some are so jam-packed with information that they become hard to read. A few are printed with text upside down so that it is easiest to turn the book 180°. A few others lacked sufficient documentation to understand all that Morley was trying to convery. Because the figures were so full of information, however, it was possible to gain something from each one, even if one cannot interpret every symbol presented. I recommend reading this book with an atlas at your side, because even with the very excellent maps included with each chapter, there was insufficient detail to locate every place name that was referenced in the text.

This book is a monumental work and stands as an excellent compliment to paleontological works like Carroll (1998), or modern tropical forest ecology such as Richards (1996). It would form the basis for an excellent graduate seminar on tropical rain forest origins and evolution, and should be an integral part of any course on paleobotany and paleoecology. If linked with a complimentary solid text on mammalian evolution and ecology, the two would form an excellent basis for a course on Evolution of Terrestrial Ecosystems: Cretaceous to Present. Check it out soon, it will often be loaned out of your favorite tropical library.

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Numerical Experiments in Stratigraphy: Recent Advances in Stratigraphic and Sedimentologic Computer Simulations: SEPM Special Publication No. 62, John W. Harbaugh, W. Lynn Watney, Eugene C. Rankey, Rudy Slingerland, Robert H. Goldstein, and Evan K. Franseen (Editors), 1999, SEPM, Tulsa, 362 p. plus CD-ROM ($170 non-members, $120 members) ISBN: 1-56576-061-1.

This volume presents the results of a three-day workshop on stratigraphic and sedimentologic modeling held at the University of Kansas in May, 1996. The goals of the workshop were to demonstrate, characterize, and compare computing procedures used in simulating stratigraphic sequences. This workshop follows on the successes of two previous modeling workshops held at the University of Kansas. The first, held in 1962, resulted in the 1964 publication of Kansas Geological Survey Bulletin 162. The second, held in 1989, culminated in the 1991 publication of Kansas Geological Survey Bulletin 233.

This newest volume is divided into four sections. Part I is an introduction by the editors on current approaches and future opportunities in stratigraphic simulation models. Part II consists of a pair of white papers on parameterization and inverse models that were produced from the workshop. Part III contains four papers on model testing, inverse methods, sensitivity analysis, and optimization. Part IV forms the bulk of the volume and consists of nineteen papers on forward modeling. It is divided into three sections on general aspects of forward models, evaluating uncertainty through modeling, and coupled models.

The introduction and white papers (Parts I and II) are an excellent introduction to the current state of sedimentary modeling. They discuss basic issues such as types of models, parameters, algorithms, inverse methods, model output, and overall modeling philosophy. Numerous opportunities for future work, as well as questions raised during the discussions at the meeting, are noted. Although these discussions are not described in detail, they convey well the concerns and tenor of the meeting. They are also a prime starting point for anyone thinking of research into sedimentary models.

Part III on model testing, inverse methods, sensitivity analysis, and optimization contains some of the strongest contributions to the volume. Given the number of parameters in many sedimentary models, it is hard not to be impressed at the diversity of model results. When one tries to mimic a given geologic situation, it quickly becomes apparent that achieving a match between model and reality is not easy. This is partly because many model parameters may have similar effects and partly because parameters can differ greatly in their sensitivity. Bagirov and Lerche address these issues with a modeling approach that estimates the relative importance of uncertainties in model inputs. From this, one would be able to determine, with relatively little effort, which model inputs need to be more tightly constrained and to what degree. Such an approach would guide researchers in minimizing their time and money in estimating model inputs. Cross and Lessenger demonstrate a stratigraphic inverse model, that is, a forward model that is repeatedly run and adjusted until the model output reaches a tolerable fit to the data. Their paper is a lucid primer on inverse models and includes a worked example. Results of their model are used to show how sediment supply and eustasy change through time, and how tectonic subsidence changes across the basin and through time. Bornholdt, Nordlund, and Westphal describe another type of inverse approach that uses genetic algorithms that follow rules much like natural selection. They allow relatively accurate simulations to propagate and spawn other sets of simulation parameters, while relatively poor simulations are removed. Such genetic algorithms may be less likely than other algorithms to get trapped in local minima; that is, sets of parameters that offer an adequate fit to the data when other sets of parameters that offer a better fit exist. Prins and Weltje finish the section with a method for estimating the end members of mixed grain-size distributions.

