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MX SITING INVESTIGATION. GRAVITY SURVEY - SOUTHERN WHITE RIVER --ETC(U)
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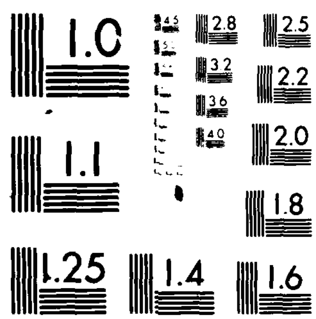

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MX SITING INVESTIGATION

GRAVITY SURVEY - SOUTHERN WHITE RIVER VALLEY

NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, Califorr: 409

Prepared by:

Fugro National, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

22 May 1980

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER FN-TR-33-WR ~~FN-TR-33-WR~~	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MX Siting Investigation Gravity Survey Southern White River Valley NV.		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER FN-TR-33-WR
7. AUTHOR(s) Fugro National, 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 22 May 80
		13. NUMBER OF PAGES ~~23~~ 35
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)

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

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18. SUPPLEMENTARY NOTES

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

Gravity survey, ~~Geologic Sur...~~ 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 southern White River Valley of Central Nevada indicates there are major range bounding normal fault systems on both sides of the valley. The major [illegible] on the east is the Egan Fault and is generally close to the mountain rocks. The western fault system is several miles east of the mountain front. The primary graben block is calculated to be between 55[illegible] feet deep in the north end of the valley and 8200 feet deep near the valley cent[illegible].

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FOREWORD

Methodology and Characterization studies during fiscal years 1977 and 1978 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 Fugro National's Characterization Reports (FN-TR-26a through e).

During the FY 77 surveys, measurements were made to form an approximate one-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, Reveille and Railroad valleys, a sufficient density of library data is 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 and Garden Coal valleys, Nevada became available from the field in early October, 1979.

A continuation of gravity interpretations has been incorporated into the FY 80 program and the results are being summarized in a series of valley reports. In reports covering Nevada-Utah gravity studies will be numbered, "FN-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 are being prepared. Verification studies are continuing in FY 80 and gravity studies are included in the program. DMA will continue to obtain the field measurements and it is planned to return to the grid pattern. The interpretation of the grid data will allow the production of contour maps which will be 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., Fugro National and the DMA. Conduct of the gravity studies is a joint effort between DMA and Fugro National. 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, calculates outer zone terrain corrections.

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

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

TABLE OF CONTENTS (Cont.)

Page

LIST OF FIGURES (Cont.)

LIST OF TABLES

LIST OF DRAWINGS

1.0 INTRODUCTION

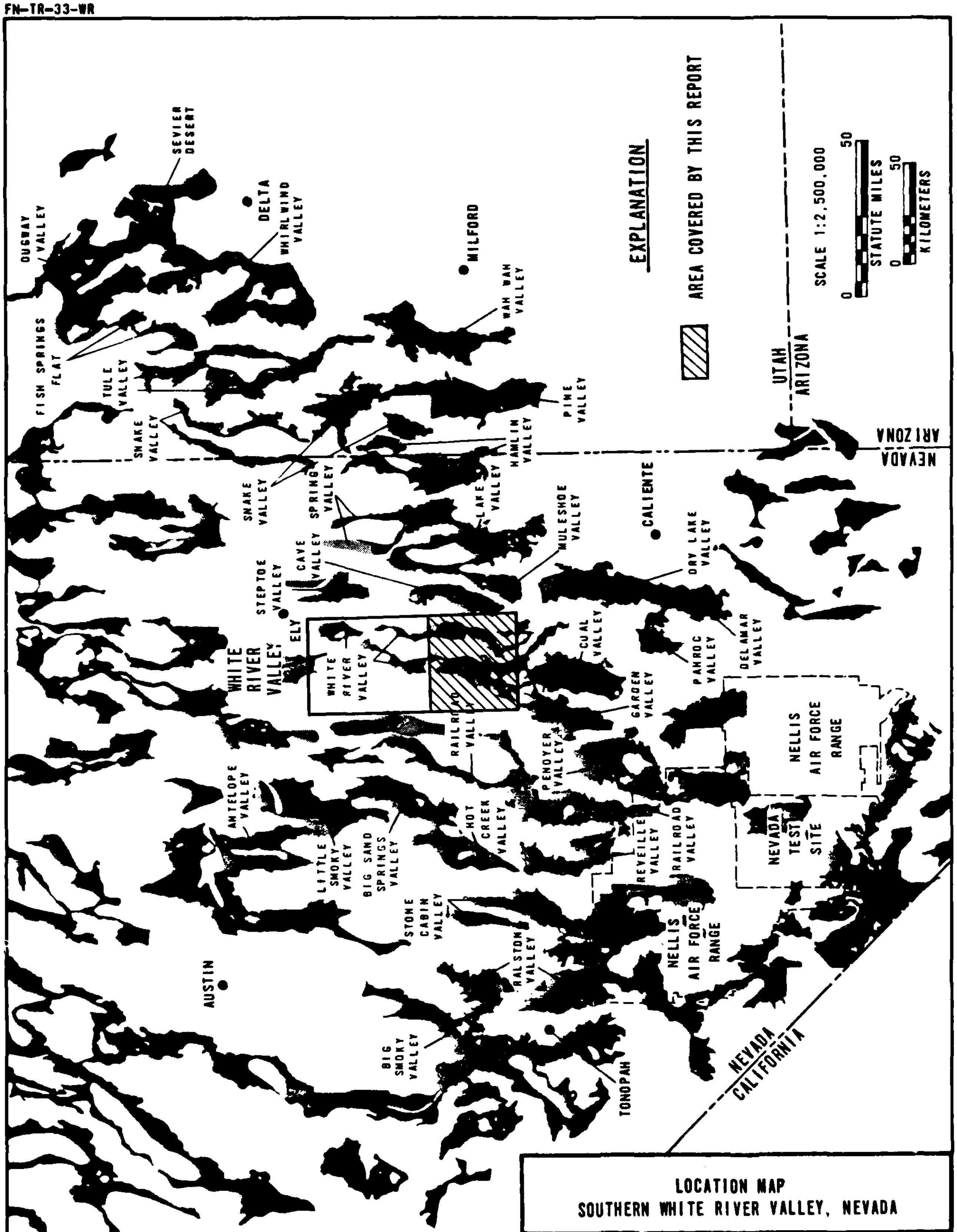
1.1 OBJECTIVE

Gravity measurements were made in Southern White River 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

White River Valley is located principally in northeastern Nye county with portions in Lincoln and White Pine counties in east central Nevada (Figure 1). The study area covered by this report is the southern part of the valley which is approximately 60 miles (97 km) south-southwest of Ely, Nevada. The nearest town is Lund, Nevada along the northern edge of the valley. Although the only paved road within the site is State Highway 38, which traverses the eastern side of the valley, access is fair along a system of unmaintained roads.

White River Valley is bounded by mountain ranges on three sides and open to Jakes Valley on the north (Figure 2). The Egan Range forms the eastern boundary of the valley. The Horse and Grant Ranges comprise the western side and the Golden Gate and Seaman Ranges form the southern boundary. Most of the valley is undeveloped rangeland with several ranches and agricultrual fields.



LOCATION MAP
SOUTHERN WHITE RIVER VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 1

FUGRO NATIONAL, INC.

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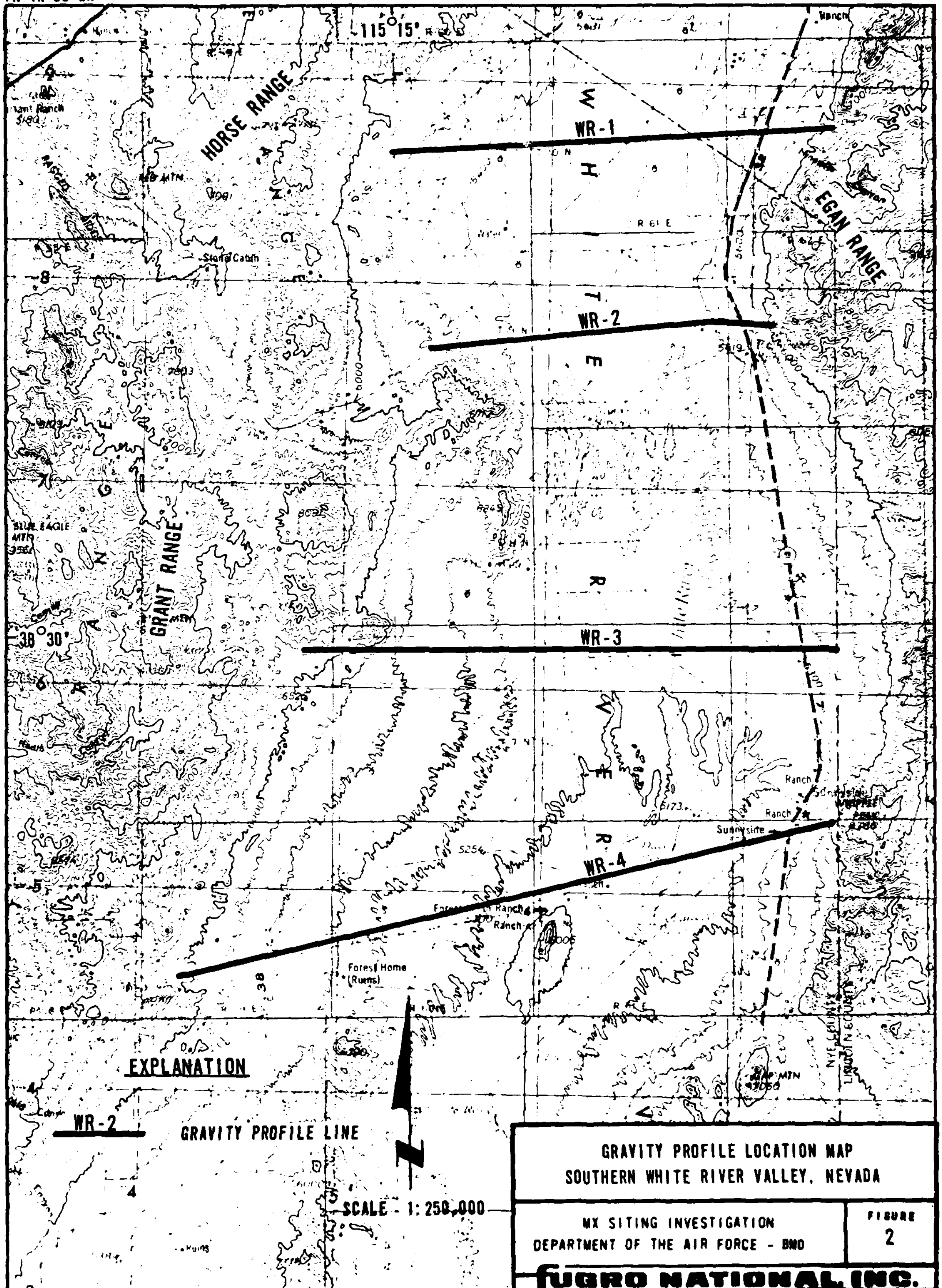

GRAVITY PROFILE LOCATION MAP
SOUTHERN WHITE RIVER VALLEY, NEVADA

MX SITING INVESTIGATION
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FIGURE 2

FUGRO NATIONAL, INC.

22 MAY 80

1.3 SCOPE OF STUDY

The Defense Mapping Agency Hydrographic-Topographic Center/ Geodetic Survey Squadron (DMAHTC/GSS) obtained 152 gravity measurements along four cross valley profiles used in this study (*Appendix A2.0*). Profile positions are shown in Figure 2 and the locations of the individual stations are shown in Drawing 1. The profiles are oriented approximately east-west. They are between 10 miles and 20 miles (16 to 32 km) long and are spaced approximately 7 miles (11 km) apart. The gravity sampling interval was 1 mile (1.6 km) over the central valley section and .25 mile (.4 km) near the valley margins. The more dense sampling was used on the valley flanks to define any steep gravity gradients associated with boundary faults and to resolve anomalies with high spatial frequency that could be associated with shallow bedrock.

The tolerance for establishing station elevations was 5 feet (1.5 m), which limits the gravity precision to 0.3 milligals.

2.0 GRAVITY DATA REDUCTION

DMAHTC/GSS obtained the basic observations and reduced them to Simple Bouguer Anomalies (SBA) for each station as described in Appendix A1.0. Up to three levels of terrain corrections were applied to convert the SBA to the Complete Bouguer Anomaly (CBA). First, the Defense Mapping Agency Aerospace Center (DMAAC), St. Louis, 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. The CBA data for the Southern White River Valley stations are listed in Appendix A2.0.

3.0 GEOLOGIC SUMMARY

The structural geologic setting, major rock types, and depositional regime of the valley fill material are important considerations in the interpretation of gravitational field data.

White River Valley is an elongate, north-south trending, alluvial basin which was formed as a result of Basin and Range, extensional block faulting. The basin is a graben which is separated from its adjacent mountain ranges (horsts) by steeply dipping normal fault systems. The mountain blocks are composed of Paleozoic rocks which dip eastward from 20 to 40 degrees (Kleinhample and Ziony, 1967). This regional dip is primarily a result of late Tertiary, tilt-block faulting. This Basin and Range-type normal faulting continued well into the late Quaternary and is probably active today as indicated by young faults and scattered earthquakes (Fugro National, Inc., FY 80, FN-TR-38).

The major fault in White River Valley is the Egan fault system which lies along the eastern side of the valley. The Egan fault displaces late Quaternary alluvial fans forming a fairly continuous escarpment within about 1 mile of the base of the bedrock mountain block (FNI, FY 80, FN-TR-38; Stewart and Carlson, 1978).

The mountain ranges along the east and west sides of the valley are composed predominantly of thick, sequences of complexly faulted Paleozoic limestone and dolomite with interbedded shales and quartzites. Tertiary welded ash-flow tuffs and rhyolitic and andesitic flows primarily occur in the southeastern and southern portions of the valley in the Grant, Golden Gate, and Seaman ranges. A few volcanic outliers occur locally in the northeastern and northwestern parts of the valley.

Most of the surficial deposits in White River Valley are late Tertiary lake deposits and younger alluvial fans (Eakin, 1966). Basin fill deposits are described in the Verification Studies (FNI, FY 79, FN-TR-27-V). The older lacustrine deposits cover approximately one-half of the valley's surface area. This unit is concentrated primarily in a band along the valley axis and is composed of predominately fine-grained deposits such as siltstone, mudstone, and travertine but some sand and gravel may be included near the edges of the lake deposits. Two ages of alluvial fans are recognized in the valley based on geomorphic analysis. The intermediate fans, chiefly gravelly sands, form a narrow strip along the valley margins and cover about one-sixth of the site. The younger alluvial fans and modern stream channel deposits are quite similar in composition to the older fans but may be finer grained with greater distances from the mountain block. These units occupy about one-third of the valley and are located basinward of the intermediate alluvial fans.

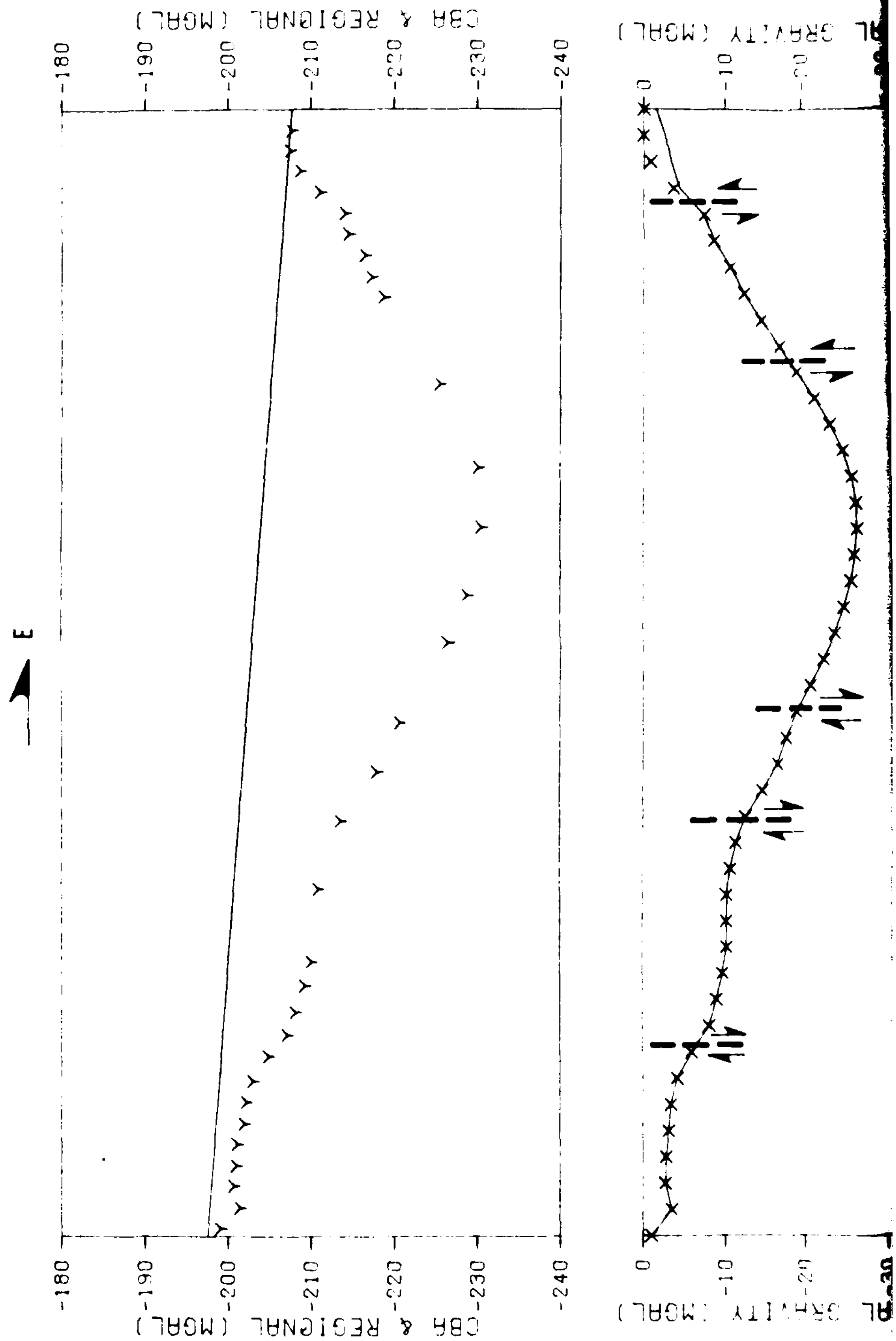
4.0 INTERPRETATION

A valley filled with alluvium which has a low-density relative to the surrounding bedrock creates a negative gravity anomaly. Gravity profiles across such valleys are often U-shaped, low in the middle of the valley where the fill is thickest and high on the ends where the fill thins and bedrock emerges. Interpretation requires removal of regional trends leaving the gravity reflection of the valley fill. The gravity data and interpreted geologic models for the four profiles across Southern White River Valley are shown in Figures 3 through 6.

4.1 REGIONAL-RESIDUAL SEPARATION

A fundamental step in gravity interpretation is isolation of the part of the CBA which represents the geologic feature of interest, in this case the relatively low density valley fill. The portion of the CBA which corresponds to this alluvial material is called the "residual anomaly".

