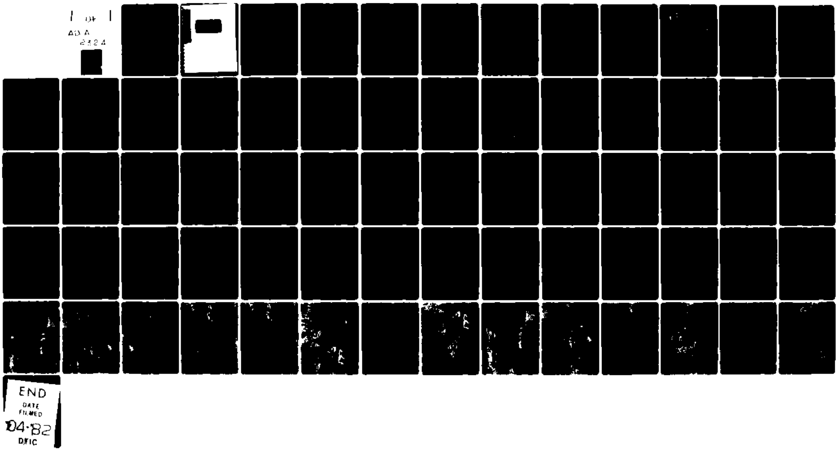
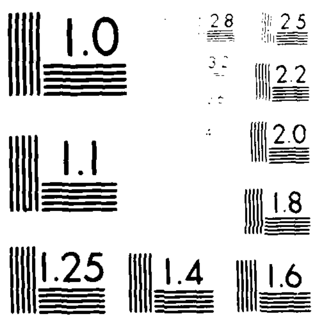
AD-A112 324 ERTEC WESTERN INC LONG BEACH CA F/G 8/5

MX SITING INVESTIGATION GRAVITY SURVEY - PINE VALLEY, UTAH. REV--ETC(U)

MAY 81 F04704-80-C-0006

UNCLASSIFIED E-TR-33-PI-REV NL




1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

PHOTOGRAPH THIS SHEET

AD-A112 324

DTIC ACCESSION NUMBER

II

LEVEL

1

INVENTORY

E-TR-33-PI

DOCUMENT IDENTIFICATION

This ... for public ... distribution is unlimited.

DISTRIBUTION STATEMENT

ACCESSION FOR		
NTIS	GRA&I	X
DTIC	TAB	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION /		
AVAILABILITY CODES		
DIST	AVAIL AND/OR SPECIAL	
A		

DISTRIBUTION STAMP

DTIC

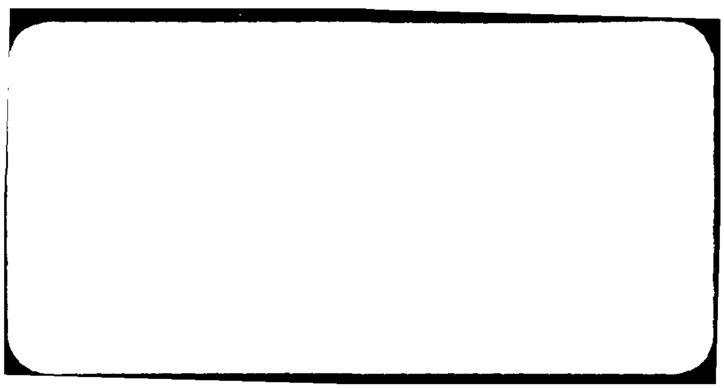
DATE ACCESSIONED

DATE RECEIVED IN DTIC

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDA-2

DTIC FORM OCT 79 70A

DOCUMENT PROCESSING SHEET



E-TR-33-PI

MX SITING INVESTIGATION
GRAVITY SURVEY - PINE VALLEY
UTAH

Prepared for:

U.S Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

Ertec Western, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

2 March 1981
Revised
15 May 1981

Ertec

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER E-TR-33-PI	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MX Siting Invest. Gravity Survey Pine Valley Utah		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER E-TR-33-PI
7. AUTHOR(s) Ertec Western Inc.		8. CONTRACT OR GRANT NUMBER(s) F04704-80-C-0006
9. PERFORMING ORGANIZATION NAME AND ADDRESS Ertec Western Inc. (formerly Fugro National) P.O. Box 7765 Long Beach Ca 90807		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 64312 F
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Department of the Air Force Space and Missile Systems Organization Norton AFB Ca 92409 (SAMSO)		12. REPORT DATE [illegible] 15 Nov 81
		13. NUMBER OF PAGES 40
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) --
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Distribution Unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Gravity survey, Geology, Bouguer Anomaly, Depth to Rock, Valley Fill, Faults, gravity profile, graben

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Results of a gravity survey in the Pine Valley of southwestern Utah indicate that the valley occupies the [illegible] portion of an asymmetric fault block. The fault block is separated from the Wah Wah Mountains by a major range-bounding fault system. A number of [illegible], [illegible] the northern part of the valley.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FOREWORD

Methodology and Characterization studies during Fiscal Years 1977 and 1978 (FY 77 and 78) included gravity surveys in ten valleys in Arizona (five), Nevada (two), New Mexico (two), and California (one). The gravity data were obtained for the purpose of estimating the gross structure and shape of the basins and the thickness of the valley fill. There was also the possibility of detecting shallow rock in areas between boring locations. Generalized interpretations from these surveys were included in Ertec Western's (formerly Fugro National) Characterization Reports (FN-TR-26a through e).

During the FY 77 surveys, measurements were made to form an approximate 1-mile grid over the study areas, and contour maps showing interpreted depth to bedrock were made. In FY 79, the decision was made to concentrate on verifying and refining suitable area boundaries. This decision resulted in a reduction in the gravity program. Instead of obtaining gravity data on a grid, the reduced program consisted of obtaining gravity measurements along profiles across the valleys where Verification studies were also performed.

The Defense Mapping Agency (DMA), St. Louis, was requested to provide gravity data from their library to supplement the gravity profiles. For Big Smoky, Hot Creek, and Big Sand Springs valleys, a sufficient density of library data was available to permit construction of interpreted contour maps instead of just two-dimensional cross sections.

In late summer of FY 79, supplementary funds became available to begin data reduction. At that time, inner zone terrain corrections were begun on the library data and the profiles from Big Smoky Valley, Nevada, and Butler and La Posa valleys, Arizona. The profile data from Whirlwind, Hamlin, Snake East, White River, Garden, and Coal valleys, Nevada, became available from the field in early October 1979.

A continuation of gravity interpretations has been incorporated into the FY 80-81 program, and the results are being summarized in a series of valley reports. Reports covering Nevada-Utah gravity studies are numbered "E-TR-33-" followed by the abbreviation for the subject valley. In addition, more detailed reports of the results of FY 77 surveys in Dry Lake and Ralston valleys, Nevada, were prepared. Verification studies were continued in FY 80 and 81, and gravity studies were included in the program. DMA continued to obtain the field measurements, and there was a return to the grid pattern. The interpretation of the grid data allows the production of contour maps which are valuable in the deep basin structural analysis needed for computer modeling in the water resources program. The gravity interpretations will also be useful in Nuclear Hardness and Survivability (NH&S) evaluations.

The basic decisions governing the gravity program are made by BMO following consultation with TRW, Inc., Ertec Western, and the DMA. Conduct of the gravity studies is a joint effort between DMA and Ertec Western. The field work, including planning, logistics, surveying, and meter operation is done by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC), headquartered in Cheyenne, Wyoming. DMAHTC reduces the data to Simple Bouguer Anomaly (see Section A1.4, Appendix A1.0). The Defense Mapping Agency Aerospace Center (DMAAC), St. Louis, Missouri, calculates outer zone terrain corrections.

Ertec Western provides DMA with schedules showing the valleys with the highest priorities. Ertec Western also recommended locations for the profiles in the FY 79 studies with the provision that they should follow existing roads or trails. Any required inner zone terrain corrections are calculated by Ertec Western prior to making geologic interpretations.

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

TABLE OF CONTENTS (cont.)

LIST OF TABLES

LIST OF DRAWINGS

1.0 INTRODUCTION

1.1 OBJECTIVE

Gravity measurements were made in Pine Valley for the purpose of estimating the overall shape of the structural basin, the thickness of alluvial fill, and the location of concealed faults. The estimates will be useful in modeling the dynamic response of ground motion in the basin and in evaluating ground-water resources.

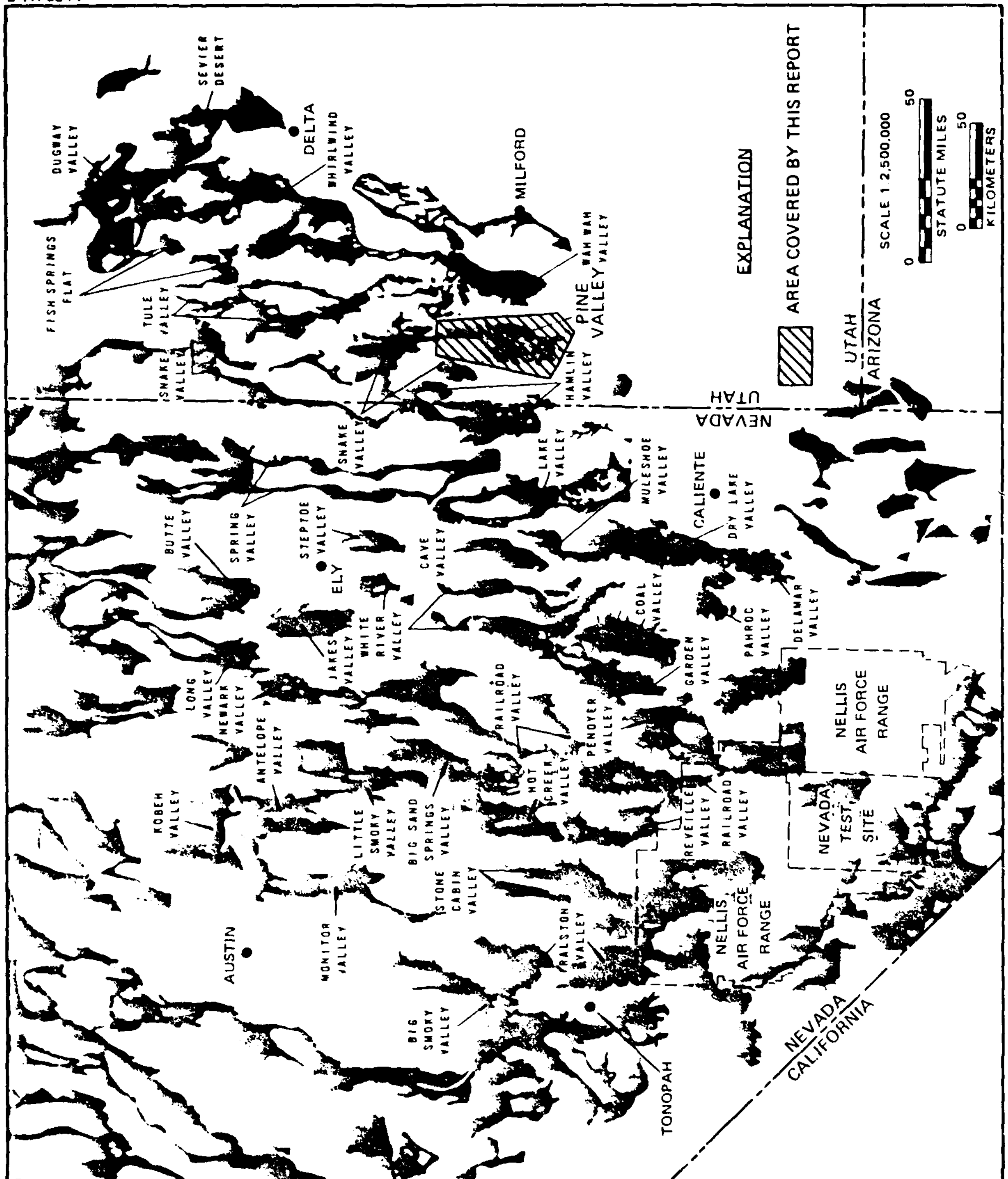
1.2 LOCATION

Pine Valley is located in the southwestern part of Utah (Figure 1) in Beaver and Millard counties. The town of Milford, Utah, is approximately 36 miles (58 km) east of the valley on Highway 21. Access throughout the valley is good due to an extensive network of well-maintained, unpaved roads. The valley is principally rangeland.

Pine Valley is bounded on the east by the Wah Wah Mountains and on the west by the Needle Range (Figure 2). The area covered by this report lies between North latitudes 38° 00' and 38° 45' and West longitudes 113° 30' and 114° 00'. The valley is approximately 12 miles (19 km) wide and 40 miles (64 km) long.

1.3 SCOPE OF WORK

A total of 439 gravity stations was used in this report. The Defense Mapping Agency Aerospace Center (DMAAC) supplied 151 gravity stations from its library, and 288 new gravity

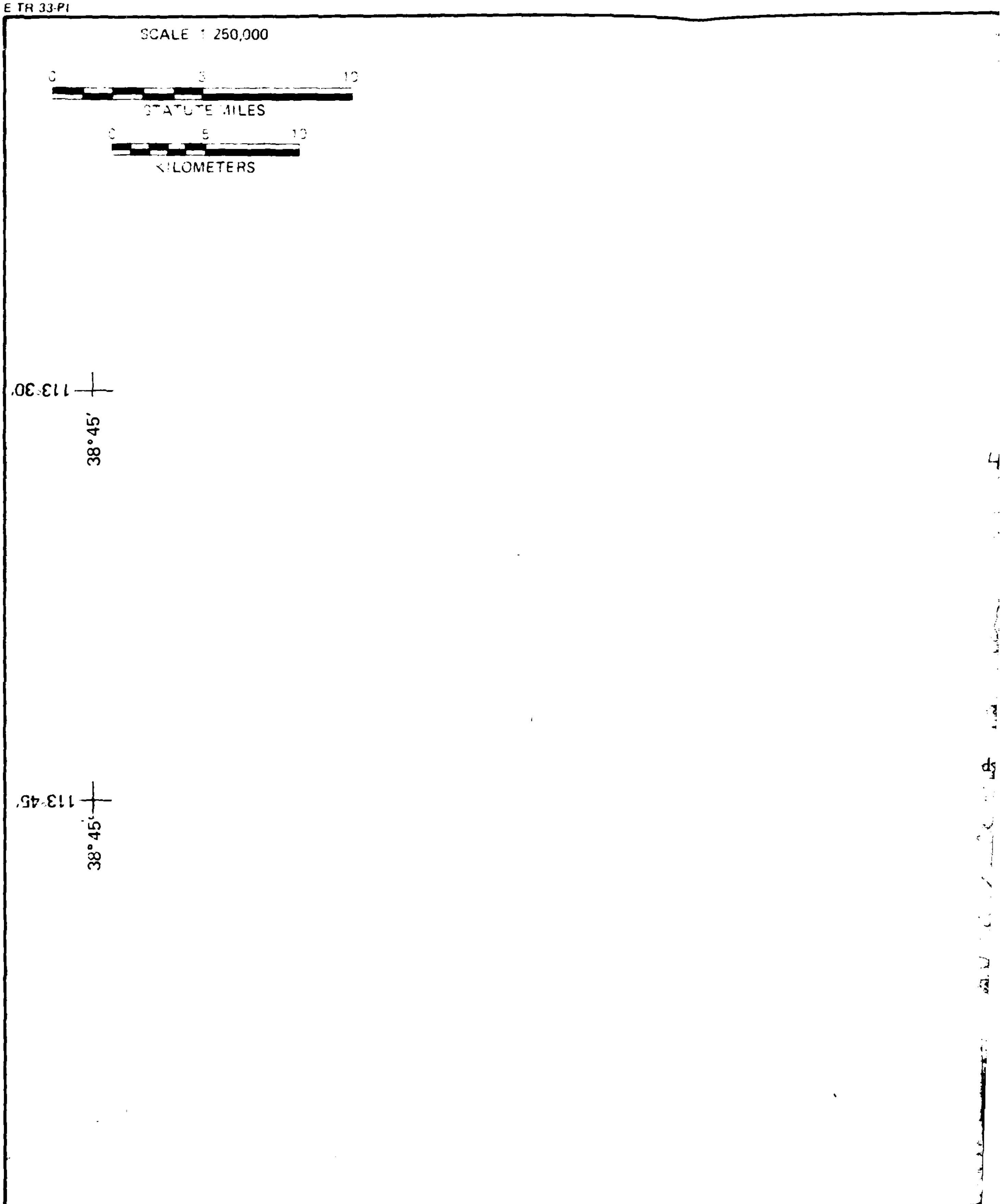


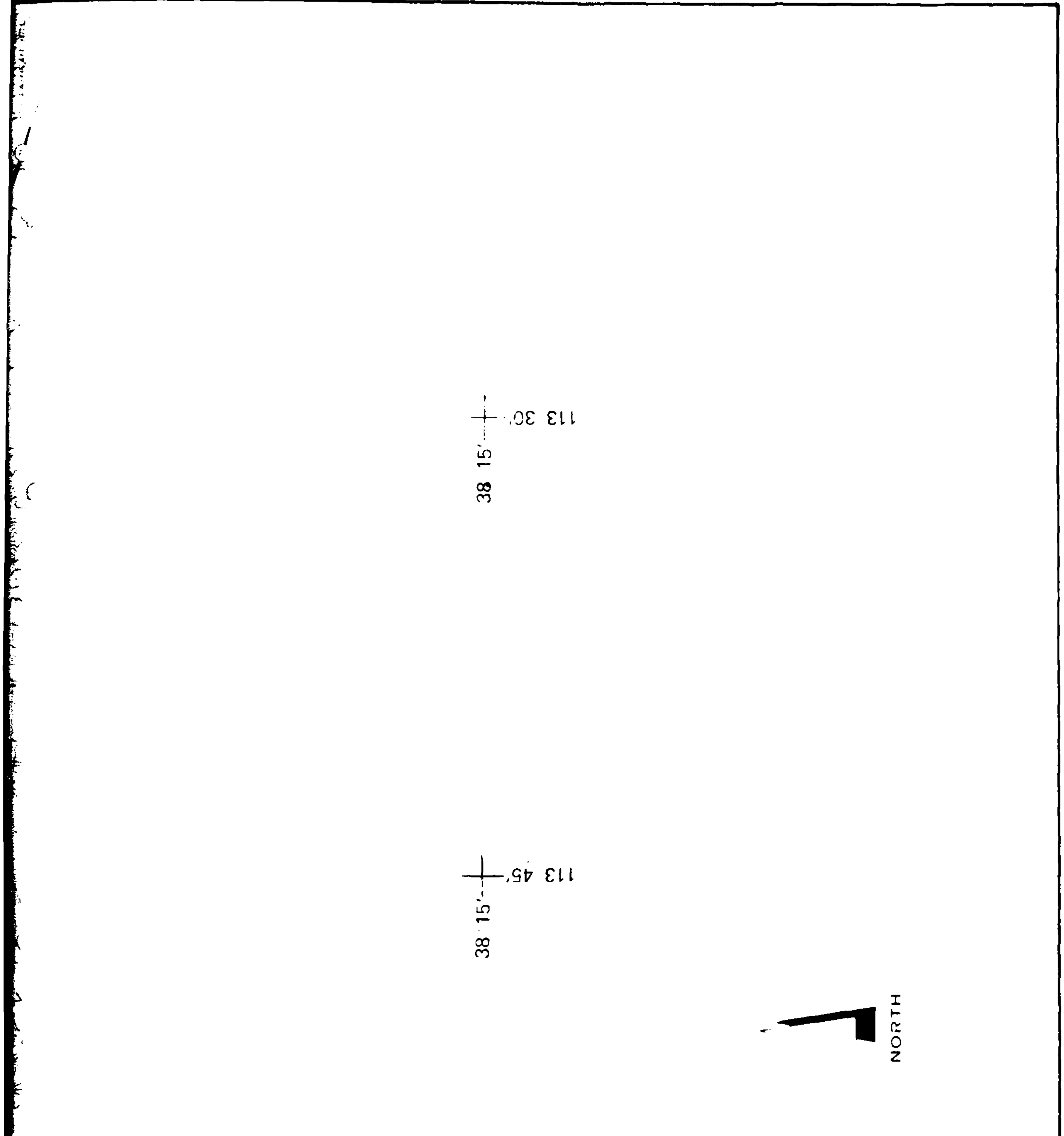
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

LOCATION MAP
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

FIGURE 1


SCALE 1:250,000
0
5
10
STATUTE MILES
0
5
10
KILOMETERS
113°30'
38°45'
113°45'
38°45'



Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

TOPOGRAPHIC SETTING
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

FIGURE 2

measurements were made by the Defense Mapping Agency Hydrographic Topographic Center/Geodetic Survey Squadron (DMAHTC/GSS).

