MAP GP-997

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MAP SHOWING INTERPRETATION OF GEOPHYSICAL ANOMALIES OF THE NORTHWESTERN UNCOMPAHGRE UPLIFT AND VICINITY, GRAND COUNTY, UTAH, AND MESA COUNTY, COLORADO

By James E. Case, Robert L. Morin,
and Robert P. Dickerson

GEOPHYSICAL INVESTIGATIONS MAP
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CASE AND OTHERS—GEOPHYSICAL ANOMALIES, GRAND COUNTY, UTAH, AND MESA COUNTY, COLORADO 1:125,000 MAP GP-997

INTERPRETATION OF GEOPHYSICAL ANOMALIES OF THE NORTHWESTERN UNCOMPAHGRE UPLIFT AND VICINITY, GRAND COUNTY, UTAH, AND MESA COUNTY, COLORADO

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STUDIES RELATED TO WILDERNESS

BUREAU OF LAND MANAGEMENT WILDERNESS STUDY AREAS

The Federal Land Policy and Management Act (Public Law 94-579, October 21, 1976) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a geophysical survey of the Black Ridge Canyons (CO-070-113/113A; UT-060-116/117) Wilderness Study Area, Mesa County, Colorado, and Grand County, Utah, and the Westwater Canyon (UT-060-118) Wilderness Study Area, Grand County, Utah.

INTRODUCTION

Gravity and magnetic surveys were conducted for areas covering the northwestern Uncompahgre uplift and vicinity, including the Black Ridge Canyons, Colorado, and the Westwater Canyon, Utah, Wilderness Study Areas (Dickerson and others, 1988), to provide data on the distribution of exposed and concealed Precambrian rocks and on the thickness and structure of the sedimentary rocks (fig. 1, index map). These geophysical data were also used in determining the amount of structural relief across the faulted northeastern and southwestern flanks of the uplift and may be pertinent to the evaluation of potential oil and gas and metallic resources in the area.

This report is a regional interpretation of gravity and aeromagnetic data obtained in 1985–87 as part of the Wilderness program that covers an area broader than the specific wilderness study areas. It incorporates interpretations of older gravity and magnetic data from the western part of the study area (Case, 1966; Case and Joesting, 1972).

Gravity and magnetic data used in this report were collected in several stages. West of long 109° W., including the Westwater Canyon Wilderness Study Area, gravity and magnetic surveys were made as part of the Colorado Plateau Regional Studies project of the U.S. Geological Survey, and the data and interpretations were reported by Case (1966), Joesting and Case (1962), and Case and Joesting (1972). For the Black Ridge Canyons Wilderness Study Area (generally east of long 109° W.), new aeromagnetic surveys were flown in 1985 (U.S. Geological Survey, 1987). We also included in our compilation additional gravity surveys that were made in 1986 in both the Black Ridge Canyons and Westwater Canyon areas (Morin, 1987).

Gravity and magnetic maps (sheets 2 and 3) were compiled at a scale of 1:125,000 to aid in the appraisal of the mineral resource potential of the wilderness study areas (Dickerson and others, 1988). A 1:24,000-scale geologic map emphasizing the Proterozoic geology has been prepared for the Westwater Canyon and western Black Ridge Canyons areas and vicinity (Case, 1991) to assist in the interpretation of the geophysical anomalies of the Uncompahgre uplift as well as to establish the regional geologic framework of the crystalline basement (see also, Case, 1966). Additional information on Proterozoic rocks east of long 109° W. is found in reports by Lohman (1965), Toth and others (1983), and Dickerson and others (1988).

An interpretation of the predominant, unexposed Proterozoic rock types based on the aeromagnetic and gravity surveys is superimposed on a simplified geologic and structural map (sheet 1). We have interpreted the unexposed Proterozoic rock types to be those that are exposed on the Uncompahgre uplift. It is very possible that some geophysical anomalies are produced by presently unexposed Proterozoic rocks, such as other lithologic varieties that have been mapped in the Gunnison uplift (Hansen, 1971) and Needle Mountains (Barker, 1969) of western Colorado.

GEOPHYSICAL SURVEYS

Magnetic surveys were flown in 1956–58 over the area west of long 109° W. (sheet 3). Flightlines were spaced about 1.7 to 3.2 km apart on east-west lines at a barometric elevation of about 2,590 m above sea level. A fluxgate magnetometer was used for the measurements. The 1985 survey between long 108°42′ W. and long 109°02′ W. (sheet 3) was flown approximately 150 m above the mean terrain elevation along lines spaced approximately 800 m apart. A proton-precession magnetometer, enhanced by a horizontal gradiometer, was used for this survey. Details of the survey, including parameters of data reduction, are provided as marginal data for the magnetic map (U.S. Geological Survey, 1987). A magnetic survey of the study area was flown approximately 120 m above the mean terrain elevation as part of the National Uranium Resource Evaluation (NURE) program, and results were interpreted in terms of basement lineaments (Johnson, 1983). This survey was flown along flightlines spaced approximately 4.8 km apart, and substantial differences can be seen between the contour maps of the NURE data (not used for this report) and the maps of this report, which are based on more closely spaced data.

Gravity data used for this report were compiled from surveys made in 1962–63. The survey used a Worden gravity meter; altimetric surveys, photogrammetric spot elevations, and a few bench marks provided elevation control. Another survey was made in 1986 using a LaCoste and Romberg gravity meter. Both surveys were reduced using standard procedures (Morin, 1987). The Bouguer anomaly map (sheet 2) was subsequently prepared using a reduction density of 2.67 g/cm^3, and terrain corrections were applied to distances of 0.4 to 166.7 km from each station.

