Lunch & Learn Presented by DiGioia Gray & Associates

Supplemental Geotechnical & Technology Information Exchange

September 2020

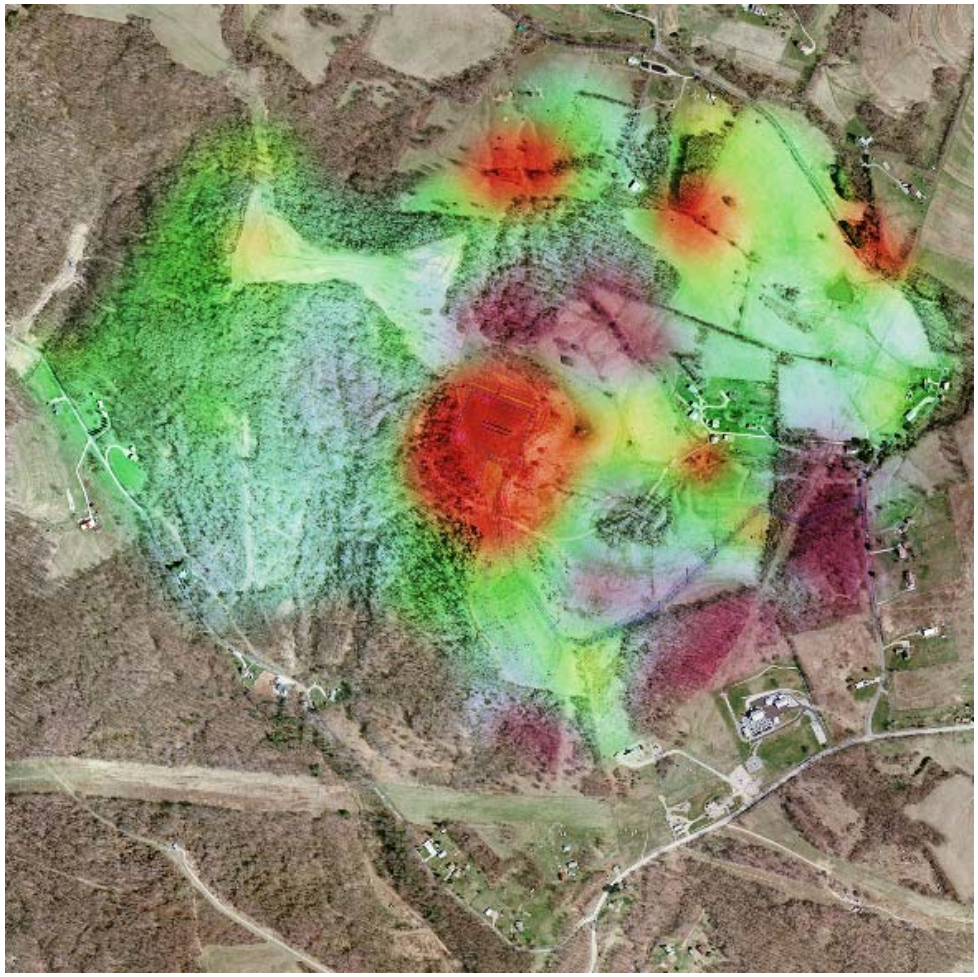
Presented To Shale Insight Conference

Engineering Advances

Oil & Gas Business Sector

Agenda

- Introductions & Safety Moment
- About DiGioia Gray
- Technical Services
  - *Geotechnical Practice*
  - *Innovation & Technology Practice*
  - *Specialty Engineering Services*
  - *WELLSCOUT^{SM}*
  - *Research & Development*



UAV Aerial Locating of Legacy Oil & Gas Wells

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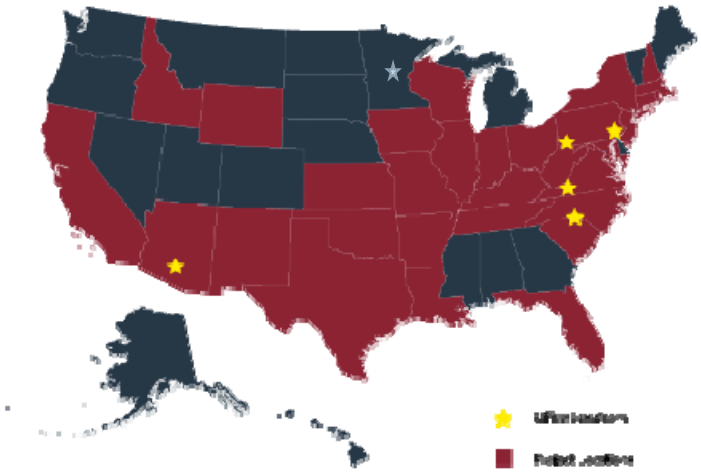
About Us

Founders: Tony DiGioia Jr. and Dick Gray

- Pittsburgh born in 2004
- Founders previously founded GAI Consultants
- Offices in Roanoke, Charlotte, Minneapolis, Pittsburgh (2), Philadelphia and Phoenix
  - ~ 105 professional staff members /~ 40 Licensed Professionals
- Oil & Gas and Power Delivery engineering services- Over 30 Energy Clients
- Project experience in over 30 States … worked on ~30 landslides in Appalachia in 2020
- ***Practice Areas:*** *Structural Engineering – Geotechnical & Civil Engineering -Technology & Innovation – Geosciences & Geosciences- Foundations- Applied Research & Training -Unmanned Aerial Vehicles (UAVs)*

  - Power Delivery/ Electrical Engineering



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Safety Minute

Emergency Prep

Know Your Exits

Universitetet metro station, Stockholm

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Presenters

Erich Zorn, P.G., Ph.D.

Project Manager / Senior Geologist
Geosciences & Civil Engineering

Andrew Zorn, P.E.

Service Line Manager
Innovation & Technology

Geotechnical Practice

Full Service Geotechnical Support for:

- Compressor Station, POD, and Metering Station Pads and Access Roads
  - Subsurface Exploration & Laboratory Testing Programs
  - Geophysical Exploration Programs
  - Foundation Recommendations
  - Retaining Wall Design
  - Slope Stability
  - Cut Slope and Fill Embankment Design Recommendations
- Open Cut and Trenchless Pipeline Installation
  - Subsurface Exploration
  - Soils Data Reports and Hydrofracture Analyses
  - Landslides and Geohazards mitigation

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Innovation & Technology Practice

Improving Project Performance through Advanced Technology

January 2016, Innovation & Technology group formed

- Streamline workflow through technology
- Identify new technologies to better serve our clients

Technologies and Workflows

- Horizontal Directional Drilling (HDD) design
- UAV Based Rockfall Hazard Analysis
- Geohazard Risk Evaluation – Landslides & Karst
- UAV Topographic Mapping (landslides)
- WELLSCOUT^{SM} – Aeromagnetic Surveying Platform
- In Development: NDVI (Vegetation Survey)

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Specialty Engineering Services

- Horizontal Direction Drilling (HDD)
  - Geotechnical & Hydrofracture Analysis
- Rockfall Hazard Analysis
- Landslide Risk Evaluation
  - Field Assessments
  - GIS-based Assessments
  - UAV Mapping
- Landslide Remediation
  - Instrumented Monitoring
  - Engineered Designs
  - Construction Monitoring
- Karst Surveys & Inventory
- Designing and Constructing in Karst

