



The Elegance of Drone Geoscience

UAV Enabled Surface and Subsurface Imaging

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Today's Talking Points

- UAV Sensors for Geoscience
- 10 Drone Geoscience Applications
- Benefits & Factors Impacting Drone Mapping
- Drone Surveys vs Ground Surveys
- Drone Surveys are scalable
- UAV Geophysics Examples
- Summary
- What's next!



REMOTE SENSING

Color Photographs

Color Video (4K)

Near Infrared

Multi- / hyper- spectral

Thermal Infrared

Short Wave Infrared

LiDAR

Gamma Ray Spectrometry

Ground Penetrating Radar

Magnetic

ElectroMagnetic (EM)

Seismic

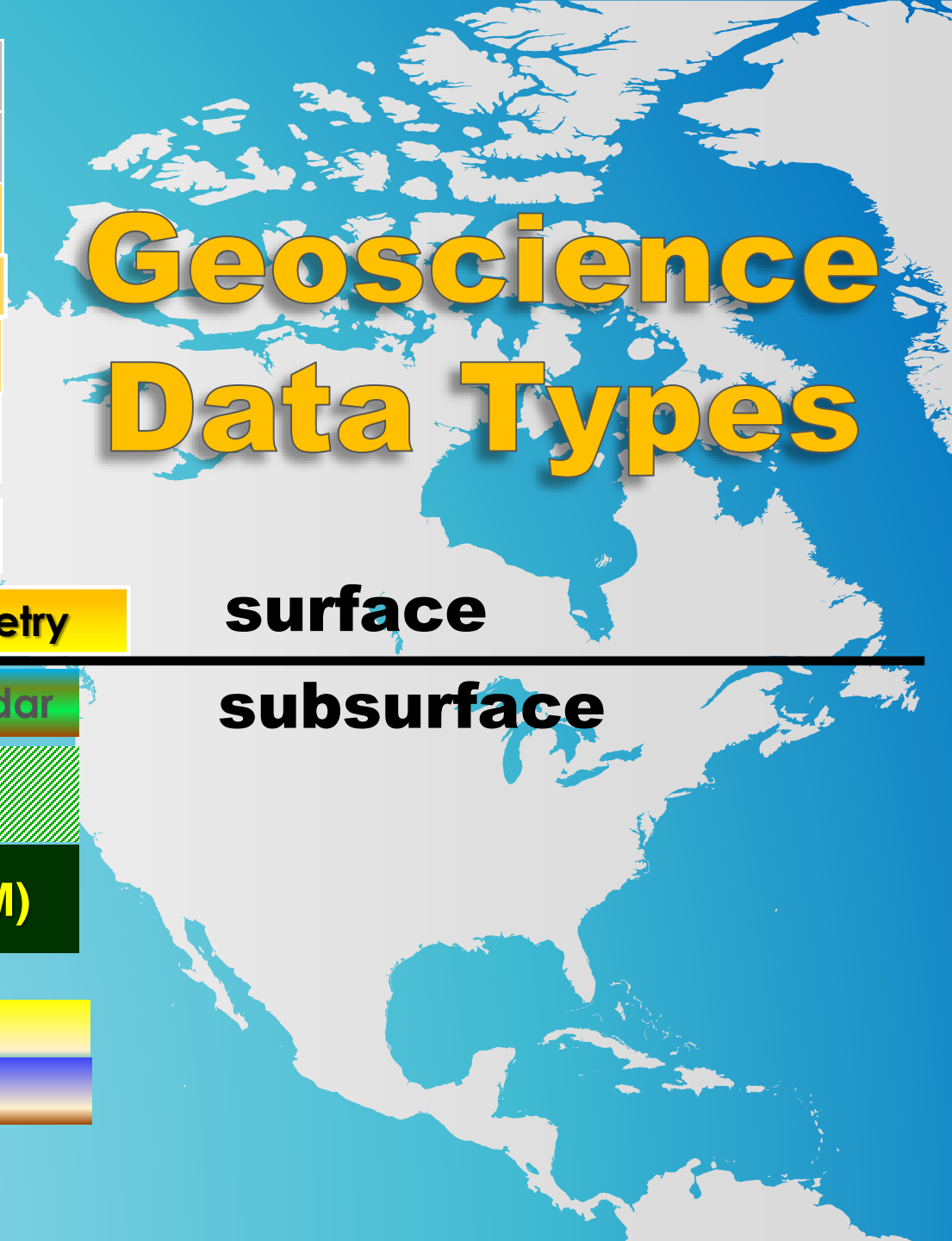
Gravity ?

Geoscience Data Types

surface

subsurface

GEOFYSICS



10 Geoscience Applications of Drones

- #1 – Identifying surface features of interest**
- #2 – Topographic mapping, land surveying, & asset management**
- #3 – Surface mapping rock type, structure, and alteration**
- #4 – Sub-surface mapping rock type, structure, alteration, groundwater**
- #5 – Detection and delineation of geohazards – sink holes, landslides, etc.**
- #6 – Detection and delineation of contamination (surface & subsurface)**
- #7 – Detection and delineation unexploded ordnance (UXO)**
- #8 – Characterization and assessment of infrastructure – e.g. wells & pipelines**
- #9 – Monitoring natural and extractive processes**
- #10 – Detecting gaseous emissions**

Benefits of UAV Geoscience Surveys



- Access difficult areas
- Ultra-low altitude surveys
- Improved spatial data density
- Enhanced signal strength
- Lower operational cost
- Improved safety of field staff
- Reduced risk of property damage
- Facilitates temporal change detection
- Quick turnaround of data products

Factors Impacting UAV Surveys

Limitations

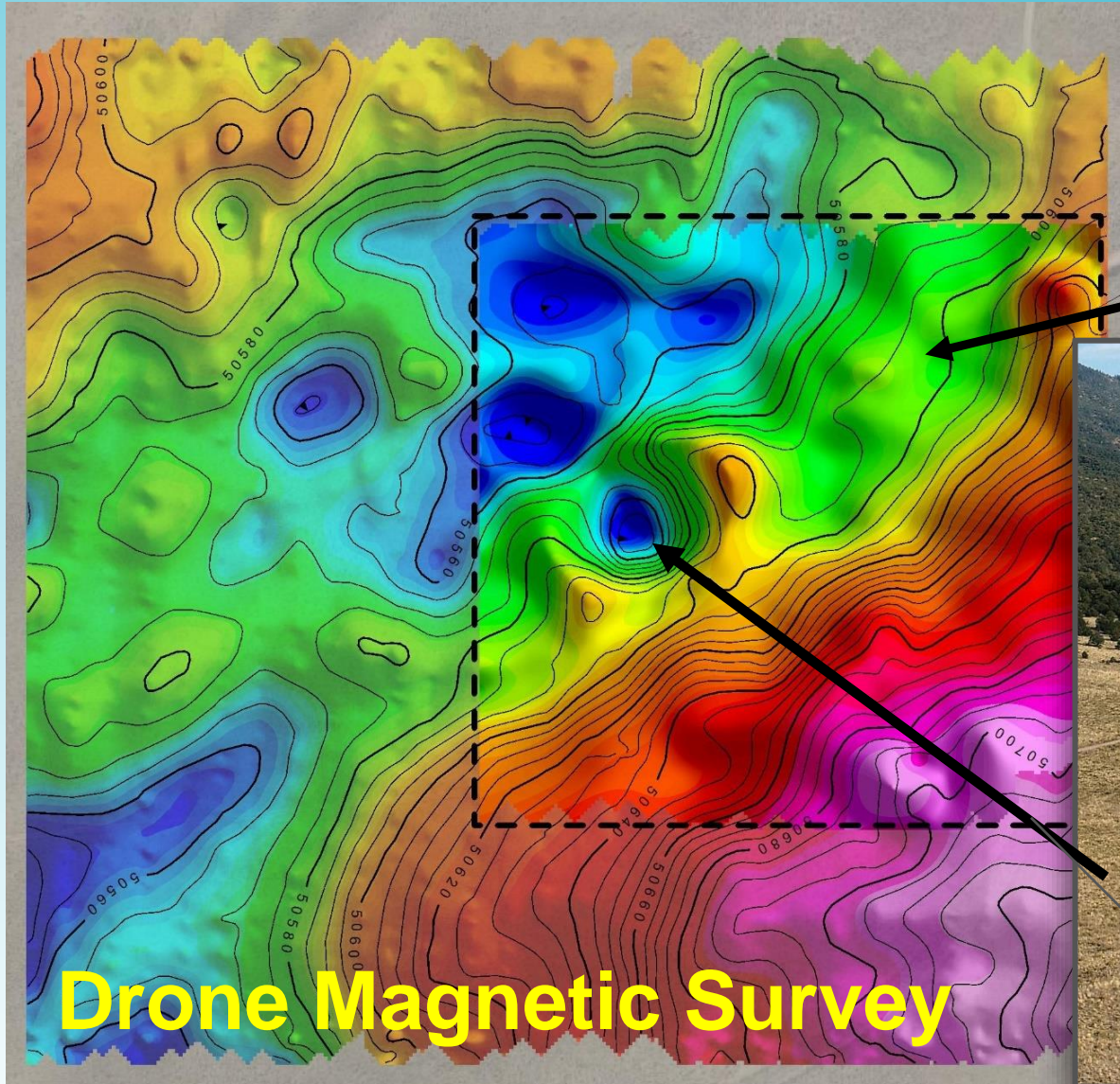
- *weather*
- site access
- size of survey area
- topography
- vertical structures i.e. trees
- UAV flight characteristics
- short duration flights
- small payload (typically < 5 kg)