Pine Valley and Wah Wah Valley were studied together, with the results presented in separate reports. The rectangular region containing both valleys is the area between North latitudes 38° 00' and 38° 45' and West longitudes 113° 05' and 114° 00'. There are 778 gravity stations in the region. All were used to establish a common regional gravity trend for the two valleys.

Following residual separation, the geologic modeling of the two valleys was done independently.

2.0 GRAVITY DATA REDUCTION

DMAHTC/GSS obtained the basic observations for the new stations and reduced them to Simple Bouguer Anomalies (SBA) as described in Appendix A1.0. Up to three levels of terrain corrections were applied to the new stations to convert the SBA to the Complete Bouguer Anomaly (CBA). Only the first two levels of terrain corrections described below were applied to the library stations.

First, the DMAAC, St. Louis, Missouri, used its library of digitized terrain data and a computer program to calculate corrections out to 104 miles (167 km) from each station. When the program could not calculate the terrain effects near a station, a ring template was used to estimate the effect of terrain within approximately 3000 feet (914 m) of the station. The third level of terrain corrections was applied to those stations where 10 feet (3 m) or more of relief was observed within 130 feet (40 m). In these cases, the elevation differences were measured in the field at a distance of 130 feet (40 m) along six directions from the stations. These data were used to calculate the effect of the very near relief.

3.0 GEOLOGIC SUMMARY

Pine Valley is a closed drainage basin that lies within the Basin and Range Physiographic Province. The rocks that crop out in the adjacent mountains range in age from early Cambrian to Tertiary.

Rocks exposed in the Wah Wah Mountains to the east are primarily north-to-northeast dipping early Cambrian to middle Ordovician sedimentary and metasedimentary quartzite and shale and middle Cambrian to Permian limestone and dolomite. Tertiary mafic to felsic lava flows and ash-flow tuffs crop out along the south-eastern and southern edges of Pine Valley. The same type of Tertiary extrusive rocks are predominant in the Needle Range on the west. Tertiary intrusive quartz-monzonite crops out locally on both sides of the valley.

From late Precambrian to late Permian time, a westward thickening wedge of clastic and carbonate sediments was deposited in western Utah along a north-to-northeast trending continental shelf. Thrusting and folding began west of this region in the Jurassic and terminated to the east with late Precambrian and early Paleozoic rocks overthrusting late Paleozoic strata during the Cretaceous Sevier Orogeny (Thorman and Ketner, 1979). Early Tertiary was a time of widespread siliceous volcanism. Beginning in the Miocene, extensional block faulting began in western Utah. It was accompanied by volcanism that produced felsic and mafic-to-felsic lava flows.

The present day Pine Valley is an eastward-tilted graben whose ground-water basin is thought to be interconnected with that of Wah Wah Valley to the east (Stephens, 1976). The valley is bounded by inferred, north-trending, high-angle faults along the western side of the Wah Wah Mountains and eastern side of the Needle Range (Stephens, 1976).

The valley is underlain with uncemented to well-cemented, older Quaternary basin-fill deposits with interbedded volcanic flows (Stephens, 1976). Major surficial Quaternary deposits include fine-grained lacustrine and playa deposits, alluvial fan-gravels, eolian sand, and stream-channel deposits.

4.0 INTERPRETATION

The basis of interpretation is the Complete Bouguer Anomaly (CBA). Drawing 1 shows the CBA gravity field contoured from gridded values and the location of the gravity stations.

Mathematical treatment of irregularly spaced data is inefficient. In order to simplify the computer processing, the station CBA and elevation data are reduced to sets of values at uniformly spaced points (nodes) in a geographic array, or grid. The values at each node are calculated from the station data within a circular area around the node. A bell-shaped weighting function assigns greater weight to the nearer data points. The node spacing is chosen to match the average data spacing. A 1.2-mile (2-km) grid spacing was used for this analysis.

4.1 REGIONAL-RESIDUAL SEPARATION

A fundamental part of the gravity interpretation is the separation of regional effects from the local effects of the valley and its fill. The CBA contains long wavelength components from deep and broad geologic structures extending far beyond the valley. These long wavelength components, called the regional gravity, were approximated by upward continuation of the gravity field. Upward continuations were made to successively higher elevations until the negative anomaly over the valley was essentially smoothed out. The final continuation was calculated at an elevation of 140,000 feet (42,672 m). This regional field was subtracted from the CBA and the resulting residual gravity anomaly was adjusted by a constant -5.0 milligals so that the zero residual would fit approximately the existing rock outcrops.

4.2 DENSITY SELECTION

The construction of a geologic model from the residual anomaly requires selection of density values representative of the alluvial fill and of the underlying rock. Since only very generalized density information is available, the geologic interpretation of the gravity data can be only a coarse approximation. Seven borings were drilled approximately 160 feet (49 m) into the alluvium during Verification studies. The average of the densities measured at the bottom of these borings was 2.2 g/cm^3. To account for compaction with depth (Woollard, 1962; and Grant and West, 1965), 2.3 g/cm^3 was used in the modeling process.

Based on the geology of the surrounding mountain ranges, the basement rocks underlying Pine Valley are composed of Precambrian quartzites and shales and Paleozoic carbonates and siliceous clastic strata. Basement rocks throughout the Great Basin primarily comprise Precambrian and Paleozoic siliceous clastic and carbonate strata with densities generally between 2.6 to 2.9 g/cm^3. The Paleozoic carbonate rocks in Nevada and Utah are generally reported to be relatively high in density, on the order of 2.8 g/cm^3. This value was selected to represent the density of the basement rock. The density contrast used for modeling was -0.50 g/cm^3.

4.3 MODELING

Modeling was done with the aid of a computer program which iteratively calculates a three-dimensional solution of gravity anomaly data (Cordell, 1970). The gravity anomaly is represented by discrete values on a two-dimensional grid. The source of the anomaly (the volume of low-density valley fill) is represented by a set of vertical prism elements. The tops of the prisms lie in a common horizontal plane. The bottoms of the prisms collectively represent the bottom of the valley fill. Each prism has a cross-sectional area equal to one grid square and a uniform density. A grid square of 1.2 miles by 1.2 miles (2 km by 2 km) was selected as representative of the gravity station distribution. Computations were made for five iterations of mutually interactive prism adjustments. The root-mean-square error for the entire grid was less than 0.7 milligal.

The calculated thickness of the valley fill depends upon the density contrast (i.e., fill density minus rock density) used. Since neither density is perfectly known, nor even uniform, the calculated thickness should be expected to contain a corresponding degree of uncertainty. A source of error in modeling Pine Valley as a simple alluvium basement rock system is the widespread volcanic material throughout the valley.

Eight seismic refraction lines (Table 1) and six borings (Table 2) were used as constraints in the modeling process. Their locations are marked in Drawing 2. The seismic refraction

SELECTED VERIFICATION SEISMIC REFRACTION RESULTS *			
LINE NUMBER	DEEPEST LAYER fps / (mps)	@	feet / (meters)
PI - S-6	9400 / 2865	@	115 / 35
PI - S-8	11850 / 3612	@	28 / 9
PI - S-12	9150 / 2789	@	90 / 27
PI - S-13	8250 / 2515	@	65 / 20
PI - S-14	10450 / 3185	@	60 / 18
PI - S-16	9300 / 2835	@	162 / 49
PI - S-19	10200 / 3109	@	110 / 34
PI - S-21	9350 / 2850	@	50 / 15

* LOCATIONS MARKED IN DRAWING 2.
FROM FUGRO NATIONAL 1981

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

GEOTECHNICAL DATA
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

TABLE 1

I.D.	COMPANY	LOCATION	REMARKS
BORING (A)	ERTEC WESTERN PI-104	NE ¼ of SEC. 10 T26S-R17W BEAVER COUNTY, UTAH	1157 FT (353m) SAND AND CLAY
BORING (B)	PHELPS DODGE CORP.	SE ¼ OF SEC. 22 T28S-R17W BEAVER COUNTY, UTAH	2006 FT (611m) QUARTZITE
BORING (C)	PHELPS DODGE CORP.	SW ¼ OF SEC. 11 T28S-R17W BEAVER COUNTY, UTAH	1305 FT (398m) QUARTZITE
BORING (D)	DESERT EXPERIMENTAL RANGE	SE ¼ OF SEC. 33 T25S-R17W BEAVER COUNTY, UTAH	649 FT (198m) SAND ROCK
BORING (E)	A. ANDERSON	SE ¼ OF SEC. 17 T26S-R17W BEAVER COUNTY, UTAH	801 FT (244m) RED CLAY
BORING (F)	U.S BUREAU OF LAND MANAGEMENT	NE ¼ OF SEC. 27 T30S-R17W BEAVER COUNTY, UTAH	648 FT (198m) GRANITE (SOFT)

LOCATIONS MARKED IN DRAWING 2.

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

BORINGS FROM LITERATURE
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

TABLE 2

lines located near the mountain flanks recorded high velocities which may represent the basement material. The alluvial fill material in the center of the valley is at least 1157 to 2006 feet (353 to 611 m) thick according to three of the borings described in the literature. The thickness of basin fill (or depth to rock) based on the interpretation of gravity data is contoured in Drawing 2.

4.4 DISCUSSION OF RESULTS

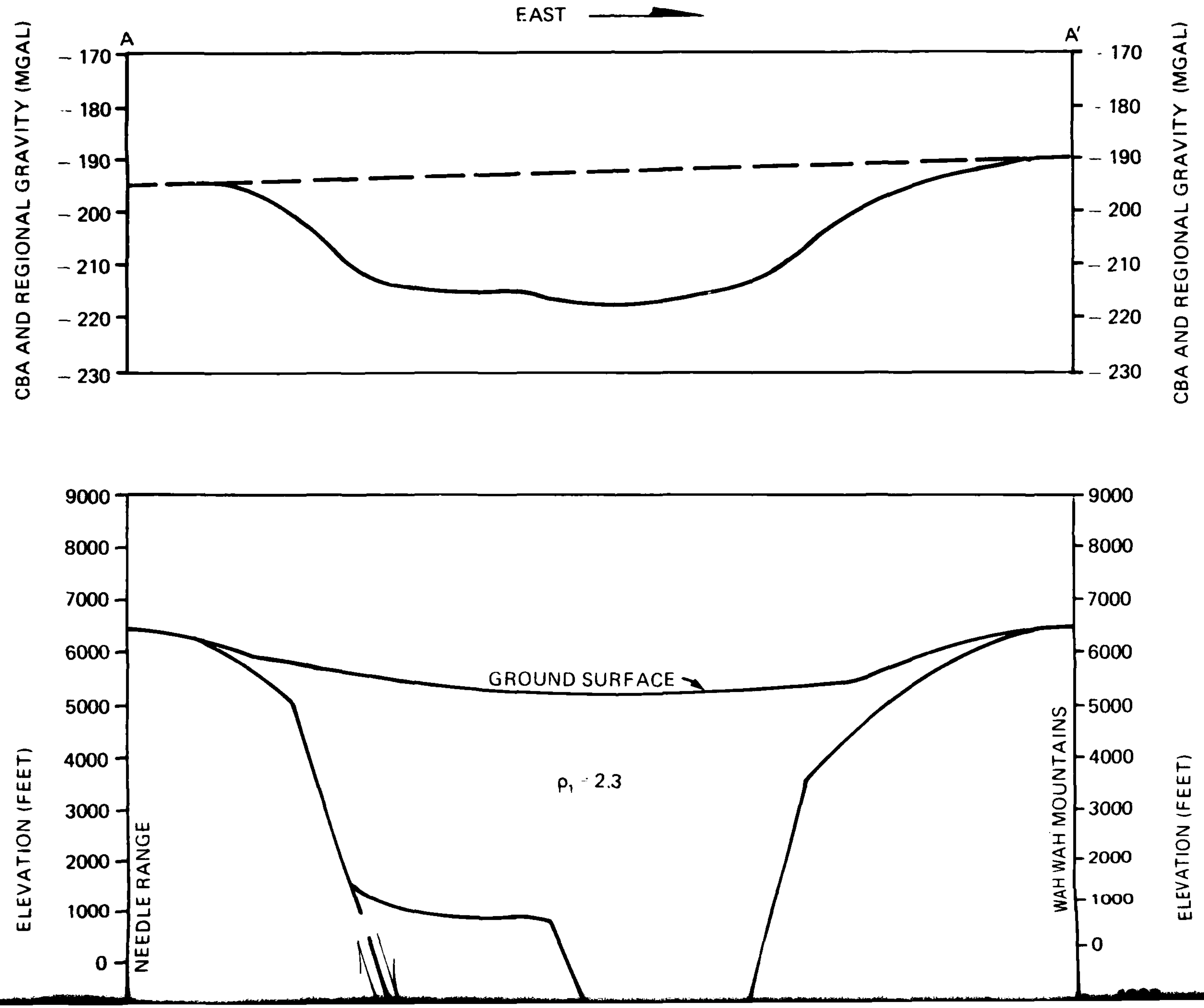
The geologic structure of Pine Valley is interpreted on the depth-to-rock contour map (Drawing 2). The interpretation is based on geologic information from published reports, analysis of aerial photographs, and geologic field reconnaissance as well as gravity data. The analysis of the gravity data included calculation of the second vertical derivative (SVD) of the CBA field. One property of the SVD is that its zero value marks the steepest gradients of the input CBA field. This property was used to guide the placement of faults in the structural interpretation. The interpreted faults represent only the major fault systems which probably comprise many smaller fault zones. There may be other discrete faults that had a minor role in basin formation, but with displacements so small that they were not resolved by the widely spaced gravity data available for this study.

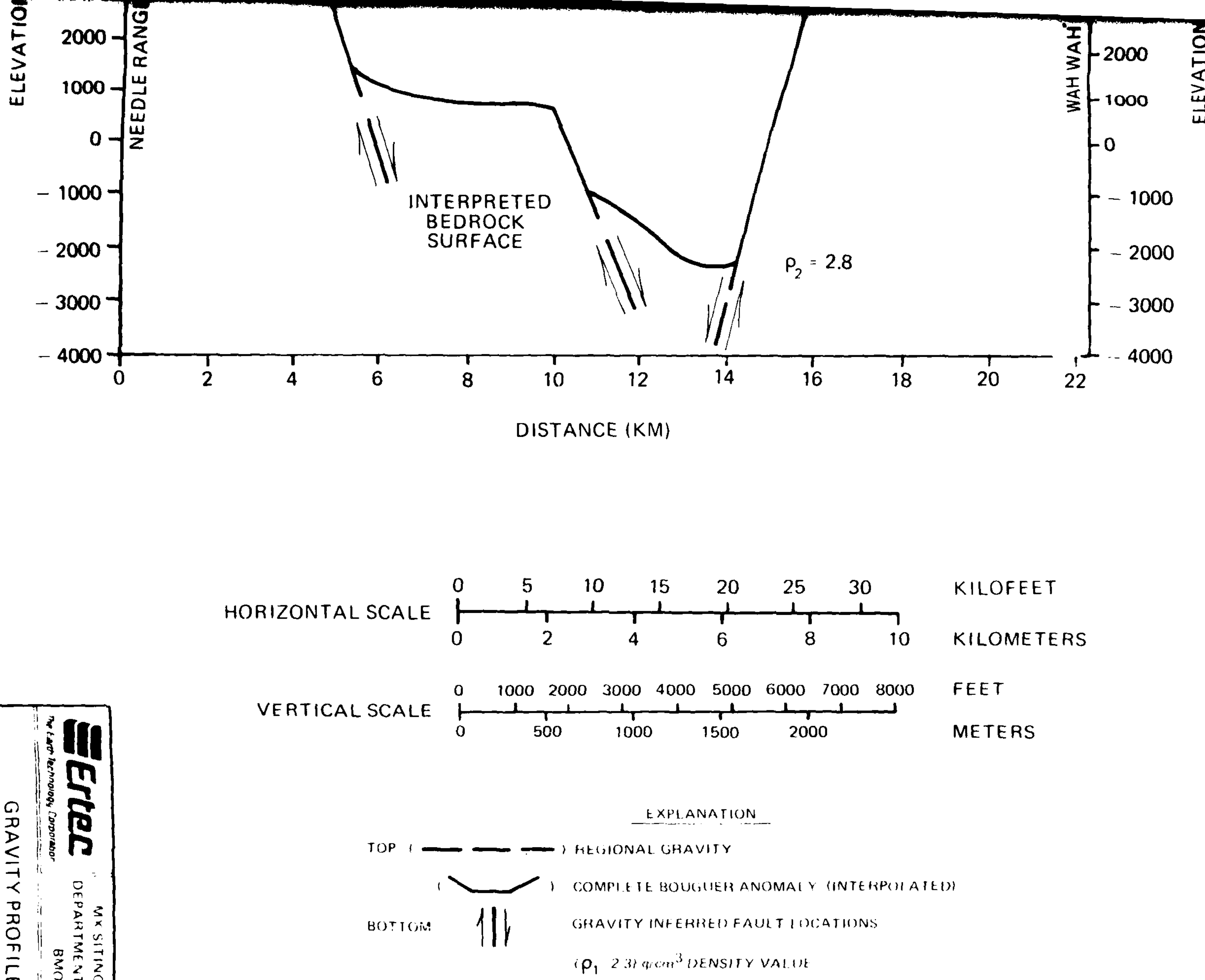
The depth-to-rock contours define a major elongate north-south trending trough coincident with the valley physiography. These contours appear to define two subsurface basins; a north-trending northern basin about 8000 feet (2438 m) deep and a southern basin which is about 3500 feet (1067 m) deep and trends slightly west of north (Drawing 2).

The northern basin contains a major graben. The eastern side of the graben has a steep linear gradient separating it from the Wah Wah Mountains. This pattern suggests there is a continuous major fault system along the base of the Wah Wah Mountains. West of the northern end of the major graben, a complex pattern of minor steep gradients suggests an intricate arrangement of faults of varying displacements (Drawing 2, Figure 3). Farther south, in the vicinity of profile B-B' (Drawing 2, Figure 4), the smoother bedrock contours on the western side of the basin indicate that the bedrock dips gently eastward from the Needles Range for several miles before it is faulted down into the major graben.

The southern basin is more simple structurally. It is interpreted to be an eastward tilted block instead of a graben (Figure 5).

The two basins are separated by a northwesterly trending transverse fault which has allowed the northern basin to drop more deeply than the southern basin. This interpretation is in accord with studies of surficial geology and geomorphology which indicate that displacement on the eastern basin-bounding fault system diminishes southward. The fault appears to be terminated before it reaches the southern end of Pine Valley where no evidence of major fault displacements is found in Tertiary lava flows.


