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# GRAVITY AND MAGNETIC DATA OF MIDWAY VALLEY, SOUTHWEST NEVADA

*By*

**D.A. Ponce, V.E. Langenheim, and R.F. Sikora[1]**

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[1] **U.S. Geological Survey, Menlo Park, CA**

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## ABSTRACT

Detailed gravity and ground magnetic data collected along five traverses across Midway Valley on the eastern flank of Yucca Mountain in southwest Nevada are described. These data were collected as part of an effort to evaluate faulting in the vicinity of proposed surface facilities for a potential nuclear waste repository at Yucca Mountain. Geophysical data show that Midway Valley is bounded by large gravity and magnetic anomalies associated with the Bow Ridge and Paintbrush Canyon faults, on the west side of Exile Hill and on the west flank of Fran Ridge, respectively. In addition, Midway Valley itself is characterized by a number of small-amplitude anomalies that probably reflect small-scale faulting beneath Midway Valley.

## INTRODUCTION

A gravity and magnetic investigation of Midway Valley was begun as part of an effort to help characterize faulting in Midway Valley near proposed surface facilities for a potential site for a nuclear waste repository at Yucca Mountain. Midway Valley is a linear feature that extends for about 5 km (3 mi) along the east side of Yucca Mountain. The study area is in the southwest quadrant of the Nevada Test Site (NTS) and is bounded by Yucca Mountain to the west, Yucca Wash to the north, Fortymile Wash to the east, and Bow Ridge to the south (fig. 1).

Because previous gravity data (Ponce and others, 1992) revealed an anomaly in Midway Valley associated with a concealed fault mapped by Lipman and McKay (1965), additional data were collected to better define the location of this fault and to possibly locate other unknown faults. The possible occurence of faults beneath Midway Valley is important to the siting of the proposed surface facilities and the hydrology of the waste repository.

## ACKNOWLEDGMENTS

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## GENERAL GEOLOGY

The general stratigraphy that underlies Midway Valley is composed of Precambrian and Paleozoic rocks, a series of Miocene ash-flow tuffs interbedded with relatively thin ash-fall and re-worked tuffs, and late Tertiary and Quaternary surficial deposits. Pre-Cenozoic sedimentary and metamorphic rocks in the study area are predominantly limestone and dolomite, with lesser amounts of argillite, quartzite, and marble (U.S. Geological Survey, 1984). The Paleozoic Devils Gate Limestone, Nevada Formation, and Eleana Formation are exposed in the northeastern part of the study area at Calico Hills (McKay and Williams, 1964). The Lone Mountain Dolomite and the Roberts Mountain Formation were penetrated in drill-hole UE-25p#1 west of Fran Ridge (fig. 1, p#1), at depths of 1,244 and 1,667 m, respectively (Muller and Kibler, 1984).

Five major Cenozoic volcanic rock units occur; in ascending order these are: (1) older ash-flow tuffs, (2) Lithic Ridge Tuff, (3) Crater Flat Tuff, (4) tuffaceous beds of Calico Hills, and (5) 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 (Spengler and other, 1981).

## GRAVITY DATA

Detailed gravity data were collected along five profiles across Midway Valley (fig. 1) using LaCoste and Romberg gravity meters G17C and G614. Gravity meter performance and calibration factors were checked over the Mount Hamilton calibration loop near Menlo Park, California (Ponce and Oliver, 1981). Gravity data were reduced using the Geodetic Reference System of 1967 (International Union of Geodesy and Geophysics, 1971) and referenced to the International Gravity Standardization Net 1971 gravity datum (Morelli, 1974, p. 18). Observed gravity values were tied to base station MERC, at the USGS core library building at Mercury, Nevada (Ponce and Oliver, 1981, p. 13). Because of building construction near base station MERC, a new value of 979,518.91 mGal was determined by repeated ties to absolute gravity stations at TCCA and CP2A, at Test Cell C south of Calico Hills and near Control Point 2, respectively (Harris and others, 1989). Gravity data were reduced to complete Bouguer anomalies for reduction densities of 2.67 and 2.00 g/cm$^3$ and include earth-tide, instrument drift, free-air, Bouguer, latitude, earth-curvature, and terrain corrections. In general, observed gravity values are accurate to about 0.05 mGal, while Bouguer gravity anomalies are accurate to about 0.1 mGal.

