Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences
Tome 58, No 10, 2005

GEOLOGIE
Géotectonique

ABOUT THE POSITION OF DYKE BODIES AND MAGMA MINGLING PROCESSES IN VEJEN PLUTON, CENTRAL STARA PLANINA MOUNTAINS[1]

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(*Submitted by Corresponding Member Ch. Dabovski on July 8, 2005*)

Abstract

Vejen pluton is a part of the Variscan Stara Planina granodiorite-granite complex. Important elements of the structure of the intrusive are mafic and felsic dykes as well as mafic microgranular enclaves. Close spatial and genetic relationships between mafic dykes and enclaves suggest magma mingling processes at this level of the pluton. Structural data testify about an approximately contemporaneous formation of the mafic and felsic veins.

Key words: Vejen pluton, dykes, enclaves, magma mingling, structure

Introduction. The presence of mafic rocks often occurring as enclaves, dykes or sheet-like bodies is a common feature of granitoid plutons [1–4]. Usually such coexistence is closely related to mixing and mingling processes of felsic and mafic magmas. The Upper Carboniferous Vejen pluton is composed mainly of granodiorites, but a great number of dykes and microgranular enclaves both mafic in composition are widespread. Another element of the structure of the pluton are different in size and shape bodies of granodiorite porphyrites. The purpose of this paper is to present some field characteristics of mafic dykes, enclaves and bodies of granodiorite porphyrites, and to suggest possible mechanisms of their formation.

Geological setting. The E-W elongated 314±4.8 Ma [5] Vejen pluton is a part of an association of Variscan intrusive hypabyssal bodies forming the so-called "Stara Planina calc-alkaline formation" [6,7]. The pluton crops out over an area of about 250 km^2 in the central part of Stara Planina Mts. between the town of Etropole and Vejen Peak (Fig. 1). To the south, the intrusive contacts a very low- to low-grade greenschist sequence considered as a part of the so-called "Diabase-phyllitoid complex" [5,6,9,10]. This sequence is composed mainly of metasediments, including also metagabbroic, metadiabasic and metagranitic sheets and blocks [8]. These host rocks suffered contact metamorphism during the emplacement of the pluton and were transformed into hornfelses, amphibolites and andalusite-cordierite schists within approximately 250 m wide contact aureole [6,7,11]. To the north the pluton is rimmed by the so-called "Stara Planina high-grade metamorphic formation" [12] comprising biotite gneisses and

[1]This research was financially supported by "Elatsite-Med" AD.

schists, amphibolites, marbles as well as chlorite schists. The boundary of this unit with the intrusive is interpreted as tectonic [9,13], and the high-grade metamorphism of the rocks – as a result of migmatization of the "Diabase-phyllitoid complex" during granite emplacement [12].

Vejen pluton consists mainly of equigranular biotite-hornblende or hornblende-biotite granodiorites and minor granites, but tonalites, monzodiorites, diorites, gabbro, etc. rock varieties are also present [5,10]. Dykes and complex bodies of diorite, granodiorite and syenite porphyrites [9] are widespread in the pluton. Mafic microgranular enclaves (gabbro, diorite and monzodiorite in composition, [5]) and aplite veins are also common [5,6,9]. Geochemical data [5] confirm the calc-alkaline affinity, metaluminous to peraluminous composition of the intrusive body and suggest a mixed crust-mantle magma source. The tectonic discriminations are equivocal. There are several different interpretations of the generation mechanism of the pluton: differentiation of a parental mafic magma [6,7]; double-phase composite intrusion [9]; assimilation and contamination of granodioritic magma with gabbroic varieties from the host rocks [10]; mixing and mingling processes of coexistent felsic and mafic magmas [5].

Irrespective of the above mentioned data, there is a considerable gap in our knowledge about the position, relationships and specific features of dykes, more complex bodies and enclaves, all representing an inseparable part of Vejen pluton. The present paper is an attempt to solve these enigmatic aspects.

