

# CORPORATE PROFILE

*Airborne Geophysics for Mineral Exploration*

Precision  
GeoSurveys

## Your Best Choice for Mountainous and Remote Terrain

### At a Glance

Full-service airborne geophysical contractor

Industry leader in providing high resolution surveys in mountainous and remote terrain

Highly skilled in electromagnetics, magnetics, and radiometrics

Full capabilities in data acquisition, processing, inversions, interpretations, and integrations

Rapid turn-around of high resolution data

R&D focused - continually developing new technologies and better survey methods

### Hundreds of Surveys on Four Continents

Mineral deposits are where you find them - which means you can't let tough conditions impede your exploration program. So call on Precision GeoSurveys for high resolution airborne geophysical surveys in mountainous and remote terrain. We've flown hundreds of projects on four continents, so you know we'll get the job done.

Our goal is to provide you with the most detailed data no matter what the conditions.

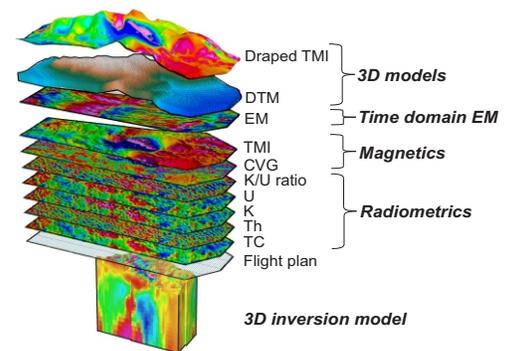
### State-of-the-Art Equipment. Fast Results

When you choose Precision GeoSurveys, you get specially-trained pilots and helicopters equipped and modified specifically for airborne geophysics. The result is enhanced data quality and reduced delivery time. We also offer full capabilities in data acquisition,

survey design, processing, inversions, interpretations, and integrations.

You'll appreciate our dedication to fast turn-around, too. Following a data review with an intensive QA/QC routine, you'll generally receive preliminary data at the end of each day.

Give us a call or send an email.



Simultaneous collection of multiple data sets allows quick and cost-effective evaluation of mineral potential



### MAGNETICS

- maps the distribution of magnetic minerals
- useful for all types of geology and mineral deposits
- cost-effective
- applicable in all types of terrain

### ELECTROMAGNETICS

- maps conductivity and resistivity
- particularly effective for massive sulfides
- can be applied to a wide variety of deposit styles
- consistent coverage over large and inaccessible areas



### RADIOMETRICS

- maps the distribution of radioisotopes
- particularly effective for porphyries and REE
- easily combined with magnetics
- isotope ratios enhance detection of subtle features

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# DESIGNING AN AIRBORNE SURVEY

## Maximizing Value in Airborne Geophysics

### Benefits of Airborne Surveys

Ideal for early to mid-stage exploration projects

Suitable for a wide variety of minerals

Independent of access and terrain

Provides critical data for exploration managers

Efficient and affordable

Minimal permitting and environmental impact

Year-round capabilities

Uniform coverage over large areas

Not all technologies work in all environments

Airborne geophysical surveys are used in a wide variety of geological, mineral exploration, oil exploration, and geotechnical applications to investigate the subsurface. In mineral exploration, airborne geophysical surveys are commonly used in early to mid-stage exploration projects and have contributed to the discovery of many ore deposits. The main airborne technologies are magnetics, radiometrics, and electromagnetics.

### How can Airborne Geophysics Benefit Your Exploration Program?

Many mineral deposits have features which can be mapped, directly or indirectly, with airborne geophysical methods. Every mineral deposit is unique. An exploration manager must consider many variables in geology, deposit style, technology, logistics, terrain, and budget to maximize value in the survey investment. Airborne geophysics can provide your

exploration managers with data critical for complex decisions.

Airborne geophysical surveys have never been more efficient or affordable. Advances in sensor design, digital data collection, computer processing and GPS navigation have revolutionized the way geophysical surveys are conducted, how data are processed, and how results are interpreted. Airborne geophysics offers year-round capabilities with minimal permitting and environmental impact compared to ground surveys. Airborne surveys offer uniform coverage over large areas at a much lower cost than an equivalent ground survey.

Not all mineral deposits or geological settings respond to all types of geophysics. The right technology and the right survey parameters must be selected for the survey to be effective.

