

---

# GRAVITY SURVEY

over

the

## ALUM AND SILVER PEAK PROSPECTS

ESMERALDA COUNTY, NEVADA

---

for

## SIERRA GEOTHERMAL POWER CORP.

### MARCH 2008

---

**SUBMITTED BY**

**Magee Geophysical Services LLC**

10075 Timberwolf Drive  
Reno, Nevada 89523 USA

TEL 775-742-8037

FAX 775-345-1715

Email: [chris\\_magee@gravityandmag.com](mailto:chris_magee@gravityandmag.com)

Website: [www.gravityandmag.com](http://www.gravityandmag.com)



**TABLE OF CONTENTS**

<b><u>INTRODUCTION</u></b> .....	1
<b><u>DATA ACQUISITION</u></b> .....	1
Survey Personnel.....	1
Gravity Meters .....	1
Gravity Bases .....	1
GPS Equipment .....	1
Geodetic Survey Control.....	2
Topographic Surveying of Gravity Stations .....	2
Gravity Stations .....	3
<b><u>DATA PROCESSING</u></b> .....	4
Overview.....	4
Data Processing Parameters.....	4
Terrain Corrections.....	4
Gravity Repeats and Loop Closures .....	4
Derivative, Gradient, and Residual Maps .....	5
<b><u>DATA FILES</u></b> .....	5
Raw Data Files .....	5
Final Gravity XYZ File .....	5
Grid and Terrain Files .....	5
GeoSoft Database Files.....	5
GPS Data Files.....	6
<b>APPENDIX A</b> <b><u>GRAVITY BASE DESCRIPTIONS</u></b>	
<b>APPENDIX B</b> <b><u>GEODETIC CONTROL - OPUS RESULTS</u></b>	
<b>APPENDIX C</b> <b><u>GRAVITY LOOP CLOSURES</u></b>	
<b>APPENDIX D</b> <b><u>GRAVITY MAPS</u></b>	

## INTRODUCTION

Gravity data were acquired over the Alum and Silver Peak Prospects in Esmeralda County, Nevada for Sierra Geothermal Power Corp. The gravity survey was conducted during the period of February 7 through February 24, 2008.

A total of 1330 new gravity stations were surveyed including 571 stations on a 250m grid over the Silver Peak Prospect, 493 stations on a 250m grid over the Alum Prospect, and 266 regional stations around and between the two prospects. The regional stations were generally spaced at nominal ½ mile intervals.

Relative gravity measurements were made with LaCoste & Romberg Model-G gravity meters. Topographic surveying was performed with Trimble Real-Time Kinematic (RTK) and Fast-Static GPS. Field operations were based out of Tonopah, Nevada.

Gravity data were processed to Complete Bouguer Gravity and forwarded to Consulting Geophysicist, Bill Doerner, for interpretation. Maps of Complete Bouguer Gravity, Horizontal Gravity Gradient, First Vertical Derivative, and Residual Gravity are included with this report.

## DATA ACQUISITION

### Survey Personnel

Data acquisition and surveying were performed by Brian Page, Steve Michalowski, and David Merkel. Christopher Magee supervised all operations and completed final data processing.

### Gravity Meters

Three LaCoste & Romberg Model-G gravity meters with serial numbers G-603, G-406, and G-392, were used on the survey. Model-G gravity meters measure relative gravity changes with a resolution of 0.01 mGal. The manufacturer's calibration tables used to convert gravity meter counter units to milliGals are included with the delivered data.

### Gravity Bases

The gravity survey is tied to two absolute gravity bases designated SP2 and TONOPAH. Station TONOPAH is a US Department of Defense network base (DoD Reference 0455-2.) Information on these two bases is listed below and gravity base descriptions are included in Appendix A.

<u>Base</u>	<u>Absolute Gravity</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Elevation</u>
TONOPAH	979443.87	N38°04'06.0"	W117°13'49.8"	1837.90m
SP2	979508.33	N37°48'49.9"	W117°38'27.3"	1403.41m

### GPS Equipment

All gravity stations were surveyed using the Real-Time Kinematic (RTK) GPS method or, where it was not possible to receive GPS base information via radio modem, the Fast-Static method was used. The following GPS equipment was used on the project:

Trimble Model 5700 Dual-Frequency GPS Receivers with built in UHF radios  
 Trimble Model TSCe Data Collector/controllers  
 Trimble TrimMark III base radios  
 Trimble Zephyr GPS antennas  
 Trimble Geomatics Office (Version 1.63) was used for GPS data processing

## Geodetic Survey Control

Two GPS base stations, designated SP1 and SP2, were used on this project. The coordinates and elevation of these base station locations were determined by making simultaneous GPS occupations in the Fast Static mode with Continuously Operating Reference Stations (CORS). GPS data for station SP1 and SP2 were submitted to the National Geodetic Survey (NGS) OPUS service which is an automated system that uses the three closest CORS stations to determine coordinates and elevations for unknown stations. The OPUS results are included in Appendix B. The coordinates and elevation of stations SP1 and SP2 are listed below.

Station	WGS-84 Latitude	WGS-84 Longitude	WGS-84 Ellipsoid Ht.
SP1	39° 54' 29.40599"	-117° 40' 40.36412"	1496.406m
SP2	39° 48' 49.61151"	-117° 38' 30.63122"	1378.734m
	NAD27 UTM Northing	NAD27 UTM Easting	Elevation NAVD29
SP1	4195644.383m	440489.800m	1520.867m
SP2	4185149.846m	443585.722m	1403.405m

## Topographic Surveying of Gravity Stations

All topographic surveying was performed simultaneously with gravity data acquisition. The gravity stations were surveyed in NAD27 UTM Zone 11 North coordinates in meters. The Datum Grid method (NADCON) was used to transform from the WGS-84 (NAD83) datum to the NAD27 datum and the GEOID03 geoid model was used to calculate NAVD88 elevations from ellipsoid heights. The elevations were then converted to North American Vertical Datum of 1929 (NAVD29) using the NGS program VERTCON. The coordinate system parameters used on this survey are summarized below.

