MAGMATIC COMPLEXES IN THE MOMCHILGRAD DEPRESSION (EASTERN RHODOPES)

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ABSTRACT

The products of the Paleogene magmatic activity in the Momchilgrad depression have been divided into several magmatic complexes. The Kalabak andesite, Rabovo latite-andesite, Zvezdel basaltic-andesite, Sveti Ilia trachyrhyodacite, Momchilgrad trachydacite and Raven rhyolite complexes, formed into Dambalak group, have the same area of distribution and similar geochemical and isotope features. They might have resulted from the evolution on a intermediate magma reservoir as their composition evolved from intermediate to acid. Extrusive bodies of the Perperek trachyrhyolite and Ustren rhyolite complexes are located apart from the main volcanic edifices and have specific geochemical features, and probably resulted from evolution of separate acid magma reservoirs.

INTRODUCTION

Two general papers concerning Paleogene deposits and magmatic activity were published in one issue in 1960 (Goranov, 1960; Ivanov, 1960). They have many similarities - both authors used the lithostratigraphic approach in the subdivision of magmatic products and they both recognized three intermediate and three acid vocanic horizons. According to Goranov these horizons are Pr_4 , Ol_2 , Ol_5 (intermediate) and Ol_1 , Ol_3 , Ol_5 (acid). Ivanov localized the most of the magmatic centers and described Borovitsa and Momchilgrad volcanic areas and Arda volcanic strip. He also suggested three magmatic cycles as an acid phase follows every intermediate one - I, II, III intermediate and I, II, III acid phases, respectively.

These investigations are a great achievement in studying of the magmatic activity in the Eastern Rhodopes. As popular has been accepted the scheme of Ivanov (1960). During the following 40 years the concept of cyclic character of the Eastern Rhodopes magmatism has been in the basis of the most subdivisional schemes of the Eastern Rhodopes magmatic rocks. Only the number of the cycles (three or four) and the spanning of the horizons or units used have been changed (Ivanov, 1961; Goranov, Shilyafova, 1995; Yanev et al., 1998).

NOTES ON METHODOLOGY

The aspiration for creating of an universal lithostratigraphic scheme of the Paleogene magmatic products in the Eastern Rhodopes had led to the idea of cyclic character of the volcanism. Paleogene magmatism in the Eastern Rhodopes is localized in several areas - products of the evolution of separate magma reservoirs originated in common collisionrelated tectonomagmatic setting (Harkovska et al., 1989; Yanev et al., 1995). However, these separate magma reservoirs had different composition and probably resulted from mobilization of earth crust different types (Yanev et al., 1995). They had similar but not identical and concurrent evolution. Therefore, the correlation and integration of the rocks generated by different magma chambers in an uniform scheme is not correct. Independent subdivision of the separate areas produced by different reservoirs is more advisable.

The term "complex" is used in the reported subdivision of the magmatic rocks in the sense of the Stratigraphic code of Bulgaria (Nikolov, Sapunov, 2002) as an official lithostratigraphic unit applied to mixed rocks. This term is preferred because of the great diversity of the rocks varieties included in the complexes - stratified effusives, pyroclastics, epiclastic and sedimentary rocks as well as cross-cut subvolcanic bodies, dykes and intrusive rocks.

The criteria for the recognizing of the complexes are: similar mineral and chemical composition, similar age, same spatial and time relations to the neighbouring units, same area of distribution (inferring same magma source), "mappability" of the separate units.

The volcanic activity in the Momchilgrad depression occurred in shallow marine basins as volcanoes formed islands (atolls). Only rocks of volcanic facies (explosive, effusive and subvolcanic) were emplaced near volcanic vents areas in subaerial setting. Rocks of sedimentavy facies (epiclastics, terrigeneous sediments and reef limestone) overlap volcanics on the volcanic slopes and in the base of cones. Some of the magmatic complexes (phases) are present in several different volcanic edifices, as in between tuffs and lava flows, erupted from different vents but having same or similar composition (belonging to one complex).

The thickness of the lava flows and tuffs fast decrease with increasing the distance from volcanic centers. And vice versa; the sedimentary deposits increase in thickness apart from the vents. The maximum thickness of the units is reported below, were the description of the composite type sections is given. Pyroclastic and epiclastic rocks have been classified according to Le Maitre (1989). Available K-Ar ages are summarized in

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DESCRIPTION OF THE COMPLEXES

Kalabak andesite complex (Калабашки андезитов комплекс)

Nomenclature: Named after the Kalabak Peak, Krumovgrad District.

