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Seafloor in the Expanded Malaysia Airlines Flight MH370 Search Area

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Abstract. Smith and Marks (*Eos* Trans. AGU, 95(21), 27 May 2014) illustrated a map of the seafloor in the Malaysia Airlines Flight MH370 search area. This map showed a bathymetric model that is constructed from a combination of available ship soundings and depths estimated from satellite altimetry. They noted that available depth measurements covered only 5% of their study region, and that very few of these measurements were collected using modern multibeam and navigation systems.

Recently the MH370 search has been expanded along the "7th Arc" to encompass newly prioritized underwater search areas identified in an Australian Transport Safety Bureau report (AE-2014-054, 26 June 2014; updated 12 August 2014). The new "Wide" search area extends beyond the region evaluated in Fig. 1 of the *Eos* article. Additionally, multibeam data that were not incorporated in the bathymetric model have been made available to us after the *Eos* article was published.

This presentation updates and extends the study published in Eos. We present illustrations of the expanded region, sounding coverage, and tectonic features that are associated with steep topographic slopes. Our results include comparisons of multibeam survey depths and bathymetric model depths. The standard deviation of the differences is 233 m, with the greatest differences (exceeding 1000 m) over steep topographic slopes, and the smallest over low-relief ocean floor. This is consistent with differences found by Smith and Sandwell (JGR, 99(B11), 1994) between soundings and bathymetric predictions from altimetry. Such depth differences are common where bathymetric model constraints are sparse, which is typical of many of the world's oceans.

References

- GEBCO_2014 - Global continuous terrain model for ocean and land on a 30 arc-second grid (version 20140930, http://www.gebco.net). Bathymetric portion is based on SRTM30_Plus V5 (Becker et al., Marine Geodesy, 2009)
- Tracklines and surveys are from IHO DCDB (International Hydrographic Organization Data Center for Digital Bathymetry), (http://www.ngdc.noaa.gov/mgg/bathymetry/iho.html) and other sources
- 50 m Multibeam Dataset of Australia 2012* (Geosciences Australia (http://www.ga.gov.au)
- RV *Southern Surveyor* 2011 Voyage 6 multibeam data* (CSIRO Marine and Atmospheric Research, http://www.marine.csiro.au)

