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HIGH-PRECISION MULTILEVEL AEROMAGNETIC SURVEY

over

DIXIE VALLEY, NEVADA

Townships 22 North to 24 North
Ranges 35 East to 37 East
In Churchill County, Nevada

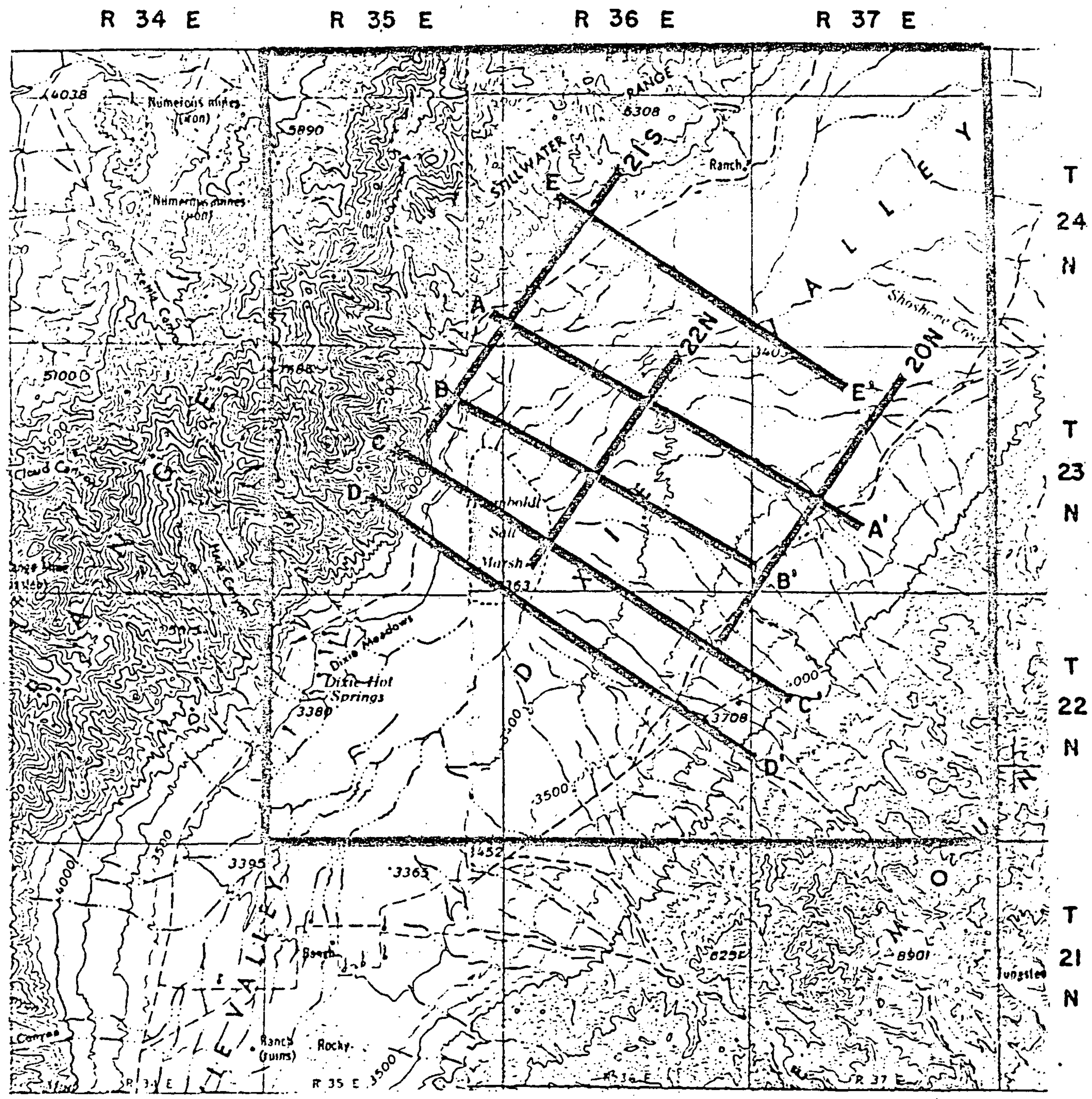
October 1977

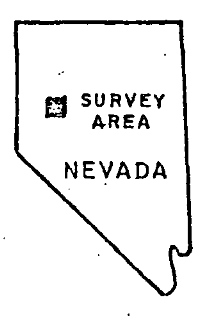
Submitted & Reviewed 11-1-77
in Keplinger's offices (Houston)
in joint session with Millican

Senturion Sciences, Inc., has performed the field work, analyzed the data, and interpreted the results for this task. All the data and information resulting from this survey are the property of Southland Royalty Company.

SURVEY SPECIFICATIONS

LOCATION:	Dixie Valley, Nevada
AREA COVERED:	Approximately 100 square miles
ACQUISITION DATE:	October, 1977
CREW:	Senturion Sciences #8
CODE:	South Dixie, #233
NUMBER OF PROFILES:	MultiLevel - five Single-Level - three
NUMBER OF CONGRUENT LEVELS PER PROFILE:	Five
MULTILEVEL GROUND MILES:	48
SINGLE-LEVEL GROUND MILES:	21
GEOPHYSICIST:	M. D. Quigley





SINGLE LEVEL
MULTILEVEL

SOUTH DIXIE VALLEY, NEV.
AEROMAGNETIC SURVEY

SCALE: 1/4" = 1 MILE
FIGURE 1 SENTURION SCIENCES, INC.

SOUTHLAND ROYALTY COMPANY'S

SOUTH DIXIE, NEVADA

MULTILEVEL AEROMAGNETIC SURVEY REPORT

SUMMARY

Five MultiLevel Aeromagnetic (MAM) profiles flown to resolve location, attitude, and vertical extent of faults mapped six normal faults and a major thrust fault (Figure 1). The Old Stillwater Fault (Figure 2 and Plate 1), which is the westernmost fault within the survey, was noted to hade slightly toward the west, and its vertical extent ran from surface to basement. The attitude of the Old Stillwater Fault is surprising when viewed with respect to theses existing prior to this survey; yet from a structural mechanics point of view, it is quite acceptable.

The Stillwater Thrust Fault (Figure 2 and Plate 1) is likewise surprising in that this thrust fault mapped on Profiles A and E (Figure 1) aligns with a fault that was previously known, and in fact, was thought to be an extension of the Old Stillwater Fault.

