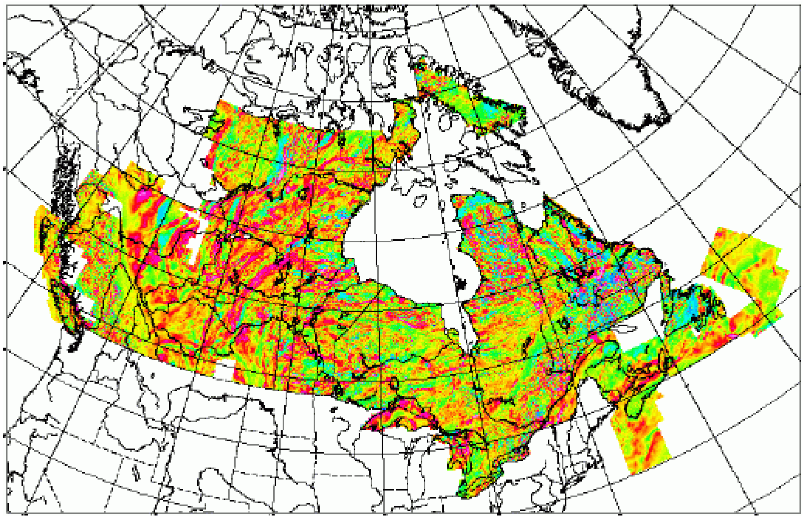
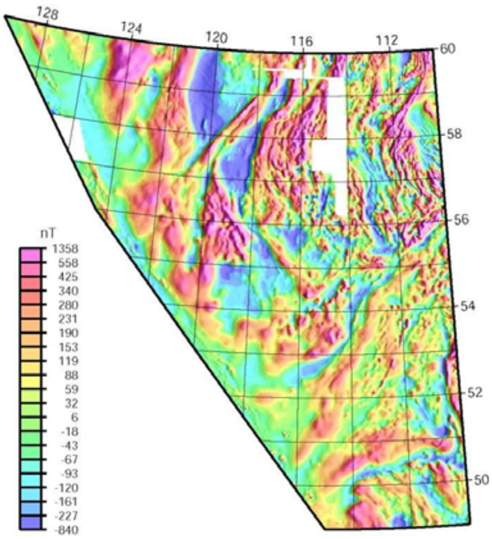
Geophysics 325

D6 Magnetic exploration methods – data analysis techniques

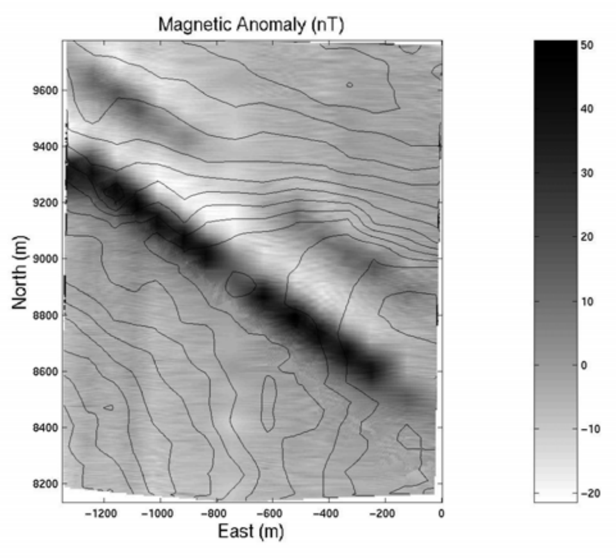
6.1 Magnetic anomaly maps





- Widely available and often produced by government agencies.
- Upward and downward continuation is needed to merge data sets collected at different elevations.
- Aeromagnetic data is often used for finding the lateral extent of structures or for locating anomalies that are then investigated in more detail during follow up on the ground.

- Magnetic anomalies are smaller when measured at flight elevation than at ground level. This can be both good and bad.



- Ground magnetic anomaly maps can be used to focus on a specific target. The example on the left is a dataset set collected at Milk River during the Geophysics Field School. A shallow dike causes the linear magnetic anomaly.The black contours show surface elevation.

Magnetic field data courtesy of Moritz Heimpel.

6.2 Half-width techniques

- In section D4.1 we considered the magnetic anomaly due to a vertical dike at a depth *d* below the Earth's surface (essentially a monopole). We showed that the half width in the vertical component anomaly (Z) was given by

$$x_{½} = 0.766\ d$$

Other approximate rules can be derived (Telford p. 113), but they must be used with **considerable** caution.

