Geophysical insights on an active tectonic contact: Peceneaga-Camena Fault

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SUMMARY

The paper mainly deals with results of the research project INRAF, a joint venture of the Institute of Geodynamics of the Romanian Academy (IGAR) and Institute of Geophysics of the National Academy of Sciences of Ukraine (IG-NASU) dedicated to the study of some active faults located in the Black Sea NW inland. Starting from a large geological and geological database additional field observations were conducted within the Peceneaga-Camena Fault (PCF) segment where a geodynamic observatory run by IGAR is located. Based on the magnetic properties contrast between the PCF flanks, high accuracy ground geomagnetic investigations were successfully conducted for revealing the path and in-depth structure within the fault segment where the Baspunar Geodynamic Permanent Station monitor slip along the fault. 2D modeling was used to construct tentative-interpretative models of the fault. The lack of magnetic properties along PCF path has been interpreted in geodynamic terms. Therefore, indirect evidence on the PCF active nature is provided, in full agreement with geodesy and geochemistry observations.
Introduction

The Peceneaga-Camena Fault (PCF) represents one of the most studied tectonic features on the Romanian territory. PCF appears as the boundary between the Moesian Platform (MP), represented in the area by Central Dobrogea (CD) unit, and North Dobrogea folded belt (ND). Geophysical evidence advocate for its in-depth lithospheric extension as the contact between East European Plate (EEP) and Moesian micro-plate (MoP). Geological evidence show a controversial PCF geodynamic evolution as a strike-slip contact with both right-lateral and left-lateral episodes.

Figure 1 Simplified tectonic setting of PCF and BGPS location. 1, ND boundaries: a, cropping out; b, covered; 2, strike-slip faults; 3, structural axes: a, syncline; b, antycline; 4, boundaries between ND main units: a, cropping out; b, buried; 5, Carjelari - Camena Formation: a, cropping out; b, covered; 6, episutural post-tectonic cover; 7, river; 8, settlements: a, major cities; b, villages; 9, BGPS location; 10, Predobrogean Depression units; 11, ND units; 12, CD units

The Baspunar Geodynamic Permanent Station (BGPS), run by the Institute of Geodynamics of the Romanian Academy, was especially designed to monitor PCF slip. Two Leica TC1201 total stations are installed on the southern PCF flank (within MoP) and point on the laser reflectors located on the northern PCF flank (belonging to EEP). The distance between the PCF flanks is observed with a 10 Hz frequency and minute averages are stored in a computer. Locations for both total stations and their reflectors has been carefully chosen based on detailed geological mapping that revealed outcrops of Triassic limestone in the neighbourhood of the reflectors, and Proterozoic crystalline series close to the total stations location.

This paper mainly deal with results of the high accuracy detailed magnetic investigations carried out on the Peceneaga-Camena Fault (PCF) segment located in the neighbourhood of the BGPS. They were aimed at revealing the path and in-depth structure of the PCF between the BGPS total stations and their reflectors, in an area where previous geochemistry observations have revealed some higher Rn concentration.

Research has been performed in the frame of the bi-lateral co-operation between the Romanian Academy and the National Academy of Sciences of Ukraine, subject to the project INRAF (“Integrated research of some active faults located in the NW inland of the Black Sea on the Romanian and Ukrainian territories”), jointly developed by the Institute of Geodynamics of the Romanian Academy (IGAR) and the Institute of Geophysics of the National Academy of Sciences of Ukraine (IG-NASU).
Local geological background

Early studies at the beginning of the last century (e.g. Macovei, 1912) have presented PCF as a reverse fault along which the crystalline series of Central Dobrogea thrust the Paleozoic / Mesozoic sedimentary deposits, sometimes intercalated with or intruded by magmatic rocks, of North Dobrogea. The main geological formations in the area were thoroughly described by various authors. The CD is mainly present here through Late Proterozoic crystalline series known as Green Schist series (GSS) formation, while ND is represented by Paleozoic sedimentary (mainly Triassic and Jurassic limestone and/or greenstone). The CD Proterozoic GSS is a complex geological formation made of various rocks with different age and grade of metamorphism, sometimes pierced by intruding rocks. Some basalt lava flows and/or diorite intrusions are also known within ND formations (Gradinaru, 1984; 1988). A geologic sketch of the study area is presented in Figure 2.