Defining characteristics: Porphyritic andesites with phenocrysts of PI, Amph, Py, and Bi - subvolcanic bodies, lava flows and tuffs.

References: Pr₄ (Goranov, 1960), I intermediate volcanism (Ivanov, 1960; Goranov, 1995).

Composite-stratotype: At Irantepe volcano, in the area of town the Krumovgrad.

Cover: Beli Plast rhyodacite complex (not described here as its vent area is out of the considered area); Rabovo latiteandesite complex.

 $K_{\rm 3}$ - Amph-Py and esites; subvolcanic bodies and lava flows (100 m);

K₂ - lapilli-tuffs and aglomerates (300 m);

K₁ - epiclastites - conglomerates, breccias, sandstones, siltstones, tuffites, limestones;

Basement: Marlstone-limestone and coal-sandstone units (Priabonian);

Distribution: Outcrops in the area between the town of Krumovgrad and the villages of Sbor and Sladkodum over an area of about 400 km². Builds the Irantepe volcano as well as several smaller edifices to the north of it.

Chronostratigraphy: According to available K-Ar measurements its age is 35.0-39.0 Ma. Based on the field observations it is defined as being of Priabonian age.



Figure 1. Geological map of the Momchilgrad depression

Quaternary; Oligocene-Miocene: 2 - Valche Pole unit; Oligocene 3 - Pcheloyad dyke complex - rhyolite bodies (a), rhyolite dykes (b), and latite dykes (c); 4 - Raven rhyolite complex - bodies (a), tuffs and tuffaceous limestones (b); 5 - Momchilgrad trachydacite complex]; 6 - Sveti-Ilia trachyrhyodacite complex - bodies (a), tuffs and tuffaceous limestones (b), dykes (c);
7 - Ustren rhyolite complex; 8 - Zvezdel basaltic-andesite complex - monzonitoid intrusion (a), subvolcanic bodies (b), dykes (c) epiclastites, lavas and tuffs (d),); 9 - Stomantsi rhyolite complex - tuffs and tuffaceous limestones; 10 - Djebel Formation; 11 - Perperek trahyrhyolite complex - bodies (a), epiclastites, tuffs and tuffaceous limestones (b); Eocene-Oligocene: 14 - Beli-Plast rhyodacite complex - tuffs and tuffaceous limestones; (b); Eocene-Oligocene: 14 - Beli-Plast rhyodacite complex - tuffs and tuffaceous limestones; (b); 16 - Eocene-Paleocene – sedimentary rocks; 17 - pre-Paleogene basement; 18 - fault; 19 - volcanic vents: Z - Zvezdel volcano, D - Dambala volcano, B - Bivoliane volcano, SI - Sveti-Ilia volcano, I - Iran-Tepe volcano; NC - Nanovitsa caldera.





Figure 2. Geological sections of the Momchilgrad depression. For the key see Fig. 1

Rabovo latite-andesite complex (Рабовски латиандезитов комплекс)

Nomenclature: The name comes from the name of Rabovo village, Kardjali District.

Defining characteristics: Vesicle-bearing greyish-black latite-andesites and trachydacites (with phenocrysts of PI, Py, Amph, and Bi) - subvolcanic bodies, lava flows and tuffs.

References: Ol₂ (Goranov, 1960); II intermediate volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995; Goranov, 1995).

Composite-stratotype: The area of the village of Rabovo.

Cover: Perperek trachyrhyolite complex, Zvezdel basalticandesite complex.

Rb7 - andesite pyroclastic breccia (70 m);

Rb₆ - fine-porphiritic andesites - lava flows (30 m);

Rb5 - lapilli-tuffs (40 m);

Rb₄ - coarse ash tuffs (30 m);

Rb₃-vesicle-bearing latite-andesites - lava flows and cross-cutting bodies (100 m);

Rb₂ - epiclastites (tuffites, tuffaceous sandstones, 100 m);

Rb1 - ash- and lapilli-tuffs (80 m).

Basement: Beli Plast rhyodacite complex.

Distribution: Outcrops in the area between the towns of Kardjali, Krumovgrad, and Momchilgrad and the villages of Potochnitsa and Podkova covering an area of nearly 750 km². This complex builds the firs phases of Studen Kladenets, Sveti Ilia, Bivolyane, and Dambalak volcanoes as well as some smaller volcanic edifices.

Chronostratigraphy: The field observations define it as Rupelian in age.

Perperek trachyrhyolite comlplex (Перперешки трахириолитов комплекс)

Nomenclature: Named after the village of Perperek, Kardjali District.

