DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

GRAVITY OBSERVATIONS ALONG A PASSCAL SEISMIC LINE IN WEST-CENTRAL NEVADA

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1987

Open-File Report 87-403

Menlo Park, California
1987

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INTRODUCTION

Forty stations, located near bench marks and at spot elevations along a NW PASSCAL seismic line in west-central Nevada (Thompson and others 1986), were collected in the summer of 1986 (figures 1 and 2). The field session was planned by the U.S. Geological Survey in conjunction with the University of Nevada at Reno. A complete Bouguer anomaly (CBA) profile (figure 3) along the line has been computed for comparison with the seismic data. Gravity measurements were made with a LaCoste-Romberg gravity meter and reduced to CBA values using standard gravity reduction methods. Isostatic corrections were calculated assuming an Airy-Heiskanen isostatic compensation model. All field data were reduced using the Geodetic Reference System of 1967 (International Union of Geodesy and Geophysics, 1971), and the observed gravity values were referenced to the International Gravity Standardization Net 1971 (IGSN71) gravity datum (Morelli, 1974).

METER

All data were collected with LaCoste and Romberg gravity meter G614. The observed meter readings were converted to mGals using a calibration factor of 1.00038, in addition to the factory calibration table. Prior to the field session, the meter performance and calibration factor were tested along the Charleston Peak high precision mountain calibration loop (Ponce and Oliver, 1981).

DATUM AND BASE STATIONS

Two base stations, Austin and Lovelock, were used to reference the relative gravity measurements to the IGSN71 gravity datum. Both base stations are part of the world relative gravity reference network (Jablonski, 1974), which lists observed gravity values of 979,514.90 mGals and 979,779.08 mGals at Austin and Lovelock respectively.

REDUCTION PROCEDURES

Meter readings were first converted to mGal-equivalents and corrected for instrument drift and earth tides. The resulting values were then reduced to free-air gravity anomalies, by correcting for the effects of elevation. Next, latitude, Bouguer, curvature, and terrain corrections were applied to yield CBA values. Latitude corrections remove influences attributed to the centrifugal force and polar flattening caused by the Earth's rotation. The Bouguer correction accounts for the effects of a horizontal slab of density 2.67g/cm^3, passing between the station and sea level. Distortions of this slab due to the curvature of the earth are removed by the curvature correction. The terrain correction, which removes the effects of topography, was calculated in three parts. For the region extending from the station to 68 m (Hayford -Bowie zones A and B), terrain corrections were determined in the field using slope and cone approximation curves. Manual terrain corrections were calculated for the region extending from the station to 0.59 km (Hayford-Bowie zones C through D), using the Hayford-Bowie (1912) system. Beyond this, out to a distance of 166.7 km, corrections were computer calculated from 1- and 3- minute digital terrain data using a procedure by Plouff (1977). Isostatic anomalies were calculated, from CBA values, using a program by Simpson and others (1983), based on an Airy-Heiskanen model of isostatic compensation (Heiskanen and Meinesz, 1958). The isostatic correction, which results in removing long wavelength features in the gravity field related to the isostatic compensation of crustal material in the mantle, was computed from the station to a radius of 166.7 km assuming a crustal density of 2.67 g/cm^3, crustal thickness of 25 km, and a density contrast between crust and mantle of 0.4 g/cm^3. Beyond 166.7 km, isostatic corrections were obtained from Karki and others (1961), and extend to an angular distance of 180° from the station. A description of the format of the principal facts is given in table 1.