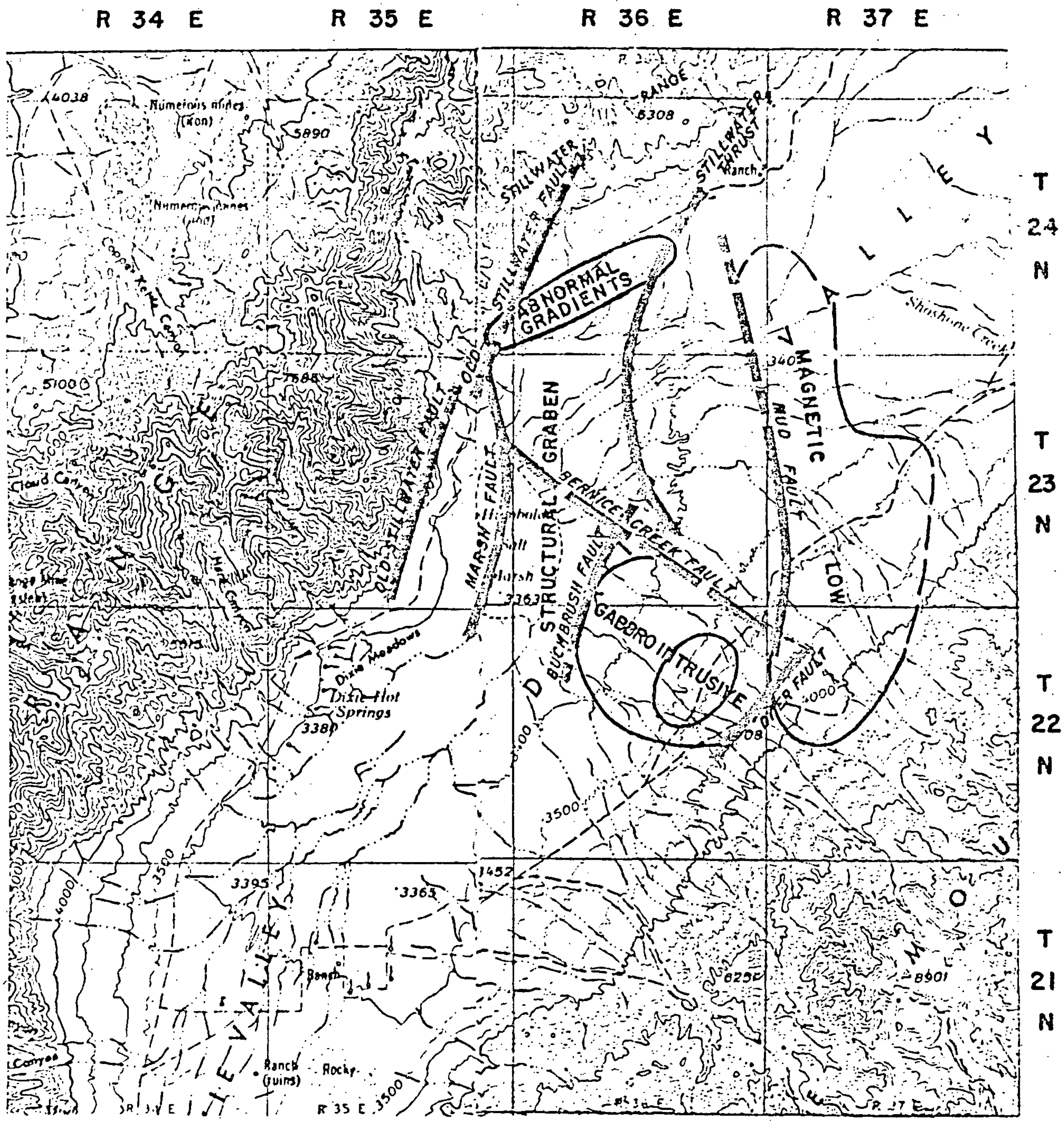
Extraordinary magnetic gradients were mapped which were indicative of heat.

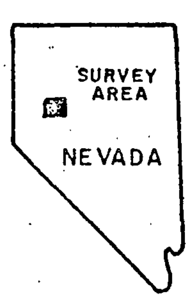
DATA ACQUISITION

Senturion flew five MultiLevel Aeromagnetic (MAM) profiles, with each profile consisting of five congruent data acquisition flight lines flown at 5000', 5500', 6000', 6500', and 7500' above sea level. Average ground elevation within the survey limits was 3700' above mean sea level. The five MultiLevel profiles shown on Figure 1 and Plate 1 all trended NW-SE, or perpendicular to the axis of Dixie Valley. The MultiLevel profiles were tied by three short, single-level lines (Figure 1 and Plate 1) flown NE-SW at 6000' above mean sea level. The survey area, which is in T22, 23, and 24N; R35, 36, and 37E of Churchill County, Nevada, is within an aircraft restricted zone which overlaps from a target range to the west in Humbolt Valley. Just this one small area of Dixie Valley is restricted, and this restriction did cause delays in data acquisition.

The high-precision survey used Senturion's Aztec N5176Y, which is equipped with Doppler navigation and our optically-pumped helium magnetometer. The data was acquired at the rate of 18 magnetic readings per flight mile with a photograph of the ground position below each sample, and both the magnetic reading and photograph were triggered by the Doppler navigation system. The magnetic readings were recorded digitally on magnetic tape concurrently with clock times and Doppler down-track and off-track information.

A base line at a constant elevation was reflown after each pass along the profiles to record diurnal variations in the earth's magnetic field.





SOUTH DIXIE VALLEY, NEV.
MAGNETIC FEATURES MAP

FAULTS

SCALE: 1/4" = 1 MILE

FIGURE 2 SENTURION SCIENCES INC.

DATA PROCESSING

After diurnal corrections were applied, each of the five congruent profiles was plotted at 18 data points per mile along with its first and second derivatives. On the multiple-level profiles, the 500-foot gradients were calculated and plotted along with the second vertical difference. Similarly, the 1000-foot gradients were calculated from the higher levels and plotted.

The multiple-level profiles were interpreted in terms of subsurface geology, and this interpretation is presented on the Profiles A-A', B-B', C-C', D-D', and E-E', which are in the pocket of this report. Each profile interpretation is discussed in this text.

The five-level total field readings along each profile have been plotted one above the other to show the field changes graphically. The field differences are plotted as indicated below.

- 5000'-5500' = 500-foot gradient
- 5500'-6000' = 500-foot gradient
- (5000'-5500')-(5500'-6000') = second 500-foot difference
- 5500'-6500' = 1000-foot gradient
- 6500'-7500' = 1000-foot gradient
- (5500'-6500')-(5600'-7500') = Second 1000-foot difference