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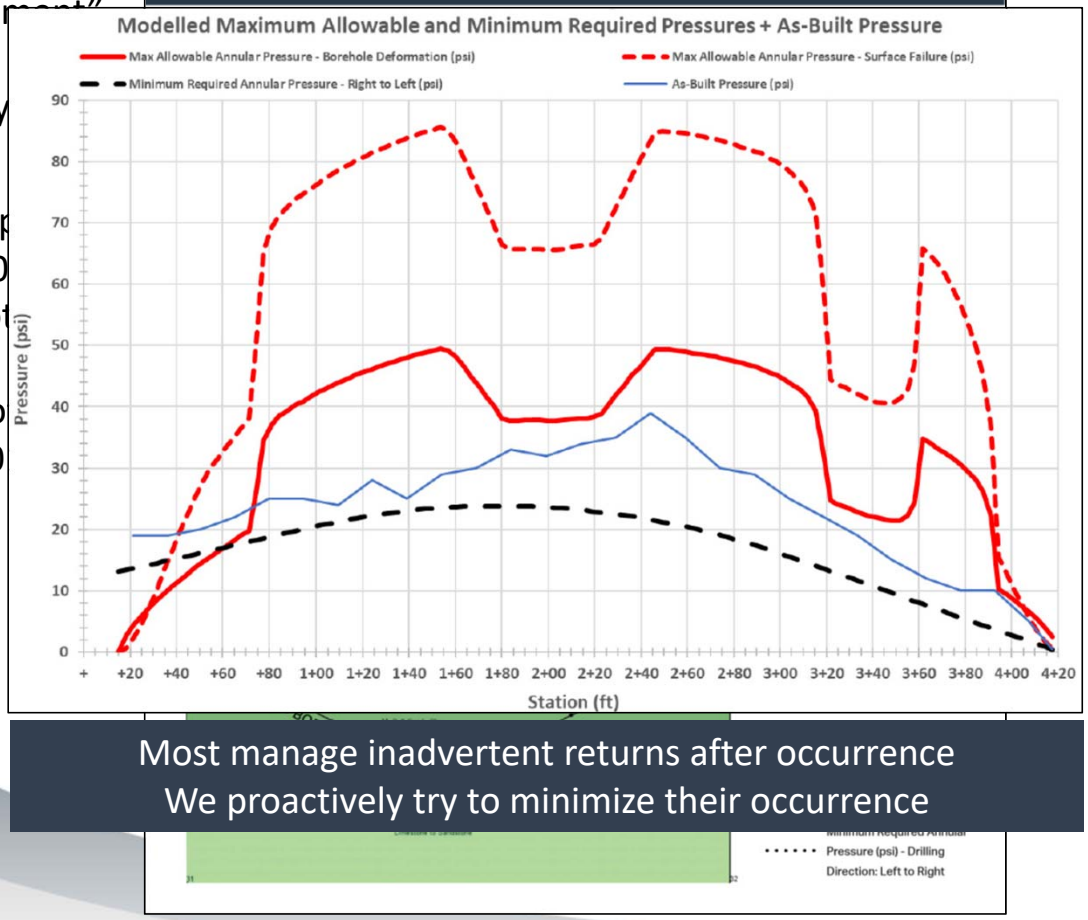
HORIZONTAL DIRECTIONAL DRILLING (HDD)

ME2 Pipeline – DEP issued 4 "Notices of Violation" and 1 "Consent Order and Agreement" with a fine of $87,600 for "inadvertent returns". (July

DEP issues Sunoco Pip LP with $12.6 M … 30 separate violation not and more than 100 inadvertent returns o drilling mud. (Feb. 20

HYDROFRACTURE AND PIPE STRESS ANALYSIS FOR HORIZONTAL DIRECTIONAL DRILLING



Most manage inadvertent returns after occurrence
We proactively try to minimize their occurrence

An inadvertent return is the unintended transfer of drilling mud to the surface.

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SUMMARY OF LANDSLIDE SERVICES

- Geological and geotechnical site reconnaissance and characterization
- Slope stability analyses (static, dynamic, rapid drawdown, staged construction)
- Soil and rock cut slope design
- Designing with geosynthetics (steepened slopes)
- Retaining / buttress structures
- Digital Terrain Models and photogrammetry of landslide sites from UAV
- Three-dimensional, georeferenced, digital outcrop mapping by UAV
- Rockfall hazard analysis
- Soil / rock slope stabilization
- Geotechnical instrumentation programs
- Geotechnical peer review services
- Geotechnical construction monitoring
- Geotechnical expert witness services

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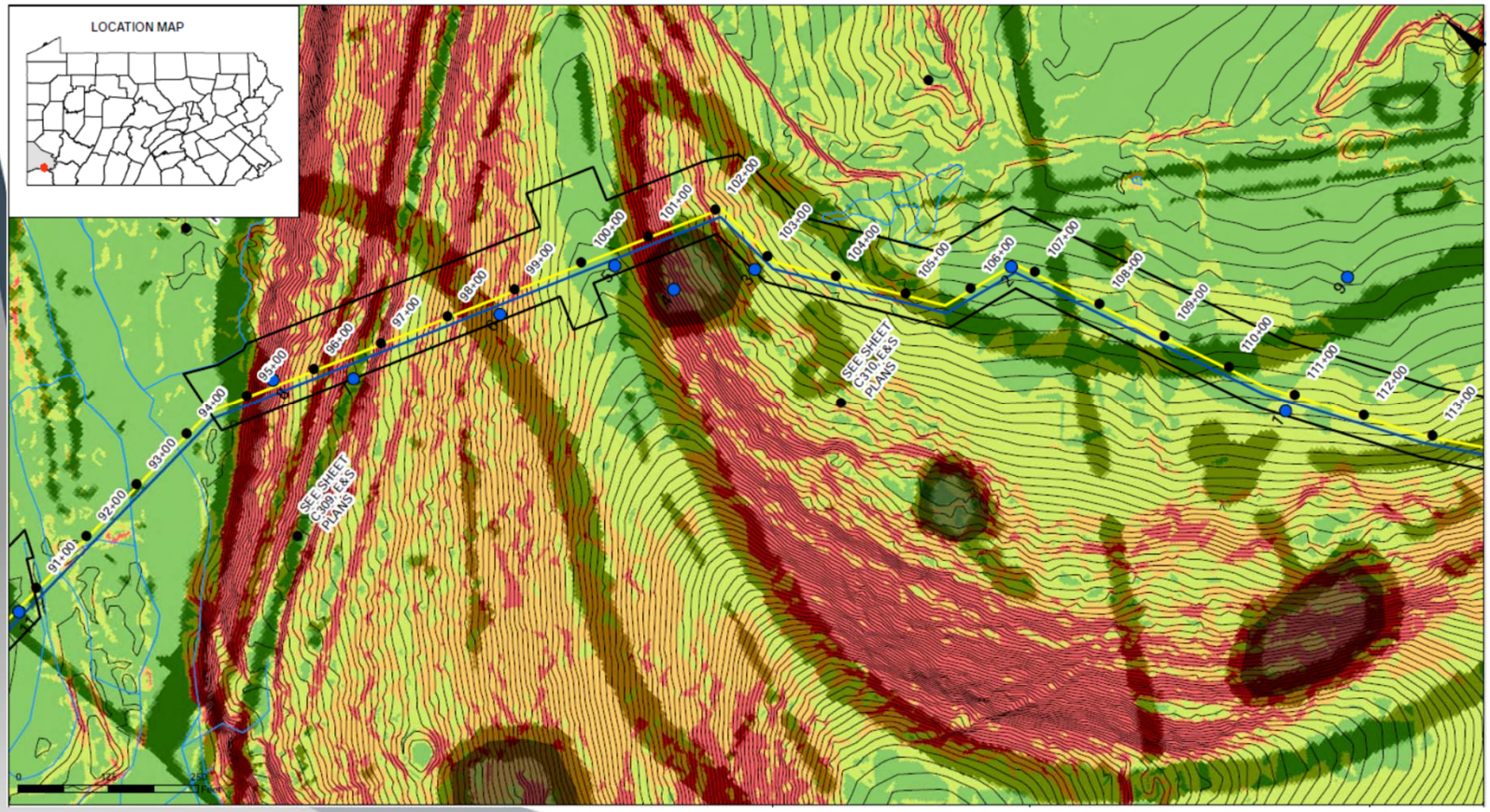
LANDSLIDE RISK EVALUATION



GIS Resources:

- Aerial Imagery
- Historical Mapped Landslides
- Soil Survey
- Topography
- Geology

