NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

PRECAMBRIAN GEOLOGY OF THE SOUTHERN PART OF THE RINCON RANGE

BY
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SUBMITTED TO THE FACULTY OF THE NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN GEOLOGY

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THE METAMORPHIC ROCKS OF THE MORA AREA HAVE BEEN DEFORMED DURING AT LEAST TWO PERIODS OF PRECAMBRIAN TECTONIC ACTIVITY. PERVERSIVE 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-NORHEAST 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.
TABLE OF CONTENTS

ABSTRACT.................................................................PAGE 1
TABLE OF CONTENTS....................................................PAGE 1
LIST OF ILLUSTRATIONS................................................PAGE 3
INTRODUCTION............................................................PAGE 7
LOCATION.................................................................PAGE 7
PHYSIOGRAPHY............................................................PAGE 8
PURPOSE OF INVESTIGATION.............................................PAGE 9
METHOD OF INVESTIGATION.............................................PAGE 10
ACKNOWLEDGEMENTS.....................................................PAGE 11
PRECAMBRIAN ROCKS....................................................PAGE 13
INTRODUCTION............................................................PAGE 13
GRANITIC GNEISS.........................................................PAGE 14
MUSCOVITE SCHIST.......................................................PAGE 30
MUSCOVITE QUARTZ SCHIST.............................................PAGE 34
PEGMATITES AND QUARTZ VEINS......................................PAGE 35
METAMORPHISM...........................................................PAGE 44
PENNSYLVANIAN ROCKS................................................PAGE 47
INTRODUCTION............................................................PAGE 47
ORTHOQUARTZITE.........................................................PAGE 49
LIMESTONE.................................................................PAGE 52
SHALE.......................................................................PAGE 53
SUBARKOSES..............................................................PAGE 54
QUATERNARY DEPOSITS................................................PAGE 57
LIST OF ILLUSTRATIONS

FIGURES

1 A COMPOSITIONAL BANDING IN GRANITIC GNEISS .......................... 16
1 B MAGNETITE BANDS IN GRANITIC GNEISS ............................... 16
2 A RELATIONSHIP OF C-AXIS TRACE AND DOMAIN BOUNDARIES IN QUARTZ ......................................................... 18
2 B MICROGRAPHIC QUARTZ IN PLAGIOCLASE OF GRANITIC GNEISS .............................. 18
2 C MUSCOVITE-MICROCLINE BOUNDARIES IN GRANITIC GNEISS ...................... 18
3 STRUCTURAL DOMAIN MAP .................................................. 24
4 TERNARY DIAGRAM OF QUARTZ-ALBITE-ORTHoclASE
PERCENTAGES FOR PRECAMBRIAN ROCKS OF THE MORA AREA ... 26
5 TERNARY DIAGRAM OF QUARTZ-MICROCLINE-PLAGIOCLASE
MINERAL PERCENTAGES FOR PRECAMBRIAN ROCKS OF THE MORA AREA ...................... 28
6 A STEEPLY DIPPING MUSCOVITE SCHIST .................................. 31
6 B INTRAFOLIAL FOLD OF QUARTZ BODY IN THE MUSCOVITE SCHIST ......................... 31
7 A NARROW PEGMATITE DIKE ............................................. 36
7 B PEGMATITE DIKE SHOWING "PINCH AND SHELL" STRUCTURE ....................... 36
7 C EN ECHelon DIKES WITH DRAG FOLDS .................................... 36
FIGURES

8 A QUARTZOFELDSPATIC BANDS COALESADING INTO PEGMATITIC BANDS ALONG THE FLANK OF A FOLD

8 B SYNFORM OUTLined BY PEGMATITE

9 PEGMATITIC BAND EXTENDING FROM THE CREST OF AN ANTIFORM

10 COMPOSITION OF PEGMATITE VS. DISTANCE FROM THE SELVAGE

11 A THIN RIND OF SELVAGE ON PEGMATITE

11 B STEEPLY PLUNGING CRENUlations IN SELVAGE

12 QUARTZ BODIES IN GRANITIC GNEISS

13 STRATIGRAPHIC COLUMNS FROM COMANCHE CANYON

14 STRATIGRAPHIC COLUMNS FROM CANADA DE LOS MAES

15 CROSS-BEDDED SUBARKOSE

16 PANORAMA OF MORA VALLEY

17 GENERALIZED SCHMIDT PROJECTIONS OF FOLIATION FROM 11 ORIGINAL SUBDOMAINS

18 SCHMIDT PROJECTION OF FOLIATION IN DOMAIN "A"

19 SCHMIDT PROJECTION OF FOLD AXES IN DOMAIN "A"

20 SCHMIDT PROJECTION OF FOLIATION IN DOMAIN "B"

21 SCHMIDT PROJECTION OF FOLD AXES IN DOMAIN "B"

22 SCHMIDT PROJECTION OF FOLIATION IN DOMAIN "C"

23 SCHMIDT PROJECTION OF FOLD AXES IN DOMAIN "C"

24 STRUCTURAL CROSS-SECTIONS A AND B

25 STRUCTURAL CROSS-SECTIONS C AND D
FIGURES

26  STRUCTURAL CONTOUR MAP .......................... 70
27  SYNOPTIC SCHMIDT PROJECTION OF PRECAMBRIAN
    FOLIATION ............................................ 71
28  SCHMIDT PROJECTION OF FOLIATION FROM SUBDOMAINS
    CONTAINING "L+" MAXIMA ............................. 73
29  SCHMIDT PROJECTION OF LINEATION FROM SUBDOMAINS
    CONTAINING "L+" MAXIMA ............................. 74
30 A  CURVIPLANAR SIMILAR FOLD IN GRANITIC GNEISS........... 79
30 B  A COMPLEX OF SIMILAR FOLDS IN GRANITIC GNEISS........... 79
31 A  ARCUATE FOLDS IN GRANITIC GNEISS ....................... 80
31 B  SIGMOIDAL FOLDS IN GRANITIC GNEISS ...................... 80
32  PEGMATITE, SIGMOIDAL, AND ARCUATE FOLDS IN
    ONE OUTCROP OF GRANITIC GNEISS ..................... 81
33 A  CONCENTRIC FOLDS (MESOSCOPIC SCALE) ...................... 83
33 B  FLANK OF LARGE CONCENTRIC FOLD ........................ 83
34  DIAGRAMMATIC DEVELOPMENT OF SIGMOIDAL
    AND ARCUATE FOLDS ..................................... 84
35  SCHMIDT PROJECTION OF POLES TO JOINTS IN
    PRECAMBRIAN ROCKS .................................... 89
36  SCHMIDT PROJECTION OF POLES TO JOINTS IN
    PENNSYLVANIAN ROCKS .................................. 91
37  SCHMIDT PROJECTION OF POLES TO SEDIMENTARY
    BEDDING PLANES ....................................... 92
FIGURES

38 DIAGRAMMATIC REPRESENTATION OF PRECAMBRIAN TECTONIC CONDITIONS

PLATES

PLATE 1 FOLIATION MAP IN POCKET
PLATE 2 LINEATION MAP IN POCKET

TABLES

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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 (Detting, 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 Tierka 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 FOUT.

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 INTERNIENT, 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 Morra 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


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, JACQUE: 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 FLEMING 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.
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.


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,
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<th>K-SPAR</th>
<th>PLagioclase</th>
<th>MUScov.</th>
<th>Biotite</th>
<th>Magnet.</th>
<th>HEMAtite</th>
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Trace amounts indicated as O.O. * = epidote in sample.
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-fourth 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 GRANITIC 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 albite 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.
Q = quartz
M = microcline
P = plagioclase
m = muscovite

c = c-crystallographic axis.
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%.

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<td>AN %</td>
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</tr>
<tr>
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<td>XXXX</td>
</tr>
<tr>
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<td>23.0</td>
<td>(?)</td>
</tr>
<tr>
<td>3 MUSCOVITE SCHIST</td>
<td>(?)</td>
<td>(?)</td>
</tr>
<tr>
<td>4 MUSCOVITE SCHIST</td>
<td>21.5</td>
<td>9.5(?)</td>
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<td>24.0</td>
<td>2.0(?)</td>
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<td>22.0</td>
<td>4.3</td>
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<tr>
<td>16 GRANITIC GNEISS</td>
<td>------</td>
<td>11(?)</td>
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</table>

| 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 | (?) |

XXXXX = 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, THEREFORE, APPEAR TO BE THE RESULT OF DIFFUSION OF SODIUM FROM THE MICROCLINE LATTICE.

THE INCLUSIONS WITHIN PLAGIOCLASE CRYSTALS COMPRIZE 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 NACRESIA.

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 SOMETIMES 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 (Fe3+) AND FERROUS (Fe2+) IRON AND MANGANESE (Mn) AND AN INCREASE IN TITANIUM AND MAGNESIUM (Mg) IN BIOTITE. 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)4Si16O22(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 HAS 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 HORA 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.
**Table 3**

QUARTZ-ALBITE-ORTHOCLOASE VALUES, BY WEIGHT %

<table>
<thead>
<tr>
<th>NO.</th>
<th>SPECIMEN</th>
<th>QTZ %</th>
<th>AB%</th>
<th>OR%</th>
<th>AB/AN</th>
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<tr>
<td>1</td>
<td>MUSC OTZ SCHIST</td>
<td><em>94.41</em></td>
<td>0.34</td>
<td>5.26</td>
<td><em>999.99</em></td>
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<tr>
<td>2</td>
<td>MUSC SCHIST</td>
<td><em>86.07</em></td>
<td>6.93</td>
<td>6.99</td>
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<td>3</td>
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<td><em>92.72</em></td>
<td>0.35</td>
<td>6.72</td>
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<td>4</td>
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<td><em>91.88</em></td>
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<td><em>34.90</em></td>
<td>18.51</td>
<td>46.59</td>
<td>3.99</td>
</tr>
</tbody>
</table>

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 Nora 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

\[ \bullet = \text{Mora area pre cambrian rocks.} \]
\[ + = \text{Woodson Mountain Granodiorite.} \]
\[ \circ = \text{Roblar Granite.} \]
\[ \phi = \text{Pegmatite from Mora area.} \]

FIGURE 5
<table>
<thead>
<tr>
<th>NO.</th>
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<th>MICROcline</th>
<th>PLAGIOCLASE</th>
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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 COUNT OF MUSCOVITE WAS MADE
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 COMPRIS 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 GRAMS ARE INTERGROWN WITH THE MUSCOVITE AND CONSTITUTE ONLY A TRACE CONSTITUENT IN THE SCHIST. THE MUSCOVITE SCHIST SAMPLES EXAMINED CONTAINED BIOTITE RANGING FROM MIL 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).
Figure 8  Concordant pegmatite bodies in Cornache Canyon.

