2011 CSPG CSEG CWLS Convention

Advances in SGL AIRGrav Acquisition and Processing

Luise Sander*
Sander Geophysics, 260 Hunt Club Road, Ottawa, Ontario, K1V 1C1 Canada
luise@sgl.com
and
Stephen Ferguson
Sander Geophysics

Abstract

Sander Geophysics (SGL) has operated its AIRGrav airborne gravity system for over ten years and continues to work to improve the accuracy and resolution of the entire system. Recent advances in SGL's gravity data processing methods, involving advanced analysis of system dynamics and improved filtering, have enhanced the gravity data. These new processing procedures help to further reduce system noise and allow high quality, low noise raw gravity data to be acquired through a wider range of survey conditions than was previously possible. New data processing techniques have also allowed the extraction of the horizontal gravity components of the airborne gravity data in addition to the traditionally used scalar gravity measurement.

Introduction

Airborne gravity data have been collected since the late 1950’s (Thompson and LaCoste, 1960). In the late 1990’s, improvements in GPS processing and the introduction of a new gravity instrument, the AIRGrav system (Argyle et al., 2000), resulted in a significant reduction in airborne gravity noise levels. To date, more than 1,500,000 line km of AIRGrav data have been collected on surveys flown throughout the world.

Processing

The AIRGrav system uses three orthogonal accelerometers, mounted on a three-axis, gyroscopically stabilized platform in conjunction with a specialized data acquisition system to monitor and record the data and parameters measuring gravimeter performance. In this paper, ‘standard' airborne gravity data processing refers to a sequence of processing steps that includes the subtraction of the vertical accelerations of the aircraft that are measured using high quality differentially corrected GPS data from the vertical accelerations measured by the gravimeter, and the application of standard corrections to remove the effects of the rotation of the Earth, the movement of the platform over the globe, and terrain effects (Sander et al., 2004). Standard processing techniques have proven successful at extracting gravity data from the very dynamic aircraft environment where accelerations can reach 1 m/s^2, equivalent to 100,000 mGal. High precision differential GPS processing techniques and a robust gravimeter system have resulted in final processed gravity grids with noise estimates of 0.1 to 0.3 mGal with a resolution of 2 kilometres. A processing procedure, which we will call ‘enhanced' data processing, involving advanced analysis and improved filtering, has been added to the data processing stream to lower the noise and improve the resolution of the gravity data.

Hydrocarbon Exploration Project, Africa

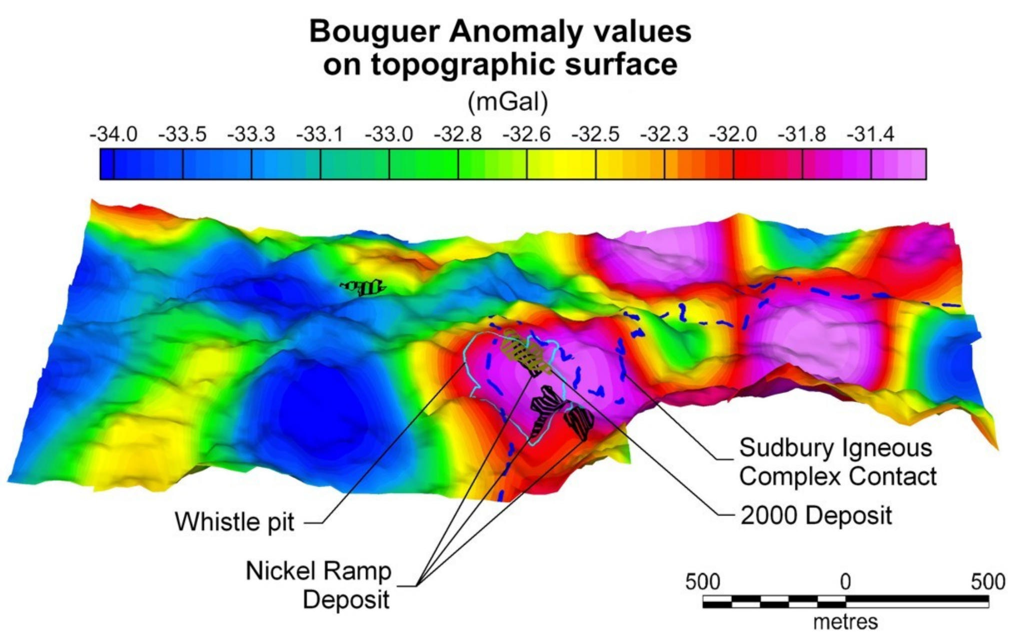
An airborne survey for hydrocarbon exploration was flown using the AIRGrav system installed in one of SGL's Cessna Grand Caravans. Data from this project were processed using the standard technique as well as the enhanced processing method, allowing a direct comparison to be made using the two resulting data sets.

