

## Magnetic Problems I – 2002; due 10/14/02

1. 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 |

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

2. 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).
  - a. Suppose a VGP is at latitude 72°N, Longitude 62.5°W. Assuming that Earth's field is that of a uniformly magnetized sphere and follows the geocentric axial dipole hypothesis, what is the declination and inclination at Missoula (46.9°N, 114°W)?
  - b. Suppose a 2001AD lava flow in Missoula records Declination = -27°, Inclination = 69°. Where is the VGP?
  - c. 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!)
3. On a cross section of Earth (a circle), **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.
4. Play with MagCad for while until you are comfortable with magnetic anomalies. Ask yourself some appropriate questions and answer them to your satisfaction using MagCad. For example:
  - Is there a rule of thumb for anomaly width versus depth?
  - How does the anomaly change for a dike when the dip changes?
  - If there is a shallow source directly over a deep source, what is the best way to separate the two (total field or gradient)?
  - How would I design a magnetic survey to detect mineralized veins with  $k=.01$  (SI) whose average width is 3-5 meters?

You don't need to turn anything in for number four but I want you to think about magnetic anomalies