### Datum

Datum Name                NAD27  
 Ellipsoid                 Clarke 1866  
 Semi-Major Axis        6378206.4 m  
 Eccentricity             0.082271854  
 Transformation        NADCON (CONUS)

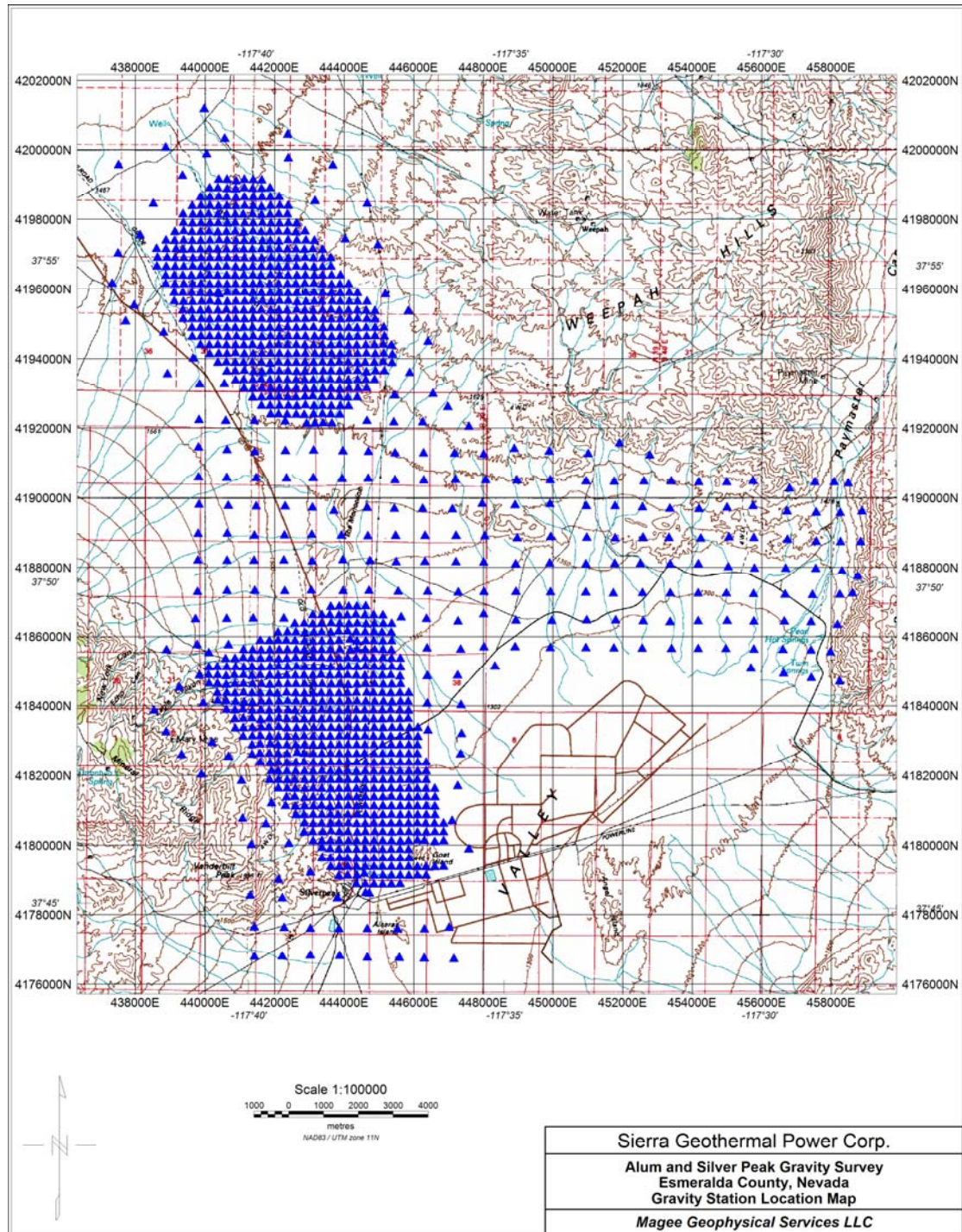
### Projection

Type                        Universal Transverse Mercator  
 Zone                        UTM 11 North  
 Origin Latitude        00° 00' 00.00000" N  
 Central Meridian       117° 00' 00.00000" W  
 Scale Factor            0.9996  
 False Northing        0  
 False Easting          500000 m  
 Geoid Model            GEOID03 (CONUS)

After completion of data acquisition and processing, final maps were prepared in NAD83 UTM coordinates.

## Gravity Stations

A total of 1330 new gravity stations were acquired. Stations were reached by ATV or on foot. A station location map is shown below.



**Alum and Silver Peak Gravity Survey  
Station Location Map**

## DATA PROCESSING

### Overview

Field data including station identifier, local time, gravity reading, measured slope, and operator remarks were recorded in the field in notebooks. The recorded data were then entered into a notebook computer in the form of GeoSoft RAW gravity files. Survey coordinates were transferred digitally.

All gravity data processing was performed with the Xcelleration Gravity module of Oasis montaj (Version 6.4). The gravity data were processed to Complete Bouguer Gravity over a range of densities from 2.00 g/cc through 3.00 g/cc at steps of 0.05 g/cc using standard procedures and formulas. A density of 2.35 g/cc was chosen to best de-correlate the Bouguer gravity with terrain in the area. A color contoured image of Complete Bouguer Gravity at density 2.35 g/cc is shown in Appendix D. A grid cell size of 40 meters was used.

