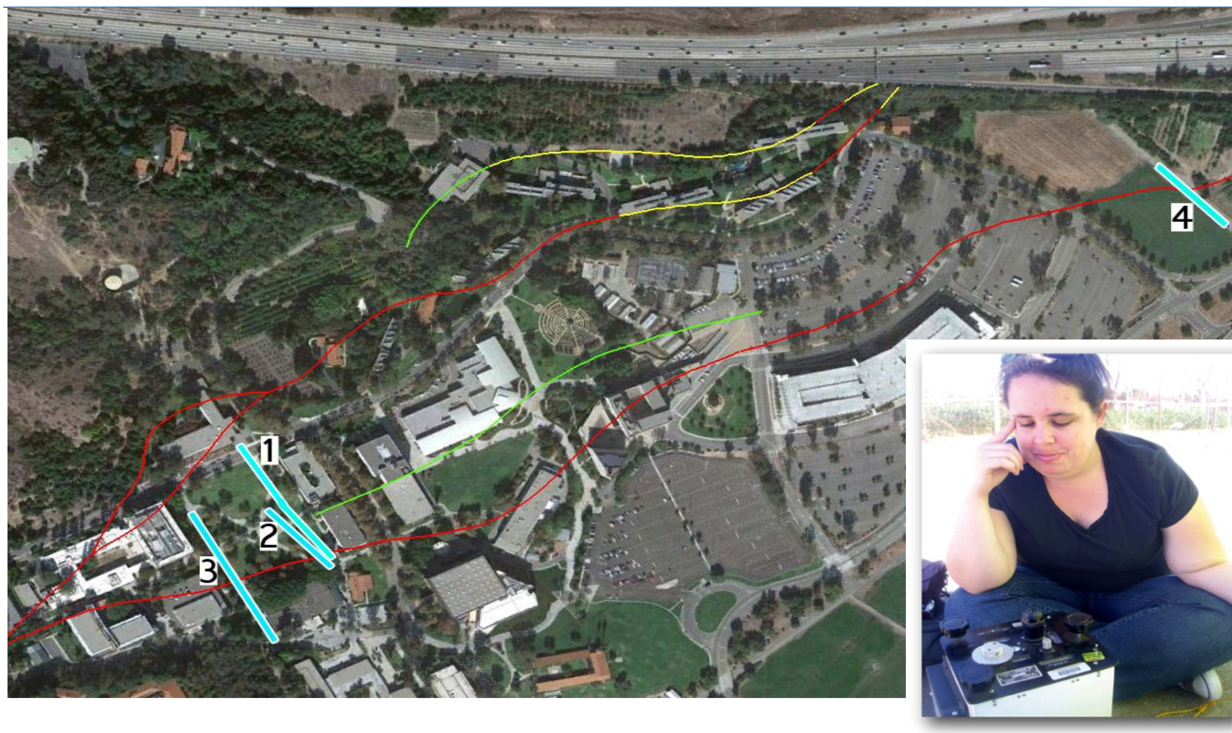
Gravity Profiles across the San Jose Fault on the Cal Poly Pomona Campus: Citrus Lane and Quad Profiles



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Senior Thesis
Submitted in partial fulfillment
for the Bachelor's of Science Geology Degree

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Abstract

Traces of the San Jose Fault are known to run through the California State Polytechnic University, Pomona campus. Several geotechnical investigations have been conducted in an attempt to locate and classify these traces, but the results have been conflicting. The disagreement in the literature about the fault type (left-lateral strike slip versus reverse) coupled with the uncertainty of the fault's location adds to the mystery of the San Jose Fault and what kind of a role it plays on the Cal Poly campus. The Seismic Review Board has classified several buildings on campus as some of the most seismically hazardous buildings of the entire CSU system. The CSU Board of Trustees recently voted to raze the iconic Cal Poly Pomona Classroom, Laboratory and Administration Building because of poor construction and seismic code concerns, giving rise to more questions about the fault's true location.

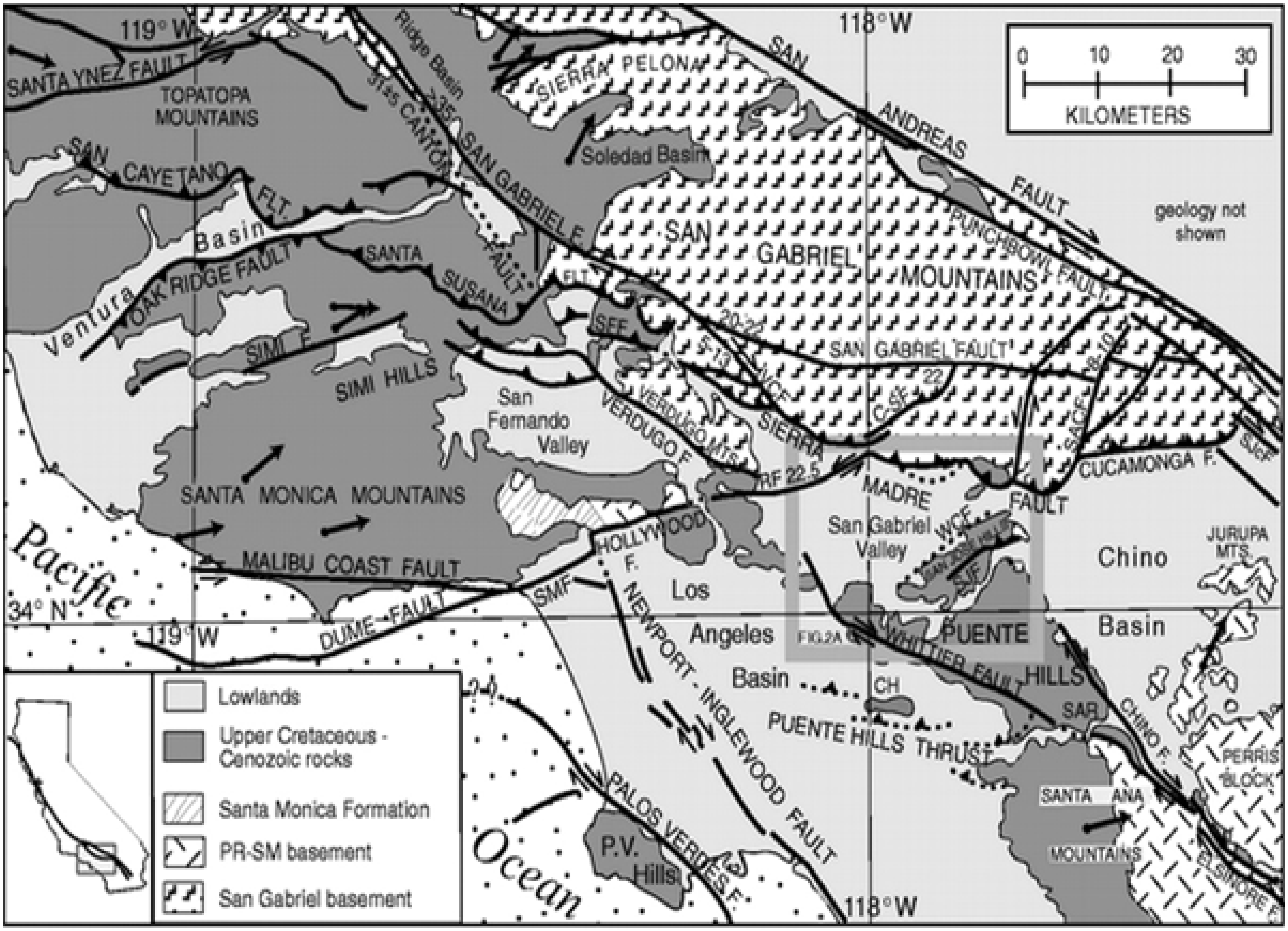
Several profiles across the campus were chosen to run gravity surveys, to determine whether lateral variations in rock density could be detected, corresponding to the proposed locations of the fault. The choice of sites of the gravity profiles were based on the traces of the San Jose Fault as mapped by the GeoCon geotechnical investigation and practical considerations of accessibility and terrain. The surveys were conducted using a LaCoste and Romberg Gravimeter and a total station surveying instrument. The use of the total station ensures accurate elevation measurements, which are required for high quality gravity corrections. Profiles of elevation and Bouguer gravity anomalies are presented and the results are compared with those from previous geotechnical trenching and geological mapping studies.

The profiles in the University Quad show what is expected as a gravity signal from a reverse fault. However, the Citrus Ln. profile is not what we would expect to see. This suggests that

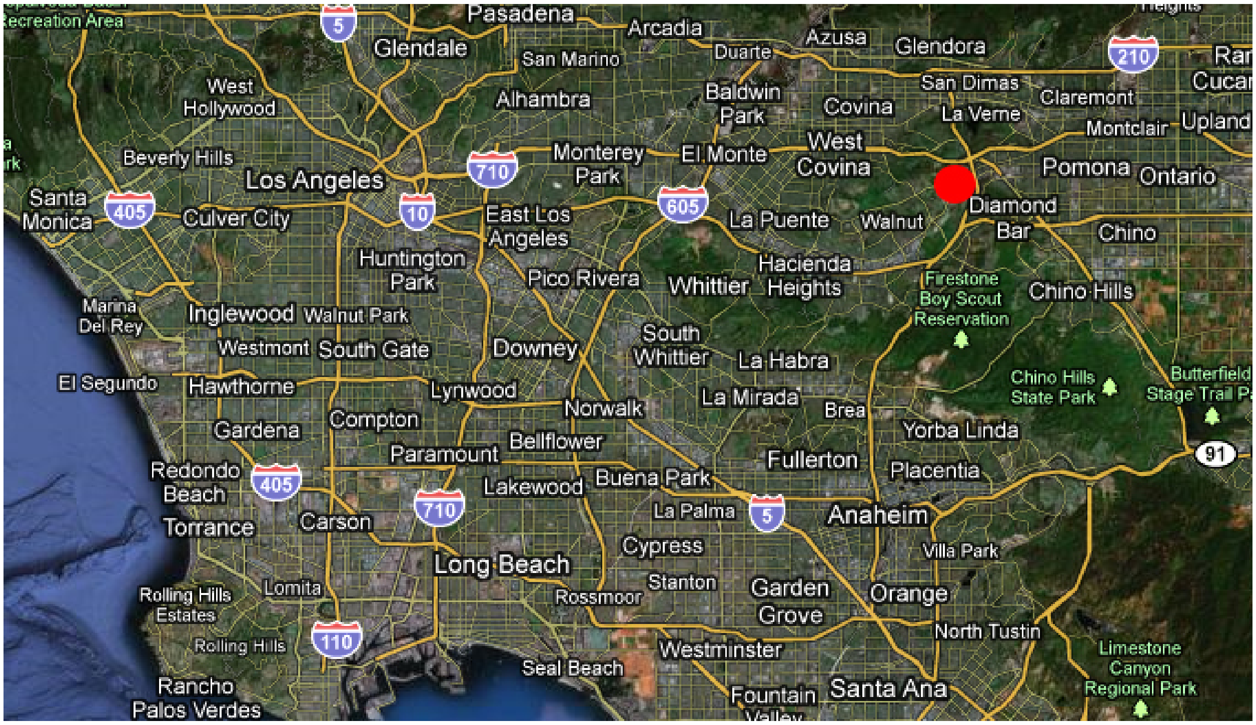
traces of the San Jose Fault may run through the quad area of campus, as indicated on the GeoCon fault map, but no clear evidence is seen in the gravity signal of the presence of a trace of the fault near Citrus Lane.

