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GEOPHYSICAL INVESTIGATIONS OF CONCEALED FAULTS NEAR YUCCA MOUNTAIN, SOUTHWEST NEVADA

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"PRELIMINARY DRAFT"

ABSTRACT

Detailed gravity and ground magnetic data collected along surveyed traverses across Midway Valley, on the eastern flank of Yucca Mountain, Nevada reveal that these methods can be used to delineate concealed faults. These studies are part of an effort to evaluate faulting in the vicinity of the proposed surface facilities for a potential nuclear waste repository at Yucca Mountain. The largest gravity and magnetic anomaly in the vicinity of Midway Valley is associated with the Paintbrush fault on the west flank of Alice Ridge. Geophysical data infer a vertical offset of about 200 m (650 ft). Another prominent gravity and magnetic anomaly is associated with the Bow Ridge fault in the western part of Midway Valley.

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INTRODUCTION

NCT 1

Gravity and magnetic data collected as part of an effort to characterize Yucca Mountain revealed a geophysical anomaly in Midway Valley near a mapped but concealed fault. Because this anomaly is in the vicinity of proposed surface facilities for a potential nuclear waste repository, a series of geophysical traverses were collected to evaluate possible faulting in Midway Valley.

Yucca Mountain is composed of older Precambrian and Paleozoic rocks, a series of Miocene ash-flow and ash-fall tuffs, and late Tertiary and Quaternary surficial deposits. Pre-Cenozoic sedimentary and metamorphic rocks are exposed northeast of Yucca Mountain at Calico Hills and are predominantly limestone and dolomite, with lesser amounts of argillite, quartzite, and marble. Although, pre-Cenozoic rocks are not exposed at Yucca Mountain, the Paleozoic Lone Mountain Dolomite and Roberts Mountain Formation were penetrated in drill-hole UE25p#1, just west of Fran Ridge (Fig. 1), at depths of 1,244 and 1,667 m, respectively[1].

Five major Miocene volcanic units occur: older ash-flow tuffs, Lithic Ridge Tuff, Crater Flat Tuff, tuffs of Calico Hills, and the Paintbrush Tuff. The Crater Flat Tuff is composed of the Tram, Bullfrog, and Prow Pass Members; the Paintbrush Tuff is composed of the Topopah Spring, Pah Canyon, Yucca Mountain, and Tiva Canyon Members. The volcanic section was observed in drill-hole USW G-1, on the east flank of Yucca Mountain, and described by Spengler and others[2].

GRAVITY DATA

Detailed gravity data at a station spacing of 50 m were collected using LaCoste and Romberg gravity meters along several profiles across Midway Valley (Fig. 1). Gravity meter performance and calibration factors were checked over a mountain gravity meter calibration loop. Gravity data were reduced using the Geodetic Reference System of 1967 and referenced to the International Gravity Standardization Net 1971 gravity datum. Gravity data were reduced to complete Bouguer anomalies and include earth-tide, instrument drift, free-air, Bouguer, latitude, curvature, and terrain corrections. Gravity stations were surveyed using an electronic-distance-measurement instrument and station elevations are accurate to about 0.03 m from a reference bench mark.

Terrain corrections were computed to a radial distance of 166.7 km and involved a 3 part process: (1) Hayford-Bowie zones A and B (outer radius of 68 m) were estimated in the field with the aid of tables and charts, or sketched and later calculated in the office, (2) Hayford-Bowie zones C and D (outer radius of 590 m) were calculated by averaging compartment elevations using a circular template over a topographic map, and (3) terrain corrections from a distance of 0.59 km to 166.7 km were calculated using a digital elevation model and a computer procedure. Observed gravity values are considerered accurate to about 0.05 mGal.