Data acquisition and processing

Field observations were conducted by using two G 856 AX magnetometers (one for local record of diurnal geomagnetic activity, and the second one for observations along the lines). Location of data points was surveyed by using a Garmin 78 GPS receiver. The geographic coordinates were then transferred into the Romanian national stereographic projection system S42. Basically, the survey lines were designed almost perpendicular to the assumed PCF strike. The lines were 4 m apart, and a step of 2 m between two consecutive stations along each line was used to survey the study areas. The geomagnetic sensor was placed at 3 m above the ground in order to avoid (or at least to diminish) shallow local effects. Routine processing has been applied to the raw observations in order to provide data consistency: removal of the effect of external sources and base reduction. As a result, a time-invariant $\Delta F$ as referred to the survey base-station was obtained. Finally, a residual geomagnetic anomaly was inferred by removing a first-order polynomial trend and geomagnetic maps were constructed (Fig. 3).
Modelling geomagnetic sources

Taking into consideration the pattern of the geomagnetic anomaly and some previous information on the study area tentative attempts for modelling the geomagnetic sources and their interpretation have been conducted (Fig. 4). To synthesize the geomagnetic effect of the assumed geological structure, the GM-SYS® software run on the Geosoft OASIS® platform has been used for 2D modelling along the survey lines. Magnetic properties of the rocks cropping out in the area have been considered according to previous rock physics determinations reviewed in some previous works (e.g. Besutiu, 1998). Because Köenigsberger coefficient overall showed low values the induced magnetization model has been considered in the computation, with the following geomagnetic parameters: 48500 nT total intensity scalar intensity; 62° N geomagnetic inclination and 3° E geomagnetic declination.

Geological and geodynamic considerations

The geological interpretation of the geomagnetic models has allowed outlining the PCF path by separating PCF flanks with distinct geomagnetic behaviour due to their different embedded geological formations (magnetic Proterozoic GSS of CD versus ND non-magnetic Paleozoic sedimentary).

The survey accuracy has also allowed discriminating some distinct layers within GSS with different magnetization, and the presence of intrusive rocks (diorite dykes) piercing the geological formation. It is also worth mentioning that basalt flows (Baspunar spilite) embedded within the Baspunar Formation (Jurassic and/or Triassic limestone) complicate the interpretation by slightly increasing the magnetic properties of the ND sedimentary pile. Another interesting result the modelling pointed out has been the revealing of the lack of magnetic properties in the central compartment located along the assumed PCF track. This has been interpreted in terms of milonitization of the contact rocks due to active slip along PCF. PCF dynamics generated some mixed breccias made of magnetic and non-magnetic rocks belonging to the both PCF flanks (Baspunar melange). However, the magnetic
elements are not expressed in the geomagnetic field due to the randomly distributed direction of the magnetization of the breccias elements. Besides, water circulating within the contact zone accelerated the minerals weathering and, consequently, the loss of magnetic properties. The geodetic records at the BGPS have confirmed the PCF active character, with a dominant right-lateral slip rate ranging between 1 – 6 mm/yr.

**Figure 4.** Tentative interpretative model of the geomagnetic anomaly across PCF. **PHYSICAL MODELS:** 1, observed field; 2, synthesized field; 3, body ID, 4, magnetic susceptibility (CGS units). **GEOLOGICAL MODEL:** 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, Baspunar spilite; 12, Camena Rhyolite; 13, Carjelari Rhyolite; CENTRAL DOBROGEA 14, diorite dykes; 15, low-grade GSS; 16, higher-grade GSS; 17, fault; CONTACT ROCKS 18, Baspunar melange

**References**