Vectors and plate motion

Geographic coordinates converted to vector form

Components for a radius vector $\mathbf{r}$ at latitude λ longitude ϕ where R is radius of the Earth

$\mathbf{r}_x = Rcos(\lambda)cos(\phi)$
$\mathbf{r}_y = Rcos(\lambda)sin(\phi)$
$\mathbf{r}_z = Rsin(\lambda)$

Components for a unit North arrow $\hat{\mathbf{N}}$ at latitude λ longitude ϕ

$\mathbf{N}_x = -sin(\lambda)cos(\phi)$
$\mathbf{N}_y = -sin(\lambda)sin(\phi)$
$\mathbf{N}_z = cos(\lambda)$

Components for a unit East arrow $\hat{\mathbf{E}}$at longitude ϕ

$\mathbf{E}_x = -sin(\phi)$
$\mathbf{E}_y = cos(\phi)$
$\mathbf{E}_z = 0$

Rate of plate motion at a point on boundary

For a point at angular distance θ from the Euler pole

$v=\omega R sin\theta$

where R is the radius of the Earth (6370 km), ω is the rate of rotation in radians per million years, and v is the rate of slip in km per million years (or mm per year)

Alternatively, in vector terms, slip vector for motion $_A\mathbf{v}_B = {_A\mathbf{\Omega}_B} \times \mathbf{r_i}$

where $\mathbf{r_i}$ is the radius vector of the earth at the point on the plate boundary and $_A\grave{\mathbf{U}}_B$ is the plate rotation vector

North component of $_A\mathbf{v_B}$ is given by $v_N = {_A\mathbf{v_B}} \,.\, \hat{\mathbf{N}}$

East component of $_A\mathbf{v_B}$ is given by $v_E = {_A\mathbf{v_B}} \,.\, \hat{\mathbf{E}}$

Vector circuit for Euler poles

For any three plates A, B, C, if $_A\mathbf{\Omega}_B$ signifies rotation of plate B relative to plate A then $_A\mathbf{\Omega}_B + {_B\mathbf{\Omega}_C} + {_C\mathbf{\Omega}_A} = \mathbf{0}$

where $_A\mathbf{\Omega}_B$ signifies motion of A relative to B

Vector circuit for triple junction

At a triple junction involving plates A, B, C, plate motion vectors obey $_A\mathbf{v}_B + {_B\mathbf{v}_C} + {_C\mathbf{v}_A} = 0$ *where $_A\mathbf{v}_B$ signifies motion of A relative to B*

Note: sign conventions here follow the text by Van der Pluijm & Marshak (2004)