BCGS

BC Geophysical Society

BC Geophysical Society Spring Workshop

May 12-13, 2022

“Drones in Geoscience”

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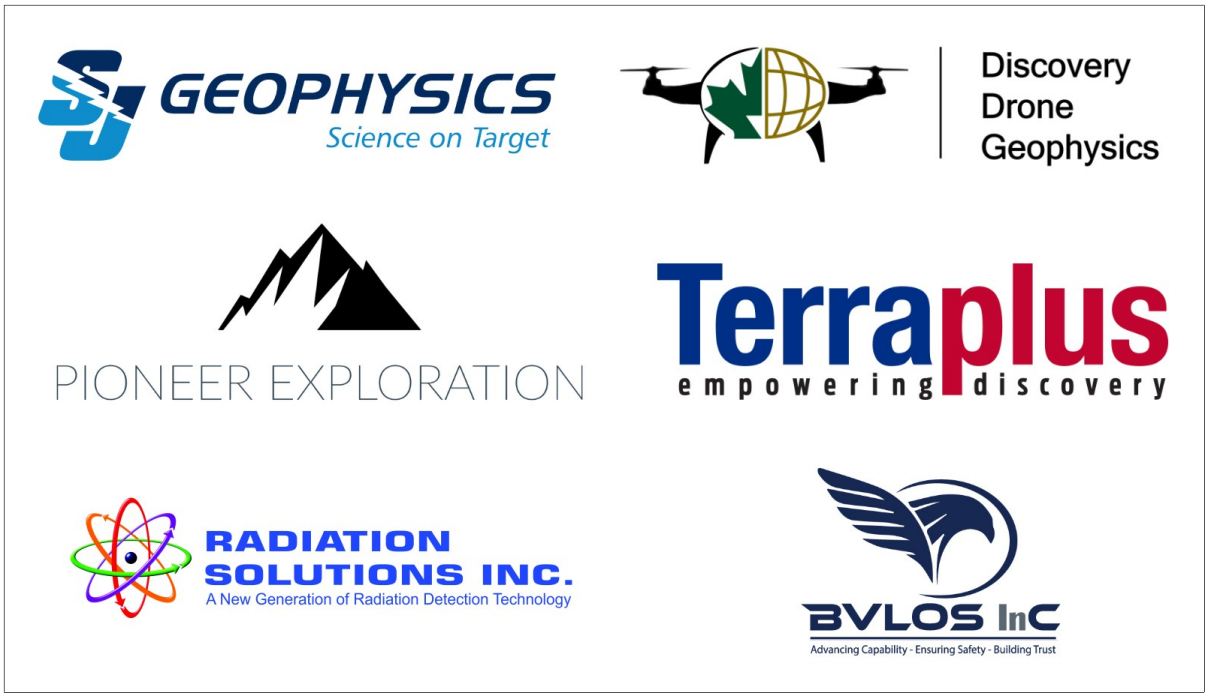

