SOUTH AUSTRALIA

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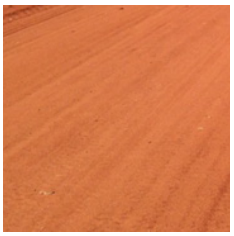
Gravity Survey 2014A1 Agnes Creek, Alcurra, and Tieyon 1:100 000 map sheets






Report Book
2014/00018

Gravity Survey 2014A1

AGNES CREEK, ALCURRA, and TIEYON 1:100 000 map sheets

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Geological Survey of South Australia
Resources and Energy Group

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Report Book 2014/00018

Government of South Australia
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AGNES CREEK, ALCURRA, and TIEYON 1:100 000 map sheets

Philip Heath

INTRODUCTION

A gravity survey conducted in two parts between 23 August – 5 September 2013, and between 16–24 May 2014, was undertaken on the ALCURRA, AGNES CREEK and TIEYON 1:100 000 map sheets in South Australia. A total of 821 readings were collected, incorporating 689 new stations, 88 repeats and 44 base measurements. This work was performed in conjunction with the ongoing Geological Survey of South Australia (GSSA) Musgrave Province mapping programme. The survey has been designated the code 2014A1 for incorporation into the South Australian government geoscience database SA_Geodata.

The survey was conducted by GSSA staff: Philip Heath and Mark Flintoft. A Scintrex CG5 Autograv instrument (S/N 050800135) was used for the duration of the survey, and position information was obtained using the Sokkia GRX1 Real Time Kinematic system.

This survey was undertaken with 4WDs. A decision was made to use 4WDs for the duration of the survey, however for future surveys where road/track availability is reduced, it is recommended that all available resources are used for this type of survey, perhaps starting with the 4WDs and then using quadbikes once some areas of interest have been defined.

No accidents or incidents occurred during this survey. Two days' work had to be repeated due to DGPS instrument issues. These issues were resolved, and a Standard Operating Procedure (SOP) document has been constructed to ensure smooth field operation of the instruments in the future. See Appendix 1 for details.

The Musgrave mapping team plan to continue mapping to the west of the current mapping area, into the APY lands. The geophysics team intend to continue collecting gravity data as part of this ongoing project.

LOCATION

Figure 1 shows the location of the survey along the Stuart Highway on the border with the Northern Territory. Figure 2 shows the stations of the survey in more detail.

The survey points were collected along roads and fence lines at approximately 2 km spacing. The southern half of the Agnes Creek map sheet was not surveyed due to access constraints. No new gravity data was collected along the Stuart Highway or along the train line, as these have already been surveyed. The survey was undertaken using two 4WD vehicles, one acquiring GPS data, the other the gravity.

A total of 821 readings were collected, incorporating 689 new stations, 88 repeats (12.77% repeat rate) and 44 base measurements.

The landscape environment varies significantly over the survey area. Figures 3 to 5 show examples of very sparsely vegetated areas to heavy scrub typical of the region, and Figures 6 and 7 show the different road types. Many of the roads on Tieyon station are very large access roads, suitable for heavy truck access and are very well maintained. The majority of other roads are basic station dirt tracks.

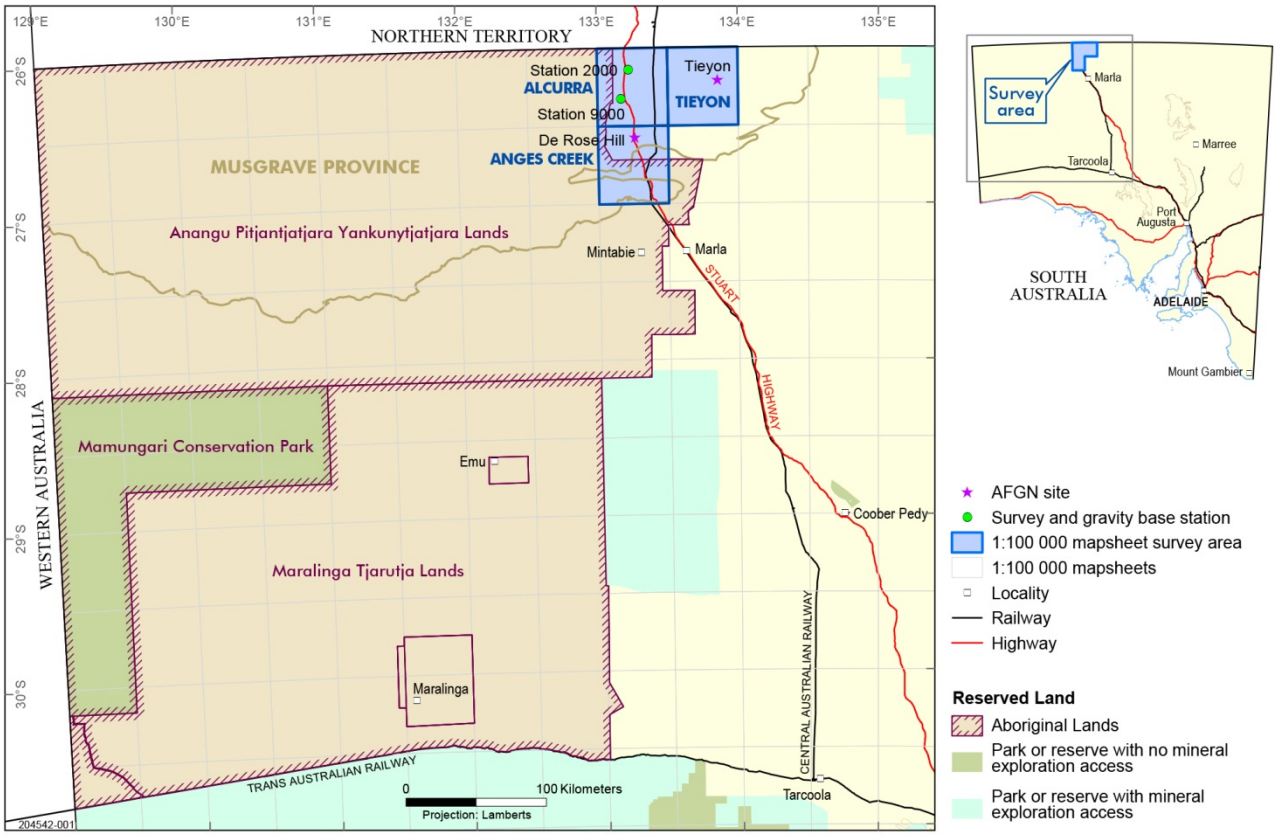

Figure 1. Location of gravity survey 2014A1 in the central north of South Australia.

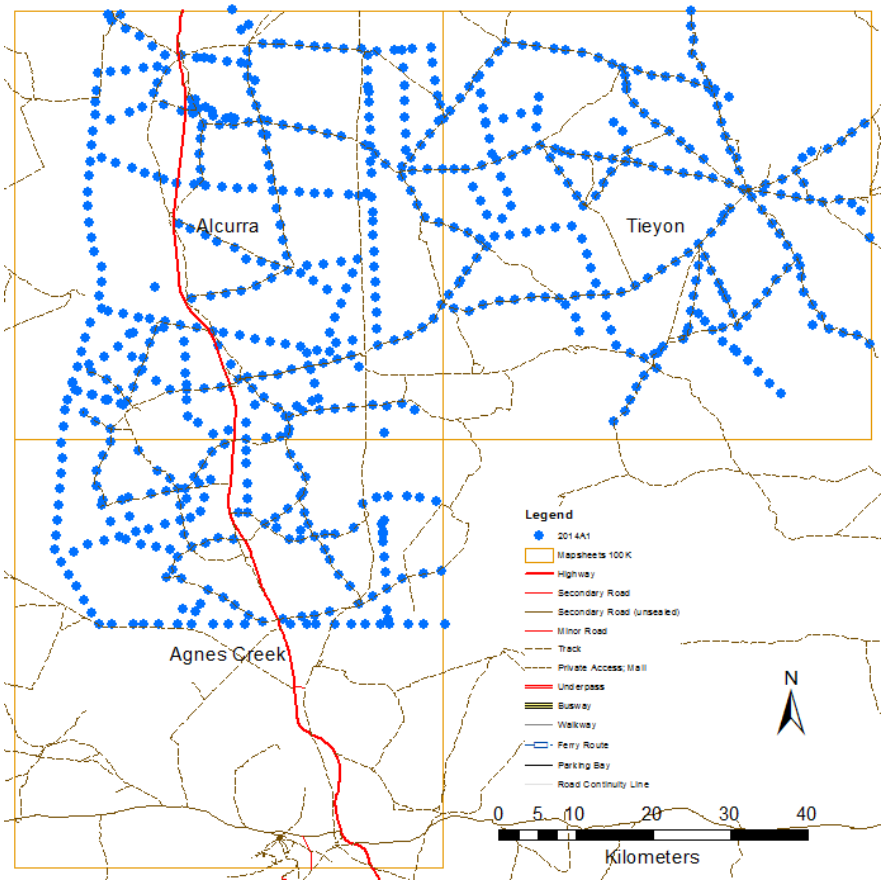

Figure 2. Enlargement of the survey area showing the survey points collected.

Figure 3. The landscape in the survey region includes areas with no hills or valleys; plains. (Photo 414123)

Figure 4. In some areas, the landscape is vegetated by saltbush and bluebush. (Photo 414124)

Figure 5. Parts of the survey region are vegetated by mulga and spinifex. (Photo 414125)

Figure 6. Many of the roads on Tieyon station are well maintained trucking routes. (Photo 414126)

Figure 7. Most of the roads in the survey area are dirt tracks. (Photo 414127)

PREVIOUS GRAVITY COVERAGE

Previous gravity coverage was regional, 7 by 7 km spaced data collected in the 1970s (see Fig. 8). Two other surveys have been undertaken along the main road and railway line. These north-south surveys were two-dimensional, each being collected along a single traverse. Figure 9 shows an image of the gravity of the area based solely on these data.

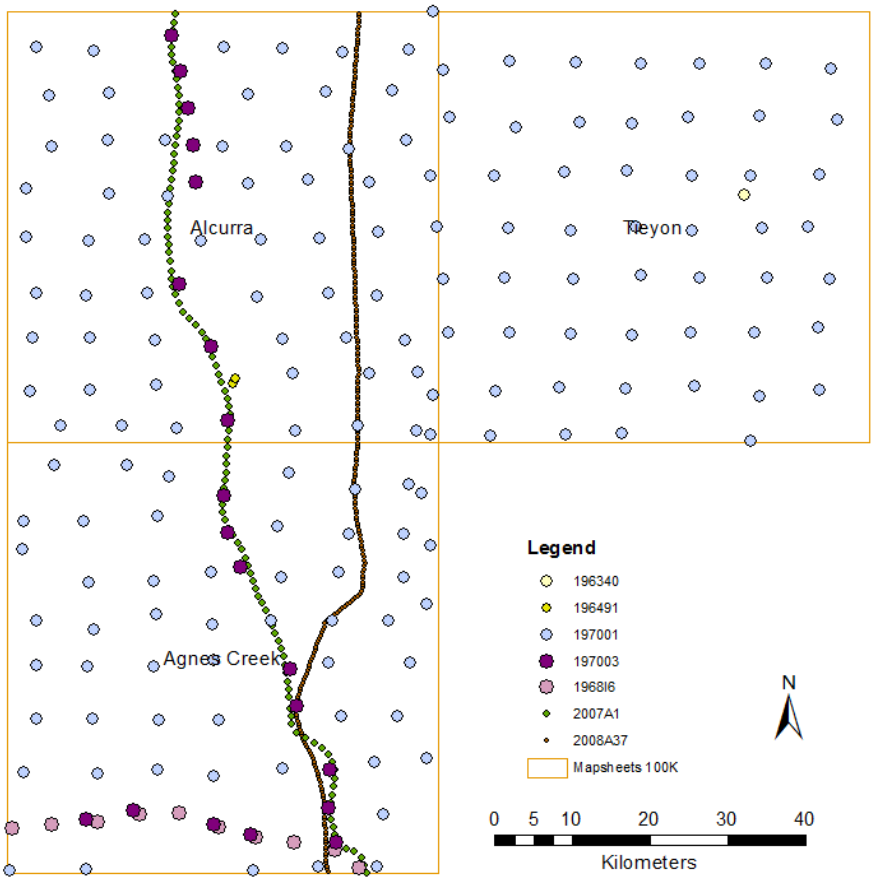

Figure 8. Previous survey coverage was largely 7 by 7 km regional survey points and some detailed work along the highway and train line.

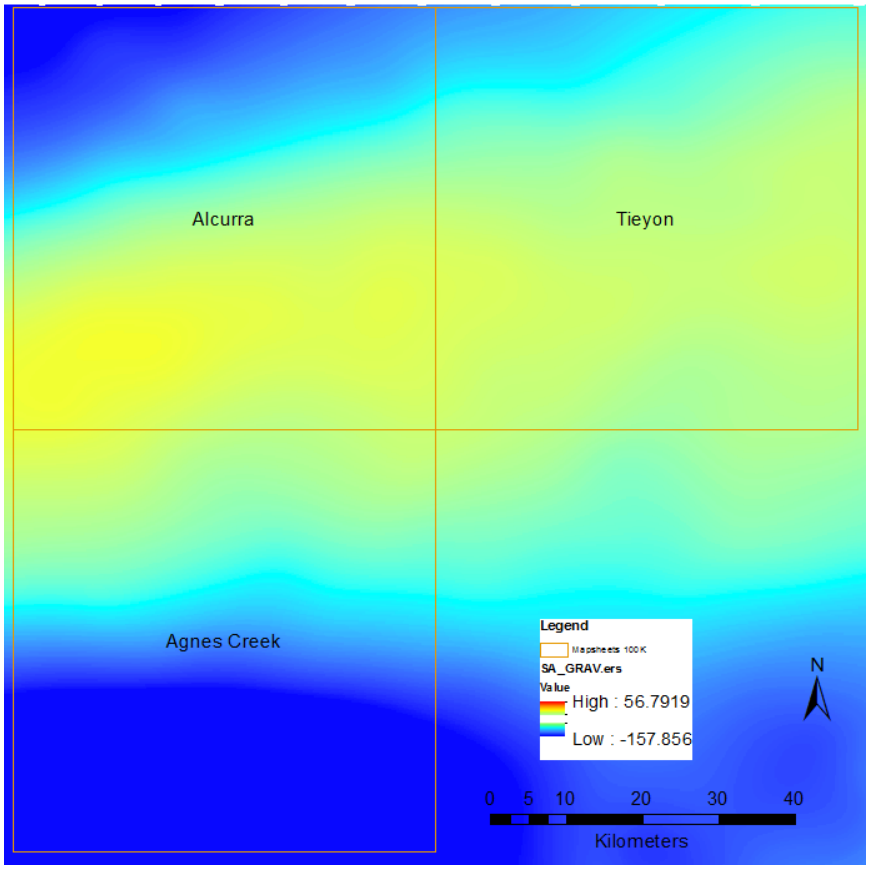

Figure 9. Gravity image of the region prior to the survey, taken from the South Australian state gravity image.

SURVEY AND GRAVITY DATUM

Horizontal Datum:	Geocentric Datum of Australia 1994 (GDA94) Map Grid of Australia 1994 (MGA94) Zone 53
Vertical Datum:	Australian Height Datum (AHD)
Gravity Datum:	Isogal 1984/ISGN 71

Raw GPS data was collected in AGD66, Australian map grid zone 53, and converted to GDA values using in-house six-parameter transform software. Raw Gravity data was collected using Isogal 1965 values, and converted to Isogal 1984 values using in-house software.

SURVEY AND GRAVITY BASE STATIONS

Two new base stations were established for the duration of the survey — stations 9000 and 2000. Stations were marked with a short star picket and removed at the conclusion of surveying.

Station 9000
Easting (MGA94): 316799.57
Northing (MGA94): 7087176.73
Zone: 53
AHD (m): 451.06
Gravity value (’65 mGals): 978956.88

Station 2000
Easting (MGA94): 322019.81
Northing (MGA94): 7107932.31
Zone: 53
AHD (m): 484.30
Gravity value (’65 mGals): 978896.80

SURVEY CONTROL

Horizontal and vertical control for stations 9000 and 2000 were established using the AusPOS online GPS processing service by Geoscience Australia. Stations were recorded with the Sokkia GRX1 receivers in static mode for a minimum of 6 hours, giving vertical control to the survey to within 10 cm. This replaces the need to locate local survey marks in the survey area. GDA coordinates are listed in the tables above.

The elevation output of the differential GPS assumes an ellipsoidal earth model. These values were converted to AHD heights using the free online service provided by Geoscience Australia.

Base position data was obtained through 6-hour measurements at the base station and using the free online AusPOS service to determine the coordinates to sufficient precision and accuracy for gravity field acquisition. Ellipsoid heights were converted to Orthometric heights (AHD) using the free online service courtesy of Geoscience Australia.

GRAVITY CONTROL

The survey was tied to the AFGN station at De Rose Hill shed (Fig. 10). The Geoscience Australia code for the site is 1964911081, and the observed gravity is 978975.46 mGal (Isogal65). The AAGD07 value is 9789612.42 μms^{-2}. The Isogal65 value was used for data processing.

Measurements were also taken at the Tieyon AFGN site in the east of the mapping area for quality control.

There appears to be a discrepancy in the gravity values given by Geoscience Australia for the De Rose Hill shed AFGN site. The AAGD07 value is 9789612.42 μms^{-2}, which in Isogal84 converts to 9789613.2 μms^{-2} (the equation is simply: AAGD07 value + 0.78μms^{-2} = Isogal84 value). There are at least two ways to calculate the Isogal65 value. The Wellman formula suggests the value is 978975.5564 mGal (Isogal65) and the fifth-order polynomial equation suggests 978975.5461 mGal (Isogal65). However the Geoscience Australia website gives the value as 978975.48 mGal (Isogal65). The differences are 0.661 or 0.764 mGal, about 7 μms^{-2}. As reported earlier, I've used the Geoscience Australia Isogal65 to tie this survey into the gravity network and the survey fits in well with surrounding surveys, so any reprocessing of the survey data appears unnecessary. Geoscience Australia has been informed of the discrepancy and they are aware of the issue. To date no resolution has been achieved.