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, have been approximated by linear interpolation between CBA values at bedrock stations on opposite ends of the profiles. Where only one end of a profile was on bedrock, the regional value on the other end was assigned a quantity consistent with the regional trend of the valley. The regional gravity was subtracted from the CBA and the resulting residual anomaly profiles were used to model the valley. This regional separation technique is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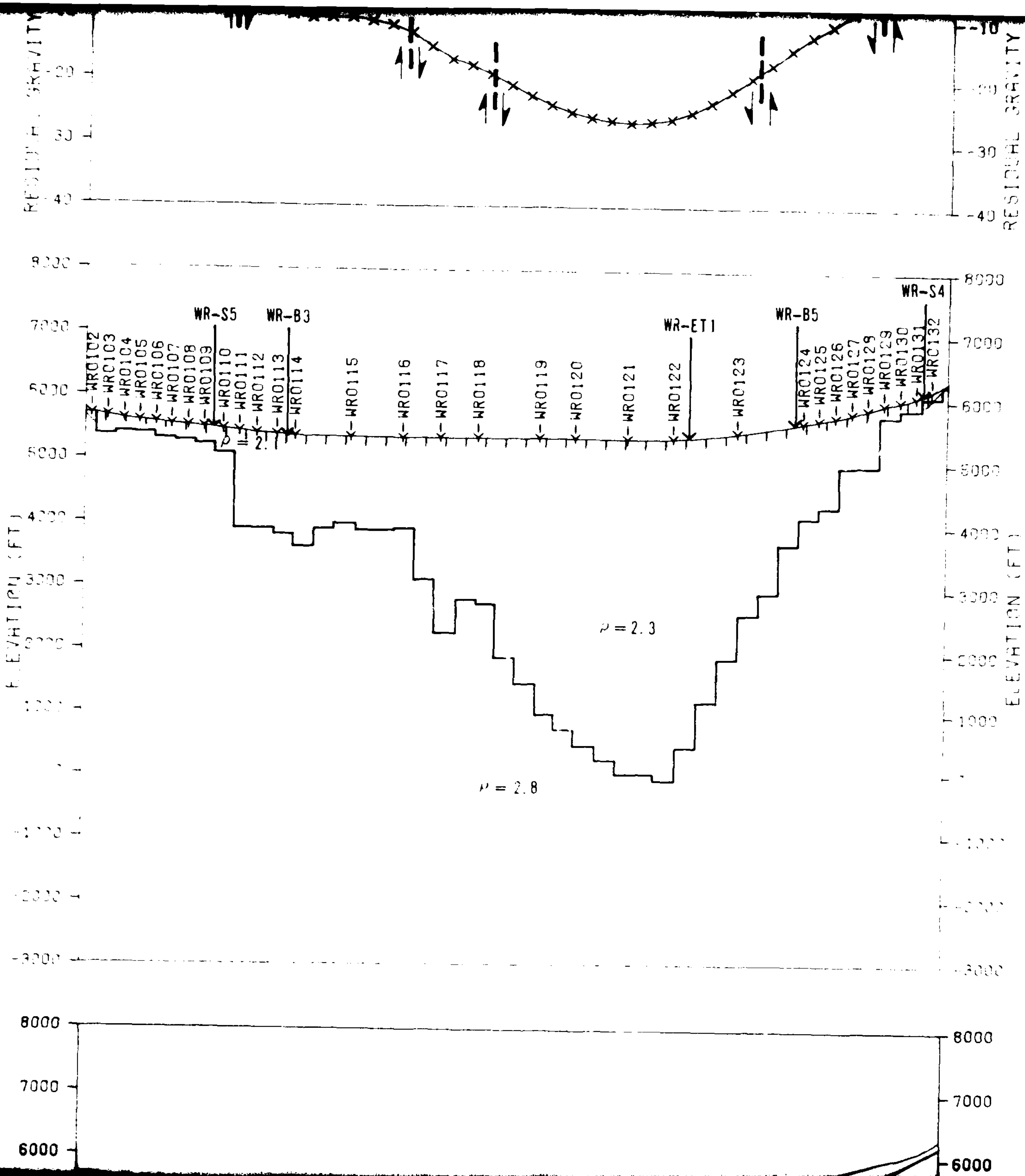
-180
-190
-200
-210
-220
-230
-240
E
0
-10
-20


RESIDUAL GRAVITY
-10
-20
-30
-40
ELEVATION (FT)
8000
7000
6000
5000
4000
3000
2000
1000
-1000
-2000
-3000
WR-S5
WR-B3
WR-ET1
WR-B5
WR-S4
WR0102
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WR0122
WR0123
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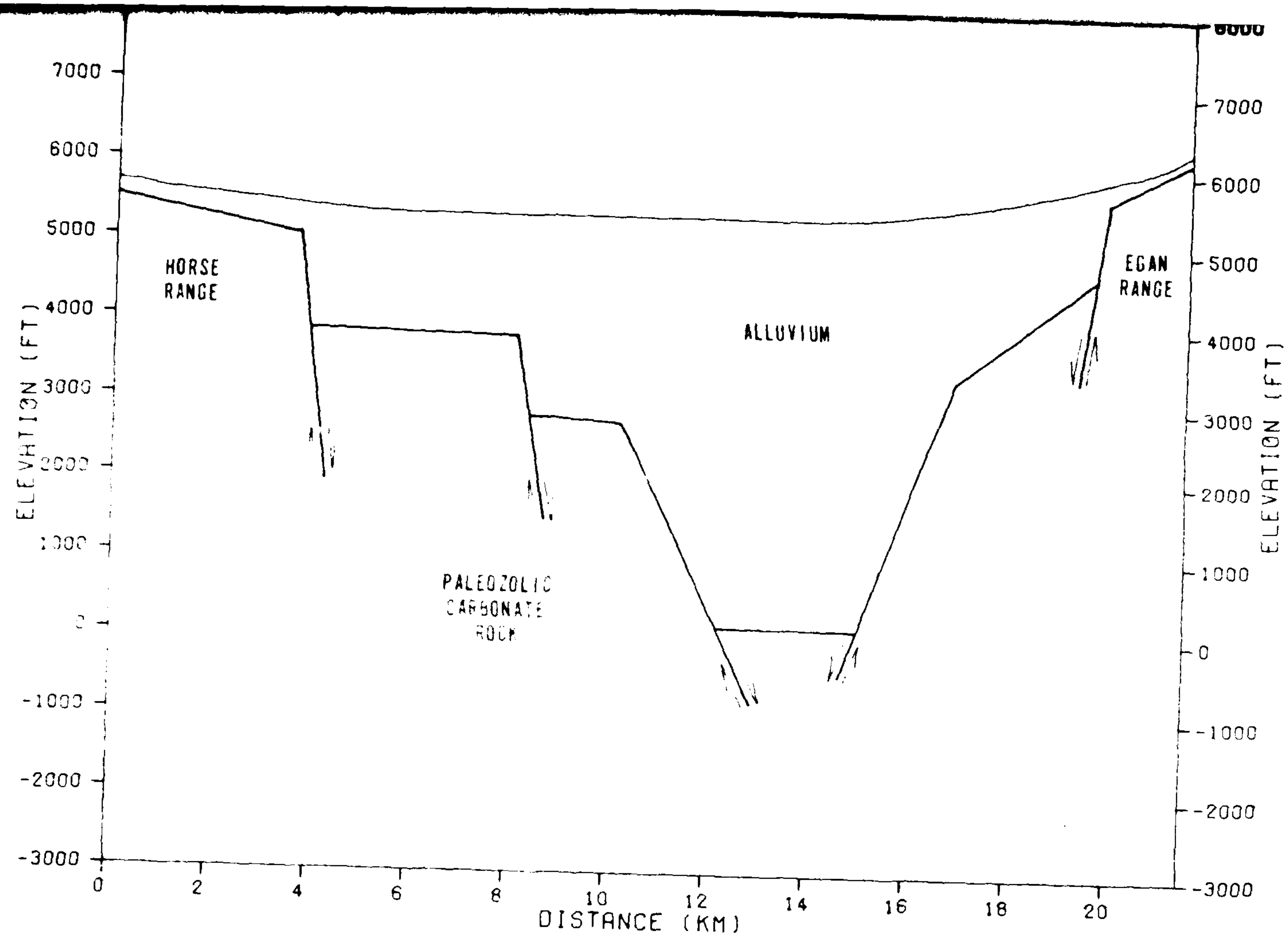
ρ = 2.3
ρ = 2.8



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0 2 4 6 8 10 KILOMETERS

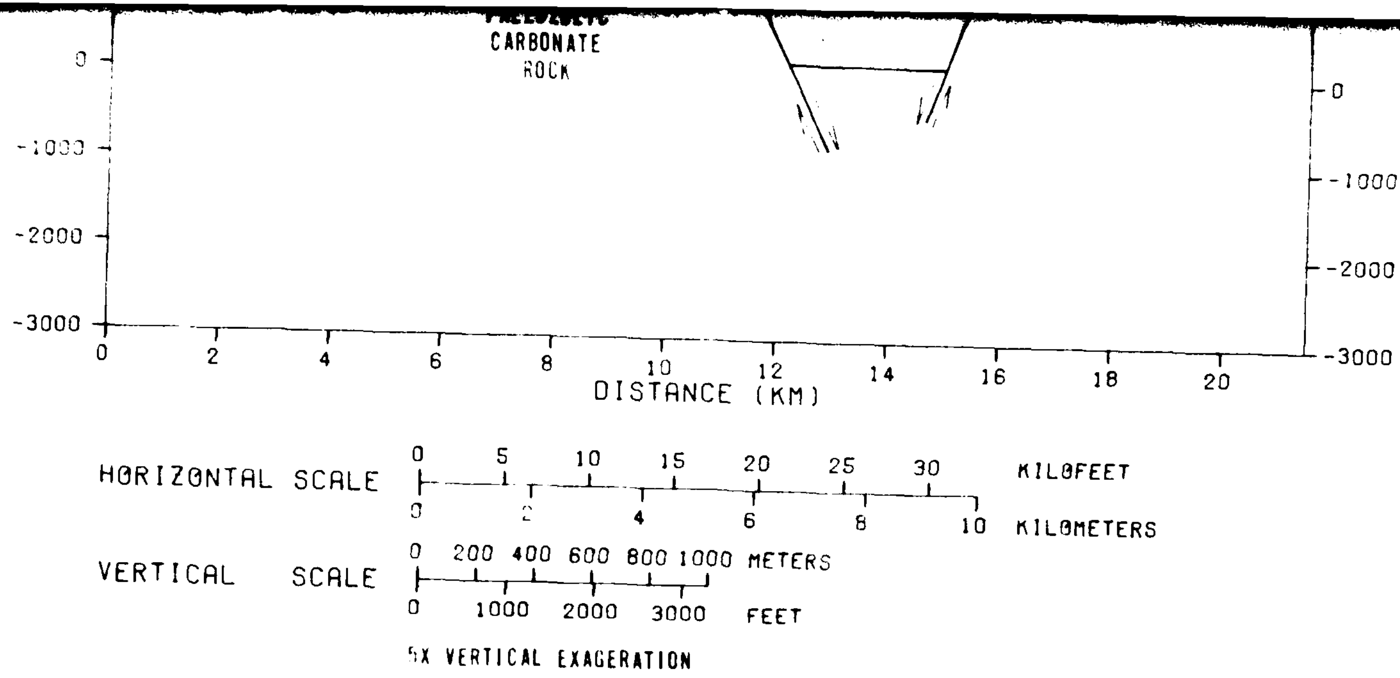
VERTICAL SCALE 0 200 400 600 800 1000 METERS
0 1000 2000 3000 FEET

5X VERTICAL EXAGERATION

EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL ( )

BLOCK 2 RESIDUAL GRAV OBSERVED VALUES (INTERPOLATED) (X)



EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL ( )

BLOCK 2 RESIDUAL GRAV OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL ( )

BLOCK 3 ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS ( )
MODEL OF BEDROCK SURFACE ( )

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE ( )
DENSITY VALUES (ρ = 2.3 g cm^3)
DISTANCE SCALE 1:125,000

GRAVITY INTERPRETED FAULT LOCATION

WR-B1 VERIFICATION ACTIVITY LOCATION

INTERPRETED GRAVITY PROFILE WR-1
SOUTHERN WHITE RIVER VALLEY NEVADA

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FIGURE 3

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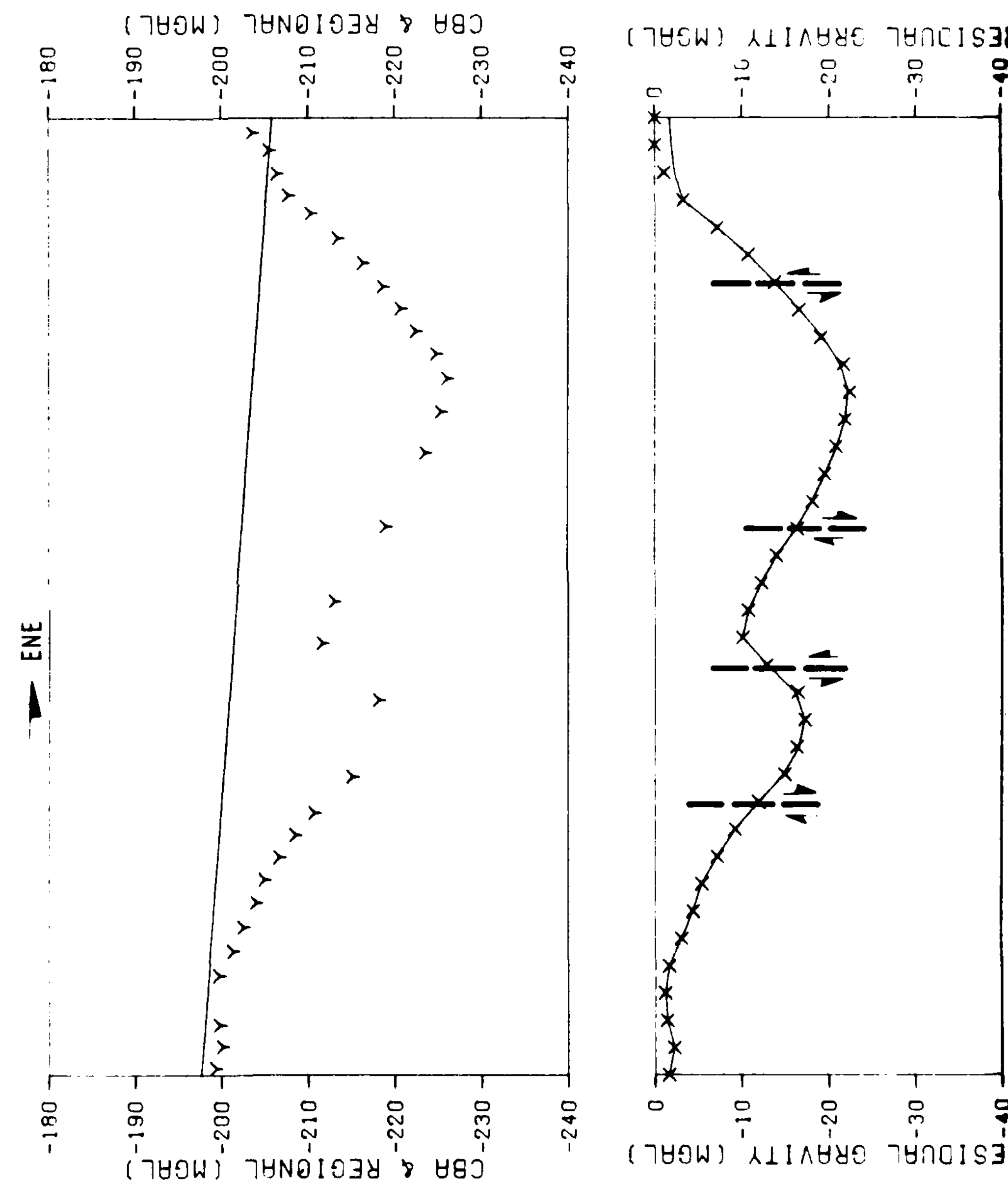
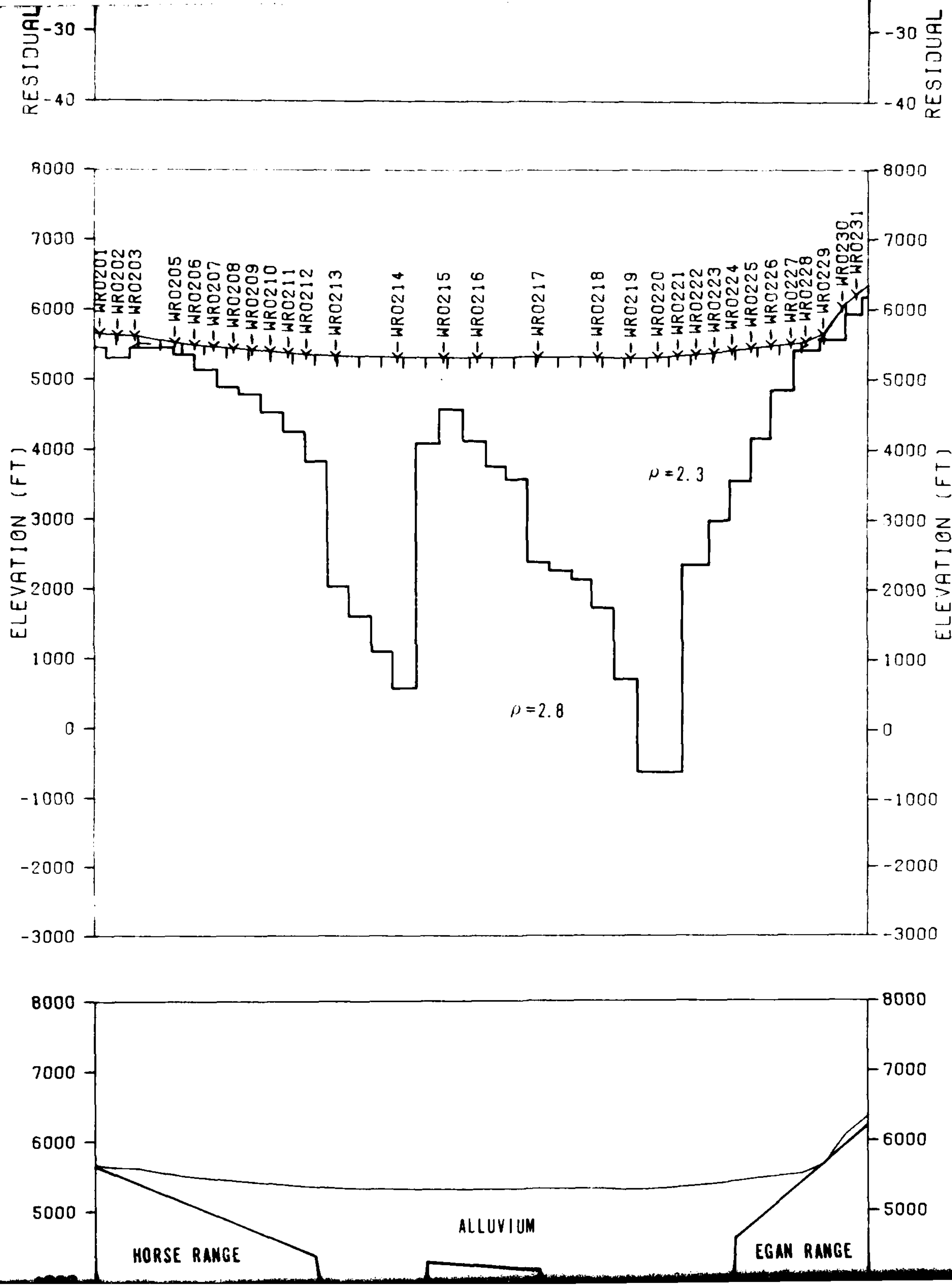