BC Geophysical Society – Spring Workshop - 12 May 2022

Drones in Geoscience

Co-Chairs: Dennis Woods & Ron Bell

Start Time	End Time	Organization	Speaker	Title
7:30	8:20	**Registration @ SFU Harbour Centre – Fletcher Challenge Theatre (Room 1900) 515 West Hastings Street, Vancouver, BC**		
8:20	8:30	BCGS	Dennis Woods	Welcome and opening remarks
8:30	9:00	Drone Geoscience, LLC	Ron Bell	Keynote: The Elegance of Drone Geoscience
9:00	9:30	Groundradar Inc.	Jan Franke	Challenges and Opportunities of Drone GPR
9:30	10:00	NAV Canada	Alan Chapman	Drones and the Airspace: Current Operations and Future Needs
10:00	10:30	**Morning Coffee Break / Display Booths in Concourse**		
10:30	11:00	Coastal Drone	Ian Willis	How I learned to love the RPAS; or Flying Drones Legally and Safely in Canada
11:00	11:30	Radiation Solutions Inc.	Nicolas Martin-Burtart	Radiometric Data collected with an UAV: Pre-flight and Post processing
11:30	12:00	British Columbia Geological Survey	Travis Ferbey	Can remotely piloted aircraft-borne radiometrics and magnetics detect Dispersal trains in subglacial tills?
12:00	13:00	**Lunch / Display Booths in Concourse**		
13:00	13:10	IAGSA	Lance Martin	Reporting Drone Geoscience survey activity to the International Airborne Geophysics Safety Association
13:10	13:40	Measur	Rees Pillizzi	Large Area UAV LiDAR Mapping: Trinity F90+ with Qube 240 LiDAR
13:40	14:10	Candrone	Zane White	Photogrammetry and LiDAR – The Facts and Myths About Modelling Our World in 3D via UAV
14:10	14:40	BVLOS InC	Steve Donovan	VLOS to BVLOS Protocols, Challenges and Solutions
14:40	15:10	**Afternoon Coffee Break / Display Booths in Concourse**		
15:10	15:40	Pioneer Exploration	Michael Burns	Lessons Learned in an Emerging Drone-Based Geophysics Industry
15:40	16:10	Seequent	Laura Quigley	UAV Geophysics Workflow for your Magnetometer Data
16:10	16:40	BCIT	Eric Saczuk	Drone-based Gas Sniffing
16:40	16:55	Terra Entheos Geoscience	Geoff Pettifer	NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards: Drone Magnetic Guidelines
16:55	17:05	BCGS	Ross Polutnik	Closing remarks
17:30	19:30	**Reception @ Moose's Down Under Basement, 830 West Pender Street, Vancouver, BC, V6C 1J8**		

The Elegance of Drone Geoscience

Ron Bell, Senior geoDRONEologist, Drone Geoscience, LLC

In 1972, conducting geophysical and geological mapping via an unoccupied remotely piloted aircraft was, at best, a concept. For most, it was simply inconceivable. Fast forward 50 years to 2022, what was an inconceivable concept has become reality and will become so commonplace that drones equipped with sensors to collect geoscience data are destined to be an essential tool for geophysicists engaged in resource exploration, environmental subsurface characterization, and basic geoscientific research. One should not be surprised by the evolution in the manner geophysical data are collected. One should be grateful.

I fall into a state of “awe” each time I see a drone equipped with a geophysical sensor go airborne to begin the task of collecting data on a pre-defined survey grid. The concept of applying small, remotely piloted aircraft to the task of mapping the surface and the subsurface is akin to seeing the iceberg on the horizon. From afar, one realized there is potential. When one gets close enough to touch the iceberg, one realizes the magnitude of the potential. It is mind boggling.

The application of drones to geoscience is maturing at a rapid rate due to the ever-increasing demand for data of all types. The drones have evolved with the market demands to become more sophisticated in response to the need to reduce the safety and risk concerns and improve the capability to address market application. Relative five (5) years ago, flight times have increased, navigation and data point positioning is more precise, and sensors for avoiding obstacles and measuring the earth have improved. Today, drones are routinely deployed to map areas previously considered to be impossible to access and along the way are capturing a greater volume and broader variety of data than could have been imagined 50 years ago. What we are witnessing is simple enough to describe. It is the Elegance of Drone Geoscience.

Bio:

In 2013, Ron began learning about remotely piloted autonomously operated aircraft for geophysical mapping of the subsurface. In 2017, he conducted field trials of the prototype version of the MagArrow, an innovative Cesium vapor magnetometer made by Geometrics, Inc. of San Jose, CA. Upon the introduction of the production version of the MagArrow in the fall of 2018, Ron has completed over 50 commercial drone magnetic survey projects. In 2020, he began conducting field trials of the GEM 2 UAV system from Geophex, Inc. In 2021, he conducted field trials of the EM 61 lite for Geonics, Ltd. and D230A Gamma Ray Spectrometer from Terraplus, Inc. In 2022, he began offering each of these systems for purchase either as a standalone or fully integrated package (i. e. UAV, sensors, software).

Ron was awarded a BS in Applied Physics from Michigan Technological University a long time ago. He has more than 40 years of experience in the acquisition, processing, and interpretation of ground, borehole, and airborne geophysical data for mineral, groundwater, and energy resource exploration and environmental subsurface characterization. To his knowledge, he is the only living geoDRONEologist on planet Earth.

Challenges and Opportunities of Drone GPR

Jan Franke, Groundradar Inc.

