GEOLOGY OF THE PRECAMBRIAN ROCKS OF THE SOUTHERN LOS PINOS MOUNTAINS, SOCORRO COUNTY, NEW MEXICO

by

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ABSTRACT

The Precambrian supracrustal section in the Los Pinos Mountains in central New Mexico is, in order of abundance, composed of: mica schists of the Blue Springs Schist (30%), quartzites of the White Ridge and Sais Quartzite (25%), siliceous metavolcanic rocks (20%) and meta-arkoses (25%) both of the Sevilleta Metarhyolite, with minor concordant hornblende schist lenses. The environment of sedimentation appears to reflect a stable shelf that received detritus from a dominantly granite-gneiss source area. Prior to regional metamorphism, siliceous volcanics were erupted into the basin and may have been partially reworked producing the intercalated arkosic sediments. Metamorphic mineral assemblages are of the upper greenschist facies and indicate a maximum temperature of 500-600°C. The major period of deformation produced NNE trending folds with steep, westerly dipping flow cleavage. Penetrative movements have partially transposed bedding, but phenocrysts in the volcanic rocks have been preserved.

The volcanic rocks represent a bimodal compositional suite and differ from typical continental rift bimodal suites in that the siliceous members greatly exceed the basaltic members in abundance. Two high-potassium, concordant, late kinematic granites intrude the section. The Los Pinos granite in the center of the range is characterized by 1) miarolitic cavities, 2) deformed plagioclase, and 3) rapakivi texture while the Sepultura granite to the south lacks most of these features although occasional deformed plagioclase crystals occur. This suggests 1) a shallow depth of emplacement, 2) residual feldspars were in the melt at time of final cooling, and 3) the formation of the granites may possibly have been during the late stages

of an orogeny. Aplites and pegmatites are uncommon in both granites suggesting a low volatile content during their final stages of crystallization; evidence of contact metamorphism is limited to the occurrence of cross-micas.

The Los Pinos Precambrian petrotectonic assemblage appears to have few Phanerozoic analogues and hence care should be used in interpreting it in terms of a particular plate-tectonic setting. Throughout central and northern New Mexico and extending WSW into Arizona, rocks of similar lithology and age can be found. These Precambrian rocks differ from those found to the north in both age and lithology, and from those found to the east in age, and may therefore represent an additional Precambrian province in the southwest United States.

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GEOLOGY OF THE PRECAMBRIAN ROCKS OF THE SOUTHERN LOS PINOS MOUNTAINS, SOCORRO COUNTY, NEW MEXICO

INTRODUCTION

In central New Mexico the eastern boundary of the Rio Grande Rift is formed by the Sandia Uplift which exposes Precambrian rocks for its entire length. The NNE trending Sandia Uplift has three principal mountain ranges, from north to south; the Sandia Mountains, the Manzano Mountains, and the Los Pinos Mountains separated by Tijeras Canyon and Abo Pass respectively. The Sandia Uplift is divided into two structural provinces, an easterly dipping structural block in the north, and to the south a north-northeast trending horst bounded on the east by the Montosa Reverse Fault, and on the west by the Tio Bartolo Fault Zone, which also forms the eastern boundary of the Rio Grande Rift. The separation of the two structural provinces occurs in the approximate center of the Manzano Mountains (Fig. 1). The Los Pinos Mountains are located in the southern portion of the horst.

The climate in the Los Pinos Mountains is that of a true desert, as it receives less than 10 inches (25 centimeters) of precipitation annually. During the winter, the highest part of the range receives snow with the total amount generally less than five or six feet. July and August see the occurrence of late afternoon thundershowers moving eastward over the area.

Several kinds of grasses are native to the region as are cholla, prickly pear, barrel and Spanish sabre cacti. Pinon and juniper forest the slopes, providing cover for a variety of wildlife including, deer, coyote, badger, rabbit, ground squirrel, rattlesnake, dove, quail, hawk, and a variety of song birds.

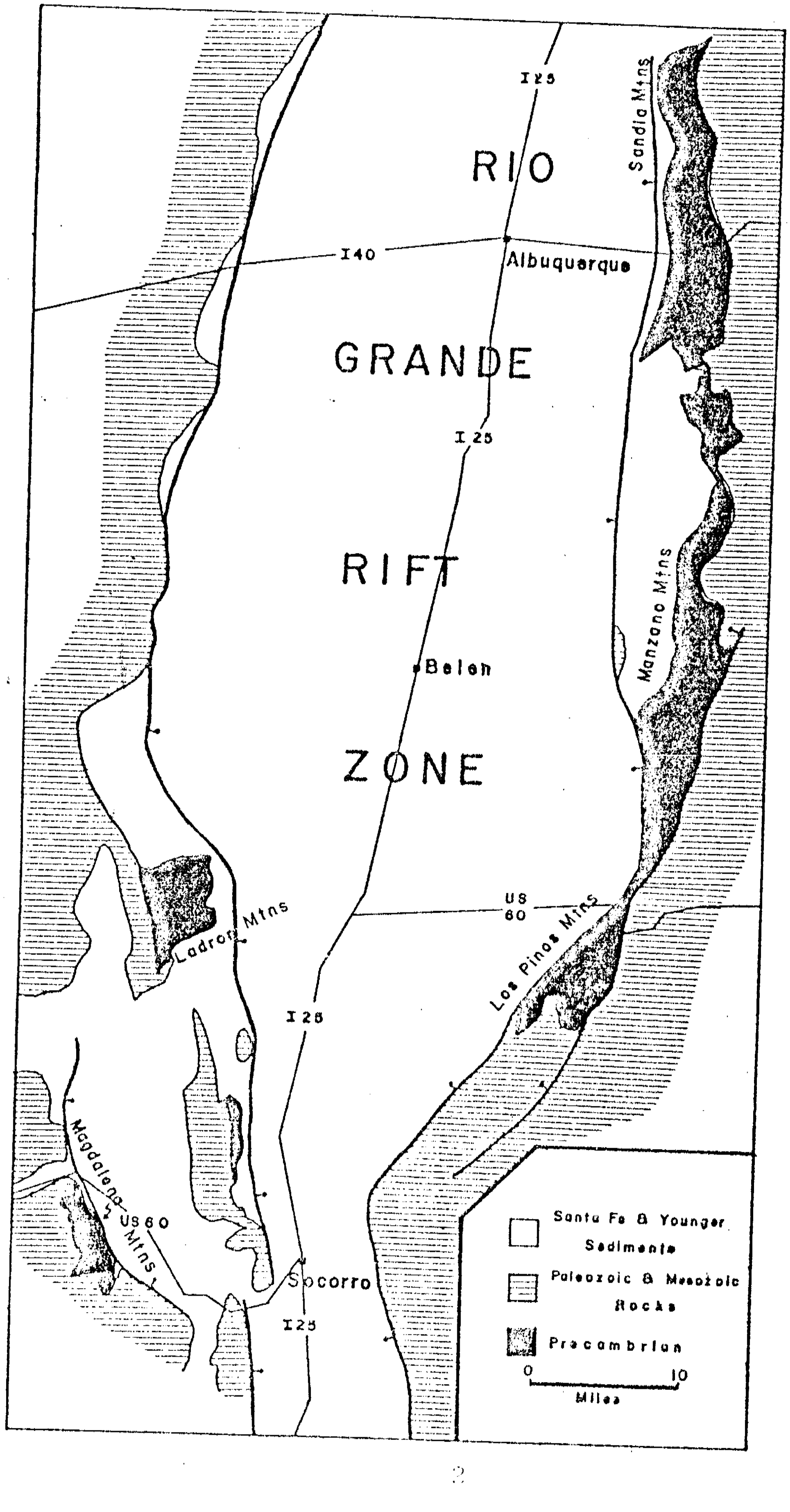


Fig. 1 Generalized map of Central New Mexico showing the location of the more important geographical and geological features of the region, (adapted from Sanford, et. al., 1972).

To the west of the Los Pinos Mountains, the grasslands of the Rio Grande Graben, named the Tio Bartolo Pediment by Denny (1941, p. 236), are inhabited by a small herd of pronghorn. The entire region is presently a wildlife refuge under the management of the Department of the Interior.

Topographically the region is quite varied. There exists nearly 2,500 feet (764 meters) of relief between the Tio Bartolo Pediment and the highest peaks in the Los Pinos Mountains. The eastern portion of the range slopes gently eastward and has local relief of only a few hundred feet.

The area can be accessed with a two wheel drive pickup with some difficulty, although four wheel drive vehicles are advisable if the existing roads are allowed to deteriorate further. The topographic base used in this paper was taken from U.S.G.S. topographic maps N3422.5-W10630/7.5 (Becker), N3415-W10630/7.5 (Cerro Montosa), and N3415-W10637.5/7.5 (Becker SW). These maps are on a scale of 1:24000.

PURPOSE

The study was undertaken to determine the geologic history of the Precambrian rocks of the Los Pinos Mountains. This was achieved by the examination of structural features such as bedding, lineation, foliation, small scale folds and related features and by the study of the petrology so the depositional and metamorphic history could be determined. It is hoped that a study of this type, both here and in surrounding areas, can lead to an understanding of the Precambrian tectonics of this region, and will eventually allow for correlation of Precambrian rock types and structures across the Rio Grande Rift Zone. During the study it has become apparent that this region may be an important key to the understanding of the Precambrian basement of the United States. Finally, the development of several computer programs has greatly increased the ability to analyze the structural data necessary to determine the major structures of the region.

ACKNOWLEDGMENTS

Of all the persons who have given me assistance in this project, three deserve special thanks. Dr. A. J. Budding, who first introduced me to the area, has been extremely helpful through his constructive criticism of the methods, ideas, and conclusions stemming from this project. Dr. Kent C. Condie allowed me the unlimited use of his data from his study of the igneous rocks of the Los Pinos Mountains. Finally, my wife, who not only encouraged me throughout the study but who also transposed my illegible rough drafts into a readable manuscript, deserves a special thanks.

In addition I would like to thank the Campbell Family Foundation, Mr. Alton Parker, and the Federal Bureau of Sport Fisheries and Wildlife for access to the study area. The New Mexico Geological Society also deserves a special thanks for their financial assistance for this project. I also wish to extend my appreciation to Dr. John MacMillan for his critical review of the manuscript and to the West Coast District of Gulf Energy and Minerals Company for allowing use of their drafting and reproduction facilities.

PREVIOUS WORK

Previous work in the area of the Los Pinos Mountains includes an unpublished Masters thesis from Northwestern University, by Staatz and Norton (1942) and a paper by Stark and Dapples (1946), which includes much of Staatz and Norton's work. These two works included the entire Los Pinos Mountains and studied not only the Precambrian, but also the late Paleozoic sediments overlying the Precambrian and were concerned with the overall geology of the range rather than any particular aspect. More recently, another unpublished Masters thesis, by Mallon (1966), from New Mexico Institute of Mining and Technology, described the northern one-third of the Los Pinos Precambrian exposures. The approach was petrographic and not structural in nature. However, the conclusions drawn by Mallon (1966) are supported by the evidence presented in this paper.

METHODS

As the use of machine methods was to be an important part of this study, it was necessary to use procedures both in the field and in the laboratory which could be readily converted to machine language. Therefore a grid system was used to locate points within the study area. The area was first divided by a grid such that each square measured one mile per side (1609 meters); these squares were called a unit square, and were numbered xy, where x, starting from the south and moving vertically, numbers each section consecutively from 0 to 9, and y, beginning from the west and moving horizontally, numbers each section consecutively from 0 to 9. Each section was then divided into 2500 smaller grid units (50 divisions per side) which are numbered from 0 to 49, beginning in the lower left hand corner and increasing vertically and horizontally, see Fig. 2. This idea is similar to using a graph with the origin at the southwest corner of the map, with x being the ordinate and y the abscissa. The fine grid scale of 50 was chosen as the map scale is 5" = 1 mile; this means each small grid unit is 1/10" on a side and has a resolution of 50 feet (15 meters) on the ground. Thus any point in the study area could be found simply by knowing its unit square number and its position with that unit square; and furthermore, its position would be within 35 feet (10.7 meters) of its true position, as it is plotted in the center of the 1/10" grid unit although its true position may be anywhere within that grid unit.

For example, a point having the location 122643 can be found by starting in the southwest corner of the map (lower left corner of unit square 00 in Fig. 2), moving north one unit square, moving east two unit squares, then counting 26 grid units to the north and 43 to the east, to

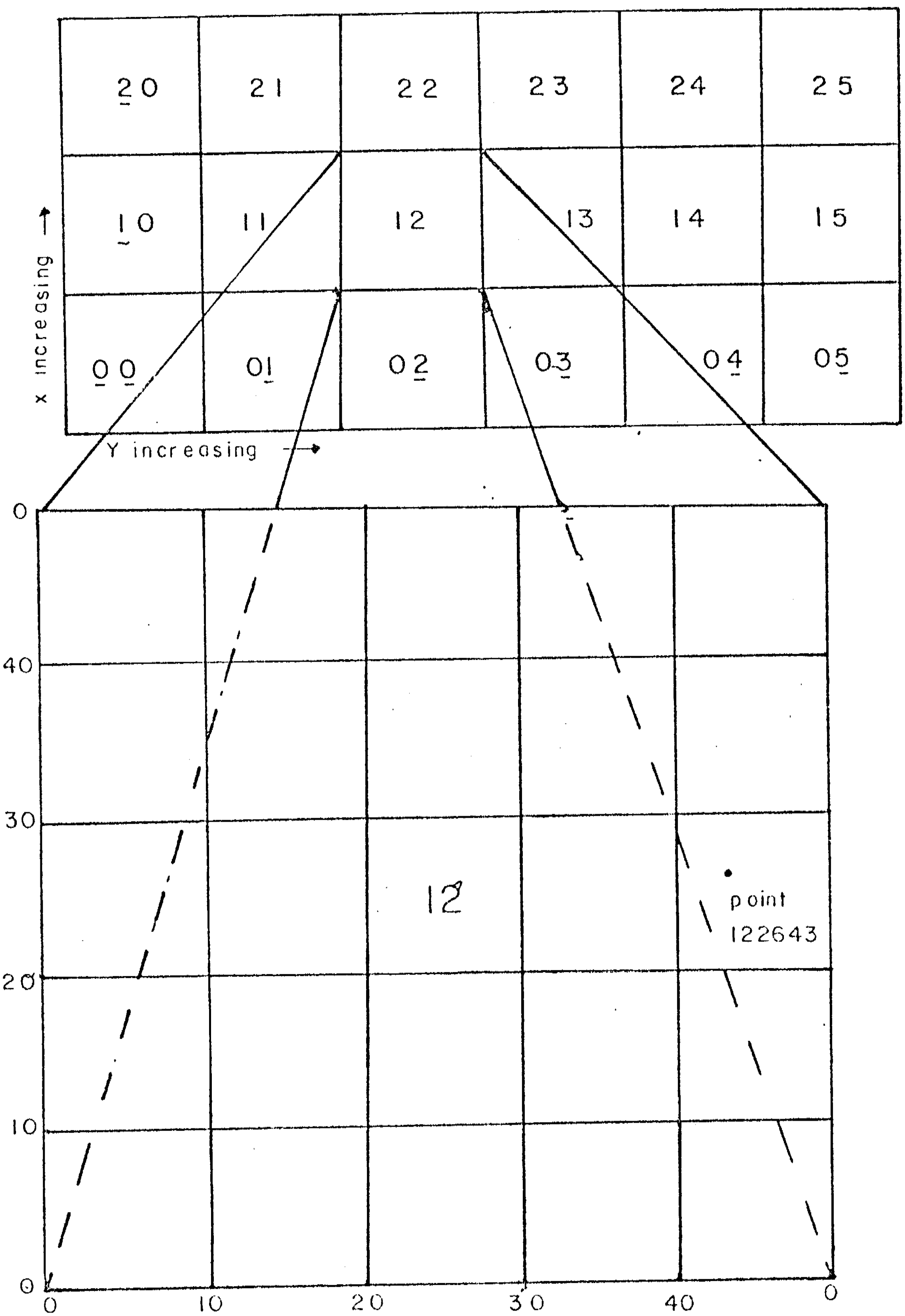


Fig. 2 A representation of the grid system used for locating data collection points for this paper. The plotting of a sample location with a location number 122643 is shown.

locate the point (Fig. 2).

Once the grid system had been established, it was necessary to develop a method of recording geologic data in a manner which could be used by the computer. A form developed for use in the Canadian Shield (Haugh, et al, 1967) proved to be adequate and needed only slight modification for use in this study (Fig. 3). In addition, it was necessary to develop a method for recording planar orientations using all four quadrants of the compass and the following method was arbitrarily chosen. The strike of a plane was a recorded direction (0° to 360°) such that when the plane was viewed along the strike it dipped to the viewer's right. Dip was taken in the conventional manner.

Once the data was recorded in numerical form, it was a simple matter to enter the information on computer cards. Several programs were written, or obtained from other sources and modified, to analyze the data. These programs, which are listed in their entirety in Appendix II, allow the plotting of directional data on stereonets, the determination of point density of both Pi and Beta diagrams, the calculation of best fit great circles, the calculation of histograms of data, and the plotting of symbols on a geologic map. The programs greatly aided in the reduction of the routine work necessary for such a structural study.

Chemical analyses of the various samples were supplied by Dr. K. C. Condie of New Mexico Institute of Mining and Technology and were obtained using neutron activation techniques and x-ray fluorescence (Condie, 1974, pers. comm.). Computer programs were used to plot rare earth element diagrams, the composition of high silica rocks in the Ab-An-Or-Q tetrahedron, and to construct silica variation diagrams for

STATION NO. SEC. N-S E-W — 1 2 | 3 4 | 5 6
GEOL. — 7 8
YEAR DAY MO. YR. — 9 10 11 12 13 14
ORIENTED SAMPLE NO:
PHOTOGRAPH
ORIENT.

TYPE		NON-DIAST. STRUCT.	TOPS	
BEDDING	1			
IGNEOUS DIFF.	2	CROSS BEDDING	yes / no	1 / 2
LIT-PAR-LIT	3			
CATACLASTIC	4	GRADED BEDDING	yes / no	3 / 4
METAMORPHIC	5			
INCLUSION LAYERS	6	PILLOWS	yes / no	5 / 6
OTHER	7			
		OTHERS	yes / no	7 / 8

LAYERING

TYPE (22) — NON DIAST. STRUCT. (23) — STRIKE (24 25 26) — DIP (27 28 29)

TYPE	
GNEISSOSITY	1
SCHISTOSITY-INDETERMINATE	2
CATACLASTIC	3
SLIP	4
FRACTURE CLEAVAGE	5
STRAIN-SLIP CLEAVAGE	6
OTHER	7

FOLIATION

TYPE (30) — STRIKE (31 32 33) — DIP (34 35)

LAYERING-FOLIATION
IF FOLDED LAYERING OR FOLIATION CODE TYPE AS ABOVE

SYMMETRY		RELIEF	
SYMMETRICAL	1	< 2 cm.	1
ASYMMETRICAL Z-SHAPED		2 - 10 cm.	2
LIMB RATIO < 4:1	2	10 - 50 cm.	3
>4<10:1	3	>50 cm.	4
>10:1	4	**STYLE**	
ASYMMETRICAL S-SHAPED		SIMILAR	1
LIMB RATIO < 4:1	5	CONCENTRIC	2
>4<10:1	6	DISHARMONIC	3
>10:1	7	CHEVRON	4
CLOSURE		PTYGMATIC	5
0° - 10°	1	INTRAFOLIAL	6
10° - 45°	2	OTHER	7
45° - 90°	3		
>90°	4		

MINOR FOLDS

LAY. (36) — FOL. (37) — SYM. (38) — CLOS. (39) — RELIEF (40) — STYLE (41)

AXIS: PLUNGE (42 43) — AZIMUTH (44 45 46)

AXIAL SURFACE: STRIKE (47 48 49) — DIP (50 51)

TYPE		SURFACE	
MINERAL LINEATIONS	1	LINEATION IN LAYERING	1
S-INTERSECTIONS	2		
MICROCRENULATIONS	3	LINEATION IN FOLIATION	2
BOUDIN AXIS	4		
DEFORMED CLASTS	5	LINEATION IN NON-LAYERED & NON-FOLIATED ROCK	3
IGNEOUS INCLUSIONS	6		
RODDING	7		
METAMORPHIC AGGR.	8		
OTHER	9		

LINEAR STRUCTURES

TYPE (52) — SURF. (53) — PLUNGE (54 55) — AZIMUTH (56 57 58)

MINIMUM SPACING	
< 10 cm.	1
10 - 50 cm.	2
50 -100 cm.	3
>100 cm.	4

JOINTS

MIN. SPAC. (59) — STRIKE (60 61 62) — DIP (63 64)

CATEGORY		FILLING	
FAULT	1	GRANITIC	1
FAULT-SLICKENSIDES	2	MAFIC	2
VEIN	3	QUARTZ	3
DYKE	4	CARBONATE	4
DYKE-SHEARED	5	QTZ. & KSPAR	5
SILL	6	QTZ. & MUSC.	6
IGNEOUS CONTACT	7	QTZ., MUSC. & KSPAR	7
APPARENT MOVEMENT		OTHER	8
NORMAL	1		
REVERSE	2		
LEFT LATERAL	3		
RIGHT LATERAL	4		

FAULTS, VEINS, DYKES, SILLS

TYPE (65) — MOV. (66) — FIL. (67) — STRIKE (68 69 70) — DIP (71 72)

SAMPLE DATA

sample no. (73) — rock type (74) — descr. (75) — sample no. (76) — rock type (77) — descr. (78 79 80)

ROCK TYPE			
GRANITE	1	LIMESTONE	8
QTZ. DIORITE	2	INTERM. GNEISS	9
APLITE/FELSITE	3	BASIC GNEISS	10
PEGMATITE	4	AMPHIBOLITE	11
VEIN MATERIAL	5	SCHIST	12
CONGLOMERATE	6	LIT-PAR-LIT/MIGMATITE	13
QUARTZITE	7	DON'T KNOW/OTHER	14

SAMPLE DESCRIPTION

GNEISSIC	1	MASSIVE	5
SCHISTOSE	2	INCLUSION	6
CATACLASTIC	3	CLAST	7
PHYLLITIC	4		

ADDITIVE CODES: ADD 30 TO ROCK TYPE IF PORPHYRITIC OR PORPHYROBLASTIC, ADD 60 IF RETROGRESSIVELY METAMORPHOSED.

Fig. 3 A sample copy of the data sheet used in the field to encode geological information (Haugh, et al, 1967).

all elements. These programs are also listed in Appendix II, and Appendix I lists the chemical analyses.

Data collection began in the summer of 1973 and was finished during the summer of 1974. A total of 597 locations were analyzed during this period. The winter of 1973-1974 was spent preparing the computer programs to work from a common data source. Although many of the methods used in this study differ somewhat from conventional geologic techniques, it is felt that they are beneficial in the amount of time saved in the handling and processing of the data.

PROPOSED NAMES

During the study of the Los Pinos Mountains it became apparent that several new informal names would have to be introduced in order to refer to the various geologic units in a systematic manner. The Los Pinos Granite, as used by previous workers, referred to the entire plutonic portion of the Los Pinos Precambrian exposures. The name is retained; however, it now refers only to the larger of the two plutonic bodies, the one exposed in unit squares 33, 34, 35, 43, 44, 45, 53, 54, 55, 64, and 65 as shown on Plate 1. The remaining granite, which differs chemically and lithologically from the Los Pinos Granite, has been named the Sepultura Granite after the large canyon that bounds it to the east. The Sepultura Granite is exposed in unit squares 1, 11, 12, 21, 22, 32, 33, 42, and 43 as shown on Plate 1. The septum which separates the two granites may be equivalent to the upper portions of the Sevilleta Metarhyolite, but in view of certain differences, it has been named the Bootleg Canyon Sequence. The name is derived from Bootleg Canyon (unit squares 33 and 43, Plate 1), where the largest exposures of this unit occur. The fault at the west side of the range, which separates the Rio Grande Rift Zone from the Los Pinos Mountains, has been named the Tio Bartolo Fault; the name is taken from the Tio Bartolo Pediment located immediately to the west of this fault. This fault is most likely a fault zone and extends northward along the base of the entire Sandia Uplift.

PRECAMBRIAN ROCKS

INTRODUCTION

The accepted method of discussing the stratigraphy of an area is to begin with the oldest unit and proceed to the youngest unit. In the Los Pinos Mountains, it is assumed that the units are upright and dipping to the west for the purpose of discussing the stratigraphy. There is, however, no conclusive evidence of this and in some cases the evidence may suggest overturning. The formational names used here are those given by Stark and Dapples (1946), and those units identified previously (p. 12). The total exposed Precambrian metasedimentary and metavolcanic section of the Los Pinos Mountains exceeds 16,000 feet (4,880 meters) in thickness, approximately half of which is accounted for by the Sevilleta Metarhyolite and associated hornblende schists. Although there is undoubtedly repetition within this section, there is still a significant thickness of Precambrian metasedimentary rocks exposed in the Los Pinos Mountains.

SAIS QUARTZITE

The Sais Quartzite appears to be the lowermost Precambrian unit in the Los Pinos Mountains. The lower contact is not exposed, as the formation is bounded to the east by the Montosa Fault. From the vicinity of the Sais Quarry approximately 5 miles (8 kilometers) north of the mapped area, the quartzite thins southward against the fault until it disappears immediately north of the area covered by this paper (Staatz and Norton, 1942; Stark and Dapples, 1946; Mallon, 1966). The unit is typically a white to light gray, nearly pure, equigranular quartzite. Thin layers of muscovite are present throughout the unit and may represent original bedding. It is believed that this unit is the metamorphic equivalent of a quartz sandstone with thin shaley or silty lenses. The best exposure of the Sais Quartzite can be found north of U.S. Highway 60 in Abo Canyon at the Sais Quarry of the A.T.&S.F. Railroad. In the Los Pinos Mountains, the maximum exposed outcrop thickness of the Sais Quartzite is approximately 1400 feet (428 meters).

BLUE SPRINGS SCHIST

The Blue Springs Schist outcrops to the west of, and appears to overlie, the Sais Quartzite; it forms very subdued outcrops in the area of low relief to the north and east of Cerro Montosa (Plate 1). Cerro Montosa is formed of Pennsylvanian rocks overlying, and in depositional contact with, the Blue Springs Schist. The maximum outcrop thickness of the Blue Springs Schist is found just north of Cerro Montosa where it reaches nearly 4,750 feet (1450 meters), assuming an outcrop width of 5,500 feet (1670 meters) and an average dip of 60°. The original thickness of the unit is indeterminable as the amount of repetition is unknown. In general, the lower five hundred to one thousand feet of the Blue Springs Schist appears texturally and lithologically different from the upper part. Notably, the lower portion appears to lack the well developed foliation characteristic of the upper portions of the Blue Springs Schist, and it is more pervasively fractured, with fracture spacing less than 2 centimeters, as opposed to a 10 to 50 centimeters fracture spacing in the upper portion. The contact between these two portions of the Blue Springs Schist is quite gradational and roughly parallels the Montosa Fault (Plate 1). It is believed that this lower zone may represent a zone of recrystallization caused by movement along the Montosa Fault. This hypothesis would account for the lack of foliation, the highly fractured nature, and most importantly, the trend of this zone which appears to cross-cut bedding as defined by the contact of the major units. Mallon reached a similar conclusion for the portion of the Sais Quartzite which borders the Montosa Fault (Mallon, 1966, p. 28).

The Blue Springs Schist is predominantly a quartz-muscovite rock with a very well developed foliation trending N20^{o}E to N30^{o}E. Layering in the Blue Springs Schist is not uncommon and can be recognized in 60-70% of the outcrops. North and east of Cerro Montosa near the Parker Ranch Headquarters, unit square 57, Plate 2, layering can be found that is oriented at a high angle (approaching 45^{o}) to the relatively consistent foliation and is an indication of plunging folds. This is the only area in the entire mapped region in which this occurs; the general trend of layering, when encountered, strikes less than 10^{o} east of the foliation trend, or parallels it.

To the north and east of Cerro Montosa the Blue Springs Schist is generally light gray in color, but changes to a light red brown or a very dark gray, nearly black color to the southeast and south of Cerro Montosa. Southeast of Cerro Montosa, relict graded bedding may be found in float. Recognition of this feature in outcrop proves difficult as outcrops are covered with soil and lichen which can not be satisfactorily removed. Fresh surfaces on the float allow a much finer detail to be seen. Consequently, the orientation of the graded bedding could not be determined.

Microscopic investigation supports the megascopic conclusions and adds some additional information. This unit contains approximately 60% quartz, 30% muscovite, 5% biotite, and 2-3% magnetite-pyrite. Traces of garnet and leucoxene are also present. Grain size of the quartz and muscovite varies between 0.02 to 0.05 millimeter. Foliation is defined by the orientation of the muscovite, with the exception of sample LP73-7 (Plate 1) in which biotite appears to define the foliation. Two thin sections, LP73-2 and LP73-1 do not show foliation although the lithology is similar to the rest of the Blue Springs Schist. These two thin sections come from, or near, the recrystallized zone at the base of this unit.

Biotite is present as idioblastic porphyroblasts approximately 0.5 millimeter in size, oriented at high angle to foliation and can be considered as cross-biotites. The presence of the cross-biotites in the Blue Springs Schist is due to further recrystallization occurring after the formation of the foliation, most probably in response to the thermal effect of the intruding granites. The lack of cross-biotites within the transition zone may be explained by one of two hypotheses. Either the cross-biotite was never formed in this region or it was formed then destroyed by cataclastic recrystallization at the time of faulting. The latter hypothesis is believed to be the more correct one as the lithology of both the upper and lower portions of the Blue Springs Schist seems similar and there appears to be no decrease in the quantity of biotite as one moves from west to east through the Blue Springs Schist toward this recrystallized zone. Such a decrease may be expected if the biotite had not formed in the transition zone originally due to the position of the biotite isograd. Further, an isograd should parallel the intruding pluton, not a later fault.

The very fine grained nature of this formation is believed to relate to the texture of the parent rock. It appears to be the metamorphic equivalent of a quartz rich siltstone or silty claystone.

The clay particles in the original sedimentary section would have provided the aluminum, alkalis, and other elements necessary for the growth of the micas upon metamorphism.

WHITE RIDGE QUARTZITE

The White Ridge Quartzite appears to overlie and be in depositional contact with the Blue Springs Schist to the north of Cerro Montosa. To the south of Cerro Montosa the two units may be in fault contact along the Paloma Reverse Fault, although the actual contact and fault are covered by alluvium. To the north of Cerro Montosa, the Paloma Reverse Fault cuts only the White Ridge Quartzite and eventually appears to die out. The relationship of the contact between the White Ridge Quartzite and the Blue Springs Schist to the Paloma Reverse Fault along the west side of Cerro Montosa is questionable as all Precambrian outcrops immediately east of the Paloma Reverse Fault are overlain by Pennsylvanian age rocks. At data station 23, unit square 46, and 400 feet west of data station 16, unit square 36 (Plate 1), cataclastically deformed White Ridge Quartzite is exposed. Data stations 1, 2, 14, and 15, unit square 35 (Plate 1) are located in Blue Springs Schist which shows no evidence of cataclastic deformation. The Paloma Reverse Fault may be contained entirely within the White Ridge Quartzite, but it does appear to approach the contact with the Blue Springs Schist to the south. Whether the fault actually follows the contact, or cuts it further to the south is unknown, as the next Precambrian outcrop along the Paloma-Montosa Fault system, is the cataclastically deformed White Ridge quartzite at data station 3, unit square 15 (Plate 1).

The White Ridge Quartzite is made up of two distinct units, a lower half which is white and an upper half which is light purple in color. Mineralogical composition is essentially the same, with 99% quartz, 1% muscovite, and a trace of hematite and magnetite. The outcrop width of this unit is about 1900 feet (590 meters), and with an average dip of 65°, its thickness is about 1700 feet (520 meters). The beds are essentially the same in all aspects, with the exception of color, which is believed to be due to different quantities of hematite (Mallon, 1966, p. 24). Individual beds within the two major units vary in thickness from 1 to 15 inches (2.5 to 37 centimeters). Outcrops are quite rugged due to the presence of several well developed joint planes. The prominant ridge in the north central portion of the mapped area is formed by the White Ridge Quartzite, with the western slope forming the dip slope.

This unit is believed to be the metamorphic equivalent of a quartzose sandstone. Cross-bedding may be present in two localities (data station 2, unit square 14, data station 3, unit square 46, Plate 1), Fig. 4, but in view of the widespread occurrence of isoclinal folds, and the contradictory evidence for "younging" supplied by the cross-beds, an interpretation of these structures as sedimentary cross-bedding may not be founded. The faint cross-bed structures can be interpreted as apparent cross-bedding, resulting from shearing of minor isoclinal folds. The amplitude of these folds is generally less than 50 centimeters, although one fold at data station 10, unit square 12, Plate 1, has an amplitude of approximately 60 inches (150 centimeters).

In thin section, quartz grains elongated parallel to dip show both undulatory extinction, and sutured grain boundaries. These features indicate recrystallization during metamorphism. Grain size is quite uniform and averages 1.5 to 2 millimeters in the long direction; the length to width ratio is approximately 2 or 3 to 1.

SEVILLETA METARHYOLITE

As the western edge of the White Ridge Quartzite is approached, it becomes arkosic and more coarse grained eventually changing from a quartzite or arkosite on the east into a fine grained muscovite schist some 200 or 300 feet to the west. Quartzite layers thin and become more widely spaced towards the west. A large concentration of hornblende schist sills is found in this area, many of which are too small to map at the scale used. The contact between the White Ridge Quartzite and the Sevilleta Metarhyolite was chosen approximately halfway through this transitional sequence.

Metarhyolite may be somewhat of a misnomer in that approximately 50% of the unit appears to be a metamorphosed arkosic sediment. The remainder of the unit is metamorphosed extrusive igneous rock, the majority of which has the appearance of ash flow tuff. The two rock types are intercalated and have formed beds several tens of feet thick. In outcrop, both rock types are schistose with well developed foliation; their color is light to medium gray with light to medium brown staining on exposed fracture surfaces. The outcrops range from poor near the contact with the quartzite to excellent as the topography becomes more rugged in its western exposures. In the metavolcanic units, relict feldspar and quartz phenocrysts, about 5 - 10 millimeters in diameter, impart a wavy appearance to the foliation surface. The spacing of these grains ranges from 1 to 4 centimeters. In the sedimentary portion these grains are missing and an occasional lithic fragment may be observed.

Chemical analyses (Condie, pers. comm.) from the Sevilleta Metarhyolite show two separate groupings in the Ab-An-Or-Q tetrahedron,

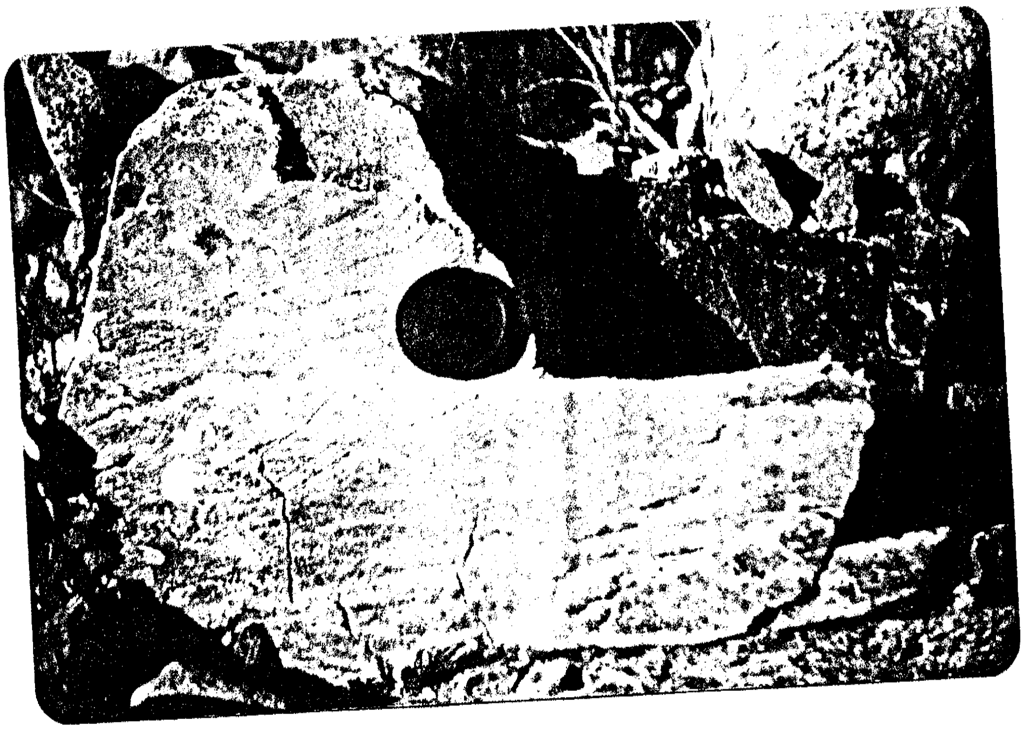


Fig. 4 "Cross-bedding" in White Ridge Quartzite at Data Station 2, Section 14. Lens cap is about 2 inches in diameter. This is the best example of cross-bedding in the Los Pinos mountains and it indicates the sample is upright with tops to the west (top of photograph).

Fig. 5. The metavolcanic rocks plot very close to the field defined by Los Pinos and Sepultura by granites, whereas the meta-arkoses are much more siliceous, plotting behind the quartz-feldspar cotectic surface and are depleted in K^+ relative to the metavolcanic rocks.

Gresens (1974, p. 112) has found that metarhyolite which has undergone shearing may have its relict phenocrysts destroyed and may be metasomatically altered such that its bulk chemical composition resembles that of an arkosic or near arkosic sediment giving the appearance of a unit formed of intercalated sediments and rhyolites. In northern New Mexico, Gresens observed that zones of shearing could be traced with care and were found to merge with other similar zones, or branch in a manner typical of zones of shearing but not of sedimentary bedding.

The thickness of the exposed outcrop of the Sevilleta Metarhyolite is approximately 8,250 feet (2500 meters); if isoclinal folding has affected these rocks, the true thickness may be substantially less. Such a thickness of ash flow tuff would accumulate over a period of time and interuptions in the volcanic activity would allow erosion of the tuff and deposition of arkosic sediments, depleted in K^+ and enriched in SiO_2 relative to the parent rock, producing a unit similar to the Sevilleta Metarhyolite in both lithology and chemical composition. If shearing occurred in the Sevilleta Metarhyolite, its effect would be similar to that described by Gresens, and its effect on intercalated sediments would be further depletion of K_2O concentration due to the metasomation. Variation in K_2O concentration in the sediments may also be due to the amount of weathering that a certain group of sediments has undergone relative to some other group of similar sediments in a

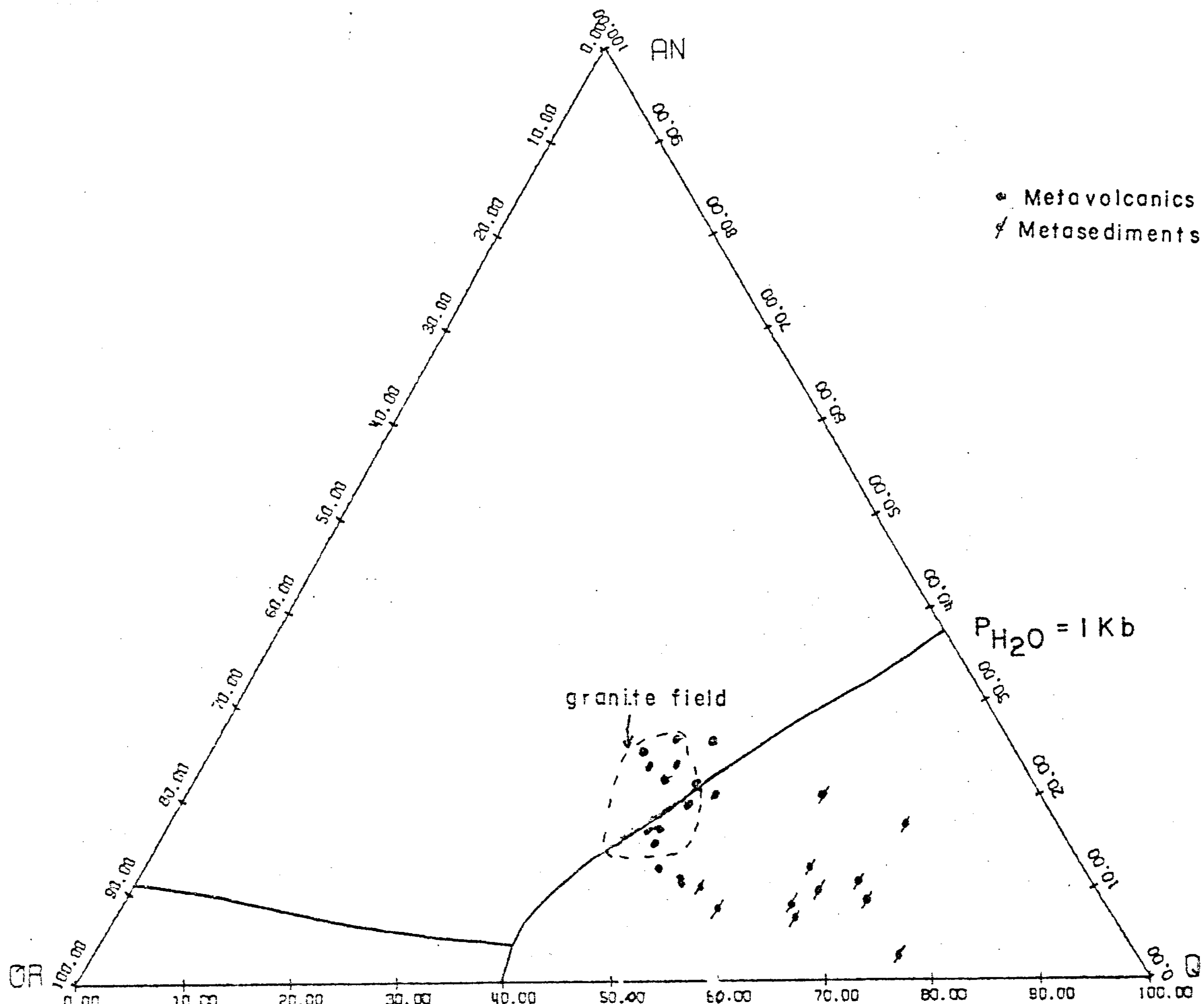


Fig. 5 POINTS PROJECTED FROM AB CORNER, (MESONORM)

Sevilleta Metarhyolite

different location. Either interpretation, as an intercalation of ash flow tuffs with arkosic sediments, or the effects of subsequent shearing, could produce a unit similar in appearance to the Sevilleta Metarhyolite, and would account for the variation in the K_2O concentration seen in the plot of metasediments in Fig. 5.

HORNBLENDE SCHIST

Hornblende schist occurs as lenses and interlayers within the White Ridge Quartzite and the Sevilleta Metarhyolite. The thickness of individual layers ranges from a few inches to approximately 150 feet (41 meters), but most layers are from 5 to 40 feet (1.5-12 meters) thick. Layers are most abundant in the central and eastern parts of the White Ridge Quartzite. Outcrops are generally poor, discontinuous, and form local topographic lows between the surrounding rocks; contacts are poorly exposed.

The rocks are essentially hornblende-chlorite schists containing hornblende, chlorite, epidote, with or without quartz, plagioclase, and scapolite.

They are most commonly dark green to black, but some had a mottled green and white coloring. Color is generally a function of the plagioclase content: the higher the percentage of plagioclase, the lighter the color. The dark green color of the rocks is due to the presence of hornblende, chlorite and epidote. The rocks are generally very schistose, with the exception of some layers with a high percentage of epidote. Consequently, some outcrops are very schistose and highly fractured, whereas others appear massive with little or no schistosity or fracture. Schistosity in hornblende schist parallels that in adjacent rocks. Mineral lineation is present in the plane of schistosity. Chlorite flakes, ranging from 0.05 to 0.2 millimeters in size, mark the prominent foliation plane. The chlorite is developed in two orientations, one defining the dominant flow cleavage, and another oriented at 90° to the flow cleavage (cross-mica). Plagioclase occurs both as twinned and untwinned grains, its composition is usually that of oligoclase (about An_{27}), but albite is also present. Calcite partially replaces plagioclase and occurs also in the matrix of the rocks. Accessory minerals are zircon, sphene and hematite; muscovite and biotite occur in a few samples.

The origin of these hornblende schists may be either from mafic flows or from sills. It is possible that the large continuous units, shown on Plate 1, are flows, whereas the smaller discontinuous lenses may be sills.

BOOTLEG CANYON SEQUENCE

The stratigraphy of this unit is very similar to the Sevilleta Metarhyolite and may in fact be its equivalent. Hornblende schists account for perhaps half of this unit, the remainder is a quartz-mica schist. In outcrop the rocks are very dark, generally black; fresh surfaces show a light gray color for the quartz-mica schist, and a dark green to black for the hornblende schists. Biotite is quite common in these rocks as opposed to the Sevilleta Metarhyolite, and may be due to a slight increase in the metamorphic grade as the unit is situated between two granite plutons. The quartz-mica schist is nearly identical to the Sevilleta Metarhyolite, with the exception that biotite replaces muscovite. This unit has been named and described separately as it cannot be correlated with the units previously described.

LOS PINOS GRANITE

This pluton is the largest of the two granites exposed in the Los Pinos Mountains and outcrops in the northwest and central portions of the mapped area (Plate 1). It is bounded to the west by the Tio Bartolo Fault Zone, to the southwest by the Bootleg Canyon Sequence, and to the east and north by the Sevilleta Metarhyolite. The southern most boundary of the granite is covered by rocks of Pennsylvanian age, and the northern most boundary is outside the map area. Mallon (1966, Plate 1) indicates that the Sevilleta Metarhyolite encloses the northern portion of the granite. In general, the Los Pinos Granite appears concordant with the Sevilleta Metarhyolite (Plate 2). However, on a smaller scale, discordant relationships exist. In the north-central region of unit square 24 (Plate 1), a hornblende schist layer is truncated by the granite. In the southwestern portion of unit square 44 (Plate 2), the granite cross-cuts foliation at nearly right angles. The northern boundary of the granite is outside the mapped area, however a brief study of this region by the author indicates that the country rock has undergone a sufficient amount of silicification to destroy any primary layering, and foliation has been destroyed as well. The southern contact is buried under several hundred feet of Pennsylvanian cover. Therefore the two most critical regions for determining the relationship of this granite to the country rock cannot be used.

The Los Pinos Granite is porphyritic with phenocrysts comprising 10-15% of the volume. The phenocrysts are predominantly plagioclase (An_{34}) with minor (10-15%) quartz and potassium feldspar crystals. The phenocrysts range from 3 to 7 millimeters in length but average between

4 and 6 millimeters. All of the plagioclase phenocrysts are albite twinned. The crystals are euhedral but many are broken, offsetting the twin planes. Others show only bent twin planes, but nearly all show some signs of deformation after growth. Occasionally the phenocrysts show evidence of both resorption and overgrowth. The ground mass of the Los Pinos Granite is composed predominantly of quartz and potassium feldspar averaging 1 millimeter in diameter. Biotite, also present, constitutes 5 to 6% of the ground mass and appears concentrated around the edges of phenocrysts, as does microcline (samples N-4, Plate 1). Magnetite accounts for 1 to 2%. Trace amounts of garnet (0.2-0.5%) have been found in samples N-2 and N-4 (Plate 1). Sericite is also present but is generally less than 1%. Approximately one half of the ground mass shows a myrmekitic intergrowth of quartz and plagioclase, which is not found in the Sepultura Granite. Rapakivi texture, potassium feldspar rimmed by plagioclase, was noted in some slides in very minor amounts and is unique to the Los Pinos Granite.

In hand specimen the Los Pinos Granite appears fresh with only minor alteration due to weathering, with the exception of the region containing data stations 33, 17, 14, and 18 in the east central portion of unit square 33 (Plate 1). Here the granite is deeply weathered, particularly along fracture zones which may be 1 or 2 inches (2-5 centimeters) wide and several inches deep. The significance of this highly weathered feature, which is topographically and structurally low as compared with surrounding granite paleo-surfaces is unknown. The Los Pinos Granite is pink both on fresh and weathered surface, the color being imparted by potassium feldspar in the ground mass. Phenocrysts are not readily apparent and twinning in the phenocrysts can be seen only occasionally and with difficulty. Miarolitic cavities are not uncommon throughout the Los Pinos Granite, but are most common at its northernmost exposures. Results of modal analysis of three samples are listed in Table 1. These results indicate a composition of 40% quartz, 38% potassium feldspar, 13% plagioclase (An_{34}), 5% biotite, 2% magnetite, and 1% sericite. The sericite is evenly scattered throughout all the feldspar grains.

SEPULTURA GRANITE

The Sepultura Granite is exposed to the southwest of the Los Pinos Granite and is separated from it by the Bootleg Canyon Sequence which forms its northern and eastern boundaries. The western boundary of the Sepultura Granite is formed by the Tio Bartolo Fault Zone. In unit square 01 (Plate 1) the Sepultura Granite is overlain by Pennsylvanian sediments, much the same as the Los Pinos Granite. The Sepultura Granite is concordant with respect to the Bootleg Canyon Sequence.

The Sepultura Granite is porphyritic and the phenocrysts, which compose less than 15% of the rock by volume, are predominantly potassium feldspar with minor (10%) plagioclase (An_{32}). This contrasts with the Los Pinos Granite in which plagioclase phenocrysts are predominant. Most of the phenocrysts are subhedral, although a few may be euhedral; grain boundaries show evidence of resorption during the final stages of crystallization. In general, the phenocrysts range from 3 to 4 millimeters in length and the ground mass minerals range from 0.5 to 1 millimeter in length. The ground mass consists predominantly of anhedral quartz and potassium feldspar and minor euhedral plagioclase (An_{32}). Minor constituents of the ground mass include euhedral to subhedral biotite and magnetite; hematite, chlorite, and sericite are also present

Table 1 Modal Analyses of Thin Sections of Los Pinos Granite

Sample No.	Grains Counted	Percent Quartz	Percent Potassium Feldspar	Percent Plagioclase	Average An Content	Percent Biotite & Chlorite	Percent Magnetite & Hematite	Percent Sericite
N2	1000	47	33	12	35	5	2	0.6
N4	1000	41	43	8	33	6	0.8	1.4
NP6*	600	33	39	19	10(?)	5	3	2
average	867	40	38	13	34	5	2	1.3

*NP6 is a thin section of poor quality.

in minor amounts.

In hand specimen, the Sepultura Granite appears fresh showing only minor alteration due to weathering and is indistinguishable from the Los Pinos Granite. The weathering is apparent along fracture systems and penetrates the rock less than 1 millimeter, leaving a brownish stain on the fracture surfaces. Weathering on outcrops is shallow, but gives rise to a surface relief of 2 to 3 millimeters; representing the differential weathering between the feldspars and quartz. On a fresh surface the rock has a pinkish cast imparted by the feldspar grains, and no twinning can be seen. Modal analyses of five samples indicate an average composition of 38% quartz, 39% potassium feldspar, 18% plagioclase (An_{32}), 4% biotite and magnetite and 1% sericite (Table 2). Sericite is found predominantly within potassium feldspar crystals and is widely scattered throughout the thin sections.

A finer grained facies of the Sepultura Granite occurs along the eastern side of the pluton and extends westward for several hundred feet. It is characterized by a ground mass of quartz and potassium feldspar 0.1 millimeter in grain size, very few phenocrysts, and an anomalously large percentage (2%) of magnetite. This zone may be an aplitic facies of the Sepultura Granite.

The northwestern boundary of the Sepultura Granite is formed by the Tio Bartolo Fault Zone, but it is likely that this fault zone coincides approximately with the original granite contact. Outcrops of the Bootleg Canyon Sequence in the NE corner of unit square 32 and in the south-central portion of unit square 11 may represent part of the country rock west of the granite.

Table 2 Modal Analyses of Thin Sections of Sepultura Granite

Sample No.	Grains Counted	Percent Quartz	Percent Potassium Feldspar	Percent Plagioclase	Average An Content	Percent Biotite & Chlorite	Percent Magnetite & Hematite	Percent Sericite
N9	817	35	28	35	31	2	1.4	-
N13	1576	41	32	17	32	6	0.6	3
NP12	1550	47	46	4	34	1.8	0.9	0.6
NP16	1000	32	47	17	31	0.6	2.2	0.5
NP19	1000	35	40	18	33	6	0.6	0.3
average	1188	38	39	18	32	3.2	1.1	0.9

PALEOZOIC ROCKS

The lower most Paleozoic rocks exposed in the Los Pinos Mountains are the Sandia Formation of Lower Pennsylvanian age, predominantly a sandstone-shale sequence but with significant limestone, (Kottlowski, 1960, p. 51). Overlying this is the Madera Formation, mostly limestone, with the lower 200 feet predominantly sandstone and shale (Kottlowski, 1960, p. 51). The color of these Pennsylvanian rocks is a light gray to a light yellow brown.

East of the Montosa Fault the Permian Bursum and Abo Formations are exposed. These formations consist of red to red brown shales and siltstones which preserve many sedimentary structures. The contact between the Bursum and Abo in the vicinity of U.S. Highway 60 is marked by a thin limestone bed; however, this bed disappears near Cerro Pelon and from there on south the two units are virtually indistinguishable. The mapped contact between the Permian beds and the Pennsylvanian beds was based on the distinct color change between the two units.

The Paleozoic rocks dip gently to the south, but immediately adjacent to the Paloma or Montosa Faults the Pennsylvanian section has a steep easterly dip or is overturned to the west. For a more detailed description of the Paleozoic sequence in the Los Pinos Mountains see Stark and Dapples (1946, p. 1143) and Kottlowski (1960).

The base of the Paleozoic section is formed by a conglomerate which is present in the southern part of the Los Pinos Mountains. The unit is approximately five feet thick where best exposed and is composed of quartzite pebbles and cobbles from 5 to 15 centimeters in diameter. A nearly pure quartz sand fills the space between the larger fragments and the entire conglomerate is cemented with silica. The lower portions of this unit may contain a small number of fragments from the underlying rocks. The best exposures are in unit square 24 where it overlies the Sevilleta Metarhyolite (Figs. 6 & 7) and in unit square 01 along the road to Sepultura Canyon, where the conglomerate overlies highly weathered Sepultura Granite (Figs. 8 & 9). Northward toward VABM Pinos (unit square 34) the lower most Paleozoic units appear to pinch out as the conglomerate is absent along the top of the ridge. A detached block of this conglomerate was found on the NW corner of Cerro Montosa, near the contact between the Paleozoic rocks and the Blue Springs Schist.

Fig. 6 Pennsylvanian conglomerate overlying Sevilleta Metarhyolite at data station 8, section 24. View is perpendicular to strike of metarhyolite.

Fig. 7 Pennsylvanian conglomerate overlying Sevilleta Metarhyolite at data station 8, section 24. View is parallel to strike of metarhyolite.

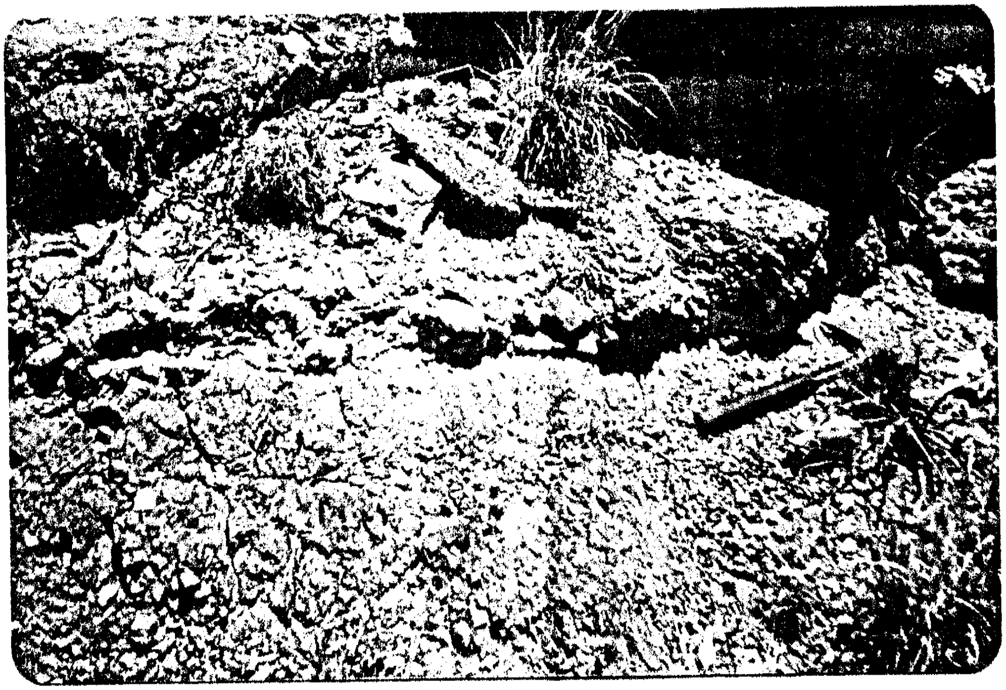


Fig. 8 Pennsylvanian conglomerate overlying Sepultura Granite at data station 2, section 01. Hammer points to the contact.

Fig. 9 Hammer points to a Precambrian granite clast in the Pennsylvanian conglomerate overlying Sepultura Granite at data station 2, section 01. Conglomerate-Granite contact crosses the hammer handle where the grip begins.

CENOZOIC ROCKS

Late Cenozoic terraces are developed along the sides of present drainage channels. The terrace fill contains cobbles of Paleozoic limestone and Precambrian quartzite and schist, in addition to numerous Precambrian granite fragments.

Alluvial fill in the arroyos ranges from boulder to sand size fragments, which in composition reflect the bed rock lithology of the drainage area. The larger, boulder and cobble size fragments are angular, indicating a relatively short distance of transport.

On the geologic map, the above units were combined with the Tio Bartolo Pediment (Denny, 1941) into a single unit named Quaternary Alluvium (Qal). The exact age of the Tio Bartolo Pediment is not known; it forms the gently westward sloping plain west of the Tio Bartolo Fault Zone.

PETROLOGY AND GEOCHEMISTRY OF THE LOS PINOS IGNEOUS ROCKS

Previous workers in the Los Pinos Mountains have mapped the Los Pinos Granite and the Sepultura Granite as one continuous igneous body. Geochemical and petrographical work indicate the existence of the two similar, but distinct, plutonic bodies. Geochemical analyses of the three Los Pinos igneous bodies (Sepultura Granite, Los Pinos Granite, and the Sevilleta Metarhyolite) are listed in Appendix I. These analyses were made by Dr. K. C. Condie during 1973-1974 using x-ray fluorescence and neutron activation.

A comparison of the median geochemical values for the Los Pinos Granite with those from the Sepultura Granite show that most elemental concentrations and ratios are essentially the same, within the margin of error. The concentration of the total Rare Earth Elements, Fe_2O_3, Sr, La, Ce, and the ratio Ba/Rb are greater in the Los Pinos Granite than in the Sepultura Granite, whereas the concentrations of K_2O, Cr, and the ratio Ni/Co have greater values in the Sepultura Granite than in the Los Pinos Granite. The volcanic rocks from the Sevilleta Metarhyolite have been divided into two suites, the Montosa section taken in unit square 57, Plate 1, and the Pinon section taken from just north of the map area in Pinon Canyon. These rocks show a much more varied composition, both within and between each group, than do the plutonic rocks of the Los Pinos Mountains, as can be seen in the graphs of Appendix III; the normative compositions of the volcanic rocks indicate a higher An content of plagioclase than are found in the granites, Tables 3, 4, and 5. These facts suggest that the volcanic rocks are not the extrusive equivalents of the granites but have a different history (Condie, et al, 1974).

All volcanic and plutonic samples were compared by a variety of methods in an attempt to determine differences between each of the three groups. The results of a simple graphic comparison of all elemental concentrations and ratios of various elements plotted vs. silica is shown in Appendix III. In nearly all cases, each group defines a specific region, but there exists varying amounts of overlap between the regions and consequently, the graphs are not totally definitive. These graphs and the list of geochemical analyses in Appendix I were the result of treating the data with the computer program DATAPLOT, Appendix II. A second comparison involved the plotting of the chondrite normalized rare earth element concentrations of the samples, Figs. 10-13, using computer program RAREEARTH, Appendix II. Figures 10, 11, and 12 plot individual samples within each igneous group and Fig. 13 compares the average values for each group. In general, the two granites seem to show the greatest amount of spread in the concentration of a given rare earth element, this may, however, be a result of the small size of the sampling. It is also interesting to note that the europium normalized values are somewhat more clustered than other elements for the metavolcanics and are more widespread than the other elements for the granites. Large negative europium anomalies are characteristic for all groups but are larger for both granites.

Negative europium anomalies may be produced in response to the selective partitioning of the europium molecule into the crystal lattice of plagioclase feldspars at the time of crystallization. By assuming a parent magma composition, knowing the partitioning factor of europium and the size of the europium anomaly, the amount of plagioclase which has been fractionally crystallized out of the magma can be determined. If the hornblende schists of the Los Pinos Mountains are assumed to

Table 3 Mesonorm of Sepultura Granite (assuming 1% magnetite & hematite)

Sample No.	Percent Anorthite	Percent Albite	Percent Orthoclase	Percent Biotite	Percent Quartz (excess SiO_2)	Percent Corundum excess Al_2O_3)
N9	2.5	35.2	26.5	3.1	32.0	0.8
N13	4.4	32.2	24.3	4.2	34.1	0.9
NP12	2.9	35.2	27.3	1.9	32.1	0.7
NP14	3.5	33.2	26.7	2.7	33.1	0.9
NP15	2.6	40.0	27.2	2.7	28.3	-0.8
NP16	2.8	37.8	27.2	1.8	30.5	-0.1
NP19	3.6	36.5	26.0	3.6	30.6	-0.3
average	3.2	35.7	36.4	2.8	31.5	0.3

Table 4 Mesonorm of Los Pinos Granite (assuming 1% magnetite & hematite)

Sample No.	Percent Anorthite	Percent Albite	Percent Orthoclase	Percent Biotite	Percent Quartz (excess SiO_2)	Percent Corundum (excess Al_2O_3)
N2	3.7	36.8	21.8	6.9	32.1	-1.4
N3	5.1	37.2	21.8	5.8	30.8	-0.6
N4	5.4	35.6	21.0	6.8	31.4	-0.2
N6	2.0	39.9	27.8	2.3	28.9	-0.9
NP2	4.0	37.2	20.9	6.4	32.7	-1.1
NP4	3.8	33.2	23.9	6.1	34.3	-1.3
NP6	2.4	40.2	19.8	6.6	33.0	-1.2
NP8	4.6	45.8	22.0	6.2	24.4	-2.9
NP9	3.1	33.4	23.4	5.4	34.8	-0.2
NP10	5.9	35.7	20.9	8.0	31.0	-1.5
average	4.0	37.5	22.3	6.0	31.3	-1.0

Table 5 Mesonorm of Los Pinos Volcanics
(assuming 1% magnetite & hematite)

Sample No.	Percent Anorthite	Percent Albite	Percent Orthoclase	Percent Biotite	Percent Quartz (excess SiO_2)	Percent Corundum (excess Al_2O_3)
NP22	11.2	32.8	23.2	3.7	29.2	0.13
NP24	9.2	41.1	19.4	6.5	24.4	-0.64
NP32	1.8	25.6	27.8	2.1	39.8	2.90
NP36	9.3	34.0	21.8	4.1	30.6	0.10
NP46	3.8	32.5	26.2	3.1	33.5	0.92
NP47	3.6	36.6	25.2	3.2	31.4	0.05
NP49	3.3	36.9	24.3	3.3	31.9	0.15
NP52	6.1	37.5	6.8	3.4	42.4	3.68
NP58	1.8	26.1	27.3	1.9	38.7	4.32
NP62	1.8	29.7	27.8	1.9	35.3	3.43
NP64	12.3	36.7	14.3	4.8	31.8	0.02
NP68	11.5	31.4	20.1	5.2	30.8	0.92
average	6.6	30.7	22.0	3.6	33.3	1.33

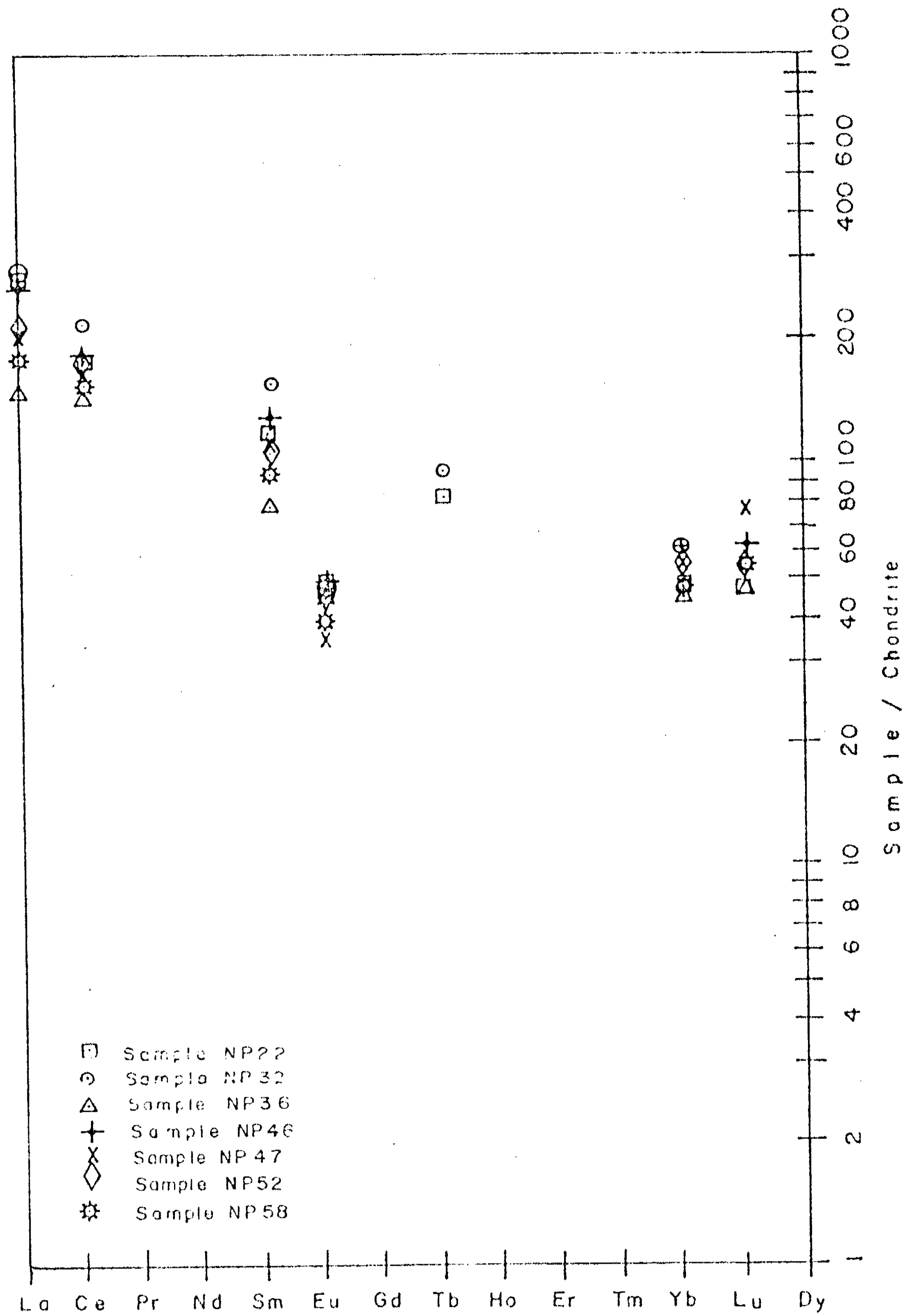


Fig 10 Rare Earth Element content of the metavolcanics.

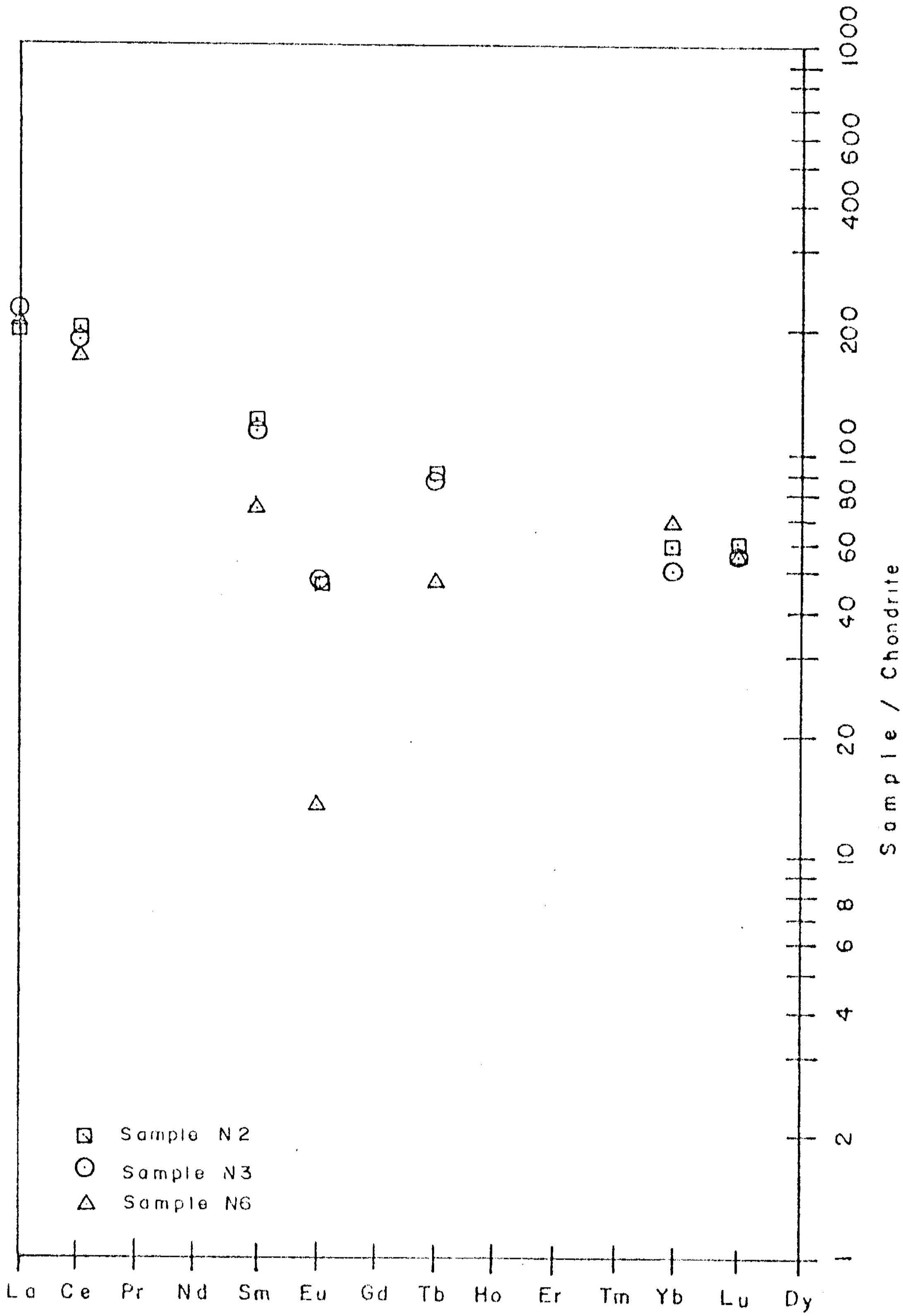


Fig 11 Rare Earth Element content of the Los Pinos Granite.

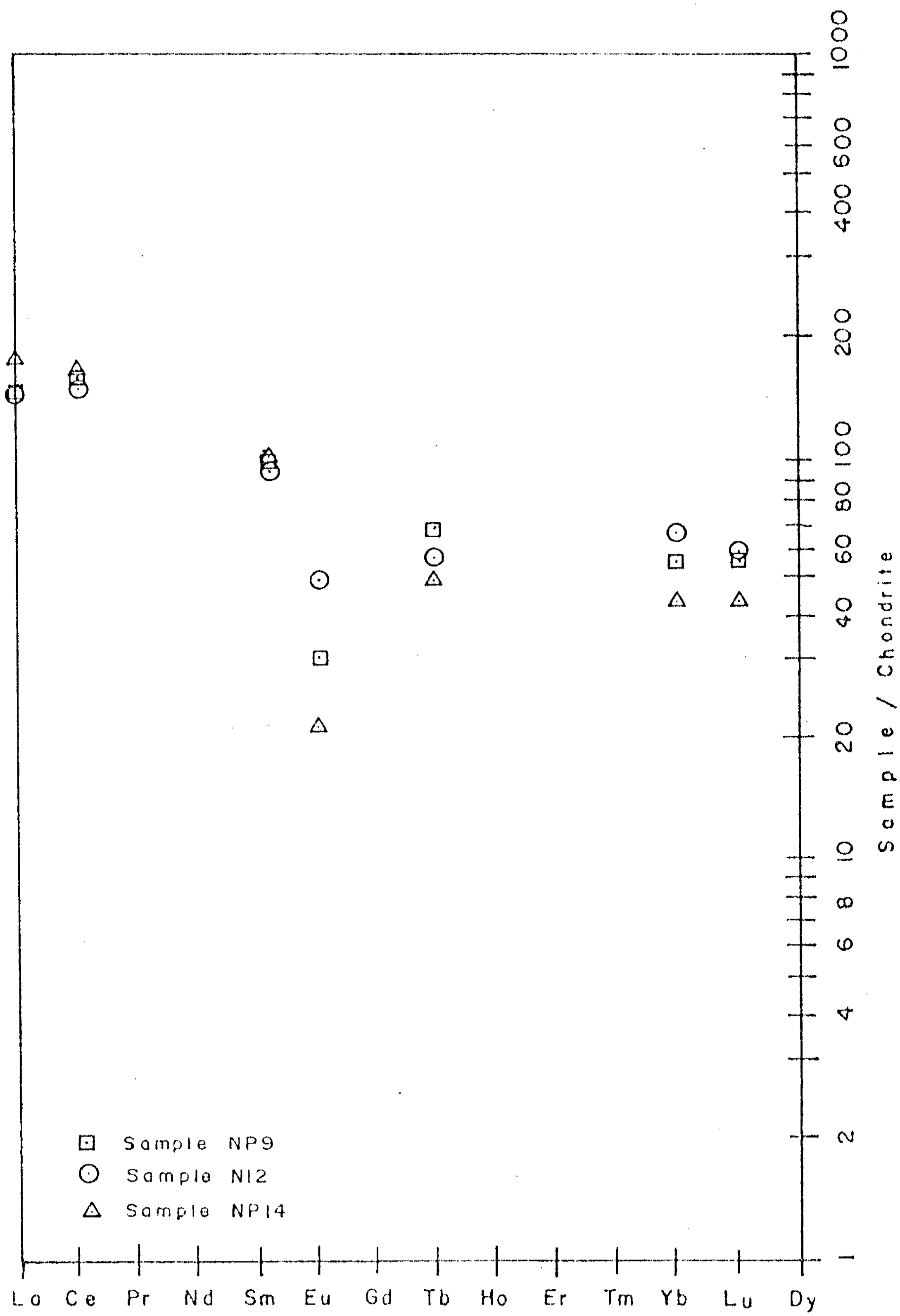


Fig 12 Rare Earth Element content
of the Sepultura Granite.