ACCURACY OF DATA

An explanation of accuracy codes, relating errors in elevation, location, and meter readings, to uncertainties in reduced gravity values, is given in table 2. Usually, the largest uncertainties are due to the control of station elevations. Most of the 40 stations presented here were established at map spot elevations, accurate to about 3 m. A 3 m error in elevation translates to an error of 0.6 mGal in observed gravity values for an elevation correction factor of 0.20 mGal/m, arrived at by assuming a crustal density model of 2.67 g/cm^3. Additional error is introduced when correcting the data for the effects of terrain. In general, the complete terrain correction is considered accurate to 5% to 10% of its total value. Therefore the largest terrain correction in the data set (11.33 mGal) is accurate to about 1 mGal, and the average (1.54 mGal) to 0.2 mGal. The remaining sources of error, including meter drift and latitude control, introduce a combined uncertainty of less than 0.25 mGal to reduced gravity values. In total it is estimated that the data, listed in table 3, are accurate to about 1 mGal.

GRAVITY PROFILE

The CBA profile, shown in figure 3, was constructed from the data presented here (table 3), and two sets of additional data. The first of these is from the Defense Mapping Agency, Aerospace Center (DMAAC), and is available from: National Geophysical Data Center, National Oceanic and Atmospheric Administration, Mail Code E/GCX2, 325 Broadway, Boulder, Colorado 80303, USA. The second set consists of unpublished gravity data (B.A. Chuchel, written commun., 1987).

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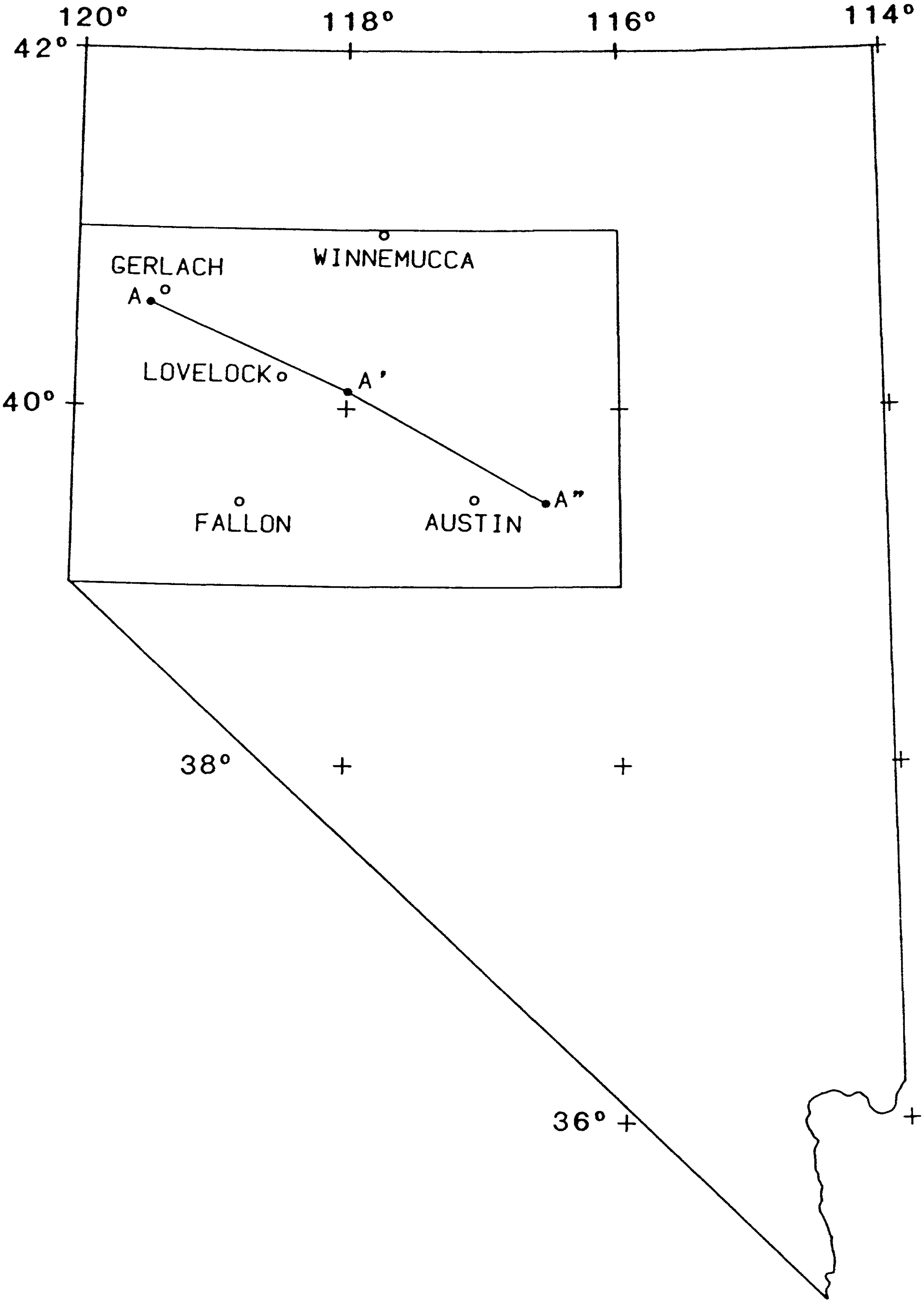