Lightweight ground penetrating radar (GPR) systems mounted on drones have seen a recent dramatic increase in popularity. Efforts by some manufacturers who promote airborne GPR systems for a myriad of applications have driven this trend, but prospective customers often overlook the stringent legal restrictions around airborne GPR in some jurisdictions including Canada, as well as the limitations imposed by physics when lifting a radar system into the air.

This talk will examine the current legal framework of airborne GPR instruments which restrict flight height to less than 1 m, as well as the complications and limitations imposed by physics when an antenna is coupled to air and not the ground. Despite restricting penetration to a small fraction of that for a ground-coupled system, there remain some viable applications in specific settings for drone based GPR surveying. Examples of successful and unsuccessful surveys will be discussed, including examples from scenarios where an airborne system is the only safe solution for data collection. Also addressed will be possible future instrumentation designs which could improve penetration depths for mineral exploration surveys.

Bio:

Jan has spent his 27-year career working with long-range GPR in 93 countries. He now develops custom radar technologies for exploration, geotechnical and security applications.

Drones and the Airspace: Current Operations and Future Needs

Alan Chapman, Director RPAS Traffic Management, NAV Canada

NAV CANADA is mandated to provide all Air Navigation Services in Canada, and aviation regulations extend to Remotely Piloted Aircraft Systems (commonly drones) which are classified as aircraft. Alan Chapman is the Director accountable for RPAS activities in NAV CANADA. This includes small RPAS operating at low altitudes and large RPAS integrating into the airspace. His responsibilities span the development of NAV CANADA's strategy, provision of service, and support for future regulations from the ANSP perspective. In this session Alan will explain NAV CANADA's mission, highlight some of the key RPAS regulations, NAV CANADA's strategy for RPAS and role in supporting VLOS flights including how requests to access controlled airspace are managed by NAV Drone. He will also cover risks associated with non-compliant drones entering controlled airspace.

Bio

Alan Chapman is the Director for Remotely Piloted Aircraft System (RPAS Traffic Management) within NAV CANADA. Alan is accountable for shaping NAV CANADA's strategy for RTM, ensuring safe integration of UAVs and traditional aviation, supporting drone incursion initiatives, and the delivery of ANSP services to meet the Canadian State plan and associated regulations.

Alan co-chairs, along with Transport Canada, the RTM Action Team, a consultative forum with stakeholders from across the RPAS industry, Alan also co-chairs the Trials Executive Steering Committee. Prior to joining NAV CANADA Alan has a long history of leadership roles supporting digitization, software solutions, innovation and integration. In his career Alan has held executive roles in large technology organizations, such as IBM, early stage/start up companies and has been an independent consultant.

How I learned to love the RPAS; or Flying Drones Legally and Safely in Canada

Ian Wills, Coastal Drone

Since 2019, Transport Canada has established a structured framework for operating a remotely piloted aircraft system (RPAS) within Canadian airspace. What was once a lengthy process of requesting permission for every commercial flight, has now transitioned to a risk-based structure that allows for low-risk operations to be conducted on short notice. This presentation will outline the process for getting certified to conduct Basic or Advanced operations across Canada with a small RPAS and what needs to happen for operations beyond the current framework

Bio:

Coming from a decade in the Commercial Helicopter industry as a pilot, operations coordinator, and business development representative, and before that a decade in Information Technology and Systems Administration, Ian brings his enthusiasm and experience in Commercial Aviation now to the drone industry. Ian leads operations and innovation as President at Coastal Drone Co., Canada's most successful online drone training school, and looks forward to the exciting growth of the drone industry as new regulations offer more permissive activities such as BVLOS, eVTOL and heavier drone delivery operations. As a product of a family of educators, Ian demonstrates a passion for continuous skill development and sharing that knowledge with others.

Radiometric Data collected with an UAV: Pre-flight and Post processing

Nicholas Martin-Burtart, Senior Scientist, Radiation Solutions Inc.

UAV platforms offer a wide range of applications for geophysical exploration. Increased payloads and autonomy allow the user to conduct a full site survey, including radiometric data acquisition.