MAGNETIC DATA

Ground magnetic data with the sensor at 2.4 m above the surface were collected along the profiles (Fig. 1). A Geometrics portable proton precession magnetometer model G-816 and base station magnetometer G-826A were used to collect data. Because the anomalies of interest were believed to be small (20 to 50 nT) a base station magnetometer was used to make corrections for diurnal time variations of the Earth's magnetic field. Nominal station spacing was 20 pacesor about 18 m, although, spacing varied from 1 to 20 paces depending on the variation of magnetic field observations. Magnetic field observations are considered accurate to about 1 to 2 nT

INTERPRETATION

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Previously collected gravity data at a station spacing of about 200 m along line 2 and magnetic data revealed that the Paintbrush Canyon fault produces the largest gravity and magnetic anomaly in the vicinity of Midway Valley (Figs 1 and 2). Because the fault is concealed, the data provide an accurate location of the fault, which is about 300 m (1,000 ft) east of its mapped but concealed location as shown on the geologic map of Lipman and McKay[3]. Since publication of Lipman and McKay's map, a more detailed geologic map utilizing geophysical evidence shows the fault in the correct location[4]. The amplitude of the gravity anomaly associated with the Paintbrush Canyon fault is about 2 mGal. Using a simple vertical fault model, the observed anomaly infers an offset up on the east side of about 160 to 240 m using a density contrast of 0.3 and 0.2 g/cm^3, respectively.

In addition, the previously collected gravity data revealed steep gradients located at the 400- and 1,000-m distances on Figure 2 and near a mapped but concealed fault[3]. This anomaly is continuous to the south for at least 2 km, has an amplitude of about 0.5 mGal, and probably represents a concealed fault. Using a simple fault model, the observed anomaly infers an offset of about 40 to 60 m using a density contrast of 0.3 and 0.2 g/cm^3, respectively. A subsequent seismic refraction profile (H.D. Ackerman, written commun., 1984) indicated a low velocity zone at depth and electromagnetic soundings[5] indicated a major lateral discontinuity coincident with the gravity anomaly.

Detailed gravity and magnetic data along profiles G1 and G4 (Figs 3 and 4) show prominent anomalies associated with both the Bow Ridge and Paintbrush faults (Fig 1). On both profiles G1 and G4, the Paintbrush Canyon fault is characterized by a gravity anomaly with an amplitude of about 2 mGal and a magnetic anomaly amplitude of about 320 nT. Other gravity data profiles in Midway Valley also show that the amplitude of the Paintbrush Canyon fault is consistently about 2 mGal.

Gravity and magnetic data along profiles G1 and G4 indicate the presence of other faults concealed under alluvium, one adjacent to the Bow

Ridge fault and others in the central part of Midway Valley. The inferred faults in the central part of Midway Valley are located at about 1,400 and 1,800 m along G1 and at about 1,500 and 1,900 m along profile G4 (Figs 3 and 4). These gradients apparently correlate to the gravity gradients along line 2 at 400 and 1,000 m (Fig 2). Together, these two faults in the central part of Midway Valley define a gravity and magnetic high referred to as the Midway Valley feature.

SUMMARY

Detailed gravity and magnetic data collected along profiles across Midway Valley reveal the presence of several unknown and concealed faults. These data are useful for delineating and mapping suspected faults in the vicinity of Yucca Mountain, the site of a potential nuclear waste repository. In addition, these detailed geophysical data provide a more accurate location of mapped but concealed faults in Midway Valley that include the Bow Ridge and Paintbrush Canyon faults.

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ACKNOWLEDGMENTS

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REFERENCES

1 M.D. Carr, S.J. Waddell, G.S. Vick, J.M. Stock, S.A. Monsen, A.G. Harris, B.W. Cork, and F.M. Byers, "Geology of drill hole UE25p#1: A test hole into pre-Tertiary rocks near Yucca Mountain, southern Nevada," *U.S.*

Geological Survey Open-File Report 86-175, 87 p. (1986)

2. R.W. SPENGLER, F.M. BYERS, JR., and J.B. WARNER, "Stratigraphy and structure of volcanic rocks in drill hole USW-G1, Yucca Mountain, Nye County, Nevada," *U.S. Geological Survey Open-File Report 81-1349,* 50 p (1981).

3. P.W. LIPMAN andE.J. MCKAY, "Geologic map of the Topopah Spring SW quadrangle, Nye County, Nevada," *U.S. Geological Survey Geologic Quadrangle Map GQ-439,* scale 1:24,000 (1965).

4. R.B. SCOTT, and JERRY BONK, "Preliminary geologic map of Yucca Mountain, Nye County, Nevada with geologic sections," *U.S. Geological Survey Open-File Report 84-494,* scale 1:48,000 (1984).