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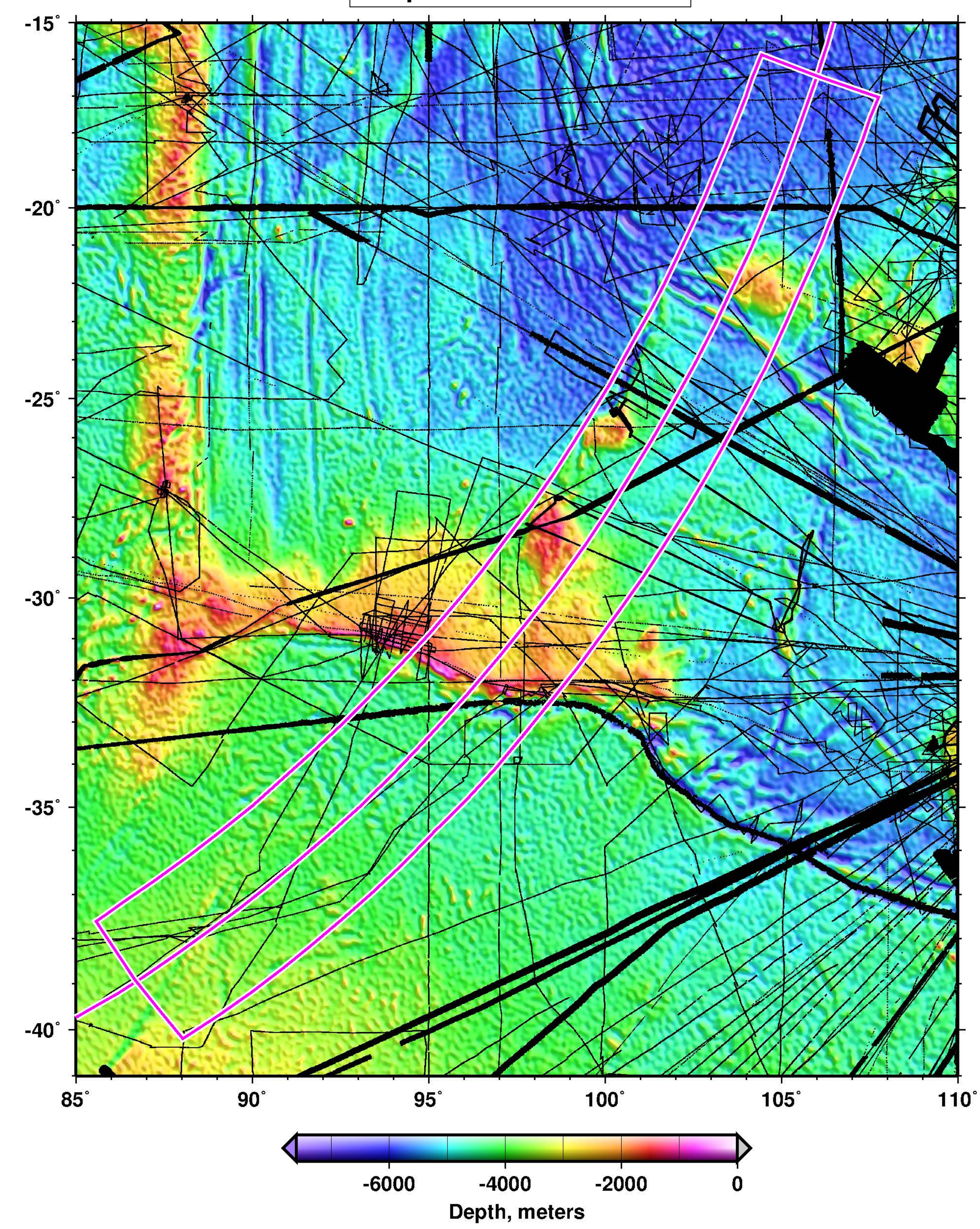
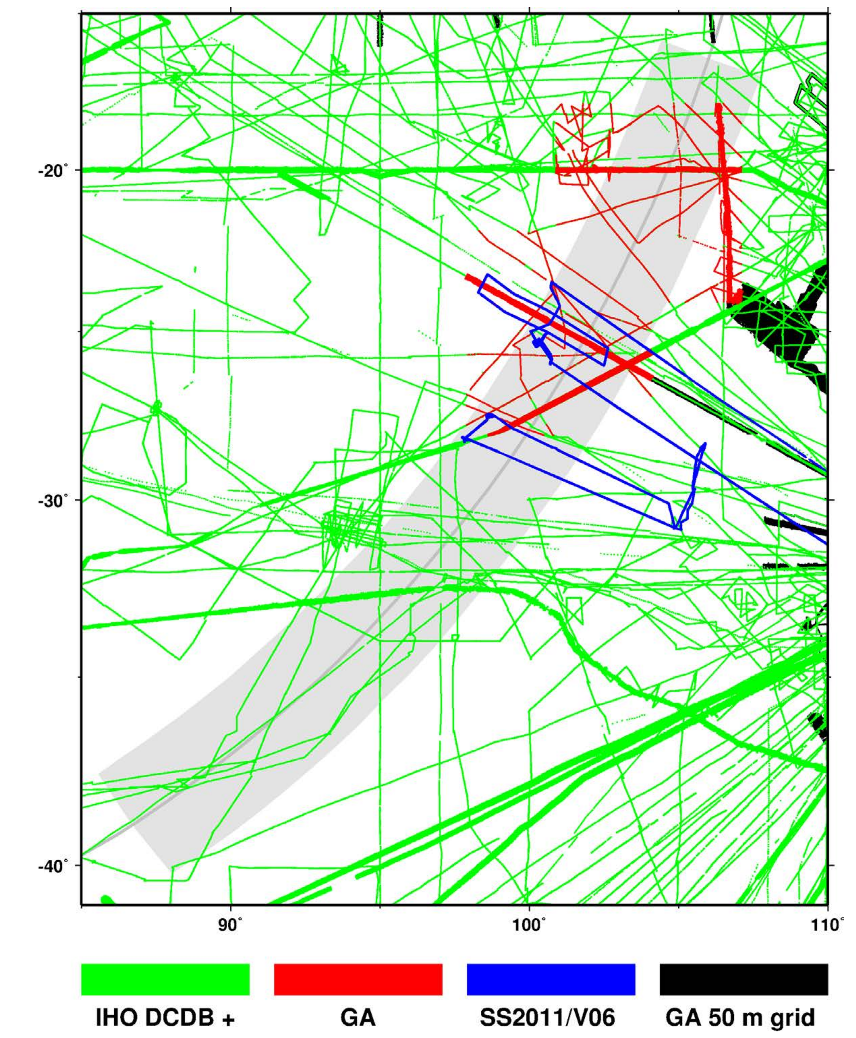
Expanded Search Area



