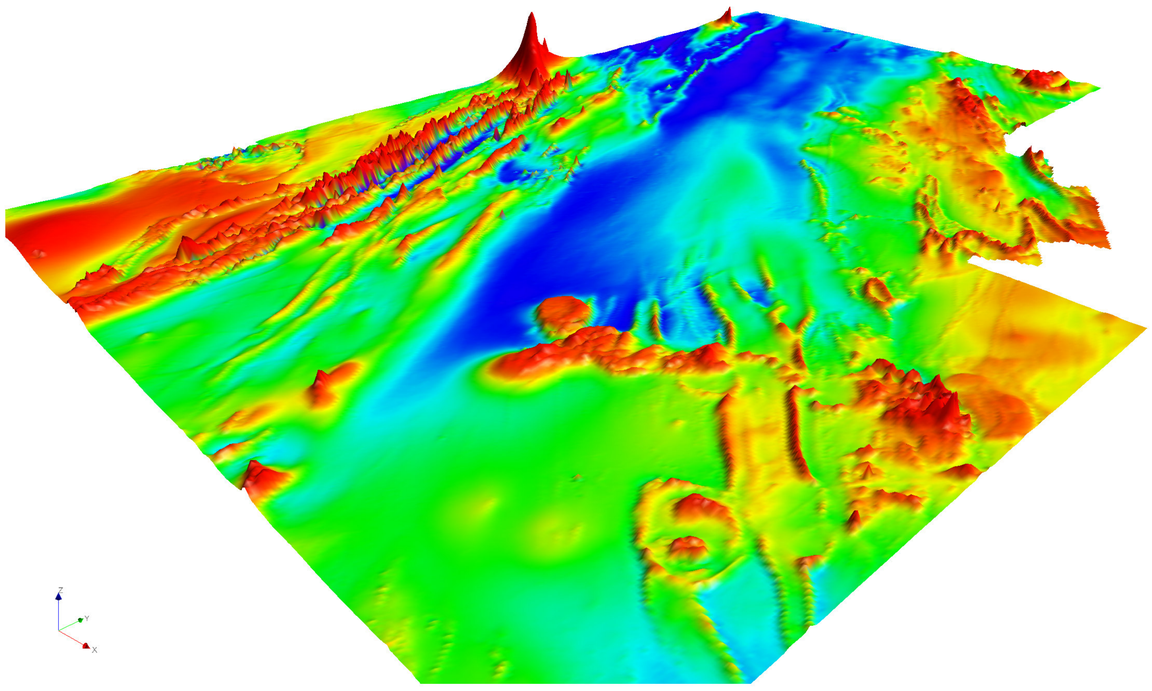
Magnetic Field Expression of the Waukarlycarly Graben



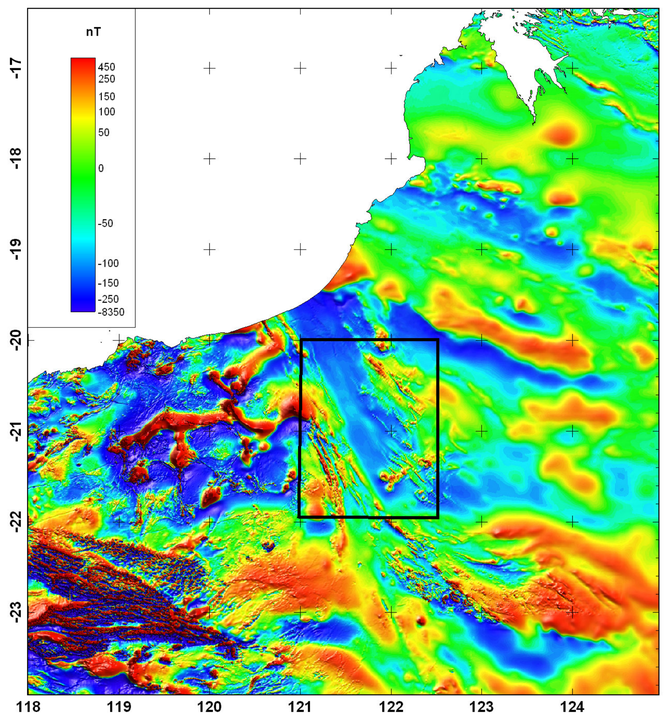
Magnetic Field and Structure

The image to the right shows the regional magnetic field intensity over north-west Western Australia. The data is part of a nation-wide data set compiled by Geoscience Australia from surveys conducted over the past 50 years.This image shows amplitude and textural variations controlled by the distribution of ferromagnetic minerals (principally magnetite) within the crust. Images of the magnetic field such as this provide the most complete and detailed mapping of basement geology across most of Australia where sparse outcrop restricts surface geological mapping. The anomaly pattern is mostly controlled by igneous and metamorphic rocks which can have high ferromagnetic mineral contents. Sedimentary cover is indirectly evident from modification of these basement-sourced anomalies where they are buried to greater depths.