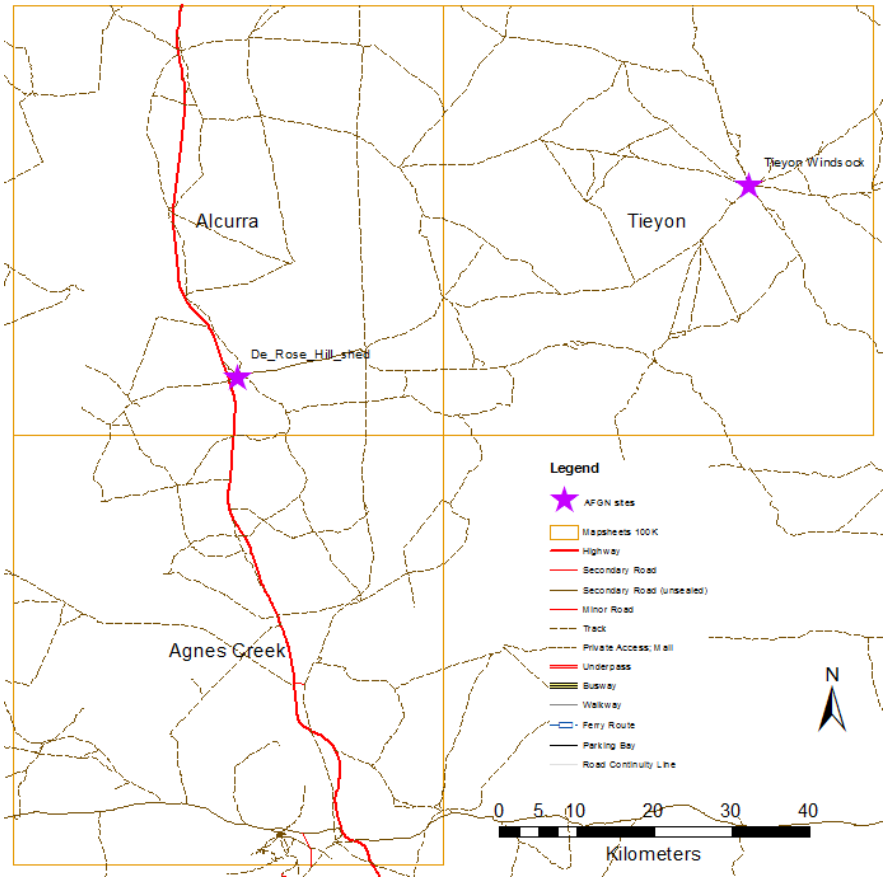

Figure 10. Two AFGN sites were in the survey area — De Rose Hill and Tieyon.

GPS OBSERVATIONS AND PROCESSING

Sokkia GRX1 differential GPS duel channel receivers were used for the duration of the survey.

Measurements for gravity observations have been made using the Real Time Kinematic (RTK) technique, which gives horizontal and vertical precisions of at least 5 cm.

Each GPS measurement includes an error in the precision of the measurement: a horizontal and vertical RMS (HRMS and VRMS). Typically, the VRMS doesn't exceed about 0.008 m (8 mm).

Measurements are recorded on a data logger and input into a field computer at the time of data collection.

The base unit setup is shown in Figure 11 and the yellow handheld data collector can been seen in Figure 12. The rover was mounted on top of one vehicle which surveyed the points and placed a

mark on the ground underneath the rover (no survey pegs or markers were left in the field). The second vehicle followed (with the gravity meter secured on the passenger seat; Fig. 12) taking gravity readings on the mark (Fig. 13).

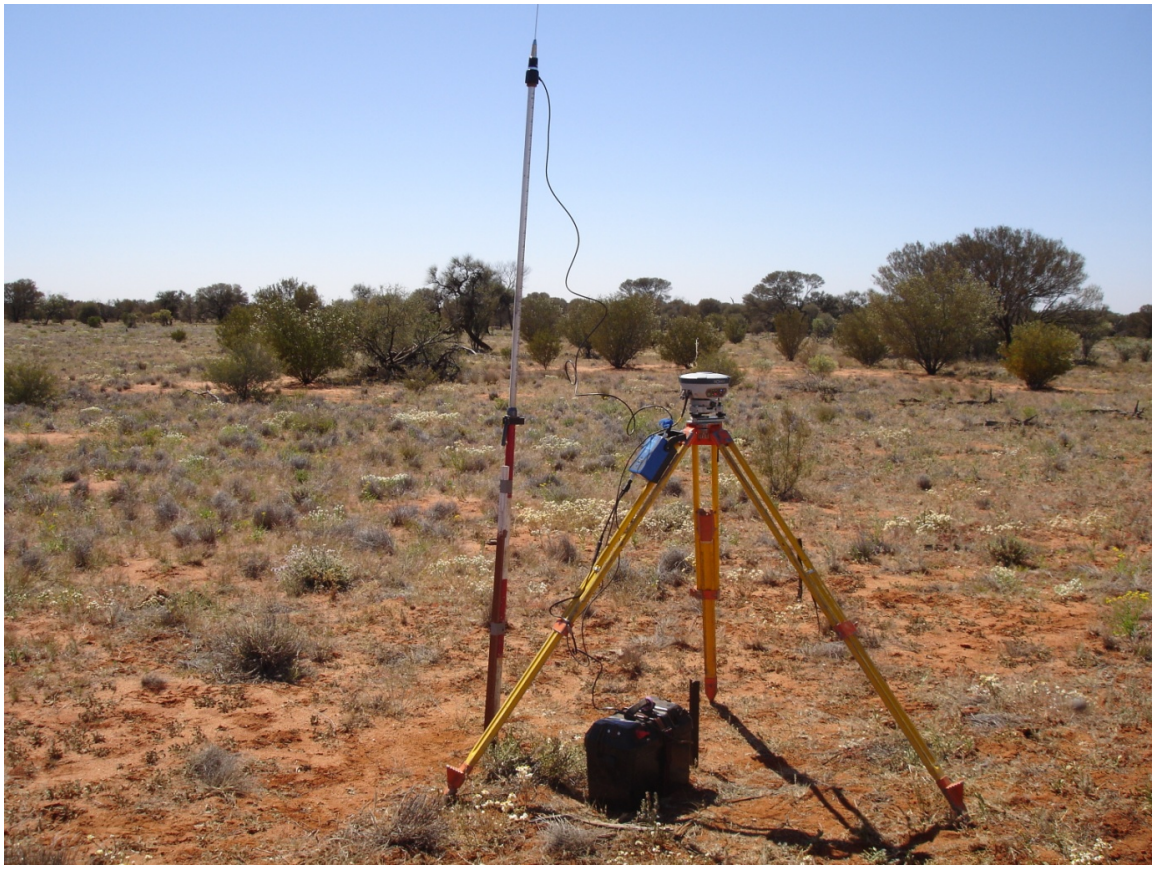

Figure 11. The base Differential GPS setup includes a radio booster (blue box) to increase survey coverage. (Photo 414128)

GRAVITY OBSERVATIONS

Gravity measurements were made using the Scintrex CG5 Autograv instrument number 50800135.

Gravity readings consisted of two 30-second measurements. These were averaged unless the standard deviation of either of the measurements exceeded 0.050 mGal. If the standard deviation of the measurements exceeded 0.050 mGal the measurements were repeated. Generally, measurements recorded SDs of less than 0.020 mGal.

Gravity and DGPS data were recorded directly onto GETAC ruggedized laptops, in addition to being stored on the gravity and GPS instruments. Gravity observations were also recorded in a field note book.

Figure 12. The CG5 gravity meter is secured during transit between stations. The yellow unit is the DGPS data collector. (Photo 414129)

Figure 13. The GPS vehicle surveys the points and marks the ground over which the gravity is recorded. (Photo 414130)

POINT NUMBERING AND MARKING

Each station has an identifying point number. The base station numbers are either 9000 or 2000 (depending on which base is used), and the station numbers start at 1000, incrementing by 1 for each new station.

The stations for the second portion of the survey (carried out in May 2014) start at point 2001 and increment by 1 for each new station.

Repeated stations have a fifth digit added to the station number. A 1 signifies the first repeat of a station and a 2 signifies the second repeat of a station. For example, station 10001 is a repeat of station 1000, and station 21433 is the third repeat of station 2143.

Apart from a cross drawn in the ground, the gravity stations have not been marked in the field.

GRAVITY PROCESSING

The CG5 Autograv automatically calculates corrections for instrument tilts, Earth Tide, and long-term meter drift. Further processing is carried out to calculate the drift between base station measurements, to calculate the Observed Gravity, and to calculate the Bouguer Anomaly.

Gravity data was reduced using in-house software OBSGRED.exe, and the Bouguer Anomaly calculated using BOUGCAL_OG84mgals.xls, an in-house spreadsheet.

The drift between base stations is simply the difference in the gravity readings. Taking into account the time of each gravity measurement, we can calculate a drift correction for each point (n).

$$Drift_n = (b_2-b_1)((t_n-t_1)/(t_2-t_1))$$

Where b_1 is the base reading at the start of the loop, and b_2 is the base reading at the end of the loop. t_n is the time of the gravity reading, t_1 is the time of the b_1 reading, and t_2 is the time of the b_2 reading.

The observed gravity at each point is then:

$$Obs\_g_n = b_g+r_n-drift_n-b_1$$

Where b_g is the known gravity value at b_1, and r_n is the reading at each point.

The theoretical gravity (g_{th}) is also needed at each point to calculate the Bouguer Anomaly. The equation is:

$g_{th} = 978031.8\ (1+0.0053024\ \sin^2\ \phi - 0.0000059\ \sin^2 2\ \phi)$, where ϕ is the latitude (WGS84).

The observed gravity is converted to Isogal 1984 values, and the Bouguer Anomaly is calculated as per:

$$Bouguer\ Anomaly\ ('84)=Obs\_g-g_{th}+0.3086*AHD-0.04191*2.67*AHD$$

RESULTS FORMAT

Appendix 1 contains selected columns of the file 2014A1.xls.

The columns of 2014A1 are:

Day	Day number of survey
station	The number of the station
type	base, station or repeat
obsg_65	observed gravity, isogal65 datum, milligals
lat_obsgred	latitude output from reduction software
long_obsgred	longitude output from reduction software
date	date of measurement
time	time of measurement
mgalrl	raw gravity reading from CG5, milligals
tide	tidal correction used in reduction software
easting66	Easting, AGD66
northing66	Northing, ADG66
zn	Zone
ellipsoidal_height_66	Ellipsoidal height AGD66
eastgda94	Easting, GDA94
northgda94	Northing, GDA94
ellipsoidal_height_gda	Ellipsoidal height GDA94
LONGDA94	Longitude GDA94
LATGDA94	Latitude GDA94
LONAGD66	Longitude AGD66
LATAGD66	Latitude AGD66
AHD_1971	Orthometric height
N value	N value used to calculate AHD
obs_g_84ums2	Observed gravity, isogal84 datum
BOUGUER_GRAV_84_mGals	Bouguer Anomaly, isogal84 datum, milligals

PRODUCTION LOG

Day	Date	Observed	Repeats	Comments	crew
0	21/08/2013			Setting up base stations, AusPOS, etc	1
1	22/08/2013	0	0	DGPS issues, no production	2
2	23/08/2013	11	0		2
3	24/08/2013	40	6		2
4	25/08/2013	34	2		2
5	26/08/2013	50	2		2
6	27/08/2013	43	2		2
7	28/08/2013	36	1		2
8	29/08/2013	42	8		2
9	30/08/2013	45	3		2
10	31/08/2013	26	3		2
11	1/09/2013	37	4		2
12	2/09/2013	15	2	wandering antenna issue	1
13	3/09/2013	50	5		1
14	4/09/2013	29	4		1
15	5/09/2013	13	3		1
16	6/09/2013	0	0	end of part 1	1
17	15/05/2014	13	1	remob	2
18	16/05/2014	30	2		2
19	17/05/2014	33	8		2
20	18/05/2014	24	8		2
21	19/05/2014	49	4		2
22	20/05/2014	47	4		2
23	21/05/2014	18	3	rain	1
24	22/05/2014	23	2	survey complete	1
25	23/05/2014			demob	1

REPEAT OBSERVATION RESULTS

Point	Details	**Observed gravity** ('65 mGals)	**Difference** (mGals)
6002	repeat of 6000	978966.51	0.03
6006	repeat of 6000	978966.61	0.13
6004	repeat of 6003	978973.48	0.00
6005	repeat of 6003	978973.56	0.08
6001	repeat of 6003	978973.45	-0.03
6002	repeat of 6000	978965.33	0.07
11371	repeat of 1137	978963.42	-0.16
11372	repeat of 1137	978963.52	-0.06
6183	repeat of 1183	978963.53	-0.02
6151	repeat of 1151	978960.70	0.07
2247	repeat of 1247	978929.92	-0.02
6281	repeat of 1281	978914.58	0.00
6282	repeat of 1281	978914.53	-0.05
5011	repeat of 5010	978863.67	0.01
5012	repeat of 5010	978863.67	0.01
5001	repeat of 5000	978974.62	0.04
5002	repeat of 5000	978974.53	-0.05
1216	repeat of 1216	978976.04	-0.15
9019	repeat of 9018	978956.95	0.07
13561	repeat of 1356	978972.09	-0.04
13562	repeat of 1356	978972.03	-0.10
13563	repeat of 1356	978971.99	-0.14
13564	repeat of 1356	978972.13	0.00
13565	repeat of 1356	978972.07	-0.06
13761	repeat of 1376	978970.65	0.09
3566	repeat of 1356	978972.08	-0.05
3567	repeat of 1356	978972.06	-0.07
13762	repeat of 1376	978970.59	0.03
13763	repeat of 1376	978970.62	0.06
13861	repeat of 1386	978959.75	-0.07
13862	repeat of 1386	978959.95	0.13
13873	repeat of 1387	978959.83	0.01
14751	repeat of 1475	978863.77	0.16
13864	repeat of 1386	978959.89	0.07
13865	repeat of 1386	978959.82	0.00
3000	repeat of 2000	978896.80	0.00
3014	repeat of 2014	978971.91	-0.01
4014	repeat of 2014	978972.05	0.13
2043	repeat of 2043	978970.19	-0.31
2043	repeat of 2043	978970.22	-0.28
2058	repeat of 2058	978969.32	0.02
2058	repeat of 2058	978969.43	0.13
2044	repeat of 2044	978956.17	0.00
20442	repeat of 2044	978956.33	0.00
20522	repeat of 2052	978954.32	-0.01

Point	Details	Observed gravity ('65 mGals)	Difference (mGals)
20523	repeat of 2052	978954.29	-0.04
20524	repeat of 2052	978954.33	0.00
21011	repeat of 2101	978931.47	-0.10
21011	repeat of 2101	978931.34	0.03
20521	repeat of 2052	978954.25	-0.08
21211	repeat of 2121	978912.68	-0.04
21212	repeat of 2121	978912.76	0.04
21652	repeat of 2165	978903.47	-0.06
21421	repeat of 2142	978911.16	0.09
21422	repeat of 2142	978911.19	0.12
20142	repeat of 2014	978972.00	0.08
21211	repeat of 2121	978912.82	0.10
21212	repeat of 2121	978912.80	0.08
20001	repeat of 2000	978896.85	0.05
20002	repeat of 2000	978896.88	0.08

Figure 14 shows the repeated values, and hence the error margins of the survey. A 12% repeat rate was obtained, with an average error of -0.0078 mGal. Figure 15 shows the standard deviations from the gravity meter. Every 'individual' reading at a site is an average of two field measurements (which are also averages of many readings). The CG5 produces a Standard Deviation (SD) for each measurement. Figure 15 shows the distribution of SD values. The average SD was 0.021 mGal. If a reading with an SD above 0.050 mGal occurs in the field, the reading is discarded and a new reading taken.

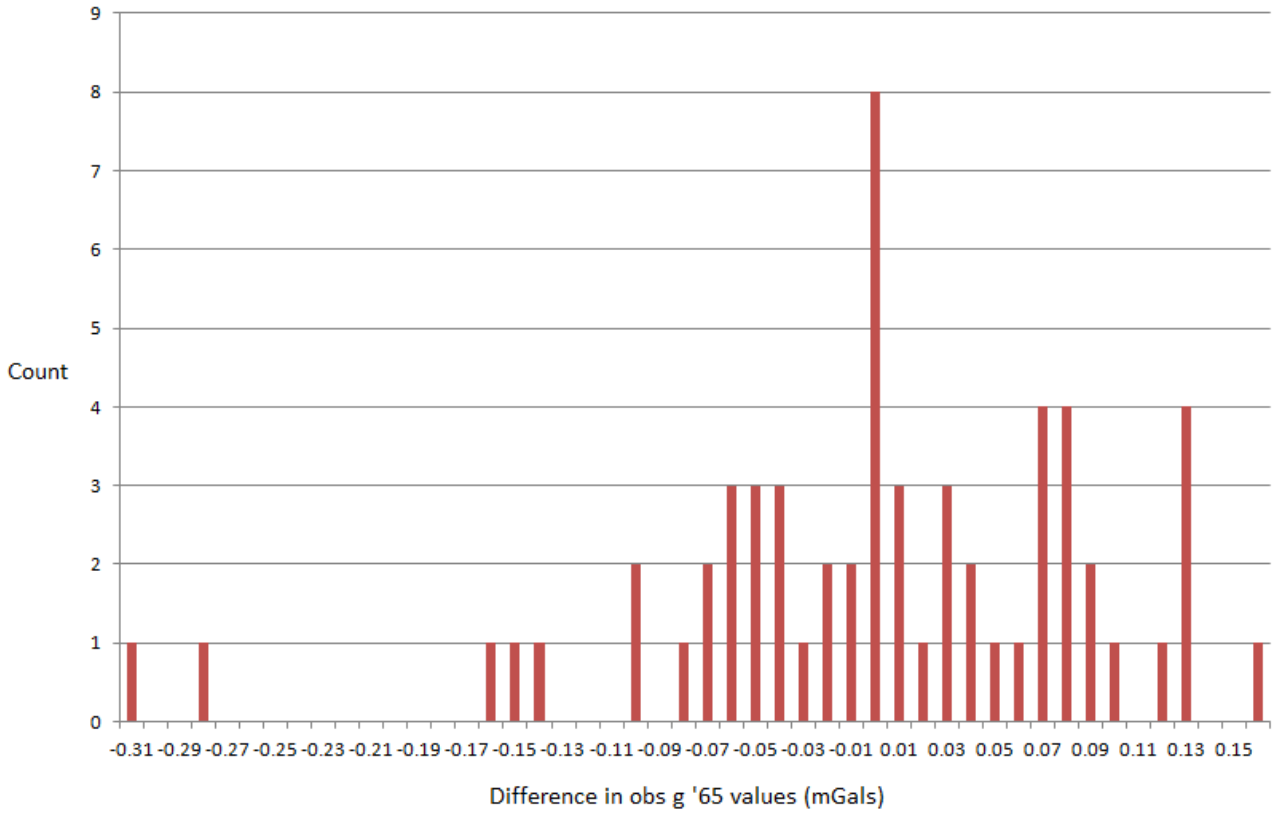

Figure 14. Repeated observed gravity ('65) values: Average = 0.00017 mGal, Standard deviation = 0.0916 mGal, variance = 0.00839 mGal.

