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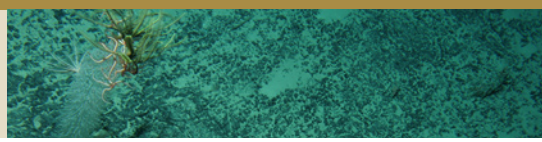
Survey of remote eastern frontier basins completed

New survey delivers high-quality prospectivity and environmental data



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A marine reconnaissance survey designed to map crustal architecture, sea-bed topography and deep sea environments in a remote eastern part of Australia's Exclusive Economic Zone (EEZ) has captured high-resolution data over the entire survey region. Shipboard gravity and magnetics are assisting in the delineation of basin geometries and structural architecture of the crust. Multibeam bathymetry data has provided a detailed map of the sea floor and assisted in the identification of sampling sites for the collection of geological and biological data in these deep-sea environments.

The seabed mapping will provide an understanding of marine habitats and biota, while subsurface imaging will be used in the assessment of the petroleum potential of selected basin areas.

Conducted between 6 October and 22 November 2007 using the New Zealand Government's research vessel *Tangaroa*, the survey was the first of a series of scientific marine reconnaissance surveys in remote frontier areas of Australia's EEZ to be completed as part of Geoscience Australia's Offshore Energy Security Program (*AusGeo News* 84).

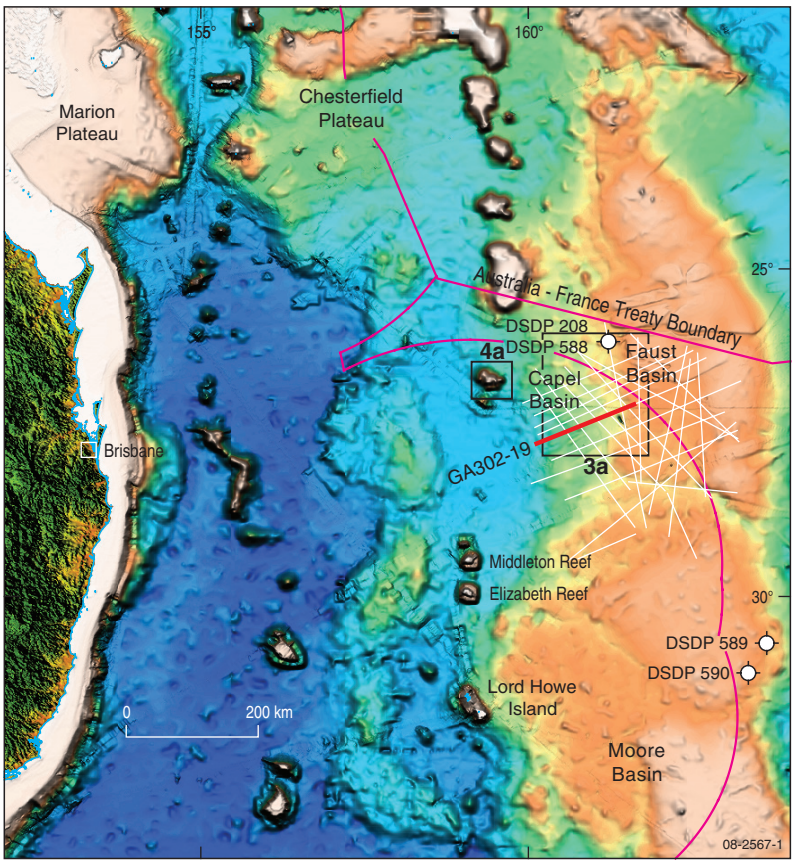

Figure 1. The study area, showing the location of S302 seismic lines (white), seismic profile depicted in figure 2 (red), political boundaries (pink) and existing drill holes.

The targeted area

The study area is 760 kilometres east of Brisbane in water depths of between 1200 and 2700 metres. Centred over the Capel and Faust Basins (figure 1) the study area forms part of a submerged marginal plateau that extends for nearly 1600 kilometres offshore of eastern Australia. A second study area, the Gifford Guyot, about 600 kilometres east of Brisbane, was selected to investigate the physical environments and ecological significance of seamounts. Water depths around this seamount are between 250 and 3100 metres.

Data and information gathered build on previous Geoscience Australia surveys—the AUSFAIR MD 153 survey in 2006 and the Capel–Faust S302 seismic survey completed in early 2007 (*AusGeo News* 86).

