NEW MODEL OF UPPER CRETACEOUS MAGMA EMPLACEMENT IN THE SOUTHWESTERN PARTS OF CENTRAL SREDNA GORA ZONE – BULGARIA

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Abstract: The structural, petrologic and magnetic (AMS) features of plutonic bodies, placed in Central Sredna Gora region, show an evidence of processes of mingling and mixing of two different compositional magmas - felsic and mafic. These two magma types have been generated at different continental lithosphere levels. The emplacement as well as a syn- and postcrystallization deformations of the plutons have been controlled by movements along the strike- slip system of Maritza fault zone.

Key words: *magmatism, mixing, mingling, strike-slip deformation*

Introduction

The subject of our petrostructural, petrologic and magnetic (AMS) study is a subequatorially elongated chain of intrusive magmatic bodies of granitoid composition - Plana, Gutsal, Varshilo, Boshulia, Elshitsa, Lesichovo, etc. This chain is situated in a marginal area between the Rhodope massif from the south and the central parts of the Sredna Gora tectonic zone from the north. Relatively large lensoid or sheet-like bodies of basites (gabbro, gabbro-diorites and diorites) are imbedded into the plutons. According to the available literature there are two opinions The earliest interpretations of co-existence of gabbros and granites within a framework of one plutonic body are related with the idea of a normal differentiation of basaltic magma (Dimitrov,1934). Another hypothesis is that these bodies are products of two well-distinguished in time magmatic epochs - Paleozoic (Variscan) and Upper Cretaceous (or Upper Cretaceous-Paleocene) and are a result from two-phase magmatic injection. The earlier phase is with more basic character (gabbro and gabbro-diorites), whereas the second one is with intermediate and acid (granodiorites and granites) character due to contamination by the preceding basic rocks (Bojadjiev & Chipchakova,

1962). The Upper Cretaceous intrusives of the second phase have been characterized as "fissure" plutons, formed in an extensional rift setting (Dabovski, 1988).

Our results, however, in combination with the recently obtained petrochemical and radiological data (Peycheva et al., 2001), show that all the plutons are product only of Upper Cretaceous magmatic activity. They are intruded into the rocks of the pre-Upper Cretaceous basement of the Central Sredna Gora zone. These plutons mark the boundary between two types of metamorphic complexes - Balkanide and Rhodope (Ivanov, 1988, 1989).

Geological setting

The plutons are elongated magmatic bodies, en-echelon situated on both sides of Iskar-Yavoritsa shear zone (IYSZ) - one of the most important tectonic elements of the region. The Iskar -Yavoritsa shear zone is a regional dextral strike-slip fault, which can be traced out at a distance of 80 - 90km south of Sofia to the latitude of the town of Pazardjik. It is trending NW-SE with a steep dip of 65-85° towards NE or SW. An intense foliation and mylonitization of the rocks of mainly ductile and brittle-ductile character mark the shear zone. The width of the zone ranges between 400-500 m up to 1 km. Shearing has influenced both gneisses of the pre-Mesozoic basement as well as Late Paleozoic - Early Mesozoic sediments of the Lozen mountain (Fig.1). The magmatic rocks of Gutsal, Varshilo and Boshulia plutons are crosscut by the shear zone in the segment confined between the town of Ihtiman and Boshulia village. Shearing of similar character, parallel to the main shear zone is found in the metamorphic rocks from the southern parts of Ihtiman Sredna Gora. This event is dated by Velichkova et al. (2001) at 102 - 100 Ma.

Petrostructural and petrographic characteristics

According to the early studies (Bojadjiev, 1962, Bojadjiev & Chipchakova, 1962, Dabovski, 1963, Belmustakova, 1984) plutonic bodies were considered separate well individualized intrusions, resulting from multiple subsequent magma injections of different composition and facies peculiarities. Field observations on the occurrence and relationships of the rocks suggest that the plutons studied represent parts of a big lacolith-like layered intrusion. Thhey were formed as a result from mingling and mixing of mafic and felsic magmas in a large granite magma chember.

Mafic rocks can be found as separate sheets or lensoid bodies, intruded into granites and granodiorites. Their thickness ranges between 30-40 to 80-100 m and covers an area of several hundred square meters. The basites are laterally connected with contaminated

levels everywhere. In the latter, basic enclaves are destigwished with centimeter, decimeter and meter sizes. They are abundantly present and often dominate over the host matrix. As a rule, the levels with enclaves are situated above the sheet-like gabbro and gabbro-diorites. Typical load-casts, "pipe" structures and chilled zones are observe in a number of cases, as well as traces of convection movements in the overlaying swarms of mafic enclaves. All these features show that the injection of the basic magma occurred in a sill-like manner into the already partly crystallized but still non-consolidated granitic melt in the magma chamber.