### Data Processing Parameters

The following parameters were used to reduce the gravity data:

<u>GMT Offset</u>	<u>Gravity Formula</u>	<u>Gravity Datum</u>
-8 hours	1967	ISGN-71

### Terrain Corrections

Terrain Corrections were calculated to a distance of 167 km for each gravity station. The terrain correction for the distance of 0 to 10 meters around each station was calculated using a sloped triangle method with the average slopes measured in the field. The terrain correction for the distance of 10 meters to 2000 meters around each station was calculated using a combination of a prism method and a sectional ring method with digital terrain from 10-meter Digital Elevation Models (DEM). The terrain correction for the distance of 2 to 167 kilometers around each station was calculated using the sectional ring method and digital terrain from 90-meter DEMs.

### Gravity Repeats and Loop Closures

Gravity repeat statistics for the Alum and Silver Peak gravity survey follow:

Total number of stations:	1330
Number of repeated stations:	71
% stations repeated:	5.3 %
Total number of readings:	1407
Number of repeat readings:	148
% readings repeated:	10.5%
Maximum repeat error:	0.0458 mGal
Mean repeat error:	0.0117 mGal
RMS error:	0.0153 mGal

A listing of all the gravity loops and their respective closure errors is included in Appendix C. The mean of the absolute value of all loop closure errors is 0.015 mGal.

## Derivative, Gradient, and Residual Maps

Using the Complete Bouguer Gravity values at density 2.35 g/cc, a series of gravity gradient, derivative and residual grids and maps were prepared and are shown in Appendix D.

## DATA FILES

### Raw Data Files

The raw data files are named with the gravity meter serial number, date, and operators initials. The format is *gnnn\_mmm\_dd\_2008\_iii.txt* where *gnnn* is the serial number of the gravity meter, *mmm* is the month, *dd* is the date on which the gravity loop was acquired, and *iii* are the operator's initials. The raw data file and GeoSoft database file (.gdb) for each day's data are included with the delivered data.

### Final Gravity XYZ File

The final XYZ file with all principle facts for the Alum and Silver Peak Gravity Survey is named *Alum\_Silver\_Peak\_Gravity\_Mar\_04\_2008.xls*. The data columns in the file include headers identifying the value of each column.

### Grid and Terrain Files

The file names for the grid files used to create the images in this report and to calculate the terrain corrections are as follows and are included with the delivered data. Each of the images included with this report have also been provided as PDF images, SHAPE files, DXF files, and registered GEOTIFF files.

Complete Bouguer Gravity grid	<i>cbg_235_feb_24.grd</i>
Horizontal Gravity Gradient	<i>cbg_235_feb_24_HG_SM.grd</i>
First Vertical Derivative	<i>cbg_235_1<sup>st</sup>_vert_der_SM.grd</i>
Residual from Upward Continued Gravity	<i>cbg_235_UC500_res.grd</i>
Residual from 10km High-Pass Filter	<i>cbg_235_10km_hi-pass.grd</i>
Local terrain file	<i>Alum_SilverPeak_10m_dem.grd</i>
Regional terrain file	<i>NV_90m_UT_CA2.grd</i>
Regional terrain correction output file	<i>Alum_SilverPeak_167km_tc2.grd</i>

### GeoSoft Database Files

All of the additional GeoSoft database (.gdb) files associated with the data processing are also included with the delivered data, these are:

Final coordinate and elevation listing	<i>coords_thru_feb24_NAVD29.gdb</i>
Master gravity database	<i>Alum_SilverPeak_master_final.gdb</i>
Gravity Base Station database	<i>alum_Grav_Base.gdb</i>

## GPS Data Files

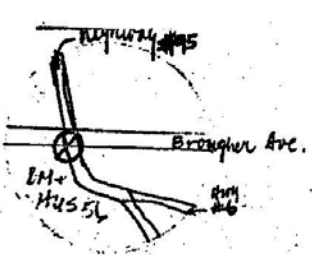
The raw and processed GPS data are included with the delivered data as Trimble Geomatics Office projects and/or included in folders organized by date.

Submitted by:

Christopher Magee  
Consulting Geophysicist



# APPENDIX A GRAVITY BASE DESCRIPTIONS

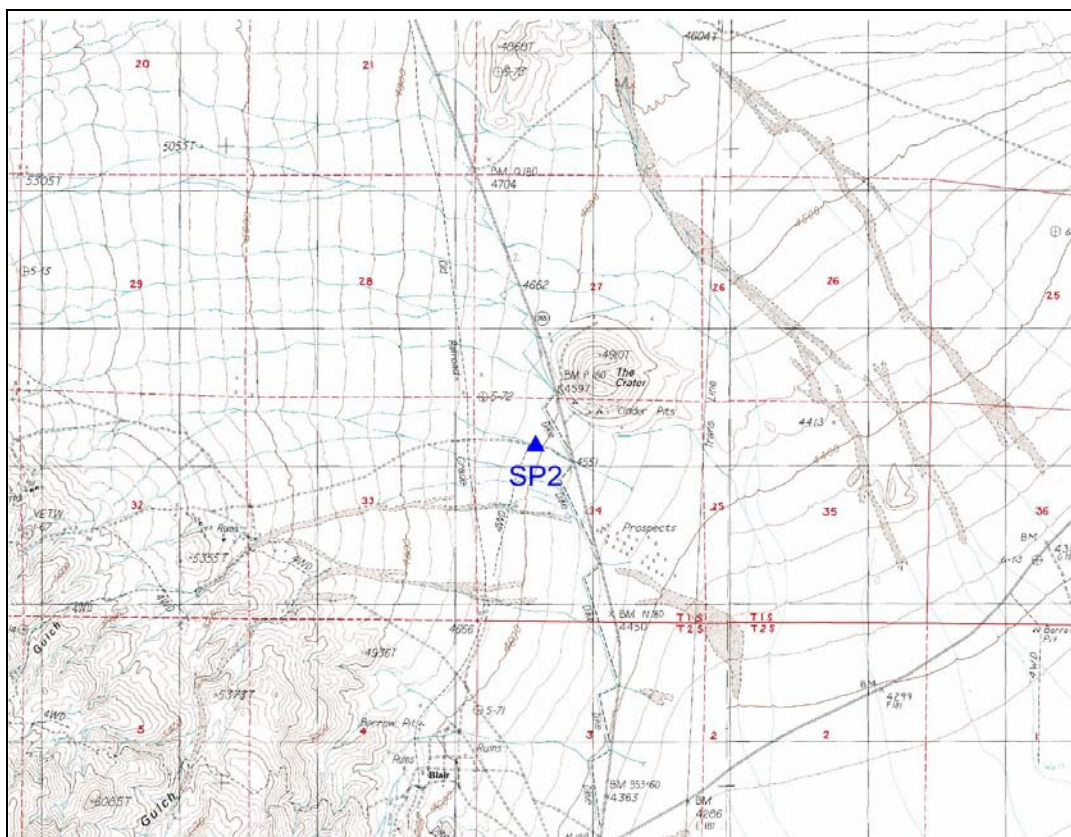
GRAVITY BASE STATION			
LATITUDE	0	STATION DESIGNATION	
	38 04.10'N (1)		
LONGITUDE	0	TONOPAH	
	117 13.83'W (1)	COUNTRY/STATE	
ELEVATION	1837.9 METERS (1)	USA/Nevada	
REFERENCE CODE NUMBERS		ADOPTED GRAVITY VALUE	
DoD 0455-2		g = 979 443.87 mgals	
HUS 56			
		ESTIMATED ACCURACY	DATE
		± 0.2 mgals	MONTH/YEAR
			July 1973
DESCRIPTION AND/OR SKETCH			
<p>T.3N., R.42E., S.35            In Tonopah, at intersection of North Main St. (hwy. #95) and Brougher Avenue, at Tonopah branch of the First National Bank building, in the northeast face of pillar at the north corner, stamping:            "H 128 1934" elevation:            6029.742 ft.</p>			
			