The Capel and Faust Basins are a frontier area for scientific investigations and have potential

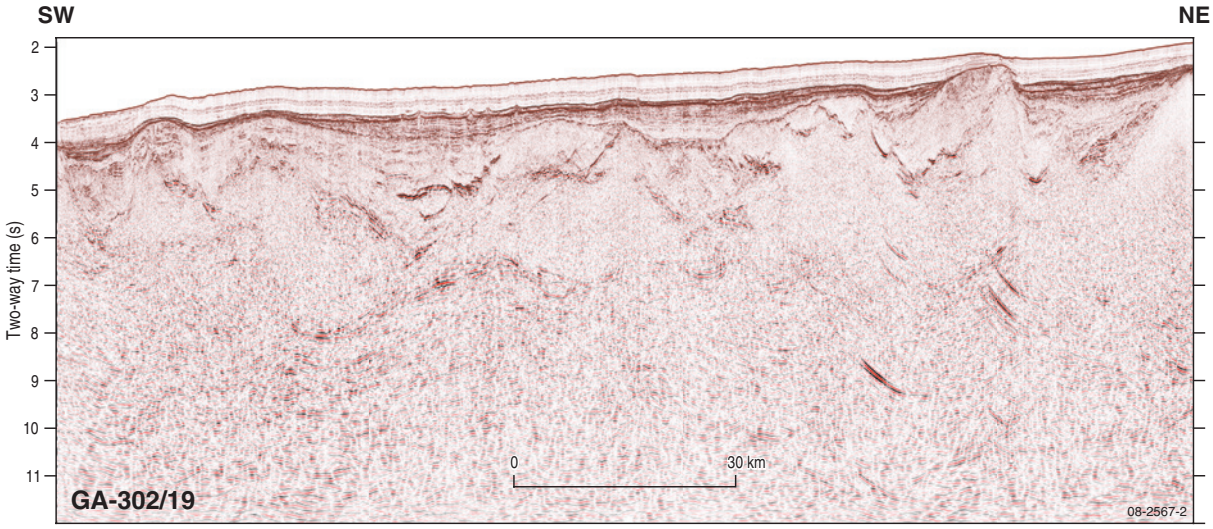

Figure 2. Profile along Line 19 of the S302 seismic survey, revealing a number of sediment-filled depocentres. The line location is shown in figure 1.

for petroleum exploration. Before the S302 survey, the seismic coverage of the area was sparse, comprising lines acquired during the Shell RV *Petrel* survey and the Australian Geological Survey Organisation S177 (1996) and S206 (1998) surveys. The only significant drilling to date consists of two Deep Sea Drilling Program holes, DSDP 208 and 588 (figure 1), which reached a maximum depth of 594 metres below the seabed in nannofossil chalk of Upper Maastrichtian (Cretaceous) age.

The MD 153 and S302 surveys in 2006 and 2007 collected new geophysical and sample data in a preliminary assessment of the area for its petroleum prospectivity. The S302 survey acquired approximately 6000 kilometres of high-quality 2D seismic data with line spacing of 15–35 kilometres, which revealed the presence of many new depocentres within the area, containing up to seven kilometres of sediments (figure 2).

Although modelled satellite gravity data provided an indication of the spatial extent of the depocentres, the seismic coverage was insufficient to validate the earlier gravity interpretations. Hence, a geophysical dataset that included shipboard gravity, magnetics, and multibeam sonar was required to map basin depocentres at the appropriate scale.

Objectives

The marine survey had three key scientific objectives:

- collect high-resolution geophysical data and geological samples to improve the understanding of the geological structure, evolution and petroleum prospectivity of the Capel–Faust area.
- characterise the physical properties of the seabed associated with the Capel and Faust Basins and the Gifford Guyot
- characterise the abiotic and biotic relationships on an offshore submerged plateau, a seamount, and areas associated with fluid escape features.

Seabed mapping focused on delineating the respective geomorphic features, and specifically targeted areas where the underlying geological structure (as indicated by the S302 seismic survey data) appeared to have an effect at the seabed, such as basement faults creating a potential for fluid migration to the seabed. Sediment and biological samples and video footage were collected to identify seabed features and investigate the marine life in these deep-sea environments.

Preliminary results

Over 45 days at sea, each study area was mapped for 100% spatial coverage using multibeam sonar, sub-bottom profiler, and marine magnetic and gravity

meters. At 25 000 square kilometres, the area of seabed mapped is the largest of any marginal plateau in Australia and provides some of the most detailed imagery of seabed environments for these features. Despite its size, the mapped area makes up only 0.2% of Australia's EEZ.

Multibeam sonar revealed the morphology of the seabed, while sub-bottom profiler data revealed the structure of shallow subsurface sediments. Favourable weather conditions permitted acquisition of gravity and magnetic data at a high resolution over most of the survey area, providing a dataset expected to significantly improve the quality of regional geophysical coverage and to assist in defining the basin architecture.

