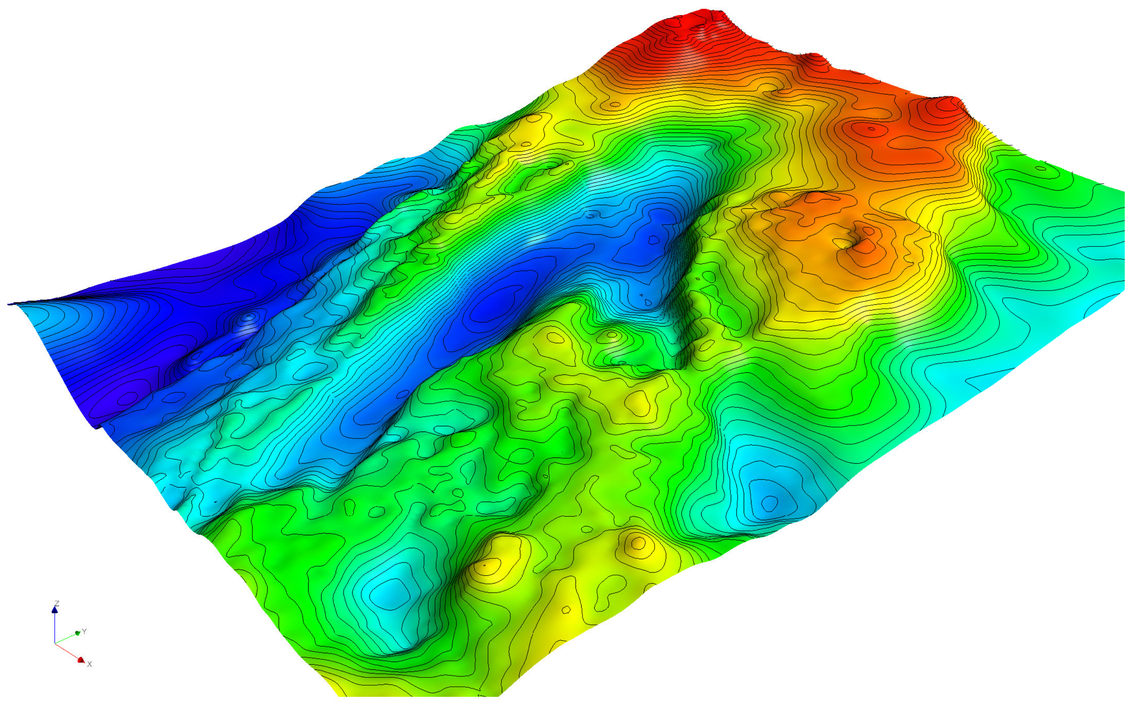
Gravity Field Expression of the Waukarlycarly Graben



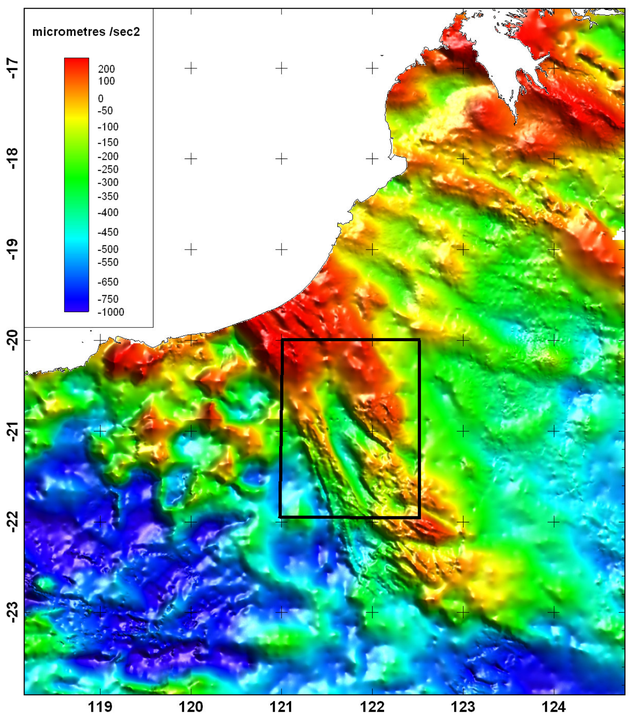
Gravity and Structure

The regional gravity variation over north-west Western Australia as imaged to the right is generated by density changes associated with variation in crustal thickness, crustal composition and thickness of sediments overlying basement. The Bouguer gravity data has been corrected for latitude and elevation effects but still include broad gradients which are the isostatic signature of major crustal structures to the north-west.

