ECONOMIC GEOLOGY OF THE MIDNIGHT, BLACK KNIGHT, AND ASSOCIATED MAGNETITE CLAIMS, LONE MOUNTAIN, LINCOLN COUNTY, NEW MEXICO

by

Cynthia L. Spahr

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science in Geology

New Mexico Institute of Mining and Technology

Socorro, New Mexico

February 1983

ACKNOWLEDGEMENTS

I would like to thank:

.....Dr. Clay T. Smith for being my advisor, providing help whenever needed, and for being THE most patient person in the world;

.....Drs. Dave Norman and Mike Payne for serving on my committee;

.....Mr. Ed Bottinelli and Mr. Carl Hartley for financial support;

.....The New Mexico Geological Society for a Summer Research Grant;

.....Mr. Gary Quintana for providing one of my many field vehicles;

.....Dr. Lynn Brandvold and her staff for testing my ore samples;

.....Mr. Carl Dotson, for allowing my access to his property;

.....Mr. Elon Tillon, for keeping an eye out on my whereabouts while in the field;

.....and KATHY, Mike, Bob and Woody, for drafting and field assistance.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	ii
LIST OF FIGURES AND TABLES	v
LIST OF PLATES AND OVERLAYS	vii
ABSTRACT	viii
INTRODUCTION	1
Study Area	1
Purpose of Study	4
Previous Work	4
Geological Methodology	4
Geophysical Methodology	6
Geography	7
GENERAL GEOLOGY	9
Regional	9
Lone Mountain	14
GEOLOGY OF THE STUDY AREA	17
Sedimentary Rocks	17
Igneous Rocks	24
Volcanic Rocks	35
Metamorphic Rocks	43
Magnetite Mineralization	48
MAGNETIC SURVEYS	54
ORE DEPOSITS	59
Black Knight	59
Midnight	67
Blue Rose 1--North	75
Others	82

Page

DISCUSSION OF ORE GENESIS....................................88

SUMMARY AND CONCLUSIONS....................................96

Geologic History and Mineralization................96

Summary of Estimated Reserves......................97

Economic Feasibility Study.........................98

APPENDICES...104

A. Sample Descriptions..............................104

Sedimentary Rocks.............................105

Igneous Rocks.................................114

Volcanic Rocks................................137

Metamorphic Rocks.............................146

B. Magnetic Profiles................................156

East Survey...................................157

West Survey...................................165

Black Knight..................................173

Midnight......................................180

Blue Rose 1--north............................187

C. Notes on Ore Reserve Estimates...................193

REFERENCES...194

LIST OF FIGURES AND TABLES

Figure | Page

1) Location map of Lone Mountain, Lincoln County, New Mexico....2
2) Location of Lone Mountain magnetite deposits....3
3) Photos showing the topography of Lone Mountain....8
4) Generalized section of sedimentary rock units in the Ruidoso-Carrizozo region....10
5) Geologic map of Lone Mountain....15
6) Photos showing the nature of limestone outcrops....18
7) Photos of altered limestone....20
8) Photos of limestone and quartzites....21
9) Photos of characteristic monzonite outcrops....25
10) Photos of monzonite samples....26
11) Photos of dike outcrops....30
12) Photos of dike samples....33
13) Photos of volcanic samples (basal)....37
14) Photos of volcanic samples (upper)....41
15) Photos of marble samples and skarn mass....44
16) Photo of skarn samples....47
17) Photos of magnetite ore....49
18) Photos of banded and veined magnetite....50
19) Photos of other magnetite samples....52
20) East magnetic survey contour map....57
21) West magnetic survey contour map....58
22) Black Knight magnetic survey contour map....60
23) Sketch map of the Black Knight deposit....61
24) Cross section A-A'....62
25) Photos of the Black Knight deposit....63

Figure Page

26) Photos of the Black Knight south deposit............65

27) Midnight magnetic survey contour map................68

28) Sketch map of the Midnight deposit..................69

29) Cross section B-B'..................................70

30) Photos of the north Midnight cut....................71

31) Photos of the Midnight ore..........................72

32) Blue Rose 1 magnetic survey contour map.............76

33) Sketch map of the Blue Rose 1 north deposit.........77

34) Cross section C-C'..................................78

35) Photos of the Blue Rose 1 north deposit.............79

36) Photo of the Blue Rose 1 south deposit..............83

37) Cross section D-D'..................................84

38) Sketches of the small ABD deposits..................86

Table Page

1) Summary of monzonite thin section data..............28

2) Summary of dike thin section data...................32

3) Summary of volcanic thin section data...............39

4) Summary of magnetite geochemical data...............53

5) Summary of estimated reserves.......................97

LIST OF PLATES AND OVERLAYS

Plate Page

1) Claim Map of the study area....................back pocket

2) Regional Geologic Map..........................back pocket

3) Geologic Map...................................back pocket

4) Location of Magnetic Surveys...................back pocket

Overlay

3.1 Sample and Cross Section Locations..........back pocket

ABSTRACT

Lone Mountain is located 12 miles NNE of Carrizozo and 2.5 miles NW of White Oaks in Lincoln County, New Mexico. The mountain was formed by a Tertiary monzonite stock which domed and protruded through Paleozoic and Mesozoic (?) sedimentary formations. Porphyritic dikes varying in composition from granitic to gabbroic intrude the stock and sediments. Trachyte, latite-andesite, and quartz latite volcanic flows cover a portion of the southern flank of the mountain. Magnetite mineralization occurs at intervals around the periphery of the stock and with large limestone xenoliths enclosed in the stock.

A group of claims on the east and south sides of Lone Mountain was mapped on a scale of 1:6000. Three of these claims contain magnetite deposits, which were studied in detail. The deposits consist of irregularly shaped pods and lenses of magnetite located at or near the igneous/sedimentary contact. They were formed when iron-rich fluids migrated upward along the contact, and encountered either the limestone/sandstone facies boundary of the San Andres formation or zones of increased permeability, such as along dikes.

Based on geologic evidence and magnetic surveying, ore reserves for this property are estimated at 88,672 tons. Included in this figure are 46,988 tons of iron and 7,558 ounces of silver.

A preliminary economic feasibility study of the deposits concludes that it would be unprofitable to mine the property at this time.

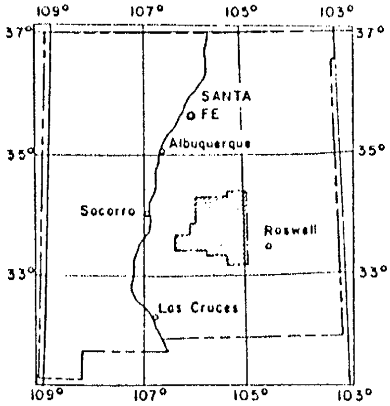
INTRODUCTION

Lone Mountain is located 12 miles NNE of Carrizozo and 2.5 miles NW of White Oaks in Lincoln County, New Mexico (Figure 1). It was formed by a Tertiary monzonite stock (laccolith?) which domed and protruded through the surrounding Paleozoic and Mesozoic sediments. The mountain is the site of several metasomatic magnetite deposits which are related to the intrusive/sedimentary contact (Figure 2).

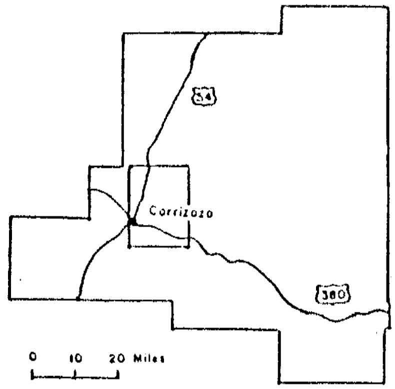
Study Area

The study area consists of an H-shaped group of 42 claims on the east and southeast flanks of Lone Mountain. The claims are in T6S, R11E and cover 1.3 square miles of sections 13, 14, 23, 24, and 25 (Plate 1). The Black Knight and Midnight claims are owned by Carl Dotson of Socorro. The claim group is currently controlled by Ed Bottinelli and Bill Hargis of Dallas, Texas. The land is in the Lincoln National Forest and surface rights are leased to the Bar W Ranch, owned by the Spencers of Carrizozo.

Access to the study area is available, with permission, via a dirt road from Carl Dotson's mine in White Oaks. Several ranch and old mining roads provide access within the study area (see Plate 1). The flat-lying road at the base of the mountain is generally passable, but those roads leading to the northern and western claims require a four-wheel drive vehicle to negotiate the steep grades and accumulations of talus. The road leading to the southern part of the Blue Rose 1 claim was washed out during recent summer thunderstorms.



INDEX MAP SHOWING LINCOLN COUNTY



LINCOLN COUNTY

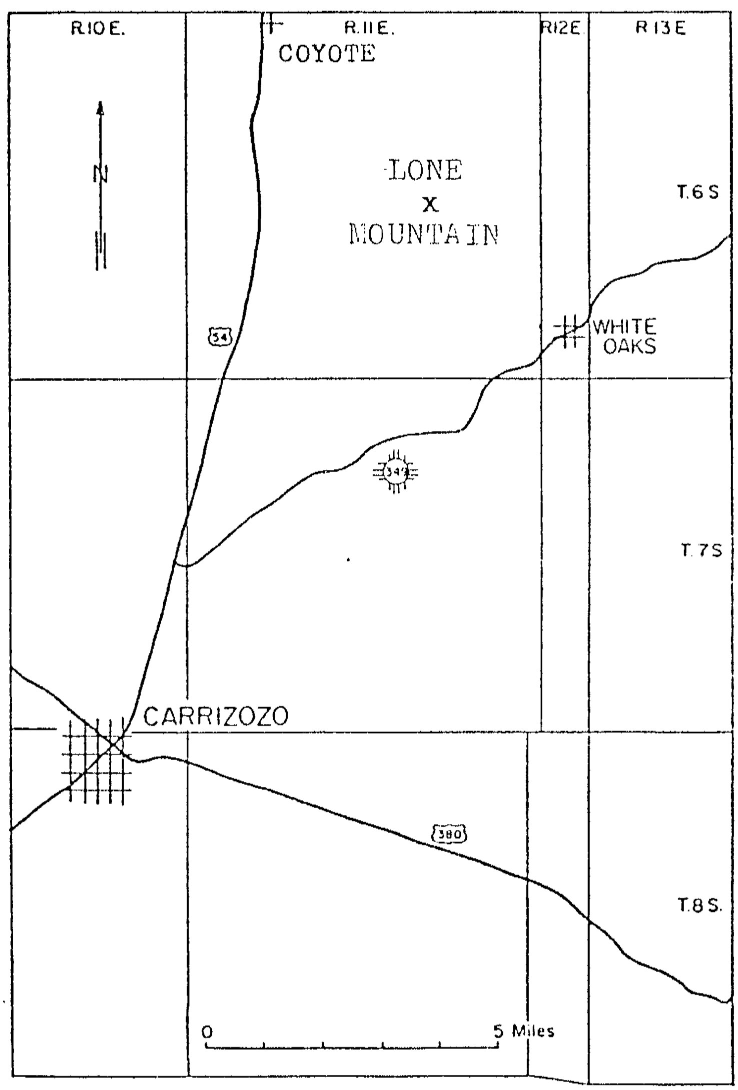
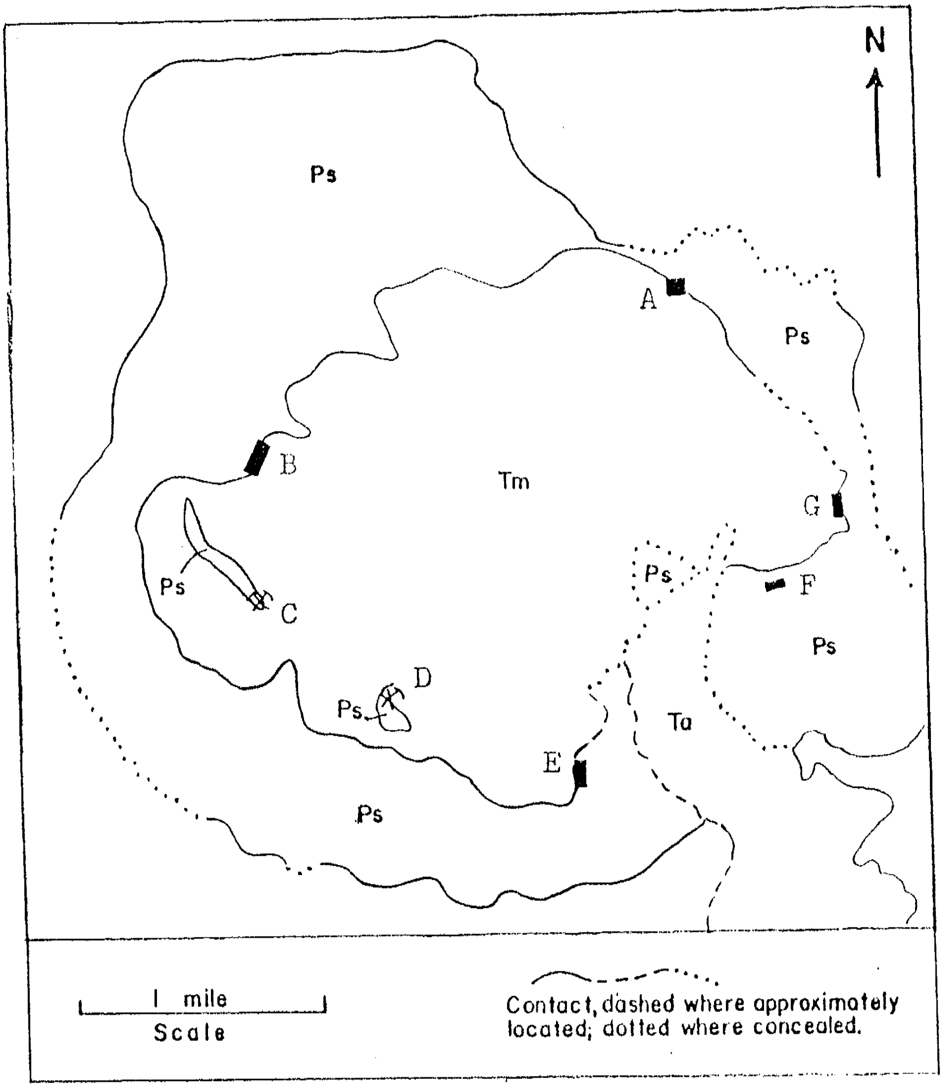


Figure 1. Location map of Lone Mountain, Lincoln County, New Mexico.



A. HOUSE PROSPECT
B. FERRO MINE
C. STODDARD MINE
D. YELLOW JACKET MINE
E. BLUE ROSE CLAIMS
F. MIDNIGHT CLAIM
G. BLACK KNIGHT CLAIM

Figure 2. Location of Lone Mountain magnetite deposits with respect to the intrusive/sedimentary contact. Geologic contacts by Smith and Budding (1959). Tm, Tertiary monzonite stock; Ps, Permian San Andres limestone; Ta, Tertiary tuff and agglomerate. Other units have been omitted.

Purpose of Study

The main purpose of this study was to map the group of claims in detail and to estimate their magnetite reserves. The reserve estimates are based on field mapping, magnetic surveying, and ore assays. Petrographic study aided rock identification and classification.

Previous Work

The first published reports of Lone Mountain's magnetite deposits were included in county or state-wide resource assessments. Sheridan (1947) reviewed Lincoln County's iron deposits and included descriptions of several Lone Mountain prospects. Kelley (1949) described these in further detail in his geologic and economic assessment of the State's iron resources. Griswold (1959) briefly discussed the major Lone Mountain prospects and Walker and Osterwald (1956) studied the Prince Mine (House prospect).

The geology of Lone Mountain was first mapped in 1958 by Smith, et al., and was included on a published 1:62500 scale reconnaissance map by Smith and Budding (1959). Smith (1964) described Lone Mountain geology in more detail in his paper on the Little Black Peak quadrangle. Butler (1964) performed quantitative spectrochemical analyses on magnetite from four Lincoln County plutons, including Lone Mountain. Schnake (1977) mapped the mountain on a scale of 1:12000 and attempted to establish the thermochemical conditions present during the formation of its iron-bearing skarns.

Geologic Methodology

The geology of the study area was mapped on a scale of

1:6000. The base map was enlarged from the USGS Little Black Peak 15 minute quadrangle (screened on Plate 3). Aerial photos were studied, but were not very useful for mapping due to the limited number of outcrops. Where outcrops were absent, float was used to locate approximate contacts. Cross sections of the magnetite deposits were drawn from field sketches and photographs. Their locations are shown on Overlay 3.1.

Five rock units were mapped. The Permian San Andres Formation was mapped as Ps. The Permo-Triassic Bernal Formation, which is not directly exposed, was dotted in on the map and labeled P$\bar{R}$ b. Igneous rocks comprise two units--Tm, the monzonite porphyry stock; and Td, the dikes. The volcanic flows were mapped as Tv.

Samples of all types of rocks were collected for later petrographic and/or geochemical investigation. The study of 50 thin sections provided the basis for rock classification. Igneous and volcanic rock classifications are based on Travis (1955) and Hyndman (1972). Limestone is classified according to Folk (1962). Ore samples were taken from all deposits and analyzed by Atomic Absorption Spectrometry and fire assay for iron content and other metals.

Ore reserve estimates are based on field observations and on magnetic profiles and contours. Thicknesses of the ore zones were measured directly where possible. Depths of the beds are questionable, but have been estimated from field and magnetic data.

Geophysical Methodology

The magnetic surveys were conducted with a GeoMetrics G-816 Proton Precession Magnetometer. The instrument measures total magnetic field and has a sensitivity of one gamma (nanotesla). A baseline was surveyed along the presumed igneous/sedimentary contact, and is divided into east and west segments by the volcanic flows. Profiles were placed perpendicular or nearly perpendicular to the baseline at 250-foot intervals. Readings were taken at paced 50-foot intervals north (toward the stock) and south (toward the sediments) of the baseline (see Plate 4). Three detailed surveys were conducted over the largest deposits on the Black Knight, Midnight, and Blue Rose 1 claims. Profiles were run at 25-foot intervals except where large amounts of rubble are present from previous mining activity. Readings were taken at 25-foot intervals near the margins of deposits and at 10-foot intervals across the deposits.

The recorded measurements are the average of three readings. Base station readings were taken at the beginning and end of each day during the main survey. The maximum daily change recorded at the base station was 77 gammas. This value is negligible when compared with anomalies (on the order of thousands of gammas) over the magnetite bodies, so corrections for diurnal fluctuations were not made.

Each measurement was corrected for background from the earth's geomagnetic field by subtracting 50,000 gammas. Profiles drawn from the corrected data are in Appendix B.

Contour maps were constructed and are located in the Magnetic Surveys and Ore Deposits sections.

Geography

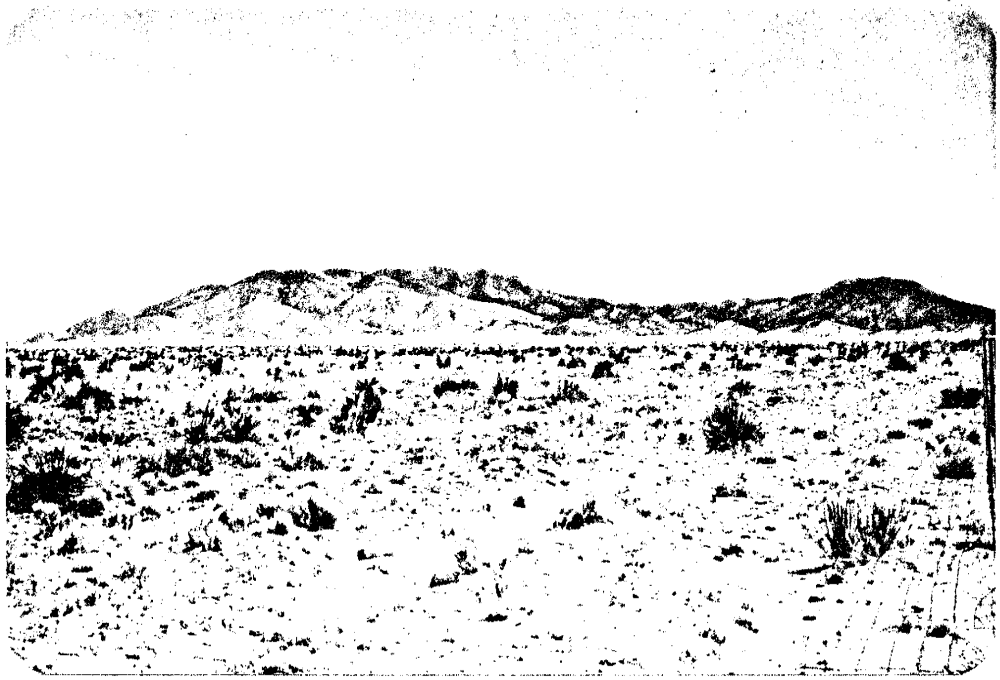
Lone Mountain has 1500 feet of relief, with its highest point at an elevation of 8137 feet. The stock is well-dissected and forms three nearly-level peaks (Figure 3). Outcrops on the mountain are very limited. Talus and rock slides cover the steep slopes, while areas at or near the base are concealed by talus or a thick soil mantle.

The climate is semi-arid, with annual rainfall averaging 12 inches per year. Summers are very hot, with frequent afternoon thunderstorms. Winters are mild to cold with some snow. The area is drained through a series of gullies and intermittent streams.

Vegetation on Lone Mountain is highly variable. Some areas are barren or occupied only by cactus. Bushes and low trees are found on the mountain peak, moderate slopes, and around streambeds. North-facing slopes are densely covered by oak brush, especially on the east side of the mountain.

The area is inhabited by mule deer, rabbits, and occasionally by bear. Birds, snakes, tarantulas, and insects are also present.

3a)



3b)

Figure 3. Topography of Lone Mountain.
a) Southwest side, from Route 349. Baxter Mountain is on the right.
b) Southeast side, from the ABD-4 claim.

GENERAL GEOLOGY

Regional

The Ruidoso-Carrizozo Region of Kelley and Thompson (1964) covers about 7500 square miles and includes the area from Corona south to Cloudcroft, and Capitan Mountain west to the Oscura and San Andres Mountains. Parts of Lincoln, Socorro, Sierra, Doña Ana and Otero Counties are covered. The region is characterized by Paleozoic sediments and Tertiary intrusives and volcanics (Plate 2). Precambrian outcrops are scattered in the eastern part of the area. Quaternary basalt flows and thick alluvium floor the valleys.

Although 75 percent of the area is covered by Permian sediments, every major period of deposition is present except for the Cambrian, Silurian, Devonian, Mississippian and Jurassic (Kelley and Thompson, 1964). Figure 4 is a generalized section of the rock units present.

The sediments in the region are intruded by numerous stocks and laccoliths, which are what Kelley and Thompson (1964) call "perhaps the greatest concentration of Tertiary intrusive centers in New Mexico." There are nine major centers located between Corona and Ruidoso. Most are less than 25 square miles in outcrop area, with the Capitan intrusive a notable exception at 110 square miles. The intrusives follow a northeast trend which is referred to as the Lincoln County Porphyry Belt. The stocks and laccoliths are alkali-rich and quartz-poor, in general, and most fall compositionally in the syenite-monzonite range. There are

Figure 4. Generalized section of exposed rock units in the Ruidoso-Carrizozo region (not to scale). Compiled from Ash and Davis (1964), Griswold (1959), and Smith (1964).

ERA	TIME PERIOD	ROCK UNIT OR FORMATION	DESCRIPTION	THICKNESS (in feet)
CENOZOIC	QUATERNARY	LITTLE BLACK PEAK BASALT FLOW	Olivine basalt	
		BROKEN BACK BASALT FLOW	Olivine basalt	
	TERTIARY	SIERRA BLANCA VOLCANICS	Andesite flow breccia, tuffs, volcanic conglomerate	
		LONE MOUNTAIN STOCK	Quartz monzonite	
		JICARILLA INTRUSIVES	Monzonite porphyry	
?	?	McRAE FORMATION or CUB MOUNTAIN FORMATION	Sandstone, chert pebble conglomerate, shale	±2000
MESOZOIC	CRETACEOUS	MESAVERDE GROUP	Sandstone, shale, coal	±500
		MANCOS SHALE	Shale, limestone, sandstone	±400
		DAKOTA SANDSTONE	Sandstone, shale, siltstone	135-175
	TRIASSIC	CHINLE FORMATION	Shale, shaley sandstone	±500
		SANTA ROSA SANDSTONE	Sandstone, chert pebble conglomerate	
	?	BERNAL FORMATION	Siltstone, sandstone, gypsum	100-350
?	?			
PALEOZOIC	PERMIAN	SAN ANDRES FORMATION	Limestone, gypsum	300-1000
		GLORIETA SANDSTONE	Sandstone	0-340
		YESO FORMATION	Siltstone, gypsum, limestone	1000-2000
		ABO FORMATION	Mudstone, sandstone, shale	0-800
		BURSUM FORMATION	Limestone, shale	0-300
	PENNSYLVANIAN	MAGDALENA GROUP	Limestone, shale, sandstone	0-3000
	ORDOVICIAN	BLISS SANDSTONE	Sandstone	0-100
PRECAMBRIAN ERA			Granite, gneiss, quartzite	

also numerous diabasic sills and dikes of various composition present.

There are two areas in the region where dikes are prominent. The Capitan swarm consists of numerous northeast-trending dikes which begin at the northeast end of Sierra Blanca and continue past the western edge of the Capitan intrusive. The Jones dike on Chupadera Mesa is the most prominent dike in the region. It is 575 feet wide and trends east-west for more than 10 miles. The dike consists of two types of diorite and is intruded by diabase sills.

Tertiary volcanics are abundant in the area. The largest accumulation is the volcanic pile which forms a belt around the northern end of the Sierra Blanca intrusives. Its thickness may be greater than 4000 feet and is primarily composed of andesites and latites (Griswold, 1959). Smaller flows, such as those on Lone Mountain, probably resulted from the same episode of volcanic activity (Smith, 1964).

Quaternary basalt flows, erupted from the Broken Back and Little Black Peak cones, floor a large part of the valley to the west of Carrizozo.

Structurally, the region can be divided into two major north-south-trending anticlinal zones. These alternate with two synclinal zones and are bordered on the east by the broad, gently dipping Pecos Slope (see Plate 2). The eastern anticlinal zone consists of the Sacramento Uplift, Mescalero Arch and Lincoln Porphyry Belt. The east limb of the Arch dips gently toward the Pecos Slope and the west limb descends into the central syncline. The Arch extends north from the Sacramento Uplift to the Gallinas laccolith, and is offset about nine miles to the west at the Capitan intrusive.

The synclinal zone, from north to south, consists of the Claunch Sag, Sierra Blanca Basin and Tularosa Basin. The western anticlinal zone includes the Chupadera Platform (Mesa), Oscura Uplift, and San Andres Uplift. It is broken at Mockingbird Gap, which is a seven mile-wide northwest-trending graben. The Jornado del Muerto Basin is the long syncline, or broad downwarp (Kelley and Thompson, 1964), which bounds the western part of the region.

There are numerous faults in the region. In general, faults to the west of the Sierra Blanca Basin trend north or northwest, while faults to the east of the Basin trend northeast or east. The mapped faults range in length from 1 to 45 miles; the major ones are labeled on Plate 2.

The Capitan lineament is a large, anomalous east-west structural trend which transects the southern part of the region. The lineament is 30 miles wide, and extends west-northwest from the Sacramento Uplift to the Rio Grande. The northern boundary extends from the Capitan intrusive through the Jones dike. Kelley and Thompson (1964) call the structure a zone of deflection and suggest that it may be due to a large, plastic, right shift in the subcrust.

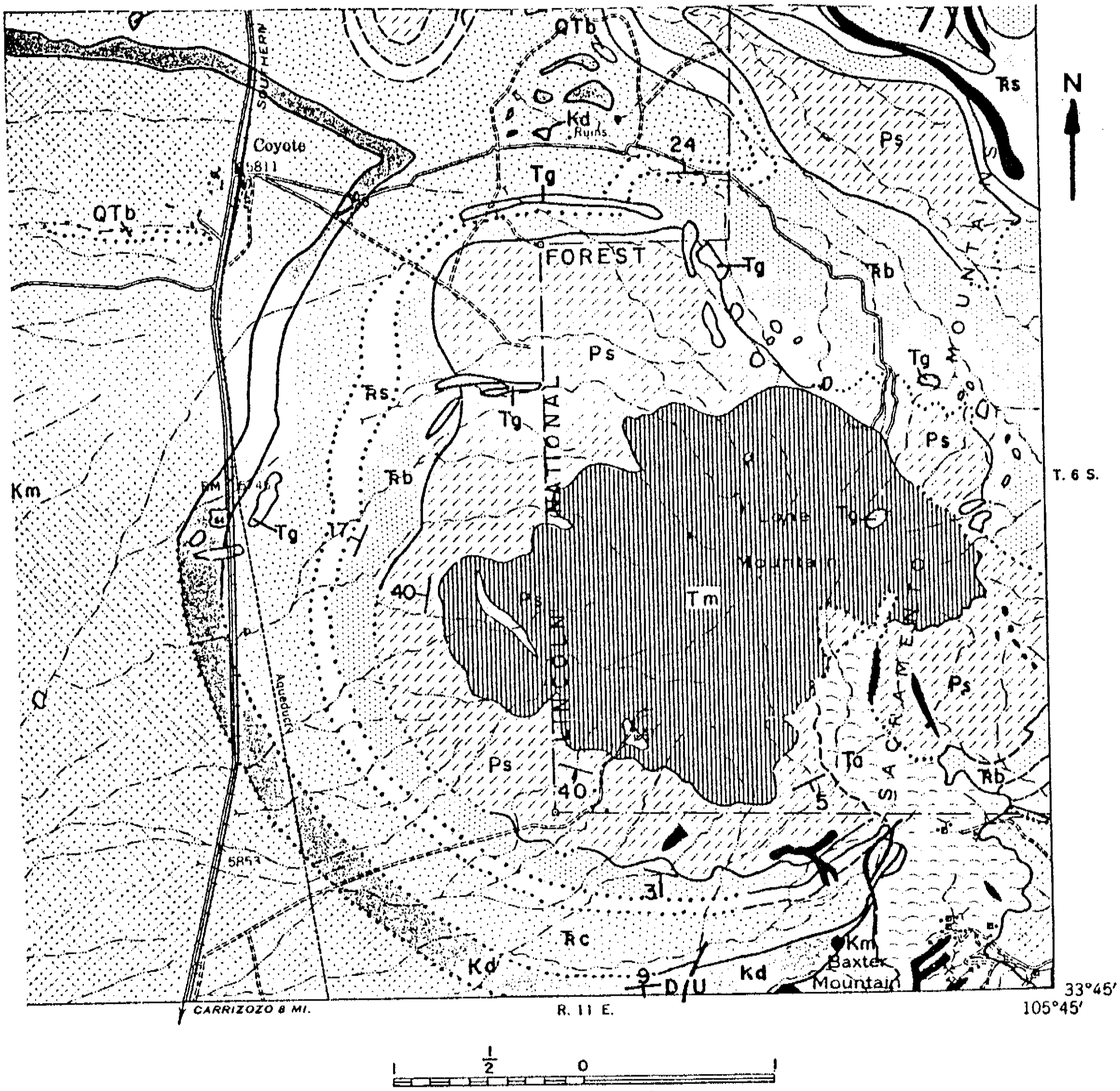
Small folds are common in the area and are almost entirely restricted to the incompetent Yeso Formation. A zone of northeast-trending folds passes through Tecolote and parallels the Corona Syncline. A large group of folds surrounds the Capitan intrusive on its north, east, and south sides. The northern and eastern folds trend northwest and north, respectively. The folds to the south of Capitan are in the Hondo drainage region and have been termed the Lincoln Fold System by Craddock (1960). The Carrizozo Anticline is formed by a broad doubly-plunging fold of the San Andres formation, and is located along the western edge of the Little Black Peak flow.

Lone Mountain

The Lone Mountain intrusive is referred to by various authors as a stock and laccolith. The intrusive is laccolithic in some places where the surrounding sedimentary beds are strongly folded. However, the majority of the contact is with gently dipping beds and thus the author agrees with Smith (1964) and Schnake (1977) that the Lone Mountain intrusive can correctly be defined as a stock. The stock is about five square miles in outcrop area and is crudely circular in shape. It has domed and protruded through (?) Paleozoic and Triassic beds, causing them to outcrop in a roughly concentric pattern (Figure 5).

Volcanic flows unconformably overly the stock and sediments on the south side of the mountain. The flows, stock and sediments are cut by various monzonitic and rhyolitic dikes. The stock and sediments are intruded by small patches of quartz-rich monzonite (Smith, 1964).

Lenses and beds of magnetite are present at intervals around the mountain. They are usually located within a few hundred feet of the igneous/sedimentary contact and are



SCALE, in miles

Figure 5. Geologic map of Lone Mountain (Smith and Budding, 1959). QTb, Quaternary and late Tertiary basic dikes and flows; Ta, Tertiary agglomerate and tuff; Tg, Tertiary quartz-rich monzonite; Tm, Tertiary monzonite and syenite; Km, Mancos shale; Kd, Dakota sandstone; ℞ c, Chinle formation; ℞ s, Santa Rosa formation; ℞ b, Bernal formation; Ps, San Andres formation.

often associated with xenoliths, or roof pendants, of limestone enclosed in the stock.

GEOLOGY OF THE STUDY AREA

Sedimentary Rocks

San Andres Formation

The San Andres Formation was established by Lee and Girty (1909) from a type section in the northern San Andres Mountains, Socorro County, New Mexico. It is upper Permian in age and conformably overlies the Yeso Formation. Its upper contact is disconformable with the overlying Permo-Triassic and Triassic beds. The presence of well-developed karst topography along the contact indicates a break in deposition and coincides with the transition from marine to non-marine environments.

The formation consists of limestone interbedded with a basal sandy member and an upper gypsiferous facies. The basal member is the Glorieta sandstone, which is described as lenticular and discontinuous beds of white, buff, or gray, fine to medium-grained, friable quartz sandstone. The limestone is massively bedded, blue to dark gray, often fetid and locally fossiliferous. Where present, gypsum beds are white, massive, and sometimes alternate with light gray limestone.

The San Andres covers most of the eastern side and the southwest corner of the field area (Plate 3). Exposure of the formation is highly variable. Massive beds crop out in stream beds south of the Blue Rose claims (Figure 6a). Contact with the stock is exposed in the bulldozer cuts on the Blue Rose 1, but the remainder of the southwest portion is covered with soil and talus. In the central area,

6a)

6b)

Figure 6. Nature of limestone outcrops.
a) Massive beds, weathering blue-gray, south of the Blue Rose 1 claim.
b) Typical weathered appearance, Midnight claim.

limestone underlying the volcanics is exposed in some stream beds. To the east of the volcanic flows, limestone crops out on the Midnight claim (Figure 6b) and forms ridges to the east. North of the Midnight, most of the formation is covered by soil, talus, and vegetation. The limestone beds contain a few lenses of dark gray shale and are locally fossiliferous (with crinoids) or marbleized.

In the study area, the limestone is dark gray to black, micritic, and relatively homogeneous. On the southern part of the Blue Rose 1 claim, however, limestone containing ovoid-shaped void fillings or intraclasts of sparry calcite is common. These ovoids are streaked and smeared near the ore deposits, which imparts a black and white appearance to some of the rock (Figure 7a). Limestone bordering the ore has veinlets of pyrite. As a result of alteration, the rock has turned bright orange and developed magnetite dendrites and veinlets (sample I-11, Figure 7b). At the Midnight cut ovoids are less common, but small-scale cross-laminations of calcite are visible on some weathered surfaces (Figure 8a). The limestone usually weathers to a light tan color, but in places becomes blue-gray, or coated with tan calcite or brilliant white caliche.

Thin section examination of samples F-8 and H-5 (see Appendix A) revealed that the limestone is composed of a micrite and magnetite matrix, crudely laminated to veined, with void and fracture fillings of sparry calcite. Magnetite composes 20-25 percent of the sections. This limestone is classified as a dismicrite (Folk, 1962).

7a)

7b)

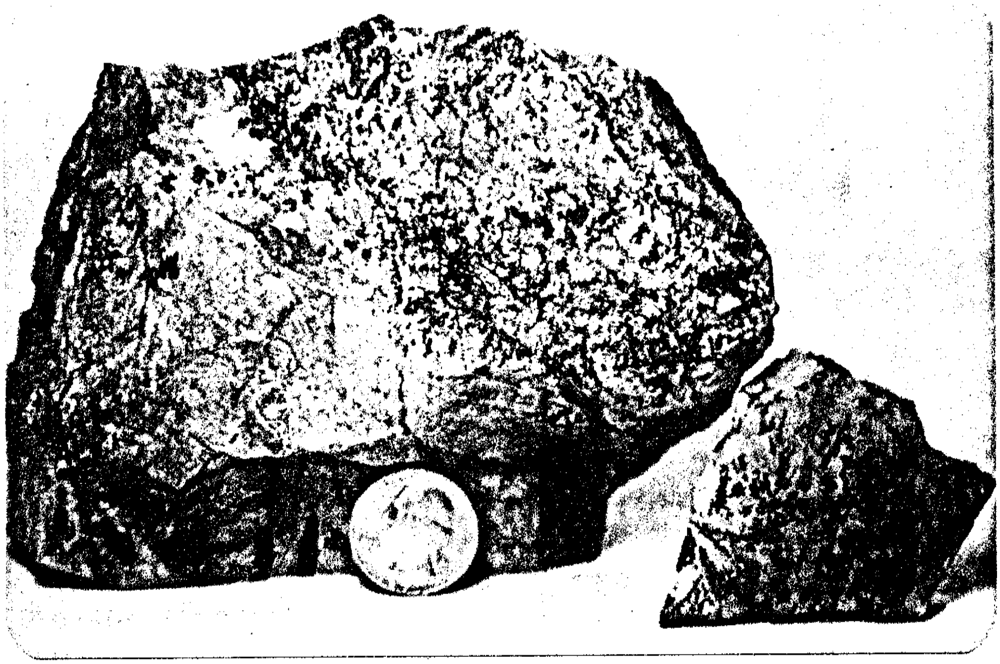
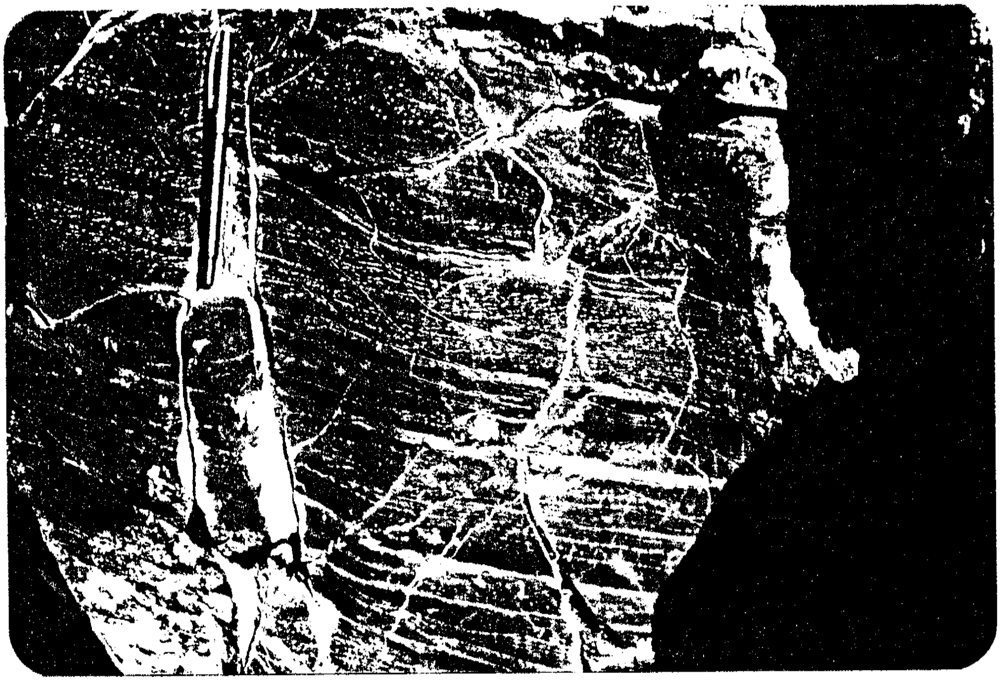


Figure 7. Altered limestone from the Blue Rose 1 south deposit.
  a) Streaked ovoids, near the deposit.
  b) Orange, pyritic limestone with magnetite dendrites, adjacent to the ore contact (sample I-11).

8a)



8b)

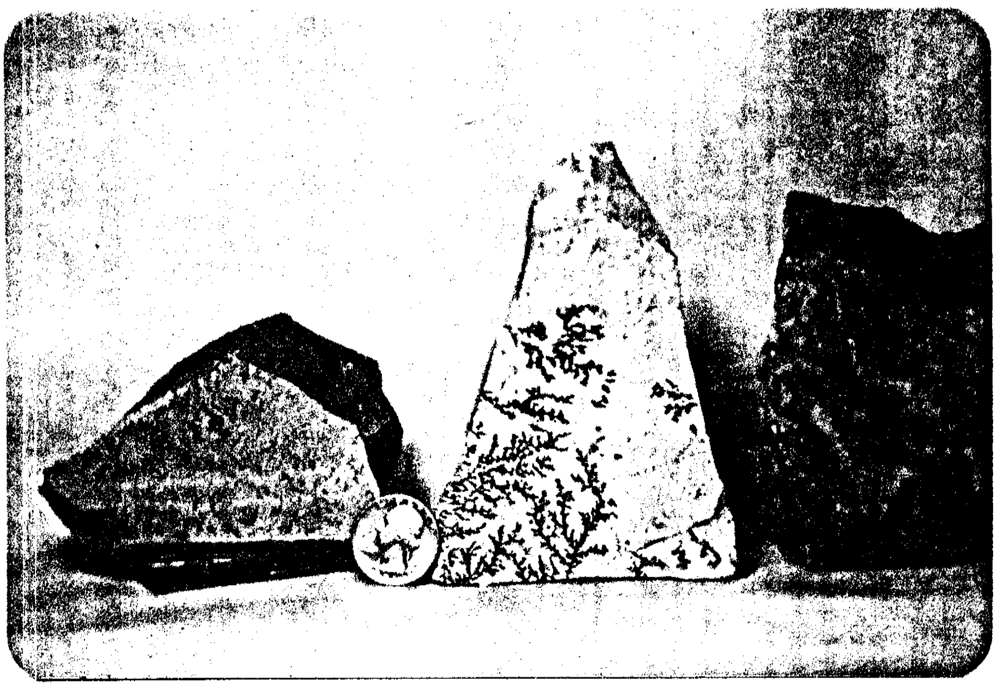


Figure 8. Limestone and quartzites.
a) Cross-laminated limestone from the Midnight cut.
b) Left and middle: fresh and weathered pink, fine-grained quartzite from the Midnight claim (sample E-34). Right: white, coarse-grained quartzite with iron alterations, from the ABD-7 claim (sample D-4).

Sandstone beds altered to quartzite, underly the limestone on the Midnight claim and also form prominent outcrops. The beds continue to the south where they are exposed in scattered, generally flat-lying outcrops.

The fresh rock (sample E-34) is a pink, well-sorted, feldspathic, fine-grained quartzite, which contains three percent magnetite. Weathered surfaces are pink to orange-tan and covered with black manganese dendrites which are sometimes gold-bearing (Figure 8b).

Quartzite near dikes or skarn zones (samples O-5, F-6) becomes further altered, usually resulting in the formation of chlorite or diopside.

Gypsum was found only on the Blue Rose 1 and ABD-1 claims.

Bernal Formation

The Bernal Formation was described by Bachman (1953) from an exposure near Bernal, Mora County, New Mexico. It has been correlated with the Chalk Bluff Formation and Whitehorse group. The fossil-free formation, originally described as an upper part of the San Andres, has been the subject of controversy as to its age. Various maps and publications list the Bernal as Permian, while others consider it to be Triassic. Smith (1964) notes that field evidence more closely allies the Bernal with overlying terrigenous Triassic beds than with the underlying marine Permian beds. Due to lack of definitive evidence in either direction, it is felt that the Bernal should be considered Permo-Triassic and transitional in nature (Clay T. Smith and John MacMillan, personal communication).

The basal part of the formation is a buff-colored, poorly sorted, medium-grained sandstone which grades upward into siltstone. It may contain thin limestone interbeds. The middle, or main part of the unit is brick red, fine-grained sandstone and siltstone interbedded with claystone. The upper beds are siltstone and claystone with small chert pebbles marking the upper contact of the formation. Most of the formation is very friable and readily alters to a conspicuous red-orange soil.

A small area of Bernal has been delineated in the extreme southeast corner of the map. The contact has been dotted, since the only definite evidence is a bed of red soil along the road leading into the study area. The contact was positioned according to this and the presence of some limestone float.

Igneous Rocks

Lone Mountain Stock

The Lone Mountain stock has been previously classified as a quartz monzonite, monzonite porphyry, kalialaskite porphyry (Johannsen, 1939), and a nordmarkite (Brogger, 1890). In accordance with classification systems by Hyndman (1972) and Travis (1955), the stock has been classified as a monzonite porphyry in this report (see Appendix A for notes on igneous and volcanic classifications). The exact age of the intrusive is not known, but it has been tentatively assigned to early Tertiary.

The stock occupies most of the north and west parts of the field area. It is a resistant unit and usually forms large, steeply dipping outcrops and vertical cliffs (Figure 9). At the top of the mountain, the rock looks like a syenite (locations Z-9 and Z-10, Overlay 3.1). It has a gray-tan to medium brown, fine-grained groundmass and contains numerous potassium feldspar (K-spar) phenocrysts averaging 5 mm in size. Weathered surfaces are lavender or dark tan, with specular hematite. The remainder of the stock is a lavender to light gray, fine to medium-grained porphyry. Near the sedimentary contact and its associated magnetite deposits, the intrusive becomes aphanitic to very fine-grained (Figure 10a). The number of phenocrysts in the rock generally decreases with groundmass size. The monzonite may also become altered by diopside skarn or magnetite (Figure 10b). Visible quartz is rare and mafic mineral content varies somewhat from place to place.

