Reduction of 2025 Gravity Data

Gavity data collected in the Mt. Soledad region have been put on the web page in a form that allows cut and pasting into a data file that can be `'load'`ed into Matlab (Matlab will ignore all the lines starting with '%').

The data files have 11 columns:

1. Entry number: this allows you to work out how to index the data to isolate each survey.
2. Station ID. For benchmarks these are the city's numbers, for other sites a negative number.
3. Latitude.
4. Longitude.
5. Height, in feet, from the city data base, except for negative ID, which are other estimates in feet.
6. Northing, in units of 100 feet, from the city database.
7. Easting, ditto.
8. Measurement time, whole hours.
9. Measurement time, closest minute.
10. Meter reading, gravimeter units.
11. Raw gravity, mgals, for previous years, and NaN for this year.

Previous year's data, with calibration and drift corrected, is in `gravity2025.txt`, The last entries are this year's data, for which column 11 has been flagged with NaNs. The first thing you need to do is replace these NaNs with raw gravity corrected for drift over the survey. That is, the value at Zumberge's lab should be zero for the two readings there.

Step 1: Correct data for meter calibration and drift.

1) Load the file `gravity2025.txt`. The 2025 survey was done with meter number CG-5 1305-41089 (owned by Dr. Mark Zumberge). The meter readings are already in milligals – no calibration is needed for this new meter.

2) Remove the drift from the observed 2025 data. First subtract the first base station reading from the entire 2025 survey to make the first base station 0.00 milligals. Then take the second base station reading and the time difference between base station readings, and use a linear relationship to correct all the measurements. When you are done, the final base station reading should be the same as the first one (i.e. zero). (If this bothers you, the absolute gravity in Mark's lab has been measured at 979531.59 mgals.)

3) Replace the NaNs with your computed values, and add your new data to the master data base.

Step 2: Compute free air gravity for the entire data base.

1) Make the latitude correction. You can't use the northings given by the city, since we don't have these for every station, so you need to use the latitudes themselves. At a latitude of 32.83° each degree of latitude corresponds to 110.901 km (based on the reference ellipsoid). (And 93.632 km/deg longitude if you want that too.) It might be easiest to make the Zumberge lab equal to zero kilometers north. Or you could compute the average latitude of the survey. Or you could use the international gravity formula, but make sure you carry enough precision. Note that in 2015 we had trouble collecting entry number 153 and it is very noisy – I have used a NaN to remove this data point.

2) Convert elevations from feet to meters.

3) Correct the gravity for elevation. This is *free-air gravity*.

Step 3: Compute Bouguer gravity.

1) Make the Bouguer corrections for all the sites, using your Bouguer density from Nettleton's method (Assignment 2).

2) Store these data as columns of longitude, latitude, and Bouguer gravity. Call this file `processedgravity2025.txt`. Here is one way of doing that:

```
data =[ grav.lon grav.lat grav.dat ];
save ('processedgravity2025.txt', 'data', '-ascii')
```

Step 4: Make a color map of gravity.

See the script on the website `PlotGrav.m`. This will read your processed gravity and make a nice plot.

Step 5: Model the gravity assuming a buried fault.

Load the data file `FaultData.txt`, which was derived by rotating the data set clockwise 40 degrees and averaging in 250 m bins across the middle of the fault. Plot it up (using symbols, which is usually best for data).

Using your fault modeling script, or the one I have provided (fault.m), fit the data as best you can. You will need a density contrast – I suggest the average crustal density minus the Bouguer density derived above. The throw can be computed from the Bouguer formula. You will need to add a constant to match the Bouguer gravity on the low side of the fault, and also an offset to match the position of the fault. The depth needs to be obtained by matching the slope of the data across the fault.

Step 6: Write everything up for the report. See the introductory notes.