

NEAR-FIELD LOW-FREQUENCY GEOLOGICAL ELECTROMAGNETIC METHODS FOR GEOLOGIC STUDIES AND SEARCH OF KARSTS, DOLINS, SAND OR CLAY LENSES, BURRIED STRUCTURES ET UTILITIES



Near-field low frequency electromagnetic methods record, without ground contact, electrical conductivity data of the near subsoil, whose variations indicate heterogeneities. The conductimeter (EM34, EM38, EM61, EMP400) comprises two transducers (magnetic dipoles made up of a current loop) connected to the control box. The source generates a primary magnetic field at a set frequency. When the primary field encounters a change in the ground conductivity, a secondary field is generated and detected by the measuring system. The secondary field vertical component in quadrature on primary field ratio is proportional to the apparent conductivity σ (unit: Siemens/meter). Apparent conductivity is the opposite of apparent resistivity ρ , expressed in ohm.meter.

The depth of investigation depends on the coil spacing, coil positioning (following a vertical or horizontal axis), and primary field frequency. As an example, here below are the theoretical depth of investigation, i.e. sensitivity to a conductivity anomaly of the underground, with the EM31 and EM34 conductivimeters from GEONICS:

METHOD	COIL AXIS	FREQUENCY IN HERTZ	COIL SPACING IN METER	DEPTH OF INVESTIGATION IN METER
EM31	Н	9800	3,66	3,7
EM31	V	9800	3,66	5,5
EM34	Н	6400	10,00	7,5
EM34	V	6400	10,00	15,0
EM34	Н	1600	20,00	15,0
EM34	V	1600	20,00	30,0
EM34	Н	400	40,00	30,0
EM34	V	400	40,00	60,0

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In all cases, the depth of investigation depends on the conductivity of the site. The higher it is, the lower the actual depth of investivation is compared to the theoretical depths.



An INNOGEO geophysical survey team taking EM34 measures in vertical dipole mode. (Coil spacing: 10m, theoretical depth: 15m)



Profiler EMP-400 in use (theoretical depth: 0-3 m)

On-site implementation

On-site, measures are taken almost continuously while moving along profiles, more or less spaced out depending on the goals of the survey. Operators generally carry out these measure on foot, but the conductivimeter can also be placed on a towed trolley. Several kilometres worth of measures can be taken each day, depending on site conditions. EM measures cannot be done near aerial electric lines, wire fences, or above buried metallic pipelines.

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Results

The example below shows the application of the EMP400 method to search for concrete structures before the start of earthworks for a building project. Power shovel soundings revealed buried concrete and metallic structures.



The following example shows the results of an EM34 survey (section: 0-15 m) along a railway route (formation showing resistance in red, conductivity in green).



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