

Drone Geophysics and Remote Sensing

For Environmental Site Characterization An Overview

Presented by:

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Senior geoDRONEologist

RemPlex Summit 2023
16 November 2023



Why Use Unoccupied Aerial Vehicles \ Systems?

- access difficult areas
- automate mapping processes
- reduce the cost per data point
- diminish impact of human error
- increase geospatial density
- reduce risk to personnel and property
- achieve goals faster
- reduce cost per data point



REMOTE SENSING

Color Photographs

Color Video (4K)

Near Infrared

Multi- / hyper- spectral

Thermal Infrared

Short Wave Infrared

LiDAR

Gamma Ray Spectrometry

Ground Penetrating Radar

ElectroMagnetic (EM)

Semi-Airborne EM (SAEM)

Magnetic

Seismic ?

Gravity ?

Geoscience Data

surface

subsurface

GEOPHYSICS



Drone Geoscience Measurement Space

120 m (400 ft) AGL

FAA Regulatory Limit

Standard Altitude

30 m (~100 ft) AGL

Top of Trees

Low Altitude

5 m (~15 ft) AGL

Vertical
Structures

Ultra-low Altitude

0.5 m AGL

GPR

EMI conductivity
metal detector

gamma ray
spectrometry

magnetics

Semi-Airborne EM

Ground Surface



MAGNETIC



MagArrow

Geometrics, Inc.
(www.geometrics.com)

ELECTROMAGNETIC



EM61 Lite

Geonics, Ltd
(www.geonics.com)

GAMMA RAY SPECTROMETRY



D230A

Gamma Ray Spectrometer

Terraplus, Inc.
(www.terraplus.ca)

GEM2 UAV

Geophex, Inc.
(www.geophex.com)



Applications of Drone Magnetics

#1 – Resource Exploration

>> minerals, groundwater, energy

#2 – Legacy O&G well location

#3 – UXO – detection, delineation, discrimination

#4 – Infrastructure - characterization and assessment

#5 – Archeaology - characterization and assessment

#6 – Geohazards – e.g. voids

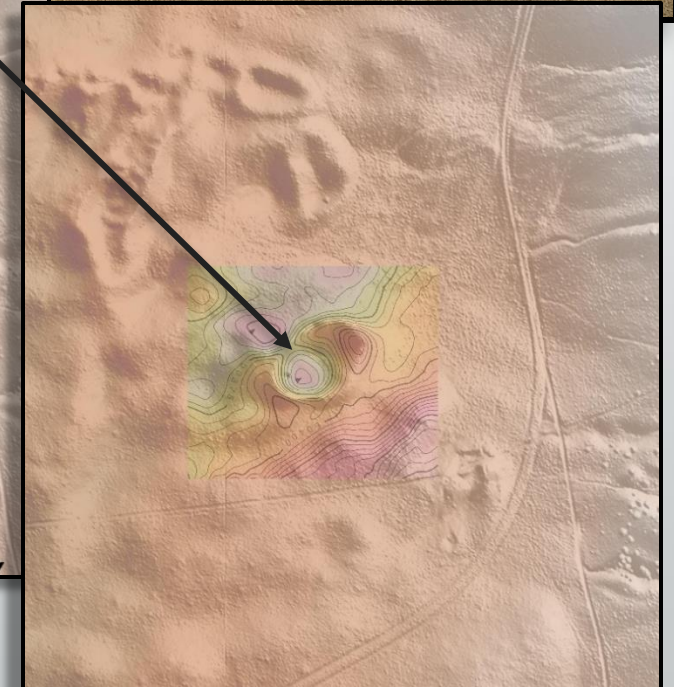
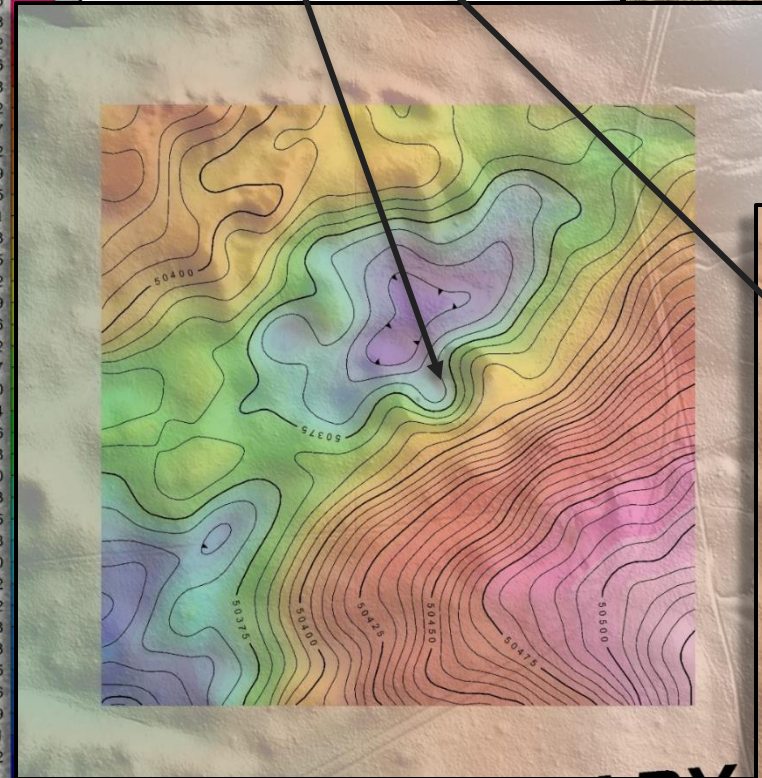
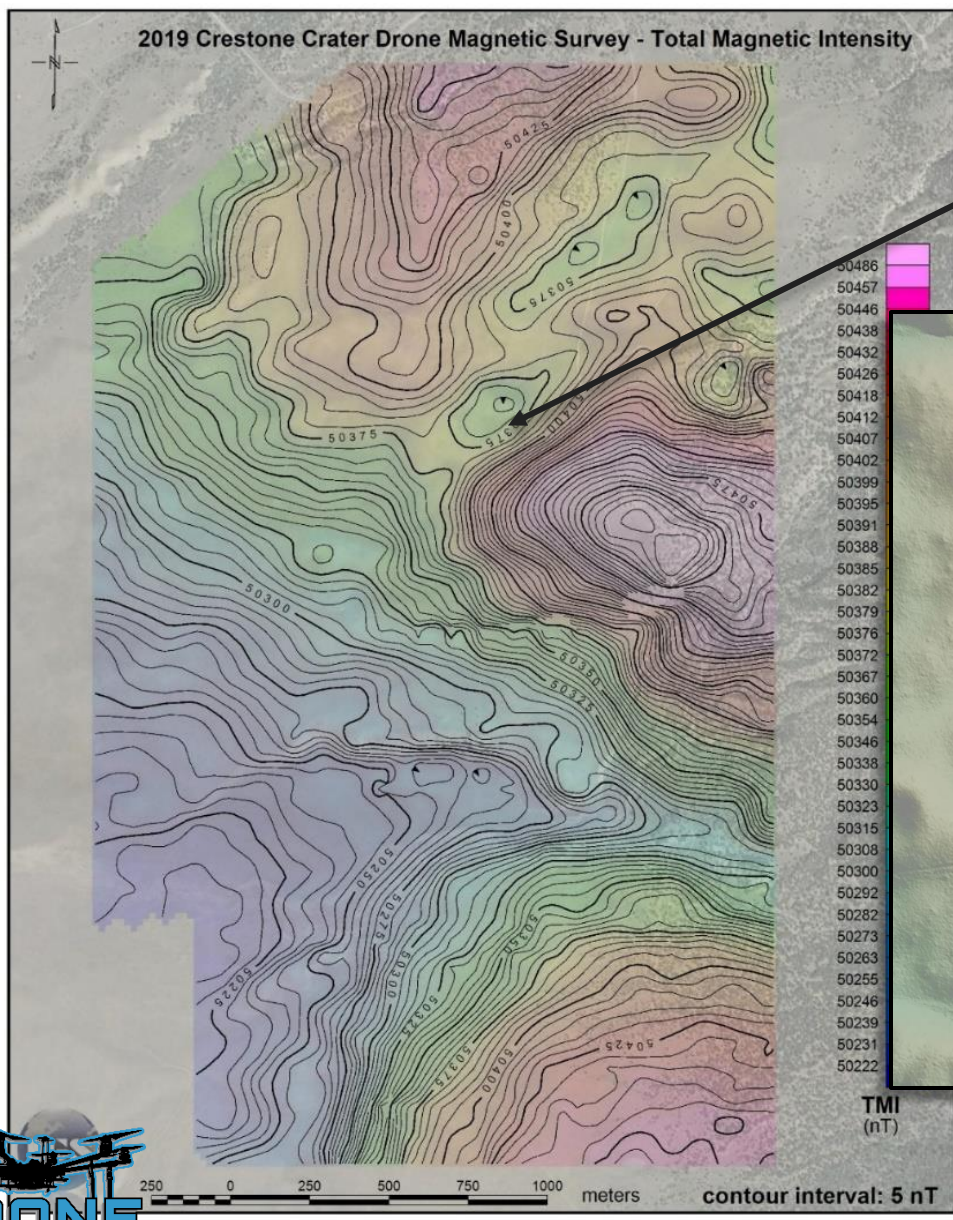
#7 – Environmental – geological mapping

