

UAV VLF-EM SYSTEM

Resistivity Mapping Solution

Our supplier, GEM Systems, is the global leader in the manufacture and sale of high precision magnetometers.

GEM Systems is the only commercial manufacturer of Overhauser magnetometers, that are accepted and used at Magnetic Observatories over the world.

GEM's Optically Pumped Potassium Magnetometers offer the highest sensitivity, resolution and absolute accuracy while maintaining the lowest heading error.

GEM's Proton sensors are considered the most practical and robust magnetometers for general field use.

Proven reliability based on R+D at GEM since 1980.

Fully integrated systems with GPS and additional survey capability with VLF-EM are available for convenience and high productivity.

GEM is creating the absolute best in airborne sensors and is leading the way with smaller and lighter sensors for practical UAV applications (DRONEmag™).

GEM Systems Potassium technology offer the highest sensitivity (20-50 fT) for use in natural hazard research and global ionospheric studies.

GEM's Leadership and Success in the World of Magnetics is your key to success in applications from Archeology, Volcanology and UXO detection to Exploration and Magnetic Observations Globally.



GEM Systems Inc. UAV VLF Systems maps resistivity contrasts accurately.

VLF Theory

The Very Low-Frequency (VLF) Electromagnetic Method (EM) survey technique is a passive method that utilizes distant, globally positioned transmitters that are broadcasting at frequencies in the range of 15.0 - 30.0kHz. In a VLF investigation the primary fields (generated by the radio transmitters) are horizontal, vertical deviations are measured (which are effected by local ground conditions).

Applications may include;

- Exploration for mineralized bodies
- Resistivity imaging for bedrock mapping
- Delineate contrasts in conductivity at depth
- Map geological contacts (i.e. faults)
- Water exploration
- Detection of underground pipelines

Surveying with UAVs and Drones

Revolutionary, Unmanned Aerial Vehicles (UAVs) can be used to perform airborne geophysical surveys. Acquiring data via drone offers many advantages such as time efficiency, being cost effective, as well as the opportunity to survey in areas that are not easily accessible (i.e. swamps) when compared to traditional manned-aircraft or ground surveys. In addition, UAV-borne VLF surveys can deliver better data quality in environments where topography and safety standards prohibit manned aircrafts from acquiring data at optimum terrain clearances.

UAV VLF System

This VLF system is an excellent mapping tool for environmental and exploration purposes.

Technically Superior

GEM Systems GSM-90AVU UAV VLF system provides **true** measurements of the Vertical in-phase & Out-of-phase components as % of total field within the VLF frequency range of 15.0 - 30.0kHz. Many older systems only measure the total field and quadrature components of the field. This VLF system features two separate sensors with three light weight orthogonal air coils in each to provide reduced noise and allow true in-phase and quadrature data to be gathered rapidly from two VLF transmitting stations simultaneously, regardless of sensor orientation. Data includes in-phase, out-of-phase, horizontal components in x and y and field strength in picoTesla (pT).



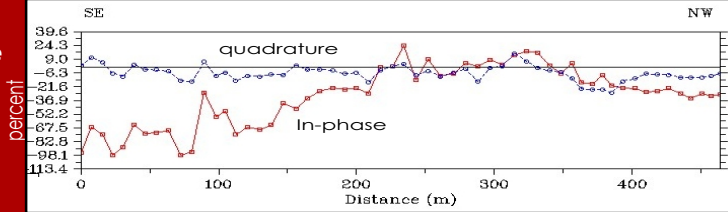
Geographic position and station name for VLF-transmitters.



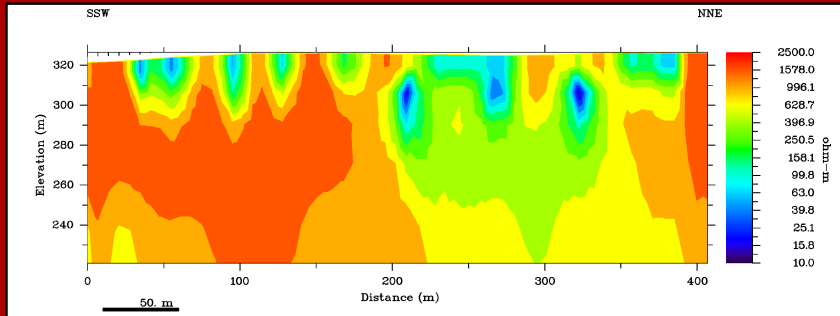
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True In-phase and quadrature VLF data:



Resistivity Depth Sections derived from VLF data provide quantitative information about the subsurface for applications requiring resistivity imaging such as mineral / water exploration or addressing environmental concern.