Each site survey presents challenging conditions and flight parameters must be chosen accordingly. The objectives and expectations of the survey can be adjusted beforehand by computing the minimum detectable activity, based on the natural background of the site, flying altitude and sensor type. A detailed example of eU vein minimum detectable activity will be presented, with different altitudes and eU background levels. The significance of the measurement (in terms of Signal-to-noise ratio) will be discussed.

If the surveyed site is large, specific post-processing methods can be used to enhance the small discrepancies that could be masked if using Total Count or Region of Interest (ROI) methods. Noise Adjusted Singular Value Decomposition (NASVD) is particularly suited for this kind of task; NASVD determines all statistically significant spectra for an entire gamma-ray data set. With this knowledge, it is then possible to reconstruct the original data set, with a lower noise level, equivalent to an increased detection volume. Traditional window stripping, spectral fitting and ROIs analysis can still be carried out on the reconstructed data. Contrast between areas can be enhanced by looking at the components' features and concentrations used during the reconstruction, highlighting spatial regions of interest. A complete case study will be presented, including raw data, NASVD parameters, and reconstructed data. This data post-processing alleviates some of the inherent limitations from the UAV platform.

Bio

Nicolas Martin-Burtart obtained his PhD in 2012 at the French Atomic Commission, where he worked on airborne gamma spectrometry, and developing algorithms for nuclide identification. He joined Radiation Solutions Inc in 2013 as Senior Scientist. His works include nuclide identification, detector characterization and neutron detection.

Reporting Drone Geoscience Survey Activity to the International Airborne Geophysics Safety Association

Lance Martin, IAGSA

The International Airborne Geophysics Safety Association (IAGSA) is a Not-For-Profit Safety Organization which promotes the safe operation of rotary and fixed-wing aircraft, regardless of how they are piloted, on airborne geophysical surveys. Our association develops recommended practices, serves as a center for exchange of safety information and as a repository for specialized statistics.

The presentation will be a quick overview of the benefits of an IAGSA membership to those operating Drones within the geoscience industry such as:

1. Access to Accident and Incident Statistics.
2. Sharing of lessons learned and safety initiatives through Member Safety Forums.
3. Access to member Self-Assessment Audit Reports.
4. Access to the IAGSA Technical Committee
5. Access to IAGSA's Safety Manual and Risk Assessment & Safety Planning Tools

Large Area UAV LiDAR Mapping: Trinity F90+ with Qube 240 LiDAR

Rees Pillizi, Measur

The Trinity F90+ from Quantum Systems is a fixed-wing VTOL (Vertical Takeoff & Land) platform designed for large area mapping. Featuring an industry leading flight time of 90+ minutes, best in class payload support, and modular design, the Trinity is the ultimate tool for large survey mapping applications. Designed in partnership between Quantum Systems and Yellowscan, the Qube 240 LiDAR payload is a powerful and precise tool consistently delivering reliable data. In this presentation, we will provide detailed information on both the Trinity and its Qube 240 LiDAR payload. Furthermore, we will cover mission planning in the included Qbase 3D software and post processing workflow in Applanix POSPac UAV and YellowScan CloudStation. Lastly, we will discuss three case studies from real world projects which utilized the Trinity F90+ and Qube 240 LiDAR.

Bio:

Rees Pillizzi is a Business Development Representative for the drones & geomatics division of Measur for British Columbia. He has a background in GIS from the University of British Columbia and a passion for UAV technology. He enjoys applying his knowledge in helping organizations incorporate UAV solutions into their workflows.

Can remotely piloted aircraft-borne radiometrics and magnetics detect dispersal trains in subglacial tills?

*T. Ferbey, E.A. Elia (British Columbia Geological Survey)**

R. Shives (GamX Inc.)

M. Best (Bemex Consulting International)

S. Monkhouse (Radiation Solutions Inc.)

B.C. Ward (Simon Fraser University)

Regional-scale till geochemistry and mineralogy surveys conducted in British Columbia have low sample densities (e.g., 1 sample/10 km2) compared to other geochemical prospecting methods like B-horizon soil geochemistry. Traditional airborne magnetic and radiometric surveys can provide insight into subglacial till composition between sample locations, however, they are often too costly, time-consuming, or have limited spatial resolution. Remotely piloted aircraft systems (RPAS) provide an opportunity to quickly collect affordable and high-resolution data but they have not been applied to drift prospecting studies. We are investigating the utility of RPAS-borne gamma-ray spectrometry and magnetometry to detect porphyry-related dispersal trains in subglacial tills.