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Management of Karst Impacted Projects

- Karst from an Engineer's Perspective
- General Site Characterization Approaches
- Engineering Over Karst locations (if selected)
  - Karst Principles
  - Case Studies
  - Treatment / Mitigation Options

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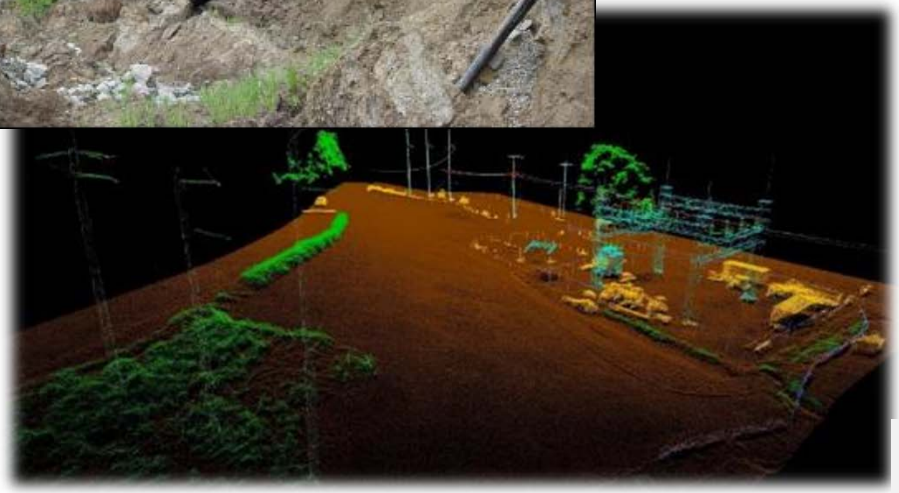
UAV Services

- Photogrammetry for Terrain and Structural Modeling
- Structural Inspection & As-Built Documentation
- Asset Inspection (T-lines, bridges, etc.)
- Landslides
- Rockfall Hazard Analysis

Volumetrics/Construction Monitoring

WELLSCOUT[SM] - Abandoned oil & gas wells



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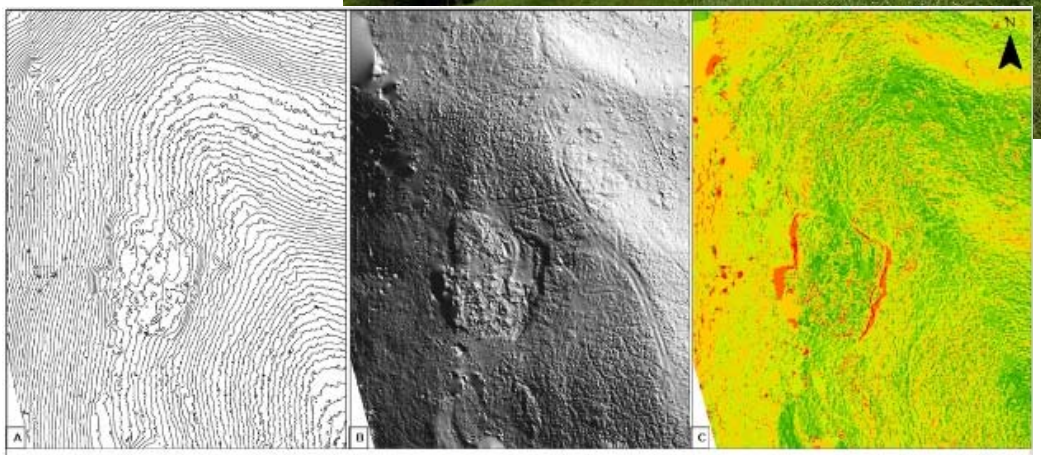
UAV MAPPING SERVICES

- Ground Surface via Photogrammetry
- Topographic Maps & Profiles
- Aerial Mapping



UAV BASED DIGITAL PHOTOGRAMMETRY DERIVED DATASETS FROM LEFT TO RIGHT. A) 2 FT CONTOURS, B) HILLSHADE DEM, C) SLOPE MAP. ALL MAPS WERE DERIVED FROM AN INITIAL RASTER DATA SET CREATED THROUGH A CLASSIFIED AND FILTERED DIGITAL PHOTOGRAMMETRY DEVELOPED 3D POINT CLOUD. ALL DATASETS DISPLAY THE EXTENTS AND CHARACTERISTIC OF A SHALLOW TRANSLATIONAL LANDSLIDE

DG AERIAL

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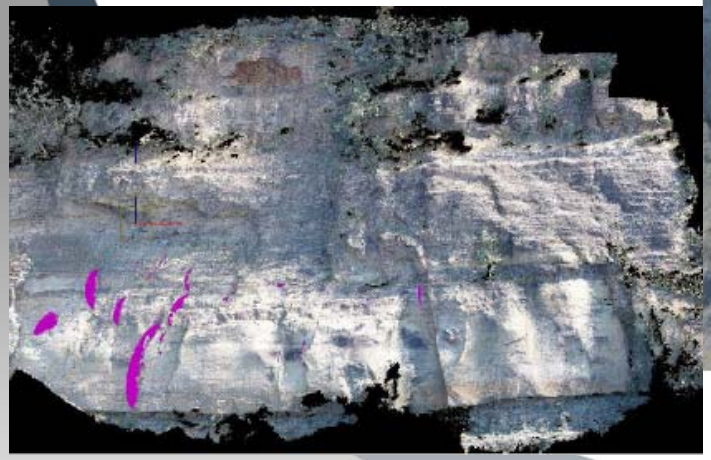
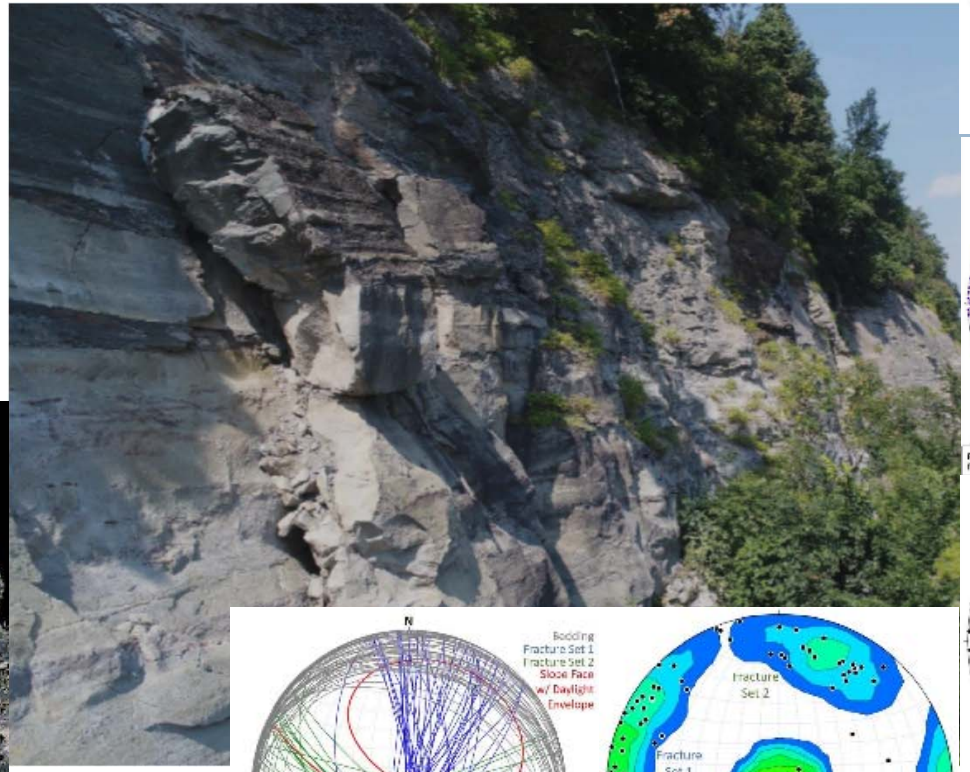
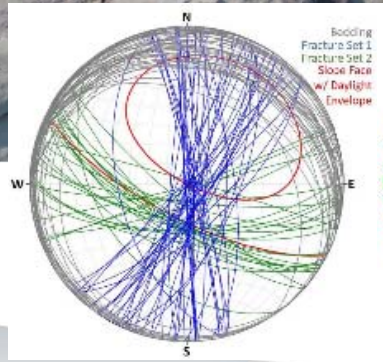
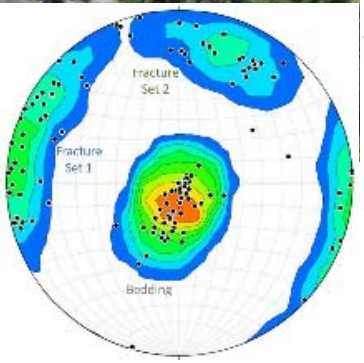
ROCKFALL HAZARD ANALYSIS FROM UAV PLATFORM