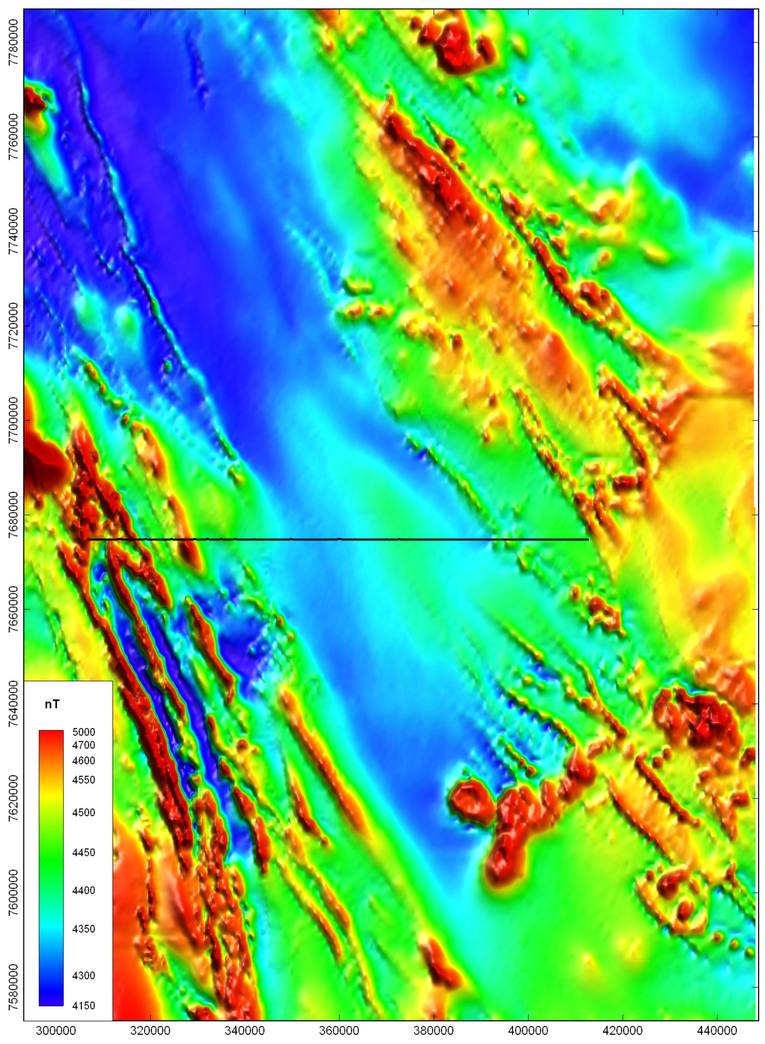
Magnetic field mapping and interpretation contributes to petroleum exploration by revealing the nature of the basement rocks, delineating structural features and zones in the basement and supplying estimates depth to basement and thereby thickness of thethe overlying sediments. Magnetic field mapping has the sensitivity to reveal subtle anomalies due to weak magnetization contrasts within the sedimentary section but such anomalies are rarely evident in regional magnetic field images which tend to be dominated by the dynamic range of baseement-sourced anomalies.

The Waukarlycarly Graben has developed over a north-west to south-east trending zone of weakly magnetic basement rocks. Anomalies within this zone are poorly imaged because of their low amplitudes relative to anomalies over adjacent banded iron formations. The low magnetization of the basement benath the Waukarlycarly Graben may be due to its composition or to extensive structural deformation with associated magnetite destruction. The structural fabric of the basement to both sides of the basin is also parallel to the basin axis as reveled by the orientation of many linear magnetic anomalies. Considerable extra detail can be seen in the regional data when it is windowed and imaged with a smaller amplitude range appropriate to the subdued field variations over the basin itself.

