# Regional Gravity Terrain Corrections: examples from South Australia

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## SUMMARY

Traditional Bouguer corrections assume that the Earth behaves as a flat slab (Bouguer reduction), an assumption that is incorrect. A more accurate method of removing the effects of an Earth model is to take into account the terrain information, and assume a curved Earth. Terrain corrections are becoming more commonplace in individual surveys as computer power increases. We have produced a regional (state-wide) scale terrain-corrected gravity grid, using a 1-second DEM to calculate the correction. The correction adds a subtle change to the state wide gravity, removing some regional lows. It can be used as a simple visual tool to determine where terrain corrections are more appropriately undertaken.

**Key words:** Gravity, Terrain Correction, Regional geophysics

## INTRODUCTION AND METHOD

The acceleration due to gravity is a measureable quantity that varies depending on the distribution of mass around the measurement point. This fact is used to build up a picture of density distribution of the materials that make up the Earth. Gravity data measured at the surface of the Earth varies from around 9.78 to 9.83 m/s2 (Sheriff 2002), but in order to understand the geology we need to undertake a series of corrections to the data to remove artefacts corresponding to other sources.

One of these corrections is called a Bouguer correction and it is used to reduce gravity values to a common datum (such as sea level). The Bouguer correction is built on the assumption that the Earth is a flat slab. This assumption is incorrect (Lane 2009), and a more accurate method would be to take into account the surrounding topography (a Terrain Correction). Modern software also allows the user to correct for a curved Earth. These corrections are computationally intensive but can be undertaken employing the use of DEM grids.

In the past, terrain corrections have often been ignored in individual gravity surveys as the difference between the Bouguer corrected and Terrain corrected gravity can be minimal, and the computations required are time-intensive. However, it is becoming more commonplace to undertake these corrections. One purpose of this paper is to demonstrate the effect of a terrain correction on the South Australian gravity data-set.

One requirement of any terrain correction procedure is the use of the best resolution terrain model possible. Primary Industries and Resources South Australia (PIRSA) have access to a 1 second resolution Digital Elevation Model (DEM) which equates to approximately a 30 metre resolution. The PIRSA gravity database includes Australian Height Datum (AHD) elevations for all gravity measurements in SA, so it is possible to calculate terrain corrected gravity values over the entire state.

Previously the terrain correction has been calculated for the entirety of Australia (Kuhn *et al.* 2009). However, this previous work used a 9 second DEM, which is equivalent to approximately 250 metre resolution.

RasterTC and Intrepid software were tested to calculate the correction, although other software exists that can perform the calculations.

Replacing the Infinite Slab with a Spherical Cap, assuming an Earth density of 2.67 g/cc, 5 calculation rings and with primary cell size of 30m, we were able to choose between using elevations from the measurement points, or elevations calculated from the DEM. Both methods were experimented with.

Using elevations from the gravity readings is beneficial in areas where accurate elevations are available, but will introduce errors in areas where the elevations are inaccurate. Using elevations from the DEM will produce smoother results where gravity elevations are inaccurate but may remove detail where the actual elevation is known.

The terrain correction is calculated from terrain information only; no gravity values are needed. As a result the output needs to be added to a Bouguer correction to obtain the final terrain corrected gravity. This is convenient as it allows us to analyse the statistics of the terrain correction separately.

To illustrate the results, we have used a gridding method described by Heath *et al.* (2010). This involves dividing the gravity data into groups based on survey quality and data density. Each group is gridded to its optimal pixel size, and then all the grids are merged together. Newer, higher quality surveys are merged above the lower quality data. It allows a more accurate representation of variably spaced data.

## RESULTS

When using the elevation data from the gravity values, the maximum terrain correction is around 40mGals. The average is about 0.25mGals with a standard deviation of about 0.47mGals.

When we repeat the calculation using elevation information interpolated from the DEM the results are noticeably different. The maximum terrain correction is about 3.2mGals with an average of -0.17mGal and standard deviation of 0.2mGal. Ultimately this is the data set that we have added to the simple Bouguer Correction to give the final total corrected gravity. Figure 1 shows this terrain correction as a grid of the state.

Figure 2 shows a comparison between the simple Bouguer corrected gravity (a) and the full Bouguer corrected gravity including the terrain correction (b) for an area north of Port Augusta in South Australia. The change is subtle, and the most change can be seen in the large gravity lows.

