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BCGS 2022 Workshop:
Drones in Geoscience

NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards: Drone Magnetic Guidelines

Presented on behalf of the Committee, by:

Geoff Pettifer

GHD & Terra Entheos Geoscience

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Outline

- Who are the Committee?
- Motivation – Why Guidelines?
- Philosophy & Structure of the Guidelines Committee
- Magnetics Guidelines
- Other Sensors – Radiometrics, EM etc.
- How you can contribute

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Who are the Committee?

NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards

(New Committee members are welcome)

Rainer Wackerle
Johannes Stoll
Steven van der Veeke
Jeff Gamey
Paul Mutton
Jean Marcel Legault
Irina Filina
James Jensen
Bruno Gavazzi
Callum Walter

Tim Archer
Elizabeth Baranyi
Geoff Pettifer
Ed Cunion
Robert Lawson
Ron Bell
Dennis Woods
Alan Reid
Jan Francke
Chase Atwood

Contacts:	Ron Bell	+1-720-220-3596	rbell@igsdenver.com
	Geoff Pettifer	+61407 841 098	geoff.pettifer@ghd.com

NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards

(*The voluntary committee members are members of one or more of these organizations*)

NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards

(The voluntary committee members are from one or more of these Companies / Universities)

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Motivation – Why Guidelines?

Motivation – Why Guidelines?

- Many new players drone operators / wannabe geophysical contractors are on a steep learning curve – some bad data is being collected
- All drone geophysics operators/contractors (geoscience-trained and “lay” personnel) need to understand the basics of good drone geophysics data acquisition, noise mitigation and data reduction and processing.
- Drone geophysics comes with different learning challenges for geoscientists backgrounded in EITHER ground OR airborne geophysics
- Bad data gives our industry and profession a bad name
- Bad safety and incidents by “rogue” operators may result in restrictions on the operations of responsible operators, that we don’t need
- Protects clients & enables multi-use of data beyond original purposes
- We need experienced operators to share their wisdom and knowledge of good practice to help bring all operators up to speed quicker

Motivation – Why not Standards instead?

- Standards are: -
  - expensive and time consuming to develop and update
  - difficult to get agreement on and
  - hard to mandate and enforce
- Guidelines provide:-
  - interim order with voluntary adoption and manifest benefits
  - continuous improvement of practices – readily updateable
  - more nimble way to keep them up to date compared to standards
  - optional approaches as new methods of data correction develop
  - if largely adopted and stabilized over time, a technology transfer pathway that may lead to development of Standards