A total of 42 priority sites were selected for detailed investigation (figures 3 and 4), covering specific seabed environments and features that may assist in the assessment of the region's petroleum prospectivity and provide ecologically important information. A range of different samples were collected at each site to characterise the seabed geology and benthic biota (table 1).

In the Capel–Faust area, a thick blanket of pelagic nannofossil mud and sand mantles most of the seabed. Rock outcrops, mostly associated with igneous activity, are isolated. The survey revealed features and seabed habitats such as slumps, plains, ridges, volcanic cones, moats and possible mega-pockmarks. An intriguing discovery was the extensive region of polygonal faulting on the western margin of the study area (figure 3a). This seabed texture is a surface expression of the underlying faulting and is caused by sediment dewatering, a process that was captured in underwater video footage (figure 3b). This is the first time such a process has been directly observed on the Australian margin.

Preliminary analysis of the bathymetric imagery in conjunction with previously acquired seismic data indicates a generally strong spatial correlation between seabed features and the underlying geological structure. Slumps appear to be associated

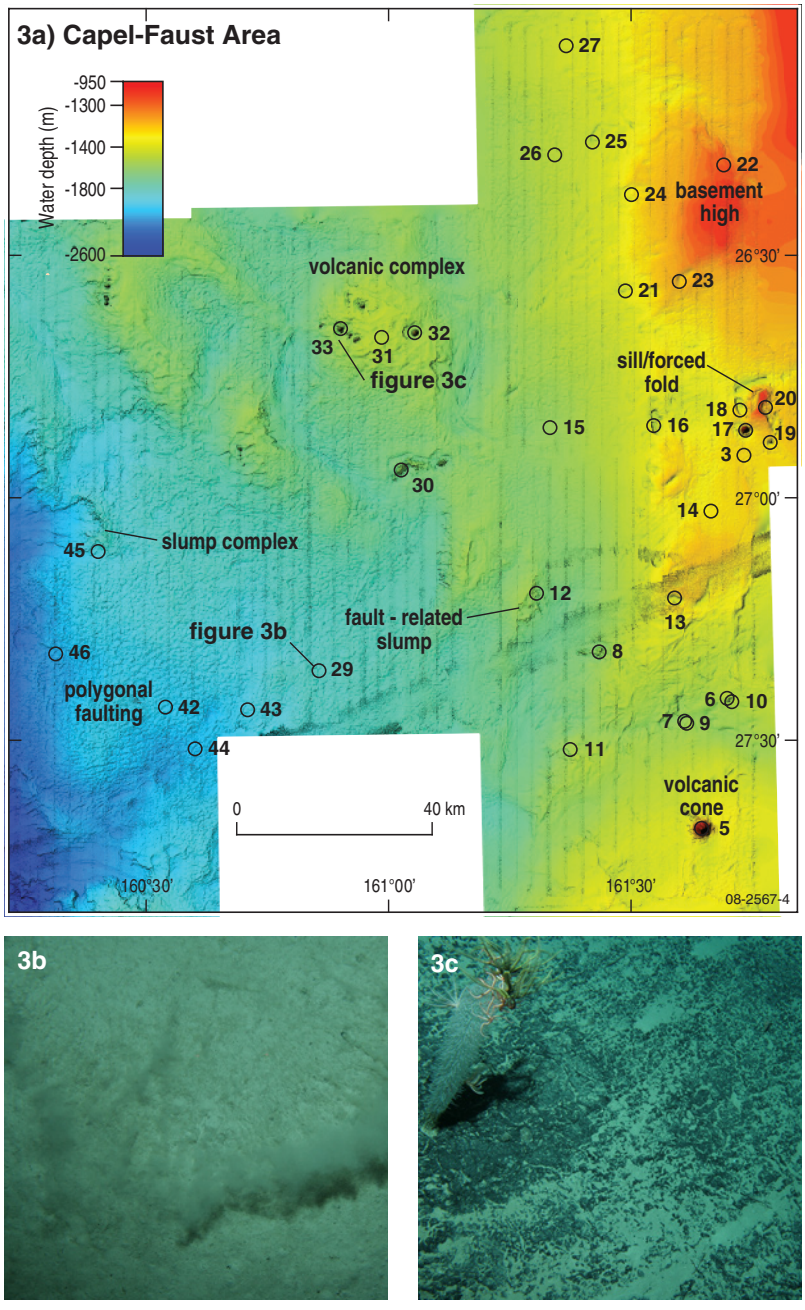

Figure 3. (a) Multibeam bathymetry image of the seabed in the Capel–Faust area, showing the sampling locations and some of the morphological features, (b) photograph of dewatering of pelagic sediments in region of polygonal faulting, (c) photograph of basalt reef containing examples of the moderate cover of benthic biota.

with areas of fluid escape, basement faults and the rugged basement topography beneath the sediment cover. The trends of some seabed features appear to follow depocentre margins, basement highs, and igneous intrusions buried by over two kilometres of sediment in some places.