CBA & REGIONAL (MGAL)
-180
-190
-200
-210
-220
-230
-240
ENE
RESIDUAL GRAVITY (MGAL)
0
-10
-20
-30
-40


RESIDUAL
-30
-40
ELEVATION (FT)
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
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WR0202
WR0203
WR0205
WR0206
WR0207
WR0208
WR0209
WR0210
WR0211
WR0212
WR0213
WR0214
WR0215
WR0216
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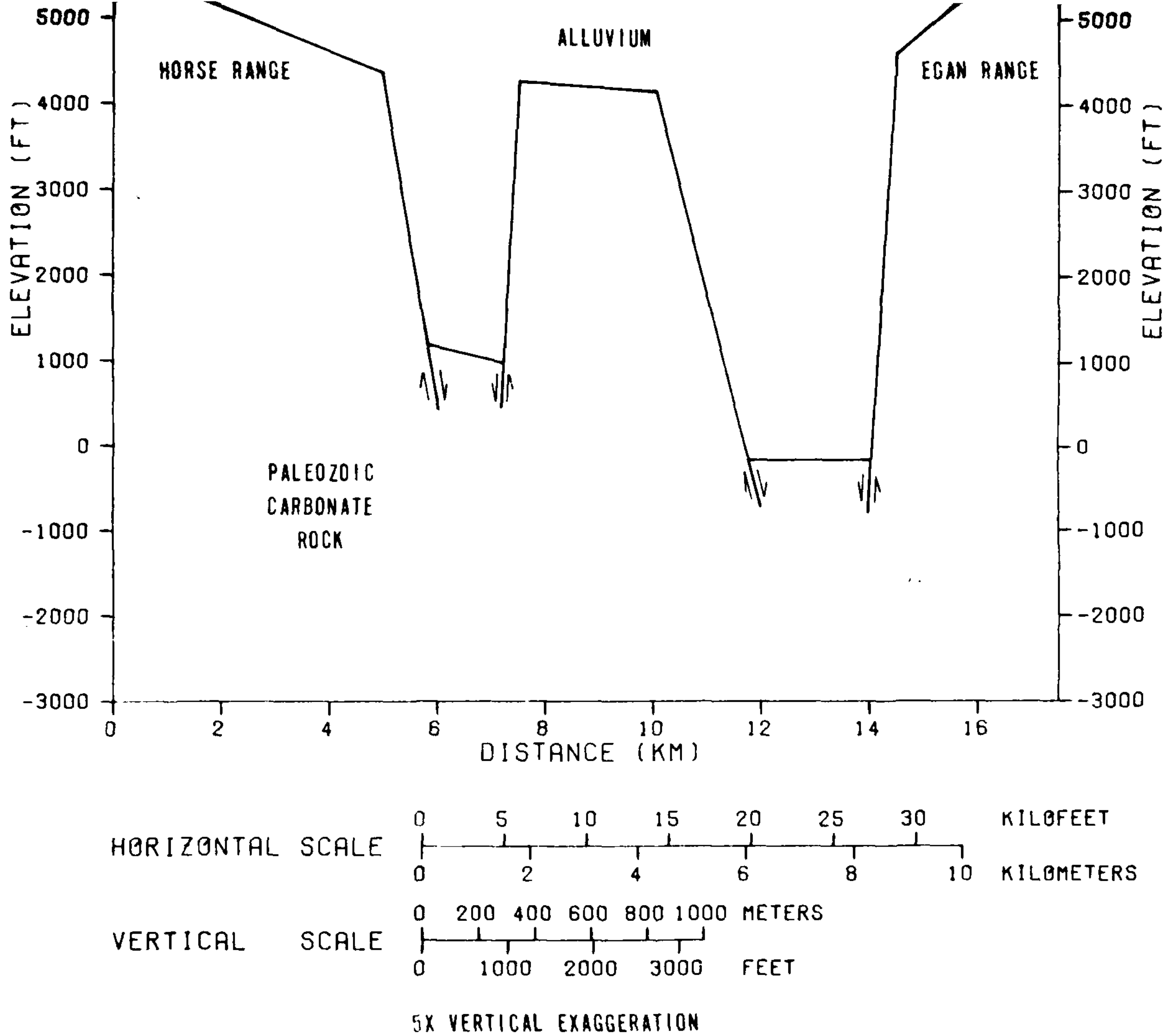
WR0219
WR0220
WR0221
WR0222
WR0223
WR0224
WR0225
WR0226
WR0227
WR0228
WR0229
WR0230
WR0231
ρ = 2.3
ρ = 2.8
HORSE RANGE
ALLUVIUM
EGAN RANGE



EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL (———)

BLOCK 2 RESIDUAL GRAV OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL (———)

BLOCK 3 ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS (———)
MODEL OF BEDROCK SURFACE (———)

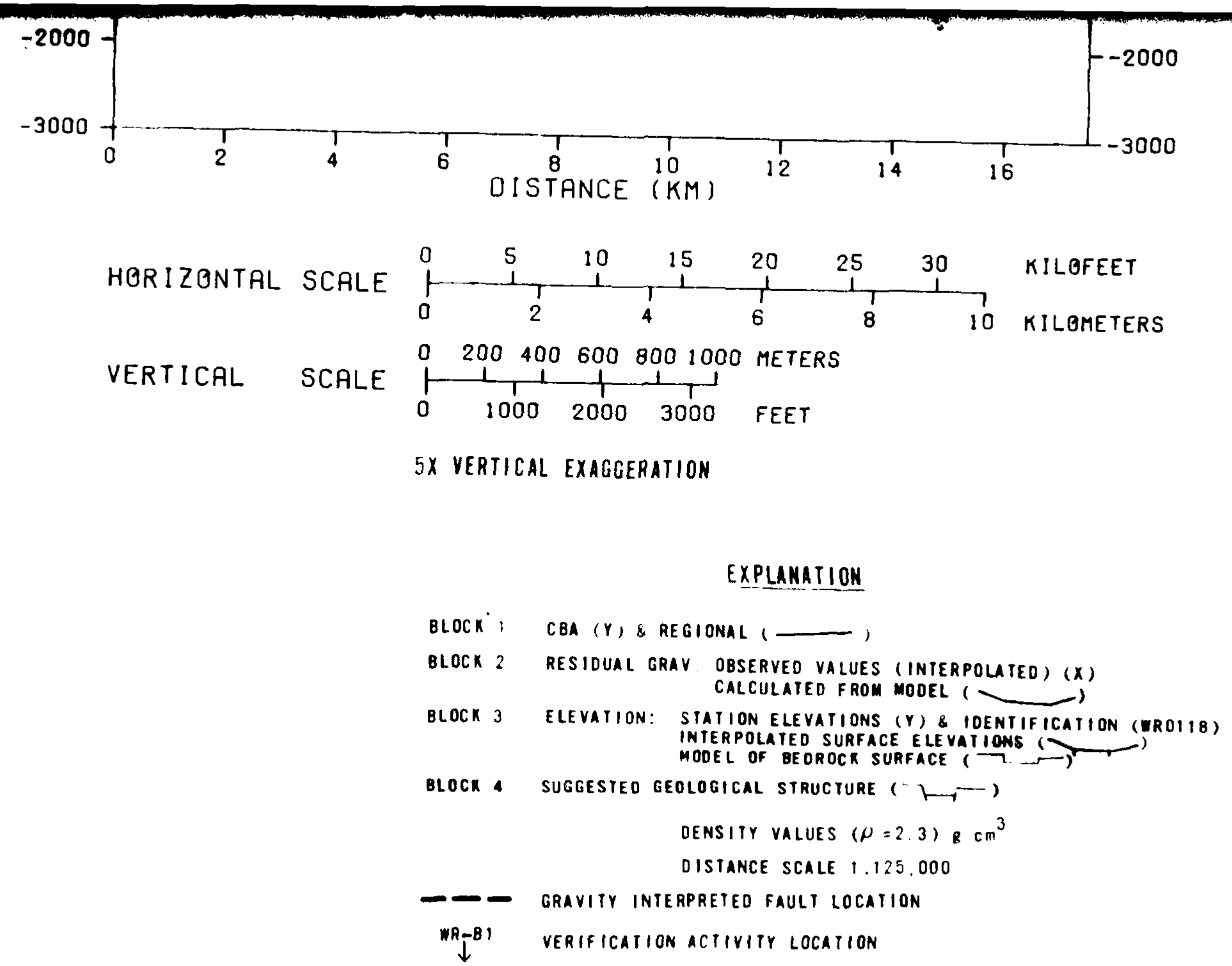
BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE (———)

DENSITY VALUES (ρ = 2 3) g cm^3

DISTANCE SCALE 1:125,000

— — — GRAVITY INTERPRETED FAULT LOCATION

WR-B1 ↓ VERIFICATION ACTIVITY LOCATION



INTERPRETED GRAVITY PROFILE WR-2
SOUTHERN WHITE RIVER VALLEY NEVADA

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FIGURE 4

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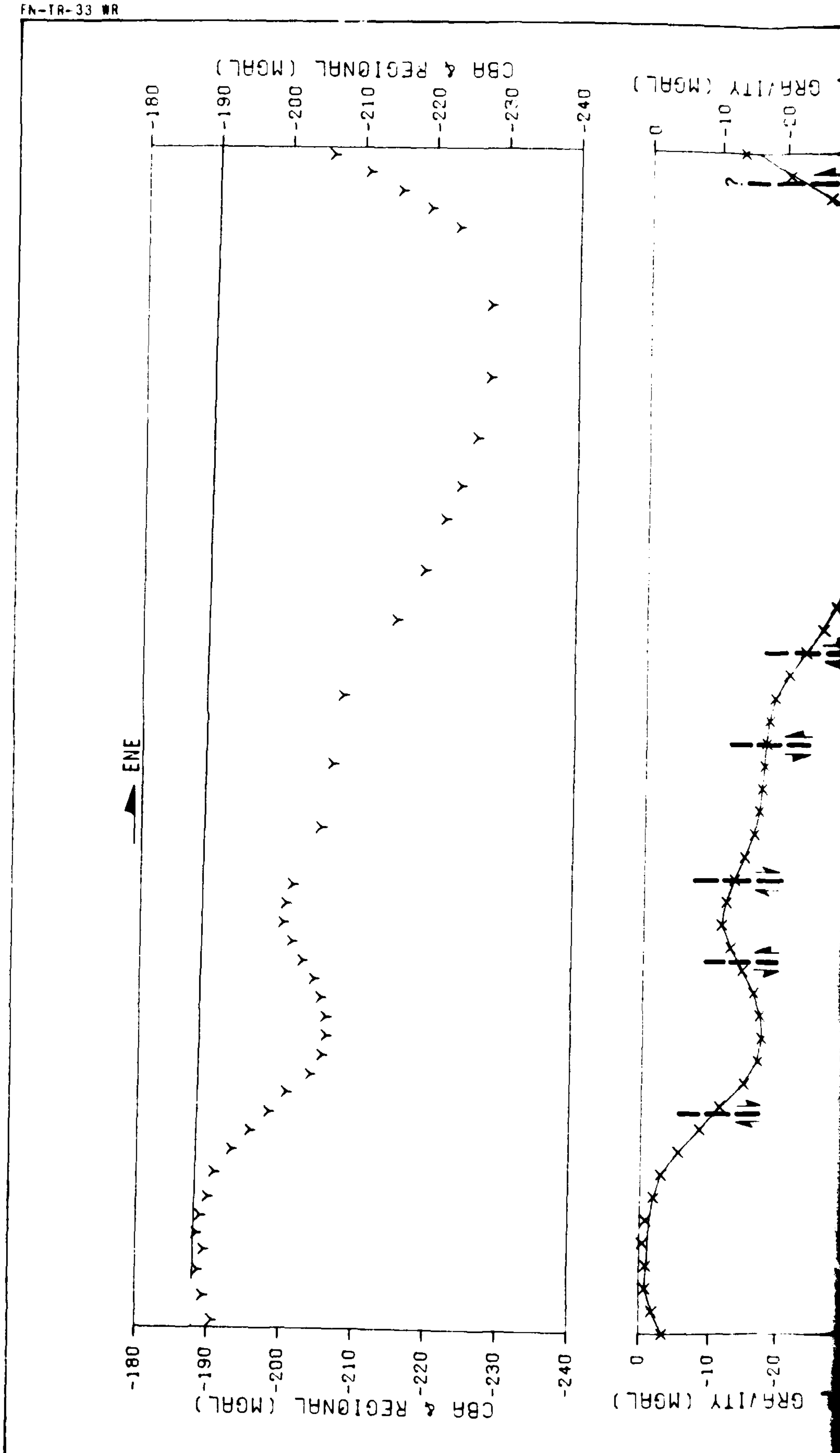
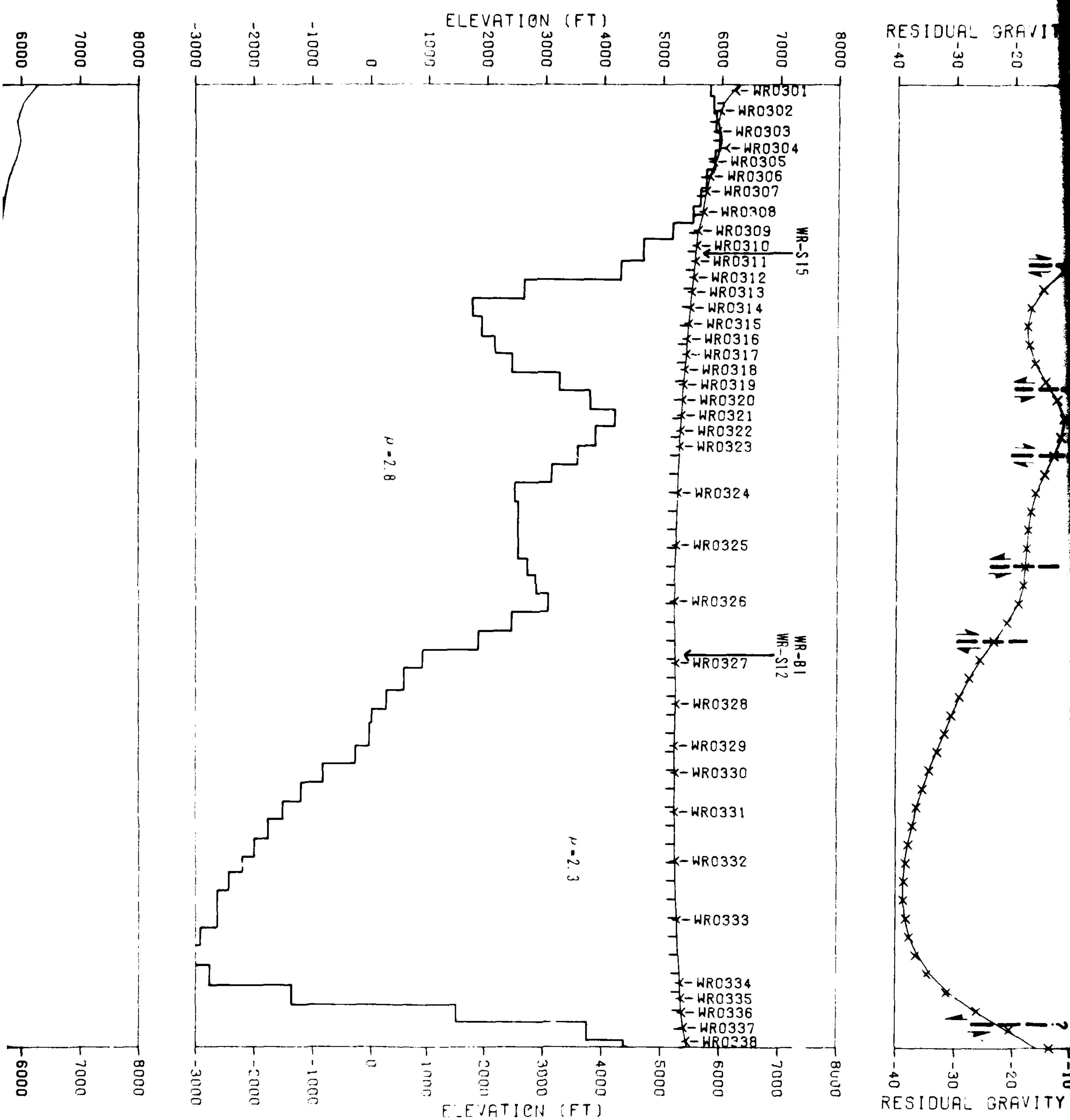

CBA & REGIONAL (MGAL)
-180
-190
-200
-210
-220
-230
-240
GRAVITY (MGAL)
0
-10
-20
ENE
?

2, MAY 80


ELEVATION (FT)
RESIDUAL GRAVITY
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WR0303
WR0304
WR0305
WR0306
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WR0308
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WR0332
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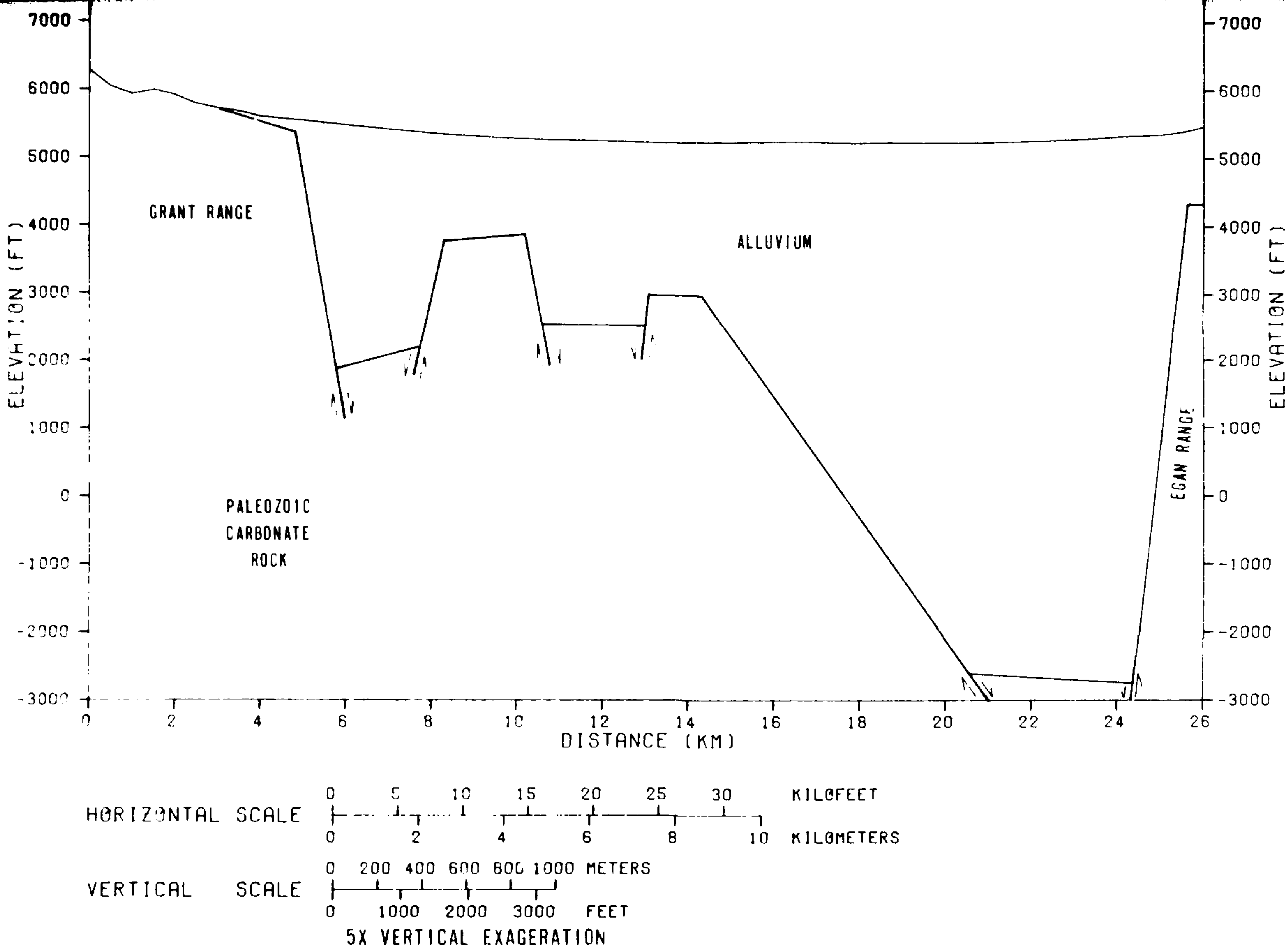
ρ=2.8
ρ=2.3



