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The application of airborne remote sensing during an On-Site Inspection

Aled Rowlands[1], Peter Labak[1], Xavier Blanchard[1]
Massimo Chiappini[2,3], Luis Gaya-Pique[3], John Buckle[4], and Henry Seywerd[4]

Application of airborne remote sensing during an On-Site Inspection (OSI)

According to paragraph 80, Part II of the Protocol to the Comprehensive Nuclear-Test-Ban Treaty, inspectors can use three airborne remote sensing techniques to characterise an inspection area.

The application of these three very different techniques will be summarised in this presentation.

"For any additional overflights […] inspectors on board the aircraft may also use portable, easily installed equipment for: multi-spectral (including infrared) imagery; gamma spectroscopy; and magnetic field mapping."

Application of airborne remote sensing during an On-Site Inspection (OSI)

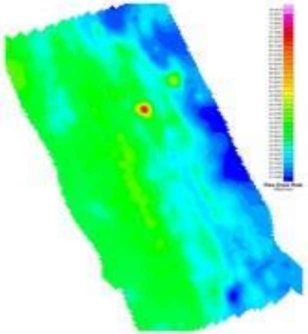
The application of any technique, ground or air, during an OSI is done through the implementation of a structured search logic, whereby missions are proposed by inspectors to answer specific questions.

Some examples of questions that could prompt missions involving airborne remote sensing techniques during an inspection are presented on this slide.

Multi-spectral imaging, MSIR

Q: Is there evidence of anthropogenic activity?

Q: Is there evidence of recent mass movement?



Measurement of levels of radioactivity - gamma spectrometers

Q: Is there evidence of a large scale (Baneberry-type) release in the inspection area?

Magnetic field mapping

Q: Is there evidence of a vertical emplacement?

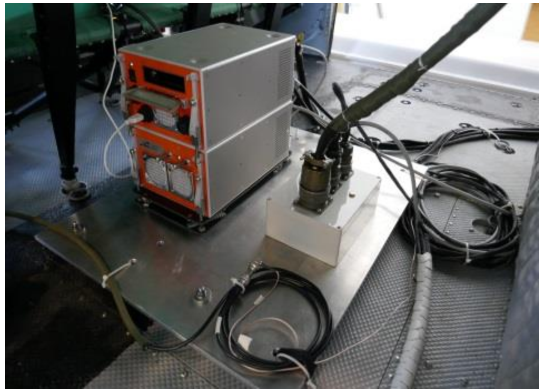
Deployment of MSIR (optical) configuration

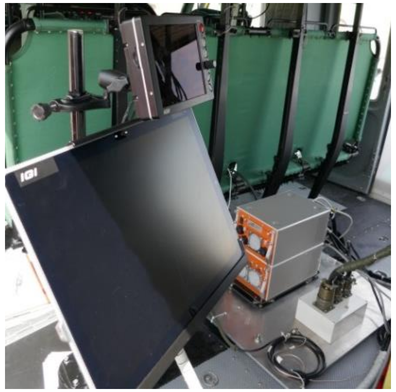
A flexible range of installation options has been developed including external pod and internal mount over an airframe hatch.

All installations have been developed with air worthiness standards in mind.

Given payload limitations and airframe hatch size it is not possible to deploy the full sensor array in each installation. The choice of sensors in this case is dependent on questions posed as part of search logic.


