**Forum** Comment
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# Revision of Paleogene plate motions in the Pacific and implications for the Hawaiian-Emperor bend

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According to literature summarized by Wright et al. (2015), it is generally accepted that hotspots have moved relative to each other since 80 Ma, and that the Hawaiian hotspot moved south relative to the spin axis during formation of the Emperor seamounts prior to 48 Ma. Koivisto et al. (2014) advanced the alternative view that the minimum relative motion between hotspots is much smaller than generally accepted, implying errors in the global plate circuit are larger than generally accepted. In particular, they suggest that the global circuits are incorrect for motion prior to 48 Ma between East and West Antarctica. In this view, southward motion of the Hawaiian hotspot is evidence for motion of the entire lower mantle relative to the spin axis.

Wright et al. defend conventional wisdom using freshly calculated relative motion solutions for plates in the Pacific basin. They conclude that the Hawaiian-Emperor bend (HEB), formed at ca. 50-42 Ma and sharpest at 47.5 Ma, is a result of the cessation of southward motion of the Hawaiian hotspot and is not a result of change of absolute motion of the Pacific plate. The purpose of this Comment is to point out that their results are at least as consistent with a large change in motion of the Pacific plate that was responsible for a significant part of the HEB.

Wright et al. calculate Pacific-Farallon finite half-rotations from the Pacific-plate record at more frequent intervals than previous workers. They recognize an acceleration from ~75 mm/yr full rate prior to 60 Ma to ~180 mm/yr after 40 Ma. According to their preferred Cande and Kent (1995) time scale, this acceleration is spread out over 57–40 Ma, but according to the Ogg (2012) time scale, the acceleration is contained within the interval of 50–43 Ma, a time interval entirely within the age span of the HEB. Their statement that their “results are not strongly dependent on the time scale used” is hard to understand. In the discussion associated with Wright et al.’s figure 3, they suggest that this acceleration is dominated by eastward acceleration of the Farallon plate in an absolute reference frame. Any conclusion that Pacific absolute motion didn’t change much is circular because they assume that one of three published models for Pacific plate absolute motion is correct, and for all of these published models, changes in Pacific plate absolute motion are small. This discussion does not address the possibility that all three of these models for absolute reference frames share common errors in the global plate circuit.

Wright et al. briefly mention their analysis of Pacific-Antarctic motion, presented in their figure 2, in terms of rate and direction of motion at the Pitman Fracture Zone in the far south Pacific. In discussion of Northern Hemisphere events possibly related to Pacific-Farallon acceleration, they suggest that westward acceleration of the Pacific plate would correspond to increased Pacific-Antarctic spreading rates. Because they observe a rate decrease at the Pitman Fracture Zone, they suggest that change in Pacific absolute motion was “relatively minor.” Here they make a serious error in failing to consider spherical geometry. The Pitman transform fault active at 48 Ma was 90–100° of arc away from the Molokai and Murray Fracture Zones, and the HEB. Their discussion frames the most relevant issue as how the motion of the Pacific plate changes at the location of the Hawaiian hotpsot. The velocity of the Pacific plate relative to Antarctica when calculated at relevant Northern Hemisphere locations does increase sharply near 48 Ma. Calculated at the location of Hawaii, the velocity of the Pacific plate changes from slow (35 mm/yr) northwest motion to fast (83 mm/yr) west-northwest motion (Fig. 1). Again relative to Antarctica, stage rotations indicate westward acceleration of the Pacific of ~50 mm/yr at the location of the then-active Murray and Molokai transform faults.

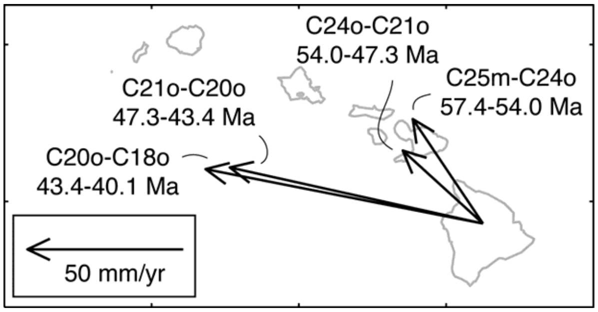

**Figure 1. Velocity vectors of the Pacific plate in the frame fixed to West Antarctica, calculated at the location of Hawaii. The velocities are calculated from differences of finite rotations, using the same values Wright et al. (2015) used for their figure 2, the values of Croon et al. (2008) for C20 and younger, and Wright et al.’s table DR4 for C21 and older. Times cale is from Ogg (2012); alternative time scales would affect the speed but not azimuth of the vectors. In this reference frame at the hotspot location, the Pacific plate accelerates westward by ~60 mm/yr at a time indistinguishable from the age of the sharpest part of the Hawaiian-Emperor bend.**

Wright et al.’s analysis of Pacific-Farallon motion has uncertainties arising from both the symmetric spreading assumption and the reversal time scale. Considering the resulting full uncertainties, it is not possible to conclude that any of their observations are inconsistent with a short-duration acceleration of at least 50 mm/yr in northern Farallon-Pacific spreading near 48 Ma. For Pacific-Antarctic motion, asymmetric spreading is irrelevant and changes in spreading direction make the time scale less relevant. Because Northern Hemisphere acceleration of the Pacific plate relative to Antarctica is comparable to plausible values of Pacific-Farallon acceleration, Wright et al.’s conclusion that the change in Pacific plate absolute motion at 48 Ma is “relatively minor” must be viewed as, at best, nonunique. The HEB is best viewed as a result of changes in both Pacific plate motion and hotspot motion, arguably perhaps 50–70 mm/yr of plate motion and 30–50 mm/yr of hotspot motion. Remaining issues include why these changes appear simultaneous, and how much the Hawaiian hotspot moved relative to other hotspots.

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