Biota was sparse across the study areas. Hard substrates, which consist mainly of basalt outcrop, contained moderate biota, with many sessile organisms (figure 3c). Benthic biota was less visible in areas covered with soft sediment; those regions were characterised by numerous burrows, mounds and tracks, indicating an abundant infauna.

A secondary outcome of the survey was the detailed mapping of the Gifford Guyot, a 3000-metre undersea volcano about 600 kilometres east of Brisbane (figure 4a). High-resolution multibeam bathymetry data revealed the 15 million year old guyot to be a complex structure, comprising basalt (figure 4b) draped with pelagic nannofossil sand and mud, and characterised by numerous slumps, aprons/fans, and slides on its steep margins. At a depth of 250 metres, the relatively flat top of the guyot contained raised rocky reefs and six-metre high sand dunes.

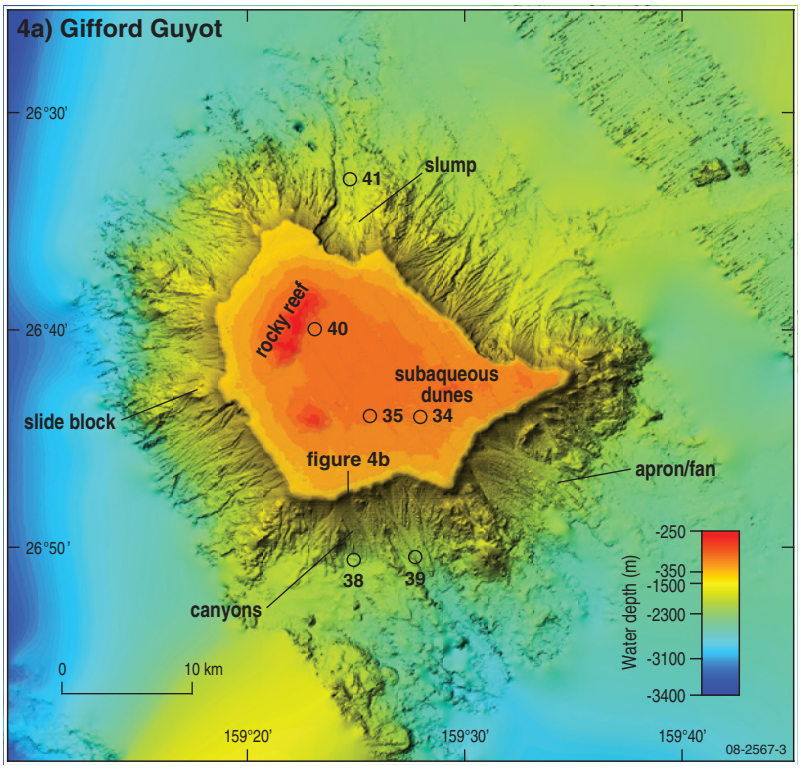

Figure 4. (a) Multibeam bathymetry image of the seabed over the Gifford Guyot, showing the sampling locations and morphological features, (b) photograph of basaltic rock recovered from the guyot flanks.

The flat top is presumed to have been formed by prolonged erosion during numerous lowstands of sea level over the past 15 million years. This spectacular feature is the first guyot to be mapped in such detail on the eastern margin of Australia, and has produced some of the best topographic data from a seamount anywhere in the world. The geophysical and geological data collected from the seamount will further our understanding of its formation and sedimentary environments. Biological data collected will help determine the significance of seamounts as hotspots for the deep-sea ecology of remote eastern Australia.

Implications

Information and data collected on the survey will be used to support the work programs of the Department of Resources, Energy and Tourism and the Department of the Environment, Water, Heritage and the Arts. These new data will be used in assessing the region's environmental significance and the design of a national system of representative marine protected areas. In addition, together with 2D seismic data acquired earlier, all information will be available, at cost of transfer, to enable industry to better assess the hydrocarbon potential of the Capel and Faust Basins.

The survey also provided an opportunity for 16 university students from Australia, Sri Lanka, Fiji and Papua New Guinea to undertake crucial training in marine science and fieldwork as part of the University of the Sea program, which is designed to provide students with opportunities which would otherwise not be available to them.

Table 1. Data collected on the survey.

Data type	Total recovery
Geophysical	
Multibeam sonar	25 800 km^2
Sub-bottom profiler	10 900 line-km
Gravity and magnetics	10 900 line-km
Physical	
Camera tows	42 (>40 hours video and >4000 still images)
Box cores	15
Piston cores	14
Rock dredges	13
Benthic sleds	11
Conductivity, turbidity, and depth casts	7
Grabs	3

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