#8 – Geotechnical - geologic mapping



UAV Magnetic Surveys are Scalable

Crestone Crater



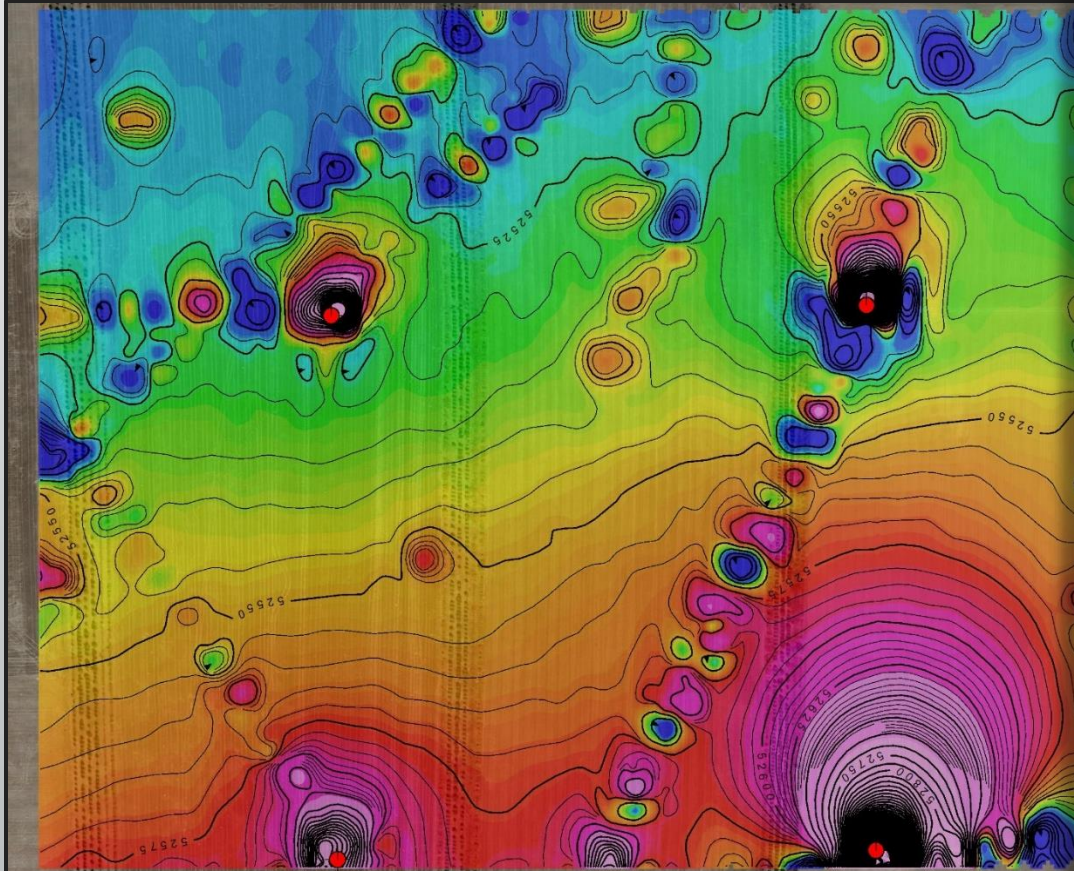
Total Magnetic Intensity

line spacing: 10 m

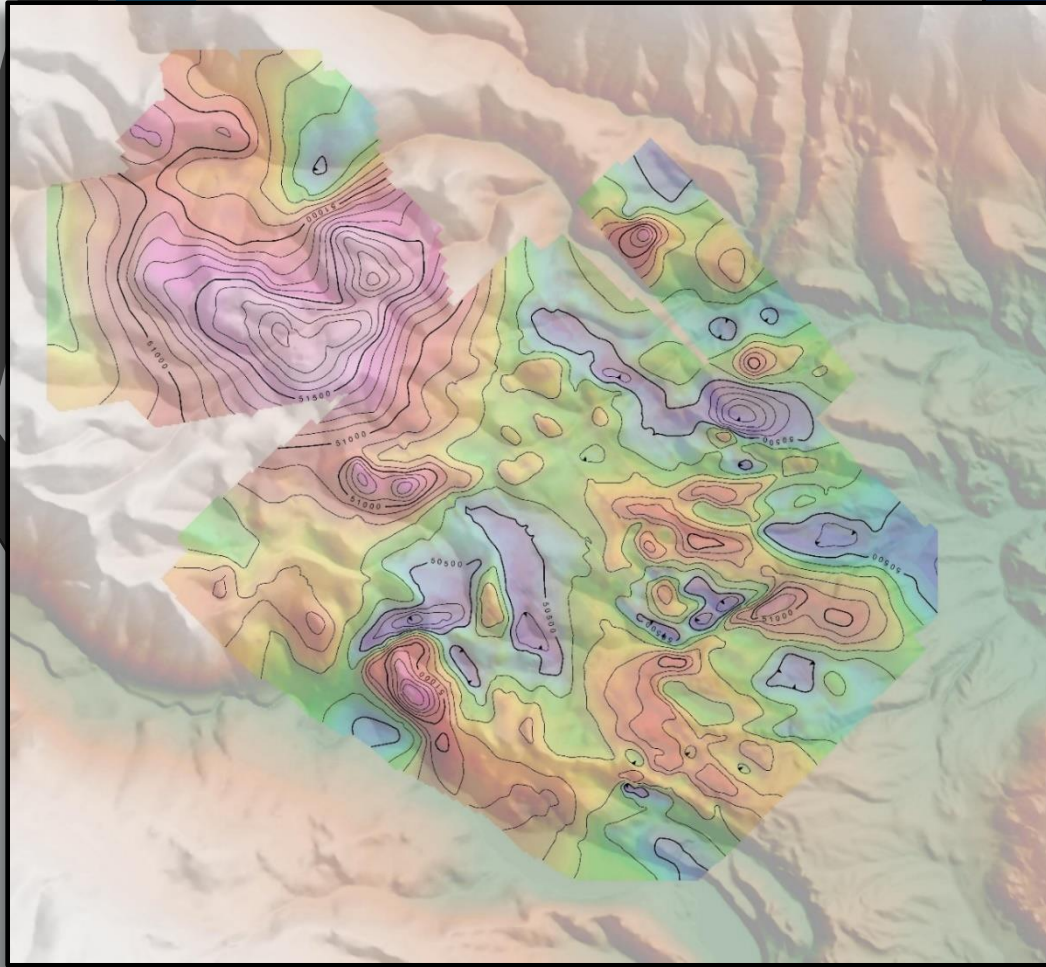
line spacing: 100 m



UAV Magnetic Survey to locate O&G wells & pipelines



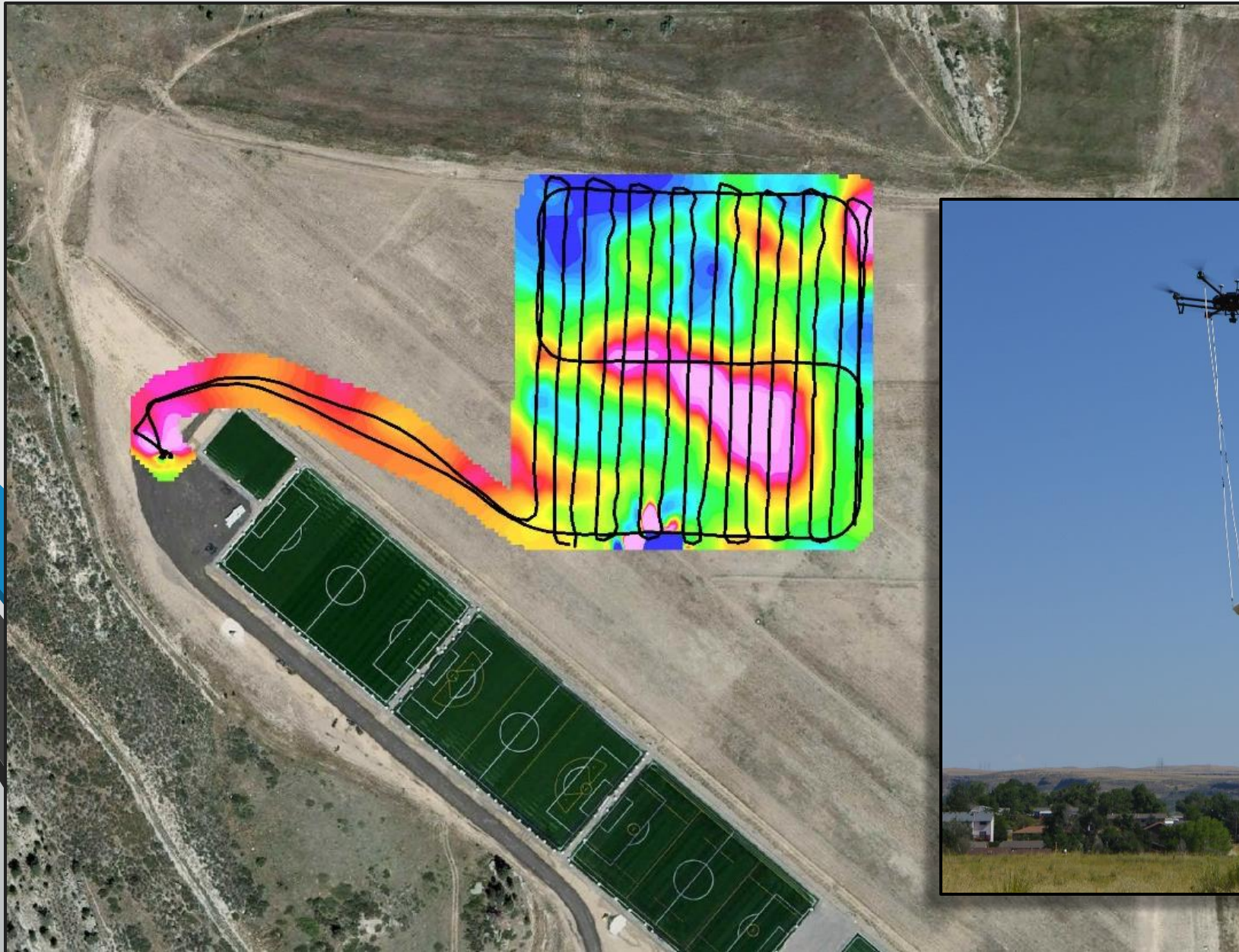
UAV Magnetic Survey for Resource Exploration



TMI Color Contours on DEM



UAV Magnetic Survey for Landfill Characterization



