Geophysical Investigative Report

Hackberry Carbon Sequestration, LLC

Geophysical Survey Services
Hackberry, LA

Respectfully Submitted

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EXECUTIVE SUMMARY

Collier Geophysics (Collier) was contracted by Hackberry Carbon Sequestration, LLC for a geophysical surveying project at Black Lake near Hackberry, LA. The project aimed to conduct geophysical surveying over an area spanning approximately 1,500 acres. The primary objective of the survey was to gather subsurface information about potential abandoned or orphaned oil and gas wells within the specified area.

To achieve the project objectives, Collier employed Unmanned Aerial Vehicle (UAV) Magnetic (Mag) data collection techniques. The survey encompassed the designated 1,500-acre Area of Investigation (AOI) and was conducted over a five day period. Multiple Flight Operation Staging Locations (FOSL) were utilized, with operations facilitated from both boat and barge platforms to access the site effectively.

Throughout the survey period, Collier successfully collected comprehensive geophysical data over the entire AOI. The UAV Mag data acquisition methodology proved efficient in capturing subsurface information pertinent to identifying potential abandoned or orphaned oil and gas wells within the surveyed area. The utilization of multiple FOSLs ensured operational flexibility and enabled systematic coverage of the designated area.

Legacy oil and gas wells will typically exhibit a distinctive circular magnetization high-intensity anomaly similar to a bullseye shape. Oil and gas anomalies usually have magnetic amplitudes of tens of nano teslas (nT) which are not present in this dataset. In addition, this bullseye shape usually has a width of approximately 50 meters or three or more survey lines, which again is not present. A review of the magnetic data does not indicate the presence of magnetic anomalies representing the presence of legacy oil and gas wells.

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1.0 INTRODUCTION

1.1 Project Overview

This report provides a summary of a geophysical survey that was conducted by Collier Geophysics, LLC (Collier) for Hackberry Carbon Sequestration LLC. Collier performed a geophysical survey at Black Lake near Hackberry, Louisiana (**Figure 1**). The objectives of the survey were to provide subsurface information related to the presence of potential abandoned/orphaned oil and gas wells.

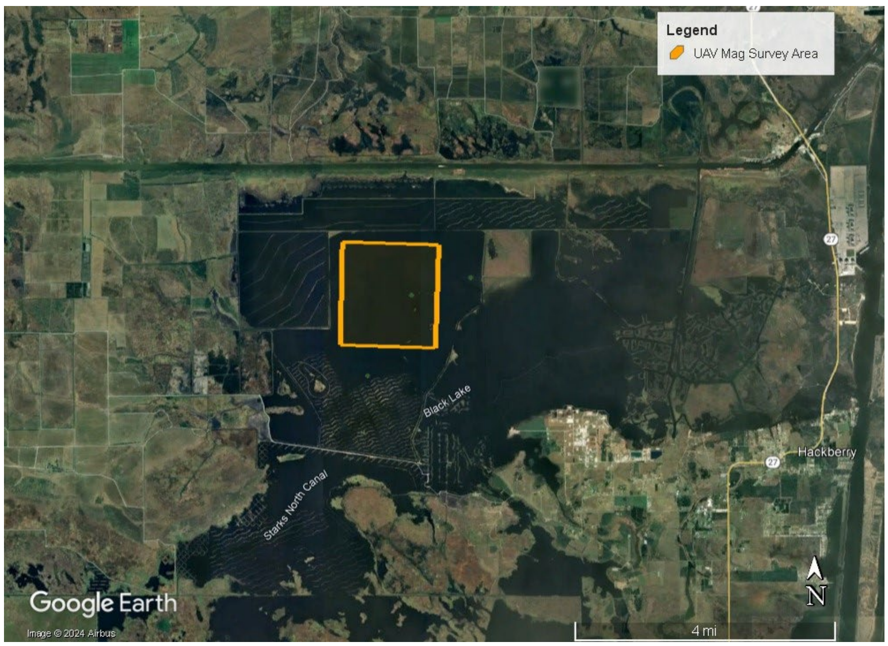


Figure 1: Geophysical survey area

To achieve the survey objectives, Collier employed an Unmanned Aerial Vehicle (UAV) with a Magnetometry sensor to image down into the subsurface to scan for potential wells.

The following sections include a methodological description of the geophysical surveying and theoretical aspects of the geophysical techniques utilized. Results of the geophysical survey are then presented along with relevant discussions of the data and identified anomalies.

1.2 Field Conditions

Field work for this investigation was performed at Black Lake in Hackberry, LA between February 19th and 24th, 2024. Access to and from the site were operated via a boat from a public launching ramp. The UAV Mag was operated from a towed-in barge at the area of investigation (**Figure 2**).

