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Geoscience Australia

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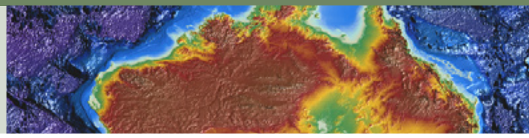
High resolution coverage of Australia's sea floor

New bathymetry and topography grid released



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Geoscience Australia, as the national co-custodian of bathymetric data for Australia with the Royal Australian Navy, has been acquiring and collating bathymetric survey data for the Australian marine jurisdiction since 1963 (Webster and Petkovic 2005). In 2000, Geoscience Australia used this data to create a one kilometre (0.01 decimal degree: dd) grid for the Australian territorial waters and beyond. A revised 250 metre (0.0025dd) version of the grid was produced in 2005 to meet client requests. Since the release of the 2005 version, data from continuing surveys and field studies have contributed to the collation of a number of new high-resolution datasets along the Australian continental shelf margin.

The new 250 metre (0.0025dd) 2009 Bathymetry and Topography Grid of Australia draws together the most recent bathymetric datasets for the Australian region (figure 1). The area covered in this grid (9°S - 45°S, 108°E - 160°E) represents the full Australian Exclusive Economic Zone including waters adjacent to the continent of Australia, Macquarie Island surrounds, and the Australian Territories of Norfolk Island, Christmas Island, and Cocos (Keeling) Islands. This coverage does not include Australia's offshore jurisdiction from the Territory of Heard and McDonald Islands or the Australian Antarctic Territory.

Data Sources

The datasets used to create the 2009 version of the grid varied greatly in resolution, source and data type. They included:

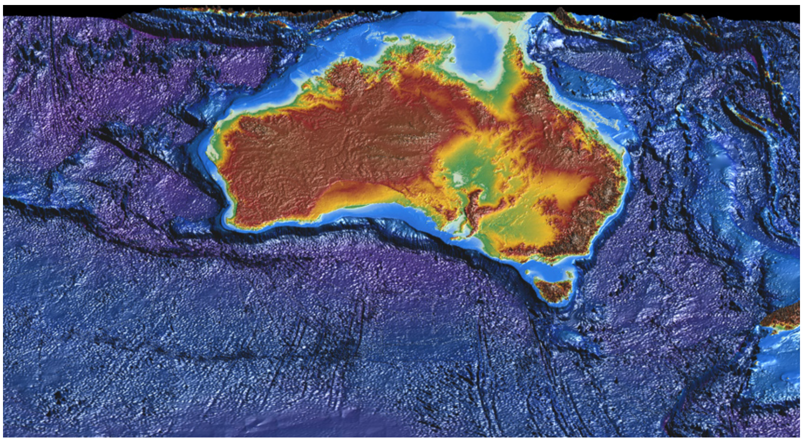

Figure 1. False-colour image showing a 3D view of the Australian Bathymetry and Topography Grid, June 2009.

- Multibeam Swath sonar bathymetry
- Fairsheets (Hydrographic Office, Royal Australian Navy)
- Laser Airborne Depth Sounder (LADS) data (only those LADS datasets that had previously been converted to a suitable datum were used in this grid)
- Deep ocean data (where high resolution data were not available) based on the ETOPO1 or ETOPOv2g data supplied by the National Geophysical Data Center, US Department of Commerce (NGDC)
- Australian Digital Elevation Model (DEM) supplied by Geoscience Australia and the Australian National University
- New Zealand DEM based on the 250 metre DEM data supplied by Geographx, New Zealand
- Indonesian and Papua New Guinean DEMs based on the SRTM DEM supplied by the CGIAR Consortium.

New high resolution datasets

A range of new high resolution datasets were used in the compilation of the 2009 version of the grid. Data from recent surveys including the Southwest Margins Marine Reconnaissance (Foster et al 2009) and the Remote Eastern Frontier Basins Reconnaissance (Heap et al 2008) covered areas along the continental margin and revealed a number of new seafloor features including small volcanic mountains (figure 2a) and canyons (figure 2b).