Defining characteristics: Porphyritic trachyrhyolites with

phenocrists of PI, Kfs, and Bi - extrusive bodies and tuffs.

References: Ol_2 , Ol_3 , Ol_5 , Ol_6 (Goranov, 1960); II intermediate and II acid volcanism (Ivanov, 1960; Goranov, 1995); III acid volcanism (Goranov et al., 1992); II acid volcanism (Yanev, 1995).

Composite-stratitype: The area of the village of Perperek.

Cover: Zvezdel basaltic-andesite complex, Djebel Formation, Valche Pole unit.

 P_{10} - pinkish-violet massive trachyrhyolites - extrusions (100 m);

 P_9 - brownish-red flow-banded trachyrhyolites – extrusions and subvolcanic dykes (160 m);

 P_8 - trachyrhyolite agglomerates and pyroclastic breccias with perlites (200 m);

P7 - coarse ash tuffs (40 m);

P₆ - tuffaceous reef limestones (70 m);

P5 - lapilli xenotuffs (80 m);

P₄ - coarse ash-and agglomerate tuffs (100 m);

- P₃ lapilli xenotuffs (50 m);
- P2 greyish-beige tuffites (50 m);

P₁ - tuffaseous reef limestones (60 m).

Basement: Rabovo latite-andesite complex.

Distribution: It is exposed in the area between the town of Kardjali, the villages of Most, and Dolen Chiflik, the town of Krumovgrad and the villages of Podkova and Ustren occupying an area of about 1200 km². According to Yanev (1995) the tuffs of this complex are erupted by vents located in the Borovitsa volcanic region. We consider that they resulted from initial stages of activity of the Perperek and Hisar volcanoes, where their thickness is greatest (up to 500 m). Some authors attribute the xenotuffs to the II intermediate volcanism.

Chronostratigraphy: Available K-Ar datas vary between 29.1 and 33.0 Ma. On the basis of the field observations it has also been considered as being of Rupelian age.

Stomantsi rhyolite complex (Стомански риолитов комплекс)

Nomenclature: It is named after the village of Stomanovo, Djebel District.

Defining characteristics: Rhyolite tuffs and tuffaceous limestones.

References: Ol_6 (Goranov, 1960); III acid volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995).

Composite-stratitype: The area of the village of Stomantsi.

Cover: Zvezdel basaltic-andesite and Ustren rhyolite complexes.

St₂ – rhyolite ash-and lapilli-tuffs (100 m);

 St_1 – tuffaseous reef limestones (70 m).

Basement: Djebel Formation

Distibution: It crops out in the area of the village of Stomantsi over an area of about 20 km².

Chronostratigraphy: The fossil species found by Atanasov et al. (1970ô) indicate Rupelian age.

Zvezdel basaltic andesite complex (Звезделски андезитобазалтов комплекс)

Nomenclature: The name comes from the name of the village of Zvezdel, Krumovgrad District.

Defining characteristics: Porphyritic andesites and basaltic-andesites with phenocrysts of Py, Pl, Ol, Amph (subvolcanic bodies, dykes, lava flows, and tuffs) and comagmatic intrusives of Q-monzogabbros and Q-monzodiorites.

References: Ol₅ (Goranov, 1960); II, III intermediate volcanism (Ivanov, 1960); III intermediate volcanism (Goranov, Shilyafova, 1995).

Composite-stratotype: At Zvezdel volcano

Cover: Sveti Ilia trachyrhyodacite, Momchilgrad trachydacite and Raven rhyolite complexes. It is intruded by the Pcheloyad dyke complex.

Z₇ - subvolcanic post-intrusive basaltic-trachyandesite dykes;

Z₆ - hypo-abyssal intrusives of fine-grained Q-monzogabbros and Q-monzodiorites;

 Z_5 - high-K basaltic-andesites - subvolcanic bodies and dykes;

Z₄ - fine-porphyritic Py-basaltic-andesites - subvolcanic bodies (magma conduits), sills, dykes, lava flows (100 m);

 Z_3 - Py-andesites to basaltic-andesites - lava flows and lava breccias with interbeds of lapilli- tuffs and agglomerates (over 500 m). At the Dambalak volcano are interbedded by acid epiclastics. Z_2 gradually replaces Z_3 . Z_2 is dominated by tuffs while in Z3 lava flows prevail.

 Z_2 - andesite and basaltic-andesite ash-and lapilli-tuffs and agglomerates (350 m) interbedded by lava flows and limestones (up to 100 m);

 Z_1 - epiclastics - conglomerates, breccias, sandstones, siltstones, tuffs and tuffites (50 m);

Basement: Djebel formation, Perperek trachyrhyolite and Rabovo latite-andesite complexes.