5 F.C. FRISCHKNECHT, and P.V. RAAB, "Time-domain electromagnetic soundings at the Nevada Test Site, Nevada," *Geophysics, v. 49, no. 7,* p. 981-992 (1984).

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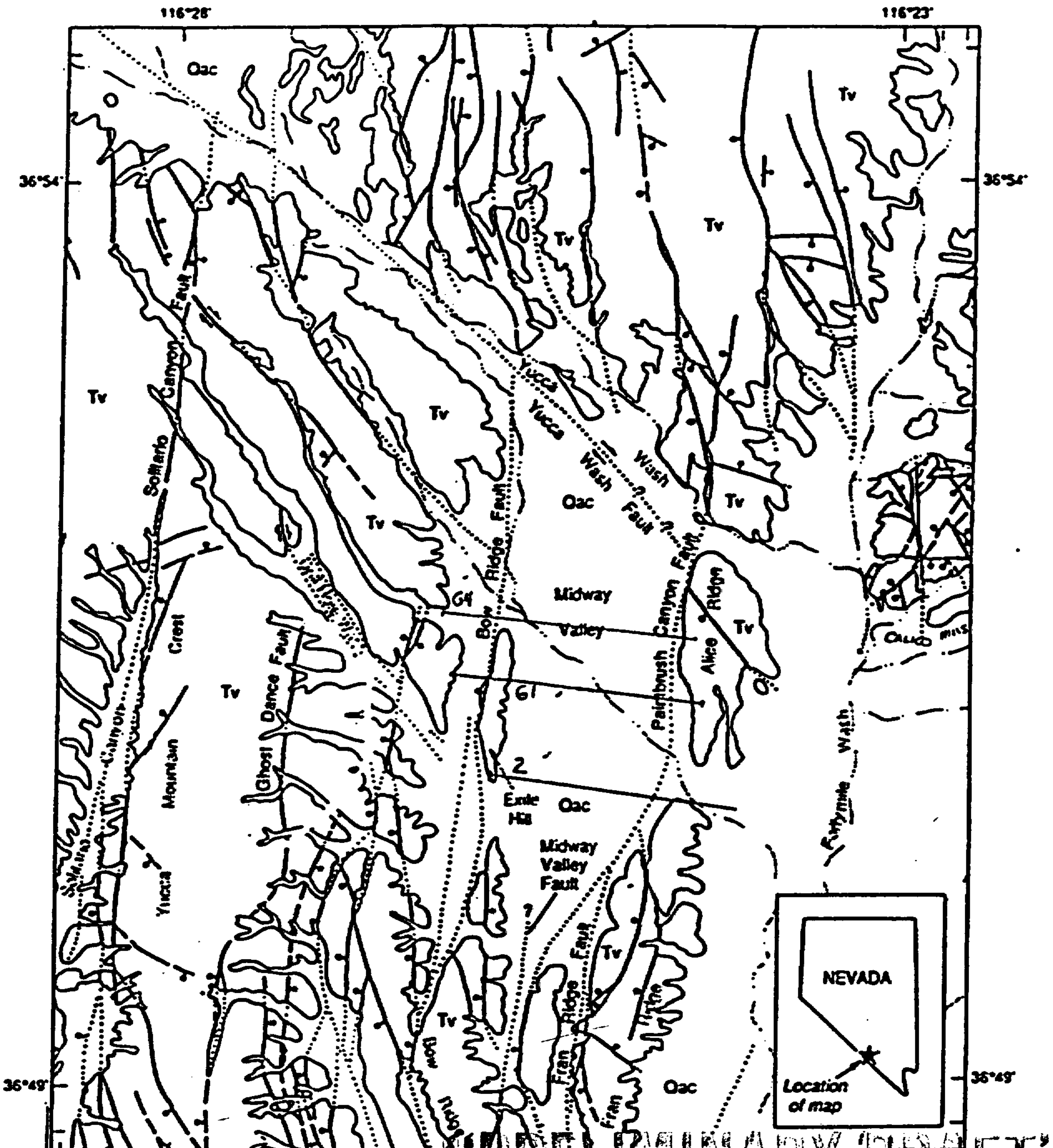
FIGURE CAPTIONS

Figure 1 - Index map of Yucca Mountain and vicinity showing generalized geology and the location of three gravity and magnetic profiles across Midway Valley (lines 2, G1, and G4). Tv, Tertiary volcanic rocks; Qac, Quaternary alluvium; Solid lines, faults; Dashed lines, concealed faults; Ball, downthrown side.