The first part of section IV on forward models focuses on their general aspects. All of the models demonstrated are stratigraphic in nature and most span time scales of 10^4 to 10^7 years and spatial scales of 10–100's km. Bowman and Vail use the model PHIL to simulate the past 30 m.y. of stratigraphy in the Baltimore Canyon region. Steckler explores the interrelationships of subsidence, erosion, and sedimentation and their effects on sequence geometry. The fine-scale effects of sedimentation processes on sequence architecture are examined by Carey and coauthors. Cowell and coauthors use a geometric model of shoreface translation that expands on Bruun's Rule to investigate coastal stratigraphy. Den Bezemer, Kooi, and Cloetingh simulate both normal and reverse faults and their effects on stratal geometry. Granjeon and Joseph use a multiple lithology diffusive model to simulate the stratigraphy of the Paris Basin. Paola and coauthors use field parameters and a diffusive model to simulate the 3-dimensional evolution of a small (<5 km) braided fan. Syvitski, Pratson, and O'Grady demonstrate the linking of a series of models for predicting the acoustic properties of coastal regions for use by the U.S Navy.

The second section of Part IV describes the use of models to evaluate uncertainty. Of all the sections in the book, this section makes the greatest use of chaos, fractals, nonlinear dynamics, and similar subjects. Doligez and coauthors use stratigraphic models to constrain reservoir geometries. Nordlund provides a lucid introduction to fuzzy logic and demonstrates how a stratigraphic model based on fuzzy logic can be used to simulate an observed stratigraphic cross-section. Fractal models can be applied to quantify completeness of the sedimentary record, bed-thickness distributions, and basin heterogeneity, as shown by Pelletier and Turcotte. Penn and Harbaugh demonstrate how complex interactions of variables can produce chaotic, unpredictable results in basin simulations. Most intriguing, they show how cyclic sedimentation can be produced with no external forcing. Plotnick shows how several metrics developed by ecologists also can be used to measure spatial heterogeneity in geological data and models; such measures could be minimized in an inverse model to achieve a better fit to data. Ray and coauthors use a stochastic model, rather than a process-based model, to simulate an aquifer in the Dakota Sandstone. Finishing this section, Zijlstra demonstrates how current ripples can be simulated with a cellular automaton.

The final section of Part IV examines the use of coupled models, in which the output of one model is used as the input for another model. Gordon and Flemings couple a basin simulation model to a groundwater flow model to simulate fluid flow within an evolving sedimentary basin. Haupt and Stattegger combine an ocean general-circulation model to a sedimentation model and thereby simulate Quaternary sedimentation in the North Atlantic. Tuttle and Wendebourg use stratigraphic simulations and geostatistics to model hydraulic conductivities. They demonstrate how simulations allow one to reproduce field conductivities to within a factor of 3. Finally, Whitaker and coauthors use a coupled diagenetic and sedimentologic model to investigate carbonate diagenesis during cyclic deposition and exposure. The Syvitski, Pratson, and O'Grady paper in the first section of part IV is another example of such a coupled model.

The volume is accompanied by a CD-ROM, which includes the models PHIL, FUZZIM, and STRATA, as well as some supplemental material for the Cross and Lessenger article. The CD-ROM is readable on both Mac and Windows, and the FUZZIM model ran on a Mac without problem. The STRATA model compiled flawlessly in UNIX. The PHIL model was not included on the CD-ROM in the review copy, although many figures and QuickTime movies for it were. These QuickTime movies and the other included models are excellent tools both for research and for the classroom.

Despite a number of strong contributions, as I read the volume, three impressions developed that detracted from the volume as a whole. First, the papers differ widely in the rigor of their analyses. After reading many of these papers, I was frustrated by the lack of testing of the results. Although the stated goal of many papers is prediction, it is uncommon to see how any predictions fare. For example, if the goal was to simulate a basin for exploration, it would be most informative to show how well such a simulation performs. Tuttle and Wendebourg's paper is a welcome exception in that it quantitatively shows the difference between the use of field data and combined model and field data in estimating hydraulic conductivities. Several papers show a stratigraphic cross-section and an accompanying modeled section, but the criteria for a successful simulation are not stated. What is frequently not stated is the desired predictive ability and resolution of a model. The papers on inverse models reveal an additional problem with such visual comparisons by demonstrating how an acceptable visual match does not necessarily mean a good quantitative match.

Second, the papers differ greatly in their accuracy and degree of documentation. Errors in equations, such as missing parentheses and incorrect symbols, are fairly common. Many papers did not fully define the terms in the equations, and even more commonly, they did not define the units of terms. The Gordon and Flemings article sets the standard for careful documentation, with a simple table of all symbols in the article, their definitions, and their units, as well as tables of the values of constants and parameters used in the simulations.

