U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Gravity data at the western rim of the Bursum caldera, New Mexico; including principal facts, profiles and gravity contour maps

by

Gerda A. Abrams, R. Michael Senterfit, and Douglas P. Klein

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INTRODUCTION

A gravity survey was made across the western rim of the Bursum caldera (Fig. 1), southwestern New Mexico in May 1991. The survey was conducted to compliment electrical geophysical studies of the area of the Mogollon Mining district which is largely centered within the caldera boundary structures (Ferguson, 1927, Ratté and others, 1984), as part of NAMRAP (North American Mineral Resources Assessment Program). Twenty-eight gravity stations were acquired at locations of the audio-magnetotelluric soundings (Senterfit and Abrams, 1991. Gravity observations were made using La Coste and Romberg gravity meter G-550. Gravity stations were referenced to the U.S. Department of Defense (Defense Mapping Agency, 1974) based at Glenwood post office, Glenwood, New Mexico (Appendix A). Gravity loops were started and closed at the post office daily. Access to the survey area was by secondary roads and jeep trails. Data acquired from this survey was merged with data from G.R. Keller (University of Texas at El Paso, written commun.) and U.S. Defense Mapping Agency (1974) to produce the maps and profiles for this report. Complete Bouguer gravity anomaly maps are presented at scales of 1:500,000 for two different reduction densities, and at 1:100,000 for the final preferred reduction density. Profiles are presented using three different reduction densities.

ELEVATION CONTROL

Twenty-eight stations (marked x on figures 5, 6 and plate 1) were obtained from locations on U.S. Geological Survey topographic map, Mogollon quadrangle, scale 1:24,000. The uncertainty of elevation is one-half the contour interval; thus on a map with 40 ft contour interval the maximum Bouguer and free-air correction error is estimated to be 1.2 mGals.

DATA REDUCTION

Computer programs of the USGS Branch of Geophysics were used to calculate principal facts and terrain-corrected gravity values. A program written by M.W. Webring (USGS, 1984, unpub. program) was used to reduce gravimeter readings to observed gravity values by calculating and correcting for earth-tides and linear meter drift. The theoretical gravity value was calculated using the 1967 formula of the Geodetic Reference System (International Association of Geodesy, 1971). Terrain corrections were computed using a program by R.H. Godson (USGS, 1978, unpub. program) correcting for the gravity effects of terrain from each station to a radius of 166.7 km using the method of Plouff (1977). Godson's program also calculates earth curvature corrections and complete (terrain corrected) Bouguer gravity anomaly values. For a complete description of gravity reduction equations and approximations used by the USGS Branch of Geophysics see Cordell and others (1982). The computed terrain corrections use mean elevation digital data on a 15-second grid for corrections from 0.59 to 5 km, 1-minute terrain data for corrections from 5 to 21 km, and 3-minute terrain data for corrections from 21 to 166.7 km. Terrain located less than 0.59 km from a station may not be corrected for by the above procedure due to the coarseness of the terrain model. An initial density of 2.67 g/cm^3 was used to calculate terrain corrections for each complete Bouguer gravity anomaly value. The second complete Bouguer gravity anomaly value is automatically calculated by the USGS programs using a reduction density of 2.45 g/cm^3. The corrections and gravity anomaly values are listed in table 1.

SELECTION OF FINAL REDUCTION DENSITY

In general a standard reduction density of 2.67 g/cm^3 is used to correct for terrain. Inspection of the initial values against topography and the foreknowledge of the general properties of silicic volcanic rocks, suggested that a reduction density closer to the 2.45 g/cm^3 might be more appropriate. Therefore a study of the range of values was undertaken to select the final reduction density. Interpretation of gravity surveys is dependent on the choice of an appropriate reduction density for making Bouguer and terrain corrections. Because elevations in the study area range from approximately 1,380 m (4,542 ft) to 3,283 m (10,770 ft), the density used for the correction procedure can significantly influence the shape of the resultant gravity anomaly field. It is not generally possible to measure density directly, however, a reasonably satisfactory estimate of the near surface density may be obtained from a representative gravity profile over the survey area ('the Nettleton method'). The field readings are reduced to produce Bouguer gravity profiles assuming several different values of σ for the Bouguer and terrain correction (Telford and others, 1986). To examine the data across the Bursum caldera we extracted 3 profiles from three gravity grids at three reduction densities 2.27 g/cm^3, 2.47 g/cm^3. The gravity profiles all show a negative trend relative to topography in the 20 to 40 km zones (figures 1-3). One should note that a gravity low (about 40 mGal) between 14 and 55 km on profile A-A' (figure 2) that coincides with a similar length topographic high is reduced by about 10 mGal by using 2.47 g/cm^3 as opposed to 2.67 g/cm^3. The gravity profile from the 2.47 g/cm^3 density appeared to have the least correlation with topography and was thus used in producing the final map (plate 1). This density, determined by the Nettleton profiling method (Telford and others, 1986, p. 28), probably represents the average bulk density of the rocks comprising uppermost parts of Bursum caldera and compares favorably with densities measured on small samples of volcanic rocks of this area as reported by Ratté and others, 1979.