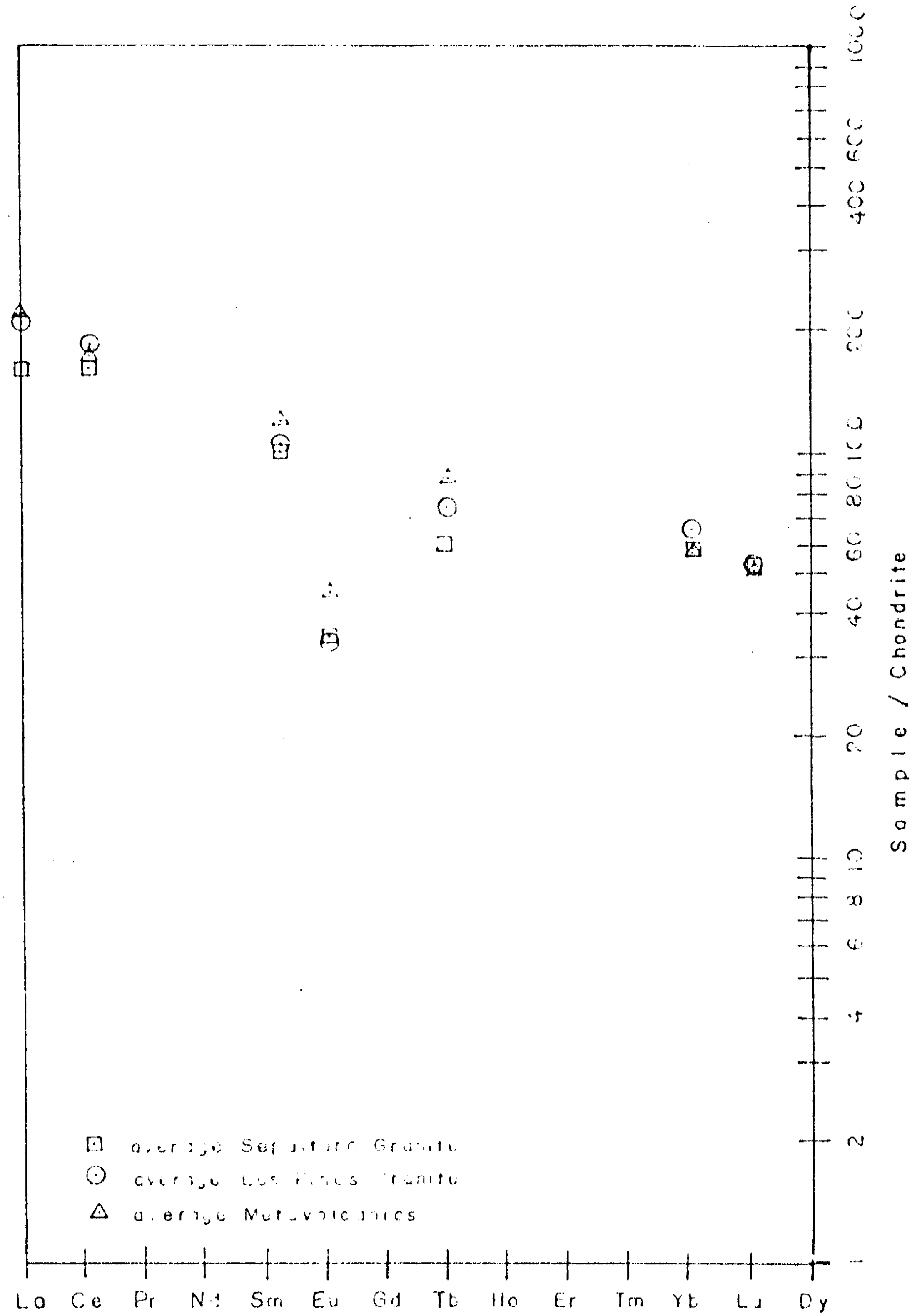


Fig 13 Average Rare Earth Element content of the Los Pinos igneous units.

represent a parent magma for either the volcanics or the granites, and a model involving progressive fractional crystallization is used, the amount of plagioclase feldspar that would have to be removed to produce the Los Pinos igneous rocks would approach 90% (Condie, et al, 1974). Since this is an unreasonable amount of feldspar to be removed, one interpretation that can be made is that the hornblende schists of the Los Pinos Mountains do not represent the parent magma for any of the more siliceous rocks found in the Los Pinos Mountains (Condie, et al, 1974; Condie & Budding, in preparation).

A third comparison involved treating the geochemical data with the computer program GRANITE. This program calculates both the mesonorm and a modified CIPW norm. Since the modified CIPW norm considers hypersthene as the dominant iron mineral it cannot be used for the Los Pinos igneous rocks as hypersthene is not present. In the calculation of the mesonorm, it is assumed that all CaO is contained in anorthite, that all Na_20 is contained in albite, that all Fe_20_3* and MgO is contained in biotite with the appropriate amount of K_20, the remaining K_20 is considered as orthoclase. Each mineral uses the necessary amount of SiO_2 and Al_20_3, and the remaining amounts are considered as quartz and corundum respectively. There may be either a positive or a negative amount of quartz or corundum indicating a surplus or dificiency of SiO_2 or Al_20_3. The assumption that biotite is the only mineral, other than magnetite, containing $Fe_20_3$and MgO is essentially correct according to modal analysis (Tables 1 & 2). However, the assumption that only the end

* The weight percent of Fe_20_3 in any magnetite or hematite present must be subtracted prior to treating this data with program GRANITE. Any FeO present is converted to Fe_20_3 for simplicity.

members of the feldspar solid solution series are present is incorrect. The weight percent of these minerals as calculated by program GRANITE are listed in Tables 3, 4, and 5. Program GRANITE also calculates the point each particular sample will define in the Ab-An-Or-Q tetrahedron and then calculates the position of its projection on each of the four faces of the tetrahedron. Each face of the tetrahedron with the samples plotted is shown in Figs. 14 to 17.

Although the table and plots produced by program GRANITE do not immediately suggest a particular model for the formation of the Los Pinos igneous rocks they do show several distinct features. None of the samples fall at the quaternary cotectic point, and most samples fall close to the quartz saturation surface; the position of which depends upon the water pressure at the time of crystallization. The Los Pinos Granite contains miarolitic cavities, a feature which can be formed only at very low total pressures, probably not exceeding 1Kb, this limits the total water pressure (P_{H_2O}) to 1Kb or less; with this low total pressure, the depth of emplacement should be shallow, possibly 1 to 2 kilometers.

An additional feature of the Los Pinos igneous rocks is their low Sr content (25-75ppm). Strontium, much like europium, can be easily accepted in the crystal lattice of plagioclase feldspars. Thus, the very low strontium values and the large negative europium anomalies strongly suggest that plagioclase feldspars played a very important role in the formation of the Los Pinos igneous rocks, as previously suggested.

A model (Condie, et al, 1974) which appears to satisfy all of the characteristics of the Los Pinos igneous rocks involves the equilibrium melting of sialic crust. The resulting magma would be anorthite rich, but depleted in strontium and europium due to their partitioning into

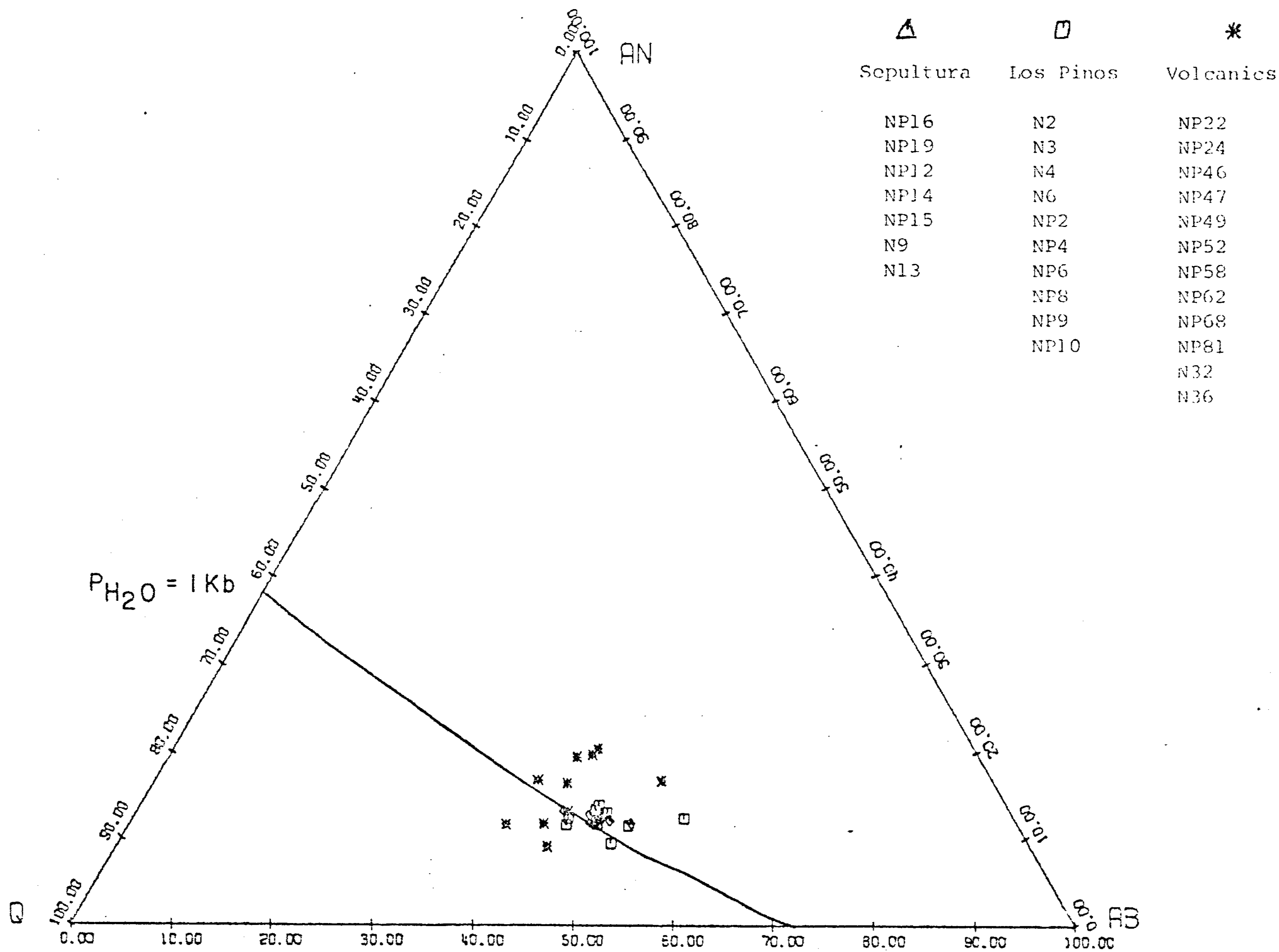


Fig 14 POINTS PROJECTED FROM OR CORNER, (MESONORM)
LOS PINOS IGNEOUS ROCKS

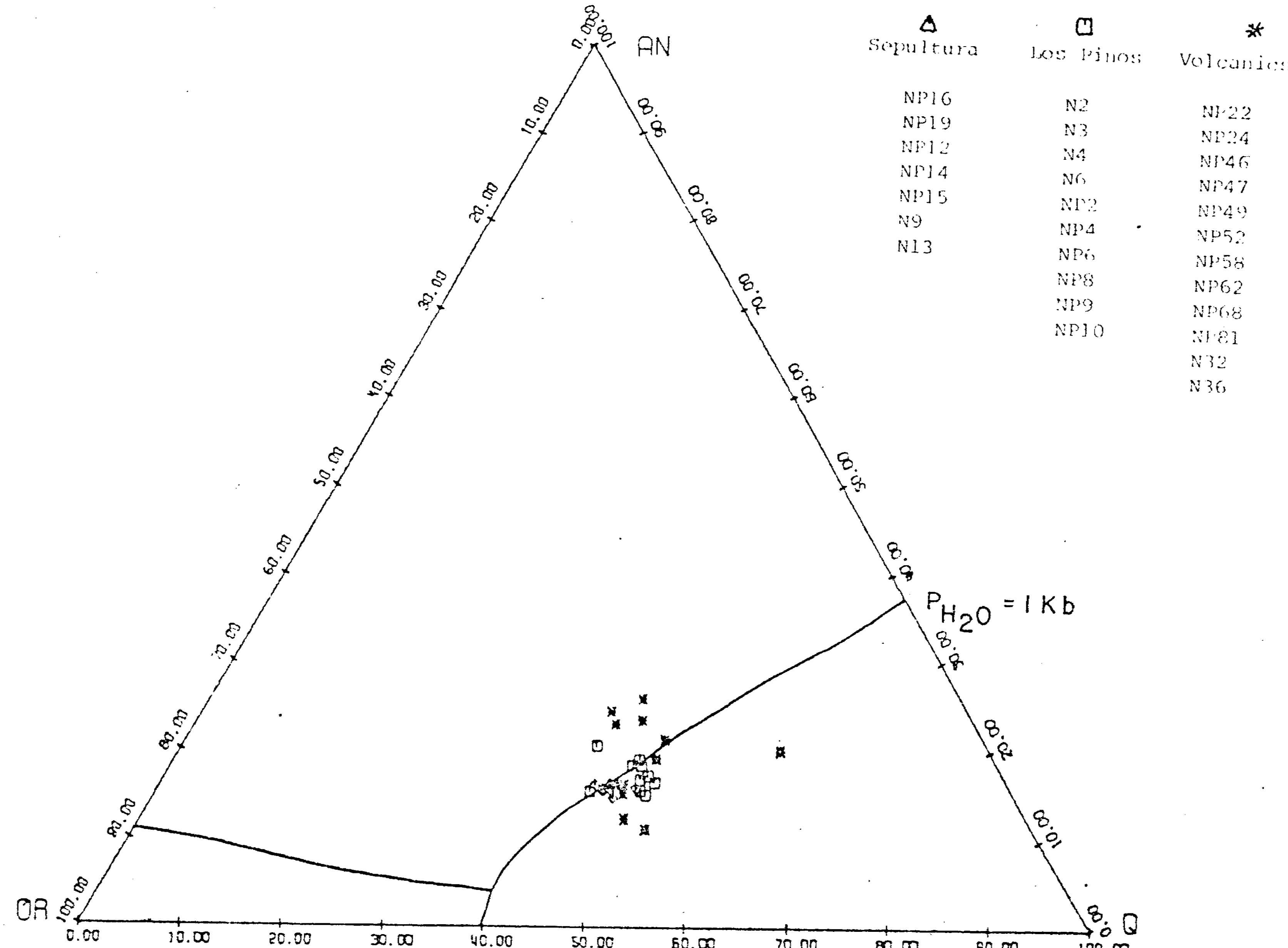


Fig. 15 POINTS PROJECTED FROM AB CORNER. (MESONORM)
LOS PINOS IGNEOUS ROCKS

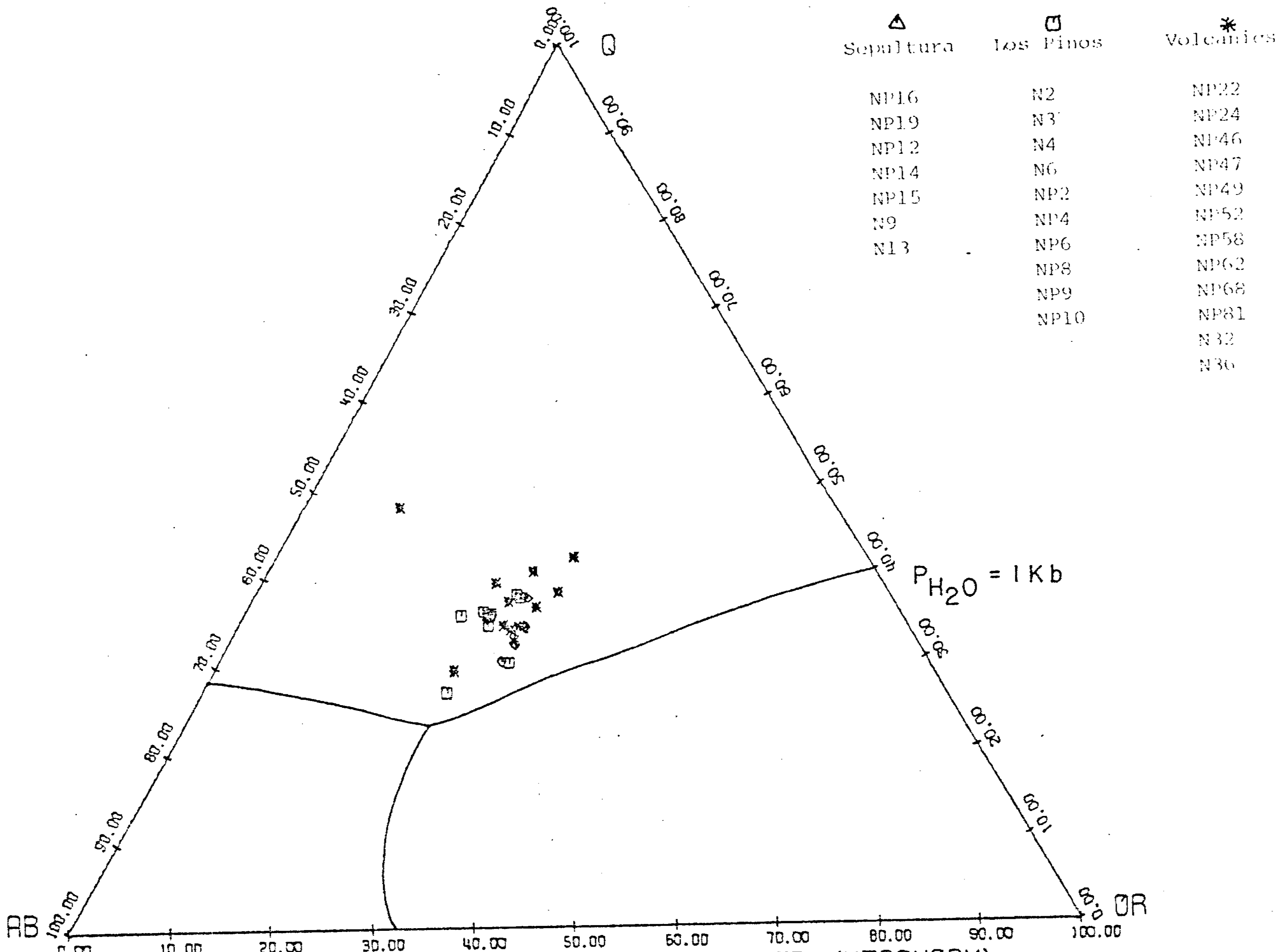


Fig 16 POINTS PROJECTED FROM AN CORNER, (MESONORM)
LOS PINOS IGNEOUS ROCKS

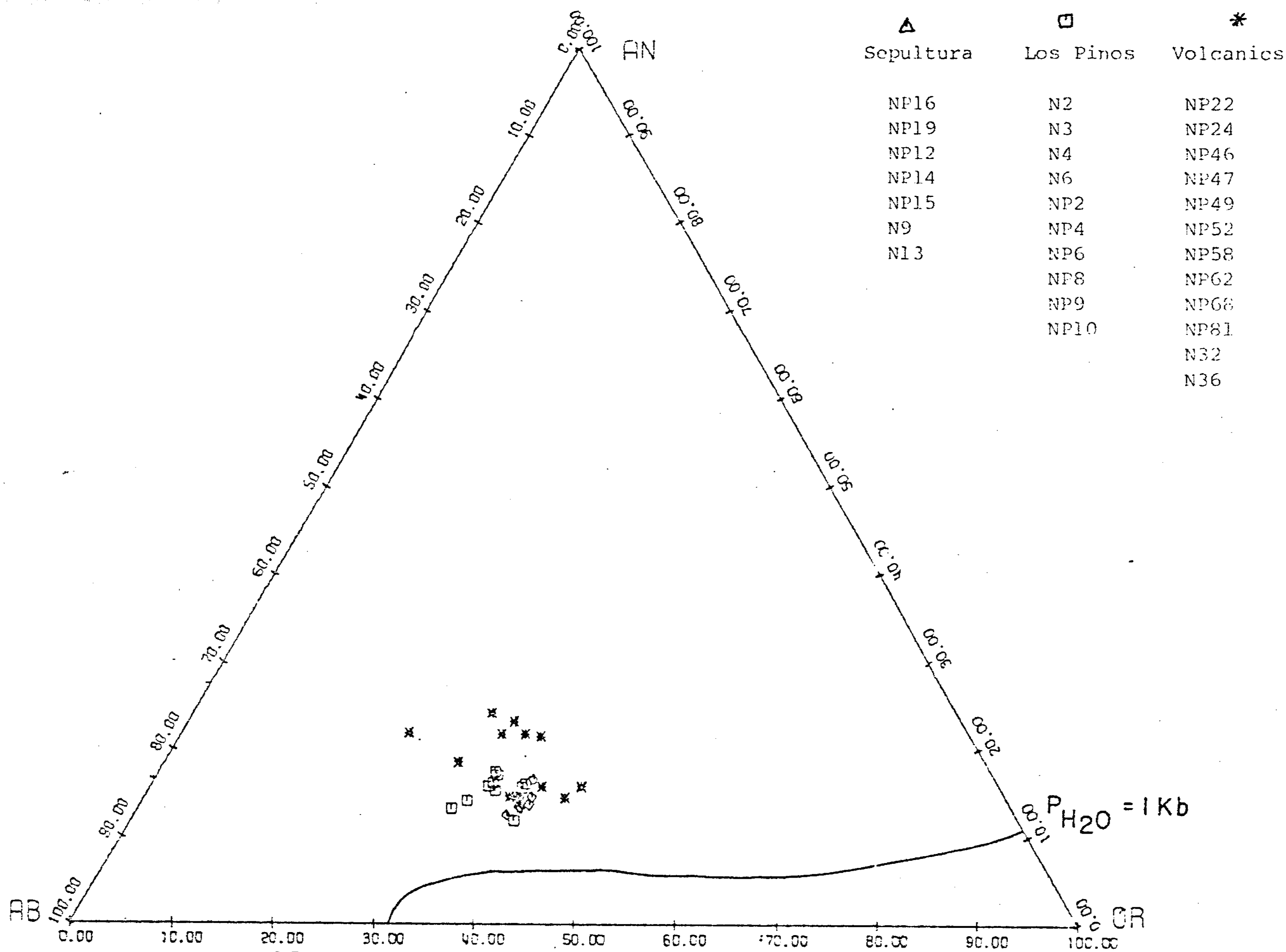


Fig 17 POINTS PROJECTED FROM Q CORNER, (MESONORM)
LOS PINOS IGNEOUS ROCKS

residual feldspars. Moderate amounts of fractional crystallization, giving rise to significant feldspar removal, could produce magmas which, when crystallized, would have compositions equivalent to the Los Pinos volcanic rocks. Further fractional crystallization could then produce a magma equivalent to the Los Pinos Granite; or the original parent magma of the Los Pinos Granite may have been somewhat more depleted in strontium and europium than the magma responsible for volcanic rocks. A similar magma which undergoes additional intense fractional crystallization, could produce a magma with a composition similar to that of the Sepultura Granite. This model does not suggest that a single period of equilibrium melting occurred in the crust giving rise to all three igneous groups found in the Los Pinos Mountains. The proposed process could have occurred several times over a large period of time. William Bolton of the New Mexico Institute of Mining and Technology is presently determining the age of the three igneous bodies of the Los Pinos Mountains (Bolton, pers. comm., 1974) using Rb-Sr whole rock isochrons. This investigation will determine if the events are related in time or if they are sufficiently separated to qualify as three distinct igneous episodes.

The fact that the samples plotted in Figs. 14 to 17 do not lie on the quaternary cotectic, but instead lie above it, suggest that some plagioclase remained with the fractionated melts at the time of final crystallization. This can be seen in Los Pinos Granite where the presence of large plagioclase phenocrysts is noted. These phenocrysts have been broken, with groundmass material filling the fractures, suggesting they were broken at the time of emplacement of the magma rather than at some later date. They may be the crystals which fractionally crystallized from the melt, or be residual feldspars from equilibrium melting that remained with the melt at the time of final crystallization at some shallower depth.

METAMORPHISM

The Precambrian rocks of the Los Pinos Mountains may have undergone as many as three separate periods of metamorphism. After the deposition of the sedimentary and volcanic sequence, the rocks were buried and underwent regional metamorphism involving both deformation and recrystallization; this period is the most widely preserved in the Los Pinos rocks. Later, at the time of intrusion of the granites, the rocks were thermally altered, most noticeable immediately adjacent to the intrusives. Finally, movement on the Montosa Fault appears to have recrystallized a portion of the adjacent Blue Springs Schist. A graph of the relative metamorphic intensity vs. time is shown in Fig. 18.

Metamorphism during the regional metamorphic stages does not appear to have exceeded upper greenschist facies to lower anphibolite facies conditions. Fig. 19 shows the plot of the volcanic and arkosic rocks in the A'KF diagram. Nearly all the samples fall within the assemblage muscovite, biotite, K-feldspar. This is quite consistant with thin section data, as these three minerals and quartz make up nearly all of the samples. Minor garnet occurs in some samples and is indicated by the sample which falls in the almandine-chlorite-muscovite-biotite boundaries. One sample in Fig. 19 suggests some kyanite may be present. Although no kyanite was seen in thin sections from this study, Mallon (1966, p. 19) indicates he recognized two grains of kyanite from the Blue Springs Schist which appears similar in composition to the Sevilleta Metarhyolite and is believed to have undergone a similar metamorphic history. The spread along the muscovite-orthoclase tie line does not appear to have any relation to the stratigraphic position of the samples. This spread may be due to initial variation in composition,

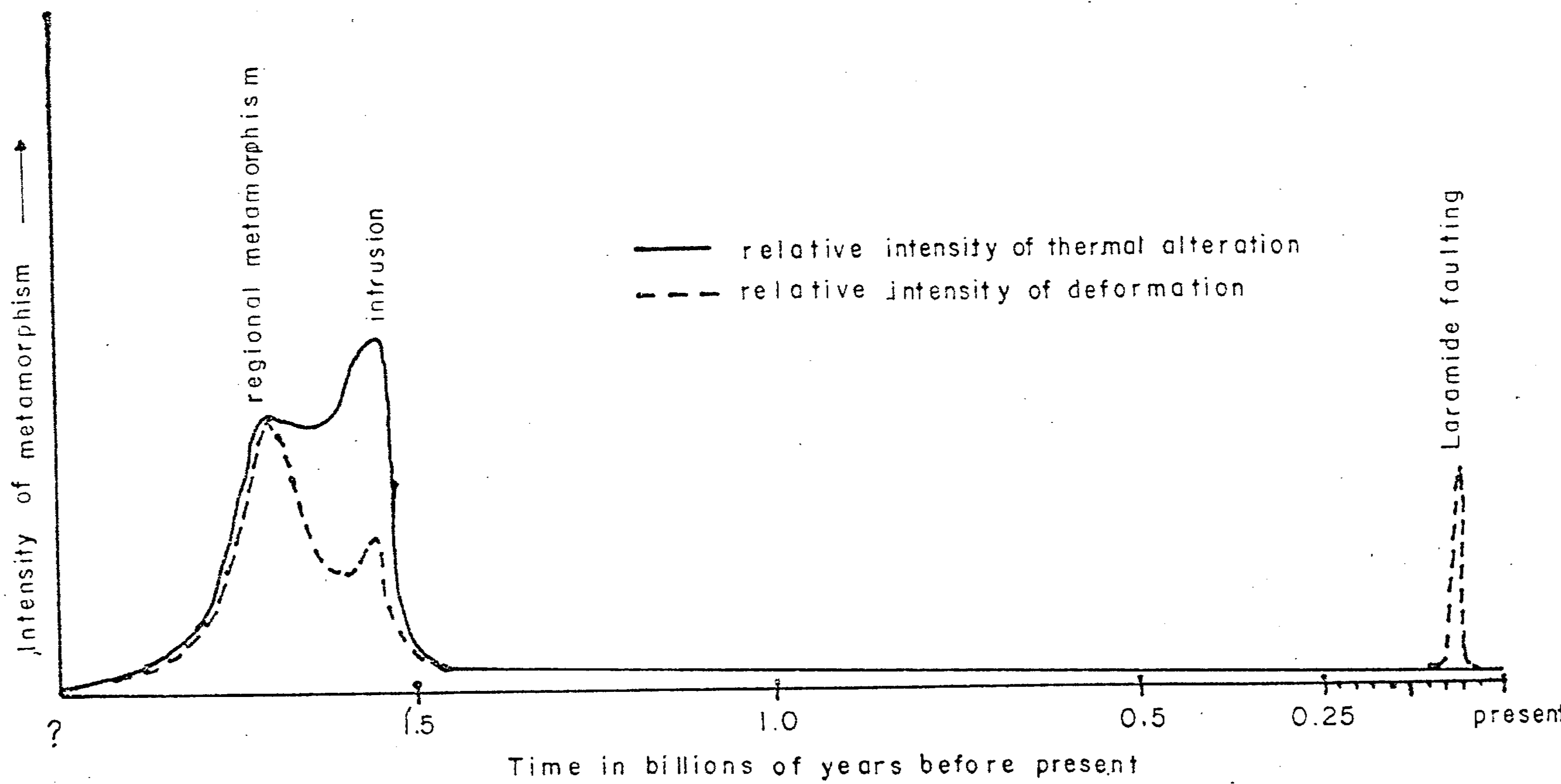
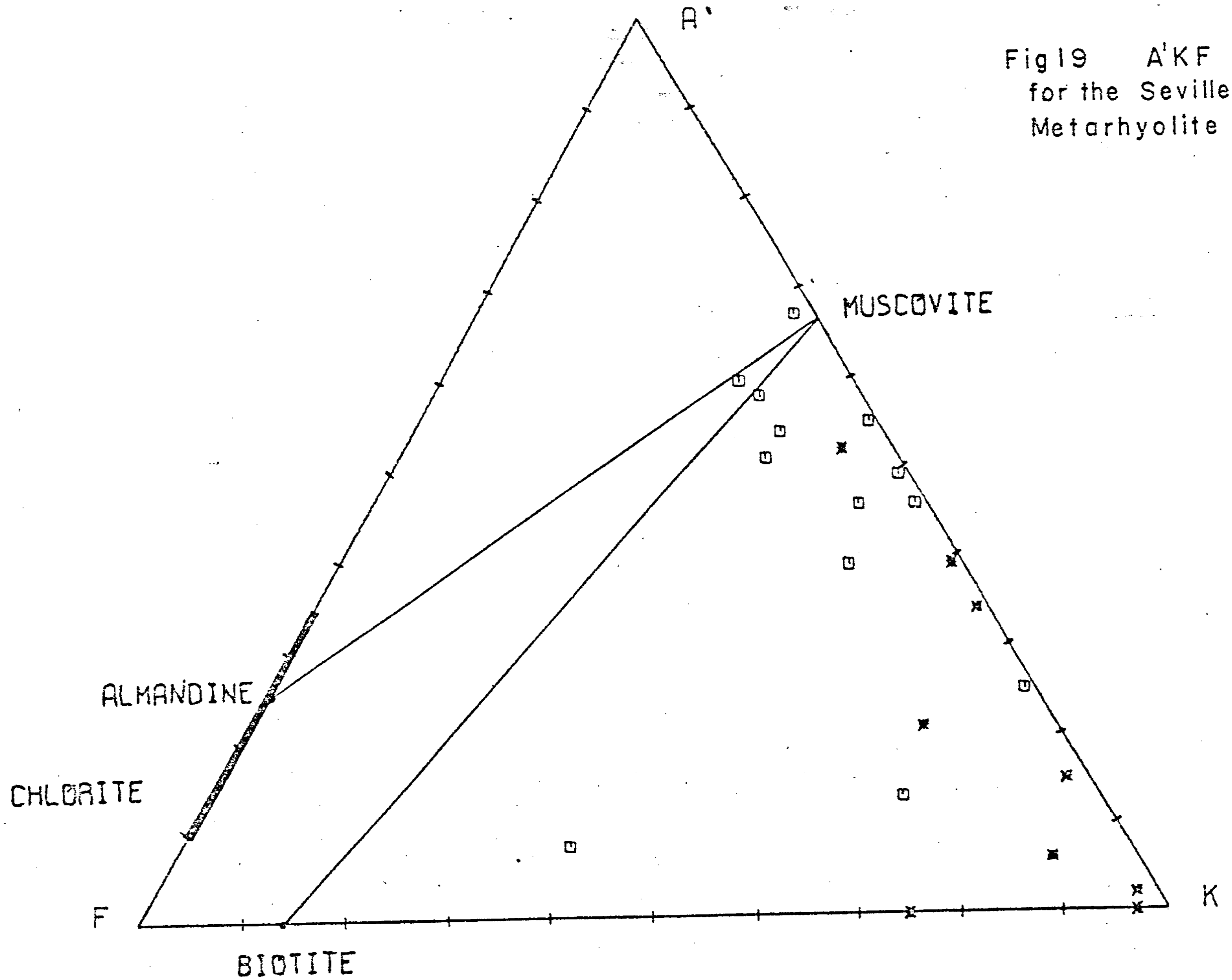


Fig 18. Graph of relative metamorphic intensity vs. time for the Los Pinos Mountains.

Fig 19 A'KF diagram for the Sevilleta Metarhyolite



RHYOLITES - SQUARE; SEDIMENTS - ASTERISK or may be due to changes in composition during metamorphism. In Fig. 19, the average composition of the metasediments appear slightly less muscovitic than does the average composition of the volcanics, or more precisely, seem to contain slightly more potassium than do the volcanic rocks; a similar plot (Fig. 5) suggests a potassium decrease for the metasediments. This difference between the two plots is explainable by the methods used to plot the values. For Fig. 5, all potassium is assumed to be in the mineral orthoclase, which is plotted vs. anorthite and quartz. In Fig. 19 K represents all potassium much the same as orthoclase in Fig. 5, A', however, is determined from the following formula: $A' = Al_2O_3 - (CaO + Na_2O + K_2O)$. Because the differences in composition between the metavolcanics and the metasediments are small (see Appendix I) the derived numerical values in Fig. 19 show an increase in potassium.

Fig. 20 shows the ACF diagram upon which the hornblende schist compositions have been plotted. This diagram shows most samples have the assemblage epidote-chlorite-actinolite, but some may have an epidote-actinolite-calcite assemblage. Again thin sections of these samples agree very closely to predicted assemblages as they did for the more siliceous rocks in the A'KF diagram. The close agreement between the predicted assemblages and the observed assemblages suggest that equilibrium was attained in this region during the regional metamorphism stage.

The primary mineral assemblages present in the regionally metamorphosed rocks include: muscovite, biotite, potassium feldspar, quartz; epidote, chlorite, hornblende, quartz; biotite, muscovite, quartz; with additional calcite, garnet and kyanite in small amounts.

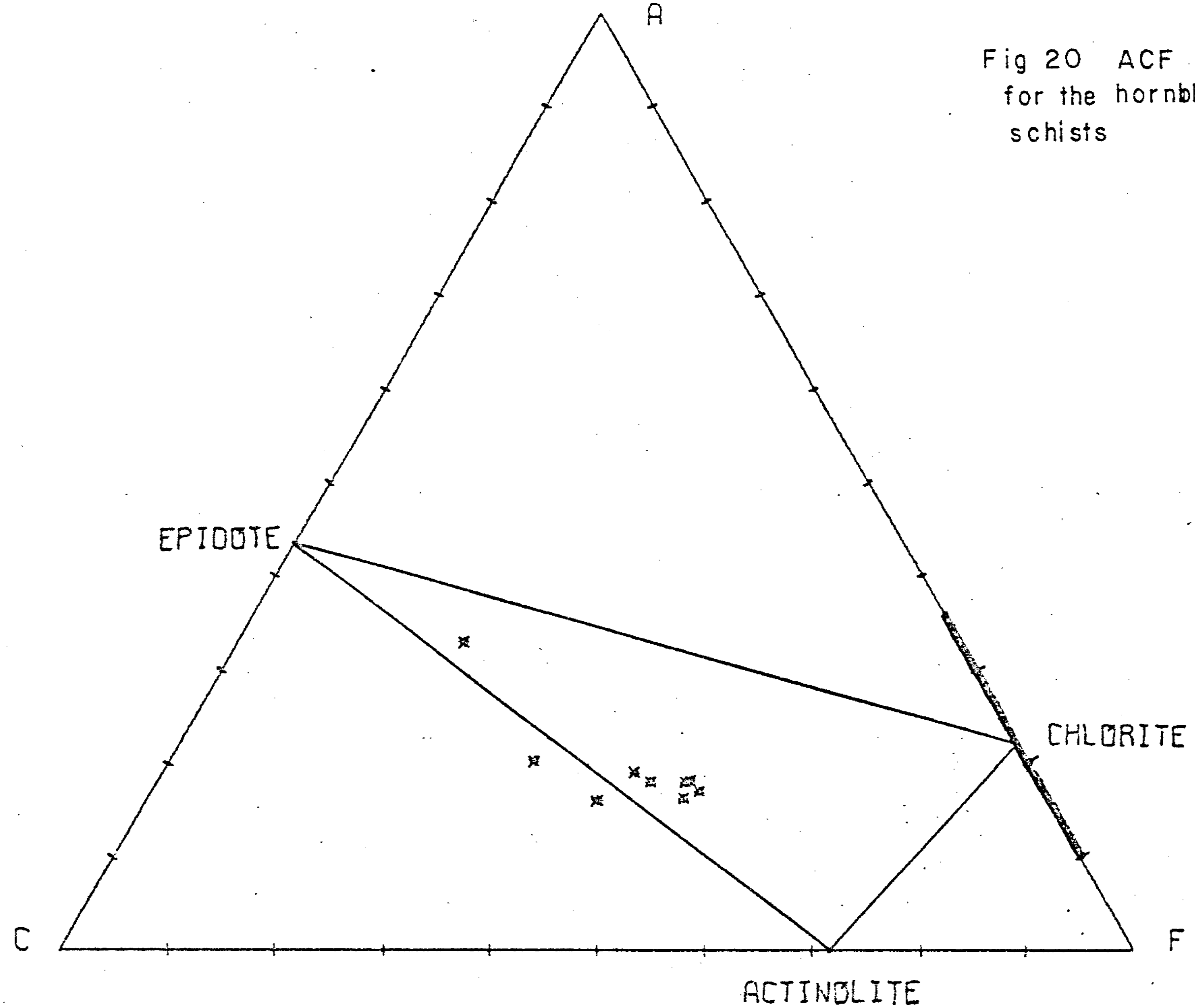


Fig 20 ACF diagram for the hornblende schists

These assemblages suggest a temperature regime not greater than 600°C nor less than 400°C with the most common temperature assemblages between 500°C (Winkler, 1974, p. 199). The pressure regime appears to be not less than 3Kb nor more than 6.5Kb. Although this is a rather large range of pressure, the minerals which are present are much more temperature dependent than pressure dependent. These temperatures and pressures correspond to upper greenschist - lower amphibolite (greenschist transition) facies metamorphism.

Deformation at this time produced steep, westerly dipping flow cleavage and penetrative movements partially transposed bedding. This deformation was not too intense as relict phenocrysts are still present in the Sevilleta Metarhyolite unit (Beers, et al, 1974, p. 425).

Cross-biotites are the most wide spread evidence of the thermal or contact metamorphism accompanying the intrusion of the granite plutons. Immediately adjacent to the plutons the country rock has been subjected to sufficient amounts of heat and pressure to destroy nearly all evidence of layering, foliation, and phenocrysts normally present in the Sevilleta Metarhyolite, and it appears highly siliceous. Thin sections of samples from this area do not show any evidence for the growth of minerals not previously recognized. Although several factors may explain this apparent lack of contact metamorphism, only three appear to be of any significant importance. First, the temperature of formation of the Sevilleta Metarhyolite during regional metamorphism is similar to the temperature that would be expected near the contact with an intruding granite body and would not give rise to a new mineral assemblage. Secondly, chemically active fluids are necessary for metamorphism to take place and both the Los Pinos and Sepultura Granites appear to have been very low in volatile content as each contain only a small number of quartz veins. These veins follow fractures and are quite thin, generally one to two inches in thickness. Finally, it has been shown that the granites intruded at a relatively shallow depth (P_{H_2O} 1Kb). Thus a low overall pressure, a lack of chemically active fluids, and the mineralogical composition of the metavolcanics all combine to limit the effects of contact metamorphism. Of all of these factors the most important seems to be the lack of volatiles in the granite as contact metamorphic aureoles are not uncommon in greenschist facies rocks.

The final period of metamorphism occurred with the movement along the Montosa Fault. The lower portion of the Blue Springs Schist appears to have the cross-biotites destroyed and to have been highly fractured. This zone, mapped as the Blue Springs Schist Transition Zone, Plate 2, parallels the Montosa Fault rather than bedding and is therefore believed genetically related to it, as previously suggested.

Evidence south of the Los Pinos Mountains, where rocks as old as Cretaceous are displaced by the Montosa Fault but Tertiary volcanics overlying the fault are not, suggests the fault to be of Laramide age. The Paloma Fault is believedto have been formed at the same time as the Montosa Fault. A very preliminary Rb-Sr whole rock isochron of the Los Pinos Granite suggests an age of about 1.62 b.y. (Condie, pers. comm.). This age is similar to the age of the Embudo Granite in the Sangre de Cristo Mountains as reported by Fullagar (1973, p. 2705) to be 1.673 $\pm$ 41 b.y. using Rb-Sr whole rock ishochron. The granite exposed in the Sandia Mountains, the northern portion of the Sandia Uplift, appears to be at least 1.47 b.y. old and may be 1.64 b.y. old (Brookins, 1973, p. 467). Further north in the LaMadera Quadrangle, just north of the Las Tables region studied by Gresens and Stensrud (1974a, 1974b), Long (1972, p. 3425) reports an age of 1.600 b.y. or older for metarhyolites using Rb-Sr whole rock isochrons. Thus the last two metamorphic events in the Los Pinos Mountains are timed rather well from data throughout New Mexico; the time of original deposition and regional metamorphism are not known but are more than 1.6 b.y. before present.

STRUCTURE OF THE LOS PINOS PRECAMBRIAN ROCKS

At first glance, Plate 2 suggests that the Precambrian exposure in the Los Pinos Mountains is a portion of a westerly dipping homocline. Closer inspection, however, reveals several areas in the Sevilleta Metarhyolite and Blue Springs Schist where foliation attitudes are somewhat steeper than layering. This suggests that the Los Pinos Mountains lie on the upright limb of an overturned antiform whose axis lies to the east.

Further efforts to delineate the suggested structure involved analyzing the 2,695 attitude of foliation, layering, fracturing, veins, axial planes, fold axes, and lineations of several types collected from the nearly 600 data stations shown on Plate 1. Equal area stereonets were used to plot various features and the results are shown in Fig. 21 through 35. The stereonets were produced by treating the data with program SCHMIDT (see Appendix II), producing a percent density per 1% area, plotted at 333 predetermined points in the stereonet. Program BETA (see Appendix II) treats the foliation attitudes in a similar manner to produce a Beta diagram. These grids were then hand contoured and reduced to 75% of their original 20 centimeter size.

The Beta diagram of planes to foliation (S_2), Fig. 21, shows a great circle distribution of the intersection points, and this suggests a structural history of superposed folding (Turner, 1963, p. 499). However, because the region appears homoclinal, this interpretation may be misleading, and the distribution of the points in the diagram may be the result of a slight undulation in the foliation attitudes, much the same as could be found on corrugated metal, but with much smaller amplitude to wave length ratio. The Pi diagrams of foliation and of

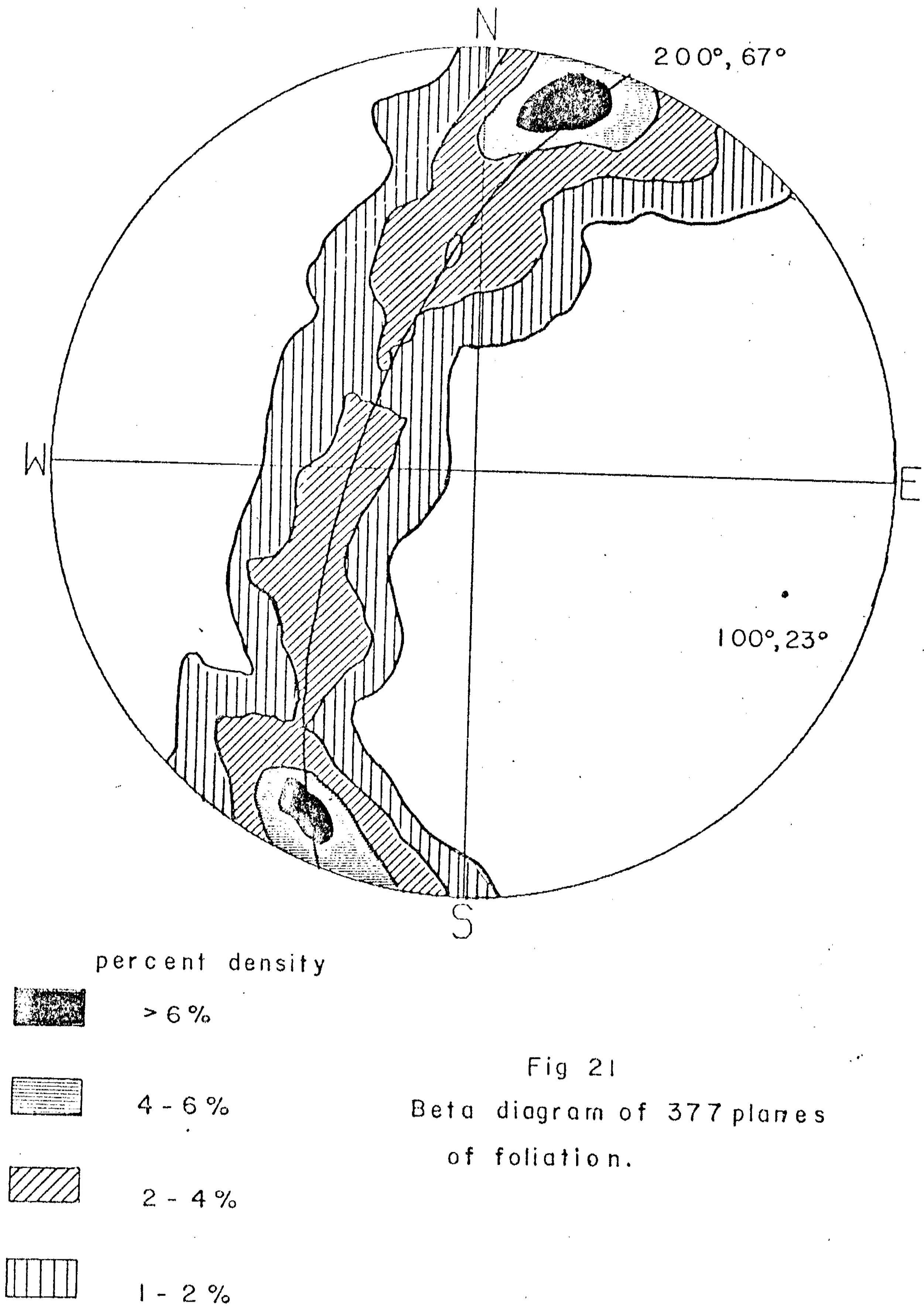


Fig 21
Beta diagram of 377 planes
of foliation.

layering (S_1), are nearly identical as is expected from their generally parallel nature, Figs. 22 & 23. These two diagrams appear to be point maxima, suggesting that only one phase of folding has occurred. A mathematically best fit great circle calculated by program GREAT CIRCLE (Appendix II) for poles to foliation has a strike of 317^o, and a dip of 32^o, to the NE with the pole to the great circle having a 58^o plunge and a trend of 227^o; poles to layering give nearly the same orientation, a strike of 304^o, dipping 35^o to the NE for the great circle and 55^o plunge and a trend of 214^o for its pole. This averages 55^o plunge and a trend of 220^o for the pole to the combined great circles, and would be the orientation of a fold axis responsible for the trends of layering and foliation. This orientation does not coincide with either maxima in Fig. 21 as would be expected in a single folding phase (Turner, 1963, p. 154), nor does it fit a pattern representative of a multiple fold history (Turner, 1963, p. 496-501). Pi diagrams of all lineation orientations, including S_1-S_2 intersections, Fig. 24, and of only S_1-S_2 intersections, Fig. 25 appears to show great circle trends parallel or nearly parallel to the great circle defined by the Beta diagram (Fig. 21), striking approximately 200^o, and dipping 70^o; program GREAT CIRCLE defined the best fit great circles to have a strike of 198^o, and a dip of 61^o to the WNW (Fig. 24) and a strike of 202^o with a dip of 59^o to the WNW (Fig. 25); nearly parallel to the great circle defined by Fig. 21. Orientations of minor fold axes, Fig. 26 show them to be quite steep, and nearly parallel to many of the lineations plotted in Figs. 24 and 25. These last three diagrams indicate that some deformation and mineral growth has occurred that is very steeply dipping and plunging in a westerly direction. The configuration in Fig. 26 may be due to the

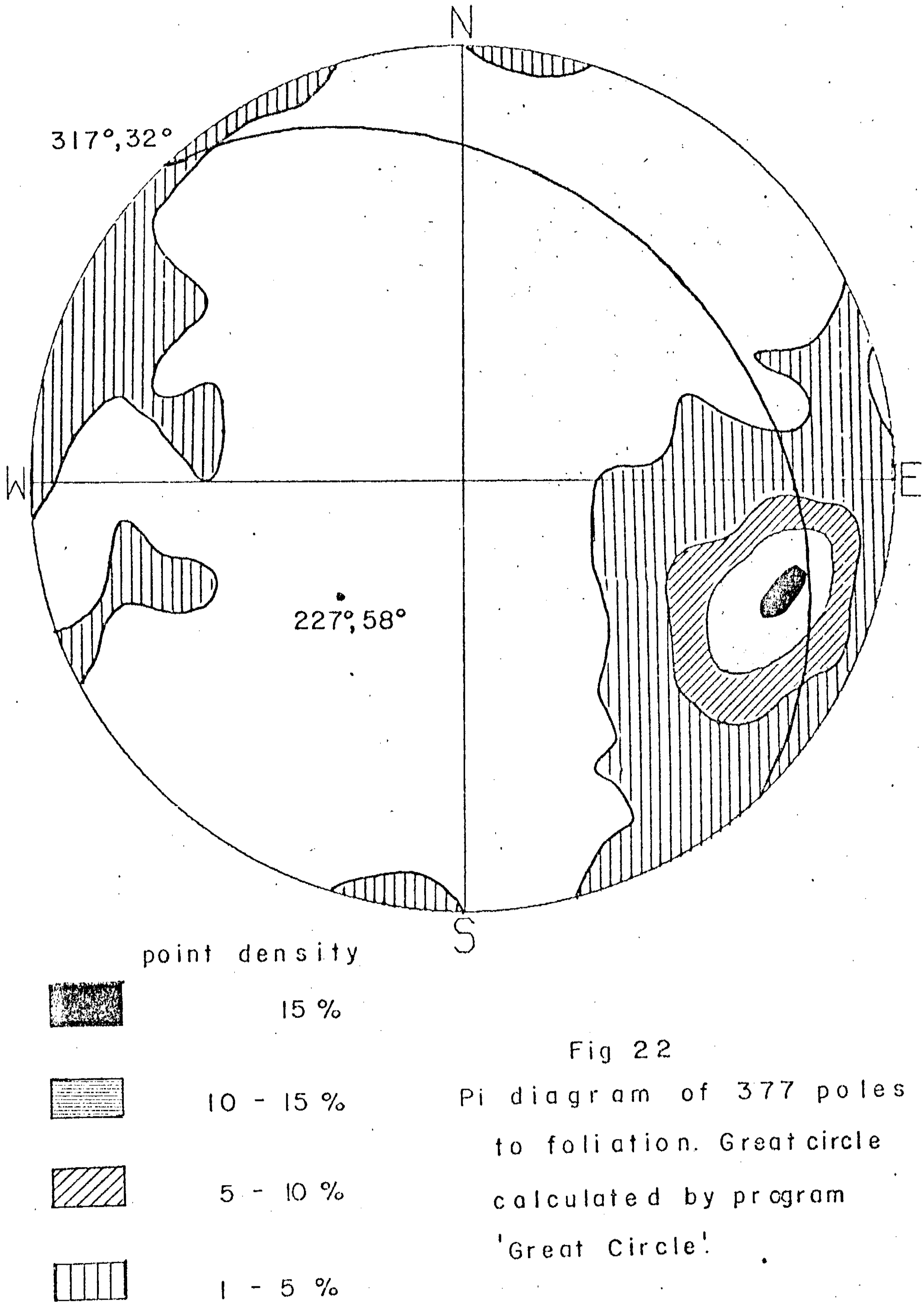


Fig 22
Pi diagram of 377 poles to foliation. Great circle calculated by program 'Great Circle'.

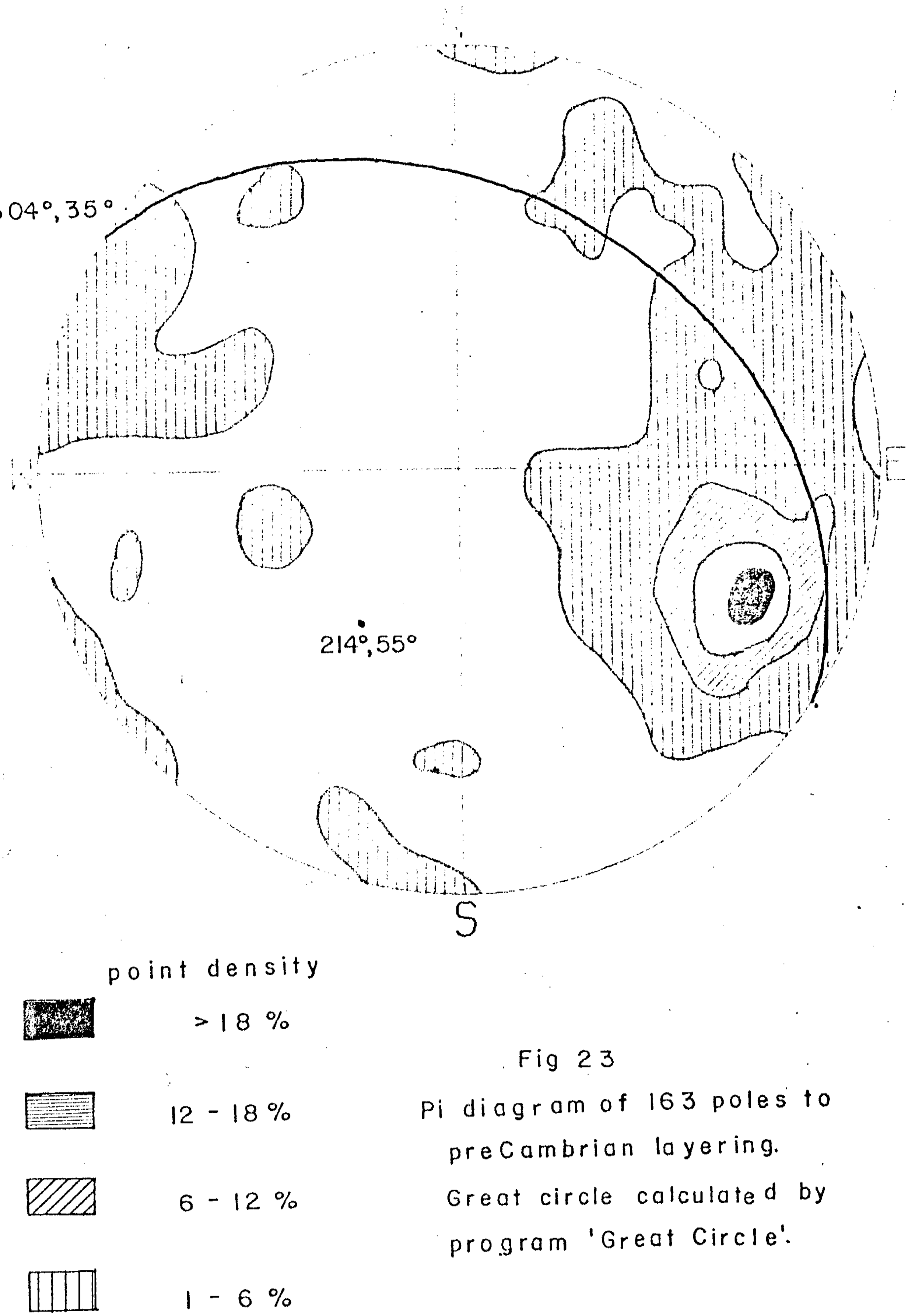
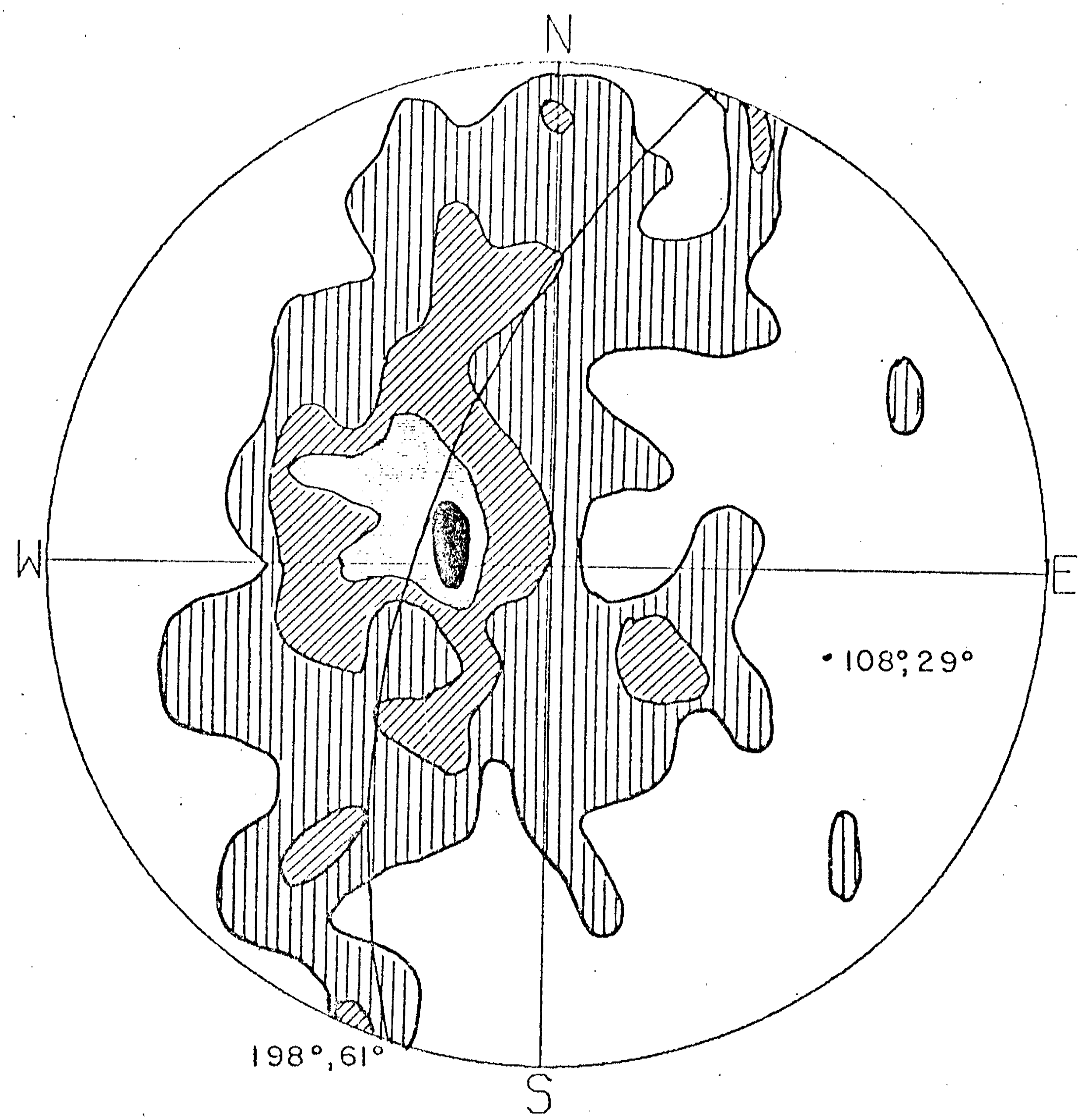


Fig 23
Pi diagram of 163 poles to preCambrian layering. Great circle calculated by program 'Great Circle'.



point density

>9 %

6 - 9 %

3 - 6 %

1 - 3 %

Fig . 24

Pi diagram of all lineations, 96 points total. Great circle calculated by program 'Great Circle'

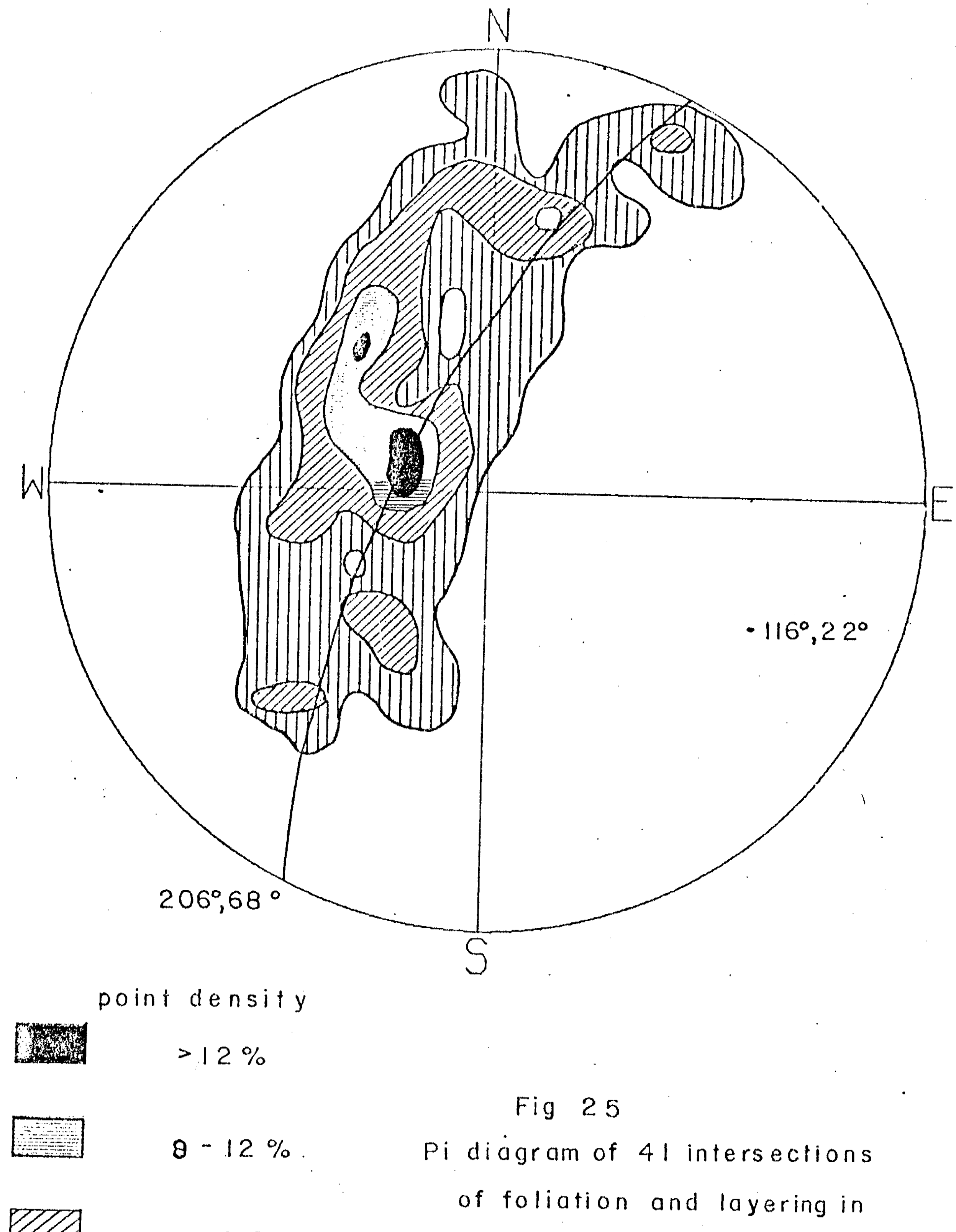
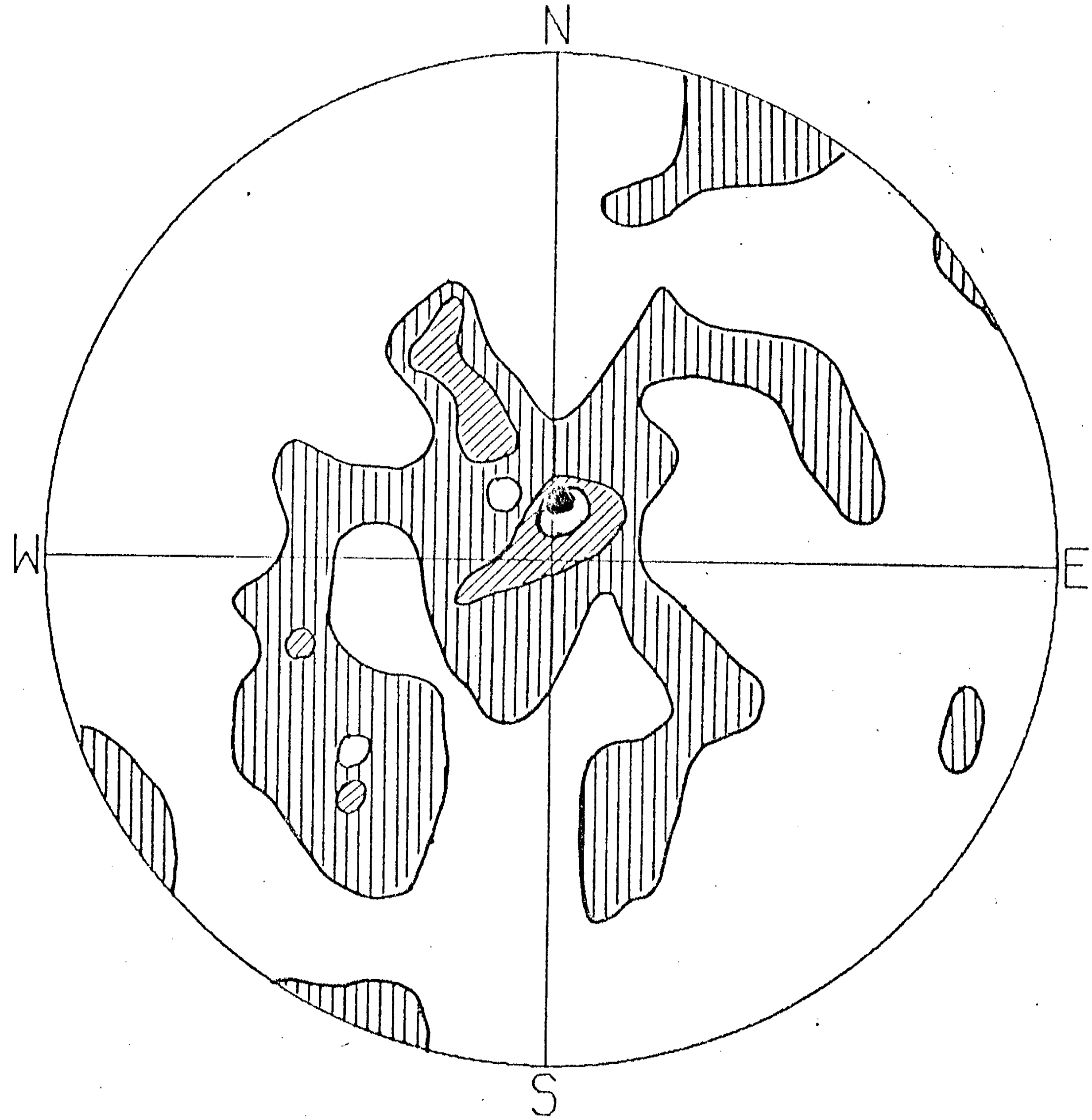


Fig 25
Pi diagram of 41 intersections of foliation and layering in the preCambrian metasediments. Great circle calculated by program 'Great Circle'.

slight undulations of foliation as predicted for Fig. 21. Axial plane orientations of minor folds, Fig. 27 show dominantly NE trend, either dipping SE, nearly horizontal, or dipping NW. These folds are thought to be related to the main NE trending folding phase. Another set of axial planes is trending N80W, and is vertical, this relates to the cross-folding, also expressed by the lineation directions of Fig. 24.

Because of the homoclinal nature of the region, the stereonets are not totally successful in defining the proper interpretation. It is believed the structure represented here is on an upright limb of an overturned antiform with a nearly horizontal axis as suggested by the foliation and layering attitudes (Figs. 22 & 23). The fold axis of the antiform would lie to the east. In support of this interpretation, Stark (1956) mapped a syncline in the Manzano Mountains, which if projected southward, would lie immediately west of the Los Pinos Mountains. It is further thought the steeply dipping fold axes of minor folds are the result of compression along the major NNE fold axis. Therefore, the minor fold lineations represent the tectonic a direction, and their steep plunge indicates a nearly horizontal position of the major antiformal axis, which parallels tectonic b.

Additional stereonets were constructed for fractures, and for veins and dikes. They are plotted for each of the granites, the combined granites, and the metasedimentary rocks. It is interesting to note that Sepultura Granite fractures, Fig. 28, are predominantly steeply dipping, striking NW, with a secondary group, also steeply dipping, striking NE. Whereas the Los Pinos Granite fractures, Fig. 29, show the predominant group to be dipping shallowly, striking toward the NE, and the secondary group striking both NW and NE and steeply dipping. The synoptic diagram



point density

> 9 %

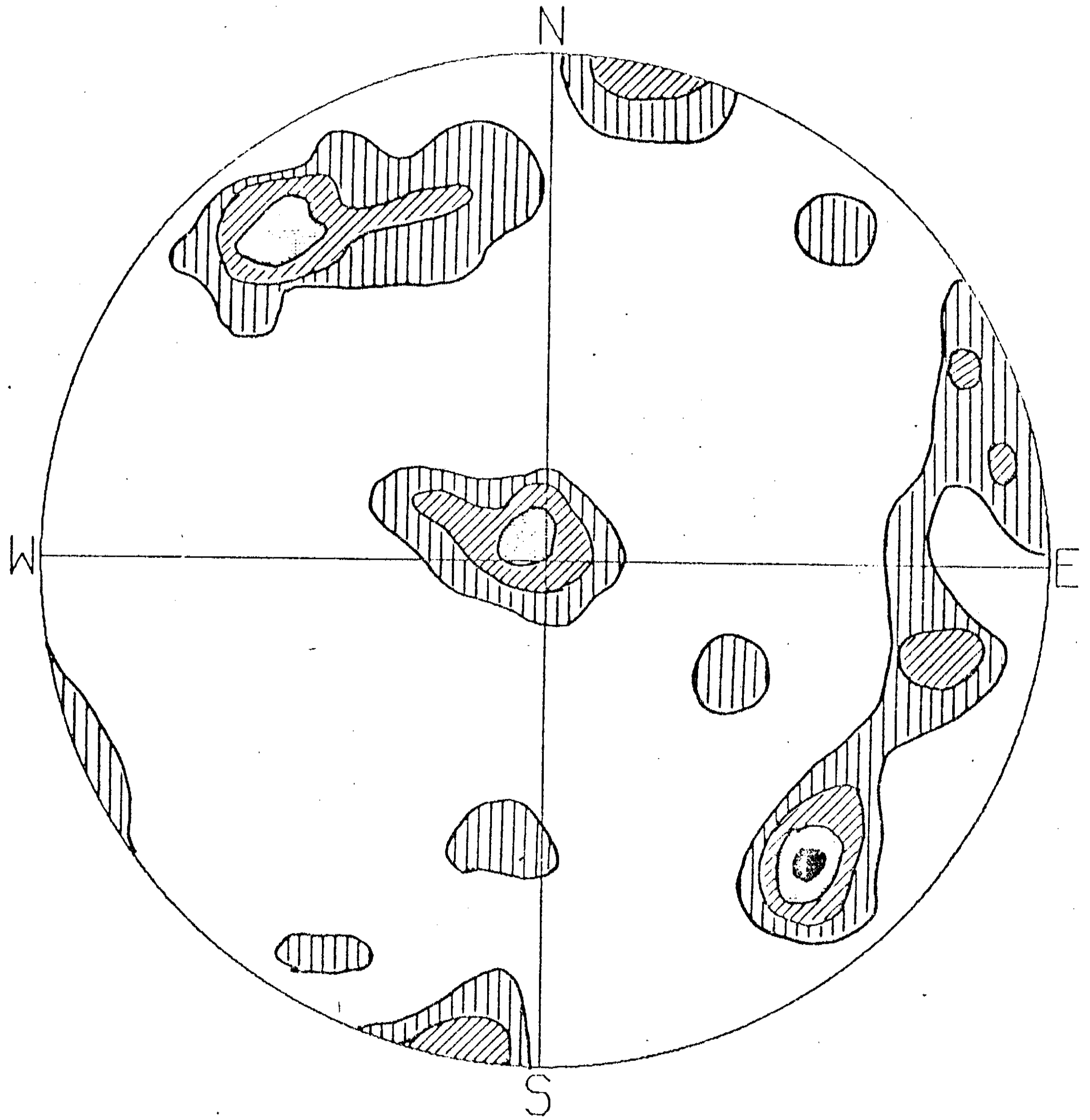
6 - 9%

3 - 6 %

1 - 3 %

Fig 26

Pi diagram of 32 minor fold axis.



percent density

12 %

8 - 12 %

4 - 8 %

1 - 4 %

Fig 27

Pi diagram of 32 poles to axial planes of minor folds.

for the two granites, Fig. 30, shows fractures to be steeply dipping, striking NW, ENE, and NE, and a smaller group striking NE and shallow dipping. Of additional interest is the lack of fracturing with dips near 40°-50° in all three of these diagrams. This would indicate that the granite plutons have been deroofed only superficially, and now expose steeply dipping cross joints and flat-lying joints, which are typical of the roof region of plutonic bodies. Marginal joints, dipping near 45°, will become more prominent at lower erosion levels (Billings, p. 378), and joints with this inclination do not figure prominently in the diagram of Fig. 30. In contrast to this, the metasedimentary section, Fig. 31, has its predominant group very steeply dipping, striking WNW, and a secondary group shallow dipping striking NE. The predominant group represent a-c joints. Also, the areas lacking fracture orientations are much smaller and of different orientation than shown by the diagrams for the granitic rock.

The orientations of quartz veins in the Sepultura Granite, Fig. 32 are primarily restricted to a NE strike and are steeply dipping. This corresponds to a secondary group of fractures in the Sepultura Granite, Fig. 28. Veins show only a random orientation in the Los Pinos Granite, Fig. 33, and are much less common than in the Sepultura Granite. A synoptic diagram of veins for the granites is controlled by the Sepultura Granite, but it can be seen the preferred orientation of the veins is along the less common fracture orientation rather than the more common ones, Fig. 34. In the metasediments, veining appears to follow foliation rather than fracturing, Fig. 35.

In the granites, the vein orientations are controlled by fracturing; they are continuous for several feet, and they are composed primarily of

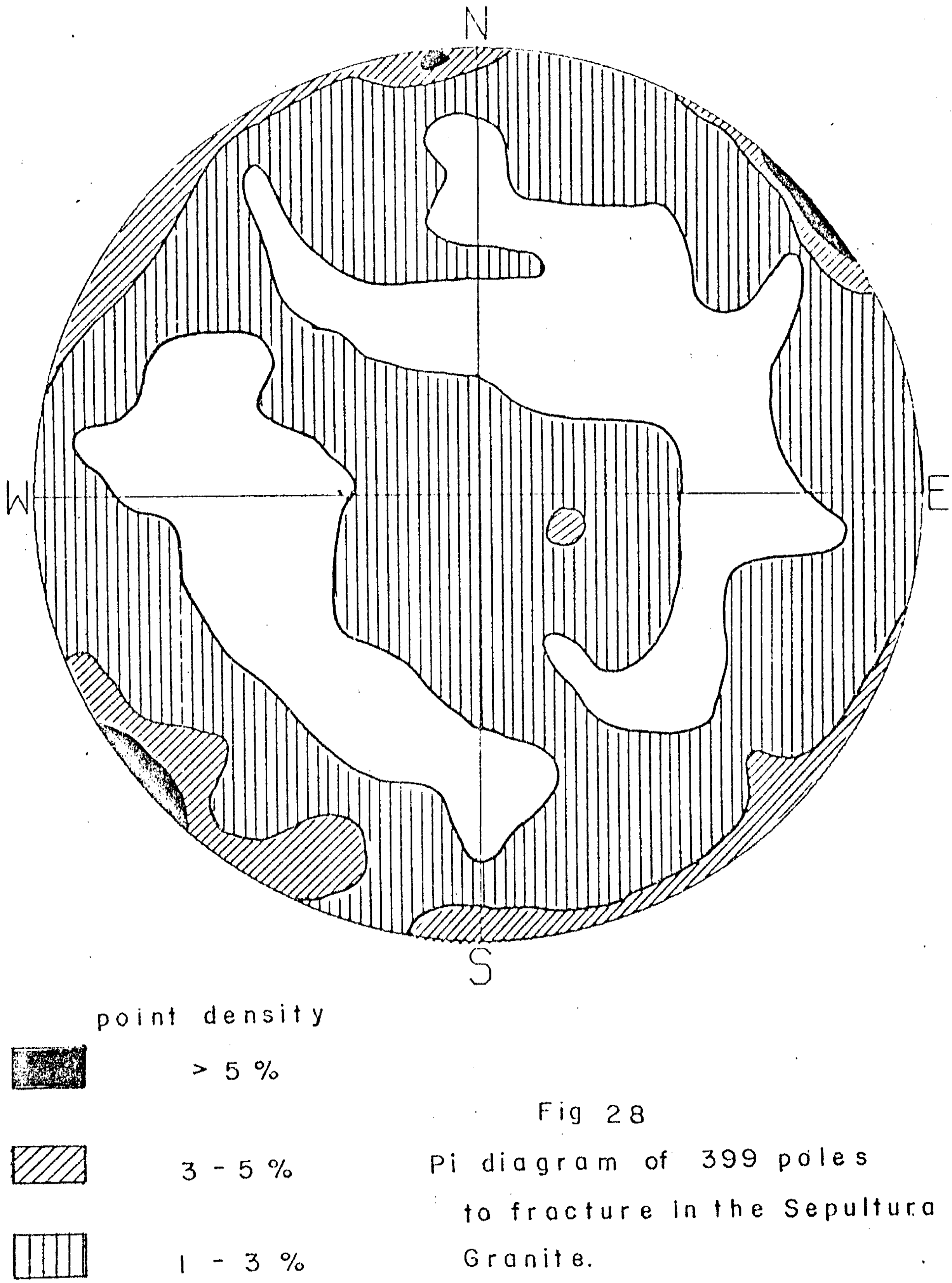


Fig 28

Pi diagram of 399 poles to fracture in the Sepultura Granite.