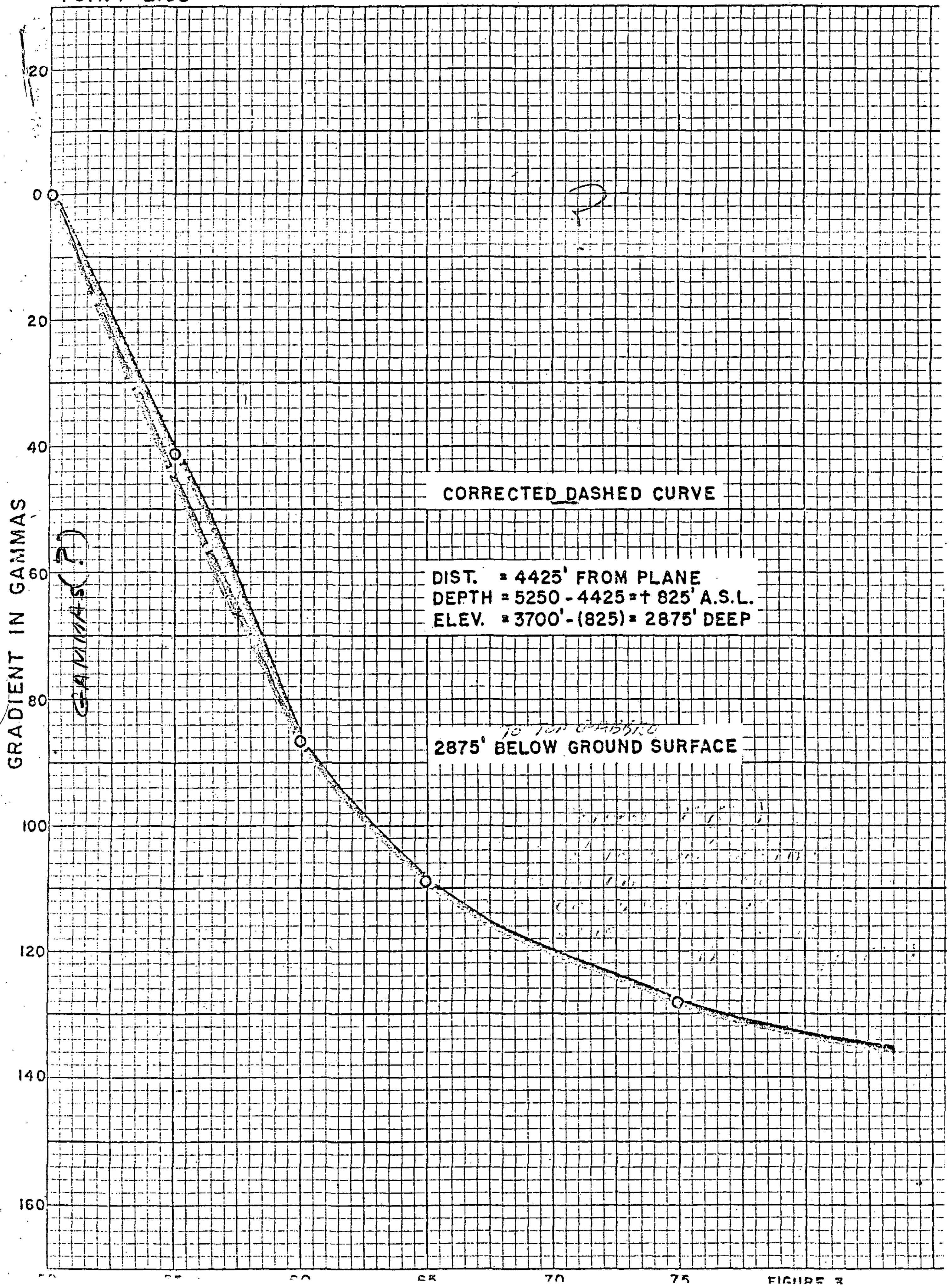
The above field-difference curves permit the plotting of a gradient profile continuously throughout the surveyed lines. One or more gradient profiles are included in the discussion of each profile to show the magnetic field relationships from one level to another. Depth calculations were derived from data contained in the gradient profiles and related to lateral changes in the gradient curves along each flight line to resolve the subsurface geology.

RESULTS

Profile D-D' (Plate 2), the most southernly profile flown, reveals the shape and depth below the surface of a gabbro intrusive at the southeast end of the profile. The depth to the topmost point of this intrusive is calculated from the magnetic gradient shown in Figure 3 and is shown to be 2875 feet beneath the surface. The shape of the intrusive was determined by model analyses. The depths to the high-susceptibility Triassic rocks, or basement, is interpreted from the lateral charge in the high-level second gradient difference curve [(5500'-6500')-(6500'-7500')].

JUTH DIXIE VALLEY, NE . .DA PRO. .LE D-D'

POINT 2193



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The positions and attitudes of the Old Stillwater and Buckbrush faults within Profile D-D' are shown on the cross-section (Plate 2). The attitudes of the faults are determined by the inflection points on the total field plats of each flight level. Since the profiles were flown parallel to the strike of the earth's magnetic field, any shift in either direction of the position of the inflection point is related to the hade of the fault plane. The Old Stillwater fault is a high-angle reverse fault, whereas the Buckbrush fault is a normal fault.

The Marsh fault occurs between the Old Stillwater and Buckbrush faults and is shown on the cross-section as well as in plain view on Figure 2 and Plate 1. This fault is not at all apparent on the total field plots and is weakly discernible on the derivative curves. This more subtle fault does cause a sudden slope change in the gradient curves which usually is very sensitive to structural or stratigraphic discontinuities below the surface. On Profile D-D' the Marsh fault is upthrown on the west and appears to be a normal fault since the hade is to the east. Normal faulting also takes place on the northwest flank of the gabbro intrusive and is labeled the 'Buckbrush fault'. The southeast flank of the gabbro intrusive has the Dyer fault, which is also a normal fault. No unusual gradients are measured along Profile D-D' that would indicate doming of the Curie Isotherm.

Profile C-C' (Plate 3) was flown over the crest of the gabbro intrusive. The gradient profile at Point 2442 is shown in Figure 4. The top of the intrusive is 1400 feet below the surface, and like Profile D-D', the intrusive has an appendage on the northwest flank that extends outward to the Buckbrush fault. Southeast of the intrusive, there is a down-faulted block that has very low total field readings. The field values are increasingly lower on the higher flight levels which is abnormal over a magnetic low, and this is interpreted as evidence of the loss of magnetism at depth, which indicates doming, or rising, of the Curie Isotherm.

