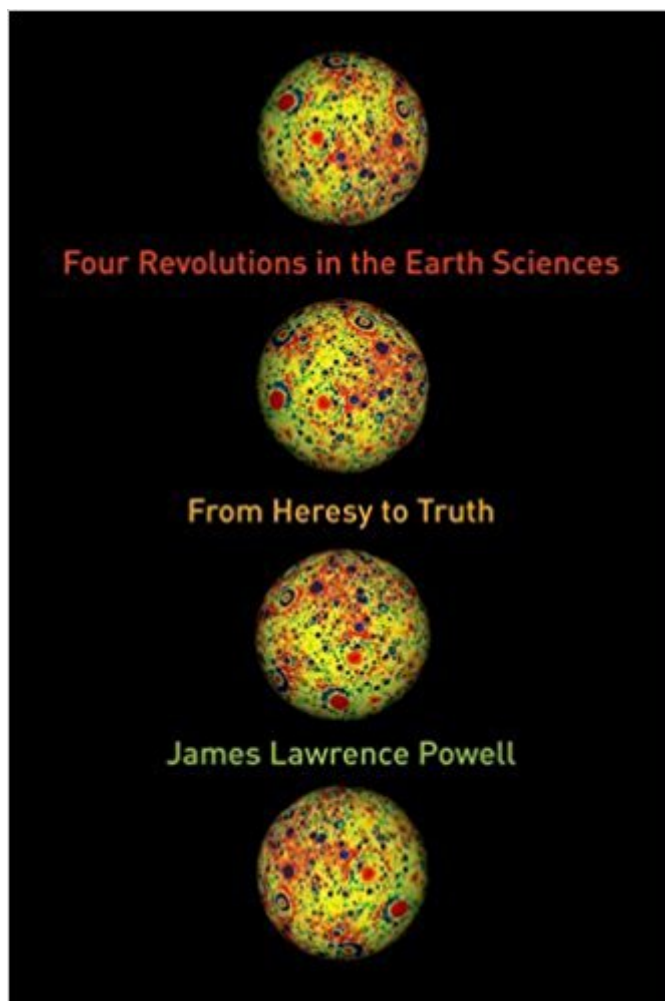




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# Four Revolutions In The Earth Sciences: From Heresy To Truth



## Synopsis

Over the course of the twentieth century, scientists came to accept four counterintuitive yet fundamental facts about the Earth: deep time, continental drift, meteorite impact, and global warming. When first suggested, each proposition violated scientific orthodoxy and was quickly denounced as scientific—and sometimes religious—heresy. Nevertheless, after decades of rejection, scientists came to accept each theory. The stories behind these four discoveries reflect more than the fascinating push and pull of scientific work. They reveal the provocative nature of science and how it raises profound and sometimes uncomfortable truths as it advances. For example, counter to common sense, the Earth and the solar system are older than all of human existence; the interactions among the moving plates and the continents they carry account for nearly all of the Earth's surface features; and nearly every important feature of our solar system results from the chance collision of objects in space. Most surprising of all, we humans have altered the climate of an entire planet and now threaten the future of civilization. This absorbing scientific history is the only book to describe the evolution of these four ideas from heresy to truth, showing how science works in practice and how it inevitably corrects the mistakes of its practitioners. Scientists can be wrong, but they do not stay wrong. In the process, astonishing ideas are born, tested, and over time take root.

## Book Information

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## Customer Reviews

James Lawrence Powell breaks new ground. His scholarship is deep, and his stories are

well-written and enriched with human detail. Anyone with an interest in how science progresses will profit from reading this book. (Spencer Weart, director emeritus of the Center for History of Physics of the American Institute of Physics, author of *The Discovery of Global Warming*) Absorbing.

(Publishers Weekly) This clear and well-written book offers four classic examples that show how science progresses—despite tough opposition, generally accepted ideas are often slowly replaced by newer, better ones. As an apocryphal medical school dean told incoming students: 'Half of what we will teach you in the next four years is wrong. The problem is that we don't know which half.'

James Lawrence Powell's new title provides a lively look at how the sciences, in this case the geosciences, really work. (Seth Stein, Northwestern University, author of *Disaster Deferred: How New Science is Changing Our View of Earthquakes in the New Madrid Seismic Zone*) This is first-rate story telling, with heroes, villains, and the often-unexpected discoveries that created revolutions in our concept of the planet. (David Morrison *Skeptical Inquirer*)

James Lawrence Powell serves as executive director of the National Physical Science Consortium, a partnership among government agencies and laboratories, industry, and higher education dedicated to increasing the number of American citizens with graduate degrees in the physical sciences and related engineering fields, emphasizing recruitment of a diverse applicant pool that includes women and minorities. He received his Ph.D from the Massachusetts Institute of Technology and has taught at Oberlin College and served as its acting president. He has also been president of Franklin and Marshall College, Reed College, the Franklin Institute Science Museum in Philadelphia, and the Los Angeles County Museum of Natural History. Presidents Ronald Reagan and George H. W. Bush both appointed Powell to the National Science Board. He is also the author of *The Inquisition of Climate Science*.