Introduction

The San Jose fault is a reverse fault with some possible left lateral component (Haukson and Jones, 1991; GeoCon Geotechnical Group, 2001), that sits at the base of the San Jose Hills in the inland empire portion of Southern California about thirty miles southeast of Los Angeles (Map 1). The San Jose Hills are considered part of the San Gabriel Basin. Located on top of the San Jose fault strands is a majority of the California State Polytechnic University, Pomona (Cal Poly Pomona) campus (Map 2). The surrounding San Jose Hills are used as farm land and for grazing cattle. There are several nearby communities, including Walnut, and schools, including Mount San Antonio College. The geology of the area is moderately complicated with several faults nearby. The San Jose Hills are mostly made up of sedimentary deposits, Puente and Fernando Formations, with some interlaid volcanic deposits, the Topanga Formation (Yeats, 2004). In Quaternary times, the area has been subject to extreme erosion. During Miocene time, the San Gabriel Basin was subject to faulting, tectonic rotation, and folding. The numerous folds in the area have significant oil deposits. Further faulting occurred during the Pliocene. In more recent times, earthquakes in 1988 and 1990, near Upland, CA, are hypothesized to be on an extension of the San Jose fault (Hauksson and Jones, 1991). According to Hauksson and Jones (1991), the portion of the San Jose fault the earthquakes occurred on is mainly left lateral. The San Jose fault can be considered, more so, a reverse fault (Yeats, 2004) due to the numerous anticline and syncline geometries of the area (Dolan et al., undated). The Upland earthquakes possibly



Map 1: Shows a tectonic overview of Southern California (Yeats, 2004). The San Jose fault is located inside the light gray square.



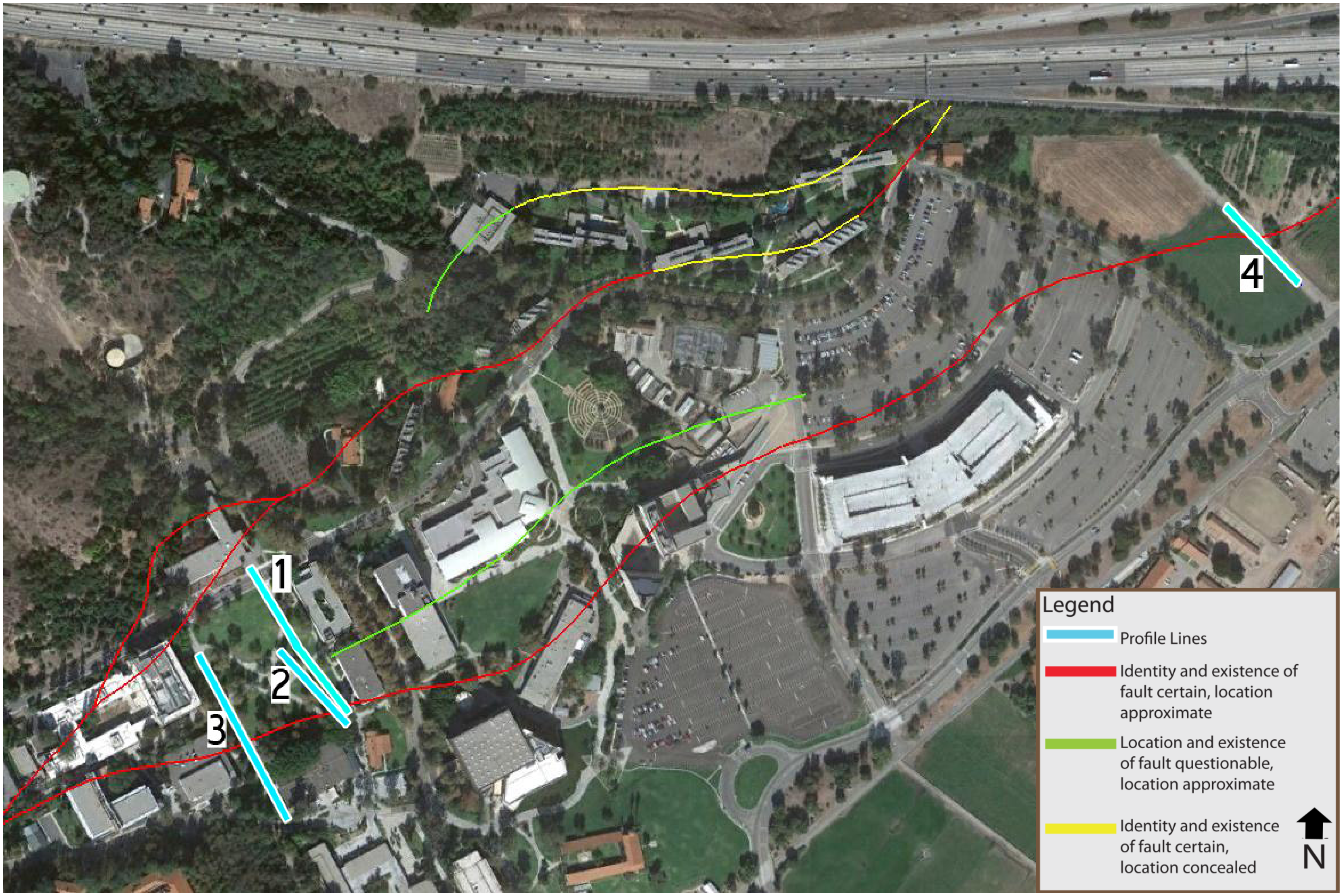
Map 2: Shows the approximate location of the Cal Poly Pomona campus relative to nearby major cities. The campus is also located nearby mountain thrust faults of the San Gabriel Mountains.

occurred on an extension of another near-by left lateral fault (Dolan et al.) instead of the San Jose fault as proposed by Hauksson and Jones.

Recently, several buildings on the Cal Poly Pomona campus have been ranked as some of the top seismically unsafe buildings in the entire California State University (CSU) system. The first on the list is the Classroom Laboratories and Administration (CLA) building that has been scheduled for demolition, by vote from the CSU Board of Trustees, by 2014 (Polycentric, 2010). The Board's decision is due to the building's proximity to the San Jose fault and the lack of seismic building restraints among other costly problems (Newfield, 2010). A better understanding of the exact location of the San Jose fault would contribute to better seismic hazard assessment of the region.

There is limited prior knowledge of the exact location of the San Jose fault. Several geotechnical reports have been conducted since the campus first started. Using information from the GeoCon Geotechnical Group report (2001), several locations were chosen based on their location of the proposed fault traces to determine gravity profiles (Map 3). Performing gravity experiments provides information about the subsurface without having to perform excavations. By comparing the location of the proposed fault traces to gravity measurements, it may be determined whether the two are consistent.

Four profiles were chosen to measure the gravity differences. One long profile in the quad area next to the Bronco student center and building 3, another long profile conducted on Citrus Lane (close to the 10 freeway), and two smaller quad profiles conducted next to the business building. This report will focus on the long quad and the long Citrus Lane profiles (Map 3). The two other profiles will be discussed in more detail by Celia Pazos (Pazos, 2011).



Map 3: Shows the fault traces as proposed by GeoCon (2001) and the four chosen profile lines. This report will focus on lines 3 and 4.

Methods

A gravimeter measures the local downward strength of the acceleration of gravity and is designed to measure tiny variations in this gravitational acceleration over the surface of the Earth due to, for example, changes in subsurface density. Materials in the subsurface have different densities, giving different gravity signals that the gravimeter can measure. Accurate elevation measurements are required to make corrections for the effects of topographic changes along the profile for the gravity measurements. A calibration sheet for the gravimeter has been included in the appendix. Free air corrections were calculated to account for the extra height between the base and profile points. Similarly, Bouguer corrections were calculated to account for the extra material between the base and profile points. These corrected gravity values are referred to as Bouguer anomalies.

If the San Jose Fault is a reverse fault, we expect to see a flat portion, a rise from left to right followed by another flat portion in our profiles (Figure 1). We expect this because the deeper layers are moved upwards, and the shallower material eventually eroded. So, more dense material on the up thrown side of the fault will be closer to the surface than the material on the other side of the fault. Higher gravity values are detected on the up thrown side of the fault.

Data/Results

Gravity measurements were taken close to buildings 8 and 2. Twenty points where chosen along the path through the quad (Map 3: profile 3), with a spacing of 30 feet in between points. Total station elevation measurements were taken at all points to ensure accurate free air and Bouguer corrections. The base station was visited several times throughout the day to determine if there was instrumental drift; the drift was not linear, so no correction was needed. Table 1 shows the

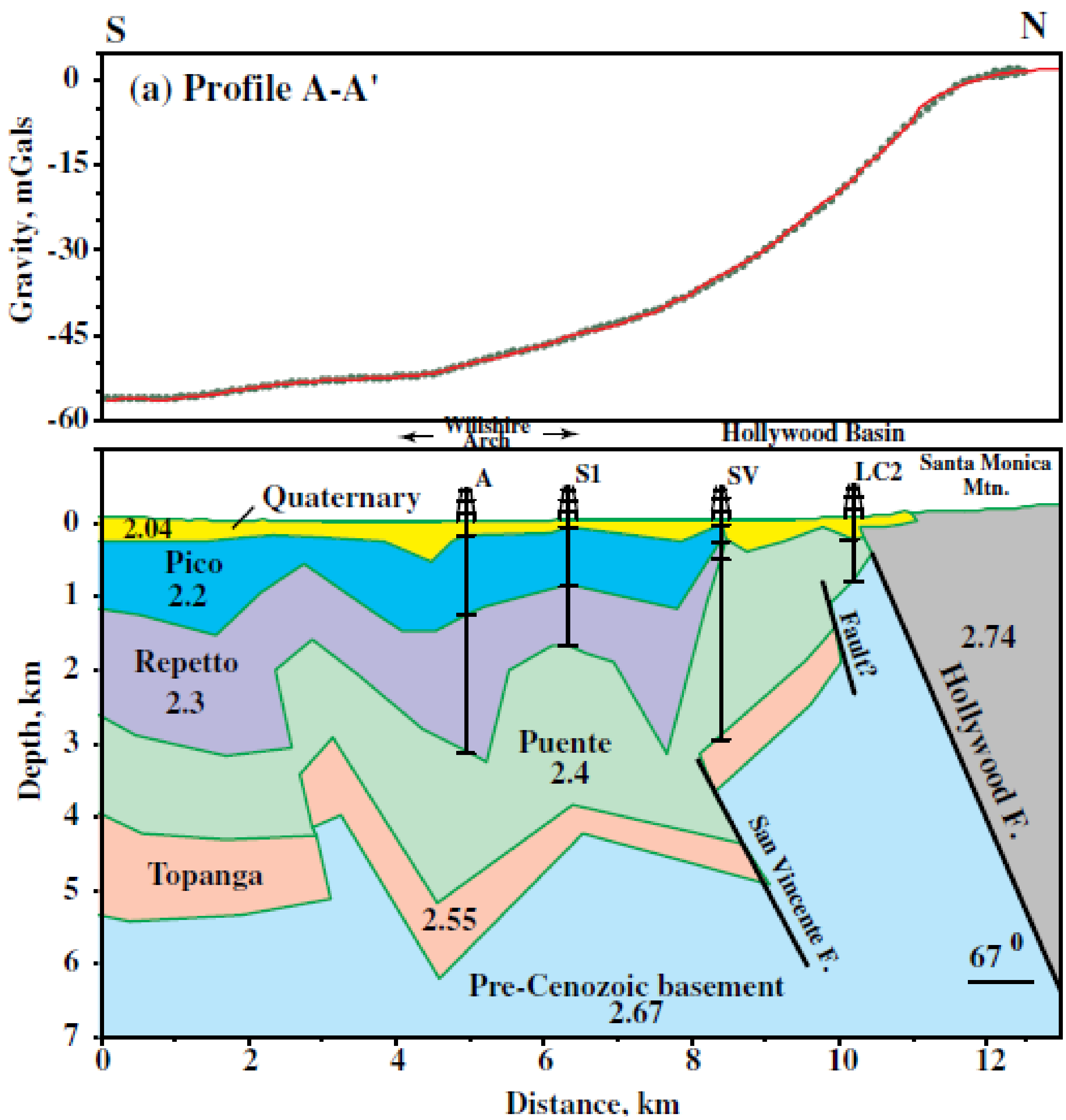


Figure 1: Example from Hildenbrand et al. (2002) shows the observed gravity signal from the Hollywood Hills reverse fault. This is the signal that is expected with a reverse fault.

