12.002 Physics and Chemistry of the Earth and Terrestrial Planets
Fall 2008

More Geomagnetism

Frozen flux theorem - field lines cannot pass in or out of a perfect conductor

Intensity - field lines per unit volume

Means that convection in conducting core fluid generates field.

Conductivity keeps the field lines from leaking out.

Paleomagnetism

Field of a Dipole

$B_r = \frac{\mu_0}{4\pi} \cdot \frac{2m\cos\theta}{r^3}$

$B_r = \frac{\mu_0}{4\pi} \cdot \frac{m\sin\theta}{r^3}$

for colatitude (□) = 90°- latitude (λ)

At equator (□=90°): B_r = 0, $B_\theta = \frac{\mu_0}{4\pi r^3}$

At geomagnetic pole (□=0° or 180°): B_θ=0, $B_r = \frac{\mu_0 m}{2\pi r^3}$

Field is 2x stronger at poles than equator.

Inclination of field:

$\tan I = \frac{B_r}{B_\theta} = 2\cot\theta = 2\tan\lambda$

At equator I = 0°

At poles I = 90°

Virtual Geomagnetic Pole (VGP) - spot reading of ancient pole when rock was magnetized.

$\sin\lambda_p = \sin\lambda_s\cos\theta + \cos\lambda_s\sin\theta\cos D$

Θ= magnetic colatitude = $\cot^{-1}(.5\tan I)$ (with respect to VGP, *not* present field pole)

$\varphi_p = \varphi_s + B$ when $\cos\theta \geq \sin\lambda_s \sin\lambda_p$

$\varphi_p = \varphi_s + 180 - B$ when $\cos\theta < \sin\lambda_s \sin\lambda_p$

λ_s = site latitude present day

λ_p = VGP latitude present day

φ_s= site longitude present day

φ_p = VGP longitude present day

D= magnetic declination

Measure D, I, φ_s, λ_s, Θ, to determine: φ_p, λ_s

Apparent polar wander (APW)– change of VGP location with time.

Continental drift: Runcorn (1957) found that APW paths of Europe and North America no not match up beyond 150 million years ago: opening of the Atlantic!