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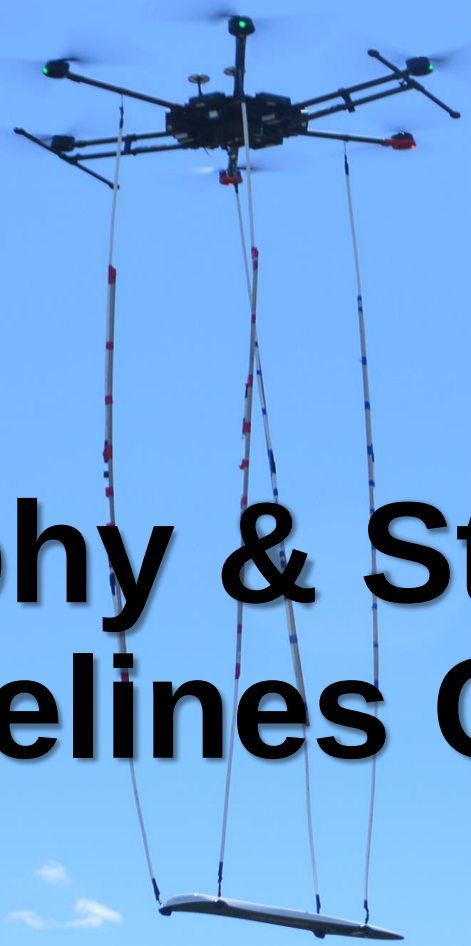
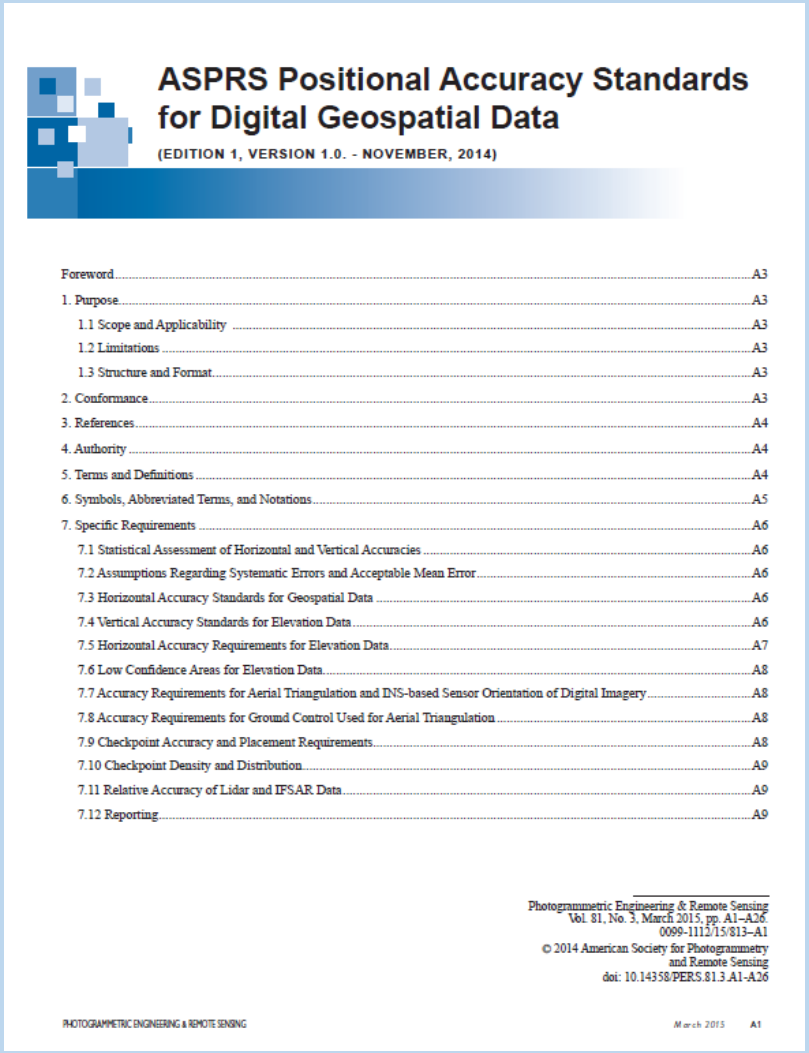


Philosophy & Structure of the Guidelines Committee

Philosophy of UAV Geophysics Guidelines?

- Primarily a primer on good practice with the relevant sensor
- Don’t re-invent the wheel. Embrace the ready made - reference the available and rapidly proliferating literature
- Reference the standards and guidelines that are in place for aspects of drone geophysics-related operations– e.g. ASPRS - LiDAR, photogrammetry
- Mindful of drone safety standards – promulgate these in the guidelines
- No endorsement of one product over another. Provide comparative tables of drone, equipment and software performance and key capabilities – tables populated by providers – we are debating whether or not to have these.
- Voluntary project – key challenge is the speed of guidelines development and change compared to the general industry speed of learning
- **We WELCOME** voluntary input to the Committee (and sub - Committee) knowledge sharing, debates and guideline document development process
- Progress reporting to, review and “endorsement” by NSG Societies

Key Standards and References



ASPRS Positional Accuracy Standards for Digital Geospatial Data

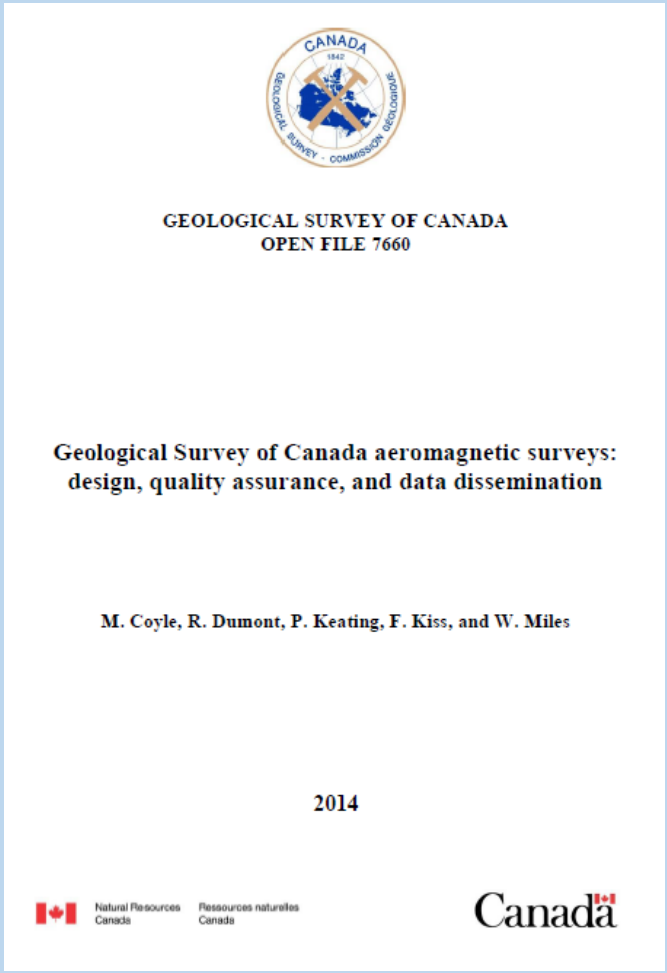
(EDITION 1, VERSION 1.0. - NOVEMBER, 2014)