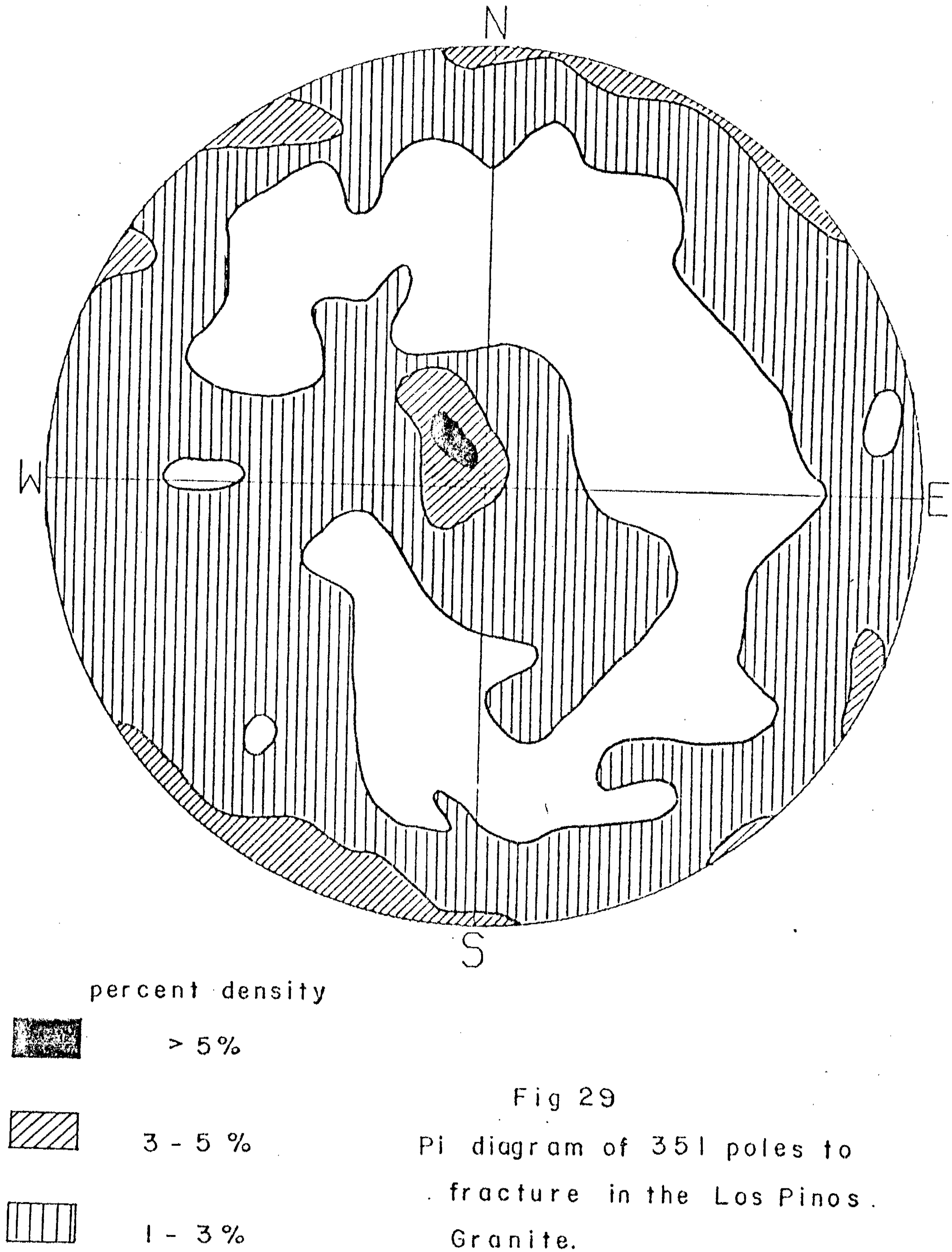
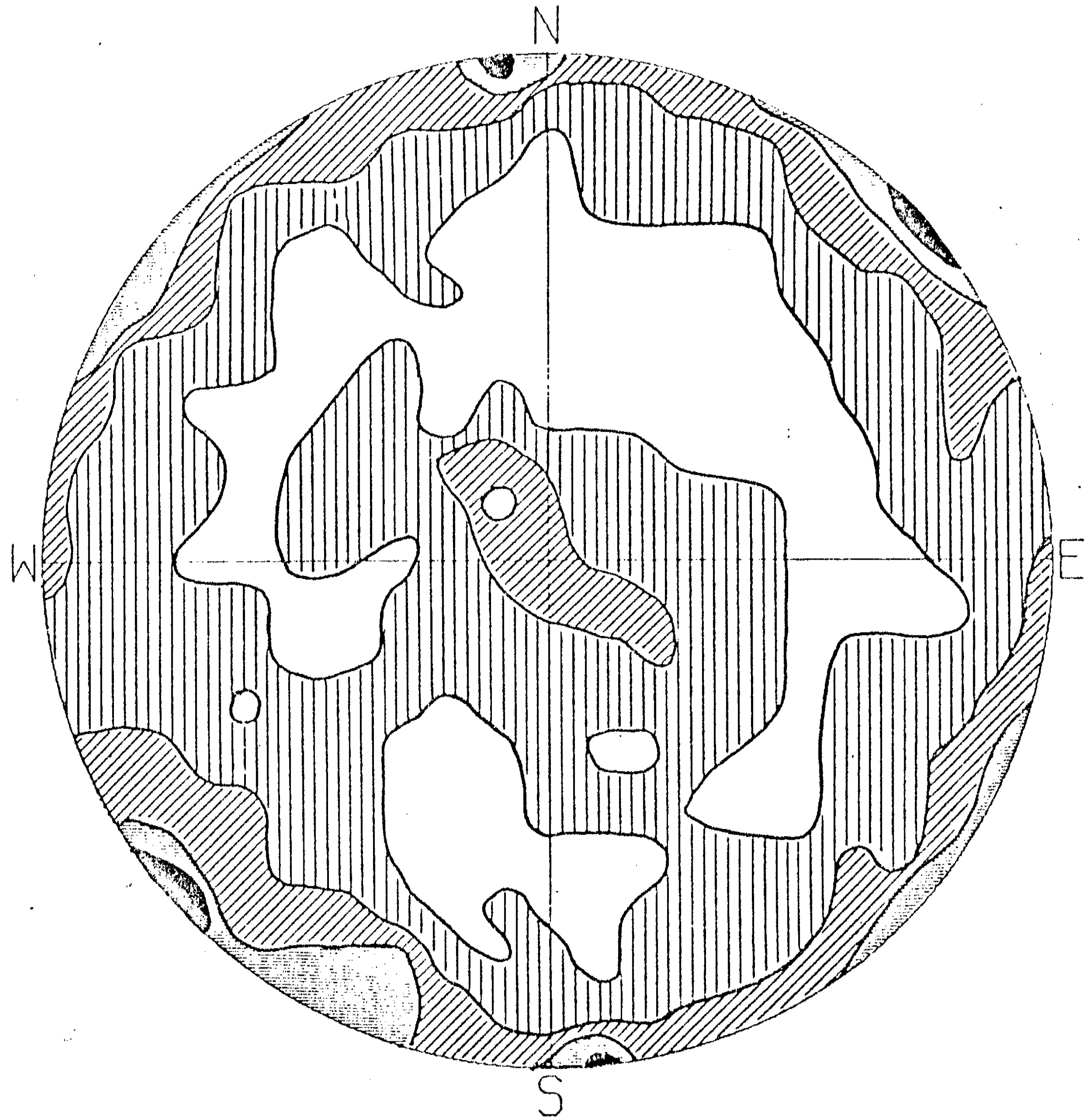


Fig 29

Pi diagram of 351 poles to fracture in the Los Pinos Granite.



point density

> 4%

3 - 4%

2 - 3 %

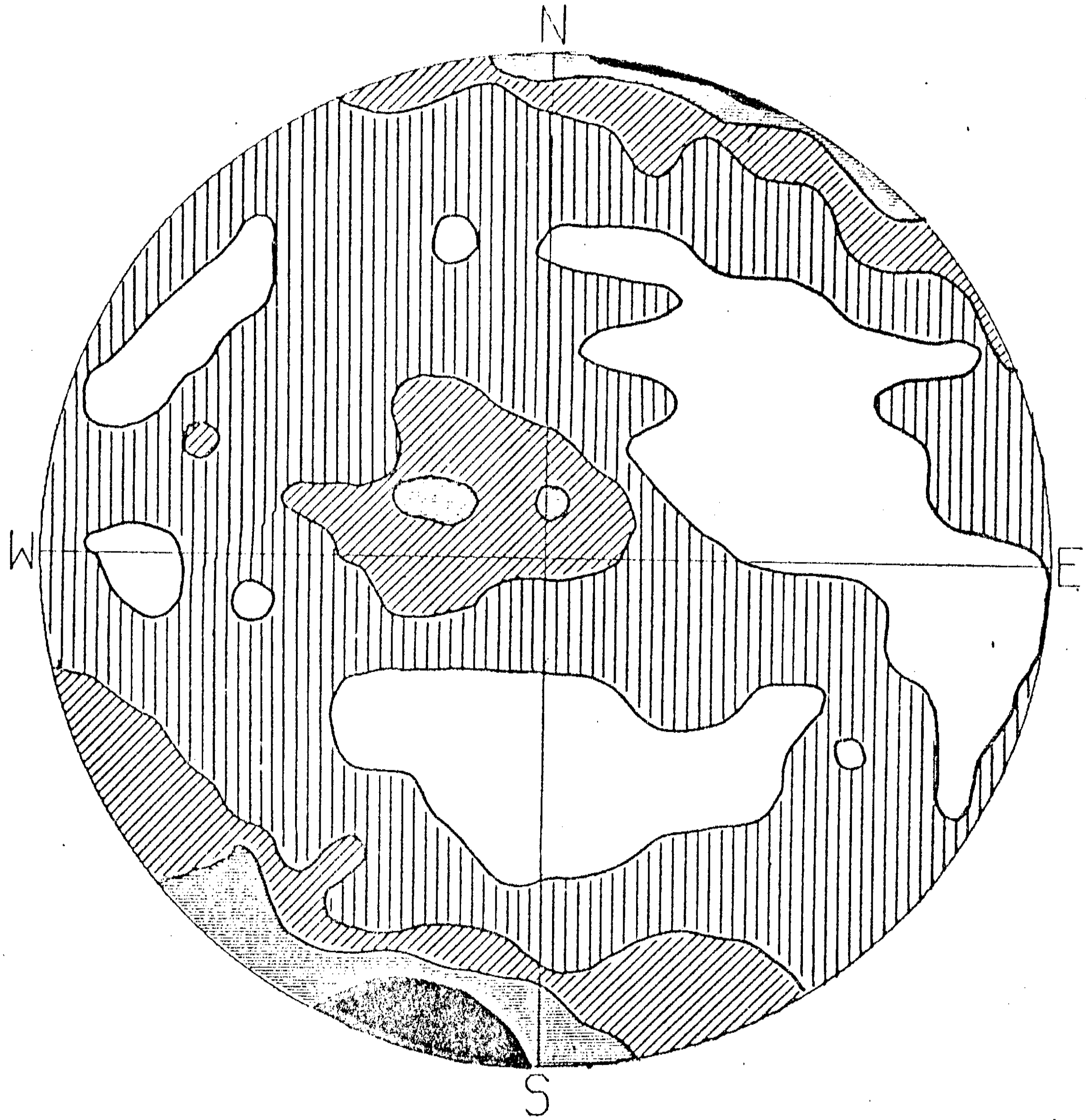
1 - 2%

Fig 30

Synoptic pi diagram of 750 poles to fracture in both preCambrian granites.

quartz and potassium feldspar. In the metasedimentary section, the vein orientation is controlled by foliation, the veins are isolated, and are composed chiefly of quartz and muscovite. These features suggest an igneous origin for the veins found in the granite, and a metamorphic origin for those veins found in the metasedimentary section. The structural and petrologic and metamorphic evidence discussed previously in this paper suggest that the Los Pinos intrusive sequence was intruded into the sedimentary section after the major period of metamorphism had occurred (Fig. 19).

East-west compression, during the Laramide Orogenic Period, near the close of the Mesozoic Era, caused reverse faults to form in this region resulting in the formation of the Montosa and Paloma Faults. Vertical throw on the Montosa Reverse Fault is in the range of 1500 to 2000 feet and vertical throw on the Paloma Reverse Fault may be as great as 500 feet (Plate 3). Later, possible extension in an east-west direction caused the Tio Bartolo Fault Zone, and this extension is associated with the formation of the Rio Grande Rift Zone immediately to the west. Vertical throw on the Tio Bartolo Fault Zone is in excess of 2000 feet (Plate 3).



point density

> 4 %

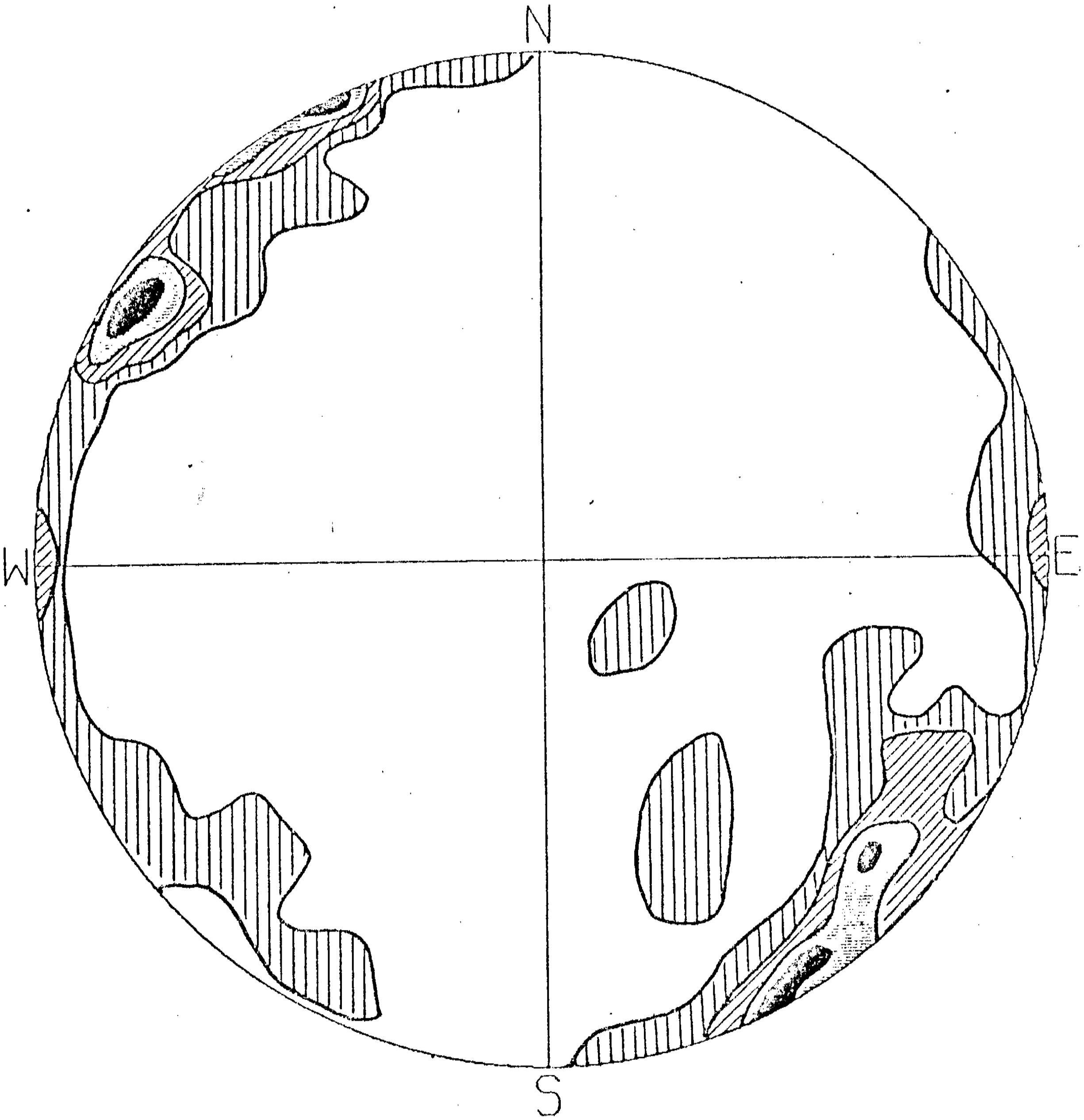
3 - 4 %

2 - 3 %

1 - 2 %

Fig 31

Pi diagram of 1113 poles to fracture in the metasediments.



point density

> 12 %

8 - 12 %

4 - 8 %

1 - 4 %

Fig 32

Pi diagram of 33 poles to veins and dikes from the Sepultura Granite.

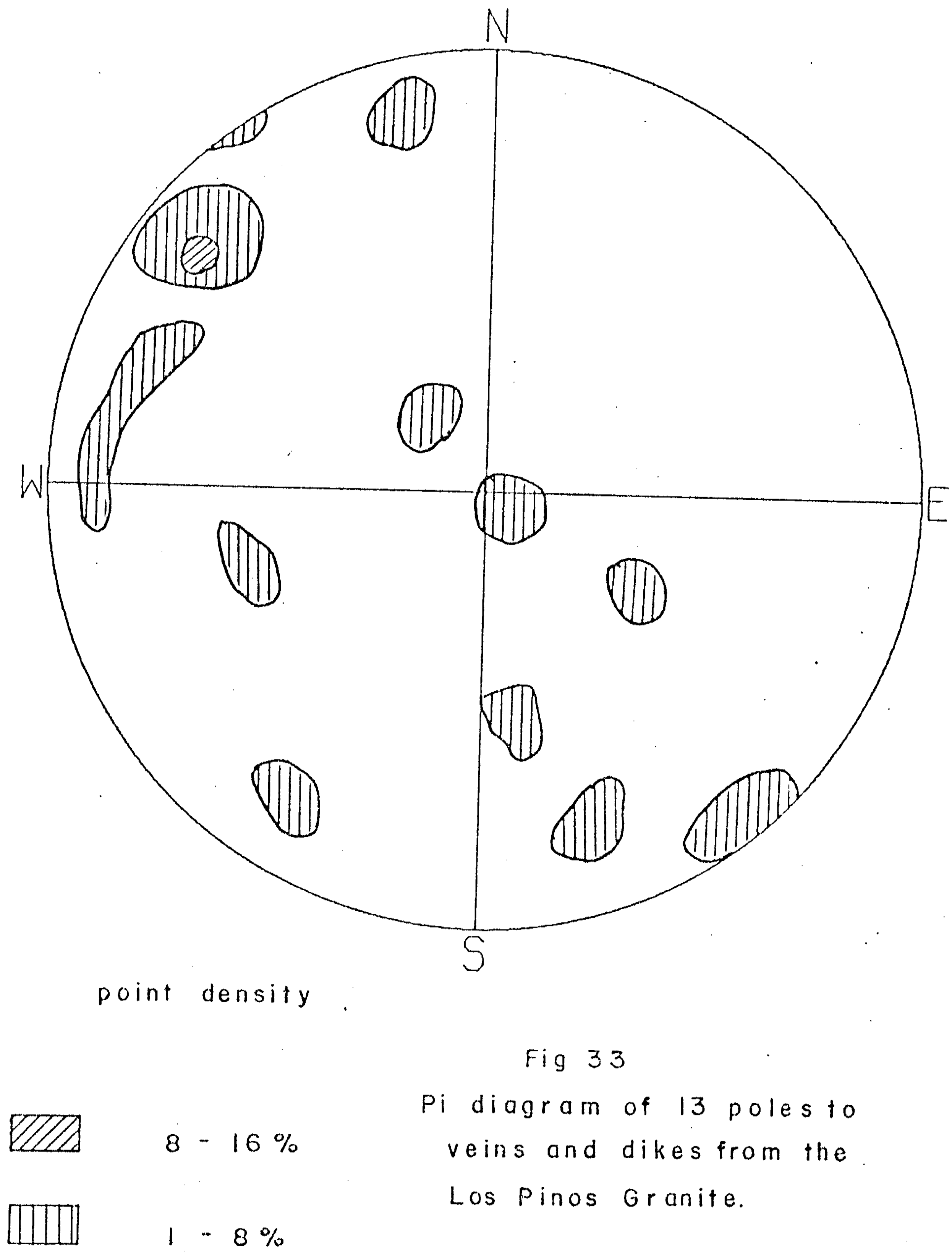


Fig 33
Pi diagram of 13 poles to veins and dikes from the Los Pinos Granite.

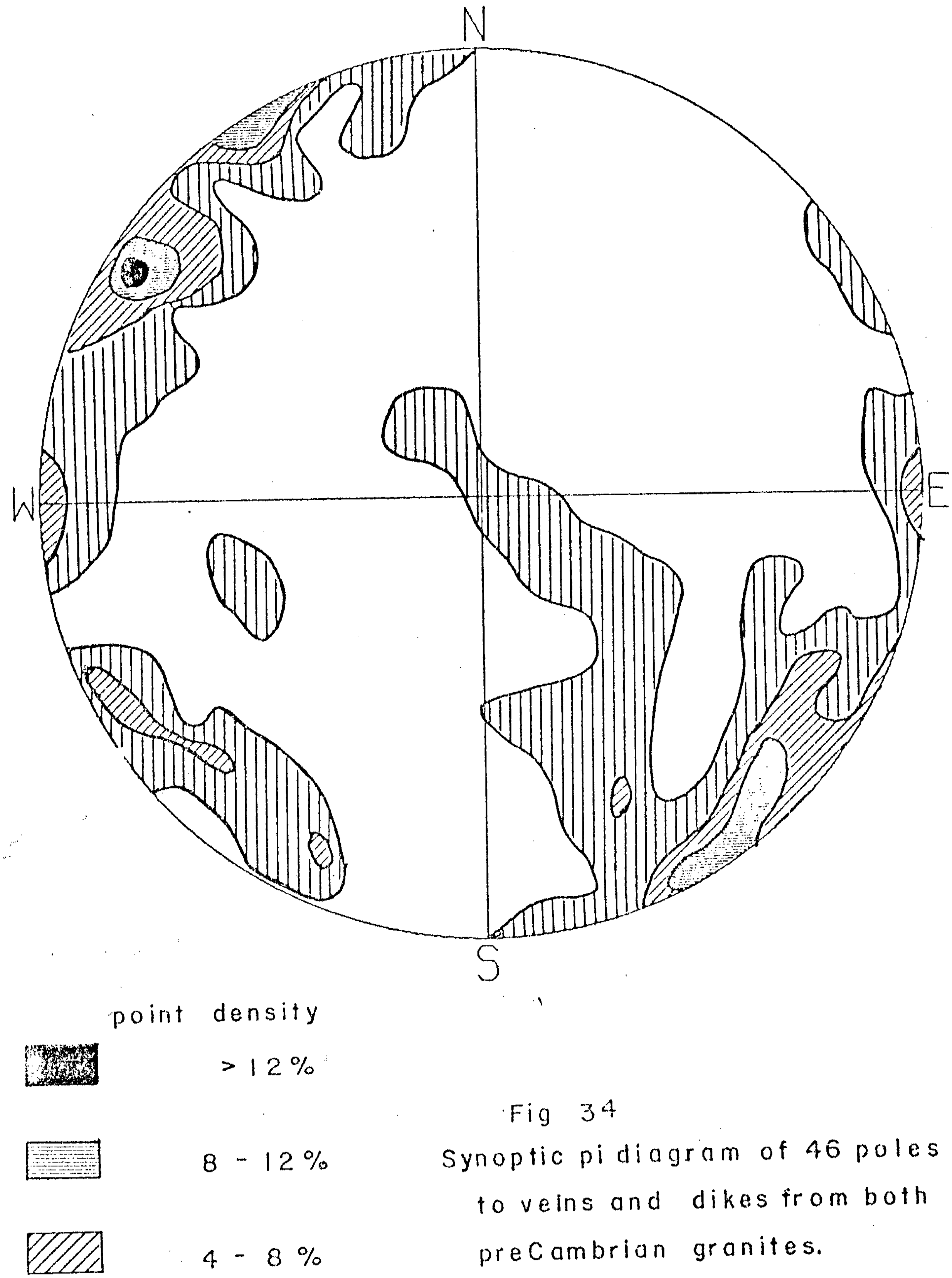
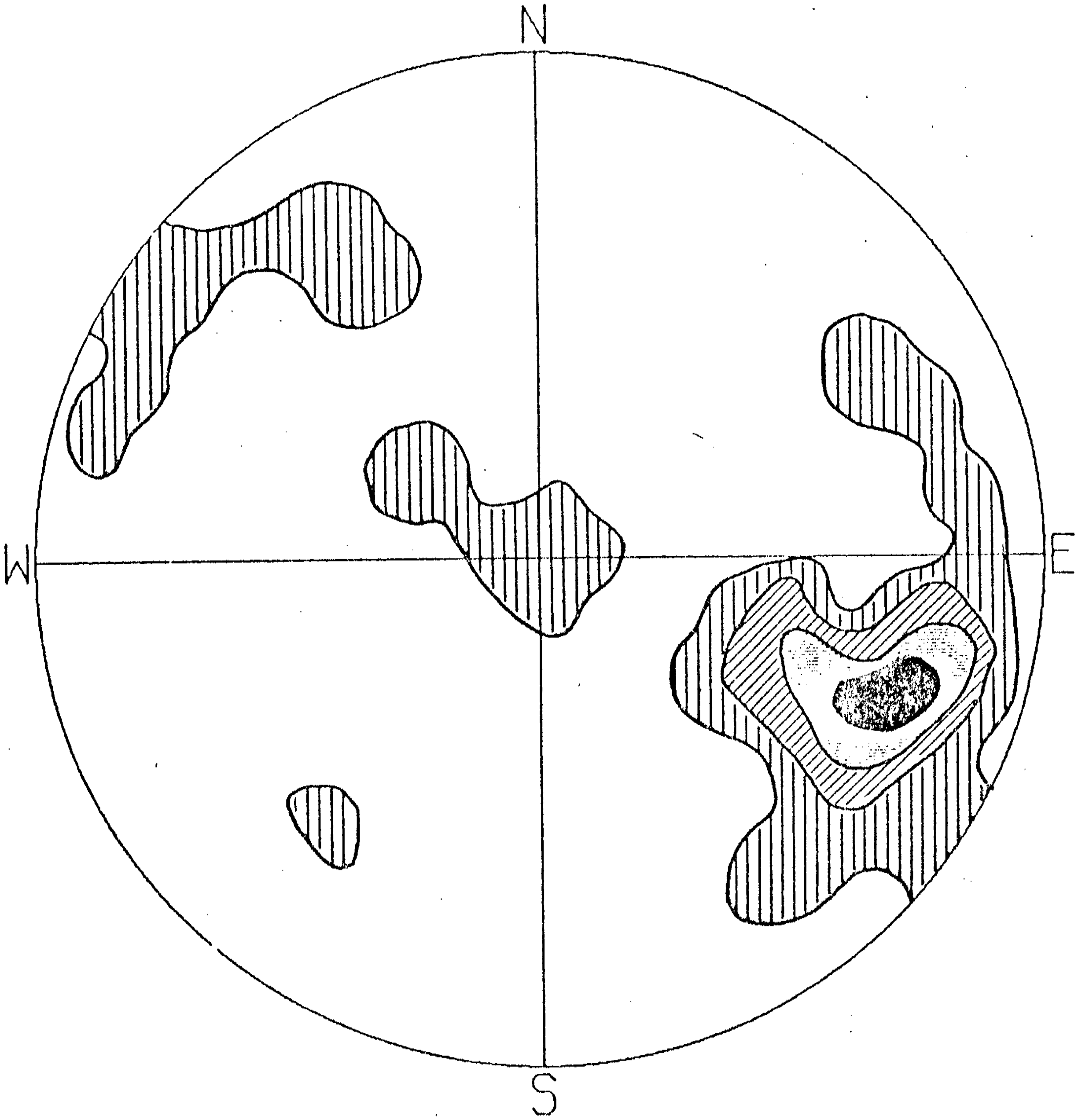


Fig 34
Synoptic pi diagram of 46 poles to veins and dikes from both preCambrian granites.



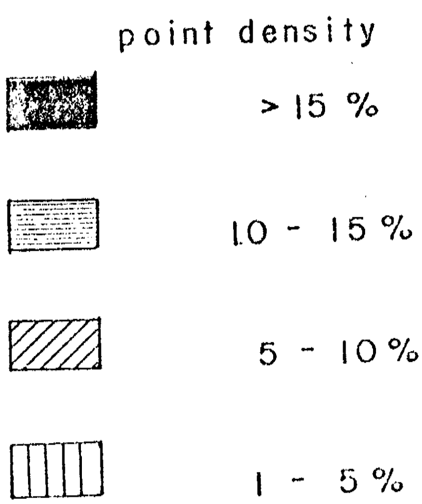


Fig 35

Pi diagram of 49 poles to veins and dikes in the metasediments.

CONCLUSIONS

Precambrian exposures in the Los Pinos Mountains do not appear to differ greatly in terms of parent lithologies from other Precambrian exposures farther north in New Mexico (Stark, 1956; Long, 1972; Gresens, et al, 1974a, 1974b). Parent lithologies are generally mature sedimentary sequences, siliceous volcanic units, and granites, often with a high potassium content. In addition, a bimodal compositional suite that differs from typical continental rift bimodal suites in that the siliceous members greatly exceed the basaltic members in abundance, is also characteristic. Ages of the intrusive igneous rocks appear to be about 1.65 b.y. (Long, 1972; Brookins, 1973; Fullagar, 1973; Condie, pers. comm.). These ages differ from the Superior Province (2.0 b.y. and older) which lies to the north, from the Central Belt Province as described by Muehlberger, et al (1967) dated about 1.4 b.y., and from dates from southern New Mexico and Texas at 1.0 b.y. (Flawn, 1956). In Arizona, Silver (1965) has dated the Mazatzal Orogeny at 1.6 b.y. The Mazatzal Orogeny deformed the Yavapai Series which exhibits greenschist to lower amphibolite facies metamorphism and is predominantly volcanic in origin.

The characteristics of the granites, notably, the rapakivi texture and the high potassium content, generally suggest formation in the late stages of an orogenic event. Furthermore, the association of a mature sedimentary sequence with siliceous volcanic rocks is also believed indicative of late stage orogenic events. A Phanoerozoic analog of this petrotectonic assemblage may be found in the Central European Permian. During the early stages of this period, which followed closely the Hercynian Orogeny, volcanic rocks of mafic (melaphyres) and silicic (ignimbrites) composition are widely distributed. The magmas are characterized by a high potassium content. The tectonic setting is one of epeirogenic warping and basin formation, followed by block faulting (Brinkmann, 1960).

Although clear association of the origin of the New Mexico Precambrian rocks with Mazatzal Orogeny is not possible, evidence suggests that both New Mexico and Arizona underwent a similar geologic event (circa 1.65 b.y. ago). This evidence includes a similarity in age, lithology, deformation, metamorphic grade, structural orientation (Anderson, 1966, p. 6 & 7), and a lack of correlation with surrounding Precambrian provinces. Although further study is necessary, it appears that another Precambrian province may exist in the areas of northern and central New Mexico and extend westward, at least into central and southern Arizona. The characteristics of this province appear to be an age (circa 1.65 b.y.) and a metamorphic grade (greenschist to amphibolite facies) both of which fall between the older more metamorphosed Superior Province and the younger, less metamorphosed Central Belt Province as previously recognized.

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APPENDIX I

Geochmeical Analysis of Igneous

and Metamorphic Rocks from the

Los Pinos Mountains, New Mexico

The samples from the Sevilleta Metarhyolite have been divided into 3 groups, the Montosa Section, taken from the northern part of the mapped area, the Pinon Section, taken from north of the mapped area, and the Metasediments, the high siliceous rocks from both sections.

Analyses were supplied by Dr. K. C. Condie of New Mexico Institute of Mining and Technology.

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

SEPULTURA GRANITE
NUMBER OF SAMPLES IN THIS GROUP = 7
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

LOS PINOS GRANITE
NUMBER OF SAMPLES IN THIS GROUP = 10
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

METAVOLCANICS (MONTOSA SECTION)
NUMBER OF SAMPLES IN THIS GROUP = 4
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

METAVOLCANICS (PINON SECTION)
NUMBER OF SAMPLES IN THIS GROUP = 8
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

AMPHIBOLITES
NUMBER OF SAMPLES IN THIS GROUP = 7
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 98.500 PERCENT

METAARKOSITES
NUMBER OF SAMPLES IN THIS GROUP = 12
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

MISCELLANEOUS ROCKS
NUMBER OF SAMPLES IN THIS GROUP = 6
TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO 99.500 PERCENT

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

SEPULTURA GRANITE

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

7 SAMPLES

NO	NAME	N9 ********	N13 ********	NP12 ********	NP14 ********	NP15 ********
1	SIO2	75.870	75.470	75.520	75.700	74.210
2	TIO2	0.120	0.0	0.500	0.090	0.0
3	AL2O3	13.740	13.690	13.710	13.800	12.980
4	FE2O3	1.320	1.780	0.770	1.130	1.120
5	MGO	0.0	0.0	0.0	0.0	0.0
6	CAO	0.500	0.880	0.580	0.700	0.510
7	NA2O	4.180	3.810	4.140	3.920	4.640
8	K2O	4.800	4.520	4.770	4.770	4.780
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	169.000	144.000	287.000	214.000	204.000
12	SR	27.000	60.000	10.000	34.000	27.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	678.000	0.0	111.000	576.000	0.0
15	CS	2.300	0.0	0.500	3.100	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.300	0.0	0.600	0.800	0.0
18	CR	8.000	0.0	0.0	2.000	0.0
19	LA	49.000	0.0	48.000	60.000	0.0
20	CE	142.000	0.0	135.000	145.000	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	13.100	0.0	17.000	18.600	0.0
23	EU	2.200	0.0	3.600	1.500	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	3.200	0.0	2.700	2.400	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	11.000	0.0	13.000	9.000	0.0
31	LU	1.900	0.0	2.000	1.500	0.0
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	39847.668	37523.223	39598.621	39598.621	39681.633
41	TI	719.400	0.0	2997.500	539.550	0.0
42	NA	31015.617	28270.215	30718.816	29086.414	34428.820
43	K/RB	235.785	260.578	137.974	185.040	194.518
44	BA/RB	4.012	0.0	0.387	2.692	0.0
45	RB/SR	6.259	2.400	28.700	6.294	7.556
46	BA/SR	25.111	0.0	11.100	16.941	0.0
47	LA/YB	4.455	0.0	3.692	6.667	0.0
48	K/CS	17325.070	0.0	79197.188	12773.746	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.285	1.327	1.289	1.361	1.153
55	REE	227.400	0.0	221.300	238.000	0.0
56	F/FM	1.000	1.000	1.000	1.000	1.000
57	RB/CS	73.478	0.0	574.000	69.032	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP16 ********	NP19 ********
1	SIO2	75.740	75.040
2	TIO2	0.0	0.0
3	AL2O3	13.360	13.210
4	FE2O3	0.730	1.540
5	MGO	0.0	0.0
6	CAO	0.560	0.730
7	NA2O	4.450	4.290
8	K2O	4.770	4.710
9	MN	0.0	0.0
10	NI	0.0	0.0
11	RB	235.000	222.000
12	SR	11.000	36.000
13	ZR	0.0	0.0
14	BA	0.0	0.0
15	CS	0.0	0.0
16	HF	0.0	0.0
17	CO	0.0	0.0
18	CR	0.0	0.0
19	LA	0.0	0.0
20	CE	0.0	0.0
21	ND	0.0	0.0
22	SM	0.0	0.0
23	EU	0.0	0.0
24	GD	0.0	0.0
25	TB	0.0	0.0
26	DY	0.0	0.0
27	HO	0.0	0.0
28	ER	0.0	0.0
29	TM	0.0	0.0
30	YB	0.0	0.0
31	LU	0.0	0.0
32	Y	0.0	0.0
33	SC	0.0	0.0
34	CU	0.0	0.0
35	ZN	0.0	0.0
36	PB	0.0	0.0
37	SB	0.0	0.0
38	TH	0.0	0.0
39	U	0.0	0.0
40	K	39598.621	39100.523
41	TI	0.0	0.0
42	NA	33019.016	31831.816
43	K/RB	168.505	176.128
44	BA/RB	0.0	0.0
45	RB/SR	21.364	6.167
46	BA/SR	0.0	0.0
47	LA/YB	0.0	0.0
48	K/CS	0.0	0.0
49	NI/CO	0.0	0.0
50	ZR/HF	0.0	0.0
51	TI/ZR	0.0	0.0
52	ZN/CU	0.0	0.0
53	TH/U	0.0	0.0
54	K/NA	1.199	1.228
55	REE	0.0	0.0
56	F/FM	1.000	1.000
57	RB/CS	0.0	0.0
58	ZN/PB	0.0	0.0

NO	NAME	NO POINTS	MEAN	MEDIAN	STD DEV	REL STD DEV
		********	*********	*********	********	********
1	SIO2	7	75.364	75.520	0.575	0.008
2	TIO2	3	0.237	0.120	0.229	0.965
3	AL2O3	7	13.499	13.690	0.317	0.023
4	FE2O3	7	1.199	1.130	0.384	0.320
5	MGO	0	0.0	0.0	0.0	0.0
6	CAO	7	0.637	0.580	0.139	0.218
7	NA2O	7	4.204	4.180	0.288	0.069
8	K2O	7	4.731	4.770	0.097	0.021
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	7	210.714	214.000	46.158	0.219
12	SR	7	29.286	27.000	16.968	0.579
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	3	455.000	576.000	302.247	0.664
15	CS	3	1.967	2.300	1.332	0.677
16	HF	0	0.0	0.0	0.0	0.0
17	CO	3	0.567	0.600	0.252	0.444
18	CR	2	5.000	5.000	4.243	0.849
19	LA	3	52.333	49.000	6.658	0.127
20	CE	3	140.667	142.000	5.132	0.036
21	ND	0	0.0	0.0	0.0	0.0
22	SM	3	17.900	18.100	0.819	0.046
23	EU	3	2.433	2.200	1.069	0.439
24	GD	0	0.0	0.0	0.0	0.0
25	TB	3	2.767	2.700	0.404	0.146
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	3	11.000	11.000	2.000	0.182
31	LU	3	1.800	1.900	0.265	0.147
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	7	39278.383	39598.621	806.905	0.021
41	TI	3	1418.816	719.400	1370.134	0.966
42	NA	7	31195.801	31015.617	2138.908	0.069
43	K/RB	7	194.075	185.040	41.568	0.214
44	BA/RB	3	2.363	2.692	1.835	0.776
45	RB/SR	7	11.248	6.294	9.782	0.870
46	BA/SR	3	17.717	16.941	7.038	0.397
47	LA/YB	3	4.938	4.455	1.545	0.313
48	K/CS	3	36431.977	17325.070	37105.582	1.018
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	7	1.263	1.285	0.074	0.058
55	REE	3	228.900	227.400	8.450	0.037
56	F/FM	7	1.000	1.000	0.0	0.0
57	RB/CS	3	238.837	73.478	290.268	1.215
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

LOS PINOS GRANITE

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

10 SAMPLES

NO	NAME	N2 ********	N3 ********	N4 ********	NP2 ********	NP4 ********
1	SIO2	75.197	75.590	74.840	75.100	73.420
2	TIO2	0.249	0.240	0.0	0.0	0.0
3	AL2O3	11.748	13.220	13.290	11.940	11.020
4	FE2O3	2.748	2.540	2.970	2.750	2.520
5	MGO	0.169	0.0	0.0	0.0	0.0
6	CAO	0.737	1.030	1.090	0.790	0.730
7	NA2O	4.321	4.440	4.230	4.350	3.770
8	K2O	4.331	4.320	4.240	4.110	4.440
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	153.000	119.000	160.000	97.000	121.000
12	SR	53.000	72.000	94.000	50.000	61.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	1090.000	978.000	0.0	0.0	0.0
15	CS	2.500	2.800	0.0	0.0	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	1.000	0.700	0.0	0.0	0.0
18	CR	0.0	2.000	0.0	0.0	0.0
19	LA	65.000	75.000	0.0	0.0	0.0
20	CE	176.000	163.000	0.0	0.0	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	22.000	21.000	0.0	0.0	0.0
23	EU	3.100	3.200	0.0	0.0	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	4.100	3.900	0.0	0.0	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	13.000	10.000	0.0	0.0	0.0
31	LU	2.000	1.900	0.0	0.0	0.0
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	35952.969	35862.898	35198.770	34119.563	36859.090
41	TI	1492.152	1438.800	0.0	0.0	0.0
42	NA	32061.051	32944.913	31386.609	32277.020	27973.418
43	K/RB	234.987	301.369	219.992	351.748	304.620
44	BA/RB	7.124	8.218	0.0	0.0	0.0
45	RB/SR	2.887	1.653	1.702	1.940	1.984
46	BA/SR	20.566	13.583	0.0	0.0	0.0
47	LA/YB	5.000	7.500	0.0	0.0	0.0
48	K/CS	14381.188	12808.176	0.0	0.0	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.121	1.080	1.121	1.057	1.318
55	REE	285.200	278.000	0.0	0.0	0.0
56	F/FM	0.942	1.000	1.000	1.000	1.000
57	RB/CS	61.200	42.500	0.0	0.0	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP6	NP8	NP9	NP10	N6
		*********	*********	*********	*********	*********
1	SIO2	73.300	75.200	76.130	74.280	71.490
2	TIO2	0.0	0.0	0.0	0.0	0.090
3	AL2O3	10.610	12.450	12.310	12.240	12.160
4	FE2O3	2.700	2.690	2.320	3.440	0.420
5	MGO	0.0	0.0	0.0	0.0	0.0
6	CAO	0.460	0.940	0.630	1.190	0.380
7	NA2O	4.530	5.470	3.970	4.210	4.430
8	K2O	3.790	4.370	4.470	4.280	4.640
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	123.000	157.000	156.000	167.000	240.000
12	SR	37.000	65.000	58.000	71.000	16.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	0.0	0.0	0.0	0.0	249.000
15	CS	0.0	0.0	0.0	0.0	3.600
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.0	0.0	0.0	0.0	0.200
18	CR	0.0	0.0	0.0	0.0	0.0
19	LA	0.0	0.0	0.0	0.0	68.000
20	CE	0.0	0.0	0.0	0.0	148.000
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	0.0	0.0	0.0	0.0	13.000
23	EU	0.0	0.0	0.0	0.0	0.880
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	0.0	2.200
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	0.0	0.0	0.0	0.0	14.000
31	LU	0.0	0.0	0.0	0.0	1.900
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	31463.055	36277.930	37108.141	35530.832	38519.414
41	TI	0.0	0.0	0.0	0.0	539.550
42	NA	33612.613	40587.422	29457.414	31238.215	32870.617
43	K/RB	255.797	231.070	237.873	212.759	160.498
44	BA/RB	0.0	0.0	0.0	0.0	1.037
45	RB/SR	3.324	2.415	2.690	2.352	15.000
46	BA/SR	0.0	0.0	0.0	0.0	15.563
47	LA/YB	0.0	0.0	0.0	0.0	4.857
48	K/CS	0.0	0.0	0.0	0.0	10699.836
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	0.936	0.894	1.260	1.137	1.172
55	REE	0.0	0.0	0.0	0.0	247.980
56	F/FM	1.000	1.000	1.000	1.000	1.000
57	RB/CS	0.0	0.0	0.0	0.0	66.667
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NO POINTS	MEAN	MEDIAN	STD DEV	REL STD DEV
		********	*********	********	********	********
1	SIO2	10	74.455	74.970	1.374	0.018
2	TIO2	3	0.193	0.240	0.089	0.463
3	AL2O3	10	12.099	12.200	0.843	0.070
4	FE2O3	10	2.510	2.695	0.793	0.316
5	MGO	1	0.169	0.169	0.0	0.0
6	CAO	10	0.798	0.763	0.266	0.334
7	NA2O	10	4.372	4.335	0.449	0.103
8	K2O	10	4.299	4.325	0.229	0.053
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	10	149.300	154.500	39.325	0.263
12	SR	10	57.700	59.500	21.114	0.366
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	3	772.333	978.000	456.666	0.591
15	CS	3	2.967	2.800	0.569	0.192
16	HF	0	0.0	0.0	0.0	0.0
17	CO	3	0.633	0.700	0.404	0.638
18	CR	1	2.000	2.000	0.0	0.0
19	LA	3	69.333	68.000	5.132	0.074
20	CE	3	162.333	163.000	14.012	0.086
21	ND	0	0.0	0.0	0.0	0.0
22	SM	3	18.667	21.000	4.933	0.264
23	EU	3	2.393	3.100	1.312	0.548
24	GD	0	0.0	0.0	0.0	0.0
25	TB	3	3.400	3.900	1.044	0.307
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	3	12.333	13.000	2.082	0.169
31	LU	3	1.933	1.900	0.058	0.030
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	10	35689.242	35907.906	1898.192	0.053
41	TI	3	1156.834	1438.800	535.249	0.463
42	NA	10	32440.887	32169.035	3329.430	0.103
43	K/RB	10	251.071	236.430	54.798	0.218
44	BA/RB	3	5.460	7.124	3.869	0.709
45	RB/SR	10	3.595	2.384	4.043	1.125
46	BA/SR	3	16.571	15.563	3.599	0.217
47	LA/YB	3	5.786	5.000	1.486	0.257
48	K/CS	3	12629.730	12808.176	1847.151	0.146
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	10	1.111	1.121	0.129	0.116
55	REE	3	270.393	278.000	19.741	0.073
56	F/FM	10	0.994	1.000	0.018	0.018
57	RB/CS	3	56.789	61.200	12.673	0.223
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

METAVOLCANICS (MONTOSA SECTION)

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

4 SAMPLES

NO	NAME	NP22 ********	NP24 ********	NP32 ********	NP36 ********
1	SIO2	70.659	72.490	76.290	70.860
2	TIO2	0.614	0.0	0.160	0.665
3	AL2O3	14.774	15.150	13.720	13.997
4	FE2O3	3.351	4.470	1.550	3.591
5	MGO	0.168	0.070	0.0	0.635
6	CAO	2.188	1.880	0.350	1.796
7	NA2O	3.752	4.920	3.010	3.859
8	K2O	3.994	3.910	4.910	4.097
9	MN	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0
11	RB	154.000	137.000	205.000	152.000
12	SR	59.000	90.000	31.000	131.000
13	ZR	0.0	0.0	0.0	0.0
14	BA	795.000	0.0	1270.000	940.000
15	CS	2.900	0.0	1.500	11.920
16	HF	0.0	0.0	0.0	0.0
17	CO	4.700	0.0	0.660	5.500
18	CR	4.000	0.0	3.000	16.000
19	LA	92.000	0.0	96.000	49.000
20	CE	150.000	0.0	199.000	125.000
21	ND	0.0	0.0	0.0	0.0
22	SM	24.000	0.0	28.000	14.000
23	EU	3.400	0.0	3.400	3.400
24	GD	0.0	0.0	0.0	0.0
25	TB	3.800	0.0	4.400	0.0
26	DY	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0
30	YB	10.000	0.0	12.000	9.400
31	LU	1.600	0.0	1.800	1.600
32	Y	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0
40	K	33154.746	32459.242	40760.840	34012.145
41	TI	3683.494	0.0	959.200	3984.612
42	NA	27837.863	36506.418	22334.211	28633.605
43	K/RB	215.291	236.929	198.833	223.764
44	BA/RB	5.162	0.0	6.195	6.184
45	RB/SR	2.610	1.522	6.613	1.160
46	BA/SR	13.475	0.0	40.968	7.176
47	LA/YB	9.200	0.0	8.000	5.213
48	K/CS	11432.672	0.0	27173.891	2853.368
49	NI/CO	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0
54	K/NA	1.191	0.889	1.825	1.188
55	REE	284.800	0.0	344.600	203.400
56	F/FM	0.952	0.985	1.000	0.850
57	RB/CS	53.103	0.0	136.667	12.752
58	ZN/PB	0.0	0.0	0.0	0.0

NO	NAME	NO POINTS ********	MEAN ********	MEDIAN ********	STD DEV ********	REL STD DEV ********
1	SIO2	4	72.575	71.675	2.609	0.036
2	TIO2	3	0.480	0.614	0.278	0.580
3	AL2O3	4	14.410	14.386	0.665	0.046
4	FE2O3	4	3.241	3.471	1.225	0.378
5	MGO	3	0.291	0.168	0.302	1.038
6	CAO	4	1.553	1.838	0.820	0.528
7	NA2O	4	3.885	3.805	0.786	0.202
8	K2O	4	4.228	4.045	0.461	0.109
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	4	162.000	153.000	29.654	0.183
12	SR	4	77.750	74.500	42.906	0.552
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	3	1001.667	940.000	243.430	0.243
15	CS	3	5.440	2.900	5.655	1.040
16	HF	0	0.0	0.0	0.0	0.0
17	CO	3	3.620	4.700	2.594	0.717
18	CR	3	7.667	4.000	7.234	0.944
19	LA	3	79.000	92.000	26.058	0.330
20	CE	3	158.333	150.000	37.207	0.235
21	ND	0	0.0	0.0	0.0	0.0
22	SM	3	22.000	24.000	7.211	0.328
23	EU	3	3.400	3.400	0.0	0.0
24	GD	0	0.0	0.0	0.0	0.0
25	TB	2	4.100	4.100	0.424	0.103
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	3	10.467	10.000	1.361	0.130
31	LU	3	1.667	1.600	0.115	0.069
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	4	35096.719	33583.438	3829.102	0.109
41	TI	3	2875.767	3683.494	1666.611	0.580
42	NA	4	28828.000	28235.734	5835.109	0.202
43	K/RB	4	218.704	219.527	15.961	0.073
44	BA/RB	3	5.847	6.184	0.593	0.101
45	RB/SR	4	2.976	2.066	2.501	0.840
46	BA/SR	3	20.539	13.475	17.970	0.875
47	LA/YB	3	7.471	8.000	2.046	0.274
48	K/CS	3	13819.977	11432.672	12334.758	0.893
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	4	1.273	1.189	0.394	0.310
55	REE	3	277.600	284.800	70.875	0.255
56	F/FM	4	0.947	0.968	0.068	0.071
57	RB/CS	3	67.507	53.103	63.201	0.936
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

METAVOLCANICS (PINON SECTION)

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

8 SAMPLES

NO	NAME	NP46 ********	NP47 ********	NP49 ********	NP52 ********	NP58 ********
1	SIO2	75.850	74.830	74.490	76.260	76.730
2	TIO2	0.240	0.220	0.0	0.270	0.190
3	AL2O3	13.790	13.280	13.120	14.760	15.430
4	FE2O3	2.550	2.420	2.710	2.460	1.420
5	MGO	0.0	0.0	0.0	0.0	0.0
6	CAO	0.770	0.710	0.660	1.230	0.360
7	NA2O	3.850	4.280	4.290	4.420	3.120
8	K2O	4.730	4.570	4.430	1.480	4.800
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	172.000	176.000	164.000	57.000	177.000
12	SR	74.000	46.000	68.000	69.000	31.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	1096.000	1013.000	0.0	700.000	1260.000
15	CS	7.100	6.400	0.0	1.600	1.300
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.340	0.420	0.0	0.950	0.900
18	CR	3.000	1.000	0.0	2.000	0.0
19	LA	88.000	64.000	0.0	66.000	58.000
20	CE	168.000	143.000	0.0	151.000	137.000
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	25.000	20.000	0.0	19.000	17.000
23	EU	3.300	2.500	0.0	3.200	2.800
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	0.0	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	12.000	11.000	0.0	11.000	10.000
31	LU	2.000	2.500	0.0	1.800	1.800
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	39266.551	37936.297	36776.078	12286.359	39847.663
41	TI	1438.800	1318.900	0.0	1618.650	1139.050
42	NA	28567.016	31757.613	31831.816	32796.414	23150.410
43	K/RB	228.294	215.559	224.244	215.550	225.128
44	BA/RB	6.372	5.756	0.0	12.281	7.119
45	RB/SR	2.324	3.826	2.412	0.826	5.710
46	BA/SR	14.811	22.022	0.0	10.145	40.645
47	LA/YB	7.333	5.818	0.0	6.000	5.800
48	K/CS	5530.496	5927.855	0.0	7678.973	30652.047
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.375	1.195	1.155	0.375	1.721
55	REE	298.300	243.000	0.0	252.000	226.600
56	F/FM	1.000	1.000	1.000	1.000	1.000
57	RB/CS	24.225	27.500	0.0	35.625	136.154
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP62 ********	NP64 ********	NP68 ********
1	SIO2	75.180	72.270	72.070
2	TIO2	0.0	0.0	0.0
3	AL2O3	15.140	14.550	15.420
4	FE2O3	1.470	4.280	4.780
5	MGO	0.0	0.420	0.180
6	CAO	0.360	2.430	2.310
7	NA2O	3.510	4.260	3.700
8	K2O	4.890	2.920	3.910
9	MN	0.0	0.0	0.0
10	NI	0.0	0.0	0.0
11	RB	169.000	57.000	130.000
12	SR	40.000	58.000	120.000
13	ZR	0.0	0.0	0.0
14	BA	0.0	0.0	0.0
15	CS	0.0	0.0	0.0
16	HF	0.0	0.0	0.0
17	CO	0.0	0.0	0.0
18	CR	0.0	0.0	0.0
19	LA	0.0	0.0	0.0
20	CE	0.0	0.0	0.0
21	ND	0.0	0.0	0.0
22	SM	0.0	0.0	0.0
23	EU	0.0	0.0	0.0
24	GD	0.0	0.0	0.0
25	TB	0.0	0.0	0.0
26	DY	0.0	0.0	0.0
27	HO	0.0	0.0	0.0
28	ER	0.0	0.0	0.0
29	TM	0.0	0.0	0.0
30	YB	0.0	0.0	0.0
31	LU	0.0	0.0	0.0
32	Y	0.0	0.0	0.0
33	SC	0.0	0.0	0.0
34	CU	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0
36	PB	0.0	0.0	0.0
37	SB	0.0	0.0	0.0
38	TH	0.0	0.0	0.0
39	U	0.0	0.0	0.0
40	K	40594.813	24240.664	32459.242
41	TI	0.0	0.0	0.0
42	NA	26044.215	31609.215	27454.012
43	K/RB	240.205	425.275	249.686
44	BA/RB	0.0	0.0	0.0
45	RB/SR	4.225	0.983	1.083
46	BA/SR	0.0	0.0	0.0
47	LA/YB	0.0	0.0	0.0
48	K/CS	0.0	0.0	0.0
49	NI/CO	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0
54	K/NA	1.559	0.767	1.182
55	REE	0.0	0.0	0.0
56	F/FM	1.000	0.911	0.964
57	RB/CS	0.0	0.0	0.0
58	ZN/PB	0.0	0.0	0.0

NO	NAME	NO POINTS	MEAN	MEDIAN	STD DEV	REL STD DEV
1	SIO2	8	74.710	75.005	1.732	0.023
2	TIO2	4	0.230	0.230	0.034	0.146
3	AL2O3	8	14.436	14.655	0.930	0.064
4	FE2O3	8	2.761	2.505	1.201	0.435
5	MGO	2	0.300	0.300	0.170	0.566
6	CAO	8	1.104	0.740	0.828	0.750
7	NA2O	8	3.929	4.055	0.462	0.118
8	K2O	8	3.966	4.500	1.195	0.301
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	8	137.750	166.500	52.021	0.378
12	SR	8	63.250	63.000	27.510	0.435
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	4	1017.250	1054.500	235.085	0.231
15	CS	4	4.100	4.000	3.076	0.750
16	HF	0	0.0	0.0	0.0	0.0
17	CO	4	0.652	0.660	0.317	0.486
18	CR	3	2.000	2.000	1.000	0.500
19	LA	4	69.000	65.000	13.115	0.190
20	CE	4	149.750	147.000	13.451	0.090
21	ND	0	0.0	0.0	0.0	0.0
22	SM	4	20.250	19.500	3.403	0.168
23	EU	4	2.950	3.000	0.370	0.125
24	GD	0	0.0	0.0	0.0	0.0
25	TB	0	0.0	0.0	0.0	0.0
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	4	11.000	11.000	0.816	0.074
31	LU	4	2.025	1.900	0.330	0.163
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	8	32926.180	37357.188	9917.629	0.301
41	TI	4	1378.849	1378.850	201.822	0.146
42	NA	8	29151.320	30088.113	3426.640	0.118
43	K/RB	8	252.993	226.711	70.581	0.279
44	BA/RB	4	7.882	6.745	2.985	0.379
45	RB/SR	8	2.674	2.368	1.771	0.662
46	BA/SR	4	21.906	18.416	13.414	0.612
47	LA/YB	4	6.238	5.909	0.736	0.118
48	K/CS	4	12447.340	6803.414	12172.301	0.978
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	8	1.166	1.188	0.430	0.369
55	REE	4	254.975	247.500	30.738	0.121
56	F/FM	8	0.984	1.000	0.032	0.033
57	RB/CS	4	55.876	31.562	53.733	0.962
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

AMPHIBOLITES

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 98.500 PERCENT

7 SAMPLES

NO	NAME	N34 ********	N35 ********	NP23 ********	NP28 ********	NP51 ********
1	SIO2	45.340	44.950	49.520	47.399	49.749
2	TIO2	0.0	0.0	0.980	0.964	1.294
3	AL2O3	14.940	12.070	14.033	14.521	12.017
4	FE2O3	13.130	13.740	12.903	13.937	13.974
5	MGO	11.200	11.500	8.382	9.506	9.245
6	CAO	9.580	11.170	8.152	8.481	10.254
7	NA2O	3.020	1.720	3.921	3.066	1.335
8	K2O	0.610	0.620	0.610	0.626	0.632
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	80.000	135.000	136.000
11	RB	0.0	5.000	0.0	11.000	10.000
12	SR	202.000	163.000	200.000	233.000	179.000
13	ZR	0.0	0.0	118.000	106.000	114.000
14	BA	0.0	0.0	0.0	0.0	0.0
15	CS	0.0	0.0	0.0	0.0	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.0	0.0	0.0	0.0	0.0
18	CR	0.0	0.0	0.0	0.0	0.0
19	LA	0.0	0.0	0.0	0.0	0.0
20	CE	0.0	0.0	0.0	0.0	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	0.0	0.0	0.0	0.0	0.0
23	EU	0.0	0.0	0.0	0.0	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	0.0	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	0.0	0.0	0.0	0.0	0.0
31	LU	0.0	0.0	0.0	0.0	0.0
32	Y	0.0	0.0	46.000	23.000	17.000
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	5063.973	5146.938	5065.000	5193.145	5246.051
41	TI	0.0	0.0	5876.293	5779.043	7760.191
42	NA	22408.414	12762.406	29092.328	22751.727	9907.289
43	K/RB	0.0	1029.397	0.0	472.104	524.605
44	BA/RB	0.0	0.0	0.0	0.0	0.0
45	RB/SR	0.0	0.031	0.0	0.047	0.056
46	BA/SR	0.0	0.0	0.0	0.0	0.0
47	LA/YB	0.0	0.0	0.0	0.0	0.0
48	K/CS	0.0	0.0	0.0	0.0	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	49.799	54.519	68.072
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	0.226	0.403	0.174	0.228	0.530
55	REE	0.0	0.0	0.0	0.0	0.0
56	F/FM	0.540	0.544	0.606	0.594	0.602
57	RB/CS	0.0	0.0	0.0	0.0	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP62 ********	NP73 ********
1	SIO2	50.874	47.910
2	TIO2	1.289	0.0
3	AL2O3	11.420	15.760
4	FE2O3	13.628	13.330
5	MGO	7.743	9.490
6	CAO	10.930	10.930
7	NA2O	1.978	2.920
8	K2O	0.639	0.600
9	MN	0.0	0.0
10	NI	0.0	0.0
11	RB	15.000	54.000
12	SR	173.000	215.000
13	ZR	0.0	0.0
14	BA	0.0	0.0
15	CS	0.900	0.0
16	HF	0.0	0.0
17	CO	68.000	0.0
18	CR	234.000	0.0
19	LA	7.200	0.0
20	CE	22.000	0.0
21	ND	0.0	0.0
22	SM	4.000	0.0
23	EU	1.300	0.0
24	GD	0.0	0.0
25	TB	0.550	0.0
26	DY	0.0	0.0
27	HO	0.0	0.0
28	ER	0.0	0.0
29	TM	0.0	0.0
30	YB	2.700	0.0
31	LU	0.490	0.0
32	Y	0.0	0.0
33	SC	0.0	0.0
34	CU	0.0	0.0
35	ZN	0.0	0.0
36	PB	0.0	0.0
37	SB	0.0	0.0
38	TH	0.0	0.0
39	U	0.0	0.0
40	K	5308.172	4980.957
41	TI	7726.488	0.0
42	NA	14678.191	21666.410
43	K/RB	353.878	92.240
44	BA/RB	0.0	0.0
45	RB/SR	0.087	0.251
46	BA/SR	0.0	0.0
47	LA/YB	2.667	0.0
48	K/CS	5897.969	0.0
49	NI/CO	0.0	0.0
50	ZR/HF	0.0	0.0
51	TI/ZR	0.0	0.0
52	ZN/CU	0.0	0.0
53	TH/U	0.0	0.0
54	K/NA	0.362	0.230
55	REE	38.240	0.0
56	F/FM	0.638	0.584
57	RB/CS	16.667	0.0
58	ZN/PB	0.0	0.0

NO	NAME	NO POINTS ********	MEAN ********	MEDIAN ********	STD DEV ********	REL STD DI ********
1	SIO2	7	47.963	47.910	2.250	0.04
2	TIO2	4	1.132	1.135	0.185	0.16
3	AL2O3	7	13.537	14.033	1.687	0.12
4	FE2O3	7	13.520	13.628	0.410	0.03
5	MGO	7	9.581	9.490	1.369	0.14
6	CAO	7	9.928	10.254	1.227	0.12
7	NA2O	7	2.566	2.920	0.912	0.35
8	K2O	7	0.620	0.620	0.014	0.02
9	MN	0	0.0	0.0	0.0	0.0
10	NI	3	117.000	135.000	32.047	0.27
11	RB	5	19.000	11.000	19.887	1.04
12	SR	7	195.000	200.000	24.772	0.12
13	ZR	3	112.667	114.000	6.110	0.05
14	BA	0	0.0	0.0	0.0	0.0
15	CS	1	0.900	0.900	0.0	0.0
16	HF	0	0.0	0.0	0.0	0.0
17	CO	1	68.000	68.000	0.0	0.0
18	CR	1	234.000	234.000	0.0	0.0
19	LA	1	7.200	7.200	0.0	0.0
20	CE	1	22.000	22.000	0.0	0.0
21	ND	0	0.0	0.0	0.0	0.0
22	SM	1	4.000	4.000	0.0	0.0
23	EU	1	1.300	1.300	0.0	0.0
24	GD	0	0.0	0.0	0.0	0.0
25	TB	1	0.550	0.550	0.0	0.0
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	1	2.700	2.700	0.0	0.0
31	LU	1	0.490	0.490	0.0	0.0
32	Y	3	30.333	28.000	14.640	0.48
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	7	5143.469	5146.988	114.759	0.02
41	TI	4	6785.504	6801.391	1106.811	0.16
42	NA	7	19038.098	21666.410	6768.926	0.35
43	K/RB	5	494.445	472.104	342.458	0.69
44	BA/RB	0	0.0	0.0	0.0	0.0
45	RB/SR	5	0.094	0.056	0.090	0.95
46	BA/SR	0	0.0	0.0	0.0	0.0
47	LA/YB	1	2.667	2.667	0.0	0.0
48	K/CS	1	5897.969	5897.969	0.0	0.0
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	3	57.463	54.519	9.485	0.16
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	7	0.308	0.230	0.128	0.41
55	REE	1	38.240	38.240	0.0	0.0
56	F/FM	7	0.587	0.594	0.035	0.05
57	RB/CS	1	16.667	16.667	0.0	0.0
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

METAARKOSITES

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

12 SAMPLES

NO	NAME	NP27 ********	NP29 ********	NP30 ********	NP33 ********	NP34 ********
1	SIO2	79.616	76.800	79.890	80.530	79.000
2	TIO2	0.282	0.0	0.440	0.160	0.0
3	AL2O3	11.914	15.890	10.120	9.890	11.420
4	FE2O3	1.972	1.430	3.000	1.350	4.050
5	MGO	0.322	0.0	0.0	0.0	0.320
6	CAO	0.282	0.320	0.310	0.360	0.670
7	NA2O	2.284	2.220	0.450	1.010	2.190
8	K2O	2.727	4.740	3.580	3.570	3.440
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	88.000	152.000	142.000	119.000	122.000
12	SR	12.000	25.000	4.500	27.000	46.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	0.0	0.0	373.000	533.000	0.0
15	CS	0.0	0.0	4.480	5.000	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.0	0.0	0.0	0.0	0.0
18	CR	0.0	0.0	4.000	1.000	0.0
19	LA	0.0	0.0	34.000	12.000	0.0
20	CE	0.0	0.0	60.000	32.000	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	0.0	0.0	9.500	2.500	0.0
23	EU	0.0	0.0	0.0	0.0	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	0.0	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	0.0	0.0	9.400	2.700	0.0
31	LU	0.0	0.0	1.900	0.570	0.0
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	22638.402	39349.570	29719.719	29636.699	28557.492
41	TI	1689.125	0.0	2637.800	959.200	0.0
42	NA	16949.023	16472.410	3339.001	7494.203	16249.805
43	K/RB	257.254	258.879	209.294	249.048	234.078
44	BA/RB	0.0	0.0	2.627	4.479	0.0
45	RB/SR	7.333	6.080	31.556	4.407	2.652
46	BA/SR	0.0	0.0	82.889	19.741	0.0
47	LA/YB	0.0	0.0	3.617	4.444	0.0
48	K/CS	0.0	0.0	6633.863	5927.340	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.336	2.389	8.901	3.955	1.757
55	REE	0.0	0.0	114.800	49.770	0.0
56	F/FM	0.860	1.000	1.000	1.000	0.927
57	RB/CS	0.0	0.0	31.696	23.800	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP56	NP57	NP61	NP65	NP66
		********	********	********	********	********
1	SIO2	77.020	77.430	61.780	74.240	74.330
2	TIO2	0.0	0.180	0.0	0.0	0.0
3	AL2O3	10.880	12.340	16.920	15.750	16.730
4	FE2O3	4.390	1.520	10.370	2.650	2.380
5	MGO	0.170	0.0	2.820	0.540	0.590
6	CAO	0.800	0.360	7.730	0.610	0.370
7	NA2O	2.060	2.950	2.010	1.210	2.010
8	K2O	2.820	4.720	3.120	4.240	3.800
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	100.000	186.000	120.000	137.000	107.000
12	SR	79.000	26.000	427.000	24.000	43.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	0.0	982.000	0.0	0.0	0.0
15	CS	0.0	2.230	0.0	0.0	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.0	0.0	0.0	0.0	0.0
18	CR	0.0	5.000	0.0	0.0	0.0
19	LA	0.0	44.000	0.0	0.0	0.0
20	CE	0.0	92.000	0.0	0.0	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	0.0	9.800	0.0	0.0	0.0
23	EU	0.0	0.0	0.0	0.0	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	0.0	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	0.0	15.500	0.0	0.0	0.0
31	LU	0.0	2.980	0.0	0.0	0.0
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	23410.590	39183.543	25900.980	35198.770	31546.070
41	TI	0.0	1079.100	0.0	0.0	0.0
42	NA	15285.211	21889.008	14914.207	8978.203	14914.207
43	K/RB	234.105	210.664	215.841	256.925	294.823
44	BA/RB	0.0	5.280	0.0	0.0	0.0
45	RB/SR	1.266	7.154	0.281	5.708	2.488
46	BA/SR	0.0	37.769	0.0	0.0	0.0
47	LA/YB	0.0	2.839	0.0	0.0	0.0
48	K/CS	0.0	17571.098	0.0	0.0	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.532	1.790	1.737	3.920	2.115
55	REE	0.0	164.280	0.0	0.0	0.0
56	F/FM	0.963	1.000	0.786	0.831	0.801
57	RB/CS	0.0	83.408	0.0	0.0	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP67 ********	NP69 ********
1	SIO2	77.120	82.920
2	TIO2	0.0	0.0
3	AL2O3	13.750	9.460
4	FE2O3	3.370	1.770
5	MGO	0.510	0.290
6	CAO	0.820	2.790
7	NA2O	1.760	0.830
8	K2O	3.590	2.330
9	MN	0.0	0.0
10	NI	0.0	0.0
11	RB	138.000	91.000
12	SR	62.000	30.000
13	ZR	0.0	0.0
14	BA	0.0	0.0
15	CS	0.0	0.0
16	HF	0.0	0.0
17	CO	0.0	0.0
18	CR	0.0	0.0
19	LA	0.0	0.0
20	CE	0.0	0.0
21	ND	0.0	0.0
22	SM	0.0	0.0
23	EU	0.0	0.0
24	GD	0.0	0.0
25	TB	0.0	0.0
26	DY	0.0	0.0
27	HO	0.0	0.0
28	ER	0.0	0.0
29	TM	0.0	0.0
30	YB	0.0	0.0
31	LU	0.0	0.0
32	Y	0.0	0.0
33	SC	0.0	0.0
34	CU	0.0	0.0
35	ZN	0.0	0.0
36	PB	0.0	0.0
37	SB	0.0	0.0
38	TH	0.0	0.0
39	U	0.0	0.0
40	K	29802.734	19342.719
41	TI	0.0	0.0
42	NA	13059.207	6158.602
43	K/RB	215.962	212.557
44	BA/RB	0.0	0.0
45	RB/SR	2.226	3.033
46	BA/SR	0.0	0.0
47	LA/YB	0.0	0.0
48	K/CS	0.0	0.0
49	NI/CO	0.0	0.0
50	ZR/HF	0.0	0.0
51	TI/ZR	0.0	0.0
52	ZN/CU	0.0	0.0
53	TH/U	0.0	0.0
54	K/NA	2.282	3.141
55	REE	0.0	0.0
56	F/FM	0.869	0.859
57	RB/CS	0.0	0.0
58	ZN/PB	0.0	0.0

NO	NAME	NO POINTS ********	MEAN ********	MEDIAN ********	STD DEV ********	REL STD DEV ********
1	SIO2	12	76.724	77.275	5.329	0.069
2	TIO2	4	0.265	0.231	0.128	0.482
3	AL2O3	12	12.922	12.127	2.776	0.215
4	FE2O3	12	3.188	2.515	2.478	0.777
5	MGO	8	0.695	0.416	0.870	1.252
6	CAO	12	1.294	0.496	2.139	1.654
7	NA2O	12	1.749	2.010	0.723	0.413
8	K2O	12	3.556	3.575	0.752	0.211
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	12	125.167	121.000	27.954	0.223
12	SR	12	67.125	28.500	115.199	1.716
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	3	629.333	533.000	315.722	0.502
15	CS	3	3.903	4.480	1.472	0.377
16	HF	0	0.0	0.0	0.0	0.0
17	CO	0	0.0	0.0	0.0	0.0
18	CR	3	3.333	4.000	2.082	0.624
19	LA	3	30.000	34.000	16.371	0.546
20	CE	3	61.333	60.000	30.022	0.489
21	ND	0	0.0	0.0	0.0	0.0
22	SM	3	7.267	9.500	4.131	0.568
23	EU	0	0.0	0.0	0.0	0.0
24	GD	0	0.0	0.0	0.0	0.0
25	TB	0	0.0	0.0	0.0	0.0
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	3	9.200	9.400	6.402	0.696
31	LU	3	1.817	1.900	1.207	0.664
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	12	29523.910	29678.207	6243.344	0.211
41	TI	4	1591.305	1384.113	767.383	0.482
42	NA	12	12975.242	14914.207	5363.195	0.413
43	K/RB	12	237.452	234.091	26.523	0.112
44	BA/RB	3	4.128	4.479	1.361	0.330
45	RB/SR	12	6.182	3.720	8.313	1.345
46	BA/SR	3	46.800	37.769	32.528	0.695
47	LA/YB	3	3.633	3.617	0.803	0.221
48	K/CS	3	10044.098	6633.863	6528.133	0.650
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	12	2.905	2.199	2.082	0.717
55	REE	3	109.617	114.800	57.431	0.524
56	F/FM	12	0.908	0.898	0.083	0.091
57	RB/CS	3	46.301	31.696	32.377	0.699
58	ZN/PB	0	0.0	0.0	0.0	0.0

IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

MISCELLANEOUS ROCKS

TOTAL WEIGHT PERCENT OXIDES RECALCULATED TO 99.500 PERCENT

6 SAMPLES

NO	NAME	N32	N36	NP81	NP25	NP53
		********	********	********	********	********
1	SIO2	71.680	69.540	71.550	54.208	74.930
2	TIO2	0.0	0.0	0.0	1.220	0.0
3	AL2O3	13.780	12.130	13.470	13.990	14.350
4	FE2O3	4.100	5.620	5.400	10.969	4.800
5	MGO	0.610	0.480	0.570	6.961	0.310
6	CAO	1.630	2.510	1.760	7.523	1.560
7	NA2O	3.230	3.800	3.640	3.940	4.020
8	K2O	4.240	3.930	3.910	0.687	3.450
9	MN	0.0	0.0	0.0	0.0	0.0
10	NI	0.0	0.0	0.0	0.0	0.0
11	RB	138.000	170.000	154.000	13.000	106.000
12	SR	114.000	130.000	135.000	118.000	111.000
13	ZR	0.0	0.0	0.0	0.0	0.0
14	BA	0.0	0.0	0.0	904.000	0.0
15	CS	0.0	0.0	0.0	4.400	0.0
16	HF	0.0	0.0	0.0	0.0	0.0
17	CO	0.0	0.0	0.0	4.200	0.0
18	CR	0.0	0.0	0.0	5.000	0.0
19	LA	0.0	0.0	0.0	90.000	0.0
20	CE	0.0	0.0	0.0	136.000	0.0
21	ND	0.0	0.0	0.0	0.0	0.0
22	SM	0.0	0.0	0.0	21.000	0.0
23	EU	0.0	0.0	0.0	2.300	0.0
24	GD	0.0	0.0	0.0	0.0	0.0
25	TB	0.0	0.0	0.0	1.900	0.0
26	DY	0.0	0.0	0.0	0.0	0.0
27	HO	0.0	0.0	0.0	0.0	0.0
28	ER	0.0	0.0	0.0	0.0	0.0
29	TM	0.0	0.0	0.0	0.0	0.0
30	YB	0.0	0.0	0.0	9.000	0.0
31	LU	0.0	0.0	0.0	1.400	0.0
32	Y	0.0	0.0	0.0	0.0	0.0
33	SC	0.0	0.0	0.0	0.0	0.0
34	CU	0.0	0.0	0.0	0.0	0.0
35	ZN	0.0	0.0	0.0	0.0	0.0
36	PB	0.0	0.0	0.0	0.0	0.0
37	SB	0.0	0.0	0.0	0.0	0.0
38	TH	0.0	0.0	0.0	0.0	0.0
39	U	0.0	0.0	0.0	0.0	0.0
40	K	35193.770	32625.281	32459.242	5706.590	28640.508
41	TI	0.0	0.0	0.0	7313.352	0.0
42	NA	23966.605	28196.016	27008.816	29238.520	29828.418
43	K/RB	255.064	191.913	210.774	438.968	270.193
44	BA/RB	0.0	0.0	0.0	69.538	0.0
45	RB/SR	1.211	1.308	1.141	0.110	0.955
46	BA/SR	0.0	0.0	0.0	7.661	0.0
47	LA/YB	0.0	0.0	0.0	10.000	0.0
48	K/CS	0.0	0.0	0.0	1296.952	0.0
49	NI/CO	0.0	0.0	0.0	0.0	0.0
50	ZR/HF	0.0	0.0	0.0	0.0	0.0
51	TI/ZR	0.0	0.0	0.0	0.0	0.0
52	ZN/CU	0.0	0.0	0.0	0.0	0.0
53	TH/U	0.0	0.0	0.0	0.0	0.0
54	K/NA	1.469	1.157	1.202	0.195	0.960
55	REE	0.0	0.0	0.0	261.600	0.0
56	F/FM	0.870	0.921	0.905	0.612	0.939
57	RB/CS	0.0	0.0	0.0	2.955	0.0
58	ZN/PB	0.0	0.0	0.0	0.0	0.0

NO	NAME	NP70
		********
1	SIO2	65.630
2	TIO2	0.0
3	AL2O3	12.780
4	FE2O3	8.220
5	MGO	4.630
6	CAO	8.880
7	NA2O	3.040
8	K2O	0.610
9	MN	0.0
10	NI	0.0
11	RB	62.000
12	SR	430.000
13	ZR	0.0
14	BA	0.0
15	CS	0.0
16	HF	0.0
17	CO	0.0
18	CR	0.0
19	LA	0.0
20	CE	0.0
21	ND	0.0
22	SM	0.0
23	EU	0.0
24	GD	0.0
25	TB	0.0
26	DY	0.0
27	HO	0.0
28	ER	0.0
29	TM	0.0
30	YB	0.0
31	LU	0.0
32	Y	0.0
33	SC	0.0
34	CU	0.0
35	ZN	0.0
36	PB	0.0
37	SB	0.0
38	TH	0.0
39	U	0.0
40	K	5063.973
41	TI	0.0
42	NA	22556.809
43	K/RB	81.677
44	BA/RB	0.0
45	RB/SR	0.144
46	BA/SR	0.0
47	LA/YB	0.0
48	K/CS	0.0
49	NI/CO	0.0
50	ZR/HF	0.0
51	TI/ZR	0.0
52	ZN/CU	0.0
53	TH/U	0.0
54	K/NA	0.224
55	REE	0.0
56	F/FM	0.640
57	RB/CS	0.0
58	ZN/PB	0.0

NO	NAME	NO POINTS	MEAN	MEDIAN	STD DEV	REL STD DEV
		********	********	********	********	********
1	SIO2	6	67.923	70.545	7.380	0.109
2	TIO2	1	1.220	1.220	0.0	0.0
3	AL2O3	6	13.417	13.625	0.824	0.061
4	FE2O3	6	6.518	5.510	2.591	0.398
5	MGO	6	2.260	0.590	2.838	1.256
6	CAO	6	3.977	2.135	3.318	0.834
7	NA2O	6	3.612	3.720	0.396	0.110
8	K2O	6	2.805	3.680	1.689	0.602
9	MN	0	0.0	0.0	0.0	0.0
10	NI	0	0.0	0.0	0.0	0.0
11	RB	6	107.167	122.000	60.001	0.560
12	SR	6	173.000	124.000	126.247	0.730
13	ZR	0	0.0	0.0	0.0	0.0
14	BA	1	904.000	904.000	0.0	0.0
15	CS	1	4.400	4.400	0.0	0.0
16	HF	0	0.0	0.0	0.0	0.0
17	CO	1	4.200	4.200	0.0	0.0
18	CR	1	5.000	5.000	0.0	0.0
19	LA	1	90.000	90.000	0.0	0.0
20	CE	1	136.000	136.000	0.0	0.0
21	ND	0	0.0	0.0	0.0	0.0
22	SM	1	21.000	21.000	0.0	0.0
23	EU	1	2.300	2.300	0.0	0.0
24	GD	0	0.0	0.0	0.0	0.0
25	TB	1	1.900	1.900	0.0	0.0
26	DY	0	0.0	0.0	0.0	0.0
27	HO	0	0.0	0.0	0.0	0.0
28	ER	0	0.0	0.0	0.0	0.0
29	TM	0	0.0	0.0	0.0	0.0
30	YB	1	9.000	9.000	0.0	0.0
31	LU	1	1.400	1.400	0.0	0.0
32	Y	0	0.0	0.0	0.0	0.0
33	SC	0	0.0	0.0	0.0	0.0
34	CU	0	0.0	0.0	0.0	0.0
35	ZN	0	0.0	0.0	0.0	0.0
36	PB	0	0.0	0.0	0.0	0.0
37	SB	0	0.0	0.0	0.0	0.0
38	TH	0	0.0	0.0	0.0	0.0
39	U	0	0.0	0.0	0.0	0.0
40	K	6	23282.363	30549.875	14021.645	0.602
41	TI	1	7313.352	7313.352	0.0	0.0
42	NA	6	26799.176	27602.414	2937.445	0.110
43	K/RB	6	241.432	232.919	117.428	0.486
44	BA/RB	1	69.538	69.538	0.0	0.0
45	RB/SR	6	0.811	1.048	0.543	0.669
46	BA/SR	1	7.661	7.661	0.0	0.0
47	LA/YB	1	10.000	10.000	0.0	0.0
48	K/CS	1	1296.952	1296.952	0.0	0.0
49	NI/CO	0	0.0	0.0	0.0	0.0
50	ZR/HF	0	0.0	0.0	0.0	0.0
51	TI/ZR	0	0.0	0.0	0.0	0.0
52	ZN/CU	0	0.0	0.0	0.0	0.0
53	TH/U	0	0.0	0.0	0.0	0.0
54	K/NA	6	0.868	1.059	0.535	0.616
55	REE	1	261.600	261.600	0.0	0.0
56	F/FM	6	0.815	0.888	0.148	0.182
57	RB/CS	1	2.955	2.955	0.0	0.0
58	ZN/PB	0	0.0	0.0	0.0	0.0

APPENDIX II

Computer programs used in this thesis. All programs were used with an IBM 360/44 computer and are written in FORTRAN 4.