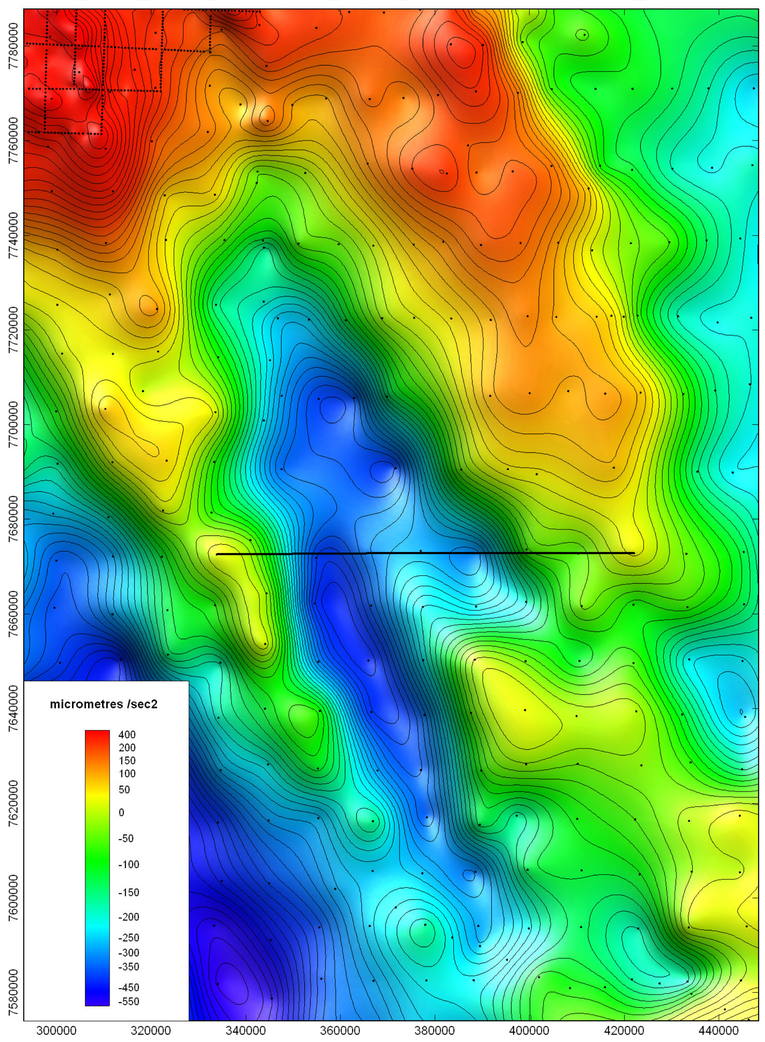
Interpretation of this gravity data essentially involves the separation and attribution of these various components of gravity variation. Information relevant to petroleum exploration which can be derived at least in part from this data are: variation in crustal thickness (important in basin history and thermal modelling studies), mapping of zones of different crustal composition and major structures (important in understanding the development and structural history of the overlying basins) and depth to basement mapping beneath the basins. Direct interpretation of gravity data is restricted to determination of subsurface density variation. These density models of the subsurface are inherently non-unique and must be constrained by independent information and geological reasoning wherever possible. Information such as the age of activation of structures or of basins imaged in the gravity data may be derived but only by indirect inference.

The inset box frames a local gravity low with sharp, linear and parallel edges of north-west to south-east trend due to the Waukarlycarly Graben. There is limited outcrop and the regional gravity and magnetic data led to the first recognition and delineation of this basin. The linear edges of the gravity low suggested that it is fault-bounded and favoured the interpretation of a basin rather than a granite. The sharp anomaly gradients require that the top of the structure is shallow. This sharpness of the anomaly also further supports a basin interpretation because granites have typical depth extents of the order of 10 km or greater and this smooths their anomalies.

