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Opposite Kinematics, no Slab dip Vs Lithosphere age Correlation, and passive Behavior of Subduction zones

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Convergence rates across subduction zones are unexpectedly different from the subduction rates. In fact, along W-directed subduction zones, the subduction rate is given by the convergence rate plus the back-arc spreading rate or slab retreat, whereas along E- or NE-directed subduction zones, the subduction rate is the convergence rate, minus the shortening adsorbed in the hangingwall lithosphere. These simple kinematics emerge when the intervening moving plate boundary (e.g., the subduction hinge) is included in the computation.

For example, along an E-directed subduction with 8 cm/yr convergence, and plate boundary converging toward the upper plate at 6 cm/yr, the subduction rate will be only 2 cm/yr, i.e., the convergence is larger than the subduction. Vice-versa, along a W-directed subduction zone, with 8 cm/yr convergence, and plate boundary diverging from the upper plate at 2 cm/yr, the subduction rate will be 10 cm/yr, i.e., the convergence is slower than the subduction.

Due to the “westward” drift of the lithosphere relative to the mantle, the subduction hinges migrate westward or southwestward along E- or NE-directed subduction zones, whereas the transient hinge is fixed relative to the mantle along the opposing W-directed subductions.

One paradigm of plate tectonics relates the dip of the slab to the buoyancy of the downgoing lithosphere along subduction zones, being the negative buoyancy proportional to the age of the oceanic lithosphere. However, when comparing the dip of the slab with the age of the subducting oceanic lithosphere, this relationship is far more irregular than previously suggested, and it is not possible to simply correlate the increase of the slab dip to the increasing age of the downgoing cooler lithosphere.

Younger oceanic lithosphere may show steeper dip than older segments of slabs, in contrast with predictions of slab pull models. This observation suggests that supplemental forces or constraints have to be accounted for to explain the deep geometry of subduction zones, particularly their asymmetry with steeper W-directed slabs.

Moreover, horizontal plate motions are generally 10 to 100 times faster than vertical motions across plate boundaries. This supports a passive nature of subduction zones and plate boundaries in general with respect to the toroidal forces acting on the lithosphere.

All these data support an astronomical tuning of plate tectonics.