On this project, a repeat test line was flown before and after each flight. An average test line response was computed by combining the data from each test line filtered using a 56 second line filter to create an "air truth" value for the test line in the manner described by Elieff and Ferguson, (2008). The RMS error for each individual test line was then calculated based on the difference in response for this pass along the test line and the average response. These calculations were repeated for data processed both in the standard and enhanced methods. The line data processed using the enhanced method shows better repeatability for all test lines. The average standard deviation for the test lines processed using standard processing was 1.26 mGal, whilst it was 1.08 mGal for the test lines processed using the enhanced method.

Helicopter-mounted AIRGrav system

Airborne gravity data have traditionally been used to define regional scale geology, an application for which standard acquisition parameters using a fixed wing aircraft were adequate. However there are applications where a higher resolution data set is preferable. Recently, the AIRGrav system was installed in a helicopter and six small survey blocks were flown at an extremely slow acquisition speed with tight line spacing. Scanning laser elevation data were concurrently acquired in order to create a high resolution 1 m grid cell size digital terrain model. This configuration, coupled with the enhanced processing technique, resulted in a gravity data set that met the requirements of this exploration project with an accuracy of 0.4 mGal at a 300 m resolution. Figure 1 shows the gravity data superimposed on the derived terrain model for a small region of the survey.

Figure 1: Bouguer gravity anomaly values for the helicopter-mounted AIRGrav survey of the Podolsky Mineral Exploration Project (300 m resolution gravity data).