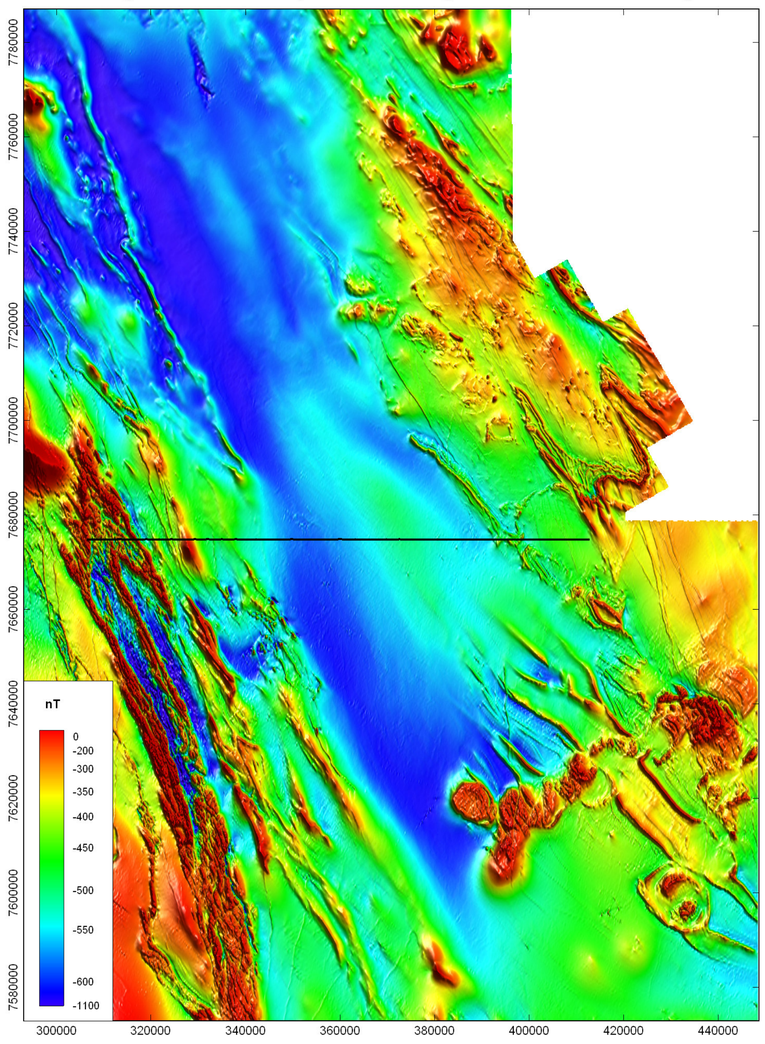
Regional Magnetic Field



RTP magnetic intensity from original government coverage



RTP magnetic intensity from new government coverage



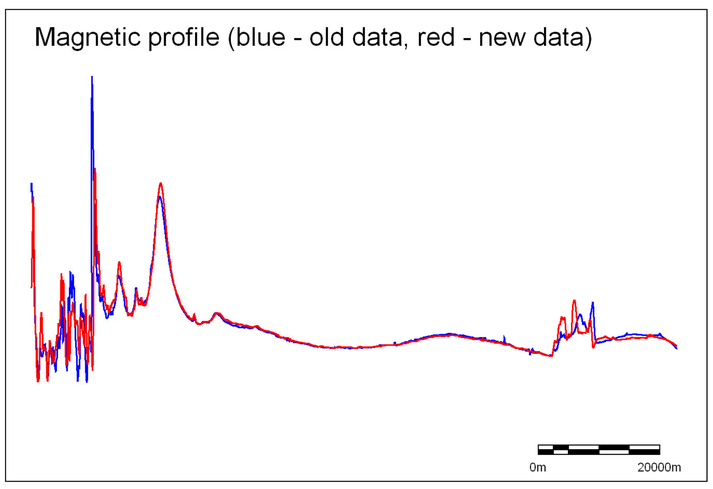
Magnetic Field Mapping

The Waukarlycarly Graben can be recognised in the regional magnetic field data acquired in the early 1990s. These data sets were acquired at a nominal 1600 metre line spacing and terrain clearance of between 60 and 100 metres. Navigation was a principal challenge in flying these surveys. Some of these surveys were able to make use of the earliest GPS coverage but there was limited real-time assistance to the pilot.