FIGURE 1.–Index map of Nevada showing location of gravity profile line.

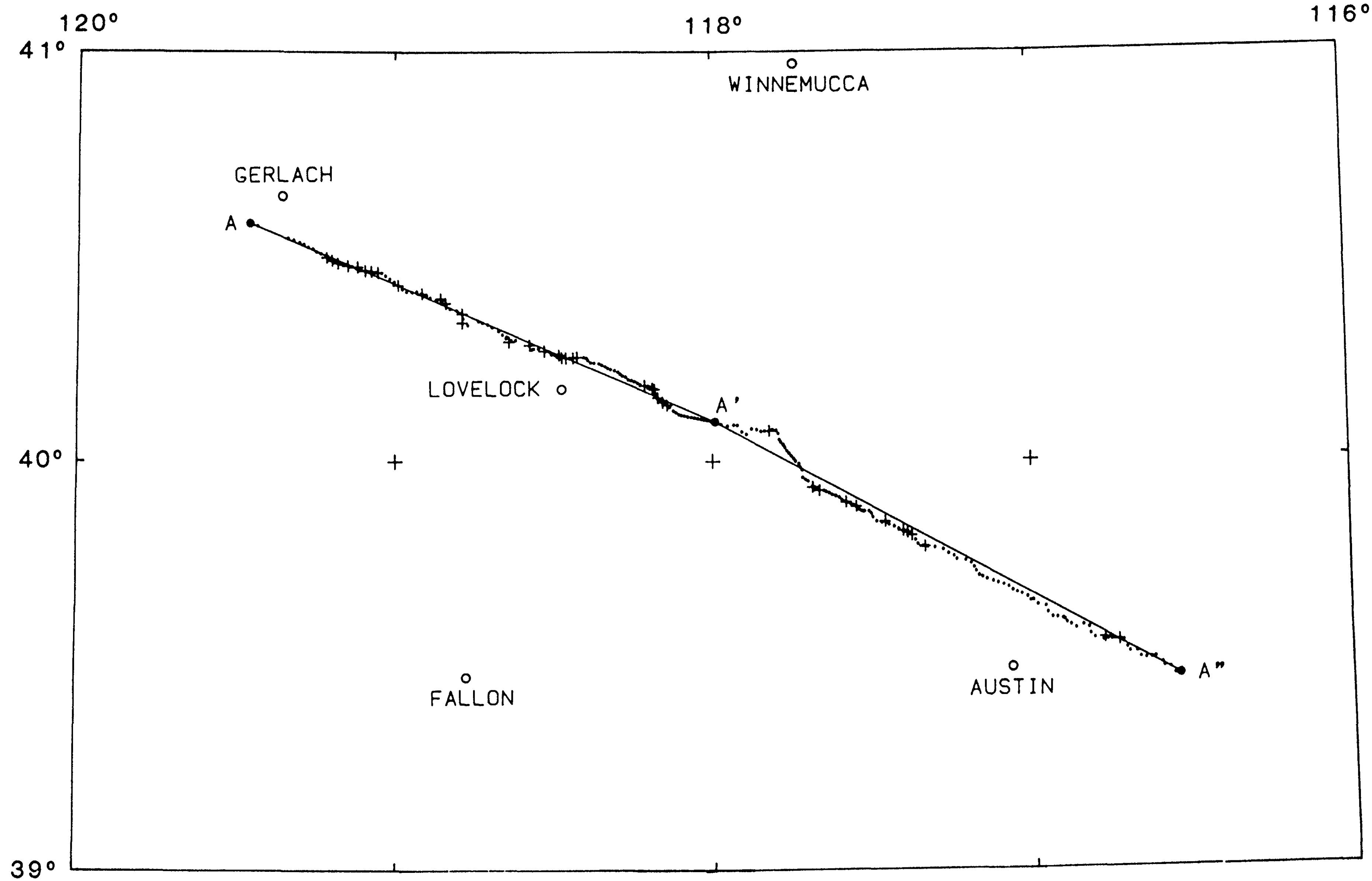

FIGURE 2.–Index map of study area showing the locations of gravity stations (small plus), geophones (small dots), and gravity profile (A-A'-A").

