Geoscience Canada

Landscape Erosion and Evolution Modeling

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Volume 30, Number 1, March 2003

URI: https://id.erudit.org/iderudit/geocan30_1br02

See table of contents

Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

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Cite this review

Duk-Rodkin, A. (2003). Review of [Landscape Erosion and Evolution Modeling]. *Geoscience Canada*, *30*(1), 31–33.

Norwegian margin).

The second section, ***Exhumed crust and mantle***, contains six papers, four of which address the Iberian Abyssal Plain and two the Alps. Abe and Hébert et al. discuss petrochemical and element analysis results that show the peridotites beneath the ocean-continent transition zone at the West Iberia margin are derived from continent-type mantle. Gardien et al. examine amphibolites from the Iberia Abyssal Plain and derive a three-stage metamorphic evolution that includes an early high-temperature and -pressure stage followed by retrogression under medium-temperature and -pressure conditions and a final metamorphic stage under sea-floor conditions. Zhao presents the results of paleomagnetic and rock magnetic studies of serpentinized peridotites from the Iberia Abyssal Plain and concludes that the peridotites were emplaced during Aptian

Barremian time and recorded the middle Cretaceous geomagnetic field. Desmurs et al. examine the field relationships of ophiolitic rocks from the Alps of eastern Switzerland and determine that the serpentinites represent subcontinental rocks exhumed to sea-floor along a low-angle detachment fault, while gabbros and younger pillow basalts indicate a steady process of extension, magma generation and emplacement at a slow-spreading ridge. Müntener and Hermann examine the petrology and microstructure of rocks from the remnants of a Mesozoic passive margin in the Southern Alps. They conclude that crustal-scale shear zones exhumed the lower crust and upper mantle to shallow crustal levels and suggest that boudinage of the lower crust occurred during early rifting.

The third section, ***Tectonics and stratigraphy***, contains ten papers representing a wide range of modelling, field mapping and laboratory studies from various margins. Buck and Lavier apply numerical modelling techniques to the study of different classes of normal faults, and determine the conditions necessary to develop large-offset normal faults. Abers uses examples from the Woodlark Basin and Gulf of Corinth to show that seismicity and movement occur on low-angle normal faults in rift zones. Roller et al., Robertson et al., Lackschewitz et al. and Resig et al. focus on the Woodlark Basin, presenting results of microstructural analysis, basin development, stratigraphic mapping, and age dating. Manatshal et al. report on microstructural investigations of detachment faulting at the West Iberia margin, while Wilson et al. examine syn-rift stratigraphy from the southern Alps and West Iberia margin. Fault analyses of the Red Sea - Gulf of Suez rift system are presented by Khalil and McClay, and Song et al. present similar work for the western margin of Australia. These two margins do not display low-angle extensional normal faults as seen on the West Iberia margin, and the role of transfer faults is discussed.

The final section of the book, ***Numerical models of extension and magmatism***, includes four papers that describe numerical studies aimed at determining the conditions under which non-volcanic rifted margins can form. A difficulty in modelling this type of margin is inhibiting melt production during the crustal extension stage, and previous models have invoked low mantle temperatures and crustal-scale detachments to explain the absence of melt. It is interesting to compare the different approaches used by these authors to explain the evolution of non-volcanic margins. Clift et al. apply the flexural-cantilever model to the South China margin to forward model extension of the upper crust (using seismic data to constrain estimates of brittle faulting) and the lower crust, which is assumed to deform in a ductile manner. Bowling and Harry use finite element models of rifting to propose that extension of a rheologically homogeneous crust can inhibit magmatism by delaying lithospheric necking and the onset of decompression melting until the last stages of rifting. Alternatively, Minshull et al. apply pure shear models of extension and suggest that melt production at the time of break-up may have been reduced by some combination of lateral heat conduction, depth-dependent stretching, and reduced mantle temperatures. Pérez-Gussinyé investigate the stretching factors at which the entire crust becomes brittle, allowing fluids to penetrate to mantle levels and begin large-scale serpentinization. If this occurs while the uppermost mantle is within the temperature stability field of serpentinite, serpentinization should commence immediately, and model results for two serpentinized margins (West Iberia and SW Greenland) are consistent with observations.

This book provides an excellent overview of recent advances in the study of non-volcanic margins. The comparisons of other non-volcanic margins, such as Woodlark Basin and preserved Mesozoic margin remnants in the Alps, with West Iberia, are particularly interesting as they give the reader a better understanding of features "typical" of non-volcanic margins and the range of interpretations supported by the data. As with most Geological Society of London special volumes, the quality of publication is quite high, with clear text and excellent reproduction of figures and photographs. Researchers working on rifted margins will definitely want to read this book, and it should also appeal to others interested in understanding the structure and evolution of passive margins.