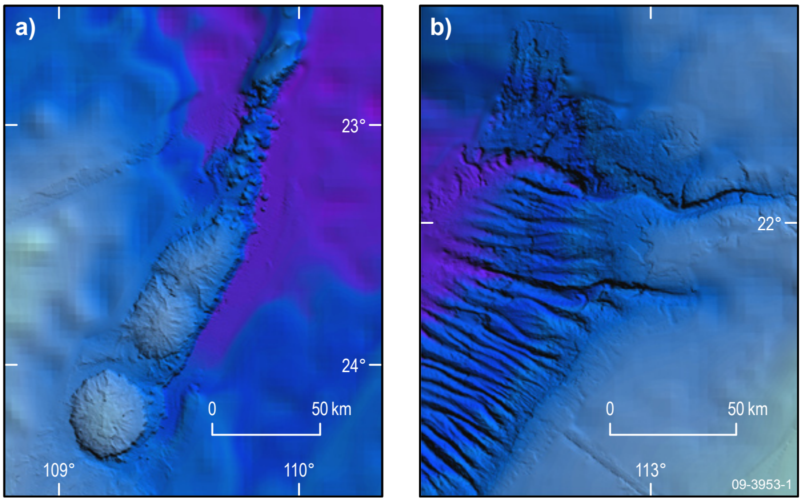

Figure 2. False-colour bathymetry images showing: (a) underwater volcanic mountains and (b) submarine canyons off Western Australia, discovered during the Southwest Margin Marine Reconnaissance Survey, October 2008 to January 2009.

New bathymetric grid compilations for Cocos (Keeling) Islands, Christmas Island and Lord Howe Island (Mleczko 2008), as well as the Gulf of Papua (Daniell 2008) are also included in this version. These datasets include the most recent and best available input data providing improved sea floor topography for these areas. This will particularly reduce the effects of invalid cliff edges caused by the lack of data and over-interpolation of data which occurred in the 2005 version of the grid.

The inclusion of higher resolution topographic grids for Australia, New Zealand and Indonesia has improved continuity between the land and bathymetric data, resulting in improved accuracy of the ocean-land interface.

The 250 metre New Zealand Digital Elevation Model (DEM) was sourced from Geographx (Geographx 2008), and for Indonesia, the 90 metre SRTM DEM (Jarvis et al 2008) was included. These datasets were resampled to 250 metre (0.0025dd) grid and added to the final product.

In 2008, Geoscience Australia completed a revised version of the 9 second DEM for Australia using ANUDEM version 5.2.2. This 9 second DEM was used in the production of the 2009 version of the grid. All other input grids were aligned to the cell location of this grid to maintain a single cell configuration throughout the processing. This also ensured the final bathymetry product could be used in conjunction with the 9 second DEM product with no cell offset.

Global bathymetry and background datasets

As well as high resolution local datasets, global scale datasets are also an important component of the Australian bathymetry grid. The resolution and accuracy of global bathymetric datasets has been constantly improving over the last ten years. The latest global relief datasets, in particular ETOPO2v2g (Smith and Sandwell 1997) and ETOPO1 (Amante and Eakins 2008) are now down to 2 arc-minute and 1 arc-minute resolution respectively. In these datasets, the bathymetric component of the data is based primarily on satellite altimetry measurements tied to ocean soundings. These grids lack much of the detailed data sourced in local and regional surveys, but provided excellent background data sources for the development of the higher resolution grid for Australian waters.

In the 2009 grid, lower resolution ETOPO2 and ETOPO1 data has been used to fill those off-shelf areas (approximately -200 metres or deeper) where higher resolution survey datasets (such as swath, fairsheets and LADS) were not available. The result in off-shelf areas is a combination grid of high resolution data where it is available and lower resolution ETOPO data elsewhere. There is also a visual difference between the ETOPO dataset in the 2005 grid compared with the 2009 grid. In the 2005 version, the ETOPO data was resampled to a 0.0025dd cell size using an interpolation process which smoothed the data and added apparent detail. In the 2009 grid, the ETOPO data was resampled to 0.0025dd using a bilinear process to minimise interpolation. As a result the ETOPO data in the 2009 grid appears coarser and seems to have less detail although it is truer to its original source (Whiteway 2009).