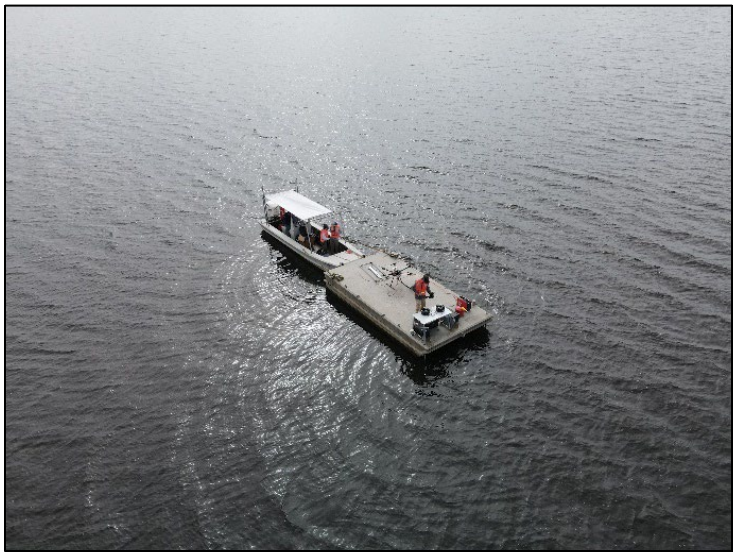


Figure 2: Picture of UAV Mag operation

Site operation was mainly in water where depth ranged from 2-6 feet deep (**Figure 3**). The weather consisted of seasonal temperatures between (56ºF-85ºF), with limited precipitation. No safety issues were encountered on site and thorough safety meetings were held before any activity was performed.

Figure 3: Examples of site conditions during data acquisition.

2.0 METHODS

The following section describes the concepts, data acquisition parameters, and processing and interpretation workflow for the geophysical method (UAV Magnetics) utilized for this project.

2.1 UAV Magnetics (UAV Mag)

2.1.1 UAV Mag Method

UAV/drone based magnetic surveys are carried out by suspending an instrument capable of measuring information about magnetic fields (magnetometer) from a UAV. Surveying is then performed in a similar way as terrestrial-based Mag surveys, by collecting data along equally spaced transects over a prescribed area.

Typical UAV systems include four or six propeller aircraft, such as the DJI M600 Pro used for this project. The most common magnetometers deployed from UAV systems are lightweight, optically-pumped cesium vapor magnetometers, such as the Geometrics MagArrow used here. These magnetometers represent the latest in sensor technology and are many times lighter than traditional terrestrial-based or manned aircraft sensors. Cesium vapor sensors like the MagArrow measure the total magnetic intensity (TMI) of magnetic fields. The TMI represents the strength of the magnetic field at the sensor location and does not include any information about the field's orientation. For this method, the UAV flies for a fifteen- to twenty-minute time period and then lands for a battery exchange. During this time the data are downloaded via WIFI and transferred to the geophysicist on site to start a QC analysis (**Figure 4**)

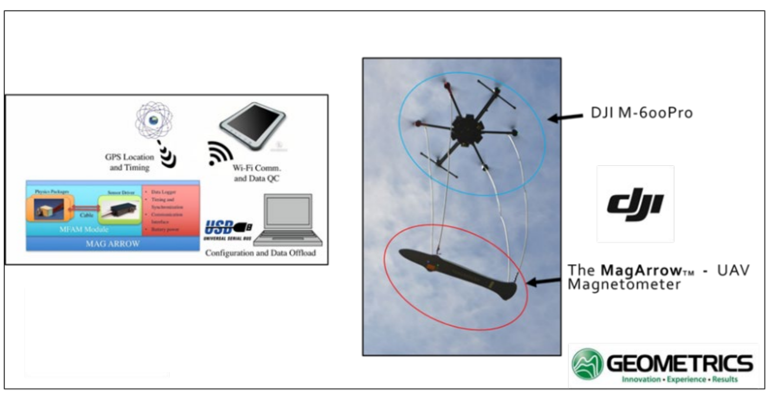


Figure 4: Equipment used for UAV-deployed magnetometry.

2.1.2 UAV Mag Survey Design

A total of 78 sorties were flown over the course of five days. The work was completed using a total of seven flight operation site locations (FOSL) for the entire 1,500 acre site. After each sortie, the measured TMI data were downloaded from the **MagArrow**™ and processed to obtain a flight path verification map to ensure TMI data quality. Data for all sorties were verified before the crew terminated survey operations.

The magnetic data were collected at 1,000 readings per second providing very high resolution along the lines (**Figure 5**). Total magnetic intensity (TMI) data were acquired at an altitude of approximately 20 meters above ground surface using the **MagArrow**™ magnetometer made by Geometrics, Inc. (www. geometrics.com) suspended from a M600 Pro UAV made by DJI, Inc. (www.dji.com). The field crew consisted of a Part 107 certified UAV Pilot in Command (PIC), two visual observer \ sensor operators (VOSO), and a Collier Geophysicist.