List of Programs, Capabilities, and Sources

Program	Capabilities	Source
LOAD	Loads information encoded from Field Data Sheet (Fig. 3) onto tape, counts the number of cards, data stations, and tape spaces.	Beers, C. A.
HISTGRAM	Constructs a printer Histgram of data, can handle 10,000 points at any one value.	Beers, C. A.
POINTPLOT	Plots location of lineation or poles to planes on a 20cm diameter stereonet.	Riese, R. W. (New Mexico Tech Masters Thesis)
SCHMIDT	Calculates the point density of either lineations or poles to planes in a stereonet. It calculates the density in 333 small circles of a specified percentage of the large circle.	Charlesworth, H. A. K. (in Muecke, G. K., et al, 1966)
BETA	Calculates the point density for the intersection of planes.	Lam, P. H.
GREAT CIRCLE	Calculates the best fit great circle to any data in a stereonet.	Beers, C. A.
GEOPLOT	Using data from tape filled by program LOAD, can construct a geologic map, less the contacts, faults, etc. Can be limited to specific areas or geologic features.	Beers, C. A.

GRANITE	Calculates the normative (both CIPW and MESO) compositions of siliceous igneous rocks, the projection ration for each face of the Ab-An-Or-Q tetrahedron, and plots the sample location on each face of the tetrahedron.	Condie, K. C. (New Mexico Tech)
DATAPLOT	Lists geochemical data and calculates the mean, median, standard deviation, and relative standard deviation for each predetermined group of samples (Appendix I). It then plots all elements for which data exists vs. SiO_2, plus 15 additional plots and three triangular diagrams if the data exists for each plot (Appendix III).	Beers, C. A.
RARE EARTH	Lists the concentration of the rare earth elements for each sample, the chrondite values and the chrondite normalized values. It then plots the chrondite normalized values vs. the rare earth elements.	Beers, C. A.

```
****************************** PROGRAM LOAD ******************************

      THIS PROGRAM IS DESIGNED TO TAKE STRUCTURAL DATA FROM THE ACC
  ING STANDARDIZED FIELD FORM (CODED ON AN 80 COLUMN MACHINE CARD) AL
  WRITE IT ON TAPE IN BLOCKS OF 240 BYTES (3 DATA CARDS).  EACH LOCA
  BEGINS A NEW  BLOCK AND ALL CARDS FROM THE SAME LOCATION ARE WRITT
  GIVEN BLOCK, OR SUCESSION OF BLOCKS IF THERE ARE MORE THAN 3 CARDS
  LOCATION.

      THE VARIABLE 'NPOINT' COUNTS THE NUMBERED LOCATIONS, AND THE
  'KOUNT' COUNTS THE  NUMBER OF BLOCKS WRITTEN.  THE VARIABLE 'NCARD
  THE NUMBER OF CARDS READ.

      THE PROGRAM THEN READS FROM THE TAPE AND PRINTS OUT THE BLOCK
  ING FOR  AN IMMEDIATE CHECK OF THE INPUT DATA.

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

      DIMENSIONIY(10),IX(10),INS(10),IEW(10),IGEO(10),IDAT(10),LYTP(10),
     2LYST(10),LYSK(10),LYDP(10),IFTP(10),IFST(10),IFDP(10),MFLY(10),
     3MFFO(10),MFSY(10),MFCL(10),MFRL(10),MFSL(10),MFPL(10),MFAZ(10),
     4MFST(10),MFDP(10),LTP(10),LSFC(10),LPLG(10),LAZM(10),JSPA(10),
     5JSTK(10),JDIP(10),IVTP(10),IVMV(10),IVFI(10),IVST(10),IVDP(10),
     6NUM1(10),NTP1(10),NDS1(10),NUM2(10),NTP2(10),NDS2(10),LOC(10),
     7IXC(10),IYC(10)
      NNN = 0

*** INITIALIZES ALL VARIABLES TO ZERO

      GO TO 51
  150 J = 1
      NCARD = 1
      NUM = 1
      KOUNT = 0
      KLOC = 0
      I = 1
      NUM = 1
      NPOINT = 0

*** READS THE FIRST DATA CARD

      READ(5,10)IY(I),IX(I),INS(I),IEW(I),IGEO(I),IDAT(I),LYTP(I),
     2LYST(I),LYSK(I),LYDP(I),IFTP(I),IFST(I),IFDP(I),MFLY(I),MFFO(I),
     3MFSY(I),MFCL(I),MFRL(I),MFSL(I),MFPL(I),MFAZ(I),MFST(I),MFDP(I),
     4LTP(I),LSFC(I),LPLG(I),LAZM(I),JSPA(I),JSTK(I),JDIP(I),IVTP(I),
     5IVMV(I),IVFI(I),IVST(I),IVDP(I),NUM1(I),NTP1(I),NDS1(I),NUM2(I),
     6NTP2(I),NDS2(I)

*** DETERMINES THE LOCATION AND THE X,Y COORDINATES FOR THE PLOTS

      LOC(I)=IY(I)*100000 + IX(I) *10000 + INS(I) *100  + IEW(I)
      KLOC = LOC(I)
      IXC(I) = IX(I) * 50 + IEW(I)
      IYC(I) = IY(I) * 50 + INS(I)
  100 I = 10
      NUM = NUM + 1

*** READS THE REMAINING DATA CARDS AND DETERMINES THE LOCATION AND THE
*** COORDINATES

      READ(5,10,END=200)IY(I),IX(I),INS(I),IEW(I),IGEO(I),IDAT(I),
     2LYTP(I),LYST(I),LYSK(I),LYDP(I),IFTP(I),IFST(I),IFDP(I),MFLY(I),
     3MFFO(I),MFSY(I),MFCL(I),MFRL(I),MFSL(I),MFPL(I),MFAZ(I),MFST(I),
     4MFDP(I),LTP(I),LSFC(I),LPLG(I),LAZM(I),JSPA(I),JSTK(I),JDIP(I),
     5IVTP(I),IVMV(I),IVFI(I),IVST(I),IVDP(I),NUM1(I),NTP1(I),NDS1(I),
     6NUM2(I),NTP2(I),NDS2(I)
      NCARD = NCARD + 1
      LOC(I)=IY(I)*100000 + IX(I) *10000 + INS(I) *100  + IEW(I)
      IXC(I) = IX(I) * 50 + IEW(I)
      IYC(I) = IY(I) * 50 + INS(I)
*** IF THIS IS THE FOURTH CARD READ SINCE THE PROGRAM HAS WRITTEN ON T
```

```
*** IT WRITES THE BLOCK AND THEN PROCEEDS.

    IF(NUM.EQ.4) GO TO 300

*** CHECKS TO SEE IF THE LOCATION OF THE CARD READ AND THE PREVIOUS CA
*** THE SAME AND IF SO IT STORES THE DATA IN THE NEXT ARRAY SLOT.  IF
*** LOCATIONS ARE NOT EQUAL, THE ARRAY IS WRITTEN ON THE TAPE MINUS TH
*** PREVIOUSLY READ CARD.

    IF(LOC(I).EQ.KLOC) GO TO 500
    KLOC = LOC(I)
    NPOINT = NPOINT + 1
300 KOUNT = KOUNT + 1
    WRITE(2,20)(LOC(I),IXC(I),IYC(I),IGEO(I),IDAT(I),LYTP(I),
   2LYST(I),LYSK(I),LYDP(I),IFTP(I),IFST(I),IFDP(I),MFLY(I),MFFO(I),
   3MFSY(I),MFCL(I),MFRL(I),MFSL(I),MFPL(I),MFAZ(I),MFST(I),MFDP(I),
   4LTP(I),LSFC(I),LPLG(I),LAZM(I),JSPA(I),JSTK(I),JDIP(I),IVTP(I),
   5IVMV(I),IVFI(I),IVST(I),IVDP(I),NUM1(I),NTP1(I),NDS1(I),NUM2(I),
   6NTP2(I),NDS2(I),I=1,3)
    J = 0
    NUM = 1

*** ZEROS ALL THE VARIABLES AFTER WRITING ON THE TAPE

 51 DO 50 K = 1,3
    IY(K) = 0
    IX(K) = 0
    INS(K) = 0
    IEW(K) = 0
    IGEO(K) = 0
    IDAT(K) = 0
    LYTP(K) = 0
    LYST(K) = 0
    LYSK(K) = 0
    LYDP(K) = 0
    IFTP(K) = 0
    IFST(K) = 0
    IFDP(K) = 0
    MFLY(K) = 0
    MFFO(K) = 0
    MFSY(K) = 0
    MFCL(K) = 0
    MFRL(K) = 0
    MFSL(K) = 0
    MFPL(K) = 0
    MFAZ(K) = 0
    MFST(K) = 0
    MFDP(K) = 0
    LTP(K) = 0
    LSFC(K) = 0
    LPLG(K) = 0
    LAZM(K) = 0
    JSPA(K) = 0
    JSTK(K) = 0
    JDIP(K) = 0
    IVTP(K) = 0
    IVMV(K) = 0
    IVFI(K) = 0
    IVST(K) = 0
    IVDP(K) = 0
    NUM1(K) = 0
    NTP1(K) = 0
    NDS1(K) = 0
    NUM2(K) = 0
    NTP2(K) = 0
    NDS2(K) = 0
    LOC(K) = 0
    IXC(K) = 0
    IYC(K) = 0
 50 CONTINUE
    IF(NNP.EQ.0) GO TO 150
```

```
*** PLACES THE DATA OF THE CARD READ IN THE NEXT AVAILABLE SLOT OF THE

300 J = J +1
    IY(J) = IY(10)
    IX(J) = IX(10)
    INS(J) = INS(10)
    IEW(J) = IEW(10)
    IGEO(J) = IGEO(10)
    IDAT(J) = IDAT(10)
    LYTP(J) = LYTP(10)
    LYST(J) = LYST(10)
    LYSK(J) = LYSK(10)
    LYDP(J) = LYDP(10)
    IFTP(J) = IFTP(10)
    IFST(J) = IFST(10)
    IFDP(J) = IFDP(10)
    MFLY(J) = MFLY(10)
    MFFO(J) = MFFO(10)
    MFSY(J) = MFSY(10)
    MFCL(J) = MFCL(10)
    MFRL(J) = MFRL(10)
    MFSL(J) = MFSL(10)
    MFPL(J) = MFPL(10)
    MFAZ(J) = MFAZ(10)
    MFST(J) = MFST(10)
    MFDP(J) = MFDP(10)
    LTP(J) = LTP(10)
    LSFC(J) = LSFC(10)
    LPLG(J) = LPLG(10)
    LAZM(J) = LAZM(10)
    JSPA(J) = JSPA(10)
    JSTK(J) = JSTK(10)
    JDIP(J) = JDIP(10)
    IVTP(J) = IVTP(10)
    IVMV(J) = IVMV(10)
    IVFI(J) = IVFI(10)
    IVST(J) = IVST(10)
    IVDP(J) = IVDP(10)
    NUM1(J) = NUM1(10)
    NTP1(J) =NTP1(10)
    NDS1(J) = NDS1(10)
    NUM2(J) = NUM2(10)
    NTP2(J) = NTP2(10)
    NDS2(J) = NDS2(10)
    LOC(J) = LOC(10)
    IXC(J) = IXC(10)
    IYC(J) = IYC(10)
    GO TO 100
100 PRINT 30, NPOINT
    PRINT 90, NCARD
    PRINT 80, KOUNT
    REWIND 2

*** GIVES A PRINT OF ALL THE DATA ON THE TAPE

    DO 41 J = 1,KOUNT
    READ (2,20)(LOC(I),IXC(I),IYC(I),IGEO(I),IDAT(I),LYTP(I),
   2LYST(I),LYSK(I),LYDP(I),IFTP(I),IFST(I),IFDP(I),MFLY(I),MFFO(I),
   3MFSY(I),MFCL(I),MFRL(I),MFSL(I),MFPL(I),MFAZ(I),MFST(I),MFDP(I),
   4LTP(I),LSFC(I),LPLG(I),LAZM(I),JSPA(I),JSTK(I),JDIP(I),IVTP(I),
   5IVMV(I),IVFI(I),IVST(I),IVDP(I),NUM1(I),NTP1(I),NDS1(I),NUM2(I),
   6NTP2(I),NDS2(I),I=1,3)
    PRINT 40,   (LOC(I),IXC(I),IYC(I),IGEO(I),IDAT(I),LYTP(I),
   2LYST(I),LYSK(I),LYDP(I),IFTP(I),IFST(I),IFDP(I),MFLY(I),MFFO(I),
   3MFSY(I),MFCL(I),MFRL(I),MFSL(I),MFPL(I),MFAZ(I),MFST(I),MFDP(I),
   4LTP(I),LSFC(I),LPLG(I),LAZM(I),JSPA(I),JSTK(I),JDIP(I),IVTP(I),
   5IVMV(I),IVFI(I),IVST(I),IVDP(I),NUM1(I),NTP1(I),NDS1(I),NUM2(I),
   6NTP2(I),NDS2(I),I = 1,3)
    PRINT 60
41  CONTINUE
    WRITE(6,500)
```

```
*** FORMATS                                                                        LOAD2170
                                                                                   LOAD2180
 10 FORMAT(2I1,3I2,I6,7X,2I1,2I3,I1,I3,I2,6I1,I2,2I3,I2,2I1,I2,I3,I1,             LOAD2190
   2I3,I2,3I1,I3,I2,I1,I2,2I1,I2,I1)                                               LOAD2200
 20 FORMAT( 3(I6,2I3,I2,I6,1X,2I1,2I3,I1,I3,I2,6I1,I2,2I3,I2,2I1,I2,               LOAD2210
   2I3,I1,I3,I2,3I1,I3,I2,I1,I2,2I1,I2,I1))                                        LOAD2220
 30 FORMAT(' '5X,'NUMBER OF LOCATIONS = 'I6)                                       LOAD2230
 40 FORMAT(' 'I6,2I3,I2,I6,1X,2I1,2I3,I1,I3,I2,6I1,I2,2I3,I2,2I1,I2,               LOAD2240
   2I3,I1,I3,I2,3I1,I3,I2,I1,I2,2I1,I2,I1)                                         LOAD2250
 60 FORMAT(/1X,100('+'),//)                                                        LOAD2260
 90 FORMAT(' '5X,'NUMBER OF BLOCKS ON TAPE = 'I6//)                                LOAD2270
 90 FORMAT(' '5X,'NUMBER OF DATA CARDS  ='I6)                                      LOAD2280
501 FORMAT('1')                                                                    LOAD2290
    CALL EXIT                                                                      LOAD2300
    END                                                                            LOAD2310
```

```
C**************************  PROGRAM HISTGRAM  ****************************
C
C     THIS PROGRAM PREPARES A PRINTER HISTOGRAM OF VARIOUS STRUCTUR
C DESIRED.  THE PROGRAM PRINTS 'X' IF THE MAXIMUM NUMBER OF VALUES I
C GIVEN RANGE IS LESS THAN 100, IT PRINTS 'Y' IF THIS NUMBER IS LESS
C 1000, AND DELETES ANY AMOUNTS LESS THAN 10, AND IT PRINTS 'Z' IF TH
C MAZIMUM NUMBER IS GREATER THAN 1000 AND DELETES ANY VALUE LESS THA
C THIS PROGRAM MAY BE USED IN CONJUNCTION WITH PROGRAM LOAD OR
C SEPERATELY
C
C      DATA CARD 1   IXMIN,IXMAX,IYMIN,IYMAX,NTYP
C                    FORMAT(5I10)
C
C  THESE ARE CONTROL VARIABLES FOR THE LOCATION AND ROCK TYPE
C
C                    IXMIN - MINIMUM VALUE FOR THE E - W COORDINATE
C                    IXMAX - MAXIMUM VALUE FOR THE E - W COORDINATE
C                    IYMIN - MINIMUM VALUE FOR THE N - S COORDINATE
C                    IYMAX - MAXIMUM VALUE FOR THE N - S COORDINATE
C                    NTYP -  THE ROCK TYPE CORRESPONDING THE THE ROCK
C                            TYPE SHOWN ON THE FIELD DATA SHEET.  ONLY
C                            ONE ROCK TYPE IS USED UNLESS NTYP IS SET
C                            EQUAL TO 500.
C
C      DATA CARD 2   FMT
C                    FORMAT(16A4)
C
C                    FMT - THE FORMAT IN WHICH THE DATA IS TO BE READ.
C                          THIS MUST CORRESPOND TO THE FORMAT USED IN
C                          PROGRAM LOAD TO PLACE THAT PARTICULAR DATA
C                          P ON TAPE, OR TO TO FORMAT WHICH IS USED TO
C                            PLACE THE DATA ON CARDS
C
C      DATA CARD 3   TITLE
C                    FORMAT(20A4)
C
C                    TITLE - A 80 CHARACTER NAME TO DESCRIBE THE GRAPH
C
C**************************************************************************
C
C
      LOGICAL *1X/'X'/
      DIMENSION KSTK(3000),A(400),JSTK(3000),JTYP(5),NTP(5),
     2IXC(5),IYC(5),FMT(16),JDIP(5),TITLE(20)
      K = 0
    5 READ(5,10,END=1000) IXMIN,IXMAX,IYMIN,IYMAX,NTYP
   10 FORMAT(5I10)
      READ(5,11) FMT
   11 FORMAT(16A4)
      READ(5,13) TITLE
   13 FORMAT(20A4)
C
C*** READS VALUES OFF OF TAPE, (MAXIMUN NUMBER 3000)
C
C*** TO CHANGE THE DATA READ, CHANGE THE FORMAT STATEMENT
C
   15 READ(2,FMT,END=20)(IXC(I),IYC(I),JTYP(I),JSTK(I),JDIP(I),NTP(I),
     2I=1,3)
      DO 50 I = 1,3
C
C*** DETERMINE IF PROPER DATA EXISTS AT THAT LOCATION.  MAY BE CHANGED
C*** TO EQUAL ONLY CERTAIN NUMBERS CORRESPONDING TO SPECIAL TYPES OF
C*** DATA. SEE FIELD DATA SHEET.
C
      IF(JTYP(I).EQ.0) GO TO 50
      IF(IXC(I).LE.IXMIN.OR.IXC(I).GT.IXMAX) GO TO 50
      IF(IYC(I).LE.IYMIN.OR.IYC(I).GT.IYMAX) GO TO 50
      IF(NTYP.EQ.500) GO TO 12
      IF(NTP(I).NE.NTYP) GO TO 50
   12 K = K + 1
      KSTK(K) = JSTK(I)
   50 CONTINUE
      GO TO 15
```

```
20 DO 40 I = 1,K
   IF(KSTK(I).EQ.0) KSTK(I) = 360
   IRNG = (KSTK(I)/5) * 5
   AVAL = (IRNG/5) + 1
   A(AVAL)= A(AVAL) + 1
40 CONTINUE
*** WRITES THE TITLE OF THE GRAPH
   WRITE(6,44) TITLE
44 FORMAT('1',5X,20A4)
*** DETERMINES WHICH CODE TO PRINT
   DO 45 I = 1,72
   IF(N.GT.A(I)) GO TO 45
   N = A(I)
45 CONTINUE
   IF(N.LE.100) GO TO 41
   IF(N.LE.1000) GO TO 42
   DO 55 I = 1,72
   IDEX = (I - 1) * 5
   K = A(I)/100
   IF(K.NE.0) GO TO 80
   PRINT 61, IDEX
   GO TO 55
80 PRINT 60, IDEX,(Z,J=1,K)
55 CONTINUE
   GO TO 65
42 DO 56 I = 1,72
   IDEX = (I - 1) * 5
   K = A(I)/10
   IF(K.NE.0) GO TO 82
   PRINT 61, IDEX
   GO TO 56
82 PRINT 60, IDEX,(Y,J=1,K)
56 CONTINUE
   GO TO 65
41 DO 46 I = 1,72
   IDEX = (I - 1) * 5
   K = A(I)
   IF(K.NE.0) GO TO 43
   PRINT 61, IDEX
   GO TO 46
43 PRINT 60, IDEX,(X,J=1,K)
46 CONTINUE
*** FORMATS
60 FORMAT( 5X,I3,2X,'|',100(A1)/ 10X,'|')
61 FORMAT(5X,I3,2X,'|')
65 WRITE(6,64)
64 FORMAT('1')
   REWIND 2
   GO TO 5
1000 CALL EXIT
   END
```

```
      THIS SECTION CONVERTS THE DIP IN DEGREES TO HADE IN RADIANS.

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

 40 DO 45 J=1,NMAX
 42 D(J)=(IABS(KD(J)))*0.00873

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

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

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

    S(J) = FLOAT(KS(J))
 44 S(J) = 360. - S(J)
    S(J)= S(J)*0.01745
    R(J)=14.14214*SIN(D(J))*0.39370
 45 CONTINUE

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

      THIS SECTION CONVERTS POLAR TO RECTILINEAR COORDINATES.

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

    WRITE(6,901) NMAX
901 FORMAT(' 'I5)
    DO 50 K6=1,NMAX
    X(K6) = R(K6)*SIN(S(K6))
    Y(K6) = R(K6)*COS(S(K6))
 50 CONTINUE

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

      THIS SECTION SORTS X AND Y INTO ASCENDING ORDER.

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

    NMAX1=NMAX-1
    DO 61 INDEX=1,NMAX1
    DO 61 L=1,NMAX1
    IF(X(L)-X(L+1))61,61,60
 60 B=X(L+1)
    X(L+1)=X(L)
    X(L)=B
    B=Y(L+1)
    Y(L+1)=Y(L)
    Y(L)=B
 61 CONTINUE
    CALL CIRCLE(J4)
    CALL POINT(NMAX)
    CALL LABEL(NMAX,J1)
    GO TO 2
200 WRITE(6,201)
201 FORMAT(' ','"5"-(OR TRAILER) CARD WAS CARRIED THRU THE'
   1'STRIKE REORIENTING COMPUTATION')
    GO TO 2
202 WRITE(6,203)
203 FORMAT(' ','ORIENTATION DATA PIECE NUMBER',1X,I4,1X,'PUNCHED'
   1'GREATER THAN 360 DEGREES')
    GO TO 2
999 CALL PLOT(0.0,0.0,999)
    CALL EXIT
    END
    SUBROUTINE CIRCLE(J4)

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

      THE CIRCLE SUBROUTINE PRODUCES A SMOOTH CIRCLE OF 20 CM.
      DIAMETER WITH TWO LINES AT RIGHT ANGLES RUNNING THE FULL
      DIAMETER AND LABELED IN THE FOLLOWING MANNER--
```

```
                                        N
      J4=1                            W   E
                                        S

                            A
      J4=2    BLANK           B
                      BLANK

                                        C
      J4=3                      BLANK     B
                                     BLANK

                            C
      J4=4    BLANK           A
                      BLANK
***************************************************************************

      CALL PLOT(14.0,-12.0,-3)
      CALL PLOT(0.0,5.5,-3)
      CALL PLOT(3.937,0.0,3)
      DO 600 I=1,10000
      B=I
      R=B*0.00062820
      X1=3.937*COS(R)
      Y1=3.937*SIN(R)
  600 CALL PLOT(X1,Y1,2)
      CALL PLOT(X1,Y1,3)
      IF(J4-1)601,601,602
  601 CALL SYMBOL(4.00,-0.15,0.3,69,0.0,-1)
      GO TO 605
  602 IF(J4-3)603,603,604
  603 CALL SYMBOL(4.00,-0.15,0.3,66,0.0,-1)
      GO TO 605
  604 CALL SYMBOL(4.00,-0.15,0.3,65,0.0,-1)
  605 CALL PLOT(3.937,0.0,3)
      CALL PLOT(-3.937,0.0,2)
      IF(J4-1)606,606,607
  606 CALL SYMBOL(-4.17,-0.15,0.3,102,0.0,-1)
  607 IF(J4-1)608,608,609
  608 CALL SYMBOL(-0.09,4.00,0.3,85,0.0,-1)
      GO TO 612
  609 IF(J4-3)610,611,611
  610 CALL SYMBOL(-0.09,4.00,0.3,65,0.0,-1)
      GO TO 612
  611 CALL SYMBOL(-0.09,4.00,0.3,67,0.0,-1)
  612 CALL PLOT(0.0,3.937,3)
      CALL PLOT(0.0,-3.937,2)
      IF(J4-1)613,613,614
  613 CALL SYMBOL(-0.09,-4.30,0.3,98,0.0,-1)
  614 RETURN
      END
      SUBROUTINE POINT(NMAX)
***************************************************************************

          THE POINT SUBROUTINE PLOTS AN X, CENTERED AT EACH POSITION
          OF NMAX, THE TOTAL OF POSITIONS TO BE PLOTTED, WITHIN A 20
          CENTIMETER DIAMETER CIRCLE.

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

      COMMON X(2000),Y(2000),K5(16)
  700 DO 701 K=1,NMAX
  701 CALL SYMBOL(X(K),Y(K),0.08,4,0.0,-1)
      RETURN
      END
      SUBROUTINE LABEL(NMAX,J1)
***************************************************************************
```

```
      THE LABEL SUBROUTINE WRITES BELOW THE 20 CM. CIRCLE THE
      FOLLOWING-----ON THE FIRST LINE FOLIATION, LINEATION,
      CLEAVAGE, OR C-AXES POLES (DEPENDING ON J). SEE PARENTHETICAL
      NUMBERS IN SECTION EXPLANATIONS IN THE MAIN PROGRAM).
      ON THE SECOND LINE THE NUMBER OF POINTS PLOTTED FOLLOWED
      BY TEN PLACES FOR CONTOUR PERCENTS.

*************************************************************************
      COMMON X(2000),Y(2000),K5(16)
      CALL PLOT(-2.56,-4.75,-3)
      CALL SYMBOL(0.0,0.0,0.3,K5,0.0,64)
      P=NMAX
      CALL NUMBER(1.81,-0.4,0.2,P,0.0,-1)
      CALL SYMBOL(2.51,-0.4,0.2,' POINTS',0.0,7)
      CALL PLOT(0.0,-0.75,-3)
      RETURN
      END
```

```
C******************** PROGRAM SCHMIDT ***********************************
C***********************************************************************
C       PROGRAM SCHMIDT IS PART OF A STRUCTURAL PROGRAM SEQUENCE
C  DESIGNED TO TAKE RAW DATA FROM THE FIELD, KEYED TO A PARTICULAR GRID
C  SYSTEM, AND ANALYZE IT.  THE DATA HAS BEEN PREVIOUSLY STORED ON TAPE
C  BY PROGRAM 'LOAD'.  SCHMIDT IS ALSO CAPABLE OF ANALYZING RANDOM DATA
C  NOT KEYED TO A GRID, BUT INPUT ON DATA CARDS.  SCHMIDT COMPUTES THE
C  DENSITY OF POINTS PER A GIVEN PERCENT AREA AS SPECIFIED BY THE
C  VARIABLE 'KPCA'.  SCHMIDT GIVES A PRINTER OUTPUT, AND IF DESIRED A
C  PLOT OF THE PERCENT DENSITY FOR 333 SPECIFIED COORDINATES.  THE PLOT
C  IS REDUCED TO OVERLAY A STANDARD 20 CM DIAMETER NET.  THE 333 CO-
C  ORDINATES ARE THE FIRST 333 DATA CARDS AND MUST BE KEPT WITH THE
C  PROGRAM AT ALL TIMES.  THE MELLIS METHOD IS USED TO DETERMINE THE
C  PERCENT DENSITY
C
C  INPUT -- FOLLOWING THE 333 COORDINATE DATA CARDS
C    CARD 1   KPCA,NZ,J4,PLOX
C             FORMAT(3I5,F5.0)
C
C             KPCA - THE PERCENT AREA TO CONSIDERED
C
C             NZ - = 1; READS STRIKE AND DIP FROM TAPE
C                  = 2; READS LINEATIONS FROM TAPE
C                  = 3; READS STRIKE AND DIP FROM CARDS
C                  = 4; READS LINEATIONS (OR POLES) FROM CARDS
C
C             J4-      SEE SUBROUTINE CIRCLE
C                  = 1; PLOTS N,E,S,W, ON STERONET
C                  = 2; PLOTS A,B, OF THE STERONET
C                  = 3; PLOTS C,B ON THE STERONET
C                  = 4; PLOTS C,A ON THE STERONET
C
C             PLOX - = 1.0; IF A PLOT OF THE DENSITY IS DESIRED
C                    = 0.0; IF A PRINTER OUTPUT ONLY IS DESIRED
C
C    CARD 2   TITLE(20)
C             FORMAT(20A4)
C
C             TITLE - THE NAME TO BE PLOTTED AND PRINTED WITH THE DENSITY
C                     OUTPUT DIAGRAM
C
C    CARD 3   IXMIN,IXMAX,IYMIN,IYMAX,NTYP
C             FORMAT(5I10)
C
C         THIS ALLOWS THE FULL GRID TO BE SUBDIVIDED INTO SEVERAL
C         SMALLER GRIDS FOR ANALYSIS.  IF DATA IS READ FROM DATA CARDS
C         USE A BLANK CARD.
C
C             IXMIN - THE MINIMUM X GRID VALUE TO BE CONSIDERED
C
C             IXMAX - THE MAXIMUM X GRID VALUE TO BE CONSIDERED
C
C             IYMIN - THE MINIMUM Y GRID VALUE TO BE CONSIDERED
C
C             IYMAX - THE MAXIMUM Y GRID VALUE TO BE CONSIDERED
C
C             NTYP - THE ROCK TYPE TO BE CONSIDERED (CODE AS PER THE
C                    FIELD DATA SHEET; IF 500 IS USED ALL ROCK TYPES IN
C                    THAT PORTION OF THE GRID WILL BE CONSIDERED)
C
C    CARD 4   NN,FMT
C             FORMAT(I5,16A4)
C
C             NN - THE NUMBER OF STRIKE AND DIP, OR TREND AND PLUNGE
C                  PAIRS PER DATA CARD; 0 IF DATA IS READ FROM TAPE
C                  LOADED BY PROGRAM 'LOAD'.
C
C             FMT - THE FORTRAN IV FORMAT IN WHICH THE ATTITUDE DATA IS
C                   TO BE PUNCHED, OR READ FROM TAPE IF THE DATA WAS
C                   STORED ON TAPE BY PROGRAM 'LOAD'.  SEE PROGRAM LOAD
C                   FOR THE PROPER FORMAT FOR RETRIEVING THIS DATA.
```

```
CARDS 5-? M(I),MN(I),ETC
        FORMAT(AS SPECIFIED WITH CARD 4)

        THE DATA MUST BE IN THE FOLLOWING ORDER: STRIKE,DIP,
        STRIKE,DIP,ETC; OR TREND,PLUNGE,TREND,PLUNGE,ETC

 PLACE A /* IN THE CARD FOLLOWING THE LAST ATTITUDE CARD.  THE
 SEQUENCE OF DATA CARDS FROM 1 - 5 CAN NOW BE REPEATED FOR A SECOND
 SET OF DATA

*************************** IMPORTANT ******************************

        IF BOTH STRIKE AND DIP OR TREND AND PLUNGE VALUES ARE
        ZERO (0) THEY ARE IGNORED.  THEREFORE HORIZONTAL BEDS
        CANNOT BE USED.

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


  DIMENSION G(2000),P(2000),COSA(333),COSB(333),COSG(333),FMT(16),
 1M(5),MM(5),MN(5),IXC(5),IYC(5),NTP(5)
  COMMON A(2000),B(2000),TITLE(20),ND(333),T(2000)
*** READS COSINES OF THE POINTS ON THE GRID WHERE PERCENTAGES ARE TO B
*** CALCULATED.  THESE MUST BE IN NUMERICAL ORDER FROM 1 TO 333
  DO 2 I=1,333
  NZ=0
  READ(5,51)COSA(I),COSB(I),COSG(I),J
51 FORMAT(7X,3F11.8,17X,I3)
  IF(I.NE.J) GO TO 23
2 CONTINUE
230 READ(5,525,END=270)KPCA,NZ,J4,PLOX
525 FORMAT(3I5,F5.0)
*** READS PERCENT AREA TO BE CONSIDERED AND THE DATA TO BE READ
  IF(KPCA.EQ.0) GO TO 24
  TEST=1.0 - 0.01 * FLOAT(KPCA)
3 DO 4 I=1,333
4 ND(I)=0
  N=0
  NCDS=0
*** READS THE TITLE OF THE PLOT
  READ(5,100)TITLE
100 FORMAT(20A4)
  READ(5,53) IXMIN,IXMAX,IYMIN,IYMAX,NTYP
53 FORMAT(5I10)
  READ(5,54) NN,FMT
54 FORMAT(I5,16A4)
  GO TO (5,10,30,40),NZ
*** READS PLANER DATA FROM THE TAPE FILLED BY PROGRAM LOAD, IF NZ = 0,
*** ADJUSTMENT OF THE FORMAT ALLOWS DIFFERENT PLANER DATA TO BE READ F
*** THE TAPE
5 READ(2,FMT,END=12)(IXC(I),IYC(I),M(I),MM(I),MN(I),NTP(I),I=1,3)
  DO 260 KI= 1,3
  IF(M(KI).EQ.0) GO TO 260
  IF(IXC(KI).LE.IXMIN.OR.IXC(KI).GT.IXMAX) GO TO 260
  IF(IYC(KI).LE.IYMIN.OR.IYC(KI).GT.IYMAX) GO TO 260
  IF(NTYP.EQ.500) GO TO 8
  IF(NTP(KI).NE.NTYP) GO TO 260
8 NSTR = MM(KI)
  NDIP = MN(KI)
*** CONVERTS PLANER DATA TO POLES
  IF(NSTR.LT.0)GO TO 12
  IF(NSTR.LE.90) GO TO 706
  NSTR = NSTR - 90
  GO TO 707
706 NSTR = NSTR + 270
707 NCDS=NCDS+1
  PL=90.-FLOAT(NDIP)
  TR=FLOAT(NSTR)
  I=NCDS
  T(I)=TR
  IF(T(I).LT.0) T(I)=T(I)+360.0
  P(I)=PL
```

```
      PL=3.1415926*PL/180.
      TR=3.1415926*TR/180.
      A(I)=COS(TR)*COS(PL)
      B(I)=SIN(TR)*COS(PL)
      G(I)=SIN(PL)
  260 CONTINUE
      GO TO (5,10,30,40),NZ
C *** READS LINEATIONS FROM THE TAPE IF NZ = 1
   10 READ(2,FMT,END=12)(IXC(IK),IYC(IK),MN(IK),M(IK),MM(IK),NTP(IK),
     2IK=1,3)
      DO 261 IK=1,3
      IF(MN(IK).EQ.0) GO TO 261
      IF(IXC(IK).LE.IXMIN.OR.IXC(IK).GT.IXMAX) GO TO 261
      IF(IYC(IK).LE.IYMIN.OR.IYC(IK).GT.IYMAX) GO TO 261
      IF(NTYP.EQ.500) GO TO 9
      IF(NTP(IK).NE.NTYP) GO TO 261
    9 NPL = M(IK)
      NTR = MM(IK)
      IF(NTR.LT.0) GO TO 12
      NCDS = NCDS + 1
      TR = FLOAT(NTR)
      PL = FLOAT(NPL)
      I=NCDS
      T(I)=TR
      IF(T(I).LT.0) T(I)=T(I)+360.0
      P(I)=PL
      PL=3.1415926*PL/180.
      TR=3.1415926*TR/180.
      A(I)=COS(TR)*COS(PL)
      B(I)=SIN(TR)*COS(PL)
      G(I)=SIN(PL)
  261 CONTINUE
      GO TO (5,10,30,40),NZ
   30 READ(5,FMT,END=12)(MM(II),MN(II),II=1,NN)
      DO 33 II = 1,NN
      IF(MM(II).EQ.0.AND.MN(II).EQ.0) GO TO 33
      IF(MM(II).LE.90) GO TO 708
      TR = FLOAT(MM(II)) - 90.
      GO TO 709
  708 TR = FLOAT(MM(II)) + 270.
  709 PL = 90. - FLOAT(MN(II))
      NCDS = NCDS + 1
      I = NCDS
      T(I)=TR
      IF(T(I).LT.0) T(I)=T(I)+360.0
      P(I)=PL
      PL=3.1415926*PL/180.
      TR=3.1415926*TR/180.
      A(I)=COS(TR)*COS(PL)
      B(I)=SIN(TR)*COS(PL)
      G(I)=SIN(PL)
   33 CONTINUE
      GO TO (5,10,30,40),NZ
   40 READ(5,FMT,END=12)(MM(II),MN(II),II=1,NN)
      DO 43 II = 1,NN
      IF(MM(II).EQ.0.AND.MN(II).EQ.0) GO TO 43
      PL = FLOAT(MN(II))
      TR= FLOAT(MM(II))
      NCDS = NCDS + 1
      I = NCDS
      T(I)=TR
      IF(T(I).LT.0) T(I)=T(I)+360.0
      P(I)=PL
      PL=3.1415926*PL/180.
      TR=3.1415926*TR/180.
      A(I)=COS(TR)*COS(PL)
      B(I)=SIN(TR)*COS(PL)
      G(I)=SIN(PL)
   43 CONTINUE
      GO TO (5,10,30,40),NZ
   12 CONTINUE
      N=NCDS
```

```
      BB=FLOAT(N)
      U=.1005*SQRT(BB)
      H=U
      PMAX=0.
C *** FINDS THE MAZIMUM PLUNGE
      DO 124 I=1,NCODS
      IF(PMAX.GE.G(I)) GO TO 124
      PMAX=G(I)
  124 CONTINUE
      PMAX=PMAX+TEST
C *** DETERMINES THE DENSITY OF POINTS AT EACH GRID POINT
      DO 16 I=1,333
      CSG=COSG(I)
      DENS=0.
      IF(PMAX.LE.CSG) GO TO 16
      CSA=COSA(I)
      CSB=COSB(I)
      DO 14 J=1,NCDS
      GEE=G(J)
      IF(ABS(GEE-CSG).GT.TEST) GO TO 14
      IF(TEST.GT.ABS(CSA*A(J)+CSB*B(J)+CSG*GEE))GO TO 14
      DENS=DENS+1.
   14 CONTINUE
   16 ND(I)=DENS
C *** CONVERTS THE DENSITY TO PERCENT
   20 DO 21 I=1,333
      RNCDS = 100./FLOAT(NCDS)
      XND=ND(I)
   21 ND(I)=XND*RNCDS+.5
C *** PRINTS THE DIAGRAM
      WRITE(6,125)TITLE
  125 FORMAT(1H1,20A4)
      WRITE(6,150) KPCA,NCDS
  150 FORMAT(25H PERCENTAGE OF POINTS PER ,I1,13H PERCENT AREA,15X,20X,
     1I4,7H POINTS)
      WRITE(6,200)    (ND(I),   I=1,333)
  200 FORMAT(50X,I5,/39X,I5,I6,I10,I6//30X,9I5///20X,13I5///15X,15I5///1
     10X,17I5///10X,17I5///5X,19I5///5X,19I5/I6,93X,I5//5X,19I
     25/I6,93X,I5//21I5//I6,9 X,I5/5X,19I5//I6,93X,I5/5X,19I5///5X,19I5/
     3//5X,19I5///10X,17I5///10X,17I5///15X,15I5///20X,13I5///30X,9I5//3
     49X,I5,I6,I10,I6,/50X,I5)
      IF(PLOX.EQ.1.) GO TO 300
      GO TO 22
  300 DO 310 I=1,333
      P(I) = ARCOS(COSG(I))/2.
      IF(COSG(I).EQ.1.) GO TO 304
      T(I) = ARSIN(ABS(COSA(I))/COS(ARSIN(COSG(I))))
      GO TO 306
  304 T(I) = 0.
  306 IF(COSA(I).LE.0..AND.COSB(I).GT.0.) T(I) = T(I) + 3.14159/2.
      IF(COSA(I).LE.0..AND.COSB(I).LE.0.)  GO TO 309
      IF(COSA(I).GT.0..AND.COSB(I).LE.0.) T(I) = T(I) + 3.*3.14159/2.
      IF(COSA(I).GT.0..AND.COSB(I).GT.0.) GO TO 308
      G(I) = 14.14214 * SIN(P(I)) * 0.39370
      A(I) = G(I) * SIN(T(I))
      B(I) = G(I) * COS(T(I))
      GO TO 310
  309 T(I) = T(I) + 3.14159
  308 G(I) = 14.14214 * SIN(P(I)) * 0.39370
      A(I) = G(I) * COS(T(I))
      B(I) = G(I) * SIN(T(I))
  310 CONTINUE
      CALL CIRCLE(J4)
      CALL POINT
      CALL LABEL(NCDS)
   22 REWIND 2
      GO TO 283
   23 WRITE(6,71)
      WRITE(6,74)I,J
   74 FORMAT(1H0,2I10)
      CALL EXIT
   24 WRITE(6,72)
```

```
      CALL EXIT
      FORMAT(44H ERROR=*** POINT-COUNTER OUT OF SEQUENCE ***,//78H PLEAS
     1E SEE TO IT THAT NUMBERS IN COLUMNS 58-60 ARE IN SEQUENCE FROM 1 T
     20 333.)
      CALL EXIT
      CALL EXIT
      FORMAT(52H ERROR= PERCENTAGE OF AREA CONSTANT MISSING OR ZERO.///2
     11X,3H OR//57H ILLEGAL CHARACTERS IN COLUMNS 7,8, AND 9 OF STATION
     2 CARD)
   35 WRITE(6,73)
      CALL EXIT
      FORMAT(44H ERROR...STATION NUMBER AND DATA CARD MIX-UP)
  710 CALL EXIT
      END
      SUBROUTINE CIRCLE(J4)
C**********************************************************************
C
C        THE CIRCLE SUBROUTINE PRODUCES A SMOOTH CIRCLE OF 20 CM.
C        DIAMETER WITH TWO LINES AT RIGHT ANGLES RUNNING THE FULL
C        DIAMETER AND LABELED IN THE FOLLOWING MANNER--
C
C                                  N
C        J4=1                    W   E
C                                  S
C
C                                  A
C        J4=2              BLANK     B
C                                BLANK
C                                  C
C        J4=3              BLANK     B
C                                BLANK
C
C                          C
C        J4=4     BLANK       A
C                      BLANK
C
C**********************************************************************
C
      CALL PLOT(12.0,6.0,-3)
      CALL PLOT(3.937,0.0,3)
      DO 600 I=1,10000
      B= I
      R= B * 0.00062820
      X1 = 3.937 * COS(R)
      Y1 = 3.937 * SIN(R)
  600 CALL PLOT(X1,Y1,2)
      CALL PLOT(X1,Y1,3)
      IF(J4-1) 601,601,602
  601 CALL SYMBOL(4.00,-0.15,0.3,69,0.0,-1)
      GO TO 605
  602 IF(J4 - 3)603,603,604
  603 CALL SYMBOL(4.00,-0.15,0.3,66,0.0,-1)
      GO TO 605
  604 CALL SYMBOL(4.00,-0.15,0.3,65,0.0,-1)
  605 CALL PLOT(3.937,0.0,3)
      CALL PLOT(-3.937,0.0,2)
      IF(J4 - 1)606,606,607
  606 CALL SYMBOL(-4.17,-0.15,0.3,102,0.0,-1)
  607 IF(J4 - 1)608,608,609
  608 CALL SYMBOL(-0.09,4.00,0.3,85,0.0,-1)
      GO TO 612
  609 IF(J4 - 3)610,611,611
  610 CALL SYMBOL(-0.09,4.00,0.3,65,0.0,-1)
      GO TO 612
  611 CALL SYMBOL(-0.09,4.00,0.3,67,0.0,-1)
  612 CALL PLOT(0.0,3.937,3)
      CALL PLOT(0.0,-3.937,2)
      IF(J4 - 1)613,613,614
  613 CALL SYMBOL(-0.09,-4.30,0.3,98,0.0,-1)
  614 RETURN
      END
      SUBROUTINE POINT
```

```
      COMMON A(2000),B(2000),TITLE(20),ND(333),T(2000)                   SHDT3610
      DO 700 K=1,333                                                     SHDT3620
      TP=FLOAT(ND(K))                                                    SHDT3630
      CALL NUMBER(A(K),B(K),0.1,TP,0.0,-1)                               SHDT3640
      RETURN                                                             SHDT3650
      END                                                                SHDT3660
      SUBROUTINE LABEL(NCDS)                                             SHDT3670
      COMMON A(2000),B(2000),TITLE(20),ND(333),T(2000)                   SHDT3680
      CALL PLOT(-4.56,-4.75,-3)                                          SHDT3690
      CALL SYMBOL(2.8,0.0,0.2,'POINT DENSITY PLOT OF',0.0,21)            SHDT3700
      CALL SYMBOL(2.0,-0.4,0.2,TITLE,0.0,64)                             SHDT3710
      CDS = FLOAT(NCDS)                                                  SHDT3720
      CALL NUMBER(5.2,-0.8,0.2,CDS,0.0,-1)                               8HDT3730
      CALL SYMBOL(4.6,-0.8,0.2,'POINTS',0.0,6)                           SHDT3740
      CALL PLOT(11.0,0.0,999)                                            SHDT3750
      CALL PLOT(0.0,-1.25,-3)                                            SHDT3755
      RETURN                                                             SHDT3760
      END                                                                SHDT3770
```

DIRECTION COSINES OF THE DENSITY GRID POINTS

0	1.00000000	0.00000000	0.00000000	1	001
1	.97799857	-.20788021	.01745240	318	002
4	.99209925	-.10427408	.06975646	319	003
4	.99209928	.10427382	.06975646	320	004
1	.97799861	.20788000	.01745240	321	005
2	.91298886	-.40648903	.03489949	2	006
6	.94584644	-.30732438	.10452845	3	007
10	.96328729	-.20475323	.17364817	4	008
11	.97624968	-.10260822	.19080898	5	009
12	.97814760	0.00000000	.20791167	6	010
11	.97624971	.10260796	.19080898	7	011
10	.96328733	.20475302	.17364817	8	012
6	.94584652	.30732414	.10452845	9	013
2	.91298894	.40648884	.03489949	10	014
0	.79863539	-.60181516	0.00000000	C11	015
6	.84340225	-.52701651	.10452845	12	016
12	.87915314	-.42879185	.20791167	13	017
16	.90329043	-.32877109	.27563734	14	018
20	.91177968	-.22733241	.34202013	15	019
22	.92027274	-.11299551	.37460657	16	020
22	.92718386	0.00000000	.37460657	17	021
22	.92027277	.11299527	.37460657	18	022
20	.91177973	.22733219	.34202013	19	023
16	.90329052	.32877085	.27563734	20	024
12	.87915324	.42879166	.20791167	21	025
6	.84340239	.52701628	.10452845	22	026
0	.79863552	.60181500	0.00000000	23	027
2	.70667584	-.70667619	.03489949	24	028
9	.74541770	-.64798200	.15643445	25	029
16	.77767695	-.56501558	.27563734	26	030
21	.80850425	-.46679039	.35836793	27	031
26	.82734421	-.35118695	.43837113	28	032
28	.84874364	-.24337353	.46947154	29	033
30	.85759727	-.12052766	.49999998	30	034
31	.85716731	0.00000000	.51503805	31	035
30	.85759731	.12052742	.49999998	32	036
28	.84874371	.24337332	.46947154	33	037
26	.82734429	.35118679	.43837113	34	038
21	.80850437	.46679019	.35836793	35	039
16	.77767705	.56501542	.27563734	36	040
9	.74541786	.64798183	.15643445	37	041
2	.70667603	.70667600	.03489949	38	042
0	.60181485	-.79863563	0.00000000	39	043
10	.64609187	-.74324395	.17364817	40	044
16	.67971449	-.67971482	.27563734	41	045
23	.70514751	-.59168925	.39073111	42	046
29	.72509247	-.48908132	.48480959	43	047
34	.73367780	-.37637533	.55919288	44	048
37	.75954745	-.24679212	.60181500	45	049
39	.76533936	-.13495011	.62932036	46	050
40	.76604445	0.00000000	.64278759	47	051

39	.76533938	.13494997	.62932036	48	052
37	.75954751	.24679192	.60181500	49	053
34	.73867789	.37637516	.55919288	50	054
29	.72509261	.48908112	.48480959	51	055
23	.70514763	.59168910	.39073111	52	056
10	.67971467	.67971464	.27563734	53	057
10	.64609203	.74324381	.17364817	54	058
0	.60181505	.79863549	0.00000000	55	059
6	.52701609	-.84340251	.10452845	56	060
16	.55501528	-.77767716	.27563734	57	061
23	.59168899	-.70514774	.39073111	58	062
30	.61237228	-.61237258	.49999998	59	063
36	.62872418	-.50913101	.58778523	60	064
41	.64691228	-.38870432	.65605901	61	065
45	.65561792	-.26488704	.70710676	62	066
48	.65683678	-.12767626	.74314480	63	067
49	.65605905	0.00000000	.75470955	64	068
48	.65683681	.12767613	.74314480	65	069
45	.65561800	.26488684	.70710676	66	070
41	.64691238	.38870415	.65605901	67	071
36	.62872430	.50913086	.58778523	68	072
30	.61237244	.61237242	.49999998	69	073
23	.59168913	.70514761	.39073111	70	074
16	.55501547	.77767702	.27563734	71	075
6	.52701636	.84340235	.10452845	72	076
2	.40648867	-.91298902	.03489949	73	077
12	.42879151	-.87915331	.20791167	74	078
21	.46679008	-.80850444	.35836793	75	079
29	.48908097	-.72509271	.48480959	76	080
37	.49168899	-.62933347	.60181500	77	081
43	.51714504	-.51714529	.68199835	78	082
49	.52395197	-.39482628	.75470955	79	083
54	.52829785	-.25766820	.80901697	80	084
56	.54258247	-.13528112	.82903755	81	085
57	.54463906	0.00000000	.83867054	82	086
56	.54258251	.13528099	.82903755	83	087
54	.52829791	.25766809	.80901697	84	088
49	.52395206	.39482617	.75470955	85	089
43	.51714518	.51714515	.68199833	86	090
37	.49168914	.62933335	.60181500	87	091
29	.48908116	.72509258	.48480959	88	092
21	.46679025	.80850433	.35836793	89	093
12	.42879178	.87915313	.20791167	90	094
2	.40648896	.91298889	.03489949	91	095
6	.30732392	-.94584659	.10452845	92	096
16	.32877064	-.90329960	.27563734	93	097
26	.35118663	-.82734435	.43837113	94	098
33	.36764883	-.75379218	.54463901	95	099
41	.37735468	-.65359773	.65605901	96	100
49	.39482607	-.52395213	.75470955	97	101
55	.39843957	-.41259647	.81915202	98	102
61	.40192534	-.27110221	.87461968	99	103
64	.41691580	-.13546426	.89879399	100	104
65	.40673674	0.00000000	.91354541	101	105
64	.41691583	.13546415	.89879399	102	106
61	.40192541	.27110210	.87461968	103	107
55	.39843970	.41259636	.81915202	104	108
49	.39482620	.52395204	.75470955	105	109
41	.37735482	.65359765	.65605901	106	110
33	.36764907	.75379207	.54463901	107	111
26	.35118689	.82734424	.43837113	108	112
16	.32877092	.90329949	.27563734	109	113
6	.30732422	.94584649	.10452845	110	114
10	.20475285	-.96328737	.17364817	111	115
19	.22874148	-.91743266	.32556813	112	116
28	.24337319	-.84874374	.46947154	113	117
37	.24679175	-.75954757	.60181500	114	118
46	.24894315	-.64851952	.71933978	115	119
54	.25766809	-.52829795	.80901697	116	120
61	.29176564	-.38718626	.87461968	117	121
66	.26488364	-.26488697	.92718382	118	122
72	.27533617	-.14029086	.95105649	119	123

0	74	.27563740	0.00000000	.96126168	120	124
17	72	.27533626	.14029079	.95105649	121	125
45	68	.26488691	.26488690	.92718382	122	126
37	61	.26404627	.40659557	.87461968	123	127
44	54	.25766816	.52829787	.80901697	124	128
39	46	.24894335	.64351945	.71933978	125	129
12	37	.24679199	.75954749	.60181500	126	130
14	28	.24337338	.84874369	.46947154	127	131
76	19	.22874176	.91742260	.32556813	128	132
78	10	.20475185	.96329190	.17365000	129	133
75	1	.15641042	-.98753793	.01745240	322	134
41	1	.15641072	.98753788	.01745240	323	135
77	11	.11963003	-.97431030	.19080898	130	136
78	21	.12992907	-.92449491	.35836793	131	137
79	30	.13547603	-.85536322	.49999998	132	138
80	39	.13494982	-.76533940	.62932036	133	139
81	48	.12767600	-.65683684	.74314480	134	140
83	56	.12579093	-.54486087	.82903755	135	141
83	64	.13546405	-.41691586	.89879399	136	142
97	72	.14029075	-.27533623	.95105649	137	143
35	78	.14701580	-.14701587	.97814757	138	144
0	82	.13917318	0.00000000	.99026805	139	145
45	78	.14701584	.14701583	.97814757	140	146
43	72	.14029083	.27533618	.95105649	141	147
12	64	.13546419	.41691582	.89879399	142	148
77	56	.12579110	.54486083	.82903755	143	149
79	48	.12767621	.65683679	.74314480	144	150
40	39	.13495005	.76533936	.62932036	145	151
41	30	.13547629	.85536318	.49999998	146	152
42	21	.12992935	.92449487	.35836793	147	153
43	11	.11963033	.97431026	.19080898	148	154
73	2	.05230391	-.99802119	.03489949	324	155
47	2	.05230412	.99802118	.03489949	325	156
70	0	-.00000018	-1.00000000	0.00000000	149	157
70	12	-.00000017	-.97814760	.20791167	150	158
70	22	-.00000016	-.92718386	.37460657	151	159
70	31	-.00000015	-.85716731	.51503805	152	160
70	40	-.00000013	-.76604445	.64278759	153	161
70	49	-.00000011	-.65605905	.75470955	154	162
70	57	-.00000009	-.54463906	.83867054	155	163
70	66	-.00000007	-.40673674	.91354541	156	164
70	74	-.00000004	-.27563740	.96126168	157	165
70	82	-.00000002	-.13917318	.99026805	158	166
0	90	.00000012	0.00000000	1.00000000	159	167
90	82	.00000001	.13917318	.99026805	160	168
90	74	.00000003	.27563740	.96126168	161	169
90	66	.00000005	.40673674	.91354541	162	170
90	57	.00000006	.54463906	.83867054	163	171
90	49	.00000008	.65605905	.75470955	164	172
90	40	.00000009	.76604445	.64278759	165	173
90	31	.00000010	.85716731	.51503805	166	174
90	22	.00000011	.92718386	.37460657	167	175
90	12	.00000012	.97814760	.20791167	168	176
90	0	.00000012	1.00000000	0.00000000	169	177
97	2	-.05230427	-.99802117	.03489949	326	178
93	2	-.05230396	.99802119	.03489949	327	179
63	11	-.11963048	-.97431024	.19080898	170	180
62	21	-.12992940	-.92449487	.35836793	171	181
61	30	-.13547634	-.85536317	.49999998	172	182
[illegible]	39	-.13495010	-.76533936	.62932036	173	183
59	48	-.12767624	-.65683679	.74314480	174	184
57	56	-.12579113	-.54486082	.82903755	175	185
52	64	-.13546425	-.41691580	.89879399	176	186
43	72	-.14029085	-.27533618	.95105649	177	187
25	78	-.14701586	-.14701582	.97814757	178	188
30	82	-.13917318	.00000002	.99026805	179	189
35	78	-.14701582	.14701585	.97814757	180	190
17	72	-.14029076	.27533622	.95105649	181	191
[illegible]	64	-.13546412	.41691584	.89879399	182	192
[illegible]	56	-.12579096	.54486086	.82903755	183	193
[illegible]	48	-.12767604	.65683683	.74314480	184	194
[illegible]	39	-.13494993	.76533939	.62932036	185	195

30	-.13547616	.85536320	.49999998	186	196
21	-.12992921	.92449480	.35836793	187	197
11	-.11963017	.97431028	.19080898	188	198
1	-.15641078	-.93753787	.01745240	328	199
1	-.15641057	.93753791	.01745240	329	200
10	-.20475329	-.96328729	.17364817	189	201
19	-.22874181	-.91743259	.32556813	190	202
28	-.24337350	-.84874365	.46947154	191	203
37	-.24679210	-.75954746	.60181500	192	204
46	-.24894338	-.64851943	.71933978	193	205
54	-.25766819	-.52829786	.80901697	194	206
61	-.26404631	-.40659554	.87461968	195	207
68	-.26488694	-.26488688	.92718382	196	208
72	-.27533622	-.14029076	.95105649	197	209
74	-.27563740	.00000004	.96126168	198	210
72	-.27533618	.14029084	.95105649	199	211
68	-.26488688	.26488693	.92718382	200	212
61	-.26404622	.40659560	.87461968	201	213
54	-.25766803	.52829794	.80901697	202	214
46	-.24894325	.64851949	.71933978	203	215
37	-.24679187	.75954753	.60181500	204	216
28	-.24337324	.84874372	.46947154	205	217
19	-.22874152	.91743265	.32556813	206	218
10	-.20475290	.96328736	.17364817	207	219
6	-.30732435	-.94584645	.10452845	208	220
16	-.32877097	-.90329047	.27563734	209	221
26	-.35118693	-.82734422	.43837113	210	222
33	-.36764911	-.75379206	.54463901	211	223
41	-.37735492	-.65359759	.65605901	212	224
49	-.39482626	-.52395198	.75470955	213	225
55	-.39843977	-.41259628	.81915202	214	226
61	-.40192546	-.27110203	.87461968	215	227
64	-.41691584	-.13546411	.89879399	216	228
66	-.40673674	.00000006	.91354541	217	229
64	-.41691532	.13546419	.89879399	218	230
61	-.40192538	.27110215	.87461968	219	231
55	-.39843964	.41259641	.81915202	220	232
49	-.39482611	.52395211	.75470955	221	233
41	-.37735472	.65359771	.65605901	222	234
33	-.36764887	.75379216	.54463901	223	235
26	-.35118667	.82734433	.43837113	224	236
15	-.32877078	.90329054	.27563734	225	237
6	-.30732407	.94584654	.10452845	226	238
2	-.40648900	-.91298887	.03489949	227	239
12	-.42879183	-.87915316	.20791167	228	240
21	-.46679037	-.80850427	.35836793	229	241
29	-.48908123	-.72509253	.48480959	230	242
37	-.49168922	-.62933329	.60181500	231	243
43	-.51714523	-.51714510	.68199833	232	244
49	-.52395211	-.39482609	.75470955	233	245
54	-.52829794	-.25766802	.80901697	234	246
55	-.54258252	-.13528093	.82903755	235	247
57	-.54463906	.00000008	.83867054	236	248
56	-.54258248	.13528109	.82903755	237	249
54	-.52829787	.25766818	.80901697	238	250
49	-.52395200	.39482625	.75470955	239	251
43	-.51714512	.51714521	.68199833	240	252
37	-.49163903	.62933344	.60181500	241	253
29	-.48908108	.72509264	.48480959	242	254
21	-.46679013	.80850441	.35836793	243	255
12	-.42879156	.87915329	.20791167	244	256
2	-.40648872	.91298899	.03489949	245	257
5	-.52701649	-.84340227	.10452845	246	258
16	-.56501556	-.77767696	.27563734	247	259
23	-.59168923	-.70514751	.39073111	248	260
30	-.61237250	-.61237236	.49999998	249	261
35	-.62872437	-.50913078	.58778522	250	262
41	-.64691242	-.38870409	.65605901	251	263
45	-.65561304	-.26488673	.70710676	252	264
48	-.65683683	-.12767602	.74314480	253	265
49	-.65605905	.00000016	.75470955	254	266
48	-.65683679	.12767622	.74314480	255	267