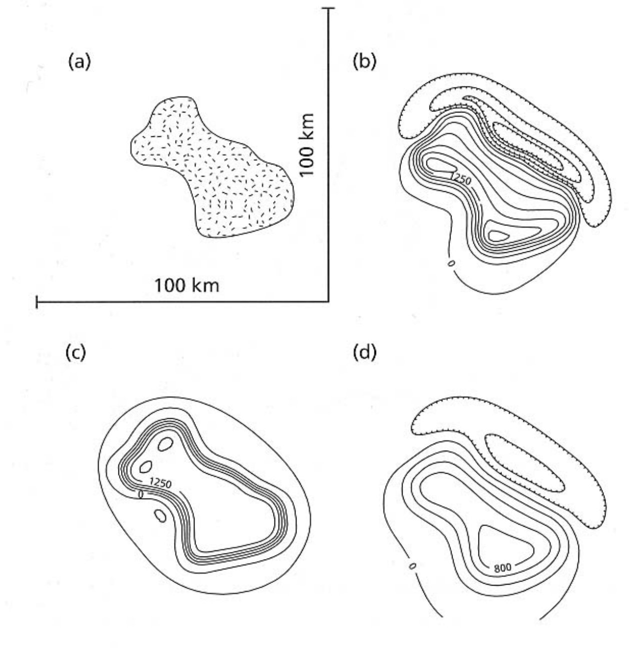
- The slope of the anomaly (dF/dx) can also be used to give constraints on the depth of the magnetic body. Smith rules for maximum depth are listed in Telford (p. 113)

6.3 Reduction to the pole

- Magnetic anomalies generally have a simpler shape when i= 90º than i = 45º or other intermediate values.

- Thus, interpretation would be easier if we could somehow change the inclination of the Earth's magnetic field. This is difficult to do in practice!

- Reduction to pole uses mathematical filtering methodology. Kearey Figure 7.23 shows an example of synthetic magnetic data when i=60 ˚ and d = 20˚.



- The measured data is shown in (b) with both positive and negative anomalies. Reduction to the pole (c) shows a simpler set of anomalies that reveal the true shape of the magnetized body.

6.4Upward and downward continuation

- Mathematical methods for predicting the magnetic field at a different elevation from that at which the data were collected.

- Can allow data to be filtered, since at higher elevation the short wavelength features will be weaker than at ground level.

- Synthetic example in Kearey figure 7.23(d) that was shown above.

- **downward continuation** emphasizes **short wavelengths** and can be mathematically unstable

- More practical details in Geophysics 437

6.5 Computer modelling in 2-D and 3-D

- Typically represent the Earth as series of complex polygons, each with a different susceptibility (*k*)

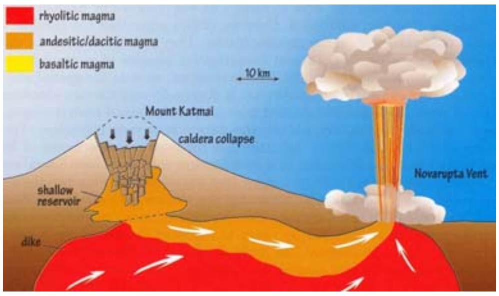
- Can usually model both **induced** and **remnant** magnetization.

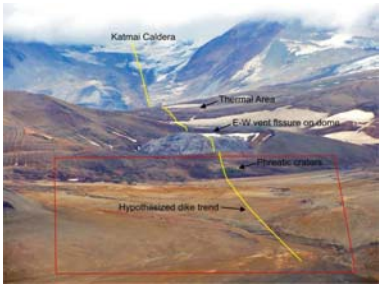
- both 2-D and 3-D computer codes are widely used

- generally the user alters the model until the predicted and measured field data agree

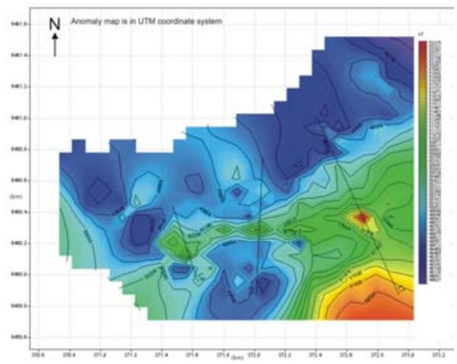
- automated inversion algorithms can be used

- example of ***Winglink*** package with data from a field study at Mount Katmai, Alaska

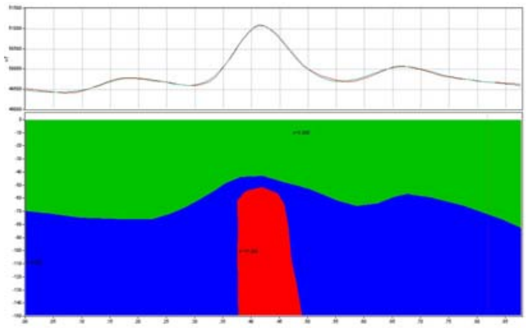




Field area, Katmai National Park: The goal of the magnetic survey was to determine if a dike connects Mt. Katmai and Novarupta. Both erupted in the 1912 eruption, but the plumbing of this volcanic system is still unknown.



Magnetic anomaly map: Note the east-west magnetic high (approximately 1000 nT) that is coincident with the hypothesized dike trend (yellow line shown above). Fieldwork by Graham Hill and John Eichelberger, Alaska Volcano Observatory, University of Alaska, Fairbanks.



Model for western profile: 2-D model with variable magnetic susceptibility that fits data for one of the profiles.

Sedimentary basement	k=0.004
Pyroclastic flow	k=0.002
Rhyolite dike	k=0.010

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