

QUALITATIVE AEROMAGNETIC INTERPRETATION

Objective - Study the correlation between the aeromagnetism and the geology of a reasonably well mapped section of the Archean Precambrian Shield.

Data:

You are supplied with 1 inch = 4 miles (approx. 1:250,000) scale geological map of a region of the Canadian Shield in Northern Ontario known as the Muskrat Dam area, and also the corresponding total field intensity aeromagnetic map. The aeromagnetic map is provided in two forms, contours of intensity and a coloured intensity map. Geologically, the region contains highly deformed Archean metavolcanic and metasedimentary strata which are pinched between granitic or granodioritic plutons of about 2.7 Ga age. All formations are eroded to a depth range of a few kilometers and partly covered with a few meters or tens of meters of Quaternary glacial drift (mostly sand and gravel, with perhaps some clay till). Lakes and muskeg cover low lying areas.

The aeromagnetic survey was flown in the late 1960's with north-south flight lines separated about a half mile (800 m), and with a terrain clearance of about 1000 ft (330 m). The original plotting scale for the aeromagnetic contoured data was 1 inch = 1 mile (~ 1:63 k). The detailed surface geology is provided in four 1 inch = 1/2 mile geological map sheets (2162, 2163, 2164 and 2164) and Ontario Geological Survey Report 74. Enlarged versions of the original aeromagnetic maps have been prepared at the same scale as the geological sheets. Mosaics of these maps are posted in the laboratory and copies may be found in the file drawers for drawing profiles.

Background:

The unit of magnetic field intensity is the nanoTesla (formerly called a gamma). Measurement accuracy is a few nT and the normal magnetic field intensity in Northern Ontario is around 60,000 nT. The data have been corrected for diurnal variation of the earth's field. This survey was carried out using a self-orienting fluxgate magnetometer that measures local magnetic field strength from an arbitrary base level. In this survey, the instrument base level was set so all measured values would plot as positive numbers. Thus, a necessary preliminary task for any interpreter is to determine the magnitude of readings in non-anomalous parts of the map. The intensity of any local magnetic anomaly is then measured from this non-anomalous background level. (Modern aeromagnetic total field intensity surveys measure the absolute intensity of earth's field and then the International Geomagnetic Reference Field is subtracted to give absolute anomaly.)

Exercise:

First, study the geology of the area, taking particular note of the main rock types, and then examine the aeromagnetic map. You will likely find it useful to overlay the transparent versions of the contoured maps on the geology map during this examination. In using the legend of mapped lithologies, keep in mind that most of the legend categories are not single rock types; usually they are groups of related rock types. You will need to decide which rock types in the map area carry appreciable magnetite (or other ferromagnetic minerals)

Note that the aeromagnetic anomaly created by a magnetic rock formation usually extends well beyond the contacts of the formation itself at the rock surface. As a rough rule of thumb, the width of the magnetic anomaly (measured at half of the peak intensity) on an aeromagnetic profile traversing across a narrow, outcropping, vertically dipping body is about twice the flight height. Greater widths

indicate either a wider causative formation or a greater depth from the flight path to the top of the formation. In the latter case, keep in mind that anomaly intensity falls off rapidly with increasing depth to top of the magnetic body. Thus, it takes a greater level of magnetization to produce a given intensity of anomaly when the body is deep. Also, note that a narrow body generates a proportionately weaker anomaly than a wider body having the same susceptibility. And for bodies substantially narrower than the flight height, amplitude is determined by the body's width * susceptibility product.

After an initial familiarization with the maps, choose at least three places to draw profiles of the aeromagnetic field intensity. Mark the mapped geology on the distance scale of the profile, and indicate where you think the magnetized rocks lie.

Exercise and Report:

Write a report on the magnetic survey in which you try to answer such questions as:

- Which of the mapped rock types appear to generate significant magnetic anomalies?
- Do these rocks show the same kind of magnetic response everywhere they occur on the geological map?
- If more than one rock type appears to be magnetic, can these types be distinguished from one-another on the aeromagnetic map? If so, how?
- Can any geological structure (faults, folds, etc.) be identified from the magnetics? How? Are they indicated in the geological interpretation?
- Can you find any indications of formations that may be magnetized in a direction different from the present Earth's field?
- What are some important features of the geology that are not indicated magnetically? What are they and why?
- Are there any contradictions between the geology as mapped and that which you interpret from the magnetics? Give at least one possible explanation.

Note:

Geologists interpreting aeromagnetics for an area like this one should keep the following in mind:- Errors in positioning and measurement do sometimes occur, but they are rare. However, the contouring of aeromagnetic maps does involve interpolation of data between flight lines, so one should remember that data plotted between flight lines is sometimes erroneous. In cases where the existence or form of an anomaly is in doubt, the magnetic intensities measured on the flight line should be referred to. Usually, apparent contradictions between what is mapped geologically and what is indicated by the aeromagnetics are the result of insufficient outcrop to constrain the geological map or are problems understanding the geochemistry of magnetite rather than the physics of magnetic fields.