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

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


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:

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>GRAIN SIZE</th>
<th>COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUARTZ</td>
<td>3.5 MM.</td>
<td>28.6%</td>
</tr>
<tr>
<td>ALKALI FELDSPAR</td>
<td>10.0 MM.</td>
<td>43.0%</td>
</tr>
<tr>
<td>PLAGIOCLASE</td>
<td>9.0 MM.</td>
<td>25.0%</td>
</tr>
<tr>
<td>MICA</td>
<td>1.5 MM.</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

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.
THE TIME OF THEIR EMBLACEMENT 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) Kind (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.
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.

THE EVIDENCE FOR THE GRADE OF METAMORPHISM FROM THE FIRST DEFORMATION COMES FROM THE QUARTZOFELDSPATIC 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-QUARTZOFELDSPATIC 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 PERVERSIVE AS THEY ARE). ALSO, THE SOURCE WOULD LIKELY HAVE BEEN FROM THE SAME MACMA 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 PERVERSIVE CHARACTER OF THESE BANDS.

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 - ORTHOCLOASE SUBFACIES OF THE ALMANDINE - AMPHIBOLITE 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 ORTHOCLOASE 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
The growth of microcline at the expense of muscovite (page 19) also indicate a high grade of metamorphism.

From the above evidence it may be concluded that during the last stage of metamorphism the conditions of the sillimanite - almandine - 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.


IN HIS SUMMARY OF PENNSYLVANIAN ROCKS OF THE SANGRE DE CRISTO MOUNTAINS, KOTTLAWSKI (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.


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 HERE 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 SPARSE 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
LITHOLOGY

F - Brownish gray, fossiliferous, limestone with clastic fragments.
E - Gray limestone.
D - Fine to coarse grained siltstone, which weathers brick-red. Upper 1/2 - 2/3: fine grained, with less quartz.
C - Dark gray to black, non-fossiliferous limestone with small quartz grains.
B - White, fine to medium grained, indurated orthoquartzite. Cross-bedded on the west.
A - Precambrian rocks.

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

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 SHALL, EQUANT QUARTZ GRAINS ABOUT 1/16 INCH LONG THROUGHOUT THE LENGTH OF THE OUTFIT.

ANOTHER LIMESTONE UNIT IS A BROWNISH GRAY, NIGACEOUS, 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 RAES AND COMANCHE CANYON AT AN ELEVATION OF 7470 FEET AND ABOUNDS WITH BROKEN MOLLUSC AND SPIKIFER BRACHYOPOD 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 (COLUMN 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 Mocs. 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.
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 FLOODED WITH DETRITAL GRAINS OF QUARTZ, FELDSPAR, AND MICA DERIVED FROM THE GRANITIC GNEISS.


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 OCCURRED WITHIN THE LAST 50 TO 75 YEARS.
Figure 16  Panoramas of Mora Valley and Creston Range beyond. Arrow indicates identical position in Creston Range.
Upper picture from head of La Tierra Amarilla Canyon.
Lower picture taken from west ridge of La Tierra Amarilla Canyon.
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:

Poles within:

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-GROUP" FOLIATION
199 POINTS, CONTOURS: 1.00% 5.00% 8.00% 12.00%
FIG. 19  "A-GROUP"  FOLD AXES

69  POINTS, 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%
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.


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
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.


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 MICROSCOPIC STRUCTURAL DATA
FROM THE
ORIGINAL ELEVEN STRUCTURAL DOMAINS

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<tr>
<th>DOMAIN</th>
<th>DEFORMATION SYMBOL</th>
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<th>GIRDLE (G) OR MAXIMUM (M)</th>
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3-POLES, AND STATISTICAL PLANES FROM EACH OF THE ORIGINAL 11
SUBDIVISIONS.

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

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

TWO BROAD CLASSES OF MESOSCOPIC FOLDS APPEAR TO EXIST. THESE CLASSES ARE DEFINED BY THE RATIO OF WAVELENGTH TO AMPLITUDE (WL:A). WHEN WL:A RATIOS VARY WITHIN THESE TWO CLASSES BUT THE APPARENT BACK OF FOLDS OF ABOUT ONE WAVELENGTH UNIT TO FOUR AMPLITUDE UNITS APPEARS TO CONSTITUTE A MAJOR DIVISION AMONGST THE FOLDS OBSERVED.


MOST FOLDS ARE RECOGNIZABLE BY COMPOSITIONAL BANDING. AN EXAMPLE OF FOLDS OUTLINED BY COARSE GRAINED QUARTZOFELDSPATHIC BANDING 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, PETYGMATIC AND INTRAFOLIAL. BETWEEN THE FIRST TWO THERE ARE MANY GRADATIONAL STYLES.

IT IS NOTABLE THAT THE SMALLER FOLDS Seldom HAVE A WL:A RATIO 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 THESE FOLDS IS SHEARED LEAVING ONLY A CROOK OR CANE SHAPE TO THE
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. Quartzofeldspathic band (QB) lies between the folds. Foliation indicated by broken line.
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.
Folds, Fig. 6B and 12. These folds are usually associated with outcrops containing a high content of quartz and/or feldspar.

Ptygmatie 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 wavelength 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.
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 quartzofeldspathic/pegmatitic material. See text for explanation.
11. 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,
52, 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.

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


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.
- $\pi$ = lineation plunges 180 degrees to that shown.
- $s$ = pi-pole 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.
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<td>5341E</td>
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<td>270</td>
<td>24</td>
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</table>
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.


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.
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.
CONCURRENTLY 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

THE METAMORPHISM PROBABLY REACHED THE SILLIMANITE - ALMANDINE - ORTHOCLSAE 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 ORTHOCLSAE LATTICE OF HIGH-GRADe METAMORPHIC ROCKS IS ABOUT 10%, WHILE THE LOWER TEMPERATURE MICROCLINE CONTAINS ABOUT 3% ALBITE. FURTHERMORE, AS THE TEMPERATURE DECLINES, THE MONOCLINE LATTICE OF ORTHOCLSAE BECOMES CONVERTED TO TRICLINIC MICROCLINE. DURING THIS CONVERSION, ALBITE IS EXCLUDED FROM THE LATTICE. IT IS CONCLUDED THAT THE FREED ALBITE REPLACED CALCUAL IN THE RIMS OF THE ADJACENT PLAGIOCLASE GRAINS. THE CALCUL 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 - ORTHOCLSAE 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.
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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-ALBIT;

7) """""" QUARTZ-ALBIT-ORTHOCLASE AND AN

ALBIT: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:

ORTH - WEIGHT PER CENT ORTHOCOLSE IN MICROCLINE,
ANFACT - " " " ANORTHITE " PLAGIOCLASE,
FEDFCT - " " " FERROUS OXIDE IN MAGNETITE,
SPGMIC - SPECIFIC GRAVITY OF MICROCLINE,
SPGPLG - " " " PLAGIOCLASE,
SPGMUS - " " " MUSCOVITE,
SPGBIO - " " " BIOTITE,
SPGMAG - " " " MAGNETITE,
SPGHEM - " " " HEMATITE,
SPGAR - " " " 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 CORRECTION 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 PRECEDES 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, RHR02120, RHR02290, RHR02420, RWR02530, RHR02640, 
RHR02740, AND RHR02860.

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.
SURPROGRAMS - 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.
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, ur-AN-AN, MgO-feO-cau, AND
QUARTZ-ALBITE-ORTHoclASE (w/ AR/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 S1O2(25),AL2O3(25),FE2O3(25),FE0(25),MgC(25),CA0(25),
SK20(25),NA20(25),ZRO2(25),TOTOX(25),0(25),PL(25),WTAN(25),
WTORM(25),WTALB(25),OR(25),AN(25),AB(25),C(25),F(25),OZ(25),
AB2(25),OR2(25),SKT(25),WFEO(25),WFE2O3(25),WT(25),WTO(25),
WTMIC(25),WT(25),WTMUS(25),WTE(25),WTMAG(25),WTG(25),WTZ(25)
REAL MICRO, MUSC, MAGN, K20, MgO, NA20, MIC(25), MM(25)
INTEGER SMPLNM(25,4)
K=0
II=5
IO=6
IP=7

ZEROS ALL ARRAYS
DO 1000 12=1,25
AL2O3(12)=0.
S1O2(12)=0.
FE2O3(12)=0.
FE0(12)=0.
MgO(12)=0.
CA0(12)=0.
SK20(12)=0.
NA20(12)=0.
ZRO2(12)=0.
TOTOX(12)=0.
O(12)=0.
PL(12)=0.
WTAN(12)=0.
WTORM(12)=0.
WTALB(12)=0.
OR(12)=0.
AN(12)=0.
AB(12)=0.
C(12)=0.
P(12)=0.
OZ(12)=0.
AR2(12)=0.
CR2(12)=0.
RTO(12)=0.
WFEO(12)=0.
WFEO203(12)=0.
WTO(12)=0.
WTHMIC(12)=0.
WTP(12)=0.
WTHMUS(12)=0.
WTH(12)=0.
WMAG(12)=0.
WTH(12)=0.
WTO(12)=0.
WTZ(12)=0.
MIC(12)=0.