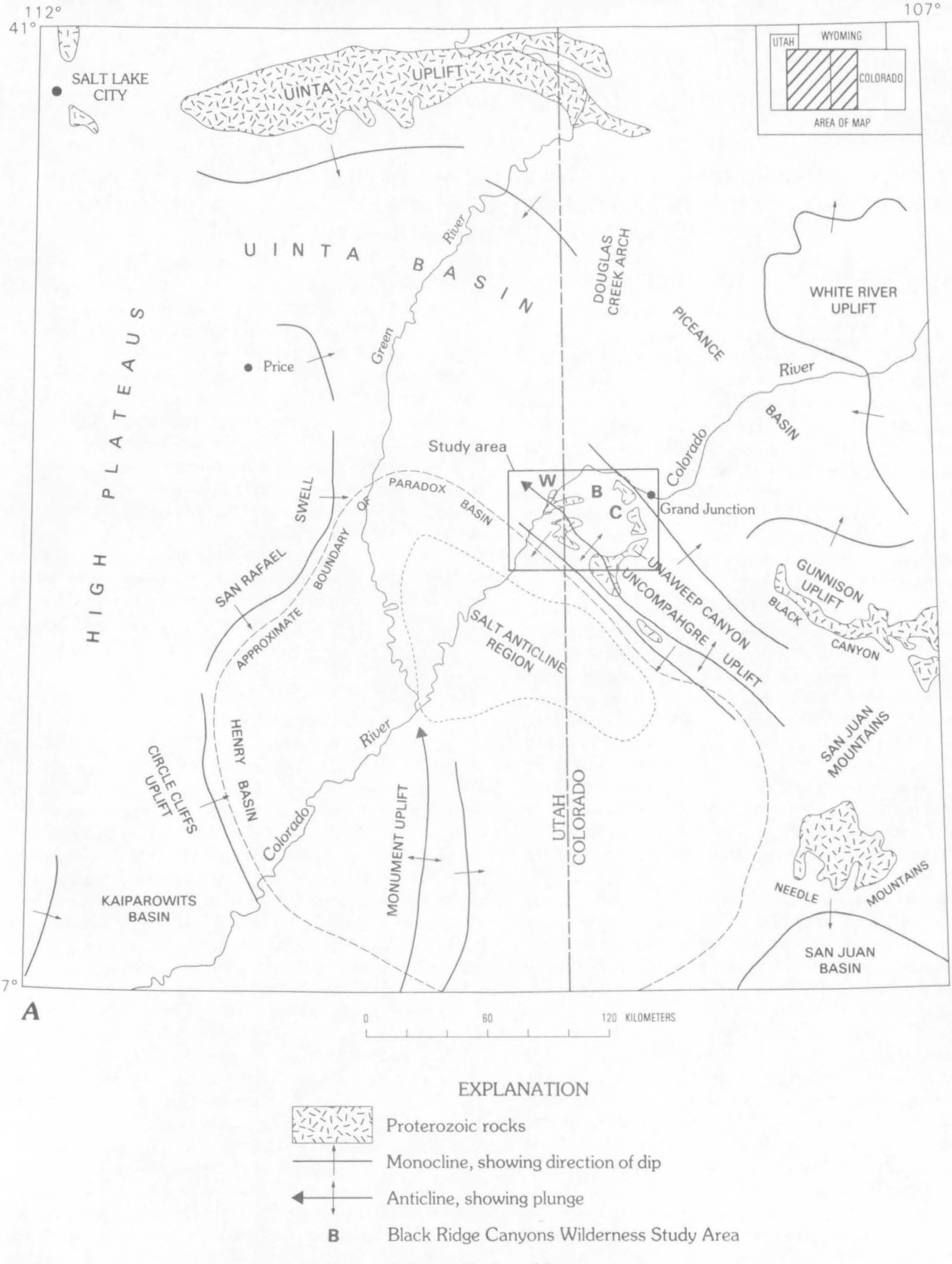
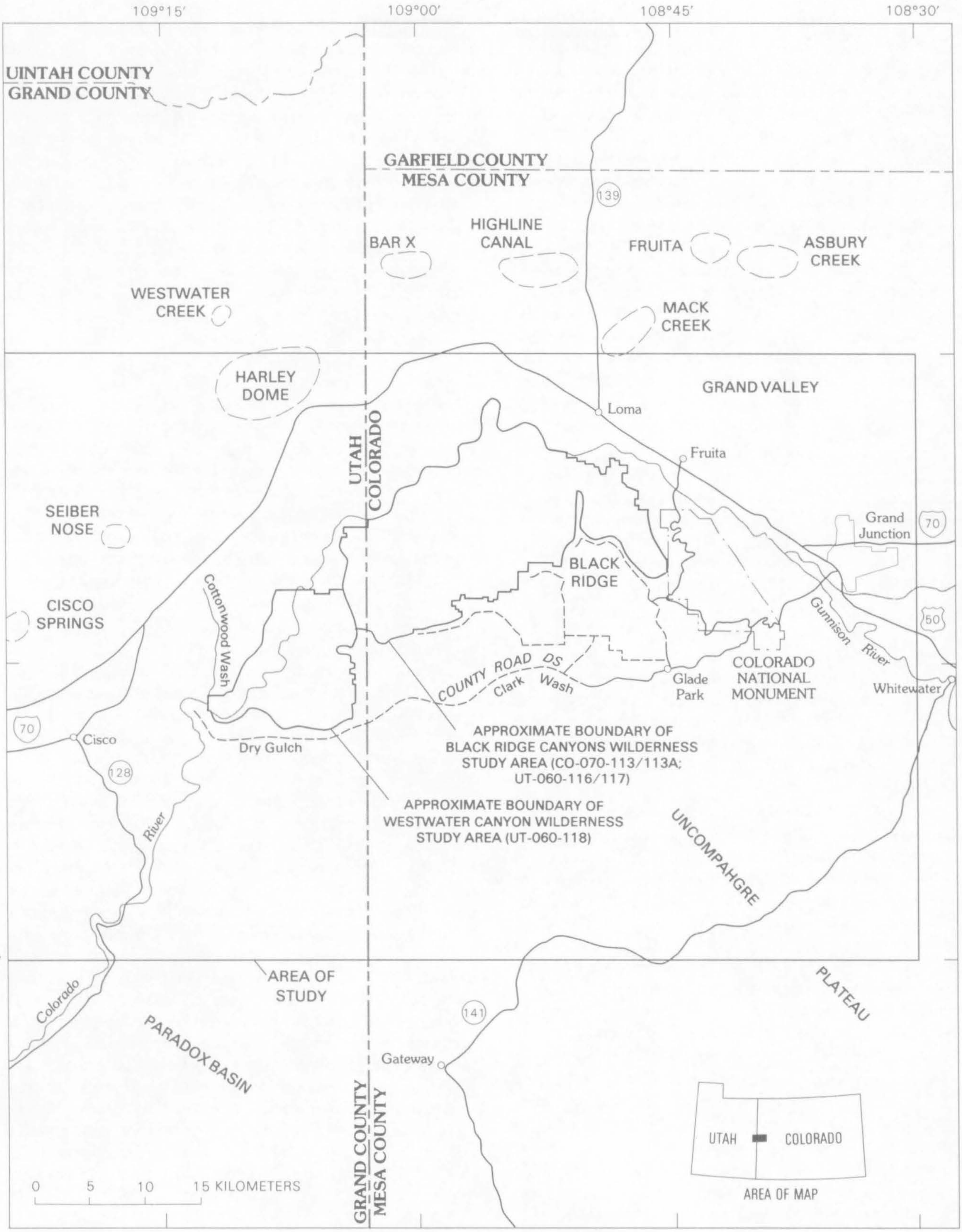


Figure 1. Index maps. ***A***, Parts of Utah and Colorado, showing location of northwestern Uncompahgre Plateau and adjacent areas discussed in this report, some regional structural features (major fold axis, solid dark line; dip, small arrows; plunge, large arrows), and larger outcrops of Precambrian rocks (patterned area). Modified from Case (1966). ***B***, Location of the Black Ridge Canyons and Westwater Canyon Wilderness Study Areas, Grand County, Utah, and Mesa County, Colorado. Oil and gas fields are outlined by long-dashed lines. Modified from Dickerson and others (1988).



B

Figure 1. Continued.

REGIONAL GEOLOGIC SETTING

The Proterozoic core of the northwestern Uncompahgre uplift, west of long 109° W., is composed of five major rock units characterized by their unique lithologic and geophysical properties (figs. 2 and 3, sheet 1). The oldest unit in the northern part of the area is a gneissic sequence (unit **p€m**, sheet 1) composed principally of metaigneous and metasedimentary rocks. Metaigneous rocks include a structurally lowest, complexly folded and interlayered feldspathic gneiss; amphibole gneiss; and porphyroblastic microcline gneiss (metaigneous). Metasedimentary rocks include migmatitic, pink biotite microcline gneiss and sillimanite gneiss (metasedimentary). The age of the metaigneous rocks is at least 1,700 Ma or older (Leon T. Silver in Case, 1991). In general, the metamorphic sequence is of high grade and represents the amphibolite facies, almandine and (or) sillimanite zones in the classification of Turner (1968). Most of this sequence is relatively nonmagnetic and of average density, about 2.7 g/cm^3. The amphibolite and amphibole gneiss are relatively dense, greater than 2.7 to 3.0 g/cm^3.

