g10 Plate rotations < kinematic model >

... a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.

—Max Planck *Scientific Autobiography*.[1]

Seminal papers on relative rotations of separate pieces of the rigid lithosphere were: "Rises, Trenches, Great Faults and Crustal Blocks," by **W. Jason Morgan**, read at the 1967 AGU meeting and published a year later in *JGR*,[2] and "The north Pacific: An example of tectonics on a sphere," by D. P. McKenzie and R. L. Parker, published in *Nature* 1967.[3] McKenzie in 2001 has remarked: "I have sometimes been asked whether the approach I used to describe plate tectonics [at the time this phrase was not in use] was modeled on the theory of the dynamics of rigid bodies that led Euler [in 1776] to his theorem. It was not. It was, however, strongly influenced by the theory of dislocations, and especially by W. T. Read's book on the subject ..." [4]

Leonhard Euler (pronounced *oiler*) (1707-1783) proved that instantaneous movement of a rigid surface of a sphere over the sphere itself is describable as rotation about a single pole of rotation (and, by definition, its anti-pole, or antipode).[5] This theorem has been invoked to describe finite motion of a lithospheric plate on spherical Earth as a rotation about a stationary pole about which the ends of offset ridge-segments trace out a small circles. However, there is nothing to justify the a priori assumption of motion that allows the pole of rotation to be stationary.[6] Proof will rests on how well transform faults joining between ridge ends accord to the fixed pole model (***Figure g10.1***). A problem is that small circle slip-surface traces are disallowed theoretically as primary fractures.[7]

In 1990, C. De Mets, Richard G. Gordon, D. F. Argus and Seth N. Stein published the first results of NUVEL-1 (Northwestern University VELocity model 1), which determines relative plate motions between the rigid interiors of thirteen plates (Africa, Antarctica, Arabia, Australia, Caribbean, Cocos, Eurasia, India, North America, Nazca, Pacific, Philippine Sea, and South America).[8] Computation inputs are the magnetic time scale (revised in 1994 for NUVEL-1A), spreading rates (as recorded by magnetic-reversal seafloor crust anomalies averaged over the last 3 million years), transform-fault azimuths, and earthquake-slip vectors. For each pair of plates, relative finite displacements found for definite durations, are reported as angular velocities about a pole assumed to be fixed in its location. For example, a NUVEL1A calculation locates the NA-Pac Euler pole at Lat 48.7 ºN Long 78.2 ºE with NA to Pac Clkwise rot 0.749 º/Myr.[9] ❑

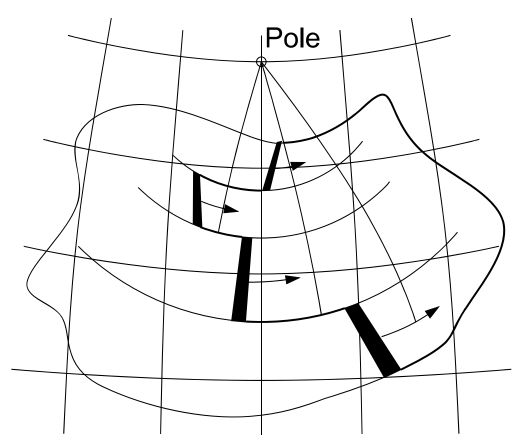

Figure g10.1 [10] The instantaneous motion of one rigid plate with respect to a second locates a Euler Pole.

The same motion continuing will leave this Pole stationary and between ridge ends transform faults will be segments of small circles centered on the Pole that is now a fixed pole of rotation, say P. This assumption is made in the NUVEL investigation of plate movements.[11]

The rate of plate-separation motion increases with angular distance from the fixed pole of rotation P to a maximum 90º away according to $V = \omega R \sin \delta$ where V is velocity, ω is angular velocity (rate) of rotation, R is Earth's radius, and δ is the angular distance from P.