



High seas and marine protected areas

GIS analysis of seafloor geomorphology exposes conservation concerns

Peter Harris

Oceans cover about 361 million square kilometres of the Earth's surface, of which 219 million square kilometres (or about 60%) is high seas. This area is outside the economic exclusion zone (EEZ) of any nation, and human activities on the high seas are largely unregulated and unrestricted.

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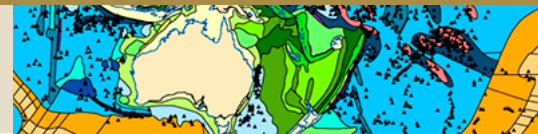
While there is increasing support for the conservation of high-seas biodiversity through declaring high-seas marine reserves, there is a lack of information on deep-sea benthic communities. An alternative that offers a quantitative and systematic approach to identifying conservation priority areas is Geographic Information System (GIS) analysis of seafloor geomorphic features as a substitute for biodiversity.

There are currently around 4600 marine protected areas (MPAs), covering 2.2 million square kilometres or about 0.6% of the ocean area. Most MPAs (62%) are within 12 miles of coastal areas, and none is on the high seas (The Sea Around Us 2006).

A geomorphic province map covering the whole of the world's oceans, originally published by Agapova et al (1979), has been scanned, geo-referenced and digitised at Geoscience Australia (figure 1). This map classifies the seafloor into 23 separate geomorphic categories. It shows that the features least common within national EEZs are hilly abyssal plains, mid-ocean rift zones and flanking ridges (that is, more than 85% of these features occur in the high-seas regions).

Hydrothermal vents rarest in Atlantic

Mid-ocean ridges are host to unique hydrothermal vent communities that metabolise hydrogen sulfide. The distribution of vent communities is related to seafloor spreading rate—fast Pacific



ridges that spread at 90 to 170 millimetres per year support one vent every ~5 kilometres of ridge crest, whereas slow Atlantic-type ridges that spread at less than 40 millimetres per year support one vent site every ~350 kilometres (Van Dover 2000). Therefore, the Atlantic Ocean may contain as few as 40 vents, whereas the other oceans (Indian, Pacific and Southern oceans) may contain as many as 12 000 vents. The protection of Atlantic Ocean vents relies more on international cooperation and high-seas MPAs because they are much rarer and isolated from each other than vents in the Pacific.

On the other hand, more than 90% of ocean trenches and island arcs are within the EEZs of individual nations. The protection of these features and their associated biological communities relies on national conservation strategies.

Seamounts scarcest in Southern Ocean

One class of seafloor feature that has attracted much international attention is undersea volcanoes, known as seamounts. Seamounts rise over 1000 metres above the surrounding ocean floor and are

