOWER PART OF THE SANDIA FORMATION IS POSSIBLY MISSISSIPPIAN OR OLDER. THEY FOUND "FUSULINELLA" FOSSILS IN THE LOWER PART OF THE LOWER GRAY LIMESTONE MEMBER, WHICH THEY EQUATED WITH THE LAMPASAS OF THE MID-CONTINENT. "FUSULLINA" FROM THE UPPER PART OF THIS MEMBER PLACES THE AGE AS DESMOINIAN. THE LOWER PART OF THE ARKOSIC MEMBER WAS DATED BY READ AND WOOD AS UPPER DESMOINIAN AND THE MIDDLE TO UPPER PARTS AS MIDDLE THROUGH UPPER PENNSYLVANIAN. THE CONTACT BETWEEN THE MADERA LIMESTONE AND OVERLYING SANGRE DE CRISTO FORMATION IS BOTH CONFORMABLE AND UNCONFORMABLE. THE MIDDLE THROUGH UPPER PARTS OF THE SANGRE DE CRISTO FORMATION WERE DATED FROM PLANT FOSSILS AS PERMIAN(?), WHICH LEAD READ AND WOOD TO THINK THAT THE LOWER SANGRE DE CRISTO MAY BE PENNSYLVANIAN IN AGE.

DISCONTINUOUS OUTCROPS OF PALEOZOIC SEDIMENTS ARE CONFINED TO THE NORTHWEST QUADRANT OF THE MORA AREA. THESE SEDIMENTS ARE ASSIGNED A PENNSYLVANIAN AGE ON THE BASIS OF SPARSE FOSSIL CONTENT, LITHOLOGIC CHARACTER AND SIMILARITY TO PENNSYLVANIAN ROCKS ELSEWHERE IN THE STATE.

THE MAXIMUM THICKNESS OF PENNSYLVANIAN SEDIMENTS IS 790

FEET, MEASURED ON THE NORTH RIM OF COMANCHE CANYON.

THE MAJOR ROCK TYPES PRESENT ARE FINE TO COARSE GRAINED SUBARKOSE, ORTHOQUARTZITE, LIMESTONE, AND SHALE. THE PROMINENT ROCK TYPE IS AN OLIVE-DRAB SUBARKOSE, WHICH WEATHERS MAROON TO BRICK-RED ON THE SURFACE.

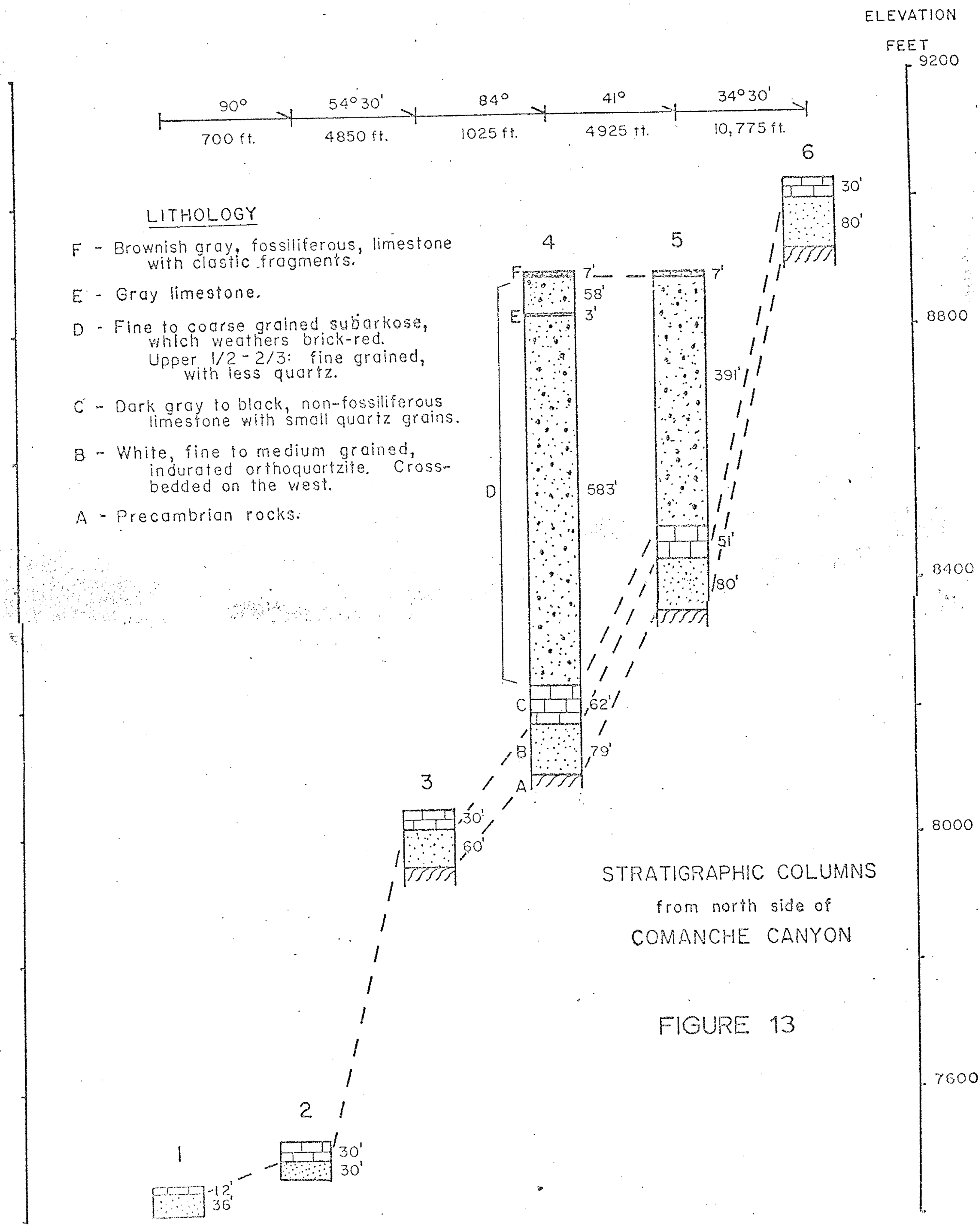
SHOWALTER (1968) HAS FOUND SEDIMENTS OF DEVONIAN(?)-MISSISSIPPIAN AGE (ARROYO PENASCO FORMATION) THROUGH ATOKAN AGE (UPPER SANDIA FORMATION) IN THE CRESTON RANGE EAST OF THE MORA VALLEY FROM THE AREA COVERED IN THIS REPORT. NO SEDIMENTS FROM THE MORA AREA COULD BE CORRELATED WITH THE SEDIMENTS DESCRIBED BY SHOWALTER FOR THE ARROYO PENASCO FORMATION. THE BRICK-RED SUBARKOSES OF THE RINCON RANGE MAY BE CORRELATED WITH THE ARKOSIC MEMBER OF THE SANDIA FORMATION, FOUND IN THE CRESTON RANGE.

THE SPARCE OUTCROPS AND THE PROFOUND FACIES CHANGES IN THE NEW MEXICO PENNSYLVANIAN MAKE CORRELATION TENUOUS. HOWEVER, THE PROBABLE CORRELATION WITHIN THE MORA AREA IS SHOWN ON THE STRATIGRAPHIC COLUMNS, FIGURES 13 AND 14. THE LOCATION OF THE COLUMNAR SECTIONS IS ALSO SHOWN ON PLATES 1 AND 2.

ORTHOQUARTZITE

THE LOWEST PENNSYLVANIAN UNIT WHICH OVERLIES THE PRECAMBRIAN ROCKS IS AN ORTHOQUARTZITE. THIS UNIT OUTCROPS ALONG THE NORTH SIDE OF COMANCHE CANYON, FIG. 13. IT IS A FINE TO MEDIUM GRAINED, WHITE, LOCALLY CROSS-BEDDED ORTHOQUARTZITE, WHICH RANGES IN THICKNESS FROM 60 TO 80 FEET.

CROSS-BEDDED OUTCROPS OF THE ORTHOQUARTZITE WERE SEEN NEAR



STRATIGRAPHIC COLUMNS
from north side of
COMANCHE CANYON

FIGURE 13

LITHOLOGY

A-Grayish white, coarse grained, subarkose. Occasionally cross-bedded.

B-Gray limestone.

C-Green-black subarkose.

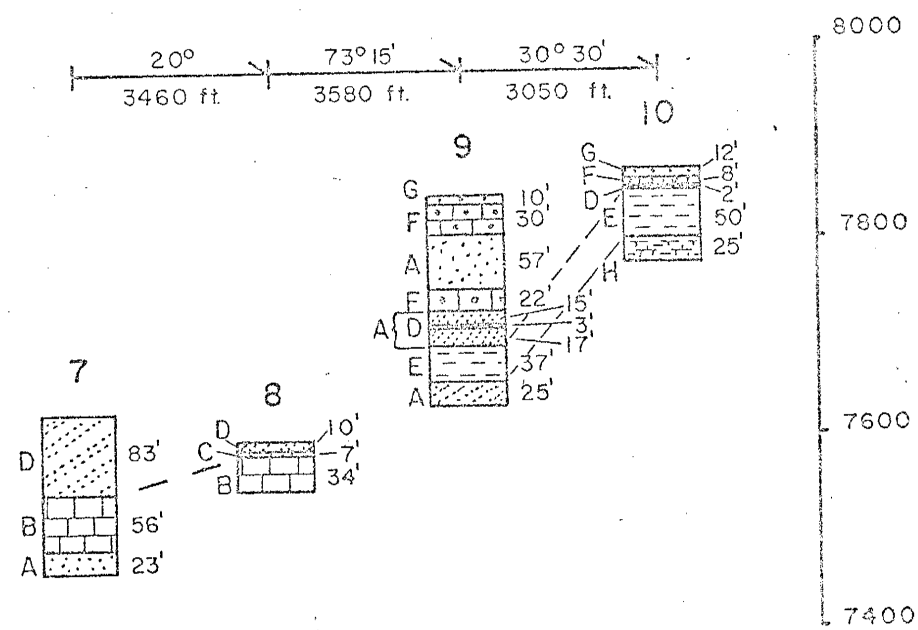
D-White, fine to medium grained, cross-bedded, indurated orthoquartzite.

E-Black, fossiliferous shale.

F-Green-gray, crinoidal limestone.

G-Fine to coarse grained subarkose, which weathers brick-red.

H-Thin, alternating beds of shale and limestone.



STRATIGRAPHIC COLUMNS
from north side of
CAÑADA DE LOS MAES

FIGURE 14

THE WESTERN END OF THE CANYON. EASTWARD INTO THE CANYON THE UNIT IS MASSIVE AND OCCASIONALLY BROKEN BY CLOSELY SPACED JOINTS. THE CONTACT BETWEEN THE ORTHOQUARTZITE AND THE UNDERLYING GRANITIC GNEISS NEAR THE MOUTH OF COMANCHE CANYON IS BURIED BENEATH THE VALLEY FILL.

LIMESTONE

MANY DIFFERENT LIMESTONE UNITS OCCUR IN THE PENNSYLVANIAN OF THE MORA AREA. THE FOUR THICKEST ONES ARE DESCRIBED BELOW.

THE LOWER UNIT IS A DARK GRAY TO BLACK FINE GRAINED LIMESTONE, WHICH CROPS OUT DIRECTLY ABOVE THE WHITE ORTHOQUARTZITE IN COMANCHE CANYON. IT HAS A THICKNESS OF 51 TO 62 FEET, FIG. 13. THIS UNIT IS NON-FOSSILIFEROUS AND CONTAINS SMALL, EQUANT QUARTZ GRAINS ABOUT 1/16 INCH LONG THROUGHOUT THE LENGTH OF THE OUTCROP.

ANOTHER LIMESTONE UNIT IS A BROWNISH GRAY, MICACEOUS, FOSSILIFEROUS LIMESTONE, WHICH MEASURED 56 FEET IN THICKNESS. THIS UNIT (COLUMN 7, FIG. 14), IS LOCATED NEAR THE WESTERN TIP OF THE RIDGE BETWEEN CANADA DE LOS MAES AND COMANCHE CANYON AT AN ELEVATION OF 7470 FEET AND ABOUNDS WITH BROKEN MOLLUSC AND SPIRIFER BRACHIOPOD TESTS. IT ALSO HAS OCCASIONAL SHALE FRAGMENTS UP TO ABOUT 1 INCH IN LENGTH WITHIN IT. THIS UNIT, BEING PARTIALLY CLASTIC IN ORIGIN, CONTAINS DETRITAL GRAINS OF QUARTZ, FELDSPAR, AND MICA RANGING TO 1 MM. IN SIZE. A SIMILAR LIMESTONE CROPS OUT ON TOP OF THE RIDGE AT AN ELEVATION OF 8880 FEET AND IS ONLY 7 FEET THICK (COLUMNS 4 AND 5, FIG. 13).

A THIRD LIMESTONE UNIT IS A DARK GRAY CRYSTALLINE, CRINOIDAL

LIMESTONE, CONTAINING FRAGMENTS OF PENNSYLVANIAN MARINE FAUNA (COLUMN 9, FIG. 14), WHICH CROPS OUT ON THE NORTH SIDE OF CANADA DE LOS MAES. THE THICKNESS OF THE DARK GRAY LIMESTONE IS AT LEAST 22 FEET THICK. THE LATERAL EXTENT COULD NOT BE DETERMINED.

THE UPPERMOST LIMESTONE UNIT IS A FINE GRAINED, GRAY LIMESTONE BRECCIA, THE BRECCIA FRAGMENTS, WHICH ARE ALSO FINE GRAINED, CONSIST OF PINK LIMESTONE AND GRAY QUARTZITE. THE BRECCIA FRAGMENTS RANGE IN SIZE FROM 1/16 TO 3 INCHES ACROSS. SMALL QUARTZ GRAINS ARE COMMON WITHIN THE GRAY MATRIX. THE LIMESTONE BRECCIA WHICH OCCURS ON THE SOUTH SIDE OF CANADA DE LOS MAES AND WEATHERS TO A RED COLOR. THIS UNIT HAS A THICKNESS OF ABOUT 20 FEET OVERLYING A COARSE GRAINED WHITE TO PALE ORANGE SUBARKOSE AND UNDERLIES A MEDIUM GRAINED OLIVE-DRAB SUBARKOSE.

SHALE

A BLACK, FINE GRAINED SHALE PROVIDES A MARKER BED ALONG PART OF THE NORTH SIDE OF CANADA DE LOS MAES, WHERE THIS BED RANGES BETWEEN 37 AND 50 FEET IN THICKNESS (COLUMNS 9 AND 10, FIG. 14).

BLACK SHALE CROPS OUT SPORADICALLY ELSEWHERE IN THE SEDIMENTARY AREA BUT CORRELATION AMONGST THESE SHALES COULD NOT BE MADE. THE SHALES ARE USUALLY FOSSILIFEROUS AND LOCALLY CONTAIN BANDS OF DISCONTINUOUS LIMONITE UP TO 1/5 INCH THICK AND UP TO 2 FEET LONG.

SUBARKOSE

SANDSTONES OF HIGH QUARTZ CONTENT CONTAIN GRAINS OF LOW SPHERICITY SUGGEST A SHORT DISTANCE OF TRANSPORT FROM A QUARTZ-RICH SOURCE SUCH AS MIGHT BE PROVIDED BY THE PRECAMBRIAN GRANITIC GNEISS.

A FINE TO COARSE GRAINED SUBARKOSE, CONTAINING APPROXIMATELY 60-75% QUARTZ, IS FOUND THROUGHOUT THE AREA. THE MATRIX IS COMPOSED OF ALTERED FELDSPAR AND IRON OXIDES. THE LATTER COMPONENT PRODUCES A MAROON TO BRICK-RED COLOR ON THE EXPOSED SURFACES, BUT SPECIMENS ARE OLIVE-DRAB ON A FRESH SURFACE. STRATIGRAPHICALLY HIGHER THE SUBARKOSE BECOMES FINE GRAINED AND HAS AN INCREASED AMOUNT OF MICA FLAKES AND REDUCED QUARTZ CONTENT. THE GRAIN SIZE IN THE UPPER PART OF THIS UNIT SELDOM EXCEEDS 0.4 MM. THIS SEQUENCE IS THE MOST ABUNDANT OF THE PENNSYLVANIAN SEDIMENTS AND TOTALS NEARLY 583 FEET IN COMANCHE CANYON. THE LOWER ONE THIRD TO ONE HALF OF THIS UNIT IS A SERIES OF ALTERNATING LAYERS OF MEDIUM AND COARSE GRAINED SUBARKOSES, WHICH GRADE RAPIDLY FROM ONE INTO THE OTHER.

ON THE NORTH SIDE OF CANADA DE LOS MAES A GRAYISH WHITE, COARSE GRAINED SUBARKOSE (COLUMN 9, FIG. 14), CONTAINS AN ABUNDANCE OF QUARTZ. THIS FACIES IS CROSS-BEDDED, FIG. 15, AND CONTAINS LESS IRON AND MORE FELDSPAR THAN THE LOWER SUBARKOSES OF COMANCHE CANYON.

PALEONTOLOGY

THE LIMITED FOSSIL COLLECTIONS MADE FROM LIMESTONE AND SHALE UNITS IN THE AREA WERE EXAMINED BY DR. R. FLOWER OF THE NEW MEXICO

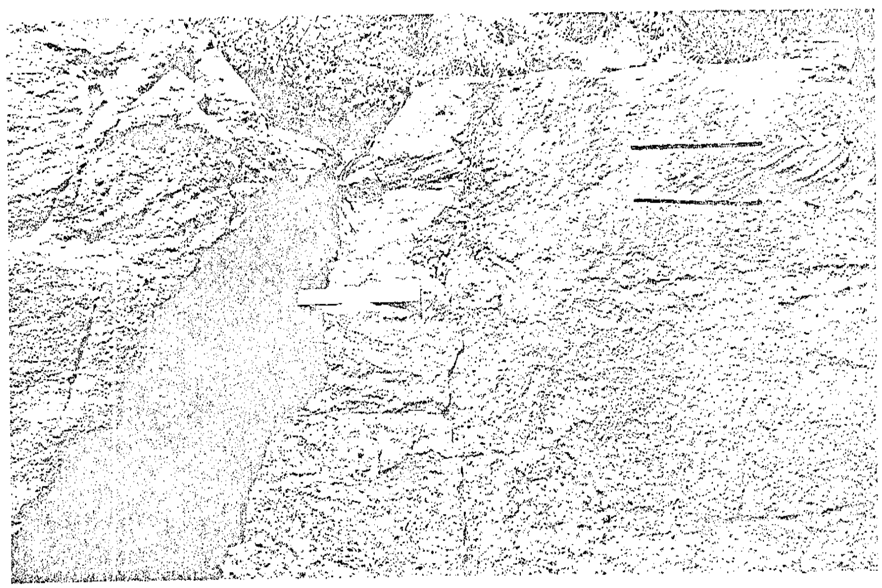


Figure 15

Cross-bedded coarse grained subarkose from Canada de Los Maes. Six inch rule for scale. Current direction is toward the west.

BUREAU OF MINES AND MINERAL RESOURCES. THE FOSSIL PRESERVATION PRECLUDES THE DETERMINATION OF SPECIES BUT COLLECTIONS WERE DATED AS PENNSYLVANIAN IN AGE.

A SINGLE UNIDENTIFIABLE PLANT FOSSIL WAS FOUND IN THE FINE GRAINED SUBARKOSE NEAR THE MOUTH OF CANADA DE LOS MAES.

QUATERNARY DEPOSITS

LOS CHUPADEROS, AN INTERMITTENT STREAM, FLOWS SOUTH THROUGH THE MORA VALLEY, FIGURE 16. THE MORA RIVER TURNS FROM ITS SOUTHWARD COURSE WEST OF MORA TO FLOW SOUTHEAST AND JOIN LOS CHUPADEROS EAST OF MORA. LOS CHUPADEROS HAS DEPOSITED A WIDE BLANKET OF SEDIMENTS, DERIVED FROM THE ADJOINING PRECAMBRIAN UPLANDS, ACROSS THE VALLEY FLOOR.

MOST OF THE CANYONS IN THE PRECAMBRIAN TERRAIN ARE FLOORED WITH DETRITAL GRAINS OF QUARTZ, FELDSPAR, AND MICA DERIVED FROM THE GRANITIC GNEISS.

THE THICKNESS OF THE SEDIMENTS ABOVE A CUT CHANNEL IN THE VALLEY, NORTHEAST OF MORA, IS 25 FEET. A DOMESTIC WELL DRILLED NEAR NEW MEXICO HIGHWAY 38 AT THE ENTRANCE TO LA TIERRA AMARILLA CANYON WENT 40 FEET WHEN IT APPEARED TO BE IN BEDROCK. THE DEPTH OF FILL IN THE VALLEY WAS ESTIMATED BY CONSTRUCTING A LINE FROM THE BASE OF THE BEDROCK HILLS THROUGH THE BOTTOM OF THIS WELL AND INTO THE VALLEY. THE RESULT SUGGESTS THAT THE ALLUVIAL FILL COULD BE AT LEAST 150 FEET THICK BELOW THE CENTER OF THE VALLEY.

ON THE SOUTHWEST SIDE OF LA TIERRA AMARILLA CANYON THE SLOPE IS COVERED 25 FEET ACROSS. THE MUSCOVITE SCHIST OUTCROPS AT THE 8330 FOOT PEAK ABOVE THE ROCKSLIDE. THUS THESE ROCKS MUST HAVE ROLLED A CONSIDERABLE DISTANCE TO THE CANYON FLOOR. JUDGING FROM THE SIZE OF THE SECONDARY GROWTH OF TREES IN THE SLIDE PATH, THE SLIDE PROBABLY OCURRRED WITHIN THE LAST 50 TO 75 YEARS.

Figure 16 Panoramas of Mora Valley and Creston Range beyond. Arrow indicates identical positon in Creston Range.
Upper picture from head of La Tierra Amarilla Canyon.
Lower picture taken from west ridge of La Tierra Amarilla Canyon.

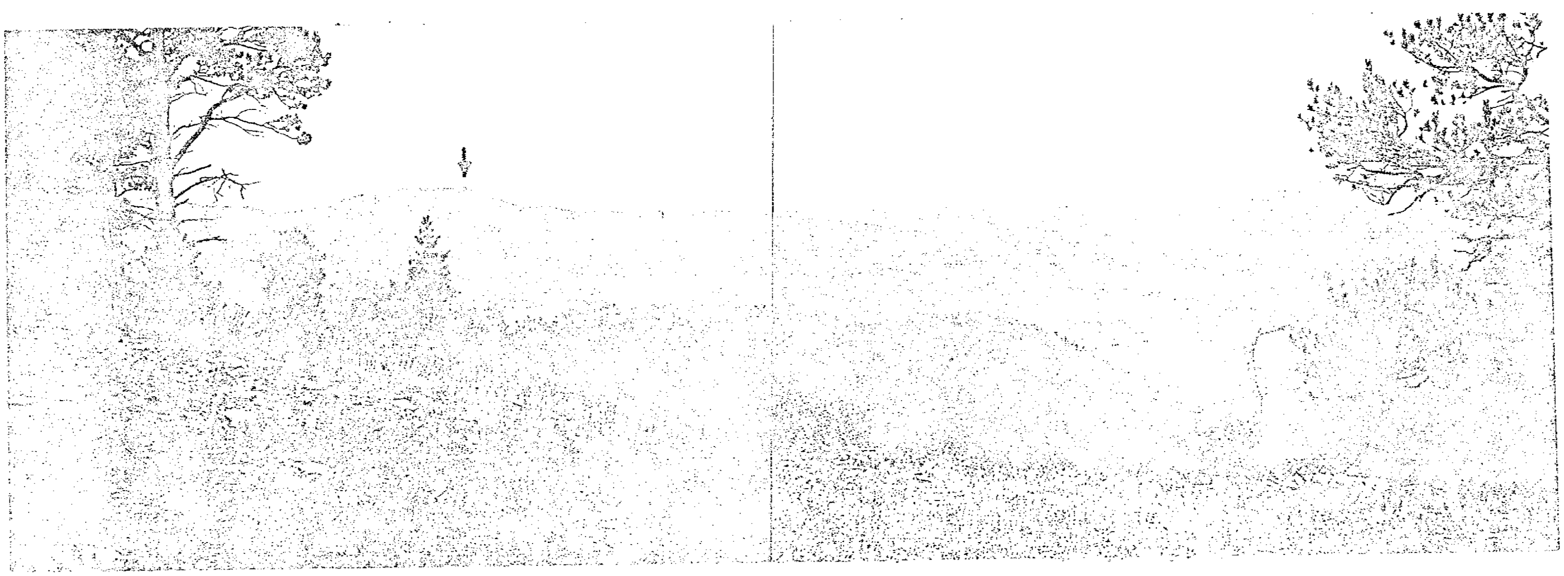


FIGURE 16

STRUCTURAL GEOLOGY

INTRODUCTION

FOR THE PURPOSE OF STRUCTURAL ANALYSIS THE AREA WAS INITIALLY PARTITIONED INTO 11 STRUCTURALLY HOMOGENEOUS DOMAINS, FIG. 3. THE LINEATION AND FOLIATION FIELD DATA FROM EACH OF THESE DOMAINS WERE THEN PLOTTED ON SCHMIDT EQUAL AREA PROJECTIONS, FIGURES 3 AND 17, USING THE PROGRAM "SMTPLT" (SEE APPENDIX. NOTE: ALL SCHMIDT EQUAL AREA PROJECTIONS IN THIS REPORT ARE PLOTTED ON THE LOWER HEMISPHERE). THE DATA FROM THESE DOMAINS WERE RECOMBINED INTO THREE LARGE HOMOGENEOUS DOMAINS, NAMED "A", "B", AND "C", FIGURES 18 THROUGH 23. THE FIRST PHASE OF THE RECOMBINING PROCEDURE WAS DONE BY VISUAL INSPECTION OF MAPS OF LINEAR AND OF PLANAR ATTITUDES PRODUCED (AT A SCALE OF 1:24,000) BY THE PROGRAMS "LINMAP" AND "MAPLAN", RESPECTIVELY.

THE FOLIATION MAP (PLATE 1) AND LINEATION MAP (PLATE 2) WERE MADE ON THE CALCOMP PLOTTER, WHICH USED INDIA INK FILLED PENS. THE RESPECTIVE ATTITUDES WERE PLACED ON TRANSPARENT PAPER, DURING EXECUTION OF THE PROGRAMS. THE TRANSPARENT PAPER WITH THE STRUCTURAL DATA WAS PLACED OVER A PLASTIC BASE MAP AND PRINTS WERE MADE ON AN OFFICE BLUEPRINT MACHINE. THE SECOND PART OF THE COMBINING PROCEDURE WAS ALSO VISUALLY DONE. THIS WAS ACCOMPLISHED BY COMPARING THE LINEATION AND FOLIATION SCHMIDT PROJECTIONS IN ORDER TO FIND STRUCTURAL SIMILARITIES AMONG THE DOMAINS.

THE MACROSCOPIC FOLD AXES WERE LOCATED BY CONSTRUCTING STRUCTURAL CROSS-SECTIONS, FIGURES 24 AND 25, TO FIND THE TRACE OF THE AXIAL

Figure 17

Generalized Schmidt equal area projections of the foliation in the original eleven structural domains. See generalized projection description figure 3.

Foliation Diagrams from Original
Structural Domains

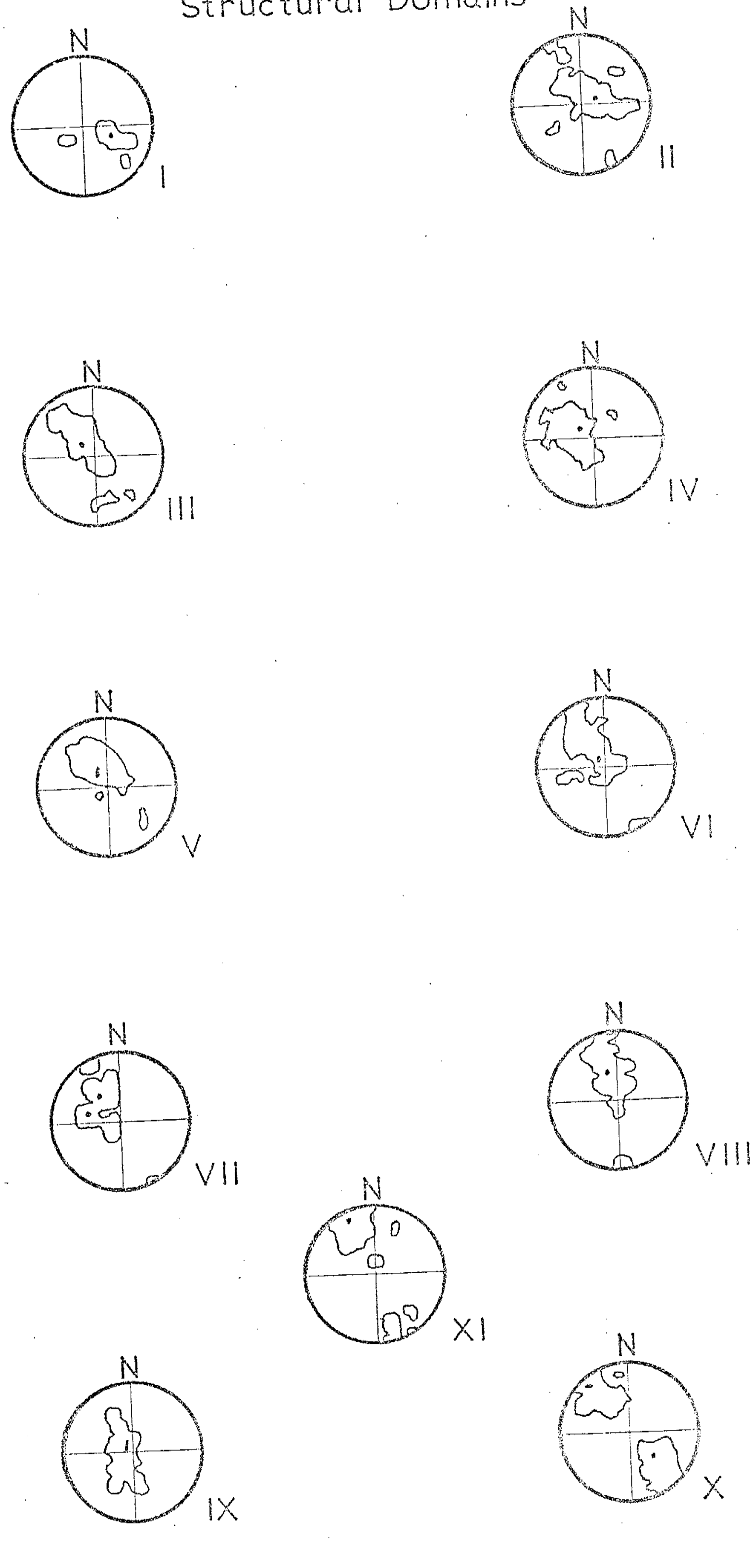


FIGURE 17

Figures 18-23

Major structural domains of Mora area. The number of observations (points) and contoured values, are indicated in each figure.

N = north, S = south, E = east and W = west.

Density shading is indicated in decreasing order from the maximum as follows:

<u>Poles within</u>:

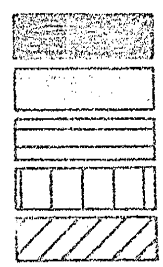
Maximum density contour value =

Next smaller density contour value =

Next smaller density contour value =

Next smaller density contour value =

1 % density contour value =



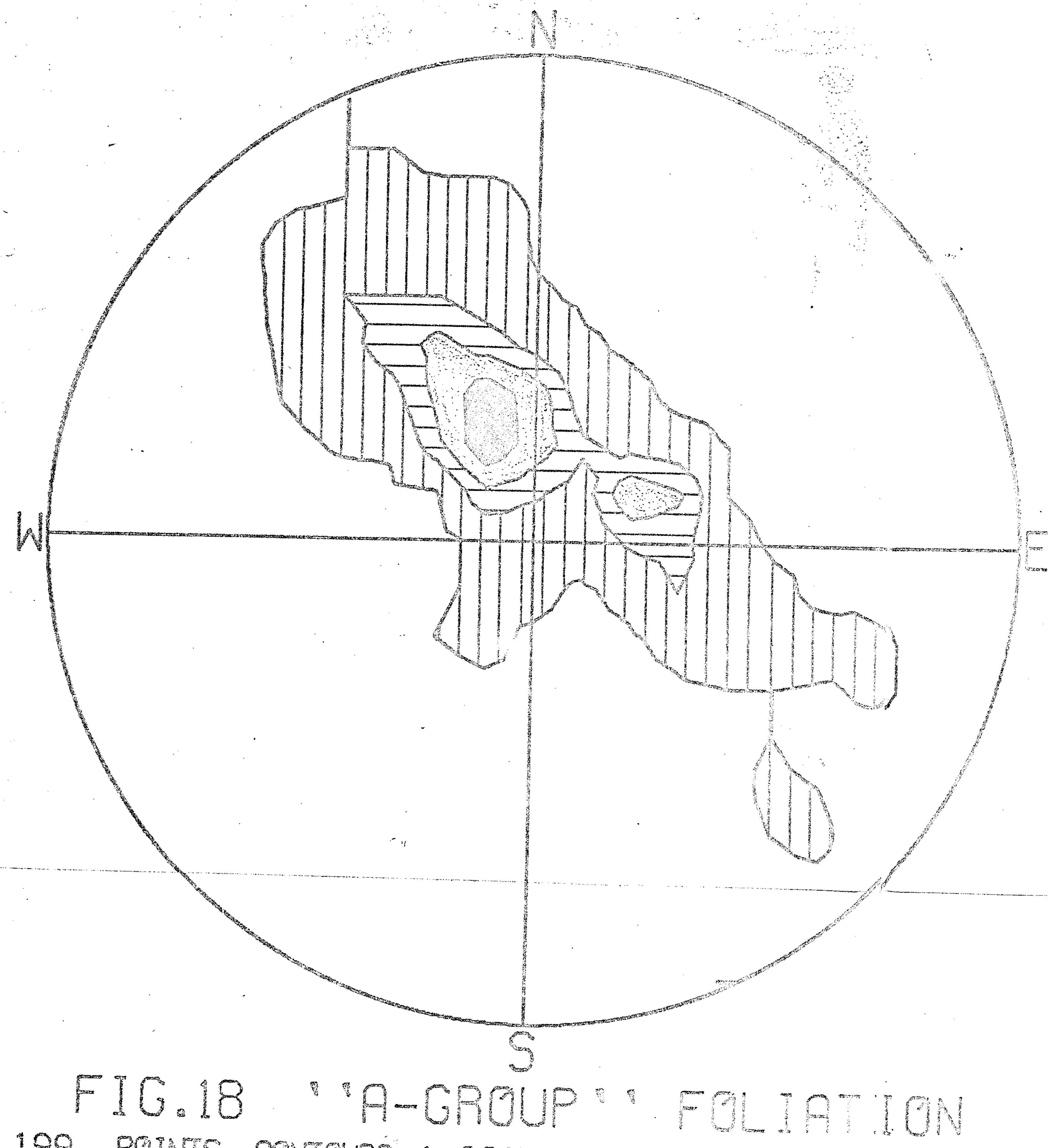


FIG.18 ''A-GRØUP'' FØLIATIØN
199 PØINTS, CØNTØURS: 1.00% 5.00% 8.00% 12.00%

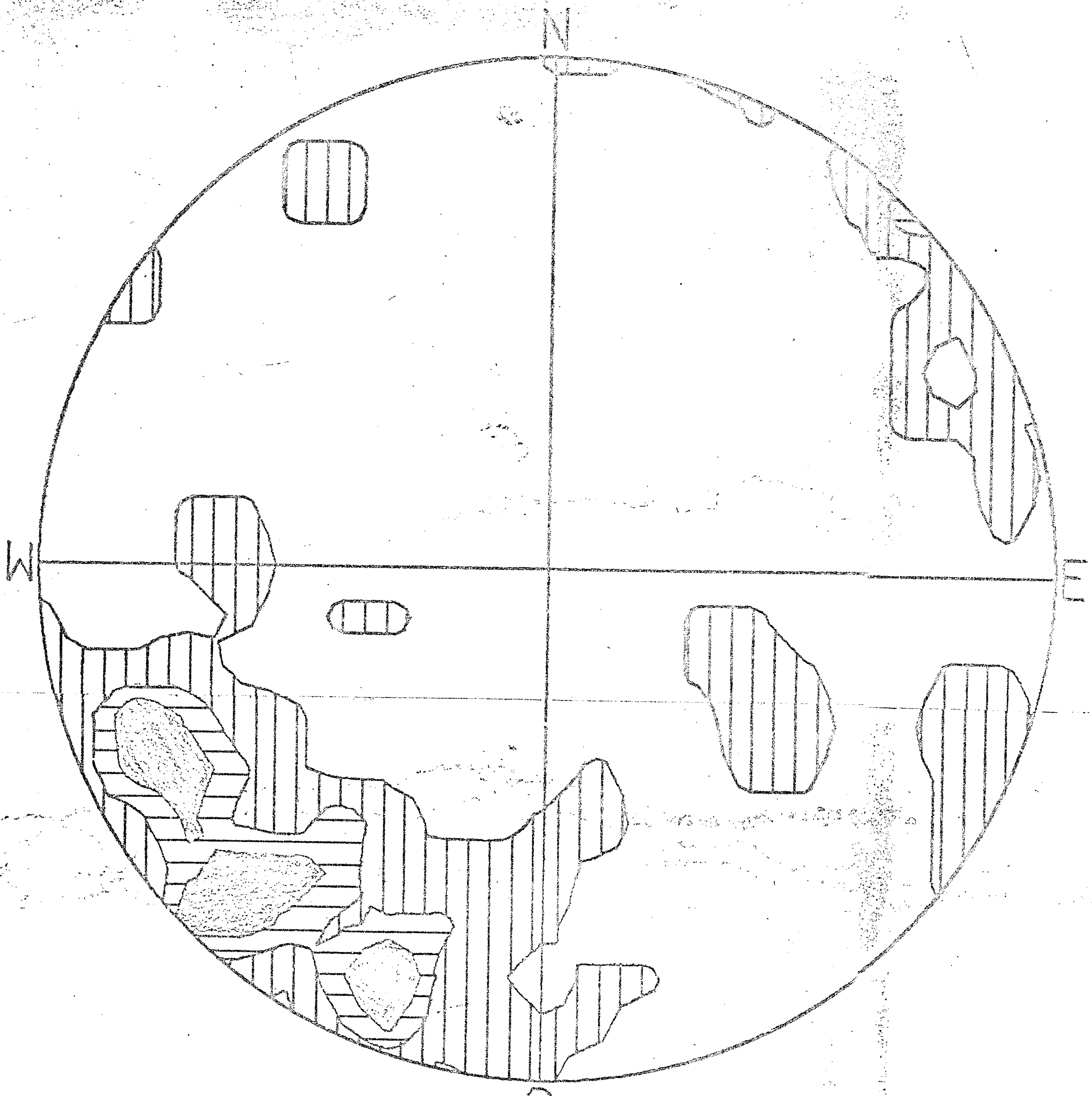


FIG.19 ''A-GROUP'' FØLD AXES

69 PØINTS, CONTOURS: 1.00% 5.00% 8.00% 12.00%

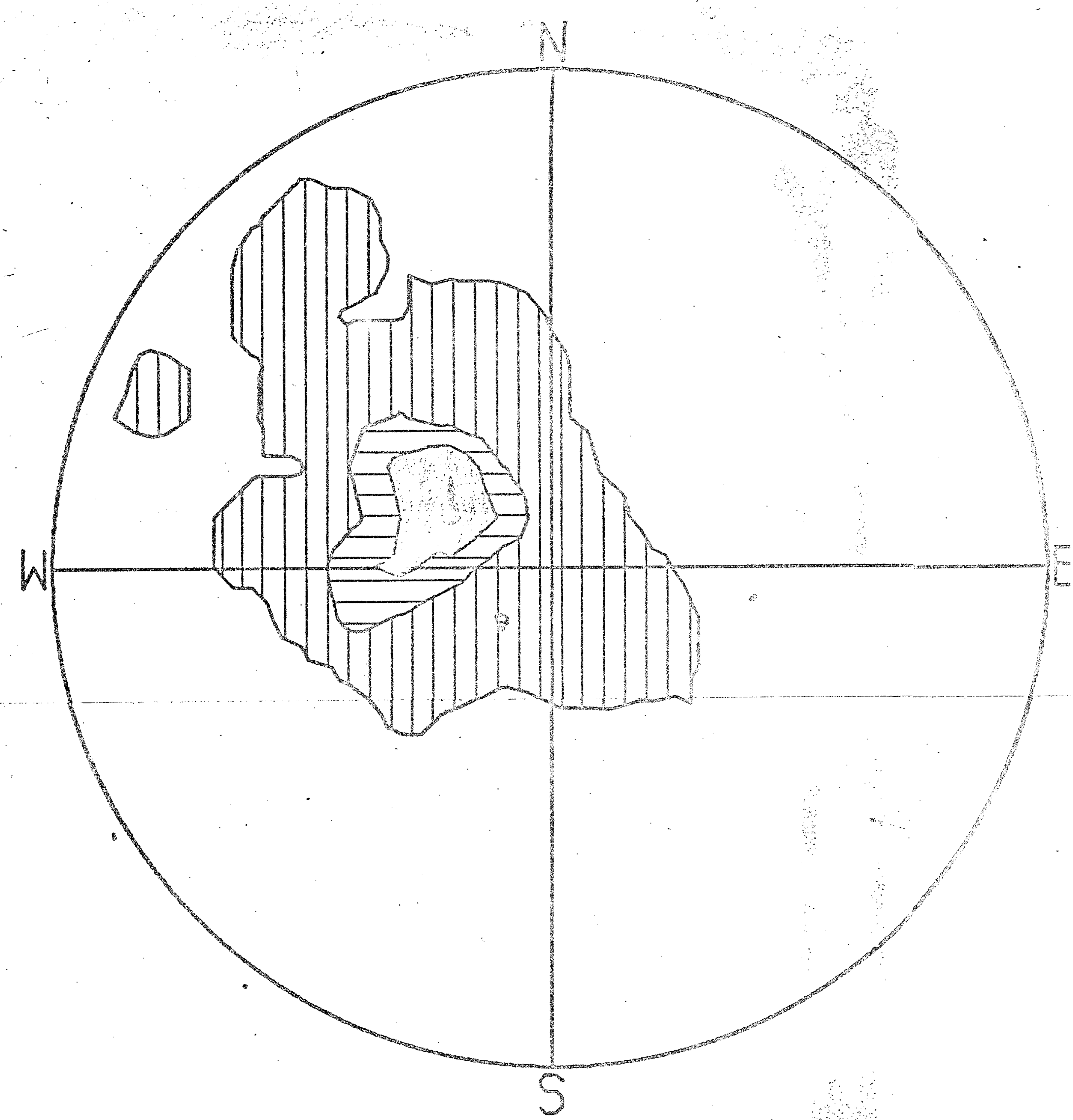


FIG. 20 ''B-GROUP'' FOLIATION
124 POINTS, CONTOURS: 1.00% 7.00% 12.00% 18.00%

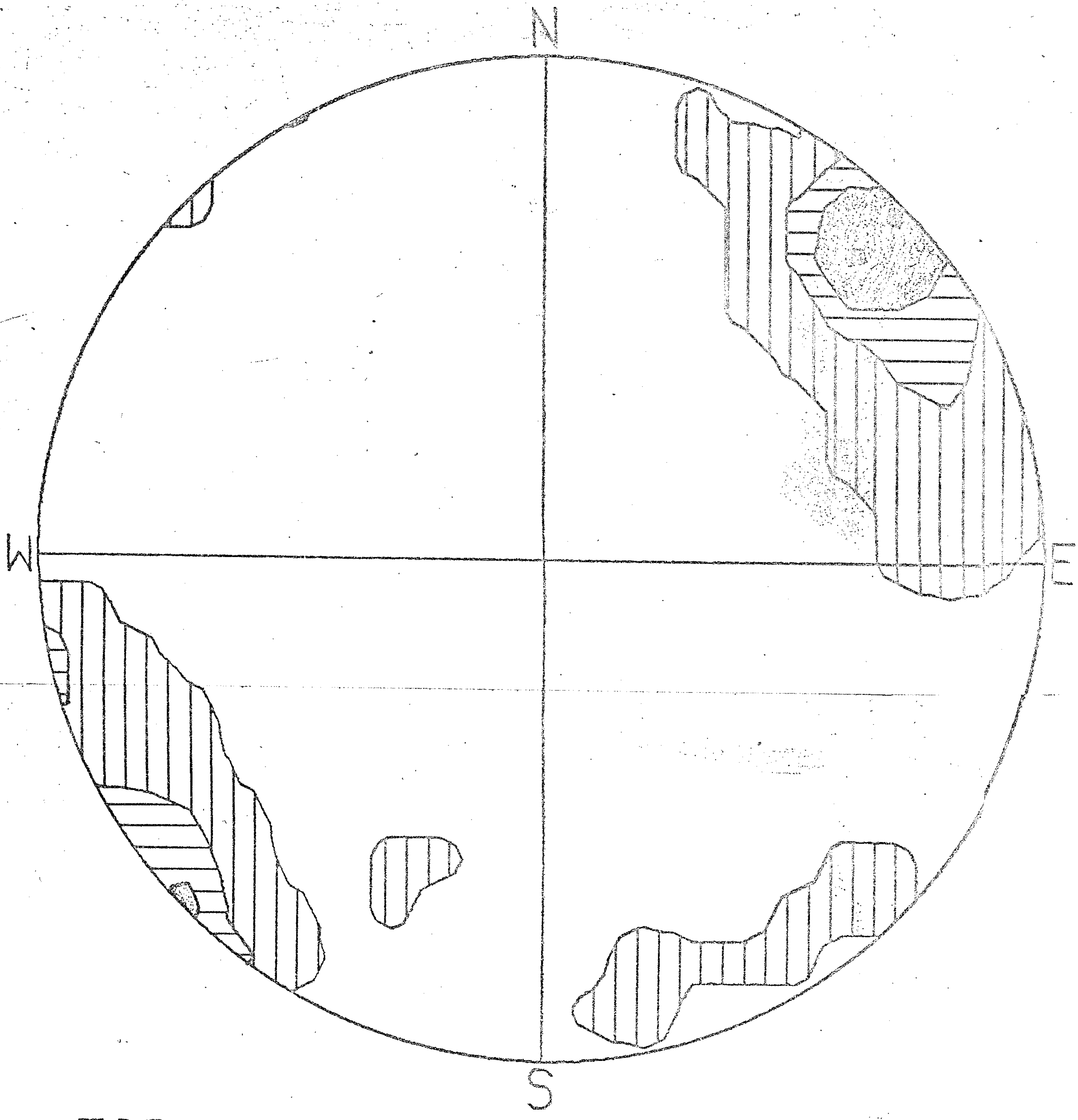


FIG. 21 ''B-GROUP'' FOLD AXES
59 POINTS, CONTOURS: 1.00% 7.00% 12.00% 18.00%

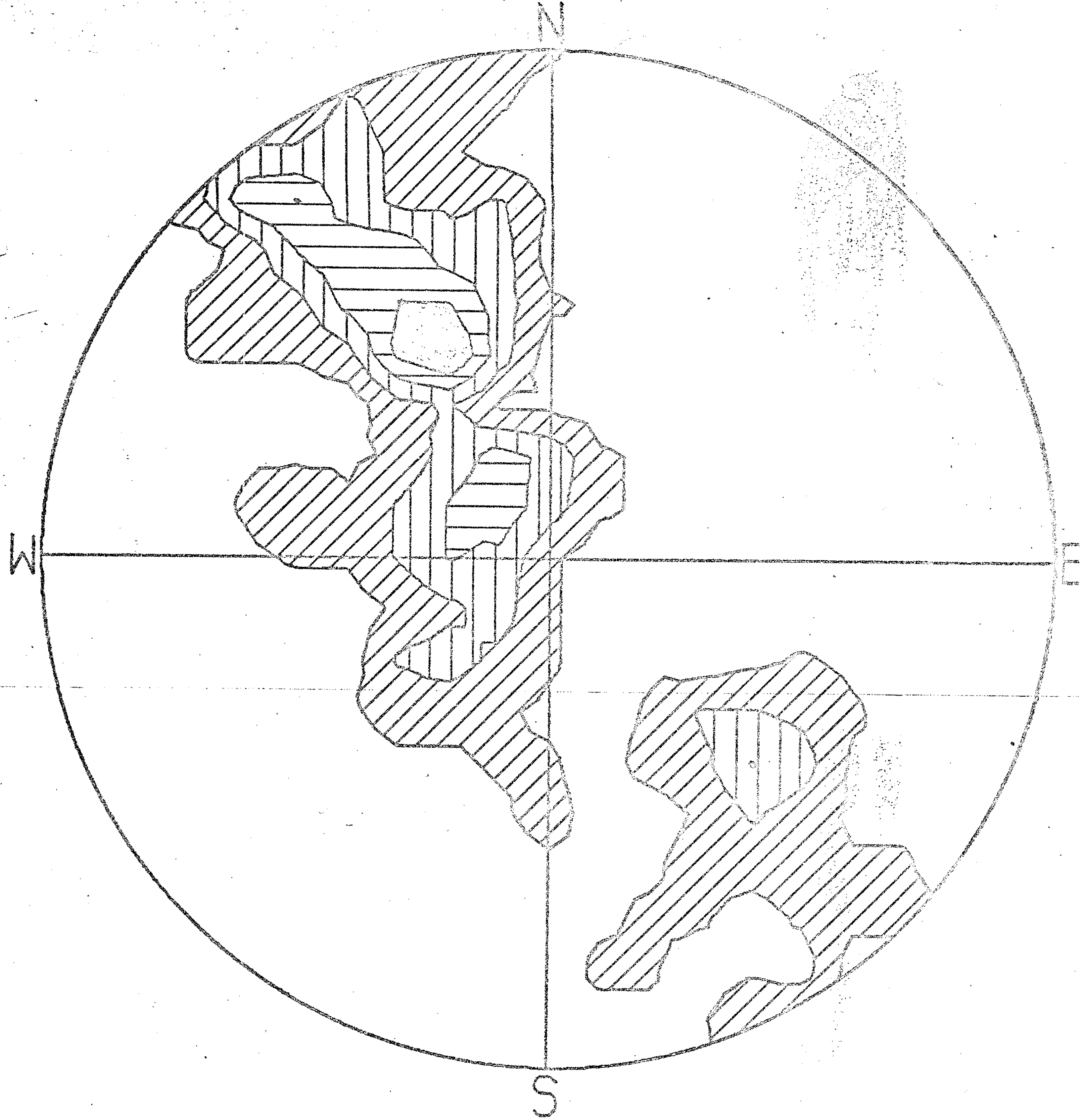


FIG. 22 ''C-GROUP'' FOLIATION
156 POINTS, CONTOURS: 1.00% 3.00% 5.00% 7.00% 9.00%

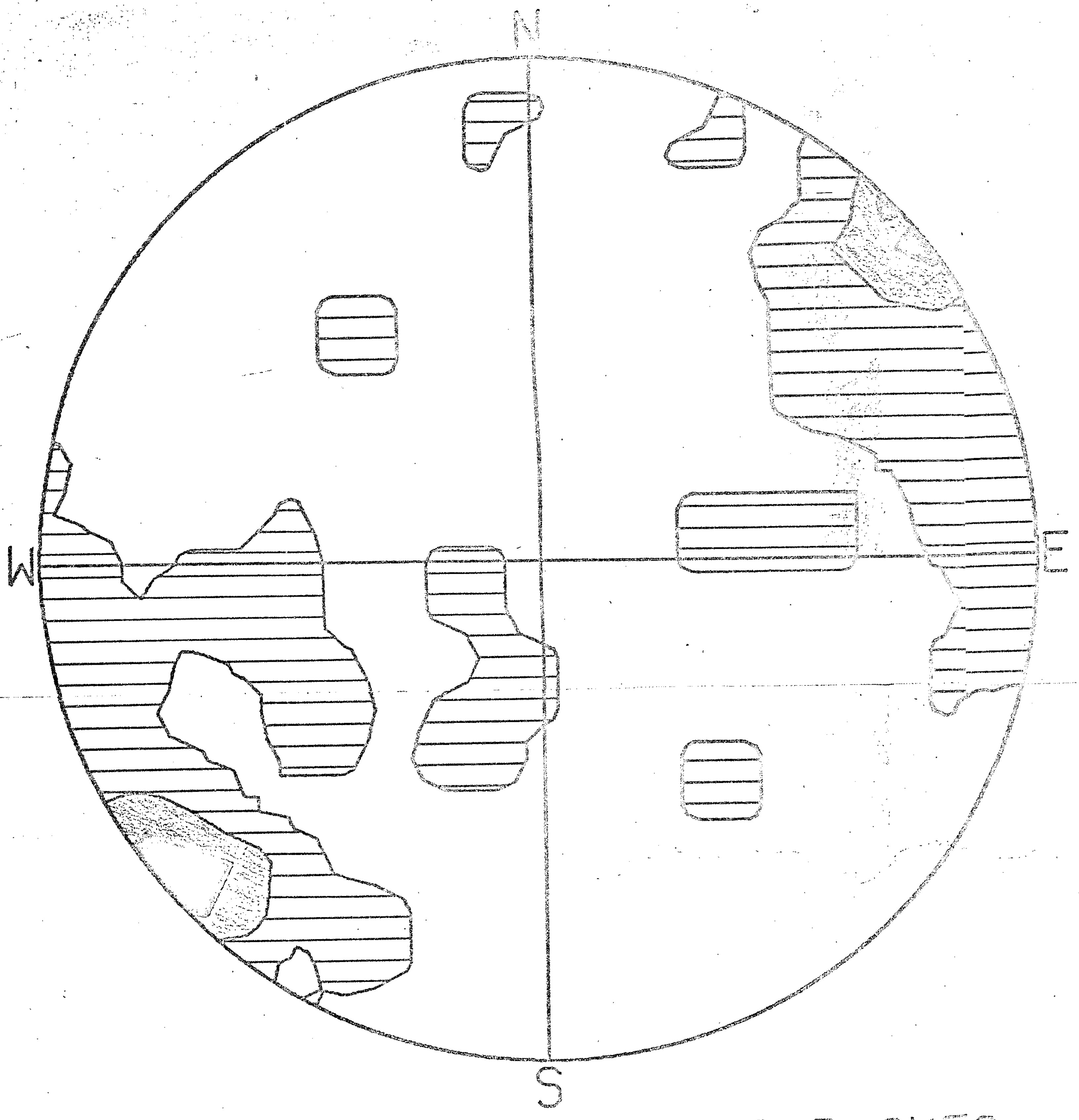
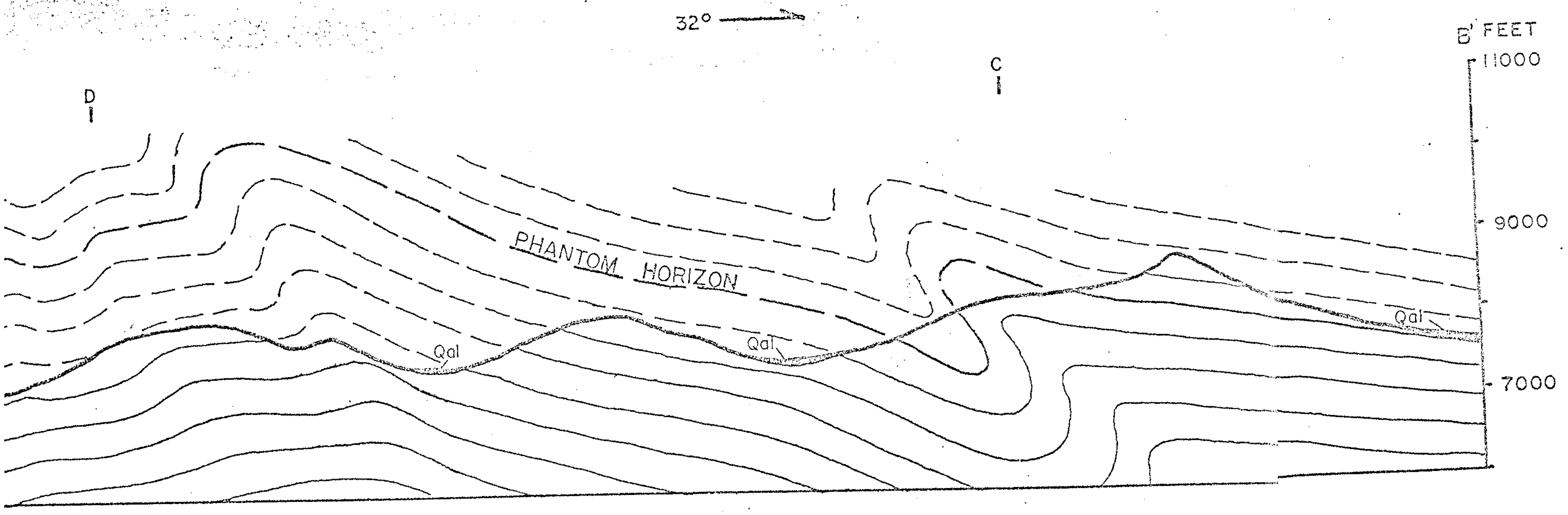


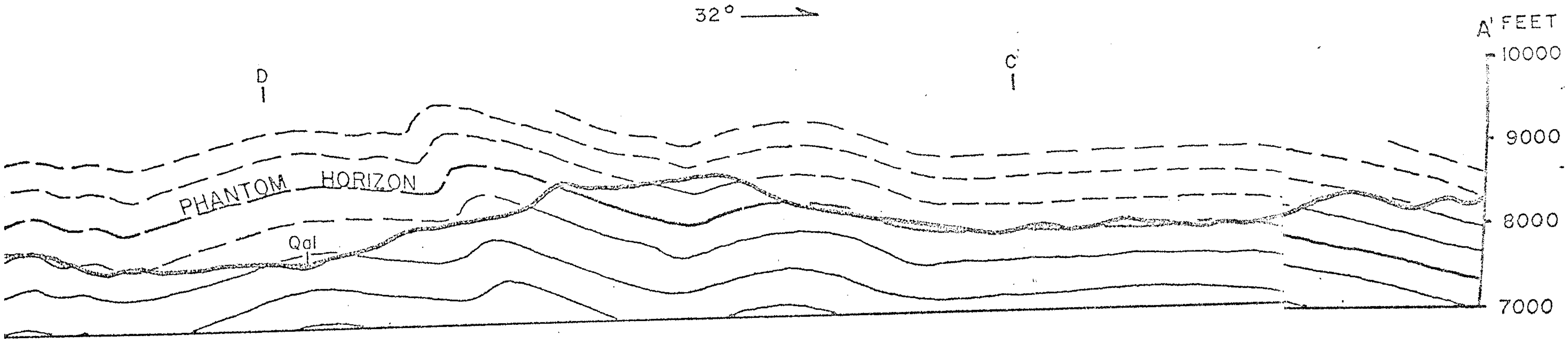
FIG.23 ''C-GROUP'' FOLD AXES

71 POINTS, CONTOURS: 1.00% 7.00% 12.00%

Figures 24 and 25 Cross-sections through the Precambrian rocks. Phantom horizon is the horizon represented in the structural contour map, figure 26. Intersections with other cross-sections indicated with letter of intersecting section above short vertical line. Qal = Quaternary alluvium. Closely spaced parallel lines indicate Paleozoic sediments.

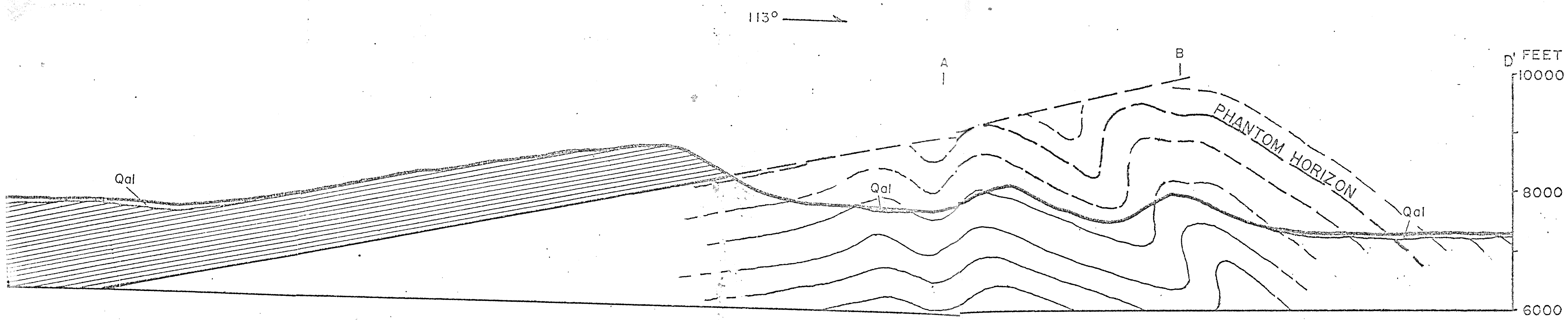


SECTION B

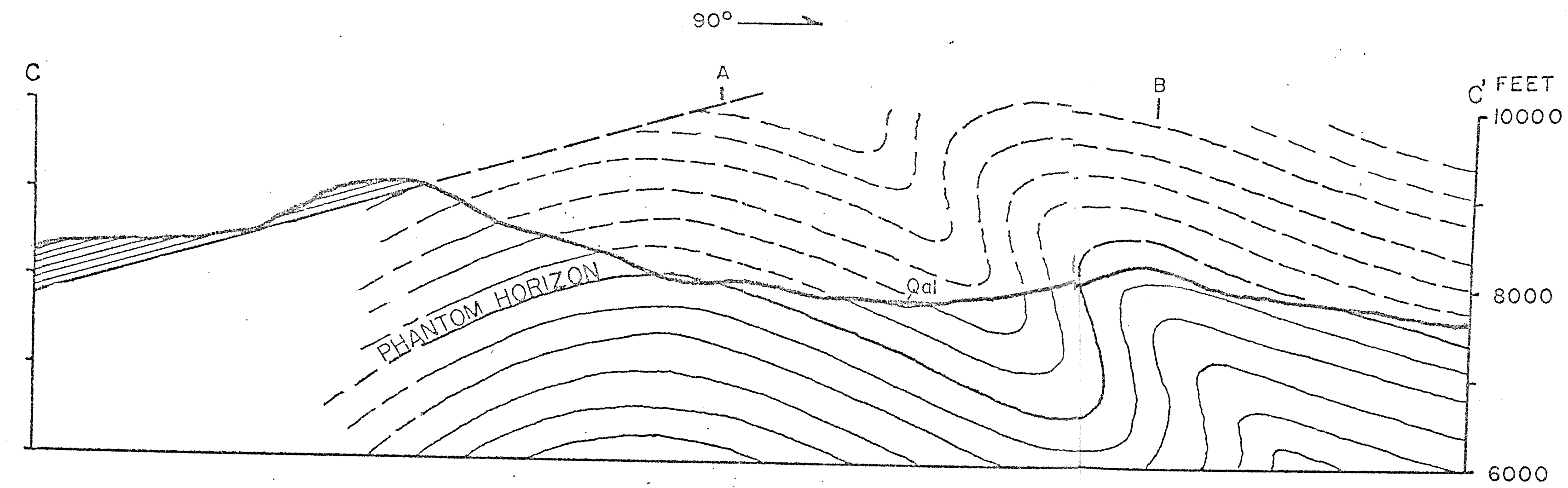


SECTION A

FIGURE 24



SECTION D



SECTION C

FIGURE 25

PLANES. FROM THE SECTIONS AND THE STRUCTURAL CONTOUR MAP, FIG. 26, THE STRUCTURE OF THE AREA, INCLUDING THE TRACE OF THE AXIAL PLANES ON THE TOPOGRAPHY WAS DETERMINED. THE RESULT OF MAPPING THE TRACE OF THE AXIAL PLANES WAS THEN COMPARED WITH THE STATISTICAL TRENDS OF THE LINEATIONS WITHIN THE ORIGINAL 11 STRUCTURAL DOMAINS. NO ADJUSTMENTS IN THE BEARING OF THE MACROSCOPIC AXES PREPARED FROM CROSS-SECTIONS WERE NECESSARY, PLATES 1 AND 2 AND FIG. 3.

TWO PROMINENT DIRECTIONS FOR THE MESOSCOPIC FOLD AXES WERE FOUND USING THE SCHMIDT EQUAL AREA PROJECTIONS, WHICH INDICATE THE TWO TECTONIC EVENTS. THESE ARE BORNE OUT BY THE TRICLINIC PATTERN OF THE SYNOPTIC FOLIATION IN FIG. 27, AND BY THE STRUCTURE CONTOURS OF THE STRUCTURE CONTOUR MAP, FIG. 26. THE EARLIER FOLD AXES, L1, TREND NNE AS SHOWN. AS A RESULT OF A LATER DEFORMATION WITH ITS ENE FOLD AXES, L2, THE PATTERN OF THE L1 AXIS BECAME SINUOUS.

THE TREND OF THE LATER, L2, AXES GENERALLY PARALLELS THE TREND OF AXES OBSERVED BY MONTGOMERY (1963) IN THE PICURIS RANGE OF THE SANGRE DE CRISTO MOUNTAINS AND BINGLER'S THIRD GENERATION FOLDING IN LA MADERA QUADRANGLE.

THE FOLD AXES DESCRIBED BY STARK (1956) FROM THE SOUTH MANZANO MOUNTAINS IS 30 DEGREES EAST OF NORTH. STARK DOES NOT DESCRIBE ANY OTHER FOLDING BUT STATES THAT THERE IS EVIDENCE OF SEVERAL PERIODS OF DEFORMATION.

REICHE (1949), IN THE NORTH MANZANO MOUNTAINS, ALSO FOUND OLDER NE-SW FOLD AXES. IN THE LAST DEFORMATION, HOWEVER, HE

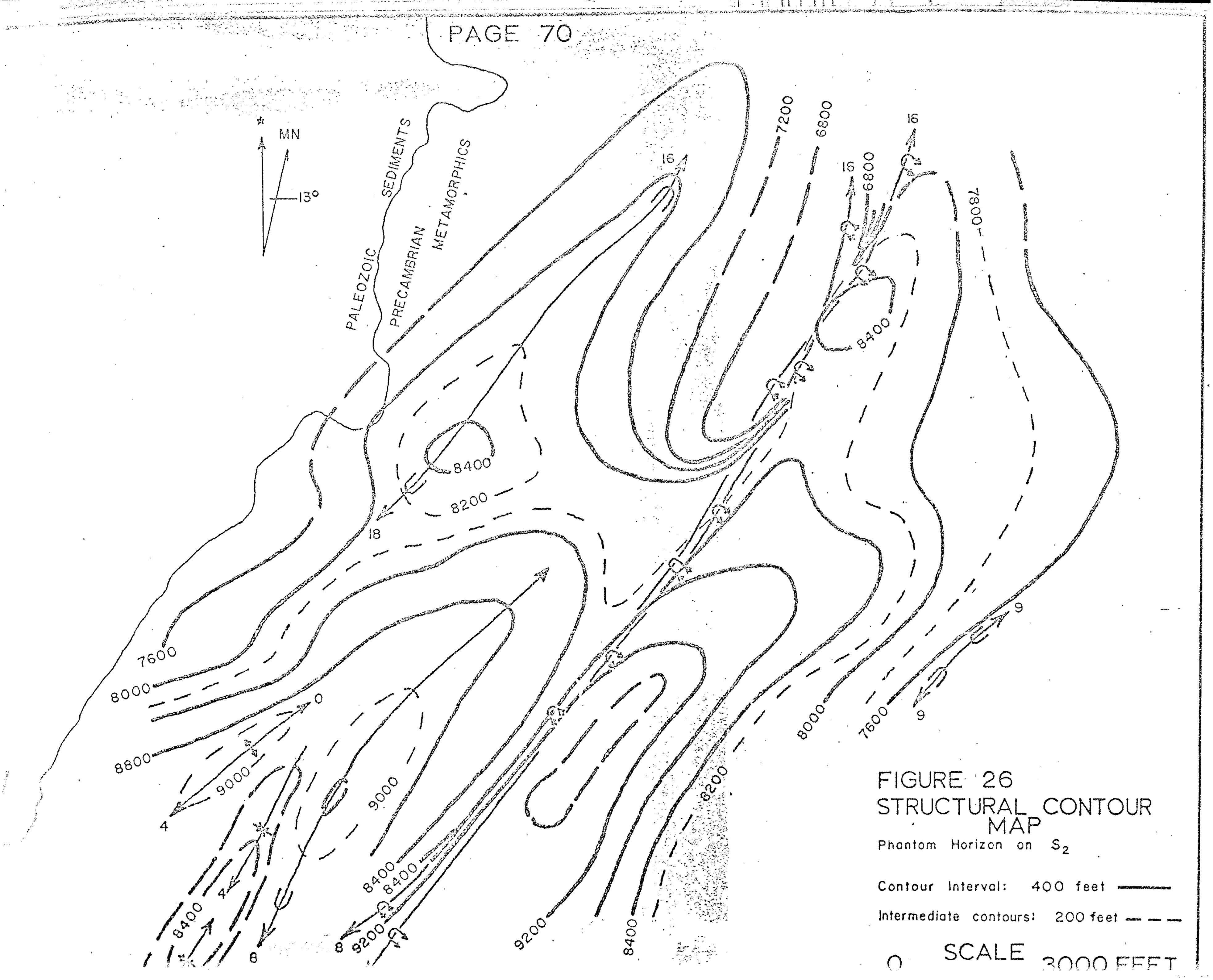


FIGURE 26
STRUCTURAL CONTOUR MAP
Phantom Horizon on S_2

Contour Interval: 400 feet

Intermediate contours: 200 feet

SCALE
0 3000 FEET

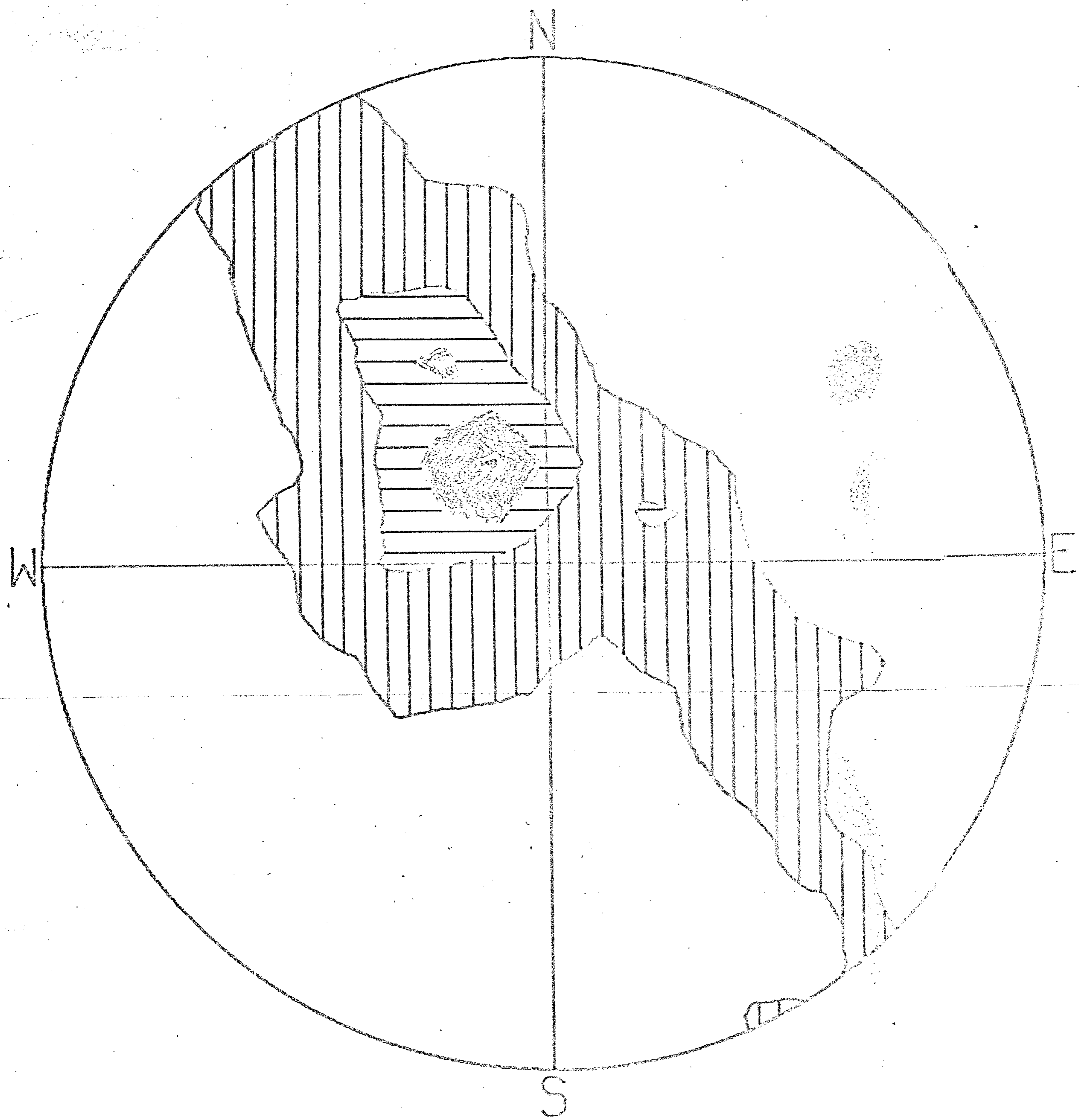


FIG. 27 INCLUSIVE S2 FOLIATIONS

480. POINTS, CONTOURS: 1.00% 4.00% 7.00% 10.00%

Figure 27 Synoptic Schmidt equal area projection of foliation. See description of projections facing page 61.

FOUND THAT THE FOLD AXES WERE ORIENTED IN A NW-SE DIRECTION.

BARKER'S (1958) TECTONIC MAP OF LAS TABLAS QUADRANGLE SHOWS A GENERAL NORTHWEST STRIKE OF THE FOLIATION, WHICH CHANGES FROM NORTH-NORTHWEST TO EAST-WEST THEN TO WEST-NORTHWEST AS THE TREND IS TRACED NORTHWARD. THE GENERAL EAST-WEST BEARING OF THE LINEATIONS COUPLED WITH THE SINUOUS STRIKE OF THE PLANAR ELEMENTS SUGGESTS A STRUCTURE SIMILAR TO THAT IN THE MORA AREA. THE EXTENSIVE FAULTING WITHIN BARKER'S AREA, HOWEVER, HAS AFFECTED THE STRUCTURAL ELEMENTS.

THIS POINTS OUT THE DIFFICULTY WHICH MAY ARISE IN ATTEMPTS TO DEFINE REGIONAL FOLD AXES FROM THE STRIKE OF PLANAR ELEMENTS WHERE GOOD STRATIGRAPHIC MARKERS ARE NOT AVAILABLE FOR STRUCTURAL CONTROL.

WEAK LINEATION POLES IN THE MORA AREA DIFFERENT THAN L1 AND L2, FOUND IN DOMAINS II, IV, V, VI, VIII, AND IX, LABELED L+, FIG. 3, ARE THOUGHT TO REPRESENT RELICS FROM A PRE-L1 TECTONIC EVENT. AS A TEST OF THIS POSSIBILITY THE PLANAR AND LINEAR ELEMENTS FROM ALL OF THE ABOVE DOMAINS WERE COMBINED AND PLOTTED ON A SCHMIDT EQUAL AREA PROJECTION, FIGURES 28 AND 29. FROM THIS EVIDENCE IT APPEARS THAT THE TAILS IN FIG. 29 AND IN THE FOLD AXES PLOTS OF GROUPS "A" AND "B" (FIGURES 19 AND 21) PROBABLY REPRESENT POLES OF THE FIRST DEFORMATION, L1, INCOMPLETELY REORIENTED BY THE LAST TECTONIC EVENT.

A SUMMARY OF STRUCTURAL INFORMATION FROM THE EQUAL AREA PROJECTIONS IS SHOWN IN TABLE 5.

IN THIS TABLE THE DATA REPRESENTED ARE MAXIMA OF FOLD AXES,

Figure 28 Schmidt projection of foliation for domains (II, IV, V, VI, VIII and IX) containing L+ maxima. See description of projections facing page 61.

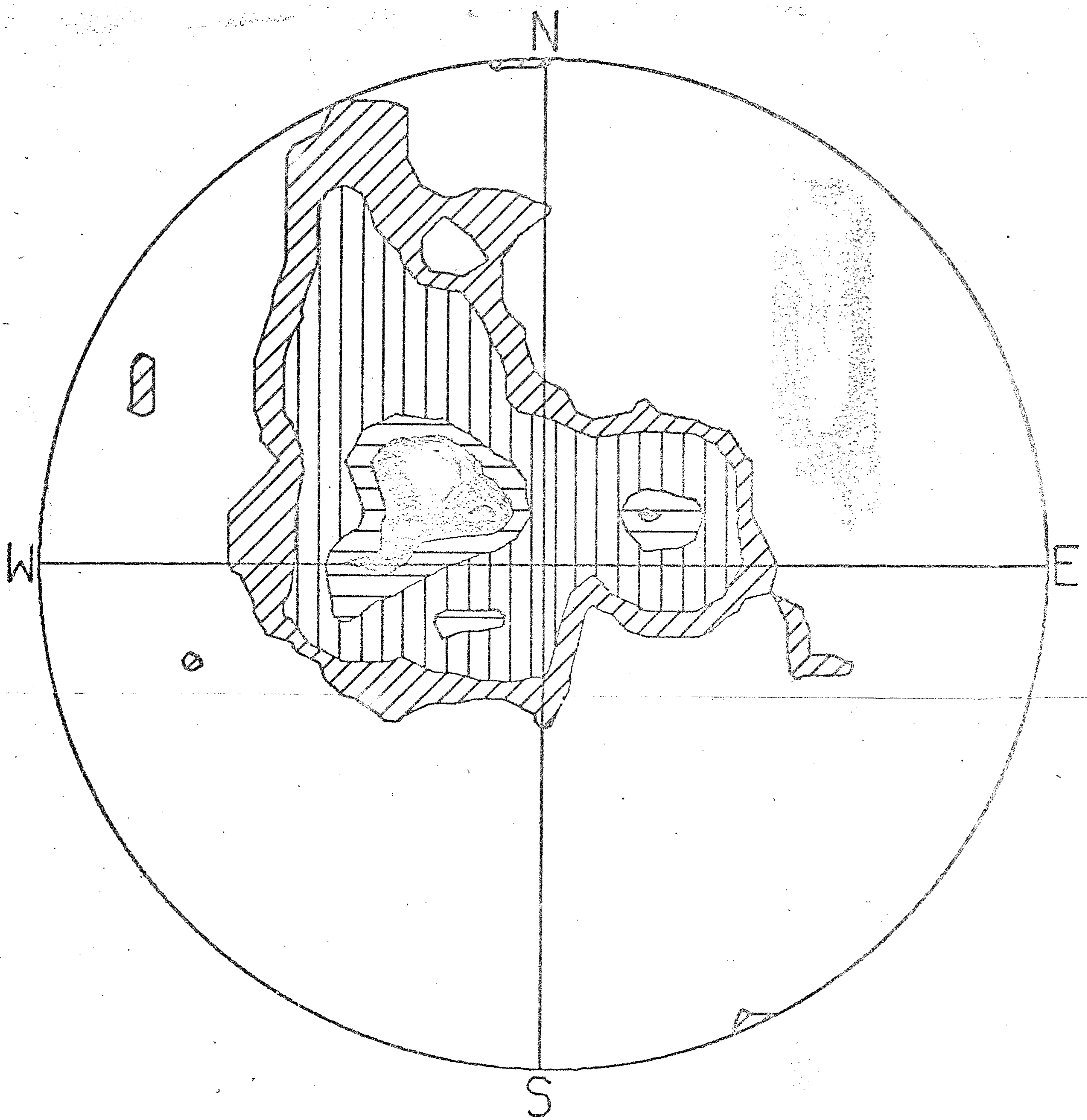


FIG. 28 ''L+ GROUP'' FOLIATION
175 POINTS, CONTOURS: 1.00% 2.00% 6.00% 8.00% 10.00%

Figure 29 Schmidt projection of fold axes from domains (II, IV, V, VI, VIII and IX) containing L+ maxima. See description of projections facing page 61.