REFERENCE SOURCE			
(1) 04099			

AC FORM 8342/ 60-11  
APR 79

PREVIOUS EDITIONS WILL BE USED

<b>Gravity Base Station Description</b>	<b>Station Designation</b> SP2	<b>Date</b> February 2008
<b>Country</b> USA	<b>State</b> Nevada	<b>City, Town or Community</b> NA
<b>County</b> Esmeralda	<b>Township/Range</b> T01S, R39E Section 34	<b>1:24,000 Scale Quadrangle</b> Silver Peak, NV
<b>Latitude WGS-84</b> 37° 48' 49.61151"	<b>Longitude WGS-84</b> -117° 38' 30.63122"	<b>Ellipsoid Height WGS-84</b> 1378.734 m
<b>Latitude NAD27</b> 37° 48' 49.86000"	<b>Longitude NAD27</b> -117° 38' 27.31200"	<b>Elevation NAVD29</b> 1403.410 m
<b>Type of Mark</b> Rebar	<b>Position Reference</b> Static GPS Survey (OPUS)	<b>Elevation Reference</b> Static GPS Survey (OPUS)
<b>Tied to Known Station</b> TONOPAH (DoD 0455-2)	<b>Estimated Accuracy of Known Station</b> ± 0.10 mGal	<b>Estimated Accuracy (Relative to Known Station)</b> ± 0.05 mGal
<b>Gravity Value</b> 979508.333 mGal		<b>Description by</b> C. Bernier

**Description:** UTM Zone 11 NAD27 Coordinates in meters E443585.296, N4185149.848



## APPENDIX B      GEODETIC CONTROL - OPUS RESULTS

### NGS OPUS SOLUTION REPORT STATION SP1

=====

USER: [dcmerk@hotmail.com](mailto:dcmerk@hotmail.com)  
 RINEX FILE: 0563039v.08o

DATE: February 10, 2008  
 TIME: 03:40:35 UTC

SOFTWARE: page5 0612.06 master.pl  
 EPHEMERIS: igr14655.eph [rapid]  
 NAV FILE: brdc0390.08n  
 ANT NAME: TRM39105.00 NONE  
 ARP HEIGHT: 1.08

START: 2008/02/08 21:45:00  
 STOP: 2008/02/08 23:59:00  
 OBS USED: 5823 / 5855 : 99%  
 # FIXED AMB: 40 / 40 : 100%  
 OVERALL RMS: 0.012(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2008.1064)

X:	-2341024.634(m)	0.014(m)	-2341025.385(m)	0.014(m)
Y:	-4463180.843(m)	0.020(m)	-4463179.565(m)	0.020(m)
Z:	3898326.207(m)	0.012(m)	3898326.167(m)	0.012(m)

LAT:	37 54 29.40599	0.019(m)	37 54 29.42056	0.019(m)
E LON:	242 19 19.63588	0.008(m)	242 19 19.58437	0.008(m)
W LON:	117 40 40.36412	0.008(m)	117 40 40.41563	0.008(m)
EL HGT:	1496.406(m)	0.018(m)	1495.764(m)	0.018(m)
ORTHO HGT:	1522.017(m)	0.031(m)	[Geoid03 NAVD88]	

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 11)	SPC (2703 NV W)
Northing (Y) [meters]	4195842.774	4350798.284
Easting (X) [meters]	440409.558	879620.216
Convergence [degrees]	-0.41649949	0.55633829
Point Scale	0.99964374	0.99997805
Combined Factor	0.99940906	0.99974330

US NATIONAL GRID DESIGNATOR: 11SMB4041095843(NAD 83)

PID	BASE STATIONS USED	LATITUDE	LONGITUDE	DISTANCE(m)
DG7018 AST1	AUSTIN 1 CORS ARP	N392324.924	W1171830.073	167677.9
AF9648 GOLD	GOLDSTONE DS STA CORS ARP	N352530.545	W1165321.252	284449.5
AI0950 EGAN	EGAN_BRGN_NV1996 CORS ARP	N392042.860	W1145619.826	286978.5

NEAREST NGS PUBLISHED CONTROL POINT				
HQ0204	V 180	N375348.	W1174136.	1866.0

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

NGS OPUS SOLUTION REPORT **STATION SP2**

=====

USER: [caitlin\\_bernier@gravityandmag.com](mailto:caitlin_bernier@gravityandmag.com)  
 RINEX FILE: 0563047q.08o

