

Geomorphological Landscapes of the World

Piotr Migoń
Editor

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 Springer

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Introduction

Geomorphology, a part of Earth Sciences, is the scientific study of landforms, their assemblages, and processes that molded them in the past and that change them today. Geomorphologists study shapes of landforms and regularities of their spatial distribution, decipher their origin and evolution, and try to establish their ages. Geomorphology is also a science of considerable practical importance since many geomorphic processes occur so suddenly and unexpectedly and with such a force that they pose significant hazards to human populations.

But geomorphology has also been named “the Science of Scenery.” And the natural scenery, which is essentially a combination of landforms of different sizes, shapes, origins, and ages, can be captivating. You do not need to be a geomorphologist to marvel at the Grand Canyon of Colorado, the fjords of Norway, or the lofty peaks of the Himalayas, to name just a few great landscapes on Earth. However, where an untrained eye sees mainly the beauty of a physical landscape, geomorphologists go a step further, trying to answer how and why such a natural beauty has come into being. Many of the great landscapes are unique by global standards and a question inevitably arises what is the reason for this uniqueness. What are the fundamental controls on the evolution of landscape? Tectonics, rocks, changing climates, or humans? In short, each geomorphological landscape tells a story and unravels pages from the history of the Earth. Yet, deciphering a complete story is not always easy and many striking landscapes still remain somewhat mysterious.

This book aims to tell some of these stories, hidden behind the marvelous sceneries. It does so in the hope that better scientific understanding will not deprive the world’s iconic landscapes of their magic, but may help us to appreciate their beauty even more than before. It is a joint endeavor of nearly 50 geomorphologists from more than 20 countries, who for many years have researched some of the most fascinating sceneries on Earth and are willing to share their knowledge. The scientific patronage for the book is provided by the International Association of Geomorphologists. Among its statutory aims are promotion of geomorphology and fostering international cooperation, and this is precisely the idea of the presented volume. The International Association of Geomorphologists, which now has more than 60 member states, was founded 20 years ago, in 1989, and so with this book we also salute its 20th anniversary and its overall success.

Altogether, there are 36 individual stories told. Selecting the landscapes to write about was an arduous task and I am fully aware of themes which some readers may miss. However, each continent is present, and the most splendid sceneries have their chapters. It was intended to present landscapes of different origin, so that the reader can learn about the complexity of processes behind the sceneries and discover that the

sadly too often used phrase “the action of water and wind” does not do justice to the geomorphological wonders of our Planet.

The primary control on the evolution of landscapes is tectonics – the movement of the Earth’s crust – but in some places its influence is clearer than in others. Landforms offer unparalleled insights into the nature of tectonic processes, and plate boundaries in particular host spectacular tectonic landscapes, however, constantly modified by erosion. A few such stories, from different tectonic and climatic settings, can be found in this volume. T. Waltham tells a geomorphic story from diverging plates in *Afar* in northeast Africa, D. Bowman presents the great strike-slip structure of the *Dead Sea Graben*, whereas a story of uplift and erosion can be read from the landscape of *Wellington* in New Zealand (M. Crozier and N. Preston). Finally, M. Fort, using the *Pokhara Valley* in the Nepal Himalaya as an example, introduces processes shaping the highest mountains on Earth, situated at a convergent plate boundary. Among the most intriguing gross geomorphic features of the world are Great Escarpments, which border ancient landmasses, particularly in the southern hemisphere. Their complex evolution is presented through the examples of the *Drakensberg* in South Africa (S. Grab) and the *Western Ghats* of India (V. Kale). In many places tectonics goes side by side with volcanism, which is one of the great sculptors of the Earth surface. Two famous volcanoes are presented in detail, the archetypal stratovolcano of *Mt. Fuji* (T. Oguchi and C. Oguchi) and the 1943-born *Parícutin* in Mexico (I. Alcántara-Ayala). However, on a larger scale, the magnificent scenery of *Iceland* is very much a product of volcanism, in addition to glacial and fluvial processes (B. Whalley).

