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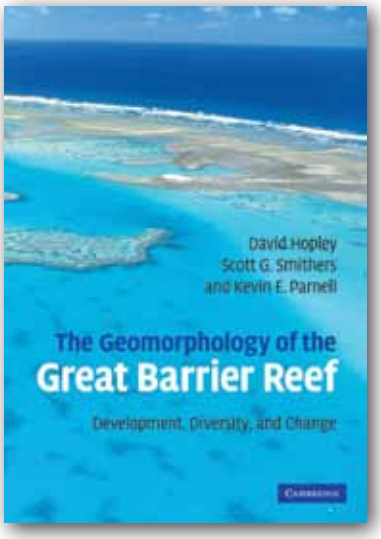
The Geomorphology of the Great Barrier Reef

Development, Diversity, and Change

By David Hopley, Scott G. Smithers, and Kevin E. Parnell, Cambridge University Press, 2007, 546 pages, ISBN 9780521853026, Hardcover, $150 US

REVIEWED BY NICK HARVEY



The Geomorphology of the Great Barrier Reef by David Hopley, Scott G. Smithers, and Kevin E. Parnell was preceded 25 years ago by Hopley's landmark book on the same topic. The first book filled a void in terms of Quaternary reef science at the time, and the recent volume provides a fresh perspective on the complexity, diversity, and volume of geomorphological research undertaken on the Great Barrier Reef (GBR) over the last 25 years. To complete this task, Hopley teamed up with two other coastal geomorphologists, Smithers and Parnell, both based at James Cook University in North Queensland. The three authors have extensive experience in reef research and are well qualified to write this book.

The book is aimed at "academic researchers in geomorphology and oceanography" and is also intended to appeal "to graduate students in related fields." The 468-page text is organized into 13 well-illustrated chapters that include over 150 black-and-white line diagrams and photographs. Although the diagrams are well drawn and clear, many of them, and most of the photographs, would have benefited considerably from being reproduced in color (I have seen some of the original photographs, which are quite spectacular). This publishing decision was undoubtedly cost-related.

The book's chapters are basically organized into three groups. The first group of four chapters provides the background to the geomorphology of the GBR including a historical perspective on previous research, the geological background, the impact of Quaternary sea-level changes, and the influence of oceanography, hydrodynamics, climate, and water quality. The next group of six chapters (5–10) takes a spatial approach in terms of an overall analysis of reef and island morphology (Chapter 5), and also deals with different areas of the reef in separate chapters such as those treating the mid-shelf reefs (Chapter 8) and the reef islands (Chapter 10). The final group of three chapters (11–13) synthesizes some of the earlier material and discusses it in a broader context. For example, Chapter 11 compares processes and rates from all the reef types and then puts them in context with examples from reefs located elsewhere. Chapter 13 summarizes the usefulness of geomorphology in GBR management.

The discussion on the foundations of the reef (Chapter 2) shows that the modern GBR is one of the world's youngest reef systems and that the major reef-building turn-on event occurred between 452 and 365 thousand years ago. However, the geomorphological characteristics of the GBR are mostly related to the last glacial period lasting for around 100 thousand years when the reef was exposed and subsequently drowned rapidly during the Holocene sea-level transgression. Chapter 3 goes into some detail regarding the importance of sea-level fluctuations in controlling reef growth, and it points out that the GBR was subject to long periods of subaerial exposure with only relatively short intervening periods of reef construction. This chapter also provides a detailed discussion on the debate around Holocene sea-level curves for the GBR region, in particular the issues of whether there was a smooth or pulsed sea-level rise, the date at which modern sea level was reached, the influence of hydro-isostasy, and the complications of using sea-level data from different sea-level indicators and from different parts of the GBR.

The next chapter, which outlines the importance of climatological and hydrodynamic influences on the GBR, comments that the modern debate on climate-change impacts needs to be in the context of the variability of the last few hundred years when climatic cycles such as the El Niño Southern Oscillation (ENSO) have been important factors. Similarly, the chapter notes the lack of Category 5 cyclones in the twentieth century compared to severe cyclogenesis in the nineteenth century based on

geomorphological evidence. This observation illustrates well the importance of geomorphological data to extend the historical record and avoid misinterpretations based on the relatively short instrumental record. Chapter 4 also provides an overview of water, sediment, and nutrient impacts on the GBR.

Chapter 5 is the first of six chapters that provides a spatial approach to explaining patterns of reef morphology throughout the GBR region. This chapter goes into some detail, supplying reef and reef-island statistics, and descriptions of classification and distribution of reefs by type (e.g., crescentic or ribbon reefs). The chapter demonstrates the non-randomness of reef type distribution and sets the scene for the following five chapters, which examine reef evolution of: non-reefal areas (Chapter 6); fringing and nearshore reefs (Chapter 7); mid-shelf reefs (Chapter 8); outer-shelf reefs (Chapter 9); and the islands (Chapter 10). Each chapter has a different focus, such as the substrate and deposits of fringing reefs in Chapter 7, and the shelf-edge morphology of and tectonic influences on the outer-shelf reefs in Chapter 9.