The second unit is composed of gneissic granodiorite (unit **p€gg**, sheet 1), which intrudes the older sequence of metamorphic rocks. Gradations from foliated gneissic rocks to massive unfoliated granodioritic or quartz monzonitic rocks are common. The unit is relatively nonmagnetic and somewhat denser than average; densities are about 2.8 g/cm^3. The age is about 1,670 Ma or older (Hedge and others, 1968).

The third unit (unit **p€qm**, sheet 1) includes parts of a quartz monzonite batholith, termed the Vernal Mesa(?) Quartz Monzonite. The batholith is composed chiefly of coarsely porphyritic biotite quartz monzonite, which is characterized by large pink euhedral phenocrysts of feldspar. The rock, which is generally unfoliated except locally, is magnetic and has a high sphene content (TiO_2 content as great as 1 percent). The rock is of average density, about 2.7 g/cm^3. The age is about 1,430 Ma (Bickford and Cudzilo, 1975).

The fourth unit of geophysical significance is a metadiorite-metagabbro pluton (unit **p€d**, sheet 1), exposed in the lower canyon of the Little Dolores River and vicinity. The pluton is a medium- to coarse-grained rock, composed mainly of variable amounts of amphibole and plagioclase, that forms a stocklike mass about 3.2 km in diameter. The pluton intrudes the older metamorphic sequences (units **p€m** and **p€gg**), but has been metamorphosed itself to some extent. The pluton is magnetic and relatively dense, about 2.8 to 3.0 g/cm^3. The absolute age is unknown. This pluton may be zoned, suggested by compositional variations, but the detailed petrographic and chemical studies to determine this have not been done.

The fifth unit, a highly magnetic unit near lat 38°56′ N., long 109°00′ W. producing anomalies of more than 1,000 gammas, may be composed of metalamprophyre or metapyroxenite, but the principal source is concealed. Johnson (1983) termed the source intrusive.

The older sequence of metamorphic rocks (the first and second units described) has been deformed at least twice: axes of older folds probably trended north, northwest, and northeast; axes of younger folds trend east to northeast (Case, 1991).

Shear zones of Proterozoic age were precursors to the east-trending Laramide Dry Gulch fault zone and possibly to the northwest-trending Little Dolores River fault zone (sheet 1).

Exposed Phanerozoic strata in the area range in age from Permian (Cutler Formation) to Tertiary (table 1). Concealed sedimentary units in the Paradox basin include Cambrian, Devonian, Mississippian, Pennsylvanian, and Permian strata. The aggregate preserved thickness of the sedimentary sequence is at least 4,900 m in the Paradox basin (see summary by Case and Joesting, 1972). Near Grand Junction, the aggregate thickness of the stratigraphic sequence from the Chinle Formation (Triassic) to the Mancos Shale (Cretaceous) is probably about 610 m (Lohman, 1965). The sedimentary sequence is regarded as effectively nonmagnetic. Densities of the sedimentary rocks have a wide range, as summarized in table 1. More detailed descriptions of the sedimentary rocks of the region are provided by a number of other authors such as Lohman (1963, 1965), Toth and others (1983), Dickerson and others (1988), Cashion (1973), Dane (1935), and Williams (1964).

Structural relief of the Proterozoic surface from the deepest part of the Paradox basin to the crest of the Uncompahgre uplift is about 6,100 m (fig. 3). In contrast, structural relief of the base of the Wingate Sandstone is about 2,100 to 2,400 m, and relief of the base of the Dakota Sandstone, from the axis of Sagers Wash syncline to the crest of the uplift is about 1,200 to 2,400 m, depending on location along the syncline (sheet 1; see summary by Case and Joesting, 1972).

INTERPRETATION OF THE GRAVITY ANOMALIES

Detailed interpretations of gravity anomalies west of long 109° W. are provided in earlier reports by Case (1966), Case and Joesting (1972), and Joesting and Case (1962).

Bouguer anomalies range from maximum values of about −174 mGal over the crest of the Uncompahgre uplift, in the Glade Park area (sheet 2) to minimum values of about −236 mGal to the southwest in the Paradox basin. To the northeast, values range from about −196 to −202 mGal in Grand Valley. Most of this variation in the anomaly values is attributed to the structural relief of the Proterozoic surface, because the Proterozoic rocks are denser (about 2.6 to 3.0 g/cm^3) than the overlying Mesozoic strata (about 2.5 g/cm^3). Relatively denser Proterozoic rocks may also be present near the crest of the uplift. Additionally, the larger negative values in the Paradox basin are partly produced by the low-density evaporites of the Pennsylvanian Paradox Member of the Hermosa Formation.

Two local gravity highs are superimposed on the main high of the uplift. The Little Dolores River pluton, composed of metagabbro-metadiorite (densities, 2.8 to 3.0 g/cm^3), causes a residual positive anomaly of 4 to 8 mGal, depending on choice of regional field (A, sheet 2). The ovoid body, which is about 3.2 km in diameter, also produces a magnetic high (A, Sheet 3). The main gravity anomaly nose is somewhat greater in breadth than that extrapolated from exposed contacts, so the breadth may increase with depth. Farther west, a gravity high of 3 to 4 mGal near lat 39° N., long 109°14′ W. (C, sheets 2 and 3) may be due to a small, concealed mafic pluton because of its associated gravity and magnetic anomalies.

A simplified gravity model (fig. 4) has been calculated across the northern flank of the Uncompahgre uplift along profile *A–A′* (sheet 2). Simplifying assumptions are that the gravity field is two-dimensional, that the mean density of the Mesozoic sequence is 2.5 g/cm^3, and that the mean density of the Proterozoic basement is about 2.7 g/cm^3. On a broad regional scale, the Bouguer anomaly field decreases northeastward and eastward toward the Sawatch Range (200 km east of the study area), where anomaly values are more negative than -300 mGal (see Behrendt and Bajwa, 1974). A positive isostatic residual anomaly of about 20 mGal has been calculated over the Uncompahgre uplift (Jachens and others, 1985). Accordingly, a northward-sloping regional field of about 0.46 mGal/km was removed from the Bouguer anomalies along profile *A–A′*. The residual anomaly has been approximately modeled by four bodies: Near the crest of the uplift (body 2, fig. 4), a relatively dense body having a density contrast of +0.25 g/cm^3 (mainly gneissic granodiorite?); farther north (body 1, fig. 4), a body having a contrast of +0.12 g/cm^3 (mainly biotite microcline gneiss and quartz monzonite?); north of the steepest gravity gradient (along the faulted monoclinal flexure (body 3, fig. 4)), a body having a contrast of -0.03 g/cm^3; and a northerly low-density body having a contrast of -0.17 g/cm^3 (body 4, fig. 4). The body of low density at the north end of the profile (body 4, fig. 4) probably represents the Burro Canyon Formation, Dakota Sandstone, and Mancos Shale, which have estimated densities of 2.3 to 2.45 g/cm^3 (Case and Joesting, 1972). The maximum thickness of the sedimentary sequence near Grand Junction is estimated at about 300 m from data of Lohman (1965). If the density of the main sedimentary sequence is 2.5 g/cm^3, the density of the southern body (2) would be 2.75 g/cm^3 (gneissic granodiorite?), that of the adjacent body (1), 2.61 g/cm^3 (biotite-microcline gneiss?), that of body 3, along the steep front, 2.47 g/cm^3, and that of the northerly body (4), 2.33 g/cm^3. It should be noted that the discrepancy between the observed and computed anomalies in the north, near body 4, and the resultant configuration of body 4 may simply be due to incorrect choice of a planar regional field—a curved field is probably more likely.

