The transient electromagnetic profiling method allows rapid acquisition of true depth, 2-D resistivity images of geological profiles. Using the Geonics Ltd. PROTEM system, detailed vertical and lateral variations in material resistivities may be obtained with a minimum of field time and cost. TEM profiling consists of a coordinated sequence of TEM soundings at a station spacing that is sufficiently close that a detailed image of the lateral variations in layer bahaviour may be developed.

The system is comprised of a PROTEM receiver and is used with a family of transmitters, each suited for a range of depth of exploration. The TEM47 is optimised for sounding work to a depth of approximately 70 metres. The higher powered TEM57 transmitter is used to provide the intermediate and lower frequency repetition rate required to obtain deeper information.

In operation, a transmit loop appropriate for the depth of exploration is laid on the ground at the measuring station. A common loop size for shallow work is 5 by 5 metres. Profiling to depths of greater than this is done by using the multiple ranges of the TEM57 transmitter and by deploying larger loops. The example shown below utilised 200 metre loops at intervals of 200 metres along the profile.

The transmitter produces a current in the loop which is rapidly terminated. This rapid change of current in the loop results in the induction of a current circulation in the ground beneath the loop, often described as a 'current filament'. This current filament moves down into the earth at velocities proportional to the resistivities of the material in each layer.

A multiturn coil connected to the receiver samples the variations in the secondary magnetic field at the surface resulting from the current filament, as it sweeps down through the earth materials. These variations in the secondary magnetic field contain diagnostic information on the resistivities and thicknesses of the layers encountered.

The maximum contribution to the response results from material in close proximity to, and directly below the transmitter loop. This is in contrast to ground contact electrical sounding surveys that may be affected by lateral changes in subsurface layering due to the large array expansions required to achieve the depth of interest.

These field data points of apparent resistivity are numerically inverted into true depth-resistivity format using a combination of ridge regression and smooth inversion techniques. Good depth resolution is ensured due to the twenty channels recorded for each transmitter range at every station.

A typical presentation of the data is in colour resistivity sections combined with plan maps of conductors at depth. Interpretable features include depth to bedrock, shear zones, resistivity contrasts due to pore fluids conductivity variation, porosity, mineralisation, alteration or silicification. The instruments large dynamic range means that it is responsive to both changes in rock types and in alluvial stratigraphy.

Applications

- Groundwater exploration investigations
- Groundwater contamination and saline intrusion
- Bedrock depth profiling, overburden layering
- Gravel, clay deposits
- Mineral exploration
- Permafrost investigations
- Tropical weathering depth investigations