DATE: February 17, 2008  
 TIME: 18:29:54 UTC

SOFTWARE: page5 0612.06 master30.pl  
 EPHEMERIS: igr14666.eph [rapid]  
 NAV FILE: brdc0470.08n  
 ANT NAME: TRM41249.00 NONE  
 ARP HEIGHT: 1.130

START: 2008/02/16 16:09:00  
 STOP: 2008/02/16 23:58:30  
 OBS USED: 21257 / 21445 : 99%  
 # FIXED AMB: 83 / 83 : 100%  
 OVERALL RMS: 0.010(m)

REF FRAME: NAD\_83(CORS96)(EPOCH:2002.0000) ITRF00 (EPOCH:2008.1280)

X: -2341157.665(m) 0.011(m) -2341158.420(m) 0.011(m)  
 Y: -4470267.367(m) 0.016(m) -4470266.087(m) 0.016(m)  
 Z: 3889980.963(m) 0.009(m) 3889980.920(m) 0.009(m)

LAT: 37 48 49.61151 0.004(m) 37 48 49.62599 0.004(m)  
 E LON: 242 21 29.36878 0.005(m) 242 21 29.31716 0.005(m)  
 W LON: 117 38 30.63122 0.005(m) 117 38 30.68284 0.005(m)  
 EL HGT: 1378.734(m) 0.021(m) 1378.089(m) 0.021(m)  
 ORTHO HGT: 1404.488(m) 0.033(m) [Geoid03 NAVD88]

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 11)	SPC (2703 NV W)
Northing (Y) [meters]	4185347.968	4340353.947
Easting (X) [meters]	443505.492	882894.814
Convergence [degrees]	-0.39352187	0.57725843
Point Scale	0.99963931	0.99998461
Combined Factor	0.99942309	0.99976831

US NATIONAL GRID DESIGNATOR: 11SMB4350585348(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
AI8802	DYER DYER CORS ARP	N374434.077	W1180221.559	35900.2
AI8823	GABB GABBS CORS ARP	N385813.180	W1175458.957	130630.1
DG7018	AST1 AUSTIN 1 CORS ARP	N392324.924	W1171830.073	177434.0

## NEAREST NGS PUBLISHED CONTROL POINT

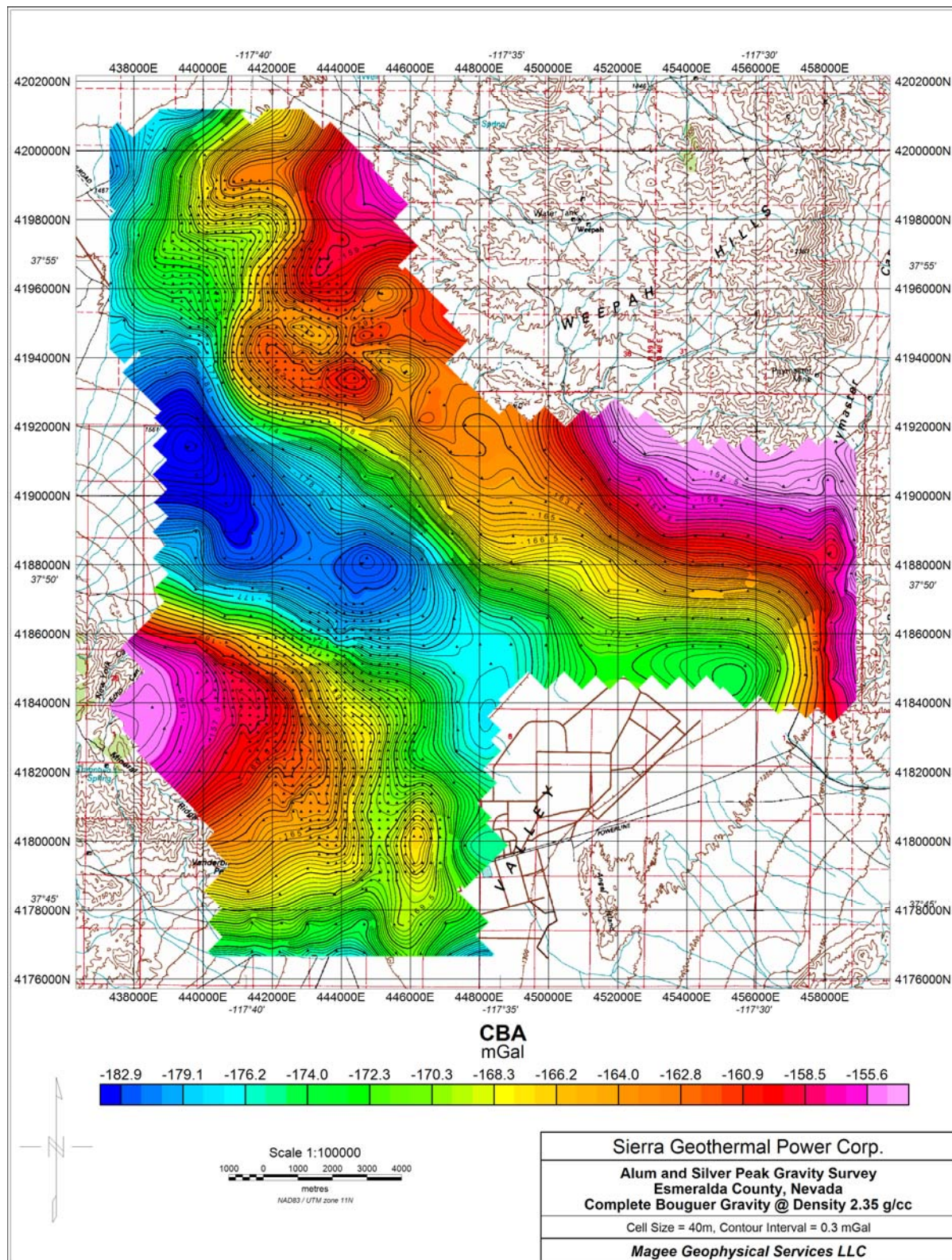
HQ0212 P 180	N374904.	W1173823.	482.4
--------------	----------	-----------	-------

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or field operating procedures used.