Structural characterization of dykes and enclaves. Our field observations in the region between the town of Etropole and Vejen Peak (Fig. 1) confirmed the presence of a great number of vein bodies within Vejen pluton. Apart from aplites and pegmatites, two other kinds of synplutonic bodies were distinguished as described below. Widespread in the pluton are aphyric or porphyric mafic dykes (gabbro, gabbro-diorite or diorite, Fig. 2*a* – *c*) 0.5 to 4 m thick. Specific features of these bodies are steeply dipping, but step-like contacts with dips varying from 45° to 85–90°, respectively. They have relatively constant NNW-SSE trends between 150–180° (Fig. 1). Another inseparable part of Vejen pluton are dykes and more complex bodies of granodiorite porphyrites, often exceeding 10–15 m in thickness. These granodiorite bodies have step-like contacts with steep- and gently-dipping sectors (Fig. 2*d*). The general trends are NNW-SSE between 160–180° (Fig. 1). Typical feature is the presence of chilled margins of different thickness depending on the size of the body. Field observations show the following relationships between mafic and more felsic bodies – equigranular granodiorites crosscut by 5 m thick granodiorite dyke, in the central part of which a mafic vein is emplaced. The contacts of both bodies have the same 165/90° orientation. Dykes of granodiorite porphyrites crosscut as well host rocks (around Svishti Plaz Peak) that are covered by Triassic sediments (including conglomerates). Some clasts in these sediments closely resemble such porphyrites.

The vein bodies in Vejen pluton include also aplites which are ubiquitous in the area. These are fine-grained, gray or pink, few centimetres thick veins with variable orientation, but dominantly steep dips. Some mafic dykes cut them.

The mafic enclaves are widespread in Vejen pluton and range from several mm up to 0.5 m in size. Chilled margins as well as molded phenocrysts from the hosting granodiorites are typical. Ovoid enclaves are common (Fig. 2*e*), but lenticular and cigar-like shapes are also observed (Fig. 2*f*). Along Malak Iskar River Valley (Fig. 1), E-W orientation of the long axis of mafic enclaves was established. In the eastern parts of the pluton (Kostina and Zavodna Rivers, Fig. 1) the orientation is dominantly ESE-WNW.

A close spatial relationship between mafic dykes and enclaves was established all over the pluton. Often in the field, mafic dykes are disaggregated in their upper parts breaking down into microgranular basic enclaves (Fig. 2*a*). Approximately similar