For on-shelf areas (approximately -200 metres or shallower) surveys completed over the last few years have greatly improved the overall accuracy and resolution of the data. In some cases there were notable discrepancies between the survey data and ETOPO datasets. These were where the difference in resolution and accuracy caused anomalous valleys or ridges as the higher resolution survey data cut through the lower resolution ETOPO data. These differences also resulted in edge effects where the edges of the different datasets did not meet at the same height. In such cases, an interpolation process was used to smooth the data artefacts.

New processing methods

The programs and processes used to create the 2009 Bathymetry and Topography Grid are described in Whiteway (2009). The major processing steps included:

- Initial raw data editing for fairsheets, gridding and mosaicing using Intrepid™ software.
- Review of gridded data, mosaicing and the creation of the lineage shapefile in ArcGIS.
- Interpolation of replacement data to fill data gaps, and data review in ER Mapper.

A number of the processes used in the creation of the 2009 grid are new techniques applied specifically to improve the land-sea confluence and the joins between high and low resolution datasets.

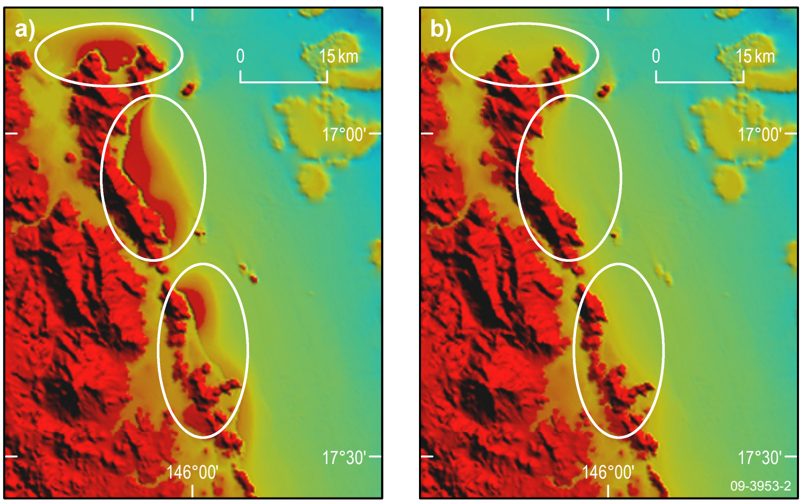

Figure 3. False-colour images showing the reduction to the interpolation artefacts between the continental shelf and land areas using the improved interpolation process. Comparison of the 2005 version of the grid (a) and the 2009 version (b) with variations highlighted by circled areas.

In an effort to reduce the interpolation effects seen in the 2005 bathymetric grid where land occurred in areas of ocean (figure 3a), the new Australian 9 Second DEM was used in the processing phase. The 9 Second DEM was set to 0 metres across the grid and this setting was then used in the interpolation process to fill the gaps between survey datasets covering the shelf and the land. Setting the land elevation to 0 metres meant that the interpolation process resulted in a smooth gradient to the coastline, reducing the areas where land occurs in the ocean (figure 3b).

The 9 Second DEM was also used in the final process, draping it over the existing data to ensure the topography matched the DEM. The combination of these processes ensures that cliffs above the waterline remain, however, it should be noted that underwater cliffs only exist in areas where the survey data meets (or is close to) the land edge. In other coastal areas, a smooth gradient will occur between survey data and the 0 metre coastline.

In the 2009 grid, a new process was also applied to allow the production of a lineage shapefile showing the overall input data type for each of the grid cells. The process involved gridding similar resolution datasets in the same process, and mosaicing them with other datasets that had been gridded together. This differed from previous grids where all datasets were gridded together. For this reason, there are smoothing artefacts around sections of data that were mosaiced, similar to those seen when all datasets are interpolated together. In the 2009 grid, however, they appear sharper in some areas, as the boundary change distance has been minimised to avoid smoothing through other higher accuracy datasets.