Figure 2 - Magnetic, gravity, and topographic profiles along line 2. Mapped faults[3] are shown as solid vertical lines.

Figure 3 - Magnetic, gravity, and topographic profiles along line G1. Mapped faults[3] are shown as solid vertical lines.

Figure 4 - Magnetic, gravity, and topographic profiles along line G4. Mapped faults[3] are shown as solid vertical lines.



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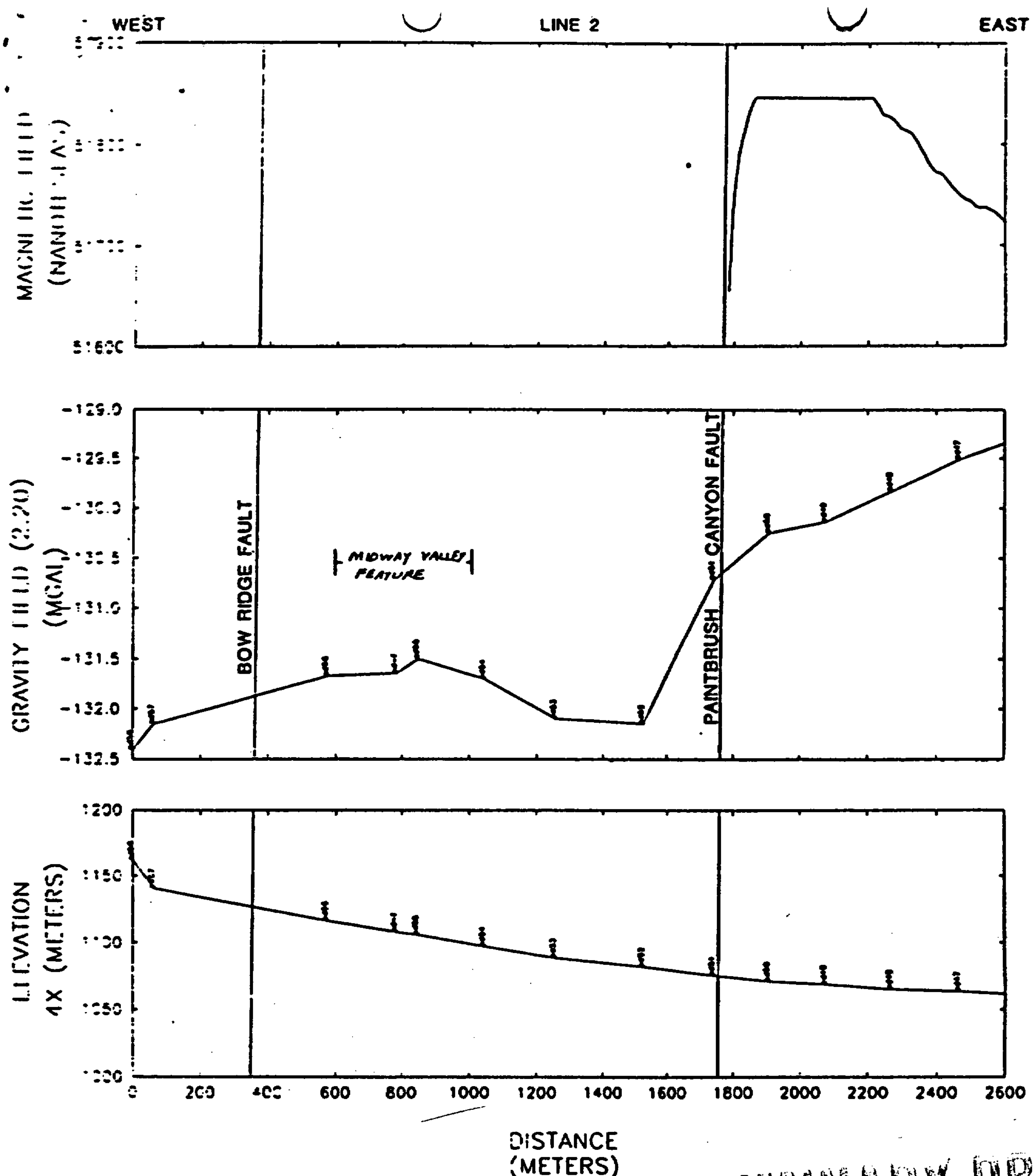

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Figure 2 - Magnetic, gravity, and topographic profiles along line 2. Mapped faults[3] are shown as solid vertical lines.

