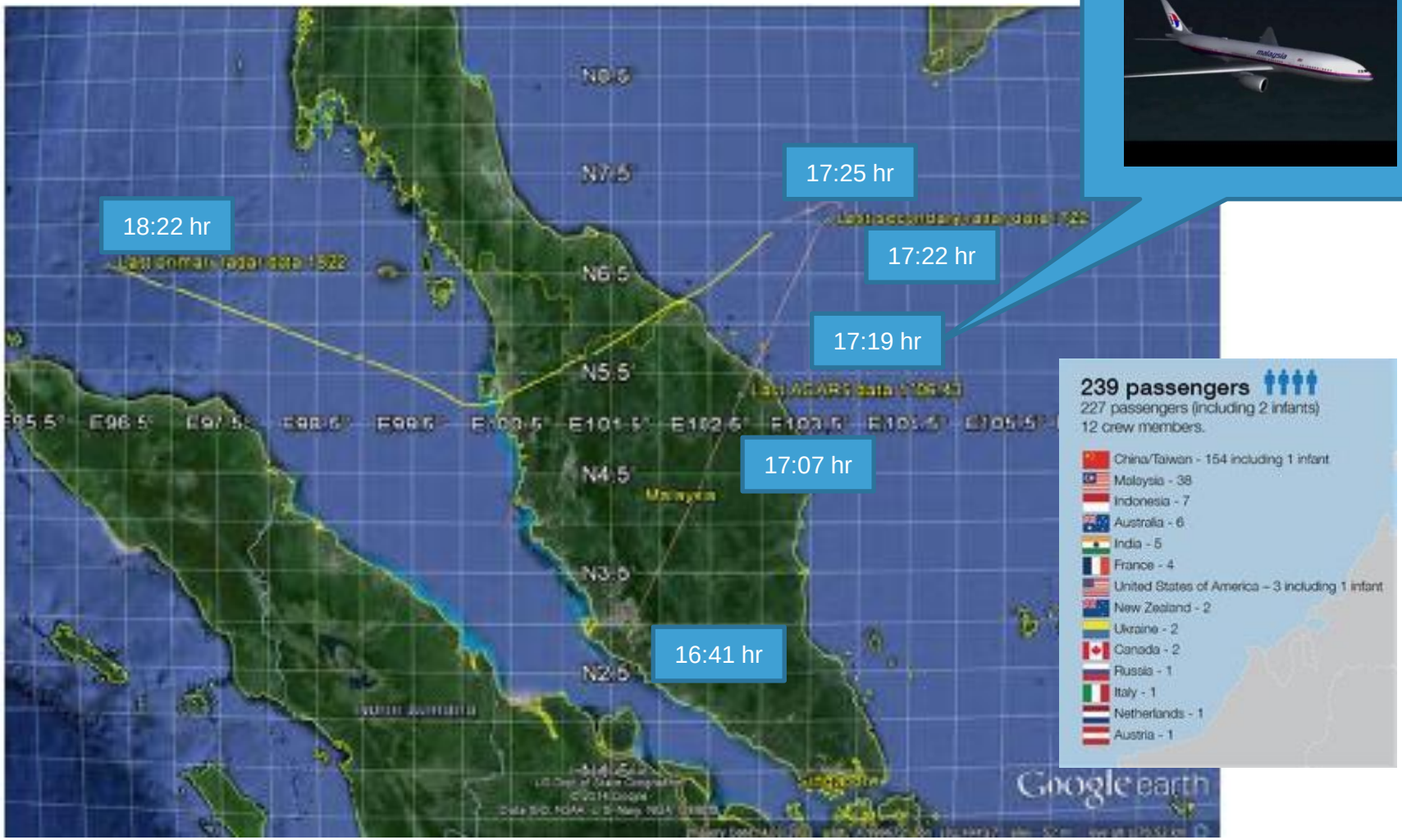
The Search for Malaysia Airlines flight MH370

The Facts – 7th March 2014

MH370 flight path derived from primary and secondary RADAR data.

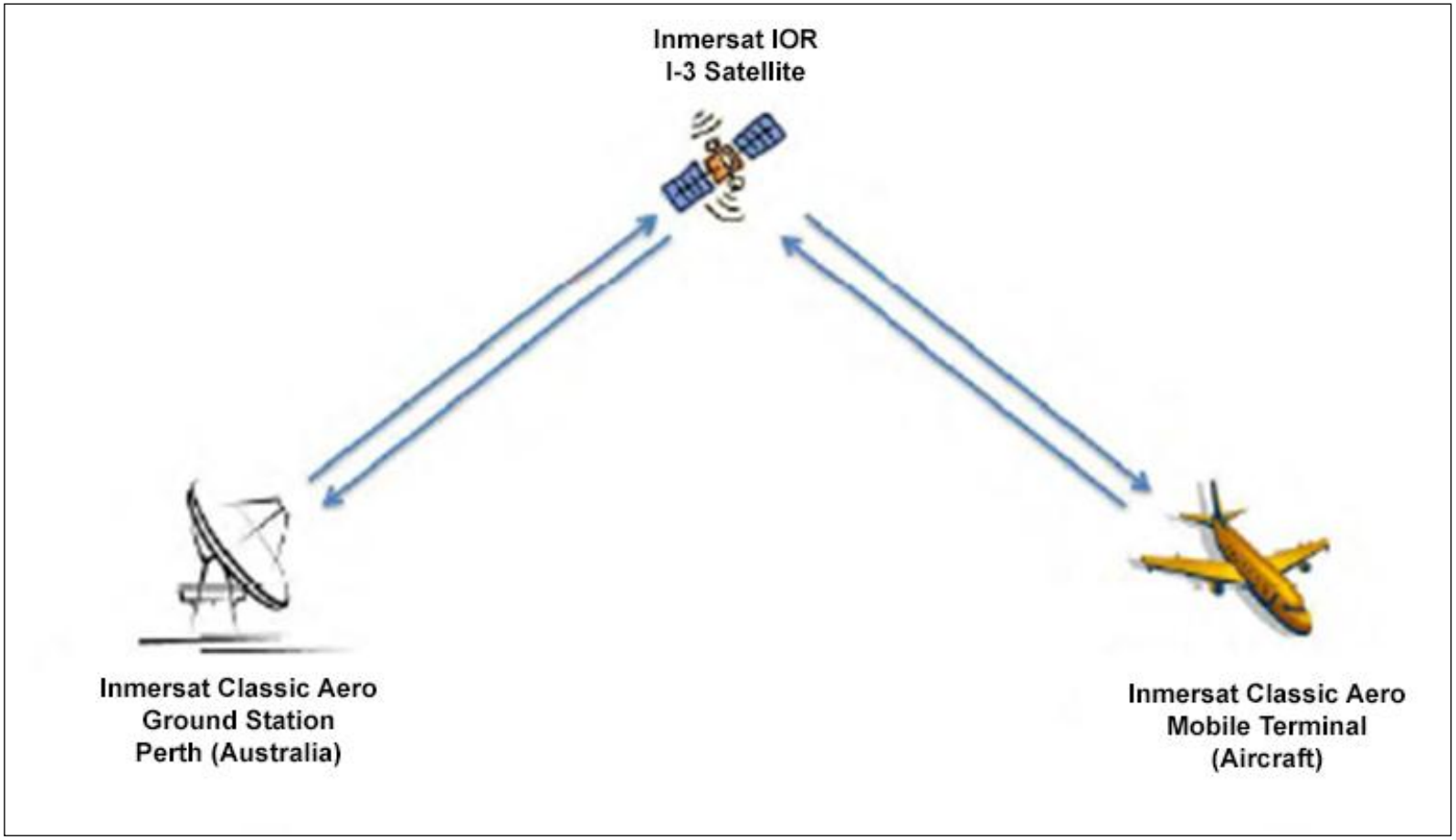


Source: JIT/Google Earth

Source ATSB Transport Safety Report – External Aviation Investigation AE-2014-054

The search area

Schematic of basic satellite communcations

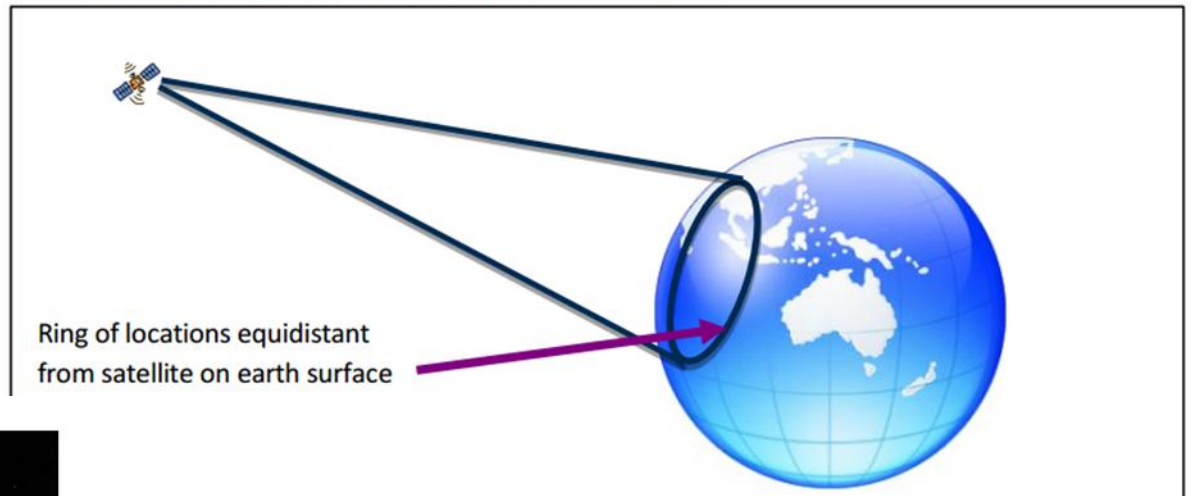


Source: Satellite Comma Working Group

Source ATSB Transport Safety Report – External Aviation Investigation AE-2014-054

