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Andrea Coronato
Grace B. Alves *Editors*

Latin American Geomorphology

From the Crust to Mars

 Springer

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Foreword

One of the most important objectives of the International Association of Geomorphologists (IAG) is to support early-career geomorphologists from all around the World, especially those from economically disadvantaged countries. Since 2020, the International Association of Geomorphologists (IAG) has been celebrating International Geomorphology Week in the first week of March every year throughout the World. To overcome the problem of the time gap between the western and eastern extremes of the World and for wide participation, IAG has divided the whole World into different regions to organize the webinars. Central and South America, one of the regions, organized this type of event from the beginning. I am glad to see that from the presentations of the young geomorphologists in the IAG Central and South American Webinar during the Geomorphology Week, 2021, Andrea Coronato and Grace B. Alves have taken the initiative to edit a full volume. The International Association of Geomorphologists (IAG) appreciates their initiative. The IAG will be glad to see the formation of one or more Young Geomorphologists Groups in Central and South America.

The book contains seven chapters on varied geomorphological issues of different regions in Latin America. All of the papers have been contributed by young researchers covering areas from Costa Rica to southern Argentina, from mountains to seas and from the Caribbean to the Scotia lithological plates as well as planetary studies. The Chapter 2, written by María Romina Onorato, deals with the landforms and processes originated by modern tectonics along a lithological plate transform boundary in Tierra del Fuego, Argentina. The evolution of rock glaciers through glacial and periglacial processes in the upper Cochiguás catchment, Coquimbo region, Chile, has been analyzed in Chap. 3 by Catalina Pino Vargas. The megafan responses to paleoenvironmental changes during the late Quaternary in the Pantanal wetland, Brazil, have beautifully been explained by Fabiano do Nascimento Pupim et al. in Chap. 4. In Chap. 5, Breylla Campos Carvalho et al. elaborated on the impact of storm events on oceanic beaches between Ilha Grande and Cabo Frio, Rio da Janeiro, Brazil. There are some indirect impacts of landforms on cyclonic storms. It has beautifully been examined by Adolfo Quesada-Román in Chap. 6 on Costa Rica through geomorphic, hydrological, dendrochronological, and risk assessments

to reduce the loss of lives and properties. New insights on Mars's water features in relation to illumination conditions in an exciting contribution by Mauro Spagnuolo et al. in Chap. 7. The volume covers the role of tectonic, glacial, and fluvial processes in geomorphic changes and the role of geomorphology on the cyclonic hazard. The last paper crossed the boundary of the Earth's surface to the extra-terrestrial sphere.

The book will likely attract the attention of the vast scientific community, including geomorphologists, environmentalists, environmental activists, and planners.

March 2023



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Sunil Kumar De, President of the International Association of Geomorphologists (IAG), period 2022–2026, and former Vice-President (period 2017–2022), when the webinar took place, gently prepared the foreword.

We are greatly indebted to the specialists who kindly review the chapters published in this volume: Julieta Nóbile (CICTERRA-CONICET, Argentina), Patricio Becerra (Microcameras & Space Exploration S. A., Swiss), Jorge Rabassa (CADIC-CONICET, Argentina), Vanda Sales (Universidade Estadual do Vale do Acaraú-UVA, Brazil), and Ivan Bergier (EMBRAPA, Brazil).

We specially thank the corresponding authors whose contributions allow the preparation of this book.

About This Book

This book compiles the topics presented by young Latin American geomorphologists in the webinar held in March 2021 for Central and South America to celebrate the International Geomorphology Week promoted by the International Association of Geomorphologists (IAG).

The webinar took place over 6 hours including six presentations from young geomorphologists coming from Costa Rica, Brazil, Uruguay, and Argentina. They presented the research done for their Ph.D., post-doctoral, or young researchers' proposals related to geomorphology and related sciences as climatology, geology, or planetary studies.

The webinar had a wide audience from different countries of the region, even from Europe, who enriched the discussions with their contributions and questions.

The activity success encouraged the organization of later webinars in 2022, 2023 and 2024 as a way to maintain alive the interest of the young generations on the geomorphology of this vast and varied continent as well as to share new methods, results, and problems.

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About the Editors

Andrea Coronato Dr. in Geography (University of Buenos Aires, Argentina, 1995). Full Researcher at CADIC-CONICET (Centro Austral de Investigaciones Científicas-Consejo Nacional de Investigaciones Científicas y Técnicas) in Ushuaia, Tierra del Fuego, Argentina. Professor at ICPA-UNTDF (Instituto de Ciencias Polares y Ambiente-Universidad Nacional de Tierra del Fuego, Antártida e Islas del Atlántico Sur), in Ushuaia, Argentina. IAG (International Association of Geomorphologists) Vice-President and Latin American co-opter (period 2022–2026), also former Latin American co-opter during period 2018–2022. Member of the Executive Committee of AACyG (Asociación Argentina de Cuaternario y Geomorfología), period 2022–2025 and former secretary during period 2012–2015. Specialist in Physical Geography, Geomorphology applied to Quaternary Geology and paleoenvironments of southern South America. Author of several chapters on glacial, periglacial, aeolian, and fluvial geomorphology of cold-semi arid environments of Patagonia and Tierra del Fuego, published in Springer Earth System Sciences and Springer Brief in Earth System Sciences volumes, among others. Author and co-author of more than 120 papers and book chapters, and co-author of two books published in international journals without interruptions since 1988. Professor of postgraduate field courses and congress field-trips in Tierra del Fuego and Patagonia organized by CADIC-CONICET and supported by IAG, NASA, among other institutions and academic societies. Promotor of science dissemination activities to primary, high-school, university, and postgraduate students, as well as to the general public, including the publication of articles in popular science journals and social media.