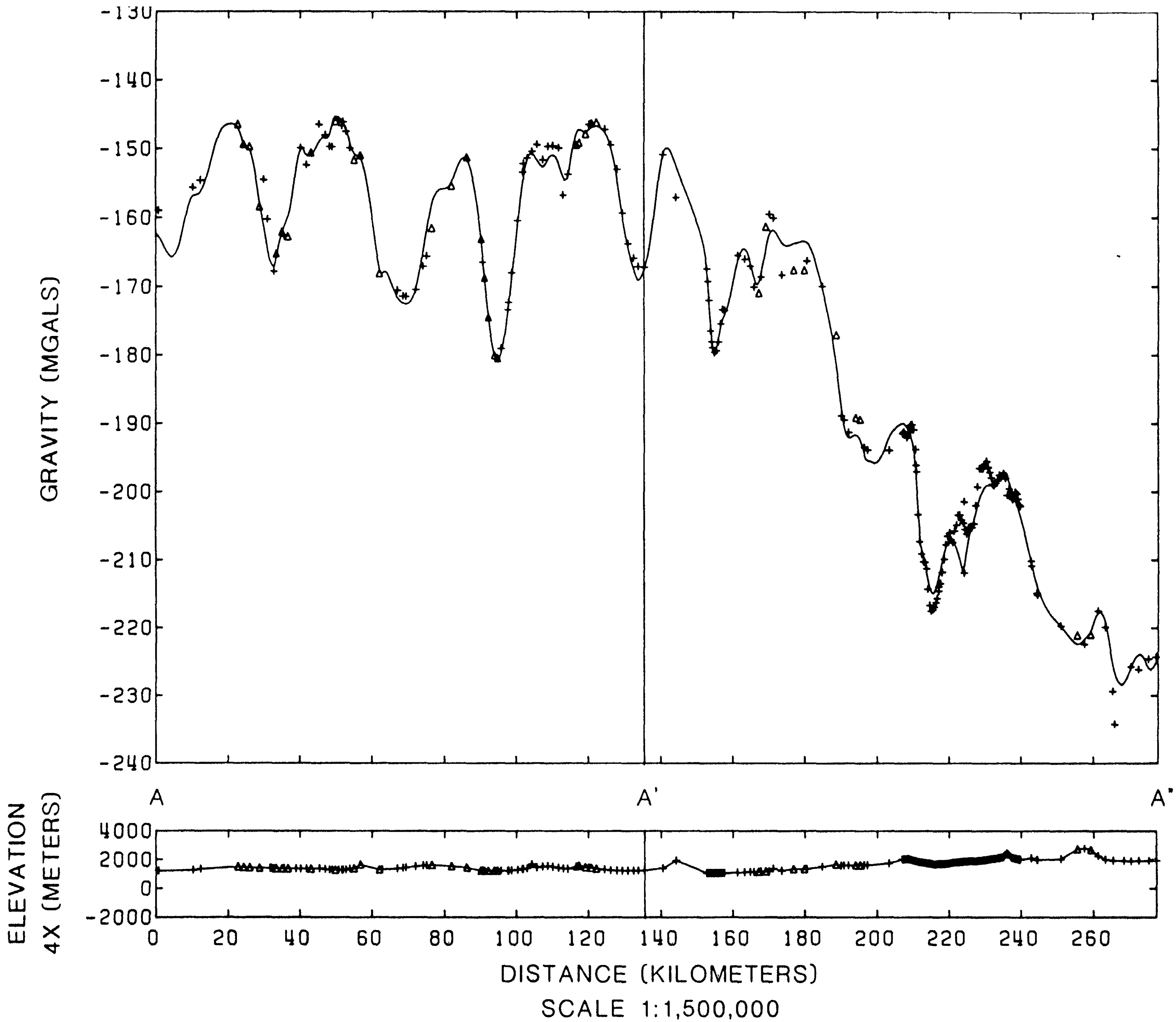

FIGURE 3.-Complete Bouguer gravity anomaly along profile A-A'-A". Stations appearing in the profile are located within 3 km of the line. The gravity profile is interpolated from a grid of new data (triangles) supplemented with old (pluses).

TABLE 1.–*Explanation of principal fact format*

Item	Explanation
STATION NAME	An alphanumeric combination of up to 8 characters used for station identification
LAT	Latitude in degrees and minutes, to 0.01 minute
LON	Longitude in degrees and minutes, to 0.01 minute
ELEV	Elevation, to 0.1 feet
OG	Observed gravity, to 0.01 mGal
AC	Four digit code describing the general location, elevation, latitude, and observed gravity accuracy
FAA	Free-air anomaly to 0.01 mGal
SBA	Simple Bouguer anomaly reduced for a density of 2.67 g/cm^3, to 0.01 mGal
ITC	Inner-zone terrain correction for a density of 2.67 g/cm^3, to 0.01 mGal, followed by a letter denoting the extent of the manual correction in the Hayford-Bowie system of zones (Hayford and Bowie, 1912)
TC	Total terrain correction from the station to 166.7 km for a density of 2.67 g/cm^3, to 0.01 mGal
CBA	Complete Bouguer anomaly reduced for a density of 2.67 g/cm^3, to 0.01 mGal
ISO	Isostatic anomaly based on Airy-Heiskanen compensation, to 0.01 mGal