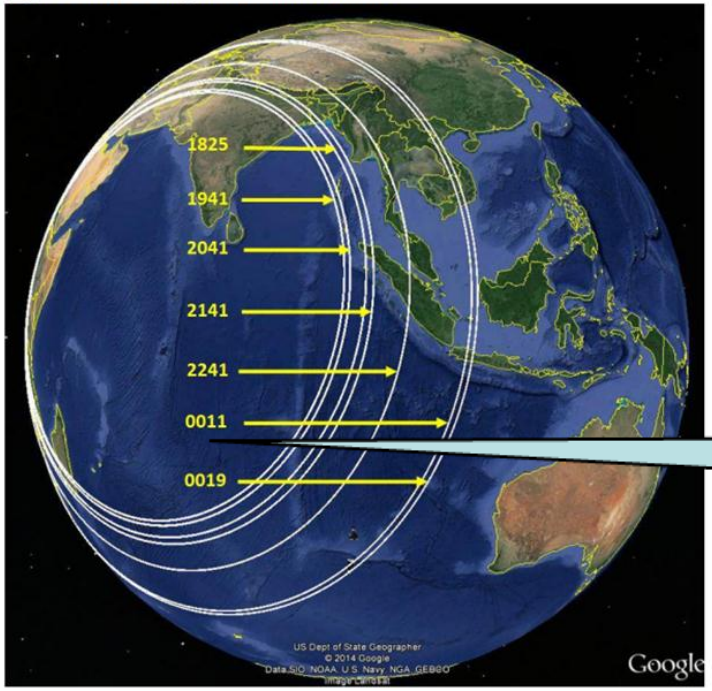
Search Area – ATSB analysis

Figure 17: Position ring defined by BTO measurement



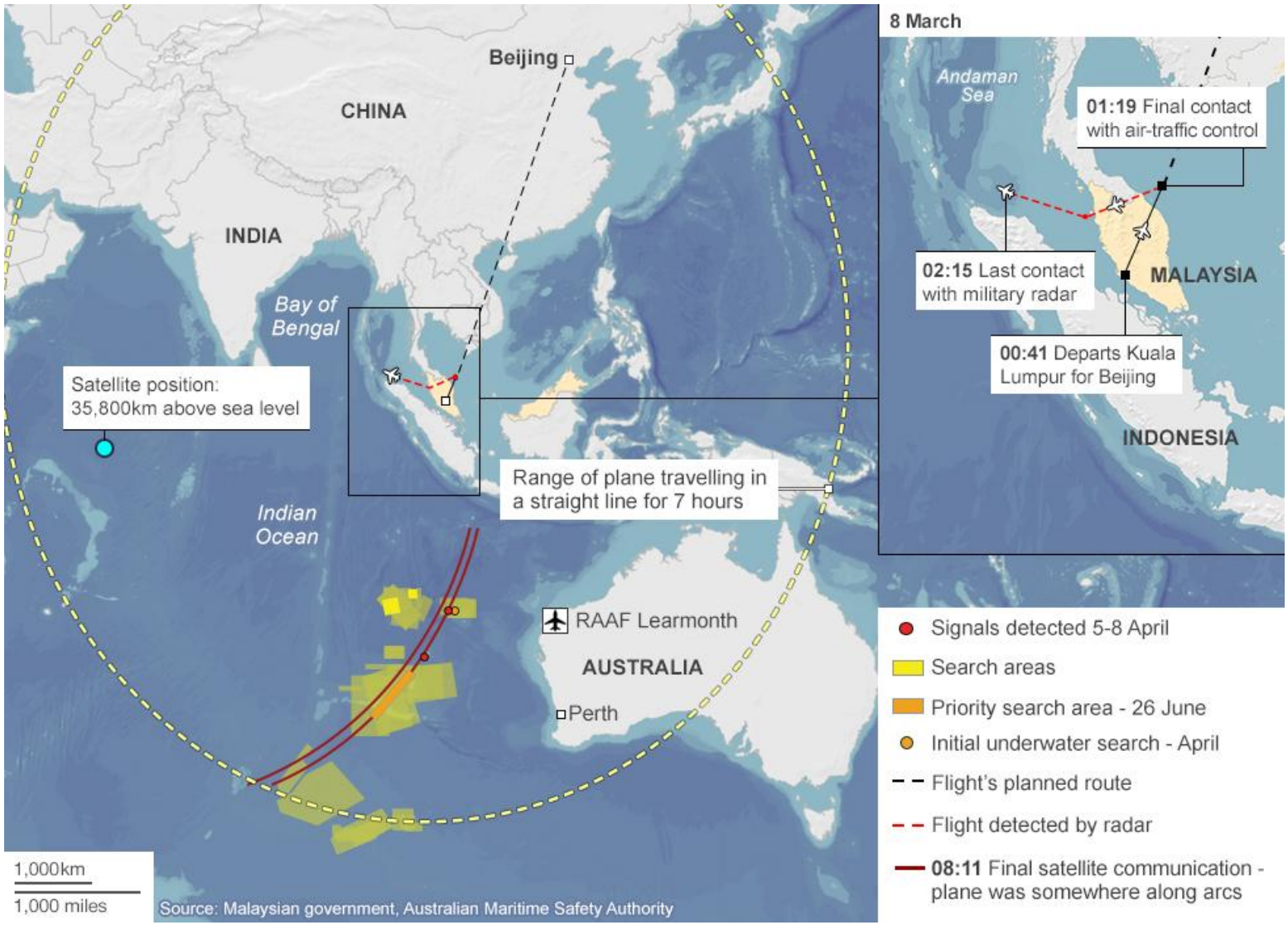
BTO: Burst Timing Offset

Figure 18: BTO ring solutions for 9M-MRO

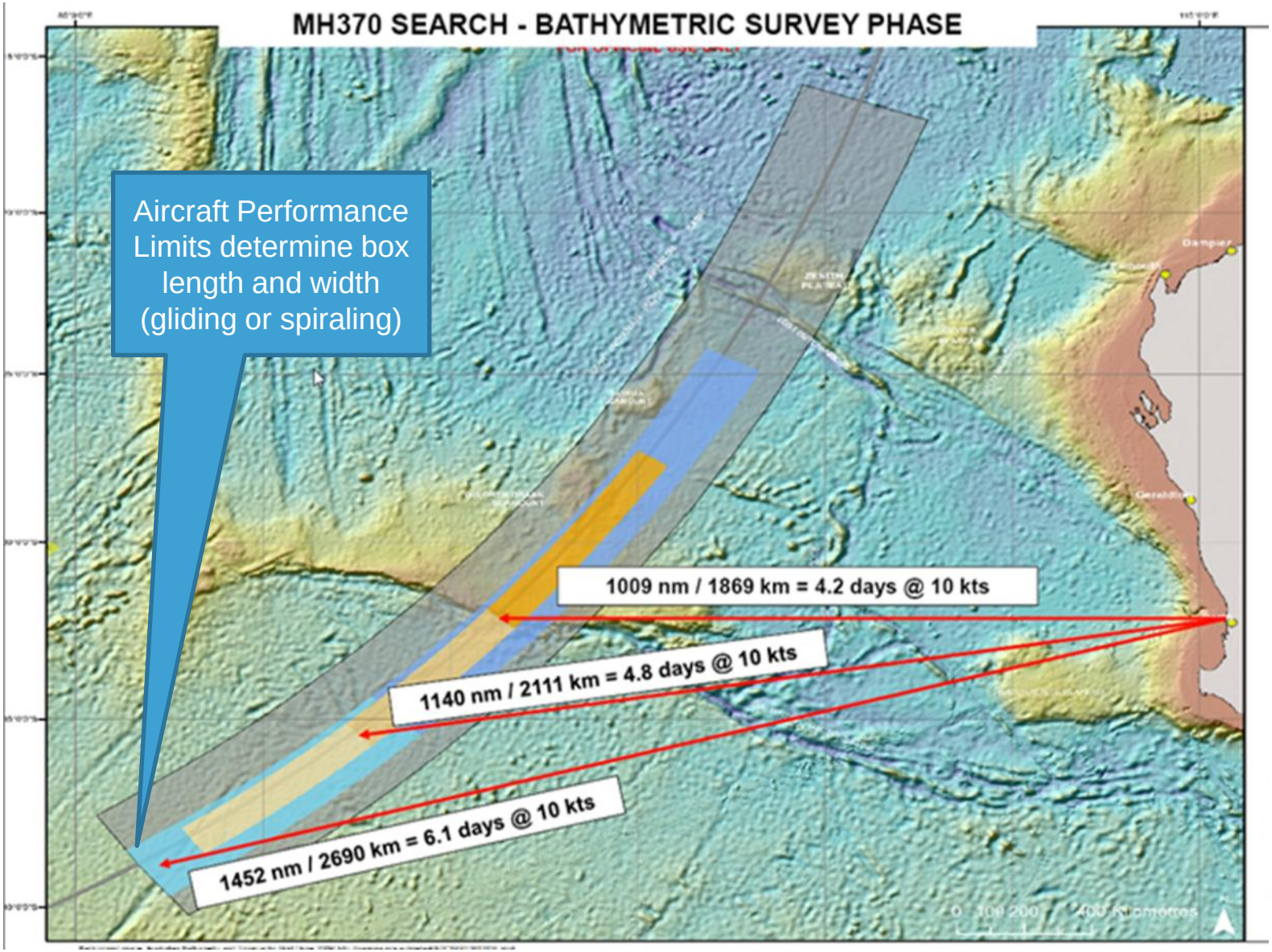


Ram Air Turbine Deploys

Source: Satellite Comms Working Group

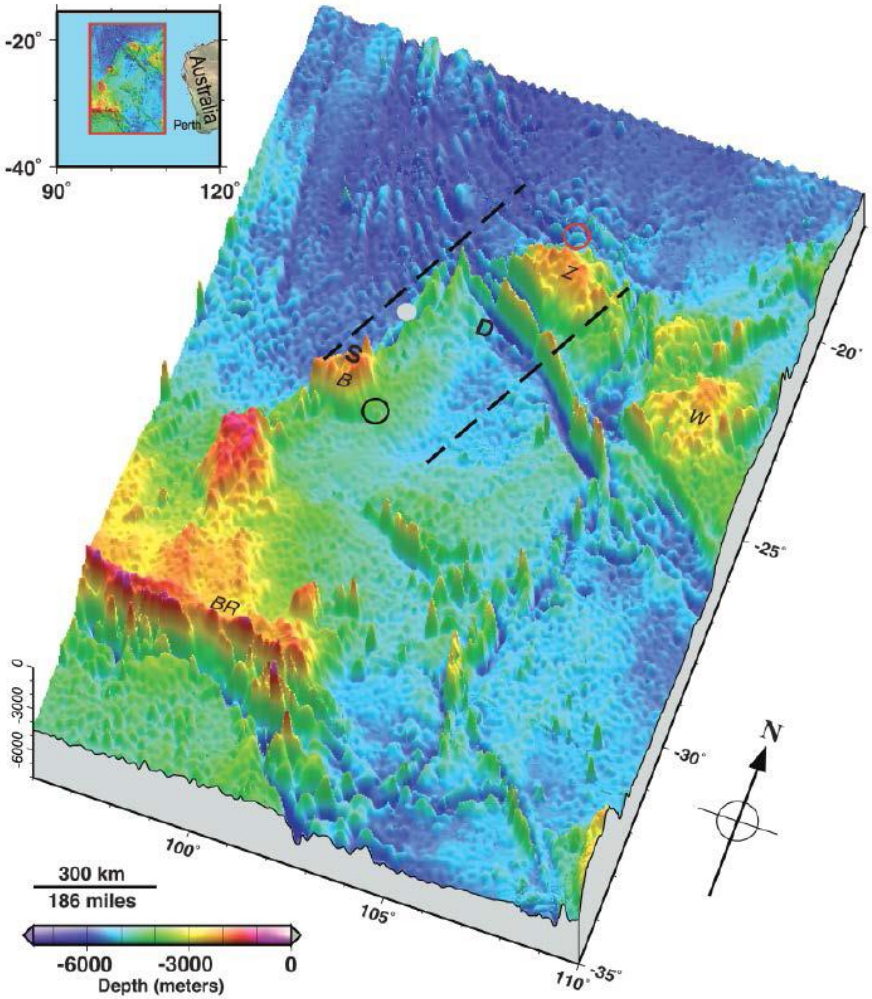

8 March
Beijing
CHINA
INDIA
Bay of Bengal
Satellite position: 35,800km above sea level
Indian Ocean
Range of plane travelling in a straight line for 7 hours
RAAF Learmonth
AUSTRALIA
Perth
Andaman Sea
01:19 Final contact with air-traffic control
02:15 Last contact with military radar
MALAYSIA
00:41 Departs Kuala Lumpur for Beijing
INDONESIA
Signals detected 5-8 April
Search areas
Priority search area - 26 June
Initial underwater search - April
Flight's planned route
Flight detected by radar
08:11 Final satellite communication - plane was somewhere along arcs
1,000km
1,000 miles
Source: Malaysian government, Australian Maritime Safety Authority