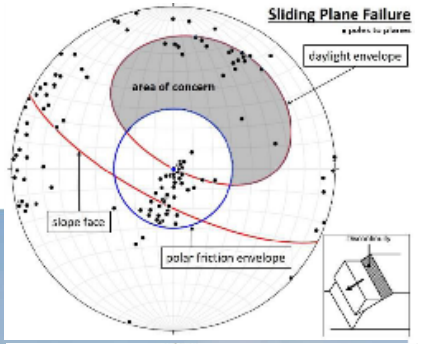
- Similar to Ground Surface
- More Complicated Flight Plans
- Determine Failure Planes
- Stereonets used for Rockfall Hazard Analysis

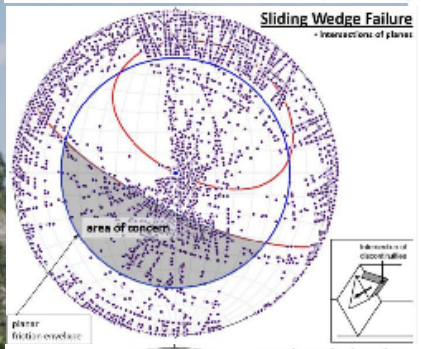


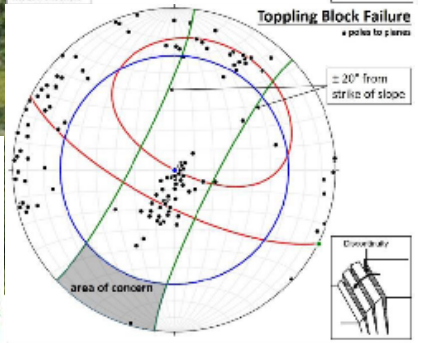












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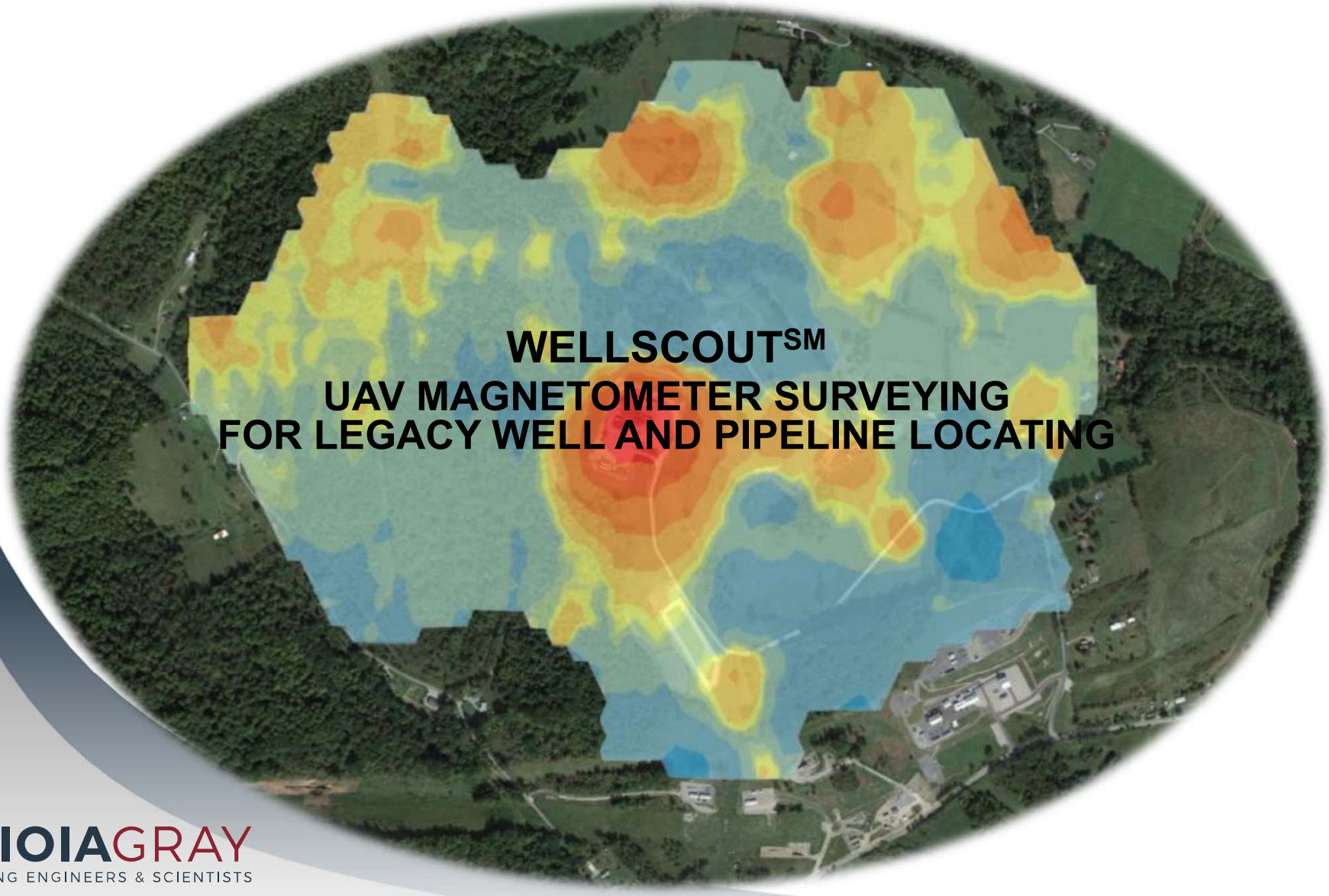

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What is WELLSCOUT^{SM}?

Demonstrated Project History

- In-house developed UAV atomic magnetometer payload
- Measures and maps the magnetic field of the earth
- Metallic objects perturb the magnetic field
  - Buried tanks
  - Well casings
  - Metallic pipelines
- Generates a magnetic “bump” map
- Consists of magnetometer payload and base station and ground-based fluxgate magnetometer for ground-truth