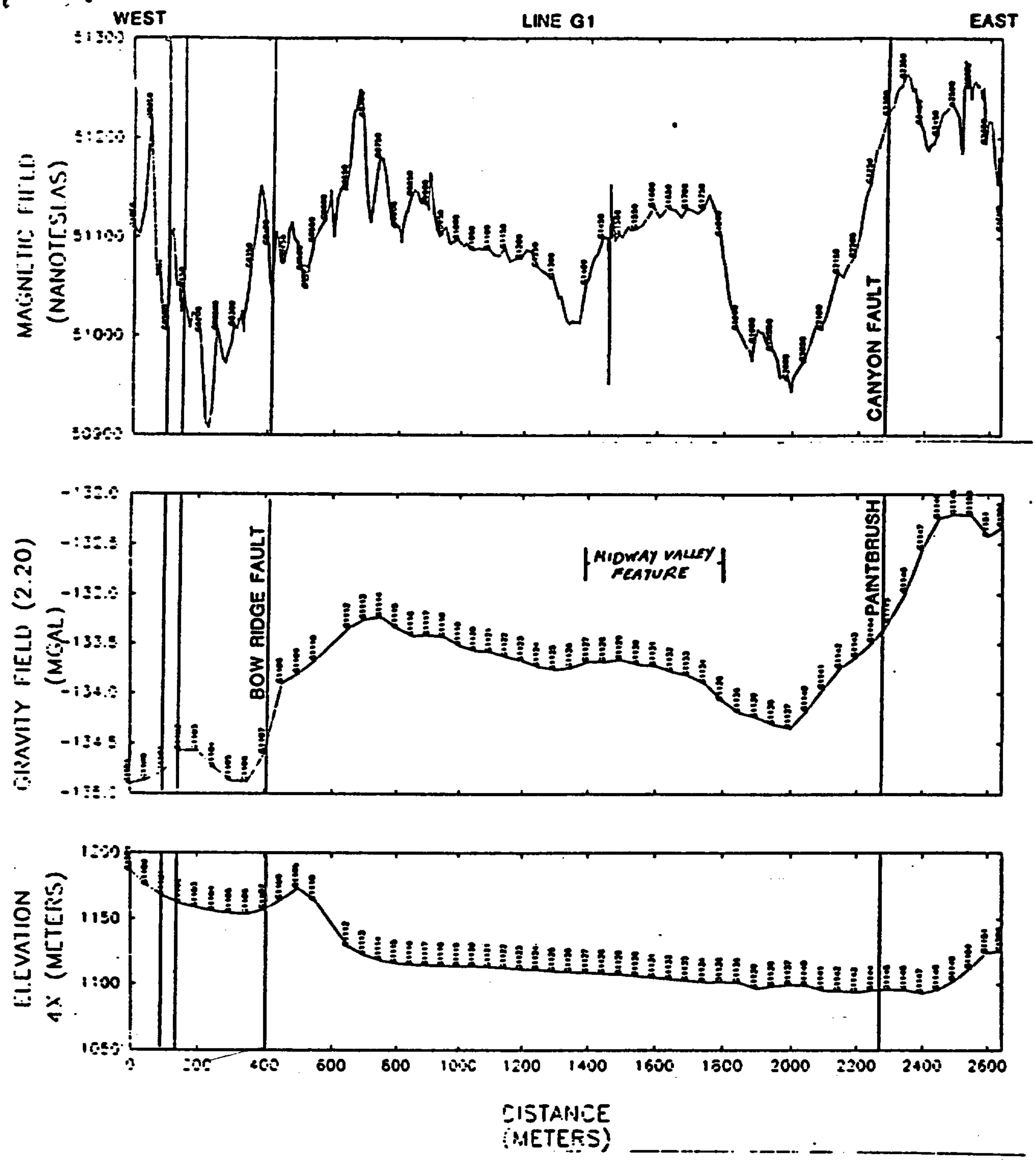

Figure 3 - Magnetic, gravity, and topographic profiles along line G1. Mapped faults[3] are shown as solid vertical lines.

