COMPARISON of GRAVITY, EM and DC-MULTI-ELECTRODE MEASUREMENTS CARRIED OUT ALONG TWO PROFILES.

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Gravimetric, DC-multi-electrode, Electromagnetic EM34 and VLF measurements were carried out on two profiles. One profile (line 1, direction WE, length = 3.8 km) led downward a hill into a flat area, the other one (line 2, direction SN, length = 1.2 km) passed the first one at its W-end and followed a road of about constant altitude. Near the downhill end of the first line a drilling was located. At this side the measurements could also be compared with older seismic data. The top layer consists of gravel sand and clay. The basement is formed by schist and limestones of high porosity. The sands and clays of the lower part of the profile are water saturated, whereas the gravels of the higher parts are dry.

MEASUREMENTS

Measurements were taken using 10m, 20m and 40m coil distance, horizontal and vertical dipole with the EM34 instrument at 10m and 20m distances between measuring points. A special technique was introduced to get the coils rapidly coplanar (horizontal) with vertical dipole arrangement: each of the two coils was suspended with three strings of equal length on a stick. If the stick is held vertical the coil remains horizontal at the height of the eyes of the user. Taking the coil with both hands one can easily move it forward and back without touching the stick. Even one-handed placement of the coil is possible. The stick changes its inclination to the surface during moving of the coil, but remains fixed at his foot point. Independent from the movement forward and back one can also change the inclination of the coil with respect to the earth. With this technique one can correct the position and the inclination of the coil for accurate measurements within a time comparable to horizontal dipole measurements. The gravity measurements followed every 50m. The instrument heights have been evaluated by geodetic methods with an accuracy better than 2 cm. Two DC multi-electrode measurements were carried out with 15 m electrode distance and 80 electrodes each. The maximum profile extension of 1200m allowed for a penetration of up to 190m of depth.

EFFECT of DISTURBANCES on EM-MEASUREMENTS

EM measurements are carried out very rapidly compared to other measurements, but are strongly affected by disturbing fields in some cases. At locations not well known testing with special instruments for locating telephone lines and mains is the usual practice for avoiding wrong interpretations. However there can be other sources more, affecting the accuracy of the measurements. Repeating the measurements at different times, shifting the location for a small amount and changing the direction (with two coil system) are means to control the validity of the measurements.

Line 1 passed a town and led along mains E of the town. VLF measurements repeated on the same location in this part of the line showed inconsistent values. For that reason EM and VLF measurements were not taken in this region. VLF measurements along line 2 taken at different days are shown in Fig. 1: Whereas the real components agree well for both days the

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imaginary components differ considerably. Good agreement in shape can be observed also for the Im-component in the middle part of the diagram apart from a vertical shift of about 20 units.

EM measurements taken at different coil separations and dipole directions are shown on Fig. 2. Two prominent peaks visible at 60m and 160m horizontal distance on the vertical dipole curves can also be observed with the horizontal dipole configuration but with considerable smaller amplitude. This peaks were not observed with the VLF instrument. The non geological nature of this peaks can be concluded from a profile (line 4) made at 40m distance parallel to line 2. The measurements on that line showed no peaks and the mean value of the apparent resistivity was considerably lower (lowest values in Fig.2, distances from 0 to 160m). The low values were confirmed by measurements with the alignment of the arrangement perpendicular to line 2 located between line 2 and line 4. However, contrary to this observation, no telephone line or main is known on line 2. The interpreted section of multi-electrode measurements on line 2 showed average high resistivity values of about 500 Ohmm (2 mS/m conductivity) for depth up to 30m with some locations of lower resistivity at shallower depth. Among the EM measurements such low values of conductivity were solely obtained with the vertical dipole configuration at 40m coil separation in the northern part of the section. The average of all EM-measurements is about 5 mS/m.

RESULTS - GRAVITY and DC

Bouguer-anomalies and interpreted depth obtained from the gravity measurements along line 1 and line 2 are drawn on Fig.3, and Fig. 4 respectively. The horizontal scale for both lines is differently, where as the vertical scales have been taken equal for better comparison. The interpretation was based on the assumption of the existence of two materials (sediment and basement) and an average crustal density of 2.67 g/cm^3 . Further confirmation was inferred by a drilling at station 2450m where competent rock was found at 190m of depth. Line 1 shows a distinct edge of the basement at 1.6 km on the local horizontal axis leading down from an approximately horizontal level at 50m of depth to more than 300m with the end of the slope not observed on the profile.

The multielectrode measurements on line1 were located between station 850m and 2050m. The measurements have been interpreted by Loke and Barker's method. The interpreted section calculated from Wenner pseudosections is drawn on Fig.5. Comparison with the gravity measurements leads to a border between basement and sediment at the 100 Ohmm line.

The sudden onset of the inclination of the slope of the basement observed with the gravity measurements can also be observed on the electric profile. For comparison the electric interpretation is also drawn into the gravity profile of Fig. 3. One recognises, that the surface of the basement is found to be shifted about 100m to W and somewhat deeper with the electric interpretation. The old refraction seismic interpretation did not fit the drilling results and could be reinterpreted with much better accuracy on basis of the gravity interpretation.

Fig. 5: Interpreted depth section of DC measurements. Resistivities along line 1

Fig.1: VLF response measured on two different days along line 2

Fig. 2: EM34 response along line 2 and line 4 (20m V-dipole only)

Fig. 3: Line 1. Bouguer anomalies and interpreted depth to basement.

Fig. 4: Line 2. Gravity profile