Gabros from Velitchkovo and other places contain significant amounts of quartz and K-feldspars (including large xenocrysts) testifying the complexly evolution of the magma chamber.

In all places, basic fragments and the above situated swarms of basic enclaves overlie the porphyric (or porphyroid) biotite-amphibole granodiorites. The latter are products of consolidation of a crystal-rich suspension "mush", "precipitated" in the lowermost part of the magma chamber. They are commonly covered by granites or granodiorites poor in crystal phase with typical characteristics of felsic magmatites.

In a regional point of view, the association of basic sheets and the overlying contaminated rocks with swarms, build up an almost continuous band of various width. It can be traced out sub-parallelly to the Iskar-Yavoritsa shear zone or NE and SW of it.

These relationships and interpretations are supported also by dating by Peycheva et al. (2001) of different parts of the system: 82.32 ± 0.5 Ma for the gabbro sheet-like bodies; 82.25 ± 0.4 Ma for the granites of Varshilo pluton considered of Hercinian age so far (the upper level of the layered intrusion); 86-82 Ma for the granodiorites of Elshitsa biotite-amphibole granites and granodiorites underlying the basites.

Petrologic and thermo-barometric data

Some of the features of mingling and mixing have been established during our petrologic studies. One of them is the presence of significant amount of potassium feldspar and quartz in the gabbroic rocks. Both minerals form a poikilitic structure and their co-existence along with clinopyroxene, basic plagioclase and high-aluminum hornblende probably mark disequilibrium mineral association. Patchy zoning in plagioclase is another sign of mixing processes. This zoning indicate a temporary corrosion or hiatus in mineral composition, suggesting sudden change in conditions of crystallization. Very illustrative to this type of relationships is the presence of two generations of plagioclase in the gabbroic rocks. The

first one is presented by plagioclase with composition between An_{92-88} and the second by An_{54-31}. The plagioclase in the intermediate and acid rock types is characterized often with oscillatory zoning. Another feature is a compositional zoning of hornblende. The cores are enriched in aluminium and the content of this element decreases towards the rims.

We have used equilibrium hornblende plagioclase pairs to calculate the temperature values and pressure of mixing processes and crystallization. We obtained three groups of results for these gabbroic rocks. The highest temperatures are around 900-800°C at the pressures around 7-6.5 kbar. This value corresponds with the depth between 19-18 km. All these calculations were made for the central parts of hornblende and of plagioclase enriched in anorthite and they show an earlier stage of crystallization of mafic magma. The second group of results with temperature between 800-700 ^{o}C at pressure between 5-3 kbar marked another stage of magma crystallization and probably is the first stage of mixing processes. That is around 15-9 km. The lowest temperature is around 680 ^{o}C at pressure 2.5-1.8 kbar and corresponds to depth between 5-3 km. These values probably reflect a subsolidus re-equilibration of the magmatic system. The results for the northern part of the Elshitsa-Boshulia pluton marked a shallower level in the magma chamber. The temperature obtained for the granitic rocks is around 750 ^{o}C at pressure around 3 kbars. These values suggest a depth of crystallization around 9 km. The results for the mafic rocks cropping out in this area are with 900-800 ^{o}C temperature and 3.5-2.6 kbar pressure.

Structural, petrologic and thermo-barometric data suggest an idealized model about the depth of generation of both magmas and probable level of mixing processes (Fig. 2).

