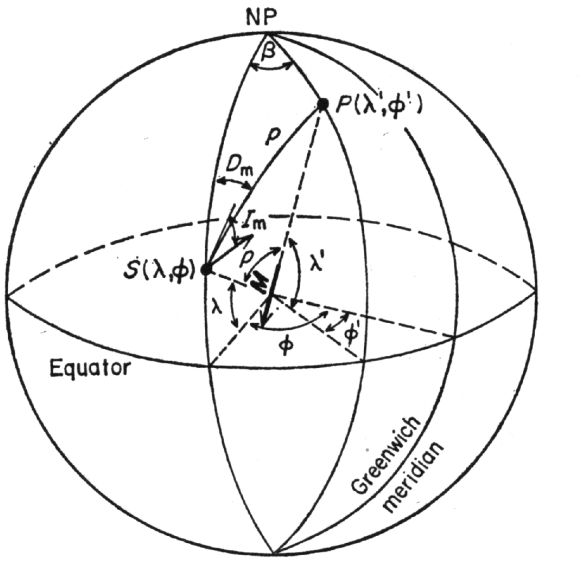
GEOL5690 Homework 4
Paleomagnetism and terranes.
Due: 15 March 2024

Recall the equations governing the position of the apparent pole at latitude λ' and longitude ϕ' from a measurement of the paleomagnetic field declination *D* and inclination *I* made at a latitude λ and longitude ϕ:

$$\begin{aligned} \sin\lambda' &= \sin\lambda\cos p + \cos\lambda\sin p\cos D \\ \phi' &= \phi + \beta \text{ when } \cos p \geq \sin\lambda\sin\lambda' \\ \text{or } \phi' &= \phi + 180° - \beta \text{ when } \cos p < \sin\lambda\sin\lambda' \\ \text{where } \sin\beta &= \sin p\sin D / \cos\lambda' \end{aligned} \quad (1)$$

Note that the latitude of the pole must be between –90° and +90°; longitude is positive east from 0°. *p* is the paleo-colatitude, which is related to the inclination *I* by tan *I* = 2 cot *p*. (0°≤ *p* ≤ 180°). Paleolatitude = 90° - *p*. Similarly, these can be reversed: if you have an apparent paleopole of latitude λ' and longitude ϕ' for a continent or terrane, then the declination *D* and inclination *I* at a locality at latitude λ and longitude ϕ on that continent or terrane can be derived from the following:



$$\cos p = \cos\lambda\cos\lambda' \cos(\phi' - \phi) + \sin\lambda\sin\lambda' \quad (2)$$

$$\begin{aligned} \cos D &= \frac{\sin\lambda' - \sin\lambda\cos p}{\cos\lambda\sin p} \\ \text{and } 0° \leq D \leq 180° &\text{ if } 0° \leq (\phi' - \phi) \leq 180° \\ \text{and } 180° \leq D \leq 360° &\text{ if } 180° \leq (\phi' - \phi) \leq 360° \end{aligned} \quad (3)$$

1) Tilt-corrected paleomagnetic measurements have been made on the rocks found at 122° W, 51°N as in this table:

Age	Rock type	Declination	Inclination
K (90 Ma)	basalt	336.0	74.4
J (170 Ma)	sandstone	312.1	-0.6
uTr (220 Ma)	granite	277.0	-61.4

Determine the paleolatitude of these rocks at these three times.

2) Studies of the paleomagnetism of rocks over North America have yielded the following apparent paleomagnetic pole positions:

Age	Latitude (λ')	Longitude (ϕ')
K	72	-165
J	65	112
uTr	56	94

Determine the paleolatitude and declination and inclination of the paleomagnetic field at 122°W, 51°N. Also compute the declination and inclination of the mean dipole field at this locality today.

3) Is the paleomagnetic data in (1) consistent with the rocks at 122°W, 51°N having been part of North America at the three times sampled? Explain (using your answer from (2)), and if not, from what direction(s) did the rocks come?

4) Consider the hypothesis that the rocks at 122°W, 51°N were in fact firmly attached to North America throughout the past 220 million years. For each rock unit, what would then be the most likely cause of any discrepancy with the expected directions for North America? (Put another way, what source of error could make it appear that these rocks had moved when they really did not?). Suggest how you could test for these possibilities.

5) Exposures of rocks at 122°W 46°N are considered by some to be part of the same block as the rocks at 122°W 51°N. Paleomag from these rocks is as follows:

Age	Rock type	Declination	Inclination
K (90 Ma)	basalt	-20.9	71.5
J (170 Ma)	sandstone	312.0	-7.3
uTr (220 Ma)	granite	272.4	-61.8

Do you think these rule out being on a common block, or is this consistent with the two sites being on a common (rigid) block? Explain your logic.