Applications of UAV Electromagnetics Induction (EMI)

#1 – Resource Exploration

>> minerals, groundwater, energy

#2 – UXO – detection, delineation, discrimination

#3 – Infrastructure - characterization and assessment

#4 – Environmental – contaminant mapping

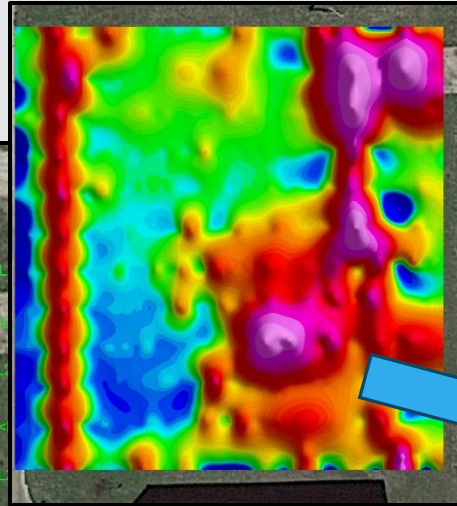
#5 – Agriculture – moisture & nutrient content

#6 – Geohazards – e.g. voids

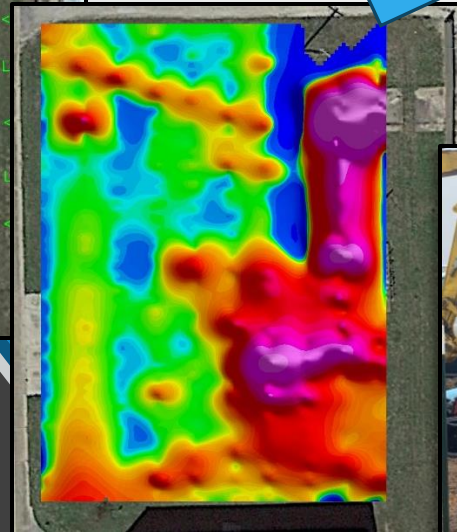
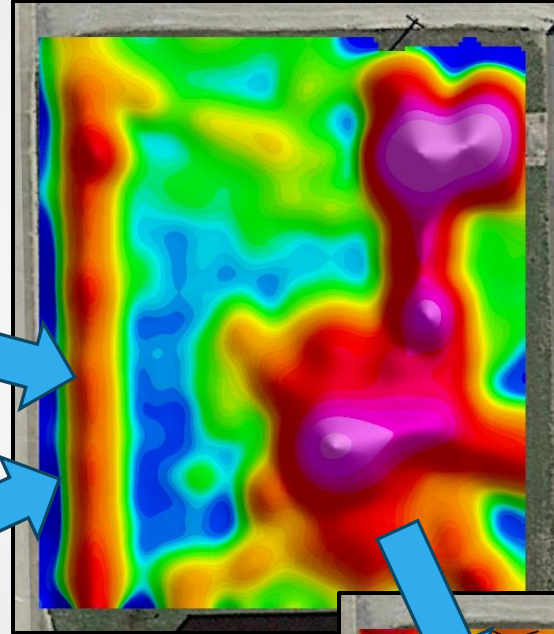
#7 – Archaeology - characterization and assessment



