210D3: Magnetic anomalies produced by simple geological structures

Remember that objects can acquire both **induced** and **remnant** magnetization.

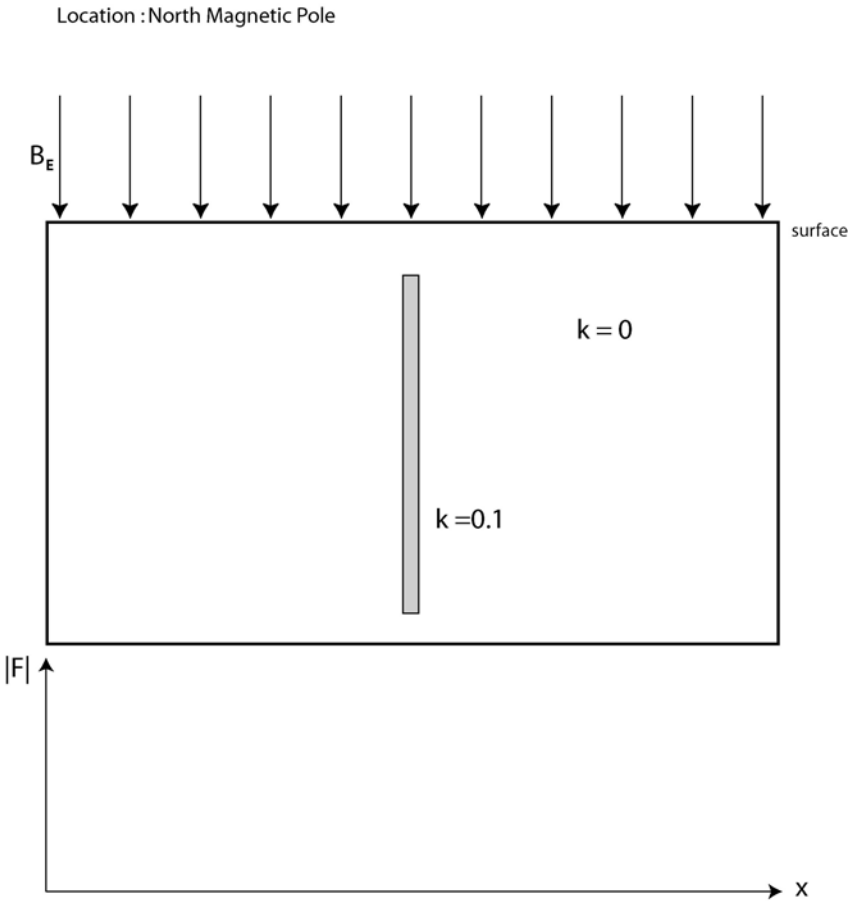
Induced magnetization will disappear when the applied magnetic field is removed.

Remnant magnetization is frozen into the material.

- In the following examples, we will consider only induced magnetization.
- This will be in a direction **parallel** to the Earth's magnetic field.
- Remnant magnetization can be in any direction.

3.1 Dike (Monopole)

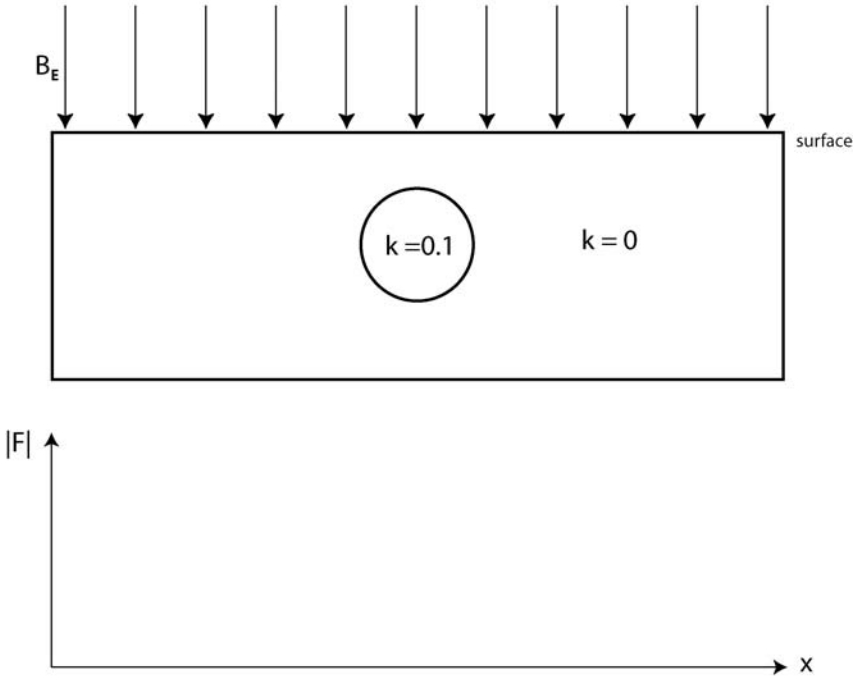
- In the presence of the Earth's magnetic field, the dike develops an **induced magnetic moment**
- If the structure extends to depth, then the lower monopole can be ignored since for a monopole, $B_r = \mu m/r^2$
- Compute **total field** at surface by adding B_r and B_E as **vectors.**
- Plot |**B**| since this is routinely measured in field surveys. The direction is not measured.