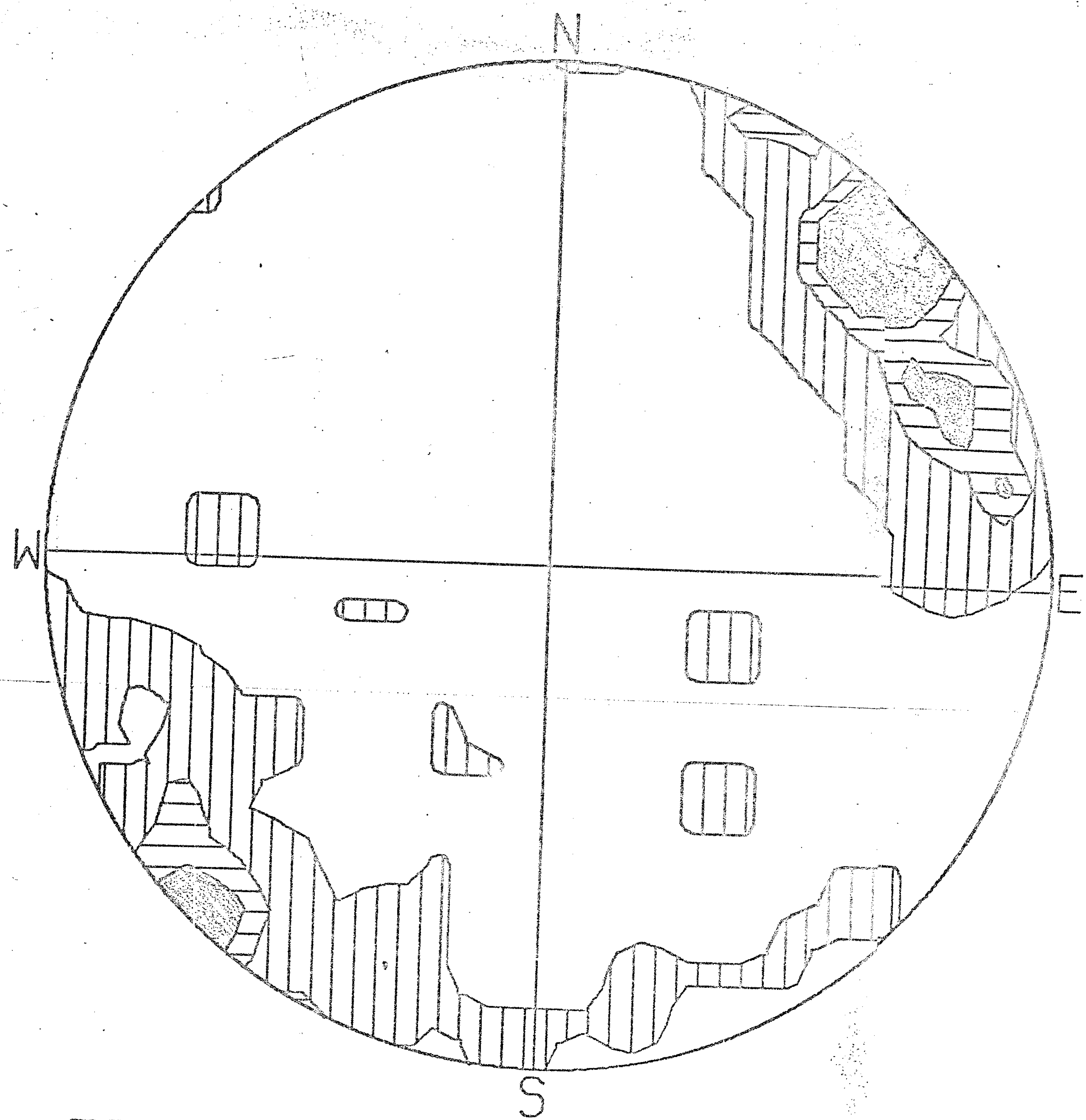


FIG. 29 ''L+ GROUP'' FOLD AXES
78 POINTS, CONTOURS: 1.00% 5.00% 7.00% 12.00%

TABLE 5

SUMMARY OF MESOSCOPIC STRUCTURAL DATA
FROM THE
ORIGINAL ELEVEN STRUCTURAL DOMAINS

DOMAIN	DEFORM-ATION SYMBOL	LINEATION POLE	π-POLE	GIRDLE(G) OR MAXIMUM(M)	STATISTICAL PLANE
I	1(?)	– –	315-37	M	25-37W
II	+	183-05	193-12	G	283-12W
	1	45-00	– –		– –
	2	249-16	247-20	M	337-20W
	+(?)	– –	320-4	G	50-4W
III	1	229-09	228-4	G	318-4W
	+(?)	– –	135-22	M	45-22E
IV	+	167-12	167-12	G	77-12E
	1	45-15	45-14	G	315-14E
	+(?)	– –	116-20	M	26-20E
V	+	109-11	88-8	G	358-8E
	1	200-18	200-20	G	290-20W
	1	220-23	228-10	G	318-10W
	2	240-21	– –		– –
	2	249-16	– –		– –
	+(?)	– –	160-22	M	70-22E
VI	+	122-59	142-11	M	52-11E
	1	199-11	14-18	G	284-18E
	1	225-03	232-0	G	322-0E
	2	77-09	– –		– –
VII	1	49-08	64-10	G	334-10E
	2	84-11	101-42	M	11-42E
	+(?)	– –	144-42	M	54-42E
VIII	+	132-42	153-38	M	63-38E
	1	240-23	72-4	G	342-4E
	2	258-09	86-16	G	356-16E

(continued)

TABLE 5
(concluded)

DOMAIN	DEFORMATION SYMBOL	LINEATION POLE	π-POLE	GIRDLE(G) OR MAXIMUM(M)	STATISTICAL PLANE
IX	+	112-09	104-16	M & G	14-16E
	+(?)	354-11	--		--
	1	45-0	--		--
	2	90-0	73-14	G	343-14E
X	1	229-10	230-6	G	320-6W
	1	238-7	--		--
	+	--	140-78	M	50-78E
	+	--	315-47	M	45-47W
XI	1	53-00	--		--
	2	261-35	244-2	G(?)	334-2W
	+(?)	--	154-89	M	64-89E

I-POLES, AND STATISTICAL PLANES FROM EACH OF THE ORIGINAL 11 UBDIVISIONS.

STATISTICAL PLANES ARE DEFINED HERE AS THE PLANE NORMAL TO HE POLE TO THE MAXIMUM (M) OR TO THE POLE WHICH BISECTS THE IRDLE (G) WHERE THE PI-POLE IS DEFINED BY A GIRDLE RATHER THAN A OINT MAXIMUM.

EACH MAJOR TECTONIC EVENT WITHIN EACH OF THE 11 SUBDOMAINS S REPRESENTED BY AN ARABIC NUMBER INDICATING ITS RELATIVE AGE. LUSES (+) ARE USED WHERE THE TREND SUGGESTS PARTIALLY REORIENTED RENDS OF THE FIRST (1) DEFORMATION.

)LD STYLES

TWO BROAD CLASSES OF MESOSCOPIC FOLDS APPEAR TO EXIST. THESE -ASSES ARE DEFINED BY THE RATIO OF WAVELENGTH TO AMPLITUDE (WL:A). HE WL:A RATIOS VARY WITHIN THESE TWO CLASSES BUT THE APPARENT ACK OF FOLDS OF ABOUT ONE WAVELENGTH UNIT TO FOUR AMPLITUDE NITS APPEARS TO CONSTITUTE A MAJOR DIVISION AMONGST THE FOLDS 3SERVED.

THE STYLE OF THE MESOSCOPIC FOLDS OF RATIOS LESS THAN 1:4 IS IMILAR, OVERTURNED AND CURVIPLANAR, FIG. 30A AND B, WITH A MEAN L:A RATIO OF 1:10. WHERE THE RATIO DECREASES BEYOND 1:12, SHEARING LONG THE AXIAL PLANE USUALLY OCCURS.

MOST FOLDS ARE RECOGNIZABLE BY COMPOSITIONAL BANDING. AN XAMPLE OF FOLDS OUTLINED BY COARSE GRAINED QUARTZOFELDSPATHIC ANDING IS SHOWN IN FIGURES 30A, 31A, 31B, AND 32. IN THE TIGHT OLDS THE BANDS THICKEN IN THE HINGES.

THE MESOSCOPIC FOLDS WITH LARGER WL:A RATIOS EXHIBIT FOUR ASIC STYLES: SIMILAR, CONCENTRIC, PTYGMATIC AND INTRAFOLIAL. ETWEEN THE FIRST TWO THERE ARE MANY GRADATIONAL STYLES.

IT IS NOTABLE THAT THE SMALLER FOLDS SELDOM HAVE A WL:A ATIO GREATER THAN ABOUT 1:2. THE AVERAGE RATIO IS ABOUT 1:2.5. HE WAVELENGTHS OF THE FOLDS RANGE BETWEEN 6 INCHES AND 20 FEET ND HAVE AN AVERAGE NEAR 2 FEET.

INTRAFOLIAL FOLDS REPRESENT THE LEAST COMMON STYLE AND THE MALLEST IN RATIO (WL:A=1). OFTEN THE MIDDLE OR COMMON FLANK OF HESE FOLDS IS SHEARED LEAVING ONLY A CROOK OR CANE SHAPE TO THE

A.

B.

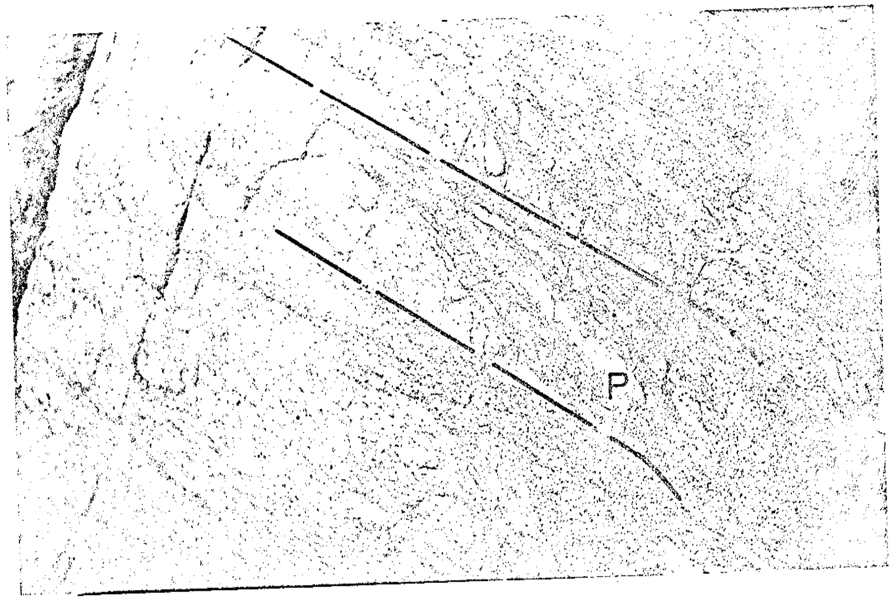
Figure 30

Similar folds in granitic gneiss from Comanche Canyon (A) and La Tierra amarilla Canyon (B). Solid lines are parallel to foliation. A. P. is the axial plane.

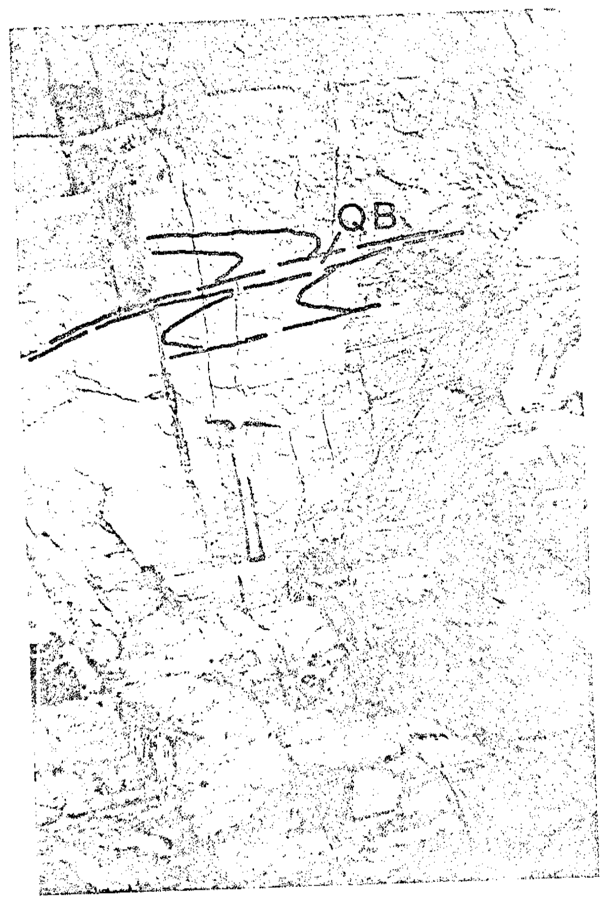
Figure 31
Arcuate and sigmoidal folding in the granitic gneiss. Photos are from the east ridge of La Tierra Amarilla Canyon.

A) Arcuate folds representing one side of similar fold with pegmatitic bands (P) outlining the folds. No arcuate folds occur below lower broken line, which is parallel to the trace of the foliation. Note that half of the fold flank occurs above the upper broken line.

B) Sigmoidal folds. Note that most of the fold flank has been omitted leaving only the hinge. Quartzo-feldspathic band (QB) lies between the folds. Foliation indicated by broken line.



A.



B.

FIGURE 31

Figure 32

Quartzofeldspathic bands (coincident with four line segments) pegmatite (P) and sigmoidal (S) and arcuate (A) folds in one outcrop of granitic gneiss from west ridge of La Tierra Amarilla Canyon.

FOLD, FIG. 6B AND 12. THESE FOLDS ARE USUALLY ASSOCIATED WITH OUTCROPS CONTAINING A HIGH CONTENT OF QUARTZ AND/OR FELDSPAR.

PTYGMATIC FOLDS ARE RELATIVELY RARE BUT WERE FOUND IN ASSOCIATION WITH OTHER FOLD STYLES. A SINGLE CHARACTERISTIC, COMMON TO ALL FOLDS OF THIS STYLE, IS THE MEDIUM GRAINED (USUALLY ABOUT 3 MM.) QUARTZOFELDSPATHIC BANDS ABOUT 1/2 TO 1-1/2 INCHES WIDE.

RARE CONCENTRIC FOLDING, FIG. 33A AND B, WITH VARIABLE WAVELENGTHS UP TO 20 FEET AND AMPLITUDES OF 1 FOOT WAS OBSERVED AS FLEXURES IN THE FOLIATION. THESE FLEXURES OCCASIONALLY HAVE DIRECTIONS THAT ARE OBLIQUE TO THE GENERAL STRIKE OF THE FOLIATION.

THE AXIAL PLANE OF SIMILAR FOLDS IS PARALLEL OR SUBPARALLEL TO THE FOLIATION SURFACE. AS THE WL:A RATIO DECREASES, FOLDING OF THE PRE-EXISTING S-PLANE SURFACE BECOMES TIGHTER UNTIL SHEARING OCCURS. THESE SHEARING PLANES ARE PARALLEL TO THE AXIAL PLANES OF THE ISOCLINAL FOLDS, FIGURES 31A, 31B, AND 32.

THE PROCESS OF TRANSPOSITION SEEMS TO FOLLOW THE SEQUENCE OF DEVELOPMENT, BELOW:

I. THE ISOCLINAL FOLDS ARE FIRST FORMED AND TILTED TOWARD THEIR PRESENT POSITION, FIG. 34A.

II. SHEAR FORCES CONTINUED TO ACT ON THE FOLDS, DEVELOPING ZONES OF CLOSELY SPACED SHEAR PLANES (SHEAR ZONES) ALONG THE THE FLANKS OF THE FOLDS, FIG. 31B. TRANSPOSITION ALONG THESE SHEAR ZONES, WHICH HAVE NOT YET INCORPORATED THE HINGE AREA, PRODUCE THE SIGMOIDAL FOLDS OF BINGLER, FIGURES 34B AND 32.

A.

B.

Figure 33
Concentric folding in granitic gneiss from canyon near south end of section B-B'.

A) Plunge of folds is to the ESE about 8 degrees.

B) Foliation indicated by broken line. Outcrop is near outcrop shown in figure 33A.

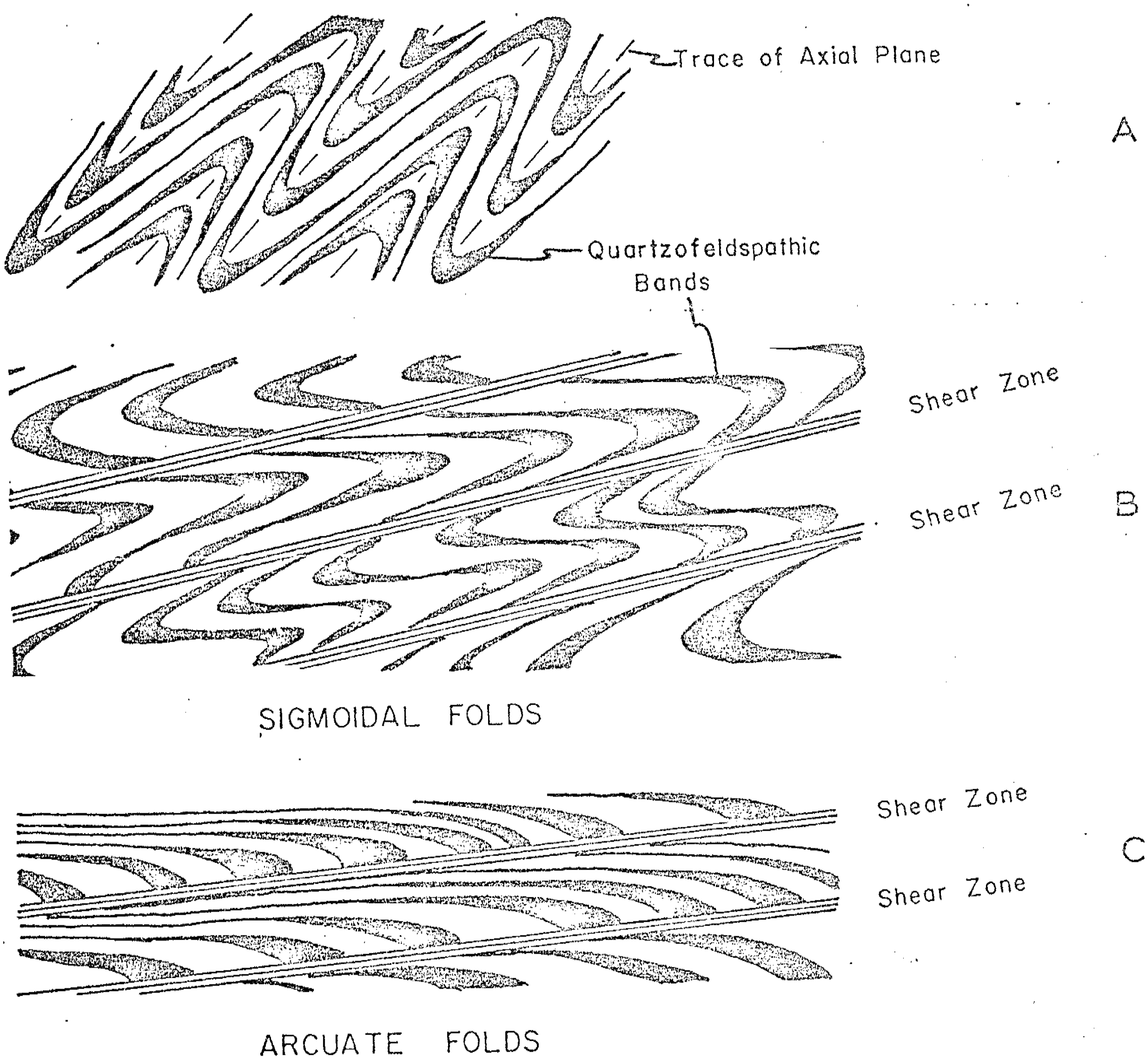


Figure 34
Sequence in the development of sigmoidal and arcuate folds. Shear zones contain quartzo-feldspathic/pegmatitic material. See text for explanation

II. AS SHEARING CONTINUES TO DEVELOP, SHEAR ZONES DEVELOP NEAR THE AXIAL PLANE AND TRANSPOSITION CONTINUES, BUT NOW THE ZONES ARE PARALLEL TO THE AXIAL PLANE. THIS RESULTS IN THE ARCUATE FOLDING OF BINGLER, FIG. 31A AND 34C.

THE ARCUATE FOLDS COULD POSSIBLY BE MISTAKEN FOR RELIC CROSS-BEDDING BUT CLOSE EXAMINATION SHOWS THIS NOT TO BE THE CASE.

LINEAR STRUCTURES

OVER 200 MEASUREMENTS OF FOLD AXES WERE MADE IN THE MORA AREA. THESE LINEAR ELEMENTS WERE SEPARATED BY FOLD STYLE AND PLOTTED AT MAP SCALE USING THE PROGRAM "LINMAP" (SEE APPENDIX). INSPECTION OF THE PLOTS OF CONCENTRIC AND OF SIMILAR FOLD AXES SHOWED NO PREFERRED ORIENTATION DIFFERENCES BETWEEN THE TWO STYLES. THUS BOTH STYLES OF FOLDS WERE PRODUCED DURING THE TWO TECTONIC EVENTS IN THIS AREA.

IN TABLE 5 THE COMPARISON OF THE LINEATION DIRECTIONS AND THE TREND OF PI-POLES MAY BE MADE. THE AGREEMENT BETWEEN THESE TWO STRUCTURAL ELEMENTS REINFORCES THE CONCEPT OF TWO TECTONIC EVENTS.

AT ONE OUTCROP, NEAR THE MOUTH OF COMANCHE CANYON JUST NORTH OF THE TRAIL, RODS ARE PRESENT IN THE GRANITIC GNEISS; THESE ARE RICHER IN QUARTZ THAN THE SURROUNDING ROCK AND ARE SEPARATED FROM THE HOST BY A THIN MICA LAYER. THE RODS ARE ABOUT 1 INCH IN DIAMETER AND 1 FOOT LONG WITH A PLUNGE OF 8 DEGREES IN THE DIRECTION OF 22 DEGREES.

CRENULATIONS ARE A UNIVERSAL CHARACTERISTIC OF THE MUSCOVITE SCHIST. THE GRANITIC GNEISS IS NOT USUALLY CRENULATED, BUT IN THE MICA-RICH BANDS OF THE GNEISS THIS WAS OCCASIONALLY OBSERVED. CRENULATIONS IN THE GRANITIC GNEISS USUALLY PLUNGE AT HIGH ANGLES TO THE SOUTHWEST.

OTHER LINEAR ELEMENTS ARE INTRAFOLIAL FOLDING AND ROTATION OF "SWELLS" ASSOCIATED WITH THE PEGMATITE DIKES. THESE ARE DESCRIBED BY RAST (1956) AS BEING RELATED TO SHEAR AND TRANSLATION INVOLVED WITH COMPRESSIONAL RATHER THAN TENSIONAL FORCES.

S-SHAPED INTRAFOLIAL FOLDS ARE SHOWN JUST EAST OF CROSS-SECTION "A" IN THE NORTHERN PART OF THE MAP AND ON THE RIDGE JUST WEST OF THE ROCKSLIDE AREA ON PLATES 1 AND 2. THESE TRENDED ABOUT 65 AND 100 DEGREES, RESPECTIVELY, AND INDICATE SHEAR STRESS.

PLANAR STRUCTURES

PLANAR STRUCTURES IN THE MORA AREA ARE OF FIVE TYPES: AXIAL/BISECTING PLANES, FOLIATION PLANES, FAULT PLANES, JOINT PLANES, AND BEDDING PLANES.

AXIAL AND BISECTING PLANES

SINCE THERE WERE TOO FEW AXIAL PLANE MEASUREMENTS TO REPRESENT EACH OF THE 11 ORIGINAL STRUCTURAL DOMAINS, BISECTING PLANES WERE CALCULATED. THE BISECTING PLANES AND AXIAL PLANES WERE PLOTTED ON EQUAL AREA PROJECTIONS, SEPARATELY AND COMBINED. IN ALL CASES IT WAS FOUND, WHEN THESE WERE COMPARED TO THE FOLIATION SURFACE, S2, THAT THE FOLIATION REPRESENTS AXIAL PLANE FOLIATION. THE PI-POLES OF BISECTING PLANES, DIFFERED A SMALL AMOUNT FROM THE FOLIATION SINCE THE BISECTING PLANE IS NOT NECESSARILY CONCOMITANT WITH THE AXIAL PLANE.

FOLIATION

OVER 400 FOLIATION MEASUREMENTS WERE MADE IN THE PRECAMBRIAN TERRAIN. IT MAY BE SEEN IN FIG. 27, WHICH REPRESENTS SELECTED ATTITUDES, THAT A TRICLINIC PATTERN OF THE POLES TO THE FOLIATION IS DEVELOPED, POINTING TO SUPERPOSITION OF FOLDS.

FAULTS

FAULTING WITHIN THE PRECAMBRIAN UNITS WAS OBSERVED ONLY IN ONE OUTCROP AND THIS FAULT WAS TRACEABLE FOR BUT A FEW FEET WITH A GOUGE ZONE LESS THAN 6 INCHES THICK. THIS FAULT IS LOCATED 2600 FEET EAST OF SECTION NUMBER 5. THE FAULT TRENDS 321 DEGREES AND DIPS 35 DEGREES WEST. BEDDING PLANE FAULTING COULD EXIST WITHIN THE PALEOZOIC UNITS BUT WOULD BE DIFFICULT TO RECOGNIZE WITHOUT A MORE EXTENSIVE SURVEY OF THESE UNITS.

JOINTS

JOINTS WERE EXAMINED FIRST WITH RESPECT TO THE MAJOR LITHOLOGIC UNITS OF THE PRECAMBRIAN. THE RESULTS OF THIS EXAMINATION (USING THE SCHMIDT PROJECTION) SHOWED NO SIGNIFICANT DIFFERENCE IN ORIENTATION OF THE PI-POLES OF THESE UNITS. THUS, THE FINAL EQUAL AREA PROJECTION USED FOR THE PRECAMBRIAN JOINTING CONTAINS 184 POLES TO JOINT PLANES REPRESENTING ALL LITHOLOGIES, FIG. 35. IN THIS PROJECTION TWO JOINT PLANES PREDOMINATE; STRIKING 330 AND 52 DEGREES AND DIPPING ABOUT 83 DEGREES EAST AND 86 DEGREES WEST, RESPECTIVELY.

THE ORIENTATION OF THE GREATEST COMPRESSIVE STRESS RESPONSIBLE FOR THE TWO JOINT PLANES WOULD BE TRENDING 198 DEGREES AND PLUNGING 10 DEGREES. BY COMPARISON, THE TREND OF THE GREATEST COMPRESSIVE STRESS FOR THE MESOSCOPIC FOLD AXES OF THE SECOND DEFORMATION IS 167 PLUS OR MINUS A MAXIMUM DEVIATION OF 17 DEGREES (I.E. 184 DEGREES). THIS LEAVES A DISCREPANCY OF 14 DEGREES BETWEEN THE TWO PRINCIPAL STRESS DIRECTIONS.

Figure 35 Schmidt equal area projection of poles to joint planes in Precambrian rocks.
See description of projections facing page 61.

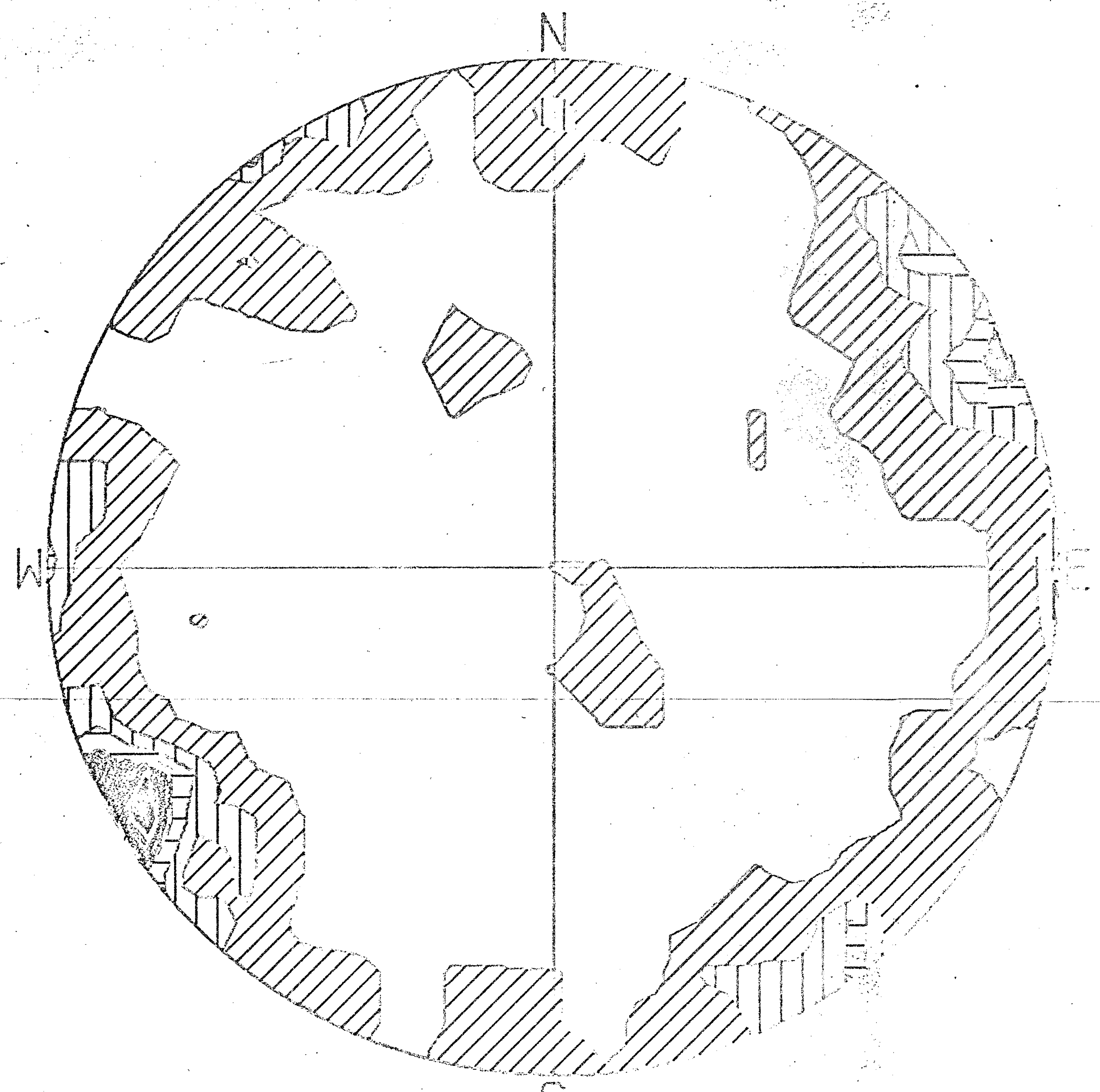


FIG. 35 PRECAMBRIAN JOINTS

184 POINTS, CONTOURS: 1.00% 3.00% 4.00% 5.00% 6.00%

A LIMITED NUMBER OF JOINTS WERE MEASURED IN THE PENNSYLVANIAN SEDIMENTS, FIG. 36, AND THE JOINT PATTERN NOTED IN THE PRECAMBRIAN IS ALSO EVIDENT IN THE PALEOZOIC SEDIMENTS.

A THIRD JOINT PLANE IN THE PRECAMBRIAN IS NEARLY HORIZONTAL. THIS IS LIKELY A RELEASE JOINT SYSTEM WHICH DEVELOPED AS A RESULT OF THE REMOVAL OF THE OVERLYING LITHOSTATIC LOAD BY EROSION.

BEDDING

THE REGIONAL DIP OF THE PENNSYLVANIAN SEDIMENTS RANGES FROM 8 TO 26 DEGREES IN THE MORA AREA. FROM FIGURE 37, IT WAS CONCLUDED THAT THE BEDS HAVE A GENERAL 40 DEGREE STRIKE AND AN 11 DEGREE WESTWARD DIP. OETKING (1967) ATTRIBUTES THE REGIONAL DIP OF THE SEDIMENTARY ROCKS OF THE SANGRE DE CRISTO RANGE TO THE DIFFERENTIAL MOVEMENT ALONG TWO MAJOR HIGH ANGLE FAULTS WHICH BRACKET THE AREA ON THE EAST AND WEST, WITH THE GREATER MOVEMENT ON THE EASTERN FAULT.

Figure 36 Schmidt equal area projection of poles to joint planes in Pennsylvanian rocks.
See description of projections facing page 61.

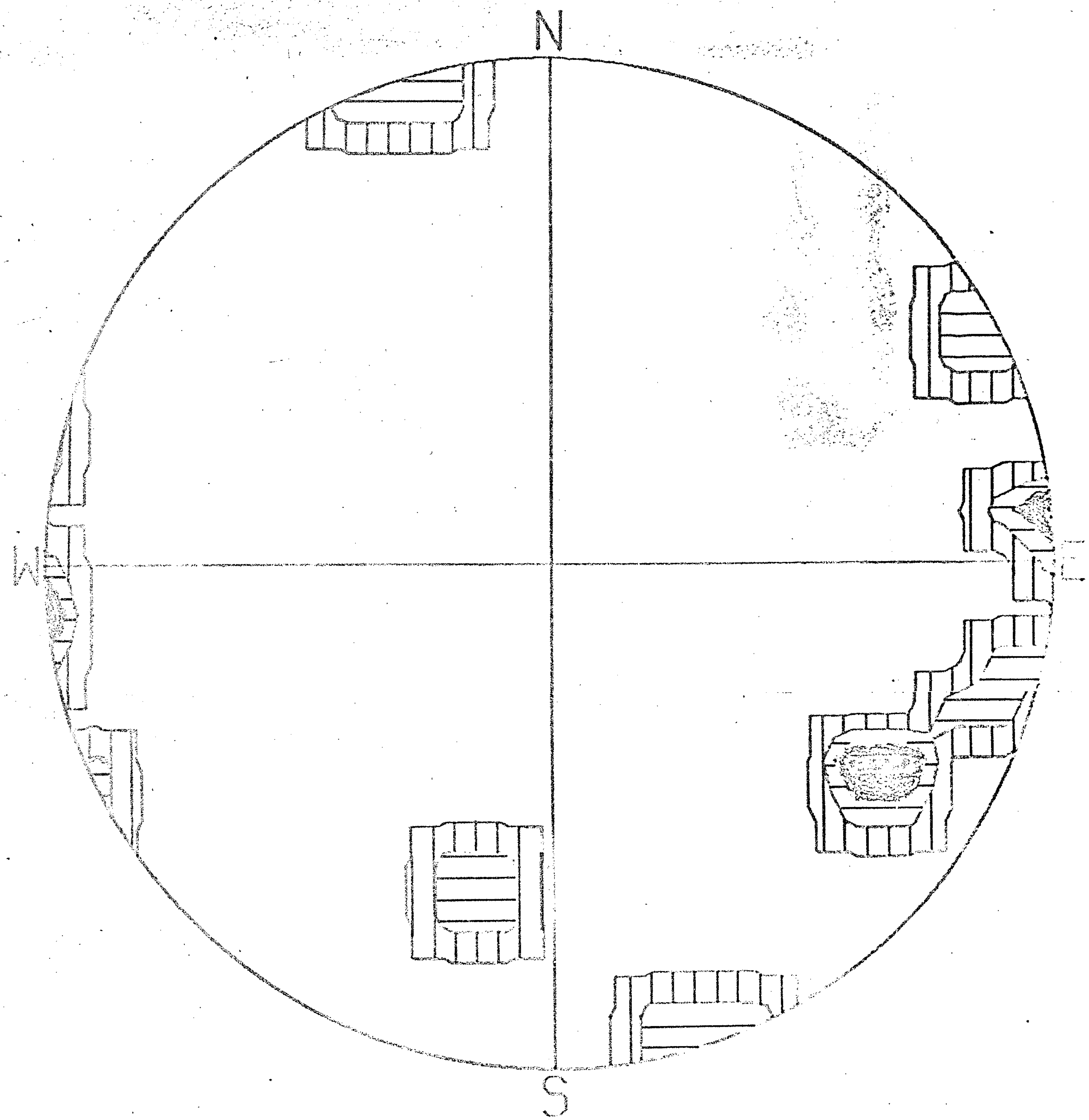


FIG. 36 PALEOZOIC JOINTS

10 POINTS, CONTOURS: 1.00% 7.00% 12.00% 18.00%

Figure 37 Schmidt equal area projections of poles to sedimentary bedding planes.
See description of projections facing page 61.