Distribution: Occurs in the area between the towns of Momchilgrad and Krumovgrad and the villages of Podkova, Studen Kladenets and Letovnik over an area of about 500 km². It composes the largest Zvezdel volcano, separate phases of Dambalak and Sveti Ilia volcanoes as well as sills within the Djebel Formation and subvolcanic bodies in the

area of Krumovgrad.

Chronostratigraphy: K-Ar ages vary from 27.7 to 35.0 Ma. Field observations define it as Rupelian.

Ustren rhyolite complex (Устренски риолитов комплекс)

Nomenclature: Named after the village of Ustren, Djebel District.

Defining characteristics: Porphyritic rhyolites with perlites containing phenocrysts of PI, Kfs, Q, and Bi.

References: Ustren rhyolite massif (Goranov, 1960); III acid volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995).

Type-locality: Exstrussions occupying up to 10 km₂ in the area of the village of Ustren. They intrude the rocks of the Zvezdel basaltic-andesite and Stomantsi rhyolite complexes, Djebel Formation and Perperek trachyrhyolite complex.

Distribution: Between the villages of Mishevsko, Ustren and Stomantsi.

Chronostratigraphy: K-Ar age are 31.0-31.5 Ma. Field relationships with the neighboring lithostratigraphic units indicate Rupelian age.

Sveti Ilia trachyrhyodacite complex (Светиилиски трахириодацитов комплекс)

Nomenclature: It is named after the Sveti Ilia Peak, Kardjali District

Defining characteristics: Redish-violet flow-banded trachyrhyodacites and trachydacites - subvolcanic bodies, dykes, lava flows and tuffs.

References: Ol₃, Ol₆ (Goranov, 1960); II acid volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995).

Composite-stratype: The area of the Sveti Ilia volcano.

Cover: Momchilgrad trachydacite complex, Raven rhyolite complex.

 \hat{S}_4 - redish-violet flow-banded trachyrhyodacites (with phenocrysts of Kfs, Q, PI, Bi) - subvolcanic bodies with perlite and lava flows (150 m);

 S_3 - Redish-violet trachydacites (having phenocrysts of Kfs, Pl, Py) - subvolcanic bodies and lava flows (70 m);

S₂ - tuffaseous reef limestones (70 m);

S1 - ash and lapilli-tuffs interbedded by xenotuffs (150 m);

Basement: Zvezdel basaltic-andesite, Perperek trachyrhyolite and Rabovo latite-andesite complexes.

Distribution: Occurs between the town of Momchilgrad and the villages of Studen Kladenets and Nanovitsa over an ara of nearly 300 km₂. It builds separate phases of Sveti Ilia, Bivolyane, and Dambalak volcanoes and is also found in the Nanovitsa caldera.

Chronostratigraphy: The foraminifers found in the limestones are dated as Rupelian. K-Ar ages are 29.5-31 Ma.

Momchilgrad trachydacite complex (Момчилградски трахидацитов комплекс)

Nomenclature: It is named after the town of Momchilgrad.

Defining characteristics: Greyish-black trachydacites with phenocrysts of Amph, Py, Bi, Kfs - lava flows and tuffs.

References: Basaltic-andesite effusion of III intermediate volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995); IV intermediate volcanism (Ivanov, 1961)

Composite-stratotipe: Dambalak volcano

Cover: Raven rhyolite complex

M₂ - trachydacites - lava flows (400 m);

M₂ - lapilli tuffs and agglomerates (200 m).

Basement: Zvezdel basaltic-andesite complex.

Distribution: Outcrops to the east and southeast of the town of Momchilgrad over an area of about 70 km². It builds the latest phase of Dambalak volcano and some parasitic cones on the slope of the Zvezdel volcano.

Chronostatigraphy: K-Ar ages are 31.0 Ma. Field observations indicate Rupelian age.

Raven rhyolite complex (Раженски риолитов комплекс)

Nomenclature: It is named after the village of Raven, Momchilgrad District.

Defining characteristics: Redish-brown rhyolites and tuffs.

References: Ol₆ (Goranov, 1960); III acid volcanism (Ivanov, 1960; Goranov, Shilyafova, 1995).

Composite-stratotype: To the east of the village of Raven. Cover: Not observed.

Rv₄ - redish-brown rhyolites - subvolcanic bodies;

Rv₃ - redish-brown rhyolite ash-tuffs (60 m);

Rv₂ – ash-tuffs interbedded by xenotuffs (150 m);

Rv1 - tuffaceous reef limestones (100 m).

