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EM4H

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EM4H | AIRBORNE ELECTROMAGNETIC SYSTEM FOR REGIONAL EXPLORATION

EM4H - is a frequency-domain airborne electromagnetic system with separate receiver towed in a bird. It was designed by GeoTechnologies in 2005, many systems were produced since, and nowadays it is widely used in Russia. More than 100 000 line kilometers of airborne geophysical survey are successfully conducted every year with these systems.

EM4H installed on AN-2 (Aerogeophysica Inc.)

EM4H installed on Mi8 (Aerogeophysica Inc.)

Technical specifications

Principle of operation	Frequency-domain
Aircrafts	Fixed-wing — An-2, An-3 Helicopter — Mi-8
Frequencies	130, 520, 2080, 8330 Hz
Dipole moments & Waveform	Sum of four harmonic signals 20000, 10000, 6000, 3000 Am^2
System geometry	Separated — transmitter is installed on an aircraft receiver is towed in a bird
Receiver positioning	Integrated positioning system spatial precision — 15 sm angular precision — 2 deg
Output data	Inphase and quadrature X,Y,Z-component
Data collecting frequency	200 kHz
Data output frequency	6,61 Hz
Total weight	200 kg
Transmitter loop area	42 m^2 for An-2, An-3, 45 m^2 for Mi-8
Tow cable length	70 m
Power requirement	30 A, 27 V
Interface	RS-232, Ethernet
Software	NavDat
Total calibration time	less than 20 minutes per flight

EM4H BENEFITS

UNIVERSALITY

Due to design features (dipole transmitting system is attached to the aircraft structure) EM4H system can be used in both fixed-wing and helicopter borne versions.
The NADVAT software, which is a part of the system, allows integration of EM4H system with airborne magnetics and gamma-ray spectrometry.

HIGH PRODUCTIVITY

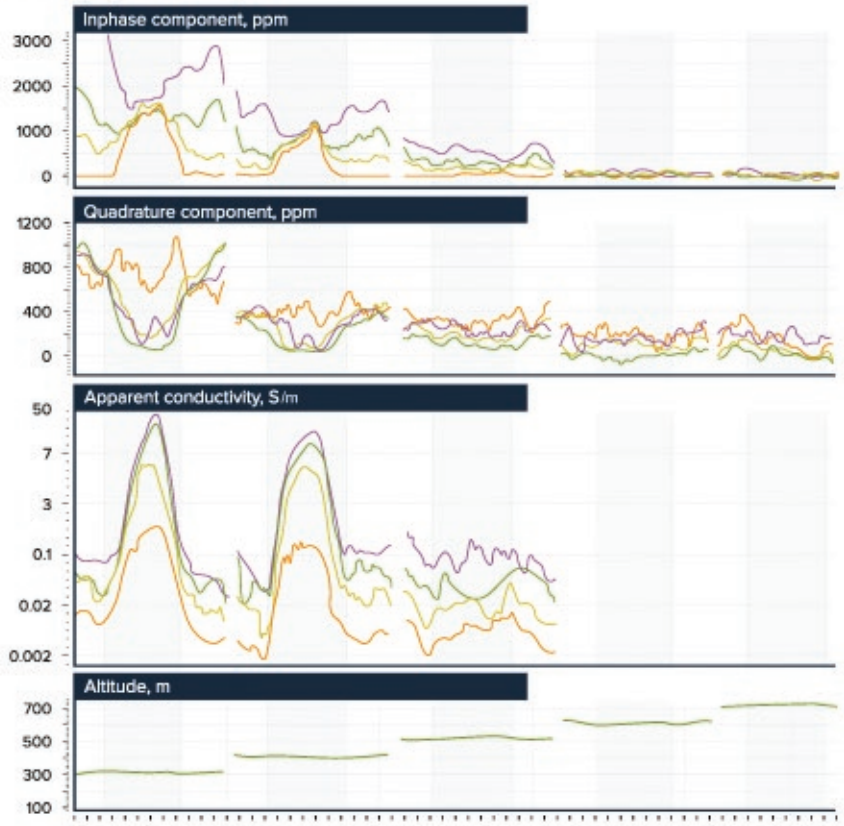
Reliability and ease of use, minimal time required for tests and calibration, high survey speed ensure high productivity - up to 1000 line kilometers per survey day.

EFFICIENCY IN MAPPING

Upper transmitter placement results in a large footprint. This makes the system well suited for regional exloration even when the distance between lines is 500 meters.