Quad Profile near Building 3 and Bronco Marketplace with GSC 415L Nov. 6th 2010

Point Name	Elevation (m)	Elevation from base (m)	Counter Reading	Dial Reading	Meter Reading	Gravity Measurement (mGal)	Free Air Correction (mGal)	Free Air Anomoly (mGal)	Bouguer Correction (mGal)	Bouguer Anomoly (mGal)	Distance from base (m)
Base	1000.132		3128.7	7.3	3128.73	3315.11					
Base	1000.132		3128.6	5.6	3128.56	3314.93					
Base	1000.132		3128.5	4.8	3128.48	3314.84					
Base	1000.132		3128.5	5	3128.50	3314.86					
1	997.872	-2.26	3127.5	4.9	3127.49	3313.79	-0.70	3313.09	-0.25	3313.35	-390
2	997.753	-2.379	3127.5	5	3127.5	3313.80	-0.73	3313.07	-0.27	3313.33	-360
3	997.715	-2.417	3127.9	8.8	3127.88	3314.21	-0.75	3313.46	-0.27	3313.73	-330
4	997.802	-2.33	3128	9.8	3127.98	3314.31	-0.72	3313.59	-0.26	3313.85	-300
5	997.681	-2.451	3127.9	9.2	3127.92	3314.25	-0.76	3313.49	-0.27	3313.77	-270
6	997.768	-2.364	3128.2	1.5	3128.2	3314.54	-0.73	3313.82	-0.26	3314.08	-240
7	997.866	-2.266	3128.2	2.3	3128.23	3314.58	-0.70	3313.88	-0.25	3314.13	-210
8	998.607	-1.525	3128.2	1.7	3128.17	3314.51	-0.47	3314.04	-0.17	3314.21	-180
9	999.31	-0.822	3128.2	1.9	3128.19	3314.53	-0.25	3314.28	-0.09	3314.37	-150
10	999.469	-0.663	3128.3	3	3128.30	3314.65	-0.20	3314.45	-0.07	3314.52	-120
11	999.586	-0.546	3128.2	2.3	3128.23	3314.58	-0.17	3314.41	-0.06	3314.47	-90
12	999.77	-0.362	3128.3	3.2	3128.32	3314.67	-0.11	3314.56	-0.04	3314.60	-60
13	999.974	-0.158	3128.5	4.6	3128.46	3314.82	-0.05	3314.77	-0.02	3314.79	-30
14	1000.132	0	3128.5	4.5	3128.45	3314.81	0.00	3314.81	0.00	3314.81	0
15	1000.193	0.061				-2.79	0.02	-2.77	0.01	-2.77	
16	1000.407	0.275	3128.6	5.8	3128.58	3314.95	0.08	3315.03	0.03	3315.00	60
17	1000.873	0.741	3128.5	5.3	3128.53	3314.89	0.23	3315.12	0.08	3315.04	90
18	1000.42	0.288	3128.6	5.9	3128.59	3314.96	0.09	3315.05	0.03	3315.02	120
19	1000.861	0.729	3128.6	6	3128.60	3314.97	0.22	3315.19	0.08	3315.11	150
20	1000.104	-0.028	3128.6	6.2	3128.62	3314.99	-0.01	3314.98	0.00	3314.98	180

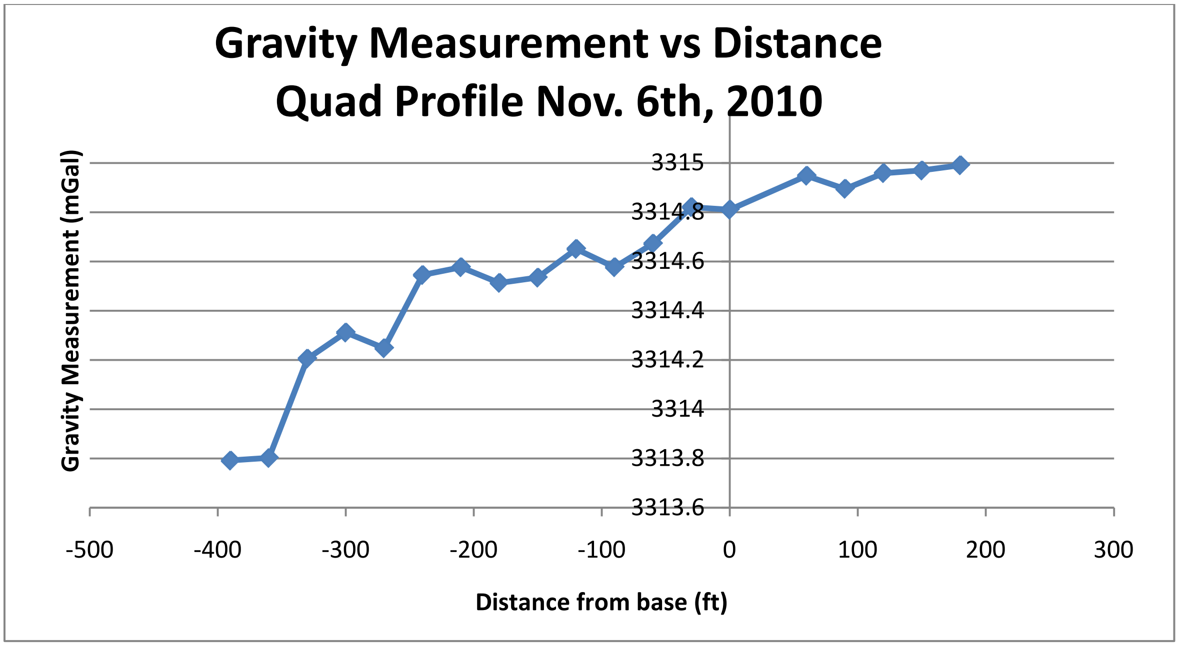
Table 1: Shows the gravity values and corrections made to obtain the Bouguer correction for the Quad Profile. The yellow highlighted row signifies that we could not measure the point easily because it was located on concrete.

data collected for the quad profile. Gravity measurement is extrapolated from the dial and counter readings (Appendix 1). Free air correction is determined by the elevation change from the base. The free air correction is then added to the gravity measurement to obtain the free air anomaly. Next, the Bouguer correction is calculated by assuming a rock density, in this case an average density of 2.67 g/cm^3 was used, and including the elevation change from the base. The Bouguer correction is subtracted from the free air anomaly to produce the final gravity anomaly (the Bouguer anomaly). The graph of the Bouguer anomaly is then used to determine the possible structure underneath the subsurface. Graph 1 shows the gravity measurement without corrections. Graph 2 shows the elevation of the points relative to the base. Graph 3 shows the Bouguer anomaly.

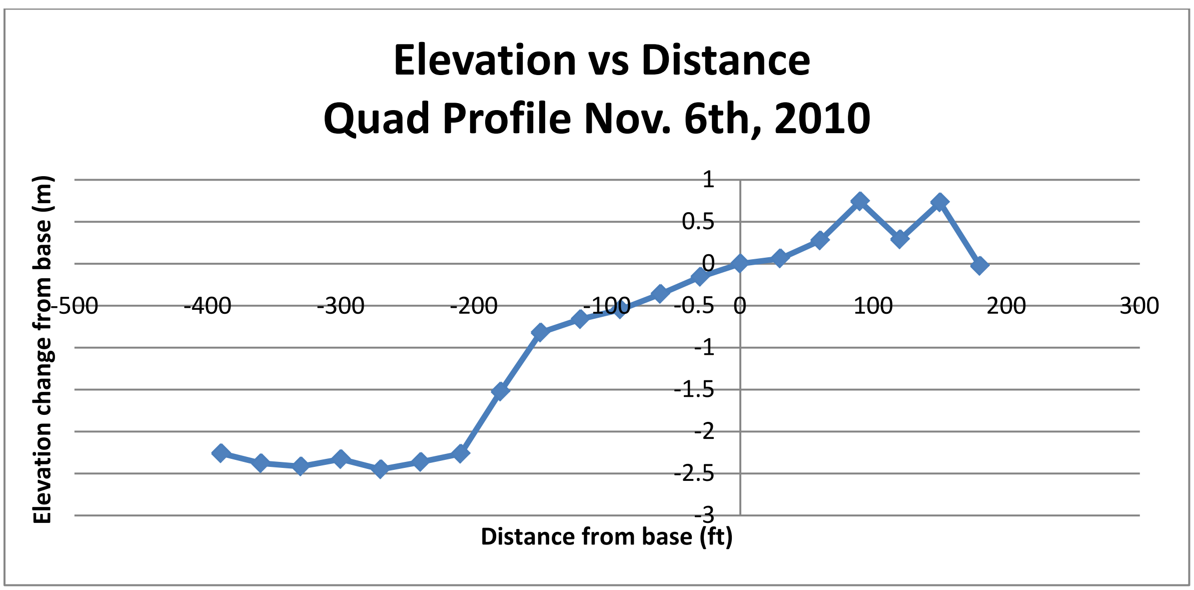
For the Citrus Ln. profile, similar steps were taken. Seventeen points were chosen along the street (Map 3: profile 4), with a spacing of 25 feet in between points. A correction for instrument drift was not necessary because the base station readings did not change over a four hour period. Graph 4 shows the gravity measurements for the Citrus Ln. profile. Graph 5 shows the elevation change relative to the base. Graph 6 shows the Bouguer anomaly for the profile.

Interpretation

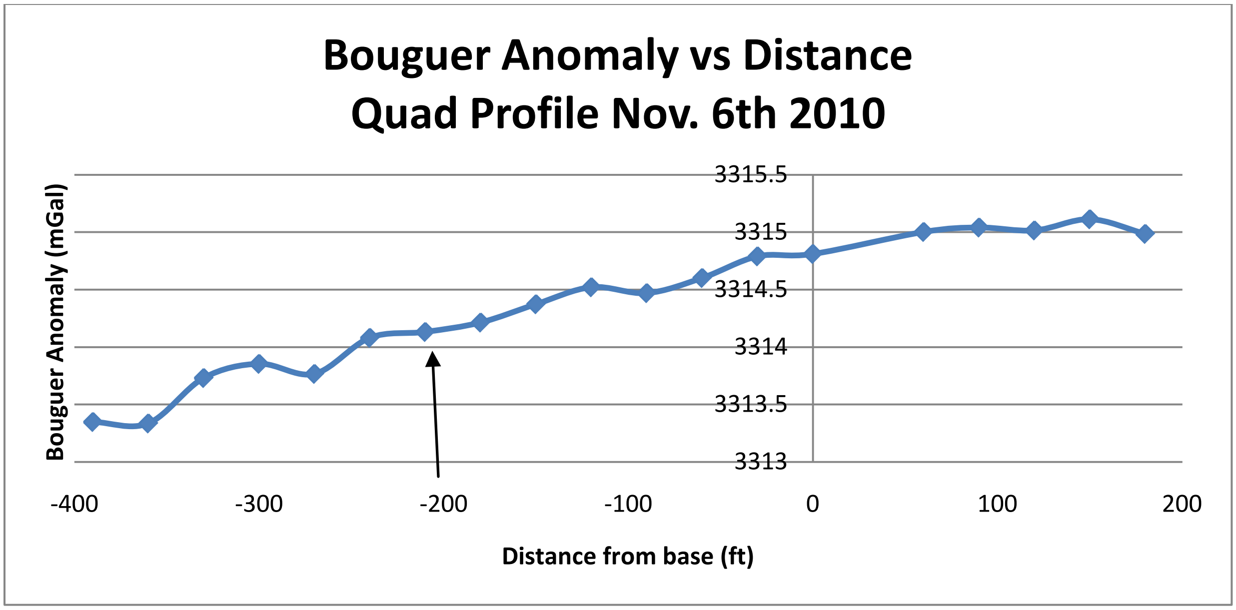
To ensure there was not a correlation between topographic density variations and gravity signals, the density values where changed, both increased and decreased until the graphs of the Bouguer anomalies leveled out. With each of the profiles, they did not flatten out until a density of more than 10g/cm^3 was chosen (Graphs 7 - 12). This density value is not physically realistic. That means the gravity anomaly cannot be explained solely by a change in topography.