Sensors in pod on Bell212


On-board computing


System monitors


Sensors in pod on Bell212


Sensors in pod on AS350

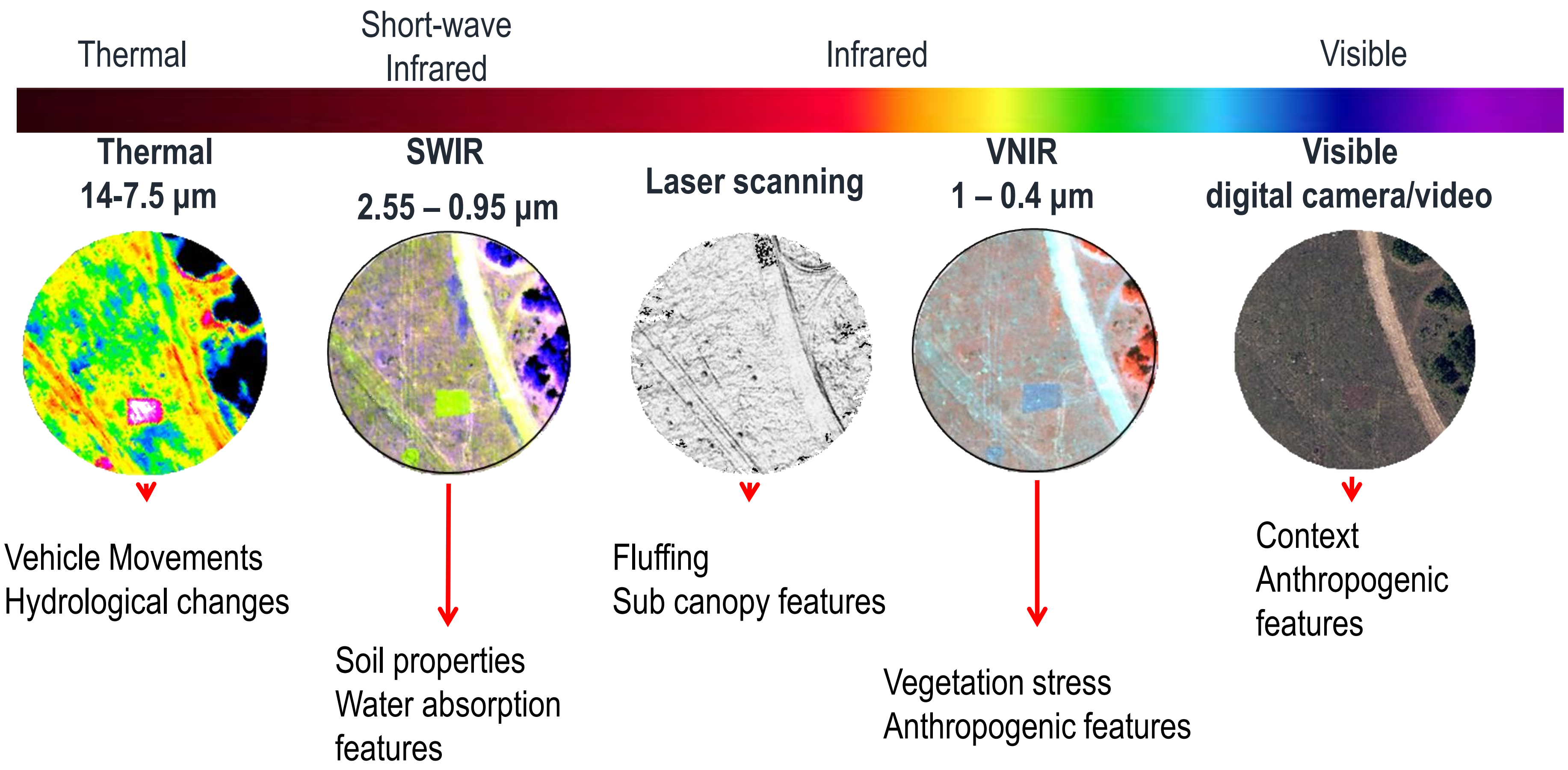

Internal AS332 mount

MSIR (optical) sensor array

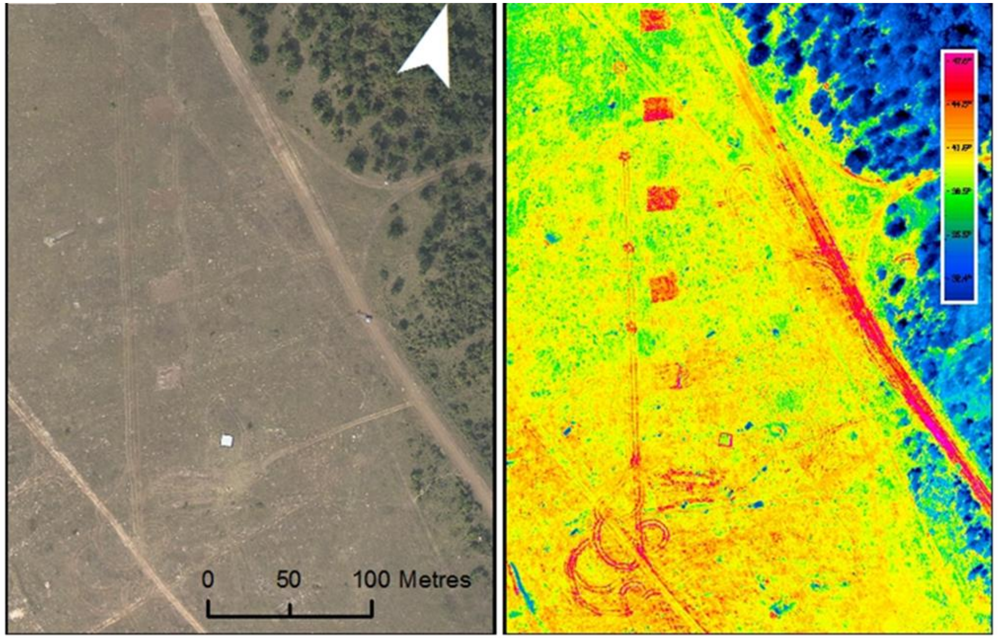
The MSIR array comprises 5 discrete sensors that provide spectral information in different parts of spectrum. The array includes:

- passive and active sensors
- broad as well as narrow-band sensors

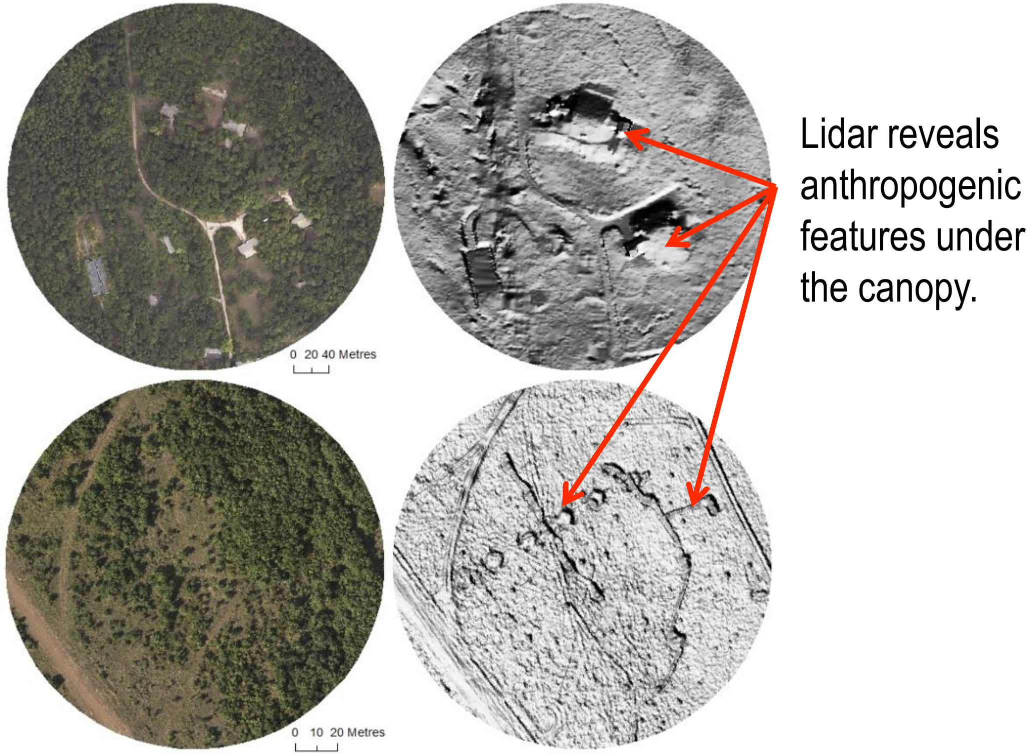
Derived data focus on the identification of OSI-relevant features.



Application of MSIR (optical) sensors
– some examples



Pair of visible and thermal images over an area of disturbed ground, where vehicle movements and construction activity are clearly visible in the infrared image.



Sequence of visible and processed lidar images showing the presence of sub canopy features in the lidar data.

Deployment of gamma survey equipment

As with the optical sensor array, a flexible range of installation options has been developed for the gamma survey equipment.

This includes a range of custom plates for the NaI detectors that are secured to hard points in an airframe cabin.