153	45	-.65561796	.26489694	.70710676	256	268
149	41	-.64691234	.38870422	.65605901	257	269
141	36	-.62872422	.50913098	.58778523	258	270
135	30	-.61237237	.61237249	.49999998	259	271
130	23	-.59168902	.70514770	.39073111	260	272
126	16	-.56501532	.77767713	.27563734	261	273
122	6	-.52701622	.84340243	.10452845	262	274
233	0	-.60181514	-.79863541	0.00000000	263	275
229	10	-.64609215	-.74324371	.17364817	264	276
225	16	-.67971474	-.67971457	.27563734	265	277
220	23	-.70514772	-.59168900	.39073111	266	278
214	29	-.72509277	-.48908098	.48480959	267	279
207	34	-.73867794	-.37637506	.55919288	268	280
198	37	-.75954754	-.24679185	.60181500	269	281
190	39	-.76533940	-.13494934	.62932036	270	282
180	40	-.76604445	.00000011	.64278759	271	283
170	39	-.76533936	.13495007	.62932036	272	284
162	37	-.75954749	.24679200	.60181500	273	285
153	34	-.73867783	.37637529	.55919288	274	286
146	29	-.72509255	.48908121	.48480959	275	287
140	23	-.70514753	.59168922	.39073111	276	288
135	16	-.67971459	.67971472	.27563734	277	289
131	10	-.64609191	.74324392	.17364817	278	290
127	0	-.60181490	.79863560	0.00000000	279	291
225	2	-.70667610	-.70667593	.03489949	280	292
221	9	-.74541794	-.64798173	.15643445	281	293
216	16	-.77767715	-.56501530	.27563734	282	294
210	21	-.80850442	-.46679010	.35836793	283	295
203	26	-.82734434	-.35113666	.43837113	284	296
196	28	-.84874373	-.24337322	.46947154	285	297
188	30	-.85759732	-.12052726	.49999998	286	298
180	31	-.85716731	.00000013	.51503805	287	299
172	30	-.85759729	.12052753	.49999998	288	300
164	28	-.84874365	.24337348	.46947154	289	301
157	26	-.82734423	.35113691	.43837113	290	302
150	21	-.80850432	.46679127	.35836793	291	303
144	16	-.77767697	.56501554	.27563734	292	304
139	9	-.74541774	.64798197	.15643445	293	305
135	2	-.70667595	.70667608	.03489949	294	306
217	0	-.79863561	-.60181488	0.00000000	295	307
212	6	-.84340244	-.52701620	.10452845	296	308
205	12	-.87915330	-.42879154	.20791167	297	309
200	16	-.90329055	-.32877076	.27563734	298	310
194	20	-.91177976	-.22733208	.34202013	299	311
187	22	-.92027277	-.11299519	.37460657	300	312
180	22	-.92718386	.00000014	.37460657	301	313
173	22	-.92027275	.11299537	.37460657	302	314
166	20	-.91177968	.22733235	.34202013	303	315
160	16	-.90329048	.32877095	.27563734	304	316
154	12	-.87915317	.42879181	.20791167	305	317
148	6	-.84340233	.52701638	.10452845	306	318
143	0	-.79863543	.60181512	0.00000000	307	319
204	2	-.91298900	-.40648870	.03489949	308	320
196	6	-.94584555	-.30732405	.10452845	309	321
192	10	-.96328736	-.20475288	.17364817	310	322
186	11	-.97624072	-.10260786	.19080898	311	323
180	12	-.97814760	.00000015	.20791167	312	324
174	11	-.97624970	.10260807	.19080898	313	325
168	10	-.96328730	.20475318	.17364817	314	326
162	6	-.94584549	.30732424	.10452845	315	327
156	2	-.91298883	.40648898	.03489949	316	328
192	1	-.97799364	-.20787986	.01745240	330	329
186	4	-.99209729	-.10427372	.06975646	331	330
174	4	-.99209727	.10427393	.06975646	332	331
165	1	-.97799353	.20788016	.01745240	333	332
180	0	-1.00000000	.00000015	0.00000000	317	333

```
      IF(IXC(I).LE.IXMIN.OR.IXC(I).GT.IXMAX) GO TO 220
      IF(IYC(I).LE.IYMIN.OR.IYC(I).GT.IYMAX) GO TO 220
      IF(NTYP.EQ.500) GO TO 16
      IF(NTP(I).NE.NTYP) GO TO 220
   16 K = K + 1
      ALPHA(K) = IEST(I)
      BETA(K) = IFOP(I)
  220 CONTINUE
      GO TO 200
C *** READS DATA FROM CARDS
  130 READ(5,FMT,END=900)(MM(I),MN(I),I=1,NN)
      DO 131 I=1,NN
C *** IF BOTH STRIKE AND DIP ARE ZERO THE PROGRAM IGNORES THEM
      IF(MM(I).EQ.0.AND.MN(I).EQ.0) GO TO 131
      K = K + 1
      ALPHA(K) = MM(I)
      BETA(K) = MN(I)
  131 CONTINUE
      GO TO 130
C *** ZERO TAB
  900 DO 10  I=1,101
      DO  10 J = 1,101
      TAB (J,I) = 0
   10 CONTINUE
      N = K
      N1 = N - 1
      DO 82 I = 1,N1
C *** READS THE I-TH VALUE OF THE DATA FROM THE DISK AND CALCULATES
C *** TRIGONOMETRIC FUNCTIONS FOR THAT DATA VALUE
      AI = ALPHA(I)/57.29578
      BI = BETA(I)/57.29578
      COSB = COS(BETA(I))
      SINA = SIN(ALPHA(I))
      SINB = SIN(BETA(I))
      COSA = COS(ALPHA(I))
      CASB = COSA * SINB
      SASB = SINA * SINB
      I1 = I +1
      DO 82 J = I1,N
C *** READS THE J-TH DATA VALUE FROM THE DISK AND COMPARES IT TO THE I-T
C *** VALUE, AND IF THEY ARE NOT EQUAL COMPUTES THE INTERSECTION POINT
      AJ = ALPHA(J)/57.29578
      BJ = BETA(J)/57.29578
      T1 = COSB * SIN(AJ) * SIN(BJ) - SASB * COS(BJ)
      T2 = COSB * COS(AJ) * SIN(BJ) - CASB * COS(BJ)
      T3 = SASB * COS(AJ) * SIN(BJ) - CASB * SIN(AJ) * SIN(BJ)
      IF (ALPHA(J) .EQ. ALPHA(I) .AND. BETA(J) .EQ. BETA(I)) GO TO 82
      IF (T3 .LE. 0.0)  GO  TO  14
      T1=-T1
      T2=-T2
      T3=-T3
   14 CONTINUE
      S1=T1**2
      S2=T2**2
      S3=T3**2
      SUM3=S1+S2+S3
      SINRB=-T3/SQRT(SUM3)
      RBETA    = ARSIN(SINRB)
      RALPHA    = ATAN2 (  T1  ,  T2  )
      IF (RALPHA    .LT. 0.0) RALPHA    =RALPHA    +6.28318
      KOUNT =  KOUNT + 1
```

```
C***FORM A VECTOR FROM EACH DATA PAIR

      KW = 61
      IR = (KW - 1)/2
      R=IR
      AD=(1.4142*R*(SIN ((1.5708-RBETA)/2.0)))
      RBETA = AD*(SIN(RALPHA))
      RALPHA = AD*(COS(RALPHA))
      DELTA = (R/10.0)+1.0

C***TRANSLATE DATA

      PI = RBETA + 100.0
      PJ = RALPHA + 100.0

C***DETERMINE LIMITS OF PRIMARY COUNT

      ICI1=PI
      ICJ1=PJ
      IDELTA = DELTA
      ICU1=ICI1+IDELTA
      ICL1=ICI1-IDELTA
      JCU1=ICJ1+IDELTA
      JCL1=ICJ1-IDELTA
      DO 63  I1=ICL1,ICU1
      DO 63  J1=JCL1,JCU1

C***SET VALUE FOR GRID POINTS OF PRIMARY COUNT

      CI=I1
      CJ=J1

C***CALCULATE DISTANCE

      ASI=CI - PI
      BSI=CJ - PJ
      CSI=ASI**2
      DSI = BSI ** 2
      SSI=SQRT (CSI + DSI)

C***DETERMINE IF TABULATION IS TO BE MADE

      IF (SSI.GT.R/10.0)       GO TO 63

C***DETERMINE COORDINATES OF TABULATION

      TI=(2*IR+2)-(J1+IR-100+1)
      TJ=I1+IR-100+1
      IF(TI.GT.101  .OR.TI.LT.1  .OR.TJ.GT.101  .OR.TJ.LT.1  ) GO TO 63

C***TABULATE

      TAB(TJ,TI)=TAB(TJ,TI) + 1.0
   63 CONTINUE
      ATPI=2.0*R/SQRT ((PI-100.0)**2 +(PJ-100.0)**2)*(-1.0)

C***FIND VALUES FOR LOCUS OF SECONDARY COUNT

      IF (ATPI .GT. (-2.0000) .OR. ATPI .LT. (-2.2222)) GO TO 82
      TPI=ATPI*(PI-100.0)
      TPJ=ATPI*(PJ-100.0)

C***SET LIMITS OF SECONDARY COUNT

      ICI2=PI+TPI
      ICJ2=PJ+TPJ
      ICL2=ICI2-IDELTA
      ICU2=ICI2+IDELTA
      JCL2=ICJ2-IDELTA
      JCU2=ICJ2+IDELTA
      DO 82  I2=ICL2,ICU2
      DO 82  J2=JCL2,JCU2
```

```
*** SET VALUE FOR GRID POINTS OF SECONDARY COUNT
      CI=I2
      CJ=J2
*** CALCULATE DISTANCE
      AS2=CI-PI-TPI
      BS2=CJ-PJ-TPJ
      CS2=AS2**2
      DS2=BS2**2
      SS2=SQRT (CS2 + DS2)
*** DETERMINE IF TABULATION IS TO BE MADE
      IF (SS2.GT.P/10.0)GO TO 82
*** DETERMINE COORDINATES OF TABULATION
   78 TI=(2*IR+2)-(J2+IR-100+1)
      TJ=I2+IR-ICC+1
      IF(TI.GT.101  .OR.TI.LT.1  .OR.TJ.GT.101  .OR.TJ.LT.1  ) GO TO 82
*** TABULATE
   81 TAB(TJ,TI)=TAB(TJ,TI) + 1.0
   82 CONTINUE
      WRITE (6,43) KOUNT
   43 FORMAT (10H- KOUNT =  , I10)
      WRITE (6,25)
   25 FORMAT (27H1 PLOTTING OF POLAR DIAGRAM /)
      DO 51 TI = 1 , 61
      DO 140 TJ = 1,31
      AN = KOUNT
      TB = TAB(TJ,TI)*1000.0/AN
      IF (TB .GT. 0.0) .AND. TB .LT. 1.0) TB = 1.0
  140 ITAB(TJ) = TB
   51 WRITE (6,99) (ITAB( TJ),TJ = 1,31)
   99 FORMAT (5HO        , 10(2I3,I4),I3)
      WRITE (6,25)
      DO 61 TI = 1,61
      DO 141 TJ = 31,61
      TB = TAB(TJ,TI)*1000.0/AN
      IF (TB .GT. 0.0 .AND. TB .LT. 1.0) TB = 1.0
  141 ITAB(TJ) = TB
   61 WRITE (6,99) (ITAB(TJ),TJ = 31,61)
      GO TO 1002
      WRITE(6,1001)
      FORMAT(2F5.0)
 1001 FORMAT(' ',5X,'STORAGE REQUIRES MORE THAN 2000 LOCATIONS')
 1002 CALL EXIT
      END
```

```
C********************* PROGRAM GREAT CIRCLE  **************************
C
C     THIS PROGRAM CALCULATES THE BEST FIT GREAT CIRCLE TO A GROUP
C OF POINTS OR PLANES.  THE PROGRAM IS DESIGNED TO RECIEVE ATTITUDE
C DATA FROM THE DATA TAPE FILLED BE PROGRAM LOAD OR FROM DATA CARDS.
C THE METHOD IS THAT DESCRIBED ON PAGE     OF 'FRACTURING AND FOLDING
C IN ROCKS ' BY RAMSEY,1967.
C
C INPUT
C  DATA CARD 1    J1,J2,IXMAX,IXMIN,IYMAX,IYMIN,NTPY
C                 FORMAT(8I5)
C
C                 J1 = 1 IF DATA TO BE USED IS PLANER
C                 J1 = 2 IF DATA TO BE USED IS LINEAR
C                 J2 = 1 IF DATA IS TO BE READ FROM TAPE
C                 J2 = 2 IF DATA IS TO BE READ FROM CARDS
C                 IXMAX = THE MAXIMUM E-W COORDINATE TO BE CONSIDERED
C                 IXMIN = THE MINIMUM E-W COORDINATE TO BE CONSIDERED
C                 IYMAX = THE MAXIMUM N-S COORDINATE TO BE CONSIDERED
C                 IYMIN = THE MINIMUM N-S COORDINATE TO BE CONSIDERED
C                 NTPY = 500 ALL ROCKS TYPES ARE ANALYZED TOGETHER (USED
C                       ONLY WITH THE TAPE)
C                     = THE NUMBER OF THE PARTICULAR ROCK TYPE TO BE
C                     =  CONSIDERED WHEN DATA IS READ FROM THE TAPE
C
C  DATA CARD 2    NDATA,FMT
C                 FORMAT(I5,5X,15A4)
C
C                 NDATA = TOTAL NUMBER OF STRIKE AND DIP OR TREND AND
C                         PLUNGE PAIRS TO BE CONSIDERED.
C                 FMT = FORMAT NEEDED TO READ DATA FROM THE TAPE
C
C***IV IS THE DIP AND IU IS THE STRIKE ********REMEMBER THIS
C
C  DATA CARD 3    TITLE
C                 FORMAT(20A4)
C
C                 TITLE = AN 80 CHARACTER NAME FOR THE DATA BEING
C                         ANALYZED
C
C  DATA CARD 4 - ? (IS(I),ID(I),I=1,NDATA)
C                 FORMAT(8(2I5))
C
C                 IS = STRIKE OR TREND OF ELEMENT
C                 ID = DIP OR PLUNGE OF ELEMENT
C
C      TYPE EIGHT PAIRS PER CARD WITH STRIKE OR TREND FIRST FOLLOWED
C      BY DIP OR PLUNGE SECOND FOR EACH PAIR
C
C    DATA CARD 4 IS NOT NEEDED IF DATA IS READ FROM TAPE
C
C*************************************************************************
C
      DIMENSION COSA(3000),COSP(3000),COSC(3000),ID(3000),IS(3000),
     1IT(3),IV(3),IU(3),IXC(3),IYC(3),NTP(3),FMT(15)
      REAL*4TITLE(15)
    5 K = 0
      KK = 0
      RAD = 3.14159/180.
      READ(5,6,END=1000) J1,J2,IXMAX,IXMIN,IYMAX,IYMIN,NTPY
    6 FORMAT(8I5)
      READ(5,7) NDATA,FMT
    7 FORMAT(I5,5X,15A4)
      READ(5,8) TITLE
    8 FORMAT(20A4)
      GO TO(15,25),J2
   15 GO TO(16,17),J1
C
C READS PLANER DATA FROM TAPE
C
   16 READ(2,FMT,END=29)(IXC(I),IYC(I),IT(I),IU(I),IV(I),NTP(I),I=1,3)
      GO TO 18
```

```
*** READS LINEAR DATA FROM TAPE

17 READ(2,FMT,END=29)(IXC(I),IYC(I),IT(I),IV(I),IU(I),NTP(I),I=1,3)
18 DO 19 J=1,3

*** CHECKS TO SEE IF THE VALUES READ ARE THE VALUES DESIRED

   IF(IT(J).EQ.0) GO TO 19
   IF(IXC(J).LE.IXMIN.OR.IXC(J).GT.IXMAX) GO TO 19
   IF(IYC(J).LE.IYMIN.OR.IYC(J).GT.IYMAX) GO TO 19
   IF(NTPY.EQ.500) GO TO 21
   IF(NTYP.NE.NTPY) GO TO 19
21 KK = KK + 1
   ID(KK) = IV(J)
   IS(KK) = IU(J)
19 CONTINUE
   GO TO (16,17),J1

*** READS STRIKE AND DIP OR TREND AND PLUNGE FROM DATA CARDS

16 READ(5,20)(IS(I),ID(I),I=1,NDATA)
20 FORMAT(8(2I5))
   IF(K.EQ.NDATA) GO TO 65
29 GO TO (30,70),J1
30 DO 60 J=1,NDATA

*** CONVERTS PLANER DATA TO POLES AND CALCULATES THE DIRECTION COSINES
*** IF BOTH THE STRIKE AND DIP ARE NOT EQUAL TO ZERO

   IF(IS(I).EQ.0.AND.ID(I).EQ.0) GO TO 60
   K = K + 1
   IF(IS(J).LE.90) GO TO 40
   SK = FLOAT((IS(J)-90)) * RAD
   GO TO 50
40 SK = FLOAT(IS(J) + 270) * RAD
   GO TO 50
50 DK = FLOAT(ID(J)) * RAD
   COSB(K) = COS(DK) *-COS(SK)
   COSA(K) = COS(DK) * SIN(SK)
   COSC(K) =-SIN(DK)
60 CONTINUE
   GO TO 65
70 DO 75 J = 1,NDATA

*** CALCUALTES THE DIRECTION COSINES FOR LINEAR DATA IF BOTH TREND AND
*** PLUNGE ARE NOT EQUAL TO ZERO

   IF(IS(J).EQ.0.AND.ID(J).EQ.0) GO TO 75
   K = K + 1
   SK = FLOAT(IS(J)) * RAD
   DK = FLOAT(ID(J)) * RAD
   COSB(K) = COS(DK) *-COS(SK)
   COSA(K) = COS(DK) * SIN(SK)
   COSC(K) =-SIN(DK)
   WRITE(6,51) IS(K),ID(K),COSA(K),COSB(K),COSC(K)
51 FORMAT(5X,2I10,3F10.5)
75 CONTINUE

*** CALCULATES THE 'AVERAGE' DIRECTION COSINES FOR THE POLE TO THE
*** LEAST SQUARED BEST FIT GREAT CIRCLE

65 SUMLM = 0.
   SUMMN = 0.
   SUMLN = 0.
   SUMM2 = 0.
   SUML2 = 0.
   DO 80 I = 2,K
   SLM = COSB(I) * COSA(I)
   SMN = COSB(I) * COSC(I)
   SLN = COSA(I) * COSC(I)
   SM2 = COSB(I) * COSB(I)
```

```
      SL2 = COSA(I) * COSA(I)
      SUMLM = SUMLM + SLM
      SUMMN = SUMMN + SMN
      SUMLN = SUMLN + SLN
      SUML2 = SUML2 + SL2
      SUMM2 = SUMM2 + SM2
   10 CONTINUE
      SUMLM2 = SUMLM * SUMLM
      A = ((SUMLM*SUMMN)-(SUMLN*SUMM2))/((SUML2*SUMM2) - SUMLM2)
      B = ((SUMLM*SUMLN) -(SUMMN*SUML2))/((SUML2*SUMM2) - SUMLM2)
      ARGU = 1./SORT(1. + A*A + B*B)

** CONVERTS THE DIRECTION COSINES FOR THE POLE TO THE BEST FIT GREAT
** CIRCLE TO ANGULAR MEASUREMENTS (STRIKE AND DIP)

      GAMA = ARGU
      ALPH = A * ARGU
      BETA = B * ARGU
      DD = ARSIN(GAMA)
      FA = ABS(ALPH)/COS(DD)
      FB = ABS(BETA)/COS(DD)
      IF(1.0-FB.LE.0.001) FB=1.0
      IF(1.0-FA.LE.0.001) FA=1.0
      WRITE(6,501) FA,FB
  501 FORMAT(5X,2F10.5)
      S1 = ARSIN(          FA          )/RAD
      SS = ARCOS(          FB          )/RAD
      IF(ALPH.LE.0..AND.BETA.GT.0.) GO TO 120
      IF(ALPH.LE.0..AND.BETA.LE.0.) GO TO 91
      IF(ALPH.GT.0..AND.BETA.LE.0.) GO TO 92
      GO TO 93
   91 S1 = 180. - S1
      SS = 180. - SS
      GO TO 120
   92 S1 =  130. + S1
      SS = 180. + SS
      GO TO 120
   93 S1 = 36). - S1
      SS = 360. - SS
  120 SAVG = (S1 + SS)/2.
      SDIF = ABS(SS- SAVG)/2.
      00 = DD/RAD
      WRITE(6,129)(TITLE(I),I=1,8)
  129 FORMAT('1',20X,15A4,//)
      WRITE(6,130) NDATA,SS,S1,SAVG,SDIF,NDATA,DD
  130 FORMAT(' ',10X,'TREND OF POLE TO BEST FIT GREAT CIRCLE&BASED ON',
     2I4,' POINTS',//,16X,'FROM: COS(A) = COS(DIP) * SIN(STRIKE)',F8.1,
     3//,16X,'FROM: COS(B) = COS(DIP) * COS(STRIKE)',F8.1,//,34X,'AVERAG
     4E VALUE:',F8.1,//35X,'PLUS OR MINUS:',F8.1///10X,'PLUNGE OF POLE T
     5O BEST FIT GREAT CIRCLE BASED ON',I4,' POINTS:',//21X,'FROM: COS(C
     6) = SIN(DIP):',F8.1)
      GO TO 5
  200 STOP
      END
```

```
*****************************  PROGRAM POINTPLOT  ******************************

      PROGRAM POINTPLOT PLOTS A LOWER HEMISPHERE STEREOGRAPHIC
PROJECTION OF EITHER PLANER OR LINEAR DATA SUPPLIED FROM TAPE OR
CARDS.  OUTPUT IS A 20 CM. DIAMETER PLOT OF THE POINTS CONSIDERED.
DATA READ FROM THE TAPE IS THE DATA LOADED BY PROGRAM 'LOAD' ON
THAT TAPE.

 INPUT

DATA CARD 1   J1,J4
              FORMAT(I1,I1)
             J1 = 1 READS PLANER DATA FROM TAPE
                = 2 READS LINEAR DATA FROM TAPE
                = 3 READS PLANER DATA FROM CARDS
                = 4 READS LINEAR DATA FROM CARDS
             J4 = THE CONTROL VARIABLE FOR THE PLOT (SEE SUBROUTINE
                  CIRCLE)

DATA CARD2    K5
              FORMAT(16A4)

             K5 = TITLE OF THE PLOT TO BE PLOTTED BELOW THE
                  STEREOGRAPHIC PROJECTION

DATA CARD 3   IXMIN,IXMAX,IYMIN,IYMAX,NTYP
              FORMAT(5I10)

              IXMIN = THE MINIMUM E-W COORDINATE TO BE CONSIDERED
              IXMAX = THE MAXIMUM E-W COORDINATE TO BE CONSIDERED
              IYMIN = THE MINIMUM N-S COORDINATE TO BE CONSIDERED
              IYMAX = THE MAXIMUM N-S COORDINATE TO BE CONSIDERED
              NTPY = 500 ALL ROCKS TYPES ARE ANALYZED TOGETHER (USED
                     ONLY WITH THE TAPE)
                   = THE NUMBER OF THE PARTICULAR ROCK TYPE TO BE
                   =  CONSIDERED WHEN DATA IS READ FROM THE TAPE

DATA CARD 4   NN,FMT
              FORMAT(I5,16A4)

              NN = THE NUMBER OF STRIKE AND DIP OR TREND AND PLUNGE
                   PAIRS PER CARD (USE ONLY IF DATA IS READ FROM CARDS)
              FMT = THE FORMAT IN WHICH THE DATA IS TO BE READ EITHER
                   FROM TAPE OR CARDS

DATA CARD 5 - ?(K1(I),K2(I),I=1,NN)
              FORMAT(DESCRIBED BY VARIABLE FMT)

              K1 = STRIKE OR TREND OF THE ELEMENT
              K2 = THE DIP OR PLUNGE OF THE ELEMENT

** USE DATA CARD 5 ONLY IF DATA IS READ FROM CARDS.

       THIS PROGRAM WAS DEVELOPED BY R.W.REISE AT NEW MEXICO TECH

*******************************************************************************
      DIMENSION KS(2000),KD(2000),D(2000),P(2000),S(2000),
     /KK(8),K1(8),K2(8),FMT(16),IXC(3),IYC(3),NTP(3)
      COMMON X(2000),Y(2000),K5(16)
    2 READ(5,3,END=99 ) J1,J4
    3 FORMAT(I1,I1)
      A=0.0
      K = 0
      NMAX  = 0
      A=A+1
      READ(5,999)(K5(IIJ),IIJ=1,16)
  999 FORMAT(16A4)
      READ(5,5)   IXMIN,IXMAX,IYMIN,IYMAX,NTYP
    5 FORMAT(5I10)
      READ(5,11) NN,FMT
   11 FORMAT(I5,16A4)
      IF(J1-5)300,99,300
```

```
 GO TO (4,30,100,110,99),J1
 READ(2,FMT,END=40)(IXC(I),IYC(I),KK(I),K1(I),K2(I),NTP(I),I=1,3)
 DO 250 I = 1,3
 IF(KK(I).EQ.0) GO TO 250
 IF(IXC(I).LE.IXMIN.OR.IXC(I).GT.IXMAX) GO TO250
 IF(IYC(I).LE.IYMIN.OR.IYC(I).GT.IYMAX) GO TO 250
 IF(NTYP.EQ.500) GO TO 12
 IF(NTP(I).NE.NTYP) GO TO 250
 K = K + 1
 IF(K1(I).LE.90)  GO TO 270
 KS(K) = K1(I) - 90
 GO TO 275
 KS(K) = K1(I) + 270
 KD(K) = K2(I)
 NMAX = NMAX + 1
 CONTINUE
 GO TO (4,30,100,110,99),J1
 READ(2,FMT,END=40)(IXC(IK),IYC(IK),KK(IK),K1(IK),K2(IK),NTP(IK),
2IK=1,3)
 DO 290 IK= 1,3
 IF(K1(IK).EQ.0.AND.K2(IK).EQ.0) GO TO 280
 IF(IXC(IK).LE.IXMIN.OR.IXC(IK).GT.IXMAX) GO TO 280
 IF(IYC(IK).LE.IYMIN.OR.IYC(IK).GT.IYMAX) GO TO 280
 IF(NTYP.EQ.500) GO TO 13
 IF(NTP(IK).NE.NTYP) GO TO 280
 K = K + 1
 KS(K) = K1(IK)
 KD(K) = 90 - K2(IK)
 NMAX = NMAX + 1
 CONTINUE
 GO TO (4,30,100,110,99),J1
 READ(5,FMT,END=40)(K1(I),K2(I),I=1,NN)
 DO 101 I=1,NN
 IF(K1(I).EQ.0.AND.K2(I).EQ.0) GO TO 101
 K = K + 1
 IF(K1(I).LE.90)  GO TO 706
 KS(K) = K1(I) - 90
 GO TO 709
 KS(K) = K1(I) + 270
 KD(K) = K2(I)
 NMAX = NMAX + 1
 CONTINUE
 GO TO (4,30,100,110,99),J1
 READ(5,FMT,END=40)(K1(I),K2(I),I=1,NN)
 DO 111 I=1,NN
 IF(K1(I).EQ.0.AND.K2(I).EQ.0) GO TO 111
 K = K + 1
 KS(K) = K1(I)
 KD(K) = 90 - K2(I)
 NMAX = NMAX + 1
 CONTINUE
 GO TO (4,30,100,110,99),J1
************************************************************************************
SE B:  C-AXES (2).  IF THE C-AXIS OR LONG-AXIS OF THE MINERAL IS
       GREATER THAN 45 DEGREES TO THE PLANE OF THE SLIDE, RECORD THE
       PLUNGE AS A POSITIVE VALUE AND THE COMPUTER WILL CALCULATE
       THE COMPLEMENT, WHICH IS THE TRUE PLUNGE.  THIS IS DONE SINCE
       THE U-STAGE ONLY INDICATES THE COMPLEMENT OF THE PLUNGE IN
       THIS CASE.  OTHERWISE RECORD THE READINGS FROM THE U-STAGE
       AS NEGATIVE VALUES.
************************************************************************************

 DO 38 M=1,NMAX
 IF(KD(M))38,38,37
 KD(M)=90-IABS(KD(M))
 CONTINUE
************************************************************************************
```

```
C*************************** PROGRAM GEOPLOT *****************************
C
C     THIS PROGRAM PLOTS LAYERING, FOLIATION, LINEATION (INCLUDING
C  ING), AND JOINTS WITH THE APPORPRIATE SYMBOL.  PROVISIONS ARE MADE
C  USER TO LIMIT THE DATA READ,I.E., IF ONLY JOINTS OF A CERTAIN ATTI
C  ARE DESIRED, ADJUSTMENT OF THE APPROPRIATE 'IF STATEMENT' WITHIN T
C  SECTION THE READS JOINT ATTITUDES WILL ACCOMPLISH THE DESIRED RESU
C  (IF DATA OF A GIVEN RECK TYPE ARE DISIRED THE READ STATEMENT MUST
C  ADJUSTED TO READ THE ROCK TYPE)
C
C  INPUT VARIABLES INCLUDE:
C       CARD ONE, FORMAT(6I5)
C              K - WHEN EQUAL TO 1, LAYERING ATTITUDES ARE READ
C              KK - WHEN EQUAL TO 1, FOLIATION ATTITUDES ARE READ
C              KKK - WHEN EQUAL TO 1, LINEATION ATTITUDES ARE READ
C              K4 - WHEN EQUAL TO 1, FOLD ATTITUDES ARE READ
C              K5 - WHEN EQUAL TO 1, JOINT ATTITUDES ARE READ
C              LAYTYP - MUST HAVE A VALUE EQUAL TO A LAYERING TYPE OF T
C                   FIELD DATA SHEET
C
C       CARD TWO, FORMAT3F10.2,I5)
C              XX - THE MAXIMUM X VALUE NEEDED TO PLOT THE GRID FOR THE
C              YY - THE MAXIMUM Y VALUE NEEDED TO PLOT THE GRID
C              W - THE SIZE OF EACH GRID INCREMENT
C            NX - ONE HALF THE NUMBER OF GRID LINES INSIDE THE BOX IN
C                   THE X DIRECTION .
C            NY - THE SAME AS NX BUT IN THE Y DIRECTION
C   MINX & MINY - THE MINIMUN GRID VALUES TO BE PLOTTED
C   MAXX & MAXY - THE MAXIMUN GRID VALUES TO BE PLOTTED
C
C  THESE DATA CARDS MAY BE REPEATED IN THE DATA DECK TO PRODUCE MORE
C  PLOT AT A TIME.
C  DATA FOR THIS PROGRAM IS OBTAINED FROM TAPE WHICH HAS BEEN LOADED
C  PROGRAM LOAD
C
C************************************************************************
C
      DIMENSION LOC(1000),XC(1000),YC(1000),STK(1000),DIP(1000),LYTP(5),
     2LYST(5),LYDP(5),IXC(5),IYC(5),IFST(5),IFDP(5),LPLG(5),LAZM(5),
     3LTP(5),LTYPE(1000),MFPL(5),MFAZ(5),JSTK(5),JDIP(5)
C
C*** READS DATA CARD ONE
C
    5 READ(5,10,END=501)K,KK,KKK,K4,K5,LAYTYP,LINTYP
   10 FORMAT(7I5)
C
C*** READS DATA CARD TWO
C
      READ(5,20)XX,YY,W,NX,NY,MINX,MAXX,MINY,MAXY
   20 FORMAT(3F10.2,6I5)
      X = W
      Y = W
      KN = 0
      KKN = 0
      K3N = 0
      K4N = 0
      K5N = 0
      CALL FACTOR(1.)
      CALL PFORMS('*WIDE PAPER*')
      CALL PLOT(0.,0.,3)
C
C*** PLOTS THE GRID SYSTEM
C
      CALL PLOT(0.0,YY,2)
      CALL PLOT(XX,YY,2)
      CALL PLOT(XX,0.0,2)
      CALL PLOT(0.,0.,2)
      DO 30 I = 1,NX
      CALL PLOT(X,0.,3)
      CALL PLOT(X,YY,2)
      CALL PLOT(X+W,YY,3)
      CALL PLOT(X+W,0.0,2)
```

```
30 X = X + 2. * W
   DO 35 I = 1,NY
   CALL PLOT(XX,Y,3)
   CALL PLOT(0.0,Y,2)
   CALL PLOT(0.0,Y+W,3)
   CALL PLOT(XX,Y+W,2)
35 Y = Y + 2. * W
   CALL PLOT(0.0,YY,-3)
*** CHECKS TO SEE IF LAYERING IS TO BE READ
50 IF(K.NE.1) GO TO 90
   N = 0
*** READS LAYERING VALUES FRCM TAPE
60 READ(2,70,END=249)(LOC(I),IXC(I),IYC(I),LYTP(I),LYST(I),LYDP(I),
  2I =1,3)
70 FORMAT(3(I6,2I3,9X,I1,1X,2I3,51X))
   DO 80 I = 1,3
*** CHECKS TO SEE OF THE LAYERING READ IS THE TYPE OF LAYERING SPECIFI
   IF(LYTP(I).NE.LAYTYP) GO TO 80
   IF(IXC(I).LE.MINX.OR.IXC(I).GE.MAXX.OR.IYC(I).LE.MINY.OR.IYC(I).
  $GE.MAXY) GO TO 80
   N = N + 1
   LOC(N) = LOC(I)
   XC(N) = -(FLOAT(IXC(I))/10 - (MINX/10))
   YC(N) = (FLOAT(IYC(I))/10. - (MINY/10))
   STK(N) = FLOAT(LYST(I))
   DIP(N) = FLOAT(LYDP(I))
   IF(N.EQ.1000) GO TO 250
80 CONTINUE
   GO TO 60
90 K = 0
   KN = 0
*** CHECK TO SEE IF FOLIATION IS TO BE READ
   IF(KK.NE.1) GO TO 130
   N = 0
*** READS FOLIATION VALUES FROM TAPE
100 READ(2,110,END=248)(LOC(I),IXC(I),IYC(I),IFST(I),IFDP(I),I=1,3)
110 FORMAT(3(I6,2I3,18X,I3,I2,45X))
   DO 120 I = 1,3
*** CHECKS TO SEE IF FOLIATION IS ZERO, I.E. THERE IS NO FOLIATION,   T
*** CAN ALSO BE USED TO RESTRICT FOLIATIONS READ
   IF(IFST(I).EQ.0) GO TO 120
   IF(IXC(I).LE.MINX.OR.IXC(I).GE.MAXX.OR.IYC(I).LE.MINY.OR.IYC(I).
  $GE.MAXY) GO TO 120
   N = N + 1
   LOC(N) = LOC(I)
   XC(N) = -(FLOAT(IXC(I))/10 - (MINX/10))
   YC(N) = (FLOAT(IYC(I))/10. - (MINY/10))
   STK(N) = FLOAT(IFST(I))
   DIP(N) = FLOAT(IFDP(I))
   IF(N.EQ.1000) GO TO 250
120 CONTINUE
   GO TO 100
130 KK = 0
   KKN = 0
*** CHECKS TO SEE IF LINEATION IS TO BE READ
   IF(KKK.NE.1) GO TO 170
   N = 0
```

```
** READS LINEATIONS FROM THE TAPE

   READ(2,150,END=247)(LOC(I),IXC(I),IYC(I),LTP(I),LPLG(I),LAZM(I),
  2I=1,3)
   FORMAT(3(I6,2I3,39X,I1,1X,I2,I3,22X))
   DO 160 I = 1,3

** CHECKS TO SEE IF LINEATIONS EXIST AT THAT LOCATION, THIS CAN BE AL
** TO RESTRICT THE LINEATIONS READ

   IF(LTP(I).EQ.0) GO TO 160
   IF(IXC(I).LE.MINX.OR.IXC(I).GE.MAXX.OR.IYC(I).LE.MINY.OR.IYC(I).
  $GE.MAXY) GO TO 160
   N = N + 1
   LOC(N) = LOC(I)
   XC(N) = -(FLOAT(IXC(I))/10 - (MINX/10))
   YC(N) = (FLOAT(IYC(I))/10. - (MINY/10))
   STK(N) = FLOAT(LAZM(I))
   DIP(N) = FLOAT(LPLG(I))
   LTYPE(N) = LTP(I)
   IF(N.EQ.1000) GO TO 250
   CONTINUE
   GO TO 140
   KKK = 0
   K3N =0

** CHECKS TO SEE IF FOLD ATTITUDES ARE TO BE READ

   IF(K4.NE.1) GO TO 210
   N = 0

** READS FOLD ATTITUDES

   READ(2,190,END = 246)(LOC(I),IXC(I),IYC(I),MFPL(I),MFAZ(I),I=1,3)
   FORMAT(3(I6,2I3,29X,I2,I3,34X))
   DO 200 I = 1,3

** CHECKS TO SEE IF FOLD ATTITUDES EXIST AT THAT LOCATION

   IF(MFPL(I).EQ.0) GO TO 200
   IF(IXC(I).LE.MINX.OR.IXC(I).GE.MAXX.OR.IYC(I).LE.MINY.OR.IYC(I).
  $GE.MAXY) GO TO 200
   N = N + 1
   LOC(N) = LOC(I)
   XC(N) = -(FLOAT(IXC(I))/10 - (MINX/10))
   YC(N) = (FLOAT(IYC(I))/10. - (MINY/10))
   STK(N) = FLOAT(MFAZ(I))
   DIP(N) = FLOAT(MFPL(I))
   LTYPE(N) = 9
   IF(N.EQ.1000) GO TO 250
   CONTINUE
   GO TO 180
   K4 = 0
   K4N = 0

** CHECKS TO SEE IF JOINT ATTITUDES ARE TO BE READ

   IF(K5.NE.1) GO TO 500
   N = 0

** READS JOINT ATTITUDES

   READ(2,230,END=245)(LOC(I),IXC(I),IYC(I),JSTK(I),JDIP(I),I=1,3)
   FORMAT(3(I6,2I3,47X,I3,I2,16X))
   DO 240 I = 1,3

** CHECKS TO SEE IF JOINTS EXIST AT THAT LOCATION, OR CAN BE USED TO
** ONLY SELECTED JOINT ATTITUDES

   IF(JSTK(I).EQ.0) GO TO 240
   IF(IXC(I).LE.MINX.OR.IXC(I).GE.MAXX.OR.IYC(I).LE.MINY.OR.IYC(I).
  $GE.MAXY) GO TO 240
```

```
      N = N + 1
      LOC(N) = LOC(I)
      XC(N) = -(FLOAT(IXC(I))/10. - (MINX/10))
      YC(N) = (FLOAT(IYC(I))/10. - (MINY/10))
      STK(N) = FLOAT(JSTK(I))
      DIP(N) = FLOAT(JDIP(I))
      IF(N.EQ.1000) GO TO 250
  240 CONTINUE
      GO TO 220
C***
C*** WHEN ALL DATA OF A PARTICULAR GROUP ARE READ, THE TAPE IS REWOUND
C*** THE VARIABLES DEFINED SO THAT THE PROGRAM WILL READ THE NEXT DESIR
C*** STRUCTURAL FEATURE
C***
  245 K5 = 0
      K5N = 1
      REWIND 2
       GO TO 250
  246 K4 = 0
      K4N = 1
      REWIND 2
       GO TO 250
  247 KKK = 0
      K3N = 1
      REWIND 2
       GO TO 250
  248 KK = 0
      KKN = 1
      REWIND 2
       GO TO 250
  249 K = 0
      KN = 1
      REWIND 2
C***
C*** SORTS THE DATA TO BE PLOTTED BY ITS LOCATION(NOT PERFECT BUT IT AI
C*** PLOTTER)
C***
  250 NM = N - 1
      DO 260 M = 1,NM
      NN = M - 1
      DO 260 I = 1,NN
      IF(LOC(I+1).GT.LOC(I)) GO TO 260
      IB = LOC(I)
      LOC(I) = LCC(I+1)
      LOC(I+1) = IB
      BB = XC(I)
      XC(I) = XC(I+1)
      XC(I+1) = BB
      BB = YC(I)
      YC(I) = YC(I+1)
      YC(I+1) = BB
      BB = STK(I)
      STK(I) = STK(I+1)
      STK(I+1) = BB
      BB = DIP(I)
      DIP(I) = DIP(I+1)
      DIP(I+1) = BB
  260 CONTINUE
C***
C*** CHECKS TO SEE IF PLOTS ARE TO BE MADE FOR LAYERING
C***
      IF(KN.EQ.1) GO TO 261
      IF(K.NE.1) GO TO 320
  261 DO 310 I = 1,N
      DO 310 I = 1,N
      IF(STK(I).LE.360.) GO TO 275
      STK(I) = STK(I) - 360.
  275 ST =-STK(I) - 90.
C***
C*** PLOTS STRIKE OF LAYERING
C***
      CALL SYMBOL(YC(I),XC(I),.25,13,ST,-1)
```

```
      IF(DIP(I).GT.90.) GO TO 270
C *** PLOTS THE DIP DIRECTION OF UPRIGHT LAYERING
      CALL SYMBOL(YC(I),XC(I),.125,15,ST,-1)
      GO TO 280
  270 THE = 51. - STK(I) * 3.1416/180.
      X = XC(I) + SIN(THE) * .0398
      Y = YC(I) + COS(THE) * .0398
      T = ST - 90.
      DIP(I) = 90. - (DIP(I) - 90.)
C *** PLOTS THE DIRECTION OF OVERTURNED LAYERING
      CALL SYMBOL(Y,X,.125,81,T,-1)
C *** DETERMINES WHERE TO PLOT THE DIP
  280 ANG =(-STK(I) - 53. + 90.) * 3.1416/180.
      IF(STK(I).LE.40) GO TO 281
      IF(STK(I).LE.120.) GO TO 290
      IF(STK(I).LE.155.) GO TO 291
      IF(STK(I).LE.250.) GO TO 292
      IF(STK(I).LE.270.)GO TO 293
      IF(STK(I).LE.300.) GO TO 294
  281 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) -.25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) -.125
      GO TO 300
  290 Y = YC(I) - .25
      X = XC(I)
      GO TO 300
  291 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) + .25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
      GO TO 300
  292 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) + .25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) -.125
      GO TO 300
  293 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
      GO TO 300
  294 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) - .062
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) + .125
C *** PLOTS THE DIP
  300 CALL NUMBER(Y,X,.100,DIP(I),-90.,-1)
  310 CONTINUE
      GO TO 50
C *** DETERMINES IF FOLIATION IS TO BE PLOTTED
  320 IF(KKN.EQ.1) GO TO 321
      IF(KK.NE.1) GO TO 360
  321 DO 350 I = 1,N
      DO 350 I = 1,N
      IF(STK(I).LE.360.) GO TO 325
      STK(I) = STK(I) - 360.
  325 ST = -STK(I) - 90.
C *** PLOTS FOLIATION SYMBOL
      CALL SYMBOL(YC(I),XC(I),.25,13,ST,-1)
      THE =(-STK(I) - 106.)* 3.1416/180.
      X = XC(I) +(SIN(THE) * .07)
      Y = YC(I) +(COS(THE) * .07)
      ST = - STK(I)
      CALL SYMBOL(Y,X,.062,101,ST,-1)
C *** DETERMINES WHERE TO PLOT THE DIP
      ANG =(-STK(I) - 53. + 90.) * 3.1416/180.
      IF(STK(I).LE.40) GO TO 322
      IF(STK(I).LE.120.) GO TO 330
      IF(STK(I).LE.155.) GO TO331
```

```
      IF(STK(I).LE.200.) GO TO 332
      IF(STK(I).LE.270.)GO TO 333
      IF(STK(I).LE.3(0) GO TO 334
 32   X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) -.25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) -.125
      GO TO 340
      Y = YC(I) - .25
      X = XC(I)
      GO TO 340
 331  X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) + .25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
      GO TO 340
 332  X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) + .25
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) -.125
      GO TO 340
 333  X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
      GO TO 340
 334  X = .13 * ABS(SIN(6.28 - ANG)) + XC(I) - .062
      Y = .13 * ABS(COS(6.28 - ANG)) + YC(I) + .125
C *** PLOTS THE DIP
 340  CALL NUMBER(Y,X,.100,DIP(I),-90.,-1)
 350  CONTINUE
      GO TO 90
C *** DETERMINES IF LINEATIONS ARE TO BE PLOTTED
 360  IF(K3N.EQ.1) GO TO 365
      IF(KKK.NE.1) GO TO 400
 365  DO 390 I = 1,N
      IF(STK(I).LE.360.) GO TO 366
      STK(I) = STK(I) - 360.
 366  ST = -STK(I) - 90.
C *** PLOTS THE LINEATION SYMBOL
      THE = (ST * 3.1416/180.)
      X = XC(I) + .062 * SIN(THE)
      Y = YC(I) + .062 * COS(THE)
      T =-STK(I) - 90.
      CALL SYMBOL(Y,X,.25,62,T,-1)
      T = -STK(I) * 3.1416/180.
      X = XC(I) + .12 * SIN(T)
      Y = YC(I) + .12 * COS(T)
      TS = -STK(2) + 90.
C *** DETERMINES WHAT TYPE OF LINEATION AND PLOTS THE APPROPRIATE SYMBOL
      NZ = LTYPE(I)
      GO TO (371,372,373,374,375,376,377,378,379),NZ
 371  IF(LTYPE(I).EQ.0) GO TO 380
      CALL SYMBOL(Y,X,.05,84,TS,-1)
      GO TO 380
 372  CALL SYMBOL(Y,X,.05,98,TS,-1)
      GO TO 380
 373  CALL SYMBOL(Y,X,.05,67,TS,-1)
      GO TO 380
 374  CALL SYMBOL(Y,X,.05,66,TS,-1)
      GO TO 380
 375  CALL SYMBOL(Y,X,.05,68,TS,-1)
      GO TO 380
 376  CALL SYMBOL(Y,X,.05,73,TS,-1)
      GO TO 380
 377  CALL SYMBOL(Y,X,.05,89,TS,-1)
      GO TO 380
 378  CALL SYMBOL(Y,X,.05,65,TS,-1)
      GO TO 380
 379  CALL SYMBOL(Y,X,.05,70,TS,-1)
C *** DETERMINES WHERE TO PLOT THE DIP AND DOES SO
```

```
30 Y = YC(I) - .062 + (.362 * COS(T))
   X = XC(I) + .062 + (.362 * SIN(T))
   CALL NUMBER(Y,X,.10,DIP(I),-90.,-1)
40 CONTINUE
   GO TO 130

*** DETERMINES IF FOLDS ARE TO BE PLOTTED AND IF SO PLOTS THEM THE SAM
*** LINEATIONS WITH A DIFFERENT SYMBOL

400 IF(K4N.EQ.1) GO TO 401
    IF(K4.NE.1) GO TO 410
401 GO TO 365

*** DETERMINES IF JOINTS ARE TO BE PLOTTED

410 IF(K5N.EQ.1) GO TO 415
    IF(K5.NE.1) GO TO 500
415 DO 440 I = 1,N
    IF(STK(I).LE.360.) GO TO 420
    STK(I) = STK(I) - 360.
420 ST =-STK(I) - 90.

*** PLOTS THE JOINT SYMBOL

    CALL SYMBOL(YC(I),XC(I),.25,13,ST,-1)
    T = -STK(I) * 3.1416/180.
    Y = YC(I) - (COS(T) * .05)
    X = XC(I) - (SIN(T) * .05)
    CALL SYMBOL(Y,X,.10,54,ST,-1)

*** DETERMINES WHERE TO PLOT THE DIP

    ANG =(-STK(I) - 53. + 90.) * 3.1416/180.
    IF(STK(I).LE.40) GO TO 421
    IF(STK(I).LE.120.) GO TO 422
    IF(STK(I).LE.155.) GO TO 423
    IF(STK(I).LE.200.) GO TO 424
    IF(STK(I).LE.270.)GO TO 425
    IF(STK(I).LE.300.) GO TO 426
421 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)  -.25
    Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)  -.125
    GO TO 430
422 Y = YC(I) - .25
    X = XC(I)
    GO TO 430
423 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)  + .25
    Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
    GO TO 430
424 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)  + .25
    Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)  -.125
    GO TO 430
425 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)
    Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)
    GO TO 430
426 X = .13 * ABS(SIN(6.28 - ANG)) + XC(I)  - .062
    Y = .13 * ABS(COS(6.28 - ANG)) + YC(I)  + .125

*** PLOTS THE DIP

430 CALL NUMBER(Y,X,.100,DIP(I),-90.,-1)
440 CONTINUE
    K5N = 0
500 CALL PLOT(0.,0.,999)
    CALL FACTOR(1.)

*** MOVES THE PEN OF THE PLOTTER TO POSITION TO DRAW THE SECOND GRID I
*** DESIRED BY THE USE MORE THAN TWO DATA CARDS

    CALL PLOT(40.,0.,-3)
    GO TO 5
501 CALL EXIT
```

```
******************************   PROGRAM GRANITE   *****************************
 COMMON     AN(150),AB(150),BI(150),OR(150),Q(150),C(150) ,ABR(150),
 1 ANR(150), ORR(150) ,ABQR(150), ANQR(150), ORQR(150), QR(150),
 2 ABAN(150), ABQ(150), ABCR(150), ANAB(150), ANQ(150), ANOR(150),
 3 ORQ(150), ORAB(150), ORAN(150), QAN(150), QOR(150), QAB(150),
 4 SUM(50), TEAN(50), X(50), S(50), RS(50),TITLE(15),XX(150),
 5YY(150),HYP(150),ORCIP(150),CCIP(150),SICP(150)
 LOGICAL*1SAMP(6,150)
***************************
INPUT FORMAT *** FOR EACH SET OF DATA,   THE FIRST CARD CONTROLS THE
PLOT OPTION.  THIS CARD CONSISTS OF THE VARIABLES PLOX(PLOT OPTION),
NSYM(SYMBOL OPTION), NTIME(PLOT OPTION), AND TITLE(FOR PLOT), TYPED
ACCORDING TO THE FORMAT F5.0,I3,I2,15A4.  IF PLOX = 1.0; A SET OF
TRIANGULAR DIAGRAMS IS PRODUCED FOR THIS SET: IF PLOX = 2.0 THE DATA
FROM THIS SET IS PLOTTED ON THE DIAGRAMS FROM THE PREVIOUS SET.
IF PLOX = 0.0 NO PLOTS ARE PRODUCED(MAY USE A BLANK CARD )
IF NSYM = 0 - 13 DIFFERENT SYMBOLS ARE PLOTTED TO REPRESENT THE DATA
POINTS; NSYM SHOULD BE CHANGED FOR EACH SET OF DATA PLOTTED ON THE
THE GRAPH.  NTIME  = 1 FOR THE FIRST SEQUENCE OF PLOTS AND MUST BE
GREATER THAN 1 FOR EACH ADDITIONAL SEQUENCE OF PLOTS.  TITLE IS A
STRING OF 60 CHARACTERS TO LABEL EACH SET OF TRIANGLES.  REMAINING
CARDS IN THE SET  *** TYPE 9 NUMBERS IN EACH CARD IN THE ORDER SIO2,
AL2O3,FEO,MGO.NA2O,K2O,CAO,CONTROL NUMBER, AND SAMPLE NUMBER
ACCORDING TO THE FORMAT7F10.5,F4.1,6A1.  LEAVE
CONTROL NO. BLANK ON EVERY CARD IN A SET OF DATA, BUT TYPE 1.0 IN THE
FIRST FIELD OF 10 ON A CARD FOLLOWING EACH SET OF DATA CARDS.  INSERT
A COMPLETELY BLANK CARD BETWEEN SETS OF DATA.  PLACE CARD WITH 1.0
IN FIRST FIELD OF 10 AFTER LAST SET OF DATA.
***************************
  MOLECULAR WEIGHTS
  SIOW = 60.09
  A2O3W = 101.96
  FEOW=71.85
  FNA2W = 61.98
  FK2OW = 94.20
  FMGOW=40.32
  CAOW=56.08
  N=0
  READ(5,5) PLOX,NSYM,NTIME,TITLE
5 FORMAT(F5.0,I3,I2,15A4)
  IF(PLOX.EQ.1.0) PHOLD = 0.0
  PRINT 15, TITLE
15 FORMAT('1',15A4,///,1H-,8HSAMP. NO,5X,4HSIO2,5X,5HAL2O3,5X,3HFEO,7
 1X,3HMGO,7X,4HNA2O,6X,3HK2O,7X,3HCAO//)
  READ (5,20) SIOP,A2O3P,FE2OP, FMGOP,FNA2P,FK2OP,CAOP,CNTRL,
 2(SAMP(J,N+1),J=1,6)
20 FORMAT(7F10.5,F4.0,6A1)
  IF(CNTRL) 50,40,50
40 N=N+1
  CALL RECALC(SIOP,A2O3P,FE2OP,FMGOP,FNA2P,FK2OP,CAOP)
  FEOP = FE2OP
  CONVERT EACH OXIDE TO MOLES
  SIOM=SIOP/SIOW
  A2O3M = A2O3P/A2O3W
  FEOM=FEOP/FEOW
  FMGOM=FMGOP/FMGOW
  FNA2M = FNA2P / FNA2W
  FK2OM = FK2OP / FK2OW
  CAOM=CAOP/CAOW
  FINT=FEOM +FMGOM
  AN(N) = CAOM*(CAOW+A2O3W+2.*SIOW)
  AB(N) = FNA2M*(FNA2W+A2O3W+6.*SIOW)
  BI(N) = FEOP+FMGOP+FINT*(SIOW+(A2O3W+FK2OW) /6. )
  OR(N) = (FK2OM-FINT/6.)*(FK2OW+A2O3W+6.*SIOW)
  Q(N) = (SIOM-(2.*CAOM+6.*FNA2M+         6.*FK2OM))*SIOW
  C(N) = (A2O3M-(CAOM+FNA2M              +FK2OM))*A2O3W
  ORCIP(N) = FK2OM * (A2O3W + 6. * SIOW + FK2OW)
  CCIP(N) = (A2O3M - (CAOM + FNA2M + FK2OM)) * A2O3W
  HYP(N) = FEOP + FMGOP + FINT * SIOW
  SICP(N) =(SIOM-(2.*CAOM + 6.*FNA2M + 6.*FK2OM + FINT))* SIOW
  WRITE(6,70)(SAMP(J,N),J=1,6),SIOP,A2O3P,FE2OP,FMGOP,FNA2P,FK2OP,
 2CAOP
```

```
70 FORMAT(1X,6A1,1X,7F10.5)
   GO TO 60
50 DO 200 JJ = 1,2
   K = N
   DO 210 N = 1,K
   CALCULATION OF RATICS
   DSUM = AB(N) + AN(N) + OR(N)
   ABR(N) = AB(N)/ DSUM
   ANR(N) = AN(N)/ DSUM
   ORR(N) = OR(N)/ DSUM
   QSUM = DSUM + Q(N)
   ABQR(N) = AB(N)/QSUM
   ANQR(N) = AN(N)/QSUM
   ORQR(N) = OR(N) /QSUM
   QR(N) = Q(N)/QSUM
    CALC. OF PROJECTION RATIOS.   THE VARIABLE ABAN IS PROJ. OF AN
   FROM AB CORNER, ANQ IS PROJ. OF Q FROM AN CORNER, ETC.
   ABAN(N) = 100.*(ANQR(N)+ABQR(N)/3.)
   ABQ(N) = 100.*(QR(N)+ABQR(N)/3.)
   ABOR(N) = 100.*(ORQR(N)+ ABQR(N)/3.)
   ANAB(N) = 100.*(ABQR(N)+ ANQR(N)/3.)
   ANQ(N) = 100.*( QR(N) + ANQR(N)/3.)
   ANOR(N) = 100.*(ORQR(N)+ ANQR(N)/3.)
   QAN(N) = 100.*(ANQR(N)+ QR(N)/3.)
   QOR(N) = 100.*(ORQR(N)+QR(N)/3.)
   QAB(N) = 100.*(ABQR(N) + QR(N)/3.)
   ORQ(N) = 100.*(QR(N)+ ORQR(N)/3.)
   ORAB(N) = 100.*(ABQR(N)+ ORQR(N)/3.)
   ORAN(N) = 100.*(ANQR(N)+ORQR(N)/3.)
210 CONTINUE
   IF(JJ.EQ.2) GO TO 52
   WRITE (6,80)
80 FORMAT(//1X,45('*'),2X,'MESONORM',2X,45('*')//,1X,8HSAMP. NO,11X,
  22HAN,8X,2HAB,8X,2HBI,8X,2HOR,9X,1HQ,9X,1HC,5X,6HAB RAT,4X,
  36HAN RAT,4X,6HOR RAT//)
   GO TO 53
52 WRITE(6,51)
51 FORMAT(//1X,45('*'),2X,'CIPWNORM',2X,45('*')//,1X,8HSAMP. NO,11X,
  22HAN,8X,2HAB,8X,2HHY,8X,2HOR,9X,1HQ,9X,1HC,5X,6HAB RAT,4X,
  36HAN RAT,4X,6HOR RAT//)
53 IF(N.EQ.0)STOP2
   DO 91 I = 1,N
   WRITE(6,90)(SAMP(J,I),J=1,6),AN(I),AB(I),BI(I),OR(I),Q(I),C(I),
  2ABR(I),ANR(I),ORR(I)
90 FORMAT(1X,6A1,8X,9F10.5)
91 CONTINUE
   WRITE (6,92)
92 FORMAT(///,8HSAMP. NO,9X,7HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,5X,
  1 5HQ RAT//)
   IF(N.EQ.0)STOP3
   DO 94 I = 1,N
   WRITE(6,93)(SAMP(J,I),J=1,6),ABQR(I),ANQR(I),ORQR(I),QR(I)
93 FORMAT(1X,6A1,8X,4F10.5)
94 CONTINUE
   WRITE(6,95)
95 FORMAT(///,8HSAMP. NO,2X,4HABAN,5X,3HABQ,6X,4HABOR,5X,4HANAB,5X,
  1 3HANQ,6X,4HANOR,5X,3HQAN,6X, 3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,
  25X,4HORAN//)
   IF(N.EQ.0)STOP4
   DO 97 I = 1,N
   WRITE(6,96)(SAMP(J,I),J=1,6),ABAN(I),ABQ(I),ABOR(I),ANAB(I),
  2ANQ(I),ANOR(I),QAN(I),QOR(I),QAB(I),ORQ(I),ORAB(I),ORAN(I)
96 FORMAT(1X,6A1,1X,12F9.4)
97 CONTINUE
   CALCULATION OF AVERAGE VALUES
   DO 98 I = 1,25
   SUM(I) = 0.0
98 CONTINUE
   IF(N.EQ.0)STOP5
   DO 100 I = 1,N
   SUM(1) = SUM(1) + AN(I)
   SUM(2) = SUM(2) + AB(I)
```

```
      SUM(3)  =  SUM(3)  +  BI(I)
      SUM(4)  =  SUM(4)  +  OR(I)
      SUM(5)  =  SUM(5)  +  Q(I)
      SUM(6)  =  SUM(6)  +  C(I)
      SUM(7)  =  SUM(7)  +  ABR(I)
      SUM(8)  =  SUM(8)  +  ANR(I)
      SUM(9)  =  SUM(9)  +  ORR(I)
      SUM(10)  =  SUM(10)  + ABQR(I)
      SUM(11)  =  SUM(11)  + ANQR(I)
      SUM(12)  =  SUM(12)  + ORQR(I)
      SUM(13)  =  SUM(13)  + QR(I)
      SUM(14)  =  SUM(14)  + ABAN(I)
      SUM(15)  =  SUM(15)  + ABQ(I)
      SUM(16)  =  SUM(16)  + ABOR(I)
      SUM(17)  =  SUM(17)  + ANAB(I)
      SUM(18)  =  SUM(18)  + ANQ(I)
      SUM(19)  =  SUM(19)  + ANOR(I)
      SUM(20)  =  SUM(20)  + QAN(I)
      SUM(21)  =  SUM(21)  + QOR(I)
      SUM(22)  =  SUM(22)  + QAB(I)
      SUM(23)  =  SUM(23)  + ORQ(I)
      SUM(24)  =  SUM(24)  + ORAB(I)
      SUM(25)  =  SUM(25)  + ORAN(I)
  100 CONTINUE
      IF(N.EQ.0)STOP100
      FN = N
      DO 101 I = 1,25
      TEAN(I) = SUM(I)/FN
  101 CONTINUE
      CALCULATION OF STD. DEV.
      DO 102 I = 1,25
      X(I) = 0.0
  102 CONTINUE
      DO 110 I = 1,N
      X(1)  =  X(1)  +  (AN(I)-TEAN(1))**2
      X(2)  =  X(2)  +  (AB(I)-TEAN(2))**2
      X(3)  =  X(3)  +  (BI(I)-TEAN(3))**2
      X(4)  =  X(4)  +  (OR(I)-TEAN(4))**2
      X(5)  =  X(5)  +  (Q(I)-TEAN(5))**2
      X(6)  =  X(6)  +(C(I)-TEAN(6))  **2
      X(7)  =  X(7)  +(ABR(I)-TEAN(7))**2
      X(8)  =  X(8)  +  (ANR(I)-TEAN(8))**2
      X(9)  =  X(9)  +  (ORR(I)-TEAN(9))**2
      X(10)  =  X(10)  +  (ABQR(I)-TEAN(10))**2
      X(11)  =  X(11)  +  (ANQR(I)- TEAN(11))**2
      X(12)  =  X(12)  +  (ORQR(I)-TEAN(12))**2
      X(13)  =  X(13)  +  (QR(I)-TEAN(13))**2
      X(14)  =  X(14)  +  (ABAN(I)-TEAN(14))**2
      X(15)  =  X(15)  +  (ABQ(I)-TEAN(15))**2
      X(16)  =  X(16)  +  (ABOR(I)-TEAN(16))**2
      X(17)  =  X(17)  +  (ANAB(I)-TEAN(17))**2
      X(18)  =  X(18)  +  (ANQ(I)- TEAN(18))**2
      X(19)  =  X(19)  +  (ANOR(I)- TEAN(19))**2
      X(20)  =  X(20)  +  (QAN(I)-TEAN(20))**2
      X(21)  =  X(21)  +  (QOR(I)-TEAN(21))**2
      X(22)  =  X(22)  +  (QAB(I)-TEAN(22))**2
      X(23)  =  X(23)  +  (ORQ(I)-TEAN(23))**2
      X(24)  =  X(24)  +  (ORAB(I)-TEAN(24))**2
      X(25)  =  X(25)  +  (ORAN(I)-TEAN(25))**2
  110 CONTINUE
      F1 = FN- 1.
      IF(F1.EQ.0.)GO TO 2000
      DO 111 I = 1,25
      S(I) =  (X(I)/F1)**.5
  111 CONTINUE
      CALCULATION OF RELATIVE STD. DEV.
      DO 114 I = 1,25
      RS(I) = S(I)/TEAN(I)
  114 CONTINUE
 2000 IF(JJ.EQ.2) GO TO 220
      WRITE (6,120) (TEAN(I),I = 1,25)
      IF(F1.EQ.0.)GO TO 2001
```

```
      FORMAT(1H-,11HMEAN VALUES,//,3H AN,8X,2HAB,8X,2HBI,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
      WRITE (6,130) (S(I), I = 1,25)
      FORMAT(////,8H STD DEV,//,3H AN,8X,2HAB,8X,2HBI,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
      WRITE (6,140) (RS(I), I = 1,25)
      FORMAT(////,11H STD DEV/AV,//,3H AN,8X,2HAB,8X,2HBI,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
      GO TO 1500
   00 WRITE (6,230) (TEAN(I),I = 1,25)
      IF(F1.EQ.0.)GO TO 2001
   00 FORMAT(1H-,11HMEAN VALUES,//,3H AN,8X,2HAB,8X,2HHY,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
      WRITE (6,240) (S(I), I = 1,25)
   40 FORMAT(////,8H STD DEV,//,3H AN,8X,2HAB,8X,2HHY,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
      WRITE (6,250) (RS(I), I = 1,25)
  250 FORMAT(////,11H STD DEV/AV,//,3H AN,8X,2HAB,8X,2HHY,8X,2HOR,9X,
     11HQ,9X,1HC,/,6F10.5,//,7H AB RAT,4X,6HAN RAT,4X,6HOR RAT,4X,
     27HABQ RAT,3X,7HANQ RAT,3X,7HORQ RAT,3X,5HQ RAT,/,7F10.5,//,
     35H ABAN,4X,3HABQ,6X,4HABOR,5X,4HANAB,5X,3HANQ,6X,4HANOR,5X,3HQAN,6
     4X,3HQOR,6X,3HQAB,6X,3HORQ,6X,4HORAB,5X,4HORAN,/,12F9.4)
   00 IF(PLOX.EQ.1.) GO TO 2400
      IF(PLOX.EQ.2.) GO TO 2500
      GO TO 2003
   00 CALL SAMPLE(SAMP,N,NTIME,JJ,PLOX,PHOLD)
      CALL TRI(PLOX,NTIME,JJ)
      CALL POINT(NSYM,N,PLOX)
      GO TO 2003
   00 CALL SAMPLE(SAMP,N,NTIME,JJ,PLOX,PHOLD)
      CALL POINT(NSYM,N,PLOX)
      GO TO 2003
   01 WRITE(6,2002)
   02 FORMAT('0','********************** S IS NOT COMPUTABLE*********')
   03 IF(JJ.EQ.2) GO TO 2004
      DO  2100 K = 1,N
      OR(K) = ORCIP(K)
      C(K) = CCIP(K)
      BI(K) = HYP(K)
      Q(K) = SICP(K)
  100 CONTINUE
  200 CONTINUE
   04 READ(5,150) DSET
  150 FORMAT (F10.0)
      IF(DSET) 160,10,160
  160 CONTINUE
      CALL PLOT(50.0,0.0,-3)
   00 STOP
      END
      SUBROUTINE RECALC(SIOP,A203P,FE20P,FMGOP,FNA2P,FK20P,CAOP)
      SU  = SIOP + A203P + FE20P + FMGOP + FNA2P + FK20P + CAOP
      SIOP = (SIOP/SU ) * 100.
      A203P = (A203P/SU ) * 100.
      FE20P = (FE20P/SU) * 100.
      FMGOP = (FMGOP/SU ) * 100.
      FNA2P = (FNA2P/SU ) * 100.
      CAOP = (CAOP/SU ) * 100.
```

```
      RETURN
      END
      SUBROUTINE SAMPLE(SAMP,N,NTIME,JJ,PLOX,PHOLD)
      LOGICAL*1SAMP(6,150)
      X = 0.
      IF(JJ.EQ.2) GO TO 6
      IF(PLOX.EQ.2.0) GO TO 12
      IF(NTIME.EQ.1) GO TO 3
    6 CALL PLOT(48.0,-1.45,-3)
      IF(PLOX.EQ.2.0) GO TO 11
      GO TO 4
    3 CALL PLOT(0.0,0.0,-3)
    4 K = N
      NN = N
      IF(NN.GE.45) NN = 45
      Y = 10.5
      CALL SYMBOL(X,Y,0.15,'SAMPLE NUMBERS',0.,14)
      Y = 10.0
      GO TO 5
   12 CALL PLOT(-62.496,0.0,-3)
      GO TO 13
   11 CALL PLOT(0.0,1.45,-3)
   13 K = N
      NN = N
      IF(NN.GE.45) NN = 45
      X = X + 1.2* PHOLD
      Y = 8.55
    5 DO 10 I = 1,NN
      Z = X
      DO 20 J=1,6
      CALL SYMBOL(Z,Y,0.15,SAMP(J,I),0.,1)
      Z = Z + .15
   20 CONTINUE
      Y = Y - 0.2
   10 CONTINUE
      X = X + 1.2
      Y = 10.0
      NN = K - 45
      IF(NN.LE.0) GO TO 16
      IF(PLOX.EQ.2.0) GO TO 11
      GO TO 5
   16 IF(JJ.EQ.1) GO TO 15
      PHOLD = PHOLD + 1.0
   15 RETURN
      END
      SUBROUTINE TRI(PLOX,NTIME,JJ)
      COMMON    AN(150),AB(150),BI(150),OR(150),Q(150),C(150) ,ABR(150),
     1 ANR(150), ORR(150) ,ABQR(150), ANQR(150), ORQR(150), QR(150),
     2 ABAN(150), ABQ(150), ABOR(150), ANAB(150), ANQ(150), ANOR(150),
     3 ORQ(150), ORAB(150), ORAN(150), QAN(150), QOR(150), QAB(150),
     4 SUM(50), TEAN(50), X(50), S(50), RS(50),TITLE(15),XX(150),
     5YY(150),HYP(150),ORCIP(150),CCIP(150),SICP(150)
      CALL FACTOR(0.906)
   10 CALL PLOT(8.0,1.6,-3)
   11 CALL AXIS(0.0,0.0,' ',1,10.,60.,100.,-10.,10.)
      CALL AXIS(0.0,0.0,' ',-1,10.,0.,0.,10.,10.)
      CALL AXIS(10.0,0.0,' ',-1,10.,120.,0.,10.,10.)
      CALL SYMBOL(-0.6,0.0,0.2,'AB',0.,2)
      CALL SYMBOL(10.35,0.0,0.2,'OR',0.,2)
      CALL SYMBOL(5.45,8.55,0.2,'Q',0.,1)
      IF(JJ.EQ.2) GO TO 12
      CALL SYMBOL(2.0,-0.5,0.2,'POINTS PROJECTED FROM AN CORNER,(MESONOR
     2M)',0.,42)
      GO TO 13
   12 CALL SYMBOL(2.0,-0.5,0.2,'POINTS PROJECTED FROM AN CORNER,(CIPWNOR
     2M)',0.,42)
   13 CALL SYMBOL(0.0,-0.9,0.2,TITLE,0.0,60)
      CALL AXIS(12.0,0.0,' ',1,10.,60.,100.,-10.,10.)
      CALL AXIS(12.0,0.0,' ',-1,10.,0.,0.,10.,10.)
      CALL AXIS(22.0,0.0,' ',-1,10.,120.,0.,10.,10.)
      CALL SYMBOL(11.4,0.0,0.2,'Q',0.,1)
      CALL SYMBOL(22.35,0.0,0.2,'AB',0.,2)
```

```
      CALL SYMBOL(17.45,8.55,0.2,'AN',0.,2)
      IF(JJ.EQ.2) GO TO 14
      CALL SYMBOL(14.0,-0.5,0.2,'POINTS PROJECTED FROM OR CORNER,(MESONO
     2RM)',0.,42)
      GO TO 15
   14 CALL SYMBOL(14.0,-0.5,0.2,'POINTS PROJECTED FROM OR CORNER,(CIPWNO
     2RM)',0.,42)
   15 CALL SYMBOL(12.0,-0.9,0.2,TITLE,0.0,60)
      CALL AXIS(24.0,0.0,' ',1,10.,60.,100.,-10.,10.)
      CALL AXIS(24.0,0.0,' ',-1,10.,0.,0.,10.,10.)
      CALL AXIS(34.0,0.0,' ',-1,10.,120.,0.,10.,10.)
      CALL SYMBOL(23.4,0.0,0.2,'AB',0.,2)
      CALL SYMBOL(34.35,0.0,0.2,'OR',0.,2)
      CALL SYMBOL(29.45,8.55,0.2,'AN',0.,2)
      IF(JJ.EQ.2) GO TO 16
      CALL SYMBOL(26.0,-0.5,0.2,'POINTS PROJECTED FROM Q CORNER,(MESONOR
     2M)',0.,41)
      GO TO 17
   16 CALL SYMBOL(26.0,-0.5,0.2,'POINTS PROJECTED FROM Q CORNER,(CIPWNOR
     2M)',0.,41)
   17 CALL SYMBOL(24.0,-0.9,0.2,TITLE,0.0,60)
      CALL AXIS(36.0,0.0,' ',1,10.,60.,100.,-10.,10.)
      CALL AXIS(36.0,0.0,' ',-1,10.,0.,0.,10.,10.)
      CALL AXIS(46.0,0.0,' ',-1,10.,120.,0.,10.,10.)
      CALL SYMBOL(35.4,0.0,0.2,'OR',0.,2)
      CALL SYMBOL(46.35,0.0,0.2,'Q',0.,1)
      CALL SYMBOL(41.45,8.55,0.2,'AN',0.,2)
      IF(JJ.EQ.2) GO TO 18
      CALL SYMBOL(38.0,-0.5,0.2,'POINTS PROJECTED FROM AB CORNER,(MESONO
     2RM)',0.,42)
      GO TO 19
   18 CALL SYMBOL(38.0,-0.5,0.2,'POINTS PROJECTED FROM AB CORNER,(CIPWNO
     2RM)',0.,42)
   19 CALL SYMBOL(36.0,-0.9,0.2,TITLE,0.0,60)
      CALL FACTOR(1.0)
      RETURN
      END
      SUBROUTINE POINT(NSYM,N,PLOX)
      COMMON     AN(150),AB(150),BI(150),OR(150),Q(150),C(150) ,ABR(150),
     1 ANR(150), ORR(150) ,ABOR(150), ANQR(150), ORQR(150), QR(150),
     2 ABAN(150), ABQ(150), ABOR(150), ANAB(150), ANQ(150), ANOR(150),
     3 ORQ(150), ORAB(150), ORAN(150), QAN(150), QOR(150), QAB(150),
     4 SUM(50), TEAN(50), X(50), S(50), RS(50),TITLE(15),XX(150),
     5YY(150),HYP(150),ORCIP(150),CCIP(150),SICP(150)
      CALL FACTOR(0.906)
      IF(PLOX.NE.2.0) GO TO 5
      CALL PLOT(8.0,0.0,-3)
    5 SIX = 60. * (3.14159/180.)
      TRE = 30. * (3.14159/180.)
      FL = 10. * SIN(SIX)
      TN = TAN(SIX)
      CS = COS(TRE)
      NPP = 1
      NP = 1
   10 DO 70 I=1,N
      GO TO (20,30,40,50,110),NP
   20 TNOR = ANQ(I)/100.
      EAS = ANOR(I)/100.
      GO TO 60
   30 TNOR = ORAN(I)/100.
      EAS = ORAB(I)/100.
      GO TO 60
   40 TNOR = QAN(I)/100.
      EAS = QOR(I)/100.
      GO TO 60
   50 TNOR = ABAN(I)/100.
      EAS = ABQ(I)/100.
   60 YY(I) = FL *TNOR
      XX(I) = ((FL * TNOR) + (10. * TN *  EAS))/TN
      GO TO (70,61,62,63,110),NPP
   61 XX(I) = XX(I) + 12.
      GO TO 70
```

```
XX(I) = XX(I) + 24.
GO TO 70
XX(I) = XX(I) + 36.
CONTINUE
DO 100 I=1,N
CALL SYMBOL(XX(I),YY(I),0.10,NSYM,0.0,-1)
NP = NP + 1
NPP = NPP + 1
GO TO 10
CALL PLOT(0.0,0.0,999)
CALL FACTOR(1.0)
RETURN
END
```

```
***************  GEOCHEMISTRY DATAPLOT PROGRAM  ************************

     THIS PROGRAM TAKES THE CONCENTRATIONS OF 8 OXIDES, AND 31
ELEMENTS, CALCULATES TI,K,AND NA, IN PPM FROM THE OXIDES, CALCUALTES
15 RATIOS AND THE TOTAL RARE EARTH ELEMENTS.  ALL VALUES ARE PLOTTED
VERSUS SILICA AND 15 ADDITIONAL PLOTS ARE MADE AS WELL AS 3
TRIANGULAR PLOTS.  A MAXIMUM OF 10 DATASETS WITH A COMBINED TOTAL
OF 100 SAMPLES IS THE MAXIMUM THAT THIS PROGRAM CAN HANDLE.

***************************  INPUT  ********************************

DATA CARD 1     PLTIME,GROUP,PINT,NDATA,NGRP,IPSTAR,IPSTOP
                FORMAT(3F10.0,4I5)

                PLTIME = 1.0 PLOTS ARE MADE FOR ELEMENTS NUMBERED
                           BETWEEN IPSTAR AND IPSTOP.
                       = 10.0 NO PLOTS ARE GENERATED

                GROUP  = 1.0 FOR PLOTS OF VALUES VS. SILICA
                       = 2.0 FOR PLOTS OF VALUES VS. NI,K,SR,LA, AND
                           THE TRIANGULAR DIAGRAMS
                       = 3.0 ALL PLOTS ARE PRODUCED

                PINT   = 1.0 A PRINT OUT OF DATA IS PRODUCED
                       = 0.0 NO PRINT OUT IS PRODUCED

                NDATA  = THE MAXIMUM NUMBER OF INPUT VALUES AND ALL
                           CALCULATED VALUES (PRESENTLY EQUALS 58)

                NGRP   = THE NUMBER OF DATASETS BEING USED

                IPSTAR = THE NUMBER OF THE ELEMENT OR OXIDE WITH WHICH
                           THE PLOTS ARE TO BEGIN (BLANK IF PLTIME = 10.0
                           EQUALS 1 IF GROUP = 3.0)

                IPSTOP = THE NUMBER  OF THE ELEMENT OR OXIDE WITH WHICH
                           THE PLOTS ARE TO TERMINATE(BLANK IF PLTIME =
                           10.0; LESS THAN OR = TO NDATA IF GROUP = 1.0;
                           LESS THAN OR = TO 15 IF GROUP = 2.0 ; = NDATA
                           IF GROUP = 3.0)

DATA CARD 2-6 ((TITLE(J,I),J=1,6),I=1,NDATA)
                FORMAT(13(6A1),2X)

                TITLE  = A SIX CAHARACTER NAME FOR ELEMENTS, OXIDES
                           AND RATIOS (E.G. SIO2,EU,RB/SR).  THERE SHOULD
                           BE NDATA NUMBER OF TITLES

DATA CARD 7     (TOTAL(I),I=1,NGRP)
                FORMAT(10F8.3)

                TOTAL  = THE TOTAL WEIGHT PERCENT TO WHICH ALL THE
                           OXIDEFS IN A DATA SET ARE TO BE NORMALIZED.
                           THERE MUST BE A TOTAL FOR EACH DATASET.

DATA CARD 8     MAST
                FORMAT(20A4)

                MAST   = THE MASTER TITLE OFR ALL DATASETS.

DATACARD(9-9+NGRP)  NAM
                FORMAT(20A4)

                NAM = THE NAME OF EACH DATASET.  THERE MAY BE 40
                           CHARACTERS IN THE NAME

DATA CARD(9+NGRP - ?) SAMP(J),(DATA(J,I),I=1,39)
                FORMAT(A8,2X,7F10.3,/,8F10.3)

                SAMP =
                SAMP   = AN 8 CHARACTER NAME FOR THE SAMPLE(E.G.MAN123)
```

```
              DATA    = CONCENTRATIONS IN WEIGHT PERSENT FOR THE
                        OXIDES AND IN PPM FOR EACH ELEMENT. INPUT
                        ORDER IS THE SAME AS THE ORDER IN 'TITLE'
 EACH SAMPLE USES FIVE CARDS - CARD 1 HAS THE SAMPLE NUMBER AND 7
 CONCENTRATIONS, THE REAMAINING FOUR CARDS HAVE 8 CONCENTRATIONS EACH.
 INPUT ORDER IS (1) SAMP.NO.,SIO2,TIO2,AL2O3,FE2O3,MGO,CAO,NA2O;
 (2)K2O,MN,NI,RB,SR,ZR,BA,CS; (3)HF,CO,CR,LA,CE,ND,SM,EU; (4)GD,TB,DY,
 HO,ER,TM,YB,LU; (5)Y,SC,CU,ZN,PB,SB,TH,U
 FOLLOW EACH DATA SET WITH 5 CARDS WITH AN * IN THE FIRST 8 COLUMNS,
 AND 999999. IN COLUMNS 11 TO 20 ON CARD 1.  THE REMAINING 4 CARDS
 ARE LEFT BLANK.
*********************************************************************
      COMMON DATA(100,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),
     $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)
      REAL*8SAMP(100)
      LOGICAL*1TITLE(6,80),BLANK/' '/
 READS CONTROL VARIABLES
   10 READ(5,20,END=1000) PLTIME,GROUP,PINT,NDATA,NGRP,IPSTAR,IPSTOP
   20 FORMAT(3F10.0,4I5)
 READS NAMES OF THE ELEMENTS AND OXIDES
      READ(5,30)((TITLE(I,J),I=1,6),J=1,NDATA)
   30 FORMAT(10(6A1),2X)
 READS THE VALUE TO WHICH THE OXIDES OF EACH DATASET ARE NORMALIZED
      READ(5,35)(TOTAL(I),I=1,NGRP)
   35 FORMAT(10F8.3)
 READS THE MAIN TITLE FOR THE PROGRAM
      READ(5,36) MAST
   36 FORMAT(20A4)
 READS THE TITLES OF EACH DATASET
      DO 38 I=1,NGRP
      READ(5,37) (NAM(I,J),J=1,10)
   37 FORMAT(10A4)
   38 CONTINUE
      J = 0
 READS THE SAMPLE NUMBER AND ALL THE VALUES
   40 J = J + 1
      READ(5,50,END=60) SAMP(J),(DATA(J,I),I=1,39)
   50 FORMAT(A8,2X,7F10.3,/,(8F10.3))
      GO TO 40
   60 NCARD = J -1
      CALL CALCUL(NCARD,NDATA)
      DO 70 J=1,NCARD
      DO 70 I=1,NDATA
      IF(DATA(J,I).EQ.999999.) DATA(J,I) = DATA(J,I) + 10.
   70 CONTINUE
 DETERMINES IF A PRINTOUT IS DESIRED
      IF(PINT.NE.1.0) GO TO 123
 WRITES THE TITLES, NUMBER OF SAMPLES AND THE NORMALIZED WEIGHT %
      WRITE(6,71) MAST
   71 FORMAT('1',//,10X,20A4)
      DO 72 KI=1,NGRP
```

```
72 WRITE(6,73) (NAM(KI,J),J=1,10),NSAM(KI),TOTAL(KI)
73 FORMAT(' ',///,20X,10A4,/,20X,'NUMBER OF SAMPLES IN THIS GROUP =',
  $I3,/,20X,'TOTAL WEIGHT PERCENT OXIDES HAVE BEEN RECALCULATED TO ',
  $F6.3,' PERCENT')
   KSTART = 1
   KK = 1
C
C  WRITES THE TITLE FOR THE FIRST GROUP OF SAMPLES
C
   WRITE(6,75) MAST,(NA4(1,J),J=1,10),TOTAL(1),NSAM(1)
75 FORMAT('1',25X,20A4,///,35X,10A4,///,35X,'TOTAL WEIGHT PERCENT OXI
  $DES RECALCULATED TO ',F8.3,' PERCENT',///55X,I3,' SAMPLES')
   DO 111 JP= 1,NCARD
   IF(DATA(JP,1).GT.1000000.) GO TO 76
   GO TO 111
76 KSTOP = JP- 1
   KINC = (KSTOP - KSTART) + 1
   M = KSTART
   N = M + 9
   IF(KINC.LE.10) N = KSTOP
C
C  WRITES THE SAMPLE NUMBER AND THE CONCENTRATION FOR EACH ELEMENT AND
C  OXIDE FOR THAT SAMPLE
C
80 WRITE(6,90)(SAMP(I),I = M,N)
90 FORMAT('1',5X,'NO',4X,'NAME',5X,A8,9(3X,A8))
   WRITE(6,91) (BLANK, I=M,N)
91 FORMAT(18X,10(2X,A1,8('*')))
   WRITE(6,92)
92 FORMAT(' ')
   DO 100 I=1,NDATA
100 WRITE(6,110)I,(TITLE(J,I),J=1,6),(DATA(K,I),K=M,N)
110 FORMAT(' ',5X,I2,3X,6A1,2X,10(1X,F10.3))
   M = M + 10
   N = N + 10
   IF(N.GT.KSTOP) N = KSTOP
   IF(M.GT.KSTOP) GO TO 112
   GO TO 80
112 CALL STAT(KSTART,KSTOP,NDATA,TITLE)
   KSTART = KSTOP + 2
   KK = KK + 1
   IF(KK-NGRP)113,113,111
C
C  WRITES  THE TITLE FOR THE NEXT GROUP OF SAMPLES
C
113 WRITE(6,75) MAST, (NA4(KK,J),J=1,10),TOTAL(KK),NSAM(KK)
111 CONTINUE
C
C  DETERMINES IF A PLOT IS TO  BE MADE
C
120 IF(PLTIME.EQ.10.0) GO TO 10
   CALL PLOT(4.0,1.0,-3)
   CALL FACTOR(1.0)
   CALL LABLE(NGRP)
   DO 130 I = 1,NDATA
   YMAX(I) = 0.
   YMIN(I) = 1000000.
   EXP(I) = 0.
   XINC(I) = 0.
   YINC(I) = 0.
130 CONTINUE
   GX = 0.
   GY = 0.
   GXX = 2.5
   GYY = 0.5
   TFAC = 1.0
   DO 190 I=1,NDATA
   DO 150 J = 1,NCARD
   IF(DATA(J,I).EQ.0..OR.DATA(J,I).GT.1000000.) GO TO 150
C
C  FINDS THE MAXIMUM AND THE MINIMUM VALUES FOR EACH ELEMENT OR  OXIDE
C
```

```
      IF(YMAX(I).GT.DATA(J,I))GO TO 140
      YMAX(I) = DATA(J,I)
  140 IF(YMIN(I).LE.DATA(J,I))GO TO 150
      YMIN(I) = DATA(J,I)
  150 CONTINUE
      IF(YMIN(I).EQ.1000000..OR.YMAX(I).EQ.0.) GO TO 190
C
C FINDS THE POWER OF 10 FOR THE MINIMUM VALUE
C
  156 A = 0.001
      DO 160 K = 1,8
      AA = A * 10.
      IF(YMIN(I).LE.AA.AND.YMIN(I).GT.A) GO TO 165
      A = AA
  160 CONTINUE
C
C DEFINES MAXIMUM AND MINIMUM VALUES IN SCIENTIFIC NOTATION BASED ON
C  THE POWER OF 10 FOR THE MINIMUM VALUE
C
  165 EXP(I) = FLOAT(K - 4)
      YMAX(I) = YMAX(I)/(10**EXP(I))
      YMIN(I) = YMIN(I)/(10**EXP(I))
C
C ROUNDS OFF THE MAXIMUM AND MINIMUM VALUES
C
      KMAX = YMAX(I)
      YMAX(I) = FLOAT(KMAX) + 1.
      KMIN = YMIN(I)
      YMIN(I) = FLOAT(KMIN)
C
C DETERMINES THE ABSCISSA AND ORDINATE INCREMENTS
C
      XINC(I) = (YMAX(I) - YMIN(I))/7.
      YINC(I) = (YMAX(I) - YMIN(I))/8.
  190 CONTINUE
C
C DETERMINES WHICH SET OF GRAPHS TO PLOT
C
      IF(GROUP.EQ.2.0) GO TO 200
C
C PLOTS GRAPHS FROM ELEMENT NUMBERED 'IPSTAR' TO ELEMENT NUMBERED
C 'IPSTOP'
C
      DO 191 I=IPSTAR,IPSTOP
      KX = 1
      KY = I
C
C IF ALL VALUES FOR A GIVEN ELEMENT OR OXIDE ARE ZERO THAT GRAPH IS
C SUPPRESSED
C
      IF(YMIN(I).EQ.1000000..OR.YMAX(I).EQ.0.) GO TO 191
C
C MAKES SURE NOT TO PLOT A GRAPH WITH THE SAME ORDINATE AND ABSCISSA
C
      IF(KY-KX)191,191,185
  185 CALL GRAPH(GX,GY,GXX,GYY,KX,KY,TITLE)
      CALL POINT(GXX,GYY,KX,KY,NCARD)
C
C RESETS THE ORIGIN TO BEGIN THE NEXT GRAPH
C
      TRAC = TRAC + 1.0
      IF(TRAC-3.)188,188,187
  187 CALL PLOT(12.0,-20.0,-3)
      TRAC = 1.0
      GO TO 191
  188 CALL PLOT(0.0,10.,-3)
  191 CONTINUE
      IF(GROUP.EQ.1.) GO TO 1200
  200 IF(GROUP.EQ.3.) IPSTOP = 15
C
C PLOTS GRAPHS FROM ELEMENT NUMBERED 'IPSTAR' TO ELEMENT NUMBERED
C 'IPSTOP'
```

```
      DO 290 IIK=IPSTAR,IPSTOP
      GO TO (205,210,215,220,225,230,235,240,245,250,255,260,265,270,
     2275),IIK
* PLOTS NI VS. MGO
  205 KX = 10
      KY = 5
      GO TO 280
* PLOTS NI VS. FE2O3
  210 KX = 10
      KY = 4
      GO TO 280
* PLOTS NI VS. CR
  215 KX = 10
      KY = 18
      GO TO 280
* PLOTS NI VS. CO
  220 KX = 10
      KY = 17
      GO TO 280
* PLOTS K VS. NA
  225 KX = 40
      KY = 11
      GO TO 280
* PLOTS K VS. CS
  230 KX = 40
      KY = 15
      GO TO 280
* PLOTS K VS. BA
  235 KX = 40
      KY = 14
      GO TO 280
* PLOTS K VS. SR
  240 KX = 40
      KY = 12
      GO TO 280
* PLOTS K VS. NA
  245 KX = 40
      KY = 42
      GO TO 280
* PLOTS SR VS. EU
  250 KX = 12
      KY = 23
      GO TO 280
* PLOTS SR VS. BA
  255 KX = 12
      KY = 14
      GO TO 280
* PLOTS SR VS. CAO
```

```
260 KX = 12
    KY = 6
    GO TO 280
C
C PLOTS LA VS. K
C
265 KX = 19
    KY = 40
    GO TO 280
C
C PLOTS LA VS. RB
C
270 KX = 19
    KY = 11
    GO TO 280
C
C PLOTS LA VS. CS
C
275 KX = 19
    KY = 15
C
C IF ALL VALUES ARE ZERO FOR A GIVEN ELEMENT  OR OXIDE THAN THAT GRAPH
C IS SUPPERSSED
C
280 IF(YMIN(KX).EQ.1000000..OR.YMIN(KY).EQ.1000000.) GO TO 290
    CALL GRAPH(GX,GY,GXX,GYY,KX,KY,TITLE)
    CALL POINT(GXX,GYY,KX,KY,NCARD)
C
C RESETS ORIGIN TO BEGIN NEST GRAPH
C
    TRAC = TRAC + 1.0
    IF(TRAC-3.)288,288,287
287 CALL PLOT(12.0,-20.0,-3)
    TRAC = 1.0
    GO TO 290
288 CALL PLOT(0.,10.,-3)
290 CONTINUE
    IF(TRAC.EQ.1.) GO TO 300
    G  = -(TRAC - 1.) * 10.
    CALL PLOT(12.0,G,-3)
300 CALL PLOT(5.0,0.0,-3)
C
C PLOTS THE TRIANGULAR DIAGRAMS
C
    CALL AFM(NCARD,GX,GY)
    GO TO 10
1000 IF(PLTIME.EQ.10.) GO TO 1200
    CALL PLOT(0.0,0.0,999)
    CALL FACTOR(1.0)
1200 CALL EXIT
    END
    SUBROUTINE CALCUL(NCARD,NDATA)
C
C*********************** SUBROUTINE CALCUL ***************************
C
C CALCULATIN OF ALL THE RATIOS FOR EACH SAMPLE AND ALL THE ADJUSTMENTS
C NEED TO ACCOMPLISH THIS.
C
C*********************************************************************
C
    COMMON DATA(100,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),
   $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)
    KK = 1
    NUSUM = 0
    DO 60 J = 1,NCARD
    IF(DATA(J,1).EQ.999999.) GO TO 52
    NUSUM = NUSUM + 1
    SUM = 0.
C
C NORMALIZES THE TOTAL WEIGHT PERCENT OXIDES FOR EACH SAMPLE
C
```

```
      DO 10 I = 1,8
      IF(DATA(J,I).EQ.0.) GO TO 25
   10 SUM = SUM + DATA(J,I)
      DO 20 I = 1,8
   20 DATA(J,I) = (DATA(J,I)/SUM) * TOTAL(KK)
C** CALCULATES K IN PPM FROM WEIGHT PERCENT K2O
   25 DATA(J,40) = 8301.6 * DATA(J,8)
C** CALCULATES TI IN PPM FROM WEIGHT PERCENT TIO2
      DATA(J,41) = 5995.0 * DATA(J,2)
C** CALCUALTES NA IN PPM FROM WEIGHT PERCENT NA2O
      DATA(J,42) = 7420.0 * DATA(J,7)
C** CALCUALTES K/RB AND BA/RB
      IF(DATA(J,11).EQ.0..OR.DATA(J,11).EQ.999999.) GO TO 30
      DATA(J,43)= DATA(J,40)/DATA(J,11)
      DATA(J,44) = DATA(J,14)/DATA(J,11)
      GO TO 31
   30 DATA(J,43) = 0.0
      DATA(J,44) = 0.0
C** CALCULATES RB/SR AND BA/SR
   31 IF(DATA(J,12).EQ.0..OR.DATA(J,12).EQ.999999.) GO TO 32
      DATA(J,45) = DATA(J,11)/DATA(J,12)
      DATA(J,46) = DATA(J,14)/DATA(J,12)
      GO TO 33
   32 DATA(J,45)= 0.0
      DATA(J,46) = 0.0
C** CALCULATES LA/YB
   33 IF(DATA(J,30).EQ.0..OR.DATA(J,30).EQ.999999.) GO TO 34
      DATA(J,47) = DATA(J,19)/DATA(J,30)
      GO TO 35
   34 DATA(J,47) = 0.0
C** CALCULATES K/CS AND RB/CS
   35 IF(DATA(J,15).EQ.0..OR.DATA(J,15).EQ.999999.) GO TO 36
      DATA(J,48) = DATA(J,40)/DATA(J,15)
      DATA(J,57) = DATA(J,11)/DATA(J,15)
      GO TO 37
   36 DATA(J,48) = 0.0
      DATA(J,57) = 0.0
C** CALCULATES NI/CO
   37 IF(DATA(J,17).EQ.0..OR.DATA(J,17).EQ.999999.) GO TO 38
      DATA(J,49) = DATA(J,10)/DATA(J,17)
      GO TO 39
   38 DATA(J,49) = 0.0
C** CALCULATES ZR/HF
   39 IF(DATA(J,16).EQ.0..OR.DATA(J,16).EQ.999999.) GO TO 40
      DATA(J,50) = DATA(J,13)/DATA(J,16)
      GO TO 41
   40 DATA(J,50) = 0.0
C** CALCULATES TI/ZR
   41 IF(DATA(J,13).EQ.0..OR.DATA(J,13).EQ.999999.) GO TO 42
      DATA(J,51) = DATA(J,41)/DATA(J,13)
      GO TO 43
   42 DATA(J,51) = 0.0
```

```
                                                                        DATO5040
                                                                        DATO5050
 LCULATES ZN/CU                                                         DATO5060
                                                                        DATO5070
 IF(DATA(J,34).EQ.0..OR.DATA(J,34).EQ.999999.) GO TO 44                 DATO5080
 DATA(J,52) = DATA(J,35)/DATA(J,34)                                     DATO5090
 GO TO 45                                                               DATO5100
 DATA(J,52) = 0.0                                                       DATO5110
                                                                        DATO5120
 LCUALTES TH/U                                                          DATO5130
                                                                        DATO5140
 IF(DATA(J,39).EQ.0..OR.DATA(J,39).EQ.999999.) GO TO 46                 DATO5150
 DATA(J,53) = DATA(J,38)/DATA(J,39)                                     DATO5160
 GO TO 47                                                               DATO5170
 DATA(J,53) = 0.0                                                       DATO5180
                                                                        DATO5190
 LCULATES K/NA                                                          DATO5200
                                                                        DATO5210
 IF(DATA(J,8).EQ.0..OR.DATA(J,8).EQ.999999.) GO TO 48                   DATO5220
 DATA(J,54) = DATA(J,40)/DATA(J,42)                                     DATO5230
 GO TO 49                                                               DATO5240
 DATA(J,54) = 0.0                                                       DATO5250
                                                                        DATO5260
 LCULATES THE TOTAL RARE EARTH ELEMENT CONCENTRATIONS                   DATO5270
                                                                        DATO5280
 SUMZ = 0.0                                                             DATO5290
 DO 50 I=19,31                                                          DATO5300
 SUMZ = SUMZ + DATA(J,I)                                                DATO5310
 DATA(J,55) = SUMZ                                                      DATO5320
                                                                        DATO5330
 LCUALTES F/FM (FE2O3/FE2O3 + MGO)                                      DATO5340
                                                                        DATO5350
 IF(DATA(J,4).EQ.0..OR.DATA(J,4).EQ.999999..AND.DATA(J,5).EQ.0.         DATO5360
2.OR.DATA(J,5).EQ.999999.) GO TO 51                                     DATO5370
 DATA(J,56) = DATA(J,4)/(DATA(J,4) + DATA(J,5))                         DATO5380
 GO TO 54                                                               DATO5390
 DATA(J,56) = 0.                                                        DATO5400
                                                                        DATO5410
 LCUALTES ZN/PB                                                         DATO5420
                                                                        DATO5430
4 IF(DATA(J,36).EQ.0..OR.DATA(J,36).EQ.999999.) GO TO 55                DATO5440
 DATA(J,58) = DATA(J,35)/DATA(J,36)                                     DATO5450
 GO TO 60                                                               DATO5460
5 DATA(J,58) = 0.0                                                      DATO5470
 GO TO 60                                                               DATO5480
                                                                        DATO5490
 IF SIO2 = 999999. ON THE DATA CARD THEN ALL ELEMENTS AND OXIDES ARE    DATO5500
 SET EQUAL TO 999999. THIS SEPERATES DATASETS                           DATO5510
                                                                        DATO5520
2 DO 53 I=1,NDATA                                                       DATO5530
 DATA(J,I) = 999999.                                                    DATO5540
3 CONTINUE                                                              DATO5550
                                                                        DATO5560
 COUNTS THE NUMBER OF SAMPLES IN EACH DATASET                           DATO5570
                                                                        DATO5580
 NSAM(KK) = NUSUM                                                       DATO5590
 KK = KK + 1                                                            DATO5600
 NUSUM = 0                                                              DATO5610
0 CONTINUE                                                              DATO5620
 RETURN                                                                 DATO5630
 END                                                                    DATO5640
 SUBROUTINE STAT(KSTART,KSTOP,NDATA,TITLE)                              DATO5650
************************** SUBROUTINE STAT ***************************DATO5660
                                                                        DATO5670
 CALCULATION OF THE MEAN, MEDIAN,STANDARD DEVIATION, AND THE RELATIVE   DATO5680
 STANDARD DEVIATON FOR EACH DATASET                                     DATO5690
                                                                        DATO5700
*********************************************************************DATO5710
                                                                        DATO5720
 COMMON DATA(150,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),       DATO5730
1TOTAL(10),MAST(20),NSAM(10),NAM(10,10)                                 DATO5740
 DIMENSION AA(80),AMED(80),AAS(80),AASA(80),NUM(80),AAM(80)             DATO5750
```

```
      LOGICAL*1TITLE(6,80)
      DO 5 I=1,NDATA
      AAM(I) = 0.
      AMED(I) = 0.
      AAS(I) = 0.
      AASA(I) = 0.
      NUM(I) = 0
    5 CONTINUE
      DO 10 KDATA = 1,NDATA
      N = 0
      DO 20 JSAMP = KSTART,KSTOP
      IF(DATA(JSAMP,KDATA).EQ.0.) GO TO 20
      N = N + 1
      AA(N) = DATA(JSAMP,KDATA)
   20 CONTINUE
      NUM(KDATA) = N
      IF(N.EQ.0) GO TO 10
      IF(N.EQ.1) GO TO 84
C
CCALCULATES THE MEAN
C
      SUM=0.
      DO 40 I=1,N
      SUM = SUM + AA(I)
      CONTINUE
      XN=N
      AAM(KDATA) = SUM/XN
      X=0.
C
CCALCULATES THE STANDARD DEVIATION AND RELATIVE STANDARD DEVIATION
C
      DO 45 I=1,N
      Z = AA(I) - AAM(KDATA)
      X = X + (Z*Z)
      CONTINUE
      AAS(KDATA) = SQRT(X/(XN-1.))
      AASA(KDATA) = AAS(KDATA)/AAM(KDATA)
      IF(N.LE.2) GO TO 83
C
CBEGIN CALCULATION OF THE MEDIAN
C
      DO 60 L=1,500
      IF (N-(2*L)) 62,62,60
      CONTINUE
      K=L-1
      DO 68 J=1,K
      CON=1.0E7
      DO 66 I=1,N
      IF (CON-AA(I)) 66,66,64
      CON=AA(I)
      LOC=I
      CONTINUE
      AA(LOC)=1.0E7
      CONTINUE
      CON=1.0E7
      DO 72 I=1,N
      IF (CON-AA(I)) 72,72,70
      CON=AA(I)
      LOC=I
      CONTINUE
      CAN=CON
      AA(LOC)=1.0E7
      CON=1.0E7
      DO 76 I=1,N
      IF(CON-AA(I)) 76,76,74
      CON=AA(I)
      LOC=I
      CONTINUE
      IF (N-(2*L)) 82,80,80
   80 AMED(KDATA) = 0.5 * (CAN + CON)
      GO TO 10
   82 AMED(KDATA) = CAN
```

```
      GO TO 10
   13 AMED(KDATA) = AAM(KDATA)
      GO TO 10
   14 AAM(KDATA) = AA(KDATA)
      AMED(KDATA) = AAM(KDATA)
      AAS(KDATA) = 0.
      AASA(KDATA) = 0.
      CONTINUE

 WRITES THE STATISTICAL PARAMETERS FOR EACH DATASET

      WRITE(6,90)
   90 FORMAT('1',5X,'NO',4X,'NAME',7X,'NO POINTS',4X,'MEAN',6X,'MEDIAN',
     $4X,'STD DEV',4X,'REL STD DEV',/,23X,'********',3X,'********',3X,
     $'********',3X,'********',3X,'******',//)
      DO 95 K = 1,NDATA
   95 WRITE(6,100)K,(TITLE(J,K),J=1,6),NUM(K),AAM(K),AMED(K),AAS(K),
     2AASA(K)
  100 FORMAT(5X,I2,3X,6A1,9X,I5,3X,4(1X,F10.3))
      RETURN
      END
      SUBROUTINE LABLE(NGRP)

********************* SUBROUTINE LABLE ***************************

 PLOTS THE TITLES, NUMBER OF SAMPLES, AND THE SYMBOL USED ON THE PLOTS
 FOR EACH DATASET

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

      COMMON DATA(100,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),
     $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)
      DIMENSION IHOLD(10)
      CALL PLOT(0.0,9.0,-3)
      CALL SYMBOL(0.0,0.0,0.2,MAST,0.0,80)
      CALL SYMBOL(1.1,-0.75,0.2,'TITLE                     NO. SAMP      SYM
     $BOL',0.0,42)
      NSYM = 0
      Y = -1.25
      DO 10 I=1,NGRP
      SSAM = NSAM(I)
      X = 0.5
      DO 20 K=1,10
      IHOLD(K) = NAM(I,K)
   20 CONTINUE
      CALL SYMBOL(X,Y,0.15,IHOLD,0.0,40)
      CALL NUMBER(5.535,Y,0.15,SSAM,0.,-1)
      CALL SYMBOL(7.7,Y,0.15,NSYM,0.0,-1)
      NSYM = NSYM + 1
      IF(NSYM.EQ.7) NSYM = NSYM + 3
      Y = Y - 0.5
   10 CONTINUE
      CALL PLOT(0.,0.,999)
      CALL PLOT(22.0,-9.0,-3)
      RETURN
      END
      SUBROUTINE GRAPH(GX,GY,GXX,GYY,KX,KY,TITLE)

********************* SUBROUTINE GRAPH ***************************

 PLOTS THE GRAPH AND LABLES THE ORDINATE AND ABSCISSA

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

      COMMON DATA(100,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),
     $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)
      LOGICAL*1 TITLE(6,80)
      GY = 0.
      GX = 0.
      GXX = GX + 2.5
      GYY = GY + 0.5
```

```
C PLOTS THE GRAPH

      CALL PLOT(GXX,GYY,3)
      CALL PLOT(GXX+8.,GYY,2)
      CALL PLOT(GXX+8.,GYY+7.,2)
      CALL PLOT(GXX,GYY+7.,2)
      CALL PLOT(GXX,GYY,2)
      GX1 = GXX
      GY1 = GYY + 0.05

C PLACES THE TIC MARKS ON EACH AXIS

      DO 20 I = 1,9
      CALL PLOT(GX1,GY1,3)
      CALL PLOT(GX1,GY1-.1,2)
      GX1 = GX1 + 1.
   20 CONTINUE
      GX1 = GXX + 7.95
      GY1 = GYY
      DO 30 I=1,8
      CALL PLOT(GX1,GY1,3)
      CALL PLOT(GX1+.1,GY1,2)
      GY1 = GY1 + 1.0
   30 CONTINUE
      GX1 = GXX + 8.0
      GY1 = GYY + 6.95
      DO 40 I=1,9
      CALL PLOT(GX1,GY1,3)
      CALL PLOT(GX1,GY1+.1,2)
      GX1 = GX1 -1.0
   40 CONTINUE
      GX1 = GXX -0.05
      GY1 = GYY + 7.0
      DO 50 I=1,8
      CALL PLOT(GX1,GY1,3)
      CALL PLOT(GX1+.1,GY1,2)
      GY1 = GY1 - 1.0
   50 CONTINUE
      XL = GXX -+ 0.1
      YL = GYY + 7.15

C NUMBERS THE TIC MARKS ON THE ORDINATE AXIS IN SCIENTIFIC NOTATION

      CALL NUMBER(XL,YL,.1,YMIN(KY),0.,2)
      XL = XL + 0.85
      VAL = YMIN(KY)+ YINC(KY)
      DO 10 J=1,8
      CALL NUMBER(XL,YL,.1,VAL,0.,2)
      VAL = VAL + YINC(KY)
      XL = XL + 1.0
   10 CONTINUE
      XL = GXX - 0.25
      YL = GYY + 7.1

C NUMBERS THE TIC MARKS ON THE ABSCISSA IN SCIENTIFIC NOTATION

      CALL NUMBER(XL,YL,.1,YMIN(KX),-90.,2)
      YL = YL -0.85
      VAL = YMIN(KX) + XINC(KX)
      DO 60 J=1,7
      CALL NUMBER(XL,YL,.1,VAL,-90.,2)
      VAL = VAL + XINC(KX)
      YL = YL - 1.0
   60 CONTINUE
      XL = GXX - 0.05
      YL = GYY + 4.95
      IF(KX.GT.8) GO TO 70

C LABLES THE AXIS INCLUDING THE EXPONENT

      CALL SYMBOL(XL,YL,.15,'WT. PERCENT ',-90.,12)
      GO TO 80
```

```
70 CALL SYMBOL(XL,YL,.15,'CCNC. IN PPM ',-90.,13)                      DATO
80 YL = YL - 1.55                                                       DATO
   DO 45 J=1,6                                                          DATO
   CALL SYMBOL(XL,YL,.15,TITLE(J,KX),-90.,1)                            DATO
   YL = YL - .15                                                        DATO
45 CONTINUE                                                             DATO
   YL = YL - .15                                                        DATO
   CALL SYMBOL(XL,YL,.15,'X 10',-90.,4)                                 DATO
   YL = YL - .6                                                         DATO
   XL = XL + .075                                                       DATO
   CALL NUMBER(XL,YL,.1,EXP(KX),-90.,-1)                                DATO
   XL = GXX + 2.5                                                       DATO
   YL = GYY + 7.5                                                       DATO
   IF(KY.GT.8) GO TO 90                                                 DATO
   CALL SYMBOL(XL,YL,.15,'WT. PERCENT ',0.,12)                          DATO
   GO TO 100                                                            DATO
90 CALL SYMBOL(XL,YL,.15,'CCNC. IN PPM ',0.,13)                         DATO
100 XL = XL + 1.55                                                      DATO
   DO 65 J = 1,6                                                        DATO
   CALL SYMBOL(XL,YL,.15,TITLE(J,KY),0.,1)                              DATO
   XL = XL + .15                                                        DATO
65 CONTINUE                                                             DATO
   XL = XL + .15                                                        DATO
   CALL SYMBOL(XL,YL,.15,'X 10',0.,4)                                   DATO
   XL = XL + .6                                                         DATO
   YL = YL + .075                                                       DATO
   CALL NUMBER(XL,YL,.1,EXP(KY),0.,-1)                                  DATO
   CALL PLOT(0.0,0.0,999)                                               DATO
   RETURN                                                               DATO
   END                                                                  DATO
   SUBROUTINE POINT(GXX,GYY,KX,KY,NCARD)                                DATO
                                                                        DATO
*********************** SUBROUTINE POINT ****************************DATO
                                                                        DATO
PLOTS THE POINT ON THE GRAPH AND USES A DIFFERENT SYMBOL FOR EACH      DATO
FOR EACH DATASET                                                        DATO
                                                                        DATO
*********************************************************************DATO
                                                                        DATO
   COMMON DATA(100,30),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),    DATO
  $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)                               DATO
   NSYM = 0                                                             DATO
   DO 20 J = 1,NCARD                                                    DATO
   IF(DATA(J,KX).EQ.0..OR.DATA(J,KY).EQ.0.) GO TO 20                    DATO
   TMIN = DATA(J,KX)/10.**EXP(KX)                                       DATO
   PMIN = DATA(J,KY)/10.**EXP(KY)                                       DATO
   PX = ((( TMIN )  - YMIN(KX))/XINC(KX)   )                            DATO
   PY = ((( PMIN )   - YMIN(KY))/YINC(KY)       )                       DATO
   PXX= (7. - PX + GYY)                                                 DATO
   PYY= PY + GXX                                                        DATO
                                                                        DATO
* CHANGES THE SYMBOL FOR SUCESSIVE DATASETS                             DATO
                                                                        DATO
   IF(DATA(J,KY).LE.100000.) GO TO 10                                   DATO
   NSYM = NSYM + 1                                                      DATO
   IF(NSYM.EQ.7) NSYM = NSYM + 3                                        DATO
   GO TO 20                                                             DATO
                                                                        DATO
* MAKES SURE THAT ONLY THOSE POINTS WITH THE PROPER X AND Y COORDINATEDATO
PLOTTED                                                                 DATO
                                                                        DATO
10 IF(PXX.LE.0.5.OR.PXX.GT.7.5.OR.PYY.LE.2.5.OR.PYY.GT.10.5) GO TO 20DATO
   CALL SYMBOL(PYY,PXX,.1,NSYM,-90.,-1)                                 DATO
20 CONTINUE                                                             DATO
   CALL PLOT(0.0,0.0,999)                                               DATO
   RETURN                                                               DATO
   END                                                                  DATO
   SUBROUTINE AFM(NCARD,GX,GY)                                          DATO
                                                                        DATO
*********************** SUBROUTINE AFM ******************************DATO
                                                                        DATO
PLOTS THREE TRIANGULAR DIAGRAMS IF ALL NECESSARY DATA IS AVAILABLE     DATO
```

```
*
*************************************************************************
*
      COMMON DATA(100,80),YMAX(80),YMIN(80),EXP(80),YINC(80),XINC(80),
     $TOTAL(10),MAST(20),NSAM(10),NAM(10,10)
      CALL FACTOR(0.906)
      GX = 0.
      GY = 0.
      DO 40 JK = 1,3
*
* DETERMINES WHICH DIAGRAM TO PLOT
*
      GO TO (11,12,13),JK
*
* CHECKS TO SEE IF VALUES EXIST FOR ALL VARIABLES ON THE PROPER DIAGRAM
*
   11 IF(YMAX(4).EQ.0..OR.YMAX(5).EQ.0..OR.YMAX(7).EQ.0..OR.YMAX(8).EQ.0
     2.) GO TO 40
      GO TO 14
   12 IF(YMAX(13).EQ.0..OR.YMAX(32).EQ.0..OR.YMAX(41).EQ.0.) GO TO 40
      GO TO 14
   13 IF(YMAX(12).EQ.0..OR.YMAX(13).EQ.0..OR.YMAX(41).EQ.0.) GO TO 40
*
* PLOTS THE TRIANGLE
*
   14 CALL AXIS(0.0,0.0,' ',1,10.,60.,100.,-10.,10.)
      CALL AXIS(0.0,0.0,' ',-1,10.,0.,0.,10.,10.)
      CALL AXIS(10.,0.,' ',-1,10.,120.,0.,10.,10.)
*
* LABLES THE CORRECT TRIANGLE
*
      GO TO (1,2,3),JK
    1 CALL SYMBOL(-0.4,0.0,0.2,'A',00.,1)
      CALL SYMBOL(10.35,0.0,0.2,'M',0.,1)
      CALL SYMBOL(5.45,8.55,0.2,'F',0.,1)
      GO TO 4
    2 CALL SYMBOL(-0.6,0.0,0.2,'ZR',0.,2)
      CALL SYMBOL(10.35,0.0,0.2,'Y.3',0.,3)
      CALL SYMBOL(5.45,8.55,0.2,'TI/100',0.,6)
      GO TO 4
    3 CALL SYMBOL(-0.6,0.0,0.2,'ZR',0.,2)
      CALL SYMBOL(10.35,0.0,0.2,'SR/2',0.,4)
      CALL SYMBOL(5.45,8.55,0.2,'TI/100',0.,6)
    4 SIX = 60. * 3.14159/180.
      TRE = 30. * 3.14159/180.
      FL = 10. * SIN(SIX)
      CS = COS(TRE)
      TN = TAN(SIX)
      NSYM = 0
      GO TO (5,6,7),JK
    5 DO 10 J = 1,NCARD
*
* CALCULATES THE VALUES FOR THE AFM DIAGRAM
*
      IF(DATA(J,1).GT.1000000.) GO TO 9
      A = DATA(J,7) + DATA(J,8)
      PM = DATA(J,5)
      F = DATA(J,4)/1.1111
      IF(A.EQ.0..OR.PM.EQ.0..OR.F.EQ.0.) GO TO 10
      SUM = A + PM + F
      PM = PM/SUM * 100.
      F  = F/SUM * 100.
      TNF = F/100.
      EAS = PM/100.
*
* CALCUALTES THE X & Y CARTESIAN COORDIANTES FOR EACH POINT AND PLOTS
* IT. THE THE VALUES OF THE TOP AND RIGHT HAND CORNERS OF THE TRIANGLE
* ARE USED.
*
      Y = FL * TNF
      X = ((FL * TNF) + (10. * TN * EAS))/TN
      CALL SYMBOL(X,Y,0.1,NSYM,0.0,-1)
```

```
      GO TO 10
   9  NSYM = NSYM + 1
  10  CONTINUE
      CALL PLOT(0.,10.,-3)
      GO TO 40
C
CALCULATES THE VALUES FOR THE TI/100,ZR,Y*3 DIAGRAM
C
   6  DO 20 J=1,NCARD
      IF(DATA(J,1).GT.1000000.) GO TO 29
      T=DATA(J,41)/100.
      Z = DATA(J,13)
      Y = DATA(J,32) * 3.
      IF(T.EQ.0..OR.Z.EQ.0..OR.Y.EQ.0.)  GO TO 20
      SUM = T + Z + Y
      T = T/SUM * 100.
      Y = Y/SUM * 100.
      TNT = T/100.
      EAS = Y/100.
C
CALCUALTES THE X & Y CARTESIAN COORDIANTES FOR EACH POINT AND PLOTS
CIT. THE THE VALUES OF THE TOP AND RIGHT HAND CORNERS OF THE TRIANGLE
CARE USED.
C
      Y = FL * TNT
      X = ((FL * TNT) + (10. * TN*EAS))/TN
      CALL SYMBOL(X,Y,0.1,NSYM,0.,-1)
      GO TO 20
  29  NSYM = NSYM + 1
  20  CONTINUE
      CALL PLOT(0.,10.,-3)
      GO TO 40
C
CALCULATES THE VALUES FOR THE TI/100,ZR,SR/2 DIAGRAM
C
   7  DO 30 J=1,NCARD
      IF(DATA(J,1).GT.1000000.) GO TO 39
      T=DATA(J,41)/100.
      Z = DATA(J,13)
      S = DATA(J,12)/2.
      IF(T.EQ.0..OR.Z.EQ.0..OR.S.EQ.0.) GO TO 30
      SUM = T + Z + S
      T = T/SUM * 100.
      S = S/SUM * 100.
      TNT = T/100.
      EAS = S/100.
C
CALCUALTES THE X & Y CARTESIAN COORDIANTES FOR EACH POINT AND PLOTS
CIT. THE THE VALUES OF THE TOP AND RIGHT HAND CORNERS OF THE TRIANGLE
CARE USED.
C
      Y = FL * TNT
      X = ((FL * TNT) + (10. * TN*EAS))/TN
      CALL SYMBOL(X,Y,0.1,NSYM,0.,-1)
      GO TO 30
  39  NSYM = NSYM + 1
  30  CONTINUE
  40  CONTINUE
      CALL PLOT(15.0,0.0,999)
      RETURN
      END
```

```
***************   RARE EARTH ELEMENT PROGRAM   *******************

THE PROGRAM PLOTS CHRONDITE NORMALIZED RARE EARTH ELEMENT VALUES
A 6.5" X 10" SEMILOG PLOT AND GIVES A PRINTOUT OF THE EXACT VALUES

 INPUT INCLUDES:

DATA CARD 1        TITLE(18)
                   FORMAT(18A4)

   TITLE - A FOUR CHARACTER REPRESENTATION FOR THE RARE EARTH
           ELEMENTS (THIS INCLUDES BLANKS),E.G._LA__SM_ETC.
           FOLLOWING THE LAST RARE EARTH ELEMENT TYPE EU*G (FOR
           EU* CALCULATED USING GD); EU*T (FOR EU* CALCULATED
           USING TM); EE*G (FOR EU/EU* BASED ON EU* CALCULATED
           FROM GD); EE*T (FOR EU/EU* BASED ON EU* CALCULATED
           FROM TM).

DATA CARD 2        CV(14)
                   FORMAT(14F5.3)

      CV - THE CHRONDITE VALUES TO BE USED IN THE PROGRAM.  THEY
           MUST BE IN THE ORDER OF THE FIRST 14 RARE EARTH
            ELEMENTS OF DATA CARD 1.

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

A CARDS 1 AND 2 SHOULD REMAIN WITH THE PROGRAM, THEY DO NOT
IANGE AND THERE IS NO REASON THE RETYPE THESE CARDS EACH TIME
IE PROGRAM IS TO BE RERUN.

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

DATA CARD 3        NSAMP,NCYCLE,THIT(8)
                   FORMAT(2I5,8A4)

   NSAMP - THE NUMBER OF SAMPLES TO BE PLOTTED ON THE GRAPH
           (10 IS MAXIMUM).

  NCYCLE - THE NUMBER OF CYCLES DESIRED ON THE 10" LOG SCALE.

    THIT - A 32 CHARACTER NAME TO BE PLOTTED BENEATH THE GRAPH.
           THIS IS PLOTTED ALONG THE ABSCISSA AND THE TYPED
           CHARACTERS SHOULD BE CENTERED IN THE 32 COLUMNS

DATA CARD 4        ((SAMP(J,I),J=1,6),I=1,NSAMP)
                   FORMAT(10(6A1))

    SAMP - A SIX CHARACTER SAMPLE NAME,E.G._NP24_MAN123ETC.

DATA CARD 5 - ? REE(J,I)
           FORMAT(7F10.3,10X)

     REE - THE RARE EARTH ELEMENT CONCENTRATIONS OF EACH SAMPLE IN
           THE ORDER OF DATA CARD 4 WITH THE ELEMENTS IN THE
           ORDER OF THE FIRST 14 RARE EARTH ELEMENTS OF DATA CARD
           1.

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

CH SAMPLE USES TWO DATA CARDS,TYPE 7 CONCENTRATIONS PER CARD WITH
SPACES PER CONCENTRATION.  A 3 DECIMAL PLACE ACCURACY IS POSSIBLE
 THE LAST 10 SPACES ON THE CARD ARE LEFT BLANK.

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

TA FOR A SUCEEDING GRAPH IS PLACED FOLLOWING THE LAST CARD WITH
EMENT CONCENTRATIONS FOR THE PRECEEDING GRAPH.  BEGIN DATA INPUT
R SUCCEDING GRAPHS WITH DATA CARD 3.

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