A major regional zone of steepened gravity gradient trends northwest, parallel to the southwestern flank of the Uncompahgre uplift. The gravity relief of about 50 mGal from the Paradox basin to the crest of the uplift can be attributed to three main factors: (1) structural relief of about 4,100-6,100 m from the axis of the Paradox basin to the crest of the uplift; (2) wedge-out of about 1,200 m of Pennsylvanian evaporites of low density against the late Paleozoic Uncompahgre front; and (3) presence of relatively dense rocks near the crestal region of the uplift, corresponding to the gneissic granodiorite, amphibolite, and amphibole gneiss within the metamorphic sequence (Case, 1966). The general relations are shown schematically for profile *B–B′* (fig. 5). The steep gravity gradient across the Uncompahgre front is matched approximately by the steep computed gravity gradient caused by the rock distribution shown in the model. The gravity data, as well as the magnetic data, indicate that the buried late Paleozoic Uncompahgre front is relatively steep (see, also, figs. 8 and 9, models near Cisco, Utah, Case and Joesting, 1972; Joesting and Case, 1962). These models show a simple near-planar interface between the Proterozoic basement and the adjacent sedimentary rocks; however, the steep gravity gradient across the front can be matched also by models in which either a set of steeply dipping, high-angle normal faults or a set of distributive reverse faults are present at depth (see, also, White and Jacobson, 1983).

A simplified model along profile *B–B′* was computed for this report to illustrate that high-angle reverse faults can also produce the observed anomalies (fig. 6). Northwest of profile *B–B′*, the Mobil No. 1 McCormick Federal "C" well (near lat 39° N., long 109°27′ W., T. 21 S., R. 22 E., sec. 11, Grand County, Utah) penetrated a reverse fault. According to Frahme and Vaughn (1983) the well "...drilled through 3,600 feet of Mesozoic rocks overlying thrusted Precambrian granite. Fourteen thousand feet of granite overhang was drilled before penetrating the Uncompahgre fault and 1,702 feet of Paleozoic rocks beneath it. The Paleozoic section had no significant hydrocarbon shows. Probable Mississippian and Devonian strata occur over apparent Paradox Formation, suggestive of overturning." Unfortunately, gravity coverage near the No. 1 McCormick Federal well is too scant to justify a gravity model.

Some of the gravity contours swing to a northeast trend around the northwestern plunging nose of the Uncompahgre uplift, and then strike southeast, parallel to the northeastern flank of the uplift.

Numerous anticlines and synclines such as Cisco anticline, Cisco syncline, Cottonwood Creek anticline, Sieber nose, Danish Flat syncline, Harley dome, and Westwater Creek anticline, trend and plunge northwest along the northwest nose of the uplift (sheet 1). These features show no correlation with gravity anomalies, perhaps because the stations are spaced rather widely and the amplitudes of the folds are relatively small.

INTERPRETATION OF MAGNETIC DATA

The Phanerozoic rocks of the area are effectively nonmagnetic as observed from 150 m or more above the surface, so that virtually all magnetic anomalies in this area are attributed to sources within the Proterozoic basement (Case and Joesting, 1972).

The more recent magnetic surveys (U.S. Geological Survey, 1987) of the Black Ridge Canyons area (east of long 109°02′ W., and north of lat 39° N.) are characterized by a series of northwest- to west-trending magnetic highs of 300 to more than 1,000 gammas in amplitude. Few of these magnetic highs coincide with gravity highs, within the limits of the rather widely spaced gravity data, so that basement rocks of average density (about 2.7 g/cm^3) and moderate to high susceptibility (0.001 to 0.003 cgs units) produce most of the magnetic anomalies. The best candidate for the source of the magnetic highs is the Vernal Mesa(?) Quartz Monzonite but no local gravity anomalies are present in areas where this type of rock is exposed (fig. 2, sheets 1-3; and Case, 1966). Magnetization of the quartz monzonite, however, is not uniform. A steep magnetic gradient near Spring Canyon (sheets 1 and 3, about lat 38°55′ N., long 109°05′ W.) is located south of the mapped contact between the quartz monzonite and metamorphic rocks, suggesting lower magnetization of the quartz monzonite to the north (Case, 1966). (An alternative explanation for the discrepancy would be a south-dipping contact, such that rocks of low magnetization underlie a thin wedge of the exposed quartz monzonite.)

Assuming that the anomalies are produced mainly by induced rather than remanent magnetization, approximate boundaries of rock units producing the anomalies should be present near the steepest gradients flanking the southerly sides of the anomalies and somewhat south of the steepest gradients on the north sides of the anomalies. These boundaries probably represent the maximum widths of the bodies causing the anomalies.

In the northern part of the map area, several small, steep-gradient anomalies are probably produced by cultural features such as power facilities, metallic buildings, or railroads (sheet 3, near northeastern corner of magnetic data). Of special interest are the small, sharp high and low near the north end of profile *C–C′*, which are located directly over the petroleum refinery complex at Gilsonite, Colo.

A model across the three main magnetic highs along profile *C–C′* has been calculated (fig. 7) after removal of the "Gilsonite anomaly" using several simplifying assumptions: (1) the anomalies are assumed to be two-dimensional approximations of three-dimensional bodies; (2) the bodies are assumed to be magnetized in the direction of the Earth's present field, which has an intensity of about 0.54 oersted, inclination about 66°, and declination about 21°; and (3) the bodies are assumed to be uniformly magnetized. The last assumption is required for ease of calculation, but cannot be correct in view of the variation in amplitudes of anomalies along strike. A planar, north-sloping regional field of 0.8 gammas per km was removed from the observed field. It should be noted that perhaps 75 percent of a magnetic anomaly is produced by the upper 25 percent of the body, so that the depth extent is not resolved by the models.

The most southerly body (D, sheet 3; body 3, fig. 7) has an apparent magnetization (product of the modeled susceptibility and the Earth's field intensity) of 0.0008 emu and a breadth of about 5,500 m. The middle body (E, sheet 3; body 2, fig. 7) has a magnetization of 0.0018 emu and breadth of about 1,400 to 2,900 m. The northerly body (F, sheet 3; body 1, fig. 7) has a magnetization of about 0.001 emu, an upper breadth of about 2,400 m, and widens at depth to 4,600 m. Obviously, slight changes in configuration or magnetization would produce a better fit between observed and calculated anomalies, but refinements are not warranted because of the variation in amplitude along the strike of the anomalies.

A very large relative residual magnetic high of about 1,500 gammas (G, sheet 3) or more, just east of the Utah-Colorado border near lat 38°56′ N., long 109°02′ W., has a largely concealed source, but small exposures of amphibole-rich rock are present there. Accordingly, a large ovoid magnetite-rich lamprophyre or metapyroxenite body is postulated as a source for the anomaly (see also, Case, 1966). The anomaly was detected on the oldest survey (Case, 1966) from data gathered approximately 600 m above the source. Magnetic surveys conducted as part of the NURE program at about 120 m above the surface likewise indicate an ovoid magnetic high of larger amplitude at the locality, which was interpreted as an "intrusion?" by Johnson (1983).