GRAVITY CONTOUR MAPS

The gravity data, reduced at 2.47 g/cm^3, for the complete Bouguer gravity anomaly map consist of 406 gravity stations; the 28 new stations, and the rest (marked with o) were acquired from G.R. Keller (University of Texas at El Paso, written commun.) and U.S. Defense Mapping Agency (1974; available from National Geophysical and Solar-Terrestrial data Center, National Oceanic and Atmospheric Administration, Boulder, Colorado). The data were gridded at 1 km interval using a minimum curvature algorithm (Briggs, 1974, and Webring, 1981). The data were contoured (Godson and Webring, 1982) at a 2 mGal or 5 mGal interval. Figure 5 and 6 compare the variation of field for reduction densities of 2.47 g/cm^3 and 2.67 g/cm^3. Our preferred gravity map (plate 1 and figure 5) is at a reduction density of 2.47 g/cm^3. The Bouguer gravity values on plate 1 range from a low of -228 mGal to a high of -165 mGal.

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Webring, M.W., 1981, MINC: A gridding program based on minimum curvature: U.S. Geological Survey Open-File Report 81-1224, 41 p.

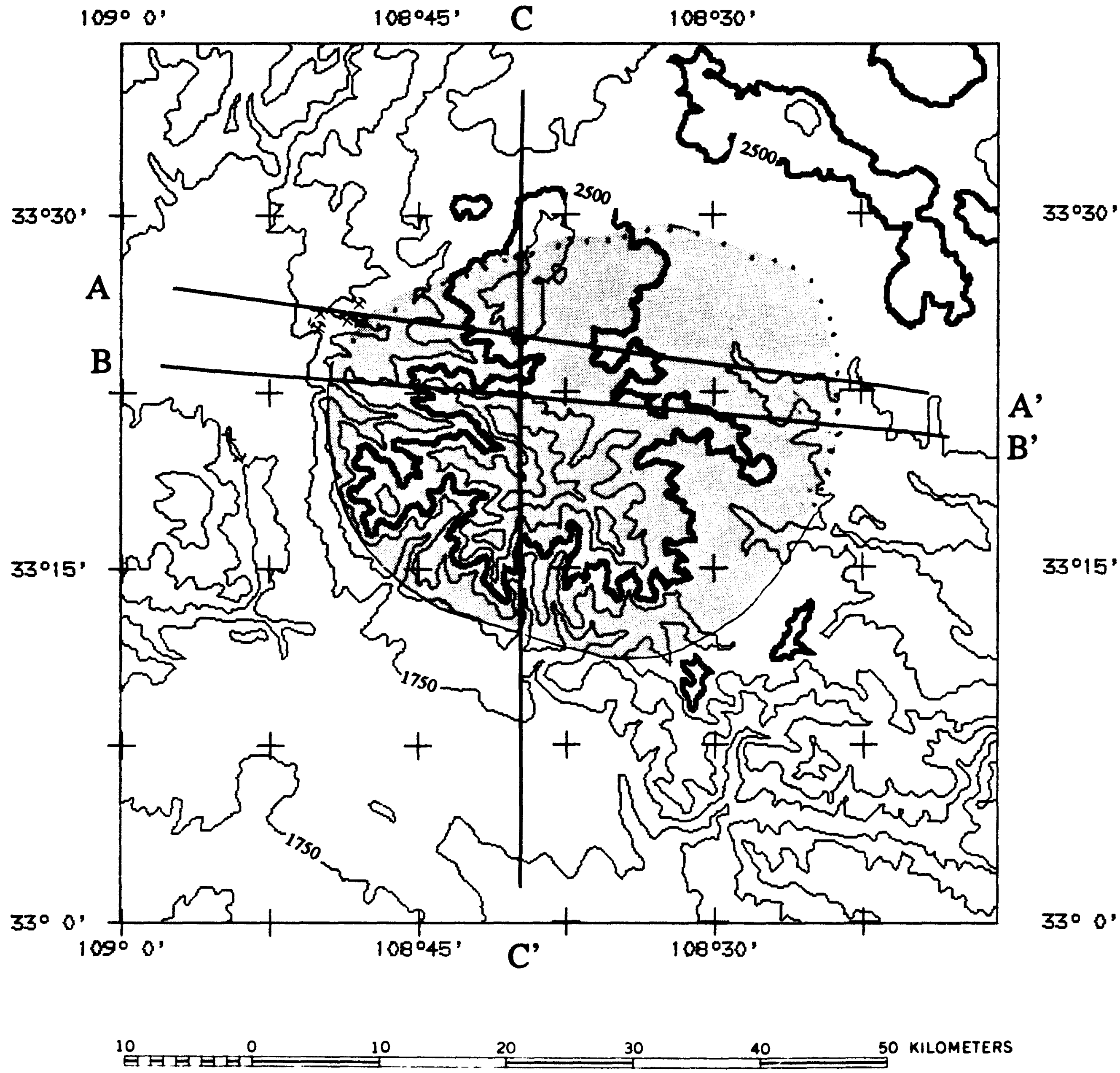


Figure 1. Location and topographic map of Bursum caldera study area.