Horizontal and vertical control of each gravity station were established using an electronic-distance-measurement instrument and station elevations are accurate to about 0.03 m from a reference bench mark. Gravity stations were spaced about 50 m apart along traverses that are about 2 to 3 km long. Principal facts of the gravity data, including their horizontal and vertical locations are contained on the diskette.

Terrain corrections were computed to a radial distance of 167 km and involved a three-part process: (1) Hayford-Bowie zones A and B with an 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 with an outer radius of 590 m were calculated by averaging compartment elevations on a circular template based on Hayford's system of zones (Swick, 1942, p. 66), and (3) terrain corrections from a distance of 0.59 km to 167 km were calculated using a digital elevation model and a procedure by Plouff (1977).

## MAGNETIC DATA

Ground magnetic data with the sensor at 2.4 m above the surface were collected along five profiles across Midway Valley (fig. 1). Maximum station spacing was 20 paces or about 18 m while minimum spacing was 1 pace or about 1 m. Locations of magnetic stations between surveyed control points (i.e., gravity stations) were determined by interpolation using the number of paces and the surveyed distances between control points.

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) and the profile lines were long (up to about 3 km), a base station magnetometer was used or a temporary base along the traverse was periodically re-occupied during the survey to make corrections for diurnal variations of the Earth's magnetic field. The base station magnetometer was located near the center of the study area (B, fig. 1) and readings were usually recorded at about 1-minute intervals. Magnetic observations are accurate to about 1 nT.

## DISCUSSION

Gravity and magnetic data (figs. 2a-e) along five traverses across Midway Valley show prominent anomalies assocated with known faults and reveal a number of possible concealed faults beneath Midway Valley. The Bow Ridge fault, on the west side of Exile Hill, is characterized by a gravity anomaly with an amplitude of about 1 mGal and a magnetic anomaly with an amplitude of about 80 nT. The Paintbrush Canyon fault, on the west flank of Fran and Alice Ridges is characterized by a gravity anomaly with an amplitude of about 2 mGal and a magnetic anomaly with an amplitude of about 320 nT and is the largest gravity and magnetic anomaly in the vicinity of Midway Valley. Using as a simple gravity model the maximum effect of a vertical fault and a density contrast of about 0.3 to 0.2 g/cm$^3$ between welded and non-welded tuff units the observed data infer a vertical offset of about 100 m for the Bow Ridge fault and about 200 m for the Paintbrush Canyon fault (see Ponce and others, 1992; Ponce, 1993).

The central part of Midway Valley is characterized by several small-amplitude anomalies that probably reflect small-scale faulting beneath Midway Valley. One such anomaly, is especially well defined by gravity and magnetic data along profiles G3, G2, G1, and G4 (figs. 2a-2d). These profiles reveal a gravity and magnetic high that probably reflects a horst-like feature in the central part of Midway Valley and is referred to as the Midway Valley fault or feature (Ponce, 1993). This feature is near the concealed fault mapped by Lipman and McKay (1965) and is characterized by a gravity anomaly with an amplitude of about 0.5 mGal and a magnetic anomaly with an amplitude of about 80 to 210 nT. Using as a gravity model the maximum effect of a vertical fault and a density contrast of about 0.3 to 0.2 $g/cm^3$ between welded and non-welded tuff units the observed data infer an offset of about 50 m for each of the faults that compose the Midway Valley feature.

Gravity and magnetic studies show that they are useful for delineating major faults at Yucca Mountain such as the Bow Ridge and Paintbrush Canyon faults, and minor faults such as those concealed beneath Midway Valley. Detailed gravity, magnetic, and electrical data could provide an effective means to better define the location of known or suspected faults and to locate concealed or unknown faults.

## DESCRIPTION OF DISKETTE

The data described in this report are available on a $3\frac{1}{2}$-inch, high-density, and double-sided diskette formatted for IBM personal computers. The diskette requires the following hardware: (1) an IBM personal computer or compatible computer running PC- or MS-DOS, and (2) a double-sided high-density disk drive.

The diskette contains a total of 12 files:

*readme.txt*, a description of the gravity and magnetic data;

*mv.cba*, principal facts of gravity data;

*g1.grv*, gravity data along profile G1;

*g2.grv*, gravity data along profile G2;

*g3.grv*, gravity data along profile G3;

*g4.grv*, gravity data along profile G4;

*ya.grv*, gravity data along profile YA;

*g1.mag*, magnetic data along profile G1;

*g2.mag*, magnetic data along profile G2;

*g3.mag*, magnetic data along profile G3;

*g4.mag*, magnetic data along profile G4; and

*ya.mag*, magnetic data along profile YA.