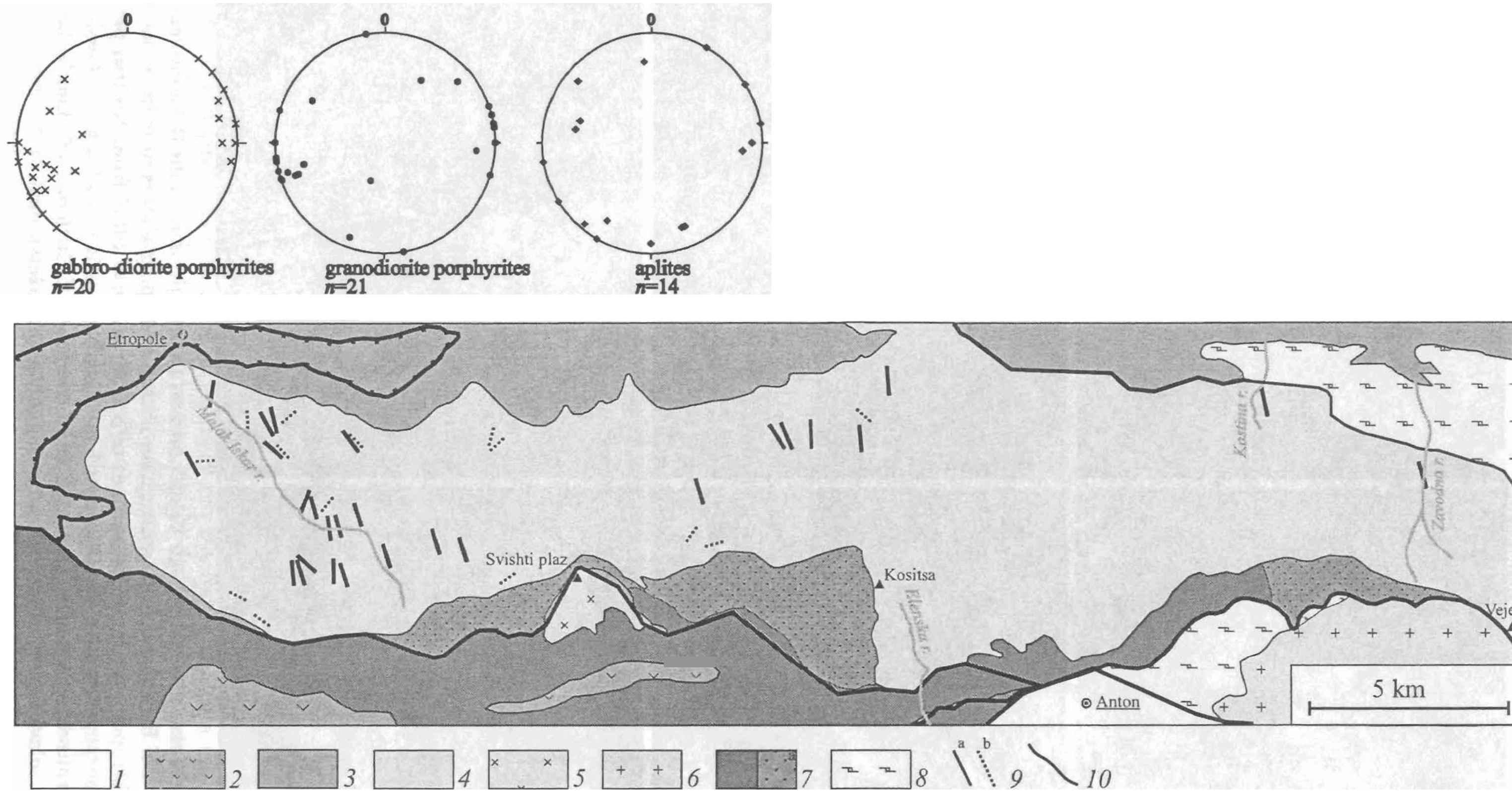

Fig. 1. Schematic geological map of the studied area. Lower-hemisphere stereograms show the orientation of the contacts of different dykes. *1* – Quaternary deposits; *2* – Upper Cretaceous sedimentary and volcanic rocks; *3* – Triassic, Jurassic and Lower Cretaceous sediments; *4* – Vejen pluton; *5* – granodiorites and granite porphyries; *6* – Anton and Klisura granites; *7* – Paleozoic low-grade metamorphic rocks; (*a*) – contact aureole; *8* – high-grade metamorphic rocks; *9* – (*a*) mafic and felsic dykes, (*b*) – aplites; *10* – shear zones

