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Plate tectonics: a recent synthesis of its conservation of angular momentum, driving force, internal mantle motions, and lithosphere deformations

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The fact that the Pacific Plate has had two periods of slow acceleration, with an intervening deceleration period, during the past 68 million years was first documented by Bowin (2004) from utilizing the geometric Pacific Plate Euler pole solutions of Harada and Hamano (2000). Iterative smoothing (1000 iterations) of those Pacific plate Euler pole positions greatly improved the consistency of their intervening stage-pole locations (Bowin and Kuiper, 2005) [viewable at ftp://ftp.whoi.edu/pub/users/cbowin/poster_agu_2005.pdf]. Bowin (2009, 2010), using 1024-interation smoothed Pacific Plate Euler poles in the fixed hotspot reference frame, allowed calculation of absolute Euler poles, at 2 Myr intervals, for the past 68 million years, from the Gordon and Jurdy (1986) relative Euler pole histories. Global maps of absolute plate velocities, as 1-degree gridded data, are included in the 2009 and 2010 publications and their supplements, and also in movie format. The gridded plate velocity data for each plate, together with each cell's area and an assumed isostatic lithosphere mass (taken to be equivalent to a point mass at 75 km depth) was used to calculate an angular momentum at each cell's center. These cell angular momentums were summed for each plate, and then the sums for each plate were added together, to obtain a global total at each 2 Myr time interval. The totals confirmed that for the past 66 Myr the Earth's total plate tectonic angular momentum is $\sim$1.4+27 kg m2 s-1. This angular momentum value is several orders of magnitude smaller than that of the Earth-moon system, and hence for practical purposes independent of the Earth's rotation.
The plate accelerations/decelerations, and the constant angular momentum, support the author's contention that the driving force for plate tectonics is the sinking of the lithosphere phase change positive mass anomalies that constitute the Earth's second largest mass anomalies (+/- N+21 grams) revealed by mass anomalies of the geoidal spherical harmonic degree 4-10 packet (Bowin, 2000). Which judging by the South American geoid high, they have equivalent point mass depths of 1200 km. The largest mass anomalies (+/- N+22 grams) comprise harmonic degrees 2-3, and are inferred to most likely arise from 2-3 km relief of the core/mantle boundary, and of an independent origin, possibly due to mass variations within the core. The presently two fastest plates are the Pacific Plate moving westward, and the Australian Plate moving northward, at 90 degrees to each other. They share a common edge along the complex transform fault zone along a line from the north end of the Tonga Trench to the south end of the Yap Trench. To this researcher, this geometric arrangement argues strongly against the existence of large thermal convection cells within the mantle. Hence, the plates of the Earth are NOT being carried along on the tops of internal thermal convection cells, but are being pulled and accelerated by the sinking of the positive phase change mass anomalies (at depths shallower than 1200 km) produced in the lithosphere under high pressure at depth. Fortunately, the hotspot rising plumes from near the core/mantle boundary have provided a reference frame with which to decipher these absolute motions. Once started, plate tectonics thereby becomes self-sustaining under conservation of angular momentum. How plate tectonics may have begun remains to be clarified. The fact that the tectonic plates slowly accelerate and decelerate indicates that surface deformations are due to impulse (force times time); equivalent to a changes of momentum.

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