9a)

9b)

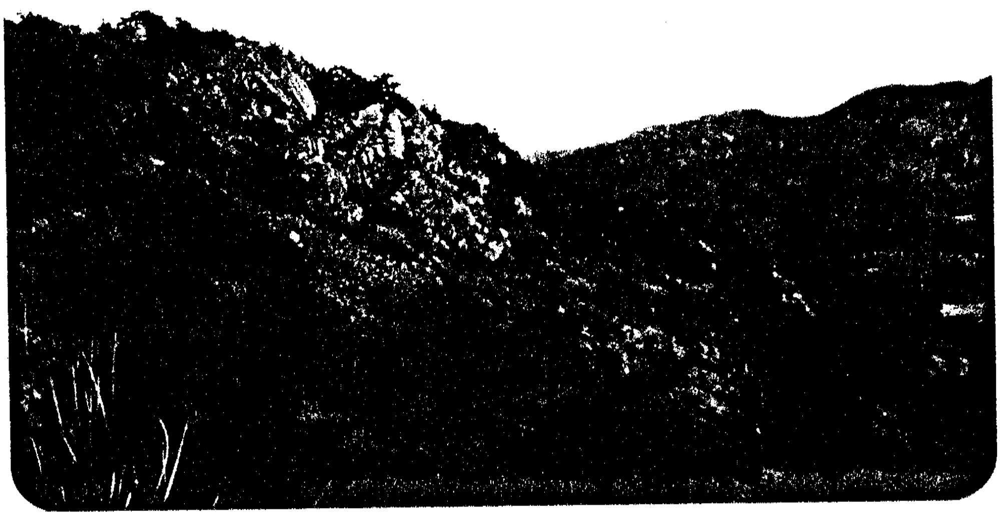
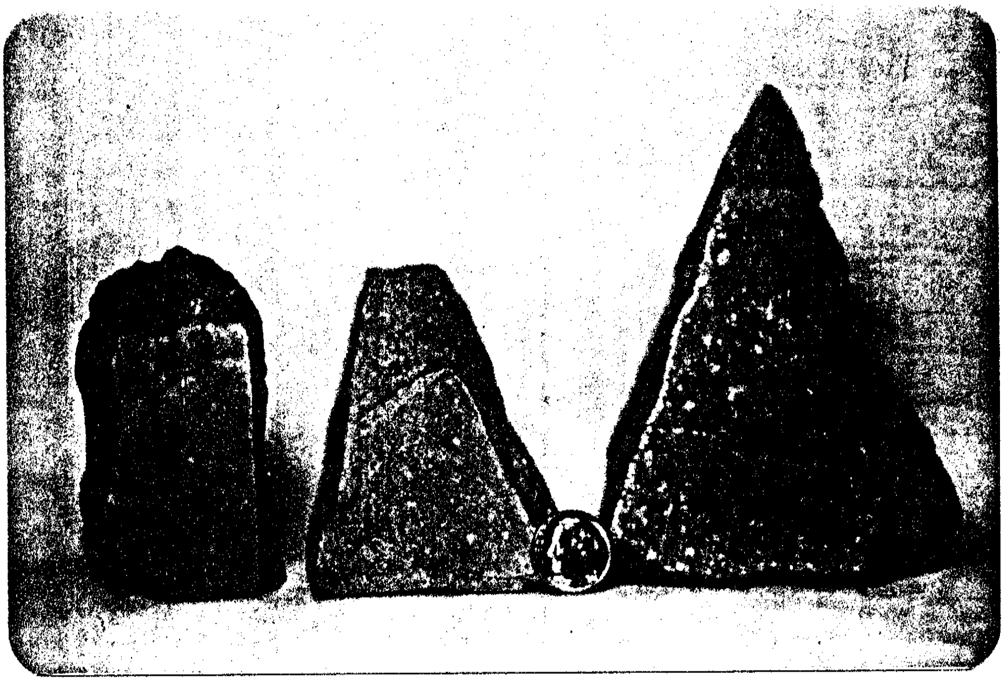


Figure 9. Characteristic monzonite outcrops.
a) Steeply dipping.
b) Nearly vertical cliffs, forming a peak. The Jicarilla Mountains are in the background.

10a)



10b)

Figure 10. Monzonite rock samples.
a) Left to right: aphanitic (sample N-3), fine-grained (sample U-4), and medium-grained (sample N-1).
b) Left: monzonite in contact with and slightly altered by dark green, crystalline diopside (sample S-4).
Middle and right: monzonite cross-cut by magnetite veinlets (samples H-3 and H-7).

The rocks weather to a light lavender or beige color, or are stained yellow-brown or red-purple from iron alterations.

Thin section examination revealed that the fine to medium-grained samples average 55 percent K-spar, 35 percent plagioclase, 4.5 percent quartz, and 6 percent mafic minerals (see Table 1). In comparison, the finer-grained samples show a marked increase in quartz and decrease in plagioclase and mafic minerals. Compositionally these are granites. Where the quartz is less than or equal to 20 percent (sample I-1) the rock is borderline with the alkali quartz syenite field of Hyndman (1972).

In the monzonite porphyry, the K-spar phenocrysts were originally identified as microperthitic orthoclase. Further examination found a few identical crystals displaying the characteristic microcline gridiron twinning. Therefore the 'microperthite' is instead believed to be vague microcline braided twinning. The phenocrysts are up to 8 mm in length, euhedral to anhedral, and sometimes have inclusions of plagioclase. The plagioclase laths are much smaller-- to 3 mm, euhedral to subhedral, and have pericline, albite, and Carlsbad twinning. Most are at least partially sericitized, with the cores being preferentially altered. Quartz, where present, is interstitial. Red-brown pleochroic biotite is the major mafic mineral, whereas further to the west of the field area hornblende is reported to be dominant (Butler, 1964). Much of the biotite has altered to magnetite, sphene, and chlorite.

A sample taken from near the volcanic contact (L-1) is

Mineral	G-11	G-8	N-1	N-3	L-1	U-4	H-7	I-1
	Estimated Volume Percent							
K-spar (M = Microcline)	45 M	55 M?	55 M?	54 M	48 M?	74 M	61 M	75-80 M
% total F-spar	50	61	61	61	55	100	88	99
Plagioclase	44	35	35	34	39	--	8	1
Quartz	1	5	5	7	3	25	25	15-20
Biotite		1	2	2		--	--	2
Magnetite Hematite	10	2	2	2	10	1	5 1	1
Chlorite		1	.5	tr		--	--	--
Sphene		1	.5	--		--	--	1
CPX-Aegirine?	--	--	--	1	--	--	--	--
Classification (Travis, 1955)	Monzo-nite	Monzo-nite	Monzo-nite	Monzo-nite	Monzo-nite	Granite	Granite	Granite

Table 1. Summary of thin section data for stock samples. Mineral percentages are based on visual estimation. All samples are porphyritic.

texturally different than the other monzonite samples. It is composed of coarse, anhedral crystals, which indicates some degree of recrystallization. Since there is no compositional difference, it can be assumed that the alteration was caused by heat only.

In the granite porphyries, the microcline averages .4 mm in size, but phenocrysts are as large as 2 mm. Braided and Carlsbad twinning are present. Some phenocrysts are extremely kaolinized. Plagioclase, where present, occurs in subhedral laths averaging .2 mm in size. Quartz averages about 20 percent of the thin sections, and is anhedral to interstitial in patches up to 1.4 mm. Undulatory extinction and the inclusion of some feldspar crystals indicates that the quartz has undergone stress and possibly some recrystallization. Biotite, along with its alteration products, is absent or much less abundant than in the previous samples.

More detailed thin section descriptions are found in Appendix A.

Dikes

Numerous dikes ranging in composition from felsic to mafic intrude the field area. All units are cross-cut by at least one type. Some dikes are ridge formers while others erode and crumble easily (Figure 11a). In the limestone, white, powdery altered zones over two feet thick have been formed along dike margins (Figure 11b). Breccia zones to three feet wide are common where dikes cut the quartzite. No dike-altered zones were seen in the stock or volcanics.

11a)

11b)

Figure 11. Dike outcrops.
a) Diorite dike (H-11) cross-cutting magnetite in the Blue Rose 1 north deposit.
b) White altered zone between monzonite dike (F-9), left, and limestone, right, in the Midnight cut.

All dikes are porphyritic. Phenocrysts of varying abundance are enclosed in aphanitic to fine-grained groundmasses. Thin section examination indicates that the groundmasses are composed of anhedral to euhedral feldspar microlites. Most dikes have trachytic to sub-trachytic textures.

Alteration of feldspars and mafic minerals has totally obscured some of the crystals. Consequently, the identification of some of the feldspars is questionable. Certain K-spars appear to be perthitic orthoclase, but the presence of similar crystals with well-developed microcline gridiron twinning again indicates that the 'microperthite' may be braided twinning. These crystals have been identified as microcline(?) in Table 2. The size of the microlites also hampered exact identification of the groundmass feldspars, unless albite or pericline twinning was visible. Questionable plagioclase percentages are also noted on Table 2.

On the basis of the thin section identifications, five types of dikes were recognized. Type 1 dikes are granitic in composition (Figure 12a). K-spar occurs as phenocrysts and in the groundmass. Plagioclase is scarce to absent and quartz comprises at least ten percent of the groundmass. Magnetite is the only mafic mineral and some is completely altered to hematite.

Type 2 dikes have more plagioclase and are therefore monzonitic in composition. Samples I-3 and I-9 are altered specimens from the quartz monzonite dike in the

Mineral	Estimated Volume Percent												
	I-7	I-14	I-3	I-9	F-3	F-9	J-1	O-7	H-11	D-13	D-23	E-10	E-28
K-spar (O= orthoclase; M=microcline)	75 O	54 M	25 O	46 M	28 M	40 M?	20 M?	25 M	10 M?	7 M?	21 M?	3 M?	--
%F-spar	88	100	34	65	35	42	27	27	11	8	22	3	0
Plagioclase	10?	0	49?	25?	53	55	55	69	80	85	74	91	64
Quartz	10	36	15	18	3	--	12	--	tr	--	--	1	--
Biotite	--	--	1	--	5	1	3	1	--	1	--	--	4
Magnetite Hematite	5	10	10	10	5 1	2	10	5	6 3	7	5	5	12 tr
Chlorite	--	--	--	1	1	2	tr	--	--	tr	--	--	tr
Aegirine-Augite	--	--	--	--	--	--	--	--	--	--	--	--	20
Muscovite	--	--	--	--	2	--	--	tr	--	--	--	--	tr
Calcite	--	--	--	--	2	--	--	--	--	--	--	--	--
Sphene	--	--	--	tr	--	--	--	--	--	--	--	--	--
Fluorite	--	--	tr	--	--	--	--	--	--	--	--	--	--
Type	1	1	2	2	2	2	3	4	4	4	4	4	5
Classification	Granite		Q.Monzonite		Monzonite		Grd.			Diorite			Gabbro

Table 2. Summary of thin section data for dikes. All samples are porphyritic.

12a)

12b)

12c)

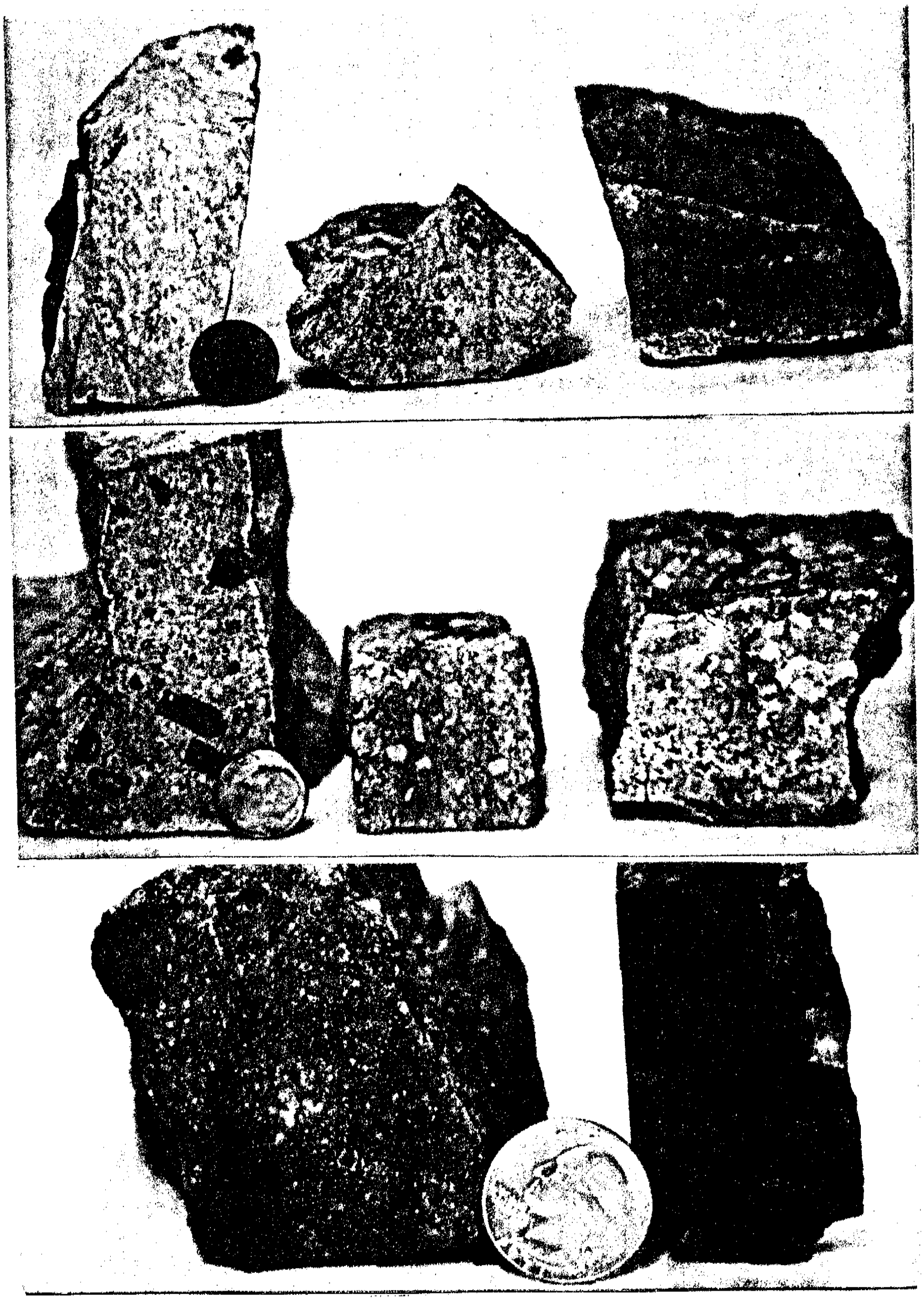


Figure 12. Dike rock examples.
a) Left and right: granite dikes (samples I-7 and I-14).
Middle: quartz monzonite dike (sample I-3).
b) Left: monzonite dike (sample F-9).
Middle and right: diorite dikes (samples H-11 and O-7).
c) Left: monzonite dike from a skarn-altered area (sample F-3).
Right: gabbro dike (sample E-28).

Blue Rose 1 south cut (Figure 12a). I-3 is mildly altered, while I-9 comes from the adjacent skarn zone. I-9 appears to have a much higher K-spar content, but it also has more phenocrysts. A hand sample description of the fresh dike, sample Z-3, is included in Appendix A.

Two other monzonite samples, F-3 and F-9, have little or no quartz (Figure 12b&c). Microcline is the dominant K-spar, and biotite and chlorite are present in addition to magnetite. Sample F-3 looks exactly like I-9 in hand specimen and is associated with the large skarn zone near the Midnight cut.

Dike Type 3, one of the least common, is a granodiorite. It has more quartz and less K-spar than the monzonites. Biotite is embayed by some of the phenocrysts and is altering to magnetite and chlorite.

Type 4 dikes are diorites that average 13 percent K-spar, 80 percent plagioclase and no quartz (Figure 12b). Some K-spars have inclusions or embayments of plagioclase. Most are extremely altered by kaolinization and are either perthitic orthoclase or microcline. All specimens have about five percent magnetite and may contain traces of biotite and its alteration products.

Type 5 dikes are dark grayish-green in hand sample, and may develop a slightly mottled appearance on weathered surfaces (Figure 12c). They have been classified as gabbro, and are composed of plagioclase (labradorite?), aegirine-augite and other mafic minerals.

Volcanic Rocks

A thick sequence of volcanic flows covers most of the central and southern portion of the field area. The flows unconformably overly the sedimentary formations and stock (?) and are reported to strike north-south and dip gently west (Smith, 1964). Field evidence shows that the flows post-date the Lone Mountain stock and predate the final stages of igneous activity. This indicates a tentative age of late Tertiary and may represent anything from late Miocene to early Pleistocene (Smith, 1964).

Smith (1964) described the unit as a sequence of extremely lenticular and variable beds of volcanic sediments, agglomerate, tuff and breccia interbedded with mudstone, sandstone, and shale. A 400 foot-thick section of the unit was measured and described in more detail from an exposure on Baxter Mountain, to the south.

In the map area, volcanics form anything from steep cliffs to flat-lying outcrops. Talus is abundant where outcrops are absent. A north-south zonation of rock types exists, which actually represents a crude cross section of the volcanic sequence. The northern-most (and highest in elevation) outcrops correlate with Smith's top, or youngest, unit. The southeastern outcrops are the older basal units.

The two basal units form the double-peaked hill (elev. 6919) in the southeast corner of the map. The lower-most unit (sample D-9) is a flow conglomerate composed of an aphanitic green matrix with oval, light pink limestone and flattened, maroon siltstone (Bernal Formation) clasts

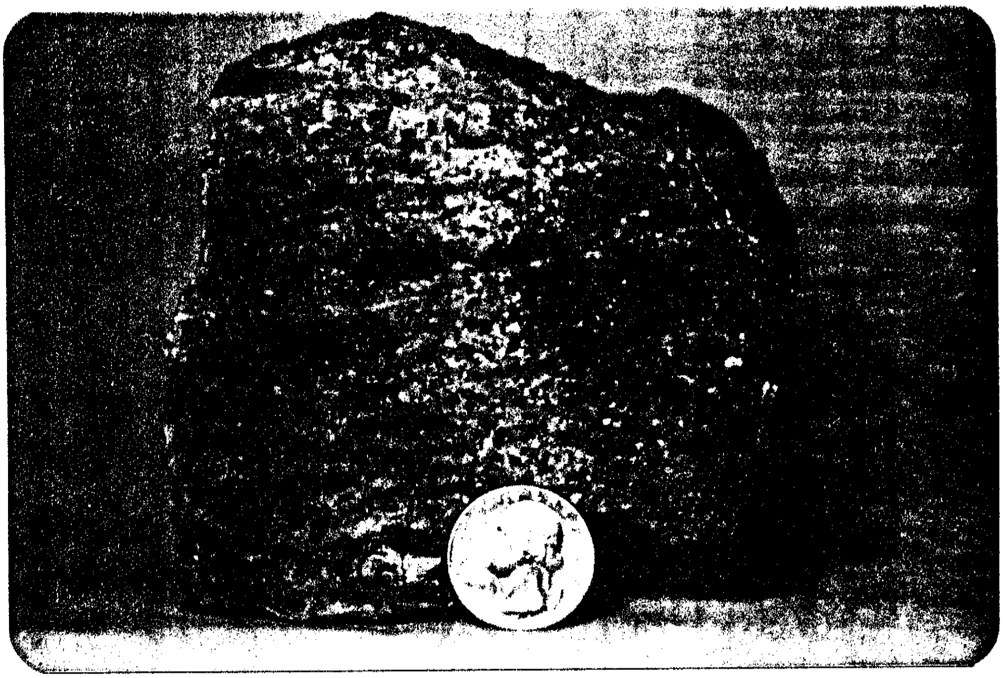
(Figure 13a). The clasts are oriented parallel to each other, which causes the flow structure. Cream-colored and bright orange alteration is formed around the clasts. Specular hematite comprises about five percent of the rock and occurs in patches and aggregates of needle-shaped crystals. Weathered rock surfaces are dark grayish-brown and pumiceous. A thin section of this sample showed the matrix to be mainly micrite, chlorite, and quartz.

The upper basal unit is a white, well-sorted, medium to coarse-grained quartzite. The quartzite was originally thought to be the basal sandstone of the Bernal Formation, but its physical characteristics are more like those of the basal volcanic unit. The presence of conglomerate near the northern base of the hill also supports this identification.

Pits D-18 and 20 are in quartzite and at D-21 pebble conglomerate is found around the surface (see Overlay 3.1 for locations). This indicates that the basal unit extends to the flat area northwest of the hill and that its upper contact is nearby.

Quartz grains in both thin sections are anhedral to subhedral; some are composite. Most show evidence of deformation and stress, such as fracturing and mild to extreme undulatory extinction. The quartzite contains about four percent interstitial magnetite which caused red (hematite) and yellow (limonite?) swirls of color upon alteration (sample D-4, Figure 8b). It is locally abundant with nodules or concretions of magnetite and hematite, which occur up to two inches in diameter

13a)



13b)

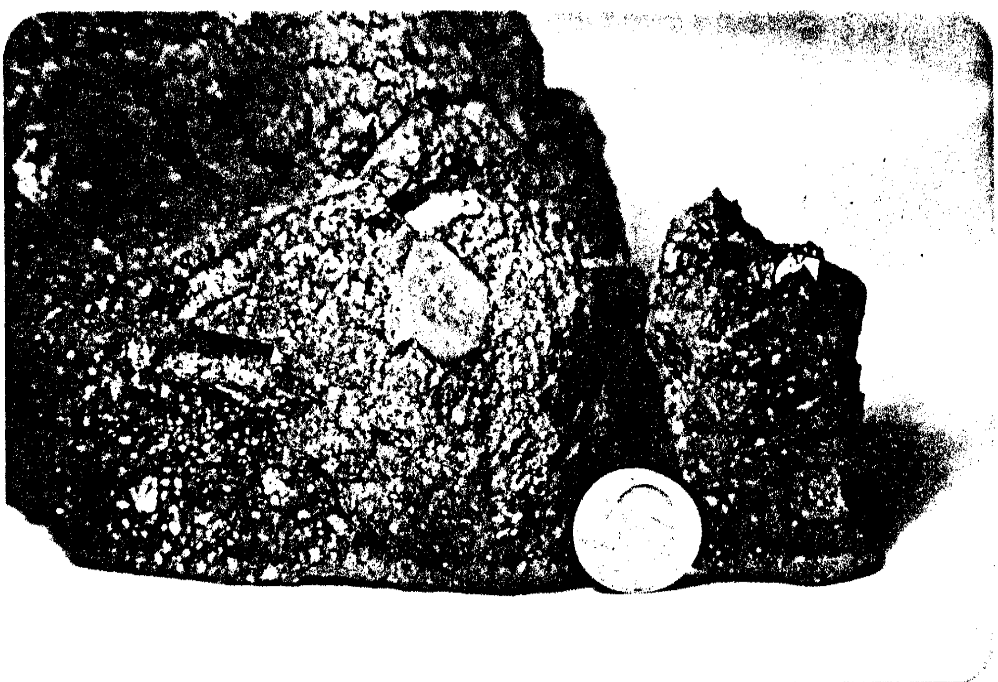


Figure 13. Volcanic rocks.
a) Basal flow conglomerate (sample D-9).
b) Latite-Andesite porphyry (sample S-7).

(sample D-7, Figure 19).

Overlying the basal quartzite (contact not seen) and limestone is a trachyte porphyry (sample B-7). The porphyry crops out rarely and is usually exposed in or near stream beds south of hill 7011. Where it overlies limestone, such as at G-2, the lower contact is conglomeratic with clasts up to one inch long.

The trachyte is light greenish-gray, amygdaloidal, and contains abundant euhedral sanidine and plagioclase phenocrysts. The oval amygdules have parallel orientation and are composed of magnetite. Both the phenocrysts and amygdules are less than or equal to .5 cm in size. Deuteric biotite and very small amounts of quartz are also present (Table 3). Ninety-five percent of the groundmass is composed of subhedral lath-shaped sanidine microlites, which form a quenched, trachytic texture. The rock weathers to a bright white or tan color. It appears tuffaceous or pumiceous due to rusting of the amygdules and weathering out of the feldspar phenocrysts.

Overlying the trachyte is a thick flow of latite-andesite porphyry. The andesite covers extensive areas on and around hill 7011. It is medium taupe-brown, weathers to grayish-tan, and is composed of an aphanitic groundmass and two types of feldspar phenocrysts (Figure 13b). The phenocrysts are abundant and can comprise up to 40 percent of the rock. The euhedral sanidine crystals are very conspicuous. They are salmon pink to light purple and frequently occur up to two cm in size. Carlsbad twinning is apparent even in hand

Mineral	B-7	[illegible]-7	S-2	U-1	U-2	T-1
			Estimated Volume Percent			
Sanidine	86	14	23	30	28	60
% total F-spar	92	19	35	50	46	71
Plagioclase	8	60	43	30	33	25
Quartz	2	--	--	25	34	--
Biotite	2	8	21	2	1	3
Magnetite	2	12	10	10	4	5
Sphene	--	4	3	--	--	2
Chlorite	--	--	--	3	--	--
Hornblende	--	2	--	--	--	2
CPX-Aegirine?	--	--	--	--	--	3
Classification (Hyndman, 1972)	Trachyte Porphyry	Latite-Andesite Porphyry		Quartz Latite Conglomerate		Trachyte Porphyry

Table 3. Summary of thin section data for volcanic rocks.

specimen. Inclusions of euhedral plagioclase and biotite are also common. White, lath-shaped plagioclase phenocrysts are euhedral to subhedral and to 1.5 mm in size. Albite, pericline, and Carlsbad twinning are usually well developed.

Mafic minerals constitute approximately 30 percent of the rock and are responsible for its brown color.

Biotite occurs in well-formed blades and laths and has been extensively altered to magnetite and sphene. Relic or skeletal biotite crystals are common. Some include or are embayed by plagioclase. Since both are included in the sanidine phenocrysts, it is evident that the plagioclase crystallized first, followed by biotite and then sanidine. Euhedral hornblende crystals are found in some specimens.

The groundmass is composed of plagioclase microlites with subordinate amounts of dusty magnetite and sanidine. The plagioclase laths are indistinct, but albite twinning was observed in some. Overall, the texture is trachytic and appears quenched.

Overlying the latite-andesite porphyry are two conglomeratic units. Both have a quartz latite matrix, or groundmass, but one type is black and the other is cream to light gray colored. The black type (sample U-1) contains numerous pink, angular to subangular lithic fragments, up to 3.5 cm in size. Some xenoliths of monzonite, greater than 8 cm in size, are included (Figure 14). The matrix is composed of roughly equal amounts of sanidine, plagioclase, and quartz microlites. Magnetite, and biotite altering to chlorite

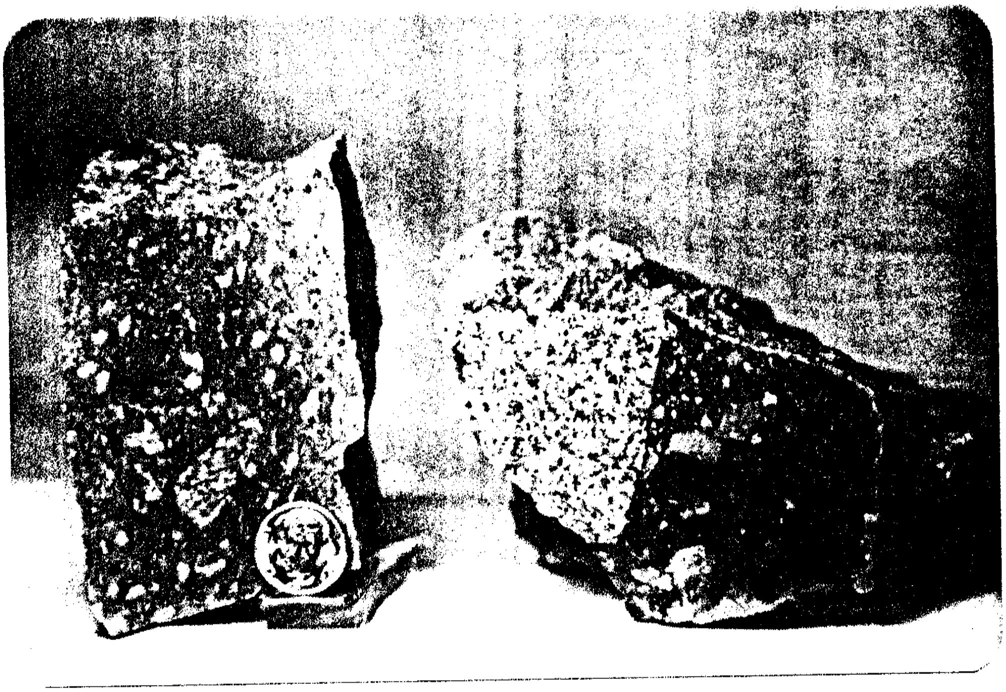


Figure 14. Rocks from the upper volcanic units.
Left: trachyte porphyry (sample T-1).
Right: black conglomeratic latite unit (sample U-1) with xenolith of altered monzonite (similar to sample L-1).

comprise about 15 percent.

The cream-colored conglomerate (sample U-2) has red, subrounded lithic fragments to 1.5 cm. Its matrix is similar to the previous type but is slightly coarser grained, has more quartz, and less biotite and magnetite.

The uppermost volcanic unit is a trachyte porphyry (bordering on latite). It is medium purplish-red to pinkish-tan in color, with white feldspar and mafic phenocrysts (sample T-1, Figure 14). Zoned, subhedral sanidine phenocrysts to 1.7 cm include plagioclase and biotite crystals. Plagioclase phenocrysts are subhedral to euhedral with extensively altered rims. The laths occur to 2 mm in size and exhibit pericline and albite twinning.

Mafic minerals again constitute about 15 percent of the rock. Biotite is altering to euhedral sphene and magnetite. Hornblende is altering to aegirine(?).

The groundmass is intensely altered and stained, but some small euhedral plagioclase laths and sanadine crystals were seen.

The trachyte contains angular xenoliths, or inclusions, of monzonite porphyry (stock). Boulder-sized inclusions up to two feet wide are present. This would indicate a close proximity to the source of the flow.

Metamorphic Rocks

Quartzite

Quartzite covers much of the southeastern portion of the map area and has already been discussed in the sedimentary and volcanic rock sections.

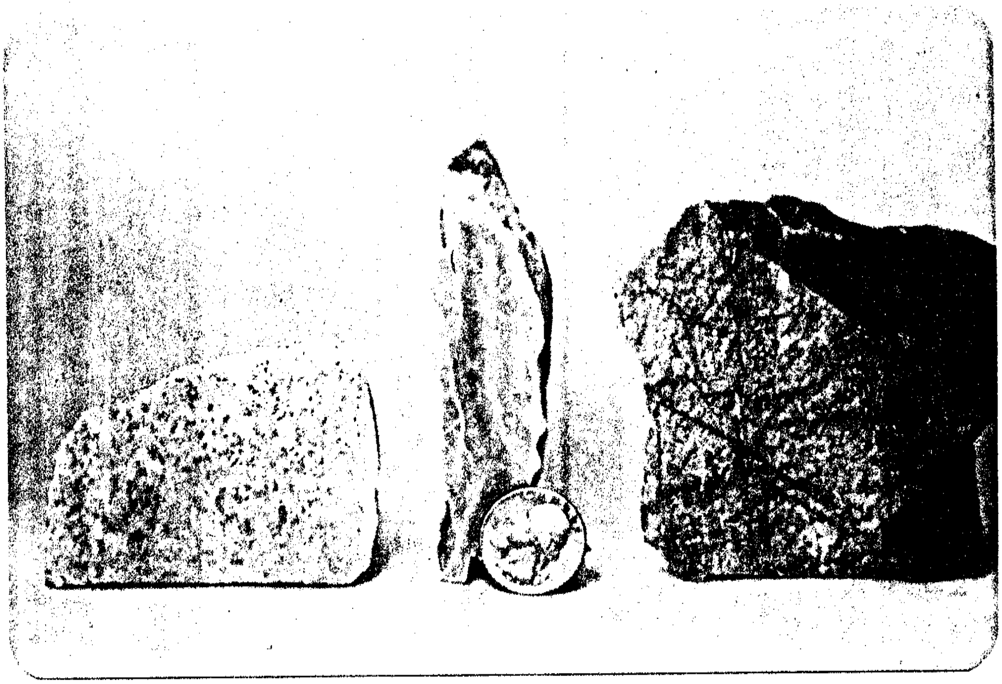
Marble

Marble is present is at least three places and is the product of limestone alteration. Since the marble is always found adjacent to a magnetite bed or pod, it is reasonable to assume that the heat of the mineralizing fluids caused the metamorphism.

The most extensive marblization has occurred at the Midnight deposit. The limestone forming the hanging wall of the ore zone has been altered to a coarsely crystalline marble. The marble is light greenish-gray and weathers to sparkly light gray, or tan and white like the unaltered limestone (sample E-32, Figure 15a). It is mainly composed of recrystallized and fractured interlocking grains of calcite. Magnetite comprises about seven percent and occurs as interstitial to anhedral grains .2 mm in size. Some of the magnetite is altering to hematite.

The marble found in pit E-10 is medium to light gray with cross-cutting brown veinlets (sample E-13, Figure 15a). The calcite grains are finer than in the previous sample. Most have dusty magnetite inclusions, and some are being altered by sericite(?). Magnetite also occurs in veinlets and small anhedral grains, and constitutes four percent of the rock.

15a)



15b)

Figure 15. Marble samples and skarn intrusion.
a) Marble rock samples (left to right: samples E-32, I-5, and E-13).
b) 'Bed' of diopside skarn in quartzite. The notebook is eight inches long.

Forsterite marble is exposed in the Blue Rose 1 south cut (sample I-5, Figure 15a). It is light gray, weathers light gray or white, and contains vague laminations of darker and lighter color. The calcite occurs in recrystallized anhedral to subhedral grains or grain aggregates and is turbid in appearance due to brownish-gray alteration. Some of the larger crystals have recrystallized or grown around the olivines. The forsterite comprises ten percent of the marble. The crystals are euhedral to subhedral and occur to 1.3 mm in size. Some are twinned or have overgrowths. Most are fractured and/or intensely altered. Magnetite constitutes one percent and occurs as small anhedral grains or as fracture fillings or inclusions (alteration?) in the olivine.

Diopside Skarn

'Beds' and zones of diopside skarn are commonly found adjacent to or near the magnetite deposits. Quartzite is the most extensively altered or intruded rock type since free quartz is abundant. Dikes in the skarn zones are also altered.

The largest area of skarn alteration is near the Midnight deposit. A dike-like mass of almost pure diopside (sample A-3) has intruded the quartzite and is exposed in the road cut approximately 120 feet south of the deposit (Figure 15b). The dark green, coarsely crystalline skarn is three feet wide and dips 24 degrees south in the cut. The 'bed' is quite extensive and can be traced along strike for 250 feet. The quartzite surrounding the skarn has been extensively altered. White, powdery bleached zones are present along the skarn's upper and lower contacts. Beyond the bleached zones, diopside impregnates the quartzite (sample F-18, Figure 16). Its concentration decreases with distance from the skarn. The area affected by this skarn alteration is about 70,000 square feet. In the magnetite bed a few one to two inch long, lime green crystalline skarn pods are present.

In the southeastern portion of ABD-2, skarn is found adjacent to a small magnetite bed. The skarn is present in light green crystalline form and as olive green altered limestone (sample E-22, Figure 16). The deposit is at the limestone/quartzite contact.

In the Blue Rose 1 south cut, skarn is found in the limestone at the ore zone contact. The skarn is light green, finely crystalline, and impregnated and veined with magnetite (sample I-13, Figure 16).

The monzonite porphyry appears to be resistant to skarn alteration. Where the two come in contact, the boundary is sharp (over 1 mm), with just a few diopside crystals forming in the monzonite (sample S-4, Figure 10b).

Figure 16. Skarn samples.
Left: altered quartzite (sample F-18).
Middle: altered limestone (sample E-22).
Right: skarn with magnetite (sample I-13).

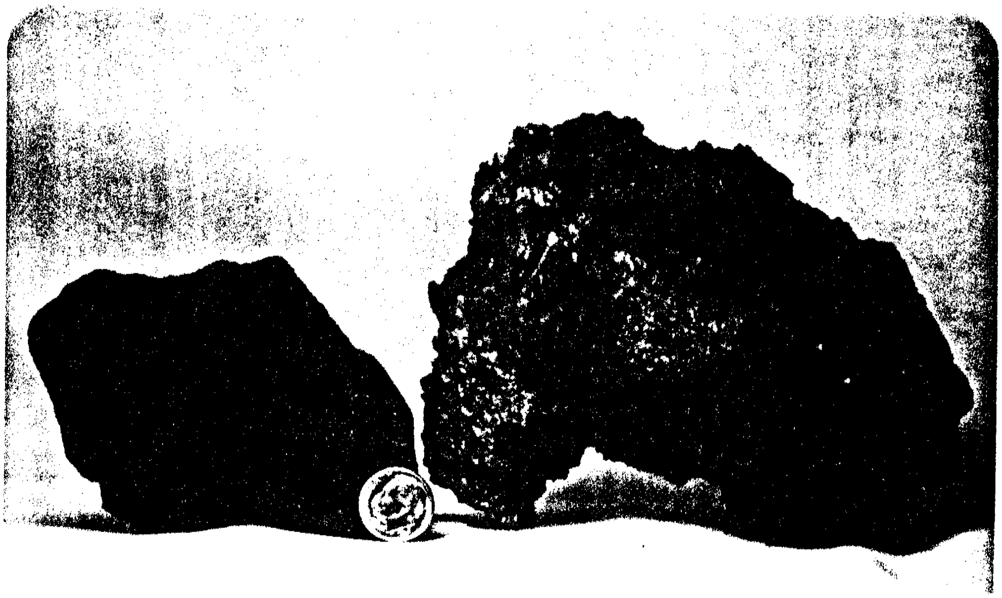
Magnetite Mineralization and Occurrence

Magnetite mineralization in the form of lenses, beds, or pods, occurs locally in the field area, and is the result of contact or metasomatic replacement of the host rocks. The major deposits are on the Black Knight, Midnight and Blue Rose 1 claims. Location of the mineralization is a function of structural and stratigraphic control. All of the deposits are located at either the intrusive/sedimentary contact or the quartzite/limestone facies boundary. Dikes and/or breccia zones are present in all deposits.

Typical ore from the igneous/sedimentary deposits is aphanitic to fine-grained, massive, and very dense (sample H-14, Figure 17a). Specular hematite appears to be present in small amounts. Ore formed in the sedimentary beds is laminated, parallel to bedding, with calcium carbonate (Figure 17b). Unreplaced pods and patches of calcium carbonate are also present. Microfractures may parallel, or cross-cut and displace the laminae. Most have been filled with calcite. Weathered ore of both types appears lateritic(?) and is much less dense (sample E-30, Figure 17a). Oxidation produces rust-colored surfaces, and coatings of magnetite crystals are sometimes present.

Thinly bedded and laminated magnetite is found in places on the Black Knight claim. Sample Q-1 is bedded with a light gray mineral, and has chalcopyrite and phlogopite on its weathered surface (Figure 18a). Sample O-8 is laminated with very pale green to cream-colored diopside and contains small amounts of muscovite (Figure 18b). The northern part

17a)



17b)

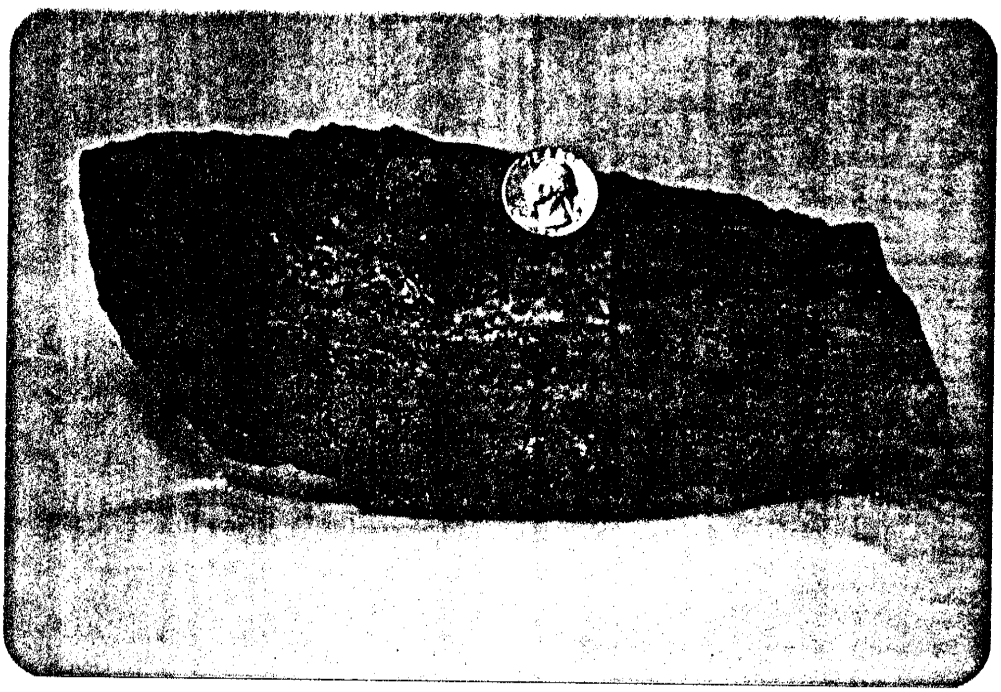
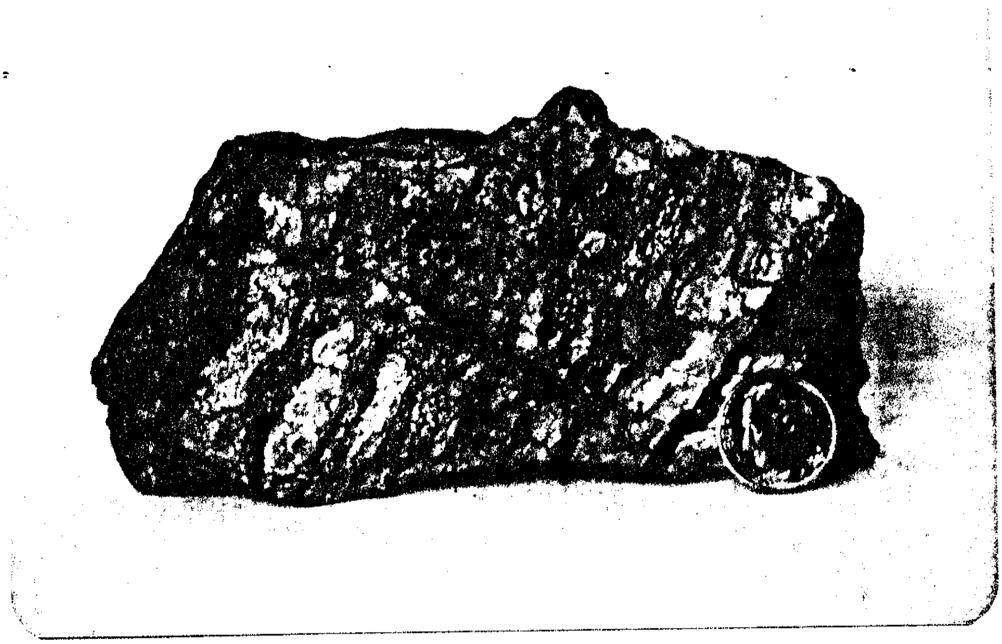


Figure 17. Magnetite ore.
a) Left: aphanitic ore from the Blue Rose 1 claim (sample H-14).
Right: typical weathered appearance.
b) Ore, laminated with calcium carbonate, from the Midnight deposit (sample E-30).

18a)



18b)

Figure 18. Banded and veined magnetite.
a) Thinly bedded magnetite (sample Q-1).
b) Left: magnetite laminated with diopside (sample O-8).
Right: magnetite veinlets in monzonite (sample S-6).

of the massive Black Knight ore is conspicuously micaceous, and pieces with muscovite-encrusted surfaces can be found (sample O-2, Figure 19).

Almost every rock in the field area contains some amount of magnetite. In the limestone it is finely disseminated and abundant. The monzonite usually contains small scattered crystals, but veinlets may also form (sample S-6, Figure 18b). Nodules of magnetite are found locally in the volcanic basal quartzite unit (sample D-7, Figure 19).

Ore samples from the major deposits and magnetite from the nodules and limestone were analyzed for iron content and trace metals (Table 4). The ore samples average 57 percent iron. Pure magnetite contains 72.4 percent iron, so some impurities are present. Trace amounts of copper are found in all samples and silver is present in most.

The values for the nodules (D-7) are artificially low due to the nature of the sample. Some quartzite was crushed along with the nodules, and was not separated due to the paucity of sample. Values for the pure magnetite would probably be doubled. Even in its unconcentrated form, this sample is the only one to contain more than trace amounts of gold, silver and copper.

The limestone sample was only tested for iron and copper, since enough magnetite for a fire assay could not be separated with the available equipment. Prior to magnetic separation, the limestone was crushed and dissolved in hydrochloric acid.

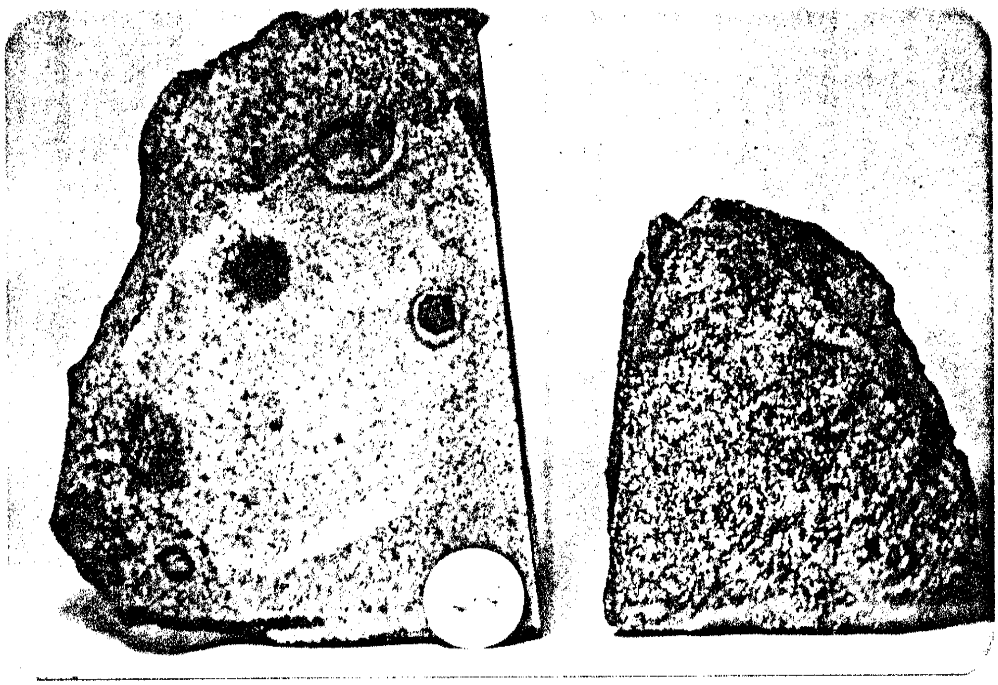


Figure 19. Other occurrences of magnetite.
Left: nodules of magnetite in quartzite (sample D-7).
Right: micaceous magnetite (sample O-2).