HIGH SENSITIVITY AND PENETRATION DEPTH

A special experiment was conducted to prove EM4H sensitivity.
Test flights were performed at different altitudes over the same object – salt lake (2 km diameter, 0.02 Ωm resistivity, 2 – 4 m depth).
The resistivity of host rocks is about 100 Ωm



Results of sensitivity testing

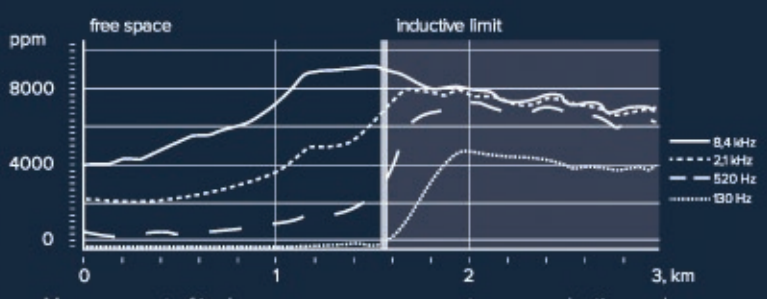
THE RESULTS ARE FOLLOWING:

1. From altitude less than 500 m EM4H detected the response from the lake and conductivity was estimated correctly.

2. At 500 meters altitude (detection limit) the response was above the noise level, but it was too weak for conductivity calculation.

FULL RESPONSE MEASURING

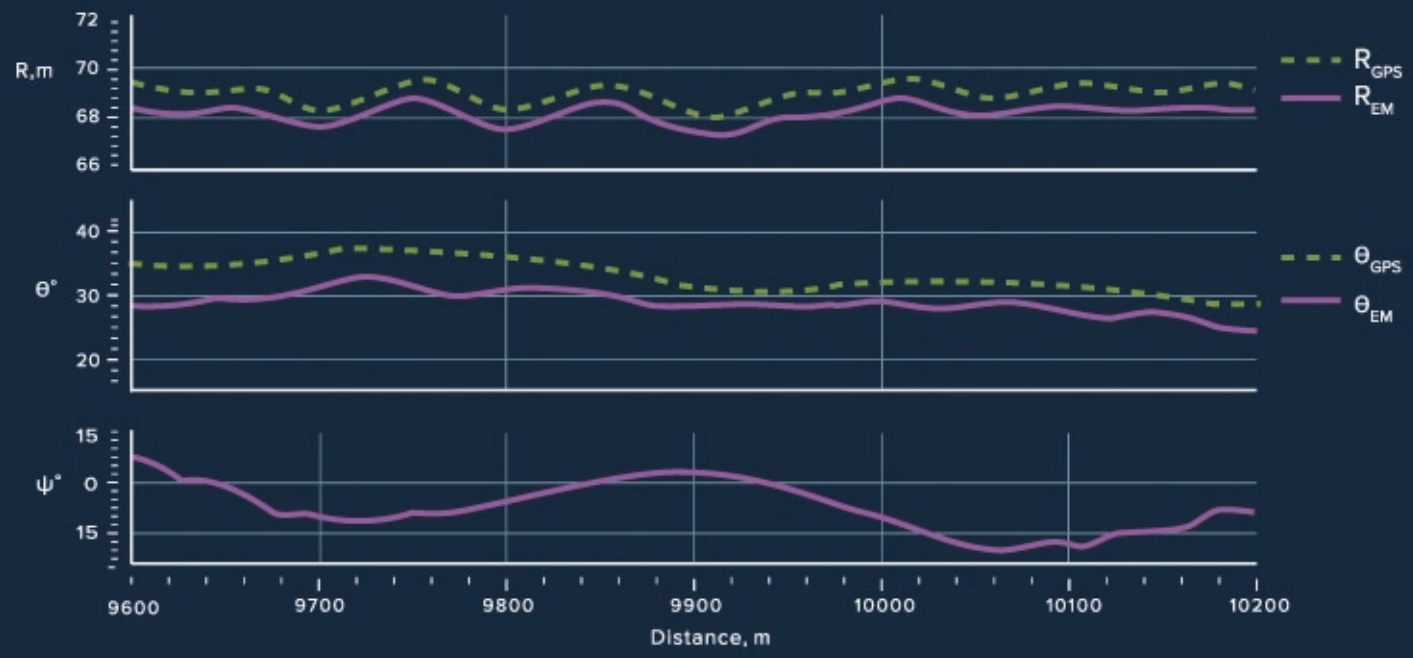
Despite the fact that EM4H geometry is not rigid - the transmitter and the receiver are connected only by flexible tow cable - the built-in system of relative angular and spatial positioning and wide frequency range provide the ability to measure full complex response vector (not only quadrature part) over environment of any conductivity.
In case of resistive area response at the lowest frequency is negligible and inphase signal at this frequency represents primary field – a 'free space' model. In case of low resistivity response at the highest frequency is close to fully reflected signal. Knowing the transmitter altitude and system geometry it is possible to detect the primary field at this frequency – an 'inductive limit' model.