Finally, and perhaps what I found the most frustrating, was that the papers differ widely in their relevance. Most useful among the forward models are those that are used heuristically; that is, to find general patterns in nature and to understand their meaning. The papers by Steckler, Carey and coauthors, den Bezemer and coauthors, and Whitaker and coauthors, for example, are outstanding in this regard. The articles on inverse methods (Bagirov and Lerche, Cross and Lessenger, Borholdt and coauthors) also are among the best of the volume. Several papers on coupled models clearly displayed the potential usefulness of stratigraphic simulations. I found less satisfying those contributions that focussed on the simulation of a single field area. Many of these papers seem to have as their main conclusion that it is possible to simulate a particular basin. Although there may be clear reasons for simulating a particular basin, such as extracting a eustatic sea-level history or predicting reservoir geometry, those goals frequently are not made explicit.

In short, there are several outstanding papers in this volume and a helpful CD-ROM, but there are also a number of papers that will be of more specialized interest. The volume is rather expensive, particularly for non-members of SEPM, which may tip the scales and cause it to be found mainly on the bookshelves of modelers.

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Evolutionary Catastrophes: The Science of Mass Extinction, Vincent Courtillot (Translation by Joe McClinton), 2000, Cambridge University Press, New York, 164p. (Hardback $24.95) ISBN: 0-521-58392-6.

Every schoolchild today "knows" that the extinction that killed the dinosaurs was caused by a meteorite impact so devastating that it practically wiped out life on Earth. For most of the populace, this "event" at the end of the Cretaceous is the "Great Extinction"—never mind that there are several others, some with even more impressive taxonomic kill ratios. The Terminal Cretaceous is everyone's favorite because it wiped out those most popular of all extinct creatures, the dinosaurs. Aided by references in the popular press and cinematography (e.g., "Armageddon", "Meteor") we are led to believe that the search for the cause of the "Great Extinction" is a *fait accompli.* Admittedly, a K/T impact is a universally captivating concept because of the scale of the associated phenomena—Richter magnitude 13 earthquakes, tsunamis 1 kilometer high. How can a mere volcano or ecosystem instability (originally included as an explanation in Crichton's "Lost World"—omitted from the Spielberg film) compete? Much of the scientific community also may have assumed that the evidence for an impact scenario is now so overwhelming and conclusive that no competing hypotheses need be considered. After all, we have the iridum layer, the tektites, the shocked quartz, the crater at Chicxulub—what more do we want? Even though I have always felt that relying on an extra-terrestrial cause for the end of the Mesozoic smacked too much of *deus ex machina*, there often appears to be little other than aesthetic grounds for objection. It is appropriate for all of us to remember that there have been other mass extinctions—and there are other causal explanations. Thus, I was delighted to see a geophysicist challenge the impact theorists.

Vincent Courtillot's *Evolutionary Catastrophes: The Science of Mass Extinction* weaves an intriguing story that combines the data, theories, and personalities surrounding the K/T event into an argument for an alternative hypothesis. It is clear from the outset that his approach is not one of impartial examination of all hypotheses, but rather that of a crusader whose goal is to attack the commonly accepted impact scenario and champion his own favorite explanation, volcanism. The book begins with a layman's introduction to the Geologic Record and the concept of extinctions, both "normal" and "mass" ("long periods of profound boredom. . . interrupted episodically by brief moments of unfathomable panic"). While five mass extinctions are mentioned, the focus is obviously on the K/T. The author continues with a chronological discussion of the development of the impact scenario by Walter and Luis Alvarez, explaining the significance of iridium anomalies, tektites, shocked quartz, radiometric dates from zircons and spinels, charcoal layers, and magnetostratigraphy. The opposition's case is briefly, but adequately, summarized.

The next four chapters construct the author's favored explanation. Beginning with research by the author and his colleagues on the Deccan Traps, he explains how massive flood basalts also can account for mass extinctions, iridium anomalies, and microspherules. Equally as important, he makes the argument that the Deccan Traps precisely overlap the K/T boundary. The origin of the traps is explained in terms of mantle plumes and hot-spots, the Deccan Traps being the first appearance of the plume now associated with the Reunion hot spot. Plumes are suggested to "result from an anomalous, unstable mode of mantle convection" that is born from an instability of a deep boundary layer in the mantle. They are presumed to be formed episodically, at random intervals, and are occasionally associated with the breakup of large continental masses. In chapter six, the author "ups the ante" and attempts to show how flood-basalt volcanism not only can explain the K/T extinction, but also the Permian/Triassic, the Triassic/Jurassic, and several others as well.

> Among the 12 traps younger than 300 Ma, at least nine can be associated with a major extinction. Seven of the ten principal extinctions can be associated with an episode of massive basaltic volcanism. (p.98)

The next two chapters attempt to debunk the concept of a period-