Restrictions

- UAVs less than 25 kg
- maximum flight altitude: 400 ft AGL
- visual line of sight (VLOS)
- nighttime operations permitted with training
- no operations over people
- one operator = one UAS
- certified unmanned aircraft pilot

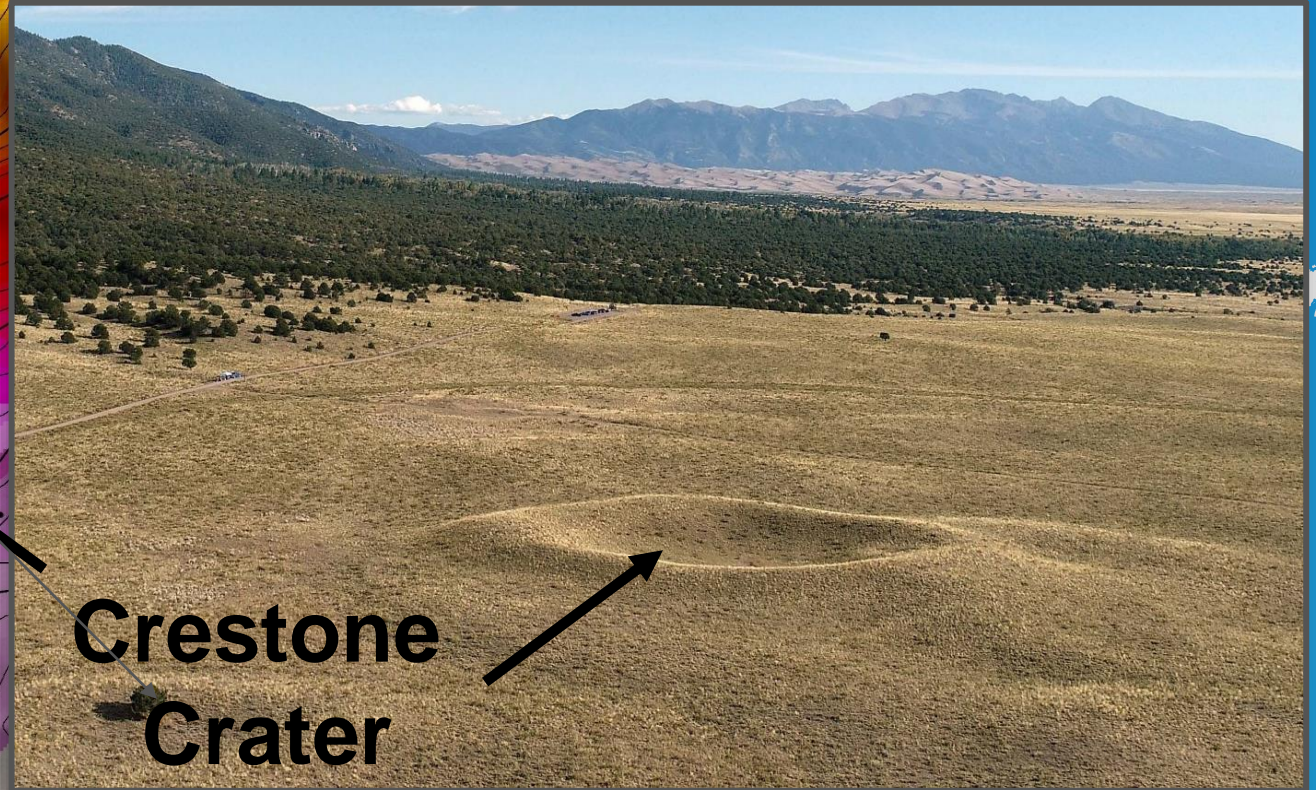


Drone Surveys vs Ground Surveys



Drone Magnetic Survey

Ground Magnetic Survey



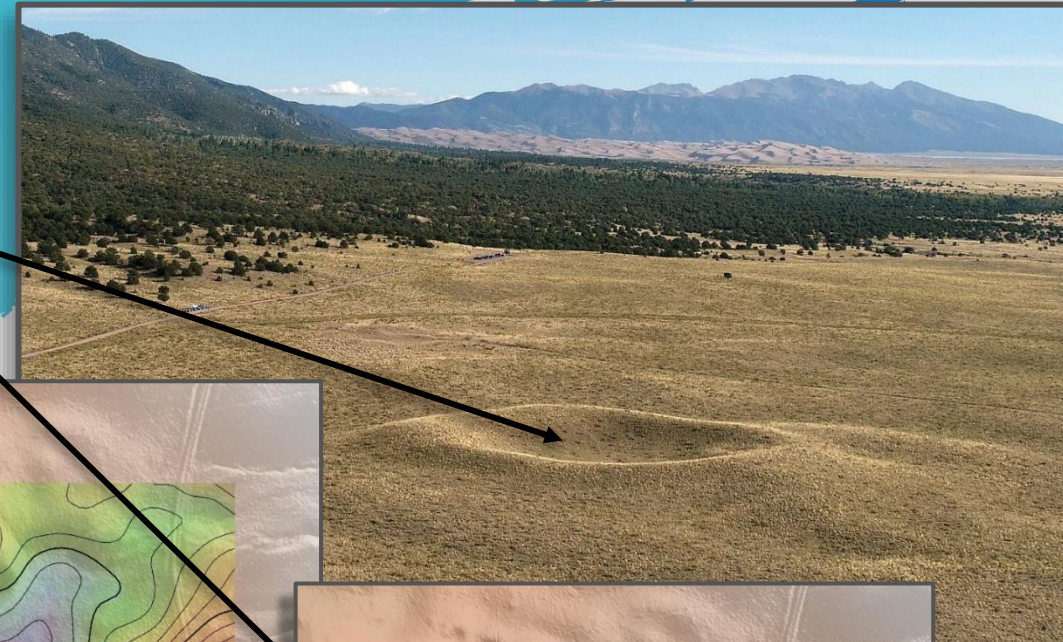
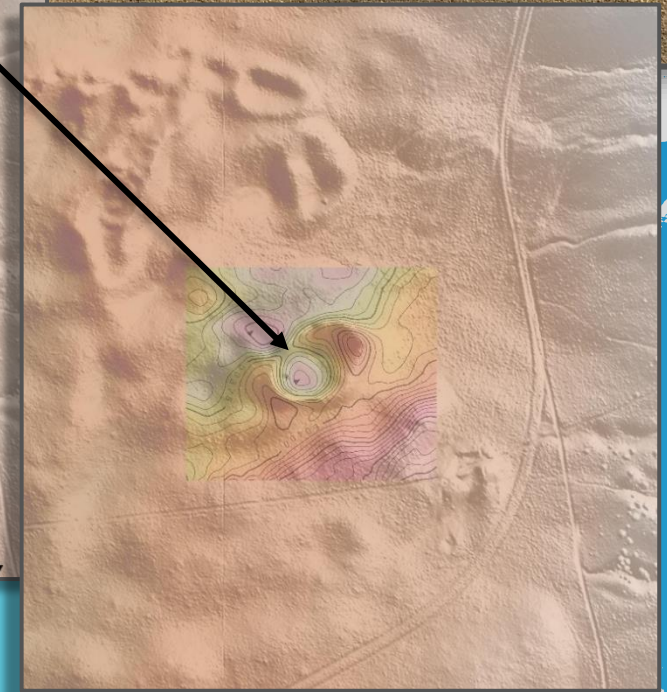
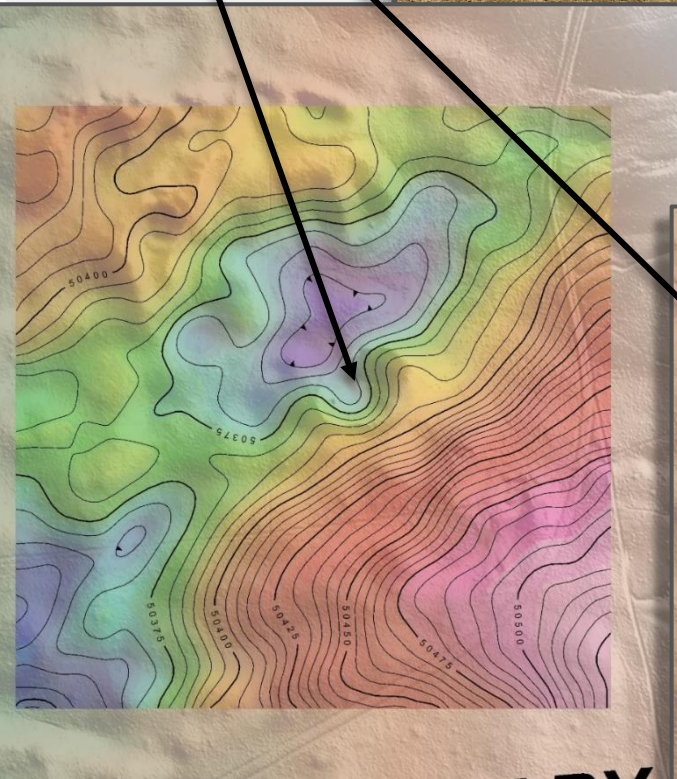
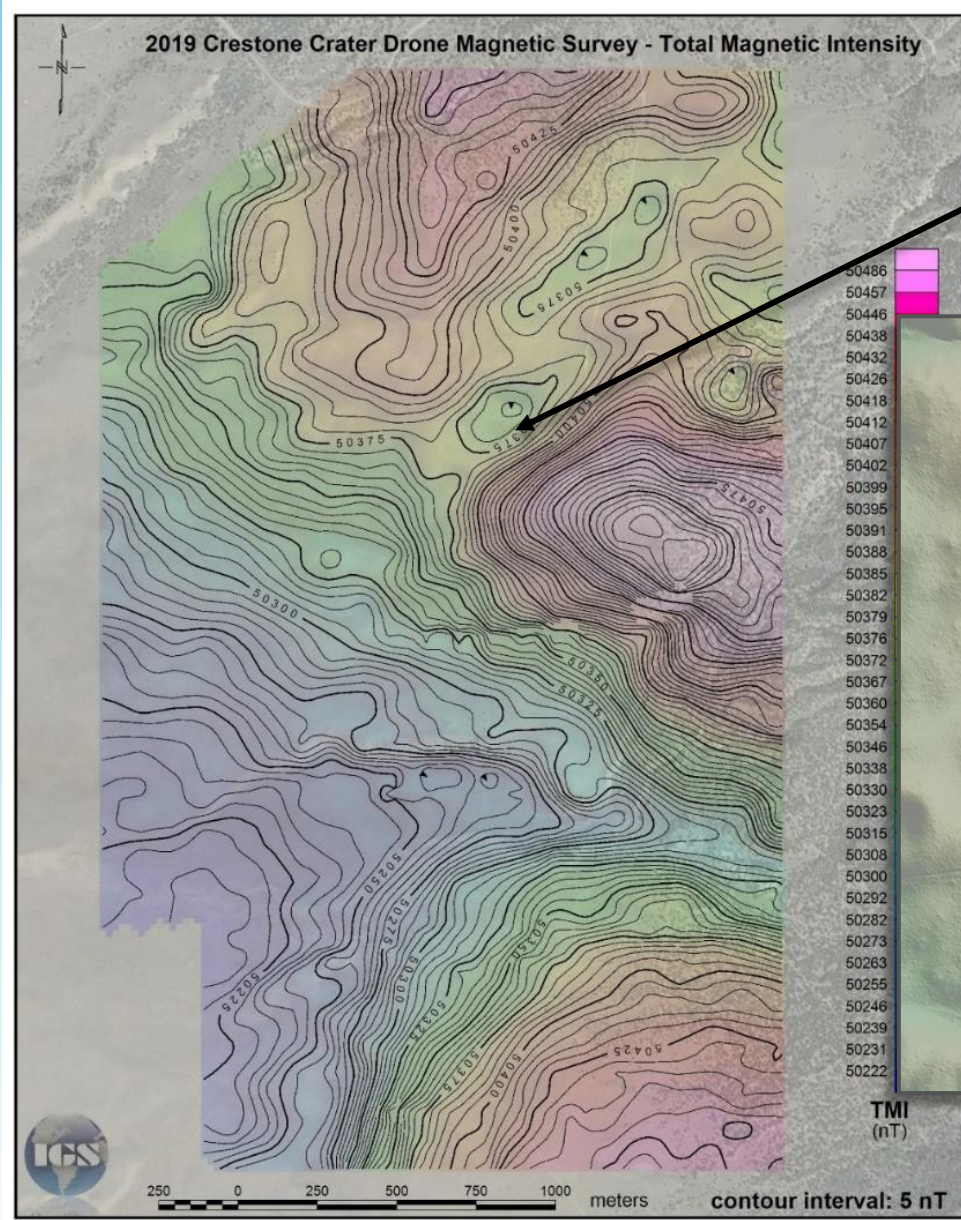
**Crestone
Crater**

2017

Total Magnetic Intensity

UAV Surveys are Scalable

Crestone Crater



Total Magnetic Intensity

The DG Measurement Space

120 m (400 ft) AGL

Air Space Regulatory limit

Standard Altitude

30 m (~100 ft) AGL

Top of Trees

Low Altitude

5 m (~15 ft) AGL

Local Vertical Structures

Ultra-low Altitude

MagArrow

0.5 m AGL

EM61 Lite

Ground Surface



UAV Geophysics

www.dronegeosci.com



MagArrow

Geometrics, Inc.
(www.geometrics.com)

MAGNETICS



EM61 Lite

Geonics, Ltd
(www.geonics.com)



GEM2 UAV

Geophex, Inc.
(www.geophex.com)

ELECTROMAGNETICS



D230A

Gamma Ray Spectrometer

Terraplus, Inc.
(www.terraplus.ca)

