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GEOMAGNETIC INSIGHTS INTO AN ACTIVE TECTONIC CONTACT: PECENEAGA-CAMENA FAULT (PCF)

Highly detailed ground magnetics were jointly conducted by Romanian and Ukrainian researchers on a PCF segment in order to reveal the potential of the geomagnetic method for investigating active faults.

Key words: magnetic survey, modelling, faults, geodynamics.

General considerations

The PCF represents one of the most studied tectonic features on the Romanian territory, even from the beginning of the 20th century. It generally appears (Fig. 1) as the boundary between the Moesian Platform (MP), represented in the area by Central Dobrogea (CD), and North Dobrogea (ND) geological units. During the time, PCF has been alternately considered as a simple reverse fault, or the overthrusting plan of the hypothetic Green Schists Nappe. More recent research pointed out its strike-slip nature (e.g. Grădinaru, 1984, Banks & Robinson, 1997) with both right-lateral and left-lateral slip episodes.

The study area mainly belongs to the so called Cîrjelari-Camena Outcrop Belt (CCOB). A thorough description of the structure and litho-stratigraphy of this unit was provided by Grădinaru (1984; 1988), and a simplified geological sketch for the study area is shown in Figure 2, along with the location of the magnetically surveyed panels.

On the overall, the study area is dominated by the presence of the Jurassic sedimentary and volcanic rocks, unconformable overlying older Palaeozoic deposits of the Macin Unit and largely covered by the post-tectonic sedimentary cover of the Cretaceous Babadag Basin and shallow Quaternary formations.

Data acquisition and processing

Field observations were conducted by using two G 856 AX magnetometers. The survey lines were designed almost perpendicular to the assumed PCF track. They were 4 m apart, with a step of 2 m between two consecutive stations. The geomagnetic sensor worked at 3 m above the ground in order to avoid (or at least to mitigate) shallow local effects. Location of data points was set by using a Garmin 78 GPS receiver.

Diurnal geomagnetic activity was observed and recorded every minute during the survey in a local base-station, located close to the surveyed area.

Routine processing has been applied in order to provide data consistency: removal of the effect of external sources and base reduction. As a result, a time-invariant ΔF as referred to the survey base-station was obtained. Finally, a residual geomagnetic anomaly was derived by removing a first-order polynomial trend from the observations, and ΔF_a geomagnetic maps were plotted (for instances, see Fig. 3).

Modelling geomagnetic sources

The software. The professional GM-SYS® software, run on the Geosoft OASIS® platform has been used for 2D modelling along the survey lines.

Rocks magnetic susceptibility. Magnetic susceptibility of the rocks in the area have been considered according to previous rock physics determinations, to which additional determinations on outcrops samples were performed within the IG-NASU laboratory.

Geological interpretation

Based on previously gathered tectonic knowledge and rock physics of the main geological formations occurring in the study area and neighbouring region, an attempt for interpreting the geomagnetic sources outlined by modelling has been made. The results are synthetically illustrated in Fig. 4. As previously mentioned, the interpretative geological cross-section laterally extends over the magnetic line in order to mitigate the effect of the signal truncation and side effects. Overall, the geological interpretation of the synthetic model has allowed outlining the PCF path by separating PCF flanks due to the general distinct geomagnetic behaviour of their different embedded geological formations (basically magnetic CD Proterozoic GSS versus non-magnetic ND Palaeozoic sedimentary). But, the survey accuracy has also allowed discriminating some distinct layers with different magnetization within GSS, as well as the presence of some intrusive rocks (diorite dykes?) penetrating the geological formations.

Basalt lava flows (Başpunar spilite) embedded within the Başpunar Fm, significantly complicates the interpretation by locally increasing the geomagnetic behaviour of the non-magnetic Jurassic and/or Triassic limestone.

Concluding remarks

Within the joint international effort of the Romanian and Ukrainian specialists, the experiment succeeded to demonstrate the potential of the old geomagnetic method for investigating structure and dynamics of some active faults. High accuracy ground magnetic survey has allowed to outline the PCF track and its in-depth structure in the BGD neighbourhood, based on the interpretation of some 2D models simulating sources of the geomagnetic effects pointed out.

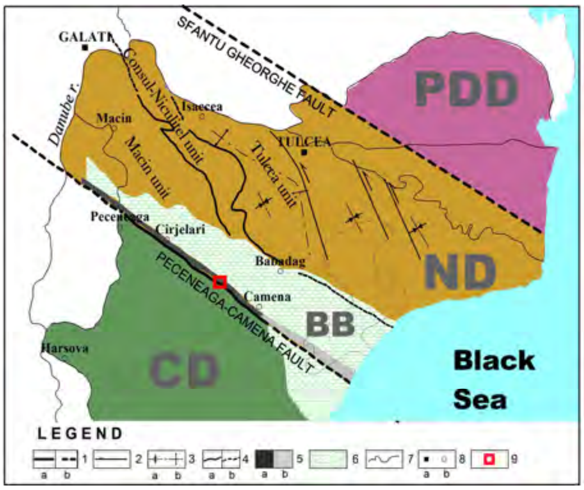

Fig. 1. Simplified tectonic setting of PCF and location of the study area.