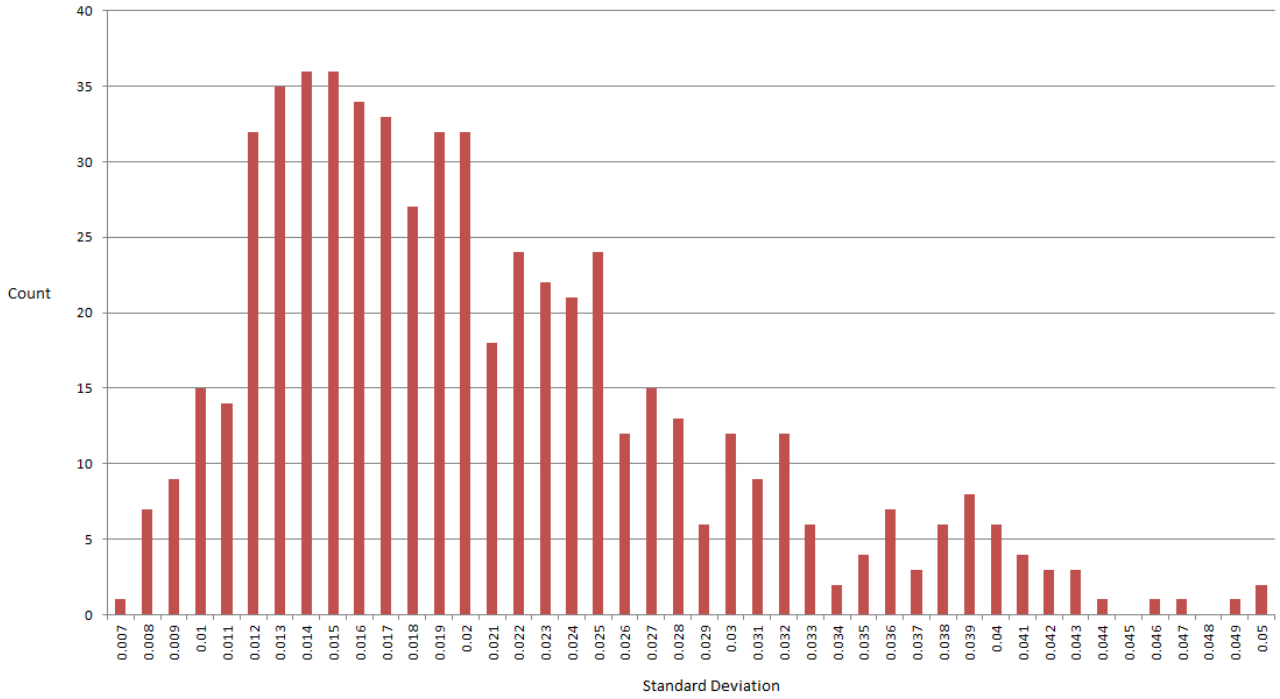

Figure 15. Standard Deviations from the gravity meter are shown above. The average SD was 0.021 mGal.

PLOTS

Figure 16 shows a grid of the Bouguer gravity data for 2014A1, incorporating all previous data. Data has been gridded to 1 km resolution, with interpolation to fill the gaps inside the survey area.

Figure 17 shows the same data with the station points superimposed, and Figure 18 shows the same image with the location of the previously surveyed points.

Figures 19 and 20 show the 1VD of the gravity, Figure 20 including the survey points. Figure 21 shows the final image of the area with some annotations. Figure 22 shows the previous state gravity image for comparison.

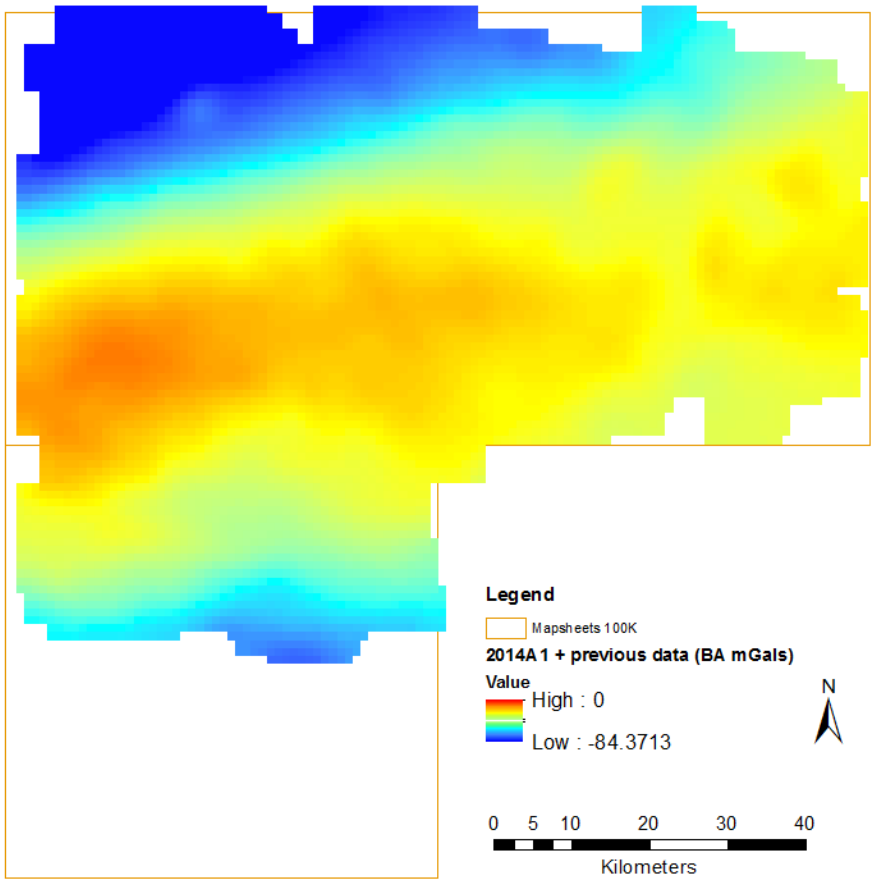

Figure 16. An image of the gravity, incorporating all available data.

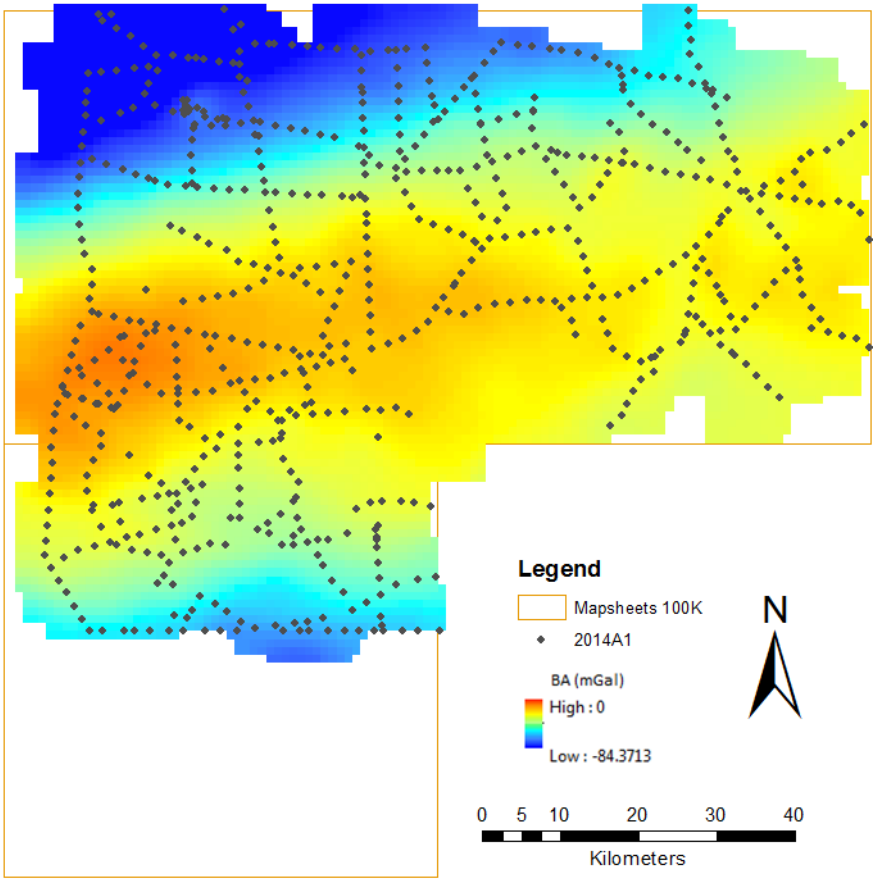

Figure 17. An image of the gravity data showing the position of gravity readings for 2014A1.

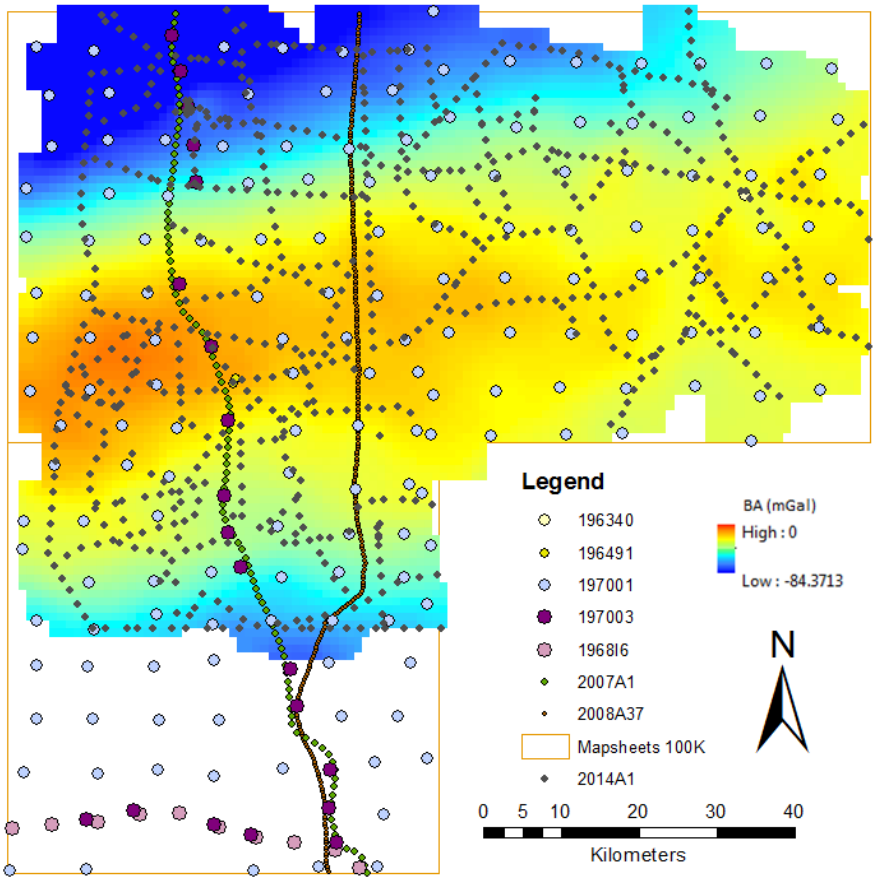

Figure 18. An image of the gravity data showing the position of all gravity readings.

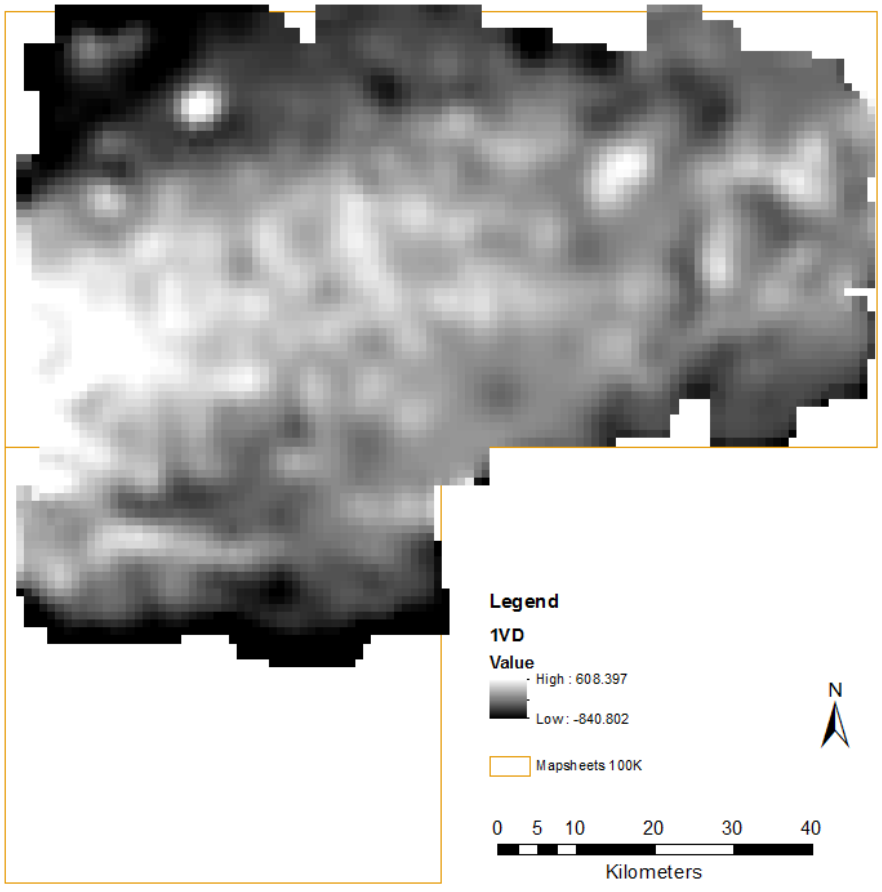

Figure 19. The 1VD image of the gravity accentuates areas where the rate of change of the gravity data is high.

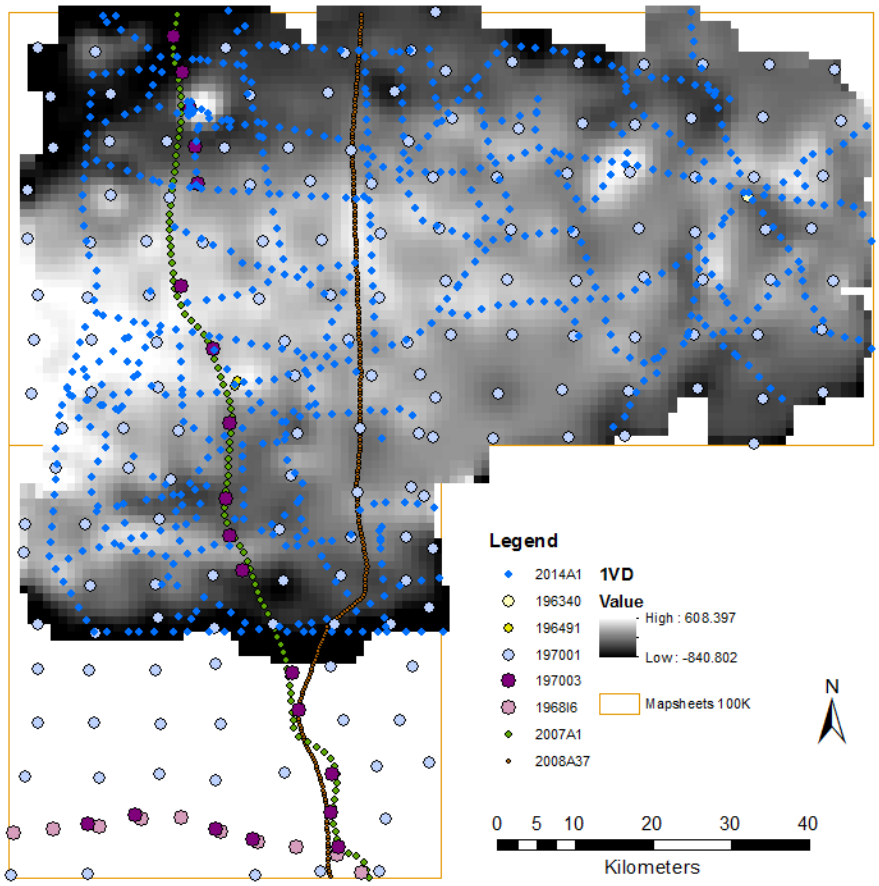

Figure 20. The 1VD image with points superimposed allows for quality control in interpretation.