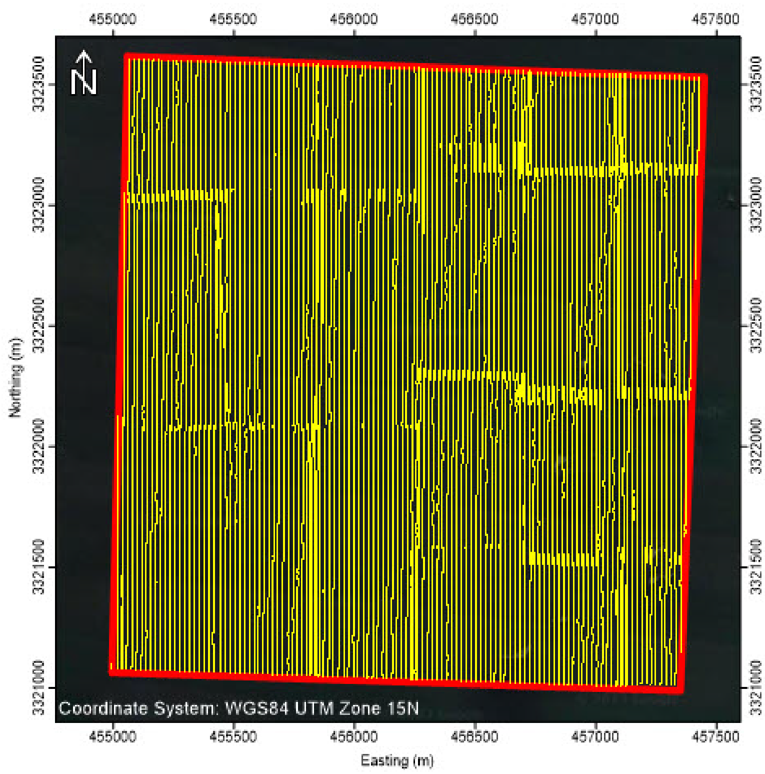


Figure 5: UAV MAG flight path

3.0 RESULTS

3.1 UAV MAG Data Processing and Interpretation

3.1.1 UAV Mag Data Processing

Upon completion of the data collection phase of the project, the measured TMI data were processed using the Oasis montaj software from Seequent, Inc. The flight lines were merged into a common database containing all flight lines and trimmed for processing purposes. Measurement biases due to the UAV flight direction were removed from the data by using a directional cosine filter, resulting in a residual magnetic intensity (RMI).

These data were then grided and contoured for presentation. The draft results for the UAV Mag survey at the Hackberry site are presented in **Figure A-1**, appended to this report. The results show two different visual representations of the data. On the left, the RMI) is presented with hot colors (pinks) as magnetic highs and light colors (green-blues) representing the background. On the right, the analytic signal results are presented with hot colors (reds) as anomalous highs, and cool colors (blues) as background. Analytic signal (AS) is an amplitude gradient computation that effectively compensates for the positive/negative magnetic dipole effects of the total field to place magnetic anomalies over their causative bodies.

3.1.2 UAV Mag Data Interpretation

Oil and gas wells typically have characteristic anomaly amplitude and shape that are mono-polar and not di-polar as typically seen on the surface and near-surface magnetic objects (**Figure 6**). These well anomalies usually have magnetic amplitudes of tens of nano teslas (nT) which are not present in this dataset. In addition, this bullseye shape usually has a width of approximately 50 meters or three or more survey lines, which again is not present.

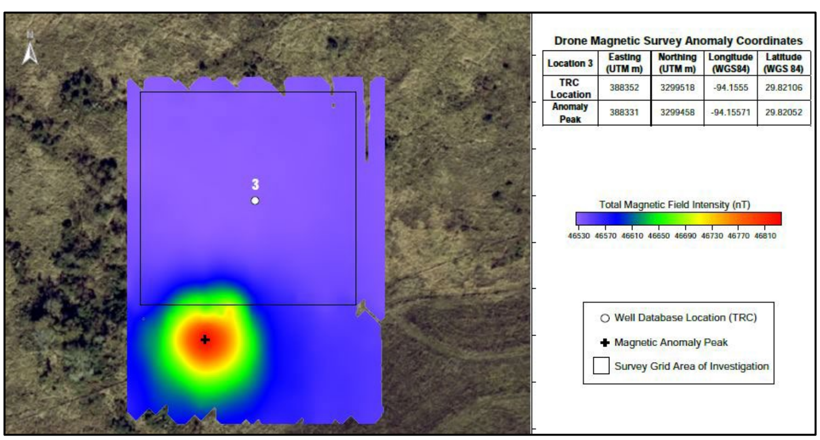


Figure 6: Example of a magnetic response of an O&G well.

