A COMPREHENSIVE PRACTICAL TRAINING IN GEOPHYSICS AND GEOLOGY FOR STUDENTS SUPPLEMENTS THE STUDIES AT THE UNIVERSITY

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ABSTRACT. In 2019, 2021, and 2022, practical training for students in geophysics and geology was conducted. During the training, the geology of the selected area was shown, and geophysical methods were demonstrated in the study of characteristic geological structures. The measurements were taken by the participating students. In this way, they had the opportunity to get acquainted with the complex geological and geophysical work in the study of a certain area. The training also included presentations to introduce the theory of the methods themselves, as well as a final seminar where the results of the measurements were presented.

Key words: practical training, geophysics.

КОМПЛЕКСНО ПРАКТИЧЕСКО ОБУЧЕНИЕ ПО ГЕОФИЗИКА И ГЕОЛОГИЯ ЗА СТУДЕНТИ ДОПЪЛВАЩО ОБУЧЕНИЕТО В УНИВЕРСИТЕТА

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РЕЗЮМЕ. През 2019, 2021 и 2022 г бяха проведени серия практически обучения за студенти по геофизика и геология. По време на обученията беше показана геологията на избрания район, а геофизични методи бяха демонстрирани при изследването на характерни геоложки структури. Измерванията бяха направени от участващите студенти. По този начин те имаха възможност да се запознаят с комплексната геоложка и геофизична работа при изследването на определен район. В обучението бяха предвидени и презентации, за представяне на теорията на самите методи, както и заключителен семинар, на който бяха представени резултатите от измерванията.

Ключови думи: практическо обучение, геофизика

Introduction

In 2019, 2021, and 2022, practical training for students in geophysics and geology was held. The training was focused at honoured BSc, MSc and PhD students from Sofia University and the University of Mining and Geology and aimed at demonstrating the application of different geophysical and geological methods for near surface investigations. Selected sites situated on the Black Sea coast were selected as representative for an introduction to facies analysis and sedimentary environment interpretation (the Galata formation) and basin development (the Aytos Pass and Cape Mona Petra). A set of geophysical methods (GPR, ERT, magnetics, kappametry, etc.) was used in the selected sited to demonstrate the application of geophysical method for solving geological tasks.

Geological sites

The main part of the practical training was practical work on site and the field trips in eastern Bulgaria and on the Black Sea Coast. The area chosen for the training event in 2019 falls within the boundaries of the Lower Kamchiya Depression (LKD), also known as the Kamchiya sub-basin (Georgiev, 2012), which is located in the coastal part of Central Eastern Bulgaria and extends offshore to the Black Sea. The LKD could most generally be described as a Tertiary basin located to the North of the Balkanides thrust front. The sedimentary fill contains Eocene to Quaternary deposits with thicknesses increasing offshore (Sinclair et al., 1997).

The field trip in 2021 was concerned with the stratigraphy, sedimentology, and structural style of the Cretaceous Paleogene successions cropped out in Northeastern Bulgaria, as well as focusing on key exposures to introduce the students in some field geological and geophysical methods. The geological field methods cover two transects/geotraverses: along the Aytos Pass and the coastal line from cape Emine to the town of Byala to the North including key exposures of the thin-skinned fold-thrust belt of the East Balkan and its foreland/subthrust zone (the Forebalkan). The outcrops provide an example of the lithologies deposited in the different parts of the basin system, facies distribution, sequence boundaries, and style of deformation. The correlation between the outcrops and transects provide an example for the practical

application of the complex geological methods and in combination with the geophysical methods (seismic profiles) to restore the basin evolution. Also, including the complex methodology, the students were involved into the methods of cross-sections balancing and back-stepping.

The field trip in 2022 was focused on the stratigraphy and paleovolcanic features of the South Black Sea coast, as well as on the diverse landforms related to the coastal relief and the interactions between the sea, the land, and the rivers. Several geological routes and localities were visited along the coast of the Strandzha Nature Park (Georgiev et al., 2014), so that the students could observe the characteristic exposures of the Late Cretaceous basin of the Eastern Srednogorie Tectonic Zone, specific structures and interesting landforms including shore platforms, cliffs, stacks, rockfalls, sea caves, sand beaches, dunes, and estuaries.

Geophysical methods

Various geophysical methods (ground-penetrating radar, geomagnetic surveying, electrical resistivity surveying, kappametry, etc.) can be applied successfully for mapping of the near surface geological section. The major advantage of these methods is that they are convenient non-invasive instruments for a relatively rapid and effective determination of the spatial boundaries of geological and hydrogeological units of different rank, as well as zones with different characteristics. One of the aims of the practical training was to demonstrate the application of different geophysical method for solving geological tasks.

During the field measurements on the Galata formation in 2019, electrical resistivity tomography (ERT), the passive and active seismic method, geomagnetic surveying, gravimetric measurements, and a ground penetrating radar (GPR) were demonstrated. All measurements on-site were taken by the attending students (Fig.1).