______ Location of gravity profiles used to compare the different reduction densities.

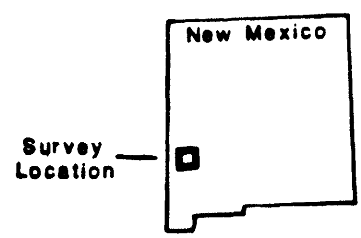
Location of Bursum caldera (after Ratté and others, 1984)

______ caldera rim covered

• • • • • • caldera rim inferred

⚒ Mines

Contour interval 250 meters



Profile # 1.

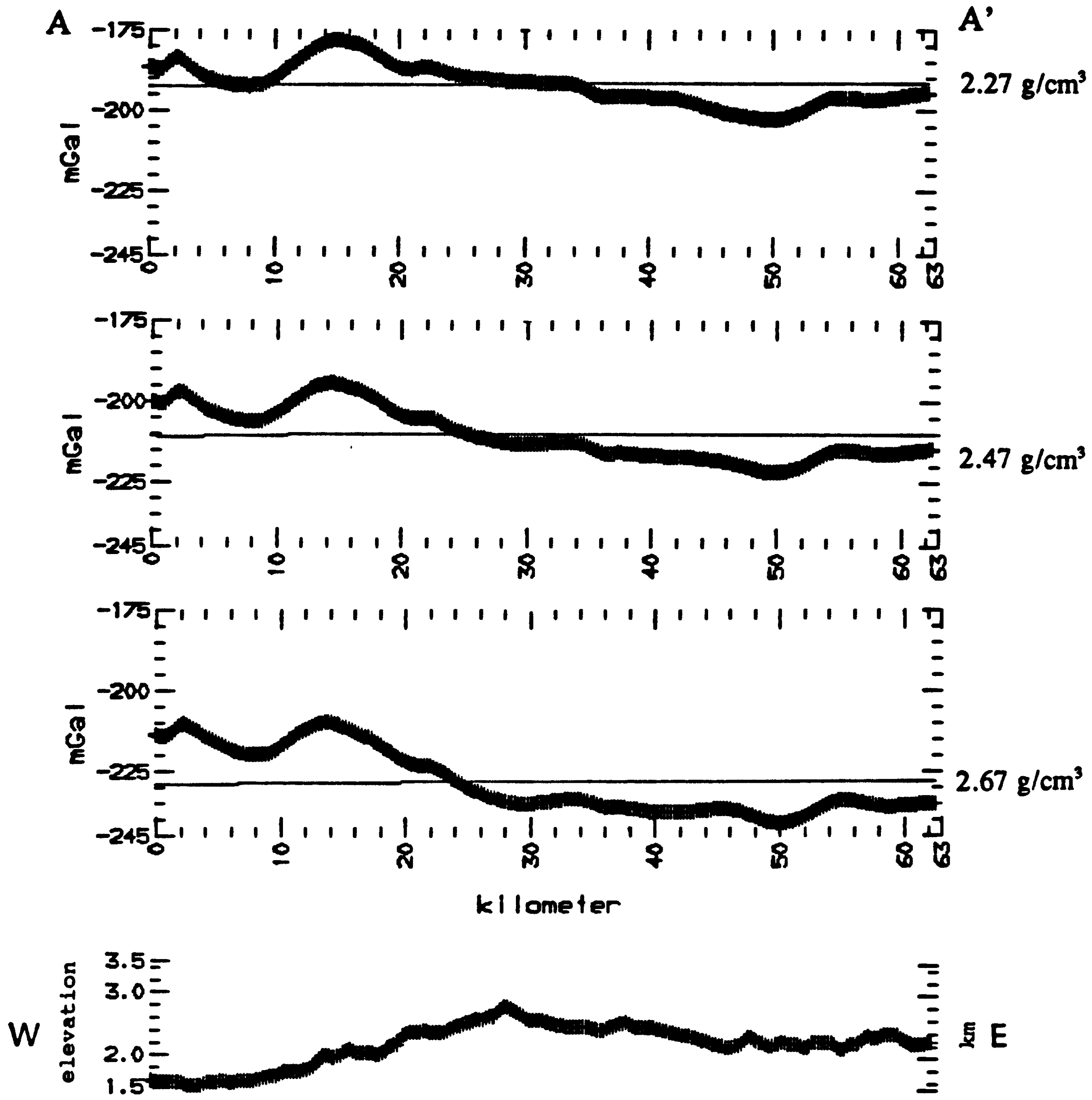


Figure 2--The bottom graph shows W-E topographic profile 1 (elevation is shown in kilometers above sealevel). The three profiles above show gravity data reduced at three densities.