4.0 CONCLUSIONS

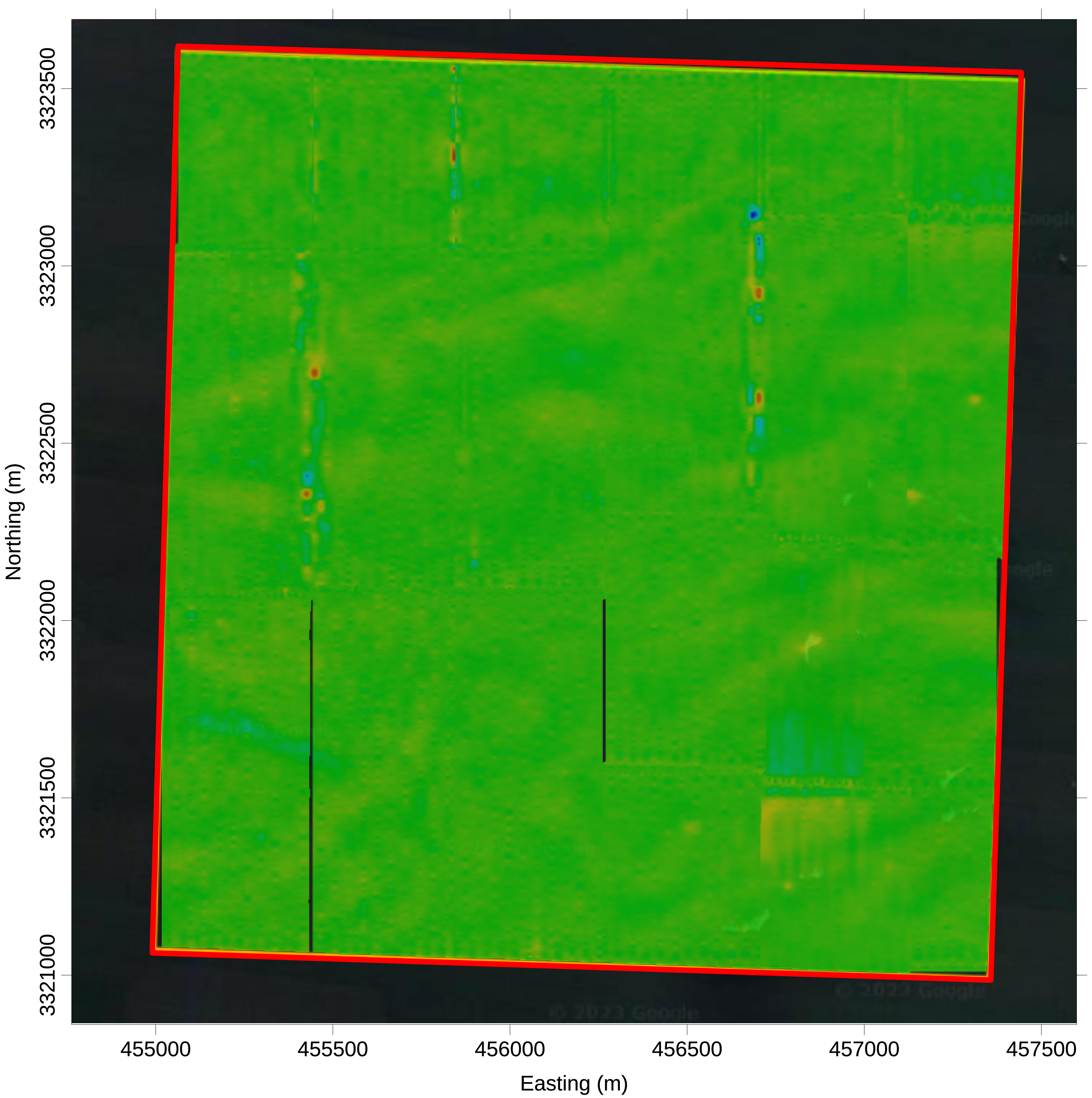
The UAV magnetic survey at the Hackberry Black Lake site resulted in the interpretation of no significant anomalous features indicating the presence of potential oil and gas wells.

The quality of the data acquired during this investigation was good and yields a high degree of confidence in the results obtained and presented in this report. The magnetic method, like any remote sensing technique, requires the subjective interpretation of indirect methods of measurement. As such, there is an inherent margin of error, which is unavoidable. Our methods of data acquisition, processing, and interpretation, are as complete as is reasonably possible, and we believe them to be a reasonable representation of the subsurface conditions. In addition, it is possible that subsurface features present at the site may be below the detection threshold of the survey method.

If you have any questions regarding the field procedures, data analysis, or the interpretive results presented herein, please do not hesitate to contact us. We appreciate working with you and look forward to providing Hackberry Carbon Sequestration, LLC with geophysical services in the future.