A=1.
WRITE(0,1)A
FORMATE(1,1)'/3',5,5,X,'TABLE','F3.0/1','50X','POINT COUNT ANALYSES'/
'5.',5,2,'VOLUMETRIC %')
WRITE(0,2)
FORMATE(1,5,X,'NO.
',SPECIMEN,'QUARTZ','KSPAR','PLAGIOCLAS',
'MUSCOVITE','BIOTITE','MAGNETITE','HEMATITE','GARNET','ZIRCON'
'10',5,X,110('1-1'))
READS DECIMAL PROPORTION OF POTASSIUM FELDSPAR IN MICROCLINE,
ANORTHITE IN PLAGIOCLASE, FERRIC IRON OXIDE IN MAGNETITE, (ALL BY
WEIGHT PROPORTIONS), FOLLOWED BY SPECIFIC GRAVITIES OF
MICROCLINE, PLAGIOCLASE, MUSCOVITE, BIOTITE, MAGNETITE,
HEMATITE, GARNET AND ZIRCON.

CONTINUE
READ(1,3)ORFACT,ANFACT,FEOFCT,SPGMIC,SPGPLG,SPGMUS,SPGBIO,
SPSMAG,SPSHEM,SPSGAR,SPSZIK,ISKIP
FORMATE(11F5.2,11)

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, HEMATITE, GARNET AND
ZIRC, FOLLOWED BY A 16 CHARACTER FIELD FOR A SAMPLE NAME.

READ(11,4) GTZ, MICRO, PLAG, MUSC, BIOT, MAGN, HEM, GARN, ZIRC,
(SMPLNM(K,1), I=1,4)
5 FORMAT(9F5.2,4A4)
7 IF(OTZ.LE.0) GO TO 7
WRITE(10,5) K, (SMPLNM(K,1), I=1,4), GTZ, MICRO, PLAG, MUSC, BIOT, MAGN,
HEM, GARN, ZIRC
5 FORMAT(6X,12,1X,4A4, 1*1, F6,2, 1*1, F6,2, 1*1, 2X, F6,2,
13X, 1*1, F6,2, 1*1, F6,2, 1*1, F6,2, 1*1, F5,2)
6 OTZ = OTZ*2.65
WMICRO = MICRO*SGMIC
WPLAG = PLAG*SGPLG
WMUSC = MUSC*SGMUS
WB1OT = BIOT*SGBI0
WMAG = MAGN*SGMAG
WHEM = HEM*SGHEM
WGARN = GARN*SGGAR
WZIRC = ZIRC*SGZIR
TWT = GTZ + WMICRO + WPLAG + WMUSC + WB1OT + WMAG + WHEM + WGARN + WZIRC
HT0(K) = NOTZ/TWT
HMIC(K) = WMICRO/TWT
HTP(K) = WPLAG/TWT
HTMUS(K) = WMUSC/TWT
HTB(K) = WB1OT/TWT
HTMAG(K) = WMAG/TWT
HTH(K) = WHEM/TWT
HTG(K) = WGARN/TWT
HTZ(K) = WZIRC/TWT

CALCULATES THE QUARTZ-PLAGIOCLASE-MICROCLINE VALUES

TOT1 = HT0(K) + HTP(K) + WMIC(K)
0(K) = HT0(K)/TOT1*100.
PL(K) = HTP(K)/TOT1*100.
MIC(K) = WMIC(K)/TOT1*100.

CALCULATION OF AB AN MOLECULE FROM PLAGIOCLASE

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

CALCULATION OF ORTHOCLASE AND ALBITE MOLECULES FROM MICROCLINE

WTORM(K) = WMIC(K) * ORFACT
WTABM = WMIC(K) - WTORM(K)
WTAB(K) = WTAB + WTABM
CALCULATION OF FeO AND Fe2O3 FROM MAGNETITE

IN ABSENCE OF CHEMICAL ANALYSIS ASSUME FEOFT IS 0.31

\[ \text{FEO(K)} = \text{WTMAG(K)} \times \text{FEOFT} \]
\[ \text{FE2O3(K)} = \text{WTMAG(K)} - \text{FEO(K)} \]

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

\[ \text{SiO}_2(K) = \text{WTM(K)} + \text{WTM(K)} \times 0.647 + \text{WTABM(K)} \times 0.687 + \text{WTAB(K)} \times 0.687 + \text{WTAN(K)} \times 0.432 + \text{WTMUS(K)} \times 0.328 \]
\[ \text{Al}_2O_3(K) = \text{WTM(K)} \times 1.184 + \text{WTABM(K)} \times 1.184 + \text{WTAB(K)} \times 1.195 + \text{WTAN(K)} \times 0.367 + \text{WTMUS(K)} \times 0.385 + \text{WTB(K)} \times 0.172 + \text{WTG(K)} \times 0.205 \]
\[ \text{Fe}_2O_3(K) = \text{WTB(K)} \times 0.022 + \text{WFEO(K)} + \text{WTG(K)} \times 0.433 + \text{WTH(K)} \]
\[ \text{FEO(K)} = \text{WTB(K)} \times 0.027 + \text{WFEO(K)} \]
\[ \text{MGO(K)} = \text{WTB(K)} \times 0.25 \]
\[ \text{CAI(K)} = \text{WTAN(K)} \]
\[ \text{K}_2O(K) = \text{WTM(K)} \times 0.169 + \text{WTMUS(K)} \times 0.118 + \text{WTB(K)} \times 0.090 \]
\[ \text{NA}_2O(K) = \text{WTABM(K)} \times 0.118 + \text{WTAB(K)} \]
\[ \text{ZRO}_2(K) = \text{WTZ(K)} \times 0.672 \]

CALCULATES THE OR-AN-AR VALUES

\[ \text{TOT}_2 = \text{WTM(K)} + \text{WTAN(K)} + \text{WTAB} + \text{WTAB} + \text{WTG} + \text{WTB} + \text{WTG} + \text{WTB} + \text{WTB} \]
\[ \text{OR}(K) = \text{WTM(K)} / \text{TOT}_2 \times 100. \]
\[ \text{AN}(K) = \text{WTAN(K)} / \text{TOT}_2 \times 100. \]
\[ \text{AR}(K) = (\text{WTAB} + \text{WTB}) / \text{TOT}_2 \times 100. \]

CALCULATES THE MGO-FeO-CAO VALUES

\[ \text{TOT}_3 = \text{MGO(K)} + \text{CAO(K)} + \text{FEO(K)} \]
\[ \text{MR}(K) = \text{MGO(K)} / \text{TOT}_3 \times 100. \]
\[ \text{CAI}(K) = \text{CAO(K)} / \text{TOT}_3 \times 100. \]
\[ \text{F}(K) = \text{FEO(K)} / \text{TOT}_3 \times 100. \]

CALCULATES THE QUARTZ-AB-OR VALUES

\[ \text{TOT}_4 = \text{WTM(K)} + \text{WTAB} + \text{WTB} + \text{WTG} + \text{WTB} \]
\[ \text{QZ}(K) = \text{WTQ(K)} / \text{TOT}_4 \times 100. \]
\[ \text{AB}2(K) = (\text{WTAB} + \text{WTB}) / \text{TOT}_4 \times 100. \]
\[ \text{OR}2(K) = \text{WTM(K)} / \text{TOT}_4 \times 100. \]
\[ \text{IF(WTAN(K), GT, 0)} \text{ RTD(K)} = (\text{WTAB} + \text{WTB}) / \text{WTAN(K)} \]
\[ \text{IF(WTAN(K), LE, 0)} \text{ RTD(K)} = 999.99 \]
\[ \text{TOTOX(K)} = \text{SiO}_2(K) + \text{Al}_2O_3(K) + \text{Fe}_2O_3(K) + \text{FeO(K)} + \text{MGO(K)} + \text{CAO(K)} + \text{K}_2O(K) + \text{NA}_2O(K) + \text{ZRO}_2(K) \]
\[ \text{IF}(\text{TOTOX(K), LT, 100, 01}) \text{ AND } (\text{TOTOX(K), GT, 99, 99}) \text{ GO TO 6} \]
\[ \text{SiO}_2(K) = \text{SiO}_2(K) / \text{TOTOX(K)} \times 100. \]
\[ \text{Al}_2O_3(K) = \text{Al}_2O_3(K) / \text{TOTOX(K)} \times 100. \]
WRITE OUT THE MOLECULAR WEIGHT PERCENTS OF MINERALS READ IN, PRECEDED BY A SAMPLE NAME AND REFERENCE NUMBER.

7 K1 = X - 1
A = A + 1
WRITE(10, 8) A
WRITE(10, 9)

WRITE(10, 10)
WRITE(10, 11)
WRITE(10, 12)
WRITE(10, 13)
WRITE(10, 14)
WRITE(10, 15)

WRITE OUT THE HEAVY PERCENT (%) OF CALCIUM OXIDES PRECEDED BY SAMPLE NAME AND REFERENCE NUMBER.