```
OMMON REE(18,10),REEN(18,10),CV(14),THIT(8)
OGICAL*1SAMP(6,10),BLANK/' '/
.EAL*4TITLE(18)

.DS ELEMENT NAMES

:EAD(5,10)(TITLE(I),I=1,18)
'ORMAT(18A4)

\DS CHRONDITE VALUES

{EAD(5,15) (CV(I),I=1,14)
'ORMAT(14F5.0)

\DS CONTROLS AND PLOT NAME

{EAD(5,30,END=1000) NSAMP,NCYCLE,THIT
'ORMAT(2I5,8A4)
[F(NSAMP.GT.10) GO TO 998
)O 35 I=1,10
)O 35 J=1,18
{EE(J,I) = 0.
{EEN(J,I) = 0.
:ONTINUE

\DS SAMPLE NUMBERS

{EAD(5,40)((SAMP(J,I),J=1,6),I=1,NSAMP)
'ORMAT(10(6A1))

ADS ELEMENT CONCENTRATIONS

READ(5,50)((REE(IE,IS),IE=1,14),IS=1,NSAMP)
FORMAT(7F10.3,10X)
CALL ADJUST(NSAMP)

ITES PLOT TITLE

WRITE(6,55)(THIT(I),I=1,8)
FORMAT('1',45X,8A4,//,45X,'INITIAL VALUES'//)

ITES SAMPLE NUMBERS

WRITE(6,60)((SAMP(J,I),J=1,6),I=1,NSAMP)
FORMAT(' ',21X,6A1,9(5X,6A1))
WRITE(6,70)(BLANK,I=1,NSAMP)
FORMAT(18X,10(2X,A1,8('*')))
WRITE(6,80)
FORMAT(' ')

ITES THE ELEMENT NAME AND THE CONCENTRATIONS FOR EACH SAMPLE

DO 90 IE = 1,14
WRITE(6,100) TITLE(IE),(REE(IE,IS),IS = 1,NSAMP)
FORMAT(' ',12X,A4,2X,10(1X,F10.4))

ITES THE CHRONDITE NORMALIZED VALUES

WRITE(6,110)
FORMAT(///,47X,'CHRONDITE NORMALIZED VALUES',//)
DO 120 IE=1,18
WRITE(6,130) TITLE(IE),(REEN(IE,IS),IS=1,NSAMP)
FORMAT(' ',12X,A4,2X,10(1XF10.4))

TERMINES THE LENGTH OF EACH CYCLE

HCYCLE = 10./FLOAT(NCYCLE)
ORD = 10.
ABS = 6.5
BASE = 0.
INCYC = NCYCLE
```

```
  THE GRAPH AND PLACED THE TIC MARKS IN THE APPROPRIATE
IONS (FROM HERE TO STATEMENT 180)

L PLOT(1.0,1.0,-3)
L PLOT(ORD,0.0,2)
L PLOT(ORD,ABS,2)
L PLOT(0.0,ABS,2)
L PLOT(0.0,0.0,2)
 0.
140 I = 1,14
L PLOT(-.05,Y,3)
L PLOT(.05,Y,2)
 Y + 0.5
TINUE
 0.
150 I = 1,14
L PLOT(9.95,Y,3)
L PLOT(10.05,Y,2)
 Y + 0.5
TINUE
 0.
180 I=1,2
170 ICYC = 1,INCYC
160 JCYC = 1,10
SP = BASE + ALOG10(FLOAT(JCYC)) * HCYCLE
L PLOT(HDISP,X+.05,3)
L PLOT(HDISP,X-.05,2)
TINUE
E = BASE + HCYCLE
TINUE
E = 0.
 6.5
TINUE
E = 0.
N = 1.

RS THE LOG AXIS

 200 I = 1,INCYC
K = FLOAT(I) * .05
 190 J = 1,9
(J.EQ.3.OR.J.EQ.5.OR.J.EQ.7.OR.J.EQ.9) GO TO 190
 = PTEN * FLOAT(J)
ISP = BASE + ALOG10(FLOAT(J)) * HCYCLE
LL NUMBER(HDISP-BACK,6.6,0.1,FPN,0.0,-1)
NTINUE
SE = BASE + HCYCLE
EN = PTEN * 10.
NTINUE
= 6.625

S THE ELEMENT NAMES

 210 I = 1,14
LL SYMBOL(-.2,Y,0.1,TITLE(I),-90.,4)
= Y - 0.5
NTINUE

LS BOTH AXIS

LL SYMBOL(5.0,6.8,0.15,'SAMPLE/CHRONDITE',0.0,16)
LL SYMBOL(-0.45,4.5,0.15,'RARE EARTH ELEMENTS',-90.,19)
= 5.5

S THE PLOT TITLE

LL SYMBOL(-0.85,Y,0.15,THIT,-90.,32)
= 6.5
YM = -1

S ALL SAMPLES FOR EACH ELEMENT THEN MOVES TO THE NEXT ELEMENT
 230 IE = 1,14
```

```
 240 IS = 1,NSAMP
.REEN(IE,IS).EQ.0.) GO TO 240
= ALOG10(REEN(IE,IS)) * HCYCLE
IY.LT.0..OR.Y.GT.6.5.OR.X.LT.0..OR.X.GT.10.) GO TO 240
/M = NSYM + 1
(NSYM.EQ.7) NSYM = NSYM + 3
_L SYMBOL(X,Y,.075,NSYM,-90.,-1)
NTINUE
= Y - 0.5
YM = -1
NTINUE

S THE PLOTTER TO BEGIN A SECOND PLOT

LL PLOT(12.0,-1.0,999)
 TO 20
ITE(6,999)
RMAT(' ',10X,'MORE THAN 10 POINTS PER PLOT IS UNACCEPTABLE')
LL EXIT
D
BROUTINE ADJUST(NSAMP)
MMON REE(18,10),REEN(18,10),CV(14),THIT(8)

.CULATES CHRONDITE NORMALIZED VALUES

) 20 IS = 1,NSAMP
) 10 IE = 1,14
EN(IE,IS) = REE(IE,IS)/CV(IE)
)NTINUE

:ULATES EU*(GD) AND EU/EU*(GD)

F(REE(7,IS).EQ.0.) GO TO 15
EEN(15,IS) =(REEN(5,IS) + REEN(7,IS))/2.
EEN(17,IS) = REEN(6,IS)/REEN(15,IS)
0 TO 17
EEN(15,IS) = 0.0
EEN(17,IS) = 0.0
F(REEN(8,IS).EQ.0.) GO TO 19

CUALTES EU*(TM) AND EU/EU*(TM)