<i>Deposit Type</i> \ <i>Geophysical Method</i>	Magnetic	Electro-magnetic	Radio-metric	Gravity
Kimberlite	Highly effective	Moderately effective	Moderately effective	Moderately effective
Lode Gold	Highly effective	Moderately effective	Moderately effective	Generally Ineffective
VMS	Highly effective	Highly effective	Moderately effective	Highly effective
MVT Pb-Zn	Highly effective	Moderately effective	Generally Ineffective	Highly effective
Porphyry Cu-Au	Highly effective	Moderately effective	Highly effective	Generally Ineffective
Uranium	Highly effective	Moderately effective	Highly effective	Generally Ineffective
IOCG	Highly effective	Highly effective	Highly effective	Highly effective
Magmatic Ni-Cu	Highly effective	Highly effective	Generally Ineffective	Highly effective
REE	Highly effective	Generally Ineffective	Highly effective	Generally Ineffective
Cost \$/km <sup>2</sup>	200-400	400-700	150-350	400-700

● Highly effective    ● Moderately effective    ● Generally Ineffective

Generalized applications of geophysical methods to mineral deposit types. Cost is based on 200 m line spacing by helicopter, and will vary according to job size, topography, and location. Combining different technologies will reduce cost but may reduce data quality.

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# HIGH RESOLUTION DATA In Airborne Geophysics

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## Maximizing Value with High Resolution Data

### high-res·o·lution

adjective

Of or relating to an output device that produces images that contain a large number of dots per unit of area and are therefore sharp and detailed

The higher the resolution, the more detail in geological mapping and mineral target identification

Almost all mineral targets are in the near-surface envelope where high resolution data are critical

Flight height, line spacing, and sample interval must be appropriate for geology, exploration model, and terrain

High resolution data does not always cost more

Sensor location is controlled by pilot skill and is a significant factor in collecting high quality data

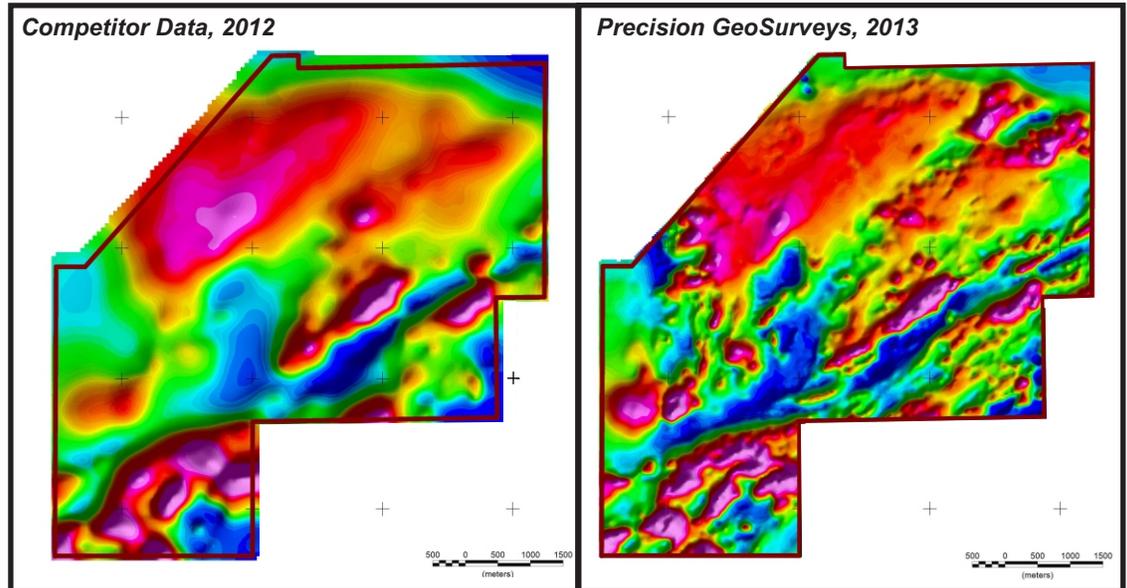
Laws of inverse squares ( $1/r^2$ ) and inverse cubes ( $1/r^3$ ) mean that low-level data collection is essential

Only low-level surveys are capable of mapping near-surface detail relevant to mineral exploration