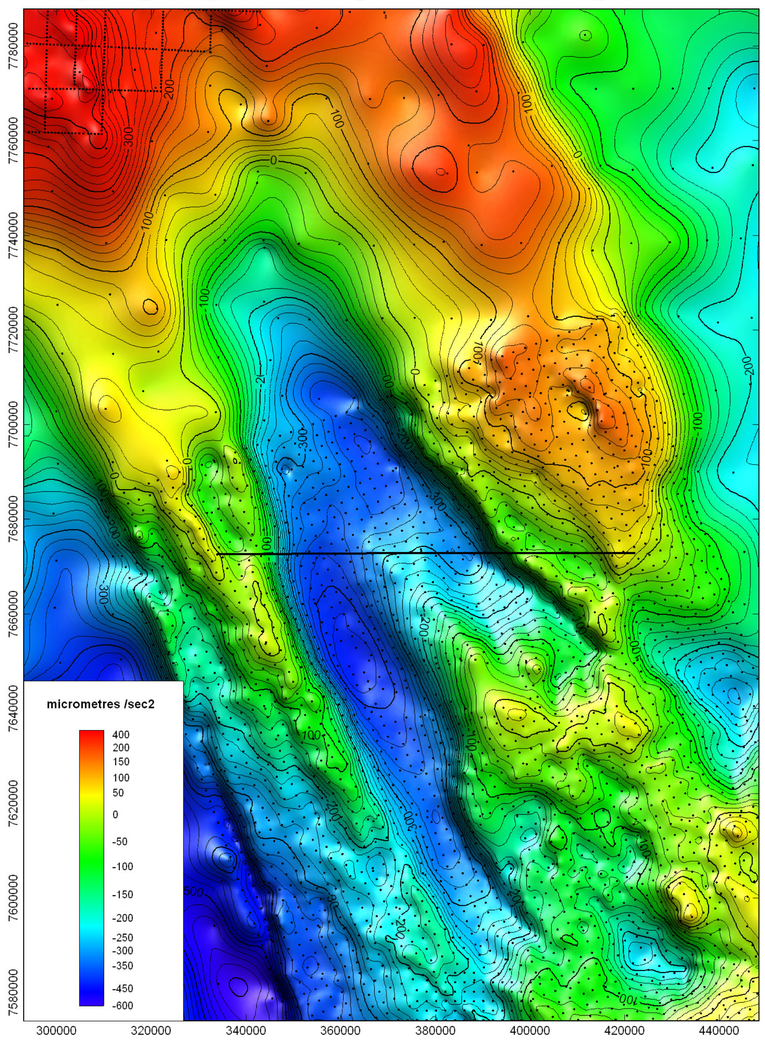
Regional Gravity



Bouguer gravity from original government coverage



Bouguer gravity from new government coverage



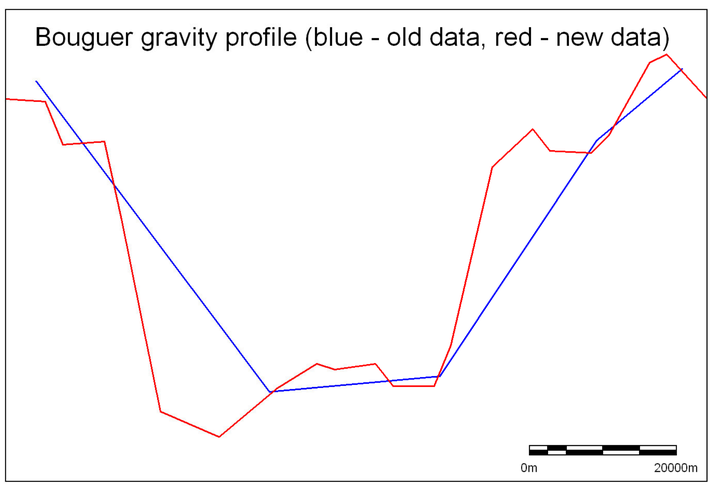
Gravity Mapping

The Bouguer gravity data by which the Waukarlycarly Graben was first recognised and defined was part of a national coverage at a nominal 11 km station spacing. Stations were located on aerial imagery which was a difficult task across relatively feartureless areas. The largest source of error in the processed gravity values at each station was from uncertainty in the elevation measurements which were determined using barometric altimeters.