Many great landscapes of the world are those of karst and these feature extensively in this volume. Examples of limestone scenery include the cold-climate karst of *South Nahanni* in Canada (D. Ford), the cockpit karst of *Jamaica* (P. Lyew-Ayee), the famous tower karst of *Guangxi* in south China (T. Waltham), and the big cave-riddled tropical karst of *Mulu* in Borneo (D. Gillieson and B. Clark). However, karst is not necessarily confined to carbonate rocks and this volume contains two fascinating stories of karst on quartzite and sandstone, of *Gran Sabana* in Venezuela (R. Wray) and *Bungle Bungle* in Australia (R. Young), respectively. Another rock which supports distinctive morphology is granite and no volume about the greatest world’s landscapes would go without stories from granite terrains. Yet these can be strikingly different as can be seen comparing ones from the wider surroundings of *Rio de Janeiro* (N. Fernandes et al.), *Sanqing Mountains* of east China (M. Thomas), and the *Spitzkoppe massif* in the Namib Desert (P. Migo). Sandstones have a decisive influence on landforms too, as explored by R. Twidale who reads the story behind one of the truly iconic landforms worldwide, *Uluru* in Australia. No less impressive are the sandstone “rock cities” of the *Saxon-Bohemian Switzerland* in Central Europe (V. Cílek) and the multitude of arches and deep canyons in the *Canyonland – Arches* area of Utah, USA (J. Dixon). Finally, the *Dolomites* of Italy (M. Soldati) tell a complex story of how rocks, glaciers, and landslides created one of the most attractive and unique mountain sceneries.

Deserts have long conquered the minds of many geomorphologists, attracted by their unusual scenery and the power of wind in shaping the surface. One of greatest sand seas on Earth, the *Namib Sand Sea*, is presented by A. Goudie, whereas D. Busche unravels the complex story behind the Saharan landscape of *northeast Niger*, which can be traced back to much wetter periods of the distant past. Wherever it is more humid, rivers assume the role of a key modeler of any scenery. However, before rainwater reaches large permanent rivers, it can do marvels on unconsolidated deposits,

creating some of the most striking erosional landscapes on the world, among which the *badlands of the Great Plains* of North America are the most famous (M. Gonzalez). The great efficiency of erosion can also be admired in the *Loess Plateau* of China, as presented by X. Yang et al. Riverine landscapes can be subtle and subdued, but can also be awe-inspiring. Such are the great waterfalls and associated canyons, including two featuring in this volume, the *Iguazu Falls* in South America (J. Stevaux and E. Latrubesse) and the *Victoria Falls* in Africa (A. Moore and F. Cotterill). A very different type of landscape is associated with great deltas, and the *Mackenzie Delta*, introduced by C. Burn, is of particular interest because much of the ground there is frozen. But perhaps *the* most famous geomorphological landscape of the world is one created by the Colorado River where it cuts through the Colorado Plateau and forms the *Grand Canyon*. Surprisingly, or maybe not, its history is still open to debate as reviewed by L. Dexter.

Rivers have great power, but even greater landscape effects are associated with megafloods, which typified the period of decay of huge Pleistocene ice sheets. The *Channeled Scablands* of the northwest USA, presented by V. Baker, is the area where this sheer power was appreciated for the first time. Megafloods occurred in Antarctica too, forming a page in the complex story of inheritance and glacial erosion deciphered in the *Dry Valleys of Antarctica* (D. Sugden). Glaciers have been of fundamental importance in morphological evolution of the *Southern Patagonian Andes* (E. Mazzoni et al.), whereas in a different location they remodeled the pre-existing fluvial landscape to create another wonder of the world – the *fjords of Norway* (A. Nesje). The fjords are not the only landscape where the meeting of land and sea produces spectacular scenery. Two other coastal sceneries are explained in the volume. The *Dorset and East Devon Coast* of southern England (D. Brunsten and R. Edmonds) is a natural laboratory for coastal geomorphology, whereas the remote *atolls of the Pacific* (P. Nunn) show how living organisms, adapting to changing conditions at the sea floor, contribute to the evolution of the Earth's surface.

The beauty of many geomorphological landscapes has long been recognized, starting from travelogues of ancient travelers and scientists. Today, many such landscapes, if easily accessible, are top tourist destinations, accommodating millions of visitors annually. They come to see the scenery, which in their eyes has outstanding universal value. However, this phrase has also a more formal meaning. Places, whose outstanding universal value can be demonstrated beyond doubt, fulfill one of the criteria to be inscribed on the prestigious list of UNESCO World Heritage properties. Among 36 landscapes presented in this volume, nearly half have already received this distinction, whereas others are protected and cherished at a national level, as national parks, reserves, and areas of outstanding beauty. The closing chapter in this volume, written by T. Badman, reviews the position of geomorphological landscapes in the World Heritage initiative and indicates the way forward.

The volume could not have been completed without the help and assistance of various individuals. First and foremost, I would like to thank the contributors themselves who enthusiastically responded to the invitation, added this one more task to their busy agendas, and came up with texts which required very limited further work. Particular thanks go to Professor Andrew Goudie, who came with the original idea of this volume, helped to select chapters and authors, and then kindly reviewed many individual chapters and corrected English of non-native authors. At the early stage of preparation I also enjoyed the assistance of Professor Denys Brunsten, Professor Michael Crozier, and Professor Carol Harden. Dr Wolfgang Eder, the former Director

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