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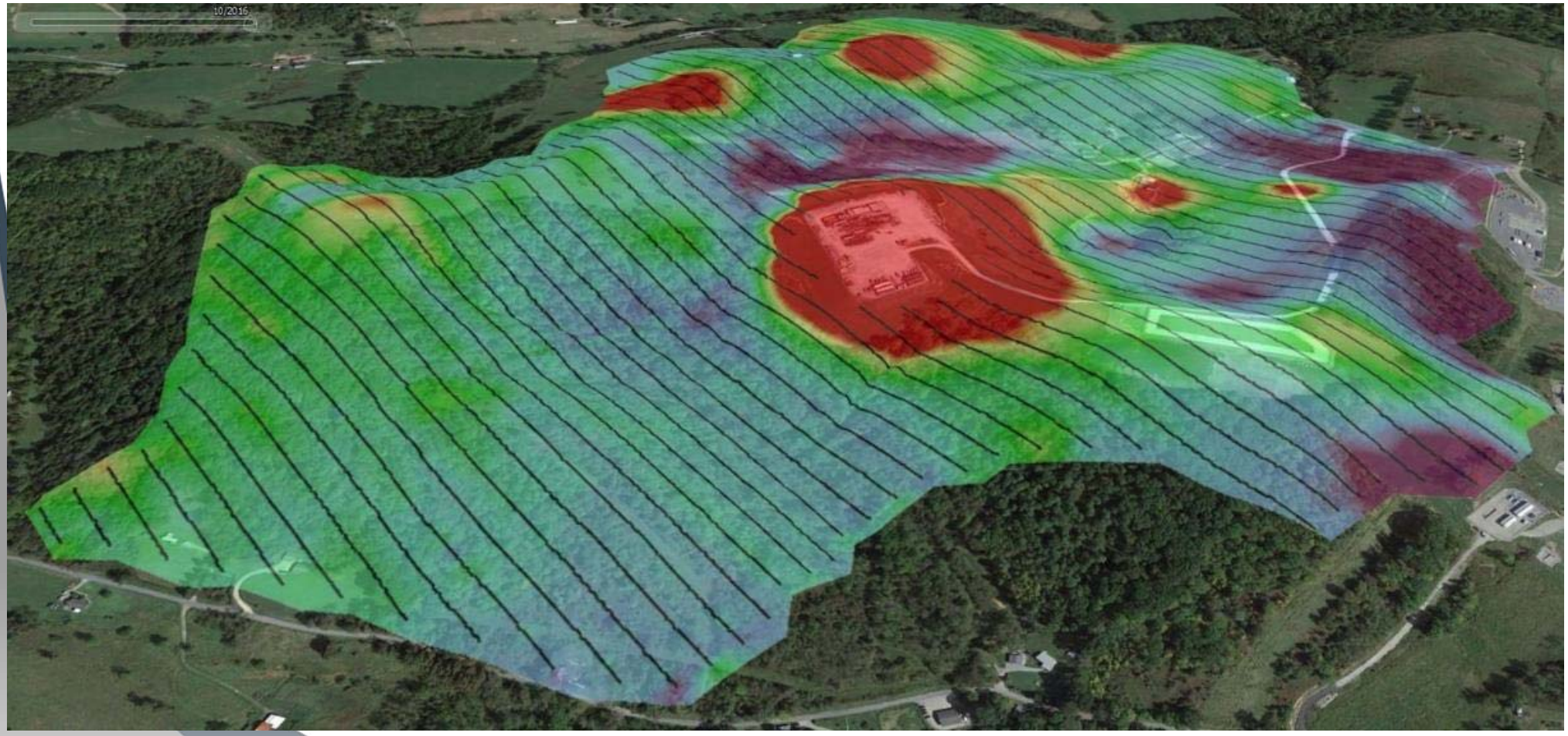
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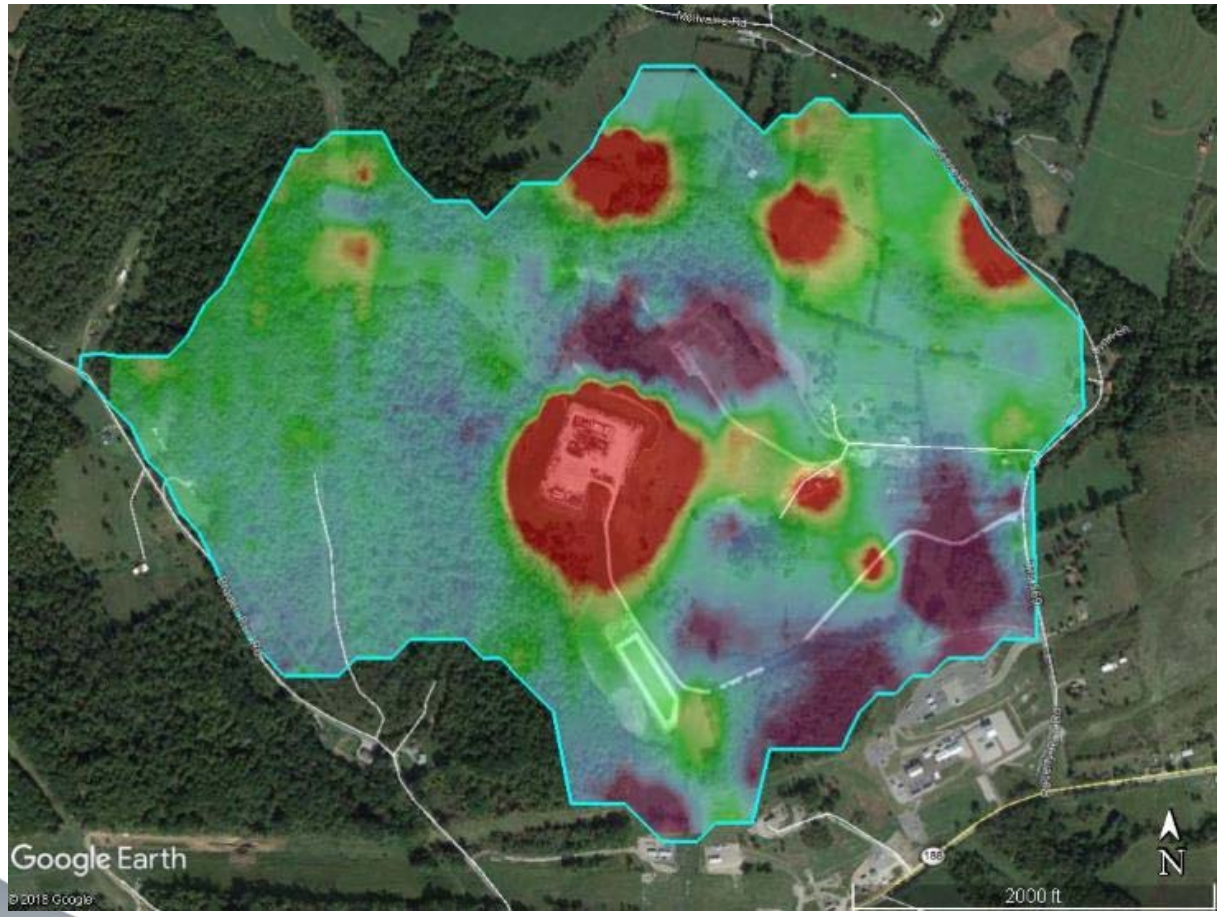
MAGNETIC ANOMALY MAPS



