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The Mellish Rise — A BIG PIECE OF THE CORAL SEA GEOLOGICAL JIGSAW PUZZLE

Geoscience Australia's contribution to understanding one of the least known parts of Australia's marine jurisdiction.

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In January–February 2005, Geoscience Australia used the National Facility research vessel *Southern Surveyor* to study the Mellish Rise and adjoining Kenn Plateau in the Coral Sea, east of Queensland (figure 1). Ship time was provided by the Steering Committee of the National Facility *Southern Surveyor*. The voyage was led by Dr Neville Exon of Geoscience Australia, who led an earlier survey to the Kenn Plateau in May 2004 (see *AusGeo News 75* at www.ga.gov.au/ausgeonews/archive/200410.jsp).

The shipboard team consisted of a core of Geoscience Australia technicians and scientists supported by scientists from the Geological Survey of Queensland, the Australian National University and the University of Sydney. CSIRO provided technical support, and P&O Australia provided the vessel's crew.

Regional setting

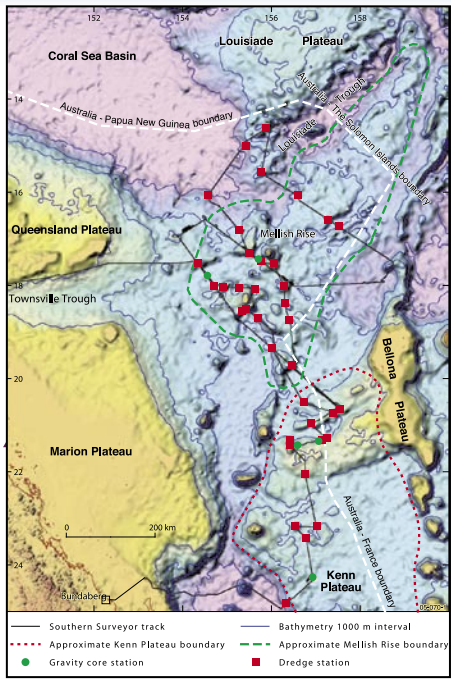
Most of the work was undertaken on the Mellish Rise, a large, complex, northeast-elongated, dissected block. It is believed to have separated from the Australian continental margin as a result of extension between the Australian, Lord Howe Rise and Louisiade Plateau crustal elements from about 52 to 62 million years ago.

The Mellish Rise's northwest margin is separated from the Louisiade Plateau by the Louisiade Trough, which may have been the prolongation of a Townsville Trough rift system before evolving into an arm of a triple junction developed between the rise and Marion Plateau (figure 1). The arcuate south-eastern margin, bordering the Kenn and Bellona Plateaus, may have formed as a strike-slip fault between the triple junction to the west and the seafloor-spreading system along the Rise's eastern margin.

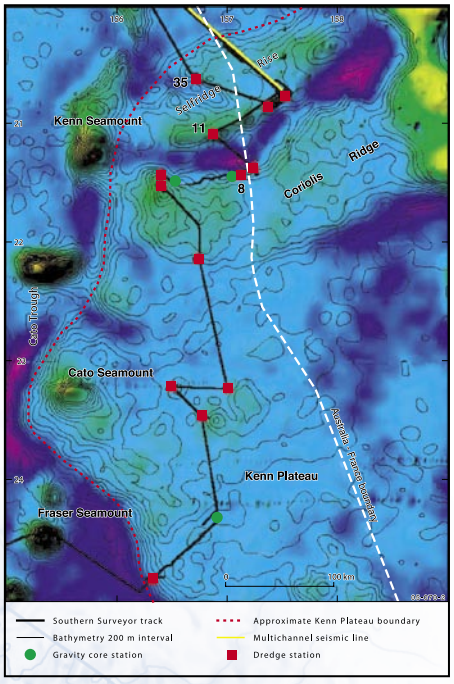
Lying mainly in water depths between 500 and 3000 metres, the Mellish Rise's total area is about 200 000 km², of which about 150 000 km²—an area twice as large as Tasmania—is under Australian jurisdiction. The eastern part of the Rise is French (New Caledonian) territory, and the northern section is Solomon Islands territory (figure 1).

Acquisition program

Previous geophysical surveys over the Coral Sea, largely undertaken as part of the Continental Margins Program by the former Bureau of Mineral Resources in the early 1970s, did not include rock sampling to enable dating and determination of the nature of the sedimentary strata and basement rocks. The latest survey (figures 1 to 3) acquired 40 dredge hauls of rocks (14 over the Kenn Plateau and 26 over the Mellish Rise), ~1200 km of multichannel seismic profiles, ~2000 km of magnetic profiles and ~7000 km of multibeam sonar data (i.e. ~18,000 km² of seabed coverage). The dredging of the Mellish Rise largely completes the geological sampling of all major plateaus off Australia, at least to reconnaissance level.



▲ **Figure 1.** Location of the Mellish Rise and Kenn Plateau in the Coral Sea, showing the track of the *Southern Surveyor* and the locations sampled. The background image shows regional bathymetry. The Mellish Rise comprises probable rifted continental and oceanic fragments.



▶ **Figure 2.** The complexity of the Kenn Plateau area is evident in this map of the Earth's gravity field recorded from satellites and ship surveys. Details of the *Southern Surveyor* survey are shown, including the positions of three key dredge sites.

