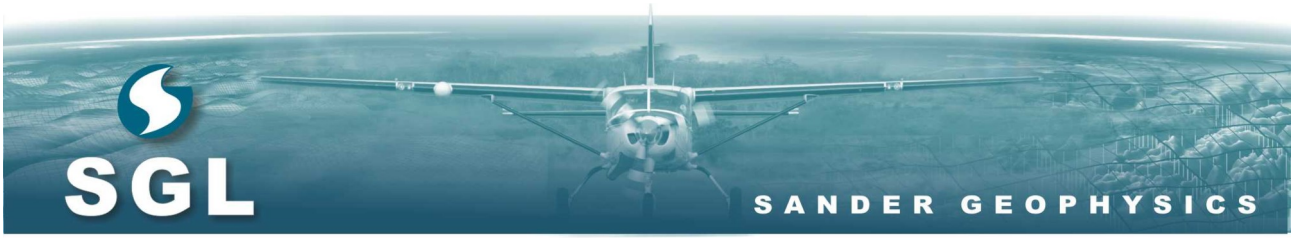

High Resolution Gamma-Ray Spectrometer Surveys

Sander Geophysics has over fifty years of experience conducting high resolution gamma-ray spectrometer surveys in Canada and internationally. The company owns and operates ten fixed wing aircraft for airborne gamma-ray spectrometry, as well as two Airbus Helicopters AS350 B3s. SGL has successfully flown numerous fixed wing and helicopter-borne spectrometer surveys. Surveys using a fixed wing aircraft offer both speed and lower operating costs, however helicopter-borne surveys are capable of defining small anomalies more accurately and result in data of higher resolution and sensitivity.

SPECTROMETER SURVEYS AT SGL

SGL's twelve airplanes include eight Cessna 208B Grand Caravans and two de Havilland DHC-6 Twin Otters each of which can accommodate 50.4 litres (3000 cu in) of downward facing crystals and 8.4 litres (512 cu in) of upward facing crystals. The helicopter-borne system can accommodate up to 33.6 litres facing down and 8.4 litres facing up. All our aircraft are equipped with an integrated navigation system, **SGNav** utilizing a NovAtel GNSS (Global Navigation Satellite System) receiver, for precise navigation and accurate flight path recovery.

	Detectors (litres)	Crystals
Helicopter	up to 33.6 downward	4 - 8
	up to 8.4 upward	1 or 2
Fixed Wing	up to 50.4 downward	8 - 12
	up to 8.4 upward	1 or 2

High resolution aeromagnetic data can be gathered simultaneously with either system. In the fixed wing aircraft, the cesium magnetometer sensor is mounted in a stinger on the tail of the aircraft with the capability to include sensors in a horizontal and/or vertical gradiometer configuration. The helicopter has either a stinger or a towed bird with cesium magnetometer sensors, singly or in a gradiometer configuration.

SGL has implemented a spectral component analysis noise reduction processing technique, based on the method of Hovgaard and Grasty (of Radiation Solutions Inc. and Gamma-Bob respectively). The noise reduction technique, called Noise Adjusted Singular Value Decomposition (NASVD), uses the full spectrum data to enhance the resolution of radiometric data. The reduction in statistical noise is equivalent to increasing the detector volume by a factor of between 3 and 4. SGL also uses a combination of spectrum fitting and NASVD to produce maps of cesium, and other man-made nuclides, from the full spectrum radiometric data.

THE SPECTROMETERS

SGL uses SGSpec and Radiation Solutions Inc. (RSI) spectrometers, which are recognized as the most advanced airborne spectrometer systems available. They include an on-board computer which allows real-time signal processing and analysis, previously available only in laboratory instruments. The combination of automatic gain control for individual crystals, multi-channel analysis, and full spectrum recording removes many of the limitations inherent in the older airborne systems.

SGSpec and RS-500 use spectrum analysis techniques to control the gain of the system. The system constantly monitors the natural thorium or potassium peak of each crystal detector, and using a Gaussian least squares algorithm adjusts the gain of each crystal individually. In addition, each crystal resolution is calculated in real-time and the operator is informed if the crystal is out of specification.

SGSpec and RS-500 are designed to provide high quality signal processing with a minimum of operator intervention. This enables the spectrometer to be operated in a variety of conditions and minimizes operator error.

CRYSTAL DETECTOR CONTROLLER

- Real-time spectrum analysis for each individual crystal ensures optimum stabilization and resolution. This is achieved by the use of a sophisticated Gaussian curve fitting algorithm for centroid analysis of the natural potassium or thorium peak.
- Each crystal has individual pole-zero cancellation, semi-Gaussian shaping and an advanced baseline restorer.
- Real-time graphical display for system and spectrum monitoring.
- Accurate pile-up rejection for simultaneous pulses allows quantitative gamma-ray spectrum analysis almost independent of system count rate. Special circuitry analyzes for pulse pile-up and permits only detector signals from single events to be analyzed.
- Residual pulse pile-up: pulses separated by more than the fast channel resolving time, and less than 1.05 x peak time are rejected.

ANALOG TO DIGITAL CONVERTER - ADC

Individual A/D converters	One per detector
Number of channels	1024 per detector
ADC clock rate	RSI: 50 MHz; SGSpec: 80 MHz
Linearity	Integral: less than 0.2% Differential: less than 1%
Average system dead-time	No conversion time
Live time channel	Actual system live time output with digital data allowing post correction of system dead-time to an accuracy of 0.1%
Maximum number of counts/channel	1,048,576 [20 bit]
Thresholds	Lower: software selectable from channel 2-50 in 1 channel steps Upper: 3 MeV, A/D offset is software selectable
Cosmic channel	All pulses above 3 MeV are summed and recorded in the cosmic channel as a direct measure of cosmic ray activity
Maximum input count rate	100,000 cps

DIGITAL DATA RECORDED

System resolution and detector resolution are automatically calculated for each crystal and are recorded to provide accurate in-flight and post-flight quality assurance.

Window mode
Eight user selectable windows, typically corresponding to the total counts, potassium, uranium and thorium. The eight windows allow these 4 parameters to be recorded in both upward and downward detectors, plus one cosmic channel for pulses >3 MeV.

Full spectrum mode
Full 1024-channel spectrum with user selected end points. Individual detector and system resolution are recorded for both upward and downward crystals providing accurate post-flight data quality control.