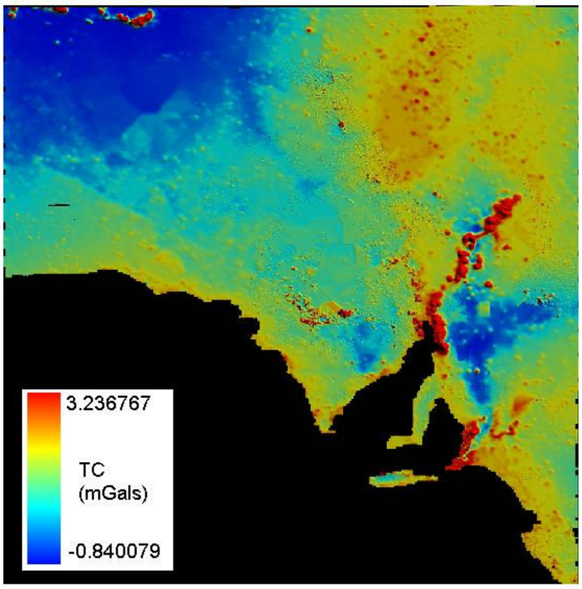


**Figure 1. An image of the terrain correction over South Australia. The image was produced using elevations from the 1-second DEM of the state.**

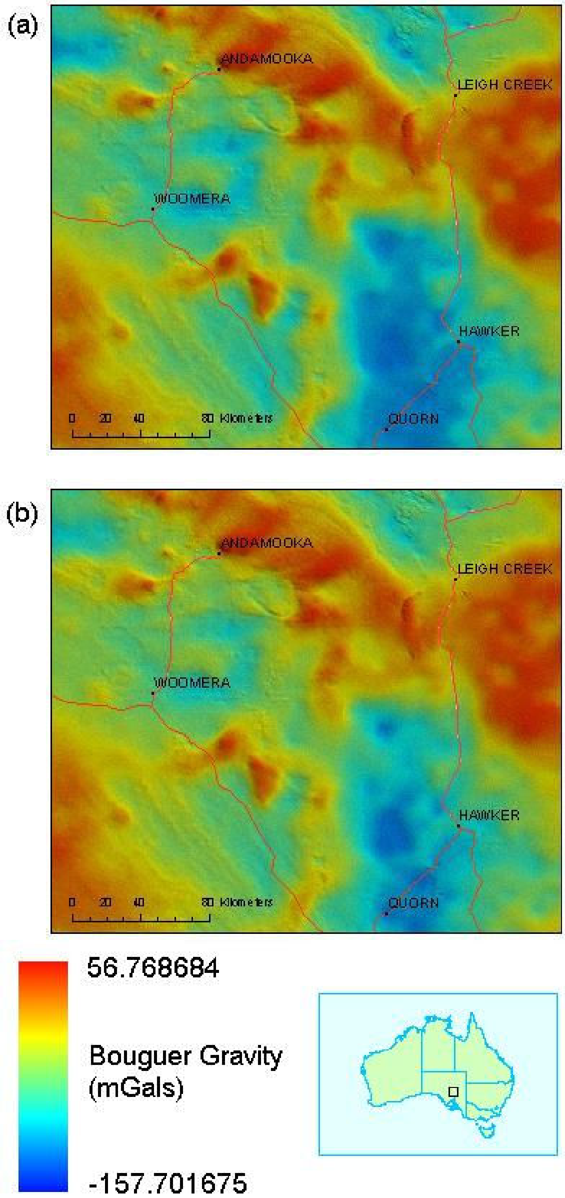


**Figure 2. A comparison of the simple Bouguer corrected gravity and total Bouguer corrected gravity (including terrain correction) over a portion of South Australia north of Port Augusta.**

## CONCLUSIONS

The terrain corrected image of South Australia shows little difference to the current Bouguer corrected image. However, there are areas in the state that dictate that a terrain correction is a necessary part of regular processing procedure.

The map of South Australia (Figure 1) illustrates areas where it is more important to undertake Terrain Corrections for future gravity surveys.

The new South Australian terrain corrected gravity grid is obtainable using the South Australian Resources Information Geoserver (SARIG, sarig.pir.sa.gov.au).

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