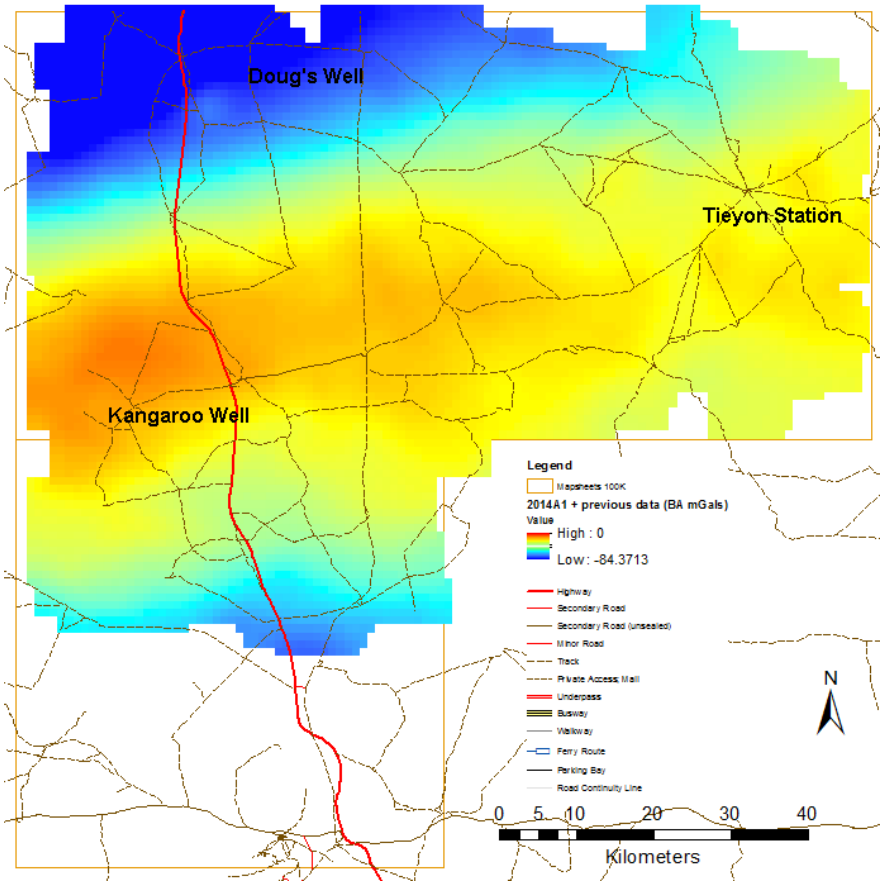

Figure 21. Some of the noticeable gravitational features can be seen around Kangaroo Well, Doug's Well and Tieyon Station.

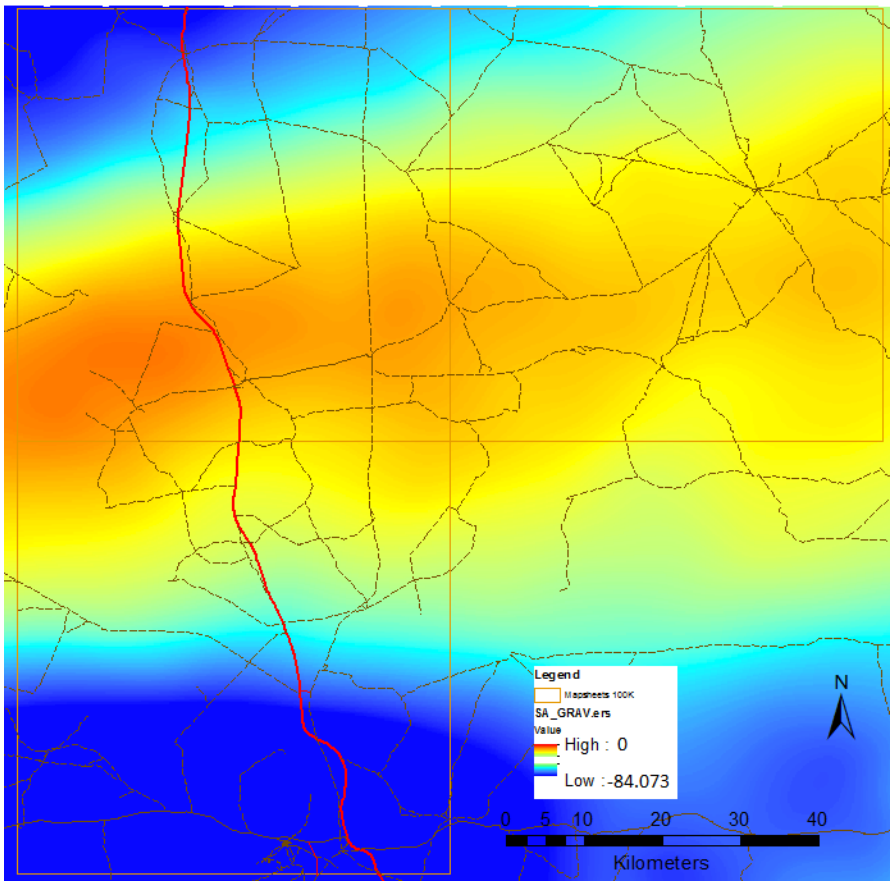

Figure 22. When the previous state grid data is rescaled to match the scale of 2014A1, the image is comparable to Figure 21, but is less detailed.

INTERPRETATION NOTES

Several new features are apparent, notably the anomaly at Doug's Well. Previously this area had no gravity coverage, but was investigated as there is a magnetic high in the area.

The gravity highs around Tieyon station are better defined, with an anomaly directly to the east of the station.

Care must be taken when interpreting these data. The gridding algorithm tries to interpolate between lines. Where data is sparse between lines this can lead to artefacts in the grid. It is therefore important to view the station points when making interpretations to ensure that the interpretation corresponds to observation, rather than gridding interpolation.

Some red areas appear to have in common a shared feature, a half-wavelength high of around 5 to 6 km. This could be due to either noisy data or under-sampled data. The errors in data are shown in Figures 13 and 14 and are not high, so I would suggest that there are more gravity features in the area that would be better resolved with a more detailed survey, for example a 1 km by 1 km grid.

As this survey is effectively a series of traverses, the interpreter should also consider individual traverses for interpretation as well as the grid images shown here.

ACKNOWLEDGEMENTS

I'd like to thank Mark Flintoft for his excellent field support and organising the DGPS, Rian Dutch for getting us out there in the first place, Lyn Broadbridge for feeding us, Mark Pawley for making us coffee every morning, Mario Werner for excellent wine, Carmen Krapf for putting up our tents and all of the above for good campfire conversation.

PROCESSED RESULTS

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
9003	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
1056	station	321662.62	7082070.41	53	436.16	978967.83	-11.77650
1057	station	319854.31	7082415.36	53	438.84	978967.76	-11.07844
1058	station	318017.24	7082767.96	53	441.74	978967.04	-10.98365
1059	station	317836.18	7082073.15	53	449.33	978966.29	-10.68948
1060	station	313981.07	7081114.88	53	455.26	978967.41	-8.98805
1061	station	312621.34	7079504.91	53	462.34	978967.43	-8.60800
1062	station	311001.74	7078159.22	53	460.61	978968.75	-8.48532
1063	station	309309.66	7077124.41	53	450.67	978970.80	-9.04480
1064	station	314310.35	7081379.78	53	455.65	978966.59	-9.56328
9004	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
9005	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
1064	station	314310.35	7081379.78	53	455.65	978966.56	-9.59330
1065	station	316786.13	7081704.34	53	447.20	978967.36	-10.26774
1066	station	316235.11	7080006.68	53	455.94	978967.56	-9.44495
1067	station	315624.49	7078123.64	53	460.93	978968.83	-8.40879
1068	station	315037.42	7076313.23	53	458.09	978969.83	-9.13711
1069	station	314392.75	7074318.13	53	451.22	978970.70	-10.90732
1070	station	313806.40	7072506.61	53	437.64	978973.56	-11.88777
1071	station	312760.72	7073839.35	53	443.08	978972.29	-11.21184
1072	station	311313.19	7075262.03	53	450.38	978970.85	-10.27951
1073	station	309531.07	7076148.75	53	450.59	978971.88	-8.61405
1074	station	313317.33	7072013.29	53	437.31	978973.95	-11.87922
1075	station	311529.24	7072586.16	53	441.80	978973.04	-11.51686
1076	station	309767.98	7073151.72	53	442.16	978971.94	-12.16130
1077	station	308034.70	7073709.03	53	444.53	978972.49	-10.76679
1078	station	307392.69	7074868.15	53	448.78	978971.82	-9.84169
1079	station	307859.91	7076803.19	53	452.18	978969.55	-10.19331
1080	station	308318.60	7078702.79	53	450.29	978968.36	-10.52641
1081	station	308774.56	7080587.17	53	454.32	978965.48	-11.39691
1082	station	309258.66	7082571.23	53	466.35	978961.61	-11.62228
1083	station	311342.55	7084039.45	53	450.25	978962.85	-12.61662
1084	station	313189.52	7083685.88	53	449.87	978964.09	-11.69629
1085	station	314939.29	7083350.10	53	448.32	978965.00	-11.32507
1086	station	316310.29	7083087.10	53	448.34	978964.80	-11.70463
6000	station	314310.35	7081379.78	53	455.65	978966.48	-9.67334
1087	station	314300.15	7078221.56	53	463.97	978968.04	-8.52415
1088	station	315506.27	7076504.21	53	458.87	978969.05	-9.64331
1089	station	317147.81	7075200.84	53	446.03	978972.01	-10.06968
1090	station	318805.15	7073965.63	53	440.79	978971.09	-12.83803
1091	station	320629.22	7074087.03	53	429.74	978973.35	-12.68717
1092	station	320622.11	7074607.01	53	429.87	978974.02	-11.65500
1093	station	320539.65	7076224.91	53	433.87	978972.60	-11.23774
1094	station	320433.16	7078211.08	53	438.47	978971.51	-10.13210
1095	station	320329.07	7080174.21	53	449.57	978966.98	-11.20708
6001	repeat	320629.22	7074087.03	53	429.74	978973.45	-12.58712
6002	repeat	314310.35	7081379.78	53	455.65	978966.51	-9.64332

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
6003	repeat	320629.22	7074087.03	53	429.74	978973.48	-12.55710
1096	station	322780.65	7074239.17	53	423.28	978973.35	-13.87844
1097	station	324609.63	7074369.83	53	415.35	978974.84	-13.88031
6004	repeat	320629.22	7074087.03	53	429.74	978973.48	-12.55710
1098	station	320716.85	7072676.09	53	426.72	978972.62	-14.93066
1099	station	320818.12	7070614.35	53	423.13	978972.88	-16.71729
1100	station	322006.37	7069742.06	53	422.69	978972.77	-17.49184
1101	station	323860.34	7068396.60	53	428.41	978969.25	-20.77993
1102	station	325665.83	7068881.04	53	420.58	978969.85	-21.42132
6005	repeat	320629.22	7074087.03	53	429.74	978973.56	-12.47706
6006	repeat	314310.35	7081379.78	53	455.65	978966.61	-9.54327
9006	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
9000	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
1103	station	319783.10	7061152.19	53	436.56	978965.32	-27.78836
1104	station	320659.41	7061299.88	53	438.25	978964.81	-27.87782
1105	station	321764.59	7062773.04	53	431.10	978965.78	-27.36486
1106	station	322699.94	7064406.49	53	428.71	978968.40	-24.15791
1107	station	323698.70	7066090.92	53	422.40	978969.83	-22.88039
1108	station	325110.75	7067095.95	53	421.01	978968.87	-23.47287
1109	station	326407.50	7054687.63	53	413.95	978970.37	-31.45937
1110	station	324566.48	7054833.64	53	425.91	978968.80	-30.56435
1111	station	323110.84	7054311.58	53	423.59	978970.20	-29.94850
1112	station	321530.13	7053654.22	53	421.78	978970.95	-29.96782
1113	station	319986.90	7052398.57	53	429.65	978968.22	-31.95758
1114	station	319306.38	7050817.00	53	429.83	978967.97	-33.19886
1115	station	318703.41	7049675.72	53	431.22	978966.52	-35.11596
1116	station	320448.32	7049569.66	53	421.19	978968.13	-35.56428
1117	station	320696.02	7055328.06	53	435.94	978969.13	-27.90347
1118	station	320083.11	7059174.96	53	443.07	978964.74	-28.38015
6000	station	319783.10	7061152.19	53	436.56	978965.26	-27.84839
1119	station	318533.69	7060923.88	53	435.72	978966.99	-26.42033
1120	station	316709.20	7060466.02	53	437.77	978967.71	-25.57868
1121	station	314122.24	7060069.33	53	441.67	978968.13	-24.62449
1122	station	313332.90	7059620.49	53	444.22	978969.40	-23.13804
1123	station	311008.59	7059041.01	53	446.42	978970.19	-22.26952
1124	station	312054.04	7056846.75	53	454.95	978969.32	-22.90215
1125	station	313124.13	7054966.72	53	457.58	978968.30	-24.64288
1126	station	311300.13	7054412.47	53	466.86	978967.03	-24.43249
1127	station	309462.69	7053798.45	53	470.73	978964.50	-26.58448
1128	station	307874.06	7052926.70	53	477.54	978963.45	-26.84893
1129	station	306341.87	7051603.40	53	471.09	978963.96	-28.45774
1130	station	307317.98	7049886.44	53	476.16	978962.73	-29.82178
1131	station	308174.20	7048378.46	53	461.46	978962.18	-34.25650
1132	station	309184.22	7046601.08	53	459.74	978960.42	-37.52803
1133	station	313807.51	7054635.69	53	455.88	978968.23	-25.26905
1134	station	315578.79	7053985.44	53	449.14	978967.73	-27.53783
1135	station	317436.18	7053723.69	53	441.21	978968.70	-28.31448
1136	station	318975.40	7053353.01	53	429.72	978969.97	-29.56099
6002	repeat	319783.10	7061152.19	53	436.56	978965.33	-27.77835
9000	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
9009	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
1137	station	307867.03	7052913.47	53	477.69	978963.58	-26.69969
1138	station	310076.81	7045028.68	53	474.92	978955.45	-40.55226
1139	station	310936.41	7043515.14	53	476.88	978953.07	-43.54486
1140	station	312450.33	7043534.71	53	474.72	978953.63	-43.41154
1141	station	314849.74	7043578.01	53	454.30	978956.77	-44.28281
1142	station	316010.58	7043581.24	53	450.49	978957.37	-44.44007

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1143	station	317837.22	7043631.88	53	445.01	978957.63	-45.24178
1144	station	320083.16	7043672.53	53	442.59	978957.87	-45.47283
1145	station	320680.21	7045700.49	53	431.19	978961.22	-43.04126
1146	station	322113.74	7045387.94	53	426.38	978961.12	-44.30622
1147	station	322610.67	7046425.28	53	424.11	978961.36	-43.83879
1148	station	323498.87	7048130.32	53	421.46	978963.95	-40.66093
1149	station	325240.53	7047219.31	53	415.56	978962.79	-43.59471
1150	station	326704.15	7046181.13	53	410.95	978960.66	-47.32337
1151	station	328314.61	7045030.15	53	405.94	978960.68	-49.05532
1152	station	323674.18	7062485.59	53	431.39	978965.19	-28.10302
1153	station	322303.53	7061850.37	53	433.66	978964.46	-28.78756
1154	station	322935.91	7060170.86	53	432.90	978964.30	-30.19649
1155	station	322566.72	7058251.08	53	440.53	978964.69	-29.55442
1156	station	320911.60	7059956.34	53	441.66	978964.27	-28.62502
1157	station	321363.30	7057536.01	53	445.76	978964.92	-28.75130
1158	station	320109.11	7057137.94	53	451.75	978965.63	-27.11080
1159	station	318341.18	7056580.94	53	444.65	978969.44	-25.04093
1160	station	316501.65	7056000.18	53	443.18	978970.84	-24.29099
1161	station	314957.54	7055512.89	53	450.04	978970.75	-23.33501
11371	repeat	307867.03	7052913.47	53	477.69	978963.42	-26.85978
1162	station	305642.61	7053113.98	53	474.36	978964.51	-26.26990
1163	station	305759.10	7054946.56	53	465.79	978965.54	-25.73030
1164	station	305879.70	7056879.04	53	457.38	978967.33	-24.33441
1165	station	306012.98	7058979.09	53	450.34	978969.31	-22.37120
1166	station	306138.15	7060965.36	53	455.17	978969.13	-20.30666
1167	station	306263.90	7062980.60	53	454.68	978974.43	-13.79035
1168	station	306268.87	7064981.80	53	460.47	978969.82	-15.96083
1169	station	306195.21	7067006.23	53	476.44	978968.10	-13.22208
1170	station	306354.81	7069035.57	53	454.47	978973.34	-10.98258
1171	station	306518.23	7071255.51	53	449.06	978972.71	-11.23524
1172	station	306840.50	7072585.72	53	447.30	978972.25	-11.17960
1173	station	307345.90	7074668.38	53	447.07	978972.76	-9.36781
1174	station	307714.26	7073810.93	53	445.62	978972.96	-10.01224
1175	station	309638.30	7073192.37	53	441.68	978972.16	-12.00774
1176	station	311301.88	7072658.95	53	441.47	978972.48	-12.09240
1177	station	313004.47	7072112.66	53	439.86	978973.42	-11.84018
1178	station	311834.67	7067109.87	53	449.61	978973.35	-13.23369
1179	station	311112.35	7065363.53	53	444.29	978974.20	-14.55921
1180	station	310379.27	7063431.50	53	449.37	978972.01	-17.00130
1181	station	310377.05	7061450.61	53	445.69	978972.21	-18.81664
1182	station	311195.18	7059633.49	53	441.40	978971.44	-21.62112
11372	repeat	307867.03	7052913.47	53	477.69	978963.52	-26.75973
9010	base	316799.57	7087176.73	53	451.06	978956.88	-16.44899
9011	base	316799.57	7087176.73	53	449.55	978956.88	-16.95280
1183	station	307867.03	7052913.46	53	475.23	978963.55	-27.42180
1184	station	314305.90	7057527.40	53	452.55	978969.26	-23.22194
1185	station	318895.42	7062574.70	53	431.90	978969.26	-24.03748
1186	station	317436.52	7063493.65	53	432.02	978972.48	-20.17831
1187	station	315201.03	7066158.01	53	436.57	978972.91	-17.09753
1188	station	311890.72	7068875.35	53	444.67	978973.15	-13.46476
1189	station	310149.22	7069830.54	53	441.68	978973.98	-12.58455
1190	station	308690.54	7070837.96	53	440.91	978974.12	-11.92722
6183	repeat	307867.03	7052913.46	53	475.23	978963.53	-27.44181
1151	station	328314.61	7045030.15	53	403.69	978960.63	-49.75833
1191	station	327810.68	7043785.97	53	405.86	978958.23	-52.54229
1192	station	325973.81	7043761.74	53	414.19	978957.32	-51.81427
1193	station	324176.22	7043737.69	53	422.88	978958.05	-49.37385