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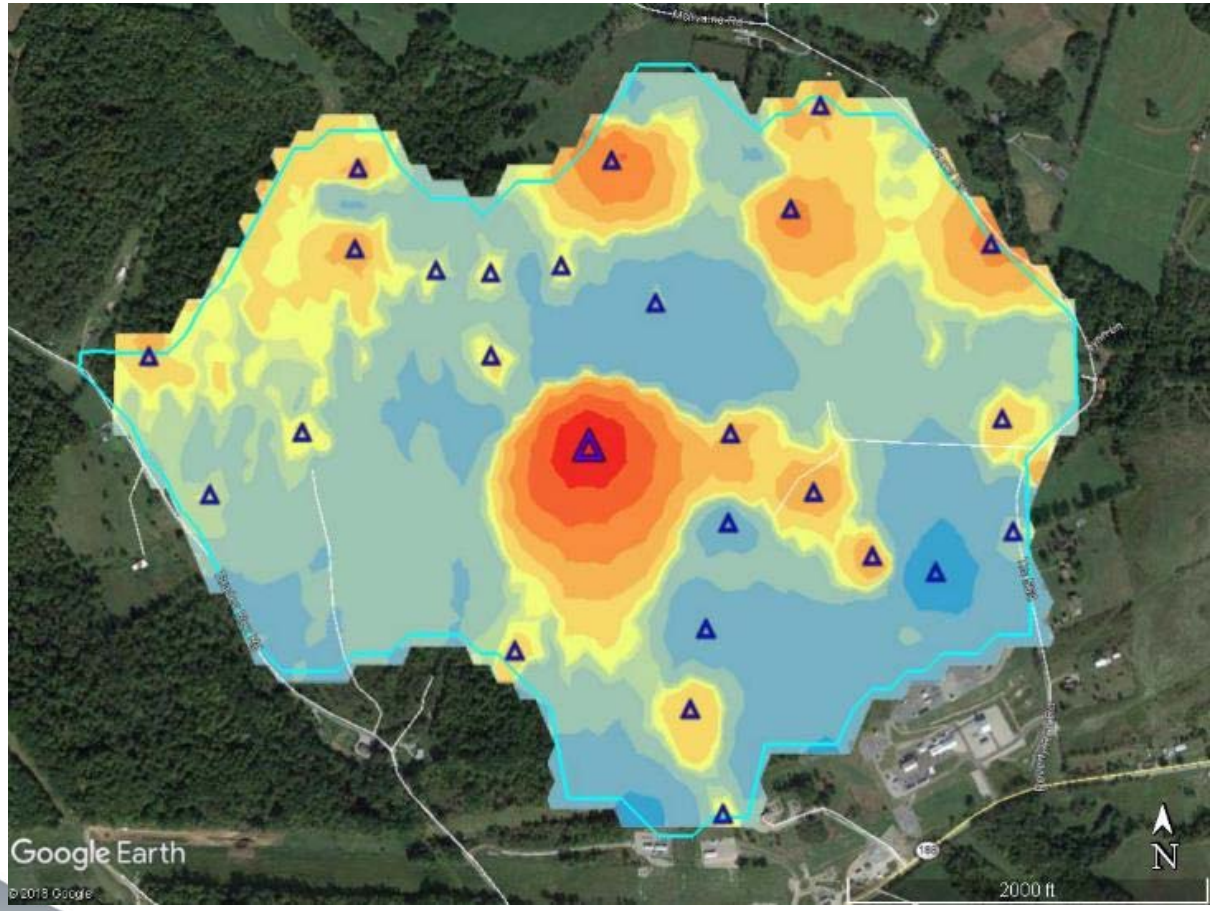
ANOMALY IDENTIFICATION



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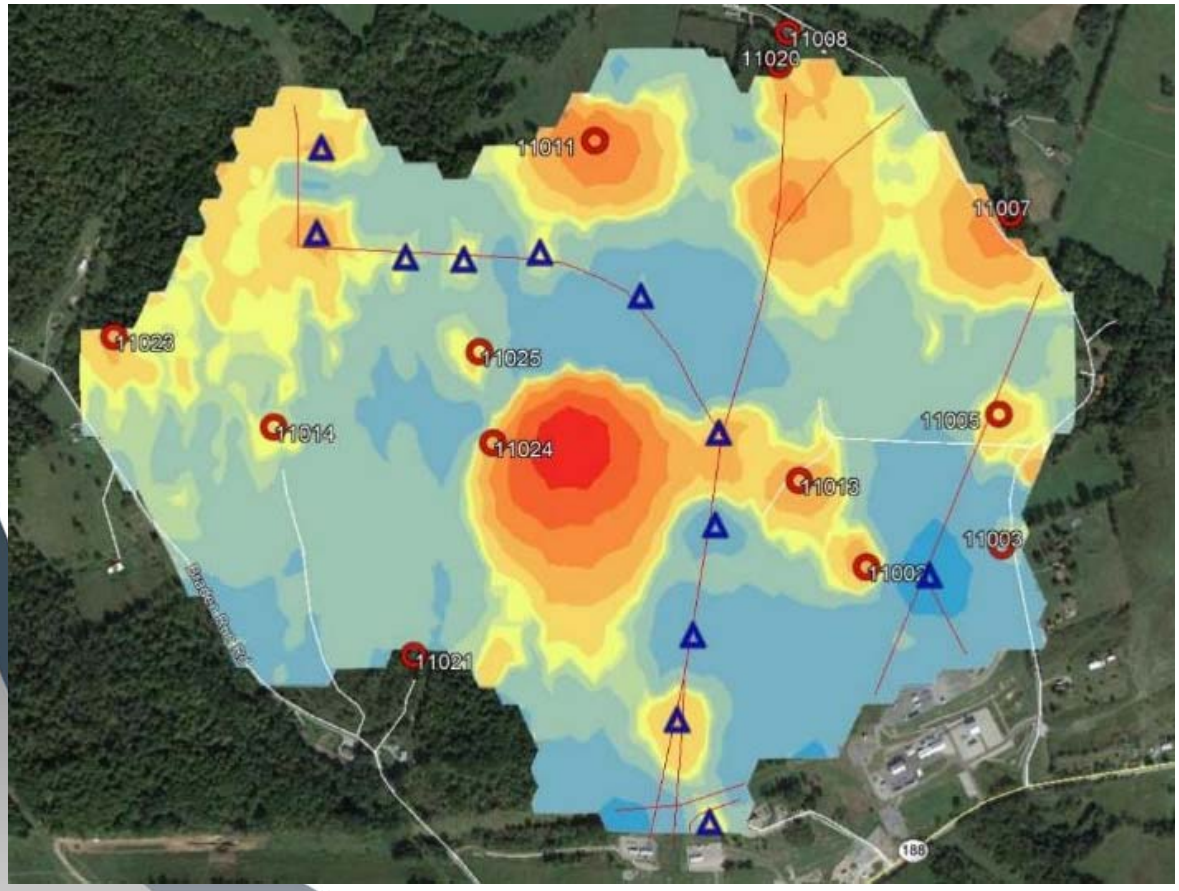
FINAL MAP AFTER GROUND-TRUTH



Positive Confirmation of:

- Five (5) producing gas wells
- Three (3) plugged gas wells
- Two (2) abandoned oil wells with pump jacks
- Three (3) abandoned wells of unknown type

LOCATED 4 WELLS WITH NO SURFACE EXPRESSION (plugged or casing pulled)

Average horizontal accuracy = +/- 44 ft (function of line spacing)

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Research and Development

- Methods for Locating Conductive Flowlines using UAV Magnetics and Electromagnetics (DGA/NETL/Range)
- Normalized Difference Vegetation Index (NDVI)