EM61Lite Survey for Pipeline Mapping



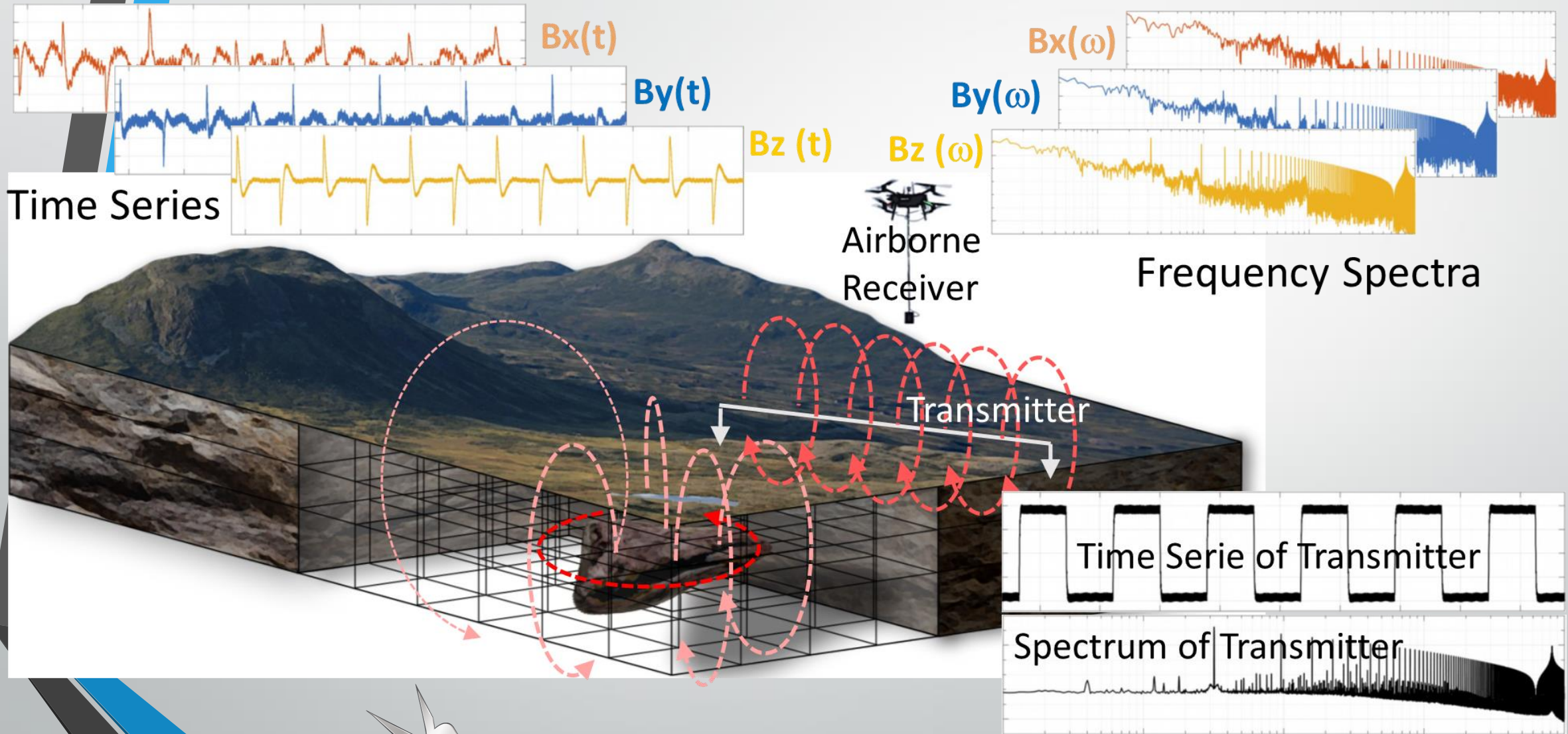
East-West



North-South



Semi-Airborne EM



Mobile Geophysical Technologies
mgt-geo.com

Drone SAM

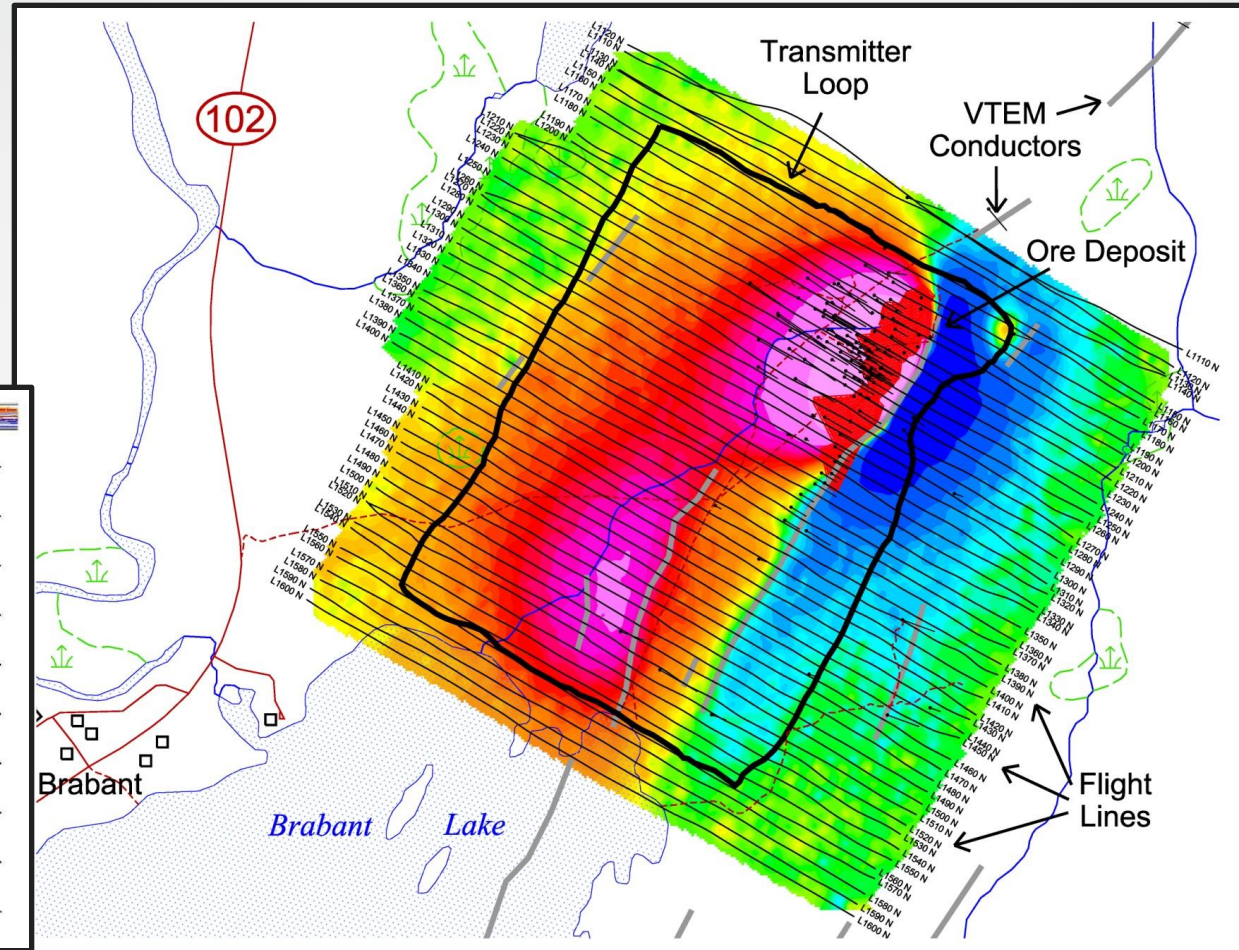
Sub Audio Frequency Magnetics

Gap Geophysics TM-7
Receiver and Recorder
GPS Receiver

Geometrics G-822A
Cesium Magnetometer