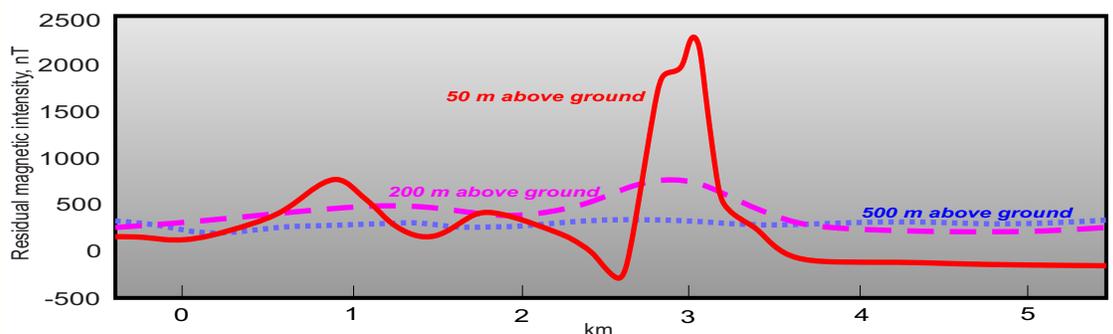
High signal/noise ratio and skilled data processing will improve data

No amount of processing will recover poorly flown data

## Can you afford to miss the details?



Helicopter-borne magnetic survey in mountainous terrain flown by competitor in 2012 (L) and delivered as “high resolution.” The same area was re-flown by Precision GeoSurveys in 2013 (R). Higher resolution resulting from lower flight height, consistent ground clearance, lower aircraft noise, superior processing, and less filtering provides significant enhancements in ability to map geology, alteration, and structure.



Note the longer wavelength and lower amplitude of the profiled anomalies at 200 m and 500 m terrain clearance. In fact, true high resolution data can only be achieved by flying close to the ground and with a constant terrain clearance. Pilot skill makes a difference!

**“Price is what you pay. Value is what you get.”**

- Warren Buffett

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### AirTEM: The New Standard in Helicopter Time Domain Electromagnetics

EM is useful for mapping conductivity and resistivity in the subsurface.

Typical applications are mineral deposits, massive sulfides, graphite, kimberlite, and groundwater.

Superior resolution for both shallow and deep targets

Search depth ranges to 300 m below surface.

Lightweight design and compact footprint

Powerful transmitter - 400 amps at 80 volts

Triangular waveform and fast ramp-off time of 35 microseconds provide unsurpassed resolution for shallow and deep targets

Rigid aerodynamic structure provides stability in mountainous flying conditions

Small size allows operation in confined areas

AirTEM is a third generation TDEM system ideal for collecting high resolution data in mountainous terrain

Very low noise data reduces filtering

Design allows for simultaneous collection of magnetic data

AirTEM data are delivered in hours - not weeks or months

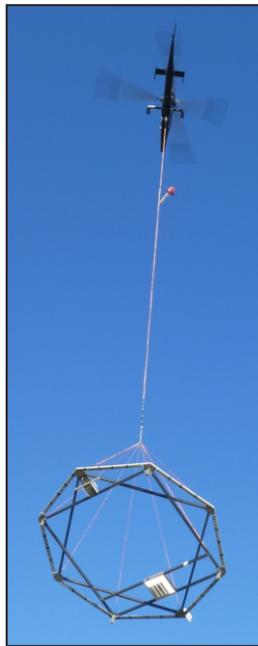
#### The Science: Mapping Conductivity

Subsurface conductivity/resistivity related to mineral deposits, geology, alteration, silicification, and groundwater can be mapped using electromagnetic methods. Time domain EM measures subsurface electrical properties by inducing an electrical current into the ground. The transmitted EM field induces a series of currents in the earth at increasing depths over time. These currents, in turn, create magnetic fields which can be measured to map subsurface conductive properties. Because measurements are made while the transmitter current is turned off, the more sensitive measurement of the magnetic field generated by the subsurface enhances resolution of conductive features at great depth.

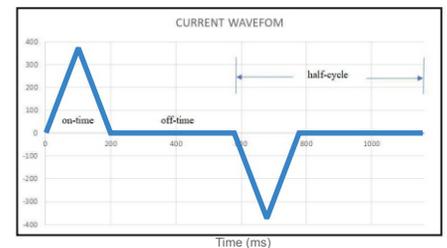
#### The Tool: AirTEM

AirTEM is an innovative third generation TDEM system developed by Triumph Instruments. A unique transmitter design provides increased sensitivity in early time gates to significantly enhance spatial and vertical resolution. AirTEM's exceptionally high signal/noise ratio and triangular wave form make it capable of measuring early time responses to enable accurate geological mapping of shallow features as well as deeper conductive responses from later time gates.

