

## Magnetic Problems II – 2005; due 10/17/05

- Set up a table in Excel and use the spherical law of cosines to find the distance between Missoula (47° North, 114° West) and the places in the table below. Convert minutes to degrees and make diligent use of absolute references:

Where?	Longitude	Latitude
Abu Dhabi	54° 28' E	24° 15' N
Port Moresby	147° 20' E	9° 34' S
Thule	68° 47' W	76° 34' N
Santiago	70° 4' W	33° 26' S
Beijing	116° 23' E	39° 55' N
Aberdeen	2° 9' W	57° 9' N
Cape Town	18° 22' E	33° 55' S
Hammerfest	23° 38' E	70° 38' N
Vladivostok	228° 0' W	43° 10' N

State the distance in radians, degrees, and kilometers (assume radius of Earth is 6,371 km).

- Virtual geomagnetic poles (VGP) are locations of the magnetic pole at a point in time. A lava flow that cools, say over weeks or months, rapidly records a VGP. VGP need to be averaged (20-30 spot measurements) over  $10^6$  to  $10^7$  years to get a good estimate of a paleopole position (like anything else you need sufficient sampling to get a good, average estimate of standard deviation).
  - Suppose a VGP is at latitude 72°N, Longitude 62.5°W. What is the declination and inclination at Missoula (46.9°N, 114°W) for this VGP? What is the declination and inclination at Baghdad (33° 20'N, 44° 26'E) and Perth (31° 56'S, 115° 50'E)?
  - Suppose a 2004AD lava flow in Missoula records Declination = -19°, Inclination = 71°. Where is the VGP?
  - What is the average position of the two VGPs from a & b? (Find the x, y, z components of each, average them, then invert back to latitude and longitude – watch your quadrants!)
- Here are four positions: (0°E, 75°N), (90°E, 75°N), (90°W, 75°N), (180°E, 75°N). Treat them as vectors, and find their average. Now, find the average (incorrectly) by averaging longitude and latitude, compare your results. Think about it.

Recommended; especially if you are having trouble visualizing the magnetic field: On a cross section of Earth, **accurately** plot vectors for a uniformly magnetized sphere every 15°. Add a contour that shows the variation in intensity (absolute value of the field strength) around the planet; use a contour that just touches the plane at the magnetic equator.