Fig. 1. Gravimetric measurements on the Romantika beach

Fig. 2 represents a map of all conducted geophysical measurements during the practical training in 2019. To determine the petrophysical properties of the sedimentary structures under study, a complex of measurements was performed, including the determination of the electrical resistivity and magnetic susceptibility characteristics of the different types of sediment. For this purpose, vertical ERT sections were also developed and the physical properties of the individual sediment varieties were determined.

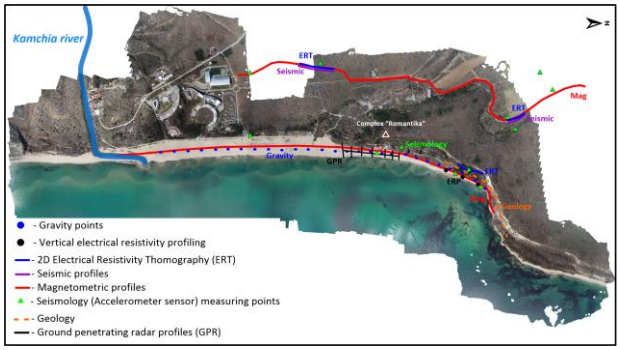

Fig. 2. Map of the conducted geophysical measurements during the practical training in 2019

The main objective of the geophysical methods during the practical trainings in 2021 and 2022 was to estimate the position in depth of faults (Cape Mona Petra), the water layer (the Dyuni beach), and to present the possibility of each method to distinguish between the different outcrops in the studied areas. The combination of detailed lithofacial profiling and 2D mapping of outcrops with extensive detection of textures-indicators is one of the most advanced 3D methods for facial and paleographic modelling, reconstruction, and stratigraphic division of continental successions.

Field measurements in 2021 were carried out on cape Mona Petra (Fig. 3). During the geological trip along the coast, the main fault visible from the sea and on the beach was shown to the students. Then the best position for ERT profiles was estimated and two profiles perpendicular to the main fault were made in the forest of the cape. An active seismic survey (refraction profiling) was also carried out on Cape Mona Petra. The profile was parallel to the ERT profile crossing the fault. The magnetic method was applied onshore over a long profile line measured along the coastline southern from the town of Obzor and crossing cape Mona Petra. In order to gain additional information about the magnetic properties of the represented in the area rocks, we made magnetic susceptibility measurements over samples, outcrops, on the ground, etc. Vertical magnetic susceptibility profiles were conducted on outcrops for stratigraphy purposes. Measurements were made with two KT-10 kappameters.

Fig. 3. Students during ERT measurements on Cape Mona Petra

ERT measurements in 2022 were made in two sites. The first one was the “Malkoto kale” archaeological site where the possibilities of the method in investigating shallow anthropogenic structures were presented to the students. The second site was the Alepu beach. GPR and passive seismic methods were also demonstrated on the Alepu beach.

Results and discussion

Two types of results from the practical trainings can be presented. On the one hand, this is the evaluation of the training from the attendees. And on the other hand, the scientific results for the near-surface structure of the studied areas should be mentioned.

28 students and lecturers from different institutions attended the training in 2019, 10 students attended the practical training in 2021, and 12 students in 2022.

After each practical training, an evaluation form was produced and the participants was given the opportunity to evaluate the training in various aspects including practical work, place of the training, the hotel, and social events. An overall assessment of the event could also be given. The main results from the feedback form from all the years show that the participants were generally very satisfied with the training and especially with the field measurements. Usually, the students in Geology like geophysical measurements best and the students in Geophysics mainly like the geological part of the training. This indicates that the students lack multidisciplinary courses in their study, on the one hand, and practical demonstration of practical application of the theoretical skills they gain in the university, on the other. Here, the comprehensive training fills this gap. This statements is also supported by the answer to the last question in the feedback form: “Would you attend such training again?” Almost all of the participants answered “Yes” and would attend such activity if it ~~is~~ were organised again.

The acquired data from the training in 2019 is far from sufficient for an adequate interpretation of the depositional environments of the sediments of the Galata Formation. The scientific results here include processed data from all geophysical measurements from which a 3D model (Fig. 4.) of the studied area was produced.

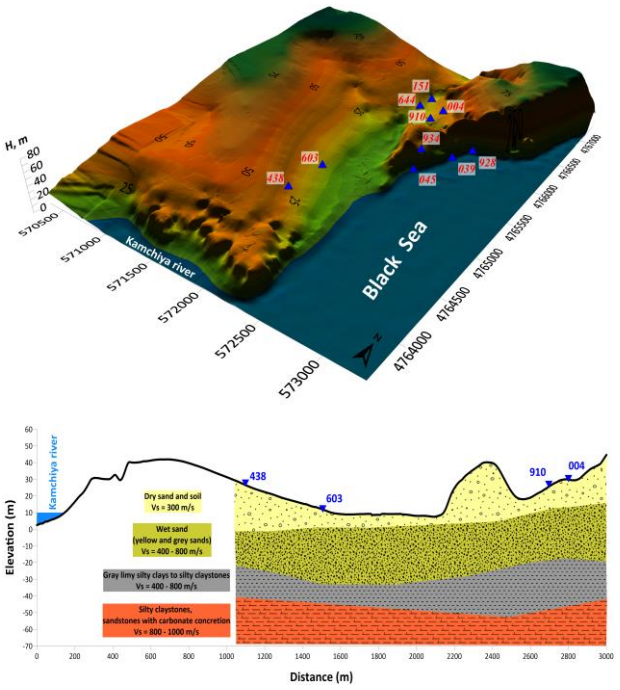

Fig. 4. 3D map representing the position of passive seismic measurements (up) and final interpretation along a profile based on all conducted geophysical measurements

