Discussion of

*The mantle plume debate in undergraduate geoscience education: Overview, history, and recommendations*

by

Brennan T. Jordan

*27th December, 2006, Robert I. Tilling*

With this chapter, Brennan Jordan has rendered a great service, not only for geoscience educators but also for geoscientists (like myself) whose research does not directly bear on plate-tectonics phenomena. Even though not personally involved in the current debate, we non-specialists still want to know its ultimate outcome and are curious whether the debate protagonists can reach some common ground, if not consensus. Toward this end, Jordan provides a highly readable historical overview and non-technical distillation of the basic arguments that the specialists—advocate or skeptic—regard as the most diagnostic and persuasive in debating the mantle-plume theory.

For added perspective in gauging the present status of the debate, he conducted an online poll of specialists following the 2005 AGU Chapman Conference on the "The Great Plume Debate," involving mostly conference participants but also some experts not at the meeting. The number of poll participants was relatively small (66 responded to the 107 requests sent), and Jordan admits that the poll is not "scientific". Yet, even though the poll results are not statistically robust, I agree with Jordan that they may be useful to "…non-specialists in trying to understand the issues involved in the debate". Particularly interesting, though hardly surprising, was the finding that age-progressive volcanic chains were considered by the majority of specialists (even 40% of the plume skeptics) to constitute the strongest line of evidence in support of the mantle-plume theory. Somewhat unexpected, however, was the poll result that some lines of evidence were viewed by many specialists as supporting or arguing against mantle plumes. This dichotomy in part reflects, in my view, the existing inconsistencies and variability in the definitions and perceptions of the elements used in framing the debate.

To evaluate the presentation of mantle-plume theory to students, Jordan surveyed the latest editions of several widely used undergraduate geoscience textbooks. Encouragingly, he found that most of these acknowledge some degree of uncertainty regarding the origin and nature of hotspots and mantle plumes, thus reflecting the recent resurgence in critically reevaluating earlier held ideas. He also worried that none of the undergraduate textbooks presented alternatives to the mantle-plume theory, and advanced textbooks also gave only scant consideration to alternative hypotheses. Jordan argues that the insufficient presentation of alternative theories in college-level textbooks might compel students to accept the mantle-plume theory presented as fact.

While I share his concern, I suspect that, at the introductory (Geology 101) level, the presentation of multiple theories might tend to confuse rather than enlighten the average undergraduate. However, I fully concur with Jordan in advocating increased focus on alternative theories in textbooks targeted for above-average students pursuing graduate studies in any of the geosciences or related disciplines. Yet interestingly, very few respondents (~ 10%) in Jordan's poll considered the mantle-plume debate to be "too complex for the introductory classroom." Of course, we must bear in mind that the poll respondents are research-focused specialists. I wonder how the results might have turned out had the same poll question been posed to non-specialists, especially teachers of geosciences.

Overall, I found Jordan's study to be a well-balanced, unbiased treatment of the relevant issues on both sides of the current debate about mantle-plume theory. The results of his informal poll conducted among specialists were especially interesting, and they beg to be followed up by more broadly based, scientifically rigorous polls, involving not only plate-tectonics specialists, but also rank-and-file practitioners of the geosciences in academia, government, and industry. Perhaps these larger polls—ideally with hundreds or thousands of participants—could be conducted under the auspices of some geoscience professional organization (e.g., American Geophysical Union, American Geological Institute, Geological Society of America) or the National Science Foundation. I wager that the results of a more comprehensive poll would afford some instructive and surprising comparisons with those from Jordan's limited poll.

*28th December, 2006, Stephen Marshak*

In response to a request from the editor, Gillian Foulger, I offer the following comments on Brennan Jordan's chapter from the perspective of a textbook author. Jordan suggests that introductory texts, such my *Earth: Portrait of a Planet and Essentials of Geology*, do not provide sufficient discussion of alternatives to plumes as an explanation for hot-spot volcanism.