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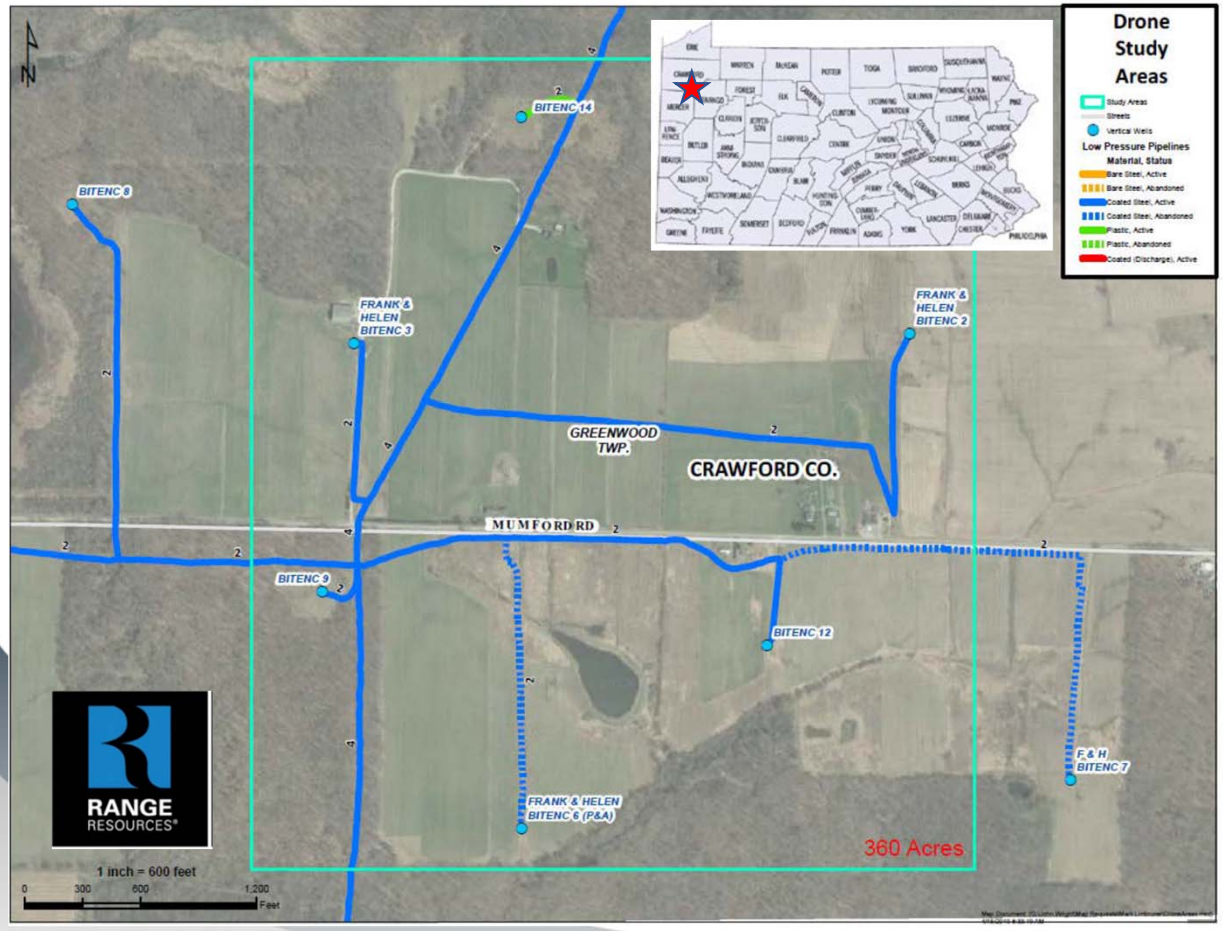
R&D – Methods for Locating Conductive Flowlines

(in partnership with DOE/NETL & Range Resources)



UAV Magnetics & Electromagnetics

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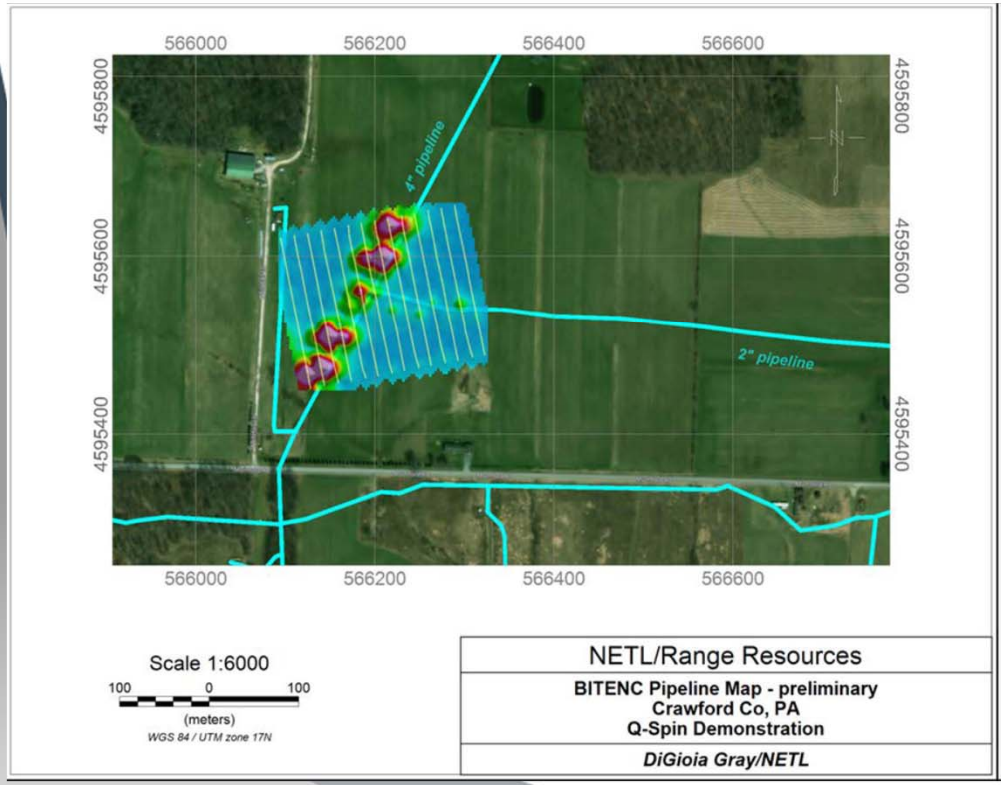
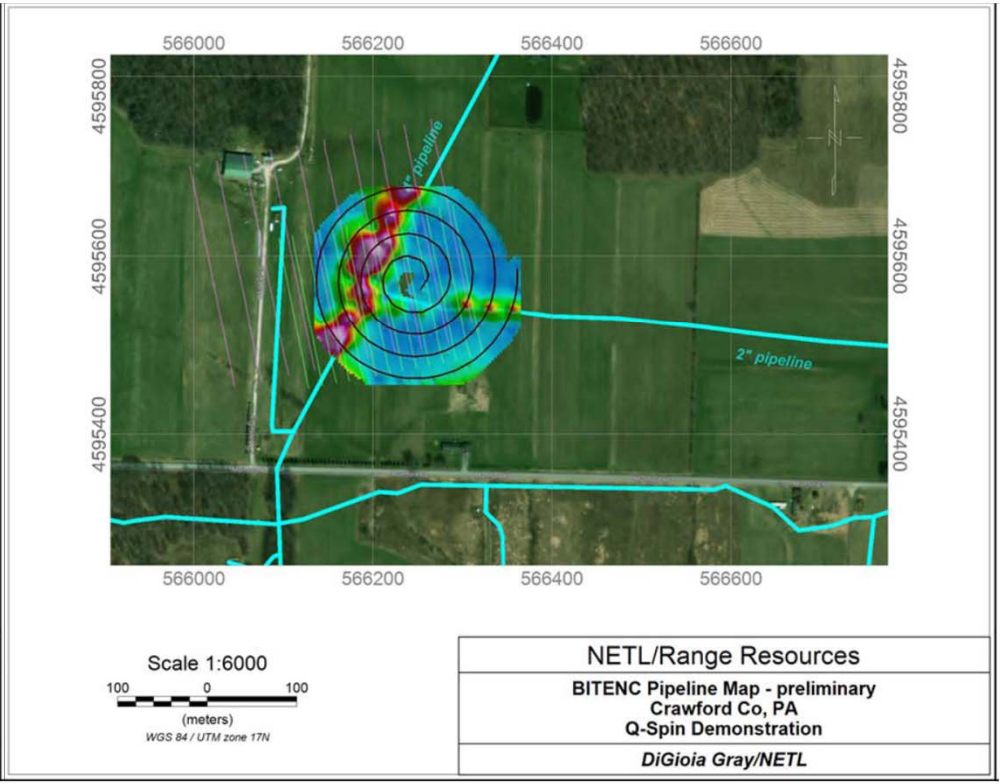
RANGE RESOURCES

NATIONAL ENERGY TECHNOLOGY LABORATORY

R&D – Methods for Locating Conductive Flowlines

(in partnership with DOE/NETL & Range Resources)





