Marine Magnetic anomalies

MRN019

The anomalies are measured with a proton precession magnetometer which measures field strength. Field direction is not measured. note therefore if the field of the rock $\underline{H}^R$ is $\perp$ to the field of the earth $\underline{H}^{\oplus}$ no anomaly is seen even if the direction of $\underline{H}^R$ reverses from lineation to lineation.

Amplitude is measured: $\quad$ Anomaly $= |\underline{H}^R + \underline{H}^{\oplus}|^2 - |\underline{H}^{\oplus}|^2$

now suppose we use a cartesian coord system with z vertical, y oriented $\parallel$ to ridge axis. Then the earths field will be

$$H_z^{\oplus} = H^{\oplus} \sin I$$

$$H_x^{\oplus} = H^{\oplus} \cos I \cos (C-D)$$

$$H_y^{\oplus} = H^{\oplus} \cos I \sin (C-D)$$

where $I =$ magnetic inclination ($\measuredangle$ from horizontal that field vector points)

$D =$ declination ($\measuredangle$ from north that vector points)

$C =$ angle from x to north

now since the magnetized blocks that cause the anomaly are taken to be infinitely long $H_y^R = 0$. The field lines cannot escape the block. the Anomaly is then

$$A = (\underline{H}^R + \underline{H}^{\oplus}) \cdot (\underline{H}^R + \underline{H}^{+}) - \underline{H}^{\oplus} \cdot \underline{H}^{\oplus}$$

$$= \underline{H}^R \cdot \underline{H}^R + \underline{H}^{\oplus} \cdot H^{\oplus} + 2\,\underline{H}^R \cdot H^{\oplus} - H^{\oplus} \cdot H^{\oplus}$$

$$\approx 2\,\underline{H}^R \cdot \underline{H}^{\oplus} \qquad \text{since } \underline{H}^R \cdot \underline{H}^R \text{ is very small.}$$

the anomaly is then given by

$$A = 2 H^{\oplus} \left[H_z^R \sin I + H_x^R \cos I \cos (C-D) \right]$$

special cases : <u>near equator</u>

$$A \propto H_X^R \cos I \cos (C-D)$$

<u>near poles</u>

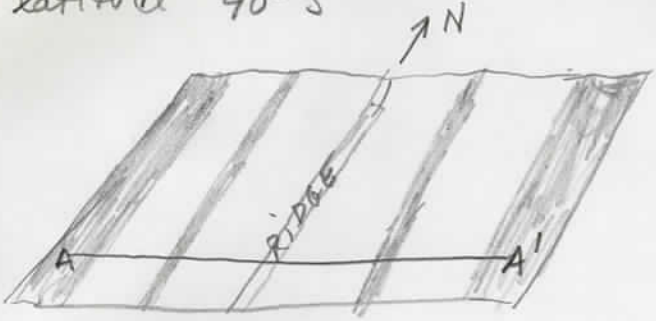
$$A \propto H_z^R \sin I$$

<u>no declination or ridge strikes N-S</u>

$$A \propto H_z^R \sin I$$

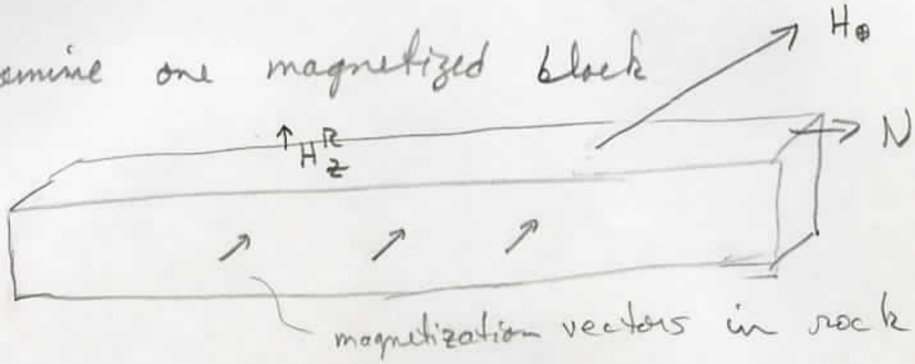
EXAMPLE # 1

suppose a ridge is striking N-S. it forms at latitude 40° S



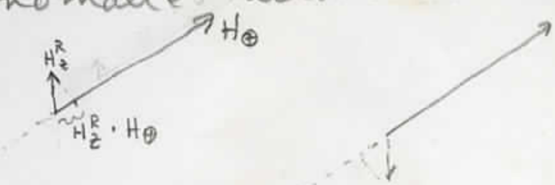
we examine one magnetized block

$H_z = H_z$
$H_y \equiv 0$
$H_x = 0$



now at 40°S the anomalies across the ridge look like:

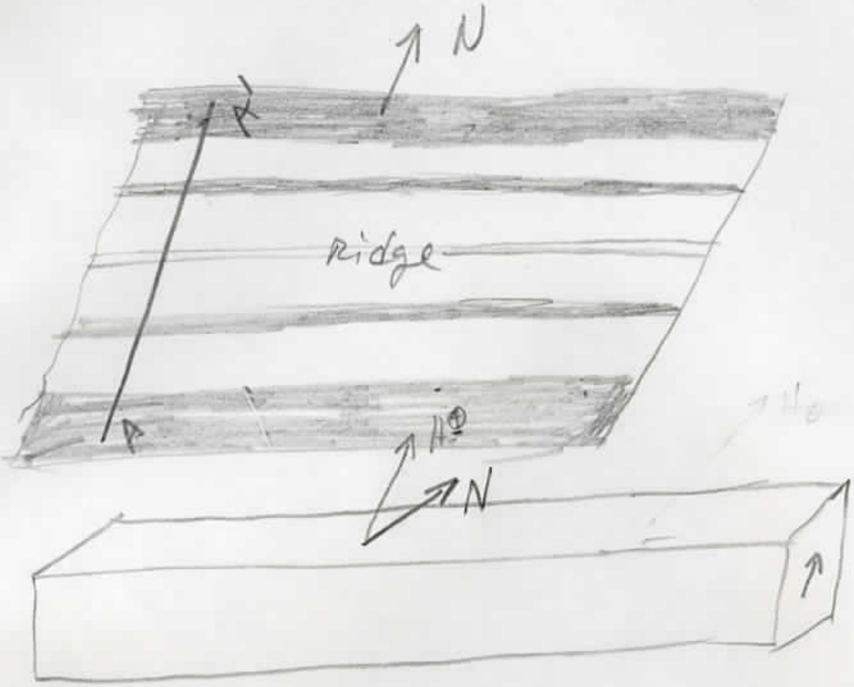
when rock mag normal



now move the block further north. as this is done the Inclination approaches 0° at the equator, $\sin I$ also $\rightarrow 0$ and the anomalies disappear. above the equator Inclination is negative and so are the anomalies.

EXAMPLE #2

Ridge striking W-E forms at 40°S and then moves North w/o rotating.



$H_z = H_z$ = positive
$H_x = H_x$ = positive
$H_y \equiv 0$
$C = 0°$

as we move the block north we decrease the inclination, then decrease the first term but increase the second. above the equator the first term becomes increasingly negative and the second, although always + becomes smaller and smaller. somewhere $\exists$ a northern latitude where the anomaly = 0