		%		oz/ton		
Sample	Description / Claim	Fe	Cu	Pt	Au	Ag
N-2	ore/Black Knight	61.20	<.03	0	0	.10
E-30	ore/Midnight	50.00	<.03	0	trace	.08
H-1	ore/Blue Rose 1 -north cut	59.40	<.03	0	0	0
H-14	ore/Blue Rose 1 -south cut	57.60	<.03	0	trace	.68
D-7*	nodules/ABD-7	16.72	<.03	0	.04	.10
F-8	limestone/ Midnight	4.36	1.16	---	---	---

*artificially low values--see text

Table 4. Summary of magnetite geochemical data. Iron and copper values from Atomic Absorption Spectrometry; gold, silver, and platinum from fire assay.

MAGNETIC SURVEYS

Five magnetic surveys were conducted in the study area. Two general surveys, the east and west, were run along the presumed igneous/sedimentary contact. These were done in order to locate any concealed or as yet unknown deposits. Three detailed surveys were conducted over the major deposits to help delimit the extent of ore, and thus determine ore reserves. Details of the survey procedure have been discussed in the Geophysical Methodology section.

The basic premise for this type of survey is that magnetic ores will create local anomalies in the natural field of the earth. The total magnetic intensity, measured in these surveys, is the sum of the earth's geomagnetic field strength (50,000 gammas in this region) and the local anomalies. The earth's field (background) is subtracted from the readings, and the resultant values are attributed to local geology.

Rocks will have magnetic intensities related to their magnetite content and magnetic susceptibility (k). Igneous rocks have the highest k and usually the most magnetite, while sedimentary rocks have the lowest. For this reason, it was presumed that the contact between the monzonite ($k=4200 \times 10^{-6}$ cgs) and the limestone ($k=23 \times 10^{-6}$ cgs) would be detected on the east and west profiles (k values from Dobrin, 1976). Unfortunately, this was not the case. Profiles across the exposed contact, such as 3000E, turned out almost perfectly flat (see Appendix B). There are two possible explanations for this. Since the limestone in this area has an unusually high magnetite content, its magnetic intensity may be heightened to the order of the monzonite's. More likely, since the stock's margins are not necessarily vertical, it may underly the limestone near the contact. This would definitely explain the equivalent values or low curve gradient, since basement rocks are detectable even through great thicknesses of sediments.

Since the differences in country rock lithology produced no change in magnetic values, it is assumed that any variation can be attributed to magnetite mineralization. The only exception appears to be where certain dikes are present.

Equations for the calculation of anomalies over various magnetic bodies are available, but will not be dealt with here. In this study, qualitative analysis is used for interpretation. Anomalies over the magnetite bodies are on the order of thousands of gammas. Near the margins of the bodies, negative values are frequently recorded. General guidelines for the interpretation of profiles relate the magnitude and shape of the curves to orebody characteristics. The magnitude of the anomaly is high for large or shallow bodies and decreases with decreasing size and increasing depth of burial. Sharp anomalies also indicate close proximity to the surface, while broader curves indicate deeper bodies. Curves are symmetrical over vertical bodies and will skew with increasing dip.

In relating these curves to contour maps, it can be seen that the numbers of contours indicates size and depth, the proximity or concentration of contours also indicates depth, and the spacing of contours relates to dip.

The east magnetic survey contour map is shown in Figure 20. The large ore deposit on the Black Knight claim shows up quite clearly, along with the smaller one to the south. A possible ore zone is indicated on the Clarita 2 claim. Its existence is substantiated by a previous survey in the area, which indicates a deposit to the west, at the intersection of the Black Knight, Lone Mountain 2 and Clarita claims. Another area of interest is the southeast corner of Lone Mountain 2. But, since mafic dikes and the volcanic contact are in the immediate vicinity, it is doubtful that the anomaly is produced by a magnetite orebody.

The west magnetic survey (Figure 21) was actually conducted over the igneous/volcanic contact north of profile 6250W (see Plate 4). Since previous maps showed the San Andres in the area enclosed by the 250-3000W baseline, it was originally thought that the sediments extended up to this point. No sediments (or anomalies) were found, however, so this portion of the survey can basically be ignored. The two NNE-trending anomalous areas in the southern part of the map are the exposed Blue Rose 1 south and north deposits. The readings of the southernmost profile, 8500W, still show fluctuation, but since numerous diggings and pits immediately to the southwest of the claim showed no ore, the survey was terminated.

Contour maps of the detailed surveys are included under their respective deposits in the following section.

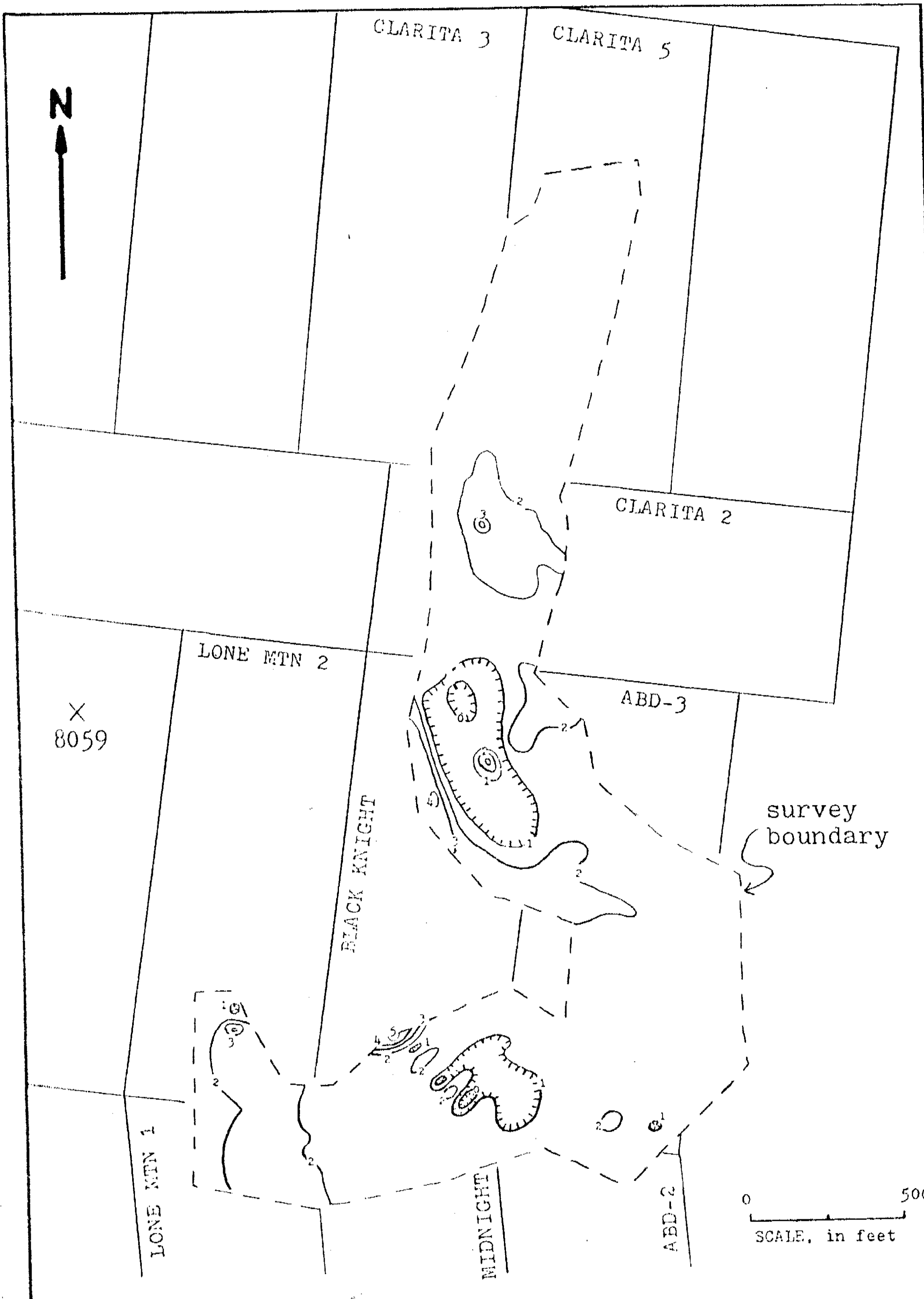


Figure 20. East magnetic survey contour map.
Scale = 1:6000
Contour interval = 1000 gammas
Contours are in 10^3 gammas

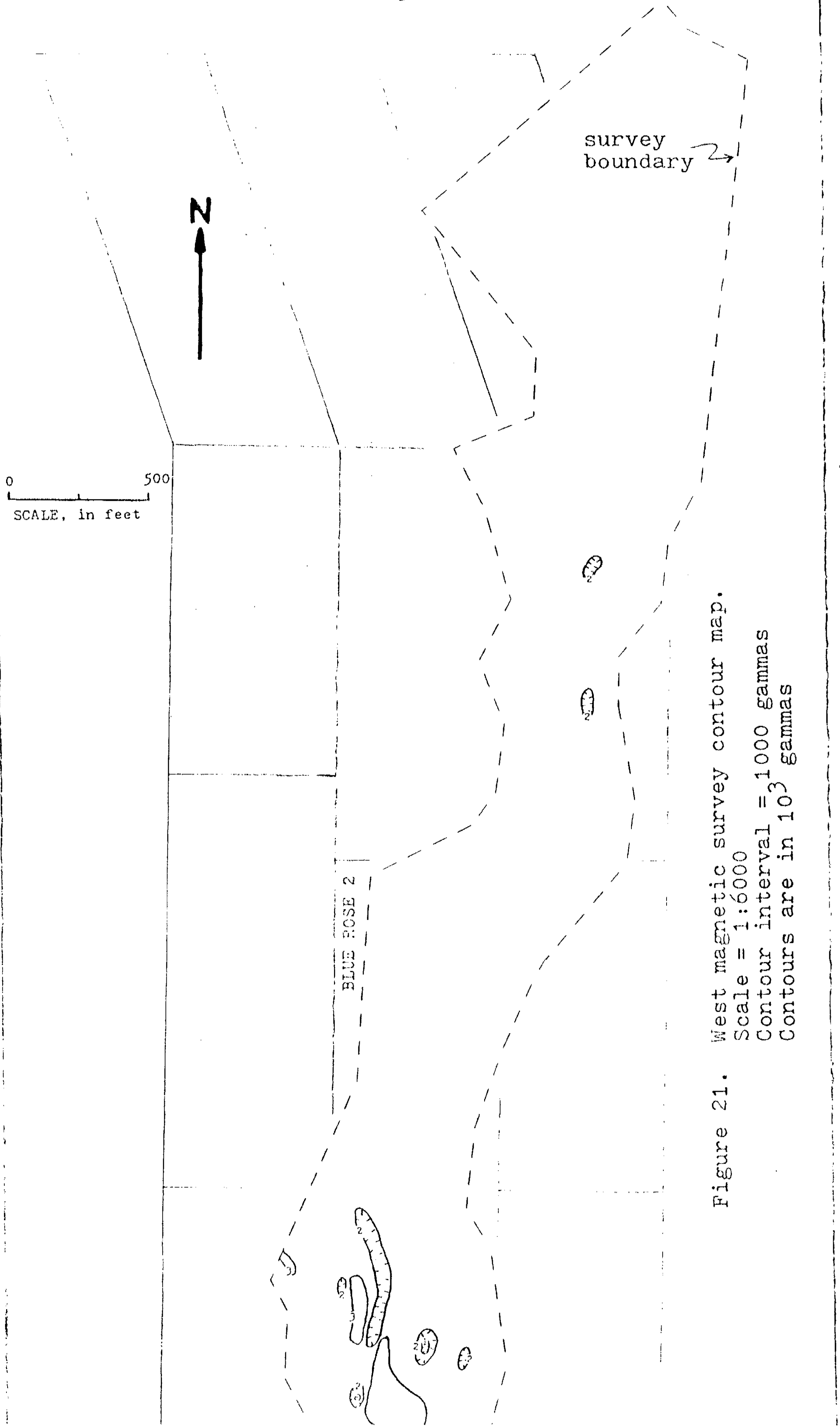


Figure 21. West magnetic survey contour map.
Scale = 1:6000
Contour interval = 1000 gammas
Contours are in 10^3 gammas

ORE DEPOSITS

Black Knight Claim

Geology

The major deposit on the Black Knight claim is located near the head of a gulley, at the monzonite/limestone contact. A lens and pod of magnetite originate at the approximately north-south contact and strike westward into the stock (Figure 23). Magnetic contours suggest a large, shallow body may be present from stations 50S to 50N (Figure 22).

Cross section A-A' (Figure 24) [illegible] along a [illegible] [illegible] shows the nature of the [illegible] [illegible] the bodies. The magnetite lens, exposed on the south, averages three to four feet of true thickness and dips steeply south (Figure 25a). The pod appears as two separate beds in cross section. The south bed, or limb, dips steeply north, varies in thickness, and is surrounded by limestone breccia in the area of the section (Figure 25b). The breccia (sample O-1) is composed of light gray, flattened clasts in a white calcium carbonate matrix. The negative magnetic anomalies (see Figure 22) may correlate with this breccia. The north limb of the magnetite pod dips steeply south and averages 20 feet of true thickness where exposed. The large magnetic anomaly over the pod suggests that the limbs join and thicken under the thin monzonite cover. The bowl-shaped pod pinches out at its east and west ends and presumably with depth.

A smaller deposit is located in the southern quarter of the claim. Here, two partially weathered ore beds are

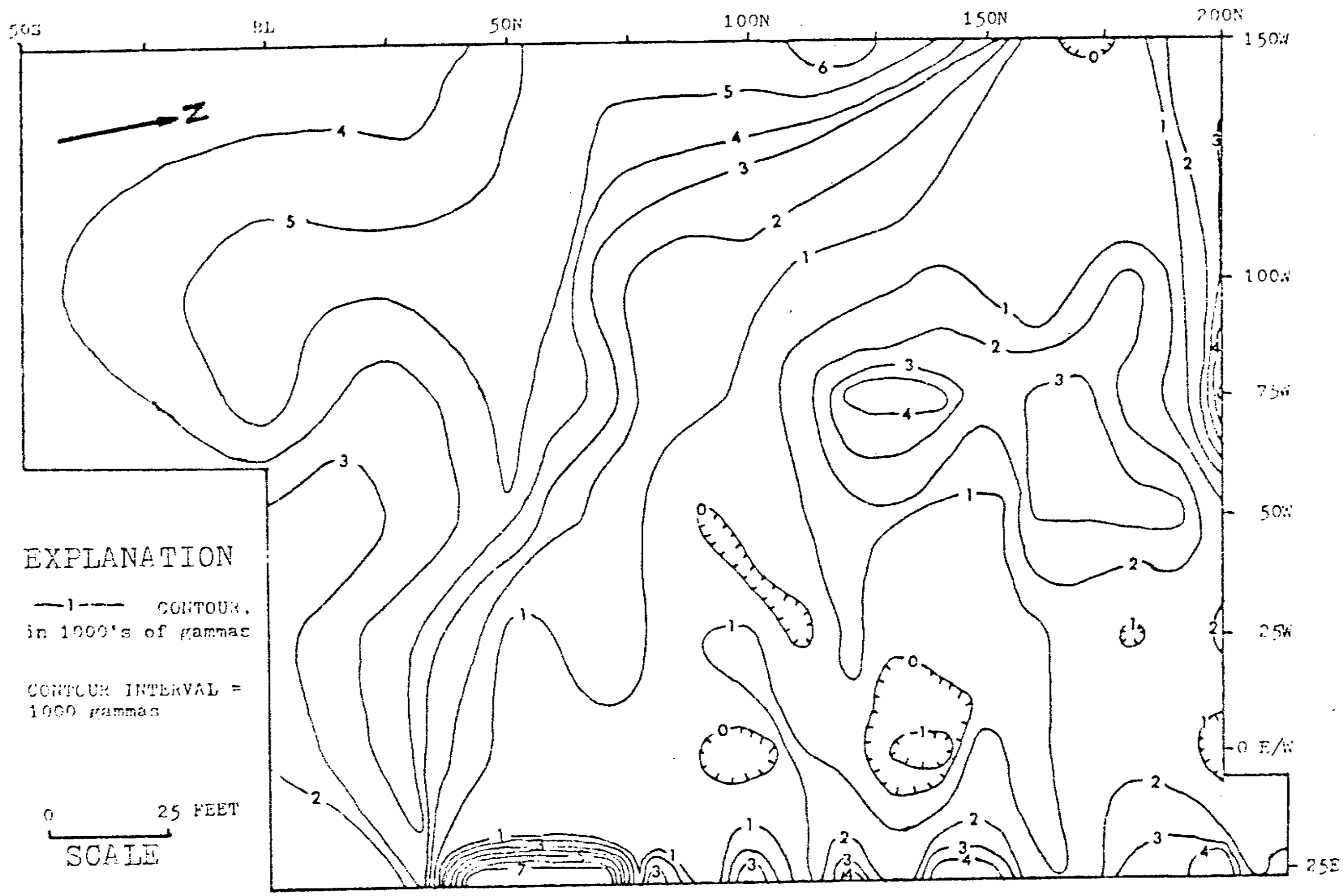


Figure 22. Black Knight magnetic survey contour map.

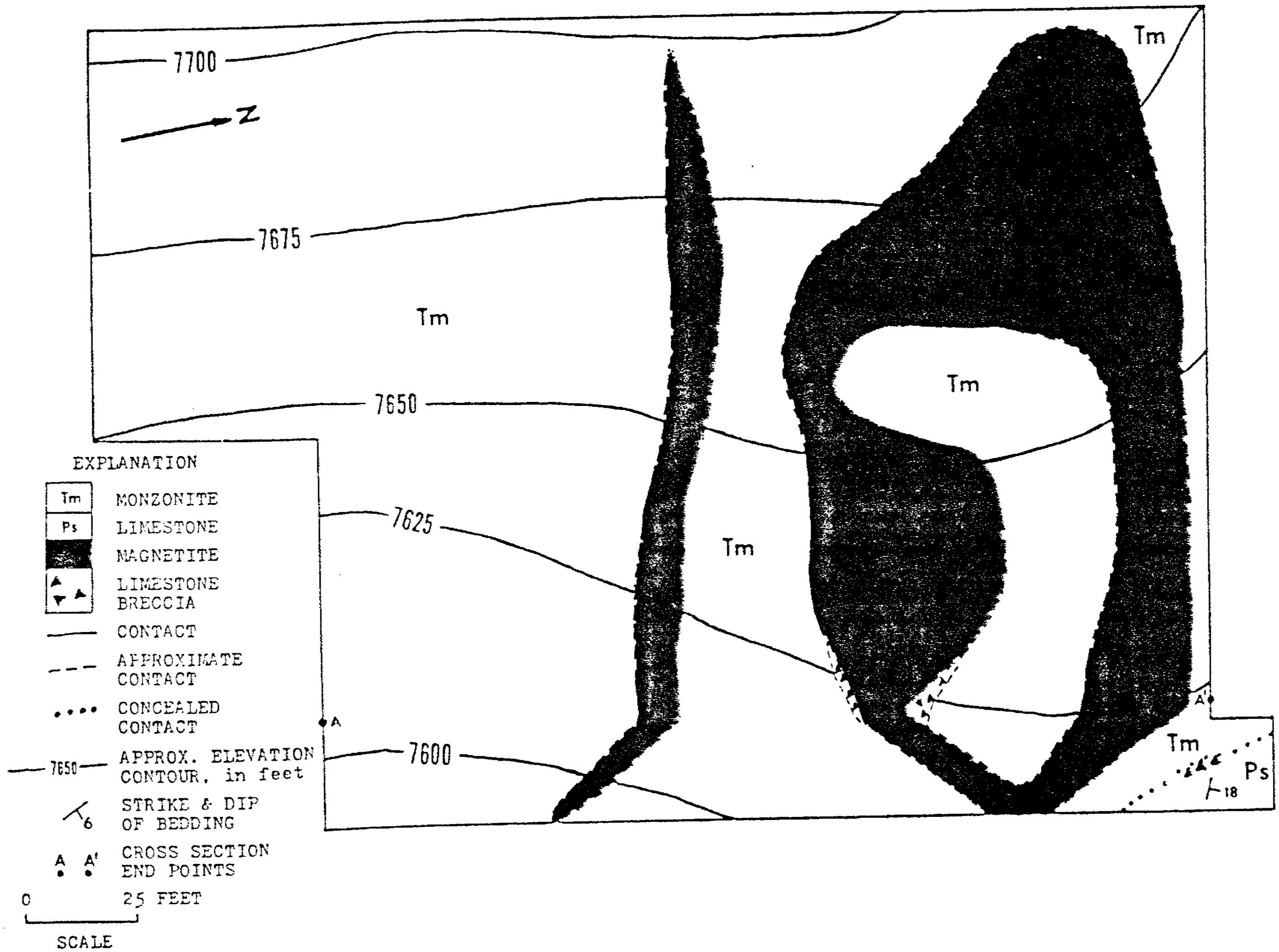


Figure 23. Sketch map of the Black Knight deposit.

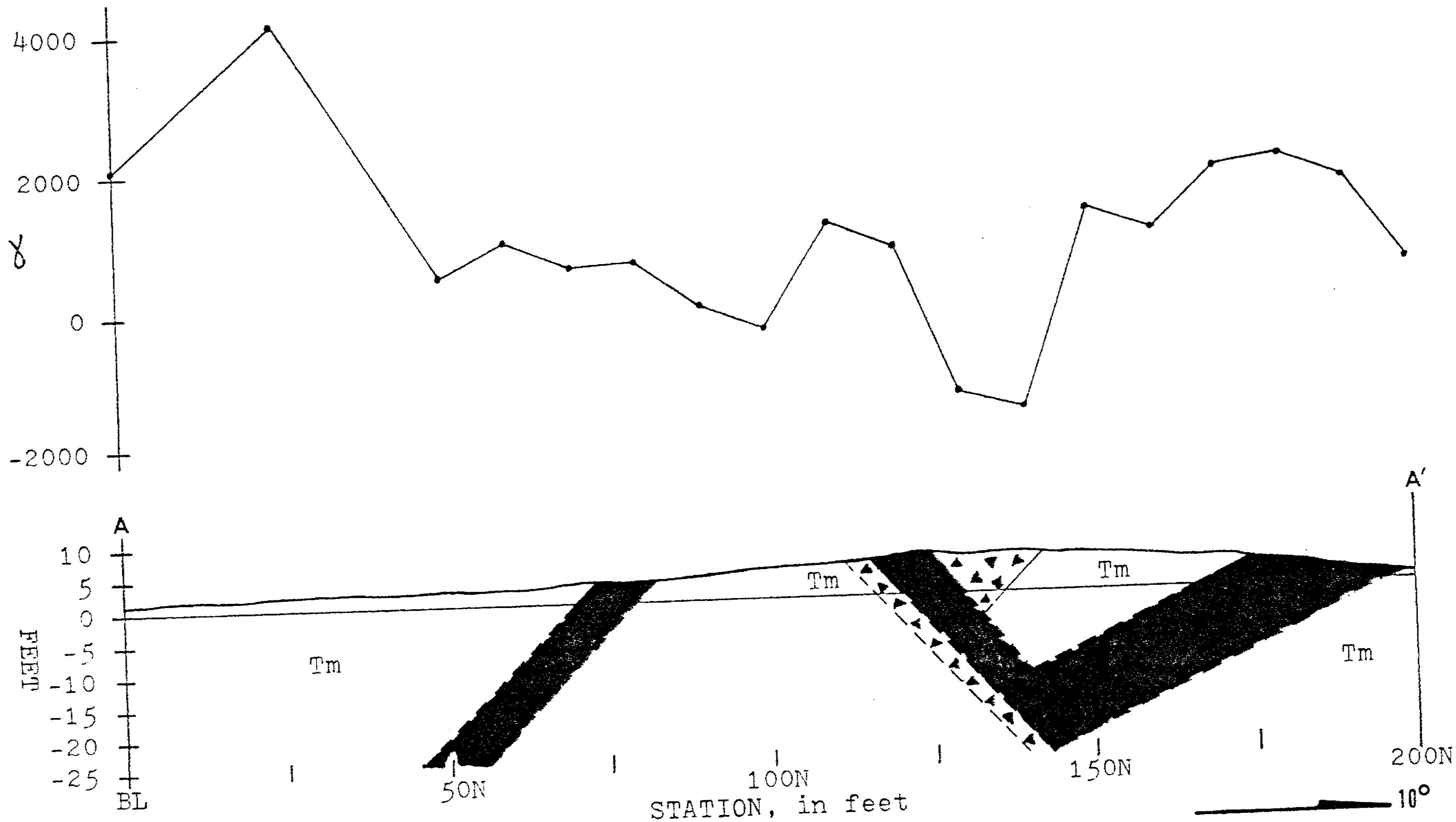


Figure 24. Cross section A-A' and corresponding magnetic profile, 0 E/W. See Figure 23 for explanation.

a) b)

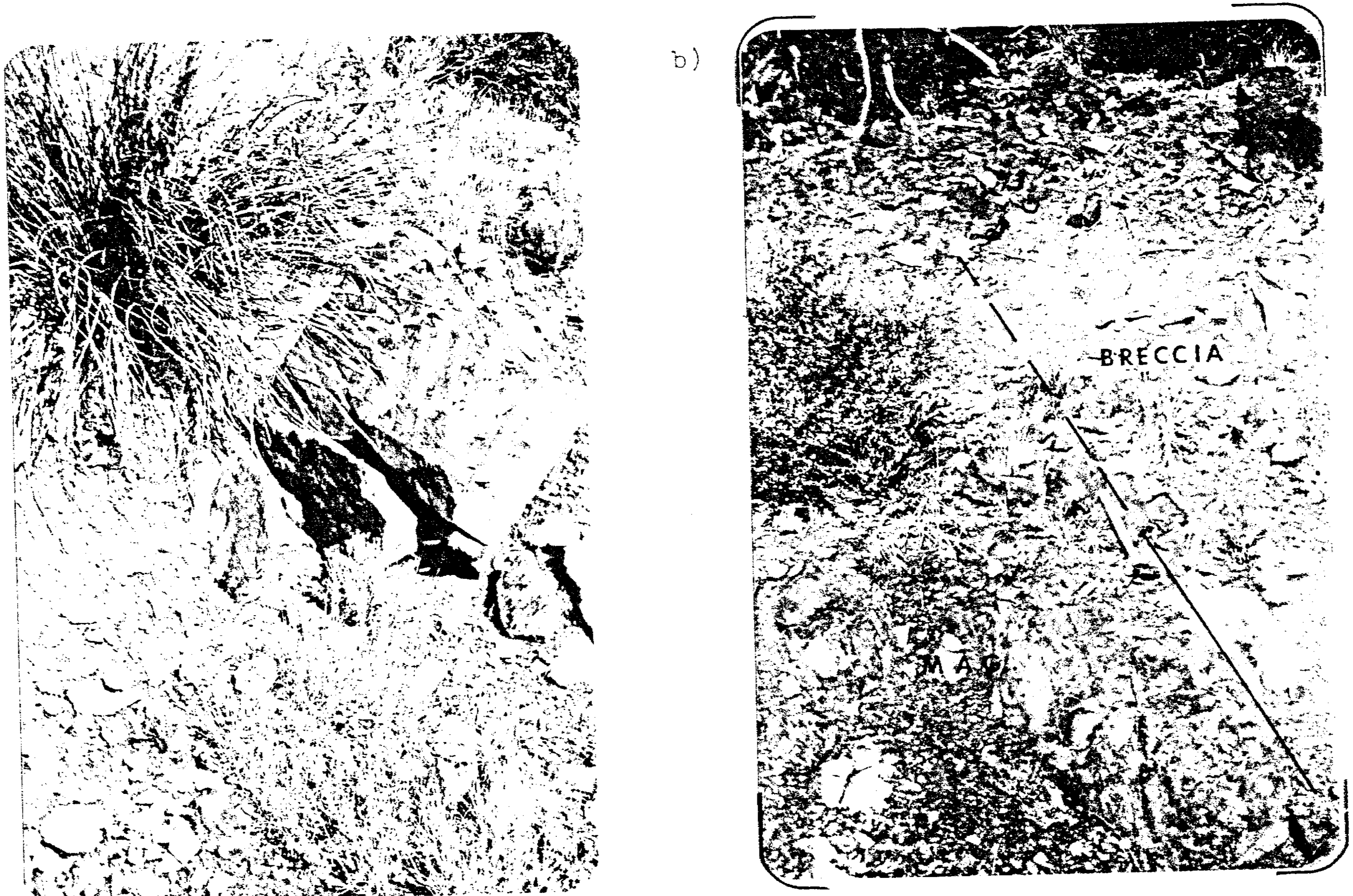


Figure 25. Photos of the Black Knight deposit.
a) Magnetite lens exposed at cross section A-A'. The lens is three to four feet thick.
b) South limb of the magnetite pod, left, in contact with breccia, right. The hammer is 14 inches long.

exposed in the road cut. One bed is also exposed below the road in a trench. The beds strike northwest and are contained, where exposed, in the soil zone above the monzonite/limestone contact. The western bed is three feet thick and dips 30 degrees east in the road bank (Figure 26a). The eastern bed averages four feet thick and dips 63 degrees east. The upper contact of this bed is exposed in the trench and consists of massive magnetite overlain by monzonite and magnetite cobbles in a gouge matrix (Figure 26b). Skarn-altered monzonite is found approximately 25 feet west of the magnetite beds.

Reserve Estimates

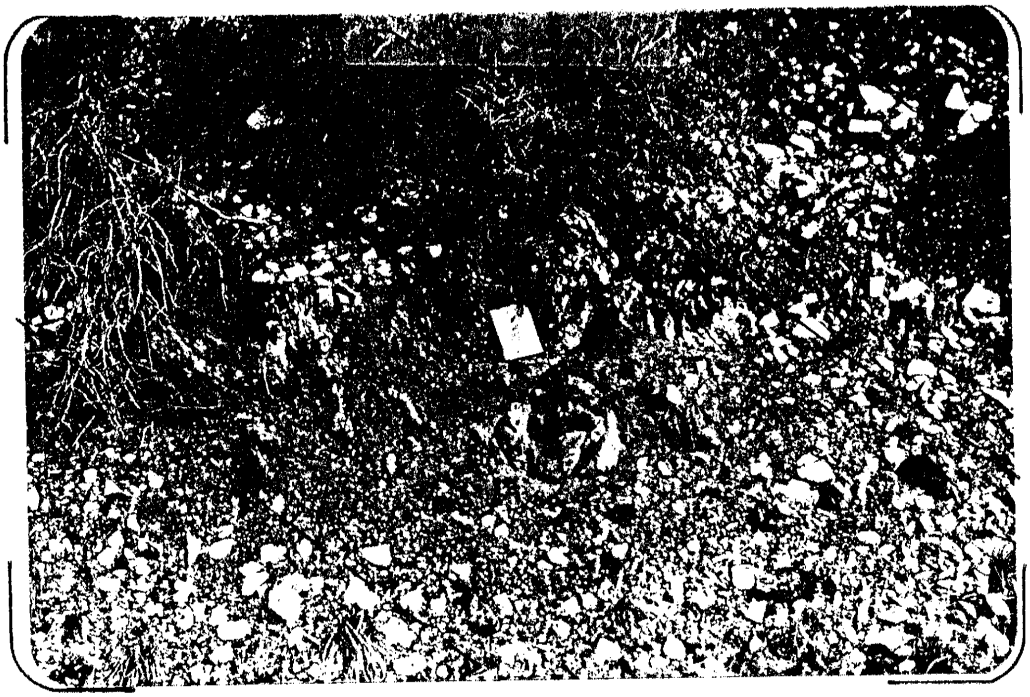
Main deposit: The true depth of the ore bodies is not known, but Sheridan (1947) stated that the magnetite is at least 20 feet deep. Field mapping suggests that the ore depth may be 25 to 50 feet. Therefore, a conservative estimate of 25 feet is used in these calculations.

Outcrop area of the magnetite lens, measured from Figure 23, is 1200 square feet. This accounts for a body 175 feet long, averaging almost 7 feet wide. Assuming the lens is 25 feet deep, its volume is 30,000 cubic feet.

The volume of the pod is calculated from its average north-south cross sectional area. Profiles of the pod, calculated to 25 feet of depth, were drawn at 25 foot intervals. The average area of these cross sections is 714 square feet. Over a length of 175 feet, the volume of the pod is then 125,169 cubic feet.

The following calculations are for the combined volumes

a)



b)

Figure 26. Black Knight south deposit.
a) Western magnetite bed, exposed in the road bank. The scale is 8 inches long.
b) Eastern magnetite bed in contact with unconsolidated breccia along its upper surface.

of the lens and pod:

Total volume: 30,000 + 125,169 = 155,169 cubic feet (cf)

Tonnage: 155,169 cf X 0.156 ton/cf* X 0.845**

= 20,454 tons ore

Amount iron: 20,454 tons X 61.2% Fe = 12,518 tons

Amount silver: 20,454 tons X .1 oz/ton Ag = 2,045 ounces

---

* tonnage factor for pure magnetite: 311.8 lb/cf X 1 ton/2000 lbs = 0.156 ton/cf

** weight factor: ratio of percent iron this sample to percent iron in pure magnetite (see Appendix C)

South deposit: This reserve estimate is for two beds, with a combined width of seven feet. The length of the beds is estimated at 300 feet, from magnetic profile 750E (see Figure 20). The depth of the ore is at least 25 feet. Ore samples from these beds were not tested. Since the deposit is located midway between the Midnight and main Black Knight deposits, the average values from their assays are used in the following calculations:

Total volume: 7 ft X 300 ft X 25 ft = 52,500 cf

Tonnage: 52,500 cf X 0.156 ton/cf X 0.768

= 6,290 tons ore

Amount iron: 6,290 tons X 55.6% Fe = 3,497 tons

Amount silver: 6,290 tons X .09 oz/ton Ag = 566 ounces

Total estimates for the Black Knight claim are: 26,744 tons of ore; 16,015 tons of iron; and 2,611 ounces of silver. See Appendix C for notes on ore reserve estimates.

Midnight Claim

Geology

The Midnight deposit consists of a lens of magnetite, formed along the contact between the quartzite and limestone horizons of the San Andres formaion (Figure 28). The ore was formed by limestone replacement and parallels the limestone bedding.

The limestone (sample F-8), which forms the hanging wall of the orebody, strikes NNE and dips ESE. The beds average three to five feet thick and contain a few shale lenses. The fresh limestone alternates with beds of marble (sample E-32). The marble is more thinly bedded and directly overlies the ore to the south (Figure 29). Both the limestone and marble are cross-cut by a large monzonite dike (sample F-9). The dike is about 20 feet thick, dips steeply northeast, and has formed three foot thick altered zones where it contacts the carbonates.

The contact between the magnetite and limestone is transitional. Between the ore and unaltered limestone is a zone of partially replaced limestone (Figure 30a). On the north side of the deposit this zone is six inches thick (Figure 30b). The nature of this type of replacement is seen on a smaller scale in the ore itself. The ore is laminated with and includes pods and lenses of calcium carbonate (Figures 31b and 17b). The high amount of calcium carbonate in the ore accounts for its relatively low iron content (see Table 4).

The contact of the magnetite with the underlying

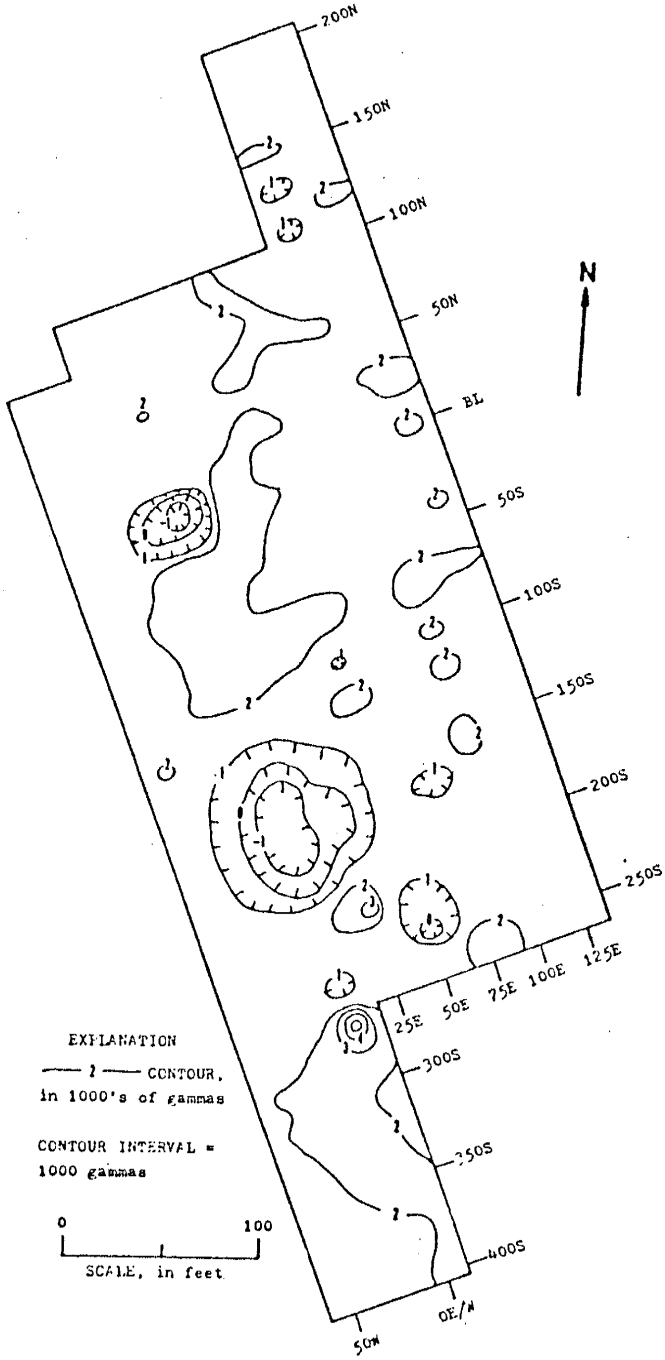


Figure 27. Midnight magnetic survey contour map.

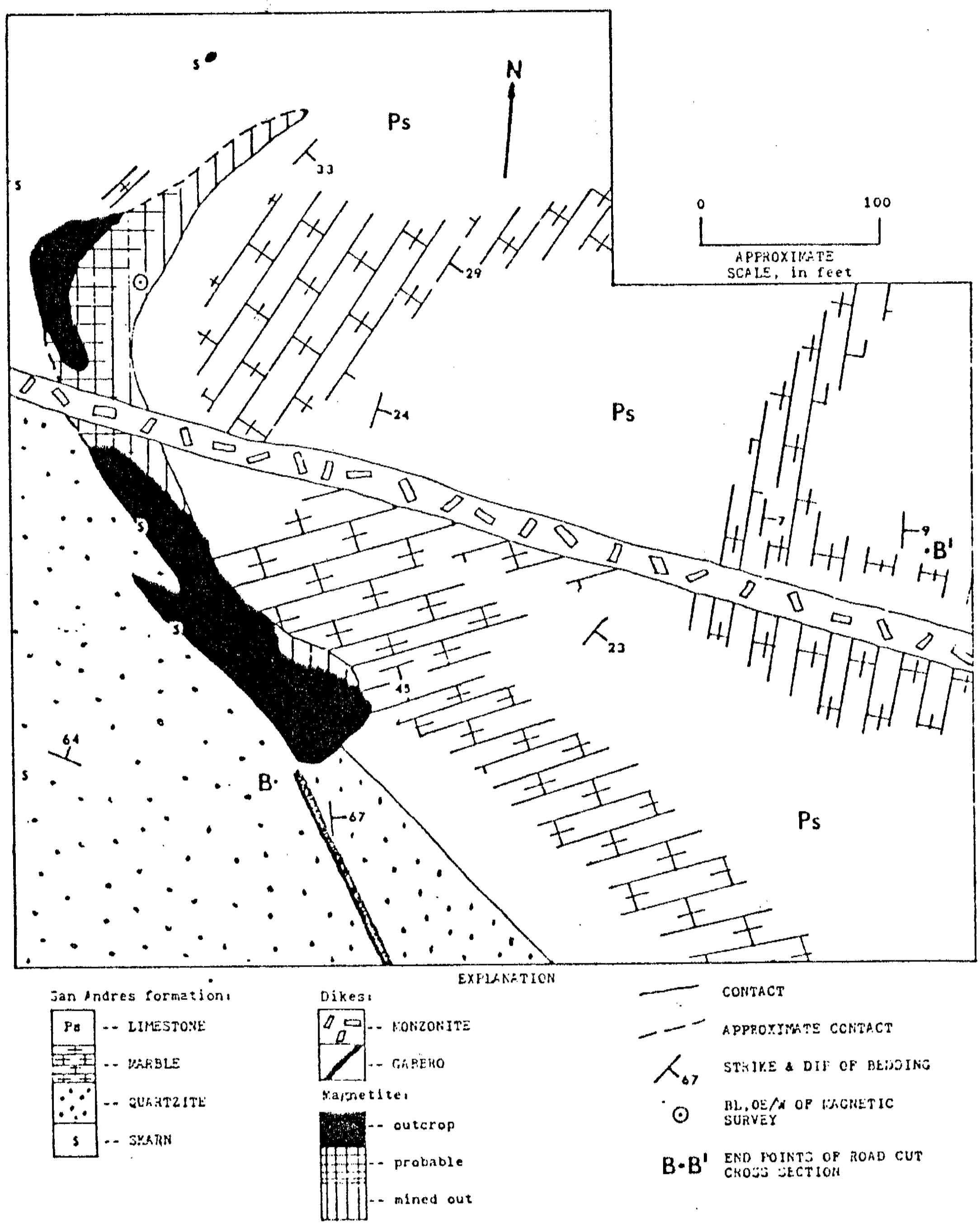


Figure 28. Sketch map of the Midnight deposit.

