Using CrowdMag to Catalog Magnetic Anomalies from Urban Infrastructure and Geological Features

Prudence Cawmer1, Rick Saltus2, Manoj Nair2

Introduction

Geomagnetism:
Study of the Earth’s magnetic field. We depend on the magnetic field for navigation, for example when using a compass.

CrowdMag:
A smartphone app that accesses the phone’s built-in magnetometer, used to crowd-source local magnetic field data.

Magnetic Anomaly:
A deviation (interference) from the normal (background) reading of the magnetic field.

Project Goal:
Collecting geomagnetic data on urban infrastructure and geological anomalies in and around the Boulder area. Then analyzing and plotting different models to show similarities or differences.

Project Question:
What are the general characteristics of the urban infrastructure anomalies as observed and modeled using CrowdMag and Excel? Would these characteristics be useful for magnetic navigation?

Measurements

- Downloaded CrowdMag app
- 12 separate locations surveyed: 11 urban infrastructure features and 1 geological feature
- Surveying at least 3m on each side of feature
- Display data and forward models

Results

We measured and modeled a number of high-amplitude magnetic anomalies over a variety of urban features (Table 1). One experiment recorded from the nine CrowdMag users; it showed similar magnetic amplitudes for the same feature (Figure 2). For the individual features, we show our spherical equivalent-source interpretations of the observed anomalies (Figs 3-14). We identified the depths of each magnetic source with certainty but our models include trade-offs in modeling size (diameter) and intensity. Our catalog showed that the bridges, pipelines, and sidewalks profiled all had unique characteristics that might serve as magnetic landmarks for alternative navigation.

For our one geologic feature, Iron Dike, we were able to use the magnetic anomaly pattern to identify its exact location underground which was further west of the area we originally thought.

Conclusions

- CrowdMag was successfully able to map magnetic anomalies of both urban and geologic structures.
- We confidently identified the depths of each magnetic source, with trade-offs in modeling between size and intensity/volume of the equivalent-source models (sets of magnetic spheres).
- Future data collection can aid in alternate navigation (e.g. indoor navigation being researched by Google/Indoor Maps), and may use these signatures as magnetic “mile markers.”

References

Bing Maps - Directions, trip planning, traffic cameras; more. https://www.bing.com/maps


Acknowledgements

I would like to thank my mentors Dr. Rick Saltus, Dr. Manoj Nair, Neesa Schnepf, and Brian Meyer for helping me with this geomagnetism project.

I would also like to thank the RECCS Program, which is funded by the National Science Foundation (grant number EAR 1757930) and co-funded by the Boulder Critical Zone Observatory (grant number 1331828).

1Pikes Peak Community College, 2NOAA Boulder, CO