(See Figure 1 for location of profile).

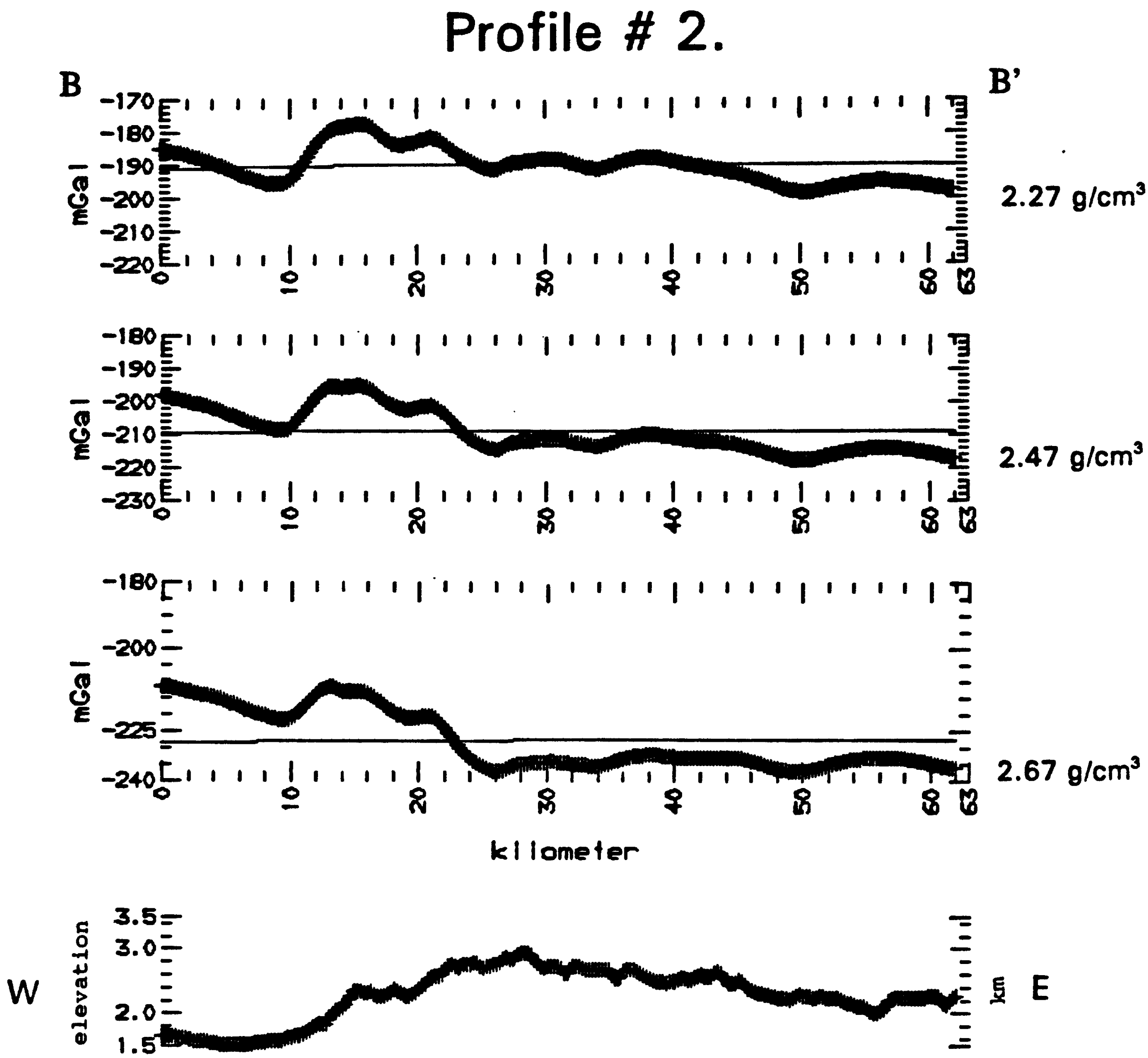


Figure 3--The bottom graph shows W-E topographic profile 2 (elevation is shown in kilometers above sealevel). The three profiles above show gravity data reduced at three densities.
(See Figure 1 for location of profile).

Profile # 3.