In 2021, we flew a total of 155 line kilometres in cutblocks near Mount Polley mine and the Woodjam prospect where existing geology, geochemistry, mineralogy, and geophysical data allow validation of our newly acquired RPAS-borne data. Low-altitude, active terrain-following, and gridded autopilot surveys were flown at 5, 7.5, or 10 m above ground level (AGL) over subglacial tills. A radar altimeter instructed the RPAS, in real-time, to maintain constant height AGL, ensuring measurements were not affected by source-detector distance variations. RPAS-borne K counts show similar patterns to traditional airborne data acquired for the same areas, but with improved spatial resolution. Work is now concentrated on separating the bedrock and near-surface sediment signatures in these data sets. Upcoming fieldwork will assess how changes in flight parameters affect data acquisition and quality. In-situ measurements will be collected to provide site and media-specific assays for calibration and interpretation of RPAS data.

Bio:

Travis Ferbey is a Quaternary Geologist with the British Columbia Geological Survey. For the past 20 years, he has mapped and described surficial deposits in British Columbia where his work has focused on using drift sampling as a tool to assess the mineral potential of underexplored areas in the central part of the province, and conducting aggregate potential surveys in the northeastern part. Travis has further developed indicator minerals in tills as a method for detecting drift-covered base and precious metal deposits, in collaboration with colleagues at the British Columbia Geological Survey, the Geological Survey of Canada and universities. More recently, he has been incorporating remotely piloted aircraft system (RPAS) photogrammetry and lidar into mapping programs, and investigating the use of RPAS-borne radiometrics and magnetometry in drift prospecting.

Photogrammetry and LiDAR – The Facts and Myths About Modelling Our World in 3D via UAV

Zane White, Candrone

Within our modern world, many industries require accurate representations of their assets and surroundings in order to accomplish a variety of goals. Everything from the energy sector, public safety, film and studio productions, firefighting, scientific research, and infrastructure inspection operate as intended through extensive mapping of our environment. Through photogrammetry and LiDAR, the three-dimensional world is as accessible outside, as it is on our computers. With both technologies being widely available through numerous distributors and 'DIY' projects, it can be challenging to decode the industry terms and choose the product that best fits your mission.

The science of photogrammetry has existed since the 19th century, and LiDAR was first effectively used in the 1960s. A careful collection of myths and assumptions will be evaluated and discussed in this workshop, and we will address the many concerns that you may have regarding this growing field. The content of this workshop will be digestible for industry newcomers, to veterans in the field. We want to understand how photogrammetry differs from LiDAR, when the two can be best applied to your research and projects, as well as best management practices for your operation.

Lastly, we want to evaluate the vehicle by which your sensors may be flown. The discussion between quadcopter, VTOL, and fixed wing UAVs is an interesting branch away from what used to be dominated by manned helicopters and low-flying planes. Here, we will identify the past, present, and future of drone-based photogrammetry and LiDAR, and how Candrone is currently at the forefront of this technology.

Bio:

I was inspired by my high school geography teacher who tasked me with locating the epicentre of an earthquake using one of the earlier releases of ESRI's ArcMap. Now with a degree in Geoscience and Geomatics, my focus surrounds the various applications of drones using LiDAR and photogrammetry payloads to map our landscape. I'm currently using experiences to work in UAV-based LiDAR and photogrammetry, building off of prior GIS research in surface water detection and urban development.

VLOS to BVLOS Protocols, Challenges and Solutions

Steve Donovan, Beyond Visual Line of Sight Innovation Centre or BVLOS InC

BVLOS InC will provide the audience a brief overview of defining VLOS, EVLOS, and BVLOS. From there we'll be looking at BVLOS applications. The main focus of the presentation will be the criteria of transitioning from VLOS to BVLOS which will incorporate the current requirements through Transport Canada (TC). With the many challenges facing the Remotely Piloted Aircraft System or RPAS operator, BVLOS InC will provide solutions in above presentation which the RPAS operator can utilise including both our RPAS Airworthiness services and utilising the Foremost UAS Test Range to provide them the opportunity to develop and test all the TC requirements with an exit strategy to fly BVLOS outside of a Test Range to enhance and provide the operator with a dramatically increase in their return of investment or ROI business model.

