Marine GeoSolutions (Pty) Ltd was contracted by the National Research Foundation (NRF) of South Africa to undertake a multibeam bathymetric survey of the northern KwaZulu-Natal submarine canyon system to define potential coelacanth habitats for the SA Coelacanth Conservation and Genome Resource Programme. Five survey blocks were defined to include all the known submarine canyons in the area. The survey blocks were systematically surveyed to develop a series of colour-draped bathymetric maps and three-dimensional models of the canyons. These maps were then used to provide information for potential submersible dive sites and produce the basal layer of a marine GIS (Geographical Information System).

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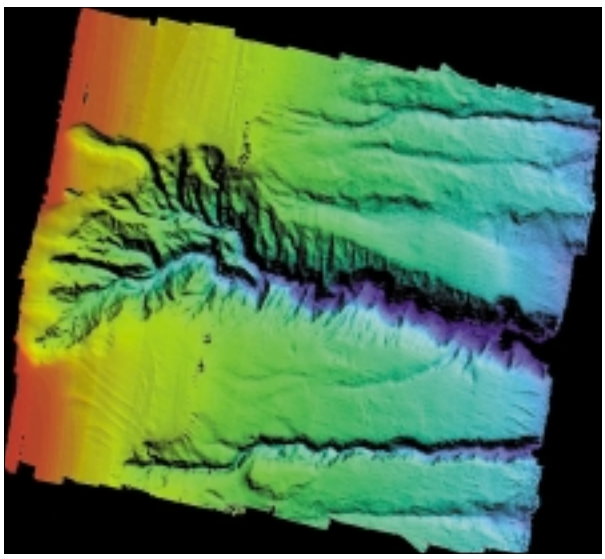
Multibeam Bathymetric Survey Defines Coelacanth Habitat

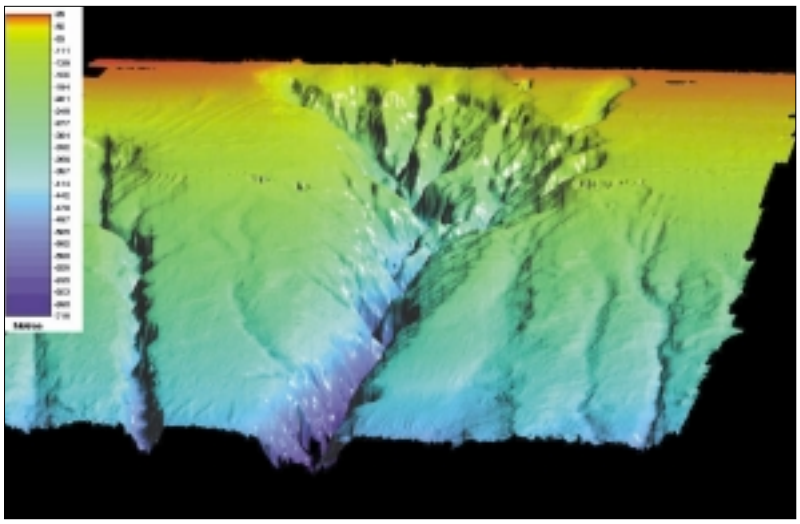
Dubbed a 'living fossil', the coelacanth is a unique fish with a history steeped in science and imagination. The coelacanth evolved 400 million years ago and lived alongside the dinosaurs. After disappearing from the fossil record 80 million years ago, scientists believed they were extinct until the discovery of a coelacanth specimen off East London, South Africa in 1938. The appearance of this 'dinofish' was hailed as the greatest biological discovery of the 20th century, the equivalent of finding a live dinosaur. Current evidence suggests that coelacanths exist in small populations, produce few young, and are specifically adapted to particular marine habitats. The coelacanth is formally recognised as an endangered species. The coelacanth remained scarce, but small populations were discovered in the Comores in 1952, Mozambique in 1991, Madagascar in 1995, and Indonesia in 1998. These populations were encountered in water depths in excess of 200 metres, making them difficult to study. In November 2000, off the coast of South Africa, recreational divers observed six coelacanths in 104 metres of water in the Greater St Lucia Wetland Park World Heritage Site near Sodwana Bay. For the first time, relatively shallow water depths in close proximity to the shore coupled with the accessibility of Sodwana Bay, presented an unrivalled opportunity to study the fish in detail. The South African Coelacanth Conservation and Genome Programme, formed by a coalition of scientific organisations, is at the vanguard of international research in marine geophysics, biology, genomics, and conservation science pertaining to coelacanths.