EXPLANATION

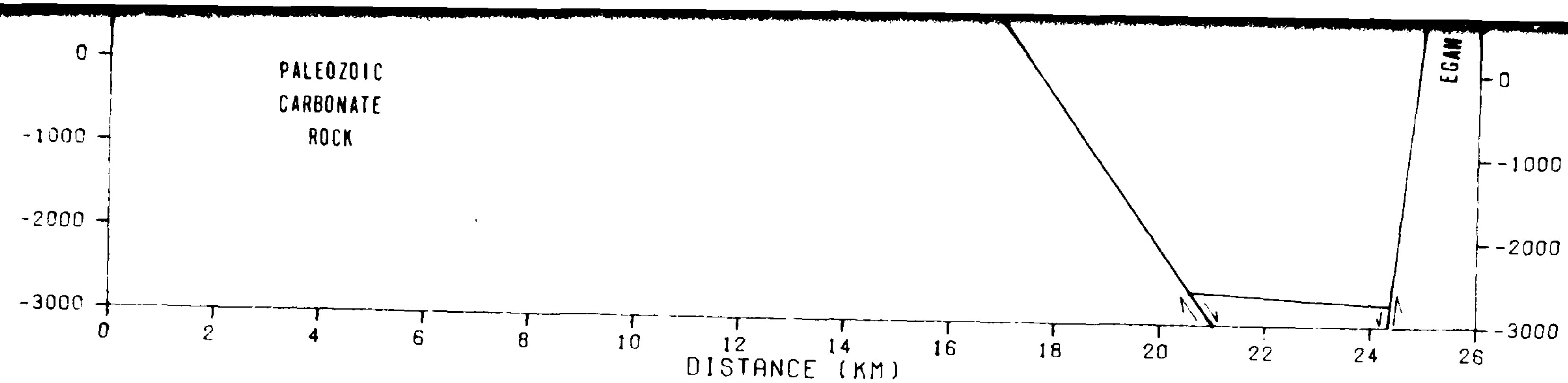
BLOCK 1 CBA & REGIONAL

BLOCK RESIDUAL GRAV OBSERVED VALUES (INTERPOLATED) CALCULATED FROM MODEL

BLOCK ELEVATION STATION ELEVATIONS IDENTIFICATION INTERPOLATED SURFACE ELEVATIONS MODEL OF BEDROCK SURFACE

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE

DENSITY VALUES (ρ=2.3) g cm^3



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VERTICAL SCALE: 0 200 400 600 800 1000 METERS; 0 1000 2000 3000 FEET

5X VERTICAL EXAGERATION

EXPLANATION

BLOCK 1 — CBA (Y) & REGIONAL (———)

BLOCK 2 — RESIDUAL GRAV. OBSERVED VALUES (INTERPOLATED) (X); CALCULATED FROM MODEL (———)

BLOCK 3 — ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION WROTE; INTERPOLATED SURFACE ELEVATIONS; MODEL OF BEDROCK SURFACE

BLOCK 4 — SUGGESTED GEOLOGICAL STRUCTURE

DENSITY VALUES (μ=2 ?) g cm³

DISTANCE SCALE 1:125,000

— — — GRAVITY INTERPRETED FAULT LOCATION

WR-B1 ↓ VERIFICATION ACTIVITY LOCATION

INTERPRETED GRAVITY PROFILE WR-3
SOUTHERN WHITE RIVER VALLEY NEVADA

FIGURE 5

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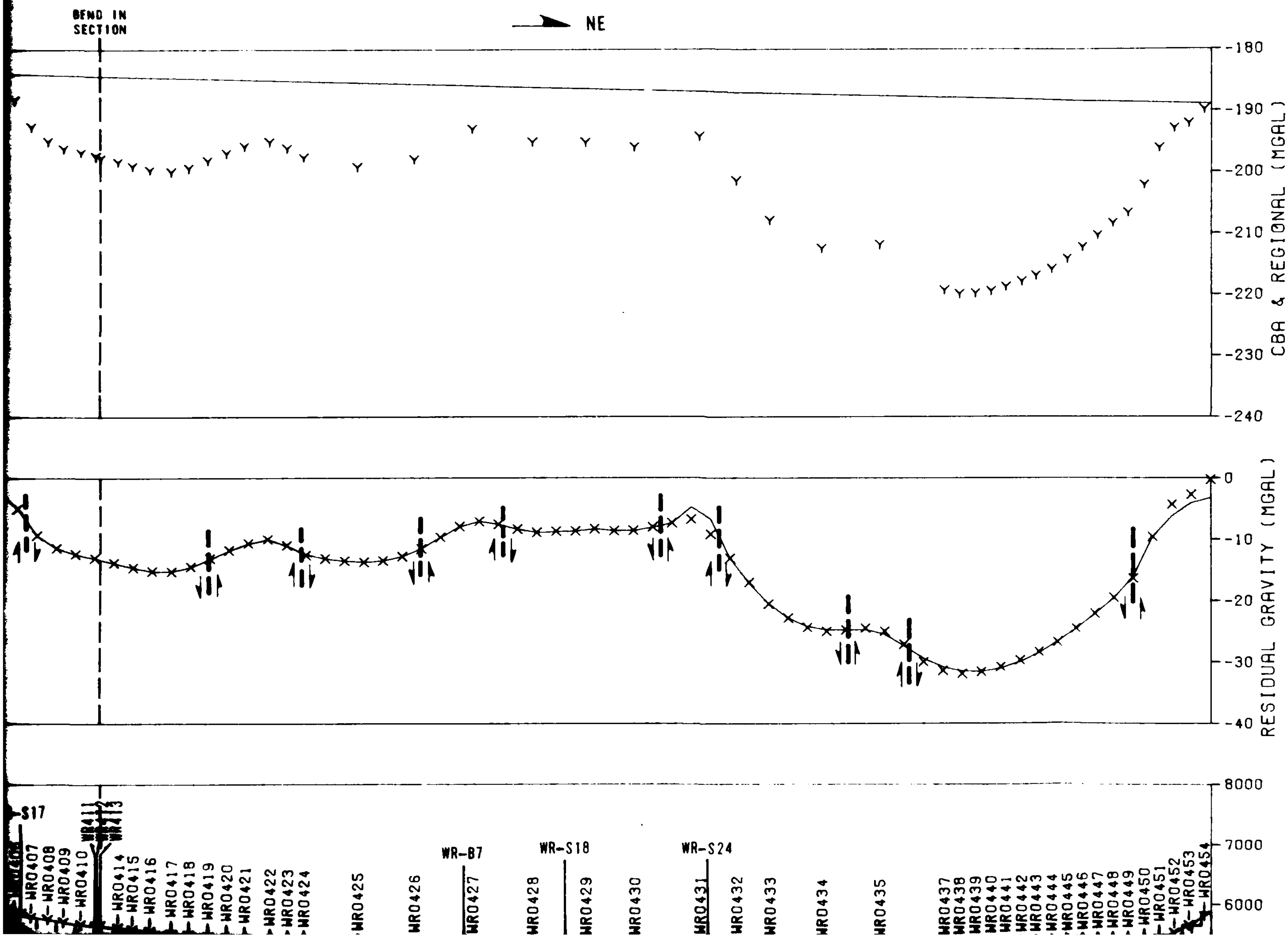
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RESIDUAL GRAVITY (MGAL)
8000
7000
6000
S17
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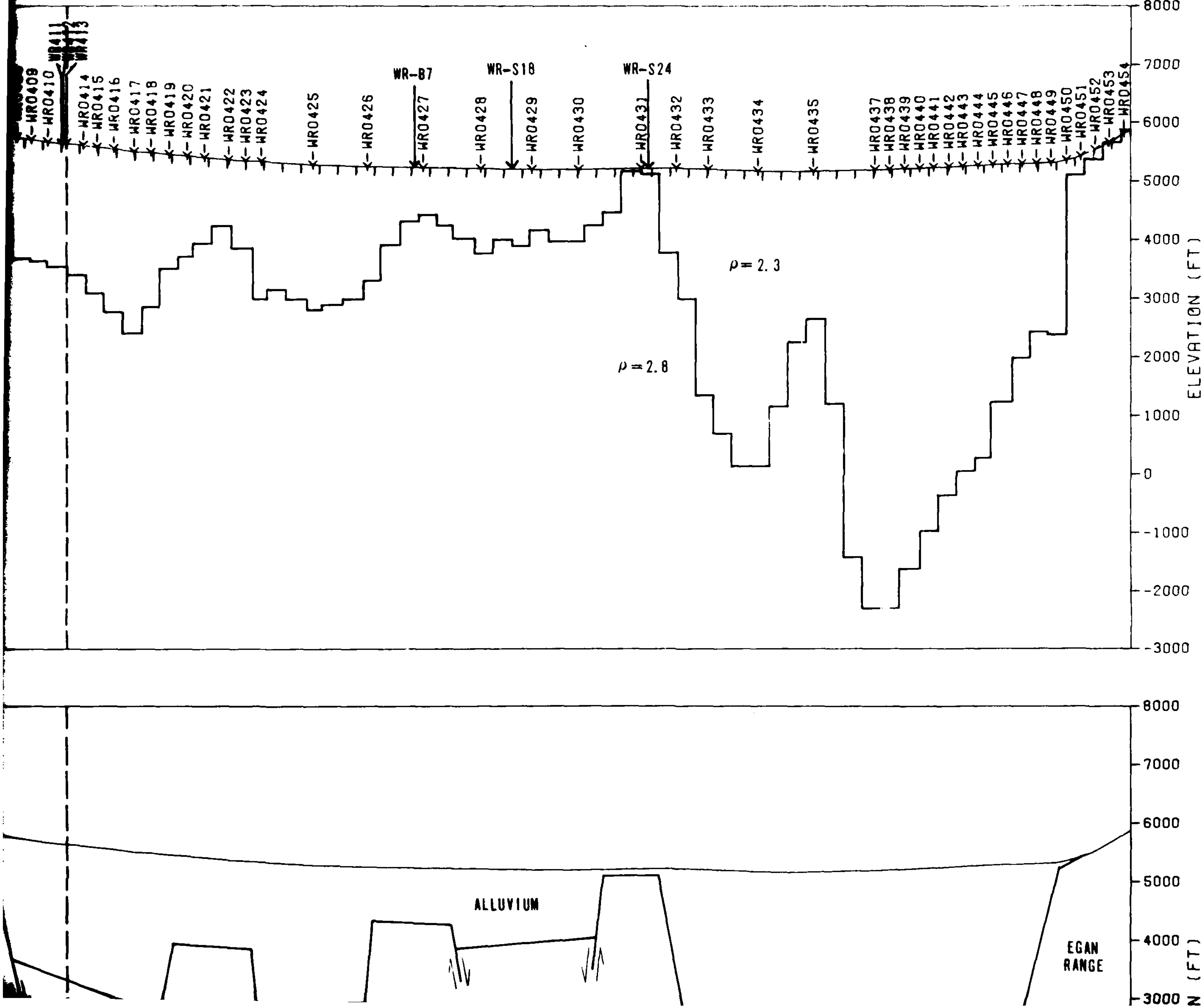
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ELEVATION (FT)
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5000
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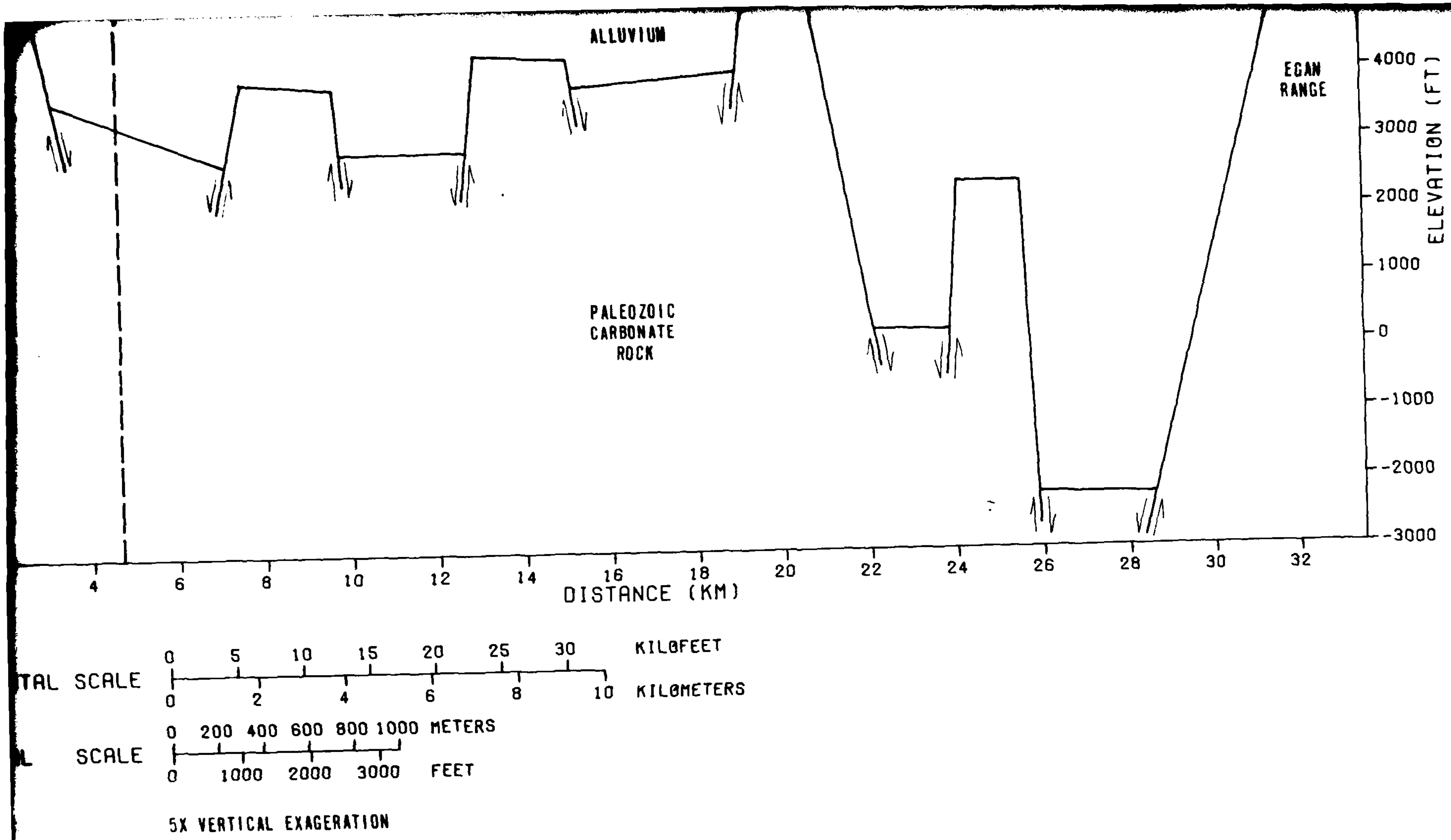
3000
2000
1000
0
-1000
-2000
-3000
ALLUVIUM
EGAN RANGE
N (FT)



EXPLANATION

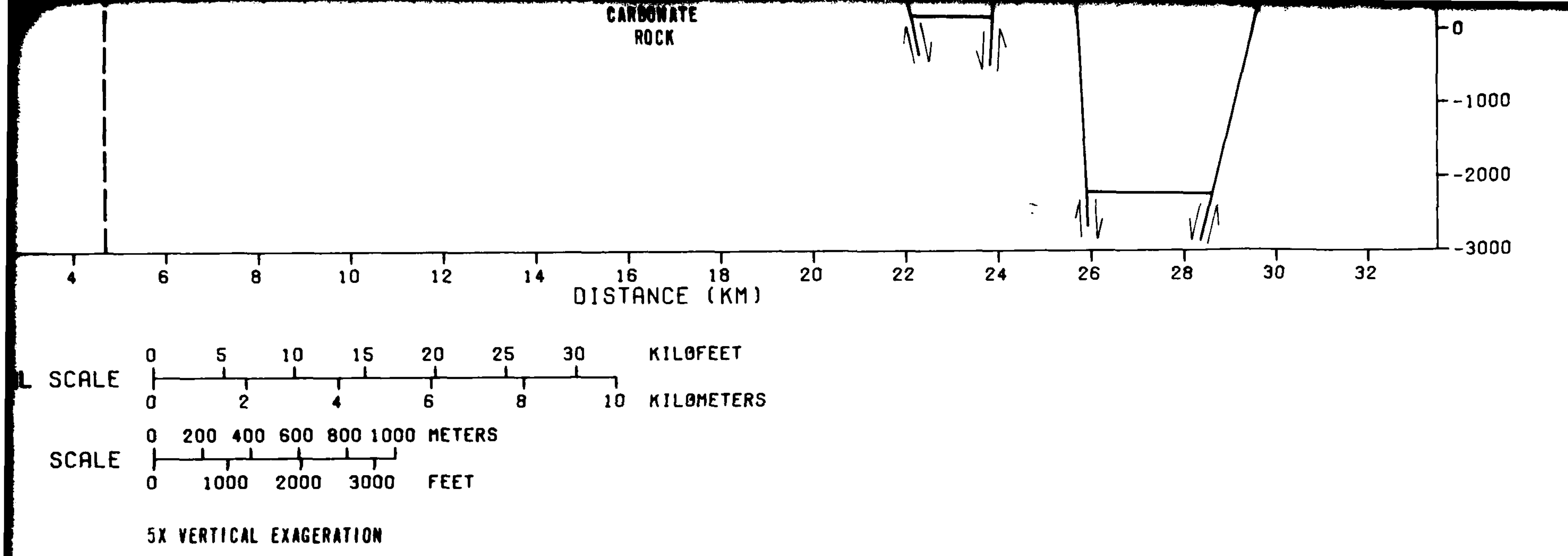
BLOCK 1 CBA (Y) & REGIONAL ( )

BLOCK 2 RESIDUAL GRAV: OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL ( )

BLOCK 3 ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS ( )
MODEL OF BEDROCK SURFACE ( )

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE ( )
DENSITY VALUES (ρ=2.3) g cm^{3}
DISTANCE SCALE 1 125,000

GRAVITY INTERPRETED FAULT LOCATION



EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL ( )

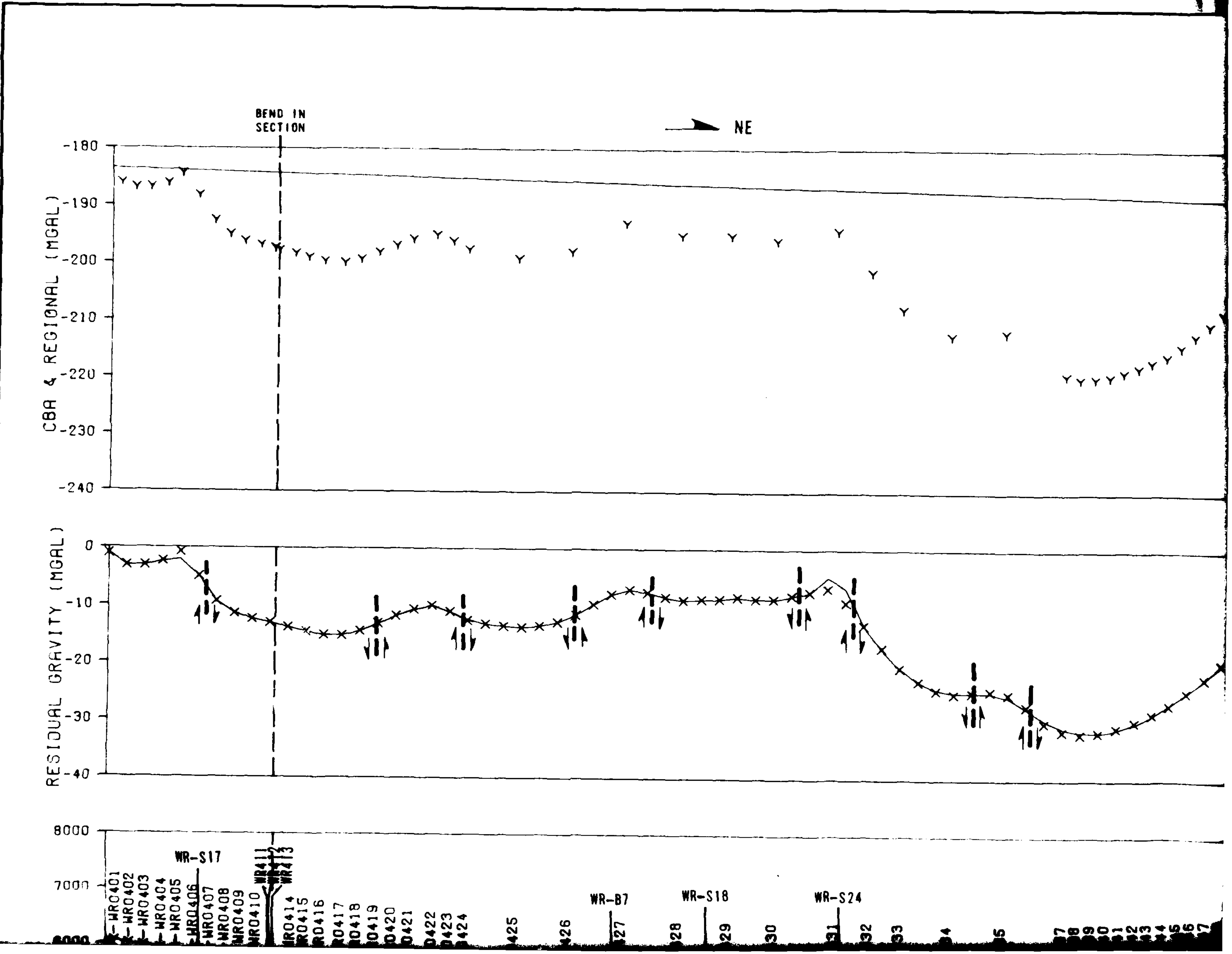
BLOCK 2 RESIDUAL GRAV: OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL ( )