Bio:

Steve is the Operations Manager at the Foremost UAS Test Range and for Beyond Visual Line of Sight Innovation Centre or BVLOS InC. The Range is owned by the Village of Foremost but overseen and managed by Steve. As the Operations Manager, he is heavily engaged in assisting UAS operators in getting their comprehensive application documentation for a Special Flight Operation Certificate or SFOC approved to fly BVLOS at the Range. All bookings for the Range are done through him and once UAS operator teams are on site, acting as the Range Safety Officer, he oversees and manages all VLOS and BVLOS missions here. Steve is also actively engaged with NAV Canada and local flyers/stakeholders in the area to keep all proactively informed by NOTAM and real time communications of any UAS activity. BVLOS InC primary services is dedicated with the Remotely Piloted Aircraft System or RPAS Airworthiness application by breaking down barriers for clients to achieve the transition from visual line of sight or VLOS to BVLOS. As the Operations Manager for BVLOS InC, Steve coordinates all aspects when testing/validation is being performed by the client at the Range.

Prior to joining UxS in 2019, Steve worked in the Defense Industry first for 10 years in the Canadian Air Force as a radar technician and then 22 years as a Defense Contractor in the Canadian Arctic, Alaska, and the Middle East. During this time, he worked in many roles, as a Air Force Supervisor, an instructor for component level complex 3D Radar system, operation/technical management roles, which include airfield management, radar technical specialist, QC/QA, and developing/administering comprehensive operating procedures for above areas. In addition, Steve has a 5 year background working in the Oil Sands as a Foreman for both electrical and instrumentation (E&I) crews, whereas safety is paramount and stressed in every task performed in this environment.

Steve has a Canadian Air Force technical training background to trade qualification level (QL) 6, equivalent to a technologist type education. He also has an Alberta Journeyman Ticket for Instrumentation.

Lessons Learned in an Emerging Drone-Based Geophysics Industry

Michael Burns, Founding Partner & President, Pioneer Exploration Consultants Ltd.

Pioneer Exploration Consultants has been involved in the drone based geophysical services market since 2014 when they conducted one of the first commercial UAV-Mag flights with a multi-copter platform in the US. Since then, Pioneer has gained vast experience providing drone based geophysical surveys and remote sensing surveys to mining industry clients in more than 10 different countries and on 4 different continents. Keeping pace with the high rate of innovation in the drone sector, in addition to investing into internal technology development has resulted in refined data acquisition systems, increased efficiency and reduced risk during data acquisition. With the advent of lower cost and more advanced drone platforms, user friendly ground control software and an iterative approach to internal risk management, incident reporting and standard operating procedures, the efforts put into making a safer and more efficient data acquisition process see significant returns. The lower barrier to entry and cost also brings new start-ups, innovators, and expansion of service providers in the drone geophysics industry.

After 9 years in the industry, several core aspects to a successful drone based geophysical company have emerged.

1. Safety is top priority; BARS, IAGSA, and internal SOP's and culture can save money and increase productivity.
2. Data – Quality is paramount. At the heart of it, we are a geophysics company providing geophysical data to our clients and drones allow this data to be captured in an effective and efficient manner.
3. Innovation is important both internally and external, keeping pace with the rate of technology can be a daunting task. Networks and partnership, as well as financial investment into new ideas is a necessity to remain competitive and to bring cutting edge solutions to the industry.

By providing an overview of Pioneers experiences from almost a decade of drone based geophysical survey services, we aim to encourage others to enter the field, and provide an opportunity to discuss the methods and strategies that make successful drone-based geophysical surveys a reality.

UAV Geophysics Workflow for your Magnetometer Data

Laura Quigley, Technical Analyst, Seequent

In this presentation we will demonstrate a UAV geophysics workflow for magnetometer data in Oasis montaj using the UAV extension. When designing UAV surveys additional requirements, compared to manned aerial surveys need to be examined. Within the UAV workflow considerations for duration of flight and visual line of sight of the drone can be prepared and managed. Survey quality control, processing of the magnetometer data and subsequent 2D gridding allow us to interpret and visualize the magnetic responses from our example project area. We will then perform a magnetization vector inversion from the UAV magnetometer data to obtain a 3D distribution of the magnetic properties of the subsurface.