A = A + 1
WRITE(10, 11) A
WRITE(10, 12)
WRITE(10, 13)
WRITE(10, 14)
WRITE(10, 15)
A=A+1.
WRITE(IO,16) A

FORMAT(11,'3',53X,'SPECIMEN',15X,QUARTZ,MICROCLASE,PLAGIOCLASE
$1,30X,55(1-1))
WRITE(IO,15)(M,(SMPLNM(I,M),I=1,4),Q(M),MIC(M),PL(M),M=1,K1)
FORMAT(11,'3',30X,12,1X,4A4,1 *,F6.2,1 *,F6.2,1 *,F6.2)

WRITES OUT MAFIC VALUES CORRECTED TO 100%.

A=A+1.
WRITE(IO,18) A

FORMAT(11,'3',53X,'SMPLNM(L,M),L=1,4),Q(M),MIC(M),PL(M),M=1,K1)
FORMAT(11,'3',39X,12,1X,4A4,1 *,F6.2,1 *,F6.2,1 *,F6.2)

WRITES OUT VALUES OF OR-AN-AR DATA CORRECTED TO 100%.

A=A+1.
WRITE(IO,20) A

FORMAT(11,'3',53X,'SMPLNM(L,M),L=1,4),Q(M),MIC(M),PL(M),M=1,K1)
FORMAT(11,'3',33X,12,1X,4A4,1 *,F6.2,1 *,F6.2,1 *,F6.2)

WRITES OUT VALUES OF QUARTZ-ALBITE-ORTHOCLASE DATA CORRECTED TO 100%.

A=A+1.
WRITE(IO,22) A

FORMAT(11,'3',60X,'DATA FOR THE ACF-AKF TERRAS
SARKY DIAGRAM, (WEIGHT %)')
WRITE(IO,23)

FORMAT(11,'3',33X,12,1X,4A4,1 *,F6.2,1 *,F6.2,1 *,F6.2)

RECALCULATES SELECTED OXIDES TO 100 PERCENT FOR ACF-AKF DATA
FE203(M) = (FE2O3(M) - WEF203(M) - WTH(M)) / TOTOX(M) * 100.
N2O(M) = NA2O(M) / TOTOX(M) * 100.
K2O(M) = K2O(M) / TOTOX(M) * 100.
CAO(M) = CAO(M) / TOTOX(M) * 100.
FEO(M) = (FEO(M) - WFEo(M)) / TOTOX(M) * 100.
MGO(M) = MGO(M) / TOTOX(M) * 100.

WRITE(10, 25) M, (SMPLN(M, i), i = 1, 4), AL2O3(M), FE2O3(M), NA2O(M),
K2O(M), CAO(M), FEO(M), MGO(M)
FORM1 = 1, 21X, I2, 1X, 4A4, '*, 1, 5, 2, '*, 1, 5, 2, '*, 1, 5, 2, '*, 1, 5, 2
WRITE(10, 2000)
FORMAT(111)
DO 28 M = 1, K1

PUNCHES CARDS WITH THE CALCULATED PERCENTS OF FOLLOWING OXIDES--
ALUMINIUM, FERRIC IRON, SODIUM, POTASSIUM, CALCIUM, FERROUS IRON
AND MAGNESIUM (FOR ACF-AKF DATA).

WRITE(1P, 27, END=26) AL2O3(M), FE2O3(M), NA2O(M), K2O(M), CAO(M), FEO(M), MGO(M)
FORMAT(5F6.2, 2(6X, F6.2))
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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).

SER 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.


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

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.
THE FIRST COLUMN ON THE HEADER CARD IS PUNCHED WITH A 2 (FOR LNP) 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.
STRUCTURAL DATA (REPRESENTS DATA AS READ FROM A 4-AXIS ZEISS UNIVERSAL STAGE)

NOTE - ALL OF THE FOLLOWING VALUES ARE RIGHT-JUSTIFIED.

IV - COLUMNS 1, 2, AND 3. VALUE READ FROM INNER VERTICAL AXIS.
NS - COLUMNS 4, 5, AND 6. REPRESENTS PLUNGE VALUE OF LINEAR ELEMENT; READ FROM THE NORTH-SOUTH AXIS. THIS IS ALSO THE DIP VALUE OF A PLANE ELEMENT; READ FROM THE EAST-WEST AXIS.
S2 - COLUMN 7. S2 IS USED TO SEPARATE ELEMENTS BASED ON ANY PARTICULAR FEATURE SUCH AS GRAIN SIZE, INCLUSIONS, CLOUDY MINERALS, 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 S PLUS L.

NOTE - AT LEAST 15 VALUES MUST EXIST IN SEPARATED MEMBER IN ORDER TO BE PUNCHED. PRINTOUT IS ALWAYS PRODUCED EXCEPT FOR THE N PLUS L COMBINATION.


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.

AFTER ALL OF THE DATA ARE READ, THE NEXT CARD (A BLANK CARD) IS READ INTO A DUMMY VARIABLE. THIS CAUSES THE LAST DATA CARD TO PASS BY THE PUNCH STATION SO IT WILL NOT BE PUNCHED.
PUNCHING OCCURS WITHOUT OPERATOR INTERVENTION.

EACH DATA SET IN THE DECK SHOULD BE SEPARATED BY (AT LEAST 3 TIMES AS MANY) BLANK CARDS AS PREVIOUS DATA CARDS.

READ(II,17) NOTIN
WRITE(II,4) (IV(I),NS(I),DN(I),S2(I),SN(I),I=1,NMAX)
END
CALCULATES THE OUTPUT FOR LINEAR DATA

113 DO 119 I=1,NMAX
114 IF(NS(I).GE.90) GO TO 98
115 IF(SM(I).EQ.P) GO TO 118
116 IF(DD(I).EQ.L) GO TO 116
117 IF(IV(I).LT.135) GO TO 115
118 IV(I)=495-IV(I)
119 GO TO 119
120 IV(I)=135-IV(I)
121 IV(I)=315-IV(I)
122 GO TO 119
123 NS(I)=90-NS(I)
124 IF(DD(I).EQ.L) GO TO 114
125 GO TO 116
126 CONTINUE
127 GO TO 131

CALCULATES THE OUTPUT FOR PLANAR DATA

130 DO 129 I=1,NMAX
131 IF(EW(I).GE.270) GO TO 121
132 EW(I)=90-EW(I)
133 GO TO 122
134 EW(I)=EW(I)-270
135 IV(I)=IV(I)-225
136 DD(I)=E0.U DD(I)=S
137 DD(I)=E0.D DD(I)=N
138 IV(I)=90
139 GO TO 129
140 IF(IV(I).LT.135) GO TO 125
141 IV(I)=495-IV(I)
142 GO TO 126
143 IV(I)=135-IV(I)
144 IF(DD(I).EQ.U) DD(I)=W
145 IF(DD(I).EQ.D) DD(I)=E
146 GO TO 129
147 IF(IV(I).GT.315) GO TO 128
148 IV(I)=315-IV(I)
149 GO TO 126
150 IV(I)=675-IV(I)
151 GO TO 126
152 CONTINUE
153 WR TE(I0,5)(NM(I),I=1,12),NMAX
154 GO TO 138

SUMMATION SECTION FOR LINEAR DATA

155 WR TE(I0,6)(NM(I),I=1,12),NMAX
156 WR TE(I0,7)(IV(I),NS(I),I=1,NMAX)
157 WR TE(I0,8)(IV(I),NS(I),I=1,NMAX)
158 WR TE(I0,17)(NM(I),I=1,12)
159 J=0

126
0 132 I=1, NMAX
IF(SZ(I).NE.S) GO TO 132

SUMMATION OF GROUP S

=J+1
T(J)=IV(I)
T(J)=NS(I)
CONTINUE
RITE(TO,9) J
RITE(TO,7) (KB(I), KD(I), I=1, J)
IF(J.LE.15) GO TO 133
RITE(IP,6) (KB(I), KD(I), I=1, J)
RITE(IP,17) (NM(I), I=1, 12)

133 =0
T=124 I=1, NMAX
IF(SZ(I).NE.K) GO TO 134

SUMMATION OF GROUP M

=J+1
S(J)=IV(I)
S(J)=NS(I)
CONTINUE
RITE(TO,10) J
RITE(TO,7) (KB(I), KD(I), I=1, J)
IF(J.LE.15) GO TO 135
RITE(IP,8) (KB(I), KD(I), I=1, J)
RITE(IP,17) (NM(I), I=1, 12)

135 =0
T=136 I=1, NMAX
IF(SZ(I).NE.L) GO TO 136

SUMMATION OF GROUP L

=K+1
T(K)=IV(I)
T(K)=NS(I)
CONTINUE

I=J+1
Z=K+1
RITE(TO,11) K2
RITE(IP,7) (KM(I), KD(I), I=K1, K)
IF(K2.LE.15) GO TO 137
RITE(IP,8) (KM(I), KD(I), I=K1, K)
RITE(IP,17) (NM(I), I=1, 12)

137 =0
RITE(IP,8) (KM(I), KD(I), I=1, K)
RITE(IP,17) (NM(I), I=1, 12)
TO 110

SUMMATION SECTION FOR PLANAR DATA

RITE(TO,12) (IV(I), EM(I), DD(I), I=1, NMAX)
RITE(IP,13) (IV(I), EM(I), DD(I), I=1, NMAX)
RITE(IP,17) (NM(I), I=1, 12)
=0
16(SE(I),NE,S) GO TO 139

SUMMATION OF GROUP S

J=J+1
KR(J)=IV(T)
KD(J)=SM(T)
SM(J)=SD(I)

139 CONTINUE
WRITE(I0,14) J
WRITE(I0,15) (KR(I),KD(I),SM(I),I=1,J)
IF(J.LE.15) GO TO 140
WRITE(IP,13) (KR(I),KD(I),SM(I),I=1,J)
WRITE(IP,17) (IM(I),I=1,12)

140 J=0
DO 141 I=1,NMAX
IF(SZ(I),NZ,L) GO TO 141

SUMMATION OF GROUP L

J=J+1
KR(J)=IV(T)
KD(J)=SM(T)
SM(J)=SD(I)

141 CONTINUE
WRITE(I0,15) J
WRITE(I0,15) (KR(I),KD(I),SM(I),I=1,J)
IF(J.LE.15) GO TO 142
WRITE(IP,13) (KR(I),KD(I),SM(I),I=1,J)
WRITE(IP,17) (IM(I),I=1,12)

142 K=J
DO 143 I=1,NMAX
IF(SZ(I),NZ,L) GO TO 143

SUMMATION OF GROUP L

K=K+1
KR(K)=IV(T)
KD(K)=SM(T)
SM(K)=SD(I)

143 CONTINUE
K1=J+1
K2=K-1
WRITE(I0,16) K2
WRITE(I0,16) (KR(I),KD(I),SM(I),I=K1,K2)
IF(K2.LE.15) GO TO 144
WRITE(IP,13) (KR(I),KD(I),SM(I),I=K1,K)
WRITE(IP,17) (IM(I),I=1,12)

144 IF(K2.LE.15) GO TO 110
WRITE(IP,13) (KR(I),KD(I),SM(I),I=1,K)
WRITE(IP,17) (IM(I),I=1,12)
GO TO 110

STOP
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 PRIMITIVE 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.