AirTEM is a fully automated system operated from a helicopter platform which provides lower operating cost with a high level of safety.



Extremely low-noise data require much less filtering than competing systems, and preliminary data can be delivered on the same day. Its simple lightweight design and stable low drag aerodynamics in horizontal, climbing, and descending flight regimes make it well suited to operations in mountainous terrain without compromising power or resolution. These advantages allow Precision GeoSurveys to provide unsurpassed resolution for both shallow and deep targets, even in steep terrain, through longer survey endurance and close terrain following - all while reducing survey costs.



Triangular waveform provides maximum power.

#### AirTEM Specifications

Diameter (m)	9
Area (m <sup>2</sup> )	375
Peak Current (amps)	400
No. of turns	6-12
Moment (Am <sup>2</sup> )	180,000-400,000
Duty Cycle (%)	25 - 45
Coil orientation	X-Y-Z
Wave form	Triangular
Base frequency (Hz)	25/30 or 75/90
Current draw (amps)	50
Weight (kg)	350 - 480

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### ANTHEM: Superior Conductivity Mapping

Introducing **ANTHEM** -  
Advanced New Technology  
Helicopter  
ElectroMagnetics

EM is useful for mapping  
conductivity and resistivity  
in the subsurface.

Typical applications are  
mineral deposits, massive  
sulfides, graphite,  
kimberlite, groundwater,  
and geological mapping.

Superior resolution  
especially for shallow  
targets.

Search depth ranges to  
40 m below surface.

Lightweight structure with  
fully digital operation.

Robust design and fast  
survey speed reduces  
survey cost.

Aerodynamic structure  
provides stability in  
mountainous flying  
conditions.

Up to five simultaneous  
frequencies, user  
programmable.

Preliminary ANTHEM data  
are delivered in hours - not  
weeks or months.

#### The Science: Mapping Conductivity

While most subsurface conductivity/resistivity measurements are now made with time domain EM technology (such as Precision's ITEM system) because of a deeper search depth, TDEM systems are expensive and are not able to map shallow geophysical features that may be desired for mineral exploration, structural mapping, and groundwater studies. For example, gravel deposits and kimberlite bodies are sometimes only detectable using frequency domain EM technologies. Frequency domain EM is traditional and proven technology for measuring subsurface electrical properties by generating an electromagnetic field that induces current in the earth which in turn causes the subsurface to create a magnetic field. By measuring this magnetic field, subsurface properties and features can be deduced. This method measures the magnitude and phase of induced electromagnetic currents, which are related to subsurface electrical conductivity. Electrical conductivity is a function of the soil and rock matrix, percentage of saturation, and the conductivity of pore fluids. FDEM instruments provide two measurements simultaneously; the electrical conductivity data and the in-phase component, which responds to magnetic susceptibility and metal.

**The Tool:** ANTHEM is an innovative, fully digital, third generation FDEM system. ANTHEM's exceptionally high signal/noise ratio makes it capable of measuring subtle differences in resistivity and conductivity.

ANTHEM is a fully automated FDEM system operated from a helicopter platform which provides lower operating cost and a high level of safety without compromising data quality. Using a unique single set of transmitter and receiver coils and up to five user-programmable frequencies, extremely low-noise data can be acquired. Clean data means less filtering than competing systems, and preliminary data can be delivered on the same day. Its simple lightweight design and stable low drag aerodynamics in horizontal, climbing, and descending flight regimes make it well suited to operations in mountainous terrain without compromising power or resolution. These advantages allow Precision GeoSurveys to provide unsurpassed resolution, even in steep terrain, through longer survey endurance and close terrain draping - all while reducing survey costs.



#### ANTHEM Specifications

Length (m)	6.5
Coplanar coils	1 Tx, 1 Rx
No. of frequencies	5
Power requirement	25 amps, 28 VDC
Base period	1/30 sec
Maximum moment, 300 Hz	500 Amp m <sup>2</sup>
Maximum moment, 1000 Hz	160 Amp m <sup>2</sup>
Maximum moment, 10,000 Hz	16 Amp m <sup>2</sup>
In-Phase and Quadrature Output	ppm
Frequency range	90 - 48,000 Hz
Weight (kg)	230

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# GRADIENT MAGNETICS

## Mapping the Earth's Subsurface

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GeoSurveys

### Why use Gradient?

Measured gradient can provide more detail than calculated gradient

Better resolution of near-surface magnetic features

Suppression of regional anomalies due to deep sources

Provides more geometric information than total magnetic field

More sensitivity to smaller features, especially if they are not directly under a flight line