**GAMMA RAY
SPECTROMETRY**

Drone Geophysics

Magnetics

Electromagnetics

GPR

metal detectors

conductivity meters

Semi-airborne EM

Depth of Investigation

0.1 m to 1000+ m

0.1 to 5+ m

0.1 to 5 m

0.1 to 3 m

1 to 500+ m

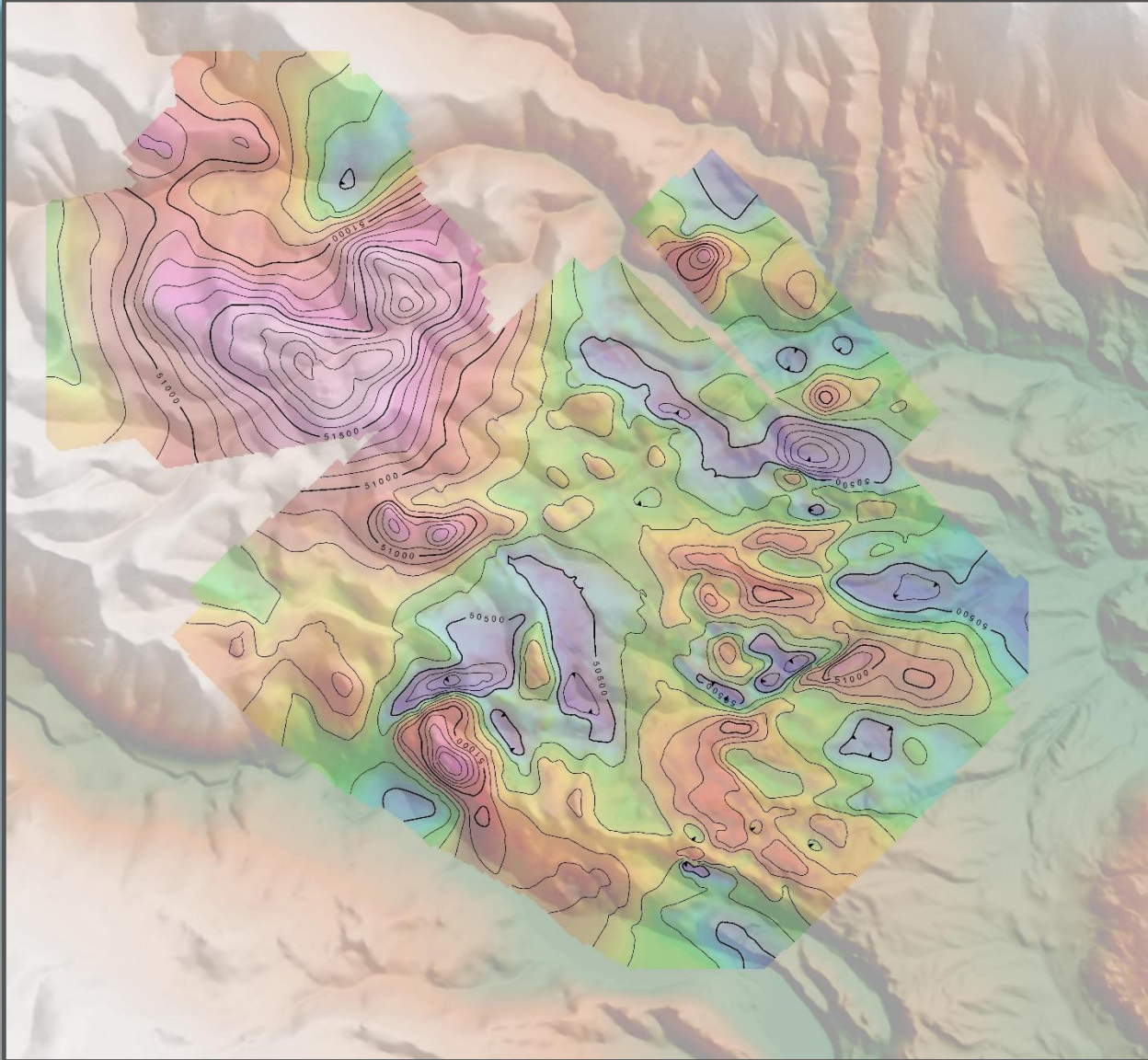


UAV MagArrow Project Types



- precisely locating legacy O&G wells
- mapping buried O&G pipelines
- landfill subsurface characterization
- groundwater resource assessment
- exploring for oil and gas resources
- mine site characterization
- mineral exploration
 - at high elevation (12,400 ft)
 - in rugged terrain
 - in tree covered areas
 - in the desert
- investigate possible impact crater