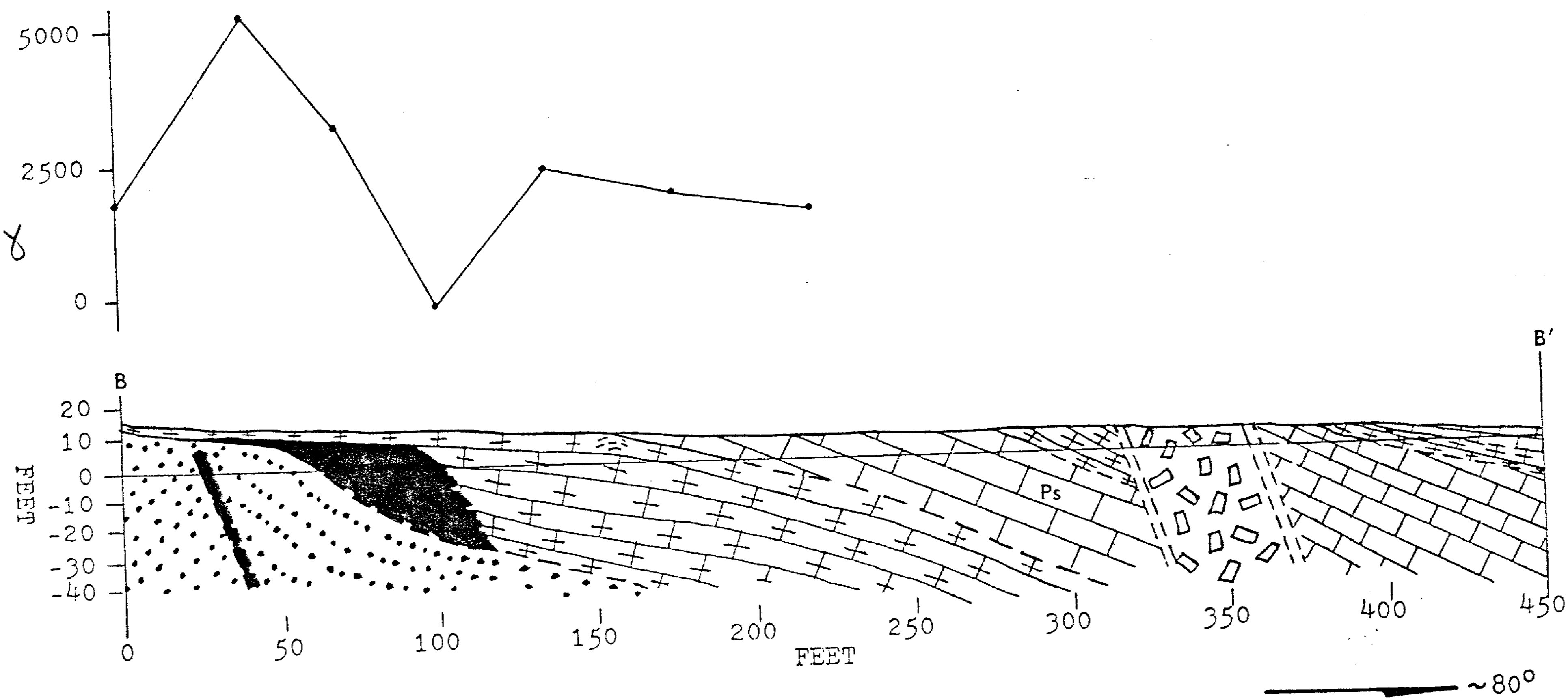
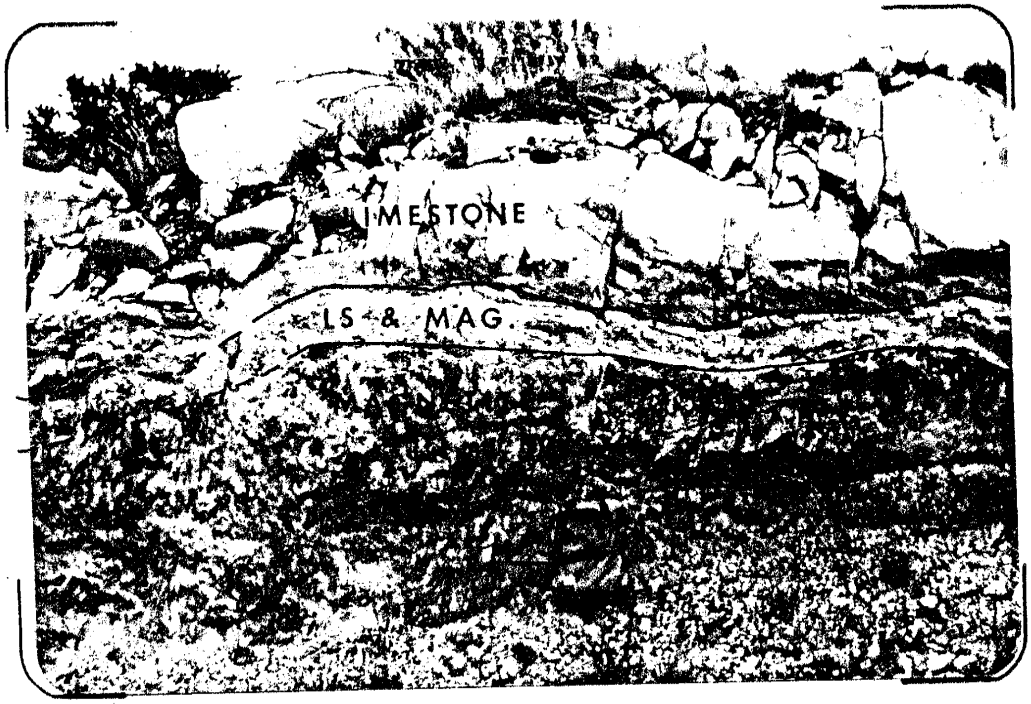


Figure 29. Cross section B-B'. Sketch of the southern road cut and its corresponding magnetic profile. See Figure 28 for explanation.

a)



b)

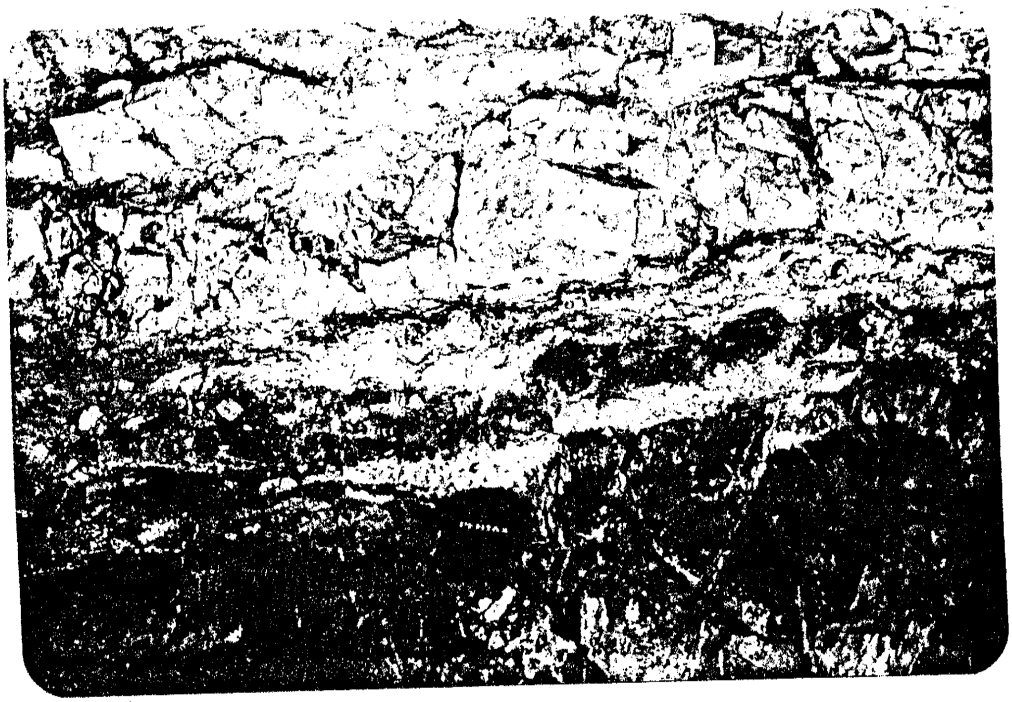


Figure 30. Upper contact of the ore body exposed in the north cut (looking southeast).
a) Magnetite, overlain by transition zone and limestone. The outcrop is seven feet high.
b) Close up of the transition zone from magnetite to limestone. The lens cap is two inches in diameter.

a)

b)

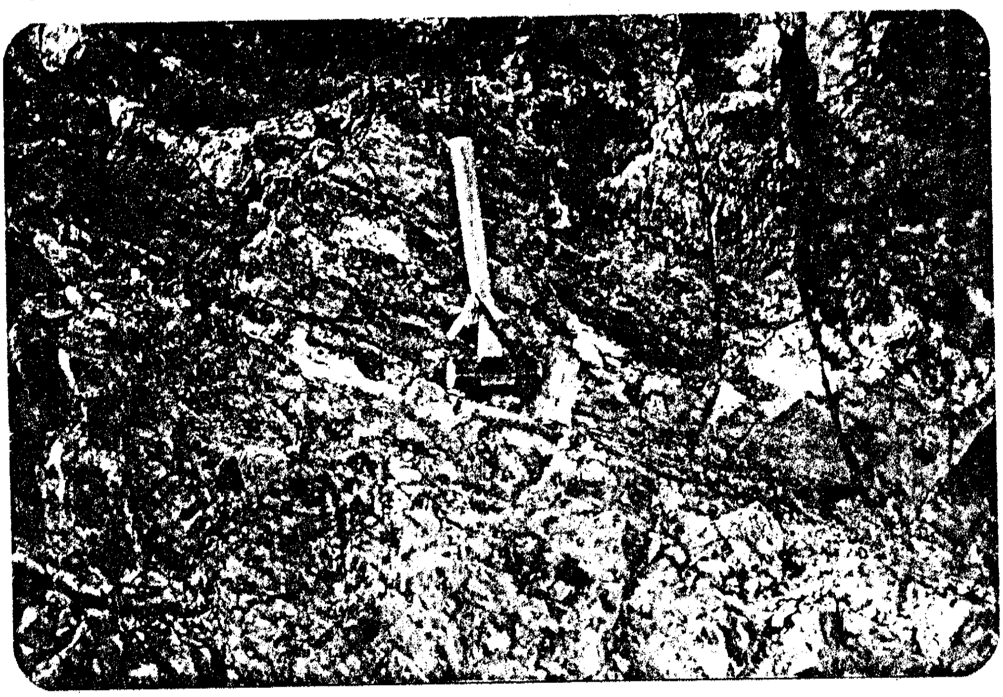


Figure 31. Southern magnetite exposure, just north of the road.
a) Magnetite, 15 feet thick, overlain by marble.
b) Close up of the ore, showing white pods of calcium carbonate.

quartzite (sample E-34) is fairly sharp, although some ore stringers intrude from the main contact. The quartzite is not impregnated with magnetite, but some patches of skarn and powdery alteration are found along the contact.

The quartzite bedding is very disturbed in the vicinity of the deposit. A three foot thick gabbro dike (sample E-28) intrudes the quartzite just below the main ore outcrop, and continues to the south. The dike dips steeply northeast and has formed a one foot thick breccia zone along its upper quartzite contact. To the west of the map area, the quartzite is host to several dike-like skarn masses (sample A-4). The masses strike northwest and are one to three feet thick. A large area of the quartzite surrounding these skarn bodies is altered.

Reserve Estimate

Reserves for this deposit are calculated for a convex lens-shaped orebody. The lens is elongated parallel to dip and narrows to the south. The strike and dip of the orebody is assumed to be equivalent to that of the overlying marble.

Due to previous mining activity, three sides of the orebody are fairly well delimited. On the north side of the north cut, the main magnetite body thins. Stringers of magnetite and skarn alteration continue to the north and are seen as small positive and negative anomalies on the magnetic coutour map (Figure 27). The western edge of the magnetite is partially exposed, especially along its lower contact. A small trench near the western contact exposes ore which is at least five feet thick. The western contact lies approximately 50 feet west of the large negative magnetic anomalies. The southern edge of the orebody is well exposed where the dozer cut intersects the road. Here, the magnetite is 15 feet thick and causes a 5000 gamma anomaly over its lower contact (see Figure 29). This outcrop is assumed to be the southern extent of the orebody, since the ore horizon is visible just south of the road and no ore is present.

The eastern limit of the ore is not known, except near the northeast edge of the lens. A group of 2000 gamma anomalies form a linear trend from near this point, south to the large exposure. The eastern edge of this trend is the estimated edge of the orebody.

Using these parameters, an average east-west cross sectional area was calculated for a lens which is 175 feet wide and 5 to 15 feet thick. The length of the deposit is estimated to be 325 feet.

Volume: 1765 sf X 325 ft = 573,625 cf

Tonnage: 573,625 cf X 0.156 ton/cf X 0.691
= 61,834 tons ore

Amount iron: 61,834 tons X 50.0% Fe = 30,917 tons

Amount silver: 61,834 tons X .08 oz/ton Ag = 4,947 ounces

Blue Rose 1--North Deposit

Geology

The Blue Rose north deposit is located at the monzonite/ limestone contact, on the boundary between the Blue Rose 1 and Blue Rose 2 claims (Figure 33). The deposit is exposed by a wide dozer cut, and consists of small dike-like and irregular bodies of magnetite (Figure 34). The orebodies are mainly enclosed in an intensely brecciated zone and appear to have formed by a combination of both mechanical emplacement and limestone replacement.

The monzonite around the deposit (sample H-7) has been altered. It is aphanitic in texture and contains an unusually high percentage of quartz. Where in contact with the orebodies, it is sometimes laminated with magnetite and stained with oxidized iron (sample H-6).

The limestone (sample H-5) is laminated with, and contains approximately 25 percent magnetite. Beneath the middle orebody, the limestone is intensely altered by magnetite replacement (Figure 35). Small areas of skarn alteration are also found along this limestone/magnetite contact.

As shown in cross section C-C', the breccia varies in composition from limestone, monzonite, or magnetite, to a combination of all three types. Monzonite breccia contacts all of the orebodies and usually has some magnetite in its matrix.

The breccia, monzonite, and limestone are cut by a two foot thick diorite dike (sample H-11) which dips NNW. The

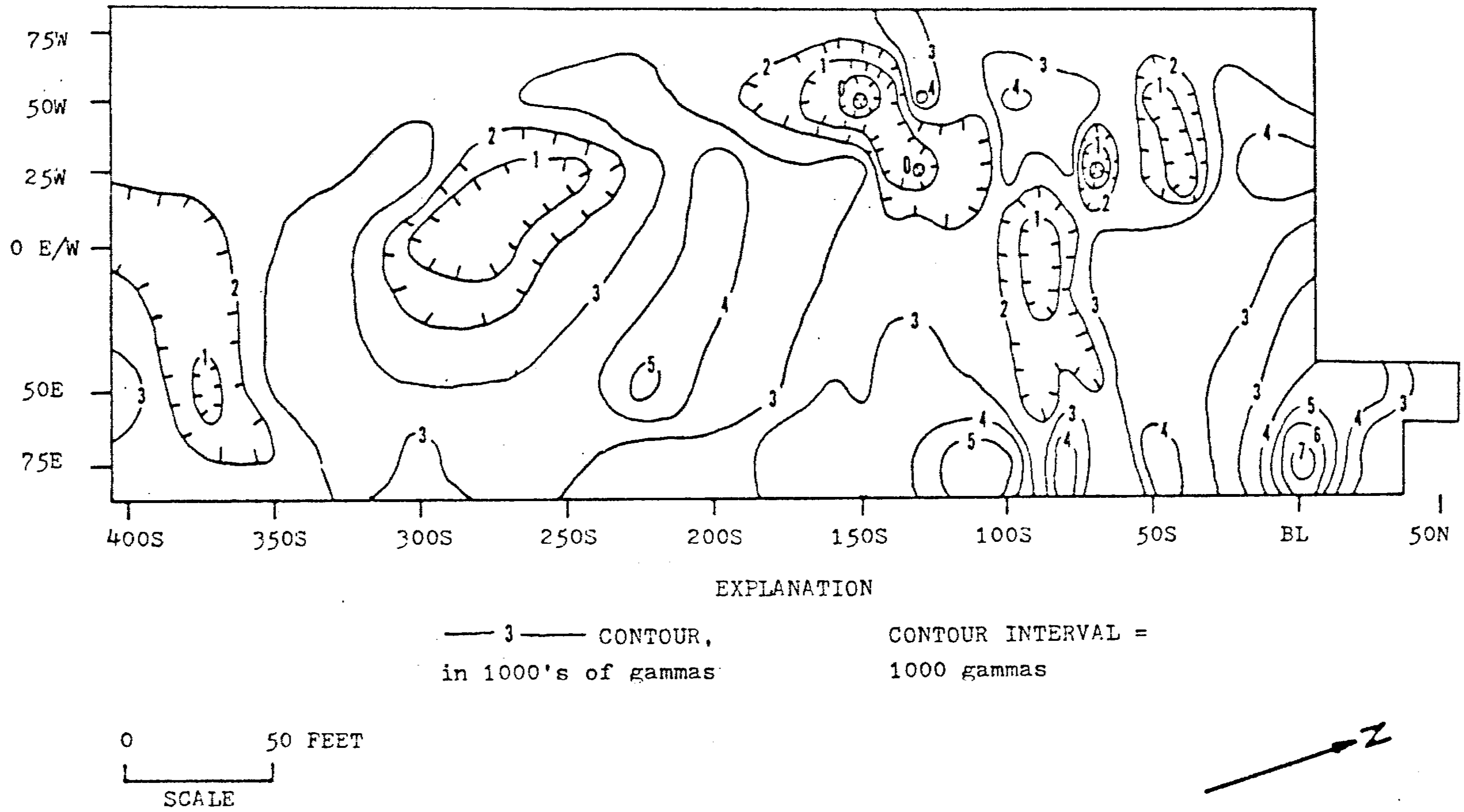


Figure 32. Blue Rose 1 magnetic survey contour map.

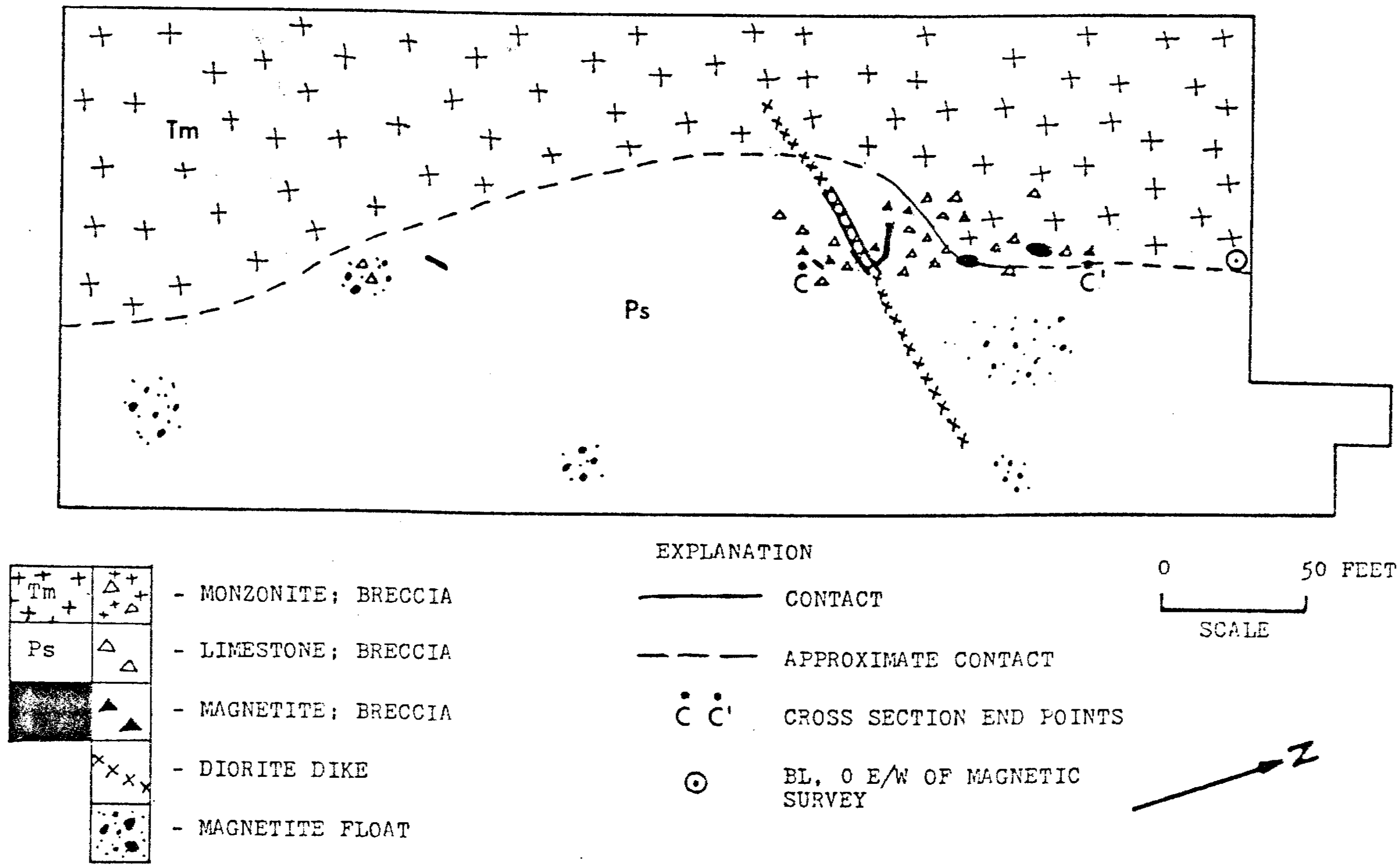


Figure 33. Sketch map of the Blue Rose 1 deposit.

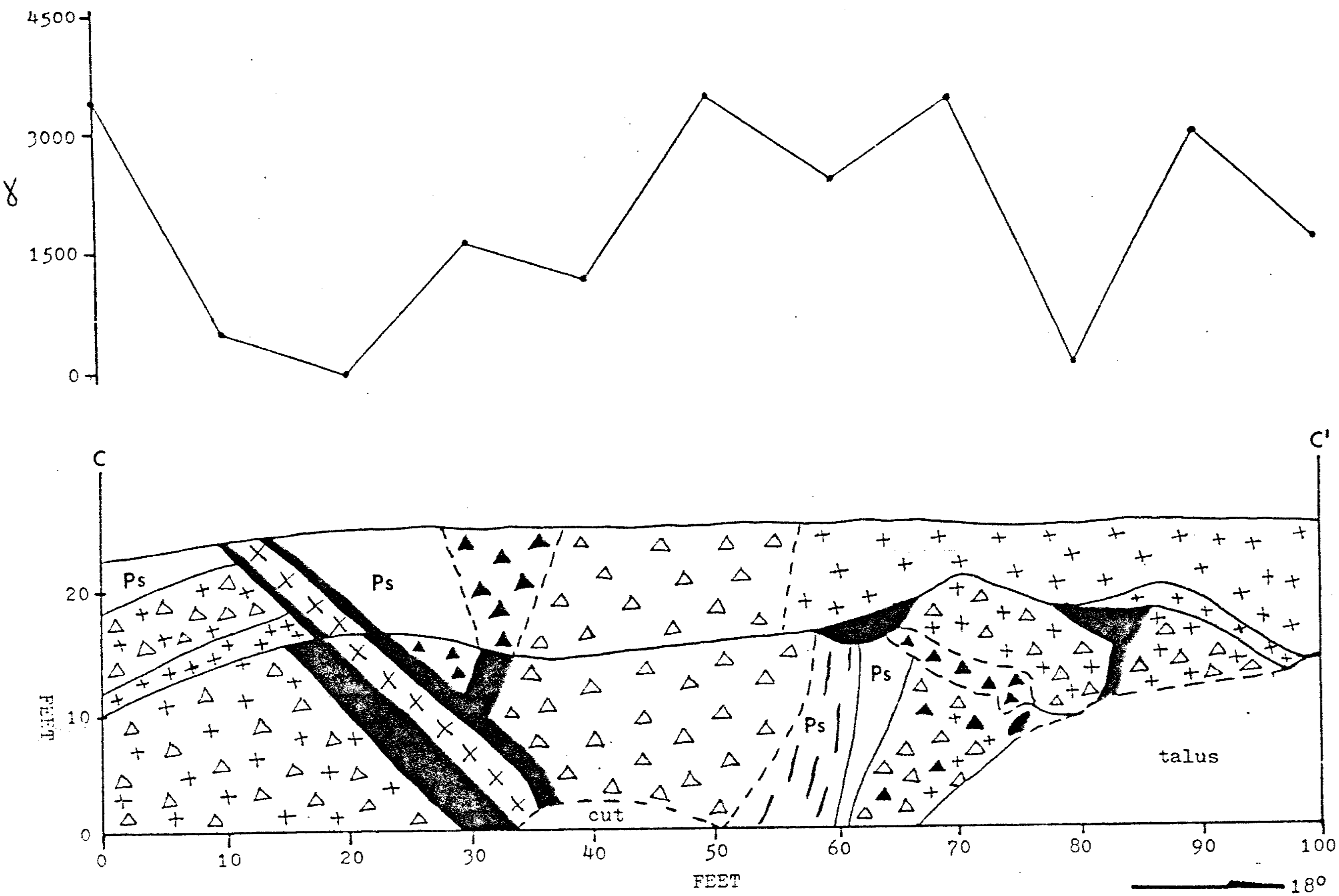
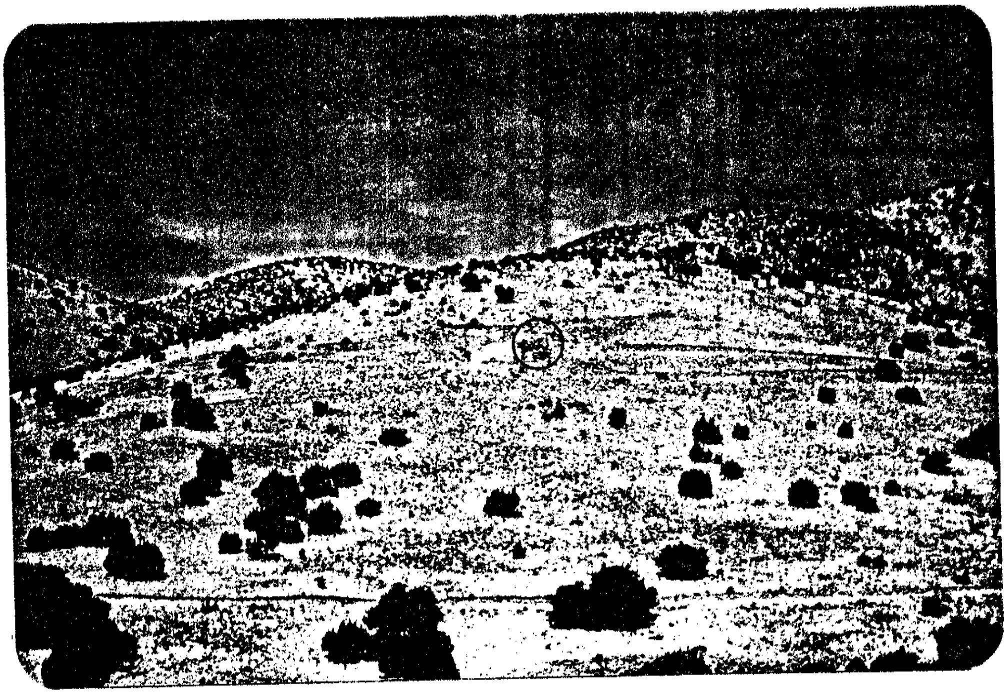


Figure 34. Cross section C-C' and corresponding magnetic profile, 25W. See Figure 33 for explanation. The section above 10 feet is set back 1-5 feet.

a)



b)

Figure 35. Photos of the Blue Rose 1 north deposit.
a) View of the deposit and cuts. The circled area is shown in the following photo.
b) View of the middle orebody, enclosed in breccia. A portion of the north orebody is in the upper right corner. The photo shows the area from 56 to 80 feet on cross section C-C' (Figure 34).

dike weathers and crumbles easily and is bounded on both sides by magnetite. This magnetite is assumed to continue along the dike contacts, thus forming two tabloid-shaped bodies. Another body of this type extends at about 90 degrees from the north side of the dike, and grades into magnetite breccia (see Figure 34).

The two irregular magnetite bodies are located to the north of the dike deposit. One body is bowl-shaped in cross section, and rests on the altered limestone and breccia. A zone of magnetite breccia is in contact with part of its lower edge. The northern-most orebody is similar in shape, but has a solid "feeder zone" of magnetite extending from its lower contact. Its overall shape resembles that of an upturned mushroom.

Reserve Estimate

Calculation of reserves for this deposit is, at this time, problematical. As already stated, the deposit is exposed due to previous mining or exploration activity. If a large volume of ore existed at all, it has been removed. The remaining orebodies are too small to make mining feasible. The tabloid bodies flanking the dike vary in width from six inches to three feet on the south side and from one to two feet on the north side. Using an outcrop height of 20 feet, and assuming that the magnetite extends at least 10 feet into the hillside, the volume of these bodies is calculated to be 625 cubic feet. The middle magnetite pod is three feet wide and two feet high. If it extends five feet into the cut, its volume is 25 cubic feet.

The top of the northern body is eight feet wide by three feet high. Its downward extension is one foot wide and is exposed for three feet. Assuming a five foot thickness for this body also, its volume is 82.5 cubic feet. The total volume of magnetite ore is then 732.5 cubic feet. The magnetite-bearing breccias are not considered here, since they are not of economic grade. The resultant values for known and probable ore are as follows:

Volume: 732.5 cf

Tonnage: 732.5 cf X 0.156 ton/cf X 0.820 = 94 tons ore

Amount iron: 94 tons X 59.4% Fe = 56 tons

The only economic hope for this deposit, is the possibility that more ore exists under the limestone cover. The magnetic contour map (Figure 32) shows numerous positive and negative anomalies to the east and south of the exposed section. Some of these correlate with areas of magnetite float and with the small ore exposure near 0 E/W, 280S. These magnetic disturbances may be caused by additional orebodies and/or a large magnetite impregnated brecciated area. If this is so, the monzonite/limestone contact may be gently dipping, ie. laccolithic, in this particular area. In view of the magnetic anomalies and the presence of unexplained magnetite float, this area warrants further investigation.

Other Deposits

Blue Rose 1--South Deposit

The Blue Rose 1 south deposit is located very close to the monzonite/limestone contact, in the southwestern corner of the claim. The deposit occurs in the limestone, along the contact of a quartz monzonite dike (samples I-3 and I-9). The dike is approximately 15 feet wide, strikes WNW, and dips steeply northeast. In the cut, much of the dike is intensely altered and powdery.

Almost all of the magnetite has been mined from this deposit (see Figure 36). A cross section of the cut, Figure 37, illustrates that the remaining magnetite is part of the transition zone between the limestone and the lower contact of the former orebody. Part of this zone is brecciated. The attitude of the transition zone indicates that the orebody was oriented north-south, dipped east, and was possibly lens-shaped.

The limestone in this deposit (sample I-11) is pyritic, due to the contribution of sulfur from a nearby gypsum lens. Immediately surrounding the dike, the limestone is extremely altered by magnetite and diopside skarn (sample I-13). To the east of the cut, the limestone is marbleized and contains olivine (sample I-5). Above the cut, the limestone is altered to bluish and white colors, probably due to its proximity to the monzonite contact.

The ore from this deposit is reddish when crushed, indicating a relatively high hematite content. It also has an unusually high silver content and traces of gold.

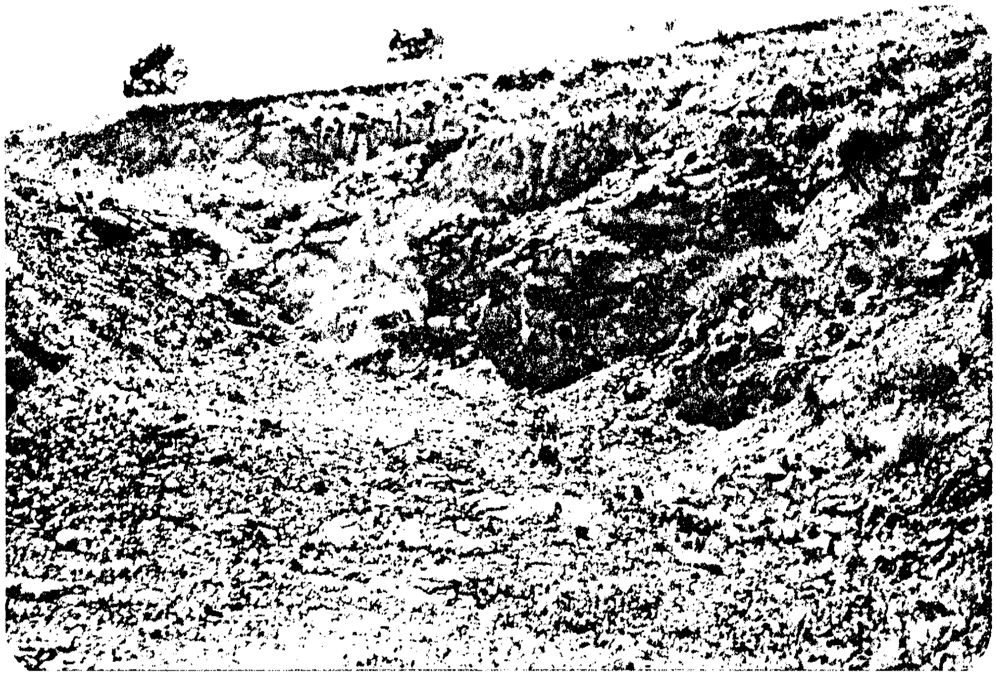


Figure 36. Photo of the Blue Rose 1 south cut. The sides of the cut are approximately 15 feet high. See Figure 37 for a diagram of this view.

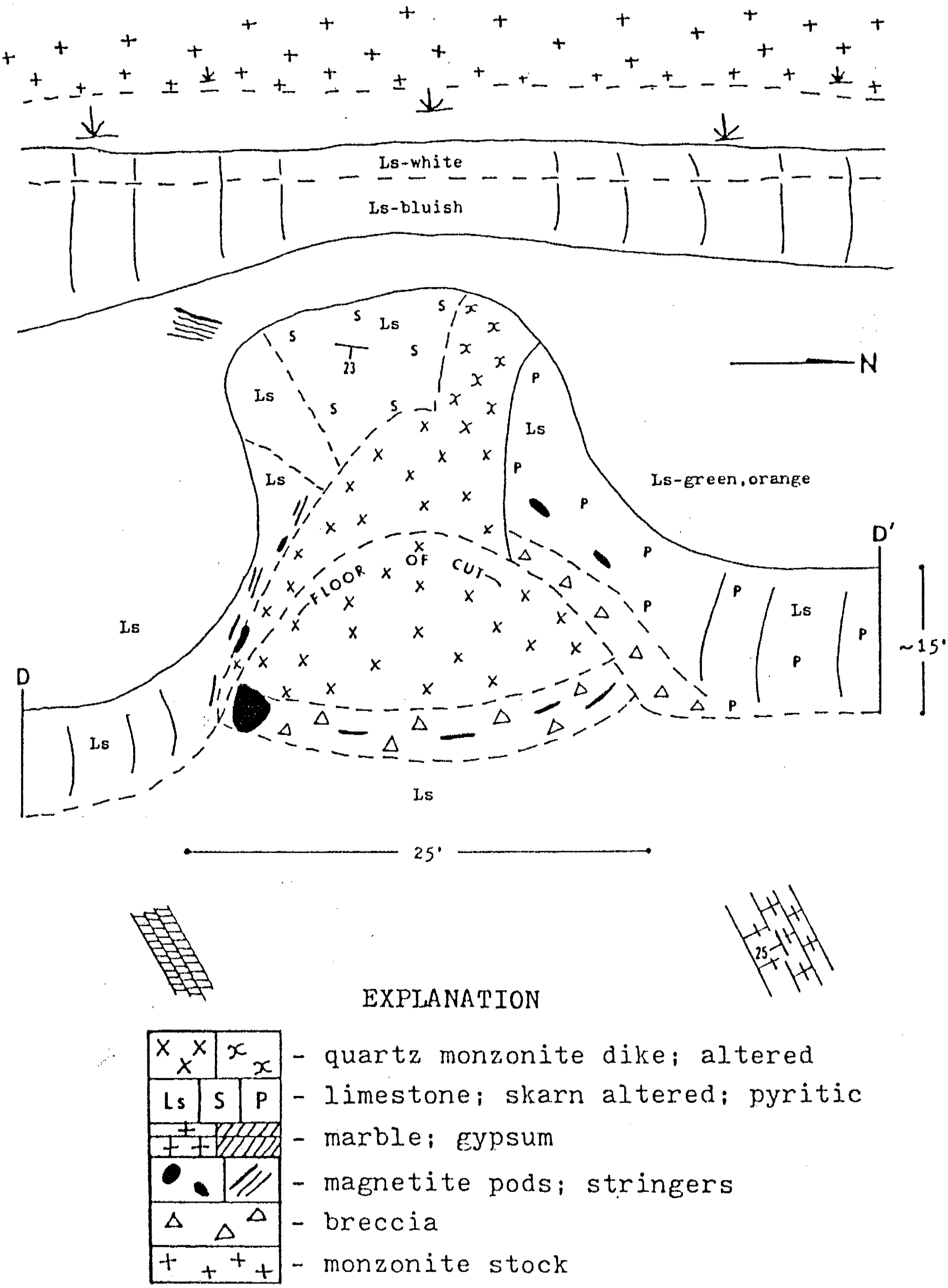


Figure 37. Cross section D-D'. Schematic sketch of the Blue Rose 1 south cut.

ABD-2

A small area of magnetite mineralization is exposed at the side of a gulley, in the southeastern part of the ABD-2 claim. This deposit, like the Midnight, occurs at the limestone/quartzite boundary of the San Andres formation. In cross section, the magnetite "bed" is one foot thick, and is bounded on both sides by quartzite breccia (Figure 38a). To the west of the breccia is a three foot thick sequence of quartzite, limestone, and black shale. Perpendicular to cross section E-E', and facing the gulley, is a breccia zone composed of large quartzite clasts in gouge. At the north side of this zone, the breccia is in contact with a four to five foot thick layer of magnetite. Along the lower margin of the magnetite is a four inch thick zone of diopside skarn (sample E-22).

ABD-1

Another small magnetite deposit is revealed nearby in a pit, in the northwestern portion of the ABD-1 claim. The pit is four feet deep and shows that the magnetite is bounded by a diorite dike (sample E-10) on the east side and gray marble (sample E-13) on the west side (Figure 38b). The dike strikes northwest and dips northeast.

The exposed magnetite is up to three feet thick and is bounded by breccia zones. Along its contact with the dike is a one foot thick zone of diorite clasts in a gouge matrix. At the marble contact, large black micrite clasts are enclosed in a cream-colored matrix (sample E-12). Most

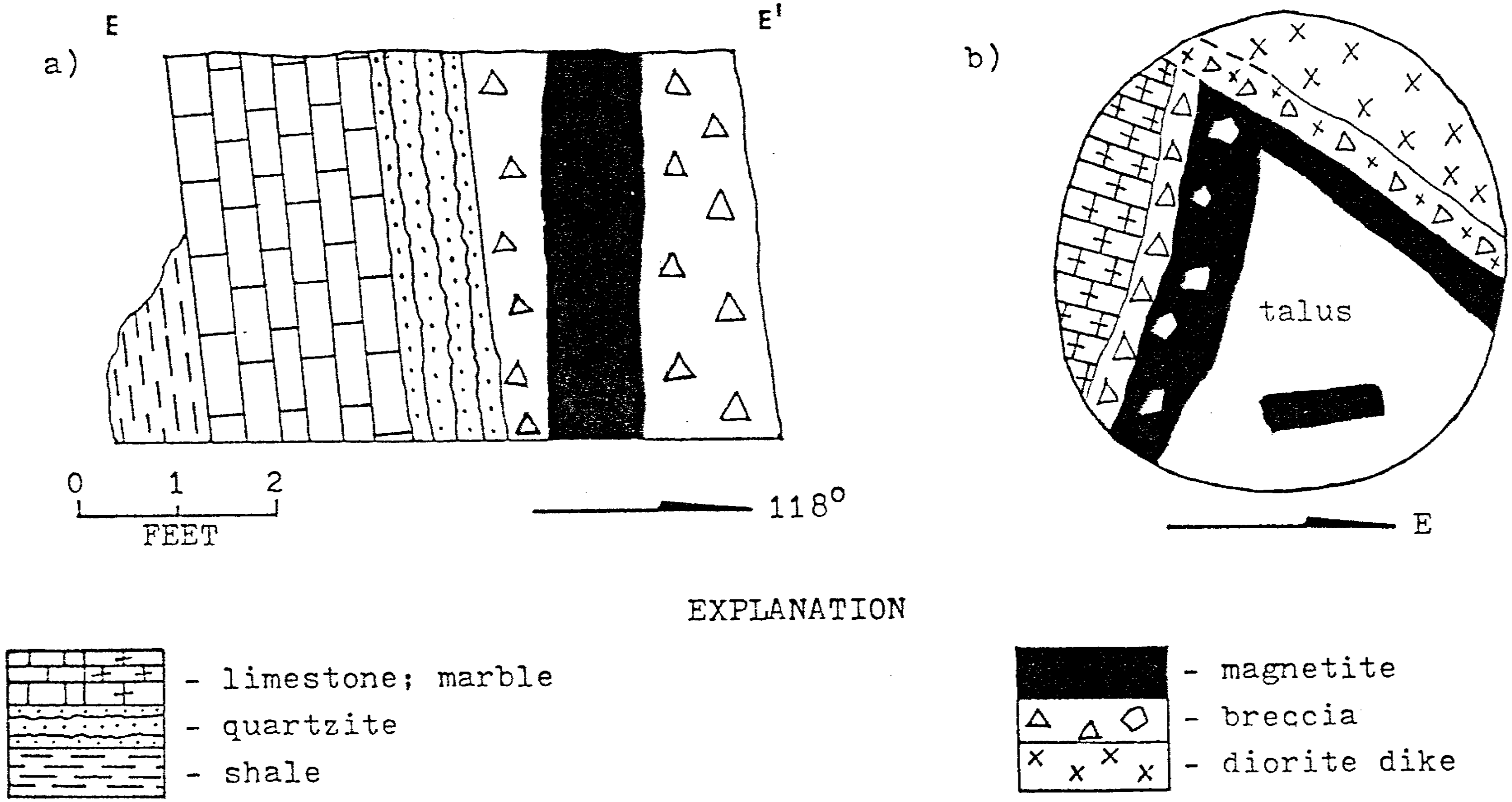


Figure 38. Sketches of the small ABD deposits.
a) Cross section E-E' in the ABD-2 claim.
b) Plan view of the pit in the ABD-1 claim.

of the ore near this contact is brecciated and contains the same angular, black micrite (or marble) clasts as the breccia.

DISCUSSION OF ORE GENESIS

Similar Deposits

The magnetite deposits of Lone Mountain belong to a group of deposits variously classified as contact metamorphic, metasomatic replacement, pyrometasomatic, hydrothermal, or magmatic injection. These deposits accompany most of the other Tertiary stocks in the vicinity of Lone Mountain and are widely distributed in New Mexico. Similar deposits also occur in Cornwall, Pennsylvania, Iron Springs, Utah, and in the Eagle Mountains of California. The majority of the world's similar deposits occur on the margins of the Pacific Basin and in other areas of strong tectonic activity. The Magnitnaya deposit, in the Ural Mountains of Russia, has been cited as a type deposit for such magnetite ores (Percival, 1954).

Magnitnaya type deposits are tectonically associated with zones of strong deformation and volcanism (Park, 1972). The orebodies are characteristically located at or near the contact of an intermediate igneous intrusion with sedimentary country rocks. However, in some Tertiary and younger deposits, ore is associated with volcanic rocks such as andesite and andesite breccia (Park, 1972). Where the host rocks are carbonates, skarns of various compositions are frequently developed. The orebodies are typically small, lenticular or irregularly shaped masses or veins, which may either replace the host rock or occur as fracture or open-space fillings in the igneous mass. The ore is usually magnetite with subordinate hematite and sulfide minerals are present locally. The orebodies are frequently cut by silicic or intermediate dikes, resulting from post-ore igneous activity (Park, 1972).

Depositional Models

The exact origin of these deposits has been a subject of controversy. Lepp (1975) states that although there is no consensus of opinion for the source of the iron, there is a general agreement among geologists that these iron-enriched bodies result from both surface and deep-seated processes.

Park (1972) examined the Pacific Basin deposits on a regional basis and reviewed available information on the genesis of individual deposits. He envisions the partial mobilization of underlying rocks as the iron source. Iron-enriched hydrothermal fluids are then trapped at depth and channeled to the surface, mainly along faults or the intrusive borders. These highly mobile ore-bearing fluids are charged with chloride and fluoride which were either contributed or activated by the magma. The fluids continue to rise until a favorable depositional environment is encountered. The iron then replaces or intrudes the favorable rocks.

A model for the deposition of the Cornwall-type deposits is described in detail by Eugster and Chou (1979). This depositional model is based on the idea of convecting, supercritical aqueous chloride solutions. They note that the essential features of their model were put forth by Spencer (1908). Spencer suggested that the orebodies were formed "by the more or less complete metasomatic replacement of sedimentary rocks by iron minerals precipitated from heated solutions set into circulation by the invading diabase." The Eugster and Chou model proposes a two-stage convection cell, based on the formation of hydrochloric acid at depth by the conversion of muscovite to potassium feldspar. The hydrochloric acid then lowers the pH and dissolves iron minerals, such as magnetite and pyrite, to form iron chloride. The iron chloride-rich fluids circulate to the cold end of the cell, which is near the intrusive and presumably shallower in depth, where they encounter the limestone country rock. The resulting increase in pH causes magnetite and pyrite to precipitate, and the remaining fluids are enriched with calcium chloride and carbon dioxide. Based on their calculations, Eugster and Chou believe that large amounts of magnetite may be transported by this process. Kalinin (1962) lends support to this model by stating that ore-bearing fluids carry iron in divalent and trivalent form as complexes with chlorine.

The genesis of these deposits has been discussed in less detail by other authors. Most agree that these deposits were formed by watery, ore-bearing fluids which are somehow related to the intrusives. Barnes (1979) believes that the intrusives are a plausible source of magmatic water but that meteoric water plays an important role in the late stages of ore formation.

Two categories of migration theory for the fluids are cited by Holser and Schneer (1961). One involves the high "volatility" of a halide gas, such as the Eugster and Chou (1979) model. The other, favored by Kalinin (1962), concerns the hydration and dissociation of hydrothermal aqueous solutions. Structures such as fractures, joints, faults and breccia zones, along with the intrusive/country rock contact are agreed to be the main controls on channeling these fluids or ore-bearing constituents to a suitable deposition site.

The deposition of iron is usually directly attributed to the increase in pH upon contact of the acidic fluids with carbonates. However, decreases in temperature, pressure, and percent of dissolved carbon dioxide upon ascension of the waters, and the presence of organics may also play a role (Eckel,1914).

The circulating ground water theory appears to be the favored mode of origin for these deposits, especially in recent studies. Gibbons (1981) studied the Jones Camp deposit, in Socorro County, which is very similar to the Cornwall, Pennsylvania deposit. He concluded that the magnetite deposits there are the result of hydrothermal activity which followed emplacement of the dike. "Iron-scavenging" waters, of meteoric origin, used the dike margins as channelways. Upon contact with carbonates, the ore-bearing waters deposited magnetite and released carbon dioxide. Schnake (1977) proposed a similar genesis for the Lone Mountain deposits. Using geochemical methods, he determined that the magnetite-bearing skarns were formed at approximately 250 degrees Celsius and 140 bars of pressure.

After applying the thermodynamic properties of the skarn minerals at this temperature and pressure, he concluded that the mineralization resulted from the interaction of meteoric ground waters with the sedimentary host rocks as the waters migrated to the igneous/sedimentary contact. The deposition of magnetite was initiated by the increase in pH due to the dissolution of calcite at the deposition site. Schnake believes that the location and size of the deposits may be a function of the presence of scattered gypsum units.

Lone Mountain

The field relations studied for this report lend support to Schnake's mode of origin for the Lone Mountain magnetite deposits. The extreme iron enrichment of the San Andres limestone in this area (20-25% magnetite vs. <1% in Socorro County) indicates a relatively widespread process. The porous nature of this limestone will allow ground water circulation (Kelley, 1952) and thus the deposition of magnetite from iron-rich waters. Heat from the stock, volcanics, and dikes could certainly have provided enough energy to drive a meteoric convective circulation system.

The proposed iron source for these deposits is the hematite in underlying sedimentary beds, specifically the Abo formation. With an estimated iron content of two percent, only 30 million cubic feet of the formation are needed to provide the iron for these deposits. At an estimated thickness of 200 feet, this constitutes a leached area of 150,600 square feet.

Fluids necessary for transport of the iron were primarily meteoric in nature, with the possible addition of post-magmatic solutions from the cooling intrusives. Gasses released during the upward movement of the stock and dikes, along with the heat they provided, presumably increased the mobility of the flowing ground water and helped to acidify it. The increase in acidity may have been caused by the hydrolysis of dissolved iron by the heated water (Schnake, 1977) or, more likely, by the release of hydrochloric acid due to mineralogical changes in the cooling intrusive (Eugster and Chou, 1979).

Upward migration of the iron-bearing waters was the result of the following structural controls: the stock contact; small faults; breccia zones; concentric joints in the stock; and radial fractures originating at the stock margins and extending outward into the country rock. The dikes on Lone Mountain, some of which are intimately associated with magnetite deposits, follow the same structural pattern. This suggests that the magnetite was not localized due to the presence of certain dikes, but rather that both the dikes and iron-bearing fluids ascended along the same fractures and weak points.

Secondary control on the locaton of many deposits was lithologic. Once fluids were channeled near to the surface, the bedding plane between the coarse-grained Glorieta sandstone and the overlying limestone was the favored site for magnetite deposition. The changes in both chemistry and permeability at this interface made it an ideal depositional environment. The skarn alteration in the Glorieta, where in contact with the magnetite, was formed by the same fluids. This shows that the sandstone was, at that time, quite permeable. The presence of gypsum lenses was not a factor in ore localization, but did contribute to the formation of sulfides.

The direct cause of magnetite deposition was the chemical reaction, and resulting change in pH, of the iron chloride-bearing waters upon contact with, and possibly migration through, the limestone. However a few deposits, such as the Black Knight, occur as open-space fillings, rather than limestone replacements. In such cases it is proposed that upon ascension, the rapid decrease in pressure and temperature of the fluids, along with some carbonate contact, was enough to initiate magnetite deposition.

The only problem with this model of ore genesis is providing an explanation for the roof pendant deposits. A circulating ground water system operating around the periphery of the impermeable monzonite does not immediately appear to be the cause. However, Park and MacDiarmid (1975) state that solutions in large amounts do move through massive bodies at depth, and that superimposed permeability due to secondary structures can be more important than original permeability for the transport and deposition of ore. Also, it is known that fluids under pressure can fracture rock or act to keep joints or fractures open, thus allowing fluids to circulate freely and permitting time for reactions and the deposition of ore. With these considerations in mind, it is plausible to assume that the ore-bearing waters invaded the stock and deposited magnetite upon contact with the carbonates.

In summary, ground water containing hydrochloric acid and hydrogen gas from the intrusive was heated and set into convective motion. The water flowed through the Abo formation and reacted with its hematite to form an iron chloride and water solution. This solution, neutralized upon carbonate contact, precipitated magnetite and produced calcium chloride, carbon dioxide, and hydrogen byproducts (Eugster and Chou, 1979).