Overview Map



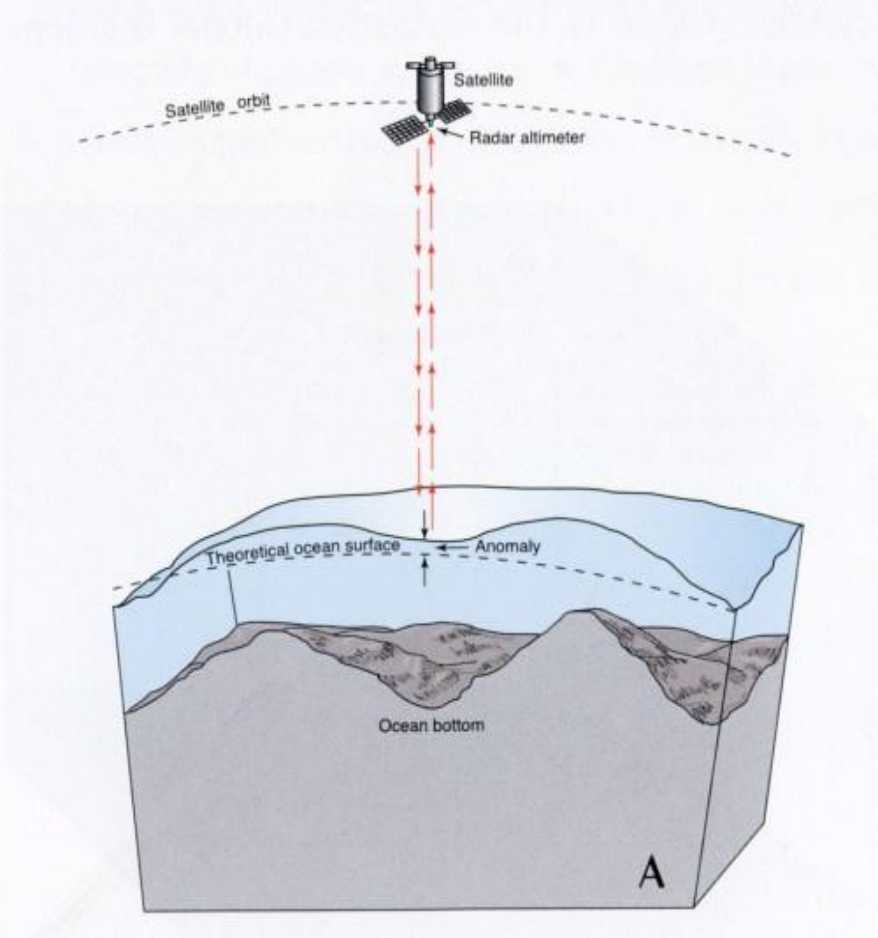
What do we know about this area?

- Available depth measurements cover only 5% of the area.
- Only few measurements were acquired with modern acoustic (single beam) equipment and positioning.
- Positioning mostly by dead reckoning or intermittened Transit satellites.
- Satellite altimetry provides some information.



What do we know about this area?

- Satellite altimetry estimates water depth by accurate and repeated measurement of the sea surface
- Depth estimates from satellite altimetry are most accurate where the oceanfloor topography is moderate and composed of ocean crust overlain by less than 200 m sediment
- Actual depth measurements have been found to be off by >250 m!

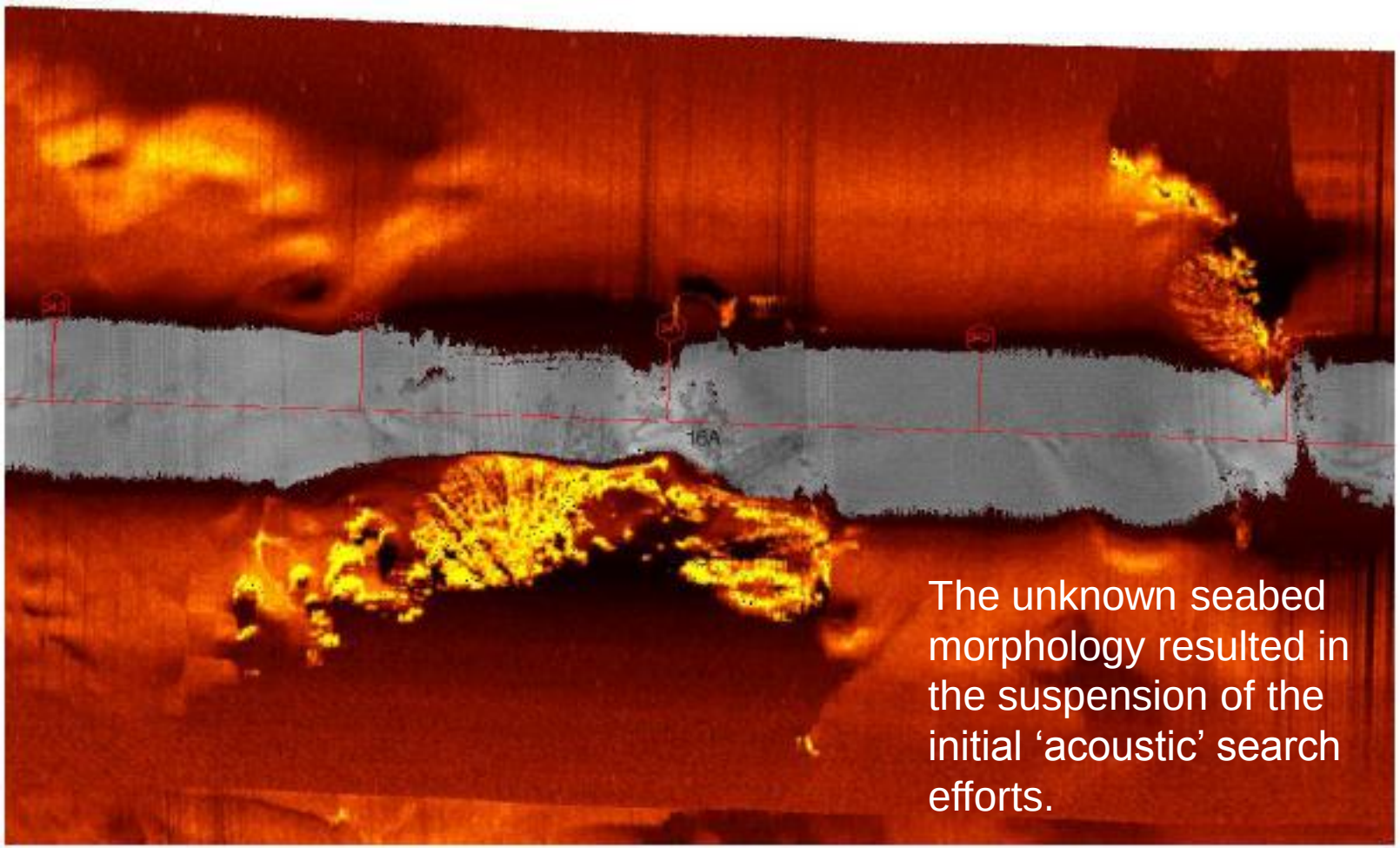


A bathymetric chart of the ocean

- Our knowledge of the ocean bottom is vastly poorer than our knowledge of the surface of Venus, Mars and the Moon!
- Satellite altimetry may be improved with new satellites but the best method for ocean bottom surveying is still a modern state of art multi beam, combined with high accuracy positioning, motion reference unit and software.
- It is estimated that it would take 200 vessel years to survey all ocean bottom on the planet > 500 m
- Typical cost would be in the order of US$ 2.8 bn (a comparison to the Rosetta space mission costing > US$ 1.7 bn)
- Published on Google Earth, accurate ocean bathymetry will be viewed by millions of people every day and will heighten the interest in “our own back yard”
- More knowledge of the ocean and ocean bottom could help to generate a better understanding of weather and climate processes; of earth geology and the geological history of the planet; or the presence of mineral resources etc.

Source: Seafloor in the Malaysia Airlines Flight MH370 Search Are Eos, Vol. 95, No. 21, 27 May 2014*a*

Deep Tow Side Scan Sonar Records

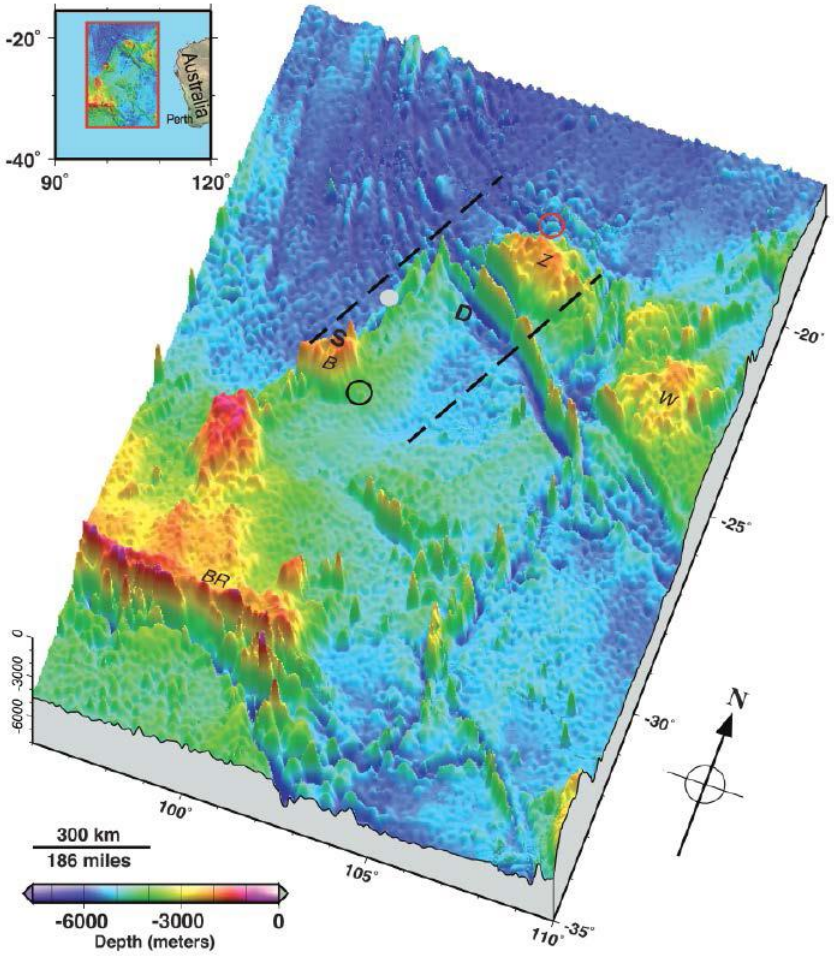


The unknown seabed morphology resulted in the suspension of the initial ‘acoustic’ search efforts.