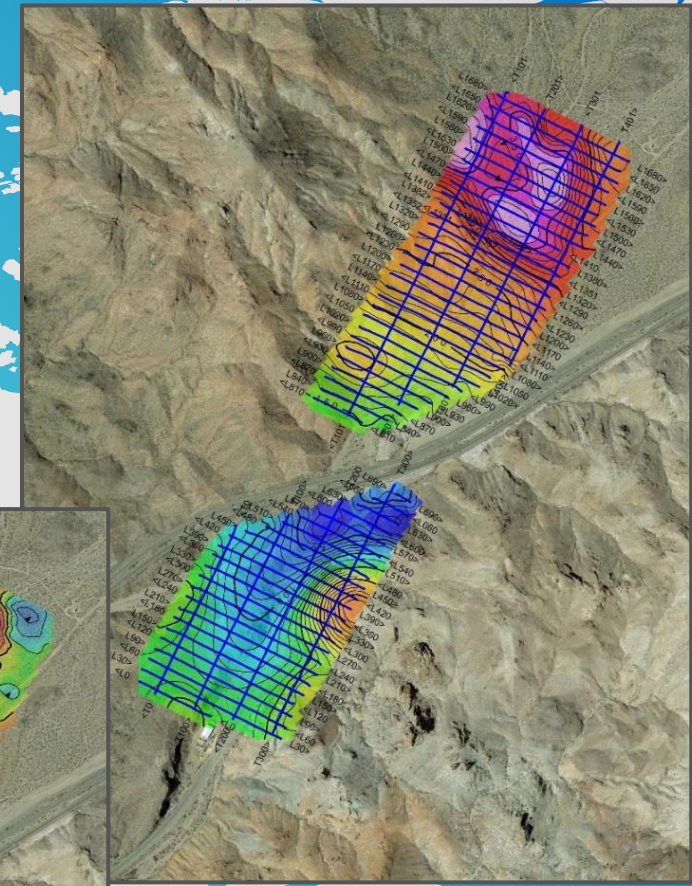
Exploring for Mineral Resources



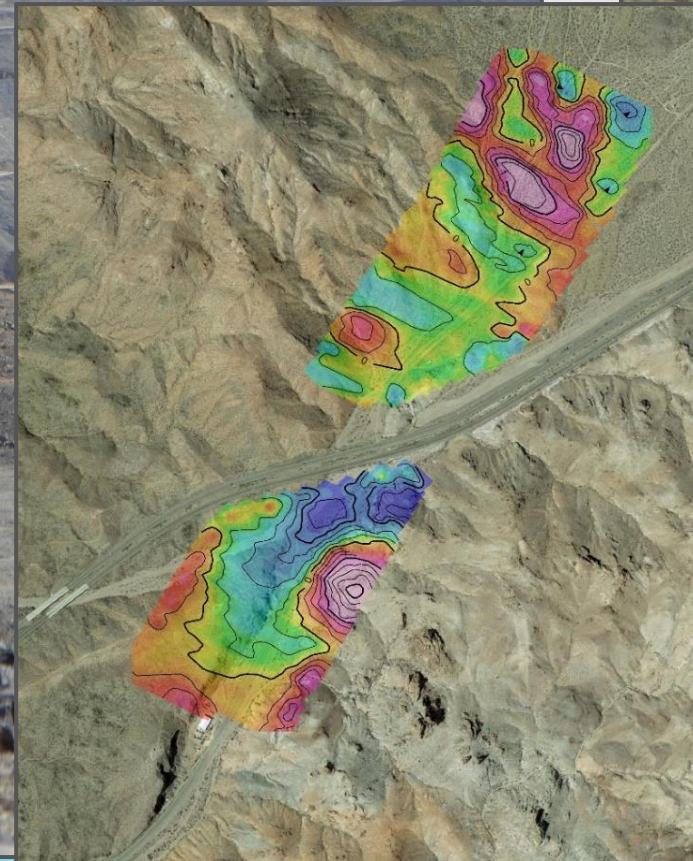
TMI Color Contours on DEM



Mine Site Characterization



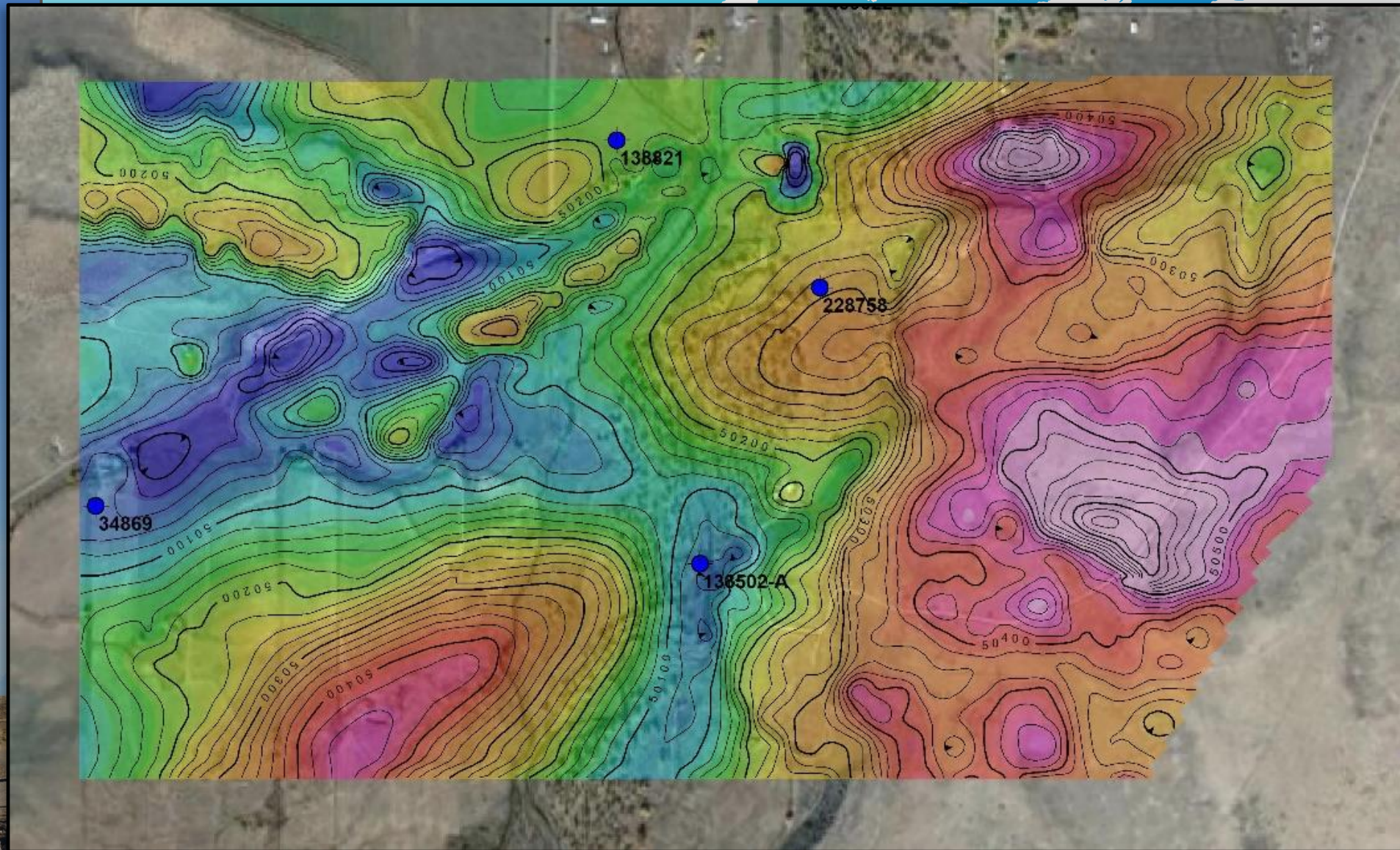
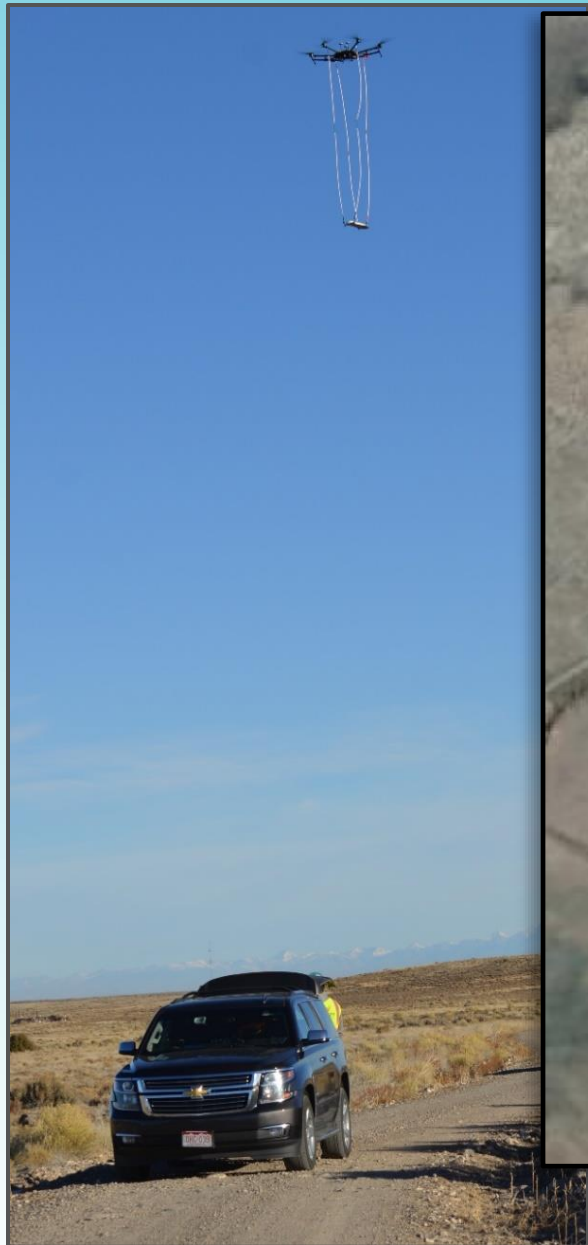
TMI with flight lines



