Kinematics and age of thrusting of the Upper onto the Lower Allochthon of the Rhodope Metamorphic Complex. An example from NW Rila Mt., Bulgaria

Кинематика и възраст на навличане на горния върху долния алохтон на Родопския метаморфен комплекс. Пример от СЗ Рила, България

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Key words: Rhodope Metamorphic Complex, compressional tectonics, allochthons, Late Cretaceous.

The Alpine age of formation of the Rhodope Metamorphic Complex is nowadays widely accepted. Its complex tectono-metamorphic history resulted from a succession of subduction, collisional and subsequent extensional events in the northern Tethyan realm. However, the particular age of the structures within the different units of the Rhodope nappe pile are still poorly studied. The complexity of this matter is mostly due to the fact that both the compressional and later extensional structures have developed under similar PT conditions and show similar senses of shear. The metamorphic basement of Northwest Rila Mountain is a coherent part of the Rhodope Metamorphic Complex. It is composed of several lithotectonic units which are in a tectonic superposition (for details see Gorinova, Georgiev, 2015). Structurally, from bottom to top these are: Malyovitsa, Kabul, Polich, Lakatishka and Verila Units. Herein, we focus on the Dodov Vrah Shear Zone (Dimov, Damyanova, 1996), a Late Cretaceous top-to-the SE thrust that separates Malyovitsa and Kabul Units, both showing considerably different pre-thrusting tectonometamorphic history.

Malyovitsa Unit is an amphibolite facies variegated metamorphic section composed of orthogneisses with ~150 Ma protholith ages (see also Sarov et al., 2011), paragneisses, amphibolites, marbles, schists and metaultrabasic rocks. No evidence for HP metamorphism or migmatisation was found in this unit. The main metamorphic foliation deeps with moderate to shallow angles to SW or W and bears a NW-SE oriented stretching lineation. The related kinematic indicators show a consistent top-to-the SE sense of shear.

Kabul Unit is a migmatized section of variegated metamorphic rocks that contains also relicts of Triassic eclogites (Miladinova et al., 2013). The unit was also affected by shearing and folding in lower-grade (amphibolite facies and greenschist facies) conditions as recorded by previous studies (Dimov, Damyanova, 1996; Kolcheva, Cherneva, 1999; Machev, 2002). However, the unit has preserved structures from its earlier higher-grade metamorphic history. In general the main metamorphic foliation dips moderately to SW or W and bears pronounced NW-SE trending stretching lineation. Related kinematic indicators show a consistent top to the NNW sense of shear. Only in the lower parts of the unit and close to the contact with Malyovitsa Unit, this older high-grade fabric was obliterated by the mylonitic fabric of Dodov Vrah Shear Zone.

Dodov Vrah Shear Zone is a relatively thick (~100–150 m) volume of intensely sheared rocks at the boundary between the lower Malyovitsa and upper Kabul Units. The foliation in the vicinity of the shear zone dips gently to the W or SW and bears a nearly horizontal, NW or SE plunging stretching lineation. Reliable kinematic criteria show a clear top-to-the SE sense of shear. The geometry of the shear zone as well as the fact that it juxtaposes higher-grade rocks in the hanging wall with lower-grade ones in the foot wall reveal its compressional, thrust nature. The temperature of shearing reached mid-amphibolite facies conditions corresponding to the Malyovitsa Unit metamorphic grade. Specific features of the shear zone are magmatic bodies (dykes and sills) which show structural and field characteristics of synkinematic emplacement. The newly obtained U/Pb zircon dating of a syn-kinematic diorite sill intruded and deformed along the shear zone shows a Late Cretaceous (76.29±0.63 Ma) age of emplacement. On the other hand the first phase of the Rila-Rhodope batholith intruded within Malyovitsa Unit at ca.70–69 Ma (Von Quadt, Peytcheva, 2005) and thus, sealed its metamorphic fabric.

Based on our studies and following the regional tectonic scheme proposed by Janák et al. (2011), where the Rhodope Metamorphic Complex is composed of 4 orogeny scale tectonic units, namely Lower, Middle, Upper and Uppermost Allochthons, we assign Malyovitsa Unit to the Middle Allochthon and Kabul Unit to the lowermost structural levels of the Upper Allochthon. Thus, the geometry, field relationships and kinematics of Dodov Vrah Shear Zone combined with U/Pb dating of synkinematic sills and dykes fix the age of the top-SE thrusting at the base of the Upper Allochthon at ca. 76 Ma. The latter is in a temporal and kinematic agreement with the tectonic environment that dominated the Sredna Gora basement in the Late Cretaceous. Thus, depending on the particular structural level the boundary between the Upper and the Middle Allochthons is represented by geometrically and kinematically different shear zones. In lower structural levels (NW Rila Mountain) the boundary is presented by top-SE thrusts like Dodov Vrah Shear Zone. Higher in the crust (north of Rila and Rhodopes Mountains) same boundary appears as dipping to NE steep or vertical dextral strike-slip to oblique-slip faults likes Iskar-Yavoritsa Shear Zone and Maritsa Shear Zone.

Our general conclusion is that the Upper and the Middle Allochthons in Rila Mountain area stacked together in the Late Cretaceous. The top-SE direction of thrusting can be linked to the oblique convergence between the active European continental margin and the north directed subduction of Vardar ocean plate at that time.

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