Complex dissected area

The Mellish Rise and Kenn Plateau form a complex area (figures 1 to 3). The seismic and multibeam data show that the rise is much like a dissected plateau, largely formed of irregularly shaped highs separated by valleys. The highs are fault-bounded basement blocks crowned in places by seamounts (for example, Mellish Reef in figure 3). Seismic profiles show that the valleys are characterised by several thick sequences, with the upper sequence thin across the highs.

The sequences in the valleys appear to comprise at least three packages: Late Cretaceous – Early Palaeocene (100–60 Ma), Late Palaeocene – Eocene (60–34 Ma) and Oligocene and younger (33–0 Ma). Several phases of tectonism are interpreted. The oldest package is related to rifting and subsequent break-up of the east Gondwana margin. The transition from the middle to youngest package is related to the onset of a period of compression from the east in the Eocene (~ 40–45 Ma).

Volcanic edifices such as the seamount underlying the Mellish Reef (figure 3) are probably part of the Tasmantid seamount chain, which was formed 30–35 million years ago and extends southward down the east Australian margin to east of Tasmania.

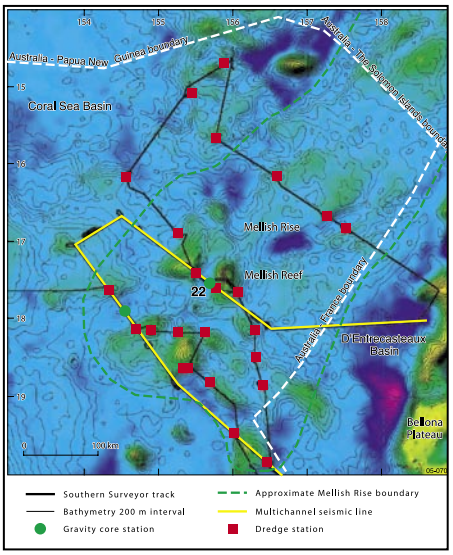


Figure 3. The complexity of the Mellish Rise is evident in this map of the Earth's gravity field recorded from satellites and ship surveys. Details of the *Southern Surveyor* survey are shown, including the position of a key dredge site (dredge 22).

Dredge information

Many types of rocks were dredged and sediment cores taken during the survey. The cores recovered mainly calcareous and foram nanno ooze. The 40 dredges (figure 1) sampled a diverse suite, including mostly siliciclastic sediments, calcarenites, felsic volcanic rocks, volcaniclastic rocks, basalts, dolerites and ubiquitous manganese crusts.

The Coriolis Ridge was sampled by dredge 8 (figure 2), which brought up sandstone and revealed a volcanic terrain supporting continental felsic volcanics. This demonstrates a continental origin for Kenn Plateau basement. Further to the north, at dredge sites 11 and 35 (figure 2) on the Selfridge Rise, just beyond the southern edge of the Mellish Rise, hauls including metamorphic quartzite and hard quartz-rich sandstone rocks further support a continental origin for the plateau and, probably, the adjoining Mellish Rise.

Typical volcanic seamount rocks and capping reefal rocks, such as basalt and calcarenite, were dredged from the seamount hosting the Mellish Reef in the centre of the Mellish Rise (dredge 22 on figures 3 and 4). If the basaltic material can be dated, this may provide the most northerly and oldest date for the Tasmantid seamount chain.

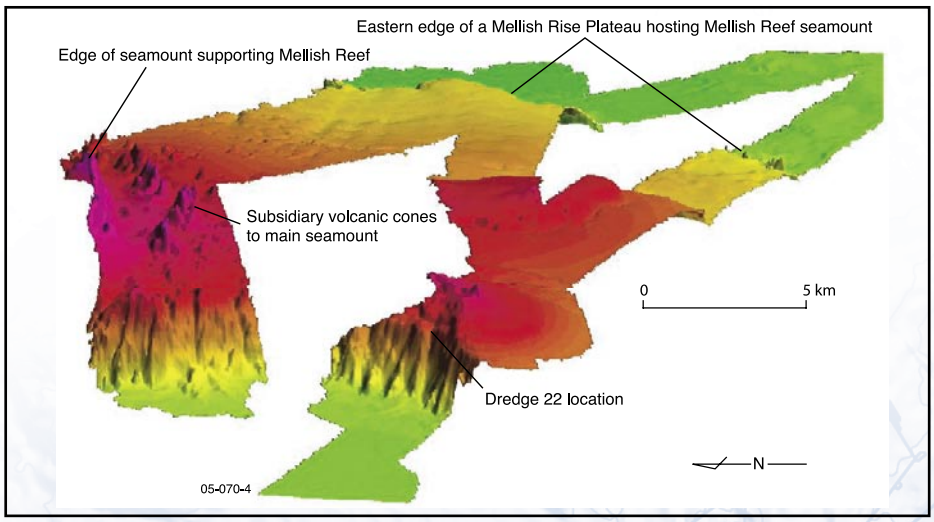


Figure 4. Example of seafloor multibeam sonar coverage south of the Mellish Reef. The site where rocks from dredge 22 were obtained is shown.

Further analysis

An excellent understanding of the geological composition and evolution of the Mellish Rise and Kenn Plateau region is expected to be gained from the interpretation of seismic profiles and seafloor morphology, petrological examination, and nannofossil and foraminiferal evaluation of the sedimentary rocks now underway. These studies will provide insight into the nature of the basement rocks underpinning the Mellish Rise, which is probably a mixture of older continental rocks and younger oceanic basaltic volcanics. The information gained will enable further refinement of the complex break-up and seafloor-spreading history of the southwest Pacific in current tectonic models. Information on seafloor morphology and sediments will also contribute to future marine planning for the area.

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