A relative residual magnetic high of about 300 to 400 gammas (A, sheet 3), as observed from data gathered approximately 900 m above the source, is produced by the Little Dolores River metagabbro-metadiorite pluton (unit p€d). An ovoid outline of the pluton is indicated by the shape of the magnetic anomaly, locations of exposed contacts, and by the general position of the residual gravity high associated with the body (A, sheet 2). Low-amplitude ovoid magnetic highs (B and C, sheet 3) just to the west may also be produced by metagabbro-metadiorite bodies at shallow depth.

Most of the small anticlines and synclines at the northwest nose of the uplift appear to have no magnetic expression on the western survey. A relative residual magnetic high of about 100 gammas underlies parts of both Harley dome and Westwater Creek anticline, but, because of the relatively gentle magnetic gradient and absence of an associated gravity high, the anomaly is interpreted as produced by magnetic quartz monzonite.

Magnetic highs (H and I, sheet 3) at the extreme west-central part of the area are on trend with the positive anomaly produced by the magnetic quartz monzonite to the southeast. They are interpreted as having quartz monzonite sources because they appear to have no associated positive gravity anomalies. Ovoid magnetic highs (J and K, sheet 3) however, may have small associated positive gravity anomalies, and metagabbro-metadiorite plutons could also be postulated as a source rather than quartz monzonite. Detailed gravity surveys should resolve the question.

The Laramide faults are only locally expressed by steepened magnetic gradients: The faulted monocline south of Fruita, Colo., locally parallels a steep magnetic gradient, but the magnetic high (L, sheet 3) is on the downthrown side of the fault. Similarly, the Little Dolores River fault is locally parallel to a steep gradient, but a magnetic high (M, sheet 3) is on the downthrown side of the fault perhaps due to magnetic quartz monzonite. These relations emphasize the intrabasement origin of most of the magnetic anomalies. The east-central segment of the Dry Gulch fault parallels a steep gradient, and the east and west segments are near the trough of a magnetic low.

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FIGURES 2-7 AND TABLE 1

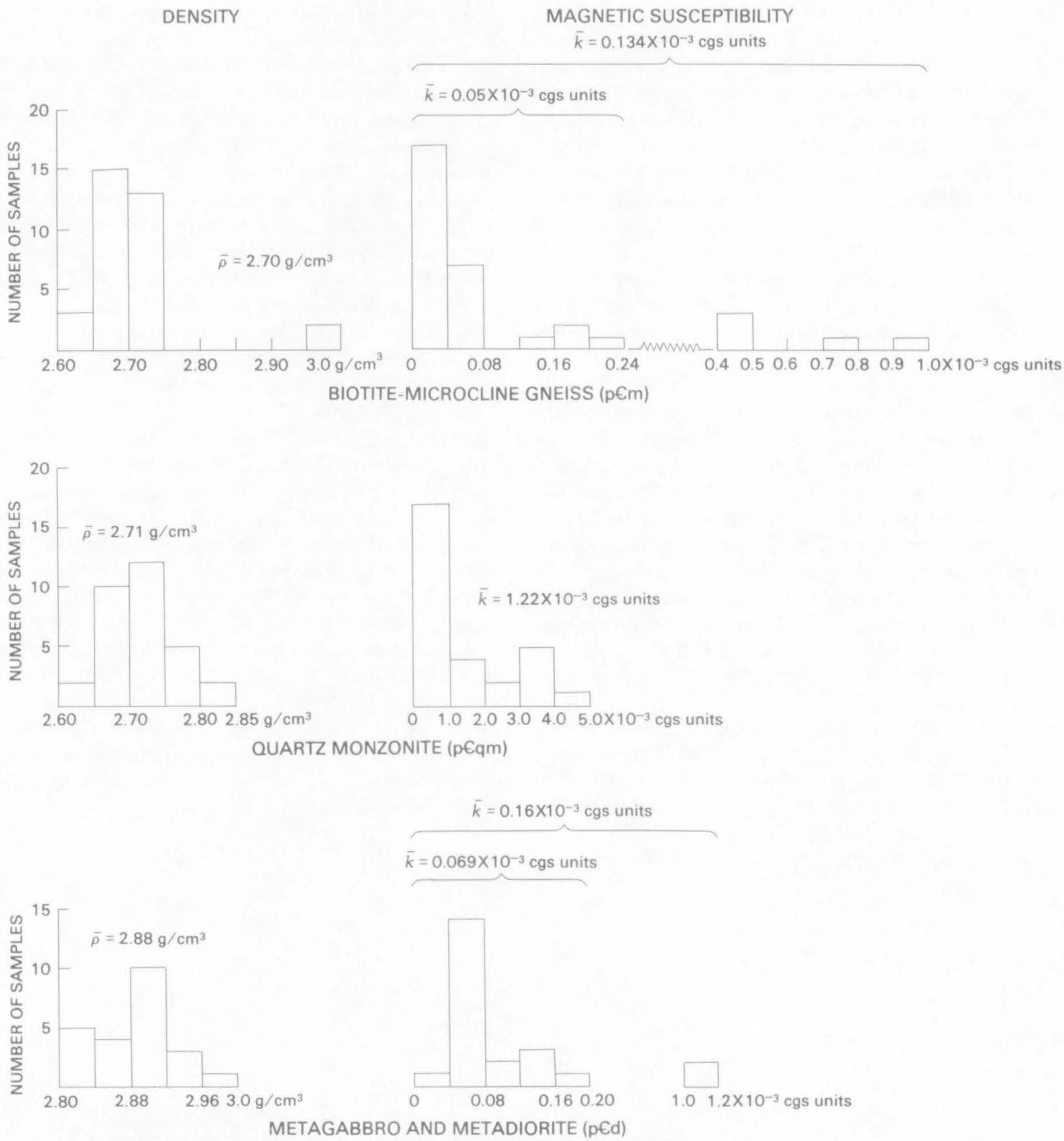

Figure 2. Density and magnetic susceptibility of some Precambrian crystalline rocks from the northwestern Uncompahgre uplift; $\bar{\rho}$, average density; $\bar{k}$, average susceptibility. Map unit symbols refer to geologic map (this report). Modified from Case (1966).

EXPLANATION FOR FIGURE 3

Vernal Mesa(?) quartz monzonite

Metadiorite and (or) metagabbro

Mafic and ultramafic rocks

Biotite gneiss, feldspathic gneiss, amphibole gneiss, and gneissic granodiorite

—*1000*— Form line—Drawn on Proterozoic surface. Contour interval 500 and 5,000 ft; datum sea level