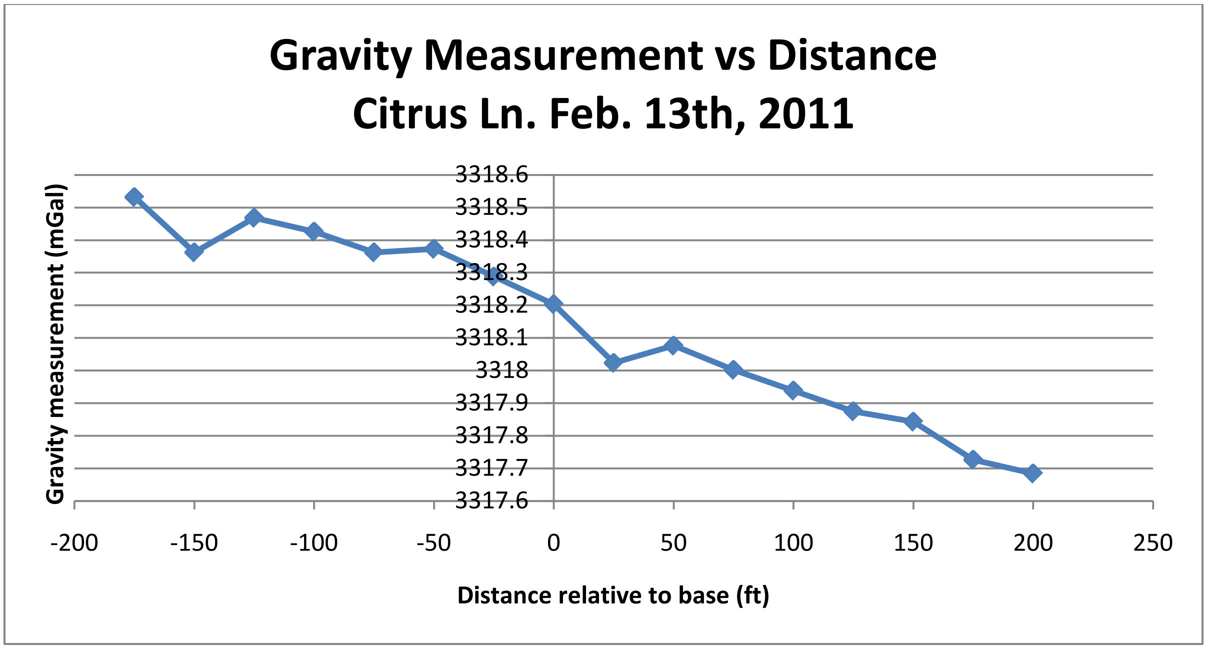
Graph 1: Shows the raw gravity measurements for the quad profile conducted on November 6th 2010 with the help of the Engineering Geology II (GSC 415) Lab.



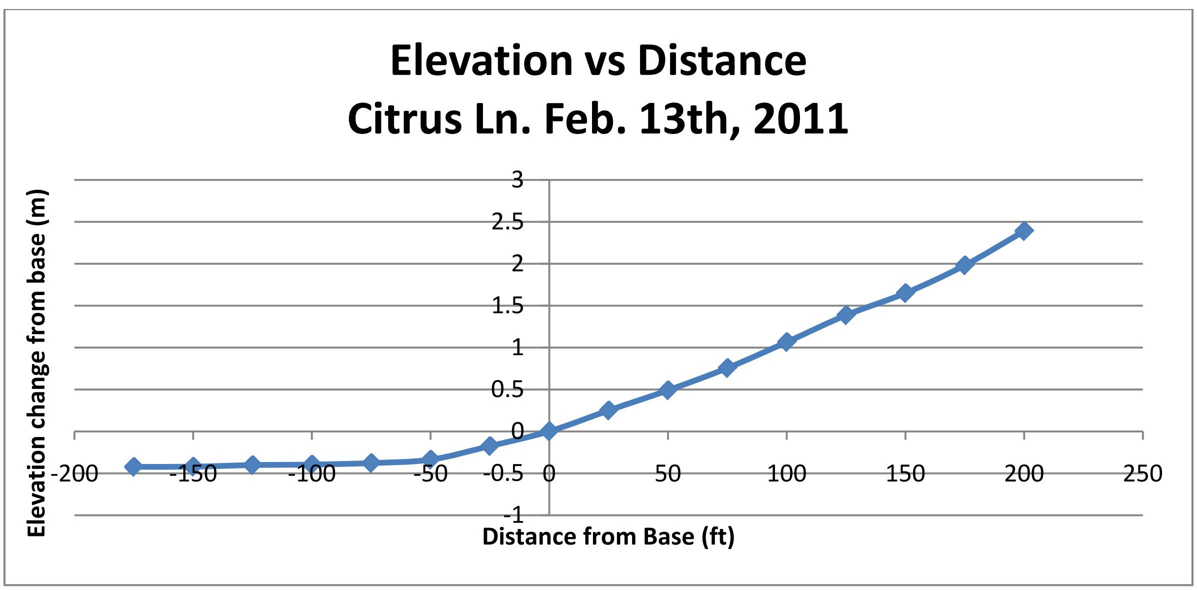
Graph 2: Shows the elevation change relative to the base for the quad profile.



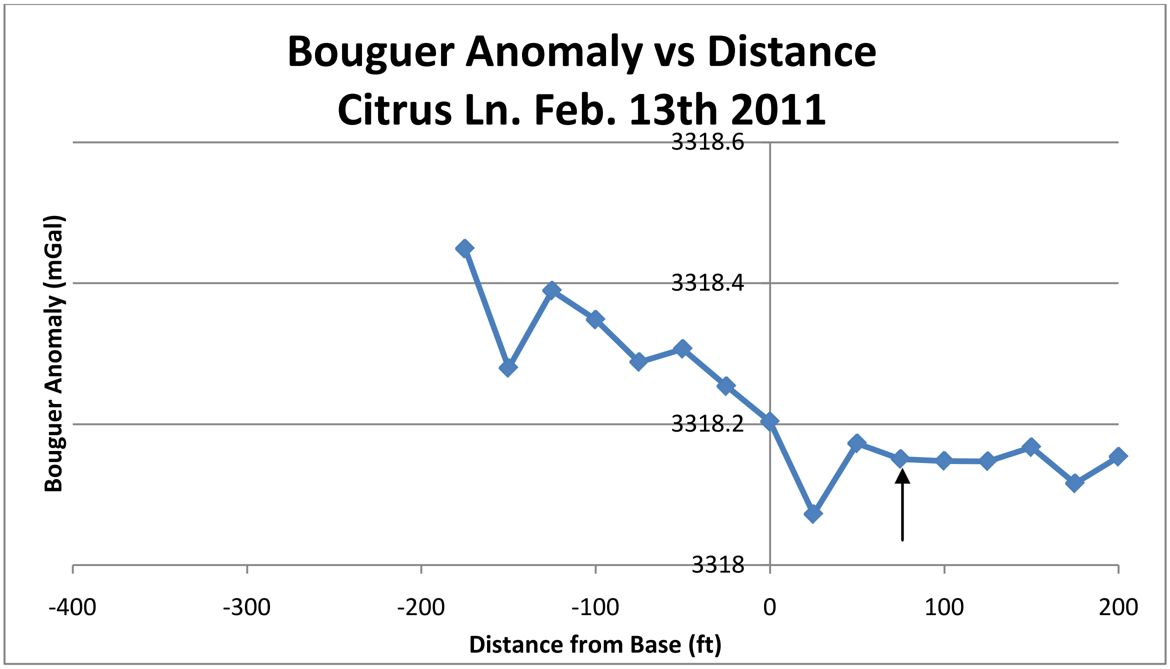
Graph 3: Shows the Bouguer anomaly in milligals for the quad profile. The arrow shows where GeoCon suggests the fault location to be: around -200 ft from the base.



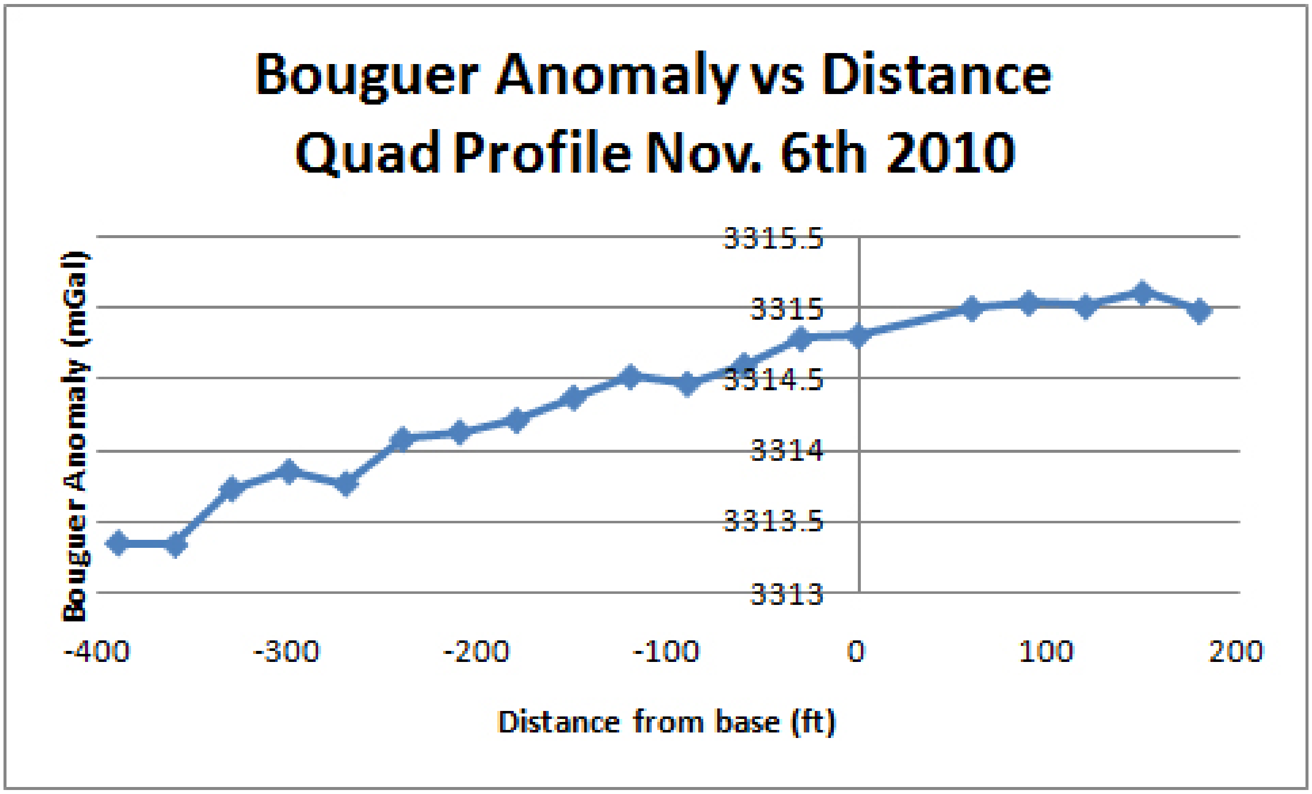
Graph 4: Shows the raw gravity measurement in milligals for the Citrus Lane profile conducted on Februray 13th, 2011.



