Plate kinematics

For calculations dealing with the whole Earth we use a coordinate system in which the origin is at the centre of the Earth. Axis 1 or x points towards the intersection of the equator and the Greenwich meridian, 2 or y is towards the intersection of the equator and 90°E, and 3 or z = is towards the north pole. Longitudes east are positive angles, west are negative.

Paleomagnetism

Spreading half-rate related to age of magnetic anomaly $v=w/t$

where v = spreading half-rate, w=distance from ridge, t=age of anomaly.

Magnetic inclination related to latitude:

$$\tan(I)=2\tan(\lambda)$$

where I = inclination, λ=latitude.

Euler poles for 12 major plates

in "no-net-rotation" reference frame. (Poles from the model NUVEL-1A by DeMets et al., Geophys. Res. Lett. Vol. 21 p. 2191-2194, 1994)

	Lat (°)	Long (°)	Rate (°/Myr)
	λ	ϕ	ω
Africa	50.57	-73.96	0.29091
Antarctica	62.99	244.24	0.23832
North America	-2.43	-85.90	0.20692
Pacific	-63.05	107.33	0.64086
Eurasia	50.62	247.73	0.23372
India/Australia	45.51	0.34	0.54535
Cocos	24.49	244.24	1.51028
Nazca	47.80	259.87	0.74318
Arabia	45.23	-4.46	0.54554
South America	-25.35	235.58	0.11643
Caribbean	25.01	266.99	0.21430
Juan da Fuca	-30.05	58.87	0.66583

Geographic coordinates converted to vector form

Components for Earth radius vector **r** at latitude λ longitude ϕ where r = 6370 km

$r_1 = r\cos(\lambda)\cos(\phi)$

$r_2 = r\cos(\lambda)\sin(\phi)$

$r_3 = r\sin(\lambda)$

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

$N_1 = -\sin(\lambda)\cos(\phi)$

$N_2 = -\sin(\lambda)\sin(\phi)$

$N_3 = \cos(\lambda)$

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

$E_1 = -\sin(\phi)$

$E_2 = \cos(\phi)$

$E_3 = 0$

Rate of plate motion at a point on boundary

In vector terms, slip vector for motion at any point on a plate boundary between plates *A* and *B:*

$${}_A\mathbf{v}_B = {}_A\mathbf{\Omega}_B \times \mathbf{r}$$

where: **r** *is the radius vector of the Earth at the point on the plate boundary and*

${}_A\mathbf{\Omega}_B$ *is the plate rotation vector*

North component of ${}_A\mathbf{v}_B$ is given by $v_N = {}_A\mathbf{v}_B \cdot \hat{\mathbf{N}}$

East component of ${}_A\mathbf{v}_B$ is given by $v_E = {}_A\mathbf{v}_B \cdot \hat{\mathbf{E}}$

Alternatively, 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)

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 B relative to A*

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 B relative to A*

Note: sign conventions here follow the convention used by most geophysicists but not the text Earth Structure by Van der Pluijm & Marshak (2004)