## APPENDIX C GRAVITY LOOP CLOSURES

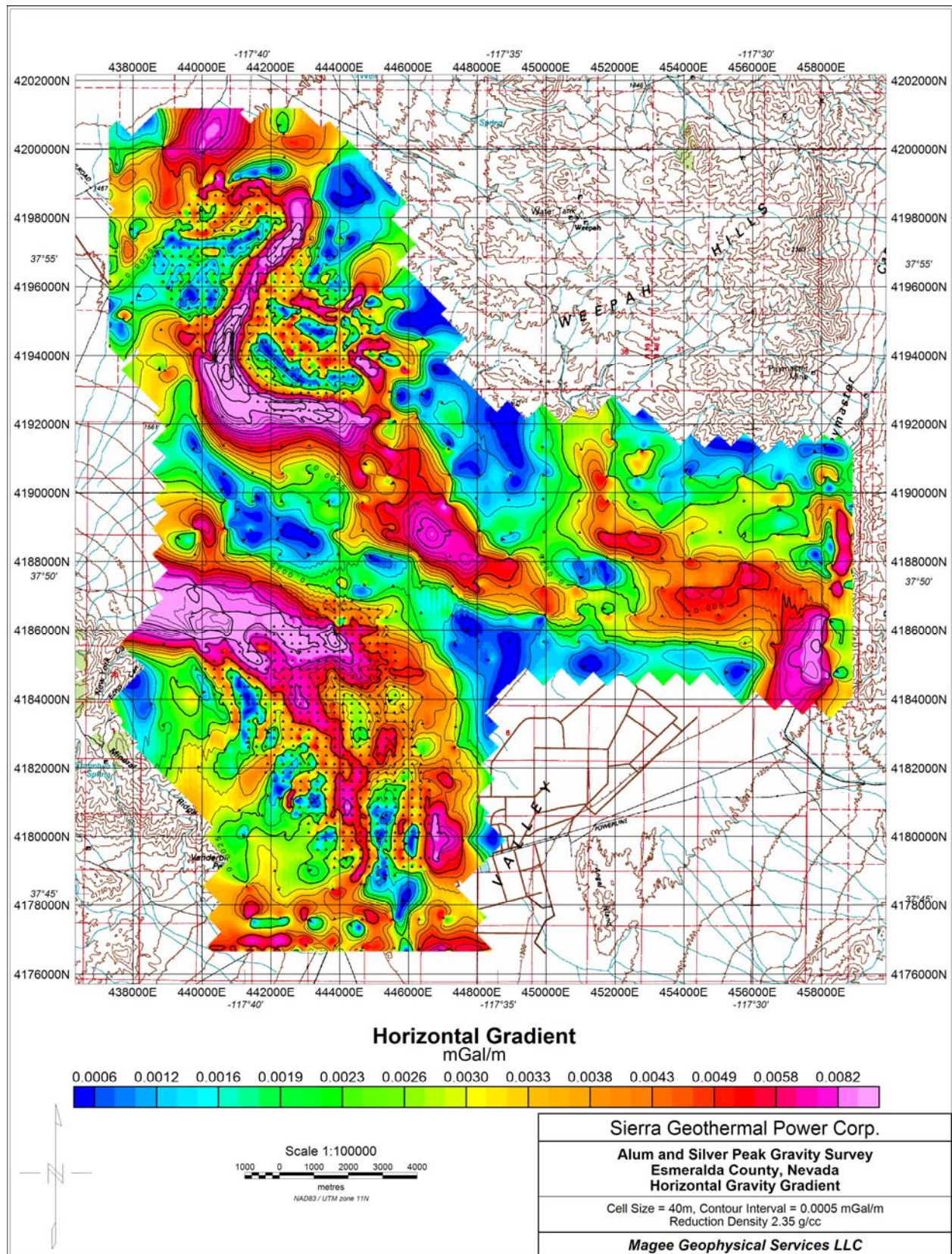
File	Loop	Closure (mGal)
G406_feb_08_2008_dm	1	0.037
G406_feb_09_2008_dm	1	-0.003
G406_feb_10_2008_dm	1	-0.009
G406_feb_11_2008_dm	1	0.081
G406_feb_12_2008_dm	1	0.027
G406_feb_13_2008_dm	1	-0.022
G406_feb_14_2008_dm	1	-0.020
G406_feb_15_2008_dm	1	-0.011
G406_feb_16_2008_dm	1	-0.057
	2	0.000
G406_feb_17_2008_dm	1	-0.014
	2	0.000
G406_feb_18_2008_dm	1	-0.034
	2	-0.007
	3	0.000
G406_feb_19_2008_dm	1	-0.056
	2	0.012
G406_feb_20_2008_dm	1	0.013
	2	0.000
G406_feb_21_2008_dm	1	-0.016
	2	0.000
G406_feb_22_2008_dm	1	-0.013
	2	-0.019
	3	0.000
G603_feb_22_2008_bnp	1	-0.014
	2	0.000
G392_feb_22_2008_sem	1	-0.037
	2	0.000
G406_feb_23_2008_dm	1	0.024
	2	0.000
G603_feb_23_2008_bnp	1	-0.027
	2	0.000
G392_feb_23_2008_sem	1	-0.005
	2	0.000
G406_feb_24_2008_dm	1	0.010
	2	0.000
G603_feb_24_2008_bnp	1	0.003
	2	0.000
G392_feb_24_2008_sem	1	-0.019
	2	0.000
<b>Average Loop Closure (Abs Value)</b>		<b>0.015</b>



