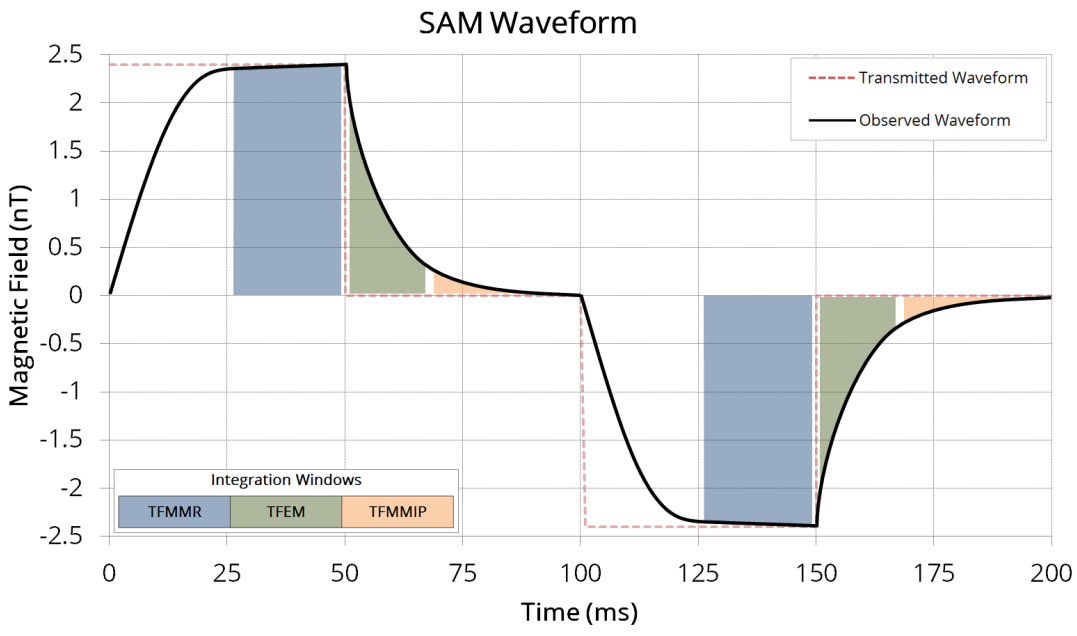
SAM Total B-field Technologies

Sub-Audio Magnetics (SAM) is a proprietary survey technique which requires a geophysical transmitter to transmit a precisely controlled signal into either an inductive transmit loop or a grounded dipole in order to induce secondary fields in sub-surface conductors. Using Gap GeoPak transmitters, currents of up to 200A are normally achieved with low resistance loops. Typically, 15-30A will be transmitted into a grounded dipole.

A Gap Geophysics TM-7 SAM Receiver is used to record the earth's total magnetic field at sample rates up to 9600Hz. The TM-7 uses a cesium vapour magnetometer sensor which provides a scalar total field measurement without the requirement of levelling or orienting the sensor. The acquired data is post-processed to extract several parameters which relate to different physical properties of the earth. The actual parameters available are dependent on the survey configuration and may include:

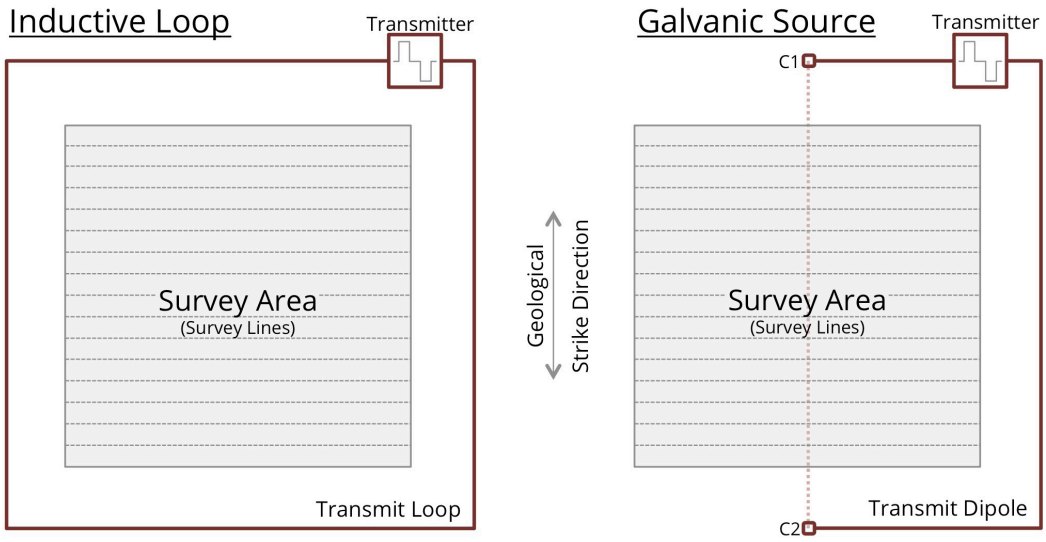
- *Total Magnetic Intensity (TMI)*
- *Total Field MagnetoMetric Resistivity (TFMMR)*
- *Total Field ElectroMagnetics (TFEM)*
- *Total Field MagnetoMetric Induced Polarisation (TFMMIP)*