Chapters 11 and 12 take a more holistic approach to GBR evolution by discussing data from all the reefs in the GBR to provide a better understanding of rates of geomorphological processes across the GBR and also in context of other reefs in different parts of the world. For example, Chapter 11 examines variations in the depth to the antecedent surface on the GBR (4–28 meters) and notes the similar depth range of this antecedent surface for other Australian reefs and also for Pacific atolls. This chapter discusses models of reef growth in response to different rates of sea-level rise and the different growth rates for various reef facies. In particular, it notes the importance of the antecedent surface structure for the take-off rate and timing of Holocene reef growth but stresses the importance of the relative sea-level curve in influencing reef facies, growth rates, and age of the near-surface reef. Here, the chapter shows how the reef reaches optimal vertical growth rates of ~ 8 mm per year at water depths of 12 to 15 meters and discusses how various reefs in the GBR either kept up with sea-level rise or got left behind and managed to catch up later after sea level had stabilized. This discussion is important when considering future reef response to projected sea-level rise associated with climate change. The chapter is also important for its comparison between the GBR, Indo-Pacific atolls, Pacific barrier and fringing reefs, Indian Ocean reefs, and Caribbean reefs.

The following chapter (12) then provides a synthesis of the Holocene evolution of the GBR by discussing key stages, such as the glacial maximum low sea level, the early sea-level transgression, the start of the Holocene, the final stage of the transgression, and then the mid-to-late Holocene. This chapter paints a picture of what the continental shelf would have looked like at various stages through the Holocene and notes that Aboriginal people in Australia were present throughout the flooding of the continental shelf and the creation of the modern GBR.

The final chapter focuses on the importance of understanding geomorphological processes for management and conservation of the GBR. It is unfortunate that its running header emphasizes "Geomorphology's contribution to the problems of the Great Barrier Reef" rather than the importance of geomorphological knowledge to understanding and solving the problems. This chapter provides useful data on reef islands, sediments, nutrients, geomorphology, and conservation, but notes that geomorphological criteria have mostly been given a low status in the manage-

UPCOMING BOOK REVIEWS

Ebb and Flow: Tides and Life on our Planet
by Tom Koppel, The Dundern Group, 292 pages

Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics
by A. Griffa, A.D. Kirwan Jr., A.J. Mariano, T. Özgökmen, and T. Rossby, Cambridge University Press, 487 pages

Climate Change: A Multidisciplinary Approach
by William James Burroughs, Cambridge University Press, 378 pages.

Arc Marine: GIS for a Blue Planet
by Dawn J. Wright, Michael J. Blongewicz, Patrick N. Halpin, and Joe Breman, ESRI Press, 216 pages

ment of the GBR compared with many terrestrial national parks. The final part of this chapter reflects on the importance of global climate change and the impact of projected sea-level rise on the GBR from a geomorphological perspective. This discussion is very relevant for the current global debate on the impacts of climate change such as the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC), in particular the report from Working Group II (Parry et al., 2007). At the regional level, this issue is also addressed in the recent volume on *Climate Change and the Great Barrier Reef* (Johnson and Marshall, 2007), which incorporates a detailed discussion on potential geomorphological impacts resulting from climate change on the GBR.

Overall, I think the book is an excellent synthesis of current knowledge on the geomorphology of the Great Barrier Reef. While I agree with the authors that understanding geomorphological reef processes is very important in the management of the GBR, I don't think that this book alone will convince managers of that need because it is largely written for a different target audience. However, the book will undoubtedly become an essential reference for reef researchers and graduate students, and I give it my strongest endorsement. I congratulate the three authors on producing such a comprehensive text.

NICK HARVEY (*nicholas.harvey@adelaide.edu.au*) *is the Executive Dean, Faculty of Humanities and Social Sciences, and Professor, Geography and Environmental Studies, The University of Adelaide, South Australia.*

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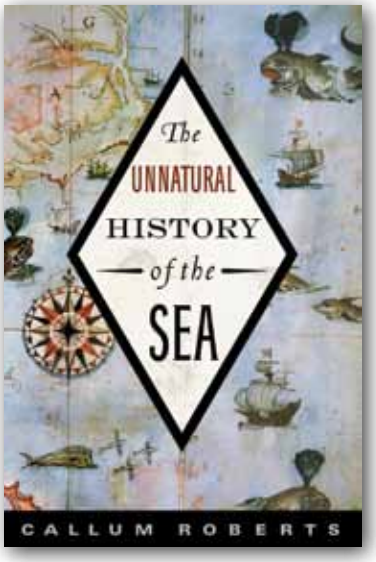
Johnson, J.E., and P.A. Marshall, eds. 2007. *Climate Change and the Great Barrier Reef: A Vulnerability Assessment*. Great Barrier Reef Marine Park Authority and Australian Greenhouse Office. 818 pp.

The Unnatural History of the Sea

We learn from history that we do not learn from history.
—Georg Wilhelm Friedrich Hegel (1770–1831)

By Callum M. Roberts, Island Press, 2007, 435 pages, ISBN 9781597261029, Hardcover, $28.00 US

REVIEWED BY ANDREW J. READ



On June 15, 2006, President George W. Bush created the world's largest fully protected marine reserve, the Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands (NWHI). Established by Presidential proclamation, the monument is the largest conservation area in the United States. In his proclamation speech, the president noted that, "our duty is to use the land and seas wisely, or sometimes not use them at all."

Coming, as it did, from a president not known for his sensitivity to environmental issues, the establishment of the Papahānaumokuākea Marine National Monument was a major victory for the conservation of marine ecosystems. Commercial fisheries, and other forms of resource extraction, are to be banned from the monument, providing an unparalleled level of protection to the fragile coral reef ecosystems of the NWHI. Coral reefs are often described as the rainforests of the sea because of their biodiversity and, in some areas, high levels of endemism.

Throughout the world ocean, coral reefs are in decline, due to the synergistic effects of overfishing, coastal development, and climate change. One of the most pervasive threats is overfishing, particularly of large, predatory fishes. In one stroke of his pen, President Bush eliminated this threat to the extensive