Bio

Laura received her Bachelor of Science degree in Geophysics from Memorial University in Newfoundland and Master of Science in Geophysics from the University of Toronto. Her professional career started with Fugro Airborne Surveys, processing and interpreting airborne geophysics data. She then worked for a marine seismic company where she participated in a number of research cruises to Greenland. After completing her master's degree in 2013, Laura moved to Australia where she worked for the University of Queensland on seismic projects for unconventional coal seam gas development, then moved to the Queensland University of Technology where she spent several years researching geodynamical processes through analogue modelling. Laura returned to Toronto, Canada in January 2020 to join Seequent as a Technical Analyst.

Drone-base Gas Sniffing

Dr. Eric Saczuk, BCIT

This demo showcases gas detection using the SoarAbility Sniffer4D v2 mounted on a DJI M300 RPAS. A collaboration between TurnTech Industries, InDro Robotics and the BCIT RPAS Hub, we will demonstrate the integrated hardware and software solution to drone-based sensing of temperature, humidity, H2S, CxHy, SO2 and VOCs in real-time.

Bio:

Dr. Eric (Arek) Saczuk, Fellow International (’18) of The Explorers Club, Transport Canada RPAS Flight Reviewer, FAA Part 107 Certified Drone Pilot and Nikon Professional Services Photographer

Born in Poland, Eric presently resides in Vancouver, BC, Canada with his wife and two daughters. With a Ph.D. in remote sensing and a short stint in the Canadian Air Force, he has spent the last 25 years teaching at the University of Manitoba, Simon Fraser University and most recently at BCIT where he Heads the RPAS Hub. Eric loves exploring RPAS applications across a wide variety of industry sectors as the Flight Operations Lead.

Outside of “work”, Eric’s images brighten the spaces of hundreds of commercial spaces all over the world as the lead photographer for Hambleton Fine Art Services. Through his company, Space Hog Graphics, he has found a means of using his artistic talents to help underprivileged children in Nepal gain access to healthcare and education. With a deep passion for adventure travel to off-the-beaten path destinations, his photographs feature prominently in the short documentaries “Beyond the Gates of Phu” (2013) and “Colours of Edziza” (2015).

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

Geoff Pettifer, GHD Geotechnics, GHD

(On behalf of the NSG Inter-Society Committee on UAV Geophysics Guidelines and Standards)

After the ***Summit on Drone Geophysics*** in 2020, a core group of the presenters and other interested people, convened to discuss the perceived need for written guidelines (perhaps as a step towards eventual standards), on the use of small unmanned aerial systems (sUAS or UAV) for geophysical and remote sensing surveys.

There was a common understanding and concern that drone geophysical data was already being acquired and processed, without proper guidelines, to a variable standard by a range of geoscientists and new players emerging all the time, all on a learning curve with dealing with the special characteristics and data processing challenges (noise types, ground clearance variation from requirements issues etc.) that typify drone acquired geophysical data compared to either ground or airborne acquired geophysical data. Accordingly a NSG Inter-Society Committee on UAS Geophysics Guidelines and Standards was formed (with members from SEG, EEGS, AGU, EAGE, ASEG, KEGS, AIG, SAGA, DGG, PESGB, IAGSA) and has met seven times since late 2020.

It was initially decided to produce a guideline draft document for circulation and comment (to all relevant NSG Societies), first for drone magnetic surveys (total field and vector), that would then serve as a template for what was agreed to be the range of other sensors also requiring guidelines (e.g. radiometrics, EM, remote sensing etc.). The guidelines are a work in progress and are being framed, drawing together the experience of the committee members and reviewers, as well as both: recognizing and referencing the rapidly proliferating literature on drone vehicles, geophysics acquisition, noise mitigation and processing in the literature; and the current published standards for other drone acquired data (e.g. photogrammetry, LiDAR etc.).