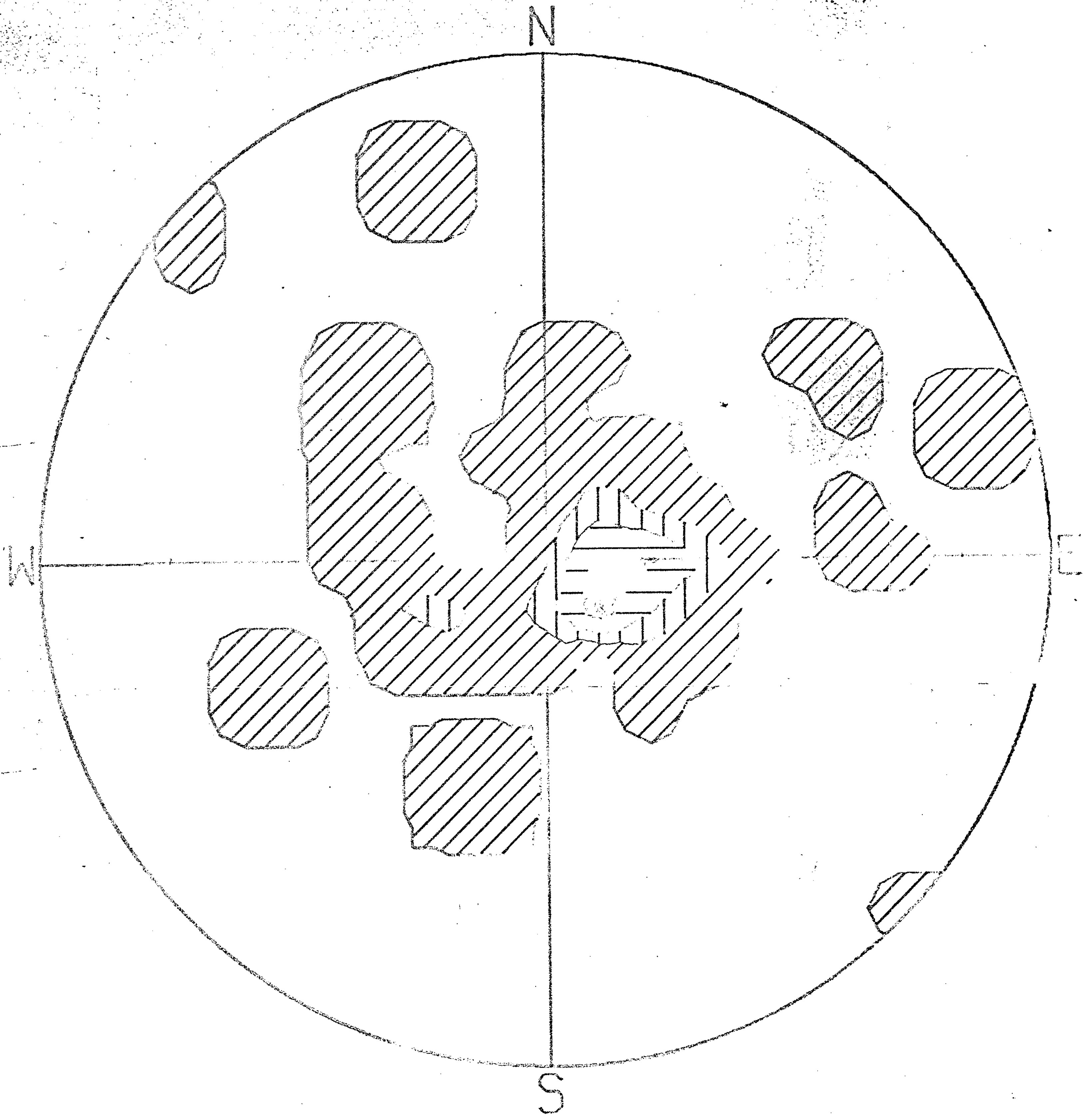


FIG. 37 SEDIMENTARY BEDDING

31 POINTS, CONTOURS: 1.00% 7.00% 12.00% 18.00% 21.00%

PETROFABRIC ANALYSIS

A PETROFABRIC EXAMINATION OF SAMPLES OF GRANITIC GNEISS (NUMBERS 5, 11, 12, 15, AND 16) WAS MADE USING A 4-AXIS UNIVERSAL STAGE ON A ZEISS PETROGRAPHIC MICROSCOPE. THE ATTITUDES OF THE OPTIC AXES OF QUARTZ AND CLEAVAGE PLANES OF MUSCOVITE WERE THUS DETERMINED.

THE VALUES READ FROM THE AXES OF THE UNIVERSAL STAGE WERE PUNCHED ON I.B.M. COMPUTER CARDS AND SUBMITTED AS DATA WITH THE PROGRAM "ORIENT", WHICH CONVERTED THESE VALUES INTO THE FORM USED BY THE "SMTPLT" PROGRAM.

THE SCHMIDT EQUAL AREA PROJECTIONS OF THE FABRIC DATA PRODUCED FROM THE "SMTPLT" PROGRAM WERE ANALYZED AND THE INFORMATION TABULATED IN TABLE 6.

TABLE 6, IN TWO PARTS, IS DIVIDED INTO NINE MAJOR COLUMNS. THE FIRST COLUMN CONTAINS THE SAMPLE NUMBER AND FABRIC AXES OR ORIENTATION NOTATION OF THE THIN SECTION EXAMINED. COLUMN TWO INDICATES THE MINERAL ON WHICH THE FABRIC DATA WAS MEASURED. COLUMN THREE SHOWS THE MAXIMA OBSERVED IN THE SCHMIDT PROJECTIONS. THE FOURTH COLUMN SHOWS THE SAME MAXIMA REPRESENTED IN THE HORIZONTAL PLANE THE FIFTH AND SIXTH COLUMNS INDICATE THE DENSITY PER CENT OF EACH MAXIMUM AND THE TOTAL NUMBER OF POLES FOR EACH FABRIC DIAGRAM, RESPECTIVELY. THE FOLLOWING THREE COLUMNS SHOW, IN ORDER, THE CORRESPONDING MESOSCOPIC STRUCTURAL MEASUREMENTS MADE NEAR THE SAMPLE, MACROSCOPIC MAXIMA FROM THE ORIGINAL SUBDOMAIN, AND THE CORRESPONDING DEFORMATION.

Table 6. Structural Maxima of Microscopic, Mesoscopic, and Macroscopic Scales. Roman numerals in "Domain" column indicate the subdomain of the original subdivision.

a, b, c	=	tectonic axes.
n, e	=	compass directions, north and east, respectively.
u	=	vertical direction (upward).
o	=	upward direction of plane that is not quite vertical.
–	=	lineation plunges 180 degrees to that shown.
π	=	pi-pole measurement.
s	=	statistical plane measurement.
intersec.	=	intersection of cleavage planes.

*Note: W and E in this column indicate dip direction as downward left and right, respectively (not west and east), as in other columns.

Sample & Orientation	Mineral	Projection Maxima*				Maxima Represented in the Horizontal Plane				Density of Maxima
		Strike	Dip	Bearing	Plunge	Strike	Dip	Bearing	Plunge	(Percent)
5 a/b	Quartz			300	20			234	53	5
				332	34			189	42	4
				45	55			132	19	3
5 a/c	Muscovite	6	90E			17	37W			24
11 a/b	Quartz			220	24			221	04	5
				322	36			126	08	5
11 a/c				118	23			313	04	7
				206	34			21	61	6
				320	20			39	14	3
11 a/b	Muscovite	76	54E			51	71W			13
		103	41E			308	52W			9
				87	15			260	55	(intersec.)
11 a/c		355	90E			3	40W			10
12 n/e	Quartz			180	11			0	11	6
				354	00			186	00	6
				234	19			305	18	5
				118	07			62	07	5
15 n/e	Quartz			222	44			Same		5
				57	12					4
				353	21					4
				0	49					4
				109	05					4
				126	17					4
15 n/u				0	08			351	00	5
				112	45			250	41	5
				20	00			0	20	4
				16	52			308	10	4
				60	20			323	44	4
[illegible] n/e	Muscovite	53	41E			53	41E			7
[illegible] n/u		348	82W			58	14E			7
		7	80E			34	12W			7
				176	45			225	03	(intersec.)
[illegible] n/o	Quartz			129	19			143	23	7
				[illegible]	[illegible]			[illegible]	[illegible]	[illegible]

Total Number of Poles	Corresponding Field Measurement: Strike	Dip	Bearing	Plunge	Corresponding Maxima from Structural Domains: Strike	Dip	Bearing	Plunge	Domain	Deformation Symbol	Sample
96			42 (pegmatite)	?			π 135	-37	A (I)	1(?)	5 a/b
100	22	42 W			25	37 W			A (I)	1(?)	5 a/c
75									C (XI)		11 a/b
78									C (XI)		11 a/c
58	65 295	80 E 62 W	260	43			53 261	00 35	C (XI)	1 2	11 a/b
52	10	47 W							C (XI)		11 a/c
75			235	07			229	09	B (III)	1	12 n/e
84							45 45 354 { 90 { 112	00 00 11 00 09	C (IX)	1 1 + 2 +	15 n/e
89							354 π 255	11 -14	C (IX)	+ 2	15 n/u
[illegible]	42	12 E							C (IX)		15 n/e
[illegible]	42	12 E					45	00	C (IX)	1	15 n/u
[illegible]	[illegible]	21 W			s 157	20 W	π [illegible]	[illegible]	A (II)	2	16 n/o

IT SHOULD BE NOTED THAT THE ATTITUDE OF A MAXIMUM WILL DIFFER IN TWO DIFFERENT PROJECTIONS OF THE SAME SPECIMEN. THE IMPORTANT FACTOR TO CONSIDER HERE IS THE BEARING OF THE MAXIMA AT THE THREE SCALES OF OBSERVATION: MICROSCOPIC, MESOSCOPIC AND MACROSCOPIC.

THE WIDE RANGE OF BEARINGS OF THE PETROFABRIC MAXIMA AND LACK OF PARALLELISM BETWEEN THE MICROSCOPIC FABRIC AND MESOSCOPIC AND MACROSCOPIC DATA IS THE MOST IMPORTANT CHARACTERISTIC OF TABLE 6. DIFFERENCES ARE OBSERVED BETWEEN THE MICROSCOPIC AND MESOSCOPIC FABRIC WHERE CLOSE AGREEMENT IN TREND SHOULD BE EXPECTED. THE DIRECTION OF THE MESOSCOPIC FABRIC, WHERE PARALLELISM IS SUGGESTED, TREND 10, 17, 22, 42, 55, 65, 80, AND 115 DEGREES. THESE DIRECTIONS DIFFER FROM THE MICROSCOPIC FABRIC BY +7, +1, +5, -16, -7, +14, 00, -13 DEGREES RESPECTIVELY (- INDICATES MESOSCOPIC LAG). MOST OF THE VARIATION IN THE TREND LIES BETWEEN L1 AND L2.

THUS THE REORIENTATION OF THE MINERAL FABRIC APPARENTLY HAD NOT BEEN COMPLETED WHEN THE SECOND DEFORMATION CEASED. CONTINUED RECRYSTALLIZATION AT HIGH TEMPERATURES AFTER THE PEAK OF THE SECOND TECTONIC EVENT (FIGURE 38) OBLITERATED MUCH OF THE EARLIER FABRIC RATHER THAN ENHANCING ANY PARTICULAR DIRECTION THROUGH MIMETIC GROWTH.

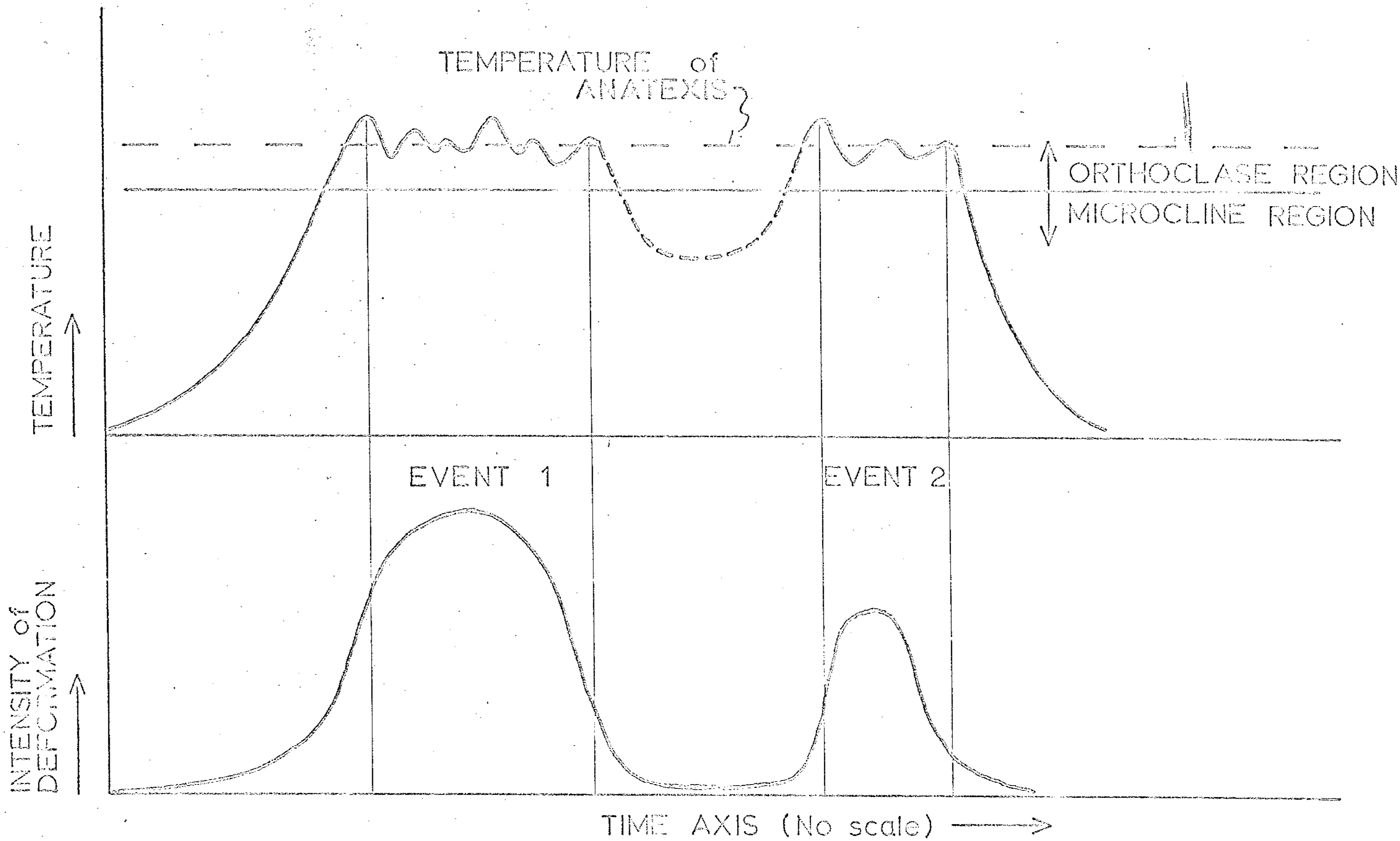


Figure 38. Diagrammatic representation of the Precambrian tectonic conditions. Temperatures may have receded more than indicated between the metamorphic events. The early decline of tectonic activity during the second event may explain the variability in microscopic structural trends.

GEOLOGIC HISTORY AND SUMMARY

THE ORIGINAL ROCK FROM WHICH THE GRANITIC GNEISS OF THE MORA AREA WAS FORMED, WAS PROBABLY A GRANITE PLUTON. THIS PLUTON WAS SUBJECTED TO TWO EVENTS OF TECTONIC ACTIVITY AND METAMORPHISM SOMETIME DURING THE PRECAMBRIAN.

DURING THE FIRST EVENT, THE GRANITIC GNEISSES WERE FOLDED INTO NNE TRENDING FOLDS, WHICH WERE OVERTURNED TO THE WEST. CONCURENTLY WITH THE DEFORMATION, METAMORPHISM AND RECRYSTALLIZATION OF THE MICROSCOPIC FABRIC WAS OCCURRING. AS SHEARING CONTINUED THE ROCK FAILED AND TRANSPOSITION PARALLEL TO THE AXIAL PLANES OF THE FOLDS PRODUCED SIGMOIDAL AND ARCUATE FOLDS.

SINCE THESE FOLDS ARE OUTLINED BY QUARTZOFELDSPATHIC AND PEGMATITIC BANDS AND SINCE THE GRANITIC GNEISS HAS APPARENTLY BEEN DERIVED FROM A GRANITIC PLUTON, THEN IN ORDER TO FORM THESE BANDS THE ROCK MUST HAVE PARTIALLY MELTED UNDER THE CONDITIONS OF ANATEXIS, AND FLOWED. THESE LOCAL BODIES OF ANATEXITES WERE THEN SQUEEZED ALONG THE S1 FOLIATION PLANES OF THE GNEISS AND BECAME CONCENTRATED IN THE FOLD AXES (L1). WHERE PLANES OF WEAKNESS ACROSS THE FOLIATION OCCURRED, THE MELT FORMED DIKES.

THE SMALL MUSCOVITE SCHIST BODIES PROBABLY REPRESENT XENOLITHS OF THE HOST WHICH THE PLUTON INTRUDED AND WHICH FAILED TO REACT COMPLETELY WITH THE GRANITIC GNEISS DURING THE METAMORPHISM.

DURING THE SECOND DEFORMATION REORIENTATION OF THE OLD (S1) FOLIATION PLANES AND LINEATIONS (L1) OCCURRED. FOLD AXES DURING THIS EVENT WERE ORIENTED EAST NORTHEAST. BEFORE THE REORIENTATION

OF THE L1 FOLDS AND RECRYSTALLIZATION OF THE MICROSCOPIC FABRIC WAS COMPLETE, THE STRESSES WERE RELEASED LEAVING THE LINEATIONS DISTRIBUTED BETWEEN THE OLD AND NEW AXIAL DIRECTIONS. RECRYSTALLIZATION CONTINUED AFTER THE DEFORMATION, SINCE CATACLASTIC TEXTURES WERE NOT OBSERVED.

THE METAMORPHISM PROBABLY REACHED THE SILLIMANITE - ALMANDINE - ORTHOCLASE SUBFACIES CONDITIONS IN THIS STAGE OF DEFORMATION. EVIDENCE OF THIS IS SEEN IN THE GROWTH OF POTASSIUM FELDSPAR AT THE EXPENSE OF THE MUSCOVITE, HIGH TITANIUM CONTENT OF THE BIOTITE, AND GROWTH OF ALMANDINE GARNETS.

BUDDING (1968) POINTS OUT THAT AT HIGHER TEMPERATURES THE CONTENT OF ALBITE IN THE ORTHOCLASE LATTICE OF HIGH-GRADE METAMORPHIC ROCKS IS ABOUT 10%, WHILE THE LOWER TEMPERATURE MICROCLINE CONTAINS ABOUT 3% ALBITE. FURTHERMORE, AS THE TEMPERATURE DECLINES, THE MONOCLINIC LATTICE OF ORTHOCLASE BECOMES CONVERTED TO TRICLINIC MICROCLINE. DURING THIS CONVERSION, ALBITE IS EXCLUDED FROM THE LATTICE. IT IS CONCLUDED THAT THE FREED ALBITE REPLACED CALCIUM IN THE RIMS OF THE ADJACENT PLAGIOCLASE GRAINS. THE CALCIUM MAY HAVE IN TURN REACTED WITH QUARTZ, WATER, IRON AND MAGNESIUM (FREED FROM THE BIOTITE) TO FORM EPIDOTE. THIS WOULD HAVE HAD TO OCCUR UNDER METAMORPHIC CONDITIONS WHERE EPIDOTE IS STABLE, I.E. BELOW THAT OF THE SILLIMANITE - ALMANDINE - ORTHOCLASE SUBFACIES.

A LONG PERIOD OF EROSION AND DENUDATION PRECEDED THE DEPOSITION OF THE PENNSYLVANIAN ROCKS. EARLY PENNSYLVANIAN CLASTIC SEDIMENTS WERE DERIVED FROM THE PRECAMBRIAN POSITIVE AREAS AND WERE DEPOSITED

IN SUBSIDING BASINS. IN THE MIDDLE PENNSYLVANIAN, MARINE DEPOSITS OF LIMESTONE OCCUR AND CONTINUE THROUGH TO NEAR THE END OF THE PERIOD. NEAR THE END OF THE PENNSYLVANIAN, THE RECORD ENDS AGAIN. LATER, PROBABLY DURING THE LARAMIDE OROGENY, THE MORA AREA WAS TILTED WESTWARD DUE TO REGIONAL FOLDING AND FAULTING.

REFERENCES

BAILEY, E.H., AND STEVENS, R.E. (1960), SELECTIVE STAINING OF K-FELDSPAR AND PLAGIOCLASE ON ROCK SLABS AND THINSECTIONS, AM. MIN., V. 45, P. 1020 - 1025.

BARKER, FRED (1958), PRECAMBRIAN AND TERTIARY GEOLOGY OF LAS TABLAS QUADRANGLE, NEW MEXICO, N. MEX. MIN. AND TECH., STATE BUR. MINES AND MINERAL RES., BULL. 45.

BATEMAN, A.M. (1959), "THE FORMATION OF MINERAL DEPOSITS", NEW YORK: JOHN WILEY & SONS INC.

BINGLER, E.C. (1965), PRECAMBRIAN GEOLOGY OF LA MADERA QUADRANGLE, RIO ARRIBA COUNTY, NEW MEXICO, N. MEX. MIN. AND TECH., STATE BUR. MINES AND MINERAL RES., BULL 80.

BUDDING, A.J. (1968), ALKALI FELDSPARS FROM GNEISSES AND GRANITES OF THE VASTERVIK AREA, S.E. SWEDEN, GEOL. FOR. I STOCKHOLM FORHANDLINGAR, V. 90, P. 504 - 518.

DEER, W.A., HOWIE, R.A., AND ZUSSMAN, J. (1966), "AN INTRODUCTION TO THE ROCK-FORMING MINERALS", NEW YORK: JOHN WILEY & SONS INC.

JUST, EVAN (1937), GEOLOGY AND ECONOMIC FEATURES OF THE PEGMATITES OF TAOS AND RIO ARRIBA COUNTIES, NEW MEXICO, N. MEX. MIN. AND TECH., STATE BUR. MINES AND MINERAL RES., BULL. 13.

KOTTLOWSKI, F.E. (1962), PENNSYLVANIAN ROCKS IN NORTH-CENTRAL NEW MEXICO, N. MEX. GEOL. SOC., "GUIDEBOOK, TWELFTH ANNUAL FIELD CONFERENCE, THE ALBUQUERQUE COUNTRY", P. 97 - 104.

LARSEN, E.S., AND BERMAN, HARRY (1964), THE MICROSCOPIC DETERMINATION OF THE NONOPAQUE MINERALS, SECOND EDITION, U.S. GEOL. SURV., BULL. 848.

MILLER, J.P., MONTGOMERY, ARTHUR, AND SUTHERLAND, P.K. (1963), GEOLOGY OF PART OF THE SOUTHERN SANGRE DE CRISTO MOUNTAINS, NEW MEXICO, N. MEX. MIN. AND TECH., STATE BUR. MINES AND MINERAL RES., MEMOIR 11.

OETKING, PHILLIP, ET. AL. (1967), GEOLOGICAL HIGHWAY MAP, SOUTHERN ROCKY MOUNTAIN REGION UTAH-COLORADO-ARIZONA-NEW MEXICO, AM. ASSOC. PETROL. GEOL.

RAST, N. (1956), THE ORIGIN AND SIGNIFICANCE OF BOUDINAGE, GEOL. MAG., V. 93, N. 5, P. 401 - 408.

READ, C.B., AND WOOD, G.H., JR. (1947), DISTRIBUTION AND CORRELATION OF PENNSYLVANIAN ROCKS IN LATE PALEOZOIC SEDIMENTARY BASINS OF NORTHERN NEW MEXICO, JOUR. GEOL.,

SHOWALTER, T.T. (1969), GEOLOGY OF PART OF THE CRESTON RANGE, MORA COUNTY, NEW MEXICO, MASTERS THESIS, UNIV. N. MEX., GEOL. DEPT.

STARK, J.T. (1956), GEOLOGY OF THE SOUTH MANZANO MOUNTAINS, NEW MEXICO, N. MEX. MIN. AND TECH., STATE BUR. MINES AND MINERAL RES., BULL. 34.

STUCK, HENRY (CA. 1967), TXTEDT, A TEXT EDITOR PROGRAM IN FORTRAN IV, N. MEX. INST. MIN. AND TECH., COMPUTER CENTER, (UNPUBLISHED).

TROGER, W.E. (1959), "OPTISCHE BESTIMUNG DER GESTEINSBILDENDEN MINERALE", TEIL 1, STUTTGART: E. SCHWEIZERBART'SCHE VERLAGSBUCHHANDLUNG.

TURNER, F.J., AND VERHOOGEN, J. (1960), "IGNEOUS AND METAMORPHIC PETROLOGY", SECOND EDITION, NEW YORK: MCGRAW-HILL BOOK COMPANY INC., P. 624.

WINKLER, H.G.F. (1965), "PETROGENESIS OF METAMORPHIC ROCKS", NEW YORK: SPRINGER-VERLAG, INC.

APPENDIX

PROGRAM NAME - OXIDE

PURPOSE - TO PRODUCE THE FOLLOWING TABLES FROM MODAL ANALYSES (WITH DATA CORRECTED TO 100%):

THE PROGRAM WILL PRODUCE THE FOLLOWING TABLES FROM MODAL ANALYSES (WITH DATA CORRECTED TO 100%):

1) VOLUME PER CENT OF MINERAL CONSTITUENTS SUBMITTED,

2) WEIGHT " " " " " ",

3) WEIGHT " " " THE OXIDES OF AL, SI, FE+++, FE++, MG, CA, K, NA, AND ZR,

4) WEIGHT PER CENT OF QUARTZ-MICROCLINE-PLAGIOCLASE,

5) " " " " MGO-CAO-FEO,

6) " " " " ORTHOCLASE-ANORTHITE-ALBITE,

7) " " " " QUARTZ-ALBITE-ORTHOCLASE AND AN ALBITE:ANORTHITE RATIO,

* 8) WEIGHT PER CENT OF OXIDES OF AL, FE+++, FE++, NA, K, AND MG FOR THE PROGRAM "ACFAKF", WHICH PLOTS TERNARY DIAGRAMS.

* TABLE 8 IS COMPUTED AND DATA CARDS FOR THE PROGRAM "ACFAKF" ARE PUNCHED ONLY IF THE PROGRAMMER SPECIFIES THE VALUE OF ISKIP AS GREATER THAN ZERO (SEE PROGRAM CONTROL VARIABLES). TABULAR DATA IS CORRECTED TO 100%. INPUT DATA MUST BE CORRECTED TO 100% BY USER OR UNRELIABLE DATA WILL RESULT.

USER VARIABLES - CORRECTION FACTORS FOR MINERALS WITH VARIABLE COMPOSITION BETWEEN END MEMBERS, FERROUS IRON CONTENT OF

MAGNETITE AND SPECIFIC GRAVITIES OF CONSTITUENT MINERALS ARE REPRESENTED ON THE HEADER CARD FOR THE DECK (OR ON THE FIRST CARD OF EACH PAIR REPRESENTING A SAMPLE, SEE REMARKS) IN AN F5.2 FORMAT (E.G. 53.41) IN THE FOLLOWING ORDER:

ORFACT - WEIGHT PER CENT ORTHOCLASE IN MICROCLINE,
ANFACT - " " " ANORTHITE " PLAGIOCLASE,
FEOFCT - " " " FERROUS OXIDE IN MAGNETITE,
SPGMIC - SPECIFIC GRAVITY OF MICROCLINE,
SPGPLG - " " " PLAGIOCLASE,
SPGMUS - " " " MUSCOVITE,
SPGBIO - " " " BIOTITE,
SPGMAG - " " " MAGNETITE,
SPGHEM - " " " HEMATITE,
SPGGAR - " " " GARNET,
SPGZIR - " " " ZIRCON.

ZERO VALUES FOR THE SPECIFIC GRAVITY VARIABLES WILL REMOVE THAT MINERAL FROM THE CALCULATIONS.

THE MINERAL CONSTITUENTS ARE READ FROM THE SECOND CARD OF EACH PAIR (OR FROM THE REMAINING SET OF DATA CARDS; SEE REMARKS) USING AN F5.2 FORMAT. THESE ARE :

QTZ - QUARTZ	MICRO - MICROCLINE	MUSC - MUSCOVITE
HEM - HEMATITE	PLAG - PLAGIOCLASE	BIOT - BIOTITE
ZIRC - ZIRCON	GARN - GARNET	MAGN - MAGNETITE

ALSO ON THIS CARD, BEGINNING IN COLUMN 46 ARE 16 COLUMNS RESERVED FOR THE SAMPLE IDENTIFICATION.

PROGRAM ALGORITHM - THE VOLUMETRIC INPUT DATA FOR EACH MINERAL IS CONVERTED TO WEIGHT PER CENT. DATA FOR EACH TABLE IS ADJUSTED TO 100%. VALUES FOR EACH TABLE ARE STORED IN SEPARATE ARRAYS. ONCE ALL OF THE DATA FOR EACH TABLE HAS BEEN CALCULATED THE TABLES ARE PRINTED.

PROGRAM CONTROL VARIABLES - WHEN "ISKP" IS PUNCHED (IN COLUMN 56) GREATER THAN 0 ON THE LAST CORECTION FACTOR CARD IN THE DATA DECK, TABLE 8 WILL BE PRINTED AND DATA CARDS PUNCHED FOR THE "ACFAKF" PROGRAM, WHICH CONSTRUCTS TERNARY DIAGRAMS ACCORDING TO THE PROCEDURE OUTLINED BY WINKLER (1965).

REMARKS -

IF THE CONTINUE STATEMENT LABELED 100 IS PLACED FOLLOWING THE FIRST READ STATEMENT, ONLY ONE CORRECTION FACTOR CARD IS USED FOR THE ENTIRE DATA SET. BUT, IF THE SAME CONTINUE STATEMENT PRECEEDS THE FIRST READ STATEMENT A CORRECTION FACTOR CARD IS USED WITH EVERY MODAL ANALYSIS.

THE TABLES WILL BE NUMBERED CONSECUTIVELY UNLESS THE VALUE OF "A" PRECEEDING THE TABLE LABEL IN THE PROGRAM IS SPECIFICALLY ASSIGNED AND SUBSTITUTED FOR STATEMENTS RWR00720, RWR02120, RWR02290, RWR02420, RWR02530, RWR02640, RWR02740, AND RWR02860.

THE SPECIMENS WITHIN EACH TABLE ARE NUMBERED CONSECUTIVELY. TABLES 1, 4, AND 7 OF THE EXAMPLE TABLES FOLLOWING THE PROGRAM OCCUR IN THE TEXT AS TABLE NUMBERS 1, 3, AND 4, RESPECTIVELY.

SUBPROGRAMS - NONE

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3, IBM 1443 LINE PRINTER, IBM 1442 CARD READ PUNCH, AND IBM 2415-II TAPE DRIVES.

STORAGE REQUIREMENTS - X'2BA0'

TIME -

COMPILE: 106 SECONDS.

LINKAGE EDITOR: 18 SECONDS.

TOTAL: 4.6 SECONDS PER SAMPLE.

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------------------------OXIDE PROGRAM---------------RIESE


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      PURPOSE OF PROGRAM
 READS VOLUMETRIC DATA ON MINERALS AND CALCULATES WEIGHT PERCENT
 OF THE MINERALS AND THE OXIDE WEIGHT PERCENT FROM THE MINERAL DATA
 IT ALSO CALCULATES TERNARY SYSTEM DATA FOR QUARTZ-ORTHOCLASE
 (MICROCLINE)-PLAGIOCLASE, OR-AN-AB, MGO-FEO-CAO, AND
 QUARTZ-ALBITE-ORTHOCLASE (W/  AB/AN RATIOS) SYSTEMS AND
 COMPILES IT IN A TABULAR FORM.
 TABULAR DATA IS ALSO PRINTED OUT FOR THE INPUT DATA.
 THE PROGRAM THEN PROCEEDS TO PRINT OUT AND PUNCH SELECTED OXIDES
 (CORRECTED TO 100 %) DATA FOR ACF-AKF DIAGRAM.

***************************************************************************

 DIMENSION SIO2(25),AL2O3(25),FE2O3(25),FEO(25),MGO(25),CAO(25),
$K2O(25),NA2O(25),ZRO2(25),TOTOX(25),Q(25),PL(25),WTAN(25),
$WTORM(25),WTALB(25),OR(25),AN(25),AB(25),C(25),F(25),QZ(25),
$AB2(25),OR2(25),RTO(25),WFEO(25),WFE2O3(25),WTH(25),WTQ(25),
$WTMIC(25),WTP(25),WTMUS(25),WTB(25),WTMAG(25),WTG(25),WTZ(25)
 REAL MICRO, MUSC, MAGN, K2O, MGO, NA2O, MIC(25), MM(25)
 INTEGER SMPLNM(25,4)
 K=0
 II=5
 IO=6
 IP=7

 ZEROS ALL ARRAYS

 DO 1000 I2=1,25
 AL2O3(I2)=0.
 SIO2(I2)=0.
 FE2O3(I2)=0.
 FEO(I2)=0.
 MGO(I2)=0.
 CAO(I2)=0.
 K2O(I2)=0.
 NA2O(I2)=0.
 ZRO2(I2)=0.
 TOTOX(I2)=0.
 Q(I2)=0.
 PL(I2)=0.
 WTAN(I2)=0.
 WTORM(I2)=0.
 WTALB(I2)=0.
```

```
      OR(I2)=0.
      AN(I2)=0.
      AB(I2)=0.
      C(I2)=0.
      F(I2)=0.
      QZ(I2)=0.
      AB2(I2)=0.
      OR2(I2)=0.
      RTO(I2)=0.
      WFEO(I2)=0.
      WFE2O3(I2)=0.
      WTQ(I2)=0.
      WTMIC(I2)=0.
      WTP(I2)=0.
      WTMUS(I2)=0.
      WTB(I2)=0.
      WTMAG(I2)=0.
      WTH(I2)=0.
      WTG(I2)=0.
      WTZ(I2)=0.
      MIC(I2)=0.
 1000 MM(I2)=0.
      A=1.
      WRITE(IO,1) A
      FORMAT('1'/'3',55X,'TABLE ',F3.0/' ',50X,'POINT COUNT ANALYSES'/
     $' ',54X,'VOLUMETRIC %')
      WRITE(IO,2)
      FORMAT('0',5X,' NO.      SPECIMEN     * QUARTZ * K-SPAR * PLAGIOCLAS
     $E * MUSCOV. * BIOTITE * MAGNET. * HEMATITE * GARNET * ZIRCON'
     $/' ',5X,110('-'))

      READS DECIMAL PROPORTION OF POTASSIUM FELDSPAR IN MICROCLINE,
      ANORTHITE IN PLAGIOCLASE, FERROUS IRON OXIDE IN MAGNETITE, (ALL BY
      WEIGHT PROPORTIONS), FOLLOWED BY SPECIFIC GRAVITIES OF
      MICROCLINE, PLAGIOCLASE, MUSCOVITE, BIOTITE, MAGNETITE,
      HAEMATITE, GARNET AND ZIRCON.

  100 CONTINUE
      READ(II,3) ORFACT,ANFACT,FEOFCT,SPGMIC,SPGPLG,SPGMUS,SPGBIO,
     $SPGMAG,SPGHEM,SPGGAR,SPGZIR,ISKIP
    3 FORMAT(11F5.2,I1)

      IF COLUMN 56 IS PUNCHED WITH A NUMBER, A DECK WILL BE PUNCHED FOR
      THE ACF-AKF PROGRAM.