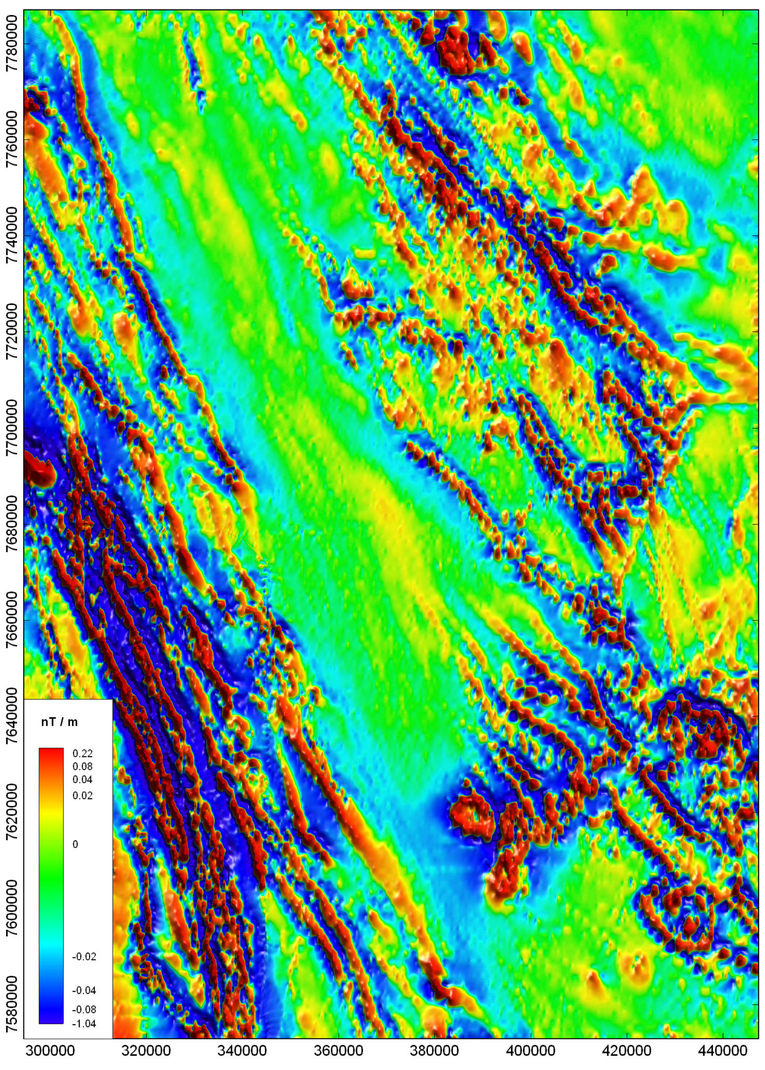
The magnetic field data has been downloaded from the Geoscience Australia national database, gridded and had a reduction-to-pole (RTP) transform applied to produce the image on the far left. The objective of the RTP transform is to simplify the magnetic field variations and place them directly above their source bodies. The Waukarlycarly Graben is evident in this image by the absence of sharp, high amplitude anomalies which characterise the adjacent areas of shallow basement. In many places the edge of the magnetic anomalies is sharp across a graben-bounding fault. These basin edges would be even more noticable were the magnetic anomalies not parallel to the basin edges. In the south and along parts of the eastern margin of the graben individual magnetic anomalies can be seen to loose sharpness and amplitude where the basement gradually deepens beneath the basin.

Recently the Geological Survey of Western Australia and Geoscience Australia have conducted detailed aeromagnetic surveys of the area and incorporated detailed company surveys into the national database. These surveys have been flown at a line spacing of between 150 and 400 metres and at ground clearances of 60 to 80 metres. The new surveys have the benefit of differential GPS positioning and of greatly improved navigational aids for the pilot. The RTP image of magnetic intensity from these new surveys is shown in the image directly to the left. The resolution improvements are most obvious for the sharp anomalies over shallow basement which were undersampled at the wider line spacing of the older surveys. Resolution of the broader anomalies from basement buried beneath the graben are essentially unchanged between the two surveys.

