Analyzing Geomagnetism using the CrowdMag App

Goals:

1. Measure the background geomagnetic field of your campus
2. Identify anomalies created by local magnetic sources.
3. Compare geomagnetic data collected by different devices

Materials:

- Your GPS-enabled smartphone or tablet (Apple or Android)
- The CrowdMag app installed on your device
- A small magnetic device such as earbuds, charging cable, or laptop

Background:

Earth's magnetic field, generated by the movement of liquid iron and nickel in the outer core, makes life on Earth possible. It prevents our atmosphere from being degraded by solar winds and allows us to use a simple compass to measure our location anywhere on Earth. An understanding of the exact location on Earth's surface is important for many industries such as mining and transportation. As movement in the outer core changes over time, so too does Earth's magnetic field vary in time and extent. Thus the magnetic poles slowly drift and are not fixed in location. Weak spots in Earth's magnetic field, primarily the South Atlantic Anomaly (SAA), present challenges to satellites and Earth's atmosphere as they are exposed to increased particle radiation from the sun. Large space weather events, such as those of the Carrington event in 1859, may also disturb Earth's magnetic field for a time. Monitoring Earth's magnetic field is of vital importance for scientists to understand what is happening deep in Earth's core and from space.

Activity:

Explore the magnetometer on your smartphone:

On your Smartphone, open the CrowdMag app and select 'Compass''. You should get an animated compass showing the direction that the top of your phone is pointing and a level bubble in the center (See images below).

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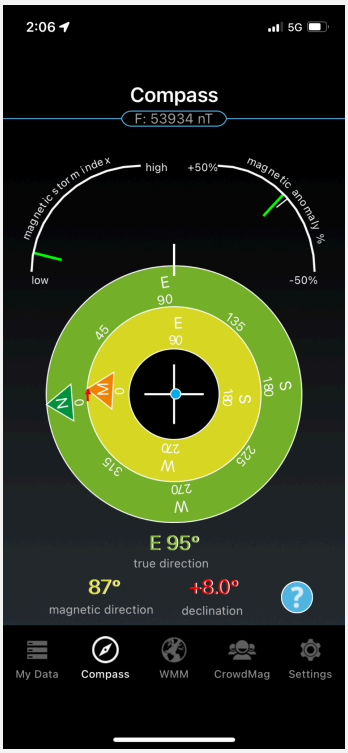


Figure 1. The compass screen on the CrowdMag app. The green triangle shows geographic or true North and the orange triangle shows magnetic North. The red line indicates the declination, or degree difference, between magnetic and geographic north. The white crosshair in the center of the circle acts as a level. When the blue circle is in the center, your phone is flat.

Use the  button to explore what the different displays on this screen mean then answer the questions below.

What is the declination at your location?

What does this mean?

What does magnetic anomaly percent mean?



Hold your phone so it is flat (the blue bubble is centered in the crosshairs) in one hand. With your other hand, move your small magnetic object slowly from left to right on the underside of your phone. Monitor the magnetic anomaly % and the total field intensity reading (F) at the top of the screen (see image to the left).

When the anomaly % spikes and the total field reaches a high, this is the location of the sensor on your phone. Have your partner record the readings in the box below.

Move the magnetic object <u>slowly</u> away from the phone and observe how the anomaly percent falls. Try this several times. Measure the distance between your phone and the point where the anomaly percent falls. Record this in the table below.

Highest anomaly %:

Highest total field intensity reading. Use nanotesla (nT) as the unit:

On average, how far away can the object be from your phone and still record an anomaly?

Based on how you answered the question above, how far away from another person's phone should you be if you want to record an accurate reading of magnetic field intensity?

Measure the local geomagnetic field:

- Select the 'WMM' screen and then press the location symbol  in the upper right to populate your location. Choose today's date and press calculate.

What is the predicted total magnetic field for your location?

- Outside the classroom, find a location away from obvious sources of magnetic interference (overhead cables, manhole covers, cars, etc.)
- Place your smartphone close to the ground on a level surface and monitor the total field measurement on the 'MyData' page for 1-2 minutes. You can press the 'Record' button on the 'MyData' page to record this data collection event.. Press 'Pause' to stop.

What is the measured magnetic field intensity? How similar is your measurement to the predicted intensity?