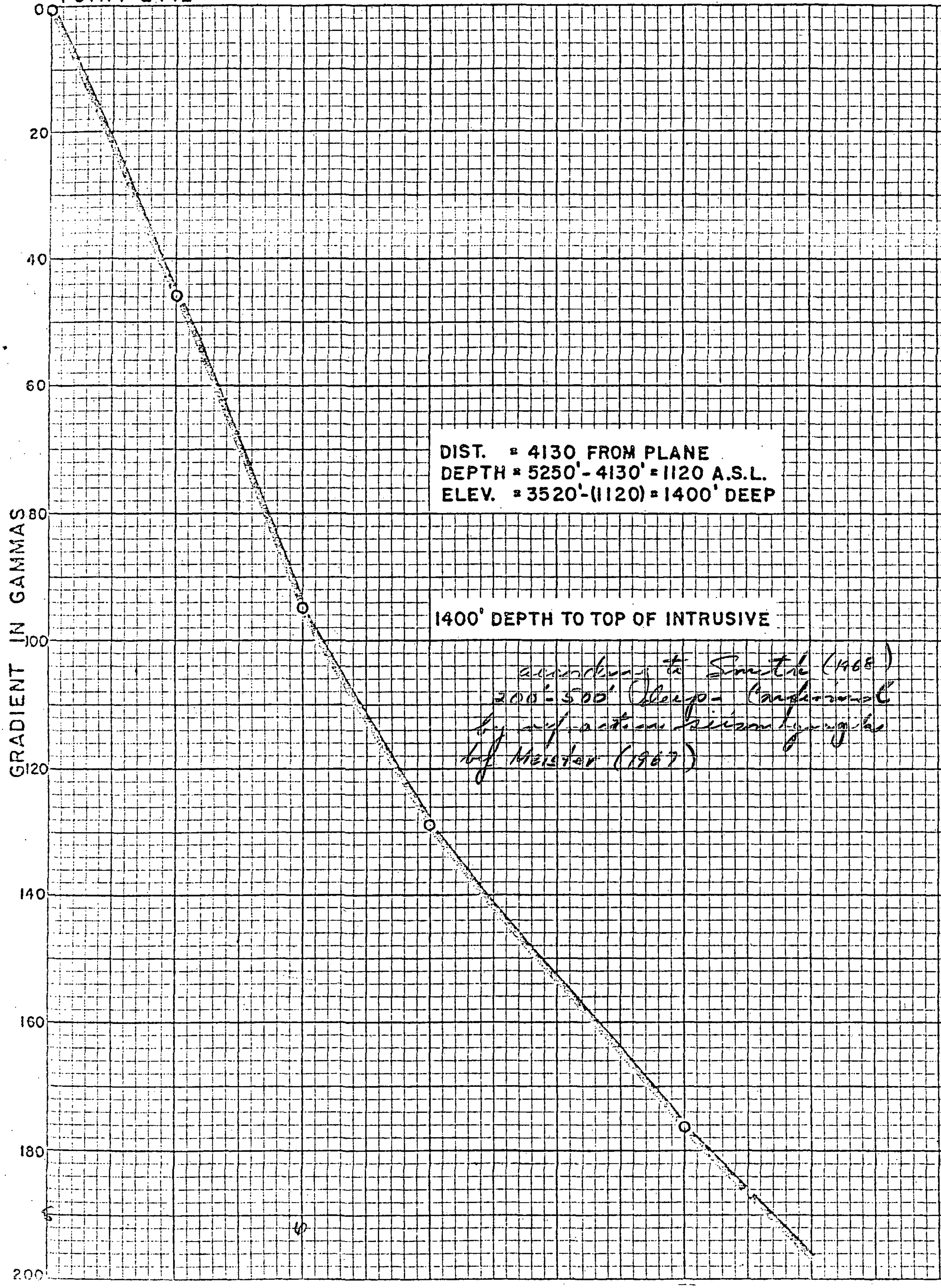
The Old Stillwater and Buckbrush faults have the same attitude that they have on Profile D-D'. The Marsh fault appears to have the same relative displacement but it gives rise to a very abnormal gradient curve. The gradient profile in Figure 5 computed at Data Point 2552 shows that the gradients are reversed above the 6000-foot flight level. Apparently both sides of the Marsh fault are influencing the gradients; or there is the possibility that the abnormal gradient area between the 5500-foot and 6500-foot flight intervals is due to extraordinary heat in the vicinity of the fault.

Profile B-B' (Plate 4) is almost featureless, showing only two faults along the profile. The easternmost fault shown on this cross-section is a thrust fault where the thrust plate has moved westward. The gradient profile at Point 1687 on Figure 6 shows the magnetic field falling off very rapidly at the highest flight interval (6500'-7500'). Such a falloff rate is unusual over a magnetic maximum and indicates a probable relationship to heat along the thrust plane.

A more normal gradient curve is plotted at Point 1783 on Figure 7. The shallow portion of the gradient curve is reversed, which indicates near-surface volcanic flows or other extrusives in the gabbroic complex that are reversely polarized. The gradient curve analyzed at Flight

JTH DIXIE VALLEY, NE PRO C-C'