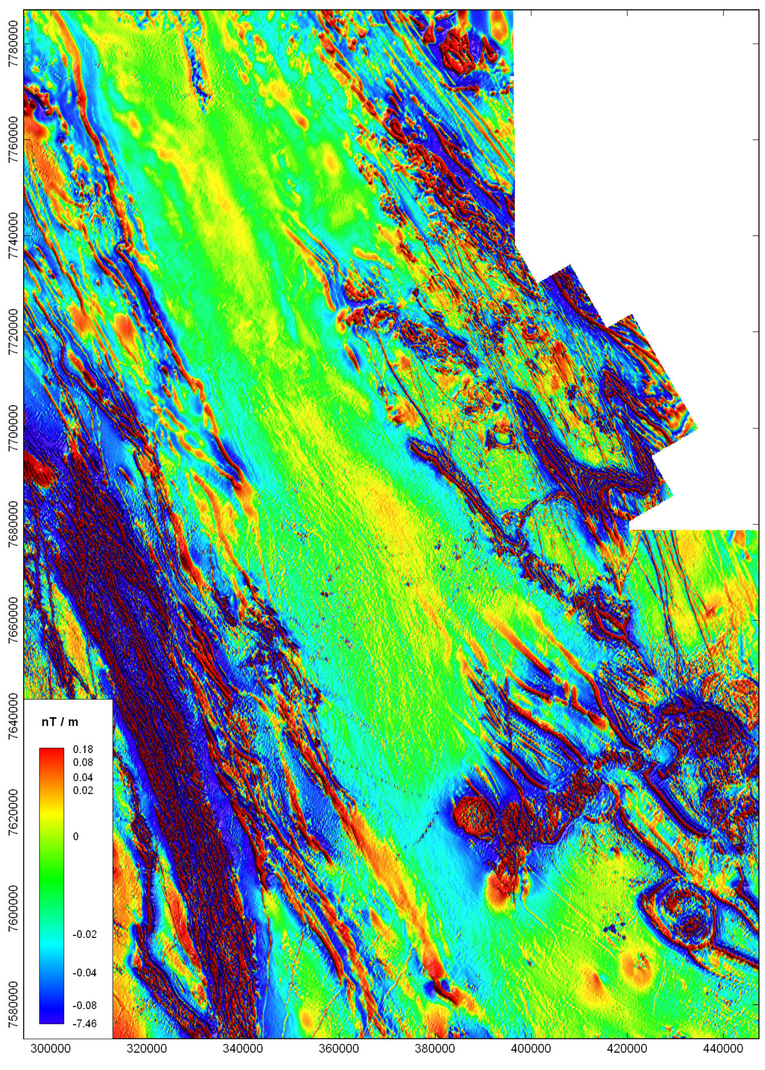
The graph below shows two adjacent (not exactly coincident) total magnetic intensity profiles across the basin from the old and new surveys. There is little difference in information content of the two profiles, and the improvement in resolution of the magnetic field by the more detailed surveys is almost exlusively due to the reduced line spacing.



Vertical derivative of RTP (original data)



Vertical derivative of RTP (new data)

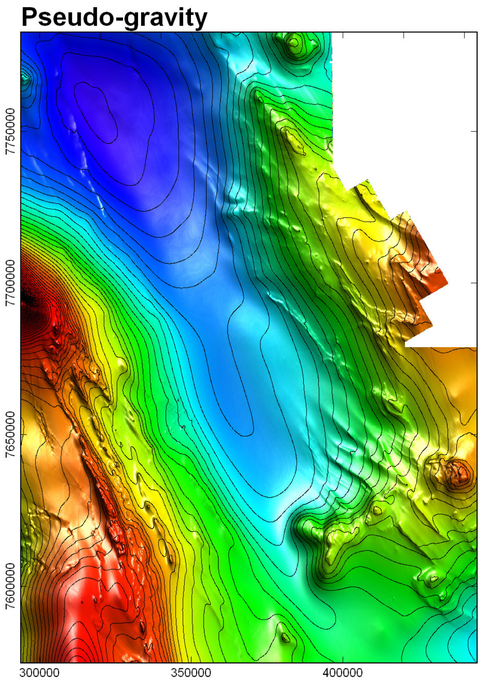


Enhancement of the Magnetic Data

The total magnetic intensity images above reveal information from a wide range of depths. Vertical gradients were derived from Fourier analysis of the RTP grids to accentuate shallow structure. The vertical derivatives of RTP magnetic intensity derived from the old and new data sets are imaged to the left. Vertical derivative enhancement of the data accentuates the improved spatial resolution of the new data set with more significant differences between the vertical derivative images than between the corresponding magnetic intensity images. These differences are most evident over the areas of shallow basement where the complexity and sharpness of the anomalies were misrepresented by the old surveys.

The vertical derivative sharpens the horizontal resolution of the magnetic field but also reduces the expression of deeper beneath the graben, and these magnetic field variations carry inns carry important structural information. Several Fourier available to adjust the balance between expressions of deep anons of deep and shallow sources. The pseudo-gravity transform gravity field with the assumption that there is one to one corresp one correspondence between density and magnetization resulting image as shown below approximately locates the grabicates the graben but not as sharply as the measured gravity because the true gravity variation is due predominantly to the dntly to the density contrast of the sediments against basement, magnetization contrasts are between individual basement units.ement units. Some parts of baseement having only weak contrast against the basin sediments. Interpretation of the magron of the magnetic field data benefits from a range of transforms vertical derivative and pseudo-gravity, each of which highlights o highlights different aspects of the geology.

Pseudo-gravity



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We would like to acknowledge the Geological Survey of Western Australia and Geoscience Australia who have supplied the data which forms the foundation for this study.

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