EAST
A
A'
CBA AND REGIONAL GRAVITY (MGAL)
170
180
190
200
210
220
230
ELEVATION (FEET)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
NEEDLE RANGE
WAH WAH MOUNTAINS
GROUND SURFACE
ρ1 = 2.3



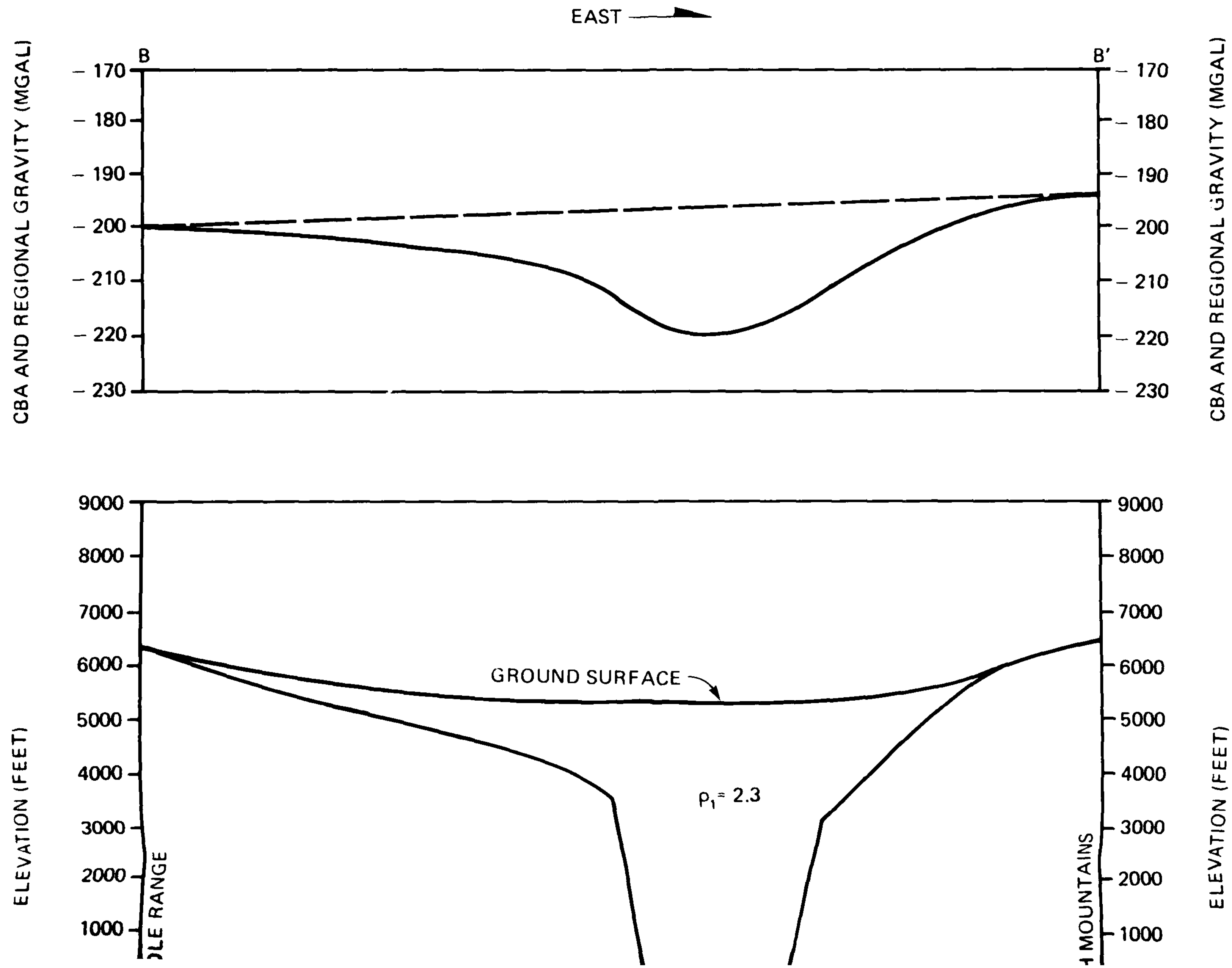
Ertec
The Earth Technology Corporation

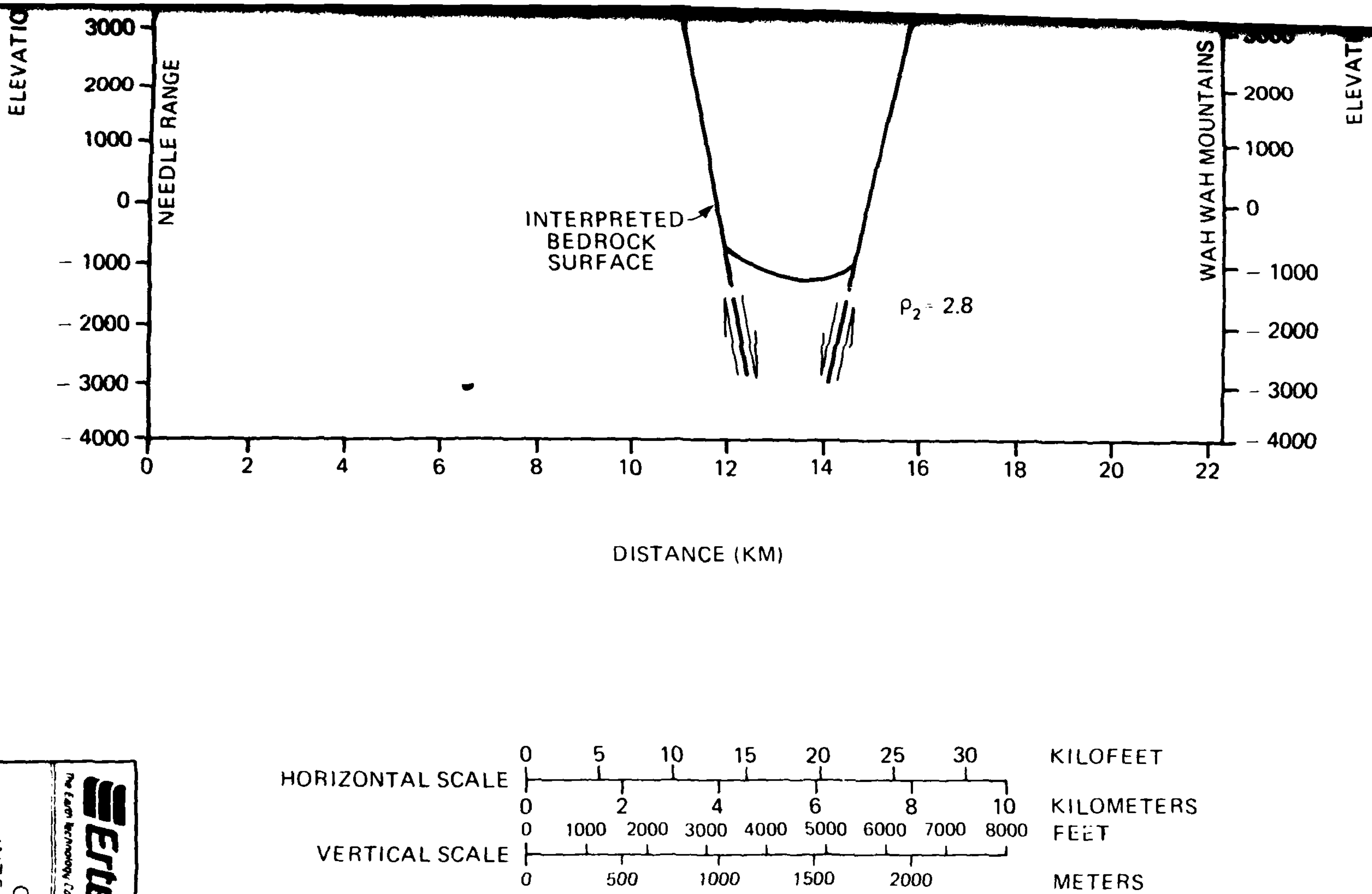
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

GRAVITY PROFILE A-A'
INTERPRETED CROSS-SECTION
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

FIGURE 3


EAST
B
B′
CBA AND REGIONAL GRAVITY (MGAL)
170
180
190
200
210
220
230
ELEVATION (FEET)
9000
8000
7000
6000
5000
4000
3000
2000
1000
GROUND SURFACE
ρ1 = 2.3
OLE RANGE
H MOUNTAINS



EXPLANATION

TOP / BOTTOM

REGIONAL GRAVITY

COMPLETE BOUGUER ANOMALY (INTERPOLATED)

GRAVITY INFERRED FAULT LOCATIONS

(ρ_1 2.3 gm/cm^3) DENSITY VALUE

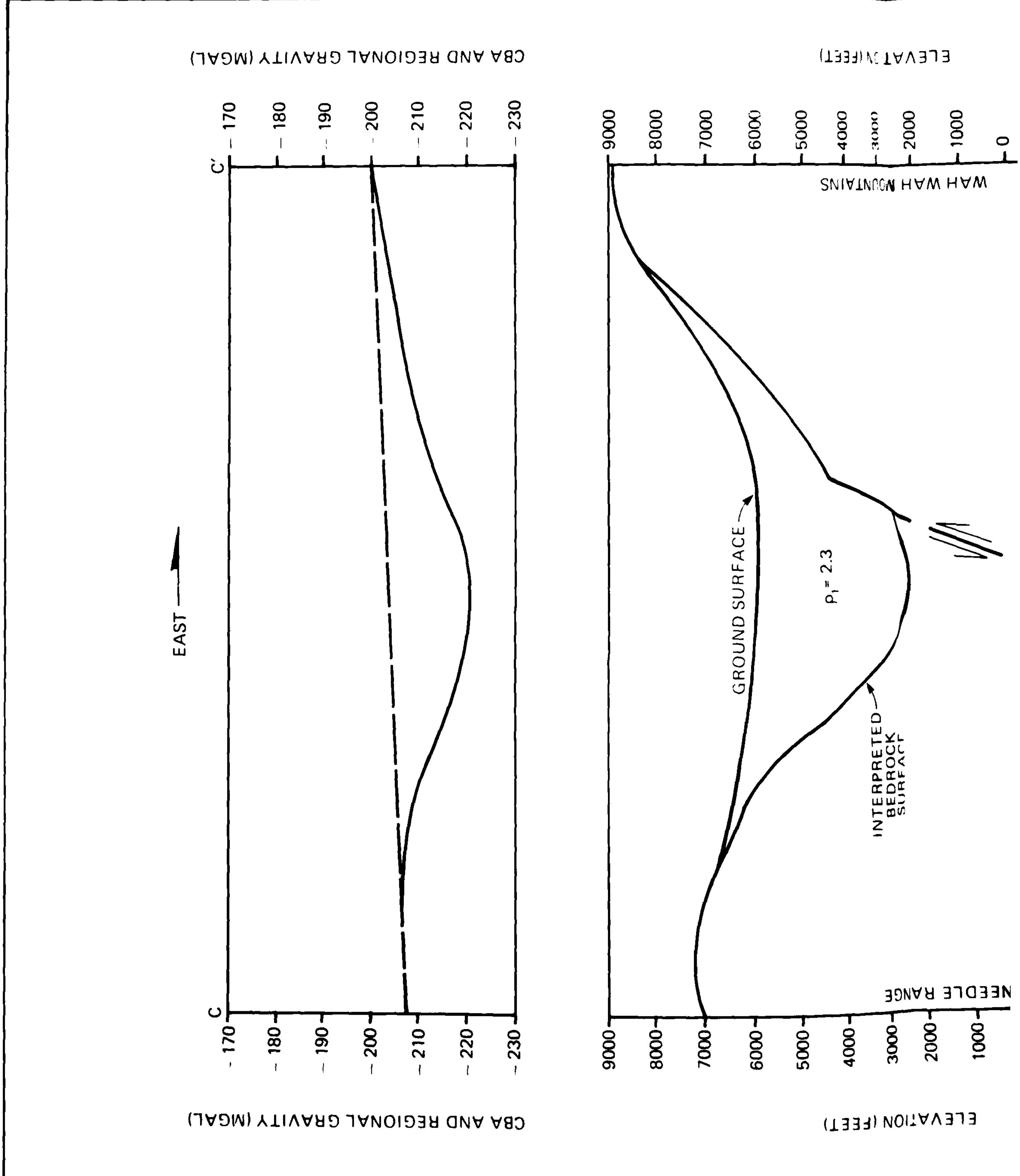
Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

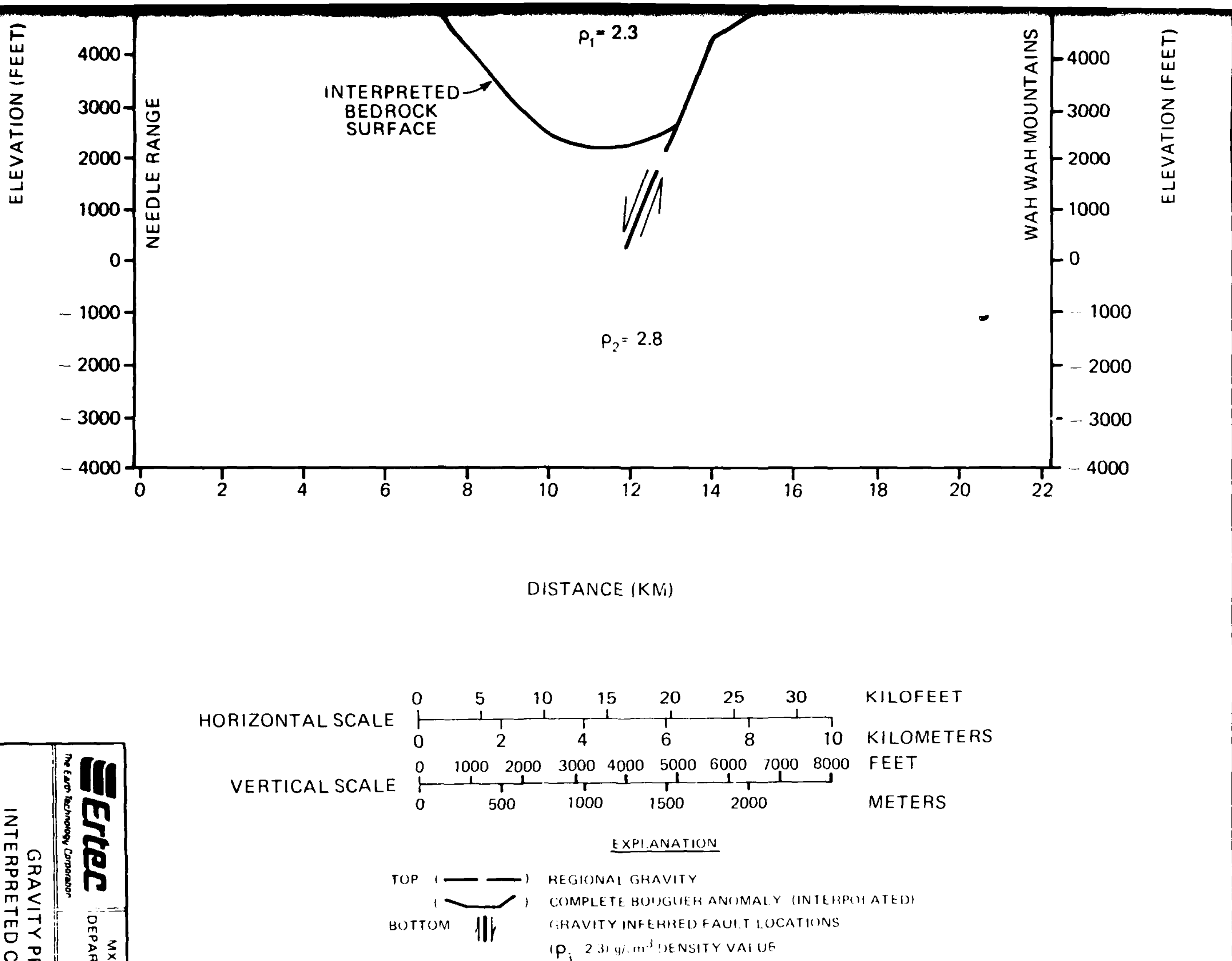
GRAVITY PROFILE B B'
INTERPRETED CROSS SECTION
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

FIGURE 4



CBA AND REGIONAL GRAVITY (MGAL)
C'
C
EAST
-170
-180
-190
-200
-210
-220
-230
ELEVATION (FEET)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
WAH WAH MOUNTAINS
NEEDLE RANGE
GROUND SURFACE
ρ1 = 2.3
INTERPRETED BEDROCK SURFACE



Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

GRAVITY PROFILE C C'
INTERPRETED CROSS SECTION
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

FIGURE 5

5.0 CONCLUSIONS

Pine Valley gravity data indicate that the valley occupies the down-tilted portion of an asymmetric fault block. This fault block is separated from the Wah Wah Mountains by a major basin-bounding fault system. A narrow graben, which is about 8000 feet (2438 m) deep, underlies the northern part of the valley.

The calculated bedrock depths are only approximations because little is known about the actual density distribution in and around the valley, and the residual gravity anomaly is necessarily based on an interpreted regional field. An average density contrast of -0.50 g/cm^3 between the alluvium and bedrock was used to calculate the thickness of the valley-fill material. Future studies that acquire better density data or measure actual depths to bedrock in deep parts of the valley can be used to refine the gravity interpretation.

REFERENCES

Cordell, Lindreth, 1970, Iterative solution of three-dimensional gravity anomaly data, Geological Survey Computer Control No. 10: U.S. Geological Survey, Washington, D.C.

Fugro National Inc., 1981, MX Siting Investigation Geotechnical Evaluation, Verification Study - Pine Valley, Nevada, FN-TR-27-PI.

Goguel, Jean, 1954. A universal table for the prediction of the lunar-solar correction in gravimetry (tide gravity correction), Geophysical Prospecting, v. II, Supplement, March.

Grant, F. S., and West, G. G., 1965, Interpretation theory in applied geophysics: McGraw-Hill Book Co., New York.

Hintze, L. F., 1963, Geologic map of Southwestern Utah; Williams and Heintz Map Co., Washington, D.C., scale of 1:250,000.

Stephens, J. C., 1976, Hydrologic reconnaissance of the Pine Valley Drainage Basin, Millard, Beaver and Iron counties, Utah: Technical Publication No. 51, Department of Natural Resources, State of Utah p. 38.

Thorman, E. H., and Ketner, K. B., 1979, West-Northwest strike-slip faults and other structures in allochthonous rocks in Central and Eastern Nevada and Western Utah; in Basin and Range symposium, by the Rocky Mountain Association of Geologists and Utah Geological Association, p. 12-133.

Woollard, G. P., 1962, The relation of gravity anomalies to surface elevation, crustal structure, and geology: University of Wisconsin, Department of Geology, Geophysical and Polar Research Center, Madison, Wisconsin, Report 62-9.

APPENDIX A1.0

GENERAL PRINCIPALS OF THE GRAVITY EXPLORATION METHOD

A1.0 GENERAL PRINCIPALS OF THE GRAVITY EXPLORATION METHOD

A1.1 GENERAL

A gravity survey involves measurement of differences in the gravitational field between various points on the earth's surface. The gravitational field values being measured are the same as those influencing all objects on the surface of the earth. They are generally associated with the force which causes a 1-gm mass to be accelerated at 980 cm/sec^2. This force is normally referred to as a 1-g force.

Even though in many applications the gravitational field at the earth's surface is assumed to be constant, small but distinguishable differences in gravity occur from point to point. In a gravity survey, the variations are measured in terms of milligals. A milligal is equal to 0.001 cm/sec^2 or 0.00000102 g. The differences in gravity are caused by geometrical effects, such as differences in elevation and latitude, and by lateral variations in density within the earth. The lateral density variations are a result of changes in geologic conditions. For measurements at the surface of the earth, the largest factor influencing the pull of gravity is the density of all materials between the center of the earth and the point of measurement.