Contact—Proterozoic unit based on geophysical data

Fault—Bar and ball on downthrown side

Dry hole

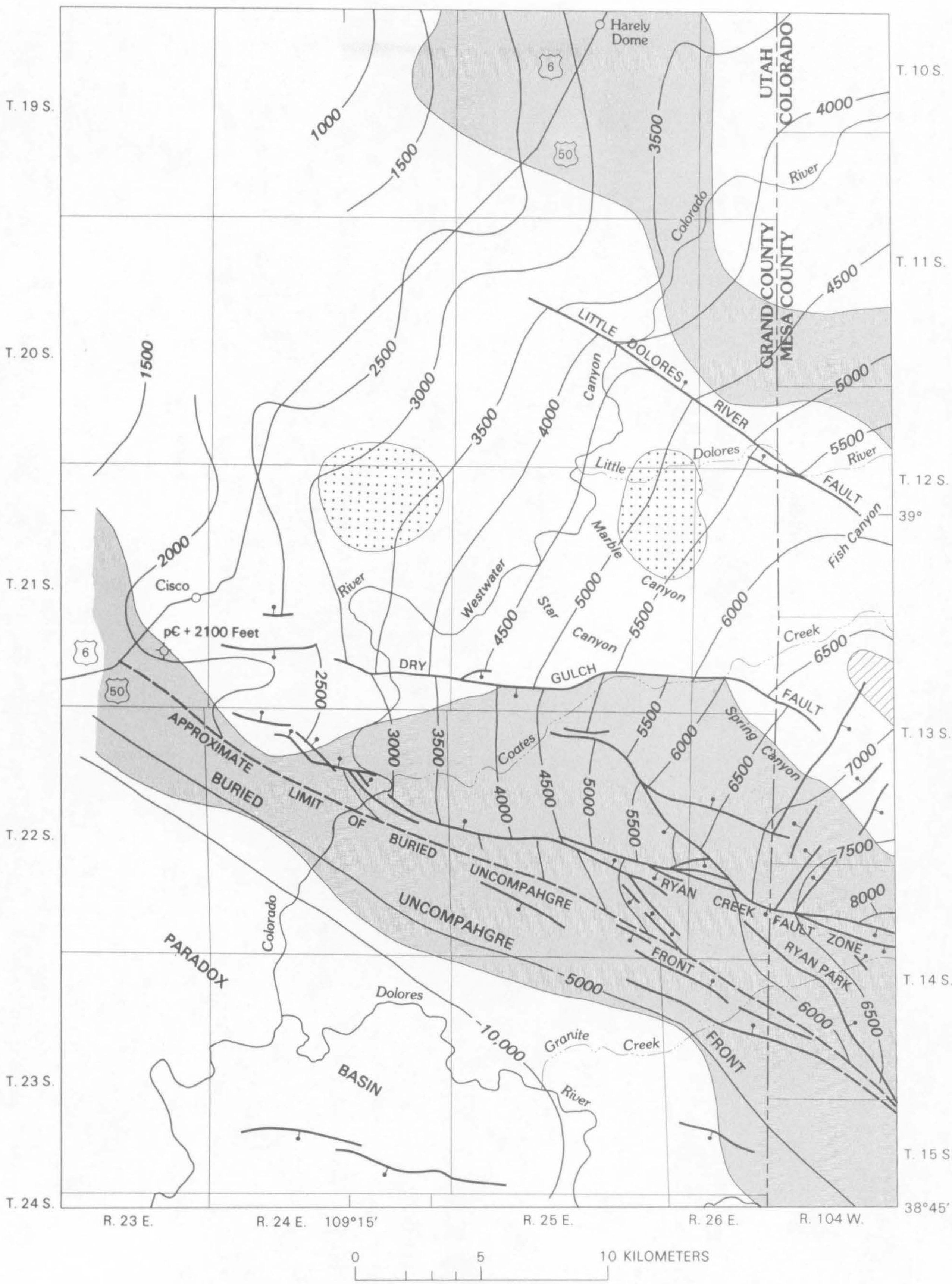

Figure 3. Distribution of known and inferred Proterozoic lithologic units, and structure of the Proterozoic surface (modified from Case, 1966).

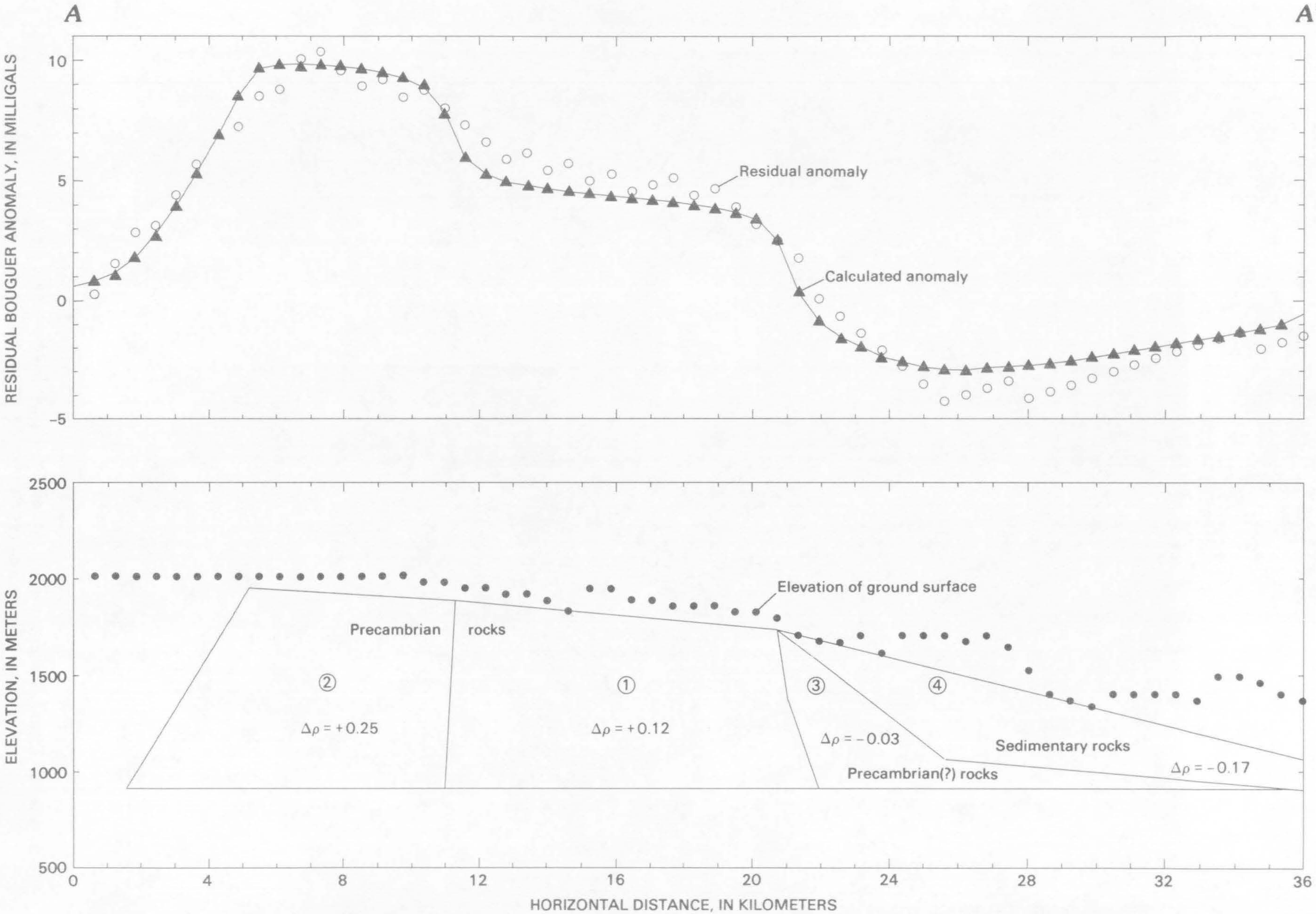

Figure 4. Interpretation of the gravity anomaly across the northern flank of the Uncompahgre uplift along profile *A–A′* (sheet 2). $\Delta\rho$ indicates density contrast in grams per cubic centimeter. Vertical exaggeration 3.8. Numbers 1–4 indicate bodies having differing density contrast, discussed in text.