What do we know about this area?

- The accuracy of seabed information is insufficient to plan a detailed search operation
- The depth in the area shown varies between 237 m on the Broken Ridge and 7883 m just south of the Zenith Plateau.
- The seabed records the complex geological history of the breakup of Australia, India and Antarctica approximately 130 million years ago.

Note: The AF 447 crash site had been covered for 100% with state-of-the art bathymetric surveys (MBES and GPS)

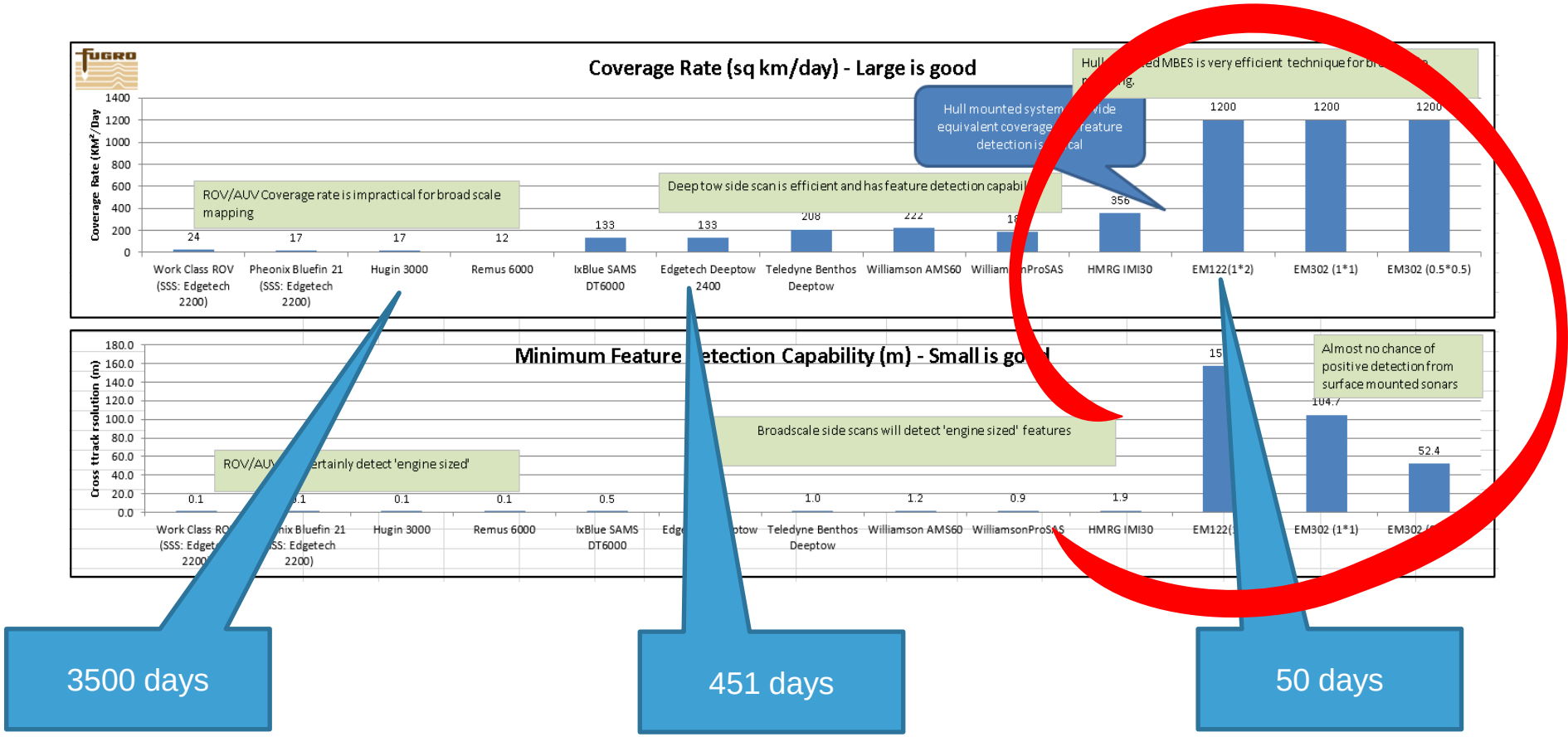


The search project

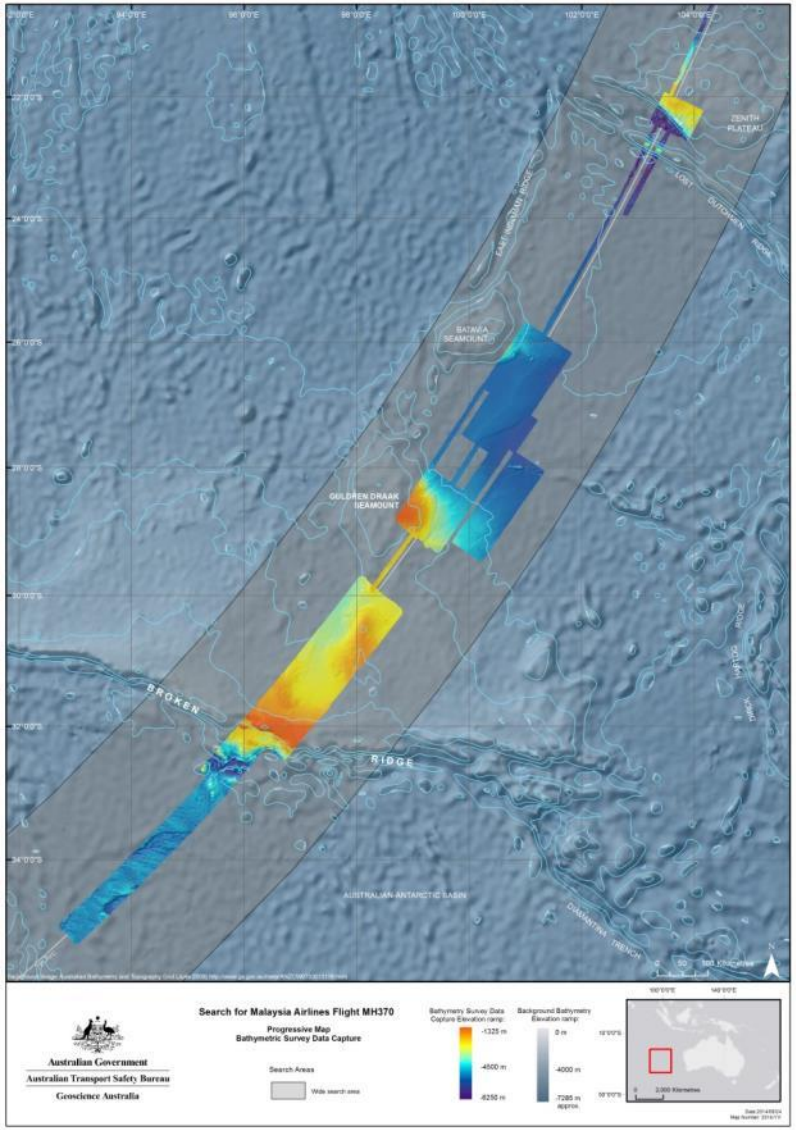
- Phase 1 - Bathymetric Survey of the Priority Area
  - Contract awarded June 10, 2014
- Phase 2 – Wide Area Search
  - Contract awarded August 7, 2014
  - Mapping and Optical Imaging
- Phase 3 – Recovery operations TBA
- Anticipated Completion – unknown

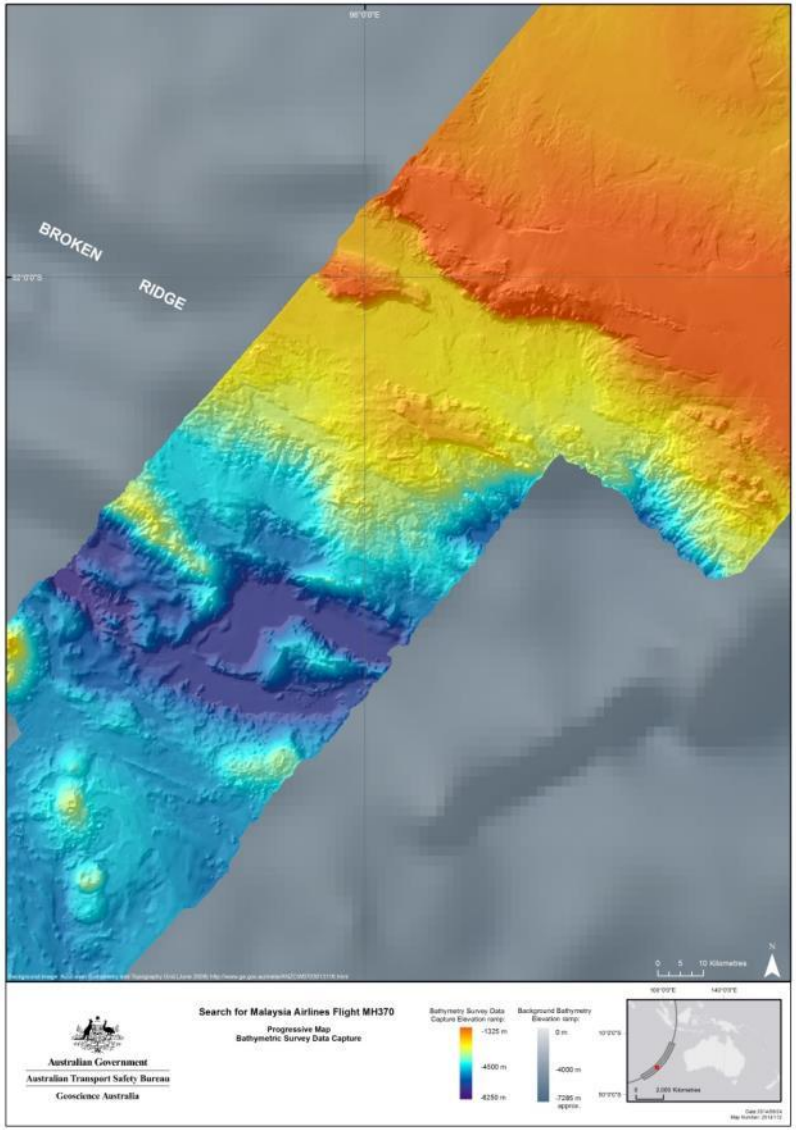
Search – Technical Evaluation

Challenge: Find the best combination of coverage rate and feature detection.