- Purple lines are the "Wide" search area and "7th Arc"
- Background is the GEBCO_2014 bathymetric model
- Black dots are the available depth soundings (see "Data Sources")
- Soundings cover only 5% of the 2450 by 2900 km study area shown above

Data Sources

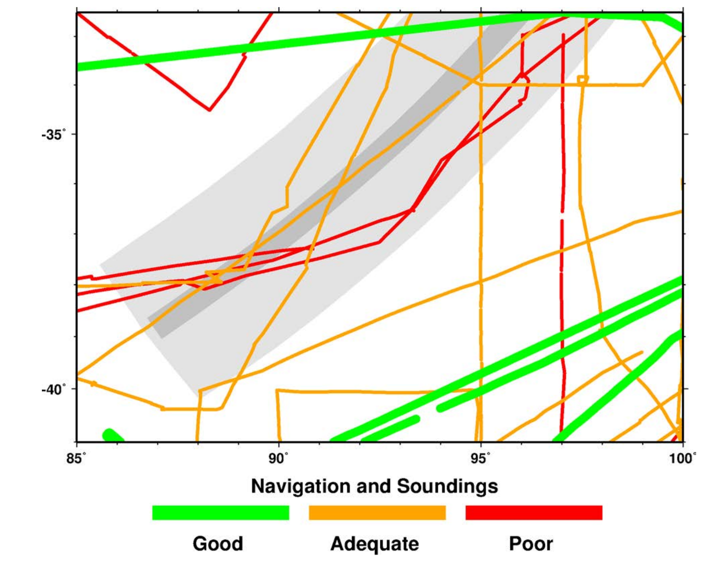


- Gray box- "Wide" search area, gray line- "7th Arc"
- White- areas in GEBCO_2014 where depths are estimated from satellite altimetry
- Green- tracklines and surveys from IHO DCDB and other sources

Data from Geoscience Australia (GA):

- Red- tracklines and surveys
- Blue- RV *Southern Surveyor* 2011 Voyage 6 multibeam
- Black- 50 m Multibeam Dataset of Australia 2012