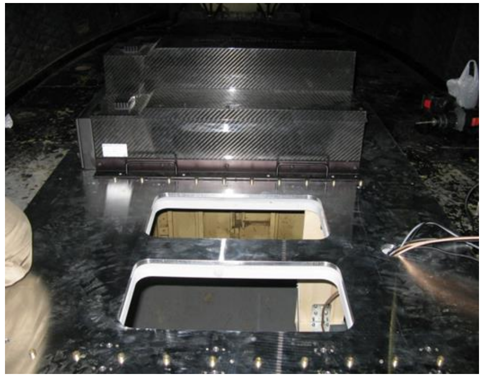
Custom mounts have been engineered for the laser distance meter and radar altimeters used to calculate distance between the airframe and the ground.

Detectors and computing on UH-60

Detectors and computing rack on AS332

Custom mount for laser distance meter for Bell 212

System installed on AS350



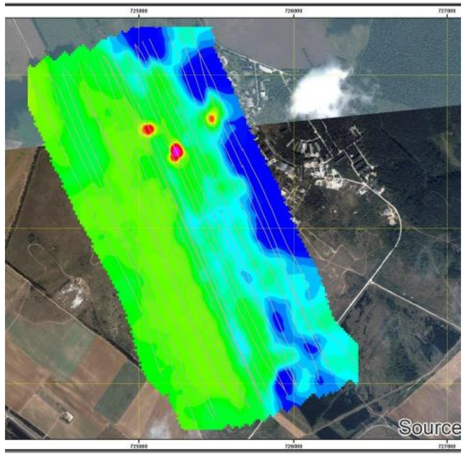
Installation plate for detectors on AS332

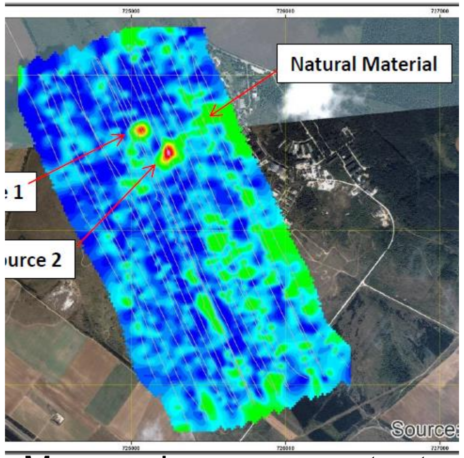
Custom mount for laser distance meter for AS332

Application of gamma radiation surveys

As part of the development of airborne gamma radiation survey capability, a concept of operation for its application in an OSI context has been developed. This considers various potential release scenarios and provides guidance to inspectors on survey design and processing routines.

To better understand the application of the technique in different environments, surveys in an environment with a thick snow blanket have also been performed.

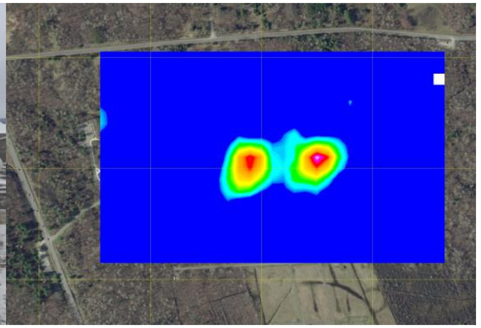

Total count rate at ground



Man made gross count rate product

Standard processing routines involve the generation of total count at ground and man made gross count data products


Bell212 with gamma survey equipment

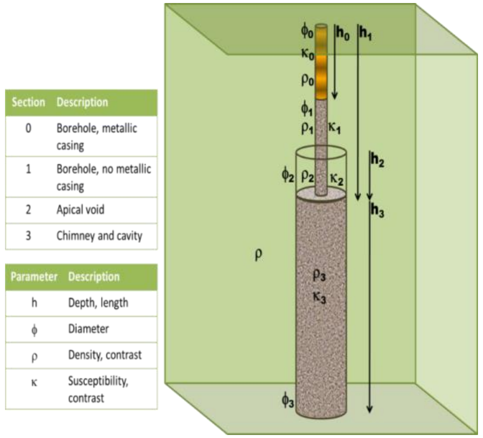

Man made gross count rate data of airborne survey in snow

Presence of snow attenuates natural background. Material from a detonation deposited on the surface, can anticipate better detectability