Calculated Vertical
Gradient of TMI

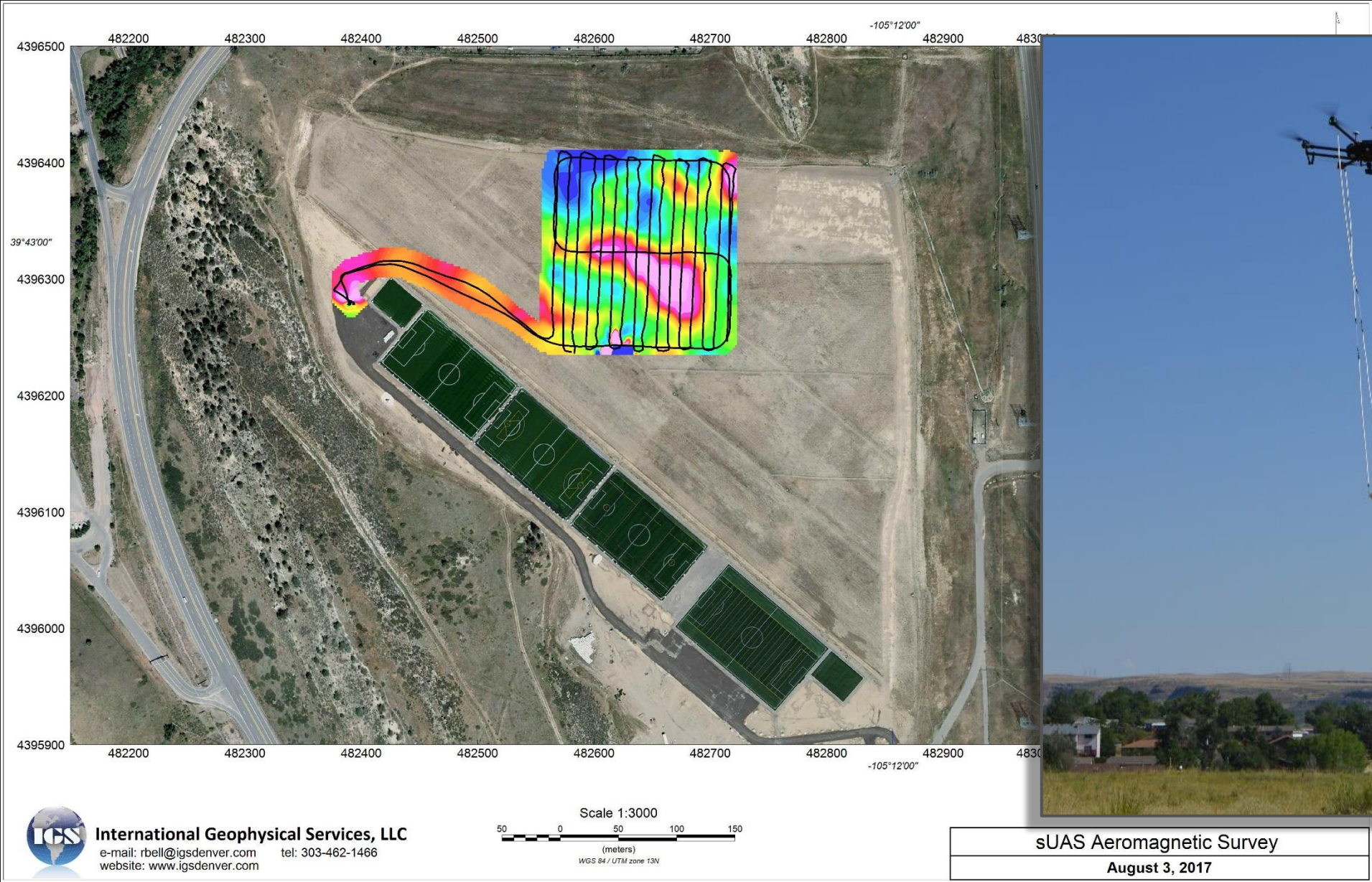


Dam Site Characterization



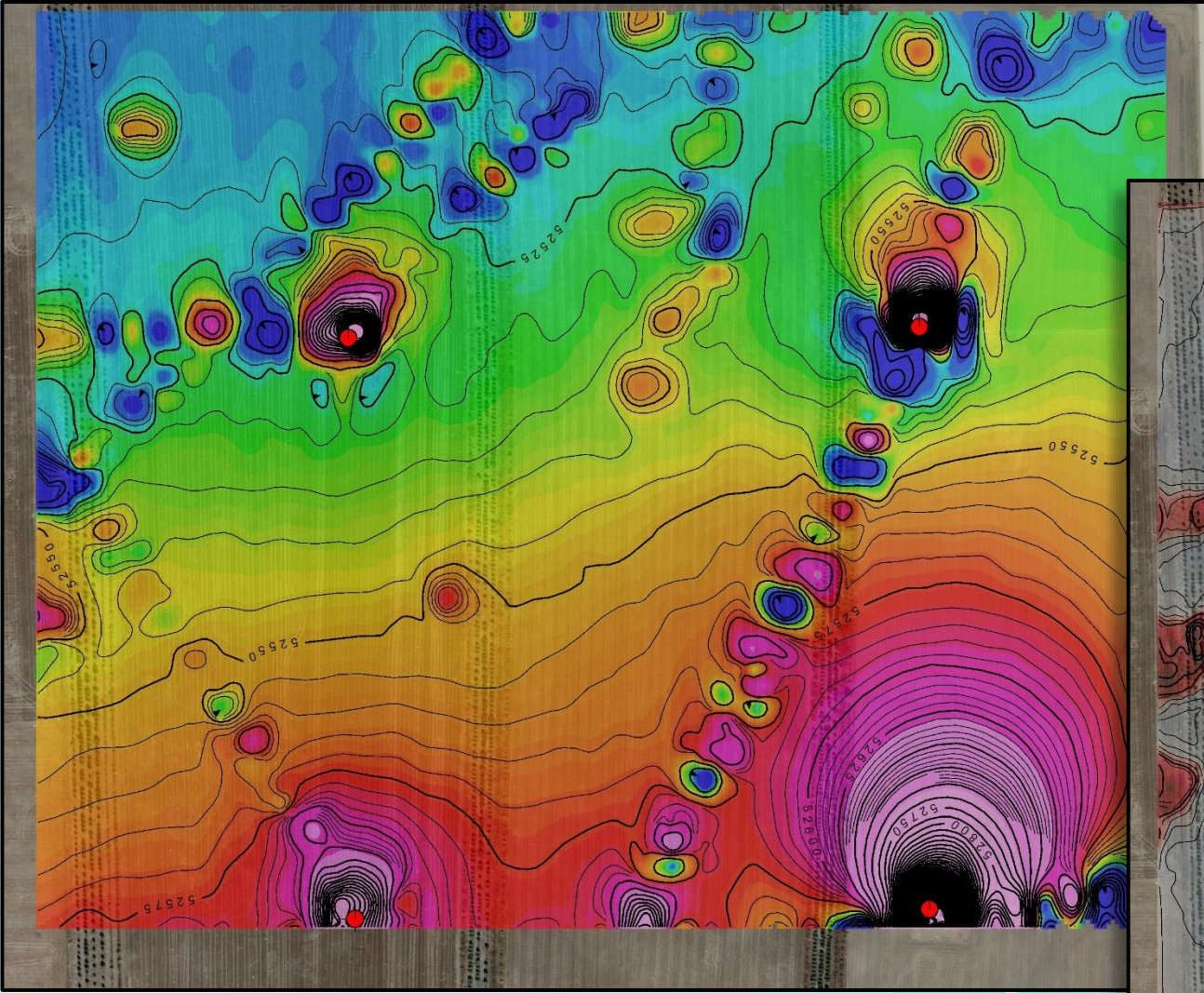
Total Magnetic Intensity (TMI)