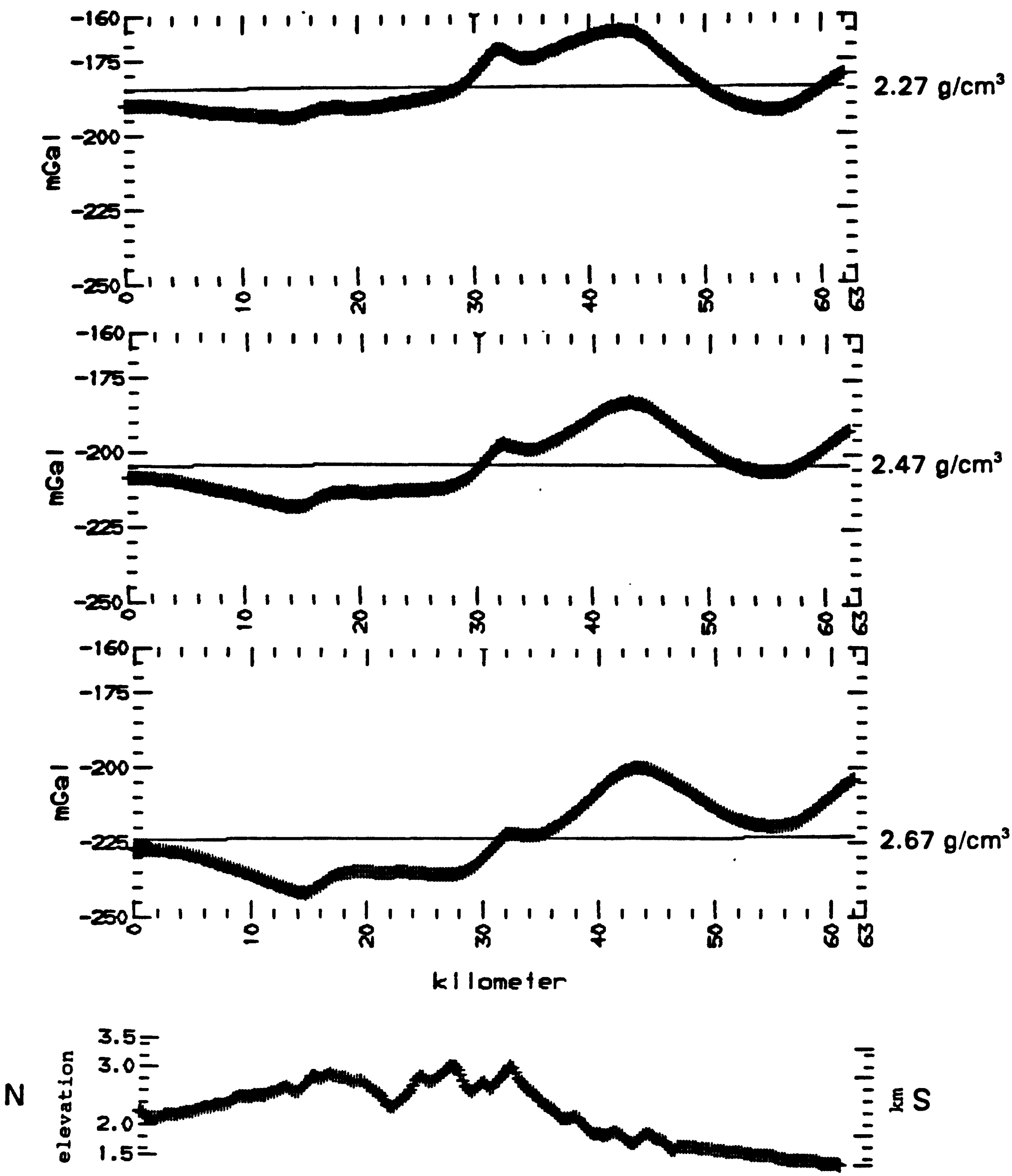


Figure 4--The bottom graph shows N-S topographic profile 3 (elevation is shown in kilometers above sealevel). The three profiles above show gravity data reduced at three densities.
(See Figure 1 for location of profile).