Photogrammetric Engineering & Remote Sensing
Vol. 81, No. 3, March 2015, pp. A1–A26
0099-1112/15/813–A1

doi: 10.14358/PERS.81.3.A1-A26

https://www.asprs.org/a/society/committees/standards/Positional_Accuracy_Standards.pdf

https://www.semanticscholar.org/paper/Geological-Survey-of-Canada-aeromagnetic-surveys%3A-Coyle-Dumont/dca2097286cb92c96101cc8498e2be99008b879d



GEOLOGICAL SURVEY OF CANADA
OPEN FILE 7660

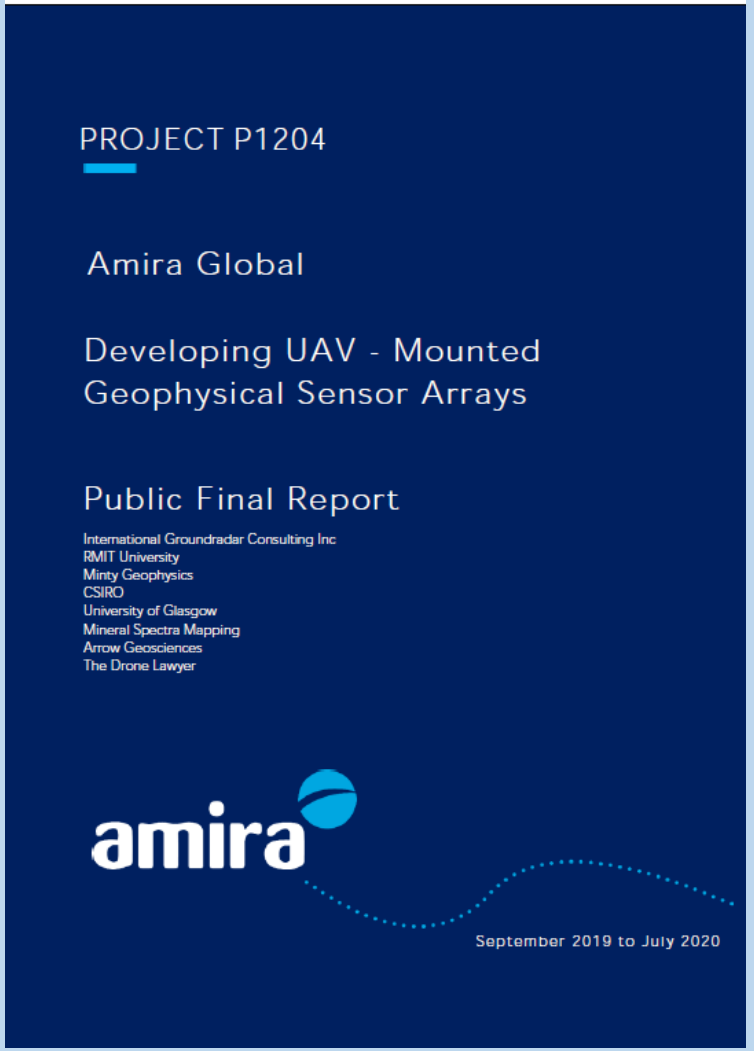
Geological Survey of Canada aeromagnetic surveys: design, quality assurance, and data dissemination

M. Coyle, R. Dumont, P. Keating, F. Kiss, and W. Miles

2014

Natural Resources Canada Ressources naturelles Canada

Canada



PROJECT P1204

Amira Global

Developing UAV - Mounted Geophysical Sensor Arrays

Public Final Report

International Groundradar Consulting Inc
RMIT University
Minty Geophysics
CSIRO
University of Glasgow
Mineral Spectra Mapping
Arrow Geosciences
The Drone Lawyer

amira

September 2019 to July 2020

https://amira.global/wp-content/uploads/Amira-P1204_Sensors-UAV_Public-Report.pdf