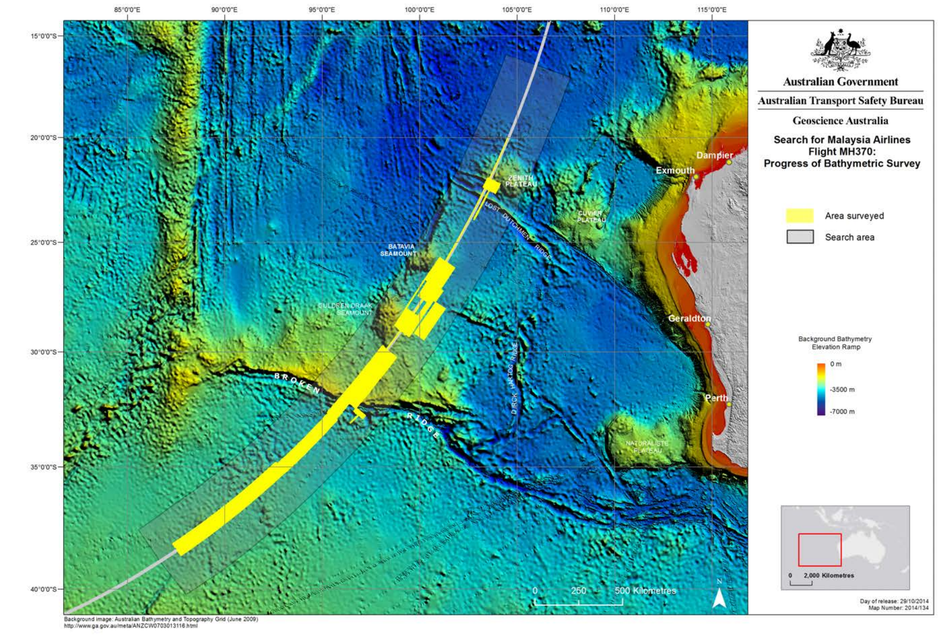
Area of Initial Underwater Search



Cruise ID	Year	Navigation	Bathymetry
NBP0406	2004	GPS	MB
MR03-K04 Leg6	2003	GPS	MB
ODP183JR	1998	GPS	SB
BMRG06MV	1996	GPS	MB
KN145L7	1995	GPS	SB
WEST10MV	1995	GPS	MB
KN145L5	1994	GPS	SB
RC2708	1986	GPS	SB
CP-36	1980	Transit Satellite	SB
ELT54	1972	Transit Satellite	SB
ELT47	1971	Transit Satellite	SB
ELT48	1971	Transit Satellite	SB
ELT49	1971	Transit Satellite	SB
ELT46	1970	Transit Satellite	SB
RC1105	1967	Transit Satellite	SB
UM66-C	1967	Celestial	SB
LUSI02HO	1962	Celestial	SB
LUSI6BAR	1962	Celestial	SB
MONS4AAR	1960	Celestial	SB
V1606	1960	Celesial	SB
OB2C	1956	Celestial	SB
	MB=Multibeam, SB=Single Beam		

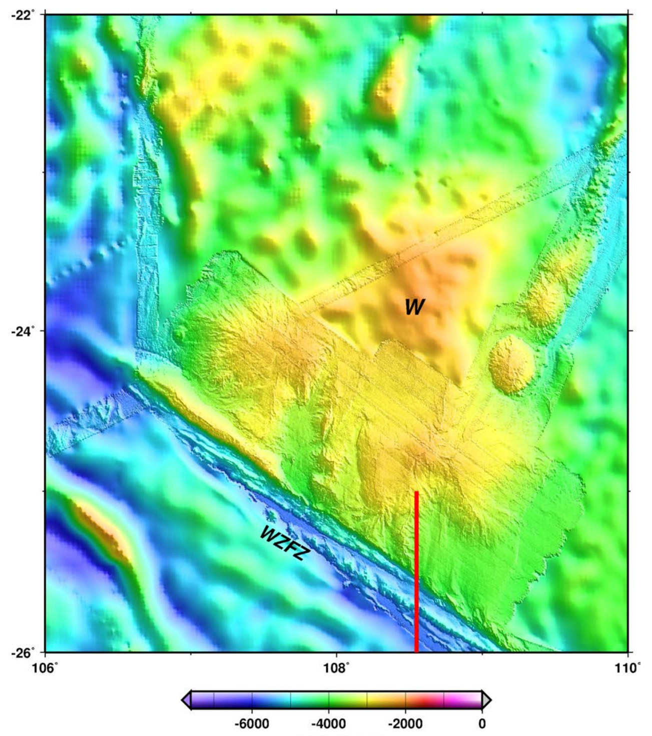
- Gray box- "Wide" search area, dark gray box- approximate area of multibeam collected under direction of ATSB to guide initial underwater search
- Most of the available ship tracks in this focused area were navigated using older techniques and/or older, low-tech echo-sounding equipment and analog records
- Soundings collected while using older navigation techniques may be mislocated by more than several kilometers, which may lead to inaccuracies in depth. Altimetric bathymetry calibrated using inaccurate and mislocated data suffers as well.
- State-of-the-art navigation and multibeam systems yield accurate depths and locations