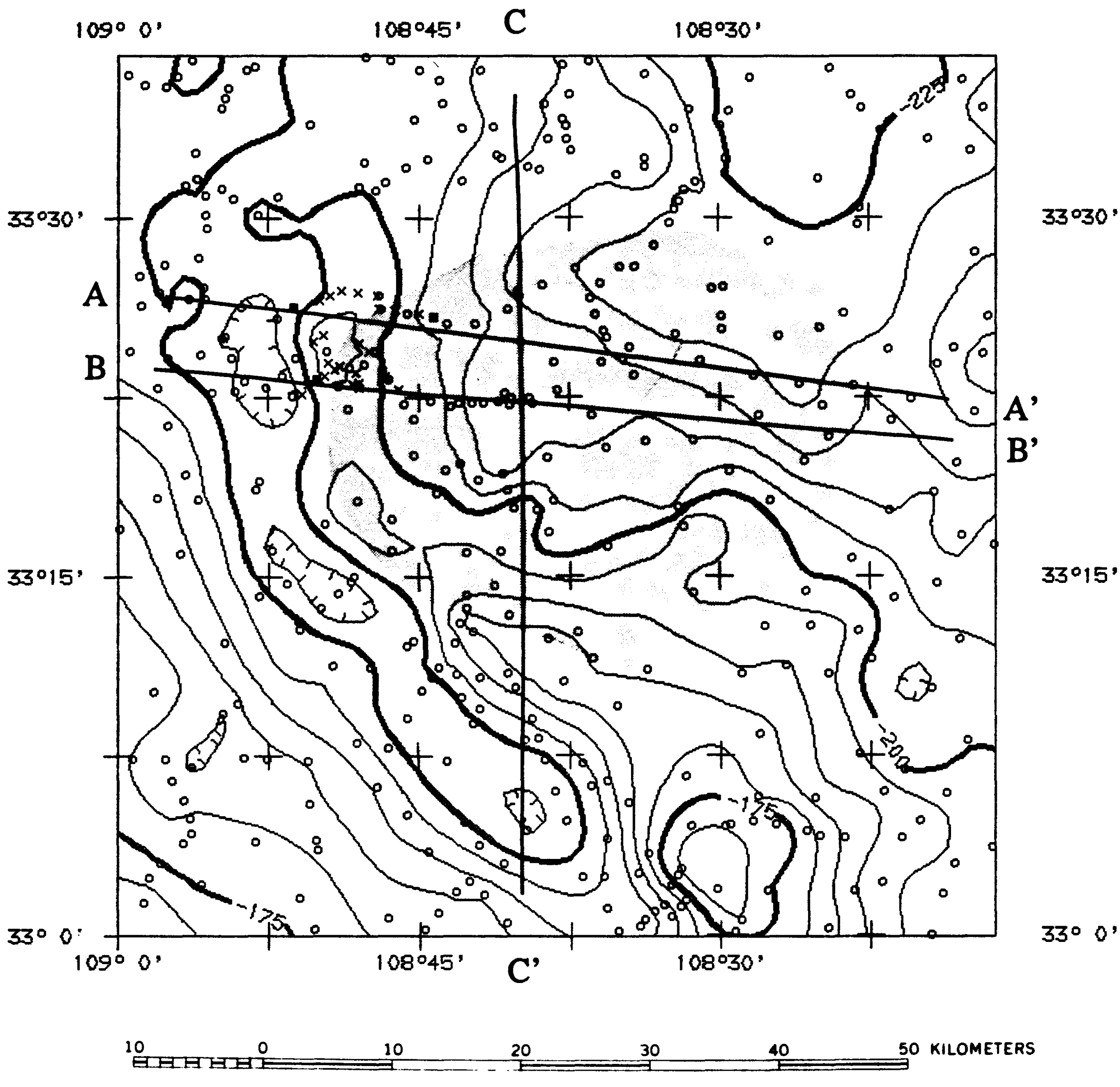


Figure 5.--Complete Bouguer gravity contour map.

