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Estimating biodiversity with deep sea images

Towards a more comprehensive characterisation of the seafloor

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Australia's marine jurisdiction is almost 14 million square kilometres. Geoscience Australia acquires geological, geophysical and ecological data to better understand the jurisdiction. These regional pre-competitive datasets, collected as part of the Offshore Energy Security Program, are available to assist the activities of Australia's offshore oil and gas industry, and the management of the marine zone.

"At first glance, these habitats seem barren, but they are actually teeming with life."

Seabed Mapping and Characterisation Project staff are currently working on the identification of representative seabed habitats. These studies will be used to characterise seabed environments for the purpose of defining Australia's little-known deep sea diversity. Among the variety of tools and techniques used to identify substrate type and characterise the biota of the seafloor are underwater video and still photography. The images collected to date show that most of the deep sea is characterised by soft sediment plains in which very few animals are seen.

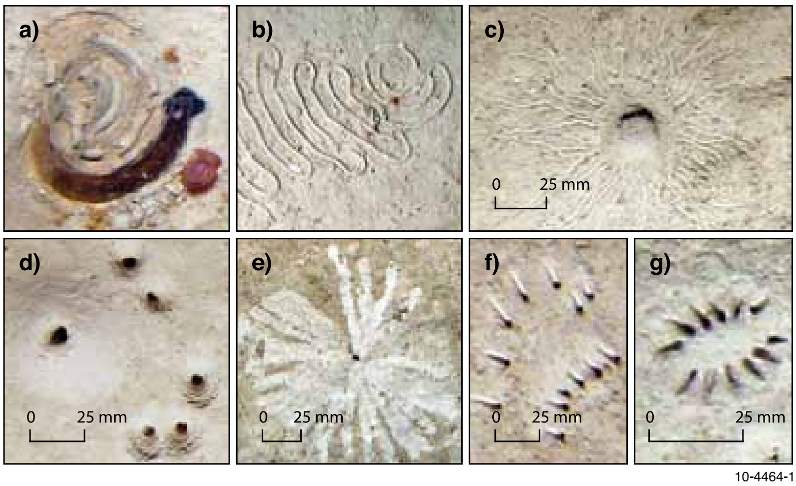

Figure 1. A sample of the types of *lebensspuren* identified from still images: a) acorn worm spiral with the animal forming the feature; b) acorn worm switchback; c) rayed mound; d) burrow cluster; e) large rosette; f) matchstick feature; g) ovoid pinnate. Scale bars are 25 millimetres. Note: scale could not be determined for images from the western margin (a, b) because of lack of size reference points on the camera.

Deep sea diversity

At first glance, these habitats seem barren, but they are actually teeming with life. Previous biological sampling of the seafloor using boxcores has suggested that the deep sea may harbour greater species abundance and diversity than shallow water areas, and in some areas may even be comparable to biodiversity hotspots such as tropical coral reefs (Grassle and Maciolek 1992).

However, most of these deep sea animals are rarely seen because they are generally small and infaunal, meaning that they spend most of their lives within the sediment. During feeding and burrowing these animals move through the soft sediment and form a range of features, including starbursts, spirals, and spaghetti-like tracks (figure 1). These features are known as *lebensspuren*, which refers to any type of sedimentary structure produced by a living organism. *Lebensspuren* have been shown to be useful surrogates for the biodiversity of larger animals in subtidal systems (Widdicombe et al 2003), but no similar research has yet been conducted in deeper waters. High resolution still photographs are often collected in conjunction with video footage during surveys but, to date, have rarely been used for habitat or biodiversity analysis of deep sea habitats. They offer a means to use *lebensspuren* as a proxy for biodiversity assessment in deep sea habitats which are normally quite difficult to quantify with video. This facilitates a more comprehensive characterisation of the seafloor across deep sea plains.