Colour-draped bathymetric map of Leven Canyon, data collected using a Reson SeaBat 8111 multibeam echo sounder

Multibeam Mapping Programme

In March and April 2002, the programme began preliminary research in the marine protected area off Sodwana Bay. The first phase was a geophysical survey performed by Marine GeoSolutions (Pty) Ltd, with the assistance of Octopus Marine, using a Reson SeaBat 8111 multibeam echo sounder. Acquisition of the 8111 bathymetry data were accomplished using Reson's 6042 multibeam acquisition and presentation software. The bathymetric data were edited for anomalous values, swell filtered, gridded and corrected for tidal variation and reduced to MSL using Caris HIPS. The gridded bathymetric data were imported as ASCII data into ERMapper for image rendering and contouring at a 10m intervals.
The survey collected invaluable bathymetry data of the submarine



Three-dimensional map of Leven Canyon, data collected using a Reson SeaBat 8111 multibeam echo sounder

canyons of the Greater St Lucia Wetland Park. Numerous unknown canyons were mapped to produce an accurate Geographic Information Systems (GIS) basal layer on which to plan future exploration.

After predetermining the search area using the SeaBat 8111, the FRS Algoa along with the Jago submersible were tasked with the second research phase to:

- Define the physical structure and oceanographic habitat of the coelacanth
- Count and identify the species
- Conduct marine biodiversity and ecological research
- Collect material for genetic and stable isotope analyses
- Promote environmental education, capacity building, and public awareness

Submarine Canyons

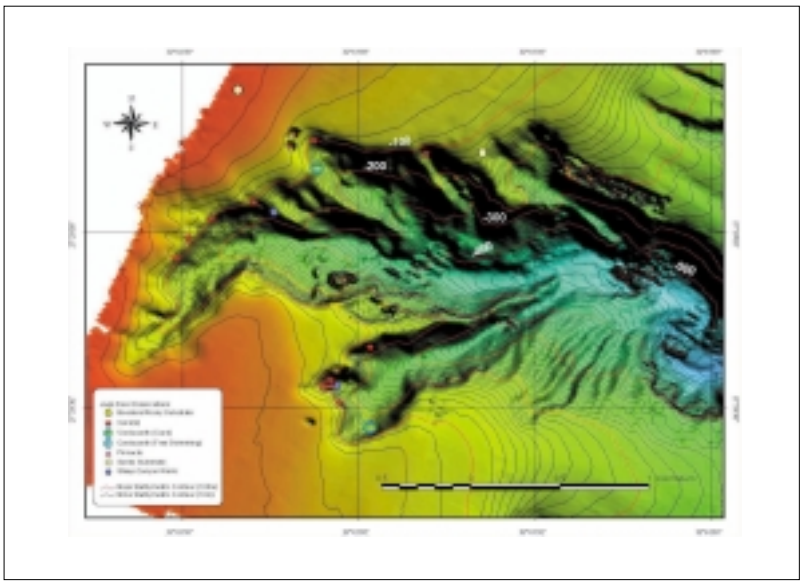
A total of twenty three canyons, including six mature-phase and seventeen youthful-phase canyons, were surveyed on the northern KwaZulu-Natal continental shelf. Suitable coelacanth habitat comprises cliffed sections of the canyons containing numerous caves and overhangs. The caves and overhangs provide shelter from sedimentation and offer protection from the southerly flowing Agulhas Current. In terms of canyon morphology, the well developed, steep-sided and more stable of the canyon heads are deemed more desirable as habitat areas. In general, the northern margins of the canyon heads are steeper and appear more stable than the southern margins. Late Pleistocene (less than 125,000 years old) sea-level deposits, including beachrock and aeolianite sandstone, are well developed as terraces and cliffs in the canyon heads. These outcrops were identified at elevations of 40 m, 55 m, 60 m, 70 m, 90 m, 95 m, 110 m, 120 m and 130 m in the survey areas. Cave formation in the canyon lithologies is facilitated by the dissolution of the carbonate rock cement by slightly acidic freshwater phreatic flow from perched water bodies on the hinterland. The terraces, located at elevations of 110 m, 120 m and 130 m, fall within the vertical range of the Comores coelacanth populations and were treated as primary coelacanth exploration targets in the steep topography of the canyon heads. Canyons in close proximity to active subaqueous dune fields were given a lower exploration status as excessive sediment movement was deemed to have an adverse effect on the stability of canyon head margins. The erosive effect of sediment slumping along unstable canyon margins would also have a negative connotation with respect to coelacanth populations, as it would probably result in habitat destruction.