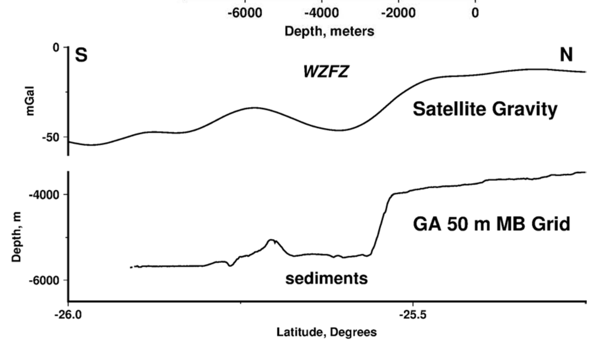
ATSB Bathymetric Survey Progress



- The Australian Transportation Safety Board (ATSB) (www.atsb.gov.au) provides regular updates on the search for MH370
- On 10/22/14, ATSB reported that 140,000 km² of seafloor had been mapped with multibeam. On 10/26/14, mapping was completed (yellow areas)
- Recently, the focus has shifted to the southern portion of the "Wide" search area
- The international marine science community would benefit greatly from the public release of these survey data

Altimetric Bathymetry Fills Gaps Between Ship Surveys

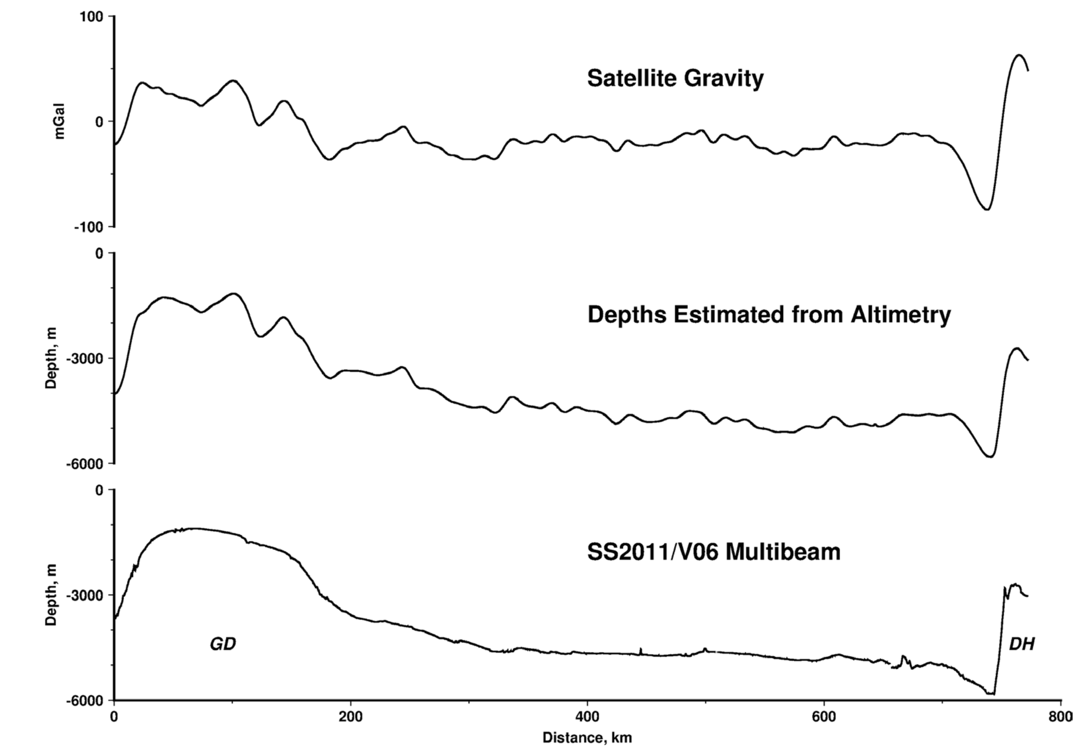




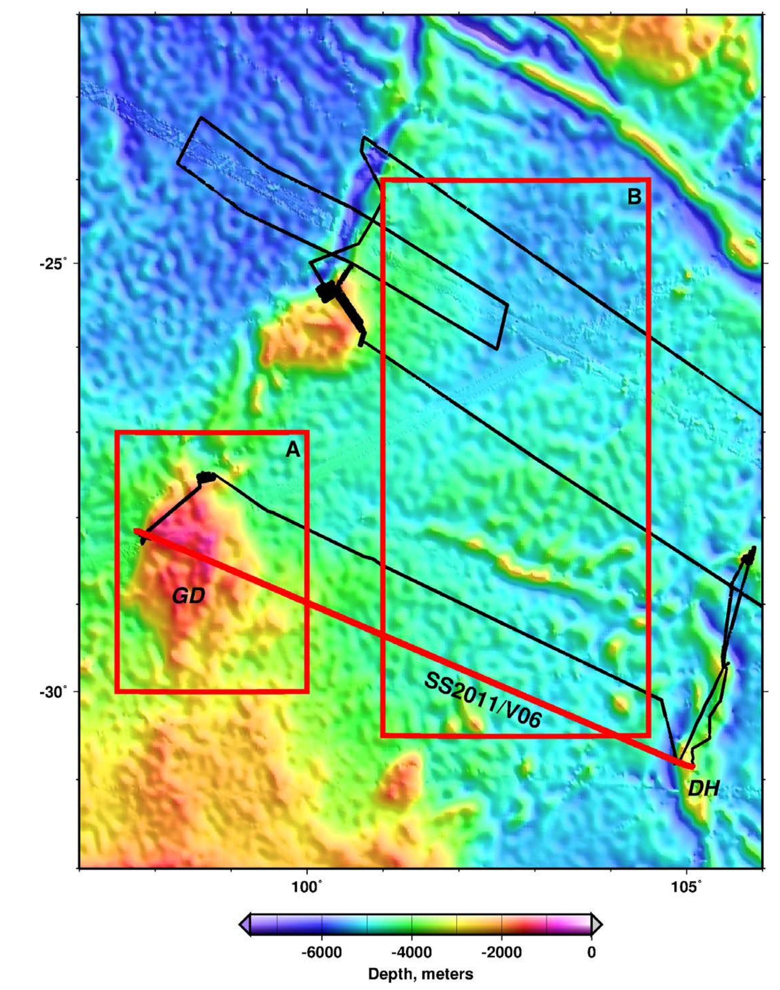
- Shallow feature is Wallaby Plateau (*W*), linear trough is Wallaby-Zenith Fracture Zone (*WZFZ*)
- Multibeam from the 2012 GA 50 m grid covers the southern part of plateau. Altimetric depths taken from GEBCO_2014 fill in the gaps
- Multibeam data can resolve seafloor structures less than 100 m across; satellite altimetry can resolve structures down to ~15 km across
- Altimetry enables mapping of the global seafloor