SUMMARY AND CONCLUSIONS

1. Geologic History and Mineralization

The Lone Mountain area was the site of almost continuous marine and terrigenous deposition throughout the Paleozoic and Mesozoic eras. In the early Tertiary, the monzonite stock intruded, domed, and probably protruded through the sediments. Igneous activity continued through the mid-Tertiary as felsic and intermediate dikes were emplaced in the stock and surrounding sediments. In the late Tertiary, the southern portion of the mountain was overlain by volcanic flows. The flows, which are mainly andesitic, are related to the Sierra Blanca volcanic complex. Following the volcanic activity granodiorite and gabbro dikes were intruded.

Shortly after emplacement of the gabbro dikes, mineralization began. Heat, fluids, and gasses from the cooling igneous and volcanic rocks warmed, acidified, and increased the mobility of the ground water surrounding the stock. The ground water, set into motion by thermal energy, circulated through iron-bearing sedimentary beds. Iron was dissolved and transported upwards along fractures, geologic contacts, and joints. When the iron-enriched waters encountered the San Andres formation, magnetite was precipitated in the limestone and along the stock margins.

2. Summary of Estimated Reserves

See Table 5.

TABLE 5

Summary of Estimated Reserves
(known & probable)

Claim	Ore Volume (ft^3)	Tons Ore [% Fe] *	Tons Fe **	Value ($)***	Oz. Ag **	Value ($)****
Black Knight main	155,169	20,454 [61.2]	12,518	786,381	2,045	21,472
south	52,500	6,290 [55.6]	3,497	219,681	556	5,943
subtotal	207,669	26,744	16,015	1,006,062	2,611	27,415
Midnight	573,625	61,834 [50.0]	30,917	1,942,206	4,947	51,944
Blue Rose -north	733	94 [59.4]	56	3,518	0	0
TOTAL	782,027	88,672	46,988	2,951,786	7,558	79,359

* Tons Ore = ft^3 X 0.156 tons/ft^3 X %Fe/72.4

** assuming 100% recovery

*** retail price, to the nearest dollar, @ $62.82/ton 100% Fe (H. LaRue, personal communication)

**** retail price, to the nearest dollar, @ $10.50/oz.

3. Preliminary Economic Feasibility Study

A preliminary economic study was undertaken to assess the feasibility of mining the claims discussed in this report. The figures are based on information available at this time, and many are order-of-magnitude. The probable error for this level of accuracy is estimated at 30% (Peters, 1978).

The proposed plan is for the smallest operation possible. The magnetite would be fractured, loaded, and trucked to the mill at Carrizozo for resale. At the mill, the ore wuld be crushed, and concentrated by means of magnetic separation. The mill would then deliver the magnetite concentrate to a contracted buyer. A summary of the proposed operation is presented on page 101.

At this time, the only market for magnetite is the cement industry. Manufacturers such as Ideal Basic Industries, operating in Tiejeras Canyon, add magnetite to their cement to increase its specific gravity and tensile strength. They require ore which has a high iron content and no gypsum impurities (Rick Dyke, personal communication, 1982). A firm mining deposits on Capitan Mountain is currently contracted to supply their magnetite. Rail service is available between the Carrizozo area and Tiejeras Canyon, but since the cost of loading and unloading is prohibitive the product is trucked (H. LaRue, personal communication, 1982).

The proposed production rate is for four employees to mine 35 tons/day, which amounts to 9660 tons/year. At this rate, the estimated mine life is 9.2 years. With time added for initial development and post-production reclamation, the project could last up to 10 years. Calculatons for the production rate and mine life are presented on page 102.

The projected gross revenue for the mining operaton is based on the sale of 100% of the estimated iron reserves (see Table 5) to the mill. The mill is expected to recover 90% of the available iron and resell it at the current price of $62.82/ton of 100% iron (H. LaRue, personal communicaton). The mine will receive 80% of the mill's gross receipts. Based on the sale of 46,988 tons of iron, the mine should gross $24/ton of ore mined. The calculations for this figure are on page 102.

Capital costs for the project, outlined on page 103, are estimated at $992,222. Since exact costs are not known for anything other than equipment, the figures are scaled down from those calculated by Bickford (1980) for the Jone's Camp deposit. His feasibility study is based on a much larger operation, which would mine 120,000 tons/year. For this study, cost estimates for items such as acquisition of right-of-way and the environmental impact study are especially questionable, since they are not directly linked to the amount or rate of production.

Estimated operating costs are also based on applicable items from Bickford's study. Interest on repayment of loans has not been included, since the amount of capital to be borrowed is unknown. Royalties are set at $10/ton for the Jone's deposit, but may be lower for the Lone Mountain claims. The basic operating costs as outlined on page 103, are calculated to be $14.34/ton, excluding interest, royalties, and any administrative costs.

Due to the present low demand and prices for iron, and the small size of these deposits, any mining operaton at this time would be economically unfeasible. According to this study, total capital and operating costs for the project would be $2,263,778, or $25.53/ton. Since the projected gross profit is $24/ton, a loss of $1.53/ton is expected even before the relatively major costs of interest and royalties are added.

The value of the silver present in most of the ore has been discounted for this study. Recovery of the silver would involve the construction of a leaching operation at the mill to extract the silver from the concentrated magnetite. If 80% of the silver could be leached out, an estimated 6,046 ounces would be recovered. At $10.50/oz. the mill would gross $63,487. Of this amount 80% would be paid to the mine, thus adding $50,790 to the mine's gross revenues. Although this would help offset the cost of mining by $0.57/ton, a loss of $0.96/ton could still be expected. Even if mining costs could be cut enough to make a marginal profit per ton, it is doubtful that a leaching operation could be constructed and run for less than $13,000. Therefore, with the recovery of silver included, the operation is still considered economically unfeasible at this time.

SUMMARY OF MINE PRODUCTION AND ESTIMATED COSTS

I. RESERVE TONNAGE & MINE LIFE

A. Estimated Tonnage & Grade

20,454	tons	@	61.2% Fe
6,290	tons	@	55.6% Fe
61,834	tons	@	50.0% Fe
94	tons	@	59.4% Fe
88,672	tons averaging		53.0% Fe

B. Proposed Production Rate

35 tons/day
9660 tons/year

C. Mine Life

9.2 years in production
~10 years including development and reclamation

II. EXPECTED GROSS REVENUE

$2,125,276 total
$231,840 /year
$24 /ton

III. ESTIMATED CAPITAL COSTS

$992,222 total
$108,095 /year
$11.19 /ton

IV. ESTIMATED DIRECT OPERATING COSTS (excluding royalties, interest, and administration)*

$1,271,556 total
$138,561 /year
$14.34 /ton

V. CALCULATION OF NET REVENUE

gross revenue	=	$24.00/ton
capital & operating costs*	=	-$25.53/ton
net loss	=	-$1.53/ton

DETAILED PRODUCTION AND REVENUE BREAKDOWN

I. RESERVE TONNAGE & MINE LIFE

A. Estimated Tonnage (in place) & grade

1. 88,672 tons ore total; 46,988 tons Fe total Summarized on Table 5; detailed calculations are in Ore Deposits section.
2. Average ore grade = [20,454(.612) + 6,290(.556) + 61,834(.500) + 94(.594)] / 88,672 = 53.0% Fe

B. Proposed Production Rate

1. 35 tons/day (8 hour shifts)
   9660 tons/year @ 276 working days/year
2. 88,672 tons @ 35 tons/day = 2533 days to remove all ore

C. Estimated Mine Life

1. 2533 days / 276 working days/year = 9.2 years

II. EXPECTED GROSS REVENUE

A. Total iron to be mined = 46,988 tons from 88,672 tons ore

B. Total iron recovered at mill after grinding and magnetic concentration @ 90% recovery = 42,289 tons

C. Market value to mill @ $62.82/ton Fe = $2,656,595

D. Revenue to mine @ 80% of market value = $2,125,276

E. Revenue per ton mined = $2-,125,276 / 88,672 tons = $24/ton

DETAILED COST BREAKDOWN

III. ESTIMATED CAPITAL COSTS

A.	Preproduction*	
1.	Development--refinement of reserve estimates by detailed magnetic & gravity surveys; drilling?; one graduate student & expenses, 4 months	$5,000
2.	Contract for environmental impact study and more detailed feasibility study	~$6,000
3.	Acquisition of right-of-way through Dotson's mine or ranch	~$10,000
4.	Road improvement 3 miles @ $10/foot	$158,400
5.	Contingency @ 5% (on $179,400)	$8,970
B.	Equipment	
1.	Cat 769C ore truck (35 ton)	$317,350
2.	Cat 988B wheel loader	$366,300
3.	drill & misc.	~$30,000
C.	Contingency @ 10% (on $902,020)	$90,202
	Total	$992,222
		= $11.19/ton

IV. ESTIMATED DIRECT OPERATING COSTS

		$/year	$/ton
A.	Labor* @ $10.22/hr/person 4 employees--driller & blaster, scraper & loader, truck driver, helper	90,263	9.34
B.	Basic Equipment*	[31,200]	[3.23]
	Cat 769C truck	9,853	1.02
	Cat 988B wheel loader	12,075	1.25
	air-track drill	3,187	0.33
	misc.	6,085	0.63
C.	Trucking included in labor & equipment costs		
D.	Reclamation*	4,830	0.50
E.	Severance & Property Taxes* N.M. Severance $.7159/ton based on $22/ton raw property $0.56/ton based on $26.861/1000 assessed value	12,268	1.27
	Total estimated operating costs (excluding royalties, interest, and administration)	$138,561	$14.34

* Figures based on study by Bickford (1980)

APPENDIX A

SUMMARY OF ROCK SAMPLE DESCRIPTIONS

Notes

1. Sample locations are noted on Overlay 3.1

2. Rock types are arranged in the same order as presented in text

3. H.S. = hand sample description
   T.S. = thin section description

4. Mineral percentages are visual estimates

5. Sedimentary classificatons
   a. micrite = calcite grains < .1 mm
   b. dismicrite = micrite with void fillings of sparry calcite (Folk, 1962)
   c. pebble parabreccia = angular clasts, 2-64 mm; matrix supported
   d. oligomictic pebble orthobreccia = angular clasts, restricted lithologies, 2-64 mm; clast supported
   e. oligomictic paraconglomerate = rounded clasts, restricted lithologies; matrix supported

6. Igneous rock classifications (Travis, 1955)

		%		
Name (dike type)	K-spar*	Plag.**	Quartz	mafics
granite (1)	>66	<33	>10	<10
quartz monzonite (2a)	33-66	33-66	>10	<20
monzonite (2b)	33-66	33-66	<10	<25
granodiorite (3)	10-33	>66	>10	<20
diorite (4)	<10	>66 Na	<10	<25
gabbro (5)	<10	>66 Ca	<10	<50
syenite	>66	<33	<10	<15
monzodiorite (Hyndman, 1972)	10-35	65-90	<5	<25

*K-spar = potassium feldspar (as % of total feldspar)
**Plag. = plagioclase (as % of total feldspar)

7. Volcanic rock classifications (Hyndman, 1972)
   a. trachyte = equivalent of syenite
   b. quartz latite (or rhyodacite) = equivalents of quartz monzonite
   c. latite-andesite = equivalent of monzodiorite

Sedimentary Rocks

Sample: E-16 Claim: ABD-2
Name: dark gray dismicrite

H.S.: Very finely laminated limestone or marble; dark gray transitional to white; white portion has 1mm thick zone of lime-green alteration, 4mm from the weathered surface; weathers to medium gray and beige colors.

T.S.:

97% CALCITE--partially recrystallized; anhedral to subhedral crystals <.1mm (some to .3mm) in size; characteristic rhombohedral cleavage shows only on larger crystals.

3% MAGNETITE--subhedral to anhedral crystals <.2mm in size; some altering to hematite.

Structures--microfractures and some pores or void spaces.

Sample: F-8 Claim: Midnight
Name: black dismicrite

H.S.: Finely crystalline limestone; dark gray to black with small crytals and aggregates of white calcite; weathers to beige color or develops a brilliant white caliche coating.

T.S.:
80% CALCITE--40% sparry, void fillings in the form of laminae and aggregates to 5mm long; anhedral to subhedral crystals averaging .5mm in size, possibly replaced crinoid fossils. 40% micrite, extensively impregnated and crudely laminated with magnetite.

20% MAGNETITE--euhedral to anhedral crystals to .4mm in size; some altering to hematite.

Claim: ABD-8

Sample: G-2
Name: dark gray dismicrite

H.S.: Finely crystalline limestone; dark gray with small, anhedral to euhedral calcite crystals or intraclasts; weathers to medium gray color with rust spots; some specular hematite on surface.

T.S.:

65% CALCITE--micrite crystals and aggregates impregnated with magnetite; some subrounded void fillings of sparry crystals to 1.2mm in size; some magnetite inclusions show parallel orientation.

20% MAGNETITE--anhedral to euhedral crystals and aggregates to .2mm in size; imparts rust-brown stain to the calcite.

15% CHLORITE--light green, subhedral crystals <.1mm in size; associated with the magnetite.

Claim: Blue Rose 1

Sample: H-5
Name: black dismicrite

H.S.: Finely crystalline limestone; dark gray to black, with void fillings or ovoid-shaped inclusions and streaks of recrystallized medium to coarse-grained calcite; structures to at least 6cm and show parallel orientation.

T.S.:
75% CALCITE--40% micrite, extremely impregnated with magnetite. 35% sparry, anhedral to subhedral crystals to 1.5mm in size; some fractured; some include dusty or detrital magnetite.

25% MAGNETITE--veinlets and laminae to .5mm wide; laminae draped over ovoid of sparry calcite, remainder is incorporated with calcite.

Sample: I-11 Claim: Blue Rose 1
Name: siliceous limestone
Photo: Figure 7b, page 20.

H.S.: Bright orange to greenish, intensely altered limestone; approximately 20% black (magnetite?) dendrites; veinlets of pyrite.

T.S.:

35% CALCITE--sparry; anhedral crystals to 1mm in size, appear to be recrystallized; also as fine-grained 'matrix' surrounding quartz, plagioclase, and magnetite crystals.

30% QUARTZ--anhedral crystals to .3mm in size, some forming very large aggregates; borders recrystallized; most display undulatory extinction; some are fractured; some severely stained or altered by limonite(?).

10% PLAGIOCLASE--anhedral to subhedral crystals averaging .1mm in size; some interstitial; twinned.

10% MAGNETITE--euhedral to anhedral crystals to 2mm in size; also in veinlets to 10mm long, some fractured, some with drag folds, some with muscovite inclusions or cross-cut by muscovite veinlets; altering to hematite and limonite(?).

10% LIMONITE(?)--as alteration; orange-brown stain throughout sample; no crystal structure.

5% MUSCOVITE--subhedral, lath to rod-shaped crystals to 1mm long; occurs in very thin veinlets or fracture fillings and as veinlets surrounding and included in the magnetite; also as sericite; extensively altering and/or included in quartz, plagioclase, and calcite crystals.

Claim: Midnight, LM-1

Sample: E-34
Name: pink, well-sorted, feldspathic, fine-grained quartzite
Photo: Figure 8b, page 21.

H.S.: Pink, well-sorted, feldspathic, fine-grained quartzite; most grains appear recrystallized; a few quartz grains to .3mm in size; feldspars fine-grained and white in color; some thin fractures with 1mm thick white bleached zones; weathered surfaces either orange-tan in color, or pink with black manganese(?) dendrites which continue throughout the inside of the rock; some dendrites contain trace amounts of gold.

T.S.:

50% QUARTZ--grains average .1mm in size; all show undulatory extinction; most angular and anhedral with indistinct, interlocking, or sutured grain boundaries; large grains to .3mm in size are fractured and may include euhedral, lath-shaped plagioclase crystals.

47% PLAGIOCLASE--euhedral to anhedral, lath-shaped crystals to .9mm in size; borders embayed by quartz or other feldspars; extensively altered or masked by red-brown stain; crude albite twinning present in some; most have undulatory extinction.

3% MAGNETITE--subhedral to anhedral crystals .2-.8mm in size or as patches of alteration in and around other grains; also as microfracture fillings (dendrites?); some altering to hematite.

Sample: O-5 Claim: LM-1
Name: greenish, well-sorted, feldspathic, chloritic, fine-grained quartzite

H.S.: Same quartzite as sample E-34, but altered to patchy green, greenish-gray, and pink colors; weathered surfaces medium gray to brown.

T.S.:

60% QUARTZ--anhedral, subangular to subrounded grains (crystals) averaging .2mm in size; sutured to mosaic textures; some with undulatory extinction; a few fractured grains; some with dusty magnetite inclusions.

20% PLAGIOCLASE--almost completely altered to sericite aggregates; crystals appear subhedral to anhedral, averaging .1-.2mm in size.

15% CHLORITE--anhedral crystals; pleochroic cream to light green, with brown alteration; associated with and altering much of the feldspar.

3% MAGNETITE--subhedral to anhedral crystals averaging .1mm in size; some as inclusions in quartz.

2% BIOTITE--brown, anhedral crystals altering to chlorite.

Sample: E-12 Claim: ABD-1
Name: limestone pebble parabreccia

H.S.: Breccia composed of subangular and subrounded, coarse sand to cobble sized (1-80mm), black limestone clasts; supported in an aphanitic, cream and dark brown colored matrix; weathered matrix is gray-tan in color and chalky textured.

T.S.:
80% Clasts--black micrite

20% Matrix--appears to be large, altered crystals, but composed of very small interlocking (mosaic texture) crystals and a few clear, rod-shaped crystals, possibly magnesite; also altered red-brown areas composed of isotropic, extremely corroded or pseudomorphic crystals to .6mm in size (limonite?).

Claim: Blue Rose 1

Sample: H-2
Name: oligomictic pebble orthobreccia

H.S.: Breccia composed of subangular to subrounded, fine to very coarse pebble sized clasts of pink monzonite and light gray limestone; extremely altered, aphanitic, orange colored matrix (similar to sample I-11); mainly clast supported.

T.S.:

75% Clasts--micrite with some magnetite, stained; quartz monzonite with phenocrysts of euhedral to subhedral microcline, anhedral quartz with microfractures, and dusty magnetite; quartzite, some with fractures.

25% Matrix--magnetite, anhedral to rod-shaped crystals to .8mm, some filling veinlets or fractures in clasts, altering to hematite; limonite(?), alteration product of magnetite, producing orange-brown stain throughtout; 2% almandite(?), isotropic, clear to pale pink, anhedral crystals to .8mm in size, no cleavage.

Igneous Rocks--stock samples

Sample: G-8 Claim: Black Knight
Name: monzonite porphyry

H.S.: Porphyritic; pink to light purple fine-grained groundmass with large (to 6mm) translucent potassium feldspar phenocrysts and smaller white plagioclase(?) phenocrysts; approximately 5% mafic minerals; no visible quartz; weathers to light purple with white, altered phenocrysts; some yellow iron staining.

T.S.:

55% MICROCLINE(?)--euhedral to anhedral, tabular to lath-shaped crystals to 6mm in size; strong concentric zonation; some kaolinization; 61% of total feldspar.

35% PLAGIOCLASE--subhedral to euhedral, tabular to lath-shaped crystals to 3mm long; pericline, albite, and Carlsbad twinning; some appear armored with microcline; sericitized, especially the cores; 39% of total feldspar.

5% QUARTZ--interstitial, to .6mm.

2% MAGNETITE--anhedral, to .6mm.

1% BIOTITE--subhedral to anhedral, pleochroic beige to light brown crystals; most corroded and altered to sphene, chlorite, and magnetite; original crystals to 2mm in length.

1% CHLORITE--anhedral to subhedral laths to 1.4mm in size; slightly pleochroic, pale bluish green to cream green.

1% SPHENE--euhedral to anhedral, to .3mm.

Sample: G-11 Claim: Black Knight
Name: monzonite porphyry

H.S : Porphyritic; gray-brown, aphanitic groundmass with purple potassium feldspar phenocrysts to 1.5cm in size and transparent to white, smaller plagioclase phenocrysts; numerous vugs, some filled with mafic minerals; weathers chalky brown.

T.S.:

45% MICROCLINE--subhedral, pitted crystals to 8mm in size; braided twinning; plagioclase inclusions; 50% of total feldspar.

44% PLAGIOCLASE--euhedral laths to 2mm in size; pericline twinning; some with magnetite inclusions; most are extremely sericitized; 50% of total feldspar.

1% QUARTZ--stained red-brown.

10% BIOTITE--euhedral laths and tabular-shaped crystals to .8mm in length; pleochroic medium brown to dark red-brown; altering to chlorite, magnetite, and sphene.

CHLORITE--euhedral, light green crystals.

MAGNETITE--subhedral to anhedral, to .8mm in size.

SPHENE--euhedral, narrow rhombs.

Sample: H-6 Claim: Blue Rose 1
Name: granite porphyry

H.S.: Black and white, laminated, aphanitic to fine-grained rock; euhedral to subhedral, white potassium feldspar (?) phenocrysts to 6mm in size; laminae folded; a few vugs filled with oxidized mafic mineral; weathered surface has yellow-brown iron stain.

T.S.:
MICROCLINE--euhedral to subhedral phenocrysts to 3.5mm in size; vague braided twinning; square to rectangular fracture or cleavage pattern; inclusions of anhedral quartz and magnetite.

QUARTZ--interstitial to anhedral crystals approximately .02mm in size; beige color where no magnetite.

MAGNETITE--altered, brown crystals forming laminae.

HEMATITE--numerous anhedral to subhedral crystals to .1mm in size.

Sample: H-7 Claim: Blue Rose 1
Name: granite porphyry
Photo: Figure 10b, page 26.

H.S.: Porphyritic; pink to lavender, aphanitic to fine-grained groundmass with white potassium feldspar and quartz(?) phenocrysts; veinlets and aggregates of mafic mineral(s); a few grains of red (hematite?) mineral; hematite and greenish mineral where veinlets intersect.

T.S.:

61% MICROCLINE--subhedral to anhedral crystals averaging .2-.4mm, with larger crystals to 1mm; vague braided twinning; extremely kaolinized; 88% of total feldspar.

25% QUARTZ--anhedral to interstitial crystals to .9mm in size; undulatory extinction; some with feldspar inclusions.

8% PLAGIOCLASE--subhedral to anhedral tabular crystals to .2mm long; faint pericline twinning; extensively sericitized; 12% of total feldspar.

5% MAGNETITE--anhedral crystals to .4mm in size; some forms veinlet with chlorite and aegirine.

1% HEMATITE--alteration of magnetite; tiny red crystals and orange-brown stain on feldspars.

Sample: I-1
Name: granite

Claim: Blue Rose 1

H.S.: Pink to lavender, coarsely crystalline, equigranular rock; twinned feldspars to 4mm in size; aggregates of mafic mineral to 1cm in size; a few small vugs; weathers to light pink and black.

T.S.:

80% MICROCLINE--subhedral to anhedral, tabular crystals averaging .3-.5mm (to 2.5mm) in size; braided and gridiron twinning; extensive kaolinization.

15% QUARTZ--anhedral to interstitial crystals averaging .4mm (to 1.4mm) in size; undulatory extinction.

2% BIOTITE--anhedral, red-brown crystals and fracture fillings; most altered to sphene and magnetite.

1% SPHENE--subhedral to anhedral crystals to .4mm in size.

1% MAGNETITE--subhedral to anhedral crystals to .3mm in size; some altered to hematite.

1% PLAGIOCLASE--subhedral laths, to .2mm; albite twinning.

Claim: DA-10

Sample: L-1
Name: monzonite

H.S.: Lavender-gray, medium to coarse-grained rock; pink potassium feldspar and white plagioclase crystals with mafic minerals; crystal boundaries indistinct--appears recrystallized or altered, probably by volcanic flows; weathers gray-tan and red-brown.

T.S.:

48% MICROCLINE(?)--interstitial to subhedral crystals to 1.4mm; strong concentric zonation; fractured; mottled appearance (twinning?) under crossed nicols; some kaolinization; 55% of total feldspar.

39% PLAGIOCLASE--subhedral to anhedral laths to 2.5mm in length; albite and pericline twinning; some appear to be cores with overgrowths; crystals extensively recrystallized; some sericitized; 45% of total feldspar.

3% QUARTZ--anhedral to interstitial, to .8mm in size.

10% HORNBLENDE--crystals or aggregates of intergrown crystals to 2mm in size; amphibole cleavage; pleochroic very pale tan-green to medium green; altering to biotite, magnetite and sphene.

BIOTITE--subhedral to anhedral, pleochroic tan to dark red-brown crystals to .3mm in size; included in and as alteraton of hornblende;

MAGNETITE--euhedral to anhedral crystals to .8mm.

SPHENE--euhedral to subhedral crystals to 1mm.

Sample: N-1 Claim: Black Knight
Name: monzonite porphyry
Photo: Figure 10a, page 26.

H.S.: Porphyritic; lavender to pinkish brown, fine-grained groundmass with large (to 8mm) translucent feldspar phenocrysts; numerous small vugs filled with mafic minerals; weathered surface lavender to gray-tan with iron oxide staining; oval aggregate of mafic mineral(s) on surface.

T.S.:

55% MICROCLINE(?)--euhedral to anhedral, tabular to lath-shaped crystals to 8mm in size; concentric zonation; some kaolinization; 61% of total feldspar.

35% PLAGIOCLASE--subhedral to euhedral, lath-shaped crystals to 3mm long; pericline, albite, and Carlsbad twinning; partially sericitized; 39% of total feldspar.

5% QUARTZ--interstitial, to .6mm.

2% BIOTITE--euhedral, pleochroic beige to light brown crystals averaging .3mm (to 4mm) in size; partially altered to magnetite, sphene and chlorite.

2% MAGNETITE--subhedral, to .6mm.

.5% CHLORITE--anhedral to subhedral laths to 1.4mm; slightly pleochroic, pale bluish green to cream green.

.5% SPHENE--euhedral to anhedral, to .2mm.

Claim: Black Knight

Sample: N-3
Name: monzonite porphyry
Photo: Figure 10a, page 26.

H.S.: Porphyritic; lavender, very fine-grained groundmass with feldspar phenocrysts and several cross-cutting veinlets composed of mafic minerals; weathered surface chalky, light to medium brown.

T.S.:

54% MICROCLINE--averages .1-.2mm in groundmass; anhedral tabular phenocrysts to 1mm, euhedral to .5mm; braided and Carlsbad twinning; 61% of total feldspar.

34% PLAGIOCLASE--averages .1-.2mm in groundmass; subhedral tabular to lath-shaped phenocrysts to .5mm in size; sericitized; 39% of total feldspar.

7% QUARTZ--anhedral to interstitial, to .5mm in size; some interlocking.

2% BIOTITE--anhedral; altering to chlorite.

2% MAGNETITE

1% AEGIRINE(?)

Sample: U-4 Claim: ABD-20
Name: granite porphyry
Photo: Figure 10a, page 26.

H.S.: Porphyritic; lavender, fine-grained to aphanitic groundmass with pink to white potassium feldspar phenocrysts; some visible quartz; dark red crystals and aggregates; mafic minerals; a few small vugs; weathered surface pinkish gray.

T.S.:

74% MICROCLINE--euhedral to anhedral, tabular and lath-shaped crystals; groundmass averages .4mm, phenocrysts to 2mm in size; kaolinized.

25% QUARTZ--anhedral to interstitial, to .5mm in size; undulatory extinction.

1% MAGNETITE--anhedral crystals ~.1mm in size; hematite alterations.

Igneous Rocks--dike samples

Sample: D-13 Claim: ABD-7/Judy 3
Name: diorite porphyry (type 4)

H.S.: Porphyritic; grayish tan aphanitic groundmass; numerous euhedral to subhedral lath and tabular-shaped feldspar phenocrysts, light gray altered to cream color, multiply twinned; weathers to a brown color.

T.S.:

85% PLAGIOCLASE--25% phenocrysts; euhedral to subhedral tabular and lath-shaped crystals to 3mm in size; albite twinning shows where sericite absent; some with biotite and magnetite. 60% groundmass; laths .1-.2mm in size; sub-trachytic texture; sericite and dusty magnetite. 92% of total feldspar.

7% MICROCLINE(?)--subhedral to anhedral phenocrysts to 5mm in size; braided twinning (or perthite); some concentric zonation; 8% of total feldspar.

7% MAGNETITE--subhedral crystals to .6mm, and dusty; also in veinlets.

1% BIOTITE--anhedral, yellowish brown crystals to 2.3mm in size; most altering to magnetite, some to chlorite.

tr CHLORITE--alteraton of biotite.

Sample: D-23 Claim: ABD-5/ABD-8
Name: porphyritic diorite (type 4)

H.S.: Porphyritic; light gray, aphanitic to fine-grained groundmass with a few white phenocrysts to 2mm; weathers grayish brown.

T.S.:

74% PLAGIOCLASE--1% phenocrysts; euhedral to subhedral, to 2.2mm; totally altered except around rims; albite twinning. 73% groundmass; subhedral to anhedral laths and blades to .7mm; albite twinning; trachytic texture. 78% of total feldspar.

21% MICROCLINE(?)--1% phenocrysts; subhedral, to 2mm in size; some kaolinization. 20% groundmass; subhedral laths averaging .5mm in length; Carlsbad twinning. 22% of total feldspar.

5% MAGNETITE--anhedral crystals to .03mm; a few altered to hematite.

Sample: E-10 Claim: Judy 1
Name: porphyritic diorite (type 4)

H.S.: Porphyritic, light gray, aphanitic groundmass with light pink to white phenocrysts to 6mm; weathers to rust orange color due to oxidation of mafic minerals.

T.S.:

91% PLAGIOCLASE--1% phenocrysts; anhedral, skeletal crystals to 1.6mm; fractures filled with quartz; extensive alteraton. 90% groundmass; indistinct, anhedral to euhedral laths .1-.2mm in size; trachytic texture. 97% of total feldspar.

5% MAGNETITE--euhedral, hexagonal to square crystals to .15mm; some is completely altered to hematite, which has stained and obscured much of the groundmass.

3% MICROCLINE(?)--1% phenocrysts; anhedral crystals to 4mm; some inclusions of and embayments by plagioclase; most obscured by extensive alteration. 2% groundmass; indistinct, anhedral crystals averaging .2mm in size. 3% of total feldspar.

1% QUARTZ--anhedral crystals to .6mm; some composite grains; undulatory extinction.

Claim: Midnight

Sample: E-28
Name: gabbro porphyry (type 5)
Photo: Figure 12c, page 33.

H.S.: Dark grayish green, mottled, aphanitic rock; weathers dark green with some iron oxide staining.

T.S.:

64% PLAGIOCLASE (calcic)--4% phenocrysts; euhedral to subhedral laths and tabular-shaped crystals to .8mm; concentric zonation and hour glass undulatory extinction; no visible twinning. 60% groundmass; anhedral, very fine-grained; obscured by dark rock color.

20% AEGIRINE-AUGITE--10% phenocrysts; euhedral to subhedral laths and blades to 1mm in length; parallel cleavage; concentric zonation; pleochroic colorless to very pale green; blades trachytic; some altered cores. 10% groundmass; tiny rod-shaped crystals.

12% MAGNETITE--euhedral to subhedral crystals averaging .05mm in size; a few altering to hematite.

4% BIOTITE--euhedral to anhedral blade-shaped phenocrysts to 1.3mm; mildly pleochroic, cream color to light greenish tan; altering to magnetite, muscovite, and a little chlorite.

Sample: F-3 Claim: LM-1/Midnight
Name: monzonite porphyry (type 2b)
Photo: Figure 12c, page 33.

H.S.: Porphyritic; purplish gray aphanitic groundmass with numerous phenocrysts; white, euhedral lath-shaped phenocrysts to 1mm in size; dark gray, euhedral tabular to blocky-shaped phenocrysts to 4mm; clear to purple crystals or aggregates to 1.4cm; mafic phenocrysts and aggregates; weathered surface rust orange, purple, brown, and green colored.

T.S.:

53% PLAGIOCLASE--23% phenocrysts; euhedral laths and tabular-shaped crystals to .9mm; albite and pericline twinning; a few completely altered to muscovite. 30% groundmass; blades and lath-shaped crystals; sub-trachytic texture; average size .06mm. 65% of total feldspar.

28% MICROCLINE--3% phenocrysts; euhedral, tabular crystals to 1mm; vague gridiron twinning. 25% groundmass; laths average .06mm; sub-trachytic texture. 35% of total feldspar.

5% BIOTITE--subhedral phenocrysts to .8mm in size; pleochroic medium yellowish brown to dark red-brown; altering to magnetite and chlorite.

5% MAGNETITE--euhedral to subhedral blades averaging .2mm (to .6mm) in size, and as veinlets.

3% QUARTZ--anhedral masses to .5mm and composite grains to 3mm; partially intergrown with calcite.

2% CALCITE--anhedral crystals to .5cm in size; partially surrounding and intergrown with quartz.

2% MUSCOVITE--as sericitic alteration of plagioclase.

1% HEMATITE--as alteration of magnetite.

1% CHLORITE--as alteration product of biotite.

Sample: F-9 Claim: Midnight
Name: monzonite porphyry (type 2b)
Photo: Figure 12b, page 33.

H.S.: Porphyritic; light pink aphanitic groundmass with numerous phenocrysts; lavender, euhedral to subhedral potassium feldspar phenocrysts to 1.5cm, with altered cores and Carlsbad twinning visible; white to gray, anhedral to euhedral plagioclase phenocrysts to 4mm in size; approximately 5% mafic minerals; weathers to a dark limonite brown color.

T.S.:

55% PLAGIOCLASE--15% phenocrysts; subhedral laths to 1.2mm long; pericline and albite twinning; some totally sericitized. 40% groundmass; subhedral to anhedral, indistinct crystals. 58% of total feldspar.

40% MICROCLINE(?)--30% phenocrysts; euhedral to subhedral to 1cm in size; slight braided twinning (or perthite?); some Carlsbad twinning; some euhedral plagioclase and small magnetite inclusions; smaller crystals are partially kaolinized. 10% groundmass; subhedral to anhedral, indistinct crystals. 42% of total feldspar.

2% MAGNETITE--anhedral to subhedral crystals, and dusty, in groundmass; alteraton product of biotite.

2% CHLORITE--subhedral to anhedral crystals; alteration product of biotite.

1% BIOTITE--subhedral, mostly skeletal, lath-shaped crystals to 1mm in size; pleochroic tan to dark greenish brown; mostly altered to magnetite and chlorite.

Sample: H-11 Claim: Blue Rose 1
Name: diorite porphyry (type 4)
Photo: Figure 12b, page 33.

H.S.: Porphyritic; pinkish buff, fine-grained, needle to lath-shaped groundmass; white to light green, euhedral and subhedral lath-shaped and tabular phenocrysts to .5cm in size, some multiply twinned or zoned; small patches of black opaques (magnetite?), some are oxidized; weathers to gray-tan.

T.S.:

80% PLAGIOCLASE--as unoriented groundmass; subhedral, blade-shaped laths averaging 1mm in size; pericline and albite twinning; 89% of total feldspar.

10% MICROCLINE(?)--subhedral to euhedral, tabular phenocrysts to 6mm; some magnetite included; crystals obscured by almost complete alteration; 11% of total feldspar.

6% MAGNETITE--euhedral, blade-shaped crystals and veinlets to .6mm in size.

3% HEMATITE--anhedral masses to 1mm; alteration of magnetite.

<1% QUARTZ--anhedral crystals, .7mm.

Sample: I-3 Claim: Blue Rose 1
Name: quartz monzonite porphyry (type 2a)
Photo: Figure 12a, page 33.

H.S.: Porphyritic; tan and gray aphanitic groundmass with white, lath-shaped phenocrysts to 4mm in size; scattered aggregates or patches of mafic minerals; sample altered; weathers brown to brownish gray.

T.S.:
49% PLAGIOCLASE--indistinct mesh of crystals averaging .2mm in size; as groundmass; 66% of total feldspar.

25% ORTHOCLASE(?)--6% phenocrysts; euhedral, to 5mm. 19% groundmass; indistinct crystals. 34% of total feldspar.

15% QUARTZ--anhedral, to .6mm.

10% MAGNETITE--subhedral, to .1mm.

1% BIOTITE--brown, anhedral crystals to .3mm; most altered to magnetite.

tr FLUORITE(?)--isotropic; clear and deep purple colored; 2 sets of cleavage; associated with quartz.

Claim: Blue Rose 1

Sample: I-7
Name: porphyritic granite (type 1)
Photo: Figure 12a, page 33.

H.S. Porphyritic; beige, aphanitic groundmass with a few lath-shaped plagioclase? phenocrysts to 3mm; some small vugs filled with oxidizing mafic mineral; weathers tan with rust-brown stain.

T.S.:

75% ORTHOCLASE--subhedral to anhedral phenocrysts to .5mm and as smaller, anhedral masses in the groundmass; 88% of total feldspar.

10% PLAGIOCLASE--subhedral laths to .2mm; twinning indistinct; 12% of total feldspar.

10% QUARTZ--anhedral crystals to .8mm, in groundmass.

5% MAGNETITE--anhedral crystals to .2mm, and dusty; altering to hematite.

Sample: I-9 Claim: Blue Rose 1
Name: quartz monzonite porphyry (type 2a)

H.S.: Porphyritic; dark grayish purple aphanitic to fine-grained groundmass; gray, euhedral to anhedral feldspar phenocrysts to 2mm; mafic minerals; some thin fractures and veinlets; weathers grayish purple with chlorite? and specular hematite on surface.

T.S.:

46% MICROCLINE--21% phenocrysts; euhedral to subhedral, tabular to hexagonal crystals, from .1-1.3mm in size; braided, gridiron, and Carlsbad twinning; some kaolinization. ~25% groundmass; pinkish beige microlites. 65% of total feldspar.

25% PLAGIOCLASE--as microlites forming part of the groundmass; 35% of total feldspar.

18% QUARTZ--euhedral to subhedral hexagonal and rhombic phenocrysts to .6mm; also as microlites in groundmass.

10% MAGNETITE--1% subhedral crystals averaging .06mm; 9% dusty grains throughout the groundmass.

1% CHLORITE--anhedral crystals .2mm in size; alteration product of biotite?.

tr SPHENE--alteration by-product.

Sample I-14 Claim: DA-5
Name: granite porphyry (type 1)
Photo: Figure 12a, page 33.

H.S.: Porphyritic; medium gray, fine-grained to aphanitic groundmass; phenocrysts and veinlets of mafic minerals; light pink, euhedral to subhedral potassium feldspar phenocrysts to .5cm in size; weathered surface has brown and yellow oxidized iron stain, which penetrates 1cm into the rock.

T.S.:

54% MICROCLINE--3% phenocrysts; subhedral, to 4mm; vague gridiron twinning; some quartz inclusions. 51% groundmass; indistinguishable crystals, obscured by magnetite.

36% QUARTZ--anhedral masses in groundmass and as crystals to .4mm; undulatory extinction.

10% MAGNETITE--euhedral to anhedral blades to .2mm long; some completely altered to hematite.

Sample: J-1 Claim: south of DA-11/DA-12
Name: granodiorite porphyry (type 3)

H.S.: Porphyritic; grayish tan aphanitic groundmass; phenocrysts and aggregates of white, subhedral to euhedral, lath-shaped feldspars 1-4mm in size; phenocrysts and aggregates of mafic minerals to 1cm in size constitute approximately 10% of the rock; weathered surface orange-brown in color.

T.S.:

55% PLAGIOCLASE--as microlites with quartz in groundmass; average size ~.02mm; 73% of total feldspar.

20% MICROCLINE(?)--subhedral phenocrysts to 2mm in size; obscured by alteration; 27% of total feldspar.

12% QUARTZ--2% phenocrysts; anhedral, to .3mm. 10% groundmass; microlites.

10% MAGNETITE--anhedral to subhedral crystals to .4mm; some altering to hematite.

3% BIOTITE--subhedral, lath-shaped crystals to .4mm; pleochroic dark beige to almost black; a few grown into microclines; altering to magnetite and chlorite.

tr CHLORITE--alteration from biotite.

Sample: O-7 Claim: east of ABD-3
Name: diorite porphyry (type 4)
Photo: Figure 12b, page 33.

H.S. Porphyritic; pinkish tan very fine-grained groundmass; pink to white phenocrysts of potassium feldspar to 1cm in size; mafic minerals in aggregates and as vug fillings; weathered surface pinkish tan with yellow iron oxide staining.

T.S.:

69% PLAGIOCLASE--4% phenocrysts; euhedral laths to .5mm; pericline twinning. 65% groundmass; indistinct subhedral blades and lath-shaped crystals form trachytic texture; some sericite. 73% of total feldspar.

25% MICROCLINE--euhedral to subhedral lath to tabular-shaped phenocrysts to 6mm in size; braided twinning; some plagioclase embayments; kaolinized cores and extremely altered crystals; 27% of total feldspar.

5% MAGNETITE--anhedral to subhedral crystals to .3mm; alteration product of biotite.

1% BIOTITE--brownish green subhedral blades to 2.5mm long; altering to muscovite and magnetite.

Sample: Z-3 Claim: Blue Rose 1
Name: quartz monzonite porphyry (type 2a)

H.S.: [fresh specimen of altered samples I-3 and I-9]
Porphyritic; light pink groundmass with numerous pink potassium feldspar phenocrysts and some white plagioclase phenocrysts; visible quartz; ~5% mafic minerals; weathered surface extensively altered to limonite and/or goethite, with mafic dendrites and large patches of specular hematite.

Volcanic Rocks

Claim: ABD-4

Sample: D-9
Name: calcareous, chloritic, oligomictic, flow paraconglomerate
Photo: Figure 13a, page 37.

H.S.: Conglomerate with oval clasts of pink micrite, and flattened oval to irregularly shaped clasts of maroon siltstone (Bernal formation), to 1.5cm in size; all clasts in parallel orientation, thus forming flow structure; clasts supported in an aphanitic green matrix; cream colored and bright orange alterations surround the clasts; specular hematite in patches and aggregates of needle-shaped crystals composes about 5% of the matrix; weathered surface is dark grayish brown and pumiceous.

T.S.:

43% CALCITE--Matrix: subhedral sparry crystals to .4mm in size and micrite; occurs in aggregates with irregular boundaries which blend into chlorite, or as continuous matrix material; pervasive red-brown stain near hematite and around siltstone clasts. Clasts: composed of micrite; rounded, to 8mm in size; some small inclusions of euhedral to anhedral magnetite and hematite crystals.

30% CHLORITE--as matrix; light green, anhedral to subhedral crystals to .1mm in size; aligned parallel to flow direction; dominant matrix material in some areas and as veinlets or fracture fillings in some clasts.

20% QUARTZ--Matrix: angular to subrounded grains to .4mm; some boundaries indistinct; some undulatory extinction; enclosed by both calcite and chlorite. Clasts: maroon or opaque siltstone (a few grains to .06mm) clasts to 4mm in size; shapes are flat and stretched, some are contorted or kinked; some borders corroded and blending into the matrix; all aligned parallel to flow.

7% MAGNETITE & HEMATITE--anhedral to euhedral blade-shaped crystals to 2mm in size; in matrix and included in some clasts.

Claim: ABD-7

Sample: D-4
Name: white, well-sorted, medium-grained quartzite
Photo: Figure 8b, page 21.

H.S.: White, well-sorted, coarse or medium-grained quartzite; swirls of bright red, orange, and black colors due to magnetite and its oxidation products; weathered surface is pinkish tan color.

T.S.:
96% QUARTZ--angular to subrounded grains averaging .4mm in size; some sutured grain boundaries and composite grains; most show mild to extreme undulatory extinction and are fractured; abundant dusty to fine-grained magnetite inclusions.

4% MAGNETITE--interstitial patches to .6mm and as inclusions in quartz; altering to hematite.

Sample: D-7 Claim: ABD-7
Name: nodular quartzite
Photo: Figure 19, page 52.

H.S.: Same quartzite as sample D-4, but with nodules of magnetite and specular hematite to 5cm in diameter; mafic mineral 'halo' or concentric zonation around nodules; color varies from buff to yellow to deep red, resulting in an overall purplish-red appearance; 2mm thick black coating on some weathered surfaces.

T.S.:

90% QUARTZ--extremely deformed, angular to subrounded grains averaging .4mm in size; fractured and mosaic grains, boundaries sutured or indistinct; some microfractures cross-cut grains.

10% MAGNETITE--composes nodules and as interstitial crystals to .5mm surrounding nodules; altering to hematite (and limonite?), which stains quartz grains.

Sample: B-7 Claim: ABD-8
Name: trachyte porphyry

H.S.: Porphyritic; white to light greenish gray, pumiceous to amygdaloidal, very fine-grained groundmass; light pink, euhedral feldspar phenocrysts to .5cm; numerous vugs <.5cm often filled with mafic minerals, parallel to subparallel orientation when oval; weathered surface tan.

T.S.:

86% SANIDINE--16% phenocrysts; euhedral to subhedral, tabular crystals to 6mm in size; some composite crystals; concentric zonation; some fractured; inclusions of anhedral quartz, plagioclase, magnetite, and biotite; kaolinized, especially the cores. 70% groundmass; anhedral to subhedral, blade-shaped, indistinct crystals averaging <.1mm in size; trachytic, quenched texture. 92% of total feldspar.

8% PLAGIOCLASE (Andesine)--7% phenocrysts; euhedral to anhedral lath-shaped crystals to 1.5mm in size; many are composite; pericline and some albite twinning; inclusions of biotite and magnetite; extensively sericitized, especially the cores. 1% groundmass; lath-shaped crystals to .4mm. 8% of total feldspar.

2% QUARTZ--anhedral crystals averaging .2mm, in groundmass.

2% BIOTITE--euhedral to subhedral, tabular to lath-shaped crystals to .6mm in size; pleochroic pale green to dark greenish brown; some plagioclase inclusions; some extremely corroded.

2% MAGNETITE--euhedral to anhedral, hexagonal crystals to .3mm; in groundmass and as inclusions in phenocrysts.

Claim: DA-11

Sample: S-2
Name: latite-andesite porphyry

H.S.: Porphyritic; gray-tan very fine-grained groundmass; light purple, euhedral, lath-shaped potassium feldspar phenocrysts to .5cm, some with altered cores, Carlsbad twinning, oriented parallel to flow causing trachytic texture; some magnetite and biotite crystals; mafic dendritic alterations; weathers to a distinctive gray-tan color with some limonite? and mafic coatings.

T.S.:

43% PLAGIOCLASE--1% phenocrysts; subhedral laths to 1.2mm; vague pericline twinning. 42% groundmass; indistinct, bladed microlites forming a quenched, trachytic texture; albite twinning. 65% of total feldspar.

23% SANIDINE--15% phenocrysts; euhedral, lath to tabular-shaped crystals to 4mm; Carlsbad twinning; inclusions of biotite and euhedral plagioclase; alteration along rims. 8% groundmass; microlites, contributing to trachytic texture. 35% of total feldspar.

21% BIOTITE--brown, subhedral to euhedral blade and lath-shaped crystals to .5mm.

10% MAGNETITE--euhedral to anhedral crystals averaging .02mm (to .3mm) in size.