Basement: Momchilgrad trachydacite and Sveti Ilia trachyrhyodacite complexes.

Distribution: Fills in part of the Nanovitsa caldera between the villages of Raven and Nanovitsa over an area of about 30 km².

Chronostratigraphy: Field observations indicate Rupelian age.

Pheloyad dyke complex (Пчелояден даиков комплекс)

Nomenclature: It is named after the village of Pcheloyad, Krumovgrad District.

Defining characteristics: The latest rhyolite and latite subvolcanic bodies and dykes.

References: Extrusion of felsitic rhyolites, Galenit tensional zone (Ivanov, 1960); tensional dyke complex (Goranov, Shilyafova, 1995).

Type-locality: The area of the village of Pcheloyad .

Pc₃ - greyish-pink rhyolite-trachyrhyolite subvolcanic dykes (with phenocrysts of Pl, Kfs, Q, Py, Amph, Bi);

Pc₂ - greyish-green latites and trachydacites (Pl, Kfs, Q, Py, Amph, Bi) - subvolcanic dykes;

Pc₁ - greyish-pink trachydacites and trachyrhyodacites (Pl, Kfs, Py, Bi, Amph) - subvolcanic bodies and dykes;

Distribution: It forms dyke swarm of WNW direction long more than 30 km and 8 km wide in the area between the villages of Mishevsko, Stareishino, Pheloyad and Sedefche.

Chronostratigraphy: K-Ar ages are 26.5-32.2 Ma. Field observations are indicative of Rupelian-Chatian age.

Dambalak Group (Дамбалска група)

Nomenclature: The name comes from the name of the of Dambala Peak, Dambalak volcano, where phases of the most of the complexes are present.

Defining characteristics: Andesites, basaltic-andesites, latites, trachyrhyodacites, trachydacites, and rhyolites (subvolcanic bodies, lava flows and tuffs) having same area of distribution and similar geochemical and isotope features (Georgiev, Milovanov, 2003b,c). They resulted from the evolution of an intermediate magma reservoir as their composition evolved from intermediate to acid.

Constituent complexes: Kalabak andesite, Rabovo latiteandesite, Zvezdel basaltic-andesite, Sveti Ilia trachyrhyodacite, Momchilgrad trachydacite and Raven rhyolite complexes.

Distribution: It crops out in the area between the town of Kardjali, the hamlet of Sladkodum, Irantepe Peak, the village of Podkova, the towns of Djebel and Momchilgrad and occupies an area of nearly 1000 km². It builds the Irantepe, Sveti Ilia, Bivolyane, Dambalak and Zvezdel volcanoes, numerous smaller parasitic and satellite volcanic edifices around them as well as sills within the Djebel Formation. It also fills in the Nanovitsa caldera situated between the main volcanoes in the middle of the depression.

Chronostratigraphy: K-Ar ages vary between 39.0 and 26.5 Ma. Observed relationships with the neighboring lithostratigraphic units (paleontologically dated) show Priabon-Rupelian age.

Field relations with neighbouring units: The materials of the Dambalak Group intrude and cover the coal-sandstone, marlstone-limestone and volcano-sedimentary units having Priabonian age. They laterally interfinger with rocks of Beli Plast rhyodacite (Priabonian) and Perperek trachyrhyolite complexes, Djebel Formation and Stomantsi rhyolite complex (Rupelian).

The intermediate Kalabak andesite, Rabovo latite-andesite and Zvezdel basaltic-andesite complexes are grouped into **Putocharka subgroup** (Путочарска подгрупа), named after the hamlet of Putocharka of the Potochnitsa village where the three complexes are exposed. The leter Sveti Ilia trachyrhyodacite, Momchilgrad trachydacite and Raven rhyolite complexes are formed into Zdravets subgroup (Здравецка подгрупа), named after the Zdravets Peak, Dambala volcano, Momchilgrad District.

CONCLUSIONS

The volcanic activity in the Momchilgrad depression can not be described as being of cyclic character. The volcances composed by the Dambalak Group register an evolution of the magma composition from intermediate to acid. Some recurrence from the Rabovo latite-andesite to the Zvezdel basaltic andesite complex and from the Sveti Ilia trachyrhyodacite to the Momchilgrad trachydacite complex can be traced but there is no alternation of intermediate and acid phases. Extrusive bodies of the Perperek trachyrhyolite and Ustren rhyolite complex are situated apart from the main volcanic edifices. They have specific geochemical and isotope features and may have resulted from the evolution of the separate acid magma reservoirs.

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