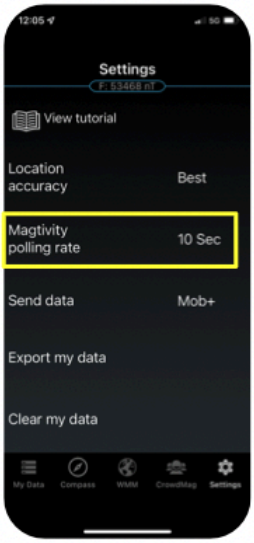
Data Comparison:

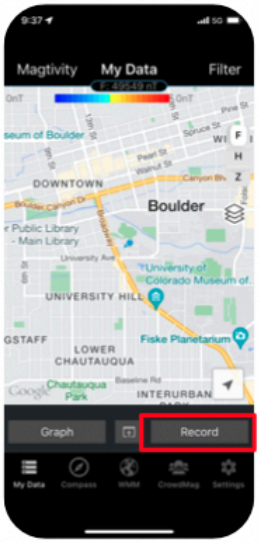
- With your lab partner, plan a route around campus to measure the intensity of the magnetic field at various locations.
- Collect data according to the instructions in the box below:

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To Collect Data:

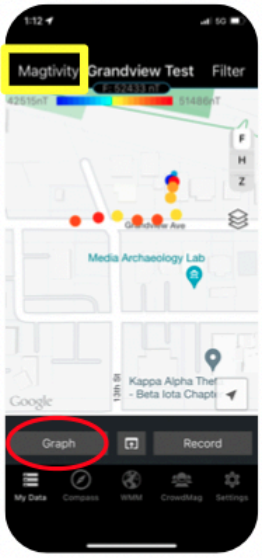
- In settings, set Magtivity polling rate at every 10 s
- Open "My Data"
- Press 'Record' to start collecting data
- Press pause to pause or complete your session

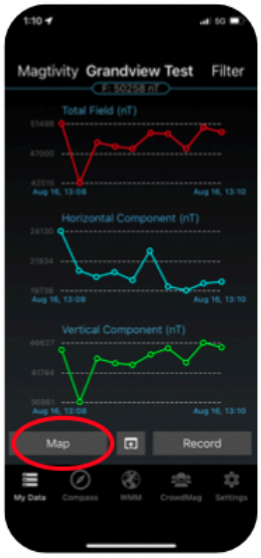




Final Data:

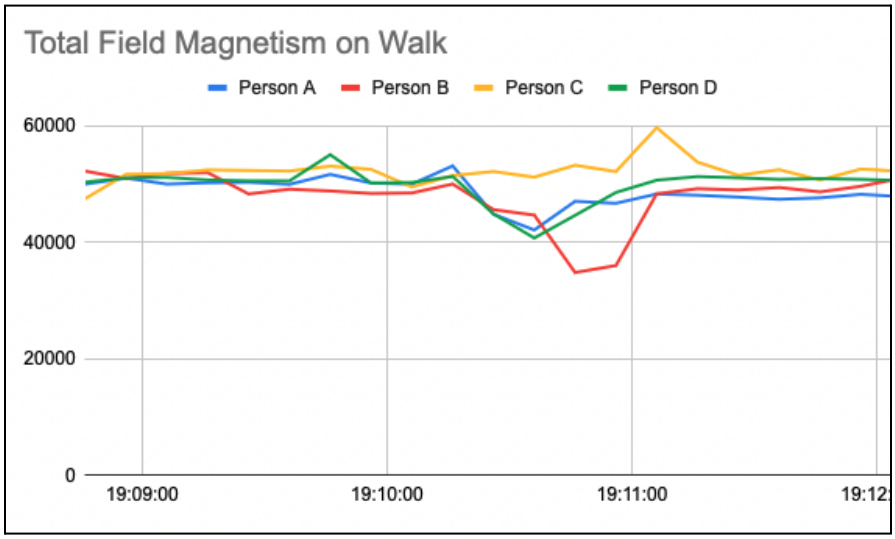
- Name your data so you can find it in the 'Magtivity' tab
- Data can be viewed in the app as a map or a graph





- Be sure that each person presses the 'Record' button at the **same** time. Everyone should walk at the same pace, but make sure to not hold your phones close to each other.

- Go to the settings tab, select export data, and choose your recent data event. This will allow you to email your data as a .csv file to your inbox.
- Import your data into a spreadsheet, such as Google Sheets or Excel. Combine your data with your partners to create a graph comparing each person's data. Use only the total field intensity data (See example below).



What was the highest magnetic intensity that you encountered on your walk and what object caused it?

Why was every person's data not identical?