3% SPHENE--euhedral crystals to 1mm; associated with biotite and magnetite.

Sample: S-7 Claim: Blue Rose 2
Name: latite-andesite porphyry
Photo: Figure 13b, page 37.

H.S.: Porphyritic; medium grayish brown, very fine-grained groundmass; white, twinned plagioclase phenocrysts <2mm in size; pink, euhedral, tabular potassium feldspar phenocrysts averaging 2cm in size; approximately 10% biotite; weathers medium brown-gray.

T.S.:

60% PLAGIOCLASE--6% phenocrysts; euhedral to subhedral laths and stubby crystals to 1.5mm; well-developed albite, pericline, and Carlsbad twinning; some extremely sericitized. 54% groundmass; indistinct lath-shaped microlites forming quenched, trachytic texture. 81% of total feldspar.

14% SANIDINE--euhedral, tabular phenocrysts to 2cm in size; inclusions of plagioclase and biotite (much altering to magnetite). 19% of total feldspar.

12% MAGNETITE--6% phenocrysts; euhedral to anhedral crystals averaging .2mm in size. 6% groundmass; crystals average .02mm in size.

8% BIOTITE--subhedral crystals to .8mm in size; strongly pleochroic, greenish cream color to dark red-brown; altering to magnetite and sphene; some plagioclase inclusions.

4% SPHENE--euhedral crystals to .8mm.

2% HORNBLENDE--euhedral crystals to .6mm in size; pleochroic tan to reddish brown.

Sample: T-1 Claim: east of ABD-20
Name: trachyte porphyry
Photo: Figure 14, page 41.

H.S.: Porphyritic; pinkish tan fine-grained groundmass; white, subhedral to anhedral phenocrysts to .5cm; anhedral mafic phenocrysts to 8mm and smaller blade-shaped crystals; biotite; weathers yellowish brown.

T.S.:
60% SANIDINE--subhedral phenocrysts to 1.7cm; zoned; plagioclase and biotite inclusions; smaller crystals in groundmass ~.3mm; 71% of total feldspar.

25% PLAGIOCLASE--subhedral to euhedral phenocrysts to 2mm; pericline and albite twinning; rims extensively altered; euhedral laths in groundmass ~.2mm; 29% of total feldspar.

5% MAGNETITE--euhedral to anhedral crystals ~.2mm in size; alteration product of biotite and hornblende.

3% BIOTITE--pleochroic cream to red-brown; altering to sphene and magnetite.

3% AEGIRINE(?)--crystals to 3mm; replacing hornblende?

2% HORNBLENDE--brown crystals, altering to aegirine and magnetite.

2% SPHENE--euhedral rhombohedral crystals; by-product of biotite alteration.

Sample: U-1 Claim: ABD-19
Name: quartz latite conglomerate
Photo: Figure 14, page 41.

H.S.: Conglomeratic; dark gray to black, very fine-grained to aphanitic groundmass (matrix); angular to subangular pink lithic fragments to 3.5cm and small xenoliths >8cm; smaller, white phenocrysts; some hematite and red staining.

T.S.:

30% SANIDINE--anhedral to euhedral, tabular to lath-shaped crystals to .6mm; concentric zonation; some kaolinizaton; 50% of total feldspar.

30% PLAGIOCLASE--subhedral, tabular to lath-shaped crystals to .8mm; albite twinning; extensively sericitized.

25% QUARTZ--anhedral crystals to .3mm; mild undulatory extinction.

10% MAGNETITE--anhedral crystals to .3mm; some altered to hematite.

3% CHLORITE--alteration product of biotite.

2% BIOTITE--subhedral lath-shaped crystals to .5mm; pleochroic tan to dark red-brown; most altered to chlorite and magnetite.

Sample: U-2 Claim: east of ABD-20
Name: quartz latite conglomerate

H.S. Conglomeratic; cream to gray fine-grained groundmass (matrix); red lithic fragments to 1.5cm; veinlets of cream-colored feldspar; numerous small vugs, filled with oxidizing mafic mineral; weathers to an orangish tan color.

T.S.:

34% QUARTZ--20% anhedral crystals to .2mm; ~14% as microlites (~.01mm) forming a groundmass with feldspars.

33% PLAGIOCLASE--15% subhedral to anhedral, tabular crystals to .4mm; albite twinning; intensely sericitized; ~18% microlites in groundmass. 54% of total feldspar.

28% SANIDINE--10% anhedral crystals ~.2mm in size; ~18% microlites in groundmass. 46% of total feldspar.

4% MAGNETITE--anhedral; alteration product of biotite.

1% BIOTITE--brown anhedral crystals to .6mm.

Metamorphic Rocks

Claim: ABD-1

Sample: E-13
Name: gray marble
Photo: Figure 15a, page 44.

H.S. Medium to light gray marble with cross-cutting brown veinlets; weathered surface medium gray.

T.S.
96% CALCITE--recrystallized, interlocking, anhedral, equidimensional crystals .2-.5mm in size; most crystals have dusty magnetite inclusions.

4% MAGNETITE--anhedral crystals to .2mm in size; also as veinlets and fracture fillings in calcite.

Sample: E-32 Claim: Midnight
Name: pale gray marble
Photo: Figure 15a, page 44.

H.S.: Pale greenish gray, medium to coarsely crystalline marble; trace amounts of metallic, mafic mineral; weathered surface white-tan or sparkly gray.

T.S.:
93% CALCITE--recrystallized, interlocking, anhedral to subhedral crystals to 1mm in size; rhombohedral cleavage on the larger crystals; many fractured.

7% MAGNETITE--anhedral to interstitial crystals to .2mm in size; some altering to hematite and/or surrounded by grayish brown alteration.

Sample: I-5 Claim: Blue Rose 1
Name: forsterite marble
Photo: Figure 15a, page 44.

H.S.: Light gray, medium to finely crystalline marble; vague darker and lighter colored laminations; weathers to a light gray or white color.

T.S.:

89% CALCITE--recrystallized, anhedral to subhedral crystals from <.1mm-.4mm in size; some interlocking; turbid appearance due to brown-gray alteration; larger crystals have recrystallized around the olivines.

10% OLIVINE (Forsterite)--euhedral to subhedral, colorless crystals to 1.3mm in size; most fractured and/or intensely altered; some with twinning, overgrowths, magnetite alterations.

1% MAGNETITE--anhedral crystals to .1mm in size; as alteration product of olivine.

tr OPAL or CHALCEDONY--as microfracture fillings to .2mm wide; clear, isotropic, negative relief, weakly birefringent in places.

Sample: A-3 Claim: LM-1/Judy 1
Name: diopside skarn
Photo: Figure 15b, page 44.

H.S.: Dark to medium green, crystalline skarn; weathers tan-brown.

T.S.:

98% DIOPSIDE--very pale green, subhedral to anhedral, blocky to lath-shaped crytals to 2.5mm in size; some concentric zonation; some extensively fractured.

1% TREMOLITE--fibrous; alteration product.

1% MAGNETITE--subhedral crystals to .6mm; some hematite alteraion around rims.

Sample: E-22 Claim: ABD-2
Name: calcareous diopside skarn
Photo: Figure 16, page 47.

H.S.: Olive green aphanitic skarn rock; swirls and patches of magnetite crystals; cream colored and light gray veinlets; altered San Andres limestone.

T.S.:

50% CALCITE--micrite matrix with blocky spar as fracture fillings.

25% DIOPSIDE--subhedral crystals averaging .2mm in size.

10% QUARTZ--anhedral to interstitial in matrix; subhedral crystals as fracture fillings with calcite.

10% MAGNETITE--aggregates composed of anhedral to subhedral crystals to .3mm in size.

5% PHLOGOPITE(?)--euhedral to subhedral, lath to blade-shaped crystals to 1.2mm long; strongly pleochroic brownish red to green; most are fractured, some broken; aggregated in certain parts of the sample.

Claim: LM-1/DA-12

Sample: F-6
Name: diopsidic quartzite skarn

H.S.: Same quartzite as sample E-34, but green due to extensive diopside alteration (see sample A-3); fresh surface green with contorted laminae or 'veinlets' of unaltered pink quartzite; weathered surface chalky green with coatings of fine-grained, dark blue-green, needle-shaped crystals.

T.S.:

49% DIOPSIDE--subhedral to anhedral tabular to lath-shaped crystals averaging .1mm (to 1.1mm) in size; faintly pleochroic medium to light green; some larger crystals broken; crystals distributed throughout the sample and as solid patches or veinlets with interstitial magnetite.

25% QUARTZ--interlocking and sutured grains averaging .1mm in size; grain boundaries indistinct.

25% PLAGIOCLASE--interlocking and sutured grains, with quartz.

1% MAGNETITE--patches to 1.2mm in size, interstitial to diopside.

Sample: F-18 Claim: Midnight
Name: diopsidic quartzite skarn
Photo: Figure 16, page 47.

H.S.: Pink quartzite (sample E-34) extensively altered by skarn; blue, green, and brown coloration.

T.S.:
50% QUARTZ--altered by skarn formation; grains forming laminae varying from pure quartz to almost pure diopside.

45% DIOPSIDE--very pale green subhedral to anhedral crystals to .6mm in size; laminae ~8mm long grade into quartzite.

5% MAGNETITE--anhedral crystals <.2mm in size; a few with hematite veinlets; associated with the diopside.

Claim: Blue Rose II

Sample I-13
Name: diopside-magnetite skarn
Photo: Figure 16, page 47.

H.S.: Light green, finely crystalline diopside skarn; extensively impregnated and veined with magnetite; weathered surface green, black, and rust colored.

T.S.:

50% DIOPSIDE--pale greenish gray, subhedral to anhedral crystals to .8mm in size; most crystal boundaries grown together and indistinct; some enclosed by magnetite; appears to be replacing quartz in places; some turbid and hematite-stained crystals; some tremolite and talc alteration.

40% MAGNETITE--blade-shaped crystals, veinlets, and large (to mm's) aggregates; altering to hematite.

10% QUARTZ--anhedral grains and very thin veinlets; intergrown with diopside and cross-cut by magnetite; undulatory extinction.

Claim: Black Knight

Sample: O-8
Name: laminated diopside-magnetite skarn
Photo: Figure 18b, page 50.

H.S.: Magnetite, laminated with very pale green diopside.

T.S.:
59% DIOPSIDE--pale greenish gray, subhedral to anhedral crystals .05-.2mm in size; laminated with magnetite.

40% MAGNETITE--laminae, composed of interconnected angular to subrounded grains, to 2mm thick; some laminae continuous, others discontinuous and non-parallel.

1% MUSCOVITE--semi-fibrous crystals to 1mm; pleochroic pale pink to pale greenish blue; mottled extinction.

Sample: S-4 Claim: Blue Rose 2
Name: diopside skarn and granite
Photo: Figure 10b, page 26.

H.S.: Sample of dark green, crystalline skarn in contact with pink monzonite? from stock; 1cm thick zone of transition at contact; weathered surface tan and black.

T.S.:
Skarn:
100% DIOPSIDE--light green, subhedral and anhedral lath-shaped crystals and aggregates to 1mm in size; scatterd crystals grade into igneous portion at the contact.

Granite:
79% MICROCLINE--euhedral to subhedral tabular crystals to 1.2mm; gridiron and braided twinning; mild to extreme kaolinization.

29% QUARTZ--anhedral to interstitial crystals to .8mm; many fractured; extreme undulatory extinction.

1% MAGNETITE--anhedral grains to .3mm; altering to hematite.

APPENDIX B

MAGNETIC SURVEY PROFILES

---Data plotted is the magnetic reading (minus 50,000 for background), in gammas, versus station, in feet.

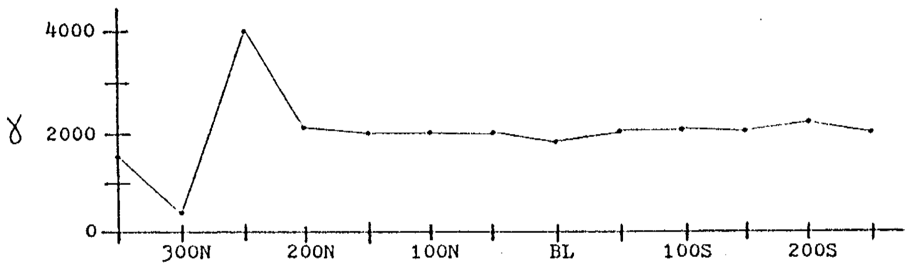
---Data points are connected with straight lines.

---BL = baseline

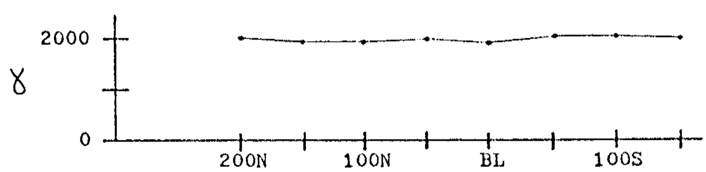
---An "m" under a point indicates that the reading was taken over a magnetite outcrop.