Coelacanths Found

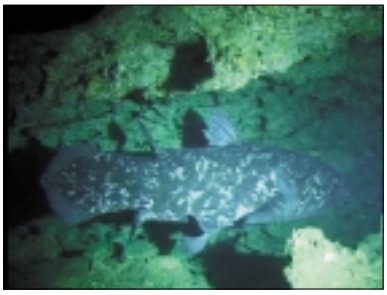
These bathymetric maps enabled scientists to plan the exploration programme for the submersible Jago in which the search pattern was predetermined and Jago was guided precisely to underwater localities. The JAGO dive team accomplished twelve dives and fifteen coelacanth sitings. It was noted that several coelacanth individuals were sited more than once by the ability to identify individuals on the basis of characteristic marking patterns.

Origin of the Submarine Canyons

The submarine canyons of southeast Africa were probably initiated during Mio-Pliocene (2 to 20 million years ago) times as mass-wasting features related to an increased sediment supply, caused by uplift of the hinterland. The mass-wasting generally occurred along older fault lines which represent zones of structural weakness. It is obvious from the orientation and spacing of the



Colour-draped bathymetric map with superimposed contours of Wright Canyon head showing the position of caves and coelacanth sitings



First coelacanth sighted on the submersible dive (with permission of the Jago submersible team April 2002)

canyons that there is an underlying structural control to these features. There is no conclusive evidence for faulting in the last two million years, so it can be assumed that modern canyon forming processes are merely exploiting older structural weaknesses in the crust. During periods of low sea-level in Pleistocene times (10,000 to 2 million years ago), the canyons were enlarged by fluvial drainage. Other processes which have contributed to canyon development include freshwater sapping and turbidity currents. Turbidity currents originate from sediment slumping into the canyon heads or from the collapse of unstable sections of the canyon walls.

It is the authors' opinion that all of the documented mechanisms of canyon development, i.e. faulting, freshwater sapping, fluvial activity, turbidity currents and mass-wasting, have had an influence on the formation and growth of northern KwaZulu-Natal submarine canyons.

Future Research

The next expedition of the South African Coelacanth Conservation and Genome Programme will consist of a detailed biophysical exploration of the east coast of South Africa. Participants will include students to encourage the study of science and marine biology. Further exploration of the Mozambique Outer Shelf will be conducted after a preliminary multibeam echo sounder survey of the sea floor to search for canyons and other habitats suitable for coelacanths. Marine Geosolutions (Pty) Ltd will once again be responsible for conducting these multibeam surveys.

Biography

Dr Peter J Ramsay and Mr Warwick R Miller co-own the marine geophysical survey company Marine GeoSolutions, which is operating from Durban, South Africa. Dr Ramsay and Mr Miller have a very strong background in marine geology, sedimentary processes and 22 years of combined experience in marine geophysical surveying and consultancy. Marine GeoSolutions offers a total solution to all near-shore survey requirements. This includes all facets of project management, including: desktop studies, survey planning, data acquisition, sediment sampling, ore reserve calculations, map generation and report writing. All tasks are performed in-house which facilitates quick turn-around times on all projects. ■

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