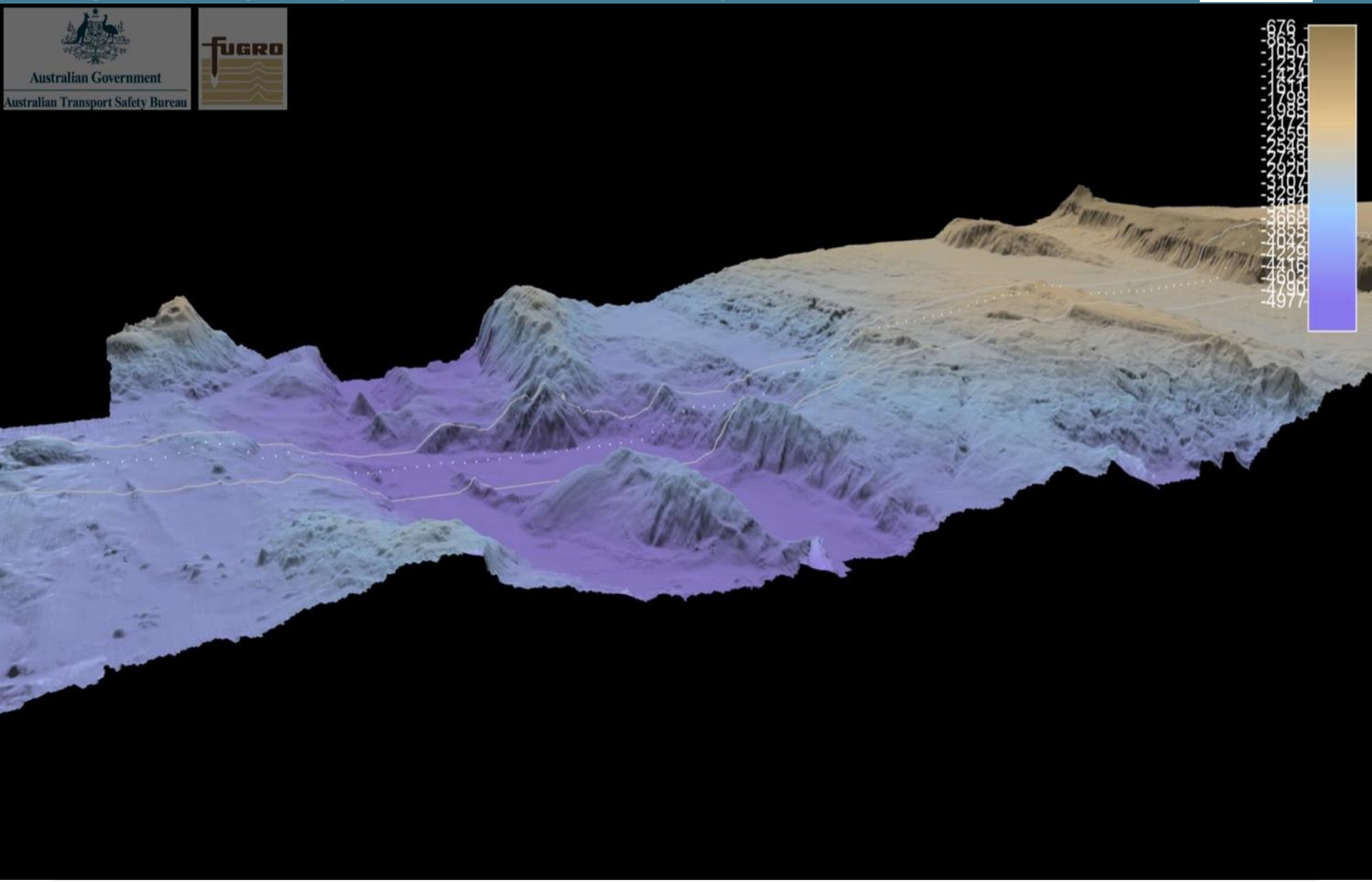


…….to survey 60,000 sq km

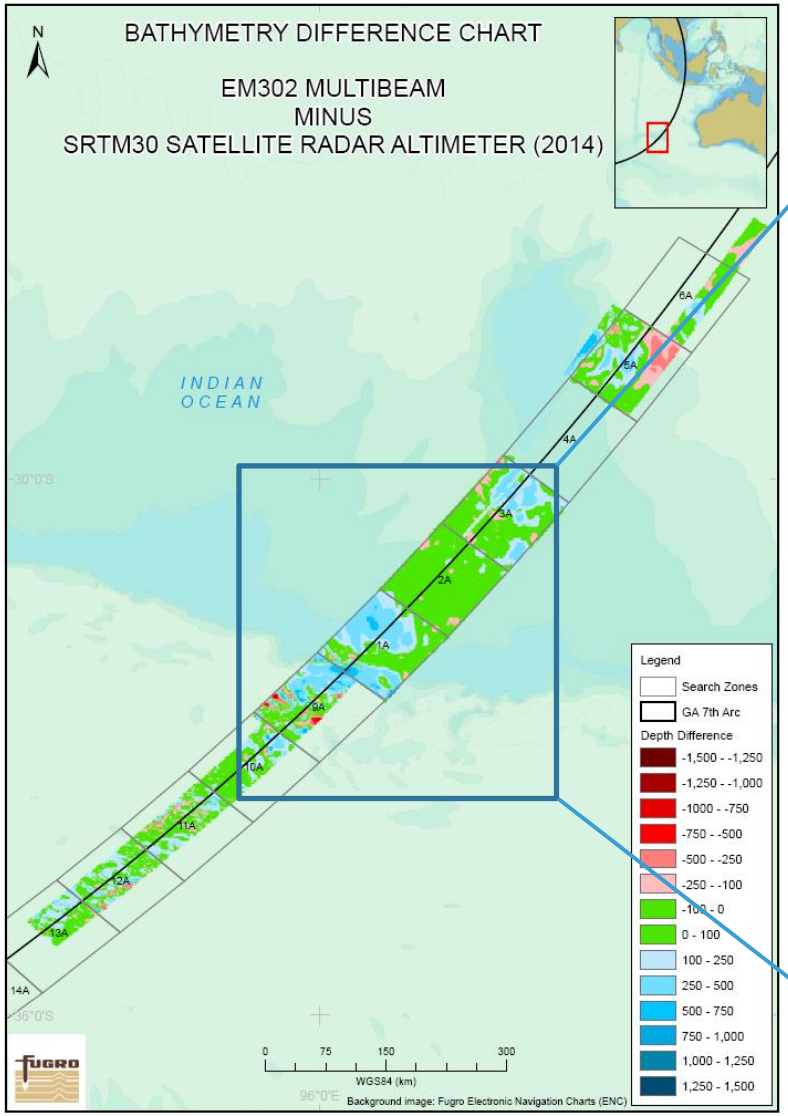

ZENITH PLATEAU
BATAVIA SEAMOUNT
GUILDREN DRAAK SEAMOUNT
BROKEN RIDGE
AUSTRALIAN-ANTARCTIC BASIN
Australian Government
Australian Transport Safety Bureau
Geoscience Australia
Search for Malaysia Airlines Flight MH370
Progressive Map
Bathymetric Survey Data Capture
Search Areas
Wide search area

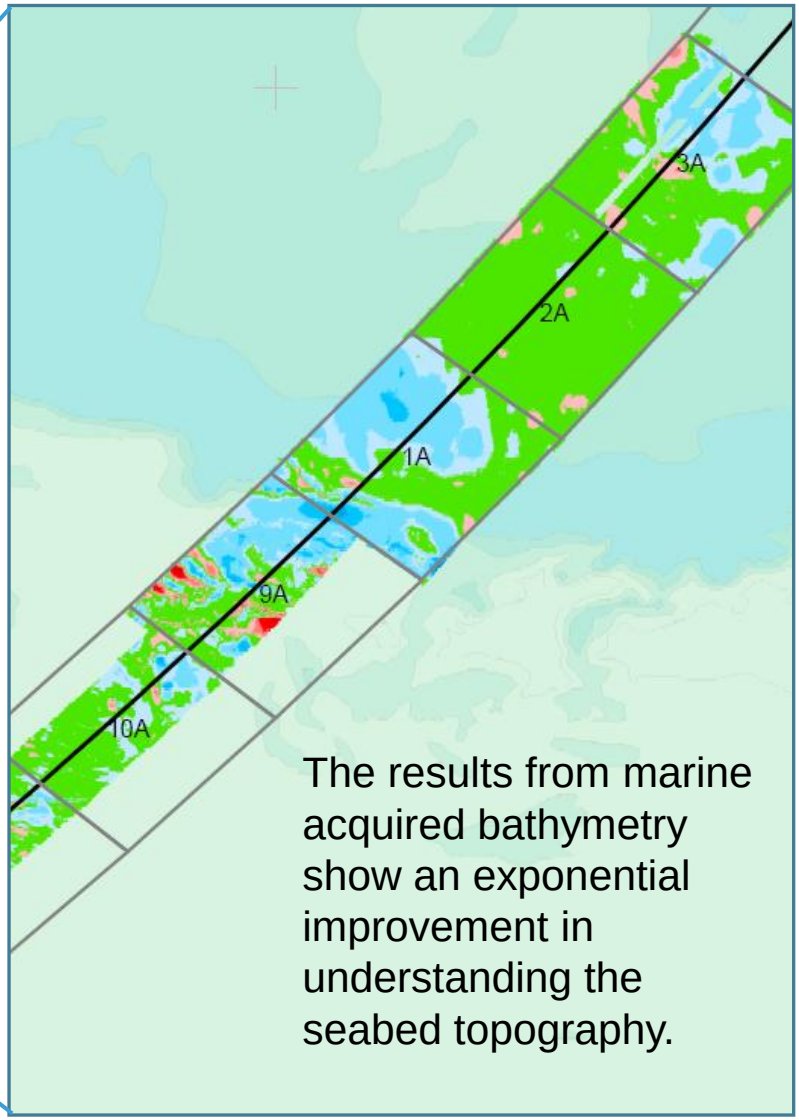

BROKEN RIDGE
Australian Government
Australian Transport Safety Bureau
Geoscience Australia
Search for Malaysia Airlines Flight MH370
Progressive Map
Bathymetric Survey Data Capture