APPENDIX A: DETAILED GEOPHYSICAL RESULTS

Residual Magnetic Intensity

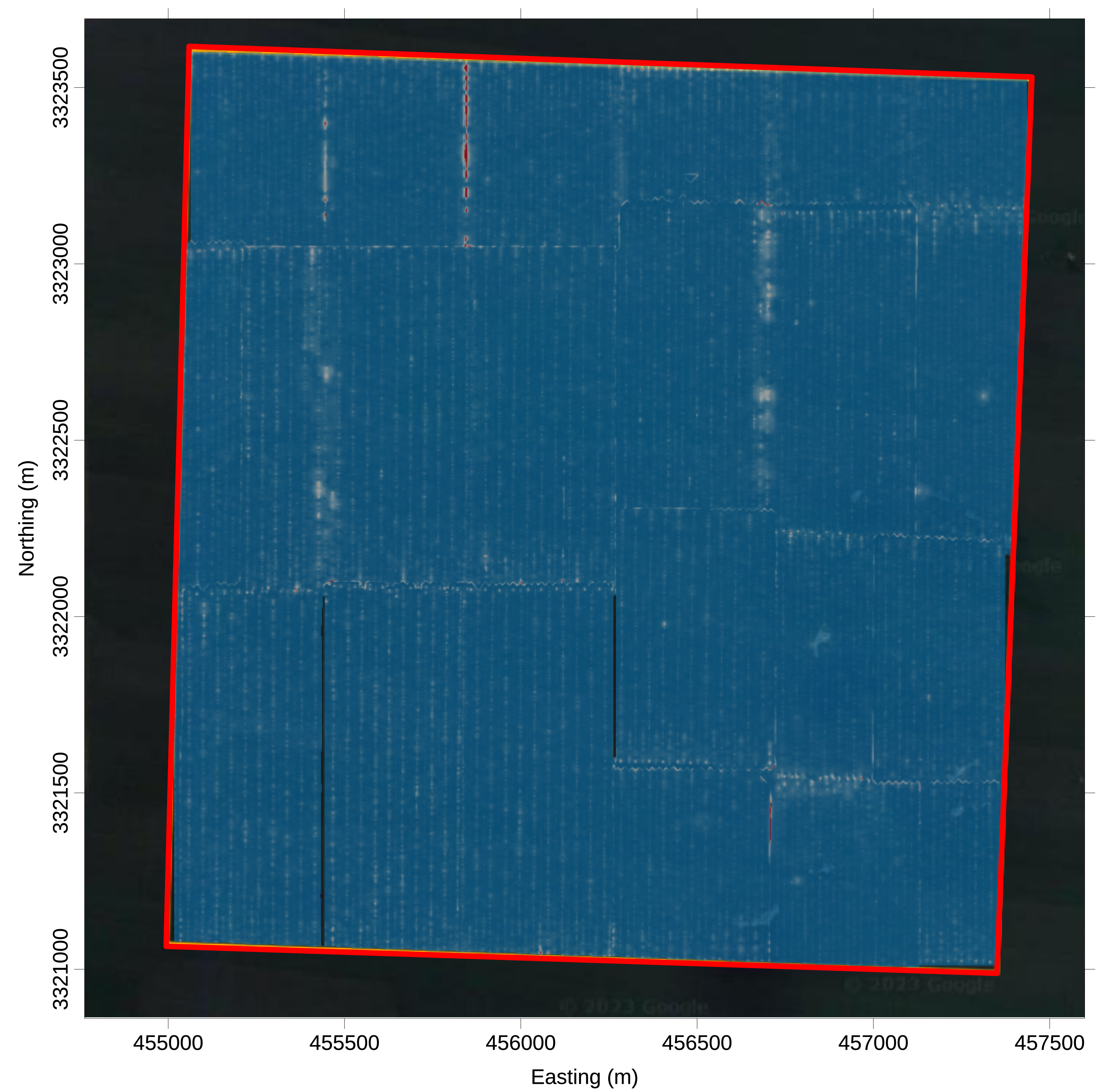


-5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Residual Magnetic Intensity (nT)

Area of Investigation

Analytic Signal



0.05 0.1 0.2 0.3 0.3 0.4 0.5 0.5 0.6 0.7 0.8 0.8 0.9 1

Amplitude of Analytic Signal (nT/m)

Coordinate System: WGS84 UTM Zone 15N

UAV MAG Results
Hackberry Site
Hackberry, LA

COLLIER GEOPHYSICS

Sempra Infrastructure

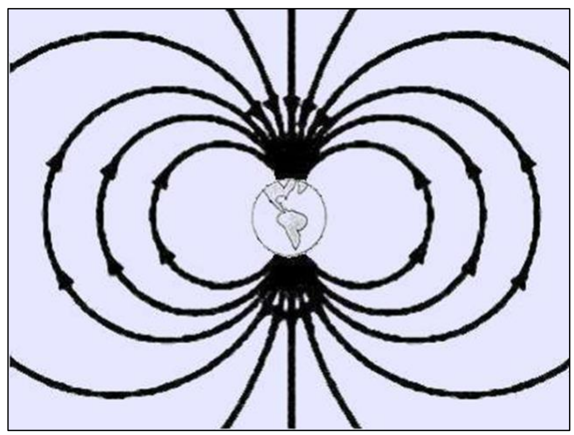
Project #: 230393 **FIGURE A-1**

Drafted by: J. Ortega | Checked by: N. Pendrigh | March 2024

APPENDIX B: METHOD APPENDIX OF UAV MAG

MAGNETOMETRY

UAV-MAGNETICS METHODS



AN INTRODUCTION TO THE MAGNETOMETRY (MAG) METHOD

INTRODUCTION:
The magnetometry (MAG) method is a non-invasive geophysical method used to measure the strength and/or direction of magnetic fields produced by magnetized objects. Many rocks and minerals are magnetized by induction of the Earth's magnetic field and cause spatial perturbations or "anomalies" in the Earth's main field. The polarization and strength of an object's magnetic field depends on its magnetic susceptibility, which is the ratio between the object's magnetization and the strength of the inducing field. Man-made objects composed of magnetic minerals containing iron are highly susceptible and can cause large anomalies thousands of times greater than geologic anomalies.

OBJECTIVE:
The objective of using a MAG survey is to detect buried magnetic objects and/or to map certain geologic features. Geologic applications of the MAG method include finding fault structures and lava tubes. Near surface applications include searching for ferrous metal drums, ferrous metal waste deposits, ferrous metal pipelines and utilities, Unexploded Ordnance (UXO), and buried ferrous archaeological treasures as well as old foundations or ancient site characterization.

UAV-DEPLOYED FIELD METHOD:

Unmanned aerial vehicle (UAV)/drone based magnetic surveys are carried out by suspending an instrument capable of measuring information about magnetic fields (magnetometer) from a UAV. Surveying is then performed in a similar way as terrestrial-based MAG surveys, by collecting data along equally spaced transects over a prescribed area. For UAV MAG surveying, typically additional sparsely spaced transects are collected perpendicular to the main survey lines. These transects, known as tie-lines, are used to correct for instrument orientation effects during surveying.

Typical UAV systems include four or six propeller aircraft, such as the DJI M600 Pro. The most common magnetometers deployed from UAV systems are lightweight, optically-pumped cesium vapor magnetometers, such as the Geometrics MagArrow. These magnetometers represent the latest in sensor technology, and are many times lighter than traditional terrestrial-based or manned aircraft sensors. Cesium vapor sensors like the MagArrow measure the total magnetic intensity (TMI) of magnetic fields. The TMI represents the strength of the magnetic field at the sensor location and does not include any information about the field's orientation.

In most cases, in addition to the measurements made by the magnetometer deployed from the UAV, one or more fixed-location ground station magnetometers are used within the survey area. These base stations are set to continuously record during the course of the UAV survey, and are used to account for temporal changes in the Earth's magnetic field.