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 - 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 1-3 AS TOPC1) 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 ARERecorded 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 EQUATORIAL 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 EQUATORIAL
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.

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

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

LANGUAGE — FORTRAN IV, PS.

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

STORAGE REQUIREMENTS — X'A6CB'.

TIME —

COMPILE: 479 SECONDS.

LINKAGE EDITOR: 50 SECONDS.

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

For group of data for a single diagram must be preceded by an 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 (MAX=).
   This is the number of attitudes to be contoured (maximum number of data points is 1000) and is right-
   justified in columns 7 through 9.

3) The next piece of information on this card is -BC-; the
   number of contours to be plotted (16 or less allowed). This number is right-justified in columns 6 and 7.

4) The value of -USR- is greater than zero (right-justified
   in columns 8 and 9) a reference line (normal to the circle)
   is punched at the angle 'USRA' and the designated symbols 'USV-
   are plotted rather than the characters 'M', 'F', 'S', and 'O'
   (as in the case -USR-). USR is zero or less.

Note - If USR=1 only one symbol and reference line is
   plotted.

   If USR is greater than or equal to 2 then both reference
texts 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 -XSEA-, the angles (in
   Degrees, 0 to 360) from north at which the reference
   lines are drawn (punched in columns 12 through 14 and
   15 through 16, right-justified, respectively).

6) Of last of the data on this card is -SYM-, the symbols which
   RWR00490
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***WRW0570  
****** THE PROGRAM TO SEARCH FOR A POINT EQUAL TO OR    
****** LESS THAN 0.0.  
****** F.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 1-3 AS TOPC1) 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

136
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., for 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 magnitude 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
THE LAST DATA CARD IN THE DATA STACK IS BLANK. THIS TERMINATES
THE PROGRAM.

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.

CONTINUE
CALL SETMSG(15, 'PLOTS FOR RIFSE')
CALL CLEAR
READ(5, 2)J1,NMAX,NC,ISR,KSRA(1),KSRA(2),SYM(1),SYM(2)
FORMAT(1L17.0,2I3,2I3,2I3,2A2)
F0(1)99,99,3
A=1.
READ(5,4)(CI(1),I=1,NC)
FORMAT(16F5.2)
NCM=NC-1
DO 6 INDEX=1,NCN
**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 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.)

---

```plaintext
100 DO 119 I=1,NMAX
   3 JJ=I
   IF(180-KS(I))102,101,101
   101 KS(I)=90-KS(I)
   60 TO 110
   IF(270-KS(I))104,103,103
```
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-IARS(KD(I)))992,116,112
112 IF(KD(I))117,113,116
113 KS(I)=0
60 TO 119
114 IF(90-IARS(KD(I)))992,118,115
115 IF(KD(I))116,113,117
116 KS(I)=KS(I)+90
60 TO 119
117 KS(I)=KS(I)-90
60 TO 119
118 KD(I)=-KD(I)
60 TO 117
119 CONTINUE
60 TO 300

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

SECTION B
LIENATIONS
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
201 KD(I)=I
202 IF(270-KS(I))202,201,201
203 KS(I)=90-KS(I)
60 TO 205
204 I(360-KS(I))992,203,204
205 KS(I)=90

*************************************************************************
K(1) = 450 - K(1)
IF(IABS(KD(I)).GT.90) GO TO 992
GO TO (990,300), J1

SECTION C

THIS SECTION CONVERTS THE DIP IN DEGREES FROM THE HORIZONTAL
TO THE ANGLE MEASURED FROM THE VERTICAL AND FINDS ONE-HALF
OF THAT ANGLE.

STATEMENT NUMBER 301 IS USED FOR CALCULATIONS OF POLES TO
PLANES.

STATEMENT NUMBER 302 IS USED FOR CALCULATIONS OF LINEATIONS
AND C-AXES POLES.

DM 401 I = 1, NMAX
IN = (1 - J1) 302, 301, 99
D(I) = (IABS(KD(I)))*0.00873
GO TO 400
302 D(I) = (90 - IABS(KD(I)))*0.00873

SECTION D

THIS SECTION DETERMINES THE POSITION OF THE POINT ON THE
EQUATORIAL PLANE REPRESENTING THE LOWER POLE INTERSECTION
WITH THE LOWER HEMISPHERE.

S(I) = K(1)*0.01745
R(I) = 14.14214*SIN(D(I))*0.39370

WHERE R = SORT(2)*RADIUS*SIN(D(I))

401 CONTINUE

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

141
THIS SECTION CONVERTS POLAR TO RECTILINEAR COORDINATES. IF A POINT IS FOUND TO BE WITHIN ONE CENTIMETER OF THE
PERIMETAL CIRCLE, IT THEN LOCATES THE CENTER-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.

\[ N = n_{\text{MAX}} \]
\[ i = 0 \]
\[ s = (3, 93700 - i) \]
\[ X(i) = X(i) - 2 * rs * \sin(s(i)) \]
\[ Y(i) = Y(i) - 2 * rs * \cos(s(i)) \]
\[ i = (i + 1) \]
\[ N = n_{\text{MAX}} \]

THIS SECTION SORTS X AND ASCENDING ORDER.

\[ n_{\text{MIN}} = n - 1 \]
\[ DO 402 INDEX = 1, n_{\text{MIN}} \]
\[ n_{\text{MIN}} = n_{\text{MIN}} - 1 \]
\[ DO 402 I = 0, n_{\text{MIN}} \]
\[ IF(X(I) - X(I + 1)) \]
\[ X(I + 1) = X(I) \]
\[ X(I) = R \]
\[ Y(I + 1) = Y(I) \]
\[ Y(I) = R \]
\[ CALL CIRCLE(ISR, KSHA, SYM) \]
\[ CALL NHARRY \]
SECTION 6

FINDS THE VALUE OF THE CELL CENTER BY AVERAGING CORNER VALUES OF EACH CELL (FROM DATA SUPPLIED BY SURROUNDBEAR WHATEVER). THIS IS ANALOGOUS TO INTERPOLATING A 1-PT SQUARE GRID.

\[ I(\text{center}) = \frac{I(1,1) + I(1,2) + I(2,1) + I(2,2)}{4} \]

THIS SECTION CALCULATES A POINT PERPENDICULAR TO CONTINUITY DISCONTINUITY PERCENT GIVEN, THEREFORE THE FIRST POINT TO BE CONTINUED, SUCCESSIVE POINTS ARE FOUND BY STEPPING THE LINE, THEN THE VALUES ARE CONTINUED WITHIN THE PRIMITIVE GRID.

PHASE 1:

PITS THE MAXIMUM DENSITY OF POINTS VALUE FROM MIDES OF THE OVERLAY GRID.

\[ \text{RE 1, FC} \]
PHASE 1-2

THE NX(N,M) ARRAY MUST BE CLEARED AFTER EACH CONTOUR OTHERWISE THE RETRACE STOPPING VALUES FOR THE PREVIOUS CONTOURS WOULD PREVENT THE FUTURE CONTOURS FROM BEING PLOTTED.

PHASE 1-3

CALCULATES THE VALUE WHICH IS SEARCHED FOR (WITHIN A HYPOTHETICAL CIRCUMSCRIBED OVERLAY GRID), TO PRODUCE THE DENSITY PERCENT CONTOUR REQUESTED.

PHASE 1-4

DETERMINES WHETHER THE VALUE OF PHASE 1-3 IS WITHIN 0.01 OF AN INTEGER VALUE IN WHICH CASE 0.01 IS DEDUCTED OR ADDED FROM OR TO THE CONTOURING VALUE. THUS NO CONTOURS WILL CROSS THE CELL CENTER OR CORNERS.

