## UAS for Magnetometry Mapping

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02 UAV Integration

**03** Methodology

04 Ex. 1 Well Head Survey



## 01 Magnetometry Overview





#### What is Magnetometry?



#### Overview

#### What is Magnetometry?

- Remote sensing method that uses a device to measure magnetic field readings, with corresponding GNSS locations
- Traditionally deployed on foot, plane or helicopter. Recently, drone mounted sensors have been growing in popularity

#### What applications is Magnetometry used for?

Common applications include locating abandoned oil and gas infrastructure, UXO (unexploded ordnances), mineral exploration, archaeology surveys, and geologic assessments

#### What are the benefits of UAV Magnetometry?

- Collect more data in less time
- Survey hazardous sites (i.e. challenging terrain or UXO) from a safe location

#### Overview

#### **Magnet Variation**

#### Variations in Earth's Magnetic Field

- Secular Variation: The magnetic axis undergoes a periodic change because of its spin around its own axis from east to west. The time cycle of this variation is 960 years.
- Eleven-year Sunspot Cycle: Once in every eleven years, the earth faces the sunspot which is a region of the strong magnetic field. Thus the magnetic activity of the earth is very much influenced by this variation.
- Daily and Annual Variation: The ultraviolet rays from the sun ionize the earth's atmosphere. As a result of which the current is generated which further produces the magnetic field. This is the result of daily and annual variations.
- Lunar Variations: Apart from the sun, the moon also influences the magnetic activity of earth. Due to the tidal motions of the earth's ionized layer during a lunar eclipse, there is variation in earth's magnetic field. This variation is the Lunar Variation.
- Irregular and Aperiodic Variation: During a particular period of time when the solar activity of the sun is more active, the radiations from the sun ionize the atmosphere of the earth. This causes current when the earth revolves around its own axis resulting in the magnetic field.

### Daily Magnetic Variation



National Geomagnetic Service, BGS, Edinburgh

## 02 UAV Integration



#### MagArrow

- Geometrics MagArrow airborne
  Magnetometer
- Laser pumped cesium vapor (Cs133 non-radioactive) total field scalar magnetometer
- 1000hz sampling rate
- Integrated GNSS antenna
- Output is a binary file that's easily converted into CSV





#### Base Station

- A Geometrics G-857 base station
  magnetometer
- Runs the complete duration of data acquisition.
- Records magnetic data and date/time at pre set intervals (1-5 second intervals typically)
- Date/Time data is used to match with UAV acquired magnetic data





### 03 Methodology





- Preprogrammed flight lines using drone navigation software (DJI, UGCS etc.) to insure consistent straight transects
- Flight time is about 20 mins per set of batteries
- Data downloads and checks inbetween battery swaps

### Flight Lines

| Measure Distance   |           |          |         |      |  |
|--------------------|-----------|----------|---------|------|--|
| P                  | Planar    |          | Miles   |      |  |
| Result             |           |          |         | ð 🤌  |  |
| Distance           |           |          |         |      |  |
| Segment (mi)       | Path (mi) | Sum (mi) |         |      |  |
| 0.62               | 0.62      |          |         | 0.62 |  |
| Path Net Bearin    | ng:       |          |         | 180° |  |
| Path Net Distance: |           |          | 0.62 mi |      |  |



### Flight Lines

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### Flight Lines

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### Post Processing

- Binary files are converted CSVs
- Trimming flight lines and variously despiking procedures and corrections are performed using geophysical processing software ( i.e. Oasis Montaj)
- For multiday projects, merging of the various acquisitions is required before data is ready for raster interpolation (gridding)



### Raster Interpolation



## 04 Well Head Survey



### Abandoned Well Location

- 1400 acres in New York state
- Abandoned Well survey for pre construction compliance
- 83 flights over eight days of flight ops



DUDEK

#### Flight Lines Somerset, NY

### Magnetic Intensity





### Analytic Signal





22

#### Possible Well Head







#### Well Head Analytic Signal Profile





### Well head Example



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# 05 Magnetometry in Hawaii



### Hawaii Example

- Approximately
  100 acres
- Thick vegetation would be challenging for a conventional ground survey







### Magnetic Intensity





### Analytic Signal







#### Summary

- UAS are a great platform for Magnetometer surveys
- Recently, drone mounted sensors have been growing in popularity replacing traditionally sensors deployed by foot, plane or helicopter
- UAS Mag surveys are suited for locating abandoned oil and gas infrastructure, UXO (unexploded ordnances), mineral exploration, archaeology surveys, and geologic assessments
- Collection of the data requires ground based calibration
- UAS surveys for hazardous sites (i.e. challenging terrain or UXO) from a safe location

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nc

#### **UAS-enabled** magnetic survey



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