BLOCK 3 ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS ( )
MODEL OF BEDROCK SURFACE ( )

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE ( )
DENSITY VALUES (ρ=2.3) $g \cdot cm^3$
DISTANCE SCALE 1:125,000

— — — GRAVITY INTERPRETED FAULT LOCATION

WR-B1 ↓ VERIFICATION ACTIVITY LOCATION


BEND IN SECTION
NE
CBA & REGIONAL (MGAL)
-180
-190
-200
-210
-220
-230
-240
RESIDUAL GRAVITY (MGAL)
0
-10
-20
-30
-40
8000
7000
WR-S17
WR-B7
WR-S18
WR-S24
WR0401
WR0402
WR0403
WR0404
WR0405
WR0406
WR0407
WR0408
WR0409
WR0410
WR411
WR413

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WR-S17
WR411
WR412
WR413
WR-B7
WR-S18
WR-S24
WR0401
WR0402
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WR0440
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WR0445
WR0446
WR0447
ρ = 2.3
ρ = 2.8
ELEVATION (FT)
8000
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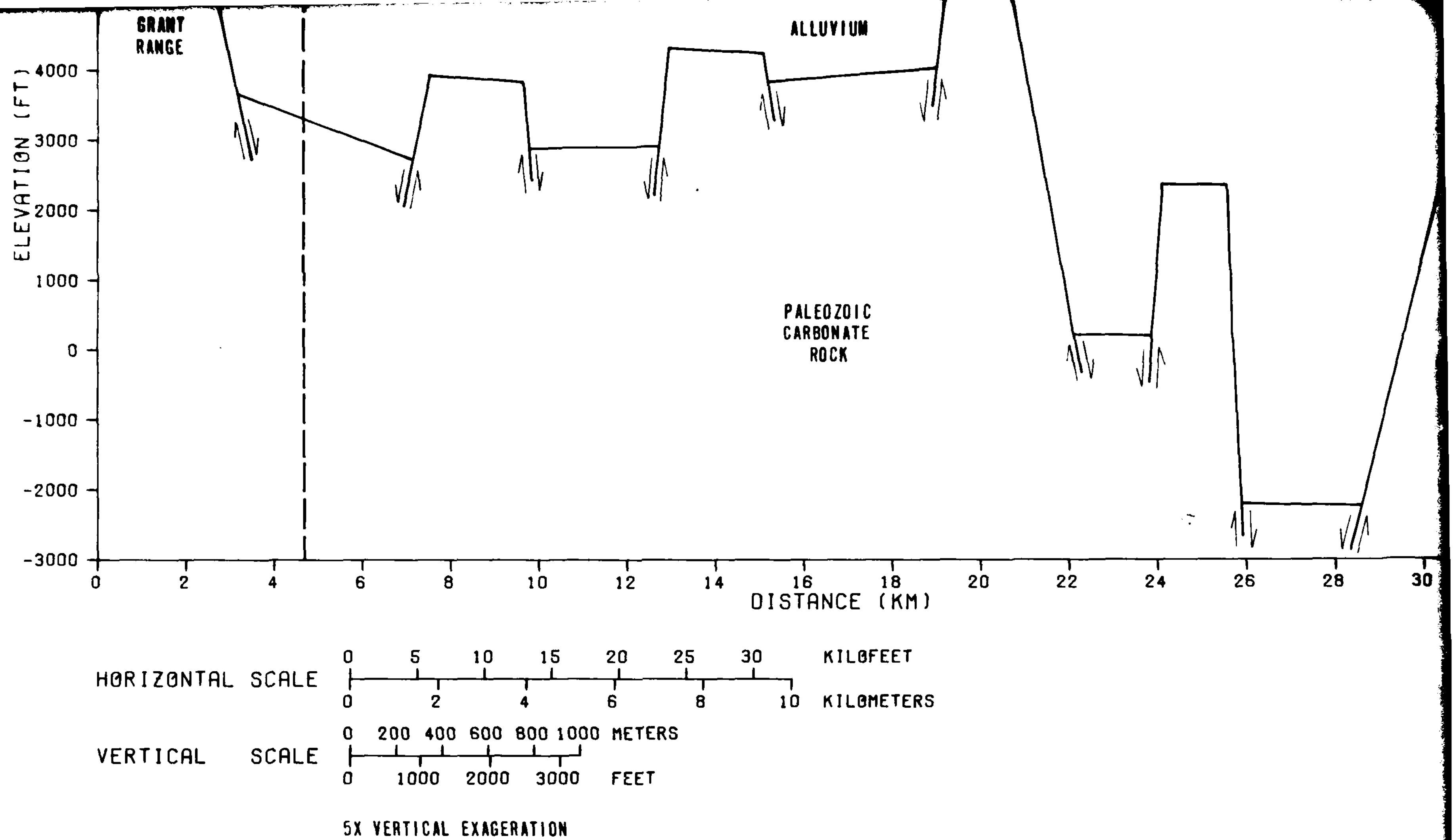
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
GRANT RANGE
ALLUVIUM
TION (FT)

6



EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL (——)

BLOCK 2 RESIDUAL GRAV: OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL (——)

BLOCK 3 ELEVATION STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS (——)
MODEL OF BEDROCK SURFACE (——)

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE (——)
DENSITY VALUES (ρ=2.3) g cm^3
DISTANCE SCALE 1:125,000

— — — GRAVITY INTERPRETED FAULT LOCATION

INTERPRETED G
SOUTHERN WHITE

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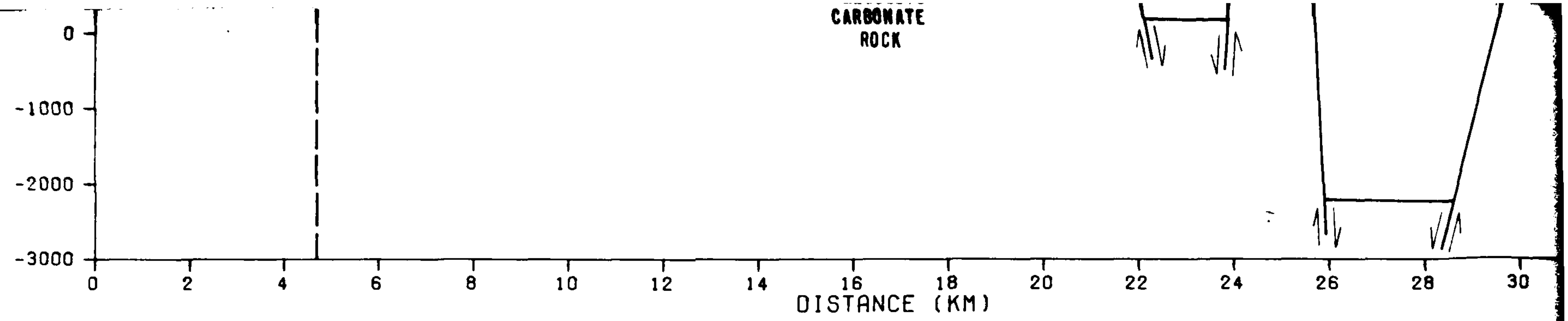
DEPARTMENT OF THE A

FUGRO N



HORIZONTAL SCALE: 0 5 10 15 20 25 30 KILOFEET; 0 2 4 6 8 10 KILOMETERS

VERTICAL SCALE: 0 200 400 600 800 1000 METERS; 0 1000 2000 3000 FEET

5X VERTICAL EXAGERATION

EXPLANATION

BLOCK 1 CBA (Y) & REGIONAL ( )

BLOCK 2 RESIDUAL GRAV: OBSERVED VALUES (INTERPOLATED) (X)
CALCULATED FROM MODEL ( )

BLOCK 3 ELEVATION: STATION ELEVATIONS (Y) & IDENTIFICATION (WR0118)
INTERPOLATED SURFACE ELEVATIONS ( )
MODEL OF BEDROCK SURFACE ( )

BLOCK 4 SUGGESTED GEOLOGICAL STRUCTURE ( )
DENSITY VALUES (ρ=2.3) $g \cdot cm^3$
DISTANCE SCALE 1:125,000

GRAVITY INTERPRETED FAULT LOCATION

WR-B1 VERIFICATION ACTIVITY LOCATION

INTERPRETED GRAVITY PROFILE WR-4
SOUTHERN WHITE RIVER VALLEY, NEVADA

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DEPARTMENT OF THE AIR FORCE BMO

FIGURE 6

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only approximate. Some regional effects may still remain after the subtraction but the error is probably small compared to the large residual anomaly values of these profiles.

The CBA values and the straight line regional field for each profile is shown in the top portion of Figures 3 through 6. The residual gravity anomaly (interpolated at evenly spaced points) is shown by the crosses (x) in the second block of Figures 3 through 6.

4.2 <u>DENSITY SELECTION</u>

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. Average in situ density of the fill material was measured between depths of 100 to 160 feet (30 to 49 m) by five shallow borings in White River Valley. The observed density range for the soil was 1.7 to 2.3 g/cm^3. These borings were drilled during the Verification Studies of White River Valley (FNI, FY 79, FN-TR-27-V). The larger density value was used in the modeling process to approximate the overall alluvium density increase due to compaction with depth (compaction with depth and age is discussed by Woollard, 1962 and Grant and West, 1965).

The basement material underlying the White River basin is believed to be the Paleozoic carbonate rocks which are found in the surrounding mountain ranges. The Tertiary volcanic outcrops along the west side of the valley (Grant Range) are considered to be isolated flow material and not representative of basement material. Published values for carbonate rocks typically range between 2.6 and 2.8 g/cm^3. The Paleozoic carbonate rocks in Nevada 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.

Relative to a given basement density, the calculated basin depth is inversely proportional to the density value assigned to the valley fill materials. A one percent change in the average alluvial fill density will result in a five percent change in the calculated fill thickness.

4.3 *MODELING*

An iterative computer program that calculates the gravitational field for two-dimensional models was used to approximate the thickness of alluvium beneath each profile. The cross-sectional models appear as a set of 0.5-km-wide blocks whose tops are at surface elevation and whose bottoms represent the alluvium-bedrock boundary. The elevations at the bottoms of the blocks were adjusted by iterative computation until the computed gravity anomaly for the valley fill differed by less than one-half milligal from the observed residual anomaly. Several borings and seismic refraction lines are located along the four gravity profiles. These activities were performed during the Verification Studies of White River Valley (FNI, FY 79, FN-TR-27-V) and the results are shown in Table 1. These data were used as constraints in the modeling process.

The computed gravity anomaly from the final model is shown as a continuous line in the second block of Figures 3 through 6. The resulting basin models are shown in the third block of Figures 3 through 6. The cross sections have a five times vertical exaggeration so that gentle slopes appear steep.

The gravity survey of Southern White River Valley indicates a complex structural basin which was formed as a deep graben bounded by steep normal faults. The interpretation shows the basin to be approximately 5600 feet (1707 m) deep in the northern narrow portion of the valley around profiles WR-1 and WR-2. The depth increases to a maximum of 8200 feet (2499 m) beneath the eastern side of profile WR-3 and decreases slightly under profile WR-4.

Steep gravity gradients in this basin and range valley are interpreted as being caused by bedrock faults. See Figure 7 for an interpretation of possible fault relationships between the gravity profiles. Major range bounding faults can be identified with confidence on the eastern end (Egan Range) of profiles WR-1,2,4. There is an indication of the eastern boundary fault on profile WR-3 but the data are incomplete in this area. The gravity interpretation indicates a relative narrow pediment-like feature on the east side of the valley where the Egan Range extends westward from the rock outcrop line at shallow depths for 1.3 to 2.8 miles (2.1 to 4.5 km) before being faulted downward.

SELECTIVE BORING RESULTS		
BORING NUMBER	TOTAL HOLE DEPTH feet (meters)	REMARKS
WR-B1	163 (50)	NO ROCK ENCOUNTERED
WR-B3	162 (49)	NO ROCK ENCOUNTERED
WR-B5	54 (16)	NO ROCK ENCOUNTERED
WR-B7	51 (16)	NO ROCK ENCOUNTERED
WR-ET1	51 (16)	NO ROCK ENCOUNTERED

SELECTIVE SEISMIC REFRACTION RESULTS				
LINE NUMBER	DEEPEST LAYER fps (mps)	@	feet (meters)	EXCLUSION DEPTH* feet (meters)
WR-S4	3350 (1021)	@	10 (3)	146 (45)
WR-S5	8150 (2484)	@	44 (13)	—
WR-S12	5050 (1539)	@	30 (9)	117 (36)
WR-S14	9900 (3018)	@	140 (43)	—
WR-S15	4950 (1509)	@	23 (7)	116 (35)
WR-S17	6350 (1935)	@	37 (11)	90 (27)
WR-S18	5050 (1539)	@	24 (7)	121 (37)
WR-S24	9700 (2957)	@	6 (2)	—

*APPROXIMATE DEPTH ABOVE WHICH THERE IS NO INDICATION OF MATERIAL WITH A VELOCITY AS GREAT AS 7000 fps (2134 mps). SEE THE APPENDIX OF THE VERIFICATION REPORT (FUGRO NATIONAL, INC., FN-TR-27-IA,B) FOR AN EXPLANATION OF HOW THIS EXCLUSION DEPTH IS CALCULATED WHEN OBSERVED VELOCITIES ARE ALL LESS THAN 7000 fps (2134 mps).

WHITE RIVER VALLEY
VERIFICATION ACTIVITY RESULTS

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TABLE 1

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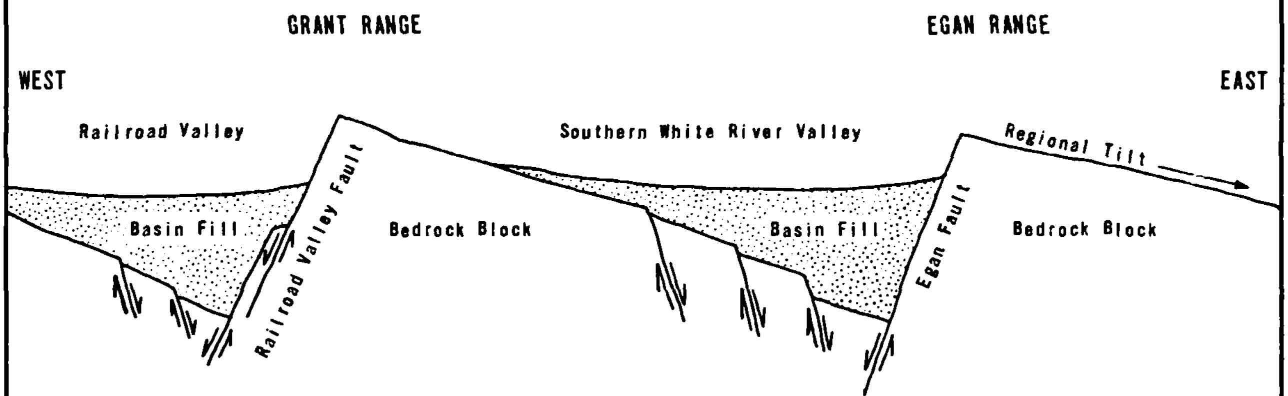

SIMPLIFIED CONCEPTUAL MODEL OF SOUTHERN WHITE RIVER VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 8

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The range bounding faults in the northwest section of the valley near the Horse Range can be easily recognized on profiles WR-1 and WR-2 about 6.5 miles (11 km) east of the outcrop line. A shallow pediment shelf between 100 and 300 feet (30 to 91 m) deep extends from the base of the Horse Range to the boundary fault. A soil density of 2.1 g/cm^3, measured at a nearby boring, was used in modeling the pediment depth. No density increase due to soil compaction with depth was added to this value since the bedrock is very shallow throughout this region. The range bounding faults are not as easily identified along the Grant Range in the southwest portion of the basin because the basement topography in this region is complex. The interpreted boundary fault is located about 9 miles (14 km) east (basinward) of the rock outcrop line forming a much broader pediment than on the eastern side of the valley. Two separate horst structures are interpreted to cross the western end of profiles WR-3 and WR-4. The basin depth in this portion of the valley ranges between 1300 and 3600 feet (396 to 1097 m) and the horsts are located about 800 feet (244 m) below the surface.

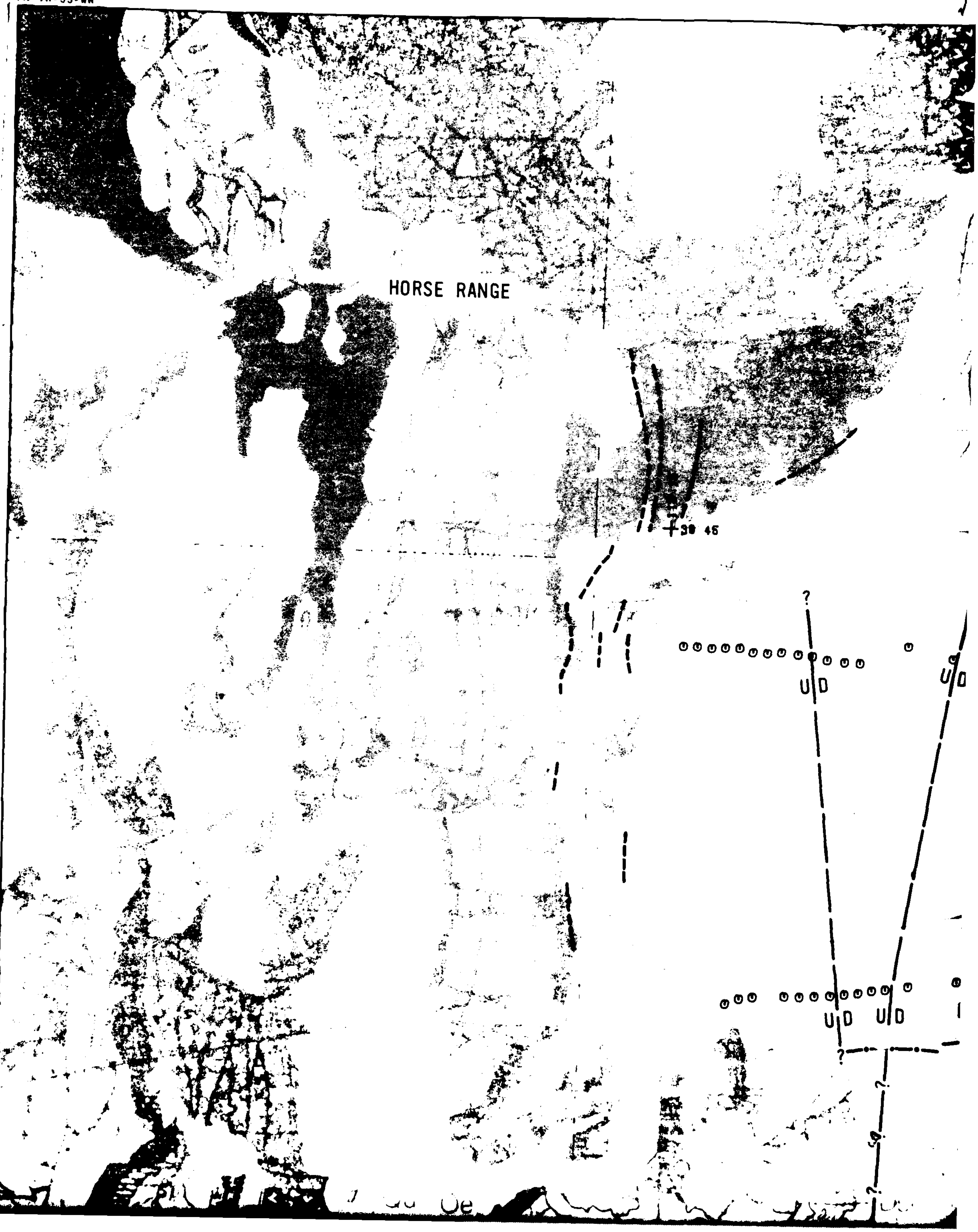
There are several short faults throughout the valley, such as the one on the west end of profile WR-1. This fault, like many others, represents a steep step of several hundred feet (tens of meters) in the bedrock depth. A horst formation traversing N-S through the center of the valley is interpreted from the gravity data on profiles WR-2,3,4. This narrow bedrock ridge outcrops at the center of profile WR-4 and about 1.5 miles (2.4 km) south of profile WR-3. The horst ranges in depth from 2100 feet (640 m) at profile WR-3 to 660 feet (201 m) at WR-2.