Landscape Erosion and Evolution Modeling

Edited by Russell S. Harmon and William W. Doe III
Kluwer Academic / Plenum Publishers
December 2001, 535 p. US$120.00
ISBN 0-306-46718-6

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Landscape evolution results from a great variety of geological and geographic conditions through time. Geological processes such as tectonics, physical characteristics such as lithology, and geographic effects exerted by climate and human activity are all involved. The interaction of these processes controls and directs denudation, drainage and therefore erosion. For example, low-order drainages are mostly controlled by a variety of climatic factors whereas high-order drainages are controlled by geological factors such as faults, fractures, and lithology. Erosion is just one aspect of overall landscape evolution. Landscape evolves as a result of the interaction of topography, weathering, climate, drainage, vegetation, soil conditions, sediment transport, depositional processes and land use.

This volume includes papers on a wide range of subjects related to erosion and denudation: geomorphology of eroded surfaces, landslide activity, denudation and erosion models, as well as prediction and simulation models. Models can simulate topography and drainage, and can be used to estimate erosion rates. In order to be accurate these models need to incorporate a great variety of parameters that are difficult to formulate. Most models do not incorporate many of the needed aspects in their formulas. The papers presented in this volume do not incorporate the notion of geological time in their models, taking only present-day processes into account.

The book contains seventeen articles organized into two groups. The first group contains case studies of areas affected by erosion and field methods to measure the process. The second group starts with an introduction to erosion modeling followed by descriptions of a series of empirical and process-based models.

The first chapter is an introduction to the study of soil erosion and evolution modeling by W.W. Doe III and R. S. Harmond. They provide a good overview of the main factors involved in erosion, detachment-transport-deposition, and the spatial distribution of the three processes within a catchment or minor watershed. They describe different aspects of erosion modeling and modeling approaches that reflect the needs of human activity on the landscape.

The second chapter, by B.E. Miller and J.C. Linn, is a description of large-scale soil failure and erosion on military testing and training lands. The authors describe the intensive erosion occurring on a military training terrain where the high impact of equipment exposes the surface. They also discuss how this practice destroys the vegetation cover resulting in a need for constant replacement, but not necessarily with native vegetation. A series of installations adapted to the topography are built such as small dams, water-retention terraces and channels for water diversion on slopes, in order to control the erosion and sedimentation, and to maintain the terrain for continued use. These installations however, are generally built without following a special management program.

Chapter three, by L.W. Gatto, J.J. Halvorson, D.K. McCool and A.J. Palazzo, refers to various concrete aspects of erosion on military training terrain. They show the direct relationship between high sediment run-off and vehicle use, and sediment run-off and soil compaction. Most interesting is the detailed study they present on the effects of freeze-thaw cycling on vehicle wheel ruts, where expansion of soil, density, erodibility of soils as well as infiltration are taken into account. They show how dynamic the process of freeze-thaw is, and how intensively it affects the sensitivity of the soil throughout the year.

Chapter four, by R.B. Chase, A.E. Kehhew, and W.W. Montgomery, looks at slope instability modeling based on a case study along the southeast shore of Lake Michigan. It provides a detailed description of various parameters such as sediments and stratigraphy, vegetation and drainage conditions, and slope instability of the site. The most active slope recession occurs along interbedded sand and clay beds. Groundwater drains through these beds at different but intercommunicating levels causing ice buildup. The authors created a model for the different aquifer levels that gives the plane of reference for landslide development along the slope. They report monitoring of the site using a pole and cable system that showed substantial deformation over four years.

Chapter five, by P. Bierman, E. Clapp, K. Nichols, A. Gillespie and M.W. Caffee, describes the use of cosmogenic nuclide measurements in sediments to estimate erosion and sedimentation of a given drainage basin. The principle is based on measurements of nuclides produced by cosmic rays on a given surface. Nuclide concentration increases with time in stable denudation conditions. In basins of intensive erosion the nuclide activity is lower. A few case studies are given, from Oregon, California and Arizona in the USA, and from Israel and Australia. The estimated error percentage (25%) is low in comparison to many other process-based models. Overall, this is an excellent method for calculating denudation rates.

Chapter six, by R.P.C. Morgan and J.N. Quinton, discusses erosion modeling, centering about the pros and cons of using empirical models versus process-based models, model testing, feasibility, and application. The authors argue that process-based models offer good information for small watersheds and empirical models are better when dealing with regional phenomena. Calibration of models, however, causes secondary errors, in particular if they are based on calibrated climate models.

Chapter seven, by D.C. Flanagan, J.C. Ascough II, M.A. Nearing, and J.M. Laflen, describes a model developed for water erosion prediction. The objective of developing a soil erosion model is to provide basic information for making assessments, not only of erosion, but also conservation. The authors discuss the *Water Erosion Prediction Project (WEPP)* model, which consists of a simulation of small watersheds with hill-slope profiles that can be used in personal computers for different types of land management. All aspects of this model are addressed, from model components (weather, irrigation, hydrology, water balance, plant growth, residue decomposition) to model application and results.