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1194	station	321645.62	7043700.48	53	431.36	978959.10	-46.65647
1195	station	329924.24	7044125.62	53	398.66	978961.20	-50.78321
1196	station	332298.51	7044581.95	53	392.61	978963.54	-49.35396
1197	station	334509.21	7044891.35	53	387.40	978965.78	-47.95359
1198	station	335939.81	7045090.18	53	382.05	978966.80	-47.86769
1199	station	337675.87	7045534.00	53	376.79	978968.74	-46.68698
1200	station	341061.64	7046585.25	53	366.01	978972.89	-43.99432
1201	station	340068.16	7048804.29	53	368.68	978974.22	-40.68040
1202	station	338720.98	7050363.13	53	371.41	978974.22	-39.11255
1203	station	337645.69	7052237.47	53	374.52	978974.02	-37.46815
1204	station	336957.80	7053602.21	53	376.44	978974.89	-35.32408
1205	station	335783.30	7055285.78	53	379.41	978974.74	-33.77995
1206	station	336936.59	7055502.83	53	377.86	978975.78	-32.91252
1207	station	338199.49	7055513.71	53	376.45	978976.46	-32.51332
1208	station	340311.80	7056364.86	53	373.96	978978.51	-30.41382
1209	station	343605.07	7057033.92	53	391.52	978976.48	-28.58159
1210	station	343680.86	7055942.71	53	404.53	978972.68	-30.53595
1211	station	343688.58	7055829.94	53	400.43	978973.53	-30.56622
1212	station	343701.85	7055651.06	53	404.84	978972.36	-30.98604
1213	station	343782.97	7054641.49	53	388.72	978975.80	-31.37402
1214	station	343915.57	7052706.95	53	374.27	978976.66	-34.62082
1215	station	344092.79	7050661.42	53	364.28	978976.45	-38.13437
1216	station	344214.67	7048666.79	53	363.95	978976.04	-39.91245
1217	station	344355.30	7045769.50	53	361.64	978974.06	-44.24435
1218	station	344510.19	7044676.25	53	360.75	978972.17	-47.02747
1219	station	343663.58	7043979.50	53	364.97	978970.53	-48.28657
1220	station	341872.76	7043957.61	53	367.45	978969.48	-48.84928
1221	station	340217.99	7043932.43	53	371.09	978968.84	-48.77573
1222	station	338288.61	7043911.59	53	376.01	978967.43	-49.21612
1223	station	336106.99	7043886.18	53	380.07	978965.74	-50.10708
1224	station	335113.38	7043871.59	53	386.25	978964.56	-50.07399
1225	station	333209.88	7043849.09	53	391.64	978963.32	-50.25305
6151	repeat	328314.61	7045030.15	53	403.69	978960.70	-49.68829
9011	base	316799.57	7087176.73	53	449.55	978956.88	-16.95280
9013	base	316799.57	7087176.73	53	449.55	978956.88	-16.95853
1226	station	321302.37	7086229.36	53	431.82	978963.50	-14.47787
1227	station	323621.73	7086574.23	53	429.04	978963.64	-14.68174
1228	station	325347.56	7086875.38	53	425.59	978964.13	-14.69146
1229	station	327140.87	7087190.47	53	429.15	978962.02	-15.91352
1230	station	328893.33	7087986.19	53	428.34	978960.99	-16.60186
1231	station	330567.22	7088868.60	53	429.47	978959.00	-17.81363
1232	station	332559.03	7089918.53	53	430.30	978958.32	-17.66870
1233	station	331027.28	7090502.98	53	433.15	978956.64	-18.39760
1234	station	329361.53	7091023.95	53	435.13	978954.20	-20.09930
1235	station	327594.55	7091358.49	53	438.05	978951.23	-22.26308
1236	station	326236.05	7092740.30	53	440.46	978949.43	-22.68609
1237	station	324211.15	7093599.03	53	444.12	978947.00	-23.82359
1238	station	322815.30	7094392.77	53	447.50	978944.71	-24.92461
1239	station	321120.04	7095151.13	53	449.39	978941.02	-27.73966
1240	station	319764.49	7095754.68	53	456.85	978937.76	-29.13194
1241	station	319425.15	7101006.04	53	467.53	978918.68	-42.72676
1242	station	321415.89	7100878.53	53	464.37	978920.88	-41.24571
1243	station	322817.68	7100787.61	53	463.75	978921.91	-40.40843
1244	station	324716.76	7100667.11	53	464.19	978923.70	-38.62500
1245	station	326389.88	7100565.31	53	461.03	978925.40	-37.62594
1246	station	328303.88	7100443.75	53	459.50	978927.51	-35.91073
1247	station	330645.18	7100299.43	53	456.05	978929.94	-34.27153

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1248	station	331725.79	7100234.60	53	454.05	978931.47	-33.18468
1249	station	333672.90	7100114.05	53	450.69	978933.88	-31.52977
1250	station	335432.40	7100005.39	53	447.31	978936.17	-29.98808
1251	station	337144.82	7099900.55	53	442.62	978937.93	-29.23076
1252	station	339523.34	7099762.45	53	439.44	978940.96	-26.93302
1253	station	340605.11	7099701.67	53	441.31	978940.91	-26.66231
1254	station	329357.64	7107633.93	53	473.10	978904.02	-52.11031
1255	station	329782.34	7105506.34	53	469.12	978910.58	-47.70463
1256	station	330158.95	7103427.10	53	463.44	978919.52	-41.22059
1257	station	330390.03	7101755.04	53	459.22	978924.80	-37.84953
2247	repeat	330645.18	7100299.43	53	456.05	978929.92	-34.29154
1258	station	331110.86	7097921.10	53	449.58	978938.32	-28.69943
1259	station	331509.61	7095871.16	53	444.99	978944.68	-24.56845
1260	station	331910.85	7093785.18	53	438.54	978949.97	-21.89610
1261	station	332268.81	7091930.43	53	434.04	978954.57	-19.38128
9013	base	316799.57	7087176.73	53	449.55	978956.88	-16.95853
9015	base	316799.57	7087176.73	53	449.55	978956.88	-16.95853
1264	station	310826.28	7084672.70	53	451.66	978960.91	-14.07745
1265	station	310584.76	7086396.96	53	452.50	978957.63	-16.07544
1266	station	310780.23	7088212.16	53	449.60	978953.72	-19.38380
1267	station	310813.16	7090183.27	53	460.86	978947.60	-22.01751
1268	station	309853.88	7091993.93	53	461.26	978941.43	-26.93118
1269	station	309495.51	7093872.07	53	462.78	978934.41	-32.43759
1270	station	309260.00	7095857.88	53	465.98	978927.48	-37.45722
1271	station	309011.61	7098019.36	53	474.59	978918.53	-43.31923
1272	station	309036.02	7099747.83	53	479.56	978912.21	-47.54949
1273	station	309178.35	7101835.81	53	486.01	978903.38	-53.76838
1274	station	309302.83	7103758.16	53	490.33	978895.37	-59.69393
1275	station	309436.56	7105804.25	53	499.82	978888.18	-63.70280
1276	station	310535.69	7104281.04	53	490.86	978894.77	-59.86404
1277	station	312217.90	7103648.88	53	483.92	978899.92	-56.49970
1278	station	314180.97	7102911.60	53	480.37	978903.35	-54.26020
1279	station	315700.67	7102340.55	53	477.64	978909.08	-49.44638
1280	station	317117.27	7101811.33	53	473.99	978912.94	-46.65713
1281	station	317834.76	7101541.37	53	472.20	978914.58	-45.54929
9015	base	316799.57	7087176.73	53	449.55	978956.88	-16.95853
6281	repeat	317834.76	7101541.37	53	472.20	978914.58	-45.54929
5000	station	310553.37	7104279.52	53	490.81	978894.87	-59.77496
1282	station	309560.26	7107653.17	53	494.02	978883.29	-68.54658
1283	station	309701.69	7109791.54	53	500.46	978877.62	-71.57705
1284	station	309797.89	7111339.77	53	509.59	978872.39	-74.01697
1285	station	309894.46	7112819.69	53	513.76	978869.17	-75.46678
1286	station	310058.86	7115161.43	53	528.75	978864.04	-76.14611
1287	station	311469.97	7115338.43	53	534.60	978862.87	-76.06616
1288	station	313244.72	7115595.85	53	527.96	978863.67	-76.42173
1289	station	315368.68	7115911.28	53	521.87	978864.59	-76.51674
1290	station	316988.23	7116151.18	53	518.42	978864.89	-76.75502
1291	station	317948.55	7115667.61	53	512.86	978867.71	-75.34584
1292	station	317015.22	7113975.28	53	515.53	978870.23	-73.38071
1293	station	316495.96	7112563.45	53	515.30	978873.35	-71.20695
1294	station	315299.62	7110817.84	53	507.65	978877.98	-69.19289
1295	station	313790.90	7110160.68	53	508.68	978878.06	-69.31976
1296	station	311587.35	7109203.36	53	501.90	978879.60	-69.70889
5001	repeat	310553.37	7104279.52	53	490.81	978894.80	-59.84500
6282	repeat	317834.76	7101541.37	53	472.20	978914.53	-45.59931
5010	repeat	317805.14	7117549.67	53	512.58	978863.66	-78.24181
1297	station	317728.24	7117614.98	53	512.53	978863.62	-78.25017

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1298	station	316292.91	7118731.39	53	517.47	978861.89	-78.27848
1299	station	314822.74	7120014.63	53	526.11	978859.77	-77.86143
1300	station	313136.59	7121003.44	53	533.09	978854.69	-80.92114
1301	station	311592.30	7121865.65	53	538.28	978849.34	-84.68514
1302	station	312524.68	7122765.29	53	541.21	978848.83	-84.05066
1303	station	311087.27	7122761.02	53	543.60	978848.49	-83.90919
5011	repeat	317805.14	7117549.67	53	512.58	978863.67	-78.23180
1304	station	319874.22	7110345.66	53	496.38	978888.47	-61.26012
1305	station	317766.04	7111127.27	53	503.51	978881.99	-65.81906
5012	repeat	317805.14	7117549.67	53	512.58	978863.67	-78.23180
9015	base	316799.57	7087176.73	53	449.55	978956.88	-16.95853
9017	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
5000	station	339838.85	7055948.99	53	391.00	978974.58	-31.26063
1306	station	341389.36	7059490.28	53	383.95	978979.39	-25.53875
1307	station	342952.11	7060348.23	53	388.65	978978.58	-24.87797
1308	station	344272.63	7060625.95	53	395.05	978977.22	-24.80875
1309	station	346490.12	7060626.81	53	403.49	978977.03	-23.35607
1310	station	348033.41	7060400.92	53	398.71	978978.21	-23.27439
1311	station	349846.82	7060010.39	53	386.59	978980.30	-23.83590
1312	station	350571.88	7051024.58	53	363.40	978977.90	-36.67012
1313	station	348461.22	7050650.76	53	373.05	978975.24	-37.66009
1314	station	345986.22	7049951.95	53	361.26	978977.32	-38.33604
1216	repeat	344214.67	7048666.79	53	363.94	978976.19	-39.76454
1315	station	344696.56	7043991.32	53	361.93	978971.83	-47.58385
1316	station	346831.70	7044019.29	53	359.28	978972.17	-47.76344
1317	station	348648.56	7044042.23	53	356.98	978974.03	-46.35572
1318	station	351081.61	7044073.85	53	352.04	978976.28	-45.07284
1319	station	342661.38	7047576.71	53	373.75	978972.56	-42.16813
1320	station	343876.79	7057390.17	53	391.45	978977.06	-27.78364
5001	repeat	339838.85	7055948.99	53	391.00	978974.62	-31.22061
1321	station	334214.85	7054821.94	53	383.78	978973.52	-34.43027
1322	station	332887.68	7054846.63	53	387.79	978972.85	-34.28559
1323	station	331368.09	7056372.33	53	395.00	978972.31	-32.39759
1324	station	329997.47	7056757.28	53	400.05	978970.90	-32.55315
1325	station	328005.84	7058247.41	53	409.30	978969.05	-31.59487
1326	station	326979.53	7058204.72	53	413.34	978968.10	-31.76968
1327	station	327935.54	7060006.46	53	417.99	978967.14	-30.64984
1328	station	327868.60	7061946.08	53	411.35	978968.22	-29.60932
1329	station	327780.80	7064576.71	53	415.52	978968.17	-27.12486
1330	station	327719.30	7066229.17	53	421.80	978967.24	-25.74472
1331	station	327662.96	7067797.47	53	420.66	978968.05	-24.13762
1332	station	327586.64	7069887.24	53	415.41	978970.55	-21.30852
1333	station	328660.82	7072186.86	53	410.93	978971.81	-19.44254
1334	station	331322.37	7071933.43	53	401.91	978972.87	-20.34352
1335	station	332194.10	7070716.43	53	399.69	978972.41	-22.04048
1336	station	332682.42	7069087.26	53	397.72	978972.01	-23.89072
1337	station	332529.78	7068391.62	53	396.49	978973.15	-23.44389
1338	station	331631.38	7068126.32	53	401.53	978971.73	-24.03859
1339	station	330008.62	7067914.58	53	406.26	978970.10	-24.86345
1340	station	332799.44	7065762.97	53	394.34	978975.00	-23.72961
1341	station	333703.04	7064125.07	53	396.95	978973.85	-25.44021
1342	station	334607.03	7062828.42	53	393.30	978973.21	-27.65153
1343	station	334357.03	7060929.73	53	389.89	978973.44	-29.32684
1344	station	334108.88	7060473.36	53	389.97	978973.28	-29.76713
1345	station	332678.93	7058805.78	53	398.81	978970.18	-32.20414
1346	station	331270.06	7057694.70	53	395.19	978971.16	-32.64775
1347	station	334521.08	7058377.91	53	391.37	978972.88	-31.26067

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1348	station	335054.24	7056803.04	53	384.21	978974.34	-32.24022
1349	station	334111.57	7056044.07	53	384.71	978973.56	-33.40888
5002	repeat	339838.85	7055948.99	53	391.00	978974.53	-31.31066
9017	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9018	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
1350	station	326756.69	7075472.53	53	410.12	978975.36	-13.89857
1351	station	327782.35	7075806.88	53	407.69	978977.33	-12.19813
1352	station	329436.32	7075951.54	53	407.61	978975.26	-14.20419
1353	station	331216.46	7076214.48	53	411.81	978972.73	-15.75550
1354	station	332934.32	7076890.03	53	425.64	978968.41	-16.93180
1355	station	334702.66	7077294.12	53	408.84	978972.12	-16.27712
1356	station	335111.84	7076878.45	53	409.32	978972.13	-16.44737
1357	station	334622.25	7078931.48	53	408.63	978971.70	-15.67575
1358	station	333797.04	7079734.94	53	410.85	978970.79	-15.62167
1359	station	332012.53	7080071.32	53	412.37	978971.20	-14.67817
1360	station	330251.56	7080406.80	53	429.88	978967.34	-14.86393
1361	station	328467.73	7080751.99	53	414.34	978971.47	-13.54996
1362	station	326701.42	7081094.06	53	418.12	978970.73	-13.30820
1363	station	324890.33	7081442.01	53	422.82	978969.43	-13.44340
1364	station	323630.56	7081542.07	53	427.52	978968.88	-12.99275
1365	station	324296.65	7079807.01	53	423.54	978970.79	-12.99674
1366	station	325803.43	7077382.18	53	416.03	978973.95	-12.89985
1367	station	328377.71	7074330.22	53	410.48	978973.95	-15.99565
1368	station	329724.01	7073176.50	53	414.68	978971.45	-18.43075
9019	repeat	316799.57	7087176.73	53	449.54	978956.95	-16.88394
13561	repeat	335111.84	7076878.45	53	409.32	978972.09	-16.48739
1369	station	335562.11	7075062.14	53	407.52	978973.53	-16.58362
1370	station	336036.07	7073103.10	53	404.20	978973.55	-18.49325
1371	station	335209.99	7072709.51	53	400.54	978973.75	-19.26198
1372	station	333536.33	7072074.37	53	423.96	978967.39	-21.41798
13562	repeat	335111.84	7076878.45	53	409.32	978972.03	-16.54742
9020	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9021	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
13563	repeat	335111.84	7076878.45	53	409.32	978971.99	-16.58744
1373	station	336509.99	7077635.45	53	406.52	978972.25	-16.39703
1374	station	338231.89	7078139.78	53	403.70	978972.26	-16.62889
1375	station	339809.02	7078678.61	53	404.73	978972.41	-15.93990
1376	station	342861.76	7080128.92	53	406.37	978970.56	-16.55082
1377	station	344757.58	7080700.50	53	406.26	978970.86	-15.91721
1378	station	346399.68	7081356.88	53	406.94	978971.36	-14.87019
1379	station	347935.68	7082421.51	53	405.93	978970.77	-14.98033
1380	station	349332.50	7083496.64	53	401.03	978969.81	-16.21761
1381	station	350118.81	7085303.02	53	398.11	978970.47	-14.96726
1382	station	351068.92	7086703.73	53	394.65	978970.80	-14.41742
1383	station	352264.10	7088210.10	53	395.19	978968.22	-15.92595
1384	station	353132.58	7089883.03	53	394.29	978967.03	-16.21565
1385	station	354234.87	7091473.62	53	392.70	978964.49	-18.04874
1386	station	354672.07	7093740.84	53	394.64	978959.82	-20.87565
13761	repeat	342861.76	7080128.92	53	406.37	978970.65	-16.46077
1387	station	339945.79	7080680.67	53	412.45	978969.78	-15.75338
1388	station	338018.47	7080289.23	53	408.75	978970.54	-15.96063
1389	station	337189.02	7079110.28	53	411.33	978970.74	-16.01102
1390	station	335715.83	7079381.56	53	420.10	978968.35	-16.48802
1391	station	337223.13	7081611.26	53	413.69	978970.17	-14.49504
1392	station	337861.86	7083561.37	53	418.22	978967.44	-15.07479
1393	station	338484.45	7085472.69	53	416.98	978966.02	-15.50733
1394	station	339120.57	7087412.83	53	418.00	978963.80	-16.27458