      K=K+1

      READS VOLUME FROM MODAL ANALYSES FOR QUARTZ, MICROCLINE,
      PLAGIOCLASE, MUSCOVITE, BIOTITE, MAGNETITE, HAEMATITE, GARNET AND
```

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      ZIRCON, FOLLOWED BY A 16 CHARACTER FIELD FOR A SAMPLE NAME.

      READ(II,4) QTZ,MICRO,PLAG,MUSC,BIOT,MAGN,HEM,GARN,ZIRC,
     $(SMPLNM(K,I),I=1,4)
    4 FORMAT(9F5.2,4A4)
      IF(QTZ.LE.0) GO TO 7
      WRITE(IO,5) K,(SMPLNM(K,I),I=1,4),QTZ,MICRO,PLAG,MUSC,BIOT,MAGN,
     $HEM,GARN,ZIRC
    5 FORMAT(' ',6X,I2,1X,4A4,' * ',F6.2,' * ',F6.2,' * ',2X,F6.2,
     $3X,' * ',F6.2,'  * ',F6.2,'  * ',F6.2,'  *  ',F6.2,'  * ',
     $F5.2,'  * ',F5.2)
    6 WQTZ=QTZ*2.65
      WMICRO=MICRO*SPGMIC
      WPLAG=PLAG*SPGPLG
      WMUSC=MUSC*SPGMUS
      WBIOT=BIOT*SPGBIO
      WMAGN=MAGN*SPGMAG
      WHEM=HEM*SPGHEM
      WGARN=GARN*SPGGAR
      WZIRC=ZIRC*SPGZIR
      TWT=WQTZ+WMICRO+WPLAG+WMUSC+WBIOT+WMAGN+WHEM+WGARN+WZIRC
      WTQ(K)=WQTZ/TWT
      WTMIC(K)=WMICRO/TWT
      WTP(K)=WPLAG/TWT
      WTMUS(K)=WMUSC/TWT
      WTB(K)=WBIOT/TWT
      WTMAG(K)=WMAGN/TWT
      WTH(K)=WHEM/TWT
      WTG(K)=WGARN/TWT
      WTZ(K)=WZIRC/TWT

      CALCULATES THE QUARTZ-PLAGIOCLASE-MICROCLINE VALUES

      TOT1=WTQ(K)+WTP(K)+WTMIC(K)
      Q(K)=WTQ(K)/TOT1*100.
      PL(K)=WTP(K)/TOT1*100.
      MIC(K)=WTMIC(K)/TOT1*100.

      CALCULATION OF AB-AN MOLECULE FROM PLAGIOCLASE

      WTAN(K)=WTP(K)*ANFACT
      WTAB=WTP(K)-WTAN(K)

      CALCULATION OF ORTHOCLASE AND ALBITE MOLUCULES FROM MICROCLINE

      WTORM(K)=WTMIC(K)*ORFACT
      WTABM=WTMIC(K)-WTORM(K)
      WTALB(K)=WTAB+WTABM
```

```
CALCULATION OF FEO AND FE2O3 FROM MAGNETITE
 IN ABSCENCE OF CHEMICAL ANALYSIS ASSUME FEOFCT IS 0.31

 WFEO(K)=WTMAG(K)*FEOFCT
 WFE2O3(K)=WTMAG(K)-WFEO(K)

 CALCULATES DECIMAL PORTION OF OXIDE OF SILICON , ALUMINIUM,
 FERRIC IRON, FERROUS IRON, MAGNESIUM, CALCIUM, POTASSIUM, SODIUM,
 AND ZIRCONIUM.

 SIO2(K)=WTQ(K)+WTORM(K)*.647+WTABM*.687+WTAB*.687+WTAN(K)*.432+
$WTMUS(K)*.452 + WTB(K)*.425 + WTG(K)*.362 + WTZ(K)*.328
 AL2O3(K)=WTORM(K)*.184+WTABM*.184+WTAB*.195+WTAN(K)*.367+WTMUS(K)
$*.385 + WTB(K)*.172 + WTG(K)*.205
 FE2O3(K)= WTB(K)*.022 + WFE2O3(K) + WTG(K)*.433 + WTH(K)
 FEO(K)= WTB(K)*.027 + WFEO(K)
 MGO(K)=WTB(K)*.25
 CAO(K)=WTAN(K)
 K2O(K)=WTORM(K)*.169+WTMUS(K)*.118+WTB(K)*.090
 NA2O(K)= WTABM*.118 + WTAB*.118
 ZRO2(K)=WTZ(K)*.672

 CALCULATES THE OR-AN-AB VALUES

 TOT2=WTORM(K)+WTAN(K)+WTABM+WTAB
 OR(K)=WTORM(K)/TOT2*100.
 AN(K)=WTAN(K)/TOT2*100.
 AB(K)=(WTABM+WTAB)/TOT2*100.

 CALCULATES THE MGO-FEO-CAO VALUES

 TOT3=MGO(K)+CAO(K)+FEO(K)
 MM(K)=MGO(K)/TOT3*100.
 C(K)=CAO(K)/TOT3*100.
 F(K)=FEO(K)/TOT3*100.

 CALCULATES THE QUARTZ-AB-OR VALUES

 TOT4=WTORM(K)+WTABM+WTAB+WTQ(K)
 QZ(K)=WTQ(K)/TOT4*100.
 AB2(K)=(WTABM+WTAB)/TOT4*100.
 OR2(K)=WTORM(K)/TOT4*100.
 IF(WTAN(K).GT.0) RTO(K)=(WTABM+WTAB)/WTAN(K)
 IF(WTAN(K).LE.0) RTO(K)=999.99
 TOTOX(K)=SIO2(K)+AL2O3(K)+FE2O3(K)+FEO(K)+MGO(K)+CAO(K)+K2O(K)+
5NA2O(K)+ZRO2(K)
 IF((TOTOX(K).LT.100.01).AND.(TOTOX(K).GT.99.99)) GO TO 6
 SIO2(K)=SIO2(K)/TOTOX(K)*100.
 AL2O3(K)=AL2O3(K)/TOTOX(K)*100.
```

```
      FE2O3(K)=FE2O3(K)/TOTOX(K)*100.
      FEO(K)=FEO(K)/TOTOX(K)*100.
      MGO(K)=MGO(K)/TOTOX(K)*100.
      CAO(K)=CAO(K)/TOTOX(K)*100.
      K2O(K)=K2O(K)/TOTOX(K)*100.
      NA2O(K)=NA2O(K)/TOTOX(K)*100.
      ZRO2(K)=ZRO2(K)/TOTOX(K)*100.
      TOTOX(K)=SIO2(K)+AL2O3(K)+FE2O3(K)+FEO(K)+MGO(K)+CAO(K)+K2O(K)+
     $NA2O(K)+ZRO2(K)
      GO TO 100

      WRITES OUT THE MOLECULAR WEIGHT PERCENTS OF MINERALS READ IN,
      PRECEDED BY A SAMPLE NAME AND REFERENCE NUMBER.

    7 K1=K-1
      A=A+1.
      WRITE(IO,8) A
    8 FORMAT('1'/'3',55X,'TABLE ',F3.0/' ',47X,'MOLECULAR WEIGHT PERCENT
     $S')
      WRITE(IO,9)
    9 FORMAT('0',' NO.      SPECIMEN     * QUARTZ * K-SPAR * PLAGIOCLASE *
     $ AN X  * MUSCOV. * BIOTITE * MAGNET. * HEMATITE * GARNET * ZIRCON'
     $/' ',1X,118('-'))
      WRITE(IO,10)(L,(SMPLNM(L,I),I=1,4),WTQ(L),WTMIC(L),WTP(L),ANFACT,
     $WTMUS(L),WTB(L),WTMAG(L),WTH(L),WTG(L),WTZ(L),L=1,K1)
   10 FORMAT(' ',1X,I2,1X,4A4,' * ',2PF6.2,' * ',2PF6.2,' * ',2X,2PF6.2,
     $2X,' * ',2PF5.2,' * ',2PF6.2,'  * ',2PF6.2,'  * ',2PF6.2,'  *  ',
     $2PF6.2,'  * ',2PF5.2,'  * ',2PF5.2)

      WRITES OUT WEIGHT PERCENT OF CALCULATED OXIDES PRECEDED BY
      SAMPLE NAME AND REFERENCE NUMBER.

      A=A+1.
      WRITE(IO,11) A
   11 FORMAT('1'/'3',48X,'TABLE ',F3.0/' ',36X,'OXIDE PERCENTS, CALCULAT
     $ED BY WEIGHT'//
     $'0',5X,'NO.',5X,'SPECIMEN     * SIO2   * AL2O3 * FE2O3 *   FEO   *  MG
     $O  *  CAO  *  K2O   * NA2O   * ZRO2   * TOTAL'/' ',5X,99('-'))
      DO 12 M=1,K1
   12 WRITE(IO,13)M,(SMPLNM(M,I),I=1,4),SIO2(M),AL2O3(M),FE2O3(M),
     $FEO(M),MGO(M),CAO(M),K2O(M),NA2O(M),ZRO2(M),TOTOX(M)
   13 FORMAT(' ',5X,I2,1X,4A4,10(' *',F6.2))

      WRITES OUT QUARTZ-MICROCLINE-PLAGIOCLASE DATA CORRECTED TO 100%.

      A=A+1.
      WRITE(IO,14) A
   14 FORMAT('1'/'3',52X,'TABLE ',F3.0/' ',33X,'QUARTZ-MICROCLINE-PLAGIO
     $CLASE VALUES, BY WEIGHT %'//
```

```
     $'0',30X,'NO.',5X,'SPECIMEN     * QUARTZ * MICROCLINE * PLAGIOCLASE'RWRO
     $/' ',30X,55('-'))                                                 RWRO
      WRITE(IO,15)(M,(SMPLNM(M,I),I=1,4),Q(M),MIC(M),PL(M),M=1,K1)      RWRO
   15 FORMAT(' ',30X,I2,1X,4A4,' * ',F6.2,' *  ',F6.2,'     *    ',F6.2) RWRO
                                                                        RWRO
      WRITES OUT MAFIC VALUES CORRECTED TO 100,.                        RWRO
                                                                        RWRO
      A=A+1.                                                            RWRO
      WRITE(IO,16) A                                                    RWRO
   16 FORMAT('1'/'3',56X,'TABLE ',F3.0/' ',42X,'MAFIC OXIDE VALUES (MCF)RWRO
     $, BY WEIGHT %'//'0',                                              RWRO
     $39X,'NO.',4X,'SPECIMEN      * MGO % * CAO % * FEO %'/' ',39X,43('-'RWRO
     $))                                                                RWRO
      WRITE(IO,17)(L,(SMPLNM(L,I),I=1,4),MM(L),C(L),F(L),L=1,K1)        RWRO
   17 FORMAT(' ',39X,I2,1X,4A4,' *',F6.2,' *',F6.2,' *',F6.2)           RWRO
                                                                        RWRO
      WRITES OUT VALUES OF OR-AN-AB DATA CORRECTED TO 100%.             RWRO
                                                                        RWRO
      A=A+1.                                                            RWRO
      WRITE(IO,18) A                                                    RWRO
   18 FORMAT('1'/'3',53X,'TABLE ',F3.0/' ',35X,'ORTHOCLASE-ANORTHITE-ALBRWRO
     $ITE VALUES, BY WEIGHT %'//                                        RWRO
     $'0',37X,'NO.   SPECIMEN      *  OR%  *  AN%  *  AB%'/' ',37X,     RWRO
     $43('-'))                                                          RWRO
      WRITE(IO,19)(L,(SMPLNM(L,I),I=1,4),OR(L),AN(L),AB(L),L=1,K1)      RWRO
   19 FORMAT(' ',37X,I2,1X,4A4,' *',F6.2,' *',F6.2,' *',F6.2)           RWRO
                                                                        RWRO
      WRITES OUT VALUES OF QUARTZ-AB-OR DATA CORRECTED TO 100%.         RWRO
      A=A+1.                                                            RWRO
      WRITE(IO,20) A                                                    RWRO
   20 FORMAT('1'/'3',53X,'TABLE ',F3.0/' ',36X,'QUARTZ-ALBITE-ORTHOCLASERWRO
     $ VALUES, BY WEIGHT %'                                             RWRO
     $//'0',33X,'NO.      SPECIMEN    * QTZ % *  AB%  *  OR%  * AB/AN'/ RWRO
     $' ',33X,51('-'))                                                  RWRO
      WRITE(IO,21)(L,(SMPLNM(L,I),I=1,4),QZ(L),AB2(L),OR2(L),RTO(L),    RWRO
     $L=1,K1)                                                           RWRO
   21 FORMAT(' ',33X,I2,1X,4A4,' *',F6.2,' *',F6.2,' *',F6.2,' *',F6.2) RWRO
      RECALCULATES SELECTED OXIDES TO 100 PERCENT (FOR ACF-AKF DATA)    RWRO
                                                                        RWRO
      IF(ISKIP.LE.0) GO TO 99                                           RWRO
      A=A+1.                                                            RWRO
      WRITE(IO,22) A                                                    RWRO
   22 FORMAT('1'/'3',60X,'TABLE ',F3.0/' ',41X,'DATA FOR THE ACF-AKF TERRWRO
     $NARY DIAGRAM, (WEIGHT %)')                                        RWRO
      WRITE(IO,23)                                                      RWRO
   23 FORMAT('0',21X, 'NO.     SPECIMEN     *  AL2O3  *  FE2O3  *  NA2O RWRO
     $*   K2O   *   CAO   *   FEO   *   MGO'/' ',21X,87('-'))           RWRO
      DO 24 M=1,K1                                                      RWRO
      TOTOX(M)=TOTOX(M)-SIO2(M)-ZRO2(M)-WTH(M)-WFE2O3(M)-WFEO(M)        RWRO
```

```
      AL203(M)=AL203(M)/TOTOX(M)*100.                                    RWR029
      FE203(M)=(FE203(M)-WFE203(M)-WTH(M))/TOTOX(M)*100.                 RWR029
      NA20(M)=NA20(M)/TOTOX(M)*100.                                      RWR029
      K20(M)=K20(M)/TOTOX(M)*100.                                        RWR029
      CAO(M)=CAO(M)/TOTOX(M)*100.                                        RWR029
      FEO(M)=(FEO(M)-WFEO(M))/TOTOX(M)*100.                              RWR030
      MGO(M)=MGO(M)/TOTOX(M)*100.                                        RWR030
   24 WRITE(IO,25) M,(SMPLNM(M,I),I=1,4),AL203(M),FE203(M),NA20(M),      RWR030
     $K20(M),CAO(M),FEO(M),MGO(M)                                        RWR030
   25 FORMAT(' ',21X,I2,1X,4A4,'*  ',F5.2,'  *  ',F5.2,'  *  ',F5.2,'   *RWR030
     $  ',F5.2,'  *  ',F5.2,'  *  ',F5.2,'  *  ',F5.2)                   RWR030
      WRITE(IO,2000)                                                     RWR030
 2000 FORMAT('1')                                                        RWR030
      DO 28 M=1,K1                                                       RWR030
                                                                         RWR030
      PUNCHES CARDS WITHE CALCULATED PERCENTS OF FOLLOWING OXIDES--     RWR030
      ALUMINIUM, FERRIC IRON, SODIUM, POTASSIUM, CALCIUM, FERROUS IRON  RWR030
      AND MAGNESIUM (FOR ACF-AKF DATA).                                  RWR031
                                                                         RWR031
   26 WRITE(IP,27,END=26)AL203(M),FE203(M),NA20(M),K20(M),CAO(M),FEO(M),RWR031
     $MGO(M)                                                             RWR031
   27 FORMAT(5F6.2,2(6X,F6.2))                                           RWR031
   28 CONTINUE                                                           RWR031
   99 STOP                                                               RWR031
      END                                                                RWR031
```

TABLE 2.

MOLECULAR WEIGHT PERCENTS

NO.	SPECIMEN	QUARTZ	K-SPAR	PLAGIOCLASE	AN %	MUSCOV.	BIOTITE	MAGNET.	HEMATITE	GARNET	ZIRCON
1	MUSC QTZ SCHIST	77.18	4.57	0.0	0.0	18.06	0.0	0.19	0.0	0.0	0.0
2	MUSC SCHIST	54.91	4.75	5.37	0.0	32.15	0.57	1.13	0.95	0.0	0.17
3	MUSC SCHIST	55.14	4.25	0.10	0.0	37.27	0.68	2.25	0.0	0.31	0.0
4	MUSC SCHIST	48.30	0.0	5.47	0.0	42.34	0.0	2.97	0.0	0.91	0.0
5	GRANITIC GNEISS	42.89	34.26	9.87	0.0	10.26	0.0	2.72	0.0	0.0	0.0
6	GRANITIC GNEISS	28.00	24.16	43.18	0.0	0.54	1.99	1.96	0.0	0.16	0.0
7	GRANITIC GNEISS	47.78	30.93	17.70	0.0	2.41	0.0	1.18	0.0	0.0	0.0
8	GRANITIC GNEISS	40.89	39.78	11.74	0.0	1.94	1.40	4.08	0.0	0.0	0.17
9	GRANITIC GNEISS	33.40	43.99	17.99	0.0	1.75	0.71	2.16	0.0	0.0	0.0
10	GRANITIC GNEISS	37.81	31.12	25.01	0.0	0.11	5.18	0.59	0.0	0.0	0.18
11	GRANITIC GNEISS	41.39	26.11	17.36	0.0	13.39	0.0	1.75	0.0	0.0	0.0
12	GRANITIC GNEISS	53.81	17.17	23.27	0.0	0.11	5.64	0.0	0.0	0.0	0.0
13	GRANITIC GNEISS	37.14	25.63	27.11	0.0	5.25	0.0	4.24	0.0	0.63	0.0
14	GRANITIC GNEISS	36.48	43.10	16.92	0.0	0.66	1.06	1.77	0.0	0.0	0.0
15	GRANITIC GNEISS	42.26	27.76	20.16	0.0	6.14	0.0	3.68	0.0	0.0	0.0
16	GRANITIC GNEISS	31.80	45.15	18.39	0.0	0.98	1.54	1.97	0.0	0.0	0.18

TABLE 3.
OXIDE PERCENTS, CALCULATED BY WEIGHT

NO.	SPECIMEN	SIO2	AL2O3	FE2O3	FEO	MGO	CAO	K2O	NA2O	ZRO2	TOTAL
1	MUSC QTZ SCHIST	89.03	7.86	0.13	0.06	0.0	0.0	2.88	0.03	0.0	100.00
2	MUSC SCHIST	76.55	14.68	1.76	0.37	0.14	1.24	4.62	0.52	0.11	100.00
3	MUSC SCHIST	76.49	15.59	1.73	0.73	0.17	0.02	5.22	0.04	0.0	100.00
4	MUSC SCHIST	71.90	17.93	2.47	0.93	0.0	1.22	5.04	0.51	0.0	100.00
5	GRANITIC GNEISS	74.90	12.41	1.85	0.83	0.0	2.34	6.56	1.11	0.0	100.00
6	GRANITIC GNEISS	66.41	14.08	1.35	0.61	0.46	9.58	3.77	3.74	0.0	100.00
7	GRANITIC GNEISS	77.50	10.46	0.79	0.35	0.0	4.11	5.03	1.75	0.0	100.00
8	GRANITIC GNEISS	74.03	10.85	2.79	1.28	0.34	2.76	6.54	1.31	0.11	100.00
9	GRANITIC GNEISS	72.06	12.70	1.46	0.67	0.17	4.01	7.03	1.89	0.0	100.00
10	GRANITIC GNEISS	72.77	11.99	0.50	0.31	1.24	5.51	5.19	2.39	0.11	100.00
11	GRANITIC GNEISS	73.42	13.68	1.18	0.53	0.0	3.89	5.58	1.72	0.0	100.00
12	GRANITIC GNEISS	78.54	9.27	0.12	0.15	1.35	5.35	3.11	2.12	0.0	100.00
13	GRANITIC GNEISS	70.10	12.63	3.06	1.26	0.0	5.95	4.48	2.53	0.0	100.00
14	GRANITIC GNEISS	73.62	11.97	1.21	0.56	0.26	3.78	6.81	1.79	0.0	100.00
15	GRANITIC GNEISS	73.40	11.78	2.46	1.11	0.0	4.30	4.97	1.99	0.0	100.00
16	GRANITIC GNEISS	71.48	12.84	1.35	0.63	0.37	4.09	7.19	1.93	0.11	100.00

TABLE 5.
MAFIC OXIDE VALUES (MCF), BY WEIGHT %

NO.	SPECIMEN	* MGO %	* CAO %	* FEO %
1	MUSC QTZ SCHIST	* 0.0	* 0.0	*100.00
2	MUSC SCHIST	* 8.13	* 70.85	* 21.03
3	MUSC SCHIST	* 18.62	* 2.42	* 78.97
4	MUSC SCHIST	* 0.0	* 56.64	* 43.36
5	GRANITIC GNEISS	* 0.0	* 73.74	* 26.26
6	GRANITIC GNEISS	* 4.33	* 89.94	* 5.73
7	GRANITIC GNEISS	* 0.0	* 92.06	* 7.94
8	GRANITIC GNEISS	* 7.82	* 63.03	* 29.14
9	GRANITIC GNEISS	* 3.54	* 82.67	* 13.79
10	GRANITIC GNEISS	* 17.58	* 78.05	* 4.37
11	GRANITIC GNEISS	* 0.0	* 88.05	* 11.95
12	GRANITIC GNEISS	* 19.73	* 78.14	* 2.13
13	GRANITIC GNEISS	* 0.0	* 82.59	* 17.41
14	GRANITIC GNEISS	* 5.62	* 82.16	* 12.22
15	GRANITIC GNEISS	* 0.0	* 79.54	* 20.46
16	GRANITIC GNEISS	* 7.29	* 80.33	* 12.38

TABLE 6.
ORTHOCLASE-ANORTHITE-ALBITE VALUES, BY WEIGHT %

NO.	SPECIMEN	*	OR%	*	AN%	*	AB%
1	MUSC QTZ SCHIST	*	94.00	*	0.0	*	6.00
2	MUSC SCHIST	*	44.08	*	12.21	*	43.70
3	MUSC SCHIST	*	91.94	*	0.50	*	7.56
4	MUSC SCHIST	*	0.0	*	22.00	*	78.00
5	GRANITIC GNEISS	*	72.98	*	5.37	*	21.65
6	GRANITIC GNEISS	*	33.73	*	15.39	*	50.89
7	GRANITIC GNEISS	*	59.79	*	8.73	*	31.48
8	GRANITIC GNEISS	*	72.59	*	5.47	*	21.95
9	GRANITIC GNEISS	*	66.72	*	6.67	*	26.60
10	GRANITIC GNEISS	*	52.11	*	10.25	*	37.64
11	GRANITIC GNEISS	*	56.46	*	9.18	*	34.35
12	GRANITIC GNEISS	*	39.90	*	13.81	*	46.28
13	GRANITIC GNEISS	*	45.68	*	11.82	*	42.50
14	GRANITIC GNEISS	*	67.50	*	6.48	*	26.01
15	GRANITIC GNEISS	*	54.45	*	9.26	*	36.30
16	GRANITIC GNEISS	*	66.80	*	6.66	*	26.54

TABLE 8.

DATA FOR THE ACF-AKF TERNARY DIAGRAM, (WEIGHT %)

NO.	SPECIMEN	*	AL2O3	*	FE2O3	*	NA2O	*	K2O	*	CAO	*	FEO	*	MGO
1	MUSC QTZ SCHIST	*	71.67	*	1.22	*	0.30	*	26.27	*	0.0	*	0.55	*	0.0
2	MUSC SCHIST	*	62.96	*	7.47	*	2.25	*	19.82	*	5.33	*	1.57	*	0.61
3	MUSC SCHIST	*	66.39	*	7.31	*	0.17	*	22.23	*	0.09	*	3.07	*	0.73
4	MUSC SCHIST	*	63.88	*	8.72	*	1.81	*	17.97	*	4.33	*	3.28	*	0.0
5	GRANITIC GNEISS	*	49.50	*	7.31	*	4.43	*	26.16	*	9.31	*	3.28	*	0.0
6	GRANITIC GNEISS	*	41.94	*	3.99	*	11.13	*	11.24	*	28.53	*	1.80	*	1.37
7	GRANITIC GNEISS	*	46.51	*	3.48	*	7.78	*	22.38	*	18.29	*	1.56	*	0.0
8	GRANITIC GNEISS	*	42.03	*	10.68	*	5.06	*	25.32	*	10.68	*	4.89	*	1.33
9	GRANITIC GNEISS	*	45.51	*	5.19	*	6.75	*	25.20	*	14.36	*	2.37	*	0.61
10	GRANITIC GNEISS	*	44.22	*	1.82	*	8.80	*	19.14	*	20.31	*	1.13	*	4.57
11	GRANITIC GNEISS	*	51.50	*	4.38	*	6.47	*	21.02	*	14.66	*	1.97	*	0.0
12	GRANITIC GNEISS	*	43.17	*	0.55	*	9.86	*	14.50	*	24.94	*	0.68	*	6.30
13	GRANITIC GNEISS	*	42.30	*	10.13	*	8.46	*	15.00	*	19.94	*	4.16	*	0.0
14	GRANITIC GNEISS	*	45.41	*	4.55	*	6.78	*	25.84	*	14.32	*	2.11	*	0.98
15	GRANITIC GNEISS	*	44.35	*	9.16	*	7.48	*	18.71	*	16.17	*	4.12	*	0.0
16	GRANITIC GNEISS	*	45.24	*	4.70	*	6.79	*	25.33	*	14.42	*	2.20	*	1.31

PROGRAM NAME - ORIENT

PURPOSE - TO ACCEPT PLANAR (E.G. MUSCOVITE CLEAVAGE PLANES) AND LINEAR (E.G. QUARTZ OPTIC AXES DATA READ FROM A ZEISS, 4-AXIS UNIVERSAL STABE AND CONVERT IT TO A FORM WHICH WILL BE ACCEPTABLE TO THE "SMTPLT" PROGRAM. THIS ALSO ALLOWS THE USE OF A THREE-FOLD SEPARATION OF THE DATA ACCORDING TO THE FEATURES THE USER DESIRES TO USE (E.G. INCLUSIONS, CLOUDINESS, SIZE, SHAPE, ETC. OF THE MINERAL).

USER VARIABLES -

HEADER CARD:

LNPL - INDICATES WHETHER DATA IS PLANAR (1) OR LINEAR (2) IS USED. PUNCHED IN COLUMN 1.

NMAX - NUMBER OF ELEMENTS IN THE PLOT TO BE MADE. MAXIMUM VALUE IS 200. LARGER VALUES WILL TERMINATE THE PROGRAM WITH "STOP 1" PRINTED ON THE CONSOLE TYPEWRITER. NMAX IS RIGHT-JUSTIFIED IN COLUMNS 2, 3, AND 4.

NM - COLUMNS 5 THROUGH 52 ARE USED FOR A TITLE WHICH APPEARS ON THE PRINTOUT AND ON THE HEADER CARD OF THE CARDS WHICH ARE PUNCHED BY THIS PROGRAM.

DATA CARDS:

NOTE - ALL OF THE FOLLOWING VALUES ARE RIGHT-JUSTIFIED AND DATA FOR THE FIRST 8 COLUMNS ARE INDICATED.

IV - COLUMNS 1, 2, AND 3. VALUE READ FROM INNER VERTICAL AXIS.

NS - COLUMNS 3, 4, AND 5. REPRESENTS PLUNGE VALUE OF LINEAR ELEMENT; READ FROM THE NORTH-SOUTH AXIS. THIS IS ALSO THE DIP VALUE OF A PLANAR ELEMENT; READ FROM THE EAST-WEST AXIS.

DD - COLUMN 6. REPRESENTS DOWNWARD TILT DIRECTION ABOUT THE NORTH-SOUTH AXIS WHEN MEASURING LINEAR ELEMENTS (L = DOWN ON THE LEFT SIDE AND R = DOWN OF THE RIGHT SIDE).

WHEN MEASURING PLANAR ELEMENTS THIS IS THE DOWNWARD TILT ABOUT THE EAST-WEST AXIS (U = TILTED AWAY FROM THE OBSERVER, D = TILTED TOWARD THE OBSERVER).

SZ - COLUMN 7. SZ IS USED TO SEPARATE ELEMENTS BASED ON ANY PARTICULAR FEATURE SUCH AS GRAINS SIZE, INCLUSIONS, ETC. THREE DIVISIONS ARE ALLOWED. THESE DIVISIONS ARE INDICATED IN COLUMN 7 BY L, M, OR S. THE OUTPUT WILL BE PUNCHED ACCORDING TO THE FOLLOWING: TOTAL CORRECTED DATA, S, M, L, AND M PLUS L.

NOTE - AT LEAST 15 VALUES MUST EXIST IN A GROUP IN ORDER TO HAVE THAT GROUP PUNCHED. PRINTOUTS OF ALL GROUPS ARE ALWAYS PRODUCED EXCEPT FOR THE M PLUS L COMBINATION.

SN - COLUMN 8. THIS IS USED EXCLUSIVELY FOR LINEAR

ELEMENTS. THE NOTATION "P" INDICATES THE OPTIC AXIS OF THE MINERAL IS PARALLEL WITH THE AXIS OF THE MICROSCOPE, WHILE "M" INDICATES THE OPTIC AXIS IS PARALLEL WITH THE EAST-WEST AXIS OF THE UNIVERSAL STAGE.

DATA FOR UP TO 8 MINERALS MAY BE PUNCHED ON A CARD. ONLY THE LAST CARD OF THE DATA DECK MAY BE PARTIALLY FILLED WITH INFORMATION, OTHERWISE THE RESULTS WILL NOT BE PREDICTABLE.

PROGRAM ALGORITHM - AFTER THE ABOVE INFORMATION HAS BEEN READ, THE STRUCTURAL ELEMENTS ARE CONVERTED INTO BEARINGS OF 0-360 DEGREES AND DIPS OR PLUNGES OF 0-90 DEGREES.

DIP DIRECTIONS OF E AND W ARE ADDED TO PLANAR DATA TO INDICATE DIPS DOWNWARD TO THE LEFT AND RIGHT ON THE PROJECTION, RESPECTIVELY. DIP DIRECTIONS DUE SOUTH OR NORTH ARE INDICATED WITH S AND N, RESPECTIVELY.

THE SEPARATIONS ACCORDING TO THE S, M, AND L NOTATION ARE GROUPED, PRINTED OUT AND PUNCHED ON CARDS IN THAT ORDER.

REMARKS - NO INTERVENTION IS REQUIRED BY THE OPERATOR TO INITIATE THE PUNCH OPERATION. USER MUST SUPPLY SUFFICIENT BLANK CARDS BETWEEN DATA SETS, WHEN RUNNING MORE THAN ONE SET OF DATA, TO PREVENT SUCCEEDING DATA FROM BEING PUNCHED.

THE PROGRAM IS TERMINATED WITH A TRAILER CARD WITH A 9 PUNCHED IN COLUMN ONE.

SUBPROGRAMS - NONE

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3, IBM 1443 LINE
PRINTER, IBM 1442 CARD READER-PUNCH.

STORAGE REQUIREMENTS - X'332C' BYTES.

TIME -

COMPILE: 75 SECONDS.

LINKAGE EDITOR: 19 SECONDS.

TOTAL: 218 SECONDS FOR 3 SETS OF DATA CONTAINING 90 ELEMENTS EACH.

```
------------------------------PROGRAM ORIENT----------------RIESE

      DIMENSION IV(200),NS(200),NM(200),KB(200),KD(200)
      INTEGER L/'L   '/,M/'M   '/,N/'N   '/,S/'S   '/,E/'E   '/,
     $W/'W   '/,U/'U   '/,D/'D   '/,DD(200),SN(200),SZ(200),EW(200),
     $P/'P   '/
      EQUIVALENCE (NS(1),EW(1))
    1 FORMAT(I1,I3,12A4)
    2 FORMAT('1',12A4,3X,'TOTAL ATTITUDES = ',I3)
    3 FORMAT(8(I3,I3,A1,A1,A1))
    4 FORMAT('0',4X,I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,
     $I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,
     $I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,
     $I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,I3,1X,I3,1X,A1,1X,A1,1X,A1,1X,
     $I3,1X,I3,1X,A1,1X,A1,1X,A1)
    5 FORMAT('1',12A4,3X,'CORRECTED PLANAR DATA'/'0',50X,'TOTAL ATTITUDE
     $S = ',I3)
    6 FORMAT('1',12A4,3X,'CORRECTED LINEAR DATA'/'0',50X,'TOTAL ATTITUDE
     $S = ',I3)
    7 FORMAT('0',7X,26I4)
    8 FORMAT(26I3)
    9 FORMAT('1',51X,'DATA OF GRADE -S-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   10 FORMAT('1',51X,'DATA OF GRADE -M-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   11 FORMAT('1',51X,'DATA OF GRADE -L-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   12 FORMAT('0',29X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,
     $I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,
     $I2,A1)
   13 FORMAT(13(I3,I2,A1))
   14 FORMAT('1',51X,'DATA OF GRADE -S-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   15 FORMAT('1',51X,'DATA OF GRADE -M-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   16 FORMAT('1',51X,'DATA OF GRADE -L-'/' ',49X,'TOTAL ATTITUDES = ',
     $I3)
   17 FORMAT(12A4)
   18 FORMAT('0',3X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,
     $I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,
     $I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,I3,1X,I2,A1,2X,
     $I3,1X,I2,A1,2X,I3,1X,I2,A1)
      II=5
      IO=6
      IP=7

      THE FIRST COLUMN ON THE HEADER CARD IS PUNCHED WITH A 2 (FOR LNPL)
      TO INDICATE THAT THE DATA TO FOLLOW ARE LINEAR ELEMENTS.   A 1 IS
      USED TO INDICATE THAT THE DATA ARE PLANAR ELEMENTS.

      RIGHT-JUSTIFIED IN COLUMNS 2, 3, AND 4 THE TOTAL NUMBER OF
      ELEMENTS (NMAX) IS PUNCHED (THE MAXIMUM ALLOWED IS 200).

      COLUMNS 5 THROUGH 52 ARE USED FOR THE LABEL WHICH APPEARS ON THE
      PRINTOUT AND ON THE LEADING CARD WHEN THE CARDS ARE PUNCHED.
```

```
110 READ(II,1)LNPL,NMAX,(NM(I),I=1,12)                                  RWR00
    IF(LNPL.EQ.0) GO TO 110                                               RWR00
    IF(NMAX)99,99,111                                                     RWR00
111 IF(NMAX-200)112,112,98                                                RWR00
112 WRITE(IO,2)(NM(I),I=1,12),NMAX                                        RWR00
                                                                          RWR00
    STRUCTURAL DATA (REPRESENTS DATA AS READ FROM A 4-AXIS ZEISS          RWR00
                  UNIVERSAL STAGE)                                        RWR00
                                                                          RWR00
    ---------------------------------------------------------------------RWR00
    NOTE - ALL OF THE FOLLOWING VALUES ARE RIGHT-JUSTIFIED.               RWR00
    ---------------------------------------------------------------------RWR00
                                                                          RWR00
    IV - COLUMNS 1, 2, AND 3.   VALUE READ FROM INNER VERTICAL AXIS.      RWR00
    NS - COLUMNS 3, 4, AND 5.   REPRESENTS PLUNGE VALUE OF LINEAR         RWR00
    ELEMENT; READ FROM THE NORTH-SOUTH AXIS.   THIS IS ALSO               RWR00
         THE DIP VALUE OF A PLANAR ELEMENT; READ FROM THE EAST-WEST       RWR00
         AXIS.                                                            RWR00
    DD - COLUMN 6.   REPRESENTS DOWNWARD TILT DIRECTION ABOUT THE         RWR00
         NORTH-SOUTH AXIS WHEN MEASURING LINEAR ELEMENTS (L = DOWN        RWR00
         ON THE LEFT SIDE & R = DOWN ON THE RIGHT SIDE).                  RWR00
         WHEN MEASURING PLANAR ELEMENTS THIS IS THE DOWNWARD TILT         RWR00
         ABOUT THE EAST-WEST AXIS (U = TILTED AWAY FROM THE OBSERVER,     RWR00
    D = TILTED TOWARD THE OBSERVER).                                      RWR00
    SZ - COLUMN 7.   SZ IS USED TO SEPARATE ELEMENTS BASED ON ANY         RWR00
         PARTICULAR FEATURE SUCH AS GRAIN SIZE, INCLUSIONS,               RWR00
         CLOUDY MINERALS, ETC.   THREE DIVISIONS ARE ALLOWED.             RWR00
         THESE DIVISIONS ARE INDICATED IN COLUMN 7 BY L, M, OR S.         RWR00
         THE OUTPUT WILL BE PUNCHED ACCORDING TO THE FOLLOWING: TOTAL     RWR00
         CORRECTED DATA, S, M, L, AND M PLUS L.                           RWR00
                                                                          RWR00
    NOTE - AT LEAST 15 VALUES MUST EXIST IN SEPARATED MEMBER IN ORDER     RWR00
         TO BE PUNCHED.   PRINTOUT IS ALWAYS PRODUCED EXCEPT FOR THE      RWR00
         M PLUS L COMBINATION.                                            RWR00
                                                                          RWR00
    SN - COLUMN 8.   THIS IS USED EXCLUSIVELY FOR LINEAR ELEMENTS.        RWR00
         THE NOTATION P INDICATES THE OPTIC AXIS OF THE MINERAL IS        RWR00
         PARALLEL WITH THE AXIS OF THE MICROSCOPE, WHILE M INDICATES      RWR00
         THE OPTIC AXIS IS PARALLEL WITH THE EAST-WEST AXIS OF THE        RWR00
         UNIVERSAL STAGE.                                                 RWR00
    ---------------------------------------------------------------------RWR00
    DATA FOR UP TO 8 MINERALS MAY BE PUNCHED ON A CARD.   ONLY THE        RWR00
    LAST CARD OF THE DATA DECK MAY BE PARTIALLY FILLED WITH               RWR01
         INFORMATION, OTHERWISE THE RESULTS WILL NOT BE PREDICTABLE.      RWR01
                                                                          RWR01
    AFTER ALL OF THE DATA ARE READ, THE NEXT CARD (A BLANK CARD)          RWR01
    IS READ INTO A DUMMY VARIABLE.   THIS CAUSES THE LAST DATA CARD       RWR01
    TO PASS BY THE PUNCH STATION SO IT WILL NOT BE PUNCHED.               RWR01
    PUNCHING OCCURS WITHOUT OPERATOR INTERVENTION.                        RWR01
                                                                          RWR01
    EACH DATA SET IN THE DECK SHOULD BE SEPARATED BY ( AT LEAST 3         RWR01
    TIMES AS MANY) BLANK CARDS AS PREVIOUS DATA CARDS.                    RWR01
                                                                          RWR01
    READ(II,17) NOTHIN                                                    RWR01
    WRITE(IO,4)(IV(I),NS(I),DD(I),SZ(I),SN(I),I=1,NMAX)                   RWR01
    GO TO(120,113),LNPL                                                   RWR01
                                                                          RWR01
```

```
      CALCULATES THE OUTPUT FOR LINEAR DATA

113   DO 119 I=1,NMAX
      IF(NS(I).GT.90) GO TO 98
      IF(SN(I).EQ.P) GO TO 118
      IF(DD(I).EQ.L) GO TO 116
114   IF(IV(I).LT.135) GO TO 115
      IV(I)=495-IV(I)
      GO TO 119
115   IV(I)=135-IV(I)
      GO TO 119
116   IF(IV(I).GT.315) GO TO 117
      IV(I)=315-IV(I)
      GO TO 119
117   IV(I)=675-IV(I)
      GO TO 119
118   NS(I)=90-NS(I)
      IF(DD(I).EQ.L) GO TO 114
      GO TO 116
119   CONTINUE
      GO TO 131

      CALCULATES THE OUTPUT FOR PLANAR DATA

120   DO 129 I=1,NMAX
      IF(EW(I).GE.270) GO TO 121
      EW(I)=90-EW(I)
      GO TO 122
121   EW(I)=EW(I)-270
122   IF(IV(I)-225)124,123,127
123   IF(DD(I).EQ.U) DD(I)=S
      IF(DD(I).EQ.D) DD(I)=N
      IV(I)=90
      GO TO 129
124   IF(IV(I).LT.135) GO TO 125
      IV(I)=495-IV(I)
      GO TO 126
125   IV(I)=135-IV(I)
126   IF(DD(I).EQ.U) DD(I)=W
      IF(DD(I).EQ.D) DD(I)=E
      GO TO 129
127   IF(IV(I).GT.315) GO TO 128
      IV(I)=315-IV(I)
      GO TO 126
128   IV(I)=675-IV(I)
      GO TO 126
129   CONTINUE
130   WRITE(IO,5)(NM(I),I=1,12),NMAX
      GO TO 138

      SUMMATION SECTION FOR LINEAR DATA

131   WRITE(IO,6)(NM(I),I=1,12),NMAX
      WRITE(IO,7)(IV(I),NS(I),I=1,NMAX)
      WRITE(IP,8)(IV(I),NS(I),I=1,NMAX)
      WRITE(IP,17)(NM(I),I=1,12)
      J=0
```

```
      DO 132 I=1,NMAX
      IF(SZ(I).NE.S) GO TO 132

      SUMMATION OF GROUP S

      J=J+1
      KB(J)=IV(I)
      KD(J)=NS(I)
  132 CONTINUE
      WRITE(IO,9) J
      WRITE(IO,7)(KB(I),KD(I),I=1,J)
      IF(J.LE.15) GO TO 133
      WRITE(IP,8)(KB(I),KD(I),I=1,J)
      WRITE(IP,17)(NM(I),I=1,12)
  133 J=0
      DO 134 I=1,NMAX
      IF(SZ(I).NE.M) GO TO 134

      SUMMATION OF GROUP M

      J=J+1
      KB(J)=IV(I)
      KD(J)=NS(I)
  134 CONTINUE
      WRITE(IO,10) J
      WRITE(IO,7)(KB(I),KD(I),I=1,J)
      IF(J.LE.15) GO TO 135
      WRITE(IP,8)(KB(I),KD(I),I=1,J)
      WRITE(IP,17)(NM(I),I=1,12)
  135 K=J
      DO 136 I=1,NMAX
      IF(SZ(I).NE.L) GO TO 136

      SUMMATION OF GROUP L

      K=K+1
      KB(K)=IV(I)
      KD(K)=NS(I)
  136 CONTINUE
      K1=J+1
      K2=K-J
      WRITE(IO,11) K2
      WRITE(IO,7)(KB(I),KD(I),I=K1,K)
      IF(K2.LE.15) GO TO 137
      WRITE(IP,8)(KB(I),KD(I),I=K1,K)
      WRITE(IP,17)(NM(I),I=1,12)
  137 IF(K.LE.15) GO TO 110
      WRITE(IP,8)(KB(I),KD(I),I=1,K)
      WRITE(IP,17)(NM(I),I=1,12)
      GO TO 110

      SUMMATION SECTION FOR PLANAR DATA

  158 WRITE(IO,12)(IV(I),EW(I),DD(I),I=1,NMAX)
      WRITE(IP,13)(IV(I),EW(I),DD(I),I=1,NMAX)
      WRITE(IP,17)(NM(I),I=1,12)
      J=0
```

```
    DO 139 I=1,NMAX
    IF(SZ(I).NE.S) GO TO 139

    SUMMATION OF GROUP S

    J=J+1
    KB(J)=IV(I)
    KD(J)=EW(I)
    SN(J)=DD(I)
139 CONTINUE
    WRITE(IO,14) J
    WRITE(IO,18)(KB(I),KD(I),SN(I),I=1,J)
    IF(J.LE.15) GO TO 140
    WRITE(IP,13)(KB(I),KD(I),SN(I),I=1,J)
    WRITE(IP,17)(HM(I),I=1,12)
140 J=0
    DO 141 I=1,NMAX
    IF(SZ(I).NE.M) GO TO 141

    SUMMATION OF GROUP M

    J=J+1
    KB(J)=IV(I)
    KD(J)=EW(I)
    SN(J)=DD(I)
141 CONTINUE
    WRITE(IO,15) J
    WRITE(IO,18)(KB(I),KD(I),SN(I),I=1,J)
    IF(J.LE.15) GO TO 142
    WRITE(IP,13)(KB(I),KD(I),SN(I),I=1,J)
    WRITE(IP,17)(HM(I),I=1,12)
142 K=J
    DO 143 I=1,NMAX
    IF(SZ(I).NE.L) GO TO 143

    SUMMATION OF GROUP L

    K=K+1
    KB(K)=IV(I)
    KD(K)=EW(I)
    SN(K)=DD(I)
143 CONTINUE
    K1=J+1
    K2=K-J
    WRITE(IO,16) K2
    WRITE(IO,18) (KB(I),KD(I),SN(I),I=K1,K)
    IF(K2.LE.15) GO TO 144
    WRITE(IP,13)(KB(I),KD(I),SN(I),I=K1,K)
    WRITE(IP,17)(HM(I),I=1,12)
144 IF(K.LE.15) GO TO 110
    WRITE(IP,13)(KB(I),KD(I),SN(I),I=1,K)
    WRITE(IP,17)(HM(I),I=1,12)
    GO TO 110
98  STOP2
99  STOP
    END
```

PROGRAM NAME - SMTPLT

PURPOSE - TO ACCEPT ATTITUDES OF LINEAR AND PLANAR ELEMENTS, WHICH ARE THEN USED TO PLOT A 20 CENTIMETER DIAMETER, CONTOURED, SCHMIDT EQUAL AREA PROJECTION ON THE LOWER HEMISPHERE.