Gravity data reduced at 2.47 g/cm^3

Contour interval= 5 mGal

Hachures -Indicate closed areas of lower density

o Existing gravity stations

x New gravity stations

—— Profiles

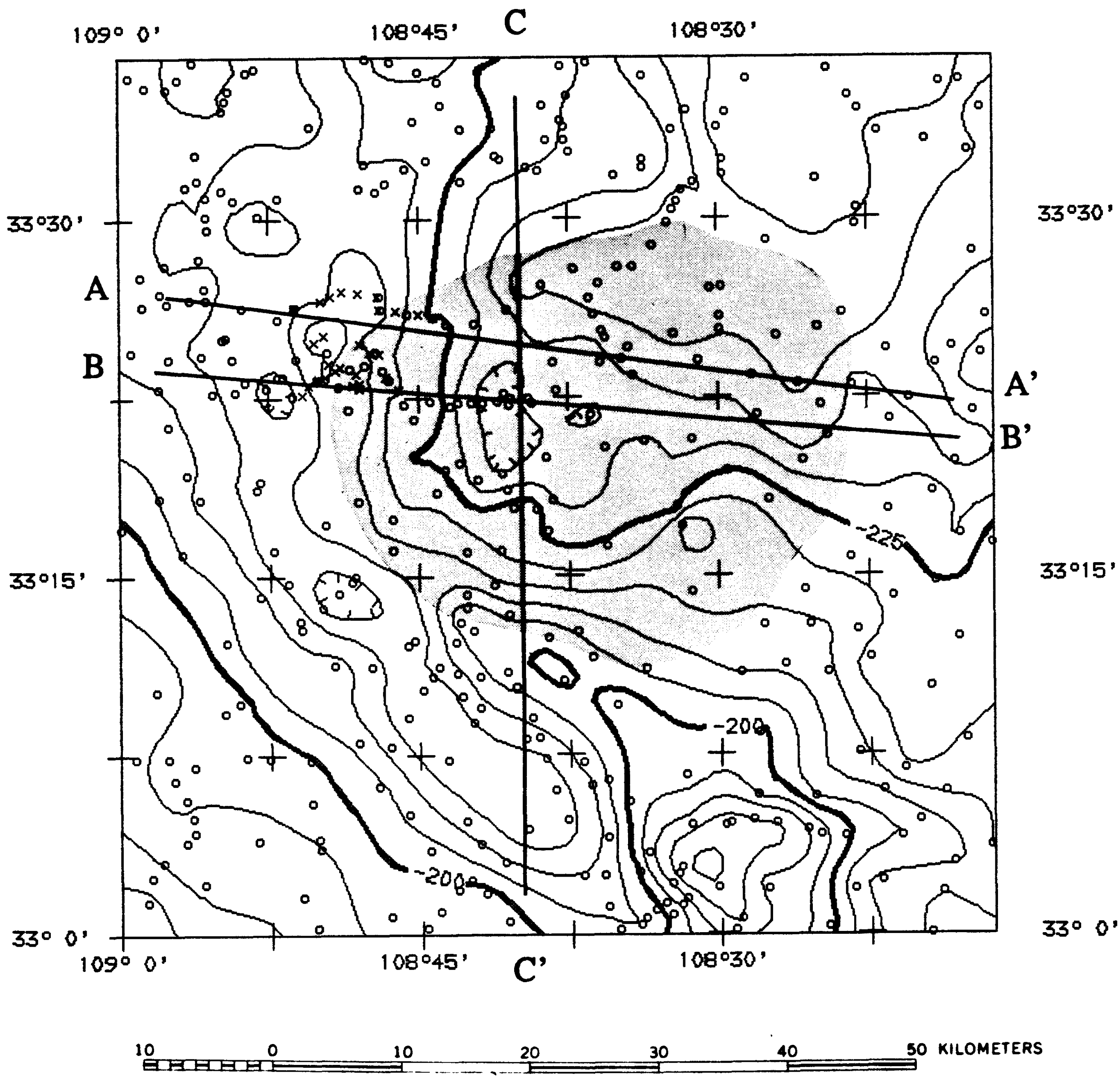


Figure 6.--Complete Bouguer gravity contour map.