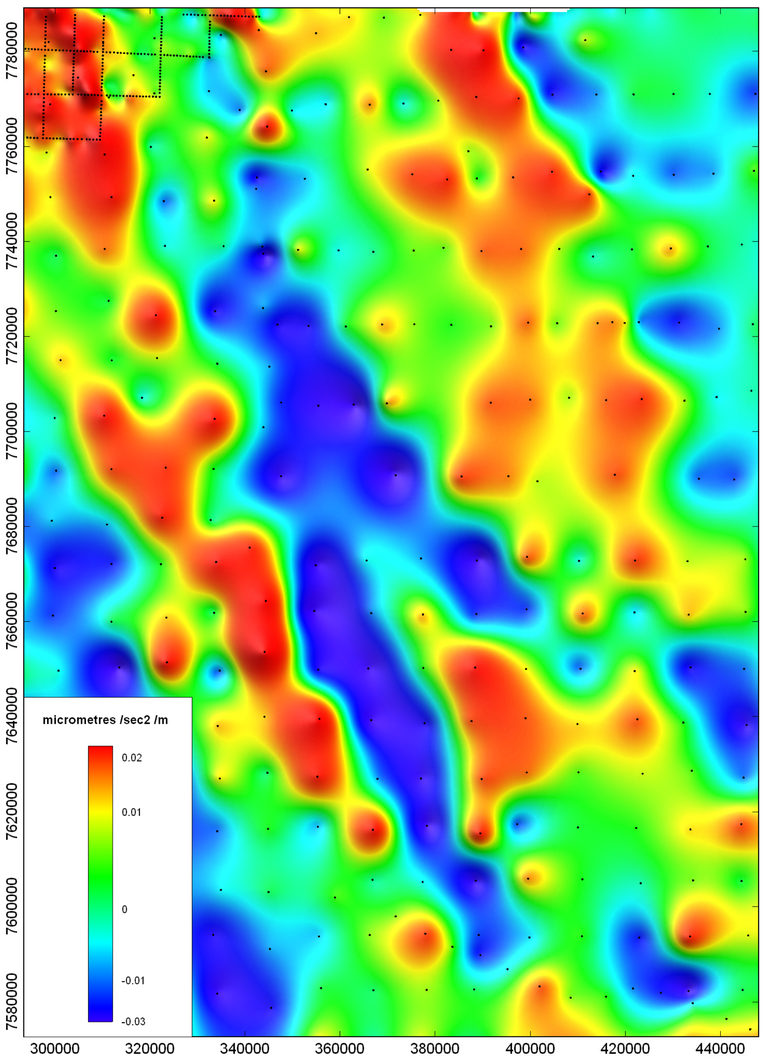
The Bouguer gravity derived from these measurements has been downloaded from the national gravity database maintained by Geoscience Australia. This database incorporates whatever validated data is available, particularly from petroleum and mineral exploration projects (such as the stations in the far north-west of the study area). This database is a very valuable exploration resource and is ideal for setting the context of more detailed prospect-scale studies. The data has been gridded and is imaged on the far left.

Recently the Geological Survey of Western Australia and Geoscience Australia conducted a detailed gravity survey which covers the southern part of the Waukarlycarly Graben with stations on a regular 2.5 km grid. This represents a 20 fold increase in station density. The new survey had the benefit of differential gps for horizontal and, critically, vertical positioning. However it is the reduced spacing between stations much more than increase in quality of the individual measurements which has improved the gravity coverage.