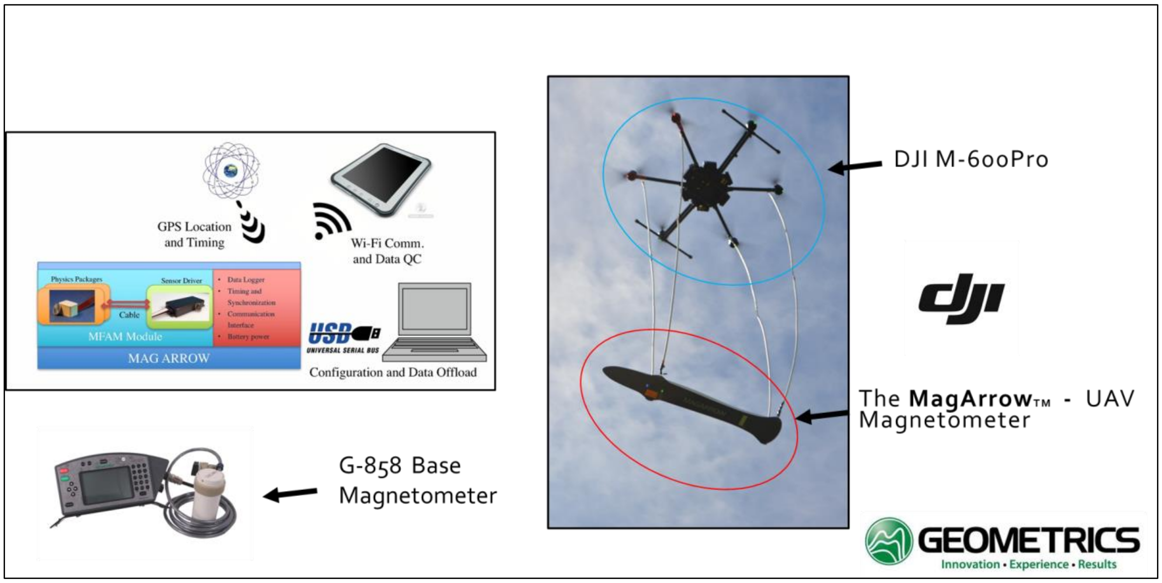


Figure 1: Examples of equipment used for UAV-deployed magnetometry.

During UAV MAG surveying the magnetometer is suspended 10 or more feet below the UAV so as to mitigate measurement interference due to magnetic fields produced by the aircraft. Survey altitudes can be as close as 10 feet from the ground, depending on vegetation limitations. With onboard GPS information, the UAV systems can complete surveys at fixed altitudes or use digital elevation model (DEM) data to perform topographically draped surveys.

Figure 2: PIC navigating UAV and magnetometer payload to begin surveying.

Mission planning software using onboard GPS and internal measurement units (IMUs) allow for precision auto-piloted navigation of survey grids by the UAV. Depending on site conditions and target objectives, survey transect spacings can range from as small as 15 feet up to several thousand feet.

Field crews consist of a FAR Part 107 certified (in the U.S.) UAV Pilot in Command (PIC), a visual observer, and a geophysicist.

LIMITATIONS:

- Non-magnetic metals are not detectable.
- Cultural interference.
- Depth of investigation can be ambiguous. A small object near the sensor can produce the same response as a large object far from the sensor.
- Can require complex modeling to determine exact geometry of source bodies/objects.

Limitations with respect to UAV MAG specifically include:

- Surveying is limited by line of sight (in the U.S.). Highly vegetated or topographically variable sites may require many small surveys that would need to be stitched together.
- Large topographic relief poses challenges, as DEM-based terrain following is not effective enough to ensure safe and accurate flight lines.
- Resolution is mainly controlled by flight elevation. For sites with tall trees or tall obstacles, the UAV may need to fly at a higher safe elevation, which would negatively impact the ability to detect small objects.

MAG SURVEY BENEFITS:

- Excellent for ferrous metals.
- Does not require ground contact.
- Images deeper than electromagnetics for ferrous metal targets.
- Good complementary data to EM, gravity, and reflection seismics.

UAV-deployed specific benefits:

- Extremely fast to collect data. Hundreds of acres can be collected in a few days at high resolution.
- Auto-piloted survey acquisition ensures precise survey lines which are not dictated by ground conditions.

RESULTS AND EXAMPLES:

MAG results are generally shown as plan view maps and represent the total field or other additionally processed versions of the data. Several examples of results are shown in **Figures 3 – 6**.

Figure 3 shows the flight paths and resulting TMI data for locating an abandoned oil and gas well in northern Colorado. Note how the response from the well is much greater than the background measurements.