To detect changes produced by differing geological conditions, it is necessary to detect differences in the gravitational field as small as a few milligals. To recognize changes due to geological conditions, the measurements are "corrected" to account for changes due to differences in elevation and latitude.

Given this background, the basic concept of the gravitational exploration method, the anomaly, can be introduced. If, instead of being an oblate spheroid characterized by complex density variations, the earth were made up of concentric, homogeneous shells, the gravitational field would be the same at all points on the surface of the earth. The complexities in the earth's shape and material distribution are the reason that the pull of gravity is not the same from place to place. A difference in gravity between two points which is not caused by the effects of known geometrical differences, such as in elevation, latitude, and surrounding terrain, is referred to as an "anomaly."

An anomaly reflects lateral differences in material densities. The gravitational attraction is smaller at a place underlain by relatively low density material than it is at a place underlain by a relatively high density material. The term "negative gravity anomaly" describes a situation in which the pull of gravity within a prescribed area is small compared to the area surrounding it. Low-density alluvial deposits in basins such as those in the Nevada-Utah region produce negative gravity anomalies in relation to the gravity values in the surrounding mountains which are formed by more dense rocks.

The objective of gravity exploration is to deduce the variations in geologic conditions that produce the gravity anomalies identified during a gravity survey.

A1.2 INSTRUMENTS

The sensing element of a LaCoste and Romberg gravimeter is a mass suspended by a zero-length spring. Deflections of the mass from a null position are proportional to changes in gravitational attraction. These instruments are sealed and compensated for atmospheric pressure changes. They are maintained at a constant temperature by an internal heater element and thermostat. The absolute value of gravity is not measured directly by a gravimeter. It measures relative values of gravity between one point and the next. Gravitational differences as small as 0.01 milligal can be measured.

A1.3 FIELD PROCEDURES

The gravimeter readings were calibrated in terms of absolute gravity by taking readings twice daily at nearby USGS gravity base stations. Gravimeter readings fluctuate because of small time-related deviations due to the effect of earth tides and instrument drift. Field readings were corrected to account for these deviations. The magnitude of the tidal correction was calculated using an equation suggested by Goguel (1954):

$$C = P + N\cos\phi\,(\cos\phi + \sin\phi) + S\cos\phi\,(\cos\phi - \sin\phi)$$

where C is the tidal correction factor, P, N, and S are time-related variables, and ϕ is the latitude of the observation point. Tables giving the values of P, N, and S are published annually by the European Association of Exploration Geophysicists.

The meter drift correction was based on readings taken at a designated base station at the start and end of each day. Any difference between these two readings after they were corrected for tidal effects was considered to have been the result of instrumental drift. It was assumed that this drift occurred at a uniform rate between the two readings. Corrections for drift were typically only a few hundredths of a milligal. Readings corrected for tidal effects and instrumental drift represented the observed gravity at each station. The observed gravity values represent the total gravitational pull of the entire earth at the measurement stations.

A1.4 DATA REDUCTION

Several corrections or reductions are made to the observed gravity to isolate the portion of the gravitational pull which is due to the crustal and near-surface materials. The gravity remaining after these reductions is called the "Bouguer Anomaly." Bouguer Anomaly values are the basis for geologic interpretation. To obtain the Bouguer Anomaly, the observed gravity is adjusted to the value it would have had if it had been measured at the geoid, a theoretically defined surface which approximates the surface of mean sea level. The difference between the "adjusted" observed gravity and the gravity at the geoid calculated for a theoretically homogeneous earth is the Bouguer Anomaly.

Four separate reductions, to account for four geometrical effects, are made to the observed gravity at each station to arrive at its Bouguer Anomaly value.

a. Free-Air Effect: Gravitational attraction varies inversely as the square of the distance from the center of the earth. Thus, corrections must be applied for elevation. Observed gravity levels are corrected for elevation using the normal vertical gradient of:

$$FA = -0.09406 \text{ mg/ft } (-0.3086 \text{ milligals/meter})$$

where FA is the free-air effect (the rate of change of gravity with distance from the center of the earth). The free-air correction is positive in sign since the correction is opposite the effect.

b. Bouguer Effect: Like the free-air effect, the Bouguer effect is a function of the elevation of the station, but it considers the influence of a slab of earth materials between the observation point on the surface of the earth and the corresponding point on the geoid (sea level). Normal practice, which is to assume that the density of the slab is 2.67 grams per cubic centimeter was followed in these studies. The Bouguer correction (B_c), which is opposite in sign to the free-air correction, was defined according to the following formula.

$$B_c = 0.01276\ (2.67)\ h_f \text{ (milligals per foot)}$$

$$B_c = 0.04185\ (2.67)\ h_m \text{ (milligals per meter)}$$

where h_f is the height above sea level in feet and h_m is the height in meters.

c. Latitude Effect: Points at different latitudes will have different "gravities" for two reasons. The earth (and the geoid) is spheroidal, or flattened at the poles. Since points at higher latitudes are closer to the center of the earth than points near the equator, the gravity at the higher latitudes is larger. As the earth spins, the centrifugal acceleration causes a slight decrease in gravity. At the higher latitudes where the earth's radii are smaller, the centrifugal acceleration diminishes. The gravity formula for the Geodetic Reference System, 1967, gives the theoretical value of gravity at the geoid as a function of latitude. It is:

$$g = 978.0381\ (1 + 0.0053204 \sin^2 \phi - 0.0000058 \sin^2 2\phi) \text{ gals}$$

where g is the theoretical acceleration of gravity and ϕ is the latitude in degrees. The positive term accounts for the spheroidal shape of the earth. The negative term adjusts for the centrifugal acceleration.

The previous two corrections (free air and Bouguer) have adjusted the observed gravity to the value it would have had at the geoid (sea level). The theoretical value at the geoid for the latitude of the station is then subtracted from the adjusted observed gravity. The remainder is called the Simple Bouguer Anomaly (SBA). Most of this gravity represents the effect of material beneath the station, but part of it may be due to irregularities in terrain (upper part of the Bouguer slab) away from the station.

d. Terrain Effect: Topographic relief around the station has a negative effect on the gravitational force at the station. A nearby hill has upward gravitational pull and a nearby valley contributes less downward attraction than a nearby material would have. Therefore, the corrections are always positive. Corrections are made to the SBA when the terrain effects were 0.1 milligal or larger. Terrain corrected Bouguer values are called the Complete Bouguer Anomaly (CBA). When the CBA is obtained, the reduction of gravity at individual measurement points (stations) is complete.

A1.5 INTERPRETATION

To interpret the gravity data, the portion of the CBA that might be caused by the light-weight, basin-fill material must be separated from that caused by the heavier bedrock material which forms the surrounding mountains and presumably the basin floor. The first step is to create a regional field. A regional field is an estimation of the values the CBA would have had if the light-weight sediments (the anomaly) had not been there. Since the valley-fill sediments are absent at the stations read in the mountains, one approach is to use the CBA values at bedrock stations as the basis for constructing a second order polynomial surface to represent a regional field over the valley.

Where there are insufficient bedrock stations to define a satisfactory regional trend, another approach is to estimate the regional by the process of upward continuation of the CBA field.

In Potential Theory, a field normal to a surface, regardless of its actual source, may be considered as originating in an areal distribution of mass on that surface. If the field strength is known the surface density of mass (grams per square centimeter) can be calculated. The observed gravity field at the surface of the earth approximately fulfills the requirements of this theory: thus the observed (Bouguer anomaly) field can be used to compute a surficial distribution of mass which would reproduce the field, and most importantly, account for the gravity field anywhere above the surface of observation. On this basis, the Bouguer anomaly field is readily "continued" to level surfaces above the ground.

An important property of such "upward continuation" is that the resultant field (which can be represented by a contour map), with increasing altitudes of continuation, changes more with respect to shallow sources than it does with respect to deeper sources. The anomalous parts of the field ascribed to shallow density distribution tend to vanish as the continuation is carried upward whereas the field produced by deeper sources changes only slightly, so that upward continuations produce "regional"-type fields.

The difference between the CBA and the regional field is called the "residual" field or residual anomaly. The residual field is the interpreter's estimation of the gravitational effect of the geologic anomaly. The zero value of the residual anomaly is not exactly at the rock outcrop line but at some distance on the "rock" side of the contact. The reason for this is found in the explanation of the terrain effect. There is a component of gravitational attraction from material which is not directly beneath a point.

If the "regional" is well chosen, the magnitude of the residual anomaly is a function of the thickness of the anomalous (fill) material and the density contrast. The density contrast is the difference in density between the alluvial and bedrock material. If this contrast were known, an accurate calculation of the thickness could be made. In most cases, the densities are not well known and they also vary within the study area. In these cases, it is necessary to use typical densities for materials similar to those in the study area.

If the selected average density contrast is smaller than the actual density contrast, the computed depth to bedrock will be greater than the actual depth and vice-versa. The computed depth is inversely proportional to the density contrast. A ten percent error in density contrast produces a ten percent error in computed depth. An iterative computer program is used to calculate a subsurface model which will yield a gravitational field to match (approximately) the residual gravity anomaly.

The second vertical derivative (SVD) of gravitational field is used to aid the interpreter in evaluating the subsurface mass distribution. Once the CBA field has been projected onto a uniform grid system, its SVD at the grid nodes is readily computed.

In accordance with La Place's Equation in Free Space, the negative of the second vertical derivative is equal to the sums of the second derivatives in the x-direction and in the y-direction. The second vertical derivative is an indication of the curvature of the Bouguer anomaly field. In particular the zero-value of the SVD indicates the inflection in the field as it changes from "concave-upward" (algebraically negative SVD) to "convex-upward" (algebraically positive SVD). In a general way the zero SVD falls on the tightest contours of the field and where contours are nearly parallel its location can be established by eye. However, where contours diverge, converge, or change direction this is not always so readily done. The zero SVD contour line may be an indicator of a line of faulting, the pinchout of a stratum, truncation of a stratum at an unconformity or merely a marked change in shape or in density of a geologic unit.

APPENDIX A2.0

PINE VALLEY, UTAH

GRAVITY DATA

PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT DEG MIN	LONG. DEG MIN	ELEV +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM	OBS. GRAV	THEO GRAV	FAA	CBA +1000
HV0912	381758	1135958	62525	0	161424258	23824142693201798			-262	78575
HV0913	381815	1135860	64529	0	175424331	23969141977201892			856	79023
HV0914	381831	1135790	66522	0	156424420	24074141451201920			2139	79648
HV0915	381829	1135726	68145	0	212424493	24170141247201975			3407	80378
HV0916	381917	1135644	69258	0	254424549	24291140719202016			3925	80544
HV0917	381922	1135572	72682	0	340424674	24400138349202112			4637	80191
HV0918	382063	1135528	74959	0	257424825	24469136864202230			5064	79549
HV0919	382079	1135435	71159	0	260424896	24606137080202281			3766	79759
HV0920	382105	1135410	70552	0	206424906	24643137952202272			3629	79782
HV0921	382112	1135382	70358	0	173424922	24684139742202302			3653	79952
HV0922	382120	1135356	69637	0	191424938	24722140158202314			3372	79522
HV0923	382129	1135331	69103	0	186424956	24759140479202327			3191	79809
HV0924	382140	1135308	68648	0	176424978	24973140769202343			3030	79795
HV0925	382152	1135284	68169	0	171425001	24829141128202361			2917	79842
HV0926	382167	1135265	67552	0	167425030	24858141550202383			2744	79972
HV0927	382193	1135246	67185	0	166425060	24885141849202406			2674	79927
HV0928	382201	1135227	66672	0	164425095	24915142227202433			2545	79970
HV0929	382216	113521166860T		0	159425123	24939142141202455			2634	79982
U733	381248	113457467198T		0	173423230	25813139410201036			1570	78843
4686	381249	113400261977T		0	138423244	26649142093201067			-760	78278
U734	381328	113487871270T		0	246423317	25372137210201095			3140	79096
67	381250	113427063219T		0	127423294	26259140833201059			-800	77777
66	381005	113516580292T		0	485423361	24954131769201120			6160	79285
U702	381431	113408761289T		0	145423547	26534142701201304			-940	78295
U701	381637	113419559977T		0	166423925	26402143672201600			-1900	78206
4701	381675	113418659797[illegible]		0	175424003	26403142692201662			-1710	78075
4702	381620	1134464612[illegible]		0	136424246	24004142781201845			-1371	77846
U688	381837	113572969009T		0	214424464	24165141252201973			3240	80274
U700	381924	113427955740T		0	157424576	26264144719202115			-2130	77967
4703	382015	113425257999T		0	166424634	26325145527202160			-2060	78318
U689	382048	113535675420T		0	269424753	24453136138202209			4850	79409
U691	382156	113249644117T		0	132424944	25318144171202382			2070	81372
U690	382198	113314366617T		0	159425012	25037142176202429			2350	79808
4706	382206	113478860502T		0	140425022	25846144978202440			-540	78970
4707	382222	113423956896T		0	122425121	26209144277202464			-2650	78072
U698	382222	113406655830T		0	200425028	26605145614202479			-1900	78510
U699	382245	113423226027T		0	154425059	26366147161202496			-2520	78424
4704	[illegible]	[illegible]		0	158425078	[illegible]202514			-1570	78633
U692	[illegible]	[illegible]		0	124425261	25683145488202641			-710	79134
68	382420	113417055659T		0	128425399	26467147564202769			-2850	78298
4700	382445	113417455535T		0	127425426	24462147593202791			-2950	78777

PINE VALLEY GRAVITY DATA

STATION IDENT	LAT DEG MIN	LONG DEG MIN / ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM / OBSV GRAV / THEO GRAV	FAA	CBA +1000
U692	382916	1134465562997	0	112425570	260421477722028?5	-2160	78752
U694	382660	1134273544007	0	108425828	263291486632030107	-3260	78258
U695	382852	1134077532728	0	108426194	266221494292030403	-3290	78059
4699	382865	1134065533407	0	108426199	266421494182030407	-3810	78108
001	383010	1132000355876T	0	240426423	281991507002027620	-350	80530
000	383040	1133730555a5T	0	171426508	271391504802033664	-900	80311
001	383100	113219061135T	0	377426597	279271479402032758	1580	81127
000	383100	113393052316T	0	121426628	265521513820332753	-3150	79141
2351	383112	1133447642111T	0	264426630	27554145903223770	2620	80969
2352	383141	113391255546T	0	191426703	266801504452038613	-1090	80151
000	383290	113429051273T	0	100426994	263291511802034032	-4040	78360
2353	383321	113443752497T	0	106427077	261251516542034092	-2080	79136
U735	383404	113460253950T	0	109427219	259921514482034199	-1970	79739
000	383490	113488057507T	0	132427390	254931459732034325	-290	80232
2354	383500	113484057507T	0	135427407	255521494213034340	-313	80205
1104	383528	113443151929T	0	103427441	261471515412034261	-3980	78403
9006	383560	113442052487T	0	107427502	260781512442034428	-3200	78407
U744	383533	113449952440T	0	109427545	260521513222034462	-2760	78449
U736	383635	113499654140T	0	124427608	253311493652034494	530	80519
000	383670	113498059162T	0	141427635	253551493902034516	520	80507
U738	383722	113524163488T	0	143427540	246371469302034566	1970	80495
2355	383770	113509061060T	0	147427915	252041478612034737	550	79697
U737	383797	113514761549T	0	126427970	251231479402034777	1050	80196
U743	383965	113459452899T	0	124428256	259321513682035024	-2950	78799
000	383980	113530060469T	0	126428316	249121491502035046	980	80496
88	384110	113585066705T	0	112428840	249461503032035232	1420	81202
1107	384135	113413551491T	0	132428852	268911522392031274	-2740	79158
89	384150	113396036036T	0	111428638	252701494162035310	-800	79347
U745	384167	113493059967T	0	107428645	254591493302035321	410	80077
U740	384172	113542059199T	0	112428677	247371503302035328	1190	81123
2356	384212	113548058061T	0	124428735	246641514582035372	700	81044
2355	384210	[illegible]	[illegible]	112428443	222591522542035574	20	81295
000	384250	[illegible]	0	119428482	245671514702035497	600	80923
U741	384270	113561136647T	0	126429051	244841520142035619	-30	80756
PV0156	383575	1134155 51081	0	116428071	2656715247420314891	-3845	78851
PV0169	383575	1134776 51651	0	115428323	262461527342034691	-3551	78942
PV0109	382535	1138148 11329	21	459416723	250111411912074?6	4944	81071
PV0179	[illegible]	[illegible]	44	[illegible]	[illegible]	8423	80766
PV0325	381444	[illegible]	76	[illegible]	25206172674202159	4656	79326
PV0244	38 121	1137763 62540	0	134422212	272621415962002?4	194	79015
PV0317	381472	1131435 78659	46	677421633	274541330452011853	6627	80153

PINE VALLEY GRAVITY DATA

STATION IDENT	LAT. DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN	TER-COR OUT / NORTH UTM	EAST UTM / OBS. GRAV / THEO GRAV	FAA	CBA +1000
WV0074	383876	1133158	59709	0	312428022	2831314998720489[illegible]	1282	81232
WV0080	382879	1133318	86959	2	0015426194	2773012948620342[illegible]	7908	81294
WV0142	380710	113 310	86950	4	0270942598[illegible]	2773312996403180	7933	81163
WV0145	383750	1133159	68030	26	463427872	2800714473920476[illegible]	4004	81292
WV0146	382850	1133100	70365	30	611427426	2805114217820441[illegible]	3990	80623
WV0077	382335	1133128	60910	14	298425217	279801462352026[illegible]	903	80440
WV0078	382636	1133139	63870	9	506425682	279761450822010[illegible]	2169	80900
WV0142	382845	1133048	66500	1	511426122	280461437512033[illegible]	2963	80794
PV0110	384430	1135193	74375	30	359425613	2498413889420236[illegible]	5224	80446
PV0111	382377	1135204	68908	51	209425346	2495914131220269[illegible]	3471	80230
PV0182	382773	1133596	63450	7	341426009	2732014521620327[illegible]	1664	80371
PV0227	381717	1134906	72229	25	367424112	2535513687420172[illegible]	3128	78825
PV0231	382226	1135040	70715	41	409425059	25189140,4120247[illegible]	4226	80555
PV0241	381326	1134803	71010	37	226422365	2548313690620113[illegible]	2608	78662
PV0296	38 656	1133729	65360	4	169422098	2702113969820016[illegible]	1046	78926
PV0306	38 402	1134111	64150	3	174421645	2644414005317798	634	78931
PV0310	38 702	1134443	67760	1	177422214	2597513548820023[illegible]	2028	79095
PV0321	381903	1133804	86528	46	131942440[illegible]	2697212763820199[illegible]	7370	79120
PV0322	382194	1133740	74467	11	691424944	2708013694320242[illegible]	4795	80033
PV0323	382551	1133681	62560	30	459425657	2718614503920399[illegible]	929	80079
PV0324	382297	1133638	73780	361	559425130	2723413730120257[illegible]	4173	79955
PV0325	38 900	1134860	75520	6	412422598	2537613452120032[illegible]	5079	79740
PV0276	381163	1133817	64675	3	141423040	2691414151820091[illegible]	1473	79560
PV0291	381148	1133343	70829	4	255422993	2760513808320088[illegible]	3852	79956
PV0318	38 738	1133703	69179	11	269422321	2779313883520736[illegible]	3580	80269
PV0044	380734	1133523	53040	0	225427996	2704415296020476[illegible]	-1896	80245
PV0048	384177	1133932	56650	0	134429027	2691815140352056[illegible]	-738	80074
PV0052	383702	1133924	51010	0	174427741	2687815249662046[illegible]	-3566	79110
PV0054	383326	1133943	51550	0	136427046	2684515264420408[illegible]	-2544	79807
PV0061	383962	1134044	51741	0	132428227	2673315297620301[illegible]	-3791	78734
PV0063	384311	1134043	55130	0	137426879	2673315226120953[illegible]	-1387	79947
PV0069	384277	1134[illegible]	[illegible]	0	144426076	26599150[illegible]	-45	80260
PV0066	384773	1134197	54900	0	131428714	26529151[illegible]	-1925	79457
PV0067	384[illegible]	1134132	[illegible]	0	124428391	2656115[illegible]	-2254	78939
PV0069	383302	1134155	50760	0	112427751	2655715147[illegible]	-4294	78416
PV0070	383528	1134155	5125[illegible]	0	109427429	265491514[illegible]	-4499	78126
PV0071	383326	1134161	51650	0	100427056	2659815061[illegible]	-4464	77947
PV0072	[illegible]	1134161	[illegible]	[illegible]	101426734	265191501[illegible]	-4249	77941
PV0073	347922	1134244	51741	[illegible]	118428236	26414152[illegible]	-3619	79532
PV0080	384710	1134264	53460	[illegible]	157426680	2643315030520955[illegible]	-206	80042
PV0086	383702	1134377	50860	0	111427760	262751527212046[illegible]	-4051	79713

PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT / NORTH UTM	EAST UTM / OBS GRAV / THEO GRAV	FAA	CBA +1000
PV0087	383529	1134377	51320	0 106427440	26226151879204382	-4206	78396
PV0088	383326	1134783	51930	0 104427065	26206151706204084	-3507	78825
PV0093	383616	1134488	52160	0 107427606	26069151552204510	-3350	78460
PV0094	383789	1134488	51640	0 116427926	26079152739204764	-3427	79076
PV0189	382109	1133937	63559	0 344424795	26789143461202258	996	79664
PV0255	38 830	1134341	65815	0 148422391	26129139426200380	987	78690
PV0275	38 807	1132838	61844	0 119422475	26867142311200463	51	79077
PV0320	382020	1133078	68205	0 195424680	25122140711202167	2739	79672
TL0459	384172	1133110	54215	0 544428392	28092154217205180	54	82109
WV0071	383322	1133056	59245	0 289426559	28118148680200726	708	80791
WV0073	383964	1133046	57278	0 182428190	28180151818205022	695	81344
WV0076	383082	1133168611427		0 316426563	27958147829203726	1646	81109
PV0309	38 626	1134272	64520	0 160422177	26224139744200213	314	78448
PV0245	38 933	1134626	70630	0 298422649	25720137899200574	3305	79513
PV0254	381282	1133685658501		0 179423255	27108141071201086	1964	79683
PV0260	381322	1133875	63750	0 178423337	26837142139201145	2979	80732
PV0329	381709	1133755	90180	282683424047	27033124639201711	7820	79773
PV0205	381575	113432259570T		0 152424378	26215144074201985	-1816	78018
PV0236	382078	1135436	71159	0 261424840	24605139077202251	3765	79759
PV0141	382211	1134500	57592	0 122425215	26001145969201594	-2146	78231
PV0155	382718	1134250	54138	0 110425935	26366149052203191	-3196	78452
PV0178	382975	1133501	60970	0 459426416	27470147045201598	1130	80793
PV0105	383188	1135026	62359	0 214426838	25264146570203881	1371	80319
PV0030	383563	1133405	89129	623153427462	27639126920204432	8721	81519
PV0051	383875	1133934	51700	0 167429061	26987152905204591	-2331	79203
PV0064	384147	1134375	54055	0 125429398	26257152886205144	-1962	79717
PV0069	384222	1134275	59645	0 192429122	26261149417218401	-389	79796
[illegible]	384238	1134576	79955	222150418983	25990136472203602	6127	81060
PV0082	384277	1134375	66520	10 284429046	26276146062205659	3012	80720
PV0029	384431	1133701	65919	404 397421090	27255146665205709	2991	81308
PV0031	388586	1137284	[illegible]	[illegible]	[illegible]	9063	81112
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4517	81125
PV0100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	842	80403
PV0107	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1522	80226
PV0108	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4380	80091
PV0193	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1297	80440
PV0238	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5906	79459
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1814	78696
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1860	79105
PV0326	381410	[illegible]	[illegible]	[illegible]	[illegible]	4618	78831
PV0327	38 779	1133545	66210	14 186421551	[illegible]	918	78542

PINE VALLEY GRAVITY DATA

STATION IDENT	LAT. DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM OBS GRAV THEO GRAV	FAA	CBA +1000
PV0228	38 920	1134806	76370	8	400422744	25460139820200643	5062	79422
SV5021	384110	1135656	66955	13	355428572	24403146039205237	3815	81349
SV5022	383879	1135785	79455	6	830428151	24202137714204597	7603	81340
SV5055	383826	1135006	68065	3	505428017	25325144338204819	3576	80972
SV5056	384071	1134921	63798	31	229428467	25467147983205179	2133	80639
SV5060	384142	1134680	61885	18	264428587	25820148347201884	1307	80479
SV5061	387690	1135069	64279	90	214427769	25230146472204619	2343	80726
SV5071	388276	1135485	70651	2	242427022	24602142[illegible]011	4875	80954
SV5073	388304	1135598	72525	5	351427449	24451141[illegible]4345	6159	81690
PV0305	38 239	1133972	64759	0	319421430	26641140145199622	1456	79629
PV0296	38 317	1133806	57910T	0	145421475	26585144929199673	-242	80153
PV0299	38 429	1133652	55599T	0	172421684	26524143948199837	-737	79448
PV0204	38 512	1134043	62046	0	148421845	26549141201199959	-366	78616
PV0300	38 514	1133642	59219T	0	177421841	26842142156199961	-1071	78908
PV0303	38 607	1133987	61620	0	125422019	26636141326200098	-775	78333
PV0301	38 610	1133864	59878T	0	167422019	26816142749200102	-996	78748
PV0307	38 657	1134142	62598	0	144422118	26412140531200170	-459	78229
PV0302	38 703	1133944	62125	0	118422195	26704141040200238	-732	78199
PV0266	38 751	1134059	63449	0	131422289	26459139944200308	-655	77839
PV0276	38 753	1133849	60900	0	136422283	26645142603200311	-390	78975
PV0244	38 799	1134565	68540	0	151422399	25512138505200378	2642	79455
PV0288	38 825	1133447	64360	0	136422416	27437141406200421	1551	79735
PV0267	38 833	1133999	62033	0	121422474	26632141442200457	-634	78330
PV0265	38 836	1134124	63433	0	131422485	26449140327200462	-435	78062
PV0275	38 837	1133836	61547	0	118422475	26867142213200463	52	79075
PV0287	38 869	1133673	63731	0	128422490	27109141415200490	907	79297
PV0256	38 872	1134636	65130	0	138422557	26258134592200515	369	78297
PV0254	38 875	1134636	65310	0	140422641	26114138971200577	751	78593
PV0292	38 941	1133394	65980	0	147422612	27520140942200586	2264	79941
PV0277	38 950	1133616	63450	0	122422702	26906141994200643	1060	79541
PV0268	38 950	1133981	63000	0	120422708	26665141310200643	-38	78594
PV0264	38 950	1134146	62734	0	124422711	26424140402[illegible]643	-256	78125
PV0257	381004	113[illegible]	64351	0	[illegible]422580	[illegible]	27	78814
PV0259	381026	113[illegible]	65391	0	13[illegible]422925	26114138[illegible]	494	78329
PV0289	381032	1132540	65659	0	144422923	27312140[illegible]748	1281	79135
PV0269	381079	1134288	63161	0	114422866	26514141[illegible]	-405	78164
PV0274	381088	1133925	62571	0	124412957	26752142[illegible]200784	201	78957
PV0263	381107	1134207	61641	0	126422953	26749140[illegible]	-344	78002
PV0285	381110	1133097	64714	0	140422937	27101141464200934	1535	79604
PV0246	381122	1134622	69140	0	105422499	25722138094200952	2317	78941
PV0251	381153	1134267	64564	0	127423045	26110140214201597	83	78200

PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
PV0270	381174	1134066	62425	0	121423072	265221415162O0927	-663	78168
PV0273	381185	1133973	6219	0	127423087	266871419942O0944	-417	78499
PV0258	381194	1134261	63435	0	127423116	262671406802O0957	-577	77916
PV0262	381212	1134163	62627	0	123423145	264111411852O0983	-921	77844
PV0250	381227	1134437	64559	0	136423163	26056140146201005	195	78213
PV0247	381236	1134619	67920	0	179423246	25748133988201048	1869	78882
PV0279	381240	1133844	63790	0	144423221	26879142112201053	1097	79484
PV0272	381282	1134020	62091	0	128423269	26524142214201086	-430	78522
PV0259	381289	1134269	63149	0	126423292	26261140853201096	-816	77774
PV0249	381319	1134435	63776	0	144423410	26022141016201184	-148	78245
PV0261	381337	1134189	62035	0	129423432	26352141482201210	-1357	77619
PV0283	381349	1133601	68670	0	255423412	27240139784201213	3204	80038
PV0245	381397	1134697	67740	0	192423510	25642139931201254	1435	78523
PV0271	381406	1134078	61440T	0	142423600	26546142699201267	-744	78443
PV0240	381415	1134806	68750	0	220423644	25484138621201280	2050	78821
PV0281	381419	1133957	62495	0	177423519	26723142923201286	452	79315
PV0282	381447	1133871	64080	0	202423568	26850142181201327	1166	79512
PV0260	381451	1134257	61890	0	136423591	26287141678201333	-1206	77821
PV0208	381503	1134476	63995T	0	137423657	25970141584201409	-152	78361
PV0195	381521	1134121	61020T	0	144423715	26475142882201436	-1123	78214
PV0187	381544	1133935	64450	0	208423750	26762141649201470	840	79065
PV0222	381553	1134763	67109	0	194423857	25556139648201527	1277	78585
PV0194	381554	1134031	62510	0	169423828	26624142090201528	-322	78444
PV0196	381616	1134175	60321T	0	161423893	26415148522201575	-1282	78305
PV0207	381624	1134348	61150	0	129423915	26164142742201587	-1292	77990
PV0209	381634	1134477	62250	0	135424035	25979142240201677	-821	78072
PV0221	381702	1134485	62490	0	134424076	25477141951201702	466	78799
PV0193	381720	1134028	63720	0	261424079	26639142038201727	283	78813
PV0197	381722	1134214	59030	0	178424091	26364144103201730	-1788	78154
PV0206	381763	1134266	60650	0	138424179	26145143091201791	-1619	77835
PV0215	381796	1134912	61700	0	133424240	25934142787201829	-982	78109
PV0198	381816	1134[illegible]	[illegible]	0	178424257	26369144[illegible]	-1769	78378
PV0192	381838	1134[illegible]	[illegible]	0	316424299	26568147[illegible]	-296	78477
PV0223	381839	1134[illegible]	63314	0	167424232	25547[illegible]	1122	79011
PV0210	381913	1134476	60[illegible]	0	135424455	25993147[illegible]	-1609	77918
PV0216	381931	1134630	62050	0	141424455	25769141184201037	-453	78525
PV0199	381437	113415[illegible]	59970	0	207424466	24461145109202045	-1064	78914
PV0234	381461	1134324[illegible]	[illegible]	0	146424628	26216144716202090	-1921	78124
PV0235	381470	1132259	[illegible]	0	244424556	24855137497202094	2969	79454
PV0226	381451	1134530	66505	0	145424598	254521412942O2110	1775	79289
PV0191	382117	1134035	62992	0	292424629	26641143562202163	684	79492

PINE VALLEY GRAVITY DATA

STATION IDENT	LAT DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM OBS GRAV THEO GRAV	FAA	CSA +1000
PV0220	382023	1134711	62300	0	144424669	25457148231202172	195	79089
PV0211	382024	1134440	59003	0	136424659	26051144600202173	-2045	77966
PV0217	382024	1134600	60980	1	128424666	25518143841202173	-940	78393
PV0200	382061	1134163	58518	0	195424716	26457145723202227	-1436	78601
PV0204	382075	1135272	68289	0	189424790	24642140833202248	2852	79748
PV0229	382097	1134973	64180	0	162424818	25279144001202280	2131	80403
PV0189	382109	1133937	63550	0	344424795	26729143487202298	1002	79671
PV0214	382111	1134482	58780	0	124424832	25991145267202301	-1912	78169
PV0203	382112	1134298	57490T	0	144424816	26260144604202302	-2150	78368
PV0219	382116	1134709	61980	0	133424841	25665144662202308	-28	79227
PV0225	382118	1134863	62900	0	149424852	25440144496202311	1386	80081
FV0201	382157	1134137	59802	0	190424892	26500145599202368	-1439	78696
PV0218	382190	1134591	59560T	0	123424954	25840145074202402	-1272	78539
PV0230	382197	1134917	62660	0	149425000	25366144431202427	1940	80376
PV0212	382198	1134374	57229T	0	129424978	26157146061202426	-2401	78171
PV0213	382198	1134487	58340T	0	124424983	25993145412202428	-1921	78236
PV0190	382215	1134048	59505	0	192424996	26633145508202453	-946	78952
PV0202	382215	1134234	56478	0	151425014	26362146918202453	-2289	78504
PV0233	382216	1135211	66880T	0	159425049	24939142179202455	2633	79981
PV0231	382226	1135040	70716	0	404425059	25129140140202470	4225	80516
PV0224	382232	1134759	60976	0	134425054	25600145520202468	331	79704
PV0237	382237	1135397	68651T	0	186425096	24669141197202485	3326	80099
PV0120	382278	1134941	63715	0	159425151	25336144631202545	2049	80478
PV0152	382234	1134358	56900	0	124425136	26195146540202595	-2464	78259
PV0175	382302	1133941	58590	0	254425152	26793146597202580	-842	79429
PV0131	382312	1134625	59160	0	125425154	25783145520202582	-1195	78664
PV0130	382310	1134760	60394	0	131425202	25601145862202592	67	79601
PV0164	382320	1134122	56600	0	155425193	26531146436202607	-2195	78587
PV0183	382339	1134218	56161T	0	130425220	26392147267202634	-2512	78466
PV0151	382338	1134353	56470	0	120425273	26196146995202643	-2527	78333
PV0119	382323	1134987	63059	0	144425947	25275145436202700	2069	80712
PV0132	382374	1134641	58724	0	119425792	25779146246202716	-1387	78761
PV0129	382376	1134899	60454	0	126425765	25468144174202719	605	79987
PV0165	382414	1134027	53604	0	137425863	26654148048202745	-2189	78940
PV0142	382426	1134478	57100	0	116425404	26018144672202760	-2144	78496
PV0174	382437	1131584	54094	0	332425399	26983148642202779	-1429	79674
PV0128	382446	1134771	59924	0	127425458	25593144447202795	-311	79516
PV0163	382457	1134161	55440	0	127425446	26481147714202809	-2910	78225
PV0150	382460	1134349	55524	0	112425562	26206145140202813	-2606	78647
PV0171	382428	1134935	61720	0	143425539	25356146194202654	1334	80426
PV0112	382473	1135090	63950	0	188425555	25131144497202561	2265	80637

PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM / OBSV GRAV / THEO GRAV	FAA	CBA +1000
PV0133	382911	1134618	57740	0	119425568	25819147070202888	-1476	78942
PV0166	382519	1133999	5469Y	0	167425556	26720149042203899	-2357	79126
PV0143	382526	1134456	5632Y	0	111425588	26056147776202409	-2128	78774
PV0154	382544	1134272	5448U	0	119425614	26324148468202936	-3191	78346
PV0173	382557	1133876	5509Y	0	213425619	26960149412202955	-1696	79727
PV0127	382572	1134763	5908Y	0	123425687	25612146770202977	-608	79369
PV0162	382586	1134155548107		0	114425686	26497148062202998	-3332	78087
PV0149	382587	1134365	55299	0	110425697	26187148353202999	-2608	78644
PV0118	382602	1135009	61908	0	125425753	25255146183203021	1421	80493
PV0122	382612	1134891	60084	0	140425767	25428146881203036	362	80021
PV0140	382623	1134570	5695Y	0	111425773	25895148036203052	-1418	79269
PV0167	382645	1133995	5420U	0	140425789	26733149097203084	-2979	78675
PV0148	382648	1134411	55345	0	108425812	26128148674203088	-2333	78901
PV0134	382656	1134697	57855	0	117425855	25713147683203115	-986	79400
PV0161	382677	1134136543117		0	110425854	26530148540203131	-3474	78105
PV0113	382701	1135060	6216Y	0	265425939	25187146279203166	1613	80677
PV0176	382709	1133763	5549Y	0	209425897	27074149682203178	-1273	80010
PV0147	382718	1134382	5478U	0	107425940	26174148941203191	-2696	78727
PV0123	382725	1134886	60058	0	146425975	25441146970203202	286	79950
PV0139	382730	1134552	55955	0	114425970	25927149083203209	-1469	79562
PV0172	382737	1133883	5370Y	0	162425954	26901150478203220	-2203	79643
PV0168	382737	1134046	5364U	0	114425961	26664149064203220	-3488	78264
PV0135	382765	1134666	56918	0	119426040	25763148435203260	-1265	79444
PV0124	382772	1134821	58859	0	134426059	25538147320203270	-563	79499
PV0114	382758	1135035	6202Y	0	302426099	25228145634203274	1652	80361
PV0156	382[illegible]	1134142	53605	0	106426065	26454149145203287	-3306	78519
PV0146	382794	1134313	54158	0	107426081	26177148671203313	-2572	78992
PV0160	382826	1134091543797		0	104426146	26604149852203365	-3776	78125
PV0138	382836	1134523	55098	0	114426165	25975149550203365	-1967	79355
PV0126	382840	1134728	5735[illegible]	0	124426191	25677148124203370	-1172	79391
PV0177	382833	1133784	5441[illegible]	0	170426155	27044150598203389	-1631	79982
PV0169	382837	1133931	5371[illegible]	0	111426178	26808150[illegible]	-3094	78585
PV0117	382874	1134925	[illegible]		156426[illegible]	25[illegible]420	276	80054
PV0145	382879	1134369	5365[illegible]	0	104426228	26173150[illegible]427	-2421	79315
PV0157	382887	1134274	5335[illegible]	0	103426249	26337150[illegible]479	-2914	78993
PV0136	382910	1134644	5611[illegible]	0	123426307	25798149[illegible]473	-1311	79671
PV0159	382912	11340475[illegible]		0	104426304	2664[illegible]491	-2968	78083
PV0115	382[illegible]	1135[illegible]04	[illegible]1441		[illegible]426[illegible]	2529[illegible]505	1209	80440
PV0171	382936	1133841	[illegible]	0	[illegible]426[illegible]21	2697[illegible]203511	-2578	79363
PV0125	382942	1134[illegible]T		0	131426371	2565[illegible]203520	-1295	79531
PV0137	382919	1134805	54123	0	119426391	260[illegible]545	-2274	79379

PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
PV0116	382976	1134887	58658	0	159426440	25454148112203570	-221	79920
PV0170	382979	1133943	52680	0	129426404	26826150595203574	-3402	78760
PV0158	382979	1134162	53524	0	102426414	26509149854203574	-4011	78076
PV0144	382979	1134384	53350	0	105426423	26185151112203574	-2254	79655
PV0039	383034	1133638	56940	0	228426493	27272149854203655	-213	80594
PV0312	383032	1134611	54575	0	119426565	25559150475203681	-1850	79657
PV0104	383052	1134951	61025	0	183426584	25322147195203681	944	80314
PV0073	383039	1134272	52490	0	102426566	26351150768203692	-3525	78674
PV0090	383060	1134494	53580	0	110426578	26031150874203694	-2394	79441
PV0056	383065	1134053	52450	0	108426569	26671150229203701	-4111	78108
PV0316	383065	1134772	56595	0	142426599	25626149222203701	-1217	79624
PV0040	383066	1133831	53160	0	152426561	26994151106203702	-2566	79454
PV0103	383114	1134828	58415	0	167426695	25460148522203773	-279	79966
PV0311	383149	1134527	53213	0	110426744	25987151165203824	-2578	79383
PV0055	383152	1133943	52210	0	129426724	26836151190203828	-3501	78820
PV0072	383152	1134161	52220	0	101426734	26519150337203828	-4347	77944
PV0089	383152	1134383	52405	0	104426743	26196151370203828	-3145	79087
PV0038	383154	1133722	53998	0	224426719	27157151601203831	-1420	80390
PV0097	383157	1134799	56738	0	157426771	25592149274203836	-1169	79629
PV0315	383181	1134608	54425	0	130426810	25755150461203871	-1946	79534
PV0074	383239	1134271	51965	0	100426899	26364151005203956	-4051	78327
PV0091	383239	1134494	52525	0	113426909	26040151706203956	-2625	79377
PV0041	383240	1133833	52120	0	177426883	27000152463203958	-2444	79956
PV0057	383240	1134054	52035	0	106426892	26679150656203958	-4336	78024
PV0098	383240	1134770	55828	0	142426923	25639149941203958	-1482	79621
PV0102	383240	1134918	59018	0	167426929	25424148347203958	-73	79967
PV0313	383269	1134631	53615	0	121426970	25842151118204000	-2429	79407
PV0054	383326	1133943	51855	0	136427046	26845151956204084	-3332	79119
SVS070	383326	1135356	66150	0	199427108	24792145035204084	3215	80852
PV0037	383327	1133723	54250	0	251427039	27165151785204085	-1244	80503
PV0106	383331	1135032	6062Y	0	174427103	25263147836204091	798	80297
PV0099	383317	1134819	56155	0	138427123	25574149955204115	-1287	79659
SVS064	383357	1135181	63178	0	177427155	25048146495204130	1824	80455
PV0314	383407	1134662	54055	0	119427227	25605151571204203	-1765	79919
PV0092	383413	1134495	52835	0	106427231	26048151435204212	-3058	79029
PV0033	383414	1133612	58135	0	318427195	27330149536204213	129	80621
PV0058	383414	1134054	51680	0	109427214	26689151546204213	-4031	78451
PV0075	383414	1134273	51565	0	101427223	26370151416204213	-4273	78243
PV0042	383415	1133833	57965	0	180427206	27010152389204215	-1985	80132
PV0101	383454	1134916	56580	0	150427325	25439150027204272	-619	80096
SVS063	383526	1135198	63135	0	146427471	25034146250204378	1285	79902

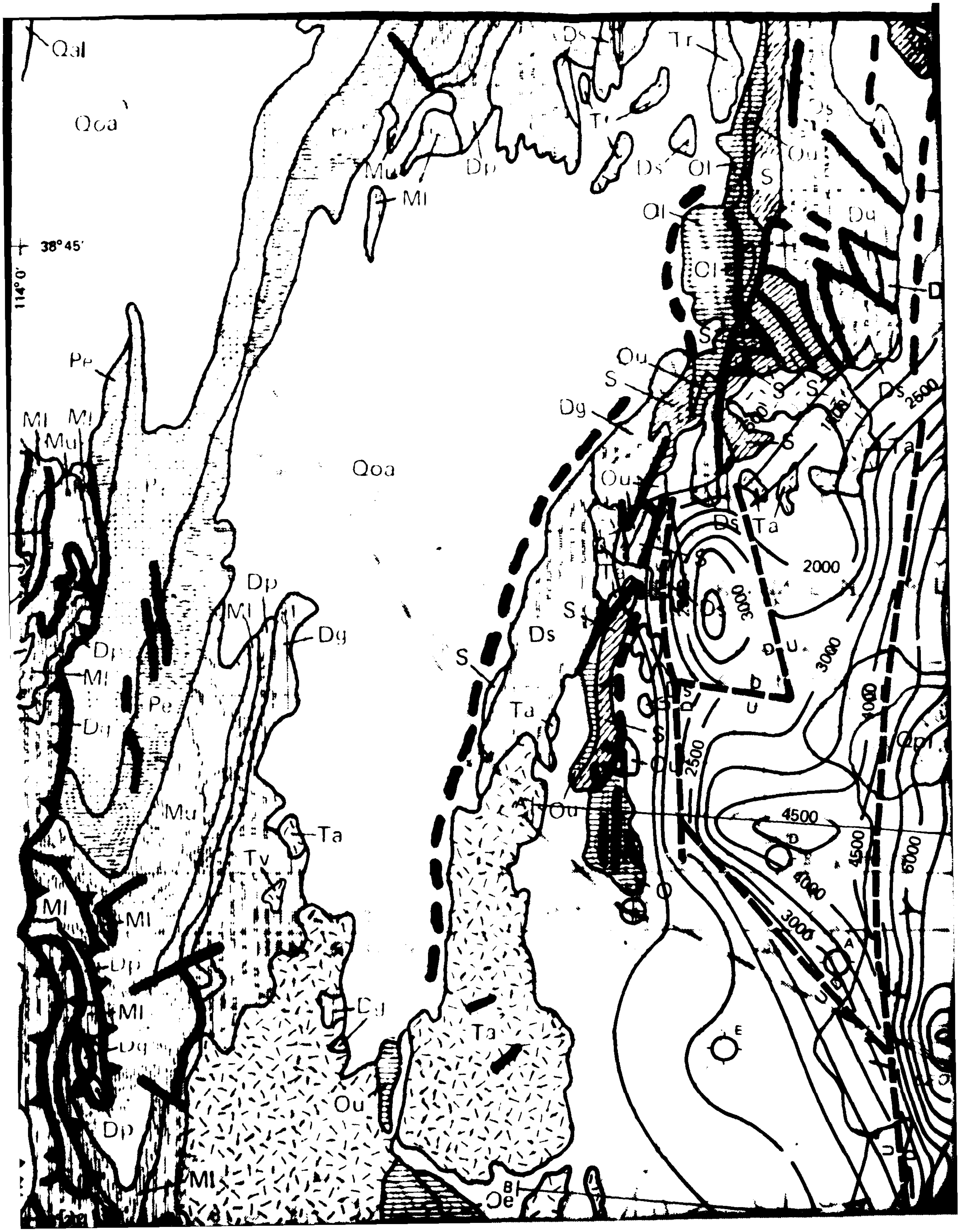
PINE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
PV0036	383528	1133716	55699	0	306427410	27185151110204381	-859	80452
PV0070	383528	113415591280T		0	109427429	26549151652204291	-4495	78127
PV0043	383615	1133922	52448	0	255427576	27036152817204509	-2340	80030
PV0059	383615	1134044	51215	0	118427585	26714151841204509	-4478	78174
PV0076	383615	1134266	50678	0	106427595	26592152259204509	-4376	78379
SVS068	383618	1135495	66020	0	192427654	24622146059420-613	3679	81353
SVS062	383620	1135210	61999	0	139427664	25022147089204590	807	79226
SVS067	383718	1135913	62339	0	140427832	24575146942204660	1987	80427
SVS045	383763	1135183	61648	0	132427913	2506914737[illegible]4729	616	79724
SVS031	383777	1135471	64760	0	130427948	24652147420204747	3625	81720
PV0034	383759	1133601	60391	0	527427889	27266148944204764	1017	80946
PV0060	383759	1134045	50764	0	130427907	26722152764204764	-4220	78557
PV0077	383789	1134266	50764	0	112427916	26401152925204764	-4069	78730
SVS032	383818	1135306	62134	0	134428072	24695149054204852	1707	80656
SVS046	383860	1135121	60794	0	139428086	25150148254204869	629	80033
SVS030	383897	1135430	63235	0	131428168	24718148221204923	2906	81454
PV0045	383962	1133823	53980	0	220428218	27053152495205019	-1722	80097
PV0095	383963	1134487	53658	0	117428248	26090152176205020	-2357	79462
SVS047	383970	1135079	60225	0	114428257	25222148553205020	199	79779
SVS025	383972	1135525	63452	0	165428311	24581148407205034	3120	81633
SVS033	383978	1135274604697		0	119428311	24949149147205042	1009	80501
SVS074	383996	1135358	61139	0	124428348	24829149297205069	1762	81040
PV0050	384018	1131922	53288	0	166428381	26900152237205145	-2766	79228
SVS044	384019	1135152	59306	0	106428436	25130149026205147	-311	79570
SVS024	384077	1135578	62955	0	165429509	24514148491205198	2550	81245
SVS034	384108	1135367	59754	0	113428555	24522151334205234	1324	81066
SVS023	384123	1135502	60660	0	131428609	24625149790205270	1611	81053
PV0074	384125	1134264	54490	0	104428556	26423151681705213	-2310	79239
PV0146	384136	1133881	56390	0	316428540	27065151524205275	-690	80396
PV0162	384126	1134043	52444	0	137428549	26743152432205275	-2790	79156
PV0096	384136	1134486	57159	0	170428965	26101150621205275	-929	79529
SVS143	384138	1135229	[illegible]	0	107426605	[illegible]	116	80152
SVS157	384170	1134901	[illegible]	0	[illegible]	25458149742[illegible]	26	7952[illegible]
SVS149	384173	1135[illegible]	[illegible]	0	[illegible]	27234149441215824	-798	7935[illegible]
SVS028	384182	1135424	[illegible]	0	[illegible]	24744150[illegible]	1201	81123
SVS023	384183	1135593	[illegible]	0	[illegible]	24499150[illegible]	1637	81166
PV0049	384223	1133972	[illegible]	0	[illegible]	26909152[illegible]	-1241	80051
SVS042	384224	1134123	[illegible]	0	[illegible]	[illegible]	-296	79823
SVS039	[illegible]	113426[illegible]	[illegible]		108428941	24494151[illegible]444	332	80566
SVS057	384271	1134616	61675	0	140428632	25627146622205473	1150	80296
SVS026	384271	1135499	950616	0	112428[illegible]	24640151466[illegible]475	676	80945

PINE VALLEY GRAVITY DATA

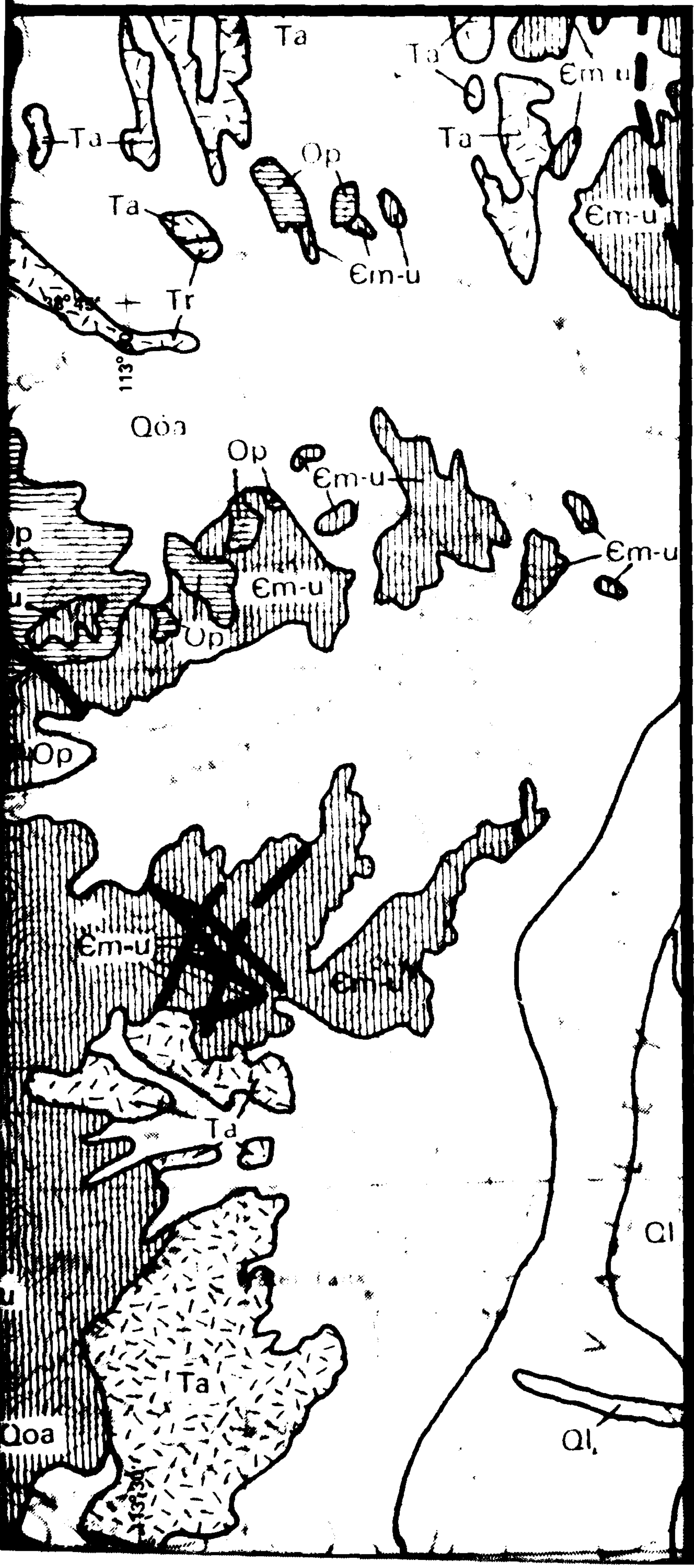
STATION IDENT	LAT DEG MIN	LONG DEG MIN	ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
SVS052	384276	1134446	59968	0	118428847	254421488722205480	-177	79490
SVS036	384276	1135370	57778	0	111428866	248281515825205460	474	80681
FV0047	384310	1133822	57398	0	197428861	270731513732205530	-183	80438
SVS049	384310	1135041	59738	0	107428914	253061495432205530	227	79962
SVS051	384258	1134959	60738	0	119428999	254281491272205602	683	80088
SVS037	384339	1135323	58615	0	107429018	249011512692205602	827	80943
SVS027	384364	1135478	57638	0	123429034	246761518052205610	432	80895
SVS041	384068	1135124	60068	0	104429025	251691500242205616	935	81557
SVS019	384396	1135922	60229	0	127429095	246141511692205687	1359	80956
SVS058	384298	1134816	63358	0	171429067	256351475322205660	1496	80063
SVS038	384428	1135352	59318	0	111429147	248631509862205704	1102	80954
SVS050	384470	1135009	61665	0	118429209	253621492192205766	1485	80573
SVS040	384492	1135185	60748	0	116429229	251081502032205784	1585	80985
FV0081	384424	1134264	62319	0	222429202	264421484282205787	1346	80216
SVS033	383978	1135274	604697	0	118428311	249491491482205048	1017	80311
SVS035	384202	1135314	58438	0	106428727	249041509262205372	543	80723
SVS054	384078	1135016	59218	0	116428484	253291490682205190	-396	79526
SVS065	383478	1135329	64728	0	162427425	248421454302204337	2007	80095
SVS066	383603	1135334	63538	0	152427620	248411463912204491	1694	80177
SVS069	383505	1135493	64710	0	158427444	246591452792204347	3716	81147
TL0448	384484	1132048	55615	0	94424152	282041536692205787	219	81346
TL0449	384347	1132137	56355	0	110428995	280411531002205654	474	81364
TL0450	384484	1132269	57565	0	110429161	278841525542205787	939	81417
TL0451	384484	1132489	61259	0	154429170	275651500662205787	1926	81189
TL0452	384247	1132380	59439	0	178429004	277181510742205659	1348	81217
TL0453	384310	1132269	57898	0	136428879	275791520702205531	994	81345
TL0454	384310	1132044	55686	0	111428931	281981520942205531	271	81391
TL0455	384224	1132260	60262	0	201428684	277041502292205404	1539	81192
TL0457	384030	1133380	62639	0	215428362	277001485182205149	2315	81169

END OF LIST

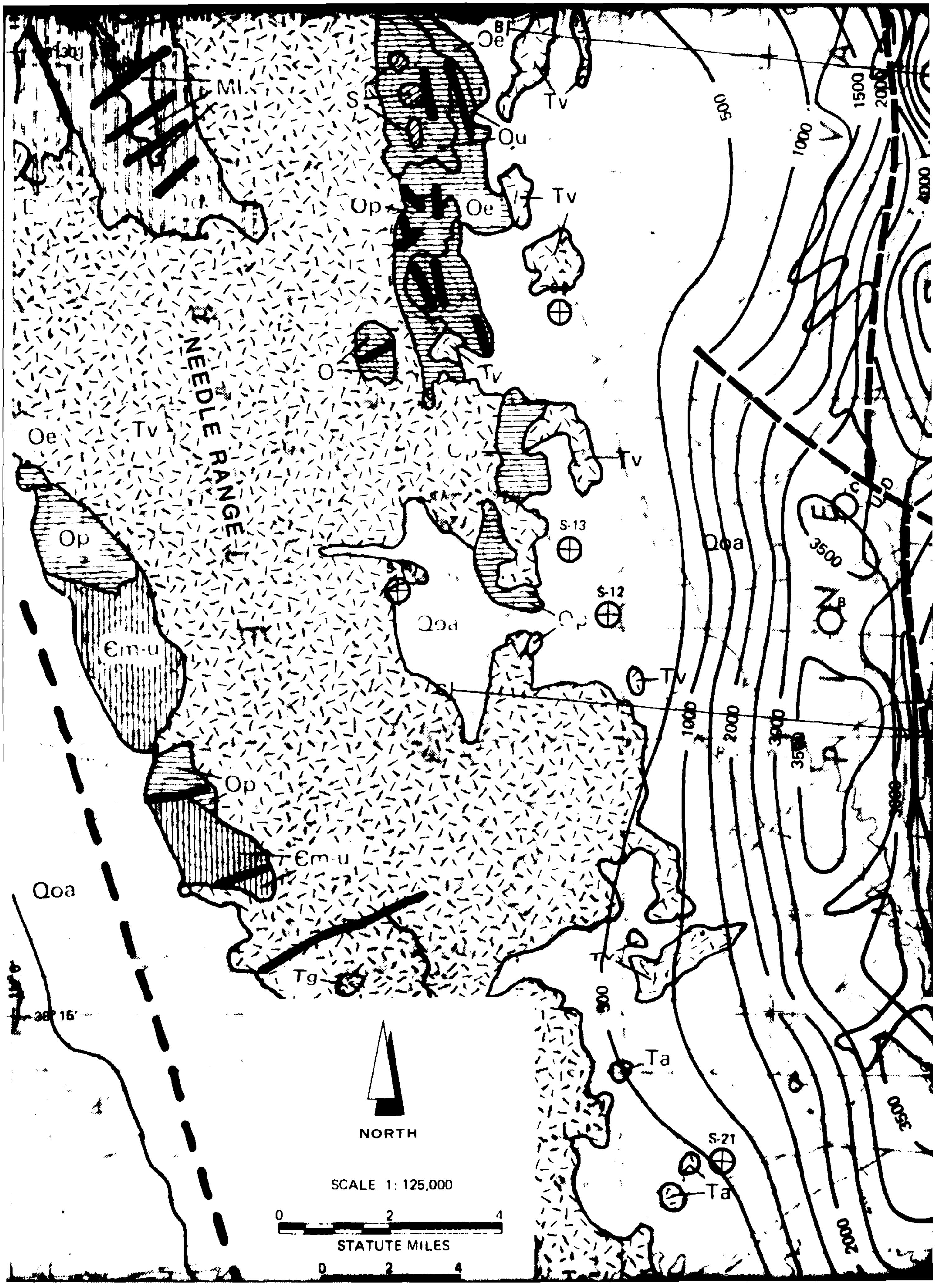

Qal
Qoa
38°45'
114°0'
Pe
Ml
Mu
Dp
Dg
Pe
Ml
Dp
Ml
Mu
Tv
Ta
Ml
Dp
Ml
Dg
Dp
Ml
Dg
Ou
Ta
Oe
Ds
Tr
Ds
Ou
Ol
S
Ol
Ol
Du
Ou
S
Dg
S
S
Ds
2500
Ou
Ta
Ds
Ta
2000
3000
3000
S
Ds
S
Ta
2500
Ou
Ou
4500
4000
4500
6000
3000