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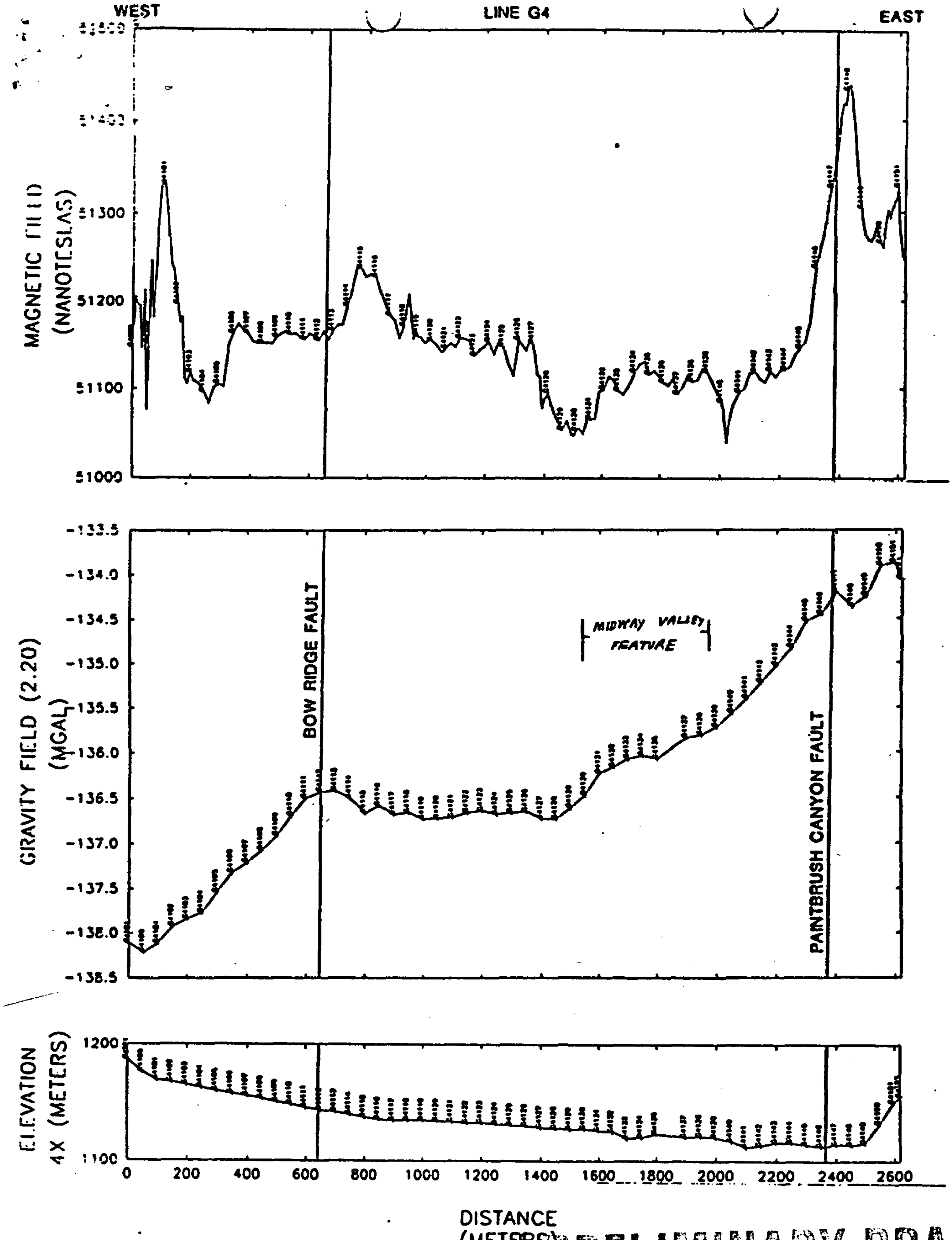

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Figure 4 - Magnetic, gravity, and topographic profiles along line G4. Mapped faults[3] are shown as solid vertical lines.