THE COMPASS DIRECTIONS, N, W, E, AND S, ARE PLACED NEAR THE PERIMETER OF THE PRIMATIVE CIRCLE. THE USER HAS THE OPTION TO PLACE OTHER NOTATION ON THE UPPER HALF OF THE CIRCLE, NEGATING THE STANDARD OPTION. UP TO 16 CONTOURS ARE ALLOWED ON A PROJECTION.

USER VARIABLES -

DATA HEADER CARDS

EACH GROUP OF DATA FOR A SINGLE DIAGRAM MUST BE PRECEDED BY DATA HEADER CARDS AS DESCRIBED BELOW.

FIRST DATA HEADER CARD

1) AN INTEGER(J1) VALUE IS PUNCHED IN COLUMN 1 FOR THE FOLLOWING RESULTS---

   J1=1 FOR POLES TO PLANES PLOT AND J1=2 FOR LINEATION PLOT,

2) THE NEXT PIECE OF INFORMATION ON THE CARD IS ALSO AN INTEGER -NMAX-. THIS IS THE NUMBER OF ATTITUDES TO

TO BE CONTOURED (MAXIMUM NUMBER OF DATA POINTS IS 1000) AND IS RIGHT-JUSTIFIED IN COLUMNS 2 THROUGH 5.

3) THE NEXT PIECE OF INFORMATION ON THIS CARD IS -NC-, THE NUMBER OF CONTOURS TO BE PLOTTED (16 OR LESS). THIS NUMBER IS RIGHT-JUSTIFIED IN COLUMNS 6 AND 7.

4) WHEN THE VALUE OF -ISR- IS GREATER THAN ZERO (RIGHT-JUSTIFIED IN COLUMNS 8 AND 9) A REFERENCE LINE (NORMAL TO THE CIRCLE AT THE ANGLES KSRA(I)) AND THE DESIGNATED SYMBOLS -SYM- ARE PLOTTED RATHER THAN THE CHARACTERS N, E, S, AND W (AS IS THE CASE WHEN -ISR- IS ZERO OR LESS).

NOTE - IF ISR=1 ONLY ONE SYMBOL AND REFERENCE LINE IS PLOTTED.

IF ISR IS GREATER THAN OR EQUAL TO 2 THEN BOTH REFERENCE LINES AND SYMBOLS ARE PLOTTED.

NOTE- THE REFERENCE LINE IS ALWAYS SHOWN ABOVE THE UPPER HALF OF THE PROJECTION.

5) THE NEXT DATA ON THIS CARD IS -KSRA-, THE ANGLES (IN DEGEEES, 0 - 360 FROM NORTH) AT WHICH THE REFERENCE LINES ARE DRAWN (PUNCHED IN COLUMNS 10 THROUGH 12 AND 13 THROUGH 15, RIGHT-JUSTIFIED, RESPECTIVELY).

6) THE LAST OF THE DATA ON THIS CARD IS -SYM-, THE SYMBOLS THE USER SELECTS TO USE TO IDENTIFY THE REFERENCE

LINE THERE ARE TWO CHARACTERS POSSIBLE PER EACH REFERENCE LINE AND THESE MUST CORRESPOND TO THE ANGLES (KRSA) DESIGNATED, RESPECTIVELY. THESE ARE PUNCHED IN COLUMNS 16 AND 17 FOR THE FIRST SYMBOL AND COLUMNS 18 AND 19 FOR THE LAST SYMBOL.

************************* CAUTION *************************

NOTE: NO CONTOUR SHOULD BE ATTEMPTED WHICH WILL CAUSE THE PROGRAM TO SEARCH FOR A POINT EQUAL TO OR LESS THAN 0.0.

NOTE: IF THE MAXIMUM POSSIBLE CONTOUR (DEFINED IN PHASE I-3 AS TOPCI) FOR A PLOT IS LESS THAN ANY OF THE CONTOURS REQUESTED THE PLOT IS TERMINATED AFTER PLOTTING THE LARGEST CONTOUR. THE MAXIMUM CONTOUR VALUE IS PRINTED OUT IN AN ERROR MESSAGE WITH THE SEQUENTIAL NUMBER OF THE PLOT IN WHICH THE ERROR OCCURRED. ONLY THE CONTOURS PLOTTED WILL APPEAR IN THE PLOT LABEL.

SECOND DATA HEADER CARD

THIS CARD CONTAINS THE PERCENTAGE VALUES TO BE CONTOURED.

DATA CARDS

POLES TO PLANES PLOT DATA

1) STRIKES ARE RECORDED ON A 360 DEGREE AZIMUTH (RIGHT-JUSTIFIED IN 3 COLUMNS).

2) DIPS ARE RECORDED FROM 0 THROUGH 90 DEGREES (RIGHT-JUSTIFIED IN 2 COLUMNS).

3) DIP DIRECTIONS FOR POLES TO PLANES PLOT

A) RECORD AS E, EAST DIPS AND HORIZONTAL DIPS.

B) RECORD AS W, WEST DIPS AND VERTICAL DIPS.

C) RECORD AS N, ALL NORTH DIPS IF THE STRIKE IS E-W.

D) RECORD AS S, ALL SOUTH DIPS IF THE STRIKE IS E-W.

NOTE-- MEASUREMENTS ARE LISTED ON THE DATA CARD AS STRIKE(1),DIP(1), DIP DIRECTION(1), STRIKE(2), ETC. (OR BEARING(1), SIGN OF PLUNGE, PLUNGE ANGLE, ETC. THERE THIRTEEN ATTITUDES PER CARD.

THESE ARE RECORDED AS BEARING (RIGHT-JUSTIFIED IN 3 COLUMNS) AND PLUNGE ANGLE (RIGHT-JUSTIFIED IN 3 COLUMNS). THUS THERE WILL BE A PLUS SIGN OR A BLANK BETWEEN THE BEARING AND PLUNGE ANGLE.

THIS CARD CONTAINS 48 COLUMNS FOR A LABEL ON THE PLOT (INSERT A BLANK CARD FOR NO LABEL).

THE CHARACTERS ARE 0.3 INCHES HIGH WITH THEIR BASE 0.4 INCHES BELOW THE BOTTOM OF THE CIRCLE.

TO CENTER A LABEL USE 32 CHARACTERS OR LESS AND CENTER THEM IN COLUMNS 1 THROUGH 32 ON THE CARD.

NOTE---IN THE EVENT AN ATTITUDE IS PUNCHED WITH A VALUE GREATER THAN SPECIFIED ABOVE AN ERROR MESSAGE REPORTS WHICH

ATTITUDE AND THE PLOT IN WHICH THE ERROR OCCURRED. THAT PLOT IS ABORTED BUT SUCCESSIVE PLOTS ARE NOT.

FOR SUCCESSIVE PLOTS THE DATA FOR EACH PLOT IS PLACED IMMEDIATELY FOLLOWING THE PREVIOUS PLOT DATA, EACH WITH THE FOREGOING INFORMATION.

DATA TRAILER CARD

THE LAST DATA CARD IN THE DATA STACK IS BLANK. THIS TERMINATES THE PROGRAM.

PROGRAM ALGORITHM - DATA IS READ IN AND USED TO DETERMINE POINTS ON THE EQUITORIAL PLANE, ACCORDING TO TRIGONOMETRIC FORMULA FOR THIS TYPE OF PROJECTION. A 22 CM. X 22 CM. SQUARE GRID IS EMPLOYED TO LOCATE THE CENTERS OF 2 CM. DIAMETER COUNTING CIRCLES. THE NUMBER OF POINTS ON THE EQUITORIAL PLANE WITHIN THE SMALL CIRCLES IS ASSIGNED TO THE RESPECTIVE GRID INTERSECTION. THE CORNER VALUES OF EACH SQUARE ARE AVERAGED AND ASSIGNED TO THE CENTER OF THAT CELL. THE GRID IS SCANNED FROM LEFT TO RIGHT AND FROM THE TOP DOWN.

THE CONTOUR POINTS ARE LOCATED BY INTERPOLATING BETWEEN CORNER VALUES OF CELL SIDES AND BETWEEN CORNER VALUES AND VALUES AT THE CELL CENTER. THE CONTOUR LINE IS DRAWN CONTINUOUSLY STARTING IN A DOWNWARD DIRECTION. WHEN THE CONTOUR TERMINATES AGAINST THE PRIMATIVE CIRCLE THE ORIGINAL STARTING POINT IS LOCATED AND THE CONTOUR IS DRAWN UPWARD.

FINALLY, THE LABEL, NUMBER OF ELEMENT POINTS, AND

CONTOUR VALUES ARE WRITTEN BELOW THE PLOT.

SUBPROGRAMS - NEW MEXICO TECH COMPUTER CENTER'S SETMSG, PLOT TAPE W/O SENSE SWITCH, AND TAPE TO PLOT ROUTINES.

THE FOLLOWING SUBROUTINES ARE INCLUDED IN THE PROGRAM:

CLEAR: CLEARS STORAGE FOR THE PROGRAM.

LABEL: PLOTS TITLE, TOTAL NUMBER OF ELEMENT POINTS AND DENSITY CONTOUR VALUES.

VHARRY: SUMS THE NUMBER OF POINTS WITHIN 1 CM. OF RADUS OF GRID INTERSECTIONS.

LOOK: INTERPOLATES CONTOUR POINTS AND CONTROLS DIRECTION OF OF CONTOUR LINE.

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3, CALCOMP 563 INCREMENTAL PLOTTER, IBM 2415 - II TAPE DRIVES, IBM 1443 LINE PRINTER, AND IBM 1442 CARD READER - PUNCH.

STORAGE REQUIREMENTS - X'A6C8'.

TIME -

COMPILE: 479 SECONDS.

LINKAGE EDITOR: 50 SECONDS.

TOTAL: 70-90 SECONDS FOR A PLOT OF 100 POINTS.

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--------SCHMIDT EQUAL AREA PROGRAM --SMTPLT---------RIESE

----------------------EQUAL-AREA PROJECTION---------------------------
------------------CONTOURED ON THE LOWER HEMISPHERE----------------
************************************************************************

                     DATA HEADER CARDS

EACH GROUP OF DATA FOR A SINGLE DIAGRAM MUST BE PRECEDED BY
2 HEADER CARDS AS DESCRIBED BELOW.


 FIRST DATA HEADER CARD

1) AN INTEGER(J1) VALUE IS PUNCHED IN COLUMN 1 FOR THE FOLLOWING
         RESULTS---
         J1=1 FOR POLES TO PLANES PLOT AND J1=2 FOR LINEATION PLOT,

2) THE NEXT PIECE OF INFORMATION ON THE CARD IS ALSO AN INTEGER
         -NMAX-.  THIS IS THE NUMBER OF ATTITUDES TO BE CONTOURED
         (MAXIMUM NUMBER OF DATA POINTS IS 1000) AND IS RIGHT-
         JUSTIFIED IN COLUMNS 2 THROUGH 5.

3) THE NEXT PIECE OF INFORMATION ON THIS CARD IS -NC-, THE
         NUMBER OF CONTOURS TO BE PLOTTED (16 OR LESS ALLOWED).
         THIS NUMBER IS RIGHT-JUSTIFIED IN COLUMNS 6 AND 7.

4) WHEN THE VALUE OF -ISR- IS GREATER THAN ZERO (RIGHT-JUSTIFIED
         IN COLUMNS 8 AND 9) A REFERENCE LINE (NORMAL TO THE CIRCLE
         AT THE ANGLES KSRA(I) AND THE DESIGNATED SYMBOLS -SYM-
         ARE PLOTTED RATHER THAN THE CHARACTERS N, E, S, AND W
         (AS IS THE CASE WHEN -ISR- IS ZERO OR LESS).
         NOTE -    IF ISR=1 ONLY ONE SYMBOL AND REFERENCE LINE IS
                             PLOTTED.
                   IF ISR IS GREATER THAN OR EQUAL TO 2 THEN BOTH
                             REFERENCE LINES AND SYMBOLS ARE PLOTTED.


*** NOTE- THE REFERENCE LINE IS ALWAYS SHOWN ABOVE THE         ***
*** UPPER HALF OF THE PROJECTION.                               ***

5) THE NEXT DATA ON THIS CARD IS -KSRA-, THE ANGLES (IN
        DEGREES, 0 TO 360 FROM NORTH) AT WHICH THE REFERENCE
        LINES ARE DRAWN (PUNCHED IN COLUMNS 10 THROUGH 12 AND
        13 THROUGH 15, RIGHT-JUSTIFIED, RESPECTIVELY).

6) THE LAST OF THE DATA ON THIS CARD IS -SYM-, THE SYMBOLS WHICH
```

```
THE USER SELECTS TO USE TO IDENTIFY THE REFERENCE LINES.
THERE ARE TWO CHARACTERS POSSIBLE PER EACH REFERENCE LINE
AND THESE MUST CORRESPOND TO THE ANGLES (KRSA) DESIGNATED,
RESPECTIVELY. THESE ARE PUNCHED IN COLUMNS 16 AND
17 FOR THE FIRST SYMBOL AND COLUMNS 18 AND 19 FOR THE
LAST SYMBOL.


************************ CAUTION ********************************
****** NOTE    NO CONTOUR SHOULD BE ATTEMPTED WHICH WILL CAUSE***
******         THE PROGRAM TO SEARCH FOR A POINT EQUAL TO OR   ***
******         LESS THAN 0.0.                                  ***
****** E.G.   50 TOTAL POINTS * 0.02% DENSITY / 100.0 = 0.01   ***
******   THIS CONTOUR (0.02%) WILL NOT BE PLOTTED.             ***
****** IF THIS IS ATTEMPTED AN ERROR MESSAGE WILL SO           ***
****** INDICATE IT AND THE NEXT LARGER CONTOUR WILL BE         ***
****** EXECUTED.                                               ***

-------------------------------------------------------------------

****** NOTE    IF THE MAXIMUM POSSIBLE CONTOUR (DEFINED IN     ***
******         PHASE I-3 AS TOPCI) FOR A PLOT IS LESS THAN     ***
******         ANY OF THE CONTOURS REQUESTED THE PLOT IS       ***
******         TERMINATED AFTER PLOTTING THE LARGEST CONTOUR   ***
******         REQUESTED (WHICH IS LESS THAN THE MAXIMUM       ***
******         POSSIBLE CONTOUR).  THE MAXIMUM CONTOUR VALUE   ***
******         IS PRINTED OUT IN AN ERROR MESSAGE WITH THE     ***
******         SEQUENTIAL NUMBER OF THE PLOT IN WHICH THE      ***
******         ERROR OCCURRED.  ONLY THE CONTOURS PLOTTED      ***
******         WILL APPEAR IN THE PLOT LABEL.                  ***
******                                                         ***
*******************************************************************



SECOND DATA HEADER CARD

THIS CARD CONTAINS THE PERCENTAGE VALUES -C(I)- TO BE CONTOURED.
     THEY ARE READ WITH A 16F5.2  FORMAT (I.E. TWO DIGITS FOR
     THE DECIMAL NUMBER, A DECIMAL POINT, AND TWO DIGITS FOR
     THE DECIMAL FRACTION).
     NO ORDER IS REQUIRED AS THEY WILL BE SORTED INTO ASCENDING
     ORDER AND SO PRINTED BELOW THE PLOT.




                   DATA CARDS
```

POLES TO PLANES PLOT DATA

1) STRIKES ARE RECORDED ON A 360 DEGREE AZIMUTH (RIGHT-JUSTIFIED IN 3 COLUMNS).

2) DIPS ARE RECORDED FROM 0 THROUGH 90 DEGREES (RIGHT-JUSTIFIED IN 2 COLUMNS).

3) DIP DIRECTIONS FOR POLES TO PLANES PLOT

A) RECORD AS E, EAST DIPS AND HORIZONTAL DIPS.
B) RECORD AS W, WEST DIPS AND VERTICAL DIPS.
C) RECORD AS N, ALL NORTH DIPS IF THE STRIKE IS E-W.
D) RECORD AS S, ALL SOUTH DIPS IF THE STRIKE IS E-W.

NOTE-- MEASUREMENTS ARE LISTED ON THE DATA CARD AS STRIKE(1), DIP(1), DIP DIRECTION(1), STRIKE(2), ETC. (OR BEARING(1), SIGN OF PLUNGE, PLUNGE ANGLE(1), BEARING(2), ETC. THERE ARE THIRTEEN ATTITUDES PER CARD.

LINEATIONS DATA

THESE ARE RECORDED AS BEARING (RIGHT-JUSTIFIED IN 3 COLUMNS) AND PLUNGE ANGLE (RIGHT-JUSTIFIED IN 3 COLUMNS). THUS THERE WILL BE A PLUS SIGN OR A BLANK BETWEEN THE BEARING AND PLUNGE ANGLE.

LABEL DATA CARD

THIS CARD CONTAINS 48 COLUMNS IN WHICH THE PROGRAMMER PLACES A LABEL (OR INSERTS A BLANK CARD FOR NO LABEL) FOR THE PLOT. THE CHARACTERS ARE 0.3 INCHES HIGH WITH THEIR BASE 0.4 INCHES BELOW THE BOTTOM OF THE CIRCLE. TO CENTER A LABEL USE 32 CHARACTERS OR LESS AND CENTER THEM IN COLUMNS 1 THROUGH 32 ON THE CARD.

NOTE----IN THE EVENT AN ATTITUDE IS PUNCHED WITH A MAGNITUDED GREATER THAN SPECIFIED ABOVE AN ERROR MESSAGE REPORTS WHICH ATTITUDE AND THE PLOT IN WHICH THE ERROR OCCURRED. THAT PLOT IS ABORTED BUT SUCCESSIVE PLOTS WILL BE PROCESSED.

****

FOR SUCCESSIVE PLOTS THE DATA FOR EACH PLOT IS

```
      PLACED IMMEDIATELY FOLLOWING THE PREVIOUS PLOT DATA, EACH WITH
      THE FOREGOING INFORMATION.


*************************************************************************


                       DATA TRAILER CARD

    THE LAST DATA CARD IN THE DATA STACK IS BLANK.  THIS TERMINATES
    THE PROGRAM.

*************************************************************************
      INTEGER SYM
      COMMON X(1600),Y(1600),CI(16),V(23),H(23),IC(22,22),
     $KS(1000),KD(1000),K(23,23),J1,NMAX,NC,NM
      DIMENSION R(1600),S(1600),D(1600),NX(22,22),KV(1600),NOGO(20),
     $SYM(2),KSRA(2)
      EQUIVALENCE (NX(1,1),KS(1)),(KV(1),X(1))
      INTEGER E/'E    '/,N/'N    '/
      A=0.

-------------------------------------------------------------------------

    CALL SETMSG PRODUCES THE CHARACTERS WITHIN APOSTROPHES (THE NUMBER
    IS THE TOTAL OF THE CHARACTERS) ON THE CONSOLE TYPEWRITER.

    PLACING THIS CARD AFTER STATEMENT NO. 1 WILL REQUIRE THAT THE
    OPERATOR TYPE IN -PLOT ALL- OR -SKIP ALL- BEFORE EACH PLOT
    IN THE DATA DECK IS MADE.  THE LATTER COMMAND IS USED TO SKIP
    ANY PARTICULAR PROJECTION IN THE SEQUENCE.

    PLACING THIS CALL BEFORE STATEMENT NO. 1 WILL CAUSE ALL
    PROJECTIONS TO BE PROCESSED SEQUENTIALLY, WITHOUT FURTHER
    OPERATOR INTERVENTION.

-------------------------------------------------------------------------

    1 CONTINUE
      CALL SETMSG(15,'PLOTS FOR RIFSE')
      CALL CLEAR
      READ(5,2)J1,NMAX,NC,ISR,KSRA(1),KSRA(2),SYM(1),SYM(2)
    2 FORMAT(I1,I4,I2,I2,2I3,2A2)
      IF(J1)99,99,3
    3 A=A+1.
      READ(5,4)(CI(I),I=1,NC)
    4 FORMAT(16F5.2)
      NCN=NC-1
      DO 6 INDEX=1,NCN
```

```
      DO 6 M=1,NCN
      IF(CI(M)-CI(M+1))6,6,5
    5 B=CI(M+1)
      CI(M+1)=CI(M)
      CI(M)=B
    6 CONTINUE
      GO TO (7,10),J1
    7 READ(5,8)(KS(I),KD(I),KV(I),I=1,NMAX)
    8 FORMAT(13(I3,I2,A1))
      DO 9 I=1,NMAX
      IF(KV(I).EQ.E) GO TO 9
      IF(KV(I).EQ.N) GO TO 9
      KD(I)=-KD(I)
    9 CONTINUE
      GO TO 100
   10 READ(5,11)(KS(I),KD(I),I=1,NMAX)
   11 FORMAT(13(I3,I3))
      GO TO 200

 ***********************************************************************

 SECTION  A

      POLES TO PLANES

 ***********************************************************************


 -----------------------------------------------------------------------

    PHASE A-1

    STRIKES ARE CONVERTED TO BE READ AS IF MEASURED TO THE
    NORTHEAST OR SOUTHEAST QUADRANTS.
                (NOTE: FOR THE CALCOMP PLOTTER, STRIKES ARE
                CHANGED FROM A 0 TO 360 DEGREES FROM NORTH AZIMUTH,
                TO AN AZIMUTH OF 0 TO +90 DEGREES FROM EAST TOWARD
                NORTH AND FROM 0 TO -90 DEGREES FROM EAST TOWARD
                SOUTH.  THESE ARE THE +Y AND -Y DIRECTIONS OF THE
                COORDINATE SYSTEM, RESPECTIVELY.)

 -----------------------------------------------------------------------

  100 DO 119 I=1,NMAX
    5 JJ=I
      IF(180-KS(I))102,101,101
  101 KS(I)=90-KS(I)
      GO TO 110
  102 IF(270-KS(I))104,103,103
```

```
103 KS(I)=270-KS(I)
    GO TO 110
104 IF(360-KS(I))992,105,103
105 KS(I)=90

 -----------------------------------------------------------------------

    PHASE A-2

    FINDS A LOWER POLE DIRECTION AT 90 DEGREES TO THE COMPUTED
    STRIKE IN THE OPPOSITE DIRECTION FROM THE DIP.

 -----------------------------------------------------------------------

110 IF(KS(I))114,115,111
111 IF(90-IABS(KD(I)))992,116,112
112 IF(KD(I))117,113,116
113 KS(I)=0
    GO TO 119
114 IF(90-IABS(KD(I)))992,118,115
115 IF(KD(I))116,113,117
116 KS(I)=KS(I)+90
    GO TO 119
117 KS(I)=KS(I)-90
    GO TO 119
118 KD(I)=-KD(I)
    GO TO 117
119 CONTINUE
    GO TO 300

 ************************************************************************

    SECTION  B

      LINEATIONS

    BEARINGS OF THE PLUNGE IN 360 DEGREES OF AZIMUTH FROM NORTH ARE
    CHANGED TO THE EQUIVALENT BEARINGS IN +180 AND -180 DEGREES
    FROM EAST (PLOTTER REQUIREMENT---SEE NOTE PHASE A-1).

 ************************************************************************

200 DO 205 I=1,NMAX
    JJJ=I
    IF(270-KS(I))202,201,201
201 KS(I)=90-KS(I)
    GO TO 205
202 IF(360-KS(I))992,203,204
203 KS(I)=90
```

```
      GO TO 205                                                         RWR0295
  207 KS(I)=450-KS(I)                                                   RWR0296
  205 IF(IABS(KD(I)).GT.90) GO TO 992                                   RWR0297
      GO TO (990,300),J1                                                RWR0298
                                                                        RWR0299
C*********************************************************************RWR0300
                                                                        RWR0301
      SECTION  C                                                        RWR0302
                                                                        RWR0303
          THIS SECTION CONVERTS THE DIP IN DEGREES FROM THE HORIZONTAL  RWR0304
          TO THE ANGLE MEASURED FROM THE VERTICAL AND FINDS ONE-HALF    RWR0305
          OF THAT ANGLE.                                                RWR0306
                                                                        RWR0307
          STATEMENT NUMBER 301 IS USED FOR CALCULATIONS OF POLES TO     RWR0308
             PLANES.                                                    RWR0309
                                                                        RWR0310
          STATEMENT NUMBER 302 IS USED FOR CALCULATIONS OF LINEATIONS   RWR0311
             AND C-AXES POLES.                                          RWR0312
C*********************************************************************RWR0314
                                                                        RWR0315
  300 DO 401 I=1,NMAX                                                   RWR0316
      IF(1-J1)302,301,99                                                RWR0317
  301 D(I)=(IABS(KD(I)))*0.00873                                        RWR0318
      GO TO 400                                                         RWR0319
  302 D(I)=(90-IABS(KD(I)))*0.00873                                     RWR0320
                                                                        RWR0321
C*********************************************************************RWR0322
                                                                        RWR0323
      SECTION  D                                                        RWR0324
                                                                        RWR0325
          THIS SECTION DETERMINES THE POSITION OF THE POINT ON THE      RWR0326
          EQUITORIAL PLANE REPRESENTING THE LOWER POLE INTERSECTION     RWR0327
          WITH THE LOWER HEMISPHERE.                                    RWR0328
                                                                        RWR0329
C*********************************************************************RWR0330
                                                                        RWR0331
  400 S(I)=KS(I)*0.01745                                                RWR0332
      R(I)=14.14214*SIN(D(I))*0.39370                                   RWR0333
                                                                        RWR0334
C---------------------------------------------------------------------RWR0335
                                                                        RWR0336
        WHERE    R=SQRT(2)*RADIUS*SIN(D(I))                             RWR0337
                                                                        RWR0338
C---------------------------------------------------------------------RWR0339
                                                                        RWR0340
  401 CONTINUE                                                          RWR0341
                                                                        RWR0342
C*********************************************************************RWR0343
                                                                        RWR0344
```

```
SECTION  E

      THIS SECTION CONVERTS POLAR TO RECTILINEAR COORDINATES.
      IF A POINT IS FOUND TO BE WITHIN ONE CENTIMETER OF THE
      PRIMATIVE CIRCLE, IT THEN LOCATES THE COUNTER-POINT AT 180
      DEGREES BUT DOES NOT ADD IT TO THE NUMBER OF POINTS TO BE
      CONTOURED.  IT DOES ADD THE POINT TO THE POINT DENSITY
      FINALLY CONTOURED, HOWEVER. THIS IS ANALOGOUS TO THE USE
      OF THE PERIPHERAL COUNTER.

**************************************************************************

    NM=NMAX
    I=0
500 I=I+1
    IF(NMAX-I)600,501,501
501 X(I)=R(I)*COS(S(I))
    Y(I)=R(I)*SIN(S(I))
    RO=SQRT(X(I)*X(I)+Y(I)*Y(I))
    IF(RO-3.56330)503,502,502
502 NM=NM+1
    RS=3.93700-RO
    X(NM)=-X(I)-(2.*RS*COS(S(I)))
    Y(NM)=-Y(I)-(2.*RS*SIN(S(I)))
503 IF(NM-I)600,600,500

**************************************************************************

SECTION  F

      THIS SECTION SORTS X INTO ASCENDING ORDER.

**************************************************************************

600 NM1=NM-1
    DO 602 INDEX=1,NM1
    NM2=NM1-INDEX
    DO 602 I=1,NM2
    IF(X(I)-X(I+1))602,602,601
601 B=X(I+1)
    X(I+1)=X(I)
    X(I)=B
    B=Y(I+1)
    Y(I+1)=Y(I)
    Y(I)=B
602 CONTINUE
    CALL CIRCLE(ISR,KSRA,SYM)
    CALL VHARRY
```

```
C
C**************************************************************************
C
C     SECTION  G
C
C        FINDS THE VALUE OF THE CELL CENTER BY AVERAGING CORNER VALUES
C        OF EACH CELL (FROM DATA SUPPLIED BY SUBROUTINE VHARRY).
C        THIS IS ANALOGOUS TO SUPERIMPOSING A 1 CM. SQUARE GRID
C        WHEN CONTOURING BY HAND.
C
C**************************************************************************
C
      DO 700 MI=1,22
      DO 700 NI=1,22
  700 IC(MI,NI)=(K(MI,NI)+K(MI+1,NI)+K(MI,NI+1)+K(MI+1,NI+1))/4
C
C**************************************************************************
C
C     SECTION  H
C
C        CLEARS THE VALUES STORED IN KS(1000) FOR FURTHER USE.
C
C**************************************************************************
C
      DO 800 I=1,1000
  800 KS(I)=0
C
C**************************************************************************
C
C     SECTION  I
C
C        THIS SECTION CALCULATES A NUMBER PROPORTIONAL TO CONTOUR
C        DENSITY PERCENT GIVEN.  THEN FINDS THE FIRST POINT TO BE
C        CONTOURED.  SUCCESSIVE POINTS ARE FOUND BY SUBROUTINE LOOK.
C        THEN THE VALUES ARE CONTOURED WITHIN THE PRIMATIVE CIRCLE.
C
C
C
C- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
C      PHASE I-1
C
C      FINDS THE MAXIMUM DENSITY OF POINTS VALUE FROM NODES OF THE
C      OVERLAY GRID.
C
C- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
      DO 980 KI=1,NC
```

```
      DO 900 M=2,22
      DO 900 J=2,22
      IF(K(J,M).LE.MAX) GO TO 900
      MAX=K(J,M)
  900 CONTINUE
C-----------------------------------------------------------------------
C
C       PHASE I-2
C
C       THE NX(N,M) ARRAY MUST BE CLEARED AFTER EACH CONTOUR OTHERWISE
C       THE RETRACE STOPPING VALUES FOR THE PREVIOUS CONTOURS WOULD
C       PREVENT THE FUTURE CONTOURS FROM BEING PLOTTED.
C
C-----------------------------------------------------------------------
      DO 910 J=1,22
      DO 910 M=1,22
  910 NX(J,M)=0
C-----------------------------------------------------------------------
C
C       PHASE I-3
C
C       CALCULATES THE VALUE WHICH IS SEARCHED FOR (WITHIN A
C       HYPOTHETICAL CIRCUMSCRIBED OVERLAY GRID), TO PRODUCE THE
C       DENSITY PERCENT CONTOUR REQUESTED.
C
C-----------------------------------------------------------------------
      PPC=NMAX*CI(KI)
      TOP=MAX
      TOPCI=TOP/NMAX
      KI2=KI
      IF(CI(KI).GE.TOPCI) GO TO 996
      IF(PPC.LE. 0.0) GO TO 970
C-----------------------------------------------------------------------
C
C       PHASE I-4
C
C       DETERMINES WHETHER THE VALUE OF PHASE I-3 IS WITHIN 0.01 OF AN
C       INTEGER VALUE IN WHICH CASE 0.01 IS DEDUCTED OR ADDED FROM OR
C       TO THE CONTOURING VALUE.  THUS NO CONTOURS WILL CROSS THE CELL
C       CENTER OR CORNERS.
C
C-----------------------------------------------------------------------
      IF((PPC.GE.(IFIX(PPC)+0.99)).AND.
```

```
    IF((PPC.GE.(IFIX(PPC)+0.99)).AND.
   $(PPC.LT.(IFIX(PPC)+1.0))) GO TO 920
    IF((PPC.LE.(IFIX(PPC)+0.01)).AND.
   #(PPC.GE.(IFIX(PPC)))) GO TO 921
    GO TO 930
920 PPC=PPC-0.01
    GO TO 930
921 PPC=PPC+0.01

 ----------------------------------------------------------------------

       PHASE I-5

       FINDS THE FIRST POINT OF A CONTOUR.

 ----------------------------------------------------------------------

930 DO 960 M=2,21
    DO 960 J=2,21
    IF(NX(J,M))960,931,931
931 IF(K(J,M).EQ.K(J+1,M)) GO TO 960
    I=0
    IF((K(J,M).LT.PPC).AND.(PPC.LT.K(J+1,M))) GO TO 932
    IF((K(J+1,M).LT.PPC).AND.(PPC.LT.K(J,M))) GO TO 932
    GO TO 960
932 I=I+1
    X(I)=V(J)+0.3937*ABS(PPC-FLOAT(K(J,M)))/ABS(FLOAT(K(J,M)-K(J+1,M))
   #)
    Y(I)=H(M)
    KP=6
    KC=1
    LAST=1
    CALL PLOT(X(1),Y(1),3)
    CALL LOOK(KP,KC,J,M,I,PPC)

 ----------------------------------------------------------------------

       PHASE I-6

       FINDS THE POINT OF INTERSECTION BETWEEN A CONTOUR AND THE
       PRIMATIVE CIRCLE AND PREVENTS THE CONTOUR FROM BEING DRAWN
       OUTSIDE OF THE PRIMATIVE CIRCLE.

 ----------------------------------------------------------------------

940 DO 952 IP=2,I
    I1=0
    IF(SQRT(X(IP)*X(IP)+Y(IP)*Y(IP)).GT. 3.9370) I1=2
    I2=1
```

```
      KK=I1+I2
      GO TO (950,941,941,951),KK
  941 IXIP=X(IP)*1000
      IXIP1=X(IP-1)*1000
      IF(IXIP-IXIP1)943,942,943
  942 XU=X(IP)
      YU=SQRT(ABS(15.49997-XU*XU))
      YU=SIGN(YU,Y(IP))
      IF(Y(IP).EQ. 0.) YU=SIGN(YU,Y(IP-1))
      GO TO 947
  943 TANG=(Y(IP)-Y(IP-1))/(X(IP)-X(IP-1))

C----------------------------------------------------------------------

C     STATEMENT 944 COMES FROM THE SLOPE INTERCEPT FORMULA OF
C     THE LINE,  Y=SLOPE*X+B.

C----------------------------------------------------------------------

  944 B=Y(IP)-X(IP)*TANG

C----------------------------------------------------------------------

C     SUBSTITUTION OF THE SLOPE INTERCEPT FORMULA INTO THE EQUATION
C     OF A CIRCLE, X**2+Y**2=R**2, AND SOLVING THE QUADRATIC FOR X
C     RESOLVES AS FOLLOWS--

C----------------------------------------------------------------------

      QDSL=SQRT(ABS(15.49997*(1.+TANG*TANG)-B*B))
      TB=-B*TANG
      DVR=1.+TANG*TANG
      XU1=(TB-QDSL)/DVR
      XU2=(TB+QDSL)/DVR

C----------------------------------------------------------------------

C     THIS IS A TEST TO DETERMINE WHICH OF THE TWO SOLUTIONS
C     FOR THE QUADRATIC IS PROPERLY POSITIONED BETWEEN THE TWO
C     VALUES OF X WITHOUT AND WITHIN THE CIRCLE.

C----------------------------------------------------------------------

      IF(((X(IP-1).LE.XU1).AND.(XU1.LE.X(IP))).OR.((X(IP).LE.XU1).AND.
     $(XU1.LE.X(IP-1)))) GO TO 945
      XU=XU2
      GO TO 946
  945 XU=XU1
  946 YU=TANG*XU+B
```

```
12 IF(KK-3)949,948,952                                                RWR05900
 8 CALL PLOT(XU,YU,2)                                                 RWR05910
   CALL PLOT(XU,YU,3)                                                 RWR05920
   GO TO 952                                                          RWR05930
 9 CALL PLOT(XU,YU,3)                                                 RWR05940
 0 CALL PLOT(X(IP),Y(IP),2)                                           RWR05950
 1 IF((X(IP).EQ.X(1)).AND.(Y(IP).EQ.Y(1))) GO TO 960                  RWR05960
 2 CONTINUE                                                           RWR05970
   GO TO (953,960),LAST                                               RWR05980
 3 IF(M-2)960,960,954                                                 RWR05990
 4 CALL PLOT(X(1),Y(1),3)                                             RWR06000
   I=1                                                                RWR06010
   KP=4                                                               RWR06020
   KC=3                                                               RWR06030
   CALL LOOK(KP,KC,J,M,I,PPC)                                         RWR06040
   LAST=2                                                             RWR06050
   GO TO 940                                                          RWR06060
 0 CONTINUE                                                           RWR06070
   GO TO 980                                                          RWR06080
 0 WRITE(6,971) A                                                     RWR06090
11 FORMAT('0','CONTOUR REQUESTED PRODUCES A SEARCH FOR A DENSITY POINRWR06100
 $T VALUE EQUUIVALENT TO ZERO-- THIS CONTOUR WAS OMITTED FROM THE PLRWR06110
 $OT'/' AND FROM THE PLOT LABEL OF PLOT SEQUENCE',F5.0)              RWR06120
70 CONTINUE                                                           RWR06130
   CALL LABEL (KI2)                                                   RWR06140
   GO TO 1                                                            RWR06150
 0 WRITE(6,991)                                                       RWR06160
 1 FORMAT(' ','A TRAILER OR HEADER CARD WAS CARRIED THROUGH THE'     RWR06170
 $'STRIKE REORIENTING COMPUTATION.')                                  RWR06180
   GO TO 99                                                           RWR06190
 2 WRITE(6,993) JJJ,A                                                 RWR06200
 3 FORMAT(' ','ORIENTATION DATUM NUMBER ',I4,' PUNCHED GREATER THAN 3RWR06210
 $60 DEGREES FOR THE BEARING OR 90 DEGREES FOR THE DIP/PLUNGE.'/' ',RWR06220
 $'PLOT NUMBER ',F5.0)                                                RWR06230
   READ(5,994)(NOGO(K1),K1=1,20)                                      RWR06240
94 FORMAT(20A4)                                                       RWR06250
   WRITE(6,995)(NOGO(K1),K1=1,20)                                     RWR06260
 5 FORMAT(' ','NEXT CARD IS -- ',20A4/)                               RWR06270
   GO TO 99                                                           RWR06280
 6 WRITE(6,997) TOPCI,A                                               RWR06290
 7 FORMAT('0','CONTOURS LARGER THAN ',F5.2,' ARE NOT DRAWN ON THE PLORWR06300
 $T OF ',F5.0)                                                        RWR06310
   CALL LABEL (KI2)                                                   RWR06320
   GO TO 1                                                            RWR06330
99 CALL PLOT(0.0,0.0,999)                                             RWR06340
   STOP                                                               RWR06350
   END                                                                RWR06360
```

```
      SUBROUTINE CLEAR
      COMMON DUMMY(6279)

*****************************************************************************
 
      SUBROUTINE CLEAR ---CLEARS COMMON STORAGE.

*****************************************************************************

      DO 1 I=1,6279
    1 DUMMY(I)=0.0
      RETURN
      END
```

```
UBROUTINE CIRCLE(ISR,KSRA,SYM)

*************************************************************************

    THE CIRCLE SUBROUTINE PRODUCES A CIRCLE OF 20 CM.
    DIAMETER WITH TWO LINES AT RIGHT ANGLES RUNNING THE FULL
    DIAMETER AND LABELED N, E, S, AND W, CLOCKWISE (IF ISR IS
    LESS THAN OR EQUAL TO ZERO) OR A REFERENCE LINE ABOVE THE E-W
    LINE (IF ISR IS GREATER THEN ZERO).

