Homework 7: Magnetization & Anomalies from Magnetized Bodies

Read Lowrie 5.2.5-5.2.7, 5.3, 5.5
Due Thu. 3/4

The problems below are taken directly from Lowrie’s textbook; they are the questions that pertain to the reading above.

1. What is remnant magnetism? Describe an example type of remnant magnetism and how it originates in each of the rock types: (a) sedimentary, (b) metamorphic, (c) igneous.

2. Figure 5.5 shows how the vertical component of the magnetic field over a rectangular block differs for blocks of different widths. Have a look at (c), \(2m = 10\) (sorry the units are not clear in the diagram). Using the concept of how \(B_z\) relates to the solid angle subtended by the top and bottom surfaces of a vertically magnetized (p. 328), block describe (a) Why \(B_z\) is most positive at \(x = 0\) (i.e., directly over the center of the block), and (b) why \(B_z\) is strongly negative just beyond the edges (i.e., near \(x/m = 2.3\)).

3. In an aeromagnetic survey over land and at a flight altitude of 2000 m (above sea-level), the maximum total field anomaly over an ore body was 30 nT. In a repeat measurement at 2500 m altitude, the maximum amplitude of the anomaly was 20 nT. Calculate the depth of the ore body (below sea-level) assuming the ore body is a simple dipole. For simplicity, assume the ore-body is magnetized with the Earth’s field and that it is located on the magnetic equator.

4. The core of an anticline is made of basalt and the host formation is limestone.
(a) Using the susceptibilities given by the median values in Fig. 5.13 compute the induced magnetization contrast of the core relative to the host rock, \(\Delta M\), when the Earth’s main field has a strength of \(B_{eu} = 36,000\) nT.
(b) Assuming the core of the anticline is shaped like a buried horizontal cylinder (see p. 330) and the magnetization \(\Delta M\) is all vertical (as is \(B_{eu}\)). Derive the equation describing the horizontal component of the magnetic anomaly \(\Delta B_x\) as a function of \(\Delta M\), position relative to the cylinder \((x,z)\), and cylinder radius \(R\). (hint: remember the relationship between \(B\) and \(W\)).
(c) Show the equation for the total field anomaly \(T\) over the anticline.