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1395	station	339735.47	7089296.10	53	418.87	978962.57	-16.12076
1396	station	340423.87	7091083.87	53	420.12	978960.27	-17.02332
1397	station	338434.07	7090799.42	53	424.06	978959.15	-17.53794
1398	station	336432.60	7090511.49	53	427.20	978957.88	-18.36020
1399	station	334440.44	7090225.19	53	430.07	978957.61	-18.23426
1400	station	336917.00	7087123.86	53	421.98	978962.91	-16.55238
1401	station	335223.30	7088254.51	53	425.20	978961.38	-16.70304
1402	station	333765.97	7089225.25	53	428.71	978959.89	-16.86397
13564	repeat	335111.84	7076878.45	53	409.32	978972.13	-16.44737
1403	station	332692.99	7070808.62	53	399.39	978972.15	-22.30255
1404	station	334335.59	7071363.10	53	428.91	978966.02	-22.28377
1405	station	336230.77	7071582.59	53	398.24	978974.39	-19.81548
1406	station	337945.62	7071777.11	53	395.59	978974.51	-20.10460
1407	station	339832.17	7071993.38	53	397.66	978974.67	-19.41120
1408	station	342339.19	7072281.42	53	402.58	978974.31	-18.63720
1409	station	340625.58	7077176.60	53	401.92	978972.85	-17.03403
13565	repeat	335111.84	7076878.45	53	409.32	978972.07	-16.50740
9021	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9000	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
3566	repeat	335111.84	7076878.45	53	409.32	978972.08	-16.49739
1410	station	343966.55	7072277.92	53	405.47	978973.93	-18.46437
1411	station	345785.48	7072539.22	53	420.33	978971.80	-17.51641
1412	station	347209.32	7071708.93	53	421.56	978972.32	-17.30544
1413	station	343697.71	7068737.29	53	408.69	978972.26	-21.80112
1414	station	342741.80	7082238.91	53	406.83	978969.57	-16.08084
1415	station	342644.96	7084264.93	53	409.40	978969.14	-14.69122
1416	station	342547.41	7086283.51	53	409.98	978966.73	-15.68033
1417	station	342451.70	7088283.45	53	412.08	978966.41	-14.29030
1418	station	342356.17	7090263.44	53	415.63	978963.07	-15.65117
1419	station	342265.38	7092145.68	53	418.75	978960.63	-16.26062
1420	station	342163.97	7094247.93	53	423.97	978956.36	-18.14676
1421	station	342080.40	7096021.39	53	438.58	978949.15	-21.33862
1422	station	342020.93	7097326.74	53	440.11	978947.12	-22.22411
1423	station	341932.79	7099240.24	53	439.14	978942.62	-25.68186
1424	station	341257.86	7099661.55	53	441.53	978940.38	-27.17531
3567	repeat	335111.84	7076878.45	53	409.32	978972.06	-16.51740
9000	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9024	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
13762	repeat	342861.76	7080128.92	53	406.37	978970.59	-16.52080
13861	repeat	354672.07	7093740.84	53	394.64	978959.75	-20.94569
1425	station	355389.61	7092902.66	53	393.21	978961.92	-19.60379
1426	station	352407.61	7088545.55	53	395.10	978967.95	-15.99743
1427	station	351703.19	7084974.36	53	399.50	978970.27	-15.11826
1428	station	353429.33	7084620.90	53	402.16	978969.66	-15.44807
1429	station	355101.09	7085406.93	53	401.04	978970.72	-14.11044
1430	station	356974.04	7085940.09	53	401.48	978968.10	-16.31296
1431	station	358770.87	7086099.94	53	396.25	978969.27	-16.07976
1432	station	360643.50	7086468.27	53	388.36	978969.98	-16.69670
1433	station	362229.51	7086496.09	53	387.50	978969.34	-17.50002
1434	station	363902.91	7086315.03	53	376.15	978971.60	-17.59865
1435	station	364614.59	7085495.19	53	376.67	978971.20	-18.43253
1436	station	365784.35	7083913.03	53	371.03	978973.11	-18.66543
1437	station	366289.84	7082120.31	53	373.45	978973.37	-19.09505
1438	station	365866.21	7086755.73	53	378.07	978969.71	-18.84097
1439	station	367573.10	7086830.99	53	379.38	978969.07	-19.18514
1440	station	369284.44	7086874.07	53	376.96	978969.06	-19.65595
1441	station	371121.20	7087288.22	53	375.77	978969.30	-19.39338

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1442	station	372728.72	7088008.27	53	371.52	978969.93	-19.14274
1443	station	374218.90	7089018.11	53	374.92	978967.02	-20.74133
1444	station	368143.24	7088296.61	53	380.21	978967.56	-19.58804
1445	station	367553.99	7090266.36	53	383.27	978963.98	-21.28807
1446	station	367014.97	7092096.31	53	385.58	978960.55	-23.07773
1447	station	366456.18	7094011.68	53	389.22	978957.61	-24.05967
1448	station	365278.88	7095787.02	53	391.74	978955.79	-24.23081
1449	station	363362.50	7095463.83	53	393.18	978957.37	-22.56227
1450	station	361635.24	7095171.77	53	393.11	978958.36	-21.76286
1451	station	359896.95	7094875.43	53	393.67	978957.93	-22.26086
1452	station	358082.99	7094564.92	53	394.30	978958.26	-21.99494
1453	station	356307.21	7094258.29	53	395.66	978958.27	-21.90361
1454	station	354550.61	7093955.59	53	395.22	978959.52	-20.92313
13862	repeat	354672.07	7093740.84	53	394.64	978959.95	-20.74558
1455	station	353139.04	7094808.84	53	398.68	978959.20	-20.00042
1456	station	351590.33	7095359.87	53	402.30	978958.22	-19.90118
1457	station	349743.87	7096067.32	53	409.14	978955.40	-20.90514
1458	station	348100.41	7096696.61	53	414.20	978954.04	-20.85200
1459	station	347201.86	7098318.07	53	421.96	978949.48	-22.83270
1460	station	346525.45	7100124.95	53	422.22	978944.72	-26.37327
1461	station	345373.60	7101809.59	53	430.21	978938.33	-30.09818
1462	station	346615.28	7102773.62	53	423.40	978937.83	-31.32493
1463	station	348406.14	7102851.56	53	420.47	978938.95	-30.74456
1464	station	350179.79	7102886.41	53	418.98	978940.28	-29.69815
1465	station	351472.79	7102939.49	53	416.21	978940.43	-30.06769
1466	station	352839.26	7102962.43	53	414.65	978939.69	-31.10940
1467	station	354761.41	7103481.94	53	411.82	978939.88	-31.15472
1468	station	356493.10	7104174.78	53	409.64	978940.47	-30.55963
1469	station	358181.38	7104857.37	53	409.74	978940.30	-30.28091
1470	station	359860.64	7105558.29	53	410.13	978939.51	-30.55528
1471	station	356852.95	7102028.35	53	406.50	978944.41	-28.62326
1472	station	357658.90	7100130.23	53	403.10	978948.38	-26.55018
1473	station	358186.09	7098311.13	53	399.57	978951.72	-25.08072
1474	station	357165.02	7096589.67	53	397.98	978955.63	-22.58832
13873	repeat	354672.07	7093740.84	53	394.64	978959.83	-20.86565
13763	repeat	342861.76	7080128.92	53	406.37	978970.62	-16.49079
9024	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9026	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
1475	repeat	317805.14	7117549.67	53	512.58	978863.61	-78.28544
1476	station	321399.57	7110052.62	53	489.70	978898.64	-52.59434
1477	station	322137.09	7108436.66	53	484.99	978896.25	-56.95875
1478	station	323965.67	7108301.08	53	484.01	978897.58	-55.92441
1479	station	325692.98	7108353.36	53	481.95	978897.93	-55.96056
1480	station	327437.57	7108700.43	53	478.17	978898.75	-55.67464
1481	station	328908.94	7109004.60	53	475.87	978899.68	-55.01410
1482	station	329610.87	7108855.29	53	476.11	978900.34	-54.40868
1483	station	331381.52	7108456.40	53	473.97	978902.71	-52.73046
1484	station	333176.66	7108079.58	53	468.96	978906.68	-50.00099
1485	station	334867.52	7107749.54	53	468.55	978908.00	-48.98814
1486	station	336660.57	7107366.92	53	460.91	978912.14	-46.60917
1487	station	338305.19	7107062.24	53	459.02	978914.58	-44.74911
1488	station	330587.90	7118858.34	53	491.74	978876.76	-68.49846
1489	station	328919.32	7118949.28	53	492.28	978875.20	-69.88062
1490	station	326330.25	7120699.82	53	498.48	978868.31	-74.40796
1491	station	325332.73	7123196.41	53	506.38	978862.34	-77.21496
1492	station	327239.61	7121266.96	53	496.52	978868.26	-74.48658
1493	station	327210.97	7117843.94	53	498.80	978875.17	-69.32356

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
1494	station	327207.52	7116270.57	53	502.59	978877.82	-66.93867
1495	station	327145.02	7114589.08	53	492.52	978883.19	-64.62666
1496	station	327670.61	7112582.62	53	486.82	978889.25	-60.98052
1497	station	328282.40	7110866.23	53	482.24	978893.70	-58.53910
1498	station	329480.37	7107098.41	53	471.29	978906.18	-50.64376
14751	repeat	317805.14	7117549.67	53	512.58	978863.77	-78.12535
13864	repeat	354672.07	7093740.84	53	394.64	978959.89	-20.80561
1499	station	355426.37	7096997.79	53	400.71	978954.42	-22.98571
1500	station	354571.38	7098796.51	53	404.26	978950.75	-24.79099
1501	station	353693.12	7100642.64	53	408.72	978945.85	-27.61664
1502	station	361488.34	7106160.29	53	408.77	978938.12	-31.83657
1503	station	363279.76	7105699.86	53	420.88	978936.60	-31.28353
1504	station	363990.95	7105368.81	53	424.42	978935.94	-31.46531
13865	repeat	354672.07	7093740.84	53	394.64	978959.82	-20.87565
9026	base	316799.57	7087176.73	53	449.54	978956.88	-16.95398
9028	base	316799.57	7087176.73	53	451.06	978956.88	-16.65637
15041	repeat	363990.95	7105368.81	53	424.64	978935.63	-31.73338
1505	station	365001.21	7105070.51	53	418.36	978937.22	-31.57762
1506	station	366737.50	7104899.49	53	414.52	978939.14	-30.53344
1507	station	368290.24	7104673.06	53	417.91	978940.50	-28.66260
1508	station	369857.98	7104423.72	53	418.88	978943.52	-25.61950
1509	station	371364.55	7104188.39	53	421.35	978943.96	-24.85672
1510	station	372837.71	7103974.20	53	427.78	978944.39	-23.30851
1511	station	374710.37	7103458.93	53	418.22	978942.19	-27.73459
1512	station	376399.87	7103071.94	53	409.59	978944.18	-27.70148
1513	station	378259.60	7102638.88	53	404.22	978946.23	-26.99637
1514	station	379942.21	7102422.04	53	402.79	978948.23	-25.42710
1515	station	381538.11	7102105.36	53	402.53	978949.81	-24.11092
1516	station	383490.75	7101375.35	53	391.12	978952.98	-23.66773
1517	station	385771.84	7100588.98	53	387.00	978954.25	-23.72761
15042	repeat	363990.95	7105368.81	53	424.64	978935.67	-31.69336
15171	repeat	385771.84	7100588.98	53	387.00	978954.34	-23.63756
9028	base	316799.57	7087176.73	53	451.06	978956.88	-16.65637
2000	base	321762.05	7107588.29	53	485.24	978896.80	-56.68283
2001	station	226664.10	7109662.41	53	475.50	978899.90	-53.10065
2002	station	226668.83	7107798.84	53	469.60	978905.19	-50.16709
2003	station	226700.38	7105685.81	53	463.83	978912.81	-45.03809
2004	station	226632.38	7103632.46	53	458.54	978921.06	-39.14582
3000	repeat	321762.05	7107588.29	53	485.24	978896.80	-56.68283
2005	station	227336.93	7113337.02	53	486.05	978894.57	-54.00308
2006	station	227828.42	7114363.32	53	490.86	978887.17	-59.80765
2007	station	221302.97	7119047.75	53	497.56	978877.72	-64.84896
2008	station	222177.53	7119160.26	53	494.81	978878.13	-64.91882
2009	station	223283.10	7119302.31	53	498.77	978875.62	-66.57471
2010	station	225133.44	7119540.22	53	505.16	978872.57	-68.24296
2011	station	226750.07	7119729.49	53	502.73	978870.04	-71.15217
2012	station	228830.49	7119954.65	53	505.01	978866.31	-74.31838
2013	station	222678.94	7111995.18	53	477.94	978895.99	-54.97822
2000	base	321762.05	7107588.29	53	485.24	978896.80	-56.68283
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2014	station	378902.54	7082187.65	53	364.36	978971.92	-22.37223
2015	station	378411.31	7081301.44	53	361.96	978971.69	-23.64576
2016	station	375400.14	7079464.70	53	355.35	978974.44	-23.36769
2017	station	375349.59	7077480.72	53	354.20	978976.07	-23.25039
2018	station	373946.64	7076488.50	53	360.16	978976.35	-22.43440
2019	station	373074.27	7074918.37	53	364.92	978974.63	-24.23248
2020	station	372355.37	7073323.67	53	378.83	978971.42	-25.74002

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
2021	station	371744.72	7071927.69	53	371.61	978973.76	-25.72314
2022	station	370461.50	7070570.03	53	365.70	978974.03	-27.48845
2023	station	375008.41	7079244.46	53	354.80	978974.97	-23.08549
2024	station	376076.05	7080170.52	53	360.72	978973.73	-22.56833
3014	repeat	378902.54	7082187.65	53	364.36	978971.91	-22.38224
2025	station	379001.89	7082806.65	53	362.07	978971.77	-22.57147
2026	station	380211.17	7084494.20	53	361.15	978970.95	-22.48455
2027	station	380955.76	7083552.62	53	358.95	978972.97	-21.51122
2028	station	381822.38	7082444.77	53	355.87	978973.24	-22.57158
2029	station	382923.98	7081049.06	53	355.34	978971.64	-25.18870
2030	station	384275.55	7080072.20	53	366.86	978970.44	-24.76483
2031	station	384654.54	7079643.14	53	358.42	978972.78	-24.36522
2032	station	385905.13	7078536.71	53	344.31	978976.39	-24.25289
2033	station	387202.56	7077097.39	53	335.82	978978.52	-24.73504
2034	station	388500.45	7075672.38	53	332.09	978979.51	-25.41049
2035	station	389788.88	7074255.24	53	329.67	978981.08	-25.24480
2036	station	382962.32	7082696.78	53	355.38	978973.00	-22.75219
2037	station	384666.73	7082989.44	53	352.95	978974.02	-22.02922
2038	station	385731.36	7084301.49	53	353.89	978974.65	-20.36971
2039	station	386921.69	7085850.91	53	354.09	978973.79	-20.19166
2040	station	388150.16	7087425.09	53	353.18	978975.09	-18.05724
2041	station	389062.52	7089016.37	53	357.85	978972.16	-19.04591
2042	station	390365.12	7090528.34	53	361.64	978970.22	-19.26784
2043	station	391577.44	7091810.19	53	361.69	978970.50	-18.15630
4014	repeat	378902.54	7082187.65	53	364.36	978972.05	-22.24217
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2044	station	383044.26	7097318.04	53	396.84	978856.17	-122.02258
2045	station	382677.55	7096580.23	53	393.92	978958.12	-21.06747
2046	station	381522.18	7095051.16	53	388.21	978960.95	-20.34017
2047	station	380108.65	7093539.29	53	379.48	978962.10	-21.87657
2048	station	378888.06	7092358.85	53	377.73	978961.93	-23.14765
2049	station	377408.88	7091300.55	53	375.33	978962.25	-23.97384
2050	station	375883.61	7090208.97	53	371.89	978966.27	-21.32553
2051	station	383644.81	7098193.60	53	394.01	978955.62	-22.51262
2052	station	385770.67	7100591.53	53	383.19	978954.18	-24.54601
2053	station	386162.85	7099700.77	53	379.63	978956.26	-23.74155
2054	station	387422.17	7097974.22	53	375.16	978957.85	-24.15419
2055	station	388655.24	7096338.74	53	365.13	978961.74	-23.29808
2056	station	389527.64	7094982.74	53	360.99	978963.55	-23.18330
2057	station	390383.71	7093447.04	53	356.27	978967.25	-21.40764
20431	repeat	391577.44	7091810.19	53	361.69	978970.19	-18.46647
2058	station	391954.94	7090828.92	53	360.31	978969.30	-20.26423
2059	station	379297.77	7084819.46	53	362.21	978969.36	-23.65089
2060	station	379601.14	7086911.61	53	365.11	978968.87	-22.21683
2061	station	379882.61	7088847.00	53	369.06	978966.42	-22.64033
2062	station	380151.78	7090817.51	53	373.29	978965.85	-21.10255
2063	station	380821.42	7091968.56	53	375.84	978966.17	-19.54118
2064	station	381640.34	7090200.79	53	371.21	978969.95	-17.81846
2065	station	382453.97	7088471.90	53	365.72	978970.13	-19.84285
2066	station	382989.11	7087324.48	53	363.35	978972.11	-19.07482
2067	station	383344.29	7086561.77	53	360.74	978971.52	-20.67343
2068	station	384112.53	7084534.22	53	356.44	978972.93	-21.42857
20441	repeat	383044.26	7097318.04	53	396.84	978956.17	-21.96958
20432	repeat	391577.44	7091810.19	53	361.69	978970.22	-18.43645
20581	repeat	391954.94	7090828.92	53	360.31	978969.32	-20.24422
2069	station	392075.62	7089343.78	53	346.99	978973.37	-19.77439