Landfill Subsurface Characterization

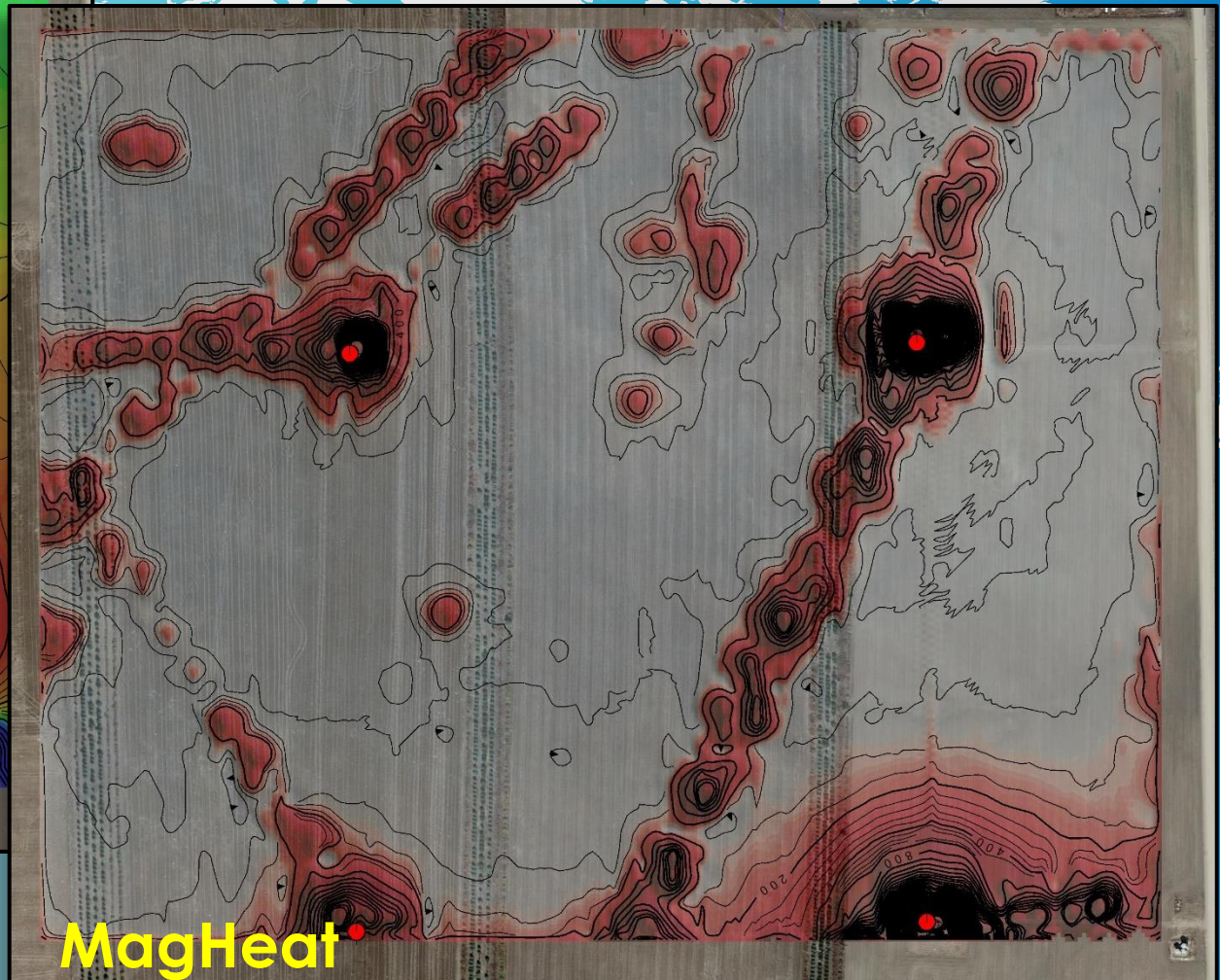


sUAS Aeromagnetic Survey
August 3, 2017

Mapping Buried Legacy O&G Wells & Pipelines