PDD, Predobrogean Depression; ND, North Dobrogea; CD, Central Dobrogea; BB, Babadag Basin. 1 – North Dobrogea boundaries: a, cropping out; b, covered; 2 – strike-slip faults; 3 – structural axes: a, syncline; b, antycline; 4 – boundaries between North Dobrogea main units: a, cropping out; b, buried; 5 – CCOB: a, cropping out; b, covered; 6 – episutural post-tectonic cover; 7 – river; 8 – settlements: a, major cities; b, villages; 9 – Baspunar Geodynamic Observatory (BGD) location

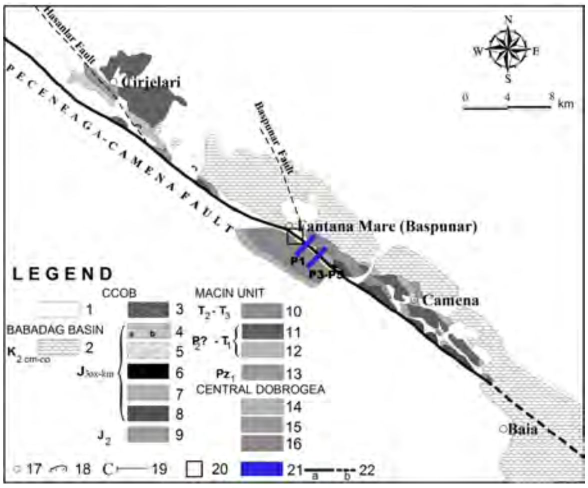

Fig. 2. Simplified geologic sketch of the study area (modified after Grădinaru, 1988).

1 – Quaternary; BABADAG BASIN 2 – Episutural sedimentary cover; CCOB 3 – Başpunar Melange; 4a – Sfanta Formation; 4b – Amara Formation; 5 – Amara Breccia; 6 – Başpunar Spilite; 7 – Başpunar Formation; 8 – Camena Rhyolite; 9 – Aiorman Formation; MACIN UNIT 10 – Uspenia Formation; 11 – Cîrjelari Rhyolite; 12 – Camena Formation; 13 – Lower Paleozoic (marbles, quartzites and argillites); CENTRAL DOBROGEA 14 – Infragrauwacke, 15, Lower Grauwacke; 16 – Upper Grauwacke; 17 – settlement; 18 – quarry; 19 – cross-section location; 20 – BGD; 21 – magnetic survey panel; 22 – PCF track (a, exposed; b, covered)

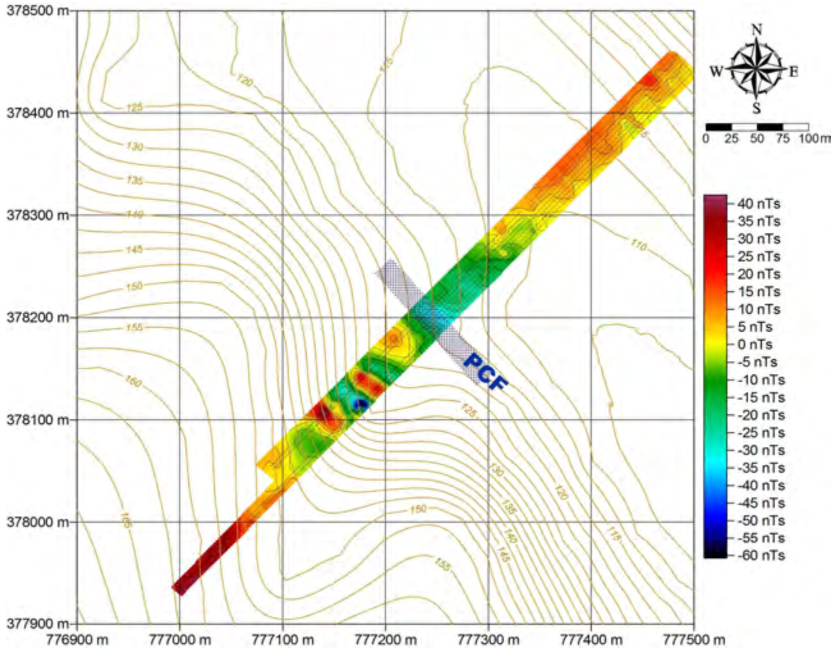

Fig 3. Residual geomagnetic anomaly along various PCF segments (micro-panel P1) as obtained after removing a first order polynomial trend. Black dots mark data points. Brown solid lines show topography contours (in meters). Dashed zone marks the assumed PCF track

The active character of the fault has been indirectly revealed through the loose of magnetic behaviour within the contact area, where active slip generated fault flanks fragmentation, with an overall random distribution of magnetisation of the rock-debris.