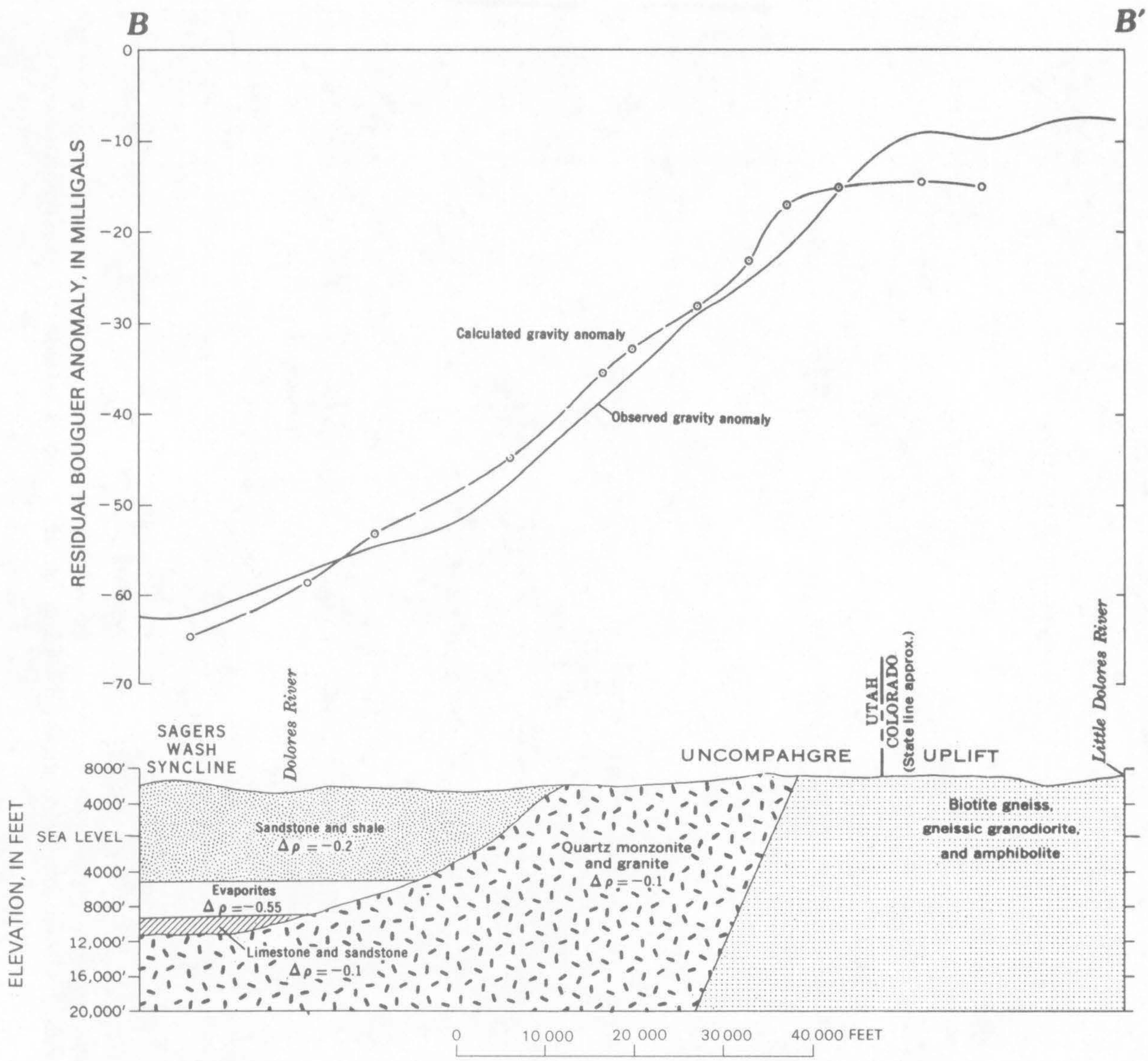

Figure 5. Interpretation of the gravity anomaly across the southwest Uncompahgre front along profile *B–B′* (sheet 2). Δρ indicates density contrast in grams per cubic centimeter. Modified from Case and Joesting (1972).

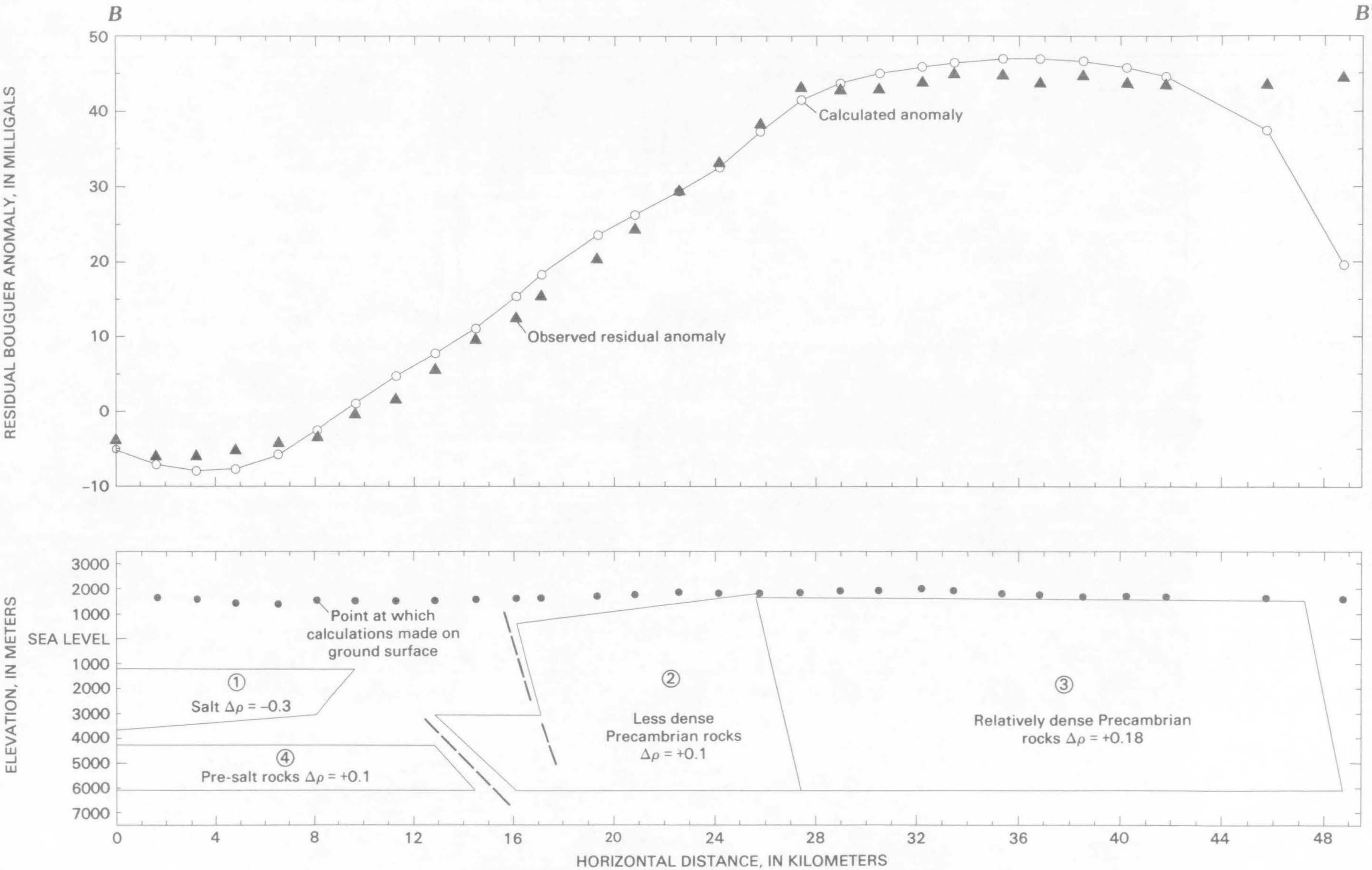

Figure 6. An alternative interpretation of the gravity anomaly across the southwest Uncompahgre front along profile *B–B′*, in which high-angle reverse faults (dashed lines) are postulated. $\Delta\rho$ indicates density contrast in grams per cubic centimeter. Numbers 1–4 indicate bodies discussed in text.