POINT 2442



[illegible]UTH DIXIE VALLEY, NE[illegible]DA PRO[illegible] C-C'
POINT 2552

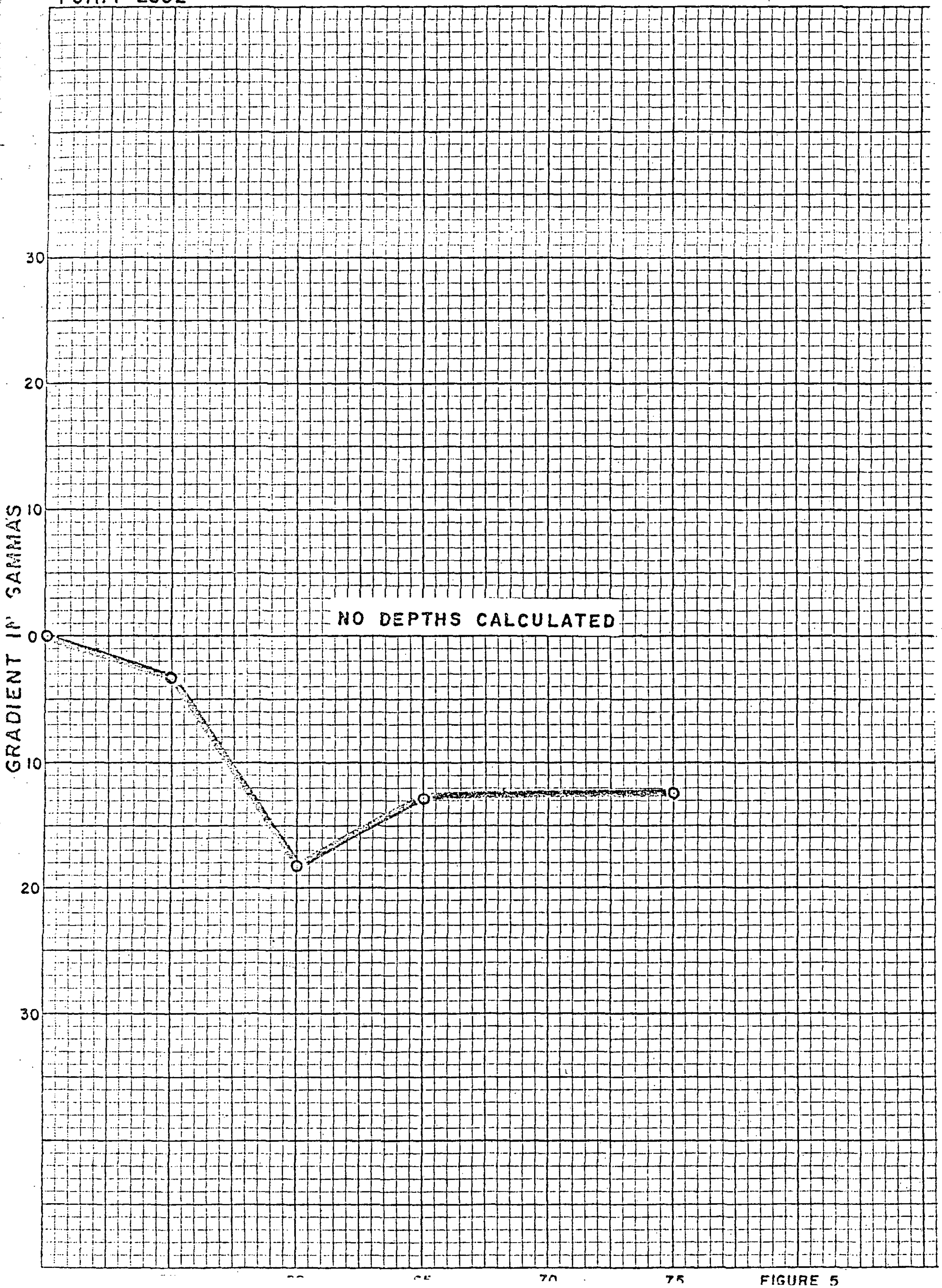
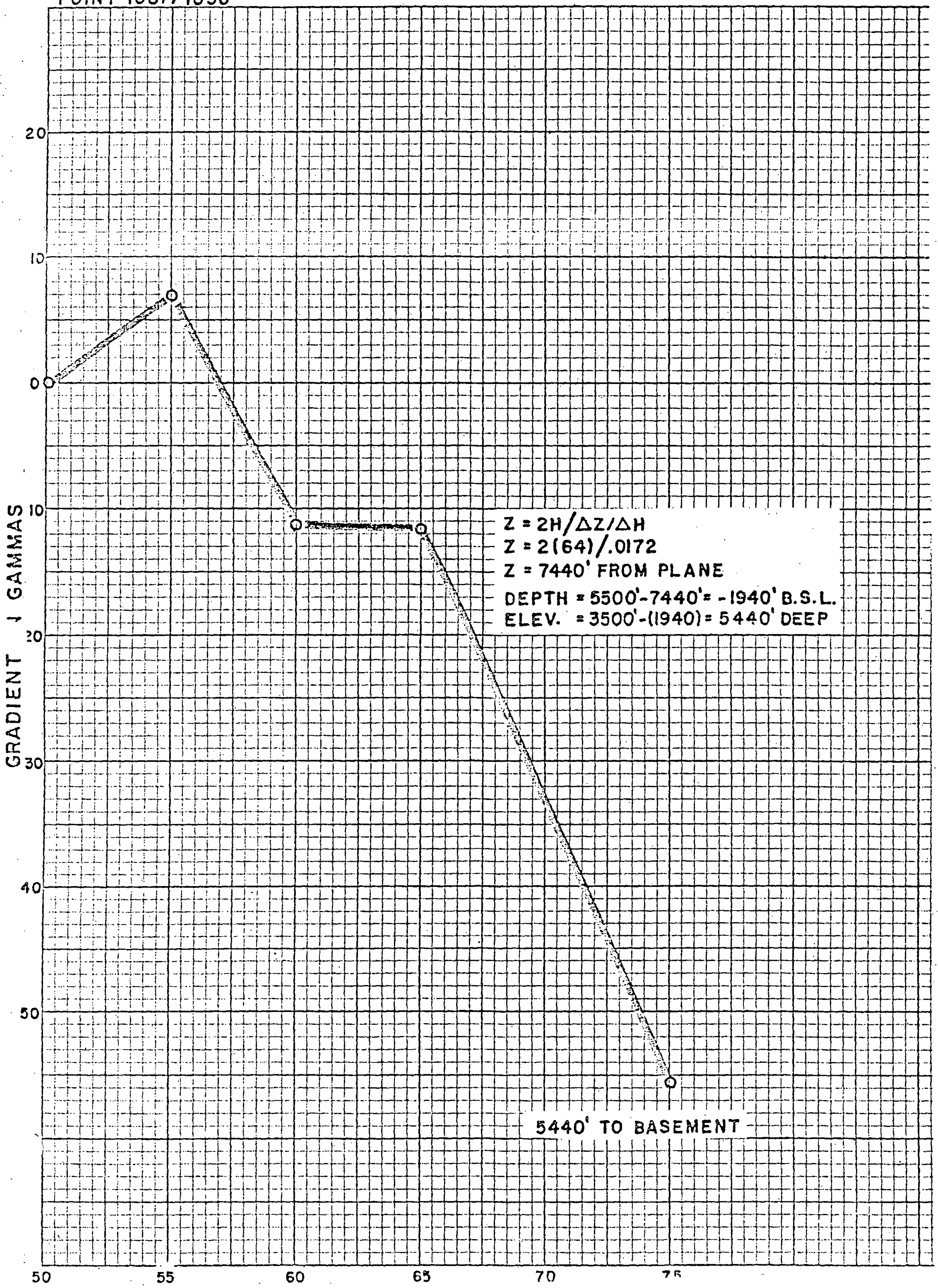


FIGURE 5

SOUTH DIXIE VALLEY, NEVADA

PROFILE B-B'

