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The geophysical identification of lateritic bauxite formation at Mandra area, Attiki (Greece)

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Determination of the physical parameters of lateritic bauxite formation with the contribution of geophysical methods. In this paper we present the results of a near-surface geophysical survey carried out for the investigation of geotechnical engineering characteristics in selected locations of the seismological stations of the National Network, Section of Geophysics and Geothermy of National and Kapodistrian University of Athens. The studied area is located at Mandra (Attiki), close to the MDRA seismological station (Figure 1) and the main task of the study was the geophysical identification of buried bauxite deposits in the area.

Geological setting

The study area is mainly covered with carbonate formations of the *Sub-Pelagonian Unit*. These formations comprise of limestones of the Upper Cretaceous (*Ks*) which overly the dolostones, dolomitic limestones and limestones of the Upper Triassic (*TRm*). In places, between the Triassic dolostones/limestones and the Cretaceous limestones, lateritic bauxite ores can be observed. Due to the mining processes that had been carried out until the early '80s, most of these bauxitic ores have been extracted and replaced by their mining wastes.

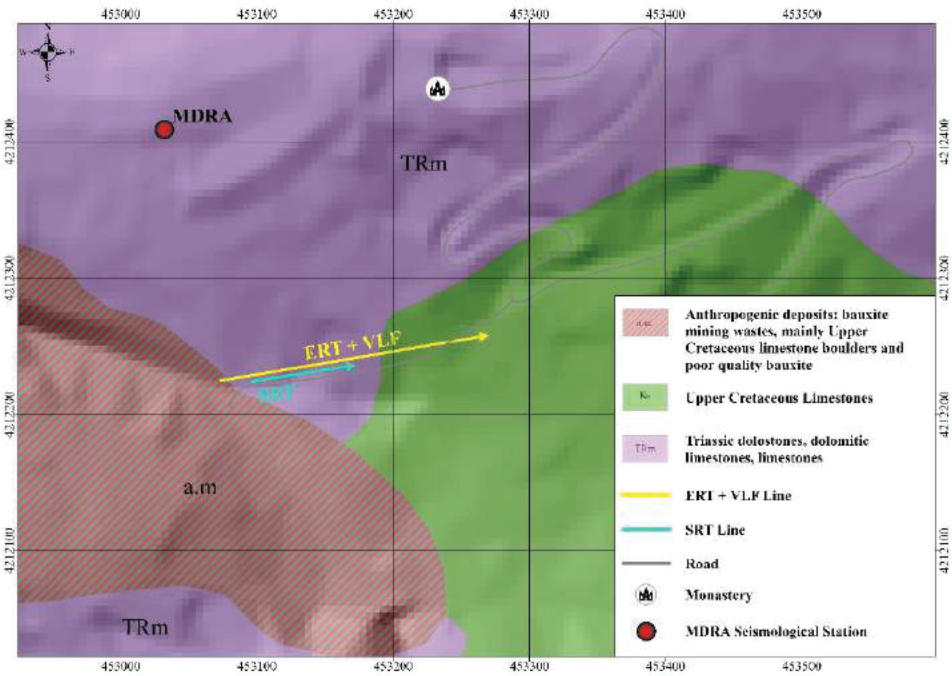

Figure 1. Modified geological map (Dounas, 1971) of the study area along with the location of the geophysical measurements

Methodology

In the context of the geophysical-geotechnical investigation of the geological formations close to the MDRA seismological station, four (4) different methodologies have been applied in order to achieve a multi-disciplinary approach. More specifically, we carried out i) an Electrical Resistivity Tomography of 200 meters total length and 2.5 meters electrode spacing, ii) a seismic refraction tomography section of 47 meters and geophone spacing 1 meter, with 48 geophones of 10Hz iii) a MASW section of 23 meters with 24 geophones of 4.5Hz (1 meter geophone spacing) and finally iv) an electromagnetic VLF section of 200 meters with a 5-meter spacing. Finally, we determined the density of the geological formations from laboratory measurements of 30 samples from each one. The determined density of the Triassic dolostones and limestones is equal to 2.71 gr/cm^3, the one of the bauxites is 3.36 gr/cm^3, while the one of the Cretaceous limestones is 2.71 gr/cm^3.

In Figure 2, the results of the Electrical Resistivity Tomography illustrate a zone of relatively vertical high electrical resistivity values (>2.500 Ohm.m) between 80 and 130 meters, up to depths of 40 meters. The first part of the geoelectrical section, up to 100 meters, we observe relatively lower resistivity values (< 500 Ohm.m), while form the 120 meters to the end of the section even lower resistivity values have been determined (<200 Ohm.m).