Guidelines Sub-Committees Focus on Sensors

- Magnetics
- Radiometrics
- Electromagnetics
- Ground Penetrating Radar (Recent New Subcommittee)
- Gravity

FOR EACH OF THESE SENSORS THE SPECIFICS OF:

- Basics of the relevant geophysical method
- Technologies, alternate sensor types
- Drone specific noise minimization challenges
- Data quality implications: end products, by application, processing levels, references

Guidelines Sub-Committees Focus on Platforms & Logistics

- Survey Planning and Execution
  - technologies: flight planning, flight execution, collision avoidance, swarms
  - data quality implications: end products, by application, processing levels, references
- Positioning
  - technologies: GPS, RTK, PPK, RTS, SLAM, IMU, altitude, attitude
  - data quality implications: end products, by application, processing levels, references
- Drone Mapping
  - technologies: Lidar, photogrammetry, video, multi-spectral, DEM
  - data quality implications: end products, by application, processing levels, references
- Safety
  - technologies: airspace awareness, reporting (nationally, IAGSA), national licensing
  - data quality: utility, reliability, ease of use
- Drone Platforms
  - technologies: electric, gas, sizes, firmware, payload, flight durations
  - data quality: noise contributions

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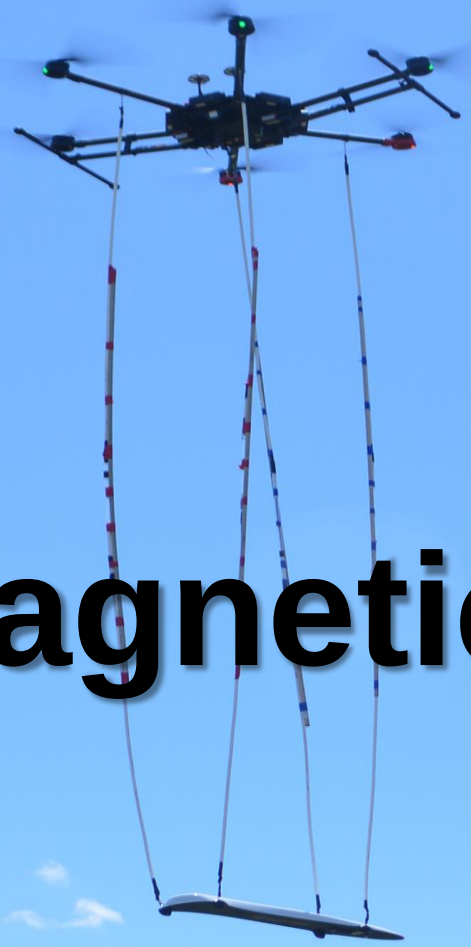