Gravity data reduced at 2.67 g/cm^3

5 Contour interval= 5 mGal

5 Hachures -Indicate closed areas of lower density

o Existing gravity stations

x New gravity stations

—— Profiles

BOUGUER GRAVITY DATA

BURSUM CALDERA,1991
NEW MEXICO
2g-550 elev=f gu=.01 srt=tme a-h i-x

STATION IDENTIFICATION proj	sta-id	LOCATIONS LATITUDE deg	min	LONGITUDE deg	min	ELE (in ft)	ST	GRAVITY OBSERVED	THEORETICAL	CORRECTIONS TERRAIN	BOUGUER (d1=2.67)	CURV	SPECIAL	ANOMALIES FREE AIR	COMPLETE-BOUGUER d1=2.67	d2=2.45	SPEC FIELDS
	:01	33	22.62	-108	50.78	5580.00	nm	979042.94	979596.57	3.21	-190.32	-1.47	0.00	-28.92	-217.49	-201.95	
	:3	33	23.90	-108	49.47	6590.00	nm	978992.04	979598.34	3.79	-224.77	-1.52	0.00	13.34	-209.15	-190.82	
	:04	33	23.76	-108	48.90	6920.00	nm	978969.15	979598.15	4.42	-236.02	-1.52	0.00	21.66	-211.46	-192.25	
	:02	33	23.27	-108	50.05	6045.00	nm	979021.48	979597.47	3.78	-206.18	-1.50	0.00	-7.57	-211.46	-194.66	
	:5	33	23.35	-108	46.64	6845.00	nm	978965.12	979597.58	6.91	-233.46	-1.52	0.00	11.15	-216.92	-198.13	
	:6	33	22.82	-108	46.00	7100.00	nm	978945.04	979596.84	8.98	-242.16	-1.51	0.00	15.77	-218.92	-199.58	
	:8	33	23.66	-108	49.17	6800.00	nm	978975.60	979598.01	4.05	-231.93	-1.52	0.00	16.98	-212.42	-193.52	
	:09	33	23.38	-108	49.69	6200.00	nm	979013.95	979597.62	4.92	-211.46	-1.51	0.00	-0.67	-208.72	-191.58	
	:10	33	23.06	-108	50.47	5810.00	nm	979032.91	979597.18	3.54	-198.16	-1.48	0.00	-17.94	-214.05	-197.89	
	:11	33	24.38	-108	47.48	7115.00	nm	978957.61	979599.01	3.11	-242.67	-1.51	0.00	27.59	-213.49	-193.62	
	:12	33	24.74	-108	47.93	7200.00	nm	978947.36	979599.50	6.48	-245.57	-1.51	0.00	24.83	-215.77	-195.94	
	:13	33	24.31	-108	47.00	7220.00	nm	978947.02	979598.91	3.62	-246.25	-1.51	0.00	26.97	-217.17	-197.06	
	:14	33	25.82	-108	44.25	7150.00	nm	978942.97	979601.00	4.49	-243.87	-1.51	0.00	14.24	-226.64	-206.80	
	:15	33	25.98	-108	45.02	6960.00	nm	978958.13	979601.22	4.33	-237.39	-1.52	0.00	11.33	-223.24	-203.91	
	:16	33	26.14	-108	46.10	6720.00	nm	978977.23	979601.44	4.26	-229.20	-1.52	0.00	7.65	-218.80	-200.14	
	:17	33	26.23	-108	46.92	6589.00	nm	978993.45	979601.56	2.81	-224.73	-1.52	0.00	11.44	-211.99	-193.58	
	:18	33	26.29	-108	51.20	5443.00	nm	979057.34	979601.65	4.39	-185.65	-1.46	0.00	-32.47	-215.18	-200.12	
	:19	33	26.77	-108	47.01	6873.00	nm	978976.62	979602.31	2.22	-234.42	-1.52	0.00	20.55	-213.17	-193.91	
	:20	33	26.92	-108	48.05	6670.00	nm	978989.78	979602.52	2.48	-227.49	-1.52	0.00	14.42	-212.11	-193.44	
	:22	33	26.98	-108	48.84	6240.00	nm	979014.36	979602.60	2.64	-212.83	-1.51	0.00	-1.49	-213.19	-195.74	
	:23	33	26.77	-108	49.45	6162.00	nm	979016.69	979602.31	2.79	-210.17	-1.50	0.00	-6.21	-215.09	-197.88	
	:24	33	26.54	-108	49.88	6080.00	nm	979020.78	979601.99	2.27	-207.37	-1.50	0.00	-9.50	-216.10	-199.08	
	:25	33	25.13	-108	49.73	5420.00	nm	979062.78	979600.04	12.68	-184.86	-1.45	0.00	-27.58	-201.22	-186.91	
	:26	33	24.81	-108	50.23	5350.00	nm	979066.98	979599.60	6.57	-182.47	-1.45	0.00	-29.53	-206.88	-192.27	
	:27	33	23.07	-108	47.98	7320.00	nm	978941.96	979597.20	4.31	-249.66	-1.51	0.00	33.02	-213.84	-193.50	
	:28	33	22.90	-108	47.95	7310.00	nm	978942.24	979596.95	5.31	-249.32	-1.51	0.00	32.60	-212.92	-192.69	
	:29	33	23.01	-108	48.28	7480.00	nm	978930.05	979597.11	6.00	-255.12	-1.50	0.00	36.23	-214.40	-193.75	
	:31	33	23.53	-108	48.07	6840.00	nm	978972.64	979597.83	3.99	-233.29	-1.52	0.00	17.96	-212.86	-193.85	

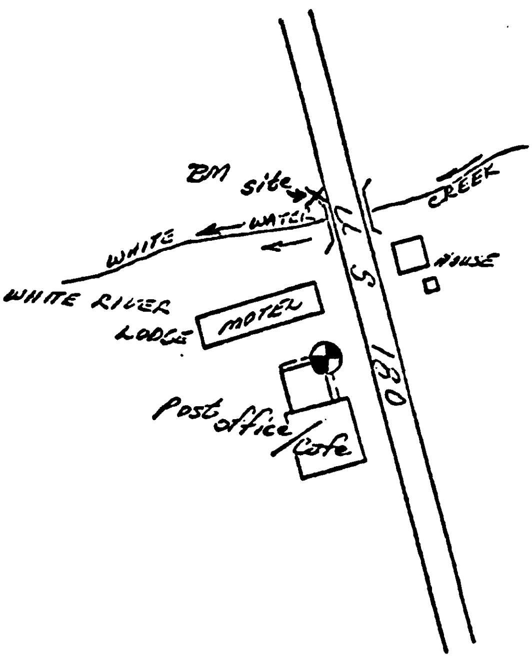
GRAVITY BASE STATION

LATITUDE		STATION DESIGNATION
33° 18.95'N (1)		GLENWOOD
LONGITUDE 108° 52.96'W (1)		
ELEVATION 4710.2 ft, 1435,6 meters)		COUNTRY/STATE USA/New Mexico

REFERENCE CODE NUMBERS		ADOPTED GRAVITY VALUE	
ACIC 4664-1		g= 979,090,56 mGals	
IGB 11938B			
		ESTIMATED ACCURACY	DATE MONTH/YEAR
		± 0.1 mgals	12/71

DESCRIPTION AND/OR SKETCH

Glenwood, New Mexico, at Glenwood post office, on north-northeast corner of building on concrete surface of walkway leading to cafe, approximately 5.0 feet south-southwest of flagpole. (1)



(1)

REFERENCE SOURCE

(1) 03390