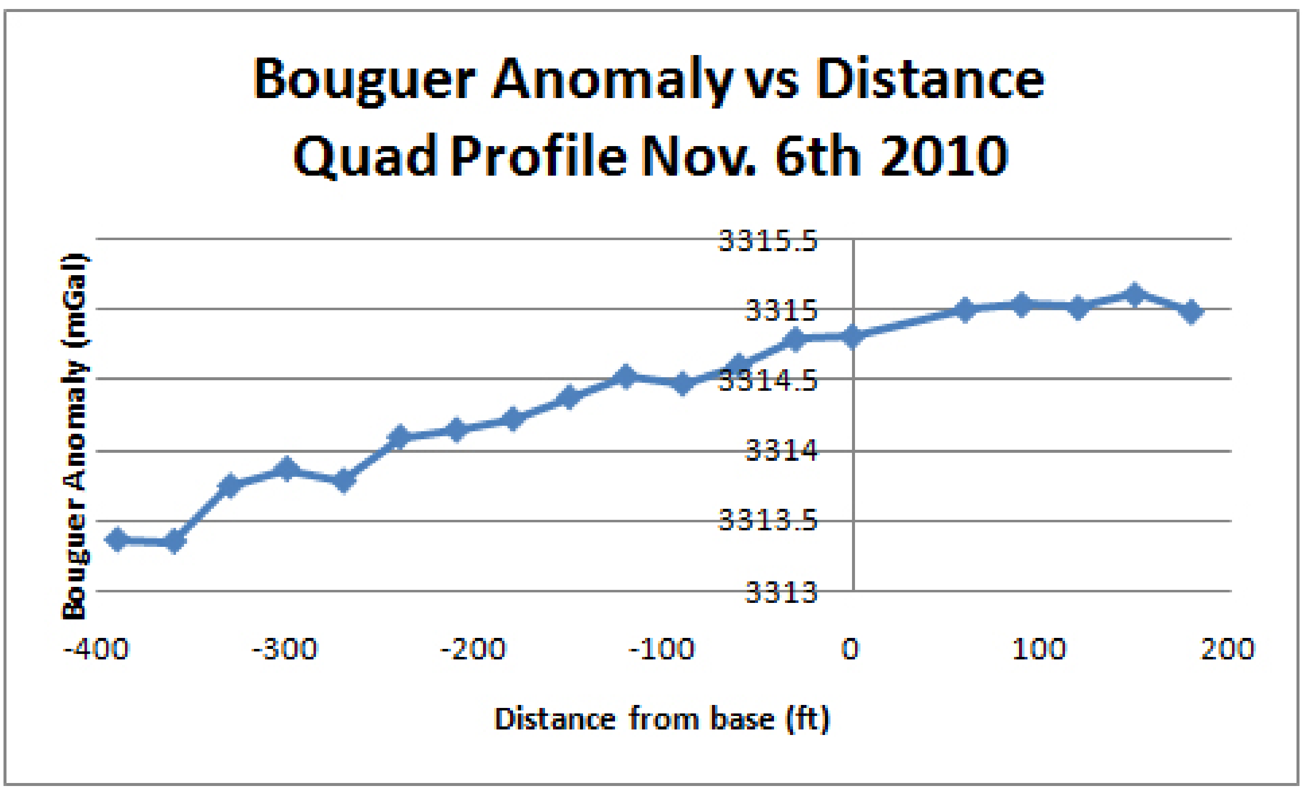
Graph 5: Shows the elevation change relative to the base.



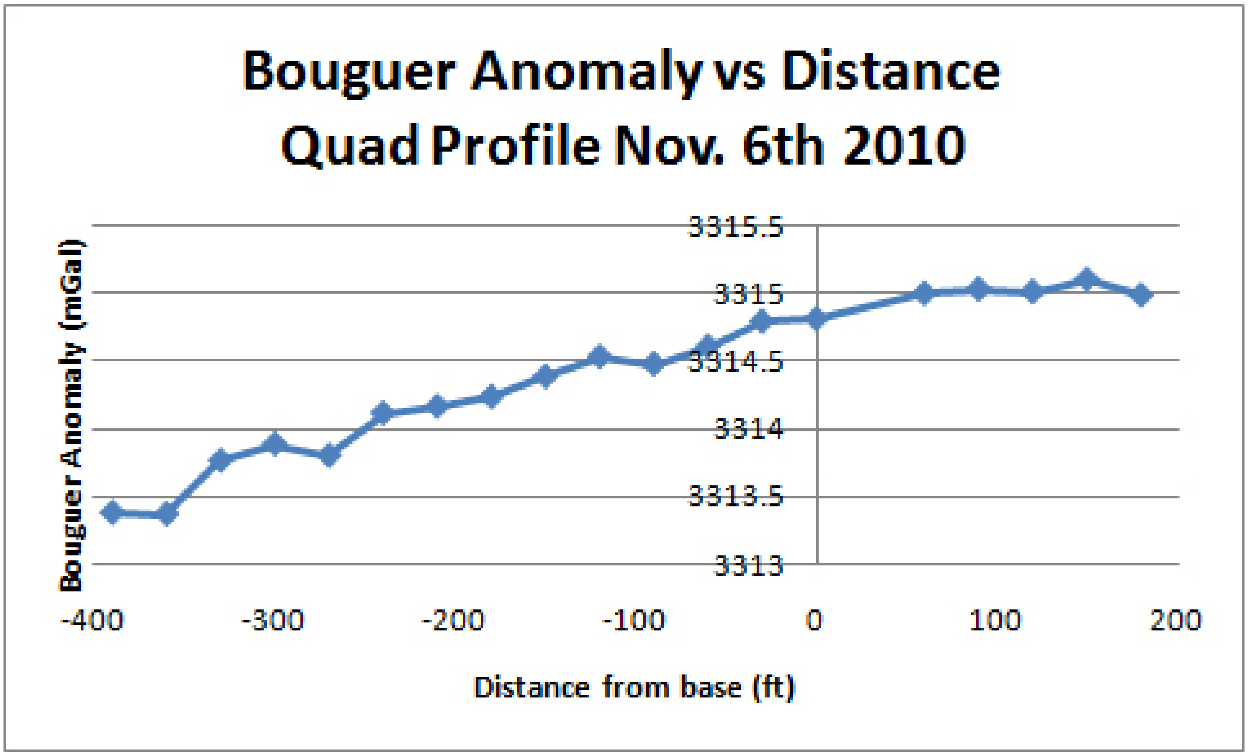
Graph 6: Shows the Bouguer anomaly in milligals. The arrow shows where GeoCon suggests the fault location to be: around positive 75 ft from the base.



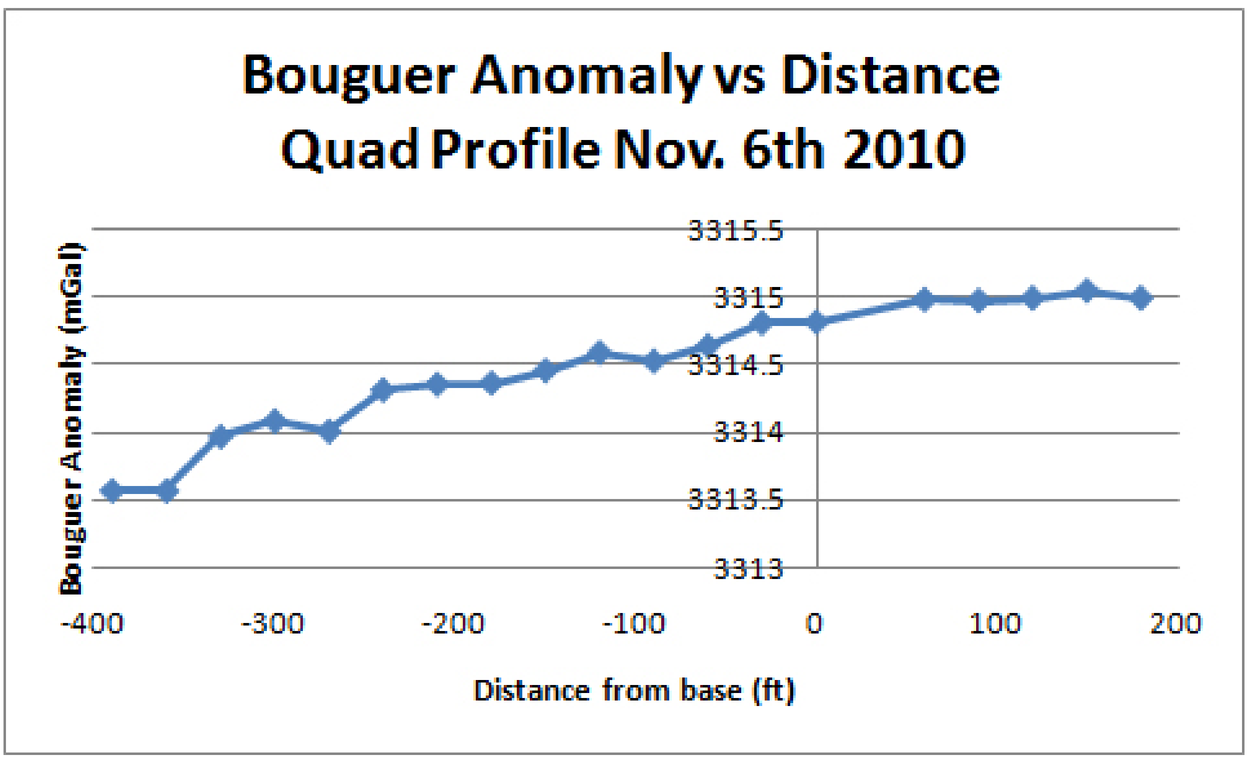
Graph 7: Shows the original Bouguer Anomaly for the Quad Profile with an assumed density value of 2.67 g/cm^3.



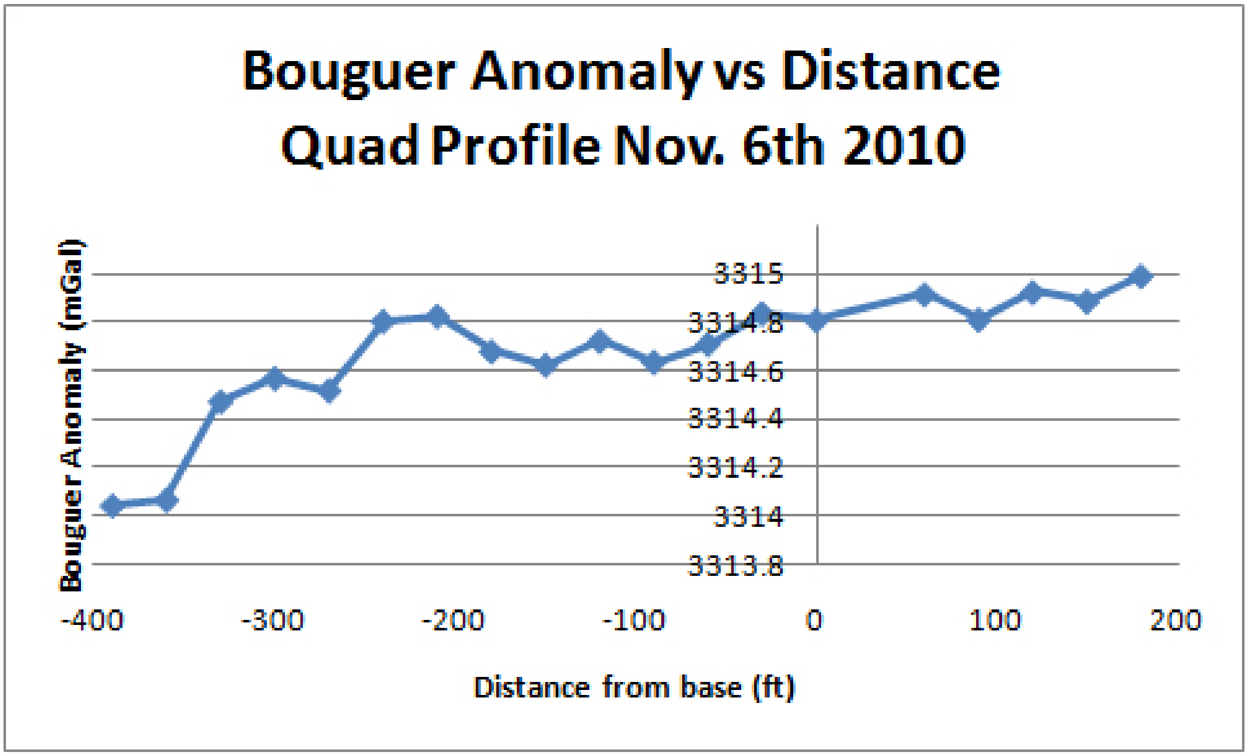
Graph 8: Shows the Bouguer Anomaly for the Quad Profile with an assumed density value of 2.80 g/cm^3.