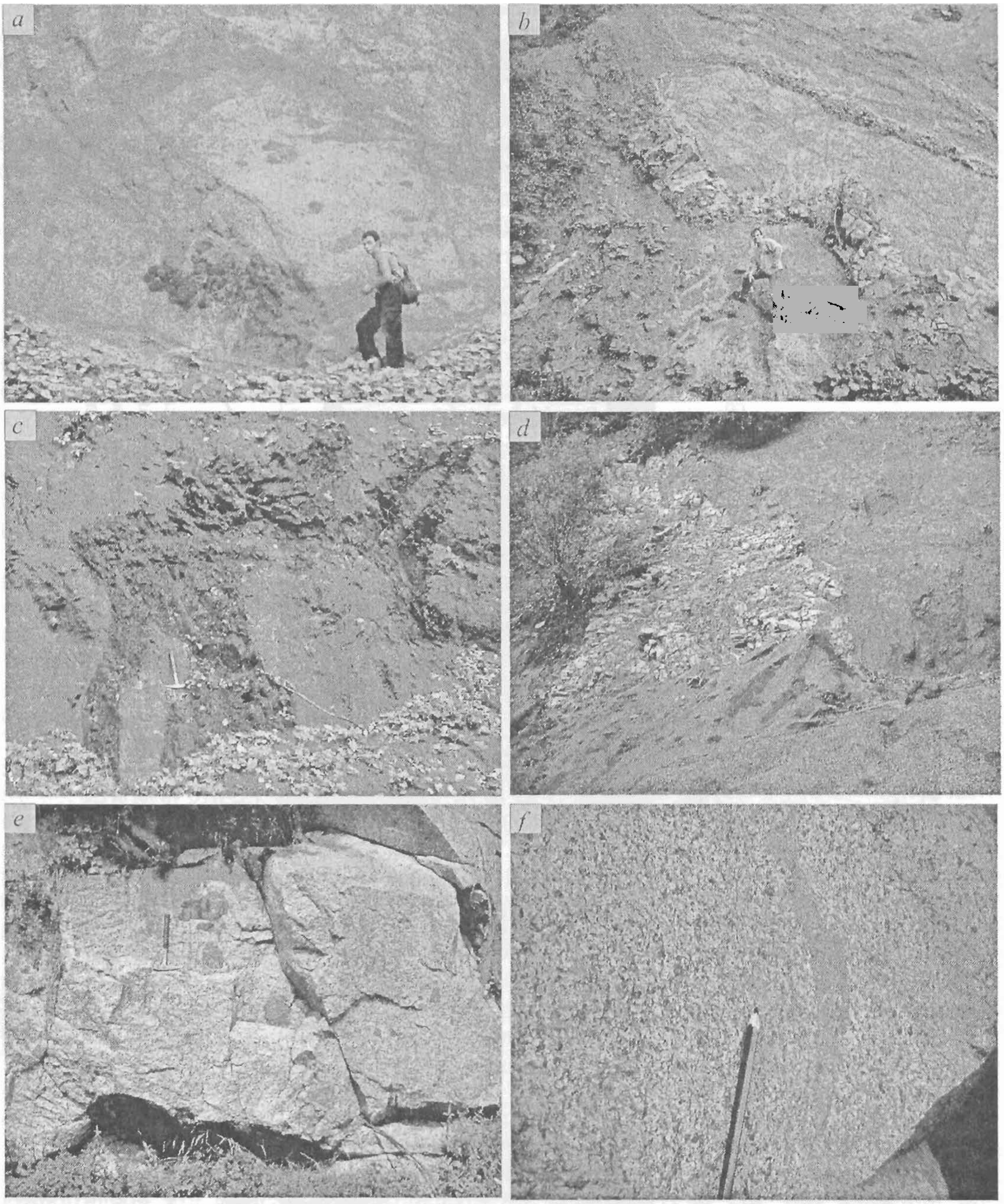

Fig. 2. Some features of dykes and enclaves in Vejen pluton. (*a*) Disruption of mafic dyke into enclaves, 8 km SE from the town of Etropole. (*b*) Fragmentation in gently-dipping sectors of mafic dyke, 10 km SE from the town of Etropole. (*c*) Irregular outlines of a mafic dyke, 5 km N from Kositsa peak. (*d*) Body of granodiorite porphyrites with step-like contacts, 5 km N from Kositsa peak. (*e*) Ovoid mafic enclaves enclosed in granodioritic matrix, 8 km SE from the town of Etropole. (*f*) Lenticular mafic enclave into granodioritic host, 5 km N from Kositsa peak