East Magnetic Survey

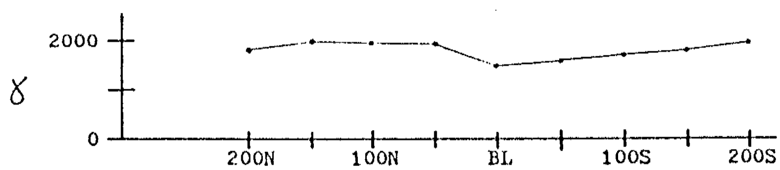
PROFILE OE



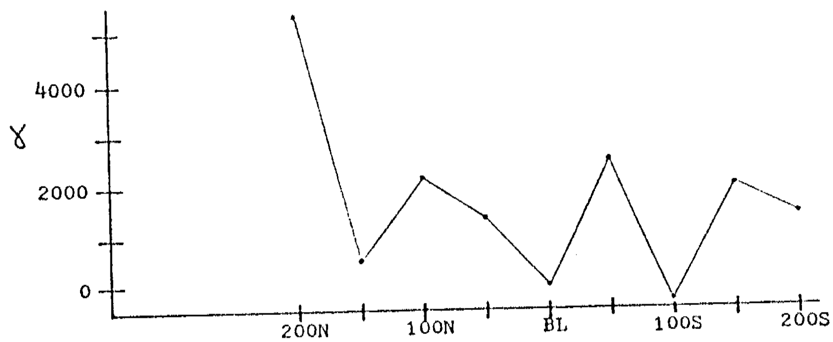
PROFILE 250E



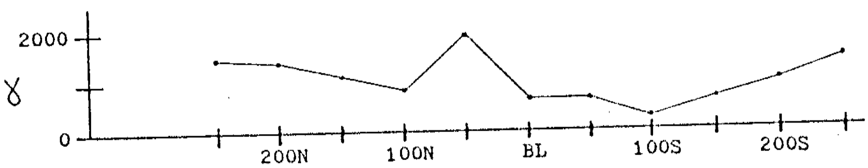
PROFILE 500E



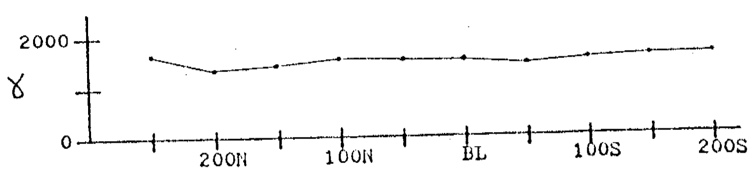
PROFILE 750E



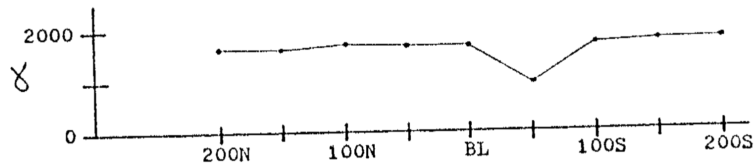
PROFILE 1000E



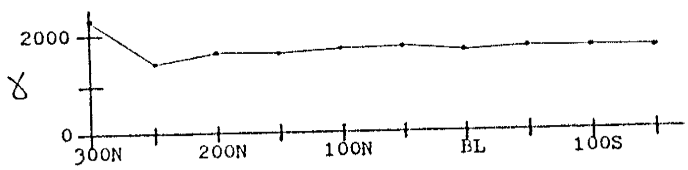
PROFILE 1250E



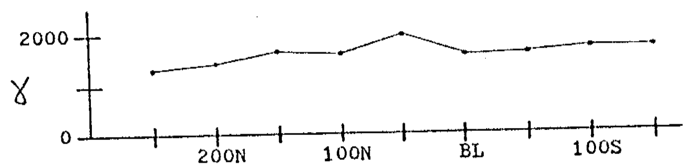
PROFILE 1500E

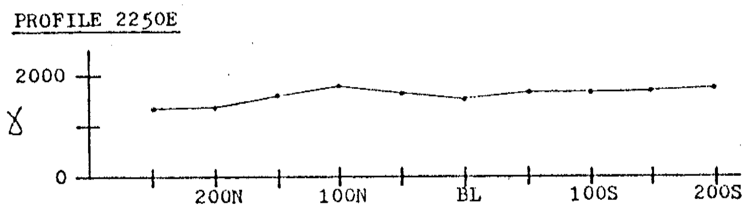


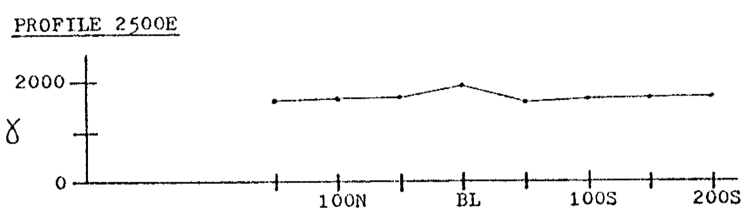
PROFILE 1750E

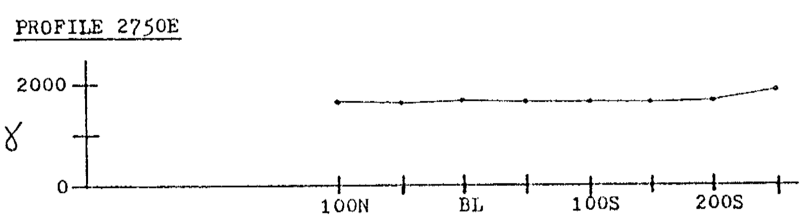


PROFILE 2000E

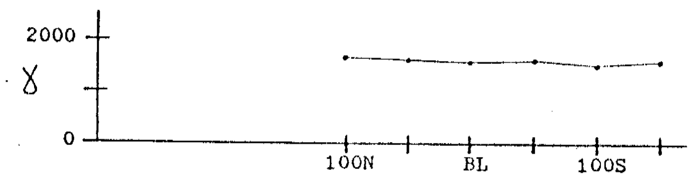



PROFILE 2250E
2000
γ
0
200N
100N
BL
100S
200S

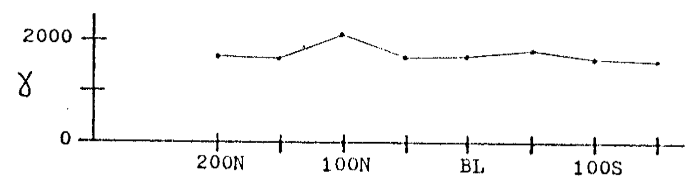

PROFILE 2500E
2000
γ
0
100N
BL
100S
200S


PROFILE 2750E
2000
γ
0
100N
BL
100S
200S

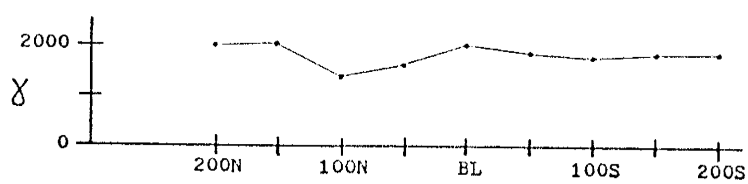
PROFILE 3000E



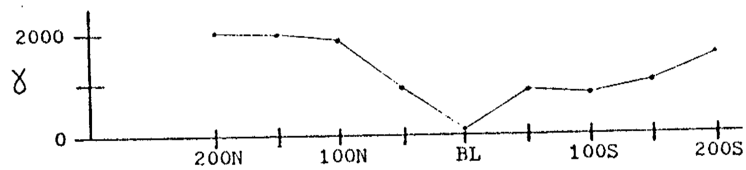
PROFILE 3250E



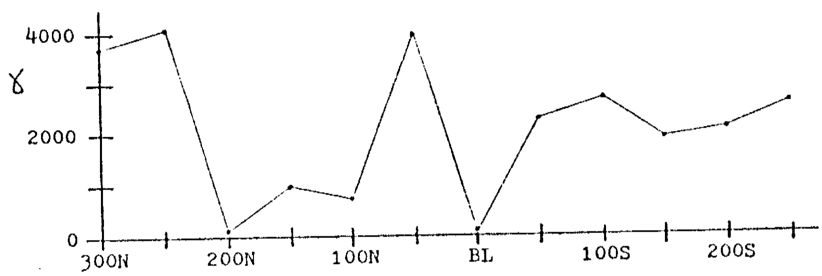
PROFILE 3500E



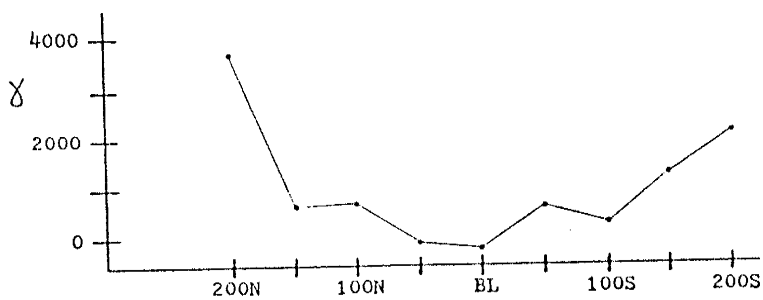
PROFILE 3750E



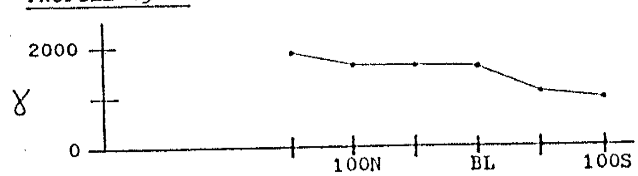
PROFILE 4000E



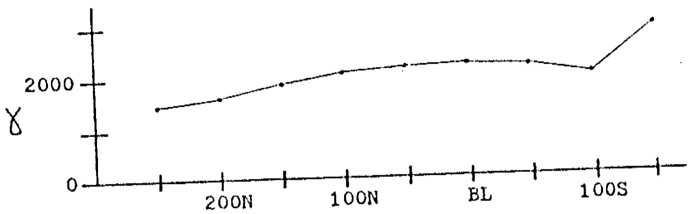
PROFILE 4250E



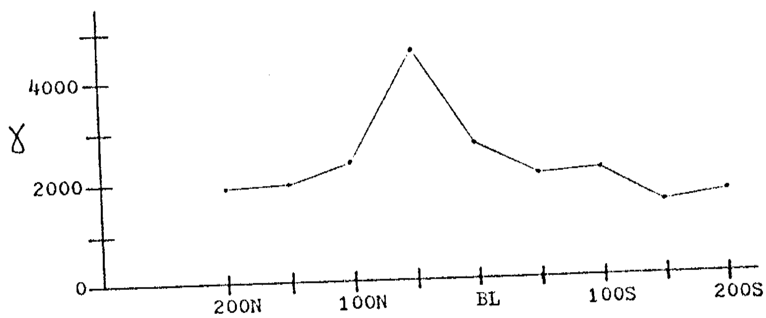
PROFILE 4500E



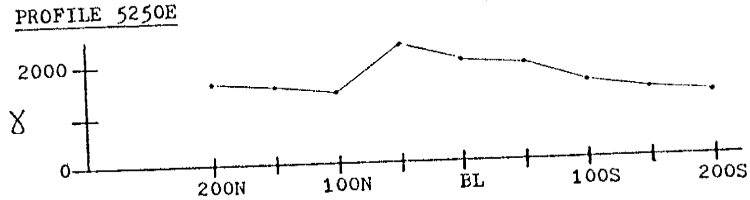
PROFILE 4750E



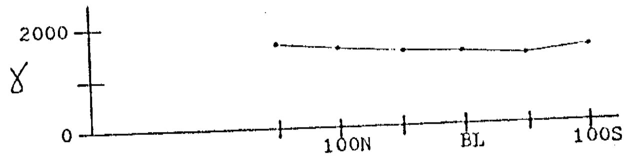
PROFILE 5000E



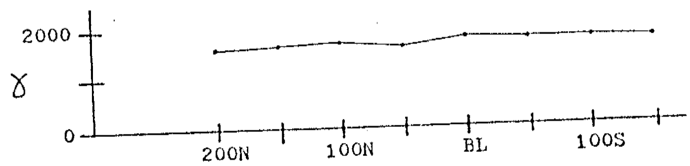
PROFILE 5250E



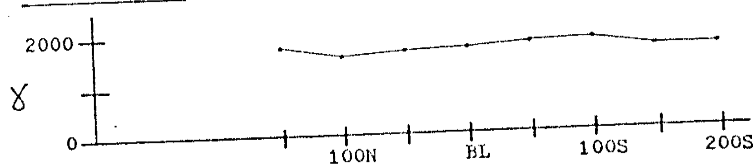
PROFILE 5500E



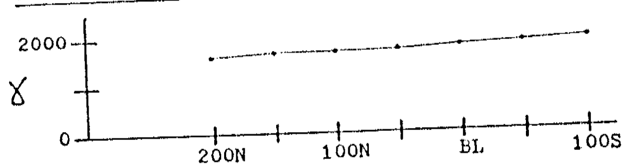
PROFILE 5750E



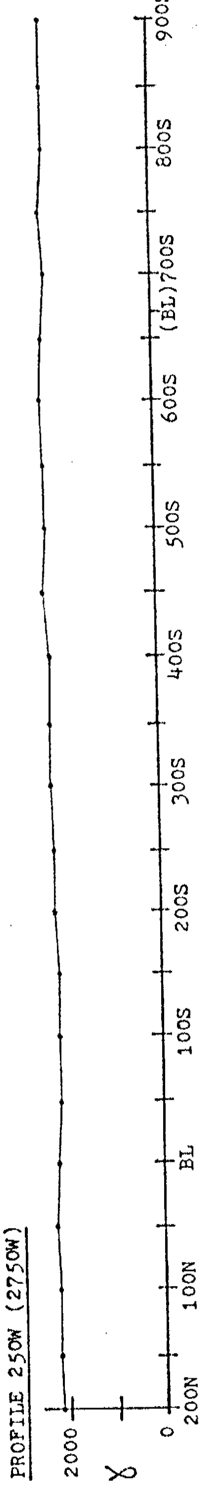
PROFILE 6000E

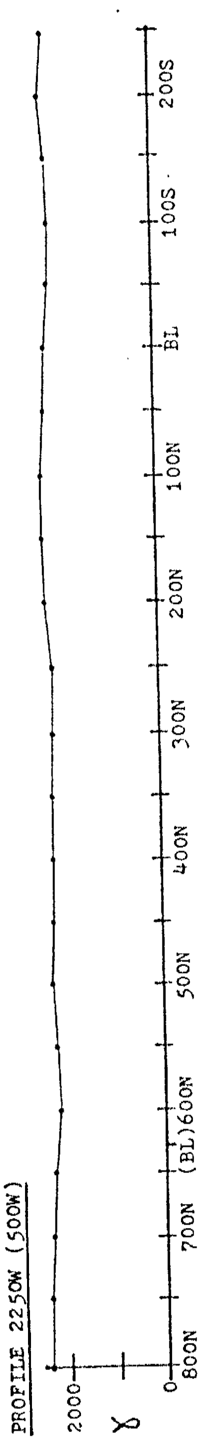


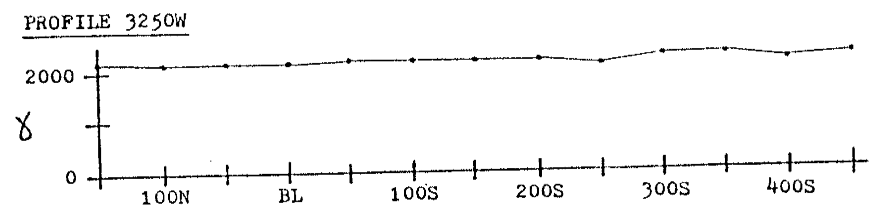
PROFILE 6250E

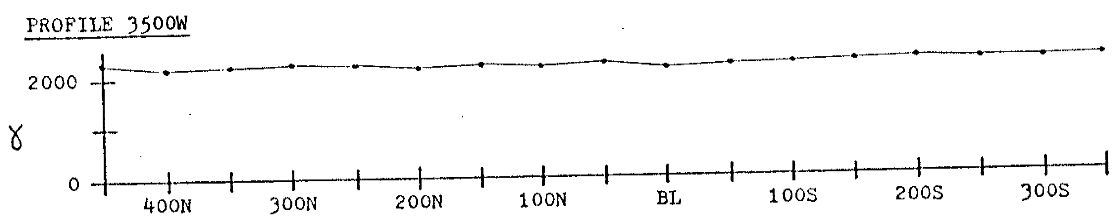


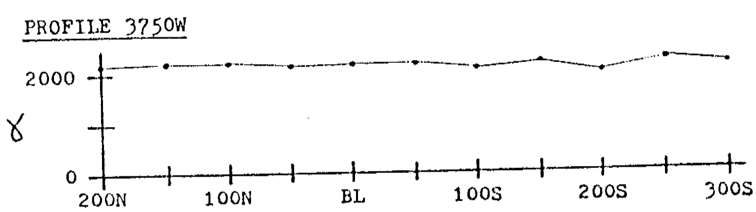
West Magnetic Survey

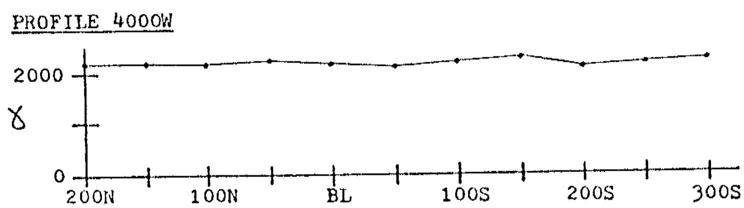


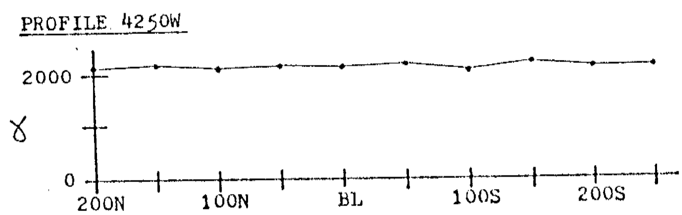


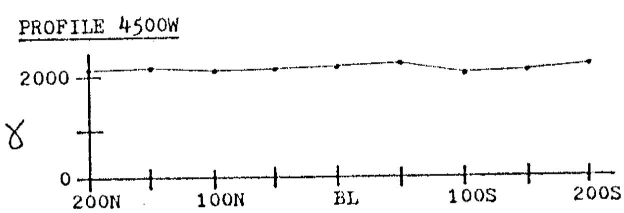

PROFILE 3250W
2000
γ
0
100N
BL
100S
200S
300S
400S


PROFILE 3500W
2000
γ
0
400N
300N
200N
100N
BL
100S
200S
300S

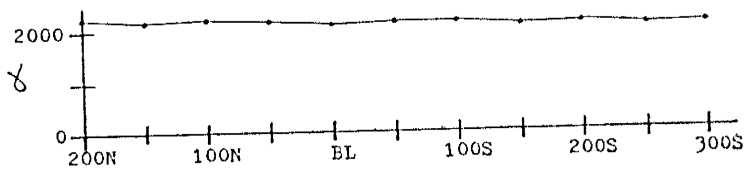

PROFILE 3750W
2000
γ
0
200N
100N
BL
100S
200S
300S


PROFILE 4000W
2000
γ
0
200N
100N
BL
100S
200S
300S

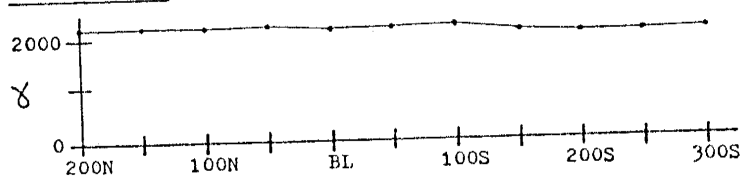

PROFILE 4250W
2000
γ
0
200N
100N
BL
100S
200S


PROFILE 4500W
2000
γ
0
200N
100N
BL
100S
200S

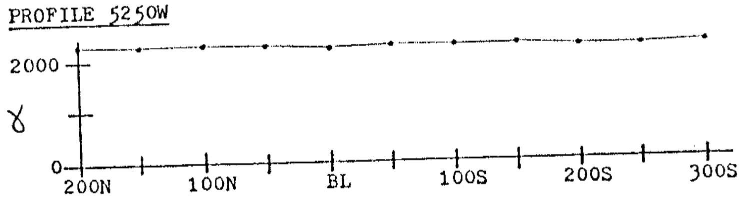
PROFILE 4750W



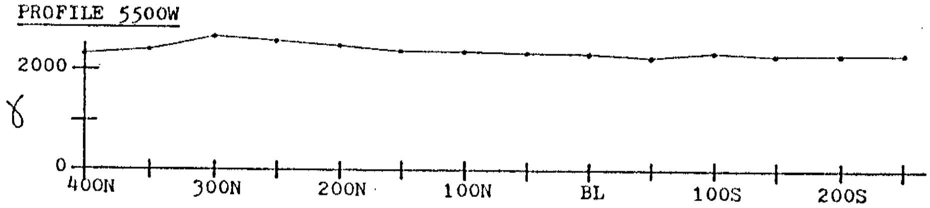
PROFILE 5000W



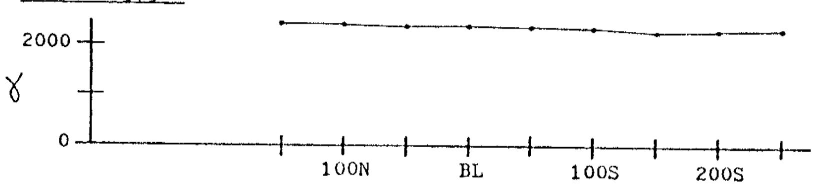
PROFILE 5250W



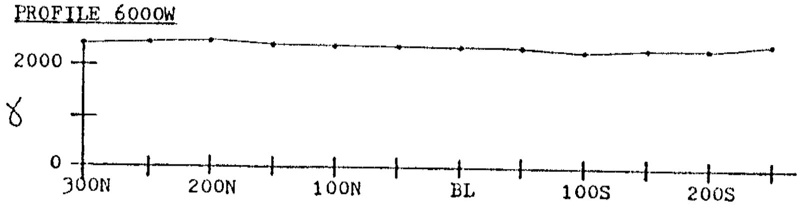
PROFILE 5500W



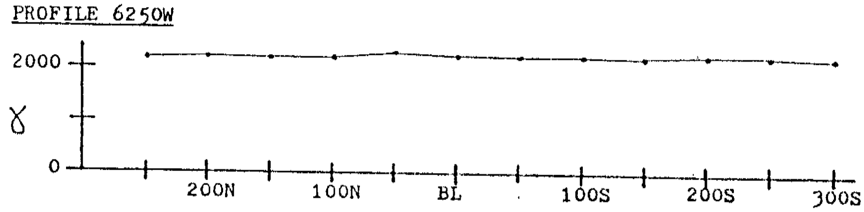
PROFILE 5750W



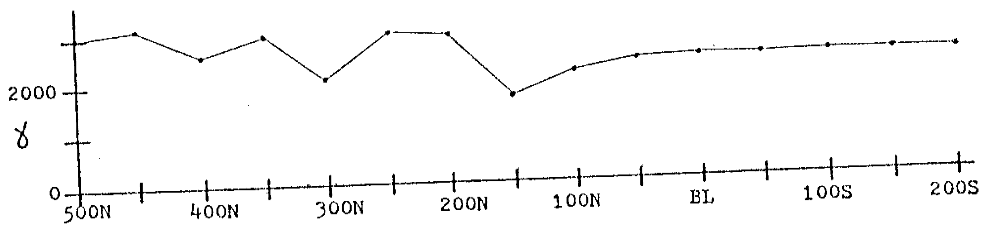
PROFILE 6000W



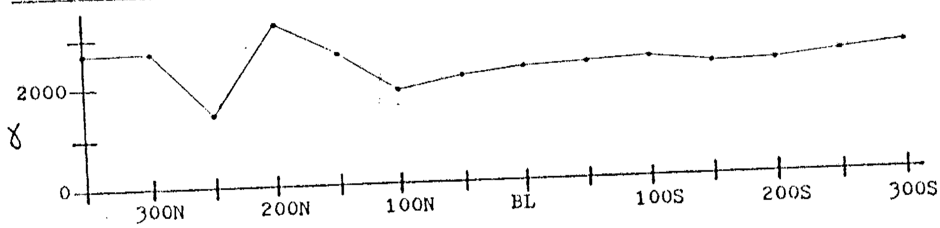
PROFILE 6250W



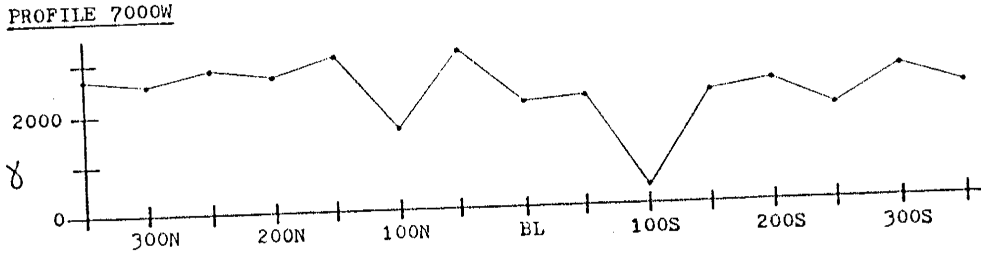
PROFILE 6500W



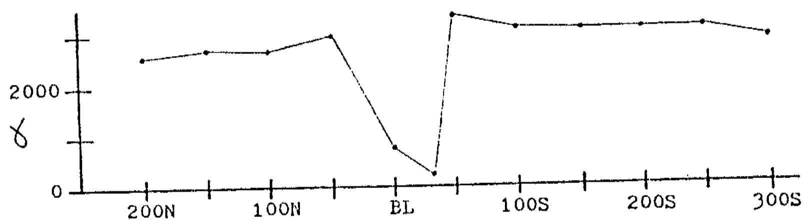
PROFILE 6750W



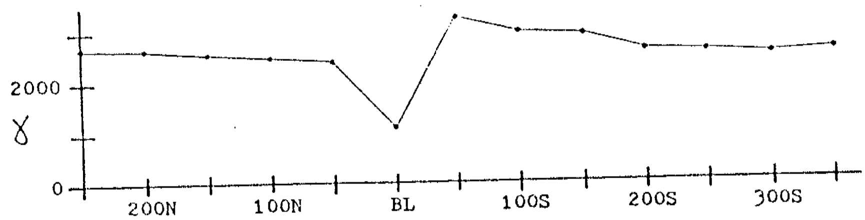
PROFILE 7000W



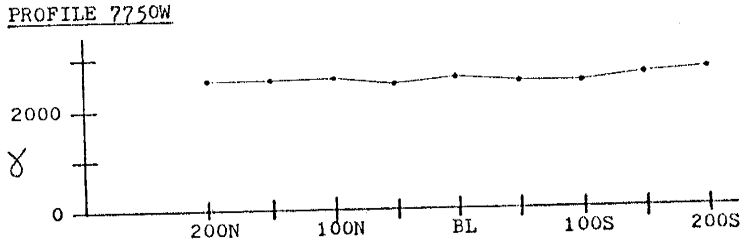
PROFILE 7250W

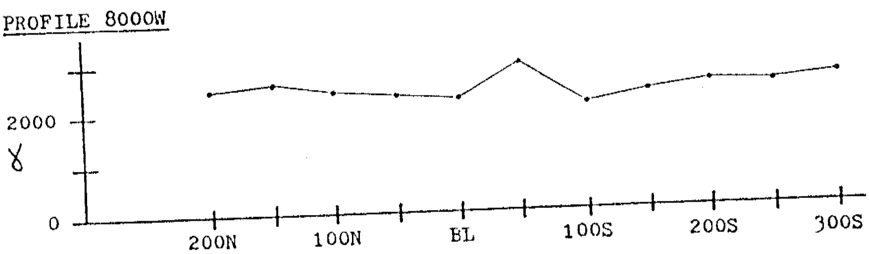


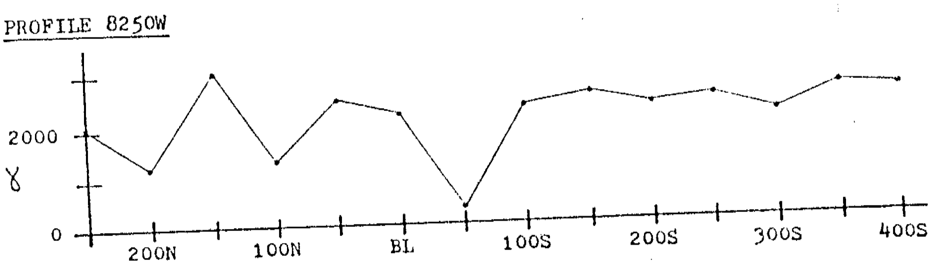
PROFILE 7500W

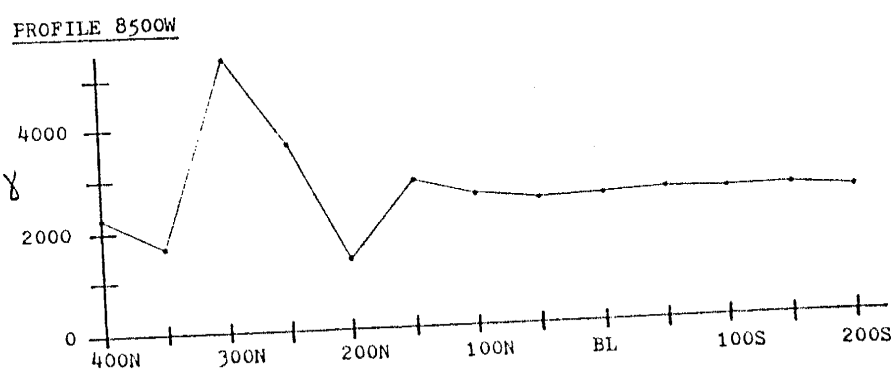


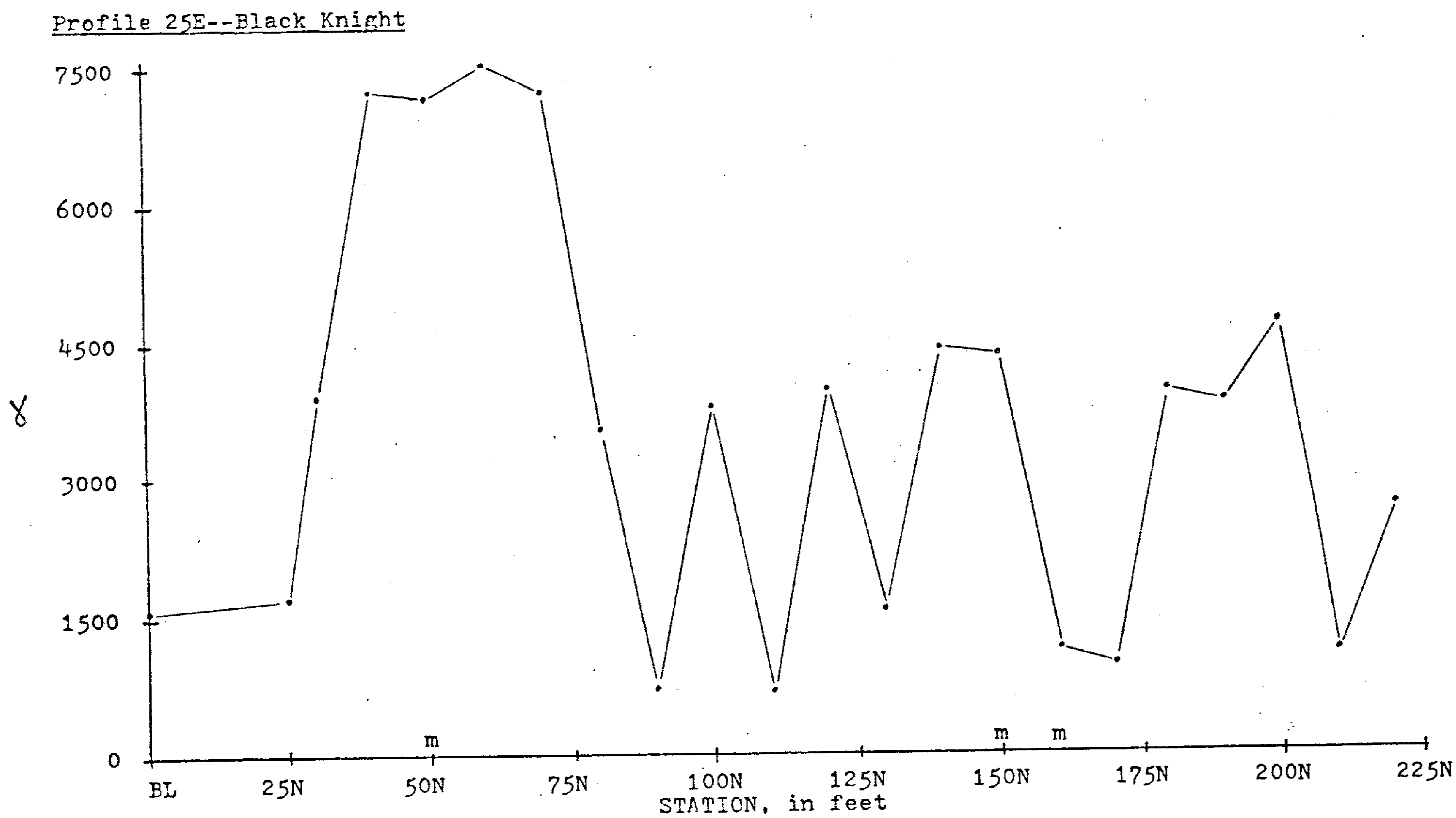
PROFILE 7750W



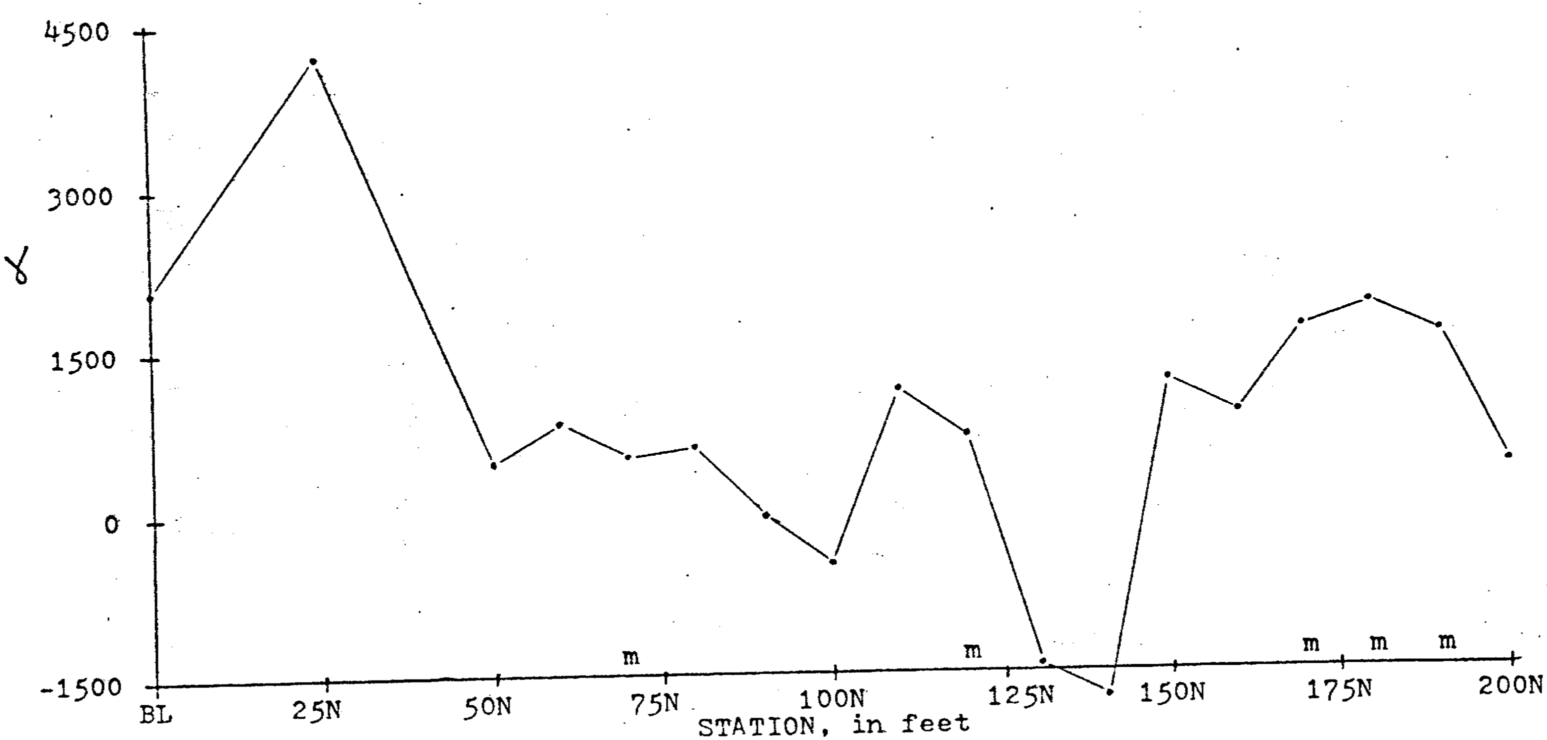

PROFILE 8000W
2000
γ
0
200N
100N
BL
100S
200S
300S

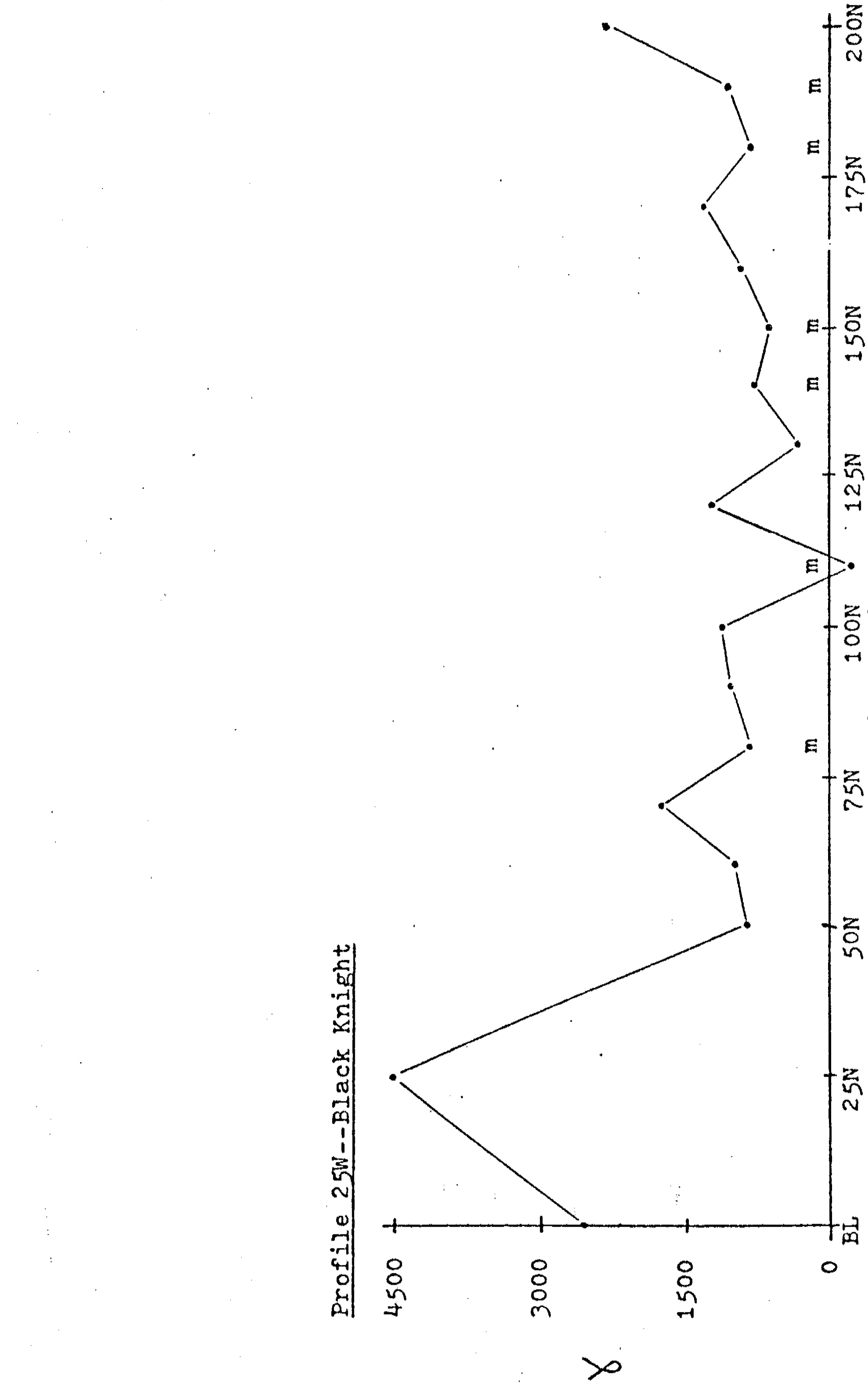

PROFILE 8250W
2000
γ
0
200N
100N
BL
100S
200S
300S
400S


PROFILE 8500W
4000
γ
2000
0
400N
300N
200N
100N
BL
100S
200S

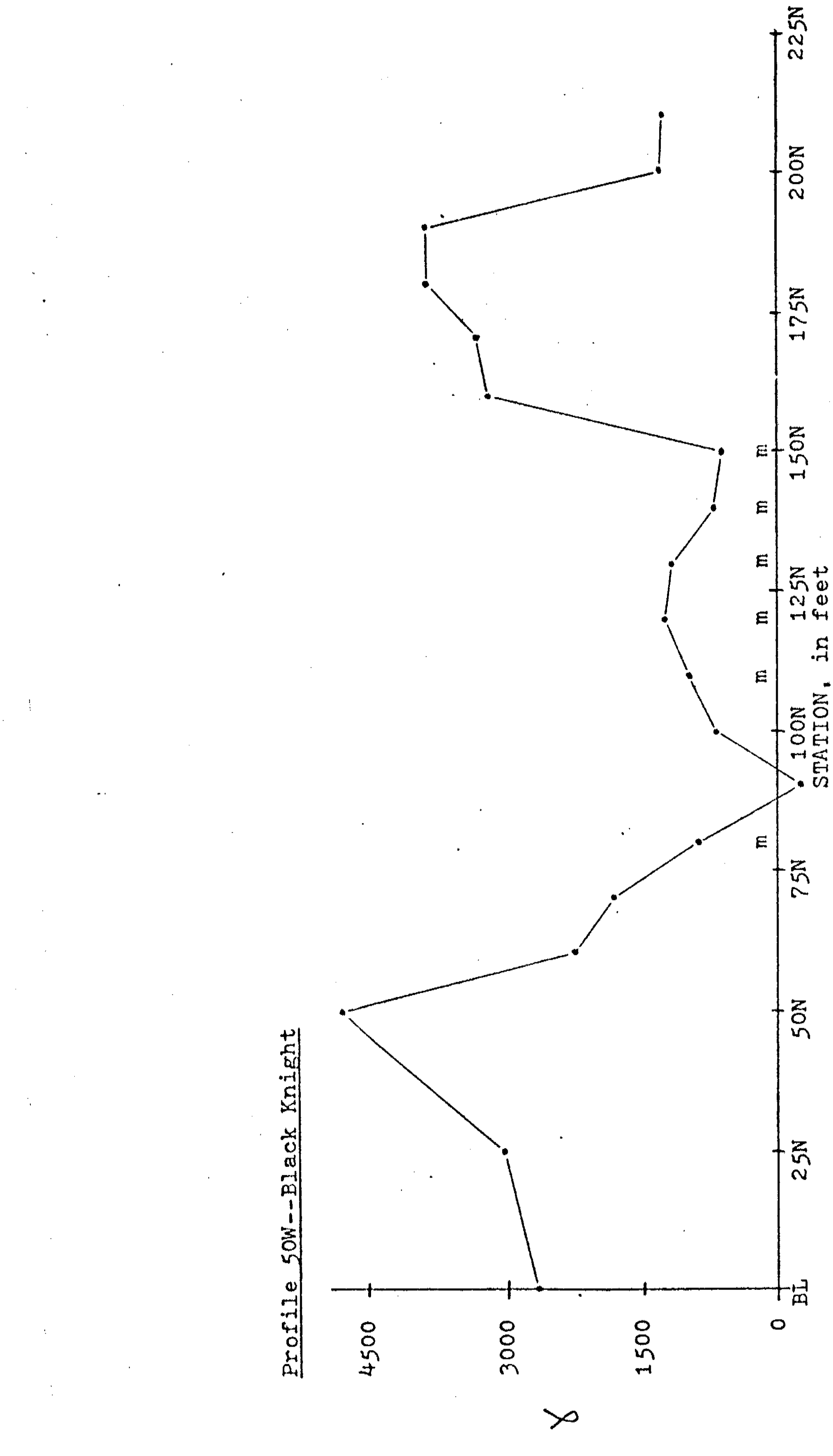

Profile 25E--Black Knight
γ
7500
6000
4500
3000
1500
0
BL
25N
50N
75N
100N
125N
150N
175N
200N
225N
m
m
m
STATION, in feet

Profile 0 E/W--Black Knight

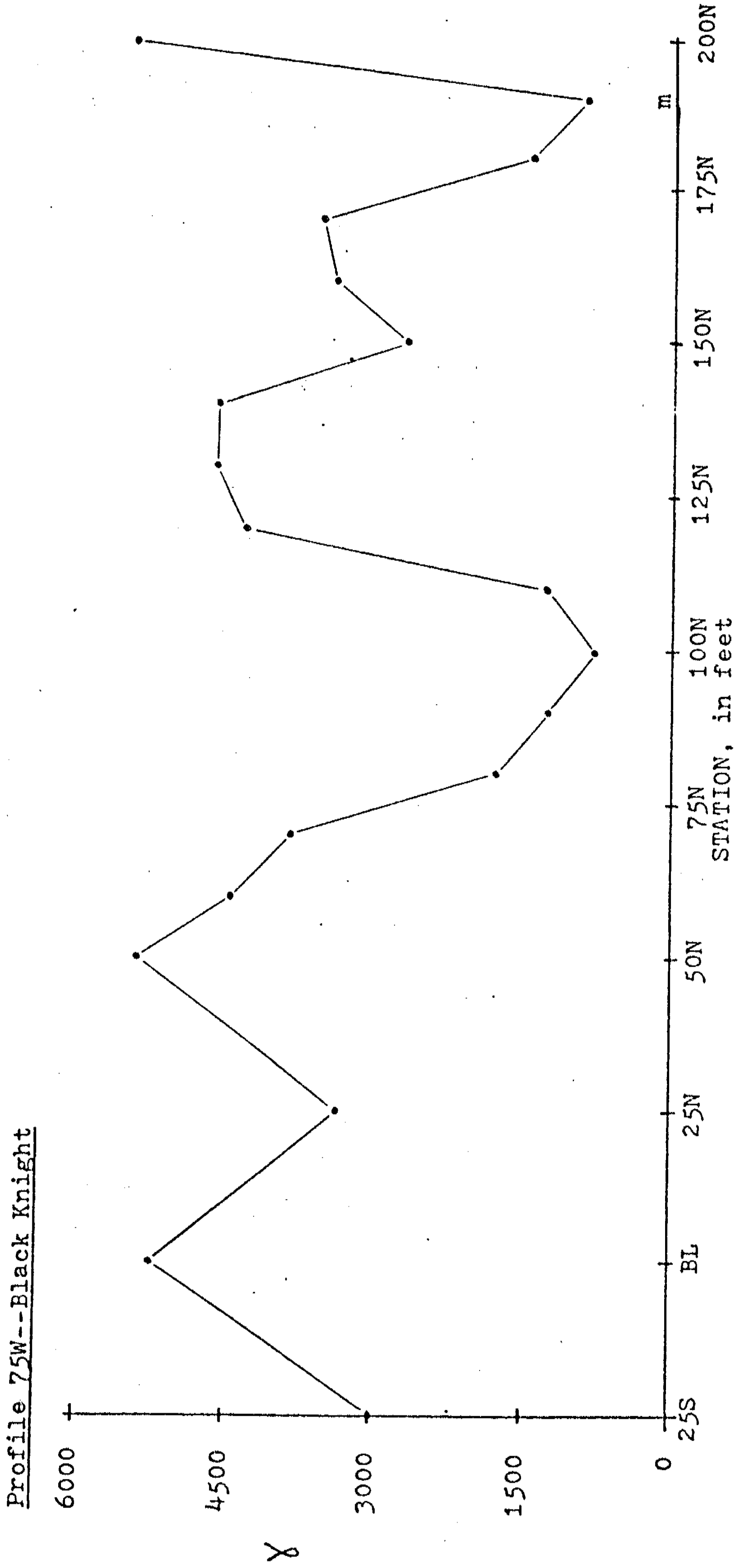




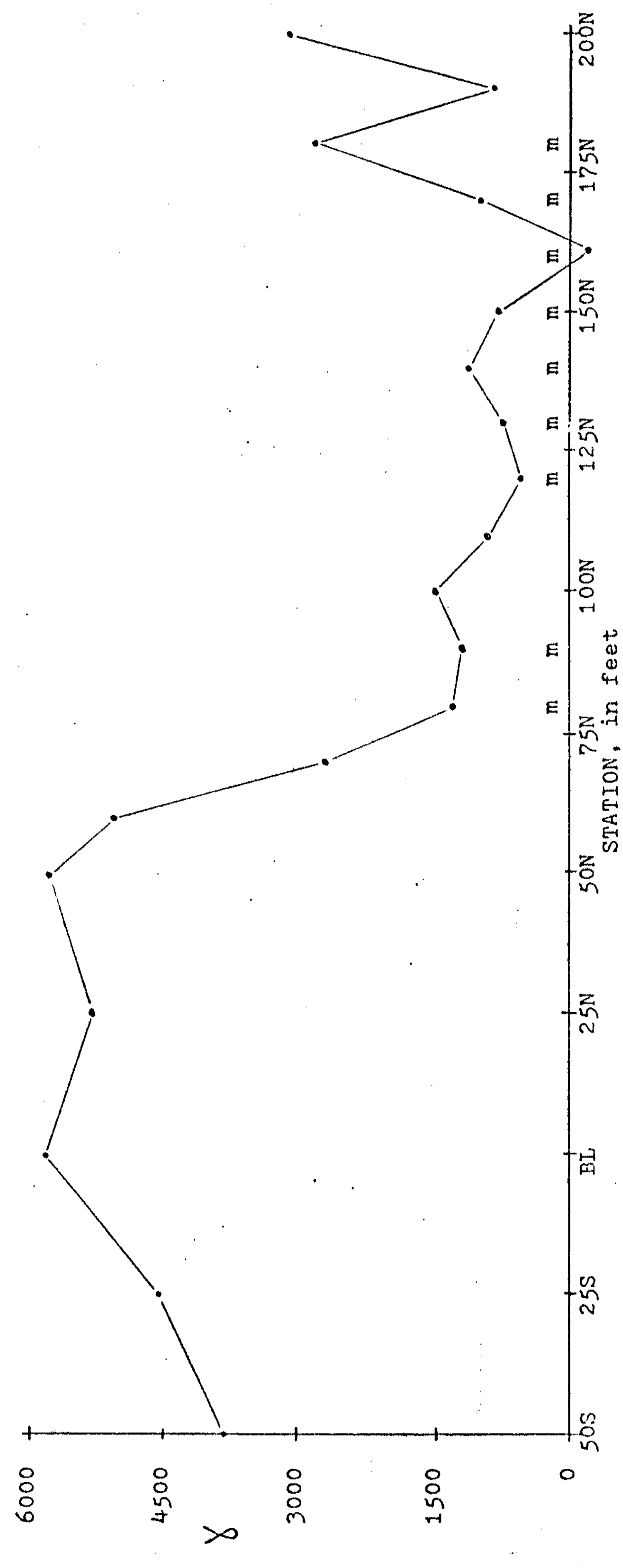
Profile 25W--Black Knight
γ
4500
3000
1500
0
BL
25N
50N
75N
100N
125N
150N
175N
200N
STATION, in feet
m
m
m
m
m
m



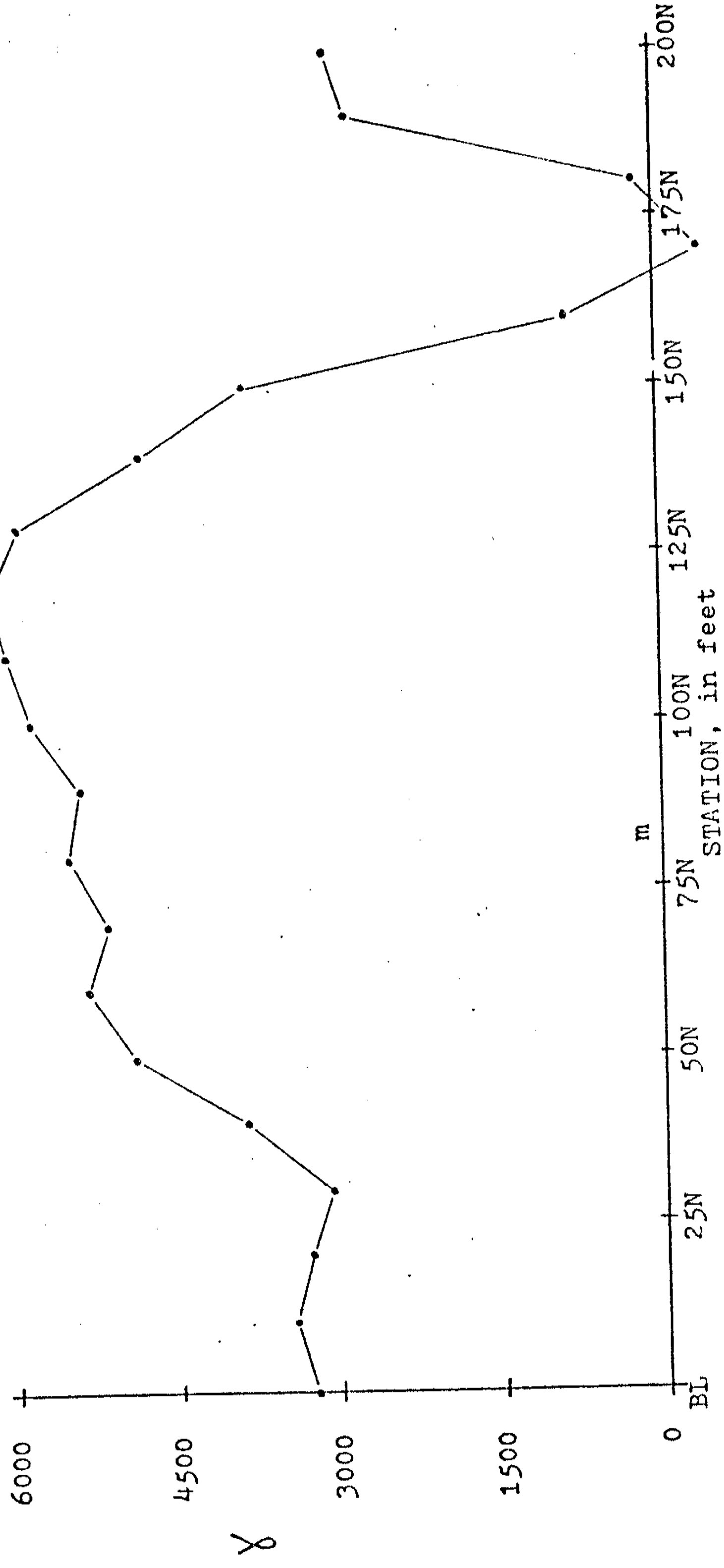
Profile 50W--Black Knight


Profile 75W--Black Knight
γ
6000
4500
3000
1500
0
25S
BL
25N
50N
75N
100N
125N
150N
175N
m
200N
STATION, in feet

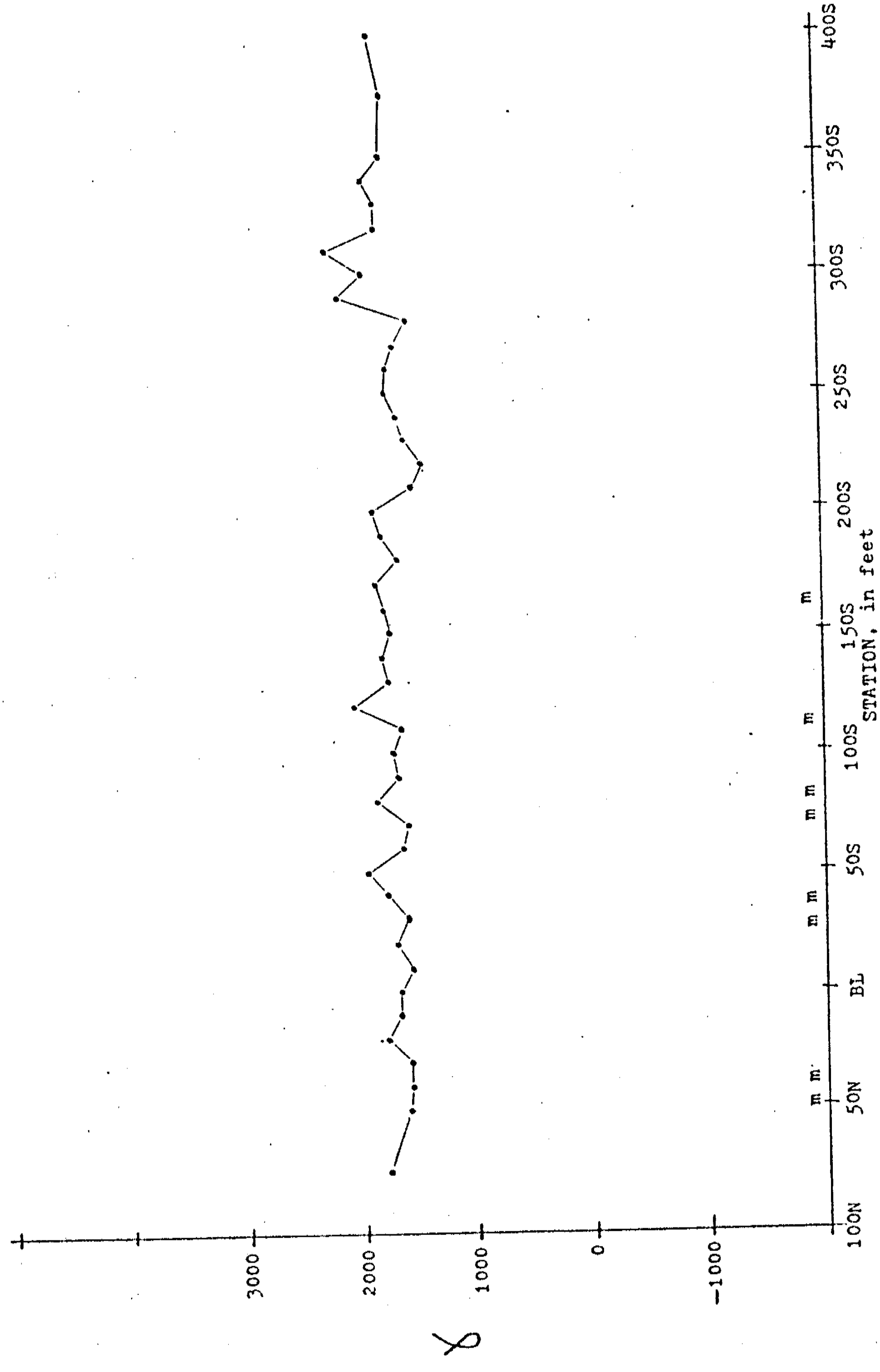
Profile 100W--Black Knight

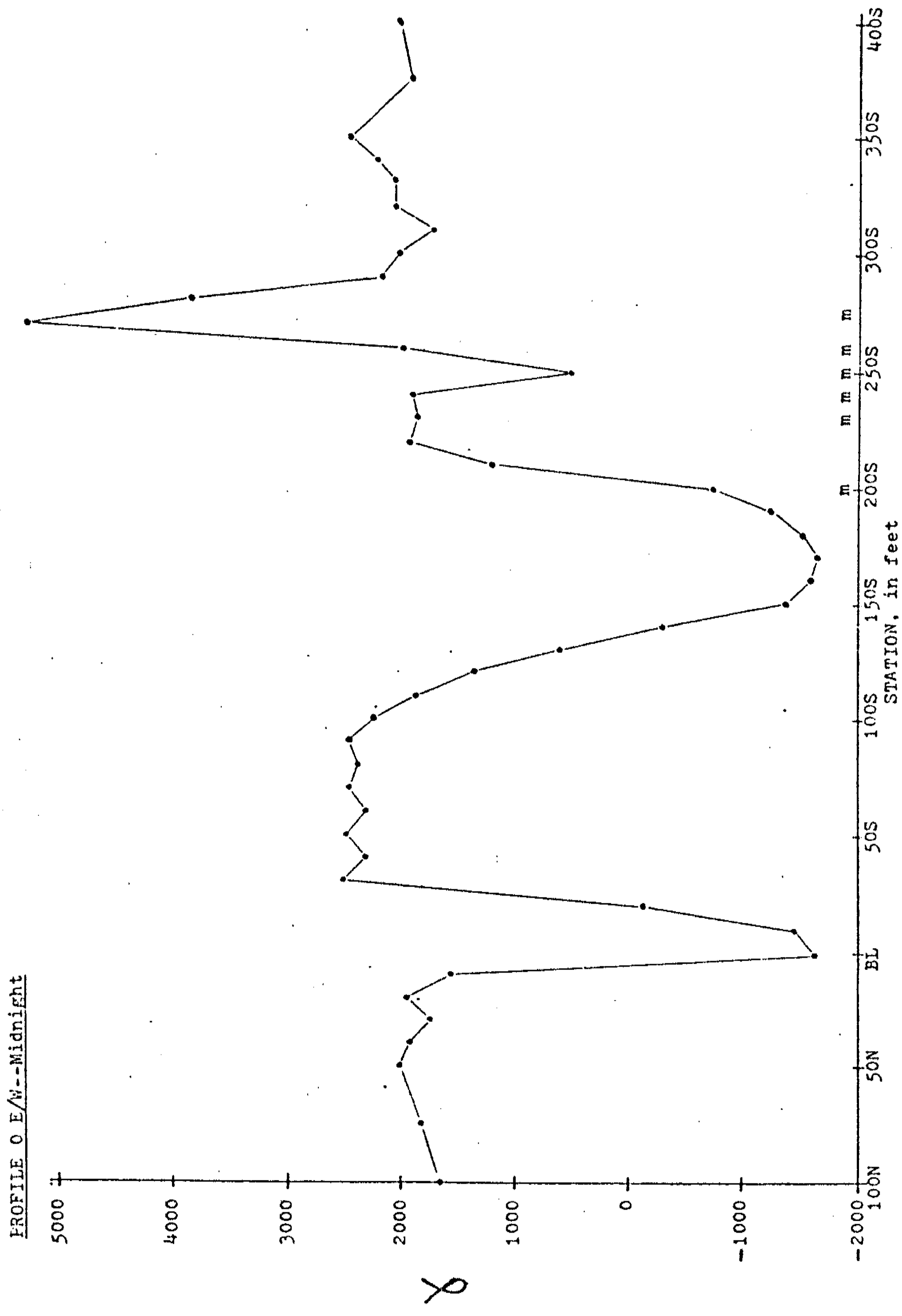


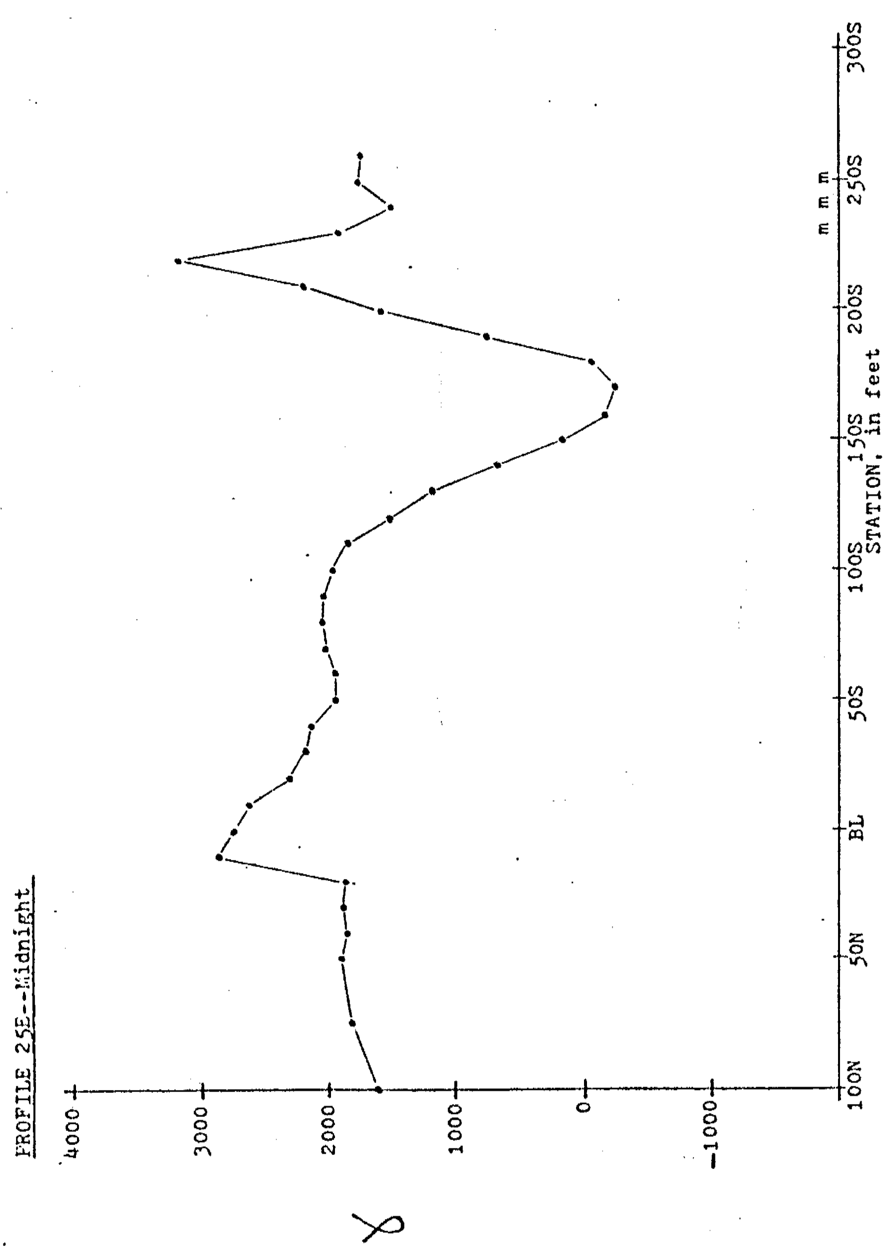
Profile 150W--Black Knight

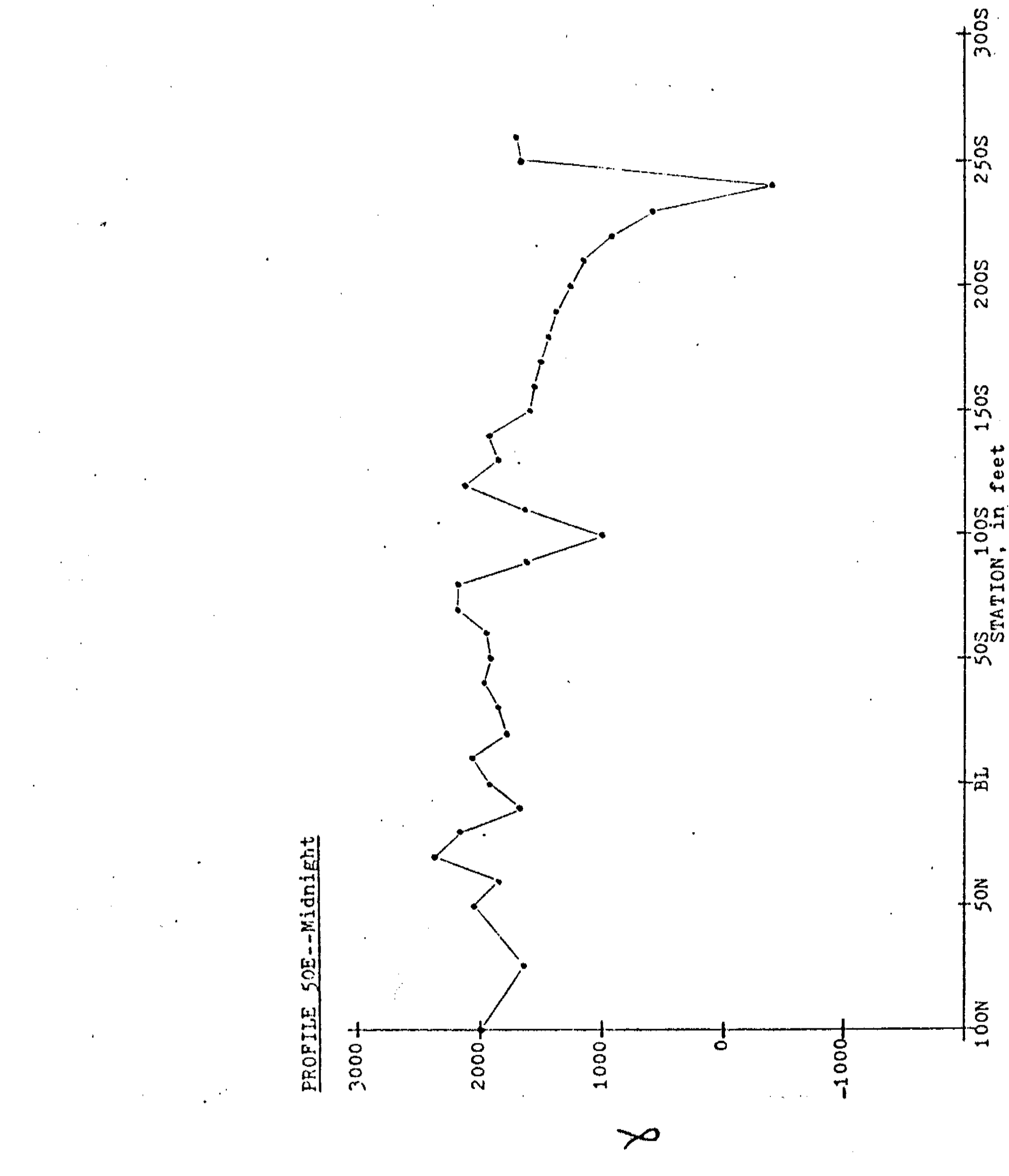


PROFILE 50W--Midnight

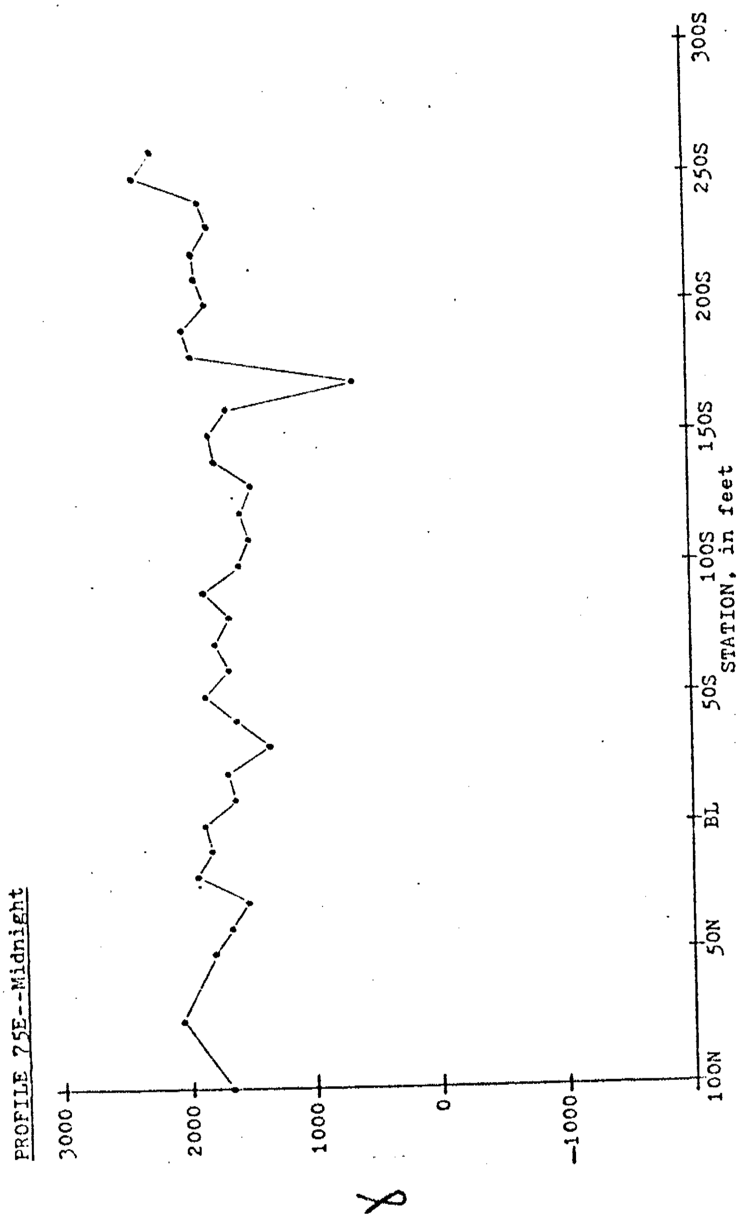


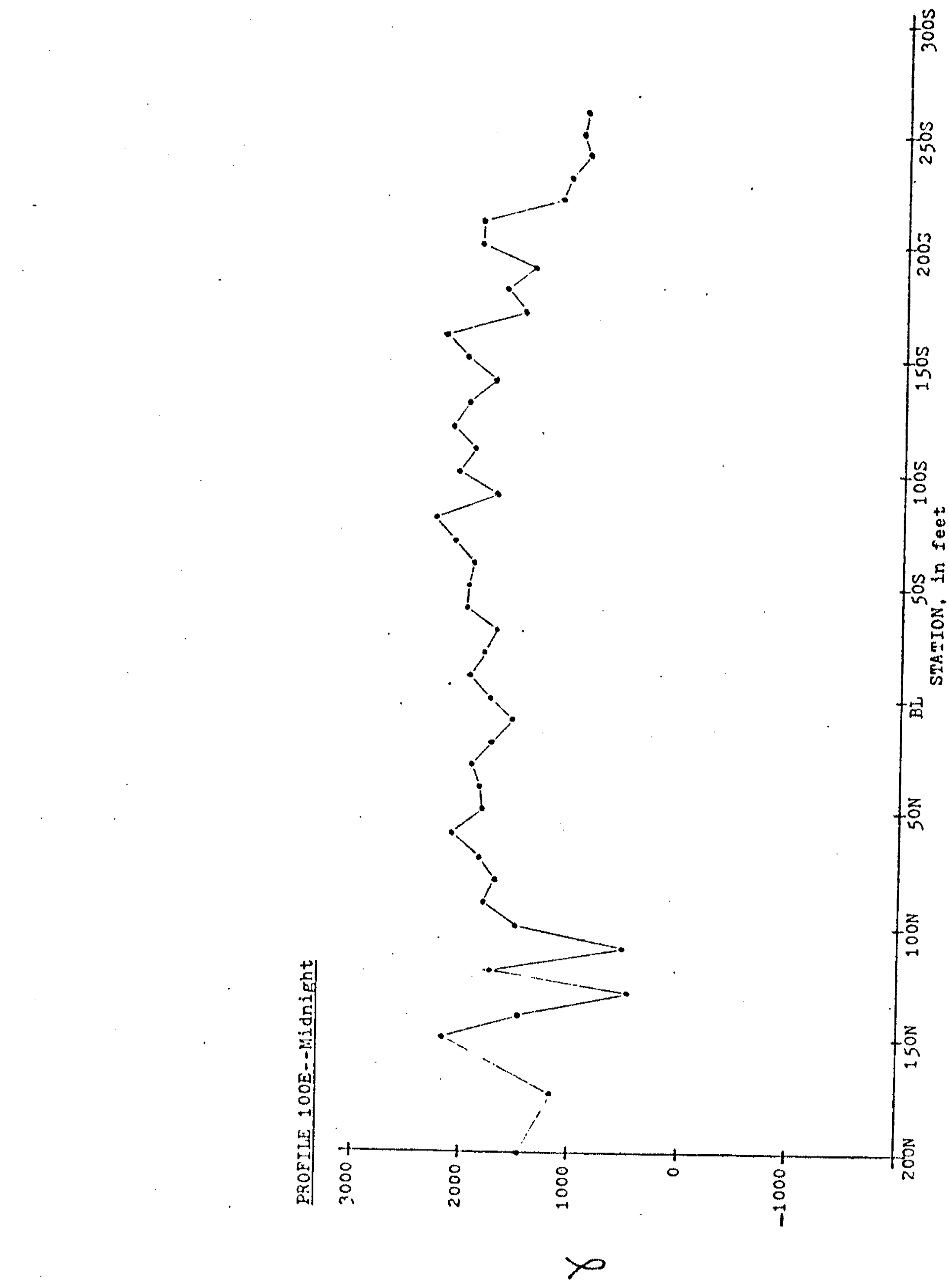

PROFILE O E/W--Midnight
5000
4000
3000
2000
1000
0
-1000
-2000
γ
100N
50N
BL
50S
100S
150S
200S
250S
300S
350S
400S
STATION, in feet
m
m
m
m
m
m


PROFILE 25E--Midnight
4000
3000
2000
1000
0
-1000
γ
100N
50N
BL
50S
100S
150S
200S
250S
300S
m m m
STATION, in feet

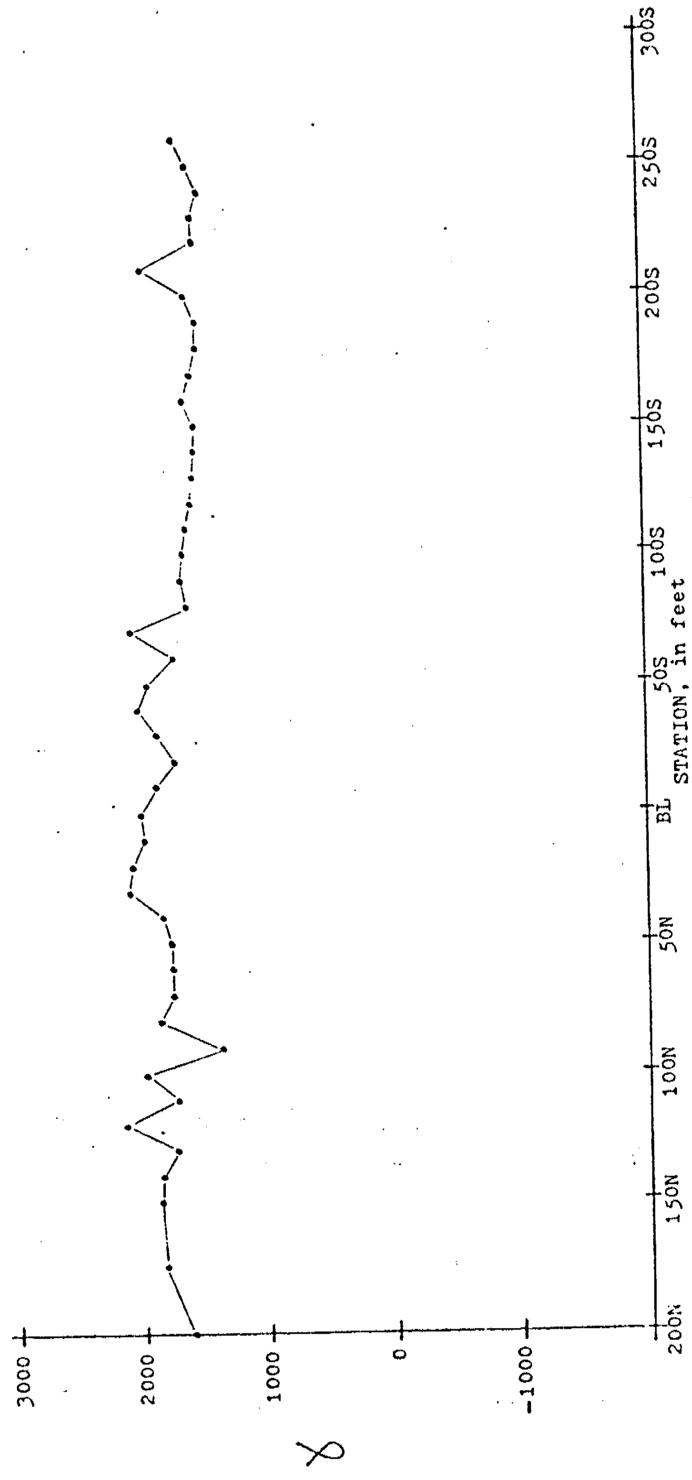


PROFILE 50E--Midnight
3000
2000
1000
0
-1000
γ
100N
50N
BL
50S
100S
150S
200S
250S
300S
STATION, in feet

