Compatibility of ground and airborne gravity data in the Western Australia 'Generation 2' reconnaissance gravity mapping project

by

SHD Howard

Introduction

The first Gravity Map of Australia published in 1976 by the then Australian Bureau of Mineral Resources, Geology and Geophysics (BMR) was a seminal product in Australia and the world (Anfiloff et al., 1976; BMR, 1976). More than 40 years later, the underlying 'first generation' data — mostly at 11 km station spacing — still provided the best coverage available over a substantial part of the continent.

It was not until the late 1990s that advances in technology served to bring down gravity survey costs substantially and heralded a 'second generation' of regional ground gravity surveys by Australian geological surveys at a quasi-standard station spacing of 4 km. In 2005, the Geological Survey of Western Australia (GSWA) adopted a nominal 2.5 km station spacing for its own systematic program of second-generation ground gravity surveys. Working together with Geoscience Australia (GA), coverage of the southwestern half of the state was complete by 2016.

With ground access in the north and east of the State becoming increasingly difficult, GSWA turned to the use of airborne gravity surveys after an assessment of existing datasets led to the conclusion that airborne surveys at a line spacing of 2.5 km should provide 'interpretability equivalence' with regional ground surveys on a 2.5 km grid of stations.

In June 2016, GSWA and GA contracted Sander Geophysics Limited (SGL) to conduct an airborne gravity survey with its AIRGrav system over approximately 84 000 km^2 in the east Kimberley region of Western Australia. All data and the survey operations and processing reports are contained in the GSWA data delivery package (Fig. 1; Sander Geophysics Ltd, 2017).

Further results and interpretation from that survey, and assessment of the suitability of airborne gravimetrics for capturing regional gravity data, were presented at the Australian Exploration Geoscience Conference, Sydney, 18–21 February 2018.

Compatibility of airborne and ground data

Comparisons of two airborne Bouguer anomaly profiles with coincident profiles of ground data at 1 km spacing from a 2007 survey show a match to within 1%. Grids made from both datasets demonstrate equally good correspondence.

From 18 passes during the course of the survey over a 50 km test line, the linear precision of the Bouguer gravity data after filtering with a 100-second low-pass filter is about 0.5 mGal (Fig. 2). A similar figure is obtained for the overall survey precision based on traverse tie-line intersections after final 2D spatial filtering to smooth the data to the nominal target survey spatial resolution of 5 km. This is about the same as the 'sampling precision' of regional ground surveys at 2.5 km station spacing demonstrated in an analysis of ground data from the Kauring gravity test range (Elieff, 2017).

The mean values from the test line were used to check along-line spatial resolution of the airborne data in comparison with two well-defined anomalies from ground measurements ('N' and 'B' in road data, Fig. 2a). As expected, the airborne data after filtering cannot fully resolve features less than the nominal 5 km full-wavelength resolution of the filter (Fig. 2b). This implies that apparent anomalies in the airborne data with wavelengths about 5 km must be regarded with caution if the amplitude is less than about 2.0 mGal (4 standard deviations of the precision measure of 0.5 mGal). Anomalies of amplitude greater than this are likely to be real; however, they may be the attenuated response of a narrow anomalous density contrast rather than the 'true' ground amplitude response of a broader feature. Features wider than 5 km appear to be well resolved in both amplitude (within the limits of the data precision) and wavelength. At a whole-of-survey level, the new data incorporate seamlessly into the Western Australia State gravity 400 m-cell compilation grid (Brett, 2017).