From the obtained 2D geoelectrical, seismological (H/V method), and seismic profiles, three major layers are very well distinguished:

- The first one is characterised by low velocities of seismic waves (about 400 m/s for P waves) and heigh values of electrical resistivity. It consists of unbound dry sands and soil.
- The second layer is with higher P wave velocities (700-900 m/s) and consists of thin, medium, thick- and massive bedded light yellow and grey sands, interbedded with thinbedded dark grey and brown non-calcareous silty clays and silts.
- The third main layer has very low values of electrical resistivity (between 20 and 50 Ωm), and very high P seismic wave velocities (above 2000 m/s). This layer consists of thin-bedded and thick-laminated grey limy and silty clays to claystones, interbedded with laterally continuous and discontinuous thin beds of fine-grained sands and silts. The upper-most section of the pack consists of 15 cm of dark grey to black soft clays. The limy clays display parallel lamination, wavy lamination, flaser bedding, small symmetrical ripple marks, convolute bedding, and concretion structure. The sands and silts are parallel laminated. A marked characteristic of the sediment of the package is the presence of abundant carbonised plant debris of a varying size (from a few cm to more than 20 cm). Casts of thick-shelled marine bivalves were also observed in the clays.

Electrical Resistivity Tomography (ERT) measurements on Cape Mona Petra

Field measurements were carried out on Cape Mona Petra (Fig.5). During the geological trip along the coast the students were shown the main fault visible from the sea and on the beach. Then, the best position for geoelectrical profiles was estimated and two profiles perpendicular to the main fault were made in the forest of the cape (Fig. 3).

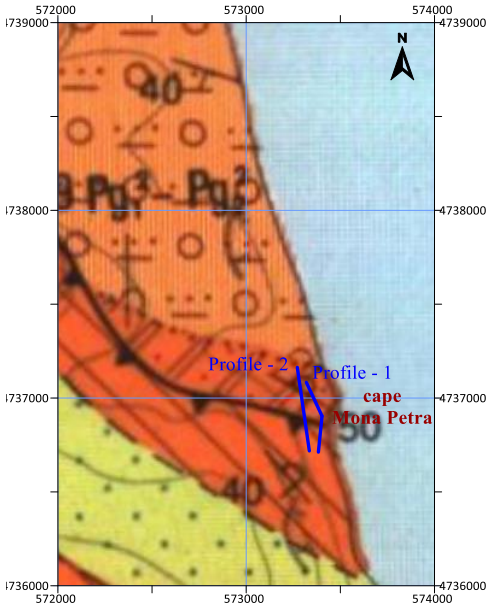

Fig. 5. Position of ERT profiles on Cape Mona Petra.

Electrotomography measurements were performed to locate the fault in our studies. The *Terrameter SAS 1000* equipment and the Wenner-Schlumberger measuring array were used. The lengths of the measured lines were 115 m - 24-electrode, measuring array with a distance of 5 m between the electrodes.

In the obtained electrical resistivity section along surveying lines (Fig.6), two main zones can be clearly distinguished. The first one is located in the southern part of the profile and is characterised by low values of electrical resistivity (4 -10 Ωm). This zone is marked as a fault zone. The second zone is situated in the northern part of the profile and is characterised by higher resistivity values (between 20 and 50 Ωm) and represents Upper Cretaceous succession sediments.

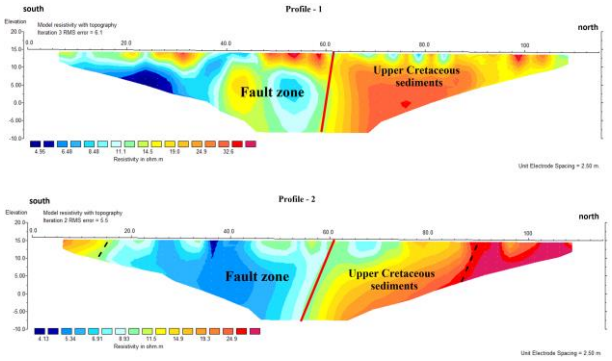

Fig. 6. ERT plots along the profiles on Cape Mona Petra

Conclusions

The trainings included practical exercises, field measurements, geological investigations and evening presentations. A significant part of the training were the field geophysical measurements and geological investigations. Everyone from the attendee had the opportunity to work with the geophysical equipment and to do measurements for a real geological task.

The planned field trips and the practical work are unique possibilities for students and lecturers in Geology and also in Geophysics from both universities to exchange knowledge on a place with a complex structure like Cape Mona Petra. The project and therefore the field work as an annual event will be a very good motivation for students to choose Geology or Geophysics for their career.

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