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
2070	station	392391.13	7087504.96	53	343.09	978976.26	-18.84319
2071	station	393427.87	7085776.72	53	339.24	978977.52	-19.46555
2072	station	394522.54	7084272.48	53	336.40	978979.04	-19.48440
2073	station	393417.91	7083244.10	53	338.93	978978.30	-20.38753
2074	station	395324.73	7082736.34	53	345.04	978977.28	-20.54593
2075	station	396991.87	7082268.72	53	331.85	978980.00	-20.73104
2076	station	398664.74	7081970.71	53	327.71	978980.75	-20.99695
2077	station	400137.95	7080790.65	53	327.16	978980.41	-22.21968
20582	repeat	391954.94	7090828.92	53	360.31	978969.43	-20.13416
20433	repeat	391577.44	7091810.19	53	361.69	978970.32	-18.33640
20521	repeat	385770.67	7100591.53	53	383.19	978954.35	-24.37592
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2044	repeat	383044.26	7097318.04	53	396.84	978956.33	-21.80949
20521	repeat	385770.67	7100591.53	53	383.19	978954.33	-24.39593
2078	station	387504.09	7100367.26	53	375.96	978956.57	-23.73153
2079	station	389630.10	7099999.09	53	369.20	978960.21	-21.66932
2080	station	391431.55	7099667.13	53	369.19	978961.95	-20.15444
2081	station	392951.64	7099366.79	53	367.73	978962.14	-20.45314
2082	station	394487.37	7099160.47	53	371.34	978961.81	-20.21546
2083	station	396357.83	7099393.48	53	377.31	978959.20	-21.51001
2084	station	397881.99	7098965.19	53	354.38	978962.72	-22.78460
2085	station	398933.75	7098004.87	53	347.97	978967.14	-20.24802
2086	station	400031.72	7094575.62	53	339.11	978970.94	-20.41245
20522	repeat	385770.67	7100591.53	53	383.19	978954.32	-24.40594
2087	station	387871.40	7101271.59	53	376.95	978956.51	-23.01487
2088	station	389752.51	7101962.41	53	375.12	978960.33	-19.11700
2089	station	391314.32	7103203.12	53	379.22	978957.52	-20.32844
2090	station	392257.14	7101577.03	53	373.74	978961.35	-18.62916
2091	station	392149.28	7104727.58	53	380.60	978655.93	-320.82895
2092	station	393174.15	7105634.46	53	380.48	978955.44	-20.60442
2093	station	395047.75	7106051.25	53	382.03	978952.13	-23.35192
2094	station	396613.67	7106943.89	53	385.31	978949.71	-24.56064
2095	station	397745.52	7108138.35	53	377.63	978952.15	-22.86523
2096	station	399329.48	7109320.37	53	374.33	978951.20	-23.71031
20523	repeat	385770.67	7100591.53	53	383.19	978954.29	-24.43595
2097	station	384687.62	7103108.68	53	397.34	978951.43	-22.88144
2098	station	384345.39	7104732.04	53	411.51	978945.88	-24.59859
2099	station	383649.82	7105784.68	53	423.97	978939.60	-27.74857
2100	station	382969.22	7107550.62	53	411.31	978938.64	-30.05617
2101	station	382535.15	7109290.61	53	419.45	978931.37	-34.60458
2102	station	385135.19	7100716.19	53	385.12	978953.88	-24.38161
20442	repeat	383044.26	7097318.04	53	396.84	978956.33	-21.80949
20524	repeat	385770.67	7100591.53	53	383.19	978954.33	-24.39593
21011	repeat	382535.15	7109290.61	53	419.45	978931.47	-34.50453
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2101	station	382535.15	7109290.61	53	419.45	978931.42	-34.55455
2103	station	382113.46	7111385.49	53	419.71	978926.68	-37.89435
2104	station	381659.14	7113070.05	53	427.00	978923.57	-38.48476
2105	station	380913.68	7114314.48	53	437.90	978918.39	-40.71680
2106	station	380140.76	7116571.15	53	437.43	978914.92	-42.82382
2107	station	379024.88	7118121.10	53	459.97	978910.87	-41.44060
2108	station	379178.47	7119872.54	53	471.21	978907.08	-41.89541
2109	station	378980.94	7121749.82	53	478.03	978903.37	-43.05851
2110	station	378853.87	7123709.97	53	462.84	978903.76	-44.39736
2111	station	381820.56	7113498.22	53	428.22	978922.65	-38.88976

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
2112	station	383428.37	7112571.35	53	419.49	978927.40	-36.46115
2113	station	381116.40	7113667.01	53	430.68	978921.26	-39.68363
2114	station	379409.99	7114409.04	53	437.51	978918.25	-40.86342
2115	station	377836.05	7115046.51	53	447.56	978914.51	-42.21023
2116	station	376088.06	7115117.55	53	458.50	978912.17	-42.34185
2117	station	374440.46	7115281.40	53	458.68	978911.58	-42.78274
2118	station	372759.90	7115920.28	53	454.40	978910.56	-44.22300
2119	station	370938.41	7116219.35	53	453.73	978909.00	-45.71109
2120	station	371330.57	7115306.41	53	453.62	978910.55	-44.77296
2121	station	371384.70	7114157.96	53	450.99	978912.72	-43.85738
2122	station	371429.43	7113501.38	53	444.29	978915.71	-42.60759
2123	station	372300.08	7111703.04	53	449.78	978917.89	-40.50863
2124	station	373555.07	7110441.15	53	450.17	978921.36	-37.78179
2125	station	374962.12	7109131.52	53	437.58	978928.05	-34.41614
2126	station	376515.67	7108129.99	53	423.60	978932.46	-33.40995
2127	station	377919.68	7106816.47	53	417.43	978935.49	-32.44681
2128	station	378932.65	7105827.05	53	413.95	978938.27	-30.99524
2129	station	380489.50	7104471.99	53	414.18	978942.84	-27.25965
21011	repeat	382535.15	7109290.61	53	419.45	978931.34	-34.63459
20521	repeat	385770.67	7100591.53	53	383.19	978954.25	-24.47597
21211	repeat	371384.70	7114157.96	53	450.99	978912.68	-43.89740
2130	station	369824.94	7116708.75	53	452.25	978906.06	-48.62123
2131	station	368193.29	7117560.63	53	451.53	978903.46	-50.80696
2132	station	366241.83	7118224.08	53	448.34	978902.88	-51.57573
2133	station	364224.02	7118488.15	53	443.24	978903.18	-52.09536
2134	station	362928.61	7118658.74	53	442.00	978902.27	-53.13097
2135	station	360956.34	7118919.63	53	437.16	978900.67	-55.50310
2136	station	359228.67	7119149.83	53	436.51	978900.28	-55.86068
2137	station	357394.85	7119419.77	53	429.59	978902.44	-54.87517
2138	station	356452.77	7118240.21	53	431.27	978905.29	-52.44385
2139	station	355361.95	7116659.27	53	431.59	978907.15	-51.52978
2140	station	354289.94	7115162.34	53	430.54	978910.43	-49.40888
2141	station	353169.56	7113608.51	53	428.12	978912.77	-48.53510
2142	station	353999.71	7114737.17	53	429.55	978911.07	-49.23436
2143	station	354376.12	7112772.25	53	425.21	978916.05	-46.37418
2144	station	354741.98	7110806.93	53	422.80	978922.31	-41.85231
2145	station	355110.12	7108839.31	53	419.20	978928.24	-37.89836
2146	station	355477.65	7106873.30	53	415.52	978934.52	-33.60855
2147	station	355847.80	7104915.75	53	411.86	978938.72	-31.39029
2148	station	360967.92	7108395.70	53	414.74	978931.74	-35.60054
2149	station	361083.85	7110517.16	53	420.46	978925.98	-38.87194
2150	station	361200.87	7112422.86	53	423.96	978920.27	-42.67020
21212	repeat	371384.70	7114157.96	53	450.99	978912.76	-43.81736
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
21421	repeat	353999.71	7114737.17	53	429.55	978911.16	-49.14431
2151	station	352055.03	7112080.93	53	428.19	978916.48	-45.78621
2152	station	350891.95	7110448.91	53	428.45	978920.62	-42.63378
2153	station	350169.44	7109547.42	53	428.45	978922.51	-41.31916
2154	station	349686.01	7111337.16	53	431.85	978916.54	-45.46771
2155	station	349446.52	7112329.61	53	434.18	978912.96	-47.94908
2156	station	349161.63	7114414.01	53	436.30	978907.73	-51.42205
2157	station	348845.28	7116714.52	53	439.30	978903.26	-53.82179
2158	station	348580.52	7118641.82	53	441.51	978898.97	-56.43717
2159	station	346434.62	7118476.62	53	445.94	978897.13	-57.49683
2160	station	344357.32	7118249.75	53	450.92	978895.79	-57.98838
2161	station	342217.89	7117987.38	53	456.10	978893.89	-59.02341

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
2162	station	341161.66	7117567.06	53	458.87	978893.14	-59.49114
2163	station	341239.40	7115620.34	53	455.55	978896.53	-58.00419
2164	station	341325.03	7113534.83	53	453.45	978901.14	-55.14817
2165	station	341367.79	7112756.81	53	451.44	978903.53	-53.65300
2166	station	341409.05	7111490.89	53	450.56	978907.25	-50.91849
2167	station	341487.46	7109606.31	53	450.58	978912.57	-46.80597
2168	station	341562.82	7107810.45	53	449.33	978916.91	-43.86870
2169	station	341648.61	7105827.12	53	442.58	978923.25	-40.13094
2170	station	341740.09	7103735.58	53	442.82	978929.49	-35.19093
2171	station	341804.14	7102284.32	53	447.77	978930.88	-33.76327
2172	station	341001.00	7105840.94	53	444.46	978922.48	-40.51930
2173	station	342288.19	7104769.67	53	439.10	978928.09	-36.66124
2174	station	343484.67	7103535.33	53	436.25	978932.56	-33.55488
2175	station	345379.08	7103141.58	53	430.72	978935.07	-32.39983
2176	station	346379.89	7104408.03	53	427.19	978932.85	-34.50518
2177	station	347532.54	7105994.44	53	427.98	978929.05	-37.13723
2178	station	348512.47	7107498.98	53	428.68	978927.13	-37.95798
2179	station	349586.22	7109184.13	53	430.06	978923.30	-40.44178
2180	station	345272.36	7118304.60	53	448.94	978896.28	-57.85893
2181	station	345385.34	7115927.82	53	447.26	978900.80	-55.19607
2182	station	345481.59	7113746.44	53	443.69	978904.74	-53.36087
2183	station	345570.86	7111701.06	53	441.78	978909.59	-50.20159
2184	station	345658.49	7109595.50	53	438.31	978916.72	-45.10816
2185	station	345746.22	7107502.18	53	436.51	978923.26	-40.26681
2186	station	345834.91	7105386.49	53	429.43	978929.98	-36.30083
2187	station	355122.61	7108958.37	53	419.02	978928.11	-37.98662
2188	station	357159.64	7109618.62	53	418.26	978926.77	-39.06632
2189	station	359144.12	7110260.34	53	418.44	978927.05	-38.35011
2190	station	361054.07	7110658.09	53	420.79	978925.89	-38.80707
21422	repeat	353999.71	7114737.17	53	429.55	978911.19	-49.11429
21651	repeat	341367.79	7112756.81	53	451.44	978903.43	-53.75305
2191	station	340428.22	7118311.70	53	460.83	978890.72	-61.04240
2192	station	338418.75	7118374.70	53	465.77	978888.15	-62.58467
2193	station	336465.95	7118494.40	53	470.61	978886.15	-63.54190
2194	station	334943.96	7118591.88	53	473.33	978884.72	-64.36166
2195	station	333174.09	7118700.79	53	479.03	978881.42	-66.45736
2196	station	331070.04	7118832.63	53	489.57	978877.60	-68.10579
2197	station	328055.69	7114184.88	53	493.64	978884.23	-63.63461
21652	repeat	341367.79	7112756.81	53	451.44	978903.47	-53.71303
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2000	base	322019.81	7107932.31	53	484.30	978896.80	-54.19347
2014	station	378902.54	7082187.65	53	364.36	978972.01	-40.77122
2198	station	373796.44	7078724.62	53	362.80	978974.42	-40.59699
2199	station	372232.98	7079333.74	53	370.15	978974.74	-41.41945
2200	station	370544.21	7080332.45	53	369.73	978974.94	-41.37301
2201	station	369945.50	7082308.62	53	364.98	978975.36	-40.84149
2202	station	369408.25	7084087.03	53	371.43	978972.25	-41.56291
20142	repeat	378902.54	7082187.65	53	364.36	978972.00	-40.77122
21211	repeat	371384.70	7114157.96	53	450.99	978912.82	-50.46576
2203	station	371604.57	7105598.59	53	422.69	978939.69	-47.29922
2204	station	371024.59	7108048.31	53	438.71	978929.83	-49.09129
2205	station	370078.72	7109256.73	53	436.99	978924.49	-48.89894
2206	station	371520.20	7104160.07	53	422.64	978943.89	-47.29329
2207	station	369838.76	7102800.63	53	412.62	978947.68	-46.17239
2208	station	368940.43	7101357.70	53	407.78	978950.06	-45.63012
2209	station	368013.42	7099698.10	53	401.04	978951.78	-44.87648
2210	station	366624.38	7098422.83	53	395.55	978952.33	-44.26137

Point	type	Easting MGA53 (metres)	Northing MGA53 (metres)	Zone	AHD 1971 (metres)	Observed Gravity ('65 mGals)	Bouguer Gravity ('84 mGals)
2211	station	365835.49	7099648.17	53	399.14	978949.09	-44.66331
2212	station	364774.27	7101293.30	53	405.19	978946.24	-45.34086
2213	station	363707.16	7102936.66	53	406.59	978942.70	-45.49752
2214	station	362645.97	7104570.53	53	414.16	978939.29	-46.34404
21212	repeat	371384.70	7114157.96	53	450.99	978912.80	-50.46576
2000	base	322019.81	7107932.31	53	484.30	978896.80	-54.19347
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773
2215	station	325833.83	7109219.15	53	483.18	978896.03	-57.06265
2216	station	324799.46	7109156.56	53	484.95	978896.78	-55.99624
2217	station	325366.15	7109331.61	53	484.82	978895.31	-57.38533
2218	station	327196.11	7116270.53	53	502.68	978877.85	-66.89087
2219	station	326409.55	7116376.28	53	500.02	978877.35	-67.83944
2220	station	324854.38	7116576.36	53	506.00	978875.13	-68.74211
2221	station	323059.81	7116801.39	53	511.54	978872.15	-70.47447
2222	station	322149.57	7116902.26	53	508.55	978870.70	-72.43976
2223	station	321296.72	7117005.20	53	508.57	978869.12	-73.94258
2224	station	319434.33	7117290.45	53	510.97	978865.78	-76.61258
2225	station	320829.65	7109808.45	53	509.86	978890.87	-56.55479
2226	station	320695.80	7110165.52	53	492.17	978893.53	-57.14244
2227	station	320680.67	7111593.01	53	496.25	978887.31	-61.64409
2228	station	321176.95	7111580.16	53	496.17	978888.30	-60.68217
20001	repeat	322019.81	7107932.31	53	484.30	978896.85	-56.81770
2229	station	321817.59	7106483.45	53	479.64	978900.91	-54.60475
2230	station	321780.73	7104479.20	53	473.45	978906.94	-51.08107
2231	station	321903.35	7102498.16	53	467.76	978914.98	-45.43583
2232	station	321883.83	7100858.43	53	463.94	978921.12	-41.10143
20002	repeat	322019.81	7107932.31	53	484.30	978896.88	-56.78768
2233	station	321020.23	7110884.15	53	492.89	978891.45	-58.62144
2234	station	321438.31	7110340.43	53	490.72	978897.56	-53.28907
2235	station	322417.42	7110554.33	53	492.10	978897.36	-53.08861
2236	station	323166.27	7110072.29	53	490.27	978897.93	-53.19568
2237	station	323217.77	7109426.05	53	489.54	978896.74	-54.94601
2000	base	322019.81	7107932.31	53	484.30	978896.80	-56.86773

APPENDIXES

1. GRX1 SOP

GRX1 static mode

Step 1

Prepare an SD card by creating a directory on it called POWERUP. In this directory place the file Powerup.gcs. This file is on the DMITRE network with the digital copy of this SOP (\\GSSA_Sourcedata_Confidential\Geophysical\Geophysics SOPs\)

Step 2

Open Powerup.gcs in a text editor and find line 24. It should read: 'em,/cur/log,def:10'. The 10 is the sample interval in seconds. If you want to change the sample interval (say to 15 seconds) change the 10 to 15, i.e., 'em,/cur/log,def:15'. 10 seconds is fine for gravity work. Save the file and insert the SD card into the GRX1.

Step 3

Set up the tripod, level unit, and GRX1. The GRX1 shouldn't contain a battery; there is an external battery in the black case that lasts longer than the GRX1 batteries. Measure the height of the antenna.

Step 4

Once everything is in place so it won't be moving for several hours, switch on the GRX1 (hold down button for 1 second) and once running, perform a factory reset: hold down the on switch for about 10 seconds until the unit says "Factory Reset". The unit will restart, and when it does it will be logging static data.

Step 5

Leave the unit undisturbed for AT LEAST 6 hours.