S
Ou
Op
Ou
Ol
Tr
Ds
Ou
Op
Єm-u
Tr
Ta
Du
Ds
Єm-u
Op
Tr
113°
Qoa
Op
Єm-u
Op
Єm-u
Op
Op
Єm-u
Op
Ds
2500
3000
4000
2500
5000
Ta
2000
6000
Qoa
1500
3000
4000
5000
4000
2000
Qpl
Ta
Єm-u
Єm-u
4500
7500
7000
6000
6000
1000
4500
6000
Ta
Ta
3000
Ql
500
Єm-u
8000
Ta
7000
Qoa
Tg
6000

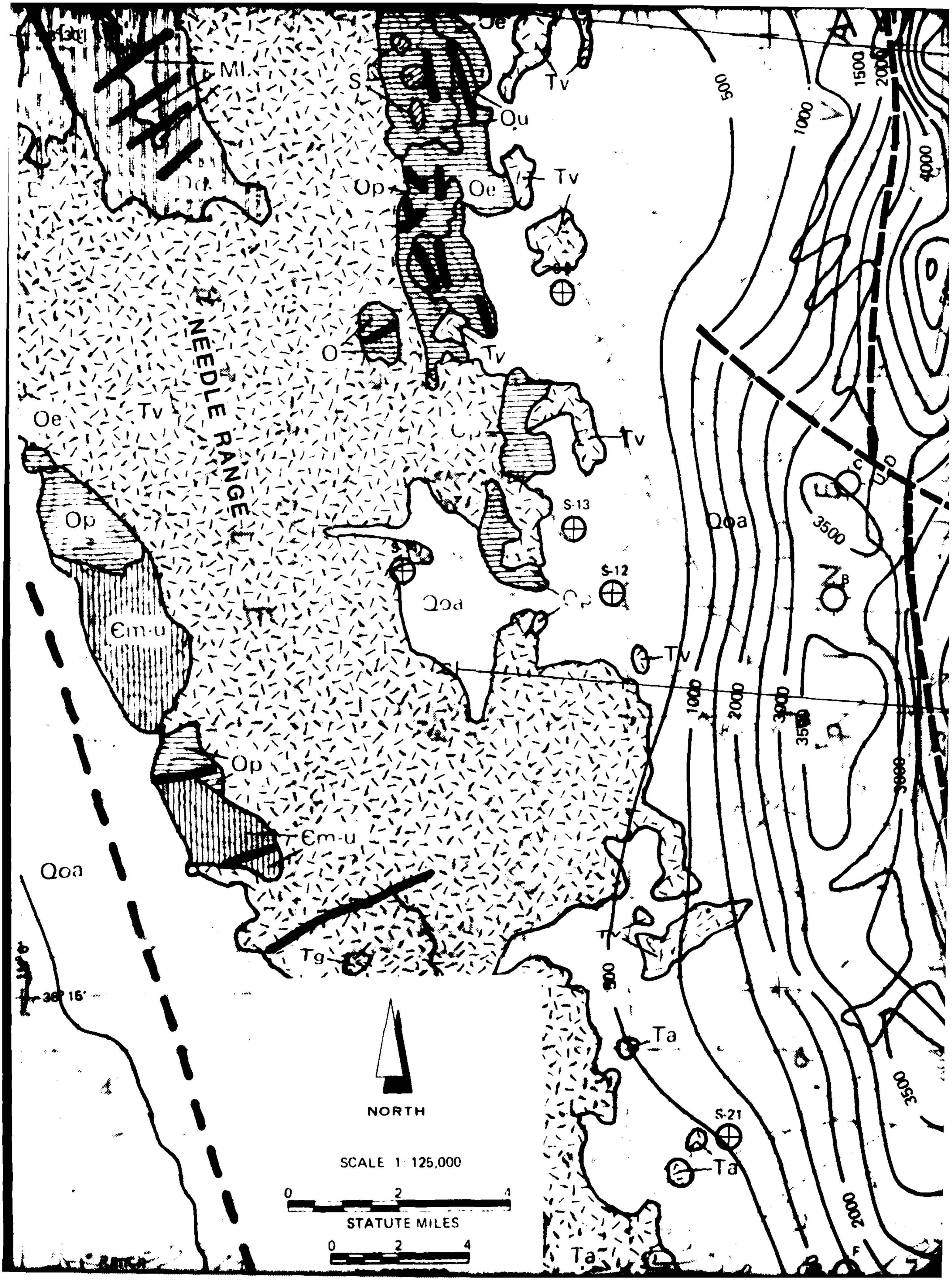
3



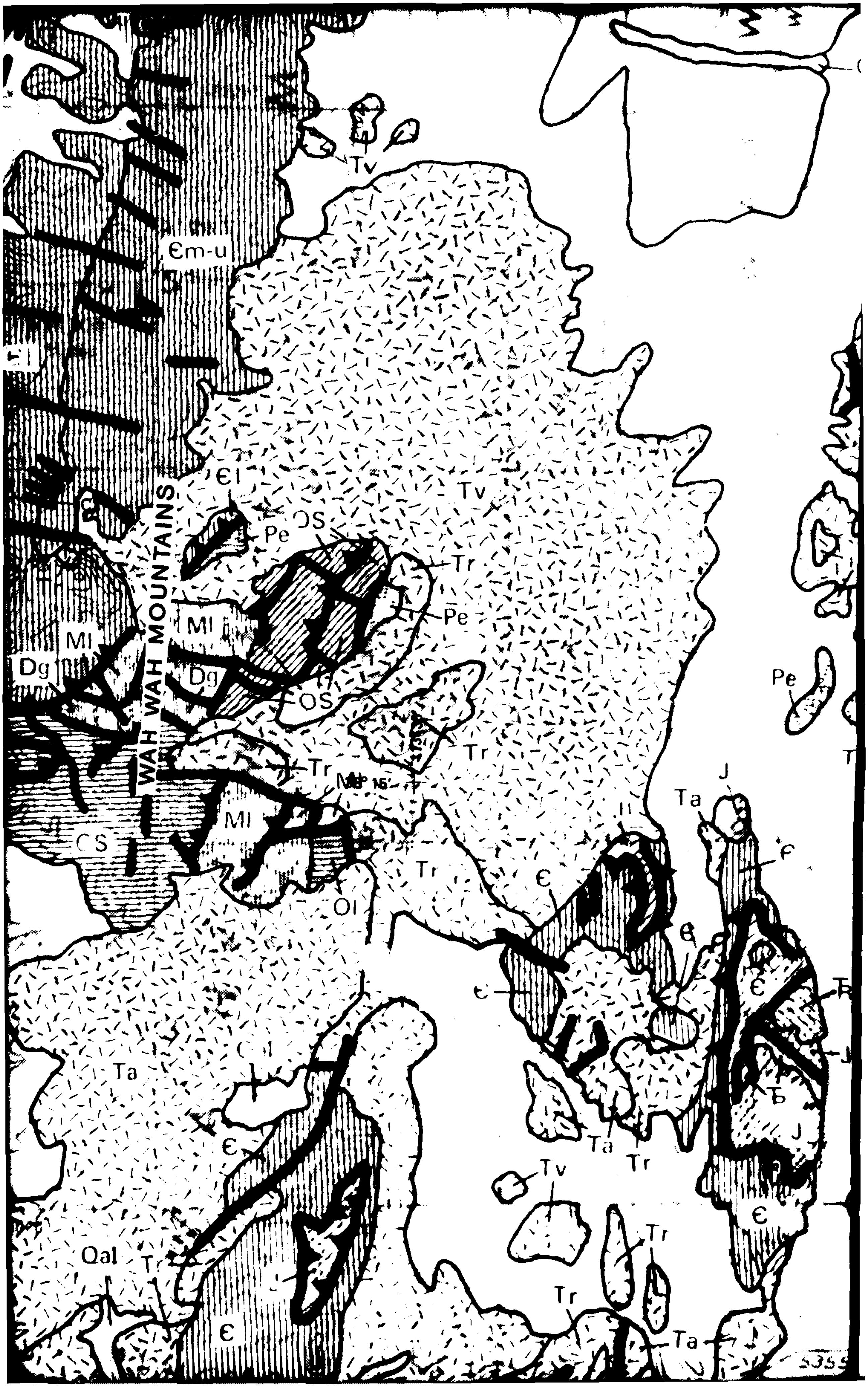
Ta
Ta
Єm-u
Ta
Ta
Ta
Op
Ta
Єm-u
Tr
113°
Qoa
Op
Єm-u
Єm-u
Op
Єm-u
Op
Op
Єm-u
Єm-u
Ta
Ql
Ta
Ql
Qoa



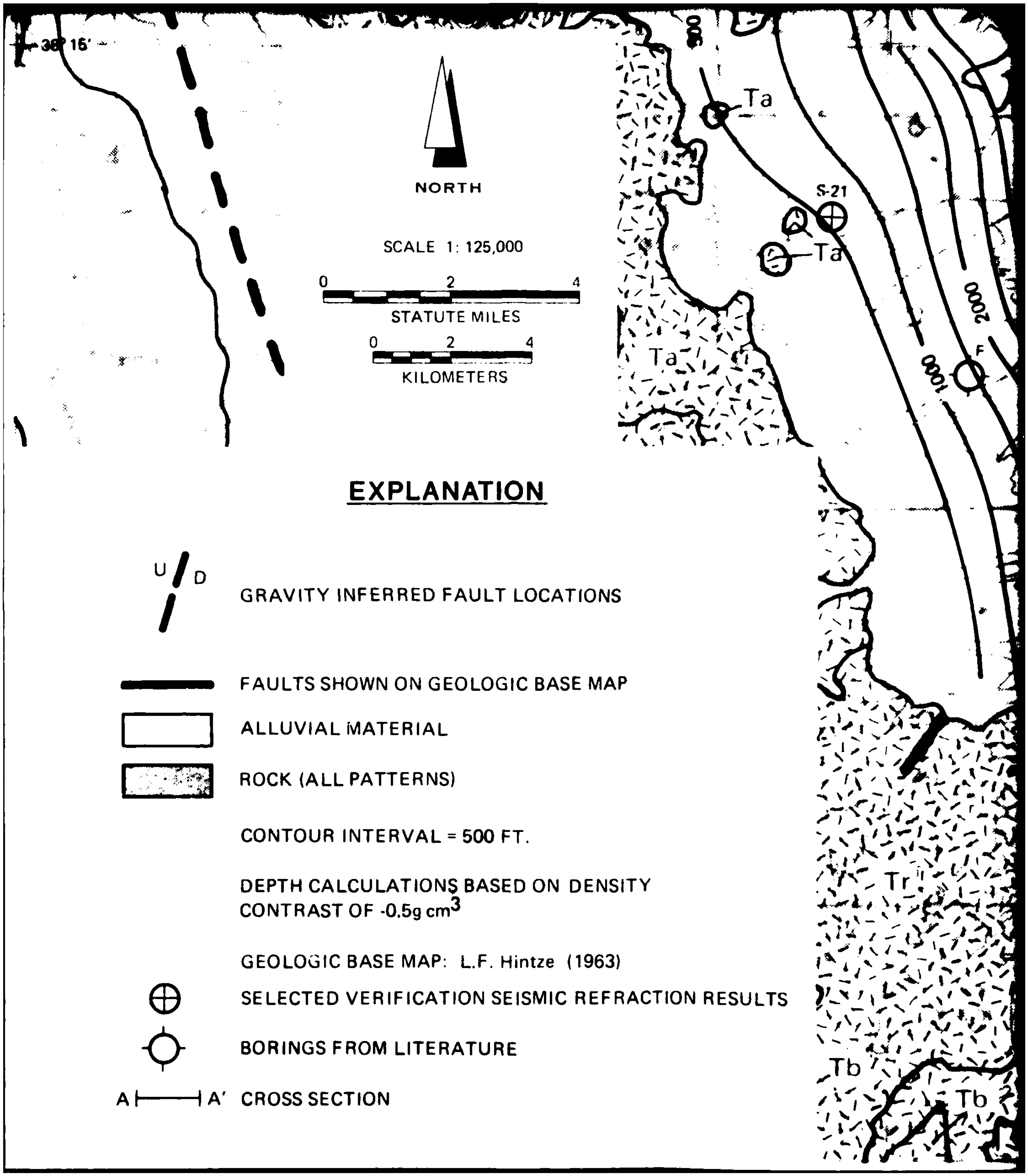
NEEDLE RANGE
Oe
Tv
Ml
S
Ou
Op
O
Qoa
Єm-u
Tg
Ta
S-13
S-12
S-21
500
1000
1500
2000
3000
3500
4000
38° 15'
NORTH
SCALE 1: 125,000
0 2 4
STATUTE MILES
0 2 4

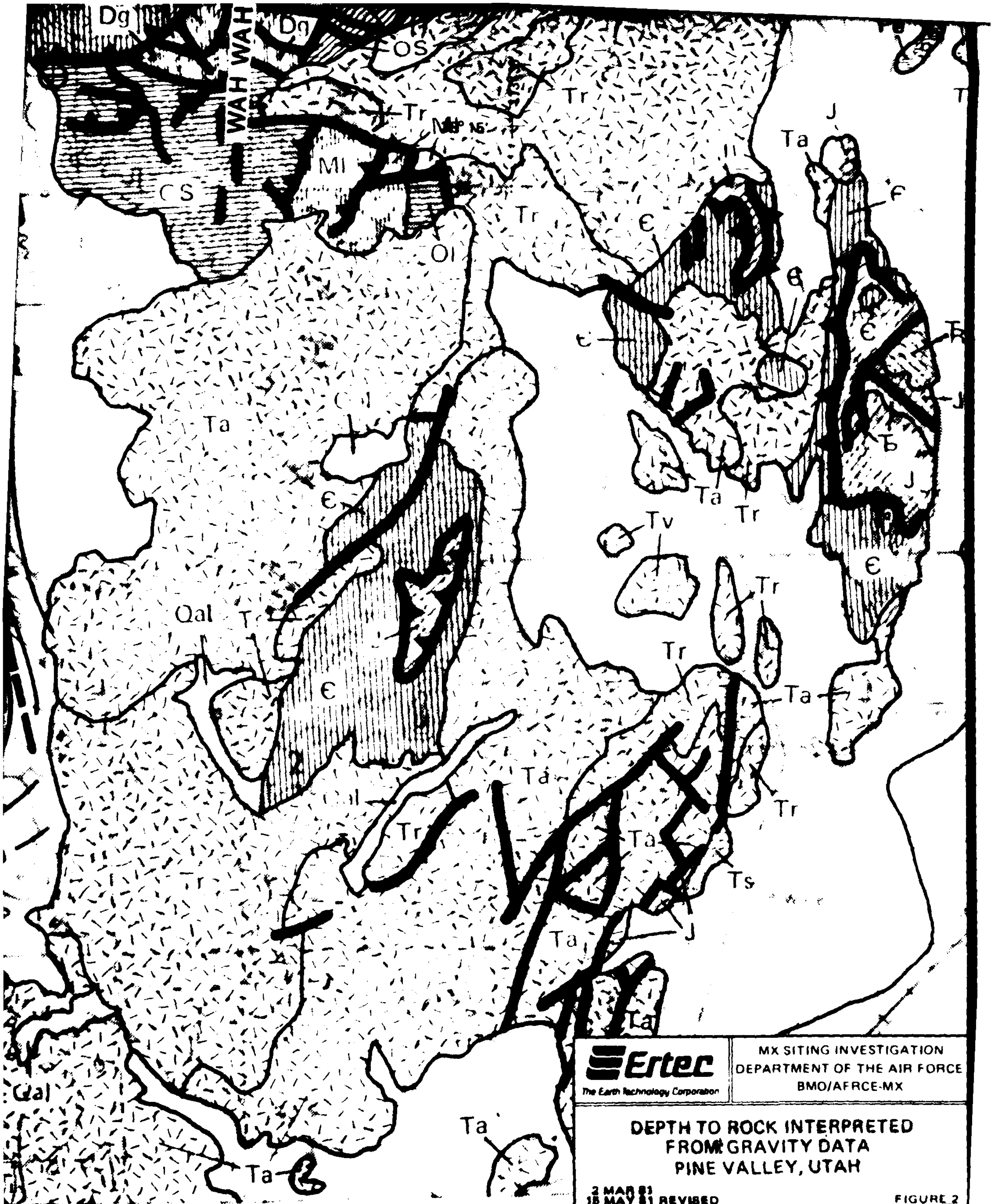


NEEDLE RANGE
Ml
S
Oe
Ou
Tv
Op
O
Op
Oe
Tv
Op
Єm-u
Op
Єm-u
Qoa
Qoa
Qoa
Tg
Ta
Ta
Ta
S-13
S-12
S-21
500
1000
1500
2000
3000
3500
4000
NORTH
SCALE 1: 125,000
0 2 4
STATUTE MILES
0 2 4



Tv
Єm-u
Єl
Pe
OS
Tr
Pe
Ml
Ml
Dg
Dg
WAH WAH MOUNTAINS
OS
Tr
Tr
Ml
CS
Tr
Ol
Ta
Є
Qal
Є
Tv
Tr
Tr
Tr
Ta
Ta
Pe
J
Ta
Є
Є
J
J
Є
Tr
5355


36° 15'
NORTH
SCALE 1: 125,000
0 2 4
STATUTE MILES
0 2 4
KILOMETERS
Ta
S-21
500
1000
2000
F
Tr
Tb
EXPLANATION
U D
GRAVITY INFERRED FAULT LOCATIONS
FAULTS SHOWN ON GEOLOGIC BASE MAP
ALLUVIAL MATERIAL
ROCK (ALL PATTERNS)
CONTOUR INTERVAL = 500 FT.
DEPTH CALCULATIONS BASED ON DENSITY CONTRAST OF -0.5g cm3
GEOLOGIC BASE MAP: L.F. Hintze (1963)
SELECTED VERIFICATION SEISMIC REFRACTION RESULTS
BORINGS FROM LITERATURE
A A' CROSS SECTION