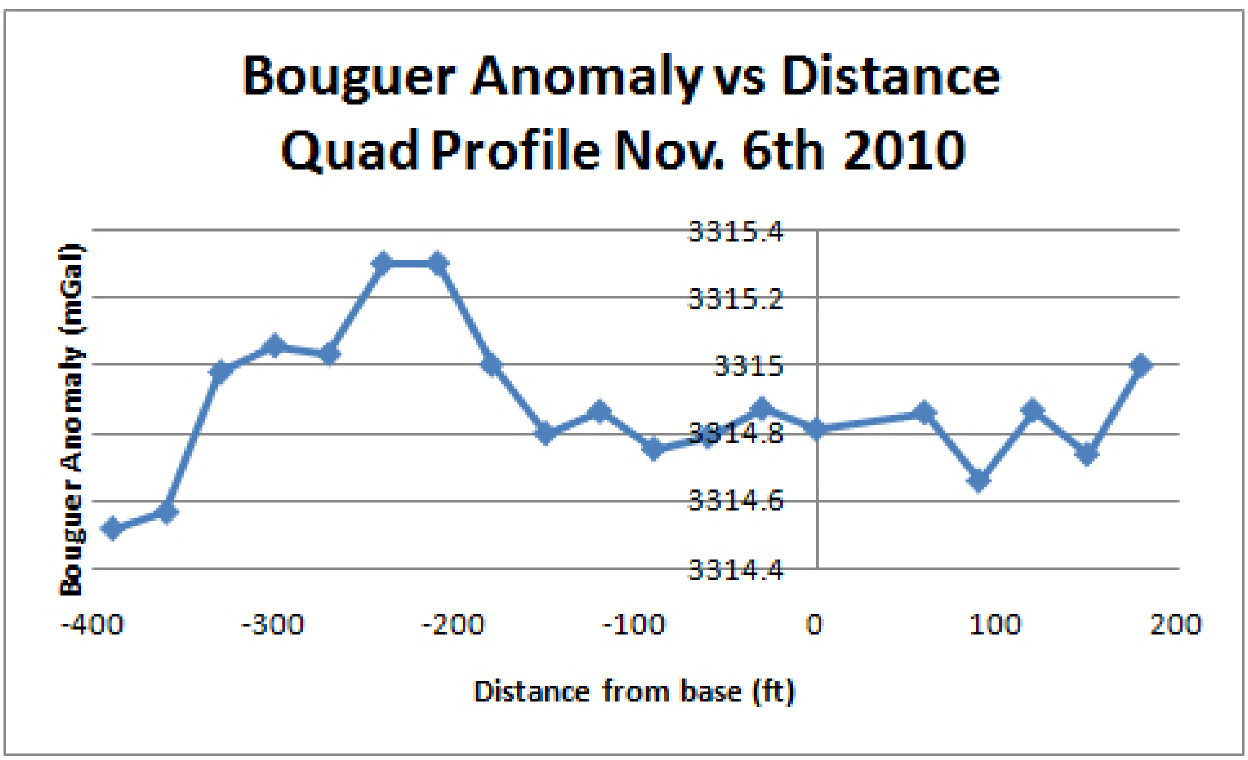
Graph 9: Shows the Bouguer Anomaly for the Quad Profile with an assumed density value of 3.0 g/cm^3.



Graph 10: Shows the Bouguer Anomaly for the Quad Profile with an assumed density value of 5.0 g/cm^3.



Graph 11: Shows the Bouguer Anomaly for the Quad Profile with an assumed density value of 10.0 g/cm^3.



Graph 12: Shows the Bouguer Anomaly for the Quad Profile with an assumed density value of 15.0 g/cm^3.

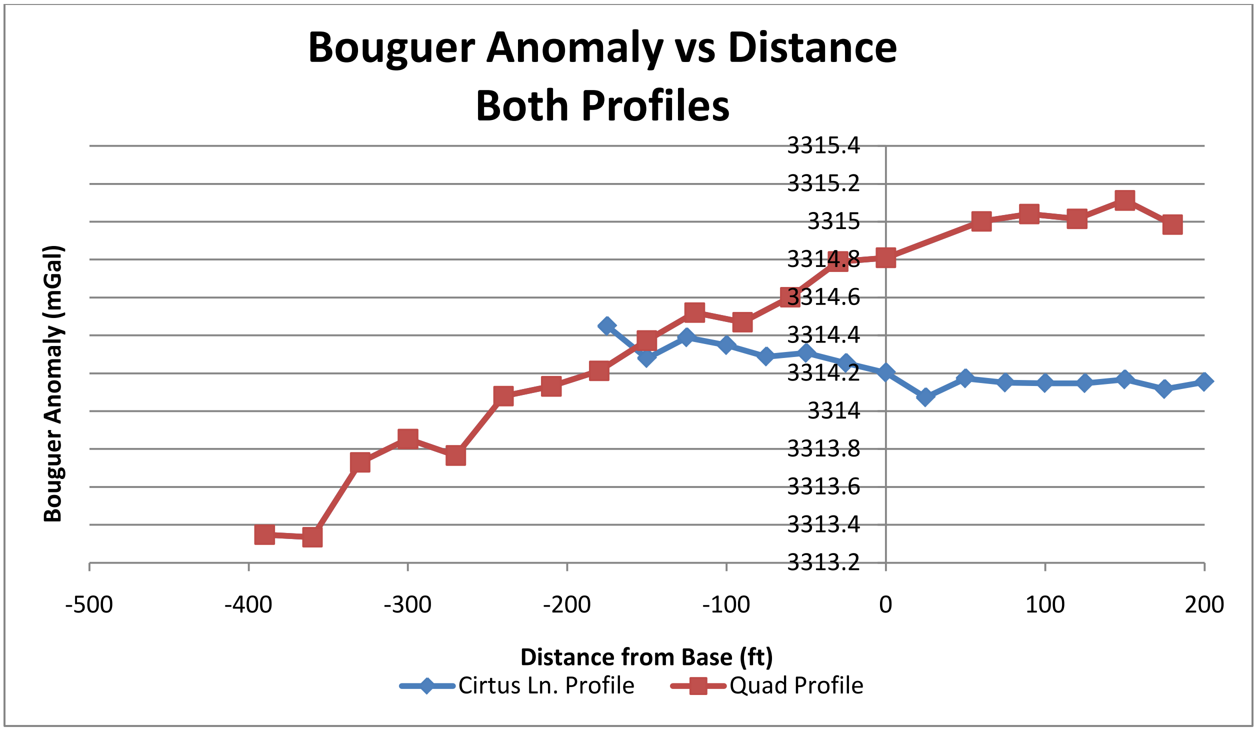
If the San Jose Fault is a reverse fault, we expect to see a flat portion, a rise from left to right, should be an increase in gravitation acceleration when moving towards the hanging wall, followed by another flat portion in our profiles (Figure 1). We expect this because the deeper layers are moved upwards, and the shallower material eventually eroded. So, more dense material on the up thrown side of the fault will be closer to the surface than the material on the other side of the fault. Higher gravity values are detected on the up thrown side of the fault.

The quad profile shows a density contrast that would be expected with a reverse fault through this area. However, the Citrus Lane profile is not what would be expected from a reverse fault (Graph 13). This potentially means that the fault does not run through Citrus Lane as suggested by the GeoCon geotechnical report.

Conclusions

Further gravity experiments need to be conducted. Profiles need to be able to potentially measure the complete gravity profile across the fault. More areas of the campus should be covered by gravimeter surveys.

Overall, the gravity surveys show what we would expect to see as a reverse fault in the Quad area, but not what we would expect to see in the Citrus Ln. Profile. The San Jose fault may trend in a more oblique fault trace in some areas, and more reverse trace in others. The fault may also lie in different areas of campus not suggested by the GeoCon report.



Graph 13: Shows the Bouguer anomaly in milligals for the Citrus Lane profile (blue) and the Quad Profile (red). A stronger signal is seen in the Quad Profile.

Appendix 1 – Gravimeter Calibration Sheet

MILLIGAL VALUES FOR LACOSTE & ROMBERG, INC. MODEL G GRAVITY METER #G- 423

COUNTER READING*	VALUE IN MILLIGALS	FACTOR FOR INTERVAL	COUNTER READING*	VALUE IN MILLIGALS	FACTOR FOR INTERVAL
000	000.00	1.06033			
100	106.03	1.06003	3600	3815.00	1.06114
200	212.04	1.05982	3700	3921.12	1.06129
300	318.02	1.05967	3800	4027.25	1.06144
400	423.99	1.05955	3900	4133.39	1.06160
500	529.94	1.05946	4000	4239.55	1.06172
600	635.89	1.05938	4100	4345.72	1.06184
700	741.82	1.05931	4200	4451.91	1.06194
800	847.76	1.05926	4300	4558.10	1.06203
900	953.68	1.05921	4400	4664.30	1.06212
1000	1059.60	1.05918	4500	4770.52	1.06219
1100	1165.52	1.05916	4600	4876.74	1.06226
1200	1271.44	1.05916	4700	4982.96	1.06233
1300	1377.35	1.05917	4800	5089.19	1.06240
1400	1483.27	1.05918	4900	5195.43	1.06245
1500	1589.19	1.05921	5000	5301.68	1.06251
1600	1695.11	1.05925	5100	5407.93	1.06256
1700	1801.03	1.05929	5200	5514.19	1.06262
1800	1906.96	1.05934	5300	5620.45	1.06266
1900	2012.90	1.05939	5400	5726.71	1.06274
2000	2118.84	1.05945	5500	5832.99	1.06276
2100	2224.78	1.05950	5600	5939.26	1.06272
2200	2330.73	1.05956	5700	6045.54	1.06263
2300	2436.69	1.05962	5800	6151.80	1.06253
2400	2542.65	1.05971	5900	6258.05	1.06241
2500	2648.62	1.05977	6000	6364.29	1.06230
2600	2754.60	1.05987	6100	6470.52	1.06216
2700	2860.58	1.05997	6200	6576.74	1.06201
2800	2966.58	1.06008	6300	6682.94	1.06185
2900	3072.59	1.06021	6400	6789.13	1.06169
3000	3178.61	1.06033	6500	6895.29	1.06152
3100	3284.64	1.06046	6600	7001.45	1.06133
3200	3390.69	1.06059	6700	7107.58	1.06116
3300	3496.75	1.06072	6800	7213.70	1.06099
3400	3602.82	1.06085	6900	7319.79	1.06080
3500	3708.90	1.06100	7000	7425.87	

* Note: Right-hand wheel on counter indicates approximately 0.1 milligal.

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Appendix 1: Calibration sheet used to correct meter readings from the gravimeter to dial readings.