TABLE 2.–*Explanation of accuracy codes*

Code	Explanation			
	General location code–1st digit			
A	Altimetry, good control			
B	On level-line bench mark			
C	Contour line interpolation			
D	Destroyed or not found reference mark			
F	Map elevation, black or field checked			
G	Map elevation, brown or not field checked			
H	Near vertical angle bench mark			
I	Special source			
J	Photogrametric elevation			
L	Photogrametric elevation by laser method			
N	Near level-line bench mark			
P	On or near surveyed reference mark			
Q	River gradient interpolation			
R	Lake or resevoir elevation by leveling			
S	Sea level elevation			
T	Photogrametric elevation by Kelsh plotter or least squares			
U	Unknown elevation source			
V	On vertical angle bench mark			
W	Map elevation, blue			
X	On or near boundary marker (e.g. section corner)			
Y	Altimetry, poor control			
t	Relative Elevation with closures within 0.1 ft			
	Elevation code–2nd digit		Elevation accuracy (ft)	Approximate gravity effect (mGal)
1	On bench mark		0.2	0.01
2	Near bench mark		0.3	0.02
3	Transit and good alidade surveys		1.0	0.05
4	VABM and black map elevation		2.0	0.10
5	Black map elevation and good photogrammetry		4.0	0.20
6	Brown map elevation and good photogrammetry on 20 ft contour interval map		10.0	0.50
7	Brown map elevation on 80 ft contour interval map and good altimetry		20.0	1.20
	Latitude code–3rd digit (based at lat 37°)	Latitude accuracy (ft)	Distance accuracy (min)	Approximate gravity effect (mGal)
1	Triangulation or special survey data	0.0075	42	0.01
2	Location known to 0.04 in on 1:24,000 map (special care)	0.014	84	0.03
3	0.10 in on 1:24,000 map or 0.04 in on 1:62,500 map	0.035	210	0.06
4	0.21 in on 1:24,000 map or 0.08 in on 1:62,500 map	0.075	420	0.1
5	0.42 in on 1:24,000 map or 0.16 in on 1:62,500 map	0.14	840	0.2
6	0.40 in on 1:62,500 map or 0.1 in on 1:250,000 map	0.35	2,100	1.0
7	0.80 in on 1:62,500 map or 0.2 in on 1:250,000 map	0.75	4,200	2.0
	Observed gravity code–4th digit			Approximate gravity effect (mGal)
1	Local surveys with special gravity meters			0.01
2	Multiple observations with LaCoste and Romberg gravity meter			0.02
3	Average LaCoste and Romberg or multiple observations with Worden gravity meters			0.05
4	LaCoste and Romberg observations with small vibrations and average Worden gravity meters			0.10
5	Data from loops with closure errors this large			0.20
6	Data from loops with closure errors this large			0.50
7	Data from loops with closure errors this large			1.00

Table 3.—*List of principal facts of gravity data along a NW-PASSCAL seismic line*