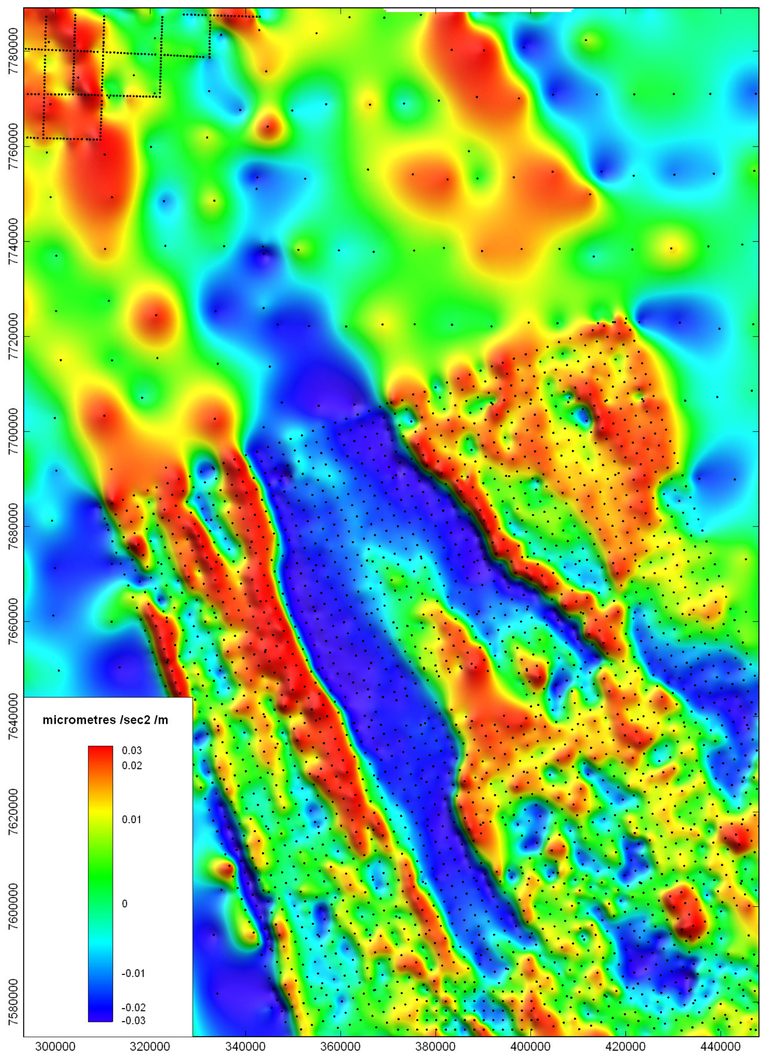
The importance of station spacing is shown by the coincident old and new gravity traverses graphed below. There is a close agreement between the old and new station gravity values but the 5 old stations which spanned the width of the Waukarlycarly Graben provided an insufficient sampling of the gravity field. The closer spacing of the new data provides a much better estimate of the local gradients of the gravity field which are of critical importance in its interpretation.



Vertical derivative of Bouguer gravity (original data)



Vertical derivative of Bouguer gravity (new and original data)

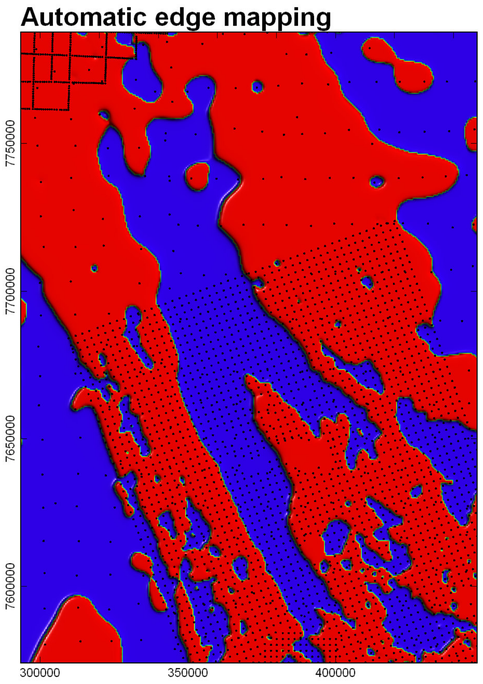


Enhancement of the Gravity Data

The Bouguer gravity variations imaged above are due to density changes across a wide range of depths. To accentuate shallow structure vertical gradients were derived from Fourier analysis of the Bouguer grids. The vertical derivative of Bouguer gravity derived from the old and new data sets are imaged to the left. In both cases a mild pre-conditioning has been applied to restrict amplification of any noise. The vertical derivative enhancement of the data accentuates the improved spatial resolution of the new survey data, with more significant differences between the vertical derivative images than between the corresponding Bouguer images. These differences are most evident where sharp gradients at the graben edges terminate at the northern end of the new survey. Apparent change of gradient at this point is due to sampling issues and not geology.

The image below shows a more extreme enhancement of the data derived from a combination of vertical and horizontal field gradients. This enhancement is designed to terrace the data with abrupt transitions at the locations of steepest gradient. These transitions in the transformed data are interpreted to locate the basin edges. Edge mapping is most succesful in the high data density area of the new survey but unfortunately lacks resolution to the north where there is both a lower density of data coverage and a greater complexity of the gravity field.

Automatic edge mapping



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