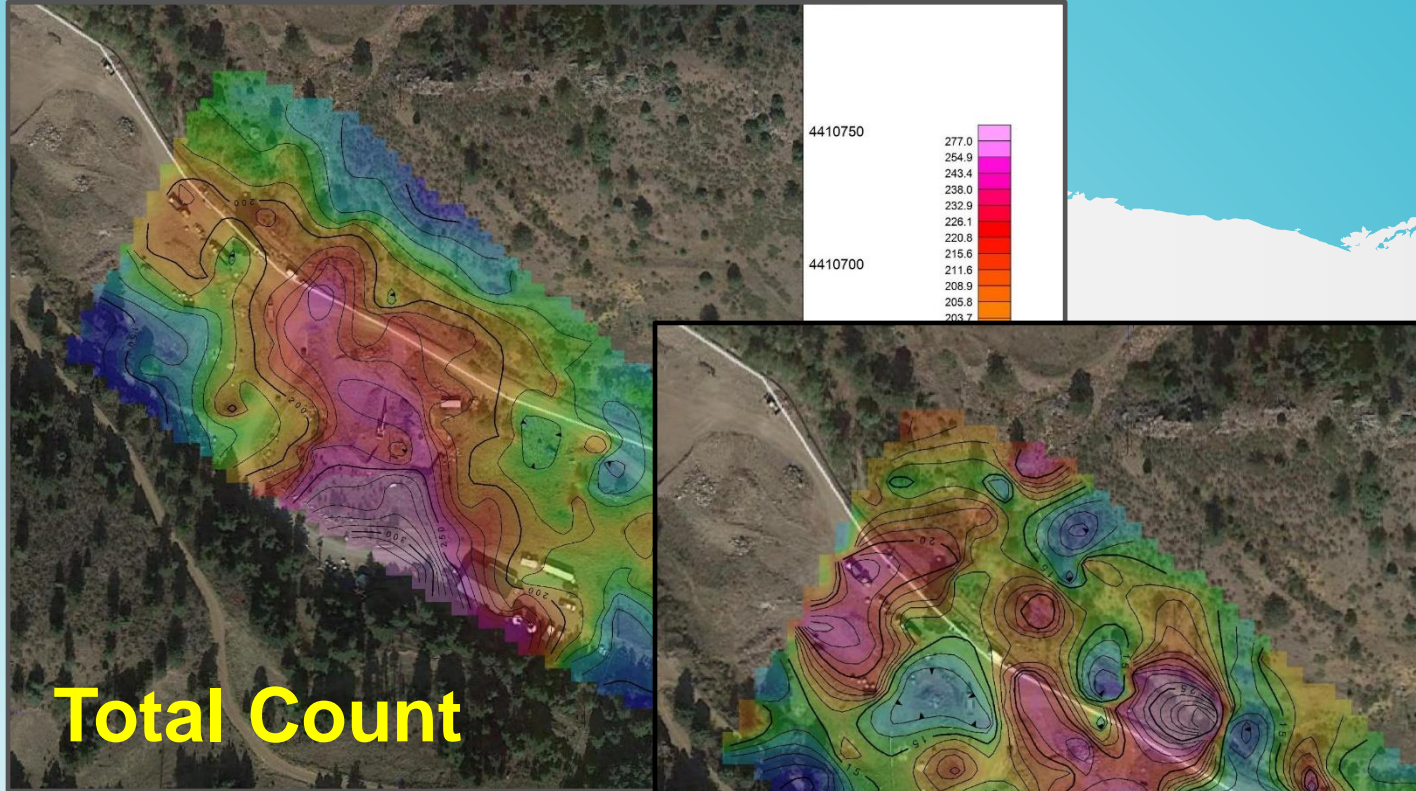


Total Magnetic Intensity

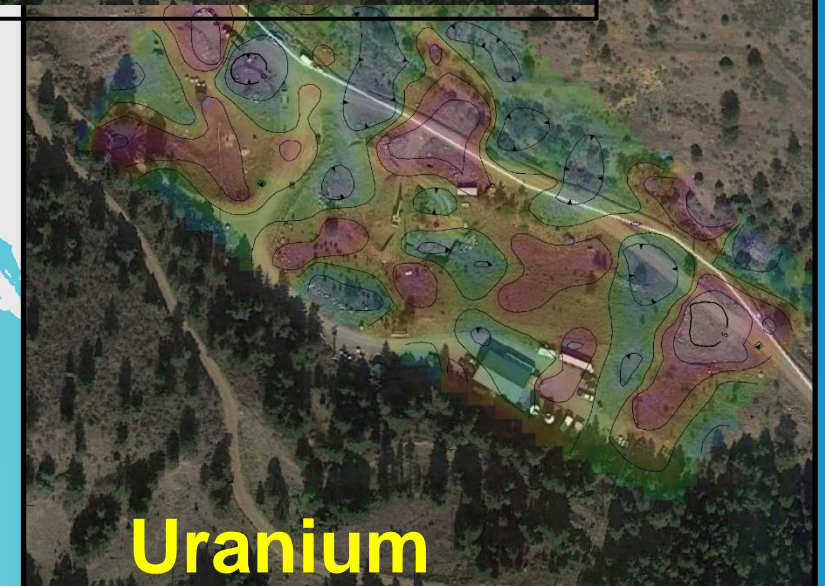
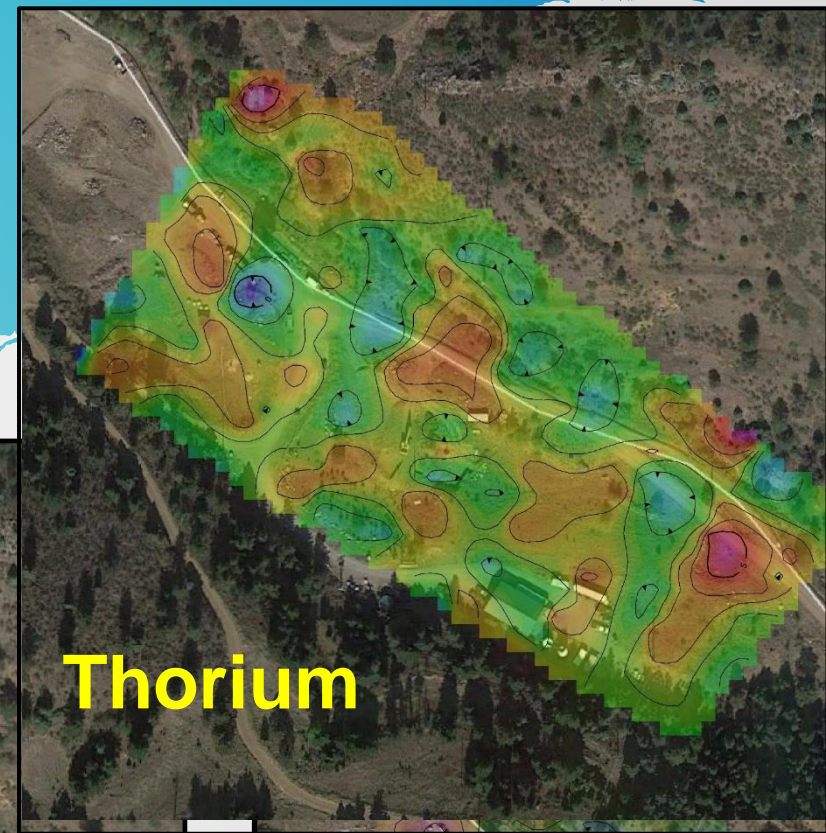
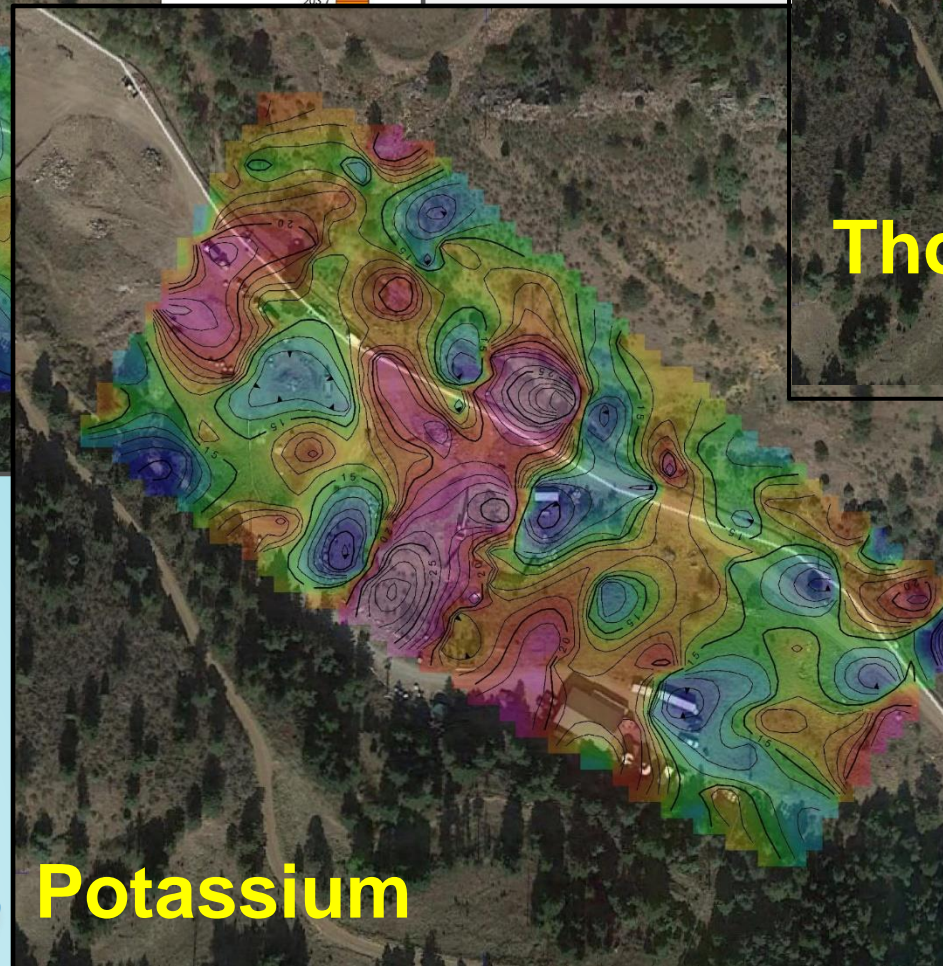


