

book reviews

“Let us pull ourselves from the slough of despond in which the implications of the new observations threaten to drown us. Rather let us lift our spirits by celebrating the new astronomical powers of insight that have brought us the latest news about the universe.” A splendid idea. A few hours spent with this book is just the way to get those spirits hoisted. ■

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Stopping the tectonic conveyor belt

Dynamic Earth: Plates, Plumes and Mantle Convection

by Geoffrey F. Davies

Cambridge University Press: 1999. 470 pp.
£60, \$90 (hbk)/£24.95, \$39.95 (pbk)

David Bercovici

Geology students today are presented with the theory of plate tectonics as the grand model of how the Earth works. Centuries from now, however, it may well be viewed in the same way that we now view Kepler's laws of planetary orbits — as a set of descriptive, largely empirical rules that support a generalizable physical theory. In the case of Kepler's laws, the physical theory was Newtonian physics.

The physical theory that best accounts for plate tectonics is that of thermal convection in the mantle. In this theory, Earth's solid mantle, acting like a very viscous fluid over millions of years, loses heat as cold rock currents sink from near the surface to cool the mantle, while hot rising currents transport heat out of the mantle's deeper interior.

Convection is both elegant and universal, playing a part in everything from our cups of coffee to the interior machinations of stars. Mantle convection is thus a more fundamental theory of geology than is plate tectonics, although its presentation in most Earth-science texts is either muted or incorrect. In this regard, Geoffrey Davies' *Dynamic Earth* attempts to set the record straight: mantle convection is neither the oft-taught big wheel driving the tectonic conveyor belt nor merely small-scale circulation, unrelated to plates. As the book stresses repeatedly, the plates *are* mantle convection.

The book's underlying theme concerns the mantle's thermal boundary layers. These are relatively thin horizontal layers across which the high temperature of the mantle changes either to the colder temperatures of the atmosphere and oceans, at the upper boundary, or to the hotter temperature of the molten-iron outer core at the mantle's lower boundary. As these boundary layers retain most of the temperature contrasts of the



Magma event remembered

It is 20 years ago this month since Mount St Helens was transformed from a symmetrical cone of a mountain into a smoking crater. Its eruption killed 57 people and millions of animals, and decimated the landscape around it for hundreds of square miles. *Mount St. Helens: The Eruption and Recovery of a Volcano*

by Rob Carson (Sasquatch Books, \$19.95) tells the story of the event, from the preliminary, mile-high bursts of steam and ash seen throughout April, when a crater first began to open (inset, left), to the eruption itself (inset, right), its immediate aftermath, and the way in which life has slowly returned to the area.

system, they are also the primary sources of the thermal buoyancy that drives convection. The tectonic plates are thus formed from the upper thermal boundary layer, often sinking convectively along their edges in the form of cold subducting slabs which, in turn, pull the plates in their wake, hence driving plate motion. Hot mantle plumes, which cause areas of active volcanism such as occur at Hawaii and Iceland, probably emanate from the lower boundary layer.

In contrast, mid-ocean ridges, which occur in regions where plates are moving away from each other, are not pried apart by the hot upwelling currents of some giant, wheel-like convective circulation, but are pulled open passively, primarily from the force of sinking slabs. The author establishes the physical basis for this picture with clear explanations and simple equations, and uses it to explain the first-order observations, such as the surface features of the sea floor, seismic images, heat flow and mantle geochemistry.

Apart from various technical issues that I might quibble over, two philosophical problems lead me to recommend the book with caution. First, the author's presentation is

quite one-sided, drawing inordinately on his own two-dimensional view of mantle convection, and only mentioning alternative ideas if he can dispatch them quickly in a few sentences. Second, he gives the impression (and even explicitly states in the introduction) that our broad understanding of mantle convection will change little beyond the views presented in the book. In science there is no progress without obsolescence, and the suggestion that little significant work remains to be done only detracts from the excitement of an active scientific field. In the end, students and instructors alike should be wary of dogmatic books that claim to be the last word on a subject.

However, despite these cautionary statements, the book is an elegant and readable exposition with a clear message of how the plates and mantle probably work. The entrance of mantle-convection theory into mainstream Earth-science education is an important cause which this book champions admirably. ■

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