Magnetics

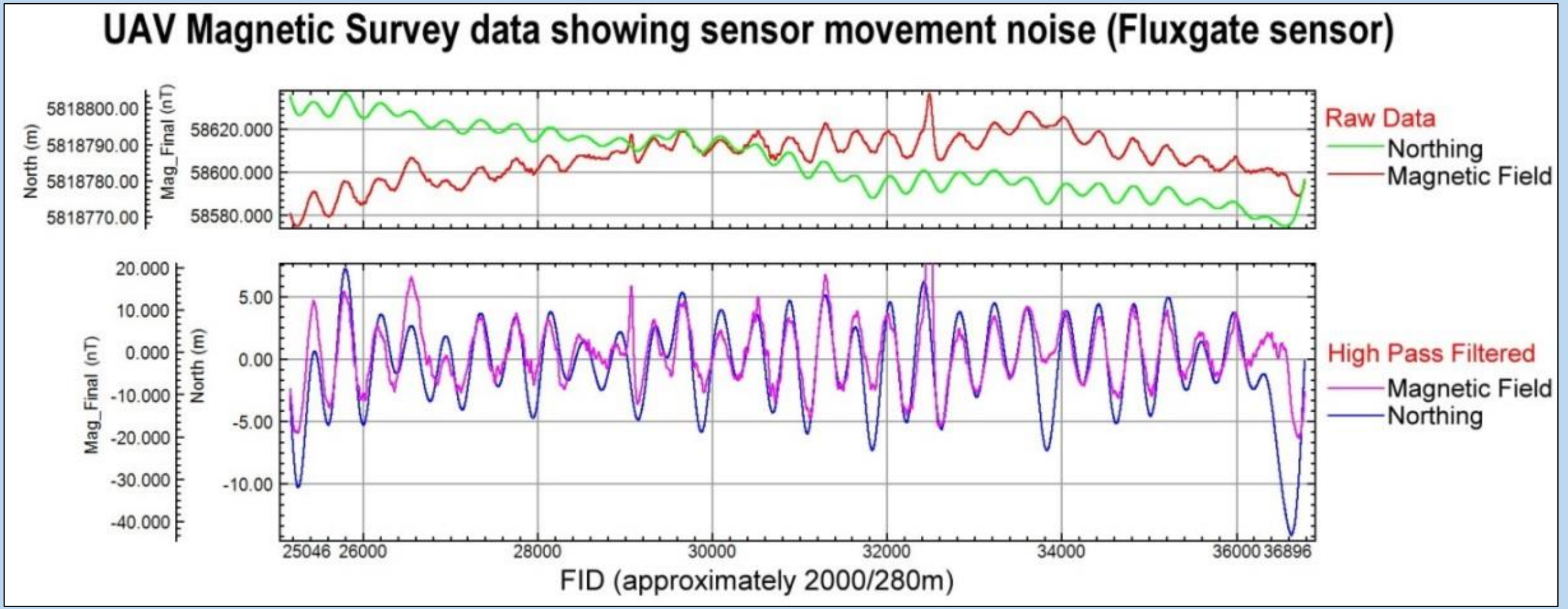
1st Public Draft of the UAV Magnetics Guidelines
Expected release (for review) – latter half of 2022

Draft Structure of the Magnetics Guidelines Document

1. Introduction
2. Magnetics Fundamentals
3. Magnetic Sensors
4. Building a UAV Magnetometer System – Technical Considerations
5. Survey Types
6. Survey Planning and Safety
7. Magnetic Survey Noise Sources
8. Compensation and Calibration
9. Vector Mag Systems
10. Processing Airborne and UAV Magnetic Data
11. Imaging and Interpretation of UAV Magnetic Data
12. References & Bibliography