Each parameter extracted from a different part of the received waveform as illustrated below. TFMMR is an ON-time measurement as it occurs whilst current is being transmitted into the dipole where as TFEM and TFMMIP are OFF-time measurements as they occur whilst the transmitter is switched off. TMI is recovered from the low frequency component of the waveform.



From these direct measurements, 3-component EM and Magnetometric Conductivity (MMC) can be calculated. MMC data is only available when a survey is conducted with a Galvanic Source.

The differences in survey design are illustrated below:



Galvanic surveys have two electrodes and a half loop located outside the survey area. Whilst transmitting, Current flows through the ground from the source to the sink electrode. Current flows along relative conductors or structures which in turn create secondary fields that are detected by the receiver.

Inductive surveys measure the magnetic component of the eddy currents that are generated when the transmitter shuts off. These currents circulate in a conductor for a short period after turnoff and decay as they lose energy.

Depending on the requirements, SAM B-field technologies can be deployed in a number of ways.

SAMSON

SAMSON is a powerful, low noise, deep search technique. SAMSON is collected as stationary measurements typically 50m apart in either a moving loop or fixed loop configuration. SAMSON is typically quicker to acquire than SQUID or fluxgate data as there is no setup of the sensor at each station. SAMSON has successfully detected high conductance (Cu, Ni) ore bodies in excess of 700m below surface.

A low transmit frequency allows for greater discrimination between near surface and deep conductors. Data quality is monitored in real time via on screen decays and audio alerts.

UltraSAM

UltraSAM is a high definition, high quality technique for mapping small metallic items such as Unexploded Ordnance (UXO), ground engaging tools (GETS) or other metallic scrap. Data is typically collected with a 4 sensor array with a sensor spacing ranging from 30cm to 1m. The survey can be deployed using a 40 m x 40 m fixed loop up to a 110 m x 110 m fixed loop depending on the target size. UltraSAM has successfully mapped GETS and 500 lb MK82 bombs to 6 m in an environment with low magnetic gradients.

LFSAM

LFSAM is a hybrid technique utilising a transmit frequency of 1 Hz. Data is continually collected along line whilst walking but also stopping at preset stations. From this data, the moving and stationary data are extracted and processed independently. The stationary measurements provide low definition, high quality EM readings where the dynamic data provides high definition, low-medium quality EM readings in addition to TMI data. This technique is faster than SAMSON but is not as sensitive to deep ore bodies due to the increased transmit frequency and higher noise floor.

SAM

SAM is a dynamic survey which is collected with either an inductive or galvanic source. SAM is the fastest and most cost effective data to collect. As an EM tool, SAM is best suited to environments with minimal conductive cover and low magnetic gradients. MMC on the other hand can be used in very conductive environments such as a salt lake. SAM TFEM successfully detected the IR4 ore body at 400m depth at the Forrestania EM test range. SAM TFEM is an excellent alternative to moving loop EM (when using multiple loops) due to the large production rates and high definition coverage.

HeliSAM

HeliSAM is an extension of SAM. The same transmit frequencies are used but data is collected with a helicopter and a towed bird.

HeliSAM achieves much greater production rates with typical survey speeds of 80 km/h. HeliSAM successfully detected the Lalor VMS deposit in Manitoba, Canada that lies between 700m – 1000m below surface.

The SAM B-field technologies can be summarised in the following table

Technology	Configuration	Frequency (Hz)	Sample Interval	Acquired Parameters	Daily Production	Noise Levels
UltraSAM	Fixed Loop	4 Hz – 12.5 Hz	0.05m	TMI, TFEM, 3-C	1 Ha per day	Very Low
SAMSON	Fixed or Moving Loop	0.125 Hz – 1 Hz	50m	TFEM, 3-C	50+ stations	Very Low
LFSAM	Loop or Dipole	1 Hz - 2 Hz	25m - 50m	TMI, TFEM, TFMMIP 3-C	Up to 10 km	Low
SAM	Loop or Dipole	3.125 Hz - 8 Hz	3m -5m	TMI, MMR (dipole), TFEM, TFMMIP, 3-C,	Up to 20 km	Medium
HeliSAM	Loop or Dipole	3.125 Hz - 8 Hz	5m -10m	TMI, MMR (dipole), TFEM, 3-C	300+ km	Low-Medium