MagHeat

Gamma Ray Spectrometry



D230A

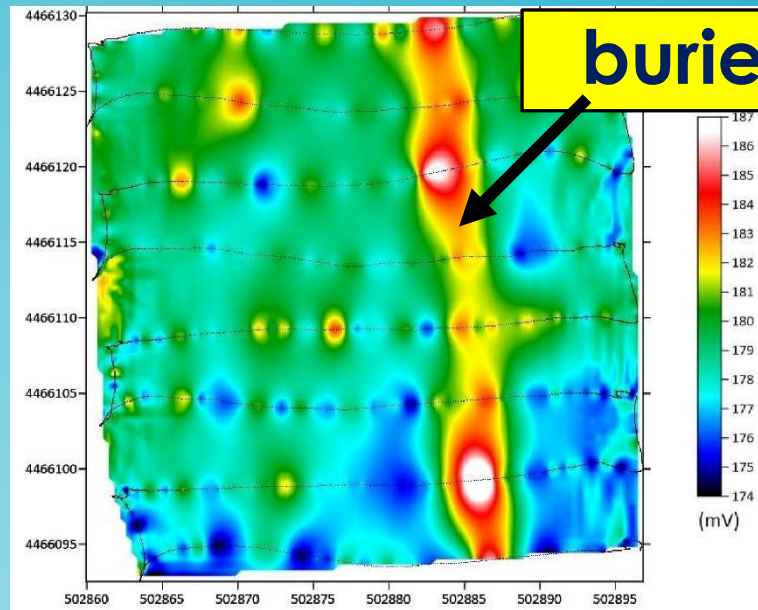




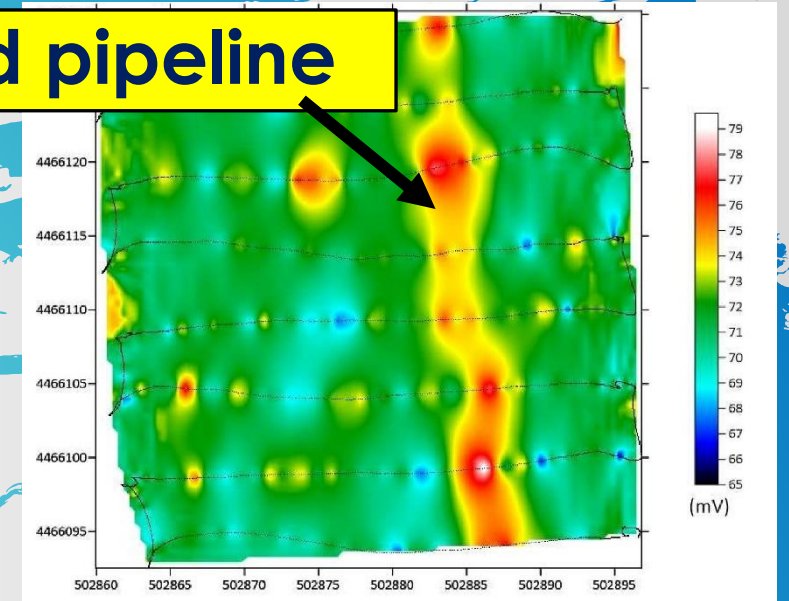
<https://www.geonics.com>

EM 61 Lite

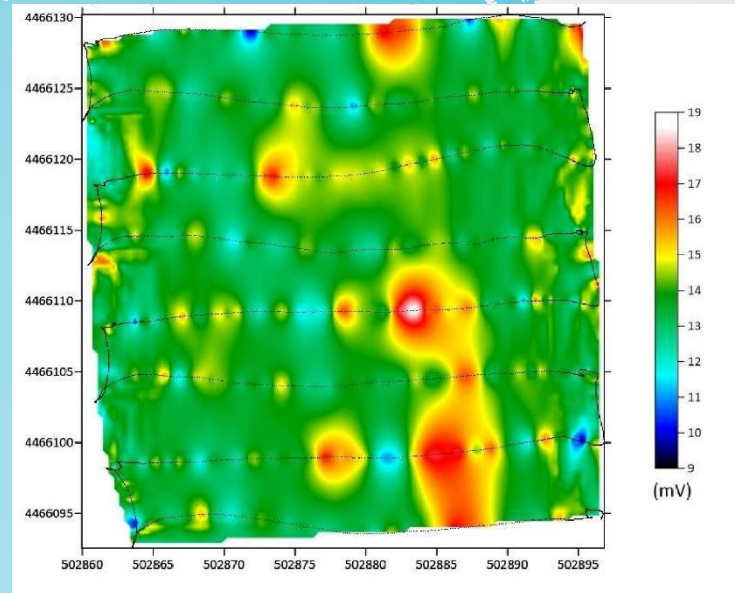
**Drone
Geoscience**



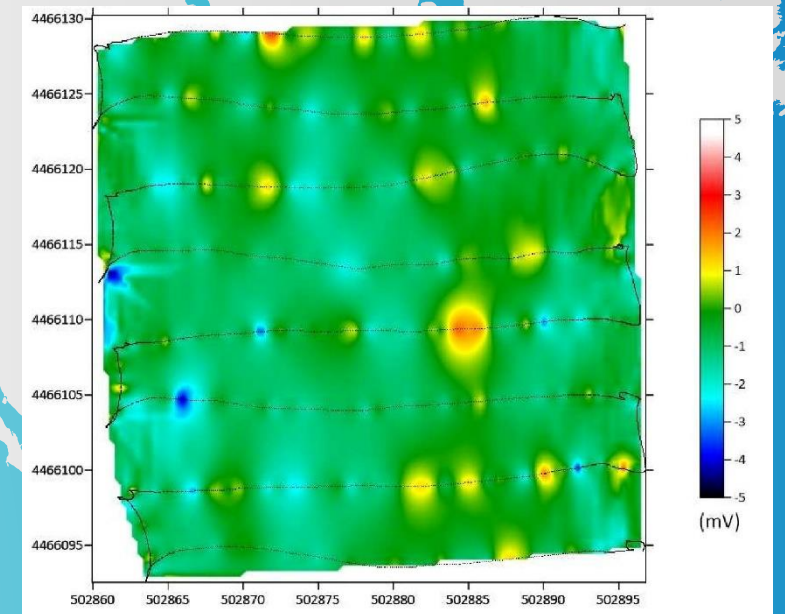
Channel 1



Channel 2



Channel 3



Channel 4

Summary on Drone Geophysics

- UAV magnetometry is established for subsurface geological mapping for resource exploration and is being increasingly applied to detect and map buried objects (i.e. legacy infrastructure, etc.)
- EM 61 Lite is applicable to detecting & delineating highly electrically conductive objects within the subsurface (i.e. UXO, etc.)
- The GEM 2 UAV EMI Conductivity meter and D230A Gamma Ray Spectrometer are emerging geophysical methods with numerous applications in the environmental, agriculture, infrastructure, & security sectors.
- The data from each geophysical tool combines well with data from commonly used drone mapping methods (i. e. photogrammetry, LiDAR, infrared spectral imaging, etc.).
- The result is the cost effect data volume providing information about the surface AND subsurface.



MagArrow™

Geometrics, Inc. (www.geometrics.com)



What's Next?

- BVLOS
- New Sensors
 - > EM
 - > gravity
 - > seismic
 - > detect and avoid
 - > innovative thinking
- UAV
 - > fixed wing VTOL
 - > larger UAV > heavier payloads
 - > purpose built UAV / sensors
- multiple sensor \ data types
- Near real time data processing \ analysis
- Machine Learning \ Artificial Intelligence



Thank you for your attention.



To learn more, contact

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