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Latitudinal shift of the Hawiian hotspot: Motion relative to other hotspots or motion of all the hotspots in unison relative to the spin axis (i.e., true polar wander)?

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Recent results from deep sea drilling confirm a large southward drift of the Hawaiian hotspot since Campanian and Maastrichtian time (≈70 to 83 Ma), as was previously found from prior paleomagnetic results from drilling (Kono, 1980; Jackson et al. 1980), from skewness analysis of Pacific magnetic anomalies (Gordon 1982, Petronotis & Gordon 1989, 1999; Petronotis et al. 1992, 1994; Acton & Gordon, 1991; Vasas et al. 1994; Horner-Johnson & Gordon 2003), and from other paleomagnetic and paleolatitude data (Gordon & Cape 1981; Sager & Bleil 1987). This southward drift could have resulted from motion of the Hawaiian hotspot relative to some other hotspots, or of all the hotspots moving in unison relative to the spin axis (i.e., true polar wander), or some combination of the two. Tarduno et al. (2003) have recently presented an extreme interpretation of these results as being entirely due to southward motion of the Hawaiian hotspot relative to other hotspots. Here we show that this extreme interpretation is not supported by available data.

While the Pacific plate paleomagnetic data are sufficient to show that the Hawaiian hotspot has moved southward relative to the spin axis, alone they cannot be used to demonstrate motion relative to the mantle or relative to other hotspots. To do so, coeval paleomagnetic poles are needed from the continents bordering the Atlantic and Indian Oceans. Here we show that few, if any, of the coeval paleomagnetic poles from the continents incorporated into widely used reference paths pass minimum reliability criteria. Instead we use the sparse reliable inclination-only data to estimate the paleomagnetic pole for the Indo-Atlantic hotspots and find that the data are consistent with hotspot fixity, although some motion between hotspots is certainly allowed within the uncertainties in the poles.

We further show that other earlier studies purporting to show motion between hotspots from paleomagnetic data are now invalid because of revisions to paleomagnetic poles from the continents or because of flaws in analysis. Updated paleomagnetic analyses indicate that little motion has occurred between Pacific hotspots and Indo-Atlantic hotspots. Instead, available data are consistent with the hypothesis that the southward motion of the Hawaiian hotspot relative to the spin axis is mainly caused by true polar wander.

Finally, we construct a global self-consistent model of the motion of the plates relative to the hotspots for the past 50 Myr. We then rotate both Pacific and Indo-Atlantic related paleomagnetic poles into the hotspot reference frame. The resulting optimal path of apparent polar wander of the hotspots indicates a systematic offset of the spin axis, showing that the hotspots have moved substantially ($\approx$10 degrees) and largely in unison relative to the spin axis since mid-Cenozoic time.