144
FINDS THE POINT OF A CONTOUR.

IF

PHASE 1-8

FINDS THE POINT OF INTERSECTION BETWEEN A CONTOUR AND THE PRIMITIVE CIRCLE AND PREVENTS THE CONTOUR FROM BEING DRAWN OUTSIDE OF THE PRIMITIVE CIRCLE.
GO TO (950,941,941,951), KK

941 IXIP=X(IP)*1000
     IXIP1=X(IP-1)*1000
     IF(IXIP-IXIP1.943,942,943
     XU=X(IP)
     YU=SORT(ARS(15.49997-XU*XU))
     YU=SIGN(YU,Y(IP))
     IF(Y(IP).EQ.0.) YU=SIGN(YU,Y(IP-1))
     GO TO 947
     TANG=(Y(IP)-Y(IP-1))/(X(IP)-X(IP-1))

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

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

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

ODSL=SORT(ARS(15.49997*(1.+TANG*TANG)-B*B))
     TB=-B*TANG
     DVR=1.+TANG*TANG
     XU1=(TB-ODSL)/DVR
     XU2=(TB+ODSL)/DVR

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

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
     XU=XU1
     YU=TANG*XU+R
IF(KK=3)949,948,952
CALL PLOT(XU,YU,2)
CALL PLOT(XU,YU,3)
GO TO 952
CALL PLOT(XU,YU,3)
CALL PLOT(X(IP),Y(IP),2)
IF(X(IP).EQ.X(I)) AND (Y(IP).EQ.Y(I))) GO TO 960
CONTINUE
GO TO (953,960),LAST
IF(K-2)1960,960,954
CALL PLOT(X(1),Y(1),3)
K=1
K=4
CALL LOOK(KP,KC,J,M,I,PPC)
LAST=2
GO TO 940
CONTINUE
GO TO 980
WRITE(6,971) A
FORMAT('0',1CONTOUR REQUESTED PRODUCES A SEARCH FOR A DENSITY PAIR
VALUE EQUIVALENT TO ZERO-- THIS CONTOUR WAS OMITTED FROM THE PL
AND FROM THE PLOT LABEL OF PLOT SEQUENCE',F5.0)
CONTINUE
CALL LABEL(KI2)
GO TO 1
WRITE(6,991)
FORMAT(' A TRAILER OR HEADER CARD WAS CARRIED THROUGH THE
STRIKE REORIENTING COMPUTATION.')
GO TO 99
WRITE(6,993) JJJ, A
FORMAT(' ORIENTATION DATUM NUMBER ',I4,' PUNCHED GREATER THAN
60 DEGREES FOR THE BEARING OR 90 DEGREES FOR THE DIP/PLUNGE.',F5.0)
READ(5,994)(NOGO(KI),KI=1,20)
FORMAT(20A4)
WRITE(6,995)(NOGO(KI),KI=1,20)
FORMAT(' NEXT CARD IS ',20A4/)
GO TO 99
WRITE(6,997) TOPCI,A
FORMAT(' CONTOURS LARGER THAN ',F5.2,' ARE NOT DRAWN ON THE PLO
OF ',F5.0)
CALL LABEL(KI2)
GO TO 1
CALL PLOT(0.0,0.0,999)
STOP
END
SUBROUTINE CLEAR
COMMON DUMMY(6279)

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

SUBROUTINE CLEAR --- CLEARS COMMON STORAGE.

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

DO 1 I=1,6279
  DUMMY(I)=0.0
RETURN
END
**SUBROUTINE 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 THAN ZERO).

**--------------------------------------------------------------------------------**

INTEGER SYM(2)
DIMENSION SRA(2), KSRA(2)
CALL PLOT(14.0, -12.0, -3)
CALL PLOT(0.0, 6.2, -3)
CALL PLOT(3.937, 0.0, 3)
DO 1 I = 1, 10000
  R = R * 0.00062820
  X(I) = 3.937 * COS(R)
  Y(I) = 3.937 * SIN(R)
  CALL PLOT(X(I), Y(I), 2)
  CALL PLOT(X(I), Y(I), 3)
  IF(ISR) 2, 2, 3
  CALL SYMBOL(4.00, -0.15, 0.3, 0.0, 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, 1.02, 0.0, -1)
  CALL SYMBOL(-0.09, 4.00, 0.3, 0.85, 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, 0.98, 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.

**--------------------------------------------------------------------------------**

**--------------------------------------------------------------------------------**

 Fo 14 I=1, ISR
 IF(KSRA(I) - 270) 10, 9, 9
 SRA(I) = (450 - KSRA(I)) * 0.01745
 Fo TO 13
F(KSRA(I) - 90)11,11,12
SRA(I) = (90 - KSRA(I)) * 0.01745
GO TO 13
SRA(I) = KSRA(I) + 180
GO TO 8
Y = 3.987 * COS(SRA(I))
X = 3.987 * SIN(SRA(I))
Z = 4.287 * COS(SRA(I))
Z = 4.287 * SIN(SRA(I))
X = X + 0.05
Y = Y + 0.05
IF(X2.LT.0.) X3 = X2 - 0.25
ALL PLOT(X1,Y1,3)
ALL PLOT(X1,Y1,2)
IF(ISR.LT.2) GO TO 14
ALL PLOT(X2,Y2,2)
ALL SYMBOL(X3,Y3,0.2,SYM(1),0.0,2)
RETURN
END
SUBROUTINE LABEL(KI2)
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 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
CONTINUING 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)=87
L(10)=86
L(11)=85
L(12)=99
L(13)=86
L(14)=100
L(15)=99
L(16)=98
L(17)=122
S=0.85
G::=2 M=1,17
CALL SYMBOL(-0.4,0.2,L(M),0.0,-1)
L::=E+0.14
IF(KI2.LT.NC) NC=KI2-1
NN=5
IF(NC=5)3,4,4
NN=NC
E=3,29
NR=1
JC=CI(1)*100.
IF(JC.GT.0) GO TO 6
5
NB=2
6
DO 12 M=NR,NN
CALL NUMBER(E,-0.4,0.2,CI(M),0.0,2)
JC=CI(M)*10.
12
IF(JC=10)10,9,7
IF(JC=100)9,8,8
F=E+0.88
GO TO 11
11
F=E+0.7
GO TO 11
6
F=E+0.53
CALL SYMBOL(E,-0.4,0.2,108,0.0,-1)
E=E+0.34
IF(NC=5)24,24,13
IF(NC=13)14,14,15
NN=NC
GO TO 16
16
NN=12
NR=6.
3=-0.8
7
E=0.0
DO 23 M=NR,NN
CALL NUMBER(E,B,0.2,CI(M),0.0,2)
JC=CI(M)*10.
IF(JC=10)21,20,18
IF(JC=100)20,19,19
7
F=E+0.88
GO TO 22
22
F=E+0.7
GO TO 22
F=E+0.53
CALL SYMBOL(E,B,0.2,108,0.0,-1)
3=E+0.34
IF(NC=12)26,26,24
IF(NN=NC)25,26,26
A=-1.2
NN=NC
NR=13
GO TO 17
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),
K(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
M=4.33070
DO 2,M1=1,23
H(M1)=M
2 A=A-0.39370
DO 4,N1=1,23
DO 3,M1=1,23
3 X(N1,M1)=0
4 CONTINUE
GO TO 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
12 IF(N1-1)600,10,10

154
SECTION C

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

\[ \text{IF}(X(J2)-V(N1)) \geq 30,30,21 \]
\[ M1 = M1 + 1 \]
\[ \text{IF}(M1-23) \geq 20,20,600 \]

SECTION D

DETERMINES WHETHER Y IS POSITIVE OR NEGATIVE.

\[ M1 = 12 \]
\[ \text{IF} (Y(J2)) \geq 40,50,50 \]

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.

\[ \text{IF}(Y(J2)-H(M1)) \leq 41,60,60 \]
\[ M1 = M1 + 1 \]
\[ \text{IF}(M1-23) \leq 40,40,600 \]

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.

\[ \text{IF}(Y(J2)+H(M1)) \geq 41,60,60 \]
\[ M1 = M1 + 1 \]
\[ \text{IF}(M1-23) \geq 40,40,600 \]
IF Y(J2) - H(M1) > 60, 60, 51
M1 = M1 - 1
IF (M1 = 1) 600, 50, 50

SECTION G

TALLIES POINTS ABOUT THE ORIGIN FOR DATA POINTS ON THE ORIGIN

IF (X(J2) > 62, 61, 62
IF (Y(J2) > 62, 103, 62
IF (V(12) - V(IN1) > 63, 64, 64
IF (H(12) - H(M1) > 100, 400, 400
IF (H(12) - H(M1) < 200, 300, 300

COMPUTATION FOR QUADRANT 1.

IF (V(IN1) > X(J2) > 500, 101, 102
IF (H(M1) > Y(J2) > 500, 103, 104
IF (H(M1) > Y(J2) > 500, 105, 106
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
GO TO 600
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
P = SORT((ABS(X(J2) - V(IN1)) ** 2) + (ABS(Y(J2) - H(M1)) ** 2))
H = SORT((ABS(X(J2) - V(IN1)) ** 2) + (ABS(Y(J2) - H(M1)) ** 2))
C = SORT((ABS(X(J2) - V(IN1)) ** 2) + (ABS(Y(J2) - H(M1+1)) ** 2))
W = SORT((ABS(X(J2) - V(IN1)) ** 2) + (ABS(Y(J2) - H(M1+1)) ** 2))
IF (0.39370 - P) 108, 107, 107
K(N1, M1) = K(N1, M1) + 100
IF (0.39370 - R) 110, 109, 109
K(N1-1, M1) = K(N1-1, M1) + 100
IF (0.39370 - C) 112, 111, 111
K(N1-1,M1+1)=K(N1-1,M1+1)+100
IF(0.39370=W) 600,113,113
K(N1,M1+1)=K(N1,M1+1)+100
GO TO 600

COMPUTATION FOR QUADRANT 2.

IF(V(N1)=X(J2)) 202,201,500
IF(H(N1)=Y(J2)) 1500,103,204
IF(H(M1)=Y(J2)) 500,205,206
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,M1+1)=K(N1,M1+1)+100
GO TO 600

V=SORT([ABS(X(J2)-V(N1))**2]+[ABS(Y(J2)-H(M1+1))**2])
W=SORT([ABS(X(J2)-V(N1))**2]+[ABS(Y(J2)-H(M1))**2])
S=SORT([ABS(X(J2)-V(N1+1))**2]+[ABS(Y(J2)-H(M1))**2])
IF(0.39370=W) 209,207,207
K(N1,M1)=K(N1,M1)+100
IF(0.39370=C) 210,209,209
K(N1,M1+1)=K(N1,M1+1)+100
IF(0.39370=W) 212,211,211
K(N1,M1+1)=K(N1,M1+1)+100
IF(0.39370=W) 600,213,213
K(N1,M1+1)=K(N1,M1+1)+100
GO TO 600

COMPUTATION FOR QUADRANT 3.