Measurement of inphase response component over conductive and non-conductive zones

INVARIABILITY TO THE MEASURING CONDITIONS

The built-in positioning system provides geometry control and allow using of the transmitter and receiver coordinates during data interpretation. Accuracy of positioning system was confirmed by comparison with solution of satellite navigation system GPS in differential mode.

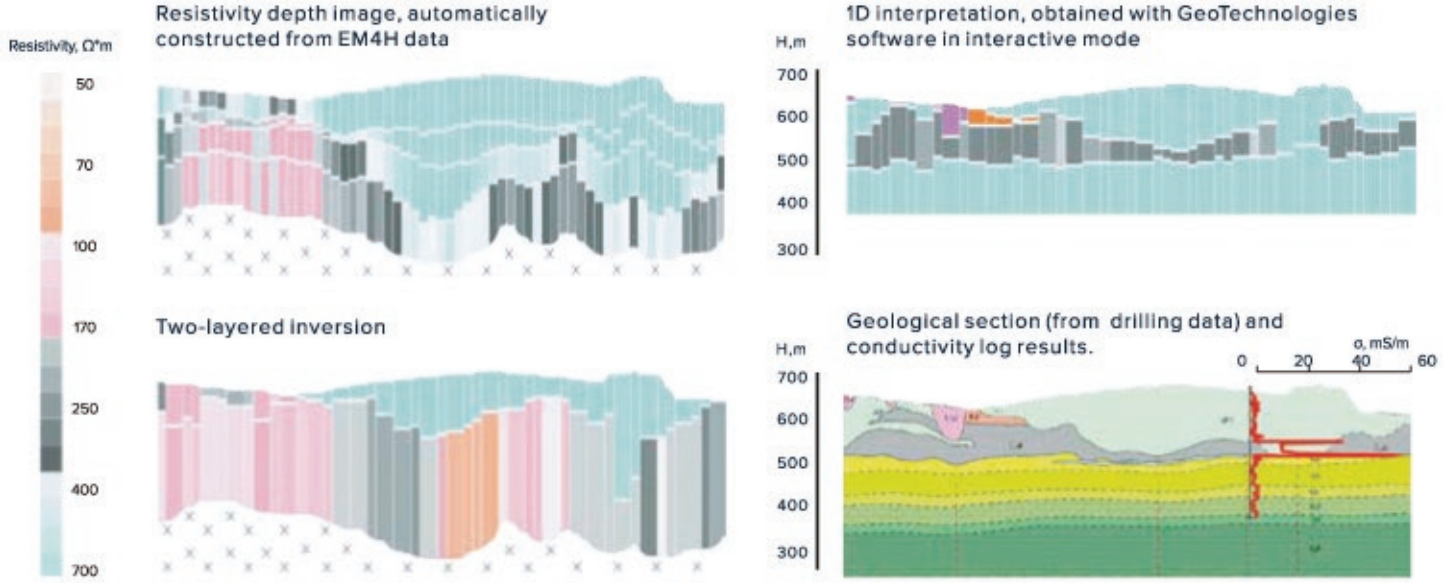


Testing of accuracy of built-in positioning system.

- R_{GPS} - the distance between aircraft and towed bird, measured by GPS
- R_{EM} - the distance between receiver and transmitter, measured by built-in positioning system
- $θ_{GPS}$ - the angle between vertical direction and transmitter-reciever radius-vector, measured by GPS
- $θ_{EM}$ - the angle between axis of transmitting dipole and transmitter-reciever radius-vector, measured by built-in positioning system
- ψ - the angle between aircraft longitudinal plane containing axis of transmitting dipole and transmitter-reciever radius-vector, measured by built-in positioning system

INTERPRETATION EFFICIENCY

During the years of surveys GeoTechnologies designed and tested data interpretation methods specific for EM4H. They allow not only to get resistivity maps, but also to analyze conductivity depth distribution.



Geological section (from drilling data) and conductivity log results