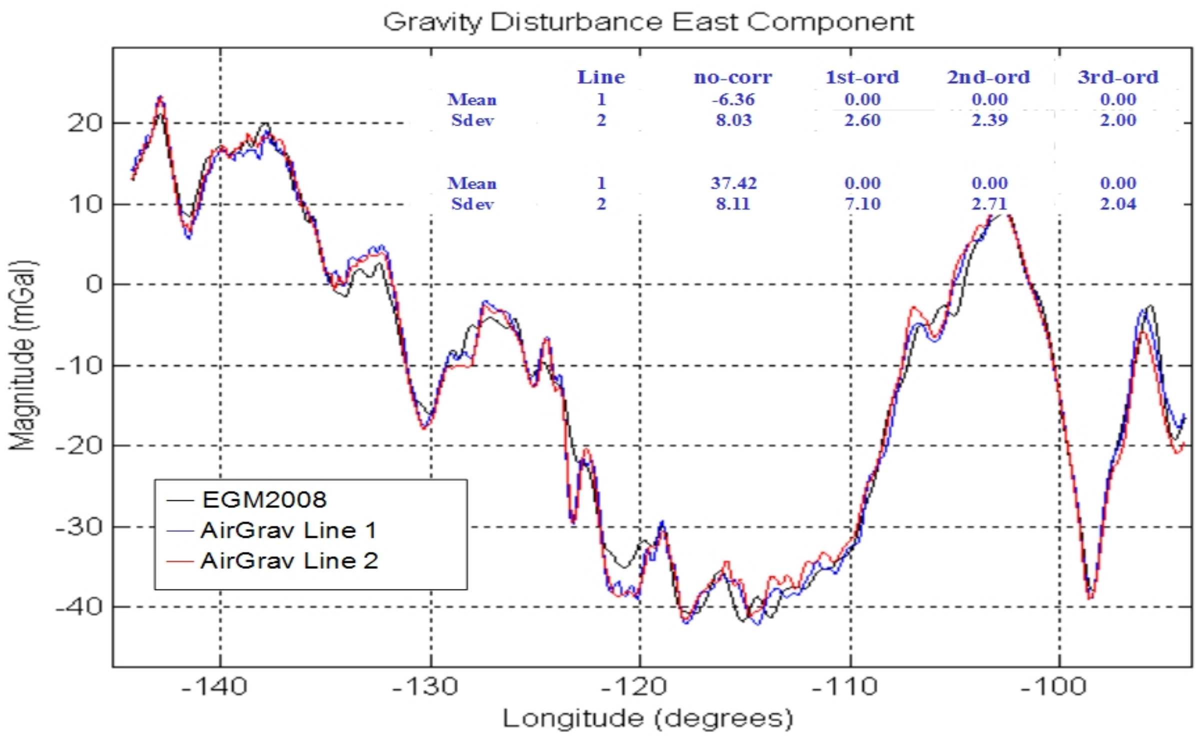


Horizontal gravity components

A repeat line was flown in two directions, each 1325 km long, acquiring AIRGrav data in NASA's DC8 as part of the ICEBRIDGE 2010 mission. Data were processed using the enhanced procedure to extract the three gravity components and compared to the EGM 2008 gravity model. The test successfully demonstrated that the three spatial components of the gravity vector can be measured with high repeatability using the AIRGrav system and that the measured horizontal components agree well with geoid models of the highest order available.

Figure 2 illustrates the gravity east component, and a comparison profile extracted from the EGM 2008 gravity model. Comparison statistics are listed for each line and after fitting the AIRGrav data to the model using a 1st, 2nd and 3rd order fit. From these results we can conclude that the AIRGrav system has repeatability better than the agreement of its estimates with the model data. The consistency of the short wavelength data in the AIRGrav data shows greater detail than the model data.

Figure 2: Gravity East Component, ICEBRIDGE Repeat Line.



Conclusions

Recent advances in SGL's gravity data processing methods have been shown to produce higher quality, lower noise gravity data. Modified survey design parameters involving the use of a helicopter rather than a fixed wing aircraft have been used to acquire data for a mineral exploration project resulting in an accuracy of 0.4 mGal at a 300 m resolution. The new processing techniques have also allowed horizontal gravity components of the airborne gravity data to be extracted.

Acknowledgements

The authors would like to acknowledge the support of the data processing team at Sander Geophysics, as well as the cooperation and generosity of Shell International Exploration and Production B.V. and FNX Mining Company Inc. for allowing the use of their data sets for this paper and presentation.

References

Argyle, M., Ferguson, S., Sander, L., and Sander S., 2000, AIRGrav results: a comparison of airborne gravity data with GSC test site data: The Leading Edge, 19, 1134-1138.

Elieff, S., Ferguson, S., 2008, Establishing the 'air truth' from 10 years of airborne gravimeter data: First Break, 26, 73-77.

Sander, S., Ferguson, S., Sander, L. and Lavoie, V., 2004, The AIRGrav airborne gravity system: In R. J. L. Lane (editor), Airborne Gravity 2004 - Abstracts from the ASEG-PESA Airborne Gravity 2004 Workshop: Geoscience Australia Record 2004/18, 49-54.

Thompson, L., and LaCoste, L., 1960 Aerial Gravity Measurements: Journal of Geophysical Research, 65, 305-322.