Appendix 2 – Citrus Lane Profile Data Sheet

Citrus Ln. Profile Feb. 13th, 2011

Point Name	Elevation (m)	Elevation Difference (m)	Counter Reading	Dial Reading	Meter Reading	Gravimeter (mGal)	Free air Correction (mGal)	Free air Anomaly (mGal)	Bouguer Correction (mGal)	Bouguer Anomaly (mGal)	Distance from base (ft)
2	1000.056	-0.424	31320	9.6	3131.96	3318.532302	-0.130846	3318.401	-0.0474681	3318.449	-175
3	1000.058	-0.422	31318	8	3131.80	3318.362628	-0.130229	3318.232	-0.0472442	3318.28	-150
4	1000.077	-0.403	31319	9	3131.90	3318.468674	-0.124366	3318.344	-0.0451171	3318.389	-125
5	1000.083	-0.397	31319	8.6	3131.86	3318.426256	-0.122514	3318.304	-0.0444454	3318.348	-100
6	1000.101	-0.379	31318	8	3131.80	3318.362628	-0.116959	3318.246	-0.0424302	3318.288	-75
7	1000.142	-0.338	31318	8.1	3131.81	3318.373233	-0.104307	3318.269	-0.0378401	3318.307	-50
8	1000.304	-0.176	31317	7.3	3131.73	3318.288396	-0.054314	3318.234	-0.0197037	3318.254	-25
9(base)	1000.48	0	31317	6.5	3131.65	3318.203559	0	3318.204	0	3318.204	0
10	1000.729	0.249	31315	4.8	3131.48	3318.023281	0.0768414	3318.1	0.02787632	3318.072	25
11	1000.97	0.49	31315	5.3	3131.53	3318.076304	0.151214	3318.228	0.05485702	3318.173	50
12	1001.235	0.755	31314	4.6	3131.46	3318.002072	0.232993	3318.235	0.08452459	3318.151	75
13	1001.545	1.065	31314	4	3131.40	3317.938444	0.328659	3318.267	0.11923005	3318.148	100
14	1001.866	1.386	31313	3.4	3131.34	3317.874816	0.4277196	3318.303	0.155167	3318.147	125
15	1002.129	1.649	31313	3.1	3131.31	3317.843003	0.5088814	3318.352	0.18461066	3318.167	150
16	1002.461	1.981	31312	2	3131.20	3317.726352	0.6113366	3318.338	0.22177909	3318.116	175
17	1002.869	2.389	31312	1.6	3131.16	3317.683934	0.7372454	3318.421	0.26745596	3318.154	200

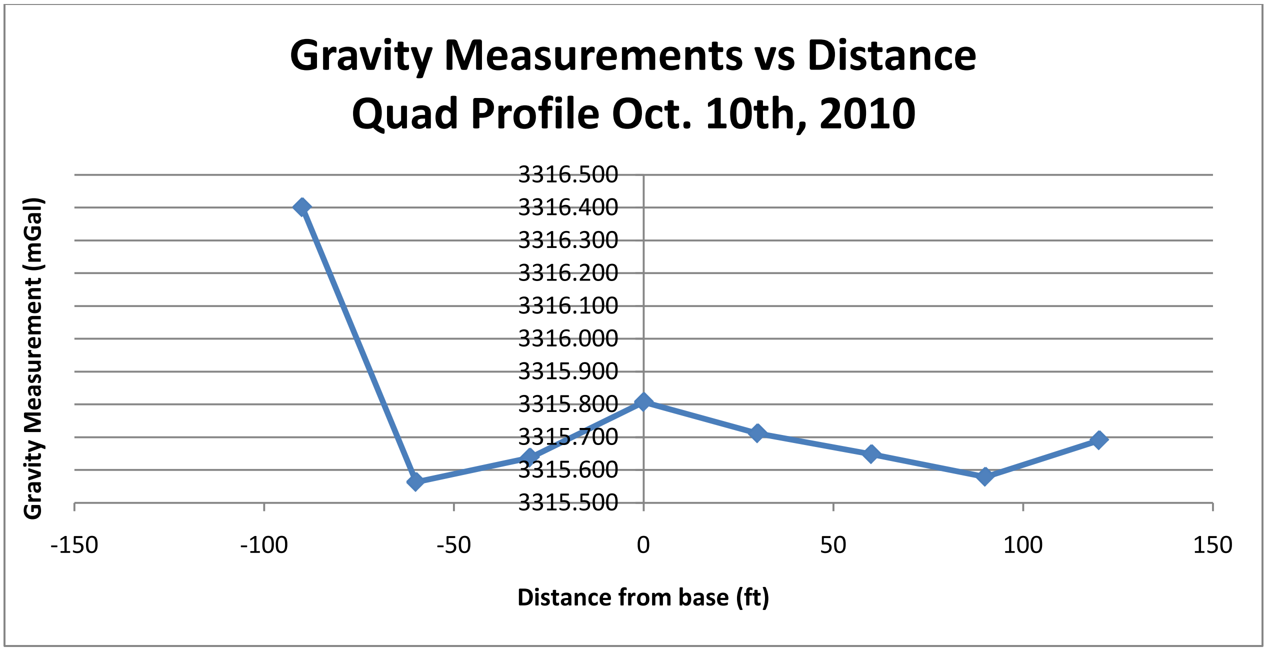
Table 2: Shows the gravity values and corrections made to obtain the Bouguer correction for the Citrus Ln. Profile. The first point we marked for measurement was near a sewage pipe, so we did not measure it because the pipe might interfere in with gravity signals.

Appendix 3 – Other Quad Profiles and Tables from Pazos, 2011

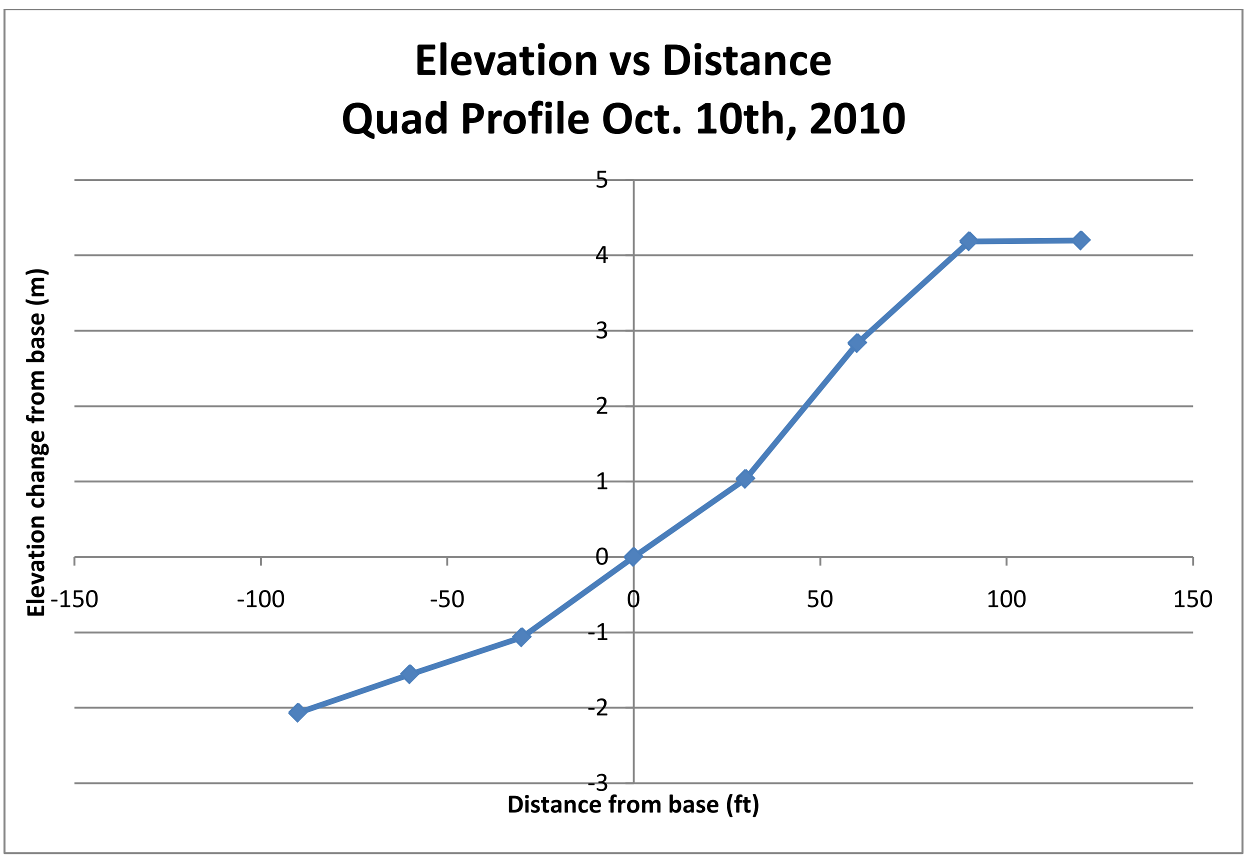
Quad Profile Oct. 10th, 2010

Point Name	Elevation (m)	Elevation Change (m)	Counter Reading	Dial Reading	Meter Reading	Gravity (mGal)	Free-Air Correction (mGal)	Free Air Anomaly (mGal)	Bouguer Correction (mGal)	Bouguer Anomaly (mGal)	Distance from base (ft)
Base	999.565	0	31294	4.2	3129.42	3315.839	0.000	3315.839	0.000	3315.839	
Base	999.565	0	31294	4.2	3129.42	3315.839	0.000	3315.839	0.000	3315.839	
Base	999.565	0	31294	3.9	3129.39	3315.807	0.000	3315.807	0.000	3315.807	
1	997.5	-2.065	31290	9.5	3129.95	3316.401	-0.637	3315.764	-0.231	3315.995	-90
2	998.01	-1.555	31291	0.6	3129.16	3315.563	-0.480	3315.083	-0.174	3315.257	-60
3	998.5	-1.065	31292	2.3	3129.23	3315.637	-0.329	3315.309	-0.119	3315.428	-30
Base	999.565	0	31294	3.9	3129.39	3315.807	0.000	3315.807	0.000	3315.807	0
4	1000.6	1.035	31293	3	3129.3	3315.711	0.319	3316.031	0.116	3315.915	30
5	1002.4	2.835	31292	2.4	3129.24	3315.648	0.875	3316.523	0.317	3316.205	60
6	1003.75	4.185	31291	1.75	3129.175	3315.579	1.291	3316.870	0.469	3316.402	90
7	1003.76	4.195	31293	2.8	3129.28	3315.690	1.295	3316.985	0.470	3316.515	120

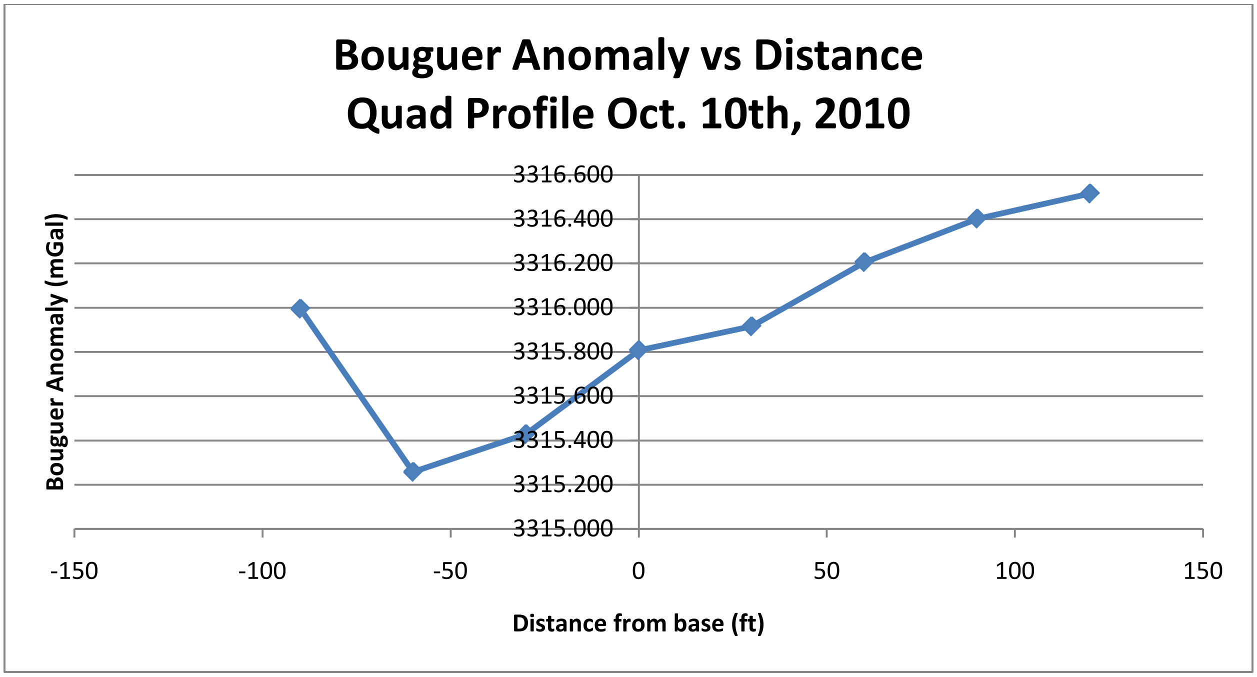
Table 3: Shows the gravity values and corrections made to obtain the Bouguer correction for the Quad Profile (profile 1 on Map 3).



Graph 14: Shows the raw gravity measurements in milligals versus distance from the base for the Quad profile (profile 1 on map 3).



