Geophysical Research Abstracts
Vol. 13, EGU2011-11118, 2011
EGU General Assembly 2011

No-net Torque and Hotspot Reference Frames: Implications for strong lithosphere-mantle coupling beneath continental cratons and weak (asthenosphere-lubricated) coupling elsewhere

Jason Phipps Morgan (1) and W. Jason Morgan (2)
(1) Cornell University, Ithaca, NY, United States (jp369@cornell.edu), (2) Harvard University, Cambridge, MA, United States

The no-net rotation reference frame has been an endless source of confusion in geodynamics. While making perfect sense as one possible geodetic reference frame (of many!), it makes little dynamic sense, since it is the net torque from lithosphere motions that is zero, not the net rotation — the two will only be the same if the mantle viscosity were uniform beneath all lithosphere, which it almost certainly is not.

It is well-known that the no-net rotation frame differs considerably from the reference frame associated with no-net rotation relative to hotspots. This latter frame is based on the assumption that hotspots move as little as possible with respect to the deep mantle that their associated plumes are embedded in. Interestingly, if we imagine that only cratons couple strongly to the deeper mantle, then the no-net-torque-from-cratons reference frame is much closer to the hotspot reference frame. Furthermore, if oceanic lithosphere is coupled $\sim$10-20x more weakly to the deep mantle than cratons, the resulting no-net-torque-with-variable-lithosphere-coupling frame is extremely close to that which minimizes net plume/hotspot drift w.r.t. the lower mantle.

There are several further dynamic and quasi-kinematic tests of this hypothesis. One is to directly calculate the net torque on the lower mantle for geodynamic models that include lateral viscosity variations between craton roots and suboceanic asthenosphere. Another is to test if the same patterns hold true prior to 50Ma when plate motions, and the implied no-net-rotation frame differed considerably from present-day values.