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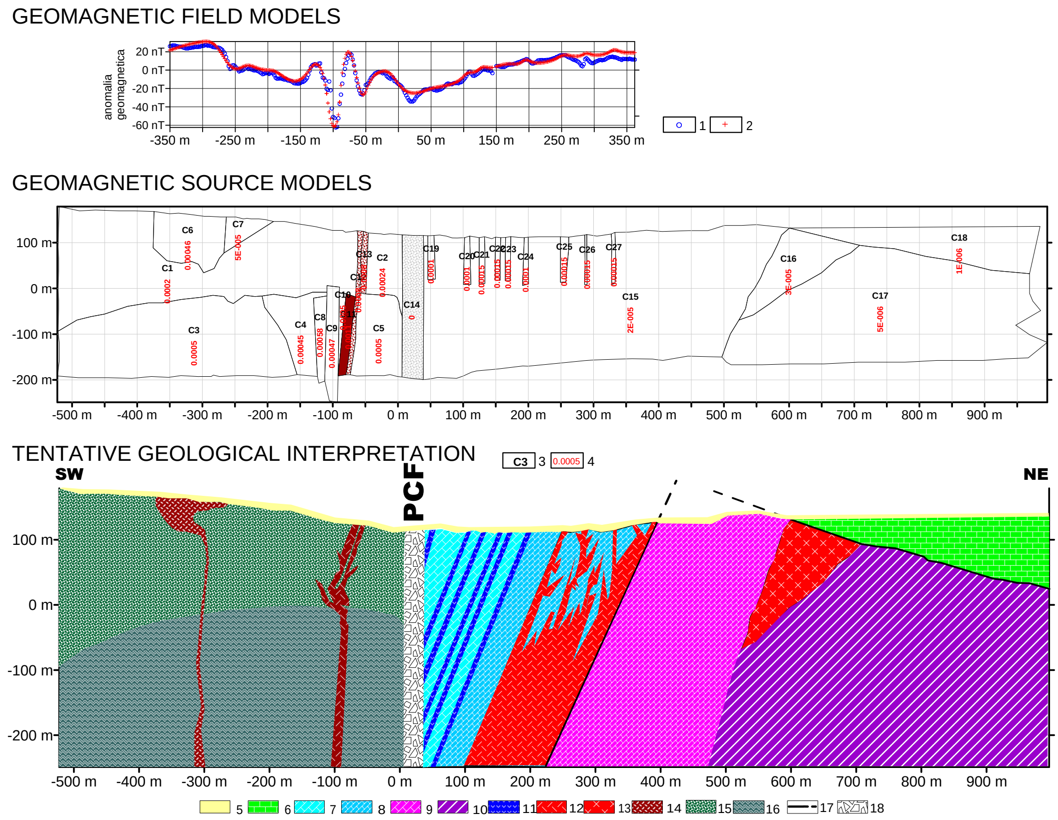

Fig. 4. Tentative interpretative model of the geomagnetic anomaly across PCF: 1 – residual geomagnetic anomaly; 2 – predicted field; 3 – body ID, 4 – magnetic susceptibility (in 10^{-6} CGSu). **North Dobrogea**: 5 – loess; 6, post-tectonic cover (K2); 7 – Upper Jurassic limestone; 8 – Lower Jurassic; 9 – Triassic limestone; 10 – Camena Fm (P2-T1); 11 – Başpunar spilite; 12 – Camena Porphyry; 13 – Cîrjelari Rhyolite. **Central Dobrogea**: 14 – diorite dykes; 15 – low-grade GSS; 16 – higher-grade GSS; 17 – secondary fault; 18 – breccias zone generated by fault dynamics

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ГЕОМАГНІТНІ СПОСТЕРЕЖЕННЯ НА АКТИВНОМУ ТЕКТОНІЧНОМУ КОНТАКТІ: РОЗЛОМ ПЕЧЕНЕАГА-КАМЕНА

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Спільними зусиллями румунських та українських дослідників було проведено високоточну наземну магнітну зйомку в районі розлому Печенеага-Камена з метою визначення можливості використання геомагнітного методу при дослідженнях активних розломів.

Ключові слова: магнітна зйомка, моделювання, розломи, геодинаміка.

ГЕОМАГНИТНЫЕ НАБЛЮДЕНИЯ НА АКТИВНОМ ТЕКТОНИЧЕСКОМ КОНТАКТЕ: РАЗЛОМ ПЕЧЕНЕАГА-КАМЕНА

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Совместными усилиями румынских и украинских исследователей была проведена высокоточная наземная магнитная съемка в районе разлома Печенеага-Камена с целью определения возможности использования геомагнитного метода при исследованиях активных разломов.

Ключевые слова: магнитная съемка, моделирование, разломы, геодинамика.

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