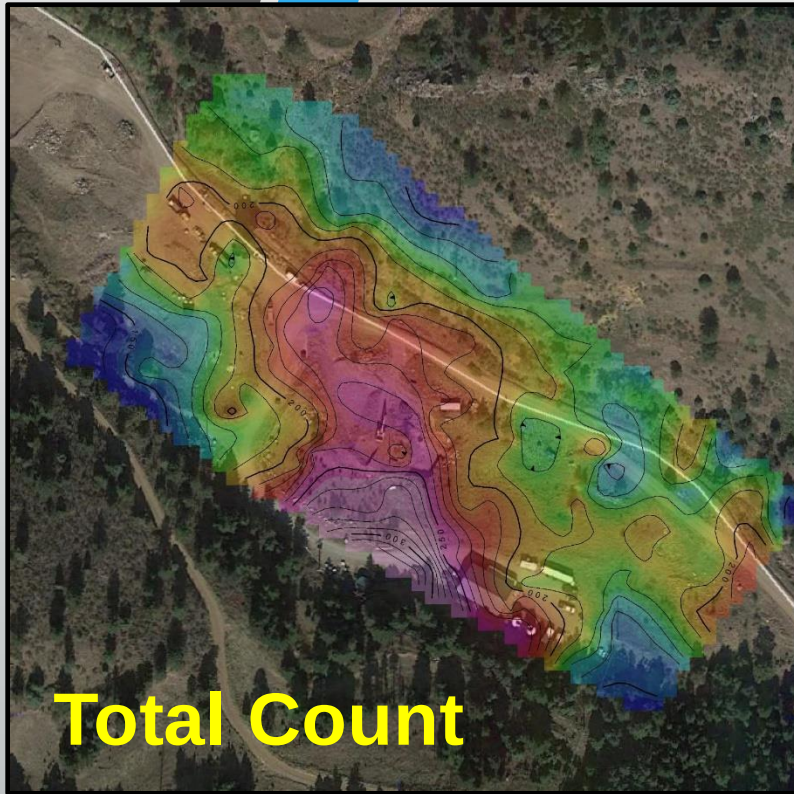
CROSS-SECTION VIEW
LOOKING SOUTHEAST

VPem3D Inversion and DDH

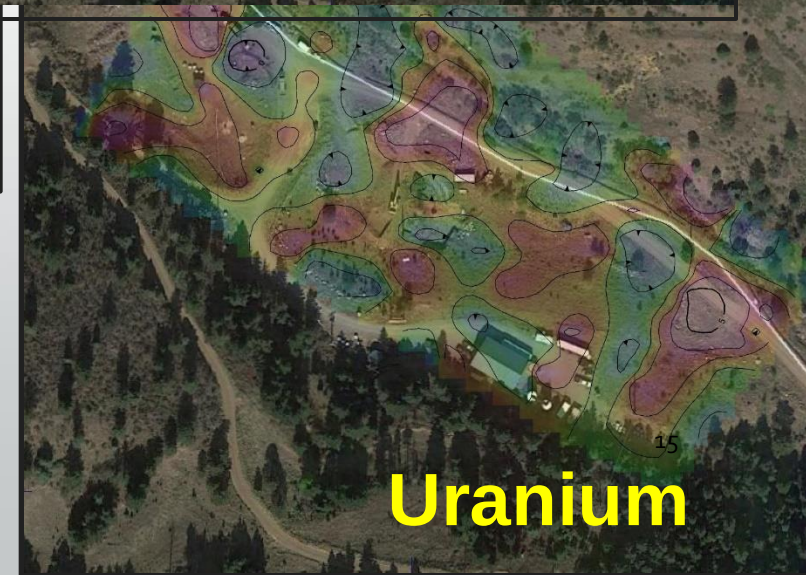
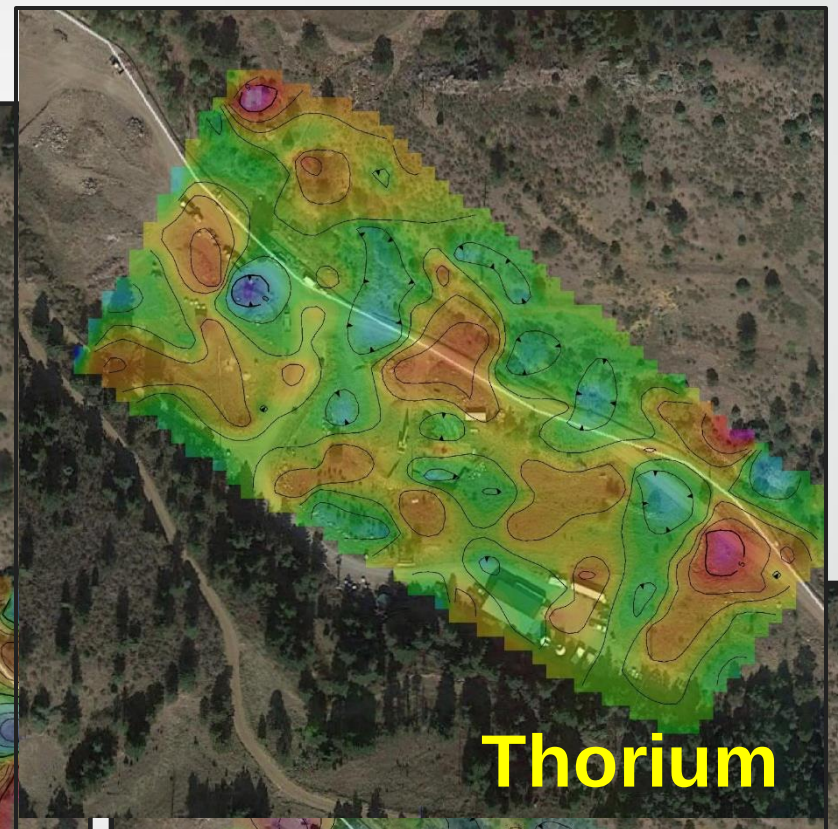
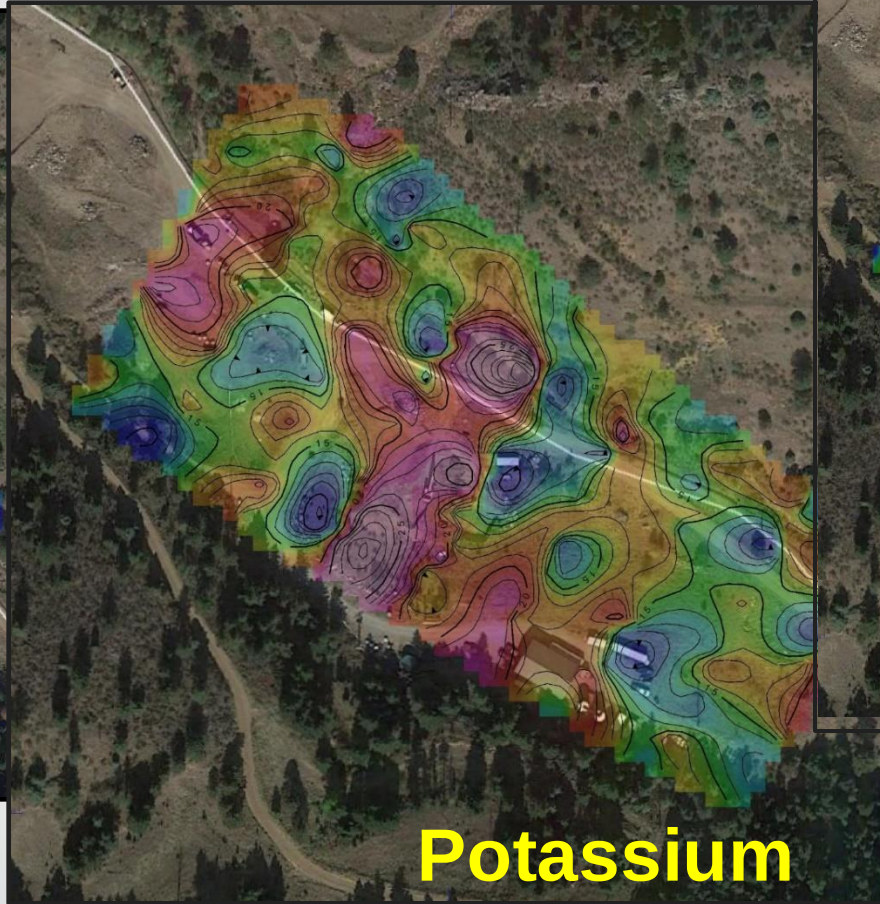


Historic drill holes: grey
Previous Murchison drilling: black
Recent Murchison drilling: red
Drill holes to test VPem3D inversion: bold red