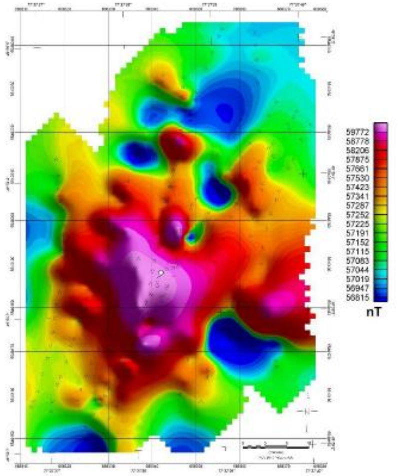
Magnetic field mapping

Although magnetic anomalies created by OSI-relevant observables such as vertical emplacements with metallic casing can reach amplitudes of thousands of nanotesla on the ground, the amplitude decreases quickly with height and its value at the altitude of a typical aeromagnetic survey is of the same order or smaller than the changes in the magnetic field due to the diurnal variation.

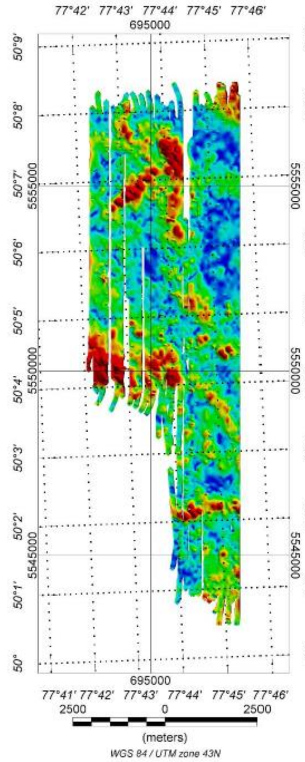
Modelling potential magnetic signals is supporting the development of a concept of operations for the application of airborne magnetic surveys in an OSI-context.



Schematic diagram of a vertical emplacement for which a magnetic anomaly can be modelled



Total magnetic field reduced to the pole measured at ground level over a nuclear vertical emplacement in the former Semipalatinsk Nuclear-Test Site (Gaya-Piqué et al., 2009). The solid white circles show the position of the boreholes.



Analytical signal of the measured magnetic intensity from an airborne survey in Semipalatinsk

Magnetic field mapping

As with all airborne techniques, the development of an aeromagnetic platform for OSI purposes cannot be done without knowledge about the type of aircraft where the equipment will be installed/deployed. Therefore, detailed technical specifications of aircraft of potential use during an OSI must be developed.

Typically, for OSI operations, rotary aircraft are the preferred choice but fixed wing aircraft should not be dismissed.

Airborne magnetic field mapping using a 'bird' deployed from an AS365 helicopter as part of an OSI test event in Hungary

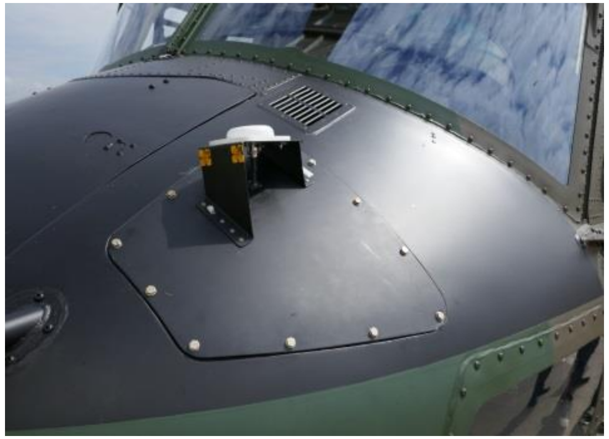
Deploying a magnetometer during an OSI training event in Sicily from an AS350 helicopter

Positon finding and operations:
GNSS antenna and navigation panels

To facilitate airborne operations, a range of position finding options have been developed.

Options cater for different airframe types and restrictions imposed by the air operator, these include:

- GNSS external and internal mounts;
- Pilot and operator navigation panels.


GNSS antenna mount on Bell212


Pilot navigation panel on AS332


GNSS antenna mount on AS350


External pod mounted antenna for Bell212

Conclusions

As with all techniques that can be applied during an OSI, it is important to understand the limitations of each airborne technique and to manage expectations about their applicability.

This is achieved through a detailed understanding of OSI-related features and how they relate to techniques.

A well-defined concept of operations for each technique provides guidance to inspectors on how each airborne technique could be applied during OSI to advance the inspection.