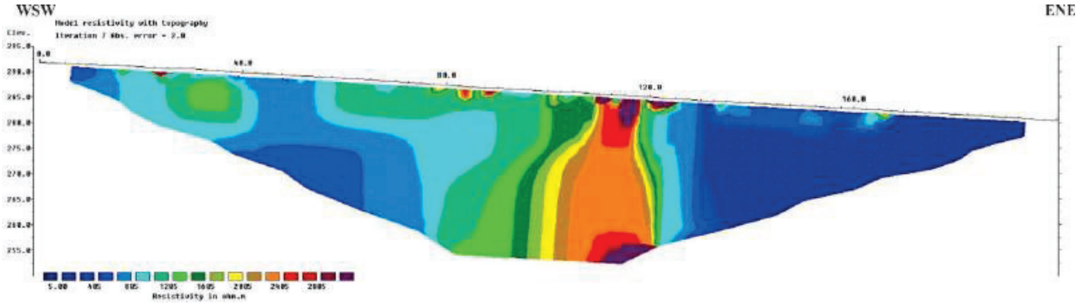

Figure 2. Electrical Resistivity Tomography

As it concerns the electromagnetic VLF section, the processing results, after the 3-point smoothing and the Karous-Hjelt filter the pseudo-section of the current density distribution has been produced (Figure 3). The results are similar to the resistivity model of Figure 2, since a zone of low current density is located between 70 and 135 meters. At this part of the Resistivity Tomography we investigated a resistant formation.

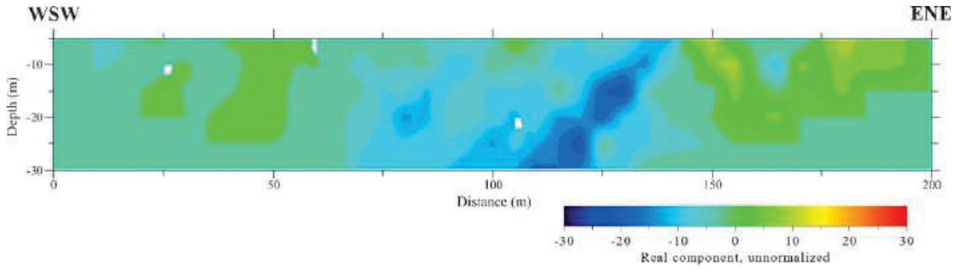

Figure 3. The Karous-Hjelt pseudo-section for current density distribution

Finally, for the estimation of P-waves velocity the geophysical method of Seismic Refraction Tomography was applied. In total, thirteen (13) shots were carried out, with a spacing of four (4) meters, using a 6kg seismic source (sledgehammer). In Figure 4, we can observe the upper formation with reddish colors, thickness 1-3 meters and V_1=1.940–2.200 m/s but also the underlying one with V_2=2.400-3.650 m/s and thickness ranging from 1,0 to 2,5 meters. Finally, the deeper formation has been investigated with V_3=3.800-4.135 m/s at depths from 3,0 meters (middle of the section) up to 6,0 meters (end of section).

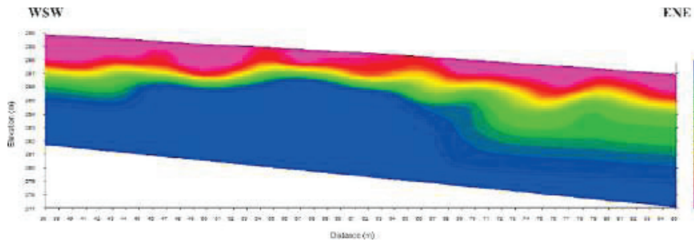

Figure 4. Seismic Refraction Tomography (the distance axis is referred to ERT meters)

Conclusions

The results of the geophysical measurements reveal an intense lateral inhomogenous zone between 90 and 120 meters of the ERT profile. Taking into consideration that the existence of the contact between the Triassic dolostones/ limestones and the Cretaceous limestones has been verified from field observations of the authors, the prementioned area could be interpreted as a possible fracture zone, where bauxite ore remains are expected to be found. Therefore, the Triassic dolostones and limestones have been investigated with values of 500-1200 Ohm.m, the Cretaceous limestones with values <800 Ohm.m, while the bauxites seem to have values >1700 Ohm.m, similar with published literature from other researchers (Amosun *et al.,* 2020; Eluwole *et al*., 2019).

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