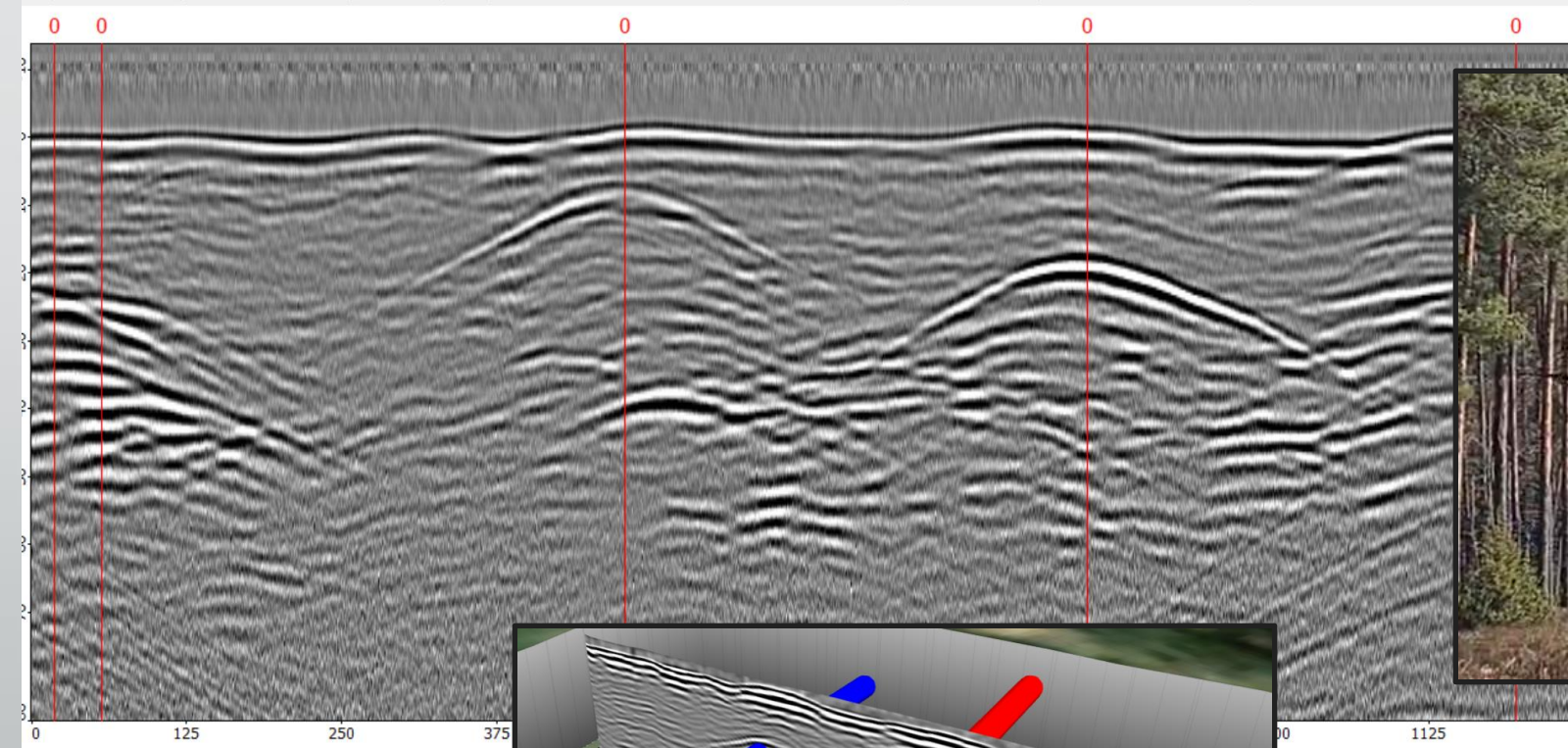
Gamma Ray Spectrometry



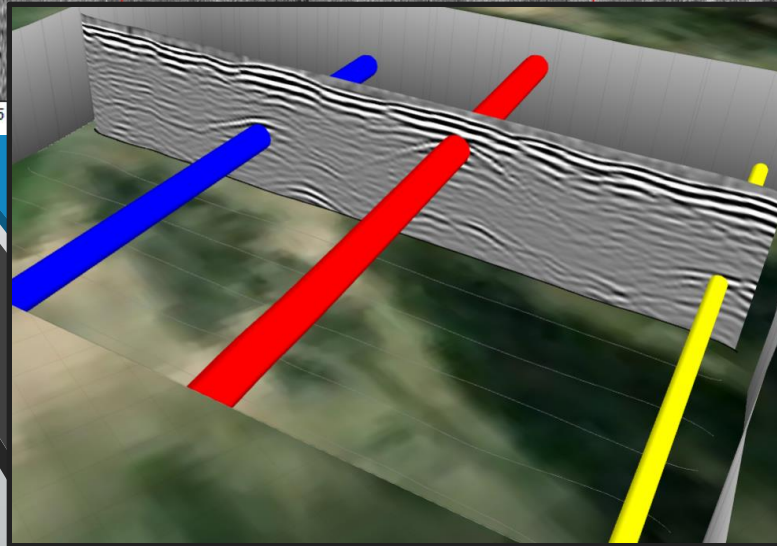
D230A



UAV GPR



Radar Systems ZOND Aero 500



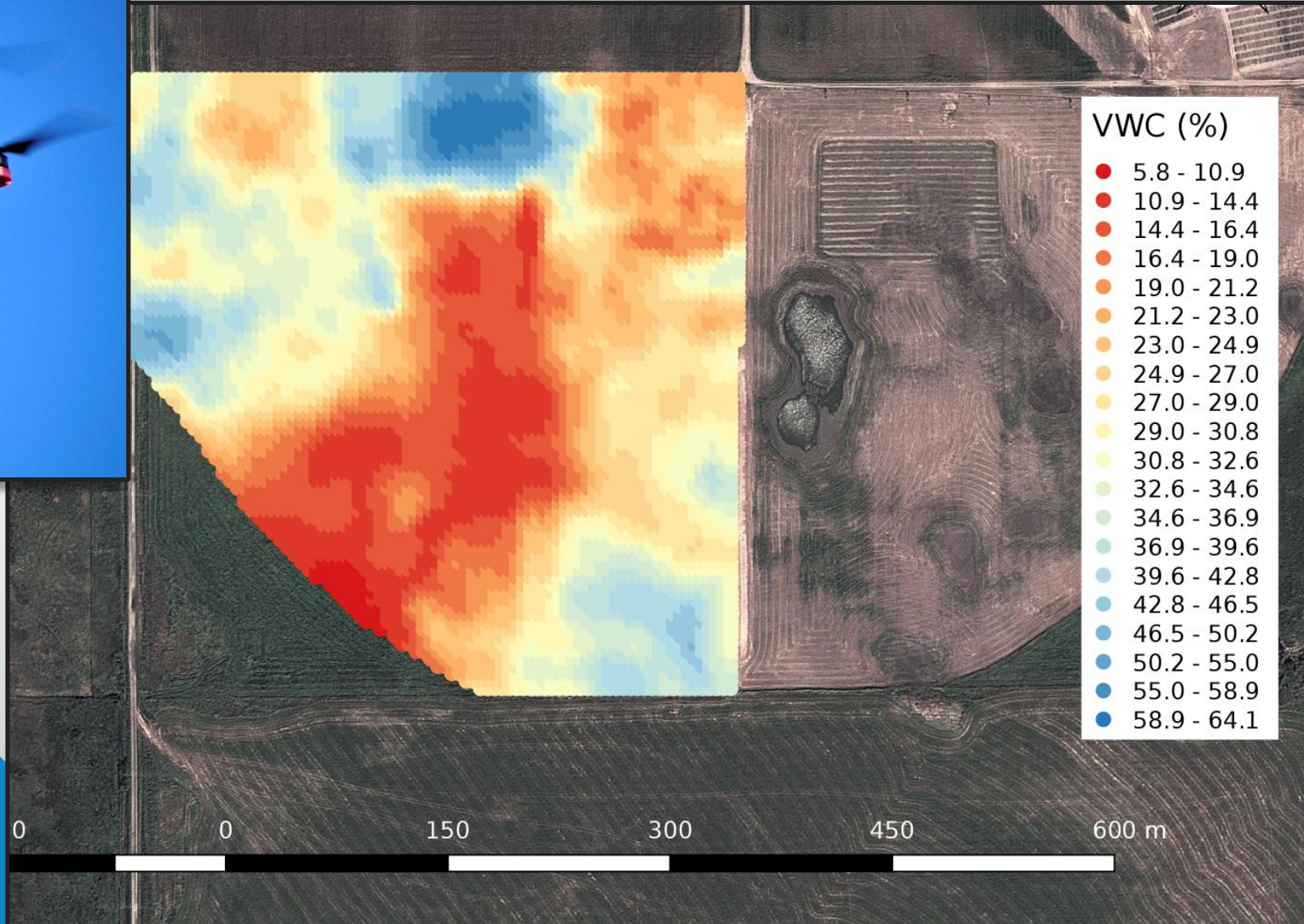
UgCS UAV Integrated Systems by SPH Engineering | UgCS Integrated Systems