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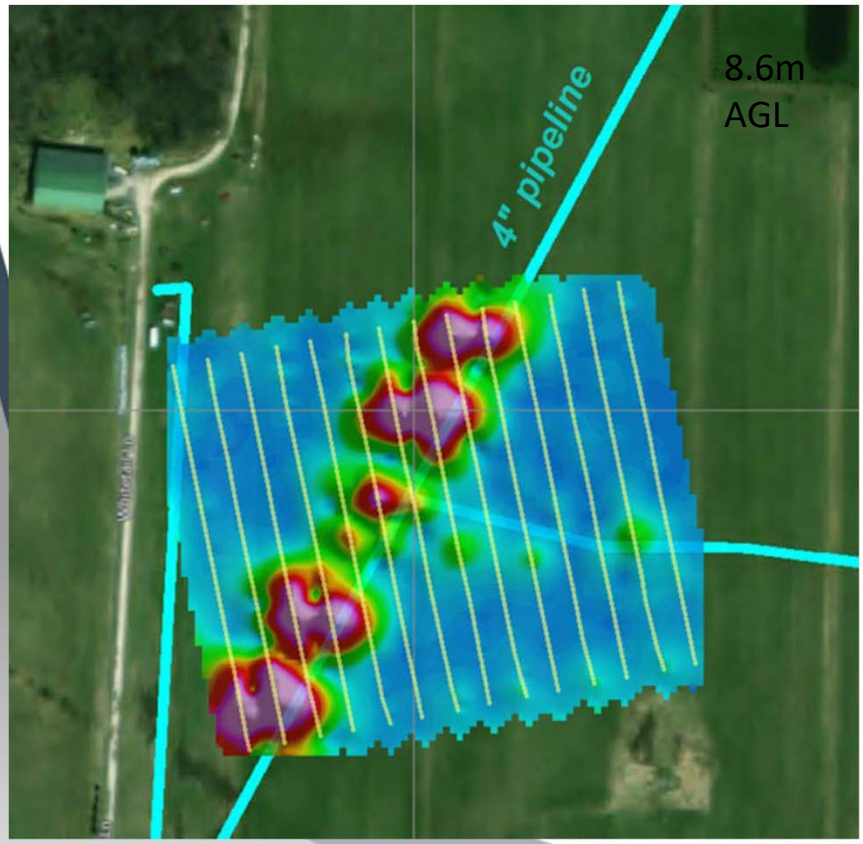

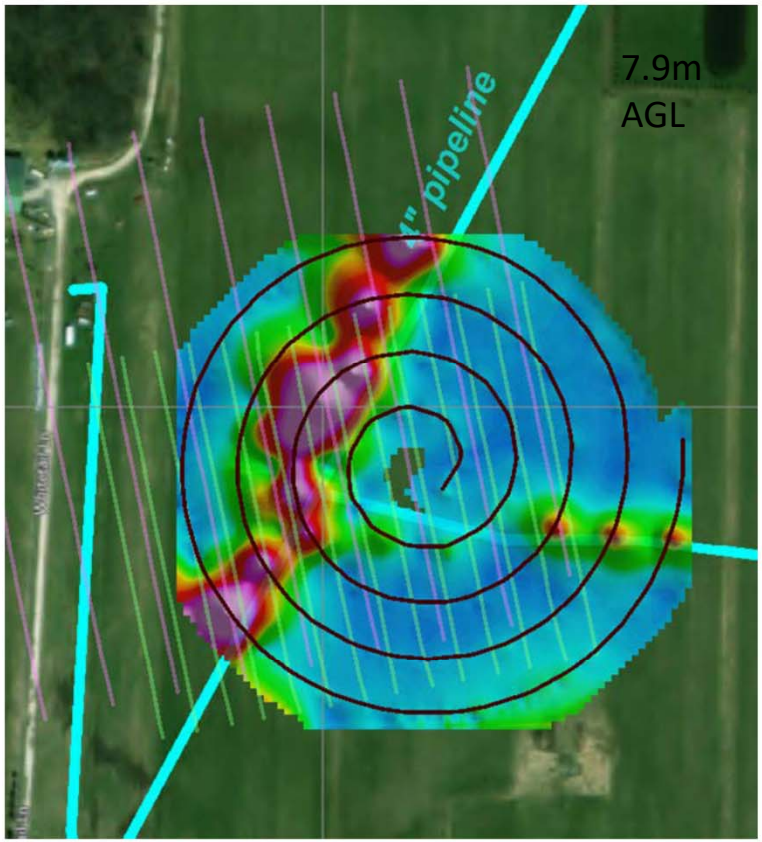

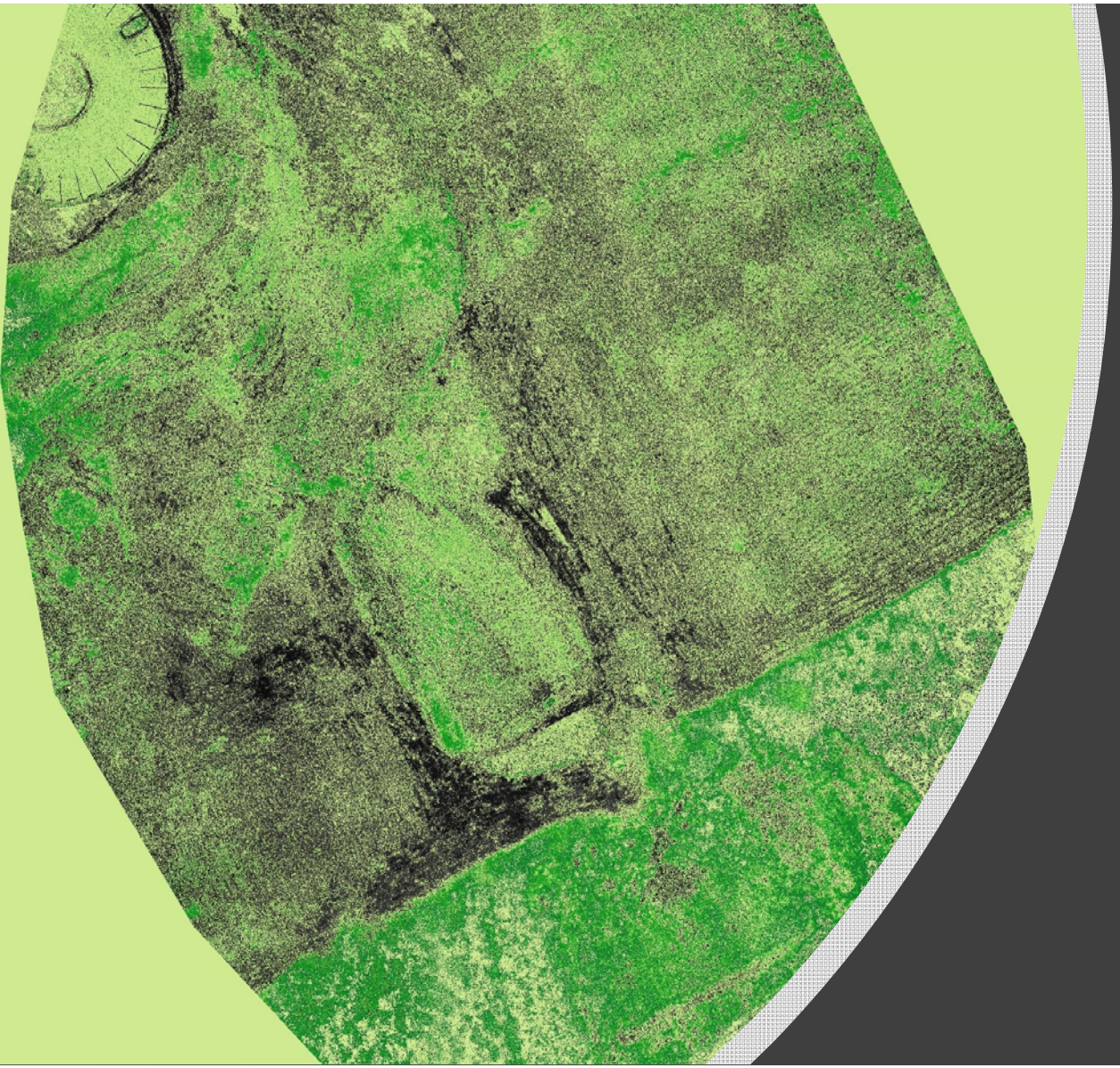

R&D – Normalized Difference Vegetation Index

Thank you!

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