Graph 15: Shows the elevation change from the base versus distance from the base for the Quad profile (profile 1 on map 3).

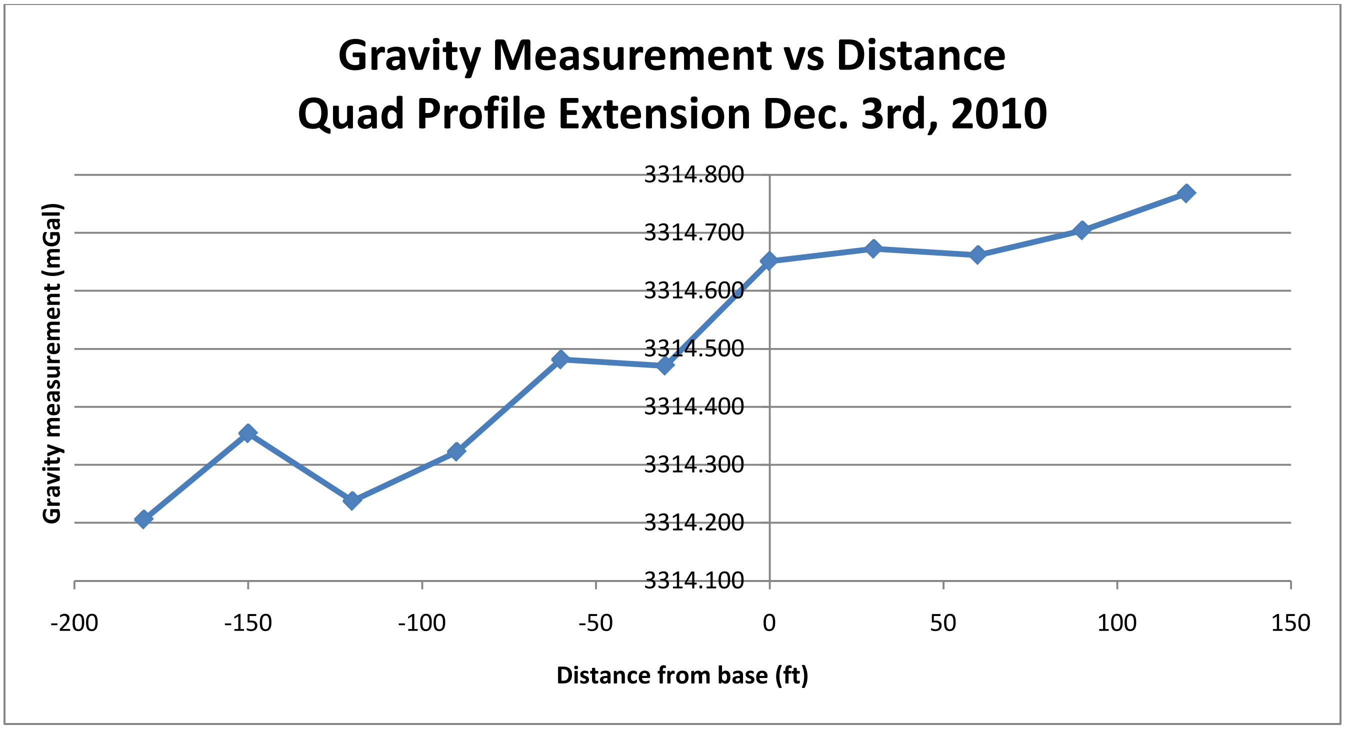


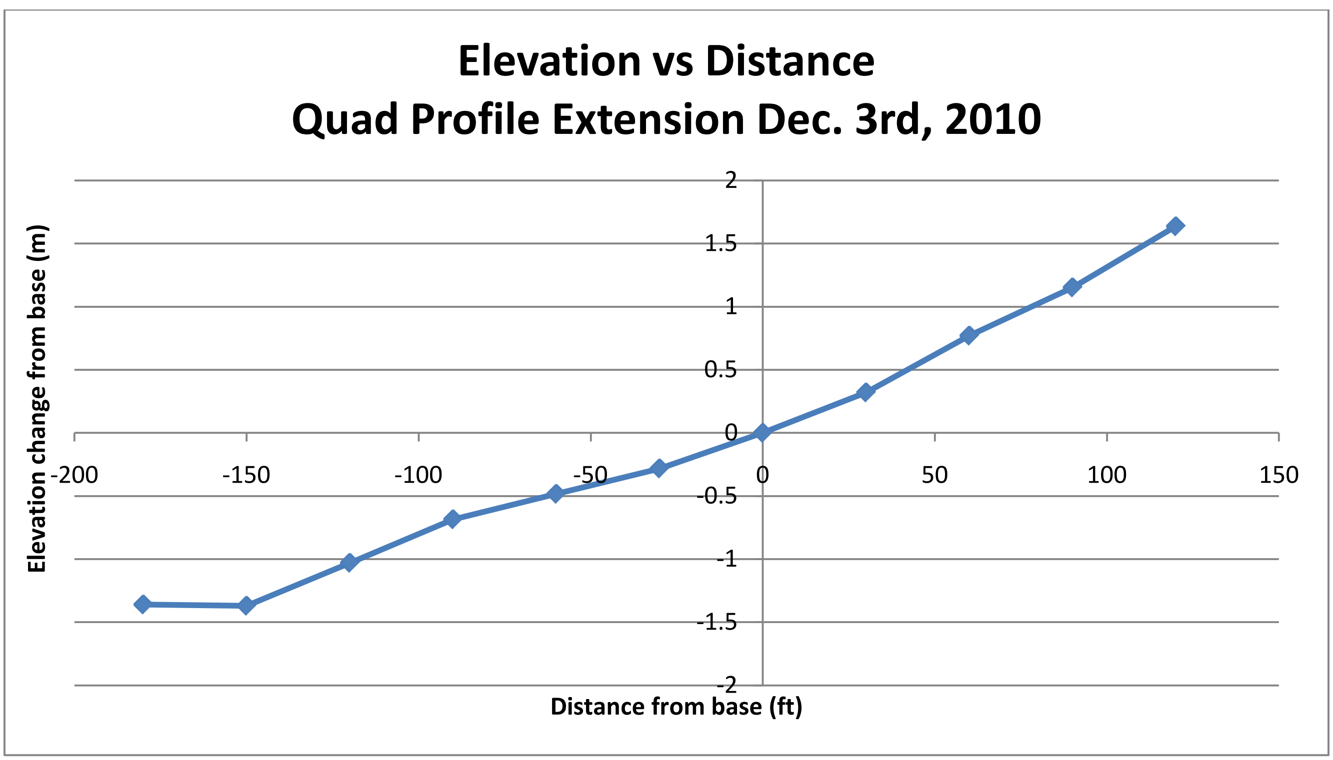
Graph 16: Shows the Bouguer Anomaly in milligals versus distance from the base for the Quad profile (profile 1 on map 3).

Quad Profile Extension Dec. 3rd, 2010

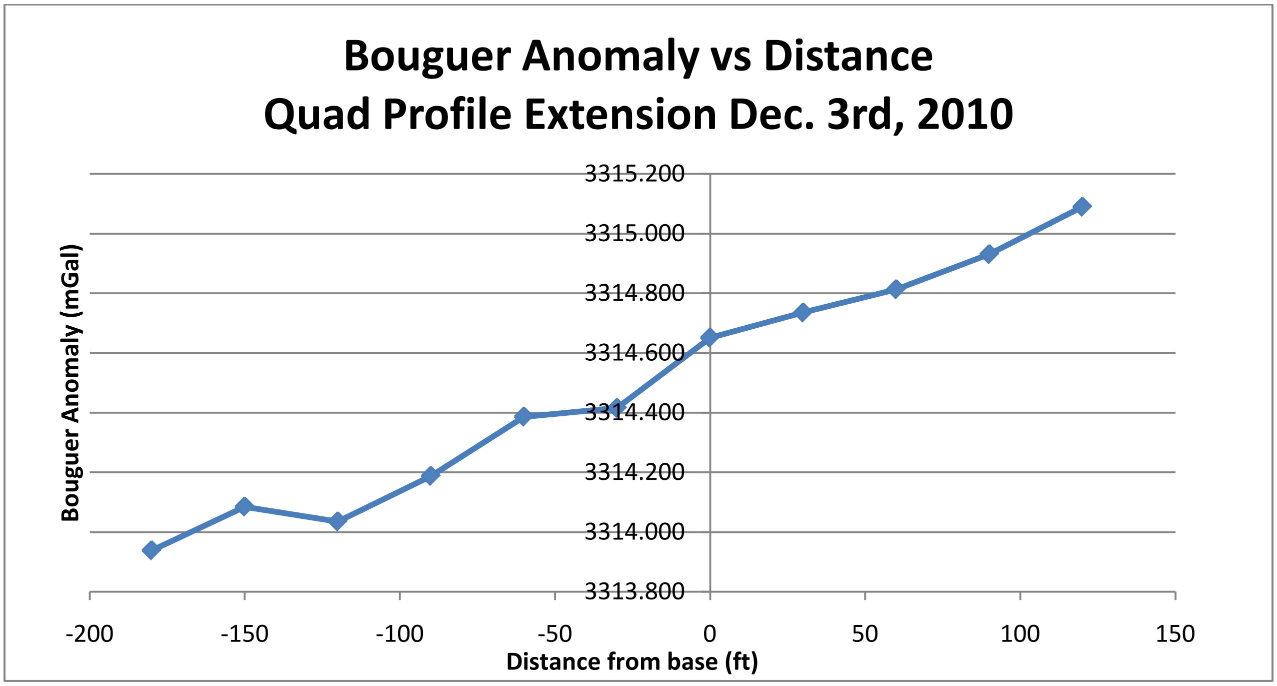
Point Name	Elevation (m)	Elevation Difference(m)	Counter Reading	Dial Reading	Meter Reading	Gravity (mGal)	Free Air Correction (mGal)	Free Air Anomaly (mGal)	Bouguer Correction (mGal)	Bouguer Anomaly (mGal)	Distance from base (ft)
Base	997.89	0	31282	2.1	3128.21	3314.556	0.000	3314.556	0.000	3314.556	
Base	997.89	0	31283	3	3128.3	3314.651	0.000	3314.651	0.000	3314.651	
Base	997.89	0	31282	2.7	3128.27	3314.619	0.000	3314.619	0.000	3314.619	
1	999.526	1.636	31284	4.1	3128.41	3314.768	0.505	3315.273	0.183	3315.089	120
2	999.042	1.152	31284	3.5	3128.35	3314.704	0.356	3315.060	0.129	3314.931	90
3	998.66	0.77	31283	3.1	3128.31	3314.662	0.238	3314.899	0.086	3314.813	60
4	998.21	0.32	31283.0	3.2	3128.3	3314.672	0.099	3314.771	0.036	3314.735	30
5 (base)	997.89	0	31283	3	3128.3	3314.651	0.000	3314.651	0.000	3314.651	0
6	997.608	-0.282	31281	1.3	3128.13	3314.471	-0.087	3314.384	-0.032	3314.415	-30
7	999.021	-0.4835	31281	1.4	3128.14	3314.481	-0.149	3314.332	-0.054	3314.386	-60
8	997.205	-0.685	31279	9.9	3127.99	3314.322	-0.211	3314.111	-0.077	3314.188	-90
9	996.86	-1.03	31279	9.1	3127.91	3314.237	-0.318	3313.920	-0.115	3314.035	-120
10	996.52	-1.37	31280	0.2	3128.02	3314.354	-0.423	3313.931	-0.153	3314.085	-150
11	996.53	-1.36	31278	7.8	3127.88	3314.206	-0.420	3313.786	-0.152	3313.938	-180

Table 4: Shows the gravity values and corrections made to obtain the Bouguer correction for the Quad Extension Profile (profile 2 on Map 3). The highlighted number is because of an elevation inaccuracy. An elevation between the elevation above and elevation below was used.





Graph 18: Shows the elevation change from base versus distance from the base for the Quad profile (profile 2 on map 3).



Graph 19: Shows the Bouguer Anomaly in milligals versus distance from the base for the Quad profile (profile 2 on map 3).

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