

Investigating magnetic fields with your phone - you can do it too!



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Introduction

The Earth has a dynamic magnetic field. Magnetic objects (for example metal pipes or culverts) cause disturbances in the magnetic field. Modern cellphones have a magnetometers in them (so that they have a compass capability).

CrowdMag: An app installed on your phone that utilizes the phone's built in magnetometer. We use it to collect magnetic data.

Motivation: We collect magnetic data in order to improve navigation and be able to find metallic objects that we'd want to locate (for example, barrels in a field or buried pipes), also the data from this research can help understand when they are getting too close to vehicles like tractors or cars. In terms of navigation this can help understand their surrounding, especially if other sensors are not working (like cameras in the dark or GPS in a tunnel).

Methodology

- Step one:** Download the Crowdmag app.



- Step two:** Identify traverse location to collect data



This is a screenshot of where my mentors Rick and Neesha collected data in Boulder.

- Step three:** Get out there and collect data by walking along the traverse!



Neesha collecting data in Boulder

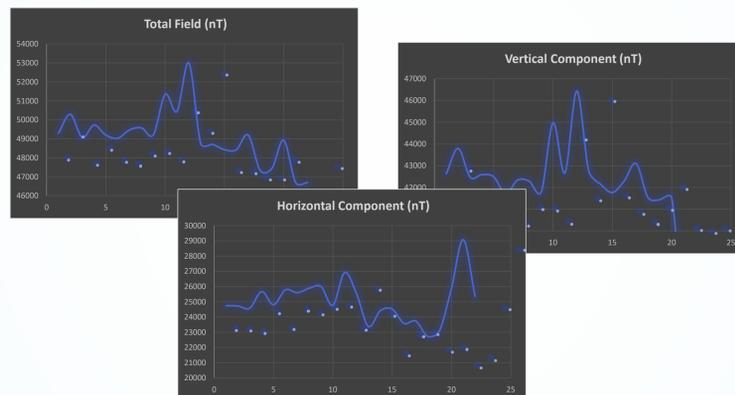
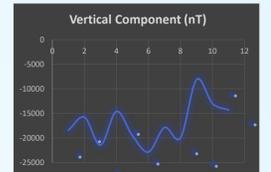
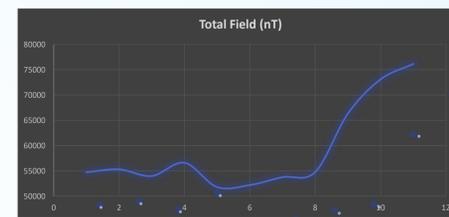
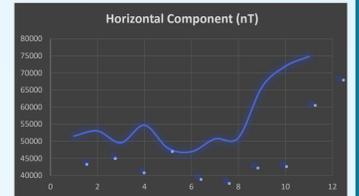
- Step five:** Make data graphs and calculate some statistics

ANALYSIS				
Normal Background	Average	Median	Stdev	
Horizontal*	50688	50869	2532	
Vertical*	-18787	-18958	2744	
Total Field	54151	54361	1586	
Anomaly				
	Average	Median	Stdev	
Horizontal*	70852	71929	4579	
Vertical*	-11823	-12998	3248	
Total Field	71860	73094	5026	

Results

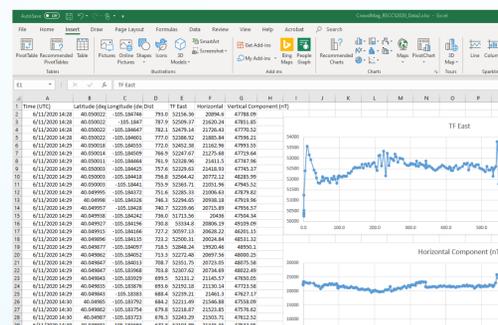
- When I went about collecting my data I was going to download the app and start collecting data but it didn't work as planned.
- We discovered that some phones (like mine) don't work with the CrowdMag App!
- My mentors sent me an Android test phone and that worked for collecting data.
- I was able to collect some data around my house and gain experience with working on actual data using Excel (making plots, calculating statistics).
- Here are some examples of my results:

#	A	B	C	D	E	F	G
1	Time (UTC)	Latitude (deg)	Longitude (deg)	Total Field (nT)	Horizontal	Vertical	Component (nT)
2	10:27:18 PM	38.094166	-103.161873	54726.43	51545.76	-18885	
3	10:27:21 PM	38.094158	-103.161827	55110.83	53014.2	-15773	
4	10:27:24 PM	38.094135	-103.161804	53994.97	49570.75	-21406	
5	10:27:27 PM	38.094131	-103.161781	56613.11	54701.5	-14587	
6	10:27:30 PM	38.094131	-103.161781	51810.25	47988.31	-19530	
7	10:27:33 PM	38.094162	-103.161751	52200.37	46948.41	-22819	
8	10:27:36 PM	38.094158	-103.161736	53764.35	50710.05	-17863	
9	10:27:39 PM	38.094162	-103.16172	54784.43	51028.47	-19936	
10	10:27:42 PM	38.094166	-103.161697	66332.64	65829.91	-3151.3	
11	10:27:45 PM	38.094154	-103.161667	72094.2	71509.23	-12998	
12	10:27:49 PM	38.094139	-103.161682	76154.5	74795.89	-14321	
13							
14							
15							
16	ANALYSIS						
17	Normal Background	Average	Median	Stdev			
18	Horizontal*	50688	50869	2532			
19	Vertical*	-18787	-18958	2744			
20	Total Field	54151	54361	1586			
21							
22	Anomaly						
23	Horizontal*	Average	Median	Stdev			
24	Vertical*	-11823	-12998	3248			
25	Total Field	71860	73094	5026			
26							

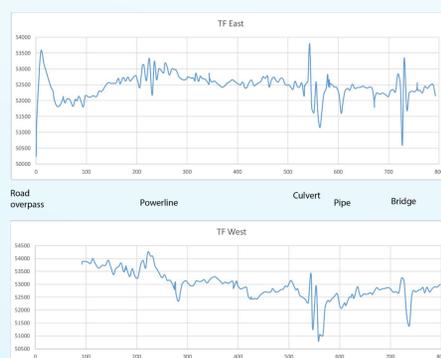


#	A	B	C	D	E	F	G
1	Time (UTC)	Latitude (deg)	Longitude (deg)	Total Field (nT)	Horizontal Co	Vertical Component	
2	7:32:03 PM	38.094036	-103.161034	49501.59	24746.31	42641.07	
3	7:32:06 PM	38.094032	-103.161049	50294.3	24724.59	43797.39	
4	7:32:09 PM	38.094036	-103.161064	49075.9	24580.59	42476.33	
5	7:32:12 PM	38.094032	-103.161087	49726.3	24607.17	42952.16	
6	7:32:15 PM	38.094028	-103.161125	49200.14	24806.59	42488.66	
7	7:32:18 PM	38.094028	-103.161156	49036.64	25784.42	41710.38	
8	7:32:21 PM	38.094025	-103.161194	49475.8	25999.45	42338.19	
9	7:32:24 PM	38.094021	-103.161224	49580.7	25886.74	42266.2	
10	7:32:27 PM	38.094025	-103.16127	49217.05	26002.91	41787.16	
11	7:32:31 PM	38.094025	-103.161293	51444.89	24767.78	44975.26	
12	7:32:34 PM	38.094017	-103.161346	50544.35	24608.3	42673.28	
13	7:32:38 PM	38.094017	-103.161346	52089.32	25524.89	46456.49	
14	7:32:39 PM	38.094027	-103.161346	48751.38	23376.45	42781.29	
15	7:32:42 PM	38.094026	-103.161392	48711.73	24408.19	42125.22	
16	7:32:45 PM	38.093983	-103.161423	48434.86	24518.64	41770.47	
17	7:32:48 PM	38.093956	-103.161461	48431.52	23582.97	42301.96	
18	7:32:51 PM	38.093941	-103.161499	49202.79	23766.27	42104.27	
19	7:32:54 PM	38.093934	-103.161522	47505.55	22724.56	41541.62	
20	7:32:57 PM	38.093887	-103.161537	47447.1	23118.9	41431.61	
21	7:33:00 PM	38.093884	-103.161556	48530.21	25874.61	41529.15	
22	7:33:03 PM	38.093857	-103.161591	46701.48	25075.59	40546.38	
23	7:33:06 PM	38.093857	-103.161583	46704.21	25342.97	39230.31	
24							
25	All data	Average	49107.47045	25034.53636	42208.95136		
26		Median	49138.02	24787.175	42320.075		
27		Stdev	1426.668762	1390.579944	1864.127805		
28							
29	Anomaly						
30	Average	51595.42	25737.16	44695.04333			
31	Median	51344.09	25524.89	44975.26			
32	Stdev	1286.11188	1091.12188	1897.140019			
33							
34	Quiet area	Average	49434.48444	25310.99667	42457.50222		
35		Median	49301.23	25099.45	42476.33		
36		Stdev	396.1423375	360.4315967	602.0369433		

- Step four:** Email data to yourself and open in Excel



Example of CrowdMag data viewed in Excel



Conclusion

- You can use your phone to collect magnetic data (although I discovered some phones don't work)
- Magnetometers can measure magnetic variations caused by metal objects like tractors, metal pipes, power lines and bridges.
- I had some issues while collecting research.
- One issue I had was my original phone didn't work with Crowdmag, I got zero values.
- Another challenge was the time frame in which to complete the project.

Acknowledgements

Thanks to the RECCS 2020 team for this opportunity – looking forward to an in-person experience next summer.