Independent of magnetic storms and diurnal changes

Best suited for shallow targets in gentle terrain

Can be flown by helicopter or fixed wing

No loss of standard TMI signal, normally measured by center sensor

3D inversions provide detailed subsurface structural information

### Gradient Dimensions

**Fixed wing** (Navajo)  
crossline (x) 14.7 m  
inline (y) 8.8 m

**Helicopter** (AS350 booms)  
crossline (x) 11.4 m  
inline (y) 7.2 m

**Triaxial** (helicopter bird)  
crossline (x) 3.2 m  
inline (y) 3.6 m  
vertical (z) 3.2 m

## Gradiometry -

### When single sensor surveys aren't enough

#### The Science: Collecting more detail in aeromagnetic surveys

Aeromagnetic surveys are commonly flown with a single magnetic sensor, but there are circumstances where additional magnetic sensors can be beneficial. Multiple sensors taking simultaneous measurements in fixed relative positions allows the magnetic gradient to be measured rather than calculated.

#### The Tool: Gradient Magnetic Surveys

When an aeromagnetic survey is flown with two or more magnetic sensors with a known separation, the magnetic gradient can be directly measured as the difference in magnetic field between the sensors divided by the distance. This has significant advantages in certain situations, especially when the magnetic targets are shallow.

Gradient magnetic surveys can be flown by fixed wing or helicopter. Precision's helicopters and fixed wing survey aircraft can be equipped with three magnetic sensors in a fully certified triple boom configuration providing a large amount of separation in the x and y axes. Our slung, aerodynamically stable, four-sensor magnetometer system provides gradient measurements in the x, y, and z axes for the ultimate in low-noise triaxial resolution and versatility using local helicopters.

Compensation and 3D positioning of individual magnetic sensors reduce aircraft noise and improve sensitivity. By applying intelligent gridding algorithms to 2-axis or 3-axis gradient data, a significant improvement in the spatial positioning of small magnetic bodies can be achieved. Laterally continuous horizons, especially if they are parallel with the flight line direction, will be more apparent.



Precision's 3-sensor fixed-wing system provides economical 2-axis gradient data suitable for gentle terrain.



Precision's helicopter-mounted 3-sensor system provides 2-axis gradient data in steep terrain.



Precision's unique 4-sensor gradient system provides 3-axis data under a helicopter. Best suited for gentle to moderate terrain.

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# MAGNETICS

## Mapping the Earth's Subsurface

### Aeromagnetics -

### Powerful data applicable in all geological environments

#### Why use Magnetics?

Aeromagnetic surveys are cost-effective exploration tools, and very popular for early to mid stage projects

Earth's magnetic field is affected by the distribution and concentration of magnetic minerals in the subsurface

Many mineral deposits are related to variances in magnetic minerals, which can be mapped by aeromagnetic surveys

Useful for mapping of lithology, structure, and alteration

Applicable to most types of mineral deposits and geological settings

Modern magnetometers are lightweight, reliable, and very accurate

Stinger mag with 3D compensation provides high resolution data in mountainous terrain

Gradient mag is useful for shallow targets in gentle terrain

Towed heli-mag is best suited for flat terrain

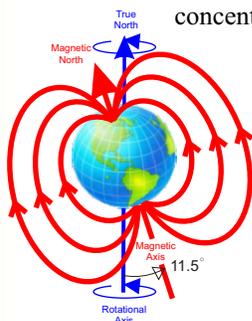
Fixed wing mag is best suited to large surveys over gentle terrain

#### The Science: Mapping the Earth's Magnetic Field

Aeromagnetic surveys map the Earth's magnetic field. The magnetic field is influenced by many factors including the distribution and concentration of magnetic minerals (primarily magnetite) in the subsurface.

#### The Tool: Aeromagnetic Surveys

Most lithologies and mineral deposits are associated with changes in the concentration and distribution of magnetic minerals. Because aeromagnetic surveys can map these changes, they're very useful and cost-effective tools for mineral exploration programs - especially for early to mid-stage projects.



Aeromagnetic maps show the spatial distribution and relative abundance of magnetic minerals in the survey area. Rock types differ in their content of magnetic minerals, allowing a visualization of the geological structure. Most evident are the spatial geometry of bodies of rock and the presence of faults, folds, and hydrothermal alteration zones. These maps are particularly useful where surficial deposits of sand, soil or water obscure bedrock.



