

Vine F J. Spreading of the ocean floor: new evidence *Science* 154:1405-15, 1966.
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Anomalies in the intensity of the Earth's magnetic field observed at a number of widely separated points on the crest of the world-encircling mid-ocean ridge system were shown to be explicable in terms of reversals of the Earth's magnetic field and constant rates of sea-floor spreading during the past few million years [The SCJ⁹ indicates that this paper has been cited in over 440 publications since 1966]

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October 28, 1985

The idea that the magnetic anomalies observed over mid-ocean ridges might result from a combination of sea-floor spreading and reversals of the Earth's magnetic field was first published by Drummond Matthews and me in 1963,¹ whilst I was a graduate student at Cambridge University, England. At the time it was generally considered to be an unconvincing and somewhat heretical explanation that was at best ignored and at worst derided in the literature.

There were two major developments in 1965 that transformed this situation. The first was the recognition, by J. Tuzo Wilson, of the Juan da Fuca ridge off Washington and Oregon. This area was covered by a detailed magnetic survey that revealed remarkably linear and symmetrical anomalies about the ridge crest as predicted by the model.² Previously, we had used profile data from the North Atlantic and Northwest Indian Oceans that revealed neither the linearity (because the data were not extensive enough) nor the symmetry (because, it transpired, the spreading rates are low compared to the Pacific, and as a result the record is less clearly written).

Once a clearer record had been recognised, the remaining requirement was an accurate geomagnetic-reversal time scale. This became available to me when, newly installed as an instructor at Princeton University, I attended the annual meeting of the Geological Society of America in November 1965. Brent Dalrymple, of the triumvirate of Cox, Doell, and Dalrymple, who were painstakingly refining the reversal time scale, was there

and presented their latest result. It differed not only from their earlier time scales but also from the description in their abstract, the crucial difference being the definition of the Jaramillo event.³ Immediately, I realised that this detail was present in the Juan da Fuca survey data and that the event could have been predicted from these had we assumed a constant rate of spreading.

On the basis of these developments, I resolved to write this paper. Between its conception and publication, further corroborative evidence became available. In February 1966 Neil Opdyke invited me to visit the then-named Lamont Geological Observatory of Columbia University where I met Walter Pitman. He was working on magnetic profiles of the Pacific-Antarctic ridge that revealed an even more remarkable symmetry about the ridge crest and additional details of the reversal time scale. Opdyke had independently discovered the Jaramillo event in his studies of the paleomagnetism of deep-sea sediments.

Pitman and his supervisor, Jim Heirtzler, generously allowed me to use the South Pacific data in my paper, at the same time writing their own paper on the South Pacific data alone, which they suggested should be published simultaneously with mine. In any event, their paper appeared in *Science* two weeks before mine.⁴ I suspect that we were the victims of a long-standing feud between their boss, Maurice Ewing, and mine, Harry Hess. According to Hess, Ewing tried to prevent or at least delay the publication of my paper, but Hess managed to convince Philip Abelson, the editor of *Science*, that it was a very significant paper.

It is clear in hindsight that, for many people, particularly in North America, this paper marked something of a turning point in the continental drift debate.³ Together with the work of Lynn Sykes, confirming Wilson's concept of transform faults (published six months later),⁵ it provided compelling evidence for the reality of sea-floor spreading and paved the way for the formulation of the concept of plate tectonics. It also provided the first quantitative estimates of sea-floor spreading rates worldwide.

Drum Matthews and I have been honoured many times for our heretical idea of 1963, but it seems probable that the award of the Day Medal of the Geological Society of America, the Bigelow Medal of the Woods Hole Oceanographic Institution, and the Bigsby Medal of the Geological Society of London to me personally in 1968, 1970, and 1971 was largely on the basis of this paper. A review of the eventual outcome of this work is provided by Pitman *et al.*⁶

1. Vine F J & Matthews D H. Magnetic anomalies over oceanic ridges *Nature* 199:947-9, 1963 (Cited 440 times)
2. Vine F J & Wilson J T. Magnetic anomalies over a young oceanic ridge off Vancouver Island. *Science* 150:485-9, 1965 (Cited 95 times)
3. Glen W. *The road to Jaramillo critical years of the revolution in earth science* Stanford, CA. Stanford University Press, 1982 460 p
4. Pitman W C & Heirtzler J R. Magnetic anomalies over the Pacific Antarctic ridge *Science* 154:1164-71, 1966 (Cited 135 times.)
5. Sykes L R. Mechanism of earthquakes and nature of faulting on the mid-ocean ridges *J Geophys Res* 72:2131-53, 1967 (Cited 305 times.)
6. Pitman W C III, Larson R L & Herron E M. *The age of the ocean basins and magnetic lineations of the oceans* (Charts.) Boulder, CO: Geological Society of America, 1974 Map and Chart Series-6.