Geological Society of America
Structural Geology & Tectonics Division

2014
Outstanding Publication Award

Presented to John A. Tarduno and co-authors

Tarduno, J.A., Duncan, R.A., Scholl, D.W., Cottrell, R.D., Steinberger, B., Thordarson, T., Kerr, B.C., Neal, C.R., Frey, F.A., Torii, M., & Carvallo, C. (2003) *The Emperor Seamounts: Southward motion of the Hawaiian Hotspot plume in Earth's mantle.* Science 301, 1064-1069.

Citation by Peter C. Lippert

My fellow nominators and I are pleased to recognize The Emperor Seamounts: Southward motion of the Hawaiian hotspot plume in Earth's mantle by John Tarduno, Rob Duncan, and colleagues as the recipient of 2014 Outstanding Publication Award of the Structural Geology & Tectonics Division of GSA.

I nominated this paper primarily for two simple reasons: its elegance in design and its impact on our understanding of both mantle and crustal Earth processes. Just over a decade ago, the majority of the geosciences community regarded oceanic hotspot tracks as passive recorders of absolute plate motion. The pioneering work of Jason Morgan continued to fix everyone's eyes on the Hawaiian-Emperor hotspot chain as the prime example of abrupt changes in plate motions. But there had been rumblings within the community for years that it was not just the Pacific Plate that moved, but the Hawaiian-Emperor plume, too. The evidence used to demonstrate plume motion, however, relied on incomplete paleomagnetic records and on plate circuits, and thus the notion of fixed hotspots remained, well…fixed.

Tarduno et al.'s 2003 Science paper addressed the issue of hotspot motion head-on with a simple test: the latitude history of the Hawaiian-Emperor plume. If the hotspot was fixed, then each and every seamount in the chain would have formed at the same latitude; but if the hotspot moved in the mantle, then the seamounts would have formed at different latitudes. The test required paleomagnetic records from just a single chain. Although records from other seamount chains would make the test more robust, they weren't necessary to demonstrate the key issue. The test also obviated the use of plate circuits. The results would speak for themselves: was the source of the Hawaiian-Emperor seamount chain fixed in the mantle or not?

"The Emperor Seamounts" demonstrated that the plume moved; it had moved a lot. The paradigm of fixed hotspots shifted. While this result merits distinction in its own right, it must be noted that this paper motivated a cascade of new studies throughout the field of global tectonics, from re-evaluating and testing the Pacific-Atlantic plate circuits, to a renewed interest in high-precision geochronology and geochemistry of seamounts and the origin of mantle plumes, to a new wave of mantle convection modeling, to the development of coupled mantle convection-plate motion modeling (now a burgeoning field of study itself). Many of these fields have, in turn, spilled over to our understanding of plate boundary tectonics, plate motion, and mountain belts, topics many of us in this room hold near and dear to our hearts. Nearly every professional discussion of absolute plate motions, whether at conferences or in the literature, now considers moving hotspot reference frames. The results from this study required us to rewrite our lectures and textbooks. I have seen the results from this study taught in the core undergraduate and graduate curriculum at UC Santa Cruz and the University of Arizona and it will certainly be taught in my classes at the University of Utah; a quick internet search indicates that hotspot motion is taught widely. The fundamental nature of the problem addressed, the implications of the hotspot motion for a number of geological processes, and the simplicity of the test presented make it an ideal paper for classroom discussion. On a personal level, I had the privilege to work in John's lab while this paper was coming together; he was always impressing on me and the other undergraduates in the lab, some of whom contributed directly to this study, the importance of challenging and testing our assumptions in the Earth Sciences. It's a pleasure looking back at the 11-year history of this paper to see this point so well illustrated.

In summary, “The Emperor Seamounts” is already a landmark paper in the Earth Sciences. It has changed our understanding of first-order planetary processes, reinvigorated and even inspired entirely new fields of geoscience, and has already been widely integrated into general geoscience education. When we think about great papers about plate motions, we think of Hess, Morgan, Wilson, Atwater, Molnar, and Engebretson, to name a few. We also think about the team lead by Tarduno and Duncan. Please join us in congratulating them for the 2014 GSA Structural Geology & Tectonics Division’s Outstanding Publication Award.

Response by John Tarduno

I'd like to thank the division and nominators for this award, and especially Peter Lippert for his most gracious letter. Our work on the Emperor Seamounts was a group effort involving the Shipboard Party of Ocean Drilling Program Leg 197. Of special note, I would like to thank cochief scientist Bob Duncan who provided essential age data and assembled a top team of petrologists, led by Clive Neal and Fred Frey at sea. Thor Thordarsson provided key insights on volcanology whereas Rory Cottrell led the crucial onboard paleomagnetism measurement program. David Scholl revived the approach of collecting seismic data immediately before drilling to refine site locations. Although it would take a year to verify the results, Leg 197 set a new standard. The key result of the test- the pattern of decreasing paleolatitude as one moves south along the Emperor Seamount lineament- was available at our last scientific meeting on the ship, before we reached port in Yokohama. This real time data collection and analysis effort convinced even some of the most diehard believers of absolute fixity that hotspots can drift in the mantle. Any ocean drilling expedition is a huge effort relying, of course, not just on the scientific party but also the JOIDES Resolution crew and scientific technical support staff, who deserve special recognition. Things don't always go as planned. In our case, we had a fire early in the cruise, and were dodging typhoons later in the expedition. These challenges were met deftly by the crew, who continually demonstrated calm professionalism. It is indeed my pleasure to be here not only to accept this honor, but also to see some friends who I have not seen since I worked on West Coast tectonics during my PhD studies. It is gratifying to learn that our work is having an impact on continuing studies of the tectonic development of western North America.