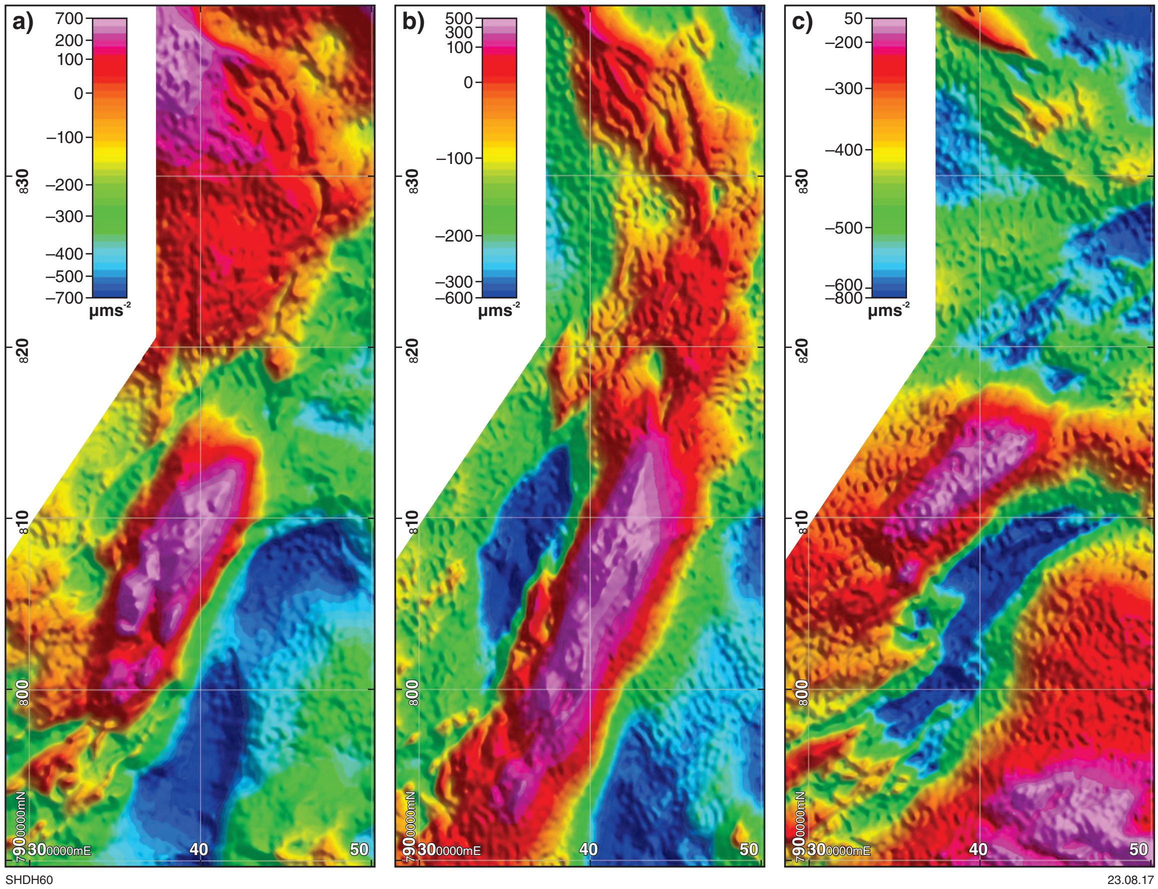

Figure 1. **East Kimberley Bouguer anomaly vector components: a) vertical; b) east; c) north. Coordinates in MGA Zone 52**

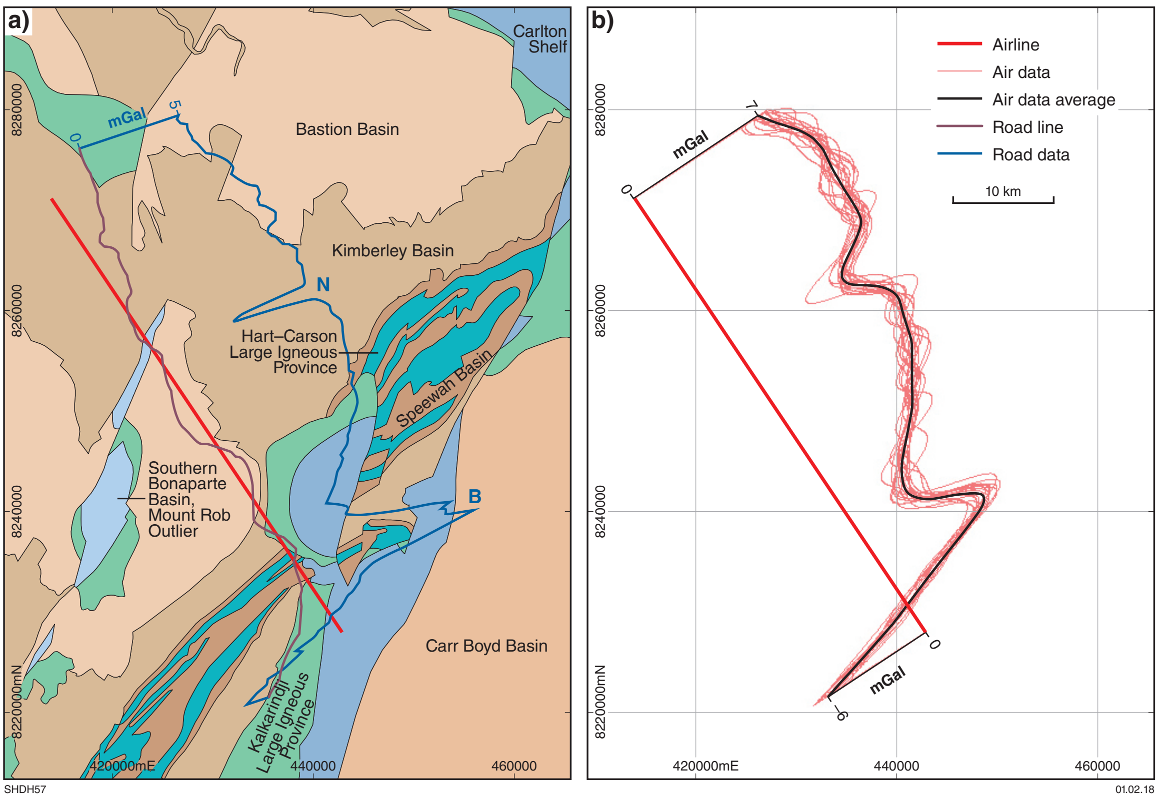

Figure 2. **a) Location of airborne test line in relation to ground traverse on local geology (for geology detail and legend see GSWA, 2016). Ground Bouguer anomaly profile with 400 m stations; b) airborne Bouguer anomaly profiles after 100 s (5000 m) filter from 18 passes (red) and average (black)**

Conclusions

By all measures, the east Kimberley survey met the expectations of both GSWA and GA to the extent that they commissioned two new aerogravity surveys in 2017: a Falcon gravity gradiometer survey over the Kidson Sub-basin for the delivery of computed vertical gravity, and a GT-2A survey over the Tanami and northeast Canning Basin. Additional surveys in the Paterson Orogen, and over the Kimberley, Gunbarrel and Officer Basins, are presently under consideration for 2018–19.

The responses tendered for the 2017 and 2018 surveys indicate that prices for large aerogravity surveys are trending downwards, so that they are becoming increasingly cost-competitive with ground surveys at this scale. If present funding levels remain, GSWA would hope to complete second-generation gravity coverage of Western Australia by 2020.

References

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