STATION NAME	LAT deg	LAT min	LON deg	LON min	ELEV ft	OG mGal	AC	FAA mGal	SBA mGal	ITC mGal		TC mGal	CBA 2.67	ISO 2.67
PA001	39	33.65	116	46.57	8944.0	979363.59	V433	74.41	-230.64	0.43	D	10.93	-221.08	-21.17
PA002	39	33.32	116	43.85	8789.0	979372.10	F433	68.85	-230.92	1.22	D	11.33	-220.97	-20.38
PA003	39	47.36	117	20.18	5458.0	979624.60	F433	-12.44	-198.60	0.01	D	0.61	-199.44	-17.13
PA004	39	49.05	117	22.66	5307.0	979641.57	N233	-12.17	-193.18	0.03	D	0.37	-194.25	-14.07
PA005	39	49.45	117	23.47	5294.0	979647.87	N233	-7.69	-188.25	0.01	D	0.31	-189.38	-9.82
PA006	39	49.73	117	24.26	5253.0	979651.01	N233	-8.82	-187.98	0.00	D	0.29	-189.13	-10.14
PA007	39	51.07	117	27.65	5424.0	979654.62	F433	8.88	-176.12	0.04	D	0.53	-177.05	-0.56
PA008	39	53.32	117	33.06	4386.0	979728.64	F433	-18.01	-167.60	0.10	D	1.35	-167.58	4.82
PA009	39	53.97	117	34.98	4386.0	979730.25	F433	-17.36	-166.95	0.03	D	0.69	-167.59	3.43
PA010	39	55.71	117	39.93	3858.0	979770.03	F433	-29.80	-161.38	0.18	D	1.31	-161.30	6.26
PA011	39	56.18	117	41.18	3769.0	979766.99	F433	-41.90	-170.45	0.09	D	0.75	-170.91	-4.17
PA012	40	4.46	117	49.26	6012.0	979646.28	G633	35.93	-169.13	1.58	D	10.26	-160.36	1.75
PA013	40	8.28	118	8.54	4514.0	979765.13	G633	8.31	-145.65	0.05	D	0.80	-146.19	10.29
PA014	40	8.67	118	9.40	4685.0	979755.24	G633	13.91	-145.88	0.08	D	0.95	-146.30	10.03
PA015	40	9.35	118	10.26	4849.0	979744.37	G633	17.45	-147.94	0.23	D	1.50	-147.83	8.40
PA016	40	10.58	118	10.89	5119.0	979728.59	G633	25.21	-149.38	0.13	D	1.65	-149.15	7.15
PA017	40	10.74	118	11.33	4972.0	979737.16	G633	19.73	-149.85	0.51	D	1.79	-149.46	6.76
PA018	40	11.17	118	12.80	4610.0	979755.09	G633	3.00	-154.24	0.05	D	0.92	-154.68	1.26
PA019	40	15.37	118	25.56	4012.0	979771.91	G633	-42.64	-179.47	0.00	D	0.24	-180.50	-26.12