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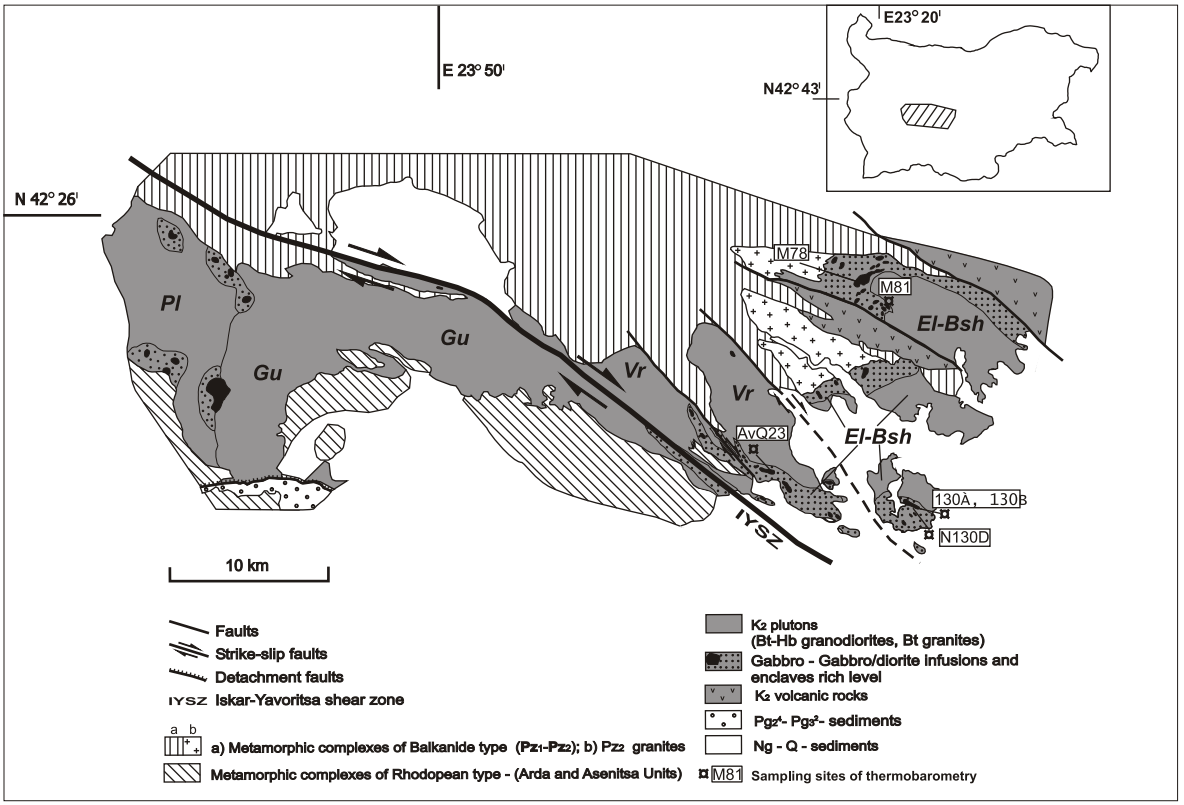

Fig.1 Geological schematic map of south-western part of Sredna Gora zone
PL - Plana pluton; ***Gu*** - Gutsal pluton; ***Vr*** - Varshilo pluton; ***El-Bsh*** - Elshitsa-Boshulla pluton

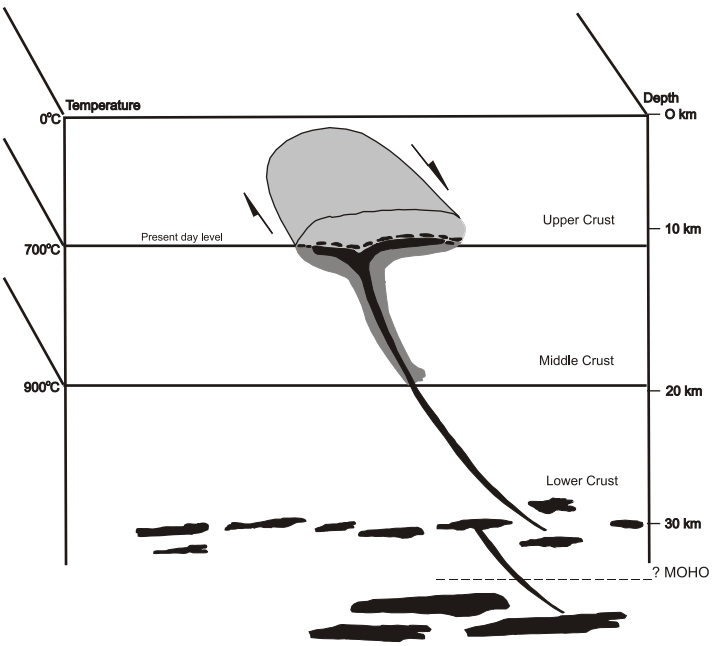

Fig. 2 Idealized crustal section showing drainage along Iskar-Yavoritsa Shear Zone