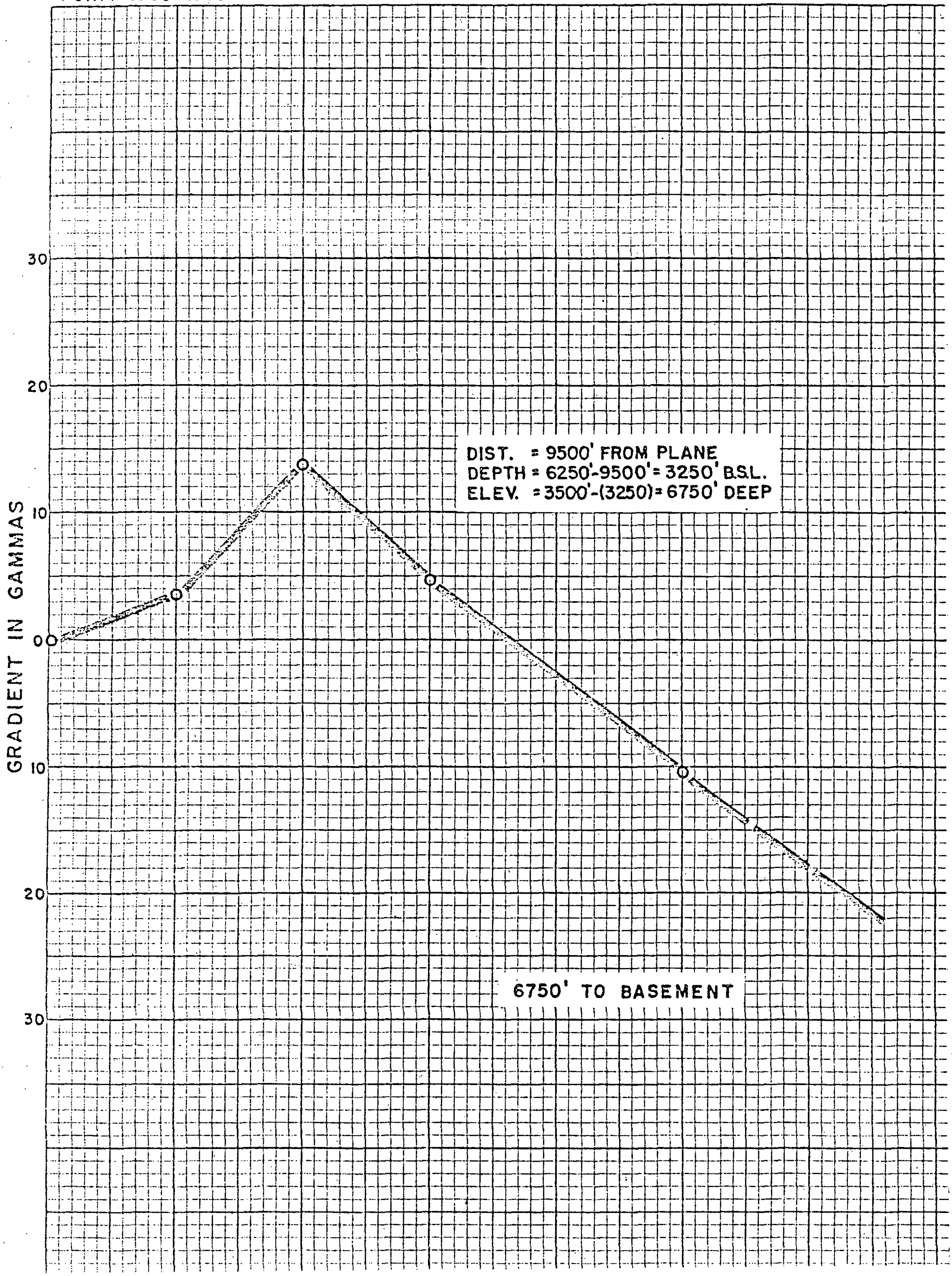
POINT 1687/1050



SOUTH DIXIE VALLEY, NEVADA

PROFILE B-B'

POINT 1783/1146



Point 1687 shows the depth to the top of the Triassic rocks as 5440', while the analyses at Flight Point 1783 reveals the depth to basement as 6750'. The normal fault at the northwest end of the profile is probably the continuation of the Marsh fault shown on Profiles D-D' and C-C'.

Profile A-A' (Plate 5) is flown over an area of interest at the northwest end of the profile. The most rapid decrease in the magnetic field readings occurs between the 5600-foot and 7500-foot flight levels. The decrease occurs on the east side of the Old Stillwater fault. Flight Point 2933 has an abnormal magnetic gradient which is easily seen in Figure 8. By extrapolation, the gradient between the 5600- and 7500-foot flight levels is 43 gammas lower than normal. Quite probably, excessive heat or hot fluids could have affected the magnetic fields at depth.

The thrust fault mapped on Profile B-B' is strongly evident on Profile A-A'. The high gradient area east of the thrust plane is reflective of a structural high on the Triassic or basement rocks. The gradient profile at Point 2817 on Mud fault (Figure 9) indicates the high susceptibility interface to be at a depth of 3660 feet below the surface. Southeast of Mud fault, which bounds the basement high, there is a magnetic low that probably is the extension of the low on the southeast end of Profile C-C'. Even so, the gradient relationships are normal except for the near-surface inversions that are present on all the profiles.

Profile E-E' (Plate 6) has high magnetic relief. According to the gradient curve in Figure 10 at Point 4309, the basement rocks come up to within 5975 feet of the surface. The basement high is bounded on the west by the Stillwater Thrust fault and on the east by the vertical Mud fault. Mud fault is a step fault up on to another magnetic high at the extreme southeast end of Profile E-E' (Sections 4 and 5, 23N 37E). This high could have real significance because of the high magnetic relief and the large gradients. The depth to basement rocks is not accurately resolvable because the profile terminates before it reaches the top, or closure, of the high.

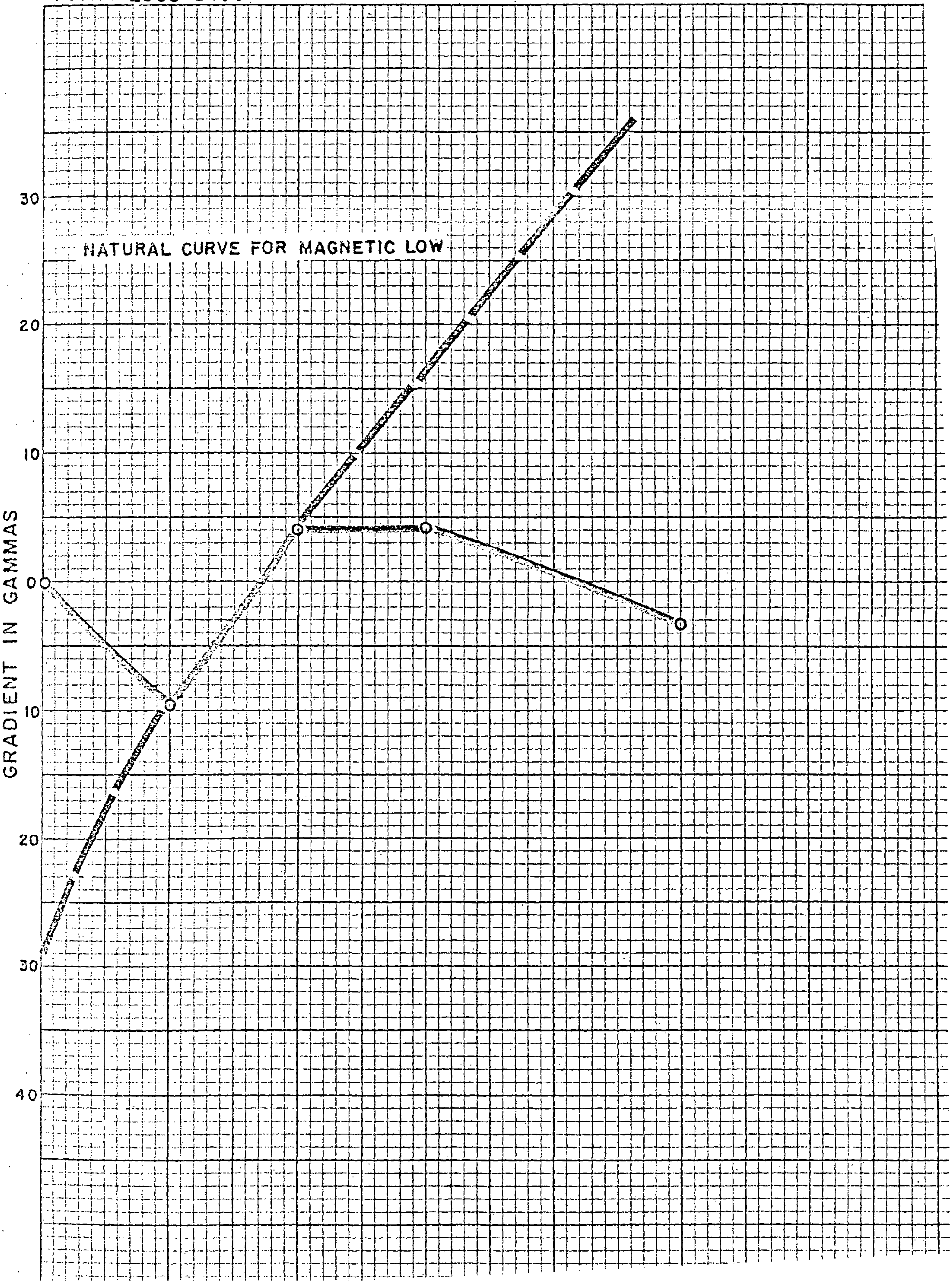
The high-angle reverse Old Stillwater fault is shown at the extreme northwest end of the profile. The structural graben between the Old Stillwater fault and the Stillwater Thrust fault has abnormal gradients. The second difference curves inverts between the shallow 500-foot plot and the deep 1000-foot plot. The deep curve [(5000'-5500')-(5500'-6000')] has a positive difference next to the Old Stillwater fault and a negative difference below the thrust. The shallow curve [(5500'-6500')-(6500'-7500')] has a strong positive difference all across the graben. The inversion indicates excessive heat beneath the thrust plane.