4.4 DISCUSSION OF RESULTS

Although the major, basin bounding fault systems trend north-south, forming a large, deep central graben, there appears to be numerous smaller faults in the subsurface below the alluvium. These smaller faults appear to bound smaller bedrock blocks and form a sometimes complex network of horsts and grabens.

The general picture of the White River Valley area is that of an assymetric, tilt-block, normal-fault system which is quite typical of the Basin and Range area (Figure 8). The gravity data indicates this simplified model is complicated by differential movements between the smaller blocks underlying the basin fill. These differential movements have resulted in subsurface horsts as well as smaller, local grabens and perhaps some transverse faults bounding the smaller fault blocks. The complexity of the subsurface faulting is illustrated by the block-model interpretation of the gravity profiles shown in the lowest section of Figures 3 through 6. Detailed interpretation may not be warranted from data so widely spaced, therefore a simplified version of the faulting is shown. The faults shown on the residual gravity profile (second block of Figures 3 through 6) should be considered as fault systems rather than specific faults or fault splays.

Even though the major fault trends are in a north-south direction there are several anomalous areas which indicate transverse


HORSE RANGE
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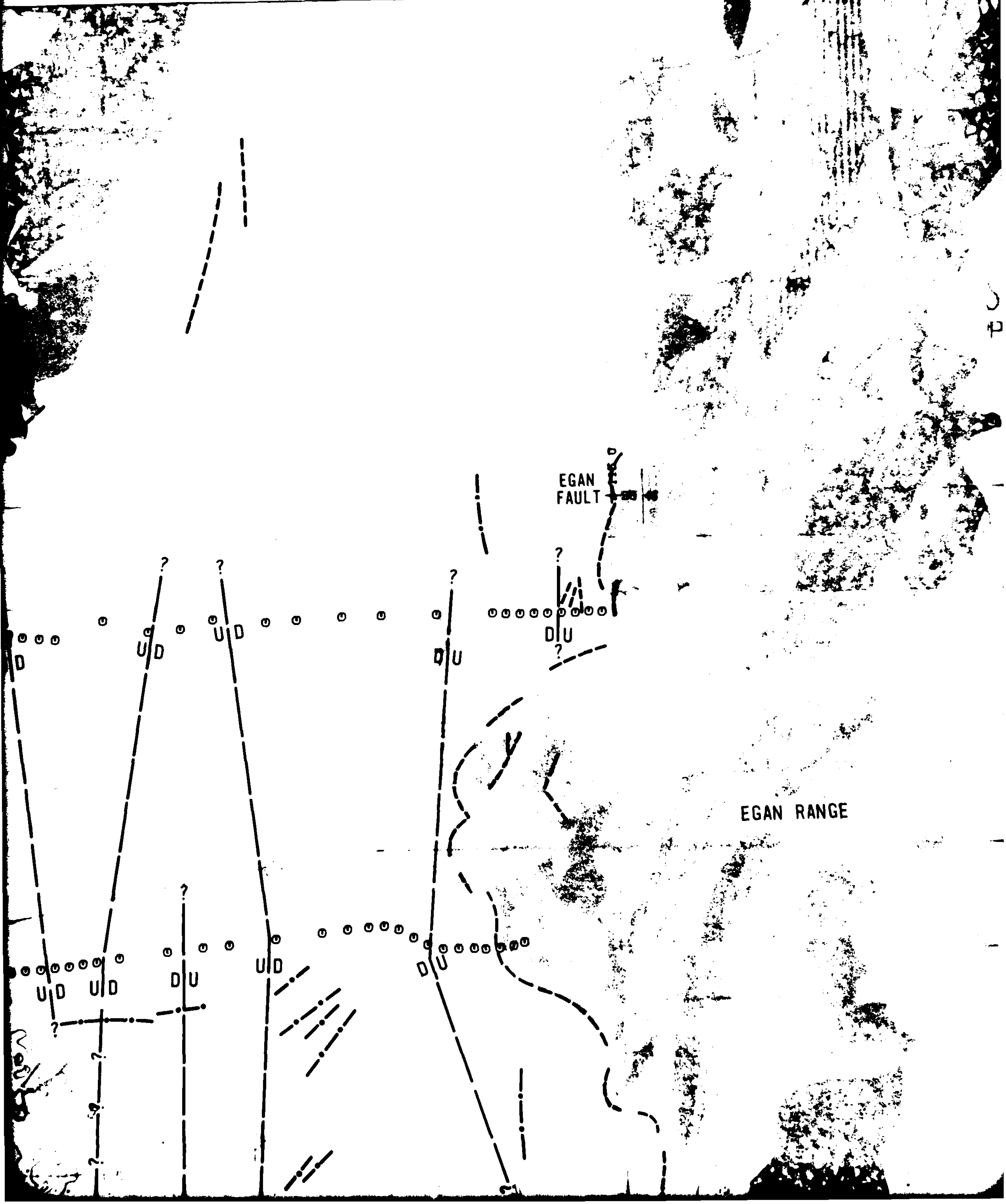
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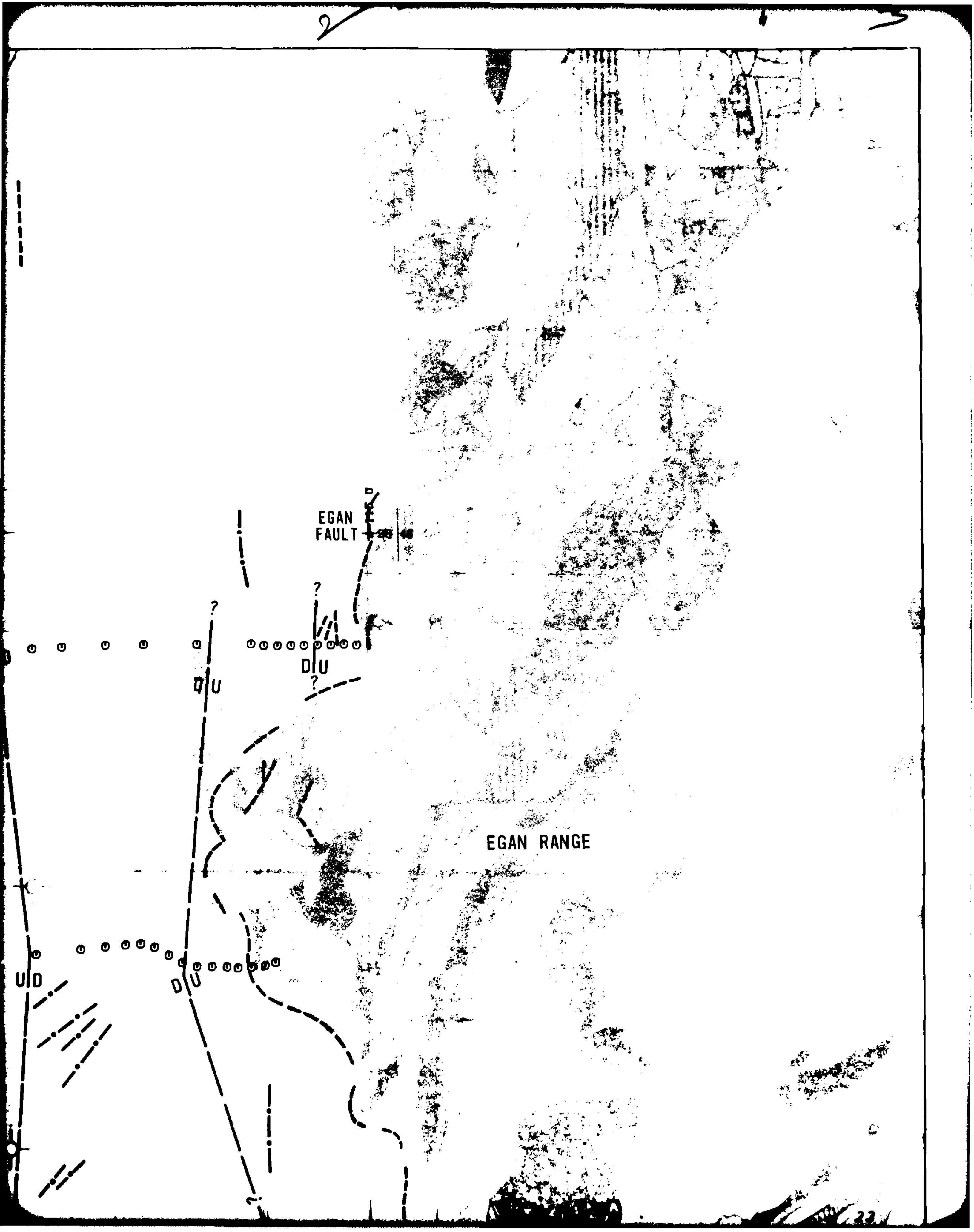
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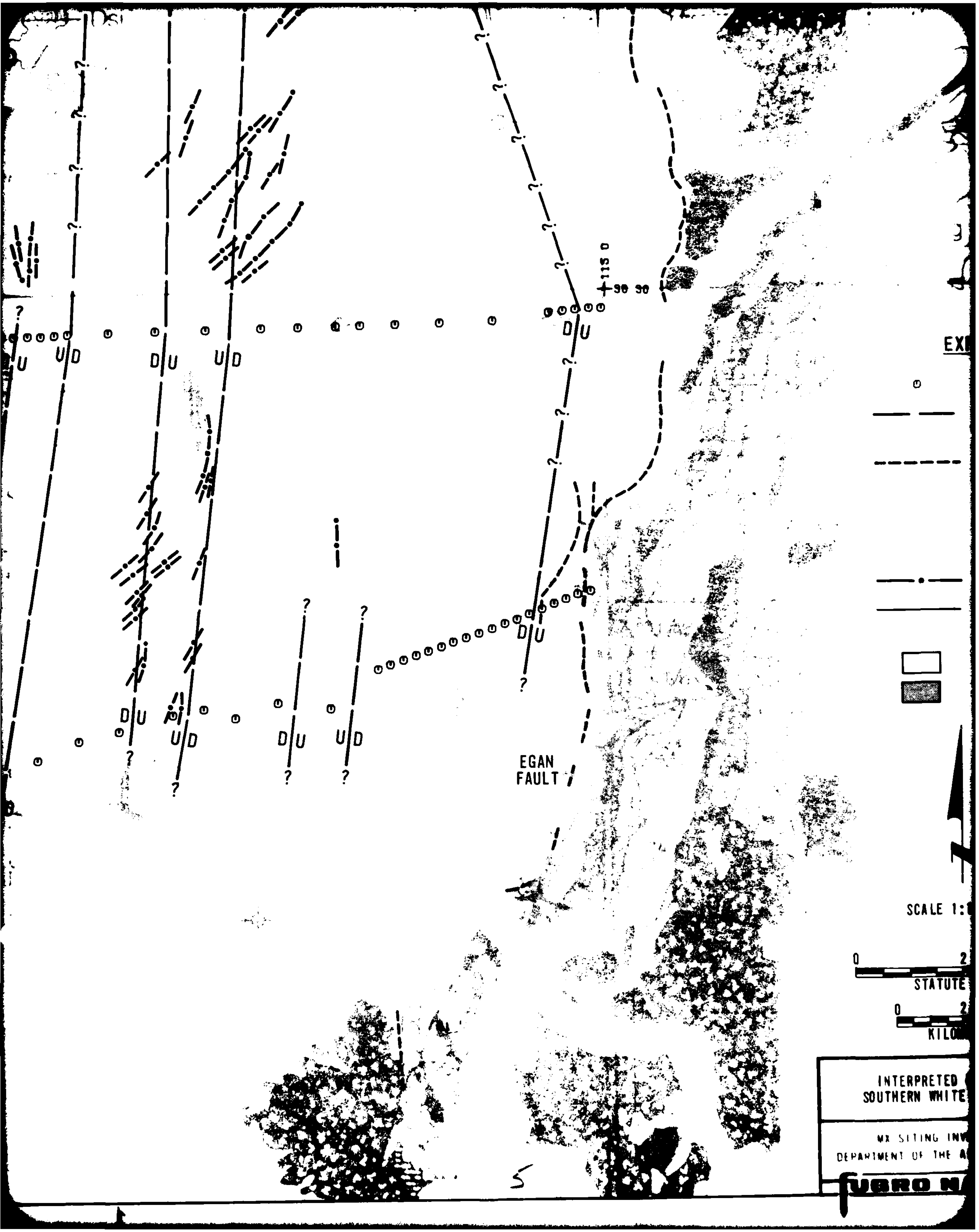

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INTERPRETED
SOUTHERN WHITE
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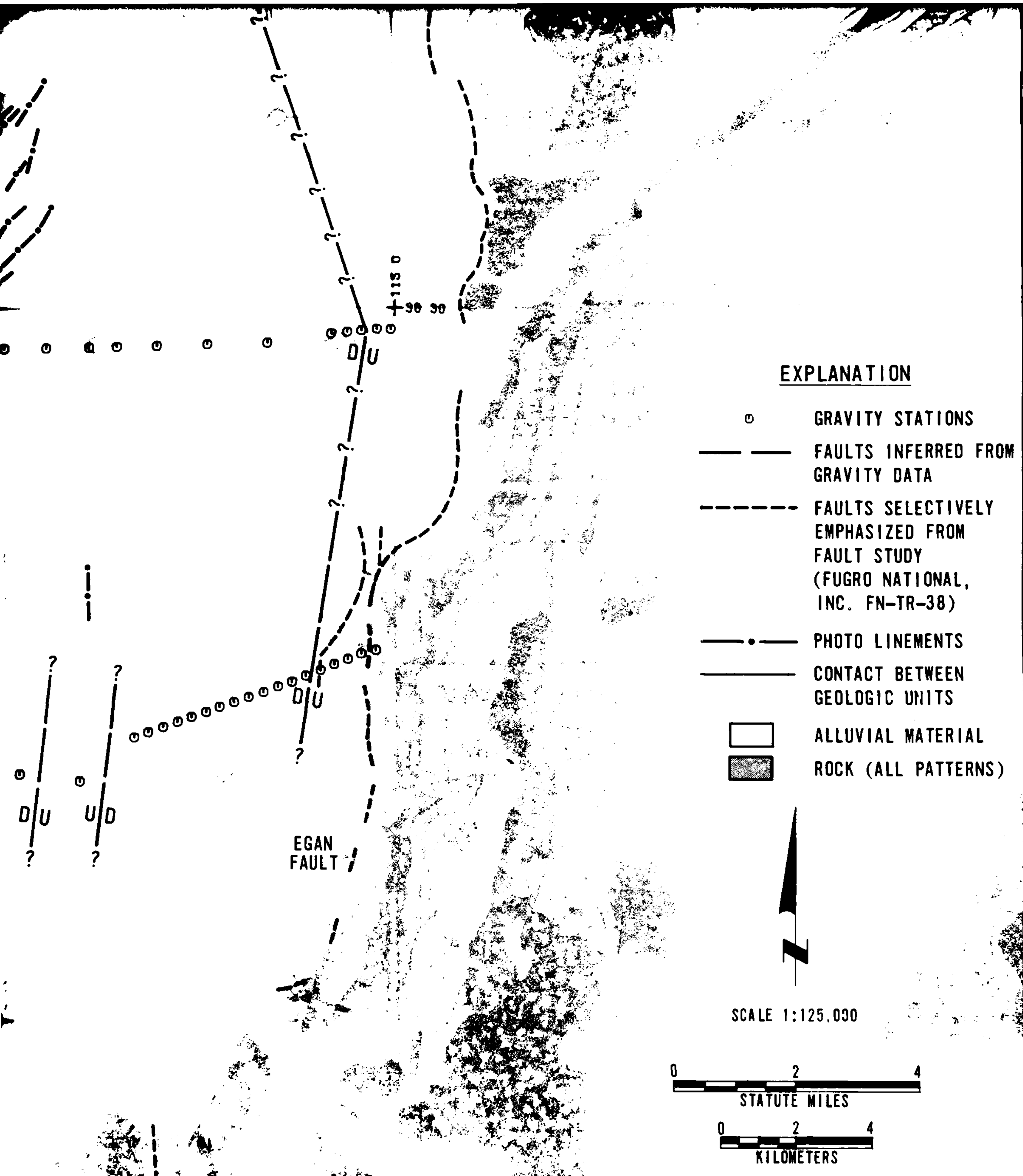

INTERPRETED FAULT RELATIONSHIPS
SOUTHERN WHITE RIVER VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

FIGURE 7

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trends. The major bounding fault on the east side of the valley (Egan fault) appears to shift position westward between profiles WR-4 and WR-3 (Figure 7). This shift is also reflected in the bedrock-alluvium contact. Whether this deflection in position is due to lateral faulting or merely a result of left-stepping en echelon faulting cannot be determined by the resolution of this gravity survey. However, geologic field reconnaissance (FNI, FY 80, FN-TR-38) has shown that surface faulting along the trace of the Egan fault has a left-stepping en echelon pattern in this area.

Aerial photograph analysis revealed several lineaments in the lake deposits of the central valley region. These lineaments are quite obvious on the aerial photographs but generally could not be found during the field reconnaissance because they do not have significant relief. These features coincide quite closely with the subsurface bounding fault systems which suggests that there may be deep seated movement on some of the subsurface faults resulting in only slight surface effects. Such an interpretation, however, should be regarded as speculative until trenching can verify a tectonic origin for these lineaments.

5.0 CONCLUSIONS

The interpretation of the gravity survey in Southern White River Valley indicates there are major range bounding normal fault systems on both sides of the valley. The major system on the east is the Egan Fault and is generally close to the mountain block. The western fault system is several miles east of the mountain front. The primary graben block between these boundary faults is oriented N-S and lies on the eastern side of the valley. It is calculated to be between 5600 feet (1707 m) deep in the north end of the valley and 8200 feet (2499 m) deep near the valley center.

Several smaller localized structures complicate the subsurface configuration in White River Valley. A narrow bedrock ridge or horst lies near the center of the valley and trends in a N-S direction. Several smaller horst-graben combinations can be identified along the western portion of the valley.

There is a large well defined negative gravity anomaly associated with Southern White River Valley. 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. The calculated bedrock depth can only be an approximation since little is known about the actual density distribution in and around the valley. Future studies that acquire better density data or depth to bedrock in deep parts of the valley can be used to refine the gravity interpretation.