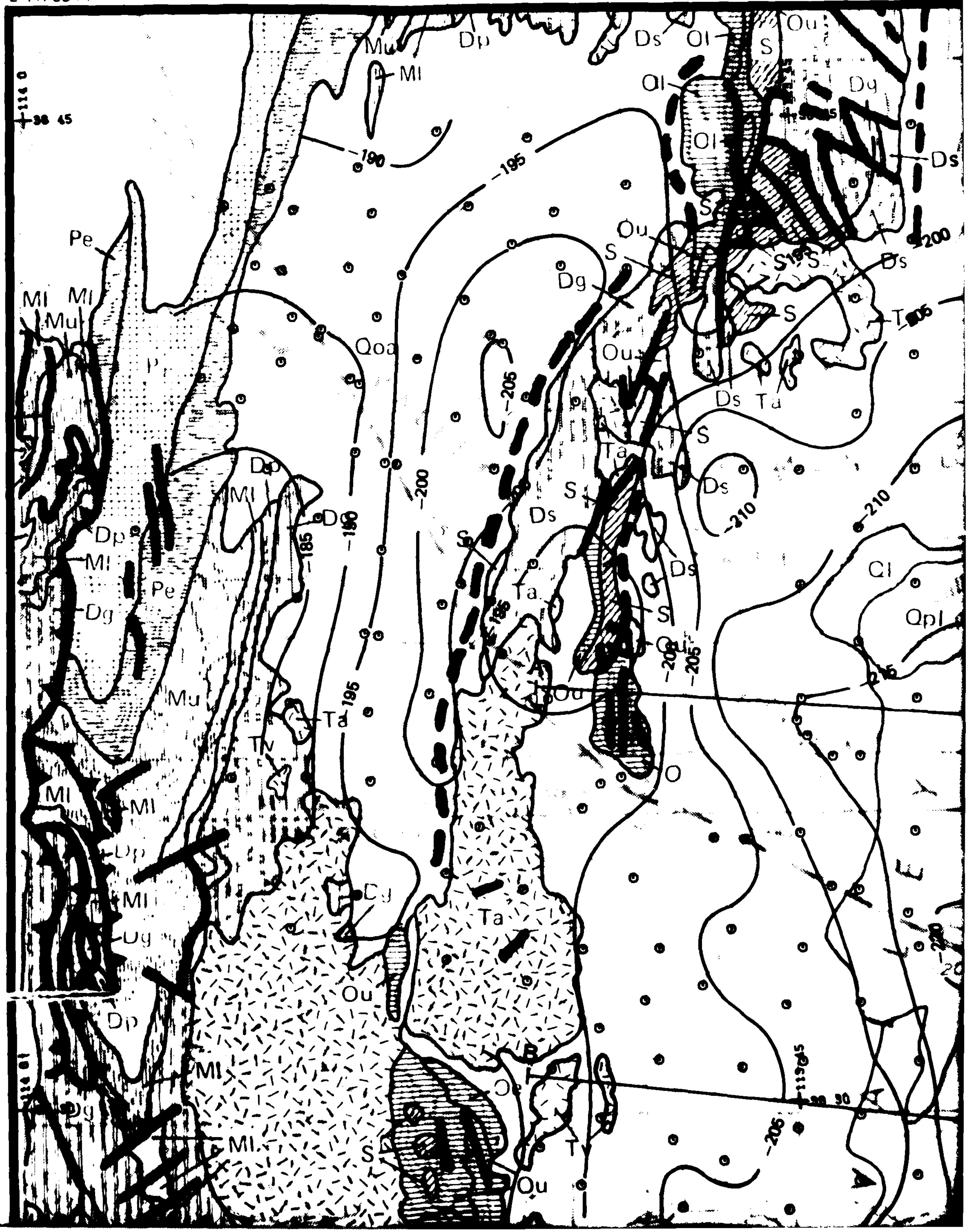


MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

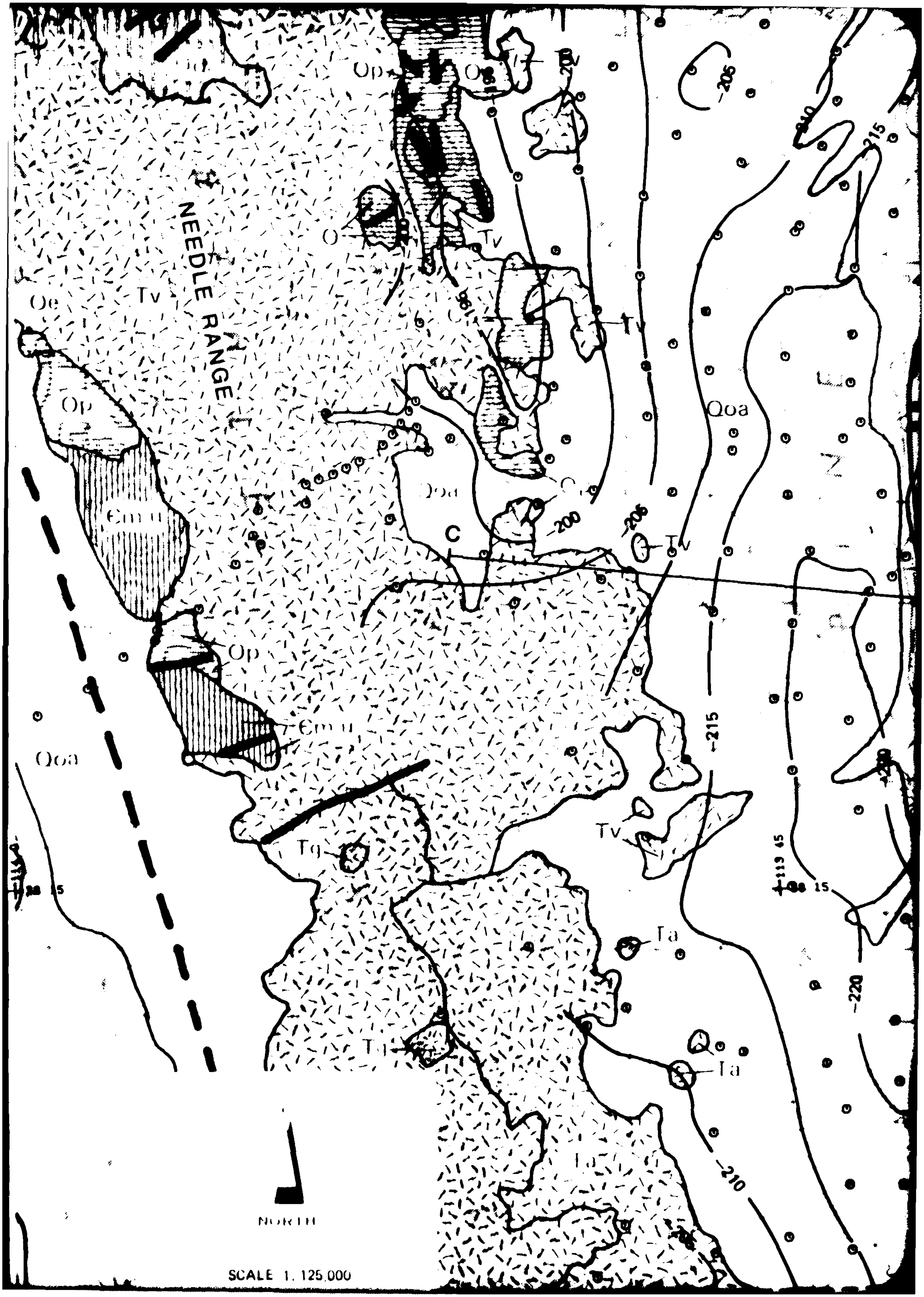
DEPTH TO ROCK INTERPRETED FROM GRAVITY DATA
PINE VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

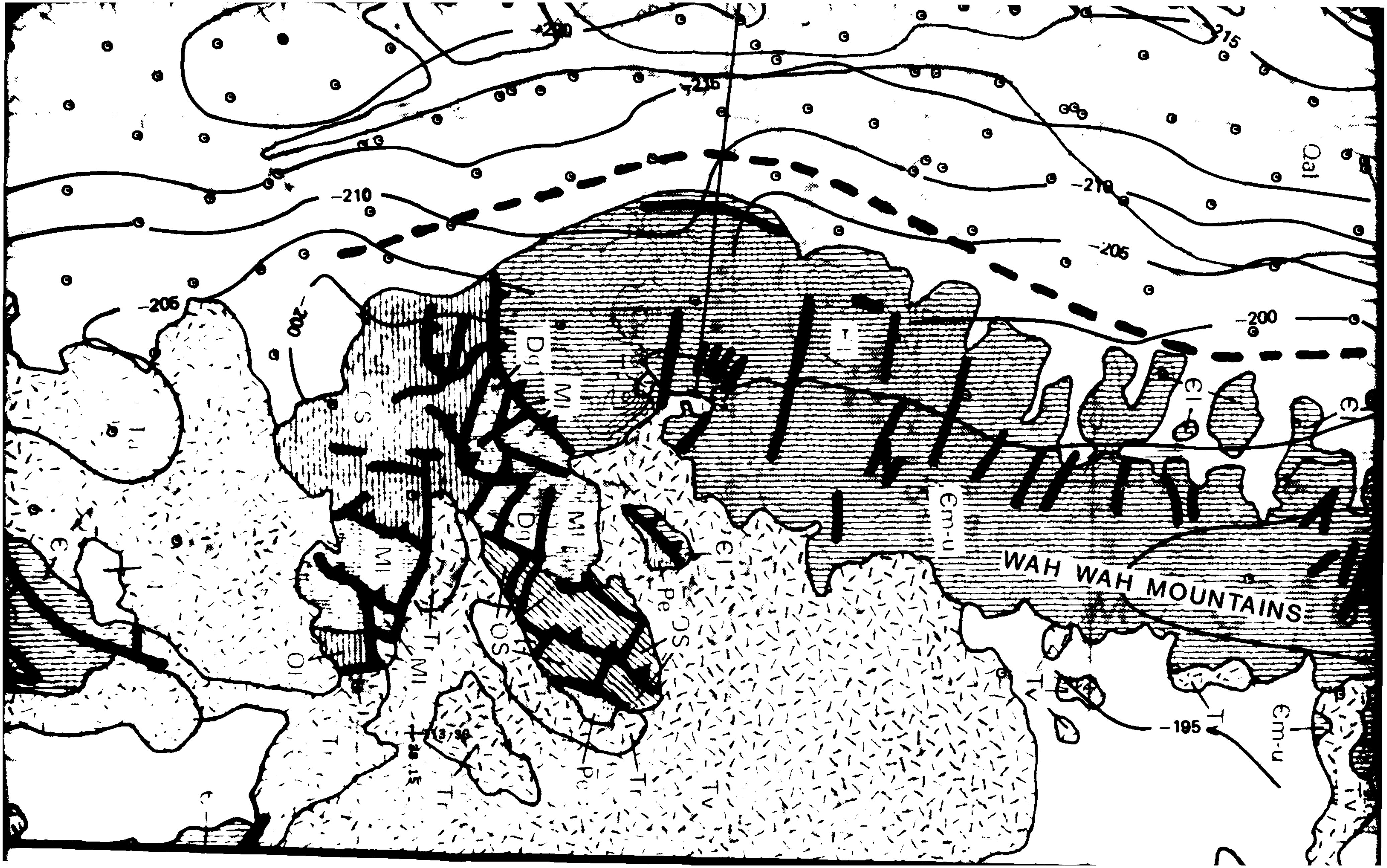
FIGURE 2

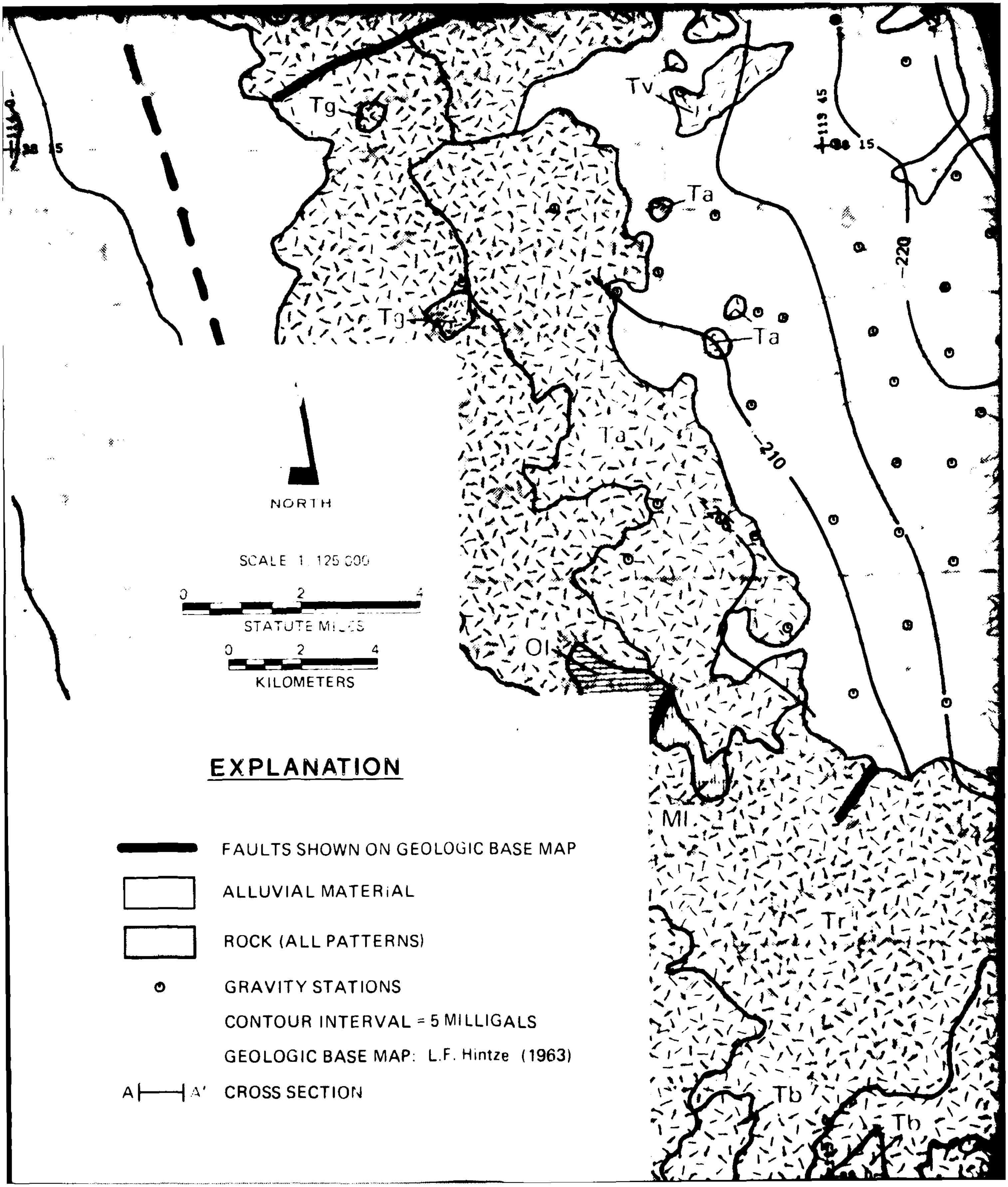

Mu
Ml
Dp
Ds
Ol
Ou
S
Dg
Pe
P
Qoa
Ta
Tv
Ql
Qpl
O
B
190
195
200
205
210
185

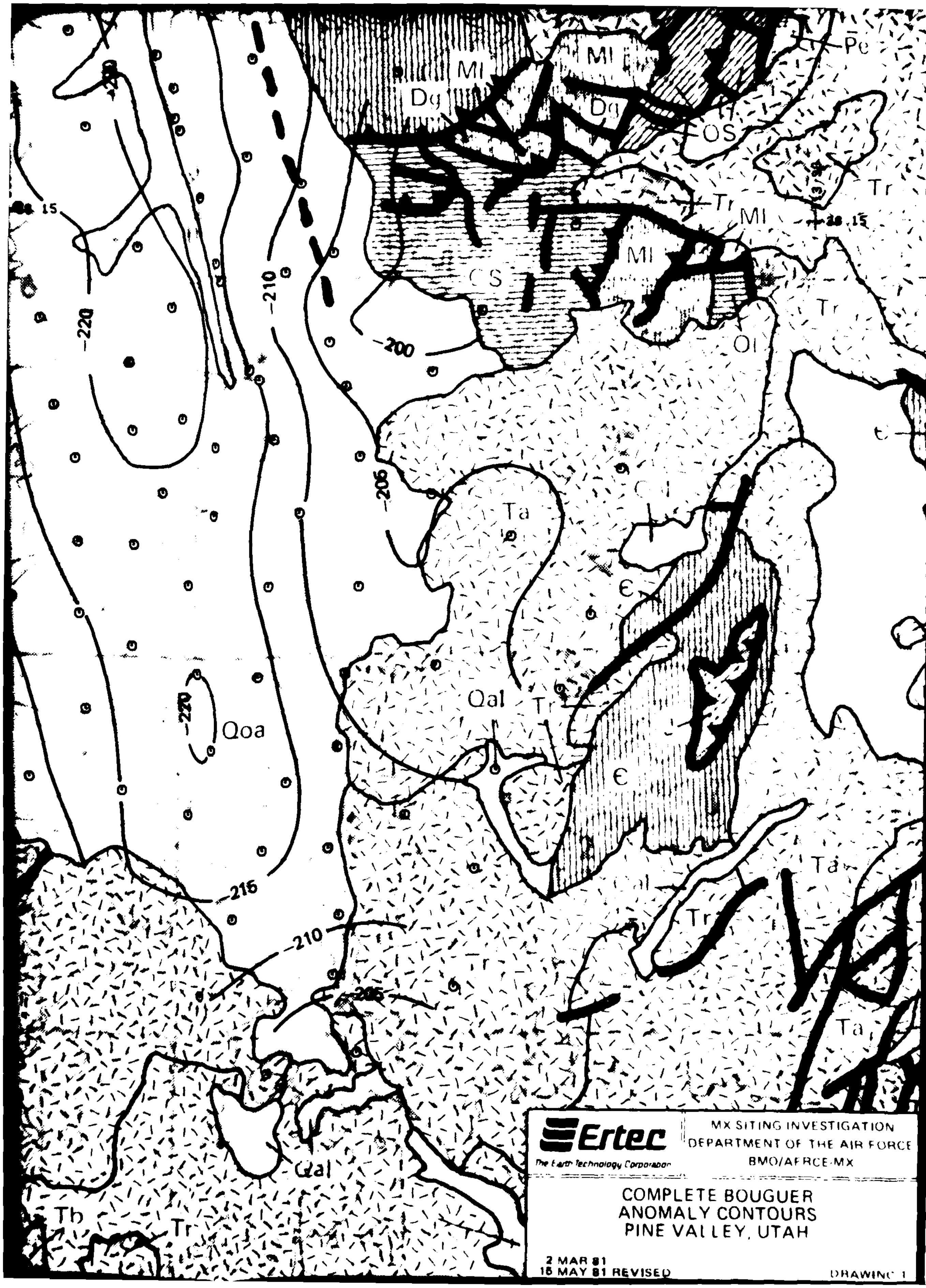

Ou
Op
Oe
Єm-u
Tr
Ta
Du
Ds
Op
Єm-u
Qoa
200
205
210
Ql
Qpl
215
Єm-u
Op
Op
Op
Ta
Ta
Ta
Ta
Ql
195
200
205
210
220
Єm-u
Qoa
Tg
Ta
Qoa
215
Qal
Єl
Tv
Єm-u



NEEDLE RANGE
Tv
Op
Em u
Qoa
Tq
Ta
-205
-210
-215
-220
-200
113 45
38 15
NORTH
SCALE 1:125,000


WAH WAH MOUNTAINS
Qal
Єm-u
Єl
Tv
Tr
Pe
OS
Ml
Dg
Ol
-195
-200
-205
-210
-215


Tg
Tv
Ta
Tg
Ta
Ta
210
220
119 45
38 15
NORTH
SCALE 1:125 000
0 2 4
STATUTE MILES
0 2 4
KILOMETERS
Ol
Ml
Tr
Tb
Tb
EXPLANATION
FAULTS SHOWN ON GEOLOGIC BASE MAP
ALLUVIAL MATERIAL
ROCK (ALL PATTERNS)
GRAVITY STATIONS
CONTOUR INTERVAL = 5 MILLIGALS
GEOLOGIC BASE MAP: L.F. Hintze (1963)
A A' CROSS SECTION


Ertec
The Earth Technology Corporation
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX
COMPLETE BOUGUER
ANOMALY CONTOURS
PINE VALLEY, UTAH
2 MAR 81
15 MAY 81 REVISED
DRAWING 1
-220
-210
-200
-205
-215
-210
-205
-220
Ml
Dg
OS
Pe
Tr
Ol
Ta
Qal
Qoa
Tb
38.15

END

DATE