Chapter eight, by L.J. Lane, M.H. Nichols, L.R. Levick, and M.R. Kidwell, presents a simulation model for erosion and sediment yield at hill slope scale. The authors address erosion modeling on non-crop lands with a process-based model. As well, they give examples of erosion models such as CREAMS and WEPP used on rangeland and hill slopes. Development of the erosion model and calibration is also given with each example site.

Chapter nine, by P.K. Haff, refers to a numerical model titled "Waterbots". This describes abstract units of runoff that reflect the result of one or many storms. Waterbots are considered to be geological parameters used in a digital landscape to create changes in it. This model is one of many quantitative models used in sediment transport and landscape evolution. It consists of estimating the trajectory of a waterbot down a given slope. The initial waterbot replaces a waterbot occupying a slope-cell and causes a chain reaction down the next cell in the trajectory by carrying an amount of sediment proportional to the slope-cell. The article discusses hill slope diffusion of parameters other than fluvial sediment transport such as rain splash and soil creep. It also considers bedrock erosion and weathering. Several examples of applications are given.

Chapter ten, by F. Ogden and A. Heilig, refers to another numerical model based on two-dimensional watershed-scale erosion modeling. Similar to the previous chapter, the authors explain the development of the hydraulic erosion model CASC2D. This model calculates the x and y directions of a flow in a given DEM grid. Calculations of flow routing, erosion and sediment transport are included in the model. This model is applied to an experimental watershed where a series of gauging stations have recorded streamflow and rain, sediment and water runoff. Calibration and performance of the model are also given. The most important parameters in this erosion model are the characteristics of the watershed and the spatial variability of rainfall.

Chapter eleven, by E. Mitasova and L. Mitas, describes multiscale soil erosion simulations for land use management. This study implements a methodology and use of simulation methods for erosion prediction and conservation measures. The method is based on a process-based model (SIMWE), and examples given by other two process-base models (RUSLE3D and USPED). The method includes simulations for overland water and sediment flow and sampling, erosion and deposition, and water depth in different topographic settings. It also considers landscape-scale erosion planning and design, which includes risk assessment and conservation strategies as well as preservation and restoration of wetlands.

Chapter twelve, by G. Tucker, S. Lancaster, N. Gasparini, and R. Bras, presents a channel-hill slope integrated landscape development model called CHILD, which addresses the relations between measurable processes and the dynamics of long-term landscape evolution related to those processes. This is a complex model that analyzes spatial-temporal topographic variability in a given terrain by studying the effects of surface hydrology, sediment transport, erosion, and other parameters in a given geological setting.

Chapter thirteen, by J. Duan, simulates stream-bank erosion processes with a two-dimensional numerical model. A dynamic theoretical simulation model was developed to evaluate stream-bank erosion for the purpose of channel restoration. Several formulas for calculation of bank erosion are given and compared. This study explains formulas of bank erosion rate due to flow and failure as part of the theoretical model analysis. A numerical simulation is given for flow, sediment transport and bank erosion. The simulation is compared to laboratory experiments.

Chapter fourteen, by V.G. Jetten and A.P.J. de Roo, describes spatial analysis of erosion conservation measures with LISEM. LISEM is a physically based hydrological and soil-erosion model. The model simulates runoff and erosion from single rainstorms for a relatively small area (10 km^2). The framework of LISEM includes various parameters: rain intensity from rain-gauges, which is mapped according to rainfall input and surface covered by vegetation; infiltration depending on the substrate; potential of micro-depression storage for overflow; different types of surface morphology; erosion-deposition model; and flow. This model is integrated into a raster GIS.

Chapter fifteen, by G.A. Oliphant, A. Alhawas, and G.S. Fraser, is about numerical simulation of sediment yield, storage and channel bed adjustments. This numerical simulation uses drainage classification to relate different stream orders to inflow and sediment, and shows that low-order streams respond more readily to input of water and sediments than do higher order streams. This is a very interesting conclusion as it relates lower order drainages to exogenous factors rather than structural-geological factors.

As part of the overall conclusion for the book, chapters sixteen and seventeen discuss the limits of erosion modeling and the future for managing land and water resources.

The quality of articles in this book is uneven, ranging from poor to excellent. The quality of the editing is also uneven: there are numerous typographical errors and many figures lack clear lettering. Also, some of the figures have handwritten comments on them. Nevertheless, the book will be of interest to those involved in the modeling of landscape evolution.

Coastal Environment: Environmental Problems in Coastal Regions IV

Edited by C.A. Brebbia
WIT Press, Southampton/Boston
c/o Computational Mechanics Inc.
2 Bridge Street
Billerica, MA 01821 USA
2002, 456 p., US$247.00 hardcover
ISBN 1-85312-921-6

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The coastal zone of the eastern Mediterranean has been subject to human modification and environmental impact for several millennia. It is therefore appropriate that the Fourth International Conference on Environmental Problems in Coastal Regions was convened in 2002 on the island of Rhodes. This was the birthplace of the earliest known maritime law, dating back to about 900