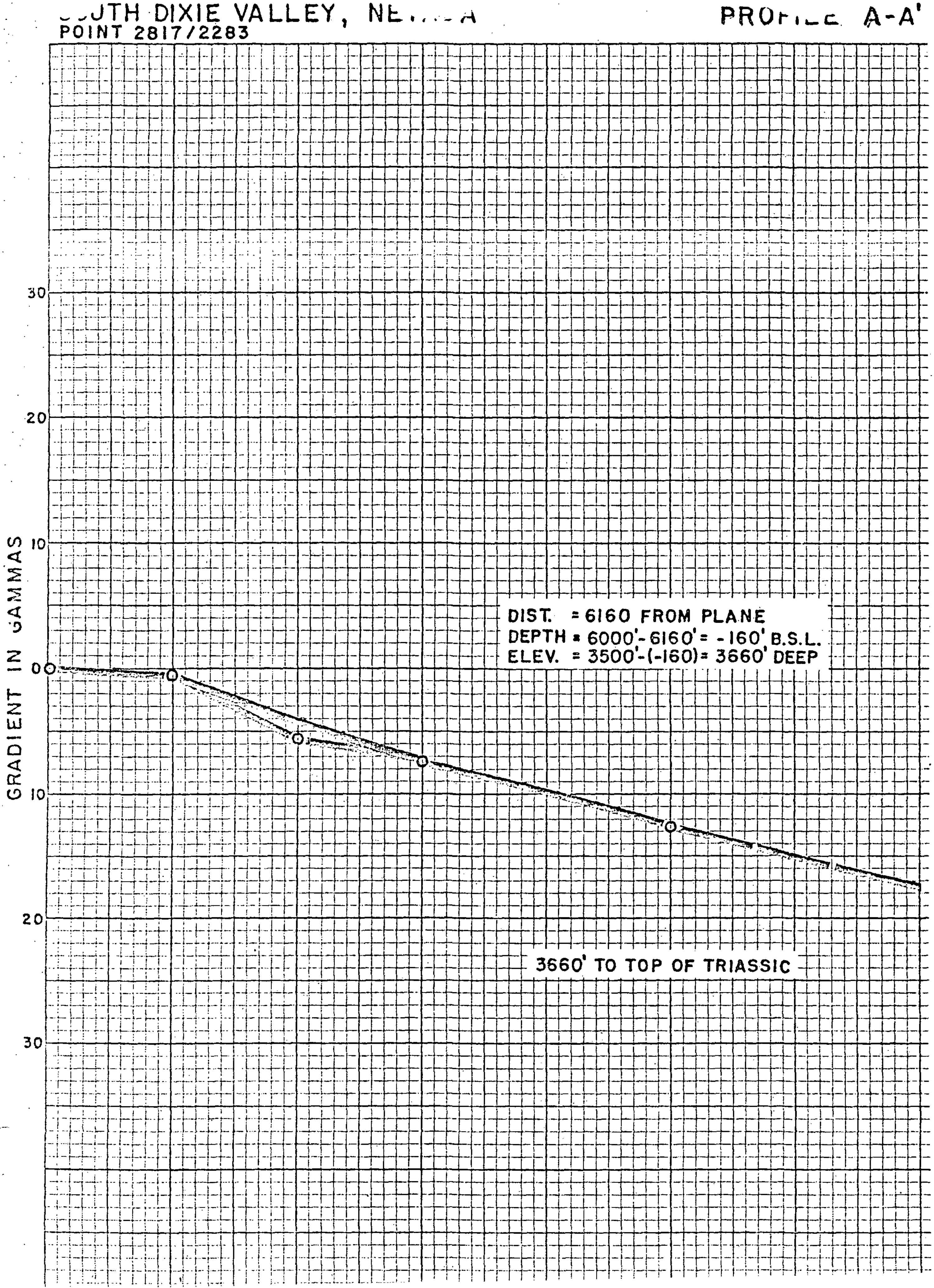
CONCLUSIONS

The magnetic features map (Figure 2 and Plate 1) is submitted to try to tie the magnetic events along one profile with those on the adjacent profile. Unfortunately, the three tie lines are insufficient to do a credible job of removing possible errors in tying all the profiles together. Even so, the features map is helpful in determining those areas where more detailed information is needed. The features map is made from the profiles at the 6000-foot level so all the events are positioned accurately in relationship to each other and to the ground.