The choice of deciding what to include and what not to include in an introductory text proves to be a delicate balancing act. Jordan wants to see more coverage of plume alternatives, but reviewers argue that alternatives are too hard to explain using requisite simplified terminology so students become frustrated when reading about them. Further, reviewers emphasize that 99% of the students in an introductory geology course will not become geologists, so an extended discussion of plume alternatives goes beyond the needs of an introductory course. Such comments highlight the fact that, in the case of introductory texts, too much detail may be worse than too little detail, if the book is to appeal to the broadest audience.

The debate about plume coverage reflects the broader dilemma, that adopters have conflicting desires when choosing texts. They want to see more topics covered, and more detail provided (especially as regards their personal area of expertise), but at the same time want the books to be shorter and simpler because the bulk of students are non-majors and don't have the patience to read long texts. For this reason, it is not surprising that authors tend to wait for the dust to settle

before committing precious page space to ideas that have not yet stood the test of time. Also, since publishers do not want the page count of a book to become too large, one can ask: In the space available, is it more important to have an extended discussion of Hurricane Katrina and the Indian Ocean tsunami, or an extended discussion of plume alternatives?

Adopters generally indicate a preference for more discussion of issues that have societal impact than of ones that are primarily of academic concern. That said, introductory books should reflect the latest discoveries in geoscience and should convey a sense that active research continues to take place. In the case of the plume debate, the growth of literature about alternatives implies that the subject has matured sufficiently for a brief mention of alternatives to be appropriate. Thus, the third edition of my book will include one.

*7th February, 2007, Brennan T. Jordan*

I thank Tilling and Marshak for their comments on my manuscript, and have several comments to offer in reply. Tilling's comments generally reflect the perspective with which I hope this contribution is received. I aimed to provide an unbiased overview of mantle plume theory and the history, and current state, of presentation of this subject matter in undergraduate textbooks. I believe that while the poll I conducted in the wake of the 2005 Chapman Conference is a non-scientific poll of a very narrow subset of the geoscience community, it provides insights into the debate that can be considered with value to both the specialist and non-specialist. Perhaps the most important result from this poll is that most lines of evidence considered in the plume debate are used to argue both ways, and apparently effectively, as people with strong feelings on either side find these lines of evidence compelling in their favor. I believe that what one should take away from this observation is that we need new data, better data, or new perspectives to resolve this debate; arguing about the existing data set has created a deadlock.

There is one additional poll result that I will report in this reply. Tilling points out that, in regard to the low proportion of poll respondents (10%) that believe that the mantle plume debate is too complex for introductory students, "we must bear in mind that the poll respondents are research-focused specialists." Certainly, all of the participants in the conference are researchers, but a significant number are also educators; 57% of the poll respondents indicted that they teach introductory geoscience course, and 60% indicated that they teach upper-division undergraduate courses. Tilling's point is still well-taken, the respondents are not representative of the overall geoscience community, and, given their interests, they are more likely to conceive of approaches to distill the complicated aspects of this issue for introductory students.

Both Tilling and Marshak comment on issues and limitations of presenting controversies in introductory textbooks. As Marshak is the author of one of the leading physical geology textbooks, I am most grateful for his perspective. I am sensitive to the delicate balance that authors of introductory textbooks must try to strike, and I do not want this paper to be read as critique of their coverage. Authors are tugged in opposing directions by publishers, adopters, and reviewers. In that sense, this paper, recommending the inclusion of an alternative hypothesis to

add depth to the now commonly portrayed uncertainty in the plume hypothesis, only contributes to the authors' struggle. I know that textbook authors cannot thoroughly convey the standing of every theory in their field, or present both sides of every controversy; to do so would produce a long, baffling text that portrayed a science in disarray. But I do think that it is healthy to present at least a couple of controversies, to demonstrate that the science is still actively addressing fundamental issues. This should be exciting to the more interested students. If controversies are to be presented, students will only appreciate that both sides have merit if alternative hypotheses are presented. The essence of my recommendations is that I believe that the mantle plume debate is a worthy candidate for this kind of coverage.

*References*

Marshak, S., 2005, *Earth: Portrait of a Planet*, 2nd edition: W.W. Norton & Co., New York.
Marshak, S., 2007, *Essentials of Geology*, 2nd edition: W.W. Norton & Co., New York.