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

C = SORT((ABS(X(J2) - V(N1)) ** 2) + (ABS(Y(J2) - H(M1)) ** 2))

W = SORT((ABS(X(J2) - V(N1)) ** 2) + (ABS(Y(J2) - H(M1 - 1)) ** 2))

P = SORT((ABS(X(J2) - V(N1 + 1)) ** 2) + (ABS(Y(J2) - H(M1 - 1)) ** 2))

R = SORT((ABS(X(J2) - V(N1 + 1)) ** 2) + (ABS(Y(J2) - H(M1)) ** 2))

IF (0.39370 - C) 30R, 307, 307

IF (0.39370 - W) 310, 309, 309

K(N1, M1) = K(N1, M1) + 100

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) 310, 313, 313

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 = SORT((ABS(X(J2) - V(N1)) ** 2) + (ABS(Y(J2) - H(M1)) ** 2))

P = SORT((ABS(X(J2) - V(N1)) ** 2) + (ABS(Y(J2) - H(M1 - 1)) ** 2))

R = SORT((ABS(X(J2) - V(N1 - 1)) ** 2) + (ABS(Y(J2) - H(M1 - 1)) ** 2))

C = SORT((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

GO TO 600

WRITE(6, 501)

FORMAT(1, ', 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 WHARRY. THE VALUE IS THE TOTAL POINTS WITHIN A 1 CM. RADIUS TIMES 100.

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


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). THIS IN THE FINAL ANALYSIS THE COMPUTER IS ON ONE LEG OF A TRIANGLE AND EXAMINES THE OTHER TWO (WRW11020) 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
LOWER HALF OF THE NEGATIVELY SLOPING DIAGONAL = 6
LOWER HALF OF THE POSITIVELY SLOPING DIAGONAL = 8
IF CONTOURING FROM THE RIGHT TOWARD A VERTICAL BOUNDARY = 5
IF CONTOURING FROM THE LEFT TOWARD A VERTICAL BOUNDARY = 7
IF CONTOURING FROM ABOVE TOWARD A HORIZONTAL BOUNDARY = 1
IF CONTOURING FROM BELOW TOWARD A HORIZONTAL BOUNDARY = 3

2) ONCE THE CONTOUR HAS CLOSED THE SEARCH IS REINITIATED ON THE
SAME HORIZONTAL BOUNDARY BUT ONE CELL TO THE RIGHT OR
(IF IT HAS REACHED ITS MAXIMUM RIGHTWARD EXTENT) ON THE
LEFT-MOST CELL 1 CM. BELOW.

3) IF THE CONTOUR DOES NOT CLOSE BUT THE ENDS MEET THE GRID SIDES
(AS PROVISION FOR OMITTING THE CONTOUR OUTSIDE OF THE
PRIMITIVE CIRCLE IS MADE IN ANOTHER PART OF THE PROGRAM)
THE CONTOURING ROUTINE DRAWS ONE LEG DOWNWARD FIRST THEN
RETURNS TO THE INITIAL POINT AND COMPLETES THE UPWARD LEG.

4) EACH TIME A CONTOUR PASSES THROUGH A VERTICAL OR A HORIZONTAL
CELL BOUNDARY FOR A PARTICULAR VALUE OF CONTOUR IT IS RECORDED
IN THE NX(N,M) ARRAY SO THOSE POINTS WILL NOT BE USED FOR OTHER CONTOUR LINES OF THAT VALUE.

COMMON X(1600), Y(1600), CI(16), CV(23), NH(23), IC(22,22),
# KS(1000), KD(1000), K(23,23), J1,NMAX, NC, NM
DIMENSION NX(22,22)
EQUIVALENCE (NX(1,1), KS(1))
N1=N


```
M1=6
JKE=1
J1=1

1 IF (JKE( KC, 2)) 11, 11, 2
2 IF (KC=3) 9, 6, 7
3 GO TO (15, 4), JJ
4 M1=M1+1
5 JJ=2
6 GO TO 100
7 M1=M1-1
8 JJ=2
9 GO TO 120
10 IF (KC.EQ.5) GO TO 10
11 GO TO (9, 8), JJ
12 M1=M1+1
13 JJ=2
14 GO TO 100
15 M1=M1-1
16 JJ=2
17 GO TO 120
18 IF (KC. EQ. 4) 13, 16, 14
19 IF (KC. EQ. 4) 15, 13, 16
20 IF (KP.EQ.5).OR.(KP.EQ.6).GO TO 160
21 GO TO 170
22 IF (KP.EQ.2).OR.(KP.EQ.5).GO TO 160
23 GO TO 140
24 IF (KP.EQ.2).OR.(KP.EQ.7).GO TO 150

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

TEST 100 CONDITION CODES
KC=1, KP=ANY -- KC=2, KP=5 OR 6 IF TEST 160 FAILED.

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

20 IF (IC(M1,M1),LE,K(M1,M1)) GO TO 10.
21 IF (K(M1,M1).LT.PPC).AND.(PPC.LT.1C(M1,M1))) GO TO 162
22 IF (K(M1,M1).LT.PPC).AND.(PPC.LT.K(M1,M1))) GO TO 102
23 IF (K(M1,M1),LT,110) GO TO 110
24 IF (KP.EQ.0) GO TO 160
25 IF (KP.EQ.0) GO TO 160
26 IF (KP.EQ.0) GO TO 120
27 HV=(0.274+ABS(PPC-FL0AT(K(P1,P1))))/ABS(FL0AT(1C(P1,P1)-K(P1,P1)))R12050
28 X(1) = W(N1) + HV
29 Y(1) = E(M1) + HV
30 KEP=K
```
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
130 IF( K(N1+1,M1+1) .LT. PPC ) .AND. ( PPC .LT. IC(N1,M1) ) GO TO 132
130 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,M1+1) ) )
 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
140 IF( K(N1,M1) .LT. PPC ) .AND. ( PPC .LT. K(N1+1,M1) ) GO TO 142
140 IF( PPC .LT. K(N1+1,M1) ) .AND. ( PPC .LT. K(N1+1,M1) ) GO TO 142

141 IF( KC .EQ. 2 ) GO TO 100
141 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+1) - HH
 Y(I) = H(M1+1)

143 SF(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
IF(KC.EQ.6) GO TO 120
IF(KC.EQ.8) GO TO 130
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
Y(I)=H(M1+1)
IF(M1+1-JK)155,154,154
NX(N1,M1+1)=-1
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

IF(K(N1,M1).EQ.K(N1,M1+1)) GO TO 188
VV=0.3937*ABS(PPC-FLOAT(K(N1,M1)))/ABS(FLOAT(K(N1,M1)-K(N1+1,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

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
IF(K(N1+1,M1+1).LT.PPC).AND.(PPC.LT.K(N1+1,M1+1))) GO TO 172
IF(KC.EQ.2) GO TO 130
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
X(I)=V(N1+1)
KP=KC
KC=7

TEST TO DETERMINE A CLOSED CONTOUR.
185 IF((X(I).EQ.X(I))).AND.((Y(I).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(1X, '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),

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

PROGRAM CONTROL VARIABLES - NONE

PROGRAM ALGORITHM -

1) READS "NP" FROM DATA CARD AND WRITES IT ON TAPE.
2) READS "LOC", "XC", AND "YC", SETS, IN THAT ORDER, UNTIL "NP" 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 "MAPLOG" 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.
THE PURPOSE OF LOGTAP IS TO READ IN THE LOCATION NUMBER
AND X AND Y COORDINATES IN INCHES IN ORDER TO BUILD A TAP
FOR USE WITH PROGRAMS MAPLAN AND LINMAP.

DIMENSION LOC(1000), XC(1000), YC(1000)

FORMATT(14)

READ(5,1) MP
WRITE(8) MP
READ(5,2) (LOC(I), XC(I), YC(I), I=1, MP)
MP1=MP-1
MP=MP1

DIM NP=1, MP

IF (LOC(I)-LOC(I+1))<4, 4, 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

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 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 ARE 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 OCCUR 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.

KCHANGE - 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),LOC1(500),LOC2(500),LOCU(500),LOC2(500),
$LOC2(500),C0(500),C1(500),C2(500),XC(500),Y(500),NTITL(14),
INTEGER S/4/8/C/C1/C1/2/I/I/U/U,BEAR(500),BEARS(500),
$BEARU(500),BEAD(500),BEARU(500),PLG(500),PLG2(500),PLG3(500),
$PLG4(500),PLG5(500),PLG6(500),PLG7(500),PLG8(500),PLG9(500),
CALL SETMSG(42,'PLACE PEN TO RIGHT AND ADVANCE PAPER-RIESE')
II=5
I0=6
ITY=15
READ(I1,1)KEND,(NTITL(I),I=1,14)
1 FORMAT(I4,13A4,A2)
READ(I1,2)LOC(1),BEAR(1),PLG(1),STYL(1),I=1,KEND)
2 FORMAT(I6,I3,12,A1,I6,I3,12,A1,I6,I3,12,A1,I6,I3,12,A1)
L1=4
KTP=0
GO TO 3

PLOT CONTROL CARDS

AFTER THE DATA DECK THE USER MAY INSERT A CARD PUNCHED IN COLUMN 1 R
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.