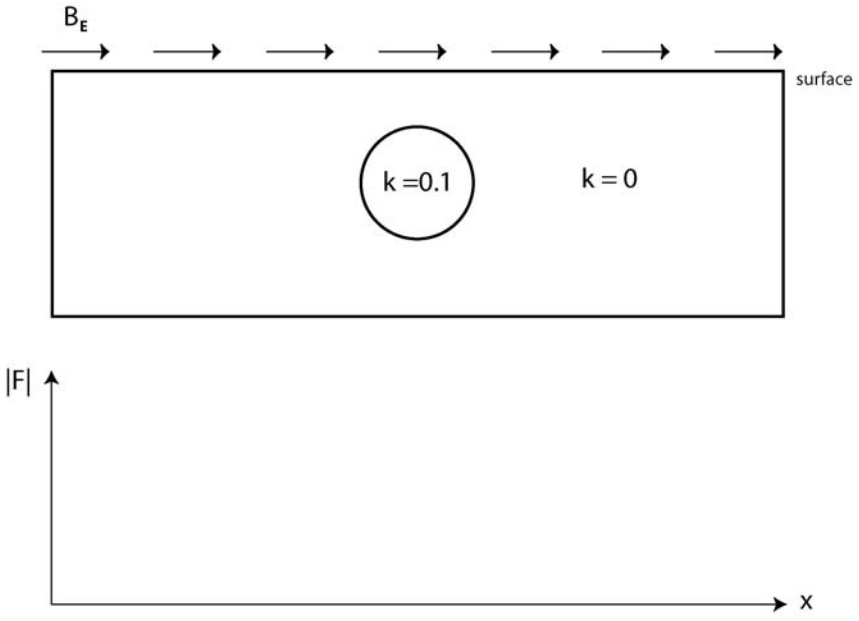
3.2 Cylinder

- The cylinder has an **induced magnetization** with negative monopoles on upper surface and positive monopoles on the lower surface.
- Effect is a dipole at centre of cylinder, the magnetic field falls away as $1/r^3$
- The magnetic field anomaly will be different at the magnetic north pole and equator