**APPENDIX D      GRAVITY MAPS**

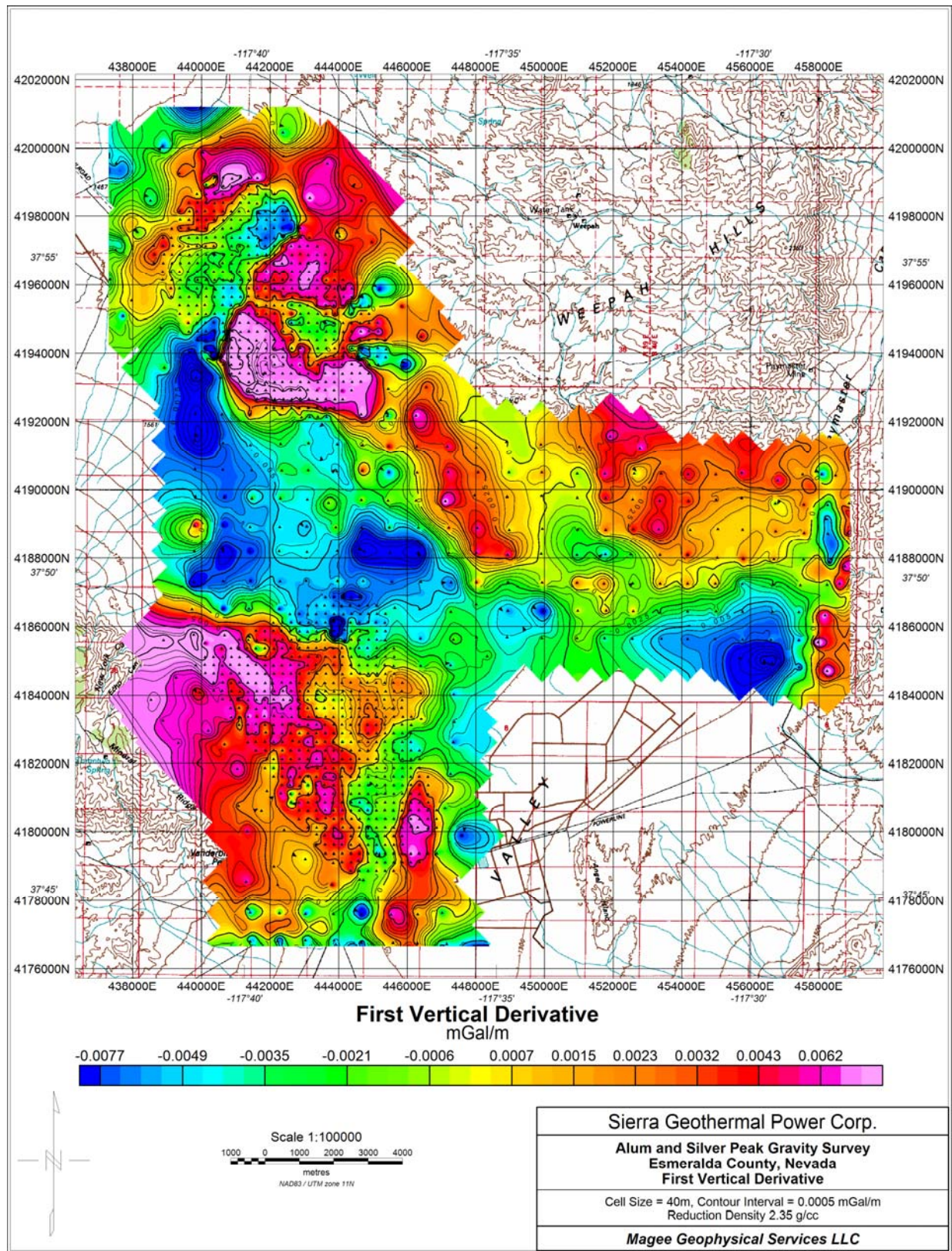
**Alum and Silver Peak Gravity Survey  
Complete Bouguer Gravity @ Density 2.35 g/cc**





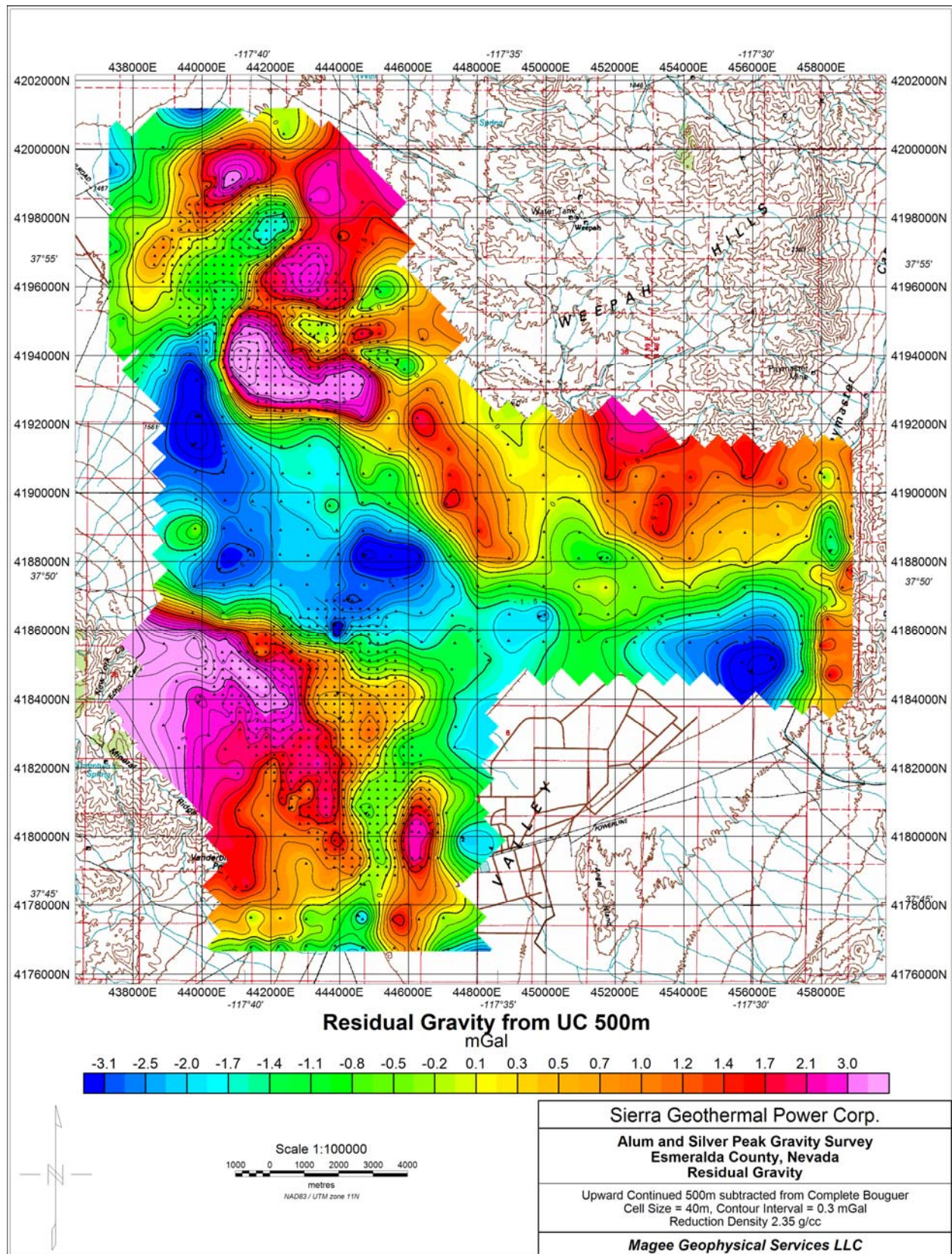
**Alum and Silver Peak Gravity Survey  
Horizontal Gravity Gradient**