Step 6

Switch off the unit before dismantling everything.

Step 7

Before submitting the data to Auspos you'll need to wait until the next UT day.

Step 8

Take the .tps file from the SD card and navigate to http://www.ga.gov.au/bin/gps.pl. Choose your file, enter the antenna height, choose SOKGRX1 NONE from the dropdown list, and enter your email address. Click submit and within a few minutes you should have received an email with the Auspos report.

Step 9

Auspos reports typically have 10 pages. For typical gravity work you'll be interested in the first line of section 3.3. Note that these are MGA coordinates, the GRX1 in RTK mode requires ADG66 coordinates. You can convert these easily using the GDA_AGDconvert.xls file.

Step 10

The uncertainty of the height is given in the first line of table 3.4.

GRX1 Real Time Kinematic

Step 1

Set everything up, hook everything up including batteries. Radio booster unit (small blue box) will power on automatically when plugged into power. Use unit 42 as base and 46 as rover.

Step 2

Measure heights of base and rover.

Step 3

Switch on base and rover units (hold button down for a second). Unit should say “Receiver ready”. Find the yellow handheld data logger and switch that on too. There’s a little pen to tap the screen with.

Step 4

On datalogger: continue without connecting, quit everything, get back to windows screen.

Step 5

Open ServCE and start a new project. Give it a filename like yyyymmddarea1.crd. Click on tick button.

Step 6

Check the job settings (File tab, job settings) and make sure it’s set to AGD66 and the correct zone (in the system tab). If you need to change it click on it and select an alternative from the drop down list. Click OK/tick.

Step 7

Choose the Equip tab and click on GPS Base. A list should appear with two available Bluetooth devices. Ensure you’re pointing the logger at the base, click on the number ending with 42, and click select. The logger should connect to the base, (you’ll hear the base say “Bluetooth connected”), and a new window should appear for the base settings.

Step 8

Click on the Receiver tab and enter the antenna height (in metres) in the antenna height field. Click on the Green tick. The logger will send this info to the base.

Step 9

You’ll need to tell the base where it is. You should have coordinates in ADG66 on standby. Click on Enter Grid System Coordinates.

Step 10

Enter your easting, northing and ellipsoidal height for the base station and click on the green tick (note you can’t use Orthometric (AHD) heights). This information will now be sent to the base and you’ll get the opportunity to save these coordinates to file (I haven’t recalled any saved values but usually save them anyway – use the same file name as before – you should just have to click the green tick). You’ll then get returned to the Equip tab.

Step 11

Click on localization and ensure nothing is listed under the Points tab. If there is, delete it.

Step 12

Click on GPS Rover. Connect to instrument with serial number ending with 46.

Step 13

Go straight to the receiver tab and enter the antenna height, and click on the green tick.

Step 14

You'll probably get an error message ("The device did not respond to command"). Click OK, and click on GPS Rover again.

Step 15

Go straight to receiver tab and click the green tick. It usually works this time.

Step 16

Click on the Survey tab, and Store Points. A new window should open with a map screen. After a second or so the rover will *ding* and say "RTK fixed".

Step 17

The numbers at the bottom of the screen are the coordinates for the rover. You can write these in your notebook or computer, or hit the S button to save them to the unit (I haven't yet extracted numbers from the unit so I recommend writing them down).

Step 18

The HRMS and VRMS are the errors: 1 = 1 metre, 0.1 = 10 centimetres, 0.01 = 1 centimetre, 0.001 = 1 millimetre. You will lose signal before the errors get too high for gravity.

Step 19

As the rover moves it will lose signal and regain it again. The screen will go blank after a while, just hit the power button to bring everything back.

Step 20

A final note: the heights are ellipsoidal heights. If undertaking gravity work these values can be converted to AHD using a free online service provided by Geoscience Australia (http://www.ga.gov.au/ausgeoid/nvalcomp.jsp). Points can be input individually or as batch.

2. CG5 SOP

This isn't so much an SOP as a compilation of information. The notes are compiled primarily from notes taken at training courses. Anyone who needs to use the instrument should undertake some basic training, conducted by a GSSA Geophysicist or suitably qualified person prior to use.

If at any time the instrument shows irregular or erratic behaviour, please return it to somewhere safe, plug it into power, and contact a suitably qualified person with details on the problem.

A separate SOP exists for operating the DGPS. Digital copies of these SOPs should be kept within gravity survey folders, as well as on the Geological Survey of South Australia computer network.

Planning a survey

- Prepare a detailed survey plan.
- Ensure all equipment is available and operational (CG5, computers and DGPS).
- Ensure AFGN site is nearby and accessible.
- Perform a drift calculation.
- Calculate a calibration factor.
- Ensure all software is working on the field computer prior to leaving for the field.

Some basics

- Before taking into the field, spend a few hours (re-)familiarising yourself with the instrument and menu options.
- Keep in big green box for transit. Ensure CG5 is not unpowered for more than 20 hours. It takes a week to warm up from scratch.
- At the end of each day, plug in to recharge, swap batteries, and clean the tripod with silicon spray. Download the data and process to see if there are any issues that need dealing with.

Placing the meter on the tripod

- Place tripod on ground. DO NOT step on it to push it into the ground (it can bend and break). For consistency, keep the bubble in the same position for the survey.
- Hold handle of meter in right hand, hold back bottom left corner in left hand and place this corner on the back left tripod spoke. Once this is in place, place the other rear corner in place, and then the front spoke.
- Ensure that the GPS and antenna are plugged in. GPS is plugged into the 3rd port.

Setting up a survey

- Switch the meter on by pressing the ON/OFF button. If the station designation window appears, press ESC (0).
- Otherwise, press F5 to go into the survey menu. Ensure the header info is correct. Use the arrows to change fields and F3 to make changes. Press F2 to get the GPS info from the GPS. When complete, press F5. If no changes need making, press F4.
- Use the arrows to select Autograv and press F5. Most common setting is Yes, No, Yes, No, Yes, No. If you make any changes press F5. If no changes need making, press F4.

To take a measurement

- Place the meter on tripod away from any noise sources and switch it on. If the meter does not go straight to the "Station Designation" screen, simply press the MEASURE CLR button to take you there. If this is the first measurement of a survey/day, press F1 to set your options (suggested options below). Press OK when done.
- Check the Station and line number are correct (don't use the auto-increment option if you're using the GPS) and press F5 (or the remote button). Level the meter by twiddling the knobs on the tripod. Stand back and press the remote button to take the measurement.

- Once the measurement is complete, check the stats (see below) and if all is good, press the remote button again and switch the unit off before moving to the next station.

We recommend keeping a field book and recording the measurement number, time (mm:ss) and the measurement value.

Measurement times and notes

Regional surveys: Two 20-second measurements

Calibration: Five 60-second measurements

SD < 0.050 is acceptable, if 10% rejects or higher, repeat the measurement.

Set the Elevation field (in the Station Designation window) to 0.17 (sensor height from ground is about 17 cm).

Recommended station naming convention: 9000 (base), 1000, 1001, 1002… 10021 (repeat of 1002), 9001 (base) for day one, then 9002 (base), 2000, 2001, 2002… 20022 (repeat of 2002), 9002 (base) for day two and so on. Don't use auto-increment if using the GPS. A 10% repeat rate is recommended.

If you're not using the GPS you'll need to enter an average GPS coordinate of your survey manually. This is required for the Earth Tide correction.

Note that the GPS and antenna can easily snap off. Care must be taken if transporting the CG5 with either of these attached.

If the CG5 is misbehaving and ON/OFF doesn't work, press F1 and ON/OFF at the same time. This is a soft reboot (aka a slap across the face). If the CG5 hasn't been used in a while it may require a few of these.

To download data

Start with your computer on, NOT plugged into the CG5, and with the CG5 off. Follow these actions in this order:

Step 1 USB cable into computer
Step 2 Switch CG5 on
Step 3 Plug cable in CG5
Step 4 Open program (Launch SCTUTIL.exe)
Step 5 Keep log + create xyz
Step 6 Com params – baud rate to 9600 – click OK
Step 7 Dump tab, Start Dump
Step 8 Convert
Step 9 Disconnect safely
Step 10 Unplug at computer first
Step 11 Ensure you have the correct software installed on your computer.

Calculating the drift factor

Prior to undertaking a survey, a drift calculation should be undertaken. This calculates a number which is used to correct measured data on a day to day basis. It requires a minimum of 6 hours in a quiet environment to calculate. We recommend either taking the CG5 home and leaving in your shed overnight to perform the calculation, or leaving it at the core library overnight. Do this with enough time prior to the survey to repeat the calculation should you need (~two weeks prior to survey is good).

Step 1 Set up instrument where it will be quiet for (say) 12 hours. In your shed overnight is good. Make sure it's plugged in to power.
Step 2 Erase memory
Step 3 Survey, survey ID (don't press OK)
Step 4 Parameters (F1), System XYm then OK and OK again
Step 5 Autograv: YYYNYY, record
Step 6 Options: Readtime = 60, # cycles = number of hours * 60 (e.g. 720 for 12 hours (min. 6 hours))
Step 7 Start delay = sufficient time to get away (60 = one minute)
Step 8 OK
Step 9 Service, calibrations, drift, OK
Step 10 Measure, leave as 99999, measure (don't use F5)
Step 11 Level the CG5 and press measure (don't use F5)
Step 12 Leave the CG5 alone for the duration of the drift calculation. You can use the remote to stop the drift calibration.
Step 13 Once the 12 hours is up, press F5 and take note of the drift factors. You want the SD to be less than 0.0040. If it is above this value you'll need to let the instrument stabilise and undertake the calculation again.
Step 14 Record the drift factor to the CG5.

Calibration

Prior to undertaking a survey, you'll need to calculate a calibration factor. Think of this as a measurement of how accurate the CG5 is. It should be very close to 1.000. The procedure below is 'ABABA' (five measurements, three A, two B) and is the minimum required to calculate the calibration factor. It can easily be extended to an ABABABA (or more) but the calculation will need to be modified accordingly.

Step 1 You'll need the CG5, tripod, notebook, pen.
Step 2 (optional: erase the memory)
Step 3 Set up the CG5 for five 60-second measurements
Step 4 Go to base station 1 (Kensington Gardens Sports field) and record gravity at the survey mark. Take note of the time and the five gravity values. If the values are erratic, repeat the measurement until consistent readings are obtained.
Step 5 Go to base station 2 (Norton Summit Cemetery) and repeat at the survey mark.
Step 6 Visit Kensington Gardens again, then Norton Summit, then Kensington Gardens.
Step 7 On the gravity computer, insert the times and values into the calibration spreadsheet. If you don't have a spreadsheet, undertake the following…
Step 8 Calculate average times and values for each of the sites. You should now have 5 times and 5 gravity values (t1 to t5 corresponding to KGg1, NSg1, KGg2, NSg2, KGg3)
Step 9 Calculate three values: KGg1-NSg1, KGg2-NSg2 and KGg3-NSg2.
Step 10 Calculate the average of those three values. Call this value D.
Step 11 Now the known difference between the known gravity values at the two sites should be 75.34 mGal (using AAGD07 values: KG 979698.51 mGal – NS 979623.17 mGal = 75.34 mGal). Call this value DD.
Step 12 The calibration factor = D/DD. It should be approximately = 1 (e.g., 0.999704)
Step 13 (optional: plot the gravity values against time and check that the drift is linear)
Step 14 Note this calibration factor: you'll need it for daily processing for the duration of the survey.

General calibration equation can be written:

$$Calibration\ Factor = \frac{KG_1 + KG_2 + \cdots + KG_{n-1} + KG_n - NS_1 - NS_2 - \cdots - 2NS_{n-1}}{n \times DD}$$

Where KG_n is an averaged dial reading from each Kensington Garden site (similarly for NS_n). If the final reading is taken at Norton Summit, replace $-2NS_{n-1}$ with $-NS_{n-1}-NS_n$).

Data processing (Gravity reduction)

Step 1

Base station pre-processing (needs to be done prior to survey, or on first day of processing):

- Get actual base station value from AFGN e.g. Leigh Creek:
  - Station No.: 200890.9937
  - Latitude (GDA94): -30.5972
  - Longitude (GDA94): 138.4218
  - Easting (GDA94): 252800.4
  - Northing (GDA94):6612204.9
  - Elevation (AHD): 259
  - Gravity (AAGD07): 9793074.47 micrometres/sec/sec
- Convert Gravity (AAGD07) to Gravity (84) by adding 0.78 um/s^2
  - Gravity (84): 9793075.25
- Open BOUGCAL_OG84mgals.xls
  - Place Gravity (84) in column "*original '84ums2"* (Column H)
  - Copy formulas down and take value from *"'65mgals from '84ums2"* (Column G)
    - Gravity (65) = 979321.58

Step 2

Pre-processing: file and folder setup (needs to be done prior to survey, or on first day of processing):

Be consistent for the duration of your survey regarding how you manage data. We recommend a simple folder structure as follows:

Survey_folder
- Day01
  - Raw
  - Processed
- Day02
  - Raw
  - Processed

…
- Final_data
- Other_info
- Raw_backup
- Software

Place copies of software and excel spreadsheets in the software directory, and make copies to the daily raw folder as you need. The files/programs needed are:

- BOUGCAL_OG84mgals.xls
- Calibration_run.xls
- GDA_AGDconvert.xls
- libGDA94convert.dll
- OBSGRED.EXE
- OBSGRED.MOD

Step 3

Pre-processing: formatting the data

- Ensure that there is a single point of truth for the raw data (in case any re-processing is required). Combine gravity and GPS data into an Excel spreadsheet to create the following table:

Date	Time	Line	Station	Grav	Easting	Northing	Zone
ddmmyy	hhmm (24 hr)	0	0000…	0000.000 (3 decimals)	000000.00 (2 decimals)	0000000.00 (2 decimals)	00

- Make some space between columns but not too much (needs to space titles and data correctly for formatting reasons – trial and error).
- If data has been tied correctly then the first and last base station readings require the same station number to enable the program to calculate the loop so change this manually (i.e. first and last row of data must have identical values in Station column).
- Save file as *.prn and check that formatting is correct – if not, re-space and resave.

Step 4

Gravity reduction processing

- Place data file in a folder with OBSGRED.EXE and OBSGRED.MOD – there is a limit to the number of characters that can be used when directing the program to the file so make sure file names are short and the folder is not buried too deep – root level is ideal.
- Execute OBSGRED.EXE
  - *"Enter input file name"*
    Enter full *.prn filename along with complete path

    O:\Grav\Line1.prn ↵
  - *"Skip how many lines?"*
    Enter 1 if there is a header row, 0 if not

    1 ↵
  - *"Enter Format Specification"*
    Codes come up for this however if the format is as listed in the table design the following works ; null values (i.e. between columns) are represented by spaces and decimals are represented by the same format code as the adjacent numbers (yes sorry you have to type this out)

    DDMMYY hhmm L SSSS RRRRRRRR EEEEEEEE NNNNNNNNN ZZ ↵
  - *"Output file names are LOOPS and GRAV – press Enter"*
    This step just creates the files where data will be saved – just press enter

    ↵
  - *"Meter sensitivity"*
    Enter either the calibration factor from calibration run or the value 1

    1 ↵
  - *"Tidal corr? Y/N"*
    If the gravity metre had the tidal correction selected whilst surveying select N otherwise select Y

    N ↵
  - *"Daylight saving Y/N"*
    Yes if gravity metre running on daylight saving time, no if recorded in normal time

    N ↵
  - *"1 **** repeated – enter value or 0"*
    The **** is an actual number – should be the repeated station number that appears on the first and last data rows

This is where the base station value should be entered or if unknown (i.e. not tied into a known value) enter 0

979321.58 ↵

- *"move screen Up, Down, do a Loop or Finish"*
  Select L to loop

  L ↵
- *"Enter start Ref number"*
  This number is written in the top half of the screen

  0 ↵
- *"Enter finish Ref number"*
  This number is written in the top half of the screen

  1 ↵
- *"command U D L F?"*
  Select F to finish

  F ↵

Step 5

Coordinate conversion

- Open GDA_AGDconvert.xls
  - Paste Easting, Northing and Zone values into the *"Input"* columns (B, C and D respectively) of the sheet named 'Grid'
  - Convert values

    ctrl + T
  - If an error message comes up at this stage go to the *"Save As"* menu and then navigate to the folder you are working in then exit menu – this should fix the problem
  - Select AGD to GDA

    Yes
  - Copy latitude and longitude *"Output"* values (columns F and G) and paste into the *"Input"* columns (B and C) of the sheet named *"LonlatDD"*
  - Convert values

    ctrl + T
  - Select GDA to AGD

    No
  - The latitude *"Output"* values (column F) is used for the Bouguer calculations

Step 5a

Convert ellipsoidal heights to AHD

- Prepare a spreadsheet with columns point_number, latitude (GDA94), longitude (GDA94), ellipsoidal height (GDA94).
- Save as a .csv file with no column headers.
- Go to http://www.ga.gov.au/ausgeoid/nvalcomp.jsp and submit the data there.
- AHD data is returned in less than a minute.

Step 6

Calculate Bouguer gravity

- Open BOUGCAL_OG84mgals.xls
  - Paste values from *"obsg"* column of GRAV file (created with OBSGRED.EXE) into *"Obs '65 mgals"* (column A)
  - Paste latitude values (from GDA_AGDconvert.xls) into *"Latitude"* (column B) and elevation values (from original data) into *"Elevation (AHD)"* (column C)
  - Fill down the equations in the remaining columns to calculate values

“BA84mgals” (column M) from BOUGCAL_OG84mgals.xls appears equivalent to “BA267_1984_MGALS” within the NOD Data (column AB)

Step 7

Data checks: QA/QC and data compilation

Combine daily data into a master spreadsheet or database. View the gravity data however you like and look for inconsistencies and values that don’t fit in. Check the repeat values – standard deviation on repeats should be < 0.01mGal.

Step 8

Data compilation and backup

Ensure that all raw data is separated from processed data. Data to be backed up **daily**. No exceptions.

For further information, please contact any of the GSSA geophysicists.