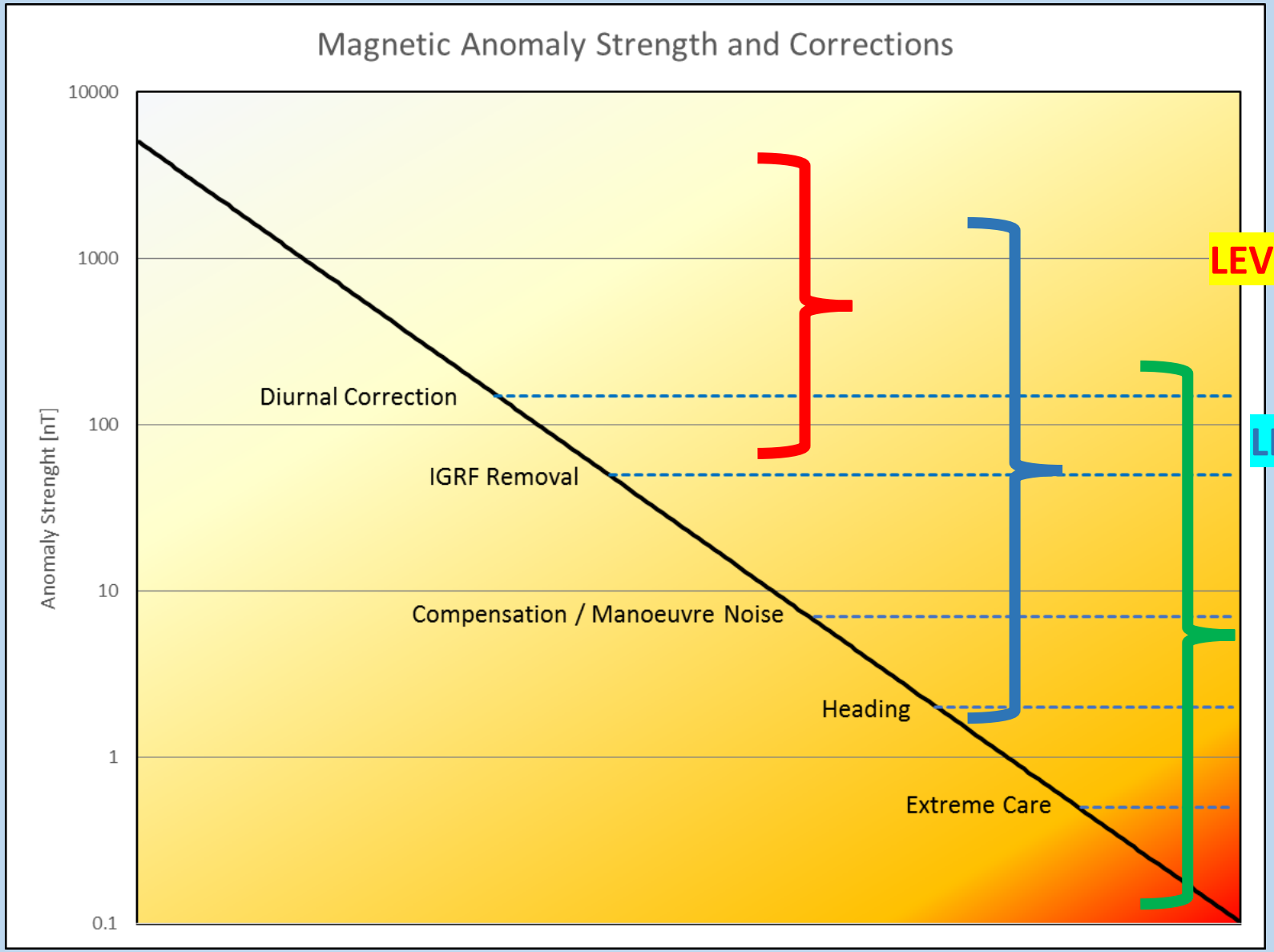
CLOSE TO COMPLETION **IN PREPARATION**

Magnetics Guidelines – Fluxgate Sensor Motion Noise



Example of an E-W line flown with a Fluxgate system flown under very windy conditions. The top panel shows the recorded magnetic data (red) and the north position of the sensor with the respective high-pass filtered version in the bottom. [Source: Paul Mutton – Touchstone Geophysics]