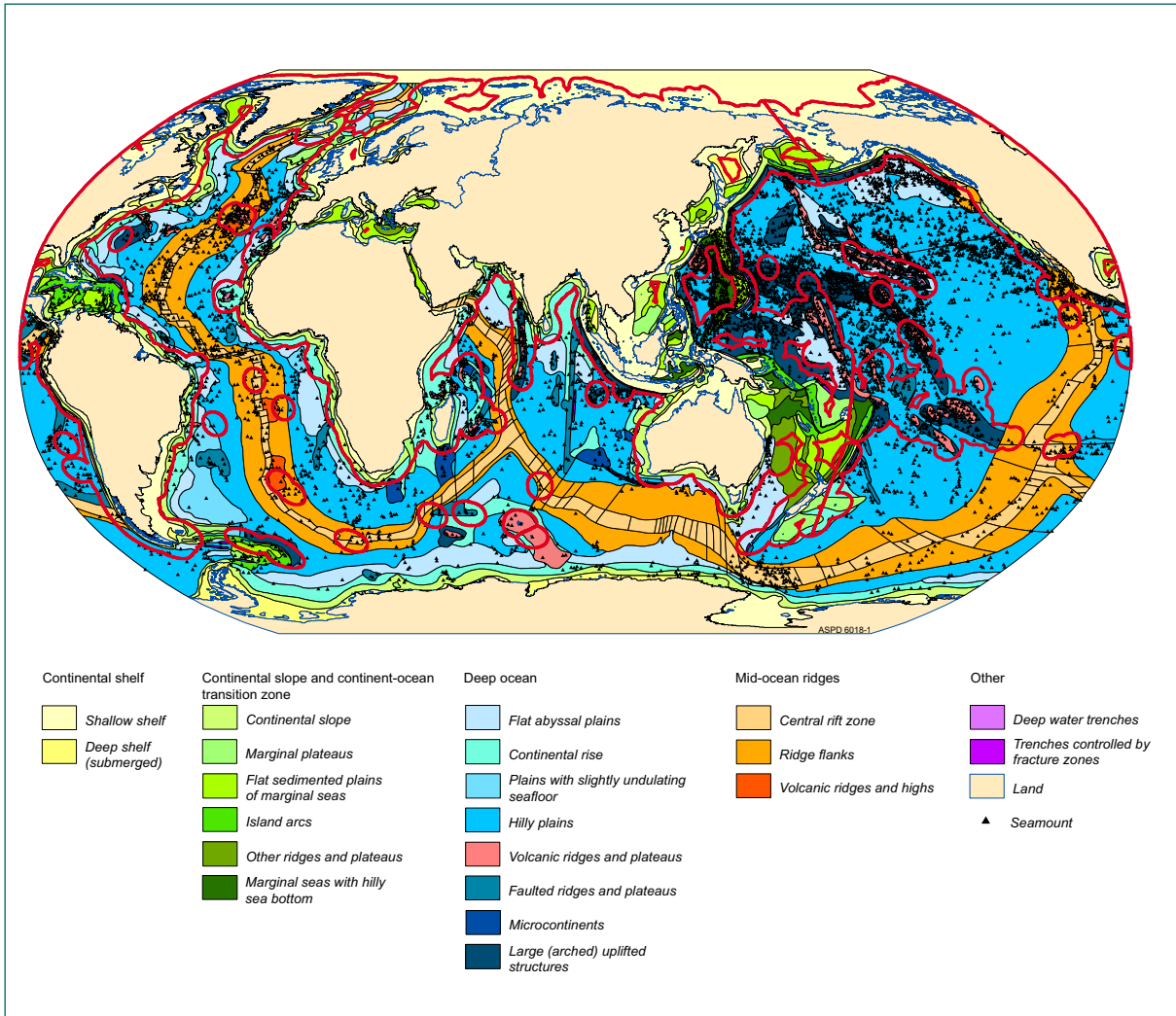


Figure 1. Map of seafloor geomorphic features (after Agapova et al 1979), with distribution of seamounts (after Kitchingman & Lai 2004) superimposed relative to the 200-mile EEZ.

known to interact with the ocean waters moving over them, causing current intensification, upwelling and increased primary production. They support unique faunas that are often peculiar to the area and are directly threatened by destructive bottom-trawl fishing practices which damage coral communities found on seamount summits. These factors make seamounts prime sites for biodiversity conservation.

A number of studies have estimated the number of seamounts in the ocean. The most recent estimate of 14 287 seamounts, published by Kitchingman & Lai (2004), was based on an analysis of the ETOPO2 raster bathymetric dataset produced by the United States National Oceanographic and Atmospheric Agency. The map of geomorphic features (figure 1) shows 6739 seamounts (47%) within EEZs, with the remainder (7548 or 53%) on the high seas. The total area of the oceans covered by seamounts is very small (probably less than 1%), since most seamounts are less than 20 kilometres in radius.

The distribution of seamounts is not equal across the oceans. The

highest density of seamounts occurs in the Pacific Ocean (49.7 per million square kilometres), followed by the Atlantic Ocean (25.8), the Indian Ocean (22.3) and the Southern Ocean (4.3). Consequently, Southern Ocean seamounts are rarer and more isolated from each other than seamounts in the other oceans, resulting in implications for recolonisation and connectivity. This issue would need to be addressed in the declaration of future high-seas MPAs.



Australian EEZ features and the global picture

The significance of this work for Australia is that it places the distribution of geomorphic features within our EEZ into a global context. Australia claims the third largest EEZ in the world, equal to 8.1 million square kilometres (excluding the Australian Antarctic Territory) or around 2.2% of the world's ocean area. The global map of geomorphology identifies some interesting aspects of its composition. For example, Australia's EEZ contains over 10% of the world's marginal plateaus (such as the South Tasman Rise and the Queensland, Marion, Naturaliste, Exmouth and Kerguelen plateaus). Seamounts along Australia's Southern Ocean margin are rare in comparison with seamounts in other oceans. The global context of the geomorphic composition of Australia's EEZ can be a valuable tool in determining the design of our National Representative System of MPAs.

This study demonstrates how information on the geomorphology of the ocean floor can be useful for establishing ocean conservation priorities for Australia and the rest of the world. Future research at Geoscience Australia will aim to refine the global seabed characterisation and improve information on Australia's EEZ.

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GEOSCIENCE AUSTRALIA OPEN DAY

Sunday 26 August 10am – 4pm

Explore science and careers displays
View Australia in 3D
Hear from our leading scientists
Pan for gold, sieve for sapphires
Bring your own rocks for identification

Tour the building
Children's program includes:
fossil fun, treasure hunt, story-telling, stone
bracelet making
Meet a Geo-Superhero!

