THE GEOMORPHOLOGY OF THE GREAT BARRIER REEF

Over the last 25 years considerable information on the geomorphological evolution of the world's largest coral reef system, the Great Barrier Reef, has become available. This book reviews the history of geomorphological studies of the Great Barrier Reef and assesses the influences of sea-level change and oceanographic processes on the development of reefs over the last 10 000 years. It presents analyses of recently attained data from the Great Barrier Reef and reconstructions of the sequence of events that have led to its current geomorphology. The authors emphasize the importance of the geomorphological time span and its relevance for present management applications. This is a valuable reference for academic researchers in geomorphology and oceanography, and will also appeal to graduate students in related fields.

DAVID HOPLEY is Adjunct Professor in the School of Earth and Environmental Sciences (formerly the School of Tropical Environment Studies and Geography) at James Cook University, Queensland, Australia. He has spent over 40 years working on the Great Barrier Reef and has been a consultant in coastal and coral reef management since 1997.

SCOTT SMITHERS is Senior Lecturer in the School of Earth and Environmental Sciences at James Cook University. He has worked on the Great Barrier Reef and in the Pacific and Indian Oceans. His broad research interests are in the Quaternary evolution of coastal environments, especially coral reefs and tropical coasts.

KEVIN PARNELL is Associate Professor in the School of Earth and Environmental Sciences at James Cook University. After completing a Ph.D. at JCU, he worked on temperate beach systems at the University of Auckland before returning to JCU in 2003, undertaking research on reef and tropical beach systems.

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Development, Diversity, and Change

DAVID HOPLEY
SCOTT G. SMITHERS
KEVIN E. PARNELL
James Cook University

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Preface

In the preface to *The Geomorphology of the Great Barrier Reef: Quaternary Development of Coral Reefs* published by one of the present authors in 1982, the opportunity for a synthesis of ideas on the geomorphology of coral reefs was identified. Almost 25 years later and with a wealth of new research and publications, there is again the need for a holistic view of the evolution of the present geomorphological features of the world's largest coral reef system, which it is hoped this book will provide. However, it is very different from the 1982 publication which attempted to fill a wide area of coral reef science, using the Great Barrier Reef as an example. This volume is much more focused on the Great Barrier Reef (GBR) region and the way its features have evolved especially during the Holocene period of the last 10 000 years.

Much of the data for this period has come from programs of drilling into the reef to depths up to 25 m during the 1980s and 1990s, some of it for specific engineering or non-geomorphological purposes. By far the largest programs, however, were those headed by Professor Peter Davies (now Sydney University) of what was then the Bureau of Mineral Resources, Canberra, and one of the present authors (D. H.) and his postgraduate students. These and other drilling programs have created a data bank which could only be imagined in 1982 but it is not the only area in which the geosciences have added to the understanding of the development and processes which sustain the Reef. Studies of sedimentation patterns, hydrodynamics, and other geomorphological processes are integral areas of coastal geomorphology but over the last ten years in particular on the GBR such studies have often been undertaken by non-geoscientists. Whilst the quality of the data collected is unquestionable its use and interpretation has sometimes suffered from a lack of understanding of geomorphological processes, a theme that is taken up in the latter part of this book.

The geomorphological timescale is also a feature of the present work. In the past 15 years there has often been a division between geologists who see reefs as

robust systems, surviving major climate and sea-level change over millions of years, and ecologists with a contrary view, monitoring the decline in reef systems over the last 50 years or more and interpreting them as fragile. The timescales used by each discipline are critical to the contradictory interpretations both of which are correct within their own dimensions. The boundary between the two is not sharp and is covered by the period considered basic to geomorphological understanding. Even since sea level reached its present position 6500 years ago, the GBR has changed enormously. It will be shown that maximum growth rates and maximum number of habitats occurred in early to mid-Holocene times. According to parameters by which ecologists may evaluate the health of a reef system, the GBR is already in a state of natural decline without any consideration of human impact. This needs to be acknowledged by management agencies that may only recognize the dynamic nature of the reef system at an ecological scale, for example, the importance of natural disturbances in creating biological diversity. However, these disturbances are superficial and changes, for example, to reef morphology and natural sediment build-up are measured at the geomorphological timescale and this provides the background trend upon which ecological periodicity is superimposed.

Thus the usefulness of geomorphology for reef management provides the theme for the final chapter in this book, drawing on the information provided earlier. The book moves from long- and short-term processes (sea-level change and oceanography) through an analysis of the GBR on a basic spatial division (inter-reefal areas, fringing reefs, mid-shelf reefs, outer shelf reefs, and reef islands). The final chapters provide a more holistic view of the data, describing the processes and rates of GBR evolution during the Holocene, and the way in which the Reef has changed dramatically over a relatively short period of 10 000 years, changes that were witnessed by the original Australians.

An enormous amount of new information has become available over the last 25 years and we have attempted the task of summarizing this and incorporating it into our ideas of how the GBR has evolved. Even as the manuscript was being written it was clear that the data flow is if anything increasing and it is our conclusion that, as in other disciplines, compilations that build on the foundations laid by earlier workers but incorporating the new data will be needed more frequently than the approximately 25 years since the publication of *The Geomorphology of the Great Barrier Reef* in 1982. Geomorphology is essential for the understanding of coral reefs and it is through compilations like this that professional geomorphologists can communicate their thoughts, ideas, and data to other disciplines.

Please note that SI units are used throughout this work except where taken from other works. Abbreviations include time units: millions of years (Ma) and thousands of years (ka). Many radiocarbon dates and other radiometric dates are as recorded in the quoted literature. Unpublished dates from the present authors are all reported as conventional radiocarbon years, without environmental correction.

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A number of individuals and organizations have provided photographs or have given permission to use diagrams, and these are acknowledged with the appropriate figures. Many of the figures produced for this book incorporate data which is © Commonwealth of Australia (Geoscience Australia) 2001–2004, and/or data provided courtesy of the Great Barrier Reef Marine Park Authority. The assistance of Paul Tudman of the Great Barrier Reef Marine Park Authority in accessing spatial data is gratefully acknowledged. We have endeavored to acknowledge the source of all diagrams used in the book that are not our own. We apologize for any inadvertent omissions.

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David Hopley
Scott G. Smithers
Kevin E. Parnell