Significant geological features - challenges



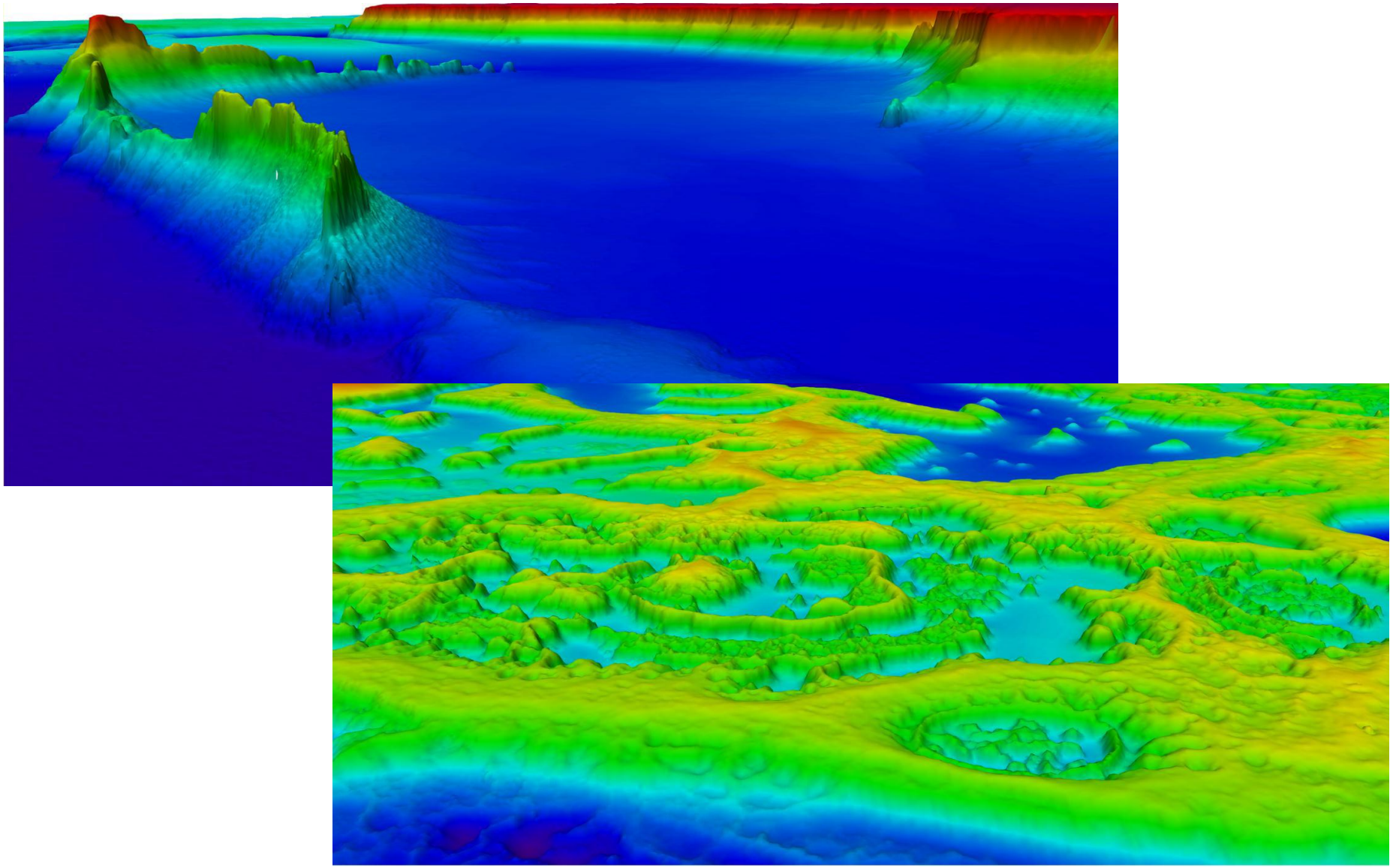
Bathymetric Difference Chart



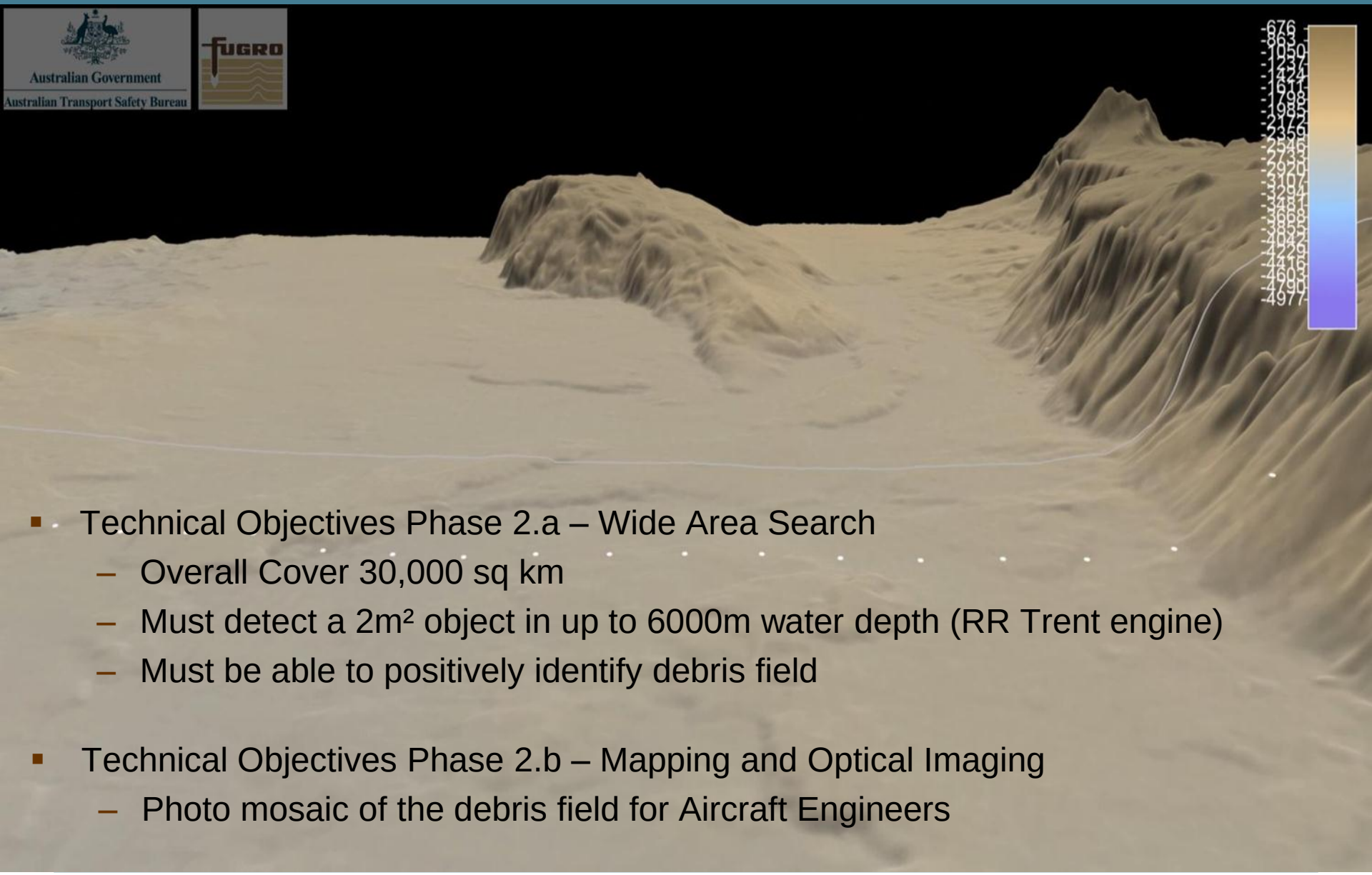


The results from marine acquired bathymetry show an exponential improvement in understanding the seabed topography.

Extreme Bathymetry in this Region



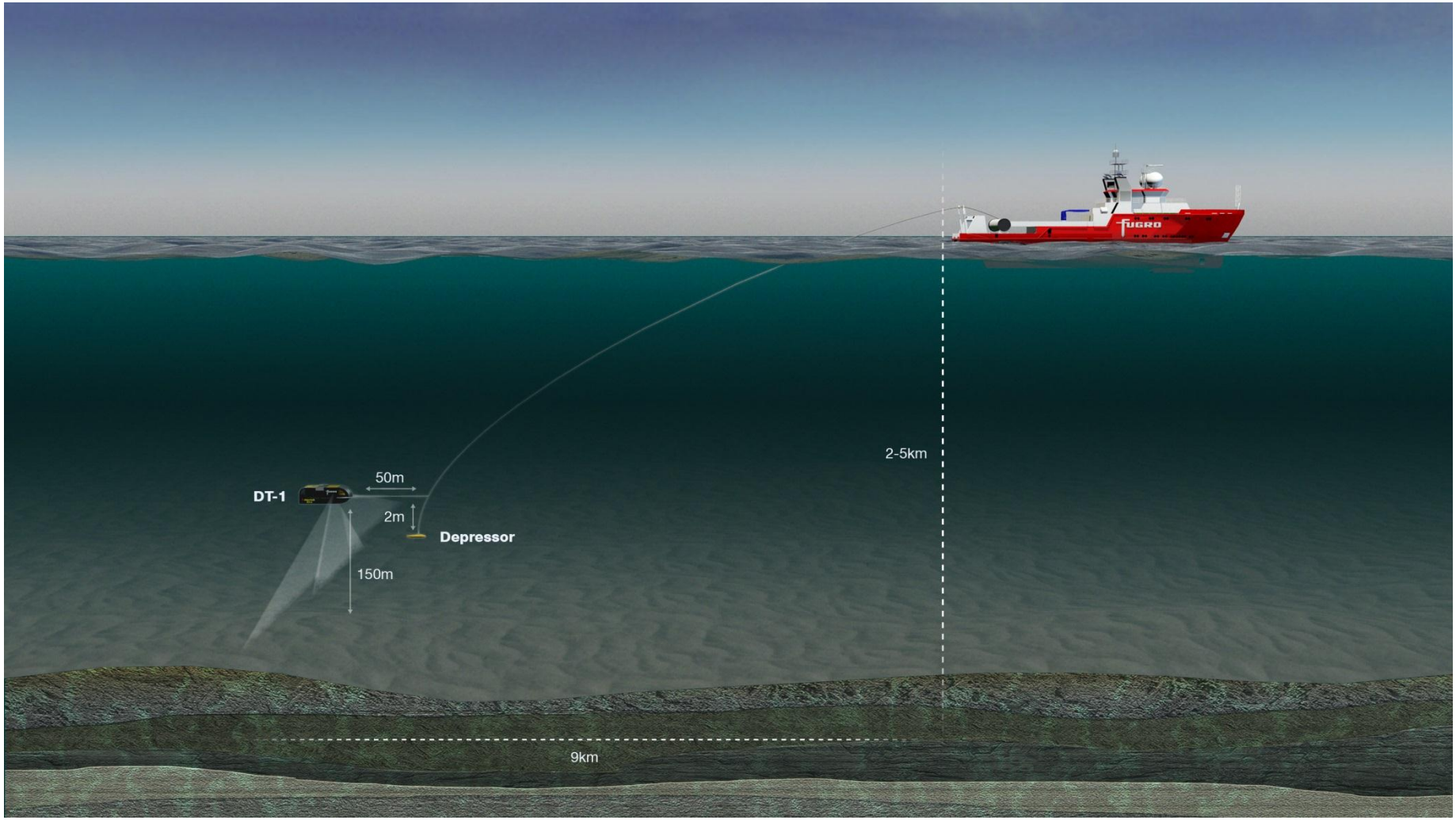
Wide Area Search Objectives



- Technical Objectives Phase 2.a – Wide Area Search
  - Overall Cover 30,000 sq km
  - Must detect a 2m² object in up to 6000m water depth (RR Trent engine)
  - Must be able to positively identify debris field

- Technical Objectives Phase 2.b – Mapping and Optical Imaging
  - Photo mosaic of the debris field for Aircraft Engineers

Phase 2.a – Wide Area Search



Phase 2.a – Wide Area Search

Wreck search techniques:

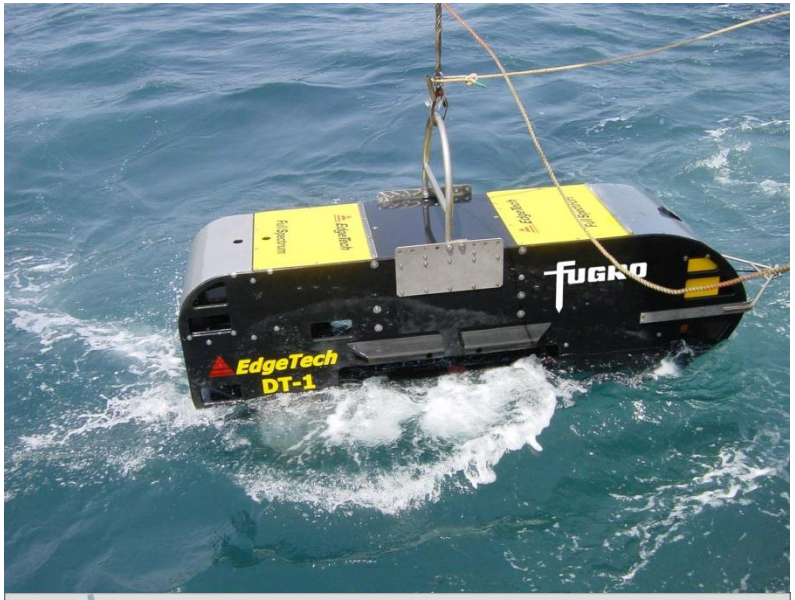
Ears - combination of (acoustic) SSS & MBES

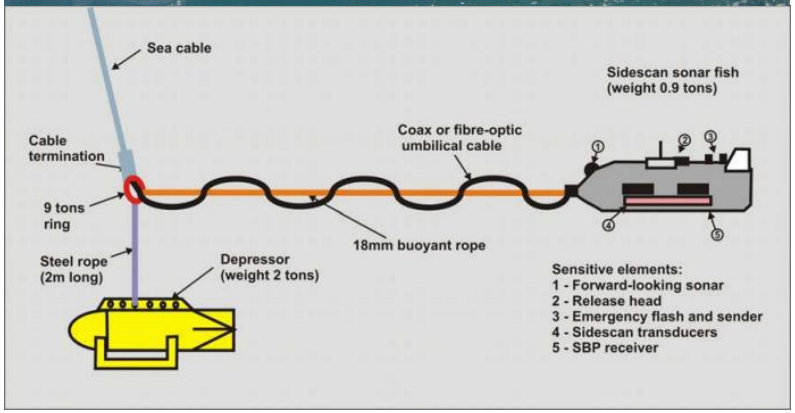
Nose - Hydrocarbon ‘sniffer’ sensors

Eyes - camera for low pass over any anomalies for visual identification

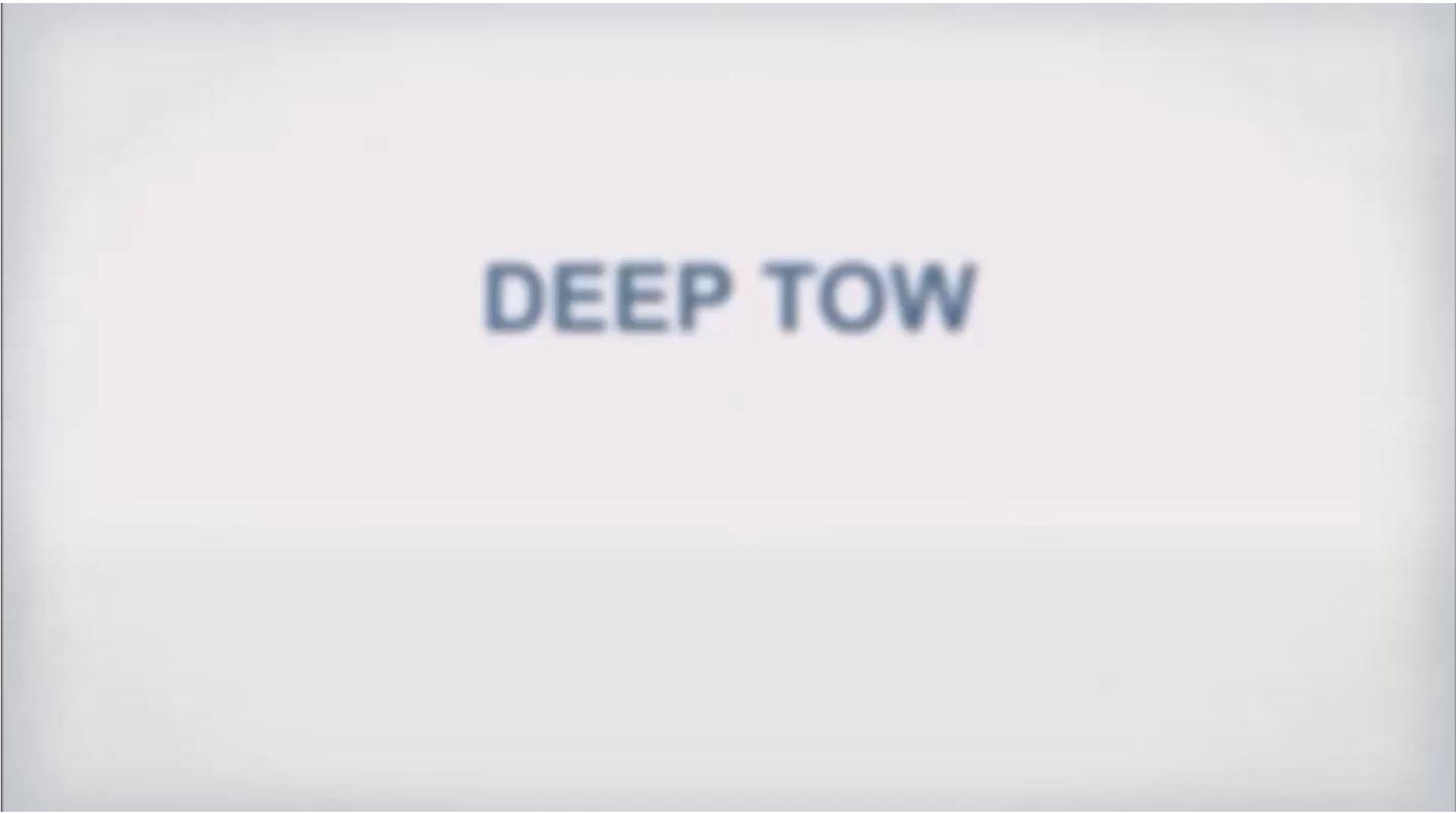
Dimensions :

Length	305 cm
Width	92 cm
Height	104 cm
Weight in air	910 kg
Weight in salt water	Positively buoyant