Excellent and fast shipping.

Jim Powell has written a welcome history of some of the most important and contentious ideas in science. Almost everyone has heard of the topics he analyzes: the age of the Earth and Moon, plate tectonics, the discovery that the Earth and Moon have been battered by cosmic impacts, the impact extinction of the dinosaurs, and global warming. While these basic concepts are widely accepted by scientists, there are still influential members of the public (like politicians who love to expose their ignorance by answering questions with 'I am not a scientist') who oppose them.

Powell has written a lively history of these ideas, and this book provides a welcome window into the

basics of modern geosciences. This book is more than a good read; Powell has an important message for us. He uses the sometimes tortured history to explore the basic questions of how scientists decide what is correct – not absolute truth, which is never possible, but at least a consensus with a high level of confidence. This is not a pretty history, with many wrong turns and quite a few villains who refused to believe evidence that undercut their own pet ideas. When the deniers held senior positions in universities or government agencies, they were able to block progress for as much as a generation. One motivation was an inherent distrust of outsiders, especially the arrogant physicists who questioned the geological consensus. Another important factor in the first two case studies was the very small numbers of scientists who were working in a given field, and the absence of real data with which to test theories. In the second half of the twentieth century, there are many more researchers, equipped with marvelous facilities and aided by powerful computers, and communication among them is far easier than in the past. Yet at a major international conference on lunar geology held shortly before the Apollo landing, there was still virtual unanimity among those present that the lunar craters were volcanic and impacts had played little if any role in lunar history. The most provocative discussion in Powell's book concerns climate change and global warming. The basics of the greenhouse effect and the role of atmospheric carbon dioxide in determining surface temperatures were established a century ago, and by the 1970s a consensus was beginning to emerge about the role of industrial pollution in raising temperatures. By the 1990s the direct evidence for global warming was pouring in, and today it is impossible to deny the reality of large-scale climate change. But – scientific consensus – is a tricky concept. In his earlier examples, Powell documented cases of consensus in other areas of the geosciences that persisted for decades and then were overthrown by new discoveries, sometimes coming from other fields of science. Powell asks the important question whether this current consensus is any more durable than some of the widely held misconceptions of the past. This is our conundrum when we find ourselves in the midst of a scientific revolution. Does heresy in science always give way to truth, as implied in the subtitle to this book? And how do we know when we have it right with enough confidence to take action to save ourselves from possible planetary catastrophe.

One of the many great things about *Four Revolutions* is that it jumps right in. There isn't the endless groundwork and foundation building of so many such efforts. It is captivating right off the top. Being the history of discovering how the Earth works, it is intuitive and has universal appeal. Its cast of miscreants and creatives makes it colorful. And Powell has a terrific knack for harpooning

just the right keywords for the titles and subtitles, along with dramatic endings for sections. The four revolutions are: -determining the age of rocks and the Earth-continental drift-meteorite impacts on the moon, and dinosaur extinction here-global warming. While the first is a quite civil disagreement among natural philosophers (as scientists were called), the second gets into vicious mudslinging, as scientists use ad hominem attacks on each other to denigrate their theories, their qualifications and even their personalities. Continental drift had all the appeal of forced abortion to American scientists in the first half of the last century. It is astonishing how they wielded their ignorance as if it were unimpeachable truth, and accused each other of being unqualified quacks. Rather than consider a new theory, they would conjure absurd patches to paper over faults in their own work. They worked to banish the printing of references in textbooks, or even the names of the perpetrators. They refused to cite competitors in their papers. It has of course, been this way for centuries. Global warming is the most obnoxious story. It was theorized in the late 1800s. "Greenhouse Effect" was coined in 1913. And the issue has been proven again and again and again since. However, certain fossil fuel giants as well as conservatives have spent millions to counter the science. In "Unaccountable: How Elite Power Brokers Corrupt our Finances, Freedom, and Security," Janine Wedel cites studies that of the more than one thousand books published on the topic, maybe 25 deny it. 72% of those denial books have a verifiable link to (conservative) "think tanks", and 40% of those were written or edited by people with NO relevant scientific credentials. Yet that is what is holding up the whole planet from taking action, as the media repeatedly focus on the deniers in order to be "balanced". Powell says there is no balance. This is settled science. You can see the same process underway in geology today. The astrophysicist Marvin Herndon has disproven (not theorized, but disproved, which Powell says is far more difficult) convection as the motor of continental drift. He has postulated a unified theory in which all planets began as gas giants like Jupiter, and that particles rained in from the gas clouds over billions of years to produce the rock cores we call planets. His "Maverick's Earth and Universe" is both inspiring and sad. Sad to see the entire scientific community actively ignore this theory, and refuse to cite it, just as Powell describes in Four Revolutions. These are most worthy reads. Four Revolutions is a fascinating record of small minds obfuscating big issues for personal gain. David Wineberg

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