Shaking up seismology

The Big One: The Earthquake That Rocked Early America and Helped Create a Science

by Jake Page & Charles Officer
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Naomi Oreskes

In the winter of 1811–12, three major earthquakes struck an area of the North American mid-continent in rapid succession. According to eye-witnesses, the ground ruptured profoundly in numerous locations, lakes appeared where there had been none, and the mighty Mississippi River flowed backwards. The earthquakes, felt as far away as Montreal in Canada, affected an area of more than a million square miles. Their magnitudes have since been estimated at between 7.8 and 8.3, greater the 7.6 of the famous San Francisco earthquake of 1906, and making them among the most powerful quakes to strike the United States in recorded history.

The United States was a young and sparsely settled country, and the theory of plate tectonics was far in the future, so there is no meaningful sense in which these earthquakes could have been considered "anomalous" at the time. Nonetheless, they are scientific anomalies now: the theory of plate tectonics explains large earthquakes as the release of stress built up as the Earth's crustal plates slowly grind past one another, but the quakes of New Madrid (to rhyme with Hagrid) occurred nowhere near a plate boundary.

If the theory of plate tectonics does not explain 'intra-plate' earthquakes, then what caused the New Madrid quakes? And why hasn't this conspicuous anomaly caused a crisis for the current theory? These are intriguing questions, and *The Big One* begins with the promise of answering them. Unfortunately, that promise remains unfulfilled.

The book opens with a fast-paced description of the events of that winter and the background to European settlement in the region. It then switches to the history of science: most of the remainder of the book is a historical discussion of developments in the Earth sciences, leading to present-day theories of the origins of the New Madrid events. Sadly, this material is filled with factual errors and presents little that is not better treated elsewhere.

It would be tedious to recount the numerous mistakes and misrepresentations; a few will suffice to make the point. Lord Kelvin did not originate the idea that Earth was progressively cooling — that honour, if that's what it is, belongs to Georges-Louis Leclerc de Buffon, Immanuel Kant and Pierre

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Laplace. Isostasy — the theory that the Earth's crust sits in hydrostatic equilibrium on a denser substrate — is not the theory of glacial rebound; glacial rebound is merely one example of an isostatic effect. Alfred Wegener, the author of continental drift theory, did not die attempting to bring help to stranded members of his 1930–31 Greenland expedition, but on a trip to equip an inland observation station. And no one in the 1920s pejoratively called Wegener's work "geopoetry" — that term was introduced later by the Dutch geophysicist J. H. F. Umbgrove as an approbative term for creative speculation, a concept later used to great effect by US geologist Harry Hess.

The authors' treatment of continental drift and plate tectonics is particularly beset by peculiar biases. They perpetuate the well-worn but erroneous view that continental drift was rejected for lack of a causal mechanism, whereas in fact mantle convection was widely discussed in the 1920s and 1930s as a plausible mechanism. They credit the idea of mantle convection to seismologist Beno Gutenberg at Caltech in the 1950s, but its earliest prominent and credible advocate was the British geologist Arthur Holmes, 30 years before. More oddly, the authors approvingly discuss the scientific contributions of Maurice Ewing and Bruce Heezen of Columbia University, both of whom opposed plate tectonics, yet make no mention of Hess, a principal architect of the theory and the man most responsible for reopening the debate in the United States.

Small errors are most relevant when they add up to a big problem, and the big problem here is the underlying theme of the book. Encaspulated by its subtitle, the suggestion is that the New Madrid quakes helped to launch the speciality of seismology, perhaps even the whole science of geology. The authors claim, for example, that geology in the early nineteenth century was "in its infancy"; that "most people who thought of themselves as scientists still believed generally in the history of the world as specified in the book of Genesis"; that many (if not most) geologists accepted the chronology of Archbishop Ussher that Earth was created on 23 October 4004 BC; and that Charles Lyell was the founder of modern geology.

These claims represent views that have long been discredited by professional historians. By 1811 there were well developed empirical and theoretical frameworks for the Earth sciences, developed primarily in continental Europe but rapidly making their mark in Britain and the United States as well. Conversely, seismology had its early roots primarily in Italy, but developed as an organized scientific discipline in the late nineteenth century in Japan, India and Germany. In Japan, the constant threat of severe earthquakes in a densely populated country hemmed in by the sea provided strong moti-

vation; in India, Richard Dixon Oldham's study of Indian quakes led to his discovery of P and S waves; and in Germany, precision instrument-building led to the manufacture of good seismographs. New Madrid had nothing to do with these developments. *The Big One* is a sloppy book, based on an erroneous premise. ■

Naomi Oreskes is in the Department of History, University of California, San Diego, La Jolla, California 92093-00104, USA.