NORTH POLE

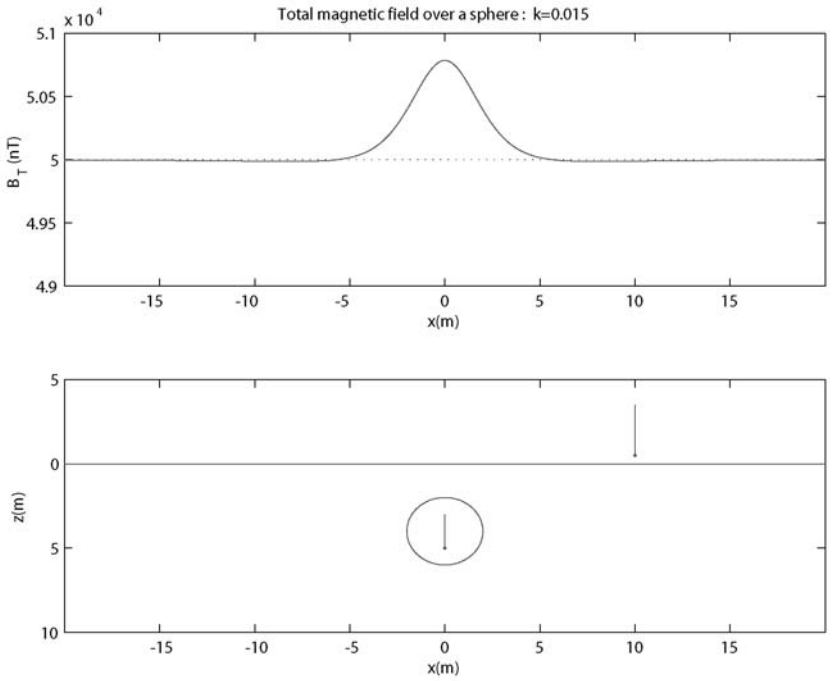


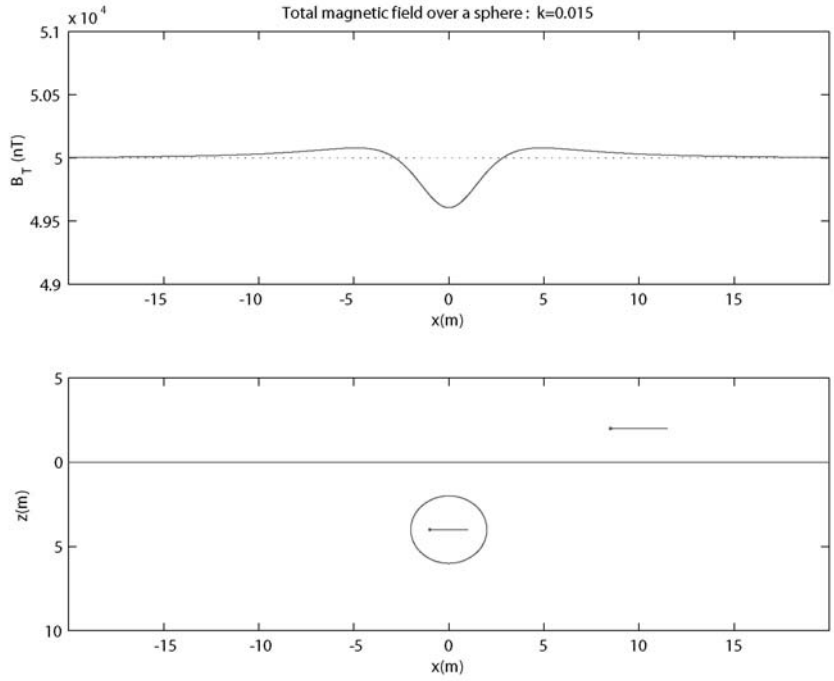
EQUATOR

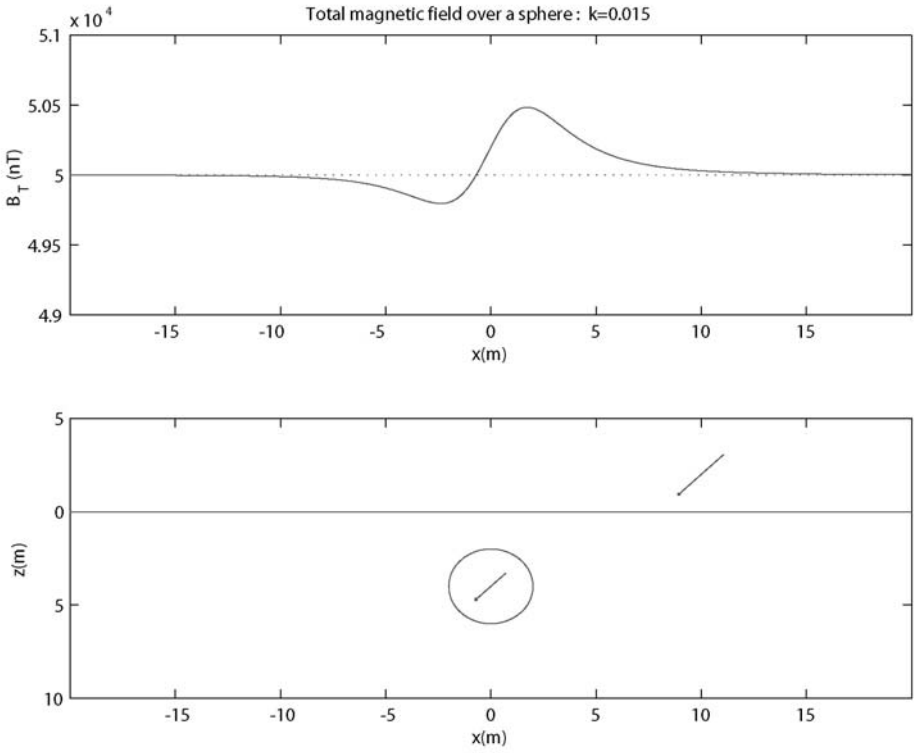


3.3 Sphere

- As for cylinder, the sphere develops an induced magnetic moment, which is equivalent to a dipole at the centre.

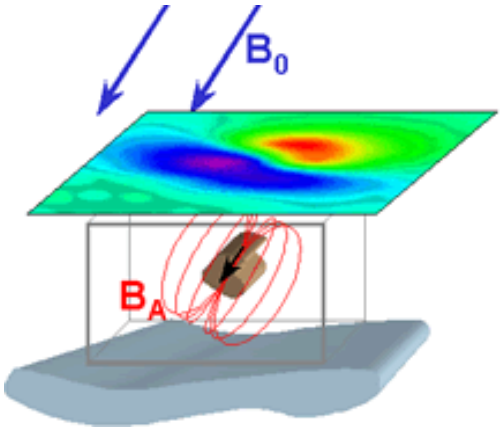






Map view

- Positive anomaly $B > B_0$ (red)
- Negative anomaly $B < B_0$ (blue)
- At the magnetic poles the positive anomaly is above the magnetic body.
- When I = 45°, that positive anomaly is not directly above the target.



From *http://www.gif.ubc.ca*

3.4 Thin sheet or slab

- An infinite sheet develops negative poles (South poles) on the upper surface and positive poles (North) poles on the lower surface.
- If the sheet is thin in the vertical direction, then the magnetic fields due to the upper and lower surfaces cancel to give no net magnetic field at the surface.
- When the sheet is finite in horizontal distance, the magnetic poles near the edge do not cancel and a positive-negative anomaly is observed.
- The magnetic anomaly is sensitive to the edges of structures