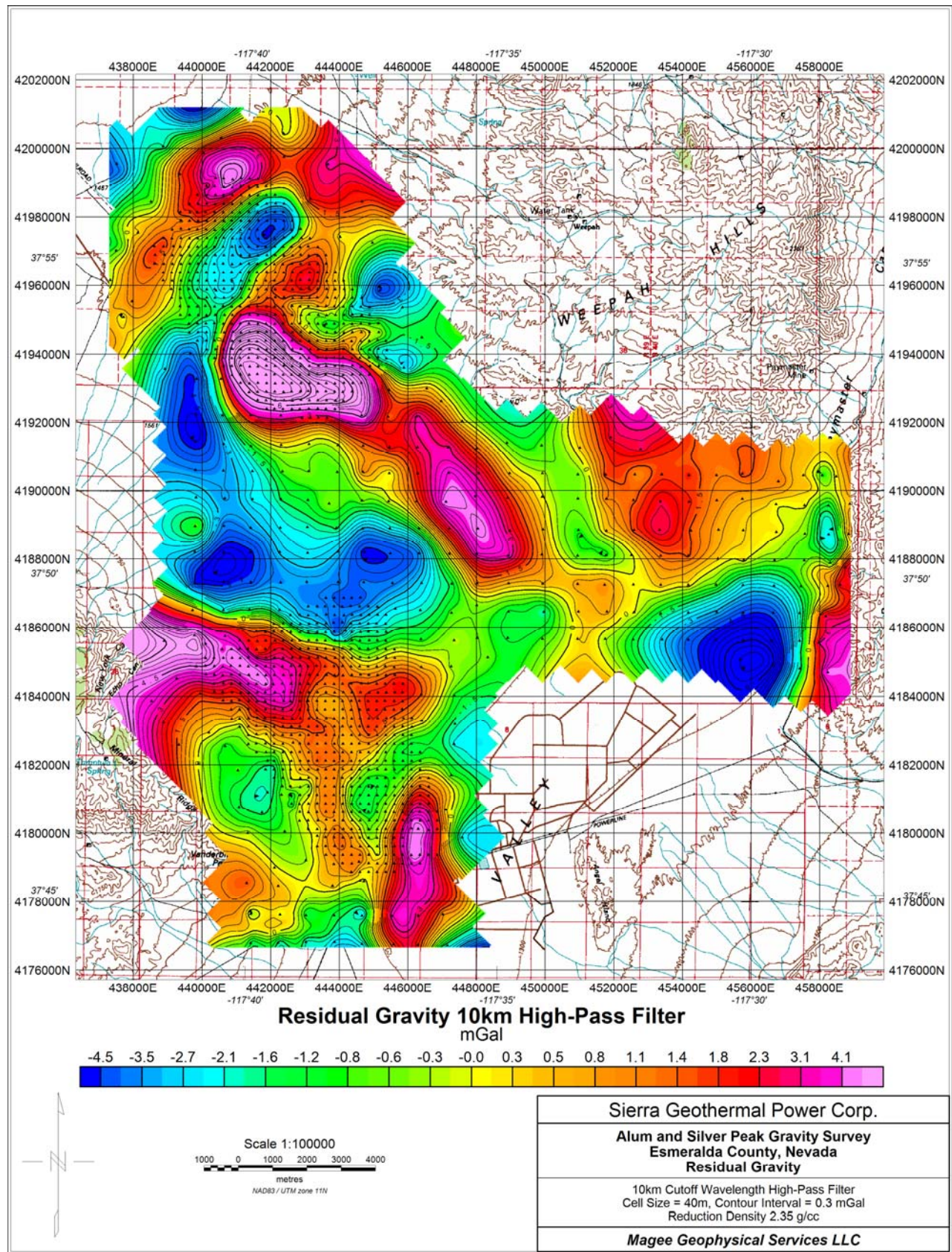
**Alum and Silver Peak Gravity Survey  
First Vertical Derivative**





**Alum and Silver Peak Gravity Survey**  
**Residual Gravity from subtraction of 500m upward continued gravity**





**Alum and Silver Peak Gravity Survey**  
**Residual Gravity from 10km high-pass filter**