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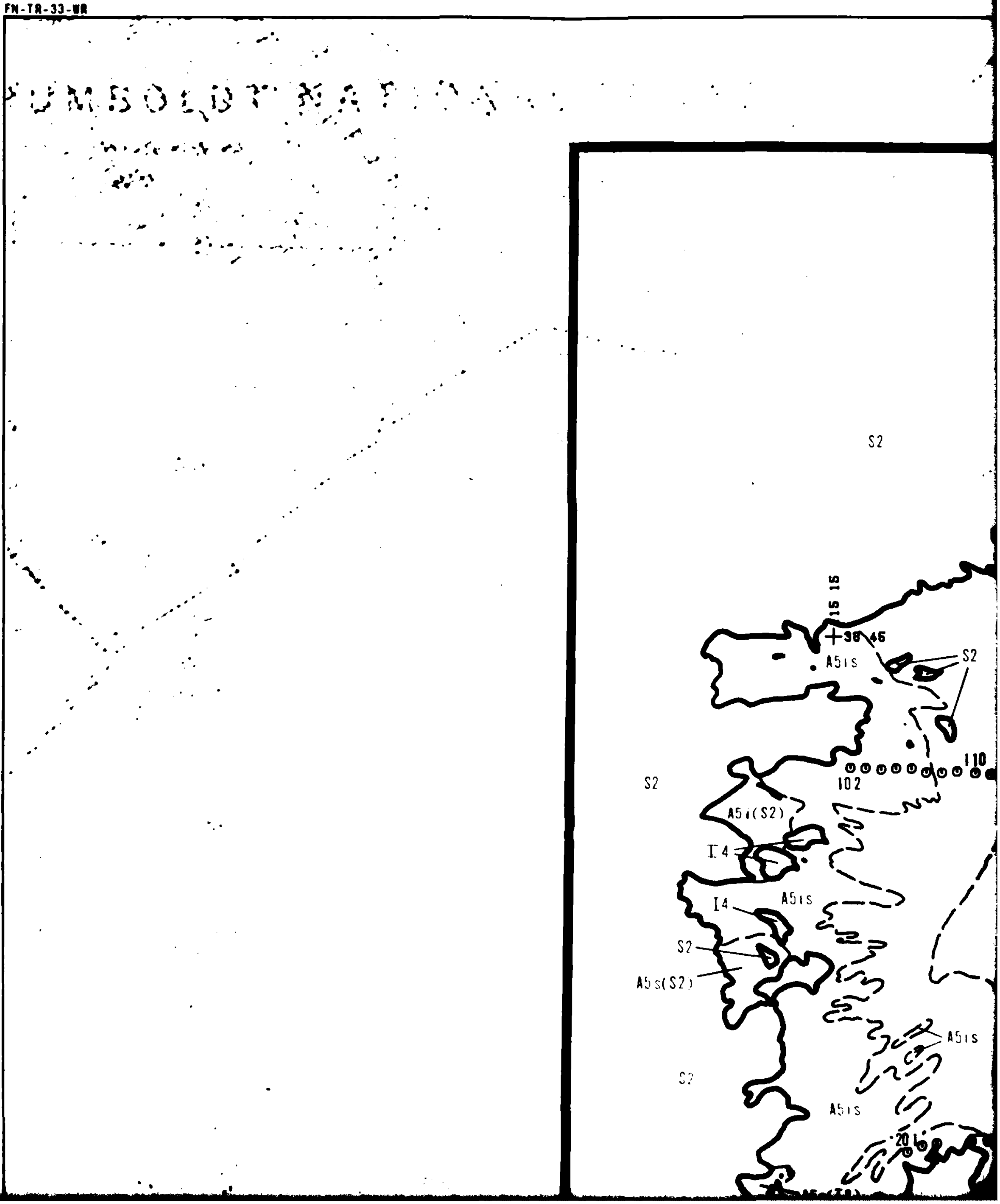
S2
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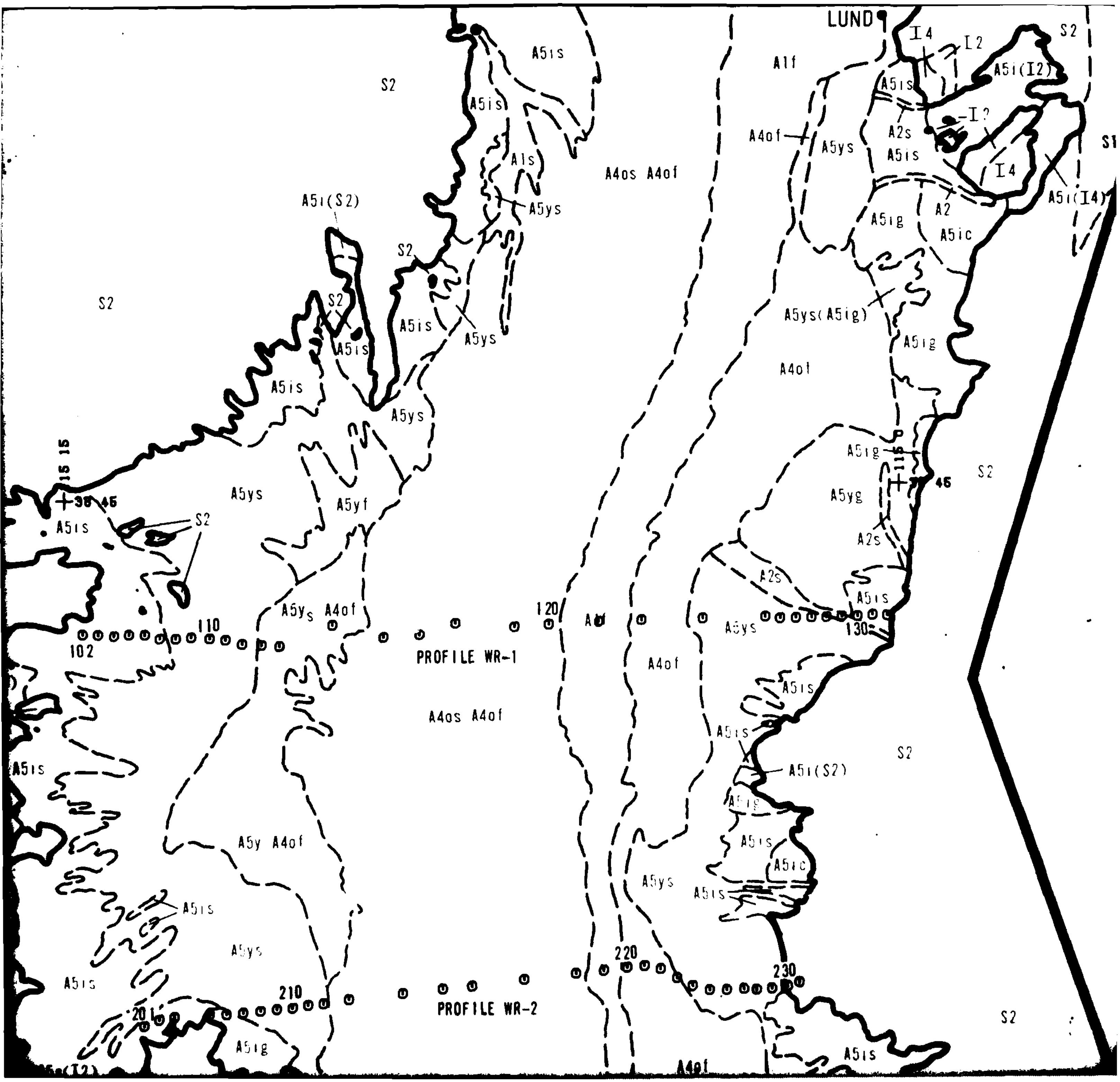
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PROFILE WR-1
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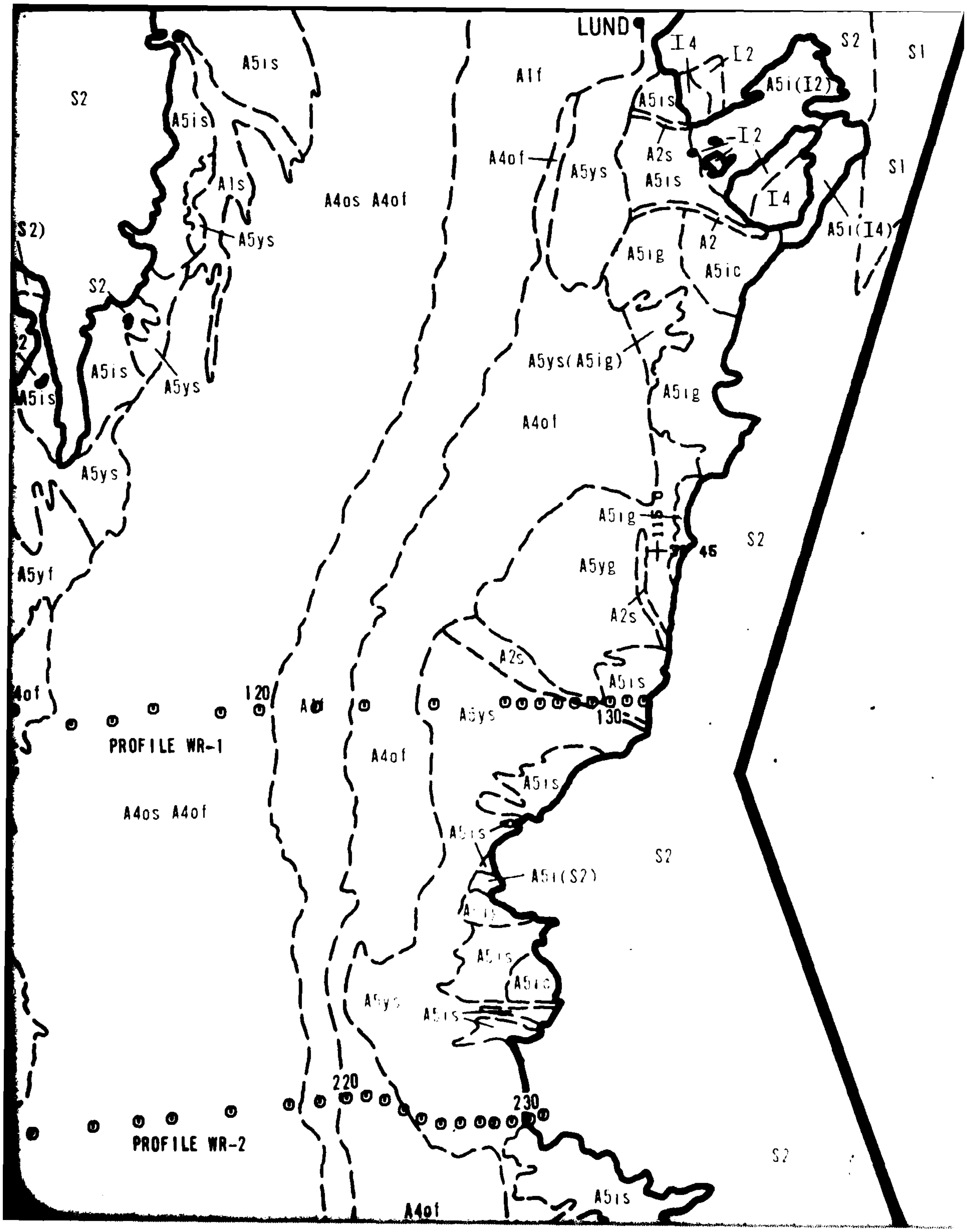
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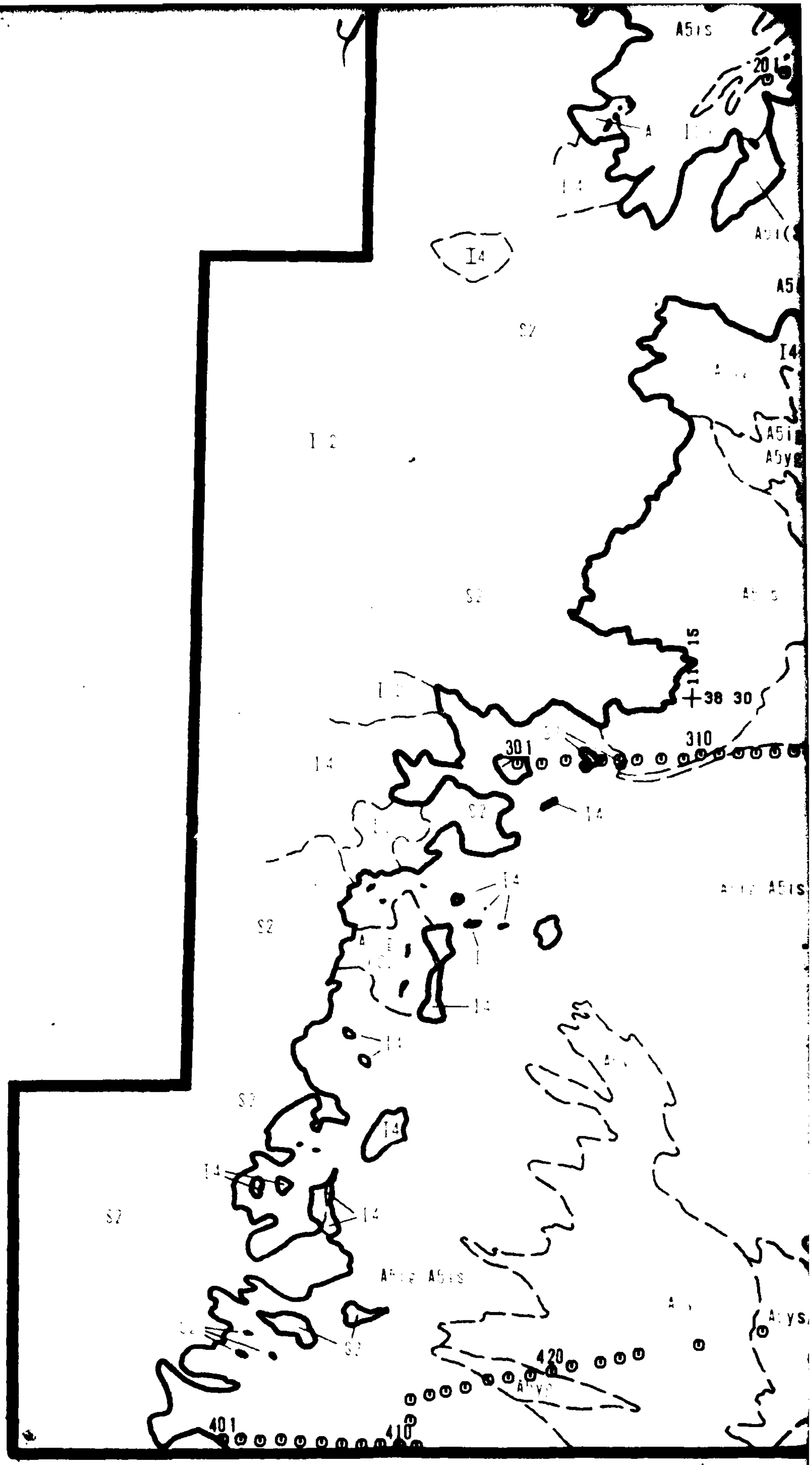

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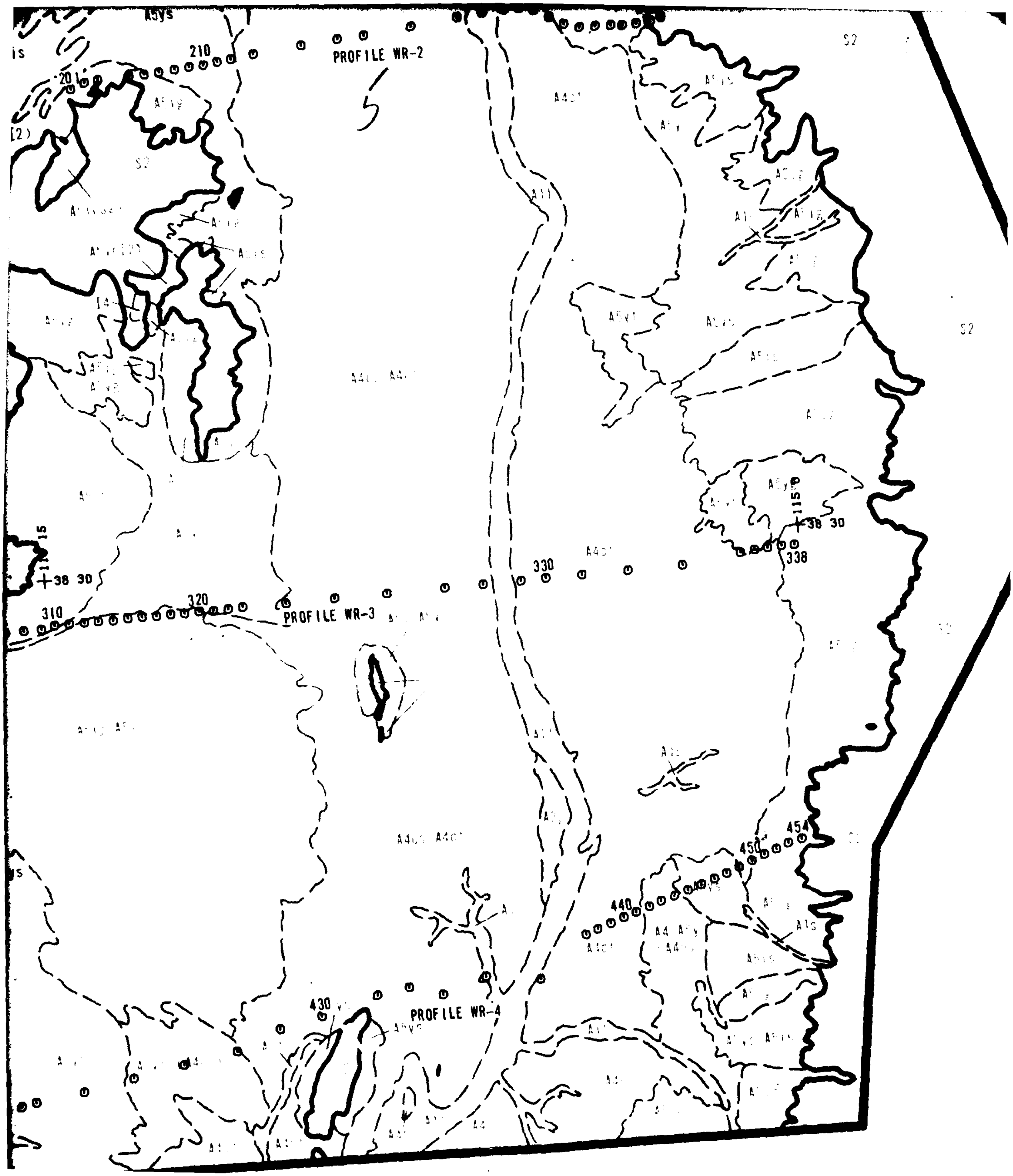