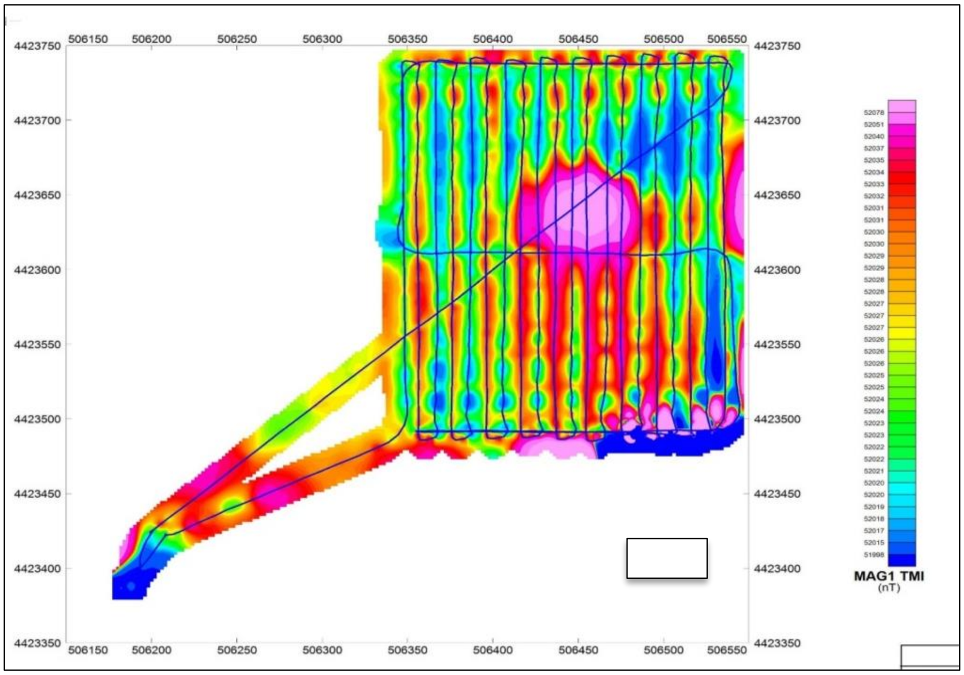


Figure 3: Example data and flight lines (blue) identifying a single abandoned oil and gas well.

Figure 4 shows the results for a ~390 acre site searching for abandoned infrastructure in southern Texas. Here, many individual anomalies were identified, many of which we successfully mapped as abandoned oil and gas wells. Other features identified from this data include gas flow lines as well as abandoned building foundations. Note that the flow lines produce complex series of peaks in the TMI results. This is due to the superposition of many magnetic fields occurring from individual pipe segments making up the flow line. The rightmost image in **Figure 4** shows the results of processing the TMI data as the amplitude of the analytic signal. As is shown, this image processing result is much simpler to interpret, as the dipolar patterns of many anomalies are reduced to single positive peaks.

Figure 5 displays the results of a UAV MAG surveying West Texas. Here, the location of an abandoned oil and gas well (anomaly #1, **Figure 5**), along with several underground flow lines (black dashed lines, **Figure 5**) were identified from the results. The nethermost flow line was less than 6 inches in diameter and was successfully identified from data flown at 20 meters elevation from this survey.

Figure 6 shows the results of a UAV deployed magnetics survey over the area surrounding the Crestone Crater in central Colorado. The TMI data clearly delineate the magnetic minerals associated with the igneous rocks of the mountain front in the southeast corner of the survey area. Subtle magnetic variations are associated with the crater, providing further insights into its formation and geologic history.

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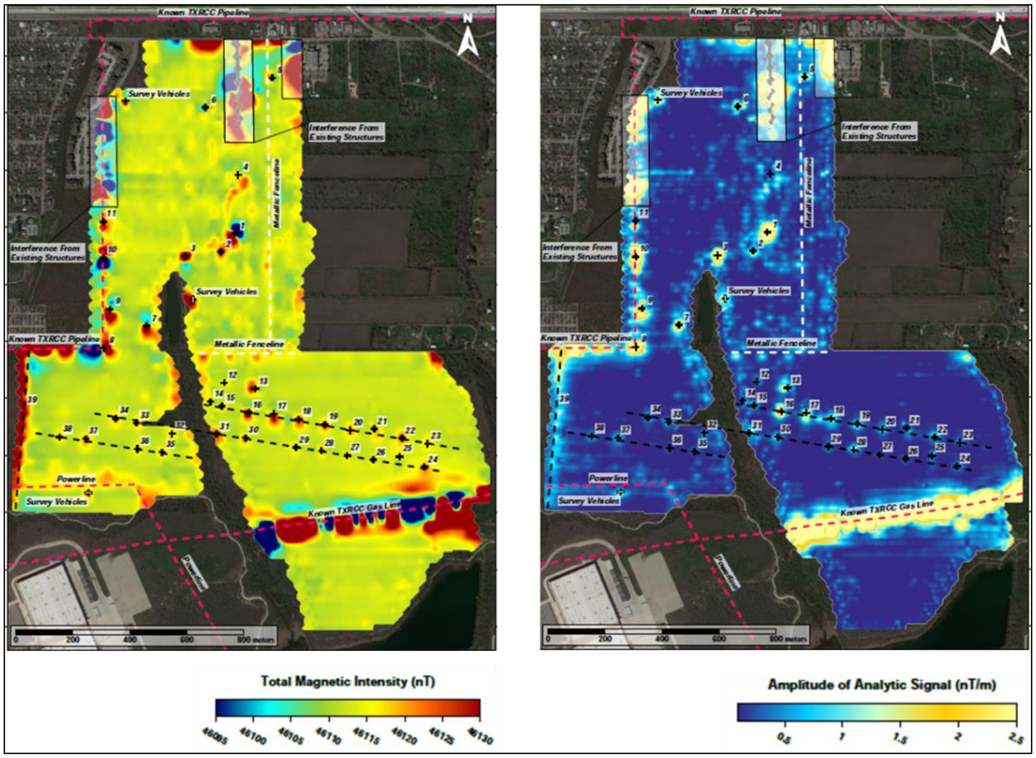

Figure 4: UAV magnetics data targeting abandoned infrastructure over a large site in southern Texas. Lett image represents the processed TMI data and right image is the amplitude of the analytic signal of the TMI data.