Altimetric Bathymetry

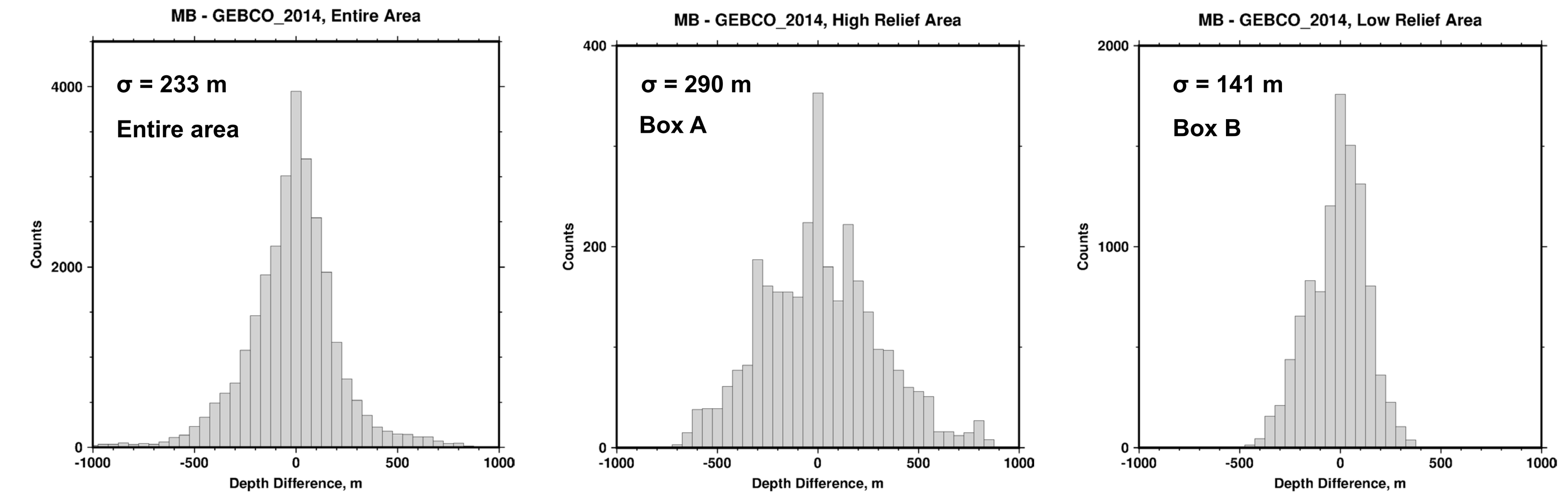
- Gravity anomalies <160 km in wavelength may be correlated with seafloor topography
- Satellite gravity is filtered and combined with soundings to estimate depths (Smith and Sandwell, JGR, 1994)
- Satellite track spacing and water depth can impact gravity anomaly resolution and hence resolution of derived depths
- Gravity "sees through" sediments, instead reflecting the underlying basement topography
- Profile (left; located along red line above left) shows flat sediments and gravity low over fracture zone trough



- SS2011/V06 multibeam profile (red line on map to right) shows the steep flanks of Gulden Draak Rise (*GD*) and Dirck Hartog Ridge (*DH*), and flat seafloor between them
- Note the large satellite gravity anomalies over *GD* and *DH*
- Estimated depths resolve *GD* and *DH*, however bumpiness over flat seafloor may be noise or filtering artifacts



Comparisons of MB Depths and Bathymetric Model Depths



- SS2011/V06 multibeam data were not incorporated into GEBCO_2014 bathymetric model
- Differences are between median multibeam depths over 30 arc-second cells and bathymetric model, σ is standard deviation
- σ = 233 m over entire study area, σ = 290 m over high relief Gulden Draak Rise (Box A), and σ = 141 m over flat seafloor (Box B)
- Depth differences are greatest over areas of sharp topographic relief because of altimetric bathymetry resolution limitations
- Such depth differences are common where bathymetric model constraints are sparse

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