EEN(16,IS) = REEN(5,IS) - ((REEN(5,IS) - REEN(8,IS))/3.)
EEN(18,IS) = REEN(6,IS)/REEN(16,IS)
0 TO 20
EEN(16,IS) = 0.0
EEN(18,IS) = 0.0
ONTINUE
ETURN
END
```

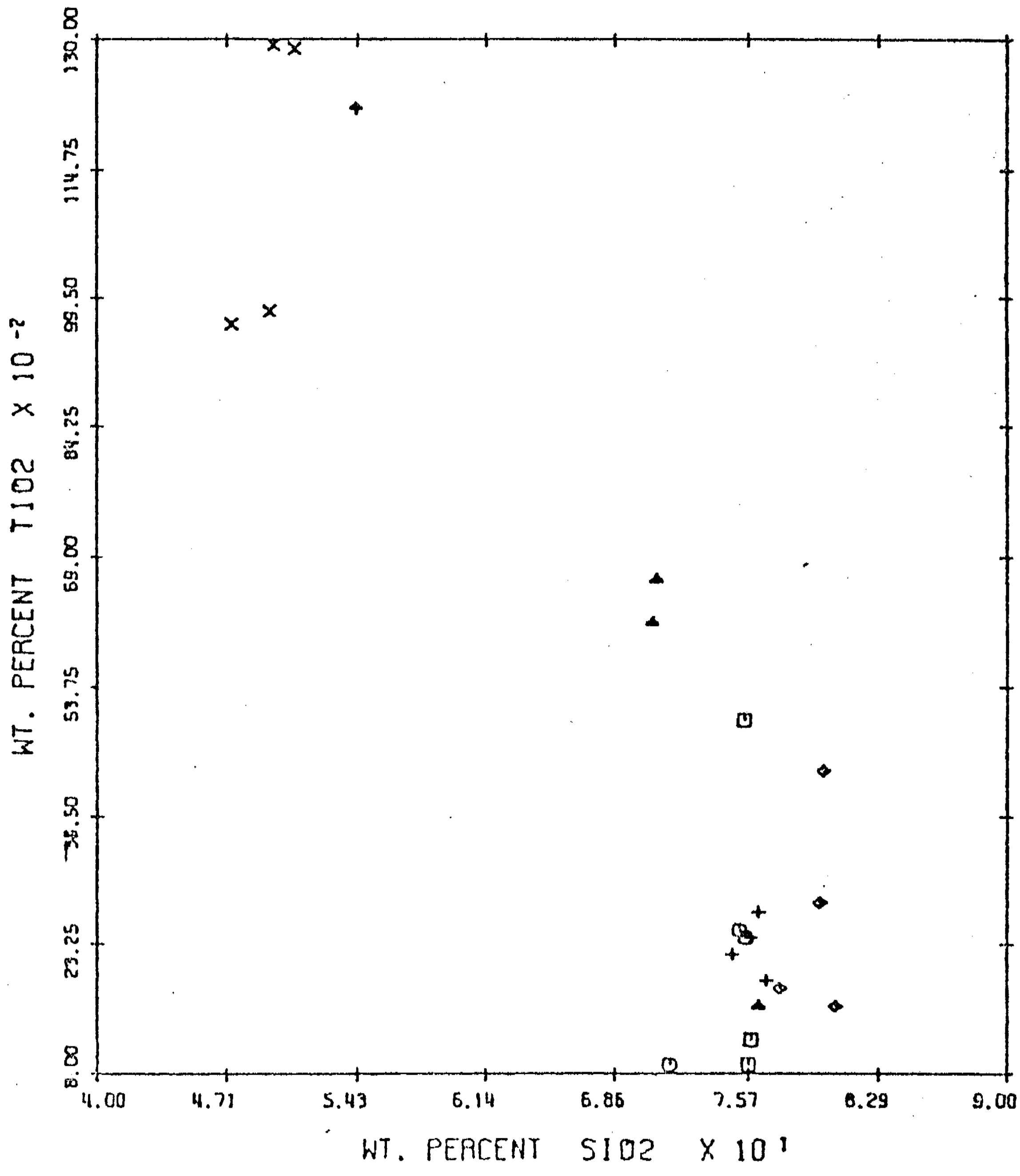
```
C******************************  PROGRAM BETA  ******************************
C
C        THIS PROGRAM READS PLANER DATA FROM BOTH TAPE AND CARDS. AND
C THEN DETERMINES A PERCENT DENSITY PLOT OF THE LOWER HEMISPHERE. THE
C OUTPUT IS A 61 X 61 SQUARE MATRIX WHICH REPRESENTS THE LOWER
C HEMISPHERE.  AN INSCRIBED CIRCLE REPRESENTS THE PRIMITIVE CIRCLE.
C THE DENSITY IS MULTIPLIED BY 10 TO GIVE AN ACCURACY TO ONE
C DECIMAL PLACE.
C  INPUT
C
C DATA CARD 1  IXMIN,IXMAX,IYMIN,IYMAX,NTYP
C              FORMAT(5I10)
C
C                IXMIN = THE MINIMUM E-W COORDINATE TO BE CONSIDERED
C                IXMAX = THE MAXIMUM E-W COORDINATE TO BE CONSIDERED
C                IYMIN = THE MINIMUM N-S COORDINATE TO BE CONSIDERED
C                IYMAX = THE MAXIMUM N-S COORDINATE TO BE CONSIDERED
C                NTPY = 500 ALL ROCKS TYPES ARE ANALYZED TOGETHER (USED
C                   ONLY WITH THE TAPE)
C                     = THE NUMBER OF THE PARTICULAR ROCK TYPE TO BE
C                     =  CONSIDERED WHEN DATA IS READ FROM THE TAPE
C
C DATA CARD 2   J1,NN,FMT
C              FORMAT(2I5,16A4)
C
C              J1 = 1 IF DATA ID TO BE READ FROM TAPE
C                 = 2 IF DATA IS TO BE READ FROM CARDS
C              NN = THE NUMBER OF PAIRS OF STRIKE AND DIP PER CARD
C              FMT = THE FORMAT TO READ THE DATA FROM TAPE OR CARDS
C
C DATA CARD 3  TITLE
C              FORMAT(20A4)
C
C              TITLE = AN 80 CHARACTER NAME FOR THE DATA
C
C DATA CARD 4 - ? (MM(I)MMN(I),I=1,NN)
C              FORMAT (DEFINED BY VARIABLE FMT)
C
C              MM(I) = THE STRIKE OF THE ELEMENT TO BE CONSIDERED
C              MN(I) = THE DIP OF THE ELEMENT TO BE CONSIDERED
C
C* DATA CARD 4 IS USED ONLY IF THE DATA IS READ FROM CARDS
C
C        THIS PROGRAM WAS DEVELOPED BY MR.W.P.H. LAM AT THE UNIVERSITY
C MELBOURNE, VICTORIA, AUSTRALIA.  FOR FURTHER DISCUSSION OF THE
C PROGRAM THE USER IS REFERRED TO A.J.S., VOL26 ,P.   .
C
C*****************************************************************************
C
      DIMENSIONTAB(101,101),ITAB(101),IFTP(6),IFST(6),IFDP(6),TITLE(20),
     2ALPHA(1000),BETA(1000),NTP(5),IXC(5),IYC(5),FMT(16),MM(8),MN(8)
      INTEGER TI , TJ
      KOUNT = 0
      K = 0
      READ(5,15) IXMIN,IXMAX,IYMIN,IYMAX,NTYP
   15 FORMAT(5I10)
      READ(5,5)  J1,NN,FMT
    5 FORMAT(2I5,16A4)
      READ(5,6)  TITLE
    6 FORMAT(20A4)
      GO TO (200,130),J1
C
C READS DATA TO BE USED FROM TAPE
C
  200 READ(2,FMT,END=900) (IXC(I),IYC(I),IFTP(I),IFST(I),IFDP(I),NTP(I),
     2I=1,3)
      DO 220 I = 1,3
C
C CHECKS TO SEE IF DATA EXISTS AT THAT LOCATION, OR IF THE DATA IS T
C WHICH THE USER DESIRES
C
      IF(IFTP(I).GT.2.OR.IFTP(I).EQ.0) GO TO 220
```

APPENDIX III

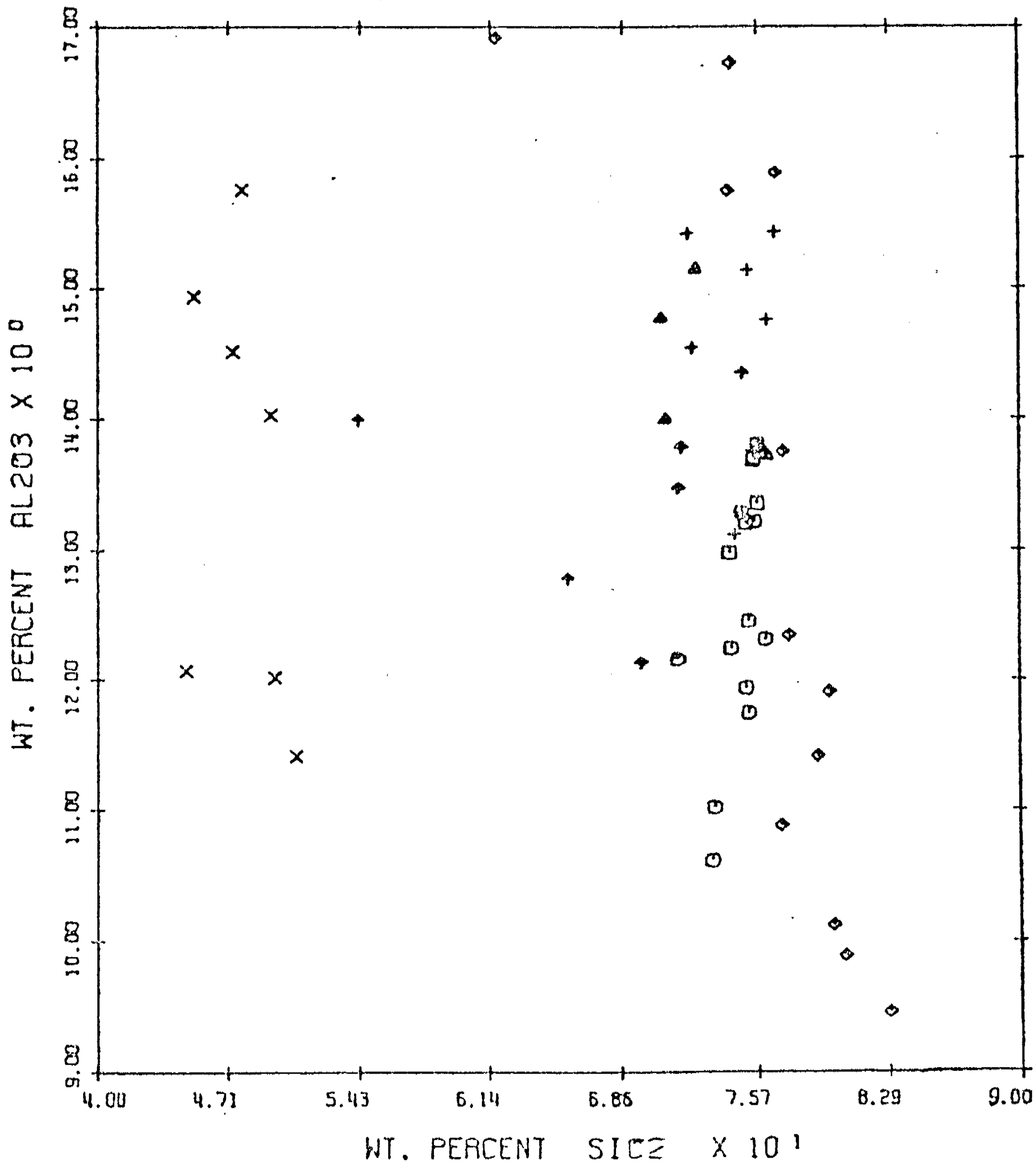
Diagrams plotted by program DATAPLOT using chemical analyses listed in Appendix I. Plots include SiO_2 vs. TiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, Ni, Rb, Sr, Zr, Ba, Cs, Co, Cr, La, Ce, Sm, Eu, Tb, Yb, Lu, Y, K, Na, Ti, K/Rb, Ba-Rb, Rb/Sr, Ba/Sr, La/Yb, K/Cs, Ti/Zr, K/Na, REE (total rare earth elements), F/Fm (Fe_2O_3/(Fe_2O_3+ MgO)), and Rb/Cs. Additional plots include K vs. Sr, Na, Cs, and Rb; La vs. K, Cs, and Rb; Sr vs. CaO, Ba, and Eu; Ni vs. Fe_2O_3 and MgO.

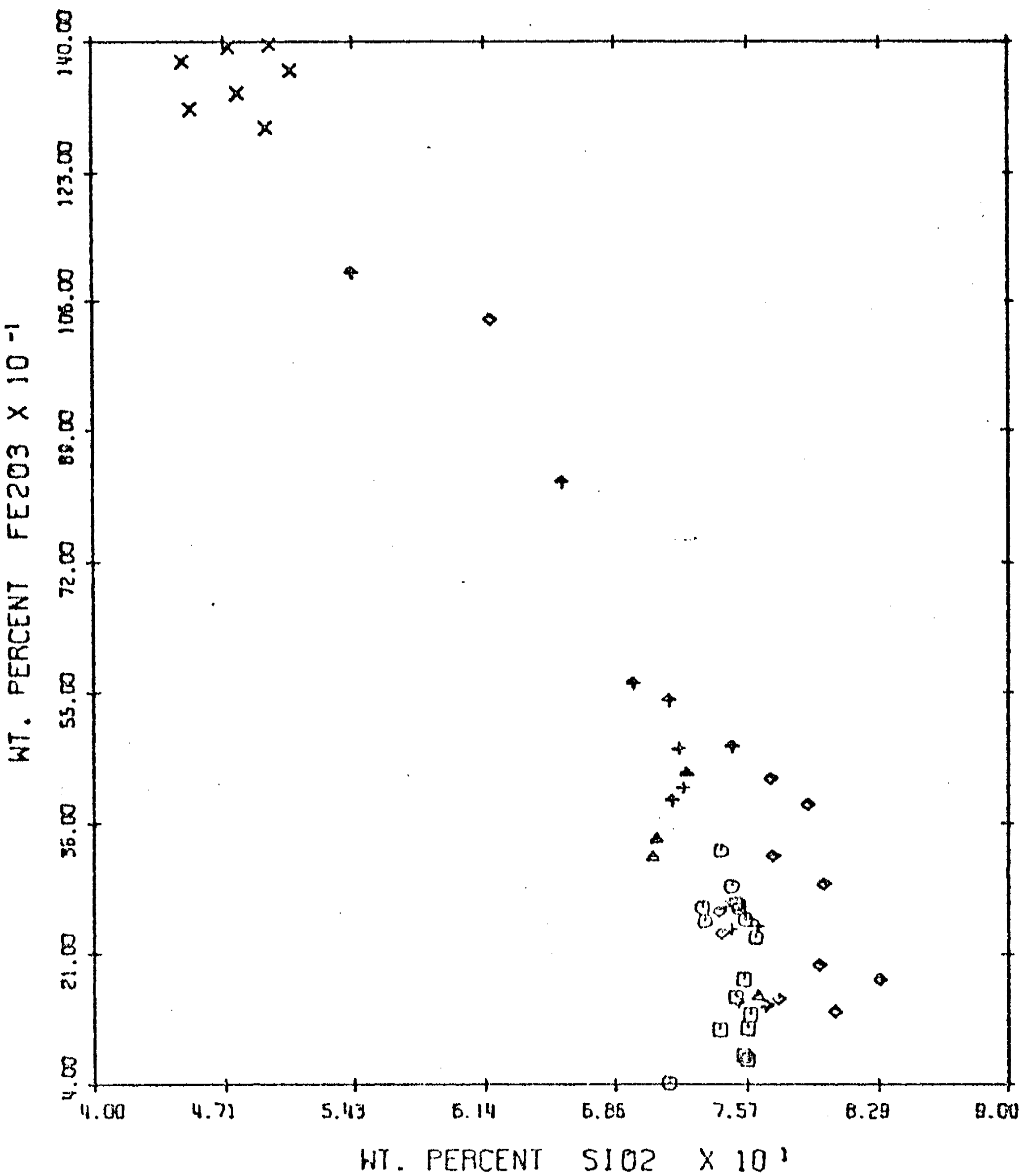
IGNEOUS ROCKS OF THE LOS PINOS MOUNTAINS

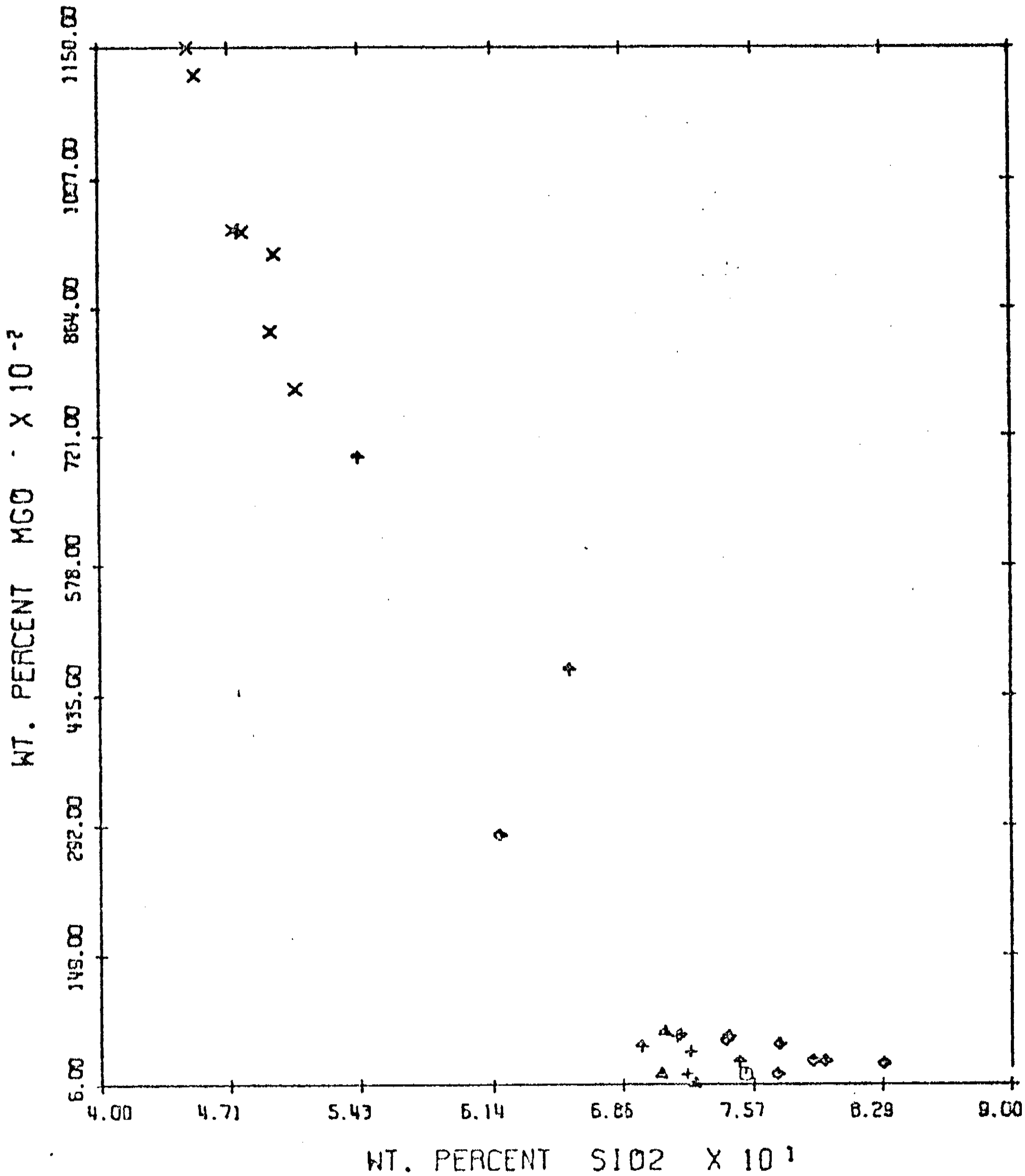
TITLE	NO. SAMP	SYMBOL
SEPULTURA GRANITE	7	⊡
LOS PINOS GRANITE	10	○
METAVOLCANICS (MONTOSA SECTION)	4	△
METAVOLCANICS (PINON SECTION)	8	+
AMPHIBOLITES	7	X
METAARKOSITES	12	◇
MISCELLANEOUS ROCKS	6	⊹



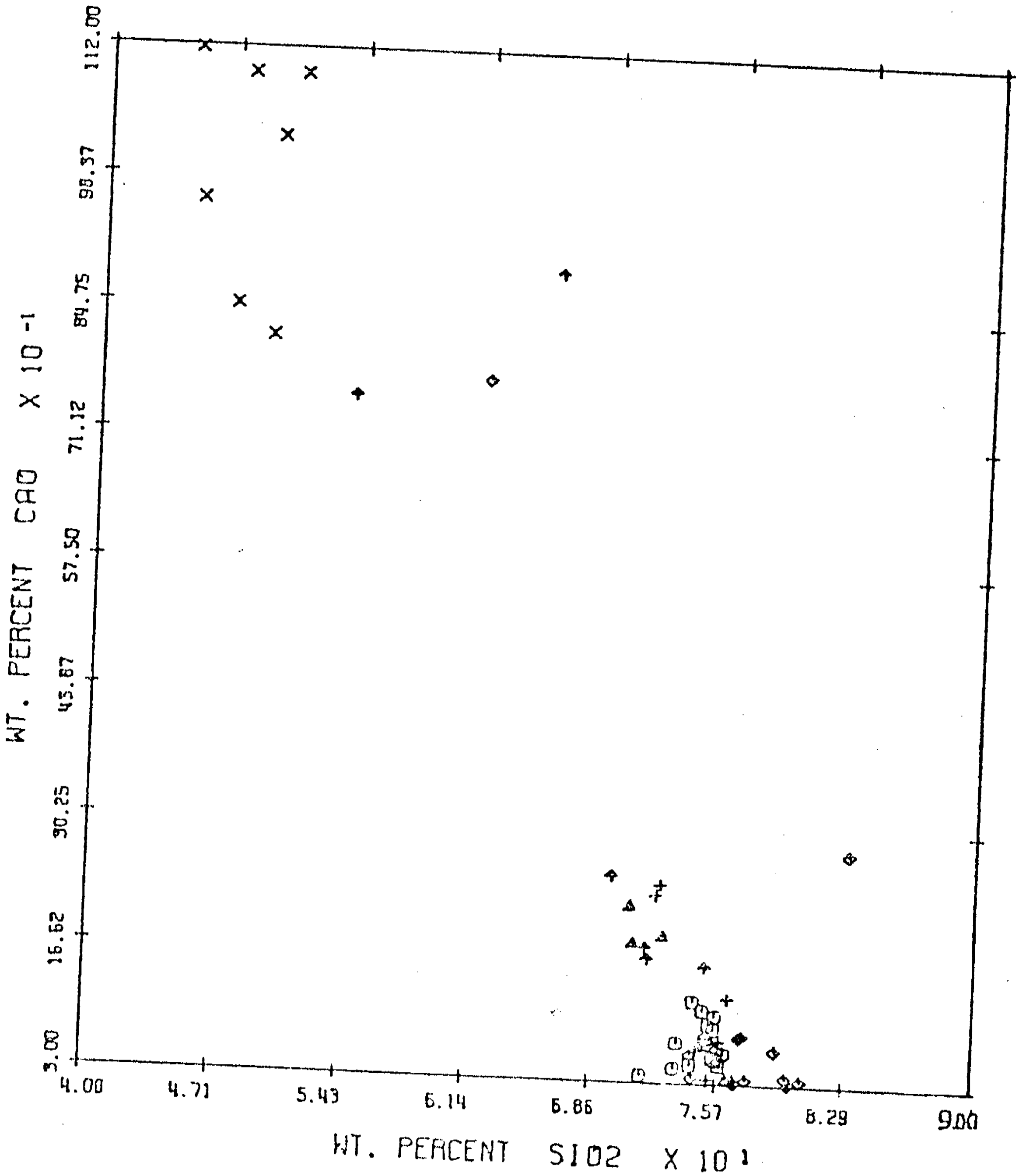
WT. PERCENT TIO2 X 10 -2
130.00
114.75
99.50
84.25
69.00
53.75
38.50
23.25
8.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

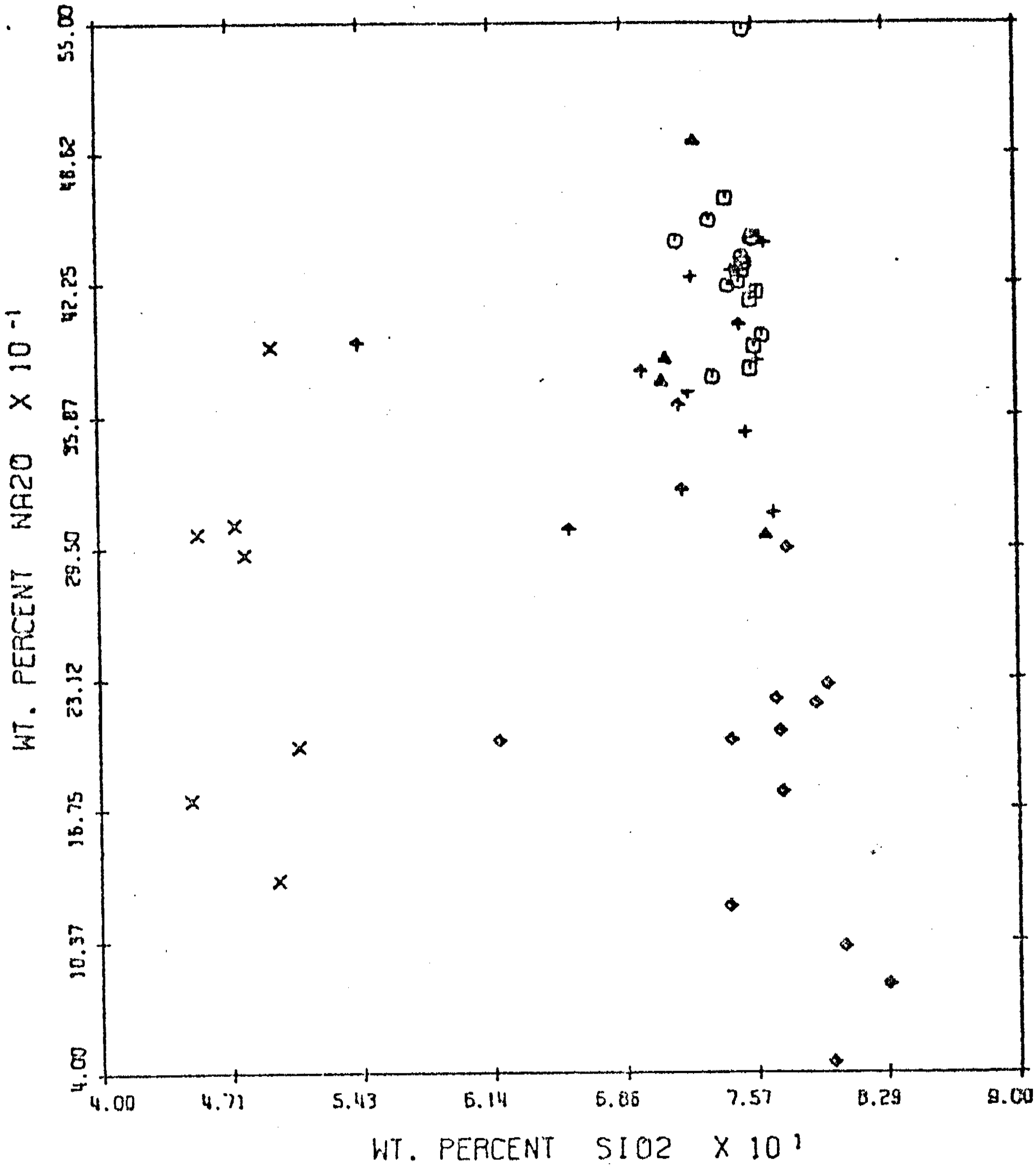

WT. PERCENT AL2O3 X 10⁰
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10¹

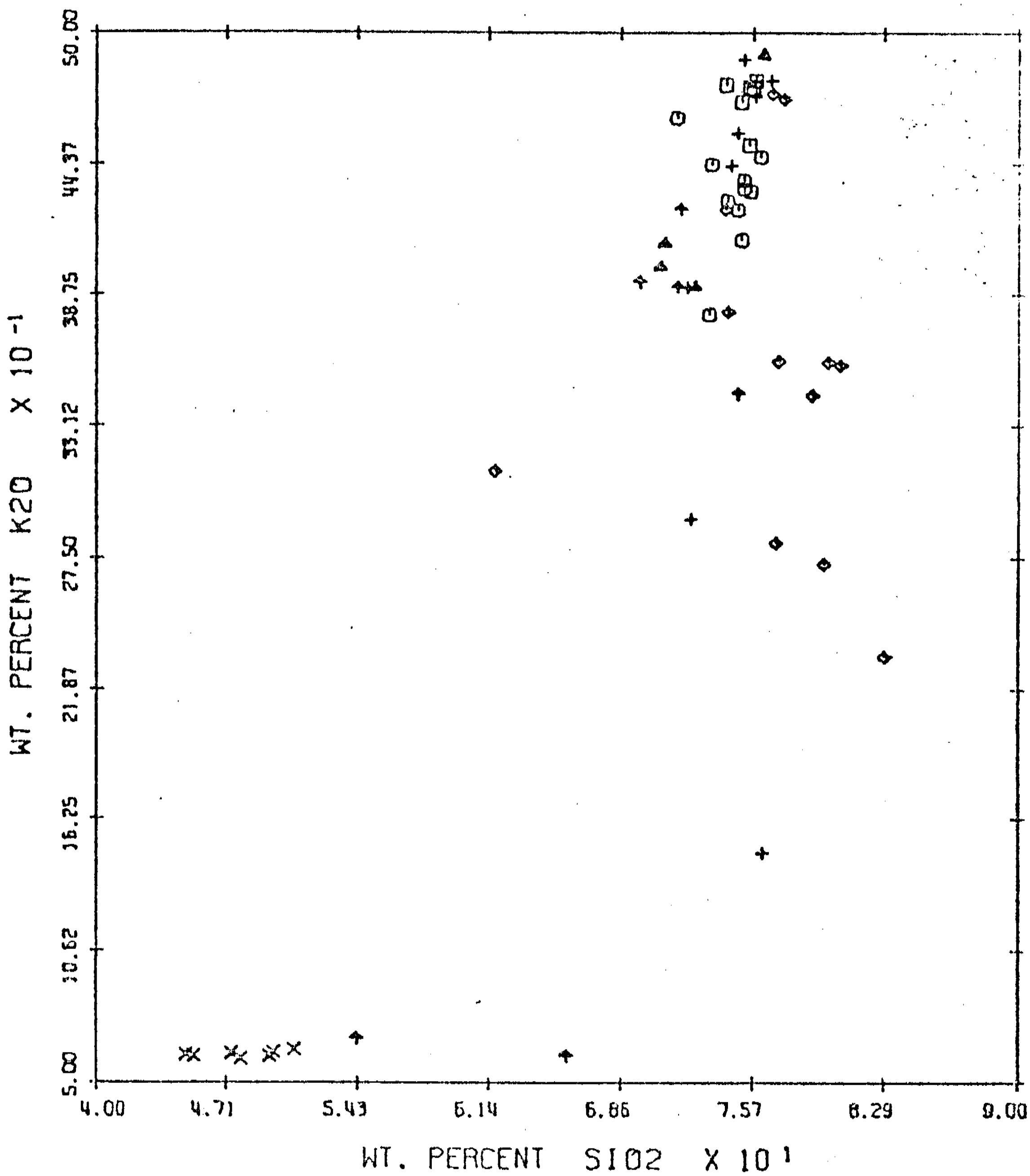

WT. PERCENT FE2O3 X 10 -1
140.00
123.00
106.00
89.00
72.00
55.00
38.00
21.00
4.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

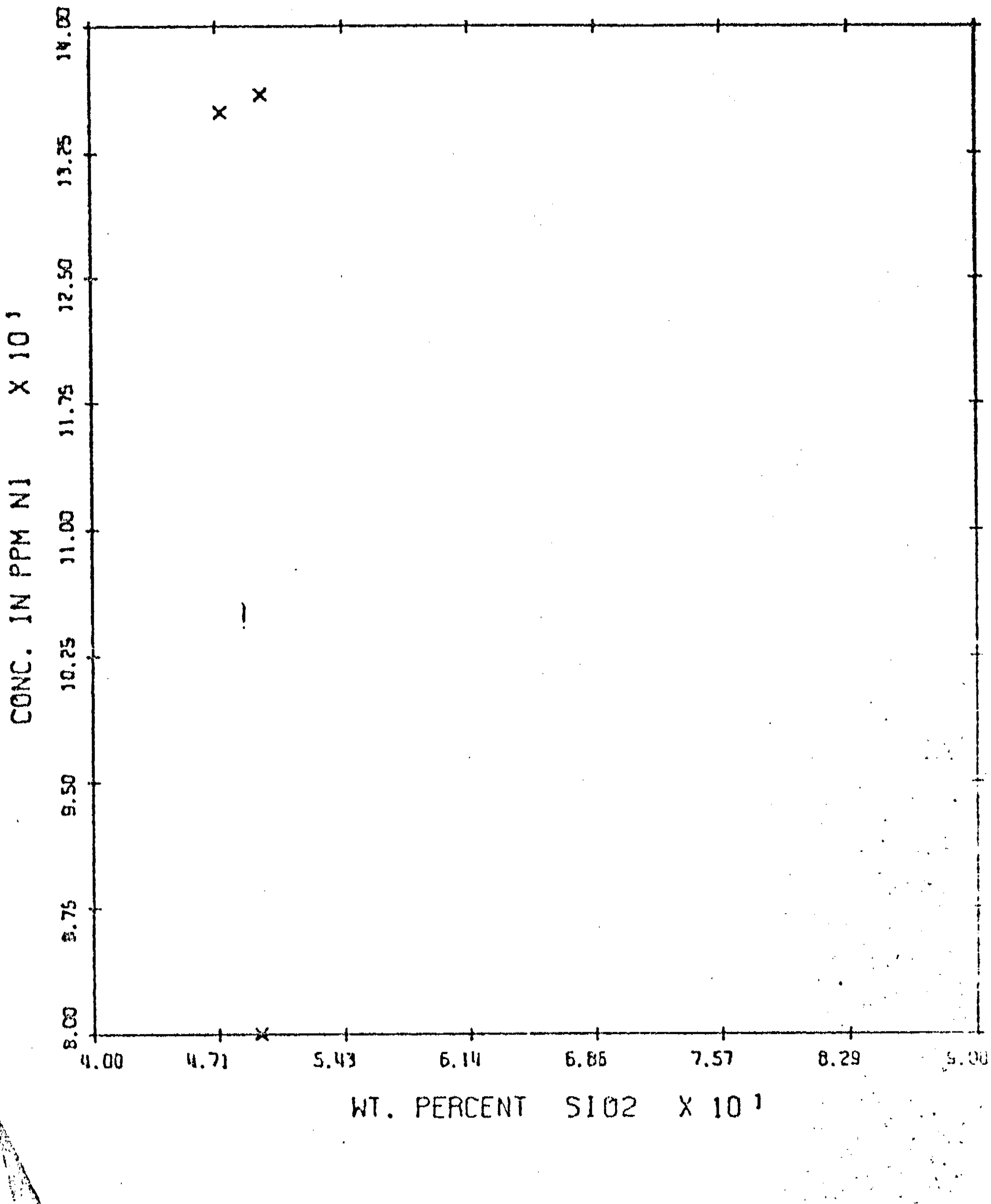


1150.00
1007.00
864.00
721.00
578.00
435.00
292.00
149.00
6.00
WT. PERCENT MGO · X 10 -2
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

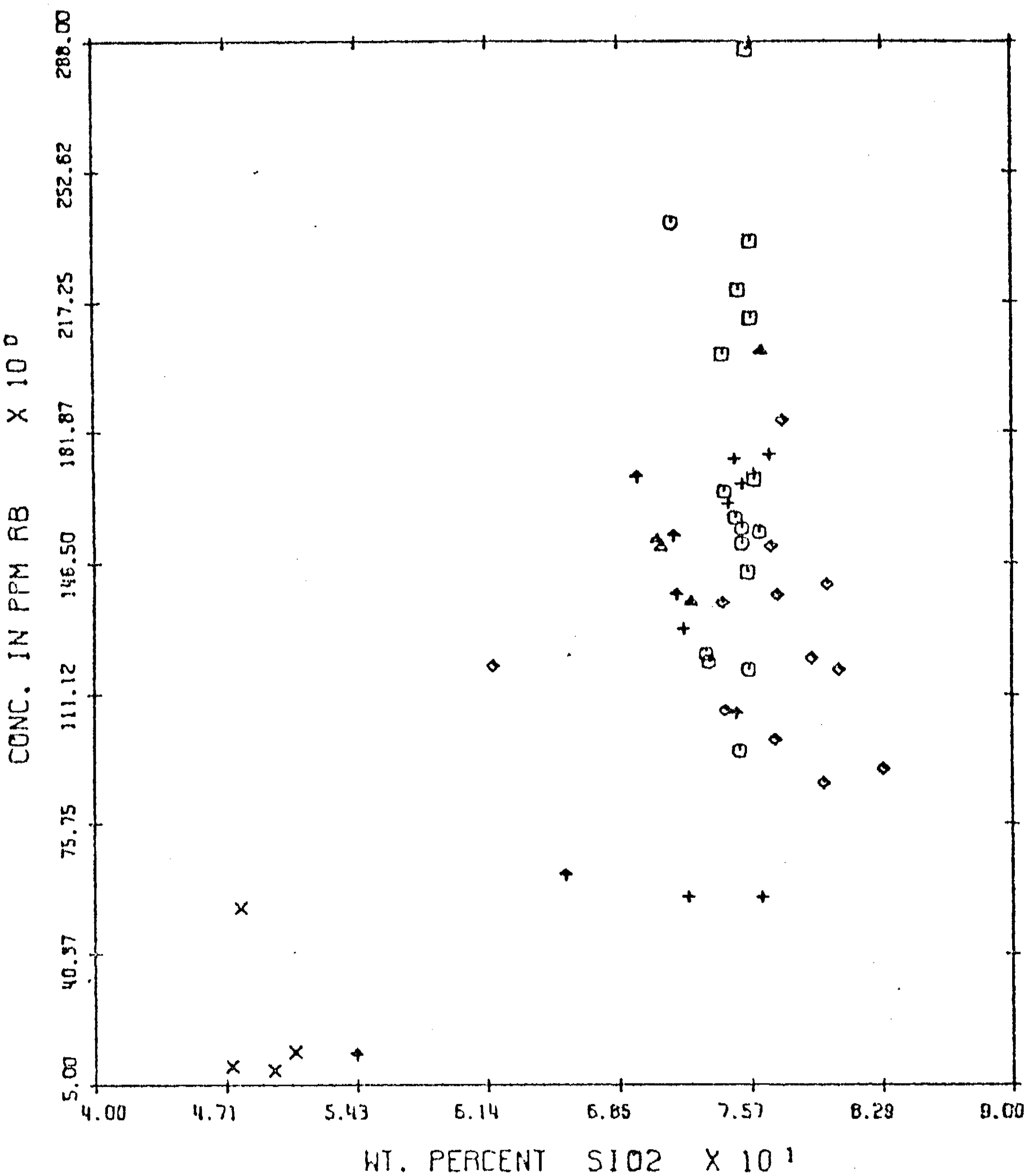

WT. PERCENT CAO X 10 -1
112.00
98.37
84.75
71.12
57.50
43.87
30.25
16.62
3.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

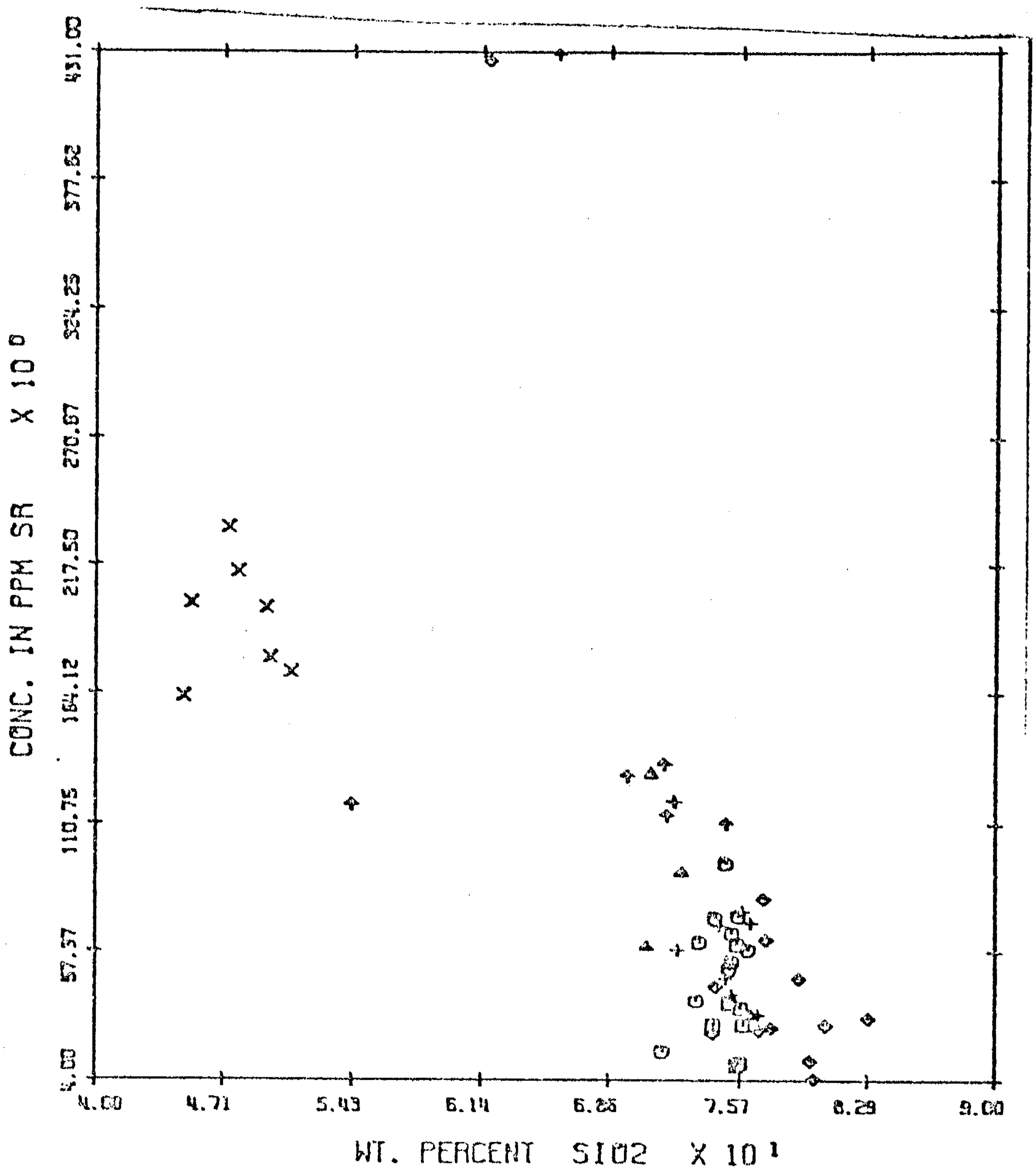

55.00
48.62
42.25
35.87
29.50
23.12
16.75
10.37
4.00
WT. PERCENT NA2O X 10 -1
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

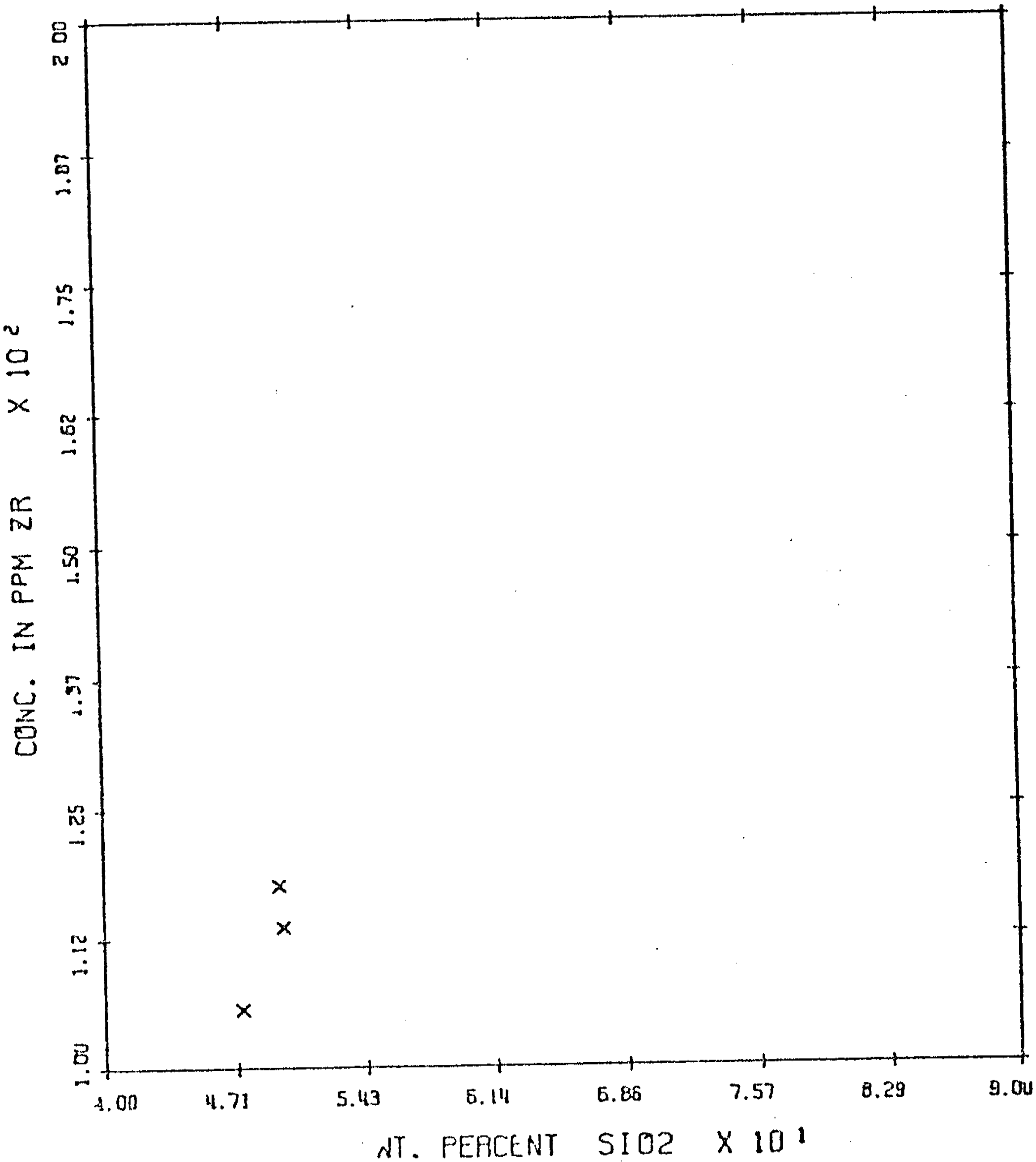

WT. PERCENT K2O X 10 -1
50.00
44.37
38.75
33.12
27.50
21.87
16.25
10.62
5.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1



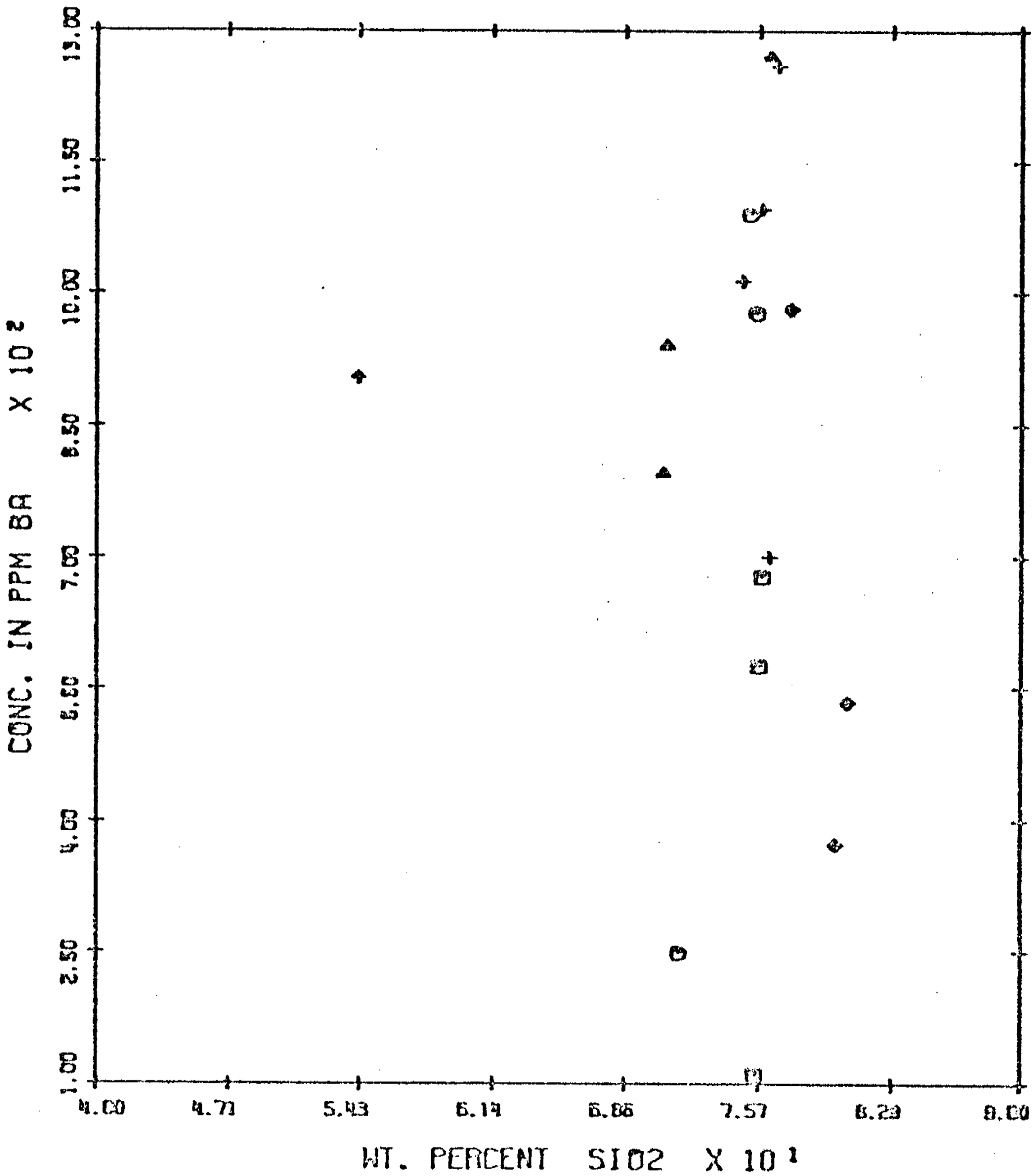
14.00
13.25
12.50
11.75
11.00
10.25
9.50
8.75
8.00
CONC. IN PPM NI X 10 1
4.00
4.71
5.43
6.14
6.86
7.57
8.29
WT. PERCENT SIO2 X 10 1


CONC. IN PPM RB X 10^0
288.00
252.62
217.25
181.87
146.50
111.12
75.75
40.37
5.00
4.00
4.71
5.43
6.14
6.85
7.57
8.28
9.00
WT. PERCENT SIO2 X 10^1

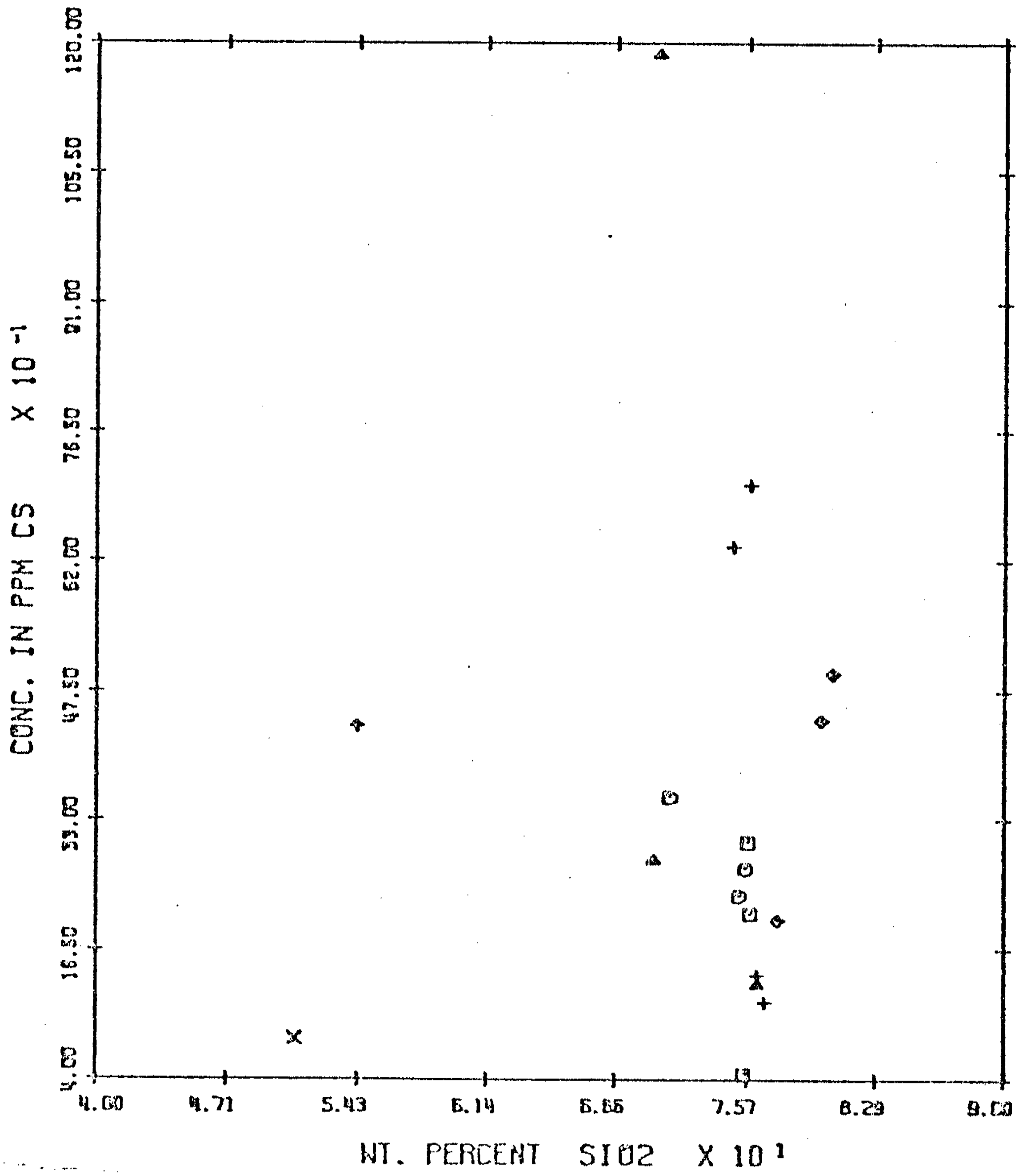

431.00
377.62
324.25
270.87
217.50
164.12
110.75
57.37
4.00
CONC. IN PPM SR X 10 0
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

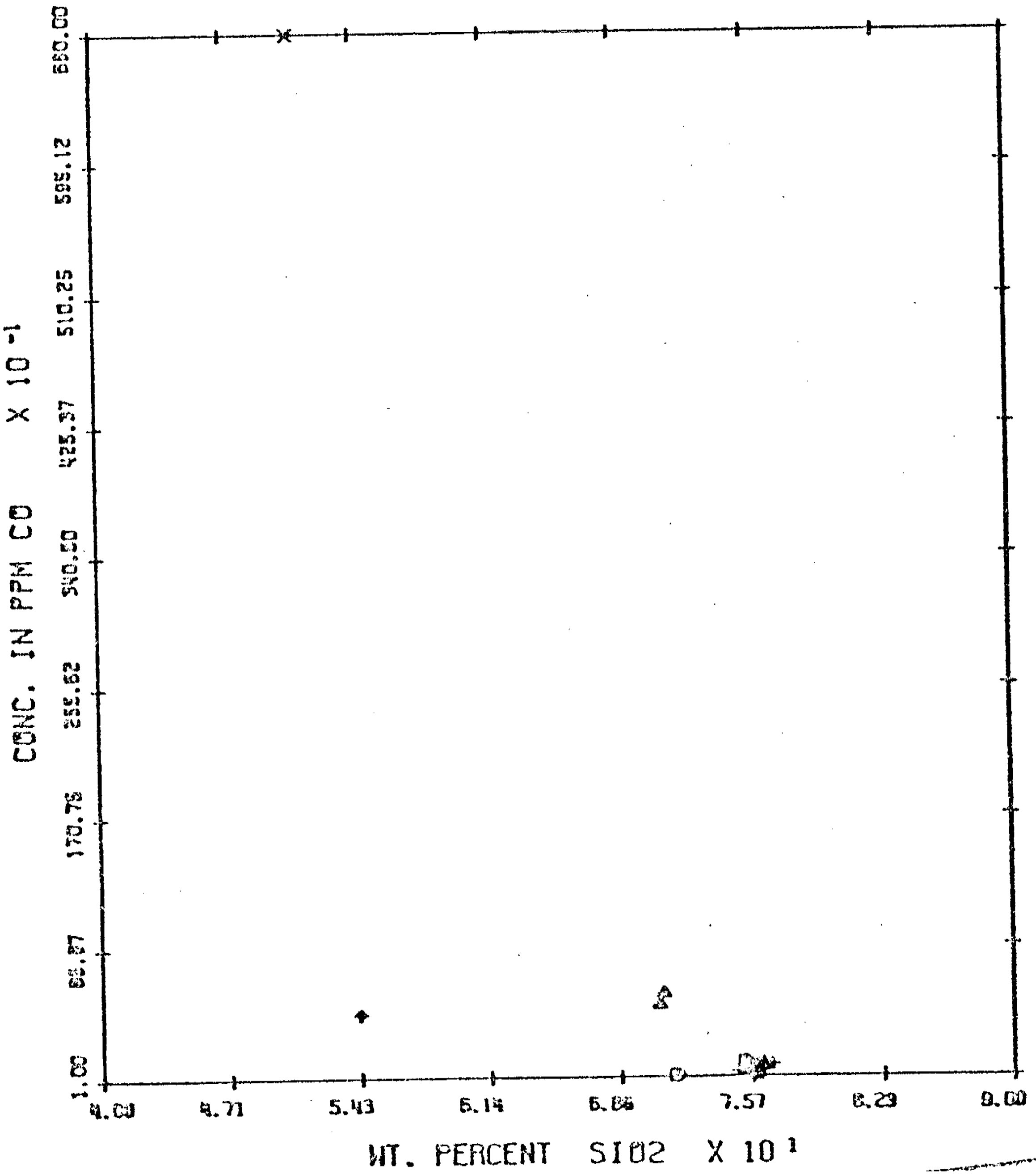


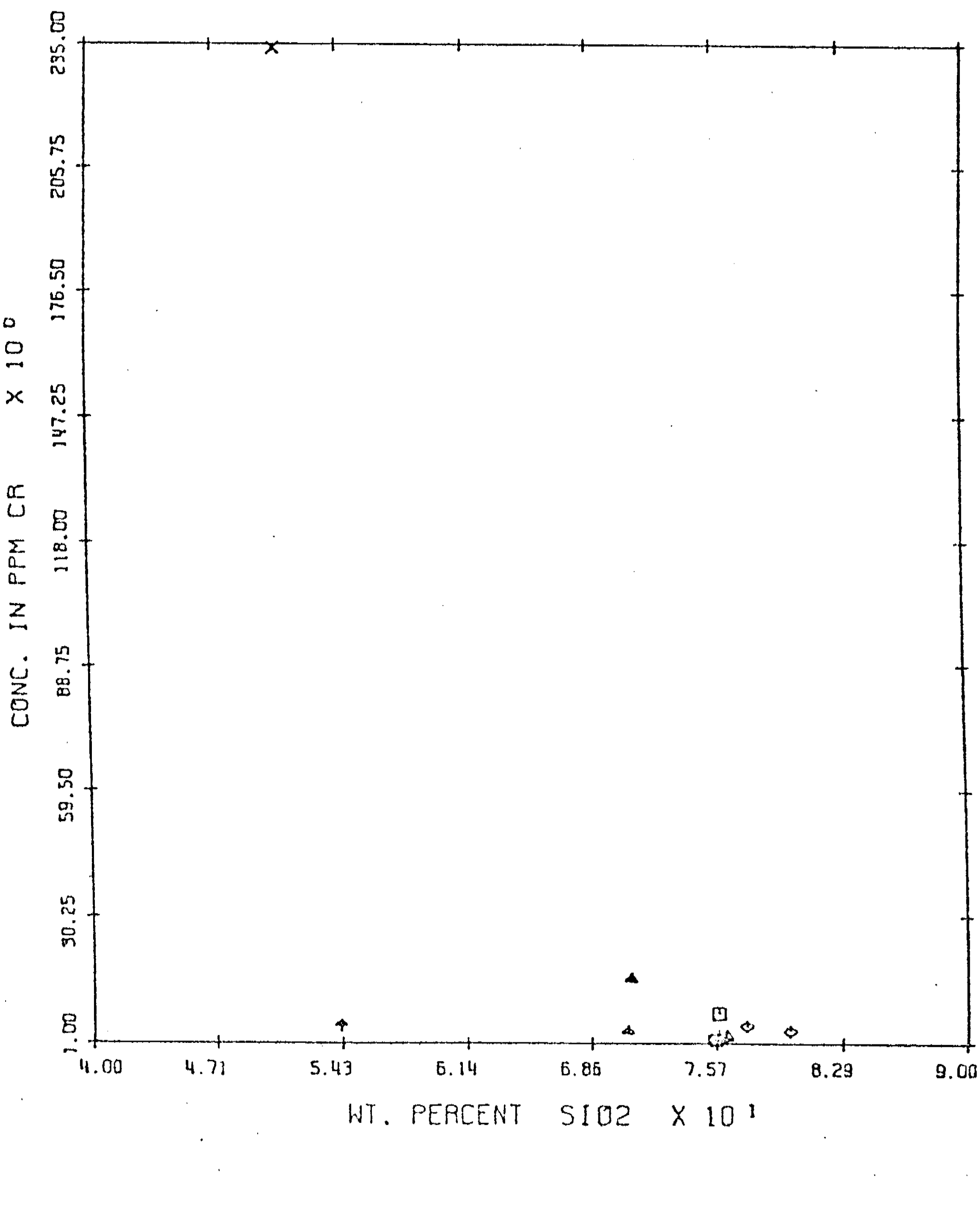
2.00
1.87
1.75
1.62
1.50
1.37
1.25
1.12
1.00
CONC. IN PPM ZR X 10 2
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

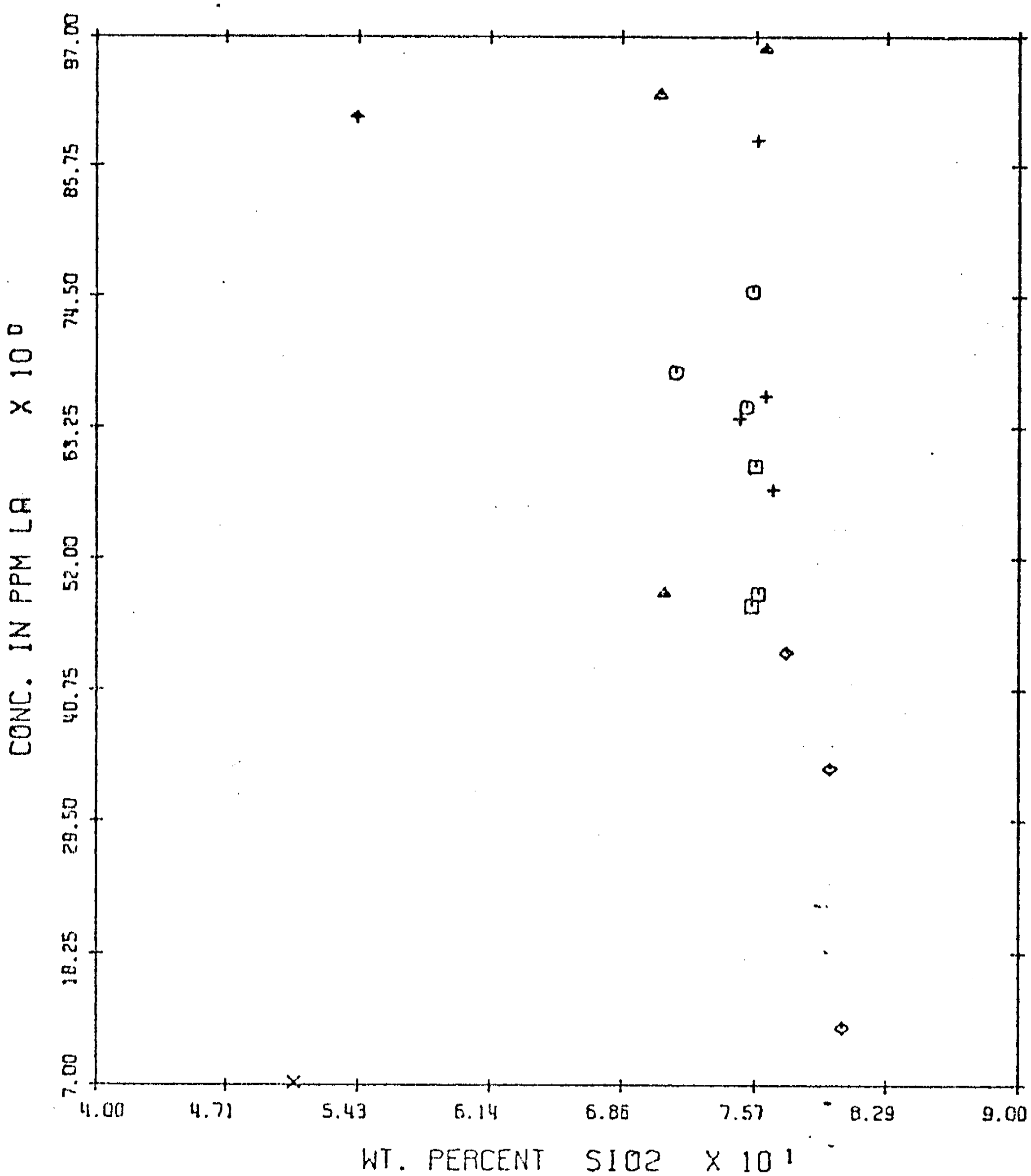


13.00
11.50
10.00
8.50
7.00
5.50
4.00
2.50
1.00
CONC. IN PPM BA X 10 2
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

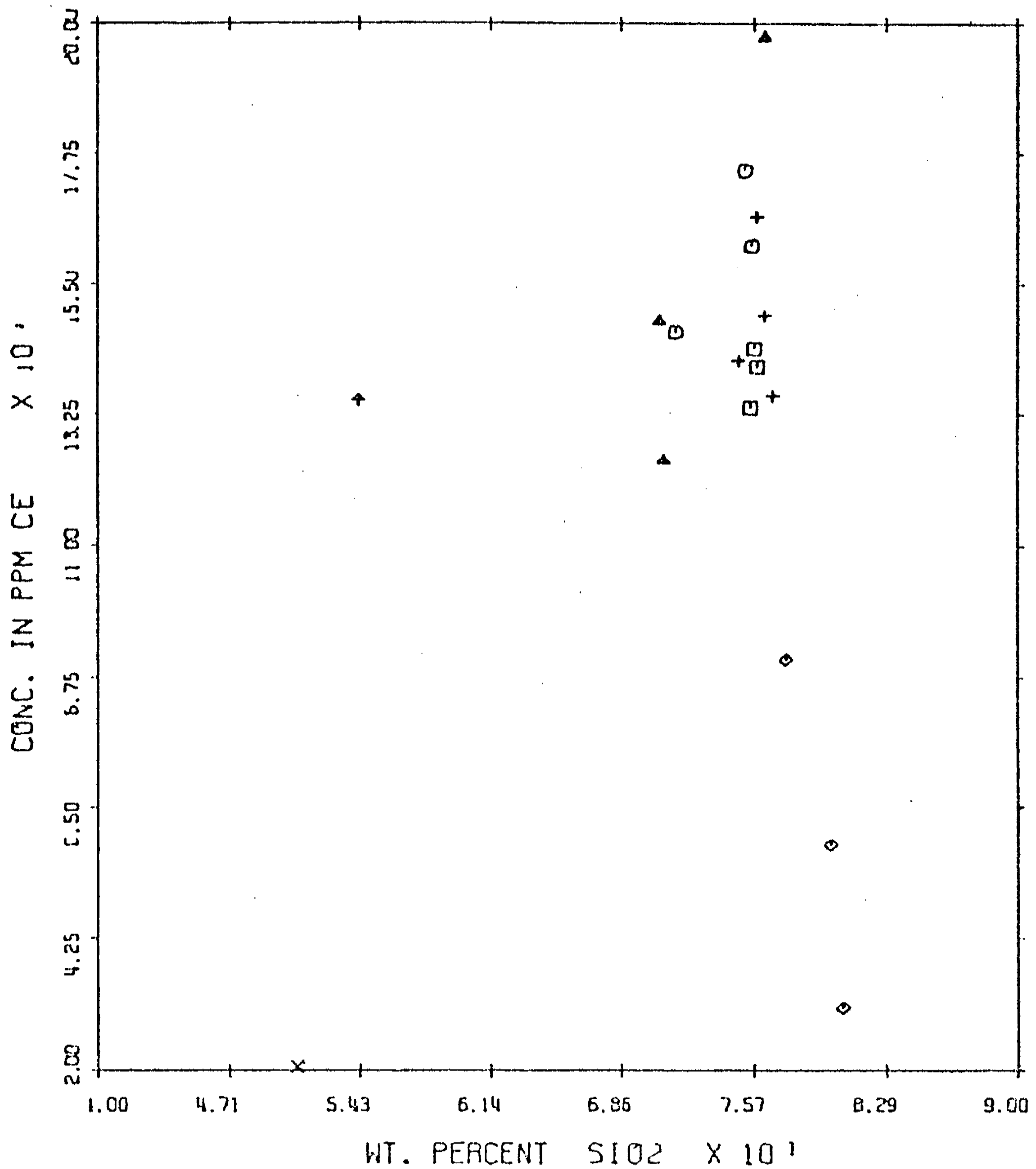

CONC. IN PPM CS X 10 -1
120.00
105.50
91.00
76.50
62.00
47.50
33.00
18.50
4.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1


CONC. IN PPM CO X 10 -1
680.00
595.12
510.25
425.37
340.50
255.62
170.75
85.87
1.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1

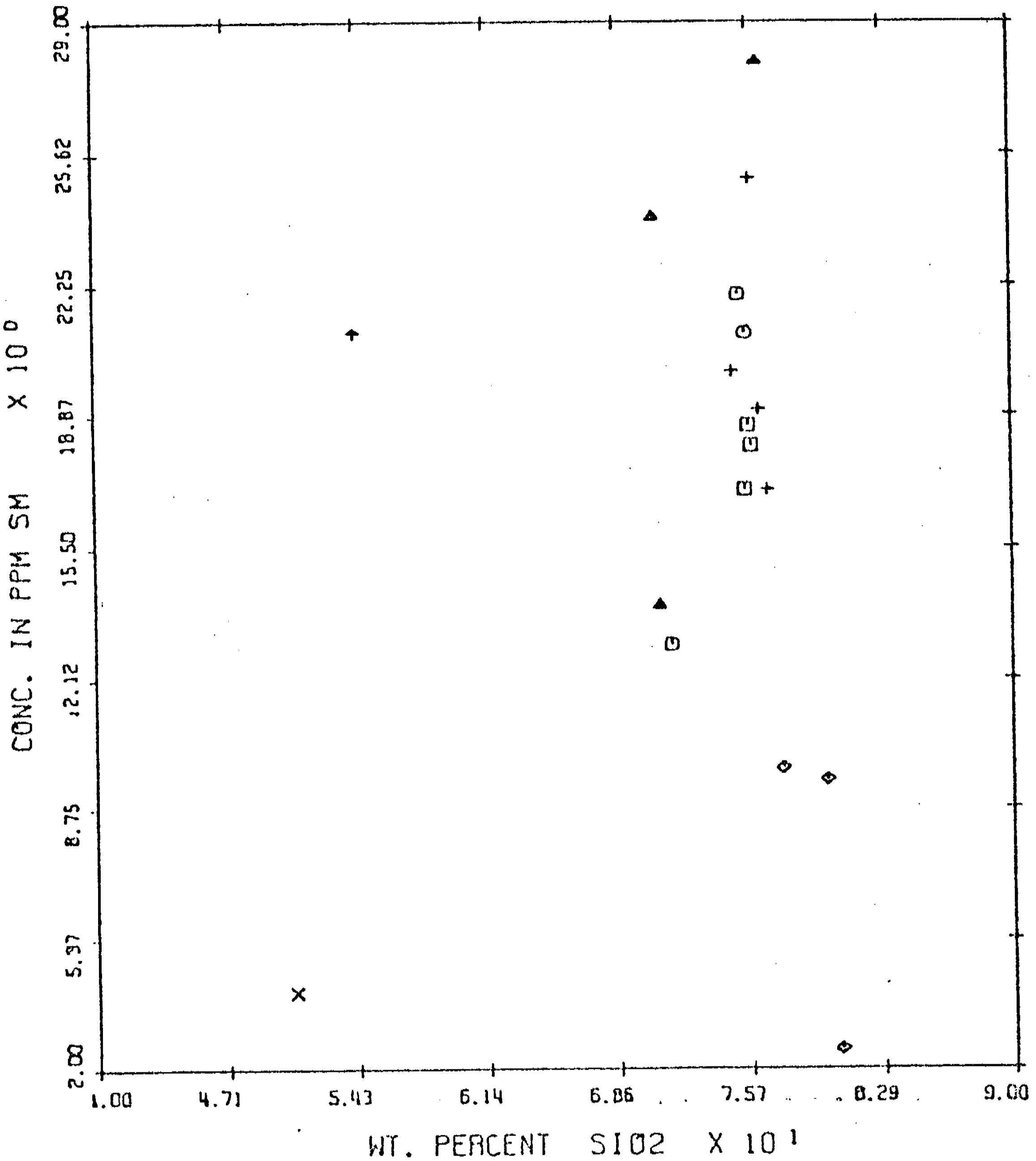

CONC. IN PPM CR X 10 0
235.00
205.75
176.50
147.25
118.00
88.75
59.50
30.25
1.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1



CONC. IN PPM LA X 10⁰
97.00
85.75
74.50
63.25
52.00
40.75
29.50
18.25
7.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10¹



CONC. IN PPM CE X 10¹
20.00
17.75
15.50
13.25
11.00
8.75
6.50
4.25
2.00
1.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10¹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22.25
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12.12
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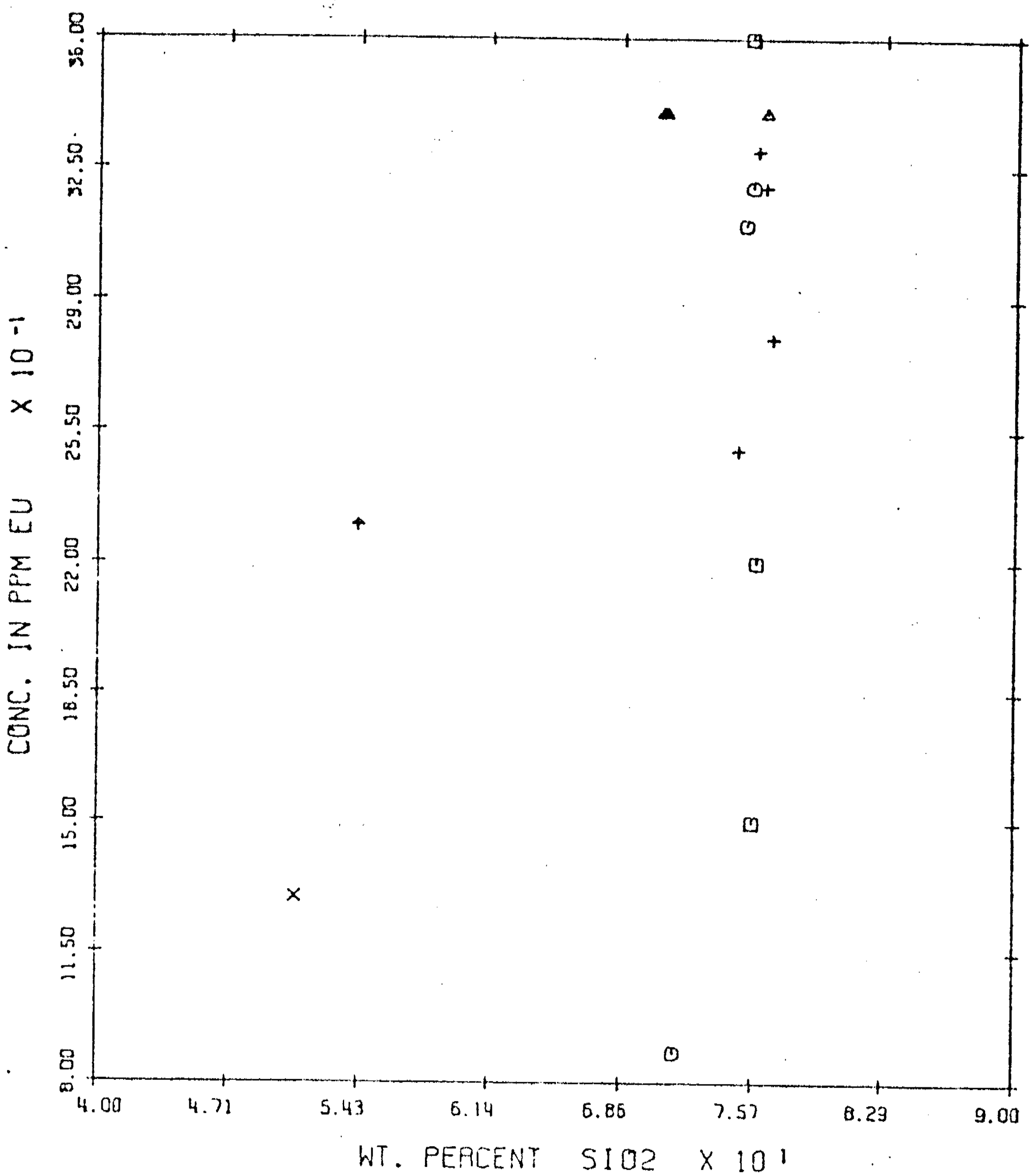
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1



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6.14
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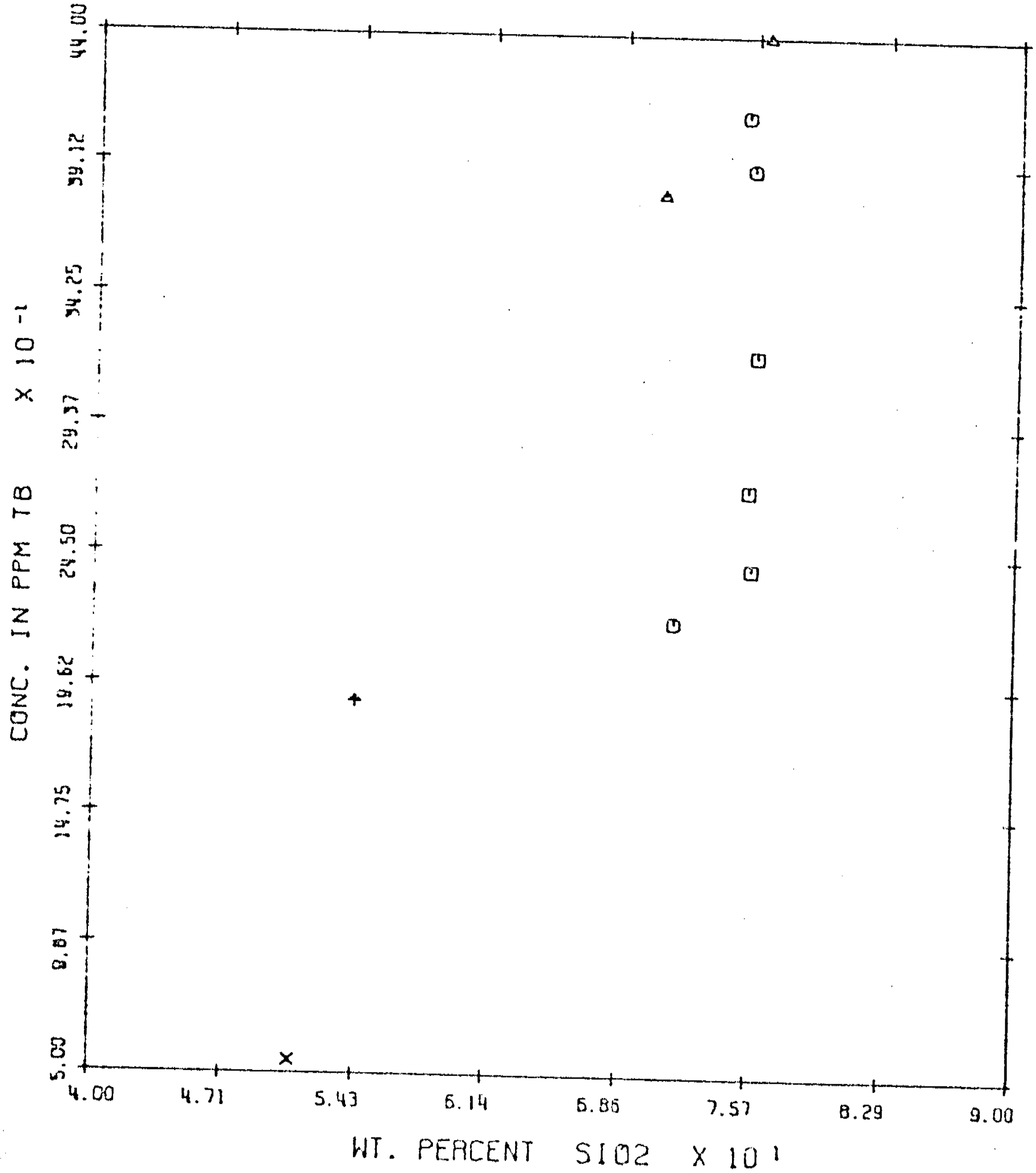