Stinger-mounted mag sensor

While some mineral deposits contain an abundance of magnetic minerals and are direct targets for aeromagnetic surveys, the most valuable contribution of aeromagnetic data in most mineral exploration applications is the identification of lithology, structure, and alteration.



High resolution single-sensor magnetic survey by helicopter



Multi-sensor (gradient) fixed wing survey



Multi-sensor (gradient) helicopter survey

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# RADIOMETRICS

## Mapping Radioactive Sources

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### Mapping radioisotopes with gamma rays

#### Why use Radiometrics?

All geological materials contain varying concentrations of the natural radioisotopes U, Th, and K.

Radiometric surveys map the concentration and distribution of natural gamma rays generated by radioactive isotopes.

Distinguishing between the individual isotopes is called gamma ray spectrometry.

Many mineral deposits are related to distinctive changes in U, Th, and K concentrations to help map geochemistry from the air.

Relative proportions of the various radioisotope contributions are often characteristic of specific alteration patterns, lithologies, and geological units.

Gamma rays are attenuated by mass, therefore, radiometric surveys map isotope concentrations at the Earth's surface.

Low level flights enhance resolution.

Particularly effective for porphyry exploration, uranium exploration, and REE exploration.

Easy add-on with stinger mag survey, without compromising either data set.

#### The Science: Natural Radioisotopes

All geological materials contain trace amounts of the natural radioisotopes uranium (U), thorium (Th), and potassium (K). Many mineral deposits are related to distinctive changes in U, Th, and K concentrations. Radioactive isotopes generate gamma rays, which are useful in exploration geophysics.

#### The Tool: Radiometric Surveys

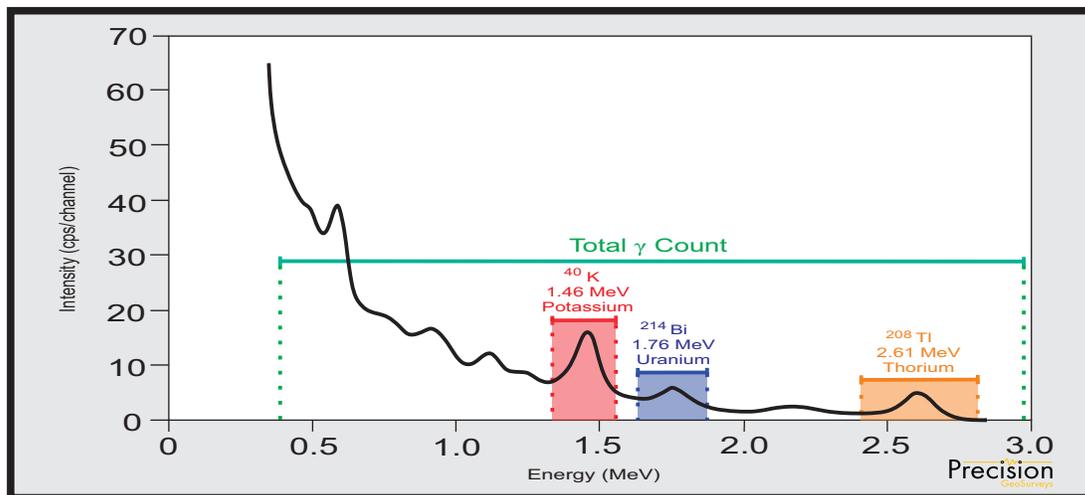
Gamma rays generated by radioisotope decay can be detected and mapped with spectrometers. Precision GeoSurveys uses Scionix self-calibrating NaI(Tl) spectrometer crystals which measure the full spectrum of radioactive elements including U, Th, and K. The system records 256/512 channels to detect and map individual radioisotope sources for processing using PC-based Praga-3 software.

Maximum quality of radiometric data is achieved by increasing crystal volume and decreasing flight height. Most of Precision's surveys are flown with 8.4 to 21 liters of crystals within 50 m of ground level.

Radiometric surveys are particularly useful for detecting uranium and rare earth element deposits, and mapping K enrichments in potassic alteration zones in porphyry environments. Other applications are geological mapping, nuclear investigations and soil mapping.



Spectrometer crystals installed in AS350 survey helicopter



Gamma ray spectrum from porphyry target in northern BC, measured at 40 m ground clearance. 256 channels identify individual radioisotopes, including distinctive potassium channel.

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