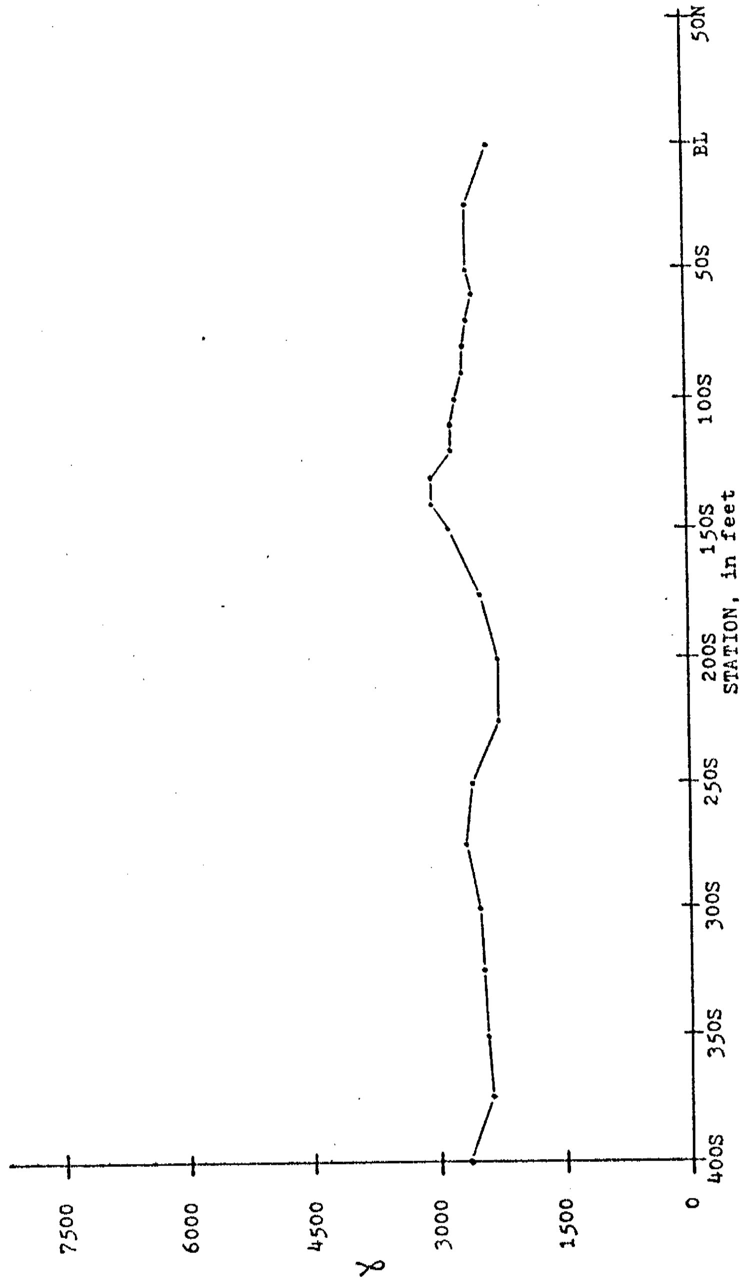

PROFILE 75E--Midnight
γ
3000
2000
1000
0
-1000
100N
50N
BL
50S
100S
150S
200S
250S
300S
STATION, in feet


PROFILE 100E--Midnight
3000
2000
1000
0
-1000
γ
200N
150N
100N
50N
BL
50S
100S
150S
200S
250S
300S
STATION, in feet

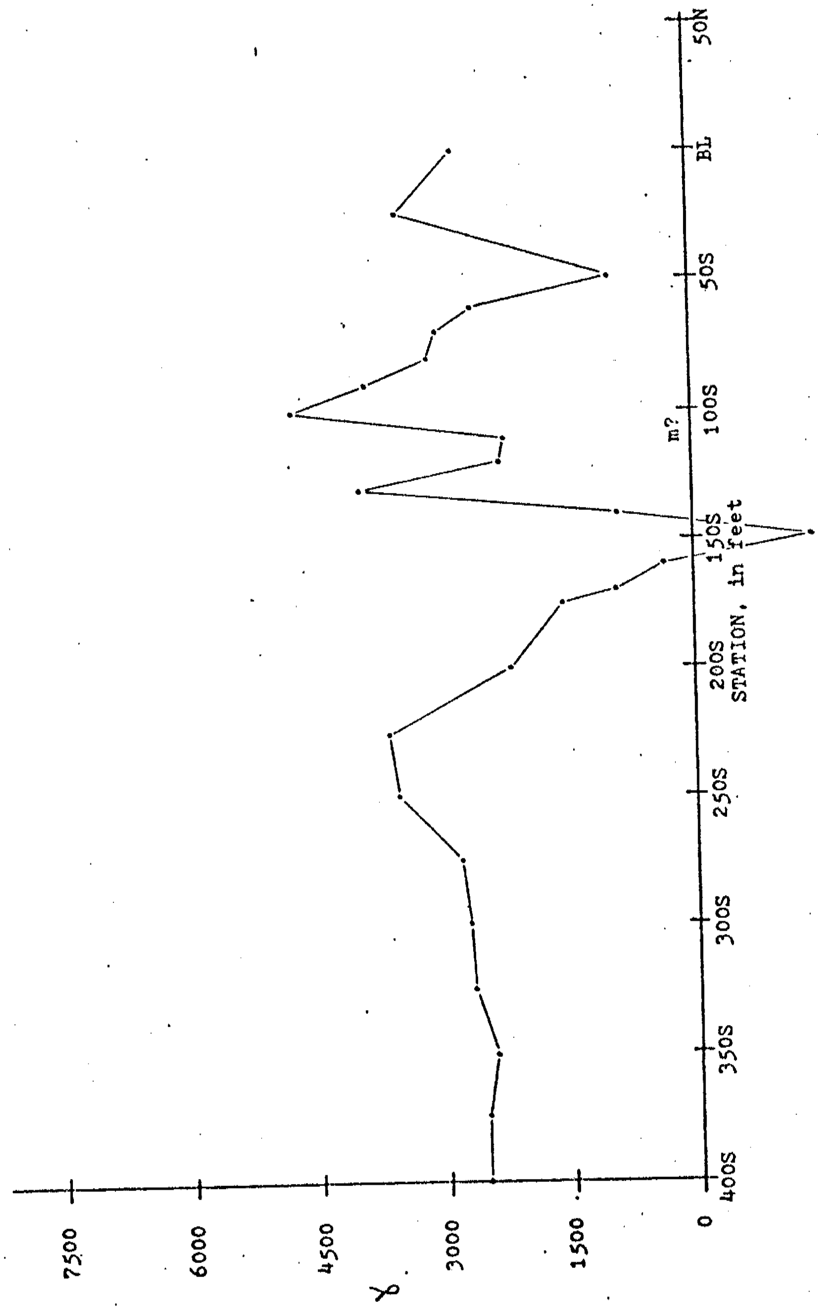
PROFILE 125E--Midnight



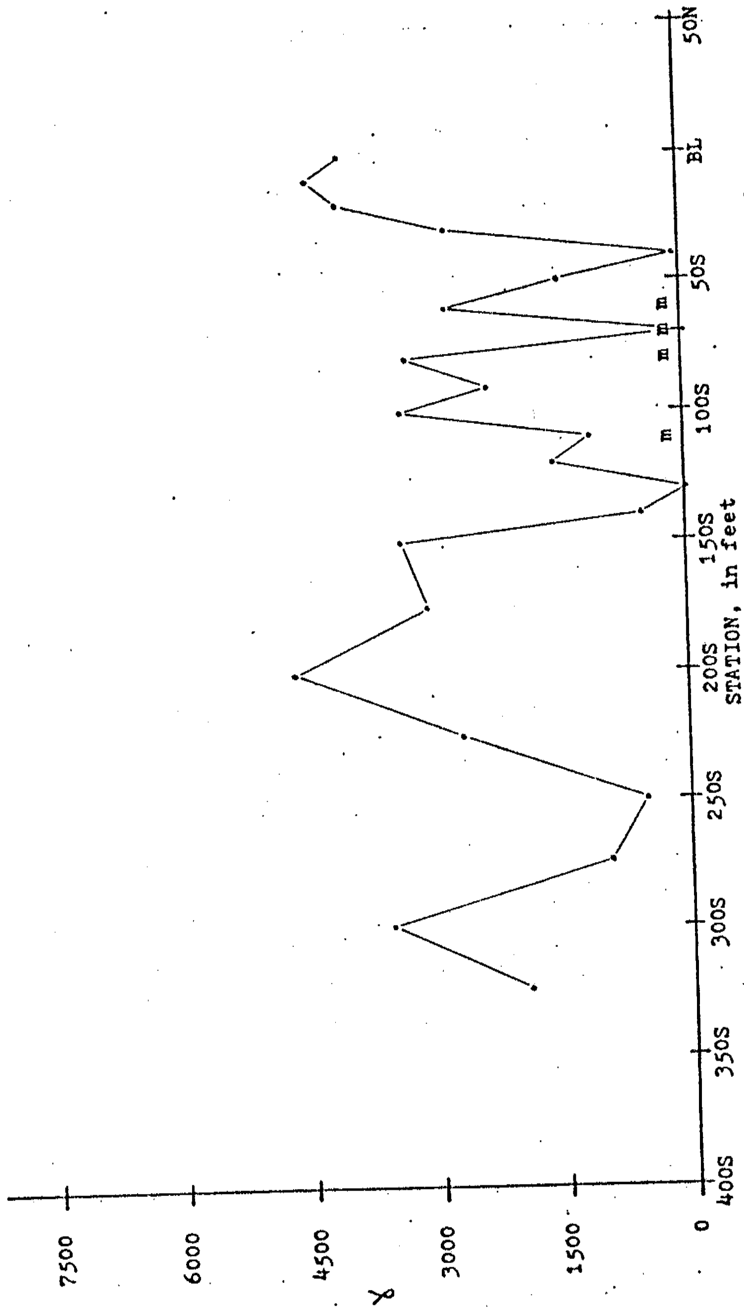
PROFILE 75W--Blue Rose 1



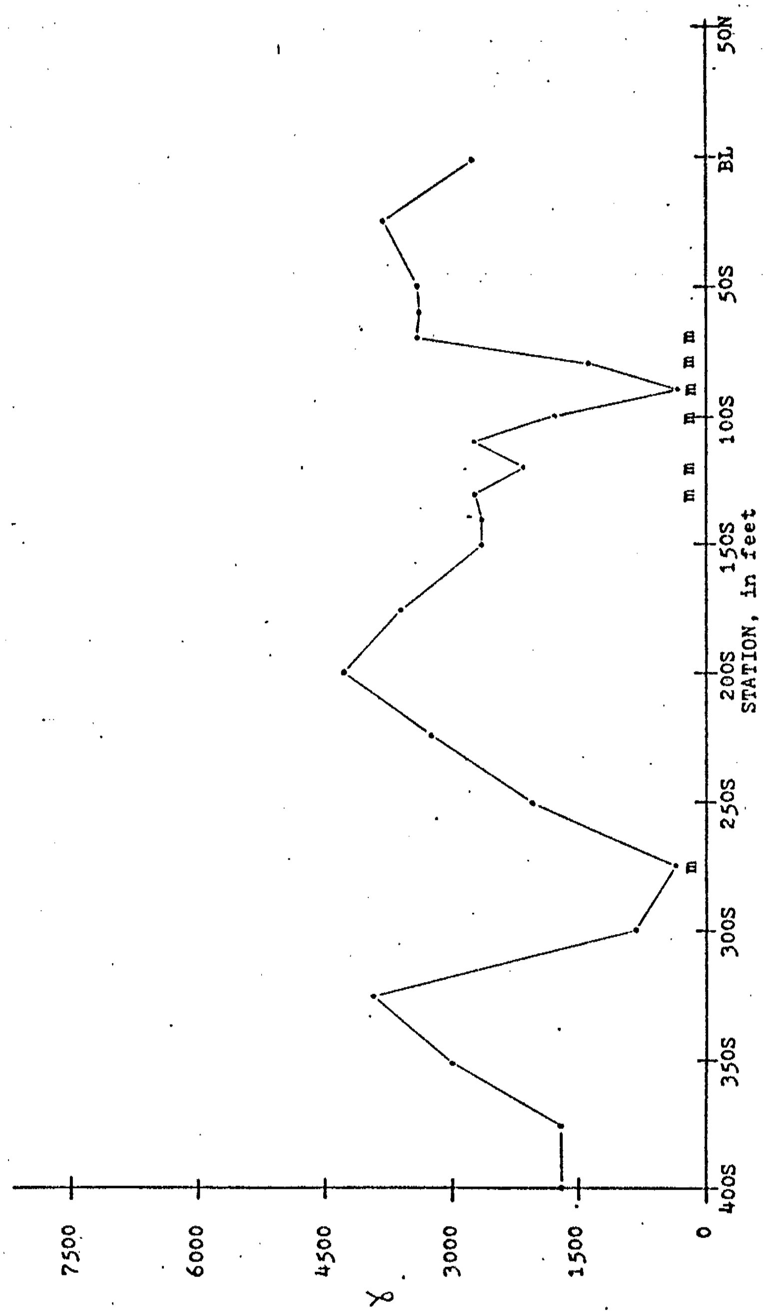
PROFILE 50W--Blue Rose 1



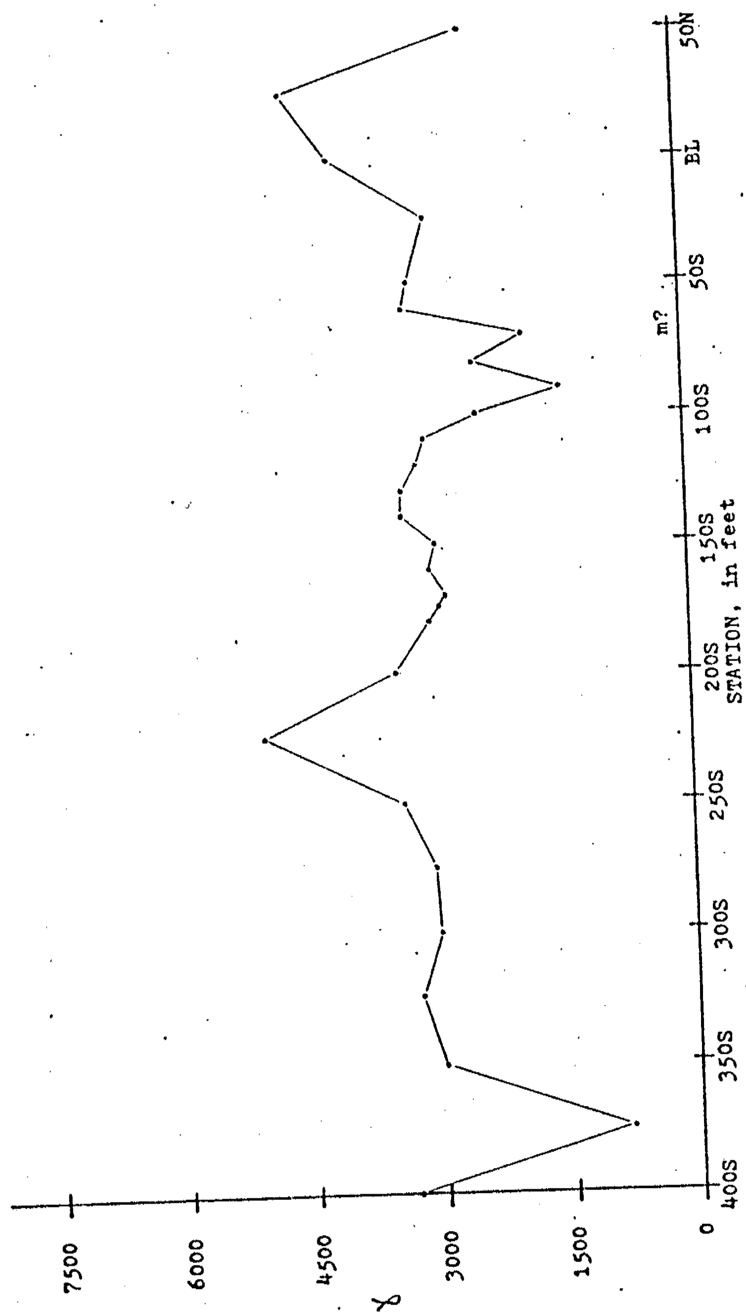
PROFILE 25W--Blue Rose 1



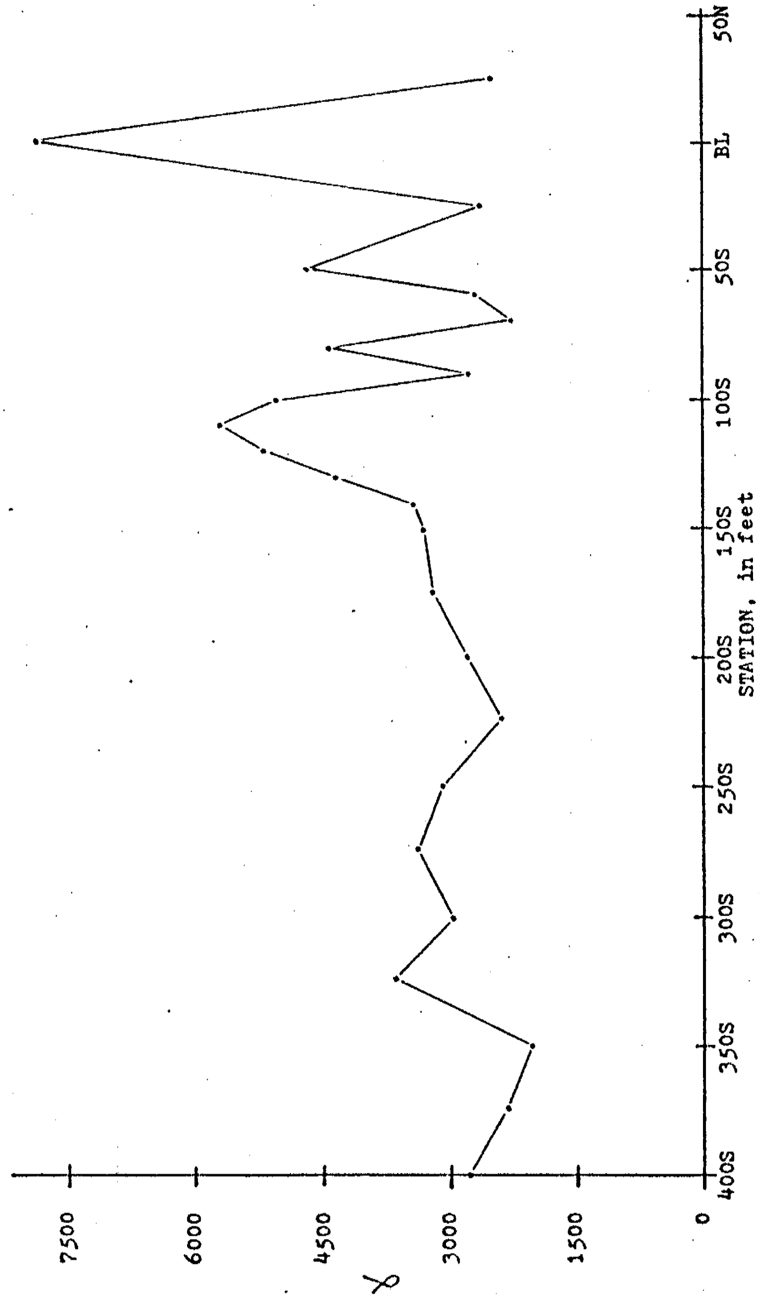
PROFILE 0 E/W--Blue Rose 1



PROFILE 50E--Blue Rose 1



PROFILE 75E--Blue Rose 1



APPENDIX C

NOTES ON ORE RESERVE ESTIMATES

Final tonnage figures are rounded to the nearest ton.

In calculating the ore reserves, the following assumptions were made:

1. The volume is for known and probable ore, and is estimated according to the parameters given for each orebody. These parameters can be adjusted if more informaion becomes available.
2. The grade of the entire orebody is consistant with the assayed samples.
3. The specific gravity of the ore is proportional to the ratio of the iron content of the ore to the iron content of pure magnetite (72.4%).

REFERENCES

Ash, S.R., and Davis, L.V., eds., 1964, Ruidoso country formations: N. Mex. Geol. Soc., 15th Field Conf., Guidebook of the Ruidoso Country, [p. i].

Bachman, G.O., 1953, Geology of a part of northwestern Mora County, New Mexico: U.S. Geol. Survey Oil and Gas Inv. Map OM 137.

Barnes, H.L., ed., 1979, Geochemistry of hydrothermal ore deposits, 2nd ed.: New York, John Wiley & Sons, 798p.

Bickford, D.A., 1980, Economic geology of the Jones camp iron deposit, Socorro County, New Mexico: unpublished Master's thesis, N. Mex. Inst. of Min. and Tech.

Brogger, W.C., 1890, Syenitpegmatitgange, in Die mineralien der syenitpegmatitgange der sudnorwegischen Augitund nephelinsyenite: Zeitschr. fur Kryst, v. 16, p. 54-56.

Butler, P., Jr., 1964, Magnetite from intrusives and associated contact deposits, Lincoln County, New Mexico: unpublished Master's thesis, N. Mex. Inst. of Min. and Tech.

Craddock, C., 1960, The origin of the Lincoln fold system, southeastern New Mexico, in Structure of the earth's crust and deformation of rocks: Internat. Geol. Cong., 21st, Copenhagen, Rept., pt. 18, p. 34-44.

Dane, C.H., and Bachman, G.O., 1965, Geologic map of New Mexico: U.S. Geol. Survey state map.

Dobrin, M.B., 1976, Introduction to geophysical prospecting: New York, McGraw-Hill Book Co., 630p.

Eckel, E.C., 1914, Iron ores: New York, McGraw-Hill Book Co., 430p.

Eugster, H.P., and Chou, I-M, 1979, A model for the deposition of Cornwall-type magnetite deposits: Ec. Geol., v. 74, p. 763-774.

Folk, R.L., 1962, Spectral subdivision of limestone types: AAPG Memoir 1, p. 62-84.

Gibbons, T.L., 1981, Geochemical and petrographic investigation of the Jones camp deposit, Socorro County, New Mexico: unpublished Master's thesis, N. Mex. Inst. of Min. and Tech.

Griswold, G.B., 1959, Mineral deposits of Lincoln County, New Mexico: N. Mex. Inst. of Min. and Tech., State Bur. of Mines and Min. Res. Bull. 67, 117p.

Holser, W.T., and Schneer, C.J., 1961, Hydrothermal Magnetite: Geol. Soc. Am. Bull., v. 72, p. 369 -386.

Hyndman, D.W., 1972, Petrology of igneous and metamorphic rocks: New York, McGraw-Hill Book Co., 533p.

Johannsen, A., 1939, A descriptive petrography of the igneous rocks: Chicago, University of Chicago Press, 1578p.

Kalinin, D.V., 1962, Formation of magnetite in contact metasomatic iron deposits: Geochemistry, no. 7, p. 624-628.

Kelley, V.C., 1949, Geology and economics of New Mexico iron-ore deposits: Univ. N. Mex. Pub. in Geology, no. 2, 246p.

Kelley, V.C., 1952, Origin and pyrometasomatic zoning of the Capitan iron deposits, Lincoln County, New Mexico: Ec. Geol., v. 47, p. 64-83.

Kelley, V.C., and Thompson, T.B., 1964, Tectonics and general geology of the Ruidoso-Carrizozo region, central New Mexico: N. Mex. Geol. Soc., 15th Field Conf., Guidebook of the Ruidoso Country, p. 110-121.

Lee, W.T., and Girty, G.H., 1909, The Manzano group of the Rio Grande valley, New Mexico: U.S. Geol. Survey Bull. 389, 141p.

Lepp, H., ed., 1975, Geochemistry of iron: Stroudsburg, Pa., Dowden, Hutchinson & Ross, Inc., 464p.

Park, C.F., Jr., 1972, The iron ore deposits of the Pacific basin: Ec. Geol., v. 67(3), p. 339-349.

Park, C.F., Jr., and MacDiarmid, R.A., 1975, Ore deposits, 3rd ed.: San Francisco, W.H. Freeman & Co., 530p.

Percival, F.G., 1954, Nature and occurrence of iron ore deposits, in Survey of the world iron resources: New York, United Nations Dept. of Economic and Social Affairs publication, 345p.

Peters, W.C., 1978, Exploration and mining geology: New York, John Wiley & Sons, 696p.

Schnake, D.W., 1977, Conditions of formation of the iron-bearing skarns at Lone Mountain, Lincoln County, New Mexico: unpublished Master's thesis, N. Mex. Inst. of Min. and Tech.

Sheridan, M.J., 1947, Lincoln County iron deposits, New Mexico: U.S. Bur. Mines Rept. Inv. 3988, 19p.

Smith, C.T., 1964, Geology of the Little Black Peak quadrangle, Socorro and Lincoln Counties, New Mexico: N. Mex. Geol. Soc., 15th Field Conf., Guidebook of the Ruidoso Country, p. 92-99.

Smith, C.T., and Budding, A.J., 1959, Reconnaissance geologic map of the Little Black Peak quadrangle, east half: N. Mex. Inst. of Min. and Tech., State Bur. of Mines and Min. Res. Geol. Map 11.

Spencer, A.C., 1908, Magnetite deposits of the Cornwall type in Pennsylvania: U.S. Geol. Survey Bull. 359, 102p.

Travis, R.B., 1955, Classificaton of rocks: Quarterly of the Colorado School of Mines, vol. 50, no. 1, 98p.

Walker, G.W., and Osterwald, F.W., 1956, Uraniferous magnetite-hematite deposit at the Prince mine, Lincoln County, New Mexico: Ec. Geol., v. 51, p. 213-222.

This thesis is accepted on behalf of the faculty

of the Institute by the following committee:

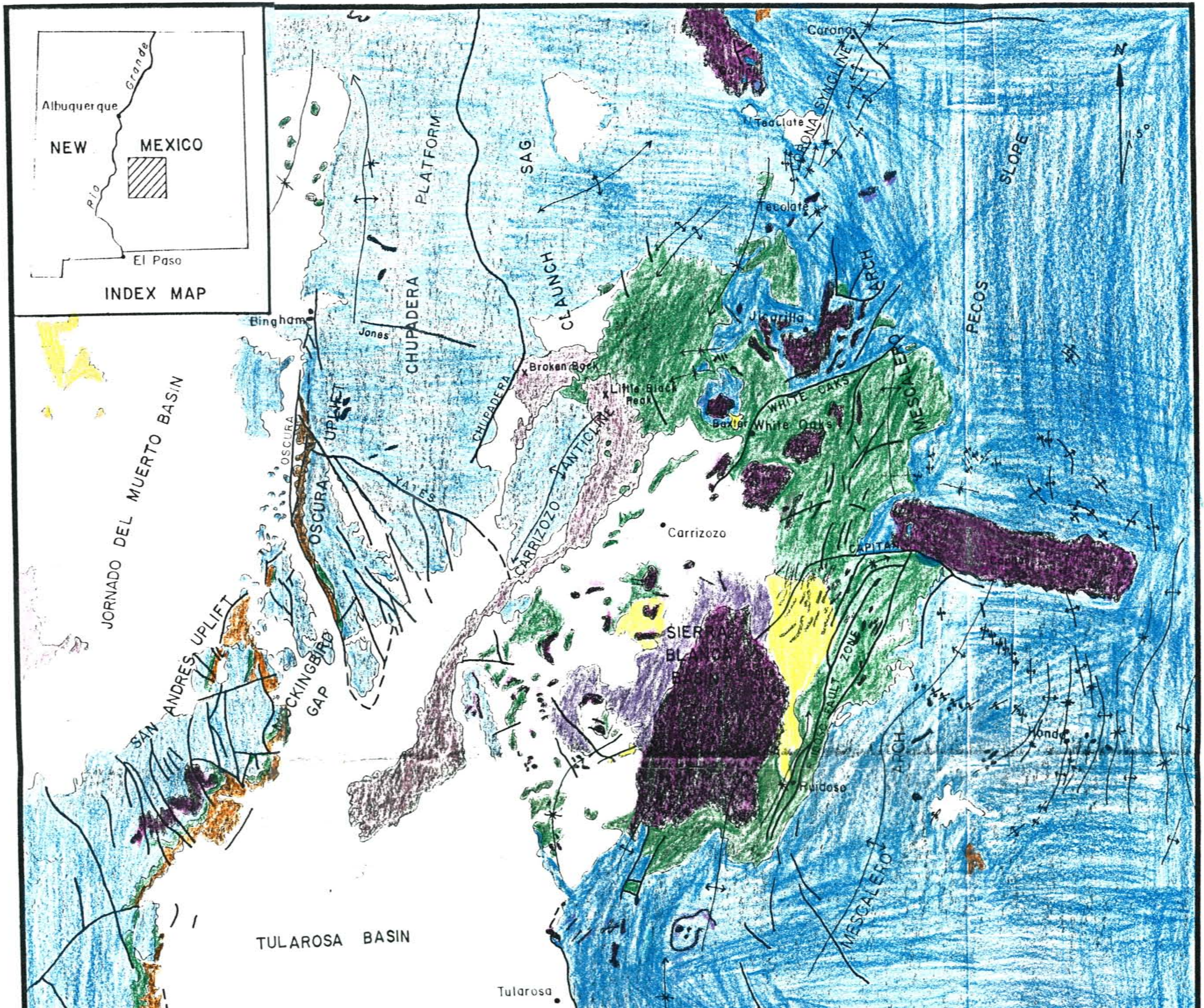
Clay T. Smith
Adviser

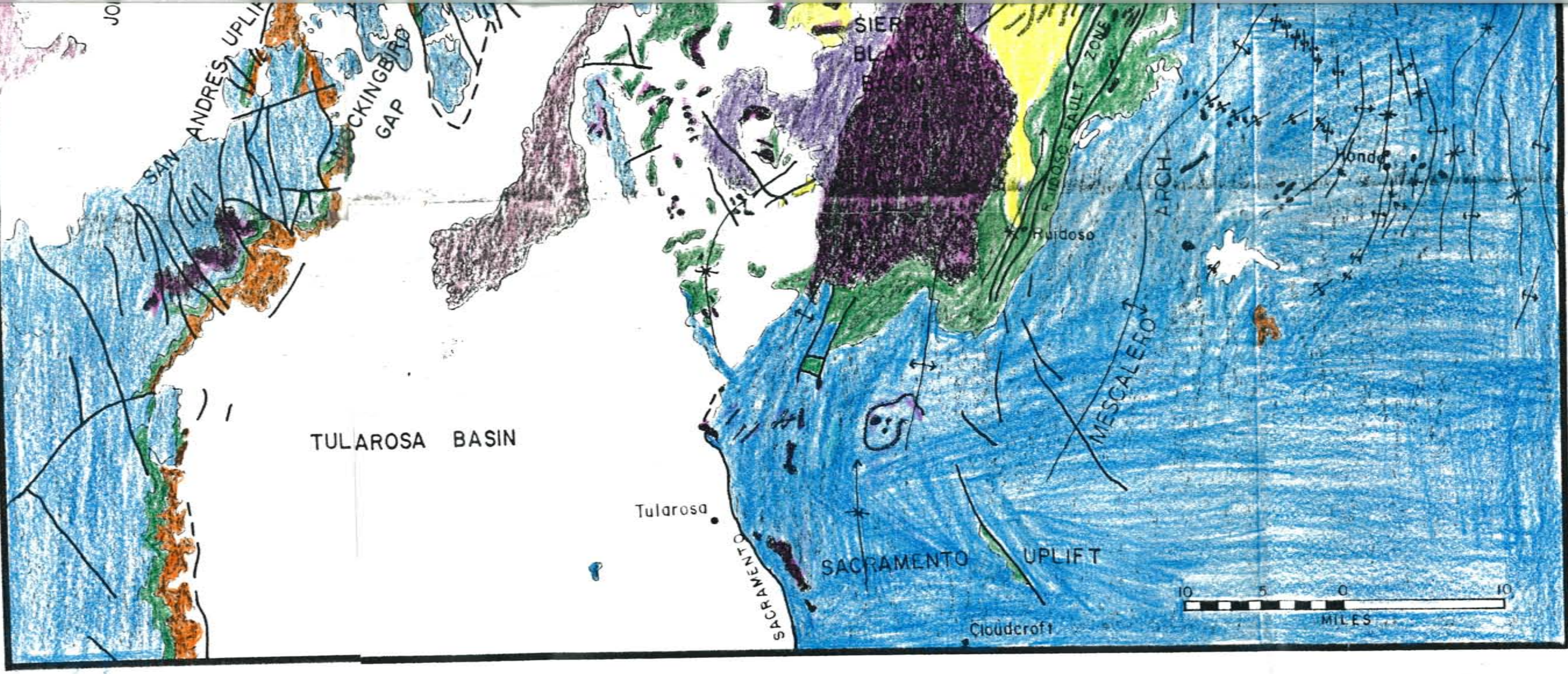
David I. Norman

Mike Payne by mw

4 May 1983
Date

PLATE 2


INDEX MAP
NEW MEXICO
Albuquerque
Rio Grande
El Paso
N
11.5°
Corona
CORONA SYNCLINE
Tecolote
SAG
PLATFORM
CHUPADERA
CLAUNCH
ARCH
PECOS
SLOPE
Bingham
Jones
Jicarilla
Broken Back
Little Black Peak
CHUPADERA
WHITE OAKS
White Oaks
Baxter
MESCALERO
JORNADO DEL MUERTO BASIN
OSCURA
UPLIFT
OSCURA
YATES
CARRIZOZO ANTICLINE
Carrizozo
CAPITAN
SIERRA BLANCA BASIN
SAN ANDRES UPLIFT
MOCKINGBIRD GAP
FAULT ZONE
ARCH
MESCALERO
Hondo
Ruidoso
TULAROSA BASIN
Tularosa



GEOLOGIC MAP OF THE RUIDOSO - CARRIZOZO REGION

(Compiled from Dane and Bachman, 1965, and Kelley and Thompson, 1964)

1 : 506,880

EXPLANATION

SEDIMENTARY UNITS

- Quaternary
- Tertiary
- Mesozoic
- Paleozoic (Permian except in the San Andres Mountains)

INTRUSIVE AND EXTRUSIVE UNITS

- Quaternary basalt flows
- Tertiary volcanics
- Tertiary intrusives
- Precambrian

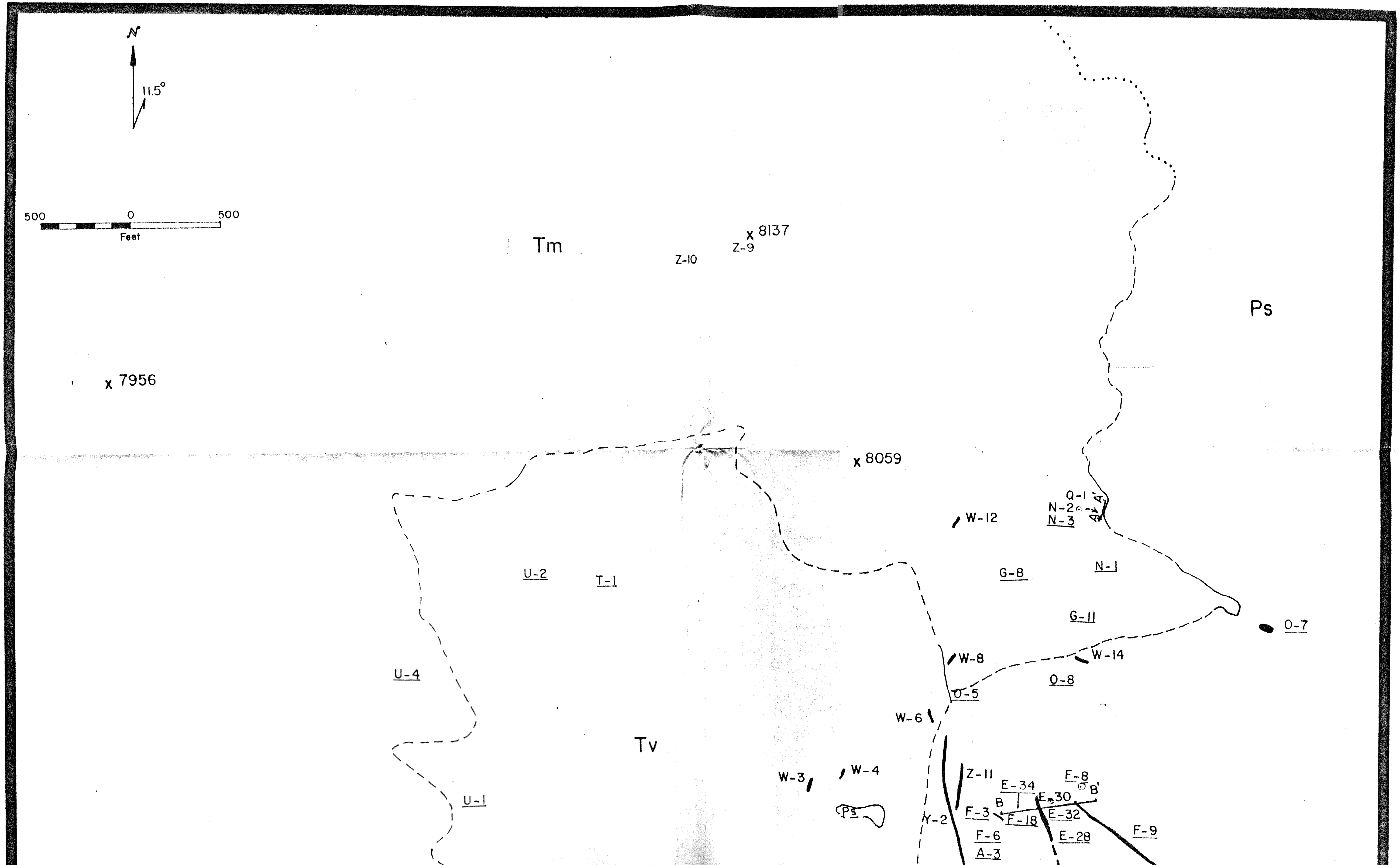
Geologic contact

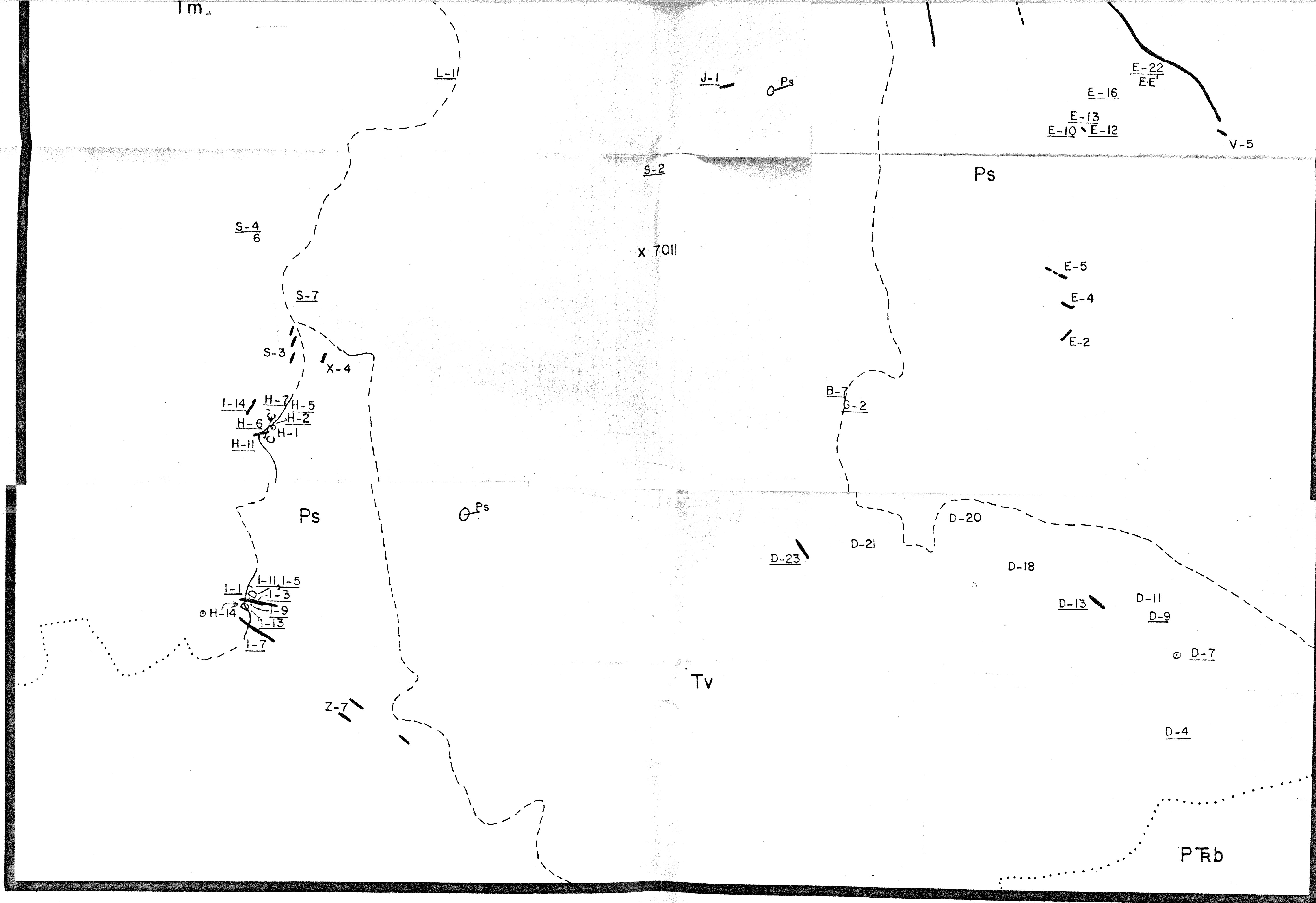
Fault, dashed where inferred

Anticline axis

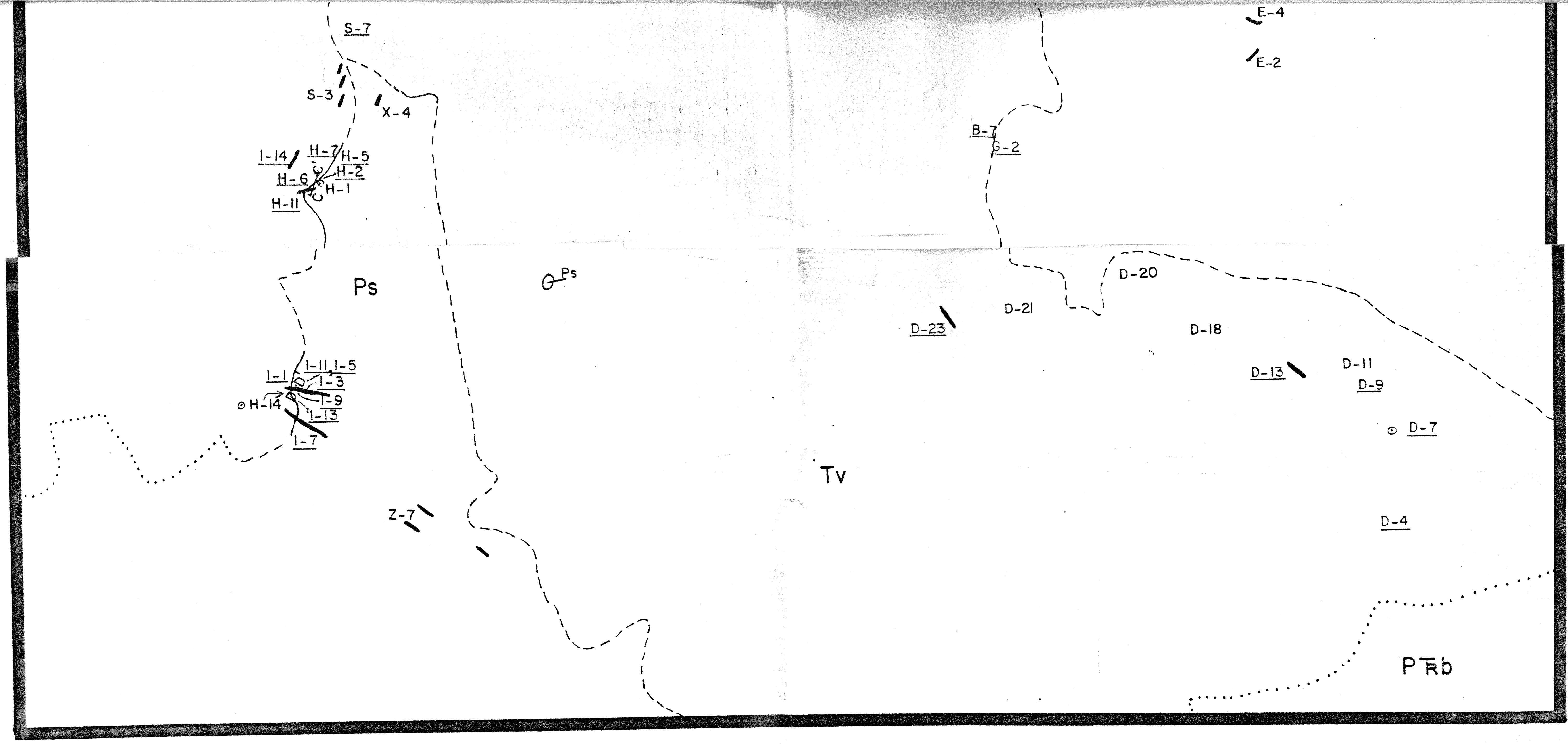
Syncline axis

OVERLAY 3.1


N
11.5°
500
0
500
Feet
Tm
x 8137
Z-9
Z-10
x 7956
x 8059
Ps
Q-1
N-2
N-3
W-12
G-8
N-1
G-11
O-7
U-2
T-1
U-4
W-8
W-14
O-8
O-5
W-6
Tv
W-3
W-4
Z-11
E-34
F-8
B'
E-30
B
F-3
F-18
E-32
Ps
Y-2
F-6
E-28
F-9
A-3
U-1



LOCATION OF SAMPLES AND CROSS SECTIONS



LOCATION OF SAMPLES AND CROSS-SECTIONS

1 : 6000

EXPLANATION

W-4 :	Location or feature referred to in text	S-2 :	Sample location (described in Appendix A)
⊙ H-1 :	Location of assayed magnetite ore (see Table 4)	X ___ X' :	Cross-section location