<https://integrated.ugcs.com/>



Soil Moisture Mapping

UAV L-band radiometer

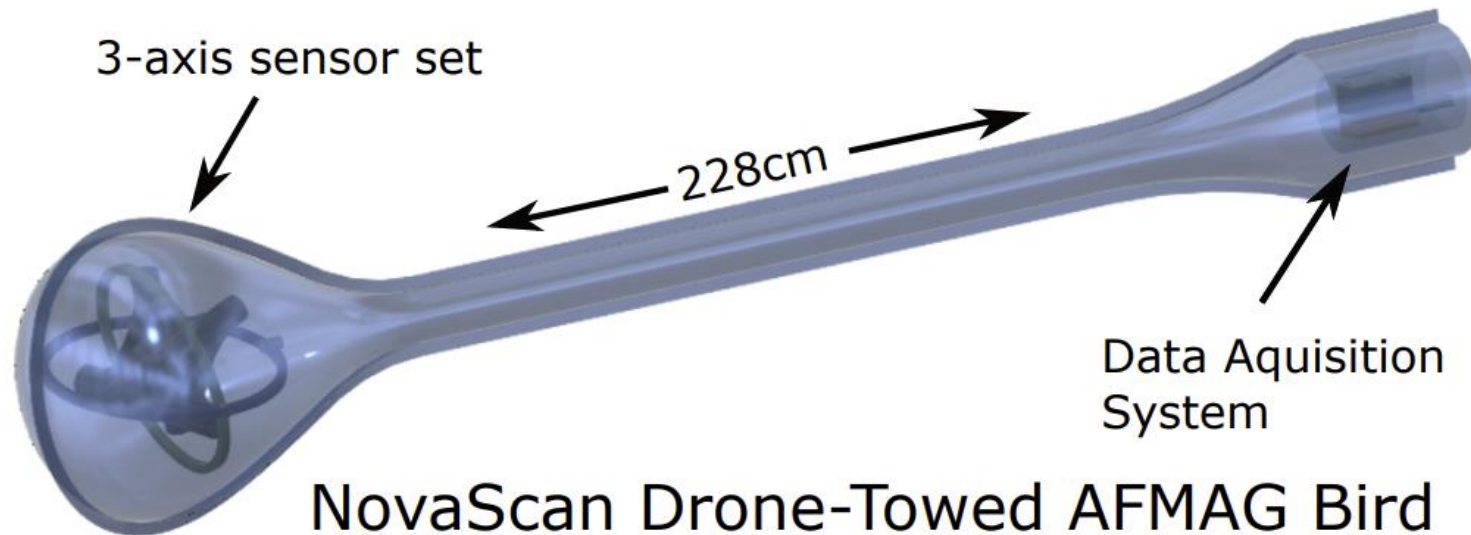


Skaha Labs

skahasensing.ca

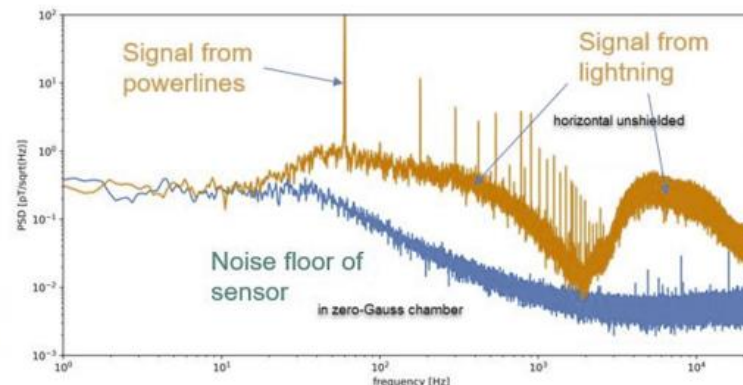
NovaScan UAV Full-Tensor AFMAG System

- Deep mapping of earth conductivity (to 1 km) using “sferic” energy from worldwide lightning strikes (AFMAG).
- Lithological mapping, mapping of conductive mineralization and alteration, groundwater contamination mapping.

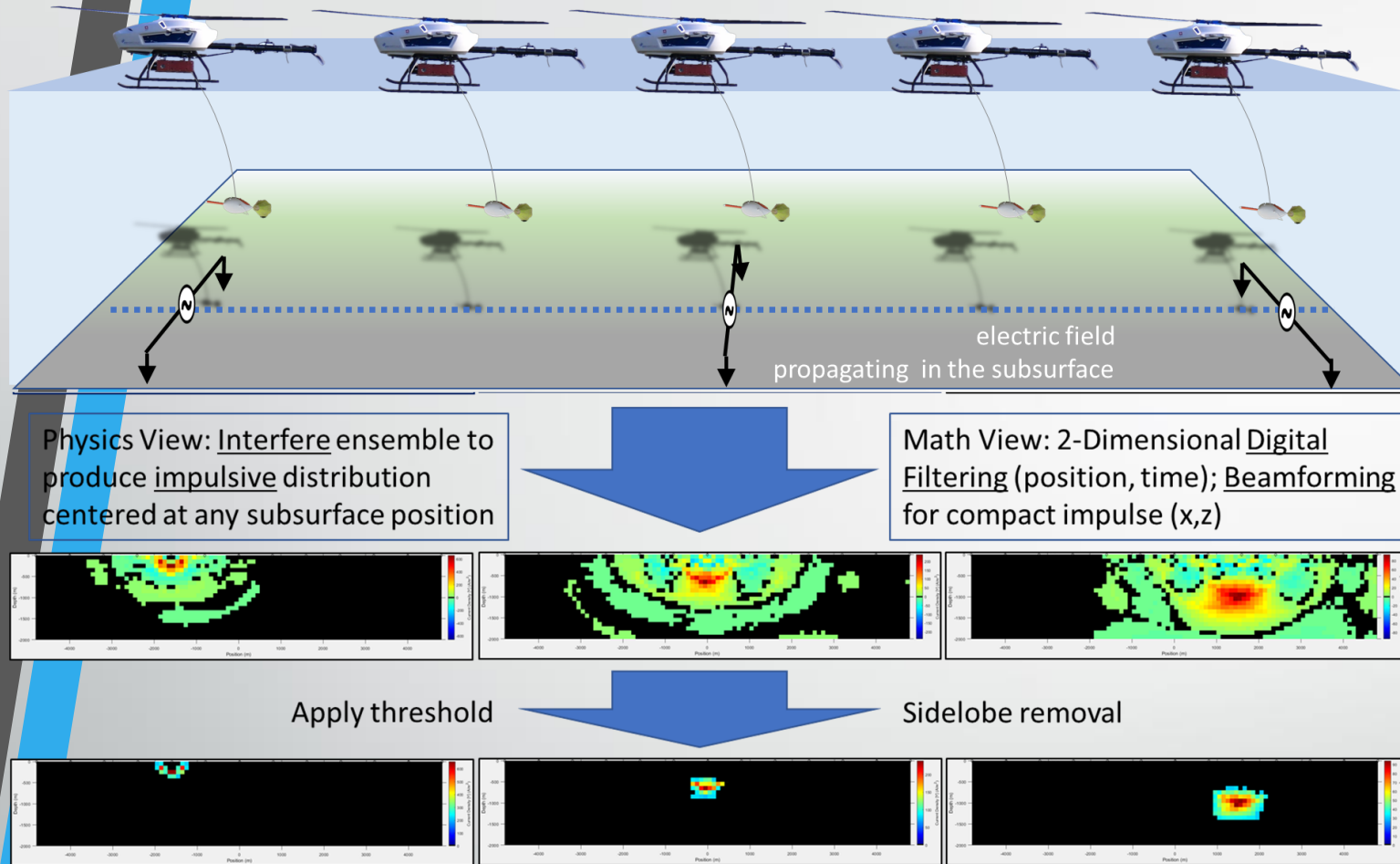


NovaScan Drone-Towed AFMAG Bird

Weight: 4Kg
Bandwidth: 100Hz-25kHz
Noise Floor: 4fT/rt(Hz) @5kHz
Noise Floor: 80fT/rt(Hz) @100Hz
Data Rate: 50,000 x 3 ch
Orientation: Low-drift gyro
Post processing: Scalar, Full Tensor



ITEM: Resolution Enhancement and Imaging



DITEM: Drone-enabled Interferographic Transient ElectroMagnetics

The weights calculated to produce reference model electric field spatial impulses in the subsurface are also applied to acquired and reference model magnetic field profiles. The magnetic field profiles (next slide) then also display a main lobe and additional sidelobes.