Magnetics Guidelines Example Processing Levels

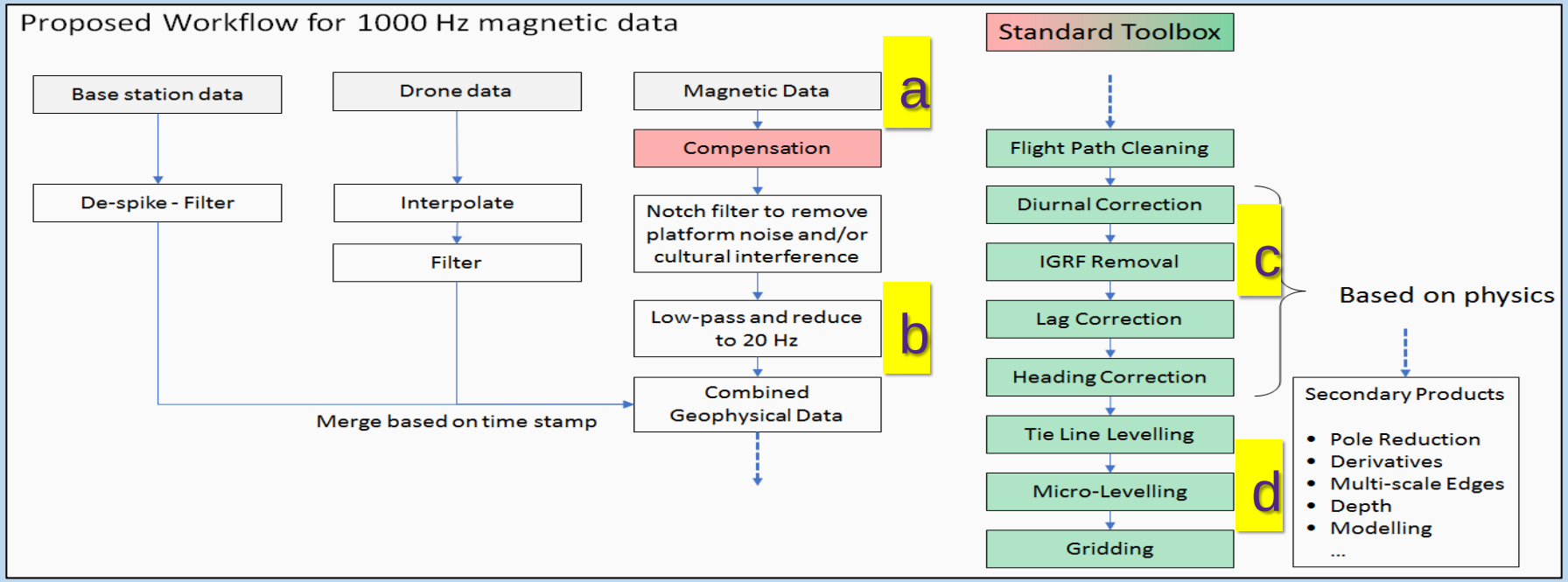


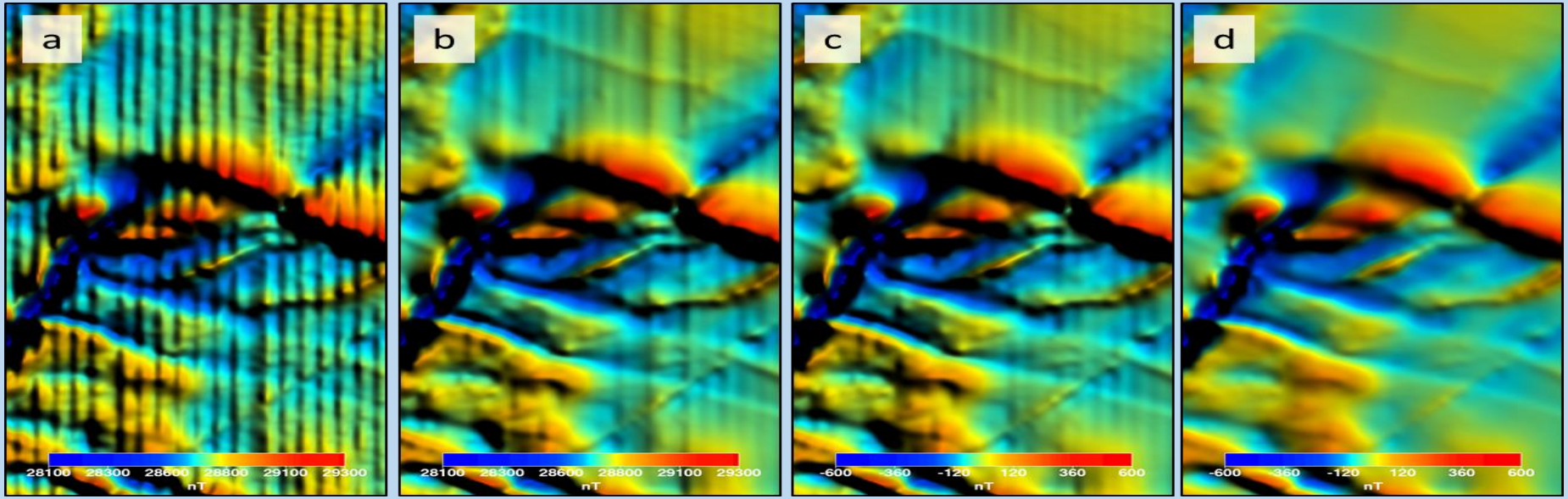
LEVEL 1 – LARGE ANOMALY DEFINITION – E.G. ABANDONED OIL WELLS

LEVEL 2 – GEOLOGICAL / GEOTECHNICAL MAPPING APPLICATIONS

LEVEL 3 – UXO / ARCHAEOLOGICAL MAPPING APPLICATIONS

Magnetics Guidelines - Level 3 Processing





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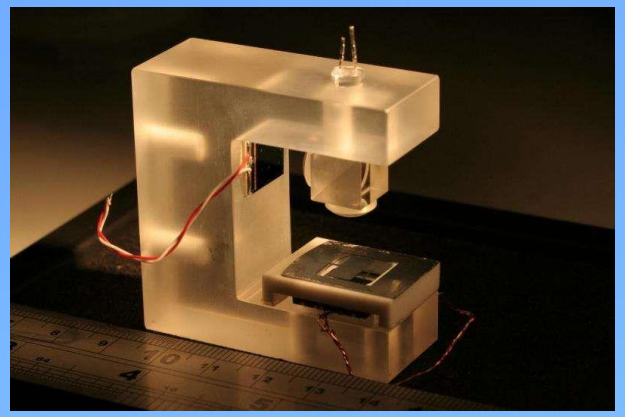
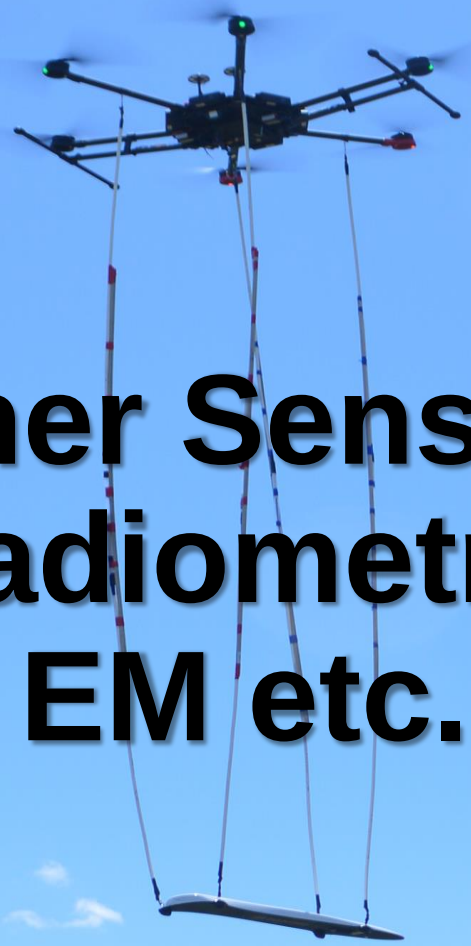
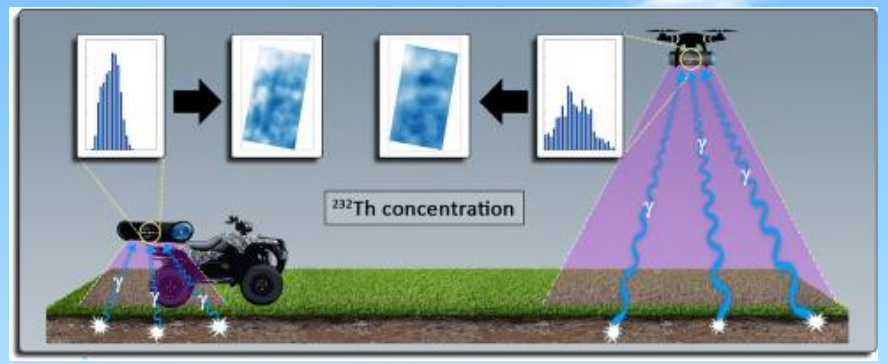
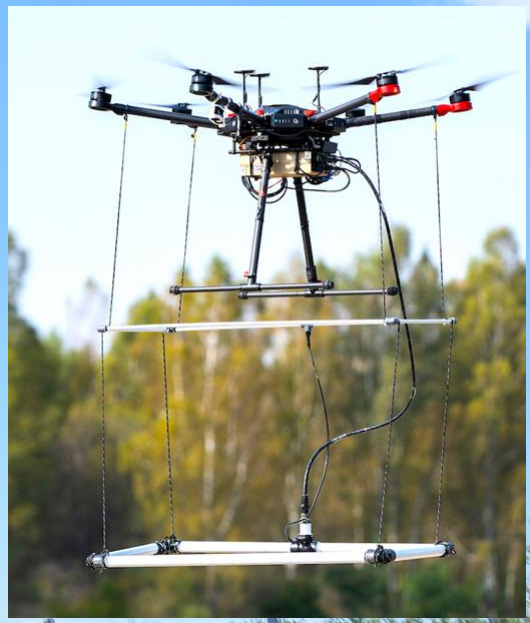




Other Sensors – Radiometrics, EM etc.





NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards – Other Sensors

- Sub-committees at work – EM, Radiometrics, GPR, ?Gravity,
- Use the magnetics guidelines document as a template
- Frequency domain systems Tx / Rx on drone – GEM2, EM61 Lite
- Frequency domain Rx. Ground cable source – MGT
- Passive EM signal systems – RMT, GEM VLF
- Drone Radiometrics – Medusa, Canadian & US detectors and systems
- GPR Systems
- Drone gravity – Glasgow University MEMS gravity sensor and UC Berkely MiniG gravimeter and FlyG gravity gradiometer– watch this space
- Thermal and Hyperspectral imaging ?

How you can contribute

- Join the Committee and/or a Sub-committee
- Review the draft guidelines
- Send in your ideas to any of the committee
- Send in good examples of noise, processing workflows, processed data, case studies
- Advise of good references to follow up
- Contact Ron Bell (+1-720-220-3596) or Geoff Pettifer (+61407 841 098)

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Thankyou
Questions and Discussions

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