A range of errors were identified in the 2005 grid, including irregular ship track lines, swath spikes, ETOPO gravity anomaly highs and fairsheet digitising errors. Generally these errors are products of the raw data, causing high and low anomalies, lines of erroneous data and large-scale interpolation artefacts. When identified these errors were removed through editing the output grid. However, the prolific errors seen in the single beam data meant that this entire dataset was removed prior to interpolation.

Final products

The final 250 metre (0.0025dd) 2009 Bathymetric and Topographic Grid has been produced in two main formats: ESRI™ grid and ER Mapper™ (ers), and additionally as an ascii bil file. There are also two vector files. A lineage shapefile that can be used to identify the general source data for each cell in the grid, and a 500 metre contour shapefile produced in ArcMap™. The data can be ordered on DVD from the Geoscience Australia Sales Centre.

The 2009 bathymetry grid provides excellent regional context (figure 4), and the greater volume of high accuracy data on the continental shelf provides an improving local context. The production of an Australian region bathymetric grid, however, should be seen as a process of review and re-compilation to fully exploit the latest methods for managing and gridding new data.

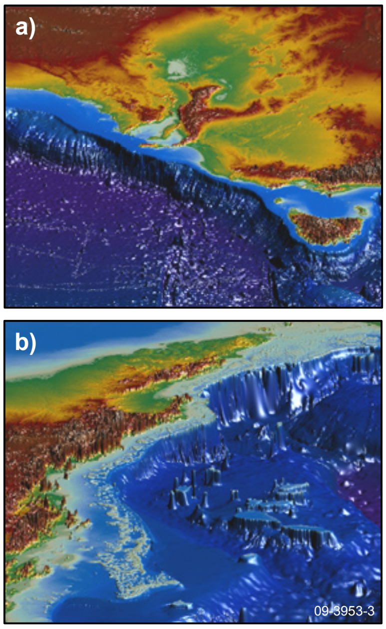

Figure 4. False-colour images showing 3D views of (a) Tasmania and Spencer Gulf and (b) a section of Queensland and the Great Barrier Reef.

For more information

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References

Amante C & Eakins BW. 2008. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. National Geophysical Data Center, NESDIS, NOAA, United States Department of Commerce, Boulder, CO, August 2008. Available www.ngdc.noaa.gov/mgg/global/etopo1sources.html

Daniell JJ. 2008. Development of a bathymetric grid for the Gulf of Papua and adjacent areas: A note describing its development. Journal of Geophysical Research 113.

Foster C, Goleby B, Borissova I & Heap A. 2009. Southwest Margins surveys completed. *AusGeo News 94*. Available at: www.ga.gov.au/ausgeonews/ausgeonews200906/surveys.jsp

Geographx, 2008. New Zealand 250m Digital Elevation Model. Available at: www.geographx.co.nz/downloads.html

Heap A, Hashimoto R & Rollet N. 2008. Survey of remote eastern frontier basins completed. *AusGeo News 89*. Available at: www.ga.gov.au/ausgeonews/ausgeonews200803/survey.jsp

Jarvis A, Reuter HI, Nelson A & Guevara E. 2008. Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT). Available at: http://srtm.csi.cgiar.org

Mleczko R. 2008. Cocos, Christmas and Lord Howe Island Bathymetric grids, Unpublished bathymetric collations, Geoscience Australia.

Smith WHF & Sandwell DT. 1997. Global seafloor topography from satellite altimetry and ship depth soundings. Science 277:1957–1962.

Webster MA & Petkovic P. 2005. Australian Bathymetry and Topography Grid, June 2005. Geoscience Australia Record 2005/12.

Whiteway TG. 2009. Australian Bathymetry and Topography Grid, June 2009. Geoscience Australia Record 2009/21.

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