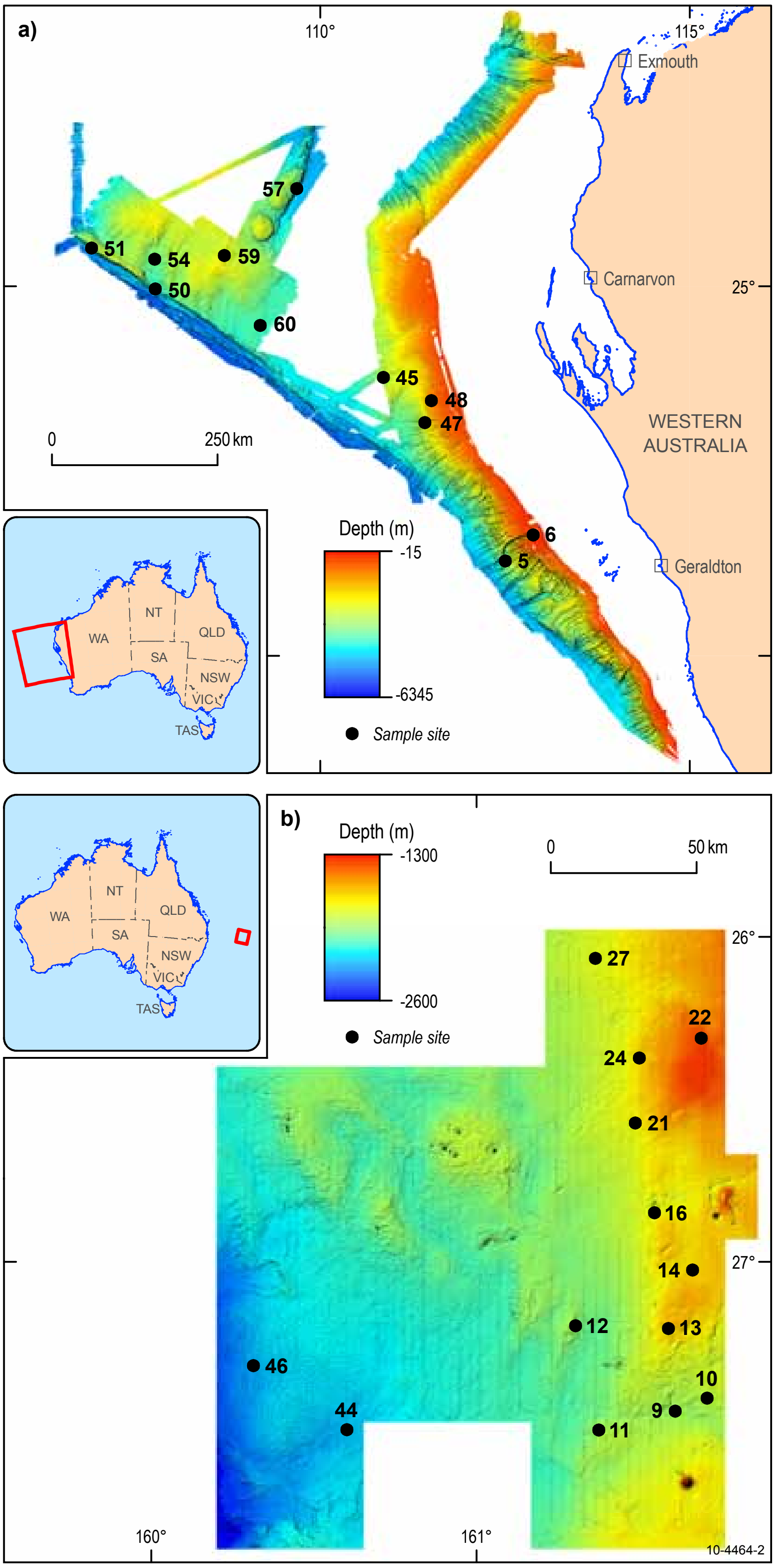

Figure 2. Survey areas for the eastern and western margins, including stations (locations) from which still images were analysed.

The study

Still images collected on the eastern and western Australian margins were analysed for *lebensspuren* (figure 2). The study areas were based on marine reconnaissance surveys undertaken by Geoscience Australia: Survey GA0427 (TAN0713) on the eastern margin and Survey GA2476 on the western margin (figure 2). These areas were chosen because they represent different geomorphic and geological settings; two parameters that may affect the abundance and type of biota in the sediments. The aims of the study were to:

- catalogue the different types of *lebensspuren*
- quantify the diversity of *lebensspuren* as a potential proxy for deep-sea biodiversity
- evaluate whether the quantification of *lebensspuren* from still images is an appropriate technique for broadly quantifying biological activity and diversity in the deep sea.

The latter assessment was based on the detection of known biological relationships between environmental variables and biodiversity, as well as the expected biological differences between the eastern and western Australian margins.

For each region, selected still images were examined, and the different types of *lebensspuren* were recorded. Since very common features were difficult and time-consuming to count, only their presence or absence was recorded. The types of *lebensspuren* were named, classified according to the likely mechanism of formation (such as feeding, dwelling, waste), and compiled into a directory (Dundas and Przeslawski 2009).

Lebensspuren were then correlated with environmental data collected concurrently during the survey to identify any significant relationships. In both the eastern and western margins, the *lebensspuren* were analysed with depth and sediment properties (such as percentage mud or carbonate). At selected stations on the eastern margin, *lebensspuren* were also analysed with geochemical parameters (such as extractable metals, measures of organic freshness, carbon and nitrogen expressed on carbonate-free basis).