SOUTH DIXIE VALLEY, NEVADA PROFILE A-A

POINT 2933/2400

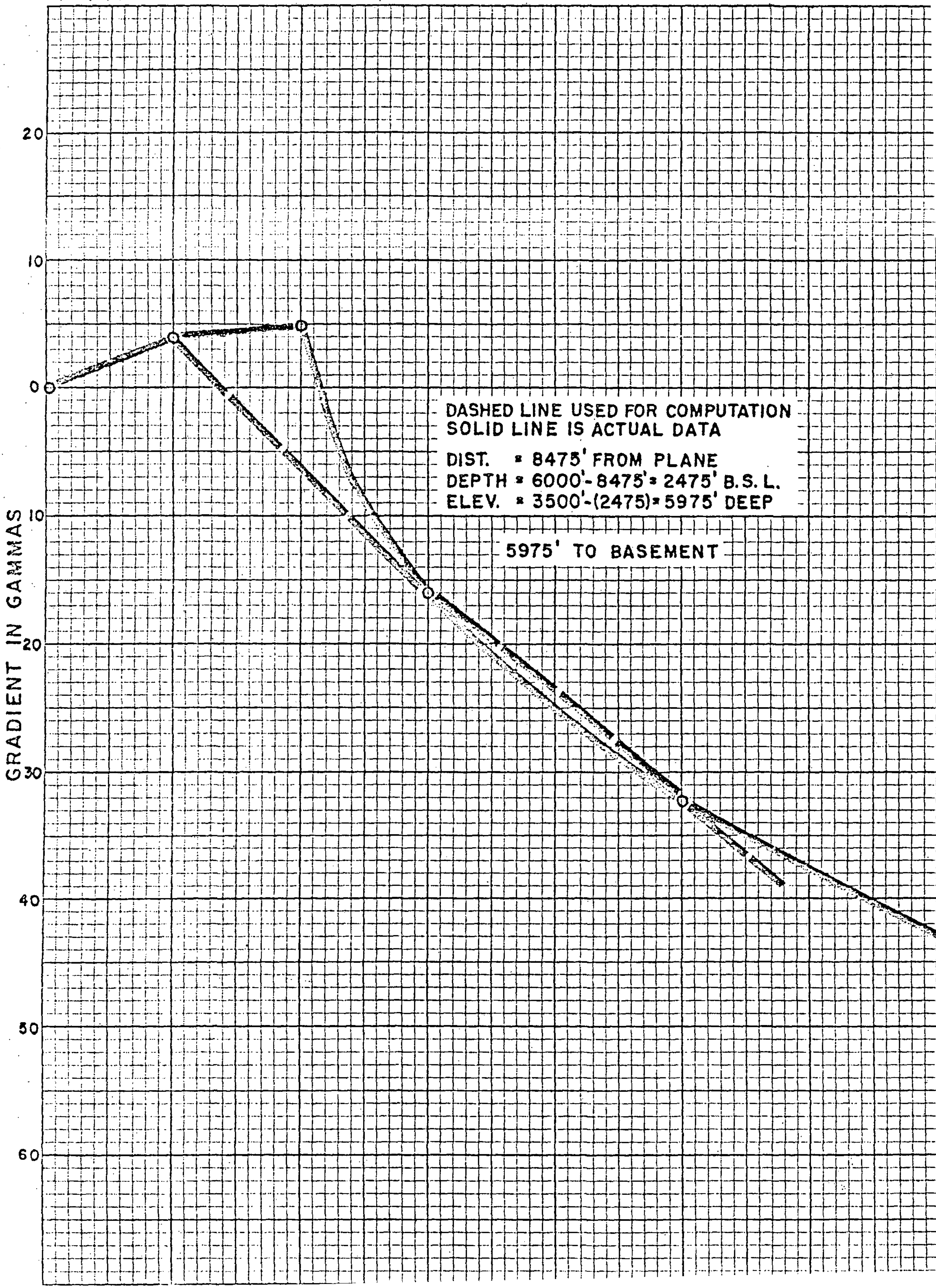




SOUTH DIXIE VALLEY, NE...A
POINT 2817/2283
PROFILE A-A'
GRADIENT IN GAMMAS
30
20
10
0
10
20
30
DIST. = 6160 FROM PLANE
DEPTH = 6000'-6160' = -160' B.S.L.
ELEV. = 3500'-(-160) = 3660' DEEP
3660' TO TOP OF TRIASSIC
47 0730

UTH DIXIE VALLEY, N A PRO E-E

POINT 4309/4085



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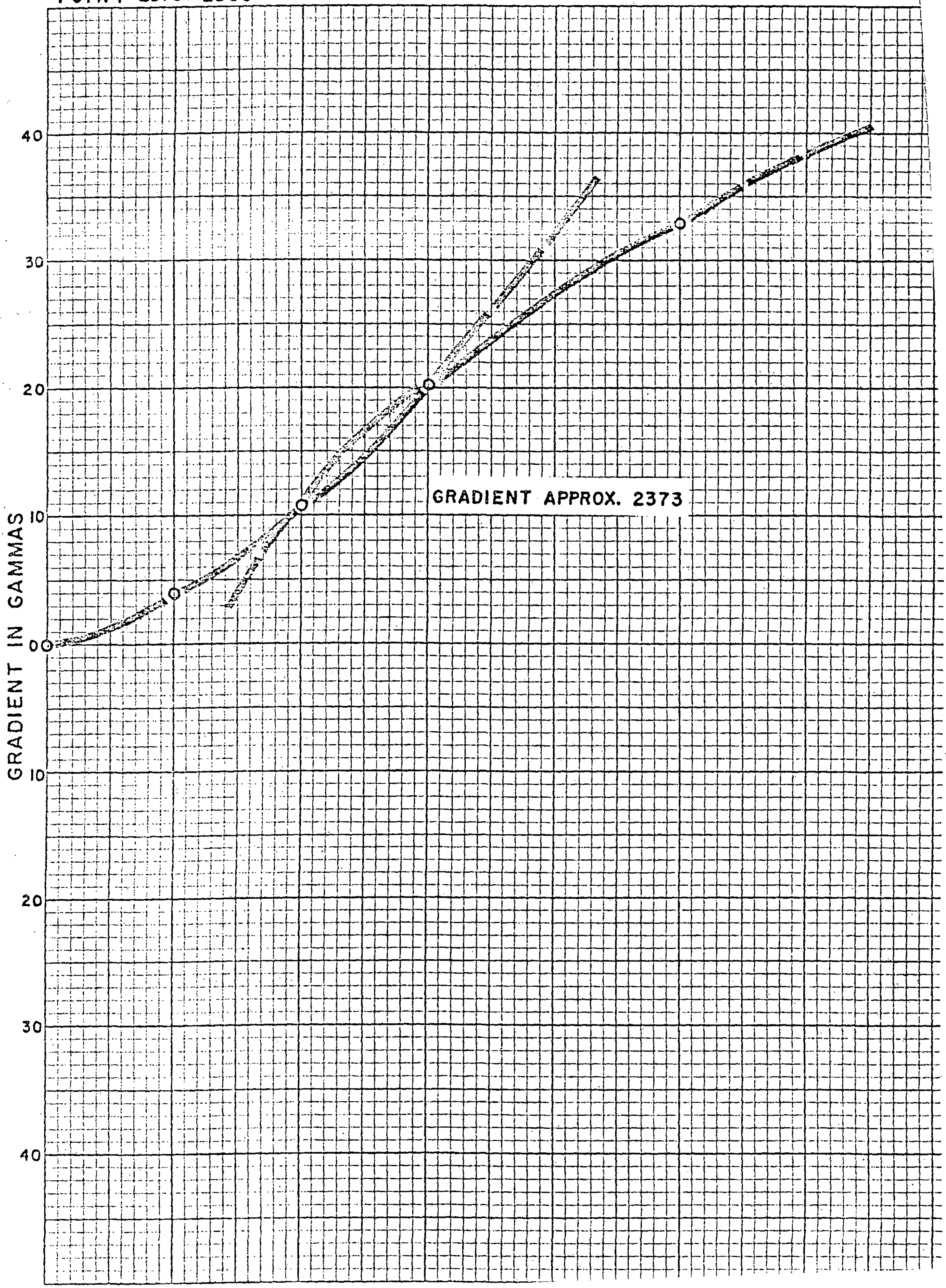
POINT 2373/2905



The Old Stillwater fault appears to be a series of *en echelon* faults that may be offset by other intersecting faults. The northeast corner of Township 23N 35E is an area where several faults intersect and could be a focus for migrating fluids from hot magnetic sources. Just northeast of this point in the southwest quarter of T24N 36E is the area of abnormal gradients that was evident on Profiles A-A' and E-E'.

The thrust plate in the east half of T23 and 24N 36E has probable geothermal potential. However, confirmation either from magnetotellurics or calibration by tying to a well or heat flow hole is needed because the gradients over a thrust plate are frequently reversed.

The large magnetic low at the east end of the profiles may be of interest. Only Profile C-C' extended far enough east to give any evaluation of the magnetic features, and that profile may have been near the southern limits of the magnetic low.

The MultiLevel magnetic profiles are informative as to the nature of the subsurface geology along the flight lines. The gradient curves show several abnormalities that may have been caused by high rock temperatures. Not all the structural relationships are correct and the depth determinations may contain errors due to not being able to calibrate to specific temperatures at specific depths or incorporate the magnetotellurics, and most unfortunately because the MultiLevel profiles were not preceded by a tightly-gridded single-level survey.