READ(I1,1)L1,(NTITL(I),I=1,14)
IF(L1=1)999,7,3
3 J=0
K=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

1 TO RES UNDEFINED STYLE FOLDS.

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

2 TO RES SIMILAR FOLDS.

173
J=J+1
LOCJ(J)=LOC(I)
BEARJ(J)=BEAR(I)
PLG(J)=PLG(I)
GO TO 6

STORES CONCENTRIC FOLDS.

K=K+1
LOCC(K)=LOC(I)
BEARC(K)=BEAR(I)
PLGC(K)=PLG(I)
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.

READ(I1,8) L,KCHANGE
FORMAT(211)
IF(KCHANGE,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 KCHANGE LARGER THAN ZERO (IN COLUMN 2).
CALL PLOT(0.0,0.0,0.3)
CALL PLOT(0.0,0.0,0.999)
CALL SETMSG(10,'CHANGE PEN')
CALL PLOT(0.0,0.0,-3)
READ(I1,11)IBEAR1,IBEAR2,IP1G1,IP1G2
FORMAT(413)
GO TO (36,30,32,34),L

M=0

SEPARATES OUT BEARINGS WITHIN SPECIFIED INTERVAL.

DO 14 I=1,J
IF((BEAR(A(I)).LT.IBEAR1).OR.(BEAR(A(I)).GT.IBEAR2)) GO TO 14
M=M+1
TL(M)=LOCA(I)
TB(M)=BEAR(A(I))
TP(M)=PLGA(I)
CONTINUE

IF(M.NE.0) GO TO 16
WRITE(ITY,15) IBEAR1,IBEAR2
FORMAT('NO BEARING EXISTS IN THE INTERVAL ','I4','--SPECIFY NEW INTERVALS OF BEARING AND PLUNGE.')
GO TO 99
SEPARATES OUT PLUNGES WITHIN THE SPECIFIED INTERVAL.

N=0
DO 17 I=1,N
IF((TP(I).LT.IPLG1).OR.(TP(I).GT.IPLG2)) GO TO 17
N=N+1
LOC(A(N))=TL(I)
BEAR(A(N))=TB(I)
PLG(A(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

SETS BEARING TO CALCOMP COORDINATE SYSTEM

19 DO 22 I=1,N
IF(BEAR(A(I))<270)21,20,20
BEAR(A(I))=450-BEAR(A(I))
GO TO 22
21 BEAR(A(I))=90-BEAR(A(I))
22 CONTINUE
IF(KTAP.GT.0) GO TO 23
KTAP=1
READ(8) MP
READ(8) (LOC(I),XC(I),YC(I),I=1,MP)
23 DO 29 I=1,N
CX(I)=-5
DO 25 I2=1,MP
IF(LOC(I2)-LOC(A(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
WRITE(10,28)LOC(A(I))
27 FORMAT(' LOCATION ',I6,' IS NOT ON LOCATAP.')
28 CONTINUE
GO TO 38

PLACES DATA FOR STYLES INTO A TEMPORARY ARRAY.

30 DO 31 I=1,K
LOC(A(I))=LOC(I)
BEAR(A(I))=BEAR(I)
PLG(A(I))=PLG(I)
J=K
GO TO 12
31 DO 33 I=1,KEND
LOC(A(I))=LOC(I)
BEAR(A(I))=BEAR(I)
PLG(A(I))=PLG(I)
J=KEND
GO TO 12

175
DO 35 I=1,JK
  LOCA(I)=LOCU(I)
  BEARA(I)=BEARU(I)
  PLGA(I)=PLGU(I)
  J=JK
  GO TO 12
35  DO 37 I=1,J
  LOCA(I)=LOGS(I)
  BEARA(I)=BEARS(I)
  PLGA(I)=PLGS(I)
  GO TO 12
37  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,NXTIL,0.0,54)

ARROW LENGTH IS 0.4 INCHES LONG AND DIP VALUE SYMBOL IS A FUNCTION.
50 KIND=01
51 CALL SYMBOL(CX(I),CY(I),0.06,KIND,ANGLE,-1)
52 CALL NUMBER(A,B,HTS,PLUNGE,0.0,-1)
99 GO TO 100
     CALL PLOT(0.0,0.0,999)
     STOP
     END
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.
Author: I.D. Reaves
Title: SP.A.I. Computer PROGRAM
Place of Publication: [Blank]
Edition: [Blank]
Year: [Blank]
ISBN: [Blank]
Publisher: [Blank]
(See LUCERT PROGRAM)

READ(8) ND
READ(8)(LOCZ(I),XC(I),YC(I),I=1,NP)
REMAIND R

DO 17 I=1,NMAX
CX(I)=-5

COMPARES ALL LOCATION NAMES (FROM CARDS AND STORES COORDINATES IN
NEW STORAGE WHEN LOCATIONS ARE EQUIVALENT.

DO 12 K=1,NP
IF (LOC(I)-LOCZ(J))14,13,14
14 CX(I)=XC(J)
CY(I)=YC(J)
GO TO 17
15 CONTINUE

16 CONTINUE

IF (COUNT-1)20,20,21
20 CALL PLOT(0.0,-22.0,-3)
GO TO 22
21 CALL PLOT(22.0,0.0,-3)
GO TO 23
22 CALL PLOT(2.0,8.0,-3)
23 CALL PLOT(0.0,18.0,2)
CALL PLOT(18.0,10.0,2)
CALL PLOT(18.0,10.0,2)
CALL PLOT(0.0,0.0,2)
CALL SYMBOL(0.0,-1.6,0.4,NTITL,0.0,56)
SANSY=SYNO-0.25
GO 90 I=1,NMAX
ANG=1STKTL*0.01745
SYMANG=1STKTL-90

CAUSES STRIKE LINE TO BE PLOTTED.

CALL SYMBOL(CX(I),CY(I),HT,13,SYMANG,-1)
ENTRY POINT FOR FUTURE PLANES SYMBOLS (E.G. JUINIS-54, BEDDING-96,
AND SLIP CLEAVAGE-35 (NO. KADIX 10)
TESTS IS THE ENTRY POINT FOR A WITH STATEMENT FOR FUTURE SYMBOLS
HYP=1T×0.125×0.86
XF=HYP×COST(ANG)
YF=HYP×SINT(ANG)
TF(I,DP,I),29,25,25
TF(I,STK(I)),27,27,26
X=XSTK(I)+XF
Y=CY(I)+YF
SYMBN=STK(I)+180
TF(I,DP(I),FO,0),OR,(I,DP,I),FO,90),GO TO 20
ANGL=I(STK(I)+90)+0.01745
YN=CY(I)+RV×COST(ANGL)+0.03
YN=CY(I)+RV×SINT(ANGL)+0.1
TF(I,STK(I),FO,0),YN=CY(I)+RV×SINT(ANGL)+0.1
GO TO 28

Y=XSTK(I)-XF
Y=CY(I)-YF
SYMBN=STK(I)
TF(I,DP(I),FO,0),OR,(I,DP,I),FO,90),GO TO 20
ANGL=I(STK(I)+90)+0.01745
YN=CY(I)+RV×COST(ANGL)+0.03
YN=CY(I)+RV×SINT(ANGL)+0.03
CALL SYMBN(X,Y,SYMBN,TB,SYMBN,-1)
TF(I,DP,I),FO,0),OR,(I,DP,I),FO,90),GO TO 33
TF(I,STK(I),DP(I))

CAUSES DIP VALUE TO BE PLOTTED.

CALL SYMBN(X,Y,SYMBN,0.07,DP,0.0,-1)
GO TO 90

TF(I,STK(I))31,31,36
X=XSTK(I)+XF
Y=CY(I)-YF
SYMBN=STK(I)
ANGL=I(STK(I)+90)+0.01745
YN=CY(I)+RV×COST(ANGL)+0.03
YN=CY(I)+RV×SINT(ANGL)+0.03
GO TO 32

Y=XSTK(I)+XF
Y=CY(I)-YF
CALCULATES REFERENCE POINT FOR DIP VALUE NUMBER.

SYMBN=STK(I)+180
ANGL=(I(STK(I)+90)+0.01745
YN=CY(I)+RV×COST(ANGL)+0.03
YN=CY(I)+RV×SINT(ANGL)+0.03

CAUSES THE DIP DIRECTION OF FORMATION SYMBOL TO BE PLOTTED.

182
CALL SYMBOL(X,Y,SMASZ,10,SYMANG,-1)
DIP=JAMS(TDP(I))

CAUSES THE DIP VALUE TO BE PLOTTED.

CALL SYMBOL(XH,YH,0.01,DIP,0.01,-1)
GO TO 90
9 T=(TSK(I))*35,35,35
X=CX(I)-XF
Y=CY(I)-YF
SYMANG=TSK(I)
TFT(TSK(I),EO,01) GO TO 36
GO TO 37
36 X=CX(I)+XF
Y=CY(I)+YF
SYMANG=TSK(I)+180

CAUSES THE DIP DIRECTION OF Elevation SYMBOL TO BE PLOTTED.

7 CALL SYMBOL(X,Y,SMASZ,10,SYMANG,-1)
IF(TDP(I),EO,0) GO TO 38
GO TO 60
38 SYMANG=SYMANG+90.

CAUSES THE STRIKE LINE TO BE PLOTTED.

CALL SYMBOL(CX(I),CY(I),MT,12,SYMANG,-1)
GO TO 60
3 CONTINUE
GO TO 7
7 MTHF(6,98) 1
8 FORMAT(1,1,STRIKE 60, 1,14,1 IS GREATER THAN 360,1)
9 CALL PLOTT(0.0,0.0,0.999)
SYMP
END
This thesis is accepted on behalf of the faculty of the Institute by the following committee:

[Signatures]

Date: October 20, 1969