PA020	40	15.27	118	26.32	4005.0	979772.61	G633	-42.45	-179.05	0.01	D	0.24	-180.07	-25.82
PA021	40	15.27	118	27.65	3998.0	979778.55	G633	-37.17	-173.53	0.00	D	0.28	-174.50	-20.42
PA022	40	15.33	118	28.43	4001.0	979784.15	G633	-31.38	-167.84	0.00	D	0.35	-168.75	-14.76
PA023	40	15.70	118	28.96	4035.0	979788.15	G633	-24.73	-162.35	0.01	D	0.50	-163.12	-9.09
PA024	40	16.27	118	31.68	4715.0	979759.34	G633	9.53	-151.29	0.44	D	1.36	-151.30	2.60
PA025	40	17.15	118	34.46	5038.0	979736.55	G633	15.79	-156.04	0.70	D	2.05	-155.40	-1.53
PA026	40	17.61	118	38.36	5340.8	979714.04	G633	21.06	-161.10	0.07	D	1.03	-161.52	-7.84
PA027	40	20.40	118	47.19	4303.0	979773.98	G633	-20.70	-167.46	0.03	D	0.41	-168.36	-14.77
PA028	40	21.71	118	47.19	4247.9	979779.50	G633	-22.30	-167.19	0.01	D	0.40	-168.09	-14.28
PA029	40	23.91	118	51.32	4538.5	979780.44	F433	2.68	-152.12	0.52	D	1.81	-151.66	2.21
PA030	40	23.24	118	50.35	5392.7	979726.38	G633	29.90	-154.03	1.21	D	4.50	-150.98	2.86
PA031	40	24.64	118	54.88	4172.5	979810.21	N233	-3.04	-145.35	0.02	D	0.62	-146.02	7.72
PA032	40	25.85	118	59.42	4445.7	979791.47	N233	2.10	-149.53	0.00	D	0.28	-150.59	3.02
PA033	40	27.73	119	3.26	4511.6	979778.28	N233	-7.70	-161.57	0.00	D	0.17	-162.75	-9.22
PA034	40	27.87	119	4.50	4525.7	979778.40	N233	-6.46	-160.82	0.00	D	0.11	-162.06	-8.60
PA035	40	27.99	119	5.66	4537.9	979774.70	N233	-9.19	-163.96	0.00	D	0.10	-165.21	-11.82
PA036	40	28.51	119	7.07	4556.3	979774.71	N233	-8.23	-163.63	0.00	D	0.10	-164.88	-11.54
PA037	40	28.72	119	8.91	4615.0	979777.97	G633	0.23	-157.17	0.00	D	0.15	-158.38	-5.15
PA038	40	29.11	119	10.78	4747.8	979779.01	G633	13.18	-148.75	0.12	D	0.43	-149.70	3.44
PA039	40	29.53	119	11.86	4800.3	979776.81	G633	15.29	-148.44	0.02	D	0.46	-149.36	3.75
PA040	40	29.96	119	12.87	4926.6	979772.28	G633	21.99	-146.04	0.32	D	0.98	-146.46	6.62