*************************************************************************

NTEGER SYM(2)
)IMENSION SRA(2),KSRA(2)
:ALL PLOT(14.0,-12.0,-3)
:ALL PLOT(0.0,6.2,-3)
:ALL PLOT(3.937,0.0,3)
)O 1 I=1,10000
3=I
R=B*0.00062820
(1=3.937*COS(R)
Y1=3.937*SIN(R)
CALL PLOT(X1,Y1,2)
CALL PLOT(X1,Y1,3)
IF(ISR)2,2,3
CALL SYMBOL(4.00,-0.15,0.3,69,0.0,-1)
CALL PLOT(3.937,0.0,3)
CALL PLOT(-3.937,0.0,2)
IF(ISR)4,4,5
CALL SYMBOL(-4.17,-0.15,0.3,102,0.0,-1)
CALL SYMBOL(-0.09,4.00,0.3,85,0.0,-1)
CALL PLOT(0.0,3.937,3)
CALL PLOT(0.0,-3.937,2)
IF(ISR)6,6,7
CALL SYMBOL(-0.09,-4.30,0.3,98,0.0,-1)
RETURN

-------------------------------------------------------------------------

   THIS PART OF THE CIRCLE ROUTINE IS TO PRODUCE A (ONE-HALF
   INCH) REFERENCE LINE OUTSIDE THE CIRCLE AT THE GIVEN
   ANGLE---KSRA, IF ISR IS GREATER THAN ZERO.

-------------------------------------------------------------------------

DO 14 I=1,ISR
IF(KSRA(I)-270)10,9,9
SRA(I)=(450-KSRA(I))*0.01745
GO TO 13
```

```
IF(KSRA(I)-90)11,11,12                      RWR06990
SRA(I)=(90-KSRA(I))*0.01745                 RWR07000
GO TO 13                                    RWR07010
KSRA(I)=KSRA(I)+180                         RWR07020
GO TO 8                                     RWR07030
X1=3.987*COS(SRA(I))                        RWR07040
Y1=3.987*SIN(SRA(I))                        RWR07050
X2=4.287*COS(SRA(I))                        RWR07060
Y2=4.287*SIN(SRA(I))                        RWR07070
X3=X2+0.05                                  RWR07080
Y3=Y2+0.05                                  RWR07090
IF(X2.LT.0.) X3=X2-0.25                     RWR07100
CALL PLOT(X1,Y1,3)                          RWR07110
CALL PLOT(X1,Y1,2)                          RWR07120
IF(ISR.LT.2) GO TO 14                       RWR07130
CALL PLOT(X2,Y2,2)                          RWR07140
CALL SYMBOL(X3,Y3,0.2,SYM(I),0.0,2)         RWR07150
RETURN                                      RWR07160
END                                         RWR07170
```

```
 SUBROUTINE LABEL(KI2)
 COMMON X(1600),Y(1600),CI(16),V(23),H(23),IC(22,22),
5KS(1000),KD(1000),K(23,23),J1,NMAX,NC,NM
 DIMENSION L(17),J(12)

***********************************************************************

   THE LABEL SUBROUTINE WRITES BELOW THE 20 CM. CIRCLE THE
  LABEL FROM THE LABEL CARD ON THE FIRST LINE AND ON THE NEXT
  THREE LINES IT WRITES THE TOTAL NUMBER OF POINTS AND THE
  CONTOURING VALUES.

***********************************************************************

 CALL PLOT(-4.10,-4.75,-3)

  READS AND PRINTS THE LABEL GIVEN BY THE PROGRAMMER.

 READ(5,1)(J(N),N=1,12)
1 FORMAT(12A4)
 CALL SYMBOL(0.0,0.0,0.3,J,0.0,48)
 P=NMAX
 CALL NUMBER(0.0,-0.4,0.2,P,0.0,-1)

   ARRAY  L(I)  SPELLS OUT--POINTS, CONTOURS---BELOW THE PLOTTED
  OUTPUT.

 L(1)=87
 L(2)=86
 L(3)=73
 L(4)=85
 L(5)=99
 L(6)=98
 L(7)=107
 L(8)=64
 L(9)=67
 L(10)=86
 L(11)=85
 L(12)=99
 L(13)=86
 L(14)=100
 L(15)=89
 L(16)=98
 L(17)=122
 E=0.85
 DO 2 M=1,17
 CALL SYMBOL(E,-0.4,0.2,L(M),0.0,-1)
2 E=E+0.14
```

```
      PLOTS THE CONTOURING VALUES (UP TO 3 LINES IF NECESSARY)
    BELOW THE PLOTTED OUTPUT.

   IF(KI2.LT.NC) NC=KI2-1
   NN=5
   IF(NC-5)3,4,4
 3 NN=NC
 4 E=3.29
   NB=1
   JC=CI(1)*100.
   IF(JC.GT.0) GO TO 6
 5 NB=2
 6 DO 12 M=NB,NN
   CALL NUMBER(E,-0.4,0.2,CI(M),0.0,2)
   JC=CI(M)*10.
   IF(JC-10)10,9,7
 7 IF(JC-100)9,8,8
 8 E=E+0.88
   GO TO 11
 9 E=E+0.7
   GO TO 11
10 E=E+0.53
11 CALL SYMBOL(E,-0.4,0.2,108,0.0,-1)
12 E=E+0.34
   IF(NC-5)24,24,13
13 IF(NC-13)14,14,15
14 NN=NC
   GO TO 16
15 NN=12
16 NB=6
   B=-0.8
17 E=0.0
   DO 23 M=NB,NN
   CALL NUMBER(E,B,0.2,CI(M),0.0,2)
   JC=CI(M)*10.
   IF(JC-10)21,20,18
18 IF(JC-100)20,19,19
19 E=E+0.88
   GO TO 22
20 E=E+0.7
   GO TO 22
21 E=E+0.53
22 CALL SYMBOL(E,B,0.2,108,0.0,-1)
23 E=E+0.34
   IF(NC-12)26,26,24
24 IF(NN-NC)25,26,26
25 B=-1.2
   NN=NC
   NB=13
```

```
      GO TO 17
   16 CALL PLOT(4.10,4.75,-3)
      RETURN
      END
```

```
      SUBROUTINE VHARRY
      COMMON X(1600),Y(1600),CI(16),V(23),H(23),IC(22,22),
     KS(1000),KD(1000),K(23,23),J1,NMAX,NC,NM

*********************************************************************

     SUBROUTINE VHARRY TALLIES ALL DATA POINTS WITHIN A 1 CM.
     RADIUS OF EACH 1 CM. INTERSECTION OF A 22 BY 22 CM. GRID
     SYSTEM.
*********************************************************************

      A=-4.33070
      DO 1 N1=1,23
      V(N1)=A
    1 A=A+0.39370
      B=4.33070
      DO 2 M1=1,23
      H(M1)=B
    2 B=B-0.39370
      DO 4 N1=1,23
      DO 3 M1=1,23
    3 K(N1,M1)=0
    4 CONTINUE
      DO 600 J2=1,NM
      N1=12

*********************************************************************

     SECTION  A

     DETERMINES WHETHER X IS POSITIVE OR NEGATIVE.

*********************************************************************

      IF(X(J2))10,20,20

*********************************************************************

     SECTION  B

     FINDS THE ORDINATE LINE (V(N1), VERTICAL) WHICH IS JUST
     LESS THAN OR EQUAL TO THE VALUE OF THE NEGATIVE X COORDINATE
     OF THE DATA POINT.

*********************************************************************

   10 IF(X(J2)-V(N1))11,30,30
   11 N1=N1-1
      IF(N1-1)600,10,10
```

```
*********************************************************************

SECTION   C

     FINDS THE ORDINATE LINE (V(N1), VERTICAL) WHICH IS JUST
     GREATER THAN OR EQUAL TO THE VALUE OF THE POSITIVE X COORDINA
     OF THE DATA POINT.

*********************************************************************

20   IF(X(J2)-V(N1))30,30,21
21   N1=N1+1
     IF(N1-23)20,20,600

*********************************************************************

SECTION   D

     DETERMINES WHETHER Y IS POSITIVE OR NEGATIVE.

*********************************************************************

30   M1=12
     IF(Y(J2))40,50,50

*********************************************************************

SECTION   E

     FINDS THE ABSCISSA LINE (H(M1), HORIZONTAL WHICH IS JUST
     LESS THAN OR EQUAL TO THE VALUE OF THE NEGATIVE Y COORDINATE
     OF THE DATA POINT.

*********************************************************************

40   IF(Y(J2)-H(M1))41,60,60
41   M1=M1+1
     IF(M1-23)40,40,600

*********************************************************************

SECTION   F

     FINDS THE ABSCISSA LINE (H(M1), HORIZONTAL WHICH IS JUST
     GREATER THAN OR EQUAL TO THE VALUE OF THE POSITIVE Y
     COORDINATE OF THE DATA POINT.

*********************************************************************
```

```
50    IF(Y(J2)-H(M1))60,60,51
51    M1=M1-1
      IF(M1-1)600,50,50

******************************************************************

      SECTION  G

            TALLIES POINTS ABOUT THE ORIGIN FOR DATA POINTS ON THE ORIGIN

******************************************************************

60    IF(X(J2))62,61,62
61    IF(Y(J2))62,103,62
62    IF(V(12)-V(N1))63,64,64
63    IF(H(12)-H(M1))100,400,400
64    IF(H(12)-H(M1))200,300,300

******************************************************************

            COMPUTATION FOR QUADRANT 1.

******************************************************************

100   IF(V(N1)-X(J2))500,101,102
101   IF(H(M1)-Y(J2))500,103,104
102   IF(H(M1)-Y(J2))500,105,106
103   K(N1,M1)=K(N1,M1)+100
      K(N1,M1+1)=K(N1,M1+1)+100
      K(N1,M1-1)=K(N1,M1-1)+100
      K(N1-1,M1)=K(N1-1,M1)+100
      K(N1+1,M1)=K(N1+1,M1)+100
      GO TO 600
104   K(N1,M1)=K(N1,M1)+100
      K(N1,M1+1)=K(N1,M1+1)+100
      GO TO 600
105   K(N1,M1)=K(N1,M1)+100
      K(N1-1,M1)=K(N1-1,M1)+100
      GO TO 600
106   P=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1))**2))
      B=SQRT((ABS(X(J2)-V(N1-1))**2)+(ABS(Y(J2)-H(M1))**2))
      C=SQRT((ABS(X(J2)-V(N1-1))**2)+(ABS(Y(J2)-H(M1+1))**2))
      W=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1+1))**2))
      IF(0.39370-P)108,107,107
107   K(N1,M1)=K(N1,M1)+100
108   IF(0.39370-B)110,109,109
109   K(N1-1,M1)=K(N1-1,M1)+100
110   IF(0.39370-C)112,111,111
```

```
111 K(N1-1,M1+1)=K(N1-1,M1+1)+100
112 IF(0.39370-W)600,113,113
113 K(N1,M1+1)=K(N1,M1+1)+100
    GO TO 600

    ******************************************************************************

        COMPUTATION FOR QUADRANT 2.

    ******************************************************************************

200 IF(V(N1)-X(J2))202,201,500
201 IF(H(M1)-Y(J2))500,103,204
202 IF(H(M1)-Y(J2))500,205,206
204 K(N1,M1)=K(N1,M1)+100
    K(N1,M1+1)=K(N1,M1+1)+100
    GO TO 600
205 K(N1,M1)=K(N1,M1)+100
    K(N1+1,M1)=K(N1+1,M1)+100
    GO TO 600
206 B=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1))**2))
    C=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1+1))**2))
    W=SQRT((ABS(X(J2)-V(N1+1))**2)+(ABS(Y(J2)-H(M1+1))**2))
    P=SQRT((ABS(X(J2)-V(N1+1))**2)+(ABS(Y(J2)-H(M1))**2))
    IF(0.39370-B)208,207,207
207 K(N1,M1)=K(N1,M1)+100
208 IF(0.39370-C)210,209,209
209 K(N1,M1+1)=K(N1,M1+1)+100
210 IF(0.39370-W)212,211,211
211 K(N1+1,M1+1)=K(N1+1,M1+1)+100
212 IF(0.39370-P)600,213,213
213 K(N1+1,M1)=K(N1+1,M1)+100
    GO TO 600

    ******************************************************************************

        COMPUTATION FOR QUADRANT 3.

    ******************************************************************************

300 IF(V(N1)-X(J2))302,301,500
301 IF(H(M1)-Y(J2))304,103,500
302 IF(H(M1)-Y(J2))306,305,500
304 K(N1,M1)=K(N1,M1)+100
    K(N1,M1-1)=K(N1,M1-1)+100
    GO TO 600
305 K(N1,M1)=K(N1,M1)+100
    K(N1+1,M1)=K(N1+1,M1)+100
    GO TO 600
```

```
306 GO TO 600
    C=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1))**2))
    W=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1-1))**2))
    P=SQRT((ABS(X(J2)-V(N1+1))**2)+(ABS(Y(J2)-H(M1-1))**2))
    B=SQRT((ABS(X(J2)-V(N1+1))**2)+(ABS(Y(J2)-H(M1))**2))
    IF(0.39370-C)308,307,307
    K(N1,M1)=K(N1,M1)+100
    IF(0.39370-W)310,309,309
    K(N1,M1-1)=K(N1,M1-1)+100
    IF(0.39370-P)312,311,311
    K(N1+1,M1-1)=K(N1+1,M1-1)+100
    IF(0.39370-B)600,313,313
    K(N1+1,M1)=K(N1+1,M1)+100
    GO TO 600

****************************************************************************

     COMPUTATION FOR QUADRANT 4.

****************************************************************************

    IF(V(N1)-X(J2))500,401,402
    IF(H(M1)-Y(J2))404,103,500
    IF(H(M1)-Y(J2))406,405,500
    K(N1,M1)=K(N1,M1)+100
    K(N1,M1-1)=K(N1,M1-1)+100
    GO TO 600
    K(N1,M1)=K(N1,M1)+100
    K(N1-1,M1)=K(N1-1,M1)+100
    GO TO 600
    W=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1))**2))
    P=SQRT((ABS(X(J2)-V(N1))**2)+(ABS(Y(J2)-H(M1-1))**2))
    B=SQRT((ABS(X(J2)-V(N1-1))**2)+(ABS(Y(J2)-H(M1-1))**2))
    C=SQRT((ABS(X(J2)-V(N1-1))**2)+(ABS(Y(J2)-H(M1))**2))
    IF(0.39370-W)408,407,407
    K(N1,M1)=K(N1,M1)+100
    IF(0.39370-P)410,409,409
    K(N1,M1-1)=K(N1,M1-1)+100
    IF(0.39370-B)412,411,411
    K(N1-1,M1-1)=K(N1-1,M1-1)+100
    IF(0.39370-C)600,413,413
    K(N1-1,M1)=K(N1-1,M1)+100
    GO TO 600
    WRITE(6,501)
    FORMAT(' ','A POINT WAS ENCOUNTERED BEYOND THE CIRCLE PERIMETER ')
    CONTINUE
    RETURN
    END
```

```
SUBROUTINE LOOK(KP,KC,N,M,I,PPC)

**********************************************************************

                     CONTOUR SEARCH ROUTINE

A. THE METHOD USED TO FIND THE FIRST DENSITY POINT VALUES TO
   CONTOUR IS AS FOLLOWS--

1) A SQUARE GRID 22 CM. ON A SIDE IS CENTERED ON A CIRCLE OF
   20 CM. DIAMETER.

2) THE GRID IS SUBDIVIDED INTO 1 CM. SQUARE CELLS THE CORNERS
   OF WHICH REPRESENT NODES OR INTERSECTIONS.

3) THE NODE VALUES HAVE BEEN ASSIGNED FROM SUBROUTINE VHARRY.
   THE VALUE IS THE TOTAL POINTS WITHIN A 1 CM. RADIUS OF THE
   NODE TIMES 100.

4) EACH CELL IS DIVIDED BY TWO DIAGONALS, THE INTERSECTION
   OF WHICH HAS BEEN ASSIGNED THE AVERAGE OF THE CORNER VALUES.

5) BEGINNING 1 CM. FROM THE TOP AND FROM THE LEFT THE GRID IS
   SEARCHED ALONG THE HORIZONTAL BOUNDRIES OF THE CELLS.
   THE SEARCH MOVES ALONG A HORIZONTAL BOUNDRY UNTIL IT HAS
   SENSED THROUGH TO 1 CM. FROM THE RIGHT AND RETURNS TO THE
   LEFT, REINITIATING THE SEARCH 1 CM. BELOW THE CONCLUDED
   HORIZONTAL BOUNDRY AND REPEATS THE PROCEDURE TO WITHIN
   1 CM. OF THE BASE OF THE GRID.

B. WHEN THE FIRST POINT IS FOUND THE COMPUTER ASSUMES THE CONTOUR
   IS BEING DRAWN FROM ABOVE AND THUS MOVES DOWNWARD IN THE
   FOLLOWING MANNER--

1) CELL SIDES ARE ASSIGNED ARBITRARY NUMBERS SO THAT THE COMPUTER
   KNOWS WHERE IT IS (KC= CURRENT POSITION) AND WHERE IT JUST WAS
   (KP= PREVIOUS POSITION).  THUS IN THE FINAL ANALYSIS THE
   COMPUTER IS ON ONE LEG OF A TRIANGLE AND EXAMINES THE OTHER TWO
   ON ONLY ONE OF WHICH IT CAN FIND THE VALUE DESIRED.

**********************************************************************

  NOTE-- THE NUMBERING IS AS FOLLOWS--
UPPER HALF OF THE NEGATIVELY SLOPING DIAGONAL = 4
UPPER HALF OF THE POSITIVELY SLOPING DIAGONAL = 2
```

```
                    1                                                          RWR1112
          ********************                                                 RWR1113
          **         3        **                                               RWR1114
          *   *             *   *                                              RWR1115
          *     4*       *2     *                                              RWR1116
          *        *   *        *                                              RWR1117
          *          **         7*5                                            RWR1118
        7*5          **         *                                              RWR1119
          *        *   *        *                                              RWR1120
          *     8*       *6     *                                              RWR1121
          *   *             *   *                                              RWR1122
          **         1        **                                               RWR112
          ********************                                                 RWR1
                   3                 ONE CELL OF THE GRID                      R
                                                                               RWR
                                                                               RWR112
  LOWER HALF OF THE NEGATIVELY SLOPING DIAGONAL = 6                            RWR1128
  LOWER HALF OF THE POSITIVELY SLOPING DIAGONAL = 8                            RWR1129
  IF CONTOURING FROM THE RIGHT TOWARD A VERTICAL BOUNDRY = 5                   RWR1130
  IF CONTOURING FROM THE LEFT TOWARD A VERTICAL BOUNDRY = 7                    RWR1131
  IF CONTOURING FROM ABOVE TOWARD A HORIZONTAL BOUNDRY =1                      RWR1132
  IF CONTOURING FROM BELOW TOWARD A HORIZONTAL BOUNDRY =3                      RWR1133
                                                                               RWR1134
*******************************************************************************RWR1135
                                                                               RWR1136
 2) ONCE THE CONTOUR HAS CLOSED THE SEARCH IS REINITIATED ON THE               RWR1137
    SAME HORIZONTAL BOUNDRY BUT ONE CELL TO THE RIGHT OR                       RWR1138
    (IF IT HAS REACHED ITS MAXIMUM RIGHTWARD EXTENT) ON THE                    RWR1139
    LEFT-MOST CELL 1 CM. BELOW.                                                RWR1140
                                                                               RWR1141
 3) IF THE CONTOUR DOES NOT CLOSE BUT THE ENDS MEET THE GRID SIDES             RWR1142
    (AS PROVSION FOR OMITTING THE CONTOUR OUTSIDE OF THE                       RWR1143
    PRIMATIVE CIRCLE IS MADE IN ANOTHER PART OF THE PROGRAM)                   RWR1144
    THE CONTOURING ROUTINE DRAWS ONE LEG DOWNWARD FIRST THEN                   RWR1145
    RETURNS TO THE INITIAL POINT AND COMPLETES THE UPWARD LEG.                 RWR1146
                                                                               RWR1147
 4) EACH TIME A CONTOUR PASSES THROUGH A VERTICAL OR A HORIZONTAL              RWR1148
    CELL BOUNDRY FOR A PARTICULAR VALUE OF CONTOUR IT IS RECORDED              RWR1149
    IN THE NX(N,M) ARRAY SO THOSE POINTS WILL NOT BE USED FOR OTHERRWR1150
    CONTOUR LINES OF THAT VALUE.                                               RWR1151
                                                                               RWR1152
*******************************************************************************RWR1153
                                                                               RWR1154
                                                                               RWR1155
      COMMON X(1600),Y(1600),CI(16),V(23),H(23),IC(22,22),                     RWR1156
     $KS(1000),KD(1000),K(23,23),J1,NMAX,NC,NM                                 RWR1157
      DIMENSION NX(22,22)                                                      RWR1158
      EQUIVALENCE (NX(1,1),KS(1))                                              RWR1159
      N1=N                                                                     RWR1160
```

~~PROGRAM NAME LOCTAD~~

```
      M1=M
      JK=M1
      JJ=1
    1 I=I+1
      IF(MOD(KC,2))11,11,2
    2 IF(KC-3)3,6,7
    3 GO TO (5,4),JJ
    4 M1=M1+1
    5 JJ=2
      GO TO 100
    6 M1=M1-1
      JJ=2
      GO TO 120
    7 IF(KC.EQ.5) GO TO 10
      GO TO (9,8),JJ
    8 N1=N1+1
    9 JJ=2
      GO TO 100
   10 N1=N1-1
      JJ=2
      GO TO 130
   11 IF(KC-6)12,14,16
   12 IF(KC-4)13,15,14
   13 IF((KP.EQ.5).OR.(KP.EQ.6)) GO TO 140
      GO TO 170
   14 IF((KP.EQ.2).OR.(KP.EQ.5)) GO TO 150
      GO TO 110
   15 IF((KP.EQ.1).OR.(KP.EQ.2)) GO TO 120
      GO TO 140
   16 IF((KP.EQ.4).OR.(KP.EQ.7)) GO TO 150
C
C-----------------------------------------------------------------------
C
C     TEST 100 CONDITION CODES
C          KC=1, KP=ANY --     KC=2, KP=5 OR 6 IF TEST 140 FAILED.
C
C-----------------------------------------------------------------------
  100 IF(IC(N1,M1).EQ.K(N1,M1)) GO TO 101
      IF((K(N1,M1).LT.PPC).AND.(PPC.LT.IC(N1,M1))) GO TO 102
      IF((IC(N1,M1).LT.PPC).AND.(PPC.LT.K(N1,M1))) GO TO 102
  101 IF(KC.EQ.1) GO TO 110
      IF(KC.EQ.8) GO TO 160
      IF(KC.EQ.7) GO TO 120
  102 HV=(0.2784*ABS(PPC-FLOAT(K(N1,M1)))/ABS(FLOAT(IC(N1,M1)-K(N1,M1)))
     5)*0.7071
      X(I)=V(N1)+HV
      Y(I)=H(M1)-HV
  103 KP=KC
```

```
      KC=4
      GO TO 180

 ---------------------------------------------------------------------

    TEST 110 CONDITION CODES
         KC=6, KP=3 OR 8 -- KC=1, KP=ANY      IF TEST 100 FAILED
                            KC=4, KP=7 OR 8  IF TEST 140 FAILED
                            KC=5, KP=ANY      IF TEST 130 FAILED

 ---------------------------------------------------------------------

110   IF(IC(N1,M1).EQ.K(N1+1,M1)) GO TO 111
      IF((K(N1+1,M1).LT.PPC).AND.(PPC.LT.IC(N1,M1))) GO TO 112
      IF((IC(N1,M1).LT.PPC).AND.(PPC.LT.K(N1+1,M1))) GO TO 112
111   IF(KC.EQ.6) GO TO 170
      GO TO 185
112   HV=(0.2784*ABS(PPC-FLOAT(K(N1+1,M1)))/ABS(FLOAT(IC(N1,M1)-K(N1+1,M
     $1))))*0.70711
      X(I)=V(N1+1)-HV
      Y(I)=H(M1)-HV
113   KP=KC
      KC=2
      GO TO 180

 ---------------------------------------------------------------------

    TEST 120 CONDITION CODES
         KC=3, KP=ANY OR KC=4, KP=1 OR 2 --
                            KC=6, KP=2 OR 5  IF TEST 150 FAILED
                            KC=7, KP=ANY      IF TEST 100 FAILED

 ---------------------------------------------------------------------

120   IF(IC(N1,M1).EQ.K(N1,M1+1)) GO TO 121
      IF((K(N1,M1+1).LT.PPC).AND.(PPC.LT.IC(N1,M1))) GO TO 122
      IF((IC(N1,M1).LT.PPC).AND.(PPC.LT.K(N1,M1+1))) GO TO 122
121   IF(KC.EQ.3) GO TO 130
      IF(KC.EQ.4) GO TO 160
      GO TO 185
122   HV=(0.2784*ABS(PPC-FLOAT(K(N1,M1+1)))/ABS(FLOAT(IC(N1,M1)-K(N1,M1+
     $1))))*0.70711
      X(I)=V(N1)+HV
      Y(I)=H(M1+1)+HV
123   KP=KC
      KC=8
      GO TO 180

 ---------------------------------------------------------------------
```

```
 TEST 130 CONDITION CODES
      KC=5, KP=ANY --      KC=2, KP=ANY     IF TEST 170 FAILED
                           KC=3, KP=ANY     IF TEST 120 FAILED
                           KC=8, KP=4 OR 7  IF TEST 150 FAILED

--------------------------------------------------------------------

130 IF(IC(N1,M1).EQ.K(N1+1,M1+1)) GO TO 131
    IF((K(N1+1,M1+1).LT.PPC).AND.(PPC.LT.IC(N1,M1))) GO TO 132
    IF((IC(N1,M1).LT.PPC).AND.(PPC.LT.K(N1+1,M1+1))) GO TO 132
131 IF(KC.EQ.5) GO TO 110
132 HV=(0.2784*ABS(PPC-FLOAT(K(N1+1,M1+1)))/ABS(FLOAT(IC(N1,M1)-K(N1+1
   8,M1+1))))*0.70711
    X(I)=V(N1+1)-HV
    Y(I)=H(M1+1)+HV
133 KP=KC
    KC=6
    GO TO 180

--------------------------------------------------------------------

 TEST 140 CONDITION CODES
      KC=2, KP=5 OR 6 AND KC=4, KP=7 OR 8

--------------------------------------------------------------------

140 IF(K(N1,M1).EQ.K(N1+1,M1)) GO TO 141
    IF((K(N1,M1).LT.PPC).AND.(PPC.LT.K(N1+1,M1))) GO TO 142
    IF((K(N1+1,M1).LT.PPC).AND.(PPC.LT.K(N1,M1))) GO TO 142
141 IF(KC.EQ.2) GO TO 100
    IF(KC.EQ.4) GO TO 110
142 HH=0.3937*ABS(PPC-FLOAT(K(N1,M1)))/ABS(FLOAT(K(N1,M1)-K(N1+1,M1)))
    X(I)=V(N1)+HH
143 Y(I)=H(M1)
    IF(M1-JK)145,144,144
144 MX(N1,M1)=-1
145 KP=KC
    KC=3
    GO TO 180

--------------------------------------------------------------------

 TEST 150 CONDITION CODES
      KC=6, KP=2 OR 5 AND KC=8, KP=4 OR 7

--------------------------------------------------------------------

150 IF(K(N1,M1+1).EQ.K(N1+1,M1+1)) GO TO 151
```

```
      IF((K(N1,M1+1).LT.PPC).AND.(PPC.LT.K(N1+1,M1+1))) GO TO 152
      IF((K(N1+1,M1+1).LT.PPC).AND.(PPC.LT.K(N1,M1+1))) GO TO 152
151   IF(KC.EQ.6) GO TO 120
      IF(KC.EQ.8) GO TO 130
152   HH=0.3937*ABS(PPC-FLOAT(K(N1,M1+1)))/ABS(FLOAT(K(N1,M1+1)-K(N1+1,
     #M1+1)))
      X(I)=V(N1)+HH
153   Y(I)=H(M1+1)
      IF(M1+1-JK)155,154,154
154   NX(N1,M1+1)=-1
155   KP=KC
      KC=1
      GO TO 180

 -----------------------------------------------------------------------
 -----------------------------------------------------------------------
    TEST 160 CONDITION CODES
                          KC=4, KP=1 OR 2 IF TEST 120 FAILED
                          KC=8, KP=ANY    IF TEST 100 FAILED
 -----------------------------------------------------------------------
 -----------------------------------------------------------------------
160   IF(K(N1,M1).EQ.K(N1,M1+1)) GO TO 188
161   VV=0.3937*ABS(PPC-FLOAT(K(N1,M1)))/ABS(FLOAT(K(N1,M1)-K(N1,M1+1)))
      Y(I)=H(M1)-VV
      X(I)=V(N1)
      KP=KC
      KC=5
      GO TO 180

 -----------------------------------------------------------------------
 -----------------------------------------------------------------------
    TEST 170 CONDITION CODES
                          KC=6, KP=3 OR 8 IF TEST 110 FAILED
 -----------------------------------------------------------------------
 -----------------------------------------------------------------------
170   IF(K(N1+1,M1).EQ.K(N1+1,M1+1)) GO TO 171
      IF((K(N1+1,M1).LT.PPC).AND.(PPC.LT.K(N1+1,M1+1))) GO TO 172
171   IF((K(N1+1,M1+1).LT.PPC).AND.(PPC.LT.K(N1+1,M1))) GO TO 172
      IF(KC.EQ.2) GO TO 130
172   VV=0.3937*ABS(PPC-FLOAT(K(N1+1,M1)))/ABS(FLOAT(K(N1+1,M1)-K(N1+1,
     #M1+1)))
      Y(I)=H(M1)-VV
173   X(I)=V(N1+1)
      KP=KC
      KC=7

    TEST TO DETERMINE A CLOSED CONTOUR.
```

```
180   IF((X(1).EQ.X(I)).AND.(Y(1).EQ.Y(I))) GO TO 190

         TEST TO DETERMINE IF CONTOUR ENDS ON PERIMETER OF GRID.

      IF(ABS(X(I)).GE. 4.330699) GO TO 190
      IF(ABS(Y(I)).GE. 4.330699) GO TO 190
      GO TO 1

         IF NO APPROPRIATE VALUE FOUND ON TWO LEGS OF TRIANGLE THE
         FOLLOWING RESULTS----

185   I=I-1
      X(I)=0.
      Y(I)=0.
      GO TO 190
188   WRITE(6,189) KP,KC
189   FORMAT('0','PREVIOUS POINT (KP) = ',I1,' CURRENT POINT (KC) = ',
     $I1,' AN ATTEMPT WAS ABOUT TO BE MADE TO DIVIDE BY ZERO IN '
     $'STATEMENT NO. 161.')
190   RETURN
      END
```

PROGRAM NAME - LOCTAP

PURPOSE - THIS PROGRAM MAKES A TAPE OF STATION NUMBERS, AND THE ASSOCIATED X,Y MAP COORDINATES. THE TAPE IS USED IN CONJUNCTION WITH OTHER PROGRAMS AS A LOOK-UP TABLE.

USER VARIABLES -

LOC - A SIX DIGIT INTEGER TO LABEL THE MAPPED POSITION (ANY NUMBER TO 999999 IS USABLE),

XC - X COORDINATE MEASURED IN INCHES AND DECIMAL FRACTIONS THEREOF FROM THE WESTERN-MOST MAP BOUNDARY TO THE STATION OF THE MEASUREMENT (I.E. POSITIVE VALUES),

YC - Y COORDINATE (SAME AS FOR XC, EXCEPT MEASURED FROM THE SOUTHERN-MOST BOUNDARY),

MP - TOTAL NUMBER OF STATIONS. VALUE MUST BE LESS THAN OR EQUAL TO 1000.

PROGRAM CONTROL VARIABLES - NONE

PROGRAM ALGORITHM -

1) READS "MP" FROM DATA CARD AND WRITES IT ON TAPE.

2) READS "LOC", "XC", AND "YC", SETS, IN THAT ORDER, UNTIL "MP" SETS HAVE BEEN READ.

3) SORTS THESE SETS IN ASCENDING ORDER OF "LOC" MAGNITUDE.

4) WRITE THE SORTED SETS ON THE LINE PRINTER AND THEN ON THE TAPE.

REMARKS - A TAPE PREPARED BY "LOCTAP" IS REQUIRED FOR PROGRAMS "MAPLAN" AND "LINMAP".

INFORMATION PLACED ON THE TAPE IS UNFORMATTED.

SUBPROGRAMS - NONE

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3, IBM 1443 LINE PRINTER, IBM 1442 CARD READ PUNCH AND IBM 2415-II TAPE DRIVES.

STORAGE REQUIREMENTS - X'3310' BYTES.

TIME -

COMPILE: 20 SECONDS.

LINKAGE EDITOR: 16 SECONDS.

TOTAL: 119 SECONDS FOR 436 LOCATION SETS.

```
C-------------------------LOCTAP PROGRAM-----------------RIESE
C
C*****************************************************************
C
C THE PURPOSE OF LOCTAP IS TO READ IN THE LOCATION NUMBER
C AND X AND Y COORDINATES IN INCHES IN ORDER TO BUILD A TAPE
C FOR USE WITH PROGRAMS MAPLAN AND LINMAP.
C
C*****************************************************************
C
      DIMENSION LOC(1000),XC(1000),YC(1000)
    1 FORMAT(I4)
    2 FORMAT(I6,F6.3,F6.3,I6,F6.3,F6.3,I6,F6.3,F6.3,I6,F6.3,F6.3)
      READ(5,1) MP
      WRITE(8)   MP
      READ(5,2)(LOC(I),XC(I),YC(I),I=1,MP)
      MP1=MP-1
      DO 4 J=1,MP1
      NM=MP-J
      DO 4 I=1,NM
      IF(LOC(I)-LOC(I+1))4,4,3
    3 T1=LOC(I)
      LOC(I)=LOC(I+1)
      LOC(I+1)=T1
      T1=XC(I)
      XC(I)=XC(I+1)
      XC(I+1)=T1
      T1=YC(I)
      YC(I)=YC(I+1)
      YC(I+1)=T1
    4 CONTINUE
      WRITE(6,5)(LOC(I),XC(I),YC(I),I=1,MP)
    5 FORMAT(' ',I6,3X,F6.3,3X,F6.3,7X,I6,3X,F6.3,3X,F6.3,7X,
     1I6,3X,F6.3,3X,F6.3)
      WRITE(8)   (LOC(I),XC(I),YC(I),I=1,MP)
      STOP
      END
```

PROGRAM NAME - LINMAP

PURPOSE - TO PLOT LINEATION SYMBOLS AND PLUNGE VALUES AT APPROPRIATE MAP LOCATIONS ON TRANSPARENT PAPER.

USER VARIABLES -

KEND - NUMBER OF LINEATIONS BEING READ IN FROM CARDS (MAXIMUM POSSIBLE = 500).

NTITL - TITLE TO BE PRINTED BELOW MAP. UP TO 54 CHARACTERS (0.4 INCHES HIGH) MAY BE USED.

LOC - LOCATION NUMBER OF STATION WHERE THE LINEATION SYMBOL WILL BE PLOTTED (6 CHARACTERS).

BEAR - BEARING OF LINEATION (3 DIGITS MAXIMUM, RIGHT-JUSTIFIED). THIS VALUE MAY RANGE FROM 0 THROUGH 360 DEGREES.

PLG - PLUNGE OF LINEATION (2 DIGITS MAXIMUM, RIGHT-JUSTIFIED). THIS VALUE MAY RANGE FROM 0 THROUGH 90 DEGREES.

STYL - STYLE OF LINEATION (FOLD AXIS). A THREE- FOLD CLASSIFICATION MAY BE USED

CLASSIFICATION MAY BE USED BASED ON THE STYLES OF CONCERN TO THE USER. THE USER MUST USE THE SYMBOLS S, C, AND U FOR THE CLASSIFICATION.

IBEAR1

/- LOWER (IBEAR1) AND UPPER INCLUSIVE VALUES IN THE

IBEAR2 RANGE OF BEARINGS TO BE PLOTTED.

IPLG1
/ - LOWER (IPLG1) AND UPPER INCLUSIVE VALUES IN THE
IPLG2 RANGE OF PLUNGES TO BE PLOTTED.

L1, L, AND KHANGE - SEE PROGRAM CONTROL VARIABLES.

PROGRAM ALGORITHM - THE TOTAL NUMBER OF LINEATIONS AND TITLE ARE READ FROM CARDS. THEN THE LINEAR ELEMENTS ARE READ AND STORED INTO LOC, BEAR, PLG, AND STYL. LINEAR ELEMENTS AR THEN SEPARATED ACCORDING TO STYLE. THE NEXT CARD READ CONTAINS THE STYLE TO BE PLOTTED AND A VALUE TO INDICATE IF THE PEN IS TO BE CHANGED DURING THE PLOT. THE INCLUSIVE RANGES FOR BEARINGS AND PLUNGES ARE READ NEXT. LINEATIONS OF A PARTICULAR STYLE ARE SELECTED, WHICH LIE WITHIN THE BEARING RANGE. THIS GROUP IS THEN REDUCED TO THOSE ATTITUDES, WHICH ARE WITHIN THE PLUNGE RANGE. IF NO VALUES OCCURE IN SPECIFIED RANGES, TERMINATION OF THE PROGRAM RESULTS.

THE LOCATION TAPE IS THEN READ AND A SEARCH IS CARRIED OUT TO FIND MATCHING LOCATION NUMBERS BETWEEN THE LOCATIONS FOR THE ATTITUDES AND THE LOCATIONS OF MAP COORDINATES ON THE LOCATION TAPE IF THE LOCATION NUMBER OF THE ELEMENT DOES NOT OCCUR ON THE TAPE A MESSAGE IS PRINTED SO STATING. SUCH AN ERROR WILL NOT CAUSE THE PROGRAM TO TERMINATE, BUT THAT ELEMENT INVOLVED WILL BE MISLOCATED.

PROGRAM CONTROL VARIABLES -

L1 - CAUSES THE FOLLOWING OPERATIONS TO OCCUR DEPENDING

ON THE VALUES BELOW:

0 = TERMINATION OF THE PROGRAM. THIS IS THE ONLY WAY TO TERMINATE THE PROGRAM WITHOUT ERROR.

1 = CONTINUE THE SAME PLOT WITH DIFFERENT ELEMENTS FROM THE STORED DATA.

2 = START A NEW PLOT WITH ELEMENTS ALREADY STORED. NOTICE ONLY ONE SET OF DATA MAY BE USED PER RUN.

L - VALUES ASSIGNED TO THIS VARIABLE DETERMINE WHICH SPECIFIC STYLE WILL BE PLOTTED OR IF ALL DATA WILL BE PLOTTED.

1 = S GROUP STYLE.

2 = C GROUP STYLE.

3 = ALL DATA TOGETHER.

4 = U GROUP STYLE.

NOTE- VALUES OTHER THAN 1, 2, 3, OR 4 WILL CAUSE ERRORS.

KHANGE - ANY POSITIVE INTEGER FROM 1 THROUGH 9 MAY BE ASSIGNED TO THIS VARIABLE TO ALLOW PENS TO BE CHANGED. A ZERO VALUE NEGATES THIS OPTION.

NOTE- S GROUP HAS A BAR ACROSS THE ARROW SHAFT, C GROUP HAS AN X ON THE SHAFT AND U GROUP HAS AN OCTAGON ON THE SHAFT.

REMARKS - FOR EACH MAP, BOUNDARIES MUST BE ASSIGNED AS REQUIRED BY THE USER. THUS CARDS RWR01910 THROUGH RWR01950 MUST

BE MODIFIED FOR EACH MAP.

SUBPROGRAMS - NEW MEXICO TECH COMPUTER CENTER'S SETMSG, PLOT TAPE W/O SENSE SWITCH AND TAPE TO PLOT ROUTINES.

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3, CALCOMP 563 INCREMENTAL PLOTTER, IBM 2415-II TAPE DRIVES, IBM 1443 LINE PRINTER, AND IBM 1442 CARD READER-PUNCH.

STORAGE REQUIREMENTS - X'CEFC' BYTES.

TIME -

COMPILE: 88 SECONDS.

LINKAGE EDITOR: 41 SECONDS.

TOTAL: 221 SECONDS TO LOAD PLOT TAPE WITH PLOT OF 103 LINEAR ELEMENTS.