GEM/EMTOMO - VLF Resistivity

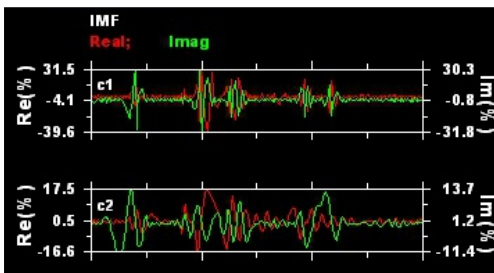
GEM uses the **VLF2D** Software platform created by EMTOMO™. This program provides **2D inversion of multi-frequency VLF-EM data**.

The package includes a map module that can display survey results as well as capability to select profiles for inversion. The program can also be used for modeling studies as users have the ability to build a complex resistivity model and calculate its VLF-EM response.

Features include;

- 2d resistivity sections
- Resistivity depth plan slices
- Forward Modeling
- Fraser Filter
- Karous-Hjelt Filter (current density sections)

The inversion procedure used in **VLF2D** is two-dimensional (2-D) and is based on the Occam technique (e.g. DeGroot and Constable 1990, Sasaki 1989, Sasaki 2001). The forward modelling of **VLF2D** is based on the finite-element method.



WHY USE VLF

VLF-EM surveying has been utilised since 1964 as a rapid means to find large linear conductive features, providing specific information about the subsurface for geological mapping. Large area surveys have yielded regional structural details but due to a lack of quantitative information such as depth to structure, the method had been marginalised until quite recently. In 2007, the Geological Survey of Sweden demonstrated that not only could VLF data be rapidly and efficiently collected it could also provide excellent structure and resistivity information to depths of 100 m and theoretically to over 200 m. (Pedersen, L.B., Persson, L., Bastani, M., Byström, S., (2009). Airborne VLF measurements and mapping of ground conductivity in Sweden. Journal of Applied Geophysics, 67, (3), p. 250-258.)

Advances in both technology to collect VLF data and computing technology (including mathematical inversion techniques) have provided the industry with a new cost-effective means for imaging the near subsurface. The robust GEM Systems multi-frequency GSM-90AVU VLF system, provides the user with a practical way to collect meaningful, resistivity information in a very cost effective manner. In addition, the VLF system can be easily combined with GEM Systems magnetometers for additional subsurface insight.

Specifications

Components:

- Two (2) VLF UAV Sensor coils with cables
- GSM-90AVU v7.0 VLF Electronics
- UAV VLF shell with 10m tow line
- Laser altimeter
- GPS (1.5m L1, 0.6m SBAS resolution)
- Radio Link (base station and remote)
- Ground station computer and GEM Airborne logger software (GEMDAS Data acquisition)

VLF Frequency:

- Two (2) user selected stations in the frequency range of 15.0 - 30.0kHz (simultaneous measurements).

Parameters:

- Vertical in-phase and out-of-phase (quadrature) components as % of total field.
- 2 components of horizontal field amplitude and total field strength in pT.

Resolution:

- 0.1% of total field (VLF fields >5 pT)

Tilt Correction:

- +/- 10 degrees (off horizontal)

Performance:

- 10, 5, 2, 1 Hz (Sample Rate)
- Operating Temperature : -40°C to +50°C

Dimensions:

Sensor : 14 x 15 x 11 cm. (5.5 x 6 x 5 inches)

Console: 22.3 x 6.9cm x 2.4 cm

Weights:

Sensors : 0.65 kg (1.43 lb.)

Electronics : 1.21 kg (2.66 lb.)

Towed Bird : 4.4 kg (9.68 lb.)

Power Source:

11.1V 1.3Ah Lithium Battery

Output:

UTC time, GPS Position (latitude, longitude), altitude, pitch, roll, yaw, EM field, frequency, in- and out-of-phase vertical, and both horizontal components for each selected station. Data export in standard XYZ (i.e. line-oriented) format for easy use in standard commercial software programs such as **VLF2DAB** or **VLF2DMF** by EMTOMO (Optional).

The GSM-90AVU VLF system comes complete with an industry leading three year warranty



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