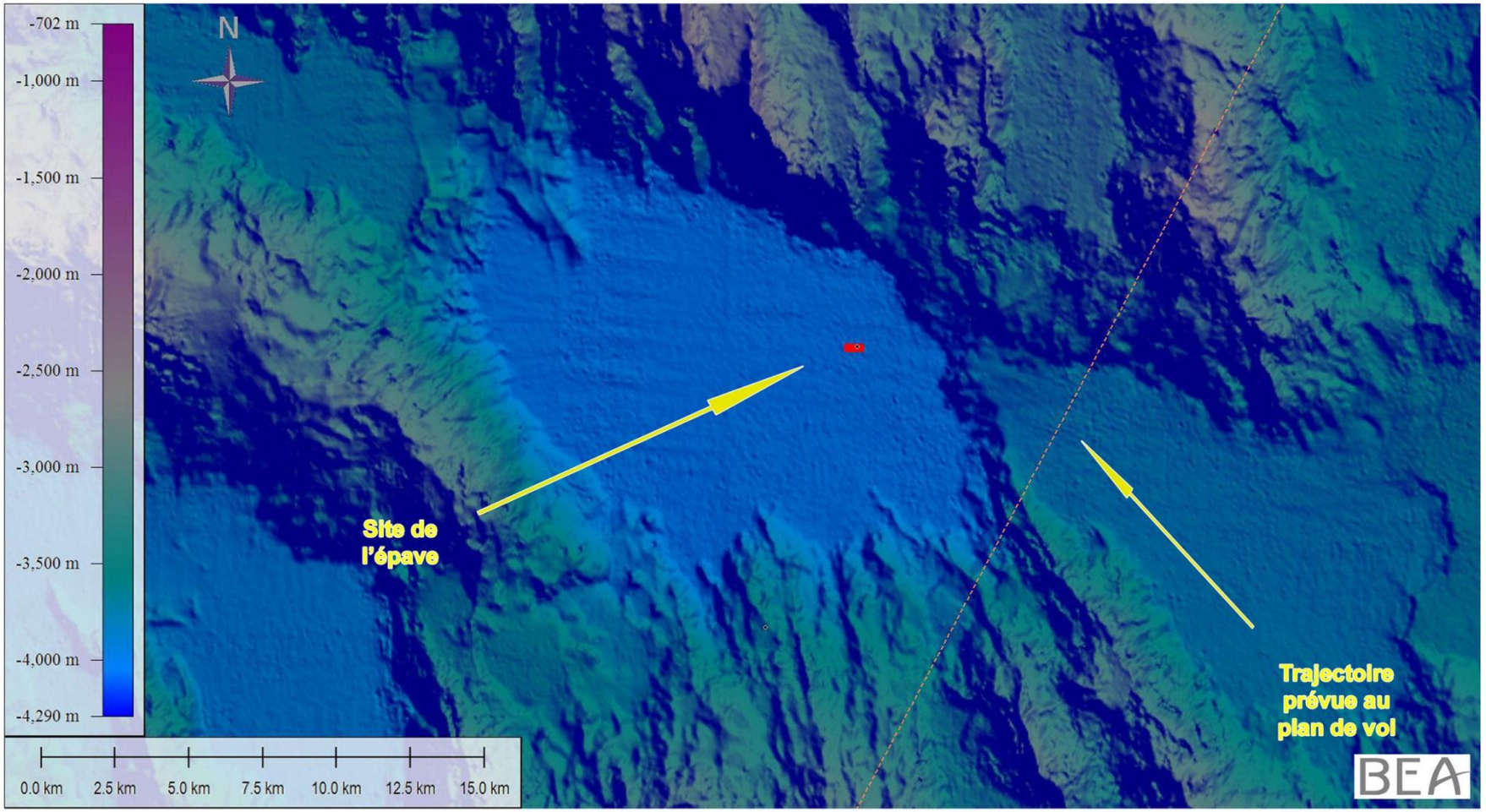




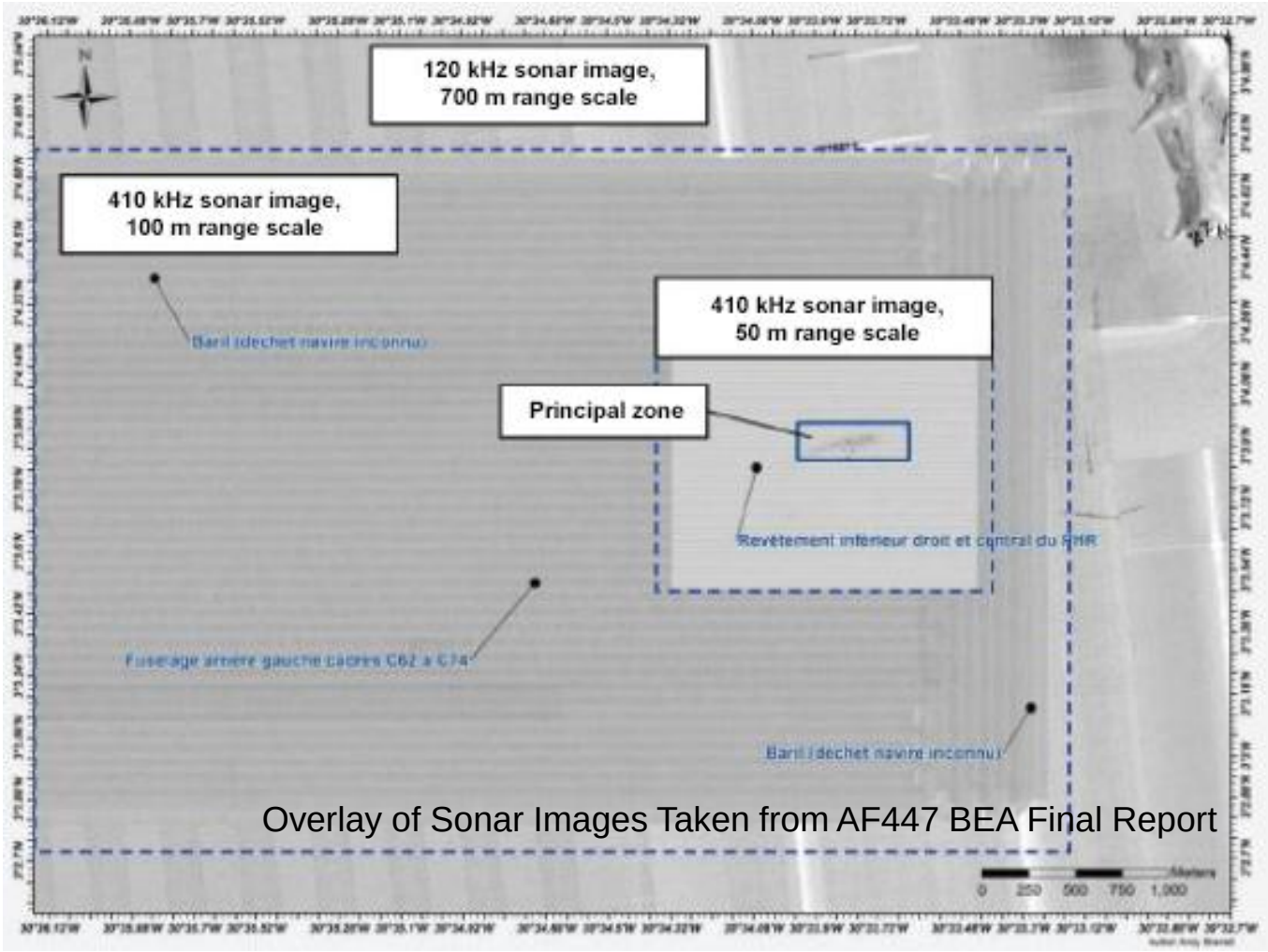
Deep Tow Survey



Air France 447 – Search area



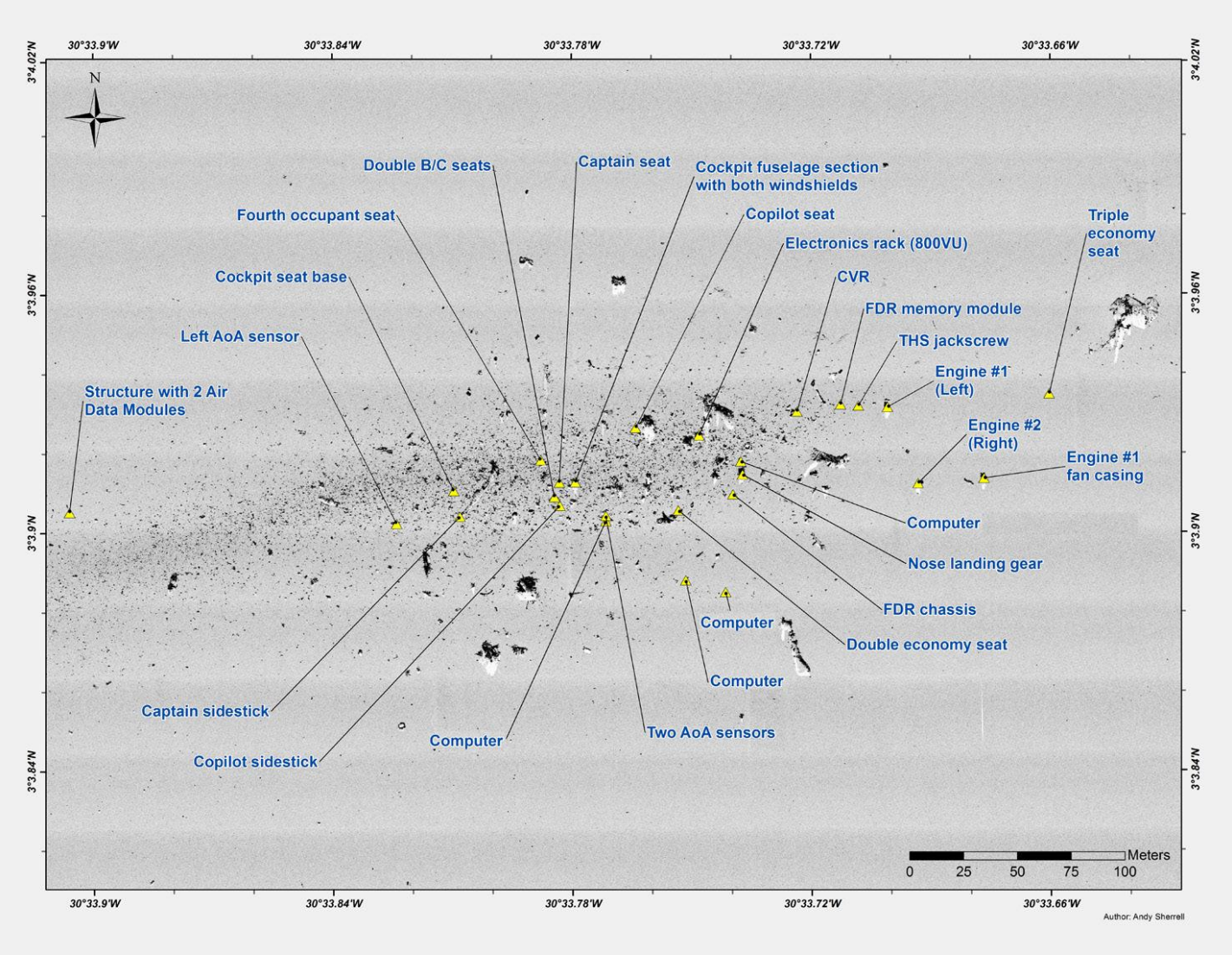
Phase 2.a – Mapping



Overlay of Sonar Images Taken from AF447 BEA Final Report

- Wide area covered by sidescan approx. 5km x 4km
- Higher frequencies used where more detail required i.e. Over the principle zone.

AF 447 – Detailed map of crash site



Phase 2.b – Optical Mapping

- Preferred Tool:
  - Autonomous Underwater Vehicles
    - Kongsberg Hugin & Remus

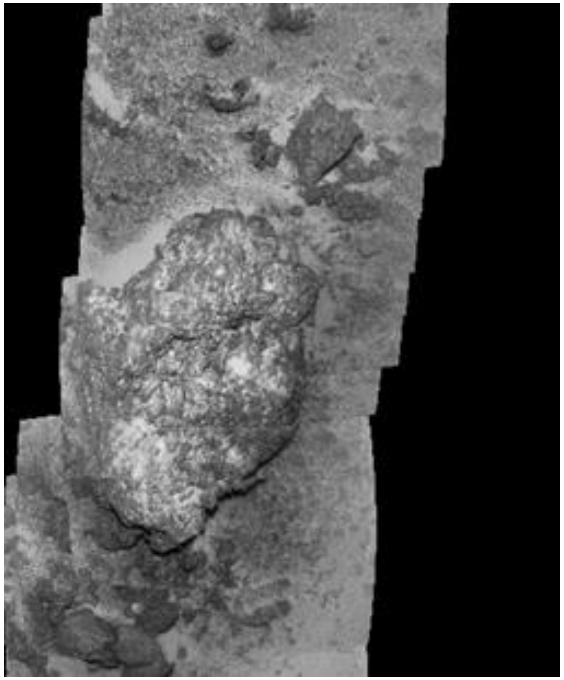
- State of the Art technology
  - Accurate, high definition 3D information
  - High definition photographs

but……..

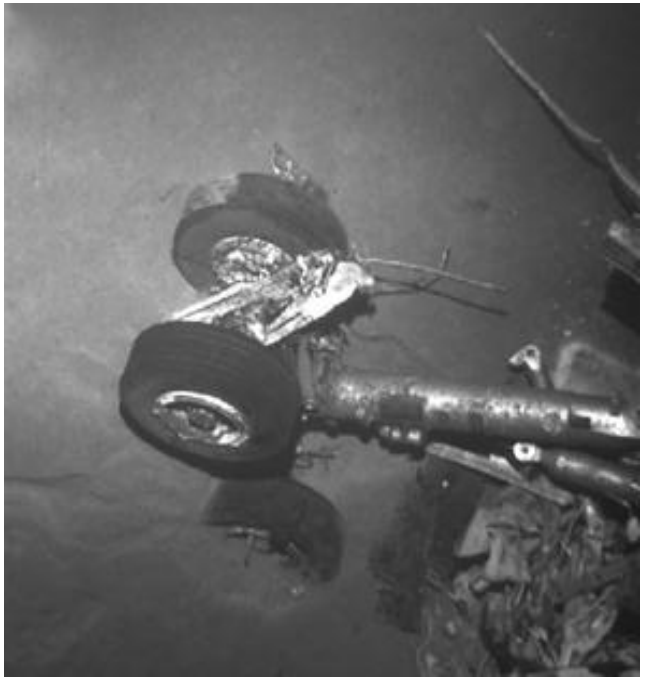
- *Proving to be very challenging and time consuming operation under the prevailing sea & site conditions.*

Phase 2.b – Optical Mosaics - AF 447 – 85,000 Photographs

Unprocessed mosaic



Processed mosaic



Visual i.d.

Processed data from the Hugin 1000 AUV camera picks out a possible man-made object, approximately 10 m in length.

Image taken using WHOI's Remus 600 during the search for Flight 447

AF 447 Flight Data Recorder

The passengers of flight MH370

The search for MH370 – Dedicated to the passengers, their loved ones and all people in the world who care.

THANK YOU