A set of topics to be included in the guideline(s) were discussed and a common agreement reached, that the goal is simply to inform and educate those engaging in or contracting drone geophysics on the options and best practices in regard to acquiring and processing geophysical and remotely sensed data using a drone. For magnetics, for example pragmatically, there were recognized three levels of rigor required for producing drone magnetics data depending on the end use of the data: (1) large anomalies (e.g. abandoned wells); (2) geological / geotechnical mapping; (3) UXO and archaeology. As well there were the different approaches to total field and vector magnetics acquisition and processing if either is use for these three applications.

In parallel to preparation of the first guideline document on magnetics, subcommittee members were working on gathering the specifics relevant to other sensors (in particular EM and radiometrics) in preparation for these follow-on other sensor guideline documents.

Assignments were made, draft versions of each chapter of the drone magnetics guidelines, were penned and critically reviewed, and revisions were made and collated into a draft (progress) document. All the while, every person on the voluntary committee attended to their respective obligations to regular jobs, education, and\or business. As this is a voluntary project, progress has been slow depending as it does on the availability of these busy

people in our industry.

A progress report is given on the guidelines process and the draft document tentatively titled: **UAV Total and Vector Field Magnetics Surveying Guidelines.**

The Draft Table of Contents for the **UAV Total and Vector Field Magnetics Surveying Guidelines** document is as follows:

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

The following is a list of topics or subjects covered in the proposed wider series of guidelines documents for all UAV geophysical sensor systems:

Magnetics	Drone Mapping
Radiometrics	Survey Planning and Execution
Electromagnetics	Data Point Positioning and Navigation
GPR	Post-Acquisition Processing
Remote Sensing Systems	Legal Considerations
UAV Platforms	Emerging Technologies
Best Safety Practices	Interpretation

NSG Inter-Society *Committee on UAV Geophysics Guidelines*

(New Committee members are welcome)

Rainer Wackerle	Tim Archer
Johannes Stoll	Elizabeth Baranyi
Steven van der Veeke	Geoff Pettifer
Jeff Gamey	Ed Cunion
Paul Mutton	Robert Lawson
Jean Legault	Ron Bell
Irina Filina	Dennis Woods
James Jensen	Alan Reid
Bruno Gavazzi	Jan Francke
Callum Walter	Chase Atwood

Contacts:

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

Bio:

Geoff is a Technical Director – Hydrogeology and Geophysics in GHD, and Principal in Terra Entheos Geoscience with 50+ years specialised experience in the practical application of almost all NSG airborne, surface, marine and downhole geophysical methods to mining, groundwater, geotechnical, environmental, oil and gas and mineral resource assessment, CO2 sequestration, geothermal, salinity, soil mapping and bore geophysical logging and condition assessment projects.

He has additional varied experience and training in irrigation review and management, water resources, remote sensing, image processing, information management, GIS and database, flood mapping, asset management, catchment management and community engagement. Geoff also has extensive groundwater, salinity, major infrastructure and international development assistance project management experience and not-for-profit board voluntary service experience.

His consulting interests include sustainable groundwater usage, sustainable irrigation, sustainable mining and mine development, geotechnical, environmental investigations and international development assistance and community / stakeholder engagement.

With the advent of UAVs to make the conduct of airborne geophysical surveys more accessible to geophysicists, non-geophysicists and clients he is on a learning curve with deployment and processing of magnetics, radiometrics and EM data and with other professionals is volunteering his efforts to develop guidelines for quality acquisition of geophysical data with the new UAV technology for geophysicists and particularly non-geophysicists and clients.

Geoff is a member of SEG, EEGS, EAGE, ASEG, IAH and AEG and has worked and consulted throughout Australia and overseas in Papua New Guinea, Indonesia, Malaysia, Bangladesh, China, Russia, Canada, US, Philippines and Africa.

Drone Demonstrators

Drone Geoscience, LLC
https://www.dronegeosci.com/

Discovery International Geophysics
https://discogeo.com/

Measur
https://drones.measur.ca/

Pioneer Exploration
http://www.pioneerexploration.ca/

Turntech Solutions Inc.
https://turntechs.ca/

Candrone
https://candrone.com/

Radiation Solutions Inc.
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Terraplus Inc.
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Geodrones Systems Inc.
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