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During her Ph.D., she delved into exploring the role of soil in landscape evolution, including its contribution to lake formation and the expansion of drainage networks in tropical conditions. She has published several articles in English and Portuguese on topics such as the geodiversity of Brazil, the physical properties of soils, and the landscape evolution. Additionally, she is a coordinator of the Genesis and Morphology of Soil Commission, belonging to the Núcleo Regional Nordeste of the SBCS (Brazilian Soil Science Society).

Chapter 1

Introduction



Andrea Coronato and Grace B. Alves

Abstract The Central and South American regions present diverse environments, landforms, and geomorphic processes that result from different processes produced in diverse climates, including equatorial, tropical, subtropical, temperate, and cold climates. These varied conditions have resulted in complex interactions among tectonic, climatic, and biotic factors, resulting in a wide array of landscapes. In this book, young geomorphologists from Central and South American countries present their research findings, showcasing the exciting topics and methods currently used in the field, presented during the 1st first webinar organized by the International Association of Geomorphologists in 2021. This research highlights the impact of endogenic forces, climatic events, and anthropic influences on the region's geomorphic processes and the potential for planetary geomorphology and remote sensing techniques to contribute to the field. This book emphasizes the importance of studying geomorphology to understand the region's history, evolution, and current dynamics to inspire scientists and contribute to active geomorphology in Central and South America.

Keyword Central America · South America · Young geomorphologists · Geomorphology

Central and South American regions encompass diverse environments, including tropical rainforests, high-altitude mountains, arid deserts, and coastal plains. For millions of years, these landscapes have been shaped by a complex interplay of

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tectonic, climatic, and biotic factors, resulting in various landforms and geomorphic processes. Studying these features, known as geomorphology, is critical for understanding the history, evolution, and current dynamics of these regions. In this book, we present the results of geomorphic research by young geomorphologists from Central and South American countries and show exciting topics and methods currently used. The chapters in the book result from presentations during the 1st webinar organized by the International Association of Geomorphologists (IAG) to celebrate International Geomorphology Week in Central and South America in March 2021.

Examples of different geomorphic processes and landforms that sculptured Central and South American spots are included, some generated by endogenic forces or triggered by climatic events or regimes. In addition, global advances in planetary geomorphology studies have encouraged young professionals to research combining physics and geomorphology through remote sensing techniques to replace fieldwork.

Central and South America is a vast portion of emerging lands of the western hemisphere, extending from 20°N to 55°S and covering approximately 20,425,000 km² (World Bank 2023a). They are supported by the Caribbean and South American lithospheric plates moving westward to the Cocos and Nazca plates, which move underneath by subduction. The Scotia and Antarctica plates developed transformation and convergence boundaries in the south.

Central American continental and marine reliefs result from the complex dynamics between the North and South American plates, in the middle of which the Caribbean originated. Inland tablelands, lacustrine basins, coastal plains, and volcanic arcs formed the main reliefs. Tectonic dynamics reflect processes triggered by trans-compressive-transcurrent borders on the north and south sides of the plate and by a collisional subduction border in the west (Cocos plate) and east. Active volcanism at these borders generates the most conspicuous relief in the continental and insulated territories.

South America has a complex origin. The territory began to set up during Precambrian times, when the Guyana, Brazil, and Patagonia shields formed in the Gondwana continent and moved westward during the Jurassic Meso-Atlantic range, separating the present American and African continents. Puna, Tandilia, and Ventania are old structures. The westward migration of the South American plate generates a collision with the border between the Nazca and Antarctic plates, causing uplifting and folding and forming the widest and highest section of the Andean Cordillera in Perú, Chile, and Argentina. During the Paleogene, the main orogenic episode lifted the Central America Mountains, the Andean Cordillera, and the Pampean Range in South America. Volcanism triggered by the subduction of the Pacific oceanic plates below South America generated volcanoes of various types almost along the entire Andes. Fissure volcanism formed tableland, cones, and maaric landscapes of varied ages eastward of the Andes. Between the oldest shields and the Cenozoic mountains, the extent and deep sedimentary basins of the Orinoco, Amazonas, and Paraguay-Paraná-Uruguay Rivers developed dense and active fluvial systems flowing from the Andes to the Atlantic. Low regions with impeded drainage in these units form extensive wetlands, such as the Pantanal, Bañados del Bermejo, and Ibera.