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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4.71
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6.14
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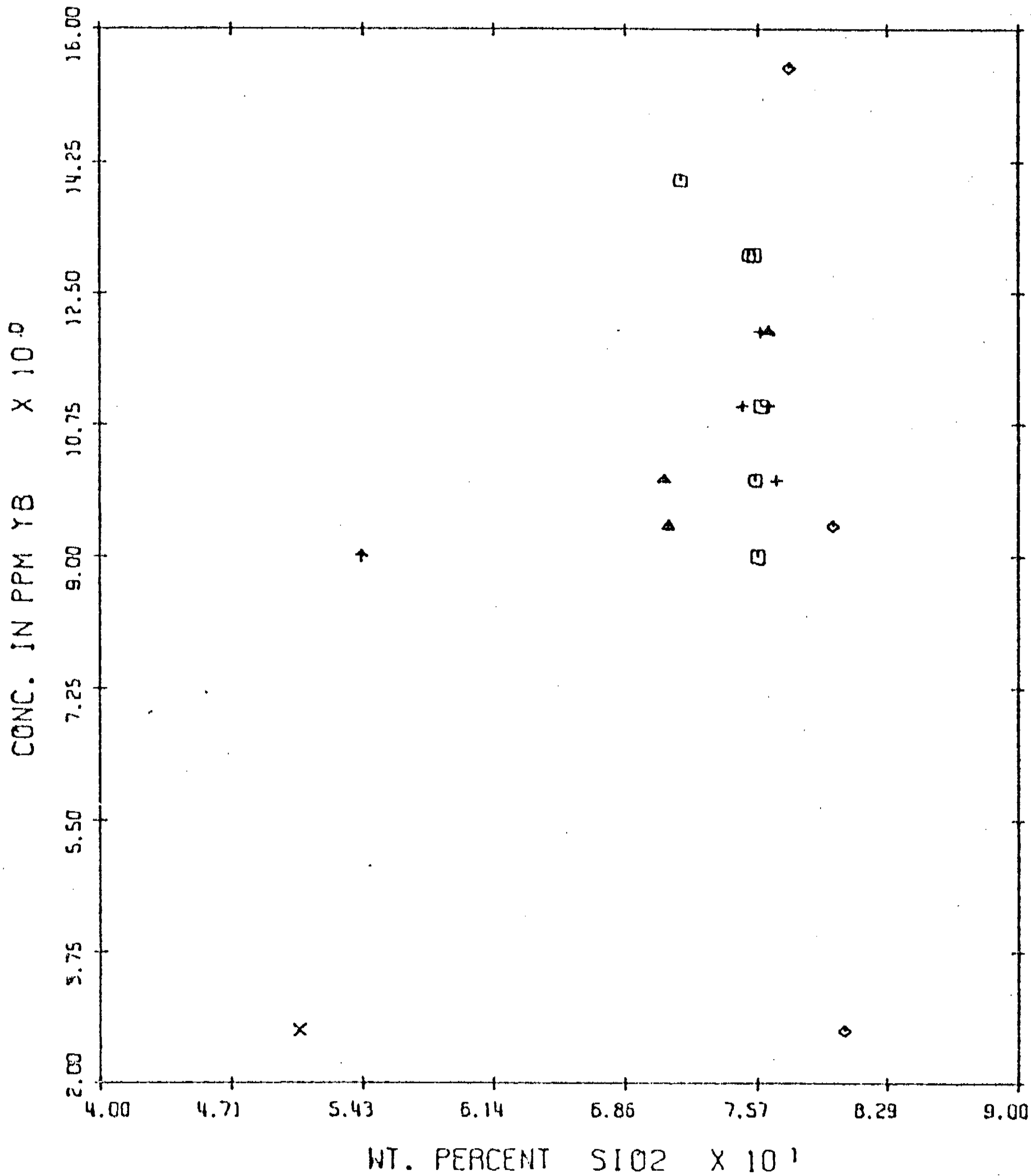
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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9.00
7.25
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6.86
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8.29
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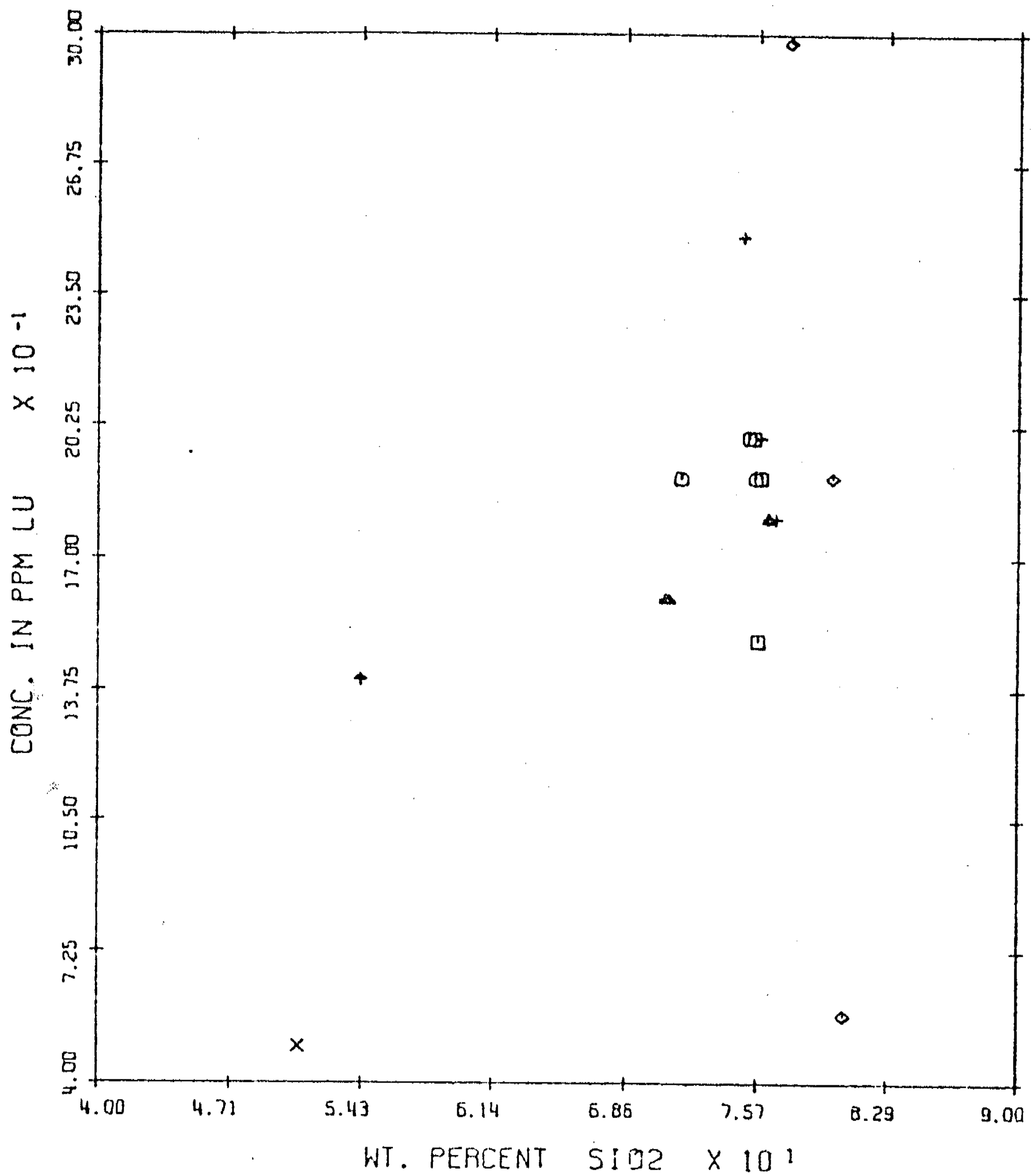
WT. PERCENT SIO2 X 10 1


CONC. IN PPM LU X 10 -1
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23.50
20.25
17.00
13.75
10.50
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4.00
4.71
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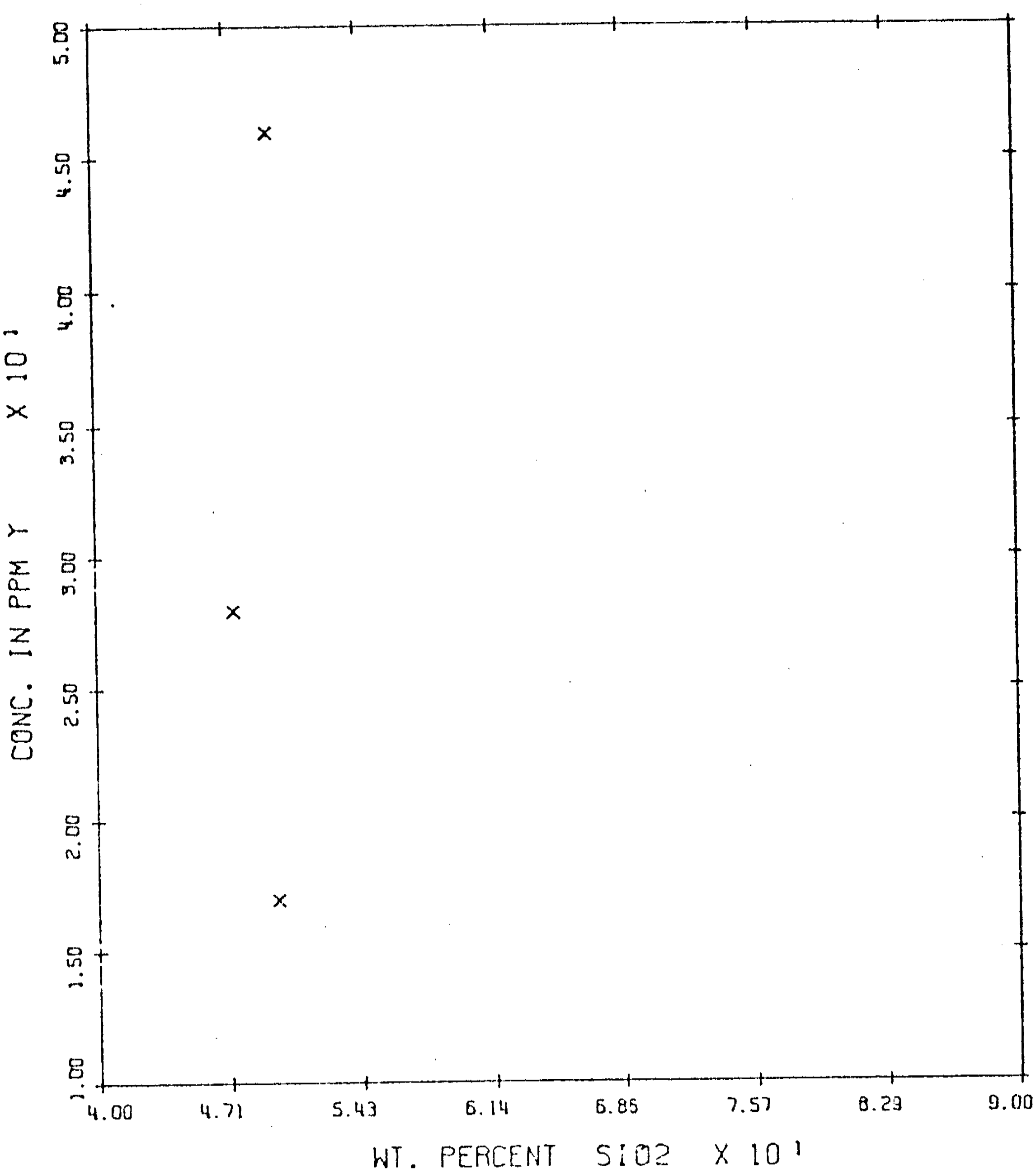
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1



CONC. IN PPM Y X 10 1
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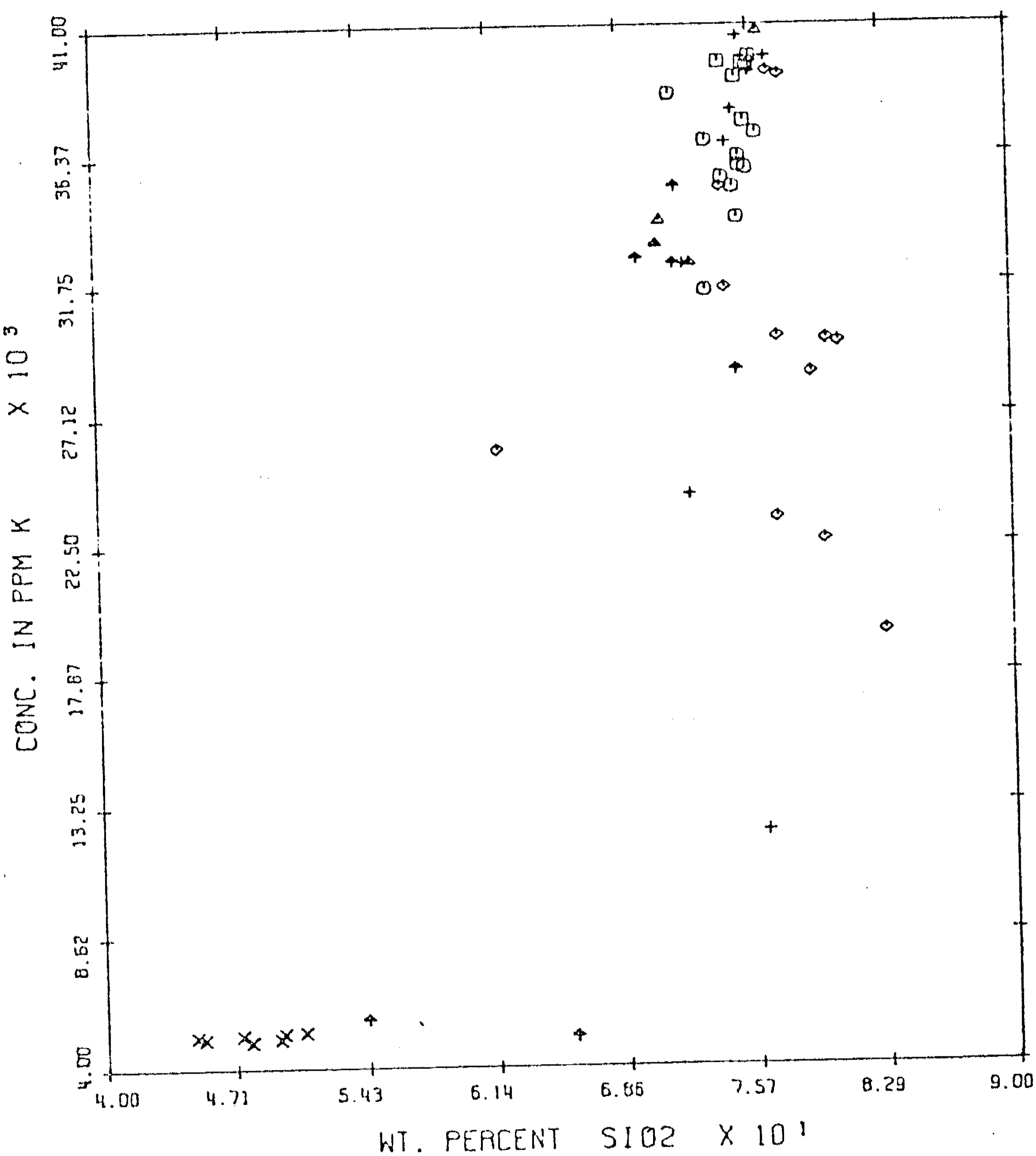
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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22.50
17.87
13.25
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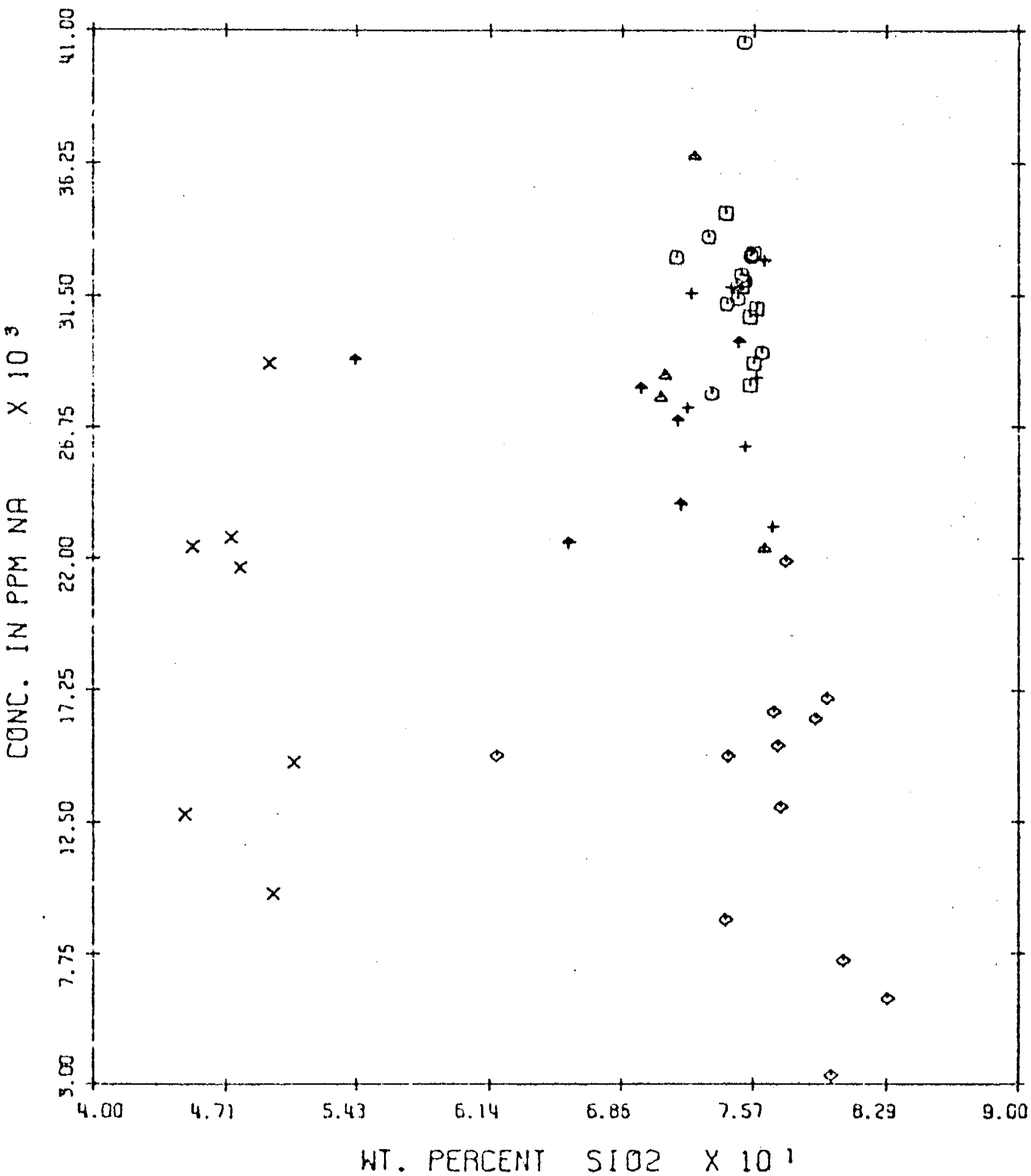
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1


CONC. IN PPM NA X 10 3
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31.50
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22.00
17.25
12.50
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4.71
5.43
6.14
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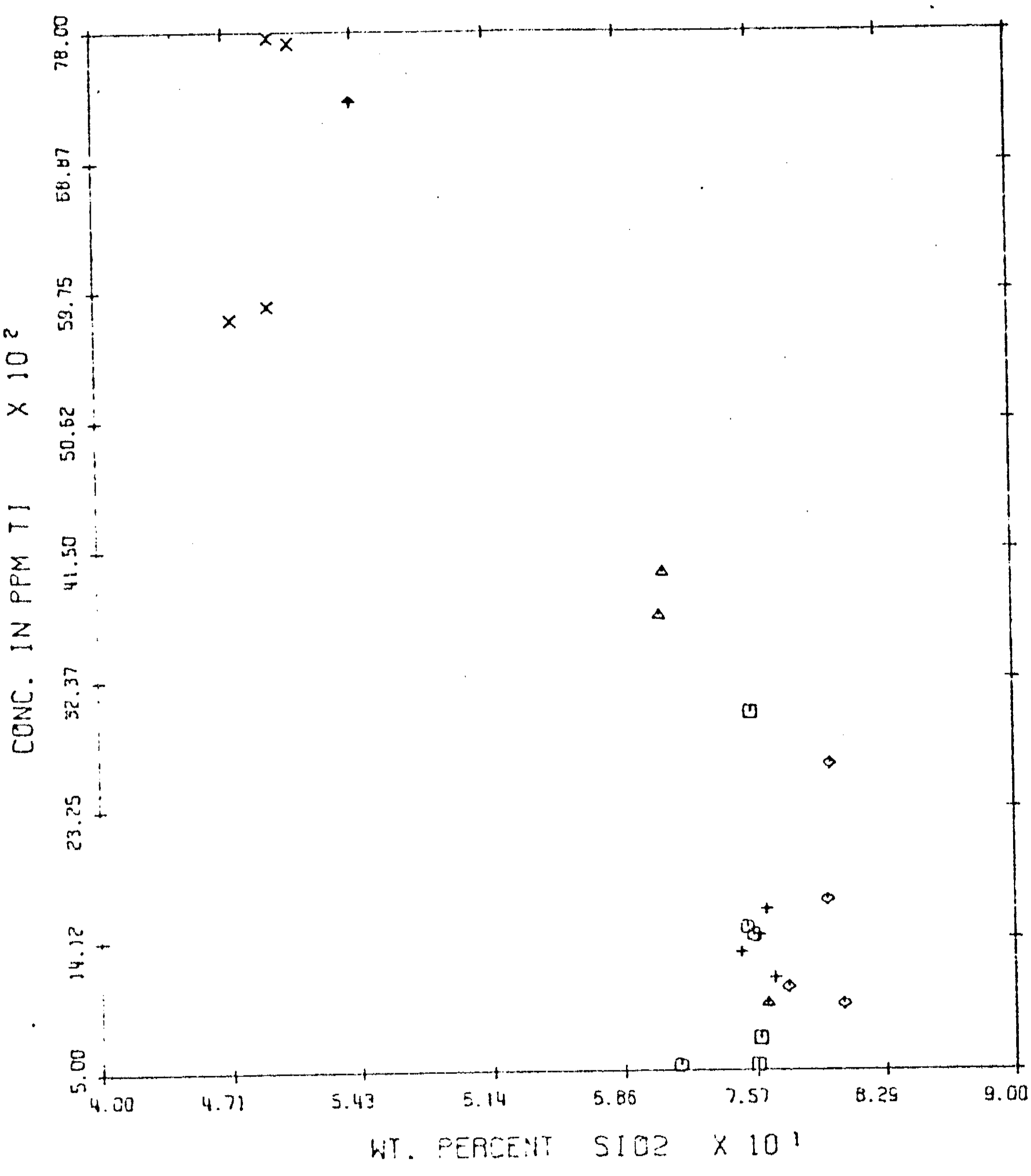
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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32.37
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4.71
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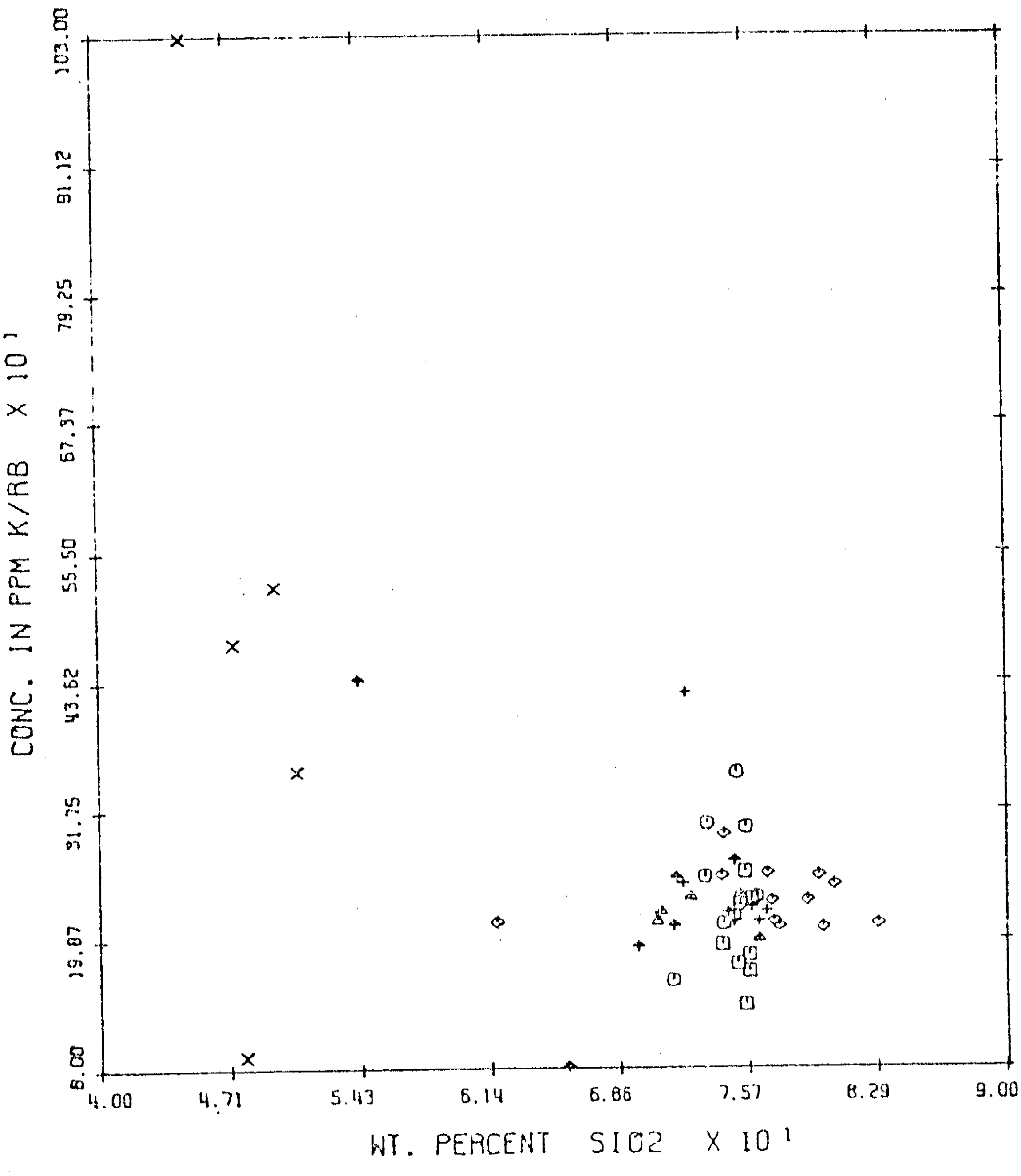
5.14
5.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10¹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79.25
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55.50
43.62
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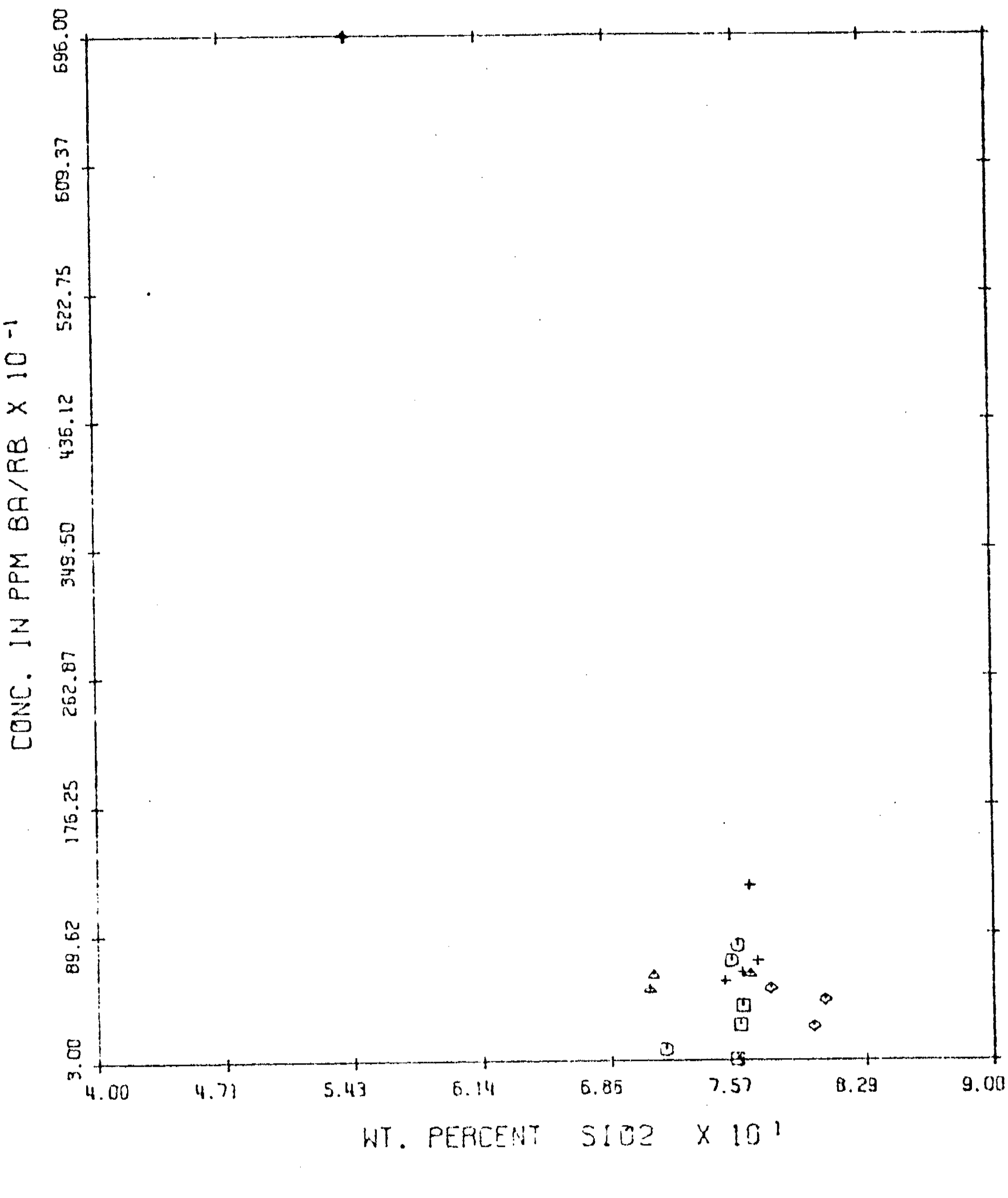
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1



CONC. IN PPM BA/RB X 10 -1
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349.50
262.87
176.25
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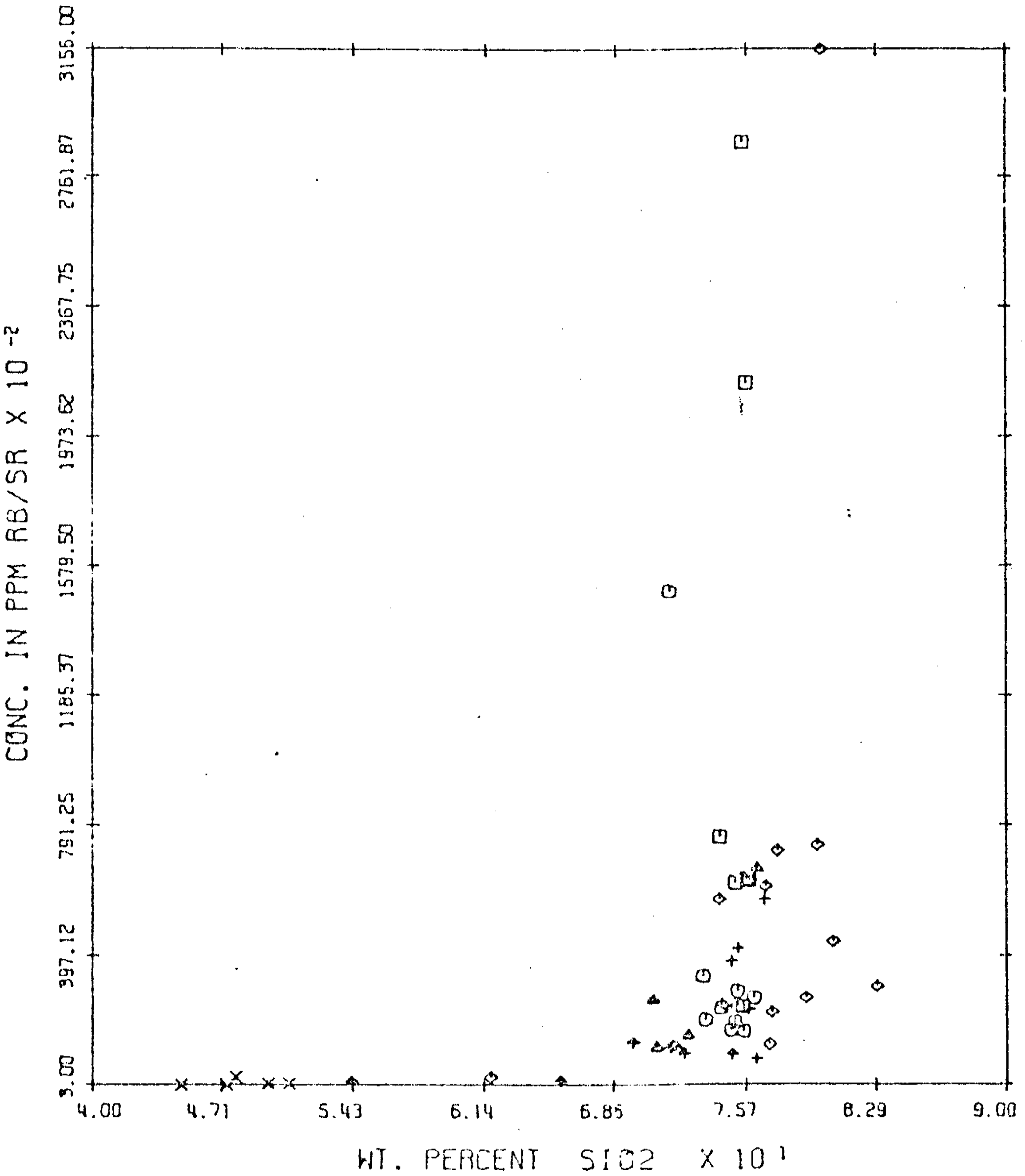
6.14
6.85
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1


CONC. IN PPM RB/SR X 10 -2
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1579.50
1185.37
791.25
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4.71
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6.14
6.85
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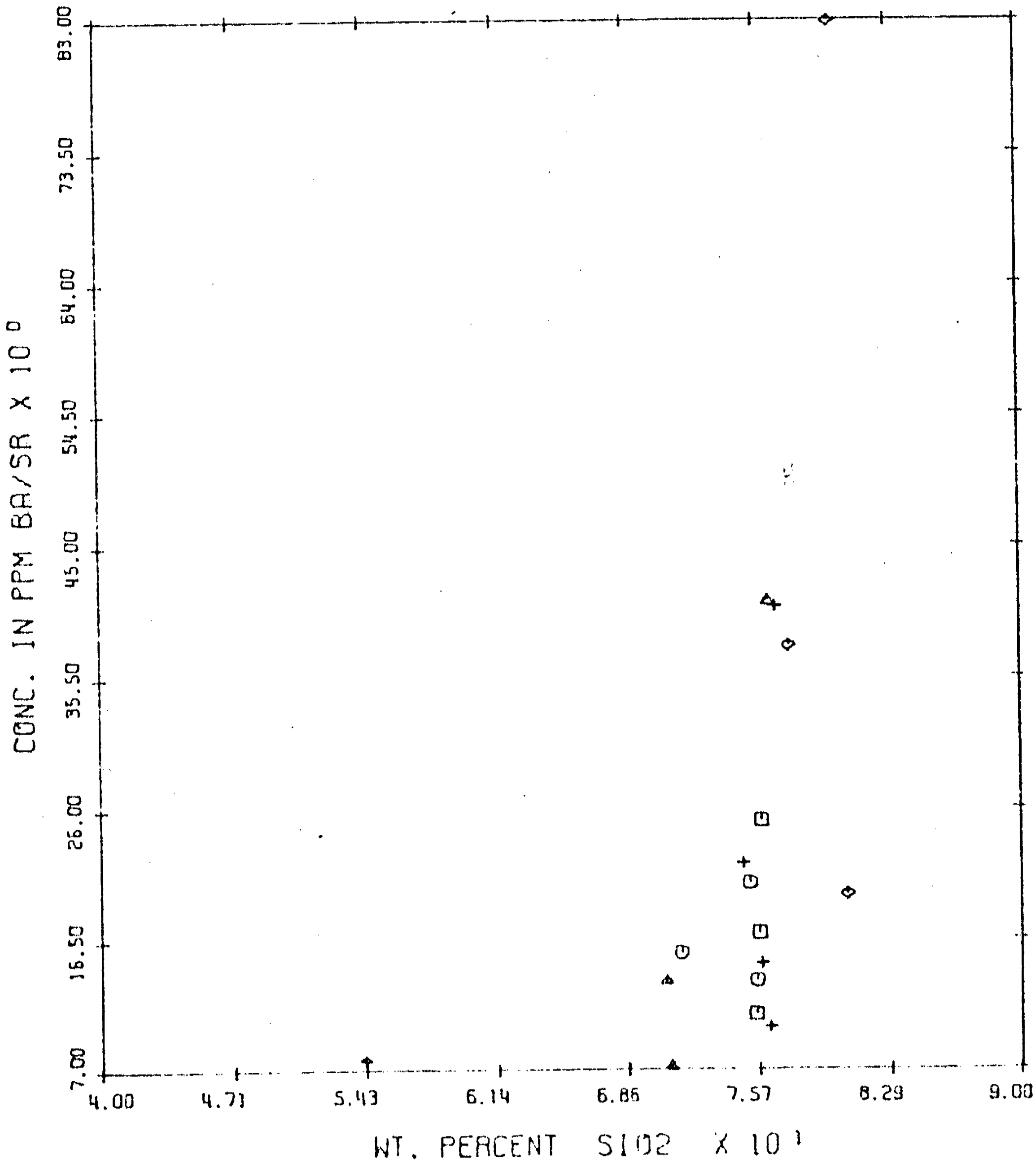
8.29
9.00
WT. PERCENT SIO2 X 10 1



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64.00
54.50
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35.50
26.00
16.50
7.00
CONC. IN PPM BA/SR X 10 0
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4.71
5.43
6.14
6.86
7.57
8.29
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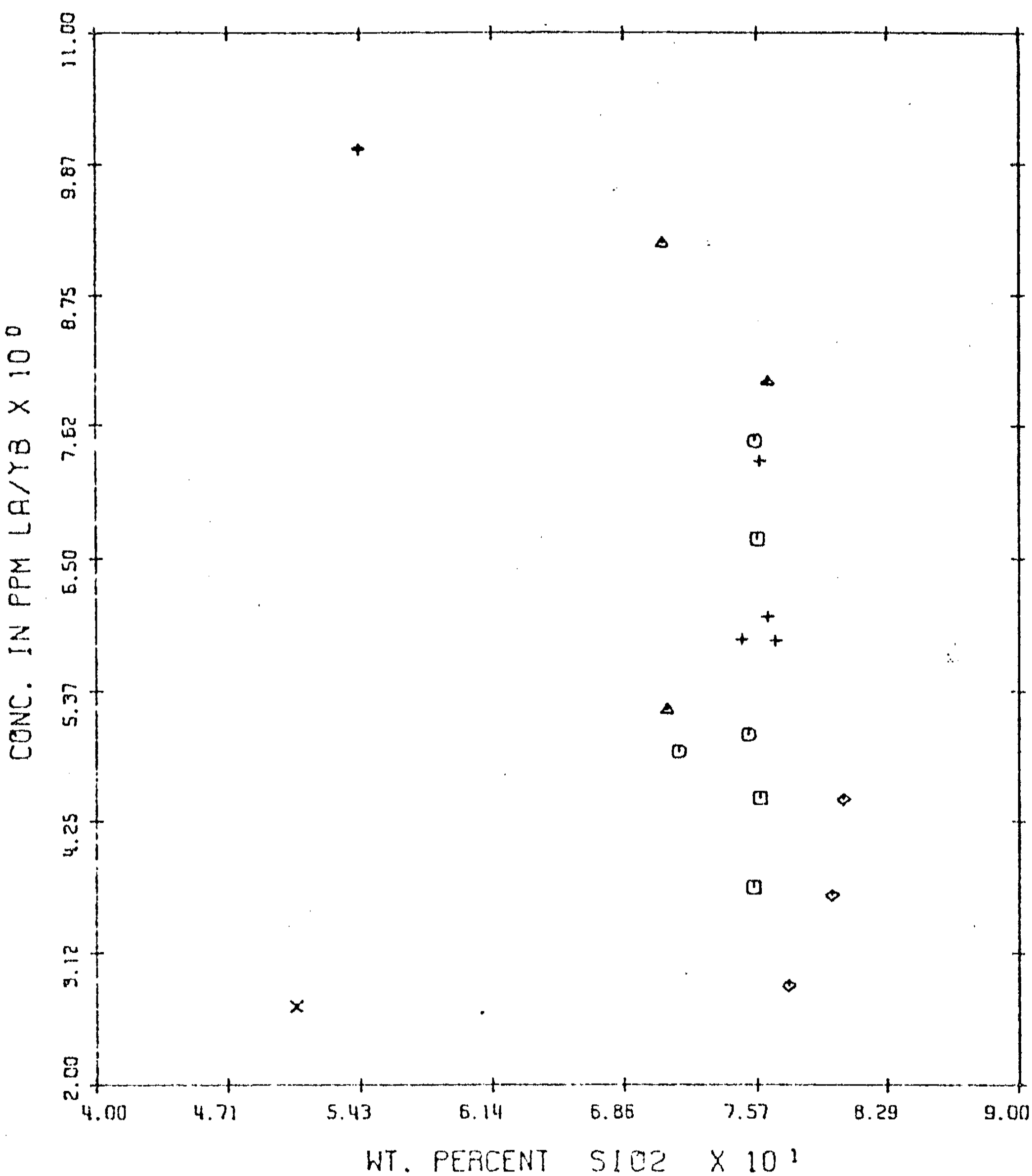
WT. PERCENT SIO2 X 10 1



CONC. IN PPM LA/YB X 10 0
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6.50
5.37
4.25
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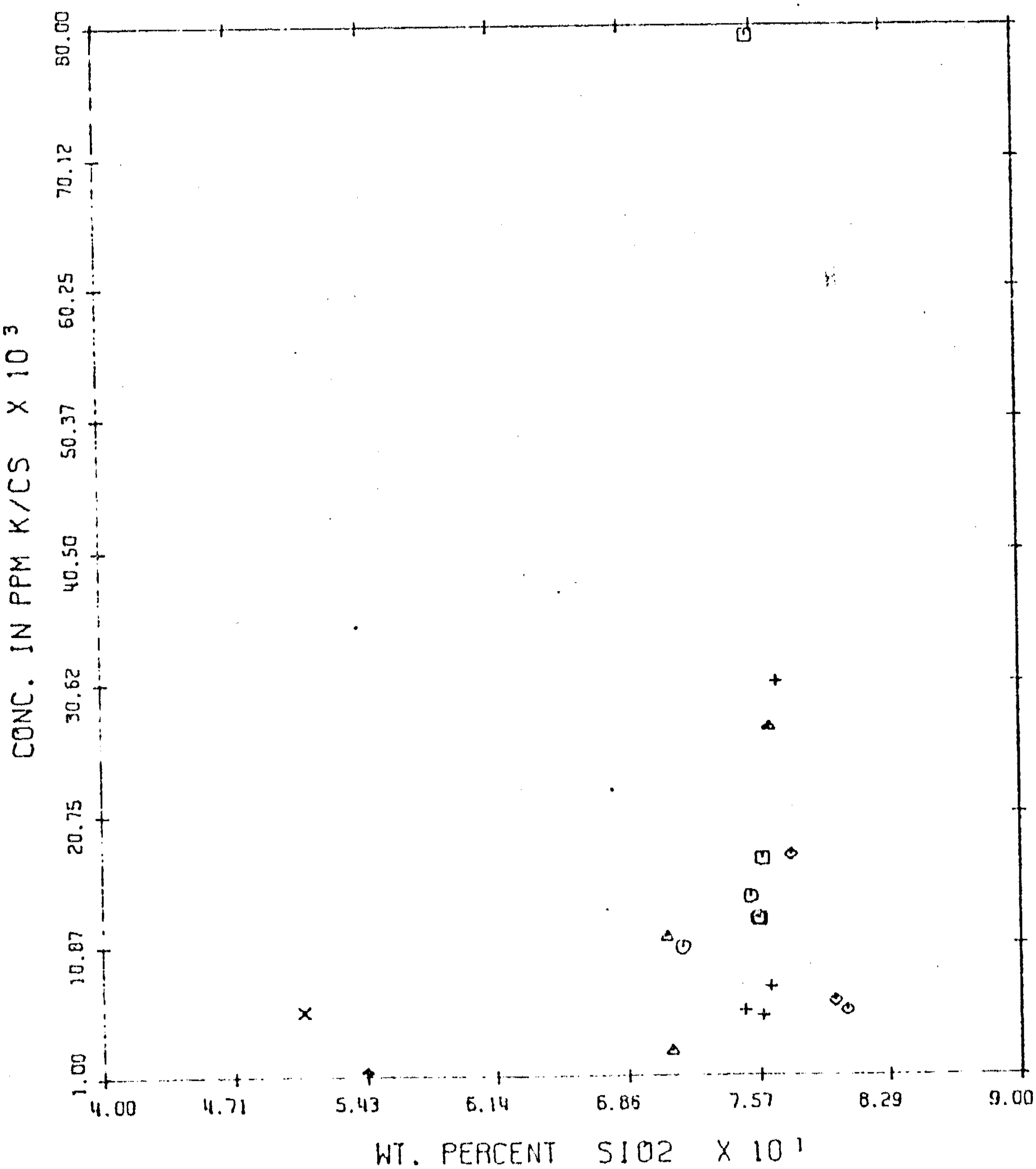
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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5.43
6.14
6.86
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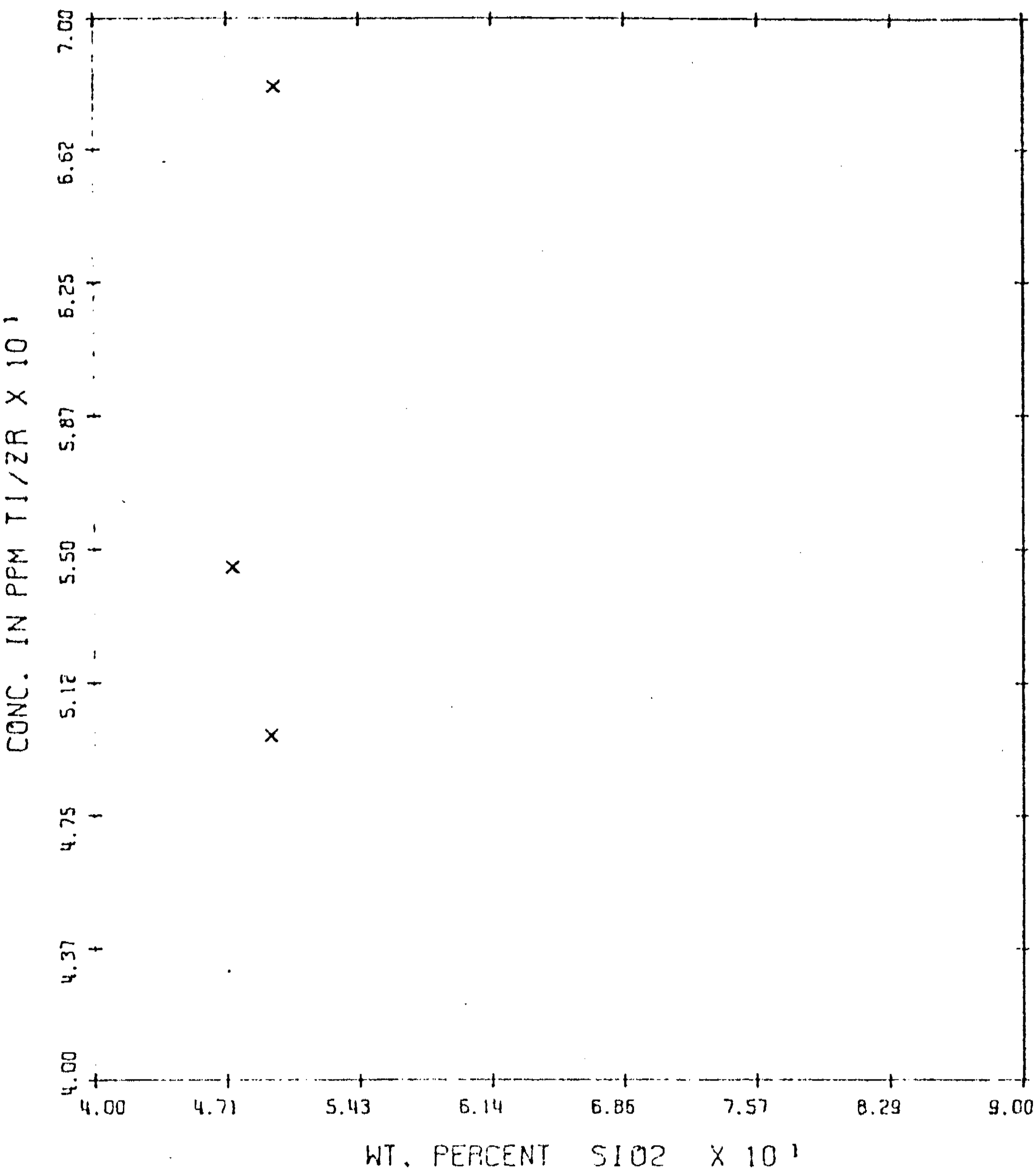
8.29
9.00
WT. PERCENT SIO2 X 10 1



CONC. IN PPM TI/ZR X 10 1
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5.50
5.12
4.75
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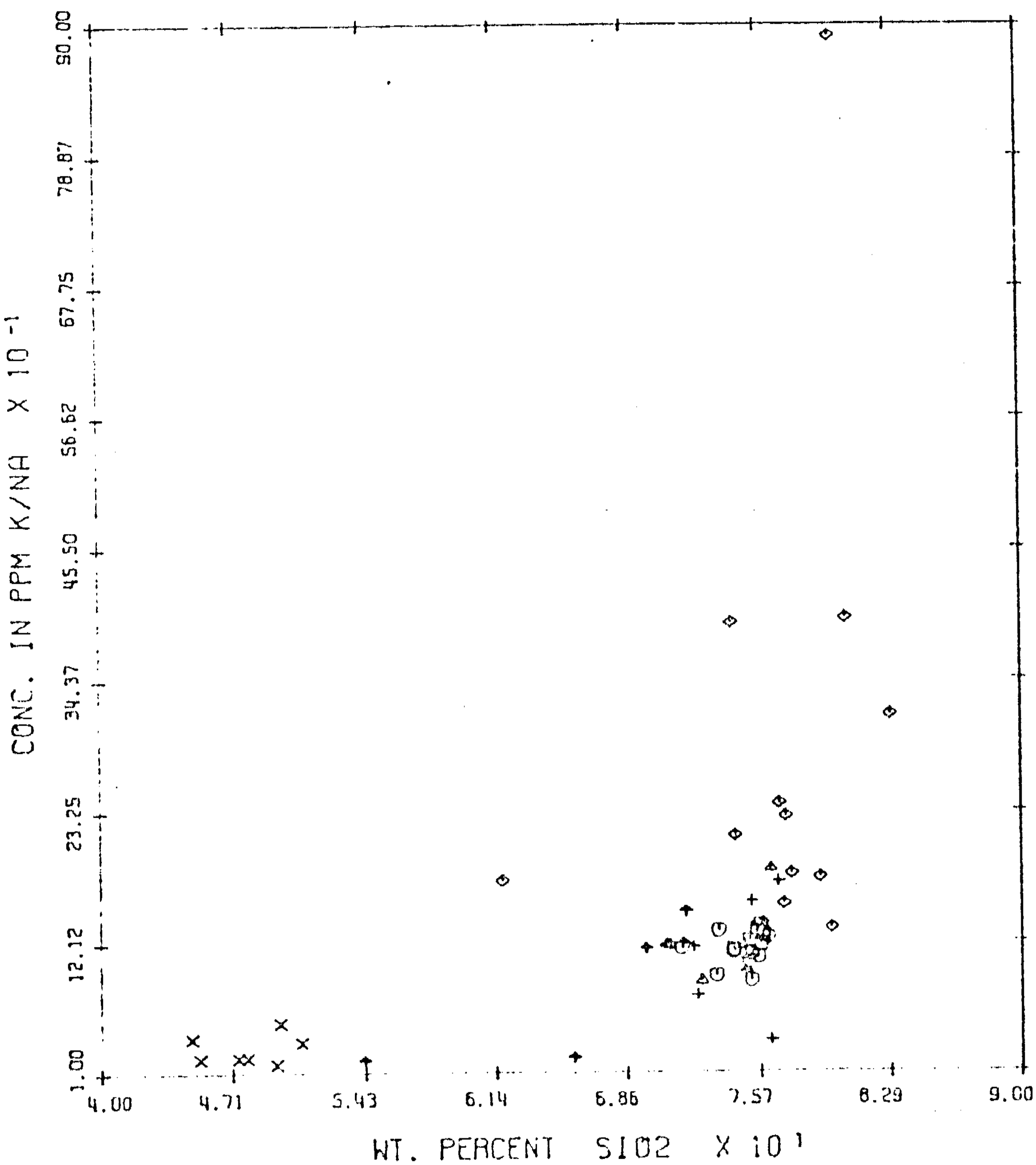
4.00
4.71
5.43
6.14
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10 1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8.29
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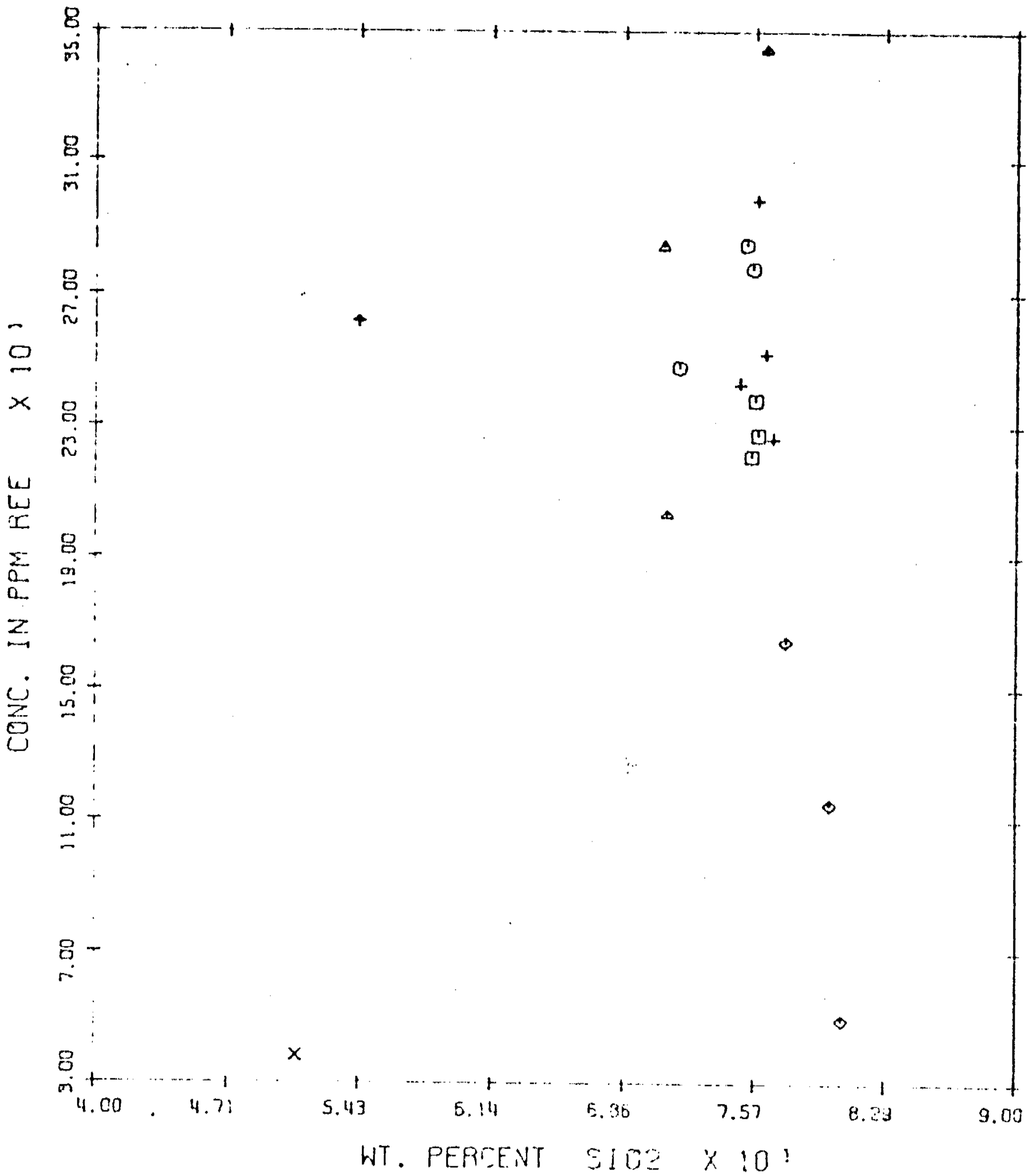
WT. PERCENT SIO2 X 10 1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4.71
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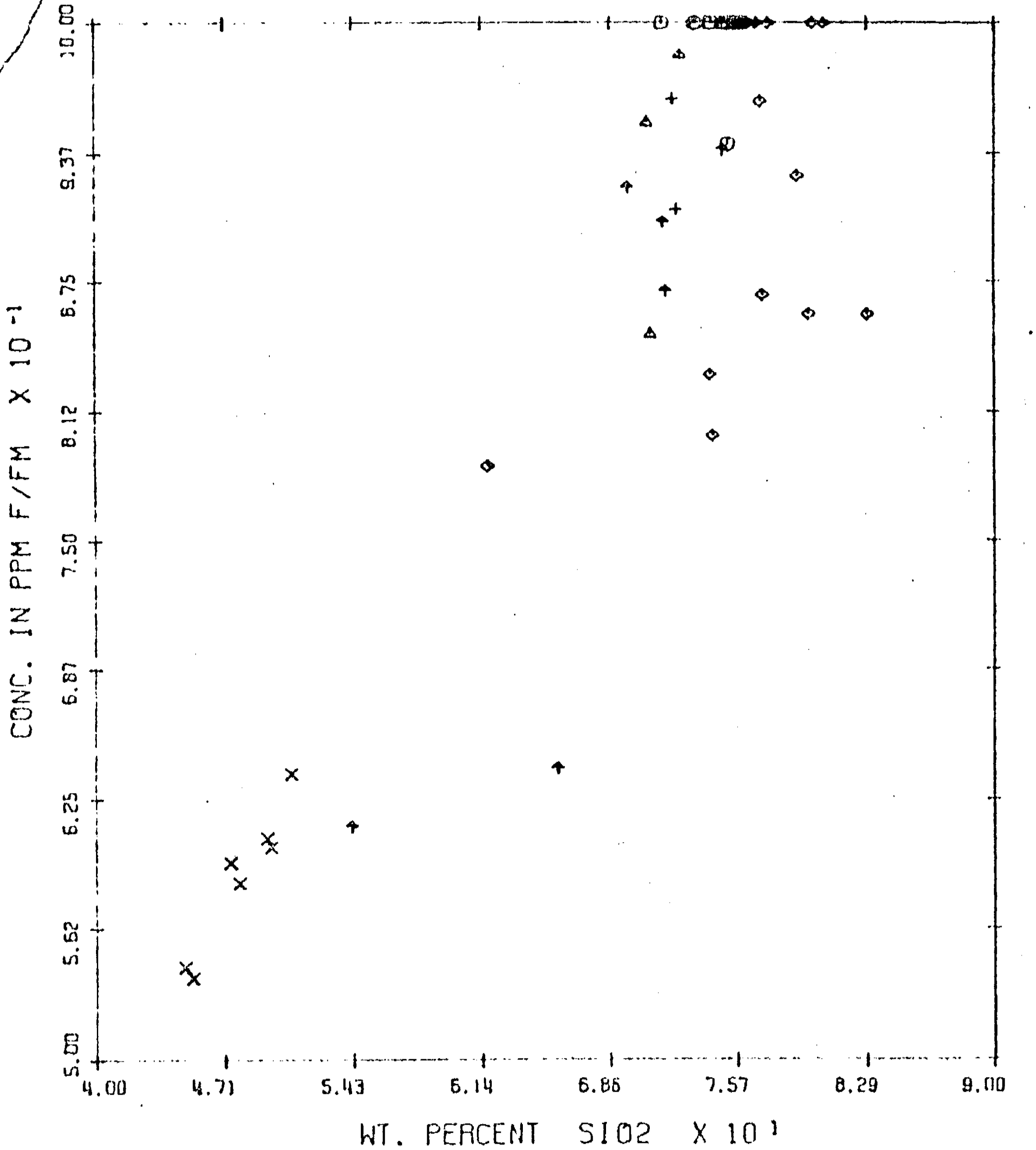
6.86
7.57
8.29
9.00
WT. PERCENT SIO2 X 10^1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6.25
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4.71
5.43
6.14
6.86
7.57
8.29
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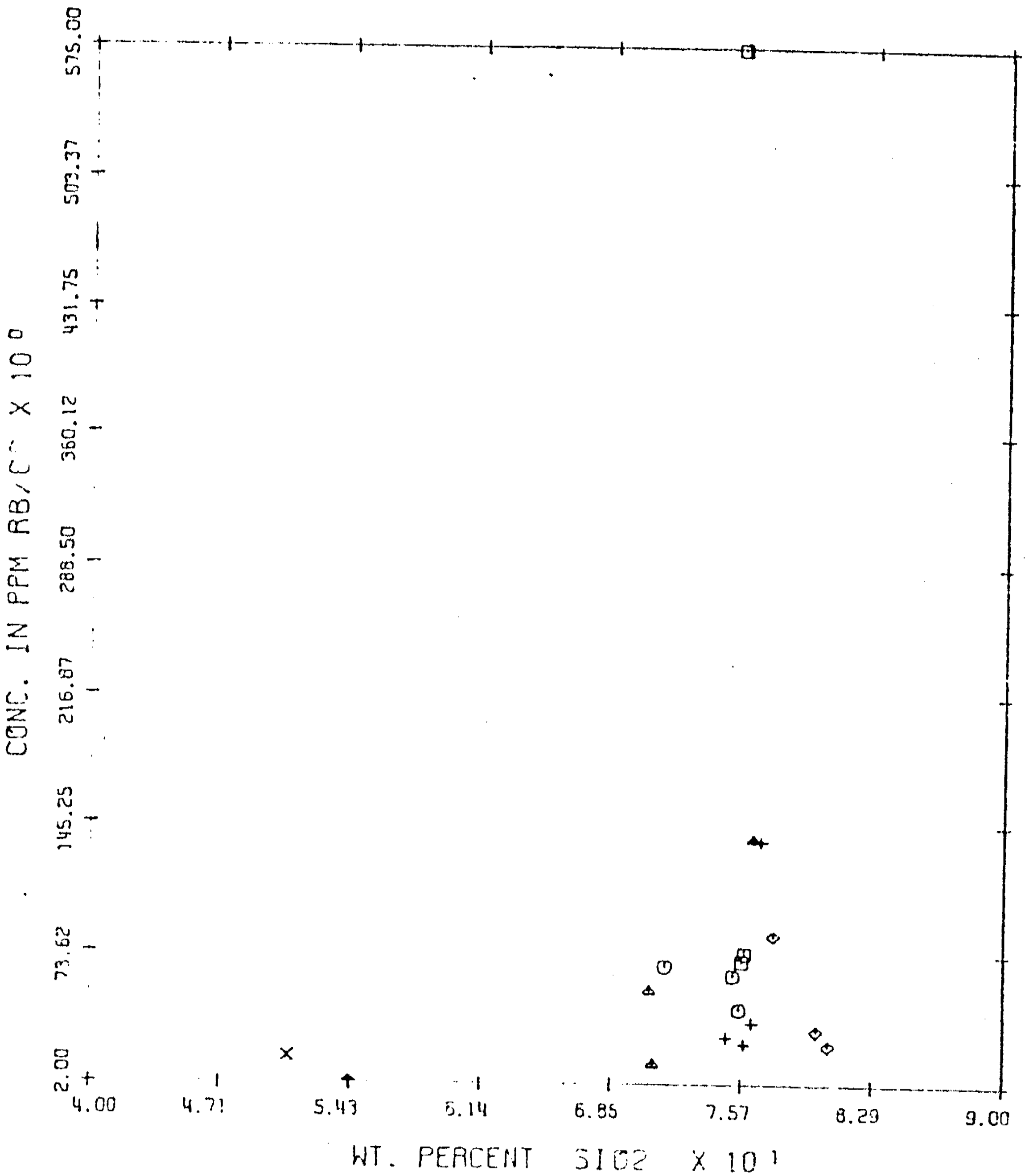
WT. PERCENT SIO2 X 10 1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145.25
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6.85
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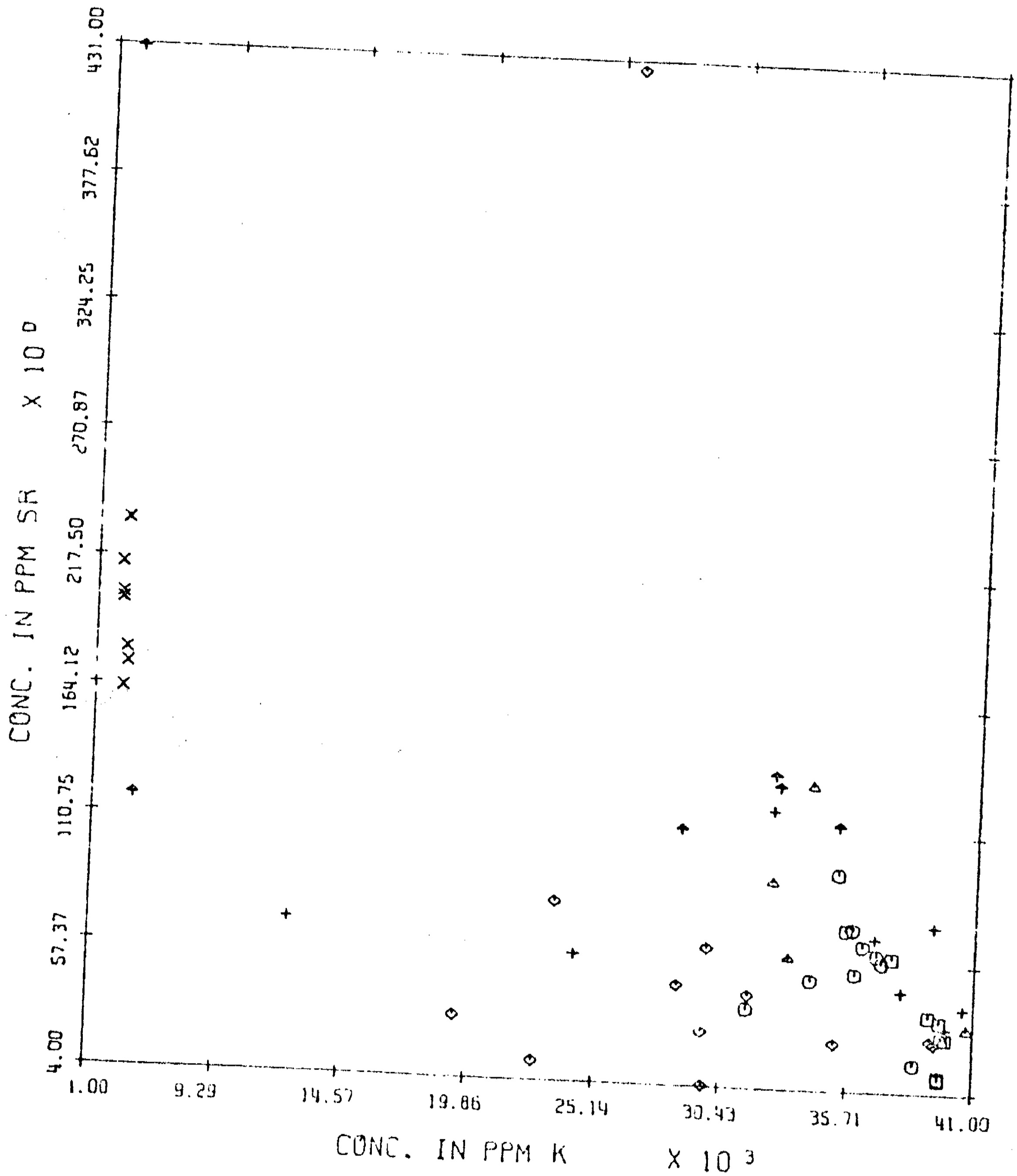
8.29
9.00
WT. PERCENT SIO2 X 10 1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14.57
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25.14
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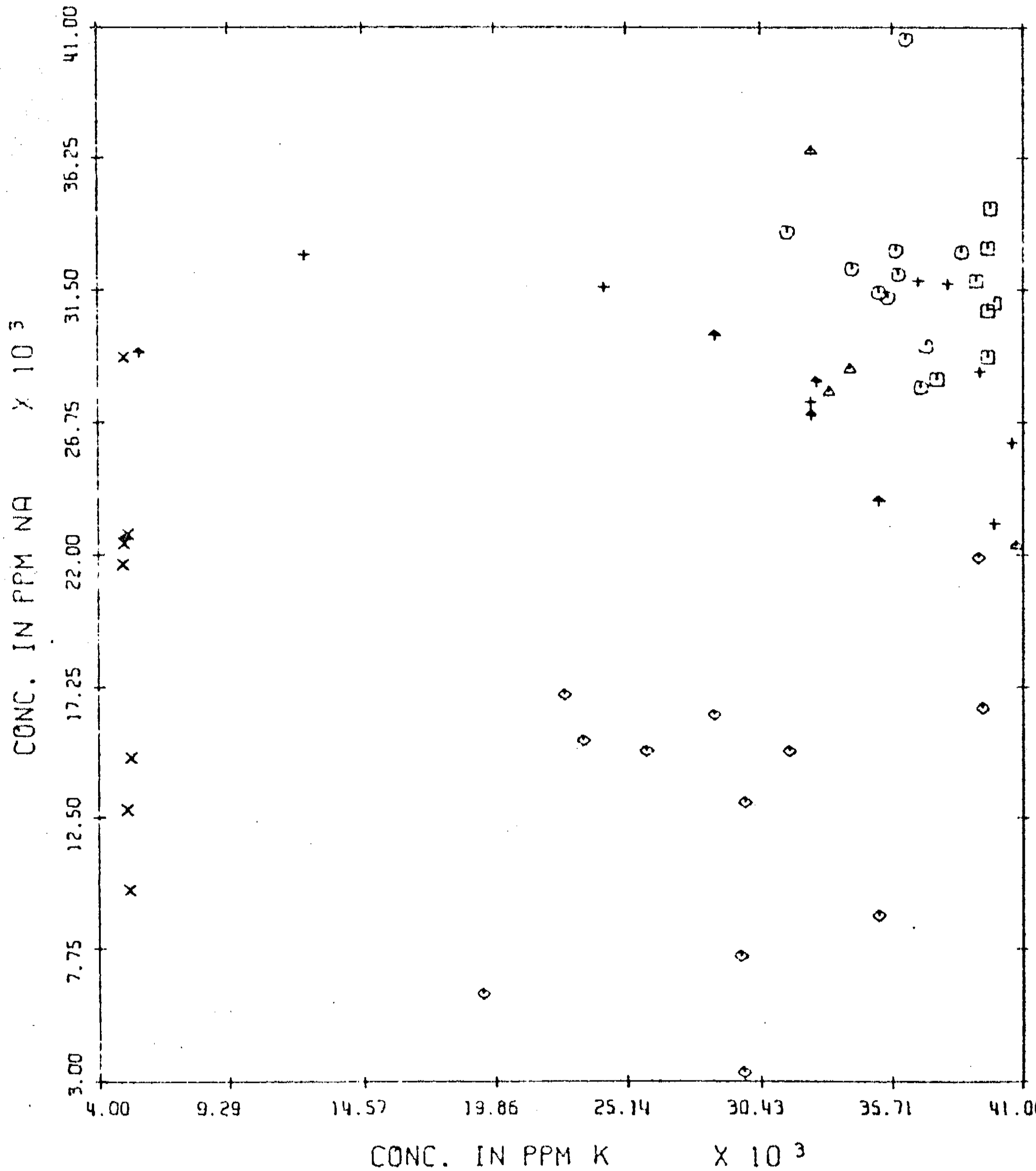
CONC. IN PPM K X 10 3


CONC. IN PPM NA X 10 3
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17.25
12.50
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14.57
19.86
25.14
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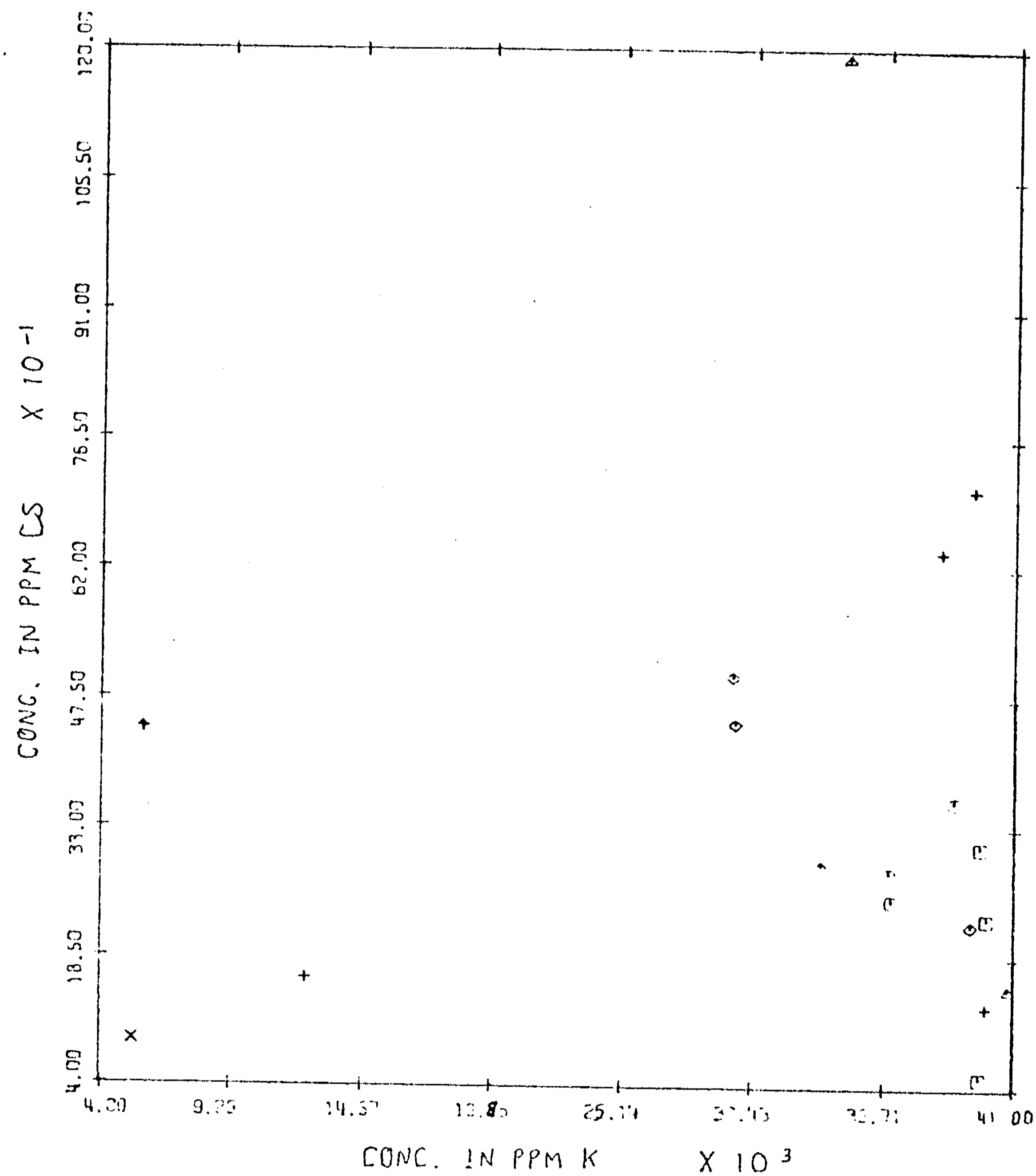
35.71
41.00
CONC. IN PPM K X 10 3


CONC. IN PPM CS X 10 -1
CONC. IN PPM K X 10 3
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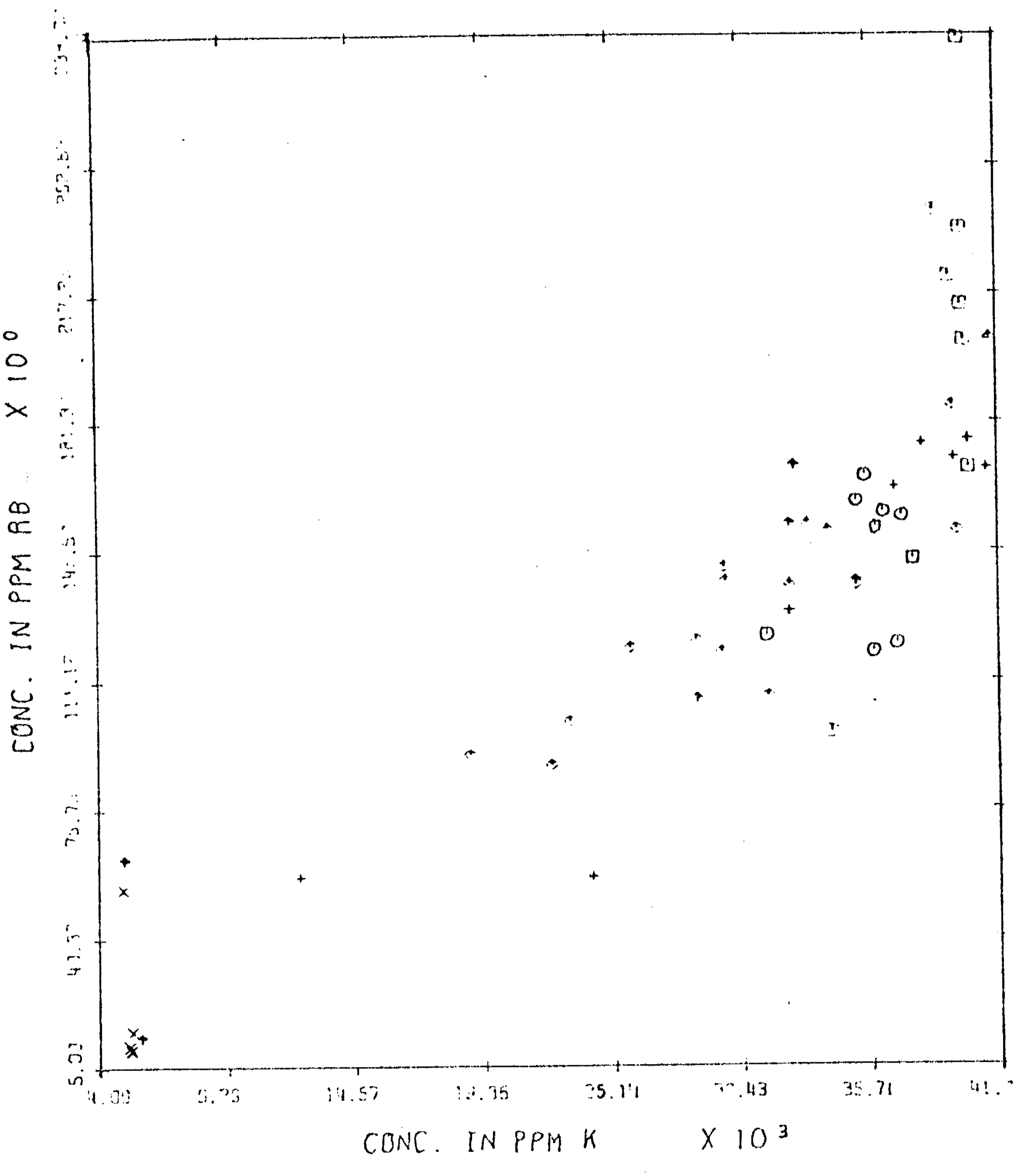
41 00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CONC. IN PPM K X 10³
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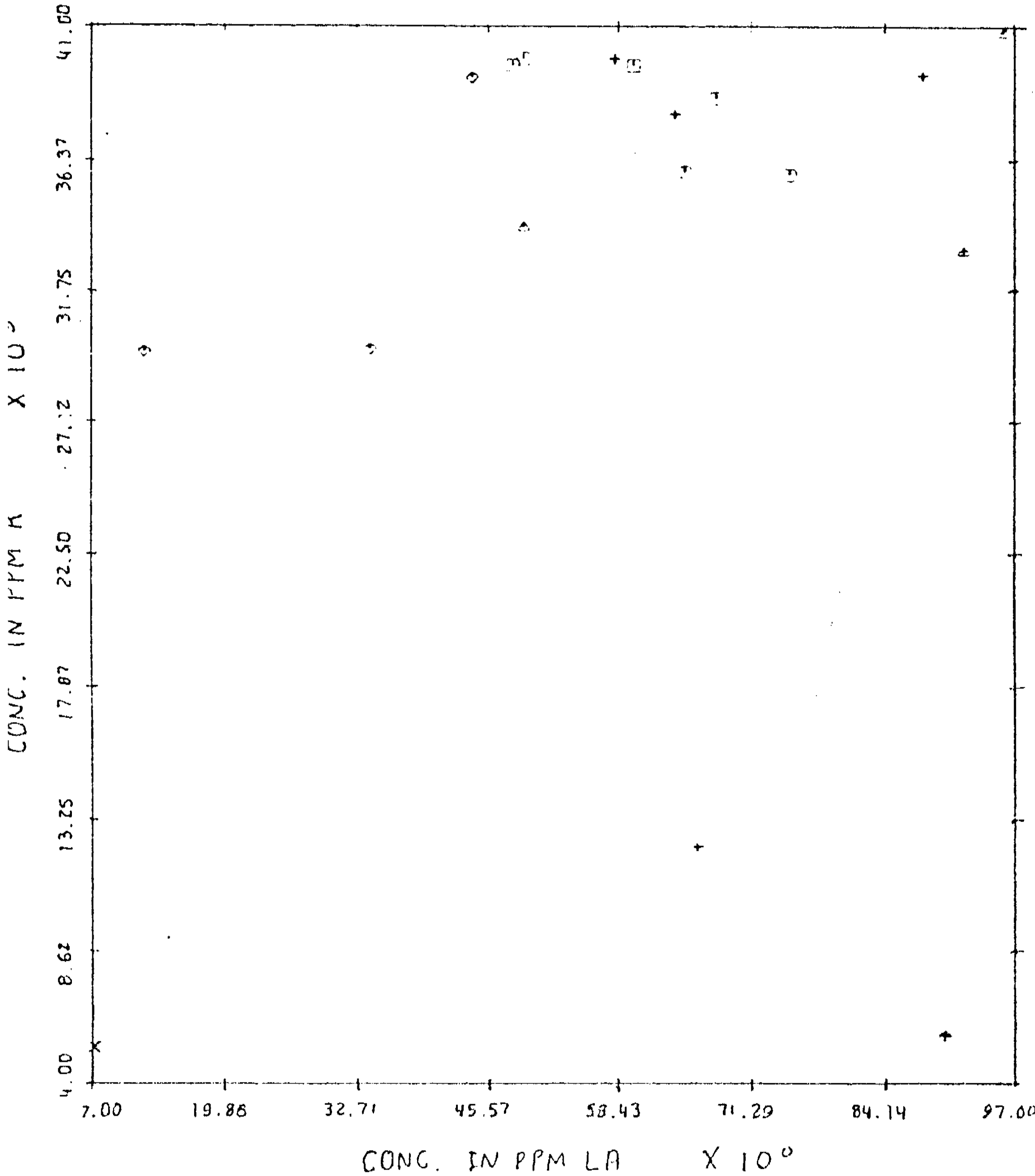
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45.57
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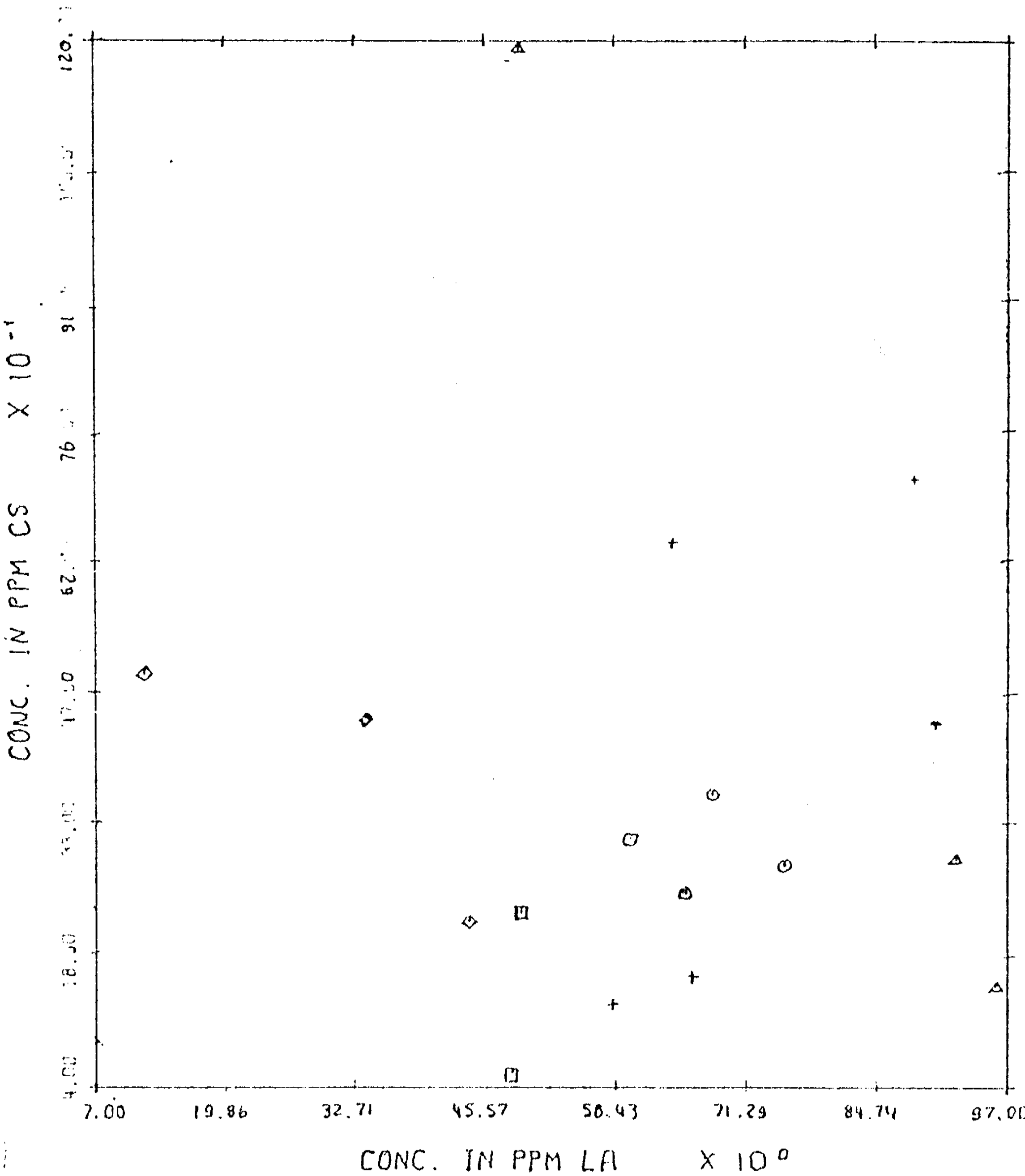
97.00
CONC. IN PPM LA X 10⁰


CONC. IN PPM CS X 10⁻¹
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76
62.
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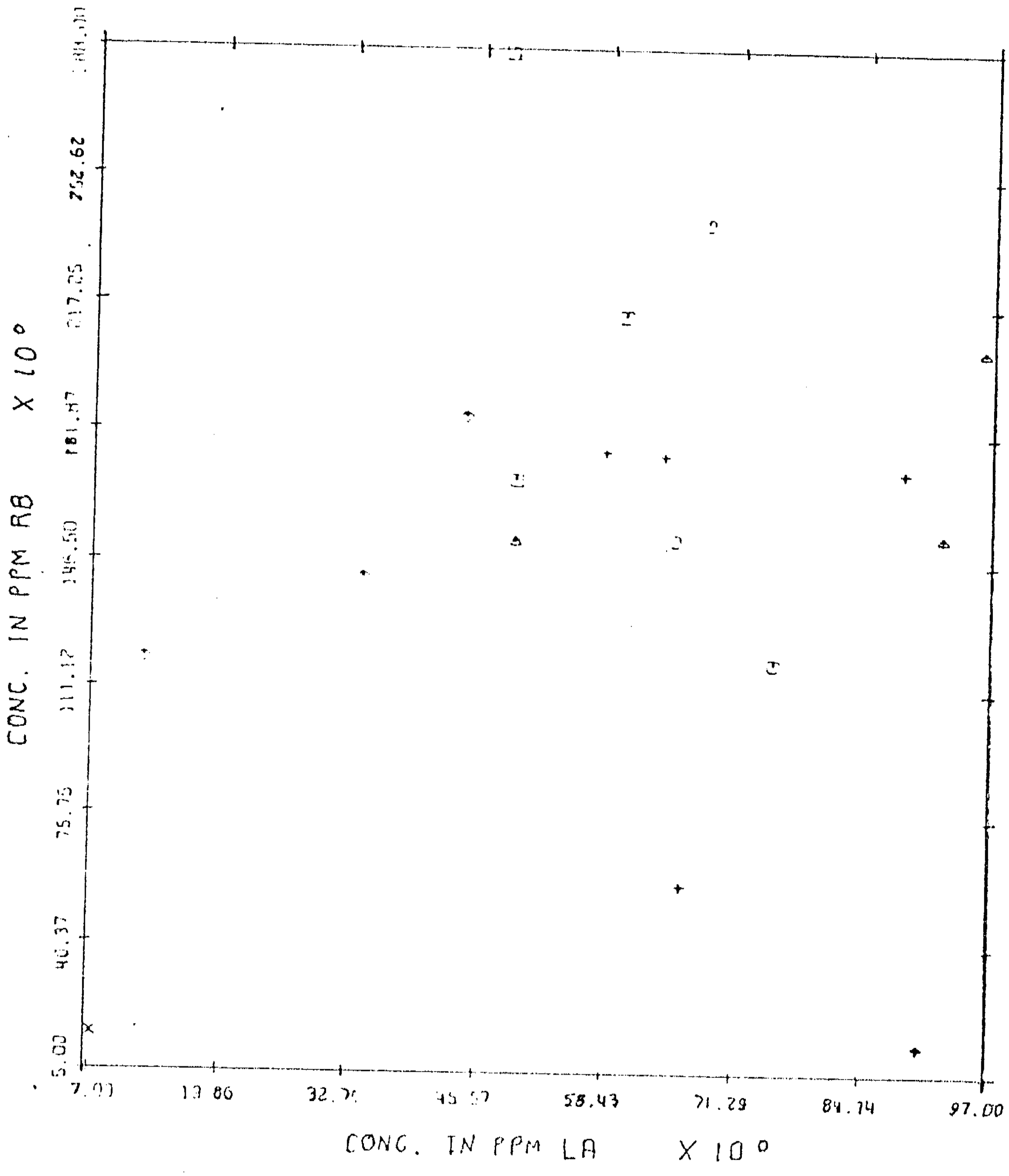
CONC. IN PPM LA X 10⁰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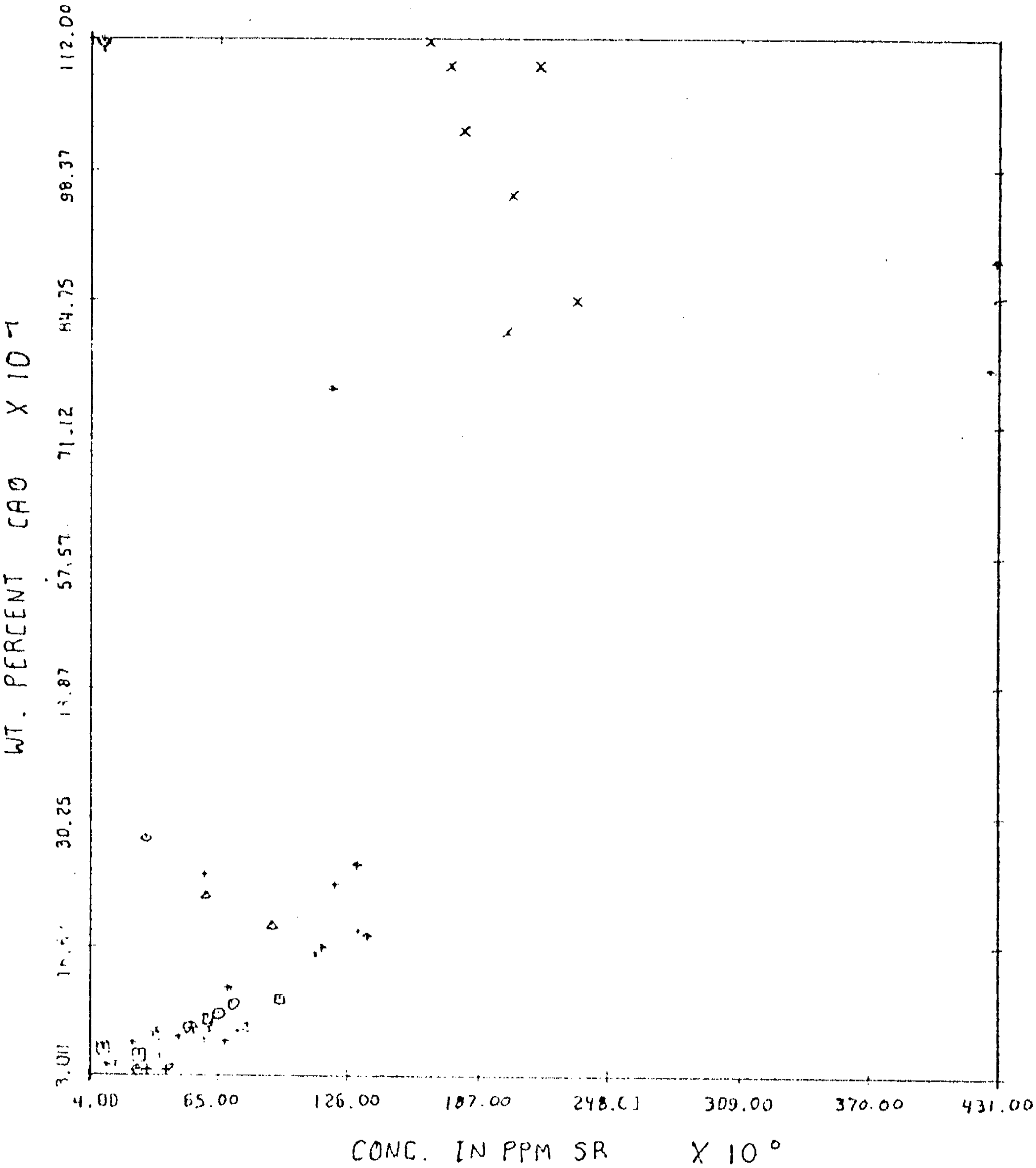
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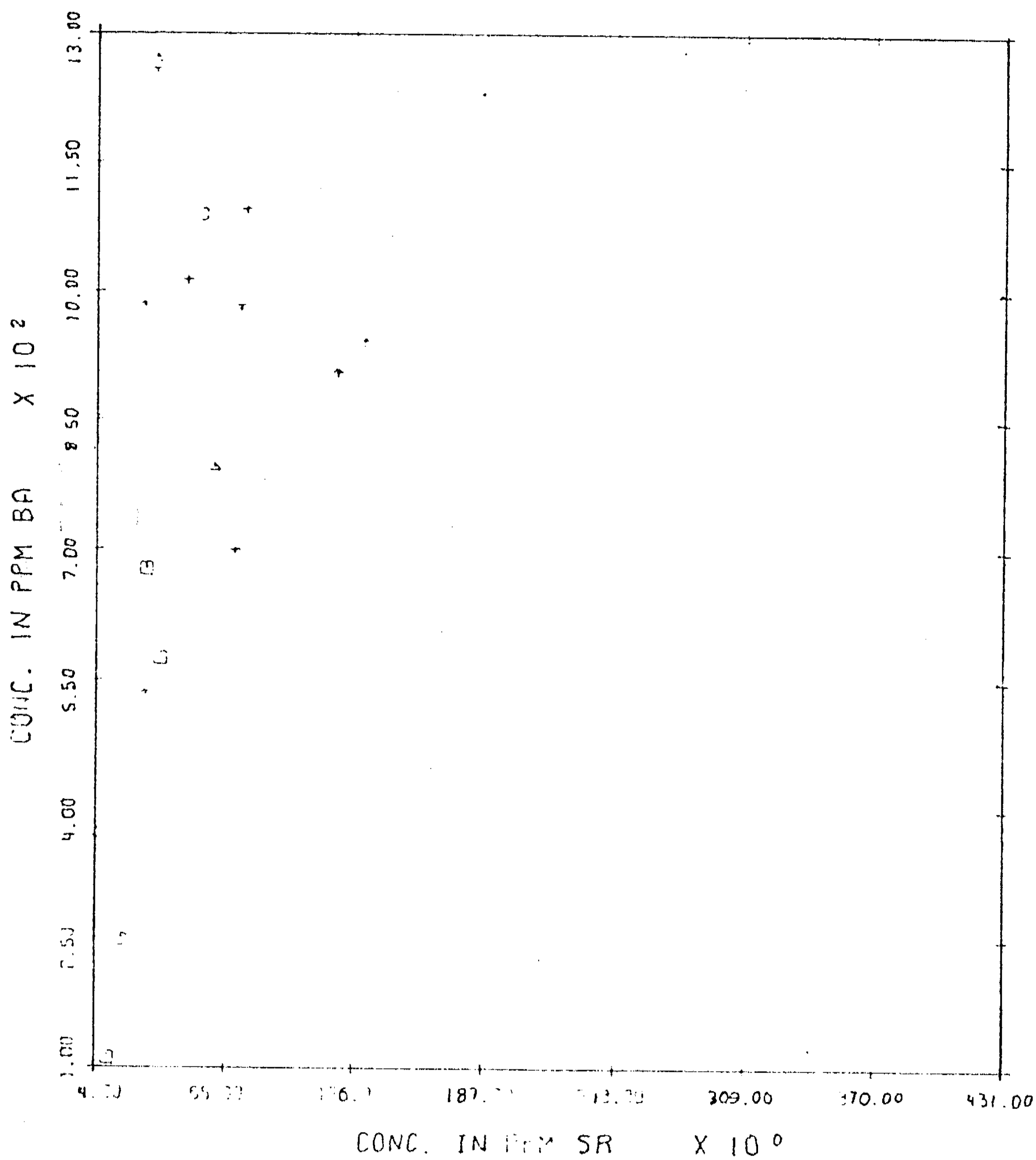
CONC. IN PPM SR X 10⁰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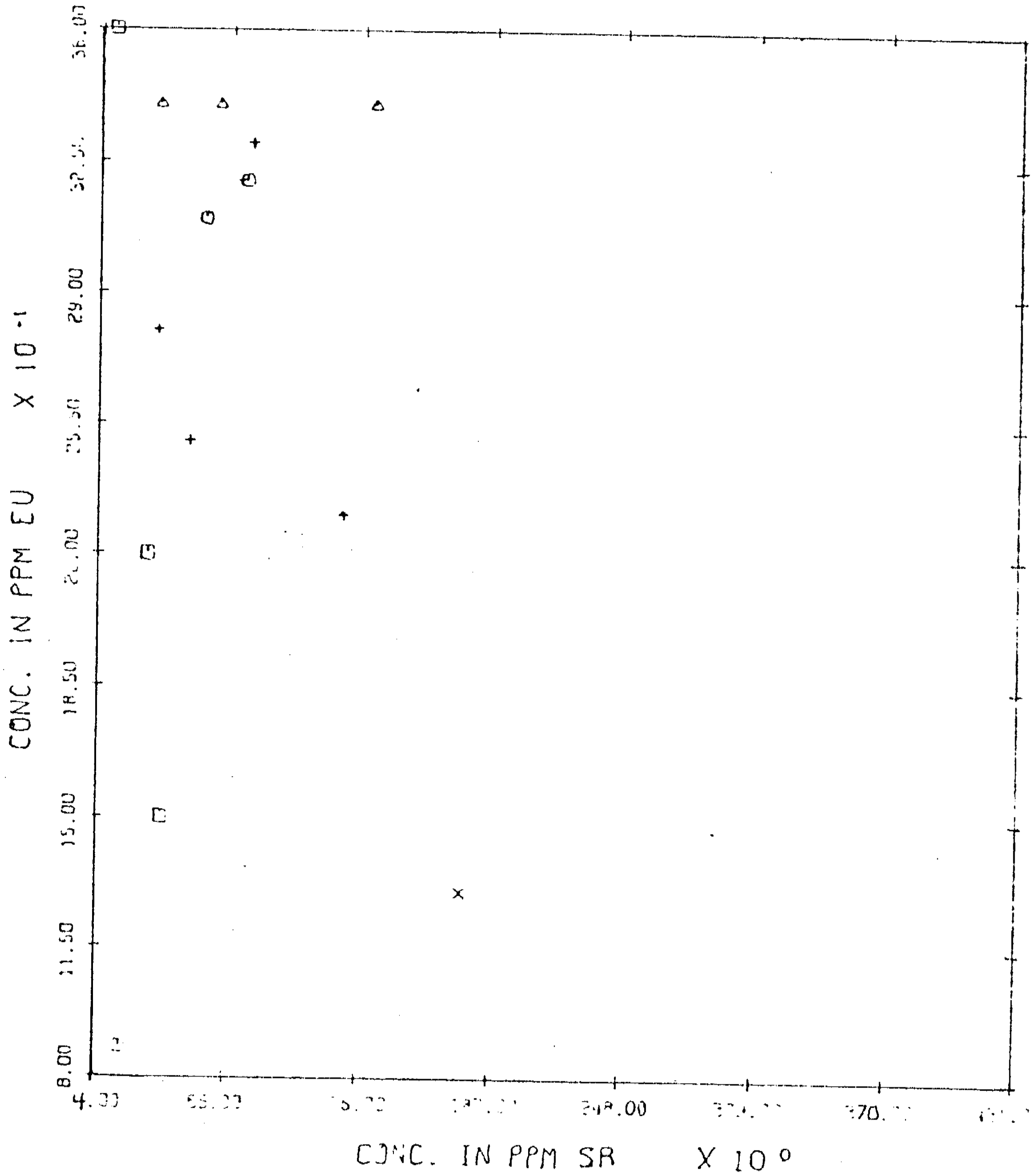
CONC. IN
SR X 10⁰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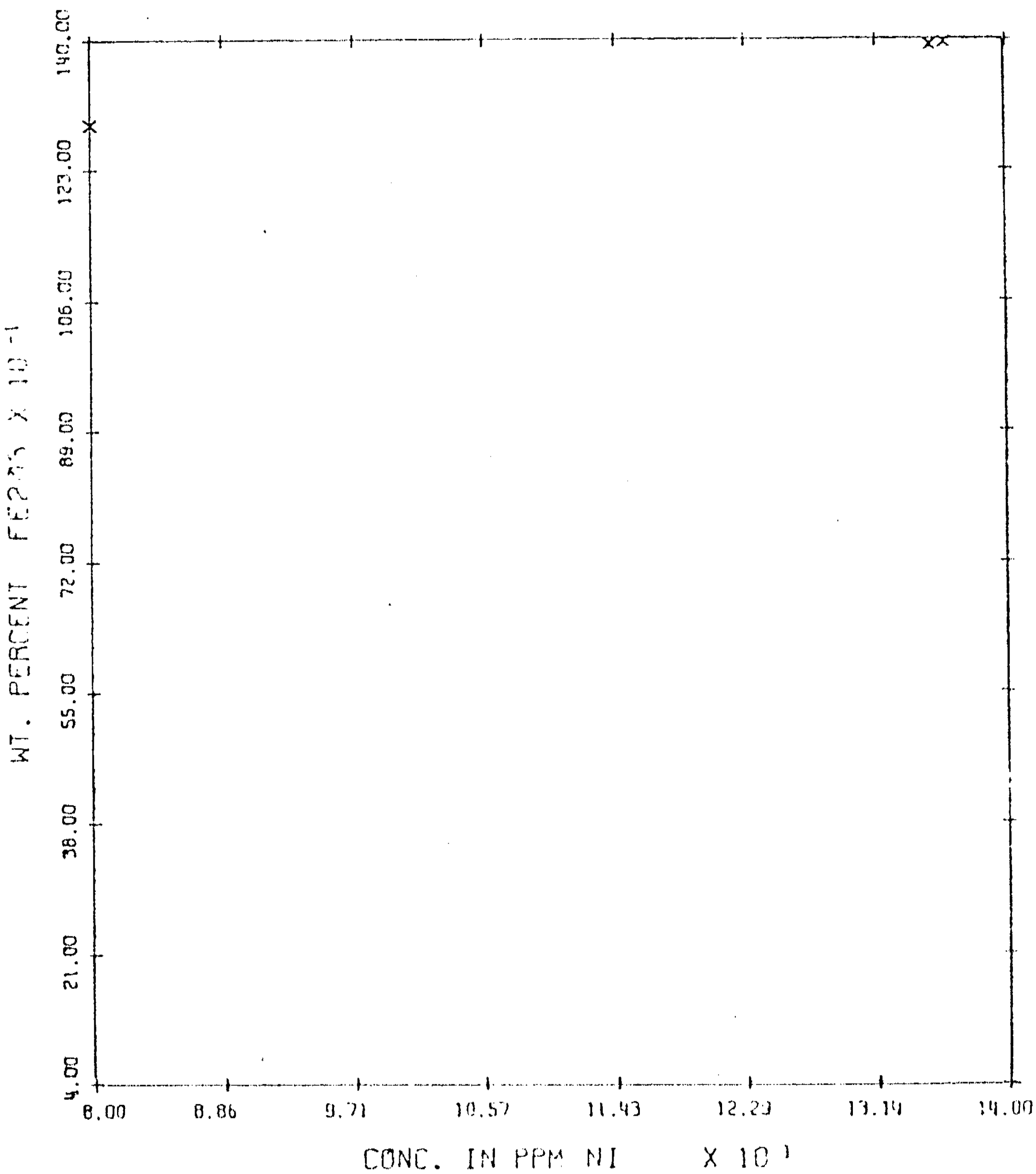
CONC. IN PPM SR X 10 0



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X 10 -1
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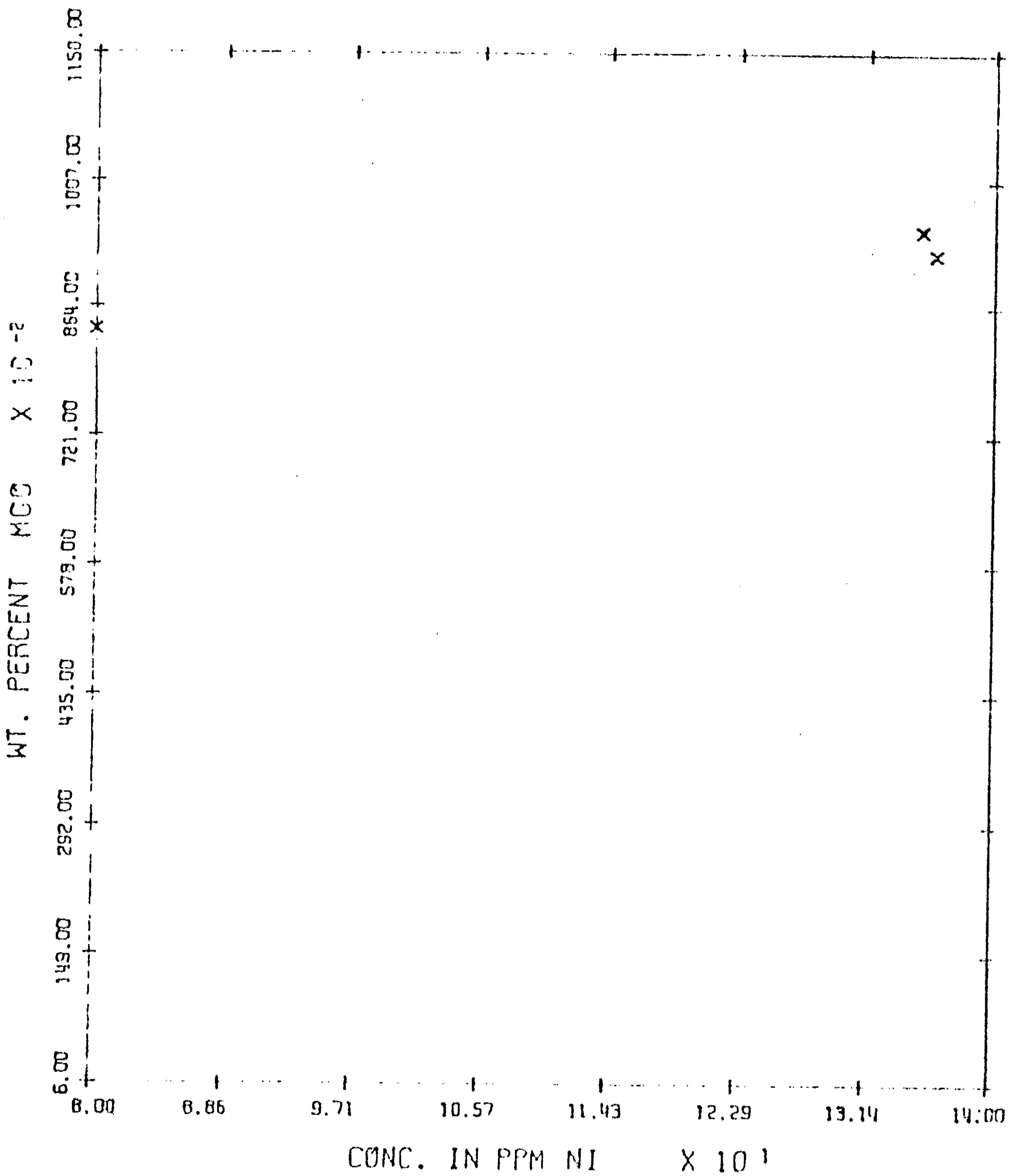
CONC. IN PPM NI X 10 1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8.00
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9.71
10.57
11.43
12.29
13.14
14.00
CONC. IN PPM NI X 10 1

This dissertation is accepted on behalf of the faculty of the

Institute by the following committee:

A. J. Bradding
Adviser

____

John R. McMillan

____

____

March 8, 1976
Date