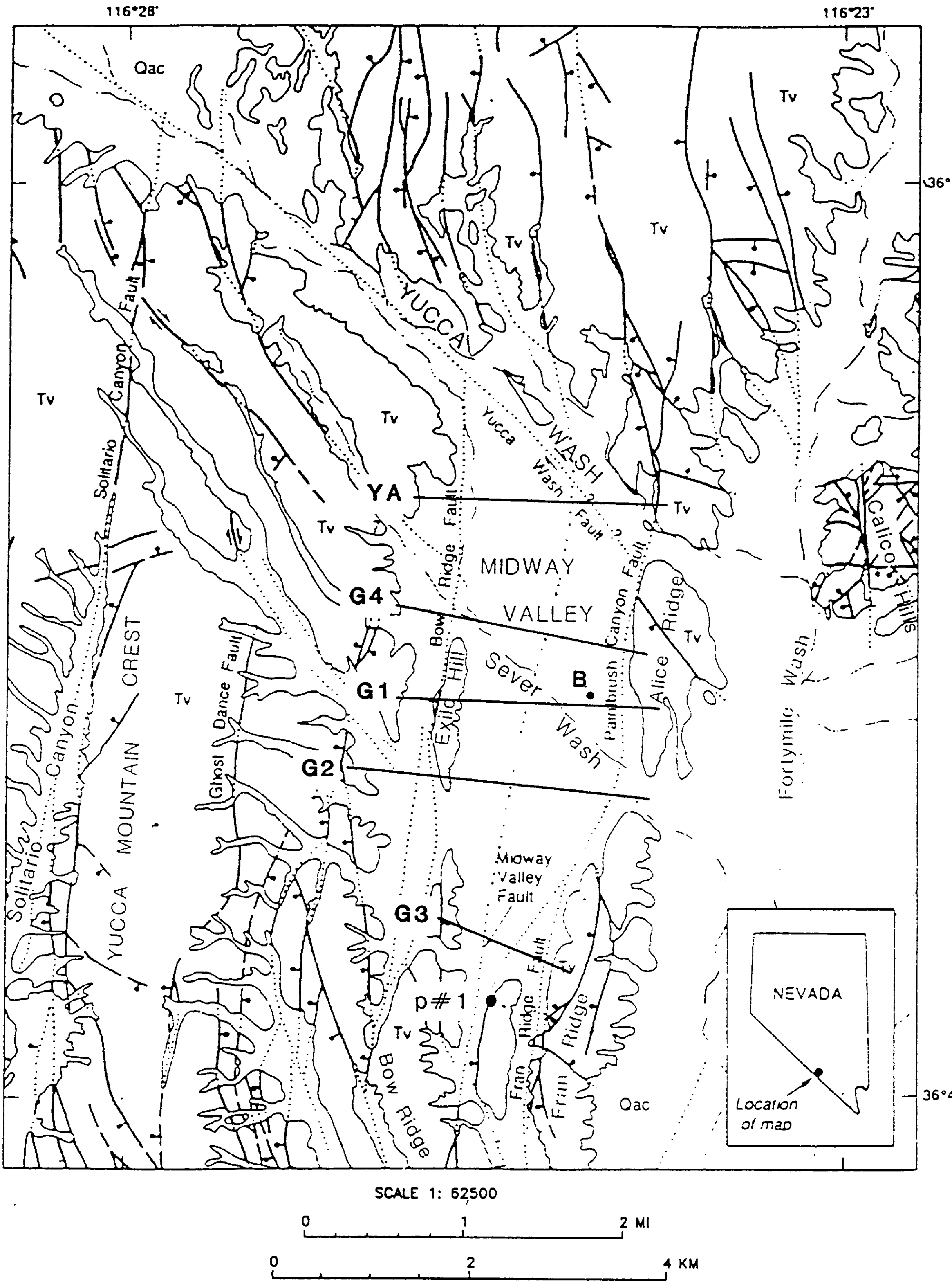


FIGURE 1.–Generalized geologic map of the study area showing locations of gravity and magnetic profiles across Midway Valley. B, approximate location of base station magnetometer; Tv, Tertiary volcanic rocks; Qac, Quaternary alluvium and colluvium; Bold lines, faults, dotted where concealed, ball and bar on downthrown side, arrows indicate relative movement. (Modified form Lipman and McKay, 1965; Scott and Bonk, 1984).

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