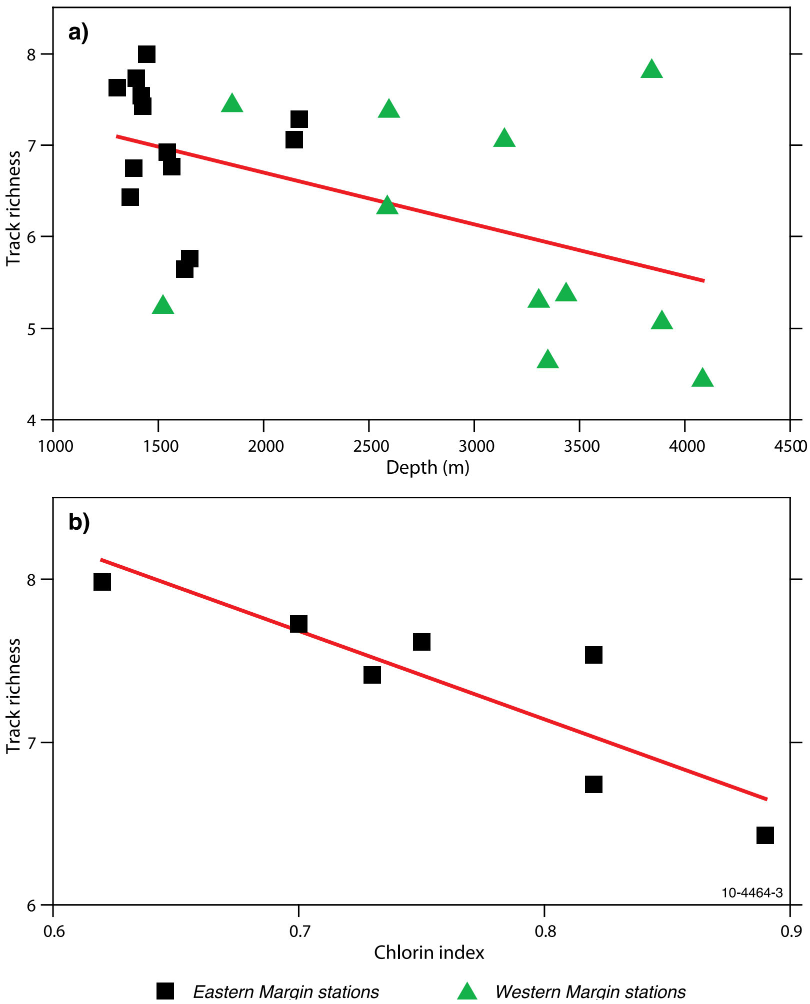

Figure 3. Relationships between *lebensspuren* track richness and a) depth and b) chlorin index, a measure of products from degraded chlorophyll. Dark squares are eastern margin stations while green triangles are western margin stations.

A total of 46 different types of *lebensspuren* were recorded from the eastern and western margins, some of which are shown in figure 1. Very few organisms were directly observed forming *lebensspuren* (figure 1a) which highlights a major difficulty when observing these animals in traditional video and image analysis.

Multivariate analyses confirmed significant regional differences in *lebensspuren* abundance and types between the eastern and western margins, with the eastern margin showing higher *lebensspuren* abundance and diversity. *Lebensspuren* were significantly correlated to depth and freshness of organic matter, with more types of *lebensspuren* associated with shallower depths and sediments with high organic freshness (figure 3). Depth accounted for 22 per cent of the variation in *lebensspuren* types among stations (locations) while organic freshness accounted for 70 per cent. Mud and carbonate content were also significantly related to *lebensspuren* but were confounded with depth.

Overall, the method of using still images to quantify *lebensspuren* as a proxy for deep seafloor biodiversity warrants further use and research. Clear geographic differences were seen in *lebensspuren* assemblages, and these differences were associated with environmental factors such as depth. These patterns parallel known biological patterns, thus suggesting that quantification of *lebensspuren* may be suitable for broad-scale comparisons of biological diversity among deep sea sites. The advantages and disadvantages of using video and still images to collect biological data indicate that optimal results are likely to be obtained when biotic and abiotic samples are collected concurrently with deep-sea video and still imagery.

Findings from this study will assist in the characterisation of deep sea areas which cover much of Australia's marine jurisdiction. This environment is one in which the biology is difficult to investigate because of the prevalence of small infauna and the logistical constraints associated with sampling in deep waters. The use of still images to quantify *lebensspuren* offers a cost-effective means to analyse data that are normally not assessed during deep-sea surveys. This option should increase the scope of biodiversity analyses and results from this study have been promoted through the Census of Marine Life and several other international research organisations.

For more information

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Widdicombe S, Kendall MA, & Parry DM. 2003. Using the surface-features created by bioturbating organisms as surrogates for macrofaunal diversity and community structure. Vie Milieu 53: 179–86.

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AusGeo News 94: Revealing the Wallaby Plateau
www.ga.gov.au/ausgeonews/ausgeonews200906/wallaby.jsp

Census of Marine Life
www.coml.org

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Geoscience Australia and the Australian Science Teachers Association will host the *Geologi2010* as part of Earth Science Week celebrations being held from 10–16 October.

All Australian primary and secondary school students are invited to submit a short film highlighting the role Earth Science plays in our interactions with an 'Ever-changing Earth'.

To enter all you have to do is make a film that explains how one of the following relates to the theme 'Ever-changing Earth':

- Natural hazards
- Rocks and minerals
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