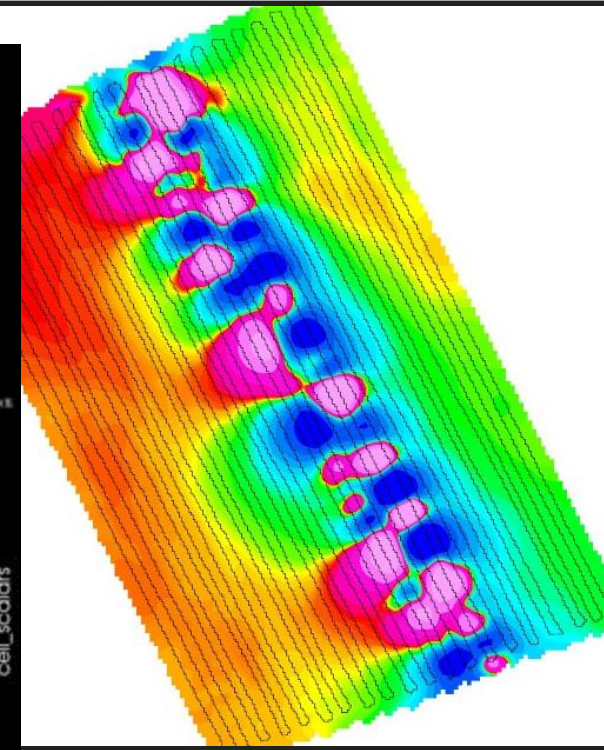
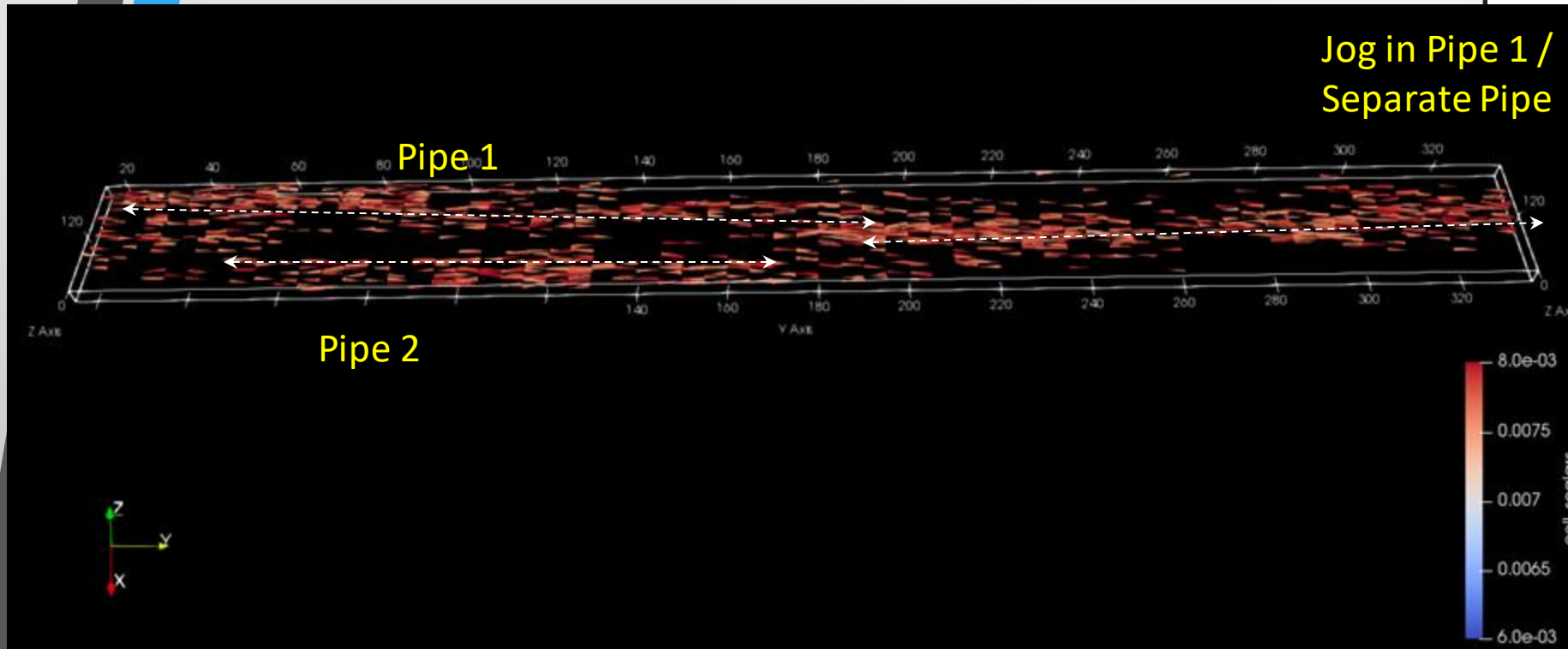
Enhancement of Resolution through Synthetic Concentration of Electric Field at Every Position in the Subsurface. $\sim 4X$ contraction of distribution achieved in this example (1/2 amplitudes).

Electromagnetic Geophysical Imaging Solutions, LLC

email: bryanlkd@gmail.com tel: 303-807-8078

Bryan James, PhD

Machine Learning (ML) & Artificial Intelligence (AI)



UAV Magnetic Data

The top of pipes seem to be buried < 50 cm below ground in most places reaching upto 1 - 1.5 m in some places.

Inversion Results



EmPact.AI

empact-ai.com



SUMMIT ON DRONE GEOPHYSICS

23–26 OCTOBER 2023 • VIRTUAL



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Summit on Drone Geophysics - Day #1

October 23, 2023

Theme: GPR & UXO

GPR

Keynote Speaker **Software Defined GPR** - Matha Moghaddam – USC

Application of Drone GPR for Measure Snowpack Depth – Bastien Dupuy - SINTEF

3D & 4D Drone GPR over Glaciers - Bastien Rouls – Univ of Luzanne

Drone GPR for Ice Thickness - Yunlon Lian – Gaungshou Univ.

UAV GPR to Identify Hot Spots in Peat Soils - Xavier Comas – Florida Atlantic Univ.

UXO

Keynote Speaker **Semi-Airborne TEM** - Esben Auken – TEMcompany .

GEON 61: a UAV EM metal detector – Steve Millaway – Arrotech

UAV Scalar Magnetics for UXO – Conrad Wright – Alchemy Analytics

UAV Fluxgate Magnetometer Array – Sumana Basu – Brimstone Site

AI and ML for Magnetic Data – Souvick Muharjee – Empact AI



Summit on Drone Geophysics - Day #1

October 23, 2023
Theme: Magnetism

Keynote Speaker

The Journey to a Modern Drone Magnetometer - Mike Willson – GEM Systems

An Innovative Drone Magnetometer – Alexey Dobrovosky – SPH Engineering

Vertical Gradient UAV Magnetometer - Fillipo Accomando – Naples

UAV Magnetic, Hyperspectral & Lidar data - Andron Gangnon-Nanpra – Pioneer Resources

Processing UAV Magnetic Data - Farazneh Farahani-Seequent

Small UAV with a Magnetometer - Bruno Gavzzi - Enerex

Measuring Magnetic Noise of Drone Motors – Hamza Reci – Mobile geophysical

Fluxgate Gradient Magnetometer – Hiedi Meyers – Univ ff Maryland

AI and ML for Magnetic Data – Souvick Muharjee – Empact AI



Summit on Drone Geophysics - Day #3 October 25, 2023 Theme: Electromagnetics

Electromagnetics

Keynote Speaker **The Modes of EM Investigations** - Dennis Woods – Woods Geophysical Consulting

SAEM – 2D& 3D Joint Inversion– Raphel Rocklitz – Libniz Institute

Drone TEM - Seogi Kang – Stanford Univ

Drone Gamma Ray Spectrometer - Ronald Kooman – Medusa Radiometrics

Fixed Wing Drone SAEM - Basel Aleid – Mobile Geophysical Technologies

Optimized UAV Gamma Ray Collection - Carleen van Hengel – Meduas Radiometrics



Summit on Drone Geophysics - Day #4 October 26, 2023

Theme: Multi-platform & Multisensor

Keynote Speaker

The Legalities for Drone Geophysical Mapping - Ryan North – ICS Geosciences

UAV Magnetic and Thermal Imaging of Geothermal System – Grant Rea-Downing - USGS

SP & UAV GPR on Earthen Dams - Farag Meafy – Oklahoma State

A Vision for Future Drone Technology - Stephen Van Der Veeke – Medusa Radiometrics

Perimeter 8 a Gas Electric UAV – Troy Mestler – Skyfront

A Unique UAV Seismic System – Pavel Colikov – Saudi Aramco

Neural Network Processing of Drone EM Data – Evan Shapiro, PNNL



Call For Abstracts

Special Session

Drone Geophysics and Remote Sensing

SAGEEP 2024

March 24-28, 2024

Tucson, Arizona

Tel: 303-462-1466

Email: ron@dronegeosci.com



Thank you for your attention.

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