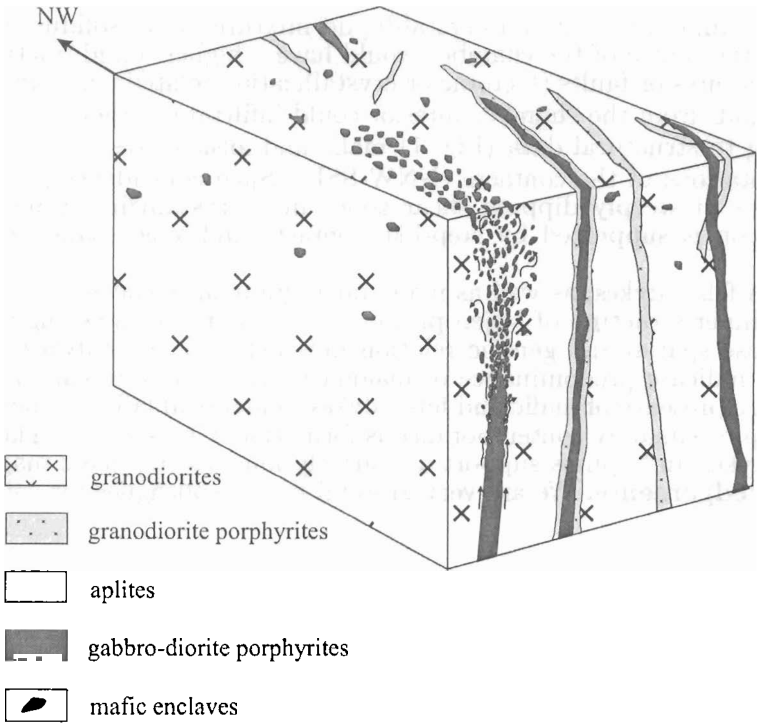

Fig. 3. Schematic model presenting some field characteristics of mafic dykes, enclaves and bodies of granodiorite porphyrites in Vejen pluton. Considering the fragmentation of mafic dyke into enclaves we refer to WEIBE & COLLINS's model [4]. It could be proposed the generation of "eddy "currents during emplacement, cooling and crystallization of mafic magma which are capable of ripping globules (i.e. future mafic enclaves) off the upper part of the duke

compositions of both of them support such an assumption. Likewise, fragmentation into enclaves along gently dipping sectors of the dykes was observed (Fig. 2*b*).

Discussion and conclusions. The above observations argue for mafic magma intrusion into the earliest fractures within a still mobile and crystallizing granodioritic host – Vejen pluton. According to some studies [1,14] mafic dykes dismemberment into microgranular enclaves at some level in the pluton is the strongest evidence for syn-plutonic emplacement of such bodies. Relatively small mafic magma volume and pronounced rheological contrast between mafic and felsic magma as well as rapid crystallization in the shallow level Vejen pluton suggests a prevailing role of magma mingling. On the basis of our field observations we propose a schematic model of disintegrated mafic dykes (Fig. 3). Scattering of mafic enclaves across the pluton was probably due to convection processes in a progressively crystallizing magma chamber.

On the other hand, the presence of mafic dykes, which are not disintegrated into enclaves and crosscutting aplite veins, supports the idea about an approximately long lasting process of mafic magma supply.

We propose the following idea for the origin of the widespread granodiorite porphyrite dykes in the pluton. Considering Vejen pluton as a shallow intrusive, it could be supposed that the crystallization process proceeded from the margins of the magma chamber inward. In that case there would be a transition from cooled material at or below solidus temperatures into a crystal-liquid mixture above solidus [15]. Those regions close to the centre of the chamber would have a higher liquid fraction and lower viscosity. If fractures or faults (tectonic or crystallization related) initiated in the outer parts then liquids from the chamber interior could infiltrate in them (Fig. 3).

According to structural data (Fig. 1) mafic and felsic dykes show approximately identical orientations of the contacts (NNW-SSE). Such coincidence could be related to development of steeply dipping shear zones in a crystallizing granodiorite melt. This assumption is supported by step-like contacts and single sallow-dipping (25°) slickensides.

Mafic and felsic dykes, as well as mafic microgranular enclaves are important elements of the inner structure of Vejen pluton. Field observations strongly support the idea about close spatial and genetic relationships between mafic dykes and enclaves. Such features indicate predominance of magma mingling over mixing at this level of the pluton. The presence of mafic and felsic dykes in identical failure zones corresponds probably to approximately contemporaneous formation. Crosscutting relationships between mafic dykes and aplites support a relatively long lasting mafic magma supply.

Acknowledgements. We are very grateful to our colleagues for collaboration in the field.

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