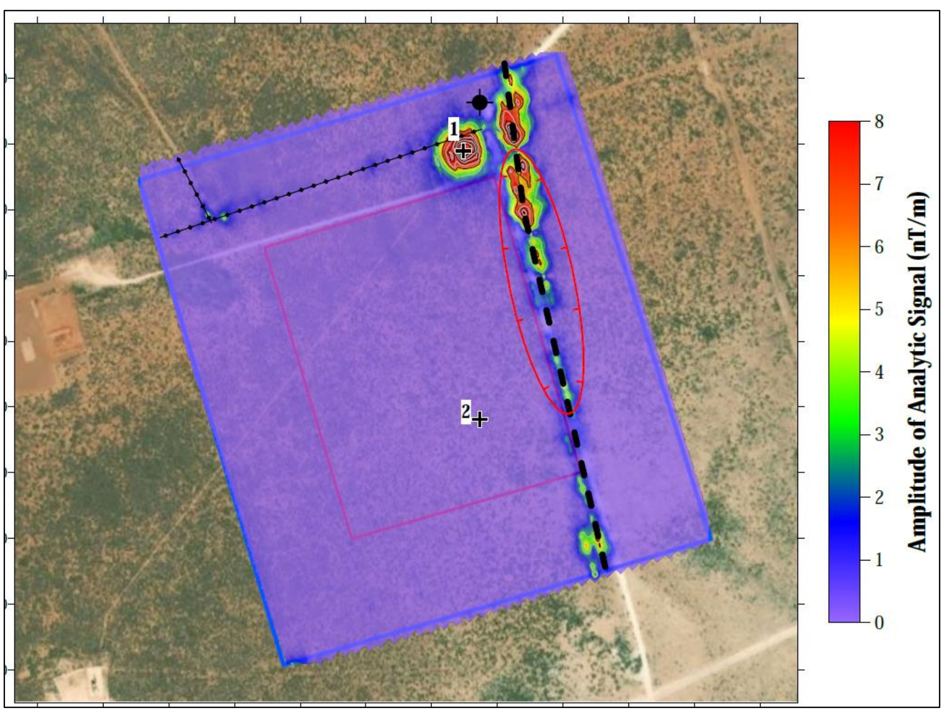

Figure 5: UAV-deployed magnetics data, processed as the amplitude of the analytic signal from West Texas. Interpretations of abandoned oil and gas infrastructure are shown.

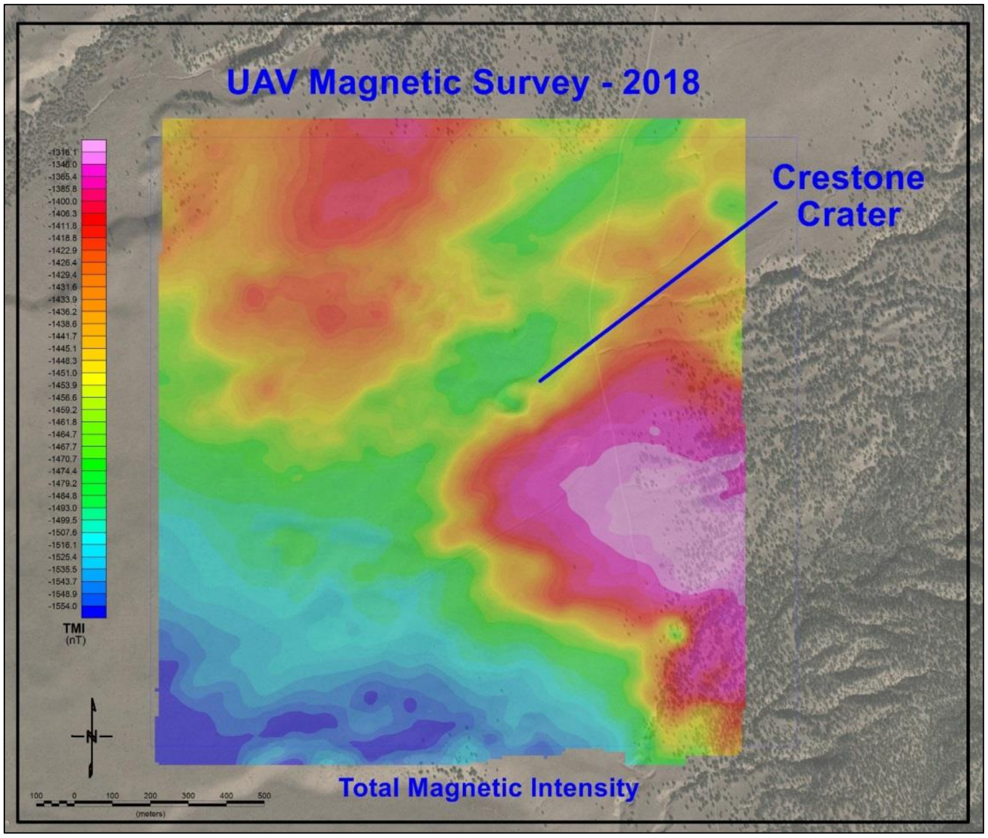

Figure 6: UAV magnetic results from an instigation of the Crestone Crater in central Colorado.