```
      ------------------------LINMAP PROGRAM---------------RIESE
      DIMENSION LOC(500),LOCS(500),LOCC(500),LOCU(500),LOC2(500),
     $LOCA(500),CX(500),CY(500),XC(500),YC(500),NTITL(14)
      INTEGER S/'S   '/,C/'C   '/,U/'U   '/,BEAR(500),BEARS(500),
     $BEARC(500),BEARU(500),BEARA(500),PLG(500),PLGS(500),PLGC(500),
     $PLGU(500),PLGA(500),TL(500),TB(500),TP(500),STYL(500)
      CALL SETMSG(42,'PLACE PEN TO RIGHT AND ADVANCE PAPER-RIESE')
      II=5
      IO=6
      ITY=15
      READ(II,1)KEND,(NTITL(I),I=1,14)
    1 FORMAT(I4,13A4,A2)
      READ(II,2)(LOC(I),BEAR(I),PLG(I),STYL(I),I=1,KEND)
    2 FORMAT(I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1
     $,I6,I3,I2,A1)
      L1=4
      KTAP=0
      GO TO 3


      PLOT CONTROL CARDS

      AFTER THE DATA DECK THE USER MAY INSERT A CARD PUNCHED IN COLUMN 1
      FOR THE FOLLOWING RESULTS-

      0   TO TERMINATE THE PROGRAM (MUST BE THE LAST CARD IN THE DECK.)

      1   TO CONTINUE THE SAME PLOT WITH NEW DATA AS SPECIFIED BELOW.

      CAUTION, OVERLAP OF BEARING & PLUNGE VALUES MAY OCCUR AT THIS
      POINT IF CARE IS NOT EXERCIZED.

      2   TO START A NEW PLOT.


   10 READ(II,1)L1,(NTITL(I),I=1,14)
      IF(L1-1)99,7,3
    3 J=0
      K=0
      JK=0
      DO 6 I=1,KEND

      TEST FOR SIMILAR(S), CONCENTRIC(C),OR UNDEFINED(U) STYLE FOLDS.

      IF(STYL(I).EQ.C) GO TO 5
      IF(STYL(I).EQ.S) GO TO 4

      STORES UNDEFINED STYLE FOLDS.

      JK=JK+1
      LOCU(JK)=LOC(I)
      BEARU(JK)=BEAR(I)
      PLGU(JK)=PLG(I)
      GO TO 6

      STORES SIMILAR FOLDS.
```

```
4 J=J+1
  LOCS(J)=LOC(I)
  BEARS(J)=BEAR(I)
  PLGS(J)=PLG(I)
  GO TO 6

  STORES CONCENTRIC FOLDS.

5 K=K+1
  LOCC(K)=LOC(I)
  BEARC(K)=BEAR(I)
  PLGC(K)=PLG(I)
6 CONTINUE


  STYLE CONTROL CARDS

  ONE OF THE FOLLOWING VALUES (OF L PUNCHED IN COLUMN 1) MUST FOLLOW
  THE ABOVE MENTIONED PLOT CONTROL CARDS.

  1    FOR SIMILAR FOLDS ONLY.

  2    FOR CONCENTRIC FOLDS ONLY.

  3    FOR ALL FOLD DATA.

  4    FOR FOLDS OF UNDETERMINED OR DIFFERENT STYLES.

7 READ(II,8) L,KHANGE
8 FORMAT(2I1)
  IF(KHANGE.EQ.0) GO TO 10
  THIS SECTION IS USED IN CASE THE USER WISHES TO DIFFERENTIATE
  THE DATA BY VARYING THE PEN SIZE OR COLOR.  THIS IS ACCOMPLISHED
  BY MAKING KHANGE LARGER THAN ZERO (IN COLUMN 2).
  CALL PLOT(0.0,0.0,3)
  CALL PLOT(0.0,0.0,999)
  CALL SETMSG(10,'CHANGE PEN')
  CALL PLOT(0.0,0.0,-3)
10 READ(II,11)IBEAR1,IBEAR2,IPLG1,IPLG2
11 FORMAT(4I3)
  GO TO (36,30,32,34),L
12 M=0

  SEPARATES OUT BEARINGS WITHIN SPECIFIED INTERVAL.

13 DO 14 I=1,J
  IF((BEARA(I).LT.IBEAR1).OR.(BEARA(I).GT.IBEAR2)) GO TO 14
  M=M+1
  TL(M)=LOCA(I)
  TB(M)=BEARA(I)
  TP(M)=PLGA(I)
14 CONTINUE
  IF(M.NE. 0) GO TO 16
  WRITE(ITY,15) IBEAR1,IBEAR2
15 FORMAT('NO BEARING EXISTS IN THE INTERVAL ',I4,'-',I4,' --SPECIFY
8 NEW INTERVALS OF BEARING AND PLUNGE.')
  GO TO 99
```

```
C
C     SEPARATES OUT PLUNGES WITHIN THE SPECIFIED INTERVAL.
C
16    N=0
      DO 17 I=1,M
      IF((TP(I).LT.IPLG1).OR.(TP(I).GT.IPLG2)) GO TO 17
      N=N+1
      LOCA(N)=TL(I)
      BEARA(N)=TB(I)
      PLGA(N)=TP(I)
17    CONTINUE
      IF(N.NE. 0) GO TO 19
      WRITE(ITY,18)IPLG1,IPLG2
18    FORMAT('NO PLUNGE EXISTS IN THE INTERVAL ',I3,'-',I3,' ---SPECIFY
     $NEW INTERVALS OF BEARING AND PLUNGE.')
      GO TO 99
C
C     SETS BEARING TO CALCOMP COORDINATE SYSTEM
C
19    DO 22 I=1,N
      IF(BEARA(I)-270)21,20,20
20    BEARA(I)=450-BEARA(I)
      GO TO 22
21    BEARA(I)=90-BEARA(I)
22    CONTINUE
      IF(KTAP.GT.0) GO TO 23
      KTAP=1
      READ(8) MP
      READ(8) (LOC2(I),XC(I),YC(I),I=1,MP)
23    DO 29 I=1,N
      CX(I)=-5
      DO 25 I2=1,MP
      IF(LOC2(I2)-LOCA(I))25,24,25
24    CX(I)=XC(I2)
      CY(I)=YC(I2)
      GO TO 26
25    CONTINUE
26    IF(CX(I))27,29,29
27    WRITE(IO,28)LOCA(I)
28    FORMAT(' LOCATION ',I6,' IS NOT ON LOCTAP.')
29    CONTINUE
      GO TO 38
C
C     PLACES DATA FOR STYLES INTO A TEMPORARY ARRAY.
C
30    DO 31 I=1,K
      LOCA(I)=LOCC(I)
      BEARA(I)=BEARC(I)
31    PLGA(I)=PLGC(I)
      J=K
      GO TO 12
32    DO 33 I=1,KEND
      LOCA(I)=LOC(I)
      BEARA(I)=BEAR(I)
33    PLGA(I)=PLG(I)
      J=KEND
      GO TO 12
```

```
34 DO 35 I=1,JK
   LOCA(I)=LOCU(I)
   BEARA(I)=BEARU(I)
35 PLGA(I)=PLGU(I)
   J=JK
   GO TO 12
36 DO 37 I=1,J
   LOCA(I)=LOCS(I)
   BEARA(I)=BEARS(I)
37 PLGA(I)=PLGS(I)
   GO TO 12
38 IF(L1-2)44,40,39
39 CALL PLOT(6.0,-30.0,-3)
   GO TO 41
40 CALL PLOT(22.0,0.0,-3)
   GO TO 42
41 CALL PLOT(0.0,8.0,-3)
42 CALL PLOT(0.0,15.19,2)
   CALL PLOT(18.51,15.19,2)
   CALL PLOT(18.51,0.0,2)
   CALL PLOT (0.0,0.0,2)
   CALL PLOT (0.0,0.0,3)
   CALL SYMBOL(0.0,-1.6,0.4,NTITL,0.0,54)

   ARROW LENGTH IS 0.4 INCHES LONG AND DIP VALUE SYMBOL IS A FUNCTION
   THEREOF.

   HT=0.4
43 HTS=0.08
   PI=3.141593
   PI2=1.570796
   HT2=HT*0.86*0.5
   WD=HT2-HT*0.86*0.162
   RS=SQRT(WD*WD+HT2*HT2)
44 DO 52 I=1,N
   BR=BEARA(I)
   ANG=BEARA(I)*0.01745
   ANGTOT=ANG+ARSIN(HT2/RS)
   Y=CY(I)-RS*SIN(ANGTOT)
   X=CX(I)-RS*COS(ANGTOT)
   CALL SYMBOL(X,Y,HT,20,BR,-1)
   PLUNGE=PLGA(I)
   IF(PLGA(I).LT.10) GO TO 45
   A=CX(I)-0.045+COS(ANG)*0.285
   B=CY(I)-0.045+SIN(ANG)*0.285
   GO TO 46
45 A=CX(I)-0.032+COS(ANG)*0.242
   B=CY(I)-0.032+SIN(ANG)*0.242
46 ANGLE=BR
   GO TO (47,48,49,50),L
47 KIND=13
   GO TO 51
48 KIND=04
   GO TO 51
49 KIND=16
   ANGLE=0.0
   GO TO 51
```

```
50 KIND=01                                                    RWR0228(
51 CALL SYMBOL(CX(I),CY(I),0.06,KIND,ANGLE,-1)                RWR0229(
52 CALL NUMBER(A,B,HTS,PLUNGE,0.0,-1)                         RWR0230(
   GO TO 100                                                  RWR0231(
99 CALL PLOT(0.0,0.0,999)                                     RWR0232(
   STOP                                                       RWR0233(
   END                                                        RWR0234(
```

PROGRAM NAME - MAPLAN

PURPOSE - PLOTS FOLIATION SYMBOL AND DIP VALUE AT APPROPRIATE LOCATIONS WITHIN THE BASE MAP BOUNDARIES.

USER VARIABLES -

ISTK - STRIKE OF THE FOLIATION (ANY POSITIVE INTEGER FROM 0 THROUGH 360),

IDP - DIP OF THE FOLIATION (ANY POSITIVE INTEGER FROM 0 THROUGH 90),

IDIR - DIP DIRECTION (USE: N FOR NORTH, S FOR SOUTH, E FOR EAST, AND W FOR WEST, ONLY),

LOC - STATION LOCATION NUMBER (USED TO LOCATE COORDINATES) OF ATTITUDE READ FROM DATA CARDS,

LOC2 - STATION LOCATION READ FROM THE TAPE CONSTRUCTED BY THE PROGRAM "LOCTAP",

XC - X COORDINATE MEASURED (IN INCHES AND DECIMAL FRACTIONS THEREOF) FROM THE LOWER LEFT HAND CORNER OF THE MAP TO THE STATION,

YC - Y COORDINATE (SAME AS FOR XC),

NTITL- 54 CHARACTER TITLE FOR MAP OF ATTITUDES PRODUCED BY THE CALCOMP PLOTTER.

PROGRAM ALGORITHM - DATA ARE READ INTO ARRAYS AND VARIABLE ABOVE. A SEARCH IS EXECUTED BETWEEN THE LOCATION NUMBER ACCOMPANYING EACH OF THE PLANAR ELEMENTS AND THOSE ON THE LOCATION TAPE. WHEN EQUALITY IS ACHIEVED THE COORDINATES ARE STORED IN ARRAYS. THE MAP PERIMETER (SEE REMARKS) IS

THEN PLOTTED AND THE TITLE IS WRITTEN BELOW THE MAP.

THE ATTITUDES ARE THEN PLOTTED AT THE LOCATION OF THE X,Y COORDINATES FOR THAT LOCATION.

PROGRAM CONTROL DATA CARDS -

THE LAST CARD OF THE DATA DECK MUST BE A BLANK TRAILER CARD.

REMARKS - FOR EACH INDIVIDUAL MAP, THE MAP CORNER COORDINATES ON PROGRAM CARDS RWR00790 THROUGH RWR00830 MUST BE CHANGED TO SUIT THE USERS BASE MAP.

SUBPROGRAMS - CALCOMP 563 PLOTTER SUBROUTINE SET AND NEW MEXICO TECH COMPUTER CENTER'S TAPE TO PLOT AND PLOT TAPE W/O SENSSW ROUTINES.

LANGUAGE - FORTRAN IV, PS.

EQUIPMENT - IBM 360/44, LEVEL 1, VERSION 3 WITH CALCOMP 563 INCREMENTAL PLOTTER, IBM 2415-II TAPE DRIVES, IBM 1443 LINE PRINTER, AND IBM 1442 CARD READER-PUNCH.

STORAGE REQUIREMENTS - X'9DF4' BYTES.

TIME -

COMPILE: 88 SECONDS.

LINKAGE EDITOR: 41 SECONDS.

TOTAL: 175 SECONDS FOR 131 PLANAR ATTITUDES.

```
      ----------------------MAPLAN PROGRAM-----------------RIESE

      DIMENSION LOC(1000),ISTK(1000),IDP(1000),IDIR(1000),LOC2(1000),
     *XC(1000),YC(1000),CX(1000),CY(1000),NTITL(14)
      INTEGER W/'W   '/,S/'S   '/
      KOUNT=0

      READS IN THE TOTAL NUMBER OF POINTS (MAXIMUM=1000), SYMBOL TYPE,
      AND THE HEIGHT OF THE PLANAR SYMBOL (IN INCHES AND TENTHS).
      THIS IS FOLLOWED BY, ON THE SAME CARD, THE LABEL FOR THE PLOT,
      WHICH MAY CONTAIN UP TO 54 CHARACTERS.

    1 CONTINUE
      CALL SETMSG(15,'PLOTS FOR RIESE')
      READ(5,2)NMAX,ISYMBL,HT,(NTITL(I),I=1,14)
    2 FORMAT(I4,I1,F3.1,1X,13A4,A2)
      KOUNT=KOUNT+1
      IF(NMAX)99,99,3

      READS LOCATION NUMBER AND ATTITUDES FROM CARDS

    3 READ(5,4)(LOC(I),ISTK(I),IDP(I),IDIR(I),I=1,NMAX)
    4 FORMAT(I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1,I6,I3,I2,A1
     *,I6,I3,I2,A1)
      DO 100 I=1,NMAX

      CAUSES DIP VALUE TO BE NEGATIVE IF DIP DIRECTION IS SOUTH OR WEST

      IF(IDIR(I).EQ.W) IDP(I)=-IDP(I)
      IF(IDIR(I).EQ.S) IDP(I)=-IDP(I)
      IF(IABS(IDP(I)).EQ.90) IDP(I)=90

      CAUSES STRIKES TO BE 0 TO +180 DEGREES CLOCKWISE AND 0 TO -180
      DEGREES COUNTER-CLOCKWISE FROM EAST.

      IF(360-ISTK(I))97,5,6
    5 ISTK(I)=90
      GO TO 100
    6 IF(ISTK(I)-270)8,7,7
    7 ISTK(I)=270-ISTK(I)
      GO TO 100
    8 IF(ISTK(I)-180)10,10,9
    9 ISTK(I)=ISTK(I)-180
      GO TO 100
   10 ISTK(I)=90-ISTK(I)
  100 CONTINUE

      READS LOCATION NUMBER AND COORDINATES FROM LOCATION TAPE
```

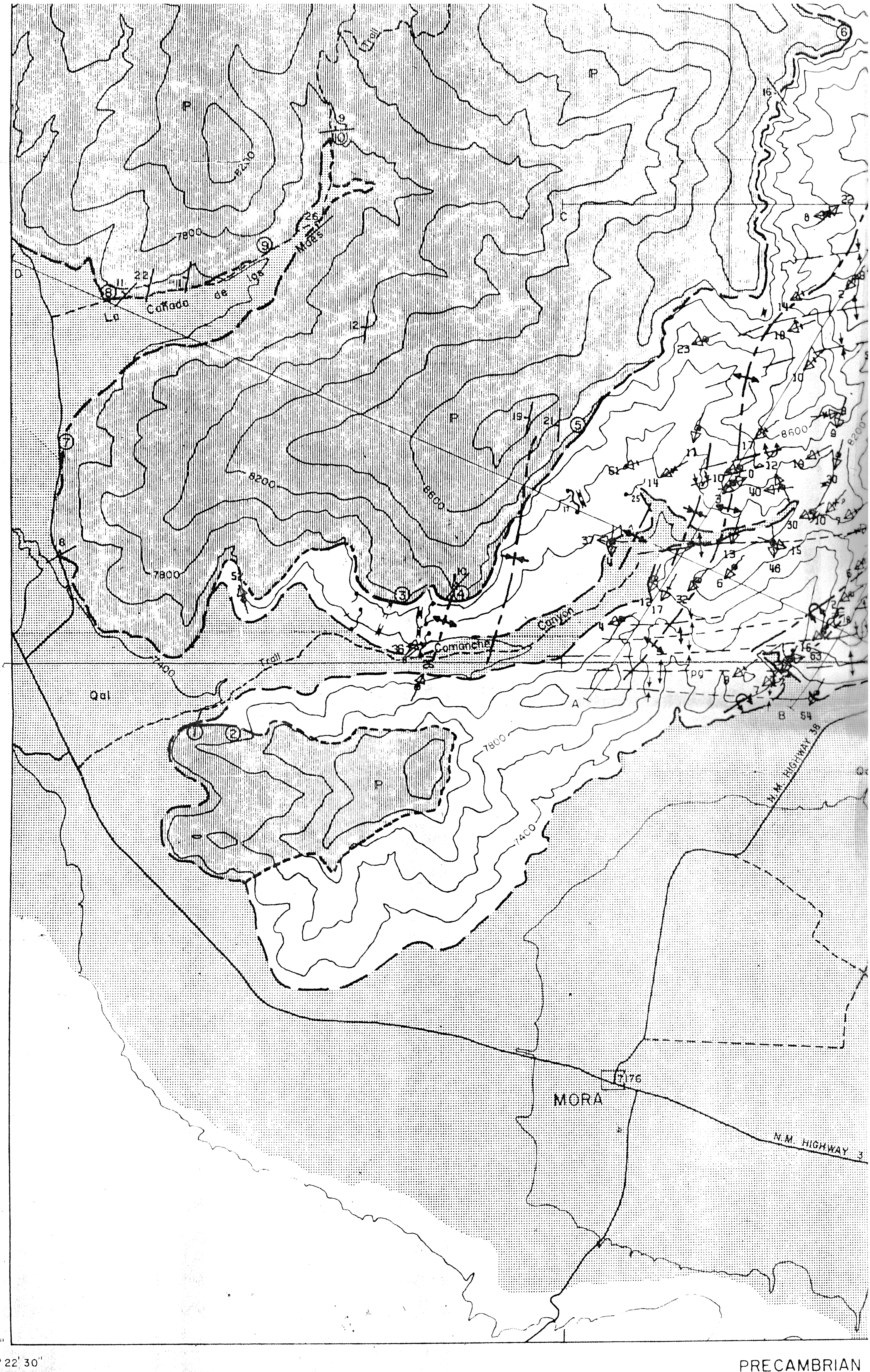
```
      (SEE LOCTAP PROGRAM)                                                     RWR005
                                                                               RWR005
      READ(8) MP                                                               RWR005
      READ(8)(LOC2(I),XC(I),YC(I),I=1,MP)                                      RWR005
      REWIND 8                                                                 RWR005
      DO 17 I=1,NMAX                                                           RWR005
      CX(I)=-5                                                                 RWR005
                                                                               RWR005
      COMPARES ALL LOCATION NAMES (FROM CARDS AND STORES COORDINATES IN        RWR005
      NEW STORAGE WHEN LOCATIONS ARE EQUIVALENT.                               RWR005
                                                                               RWR006
      DO 14 J=1,MP                                                             RWR006
      IF(LOC(I)-LOC2(J))14,13,14                                               RWR006
   13 CX(I)=XC(J)                                                              RWR006
      CY(I)=YC(J)                                                              RWR006
      GO TO 17                                                                 RWR006
   14 CONTINUE                                                                 RWR006
      IF(CX(I))15,17,17                                                        RWR006
   15 WRITE(6,16) LOC(I)                                                       RWR006
   16 FORMAT(' ','LOCATION ',I6,' IS NOT ON LOCATION TAPE')                    RWR006
   17 CONTINUE                                                                 RWR00
                                                                               RWR00
                                                                               RWR00
                                                                               RWR00
                                                                               RWR00
      IF(KOUNT-1)20,20,21                                                      RWR00
   20 CALL PLOT(0.0,-22.0,-3)                                                  RWR00
      GO TO 22                                                                 RWR00
   21 CALL PLOT(22.0,0.0,-3)                                                   RWR00
      GO TO 23                                                                 RWR00
   22 CALL PLOT(2.0,8.0,-3)                                                    RWR00
   23 CALL PLOT(0.0,15.19,2)                                                   RWR00
      CALL PLOT(18.51,15.19,2)                                                 RWR00
      CALL PLOT(18.51,0.0,2)                                                   RWR00
      CALL PLOT(0.0,0.0,2)                                                     RWR00
      CALL SYMBOL(0.0,-1.6,0.4,NTITL,0.0,54)                                   RWR00
      SMBSZ=HT*0.25                                                            RWR00
      DO 90 I=1,NMAX                                                           RWR00
      ANG=ISTK(I)*0.01745                                                      RWR00
      SYMANG=ISTK(I)-90                                                        RWR00
                                                                               RWR00
      CAUSES STRIKE LINE TO BE PLOTTED.                                        RWR00
                                                                               RWR00
      CALL SYMBOL(CX(I),CY(I),HT,13,SYMANG,-1)                                 RWR00
      RV=HT*0.25*0.56                                                          RWR00
                                                                               RWR00
      ENTRY POINT FOR FUTURE PLANAR SYMBOLS (E.G. JOINTS-54, BEDDING-96,       RWR00
      AND SLIP CLEAVAGE-35 (NOS. RADIX 10)                                     RWR00
      THIS IS THE ENTRY POINT FOR A GO TO STATEMENT FOR FUTURE SYMBOLS         RWR00
                                                                               RWR00
```

```
24 HYP=HT*0.125*0.56                                              RWRO
   XF=HYP*COS(ANG)                                                RWRO
   YF=HYP*SIN(ANG)                                                RWRO
   IF(IDP(I))29,25,25                                             RWRO
25 IF(ISTK(I))27,27,26                                            RWRO
26 X=CX(I)+XF                                                     RWRO
   Y=CY(I)+YF                                                     RWRO
   SYMBAN=ISTK(I)+180                                             RWRO
   IF((IDP(I).EQ.0).OR.(IDP(I).EQ.90)) GO TO 28                   RWRO
   ANGL=(ISTK(I)-90)*0.01745                                      RWRO
   XN=CX(I)+RV*COS(ANGL)+0.03                                     RWRO
   YN=CY(I)+RV*SIN(ANGL)-0.1                                      RWRO
   IF(ISTK(I).EQ.0) YN=CY(I)-RV*SIN(ANGL)-0.1                     RWRO
   GO TO 28                                                       RWRO
27 X=CX(I)-XF                                                     RWRO
   Y=CY(I)-YF                                                     RWRO
   SYMBAN=ISTK(I)                                                 RWRO
   IF((IDP(I).EQ.0).OR.(IDP(I).EQ.90)) GO TO 28                   RWRO
   ANGL=(ISTK(I)+90)*0.01745                                      RWRO
   XN=CX(I)+RV*COS(ANGL)+0.03                                     RWRO
   YN=CY(I)+RV*SIN(ANGL)+0.03                                     RWRO
28 CALL SYMBOL(X,Y,SMBSZ,18,SYMBAN,-1)                            RWRO
   IF((IDP(I).EQ.0).OR.(IDP(I).EQ.90)) GO TO 33                   RWRO
   DIP=IABS(IDP(I))                                               RWRO
                                                                  RWRO
   CAUSES DIP VALUE TO BE PLOTTED.                                RWRO
                                                                  RWRO
   CALL NUMBER(XN,YN,0.07,DIP,0.0,-1)                             RWRO
   GO TO 90                                                       RWRO
29 IF(ISTK(I))31,31,30                                            RWRO
30 X=CX(I)-XF                                                     RWRO
   Y=CY(I)-YF                                                     RWRO
   SYMBAN=ISTK(I)                                                 RWRO
   ANGL=(ISTK(I)+90)*0.01745                                      RWRO
   XN=CX(I)+RV*COS(ANGL)-0.16                                     RWRO
   YN=CY(I)+RV*SIN(ANGL)+0.03                                     RWRO
   GO TO 32                                                       RWRO
31 X=CX(I)+XF                                                     RWRO
   Y=CY(I)+YF                                                     RWRO
                                                                  RWRO
   CALCULATES REFERENCE POINT FOR DIP VALUE NUMBER.               RWRO
                                                                  RWRO
   SYMBAN=ISTK(I)+180                                             RWRO
   ANGL=(ISTK(I)-90)*0.01745                                      RWRO
   XN=CX(I)+RV*COS(ANGL)-0.16                                     RWRO
   YN=CY(I)+RV*SIN(ANGL)-0.1                                      RWRO
                                                                  RWRO
   CAUSES THE DIP DIRECTION OF FOLIATION SYMBOL TO BE PLOTTED.    RWRO
                                                                  RWRO
```

```
2 CALL SYMBOL(X,Y,SMBSZ,18,SYMBAN,-1)                          RWRO
  DIP=IABS(IDP(I))                                             RWRO
                                                               RWRO
  CAUSES THE DIP VALUE TO BE PLOTTED.                          RWRO
                                                               RWRO
  CALL NUMBER(XN,YN,0.07,DIP,0.0,-1)                           RWRO
  GO TO 90                                                     RWRO
3 IF(ISTK(I))35,35,34                                          RWRO
4 X=CX(I)-XF                                                   RWRO
  Y=CY(I)-YF                                                   RWRO
  SYMBAN=ISTK(I)                                               RWRO
  IF(ISTK(I).EQ.0) GO TO 36                                    RWRO
  GO TO 37                                                     RWRO
5 X=CX(I)+XF                                                   RWRO
  Y=CY(I)+YF                                                   RWRO
6 SYMBAN=ISTK(I)+180                                           RWRO
                                                               RWRO
  CAUSES THE DIP DIRECTION OF FOLIATION SYMBOL TO BE PLOTTED.  RWRO
                                                               RWRO
7 CALL SYMBOL(X,Y,SMBSZ,18,SYMBAN,-1)                          RWRO
  IF(IDP(I).EQ.0) GO TO 38                                     RWRO
  GO TO 90                                                     RWRO
8 SYMANG=SYMANG+90.                                            RWRO
                                                               RWRO
  CAUSES THE STRIKE LINE TO BE PLOTTED.                        RWRO
                                                               RWRO
  CALL SYMBOL(CX(I),CY(I),HT,13,SYMANG,-1)                     RWRO
  GO TO 90                                                     RWRO
0 CONTINUE                                                     RWRO
  GO TO 1                                                      RWRO
7 WRITE(6,98) I                                                RWRO
8 FORMAT(' ','STRIKE NO. ',I4,' IS GREATER THAN 360.')         RWRO
9 CALL PLOT(0.0,0.0,999)                                       RWRO
  STOP                                                         RWRO
  END                                                          RWRO
```

This thesis is accepted on behalf of the faculty of the Institute by the following committee:

Date: October 20, 1969



35°57'30"
105°22'30"

Topography and culture for the north and south halfs of map were compiled from the U.S. Geological Survey's Comanche Peak and Mora, N.M. quadrangles, respectively.

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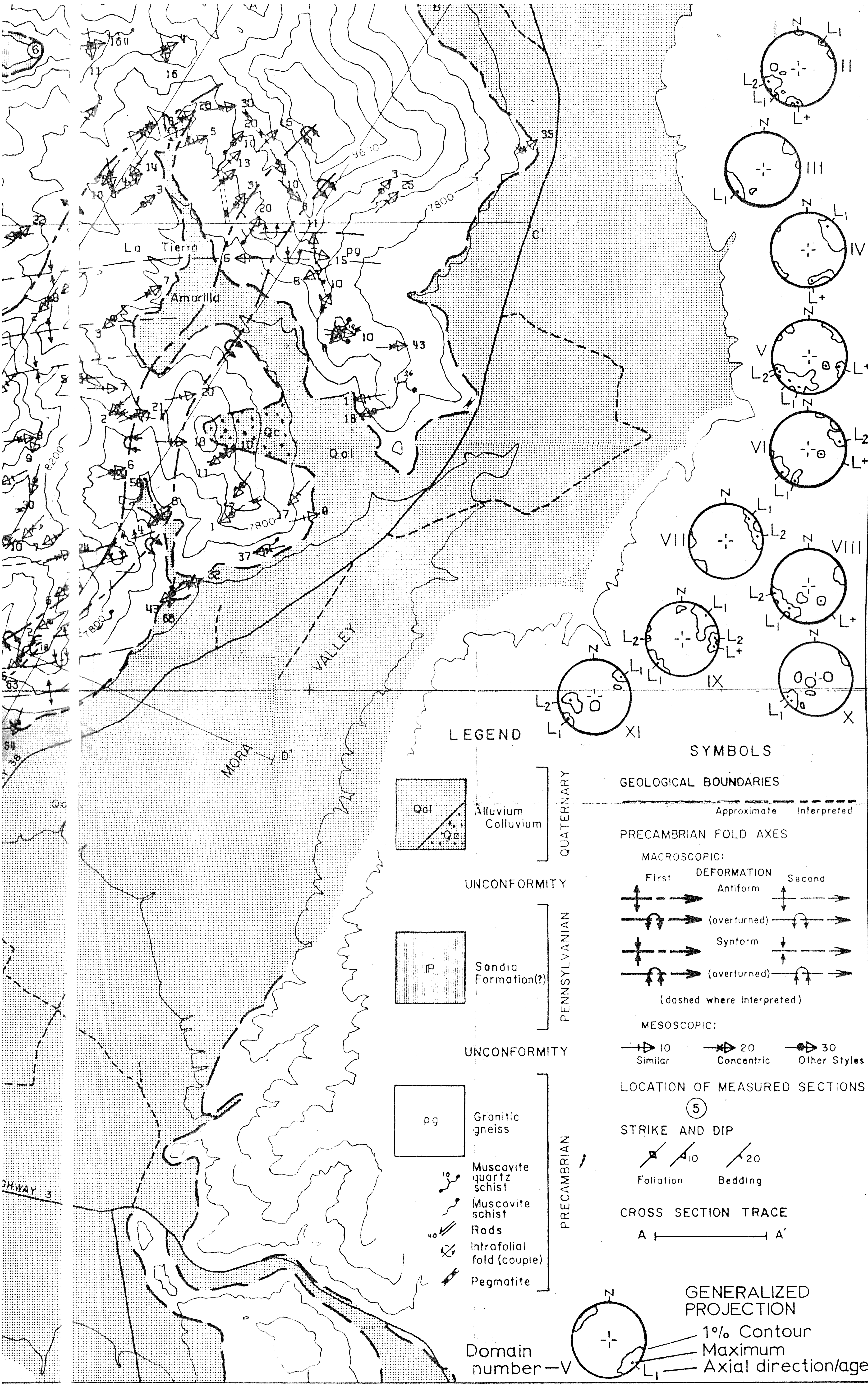

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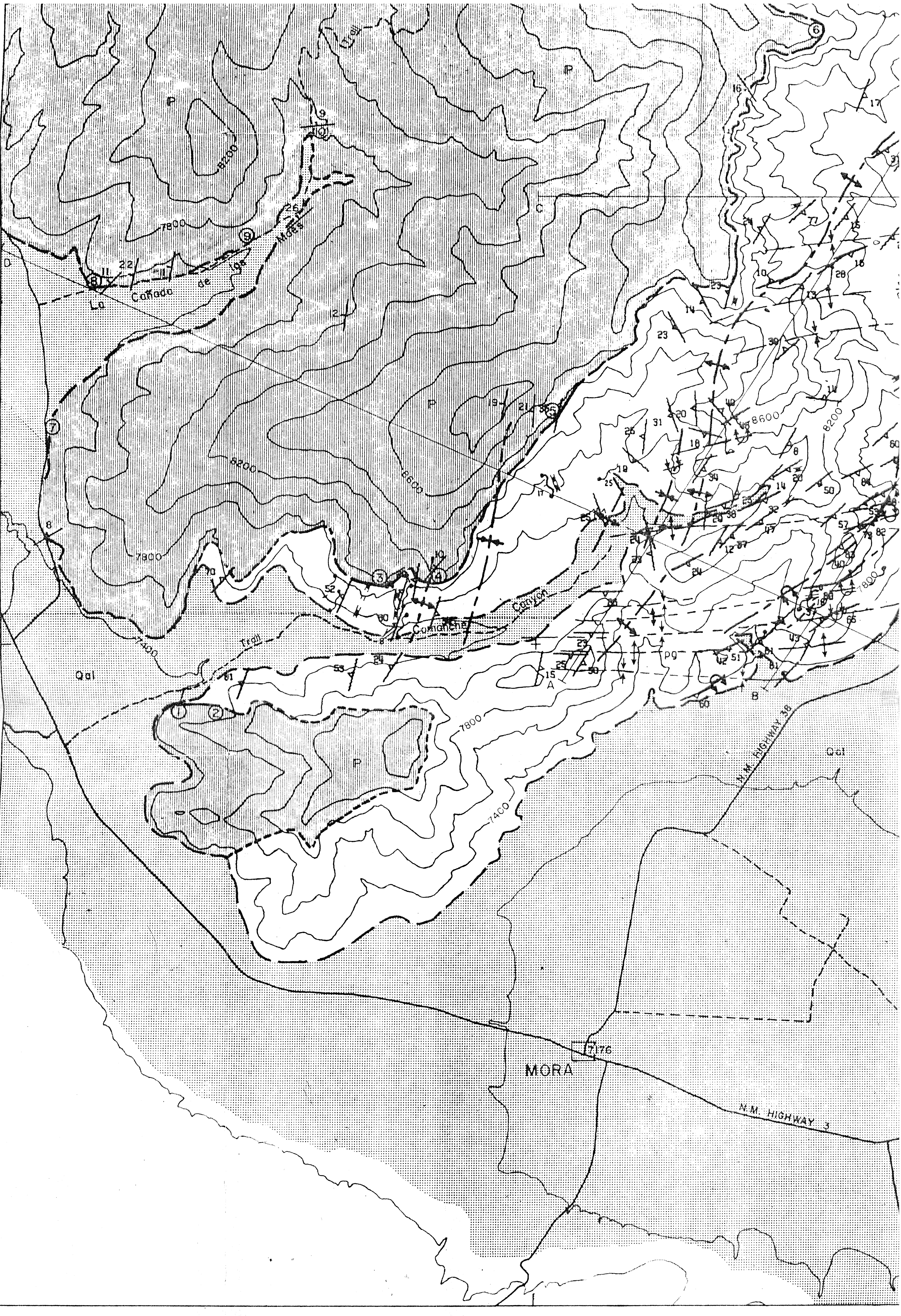

Topography and culture for the north and south halfs of map were compiled from the U. S. Geological Survey's Comanche Peak and Mora, N. M. quadrangles, respectively.

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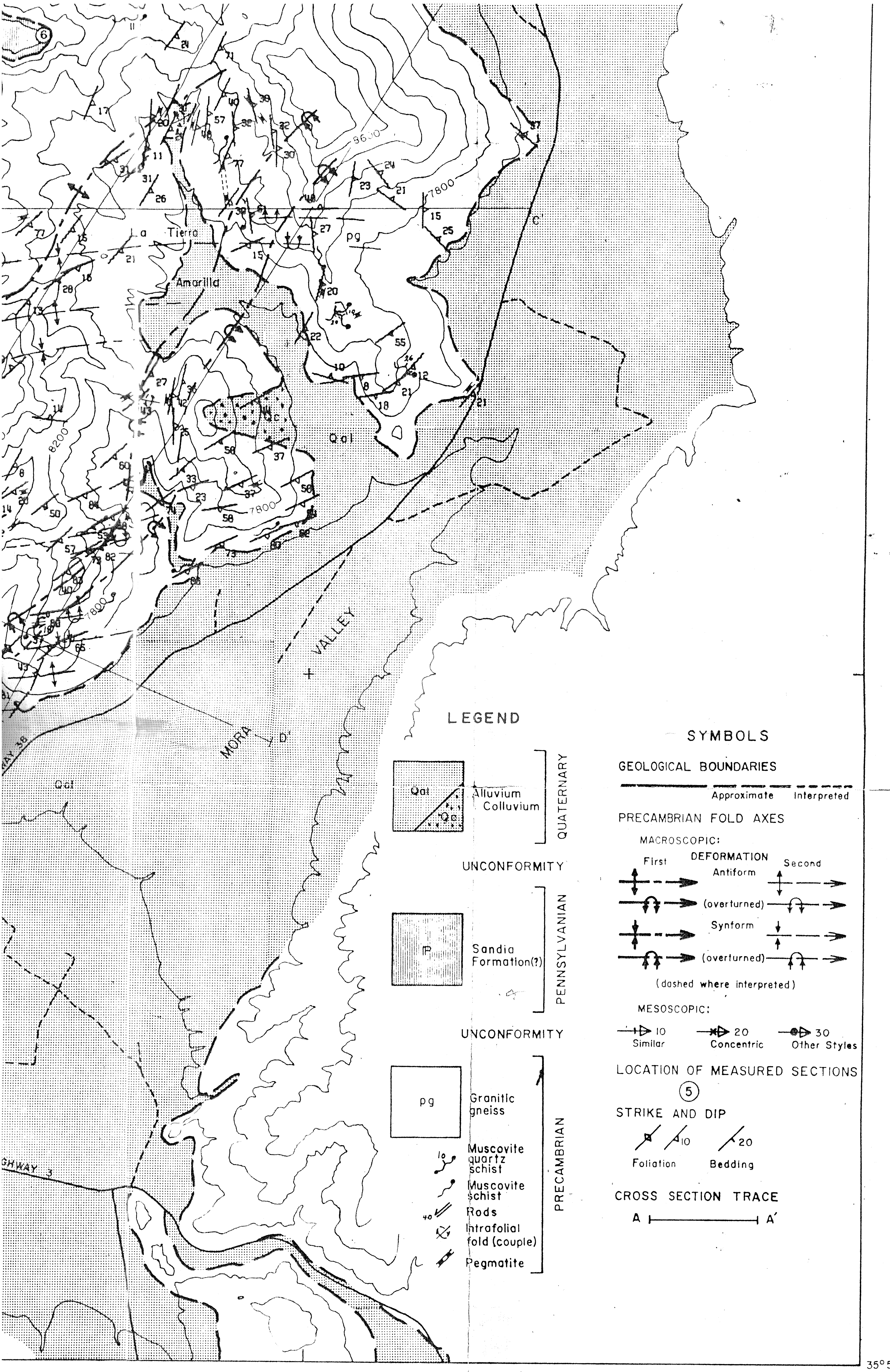

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N. M.

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