A5ys
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320
PROFILE WR-3
330
338
115
+38 30
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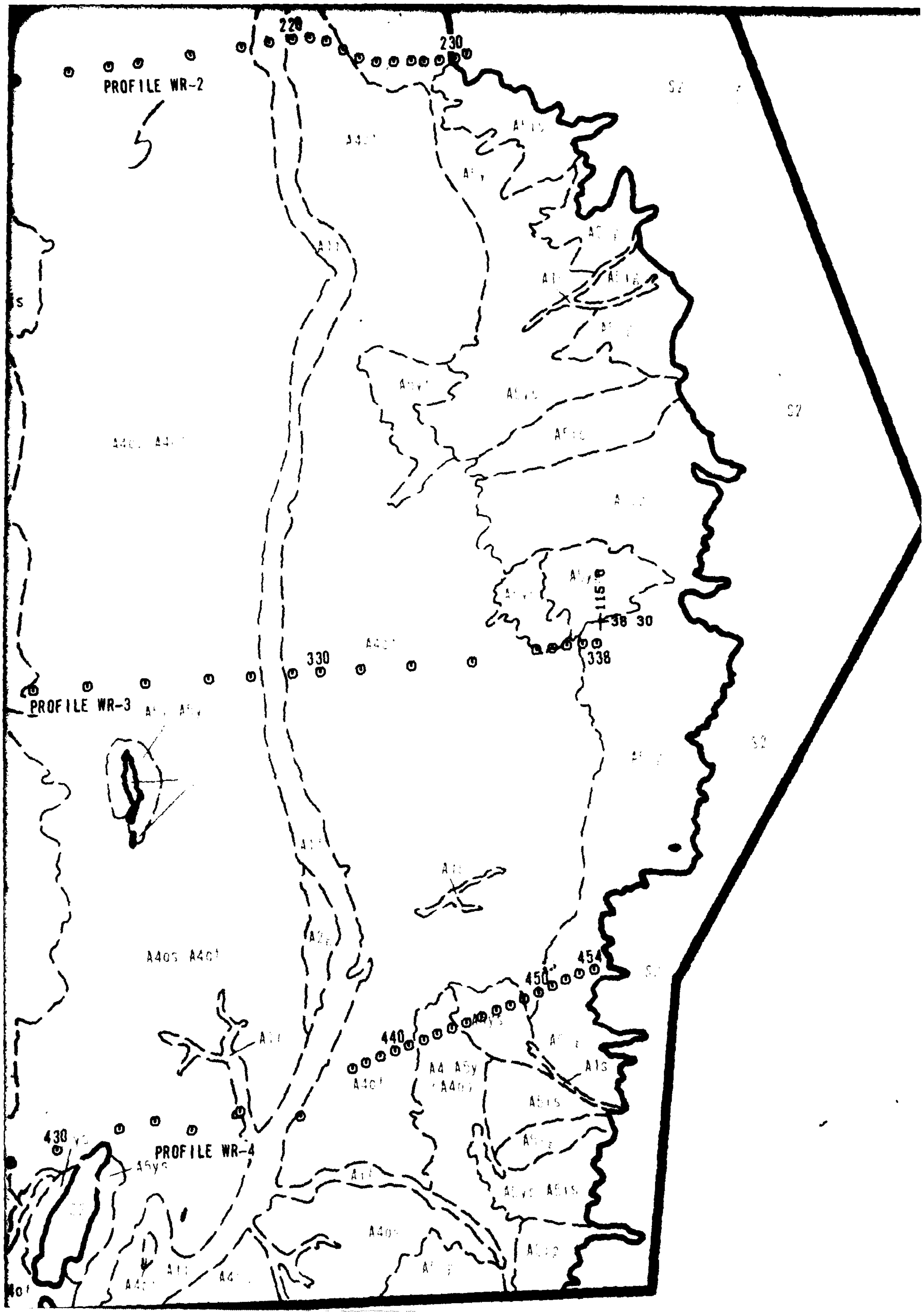
450
454
430
PROFILE WR-4
A4



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440
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PROFILE WR-4
A4os A4ot

7

EXPLANATION

SURFICIAL BASIN-FILL UN

A1f / A1s — Younger Fluvial Deposits - Modern stream channel and fl and sandy silt (CL,ML), and A1s, silty sand and gravell

A2s / A2g — Older Fluvial Deposits - Older stream channel and flood of; A2s, silty sand and gravelly sand (SM,SP); and A2g,

A4of / A4os — Older Lacustrine Deposits - Older bed lake and abandone A4of, sandy silt and sandy clay (CL,ML); and A4os, weak

A5yf / A5ys / A5ig — Younger Alluvial Fan Deposits-Active, younger alluvial A5ys, silty sand and gravelly sand (SM); and A5yg, sandy

A5is / A5ig / A5ic — Intermediate Alluvial Fan Deposits - Inactive, intermedi cemented silty sand and gravelly sand (SM); A5ig, weakly cemented gravelly sand with greater than 30 percent cobb

ROCK UNITS

Igneous (I)

I2 — Rhyolite, quartz latite, rhyodacite, and andesite flows a

I4 — Welded ash-flow tuff

Sedimentary (S)

S1 — Orthoquartzite

S2 — Dolomite and limestone locally cherty, with interbedded

A5ig A5is Combination of geologic unit symbols indicates a mixture or rock units inseparable at map scale.

A5i (I2) Parenthetic unit underlies surface unit at shallow depth

SYMBOLS

Contact between rock and basin-fill.

Contact between surficial basin-fill or rock units.

Fault, trace of surface rupture of faults offsetting su ball on downthrown side

NATION

SIN-FILL UNITS

channel and flood-plain deposits of A1f. sandy clay
nd and gravelly sand (SM, SP).

nel and flood-plain deposits in terraces composed
,SP); and A2g, sandy gravel (GP).

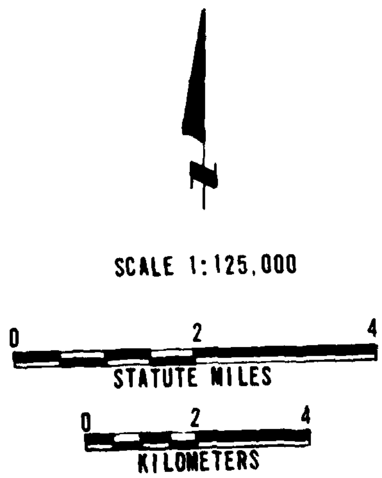
and abandoned shoreline deposits of
and A4os, weakly cemented silty sand (SM)

nger alluvial fan deposits of: A5yf, sandy silt (ML);
and A5yg, sandy gravel (GM, GP).

tive, intermediate-age alluvial fan deposits of: A5is, weakly
); A5ig, weakly cemented sandy gravel (GP, GM); A5ic, weakly
30 percent cobbles

K UNITS

andesite flows and plugs



ith interbedded shale

dicates a mixture of either surficial basin-fill

at shallow depth.

YMBOLS

rock units.

8

9

s of A1f. sandy clay

in terraces composed
).

sits of
sand (SM)

A5yf, sandy silt (ML);

fan deposits of: A5is, weakly
gravel (GP,GM); A5ic, weakly

SCALE 1:125,000

0 2 4
STATUTE MILES

0 2 4
KILOMETERS

rficial basin-fill

A4of Older Lacustrine Deposits - Older bed lake and
A4os A4of, sandy silt and sandy clay (CL,ML); and A4os, weakly c

A5yf
A5ys Younger Alluvial Fan Deposits-Active, younger alluvial fan d
A5ig A5ys, silty sand and gravelly sand (SM); and A5yg, sandy gra

A5is Intermediate Alluvial Fan Deposits - Inactive, intermediate-
A5ig cemented silty sand and gravelly sand (SM); A5ig, weakly ce
A5ic cemented gravelly sand with greater than 30 percent cobbles

ROCK UNITS

Igneous (I)

I2 Rhyolite, quartz latite, rhyodacite, and andesite flows and

I4 Welded ash-flow tuff

Sedimentary (S)

S1 Orthoquartzite

S2 Dolomite and limestone locally cherty, with interbedded sha

A5ig A5is Combination of geologic unit symbols indicates a mixture of or rock units inseparable at map scale.

A5i (I2) Parenthetic unit underlies surface unit at shallow depth.

SYMBOLS

Contact between rock and basin-fill.

Contact between surficial basin-fill or rock units.

Fault, trace of surface rupture of faults offsetting surfic bali on downthrown side.

Gravity Station

NOTES: 1. Surficial basin-fill units pertain only to the upper several fee deposits and scale of map presentation. unit descriptions refer Varying amounts of other soil types can be expected within each

2. The distribution of geologic data stations is presented in Volu all station data and generalized description of all geologic un Section 1.0.

3 Geology in areas of exposed rock from Hose and Blake (1976), Kl and Pampeyan (1970).

22 MAY 80

abandoned shoreline deposits of
A4os, weakly cemented silty sand (SM)

alluvial fan deposits of: A5yf, sandy silt (ML);
A5yg, sandy gravel (GM,GP).

, intermediate-age alluvial fan deposits of: A5is, weakly
5ig, weakly cemented sandy gravel (GP,GM); A5ic, weakly
rcent cobbles

ITS

site flows and plugs

interbedded shale

tes a mixture of either surficial basin-fill

shallow depth.

LS

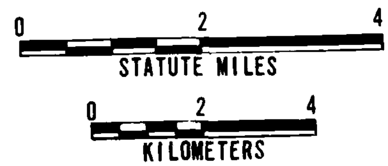
k units.

ffsetting surficial basin-fill deposits,

upper several feet of soil. Due to variability of
scriptions refer to the predominant soil types.
cted within each geologic unit.
resented in Volume V, Drawing 1. A tabulation of
all geologic units is included in Volume V,

Blake (1976), Kleinhampl and Ziony (1967), Tschanz

SCALE 1:125,000



GRAVITY STATION LOCA
SOUTHERN WHITE RIVER VAL

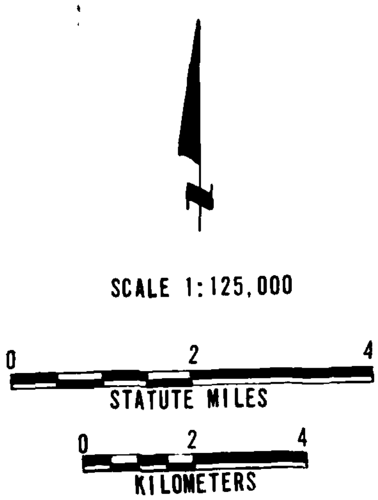
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE -

FUGRO NATION

ts of
sand (SM)

A5yf, sandy silt (ML);

fan deposits of: A5is, weakly
gravel (GP, GM); A5ic, weakly



ficial basin-fill

fill deposits,

Due to variability of
minant soil types.
lt.
1. A tabulation of
ed in Volume V,

Ziony (1967), Tschanz

GRAVITY STATION LOCATION MAP
SOUTHERN WHITE RIVER VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

DRAWING
1

FUGRO NATIONAL, INC.

11

12

APPENDIX A1.0

GENERAL PRINCIPLES OF THE GRAVITY EXPLORATION METHOD

A1.0 GENERAL PRINCIPLES 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/second^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 mg/ft (-0.3086 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.

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

$B_c = 0.04185\ (2.67)\ h_m$ (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.

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.

APPENDIX A2.0

SOUTHERN WHITE RIVER VALLEY

GRAVITY DATA

SOUTHERN WHITE RIVER VALLEY PROFILE LINE NO. 1

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR. IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEC GRAV	FAA	CBA +1000
WR0102	384313	1151472	5690S	0 135428683	65255151340205535	-644	80084
WR0103	384312	1151444	5662S	0 130428682	65295151266205534	-981	79836
WR0104	384310	1151416	5610S	0 125428679	65336151657205530	-1077	79914
WR0105	384311	1151389	5591S	0 121428682	65375151747205532	-1166	79885
WR0106	384311	1151361	5570S	0 115428682	65416151869205532	-1242	79875
WR0107	384305	1151334	5540S	0 113428672	65455151954205523	-1431	79786
WR0108	384304	1151306	5520S	0 109428671	65496152051205522	-1520	79762
WR0109	384306	1151278	5503S	0 108428675	65536152082205525	-1653	79686
WR0110	384303	1151245	5470S	0 105428671	65584152090205520	-1951	79497
WR0111	384301	1151217	5440S	0 104428668	65625152041205517	-2280	79270
WR0112	384295	1151187	5416S	0 103428658	65668152080205509	-2458	79173
WR0113	384293	1151153	5390S	0 102428655	65718152123205505	-2657	79062
WR0114	384291	1151121	5374Y	0 101428652	65764152132205502	-2795	78977
WR0115	384319	1151025	5364Y	0 99428707	65902152157205544	-2906	78896
WR0116	384300	115 935	5356Y	0 99428674	66033151917205516	-3193	78638
WR0117	384303	115 871	5361Y	0 98428682	66126151449205520	-3618	78195
WR0118	384318	115 806	5366U	0 100428711	66220151161205542	-3881	77917
WR0119	384311	115 700	5365Y	0 106428702	66374150582205532	-4459	77348
WR0120	384314	115 638	5370S	0 111428709	66463150312205537	-4687	77108
WR0121	384317	115 548	5358S	0 126428717	66594150205205541	-4911	76940
WR0122	384317	115 469	5375S	0 146428720	66708150113205541	-4844	76970
WR0123	384317	115 359	5473S	0 176428723	66868149958205541	-4075	77434
WR0124	384318	115 246	5636S	0 224428728	67031149604205542	-2897	78105
WR0125	384315	115 219	5688D	0 239428724	67070149421205538	-2585	78253
WR0126	384315	115 191	5738D	0 255428724	67111149185205538	-2351	78339
WR0127	384315	115 163	5800D	0 275428725	67152148995205538	-1957	78536
WR0128	384315	115 136	5860D	0 294428726	67191148654205538	-1732	78575
WR0129	384315	115 108	5940D	1 319428727	67231148448205538	-1185	78875
WR0130	384315	115 80	6000D	2 341428726	67272148304205538	-764	79114
WR0131	384316	115 53	6055D	2 385428731	67311148053205539	-499	79236
WR0132	384315	115 27	6160D	5 405428730	67349147378205538	-184	79216

END OF LIST

SOUTHERN WHITE RIVER VALLEY PROFILE LINE NO. 2

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM / OBSV GRAV / THEO GRAV	FAA	CBA +1900
WR0201	383758	1151375	5645S	0	128427659	65415150772204719	-819	80055
WR0202	383766	1151348	5620S	0	126427675	65454150858204730	-981	79977
WR0203	383769	1151321	56142T	0	127427681	65493150936204735	-965	80014
WR0205	383772	1151258	5515S	0	121427683	65584151550204740	-1287	80024
WR0206	383772	1151228	5484S	0	114427689	65628151573204740	-1556	79854
WR0207	383774	1151198	5460S	0	108427694	65671151610204742	-1747	79739
WR0208	383776	1151167	5432Y	0	105427698	65716151635204745	-1988	79588
WR0209	383778	1151138	5410S	0	100427703	65758151679204748	-2154	79494
WR0210	383780	1151110	5390S	0	98427707	65799151633204752	-2392	79322
WR0211	383783	1151082	5370S	0	96427714	65839151577204755	-2641	79140
WR0212	383785	1151055	5350S	0	97427718	65879151484204759	-2926	78924
WR0213	383790	1151009	53271T	0	94427729	65945151191204766	-3442	78483
WR0214	383798	115 913	53110T	0	93427746	66084150995204777	-3801	78173
WR0215	383803	115 841	5308U	0	93427758	66188151671204785	-3160	78829
WR0216	383806	115 789	5308U	0	95427765	66264151540204789	-3296	78695
WR0217	383814	115 695	5318S	0	102427782	66400150880204802	-3873	78091
WR0218	383822	115 602	5317S	0	114427800	66534150429204813	-4345	77634
WR0219	383826	115 551	5300S	0	128427809	66608150344204819	-4598	77453
WR0220	383829	115 509	5317S	0	139427816	66669150164204823	-4620	77384
WR0221	383831	115 478	5337D	0	156427820	66714150156204827	-4443	77509
WR0222	383825	115 449	5357B	0	168427810	66756150256204817	-4151	77746
WR0223	383812	115 420	5380D	0	178427787	66799150260204798	-3906	77922
WR0224	383800	115 392	5415D	0	187427766	66840150227204780	-3592	78126
WR0225	383793	115 361	5456S	0	202427754	66885150189204770	-3234	78359
WR0226	383793	115 330	5493D	0	227427755	66930150234204770	-2841	78651
WR0227	383793	115 299	5516D	0	267427756	66975150365204770	-2493	78961
WR0228	383792	115 276	5540D	0	307427754	67008150435204769	-2196	79216
WR0229	383793	115 249	5651Y	3	330427757	67048149872204770	-1715	79340
WR0230	383795	115 220	6040D	0	334427762	67090147630204773	-297	79436
WR0231	383800	115 198	6210Y	11	351427772	67121146780204780	446	79627

END OF LIST

SOUTHERN WHITE RIVER VALLEY PROFILE LINE NO. 3

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
WR0301	382921	1151774	6221Y	10	190426100	64865146873203489	1935	80917
WR0302	382921	1151736	5961V	0	182426101	64920148582203489	1195	81046
WR0303	382924	1151698	5913Y	1	173426108	64975148957203494	1114	81120
WR0304	382916	1151667	6060Y	13	167426094	65021147976203482	1528	81039
WR0305	382924	1151642	5842V	0	167426109	65057149410203494	898	81140
WR0306	382924	1151615	5788V	0	169426110	65096149687203494	667	81094
WR0307	382924	1151587	5732S	0	168426111	65137149924203494	377	80994
WR0308	382925	1151549	5682V	0	151426114	65192150150203495	134	80905
WR0309	382925	1151514	5595V	0	145426115	65243150442203495	-397	80665
WR0310	382930	1151487	5574S	0	137426125	65282150332203502	-712	80414
WR0311	382931	1151458	5553S	0	126426127	65324150217203504	-1026	80160
WR0312	382931	1151428	5525S	0	120426128	65368150148203504	-1359	79917
WR0313	382931	1151400	5498S	0	114426129	65408149990203504	-1771	79591
WR0314	382931	1151371	5470S	0	111426130	65451150000203504	-2025	79430
WR0315	382933	1151341	5445S	0	105426134	65494150111203507	-2152	79382
WR0316	382933	1151313	5420S	0	102426135	65535150274203507	-2224	79392
WR0317	382933	1151284	5400S	0	98426136	65577150462203507	-2225	79455
WR0318	382934	1151256	5376S	0	96426139	65618150706203509	-2208	79552
WR0319	382934	1151228	5355S	0	94426139	65658151002203509	-2110	79720
WR0320	382935	1151199	5336S	0	92426142	65700151273203510	-2019	79873
WR0321	382935	1151171	5324S	0	90426143	65741151467203510	-1938	79994
WR0322	382936	1151142	5305S	0	88426145	65783151554203511	-2031	79963
WR0323	382937	1151113	5293S	0	86426148	65825151535203513	-2164	79869
WR0324	382938	1151027	5266Y	0	82426152	65950151324203514	-2631	79490
WR0325	382940	115 930	5244Y	0	80426159	66091151310203517	-2855	79339
WR0326	382941	115 826	5220S	0	80426164	66242151318203519	-3075	79201
WR0327	382943	115 712	5245Y	0	80426171	66408150436203522	-3725	78466
WR0328	382944	115 636	5250Y	0	426175	66519150025203523	-4090	78086
WR0329	382945	115 558	5224Y	0	86426179	66632149906203524	-4455	77813
WR0330	382946	115 508	5239Y	0	89426183	66705149604203526	-4618	77603
WR0331	382947	115 435	5230S	0	96426187	66811149431203527	-4877	77381
WR0332	382949	115 343	5242S	0	106426193	66944149176203530	-5021	77206
WR0333	382951	115 234	5277S	0	122426200	67103148952203534	-4919	77205
WR0334	382964	115 117	5330Y	0	154426228	67272149081203552	-4310	77665
WR0335	382966	115 88	5344S	0	168426233	67314149385203555	-3877	78064
WR0336	382968	115 62	5355S	0	181426237	67352149713203559	-3448	78469
WR0337	382970	115 34	5392S	0	196426242	67393149935203561	-2881	78924
WR0338	382970	115 8	5440S	0	213426242	67430150124203561	-2240	79419

END OF LIST

SOUTHERN WHITE RIVER VALLEY PROFILE LINE NO. 4

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
WR0401	382089	1152245	6055V	0	221424549	642071471082022269	1227	81396
WR0402	382089	1152217	6018B	0	195424550	642481472772022269	1646	81316
WR0403	382087	1152187	5974V	0	189424547	642921475502022266	1510	81323
WR0404	382088	1152154	5928V	0	173424550	643401479102022267	1435	81390
WR0405	382086	1152124	5904V	0	166424547	643841482322022264	1534	81563
WR0406	382084	1152090	5824V	0	156424544	644331483372022261	489	81181
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8