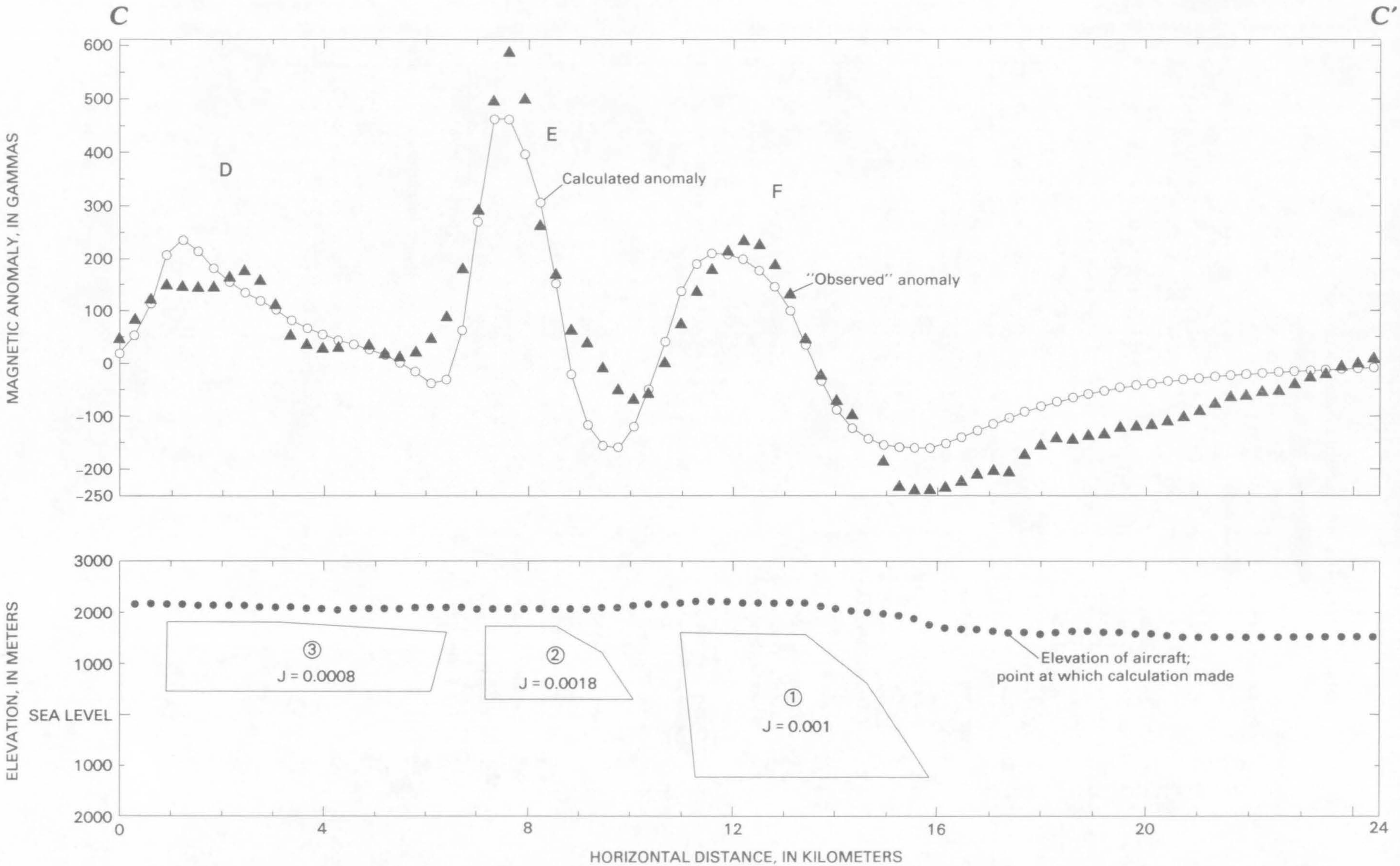

Figure 7. Interpretation of the magnetic anomalies across the northern flank of the Uncompahgre uplift along profile *C–C′*. J, apparent magnetization in electromagnetic units (emu). Numbers 1–3 indicate magnetic bodies discussed in text. Letters D, E, and F are anomalies (see text and sheet 3).

Table 1. *General stratigraphy of the central Colorado Plateau*

[Modified from Case and Joesting (1972)]

System	Group	Stratigraphic unit	Thickness (feet)	Lithology	Estimated density (g/cm^3)
Quaternary			0–500?	Alluvial sand, silt, and gravel, talus, and windblown deposits. Local glacial deposits.	2.2–2.4
Tertiary		Chuska Sandstone Green River Formation Wasatch Formation	0–2,000?	Sandstone, tuff, siltstone, and conglomerate.	2.3–2.4
Cretaceous		Mesaverde Group Mancos Shale	2,500?	Shale and siltstone.	2.3–2.45
		Dakota Sandstone Burro Canyon Formation	200?	Sandstone and conglomerate.	
Jurassic		Morrison Formation	540–850	Shale, siltstone, sandstone, and conglomeratic sandstone.	2.3–2.5
	San Rafael Group	Summerville Formation Curtis Formation Entrada Sandstone Carmel Formation	400–750	Sandstone and siltstone.	
Jurassic, Triassic(?), and Triassic	Glen Canyon Group	Navajo Sandstone Kayenta Formation Wingate Sandstone	550–1,100	Sandstone and siltstone.	
Triassic		Chinle Formation Moenkopi Formation	0–1,600	Shale, siltstone, sandstone, and conglomerate.	
Permian		Cutler Formation	0–8,000	Arkosic sandstone, quartzose sandstone, and shale.	2.58–2.65
		Rico Formation	0–575	Limestone, shale, and arkosic sandstone.	
Pennsylvanian	Hermosa Formation	Upper member	0–2,500	Limestone, shale, and sandstone.	
	Hermosa Formation	Paradox Member	0–4,000+	Salt, gypsum, black shale, and limestone.	2.2–2.3?
	Hermosa Formation	Lower member	0–400	Limestone and shale.	2.6–2.7
		Molas Formation	0–150	Shale, sandstone, and limestone.	
Mississippian, Devonian, and Cambrian			0–4,200	Limestone, shale, dolomite, and sandstone.	
Precambrian				Quartz monzonite, granite, schist, gneiss, metagabbro, amphibolite, quartzite, and argillite.	2.6–3.2?